ANNUAL REPORT

OF THE

SECRETARY OF WAR

FOR

THE YEAR 1893.

IN FOUR VOLUMES.

VOLUME II—IN SIX PARTS.
PART 6.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.

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CONTENTS.

[Alphabetical index will be found at the end of each part.]

PART I.

OFFICERS OF THE CORPS OF ENGINEERS.

FORTIFICATIONS.

PROTECTION OF SITE OF FORT NIAGARA, NEW YORK.

SEA WALL AND EMBANKMENT AT DAVIDS ISLAND, NEW YORK HARBOR.

SEA WALLS AT GOVERNORS ISLAND, NEW YORK HARBOR.

WATER SUPPLY AND SEWERAGE SYSTEM AT FORT MONROE, VA.

THE BOARD OF ENGINEERS.

POST OF WILLETS POINT, NEW YORK—U. S. ENGINEER SCHOOL.—BATTALION OF ENGINEERS.—ENGINEER DEPOT.

RIVER AND HARBOR IMPROVEMENTS.

ATLANTIC COAST AND GULF OF MEXICO.

WESTERN RIVERS.

IN THE CHARGE OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS—

IN THE CHARGE OF MAJ. WILLIAM LUDLOW, CORPS OF ENGINEERS—

IN THE CHARGE OF COL. O. M. POE, CORPS OF ENGINEERS—

IN THE CHARGE OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS—

IN THE CHARGE OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS—

IN THE CHARGE OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS—

IN THE CHARGE OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS—

PACIFIC COAST.

IN THE CHARGE OF COL. G. H. MENDELL, CORPS OF ENGINEERS—

IN THE CHARGE OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS—

BRIDGES OBSTRUCTING NAVIGATION.

MISCELLANEOUS.

WASHINGTON AQUEDUCT.

PUBLIC BUILDINGS AND GROUNDS AND WASHINGTON MONUMENT, DISTRICT OF COLUMBIA.

NORTHERN AND NORTHWESTERN LAKES.

CONSTRUCTION AND IMPROVEMENT OF ROADS AND BRIDGES IN YELLOWSTONE NATIONAL PARK.

RECONNAISSANCES AND EXPLORATIONS.

OFFICE OF THE CHIEF OF ENGINEERS.

FORTIFICATIONS, ETC.

APPENDIX No. 1.

REPORT OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS.

APPENDIX No. 2.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

APPENDIX No. 3.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

APPENDIX No. 4.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

APPENDIX No. 5.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

APPENDIX No. 6.

REPORT OF MAJOR CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

APPENDIX NO. 7.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

RIVERS AND HARBORS, ETC.

APPENDIX A.

REPORT OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS.

APPENDIX B.

REPORT OF LIEUT. COL. S. M. MANSFIELD, CORPS OF ENGINEERS.

APPENDIX C.

REPORT OF CAPT. W. H. BIXBY, CORPS OF ENGINEERS.

APPENDIX D.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

APPENDIX E.

REPORT OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS.

APPENDIX F.

REPORT OF CAPT. THOS. L. CASEY, CORPS OF ENGINEERS.

PART II.

APPENDIX G.

REPORT OF MAJOR C. W. RAYMOND, CORPS OF ENGINEERS.

APPENDIX H.

REPORT OF WM. F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, U. S. ARMY, RETIRED.

APPENDIX I.

REPORT OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

APPENDIX J.

REPORT OF MAJOR CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

APPENDIX K.

REPORT OF LIEUTENANT EDWARD BURR, CORPS OF ENGINEERS.

APPENDIX L.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS.

APPENDIX M.

REPORT OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS.

APPENDIX N.

REPORT OF CAPT. O. M. CARTER, CORPS OF ENGINEERS.

APPENDIX O.

REPORT UPON WORKS IN CHARGE OF MAJ. J. C. MALLERY AND LIEUTENANT A. M. D'ARMIT, CORPS OF ENGINEERS.

APPENDIX P.

REPORT OF CAPT. PHILIP M. PRICE, CORPS OF ENGINEERS.

APPENDIX Q.

REPORT OF MAJOR A. N DAMRELL, CORPS OF ENGINEERS.

PART III.

APPENDIX R.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS.

APPENDIX S.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS.

APPENDIX T.

REPORT OF CAPTAIN JOHN MILLIS, CORPS OF ENGINEERS.

APPENDIX U.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS.

APPENDIX V.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

APPENDIX W.

REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

APPENDIX X.

REPORT OF CAPT. S. W. ROESSLER, CORPS OF ENGINEERS.

APPENDIX Y.

REPORT OF MAJOR CHAS. J. ALLEN, CORPS OF ENGINEERS.

APPENDIX Z.

REPORT OF MAJOR ALEXANDER MACKENZIE, CORPS OF ENGINEERS.

APPENDIX A A.

REPORT OF MAJOR W. A. JONES, CORPS OF ENGINEERS.

APPENDIX B B.

REPORT OF LIEUT. COL. CHAS. R. SUTER, CORPS OF ENGINEERS.

APPENDIX C C.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS.

APPENDIX D D.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS.

APPENDIX E E.

REPORT OF CAPT. GEO. W. GOETHALS, CORPS OF ENGINEERS.

APPENDIX F F.

REPORT OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS.

APPENDIX G G.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

APPENDIX H H.

REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

APPENDIX I I.

REPORT OF MAJOR D. W. LOCKWOOD, CORPS OF ENGINEERS.

PART IV.

APPENDIX J J.

REPORT OF MAJOR CLINTON B. SEARS, CORPS OF ENGINEERS.

APPENDIX K K.

REPORT OF MAJOR JAMES F. GREGORY, CORPS OF ENGINEERS.

APPENDIX L L.

REPORT OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS.

APPENDIX M M.

REPORT OF MAJOR WILLIAM LUDLOW, CORPS OF ENGINEERS.

APPENDIX N N.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS.

APPENDIX O O.

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS.

APPENDIX P P.

REPORT OF MAJOR E. H. RUFFNER, CORPS OF ENGINEERS.

APPENDIX Q Q.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

APPENDIX R R.

REPORT OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS.

APPENDIX S S.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

APPENDIX T T.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

APPENDIX U U.

REPORT OF MAJOR W. H. HEUER, CORPS OF ENGINEERS.

APPENDIX V V.

REPORT OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS.

APPENDIX W W.

REPORT OF MAJOR THOS. H. HANDBURY, CORPS OF ENGINEERS.

APPENDIX X X.

REPORT OF CAPT. FREDERICK RODGERS, UNITED STATES NAVY.

PART V.

APPENDIX Y Y.

REPORT OF THE MISSISSIPPI RIVER COMMISSION.

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

PART VI.

APPENDIX Z Z

REPORT OF THE MISSOURI RIVER COMMISSION.

APPENDIX A A A.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.

APPENDIX B B B.

REPORT OF COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS.

APPENDIX C C C.

REPORT OF COL. JOHN M. WILSON, UNITED STATES ARMY.

APPENDIX D D D.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES.

[To be inserted at page 3921, Annual Report Chief of Engineers, 1893.]

ERRATA IN THE REPORT OF THE MISSOURI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1893, APPENDIX ZZ, ANNUAL REPORT CHIEF OF ENGINEERS, 1893. (UNIMPORTANT ERRATA NOT INCLUDED.)

Page 3944. In table and plat facing page 3944, diminish all elevations for the Rulo bridge thirteen-hundredths of a foot.
Page 3955. Line 27 from bottom, for p. 55 read p. 2955.
Page 3962. Lines 14 to 40, for P. B. M. 12 read P. B. M. 20 (8 cases).
Page 3980. Column 2, item 4, for 5 read 517.
Page 3993. Column 13, item 5 from bottom, for 97.66760 read 92.66760.
Page 3996. Column 6, item 8, for 388.9 read 388.9†.
Page 4027. Column 4, item 3 from bottom, for 346.414 read 345.414.
Page 4031. Column 6, item 2, for 63.89 read 639.8.
Page 4035. Column 1, item 3, for 156 read 129.
Page 4062. Column 1, item 2, for $66\frac{2}{10}$ read $66=\frac{2}{10}$.
Page 4073. Column 1, item 3 from bottom, place Becker under P. B. M. 39.
Page 4077. Column 1, item 2 from bottom, place Drew under T. B. M. 51.
Page 4086. Column 2, item 3, for P. B. M. 9 read T. B. M. 9.
Page 4087. Column 6, item 11, for 253.1 read 263.1.
Page 4100. Under Description, line 35 from bottom, for $1\frac{1}{2}$ read $1\frac{1}{4}$.
Page 4100. Under Description, line 29 from bottom, for 7,628 read 5,900.
Page 4105. Under Description, line 2, for center read coulee.
Page 4116. Under Description, line 38, for 1064 read 1640.
Page 4126. Under Number, item 8, for T. B. M. 485 read T. B. M. 487.
Page 4127. Under Description, line 37, for northeast read southeast.
Page 4128. Column 4, item 10, for 342.47 read 342.847.
Page 4130. Column 4, item 6, for 381.082 read 381.032.
Page 4153. Column 1, item 1, below P. B. M. 374 insert Blencoe.
Page 4179. Column 13, item 2 from bottom, for 167.9325 read 161.9325.
Page 4188. Column 1, item 6, for $320\ \frac{1\,9\,7}{2}$ read $320=\frac{1\,9\,7}{2}$.
Page 4189. Column 14, item 3 from bottom, for 477.716 read 479.716.
Page 4198. Column 14, item 1, for 440.744 read 440.704.
Page 4205. Column 3, item 7, for 1,029 read 1,092.
Page 4205. Column 1, last item, for P. B. M. 294 read *P. B. M. 294.
Page 4213. Under Description, lines 25 and 61, for R. 42 W. read R. 43 W.
Page 4215. Column 4, item 12, for 594.128 read 594.123.
Page 4215. Column 4, item 13, for 592.933 read 592.938.
Page 4222. In table, for +1.259 read +1.270, for −0.187 read −0.321, and for +1.620 read +1.294.
Page 4231. Line 9 from bottom, after in insert holding.
Page 4235. Line 18, for 1.677 read 1,677.
Page 4248. Column 8, item 29, for +111 read −111.
Page 4248. Column 2, items 16, 17, and 18 from bottom, for 1893 read 1892.
Page 4249. Column 1, for Dike 12' and Dike 16 read Do.
Page 4250. Table II, column 4, item 4, for 22.1 read −2.1.
Page 4259. Line 27 from bottom, for 100 feet by $\frac{1}{2}$ foot read $100\frac{1}{2}$ feet.
Page 4259. Line 25 from bottom, for 74 feet by $\frac{2}{3}$ foot read $74\frac{2}{3}$ feet.

APPENDIX Z Z.

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

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1893.

SIR: The Missouri River Commission beg leave to submit herewith heir annual report for the fiscal year ending June 30, 1893:

SURVEYS AND EXAMINATIONS.

Work has been continued during the past year on the reduction of maps of the recent survey of the river. The publication of these maps has been commenced and will be pushed to completion as rapidly as possible. The line of precise levels between Sioux City, Iowa, and St. Charles, Mo., in progress at date of last report, has been completed, and the resulting elevations so far as worked out are appended to this report.

Twenty-one gauges have been maintained during the year, and much miscellaneous work has been done in the office of the Commission, including the continuation of the reduction and study of physical data.

For details see report of the Secretary of the Commission (Appendix A).

CONSTRUCTION.

For details see appendices B, C, D, E, and F.

Sioux City, Iowa.—No work was required at this point during the year; the dikes are in good condition and have entirely accomplished the object of their construction. The small balance remaining of preceding appropriation has been expended in care and repair of plant.

Council Bluffs, Iowa.—The revetment of the Iowa shore was extended 3,040 feet to close a gap and make the protection continuous. Some apprehension was felt about the safety of the revetment in the pocket near the foot of Iowa Lake, and 2 pile dikes were constructed there in hopes of filing out the shore line. These dikes unfortunately were destroyed by ice in the spring of 1893, and so much damage done to this part of the revetment that its reconstruction will be necessary during the current season. An allotment has been made for that purpose. Some small breaks in other portions of the revetment have been repaired, and, with the exception of the pocket alluded to, the work is in good shape. The plant used on the Omaha division has been repaired and sent to the mouth of the Gasconade for work on the First Reach.

The death of Mr. C. F. Potter, Division Engineer, which occurred September 28, 1892, was a severe loss to the work.

Nebraska City, Nebr.—No work was required at this point, the revetment on the island remaining intact. The small balance of allotment remaining has been expended in care and repair of plant.

St. Joseph, Mo.—Work at this point has consisted in repairs to the revetments in Bon Ton and Belmont bends. At the former place some 1,200 feet of revetment required and received repair. At Belmont Bend the lower end of the work, where it joined the Elwood revetment, was very seriously damaged during the summer high water. Under the circumstances it was not deemed expedient to reconstruct the revetment, and 13 pile dikes were built along the open gap to serve as a temporary protection till the river channel had readjusted itself. These dikes were destroyed during the recent high water, but the object sought seems to have been substantially accomplished, and an allotment has been made for reconstructing the revetment during the current season. The plant employed on this work has been repaired. It was first sent to Kansas City for use in that vicinity, and is now being transferred to the mouth of the Gasconade for use on the First Reach.

Atchison, Kans.—As reported last year, the cut-off which occurred above the works designed to control the approach to the Atchison bridge has so changed the direction of flow that the complete destruction of these works is only a question of time. They are gradually disintegrating under the attacks of the current, though still fulfilling the object of their construction. No work has been possible or advisable and the small balance of appropriation has been expended in care and repair of plant.

Kansas City, Mo.—The extensive works constructed in former years in this vicinity were more or less damaged during the season. The most serious injury was to the East Bottoms revetment, 1,500 feet of which had to be renewed this spring. The Harlem revetment was extended up stream 950 feet to meet a change in the direction of the current. Nothing more is contemplated at present.

Under instructions from the Secretary of War the Commission have had under consideration the fixing of harbor lines in front of Kansas City, Mo., and Kansas City, Kans. The field work is completed and their report with recommendations will soon be submitted.

SYSTEMATIC IMPROVEMENT OF FIRST REACH.

The work of systematic and continuous channel improvement mentioned in last report has been continued during the year. The head of the work is in Murrays Bend, just above Jefferson City, and extends down to Dodds Island below the Osage, a total distance of about 14 miles. Work was carried on wherever necessary along this whole distance and made fair progress. With the exception of the Murrays Bend revetment, designed to secure the head of the work, the construction of pile dikes for channel contraction and regulation has mainly occupied the force. Seventeen thousand feet of pile dike has been built during the season, involving the driving of 5,737 piles to an average depth of 21 feet. Several years must elapse before the full effect of these works can be realized, but even in their present state the results obtained are exceedingly gratifying, and leave little room for doubt as to the ultimate success of the work, provided the funds necessary for its continuous prosecution are furnished.

During the current season it is hoped to extend the work over about 16 additional miles of river, of which 8 will be in immediate continuation of that already done, and a similar amount above and near the mouth of the Gasconade River.

The revetment of Murrays Bend will be about 15,000 feet long. Three thousand two hundred and fifty feet was built last fall, and the remainder will be built as soon as the river falls to the proper stage. In addition to this, 1,200 feet of revetment was built in front of the United States storage yard at Bonnots Mill, and 3,260 feet in front of the United States storage depot and boat yard at Gasconade. Extensive repairs and additions have been made to the old plant and will be continued during the coming year, being necessitated by the great expansion of the work and the shortness of the season favorable for field operations.

REMOVAL OF OBSTRUCTIONS.

The snag-boat belonging to the Commission began work July 28, 1892, and remained in active service till December 5, 1892, when she was laid up for the winter. Operations were resumed March 16, 1893, and continued until June 16, when the boat was temporarily laid up for high water. The work extended from the mouth to Kansas City, the boat passing eight times over the lower portion of the river and twice over the upper portion. Two thousand two hundred and forty-six snags were removed and destroyed, to the great benefit of navigation.

Table of work done by snag boat.

Name of river.	Snags destroyed.		Trees cut.	Drift piles removed.	Miles run.
	Number.	Estimated weight in tons of 2,000 pounds.			
Mississippi					219
Missouri	2,246	27,079.1	826	4	2,018
Total	2,246	27,079.1	826	4	2,237

The appropriation of March 3, 1893, of which $700,000 is available for the works under the Commission, has been, with the approval of the Secretary of War, allotted as follows:

For office and traveling expenses and salaries of Commission	$20,000
For surveys, gauges, physical data, and publications	15,000
For operating snag boat	35,000
For repair of revetment in vicinity of Council Bluffs, Iowa	15,000
For repair of revetment in Belmont Bend	30,000
For systematic improvement in First Reach	585,000
Total	700,000

For the fiscal year ending June 30, 1895, the Commission beg leave to submit the following estimates:

For office and traveling expenses and salaries of Commission	$20,000
Surveys, gauges, physical data, and publications	30,000
Operating snag boat	35,000
Systematic improvement in First Reach	665,000
Total	750,000

Money statement.

July 1, 1892, balance unexpended	$201,816.75
Amount appropriated by act approved July 13, 1892	600,000.00
Amount refunded on account of overpayment	1.25
Amount appropriated by sundry civil act approved March 3, 1893	700,000.00
	1,501,818.00
June 30, 1893, amount expended during fiscal year	650,135.61
July 1, 1893, balance unexpended	851,682.39
July 1, 1893, outstanding liabilities	175,016.93
July 1, 1893, balance available	676,665.46
Amount that can be profitably expended in fiscal year ending June 30, 1895 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	750,000.00

Respectfully submitted.

CHAS. R. SUTER,
Lieut. Colonel of Engineers,
President Missouri River Commission.
A. MACKENZIE,
Major of Engineers.
O. H. ERNST,
Major of Engineers.
G. C. BROADHEAD.
R. S. BERLIN.

The Honorable SECRETARY OF WAR.
(Through the Chief of Engineers, U. S. A.)

Financial statement from July 1, 1892, to June 30, 1893.

Work.	Amount available July 1, 1892.	Appropriation act of July 13, 1892.	Refunded on account of over payment.	Received by transfer from other allotments.	Totals.	Amount expended.	Transferred to other allotments.	Total expended and transferred, etc.	Total balances June 30, 1893.	Outstanding liabilities June 30, 1893.	Balances available June 30, 1893.
Improving Missouri River from mouth to Sioux City, Iowa.											
Office and traveling expenses and salaries of Commission	$11,878.32	$15,000.00	$1.25		$26,879.57	$20,242.03	$2,500.00	$22,742.03	$4,137.54	$838.16	$3,299.38
Sioux City, Iowa	1,382.35				1,382.35	1,382.35		1,382.35			
Atchison, Kans	1,158.55				1,158.55	1,158.55		1,158.55			
Extending and completing revetment in vicinity of Council Bluffs, Iowa	6,238.51				6,238.51	6,055.53		6,055.53	182.98	182.98	
Repair and completion of revetment in vicinity of Council Bluffs, Iowa		30,000.00			30,000.00	29,713.94		29,713.94	286.06	286.06	
Completion of revetment on Nebraska City Island	116.16				116.16	116.16		116.16			
Continuation and completion of revetment in Belmont Bend	2,658.27				2,658.27	2,658.27		2,658.27			
Repair of revetment in Bon Ton Bend	869.49				869.49	869.49		869.49			
Repair of revetment in Belmont and Bon Ton bends		30,000.00			30,000.00	29,098.25		29,098.25	901.75	901.75	
Repair and maintenance of works in vicinity of Kansas City	15,994.22	5,000.00			20,994.22	10,468.66		10,468.66	10,525.56	10,525.56	
Systematic improvement in First Reach	116,933.33	180,000.00			296,933.33	228,109.10		228,109.10	68,824.23	68,824.23	
Maintenance of gauges, collection of physical data, and publications	7,658.49				7,658.49	7,658.49		7,658.49			
Gauges, physical data, and publications		25,000.00			25,000.00	11,748.87		11,748.87	13,251.13	2,946.71	10,304.42
Surveys and examinations between Sioux City, Iowa, and the mouth of the river	7,798.23			$2,500.00	10,298.23	10,298.23		10,298.23			
Surveys and observations		30,000.00			30,000.00	13,772.33		13,772.33	16,227.67	1,168.58	15,059.09
Construction, repair, and care of plant		250,000.00			250,000.00	234,104.78		234,104.78	15,895.22	15,895.22	
Operating snag boat	27,698.71	35,000.00			62,698.71	41,248.46		41,248.46	21,450.25	1,392.67	20,057.58
Removing obstructions in Missouri River from St. Joseph, Mo., to mouth	1,432.12				1,432.12	1,432.12		1,432.12			
Totals	201,816.75	600,000.00	1.25	2,500.00	804,318.00	650,135.61	2,500.00	652,635.61	151,682.39	102,961.92	48,720.47

Detailed statement July 5, 1884, to June 30, 1893.

Work.	Balances of appropriations of 1882.	Appropriations and allotments.	From sales, etc.	Total available.	Expended to May 31, 1893.	Expended during the month of June, 1893.	Total expended to June 30, 1893.	Total balances June 30, 1893.	Outstanding liabilities June 30, 1893.	Balances available June 30, 1893.
Survey of the Missouri River above the Missouri River Falls, Fort Benton, Mont.		$15,000.00		$15,000.00	$15,000.00		$15,000.00			
Between Fort Benton, Mont., and Sioux City, Iowa:										
Office and inspection expenses of district officer	$2,000.00	4,749.00		6,749.00	$6,749.00		6,749.00			
Purchase and repair of plant	2,000.00	58,751.00		60,751.00	60,751.00		60,751.00			
Work below Fort Benton		31,500.00		31,500.00	31,500.00		31,500.00			
Improving Missouri River between Sioux City and Fort Benton		48,250.00	$0.75	48,250.75	48,250.75		48,250.75			
Survey between Fort Benton and Sioux City		73,250.00	1.72	73,251.72	73,251.72		73,251.72			
Office expenses and expenses of Commission		5,000.00	53.24	5,053.24	5,053.24		5,053.24			
Expenses proper of Commission, gauges, and physical data		3,500.00	20.62	3,520.62	3,520.62		3,520.62			
	4,000.00	225,000.00	76.33	229,076.33	229,076.33		229,076.33			
Survey of Missouri River from its mouth to Fort Benton	8,844.39			8,844.39	8,844.39		8,844.39			
Between Sioux City, Iowa, and mouth of river:										
Office and traveling expenses and salaries of Commission		97,500.00	710.36	98,210.36	91,515.06	$2,557.76	94,072.82	$4,137.54	$838.16	$3,299.38
Additional surveys and establishment of permanent bench marks below Sioux City		48,000.00		48,000.00	48,000.00		48,000.00			
Care of plant, preservation and observation of gauges, and collection and compilation of physical data		37,000.00		37,000.00	37,000.00		37,000.00			
Purchase of towboat		1,100.00		1,100.00	1,100.00		1,100.00			
Improving Missouri River in vicinity of Kansas City (at Parkville, Mo.)		491,851.96	42.36	491,894.32	491,894.32		491,894.32			
Improving Missouri River in vicinity of St. Joseph, Mo		287,269.98	13.12	287,283.10	287,283.10		287,283.10			
Improving Missouri River in vicinity of Kansas City, Mo		106,150.00		106,150.00	106,150.00		106,150.00			
Special surveys		14,500.00		14,500.00	14,500.00		14,500.00			
Expenses proper of Commission, gauges and physical data		33,800.00	188.97	33,988.97	33,988.97		33,988.97			
Survey of Missouri River between Sioux City and the mouth		33,775.00	80	33,775.80	33,775.80		33,775.80			
Omaha, Nebr		120,736.64		120,736.64	120,736.64		120,736.64			
Sioux City, Iowa		80,411.67		80,411.67	80,411.67		80,411.67			
Rulo, Nebr		39,980.49		39,980.49	39,980.49		39,980.49			

Nebraska City, Nebr.		60, 298. 92		60, 298. 92	60, 298. 92		60, 298. 92			
Atchison, Kans.		60, 639. 14		60, 639. 14	60, 639. 14		60, 639. 14			
Leavenworth, Kans.		60, 213. 71		60, 213. 71	60, 213. 71		60, 213. 71			
Miami, Mo.		19, 787. 67		19, 787. 67	19, 787. 67		19, 787. 67			
Arrow Rock, Mo.		36, 294. 98		36, 294. 98	36, 294. 98		36, 294. 98			
Revetment in vicinity of Council Bluffs, Iowa.		112, 000. 00		112, 000. 00	109, 670. 40	1, 860. 56	111, 530. 96	469. 04	469. 04	
Completion of revetment on Nebraska City Island.		2, 500. 00		2, 500. 00	2, 500. 00		2, 500. 00			
Revetment in Belmont and Bon Ton bends.		142, 000. 00		142, 000. 00	141, 098. 25		141, 098. 25	901. 75	901. 75	
Repair and maintenance of works in vicinity of Kansas City		70, 500. 00		70, 500. 00	59, 974. 44		59, 974. 44	10, 525. 56	10, 525. 56	
Systematic improvement in First Reach.		528, 000. 00		528, 000. 00	453, 828. 19	5. 347. 58	459, 175. 77	68, 824. 23	68, 824. 23	
Maintenance of gauges, collection of physical data and publications.		50, 000. 00		50, 000. 00	35, 333. 28	1, 415. 59	36, 748. 87	13, 251. 13	2, 946. 71	10, 304. 42
Surveys and examinations between Sioux City, Iowa, and the mouth of the river		57, 500. 00		57, 500. 00	57, 500. 00		57, 500. 00			
Construction, repair and care of plant.		439, 764. 84		439, 764. 84	402, 192. 63	21, 676. 99	423, 869. 62	15. 895. 22	15, 895. 22	
Surveys and observations.		30, 000. 00		30, 000. 00	11, 754. 85	2, 017. 48	13, 772. 33	16, 227. 67	1, 168. 58	15. 059. 09
		3, 061, 575. 00	955. 61	3, 062. 530. 61	2, 897, 422. 51	34, 875. 96	3, 185, 219. 19	130, 232. 14	101, 569. 25	28, 662. 89
Removal of snags and other obstructions.	1, 982. 80	188, 425. 00		190. 407. 80	163, 791. 70	5, 165. 85	168, 957. 55	21, 450. 25	1, 392. 67	20, 057. 58
Grand total.	14, 827. 19	3, 490, 000. 00	1, 031. 94	3, 505, 859. 13	3, 814, 134. 93	40, 041. 81	3, 854, 176. 74	151, 682. 39	102, 961. 92	48, 720. 47

Consolidated statement, July 5, 1884, to June 30, 1893.

Act of July 5, 1884		$640,000.00
Act of August 5, 1886		375,000.00
Act of August 11, 1888		1,000,000.00
Act of February 22, 1890		75,000.00
Act of September 19, 1890		800,000.00
Act of July 13, 1892		600,000.00
Total specific appropriations		3,490,000.00
Balances from former appropriations:		
Act of August 2, 1882, applied to works above Sioux City, Iowa	$4,000.00	
Survey of Missouri River from mouth to Fort Benton	8,844.39	
Act of August 5, 1886, applied to removing obstructions from Missouri River	1,982.80	
Total balances		14,827.19
Received from sales and deposits		1,031.94
Total available		3,505,859.13
Expended to June 30, 1893		3,354,176.74
Balance June 30, 1893		151,682.39

List of civilian engineers employed on work of river and harbor improvements in charge of Missouri River Commission from July 1, 1892, to June 30, 1893, inclusive, under the river and harbor acts of August 11, 1888 (improving Missouri River), September 19, 1890, (improving Missouri River from its mouth to Sioux City, Iowa), and July 13, 1892 (improving Missouri River from its mouth to Sioux City, Iowa):

Name and residence.	Time employed. Mos.	Time employed. Dys.	Compensation per month.	Where employed.
Samuel H. Yonge, Jefferson City, Mo	12	0	$250.00	Kansas City, Mo., and First Reach, Osage division.
S. Waters Fox, Hermann, Mo	12	0	250.00	Atchison, Kans., St. Joseph, Mo., Omaha, Nebr., Kansas City, Mo., and First Reach, Gasconade division.
Charles F. Potter, Omaha, Nebr	2	28	200.00	Sioux City, Iowa, and Omaha, Nebr.
O. B. Wheeler, St. Louis, Mo	12	0	200.00	St. Louis, Mo.
J. A. Seddon, St. Louis, Mo	12	0	200.00	Do.
A. H. Blaisdell, St. Louis, Mo	12	0	200.00	Do.
O. W. Ferguson, St. Louis, Mo	4	12	175.00	In the field.*
	7	18	175.00	St. Louis, Mo.
J. A. Paige, St. Louis, Mo	3	0	175.00	In the field.*
	3	9	175.00	St. Louis, Mo.
C. M. Winchell, St. Louis, Mo	12	0	150.00	Do.
R. H. Bacot, Jefferson City, Mo	12	0	150.00	Kansas City, Mo., and First Reach, Osage division.
J. C. Meredith, Hermann, Mo	12	0	150.00	St. Joseph, Mo., and First Reach, Gasconade division.
K. H. Will, Lincoln, Nebr		1	150.00	In the field.*
A. L. Johnson, St. Louis, Mo	4	12	150.00	Do.
	7	18	125.00	St. Louis, Mo.
O. H. B. Turner, St. Louis, Mo	1	9	187.50	In the field (includes subsistence)*.
	3	0	150.00	In the field.*
	7	21	137.50	St. Louis, Mo.
L. P. Butler, St. Louis, Mo	12	0	125.00	Do.
R. A. Crawford, Jefferson City, Mo	12	0	125.00	Kansas City, Mo., and First Reach, Osage division.
Ed. Jones, Hermann, Mo	12	0	125.00	Omaha, Nebr., and First Reach, Gasconade division.
A. H. Weber, Jefferson City, Mo	12	1	125.00	Kansas City, Mo., and First Reach, Osage division.
J. F. Streeter, Gasconade, Mo	1	2	125.00	First Reach, Gasconade division.
Bathurst Smith, Hermann, Mo	3	1	137.50	Includes subsistence.
	4	29	100.00	First Reach, Gasconade division.
J. C. Gilchrist, Hermann, Mo	2	0	120.00	Do.
	6	0	100.00	Do.
G. F. Bird, Hermann, Mo	1	6	120.00	Do.

* On survey of Missouri River.

List of civilian engineers employed on work of river and harbor improvements in charge of Missouri River Commission, etc.—Continued.

Name and residence.	Time employed.	Compensation per month.	Where employed.
	Mos. Dys.		
C. E. Taylor, St. Louis, Mo	2 21	$100.00	St. Louis, Mo.
	8 9	110.00	Do.
J. Wm. Link, St. Louis, Mo	8 9	110.00	Do.
K. A. Widen, St. Louis, Mo	2 21	100.00	Do.
	9	115.00	Do.
E. D. Williams, St. Louis, Mo	12 0	100.00	Do.
J. Van Brunt, Hermann, Mo	7 28	100.00	First reach, Gasconade division.
S. W. Benedict, Jefferson City, Mo	8 0	100.00	Kansas City, Mo., and first reach, Osage division.
J. C. Auld, Hermann, Mo	5 13	100.00	First reach, Gasconade division.

APPENDIX A.

ANNUAL REPORT OF THE SECRETARY OF THE MISSOURI RIVER COMMISSION, 1893.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1893.

SIR: I have the honor to submit the following report of the work in charge of the Secretary of this Commission for the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

J. C. SANFORD,
First Lieutenant of Engineers, Secretary.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

SURVEYS.

Secondary triangulation.—During the fieldwork on the secondary triangulation of the river numerous incidental points were located by side shots. The geodetic positions of these points have been computed, and the results for 154 of those that are most permanently marked and can be best described are appended (Appendix A 2).

Mapping.—The 32 detail maps (scale, 1 inch = 400 feet) covering that portion of the river from Fort Benton, Mont., to Three Forks, Mont., 266 miles, and described in my last annual report, have been completed. An office index map (scale, 1 inch = 2 miles) has been made for use in connection with the above maps.

Of the 27 detail maps (scale 1 inch=1,000 feet) extending from Sioux City (Big Sioux River) to the mouth of the river, 811 miles, 13 were unfinished at the beginning of the fiscal year. These have been completed.

The series of reduced maps (scale 1 inch=1 mile) to be photolithographed, which were referred to in my last annual report, will extend from No. 1 at the mouth of the river to No. 83 at Three Forks, Mont. Of these, Nos. 1 to 10, inclusive, extending from the mouth to Brunswick, Mo., 262 miles, and Nos. 73 to 76, inclusive, extending from 97 miles below to 28 miles above △ Benton, had been completed at the date of the above report. Nos. 11–16, 18, 19, 22, 24–27, and 77–83, covering 783 miles of river distance, have been completed within the past year. The remaining 4 of the 27 below Sioux City are in progress.

In connection with this series there will be 9 index maps (scale 1 inch=8 miles). No. 9, covering inch-mile maps Nos. 76–83, has been completed; and No. 1, covering inch-mile maps Nos. 1–10, has been begun.

Inch-mile maps Nos. 1–14, 76, 77, and 80–83, have been published during the year. Nos. 15, 16, 18, 19, 22, 24–27, 78 and 79, and index map No. 9, are in the hands of the printer. Proofs of Nos. 24, 25, 78, and 79 have been received, corrected, and returned for printing.

All mapping work has been under supervision of Assistant Engineer O. B. Wheeler.

Special surveys.—The following special surveys were made under the direction of the division engineers during the year:

- Florence Lake and right bank of river in its vicinity, East Omaha, Nebr.
- Omaha Reach, Iowa and Nebraska. Vicinity of revetment and location of Council Bluffs and East Omaha Bridge.
- Lower part of Belmont Bend, Missouri and Kansas.
- Lower part of Bee Creek Bend, Missouri and Kansas.
- From Lower Kaw Bend, Missouri and Kansas, to Randolph Bridge, Missouri.
- From mouth of Kansas River, Kansas, to Randolph Bridge, Missouri.
- River front of Kansas City, Mo., and Kansas City, Kans., to locate harbor lines.
- Kansas River at Union Pacific Railroad Bridge, Kansas City, Kans.
- Kansas River at Riverview Bridge, Kansas City, Kans.
- Missouri River at Hannibal and St. Joseph Railroad Bridge, Kansas City, Mo.
- From Stanley Island, Missouri, to mouth of Gasconade River, Missouri.
- From mouth of Little Tavern Creek, Missouri, to New Haven, Mo.

In addition to the above, numerous surveys and observations were made by Division Engineer Yonge in the vicinity of the mouth of the Osage River, Missouri, with a view to laying out construction work, or to determining the effect of work done.

PRECISE LEVEL BENCH MARKS.

At the beginning of the fiscal year, two double precise level parties were in the field, engaged in extending from St. Charles, Mo., to Sioux City, Iowa, the line of precise levels that had been run in 1887 from the St. Louis City Directrix to St. Charles. Each party was working downstream, being subsisted on a quarter boat. The first of these parties, under Assistant Engineer O. W. Ferguson, with Assistant Engineer A. L. Johnson, which had begun work March 17, 1892, at the United States boat yard near St. Joseph, Mo., had reached De Witt, Mo., having covered 220 miles, river distance. The second party, under Assistant Engineer James A. Paige, with Assistant Engineer O. H. B. Turner, which had begun work at Sioux City (Big Sioux River) April 16, 1892, had reached the United States boat yard at Council Bluffs, Iowa, 148 miles, river distance, below the head of the work.

Mr. Ferguson's party reached St. Charles and connected with the precise levels of 1887 on October 31. There being few precise level bench marks between the St. Charles Bridge and the mouth of the river, a distance of 28 miles, the party was ordered to establish a number of them on this reach, connecting them with the two old bench marks, Nos. 8 and 11, that had been connected with in 1887, and with any temporary bench marks of that year that still existed and were reliable. The work was completed November 11, the quarter boat floated to Bushberg, and left in care of the fleet watchman, and the party disbanded. The following is a summary of the work done during the season by this party:

River distance covered ....miles..	487
Line leveled and checked ....do....	435
River crossings made	4
Precise bench marks, stone and pipe, set	88
Precise bench marks, copper bolts, set	101
Old bench marks, stone and pipe, connected with, and pipe replaced by new...	92
Other old engineer bench marks connected with	67
U. S. Coast and Geodetic Survey bench marks connected with	22
City datums connected with	7
City bench marks connected with	8
Gauges connected with	12

Mr. Paige's party reached the St. Joseph boat yard, and connected with the bench marks of the first party on September 26. The party was then disbanded, the quarter boat being left at the boat yard. The following is a summary of the party's work during the season:

River distance covered ....miles..	324
Line leveled and checked ....do....	247
River crossings made	1
Precise bench marks, stone and pipe, set	64
Precise bench marks, copper bolts, set	18
Old bench marks, stone and pipe, connected with, and pipe replaced by new...	25
Other old engineer bench marks connected with	4
City bench marks connected with	1
Gauges connected with	0

In addition to the number of stone and pipe, and copper bolt, bench marks set, as indicated in the above summaries, a large number of other bench marks were also established, which, while serving a temporary purpose, are in many cases of quite a permanent character. The more permanent of these are described in the reports of the chiefs of parties.

The instructions given both parties differed but slightly from those issued by the Mississippi River Commission in 1891 (see Annual Report of the Chief of Engineers for 1891, p. 3476). The few modifications that were made are given in Mr. Ferguson's report.

Mr. Ferguson has since made the reduction of his own line, with the assistance of Mr. Johnson. Mr. Paige, assisted by Mr. Turner, was engaged in reducing his work until January 9, when he left the office, to take charge of field work for the Mississippi River Commission. The reduction was at that time about two-thirds completed, and has since been completed by Mr. Turner, under direction of Mr. Ferguson.

The results are as follows:

St. Joseph boat yard to St. Charles, main line, 622.47 kilometers:

	Mm.
Probable error of final bench	14.35
Probable error per kilometer	0.575

Sioux City to St. Joseph boat yard, main line, 369.54 kilometers:

Probable error of final bench	17.00
Probable error per kilometer	0.884

Full details of the season's work, with tabulated results and descriptions and elevations of bench marks, are given in the appended reports of Mr. Ferguson (Appendix A 5) and of Mr. Paige (Appendix A 6).

In May, 1893, a single precise level party, under Assistant Engineer Turner, was sent out to connect with the precise level line of 1892, the Commission's gauges at Blair, Nebr., Plattsmouth, Nebr., Nebraska City, Nebr., Rulo, Nebr., Brownville, Nebr., Randolph, Mo., and DeWitt, Mo., which, on account of their distance from the main line, were not connected with when the line was run. The party began work at Blair May 22, and completed their work at DeWitt June 27.

The following is a summary of the work done:

Line leveled and checked ... miles	32
River crossings made	7
Precise bench marks set	7
Old bench marks connected with	23

Full details of the field work are given in Mr. Turner's report (Appendix A 7). The reduction is not yet completed.

GAUGES AND PHYSICAL DATA.

Twenty-one permanent gauges have been maintained by the Commission throughout the year. It has been decided to reëstablish the gauge on the bridge at Randolph, Mo., which was discontinued as a permanent gauge in January, 1891; and its readings will probably begin to-morrow. It is a cable gauge of the Commission's standard bridge pattern, as described in the Annual Report of the Chief of Engineers for 1891, p. 3820.

A temporary gauge has also been maintained throughout the year at Ewings Landing, Mo., by Division Engineer Yonge, and its readings sent weekly (as are those of the Commission's permanent gauges) to this office.

Readings have also been received weekly throughout the year from the gauges at Bushberg, Mo., and Bismarck, N. Dak.; and, during part of the year from those at Running Water, S. Dak., and Wolf Point, Mont.

The gauges at Hermann, Mo., Randolph, Mo., Leavenworth, Kans., St. Joseph Water Works, Mo., White Cloud, Kans., and Sioux City (Perry Creek), Iowa, which had been temporarily reëstablished in May, 1892, in order to obtain data concerning the extraordinarily high water of that year, were discontinued at the end of August.

The inclined shore gauges at Jefferson City, Mo., Waverly, Mo., and Lexington, Mo., were renewed in September last.

The inspection of the gauges has been satisfactorily performed by Assistant Engineer Butler, who has made three complete inspection trips during the year.

In accordance with a resolution of the Commission, bulletins have been erected at all the Commission's gauges below Kansas City, including the reëstablished gauge at Randolph, Mo., for the purpose of indicating to pilots the daily stage of water.

On the high bridges at St. Charles, Glasgow, Sibley, and Randolph, two bulletins have been erected, the one showing upstream and the other downstream. At all the other gauges a similar bulletin is used, exhibiting figures and letters of smaller dimensions than those shown on the high bridges. In order that the stages exhibited on the bulletins should agree as closely as possible with the daily published readings of the Weather Bureau gauges, it was decided that the bulletins should indicate heights above a plane 5.1 feet below the standard low-water plane of the Missouri River Commission. Detailed descriptions, with drawings, of these bulletins, and a full account of the year's gauge work, are given in report of Assistant Engineer A. H. Blaisdell (Appendix A 8).

Careful measurements were made during the year at all bridges over the Missouri River below Sioux City, to determine the lowest points of superstructure of all through spans, clear opening between piers, and between piers and shore, and width and batter of piers. The results of these measurements are shown in the table appended (Appendix A 3) and on the accompanying plate. The manner of lighting the above bridges was also determined.

A table of river distances has been compiled, covering that portion of the river between its mouth and the mouth of the Big Sioux River, and between Fort Benton, Mont., and Three Forks, Mont. (Appendix A 4).

Assistant Engineer J. A. Seddon has been engaged during the year in continuing the study of flood measurements by the method of gauge relations.

Discharge measurements and slope observations have been made by Division Engineer Yonge in the vicinity of the mouth of the Osage River.

COMMERCIAL STATISTICS.

An effort has been made to obtain, for the calendar year 1892, as accurate statistics as possible of the amount of commerce on the Missouri River between Sioux City and the mouth. The method of collecting these statistics and the results obtained are given in report on this subject appended (Appendix A 1).

ESTIMATES.

Office and traveling expenses and salaries of Commission	$20,000
Surveys, gauges, physical data, and publications	30,000
Total	50,000

APPENDIX A 1.

REPORT ON THE COMMERCE OF MISSOURI RIVER DURING YEAR 1892.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1893.

SIR: I have the honor to submit the following report on the commerce of the Missouri River between Sioux City (Big Sioux River) and the mouth, during the calendar year 1892.

The methods employed were similar to those employed in obtaining statistics for 1891, though somewhat more elaborate. Lists were first obtained from the surveyors of customs at St. Louis, Mo., Kansas City, Mo., St. Joseph, Mo., and Omaha, Nebr., giving the names of all steamboats enrolled at those points in 1892, and plying on the Missouri River between Sioux City and the mouth in that year; also the names and addresses of owners and various detailed information regarding the boats, all of which is included in Tables 5 to 11. It having been learned that three other steamboats, registered, respectively, at St. Paul, Minn., Dubuque, Iowa, and New Orleans, La., had been engaged in Missouri River trade in 1892, the dimensions, etc., of these boats were obtained from the surveyors of customs at the above ports.

Blanks covering in detail almost every article of freight carried were then sent to the owners of various boats, with a circular explaining the blanks, and requesting that they be filled out.

In most cases these blanks were returned to me filled out as requested, though not always in desired detail. In the case of the long-trade packets, the owners of the boats kindly placed in my hands their freight books, from which most of the data in relation to this class of boats in Table 1 was derived.

To obtain the business of such boats as had rendered no returns or the returns of which were not sufficiently detailed, an assistant was sent out from this office. As most of the boat owners that he visited kept no books, the results obtained by him are mainly estimates.

In an endeavor to compile statistics of commerce for a stream as large as the Missouri, and for a length of 811 miles, there will of necessity be items missed, and the totals will naturally fall under rather than over the actual business done. At the same time the following table, giving the amount of freight carried, towed, and rafted in 1892, and the number of passengers, is believed to be a close approximation to the actual trade:

TABLE 1.

	Grain.	Live stock.	Wood, lumber, and railroad ties.	Sand and building materials.	Miscellaneus farm produce and general merchandise.	Totals.	Mile-tons.	Passengers.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*		*No.*
Long-trade packets	8,958.0	1,088.9	1,374.5	521.6	18,429.3	30,372.3	6,112,179.6	4,450
Short-trade packets and miscellaneous steamers	31,783.4	2,721.1	26,117.7	40,994.6	8,882.3	110,499.1	1,411,529.6	*41,823
Sand and wood steamers and barges			6,260.1	84,832.5		91,092.6	327,561.7	
Rafts			4,908.9			4,908.9	522,700.8	
Totals	40,741.4	3,810.0	38,661.2	126,348.7	27,311.6	236,872.9	8,373,971.7	*46,273

* Includes 34,693 excursion passengers.

The following comparative table gives the totals for the different classes of trade in 1892 and 1891, statistics for previous years not being sufficiently detailed to admit of such comparison:

TABLE 2.

	Total number of tons carried.		Mile-tons.		Passengers.	
	1892.	1891.	1892.	1891.	1892.	1891.
Long-trade packets	30,372.3	31,458.4	6,112,179.6	6,437,472.8	4,450	6,000
Short-trade packets and miscellaneous steamers	110,449.1	73,866.3	1,411,529.6	1,455,627.6	*41,823	8,000
Sand and wood steamers and barges	91,092.6	71,103.3	327,561.7	145,868.7		
Rafts	4,908.9	3,118.1	522,700.8	158,262.3		
Totals	236,872.9	189,546.1	8,373,971.7	8,197,231.4	*46,273	14,000

*Includes 34,693 excursion passengers.

It should be stated that in the above tables the river commerce of the port of Sioux City is included; but, in reducing to mile-tons the freight carried between Sioux City and points above, only the distance between the landing at Sioux City and the mouth of the Big Sioux River is used as a multiplier.

Part of the apparent increase in mile-tons in 1892 is due to the obtaining of more complete statistics of the rafting business for that year. A considerable increase has occurred, however, in the sand and lumber trade.

The following table gives the number and total registered tonnage of steamboats plying on the Missouri River in the years 1889–1892:

TABLE 3.

Enrolled at—	1892.		1891.		1890.		1889.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
St. Louis, Mo	24	2,562.78	19	2,504.31	18	1,840.61	16	1,812.66
Kansas City, Mo	12	2,980.08	18	3,398.13	17	1,270.33	15	1,626.26
St. Joseph, Mo	3	148.88	5	265.41	5	277.62	5	277.62
Omaha, Nebr	11	912.29	12	794.21	10	504.72	13	1,329.85
Louisville, Ky					1	1,130.34		
St. Paul, Minn	1	324.09						
Dubuque, Iowa	1	58.32						
New Orleans, La	1	358.31						
Totals	53	7,344.75	54	6,962.06	51	5,023.62	49	5,046.09

The steamboats engaged in Missouri River trade are employed as packets, in short-trip coasting trade, as towboats, as excursion boats, or as ferryboats. Nearly all of them are at different times employed for a variety of purposes.

In addition to the steamboats there are six gasoline boats, which are not subject to Government inspection. Their dimensions range from 57 feet by 16 feet to 78 feet by 14 feet. The freight carried by these boats is included in the totals of Table 1.

The gauge observers under the Commission record and report weekly the number and names of steamboats passing their respective gauges. From these reports and from the known tonnage of the boats, the following table, for six of the gauge stations, is made up:

TABLE 4.

Locality.	Number of steamers passed.		Registered tonnage.	
	Up.	Down.	Up.	Down.
St. Charles, Mo	75	76	29,792.95	30,159.64
Cole Creek, Mo. (3.6 miles above Hermann)	198	199	36,671.46	37,061.87
Jefferson City, Mo	81	82	30,438.01	30,837.21
Boonville, Mo	69	70	21,190.95	21,627.78
Kansas City, Mo	18	19	17,381.22	17,459.30
Sioux City, Ia	19	17	3,411.64	3,230.22

Rates of insurance on the river have remained unchanged since July 1, 1889. They are believed to be higher than on any other river comparable in size with the Missouri.

No new line of transportation on the river below Sioux City has been established during the fiscal year 1892–'93. The steamer *John L. Ferguson*, however, which in 1892 ran between St. Louis and Portland, Mo., 138 miles, has, during the spring of 1893, been running as far as Jefferson City, 169 miles.

The steamer *State of Kansas*, of the Kansas City and Missouri River Transportation Company's line, was sold about May 20, 1893, for use in the lower Mississippi trade. The steamer *State of Missouri*, of the same line, but which has never been in service on the Missouri River, will, it is expected, take the place of the *State of Kansas*.

The Farmers' Packet and Transportation Company, spoken of in my last annual report, were prevented, by accidents to both of their boats, from entering the Missouri River trade last season. The company has since gone out of business.

.E 5.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of St. Louis, Mo., during the year 1892.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Depth.	Total tonnage.
				Feet.	*Feet.*	*Feet.*	
. Ewing	Osage City, Mo	1878	Apr. 25, 1892	......	......	......	4
n	Pittsburg, Pa	1875	Aug. 11, 1892	197	33	5	394.08
Diamond	Portland, Mo	1886	May 17, 1892	72.5	14.4	2.3	18.40
odore	New Haven, Mo	1890	June 15, 1892	97	23.2	3.2	86.45
Clyde	Rock Island, Ill	1883	July 18, 1892	95.8	17.4	3.9	76.84
in, No. 2	Jeffersonville, Ind	1891	Aug. 2 , 1892	150	30	4.5	186.03
	Boonville, Mo	1887	Apr. 26, 1892	102.4	21.5	4.7	80.35
	Hermann, Mo	1880	Apr. 29, 1892	91.8	19.1	3.4	73
rick	Tuscumbia, Mo	1883	Apr. 25, 1892	96.4	14.3	3	82.51
nade	Hermann, Mo	1891	July 1, 1892	107.4	29.4	3.5	74.35
e Hayes	Franconia, Minn	1879	....	117.4	14.5	3.6	87.07
M. Abbott	Madison, Ind	1883	Apr. 30, 1892	92	20	3.6	97.78
Bertram	Jeffersonville, Ind	1880	Aug. 16 18.2	180	34	5	390.49
L. Ferguson	Grafton, Ill	1876	Oct. 25, 1892	111.6	26.6	3.6	79.81
R. Hugo	Evansville, Ind	1879	Apr. 25, 1892	127	20	3	136.88
Eagle, No. 2	Jeffersonville, Ind	1877	June 7, 1892	130.4	19.2	3.9	82.65
Bryan	do	1875	Dec. 1, 1892	115	28	4.5	97.40
nce	Rock Island, Ill	1882	Apr. 11, 1892	76.3	15.7	3.2	48.93
ne	Louisville, Ky	18 0	....	95	23.5	3.3	60.35
in	Burlington, Iowa	1887	May 10, 1892	80	16.6	3.4	60.68
ak	Hermann, Mo	1888	Apr. 25, 1892	95	17.5	2.2	43.05
Wave	Jeffersonville, Ind	1885	Feb. 26, 1892	146	25.7	5	150.34
	Hermann, Mo	1884	Apr. 25, 1892	86.6	24	3	44.82
Fisher	Jeffersonville, Ind	1875	Apr. 26, 1892	122	28.8	4.6	106.52

Name.	State rooms.	Berths.	Passengers. Permitted to carry.	Passengers. First cabin.	Passengers. Steerage or deck.	Engines. Number.	Engines. Diameter.	Engines. Stroke.	Boilers. Number.	Boilers. Length.	Boilers. Diameter.	Boilers. Flues. Number.	Boilers. Flues. Diameter.
							In.	*Ft.*		*Ft.*	*In.*		*In.*
Ewing	......	......	8	......	8	1	6	[illegible]	1	3	40	70	1¼
n	18	36	66	30	36	2	15½	5	3	24	38	6	13½
Diamond	......	......	10	......	10	2	6	3	1	14	30	21	3
odore	......	......	30	......	30	2	10	4	1	20	44	6	{ 2–12 { 4–6
Clyde	......	6	31	......	31	2	12	3	1	20	40	9	6
in, No. 2	8	16	35	20	15	2	18	7	3	26	42	2	15
	6	12	33	8	25	2	8	3½	1	14	44	10	6
	3	......	50	20	30	2	8	2	1	14	42	4	{ 2–10 { 2–12
rick	4	13	28	13	15	2	7	2½	1	14	36	6	6
nade	3	6	35	5	30	2	9	3½	1	20	42	5	6–10
e Hayes	......	......	......	......	......	2	10	6	1	16	34	5	7
M. Abbott	......	......	17	......	17	2	9	4	1	20	42	6	6–10
Bertram	......	......	......	......	......	2	20	6½	4	24	38	......	......
L. Ferguson	......	......	20	......	20	2	11	4	1	16	42	12	5
R. Hugo	5	9	40	10	30	2	8	3	1	16	42	5	10
Eagle, No. 2	6	12	18	8	10	2	14	5	2	20	38	10	8
Bryan	......	......	50	......	50	1	16	5	1	22	44	5	{ 3–10 { 2–12
nce	......	......	57	......	57	2	8½	3$\frac{1}{16}$	1	15	40	7	{ 2–6 { 3–7
ne	5	8	......	......	......	2	10½	3	1	24	40	2	15
in	......	......	......	......	......	2	10	3½	1	18	42	7	7
ak	......	......	20	......	20	2	8	2½	1	17	40	36	3
Wave	......	......	......	......	......	2	20½	6	3	26	44	6	{ 2–12 { 4–7
	......	......	20	......	20	2	8	2½	1	12	36	5	7
Fisher	......	......	25	......	25	1	16½	5	1	22	42	5	10

Table 5.—*List of steamers plying on the Missouri River, etc.*—Continued.

Name.	Boilers.			Licensed to run on—	Name and address of sole or managing owner.
	Steel or iron.	When built.	Steam pressure allowed.		
			Lbs.		
A. W. Ewing	Steel	1885	125	Mississippi and tributary rivers.	C. C. Turner, Osage City, Mo.
Benton	Iron	1875	125	do	J. R. Ern, St. Louis, Mo.
Black Diamond	Steel	1886	130	do	Otto Marker, Osceola, Mo.
Commodore	Steel	1890	153	do	S. H. Schlief, New Haven, Mo.
Dick Clyde	Steel	1883	150	do	Josie Sirsley, St. Louis, Mo.
Dolphin, No. 2	Steel	1891	161	do	Dolphin Transportation Co., St. Louis, Mo.
Edna	Steel	1887	160	do	L. C. Lohman, Jefferson City, Mo.
Fawn	Iron	1877	110	do	Chas. B. Able, St. Charles, Mo.
Frederick	Iron	1883	150	do	Henry Castrop, Tuscumbia, Mo.
Gasconade	Steel	1891	160	do	Hermann Ferry and Packet Co., Hermann, Mo.
Jennie Hayes	Steel	1879	147	do	T. and H. Parker, St. Louis, Mo.
John M. Abbott	Iron	1883	142	do	Henry & Balch, Minneapolis, Minn.
John Bertram	Iron	1880	150	do	St. Louis, Keokuk and North-Western Railroad Co.
John L. Ferguson	Iron	1864	91	do	Austin Owen, St. Charles, Mo.
John R. Hugo	Iron	1882	119	do	R. M. Marshall, Tuscumbia, Mo.
Little Eagle, No. 2	Iron	1877	151	do	Southern Transportation and Lumber Co., St. Louis, Mo.
May Bryan	Iron	1875	113	Missouri River	Washington Ferry Co., Washington, Mo.
Patience	Steel	1890	145	Mississippi and tributary rivers.	Henley H. Moore, Jefferson City, Mo.
Pauline	Steel	1883	160	do	St. Louis, Keokuk and North-Western Railroad Co.
Penguin	Iron	1877	115	do	Louis M. Loss, Alton, Ill.
Pin Oak	Steel	1888	125	Missouri and tributary rivers.	Hermann Ferry and Packet Co., Hermann, Mo.
Polar Wave	Steel	1885	165	Mississippi and tributary rivers.	Huse & Loomis Ice and Transportation Co., St. Louis, Mo.
Royal	Steel	1884	125	Missouri and tributary rivers.	Hermann Ferry and Packet Co., Hermann, Mo.
Statie Fisher	Steel	1875	140	Missouri River	Capital City Ferry Co., Jefferson City, Mo.

Table 6.—*List of steamers plying on the Missouri River in the district of New Orleans, enrolled at the port of Kansas City, Mo., during the year 1892.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions.			Total tonnage.
				Length.	Breadth.	Depth.	
				Feet.	*Feet.*	*Feet.*	
A. L. Mason	Madison, Ind	1890	June 25, 1892	252.	52.6	6.	1,130.34
Alda	Boonville, Mo	1891	May 19, 1892	121.	21.2	4.	73.80
Annie Cade	Leavenworth, Kans	1879	May 20, 1892	127.5	32.	4.5	178.32
City of Brunswick	Brunswick, Mo	1890	Aug. 12, 1892	87.9	19.6	3.9	73.80
Jennie Gilchrist	Le Claire, Iowa	1871	May 21, 1892	105.5	18.5	3.8	74.40
Jos. L. Stephens	Jeffersonville, Ind	1887	May 19, 1892	103.	29.4	4.2	85.95
Krata	St. Louis, Mo	1888	Sept. 7, 1892	......	......	......	*5.
Mattie Lee	Grafton, Ill	1881	May 21, 1892	110.	28.	4.	104.81
Plow Boy	Sioux City, Iowa	1884	May 19, 1892	77.7	21.4	5.6	29.22
Roy Lynds	Jeffersonville, Ind	1887	do	87.	25.	3.6	66.09
St. Elmo	Dewitt, Mo	1891	June 16, 1892	57.	17.4	3.	28.01
State of Kansas	Madison, Ind	1890	Aug. 1, 1892	252.	52.6	6.	1,130.34

TABLE 6.—*List of steamers plying on the Missouri River, etc.*—Continued.

Name.	State rooms.	Berths.	Passengers.			Engines.			Boilers.			Flues.	
			Permitted to carry.	First cabin.	Steerage or deck.	Number.	Diameter.	Stroke.	Number.	Length.	Diameter.	Number.	Diameter.
							In.	Feet.		Feet.	In.		Inches.
A. L. Mason	11	22	100	50	50	2	20	7	4	28	42	16	10
Alda	6	12	58	8	50	2	10	5	1	22	42	10	6
Annie Cade	......	......	......	......	......	1	$20\frac{5}{16}$	$5\frac{1}{2}$	2	16	42	......	......
City of Brunswick	4	12	25	8	17	2	8	3	1	16	44	10	6
Jennie Gilchrist	......	......	8	......	8	2	12	3	2	20	31	10	6
Jos. L. Stepheus	......	......	......	......	......	2	10	$3\frac{1}{2}$	1	16	48	......	......
Krata	......	......	......	......	......	2	$5\frac{1}{2}$	$\frac{10}{12}$	1	12	40	53	2-03
Mattie Lee	2	4	30	......	30	1	16	$4\frac{1}{2}$*	1	20	48	6	2-14 / 4-08
Plow Boy	......	......	10	......	10	2	8	2	1	14	40	40	3
Roy Lynds	......	......	......	......	......	2	9	3	1	18	42	......	......
St. Elmo	......	......	25	......	25	2	7	3	1	12	40	......	......
State of Kansas	11	22	125	50	75	2	20	7	4	28	42	16	10

Name.	Boilers.			Licensed to run on—	Name and address of sole or managing owner.
	Steel or iron.	When built.	Steam pressure allowed.		
			Lbs.		
A. L. Mason	Steel	1890	160	Mississippi and tributary Rivers.	Kansas City and Missouri River Transportation Co., Kansas City, Mo.
Alda	Steel	1891	153	......do	A. B. Eads and others, Boonville, Mo.
Annie Cade	Iron	1879	119	Missouri River and opposite shore 5 miles above and below.	Wm. A. Cade, Kansas City, Mo.
City of Brunswick	Steel	1890	141	Mississippi and tributary rivers.	John B. Gum, Havana, Ill.
Jennie Gilchrist	Steel	1879	169	Mississippi and tributary rivers 2,000 miles and return.	Argentine Sand Co., Kansas City, Mo.
Jos. L. Stephens	Steel	1887	125	Missouri River to opposite shore at ferry crossings.	John Porter, Boonville, Mo.
Krata	Iron	1884	80	Missouri and tributary rivers 2,000 miles and return.	Hale Chapman, Armourdale, Kans.
Mattie Lee	Steel	1881	130	Missouri River at Miami and 10 miles above and below.	John Burruss, Miami, Mo.
Plow Boy	Steel	1889	150	Mississippi and tributary rivers 2,000 miles and return.	DeWitt N. Smith, Boonville, Mo.
Roy Lynds	Steel	1887	125	Missouri River and opposite shore at Lexington.	Lexington Ferry, Coal, Railroad and Transportation Co., Lexington, Mo.
St. Elmo	Steel	1891	155	Missouri and tributary rivers 1,000 miles and return.	Samuel B. Casebolt, DeWitt, Mo.
State of Kansas	Steel	1890	160	Mississippi and tributary river.	Kansas City and Missouri River Transportation Co., Kansas City, Mo.

*Estimated.

TABLE 7.—*List of steamers plying on the Missouri River in the district of New Orleans, enrolled at the port of St. Joseph, Mo., during the year 1892.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Depth.	Total tonnage.
				Feet.	*Feet.*	*Feet.*	
Harry Lynds	White Cloud, Kans	1892	Mar. 1, 1892	64	18	3	27.06
Belle of Brownville	Grafton, Ills	1880	May 20, 1892	110	30	4	102.44
J. K. Yazel	Atchison, Kans	1886	May 20, 1892	44	12	$3\frac{5}{12}$	19.36

Name.	Staterooms.	Berths.	Passengers. Permitted to carry.	Passengers. First cabin.	Passengers. Steerage or deck.	Engines. Number.	Engines. Diameter.	Engines. Stroke.	Boilers. Number.	Boilers. Length.	Boilers. Diameter.	Boilers. Flues. Number.	Boilers. Flues. Diameter.
							Inch.	*Feet.*		*Feet.*	*Inch.*		*Inches.*
Harry Lynds	......	......	20	......	20	1	7	$1\frac{1}{2}$	1	7	30	1	12
Belle of Brownville	......	......	......	......	......	1	16	4	1	18	48	......	......
J. K. Yazel	......	......	......	......	......	1	8	1	1	$11\frac{5}{8}$	34	28	3

Name.	Boilers. Steel or iron.	Boilers. When built.	Boilers. Steam pressure allowed.	Licensed to run on—	Name and address of sole or managing owner.
			Lbs.		
Harry Lynds	Iron	1883	120	Missouri River 10 miles above and below White Cloud, Kans.	John H. Lynds, White Cloud, Kans.
Belle of Brownville	Steel	1880	145	Missouri River between St. Joseph and opposite shore.	F. J. Clarkson, Elwood, Kans.
J. K. Yazel	Steel	1887	120	Missouri and tributary rivers.	John D. Davis, St. Joseph, Mo.

TABLE 8.—*List of steamers plying on the Missouri River in the District of New Orleans, enrolled at the port of Omaha, Nebr., during the year 1892.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Depth.	Total tonnage.
				Feet.	*Feet.*	*Feet.*	
Andrew S. Bennett	Sioux City, Iowa	1880	Oct. 26, 1892	115	30	3.5	78.06
Capitola Butt	Montrose, Iowa	1885	May 2, 1892	83.7	23.3	3.3	57.31
Josie L. K	Chamberlain, S. Dak	1884	Aug. 24, 1892	60	14	2.5	22.75
Last Chance	Burlington, Iowa	1870	Sept. 26, 1892	98.2	17.8	3	50.47
Little Maud	Sioux City, Iowa	1882	June 28, 1892	92	20	3.4	58.66
Mary E. Bennett	Covington, Nebr	1888	Sept. 6, 1892	65	14	2	21.71
Queen No. 2	Tieville, Iowa	1879	Aug. 24, 1892	44	12	2	12
Rosebud	Pittsburg, Pa	1877	July 12, 1892	177.4	31.3	4	286.49
Vint Stillings	Metropolis, Ill	1881	June 10, 1892	131	31.6	4.8	177.47
Castalia	Sioux City, Iowa	1892	Sept. 6, 1892	110	26.2	3.7	90.06
Jim Leighton	......do	1880	Aug. 15, 1892	......	......	......	57.39

TABLE 8.—*List of steamers plying on the Missouri River, etc.*—Continued.

Name.	Staterooms.	Berths.	Passengers. Permitted to carry.	Passengers. First cabin.	Passengers. Steerage or deck.	Engines. Number.	Engines. Diameter.	Engines. Stroke.	Boilers. Number.	Boilers. Length.	Boilers. Diameter.	Boilers. Flues. Number.	Boilers. Flues. Diameter.
							Inch.	*Feet.*		*Feet.*	*Inch.*		*Inches.*
Andrew S. Bennett	......	......	75	......	75	2	11½	4½	1	22	48	6	{2–14 4–7½}
Capitola Butt	......	......	20	......	20	2	11	3½	1	20	46	10	8
Josie L. K	......	......	30	......	30	1	6	1	1	6$\frac{9}{12}$	42	52	2½
Last Chance	......	......	32	2	30	2	11	3	1	18	42	4	{2–8 2–10}
Little Maud	......	......	......	......	......	2	10½	3	1	26	40	....	......
Mary E. Bennett	......	......	10	......	10	2	{7½ 7¾}	2½	1	16	38	5	8
Queen No. 2	......	......	......	......	......	1	7½	¾	1	7½	30	....	......
Rosebud	11	20	23	23	......	2	13	5	2	24	45	10	9
Vint Stillings	......	......	......	......	......	1	20	5	2	22	42	....	......
Castalia	6	12	22	7	15	2	10	4	1	20	42	6	{4–6 2–10}
Jim Leighton	......	......	......	......	......	2	11	3½	1	22	47	....	......

Name.	Boilers. Steel or iron.	Boilers. When built.	Boilers. Steam pressure allowed.	Licensed to run on—	Name and address of sole or managing owner.
			Lbs.		
Andrew S. Bennett	Steel	1883	140	Mississippi and tributary rivers.	D. Ayers, Ponca, Dixon County, Nebr.
Capitola Butt	Steel	1885	145	Mississippi and tributary rivers.	E. A. Conway and Bonus Milner Milling Co., Sioux City, Iowa.
Josie L. K	Steel	1888	120	Mississippi and tributary rivers.	Yankton Bridge & Ferry Co., Yankton, S. Dak.
Last Chance	Iron	1870	83	Mississippi and tributary rivers.	M. K. King, Chamberlain, S. Dak.
Little Maud	Steel	1889	156	Missouri and tributary rivers, between Fort Randall and Niobrara.	Jos. Leach, Sioux City, Iowa.
Mary E. Bennett	Steel	1891	177	Mississippi and tributary rivers.	R. A. Talbot, Covington, Nebr.
Queen No. 2	Iron	1877	110	Missouri River, at ferry crossings.	Geo. Anderson, Decatur, Nebr.
Rosebud	Steel	1882	149	Mississippi and tributary rivers.	The Sioux City Packet Co., Sioux City, Iowa.
Vint Stillings	Iron	1878	135	Missouri River and opposite shore.	Nick Maher, Sioux City, Iowa.
Castalia	Steel	1892	160	Mississippi and tributary rivers.	B. S. Holmes, Sioux City, Iowa.
Jim Leighton	Steel	1891	135	Missouri River at Pierre, S. Dak., and opposite shore.	C. & N. W. Rwy. Co.

TABLE 9.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of St. Paul, Minn., during the year 1892.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Depth.	Total tonnage.
				Feet.	*Feet.*	*Feet.*	
Libbie Conger	Dubuque, Iowa	1878.	May 18, 1892.	168	29.5	4.5	324.09

Name.	Staterooms.	Berths.	Passengers. Permitted to carry.	Passengers. First cabin.	Passengers. Steerage or deck.	Engines. Number.	Engines. Diameter.	Engines. Stroke.	Boilers. Number.	Boilers. Length.	Boilers. Diameter.	Boilers. Flues. Number.	Boilers. Flues. Diameter.
							Ins.	*Feet.*		*Feet.*	*Ins.*		*Inches.*
Libbie Conger	28	52	100	60	40	2	17	4	2	24	37	10	8

Name.	Boilers. Steel or iron.	Boilers. When built.	Boilers. Steam pressure allowed.	Licensed to run on—	Name and address of sole or managing owner.
			Lbs.		
Libbie Conger	Steel	1878	165	Mississippi and tributary rivers.	Jacob Richtman, Fountain City, Wis.

TABLE 10.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of New Orleans, La., during the year 1892.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Depth.	Total tonnage.
				Feet.	*Feet.*	*Feet.*	
City of Florence	Jeffersonville, Ind	1882	June 7, 1892	160	32	5	358.31

Name.	Staterooms.	Berths.	Passengers. Permitted to carry.	Passengers. First cabin.	Passengers. Steerage or deck.	Engines. Number.	Engines. Diameter.	Engines. Stroke.	Boilers. Number.	Boilers. Length.	Boilers. Diameter.	Boilers. Flues. Number.	Boilers. Flues. Diameter.
							Ins.	*Feet.*		*Feet.*	*Ins.*		*Inches.*
City of Florence	34	72	150	75	75	2	15	5	2	24	45	6	{ 3-9 { 3-10

TABLE 10.—*List of steamers plying on the Missouri River, etc.*—Continued.

Name.	Boilers.			Licensed to run on—	Name and address of sole or managing owner.
	Steel or iron.	When built.	Steam pressure allowed.		
			Lbs.		
City of Florence	Steel..	1882	152	Mississippi and tributary rivers.	McCormack & O'Meara, St. Louis, Mo.

TABLE 11.—*List of steamers plying on the Missouri River, in the district of New Orleans, enrolled at the port of Dubuque, Iowa, during the year 1892.*

Name.	Where built.	Year.	Date of last inspection.	Dimensions.			Total tonnage.
				Length.	Breadth.	Depth.	
				Feet.	*Feet.*	*Feet.*	
Geo. L. Bass...........	Dubuque, Iowa..........	1885	June 4, 1892	91	21	3.3	58.32

Name.	Staterooms.	Berths.	Passengers.			Engines.			Boilers.				
			Permitted to carry.	First cabin.	Steerage or deck.	Number.	Diameter.	Stroke.	Number.	Length.	Diameter.	Flues.	
												Number.	Diameter.
							Ins.	*Feet.*		*Feet.*	*Ins.*		*Inches.*
Geo. L. Bass...........	......	......	60	All grades.		2	10	4	1	16	42	10	6

Name.	Boilers.			Licensed to run on—	Name and address of sole or managing owner.
	Steel or iron.	When built.	Steam pressure allowed.		
			Lbs.		
Geo. L. Bass	Steel..	1885	166	Mississippi and tributary rivers.	Jas. Johnson, Dubuque, Iowa.

Very respectfully, your obedient servant,

J. C. SANFORD,
First Lieut. of Engineers, Secretary.

Lieut. Col. CHAS. R. SUTER,
orps of Engineers, U. S. A.,
President Missouri River Commission.

APPENDIX A 2.

TABLE OF GEOGRAPHICAL POSITIONS.

Latitude and longitude of points incidentally determined in connection with the secondary triangulation of the missouri River.—These results depend upon the latitude and longitude of the Morrison Observatory at Glasgow, Mo., as published in 1891, namely: Dome Morrison Observatory, latitude = 39° 13′ 45.59″; longitude = 92° 49′ 30.00″.

BELOW FORT BENTON.

Object.	Latitude.	Longitude.
	° ′ ″	° ′ ″
SW. corner sec. 9, T. 43 N., R. 1 E	38 28 15.1	90 55 30.5
SW. corner sec. 5, T. 44 N., R. 1 E	38 35 18.9	90 56 49.0
Church (spire), Dutzow, Mo	38 35 31.26	90 59 05.65
Catholic church (spire), Washington, Mo	38 33 30.96	91 00 51.26
School (cupola), Washington, Mo	38 33 20.80	91 00 53.29
SE. corner of NW. ¼ of sec. 21, T. 44 N., R. 1 W	38 33 08.2	91 02 02.4
Brick church (spire), New Haven, Mo	38 36 25.84	91 13 11.85
NE. corner of NW. ¼ of sec. 12, T. 45 N., R. 4 W	38 40 06.5	91 19 20.1
Quarter post between secs. 17 & 18, T. 46 N., R. 4 W	38 44 58.8	91 23 58.2
Center of NE. ¼ of sec. 31, T. 46 N., R. 4 W	38 41 56.0	91 24 37.8
White House hotel (flag pole), Hermann, Mo	38 42 24.01	91 26 01.30
SW. corner Buckar's House, Hermann, Mo	38 44 25.75	91 29 49.14
NW. corner of SW. ¼ of SE. ¼, sec. 7, T. 45 N., R. 6 W	38 39 43.1	91 37 52.4
Stone monument on left bank bluff on county line between Callaway and Montgomery counties, Mo	38 42 55.6	91 38 48.8
Center of sec. 32, T. 46 N., R. 7 W	38 42 44.6	91 44 00.2
Quarter post on E. line of sec. 24, T. 45 N., R. 9 W	38 38 41.5	91 51 52.0
Center of sec. 23, T. 45 N., R. 9 W	38 39 26.8	91 54 22.0
SW. corner sec. 34, T. 45 N., R. 9 W	38 36 14.7	91 55 35.1
SW. corner of T. 49 N., R. 9 W	38 37 20.1	91 59 42.8
Quarter post on N. line of sec. 22, T. 44 N., R. 11 W	38 33 11.3	92 00 38.2
Capitol (dome), Jefferson City, Mo	38 34 45.22	92 10 22.64
SW. corner sec. 13, T. 44 N., R. 12 W	38 33 15.9	92 12 16.8
Quarter post on W. line of sec. 24, T. 45 N., R. 12 W	38 39 45.6	92 14 05.5
Missouri State University (dome) (burned 1892), Columbia, Mo	38 56 44.29	92 19 45.22
SE. corner of T. 46 N., R. 13 W	38 43 01.5	92 19 55.9
SW. corner sec. 15, T. 45 N., R. 13 W	38 38 20.5	92 20 16.2
SW. corner sec. 15, T. 46 N., R. 13 W	38 45 41.9	92 23 12.0
SW. corner sec. 16 T. 47 N., R. 13 W	38 51 16.4	92 24 12.0
Quarter post between secs. 1 and 2, T. 46 N., R. 14 W	38 46 04.1	92 24 40.6
SW. corner sec. 32, T. 48 N., R. 14 W	38 51 53.9	92 28 54.2
SW. corner sec. 22, T. 48 N., R. 14 W	38 55 49.8	92 29 48.9
SW. corner sec. 6, T. 48 N., R. 14 W	38 58 33.0	92 33 03.3
Center sec. 5, T. 48 N., R. 15 W	38 57 00.3	92 34 56.9
SW. corner sec. 29, T. 49 N., R. 15 W	39 00 21.2	92 38 34.7
Center sec. 34. T. 48 N., R. 17 W	38 58 13.8	92 45 45.8
SW. corner sec. 25, T. 49 N., R. 17 W	39 00 39.1	92 47 34.5
Pritchett Institute (cupola), Glasgow, Mo	39 13 37.48	92 50 04.70
Baptist church spire, Glasgow, Mo	39 13 35.98	92 50 39.68
SW. corner Glasgow Hotel, Glasgow, Mo	39 13 34.86	92 50 50.02
Middle pier Glasgow Bridge, Glasgow, Mo	39 13 19.4	92 51 03.0
Center of sec. 13, T. 52 N., R. 18 W	39 18 34.5	92 53 06.4
"Old Ash Corner" between secs. 13 & 14, T. 50 N., R. 18 W	39 08 12.9	92 53 56.5
Center of sec. 13, T. 51 N., R. 19 W	39 11 45.9	92 56 02.2
Center of sec. 25, T. 51 N., R. 19 W	39 10 13.9	92 56 13.9
Center of sec. 1, T. 51 N., R. 19 W	39 03 23.0	92 56 37.1
SE. corner of SW. ¼ of sec. 16, T. 52 N., R. 19 W	39 16 47.8	92 59 33.0
NE. corner of NE. ¼ of SE. ¼ sec. 11, T. 52 N., R. 20 W	39 18 18.2	93 03 24.1
Brunswick Seminary (cupola), Brunswick, Mo	39 25 33.6	93 07 55.6
NW. corner SW. ¼, NE. ¼ sec. 26, T. 53 N., R. 21 W	39 22 39.1	93 14 01.7
SE. corner SW. ¼ of sec. 4, T. 51 N., R. 22 W	39 13 39.8	93 19 26.5
Center of sec. 27, T. 51 N., R. 27 W	39 11 34.4	93 52 31.0
Standpipe, Lexington, Mo	39 11 23.53	93 52 45.34
Court-house (cupola), Lexington, Mo	39 11 05.05	93 52 59.58
NW. corner of sec. 8, T. 51 N., R. 27 W	39 14 54.5	93 57 18.7
SW. corner of sec. 23, T. 51 N., R. 28 W	39 12 18.0	94 01 06.3
SW. corner of SE. ¼, NE. ¼ sec. 29, T. 51 N., R. 28 W	39 11 54.4	94 03 42.2
Court-house (cupola), Independence, Mo	39 05 30.89	94 24 59.64
SE. corner of NE. ¼, sec. 4, T. 50 N., R. 32 W	39 10 21.9	94 29 38.7
NE. corner of sec. 3, T. 50 N., R. 33 W	30 09 58.3	94 35 28.7
Flagstaff, Fort Leavenworth, Kans	39 21 19.20	94 55 10.91
Smokestack electric plant, Atchison, Kans	39 33 41.22	95 06 54.21
Spire on Central school, Atchison, Kans	39 33 50.49	95 07 10.86
Spire on Soldiers' Orphan Home, Atchison, Kans	39 35 17.81	95 06 44.23
Spire on convent, St. Joseph, Mo	39 45 45.28	94 50 41.83
Court-house (cupola), St. Joseph, Mo	39 46 04.94	94 51 18.66
Smokestack, pump house, St. Joseph, Mo	39 48 19.18	94 52 29.38
Flag pole, normal school, Peru, Nebr	40 28 28.09	95 43 55.90
Church spire, Watson, Mo	40 28 50.73	95 37 20.64
Water tower, Nebraska City, Nebr	40 40 30.02	95 51 58.58

BELOW FORT BENTON—Continued.

Object.	Latitude.	Longitude.
	° ′ ″	° ′ ″
d asylum, Nebraska City, Nebr	40 41 10.14	95 51 21.73
ola), Plattsmouth, Nebr	41 00 39.66	95 53 26.13
r, Plattsmouth, Nebr	41 01 06.43	95 53 14.38
and Geodetic Survey station, Omaha, Nebr	41 15 33.89	95 56 37.08
(cupola), Omaha, Nebr	41 15 36.1	95 56 38
aterworks, Florence, Nebr	41 20 32.90	95 57 34.17
ge (cupola), Blair, Nebr	41 33 01.16	96 09 23.56
(belfry), Decatur, Nebr	42 00 19.53	96 15 16.58
hoolhouse, Onawa, Iowa	42 01 26.41	96 05 53.80
ill (△ station), Sioux City, Iowa	42 29 35.65	96 24 57.60
court house, Sioux City, Iowa	42 29 43.48	96 24 17.25
ple, Sioux City, Iowa	42 30 50.14	96 27 33.01
ple, Jefferson, S. Dak	42 36 12.62	96 33 37.41
urch steeple, Elk Point, S. Dak	42 41 00.40	96 41 00.35
nokestack), Westfield, Iowa	42 45 37.93	96 37 59.93
on city hall, Vermillion, S. Dak	42 46 42.99	96 55 52.03
iversity, Vermillion, S. Dak	42 46 59.40	96 55 27.82
ndian Mission school, Santee Agency, S. Dak	42 50 21.19	97 51 14.45
ple, NW. part of Springfield, S. Dak	42 51 25.23	97 54 03.89
of college, Yankton, S. Dak	42 52 48.13	97 23 25.28
e, Bonhomme, S. Dak	42 53 36.52	97 45 47.19
tate Insane Asylum of South Dakota	42 54 41.94	97 24 14.65
overnment school building, Yankton Agency, S. Dak	42 55 12.90	98 22 49.27
church, Mission Hill, S. Dak	42 55 23.20	97 16 45.61
raska State line on right bank bluff	42 56 06.76	98 28 40.58
urt-house, Tyndall, S. Dak	42 59 35.03	97 51 58.16
t. Randall, S. Dak	43 02 57.46	98 33 36.41
ill, S. Dak	43 25 29	99 13 15
itte	43 57 52	99 36 15
college, East Pierre, S. Dak	44 21 46.16	100 19 13.30
court-house, Pierre, S. Dak	44 22 06.78	100 21 01.50
	44 58 30	100 12 27
ll (smokestack), Forest City, S. Dak	45 00 42.93	100 17 12.82
Butte	45 11 57	100 25 56
s Church (spire)	45 15 13.80	100 16 10.84
ort Yates, N. Dak	46 05 23.31	100 37 41.77
hoolhouse, Winona, N. Dak	46 06 23.92	100 35 55.27
s (highest point)	46 23 53	100 37 05
e	46 29 35	100 38 58
Butte	46 38 22	100 52 42
court-house, Bismarck, N. Dak	46 48 26.32	100 46 59.49
ailroad bridge, Bismarck, N. Dak	46 49 00.23	100 49 43.43
of upstream truss of middle span of railroad bridge, Bis- Dak	46 49 02.39	100 49 35.45
of capitol, Bismarck, N. Dak	46 49 09.18	100 46 51.94
court-house, Mandan, N. Dak	46 49 52.08	100 53 28.99
United States sod house, Rock Haven, N. Dak	46 52 29.53	100 53 20.05
ry), Coal Harbor, N. Dak	47 30 30.17	101 20 28.70
e, Stanton, N. Dak	47 19 10.77	101 22 57.47
(cupola), Stanton, N. Dak	47 19 15.09	101 23 04.58
.46 and 147 N., Rs. 84 and 85 W	47 24 51.8	101 26 24
ission school, Fort Berthold, N. Dak	47 30 29.58	101 57 01.68
'ort Stevenson, N. Dak	47 34 05.25	101 29 11.65
Saddle Mountain	47 51 38	102 43 30
flag pole), Williston, N. Dak	48 08 15.41	103 37 23.48
k, Williston, N. Dak	48 08 33.07	103 37 26.40
tion, Trenton, N. Dak	48 04 09.45	103 50 06.08
ation, Fort Buford, N. Dak	47 59 53.86	103 59 20.15
rworks, Fort Buford, N. Dak	47 58 59.89	103 59 30.63
ort Buford, N. Dak	47 59 12.68	104 00 05.05
t on right bank bluff of Missouri River, on State line between and N. Dakota. Bearing from Triangulation Station Ferry, .; distance 8 027 feet	47 58 08.22	104 02 32.61
k near Fort Buford, Mont	48 00 07.69	104 02 34.20
se, Lanark, Mont	48 08 28.85	104 21 40.13
uff	48 04 42	104 22 24
nt, on middle butte of three, SE. of Triangulation Station	48 01 52	104 25 30
k, Culbertson, Mont	48 08 30.36	104 30 54.70
k, Big Muddy, Mont	48 08 44.52	104 36 47.17
se, Belair, Mont	48 08 44.04	104 38 03.09
k, Calais, Mont	48 07 27.35	104 49 44.51
ouse, Poplar, Mont	48 06 35	105 11 31
ear Chelsea Siding, Mont	48 07 50.50	105 20 12.79
. S. Storehouse, Wolf's Point, Mont	48 04 41.31	105 38 41.41
se, Oswego, Mont	48 03 21.02	105 52 57.86
k, Lenox, Mont	48 03 40.25	106 02 31.27
se, Kintyre, Mont	48 04 19.04	106 08 26.99
	47 59 08	106 18 05
(iron rod)	48 07 29.03	106 31 50.22
(iron rod)	47 39 00.65	107 07 33.74

ABOVE FORT BENTON.

Object.	Latitude.	Longitude.
	° ′ ″	° ′ ″
North chimney Montana Smelter, near Great Falls, Mont	47 32 01.75	111 18 20.7[illegible]
P. B. M. No. 41*	47 27 46.41	111 18 25.1[illegible]
P. B. M. No. 38*	47 25 49.80	111 20 08.[illegible]
P. B. M. No. 37* (4 feet NW. from center of sec. 24, T. 9 N., R. 1 E)	47 23 04.45	111 32 50.06
SW. corner sec. 10, T. 17 N., R. 1 W	47 19 19.19	111 35 32.43
P. B. M. No. 35*	47 18 36.04	111 38 53.43
Spire of Christian Church, Cascade, Mont	47 16 13.01	111 42 00.89
P. B. M. No. 34*	47 16 07.57	111 41 50.22
P. B. M. No. 33*	47 13 35.75	111 45 53.72
Flag pole at Ferry Landing, Craig, Mont	47 04 25.52	111 57 36.21
NW. corner upper chord of railroad bridge, Townsend, Mont	46 20 03.73	111 31 50.58
Belfry public school, Townsend, Mont	46 19 14.13	111 31 05.89
Chimney of smelter, Toston, Mont	46 09 49.30	111 26 12.[illegible]

* For description of P. B. M's. see Appendix A 2 of Report of Missouri River Commission, 1891.

APPENDIX A 4.

TABLE OF DISTANCES, MISSOURI RIVER, FROM ITS MOUTH TO BIG SIOUX RIVER, AND FROM FORT BENTON, MONT., TO THREE FORKS, MONT., AS MEASURED ON LOW-WATER CHANNEL LINE FROM MAPS OF SURVEYS MADE IN 1890.

[Compiled in the office of the Missouri River Commission.]

NOTE.—Distances are given in miles and tenths.
The letters "R" and "L" indicate the right or left bank respectively, going downstream.
When a parenthesis follows the name of a locality, it is for the purpose of indicating the exact point to which the distance is measured. The word "foot" after names of islands indicates the point of *high land* farthest downstream.
The location of landings on islands is indicated by "N. S.," north side, and "S. S.," south side of island.

MOUTH TO BIG SIOUX RIVER.

Locality.	On which bank.	Miles.
ST. LOUIS (Eads Bridge) to mouth of Missouri River		17.5
Mouth of Missouri River to—		
Mobile Island (foot)		.1
Huffs Landing	L	2.9
Cora Island (foot)		3.8
Bellefontaine Bluffs (old fort)	R	6.8
Cold Water Creek	R	7.0
Bellefontaine Bridge		8.2
Bucks Landing	L	8.4
Jamestown	R	8.5
Little Island (foot)		9.1
Evans and Winstons Landing	L	9.2
Kralmeyers Landing	L	9.3
Bradshaws Landing	L	9.5
Frans Landing	L	9.6
Carricos Landing	R	10.7
Pelican Island (foot)		12.2
Kuhns Lower Landing	L	12.4
Kuhns Upper Landing	L	12.9
Minters Landing	L	13.5
Minnemeyers Landing	L	14
Potters or Barwise Landing	L	14.7
Yellow Dog or Kortelmeiers Landing	L	15.6
Black Walnut Landing	L	17.4
Musics or Halls Ferry	R	17.7
Haiglers Landing	L	18
Mullanphy Island (foot)		18.6
Burges Landing	S. S. Mullanphy Island	19.9
Sweenys Landing	do	20.2
Orricks Landing	L	21.2
Guhres Landing	R	22.4
La Barges Landing	L	22.8
Crazy Point	L	23.6

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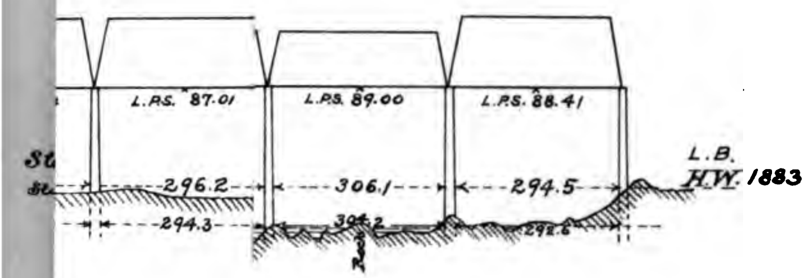
precise-lev...vations.

Second s...		Bench marks to which referred.		Remarks.
Center point or points ad... to cent...		Number.	Elevation.	
Feet.			*Feet.*	
89.0				
	20	T. B. M. 23	35.986	Span 1 used in high water by boats; occasionally 2, 4, and 5.
89.0				
194.92	14	G. B. M	177.325	
194.91	16			
247.65	2	G. B. M	209.830	Span 1 used occasionally in high water by boat.
247.61	2			
360.7		G. B. M. [B.]	291.224	Span 3 used in high water by boats.
360.7				
375.9		B. M. $\frac{73}{2}$	334.254	Span 2 used occasionally in high water by boats.
352.7	2	B. M. $\frac{73}{1}$ [Cap.]	336.958	
401.83	4	G. B. M. [a.]	372.169	Spans 2 and 3 also used in high water by boats.
401.79	4			
382.1		G. B. M	377.662	
408.58	4	B. M. 312	409.707	
408.65	4			
493.48	4	G. B. M	448.319	
493.49	4			
559.91	5	G. B. M	531.294	Span 1 also used in high water by boats.
559.93	5			
593.0		G. B. M	545.028	Span 2 also used by boats.
593.0				
614.31	6	G. B. M	559.189	
		G. B. M	559.189	
640.00	6	B. M. $\frac{142}{2}$	637.513	
640.03	6			
728.42	7	G. B. M. [Cap.]	682.015	Span 2 also used in high water by boats. During September and October, 1892, channel was under 3.
728.43	7			



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River Commission

f distances, Missouri River, from its mouth to Big Sioux River, etc.—Continued.

MOUTH TO BIG SIOUX RIVER—Continued.

Locality.	On which bank.	Miles.
ns and Niggemeiers Landing	L	23.8
Landing	L	24.3
ans Landing	L	25.2
eel Landing	L	27
les Bridge		28
ton Landing	R	28.7
rodts Landing	L	30.4
Branch	L	32.4
sons Quarry	L	32.4
uarry	L	33
gs Point	R	33.1
ucket Creek	L	33.3
ket Creek	L	33.8
anding	R	34.8
gs Landing	R	35.3
Island (foot)		35.3
ns Old Landing	R	36.8
s or Cragles Landing	L	37
me Creek	R	37.4
nding	L	37.9
Point	L	39.3
me Landing	L	39.4
me Island (foot)		39.7
Landing	R	40.9
anding	S. S. Bonhomme Island	41
s Landing	N. S. Bonhomme Island	41.5
anding	do	41.8
anding	L	42.2
s Island (foot)		42.3
Point	L	42.4
s Landing	L	42.5
ns Landing	L	42.7
gs Old Landing	R	43.4
Shop Hollow	L	43.8
lle Landing	L	44.3
Ferry Landing	R	44.8
Springs, Wards or Yarnells Landing	L	45.2
yers Landing	R	46
Island (foot)		46.6
ins Landing	R	46.9
Point	R	47.4
r Walters Landing	N. S. Howells Island	47.4
g Landing	L	48.4
orse Creek	R	48.5
s Landing	R	48.6
Osage River	L	49.1
Landing	R	49.1
s or Doziers Landing	L	49.4
wells Landing	R	49.6
anding	R	50.3
val	R	50.8
Landing	R	50.9
iln	R	51.4
anding	L	51.7
s Landing	L	53.4
nding	L	54.6
ks Landing	L	54.9
Creek	R	55
ns or Beckers Landing	R	55
Landing	L	55.6
Rocks	R	56.2
rusher Landing	R	56.8
ms or Reeds Landing	R	57.1
r or Fiddle Creek	R	57.1
Creek (foot of slough)	R	57.1
ers Landing	L	58.8
Landing	L	59.9
a Point	R	61.3
Landing	L	62.3
a or Sanders Landing	L	62.5
s Landing	R	63.5
s Landing	R	63.7
ls Landing	R	64.2
Landing	R	64.7
Landing	R	65.3
Landing	R	66.3
Creek	R	68.6
ps Landing	L	68.6
Point	R	68.8

Table of distances, Missouri River, from its mouth to Big Sioux River, etc.—**Continued.**

MOUTH TO BIG SIOUX RIVER—Continued.

Locality.	On which bank.	Miles.
Washington	R	71
North Washington	L	71.7
St. Johns Island (foot)		72.4
Hellbush Landing	L	73.1
Tuque Creek	L	73.7
Marthasville, Schwarz or Stiegens Landing	L	75.6
Charette Creek	L	75.7
Tiemans Point	R	76.9
Maupins Landing	R	78.1
Pattons Point	L	79.1
Boeuf Island (foot)		79.1
Bocklages Landing	L	79.3
Schowes Landing	L	79.4
Wessels Landing	L	79.8
Dundee (River au Boeuf)	R	80
Stoltes Landing	L	80
Bergers Landing	L	80.1
Feldmans Landing	L	80.3
Kochs Landing	L	80.4
Schormans or Hasenjaegers Landing	L	81.1
Holsteins or Lower Wehmeyers Landing	L	82.4
Sheltons Landing	N. S. Boeuf Island	83
Eimbecks Island (foot)		83.1
Schroers, Upper Wehmoyers or Brinkmans Landing	L	84
Schunes Landing	L	84.3
Eimbecks Landing	R	84.4
Parks Landing	R	85.2
Schechters Landing	L	86
New Haven (Millers Landing)	R	86.5
Pinckney Point	L	87.3
Niemeyers Landing	L	88
Berger Creek	R	88.6
Kruegerville	L	88.7
Pinckneys Landing	L	89
Humfeldts Landing	L	89.2
Meyers Landing	R	89.2
Jaegers Landing	L	89.5
Smith Creek	L	90.3
Hoewelmanns Landing	L	90.3
Sundermeyers Landing	L	90.3
Clyces Landing	L	90.4
Klusmeyers Landing	L	91.4
Saaks Landing	L	91.7
Whithouse or Zumaldts Island or Island No. 6 (foot)		93
Brinkmans or Wehmeyers Landing	L	93.3
Carls Landing	R	93.4
Hoehns Landing	R	93.5
Schowenquerdts Landing	R	93.7
Potthasts or Whithouse Landing	R	93.9
Wattenbergs Landing	R	94.9
F. Thees Landing	L	94.9
Frodemans Landing	R	95.4
Campbells Landing	R	95.5
H. Whithouse Landing	R	96
Pilchers Landing	L	97
Oettings or Bulloms Landing	L	97.2
Lost Creek	L	97.4
Rush or Bates Island (foot)		97.6
Lower Luppolds Landing	L	97.6
Luppolds Landing or Bridgeport	L	98.2
L'Outre Slough (foot)	L	98.4
Stewarts Landing	L	99.8
L'Outre Island or Prices Landing	L	101.8
Stocks or Woods Landing	L	102.4
Frame Creek	R	103
Hermann	R	103.3
Strake and Millers Landing	R	104.3
McGirks Island (foot)		105.7
Andersons Landing	L	105.8
McGirks or Van Bovens Landing	L	106
Bridges Landing	L	106.2
Cole Creek	R	107
Cole Creek Gauge	R	107.1
Rhineland Landing	L	109.2
Metzlers Landing	L	109.4
Quicks Landing	L	109.9
Gasconade River	R	110
Jones Landing	L	110.5
McFarlands Landing	L	111.5

distances, Missouri River, from its mouth to Big Sioux River, etc.—Continued.

MOUTH TO BIG SIOUX RIVER—Continued.

Locality.	On which bank.	Miles.
Island (foot)		113.4
anding	R	113.4
ek	R	113.8
ans Landing	R	114
ding	R	114.8
	L	115
Landing	L	115.9
gs Landing	R	116.7
sland (foot)		117.8
ns Landing	R	117.8
Landing	L	118.1
ern Creek	L	118.1
ne Landing	L	118.3
n Creek	L	118.9
Reform, or Readsville	L	120.3
ek	L	120.4
ek	L	120.8
ays Landing	L	122.6
reek	R	123.1
Fishers Landing)	R	124.4
Landing	L	126.6
Island (foot)		127.3
River	L	127.3
eek	L	128.4
nding	N. S. St. Aubert Island	128.7
	R	128.9
	L	130
st-Office and St. Aubert Station	R	130
er	L	131.2
anding	L	132
anding	R	133
Island (foot)		133.4
ose Creek	R	134.1
	R	134.4
achs Landing	L	135.4
nding	L	136.4
ding	R	136.5
Landing	R	137.3
ill or Dauphine Post-Office	R	138.3
nd (foot)		138.6
Dessein (Pinets Landing)	L	139
s Landing	S. S. Dodds Island	139.6
nding	S. S. Dodds Island	139.7
nding	S. S. Dodds Island	139.8
eek	L	140.3
Landing	L	140.4
er	R	141.7
le	L	141.9
(Glenns Landing)	R	142.2
anding	L	142.8
land (foot)		142.9
ge	R	143.8
ek	R	143.8
nding	R	144.3
ver	R	145.6
Landing	L	148.4
ek	R	148.9
CITY (gauge)	R	151.3
	L	151.8
eek or Cedar Slough	L	151.9
k	R	151.9
oint	L	153.8
ek	R	155
ek	L	155.5
nding	L	158.5
	L	159.1
Landing	L	159.5
and (foot)		160.6
	R	162.2
iths, Glatz, or Kreckels Landing	L	162.3
reek	R	163.1
nding	L	163.4
and (foot)		163.6
Rock	R	164.5
k	R	165.4
k	R	165.7
or Tuttles Landing	L	167
	R	167.1
reek	R	168.1

Table of distances, Missouri River, from its mouth to Big Sioux River, etc.—**Continued.**

MOUTH TO BIG SIOUX RIVER—Continued.

Locality.	On which bank.	Miles.
Factory Creek	R	168.1
Hagens, Wiltons, or Eureka Landing	L	170
Bonne Femme Creek	L	171
Wrights Landing	L	171.5
Sandy Hook Landing	R	172.8
Crooks Landing	R	173.7
Geigers or Alexanders Landing	R	174.8
Nashville or Moniteau Island (foot)		175.2
Actons Landing	L	176.1
Gillespies Landing	L	177
Little Bonne Femme Creek	L	177.7
Pecan Grove Landing	L	178
Providence	L	179.5
Perche Creek	L	179.5
Bruces Landing	R	180.3
Smiths Landing	R	180.8
Little Spice Creek	R	182.3
Big Spice Creek	R	182.7
Wolf Point or Lupus Post-Office	R	182.8
Belchers Landing	L	184.7
Mount Vernon Landing	R	184.8
Petite Saline Creek	R	185
Allens Landing	R	185.6
Soaptown Landing	R	185.9
Warren or McBains Landing	L	186
Pixleys or Whists Landing	R	186.4
Needmore Landing	L	186.4
Terrapin Island (foot)		186.6
Hunts Landing	L	187.1
Terrapin Creek	L	188.3
Scarceys Landing	L	188.3
Rymels or Vaughns Landing	N. S. Terrapin Island	188.6
Big Cave Creek	L	189.2
Taylors Landing	L	190.2
Dreskills Landing	R	190.4
Hickhams Landing	R	193.8
Rocheport	L	194.4
Moniteau Creek	L	194.5
Salt Creek	L	194.8
Overton	R	194.9
Hays Landing	R	197.3
Hobrights Landing	R	197.8
Elliotts Landing	R	198.9
Dodsons Landing	L	200
Irwins Landing	R	200
Franklin Island (foot)		201.5
Moores or Whites Landing	L	201.5
Bonne Femme Creek	L	202.8
Old Franklin	L	205.3
Loup Branch	R	205.7
Boonville (bridge)	R	205.8
Haas Brewery Landing	R	206.6
Fiddlers Coal Banks	R	208.2
Thomas Creek	R	208.3
Lamine River	R	211.2
Lamine Landing	R	211.4
Lower Arrow Rock Island (foot)		212
Blankenbakers Landing (Cedar Point)	L	212.4
Ashleys Landing	R	212.5
Moon Branch	R	213
Harrisons Landing	L	214.2
Upper Arrow Rock Island (foot)		215.6
Yates Landing	L	216.6
Salt Creek	L	217
Arrow Rock	R	221
Carsons or Maupins Landing	L	223.1
Lisbon	L	225
Woodruffs or Robinsons Landing	R	225.5
Saline City or Little Rock	R	228.5
Orearville or Lees Landing	R	228.6
Fish Creek	R	229.1
Richland Creek	R	231.2
Griffiths Landing	L	231.8
Jaegers Landing	L	232.8
Bluffport	L	234.4
Hurricane Creek	L	236.5
Greggs Creek	L	237.4
Glasgow (bridge)	L	237.6
West Glasgow	R	238.2

'istances, Missouri River, from its mouth to Big Sioux River, etc.—Continued.

MOUTH TO BIG SIOUX RIVER—Continued.

Locality.	On which bank.	Miles.
ver	L	238.5
sland (foot)		240.2
ieglers Landing	R	241.6
Switch	R	243.
	R	245.3
nding	L	245.5
Landing	L	245.6
anding	L	246.
nding	L	247.5
ing	R	248.5
nding	L	250.
	R	250.9
fort	R	252.
rs Landing	L	252.1
anding	L	252.4
Landing	L	252.5
ok (foot of old cut-off)	L	254.4
Landing	L	254.9
odyard	R	255.5
Woodyard	R	255.6
ek	R	255.7
nding	R	257.1
Point	L	257.1
(foot of slough)	R	259.
r Cromwell Point	R	259.
Island (foot)		259.
Point	L	260.6
r	L	260.7
int	R	261.9
t	R	264.
ge)	L	267.2
nding	R	271.1
	R	271.6
nd (foot)		274.2
reek	L	275.5
oodyard	L	276.8
or Steels Landing	R	279.6
nd (foot)		280.3
nding	S. S. Prunty Island	280.6
	R	283.7
Landing	R	285.4
int	L	286.7
nding	R	289.1
nding	R	290
r Cranberry Island (foot)		290.5
ols Landing, or Buffington	L	291.9
nding	L	294.3
nding	R	295.4
gauge)	R	299.1
and (foot)		300.2
anding	L	303.3
nding	L	304.8
nding	L	305.2
nding	N. S. Baltimore Bar	305.7
anding	L	307.1
nding	L	307.8
McQueens Landing	L	308.8
iders Landing	L	309.3
etts Landing	R	310.6
ng, Mills Point, or Shanghai	L	310.7
	R	312.4
	R	313.1
anding	L	314.4
	R	314.7
anding	L	315.3
nding	L	316.2
nding	L	316.4
ver	L	316.6
odyard	L	318.1
Island (foot)	L	318.2
gauge)	R	322
Landing	R	325.5
d (foot)		326.9
	R	328.4
	R	328.9
	L	329.7
Landing	L	330.7
Landing	L	331.
Landing	L	331.9

Table of distances, Missouri River, from its mouth to Big Sioux River, etc.—**Continued.**

MOUTH TO BIG SIOUX RIVER—Continued.

Locality.	On which bank.	Miles.
Reavis Landing	L	333
Steglers Landing	L	335
Coopers Landing	L	335.6
Camden	L	336.8
Burtons Landing	L	338.1
Finleys Landing	L	339
Helm Island (head)	R	340.4
Napoleon	R	342.5
Danners Landing	L	342.5
Fire Creek	R	343.4
Fishing River	L	347.9
Settles Landing	L	348
Maxwells Landing	R	348.3
Johnsons Woodyard	R	348.4
Shereds Landing	R	348.9
Wells Landing	L	348.9
Sibley (bridge)	R	350
Griffiths Landing	L	352.5
Piggs Landing	L	353.6
Hulls or Orricks Landing	L	354.7
Allens Landing	L	355
Sugar Creek	R	356.9
Little Blue River	R	358.3
Missouri City	L	362.9
Jacksons or Manns Landing	R	364.3
Hiffners Landing	R	365.9
Blue Mills Island (foot)		367
Sharps Landing	L	367.6
El Paso Landing	L	368.2
Blue Mills Ferry	R	368.7
Mill Creek	R	370.3
Liberty Landing	L	373.7
Wayne City Landing	R	378.8
Sissons Landing	L	380
Maxwells Landing	R	380.2
Rock Creek	R	380.3
Big Blue River	R	382.5
Randolph Bridge		386.7
Winner Bridge		389.1
Harlem	L	389.5
KANSAS CITY, Mo. (Hannibal and St. Joseph R. R. Bridge)	R	389.7
Kansas City, Kans. (State line, Missouri-Kansas)	R	391.8
Kansas or Kaw River	R	392
Jersey Creek	R	392.3
Dry Creek	R	392.5
Line Creek	L	396
Quindaro	R	398.8
Parkville	L	401.8
Pomeroy	R	405.7
Connors Creek	R	408.3
Connors City	R	409
Diamond Island (foot)		410.1
Waldron	L	410.8
Little Platte River	L	411.8
Hartman Landing	L	412.6
Delaware	R	415
Nine Mile Creek	R	417.2
Soldiers Home Landing	R	419
East Leavenworth	L	420.2
Leavenworth Island (foot)		420.4
Five Mile Creek	R	420.7
Stillings Landing	L	421.6
Three Mile Creek	R	421.6
Leavenworth (foot of Cherokee street)	R	421.8
Corral Creek	R	422
One Mile Creek	R	422.5
Fort Leavenworth (bridge)	R	424
Mensic	L	425.3
Beverly Junction	L	426.7
Bee Creek	L	427
Rialto	L	428.9
Kickapoo Island (foot)		430
Weston	L	430
Kickapoo	R	433.6
Iatan	L	437.5
Oak Mills	R	437.5
Port William	R	440
Walnut Creek	R	442.4
Sumner	R	442.8

Table of distances, Missouri River, from its mouth to Big Sioux River, etc.—Continued.

MOUTH TO BIG SIOUX RIVER—Continued.

Locality.	On which bank.	Miles.
Whisky Creek	R	446.1
Atchison (bridge)	R	447.8
Mud Lake (outlet)	L	449.8
Independence Creek	R	452.9
Doniphan	R	454.1
Rushville	L	457.5
Geary City	R	461.9
Halls	L	465.8
Discharge from Lake Contrary	L	466.5
Randolph Landing	R	470
Palermo	R	471.4
Wathena	R	473
Liniment Creek	L	478.1
St. Joseph (bridge)	L	479
Elwood Ferry Landing	R	480.5
Belmont	R	481.6
U. S. boatyard (abandoned)	L	487
St. Joseph Water Works Pump House	L	488.7
Dillon Creek	L	491
Amazonia	L	493.6
Nodaway River	L	498.6
Solomons Island (foot)		500.5
Dallas Station	L	501.5
Charleston	R	506.6
Charleston Creek	R	506.6
Mosquito Creek	R	509.7
Mount Vernon	R	509.8
Lafayette Landing	R	512
Wolf Creek	R	516.3
Iowa Point	R	519
Little Tarkio Creek	L	520.9
Forest City	L	521.6
White Cloud	R	525.4
Squaw Creek	R	528.9
State Line, Kansas-Nebraska	R	528
Big Nemaha River	R	529
Big Tarkio Creek	L	531.8
Jones Point	R	534.3
Rulo (bridge)	R	537.5
Winnebago Creek	R	544.7
Arago Island (foot)	L	545.5
Arago	R	547.7
Jones Creek	R	549.1
Corning	L	556.4
Hemmies Landing	L	556.8
St. Deroin	R	561.8
Morgan Island (foot)		564
Hillsdale	R	565.8
Aspinwall	R	567.9
Little Nemaha River	R	569.6
Nemaha City	R	570.5
Brownville (gauge)	R	577.6
Sonora Island (foot)		579.7
Honey Creek	R	583
Sonora	L	584.3
Peru	R	587.2
Buck Creek	R	587.4
Nishnabotna River	L	588.4
Line Island (foot)		595
State Line, Missouri-Iowa	L	596.9
Minersville or Otoe City	R	597.8
Sidney Landing	L	600.8
Frasers Island (foot)	R	603
Paynes Landing	L	603.2
Eastport	L	607
Nebraska City (bridge)	R	607.7
Nebraska City Island (foot)	L	609.2
Walnut Creek	R	611.4
Squaw Creek	R	612.2
Wyoming or Neighs Landing	R	614
Spring Branch Creek	R	614
Weeping Water Creek	R	614
Keg Island (foot)	L	618.7
Jones Point	R	618.7
Bartlett	L	624.5
Calumet Point	R	626.2
Rock Bluff	R	626.5
Rock Bluff Point	R	627.9
Tobacco Island (foot)	R	628

Table of distances, Missouri River, from its mouth to Big Sioux River, etc.—Continued.

MOUTH TO BIG SIOUX RIVER—Continued.

Locality.	On which bank.	Miles.
Keg Creek	L	629.8
Plattsmouth Bridge		633.6
Plattsmouth (foot of Main street)	R	634.5
Platte River	R	635
Big Papillon Creek	R	637.9
St. Marys Island (foot)	R	643
Bellevue	R	645.8
Mosquito Creek	L	650.7
Manawa Landing	L	650.7
Gibsons Landing	L	654
Indian Creek	L	657.3
Union Pacific Railway Bridge, Omaha		659.1
Otoe Creek	R	659.3
OMAHA (Omaha and Council Bluffs Bridge)	R	659.8
Council Bluffs and East Omaha Bridge		662.2
U. S. Boatyard (abandoned)	L	662.7
Outlet to Iowa Lake	L	662.9
Chicago and Northwestern Railway dikes	L	666.1
Florence Lake	R	667.7
Florence	R	670.5
Mill Creek	R	670.9
Pigeon Creek	L	672.3
Ponca Creek	R	673.3
Boyer Creek	L	674
Fort Calhoun	R	682.4
Lone Tree Lake	L	688
California Junction	L	688.2
Fish Creek	R	691.3
De Soto	R	691.3
Blair (bridge)	R	694.6
Soldier River	L	698.6
Little Sioux River	L	722.2
Newton	R	725
Tieville	L	744.6
Decatur	R	744.7
Blackbird Hill	R	753.4
Blackbird Creek	R	755.1
Forsyth	L	758.4
Omaha Mission	R	764.5
Spring Creek	R	768.3
Sand Hill Lake	L	779
Omadi Landing	R	795.3
Omadi Creek	R	705.3
Dakota City	R	801
Chicago, St. Paul, Minneapolis and Omaha Rw'y Bridge, Sioux City		805.7
Floyd River	L	806.2
Covington	R	807.3
SIOUX CITY (Perry Creek)	L	807.4
Pacific Short Line Bridge		807.5
Big Sioux River	L	810.6

FORT BENTON, MONT., TO THREE FORKS, MONT.

FORT BENTON (bridge) to—		
Crescent Island (foot)		3.2
State Island (foot)		5.7
Robbin's Ranch (foot of Grove Island)	L	7.5
Black Bluff Island (foot)		9
Gibson's Ranch (opposite Cherry Coulée)	L	10.2
Little Cottonwood Ripple		14
Brown's Ranch (opposite Bullhead Coulée)	R	15.2
Blacktail Deer Ripple		16
Pebloe Island (foot)		17.5
Evans' Ranch (foot of Snipe Island)	R	19
Black Eagle Ripple		21
Huntzberger's Ranch	L	21.3
Grass Island (foot)		23.1
Highwood Creek	R	25.2
Antelope Ripple		26
Smith's Ranch	R	27.2
Portage Coulée	L	29.2
Belt River	R	31.3
Boxelder Creek	R	35.3
The Great Falls		37.2
Box Canyon	L	41.2

stances, Missouri River, from its mouth to Big Sioux River, etc.—Continued.

FORT BENTON, MONT., TO THREE FORKS, MONT.—Continued.

Locality.	On which bank.	Miles.
lls		41.6
ills		42.1
ielter	R	43.4
t Falls	L	44.8
Falls		45.3
ts (railroad bridge)	R	48.6
	L	49.3
Island (foot)		49.7
Island (foot)		51.9
Creek	R	53.2
land (foot)		56.5
		60
Barker Island (foot)		63.7
nch	L	69.2
Ranch	L	76.2
r	R	77.5
	L	79.3
land (foot)		80.5
d (foot)		83.3
ch	L	89.9
anch	L	91.8
ain or Muddy Creek	L	93.0
	R	95.9
anch	L	98
Ripple		102.7
bson's Ferry)	L	103.6
	R	103.6
unch	R	107.2
anch	L	110
ipple		111
nch	L	111.7
nch	L	113.3
ion	L	114.3
or Lone Pine Rapids (head)		114.8
k	R	114.9
k	L	115.9
	L	116.7
land (foot)		116.8
h	L	120.8
Station	L	123
nd (foot)		123.7
Ranch	R	124.3
iver	L	125
Island (foot)		126.8
(opposite Stickney Creek)	L	127.7
		129
Ranch	L	129.5
eek and head of O. K. Island	R	130.7
n (Stickney's Ferry)	L	130.9
Rock	L	131.4
y's Ranch (Dog Creek)	L	131.6
Ranch	L	131.7
ipple		134.3
anch (Rock Creek)	L	135.5
ly Pear Creek	L	136.3
sland (foot)		137.6
ch	R	140
nd (foot)		141.2
e Islands (foot)		141.8
d and Mandible Point		146.4
Creek	R	149.7
ls (head)		150.9
k	R	152.1
Rapids (head)		153.5
ite Rock Canyon (Willow Creek)		155.1
Rapids		156.8
ite Rock Canyon (Cone Rock)		160.4
ach (foot of Twin Islands)	L	161.5
Bar	R	163
Canyon		164.5
ena Canyon (Beaver Creek)		165.8
s		166.2
r Creek	L	169.6
nyon (Soup Creek)		173.7
le		176.3
anch	L	177.7
Ripple		178.8
ry	L	179
eek	L	180.3

Table of distances, Missouri River, from its mouth to Big Sioux River, etc.—**Continued.**

FORT BENTON, MONT., TO THREE FORKS, MONT.—Continued.

Locality.	On which bank.	Miles.
French Bar Gold Mines	L	183.8
St. Germain Rapids		185.1
Canyon Ferry	R	185.8
Head of Black Rock Canyon (Magpie Gulch)		186.5
Willow Rapids		187
Frog Rapids (foot)		188
Snelling Rapids (Hell Gate Gulch)		190
Cooney's Ranch (Avalanche Gulch)	R	191.6
County Line, Jefferson-Lewis and Clarke	L	193.4
Young Duck Rapids		193.4
McMillan's Ranch (Beaver Creek)	L	195.7
White Gulch Creek	R	198.2
Falon's Ranch (Pine Tree Rapids)	L	199.7
Diamond Island (foot)		200.1
White Gulch and Blake's Ferry	R	200.8
Bald Face Rapids		201.2
Confederate Creek	R	204.4
Duck Creek	R	204.5
Pickering Ferry		204.8
Phelan Rapids		205.6
Fletcher's Ranch	R	206.5
Spit-up Rapids		206.8
Snag Rapids		208.2
Fishers Rapids		210.1
Canton	R	211
Fork Rapids		211.6
Eight Mile Slough (foot)	L	211.6
Diamond Ferry		215.5
Whaley's Ranch (Haystack Ripple)	L	215.6
Dolly Varden Ripple		216.9
Centerville	R	218.7
Northern Pacific Railroad Bridge		219.3
Ferry Rapids		219.9
TOWNSEND (Sweeny Rapids)	R	220.6
Wall Rapids		221.1
Slough Rapids		221.9
Thompson's Ranch (Deep Creek)	R	223
Montana Rapids		223.7
Grimm Bros.' Ranch	R	224.6
Greyson Creek	R	224.9
Bull Rapids		225.2
John Smith's Ranch	R	226
Hossfeld's Ranch	L	227
Reeves' Ranch (opposite foot of Horse Island)	R	228.7
Wind Island		230.5
Sharp Bros.' Ranch	R	232.7
Crow Creek	L	232 7
Six Mile Creek	R	233.8
Toston (foot of High street)	R	235
McFarland's Ranch	L	236.8
Goose Rapids		238.1
Mammoth Spring	R	239.6
Painted Rock Station	R	243.7
Sixteen Mile Creek	R	245.3
Red Rock Canyon (head)		246.3
Carolus' Ranch	R	247
Sawyer's Ranch	R	250.2
Magpie Station	R	251.1
Lower Mosquito Rapids		252.8
Upper Mosquito Rapids		253.3
Eagle Rock	R	255.7
HEAD OF MISSOURI RIVER (mouth of Gallatin River)		261,5
Miss Campbell's Ranch	L	261.7
Madison-Jefferson River, confluence		262.8
Three Forks (wagon bridge over Jefferson River)	L	266.2

APPENDIX A 5.

ANNUAL REPORT OF MR. O. W. FERGUSON, ASSISTANT ENGINEER, 1893.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., July 11, 1893.

SIR: I have the honor to present the following report on field work of precise levels between the United States boat yard above St. Joseph and St. Charles.

The river distance to be covered was 487 miles, an unprecedentedly large undertaking for one season.

For this work a double precise level party was organized, with O. W. Ferguson, assistant in charge, to run one instrument; A. L. Johnson, assistant engineer, to run the other instrument; F. B. Williams and John P. Baker, recorders; F. F. Harrington, Charles C. McGregory, Charles J. Sheehan, and John Gremor, jr., rodmen; F. P. Marsh, foreman; John Zrenner, Erick O. Shervey, and Andrew Hemenway, axmen; George Marto, cook; W. B. Hannaford, waiter.

It was desired that we take the field as early as the season would permit. March 17, 1892, was set as the date for the party to report for duty at the United States boat yard above St. Joseph.

A stone barge, No. 16, strongly made, 64 by 16 feet, provided with bunk frames and three tables, covered with a 10-ounce canvas tent, was provided by United States Division Engineer S. Waters Fox for the accommodation of this party. There were on board the barge, also, supplies for two months. This quarter boat was the same as the one described in the report of the Commission for 1892, Appendix A, page 3259.

Instructions.—The instructions for doing this work were the same as those furnished by the Mississippi River Commission, in report for 1891, page 3476, excepting that the top of caps of stone and pipe P. B. M's. (permanent precise bench marks) were set but 6 inches above ground, and the P. B. M's. were set a less distance apart. When the line passed within one-half mile of a stone and pipe B. M. on an old "stone line," it was connected with by a side line. When the distance was greater than a half mile, a new stone and pipe were set as nearly on this line as practicable. If the stone lines were more than 3 miles apart, a new stone and pipe P. B. M. was ordered set as nearly midway as practicable. It was also ordered to set copper bolts in the ledges of rocks and on structures, particularly when near the stone and pipe P. B. M's.

The regulation P. B. M. is similar to that used by the Mississippi River Commission, excepting that a stone 18 by 18 by 4 inches is used instead of a tile of same size, and a plate-ring 10 inches in outer diameter is slid to the bottom of pipe, where it is stopped and held by the spread end of pipe, making it impossible to get the pipe away from its place without a large amount of digging.

Instruments.—The usual Kern precise leveling instruments, level tubes, and rods were used on this work, as described in report of Mississippi River Commission for 1892, p. 55. Levels Nos. 3 and 4, tubes 5 and 6, and rods X, XIII, XVIII, and XIX were provided.

On arriving at the quarter boat, the first thing necessary was to prepare to resist the very cold and stormy weather, that continued until March 24. Straw was gotten, ticks filled, beds made, stoves set up, subsistence stores and engineer property then checked off and receipted for to different officers, from whom received. The quarter boat furnished no place for placing dishes or other articles. Four hundred feet of pine lumber was worked up into tables, shelves, drawers, and decks, to provide places for articles. An ice box was made by the yard carpenter, mostly from rough lumber picked up around the boat yard; a large supply of wood was also made from pile chunks on the yard, and stowed away in the hold. While these works were going on, good use was made of all the time, in which weather would permit, to get observations for finding the instrumental functions. These are:

(1) Value in seconds (n) of one division of level tube.
(2) Inequality of telescope rings, in seconds.
(3) Angular value of wire intervals in seconds.
(4) To make the "A's" of *rods used together* of the same length.
(5) Value of "A" of all rods.
(6) Comparative lengths of rods.
(7) Value of B_r and B_l of all rods.

From these results we computed:

(1) Distance "S" at which a movement of bubble through one division subtends 1 millimeter on rod.
(2) Table giving difference of interval for various distances.
(3) Table giving distance corresponding to any given total interval.
(4) Table for finding correction for inclination in millimeters per meter, for any error of bubble.

These having been completed, on the evening of March 24 actual fieldwork was begun.

Line of work.—In projecting a line of precise levels good ground to operate on is of prime importance. If running through sectionized country it is preferable to follow the beaten earthen roads over two sides of the right-angle triangle to following the hypothenuse across corn and wheat fields or meadows.

During the first three months of the season the river was very high and the ground was all kept very soft by high water and frequent rains, requiring special care in setting instruments and rod supports; causing also hard walking and longer, as we could only follow the high ridges going to and from work.

An ordinary railroad furnishes a very good ground for precise level work; the distances, too, are usually about the shortest. There will always be some disturbance from trains on the road; but, by knowing the times of the trains and setting out of the way whenever this choice is offered, the time lost by these disturbances is but a small per cent.

Route.—The line followed the left bank to opposite Atchison, Kans., where we crossed to right bank over the railway bridge; followed the right bank to opposite Glasgow, crossed to left bank, over the Chicago and Alton Railway Bridge; followed the left bank to opposite Boonville, where we crossed on the Missouri, Kansas and Texas Railway Bridge; followed then the right bank to mouth of the river, P. B. M. ‡.

At St. Charles we made a river crossing from shore to shore, a distance of 645 meters (discrepancy 0.4^{mm}), by the process of reciprocal leveling, locating several P. B. M.'s in St. Charles.

254.1 miles of the main line followed railroads = 66 per cent.

132.7 miles of the main line followed through country near the river = 34 per cent.

Stretches away from railroad.

	Miles.
Just below Sibley	5.5
Grand Pass Lake to near Glasgow	46.1
Glasgow to near Jefferson City	69.2
Creve Coeur Lake to Charbonnier Point	11.9
Total	132.7

In selecting the route care was taken that the P. B. M's be set as near the river as practicable.

Thus three river crossings were made over bridges and one from shore to shore.

Connections with old points—As the line progressed lookout was kept for old B. M's, we being provided with a pretty full list of old descriptions. No reasonable pains was spared to connect with these when they could be found, though in poor condition. These consisted of old U. S. Engineer B. M's, some Commission B. M's, U. S. Coast and Geodetic Survey B. M's, city B. M's, city datums, and Commission and Signal Service gauges.

With the exception of stone lines 75, 70, 65, and 42, at least one stone on every line from 90 to 1, both inclusive, was connected with; and in these exceptions an additional stone and pipe P. B. M. was set approximately on old line.

From the column, in tabulation of final results following, of "Discrepancies," it may be seen that—

Old B. M's checked with mean of precise-level results between—

0.0 and 0.1 feet	38
0.1 and 0.2 feet	41
0.2 and 0.3 feet	43
0.3 and 0.4 feet	11
0.4 and 0.5 feet	2
0.5 and 0.6 feet	2
0.6 and 0.7 feet	1
0.9 and 1.0 feet	1
1.0 and 1.5 feet	5
1.5 and 2.0 feet	2
2.0 and 2.5 feet	2
2.5 and 3.0 feet	1
3.0 and 3.5 feet	1

The connections with the U. S. Coast Survey P. B. M's between Kansas City and St. Louis show a quite continuous divergence of the two lines.

At Kansas City on old cap ${}^{4}_{1}{}^{3}$ it is just 1 foot, a constant divergence of 0.0035 foot per mile, railroad distance.

Between St. Louis and Jefferson City the divergence for this 125 miles is much larger than this average, being 0.0059 foot per mile.

Between Jefferson City and Kansas City, a distance of, approximately, 160 miles by railroad, this divergence, though of the same sign, is less, being 0.0016 foot per mile.

Table of distances and discrepancies between these precise levels and those of the U. S. Coast and Geodetic Survey.

[— = U. S. C. S. too low; + = U. S. C. S. too high.]

Bench mark.	Railway distance from St. Louis.	River distance from mouth.	Distance from Kansas City as per line run.	Discrepancy.
	Miles.	*Miles.*	*Miles.*	*Feet.*
P. B. M. 232 = Old B. M. 243, copper bolt, Kansas City	283	391	0	—1.004
Cap over, $^7_1{}^3$, Kansas City	283	391	0	—1.000
P. B. M. 231 = Old B. M. 244	283	391	0	—1.002
LVIII, Big Blue River	277	382	0	—0.971
XXVII, Jefferson City	125	152	196	—0.736
+ in Capitol, Jefferson City	125	152	196	Not given.
XXVI, Moreau River	121	146	200	—0.642
XXV, Ewings Landing	119	144	201	—0.609
XXIV, Osage	117	142	204	—0.628
P_3 Bonnots Mill	113	138	208	—0.578
XXII, Loose Creek Landing	109	134	212	—0.543
XX. St. Aubert	105	130	216	—0.544
O_3 Chamois	100	124	221	—0.527
XIX, Morrison	93	117	228	—0.455
XVIII, Gasconade	89	110	232	—0.436
XVII, Gasconade	88	110	233	—0.449
XVI, Cole Creek	84	107	237	—0.413
N_3 Hermann	81	103	240	—0.309
XV, Berger	75	98	246	—0.257
XIV, Etlah	71	93	250	—0.241
L_3 Washington	54	71	267	—0.201
P. B. M. 49 = Old B. M. 41 = XII, South Point	52	69	269	—0.250
K_2 = St. Louis Directrix	0	....	....	+0.000

NOTE.—For connections between St. Louis City Directrix, Mississippi River Commission P. B. M. 15, and U. S. Coast Survey P. B. M. J_3 in south face of west land pier of the Eads Bridge, see my manuscript report of November 12, 1887, to First Lieut. Theo. A. Bingham, Corps of Engineers, Secretary Missouri River Commission.

On B. M. stone $^7_1{}^3$ at Kansas City our variation from the line of common levels as published, that were run with unusual care, is —0.214; at St. Charles our variation being 0.000; showing a divergence of this former line, in the same direction as the Coast Survey line, from our line of 0.0007 foot per mile, using the distance, 310 miles, by the way of Glasgow and Boonville, as given by our line.

Bench marks.—The standard form of bench marks, being top of copper bolt in stone 18 by 18 by 4 inches, set 3½ feet below surface of ground, was used..

Plan and description of this is given on page 36 of the report of the Commission for 1886. The top of cap is also taken for a P. B. M.

These are an excellent form of P. B. M's. The stone is very rarely disturbed, and the pipe, in the 92 old stone and pipe B. M's. connected with, were all right, excepting three. The new style of pipe will make these still more secure. Every old stone connected with and new one set was surmounted by the new style of pipe.

The three-eighths-inch copper bolt P. B. M's, leaded vertically or horizontally in masonry or in natural ledges of rock, were also generally set. They make the very best precise bench mark; particularly those set horizontally. They are especially adapted to towns and cities.

Many of the T. B. M's on ledges, trees, and masonry are of a quite durable nature; 432 of them were considered worth describing, and are given in their order in the list of descriptions appended.

Over the 386.8 miles of main line and 487 miles of river there are distributed 312 P. B. M's, 180 top of cap P. B. M's, and the 432 T. B. M's.

New stone and pipe P. B. M's, set	88
New copper bolt P. B. M's, set	101
Old stones connected with and pipe replaced by new	92
Old copper bolt P. B. M's connected with	9
U. S. Coast and Geodetic Survey P. B. M's connected with	22
City datums connected with	7
City B. M's connected with	8
Gauges connected with	12
Other old B. M's connected with	58

Methods of field work.—These were quite similar to what is given in Report of Mississippi River Commission for 1892, p. 2950. Each observer duplicated his own work in opposite directions, handled his own instrument, and made the complete observation himself. The steel pins were used the entire year for rod supports. Unusual care was taken that the *sum of fore sights* was kept running equal to the *sum of back sights*, and that they were equal at close of stretch.

The Kern level tubes seem to be very smooth on their inner surfaces, and the liquid is very sensitive. The bubbles move with the greatest fluidity, but the tubes all seem to have spots where the bubble does not move proportionally to the turn of the elevating screw, but, refusing to move, will at an additional touch shoot ahead. This is, very likely, sometimes due to eccentricity, but many times it seems to be only due to the tubes not being ground truly. During this season the observers took unusual care to become more acquainted with these peculiarities. The results obtained are somewhat superior to those of any previons season, and are, I believe, the best on record.

The prescribed allowable limit of error between direct and reverse lines of the same set was, 3mm. $\sqrt{\text{twice the distance between B. Ms in km.}}$, and successive sets of lines were run until this limit was satisfied.

The character of ground passed over was very varions. During the rainy season a large part of the ground was too soft. In patches along the railroads the cinder ballast was troublesome. During dry weather in the roads dry sloughs and meadows, *dry cracked or broken up gumbo ground* had to be guarded against. Meadows, cornfields, and wheat fields furnish poor and slow ground to work on. There were about 70 miles of this kind of line and about 62 miles on country roads, the remainder being on railroads.

Local refraction, or a large change of refraction, while at one setting of the instrument, was a difficult thing to contend with. There is a large amount of this disturbance along the Missouri River, owing to the varying cool and warm, wet and dry areas of ground or masses of air coming from shaded or heated bluffs, from ravines, heated fields, or cool woods. Short observations and similarity between back and foresights were the means adopted to reduce these errors.

On October 31, 1892, work was completed to St. Charles. Old B. M. 17 and old T. B. M. 2, being in good condition, were connected with. Here I received your orders to continue to set benches and connect with old stone lines between this place and the mouth, a distance of 28 miles, in the same manner as we had done above St. Charles, by running from old B. Ms 8 and 11, connected with by precise levels of 1887, and any of the T. B. Ms of that year that were reliable.

Before dropping below St. Charles observations were made for all instrumental functions, the same as at the beginning of the season.

I finished the work to the mouth (B. M. ¼) on November 11. The winds by this date had begun to prevail, and most of the moving of quarter boat had to be done early in the morning or late in day. We reached St. Louis with the quarter boat, by hard pushing, at noon on November 12. Here Chief Assistant O. B. Wheeler met the party. We transferred the notebooks, office supplies, and instruments to the office of the secretary. Assistant A. L. Johnson reported for duty at the office, and began office work on the notes. Recorder W. S. Williams, who had succeeded F. B. Williams (resigned), was relieved. Recorder John P. Baker and myself proceeded with a reduced crew, contending with slow current and adverse winds, to lay the quarter boat up at Bushberg, turn the property over to the watchman, and receive receipt for the same. This was completed and party disbanded on November 17, 1892.

The notes were recorded with the fountain pen, in writing fluid, making very clean, clear, and permanent notes. This is far the most creditable way of keeping precise level records. After the notes were checked and computation of difference of elevation made out in manner as given in report of Mississippi River Commission for 1892, p. 2951, the result of every line run in the field was entered on a similar tabulation, containing, however, twenty-three instead of nineteen columns—two additional for "book" and "page," one for "month" and "day," and one for "a. m." or "p. m."

From this tabulation a profile, showing the same elements graphically, was made on profile paper to scale of 800 meters to an inch horizontally and 6 mm. to an inch vertically.

The greatest variation between the two independent direct and reverse lines was at a point 1 mile below Gasconade, where it was + and — 14.81 mm. At the end of the main line, at Charbonnier Point, it was — and + 2.70 mm.

The high degree of reliability of the results obtained by our system of precise leveling, in that they may be considered free from large errors, is one of the most commendable features of the system. This fact is evidenced by this season's work, as it has often been before, as the following considerations will show:

	Km.	Miles.
Length of main line completed	622.47 =	386.8
Length of side line completed	77.09 =	47.9
Total	699.56 =	434.7

There were in all 1,106 lines run on side line work; average length 141 meters. There were in all 1,162 lines run on main line work; average length of stretch 1,134 meters. A total of 2,268 lines were run from B. M. to B. M.; of these, one pair of lines varied one meter. This was discovered and located on the same day.

There were several errors made of reading a wire 100 mm. wrongly. The error was nearly always apparent on inspection, but no arbitrary corrections were made until definitely hunted down, located, and tested.

The greatest variation from good means of any of these 2,268 lines are one of 9.9 mm., one of 8.7 mm., one of 5.8 mm., and five lines varying 5 mm. from the means.

Degree of certainty of fulfilling the requirements of the limit, 3 mm. $\sqrt{2K}$. in the first set of lines; also showing the amount of line run.

Number of times line was run.	Length of line.	Total length of single line run.	Ten thousandths of the whole.
	Meters.	*Meters.*	
1	377	377	0.0003
2	662,425	1,324,850	0.9000
3	1,579	4,737	0.0032
4	34,494	137,976	0.0937
6	685	4,110	0.0028
Total	699,560	*1,472,050	1.0000

*914.7 miles.

Number of points whose elevation was determined during the season and given in tabulation, 1,101; total duration of organization of party, 246 days; from beginning to end of actual field work, March 24, to November 11, both inclusive, 233 days; excluding 33 Sundays on which no work was done, 200 days; length of single line run each day, 7,360 meters; length of single line run by each party, 3,680 meters, = 2.29 miles. The fieldwork is comprised in 72 precise-level notebooks of 60 double pages each.

Assistant A. L. Johnson contributed his full share to the success of the work.

By systematically feeling of the bubble by means of the elevating screw, just before reading, he gets a true reading, quite independent of the imperfections of the level tube, and thus is master of his work to a degree thought to be entirely impracticable by the average precise levelman. I wish also to state that this work was particularly favored in having three of the best recorders possible, F. B. Williams, John P. Baker, and W. S. Williams, all young college men, used to farm work, practical to the extent of climbing wire fences on very hot days encumbered with fountain pen, note-book, and leveling instrument. All were neat penmen. They were punctilious in getting down the observations as rapidly as called out by the observers and showed becoming anxiety that no mistakes should occur.

The rodmen were very faithful in the discharge of their duty, an essential element in precise level work. F. P. Marsh, foreman, a practical riverman and skillful workman, was of great usefulness in navigating the river. He is a good pilot of the Missouri River, though without the license. The party was in all departments quite satisfactory.

Office reduction of notes.—Following I present my report on office reduction of the above precise level work:

This has been done by myself, Assistant A. L. Johnson, and Recorder John P. Baker. Mr. Johnson began the work on November 13, myself and Mr. Baker on November 18, 1892. Mr. Baker resigned for other work on January 14, 1893. Since about the 22d of May Mr. Johnson has been engaged on other work.

In the work of making copies of final results, I have been assisted by Messrs. S. F. Crecelin, C. E. Taylor, J. W. Link, and L. Maury, at different times.

The field books were first indexed and labeled, then we checked and recomputed all observations for instrumental factors, both those taken at beginning and end of season.

A résumé of these results is as follows:

Recapitulation of instrumental values.

Value of one division of level tubes in seconds of angle=n.					Inequality of telescope rings.				
No. of tube.	Date of observation.	n.	Subtends 1 mm. at S.	Used by—	No. of telescope.	Date of observation.	Value of p.	Correction per m.	Used by—
		Seconds.	*M.*				*Seconds.*	*Mm.*	
5	Mar. 21	2.452	84.12	O. W. F.	4	Mar. 19	−6.5150	−.031585	O. W. F.
6	Mar. 21	2.185	94.40	A. L. J.	3	Mar. 19	+0.5397	+.002617	A. L. J.
5	Nov. 1	2.884	71.52	O. W. F.	4	Nov. 3	−9.7825	−.047427	O. W. F.
6	Nov. 1	3.196	64.54	A. L. J.	3	Nov. 3	−0.1982	−.000961	A. L. J.

Angular value of wire intervals.

No. of telescope.	Date of observation.	First interval.	Second interval.	Total interval.	Spread beyond (c. + f.) for 1m.	Used by—
		° ′ ″	° ′ ″	° ′ ″	*Mm.*	
4	Mar. 21	0 07 56.85	0 08 01.30	0 15 58.15	4.686222	O. W. F.
3	Mar. 21	0 08 30.00	0 08 55.65	0 17 25.65	5.124778	A. L. J.
4	Nov. 1	0 07 58.40	0 08 01.91	0 16 00.31	4.709778	O. W. F.
3	Nov. 1	0 08 30.94	0 08 55.64	0 17 25.59	5.129222	A. L. J.

Value of A of Rods X, XIII, XVIII, and XIX, Br. and Bl. of Rods X, XIII, XVII and XIX.

No. of rod.	Date of measurement.	From first graduation to spur.	A of rod.	Used by—	No. of rod.	Date of observation.	Br.	Bl.	Used by—
		Mm.	*Mm.*				*Mm.*	*Mm.*	
X..	Mar. 19	44.89	55.11	O. W. F.	X.......	Mar. 23	16.78	16.13	O. W. F.
XIII..	Mar. 19	44.86	55.14	O. W. F.	XIII...	Mar. 23	17.35	16.80	O. W. F.
XVIII..	Mar. 19	44.29	55.71	A. L. J.	XVIII..	Mar. 23	15.85	16.05	A. L. J.
XIX..	Mar. 19	44.37	55.63	A. L. J.	XIX....	Mar. 23	16.12	15.80	A. L. J.
X..	Nov. 3	45.00	55.00	O. W. F.					
XIII..	Nov. 3	44.95	55.01	O. W. F.					
XVIII..	Nov. 3	44.49	55.51	A. L. J.					
XIX..	Nov. 3	44.31	55.69	A. L. J.					

Standard length of 1 m. on rods used.

No. of rod.	Compared with standard Oct. 31, 1891.	Compared with standard Apr. 12, 1893.	Value used for season of 1892.
	M.	*M.*	*M.*
X....	Not taken.	1.000222	1.000200
XIII....	1.000135	1.000243	1.000162
XVIII....	1.000088	1.000221	1.000121
XIX....	1.000134	1.000148	1.000138
Mean..	....	....	1.000155

n = number of seconds in 1 division of tube.
S = distance at which horizontal wire moves over 1 mm. for a movement of bubble through 1 divis of tube.
p = one-half of the angle of cone enveloping the telescope rings.
(c+f) = distance from center of instrument to a point in front of object glass, where rays diverge
A = correction to rod reading to make the reading refer to point held on.
Br. and Bl. are the respective distances from right shoulder and left shoulder of iron shoe of rod the bottom of spur of rod.

The curvature of both tubes used was decidedly greater at the end of the seas than at the beginning, caused by the way they happened to bind and by jars ceived during the work. This is ordinarily a factor of very little consequen since nearly all of the readings are taken with end readings of bubble the same.

Material changes in this valve (n) of one division of tube is of common occurrence during a season's work; it further shows the superiority of the method of reading bubble at center rather than at any other point, and attempting to apply its value to half the difference of end readings. The value of wire interval showed but little change.

From the mean of the means of these values at the beginning and end of the season with the values at the beginning and end, two sets of tables were constructed, to facilitate the office computation, one for the first half of the season, to July 10, 1892, and the other for the remainder of the season. These were:

(1) A table giving correction in millimeters per meter for any mean difference in end readings of bubble, inclination;

(2) Table giving the correction in millimeters per meter for collimation, from the difference between normal and inverted readings through telescope, and distance between rod and instrument, devised by Mr. Johnson;

(3) Table giving the distance in meters for any given total summation of intervals of stretch and the average length of shot. This gives the distance very quickly and a good deal more accurately than the process of looking out each shot to the nearest meter. Both this table and (2) are something entirely new on our precise level work;

(4) Table giving the length of shot in metres for any given total interval;

(5) Table converting meters into feet and *vice versa*. Also the quantities S, *p*, A, Br. and Bl. were taken out for these two periods.

All observations for collimation and inclination, taken at the end of each day's work, were checked and reduced, and corresponding corrections in millimeters per meter taken out. The algebraic sum of these two corrections and the correction for inequality of telescope rings in millimeters per meter, were then gotten for each instrument for each day, to be applied to excess of backsights over foresights or *vice versa*.

Checked all quantities and deduced quantities in and from observations, and all means and summations in the seventy-two field books.

Then the difference of elevation from B. M. to B. M., with sign, was recomputed, by taking all quantities from the field books and transcribing them on computation sheets, printed and divided expressly for this purpose; giving all information concerning date, location, and deduction, by filling out the headings and columns. As this work was finished, stretch by stretch, it was compared with the field reduction, and the cause of all variations from this, in sign and amount, located.

Beginning at P. B. M. $\frac{6}{2}$, with its old elevation, 124.10796 meters=407.182 feet, these final results were entered on a new tabulation on sheets designed for this purpose.

The preface sheet gives an explanation of the contents of each column in this tabulation, following this report. These deductions were regularly compared with the field tabulation, and were subsequently rigidly checked, at great labor; depending, as they do mainly, on each other, as links in a chain: if an error is made in one, all are wrong.

The largest error in the field reduction was one of 10 mm., in computation, in the reverse line from U. S. Coast Survey, XV at Berger to T. B. M. 127, a stretch of 1677 meters. The field reduction gave these residuals as $\pm$ 1.50 mm. A sum of residuals of 5.5 mm. is the limit for this distance, but having discovered the 10. mm. it now stands $\mp$ 3.50 mm., 1.5 mm. beyond the limit. It is the only line in the system that is beyond the limit, and gives a probable error, in mean determination of $r = \pm 2.33$ mm.

The 100 km. comprising this stretch gives the greatest probable error per km., due to this error. If it had remained at 3.0 mm., "x" would have been $\pm$ 0.58 mm. per km. over this 100 km's, instead of $\pm$ 0.62 mm. per km. as it now stands; one error of 2 millimeters and several of 1 millimeter, and a good many affecting the tenths of millimeters, were discovered; but they compensated to such an extent that on P. B. M. 12=old B. M. 17, at St. Charles, the office reduction made the elevation only 2.5 mm. different, higher than the field computation. In this final reduction the greatest divergence between the independent direct and reverse lines from the mean line is $\pm$ 16.03 mm., or 32.06 mm., which is at Gasconade.

STANDARD LENGTH OF METER ON PRECISE LEVELING RODS.

X, XIII, XVIII and XIX.—Comparison with the 3-meter space on 15-foot Lake Survey bar, in the office of the Mississippi River Commission, on October 31, 1891, (see Report of Mississippi River Commission for 1892, p. 2955), were taken. (See Recapitulation of Instrumental Values.) The legend on this bar states that its length is 179.993 inches, at 32° F., and that it expands 0.00114 inch for each degree. Therefore it is standard at 69.7° F., and its coefficient of expansion is 0.0000063.

On April 12, 1893, by aid of magnifying glasses, hair spring dividers, and a standard thermometer, eight observations were made of the lengths of all of these rods;

four with the rod direct, and four with the rod reversed. (See Recapitulation of Instrumental Values.)

In April, 1893, the rods all proved longer than on October 31, 1891, for the reason, I presume, that they had just returned from a wet field season of the winter of 1893.

As the rods were used during the spring, summer, and fall of 1892, all through the dry season, the measurements of October, 1891, are given three weights, and those of April 12, 1893, one weight, in determining the lengths to ascribe to XIII, XVIII and XIX. Rod X is placed at 1.000200 meters.

All rods being equally concerned in the season's work, the meter used is the mean value = 1.000155 meters.

The "rod correction" is computed from this function, to correct elevations to expressions in the standard meter = 3.2808693 feet.

Connection at St. Charles with precise levels of 1887.—There are two bench marks in common, P. B. M. 12 = Old B. M. 17 and T. B. M. 20 = Old T. B. M. 2.

		Meters.
The elevation of P. B. M. 12 as found by precise levels of 1887		9.20740
The elevation of this brought from St. Joseph	9.26920	
Rod correction for this elevation	—0.01781	
Corrected elevation		9.25139
Constant correction as per P. B. M. 12		—0.04399
The elevation of T. B. M. 20 as found by precise levels of 1887		8.7260
The elevation of this brought from St. Joseph	8.78245	
Rod correction for this elevation	—0.01788	
Corrected elevation		8.76457
Constant correction as per T. B. M. 20		—0.03857

P. B. M. 12 is a copper bolt leaded horizontally in land pier of St. Charles Bridge.

T. B. M. 20 is a nail in root of elm tree standing on edge of bank.

The above connections show that, since 1887, P. B. M. 12 and T. B. M. 20 have changed their relative elevation 5.42 mm., by P. B. M. 12 rising or T. B. M. 20 settling, or both.

It is thought that quite probably T. B. M. 20 settled somewhat, as the roots have since become exposed; but it is not thought that P. B. M. 12 is any higher.

Therefore, in the reduction, to correct St. Louis City Directrix, P. B. M. 12 is taken to be correct at 9.20740 meters, and after the rod correction was applied, the constant 0.04399 was subtracted from all elevations computed from the starting point, P. B. M. 290 = $\frac{3}{2}^0$.

In the total of 2,268 stretches, only nine lines, considered erratic, were rejected; these are given in the tabulation, followed by the (†) dagger.

The probable error in the final elevation of P. B. M. 16 = $\frac{0}{1}$, carried from P. B. M. 290 = $\frac{3}{2}^0$ (or *vice versa*), as computed through the probable error of each stretch, is the 622.484 km. intervening = ± 14.4 mm.

The probable error x in each kilometer of the whole line = ± 0.58 mm.

Probable error x in each kilometer of—

	mm.
First 50 km	± 0.58
First 100 km	± 0.56
Second 100 km	± 0.56
Third 100 km	± 0.54
Fourth 100 km	± 0.59
Fifth 100 km	± 0.63
Remaining 22.5 km	± 0.54

Showing that the work is all of about the same degree of precision.

Description of bench marks.—In making out the list of descriptions of bench marks, all U. S. Coast and Geodetic Survey P. B. Ms are only given with their own numbering, all others are classed under one of the two heads, P. B. Ms and T. B. Ms, and are numbered from the mouth of river up. Whenever the B. M. described was an old B. M., this was mentioned, and, if it had an old number, this was also given immediately after its new number.

We wrote the descriptions from data in note books of 432 T. B. Ms, 312 P. B. Ms, 180 Top of Cap P. B. Ms, 22 U. S. Coast and Geodetic Survey P. B. Ms, 8 City B. Ms, and 12 gauges; total in list, 966, with elevations given both in meters and feet. The work between Sioux City and St. Joseph has been under my supervision since Assistant J. A. Paige left the work, early in January last, with a view to obtaining similarity of presentation. The mean elevations of B. Ms common to the two lines in the vicinity of U. S. Boat-yard and St. Joseph waterworks, as carried from St. Charles, were taken up in this work and continued to the Big Sioux River.

Also the numbering of P. B. Ms and T. B. Ms was taken up and continued to the same place.

Similarity has been secured in the tabulation, with the exception that, as was Mr. Paige's habit in the field work, the letters "N" and "S" are used to denote the direction of the line instead of "direct and reverse." Also no lines in his tabulation are marked as rejected, since all erratic lines, as shown by the preliminary field computation, not being considered worthy of equal weight with others, were not reduced, but left in the note books, not appearing in either the field or office tabulation. Assistant O. H. B. Turner and Mr. S. F. Crecelius have been charged with the completion of this work.

In my office reduction, I have not only been efficiently aided by Assistant A. L. Johnson, but have been able to obtain and present results in better form through his thought and care.

Respectfully submitted,

O. W. Ferguson,
Assistant Engineer.

1st Lieut. J. C. Sanford,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

TABULATION OF PRECISE LEVEL RESULTS, ST. JOSEPH, MO., TO THE MOUTH OF MISSOURI RIVER, 1892.

The following tabulation of results of final reduction furnishes the data for determining the elevation and for discussing the results of the work.

Bench marks marked with an asterisk (*) are not in the main line of levels.

This tabulation proceeds in the direction that the work did, down the river, though the numbering and order of the list of descriptions of bench marks following this tabulation are made to proceed from the mouth up.

Column 1 gives the number and character of the bench sought and the names of towns and cities passed through.

Column 2 gives the number and character of the bench mark from which the bench mark in column 1 was determined.

Column 3 gives the length of single line run between the benches in the two preceding columns.

Column 4 gives the total length of single line run from the initial point to each bench.

Column 5 gives the direction the work proceeded in each line run. If proceeding from a point whose elevation in the chain had previously been determined to an additional point to the chain, it is called Dir. = direct; if in opposite direction, Rev. = reverse.

Column 6 gives the difference in elevation determined by each run and its sign, + indicating that the forward bench is the higher, — that the forward bench is lower. The dagger (†) indicates that the line was rejected.

Column 7 gives the residuals or the correction for each line to bring it to the mean.

Columns 8 and 9 give the continuous algebraic summation of the residuals, and shows at every bench the amount that the two independent (direct and reverse) lines diverge from the mean.

Column 10 gives the probable error of the mean determined for each stretch, computed from the formula $r = 0.6745\sqrt{\frac{\Sigma\,r^2}{m\,(m-1)}}$

Column 11 gives the probable error of the mean final result computed from the intitial point. It is $R = \sqrt{\Sigma r^2}$

Column 12 gives the — rod correction to apply to the elevation to correct meter on rods used to standard.

Columns 13 and 14 give the final elevations in meters and feet above St. Louis City directrix with all corrections applied. Value of meter, = 3.2808693 feet.

Column 15 gives the elevation of old bench marks as previously determined by common level.

Colnmn 16 gives the amount of the discrepancy between these elevations and the precise elevations.

Column 17 gives the observer: F. = O. W. Ferguson, J. = A. L. Johnson, B. = J. P. Baker, and W. = F. B. Williams.

P. B. M. = a permanent precise bench mark. T. B. M. = a temporary precise bench mark, that in many cases is quite permanent.

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
P. B. M. 290 =$\frac{80}{3}$			.00						0.0	0.0	0.0	124.06397	407.038	407.182	+0.144	
P. B. M. 289	P. B. M. 290=$\frac{80}{3}$	316	.316	Dir	+ 948.9	+0.05	+0.05	—0.05	0.03	0.0	+0.15	125.01107	410.145			F.
				Rev	+ 949.0	—0.05										
				Mean.	+ 948.95											
* Cap over P. B. M. 290	P. B. M. 289	316	.000	Dir	+ 240.6	—0.15	—0.10	+0.10	0.10	0.1	+0.18	125.25155	410.934			F.
				Rev	+ 240.3	+0.15										
				Mean.	+ 240.45											
T. B. M. 589	P. B. M. 289	1,606	1.922	Dir	— 989.0	+2.50	+2.55	—2.55	1.67	1.7	0.00	124.02442	406.908			F.
				Rev	— 984.0	—2.50										
				Mean.	— 986.50											
* P. B. M. 288	T. B. M. 589	42	1.964	Dir	—2,286.5	—0.10	+2.45	—2.45	0.07	1.7	—0.36	121.73746	399.405			F.
				Rev	—2,286.7	+0.10										
				Mean.	—2,286.60											
* Cap over P. B. M. 288	T. B. M. 589	42	1.964	Dir	—1,053.5	+0.05	+2.60	—2.60	0.03	1.7	—0.17	122.97080	403.451			F.
				Rev	—1,053.4	—0.05										
				Mean.	—1,053.45											
* T. B. M. 588	T. B. M. 589	1,078	3.000	1 Dir.	— 863.7	—0.32	+3.07	—3.07	0.32	1.7	—0.14	123.16026	404.073			J.
				1 Rev.	— 863.2	—0.82										
				2 Dir.	— 865.4	+1.38										
				2 Rev.	— 863.8	—0.22										
				Mean.	— 864.02											
* P. B. M. 287=89½. U. S. Boat Yard.	T. B. M. 588	904	3.994	Dir	— 84.8	—1.95	+1.12	—1.12	1.30	2.1	—0.16	123.07349	403.788	403.900	+0.112	F.
				Rev	— 88.7	+1.95										
				Mean.	— 86.75											

*Cap over P. B. M. 287	P. B. M. 287	75	3.994	Dir	+ 1,220.3	+0.15	+1.27	−1.27	0.10	2.1	+0.03	124.29413	407.793			F.
				Rev	+ 1,220.6	−0.15										
				Mean	+ 1,220.45											
T. B. M. 587	T. B. M. 589	1,262	3.184	1 Dir	+ 403.4†	+9.93	+2.65	−2.65	0.62	1.8	+0.06	124.43781	408.264			J.
				1 Rev	+ 411.8	+1.53										
				2 Dir	+ 413.2	+0.13										
				2 Rev	+ 415.0	−1.67										
				Mean	+ 413.33											
T. B. M. 586	T. B. M. 587	1,802	4.986	Dir	+ 2,067.8	−2.50	+0.15	−0.15	1.67	2.4	+0.37	126.50342	415.041			J.
				Rev	+ 2,062.8	+2.50										
				Mean	+ 2,065.30											
*T. B. M. 585 City B. M.	T. B. M. 586	224	5.210	Dir	+ 2,760.1	−0.45	−0.30	+0.30	0.30	2.4	+0.81	129.26351	424.097			F.
				Rev	+ 2,759.2	+0.45										
				Mean	+ 2,759.65											
St. Joseph Datum	T. B. M. 585				−ft. 23.832								400.265			
*P. B. M. 286	T. B. M. 585	19	5.229	Dir	+ 1,243.6	−0.10	−0.40	+0.40	0.07	2.4	+1.01	130.50721	428.177			F.
				Rev	+ 1,243.4	+0.10										
				Mean	+ 1,243.50											
*P. B. M. 285 St. Joseph	T. B. M. 585	724	5.934	Dir	+11,346.6	+1.30	+1.00	−1.00	0.86	2.6	+2.57	140.61317	461.333			F.
				Rev	+11,349.2	−1.30										
				Mean	+11,347.90											
T. B. M. 584	T. B. M. 586	1,594	6.580	Dir	+ 421.1	−1.40	−1.25	+1.25	0.93	2.6	+0.45	126.92320	416.418			F.
				Rev	+ 418.3	+1.40										
				Mean	+ 419.70											
*P. B. M. 284	T. B. M. 584	8	6.588	Dir	+ 886.3	−0.05	−1.30	+1.30	0.03	2.6	+0.58	127.80958	419.326			J.
				Rev	+ 886.2	+0.05										
				Mean	+ 886.25											
T. B. M. 581	T. B. M. 584	566	7.146	Dir	− 1,447.2	+0.35	−0.90	+0.90	0.23	2.6	+0.22	125.47612	411.671			F.
				Rev	− 1,446.5	−0.35										
				Mean	− 1,446.85											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 283=$^{82}_{3}$	T. B. M. 581	142	7.288	Dir	−1,444.2	+0.35	−0.55	+0.55	0.23	2.6	0.00	124.03205	406.933	407.035	+0.102	J.
				Rev	−1,443.5	−0.35										
				Mean	−1,443.85											
*Cap over P. B. M. 283	T. B. M. 581	142	7.288	Dir	−218.3	+0.20	−0.70	+0.70	0.13	2.6	+0.19	125.25799	410.955	....	....	J.
				Rev	−217.9	−0.20										
				Mean	−218.10											
*T. B. M. 583=Old B. M. 312	T. B. M. 581	313	7.459	Dir	−599.3	+0.80	−0.10	+0.10	0.53	2.7	+0.12	124.87752	409.707	409.844	+0.137	J.
				Rev	−597.7	−0.80										
				Mean	−598.50											
*T. B. M. 582=Old B. M. 313.	T. B. M. 583=Old B. M. 312.	110	7.569	Dir	+220.5	+0.20	−0.10	+0.10	0.13	2.7	+0.16	125.09826	410.431	410.590	+0.159	J.
				Rev	+220.9	−0.20										
				Mean	+220.70											
*Zero gauge	T. B. M. 583=Old B. M. 312.	142	7.601	Dir	−124,952.5	+0.30	+0.20	−0.20	0.20	2.7	+0.10	−0.07470	−0.245	000.000	+0.245	J.
				Rev	−124,951.9	−0.30										
				Mean	−124,952.20											
*P. B. M. 282	T. B. M. 583=Old B. M. 312.	109	7.568	Dir	−750.5	−0.15	−0.25	+0.25	0.10	2.7	+0.02	124.12677	407.244	....	....	J.
				Rev	−750.8	+0.15										
				Mean	−750.65											
T. B. M. 580	T. B. M. 581	1,228	8.374	Dir	+496.2	−0.45	−1.35	+1.35	0.30	2.6	+0.30	125.97195	413.297	....	....	J.
				Rev	+495.3	+0.45										
				Mean	+495.75											
T. B. M. 579	T. B. M. 580	2,324	10.698	Dir	−1,503.6	+0.10	−1.25	+1.25	0.07	2.6	+0.06	124.46821	408.364	....	....	F.
				Rev	−1,503.4	−0.10										
				Mean	−1,503.50											

*P. B. M. 281 St. George	T. B. M. 579	190	10.888	Dir ... Rev ..	+ 864.4 + 865.6	+0.60 —0.60	—0.65	+0.65	0.40	2.7	+0.21	125.33336	411.202	....	....	J.
				Mean .	+ 865.00											
*Cap over 281	T. B. M. 579	190	10.888	Dir ... Rev ..	+2,098.8 +2,099.9	+0.55 —0.55	—0.70	+0.70	0.37	2.7	+0.039	126.56789	415.253	....	....	J.
				Mean .	+2,099.35											
T. B. M. 578	T. B. M. 579	1,169	11.807	1 Dir . 1 Rev. 2 Dir . 2 Rev.	—1,332.9 —1,338.7† —1,334.8 —1,333.2	—0.73 +5.07 +1.17 —0.43	—0.93	+0.92	0.40	2.7	—0.14	123.13438	403.988	....	....	J.
				Mean .	—1,333.63											
T. B. M. 577	T. B. M. 578	1,236	13.103	1 Dir . 1 Rev. 2 Dir . 2 Rev.	+1,868.3† +1,874.7 +1,875.8 +1,871.9	+5.83 —0.57 —1.67 +2.23	—2.17	+2.17	0.77	2.8	+0.16	125.00881	410.138	....	....	W. & F.
				Mean .	+1,874.13											
T. B. M. 576	T. B. M. 577	1,527	14.650	Dir ... Rev ..	—2,340.4 —2,341.6	—0.60 +0.60	—2.77	+2.77	0.40	2.8	—0.22	122.66743	402.456	....	....	F.
				Mean .	—2,341.00											
*T. B. M. 575	T. B. M. 576	724	15.354	Dir ... Rev ..	+2,430.3 +2,428.5	—0.90 +0.90	—3.67	+3.67	0.60	2.9	+0.16	125.09721	410.428	....	....	F.
				Mean .	+2,429.40											
*P. B. M. 280=$\frac{8^{2}}{2}$	T. B. M. 575	111	15.465	Dir ... Rev ..	+ 490.6 + 490.6	0.00 0.00	—3.67	+3.67	0.00	2.9	+0.24	125.58789	412.037	412.086	+0.049	F.
				Mean .	+ 490.60											
*Cap over 280	T. B. M. 575	111	15.465	Dir ... Rev ..	+1,716.9 +1,716.5	—0.20 +0.20	—3.87	+3.87	0.13	2.9	+0.44	126.81419	416.061	....	....	F.
				Mean .	+1,716.70											
T. B. M. 574	T. B. M. 576	2,154	16.784	Dir ... Rev ..	—1,734.2 —1,731.9	+1.15 —1.15	—1.62	+1.62	0.77	2.9	—0.48	120.93412	396.769	....	....	F.
				Mean .	—1,733.05											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	r. ∓	R. ∓	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 573	T. B. M. 574	613	17.397	Dir ...	— 216.9	—1.30	—2.92	+2.92	0.87	3.0	—0.52	120.71588	396.053	....	....	W.
				Rev ...	— 219.5	+1.30										
				Mean .	— 218.20											
*P. B. M. 279	T. B. M. 573	23	17.420	Dir ...	—1,167.3	—0.15	—3.07	+3.07	0.10	3.0	—0.70	119.54825	392.222	....	....	J.
				Rev ...	—1,167.6	+0.15										
				Mean .	—1,167.45											
*Cap over 279..........	T. B. M. 573	23	17.420	Dir ...	+ 74.9	0.00	—2.92	+2.92	0.00	3.0	—0.52	120.79078	396.299	....	....	J.
				Rev ...	+ 74.9	0.00										
				Mean .	+ 74.90											
T. B. M. 572	T. B. M. 573	1,146	18.543	Dir ...	— 244.7	+2.00	—0.92	+0.92	1.33	3.3	—0.56	120.47314	395.257	....	....	J.
				Rev ...	— 240.7	—2.00										
				Mean .	— 242.70											
T. B. M. 571	T. B. M. 572	769	19.312	Dir ...	+ 176.5	+0.80	—0.12	+0.12	0.53	3.4	—0.53	120.65047	395.838	....	....	J.
				Rev ...	+ 178.1	—0.80										
				Mean .	+ 177.30											
T. B. M. 570	T. B. M. 571	1,927	21.239	Dir ...	—1,143.6	+1.70	+1.58	—1.58	1.13	3.6	—0.70	119.50840	392.091	....	....	J.
				Rev ...	—1,140.2	—1.70										
				Mean .	—1,141.90											
T. B. M. 568	T. B. M. 570	808	22.047	Dir ...	+ 27.1	—0.85	+0.73	—0.73	0.57	3.6	—0.70	119.53465	392.173	....	....	J.
				Rev ...	+ 25.4	+0.85										
				Mean .	+ 26.25											

*T. B. M. 569	T. B. M. 568	936	22.983	Dir	+4,326.6	+0.80	+1.53	−1.53	0.58	3.7	−0.03	123.86272	406.877	....	....	J.
				Rev	+4,328.2	−0.80										
				Mean	+4,327.40											
*P. B. M. 278 = 4½ Kenmoor.	T. B. M. 569	73	23.056	Dir	− 518.7	−0.15	+1.38	−1.38	0.10	3.7	−0.11	123.34379	404.675	404.750	+0.075	J.
				Rev	− 519.0	+0.15										
				Mean	− 518.85											
*Cap over 278	T. B. M. 569	73	23.056	Dir	+ 709.8	0.00	+1.53	−1.53	0.00	3.7	−0.08	124.57247	408.706	....	....	J.
				Rev	+ 709.8	0.00										
				Mean	+ 709.80											
T. B. M. 567	T. B. M. 568	772	22.819	Dir	− 246.7	+0.55	+1.28	−1.28	0.37	3.6	−0.75	119.28845	391.370	....	....	J.
				Rev	− 245.6	−0.55										
				Mean	− 246.15											
T. B. M. 566	T. B. M. 567	1,701	24.529	Dir	− 603.7	+0.90	+2.18	−2.18	0.60	3.7	−0.84	118.68556	389.393	....	....	F.
				Rev	− 601.9	−0.90										
				Mean	− 602.80											
*P. B. M. 277 Halls.	T. B. M. 566	52	24.572	Dir	−1,351.2	−0.20	+1.98	−1.98	0.13	3.7	−1.03	117.33397	384.958	....	....	B.
				Rev	−1,351.6	+0.20										
				Mean	−1,351.40											
*Cap over 277	T. B. M. 566	52	24.572	Dir	− 114.3	−0.05	+2.13	−2.13	0.03	3.7	−0.86	118.57119	389.016	....	....	B.
				Rev	− 114.4	+0.05										
				Mean	− 114.35											
T. B. M. 565	T. B. M. 566	1,531	26.051	Dir	−1,267.3	+0.50	+2.68	−2.68	0.33	3.7	−1.02	117.41858	385.235	....	....	F.
				Rev	−1,266.3	−0.50										
				Mean	−1,266.80											
T. B. M. 564	T. B. M. 565	910	26.961	Dir	− 190.0	−1.25	+1.43	−1.43	0.83	3.8	−1.05	117.22730	384.608	....	....	F.
				Rev	− 192.5	+1.25										
				Mean	− 191.25											
T. B. M. 563	T. B. M. 564	787	27.748	Dir	− 176.9	−1.30	+0.13	−0.13	0.87	3.8	−1.08	117.04907	384.023	....	....	F.
				Rev	− 179.5	+1.30										
				Mean	− 178.20											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	r. ∓	R. ∓	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 573	T. B. M. 574	613	17.397	Dir	− 216.9	−1.30	−2.92	+2.92	0.87	3.0	−0.52	120.71588	396.053	....	....	W.
				Rev	− 219.5	+1.30										
				Mean	− 218.20											
*P. B. M. 279	T. B. M. 573	23	17.420	Dir	−1,167.3	−0.15	−3.07	+3.07	0.10	3.0	−0.70	119.54825	392.222	....	....	J.
				Rev	−1,167.6	+0.15										
				Mean	−1,167.45											
*Cap over 279	T. B. M. 573	23	17.420	Dir	+ 74.9	0.00	−2.92	+2.92	0.00	3.0	−0.52	120.79078	396.299	....	....	J.
				Rev	+ 74.9	0.00										
				Mean	+ 74.90											
T. B. M. 572	T. B. M. 573	1,146	18.543	Dir	− 244.7	+2.00	−0.92	+0.92	1.33	3.3	−0.56	120.47314	395.257	....	....	J.
				Rev	− 240.7	−2.00										
				Mean	− 242.70											
T. B. M. 571	T. B. M. 572	769	19.312	Dir	+ 176.5	+0.80	−0.12	+0.12	0.53	3.4	−0.53	120.65047	395.838	....	....	J.
				Rev	+ 178.1	−0.80										
				Mean	+ 177.30											
T. B. M. 570	T. B. M. 571	1,927	21.239	Dir	−1,143.6	+1.70	+1.58	−1.58	1.13	3.6	−0.70	119.50840	392.091	....	....	J.
				Rev	−1,140.2	−1.70										
				Mean	−1,141.90											
T. B. M. 568	T. B. M. 570	808	22.047	Dir	+ 27.1	−0.85	+0.73	−0.73	0.57	3.6	−0.70	119.53465	392.173	....	....	J.
				Rev	+ 25.4	+0.85										
				Mean	+ 26.25											

*T. B. M. 558	T. B. M. 557	383	33.174	Dir	− 34.0	+0.60	+0.88	−0.88	0.40	4.0	−0.83	118.74085	389.603	....	....	J.
				Rev	− 33.7	−0.60										
				Mean	− 34.30											
*P. B. M. 275=[illegible] Rushville.	T. B. M. 558	20	33.104	Dir	+1,094.5	+0.20	+1.08	−1.08	0.13	4.0	−0.65	119.84473	393.195	393.254	+0.059	J.
				Rev	+1,094.9	−0.20										
				Mean	+1,094.70											
*Cap over 275	T. B. M. 558	20	33.104	Dir	+2,323.8	0.00	+0.88	−0.88	0.00	4.0	−0.47	121.07401	397.228	....	....	J.
				Rev	+2,323.8	0.00										
				Mean	+2,323.80											
T. B. M. 556	T. B. M. 557	1,482	34.273	Dir	−4,472.5	−0.35	−0.07	+0.07	0.28	4.0	−1.51	114.31062	375.038	....	....	F.
				Rev	−4,473.2	+0.35										
				Mean	−4,472.85											
T. B. M. 555	T. B. M. 556	1,996	36.269	Dir	+1,330.5	−0.90	−0.97	+0.97	0.60	4.0	−1.30	115.64043	379.401	....	....	F.
				Rev	+1,328.7	+0.90										
				Mean	+1,329.60											
*P. B. M. 274	T. B. M. 555	34	36.303	Dir	−1,323.1	+0.15	−0.82	+0.82	0.10	4.0	−1.50	114.31728	375.060	....	....	F.
				Rev	−1,322.8	−0.15										
				Mean	−1,322.95											
*Cap over 274	T. B. M. 555	34	36.303	Dir	−91.5	+0.15	−0.82	+0.82	0.10	4.0	−1.33	115.54905	379.101	....	....	F.
				Rev	−91.2	−0.15										
				Mean	−91.35											
T. B. M. 554	T. B. M. 555	684	36.953	Dir	−1,352.3	−1.10	−2.07	+2.07	0.73	4.1	−1.53	114.28680	374.960	....	....	F.
				Rev	−1,354.5	+1.10										
				Mean	−1,353.40											
T. B. M. 552 Winthrop.	T. B. M. 554	1,846	38.799	Dir	−261.2	−1.10	−3.17	+3.17	0.73	4.2	−1.55	114.02448	374.090	....	....	F.
				Rev	−263.4	+1.10										
				Mean	−262.30											
*T. B. M. 553	T. B. M. 552	1,256	40.055	Dir	−101.1	−2.05	−5.22	+5.22	1.37	4.4	−1.57	113.92131	373.701	....	....	J.
				Rev	−105.2	+2.05										
				Mean	−103.15											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r. ∓	R. ∓	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 562	T. B. M. 563	508	28.256	Dir ...	+ 397.9	—0.95	—0.82	+0.82	0.63	3.9	—1.03	117.44607	385.325	....	....	F.
				Rev ..	+ 396.0	+0.95										
				Mean.	+ 396.95											
*P. B. M. 276=¾	T. B. M. 562	28	28.284	Dir ...	+2,293.4	+0.30	—0.52	+0.52	0.20	3.9	—0.67	119.74013	392.852	392.957	+0.105	F.
				Rev ..	+2,294.0	—0.30										
				Mean.	+2,293.70											
*Cap over 276..........	T. B. M. 562	28	28.284	Dir ...	+3,525.4	0.00	—0.82	+0.82	0.00	3.9	—0.48	120.97202	396.893	....	....	F.
				Rev ..	+3,525.4	0.00										
				Mean.	+3,525.40											
T. B. M. 561	T. B. M. 562	1,222	29.478	Dir ...	— 231.0	+0.05	—0.77	+0.77	0.03	3.9	—1.05	117.21510	384.567	....	....	F.
				Rev ..	— 230.9	—0.05										
				Mean.	— 230.95											
T. B. M. 560	T. B. M. 561	864	30.342	1 Dir..	+1,907.9†	+4.73	—0.82	+0.82	0.27	3.9	—0.77	119.12801	390.843	....	....	J.
				1 Rev.	+1,913.3	—0.67										
				2 Dir..	+1,912.7	—0.07										
				2 Rev.	+1,911.9	+0.73										
				Mean.	+1,912.63											
T. B. M. 559	T. B. M. 560	999	31.341	Dir ...	—3,021.2	0.00	—0.82	+0.82	0.00	3.9	—1.23	116.10635	380.930	....	....	J.
				Rev ..	—3,021.2	0.00										
				Mean.	—3,021.20											
T. B. M. 557	T. B. M. 559	1,450	32.791	Dir ...	+2,676.3	+1.10	+0.28	—0.28	0.73	4.0	—0.83	118.78415	389.715	....	....	J.
				Rev ..	+2,678.5	—1.10										
				Mean.	+2,677.40											

				Mean .	+900.20											
*Atchison Datum	T. B. M. 548	.....	.....	.....	—ft. 41.59	.....	.....	.....	.....	.....	.....	.....	346.597	.....	.....	
*T. B. M. 549	T. B. M. 548	490	41.505	Dir ...	+10,757.1	—0.35	—3.50	+3.50	0.23	4.3	+0.77	129.07677	423.484	.....	.....	J.
				Rev ..	+10,756.4	+0.35										
				Mean .	+10,756.75											
*P. B. M. 270	T. B. M. 549	20	41.525	Dir ...	+740.78	—0.02	—3.52	+3.52	0.01	4.3	+0.90	129.81766	425.915	.....	.....	J.
				Rev ..	+740.73	+0.02										
				Mean .	+740.76											
T. B. M. 547	P. B. M. 271	558	41.301	Dir ...	+1,761.7	+0.10	—2.85	+2.85	0.07	4.3	—0.77	119.18008	391.014	.....	.....	F.
				Rev...	+1,761.9	—0.10										
				Mean .	+1,761.80											
*P. B. M. 269 = ²⁴⁄₁	T. B. M. 547	15	41.316	Dir ...	—1,860.9	+0.05	—2.80	+2.80	0.03	4.3	—1.04	117.31896	384.908	385.052	+0.144	F.
				Rev...	—1,860.8	—0.05										
				Mean .	—1,860.85											
* Cap over 269	T. B. M. 547	15	41.316	Dir ...	—635.0	—0.10	—2.90	+2.90	0.07	4.3	—0.86	118.54489	388.930	.....	.....	F.
				Rev...	—635.2	+0.10										
				Mean .	—635.10											
T. B. M. 546	T. B. M. 547	848	42.149	Dir ...	—5,439.2	—0.05	—2.90	+2.90	0.03	4.4	—1.60	113.74000	373.166	.....	.....	F.
				Rev...	—5,439.3	+0.05										
				Mean .	—5,439.25											
T. B. M. 545	T. B. M. 546	1,552	43.701	Dir ...	+705.0	+2.35	—0.55	+0.55	1.57	4.5	—1.49	114.44746	375.487	.....	.....	F.
				Rev...	+709.7	—2.35										
				Mean .	+707.35											
P. B. M. 268 = Old B. M. 287.	T. B. M. 545	534	44.235	Dir ...	+3,125.2	+0.85	+0.30	—0.30	0.57	4.5	—1.02	117.57398	385.745	385.836	+0.091	F.
				Rev...	+3,126.9	—0.85										
				Mean .	+3,126.05											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 544	P. B. M. 268	1,221	45.456	Dir	−2,476.2	−0.50	−0.20	+0.20	0.33	4.6	−1.39	115.09691	377.618			F.
				Rev	−2,477.2	+0.50										
				Mean	−2,476.70											
T. B. M. 543	T. B. M. 544	394	45.850	Dir	−256.7	−0.30	−0.50	+0.50	0.20	4.6	−1.43	114.83987	376.775			J.
				Rev	−257.3	+0.30										
				Mean	−257.00											
*P. B. M. 267	T. B. M. 543	18	45.868	Dir	+1,814.9	0.00	−0.50	+0.50	0.00	4.6	−1.15	116.65505	382.730			J.
				Rev	+1,814.9	0.00										
				Mean	+1,814.90											
* Cap over 267	T. B. M. 543	36	45.868	Dir	+3,053.0	−0.20	−0.70	+0.70	0.13	4.6	−0.97	117.89313	386.792			J.
				Rev	+3,052.6	+0.20										
				Mean	+3,052.80											
T. B. M. 542	T. B. M. 543	1,659	47.509	Dir	−652.7	+1.45	+0.95	−0.95	0.97	4.7	−1.54	114.18851	374.638			J.
				Rev	−649.8	−1.45										
				Mean	−651.25											
T. B. M. 541	T. B. M. 542	2,168	49.677	Dir	+341.2	+0.75	+1.70	−1.70	0.50	4.7	−1.47	114.53053	375.760			F.
				Rev	+342.7	−0.75										
				Mean	+341.95											
*P. B. M. 266 = $\frac{53}{1}$ Walnut Creek.	T. B. M. 541	11	49.688	Dir	−1,396.8	+0.20	+1.90	−1.90	0.13	4.7	−1.69	113.13371	371.177	371.429	+0.252	F.
				Rev	−1,396.4	−0.20										
				Mean	−1,396.60											
*Cap over 266	T. B. M. 541	11	49.688	Dir	−169.8	0.00	+1.70	−1.70	0.00	4.70	−1.52	114.36068	375.202			F.
				Rev	−169.8	0.00										
				Mean	−169.80											

				Mean .	—1,038.60											
T. B. M. 539 = old B. M. (no name.)	T. B. M. 540	487	52.814	Dir ...	—1,039.8	—0.25	+1.85	—1.85	0.17	4.7	—1.80	112.45205	368.941	....	....	J.
				Rev...	—1,039.8	+0.25										
				Mean .	—1,039.55											
T. B. M. 538	T. B. M. 539	1,190	50.504	Dir ...	+1,840.7	—2.00	—0.15	+0.15	1.33	4.9	—1.53	114.29102	374.974	....	....	J.
				Rev...	+1,836.7	+2.00										
				Mean .	+1,838.70											
*P. B. M. 205	T. B. M. 538	39	53.543	Dir ...	—831.0	+0.10	—0.05	+0.05	0.07	4.9	—1.67	113.35998	371.019	....	....	J.
				Rev...	—830.8	—0.10										
				Mean .	—830.90											
*Cap over 205	T. B. M. 538	39	53.543	D'r ...	+299.6	+0.15	0.00	0.00	0.10	4.9	—1.48	114.59082	375.958	....	....	J.
				Rev...	+299.9	—0.15										
				Mean .	+299.75											
T. B. M. 537	T. B. M. 538	1,176	54.680	Dir ...	—679.3	—0.60	—0.75	+0.75	0.40	4.9	—1.63	113.61102	372.743	....	....	J.
				Rev...	—680.5	+0.60										
				Mean .	—679.90											
T. B. M. 536	T. B. M. 537	1,420	56.100	Dir ...	—1,366.4	+1.50	+0.75	—0.75	1.00	5.0	—1.84	112.24591	368.264	....	....	J.
				Rev...	—1,363.4	—1.50										
				Mean .	—1,364.90											
T. B. M. 535	T. B. M. 536	1,181	57.284	Dir ...	+1,513.3	+0.70	+1.45	—1.45	0.47	5.0	—1.60	113.76015	373.232	....	....	J.
				Rev...	+1,514.7	—0.70										
				Mean .	+1,514.00											
* P. B. M. 264 = 42 ...... Oak Mills.	T. B. M. 535	24	57.308	Dir ...	—1,762.0	—0.20	+1.25	—1.25	0.13	5.1	—1.88	111.99767	367.450	367.467	+0.017	F.
				Rev...	—1,762.4	+0.20										
				Mean .	—1,762.20											
*Cap over 264	T. B. M. 535	24	57.308	Dir ...	—523.4	+0.20	+1.65	—1.65	0.13	5.1	—1.68	113.23687	371.515	....	....	F.
				Rev...	—523.0	—0.20										
				Mean .	—523.20											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 263	T. B. M. 535	24	57.308	Dir ...	+1,067.83	−0.02	+1.43	−1.43	0.01	5.0	−1.43	114.82812	376.736	....	....	J.
				Rev ...	+1,067.78	+0.02										
				Mean .	+1,067.80											
T. B. M. 534	T. B. M. 535	2,091	59.375	Dir ...	−4,270.5	+1.00	+2.45	−2.45	0.67	5.1	−2.27	109.48998	359.222	....	....	F.
				Rev ...	−4,268.5	−1.00										
				Mean .	−4,269.50											
T. B. M. 533	T. B. M. 534	830	60.205	Dir ...	+1,140.5	−0.10	+2.35	−2.35	0.07	5.1	−2.08	110.63057	362.964	....	....	F.
				Rev ...	+1,140.3	+0.10										
				Mean .	+1,140.40											
*P. B. M. 262	T. B. M. 533	38	60.243	Dir ...	−598.2	−0.20	+2.15	−2.15	0.13	5.1	−2.17	110.03208	361.001	....	....	F.
				Rev ...	−598.6	+0.20										
				Mean .	−598.40											
*Cap over 262	T. B. M. 533	38	60.243	Dir ...	+632.7	−0.10	+2.25	−2.25	0.07	5.1	−1.98	111.26327	365.040	....	....	F.
				Rev ...	+632.5	+0.10										
				Mean .	+632.60											
T. B. M. 532	T. B. M. 533	2,106	62.311	Dir ...	+8,251.8	+1.30	+3.65	−3.65	0.87	5.2	−0.81	118.88494	390.046	....	....	J.
				Rev ...	+8,254.4	−1.30										
				Mean .	+8,253.10											
T. B. M. 531	T. B. M. 532	818	63.129	Dir ...	−1,969.7	+0.60	+4.25	−4.25	0.40	5.2	−1.10	116.91555	383.585	....	....	F.
				Rev ...	−1,968.5	−0.60										
				Mean .	−1,969.10											
*P. B. M. 261—¼ .... Kickapoo.	T. B. M. 531	24	63.153	Dir ...	+1,324.2	−0.20	+4.05	−4.05	0.13	5.2	−0.90	118.23975	387.929	387.850	−0.079	F.
				Rev ...	+1,323.8	+0.20										
				Mean .	+1,324.00											

*Cap over 261	T. B. M. 531	24	63.153	Dir	+2,562.1	0.00	+4.25	−4.25	0.00	5.2	−0.72	119.47803	391.902		F.
				Rev	+2,562.1	0.00									
				Mean	+2,562.10										
T. B. M. 530	T. B. M. 531	302	63.431	Dir	−1,223.8	−0.30	+3.95	−3.95	0.20	5.2	−1.30	115.69125	379.5[illegible]8		F.
				Rev	−1,224.4	+0.30									
				Mean	−1,224.10										
*T. B. M. 529=old B. M. 278.	T. B. M. 530	12	63.443	Dir	+570.6	−0.10	+3.85	−3.85	0.07	5.2	−1.21	116.26184	381.440	381.860	−0.074	F.
				Rev	+570.4	+0.10									
				Mean	+570.50										
*P. B. M. 260	T. B. M. 530	13	63.444	Dir	+446.2	−0.10	+3.85	−3.85	0.07	5.2	−1.23	116.13742	381.032		F.
				Rev	+446.0	+0.10									
				Mean	+446.10										
T. B. M. 528	T. B. M. 530	1,585	65.016	Dir	−5,259.1	−1.15	+2.80	−2.80	0.77	5.2	−2.12	110.43018	362.307		F.
				Rev	−5,261.4	+1.15									
				Mean	−5,260.25										
T. B. M. 527	T. B. M. 528	715	65.731	Dir	+501.0	−0.50	+2.30	−2.30	0.33	5.3	−2.04	110.93076	363.949		F.
				Rev	+500.0	+0.50									
				Mean	+500.50										
*P. B. M. 259	T. B. M. 527	150	65.881	Dir	−1,104.3	0.00	+2.30	−2.30	0.00	5.2	−2.20	109.82630	360.3[illegible]6		J.
				Rev	−1,104.3	0.00									
				Mean	−1,104.30										
*Cap over 259	T. B. M. 527	150	65.881	Dir	+131.6	+0.30	+2.60	−0.60	0.20	5.3	−2.02	111.06268	364.[illegible]82		J.
				Rev	+132.2	−0.30									
				Mean	+131.90										
T. B. M. 526	T. B. M. 527	804	66.535	Dir	−591.1	+0.10	+2.40	−2.40	0.07	5.3	−2.13	110.33967	362.010		F.
				Rev	−590.9	−0.10									
				Mean	−591.00										
T. B. M. 525	T. B. M. 526	1,197	67.732	Dir	−530.6	−0.30	+2.10	−2.10	0.20	5.3	−2.20	109.80870	360.2[illegible]8		J.
				Rev	−531.2	+0.30									
				Mean	−530.90										

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 258—?	T. B. M. 525	83	67.815	Dir ...	—1,386.0	—0.20	+1.90	—1.90	0.13	5.3	—2.43	108.42227	355.719	355.659	—0.060	J.
				Rev ..	—1,386.4	+0.20										
				Mean .	—1,386.20											
*Cap over 258—..........	T. B. M. 525	83	67.815	Dir ...	—143.2	+0.05	+2.15	—2.15	0.03	5.3	—2.24	109.66551	359.798	....	....	J.
				Rev ..	—143.1	—0.05										
				Mean .	—143.15											
T. B. M. 524.	T. B. M. 525	1,022	68.754	Dir ...	+194.5	+0.05	+2.15	—2.15	0.03	5.3	—2.19	110.00326	360.906	....	....	J.
				Rev ..	+194.6	—0.05										
				Mean .	+194.55											
T. B. M. 523	T. B. M. 524	704	69.458	Dir ...	+611.1	+0.20	+2.35	—5.35	0.13	5.3	—2.08	110.61467	362.912	....	....	F.
				Rev ..	+611.5	—0.20										
				Mean .	+611.30											
*P. B. M. 257	T. B. M. 523	18	69.476	Dir ...	—925.3	+0.15	+2.50	—2.50	0.10	5.3	—2.24	109.68936	359.876	....	....	F.
				Rev ..	—925.0	—0.15										
				Mean .	—925.15											
*Cap over 257...........	T. B. M. 523	18	69.476	Dir ...	+314.5	0.00	+2.35	—2.35	0.00	5.3	—2.03	110.92922	363.944	....	....	F.
				Rev ..	+314.5	0.00										
				Mean .	+314.50											
T. B. M. 522	T. B. M. 523	1,194	70.652	Dir ...	+3,860.0	—1.05	+1.30	—1.30	0.70	5.3	—1.49	114.47421	375.575	....	....	F.
				Rev ..	+3,857.9	+1.05										
				Mean .	+3,858.95											
*P. B. M. 256 .... Fort Leavenworth.	T. B. M. 522.......	80	70.732	Dir ...	—3,974.3	—0.05	+1.25	—1.25	0.03	5.3	—2.12	110.49923	362.534	....	....	F.
				Rev ..	—3,974.4	+0.05										
				Mean .	—3,974.35											

T. B. M. 520	T. B. M. 523	712	71.364	Dir ...	−2,114.4	−0.30	+1.00	−1.00	0.20	5.3	−1.82	112.35018	368.636	....	....	F.
				Rev ..	−2,125.0	+0.30										
				Mean .	−2,114.7											
*T. B. M. 521, Gauge B. M. Ft. L.	T. B. M. 520	8	71.872	Dir ...	+1,076.75	0.00	+1.00	−1.00	0.00	5.3	−1.65	113.43610	372.169	372.239	+0.070	J.
				Rev ..	+1,076.75	0.00										
				Mean .	+1,076.75											
* Zero gauge	T. B. M. 521	80	71.452	Dir ...	−113,549.4	−3.70	−2.70	+2.70	2.47	5.8	−1.50	−0.11685	−0.383	00.000	+0.383	J.
				Rev ..	−113,556.8	+3.70										
				Mean .	−113,553.10											
*P. B. M. 255	T. B. M. 520	10	71.874	Dir ...	+1,951.23	+0.03	+1.03	−1.03	0.02	5.3	−1.51	114.31075	375.039	....	....	J.
				Rev ..	+1,951.28	−0,03										
				Mean .	+1 951.26											
*P. B. M. 254=½	T. B. M. 520	20	71.384	Dir ...	+1,812.6	−0.10	+0.90	−0.90	0.07	5.3	−1.53	114.17197	374.583	376.569	+1.986	J.
				Rev ..	+1.812.4	+0.10										
				Mean .	+1,812.5											
* Cap over 254	T. B. M. 520	20	71.384	Dir ...	+3,057.7	−0.05	+0.95	−0.95	0.03	5.3	−1.34	115.41731	378.669	....	....	J.
				Rev ..	+3,057.6	+0.05										
				Mean .	+3,057.65											
T. B. M. 519 = Old B. M. 271.	T. B. M. 520	1,061	72.425	Dir ...	−5,399.2	+1.05	+2.05	−2.05	0.70	5.3	−2.66	106.96019	350.922	352.019	+1.097	J.
				Rev ..	−5,397.1	−1.05										
				Mean .	−5,398.15											
T. B. M. 518	T. B. M. 519	1,128	73.553	Dir ...	+4,363.9	+0.45	+2.50	−2.50	0.30	5.3	−1.07	111.32523	365.244	....	....	J.
				Rev ..	+4,364.8	−0.45										
				Mean .	+4,364.35											
T. B. M. 517	T. B. M. 518	1,328	74.881	Dir ...	−2,155.7	−0.65	+1.85	−1.85	0.43	5.4	−2.31	109.16854	358.168	....	....	F.
				Rev ..	−2,157.0	+0.65										
				Mean .	−2,156.35											
* T. B. M. 516 = Old B. M. 270.	T. B. M. 517	102	74.983	Dir ...	−686.1	0.00	+1.85	−1.85	0.00	5.4	−2.43	108.48232	355.916	355.822	−0.094	J.
				Rev ..	−686.1											
				Mean .	−686.10											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Leavenworth datum...	T. B. M. 516	....			—ft. 23.83							....	332.086	....	....	F.
*P. B. M. 251	T. B. M. 516.......	174	75.157	Dir ...	+3,881.5	+0.15	+2.00	—2.00	0.10	5.4	— 1.82	112.36458	368.654	....	....	F.
				Rev ..	+3,881.8	—0.15										
				Mean .	+3,881.65											
*P. B. M. 253 .... Leavenworth.}	T. B. M. 517	77	74.958	Dir ...	+1,095.48	+0.09	+1.94	—1.94	0.06	5.4	—2.14	110.26428	361.763	....	....	J.
				Rev ..	+1,095.66	—0.09										
				Mean .	+1,095.57											
*P. B. M. 252	T. B. M. 5	337	75.218	Dir ...	+4,669.6	—0.25	+1.60	—1.60	0.17	5.4	—1.58	113.83862	373.490	....	....	F.
				Rev ..	+4,669.1	+0.25										
				Mean .	+4,669.35											
T. B. M. 515	T. B. M. 517	1,293	76.274	Dir ...	—1,236.7	+0.85	+2.70	—2.70	0.57	5.4	—2.50	107.93250	354.112	....	....	F.
				Rev ..	—1,235.0	—0.85										
				Mean .	—1,235.85											
T. B. M. 514	T. B. M. 515	1,385	77.659	Dir ...	+969.8	+0.10	+2.80	—2.80	0.07	5.4	—2.37	108.90253	357.295	....	....	J.
				Rev ..	+970.0	—0.10										
				Mean .	+969.90											
*P. B. M. 250=7/1	T. B. M. 514	107	77.766	Dir ...	+11,381.5	+0.30	+3.10	—3.10	0.20	5.4	—0.59	120.28611	394.643	394.956	+0.313	J.
				Rev ..	+11,382.1	—0.30										
				Mean .	+11,381.80											
*Cap over 250...........	T. B. M. 514	107	77.766	Dir ...	+12,620.3	+0.40	+3.20	—3.20	0.27	5.4	—0.39	121.52521	398.708	....	....	J.
				Rev ..	+12,621.1	—0.40										
				Mean .	+12,620.70											

T. B. M. 513	T. B. M. 514	1,410	79.060	Dir	−2,221.2	+0.35	+3.15	−3.15	0.23	5.4	−2.70	106.07835	349.998			J.
				Rev	−2,223.5	−0.35										
				Mean	−2,223.85											
T. B. M. 512	T. B. M. 513	1,707	80.776	Dir	−1,054.3	−0.35	+2.80	−2.80	0.23	5.4	−2.86	105.62354	346.537			F.
				Rev	−1,055.0	+0.35										
				Mean	−1,054.65											
T. B. M. 511	T. B. M. 512	554	81.330	Dir	+133.0	−0.30	+2.50	−2.50	0.20	5.4	−2.84	105.75626	346.972			F.
				Rev	+132.4	+0.30										
				Mean	+132.70											
*P. B. M. 249 Leavenworth Junction.	T. B. M. 511	26	81.356	Dir	−1,153.6	−0.10	+2.40	−2.40	0.07	5.4	−3.03	104.60237	343.187			F.
				Rev	−1,153.8	+0.10										
				Mean	−1,153.70											
*Cap over 249	T. B. M. 511	26	81.356	Dir	+84.9	+0.15	+2.65	−2.65	0.10	5.4	−2.83	105.84132	347.252			F.
				Rev	+85.2	−0.15										
				Mean	+85.05											
T. B. M. 510	T. B. M. 511	1,386	82.716	Dir	−1,256.0	−1.35	+1.15	−1.15	0.90	5.5	−3.04	104.49871	342.847			F.
				Rev	−1,258.7	+1.35										
				Mean	−1,257.35											
T. B. M. 508	T. B. M. 510	1,082	83.798	Dir	+2,547.7	+0.45	+1.60	−1.60	0.30	5.5	−2.64	107.04726	351.208			J.
				Rev	+2,548.6	−0.45										
				Mean	+2,548.15											
†T. B. M. 509=old B. M. 266. Delaware.	T. B. M. 508	418	84.216	Dir	−543.6	+0.20	+1.80	−1.80	0.13	5.5	−2.72	106.50378	349.425	349.317	−0.108	J.
				Rev	−543.2	−0.20										
				Mean	−543.40											
T. B. M. 507	T. B. M. 508	1,498	85.296	Dir	−473.7	−0.20	+1.40	−1.40	0.13	5.5	−2.72	106.57328	349.653			J.
				Rev	−474.1	+0.20										
				Mean	−473.90											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1893—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 248=7/1	T. B. M. 507	810	86.106	1 Dir	+11,148.7	—1.00	+1.32	—1.32	0.37	5.5	—0.98	117.72272	386.233	386.097	—0.136	J.
				1 Rev	+11,153.8†	—6.10										
				2 Dir	+11,146.8	+0.90										
				2 Rev	+11,147.6	+0.10										
				Mean	+11,147.70											
*Cap over 248	T. B. M. 507	810	86.106	1 Dir	+12,391.7	—1.20	+1.03	—1.03	0.41	5.5	—0.79	118.96571	390.311			J.
				1 Rev	+12,396.1†	—5.60										
				2 Dir	+12,389.8	+0.70										
				2 Rev	+12,390.0	+0.50										
				Mean	+12,390.50											
T. B. M. 506 Popes.	T. B. M. 507	926	86.222	Dir	—316.2	+0.35	+1.75	—1.75	0.23	5.5	—2.77	106.25738	348.617			J.
				Rev	—315.5	—0.35										
				Mean	—315.85											
T. B. M. 505	T. B. M. 506	1,194	87.416	Dir	—1,257.4	+0.60	+2.35	—2.35	0.40	5.5	—2.97	105.00038	344.492			F.
				Rev	—1,256.2	—0.60										
				Mean	—1,256.80											
T. B. M. 504	T. B. M. 505	1,026	88.442	Dir	—367.9	—0.60	+1.75	—1.75	0.40	5.5	—3.01	104.63184	343.283			F.
				Rev	—369.1	+0.60										
				Mean	—368.50											
*P. B. M. 247	T. B. M. 504	122	88.564	Dir	—279.0	+0.15	+1.90	—1.90	0.10	5.5	—3.06	104.35294	342.368			F.
				Rev	—278.7	—0.15										
				Mean	—278.85											
*Cap over 247	T. B. M. 504	122	88.564	Dir	+955.3	+0.05	+1.80	—1.80	0.03	5.5	—2.87	105.58733	346.418			F.
				Rev	+955.4	—0.05										
				Mean	+955.35											

T. B. M. 503	T. B. M. 504	1,671	90.113	Dir	+884.3	—0.05	+1.70	—1.70	0.03	5.5	—2.87	105.51623	346.185	....	....	J.
				Rev	+884.2	+0.05										
				Mean	+884.25											
T. B. M. 502	T. B. M. 503	1,400	91.513	Dir	—1,436.2	+0.95	+2.65	—2.65	0.63	5.6	—3.10	104.08075	341.475	....	....	F.
				Rev	—1,434.3	—0.95										
				Mean	—1,435.25											
T. B. M. 501	T. B. M. 502	952	92.465	Dir	+1,280.1	+0.55	+3.20	—3.20	0.37	5.6	—2.91	105.36159	345.678	....	....	F.
				Rev	+1,281.2	—0.55										
				Mean	+1,280.65											
*P. B. M. 246 Connors City.	T. B. M. 501	204	92.669	Dir	+3,926.6	+0.05	+3.25	—3.25	0.03	5.6	—2.30	109.28885	358.562	....	....	F.
				Rev	+3,926.7	—0.05										
				Mean	+3,926.65											
*P. B. M. 245=$\frac{24}{1}$	T. B. M. 501	123	92.587	Dir	—1,317.0	—0.35	+2.85	—2.85	0.23	5.6	—3.10	104.04405	341.355	341.213	—0.142	F.
				Rev	—1,317.7	+0.35										
				Mean	—1,317.35											
*Cap over 245	T. B. M. 501	123	92.587	Dir	—76.2	0.00	+3.20	—3.20	0.00	5.6	—2.92	105.28538	345.428	....	....	F.
				Rev	—76.2	0.00										
				Mean	—76.20											
T. B. M. 500	T. B. M. 501	721	93.186	Dir	—345.0	+0.75	+3.95	—3.95	0.50	5.6	—2.95	105.01730	344.548	....	....	F.
				Rev	—343.5	—0.75										
				Mean	—344.25											
T. B. M. 499	T. B. M. 500	2,401	95.587	Dir	—1,213.2	+0.80	+4.75	—4.75	0.53	5.6	—3.14	103.80471	340.570	....	....	F.
				Rev	—1,211.6	—0.80										
				Mean	—1,212.40											
*P. B. M. 244=old B. M. 260 (center of hole).	T. B. M. 499	45	95.632	Dir	+6,143.5	—0.70	+4.05	—4.05	0.47	5.6	—2.18	109.94847	360.727	360.523	—0.204	J.
				Rev	+6,142.1	+0.70										
				Mean	+6,142.80											
T. B. M. 498	T. B. M. 499	1,032	96.619	Dir	—1,437.3	—0.35	+4.40	—4.40	0.23	5.6	—3.37	102.36683	335.852	....	....	J.
				Rev	—1,438.0	+0.35										
				Mean	—1,437.65											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V: Direct line.	Σ V: Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix: Meters.	Elevation above St. Louis City Directrix: Feet.	Elevation above St. Louis City Directrix: Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 243	T. B. M. 498	47	96.666	Dir	+1,275.1	-0.10	+4.30	-4.30	0.07	5.6	-3.19	103.64201	340.036			J.
				Rev	+1,274.9	+0.10										
				Mean	+1,275.00											
*Cap over 243	T. B. M. 498	47	96.666	Dir	+2,507.7	+0.10	+4.50	-4.50	0.07	5.6	-2.98	104.87502	344.081			J.
				Rev	+2,507.9	-0.10										
				Mean	+2,507.80											
*P. B. M. 242 Pomeroy.	T. B. M. 498	96	96.715	Dir	+7,884.81	+0.12	+4.52	-4.52	0.08	5.6	-2.14	110.25299	361.726			J.
				Rev	+7,885.05	-0.12										
				Mean	+7,884.93											
T. B. M. 497	T. B. M. 498	914	97.533	Dir	+482.1	+0.65	+5.05	-5.05	0.43	5.7	-3.29	102.84966	337.436			J.
				Rev	+483.4	-0.65										
				Mean	+482.75											
T. B. M. 496	T. B. M. 497	2,168	99.701	Dir	+2,531.8	-0.90	+4.15	-4.15	0.60	5.7	-2.91	105.38094	345.741			J.
				Rev	+2,530.0	+0.90										
				Mean	+2,530.90											
*P. B. M. 241	T. B. M. 496	17	99.718	Dir	-910.8	-0.05	+4.10	-4.10	0.03	5.7	-3.04	104.46996	342.752			W.
				Rev	-910.9	+0.05										
				Mean	-910.85											
*Cap over 241	T. B. M. 496	17	99.718	Dir	+325.6	-0.10	+4.05	-4.05	0.07	5.7	-2.85	105.70650	346.809			W.
				Rev	+325.4	+0.10										
				Mean	+325.50											
T. B. M. 495	T. B. M. 496	537	100.238	Dir	-331.3	-0.95	+3.20	-3.20	0.63	5.7	-2.95	105.04865	344.651			J.
				Rev	-333.2	+0.95										
				Mean	-332.25											

*P. B. M. 240	T. B. M. 495	14	100.252	Dir	—0.0	—0.05	+3.15	—3.15	0.03	5.7	—2.95	105.04860	344.051	....	....	W.
				Rev	—0.1	+0.05										
				Mean	—0.05											
T. B. M. 494	T. B. M. 495	1,018	101.256	Dir	—2,530.1	—0.05	+3.15	—3.15	0.03	5.7	—3.84	102.51811	336.349	....	....	J.
				Rev	—2,530.2	+0.05										
				Mean	—2,530.15											
T. B. M. 493	T. B. M. 494	1,890	103.146	Dir	+1,316.6	—1.10	+2.05	—2.05	0.73	5.8	—3.13	103.83382	340.665	....	....	J.
				Rev	+1,314.4	+1.10										
				Mean	+1,315.50											
*P. B. M. 239 Nearman.	T. B. M. 493	39	103.185	Dir	—2,066.0	+0.25	+2.30	—2.30	0.17	5.8	—3.47	101.76773	333.887	....	....	W.
				Rev	—2,065.5	—0.25										
				Mean	—2,065.75											
*Cap over 239	T. B. M. 493	39	103.185	Dir	—834.4	+0.10	+2.15	—2.15	0.07	5.8	—3.27	102.99938	337.928	....	....	W.
				Rev	—834.2	—0.10										
				Mean	—834.30											
T. B. M. 492	T. B. M. 493	2,359	105.505	Dir	+5,839.3	+1.45	+3.50	—3.50	0.97	5.8	—2.24	100.67546	359.831	....	....	J.
				Rev	+5,842.2	—1.45										
				Mean	+5,840.75											
T. B. M. 491	T. B. M. 492	1,474	106.797	Dir	—6,915.9	+0.95	+4.45	—4.45	0.63	5.9	—3.31	103.75944	337.140	....	....	F.
				Rev	—6,914.0	—0.95										
				Mean	—6,914.95											
*P. B. M. 238=¼	T. B. M. 491	22	107.001	Dir	—1,132.8	+0.05	+4.50	—4.50	0.03	5.9	—3.48	101.62652	333.423	333.149	—0.274	F.
				Rev	—1,132.7	—0.05										
				Mean	—1,132.75											
*Cap over 238	T. B. M. 491	22	107.001	Dir	+107.5	0.00	+4.45	—4.45	0.00	5.9	—3.29	102.86696	337.493	....	....	F.
				Rev	+107.5	0.00										
				Mean	+107.50											
T. B. M. 490	T. B. M. 491	700	107.679	Dir	+734.5	+0.75	+5.20	—5.20	0.50	5.9	—3.19	103.49481	339.553	....	....	F.
				Rev	+736.0	—0.75										
				Mean	+735.25											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals. = V.	± V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 237 .... Kansas City water-works.	T. B. M. 490	248	107.927	Dir ...	−143.5	+0.20	+5.40	−5.40	0.13	5.9	−3.22	103.35148	339.083	....	....	F.
				Rev ..	−143.1	−0.20										
				Mean .	−143.30											
T. B. M. 489	T. B. M. 490	1,356	109.035	Dir ...	−2,979.2	−0.30	+4.90	−4.90	0.20	5.9	−3.66	100.51484	329.776	....	....	F.
				Rev ..	−2,979.8	+0.30										
				Mean .	−2,979.50											
T. B. M. 488	T. B. M. 489	1,576	110.611	Dir ...	+3,319.5	−1.85	+3.05	−3.05	1.23	6.0	−3.13	103.83302	340.663	....	....	F.
				Rev ..	+3,315.8	+1.85										
				Mean .	+3,317.65											
*P. B. M. 236	T. B. M. 488	51	110.662	Dir ...	−1,344.9	−0.20	+2.85	−2.85	0.13	6.0	−3.34	102.48771	336.249	....	....	J.
				Rev ..	−1,345.3	+0.20										
				Mean .	−1,345.10											
*Cap over 236	T. B. M. 488	51	110.662	Dir ...	−107.0	−0.05	+3.00	−3.00	0.03	6.0	−3.15	103.72595	340.311	....	....	J.
				Rev ..	−107.1	+0.05										
				Mean .	−107.05											
T. B. M. 487	T. B. M. 488	1,574	112,185	Dir ...	+2,646.2	−0.95	+2.10	−2.10	0.63	6.1	−2.73	106.47867	349.343	....	....	J.
				Rev ..	+2,644.3	+0.95										
				Mean .	+2,645.25											
T. B. M. 484	T. B. M. 487	758	112.943	Dir ...	−6,928.0	+0.60	+2.70	−2.70	0.40	6.1	−3.80	99.55020	326.611	....	....	F.
				Rev ..	−6,926.8	−0.60										
				Mean .	−6,927.40											
*T. B. M. 485=old B. M. 248.	T. B. M. 484	351	113.294	Dir ...	+11,503.1	+0.60	+3.30	−3.30	0.40	6.1	−2.02	111.05568	364.359	364.159	−0.200	F.
				Rev ...	+11,504.3	−0.60										
				Mean .	+11,503.70											

*T. B. M. 486=City B. M. Kansas City, Kans.	T. B. M. 485	80	113.324	Dir ...	+264.5	+0.15	+3.45	—3.45	0.10	6.1	—1.97	111.32038	365.228	364.94	—0.288	F.
				Rev ...	+264.8	—0.15										
				Mean .	+264.65											
Kansas City, Kans, datum.	T. B. M. 486	....	....	....	—ft. 364.94	....	....	....	....	....	....	....	+0.288	0.000	—0.288	
*P. B. M. 285 .... Kaw River.	T. B. M. 484	12	112.955	Dir ...	+531.32	—0.03	+2.67	—2.67	0.02	6.1	—3.72	100.08158	328.855	....	....	J.
				Rev ...	+531.28	+0.03										
				Mean .	+531.30											
T. B. M. 483	T. B. M. 484	1,147	114.090	Dir ...	+2,795.8	—0.40	+2.30	—2.30	0.27	6.1	—3.37	102.34603	335.784	....	....	J.
				Rev ...	+2,795.0	+0.40										
				Mean .	+2,795.40											
*P. B. M. 234	T. B. M. 483	10	114.100	Dir ...	+1,265.58	—0.02	+2.32	—2.32	0.01	6.1	—3.18	103.61178	339.937	....	....	J.
				Rev ...	+1,265.53	+0.02										
				Mean .	+1,265.56											
T. B. M. 482	T. B. M. 483	2,212	116.302	Dir ...	—403.3	—0.65	+1.65	—1.65	0.43	6.1	—3.43	101.94202	334.458	....	....	J.
				Rev ...	—404.6	+0.65										
				Mean .	—403.95											
*P. B. M. 233	T. B. M. 482	18	116.320	Dir ...	+866.68	+0.05	+1.70	—1.70	0.03	6.1	—3.30	102.80888	337.302	....	....	J.
				Rev ...	+866.78	—0.05										
				Mean .	+866.73											
T. B. M. 481.	T. B. M. 482	538	116.840	Dir ...	+1,493.0	0.00	+1.65	—1.65	0.00	6.1	—3.20	103.43525	339.358	....	....	J.
				Rev ...	+1,493.0	0.00										
				Mean .	+1,493.00											
*P. B. M. 232=old B. M. 243=U. S. C. S. c. b., Kansas City.	T. B. M. 481	13	116.853	Dir ...	+779.7	+0.10	+1.75	—1.75	0.07	6.1	—3.07	104.21518	341.916	341.694 340.91185 U. S. C. S.	—0.222 —1.004	F.
				Rev ...	+779.9	—0.10										
				Mean .	+779.80											
*U. S. C. S.=(Top old cap over $^{I}_{1}{}^{3}$).	T. B. M. 481	32	116.872	Dir ...	—720.4	+0.10	+1.75	—1.75	0.07	6.1	—3.32	102.70583	336.964	335.9643 U. S. C. S.	—1.000	F.
				Rev ..	—720.2	—0.10										
				Mean .	—720.30											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V: Direct line.	Σ V: Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix: Meters.	Elevation above St. Louis City Directrix: Feet.	Elevation above St. Louis City Directrix: Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 230=♀	T. B. M. 481	32	116.872	Dir	−1,975.8	+0.20	+1.85	−1.85	0.13	6.1	−3.51	101.45934	332.875	332.661	−0.214	F.
				Rev	−1,975.4	−0.20										
				Mean	−1,975.60											
*Cap over 230	T. B. M. 481	32	116.872	Dir	−731.2	−0.10	+1.55	−1.55	0.07	6.1	−3.32	102.70383	336.958	....	....	F.
				Rev	−731.4	+0.10										
				Mean	−731.30											
*Zero gauge	T. B. M. 481	108	116.948	Dir	−103,363.4	+2.40	+4.05	−4.05	1.60	6.2	−3.20	+0.07425	+0.244	0.000	−0.244	F.
				Rev	−103,358.6	−2.40										
				Mean	−103,361.00											
*Kansas City datum	P. B. M. 231	....	....	....	−ft. 32.03	....	....	....	....	....	....	....	309.362	308.83	−0.532	
*P. B. M. 231=old B. M. 244 U. S. C. S.	T. B. M. 481	26	116.866	Dir	+620.2	−0.05	+1.60	−1.60	0.03	6.1	−3.10	104.05550	341.392	341.162	−0.230	F.
				Rev	+620.1	+0.05	....	....	....	....	....	....	....	340.390 U. S. C. S.	−1.002	
				Mean	+620.15											
T. B. M. 480=old B. M. 242.	T. B. M. 481	402	117.242	Dir	+4,185.8	+0.60	+2.25	−2.25	0.40	6.1	−2.55	107.62230	353.095	352.872	−0.223	F.
				Rev	+4,187.0	−0.60										
				Mean	+4,186.40											
T. B. M. 479	T. B. M. 480	1,326	118.568	Dir	−5,479.1	+1.25	+3.50	−3.50	0.83	6.2	−3.40	102.14360	335.120	....	....	F.
				Rev	−5,476.6	−1.25										
				Mean	−5,477.85											
*P. B. M. 220	T. B. M. 479	228	118.796	1 Dir	+167.5	−1.30	+3.25	−3.25	0.30	6.2	−3.37	102.30983	335.665	....	....	F.
				1 Rev	+166.0	+0.20										
				2 Dir	+165.4	+0.80										
				2 Rev	+165.9	+0.30										
				Mean	+166.20											

T. B. M. 478=old B. M. 240.	T. B. M. 479	1,678	120.241	Dir ...	—1,937.4	+1.90	+5.40	—5.40	1.27	6.8	—3.70	100.20780	328.789	328.641	—0.128	F.
				Rev ..	—1,933.6	—1.90										
				Mean .	—1,935.50											
T. B. M. 477	T. B. M. 478	1,819	122.060	Dir ...	+570.2	—1.05	+4.85	—4.85	0.70	6.8	—3.62	100.77703	330.636	....	....	F.
				Rev ..	+568.1	+1.05										
				Mean .	+569.15											
*P. B. M. 228=½	T. B. M. 477	1,058	123.118	Dir ...	—2,889.9	+0.15	+4.50	—4.50	0.10	6.8	—4.06	97.88684	321.154	320.998	—0.156	F.
				Rev ..	—2,889.6	—0.15										
				Mean .	—2,889.75											
*Cap over 228............	T. B. M. 477	1,058	123.118	Dir ...	—1,649.7	+0.35	+4.70	—4.70	0.23	6.8	—3.87	99.12743	325.224	....	....	F.
				Rev ..	—1,649.0	—0.35										
				Mean .	—1,649.35											
T. B. M. 476	T. B. M. 477	1,293	123.853	1 Dir .	—557.9	+5.77	+4.70	—4.70	0.16	6.8	—3.69	100.22483	328.824	....	....	F.
				1 Rev.	—551.9	—0.23										
				2 Dir .	—552.6	+0.47										
				2 Rev.	—551.9	—0.23										
				Mean .	—552.13											
T. B. M. 475	T. B. M. 476	989	124.342	Dir ...	—497.6	—0.40	+4.30	—4.30	0.27	6.3	—3.78	99.72674	327.190	....	....	F.
				Rev ..	—498.4	+0.40										
				Mean .	—498.00											
U. S. C. S. LVIII	T. B. M. 475	1,622	125.964	Dir ...	+2,342.2	—0.45	+3.85	—3.85	0.30	6.3	—3.42	102.06885	334.875	333.904 U. S. C. S.	—0.971	J.
				Rev ..	+2,341.3	+0.45										
				Mean .	+2,341.75											
*P. B. M. 227............ Big Blue River.	U. S. C. S. LVIII..	71	126.035	Dir ...	—4,096.5	+0.20	+4.05	—4.05	0.13	6.4	—4.04	97.97193	321.433	....	....	J.
				Rev ..	—4,096.1	—0.20										
				Mean .	—4,096.30											
*Cap over 227............	U. S. C. S. LVIII..	71	126.035	Dir ...	—2,859.5	+0.40	+4.25	—4.25	0.27	6.4	—3.86	99.20931	325.493	....	....	J.
				Rev ..	—2,858.7	—0.40										
				Mean .	—2,859.10											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892.—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
P. B. M. 226 Rock Creek.	U. S. C. S. LVIII	1,240	127.204	Dir	−1,486.1	−0.30	+3.55	−3.55	0.20	6.4	−3.64	100.58223	329.997			J.
				Rev	−1,486.7	+0.30										
				Mean	−1,486.40											
T. B. M. 471	P. B. M. 226	1,619	128.823	Dir	+2,203.3	+0.90	+4.45	−4.45	0.60	6.4	−3.31	102.78676	337.230			J.
				Rev	+2,205.1	−0.90										
				Mean	+2,204.20											
*P. B. M. 225	T. B. M. 474	82	128.905	Dir	−669.5	−0.05	+4.40	−4.40	0.03	6.4	−3.40	102.11712	335.033			J.
				Rev	−669.6	+0.05										
				Mean	−669.55											
*Cap over 225	T. B. M. 474	82	128.905	Dir	+566.3	0.00	+4.45	−4.45	0.00	6.4	−3.21	103.35316	339.088			J.
				Rev	+566.3	0.00										
				Mean	+566.30											
T. B. M. 473	T. B. M. 474	2,487	131.310	Dir	−1,057.4	−0.55	+3.90	−3.90	0.37	6.4	−3.47	101.72865	333.758			J.
				Rev	−1,058.5	+0.55										
				Mean	−1,057.95											
T. B. M. 472	T. B. M. 473	2,256	133.566	1 dir	+40.6	+3.10	+5.95	−5.95	1.01	6.5	−3.47	101.77235	333.901			F.
				1 rev	+47.8	−4.10										
				2 dir	+42.7	+1.00										
				2 rev	+43.7	+0.00										
				Mean	+43.70											
*P. B. M. 224	T. B. M. 472	1,056	134.622	Dir	−279.0	−0.05	+5.90	−5.90	0.03	6.5	−3.49	101.49328	332.986			F.
				Rev	−279.1	+0.05										
				Mean	−279.05											

*P. B. M. 223=1/4 Wayne.	T. B. M. 472	83	133.509	Dir	—4,431.7	+0.05	+6.00	—6.00	0.08	6.5	—4.14	97.84003	319.360	319.035	—0.325	F.
				Rev	—4,431.6	—0.05										
				Mean	—4,431.65											
*Cap over 223	T. B. M. 472	34	133.509	Dir	—3,190.5	—0.10	+5.85	—5.85	0.07	6.5	—3.96	98.58126	323.432			F.
				Rev	—3,190.7	+0.10										
				Mean	—3,190.60											
T. B. M. 471	T. B. M. 472	666	134.232	Dir	+2,020.7	+1.50	+7.45	—7.45	1.00	6.5	—3.15	103.79487	340.537			F.
				Rev	+2,023.7	—1.50										
				Mean	+2,022.20											
T. B. M. 470	T. B. M. 471	1,259	135.491	Dir	—3,612.4	0.00	+7.45	—7.45	0.00	6.5	—3.71	100.18191	328.684			F.
				Rev	—3,612.4	0.00										
				Mean	—3,612.40											
T. B. M. 469	T. B. M. 470	1,301	136.792	Dir	—997.8	+1.10	+8.55	—8.55	0.73	6.6	—3.87	99.18505	325.413			J.
				Rev	—995.6	—1.10										
				Mean	—996.70											
*P. B. M. 222	T. B. M. 469	335	137.127	Dir	—1,829.4	—0.25	+8.30	—8.30	0.17	6.6	—4.14	97.35513	319.409			J.
				Rev	—1,829.9	+0.25										
				Mean	—1,829.65											
*Cap over 222	T. B. M. 469	335	137.127	Dir	—598.0	—0.25	+8.30	—8.30	0.17	6.6	—3.97	98.58670	323.450			J.
				Rev	—598.5	+0.25										
				Mean	—598.25											
T. B. M. 468	T. B. M. 469	1,396	138.188	Dir	—452.7	—0.05	+8.50	—8.50	0.03	6.6	—3.93	98.73224	323.928			J.
				Rev	—452.8	+0.05										
				Mean	—452.75											
T. B. M. 465	T. B. M. 468	1,204	139.392	Dir	+3,106.9	—0.80	+7.70	—7.70	0.53	6.6	—3.45	101.83882	334.120			J.
				Rev	+3,105.3	+0.80										
				Mean	+3,106.10											
*T. B. M. 466=old B. M. 33 (1878).	T. B. M. 465	83	139.475	Dir	—4,527.9	—0.20	+7.50	—7.50	0.13	6.6	—4.15	97.31002	319.262	319.021	—0.241	J.
				Rev	—4,528.3	+0.20										
				Mean	+4,528.10											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*T. B. M. 467—old B. M. "228," Blue Mills Landing.	T. B. M. 465	106	139.498	Dir ... Rev ...	—7,026.7 —7,026.3	+0.20 —0.20	+7.90	—7.90	0.13	6.6	—4.53	94.81124	311.063	310.823	—0.240	J.
				Mean .	—7,026.50											
T. B. M. 464=old B. M. "227."	T. B. M. 465	2,140	141.532	Dir ... Rev ...	—6,446.7 —6,445.8	+0.45 —0.45	+8.15	—8.15	0.30	6.6	—4.44	95.39158	312.967	312.706	—0.261	F.
				Mean .	—6,446.25											
*P. B. M. 221	T. B. M. 464	242	141.774	Dir ... Rev ...	+3,235.7 +3,234.9	—0.40 +0.40	+7.75	—7.75	0.27	6.6	—3.95	98.62737	323.584	....	....	F.
				Mean .	+3,235.30											
*Caps over 221	T. B. M. 464	242	141.774	Dir ... Rev ...	+4,468.1 +4,467.7	—0.20 +0.20	+7.95	—7.95	0.13	6.6	—3.75	99.86017	327.628	....	....	F.
				Mean .	+4,467.90											
T. B. M. 463	T. B. M. 464	1,700	143.232	Dir ... Rev ...	+93.8 +89.3	—2.25 +2.25	+5.90	—5.90	1.50	6.8	—4.43	95.48314	313.268	....	....	J.
				Mean .	+91.55											
T. B. M. 462	T. B. M. 463	1,555	144.787	Dir ... Rev ..	+804.8 +806.3	+0.75 —0.75	+6.65	—6.65	0.50	6.8	—4.32	96.28880	315.911	....	....	F.
				Mean .	+805.55											
T. B. M. 461	T. B. M. 462	830	145.617	Dir ... Rev ..	+1,701.7 +1,700.1	—0.30 +0.30	+6.35	—6.35	0.20	6.8	—4.04	97.99048	321.494	....	....	F.
				Mean .	+1,701.40											
*P. B. M. 220 .... Atherton.	T. B. M. 461	37	145.654	Dir ... Rev ..	—1,715.7 —1,716.0	—0.15 +0.15	+6.20	—6.20	0.10	6.8	—4.32	96.27435	315.864	....	....	F.
				Mean .	—1,715.85											

*Cap over 220	T. B. M. 461	87	145.654	Dir	−479.0	+0.05	+6.40	−6.40	0.03	6.8	−4.12	97.51145	319.922			F.
				Rev	−478.9	−0.05										
				Mean	−478.95											
T. B. M. 460	T. B. M. 461	1,042	146.659	Dir	−3,048.2	+0.60	+6.95	−6.95	0.40	6.8	−4.52	94.94240	311.494			F.
				Rev	−3,047.0	−0.60										
				Mean	−3,047.60											
T. B. M. 459	T. B. M. 460	996	147.655	Dir	−2,000.4	+0.70	+7.65	−7.65	0.47	6.8	−4.82	92.94240	304.932			J.
				Rev	−1,999.0	−0.70										
				Mean	−1,999.70											
*P. B. M. 219=½	T. B. M. 459	664	148.319	Dir	−519.2	−1.05	+6.60	−6.60	0.70	6.9	−4.90	92.42207	303.225	303.114	−0.111	J.
				Rev	−521.3	+1.05										
				Mean	−520.25											
*Cap over 219	P. B. M. 219	73	148.319	Dir	+1,242.7	0.00	+6.60	−6.60		6.9	−4.72	93.66495	307.302			J.
				Rev	+1,242.7	0.00										
				Mean	+1,242.70											
T. B. M. 458	T. B. M. 459	1,778	149.433	Dir	−273.9	−0.85	+6.80	−6.80	0.57	6.9	−4.87	97.66760	304.030			J.
				Rev	−275.6	+0.85										
				Mean	−274.75											
T. B. M. 457	T. B. M. 458	1,558	150.991	Dir	+4,355.5	+0.10	+6.90	−6.90	0.07	6.9	−4.18	97.02389	318.323			F.
				Rev	+4,355.7	−0.10										
				Mean	+4,355.60											
T. B. M. 456	T. B. M. 457	1,058	152.049	Dir	−4,128.0	+0.45	+7.35	−7.35	0.30	6.9	−4.83	92.89509	304.779			F.
				Rev	−4,127.1	−0.45										
				Mean	−4,127.55											
*P. B. M. 218	T. B. M. 456	855	152.404	Dir	−1,500.7	+0.05	+7.40	−7.40	0.03	6.9	−5.06	91.39481	299.854			F.
				Rev	−1,500.6	−0.05										
				Mean	−1,500.65											
*Cap over 218	T. B. M. 456	854	152.404	Dir	−268.0	+0.30	+7.65	−7.65	0.20	6.9	−4.88	92.62794	303.900			F.
				Rev	−267.4	−0.30										
				Mean	−267.70											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV Direct line.	ΣV Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 455	T. B. M. 456	1,005	153.054	Dir	+615.6	−0.10	+7.25	−7.25	0.07	6.9	−4.73	93.51229	306.802			J.
				Rev	+617.4	+0.10										
				Mean	+616.50											
T. B. M. 454	T. B. M. 455	1,506	154.560	Dir	+3,404.3	+2.25	+9.50	−9.50	1.50	7.0	−4.20	96.91937	317.980			J.
				Rev	+3,408.8	−2.25										
				Mean	+3,406.55											
T. B. M. 453	T. B. M. 454	719	155.279	Dir	+5,978.8	+0.30	+9.80	−9.80	0.20	7.0	−3.29	102.89938	337.599			F.
				Rev	+5,979.4	−0.30										
				Mean	+5,979.10											
T. B. M. 451	T. B. M. 453	622	155.901	Dir	+2,740.4	−0.05	+9.75	−9.75	0.03	7.0	−2.86	105.04016	346.592			F.
				Rev	+2,740.3	−0.05										
				Mean	+2,740.35											
*T. B. M. 452	T. B. M. 451	1,067	156.968	Dir	−13,493.2	+0.15	+9.90	−9.90	0.10	7.0	−4.94	92.14503	302.316			F.
				Rev	−13,492.9	−0.15										
				Mean	−13,493.05											
*P. B. M. 217=cap over, 44.	T. B. M. 452	804	157.772	Dir	−2,154.8	−0.10	+9.80	−9.80	0.07	7.0	−5.28	89.98979	295.245	295.140	−0.105	F.
				Rev	−2,155.0	+0.10										
				Mean	−2,154.90											
T. B. M. 450 Sibley.	T. B. M. 451	1,445	157.346	Dir	+6,142.1	−2.25	+7.50	−7.50	1.50	7.2	−1.92	111.78095	366.739			F.
				Rev	+6,137.6	+2.25										
				Mean	+6,139.85											
T. B. M. 449	T. B. M. 450	1,140	158.486	Dir	−2,259.8	−0.20	+7.80	−7.80	0.13	7.2	−2.25	109.51162	359.293			J.
				Rev	−2,260.2	+0.20										
				Mean	−2,260.00											

P. B. M. 216	T. B. M. 449	71	158.557	Dir	—8,034.8	+0.45	+7.75	—7.75	0.30	7.2	—8.51	101.47601	332.930	....	....	J.
				Rev	—8,033.9	—0.45										
				Mean	—8,034.35											
*P. B. M. 215	B. P. M. 210	116	158.673	Dir	—9,474.8	—0.10	+7.65	—7.65	0.07	7.2	—4.96	91.99966	301.830	....	....	J.
				Rev	—9,475.0	+0.10										
				Mean	—9,474.90											
*Cap over 215	P. B. M. 215	38	158.678	Dir	+1,235.1	+0.10	+7.75	—7.75	0.07	7.2	—4.78	93.23504	305.892	....	....	J.
				Rev	+1,235.3	—0.10										
				Mean	+1,235.20											
T. B. M. 448	P. B. M. 216	1,158	159.715	Dir	—10,963.0	—0.40	+7.35	—7.35	0.27	7.2	—5.20	90.51092	296.954	....	....	J.
				Rev	—10,963.8	+0.40										
				Mean	—10,963.40											
T. B. M. 447	T. B. M. 448	496	160.211	Dir	+5,562.6	—0.65	+6.70	—6.70	0.43	7.2	—4.35	96.07372	315.205	....	....	J.
				Rev	+5,561.3	+0.65										
				Mean	+5,561.95											
T. B. M. 446	T. B. M. 447	613	160.824	Dir	—3,017.3	+0.70	+7.40	—7.40	0.47	7.2	—4.81	93.05666	305.307	....	....	F.
				Rev	—3,015.9	—0.70										
				Mean	—3,016.60											
T. B. M. 444	T. B. M. 446	888	161.712	Dir	—516.6	+0.30	+7.70	—7.70	0.20	7.2	—4.88	92.54029	303.613	....	....	F.
				Rev	—516.0	—0.30										
				Mean	—516.30											
*T. B. M. 445 = old B. M. 210. Matthews Landing.	T. B. M. 444	153	161.865	Dir	+140.9	—0.10	+7.60	—7.60	0.07	7.2	—4.87	92.68110	304.075	303.835	—0.240	F.
				Rev	+140.7	+0.10										
				Mean	+140.80											
*Old B. M. 4/Y (old position).	T. B. M. 444	169	161.881	Dir	—1,472.7	—0.05	+7.65	—7.65	0.03	7.2	—5.11	91.06731	298.780	298.523	—0.257	F.
				Rev	—1,472.8	+0.05										
				Mean	—1,472.75											
* P. B. M. 214=4/Y (new position).	T. B. M. 444	132	161.844	Dir	—1,855.7	+0.15	+7.85	—7.85	0.10	7.2	—5.17	90.68445	297.524	....	....	F.
				Rev	—1,855.4	—0.15										
				Mean	—1,855.55											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
* Cap over 214	T. B. M. 444	132	161.844	Dir... Rev...	−615.6 −615.5	+0.05 −0.05	+7.75	−7.75	0.03	7.2	−4.97	91.92465	301.593	....	....	F.
				Mean.	−615.55											
T. B. M. 443	T. B. M. 444	1,690	163.402	Dir... Rev...	+1,475.2 +1,476.5	+0.65 −0.65	+8.35	−8.35	0.43	7.2	−4.66	94.01636	308.455	....	....	J.
				Mean.	+1,475.85											
T. B. M. 442	T. B. M. 443	1,162	164.564	1 Dir. 1 Rev. 2 Dir.. 2 Rev.	+383.4 +388.9 +384.2 +383.0	+0.13 −5.37 −0.67 +0.53	+7.95	−7.95	0.24	7.2	−4.59	94.39996	309.714	....	....	J.
				Mean.	+383.53											
T. B. M. 441	T. B. M. 442	1,280	165.844	Dir... Rev...	−3,450.1 −3,451.3	−0.60 +0.60	+7.35	−7.35	0.40	7.3	−5.13	90.94872	298.391	....	....	F.
				Mean.	−3,450.70											
T. B. M. 410 .... Levasy.	T. B. M. 441	1,402	167.306	Dir... Rev...	−1,145.6 −1,148.7	−1.55 +1.55	+5.80	−5.80	1.03	7.3	−5.31	89.80139	294.627	....	....	F.
				Mean.	−1,147.15											
T. B. M. 439	T. B. M. 440	1,076	168.382	Dir... Rev...	+195.5 +193.5	−1.00 +1.00	+4.80	−4.80	0.67	7.4	−5.28	89.99592	295.265	....	....	F.
				Mean.	+194.50											
T. B. M. 438	T. B. M. 439	948	169.330	Dir... Rev...	−1,342.3 −1,342.6	−0.15 +0.15	+4.65	−4.65	0.10	7.4	−5.48	88.65327	290.860	....	....	F.
				Mean.	−1,342.45											

T. B. M. 437	T. B. M. 438	496	169. 826	Dir ... Rev ...	+322. 3 +321. 9	−0. 20 +0. 20	+4. 46	−4. 46	0. 13	7. 4	−5. 43	88. 97542	291. 917	....	....	J.
				Mean .	+322. 10											
*P. B. M. 213	T. B. M. 437	83	169. 909	Dir ... Rev ...	+428. 0 +428. 2	+0. 10 −0. 10	+4. 55	−4. 55	0. 07	7. 4	−5. 37	89. 40358	293. 322	....	....	F.
				Mean .	+428. 10											
*Cap over 213	T. B. M. 437	82	169. 909	Dir ... Rev ..	+1, 664. 9 +1, 665. 1	+0. 10 −0. 10	+4. 55	−4. 55	0. 07	7. 4	−5. 17	90. 64068	297. 381	....	....	F.
				Mean .	+1, 665. 00											
T. B. M. 436	T. B. M. 437	1, 500	171. 826	Dir ... Rev ..	+4, 587. 0 +4, 589. 9	+1. 45 −1. 45	+5. 90	−5. 90	0. 97	7. 4	−4. 73	93. 56457	306. 973	....	....	J.
				Mean .	+4, 588. 45											
T. B. M. 435	T. B. M. 436	1, 514	172. 840	Dir ... Rev ..	−1, 494. 3 −1, 491. 1	+1. 60 −1. 60	+7. 50	−7. 50	1. 07	7. 5	−4. 96	92. 07164	302. 075	....	....	F.
				Mean .	−1, 492. 70											
*P. B. M. 212=[illegible] .... Napoleon.	T. B. M. 435	338	173. 178	Dir ... Rev ..	−2, 603. 3 −2, 604. 3	−0. 50 +0. 50	+7. 00	−7. 00	0. 33	7. 5	−5. 36	89. 46744	293. 531	293. 293	−0. 238	J.
				Mean .	−2, 603. 80											
*Cap over 212	P. B. M. 212	171	173. 178	Dir ... Rev ..	+1, 240. 2 +1, 240. 7	+0. 25 −0. 25	+7. 25	−7. 25	0. 17	7. 5	−5. 17	90. 70808	297. 601	....	....	J.
				Mean .	+1, 240. 45											
T. B. M. 434 .... Waterloo.	T. B. M. 435	2, 678	175. 518	Dir ... Rev ..	−3, 675. 5 −3, 677. 7	−1. 10 +1. 60	+6. 40	−6. 40	0. 73	7. 5	−5. 52	88. 39448	290. 011	....	....	J.
				Mean .	−3, 676. 60											
T. B. M. 433	T. B. M. 434	1, 785	177. 303	Dir ... Rev ..	−2, 494. 4 −2, 495. 6	−0. 60 +0. 60	+5. 80	−5. 80	0. 40	7. 5	−5. 91	85. 89909	281. 824	....	....	J.
				Mean .	−2, 495. 00											
*P. B. M. 211	T. B. M. 433	53	177. 356	Dir ... Rev ..	+187. 6 +187. 5	−0. 05 +0. 05	+5. 75	−5. 75	0. 03	7. 5	−5. 88	86. 08667	282. 439	....	....	J.
				Mean .	+187. 55											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 424	T. B. M. 425	1,787	192.604	Dir	−2,878.7	−1.00	+5.45	−5.45	0.67	7.8	−6.28	83.40717	273.648	....	....	F.
				Rev	−2,880.7	+1.00										
				Mean	−2,879.70											
*P. B. M. 205 = Old B. M. 190.	T. B. M. 424	142	192.746	Dir	+10,028.5	−0.60	+4.85	−4.85	0.40	7.8	−4.74	93.43661	306.553	306.538	−0.015	J.
				Rev	+10,027.3	+0.60										
				Mean	+10,027.90											
*P. B. M. 204 Lexington.	T. B. M. 424	7	192.611	Dir	+252.98	+0.02	+5.47	−5.47	0.01	7.8	−6.26	83.66019	274.478	....	....	J.
				Rev	+253.03	−0.02										
				Mean	+253.00											
T. B. M. 423	T. B. M. 424	672	193.276	Dir	+1,689.1	+0.90	+6.35	−6.35	0.60	7.8	−6.03	85.09742	279.194	....	....	J.
				Rev	+1,690.9	−0.90										
				Mean	+1,690.00											
*Old B. M. $\frac{42}{1}$ (old position).	T. B. M. 423	76	193.352	Dir	+6,294.2	+0.45	+6.80	−6.80	0.30	7.8	−5.06	91.39304	299.849	300.343	+0.494	J.
				Rev	+6,295.1	−0.45										
				Mean	+6,294.65											
*Cap over Old B. M. $\frac{42}{1}$ (old position.)	T. B. M. 423	76	193.352	Dir	+7,538.8	+0.15	+6.50	−6.50	0.10	7.8	−4.87	92.63753	303.932	....	....	J.
				Rev	+7,539.1	−0.15										
				Mean	+7,538.95											
*P. B. M. 203 = $\frac{42}{1}$ (new position).	T. B. M. 423	42	193.318	Dir	−1,380.2	+0.35	+6.70	−6.70	0.23	7.8	−6.25	83.71735	274.666	....	....	J.
				Rev	−1,379.5	−0.35										
				Mean	−1,379.85											
*Cap over 203	T. B. M. 423	42	193.318	Dir	−140.0	−0.05	+6.30	−6.30	0.03	7.8	−6.05	84.95735	278.734	....	....	J.
				Rev	−140.1	+0.05										
				Mean	−140.05											

* Zero gauge	T. B. M. 423	38	193.314	Dir	—24,117.7	—0.20	+6.15	—6.15	0.13	7.8	—6.42	60.97013	200.065	....	....	J.
				Rev	—24,118.1	+0.20										
				Mean	—24,117.90											
T. B. M. 422	T. B. M. 423	1,830	194.612	1 Dir	—602.8	+4.08	+8.67	—8.07	1.04	7.9	—6.13	84.49800	277.229	....	....	J.
				1 Rev	—595.5	—3.22										
				2 Dir	—599.3	+0.58										
				2 Rev	—597.3	—1.42										
				Mean	—598.72											
P. B. M. 203	T. B. M. 422	1,543	196.155	Dir	+1,581.1	—0.05	+8.62	—8.02	0.03	7.9	—5.89	86.07989	282.417	....	....	J.
				Rev	+1,581.0	+0.05										
				Mean	+1,581.05											
T. B. M. 421	P. B. M. 202	684	196.839	Dir	+2,584.5	—0.65	+7.95	—7.95	0.43	7.9	—5.48	88.66415	290.896	....	....	F.
				Rev	+2,583.2	+0.65										
				Mean	+2,583.85											
* P. B. M. 201	T. B. M. 421	53	196.892	Dir	—1,594.0	+0.30	+8.25	—8.25	0.20	7.9	—5.73	87.07020	285.666	....	....	F.
				Rev	—1,593.4	—0.30										
				Mean	—1,593.70											
* Cap over 201	T. B. M. 421	53	196.892	Dir	—353.3	+0.05	+8.00	—8.00	0.03	7.9	—5.53	88.31085	289.736	....	....	F.
				Rev	—353.2	—0.05										
				Mean	—353.25											
T. B. M. 420	T. B. M. 421	770	197.609	1 Dir	+91.8	+2.50	+9.25	—9.25	0.60	7.9	—5.47	88.75846	291.205	....	....	F.
				1 Rev	+95.8	—1.50										
				2 Dir	+94.2	+0.10										
				2 Rev	+95.4	—1.10										
				Mean	+94.30											
P. B. M. 200	T. B. M. 420	535	198.144	Dir	—2,470.2	—0.40	+8.85	—8.85	0.27	7.9	—5.85	86.28748	283.098	....	....	F.
				Rev	—2,471.0	+0.40										
				Mean	—2,470.60											
T. B. M. 419	P. B. M. 200	644	198.788	Dir	—396.7	+0.40	+9.25	—9.25	0.27	8.0	—5.91	85.89112	281.798	....	....	F.
				Rev	—395.9	—0.40										
				Mean	—396.30											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 418	T. B. M. 419	1,118	199.906	1 Dir	—2,436.9	—2.70	+8.35	—8.35	0.83	8.0	—6.28	83.45115	273.792	....	....	J.
				1 Rev..	—2,442.6	+3.00										
				2 Dir .	—2,440.5	+0.90										
				2 Rev.	—2,438.4	—1.20										
				Mean.	—2,439.60											
T. B. M. 417	T. B. M. 418	910	200.816	Dir ...	—1,617.9	0.00	+8.35	—8.35	0.00	8.0	—6.53	81.83300	268.483	....	....	J.
				Rev ...	—1,617.9	0.00										
				Mean.	—1,617.90											
*P. B. M. 199=[illegible]	T. B. M. 417	213	201.029	Dir ...	—1,653.8	+0.25	+8.60	—8.60	0.17	8.0	—6.80	80.17918	263.057	262.822	—0.235	J.
				Rev ..	—1,653.3	—0.25										
				Mean.	—1,653.55											
*Cap over 199	P. B. M. 199	51	201.029	Dir ...	+1,244.9	—0.25	+8.35	—8.35	0.17	8.0	—6.60	81.42403	267.142	....	....	J.
				Rev ..	+1,244.4	+0.25										
				Mean.	+1,244.65											
T. B. M. 416	T. B. M. 417	1,232	202.048	Dir ...	+1,032.5	—0.50	+7.85	—7.85	0.33	8.0	—6.38	82.86515	271.870	....	....	J.
				Rev ..	+1,031.5	+0.50										
				Mean.	+1,032.00											
T. B. M. 415	T. B. M. 416	1,147	203.195	Dir ...	+1,961.9	+1.20	+9.05	—9.05	0.80	8.1	—6.07	84.82856	278.311	....	....	J.
				Rev ..	+1,964.3	—1.20										
				Mean.	+1,963.10											
T. B. M. 414	T. B. M. 415	944	204.139	Dir ...	+501.4	—0.75	+8.30	—8.30	0.50	8.1	—5.99	85.32929	279.954	....	....	F.
				Rev ..	+499.9	+0.75										
				Mean.	+500.65											

*P. B. M. 198 .... Northrup.	T. B. M. 414	50	204.189	Dir ...	—1,327.2	+0.15	+8.45	—8.45	0.10	8.1	—6.21	84.00202	275.000	....	....	F.
				Rev ..	—1,326.9	—0.15										
				Mean	—1,327.05											
*Cap over 198............	T. B. M. 414	50	204.189	Dir ...	—91.0	+0.05	+8.35	—8.35	0.03	8.1	—6.02	85.23771	279.654	....	....	F.
				Rev ..	—91.5	—0.05										
				Mean .	—91.55											
T. B. M. 413	T. B. M. 414	642	204.781	Dir ...	—1,694.2	—0.15	+8.15	—8.15	0.10	8.1	—6.26	83.63467	274.394	....	....	F.
				Rev ..	—1,694.5	+0.15										
				Mean .	—1,694.35											
T. B. M. 412 .... Tabo Creek.	T. B. M. 413	1,590	206.371	Dir ...	—1,487.4	+1.15	+9.30	—9.30	0.77	8.1	—6.48	82.14820	269.518	....	....	F.
				Rev ..	—1,485.1	—1.15										
				Mean .	—1,486.25											
*P. B. M. 197	T. B. M. 412	44	206.415	Dir ...	—261.4	+0.15	+9.45	—9.45	0.10	8.1	—6.53	81.88690	268.600	....	....	F.
				Rev ..	—261.1	—0.15										
				Mean .	—261.25											
T. B. M. 411	T. B. M. 412	1,062	207.433	Dir ...	+1,270.2	—0.25	+9.05	—9.05	0.17	8.1	—6.29	83.41834	273.685	....	....	F.
				Rev ..	+1,269.7	+0.25										
				Mean	+1,269.95											
*P. B. M. 196	T. B. M. 411	7	207.440	Dir ...	—626.8	+0.15	+9.20	—9.20	0.10	8.1	—6.39	82.79159	271.628	....	....	F.
				Rev .	—626.5	—0.15										
				Mean .	—626.65											
*P. B. M. 195=$^{8}_{1}$........ Berlin.	T. B. M. 411	216	207.649	Dir ...	—1,394.9	—0.50	+8.55	—8.55	0.33	8.1	—6.50	82.02273	269.106	268.837	—0.269	F.
				Rev ..	—1,395.9	+0.50										
				Mean .	—1,395.40											
*Cap over 195...........	P. B. M. 195	144	207.649	Dir ...	+1,235.3	+0.10	+8.65	—8.65	0.07	8.1	—6.32	83.25831	273.160	....	....	F.
				Rev ..	+1,235.5	—0.10										
				Mean .	+1,235.40											
T. B. M. 410	T. B. M. 411	2,753	210.186	Dir ...	—1,906.4	—0.65	+8.40	—8.40	0.43	8.1	—6.59	81.51099	267.427	....	....	F.
				Rev...	—1,907.7	+0.65										
				Mean .	—1,907.05											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 418	T. B. M. 410	1,118	199.906	1 Dir	—2,436.9	—2.70	+8.35	—8.35	0.83	8.0	—6.28	83.45115	273.792			J.
				1 Rev	—2,442.6	+3.00										
				2 Dir	—2,440.5	+0.90										
				2 Rev	—2,438.4	—1.20										
				Mean	—2,439.60											
T. B. M. 417	T. B. M. 418	910	200.816	Dir	—1,617.9	0.00	+8.35	—8.35	0.00	8.0	—6.53	81.83300	268.483			J.
				Rev	—1,617.9	0.00										
				Mean	—1,617.90											
P. B. M. 199=?	T. B. M. 417	213	201.029	Dir	—1,653.8	+0.25	+8.60	—8.60	0.17	8.0	—6.80	80.17918	263.057	262.822	—0.235	J.
				Rev	—1,653.3	—0.25										
				Mean	—1,653.55											
*Cap over 199	P. B. M. 199	51	201.029	Dir	+1,244.9	—0.25	+8.35	—8.35	0.17	8.0	—6.60	81.42403	267.142			J.
				Rev	+1,244.4	+0.25										
				Mean	+1,244.65											
T. B. M. 416	T. B. M. 417	1,232	202.048	Dir	+1,032.5	—0.50	+7.85	—7.85	0.33	8.0	—6.38	82.86515	271.870			J.
				Rev	+1,031.5	+0.50										
				Mean	+1,032.00											
T. B. M. 415	T. B. M. 416	1,147	203.195	Dir	+1,961.9	+1.20	+9.05	—9.05	0.80	8.1	—6.07	84.82856	278.311			J.
				Rev	+1,964.3	—1.20										
				Mean	+1,963.10											
T. B. M. 414	T. B. M. 415	944	204.139	Dir	+501.4	—0.75	+8.30	—8.30	0.50	8.1	—5.99	85.32929	279.954			F.
				Rev	+499.9	+0.75										
				Mean	+500.65											

*Cap over 193	T. B. M. 405	54	215.087	Dir	+2,600.9	−0.05	+10.65	−10.65	0.03	8.3	−6.41	82.77852	271.586	....	....	J.
				Rev	+2,600.8	+0.05										
				Mean	+2,600.85											
T. B. M. 404	T. B. M. 405	731	215.764	Dir	−41.7	+0.60	+11.30	−11.30	0.40	8.3	−6.80	80.13618	262.916	....	....	J.
				Rev	−40.5	−0.60										
				Mean	−41.10											
T. B. M. 403	T. B. M. 404	2,043	217.806	Dir	+635.4	−0.60	+10.70	−10.70	0.40	8.3	−6.70	80.77108	264.999	....	....	J.
				Rev	+634.2	+0.60										
				Mean	+634.80											
P. B. M. 192 Edwards.	T. B. M. 403	32	217.838	Dir	−1,208.3	+0.20	+10.90	−10.90	0.13	8.3	−6.89	79.56279	261.035	....	....	J.
				Rev	−1,207.9	−0.20										
				Mean	−1,208.10											
*Cap over 192	T. B. M. 403	32	217.838	Dir	+35.2	−0.15	+10.55	−10.55	0.10	8.3	−6.69	80.80614	265.114	....	....	J.
				Rev	+34.9	+0.15										
				Mean	+35.05											
*P. B. M. 191	T. B. M. 403	63	217.869	Dir	+1,424.7	+0.15	+10.85	−10.85	0.10	8.3	−6.47	82.19616	269.675	....	....	J.
				Rev	+1,425.0	−0.15										
				Mean	+1,424.85											
T. B. M. 402	T. B. M. 403	2,242	220.048	Dir	+2,105.2	+0.20	+10.90	−10.90	0.13	8.3	−6.37	82.87681	271.908	....	....	F.
				Rev	+2,105.6	−0.20										
				Mean	+2,105.40											
*P. B. M. 190	T. B. M. 402	14	220.062	Dir	+534.1	+0.05	+10.95	−10.95	0.03	8.3	−6.29	83.41104	273.661	....	....	F.
				Rev	+534.2	−0.05										
				Mean	+534.15											
T. B. M. 401	T. B. M. 402	1,192	221.240	Dir	−791.3	−0.20	+10.70	−10.70	0.13	8.3	−6.49	82.08519	269.311	....	....	F.
				Rev	−791.7	+0.20										
				Mean	−791.50											
*P. B. M. 189=52	T. B. M. 401	43	221.283	Dir	+4,522.4	−0.05	+10.65	−10.65	0.03	8.3	−5.80	86.60823	284.150	283.906	−0.244	F.
				Rev	+4,522.3	+0.05										
				Mean	+4,522.35											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of the Missouri River—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals. =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Cap over 189	P. B. M. 189	33	221.283	Dir	+1,239.5	−0.05	+10.60	−10.60	0.03	8.3	−5.60	87.84788	288.217	....	....	F.
				Rev	+1,239.4	+0.05										
				Mean	+1,239.45											
T. B. M. 400	T. B. M. 401	1,316	222.556	Dir	−926.0	−0.55	+10.15	−10.15	0.37	8.3	−6.64	81.15849	266.270	....	....	J.
				Rev	−927.1	+0.55										
				Mean	−926.55											
T. B. M. 399	T. B. M. 400	1,064	223.620	Dir	−913.6	−0.95	+9.20	−9.20	0.63	8.4	−6.78	80.24380	263.269	....	....	J.
				Rev	−915.5	+0.95										
				Mean	−914.55											
T. B. M. 398	T. B. M. 399	930	224.550	Dir	+347.6	−0.80	+8.40	−8.40	0.53	8.4	−6.73	80.59065	264.407	....	....	F.
				Rev	+346.0	+0.80										
				Mean	+346.80											
*P. B. M. 188	T. B. M. 398	41	224.591	Dir	−947.1	+0.05	+8.45	−8.45	0.03	8.4	−6.88	79.64345	261.300	....	....	F.
				Rev	−947.0	−0.05										
				Mean	−947.05											
*Cap over 188	T. B. M. 398	41	224.591	Dir	+288.0	+0.10	+8.50	−8.50	0.07	8.4	−6.68	80.87880	265.353	....	....	F.
				Rev	+288.2	−0.10										
				Mean	+288.10											
T. B. M. 397	T. B. M. 398	652	225.202	Dir	−220.3	+1.05	+9.45	−9.45	0.70	8.4	−6.77	80.37186	263.688	....	....	F.
				Rev	−218.2	−1.05										
				Mean	−219.25											
* P. B. M. 187	T. B. M. 397	14	225.216	Dir	−543.7	−0.25	+9.20	−9.20	0.17	8.4	−6.84	79.82734	261.903	....	....	W.
				Rev	−544.2	+0.25										
				Mean	−543.95											

T. B. M. 396	T. B. M. 397	782	225.934	Dir	—3.5	—0.15	+9.30	—9.30	0.10	8.4	—0.77	80.36771	263.676			F.
				Rev	—3.8	+0.15										
				Mean	—3.65											
* P. B. M. 186	T. B. M. 396	15	225.949	Dir	—1,415.7	+0.05	+9.35	—9.35	0.03	8.4	—6.98	78.95185	259.031			W.
				Rev	—1,415.6	—0.05										
				Mean	—1,415.65											
T. B. M. 395	T. B. M. 396	534	226.468	Dir	+3,011.2	+0.70	+10.00	—10.00	0.47	8.4	—6.29	83.38009	273.559			F.
				Rev	+3,012.6	—0.70										
				Mean	+3,011.90											
T. B. M. 393	T. B. M. 395	1,188	227.656	Dir	—1,374.0	—0.15	+9.85	—9.85	0.10	8.4	—6.51	82.00572	269.050			J.
				Rev	—1,374.3	+0.15										
				Mean	—1,374.15											
*T. B. M. 394	T. B. M. 393	344	228.000	Dir	+778.5	+0.45	+10.30	—10.30	0.30	8.4	—6.88	82.78480	271.606			F.
				Rev	+779.4	—0.45										
				Mean	+778.95											
*P.B.M.185= 5/1 Waverly.	T. B. M. 394	11	228.011	Dir	—126.3	—0.05	+10.25	—10.25	0.03	8.4	—6.41	82.65842	271.192	271.019	—0.173	F.
				Rev	—126.4	+0.05										
				Mean	—126.35											
*Cap over 185	T. B. M. 394	11	228.011	Dir	+1,120.7	+0.10	+10.40	—10.40	0.07	8.4	—6.22	83.90576	275.284			F.
				Rev	+1,120.9	—0.10										
				Mean	+1,120.80											
*Zero gauge	T. B. M. 393	153	227.809	Dir	—21,936.4	—0.20	+9.65	—9.65	0.13	8.4	—7.37	60.06826	197.076			F.
				Rev	—21,936.8	+0.20										
				Mean	—21,936.60											
T. B. M. 392	T. B. M. 393	842	228.498	Dir	—948.4	—0.70	+9.15	—9.15	0.47	8.4	—6.65	81.05648	265.936			J.
				Rev	—949.8	+0.70										
				Mean	—949.10											
T. B. M. 391	T. B. M. 392	764	229.262	Dir	—1,439.5	0.00	+9.15	—9.15	0.00	8.4	—6.89	79.61674	261.212			J.
				Rev	—1,439.5	0.00										
				Mean	—1,439.50											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*T. B. M. 390=Old B. M. 175.	T. B. M. 391	348	229.610	Dir ...	−3,148.4	−0.35	+8.80	−8.80	0.23	8.4	−7.38	76.46750	250.880	252.154	+1.274	J.
				Rev ..	−3,149.1	+0.35										
				Mean .	−3,148.75											
*P. B. M. 184=$^{M}_{1}$	T. B. M. 390	682	230.292	Dir ...	−1,535.7	−0.30	+8.50	−8.50	0.20	8.4	−7.61	74.93127	245.840	245.602	−0.238	J.
				Rev ..	−1,536.3	+0.30										
				Mean .	−1,536.00											
*Cap over 184	P. B. M. 184	102	230.292	Dir ...	+1,240.8	+0.10	+8.60	−8.60	0.07	8.4	−7.42	76.17236	249.912	....	....	J.
				Rev ..	+1,241.0	−0.10										
				Mean .	+1,240.90											
T. B. M. 389	T. B. M. 391	1,246	230.508	Dir ...	−804.3	+0.25	+9.40	−9.40	0.17	8.4	−7.01	78.81257	258.574	....	....	J.
				Rev ...	−803.8	−0.25										
				Mean .	−804.05											
T. B. M. 388	T. B. M. 389	1,452	231.960	Dir ...	−1,969.4	−0.65	+8.75	−8.75	0.43	8.4	−7.31	76.84222	252.109	....	....	F.
				Rev ..	−1,970.7	+0.65										
				Mean .	−1,970.05											
*P. B. M. 183	T. B. M. 388	83	232.043	Dir ...	+2,537.7	+0.30	+9.05	−9.05	0.20	8.5	−6.92	79.38061	260.438	....	....	F.
				Rev ..	+2,538.3	−0.30										
				Mean .	+2,538.00											
*Cap over 183	T. B. M. 388	83	232.043	Dir ...	+3,777.3	+0.20	+8.95	−8.95	0.13	8.4	−6.73	80.62030	264.505	....	....	F.
				Rev ..	+3,777.7	−0.20										
				Mean .	+3,777.50											
T. B. M. 387	**T. B. M. 388**	384	232.344	Dir ...	−1,166.6	+0.45	+9.20	−9.20	0.30	8.5	−7.49	75.67589	248.283	....	....	F.
				Rev ..	−1,165.7	−0.45										
				Mean .	−1,166.15											

T. B. M. 386	T. B. M. 387	1,150	233.494	Dir	+1,063.0	+0.20	+9.40	—9.40	0.13	8.5	—7.33	76.73985	251.774	....	....	F.
				Rev	+1,064.0	—0.20										
				Mean	+1,063.80											
T. B. M. 385	T. B. M. 386	780	234.274	Dir	—2,126.8	0.00	+9.40	—9.40	0.00	8.5	—7.66	74.61272	244.795	....	....	F.
				Rev	—2,126.8	0.00										
				Mean	—2,126.80											
T. B. M. 384	T. B. M. 385	938	235.212	Dir	+1,097.7	+0.80	+10.20	—10.20	0.53	8.5	—7.40	75.71139	248.390	....	....	J.
				Rev	+1,099.3	—0.80										
				Mean	+1,098.50											
*P. B. M. 182=⅝	T. B. M. 384	25	235.237	Dir	—931.6	+0.05	+10.25	—10.25	0.03	8.5	—7.63	74.77970	245.342	245.188	—0.204	J.
				Rev	—931.5	—0.05										
				Mean	—931.55											
*Cap over 182	T. B. M. 384	25	235.237	Dir	+312.0	—0.15	+10.05	—10.05	0.10	8.5	—7.45	76.02328	249.422	....	....	J.
				Rev	+311.7	+0.15										
				Mean	+311.85											
T. B. M. 383	T. B. M. 384	560	235.772	Dir	—109.8	—0.15	+10.05	—10.05	0.10	8.5	—7.51	75.60142	248.038	....	....	J.
				Rev	—110.1	+0.15										
				Mean	—109.95											
T. B. M. 382	T. B. M. 383	1,796	237.568	Dir	—763.0	+0.85	+10.90	—10.90	0.57	8.5	—7.62	74.83916	245.538	....	....	J.
				Rev	—761.3	—0.85										
				Mean	—762.15											
T. B. M. 381	T. B. M. 382	2,056	239.624	Dir	—221.8	—1.65	+9.25	—9.25	1.10	8.6	—7.67	74.61566	244.804	....	....	J.
				Rev	—225.1	+1.65										
				Mean	—223.45											
T. B. M. 380	T. B. M. 381	1,166	240.790	Dir	+439.6	+1.05	+10.30	—10.30	0.70	8.6	—7.59	75.05639	246.250	....	....	F.
				Rev	+441.7	—1.05										
				Mean	+440.65											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 379	T. B. M. 380	685	241.475	1 Dir	—581.1	+0.93	+10.50	—10.50	0.61	8.6	—7.68	74.47613	244.346	....	....	F.
				1 Rev	—577.0	—3.17										
				2 Dir	—580.1	—0.07										
				2 Rev	—583.8	+3.63										
				3 Dir	—579.9	—0.27										
				3 Rev	—579.1	—1.07										
				Mean	—580.17											
*P. B. M. 181	T. B. M. 379	116	241.591	Dir	—1,018.8	+0.05	+10.55	—10.55	0.03	8.6	—7.84	73.45722	241.004	....	....	J.
				Rev	—1,018.7	—0.05										
				Mean	—1,018.75											
*Cap over 181	T. B. M. 379	117	241.591	Dir	+219.7	0.00	+10.50	—10.50	0.00	8.6	—7.65	74.69586	245.067	....	....	J.
				Rev	+219.7	0.00										
				Mean	+219.70											
T. B. M. 378	T. B. M. 379	405	241.880	Dir	—225.2	+0.10	+10.60	—10.60	0.07	8.6	—7.71	74.25100	243.608	....	....	F.
				Rev	—225.0	—0.10										
				Mean	—225.10											
T. B. M. 377	T. B. M. 378	1,482	243.362	Dir	—94.2	—0.90	+9.70	—9.70	0.60	8.6	—7.73	74.15588	243.296	....	....	F.
				Rev	—96.0	+0.90										
				Mean	—95.10											
T. B. M. 376	T. B. M. 377	1,021	244.383	Dir	—189.2	—0.65	+9.05	—9.05	0.43	8.6	—7.76	73.96600	242.673	....	....	F.
				Rev	—190.5	+0.65										
				Mean	—189.85											
*P. B. M. 180 Malta Bend Landing.	T. B. M. 376	167	244.550	Dir	—1,214.6	0.00	+9.05	—9.05	0.00	8.6	—7.94	72.75122	238.687	....	....	F.
				Rev	—1,214.6	0.00										
				Mean	—1,214.60											

*Cap over 180	T. B. M. 376	167	244.550	Dir	+25.5	+0.10	+9.15	−9.15	0.07	8.6	−7.75	73.99161	242.757			F.
				Rev	+25.7	−0.10										
				Mean	+25.60											
T. B. M. 375	T. B. M. 376	1,171	245.554	Dir	+1,039.1	+0.15	+9.20	−9.20	0.10	8.6	−7.60	75.00541	246.083			F.
				Rev	+1,039.4	−0.15										
				Mean	+1,039.25											
T. B. M. 374	T. B. M. 375	928	246.482	Dir	−1,298.6	−0.45	+8.75	−8.75	0.30	8.7	−7.81	73.70615	241.820			J.
				Rev	−1,299.5	+0.45										
				Mean	−1,299.05											
T. B. M. 373 Laynesville.	T. B. M. 374	1,486	247.968	Dir	−448.2	+0.65	+9.40	−9.40	0.43	8.7	−7.88	73.25853	240.352			J.
				Rev	−446.9	−0.65										
				Mean	−447.55											
*P. B. M. 179 = ♃	T. B. M. 373	1,624	249.592	Dir	−753.7	−0.05	+9.35	−9.35	0.03	8.7	−7.98	72.50468	237.878	237.801	−0.077	J.
				Rev	−753.8	+0.05										
				Mean	−753.75											
*Cap over 179	P. B. M. 179	67	249.592	Dir	+1,240.4	+0.05	+9.40	−9.40	0.03	8.7	−7.79	73.74532	241.949			J.
				Rev	+1,240.5	−0.05										
				Mean	−1,240.45											
T. B. M. 372	T. B. M. 373	1,815	249.783	Dir	+914.7	−0.85	+8.55	−8.55	0.57	8.7	−7.73	74.17253	243.350			F.
				Rev	+913.0	+0.85										
				Mean	+913.85											
T. B. M. 371	T. B. M. 372	760	250.543	Dir	−265.9	+0.10	+8.65	−8.65	0.07	8.7	−7.78	73.90668	242.478			F.
				Rev	−265.7	−0.10										
				Mean	−265.80											
T. B. M. 370	T. B. M. 371	818	251.361	Dir	−1,029.5	−0.35	+8.30	−8.30	0.23	8.7	−7.92	72.87669	239.099			F.
				Rev	−1,030.2	+0.35										
				Mean	−1,029.85											
T. B. M. 369	T. B. M. 370	1,551	252.912	Dir	+732.3	−0.50	+7.80	−7.80	0.33	8.7	−7.83	73.60858	241.500			J.
				Rev	+731.3	+0.50										
				Mean	+731.80											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 379	T. B. M. 380	685	241.475	1 Dir.	−581.1	+0.93	+10.50	−10.50	0.61	8.6	−7.68	74.47613	244.346	....	....	F.
				1 Rev.	−577.0	−3.17										
				2 Dir.	−580.1	−0.07										
				2 Rev.	−583.8	+3.63										
				3 Dir.	−579.9	−0.27										
				3 Rev.	−579.1	−1.07										
				Mean.	−580.17											
*P. B. M. 181	T. B. M. 379	116	241.591	Dir...	−1,018.8	+0.05	+10.55	−10.55	0.03	8.6	−7.84	73.45722	241.004	....	....	J.
				Rev...	−1,018.7	−0.05										
				Mean.	−1,018.75											
*Cap over 181	T. B. M. 379	117	241.591	Dir...	+219.7	0.00	+10.50	−10.50	0.00	8.6	−7.65	74.69586	245.067	....	....	J.
				Rev...	+219.7	0.00										
				Mean.	+219.70											
T. B. M. 378	T. B. M. 379	405	241.880	Dir...	−225.2	+0.10	+10.60	−10.60	0.07	8.6	−7.71	74.25100	243.608	....	....	F.
				Rev...	−225.0	−0.10										
				Mean.	−225.10											
T. B. M. 377	T. B. M. 378	1,482	243.362	Dir...	−94.2	−0.90	+9.70	−9.70	0.60	8.6	−7.73	74.15588	243.296	....	....	F.
				Rev...	−96.0	+0.90										
				Mean.	−95.10											
T. B. M. 376	T. B. M. 377	1,021	244.383	Dir...	−189.2	−0.65	+9.05	−9.05	0.43	8.6	−7.76	73.96600	242.673	....	....	F.
				Rev...	−190.5	+0.65										
				Mean.	−189.85											
*P. B. M. 180 .... Malta Bend Landing.	T. B. M. 376.......	167	244.550	Dir...	−1,214.6	0.00	+9.05	−9.05	0.00	8.6	−7.94	72.75122	238.687	....	....	F.
				Rev...	−1,214.6	0.00										
				Mean.	−1,214.60											

T. B. M. 362	T. B. M. 363	1,622	260.460	Dir ... Rev ...	—559.6 —561.0	—0.70 +0.70	+5.25	—5.25	0.47	8.8	—8.18	71.31448	233.974	....	....	F.
				Mean .	—560.30											
*P. B. M. 177=$\frac{14}{1}$	T. B. M. 362	14	260.483	Dir ... Rev ..	—1,272.5 —1,272.6	—0.05 +0.05	+5.20	—5.20	0.03	8.8	—8.37	70.04174	229.798	229.430	—0.368	J.
				Mean .	—1,272.55											
*Cap over 177	T. B. M. 362	14	260.483	Dir ... Rev ...	—30.0 —29.7	+0.15 —0.15	+5.40	—5.40	0.10	8.8	—8.17	71.28464	233.870	....	....	J.
				Mean .	—29.85											
T. B. M. 361	T. B. M. 362	1,481	261.950	Dir ... Rev ...	+370.4 +370.9	+0.25 —0.25	+5.50	—5.50	0.17	8.8	—8.12	71.68519	235.190	....	....	J.
				Mean .	+370.65											
T. B. M. 360	T. B. M. 361	1,024	262.974	Dir ... Rev ...	+572.3 +569.7	—1.30 +1.30	+4.20	—4.20	0.87	8.9	—8.02	72.25629	237.064	....	....	J.
				Mean .	+571.00											
T. B. M. 359	T. B. M. 360	960	263.934	Dir ... Rev ...	—3,786.2 —3,787.5	—0.65 +0.65	+3.55	—3.55	0.43	8.9	—8.62	68.46884	224.637	....	....	F.
				Mean .	—3,786.85											
*P. B. M. 176	T. B. M. 359	39	263.973	Dir ... Rev ...	+759.0 +758.9	—0.05 +0.05	+3.50	—3.50	0.03	8.9	—8.49	69.22792	227.128	....	....	W.
				Mean .	+758.95											
T. B. M. 358	T. B. M. 359	837	264.771	Dir ... Rev ...	+3,123.4 +3,120.1	—1.65 +1.65	+1.90	—1.90	1.10	8.9	—8.13	71.59108	234.881	....	....	F.
				Mean .	+3,121.75											
*P. B. M. 175=$\frac{53}{1}$ .... Miami.	T. B. M. 358	11	264.782	Dir ... Rev ...	—1,162.7 —1,162.6	+0.05 —0.05	+1.95	—1.95	0.03	8.9	—8.32	70.42824	231.066	230.775	—0.291	F.
				Mean .	—1,162.65											
*Cap over 175	T. B. M. 358	11	264.782	Dir ... Rev ...	+80.5 +80.6	+0.05 —0.05	+1.95	—1.95	0.03	8.9	—8.11	71.67165	235.145	....	....	F.
				Mean .	+80.55											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals. =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 368	T. B. M. 369	1,004	253.916	Dir	−343.1	−0.25	+7.55	−7.55	0.17	8.7	−7.88	73.26518	240.374	....	....	J.
				Rev	−343.6	+0.25										
				Mean	−343.35											
T. B. M. 367	T. B. M. 368	806	254.722	Dir	−1,099.1	−0.35	+7.20	−7.20	0.23	8.7	−8.03	72.16558	236.766	....	....	F.
				Rev	−1,099.8	+0.35										
				Mean	−1,099.45											
*P. B. M. 178	T. B. M. 367	17	254.739	Dir	−935.7	−0.15	+7.05	−7.05	0.10	8.7	−8.18	71.22958	233.695	....	....	F.
				Rev	−936.0	+0.15										
				Mean	−935.85											
*Cap over 178	T. B. M. 367	17	254.739	Dir	+295.6	+0.10	+7.30	−7.30	0.07	8.7	−8.00	72.46131	237.736	....	....	F.
				Rev	+295.8	−0.10										
				Mean	+295.70											
T. B. M. 366	T. B. M. 367	1,562	256.284	Dir	−259.6	−1.65	+5.55	−5.55	1.10	8.8	−8.08	71.90428	235.908	....	....	F.
				Rev	−262.9	+1.65										
				Mean	−261.25											
T. B. M. 365	T. B. M. 366	964	257.248	Dir	−529.4	−0.65	+4.90	−4.90	0.43	8.8	−8.16	71.37415	234.169	....	....	J.
				Rev	−530.7	+0.65										
				Mean	−530.05											
T. B. M. 364	T. B. M. 365	813	258.061	Dir	+1,051.6	−0.05	+4.85	−4.85	0.03	8.8	−8.00	72.42586	237.620	....	....	J.
				Rev	+1,051.5	+0.05										
				Mean	+1,051.55											
T. B. M. 363	T. B. M. 364	786	258.847	Dir	−552.0	+1.10	+5.95	−5.95	0.73	8.8	−8.08	71.87488	235.812	....	....	F.
				Rev	−549.8	−1.10										
				Mean	−550.90											

*P. B. M. 172	T. B. M. 352	17	268.489	Dir	—970.9	+0.05	+0.70	—0.70	0.03	9.0	—8.60	68.58091	225.005		F.
				Rev	—970.8	—0.05									
				Mean	—979.85										
*Cap over 172	T. B. M. 352	17	268.489	Dir	+261.5	—0.05	+0.60	—0.60	0.03	9.0	—8.41	69.82240	229.078		F.
				Rev	+261.4	+0.05									
				Mean	+261.45										
T. B. M. 351	T. B. M. 352	1,930	270.402	Dir	—244.8	+1.20	+1.85	—1.85	0.80	9.1	—8.48	69.31728	227.421		F.
				Rev	—242.4	—1.20									
				Mean	—243.60										
T. B. M. 350	T. B. M. 351	1,782	272.134	Dir	—45.3	—1.65	+0.20	—0.20	1.10	9.1	—8.49	69.27032	227.267		F.
				Rev	—48.6	+1.65									
				Mean	—46.95										
T. B. M. 349	T. B. M. 350	1,371	273.505	Dir	—278.7	—2.05	—1.85	+1.85	1.37	9.2	—8.54	68.98952	226.346		J.
				Rev	—282.8	+2.05									
				Mean	—280.75										
*P. B. M. 171 =^{52}	T. B. M. 349	228	273,733	Dir	—1,209.3	0.00	—1.85	+1.85	0.00	9.2	—8.72	67.78004	222.377	221.037	—1.340	J.
				Rev	—1,209.3	0.00									
				Mean	—1,209.30										
*Cap over 171	P. B. M. 171	63	273.733	Dir	+1,235.9	—0.05	—1.90	+1.90	0.03	9.2	—8.52	69.01609	226.433		J.
				Rev	+1,235.8	+0.05									
				Mean	+1,235.85										
T. B. M. 348	T. B. M. 349	1,887	275,392	Dir	—1,536.5	+0.45	—1.40	+1.40	0.30	9.2	—8.77	67.45324	221.305		J.
				Rev	—1,535.6	—0.45									
				Mean	—1,536.05										
T. B. M. 347	T. B. M. 348	786	276.178	Dir	+186.3	—0.90	—2.30	+2.30	0.60	9.2	—8.74	67.63867	221.914		F.
				Rev	+184.5	+0.90									
				Mean	+185.40										
*P. B. M. 170 =^{41}	T. B. M. 347	450	276.628	Dir	—110.0	+0.40	—1.90	+1.90	0.27	9.2	—8.75	67.52006	221.554	220.176	—1,378	F.
				Rev	—109.2	—0.40									
				Mean	—109.60										

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Cap over 170	P. B. M. 170	222	276.628	Dir	+1,239.3	−0.15	−2.05	+2.05	0.10	9.2	−8.57	68.76839	225.620	....	....	F.
				Rev	+1,239.0	+0.15										
				Mean	+1,239.15											
T. B. M. 346	T. B. M. 347	1,758	277.936	Dir	−1,393.4	−0.45	−2.75	+2.75	0.30	9.2	−8.96	66.24460	217.340	....	....	F.
				Rev	−1,394.3	+0.45										
				Mean	−1,393.85											
T. B. M. 345	T. B. M. 346	2,014	279.950	Dir	−479.5	−1.10	−3.85	+3.85	0.73	9.3	−9.03	65.76393	215.763	....	....	J.
				Rev	−481.7	+1.10										
				Mean	−480.60											
*P. B. M. 169	T. B. M. 345	210	280.160	Dir	+1,140.7	+0.05	−3.80	+3.80	0.03	9.3	−8.86	66.90485	219.506	....	....	J.
				Rev	+1,140.8	−0.05										
				Mean	+1,140.75											
*Cap over 169	P. B. M. 169	31	280.160	Dir	+1,239.5	+0.05	−3.75	+3.75	0.03	9.3	−8.65	68.14461	223.574	....	....	J.
				Rev	+1,239.6	−0.05										
				Mean	+1,239.55											
T. B. M. 344 Cromwell Point.	T. B. M. 345	1,106	281.056	Dir	+1,009.5	−0.55	−4.40	+4.40	0.37	9.3	−8.88	66.77303	219.074	....	....	J.
				Rev	+1,008.4	+0.55										
				Mean	+1,008.95											
T. B. M. 343	T. B. M. 344	1,288	282.344	Dir	+286.2	−0.65	−5.05	+5.05	0.43	9.3	−8.83	67.04863	219.978	....	....	F.
				Rev	+284.9	+0.65										
				Mean	+285.55											
T. B. M. 342	T. B. M. 343	1,286	283.630	Dir	+183.2	+0.55	−4.50	+4.50	0.37	9.3	−8.81	67.24240	220.614	....	....	F.
				Rev	+184.3	−0.55										
				Mean	+183.75											

*P. B. M. 168—[illegible]	T. B. M. 342	221	283. 851	Dir	—1, 254. 0	—0. 30	—4. 80	+4. 80	0. 20	9. 3	—9. 00	65. 98791	216. 408	215. 121	—1. 377	F.
				Rev	—1, 254. 6	+0. 30										
				Mean	—1, 254. 30											
*Cap over 108	P. B. M. 108	100	283. 851	Dr	+1, 241. 0	+0. 05	—4. 75	+4. 75	0. 03	9. 3	—8. 80	67. 22916	220. 570			F.
				Rev	+1, 241. 1	—0. 05										
				Mean	+1, 241. 05											
T. B. M. 341	T. B. M. 342	354	283. 984	Dir	+4, 574. 4	+0. 15	—4. 35	+4. 35	0. 10	9. 3	—8. 08	71. 81768	235. 624			F.
				Rev	+4, 574. 7	—0. 15										
				Mean	+4, 574. 55											
T. B. M. 340	T. B. M. 341	307	284. 291	Dir	—34. 3	+0. 45	—3. 90	+3. 90	0. 30	9. 3	—8. 10	71. 78381	235. 513			F.
				Rev	—33. 4	—0. 45										
				Mean	—33. 85											
T. B. M. 339 Graves Creek.	T. B. M. 340	809	285. 190	Dir	—6, 031. 2	+1. 25	—2. 65	+2. 65	0. 83	9. 3	—9. 03	65. 75293	215. 727			F.
				Rev	—6, 028. 7	—1. 25										
				Mean	—6, 029. 95											
T. B. M. 338	T. B. M. 339	638	285. 828	Dir	+2, 688. 2	—1. 50	—4. 15	+4. 15	1. 00	9. 4	—8. 62	68. 44004	224. 543			J.
				Rev	+2, 685. 2	+1. 50										
				Mean	+2, 686. 70											
T. B. M. 337	T. B. M. 338	1, 688	287. 516	Dir	—1, 935. 0	—1. 85	—6. 00	+6. 00	1. 23	9. 5	—8. 92	66. 50289	218. 187			J.
				Rev	—1, 938. 7	+1. 85										
				Mean	—1, 936. 85											
*P. B. M. 167	T. B. M. 337	56	287. 572	Dir	—1, 562. 3	+0. 25	—5. 75	+5. 75	0. 17	9. 5	—9. 16	64. 94060	213. 062			J.
				Rev	—1, 561. 8	—0. 25										
				Mean	—1, 562. 05											
*Cap over 167	T. B. M. 337	56	287. 572	Dir	—326. 0	—0. 05	—6. 05	+6. 05	0. 03	9. 5	—8. 96	66. 17680	217. 118			J.
				Rev	—326. 1	+0. 05										
				Mean	—326. 05											
T. B. M. 336	T. B. M. 337	691	288. 207	Dir	—1, 122. 9	+0. 65	—5. 35	+5. 35	0. 43	9. 5	—9. 08	65. 38048	214. 505			J.
				Rev	—1, 121. 6	—0. 65										
				Mean	—1, 122. 25											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V: Direct line.	Σ V: Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix: Meters.	Elevation above St. Louis City Directrix: Feet.	Elevation above St. Louis City Directrix: Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 335	T. B. M. 336	1,063	289.270	Dir	−1,261.6	−0.50	−5.85	+5.85	0.33	9.5	−9.30	64.11816	210.363	....	....	F.
				Rev	−1,262.6	+0.50										
				Mean	−1,262.10											
T. B. M. 334	T. B. M. 335	1,478	290.748	Dir	+54.6	+2.15	−3.70	+3.70	1.43	9.6	−9.28	64.17493	210.550	....	....	F.
				Rev	+58.9	−2.15										
				Mean	+56.75											
T. B. M. 333	T. B. M. 334	1,376	292.124	Dir	−295.9	+0.75	−2.95	+2.95	0.50	9.6	−9.33	63.87973	209.581	....	....	F.
				Rev	−294.4	−0.75										
				Mean	−295.15											
T. B. M. 332	T. B. M. 333	618	292.742	Dir	+2,348.6	+0.50	−2.45	+2.45	0.33	9.6	−8.97	66.22919	217.289	....	....	J.
				Rev	+2,349.6	−0.50										
				Mean	+2,349.10											
*P. B. M. 166=4^{8}_{1} New Frankfort.	T. B. M. 332	24	292.766	Dir	−1,350.8	−0.10	−2.55	+2.55	0.07	9.6	−9.17	64.87809	212.856	212.695	−0.161	J.
				Rev	−1,351.0	+0.10										
				Mean	−1,350.90											
*Cap over 166	T. B. M. 332	24	292.766	Dir	−108.5	+0.20	−2.25	+2.25	0.13	9.6	−8.99	66.12087	216.934	....	....	J.
				Rev	−108.1	−0.20										
				Mean	−108.30											
T. B. M. 331 Salt Creek.	T. B. M. 332	1,784	294.526	Dir	−2,715.4	+1.20	−1.25	+1.25	0.80	9.6	−9.40	63.51456	208.383	....	....	J.
				Rev	−2,713.0	−1.20										
				Mean	−2,714.20											
T. B. M. 330	T. B. M. 331	2,037	296.563	Dir	−36.6	−0.25	−1.50	+1.50	0.17	9.7	−9.40	63.47771	208.262	....	....	J.
				Rev	−37.1	+0.25										
				Mean	−36.85											

T. B. M. 329	T. B. M. 330	1,848	298.411	Dir ...	+1,170.7	−1.30	−2.80	+2.80	0.87	9.7	−9.23	64.64729	212.099	....	....	F.
				Rev ..	+1,168.1	+1.30										
				Mean .	+1,169.40											
*P. B. M. 165	T. B. M. 329	57	298.468	Dir ...	−1,905.1	0.00	−2.80	+2.80	0.00	9.7	−9.51	62.74190	205.848	....	....	F.
				Rev ..	−1,905.1	0.00										
				Mean .	−1,905.10											
*Cap over 165	T. B. M. 329	57	298.468	Dir ...	−667.8	−0.25	−3.05	+3.05	0.17	9.7	−9.32	63.97914	209.907	....	....	F.
				Rev ..	−668.5	+0.25										
				Mean .	−668.05											
T. B. M. 328	T. B. M. 329	1,644	300.065	Dir ...	−1,808.6	+1.55	−1.25	+1.25	1.03	9.7	−9.48	62.83998	206.170	....	....	F.
				Rev ..	−1,805.5	−1.55										
				Mean .	−1,807.05											
T. B. M. 327	T. B. M. 328	1,140	301.196	Dir ...	+975.1	−0.25	−1.50	+1.50	0.17	9.7	−9.35	63.81496	209.360	....	....	J.
				Rev ..	+974.6	+0.25										
				Mean .	+974.85											
T. B. M. 326	T. B. M. 327	736	301.931	Dir ...	+2,569.8	−0.35	−1.85	+1.85	0.23	9.7	−8.93	66.38483	217.800	....	....	J.
				Rev ..	+2,569.1	+0.35										
				Mean .	+2,569.45											
*P. B. M. 164—41	T. B. M. 326	25	301.956	Dir ...	−1,125.9	+0.05	−1.80	+1.80	0.03	9.7	−9.11	65.25880	214.106	213.806	−0.300	F.
				Rev ..	−1,125.8	−0.05										
				Mean .	−1,125.85											
*Cap over 164	T. B. M. 326	25	301.956	Dir ...	+109.8	+0.10	−1.75	+1.75	0.07	9.7	−8.92	66.49474	218.161	....	....	F.
				Rev ..	+110.0	−0.10										
				Mean .	+109.90											
T. B. M. 325	T. B. M. 326	218	302.149	Dir ...	+1,318.8	+0.10	−1.75	+1.75	0.07	9.7	−8.73	67.70393	222.128	....	....	F.
				Rev...	+1,319.0	−0.10										
				Mean .	+1,318.90											
*P. B. M. 163 .... Cambridge.	T. B. M. 325	19	302.168	Dir ...	+638.4	+0.05	−1.70	+1.70	0.03	9.7	−8.63	68.34248	224.223	....	....	F.
				Rev...	+638.5	−0.05										
				Mean .	+638.45											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 335	T. B. M. 336	1,063	289.270	Dir	−1,261.6	−0.50	−5.85	+5.85	0.33	9.5	−9.30	64.11816	210.363	.....	.....	F.
				Rev	−1,262.6	+0.50										
				Mean	−1,262.10											
T. B. M. 334	T. B. M. 335	1,478	290.748	Dir	+54.6	+2.15	−3.70	+3.70	1.43	9.6	−9.28	64.17493	210.550	.....	.....	F.
				Rev	+58.9	−2.15										
				Mean	+56.75											
[illegible]	T. B. M. 334	1,376	292.124	Dir	−295.9	+0.75	−2.95	+2.95	0.50	9.6	−9.33	63.87973	209.581	.....	.....	F.
				Rev	−294.4	−0.75										
				Mean	−295.15											
[illegible]	[illegible]	618	292.742	Dir	+2,348.6	+0.50	−2.45	+2.45	0.33	9.6	−8.97	66.22919	217.289	.....	.....	J.
				Rev	+2,349.6	−0.50										
				Mean	+2,349.10											
[illegible]	T. B. M. [illegible]	24	292.766	Dir	−1,350.8	−0.10	−2.55	+2.55	0.07	9.6	−9.17	64.87809	212.856	212.695	−0.101	J.
				Rev	−1,351.0	+0.10										
				Mean	−1,350.90											
[illegible]	B. M. [illegible]	24	292.766	Dir	−108.5	+0.20	−2.25	+2.25	0.13	9.6	−8.99	66.12087	216.934	.....	.....	J.
				Rev	−108.1	−0.20										
				Mean	−108.30											
[illegible]	B. M. [illegible]	1,784	294.526	Dir	−2,715.4	+1.20	−1.25	+1.25	0.80	9.6	−9.40	63.51456	208.383	.....	.....	J.
				Rev	−2,713.0	−1.20										
				Mean	−2,714.20											
[illegible]	B. M. [illegible]	2,037	296.563	Dir	−36.6	−0.25	−1.50	+1.50	0.17	9.7	−9.40	63.47771	208.262	.....	.....	J.
				Rev	−37.1	+0.25										
				Mean	−36.85											

T. B. M. 330	1,848	298.411	Dir	+1,170.7	−1.30	−2.80	+2.80	0.87	9.7	−9.22	64.64729	212.099			F.
			Rev	+1,168.1	+1.30										
			Mean	+1,169.40											
[illegible]	57	298.468	Dir	−1,905.1	0.00	−2.80	+2.80	0.00	9.7	−9.51	62.74190	205.848			F.
			Rev	−1,905.1	0.00										
			Mean	−1,905.10											
[illegible]	57	298.468	Dir	−667.8	−0.25	−3.05	+3.05	0.17	9.7	−9.32	63.97914	209.907			F.
			Rev	−668.3	+0.25										
			Mean	−668.05											
[illegible]	1,044	300.055	Dir	−1,808.6	+1.55	−1.25	+1.25	1.03	9.7	−9.48	62.83908	206.170			F.
			Rev	−1,805.5	−1.55										
			Mean	−1,807.05											
[illegible] M. 328	1,140	301.195	Dir	+975.1	−0.25	−1.50	+1.50	0.17	9.7	−9.35	63.81498	209.369			J.
			Rev	+974.6	+0.25										
			Mean	+974.85											
T. B. M. 327	736	301.931	Dir	+2,569.8	−0.35	−1.85	+1.85	0.23	9.7	−8.93	66.38483	217.800			J.
			Rev	+2,569.1	+0.35										
			Mean	+2,569.45											
T. B. M. 326	25	301.956	Dir	−1,125.9	+0.05	−1.80	+1.80	0.03	9.7	−9.11	65.25880	214.100	213.806	−0.300	F.
			Rev	−1,125.8	−0.05										
			Mean	−1,125.85											
T. B. M. 326	25	301.956	Dir	+109.8	+0.10	−1.75	+1.75	0.07	9.7	−8.92	66.49474	218.161			F.
			Rev	+110.0	−0.10										
			Mean	+109.90											
T. B. M. 326	218	302.149	Dir	+1,318.8	+0.10	−1.75	+1.75	0.07	9.7	−8.73	67.70393	222.128			F.
			Rev	+1,319.0	−0.10										
			Mean	+1,318.90											
T. B. M. 325	19	302.168	Dir	+638.4	+0.05	−1.70	+1.70	0.03	9.7	−8.63	68.34248	224.223			F.
			Rev	+638.5	−0.05										
			Mean	+638.45											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 324	T. B. M. 325	832	302. 981	Dir ...	—4, 623. 4	—0. 05	—1. 80	+1. 80	0. 03	9. 7	—9. 45	63. 07976	206. 956	....	....	F.
				Rev...	—4, 623. 5	+0. 05										
				Mean .	—4, 623. 45											
T. B. M. 323	T. B. M. 324	859	303. 840	Dir ...	+1, 300. 5	—0. 60	—2. 40	+2. 40	0. 40	9. 8	—9. 26	64. 37985	211. 222	....	....	F.
				Rev...	+1, 299. 3	+0. 60										
				Mean .	+1, 299. 9											
T. B. M. 322	T. B. M. 323	1, 758	305. 598	Dir ...	+4, 819. 5	+1. 70	—0. 70	+0. 70	1. 13	9. 8	—8. 50	69. 20181	227. 042	....	....	J.
				Rev...	+4, 822. 9	—1. 70										
				Mean .	+4, 821. 20											
T. B. M. 321	T. B. M. 322	540	306. 138	Dir ...	—4, 839. 3	+1. 10	+0. 40	—0. 40	0. 73	9. 9	—9. 27	64. 36284	211. 166	....	....	J.
				Rev...	—4, 837. 1	—1. 10										
				Mean .	—4, 838. 20											
*P. B. M. 162	T. B. M. 321	70	306. 208	Dir ...	+187. 4	—0. 05	+0. 35	—0. 35	0. 03	9. 9	—9. 23	64. 55023	211. 781	....	....	J.
				Rev...	+187. 3	+0. 05										
				Mean .	+187. 35											
*Cap over 162	T. B. M. 321	70	306. 208	Dir ...	+1, 427. 3	+0. 05	+0. 45	—0. 45	0. 03	9. 9	—9. 03	65. 79043	215. 850	....	....	J.
				Rev...	+1, 427. 4	—0. 05										
				Mean .	+1, 427. 35											
T. B. M. 320	T. B. M. 321	1, 378	307. 516	1 Dir .	—642. 2	+1. 62	+1. 18	—1. 18	0. 80	9. 9	—9. 36	63. 72217	209. 064	....	....	J.
				1 Rev.	—637. 2	—3. 38										
				2 Dir.	—640. 5	—0. 08										
				2 Rev.	—642. 4	+1. 82										
				Mean .	—640. 58											

T. B. M. 319	T. B. M. 320	1,498	309.014	Dir	−1,848.4	+0.10	+1.28	−1.28	0.07	9.9	−9.64	61.87359	202.990	....	....	F.
				Rev	−1,848.2	−0.10										
				Mean	−1,848.30											
T. B. M. 318	T. B. M. 319	2,406	311.420	Dir	+809.1	+0.55	+1.83	−1.83	0.37	9.9	−9.52	62.68356	205.656	....	....	F.
				Rev	+810.2	−0.55										
				Mean	+809.65											
T. B. M. 317	T. B. M. 318	1,654	318.074	Dir	+2,688.0	−1.35	+0.48	−0.48	0.90	9.9	−9.11	65.37042	214.472	....	....	F.
				Rev	+2,685.3	+1.35										
				Mean	+2,686.65											
*T. B. M. 316	T. B. M. 317	628	313.702	Dir	−3,422.6	−0.80	−0.32	+0.32	0.53	9.9	−9.63	61.94650	203.238	....	....	J.
				Rev	−3,424.2	+0.80										
				Mean	−3,423.40											
*P. B. M. 158=∀	T. B. M. 316	59	313.761	Dir	+491.4	−0.05	−0.37	+0.37	0.03	9.9	−9.56	62.43792	204.851	204.537	−0.314	W.
				Rev	+491.3	+0.05										
				Mean	+491.35											
*Cap over 158	T. B. M. 316	50	313.761	Dir	+1,729.5	−0.15	−0.47	+0.47	0.10	9.9	−9.36	63.67612	208.913	....	....	W.
				Rev	+1,729.2	+0.15										
				Mean	+1,729.35											
P. B. M. 161	T. B. M. 317	1,327	314.401	Dir	+10,837.6	+0.50	+0.98	−0.98	0.33	9.9	−7.42	76.21021	250.036	....	....	J.
				Rev	+10,838.6	−0.50										
				Mean	+10,838.10											
T. B. M. 314	P. B. M. 161	586	314.987	1 Dir	−10,319.5	−1.08	+0.26	−0.26	0.33	9.9	−9.01	65.88804	216.170	....	....	J.
				1 Rev	−10,321.8	+1.22										
				2 Dir	−10,320.2	−0.38										
				2 Rev	−10,320.8	+0.22										
				Mean	−10,320.58											
*P. B. M. 160 Glasgow.	T. B. M. 314	24	315.011	Dir	+2,366.6	+0.20	+0.46	−0.46	0.13	9.9	−8.66	68.25519	223.936	....	....	J.
				Rev	+2,367.0	−0.20										
				Mean	+2,366.80											
*P. B. M. 159=∀	T. B. M. 314	68	315.055	Dir	−3,649.2	−0.15	+0.11	−0.11	0.10	9.9	−9.58	62.23812	204.195	203.941	−0.254	F.
				Rev	−3,649.5	+0.15										
				Mean	−3,649.35											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Cap over 159	P. B. M. 159	34	315.055	Dir	+1,236.0	+0.15	+0.26	−0.26	0.10	9.9	−9.40	63.47445	208.252	....	....	F.
				Rev	+1,236.3	−0.15										
				Mean	+1,236.15											
*T. B. M. 315=Old B. M. 141a (Gauge B. M.)	T. B. M. 314	95	315.082	Dir	−4,802.8	+0.15	+0.41	−0.41	0.10	9.9	−9.76	61.08464	200.411	200.124	−0.287	F.
				Rev	−4,802.5	−0.15										
				Mean	−4,802.65											
*Zero gauge	T. B. M. 314	300	315.287	Dir	−65,808.9	−0.60	−0.34	+0.34	0.40	9.9	−9.49	+0.07806	+0.256	0.000	−0.256	F.
				Rev	−65,810.1	+0.60										
				Mean	−65,809.50											
T. B. M. 313	T. B. M. 314	576	315.563	Dir	−5,266.6	−0.20	+0.11	−0.11	0.10	9.9	−9.83	60.62042	198.888	....	....	F.
				1 Rev.	−5,267.1	+0.30										
				2 Rev.	−5,266.7	−0.10										
				Mean	−5,266.80											
T. B. M. 312 Hurricane Creek.	T. B. M. 313	1,086	316.649	Dir	−767.8	−0.30	−0.19	+0.19	0.20	9.9	−9.96	59.85219	196.367	....	....	F.
				Rev	−768.4	+0.30										
				Mean	−768.10											
T. B. M. 311	T. B. M. 312	550	317.199	Dir	+702.5	−0.20	−0.39	+0.39	0.13	9.9	−9.85	60.55460	198.672	....	....	J.
				Rev	+702.1	+0.20										
				Mean	+702.30											
T. B. M. 310	T. B. M. 311	758	317.957	Dir	−585.0	−0.55	−0.94	+0.94	0.37	9.9	−9.94	59.96896	196.750	....	....	J.
				Rev	−586.1	+0.55										
				Mean	−585.55											

T. B. M. 309	T. B. M. 310	561	318.518	Dir ...	+56.5	+0.20	—0.74	+0.74	0.13	9.9	—9.93	60.02507	196.936	....	....	F.
				Rev ..	+56.9	—0.20										
				Mean .	+56.70											
•P. B. M. 157=4½	T. B. M. 300	18	318.536	Dir ...	+47.7	0.00	—0.74	+0.74	0.00	9.9	—9.92	60.07338	197.093	196.776	—0.317	F.
				Rev ..	+47.7	0.00										
				Mean .	+47.70											
•Cap over 157............	T. B. M. 309	18	318.536	Dir ...	+1,286.0	—0.15	—0.89	+0.89	0.10	9.9	—9.74	61.31171	201.156	....	....	F.
				Rev...	+1,285.7	+0.15										
				Mean .	+1,285.85											
T. B. M. 308	T. B. M. 309	1,136	319.654	Dir ...	+912.4	—1.10	—1.84	+1.84	0.73	10.0	—9.78	60.98712	199.927	....	....	F.
				Rev...	+910.2	+1.10										
				Mean .	+911.30											
T. B. M. 307 .... Bluffport.	T. B. M. 308	831	320.485	Dir ...	+1,924.8	+1.15	—0.69	+0.69	0.77	10.0	—9.49	62.86336	206.246	....	....	J.
				Rev...	+1,927.1	—1.15										
				Mean .	+1,925.95											
T. B. M. 306	T. B. M. 307	780	321.265	Dir ...	—123.7	—0.05	—0.74	+0.74	0.03	10.0	—9.51	62.73959	205.840	....	....	J.
				Rev...	—123.8	+0.05										
				Mean .	—123.75											
T. B. M. 305	T. B. M. 306	1,156	322.421	Dir ...	—230.7	+0.55	—0.19	+0.19	0.37	10.0	—9.54	62.50941	205,085	....	....	J.
				Rev...	—229.6	—0.55										
				Mean .	—230.15											
•P. B. M. 156............	T. B. M. 305	24	322.445	Dir ...	+381.2	—0.05	—0.24	+0.24	0.03	10.0	—9.48	62.89062	206.336	....	....	F.
				Rev...	+381.1	+0.05										
				Mean .	+381.15											
•P. B. M. 155	T. B. M. 305	24	322.445	Dir ...	—2,117.7	+0.10	—0.09	+0.09	0.07	10.0	—9.87	60.39148	198.137	....	....	J.
				Rev...	—2,117.5	—0.10										
				Mean .	—2,117.60											
•Cap over 155	T. B. M. 305	24	322.445	Dir ...	—879.3	+0.05	—0.14	+0.14	0.03	10.0	—9.68	61.63002	202.200	....	....	J.
				Rev...	—879.2	—0.05										
				Mean .	—879.25											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1893—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V: Direct line.	Σ V: Reverse line.	r ±	R ±	Rod corr'n.	Elevation above St. Louis City Directrix: Meters.	Elevation above St. Louis City Directrix: Feet.	Elevation above St. Louis City Directrix: Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 304	T. B. M. 305	875	323. 296	Dir ... Rev ...	—2, 193. 1 —2, 192. 0	+0. 55 —0. 55	+0. 36	—0. 36	0. 37	10. 0	—9. 89	60. 31651	197. 891	....	....	F.
				Mean .	—2, 192. 55											
T. B. M. 303	T. B. M. 304	1, 688	324. 984	Dir ... Rev ...	+1, 207. 9 +1, 208, 2	+0. 15 —0. 15	+0. 51	—0. 51	0. 10	10. 0	—9. 69	61. 52476	201. 855	....	....	F.
				Mean .	+1, 208. 05											
T. B. M. 302	T. B. M. 303	1, 438	326. 422	Dir ... Rev ...	—2, 393. 8 —2, 394. 5	—0. 35 +0. 35	+0. 16	—0. 16	0. 23	10. 0	—10. 07	59. 13023	193. 999	....	....	J.
				Mean .	—2, 394. 15											
T. B. M. 301	T. B. M. 302	1, 369	327. 791	1 Dir.. 1 Rev. 2 Dir.. 2 Rev.	—753. 1 —758. 0 —757. 1 —756. 7	—3. 12 +1. 78 +0. 88 +0. 48	—0. 96	+0. 96	0. 71	10. 1	—10. 17	58. 37391	191. 517	....	....	J.
				Mean .	—756. 22											
• P. B. M. 154 = 4/3	T. B. M. 301	97	327. 888	Dir... Rev...	—1, 420. 6 —1, 421. 3	—0. 35 +0. 35	—1. 31	+1. 31	0. 23	10. 1	—10. 41	56. 95272	186. 854	186. 564	—0. 290	J.
				Mean .	—1, 420. 95											
• Cap over 154	P. B. M. 154	26	327. 888	Dir ... Rev...	+1, 223. 9 +1, 223. 4	—0. 25 +0. 25	—1. 56	+1. 56	0. 17	10. 1	—10. 21	58. 17657	190. 870	....	....	J.
				Mean.	+1, 223. 65											
T. B. M. 300	T. B. M. 301	526	328. 317	Dir ... Rev...	+17. 1 +14. 9	—1. 10 +1. 10	—2. 06	+2. 06	0. 73	10. 1	—10. 18	58. 38990	191. 570	....	....	F.
				Mean.	+16. 00											

*P. B. M. 153	T. B. M. 300	11	328.328	Dir	+579.7	−0.05	−2.11	+2.11	0.03	10.1	−10.00	58.06964	193.472	....	....	J.
				Rev	+579.6	+0.05										
				Mean	+579.65											
T. B. M., 200	T. B. M. 300	508	328.915	1 Dir	−641.0	+2.08	−0.73	+0.73	0.61	10.1	−10.28	57.75088	189.473	....	....	F.
				1 Rev	−636.6	−2.32										
				2 Dir	−639.5	+0.58										
				2 Rev	−638.6	−0.32										
				Mean	−638.92											
T. B. M. 298. Lisbon.	T. B. M. 299	1,084	329.999	Dir	+5,537.5	+0.35	−0.38	+0.38	0.23	10.1	−9.43	63.28058	207.645	....	....	F.
				Rev	+5,538.2	−0.35										
				Mean	+5,537.85											
T. B. M. 297	T. B. M. 298	700	330.699	Dir	−826.3	−0.45	−0.83	+0.83	0.30	10.1	−9.55	62.46271	204.932	....	....	F.
				Rev	−827.2	+0.45										
				Mean	−826.75											
*P. B. M. 152 = $\frac{4}{5}$	T. B. M. 297	14	330.713	Dir	−1,281.5	−0.10	−0.93	+0.93	0.07	10.1	−9.75	61.18091	200.727	200.279	−0.448	F.
				Rev	−1,281.7	+0.10										
				Mean	−1,281.60											
*Cap over 152	T. B. M. 297	14	330.713	Dir	−42.1	+0.05	−0.78	+0.78	0.03	10.1	−9.55	62.42066	204.794	....	....	F.
				Rev	−42.0	−0.05										
				Mean	−42.05											
T. B. M. 296	T. B. M. 297	718	331.417	Dir	−3,451.2	+1.00	+0.17	−0.17	0.67	10.1	−10.08	59.01198	193.611	....	....	F.
				Rev	−3,449.2	−1.00										
				Mean	−3,450.20											
T. B. M. 295	T. B. M. 296	2,240	333.657	Dir	−1,428.0	−1.15	−0.98	+0.98	0.77	10.2	−10.33	57.58258	188.921	....	....	J.
				Rev	−1,430.3	+1.15										
				Mean	−1,429.15											
T. B. M. 294	T. B. M. 295	1,528	335.185	Dir	+1,329.5	+1.35	+0.37	−0.37	0.90	10.2	−10.10	58.91366	193.288	....	....	J.
				Rev	+1,332.2	−1.35										
				Mean	+1,330.85											
*P. B. M. 151 = $\frac{3}{5}$	T. B. M. 294	114	335.299	Dir	+3,962.8	+0.10	+0.47	−0.47	0.07	10.1	−9.48	62.87718	206.292	204.309	−1.983	J.
				Rev	+3,963.0	−0.10										
				Mean	+3,962.90											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V.		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Cap over 151	T. B. M. 151	62	335.299	Dir	+1,238.9	−0.15	+0.32	−0.32	0.10	10.1	−9.30	64.11611	210.357			J.
				Rev	+1,238.6	+0.15										
				Mean	+1,238.75											
T. B. M 293	T. B. M. 294	435	335.620	Dir	+297.9	+0.65	+1.02	−1.02	0.43	10.2	−10.06	59.21225	194.268			F.
				Rev	+299.2	−0.65										
				Mean	+298.55											
T. B. M. 292	T. B. M. 293	1,166	336.786	1 Dir	−1,815.8	+1.32	−0.15	+0.15	1.15	10.3	−10.34	57.39749	188.314			F.
				1 Rev	−1,812.7	−1.78										
				2 Dir	−1,810.8	−3.68										
				2 Rev	−1,818.6	+4.12										
				Mean	−1,814.48											
*P. B. M. 150	T. B. M. 292	46	336.832	Dir	+134.5	−0.15	−0.30	+0.30	0.10	10.3	−10.32	57.53186	188.754			F.
				Rev	+134.2	+0.15										
				Mean	+134.35											
T. B. M. 291	T. B. M. 292	498	337.284	Dir	+1,889.1	+0.55	+0.40	−0.40	0.37	10.3	−10.04	59.28744	194.514			F.
				Rev	+1,890.2	−0.55										
				Mean	+1,889.65											
T. B. M. 290	T. B. M. 291	1,467	338.751	Dir	−717.8	+0.65	+1.05	−1.05	0.43	10.3	−10.15	58.57018	192.161			F.
				Rev	−716.5	−0.65										
				Mean	−717.15											
*P. B. M. 149	T. B. M. 290	62	338.813	Dir	−333.3	+0.30	+1.35	−1.35	0.20	10.3	−10.21	58.23712	191.068			F.
				Rev	−332.7	−0.30										
				Mean	−333.00											

*Cap over 149	T. B. M. 290	63	338. 813	Dir	+904. 1	0. 00	+1. 05	—1. 05	0. 00	10. 8	—10. 01	59. 47442	195. 128			F.
				Rev	+904. 1	0. 00										
				Mean	+904. 10											
T. B. M. 289	T. B. M. 290	410	339. 161	Dir	+1, 178. 9	+0. 85	+1. 90	—1. 90	0. 57	10. 8	— 9. 97	59. 75011	196. 032			F.
				Rev	+1, 180. 6	—0. 85										
				Mean	+1, 179. 75											
T. B. M. 288	T. B. M. 289	1, 803	340. 964	Dir	—2, 616. 0	+0. 65	+2. 55	—2. 55	0. 43	10. 8	—10. 38	57. 13435	187. 450			J.
				Rev	—2, 614. 7	—0. 65										
				Mean	—2, 615. 35											
T. B. M. 287	T. B. M. 288	1, 596	342. 560	Dir	+1, 493. 0	+0. 30	+2. 85	—2. 85	0. 20	10. 8	—10. 14	58. 62789	192. 350			J.
				Rev	+1, 493. 6	—0. 30										
				Mean	+1, 493. 30											
*P. B. M. 148	T. B. M. 287	25	342. 585	Dir	—1, 659. 0	0. 00	+2. 85	—2. 85	0. 00	10. 8	—10. 41	56. 96862	186. 907			F.
				Rev	—1, 659. 0	0. 00										
				Mean	—1, 659. 00											
*Cap over 148	T. B. M. 287	25	342. 585	Dir	—420. 1	—0. 05	+2. 80	—2. 80	-0. 03	10. 3	—10. 20	58. 20768	190. 972			F.
				Rev	—420. 2	+0. 05										
				Mean	—420. 15											
T. B. M. 286	T. B. M. 287	1, 542	344. 102	Dir	—799. 3	+1. 30	+4. 15	—4. 15	0. 87	10. 3	—10. 27	57. 82976	189. 732			F.
				Rev	—796. 7	—1. 30										
				Mean	—798. 00											
T. B. M. 285	T. B. M. 286	1, 312	346. 414	Dir	+477. 1	+0. 80	+4. 95	—4. 95	0. 53	10. 4	—10. 19	58. 30774	191. 300			F.
				Rev	+478. 7	—0. 80										
				Mean	+477. 90											
T. B. M. 284	T. B. M. 285	1, 308	346. 722	Dir	—1, 155. 4	—1. 50	+3. 45	—3. 45	1. 00	10. 4	—10. 38	57. 15065	187. 504			J.
				Rev	—1, 158. 4	+1. 50										
				Mean	—1, 156. 90											
*Old B. M. 44 (old position).	T. B. M. 284	62	346. 784	Dir	+2, 426. 7	0. 00	+3. 45	—3. 45	0. 00	10. 4	—10. 00	59. 57773	195. 467	Not taken.		J.
				Rev	+2, 426. 7	0. 00										
				Mean	+2, 426. 70											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 147 = 4/4 (new position).	T. B. M. 284	50	346.772	Dir	−1,373.8	+0.05	+3.50	−3.50	0.03	10.4	−10.57	55.77671	182.996	....	....	J.
				Rev	−1,373.7	−0.05										
				Mean	−1,373.75											
*Cap over 147	T. B. M. 284	50	346.772	Dir	−138.2	+0.05	+3.50	−3.50	0.03	10.4	−10.40	57.01248	187.051	....	....	J.
				Rev	−138.1	−0.05										
				Mean	−138.15											
T. B. M. 283	T. B. M. 284	1,536	348.258	Dir	−2,187.4	+0.55	+4.00	−4.00	0.37	10.4	−10.72	54.96346	180.328	....	....	J.
				Rev	−2,186.3	−0.55										
				Mean	−2,186.85											
T. B. M. 282	T. B. M. 283	1,938	350.196	Dir	+1,104.6	−0.40	+3.60	−3.60	0.27	10.4	−10.54	56.06784	183.951	....	....	F.
				Rev	+1,103.8	+0.40										
				Mean	+1,104.20											
*P. B. M. 146	T. B. M. 282	23	350.219	Dir	−1,230.5	−0.05	+3.55	−3.55	0.03	10.4	−10.73	54.83710	179.913	....	....	F.
				Rev	−1,230.6	+0.05										
				Mean	−1,230.55											
*Cap over 146	T. B. M. 282	23	350.219	Dir	+11.4	+0.05	+3.65	−3.65	0.03	10.4	−10.53	56.07930	183.989	....	....	F.
				Rev	+11.5	−0.05										
				Mean	+11.45											
T. B. M. 281	T. B. M. 282	1,019	351.215	Dir	+1,296.9	−0.85	+ 2.75	−2.75	0.57	10.4	−10.35	57.36408	188.204	....	....	F.
				Rev	+1,295.2	+0.85										
				Mean	+1,296.05											
*P. B. M. 145	T. B. M. 281	526	351.741	Dir	+1,900.6	−0.15	+ 2.60	−2.60	0.10	10.4	−10.05	59.26483	194.440	....	....	J.
				Rev	+1,900.3	+0.15										
				Mean	+1,900.45											

T. B. M. 280	T. B. M. 281	862	352. 077	Dir	+2, 767. 0	—0. 85	+ 1. 90	— 1. 90	0. 57	10. 5	— 9. 92	60. 13066	197. 281	....	....	J.
				Rev	+2, 765. 3	+0. 85										
				Mean	+2, 766. 15											
*P. B. M. 143	T. B. M. 280	13	352. 090	Dir	+1. 8	0. 00	+ 1. 90	— 1. 90	0. 00	10. 5	— 9. 92	60. 13196	197. 285	....	....	J.
				Rev	+1. 8	0. 00										
				Mean	+1. 80											
*P. B. M. 144=Old B. M. 121.	T. B. M. 280	89	352. 166	Dir	—7, 335. 7	+0. 30	+ 2. 20	— 2. 20	0. 20	10. 5	—11. 05	52. 79413	173. 211	172. 988	—0. 223	F.
				Rev	—7, 335. 1	—0. 30										
				Mean	—7, 335. 40											
*Zero Gauge (Signal Service.)	T. B. M. 280	238	352. 315	Dir	—13, 700. 1	+0. 10	+ 2. 00	— 2. 00	0. 07	10. 5	—10. 90	46. 42968	152. 330	....	....	F.
				Rev	—13, 699. 9	—0. 10										
				Mean	—13, 700. 00											
*High water, 1844 (on bridge.)	T. B. M. 280	146	352. 223	Dir	—3, 691. 8	+0. 05	+ 1. 95	— 1. 95	0. 03	10. 5	—10. 48	56. 43835	185. 167	....	....	F.
				Rev	—3, 691. 7	—0. 05										
				Mean	—3, 691. 75											
*Zero wire gauge	T. B. M. 280	237	352. 314	Dir	—60, 113. 1	+8. 30	+10. 20	—10. 20	5. 53	11. 8	—10. 90	+ 0. 02488	+ 0. 082	0. 000	—0. 082	F.
				Rev	—60, 096. 5	—8. 30										
				Mean	—60, 104. 80											
T. B. M. 279	T. B. M. 280	814	352. 891	Dir	—3, 450. 1	—0. 55	+ 1. 35	— 1. 35	0. 37	10. 5	—10. 44	56. 67949	185. 958	....	....	J.
				Rev	—3, 451. 2	+0. 55										
				Mean	—3, 450. 65											
*P. B. M. 142=40½ Boonville.	T. B. M. 279	22	352. 913	Dir	—1, 140. 6	—0. 05	+ 1. 30	— 1. 30	0. 03	10. 5	—10. 63	55. 53865	182. 215	....	....	F.
				Rev	—1, 140. 7	+0. 05										
				Mean	—1, 140. 65											
*Cap over 142	T. B. M. 279	22	352. 913	Dir	+100. 5	—0. 05	+1. 30	—1. 30	0. 03	10. 5	—10. 43	56. 77995	186. 287	....	....	F.
				Rev	+100. 4	+0. 05										
				Mean	+100. 45											
*High water, 1844 (on stone).	T. B. M. 279	22	352. 913	Dir	—177. 9	+0. 05	+1. 40	—1. 40	0. 03	10. 5	—10. 48	56. 50160	185. 374	184. 800	—0. 574	F.
				Rev	—177. 8	—0. 05										
				Mean	—177. 85											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 141	T. B. M. 279	84	352.975	Dir Rev	—936.1 —935.5	+0.30 —0.30	+1.65	—1.65	0.20	10.5	—10.58	55.74355	182.887	....	....	F.
				Mean	—935.80											
T. B. M. 278	T. B. M. 279	1,190	354.081	Dir Rev	—5,674.9 —5,673.2	+0.85 —0.85	+2.20	—2.20	0.57	10.5	—11.34	51.00454	167.339	....	....	F.
				Mean	—5,674.05											
T. B. M. 277	T. B. M. 278	790	354.871	Dir Rev	+1,620.0 +1,620.6	+0.30 —0.30	+2.50	—2.50	0.20	10.5	—11.07	52.62511	172.656	....	....	F.
				Mean	+1,620.30											
*P. B. M. 140 = $\frac{40}{1}$	T. B. M. 277	40	354.911	Dir Rev	+425.8 +425.8	0.00 0.00	+2.50	—2.50	0.00	10.5	—11.01	53.05097	174.053	173.685	—0.368	F.
				Mean	+425.80											
*Cap over, 140	T. B. M. 277	40	354.911	Dir Rev	+1,661.8 +1,662.2	+0.20 —0.20	+2.70	—2.70	0.13	10.5	—10.82	54.28736	178.110	....	....	F.
				Mean	+1,662.00											
T. B. M. 276	T. B. M. 277	630	355.501	Dir Rev	—275.4 —275.3	+0.05 —0.05	+2.55	—2.55	0.03	10.5	—11.12	52.34971	171.753	....	....	F.
				Mean	—275.35											
T. B. M. 275	T. B. M. 276	1,075	356.576	Dir Rev	+2,048.7 +2,049.1	+0.20 —0.20	+2.75	—2.75	0.13	10.5	—10.81	54.39892	178.476	....	....	J.
				Mean	+2,048.90											
T. B. M. 274	T. B. M. 275	576	357.152	Dir Rev	—4,327.9 —4,328.2	—0.15 +0.15	+2.60	—2.60	0.10	10.5	—11.46	50.07022	164.274	....	....	J.
				Mean	—4,328.05											

T. B. M. 273.............	T. B. M. 274	764	357.916	Dir ...	—638.7	—0.55	+2.05	—2.05	0.37	10.5	—11.57	49.48086	162.176	....	....	J.
				Rev ..	—63.80	+0.55										
				Mean .	—639.25											
*P. B. M. 139............	T. B. M. 273	65	357.981	Dir ...	+1,851.9	—0.30	+1.75	—1.75	0.20	10.5	—11.28	51.28275	168.252	....	....	J.
				Rev ..	+1,851.3	+0.30										
				Mean .	+1,851.60											
*Cap over 139...........	T. B. M. 273	65	357.981	Dir ...	+3,094.5	+0.05	+2.10	—2.10	0.03	10.5	—11.08	52.52590	172.331	....	....	J.
				Rev ..	+3,094.6	—0.05										
				Mean .	+3.094.55											
T. B. M. 272.............	T. B. M. 273	1,182	359.098	Dir ...	+2,974.8	—0.60	+1.45	—1.45	0.40	10.5	—11.11	52.40552	171.936	....	....	J.
				Rev ..	+2,973.6	+0.60										
				Mean .	+2,974.20											
*P. B. M. 138	T. B. M. 272	66	359.164	Dir ...	—85.2	—0.10	+1.35	—1.35	0.07	10.5	—11.13	52.32020	171.656	....	....	F.
				Rev ..	—85.4	+0.10										
				Mean .	—85.30											
T. B. M. 271	T. B. M. 272	1,450	360.548	Dir ...	—2,554.4	—2.35	—0.90	+0.90	1.57	10.6	—11.51	49.84837	163.546	....	....	F.
				Rev ..	—2,559.1	+2.35										
				Mean .	—2,556.75											
T. B. M. 270	T. B. M. 271	652	361.200	Dir ...	+1,377.0	—0.45	—1.35	+1.35	0.30	10.6	—11.29	51.22514	168.063	....	....	F.
				Rev ..	+1,376.1	+0.45										
				Mean .	+1,376.55											
T. B. M. 269	T. B. M. 270	1,445	362.645	Dir ...	—1,484.7	+1.30	—0.05	+0.05	0.87	10.6	—11.52	49.74151	163.195	....	....	F.
				Rev ..	—1,482.1	—1.30										
				Mean .	—1,483.40											
*P. B. M. 137—½........ Elliotts Landing.	T. B. M. 269	302	362.947	Dir ...	+6,459.9	+0.20	+0.15	—0.15	0.13	10.6	—10.53	56.20260	184.394	184.088	—0.306	J.
				Rev ..	+6,460.3	—0.20										
				Mean .	+6,460.10											
*Cap over 137...........	P. B. M. 137	30	362.947	Dir ...	+1,237.4	—0.15	0.00	0.00	0.10	10.6	—10.33	57.44005	188.453	....	....	J.
				Rev ..	+1,237.1	+0.15										
				Mean .	+1,237.25											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 136	T. B. M. 269	39	362.684	Dir ...	+5,494.4	0.00	−0.05	+0.05	0.00	10.6	−10.65	55.23678	181.225	....	....	J.
				Rev ..	+5,494.4	0.00										
				Mean.	+5,494.40											
T. B. M. 268	T. B. M. 269	1,396	364.041	Dir ...	+3,711.1	−0.40	−0.45	+0.45	0.27	10.6	−10.95	53.45278	175.372	....	....	J.
				Rev ..	+3,710.3	+0.40										
				Mean.	+3,710.70											
T. B. M. 267	T. B. M. 268	1,325	365.366	Dir ...	−2,090.3	0.00	−0.45	+0.45	0.00	10.6	−11.28	51.36215	168.512	....	....	J.
				Rev ..	−2,090.3	0.00										
				Mean.	−2,090.30											
*P. B. M. 135	T. B. M. 267	224	365.590	Dir ...	+1,651.9	−0.50	−0.95	+0.95	0.33	10.7	−11.03	53.01380	173.931	....	....	F.
				Rev ..	+1,650.9	+0.50										
				Mean.	+1,651.40											
*Cap over 135........	P. B. M. 135	64	365.590	Dir ...	+1,237.0	+0.20	−0.75	+0.75	0.13	10.7	−10.83	54.25120	177.991	....	....	F.
				Rev ..	+1,237.4	−0.20										
				Mean.	+1,237.20											
T. B. M. 266	T. B. M. 267	1,774	367.140	Dir ...	+1,350.4	+0.35	−0.10	+0.10	0.23	10.7	−11.07	52.71311	172.945	....	....	F.
				Rev ..	+1,351.1	−0.35										
				Mean.	+1,350.75											
*P. B. M. 134	T. B. M. 266	15	367.155	Dir ...	+863.9	+0.05	−0.05	+0.05	0.03	10.7	−10.94	53.57719	175.780	....	....	J.
				Rev ..	+864.0	−0.05										
				Mean.	+863.95											
T. B. M. 264........ Overton.	T. B. M. 266	1,778	368.918	Dir ...	−431.3	−0.10	−0.20	+0.20	0.07	10.7	−11.12	52.28166	171.529	....	....	F.
				Rev ..	−431.5	+0.10										
				Mean.	−431.40											

*T. B. M. 265	T. B. M. 264	406	360.324	Dir	+962.9	—0.15	—0.35	+0.35	0.10	10.7	—10.97	53.24456	174.088	....	....	F.
				Rev	+962.6	+0.15										
				Mean	+962.75											
*P. B. M. 133=[illegible]	T. B. M. 265	123	369.447	Dir	+1,459.6	0.00	—0.35	+0.35	0.00	10.7	—10.76	54.70437	179.478	179.258	—0.220	J.
				Rev	+1,459.6	0.00										
				Mean	+1,459.60											
*Cap over 133	T. B. M. 265	123	369.447	Dir	+2,702.3	—0.25	—0.60	+0.60	0.17	10.7	—10.56	55.94702	183.555	....	....	J.
				Rev	+2,701.8	+0.25										
				Mean	+2,702.05											
T. B. M. 263	T. B. M. 264	2,239	371,157	Dir	—1,097.2	—1.25	—1.45	+1.45	0.83	10.7	—11.30	51.18303	167.925	....	....	J.
				Rev	—1,099.7	+1.25										
				Mean	—1,098.45											
T. B. M. 262	T. B. M. 263	1,682	372.839	Dir	—140.1	+0.25	—1.20	+1.20	0.17	10.7	—11.33	51.04315	167.466	....	....	J.
				Rev	—139.6	—0.25										
				Mean	—139.85											
*P. B. M. 132	T. B. M. 262	13	372.852	Dir	—1,249.4	—0.05	—1.25	+1.25	0.03	10.7	—11.51	49.79352	163.366	....	....	J.
				Rev	—1,249.5	+0.05										
				Mean	—1,249.45											
*Cap over 132	T. B. M. 262	13	372.852	Dir	—12.4	+0.05	—1.15	+1.15	0.03	10.7	—11.33	51.03080	167.425	....	....	J.
				Rev	—12.3	—0.05										
				Mean	—12.35											
T. B. M. 261	T. B. M. 262	726	373.565	Dir	+450.5	+0.20	—1.00	+1.00	0.13	10.7	—11.25	51.49393	168.945	....	....	F.
				Rev	+450.9	—0.20										
				Mean	+450.70											
T. B. M. 260	T. B. M. 261	1,212	374.777	Dir	—1,937.7	—0.30	—1.30	+1.30	0.20	10.7	—11.55	49.55563	162.586	....	....	F.
				Rev	—1,938.3	+0.30										
				Mean	—1,938.00											
T. B. M. 259	T. B. M. 260	1,878	376.655	Dir	—56.8	—2.40	—3.70	+3.70	0.60	10.8	—11.56	49.49642	162.391	....	....	F.
				Rev	—61.6	+2.40										
				Mean	—59.20											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V: Direct line.	Σ V: Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix: Meters.	Elevation above St. Louis City Directrix: Feet.	Elevation above St. Louis City Directrix: Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 257	T. B. M. 259	500	377.155	Dir Rev	+1,249.4 +1,248.6	−0.40 +0.40	−4.10	+4.10	0.27	10.8	−11.37	50.74561	166.490			J.
				Mean	+1,249.00											
*T. B. M. 258	T. B. M. 257	533	377.688	Dir Rev	+1,749.8 +1,748.3	−0.75 +0.75	−4.85	+4.85	0.50	10.8	−11.09	52.49494	172.229			J.
				Mean	+1,749.05											
*P. B. M. 131 = ▽	T. B. M. 258	10	377.698	Dir Rev	−906.1 −905.9	+0.10 −0.10	−4.75	+4.75	0.07	10.8	−11.23	51.58880	169.256	169.148	−0.108	J.
				Mean	−906.00											
*Cap over 131	T. B. M. 258	10	377.698	Dir Rev	+335.6 +336.1	+0.25 −0.25	−4.60	+4.60	0.17	10.8	−11.04	52.83084	173.331			J.
				Mean	+335.85											
T. B. M. 256	T. B. M. 257	2,411	379.566	Dir Rev	−2,512.4 −2,514.4	−1.00 +1.00	−5.10	+5.10	0.67	10.8	−11.76	48.23182	158.242			J.
				Mean	−2,513.40											
T. B. M. 255	T. B. M. 256	2,004	381.570	Dir Rev	+1,219.7 +1,223.8	+2.05 −2.05	−3.05	+3.05	1.37	10.9	−11.57	49.45376	162.251			F.
				Mean	+1,221.75											
T. B. M. 254	T. B. M. 255	906	382.476	Dir Rev	−1,182.2 −1,184.5	−1.15 +1.15	−4.20	+4.20	0.77	10.9	−11.76	48.27022	158.368			F.
				Mean	−1,183.35											
T. B. M. 253	T. B. M. 254	961	383.437	Dir Rev	−2,158.5 −2,160.0	−0.75 +0.75	−4.95	+4.95	0.50	11.0	−12.08	46.11065	151.283			J.
				Mean	−2,159.25											

*P. B. M. 130 .... Mt. Vernon.	T. B. M. 253	22	383.459	Dir ..	+3,437.8	—0.10	—5.05	+5.05	0.07	11.0	—11.55	49.54888	162.563	....	....	J.
				Rev...	+3,437.6	+0.10										
				Mean .	+3,437.70											
*P. B. M. 129	T. B. M. 253	129	383.560	Dir ...	+6,964.2	—0.20	—5.15	+5.15	0.13	11.0	—11.01	53.07572	174.135	....	....	J.
				Rev...	+6,963.8	+0.20										
				Mean .	+6,964.00											
*Cap over 156..........	P. B. M. 129	22	383.566	Dir ..	+1,236.1	—0.10	—5.25	+5.25	0.07	11.0	—10.83	54.31190	178.190	....	....	J.
				Rev...	+1,235.9	+0.10										
				Mean .	+1,236.00											
T. B. M. 252	T. B. M. 253	1,024	384.461	Dir ...	—1,437.4	—1.45	—6.40	+6.40	0.97	11.0	—12.30	44.67158	146.562	....	....	J.
				Rev...	—1,440.3	+1.45										
				Mean .	—1,438.85											
T. B. M. 251	T. B. M. 252.......	1,302	385.703	Dir ...	+954.3	—0.15	—6.55	+6.55	0.10	11.0	—12.15	45.62588	149.692	....	....	F.
				Rev...	+954.0	+0.15										
				Mean .	+954.15											
T. B. M. 250	T. B. M. 251	916	386.679	Dir ...	+5,402.5	—0.35	—6.90	+6.90	0.23	11.0	—11.34	51.02884	167.419	....	....	F.
				Rev...	+5,401.8	+0.35										
				Mean .	+5,402.15											
*P. B. M. 128	T. B. M. 250	96	386.775	Dir ...	+7,583.8	—0.30	—7.20	+7.20	0.20	11.0	—10.15	58.61353	192.303	....	....	F.
				Rev...	+7,583.2	+0.30										
				Mean .	+7,583.50											
*P. B. M. 127 = $^{36}_{1}$....... Wolf Point.	T. B. M. 250	48	386.727	Dir ...	+1,854.9	+0.05	—6.85	+6.85	0.03	11.0	—11.03	52.88410	173.506	173.369	—0.137	F.
				Rev...	+1,855.0	—0.05										
				Mean .	+1,854.95											
*Cap over 127..........	T. B. M. 250	48	386.727	Dir ...	+3,095.3	—0.05	—6.95	+6.95	0.03	11.0	—10.84	54.12459	177.576	....	....	F.
				Rev...	+3,095.2	+0.05										
				Mean .	+3,095.25											
T. B. M. 249	T. B. M. 250	784	387.403	Dir	—3,320.4	—1.65	—8.55	+8.55	1.10	11.1	—11.84	47.70629	156.518	....	....	F.
				Rev...	—3,323.7	+1.65										
				Mean .	—3,322.05											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 248	T. B. M. 249	1,244	388.707	Dir	−3,378.1	0.00	−8.55	+8.55	0.00	11.1	−12.37	44.32766	145.433	....	....	J.
				Rev	−3,378.1	0.00										
				Mean	−3,378.10											
T. B. M. 247	T. B. M. 248	1,113	389.820	Dir	+2,891.6	−0.05	−8.60	+8.60	0.03	11.1	−11.92	47.21966	154.922	....	....	J.
				Rev	+2,891.5	+0.05										
				Mean	+2,891.55											
T. B. M. 246	T. B. M. 247	1,564	391.384	Dir	+503.5	+0.85	−7.75	+7.75	0.57	11.1	−11.84	47.72409	156.576	....	....	F.
				Rev	+505.2	−0.85										
				Mean	+504.35											
*P. B. M. 126 = $^{2}_{1}{}^{8}$	T. B. M. 246	224	391.608	Dir	+2,654.9	−0.30	−8.05	+8.05	0.20	11.1	−11.43	50.37910	165.287	165.146	−0.141	F.
				Rev	+2,654.3	+0.30										
				Mean	+2,654.60											
*Cap over 126	P. B. M. 126	60	391.608	Dir	+1,239.1	+0.15	−7.90	+7.90	0.10	11.1	−11.24	51.61854	169.354	....	....	F.
				Rev	+1,239.4	−0.15										
				Mean	+1,239.25											
T. B. M. 245	T. B. M. 246	1,177	392.561	Dir	−1,203.4	−0.35	−8.10	+8.10	0.23	11.1	−12.02	46.52016	152.626	....	....	F.
				Rev	−1,204.1	+0.35										
				Mean	−1,203.75											
T. B. M. 244	T. B. M. 245	2,071	394.632	Dir	−1,063.4	+1.30	−6.80	+6.80	0.87	11.1	−12.18	45.45790	149.141	....	....	J.
				Rev	−1,060.8	−1.30										
				Mean	−1,062.10											

				Mean	+2,702.88											
T. B. M. 242	T. B. M. 243	406	396.754	Dir	—531.7	+0.35	—5.07	+5.07	0.23	11.1	—11.85	47.63976	156.267	....	....	F.
				Rev	—531.0	—0.35										
				Mean	—531.35											
*P. B. M. 125	T. B. M. 242	12	396.766	Dir	+1,701.4	+0.05	—5.02	+5.02	0.03	11.1	—11.58	49.33148	161.850	....	....	F.
				Rev	+1,701.5	—0.05										
				Mean	+1,701.45											
*P. B. M. 124. Geigers Landing.	T. B. M. 242	204	396.958	Dir	+3,481.3	0.00	—5.07	+5.07	0.00	11.1	—11.31	51.11160	167.690	....	....	F.
				Rev	+3,481.3	0.00										
				Mean	+3,481.30											
*Cap over 124	P. B. M. 124	36	396.958	Dir	+1,237.0	0.00	—5.07	+5.07	0.00	11.1	—11.12	52.34879	171.750	....	....	F.
				Rev	+1,237.0	0.00										
				Mean	+1,237.00											
T. B. M. 241	T. B. M. 242	820	397.574	Dir	—3,810.6	—0.15	—5.22	+5.22	0.10	11.1	—12.45	43.81841	143.762	....	....	F.
				Rev	—3,810.9	+0.15										
				Mean	—3,810.75											
T. B. M. 240	T. B. M. 241	1,254	398.828	Dir	+1,544.6	+0.50	—4.72	+4.72	0.33	11.1	—12.20	45.36376	148.833	....	....	F.
				Rev	+1,545.6	—0.50										
				Mean	+1,545.10											
*P. B. M. 123	T. B. M. 240	9	398.837	Dir	+1,314.5	0.00	—4.72	+4.72	0.00	11.1	—12.00	46.67846	153.146	....	....	F.
				Rev	+1,314.5	0.00										
				Mean	+1,314.50											
T. B. M. 239	T. B. M. 240	697	399.525	Dir	+2,706.9	+0.40	—4.32	+4.32	0.27	11.2	—11.77	48.07149	157.716	....	....	F.
				Rev	+2,707.7	—0.40										
				Mean	+2,707.30											
*P. B. M. 122=34. Sandy Hook.	T. B. M. 239	42	399.567	Dir	+3,003.6	+0.15	—4.17	+4.17	0.10	11.2	—11.33	51.07568	167.573	167.378	—0.195	F.
				Rev	+3,003.9	—0.15										
				Mean	+3,003.75											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Cap over 122	T. B. M. 239	42	399.567	Dir	+4,244.3	+0.15	—4.17	+4.17	0.10	11.2	—11.12	52.31659	171.644	....	....	F.
				Rev	+4,244.6	—0.15										
				Mean	+4.244.45											
T. B. M. 238	T. B. M. 239	1,155	400.680	Dir	—3,522.0	—0.90	—5.22	+5.22	0.60	11.2	—12.33	44.54803	146.156	....	....	F.
				Rev	—3,523.8	+0.90										
				Mean	−3,522.90											
T. B. M. 237	T. B. M. 238	324	401.004	Dir	+599.9	+1.00	—4.22	+4.22	0.67	11.2	—12.23	45.14903	148.128	....	....	J.
				Rev	+601.9	—1.00										
				Mean	+600.90											
*P. B. M. 121	T. B. M. 237	37	401.041	Dir	−264.8	+0.05	—4.17	+4.17	0.03	11.2	—12.27	44.88424	147.260	....	....	J.
				Rev	−264.7	—0.05										
				Mean	−264.75											
T. B. M. 236	T. B. M. 237	406	401.410	Dir	+735.2	0.00	—4.22	+4.22	0.00	11.2	—12.12	45.88434	150.540	....	....	J.
				Rev	+735.2	0.00										
				Mean	+735.20											
T. B. M. 235	T. B. M. 236	1,344	402.754	1 Dir	—862.1	—2.32	—6.29	+6.29	0.83	11.2	—12.25	45.01979	147.704	....	....	J.
				1 Rev	—867.3	+2.88										
				2 Dir	—862.6	—1.82										
				2 Rev	—865.7	+1.28										
				Mean	—864.42											
T. B. M. 234	T. B. M. 235	646	403.400	Dir	+516.7	+0.65	—5.64	+5.64	0.43	11.2	—12.17	45.53722	149.402	....	....	J.
				Rev	+518.0	—0.65										
				Mean	+517.35											

*P. B. M. 120	T. B. M. 234	55	403.455	Dir ...	+857.0	−0.05	−5.60	+5.60	0.03	11.2	−12.03	46.30521	152.217	....	....	J.
				Rev ..	+857.8	+0.05										
				Mean .	+857.85											
*Cap over 120	T. B. M. 234	5	403.455	Dir ...	+2,098.7	−0.15	−5.70	+5.70	0.10	11.2	−11.85	47.63000	156.288	....	....	J.
				Rev ..	+2,098.4	+0.15										
				Mean .	+2,098.55											
T. B. M. 233	T. B. M. 234	1,174	404.574	Dir ...	−3,817.7	−0.50	−6.14	+6.14	0.33	11.2	−12.76	41.71843	136.873	....	....	F.
				Rev ..	−3,818.7	+0.50										
				Mean .	−3,818.20											
T. B. M. 232	T. B. M. 233	921	405.495	Dir ...	+1,123.5	−0.20	−6.34	+6.34	0.13	11.2	−12.59	42.84190	140.559	....	....	F
				Rev ..	+1,123.1	+0.20										
				Mean .	+1,123.30											
T. B. M. 231	T. B. M. 232	1,040	406.535	Dir ...	−2,832.6	−1.45	−7.79	+ 7.79	0.97	11.3	−13.02	40.00742	131.259	....	....	J.
				Rev ..	−2,835.5	+1.45										
				Mean .	−2,834.05											
T. B. M. 230	T. B. M. 231	238	406.773	Dir ..	+399.3	+0.55	−7.24	+7.24	0.37	11.3	−12.07	40.40732	132.571	....	....	J.
				Rev ..	+400.4	−0.55										
				Mean .	+399.85											
*P. B. M. 119	T. B. M. 230	40	406.813	Dir ...	+4,425.9	−0.10	−7.34	+7.34	0.07	11.3	−12.29	44.83380	147.094	....	....	J.
				Rev ..	+4,425.7	0.10										
				Mean .	+4,425.80											
T. B. M. 229	T. B. M. 230	522	407.295	Dir ...	+2,291.5	+0.40	−6.84	+6.84	0.27	11.3	−12.61	42.69958	140.092	....	....	J.
				Rev .	+2,292.3	−0.40										
				Mean .	+2,291.90											
*P. B. M. 118=$\frac{M}{1}$ .... Marion,	T. B. M. 229	156	407.451	Dir ...	+6,188.8	−0.30	−7.14	+7.14	0.20	11.3	−11.66	48.88803	160.398	160.148	−0.250	J.
				Rev ..	+6,188.2	+0.30										
				Mean .	+6,188.50											
*Cap over 118	P. B. M. 118	44	407.451	Dir ...	+1,240.3	+0.15	−6.99	+6.99	0.10	11.3	−11.46	50.12968	164.469	....	....	J.
				Rev ..	+1,240.6	−0.15										
				Mean .	+1,240.45											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of the Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV Direct line.	ΣV Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 228	T. B. M. 229	678	407.973	Dir	+1,110.9	+0.80	—6.04	+6.04	0.53	11.3	—12.45	43.81144	143.740	....	....	J.
				Rev	+1,112.5	—0.80										
				Mean	+1,111.70											
T. B. M. 227	T. B. M. 228	996	408.969	Dir	+1,234.2	+0.05	—5.99	+5.99	0.03	11.3	—12.25	45.04589	147.790	....	....	F.
				Rev	+1,234.3	—0.05										
				Mean	+1,234.25											
T. B. M. 226	T. B. M. 227	819	409.788	Dir	—1,326.3	—0.95	—6.94	+6.94	0.63	11.3	—12.45	43.71844	143.434	....	....	F.
				Rev	—1,328.2	+0.95										
				Mean	—1,327.25											
T. B. M. 225	T. B. M. 226	1,023	410.811	Dir	—2,563.9	—0.65	—7.59	+7.59	0.43	11.3	—12.86	41.15348	135.019	....	....	F.
				Rev	—2,565.2	+0.65										
				Mean	—2,564.55											
T. B. M. 224	T. B. M. 225	747	411.558	Dir	+955.0	—1.55	—9.14	+9.14	1.03	11.4	—12.70	42.10709	138.148	....	....	F.
				Rev	+951.9	+1.55										
				Mean	+953.45											
T. B. M. 223	T. B. M. 224	1,222	412.780	Dir	—951.8	—0.30	—9.44	+9.44	0.20	11.4	—12.86	41.15483	135.024	....	....	J.
				Rev	—952.4	+0.30										
				Mean	—952.10											
*P. B. M. 117	T. B. M. 224	40	411.598	Dir	+6,160.3	0.00	—9.14	+9.14	0.00	11.4	—11.76	48.26833	158.362	....	....	F.
				Rev	+6,160.3	0.00										
				Mean	+6,160.30											
*Cap over 117	T. B. M. 224	40	411.598	Dir	+7,397.5	—0.05	—9.19	+9.19	0.03	11.4	—11.56	49.50568	162.422	....	....	F.
				Rev	+7,397.4	+0.05										
				Mean	+7,397.45											

				Mean .	+514.00											
T. B. M. 222	T. B. M. 223	662	413.382	Dir ...	+2,322.6	—1.15	—10.59	+10.59	0.77	11.4	—12.49	43.47665	142.641	....	....	F.
				Rev ...	+2,320.3	+1.15										
				Mean .	+2,321.45											
T. B. M. 221	T. B. M. 222	729	414.111	Dir ...	—2,600.5	+0.65	—9.94	+9.94	0.43	11.4	—12.88	40.87641	134.110	....	....	J.
				Rev ..	—2,599.2	—0.65										
				Mean .	—2,599.85											
T. B. M. 220	T. B. M. 221.......	904	415.015	Dir ...	+3,836.5	+0.30	—9.64	+9.64	0.20	11.4	—12.30	44.71379	146.700	....	....	J.
				Rev ..	+3,837.1	—0.30										
				Mean .	+3,836.80											
*P. B. M. 115	T. B. M. 220.......	16	415.031	Dir ...	—1,641.6	—0.10	—9.74	+9.74	0.07	11.4	—12.56	43.07183	141.313	....	....	J.
				Rev ..	—1,641.8	+0.10										
				Mean .	—1,641.70											
*Cap over 115...........	T. B. M. 220.......	16	415.031	Dir ...	—404.7	0.00	—9.64	+9.64	0.00	11.4	—12.87	44.30002	145.372	....	....	J.
				Rev ..	—404.7	0.00										
				Mean .	—404.70											
*P. B. M. 114............ Sugar Loaf Rock.	T. B. M. 220.......	436	415.451	Dir ...	+2,805.7	+0.40	—9.24	+9.24	0.27	11.4	—11.88	47.52031	155.908	....	....	F.
				Rev ..	+2,806.5	—0.40										
				Mean .	+2,806.10											
T. B. M. 219.............	T. B. M. 220.......	838	415.853	Dir ...	—1,381.8	+0.45	—9.19	+9.19	0.30	11.4	—12.50	43.33224	142.168	....	....	F.
				Rev ..	—1,380.9	—0.45										
				Mean .	—1,381.35											
T. B. M. 218............. Stanleys Landing.	T. B. M. 219.......	1,310	417,163	Dir ...	—367.5	0.00	—9.19	+9.19	0.00	11.4	—12.57	42.96467	140.962	....	....	F.
				Rev ..	—367.5	0.00										
				Mean .	—367.50											
T. B. M. 217.............	T. B. M. 218.......	744	417.907	Dir ...	—301.9	—0.55	—9.74	+9.74	0.87	11.4	—12.62	42.66217	139.969	....	....	F.
				Rev ..	—303.0	+0.55										
				Mean .	—302.45											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 215	T. B. M. 217	2,049	419.956	Dir Rev	−527.7 −524.2	+1.75 −1.75	−7.99	+7.99	1.17	11.5	−12.70	42.13614	138.243	....	....	J.
				Mean	−525.95											
*T. B. M. 216	T. B. M. 215	946	420.902	Dir Rev	+1,759.8 +1,761.8	+1.00 −1.00	−6.99	+6.99	0.67	11.5	−12.44	43.89720	144.021	....	....	J.
				Mean	+1,760.80											
*P. B. M. 113=$\frac{32}{1}$	T. B. M. 216	33	420.935	Dir Rev	+1,660.6 +1,660.5	−0.05 +0.05	−7.04	+7.04	0.03	11.5	−12.18	45.55801	149.470	149.124	−0.346	J.
				Mean	+1,660.55											
*Cap over 113	T. B. M. 216	33	420.935	Dir Rev	+2,899.3 +2,899.0	−0.15 +0.15	−7.14	+7.14	0.10	11.5	−11.98	46.79681	153.534	....	....	J.
				Mean	+2,899.15											
T. B. M. 214	T. B. M. 215	570	420.526	Dir Rev	−361.6 −361.2	+0.20 −0.20	−7.79	+7.79	0.13	11.5	−12.75	41.77469	137.057	....	....	F.
				Mean	−361.40											
T. B. M. 213	T. B. M. 214	622	421.148	Dir Rev	+708.3 +707.1	−0.60 +0.60	−8.39	+8.39	0.40	11.5	−12.64	42.48250	139.379	....	....	F.
				Mean	+707.70											
*P. B. M. 112	T. B. M. 213	22	421.170	Dir Rev	−875.2 −875.2	0.00 0.00	−8.39	+8.39	0.00	11.5	−12.78	41.60716	136.508	....	....	W.
				Mean	−875.20											
*Cap over 112	T. B. M. 213	22	421.170	Dir Rev	+362.3 +362.0	−0.15 +0.15	−8.54	+8.54	0.10	11.5	−12.59	42.84470	140.568	....	....	W.
				Mean	+362.15											

*P. B. M. 111	T. B. M. 213	14	421.102	Dir	+720.3	−0.05	−8.44	+8.44	0.03	11.5	−12.54	43.20285	141.743	....	....	W.
				Rev	+720.2	+0.05										
				Mean	+720.25											
T. B. M. 212	T. B. M. 213	542	421.690	Dir	−707.1	−0.15	−8.54	+8.54	0.10	11.5	−12.75	41.77514	137.059	....	....	J.
				Rev	−707.4	+0.15										
				Mean	−707.25											
T. B. M. 211	T. B. M. 212	858	422.548	1 Dir	+1,535.2	−2.05	−10.39	+10.39	0.71	11.5	−12.52	43.30852	142.090	....	....	J.
				1 Rev	+1,531.1	+2.05										
				2 Dir	+1,534.8	−1.65										
				2 Rev	+1,531.5	+1.65										
				Mean	+1,533.15											
T. B. M. 210	T. B. M. 211	1,003	423.551	1 Dir	−2,633.6	−2.57	−11.91	+11.91	0.90	11.5	−12.93	40.67194	133.439	....	....	W.
				Rev	−2,638.2	+2.03										J.
				2 Dir	−2,636.7	+0.53										J.
				Mean	−2,636.17											
T. B. M. 209	T. B. M. 210	604	424.155	Dir	−1,787.8	+0.15	−11.76	+11.76	0.10	11.5	−13.19	38.88403	127.573	....	....	F.
				Rev	−1,787.5	−0.15										
				Mean	−1,787.65											
T. B. M. 206	T. B. M. 209	1,308	425.463	Dir	+5,963.4	+0.25	−11.51	+11.51	0.17	11.5	−12.28	44.84859	147.142	....	....	F.
				Rev	+5,963.9	−0.25										
				Mean	+5,963.65											
*T. B. M. 207 Grays Creek	T. B. M. 206	320	425.783	Dir	−1,157.1	+0.30	−11.21	+11.21	0.20	11.5	−12.46	43.69161	143.346	....	....	F.
				Rev	−1,156.5	−0.30										
				Mean	−1,156.80											
*T. B. M. 208	T. B. M. 207	358	426.141	Dir	+2,909.5	−0.30	−11.51	+11.51	0.20	11.5	−12.01	46.60126	152.893	....	....	F.
				Rev	+2,908.9	+0.30										
				Mean	+2,909.20											
*P. B. M. 110 = $^{31}_{1}$	T. B. M. 208	14	426.155	Dir	−822.2	−0.05	−11.56	+11.56	0.03	11.5	−12.12	45.77890	150.195	149.799	−0.396	W.
				Rev	−822.3	+0.05										
				Mean	−822.25											
Cap over 110	T. B. M. 208	14	426.155	Dir	+420.3	+0.10	−11.41	+11.41	0.07	11.5	−11.94	47.02173	154.272	....	....	W.
				Rev	+420.5	−0.10										
				Mean	+420.40											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 205	T. B. M. 206	1,099	426.562	Dir	−108.1	+0.45	−11.06	+11.06	0.30	11.5	−12.28	44.74094	146.789	....	....	F.
				Rev	−107.2	−0.45										
				Mean	−107.65											
*P. B. M. 100	T. B. M. 205	20	426.582	Dir	+923.7	+0.05	−11.01	+11.01	0.03	11.5	−12.15	45.66482	149.820	....	....	F.
				Rev	+923.8	−0.05										
				Mean	+923.75											
T. B. M. 204	T. B. M. 205	1,135	427.697	Dir	−1,261.9	−1.45	−12.51	+12.51	0.97	11.6	−12.50	43.47737	142.644	....	....	F.
				Rev	−1,264.8	+1.45										
				Mean	−1,263.35											
*P. B. M. 108	T. B. M. 204	60	427.757	Dir	−1,035.5	−0.10	−12.61	+12.61	0.07	11.6	−12.65	42.44162	139.245	....	....	W.
				Rev	−1,035.7	+0.10										
				Mean	−1,035.60											
*Cap over 108	T. B. M. 204	60	427.757	Dir	+203.1	−0.10	−12.61	+12.61	0.07	11.6	−12.45	43.68042	143.310	....	....	W.
				Rev	+202.9	+0.10										
				Mean	+203.00											
*T. B. M. 203=Old B. M.	T. B. M. 204	16	427.713	Dir	−514.4	+0.05	−12.46	+12.46	0.03	11.6	−12.57	42.96295	140.956	....	....	F.
				Rev	−514.3	−0.05										
				Mean	−514.35											
T. B. M. 202	T. B. M. 204	2,212	429.909	Dir	+1,244.1	+1.30	−11.21	+11.21	0.87	11.6	−12.30	44.72297	146.730	....	....	F.
				Rev	+1,246.7	−1.30										
				Mean	+1,245.40											
T. B. M. 200	T. B. M. 202	512	430.421	Dir	−824.7	−0.25	−11.46	+11.46	0.17	11.6	−12.43	43.89789	144.023	....	....	J.
				Rev	−825.2	+0.25										
				Mean	−824.95											

*P. B. M. 107=[illegible]	T. B. M. 200	83	430.504	Dir ...	—1,283.9	—0.20	—11.66	+11.66	0.13	11.6	—12.63	42.61359	139.810	139.598	—0.212	J.
				Rev ..	—1,284.8	+0.20										
				Mean.	—1,284.10											
*Cap over 107	T. B. M. 200	83	430.504	1 Dir.	—45.9	—0.62	—11.94	+11.94	0.19	11.6	—12.44	43.85136	143.871	....	....	J.
				1 Rev.	—47.1	+0.58										
				2 Dir.	—46.2	—0.32										
				2 Rev.	—46.9	+0.88										
				Mean.	—46.52											
*T. B. M. 201=B. M. 90(b) "P. H"=Gauge B. M.	T. B. M. 200	70	430.491	Dir...	—3,756.5	—0.15	—11.61	+11.61	0.10	11.6	—13.01	40.14066	131.696	131.490	—0.206	J.
				Rev ..	—3,756.8	+0.15										
				Mean.	—3,756.65											
*Zero of gauge above Ferry Landing.	T. B. M. 200	115	430.536	Dir ...	—43,828.9	—0.10	—11.56	+11.56	0.07	11.6	—13.50	+ 0.06782	+0.222	00.000	—0.222	J.
				Rev ..	—43,829.1	+0.10										
				Mean.	—43,829.00											
T. B. M. 199	T. B. M. 200	470	430.891	Dir ...	—820.1	+0.30	—11.16	+11.16	0.20	11.6	—12.53	43.07797	141.333	....	....	J.
				Rev ..	—819.5	—0.30										
				Mean.	—819.80											
*T. B. M. 198=B. M. 90 (a) "C"=Gauge B. M.	T. B. M. 199	28	430.919	Dir ...	—3,976.6	—0.15	—11.31	+11.31	0.10	11.6	—13.16	39.10061	128.284	128.078	—0.206	J.
				Rev ..	—3,976.9	+0.15										
				Mean.	—3,976.75											
*Zero of gauge at Culvert.	T. B. M. 199	34	430.925	Dir ...	—43,015.9	—3.55	—14.71	—14.71	2.37	11.9	+13.47	+0.05760	+0.189	0.000	—0.189	J.
				Rev...	—43,023.0	+3.55										
				Mean.	—43,019.45											
T. B. M. 195	T. B. M. 199	418	431.309	Dir ...	+74.0	+0.60	—10.56	+10.56	0.40	11.6	—12.54	43.15258	141.578	....	....	J.
				Rev...	+75.2	—0.60										
				Mean.	+74.60											
*T. B. M. 196, gauge B. M. at Lohman's warehouse.	T. B. M. 195	12	431.321	Dir ...	+138.0	+0.15	—10.41	+10.41	0.10	11.6	—12.52	43.29075	142.031	141.796	—0.235	J.
				Rev...	+138.3	—0.15										
				Mean.	+138.15											
*P. B. M. 106=B. M. 90, Jefferson City.	T. B. M. 195	210	431.519	Dir ...	+667.6	+0.40	—10.16	+10.16	0.27	11.6	—12.44	43.82068	143.770	143.536	—0.234	J.
				Rev...	+668.4	—0.40										
				Mean.	+668.00											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 105	T. B. M. 195	77	431.386	Dir Rev	+1,430.8 +1,430.7	−0.05 +0.05	−10.61	+10.61	0.03	11.6	−12.32	44.58355	146.273	....	....	F.
				Mean	+1,430.75											
*U. S. C. S. B. M. XXVII	T. B. M. 195	224	431.533	Dir Rev	+15,533.8 +15,532.8	−0.50 +0.50	−11.06	+11.06	0.33	11.6	−10.13	58.68829	192.549	191.813 U. S. C. S.	−0.736	F.
				Mean	+15,533.30											
*T. B. M. 197	U. S. C. S. B. M. XXVII.	144	431.677	Dir Rev	+6,619.7 +6,619.1	−0.30 +0.30	−11.36	+11.26	0.20	11.6	−9.11	65.30871	214.269	....	....	F.
				Mean	+6,619.40											
*U. S. C. S. B. M. + in Capitol.	T. B. M. 197	51	431.728	Dir Rev	+190.3 +190.3	0.00 0.00	−11.36	+11.36	0.00	11.6	−9.09	65.49903	214.894	Not given	....	F.
				Mean	+190.30											
*Jefferson City B. M.	U. S. C. S. B. M. XXVII.	282	431.815	Dir Rev	+9,489.8 +9,489.4	−0.20 +0.20	−11.26	+11.26	0.13	11.6	−8.66	68.17936	223.688	....	....	J.
				Mean	+9,489.60											
*Jefferson City datum	Jefferson City, B. M.	....	....	....	ft.—200.00	....	....	....	....	....	....	....	23.688	....	....	....
T. B. M. 194	T. B. M. 195	1,638	432.947	Dir Rev	+252.6 +251.8	−0.40 +0.40	−10.96	+10.96	0.27	11.6	−12.49	43.40483	142.406	....	....	J.
				Mean	+252.20											
*P. B. M. 104	T. B. M. 194	18	432.965	Dir Rev	+891.0 +890.9	−0.05 +0.05	−11.01	+11.01	0.03	11.6	−12.37	44.29590	145.329	....	....	F.
				Mean	+890.95											
*T. B. M. 193 = old B. M. 88.	T. B. M. 194	359	433.306	Rev	+189.10	....	....	....	....	....	−12.47	43.59395	143.026	140.867	−2.159	F.

T. B. M. 193	T. B. M. 194	1,470	434.417	Dir	+131.9	+0.85	—10.41	+10.41	0.37	11.6	—12.48	43.53729	142.810			F.
				Rev	+133.0	—0.55										
				Mean	+132.45											
*P. B. M. 103	T. B. M. 193	153	434.570	Dir	—2,635.6	0.00	—10.41	+10.41	0.00	11.6	—12.80	40.90128	134.102			F.
				Rev	—2,635.6	0.00										
				Mean	—2,635.60											
*Cap over 103	T. B. M. 193	153	434.570	Dir	—1,397.9	+0.05	—10.36	+10.36	0.03	11.6	—12.60	42.13023	138.253			F.
				Rev	—1,397.8	—0.05										
				Mean	—1,397.85											
T. B. M. 191	T. B. M. 192	1,338	435.755	Dir	+6.6	+1.95	+8.46	+8.46	1.30	11.7	—12.48	43.53264	142.825			F.
				Rev	+2.7	—1.95										
				Mean	—4.65											
T. B. M. 190	T. B. M. 191	1,336	437.091	Dir	+4,513.9	+0.10	—8.36	+8.36	0.07	11.7	—11.78	48.04734	157.637			J.
				Rev	+4,514.1	—0.10										
				Mean	+4,514.00											
*P. B. M. 102	T. B. M. 190	194	437.285	Dir	—79.7	+0.10	—8.26	+8.26	0.07	11.7	—11.80	47.96772	157.376			J.
				Rev	—79.5	—0.10										
				Mean	—79.60											
*Cap over 102	P. B. M. 102	86	437.285	Dir	+1,236.9	0.00	—8.26	+8.26	0.00	11.7	—11.62	49.20480	161.434			J.
				Rev	+1,236.9	0.00										
				Mean	+1,236.90											
T. B. M. 189	T. B. M. 190	602	437.693	Dir	+2,093.4	—0.90	—9.26	+9.26	0.60	11.7	—11.45	50.14017	164.503			J.
				Rev	+2,091.6	+0.90										
				Mean	+2,092.50											
*P. B. M. 101	T. B. M. 189	28	437.721	Dir	+897.4	+0.10	—9.16	+9.16	0.07	11.7	—11.33	51.03779	167.448			J.
				Rev	+897.6	—0.10										
				Mean	+897.50											
U. S. C. S. B. M. XXVI Moreau River.	T. B. M. 189	906	438.599	Dir	+1,946.1	—0.90	—10.16	+10.16	0.60	11.7	—11.15	52.08567	170.886	170.244 U. S. C. S.	—0.642	F.
				Rev	+1,944.3	+0.90										
				Mean	+1,945.20											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct-line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 188	U. S. C. S. B. M. XXVI.	1,227	439.826	Dir ...	—4,553.1	—0.90	—11.06	+11.06	0.60	11.7	—11.87	47.53095	155.943	....	....	F.
				Rev ...	—4,554.9	+0.90										
				Mean .	—4,554.00											
T. B. M. 187	T. B. M. 188	1,324	441.150	Dir ...	—3,369.2	+0.55	—10.51	+10.51	0.37	11.8	—12.39	44.16178	144.889	....	....	J.
				Rev ...	—3,368.1	—0.55										
				Mean .	—3,368.65											
*T. B. M. 186	T. B. M. 187	956	442.106	Dir ...	—4,146.1	+0.95	—9.56	+ 9.56	0.63	11.8	—13.02	40.01600	131.287	....	....	F.
				Rev ...	—4,144.2	—0.95										
				Mean .	—4,145.15											
*P. B. M. 100=3ª .... Ewings Landing.	T. B. M. 186	18	442.124	Dir ...	—888.7	0.00	—9.56	+ 9.56	0.00	11.8	—13.18	39.12714	128.371	128.268	—0.103	F.
				Rev ...	—888.7	0.00										
				Mean .	—888.70											
*Cap over 100	T. B. M. 186	18	442.124	Dir ...	+355.2	+0.05	—9.51	+ 9.51	0.03	11.8	—12.97	40.37130	132.453	....	....	F.
				Rev ...	+355.3	—0.05										
				Mean .	+355.25											
U. S. C. S. B. M. XXV ...	T. B. M. 187	276	441.426	Dir ...	—395.2	+0.35	—10.16	+10.16	0.23	11.8	—12.44	43.76688	143.593	142.984 U. S. C. S.	—0.609	J.
				Rev ...	—394.5	—0.35										
				Mean .	—394.85											
T. B. M. 185	U. S. C. S. B. M. XXV.	638	442.064	Dir ...	—1,293.1	+0.15	—10.01	+10.01	0.10	11.8	—12.64	42.47373	139.351	....	....	J.
				Rev ...	—1,292.8	—0.15										
				Mean .	—1,292.95											
T. B. M. 184	T. B. M. 185	1,189	443.253	Dir ...	+1,695.9	—0.05	—10.06	+10.06	0.03	11.8	—12.39	44.16983	144.915	....	....	J.
				Rev ...	+1,695.8	—0.05										
				Mean .	+1,695.85											

T. B. M. 182	T. B. M. 184	1,307	444.860	Dir ... Rev ...	—1,725.5 —1,723.2	+1.15 —1.15	— 8.91	+ 8.91	0.77	11.8	—12.65	42.44522	133.257	....	....	F.
				Mean .	—1,724.35											
*U. S. C. S. B. M. XXIV.	T. B. M. 183	124	444.694	Dir ... Rev ...	—1,851.6 —1,851.2	+0.20 —0.20	— 8.71	+ 8.71	0.13	11.8	—12.94	40.59353	133.183	132.554 U. S. C. S.	—0.628	F.
				Mean .	—1,851.40											
*P. B. M. 99 .... Osage City.	T. B. M. 183	119	444.679	Dir ... Rev ...	—1,499.9 —1,499.8	+0.05 —0.05	— 8.86	+ 8.86	0.03	11.8	—12.88	40.94514	134.336	....	....	F.
				Mean .	—1,499.85											
*Cap over 99............	P. B. M. 99	57	444.679	Dir ... Rev ...	+1,238.6 +1,239.1	+0.25 —0.25	— 8.61	+ 8.61	0.17	11.8	—12.68	42.18419	138.401	....	....	F.
				Mean .	+1,238.85											
P. B. M. 98	T. B. M. 183	701	445.261	1 Dir.. 1 Rev . 2 Dir.. 2 Rev .	—1,908.5 —1,905.8 —1,908.2 —1,907.8	+0.92 —1.78 +0.62 +0.22	— 8.13	+ 8.13	0.41	11.8	—12.95	40.53784	132.998	....	....	F.
				Mean .	—1,907.58											
T. B. M. 182. Old. B. M. at Osage Bridge.	P. B. M. 98	22	445.283	Dir ... Rev ...	+5.5 +5.2	—0.15 +0.15	— 8.28	+ 8.28	0.10	11.8	—12.95	40.54269	133.015	....	....	F.
				Mean .	+5.35											
T. B. M. 181	P. B. M. 98	1,386	446.647	Dir ... Rev ...	+899.9 +897.5	—1.20 +1.20	— 9.33	+ 9.33	0.80	11.8	—12.81	41.43618	135.947	....	....	J.
				Mean .	+898.70											
T. B. M. 180	T. B. M. 181	1,044	447.691	Dir ... Rev ...	—1,743.0 —1,745.3	—1.15 +1.15	—10.48	+10.48	0.77	11.9	—13.07	39.69177	130.224	....	....	J.
				Mean .	—1,744.15											
*P. B. M. 97	T. B. M. 180	48	447.739	Dir ... Rev ...	—1,435.8 —1,435.3	+0.25 —0.25	—10.23	+10.23	0.17	11.9	—13.30	38.25599	125.513	....	....	J.
				Mean .	—1,435.55											
*Cap over 97	T. B. M. 180	48	447.739	Dir ... Rev ..	—194.2 —193.9	+0.15 —0.15	—10.33	+10.33	0.10	11.9	—13.10	39.49769	129.587	....	....	J.
				Mean .	—194.05											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 179	T. B. M. 180	1,462	449.153	Dir	−455.4	−0.50	−10.98	+10.98	0.33	11.9	−13.15	39.23579	128.728	....	....	J.
				Rev	−456.4	+0.50										
				Mean	−455.90											
T. B. M. 178. Old B. M. 81	T. B. M. 179	554	449.707	Dir	+619.4	+0.55	−10.43	+10.43	0.37	11.9	−13.05	39.85584	130.761	130.666	−0.095	F.
				Rev	+620.5	−0.55										
				Mean	+619.95											
*T. B. M. 177. Old B. M. 80.	T. B. M. 178	22	449.729	Dir	+23.9	−0.10	−10.53	+10.53	0.07	11.9	−13.04	39.87965	130.840	130.731	−0.109	F.
				Rev	+23.7	+0.10										
				Mean	+23.80											
*P. B. M. 96.	T. B. M. 178	283	449.990	Dir	+1,269.8	−0.35	−10.78	+10.78	0.23	11.9	−12.85	41.12549	134.927	....	....	F.
				Rev	+1,269.1	+0.35										
				Mean	+1,269.45											
T. B. M. 176	T. B. M. 178	816	450.523	Dir	−866.8	+1.20	−9.23	+9.23	0.80	11.9	−13.17	38.99012	127.922	....	....	F.
				Rev	−864.4	−1.20										
				Mean	−865.60											
T. B. M. 175	T. B. M. 176	749	451.272	Dir	+823.3	+0.15	−9.08	+9.08	0.10	11.9	−13.06	39.81368	130.623	....	....	F.
				Rev	+823.6	−0.15										
				Mean	+823.45											
*P. B. M. 95=♈ Bonnots Mill.	T. B. M. 175	82	451 354	Dir	−3,635.3	−0.15	−9.23	+9.23	0.10	11.9	−13.62	36.17767	118.694	118.489	−0.205	F.
				Rev	−3,635.6	+0.15										
				Mean	−3,635.45											
*Cap over 95	T. B. M. 175	82	451.354	Dir	−2,396.8	+0.20	−8.88	+8.88	0.13	11.9	−13.43	37.41671	122.759	....	....	F.
				Rev	−2,396.4	−0.20										
				Mean	−2,396.60											

T. B. M. 174	T. B. M. 175	170	451.442	Dir ...	+577.2	+0.10	—8.98	+8.98	0.07	11.9	—12.96	40.39108	132.518	....	....	F.
				Rev ..	+577.4	—0.10										
				Mean.	+577.30											
*U. S. C. S. B. M. P. 8. Bonnot's Mill.	T. B. M. 174	70	451.512	Dir ...	+1,852.3	+0.55	— 8.43	+ 8.43	0.37	11.9	—12.68	42.24421	138.598	138.020 U. S. C. S.	—0.578	F.
				Rev...	+1,853.4	—0.55										
				Mean.	+1,852.85											
T. B. M. 173	T. B. M. 174	1,401	452.843	Dir ...	—240.0	—0.80	— 9.78	+ 9.78	0.53	11.9	—13.01	40.15023	131.728	....	....	J.
				Rev...	—241.6	±0.80										
				Mean.	—240.80											
T. B. M. 172	T. B. M. 173	1,470	454.313	Dir ...	—1,935.1	—0.95	—10.73	+10.73	0.63	11.9	—13.31	38.21388	125.375	....	....	J.
				Rev...	—1,937.0	+0.95										
				Mean.	—1,936.05											
*P. B. M. 94............	T. B. M. 172	28	454.341	Dir ...	—1,111.2	—0.15	—10.88	+10.88	0.10	11.9	—13.47	37.10237	121.728	....	....	F.
				Rev...	—1,111.5	+0.15										
				Mean.	—1,111.35											
*Cap over 94............	T. B. M. 172	28	454.341	Dir ...	+123.7	+0.20	—10.53	+10.53	0.13	11.9	—13.29	38.33780	125.781	....	....	F.
				Rev...	+124.1	—0.20										
				Mean.	+123.90											
T. B. M. 171	T. B. M. 172	542	454.855	Dir ...	+885.4	—0.45	—11.18	+11.18	0.30	11.9	—13.17	39.09897	128.279	....	....	F.
				Rev...	+884.5	+0.45										
				Mean.	+884.95											
T. B. M. 170	T. B. M. 171	1,206	456.061	Dir ...	+2,723.2	+0.20	—10.98	+10.98	0.13	11.9	—12.75	41.82279	137.215	....	....	F.
				Rev...	+2,723.6	—0.20										
				Mean.	+2,723.40											
T. B. M. 169	T. B. M. 170	1,486	457.547	Dir ...	—1,482.2	+0.85	—10.13	+10.13	0.57	11.9	—12.97	40.34122	132.354	....	....	F.
				Rev...	—1,480.5	—0.85										
				Mean.	—1,481.35											
*P. B. M. 93	T. B. M. 169	14	457.561	Dir ...	+798.7	0.00	—10.13	+10.13	0.00	11.9	—12.86	41.14003	134.975	....	....	F.
				Rev...	+798.7	0.00										
				Mean.	+798.70											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV Direct line.	ΣV Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 92=$^{3}_{1}$L Isbell.	T. B. M. 169	155	457.702	Dir Rev	—4,543.2 —4,543.0	+0.10 —0.10	—10.03	+10.03	0.07	11.9	—13.68	35.79741	117.446	120.487	+3.041	F.
				Mean	—4,543.10											
*Cap over 92	P. B. M. 92	21	457.702	Dir Rev	+1,233.4 +1,233.1	—0.15 +0.15	—10.18	+10.18	0.10	11.9	—13.48	37.03086	121.493	....	....	F.
				Mean	+1,233.25											
U. S. C. S. B. M. XXII Loose Creek L'd'g.	T. B. M. 169	565	458.112	Dir Rev	—1,862.0 —1,861.0	+0.50 —0.50	— 9.63	+9.63	0.33	11.9	—13.26	38.47943	126.246	125.703 U. S. C. S.	—0.543	F.
				Mean	—1,861.50											
T. B. M. 168	U. S. C. S. B. M. XXII.	544	458.656	Dir Rev	+2,113.5 +2,111.9	—0.80 +0.80	—10.43	+10.43	0.53	11.9	—12.94	40.59245	133.178	....	....	F.
				Mean	+2,112.70											
T. B. M. 167	T. B. M. 168	1,084	459.740	Dir Rev	—1,083.5 —1,087.3	—1.90 +1.90	—12.33	+12.33	1.27	12.0	—13.10	39.50689	129.617	....	....	J.
				Mean	—1,085.40											
*P. B. M. 91 Shipley L'd'g.	T. B. M. 167	163	459.903	Dir Rev	—1,525.3 —1,525.2	+0.05 —0.05	—12.28	+12.28	0.03	12.0	—13.34	37.98140	124.612	....	....	J.
				Mean	—1,525.25											
*Cap over 91	T. B. M. 167	163	459.903	Dir Rev	—286.7 —286.9	—0.10 +0.10	—12.43	+12.43	0.07	12.0	—13.16	39.22003	128.676	....	....	J.
				Mean	—286.80											
T. B. M. 166	T. B. M. 167	2,440	462.180	Dir Rev	—198.3 —199.5	—0.60 +0.60	—12.93	+12.93	0.40	12.0	—13.14	39.30795	128.964	....	....	J.
				Mean	—198.90											

T. B. M. 165	T. B. M. 166	1,102	463.282	Dir Rev	—467.6 —470.9	—1.65 +1.65	—14.58	+14.58	1.10	12.0	—13.20	38.83864	127.424	....	....	J.
				Mean	—469.25											
U. S. C. S. B. M. XX	T. B. M. 165	572	463.854	Dir Rev	—690.0 —687.3	+1.35 —1.35	—13.23	+13.23	0.90	12.1	—13.33	38.14986	125.165	124.621 U. S. C. S.	—0.544	J.
				Mean	—688.65											
*P. B. M. 90=$\frac{12}{7}$ St. Aubert.	U. S. C. S. B. M. XX.	155	464.009	Dir Rev	+482.6 +482.3	—0.15 +0.15	—13.38	+13.38	0.10	12.1	—13.24	38.63240	126.748	126.551	—0.197	J.
				Mean	+482.45											
*Cap over 90	U. S. C. S. B. M. XX.	155	464.009	Dir Rev	+1,724.2 +1,724.2	0.00 0.00	—13.23	+13.23	0.00	12.1	—13.04	39.87435	130.822	....	....	J.
				Mean	+1,724.20											
T. B. M. 164	U. S. C. S. B. M. XX.	1,000	464.854	Dir Rev	+449.0 +451.6	+1.30 —1.30	—11.93	+11.93	0.87	12.1	—13.25	38.60024	126.642	....	....	F.
				Mean	+450.30											
T. B. M. 163	T. B. M. 164	1,008	465.862	Dir Rev	—2,160.2 —2,159.4	+0.40 —0.40	—11.53	+11.53	0.27	12.1	—13.57	36.44012	119.555	....	....	F.
				Mean	—2,159.80											
*P. B. M. 89, Old B. M. 74.	T. B. M. 163	24	465.886	Dir Rev	—1,028.0 —1,027.5	+0.25 —0.25	—11.28	+11.28	0.17	12.1	—13.72	35.41222	116.183	116.009	—0.174	F.
				Mean	—1,027.75											
T. B. M. 162	T. B. M. 163	519	466.381	Dir Rev	+2,547.7 +2,549.5	+0.90 —0.90	—10.63	+10.63	0.60	12.1	—13.17	38.98912	127.918	....	....	F.
				Mean	+2,548.60											
T. B. M. 161	T. B. M. 162	1,668	468.049	Dir Rev	—3.7 —3.8	—0.05 +0.05	—10.68	+10.68	0.03	12.2	—13.17	38.98537	127.906	....	....	F.
				Mean	—3.75											
*P. B. M. 88	T. B. M. 161	462	468.511	Dir Rev	—2,750.8 —2,749.3	+0.75 —0.75	—0.93	+0.93	0.50	12.2	—13.61	36.23488	118.882	....	....	F.
				Mean	—2,750.05											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 87	T. B. M. 161	16	468.065	Dir	−1,462.7	0.00	−10.68	+10.68	0.00	12.2	−13.41	37.52243	123.106	....	....	F.
				Rev	−1,462.7	0.00										
				Mean	−1,462.70											
*Cap over 87	T. B. M. 161	16	468.065	Dir	−219.1	+0.05	−10.63	+10.63	0.03	12.2	−13.23	38.76626	127.187	....	....	F.
				Rev	−219.0	−0.05										
				Mean	−219.05											
T. B. M. 160	T. B. M. 161	780	468.829	Dir	−1,952.0	+0.60	−10.08	+10.08	0.40	12.2	−13.48	37.03366	121.503	....	....	J.
				Rev	−1,950.8	−0.60										
				Mean	−1,961.40											
T. B. M. 159	T. B. M. 160	1,198	470.027	Dir	−2,123.6	+0.70	−9.38	+9.38	0.47	12.2	−13.82	34.91042	114.536	....	....	J.
				Rev	−2,122.2	−0.70										
				Mean	−2,122.90											
U. S. C. S. B. M. O_3	T. B. M. 159	2,083	472.110	Dir	+2,466.2	−0.50	−9.88	+9.88	0.33	12.2	−13.43	37.37651	122.628	122.101 U. S. C. S.	−0.527	J.
				Rev	+2,465.2	+0.50										
				Mean	+2,465.70											
*P. B. M. 86=$^{1}_{1}$ Chamois.	U. S. C. S. B. M. O_3.	173	472.283	Dir	−1,811.0	+0.15	−9.73	+9.73	0.10	12.2	−13.72	35.56537	116.685	116.487	−0.198	J.
				Rev	−1,810.7	−0.15										
				Mean	−1,810.85											
*Cap over 86	P. B. M. 86	30	472.283	Dir	+1,242.6	+0.10	−9.63	+9.63	0.07	12.2	−13.53	36.80826	120.763	....	....	J.
				Rev	+1,242.8	−0.10										
				Mean	+1,242.70											
*P. B. M. 85	U. S. C. S. B. M. O_3.	84	472.194	1 Dir	+500.4	+0.22	−9.60	+9.60	0.11	12.2	−13.35	37.87721	124.270	....	....	J.
				1 Rev	+501.0	−0.38										
				2 Dir	+500.3	+0.32										
				2 Rev	+500.8	−0.18										
				Mean	+500.62											

T. B. M. 158	U. S. C. S. B. M. O₁.	1,885	473.475	Dir... Rev..	−1,213.1 −1,211.2	+0.95 −0.95	−8.93	+8.93	0.63	12.2	−13.62	36.10417	118.650	....	....	F.
				Mean.	−1,212.15											
T. B. M. 157	T. B. M. 158	1,532	475.007	Dir... Rev..	+2,235.4 +2,234.8	−0.30 +0.30	−9.23	+9.23	0.20	12.2	−13.28	38.39961	125.984	....	....	F.
				Mean.	+2,235.10											
T. B. M. 150	T. B. M. 157	1,182	476.189	Dir... Rev..	−2,792.8 −2,793.2	−0.20 +0.20	−9.43	+9.43	0.13	12.2	−13.78	35.60616	116.819	....	....	F.
				Mean.	−2,793.00											
*P. B. M. 84 Portage.	T. B. M. 156	24	476.213	Dir... Rev..	−794.4 −794.9	−0.25 +0.25	−9.68	+9.68	0.17	12.2	−13.84	34.81140	114.211	....	....	B.
				Mean.	−794.65											
*Cap over 84	T. B. M. 156	24	476.213	Dir... Rev..	+443.7 +442.7	−0.50 +0.50	−9.93	+9.93	0.33	12.2	−13.64	36.04945	118.274	....	....	B.
				Mean.	+443.20											
T. B. M. 155	T. B. M. 156	1,012	477.201	Dir... Rev..	−90.8 −93.6	−1.40 +1.40	−10.83	+10.83	0.93	12.2	−13.73	35.51396	116.516	....	....	F.
				Mean.	−92.20											
T. B. M. 154	T. B. M. 155	2,124	479.325	Dir... Rev..	−319.4 −316.9	+1.25 −1.25	−9.58	+9.58	0.83	12.3	−13.78	35.19576	115.473	....	....	J.
				Mean.	−318.15											
T. B. M. 153	T. B. M. 154	1,061	480.386	1 Dir. 1 Rev. 2 Dir. 2 Rev.	+1,222.1 +1,217.4 +1,219.3 +1,222.0	−1.90 +2.80 +0.90 −1.80	−10.08	+10.08	0.76	12.3	−13.59	36.41615	119.477	....	....	J.
				Mean.	+1,220.20											
*P. B. M. 83 = 24/1	T. B. M. 153	25	480.411	Dir... Rev..	−106.9 −107.4	−0.25 +0.25	−10.33	+10.33	0.17	12.3	−13.59	36.30900	119.125	118.991	−0.134	J.
				Mean.	−107.15											
*Cap over 83	T. B. M. 153	25	480.411	Dir... Rev..	+1,129.4 +1,129.6	+0.10 −0.10	−9.98	+9.98	0.07	12.3	−13.41	37.54583	123.183	....	....	J.
				Mean.	+1,129.50											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 152	T. B. M. 153	1,084	481.470	Dir	+59.3	0.00	—10.08	+10.08	0.00	12.3	—13.57	36.47547	119.671	....	....	J.
				Rev	+59.3	0.00										
				Mean	+59.30											
*P. B. M. 82	T. B. M. 152	308	481.778	Dir	+93.5	—0.15	—10.23	+10.23	0.10	12.3	—13.57	36.56882	119.978	....	....	J.
				Rev	+93.2	+0.15										
				Mean	+93.35											
T. B. M. 151	T. B. M. 152	1,150	482.620	Dir	—2,392.5	—0.35	—10.43	+10.43	0.23	12.3	—13.95	34.08224	111.819	....	....	J.
				Rev	—2,393.2	+0.35										
				Mean	—2,392.85											
U. S. C. S. B. M. XIX. Morrison.	T. B. M. 151	1,372	483.992	Dir	+584.0	—1.65	—12.08	+12.08	1.10	12.3	—13.87	34.66467	113.730	113.275 U.S.C.S.	—0.455	F.
				Rev	+580.7	+1.65										
				Mean	+582.35											
T. B. M. 150	U. S. C. S. B. M XIX.	489	484.481	Dir	+323.9	—1.10	—13.18	+13.18	0.73	12.4	—13.81	34.98753	114.790	....	....	F.
				Rev	+321.7	+1.10										
				Mean	+322.80											
*P. B. M. 81	T. B. M. 150	19	484.500	Dir	+1,103.0	0.00	—13.18	+13.18	0.00	12.4	—13.63	36.09071	118.408	....	....	F.
				Rev	+1,103.0	0.00										
				Mean	+1,103.00											
*P. B. M. 80	T. B. M. 150	54	484.535	Dir	—294.6	0.00	—13.18	+13.18	0.00	12.4	—13.85	34.69289	113.823	....	....	F.
				Rev	—294.6	0.00										
				Mean	—294.60											
*Cap over 80	T. B. M. 150	54	484.535	Dir	+943.0	+0.15	—13.03	+13.03	0.10	12.4	—13.65	35.93084	117.884	....	....	F.
				Rev	+943.3	—0.15										
				Mean	+943.15											

T. B. M. 149	T. B. M. 150	1,036	485.517	Dir	—991.7	—1.40	—14.58	+14.58	0.93	12.4	—13.90	33.99428	111.531	....	....	F.
				Rev	—994.5	+1.40										
				Mean	—993.10											
T. B. M. 148	T. B. M. 149	1,254	486.771	Dir	—570.2	—0.50	—15.08	+15.08	0.33	12.4	—14.05	33.42349	109.658	....	....	F.
				Rev	—571.2	+0.50										
				Mean	—570.70											
T. B. M. 147	T. B. M. 148	501	487.272	Dir	+1,984.8	+1.00	—14.08	+14.08	0.67	12.4	—13.74	35.40960	116.174	....	....	F.
				Rev	+1,986.8	—1.00										
				Mean	+1 985.80											
P. B. M. 79	T. B. M. 147	384	487.656	Dir	—1,875.7	—0.05	—14.13	+14.13	0.03	12.4	—14.04	33.53355	110.019	....	....	F.
				Rev	—1,875.8	+0.05										
				Mean	—1,875.75											
T. B. M. 146	P. B. M. 79	706	488.362	Dir	—1,841.3	—0.15	—14.28	+14.28	0.10	12.4	—14.32	31.69182	103.977	....	....	F.
				Rev	—1,841.6	+0.15										
				Mean	—1,841.45											
*P. B. M. 78 = $^{2}_{1}$	T. B. M. 146	106	488.468	Dir	+2,851.0	+0.05	—14.23	+14.23	0.03	12.4	—13.88	34.54331	113.332	113.147	—0.185	J.
				Rev	+2,851.1	—0.05										
				Mean	+2,851.05											
*Cap over 78	T. B. M. 146	106	488.468	Dir	+4,088.1	+0.20	—14.08	+14.08	0.13	12.4	—13.67	35.78077	117.392	....	....	J.
				Rev	+4,088.5	—0.20										
				Mean	+4,088.30											
T. B. M. 145	T. B. M. 146	748	489.110	Dir	+2,633.4	+1.15	—13.13	+13.13	0.77	12.4	—13.90	34.32679	112.622	....	....	J.
				Rev	+2,635.7	—1.15										
				Mean	+2,634.55											
U. S. C. S. B. M. XVIII. Gasconade.	T. B. M. 145	1,906	491.016	Dir	+204.7	—1.60	—14.73	+14.73	1.07	12.5	—13.88	34.52091	113.288	112.852 U. S. C. S.	—0.436	J.
				Rev	+201.5	+1.60										
				Mean	+203.10											
P. B. M. 77	U. S. C. S. B. M. XVIII.	512	491.528	Dir	—966.6	—0.35	—15.08	+15.08	0.23	12.5	—14.04	33.56280	110.115	....	....	F.
				Rev	—967.3	+0.35										
				Mean	—966.95											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
U. S. C. S. B. M. XVII...	P. B. M. 77	71	491.599	Dir ...	+31.8	+0.05	−15.03	+15.03	0.03	12.5	−14.02	33.59467	110.220	109.771 U. S. C. S.	−0.449	F.
				Rev ..	+31.9	−0.05										
				Mean .	+31.85											
T. B. M. 144, B. M. of Gasconade River survey of 1879.	U. S. C. S. B. M. XVII.	75	491.674	Dir ...	−28.4	0.00	−15.03	+15.03	0.00	12.5	−14.04	33.56625	110.126	....	....	F.
				Rev ..	−28.4	0.00										
				Mean .	−28.40											
T. B. M. 143	T. B. M. 144	1,298	492.972	Dir ...	+754.4	−0.95	−15.98	+15.98	0.63	12.5	−13.90	34.31984	112.599	....	....	F.
				Rev ..	+752.5	+0.95										
				Mean .	+753.45											
T. B. M. 142, Old R. R. B. M.	T. B. M. 143	510	493.482	Dir ...	−2,364.1	+0.35	−15.63	+15.63	0.23	12.5	−14.28	31.95571	104.842	....	....	F.
				Rev ..	−2,363.4	−0.35										
				Mean .	−2,363.75											
*P. B. M. 76	T. B. M. 142	143	493.625	Dir ...	+723.5	0.00	−15.63	+15.63	0.00	12.5	−14.16	32.67933	107.217	....	....	F.
				Rev ..	+723.5	0.00										
				Mean .	+723.50											
*Cap over 76...........	T. B. M. 142	143	493.625	Dir ...	+1,959.5	−0.40	−16.03	+16.03	0.27	12.5	−13.97	33.91512	111.271	....	....	F.
				Rev ..	+1,958.7	+0.40										
				Mean .	+1,959.10											
T. B. M. 141	T. B. M. 142	1,027	494.509	Dir ...	+1,578.2	+0.30	−15.33	+15.33	0.20	12.5	−14.04	33.53445	110.022	....	....	F.
				Rev ..	+1,578.8	−0.30										
				Mean .	+1,578.50											
T. B. M. 140	T. B. M. 141	1,193	495.702	Dir ...	−2,092.3	+1.90	−13.43	+13.43	1.27	12.6	−14.36	31.44373	103.162	....	....	J.
				Rev...	−2,088.5	−1.90										
				Mean .	−2,090.40											

*P. B. M. 75=[illegible]	T. B. M. 140	99	495. 801	Dir ... Rev...	+2, 107. 5 +2, 107. 5	0. 00 0. 00	—13. 43	+13. 43	0. 00	12. 6	—14. 04	33. 55155	110. 078	107. 243	—2. 836	J.
				Mean .	+2, 107. 50											
*Cap over 75............	T. B. M. 140	99	495. 801	Dir ... Rev...	+3, 345. 3 +3, 345. 1	—0. 10 +0. 10	—13. 53	+13. 53	0. 07	12. 6	—13. 85	34. 78944	114. 140	....	....	J.
				Mean .	+3, 345. 20											
T. B. M. 139	T. B. M. 140	838	496. 600	Dir ... Rev...	+2, 649. 2 +2, 647. 4	—0. 90 +0. 90	—14. 83	+14. 33	0. 60	12. 6	—13. 95	34. 09244	111. 853	....	....	J.
				Mean .	+2, 648. 30											
U. S. C. S. B. M. XVI.... Cole Creek.	T. B. M. 139	1, 009	497. 609	Dir ... Rev...	—741. 7 —742. 8	—0. 55 +0. 55	—14. 88	+14. 88	0. 37	12. 6	—14. 06	33. 35006	109. 417	109. 004 U. S. C. S.	—0. 413	J.
				Mean .	—742. 25											
T. B. M. 138	U. S. C. S. B. M. XVI.	1, 656	499. 265	Dir ... Rev...	—764. 4 —761. 1	+1. 65 —1. 65	—13. 23	+13. 23	1. 10	12. 6	—14. 17	32. 58722	106. 914	....	....	F.
				Mean .	—762. 75											
P. B. M. 74	T. B. M. 138	527	499. 792	1 Dir . 1 Rev. 2 Dir . 2 Rev.	—1, 142. 3 —1, 138. 9 —1, 140. 6 —1, 141. 0	+1. 60 —1. 80 —0. 10 +0. 30	—12. 48	+12. 48	0. 47	12. 7	—14. 36	31. 44633	103. 171	....	....	F.
				Mean .	—1, 140. 70											
T. B. M. 137	P. B. M. 74	672	500. 464	Dir ... Rev...	+1, 606. 8 +1, 606. 9	+0. 05 —0. 05	—12. 43	+12. 43	0. 03	12. 7	—14. 11	33. 05343	108. 444	....	....	F.
				Mean .	+1, 606. 85											
T. B. M. 136	T. B. M. 137	242	500. 706	Dir ... Rev...	—1, 506. 3 —1, 507. 3	—0. 50 +0. 50	—12. 93	+12. 93	0. 83	12. 7	—14. 34	31. 54640	103. 500	....	....	J.
				Mean .	—1, 506. 80											
*P. B. M. 73	T. B. M. 136	91	500. 797	Dir ... Rev...	+1, 822. 2 +1, 821. 9	—0. 15 +0. 15	—13. 08	+13. 08	0. 10	12. 7	—14. 06	33. 36873	109. 478	....	....	J.
				Mean .	+1, 822. 05											
*Cap over 73............	T. B. M. 136	91	500. 797	Dir ... Rev...	+3, 061. 3 +3, 061. 5	+0. 10 —0. 10	—12. 83	+12. 83	0. 07	12. 7	—13. 88	34. 60826	113. 545	....	....	J.
				Mean .	+3, 061. 40											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 135	T. B. M. 136	2,476	503.182	Dir	+527.1	+0.70	—12.23	+12.23	0.47	12.7	—14.26	32.07428	105.232	....	....	J.
				Rev	+528.5	—0.70										
				Mean	+527.80											
*P. B. M. 72; Old B. M. 59	T. B. M. 135	262	503.444	Dir	—485.4	—0.45	—12.68	+12.68	0.30	12.7	—14.35	31.58834	103.637	103.502	—0.135	J.
				Rev	—486.3	+0.45										
				Mean	—485.85											
*U. S. C. S. B. M. N_3 Hermann.	T. B. M. 135	10	503.192	Dir	+235.9	+0.10	—12.13	+12.13	0.07	12.7	—14.23	32.31031	106.006	105.637 U. S. C. S.	—0.369	J.
				Rev	+236.1	—0.10										
				Mean	+236.00											
T. B. M. 134	T. B. M. 135	201	503.383	Dir	—1,085.2	+0.15	—12.08	+12.08	0.10	12.7	—14.42	30.98907	101.671	....	....	J.
				Rev	—1,084.9	—0.15										
				Mean	—1,085.05											
*P. B. M. 71	T. B. M. 134	34	503.417	Dir	—1,384.6	+0.15	—11.93	+11.93	0.10	12.7	—14.64	29.60440	97.128	....	....	J.
				Rev	—1,384.3	—0.15										
				Mean	—1,384.45											
*P. B. M. 70=$\frac{2}{1}$	T. B. M. 134	191	503.574	Dir	—1,330.1	+0.35	—11.73	+11.73	0.23	12.7	—14.63	29.65911	97.308	98.305	+0.997	J.
				Rev	—1,329.4	—0.35										
				Mean	—1,329.75											
*Cap over 70	P. B. M. 70	57	503.574	Dir	+1,233.7	00.0	—11.73	+11.73	0.00	12.7	—14.44	30.89300	101.356	....	....	J.
				Rev	+1,233.7	00.0										
				Mean	+1,233.70											
T. B. M. 133	T. B. M. 134	587	503.970	Dir	—192.5	—0.25	—12.33	+12.33	0.17	12.7	—14.46	30.79628	101.039	....	....	J.
				Rev	—193.0	+0.25										
				Mean	—192.75											

*P. B. M. 69	T. B. M. 133	13	503.982	Dir Rev	+1,259.8 +1,259.9	+0.05 −0.05	−12.28	+12.28	0.03	12.7	−14.26	32.05633	105.173	....	....	J.
				Mean	+1,259.85											
T. B. M. 132	T. B. M. 133	2,005	505.975	Dir Rev	−833.1 −828.5	+2.30 −2.30	−10.03	+10.03	1.53	12.8	+14.58	29.96536	98.312	....	....	F.
				Mean	−830.80											
T. B. M. 131	T. B. M. 132	492	506.467	Dir Rev	+1,671.2 +1,668.9	−1.15 +1.15	−11.18	+11.18	0.77	12.8	−14.33	31.63566	103.792	....	....	F.
				Mean	+1,670.05											
*P. B. M. 68	T. B. M. 131	142	506.609	Dir Rev	−1,931.1 −1,930.7	+0.20 −0.20	−10.98	+10.98	0.13	12.8	−14.62	29.70447	97.456	....	....	F.
				Mean	−1,930.90											
*Cap over 68	P. B. M. 68	83	506.609	Dir Rev	+1,235.2 +1,235.1	−0.05 +0.05	−11.03	+11.03	0.03	12.8	−14.43	30.93981	101.509	....	....	F.
				Mean	+1,235.15											
T. B. M. 130	T. B. M. 131	1,810	508.277	Dir Rev	−728.9 −730.5	−0.80 +0.80	−11.98	+11.98	0.53	12.8	−14.44	30.90585	101.398	....	....	F.
				Mean	−729.70											
T. B. M. 129	T. B. M. 130	1,465	509.742	Dir Rev	−1,058.5 −1,059.3	−0.40 +0.40	−12.38	+12.38	0.27	12.8	−14.60	29.84679	97.923	....	....	J.
				Mean	−1,058.90											
*P. B. M. 67	T. B. M. 129	45	509.787	Dir Rev	−1,233.8 −1,234.0	−0.10 +0.10	−12.48	+12.48	0.07	12.8	−14.80	28.61269	93.874	....	....	J.
				Mean	−1,233.90											
*Cap over 67	T. B. M. 129	45	509.787	Dir Rev	+5.1 +5.3	+0.10 −0.10	−12.28	+12.28	0.07	12.8	−14.60	29.85199	97.940	....	....	J.
				Mean	+5.20											
T. B. M. 128	T. B. M. 129	1,530	511.272	Dir Rev	−154.4 −151.1	+1.65 −1.65	−10.73	+10.73	1.10	12.8	−14.63	29.69401	97.422	....	....	J.
				Mean	−152.75											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
U. S. C. S. B. M. XV Berger.	T. B. M. 128	1,540	512.812	Dir ... Rev ..	+209.4 +210.8	+0.70 —0.70	—10.03	+10.03	0.47	12.9	—14.60	29.90414	98.112	97.855 U. S. C. S.	—0.257	F.
				Mean .	+210.10											
*P. B. M. 66 [illegible]	U. S. C. S. B. M. XV.	35	512.847	Dir ... Rev...	—1,168.5 —1,168.3	+0.10 —0.10	—9.93	—9.93	0.07	12.9	—14.78	28.73556	94.278	94.264	—0.014	F.
				Mean .	—1,168.40											
*Cap over 66	U. S. C. S. B. M. XV.	35	512.847	Dir ... Rev...	+68.1 +68.1	0.00 0.00	—10.03	—10.03	0.00	12.9	—14.58	29.97226	98.335	....	....	F.
				Mean .	+68.10											
T. B. M. 127	U. S. C. S. B. M. XV.	1,677	514.489	Dir ... Rev...	+1,358.8 +1,351.8	—3.50 —3.50	—13.53	—13.53	2.33	13.1	—14.38	31.25966	102.559	....	....	F.
				Mean .	+1,355.30											
T. B. M. 126	T. B. M. 127	1,512	516.001	Dir ... Rev ..	—2,165.3 —2,165.1	—0.10 —0.10	—13.43	—13.43	0.07	13.1	—14.72	29.09412	95.454	....	....	J.
				Mean .	—2,165.20											
*P. B. M. 65	T. B. M. 126	28	516.029	Dir ... Rev ..	+1,772.8 +1,772.6	—0.10 +0.10	—12.53	—13.53	0.07	13.1	—14.45	30.86709	101.271	....	....	J
				Mean .	+1,772.70											
T. B. M. 125	T. B. M. 126	275	516.276	Dir... Rev ..	+702.8 +703.8	+0.50 —0.50	—12.93	—12.93	0.33	13.1	—14.61	29.79753	97.762	....	....	J.
				Mean .	+703.30											
*P. B. M. 64	T. B. M. 125	30	516.306	Dir ... Rev ..	+859.1 +858.4	—0.35 +0.35	—13.28	—13.28	0.23	13.1	—14.48	30.65641	100.580	....	....	J
				Mean .	+858.75											

*Cap over 64	T. B. M. 125	30	516.306	Dir ... Rev ..	+2,090.6 +2,090.6	0.00 0.00	—12.93	+13.93	0.00	13.1	—14.29	31.88845	104.622	....	....	J.
				Mean.	+2,090.60											
T. B. M. 124	T. B. M. 125	698	516.974	Dir ... Rev ..	—495.0 —495.1	—0.05 +0.05	—12.98	+12.98	0.03	13.1	—14.68	29.30241	90.137	....	....	J.
				Mean.	+495.05											
T. B. M. 123	T. B. M. 124	703	517.677	1 Dir.. 1 Rev. 2 Dir . 2 Rev.	—911.5 —915.1 —914.0 —913.4	—2.00 +1.60 +0.50 +0.10	—13.73	+13.73	0.51	13.1	—14.83	28.38876	93.140	....	....	F.
				Mean.	—913.50											
T. B. M. 122	T. B. M. 123	561	518.238	1 Dir.. 1 Rev. 2 Dir.. 2 Rev.	+1,142.8† +1,139.6 +1,139.7 +1,139.3	—3.27 —0.07 —0.17 +0.23	—13.85	+13.85	0.25	13.1	—14.65	29.52847	96.879	....	....	F.
				Mean.	+1,139.53											
T. B. M. 121	T. B. M. 122	1,417	519.655	Dir ... Rev ..	—1,126.3 —1,125.6	+0.35 —0.35	—13.50	+13.50	0.23	13.1	—14.83	28.40234	93.184	....	....	F.
				Mean.	—1,125.95											
* P. B. M. 63 = $\frac{1}{2}$ Etlah.	T. B. M. 121	26	519.681	Dir ... Rev ..	+1,387.5 +1,387.0	—0.25 +0.25	—13.75	+13.75	0.17	13.1	—14.62	29.78980	97.736	97.581	—0.155	J.
				Mean.	+1,387.25											
*Cap over 63	T. B. M. 121	26	519.681	Dir ... Rev ..	+2,629.1 +2,629.3	+0.10 —0.10	—13.40	+13.40	0.07	13.1	—14.42	31.03195	101.812	....	....	J.
				Mean.	+2,629.20											
U. S. C. S. B. M. XIV	T. B. M. 121	534	520.189	Dir ... Rev ..	+752.2 +753.6	+0.70 —0.70	—12.80	+12.80	0.47	13.1	—14.72	29.15535	95.655	95.414 U. S. C. S.	—0.241	J.
				Mean.	+752.90											
T. B. M. 120	U. S. C. S. B. M. XIV.	400	520.589	Dir ... Rev ..	—217.4 —217.6	—0.10 +0.10	—12.90	+12.90	0.07	13.1	—14.74	28.93783	94.941	....	....	J.
				Mean.	—217.50											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 119	T. B. M. 120	1,177	521.766	Dir	+40.4	+1.80	−11.10	+11.10	1.20	13.1	−14.73	28.98004	95.080	....	....	J.
				Rev	+44.0	−1.80										
				Mean	+42.20											
T. B. M. 118	T. B. M. 119	1,168	522.934	Dir	−197.2	+1.05	−10.05	+10.05	0.70	13.2	−14.77	28.78385	94.436	....	....	J.
				Rev	−195.1	−1.05										
				Mean	−196.15											
*P. B. M. 62	T. B. M. 118	337	523.271	Dir	−593.4	+0.55	−9.50	+9.50	0.37	13.2	−14.87	28.19090	92.491	....	....	J.
				Rev	−592.3	−0.55										
				Mean	−592.85											
*Cap over 62	P. B. M. 62	77	523.271	Dir	+1,240.4	−0.70	−10.20	+10.20	0.47	13.2	−14.67	29.43080	96.558	....	....	J.
				Rev	+1,239.0	+0.70										
				Mean	+1,239.70											
*P. B. M. 61	T. B. M. 118	15	522.949	Dir	+1,504.3	−0.05	−10.10	+10.10	0.03	13.2	−14.53	30.28834	99.372	....	....	F.
				Rev	+1,504.2	+0.05										
				Mean	+1,504.25											
T. B. M. 117	T. B. M. 118	1,666	524.600	Dir	+53.5	−1.40	−11.45	+11.45	0.93	13.2	−14.76	28.83596	94.607	....	....	F.
				Rev	+50.7	+1.40										
				Mean	+52.10											
T. B. M. 116	T. B. M. 117	1,029	525.629	Dir	−774.5	−0.65	−12.10	+12.10	0.43	13.2	−14.88	28.06069	92.063	....	....	F.
				Rev	−775.8	+0.65										
				Mean	−775.15											
T. B. M. 115. New Haven.	T. B. M. 116	89	525.718	Dir	+1,144.0	+0.15	−11.95	+11.95	0.10	13.2	−14.70	29.20502	95.818	....	....	F.
				Rev	+1,144.3	−0.15										
				Mean	+1,144.15											

*P. B. M. 60=Ψ	T. B. M. 115	18	525.736	Dir	−1,607.0	−0.05	−12.00	+12.00	0.03	13.2	−14.98	27.59771	90.514	90.655	+0.111	F.
				Rev	−1,607.1	+0.05										
				Mean	−1,607.05											
*Cap over 60	T. B. M. 115	18	525.736	Dir	−367.0	+0.35	−11.60	+11.60	0.23	13.2	−14.76	28.83831	94.615			F.
				Rev	−366.3	−0.35										
				Mean	−366.65											
T. B. M. 114	T. B. M. 115	2,428	528.146	Dir	−694.8	−1.85	−13.80	+13.80	1.23	13.3	−14.82	28.50825	93.532			F.
				Rev	−698.5	+1.85										
				Mean	−646.65											
*P. B. M. 59	T. B. M. 114	20	528.166	Dir	+617.4	+0.05	−13.75	+13.75	0.03	13.3	−14.72	29.12580	95.558			J.
				Rev	+617.5	−0.05										
				Mean	+617.45											
T. B. M. 113	T. B. M. 114	1,348	529.494	Dir	−1,001.8	+1.90	−11.90	+11.90	1.27	13.8	−14.97	27.50820	90.251			J.
				Rev	−998.0	−1.90										
				Mean	−998.90											
*P. B. M. 58	T. B. M. 113	180	529.674	Dir	+415.0	+0.10	−11.80	+11.80	0.07	13.3	−14.91	27.92336	91.613			J.
				Rev	+415.2	−0.10										
				Mean	+415.10											
*Cap over 58	P. B. M. 58	41	529.674	Dir	+1,238.1	+0.05	−11.75	+11.75	0.03	13.3	−14.71	29.16171	95.676			J.
				Rev	+1,238.2	−0.05										
				Mean	+1,238.15											
T. B. M. 112	T. B. M. 113	1,401	530.895	Dir	−49.3	−0.25	−12.15	+12.15	0.17	13.3	−14.98	27.45864	90.088			J.
				Rev	−49.8	+0.25										
				Mean	−49.55											
T. B. M. 111; old B. M. 47	T. B. M. 112	1,084	531.979	Dir	−834.8	+0.35	−11.80	+11.80	0.23	13.3	−15.10	26.62107	87.350	87.200	−0.150	J.
				Rev	−834.1	−0.35										
				Mean	−834.45											
T. B. M. 110	T. B. M. 111	471	532.450	Dir	+67.5	+0.50	−11.30	+11.30	0.33	13.3	−15.09	26.60208	87.573			J.
				Rev	+68.5	−0.50										
				Mean	68.00											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 109; old B. M. 46 (*a*).	T. B. M. 110	1,445	533.895	Dir ...	+93.0	+1.80	−9.50	+9.50	1.20	13.4	−15.08	26.78689	87.884	87.736	−0.148	F.
				Rev ..	+96.6	−1.80										
				Mean .	+94.80											
*T. B. M. 108; old B. M. 46 (*b*).	T. B. M. 109	48	533.943	Dir ...	−1,872.5	−0.05	−9.55	+9.55	0.03	13.4	−15.37	24.91405	81.740	81.602	−0.138	F.
				Rev ..	−1,872.6	+0.05										
				Mean .	−1,872.55											
*T. B. M. 107; R. R. B. M.	T. B. M. 109	43	533.938	Dir ...	−19.1	+0.15	−9.35	+9.35	0.10	13.4	−15.08	26.76794	87.822	....	....	F.
				Rev ..	−18.8	−0.15										
				Mean .	−18.95											
*P. B. M. 57=♆ .... Dundee.	T. B. M. 109	393	534.288	Dir ...	−5,608.7	−0.10	−9.60	+9.60	0.07	13.4	−15.95	21.17722	69.480	69.350	−0.130	F.
				Rev ..	−5,608.9	+0.10										
				Mean .	−5,608.80											
*Cap over 57	P. B. M. 57	48	534.288	Dir ...	+1,239.2	+0.15	−9.45	+9.45	0.10	13.4	−15.76	22.41676	73.546	....	....	F.
				Rev ..	+1,239.5	−0.15										
				Mean .	+1,239.35											
T. B. M. 106 .... Dundee.	T. B. M. 109	963	534.858	Dir ...	+36.2	+0.25	−9.25	+9.25	0.17	13.4	−15.07	26.82335	88.004	....	....	F.
				Rev ..	+36.7	−0.25										
				Mean .	+36.45											
*P. B. M. 56	T. B. M. 106	20	534.878	Dir ...	+1,154.6	−0.10	−9.35	+9.35	0.07	13.4	−14.90	27.97802	91.792	....	....	F.
				Rev ..	+1,154.4	+0.10										
				Mean .	+1,154.50											
T. B. M. 105	T. B. M. 106	952	535.810	Dir ...	−1,431.2	+1.00	−8.25	+8.25	0.67	13.4	−15.29	25.39293	83.310	....	....	J.
				Rev ..	−1,429.2	−1.00										
				Mean .	−1,430.20											

*P. B. M. 55	T. B. M. 105	31	535.841	Dir	+491.5	−0.05	−8.30	+8.30	0.03	13.4	−15.22	25.88445	84.024	....	....	J.
				Rev	+491.4	+0.05										
				Mean	+491.45											
*Cap over 55	T. B. M. 105	31	535.841	Dir	+1,724.4	−0.20	−8.45	+8.45	0.13	13.4	−15.03	27.11739	88.969	....	....	J.
				Rev	+1,724.0	+0.20										
				Mean	+1,724.20											
T. B. M. 104	T. B. M. 105	1,426	537.236	Dir	+1,222.8	+0.40	−7.85	+7.85	0.27	13.4	−15.10	26.61632	87.325	....	....	J.
				Rev	+1,223.6	−0.40										
				Mean	+1,223.20											
T. B. M. 103	T. B. M. 104	988	538.224	Dir	−977.9	+0.95	−6.90	+6.90	0.63	13.4	−15.25	25.63922	84.119	....	....	J.
				Rev	−976.0	−0.95										
				Mean	−976.95											
T. B. M. 102	T. B. M. 103	1,013	539.237	Dir	−161.5	−0.15	−7.05	+7.05	0.10	13.4	−15.28	25.47754	83.588	....	....	J.
				Rev	−161.8	+0.15										
				Mean	−161.65											
*P. B. M. 54=¹⁄₁⁴	T. B. M. 102	10	539.247	Dir	−269.9	+0.05	−7.00	+7.00	0.03	13.4	−15.32	25.20765	82.703	82.602	−0.101	J.
				Rev	−269.8	−0.05										
				Mean	−269.85											
*Cap over 51	T. B. M. 102	10	539.247	Dir	+966.9	+0.15	−6.90	+6.90	0.10	13.4	−15.13	26.44474	86.762	....	....	J.
				Rev	+967.2	−0.15										
				Mean	+967.05											
T. B. M. 101	T. B. M. 102	1,320	540.557	Dir	−1,451.6	+0.95	−6.10	+6.10	0.63	13.4	−15.51	24.02666	78.828	....	....	F.
				Rev	−1,449.7	−0.95										
				Mean	−1,450.65											
T. B. M. 100	T. B. M. 101	856	541.413	Dir	+1,864.7	−0.40	−6.50	+6.50	0.27	13.4	−15.22	25.89125	84.916	....	....	F.
				Rev	+1,863.9	+0.40										
				Mean	+1,864.30											
T. B. M. 99; old B. M. 43 (a).	T. B. M. 100	508	541.921	Dir	−1,966.2	+0.80	−5.70	+5.70	0.53	13.4	−15.53	23.92554	78.497	80.852	+2.355	J.
				Rev	−1,964.6	−0.80										
				Mean	−1,965.40											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of the Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 98	T. B. M. 99	750	542.671	Dir Rev	+1,446.7 +1,446.3	−0.20 +0.20	−5.90	+5.90	0.13	13.4	−15.30	25.37227	83.243			J.
				Mean	+1,446.50											
*P. B. M. 53	T. B. M. 99	248	542.919	Dir Rev	−2,730.6 −2,730.1	+0.25 −0.25	−5.65	+5.65	0.17	13.4	−15.72	22.64150	74.284			J.
				Mean	−2,730.35											
*Cap over 53	P. B. M. 53	10	542.919	Dir Rev	+1,234.3 +1,235.0	+0.35 −0.35	−5.30	+5.30	0.23	13.4	−15.53	23.87634	78.335			J.
				Mean	+1,234.65											
*P. B. M. 52	T. B. M. 98	10	542.681	Dir Rev	+1,326.8 +1,326.8	0.00 0.00	−5.90	+5.90	0.00	13.4	−15.09	26.69928	87.597			F.
				Mean	+1,326.80											
T. B. M. 97	T. B. M. 98	1,606	544.277	Dir Rev	−1,508.5 −1,507.1	+0.70 −0.70	−5.20	+5.20	0.47	13.4	−15.53	23.86424	78.296			F.
				Mean	−1,507.80											
T. B. M. 96; old B. M. 42 (*a*).	T. B. M. 97	435	544.712	Dir Rev	−484.8 −485.9	−0.55 +0.55	−5.75	+5.75	0.37	13.5	−15.61	23.37881	76.703	76.584	−0.119	F.
				Mean	−485.35											
T. B. M. 95	T. B. M. 96	1,088	545.800	Dir Rev	+2,417.6 +2,419.1	+0.75 −0.75	−5.00	+5.00	0.50	13.5	−15.23	25.79754	84.638			F.
				Mean	+2,418.35											
*P. B. M. 51 = $\frac{18}{1}$	T. B. M. 95	14	545.814	Dir Rev	−789.6 −789.7	−0.05 +0.05	−5.05	+5.05	0.03	13.5	−15.36	25.00776	82.047	81.971	−0.076	F.
				Mean	−789.65											

[redacted]

*Cap over 51	T. B. M. 95	14	545.814	Dir Rev	+447.3 +447.1	—0.10 +0.10	— 5.10	+5.10	0.07	13.5	—15.16	28.24481	86.106			F.
				Mean	+447.20											
*T. B. M. 94, B. M. 75 of 1870.	T. B. M. 95	204	546.004	Dir Rev	—206.9 —206.8	+0.05 —0.05	— 4.95	+ 4.95	0.03	13.5	—15.27	25.59065	83.960	83.873	—0.087	F.
				Mean	—206.85											
*T. B. M. 93, B. M. 74 of 1879.	T. B. M. 95	204	546.004	Dir Rev	—588.7 —588.3	+0.20 —0.20	— 4.80	+ 4.80	0.13	13.5	—15.33	25.20894	82.707	82.587	—0.120	F.
				Mean	—588.50											
*U. S. C. S. B. M. L.[2], Washington.	T. B. M. 95	275	546.075	Dir Rev	+14,476.1 +14,476.8	+0.35 —0.35	— 4.65	+ 4.65	0.23	13.5	—12.98	40.27624	132.141	131.891 U. S. C. S.	—0.250	F.
				Mean	+14,476.45											
T. B. M. 92	T. B. M. 95	469	546.269	Dir Rev	—2,243.9 —2,243.2	+0.35 —0.35	— 4.65	+ 4.65	0.23	13.5	—15.58	23.55364	77.276			F.
				Mean	—2,243.55											
*P. B. M. 50	T. B. M. 92	18	546.287	Dir Rev	+804.5 +804.5	0.00 0.00	— 4.65	+ 4.65	0.00	13.5	—15.46	24.35826	79.916			J.
				Mean	+804.50											
T. B. M. 91	T. B. M. 92	1,036	547.305	1 Dir 1 Rev 2 Dir 2 Rev	—424.2† —428.6 —429.6 —429.1	—4.90 —0.50 +0.50 0.00	— 4.28	+ 4.28	0.19	13.5	—15.61	23.12448	75.868			J.
				Mean	—429.10											
T. B. M. 90	T. B. M. 91	827	548.132	Dir Rev	—144.8 —146.0	—0.60 +0.60	— 4.88	+ 4.88	0.40	13.5	—15.66	22.97906	75.391			J.
				Mean	—145.40											
T. B. M. 89	T. B. M. 90	1,292	549.424	Dir Rev	—139.7 —139.7	0.00 0.00	— 4.88	+ 4.88	0.00	13.5	—15.68	22.83934	74.933			F.
				Mean	—139.70											
*P. B. M. 49, old B. M. 41, U. S. C. S. B. M. XII.	T. B. M. 89	15	549.439	Dir Rev	+520.9 520.8	—0.05 +0.05	— 4.93	+ 4.93	0.03	13.5	—15.61	23.36026	76.642	76.550 76.441 U. S. C. S.	—0.092 —0.201	F.
				Mean	+520.85											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V: Direct line.	Σ V: Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix: Meters.	Elevation above St. Louis City Directrix: Feet.	Elevation above St. Louis City Directrix: Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 48, South Point	T. B. M. 89	362	549.786	Dir	−1,377.5	+1.20	−3.68	+3.68	0.80	13.5	−15.90	21.46282	70.417			F.
				Rev	−1,375.1	−1.20										
				Mean	−1,376.30											
*Cap over 48	P. B. M. 48	62	549.788	Dir	+1,239.1	−0.15	−3.83	+3.83	0.10	13.5	−15.71	22.70196	74.482			F.
				Rev	+1,238.8	+0.15										
				Mean	+1,238.95											
T. B. M. 88. Dubois Creek.	T. B. M. 89	771	550.105	Dir	−1,750.7	+0.25	−4.63	+4.63	0.17	13.5	−15.97	21.08840	69.189			F.
				Rev	−1,750.2	−0.25										
				Mean	−1,750.45											
T. B. M. 87	T. B. M. 88	585	550.780	Dir	+1,085.2	−0.55	−5.18	+5.18	0.37	13.5	−15.79	22.17343	72.748			F.
				Rev	+1,084.1	+0.55										
				Mean	+1,084.65											
T. B. M. 86	T. B. M. 87	1,702	552.482	Dir	−220.4	+1.20	−3.98	+3.98	0.80	13.5	−15.83	21.95419	72.029			F.
				Rev	−218.0	−1.20										
				Mean	−219.20											
*P. B. M. 47	T. B. M. 86	222	552.704	Dir	+2,137.7	−0.30	−4.28	+4.28	0.20	13.5	−15.50	24.09192	79.042			F.
				Rev	+2,137.1	+0.30										
				Mean	+2,137.40											
T. B. M. 85	T. B. M. 86	530	553.012	Dir	−1,081.3	+0.50	−3.48	+3.48	0.33	13.5	−15.99	20.87323	68.482			F.
				Rev	−1,080.3	−0.50										
				Mean	−1,080.80											
*P. B. M. 46=44	T. B. M. 85	82	553.044	Dir	+697.5	0.00	−3.48	+3.48	0.00	13.5	−15.87	21.57085	70.771	70.714	−0.057	F.
				Rev	+697.5	0.00										
				Mean	+697.50											

*Cap over 45	T. B. M. 85	32	553.044	Dir ...	+1,932.1	—0.10	—3.58	+3.58	0.07	13.5	—15.70	22.80552	74.822	....	....	F.
				Rev ...	+1,931.9	+0.10										
				Mean .	+1,932.00											
T. B. M. 84½............	T. B. M. 85	651	553.663	Dir ...	+1,612.1	—0.05	—3.53	+3.53	0.08	13.5	—15.75	22.48552	73.772	....	....	F.
				Rev ...	+1,612.0	+0.05										
				Mean .	+1,612.05											
T. B. M. 83	T. B. M. 84	1,478	555.130	Dir ...	+ 191.2	+0.50	—3.03	+3.03	0.33	13.5	—15.71	22.67726	74.401	....	....	J.
				Rev ..	+ 192.2	—0.50										
				Mean .	+191.70											
T. B. M. 82	T. B. M. 83	987	556.123	Dir ...	—2,409.0	+0.10	—2.93	+2.93	0.07	13.5	—16.08	20.26799	66.497	....	....	J.
				Rev ..	—2,408.8	—0.10										
				Mean .	—2,408.9											
*P. B. M. 45	T. B. M. 82	24	556.147	Dir ...	—1,895.9	+0.20	—2.73	+2.73	0.13	13.5	—16.38	18.37199	60.276	....	....	J.
				Rev ..	—1,895.5	—0.20										
				Mean .	—1,895.70											
*Cap over 45............	T. B. M. 82	24	556.147	Dir ...	—664.5	+0.10	—2.83	+2.83	0.07	13.5	—16.18	19.60349	64.316	....	....	J.
				Rev ..	—664.3	—0.10										
				Mean .	— 664.40											
T. B. M. 81, Boles.	T. B. M. 82	1,084	557.207	Dir ...	+1,684.7	+2.20	—0.73	+0.73	1.47	13.6	—15.83	21.95514	72.032	....	....	J.
				Rev ..	+1,689.1	—2.20										
				Mean .	+1,686.90											
T. B. M. 80	T. B. M. 81	1,030	558.237	Dir ...	—546.7	+0.75	+0.02	—0.02	0.50	13.6	—15.91	21.40911	70.240	....	....	J.
				Rev ..	—545.2	—0.75										
				Mean .	—545.95											
*P. B. M. 44	T. B. M. 80	16	558.253	Dir ...	+494.2	0.00	+0.02	—0.02	0.00	13.6	—15.84	21.90338	71.862	....	....	J.
				Rev ..	+494.2	0.00										
				Mean .	+494.20											
T. B. M. 79	T. B. M. 80	1,755	559.992	Dir ...	+751.7	+0.15	+0.17	—0.17	0.10	13.6	—15.79	22.16108	72.708	....	....	J.
				Rev ..	+752.0	—0.15										
				Mean .	+751.85											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV Direct line.	ΣV Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 78	T. B. M. 79	541	560.533	Dir Rev	+692.0 +695.1	+1.55 —1.55	+1.72	—1.72	1.07	13.6	—15.68	22.85474	74.983	....	....	J.
				Mean	+693.55											
*P. B. M. 43=¼	T. B. M. 78	50	560.583	Dir Rev	—6,189.6 —6,189.8	—0.10 +0.10	+1.62	—1.62	0.07	13.6	—16.64	16.66408	54.073	54.772	+0.099	J.
				Mean	—6,189.70											
*Cap over 43	P. B. M. 43	22	560.583	Dir Rev	+1,236.3 +1,235.8	—0.25 +0.25	+1.37	—1.37	0.17	13.6	—16.46	17.90031	58.729	....	....	J.
				Mean	+1,236.05											
T. B. M. 77	T. B. M. 78	674	561.207	Dir Rev	—2,492.5 —2,491.0	+0.75 —0.75	+2.47	—2.47	0.50	13.6	—16.06	20.36261	66.807	....	....	J.
				Mean	—2,491.75											
T. B. M. 76	T. B. M. 77	878	562.085	Dir Rev	+2,514.2 +2,512.6	—0.80 +0.80	+1.67	—1.67	0.53	13.7	—15.68	22.87639	75.054	....	....	F.
				Mean	+2,513.40											
*P. B. M. 42, Labadie.	T. B. M. 76	32	562.117	Dir Rev	+488.3 +488.2	—0.05 +0.05	+1.62	—1.62	0.03	13.7	—15.61	23.36471	76.656	....	....	F.
				Mean	+488.25											
T. B. M. 75	T. B. M. 76	614	562.699	Dir Rev	+10,605.5 +10,606.0	+0.25 —0.25	+1.92	—1.92	0.17	13.7	—14.04	33.48378	109.856	....	....	F.
				Mean	+10,605.75											
T. B. M. 74	T. B. M. 75	2,093	564.792	1 Dir 1 Rev 2 Dir 2 Rev	—15,369.4 —15,378.1† —15,367.3 —15,371.6	—0.03 +8.67 —2.13 +2.17	+0.30	—0.30	0.83	13.7	—16.42	18.11197	59.423	....	....	F.
				Mean	—15,369.43											

T. B. M. 73	T. B. M. 74	970	565.762	Dir Rev	+7.4 +9.3	+0.95 −0.95	+1.25	−1.25	0.63	13.7	−16.42	18.12032	50.450			J.
				Mean	+8.35											
*P. B. M. 41	T. B. M. 73	49	565.811	Dir Rev	−2,236.2 −2,235.9	+0.15 −0.15	+1.40	−1.40	0.10	13.7	−16.77	15.88302	52.113			J.
				Mean	−2,236.05											
*Cap over 41	T. B. M. 73	49	565.811	Dir Rev	−999.0 −998.8	+0.10 −0.10	+1.35	−1.35	0.07	13.7	−16.57	17.12127	56.173			J.
				Mean	−998.90											
T. B. M. 72	T. B. M. 73	595	566.357	1 Dir 1 Rev 2 Dir 2 Rev	+1,747.9 +1,751.5 +1,749.5 +1,750.9	+2.05 −1.55 +0.45 −0.95	+2.50	−2.50	0.54	13.7	−16.15	19.87054	65.193			J.
				Mean	+1,749.95											
T. B. M. 71	T. B. M. 72	1,300	567.657	Dir Rev	+2,006.8 +2,004.8	−1.00 +1.00	+1.50	−1.50	0.67	13.7	−15.84	21.87665	71.775			J.
				Mean	+2,005.80											
T. B. M. 70	T. B. M. 71	862	568.519	Dir Rev	−690.5 −689.9	+0.30 −0.30	+1.80	−1.80	0.20	13.7	−15.04	21.18635	69.510			F.
				Mean	−690.20											
*P. B. M. 40	T. B. M. 70	386	568.905	Dir Rev	−1,544.3 −1,544.5	−0.10 +0.10	+1.70	−1.70	0.07	13.7	−16.17	19.64172	64.442			F.
				Mean	−1,544.40											
Becker, *P. B. M. 39	T. B. M. 70	31	568.550	Dir Rev	−345.8 −345.6	+0.10 −0.10	+1.90	−1.90	0.07	13.7	−16.00	20.81059	68.375			F.
				Mean	−345.70											
*Cap over 39	T. B. M. 70	31	568.550	Dir Rev	+893.4 +893.4	0.00 0.00	+1.80	−1.80	0.30	13.7	−15.81	22.07988	72.441			F.
				Mean	+893.40											
T. B. M. 69	T. B. M. 70	1,885	570.404	Dir Rev	+2,519.0 +2,517.7	−0.65 +0.65	+1.15	−1.15	0.43	13.7	−15.56	23.70508	77.773			F.
				Mean	+2,518.35											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V: Direct line.	Σ V: Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix: Meters.	Elevation above St. Louis City Directrix: Feet.	Elevation above St. Louis City Directrix: Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 68	T. B. M. 69	1,240	571.644	Dir	−5,660.3	+1.50	+2.65	−2.65	1.00	13.8	−16.43	18.04541	59.204	....	....	J.
				Rev	−5,657.3	−1.50										
				Mean	−5,658.80											
*P. B. M. 38 = $^{12}_{1}$	T. B. M. 68	86	571.730	Dir	+1,877.1	+0.05	+2.70	−2.70	0.03	13.8	−16.13	19.92286	65.364	65.406	+0.042	J.
				Rev	+1,877.2	−0.05										
				Mean	+1,877.15											
*Cap over 38 St. Albans.	T. B. M. 68	86	571.730	Dir	+3,113.2	+0.20	+2.85	−2.85	0.13	13.8	−15.94	21.15930	69.420	....	....	J.
				Rev	+3,113.6	−0.20										
				Mean	+3,113.40											
T. B. M. 67	T. B. M. 68	552	572.196	Dir	−635.3	−0.50	+2.15	−2.15	0.33	13.8	−16.52	17.40952	57.118	....	....	J.
				Rev	−636.3	+0.50										
				Mean	−635.80											
T. B. M. 66	T. B. M. 67	2,116	574.312	Dir	+11,496.5	−1.60	+0.55	−0.55	1.07	13.8	−14.75	28.90619	94.837	....	....	J.
				Rev	+11,493.3	+1.60										
				Mean	+11,494.90											
T. B. M. 65	T. B. M. 66	874	575.186	Dir	−1,251.9	−0.15	+0.40	−0.40	0.10	13.8	−14.95	27.65394	90.729	....	....	B.
				Rev	−1,252.2	+0.15										
				Mean	−1,252.05											
*P. B. M. 37	T. B. M. 65	18	575.204	Dir	+267.7	−0.05	+0.35	−0.35	0.03	13.8	−14.91	27.92163	91.607	....	....	J.
				Rev	+267.6	+0.05										
				Mean	+267.65											
T. B. M. 64	T. B. M. 65	964	576.150	Dir	−8,517.6	−0.65	−0.25	+0.25	0.43	13.8	−16.27	19.13437	62.777	....	....	J.
				Rev	−8,518.9	+0.65										
				Mean	−8,518.25											

*P. B. M. 36	T. B. M. 64	40	576.190	Dir	+765.3	0.00	−0.25	+0.25	0.00	13.8	−16.13	19.80081	65.289			J.
				Rev	+765.3	0.00										
				Mean	+765.30											
*Cap over 36	T. B. M. 64	40	576.190	Dir	+2,003.8	−0.35	−0.60	+0.60	0.23	13.8	−15.95	21.13814	69.352			J.
				Rev	+2,003.1	+0.35										
				Mean	+2,003.45											
T. B. M. 63	T. B. M. 64	1,114	577.264	Dir	+398.1	−0.20	−0.45	+0.45	0.13	13.8	−16.20	19.53234	64.083			J.
				Rev	+397.7	+0.20										
				Mean	+397.90											
T. B. M. 62	T. B. M. 63	921	578.185	Dir	−1,474.8	−1.20	−1.65	+1.65	0.80	13.9	−16.43	18.05611	59.240			F.
				Rev	−1,477.2	+1.20										
				Mean	−1,476.00											
*P. B. M. 35=Y	T. B. M. 62	28	578.213	Dir	+447.3	−0.05	−1.70	+1.70	0.03	13.9	−16.30	18.50343	60.707	60.744	+0.037	F.
				Rev	+447.2	+0.05										
				Mean	+447.25											
*Cap over 35 Port Royal.	T. B. M. 62	28	578.213	Dir	+1,689.1	0.00	−1.65	+1.65	0.00	13.9	−16.17	19.74547	64.782			F.
				Rev	+1,689.1	0.00										
				Mean	+1,689.10											
T. B. M. 61	T. B. M. 62	1,076	579.261	Dir	−224.4	+0.70	−0.95	+0.95	0.47	13.9	−16.46	17.83238	58.506			F.
				Rev	−223.0	−0.70										
				Mean	−223.70											
T. B. M. 60	T. B. M. 61	1,490	580.751	Dir	−1,871.6	−1.85	−2.80	+2.80	1.23	13.9	−16.75	15.95864	52.358			F.
				Rev	−1,875.3	+1.85										
				Mean	−1,873.45											
*P. B. M. 34	T. B. M. 60	170	580.921	Dir	+1,205.0	−0.30	−3.10	+3.10	0.20	13.9	−16.57	17.16352	56.311			F.
				Rev	+1,204.4	+0.30										
				Mean	+1,204.70											
T. B. M. 59	T. B. M. 60	1,316	582.067	Dir	+123.6	−1.40	−4.20	+4.20	0.93	13.9	−16.73	16.08086	52.759			J.
				Rev	+120.8	+1.40										
				Mean	+122.20											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 33 Centaur.	T. B. M. 59	12	582.079	Dir	—1,950.5	0.00	—4.20	+4.20	0.00	13.9	—17.03	14.13006	46.359	....	....	J.
				Rev	—1,950.5	0.00										
				Mean	—1,950.50											
*Cap over 33	T. B. M. 59	12	582.079	Dir	—715.8	—0.05	—4.25	+4.25	0.03	13.9	—16.84	15.36490	50.410	....	....	J.
				Rev	—715.9	+0.05										
				Mean	—715.85											
T. B. M. 58	T. B. M. 59	1,182	583.249	Dir	+441.9	+0.50	—3.70	+3.70	0.30	13.9	—16.66	16.52383	54.211	....	....	J.
				Rev	+442.9	—0.50										
				Mean	+442.40											
T. B. M. 57	T. B. M. 58	910	584.159	Dir	—1,253.8	0.00	—3.70	+3.70	0.00	13.9	—16.86	15.26933	50.096	....	....	F.
				Rev	—1,253.8	0.00										
				Mean	—1,253.80											
T. B. M. 56	T. B. M. 57	426	584.585	Dir	—564.5	—0.15	—3.85	+3.85	0.10	13.9	—16.95	14.70459	48.244	....	....	F.
				Rev	—564.8	+0.15										
				Mean	—564.65											
*P. B. M. 31 = [illegible] Bon Homme.	T. B. M. 56	34	584.619	Dir	—537.8	—0.20	—4.05	+4.05	0.13	13.9	—17.03	14.16651	46.478	46.487	+0.009	F.
				Rev	—538.2	+0.20										
				Mean	—538.00											
*Cap over 31	T. B. M. 56	34	584.619	Dir	+699.5	+0.05	—3.80	+3.80	0.03	13.9	—16.83	15.40426	50.539	....	....	F.
				Rev	+699.6	—0.05										
				Mean	+699.55											
*P. B. M. 32	T. B. M. 56	41	584.626	Dir	+3,506.9	+0.10	—3.75	+3.75	0.07	13.9	—16.41	18.21213	59.751	....	....	F.
				Rev	+3,507.1	—0.10										
				Mean	+3,507.00											

T. B. M. 55	T. B. M. 56	2,632	587.217	Dir	—561.8	+2.25	—1.60	+1.00	1.50	14.0	—17.03	14.14496	40.408			J.
				Rev	—557.3	—2.25										
				Mean	—559.55											
*P. B. M. 30 Stevens.	T. B. M. 55	214	587.431	Dir	+19.5	—0.20	—1.80	+1.80	0.13	14.0	—17.03	14.16426	46.471			F.
				Rev	+19.1	+0.20										
				Mean	+19.30											
*Cap over 30	P. B. M. 30	132	587.431	Dir	+1,238.1	—0.05	—1.85	+1.85	0.13	14.0	—16.84	15.40250	50.534			F.
				Rev	+1,238.0	+0.05										
				Mean	+1,238.05											
T. B. M. 54	T. B. M. 55	1,134	588.351	Dir	+689.1	—0.25	—1.85	+1.85	0.17	14.0	—16.93	14.83391	48.668			F.
				Rev	+688.6	+0.25										
				Mean	+688.85											
T. B. M. 53 Gumbo.	T. B. M. 54	1,090	589.441	Dir	—166.4	+0.85	—1.00	+1.00	0.57	14.0	—16.95	14.66834	48.125			F.
				Rev	—164.7	—0.85										
				Mean	—165.55											
*P. B. M. 29=?	T. B. M. 53	92	589.533	Dir	+610.5	—0.10	—1.10	+1.10	0.07	14.0	—16.86	15.27883	50.128	50.154	+0.026	F.
				Rev	+610.3	+0.10										
				Mean	+610.40											
*Cap over 29	P. B. M. 29	43	589.533	Dir	+1,234.9	—0.05	—1.15	+1.15	0.03	14.0	—16.66	16.51388	54.180			F.
				Rev	+1,234.8	+0.05										
				Mean	+1,234.85											
T. B. M. 52	T. B. M. 53	1,269	590.710	Dir	+920.2	—0.70	—1.70	+1.70	0.47	14.1	—16.81	15.58808	51,142			F.
				Rev	+918.8	+0.70										
				Mean	+919.50											
T. B. M. 51, Drew	T. B. M. 52	2,118	592.828	Dir	—1,221.8	—1.55	—3.25	+3.25	1.03	14.1	—17.00	14.36444	47.128			J.
				Rev	—1,224.9	+1.55										
				Mean	—1,223.35											
T. B. M. 50	T. B. M. 51	744	593.572	Dir	—1,436.0	—0.25	—3.50	+3.50	0.17	14.1	—17.22	12.92797	42.415			J.
				Rev	—1,436.5	+0.25										
				Mean	—1,436.25											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 28	T. B. M. 50	49	593.621	Dir	+2,036.6	+0.10	−3.40	+3.40	0.07	14.1	−16.90	14.96499	49.098			J.
				Rev	+2,036.8	−0.10										
				Mean	+2,036.70											
*Cap over 28	T. B. M. 50	49	593.621	Dir	+3,272.2	+0.25	−3.25	+3.25	0.17	14.1	−16.72	16.20002	53.153			J.
				Rev	+3,272.7	−0.25										
				Mean	+3,272.45											
T. B. M. 49	T. B. M. 50	1,250	594.822	Dir	+154.1	−1.10	−4.60	+4.60	0.73	14.1	−17.20	13.08099	42.917			J.
				Rev	+151.9	+1.10										
				Mean	+153.00											
T. B. M. 48	T. B. M. 49	902	595.724	Dir	−447.3	−0.15	−4.75	+4.75	0.10	14.1	−17.27	12.63347	41.449			J.
				Rev	−447.6	+0.15										
				Mean	−447.45											
T. B. M. 47	T. B. M. 48	1,274	596.998	Dir	−604.8	−0.50	−5.25	+5.25	0.33	14.1	−17.36	12.02808	39.463			F.
				Rev	−605.8	+0.50										
				Mean	−605.30											
T. B. M. 46	T. B. M. 47	1,130	508.128	Dir	−6.9	−0.55	−5.80	+5.80	0.37	14.1	−17.36	12.02063	39.438			F.
				Rev	−8.0	+0.55										
				Mean	−7.45											
*P. B. M. 27 = ‡ Mons.	T. B. M. 46	40	598.168	Dir	−724.8	+0.05	−5.75	+5.75	0.03	14.1	−17.48	11.29576	37.060	37.122	+0.062	F.
				Rev	−724.7	−0.05										
				Mean	−724.75											
*Cap over 27	T. B. M. 46	40	598.168	Dir	+513.5	0.00	−5.80	+5.80	0.00	14.1	−17.28	12.53421	41.123			F.
				Rev	+513.5	0.00										
				Mean	+513.50											

T. B. M. 45	T. B. M. 46	1,780	599.858	Dir	−13.9	+0.20	−5.60	+5.60	0.13	14.1	−17.37	12.00602	39.393	....	....	F.
				Rev	−13.5	−0.20										
				Mean	−13.70											
T. B. M. 44	T. B. M. 45	366	600.224	Dir	−131.9	−0.30	−5.90	+5.90	0.20	14.1	−17.38	11.87471	38.960	....	....	J.
				Rev	−132.5	+0.30										
				Mean	−132.20											
*P. B. M. 26	T. B. M. 44	21	600.245	Dir	+1,025.7	−0.25	−6.15	+6.15	0.17	14.1	−17.23	12.90031	42.324	....	....	J.
				Rev	+1,025.2	+0.25										
				Mean	+1,025.45											
T. B. M. 43	T. B. M. 44	745	600.969	Dir	−315.1	+0.90	−5.00	+5.00	0.60	14.1	−17.44	11.56045	37.928	....	....	J.
				Rev	−313.3	−0.90										
				Mean	−314.20											
*P. B. M. 25 Creve Coeur.	T. B. M. 43	22	600.991	Dir	−1,503.8	−0.05	−5.05	+5.05	0.03	14.1	−17.67	10.05637	32.994	....	....	J.
				Rev	−1,503.9	+0.05										
				Mean	−1,503.85											
* Cap over 25	T. B. M. 43	22	600.991	Dir	−265.0	−0.05	−5.05	+5.05	0.03	14.1	−17.48	11.29536	37.059	....	....	J.
				Rev	−265.1	+0.05										
				Mean	−265.05											
T. B. M. 42	T. B. M. 43	605	601.574	Dir	−175.8	−0.10	−5.10	+5.10	0.07	14.1	−17.47	11.38452	37.351	....	....	J.
				Rev	−176.0	+0.10										
				Mean	−175.90											
T. B. M. 41	T. B. M. 42	1,775	603.349	Dir	−529.0	+1.50	−3.60	+3.60	1.00	14.2	−17.54	10.85695	35.620	....	....	J.
				Rev	−526.0	−1.50										
				Mean	−527.50											
T. B. M. 40	T. B. M. 41	1,680	605.029	Dir	+515.1	−0.20	3.80	+3.80	0.13	14.2	−17.47	11.37192	37.310	....	....	F.
				Rev	+514.7	+0.20										
				Mean	+514.90											
*P. B. M. 24=$\frac{7}{2}$	T. B. M. 40	120	605.149	Dir	−424.2	+0.45	−3.35	+3.35	0.30	14.2	−17.53	10.94811	35.919	35.926	+0.007	J.
				Rev	−423.3	−0.45										
				Mean	−423.75											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Cap over 24	T. B. M. 40	120	605.149	Dir ...	+815.3	+0.40	—3.40	+3.40	0.27	14.2	—17.34	12.18775	39.986	....	....	J.
				Rev...	+816.1	—0.40										
				Mean.	+815.70											
T. B. M. 39	T. B. M. 40	546	605.575	Dir ...	—1,985.3	—0.55	—4.35	+4.35	0.37	14.2	—17.78	9.38376	30.794	....	....	F.
				Rev...	—1,986.4	+0.55										
				Mean.	—1,985.85											
T. B. M. 38	T. B. M. 39	583	606.158	1 Dir..	—321.0	—1.80	—5.80	+5.80	0.59	14.2	—17.83	9.06291	29.734	....	....	F.
				1 Rev.	—324.9	+2.10										
				2 Dir..	—321.7	—1.10										
				2 Rev.	—323.6	+0.80										
				Mean.	—322.80											
T. B. M. 37	T. B M. 38	626	606.784	Dir ...	+714.1	—0.55	—6.35	+6.35	0.37	14.2	—17.72	9.77657	32.076	....	....	F.
				Rev...	+713.0	+0.55										
				Mean.	+713.55											
T. B. M. 36	T. B. M. 37	1,258	608.042	Dir ...	+920.4	—0.20	—6.55	+6.55	0.13	14.2	—17.57	10.69692	35.095	....	....	J.
				Rev...	+920.0	+0.20										
				Mean.	+920.20											
*P. B. M. 23	T. B. M. 36	9	608.051	Dir ...	—556.4	—0.05	—6.60	+6.60	0.03	14.2	—17.66	10.14038	33.269	....	....	J.
				Rev...	—556.5	+0.05										
				Mean.	—556.45											
*Cap over 23........	T. B. M. 36	9	608.051	Dir ...	+684.5	+0.40	—6.15	+6.15	0.27	14.2	—17.47	11.38192	37.343	....	....	J.
				Rev...	+385.3	—0.40										
				Mean.	+684.90											

T. B. M. 35	T. B. M. 36	722	608.764	Dir ...	−1,407.5	+0.40	−6.15	+6.15	0.27	14.2	−17.79	9.28000	30.478	....	....	J.
				Rev ...	−1,406.7	−0.40										
				Mean .	−1,407.10											
T. B. M. 34	T. B. M. 35	690	609.454	Dir ...	−494.6	+0.30	−5.85	+5.85	0.20	14.2	−17.87	8.79522	28.856	....	....	J.
				Rev ...	−494.0	−0.30										
				Mean .	−494.30											
T. B. M. 33	T. B. M. 34	796	610.250	1 Dir..	+4,551.2	−2.58	−7.72	+7.72	0.75	14.2	−17.16	1[illegible].34455	43.782	....	....	J.
				1 Rev.	+4,546.5	+2.12										
				2 Dir..	+4,549.8	−1.18										
				2 Rev.	+4,547.0	+1.62										
				Mean .	+4,548.62											
T. B. M. 32	T. B. M. 33	691	610.941	Dir ...	−671.2	−1.00	−8.72	+8.72	0.67	14.2	−17.27	12.67224	41.576	....	....	F.
				Rev ...	−673.2	+1.00										
				Mean .	−672.20											
*P. B. M. 22=†........	T. B. M. 32	177	611.118	Dir ...	+7,542.2	−0.35	−9.07	+9.07	0.23	14.2	−16.09	20.21527	66.324	66.416	+0.092	F.
				Rev ...	+7,541.5	+0.35										
				Mean .	+7,541.85											
*Cap over 22.........	P. B. M. 22	48	611.118	Dir ...	+1,238.2	−0.15	−9.22	+9.22	0.10	14.2	−15.90	21.45351	70.386	....	....	F.
				Rev ...	+1,237.9	+0.15										
				Mean .	+1,238.05											
T. B. M. 31	T. B. M. 32	450	611.391	Dir ...	−3,259.6	+0.25	−8.47	+8.47	0.17	14.2	−17.77	9.41239	30.881	....	....	F.
				Rev ...	−3,259.1	−0.25										
				Mean .	−3,259.35											
T. B. M. 30	T. B. M. 31	1,596	612.987	Dir ...	−2,438.9	−0.35	−8.82	+8.82	0.23	14.2	−18.15	6.97276	22.877	....	....	F.
				Rev ...	−2,439.6	+0.35										
				Mean .	−2,439.20											
T. B. M. 29	T. B. M. 30	905	613.802	Dir ...	+4,516.9	+0.80	−8.02	+8.02	0.53	14.2	−17.45	11.49116	37.701	....	....	J.
				Rev ...	+4,518.5	−0.80										
				Mean .	+4,517.70											
T. B. M. 28	T. B. M. 29	632	614.524	Dir ...	−2,203.4	+0.60	−7.42	+7.42	0.40	14.3	−17.79	9.28802	30.472	....	....	J.
				Rev ...	−2,202.2	−0.60										
				Mean .	−2,202.80											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 21 Brotherton.	T. B. M. 28	690	615.214	Dir	−1,477.3	+1.30	−6.12	+6.12	0.87	14.3	−18.02	7.81179	25.630	....	....	F.
				Rev	−1,474.7	−1.30										
				Mean	−1,476.00											
*P. B. M. 19	T. B. M. 21	83	615.297	Dir	+5,130.4	−0.20	−6.32	+6.32	0.13	14.3	−17.22	12.94279	42.464	....	....	F.
				Rev	+5,130.0	+0.20										
				Mean	+5,130.20											
*P. B. M. 18	T. B. M. 21	10	615.224	Dir	−1,252.4	0.00	−6.12	+6.12	0.00	14.3	−18.22	6.55919	21.520	....	....	F.
				Rev	−1,252.4	0.00										
				Mean	−1,252.40											
*Cap over 18	T. B. M. 21	10	615.224	Dir	−20.8	−0.35	−6.47	+6.47	0.23	14.3	−18.02	7.79064	25.560	....	....	F.
				Rev	−21.5	+0.35										
				Mean	−21.15											
*T. B. M. 22	P. B. M. 19	588	615.885	Dir	−4,592.1	−0.50	−6.82	+6.82	0.33	14.3	−17.93	8.34948	27.394	....	....	J.
				Rev	−4,593.1	+0.50										
				Mean	−4,592.60											
*P. B. M. 20, Old B. M. 17	T. B. M. 22	13	615.898	Dir	+857.8	0.00	−6.82	+6.82	0.00	14.3	−17.81	9.20740	30.208	30.208	0.000	W.
				Rev	+857.8	0.00										
				Mean	+857.80											
*T. B. M. 23, river crossing.	T. B. M. 22	645	616.530	Dir	+2,618.7	−0.20	−7.02	+7.02	0.13	14.3	−17.53	10.96838	35.986	....	....	F. & J.
				Rev	+2,618.3	+0.20										
				Mean	+2,618.50											
*T. B. M. 24, gauge B. M.	T. B. M. 23	8	616.538	Dir	−626.5	+0.10	−6.92	+6.92	0.07	14.3	−17.64	10.24187	33.602	33.526	−0.076	F.
				Rev	−726.3	−0.10										
				Mean	−726.40											

*T. B. M. 21=‖ St. Charles.	T. B. M. 23	397	616.927	Dir Rev	−1,373.7 −1,375.0	−0.65 +0.65	−7.67	+7.67	0.43	14.3	−17.74	9.59382	31.476	31.567	+0.091	F.
				Mean	−1,374.35											
*Cap over 21	P. B. M. 21	86	616.927	Dir Rev	+1,235.7 +1,236.1	+0.20 −0.20	−7.47	+7.47	0.13	14.3	−17.55	10.82991	35.532			F.
				Mean	+1,235.90											
*Zero of gauge St. Charles.	T. B. M. 23	394	616.924	Dir Rev	−10,940.2 −10,941.5	−0.65 +0.65	−7.67	+7.67	0.43	14.3	−18.35	+0.02671	+0.088	0.000	−0.088	J.
				Mean	−10,940.85											
*T. B. M. 26	T. B. M. 23	244	616.774	Dir Rev	+1,090.4 +1,090.1	−0.15 +0.15	−7.17	+7.17	0.10	14.3	−17.36	12.05880	39.563			F.
				Mean	+1,090.25											
*T. B. M. 27, old B. M. 78 of 1879.	T. B. M. 26	18	616.792	Dir	+29.30					14.3	−17.36	12.08810	39.659	39.568	−0.091	F.
* T. B. M. 25, city B. M.	Cap over 21	110	617.037	Dir Rev	+2,060.5 +2,059.2	−0.65 +0.65	−8.12	+ 8.12	0.43	14.3	−17.23	12.80008	42.291			F.
				Mean	+2,059.85											
City datum, St. Charles.	City B. M.				−ft. 119.48								−77.189			
T. B. M. 19	T. B. M. 21	2,214	617.428	Dir Rev	+1,078.3 +1,074.6	−1.85 +1.85	−7.97	+ 7.97	1.23	14.3	−17.86	8.88840	29.162			F.
				Mean	+1,076.45											
* T. B. M. 20, old T. B. M. 2 of 1887.	T. B. M. 21	1,792	617.006	Dir Rev	+909.3 +908.0	−0.65 +0.65	−6.77	+ 6.77	0.43	14.3	−17.88	8.72058	28.611	28.629	+0.018	J.
				Mean	+908.65											
T. B. M. 18	T. B. M. 19	1,405	618.833	Dir Rev	−1,004.0 −1,002.2	+0.90 −0.90	−7.07	+ 7.07	0.60	14.3	−18.01	7.88515	25.870			J.
				Mean	−1,003.10											
* P. B. M. 17	T. B. M. 18	37	618.870	Dir Rev	−673.5 −673.7	−0.10 +0.10	−7.17	+ 7.17	0.07	14.3	−18.11	7.21145	23.660			J.
				Mean	−673.60											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V Direct line.	Σ V Reverse line.	r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Ob.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Cap over 17	T. B. M. 18	37	618.870	Dir	+562.8	−0.15	−7.22	+7.22	0.10	14.3	−17.92	8.44789	27.716	....	....	J.
				Rev	+562.5	+0.15										
				Mean	+562.65											
T. B. M. 17	T. B. M. 18	1,514	620.347	Dir	+319.8	−0.25	−7.32	+7.32	0.17	14.3	−17.97	8.20474	26.919	....	....	J.
				Rev	+319.3	+0.25										
				Mean	+319.55											
T. B. M. 16	T. B. M. 17	2,125	622.472	Dir	−983.4	−0.70	−8.02	+8.02	0.47	14.35	−18.11	7.22050	23.690	....	....	F.
				Rev	−984.8	+0.70										
				Mean	−984.10											
*P. B. M. 16=† Charbonnier Point.	T. B. M. 16	12	622.484	Dir	−778.8	0.00	−8.02	+8.02	0.00	14.4	−18.23	6.44158	21.134	21.792	+0.658	J.
				Rev	−778.8	0.00										
				Mean	−778.80											
*Cap over 16	T. B. M. 16	12	622.484	Dir	+457.7	−0.05	−8.07	+8.07	0.3	14.4	−18.03	7.67823	25.191	....	....	J.
				Rev	+457.6	+0.05										
				Mean	+457.65											
T. B. M. 14, old T. B. M. 12 of 1887.	....	....	....	....	....	....	....	....	0.00	0.0	0.00	5.57130	18.279	........*	....	
*T. B. M. 15	T. B. M. 14	516	....	Dir	+32.5	−0.40	−0.40	+0.40	0.27	0.3	0.00	5.60340	18.384	....	....	J.
				Rev	+31.7	+0.40										
				Mean	+32.10											
*P. B. M. 15	T. B. M. 15	227	....	Dir	+3,962.3	0.00	−0.40	+0.40	0.00	0.3	+0.61	9.56631	31.386	....	....	F.
				Rev	+3,962.3	0.00										
				Mean	+3,962.30											

*Cap over 15	P. B. M. 15	24	....	Dir ...	+1,237.0	+0.05	−0.35	+ 0.35	0.03	0.3	+0.81	10.80356	35.445	....	.... F.
				Rev ..	+1,237.1	−0.05									
				Mean.	+1,237.05										
P. B. M. 12, old P. B. M. 11 of 1887.	....	....	....			....	....	....	0.00	0.0	0.00	7.64720	25.090	....	....
*T. B. M. 12	P. B. M. 12	11	....	Dir ...	−1,594.6	0.00	0.00	0.00	0.00	0.0	−0.25	6.05235	19.857	....	.... J.
				Rev ..	−1,504.6	0.00									
				Mean .	−1,594.60										
*T. B. M. 13	T. B. M. 12	348	....	Dir ...	+2,871.6	+0.40	+0.40	− 0.40	0.27	0.3	+0.20	8.92480	29.281	....	.... J.
				Rev ..	+2,872.4	−0.40									
				Mean .	+2,872.00										
*P. B. M. 14=† Musica Ferry.	T. B. M. 13	17	....	Dir ...	−749.1	+0.20	+0.60	− 0.60	0.13	0.3	+0.08	8.17578	26.824	26.845	+0.021 J.
				Rev ..	−748.7	−0.20									
				Mean .	−748.90										
*Cap over 14	T. B. M. 13	17	....	Dir ...	+489.0	0.00	+0.40	− 0.40	0.00	0.3	+0.27	9.41387	30.886	....	.... J.
				Rev ..	+489.0	0.00									
				Mean.	+489.00										
*P. B. M. 13	Cap over 14	10	....	Dir ...	+1,465.4	−0.10	+0.30	− 0.30	0.07	0.3	+0.51	10.87941	35.694	....	.... J.
				Rev ..	+1,465.2	+0.10									
				Mean .	+1,465.30										
T. B. M. 10, old T. B. M. 18 of 1887.	....	....	....			....	....	....	0.00	0.00	0.00	3.46340	11.363	....	....
*T. B. M. 11	T. B. M. 10	1,294	....	Dir ...	+3,403.5	−0.75	−0.75	+0.75	0.50	0.5	+0.53	6.86668	22.529	....	.... F.
				Rev...	+3,402.0	+0.75									
				Mean .	+3,402.75										
*P. B. M. 11	T. B. M. 11	14	....	Dir ...	−845.6	−0.15	−0.90	+0.90	0.10	0.5	+0.40	6.02080	19.753	....	.... J.
				Rev...	−845.9	+0.15									
				Mean .	−845.75										
*Cap over 11	T. B. M. 11	14	....	Dir ...	+393.6	0.00	−0.75	+0.75	0.00	0.5	+0.59	7.26034	23.820	....	.... J.
				Rev...	+393.6	0.00									
				Mean .	+393.60										

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 1892—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
* P. B. M. 10	T. B. M. 11	36	....	Dir ... Rev ...	+5,902.1 +5,902.2	+0.05 −0.05	−0.70	+0.70	0.03	0.5	+1.44	12.76974	41.896	....	....	J.
				Mean .	+5,902.15											
* T. B. M. 9	T. B. M. 10	1,736	....	Dir ... Rev ...	+1,015.5 +1,012.7	−1.40 +1.40	−1.40	+1.40	0.93	0.9	+0.16	4.47766	14.691	....	....	J.
				Mean .	+1,014.10											
* T. B. M. 8	P. B. M. 9	649	....	1 Dir . 1 Rev . 2 Dir .. 2 Rev .	+979.2 +973.8 +975.3 +975.5	−3.25 +2.15 +0.65 +0.45	−2.70	+2.70	0.76	1.2	+0.31	5.45376	17.893	....	....	J.
				Mean .	+975.95											
* P. B. M. 9 = $\frac{3}{1}$	T. B. M. 8	50	....	Dir ... Rev ...	+2,935.0 +2,934.8	−0.10 +0.10	−2.80	+2.80	0.07	1.2	+0.76	8.38911	27.524	27.525	+0.001	J.
				Mean .	+2,934.90											
* Cap over 9	T. B. M. 8	50	....	Dir ... Rev ...	+4,174.6 +4,174.3	−0.15 +0.15	−2.85	+2.85	0.10	1.2	+0.96	9.62886	31.591	....	....	J.
				Mean .	+4,174.45											
P. B. M. 8 = old B. M. 8 of 1887.	....	....	....	....	....	....	....	....	0.00	0.0	0.00	1.28330	4.210	....	....	
*T. B. M. 7	P. B. M. 8	187	....	Dir ... Rev ...	+5,405.7 +5,406.9	+0.60 −0.60	+0.60	−0.60	0.40	0.4	+0.84	6.69044	21.950	....	....	J.
				Mean .	+5,406.30											
*P. B. M. 7	T. B. M. 7	15	....	Dir ... Rev ...	−721.0 −720.6	+0.20 −0.20	+0.80	−0.80	0.13	0.4	+0.73	5.96953	19.585	....	....	F.
				Mean .	−720.80											

*Cap over 7	T. B. M. 7	15	....	Dir	+513.0	−0.15	+0.45	−0.45	0.10	0.4	+0.92	7.20337	23.633	....	....	F.
				Rev	+512.7	+0.15										
				Mean	+512.85											
*T. B. M. 6, old B. M. 7. Jamestown landing.	T. B. M. 7	682	....	Dir	−1,206.1	−0.40	+0.20	−0.20	0.27	0.5	+0.65	5.48375	17.991	17.986	−0.005	F.
				Rev	−1,206.9	+0.40										
				Mean	−1,206.50											
*P. B. M. 6	T. B. M. 6	88	....	Dir	−3,191.3	−0.05	+0.15	−0.15	0.03	0.5	+0.16	2.29191	7.520	....	....	J.
				Rev	−3,191.4	+0.05										
				Mean	−3,191.35											
*T. B. M. 5	T. B. M. 6	2,586	....	Dir	+261.7	+0.70	+0.90	−0.90	0.47	0.7	+0.69	5.74619	18.852	....	....	J.
				Rev	+253.1	−0.70										
				Mean	+262.40											
*P. B. M. 5	T. B. M. 5	757	....	Dir	−567.7	+0.30	+1.20	−1.20	0.20	0.7	−0.60	5.17870	16.991	....	....	J.
				Rev	−567.1	−0.30										
				Mean	−567.40											
*P. B. M. 4=?	T. B. M. 5	43	....	Dir	−747.0	0.00	+0.90	−0.90	0.00	0.7	+0.58	4.99908	16.401	16.370	−0.031	J.
				Rev	−747.0	0.00										
				Mean	−747.00											
*Cap over 4	T. B. M. 5	43	....	Dir	+491.2	+0.20	+1.10	−1.10	0.13	0.7	+0.77	6.23767	20.465	....	....	J.
				Rev	+491.6	−0.20										
				Mean	+491.40											
*T. B. M. 4	T. B. M. 5	732	....	Dir	+457.0	+1.00	+1.90	−1.90	0.67	0.9	+0.76	6.20426	20.355	....	....	J.
				Rev	+459.0	−1.00										
				Mean	+458.00											
*T. B. M. 3	T. B. M. 4	969	....	1 Dir	+2,661.9	−2.62	+0.32	−0.32	0.69	1.2	+1.17	8.86395	29.082	....	....	F.
				1 Rev	+2,657.1	+2.18										
				2 Dir	+2,659.8	−0.52										
				2 Rev	+2,658.3	+0.98										
				Mean	+2,659.28											
*T. B. M. 2	T. B. M. 3	341	....	Dir	−4,076.9	−0.35	−0.03	+0.03	0.23	1.2	+0.54	4.78607	15.702	....	....	F.
				Rev	−4,077.6	+0.35										
				Mean	−4,077.25											

Tabulation of precise level results, St. Joseph, Mo., to the mouth of Missouri River, 189?—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV		r. ±	R. ±	Rod corr'n.	Elevation above St. Louis City Directrix.			Discrepancy.	Ob.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 3	T. B. M. 2	36	....	Dir	+210.0	+0.20	+0.17	−0.17	0.13	1.2	+0.59	4.99632	16.392	....	....	F.
				Rev	+210.4	−0.20										
				Mean	+210.20											
*T. B. M. 1	T. B. M. 2	2,017	....	Dir	−565.8	+2.05	+2.02	−2.02	1.37	1.8	+0.46	4.22224	13.853	....	....	F.
				Rev	−561.7	−2.05										
				Mean	−563.75											
*P. B. M. 2–1	T. B. M. 1	30	....	Dir	−423.8	−0.05	+1.97	−1.97	0.03	1.8	+0.39	3.79832	12.462	12.462	0.000	F.
				Rev	−423.9	+0.04										
				Mean	−423.85											
*Cap over 2	T. B. M. 1	30	....	Dir	+815.3	+0.05	+2.07	−2.07	0.03	1.8	+0.58	5.03771	16.528	....	....	F.
				Rev	+815.4	−0.05										
				Mean	+815.35											

DESCRIPTIONS AND ELEVATIONS OF PRECISE LEVEL BENCH MARKS BETWEEN ST. LOUIS AND THE UNITED STATES BOAT YARD ABOVE ST. JOSEPH, MO.

All elevations are given in both meters and feet and refer to St. Louis city directrix as zero. The elevation of this above Biloxi sea level, as determined from the Mississippi River Commission P. B. M. 15, and connections made by Missouri River Commission in 1887, is 412.731 feet.

A "P. B. M." is a precise level bench mark that is set to be practically permanent.

A "T. B. M." is a precise level bench mark, generally of not as permanent a nature as a P. B. M.

All P. B. M.'s, excepting 226, which is top of an anchor bolt, 231, the point of an arrow head, and 12, a cross on vertical face of a rock are—

(1) Top of copper bolt set in the regulation "B. M." stone 18" x 18" x 4" thick, 3½ feet under ground, over and concentric with which is set an iron pipe, 4 feet long, provided with a flange at the bottom 10 inches in outer diameter and cap at top, terminating in a rounded knob, which is also taken as a P. B. M.; or,

(2) Top of copper bolt set vertically into the masonry of structures, or of natural ledges projecting about 0.002 foot above the surface; or,

(3) Center of punch mark in copper bolt, leaded horizontally into the masonry of structures, or of natural ledges about one-eighth inch deeper than the surface of rock.

In case 1, the top surface of flat stone is marked "B. M." and the cap surmounting pipe is moulded with the inscription, "Missouri River Commission."

In cases 2 and 3, all set during the season have the letters "U. S." ⊙ P. B. M. cut into the rock of size and depth to be readily seen and to last many years.

The T. B. M.'s are most generally the highest point of a rounded surface inside of a square, about 1½ inches on a side, cut into the surface of the rock, often, but not always, lettered "U. □ S.," or top of a wire spike driven to surface into a stump or root of a tree.

With the exception of but a few valuable trees, all carrying T. B. M.'s have a shoulder cut onto the root into which the spike is driven and are blazed at a point 3½ to 4 feet directly over the root, in the form of a square about 10 inches on a side.

The value of a meter used is 3.2808693 feet.

O. W. FERGUSON,
Assistant Engineer.

Descriptions and elevations of precise level bench marks between St. Louis and the United States boat yard above St. Joseph, Mo.

Number.	Description.	Elevation.	
		Meters.	Feet.
St. Louis City Directrix.	In St. Louis, on the west side of Wharf street between Market and Walnut streets, in line with curb stone, 824 feet south of the south building line of Market street, on base stone (3.8x3.8 feet) of old granite monument marked by a T cut in stone. It was torn up during the erection of the elevated road in the year 1890. It is 412.731 feet above preliminary determination of Biloxi sea level.	0.0000	0.000
P. B. M. 15........	Of Mississippi River Commission is in St. Louis, in east face of west column of arch No. 4, 20.1 feet south of the north end of column, 0.46 foot above the top course of granite; being center of punch mark in copper bolt leaded horizontally, marked U. S. in the granite below the bolt.	0.8144	2.672
P. B. M. 14........	Of Mississippi River Commission is in St. Louis, at the water-works, opposite Bissels Point, on the north side of the west engine-room 4.8 feet west of the west corner of main entrance in third course of stone; being center of punch mark in copper bolt leaded horizontally.	3.8325	12.574
P. B. M. 13........	Of Mississippi River Commission is in North St. Louis, on the east side of Broadway, 3 miles above the water-works, 369 feet south of the northern terminus of the Baden street car track and 121 feet east of the same, in small grove; being top of copper bolt in stone post.	5.3488	17.549

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	F[illegible]
P. B. M. 1	Is same as P. B. M. 12, of Mississippi River Commission, 9 miles above the St. Louis water-works, ½ mile from the river, on land of Mrs. Sophia Beine, 65 feet west of the Columbia Bottom Road, on side of bluff, 115 feet south of plum orchard and 42 feet west from a lone walnut tree 23 inches in diameter; being top of copper bolt in stone post set in ground.	13.3739	4
P. B. M. 2=[illegible]	Is about 1¼ miles below the upper end of Columbia Bottom, at point where Columbia Bottom road, running along the foot of the bluff, turns east across the bottom opposite rock quarry, at east road fence, 55 feet south of the corner; being top of copper bolt in a B. M. stone.	3.7983	1
Top of cap	Over P. B. M. 2	5.0377	1
T. B. M. 1	Is 55 feet west of P. B. M. 2, at the northeast corner of angle in Columbia Bottom road; being top of spike in west root of 20-inch honey locust.	4.2222	1
P. B. M. 3	Is at upper extremity of Columbia Bottom, at foot of bluff, 40 feet from river bank, 60 feet above rail fence over bluff, at east end of Henry Weisley's orchard, 5 feet south of wire fence 4 feet above elevation of bottom land, in exposed ledge of rock; being center of punch mark in copper bolt leaded horizontally.	4.9963	1
T. B. M. 2	Is about 95 feet west of P. B. M. 3, 240 feet below west end of Henry Weisley's orchard, on projection of natural ledge, 2 feet from end and 4 feet northwest of a blazed ash 24 inches in diameter.	4.7861	
T. B. M. 3	Is ¼ mile above the extreme upper point of Columbia Bottom, opposite head of island, 377 feet below small creek, 1,965 feet below Wm. Lindeman's house, 75 feet from river bank; being top of spike in root of black oak snag.	8.8640	
T. B. M. 4	Is about ⅜ mile below mouth of Cold Water Creek on same tree as old B. M. 6 (now gone), 1,195 feet above Wm. Lindeman's house, 130 feet above rail fence, in open woods, 35 feet from river bank; being top of spike in 2-foot red oak.	6.2043	
P. B. M. 4=[illegible]	Is at foot of bluff near site of Fort Bellefontaine; being top of copper bolt in B. M. stone.	4.9991	
Top of cap	Over P. B. M. 4	6.2377	
T. B. M. 5	Is in same locality at P. B. M. 4, 25 feet east of east bank of Cold Water Creek and 35 feet from bank of river; being top of spike in base of a 15-inch white oak.	5.7462	
P. B. M. 5	Is about ¾ mile below St. Louis, Keokuk and Northwestern Rwy bridge, 2,295 feet above mouth of Cold Water Creek, in large recess in rock bluff in which there is a small spring flowing out of a circular hole in rock 1 foot in diameter at an elevation of mean stage of river; it is in a vertical cliff, about 20 feet below top of exposed face, and 10 feet above high water; being center of punch mark in copper bolt leaded horizontally.	5.1787	
T. B. M. 6 = Old B. B. M. 7. Jamestown Landing.	Is at Jamestown Landing, on east side of ravine, at top of river bank; being top of spike in northeast root of cottonwood 2½ feet in diameter.	5.4838	
P. B. M. 6	Is at Jamestown Landing, 1,605 feet above St. Louis, Keokuk and Northwestern Rwy. bridge, 118 feet above the mouth of small creek which runs along the west side of Widow Zehe's place, in small recess in bluff bank, 75 feet below point, where rail fence intersects the river bank, 10 feet below top of bank, directly under a 10-inch hackberry, 15 feet above low water and 3 feet west of large detached rock, being center of punch mark in copper bolt leaded horizontally into natural ledge.	2.2919	
P. B. M. 7	Is 2,210 feet above Jamestown Landing, at upper edge of oak grove, 900 feet above Wm. Whittaker's house standing on bluff, 20 feet from top of high water bank and one foot east of wire fence; being top of copper bolt in B. M. stone.	5.9695	
Top of Cap	Over P. B. M. 7	7.2034	
T. B. M. 7	Is in same locality as P. B. M. 7, and but a few feet distant from same, on top of bank; being top of spike in south root of 2½ foot black hickory.	6.6904	
P. B. M. 8 = Old B. M. 8 of 1887.	Is 2,785 feet above Jamestown Landing, 500 feet below foot of island tow-head, 575 feet above fence at the upper side of woods at which is located P. B. M. 7, in north exposure of hard limestone ledge; being horizontal furrow in copper bolt.	1.2833	
P. B. M. 9=[illegible]	Is about 2 miles above Jamestown Landing, on land owned by Wm. Berger, at foot of bluff, 500 feet from river, 75 feet west of small stream; being top of copper bolt in B. M. stone.	8.3891	
Top of Cap	Over P. B. M. 9	9.6289	

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 8	Is 124 feet north of P. B. M. 9, on west bank of small stream; being top of spike in west root of 15-inch willow.	5.4538	17.893
P. B. M. 10	Is directly up the slope from P. B. M. 11, 10 feet to the right of path leading up the bluff, in vertical face of ledge, one foot below shelf of same; being center of punch mark in copper bolt.	12.7697	41.896
P. B. M. 11	Is about 2¼ miles below Music's Ferry, at foot of bluff 100 feet above Dripping Spring, coming down over side of bluff, of a peculiar porous limestone formation, 90 feet west of point where wire fence joins the bluff, on the property of S. C. Carrico; being top of copper bolt in B. M. stone.	6.0208	19.753
Top of Cap	Over P. B. M. 11	7.2603	23.820
P. B. M. 12=Old P. B. M. 11 of 1887.	Is 1,200 feet below Music's Ferry, on east side of road under overhanging rock, 220 feet below the lower end of stone quarry, 4.5 feet above ground; being a cross cut on vertical face of rock of the same elevation as old copper bolt which was destroyed before 1887.	7.6472	25.090
P. B. M. 13	Is in same yard as P. B. M. 14, in the southwest corner of the three-story stone house on the east side of wagon road, 1 foot east of corner and 5 feet above ground; being center of punch mark in copper bolt leaded horizontally into wall of house.	10.8794	35.694
P. B. M. 14=½ Music's Ferry.	Is at Music's Ferry, 500 feet below old stone house, in door yard of the large three-story stone house, at east fence of road, 19 feet south and 10 feet west of the southwest corner of house; being top of copper bolt in B. M. stone.	8.1758	26.824
Top of Cap	Over P. B. M. 14, even with surface of ground	9.4139	30.886
T. B. M. 14=Old T. B. M. 12 of 1887.	Is 1¼ miles above the creek at the upper side of Music's Ferry, at upper side of old field, at lower edge of woods, 80 feet back from river bank; being top of nail in the north base of 3-foot burr oak.	5.5713	18.279
P. B. M. 15	Is on the right bank, opposite the center of Charbonnier Island, 2,460 feet above the lower edge of first timber along river above Music's Ferry, on north end of rounding point of bluff, at rear of field, 400 feet above the upper end of present timber line running to river, 300 feet from river and 200 feet below road up side of bluff; being top of copper bolt in B. M. stone.	9.5663	31.386
Top of Cap	Over P. B. M. 15	10.8036	35.445
T. B. M. 15	Is 540 feet below P. B. M. 15 and 140 feet below the lower edge of old field in timber, about 200 feet from river bank; being spike in south root of 28-inch red elm.	5.6034	18.384
P. B. M. 16 = ½ Charbonnier Point.	Is at Charbonnier Point, in the dooryard of L. C. Knapp, north of angle in highway, 104 feet from road and 33 feet south of house, at the east yard fence; being copper bolt in B. M. stone.	6.4416	21.134
Top of cap	Over P. B. M. 16	7.6782	25.191
T. B. M. 16	Is in the same yard as P. B. M. 16 and 30 feet north from it, 30 feet south of L. C. Knapp's house, 5 feet west from the east fence; being spike in the west root of 18-inch sycamore.	7.2205	23.690
T. B. M. 17	Is 1½ miles above the turn in highway at Charbonnier Point, and 4,900 feet below George Cleberg's house, 328 feet below creek, 25 feet south of highway; being spike in the north root of 2½-foot sycamore.	8.2047	26.919
P. B. M. 17	Is 2½ miles below St. Charles Bridge, in front of George Cleberg's house, 98 feet south of public road, 98 feet north of his house on east side of driveway, 5 feet south of 10-inch maple; being copper bolt in B. M. stone.	7.2114	23.660
Top of cap	Over P. B. M. 17	8.4479	27.716
T. B. M. 18	Is in the same locality as P. B. M. 17, on old river bank, on north side of road, 215 feet north of George Cleberg's house; being spike in the south root of 3-foot cottonwood.	7.8852	25.870
T. B. M. 19	Is 1⅜ miles below the St. Charles Bridge, on line of river road, 620 feet below house occupied by Henry Remer, 50 feet below the cross rail fence at the east road fence; being spike in root of 14-inch pin-oak.	8.8884	29.162
T. B. M. 18	Is opposite St. Charles at the east foot of embankment of the Wabash Rwy. trestle and south side of the St. Charles rock road, 210 feet east of trestle and 45 feet from the road, 8 feet south from the 3½ foot elm; being top of copper bolt in B. M. stone.	6.5502	21.520
Top of cap	Over P. B. M. 18	7.7906	25.560
T. B. M. 21 Brotherton.	Is in the same locality as P. B. M. 18; being spike in root of the 3½ foot elm.	7.8118	25.630
P. B. M. 19	Is at the road crossing under track of the east approach of the St. Charles Bridge, on the up river side of trestle, on stone at base of the fourth iron column from the north side of wagon road in the southeast quarter of stone; being top of copper bolt leaded vertically.	12.9428	42.464

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Fe
P. B. M. 20 = old B. M. 17.	Is in the second pier from the east end of St. Charles Bridge on its west face. 2.8 feet south of line between rough and dressed stone, on curved surface at the south end of pier, in center of stone in the sixteenth course of masonry from starling coping of pier; being horizontal furrow in copper bolt.	9.2074	3
T. B. M. 22	Is at the same pier as P. B. M. 20, 5 feet west from same face, near north end; being spike in an oak pile.	8.3495	2
T. B. M. 23 St. Charles.	Is in St. Charles on the south side of trestle work of St. Charles Bridge on first column west of west pier on eighth course of stone from top and fourth above ground on the northeast corner at offset in masonry; being highest point in square.	10.9684	3
T. B. M. 24 = gauge B. M.	Is in St. Charles on same stone column supporting trestle as T. B. M. 23, on upstream corner nearest the river of second projecting course of masonry from top; being highest point in square.	10.2419	3
U. S. gauge	At St. Charles is standard wire cable gauge on upstream side of Wabash Rwy. Bridge over the Missouri River. Elevation of its zero.	+0.0267	+
P. B. M. 21 = ‡	Is at St. Charles, Mo., 1,310 feet above the St. Charles Bridge on the north side of Lawrence street and 25 feet west of the center of Missouri, Kansas and Eastern Rwy. track, in the southeast corner of David Lane's lot, one foot west from fence; being top of copper bolt in B. M. stone.	9.5938	3
Top of cap	Over P. B. M. 21	10.8299	3
T. B. M. 25 = City B. M. St. Charles.	Is in St. Charles on the northeast corner of Lawrence and Second streets, on top of foundation at the southwest corner of three-story brick building, city elevation given as 119.48 feet, which datum is also recorded as 115 feet below high water of 1844.	12.8901	4
City datum, St. Charles.	Of St. Charles is a plane 115 feet below high water of 1844, which is given in the city record as 119.48 feet below the city B. M.	....	−7
T. B. M. 26 = Old B. M. 78 of 1879.	Is in St. Charles at southwest corner of Second and Wood streets, on the northeast corner of brick house on top of masonry of foundation, about one inch above T. B. M. 27 (poor point).	12.0588	3
T. B. M. 27	Is on same corner as old B. M. 78 and 1 inch below; being point on projecting stone of foundation.	12.0881	3
T. B. M. 28	Is 2.065 feet above road crossing, under east trestle approach of St. Charles Bridge, on east side of wagon road; being spike in west root of the very large cottonwood.	9.2880	3
T. B. M. 29	Is 1¼ miles above east pier of St. Charles Bridge, 65 feet south of spur track from Wabash Rwy., 52 feet east of headblock for east end of siding, on south side of wagon road, on edge of bank; being spike on north side of 18-inch walnut.	11 4912	3
T. B. M. 30	Is about 1½ miles above the east end of St. Charles Bridge, on the west side of St. Charles rock road, at point where the road first reaches track, 300 feet northward from James Ashbrook's house; being spike in east one of two cottonwoods standing on south side of Wabash track.	6.9728	2
T. B. M. 32	Is about 557 feet towards St. Charles from P. B. M. 22, where branch road from the St. Charles rock road runs northeast, on north end of rock culvert, under branch road on northwest corner of stone; being highest point in square.	12.6722	4
P. B. M. 22 = ‡	Is on foot of bluff opposite St. Charles, 125 feet east of the east side of St. Charles rock road, where it enters hills, 510 feet south of road branching to northeast, opposite large brick house, on side of bluff and 30 feet from soft maple, at the northwest corner of Mr. Jones's yard; being top of copper bolt in B. M. stone.	20.2153	6
Top of cap	Over P. B. M. 22	21.4535	7
T. B. M. 33	Is 2.230 feet southwest of where the St. Charles rock road enters hills on point of land on south bank of small creek; being spike in root of large lime tree.	13.3446	4
T. B. M. 35	Is 1¼ miles above St. Charles rock road, 150 feet south of south edge of timber and 50 feet from foot of bluff; being spike in east root of 2½-foot elm on west side of path.	9.2896	3
P. B. M. 23	Is 1¾ miles above point where St. Charles Rock Road enters hills, 1,965 feet below where wagon-road running north from Vigus leaves the bottom and enters the hills, 95 feet above the ditch running east and west across the bottom, at foot of bluff, 3 feet west of rail fence and 15 feet north of 18-inch sycamore, about 65 feet north of point where rail fence joins bluff; being top of copper bolt in B. M. stone.	10.1404	3
Top of cap	Over P. B. M. 23	11.3819	3
T. B. M. 36	Is 15 feet south of P. B. M. 23; being spike in west root of the 18-inch sycamore.	10.6969	3

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 37	Is ⅜ mile below the water tank, on the north side of county road, in front of house owned by Mary Price and occupied by J. B. Bonor; being spike in root of 24-inch shell-bark hickory.	9.7766	32.076
T. B. M. 40	Is 350 feet east of P. B. M. 24, on north side of road, opposite the north end of road running south; being spike in base of an apple tree.	11.3719	37.310
P. B. M. 24-½	Is about 1,965 feet north from the north end of Creve Cœur Lake on the north side and about 607 feet from St. Louis, Kansas City and Colorado Rwy., about ¼ miles S. 83° W. (mag.) from water tank, 15 feet south of east and west wagon road, and 394 feet west of intersection of said east and west road with road running south across track; being copper bolt in B. M. stone.	10.9481	35.919
Top of cap	Over P. B. M. 24	12.1878	39.986
T. B. M. 41	Is 1⅜ miles below Creve Cœur Lake Station, 508 feet above road crossing, 80 feet east of railway; being spike in root of 50 inch elm.	10.8570	35.620
T. B. M. 42	Is 1,460 feet below Creve Cœur Lake Station, St. Louis, Kansas City and Colorado Rwy., 318 feet south of head block at the north end of siding, 35 feet south of track on west root of a 2-foot elm; being top of spike.	11.3845	37.351
P. B. M. 25 Creve Cœur.	Is 425 feet south of Creve Cœur Lake Station, St. Louis, Kansas City and Colorado Rwy., 112 feet north of Boyd's cottage, in southwest corner of field, 65 feet east of center of track, being copper bolt in B. M. stone.	10.0564	32.994
Top of cap	Over P. B. M. 25	11.2954	37.059
T. B. M. 43	Is 518 feet south of Creve Cœur Lake Station, 36 feet north of Boyd's cottage, 60 feet east from center of track; being spike in the west root of 8 inch elm	11.5604	37.928
P. B. M. 26	Is 2,950 feet above Creve Cœur Lake Station, on St. Louis, Kansas City, and Colorado Rwy., 1,000 feet above milepost 22, 744 feet above bridge 48, 1,245 feet below road crossing, on bluff side of track 35 feet from center and 4½ feet above top of rail; being center of punch mark in copper bolt leaded horizontally in vertical face of rock.	12.9003	42.324
T. B. M. 45	Is 1 mile below Mona Station, 52 feet east of road crossing, in north end of west cap of bridge No. 49; being top of drift bolt over pile marked [·].	12.0069	39.393
P. B. M. 27 = ½ Mona.	Is at Mona Station, on line of St. Louis, Kansas City and Colorado Rwy., 150 feet above road running from bottom over bluff to Lake post-office, at foot of bluff, opposite a point 60 feet above bridge 52; being copper bolt in B. M. stone.	11.2958	37.060
Top of cap	Over P. B. M. 27	12.5342	41.123
T. B. M. 48	Is 1⅜ miles below Drew Station, 85 feet below mile post 25, on south end of first pile bent from west end of bridge No. 58; being top of drift bolt over pile marked by square cut in wood.	12.6335	41.449
P. B. M. 28	Is 2,100 feet below point where Olive street road crosses the St. Louis, Kansas City and Colorado Rwy., at Drew Station, 800 feet below head block at east end of siding, 1,680 feet above milepost 26, on bluff side of track, 85 feet from center opposite bridge 61; being copper bolt in B. M. stone.	14.9650	49.098
Top of cap	Over P. B. M. 28	16.2009	53.153
T. B. M. 51, Drew	Is at Drew Station, 98 feet east of depot, in southeast corner of south abutment of iron wagon bridge on Olive street road over Bon Homme Creek, 30 feet north of center of track; being highest point in square cut on masonry at angle between face of abutment and wing wall, marked U. ☐ S.	14.3614	47.128
P. B. M. 29 = ½ Gumbo.	Is at Gumbo Station, in northeast corner of cemetery, which is 230 feet south of railroad track. A road runs from Gumbo post office over bluff along east edge of cemetery. Top of copper bolt in B. M. stone.	15.2788	50.128
Top of cap	Over P. B. M. 29	16.5139	54.180
P. B. M. 30 Stevens.	Is in Stevens, Mo., 130 feet above road crossing, 110 feet below rail fence, 45 feet below bridge 79, at foot of bluff, 50 feet from track center, 1¼ feet south of right-of-way fence; being copper bolt in B. M. stone.	14.1643	46.471
Top of cap	Over P. B. M. 30	15.4025	50.534
P. B. M. 31 = ½ Bon Homme.	Is in Bon Homme, 35 feet west of line of road running north across bottom, opposite lower end of railroad platform at foot of bluff, 18 feet east of a 20-inch sugar maple, 15 feet south from center line of road running west along foot of bluff; being copper bolt in B. M. stone.	14.1665	46.478
Top of cap	Over P. B. M. 31	15.4043	50.539
P. B. M. 32	Is 15 feet south of P. B. M. 31, 10 feet west of same, and 9½ feet higher than top of cap; being center of punch mark in copper bolt leaded *horizontally* in vertical face of ledge.	18.2121	59.751

Descriptions and elevations of precise level bench marks, etc.—**Continued.**

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 56	Is 15 feet west of P. B. M. 31, 5 feet north of a 20-inch sugar maple; being highest point in square on imbedded stone, about level with surface of ground.	14.7046	48.244
P. B. M. 33. Centaur.	Is in Centaur, 62 feet east of Centaur Lime Co.'s store, 30 feet south of St. Louis, Kansas City and Colorado R. R., opposite east end of railroad platform; being copper bolt in B. M. stone.	14.1301	46.359
Top of cap	Over P. B. M. 33	15.3649	50.410
T. B. M. 59	Is near P. B. M. 33, on bluff side of track, 30 feet from center, opposite center of railroad platform; being spike in the north root of stump.	16.0809	52.759
P. B. M. 34	Is $\frac{3}{4}$ mile above Centaur, opposite center of wooded lot on river side of track, 10 feet above upper end of Bridge 99, bluff side of track, 45 feet from center and about 5 feet above grade; being center of punch mark in copper bolt leaded horizontally into north face of vertical ledge.	17.1635	56.311
T. B. M. 61	Is $\frac{5}{8}$ mile below Port Royal, Mo., 75 feet above point of very low bluff ledge, opposite center of small cave, bluff side of track 12.1 feet from center and about level with grade; being highest point in square cut on natural ledge.	17.8324	58.506
P. B. M. 35 = $\frac{4}{1}$. Port Royal.	Is in Port Royal, 35 feet above Bridge 106, in front of section house, 2 feet back from front line and 5 feet from corner of yard fence to property owned by Charles W. Goetz, bluff side of track, 35 feet from center; being copper bolt in B. M. stone.	18.5034	60.707
Top of cap	Over P. B. M. 35	19.7455	64.782
T. B. M. 62	Is near P. B. M. 35, 40 feet above Bridge 106, 12 feet from section house and on line with east face of same, river side of track, 15 feet from center; being highest point in square cut on imbedded stone projecting about 2 inches above ground.	18.0561	59.240
T. B. M. 63	Is 3,035 feet above Port Royal, 75 feet below limekiln, and 15 feet above lower head block of limekiln siding, river side of track, 9.2 feet from the center; being highest point in square cut on rock about 1.3 feet above grade of track.	19.5323	64.083
P. B. M. 36	Is $1\frac{1}{4}$ miles above Port Royal, 557 feet above milepost 37, 10 feet above west end of Bridge 109, bluff side of track, 45 feet from center; being copper bolt in B. M. stone.	19.8998	65.289
Top of cap	Over P. B. M. 36	21.1381	69.352
P. B. M. 37	Is $1\frac{7}{8}$ miles above Port Royal, $\frac{3}{4}$ mile above milepost 37, in natural face of bare sandstone bluff, about 20 feet west of square corner of bluff, 16 feet from center of track, and 1 foot above rail; being center of punch mark in copper bolt leaded horizontally.	27.9216	91.607
P. B. M. 38 = $^{1}{}_{1}{}^{2}$. St. Albans.	Is 450 feet above St. Albans Station, 197 feet above Bridge No. 113, about 60 feet south of St. Louis, Kansas City, and Colorado Railway track, in northeast corner of Charles Boker's dooryard, 835 feet S. 85° 30′ W. (mag.) from northeast corner of sec. 10, T. 44, R. 2 E.; being copper bolt in B. M. stone.	19.9229	65.364
Top of cap	Over P. B. M. 38	21.1593	69.420
T. B. M. 69	Is 1 mile below Becker Station, 315 feet below Bridge No. 114, bluff side of track, 10.8 feet from center, 100 feet below upper end of side-hill cut; being highest point in square cut on natural ledge 1 foot above ground, and marked U. □ S.	23.7051	77.773
P. B. M. 39. Becker.	Is 800 feet above Becker Station, 1,230 feet below water tank, 75 feet above intersection of track and west road fence produced, bluff side of track, 25 feet from center, opposite cattle guard, $1\frac{1}{2}$ feet from west wing fence; being copper bolt in B. M. stone.	20.8406	68.375
Top of cap.	Over P. B. M. 39	22.0799	72.441
P. B. M 40	Is $\frac{3}{8}$ mile above Becker, 250 feet above milepost 42, 200 feet below water tank, on east abutment of Bridge No. 116, on north end of first course of stone below bridge seat course; being top of copper bolt leaded vertically.	19.6417	64.442
P. B. M. 41	Is $1\frac{1}{2}$ miles above bridge over Fiddle Creek, which is just above Becker Station, on St. Louis, Kansas City, and Colorado Railway, 2,865 feet above milepost 43, 33 feet above Bridge No. 122, 1 foot inside of south right-of-way fence, about 50 feet from center of track; being copper bolt in B. M. stone.	15.8839	52.113
Top of cap	Over P. B. M. 41	17.1213	56.173
T. B. M. 73	Is near P. B. M. 41; being highest point in square cut with chisel on top of driftbolt in north end of cap on west bent of Bridge No. 122.	18.1203	59.450
T. B. M. 74	Is $2\frac{1}{3}$ miles above Becker Station, on St. Louis, Kansas City and Colorado Railway, $1\frac{3}{4}$ miles below Missouri Pacific crossing, on first pile bent from downstream end of Bridge 124, on bluff end of bent; being highest point in square cut on top of driftbolt through cap into pile.	18.1120	59.423

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 42, Labadie.	Is at crossing of Missouri Pacific Railroad, above Labadie Station, on north end of pier on east of Missouri Pacific track, in seventeenth course of masonry from top, and in east side of center stone in course; being center of punch mark in copper bolt leaded horizontally.	23.3647	76.656
T. B. M. 76	Is near P. B. M. 42; being top of spike in idle pile directly west of center of pier on east side of Missouri Pacific Railroad. 3 feet east of right-of-way fence in second pile from north end of row.	22.8764	75.054
T. B. M. 77	Is ¾ mile above Labadie Siding, directly opposite center of Labadie Crossing, on river side of track, 75 feet from center; being top of spike in the south root of 16-inch black walnut.	20.3626	66.807
P. B. M. 43 = 13/1	Is 2 miles below Boles, 2,100 feet below milepost 46, 500 feet below post "One mile to station," opposite west end of deep thorough rock cut, 1 foot inside of north right-of-way fence, and 50 feet from center of track; being copper bolt in B. M. stone.	16.6641	54.673
Top of cap	Over P. B. M. 43	17.9003	58.729
T. B. M. 78	Is 2 miles below Boles, 2,095 feet below milepost 46, 495 feet below post marked "One mile to station," about 20 feet west of west end of deep thorough rock cut, on bluff side of track, 12 feet from center, and level with rail; being highest point in square on natural ledge marked U. □ S.	22.8547	74.983
P. B. M. 44	Is 3,005 feet below Boles, 95 feet above milepost 47, 36 feet below small bridge D_2, opposite road crossing, bluff side of track, 15 feet from center and 2 feet above rail; being center of punch mark in copper bolt leaded horizontally into natural ledge.	21.9034	71.863
T. B. M. 80	Is 3,018 feet below Boles, 82 feet above milepost 47, 49 feet below small bridge D_2, 10 feet east of road crossing, bluff side of track, 8 feet from center; being highest point in square cut on natural ledge and marked U. □ S.	21.4091	70.240
T. B. M. 81, Boles.	Is 375 feet above Boles, 50 feet above west head block for warehouse track, 27 feet above cattle guard, bluff side of track, 10 feet from center and about 1 foot above rail; being highest point in squaare cut on natural ledge and marked U. □ S.	21.9551	72.032
P. B. M. 45	Is three-quarters of a mile above Boles, 616 feet above west head block of siding, near right-of-way fence corner at right angle turn of farm road, 2 feet outside of right of way in Mr. Hinkle's field; being copper bolt in B. M. stone.	18.3720	60.276
Top of cap	Over P. B. M. 45	19.6035	64.316
T. B. M. 83	Is 1¼ miles above Boles, 295 feet below milepost 49, 872 feet below post marked "One mile to station," on bluff side of track, 10 feet from center; being highest point in square cut on large imbedded bowlder.	22.6773	74.401
T. B. M. 84	Is 2¼ miles below South Point, 623 feet below milepost 50, 115 feet below whistle post, on bluff side of track, 7.2 feet from center and about 1 foot below grade; being highest point in square cut on imbedded rock.	22.4855	73.772
T. B. M. 85	Is 1¾ miles below lower headblock of South Point Siding and opposite center of coulee, on south end of stone-box culvert. 14.5 feet from center of track, on east side of opening, on large corner stone 5.9 feet below grade; being highest point in square, marked U. □ S.	20.8732	68.482
P. B. M. 46 = 14/1	Is 1¾ miles below lower head block at South Point Siding, near upper side of coulee, 100 feet above stone culvert, 30 feet below point of bluff, bluff side of track 30 feet from center 1.5 feet north of right-of-way fence; being copper bolt in B. M. stone.	21.5708	70.771
Top of cap	Over P. B. M. 46	22.8055	74.822
T. B. M. 86	Is 1¾ miles below lower head block of South Point Siding, opposite center of small coulee, on west abutment of culvert; being highest point in square cut in center of south end and marked U. □ S.	21.9542	72.029
P. B. M. 47	Is 1¼ miles below lower head block of South Point Siding, 490 feet above small culvert, opposite center of coulee, bluff side of track, 14 feet from center and 4.6 feet above grade; being center of punch mark in copper bolt leaded horizontally into natural ledge.	24.0919	79.042
T. B. M. 87	Is ½ mile below South Point, 1,310 feet above signpost marked "Station 1 mile," 4.9 feet below wooden box drain under track, bluff side of track, 12 feet from center and about 1½ feet below grade; being highest point in square on natural ledge.	22.1734	72.748
T. B. M. 88, Dubois Creek.	Is 853 feet below lower head block of South Point siding, on north end of west abutment of Bridge No. 14 Missouri Pacific Rwy.; being highest point in square cut on northeast corner of top course of stone and marked U. □ S.	21.0856	69.189

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. F
P. B. M. 48. South Point.	Is in South Point, Mo., about opposite center of siding, 35 feet below road crossing, bluff side of track 30 feet from center, 6 inches from right of way fence; being copper bolt in B. M. stone.	21.4628	7
Top of cap	Over P. B. M. 48	22.7020	7
P. B. M. 49 = old B. M. 41 = V. S. C. S. B. M. XII.	Is about one-quarter mile above South Point, 250 feet above upper head block of siding, on bluff side of track, 9.5 feet from center and 1 foot above grade; being the horizontal furrow in copper bolt leaded horizontally into natural ledge.	23.3603	7
T. B. M. 89	Is 250 feet above upper head block of South Point siding, on bluff side of track, 10 feet from center and 1 foot below grade; 4 feet west of P. B. M. 49; being highest point in square cut on natural ledge and marked with the letters U. S. about 20 inches above the B. M.	22.8393	7
T. B. M. 90	Is 7,020 feet below Washington, 300 feet above mile post 53; being highest point in square cut on natural ledge.	22.9791	7
P. B. M. 50	Is in Washington, 900 feet below depot, on south side of water works pump house, 9 feet from southwest corner of building; being center of punch mark in copper bolt leaded horizontally into window sill.	24.3583	7
T. B. M. 92	Is in Washington on east end of door sill of south entrance to pumping station, 900 feet below depot; being the highest point in square.	23.5536	7
T. B. M. 93 = old B. M. 74 of 1879.	Is in Washington, on southeast corner of Front and Elm streets, on northwest corner of water table of three-story brick building; being top of chamfered edge of water table (not a very definite point.)	25.2089	8
T. B. M. 94 = old B. M. 75 of 1879.	Is in Washington, at southwest corner of Front and Elm streets; being highest point in square on north end of north doorstep on Elm street.	25.5906	8
U. S. C. S. B. M., L. 3. Washington.	Is in Washington on east side of German Catholic Church, on top of water table, 2 feet north of fourth window from north end of building; being bottom surface of square cavity marked— B. □ M. U. S. C. & G. S. = L. 3 1882.	40.2762	13
T. B. M. 95	Is in Washington, on south side of Front street, about 400 feet west of depot, on top of stone retaining wall under fence, on north side of William Miller's lot, 30 feet east of main entrance to house, 3 feet east of entrance to barnyard east of house; being highest point in square marked U. □ S.	25.7975	8
P. B. M. 51 = [illegible]	Is in Washington, at northwest corner of William Miller's dooryard, on south side of Front street, and 545 feet N., 71° 40′ W. (mag.). from west end of railroad station, 5 feet southeast from corner post of fence; being copper bolt in B. M. stone.	25.0078	8
Top of cap	Over P. B. M. 51	26.2448	8
T. B. M. 96 = old B. M. 42.	Is 3,855 feet above Washington Depot, on north end of east abutment of bridge, at angle in masonry formed by wing wall; being highest point in square near corner.	23.3788	7
T. B. M. 97	Is 1 mile above Washington, 200 feet above sign marked "Water Station 1 mile," on south side of track, east end of culvert, on third course of masonry from top; being highest point in square cut on southwest corner of stone.	23.8642	
P. B. M. 52	Is 2 miles above Washington, 2,214 feet below bridge over St. Johns Creek, at lower side of coulee, 125 feet below point of bluff, 35 feet below point where vertical ledge begins to run parallel to track on bluff side of track, 11.5 feet from center and 4.5 feet above grade, being center of punch mark in copper bolt leaded horizontally into natural ledge.	26.6993	
T. B. M. 98	Is 2 miles above Washington, 2,230 feet below bridge over St. Johns Creek, at upper end of rock cut, on bluff side of track 9 feet from center; being highest point in square cut on natural ledge.	25.3723	
P. B. M. 53	Is 2¼ miles above Washington, 1,445 feet below east end of bridge over St. Johns Creek, 1 foot inside of south right of way fence, 40 feet from center of track, opposite a farm crossing, at intersection of north and south rail fence with right of way fence, and 4 feet west of gate opening into field; being copper bolt in B. M. stone.	22.6415	
Top of cap	Over P. B. M. 53	23.8763	
T. B. M. 99 = old B. M. 43.	Is 2½ miles above Washington, on abutment at west end of plate girder span at west end of railroad bridge across St. Johns Creek, being highest point in square cut on southwest corner of bridge seat course.	23.9255	
T. B. M. 100	Is 2¾ miles above Washington, 150 feet above upper head block of Hootan siding, bluff side of track; being highest point in square cut on natural ledge.	25.8912	

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 54=Y	Is 3¼ miles below Dundee, 2,261 feet below mile post 59, 1,345 feet below sign post marked "½ mile to Dewey," 295 feet above upper head block of Dewey Siding, at farm crossing, one foot inside of south right of way fence, 34 feet from center of track, 12 feet west of gate; being copper bolt in B. M. stone.	25.2076	82.703
Top of cap	Over P. B. M. 54.	26.4147	86.662
T. B. M. 105	Is 1½ miles below Dundee Station, 1,289 feet below sign post marked "1 mile to station," 1,552 feet below mile post 61, on southeast corner of south wall of stone culvert; being highest point in square.	25.3929	83.310
P. B. M. 55	Is 1¼ miles below Dundee Station, 1,467 feet below mile post 61, 1,194 feet below post marked "1 mile to station," 85 feet above stone culvert, 1 foot inside of south right of way fence, 24 feet from center of track; being copper bolt in B. M. stone.	25.8844	84.924
Top of cap	Over P. B. M. 55.	27.1174	88.969
T. B. M. 106	Is 2,959 feet below Dundee Station, 360 feet below head block at east end of siding, 1,575 feet above mile post 61, at lower end of side hill rock cut on Missouri Pacific Rwy., bluff side of track, 9 feet from center and level with top of rail; being highest point in square cut on natural ledge.	26.8234	88.004
P. B. M. 56	Is 2,950 feet below Dundee Station, 400 feet below point of bluff and lower side of coulee, 200 feet below head block at east end of siding, 325 feet above small coulee, bluff side of track, 10 feet from center and 4 feet above grade; being center of punch mark in copper bolt leaded horizontally into vertical ledge.	27.9780	91.792
P. B. M. 57=Y Dundee.	Is in Dundee, 1,640 feet below east end of tunnel, at north fence of small field owned by S. S. Baily, 120 feet south of railroad track, 12 feet southwest of honey locust; being copper bolt in B. M. stone.	21.1772	69.480
Top of cap	Over P. B. M. 57.	22.4168	73.546
T. B. M. 108=Old B. M. 46 (*b*).	Is in Dundee, 328 feet below east end of tunnel, bluff side of track, 18.4 feet from center of southwest corner, west end of coping stone of east retaining wall of arch culvert over Little Bœuf Creek; being highest point in square.	24.9140	81.740
T. B. M. 107=Old R. B. M.	Is in Dundee, on same arch culvert over Little Bœuf Creek, north side of track; being the highest point in square formed on southeast quarter of cross and marked B. [1] M.	26.7679	87.822
T. B. M. 109=Old B. M. 46.	Is in Dundee, 328 feet below east end of tunnel, bluff side of track, 9.2 feet from center, southeast corner east end of coping stone over arch culvert over Little Bœuf Creek; being highest point in square.	26.7869	87.884
T. B. M. 110	Is at Kent siding, seven-eighths mile above Dundee, on bluff side of track, 21.3 feet from center of main track; being the highest point in square cut on southeast corner of masonry over tile drain under track, 490 feet above sign post marked "Kent."	26.6921	87.573
T. B. M. 111=Old B. M. 47.	Is 1¼ miles above Dundee, three-eighths mile above Kent, on northeast corner of east abutment of through railroad Bridge No. 16, Missouri Pacific Rwy. over River au Bœuf; being the highest point in square cut on northeast corner of coping stone.	26.6241	87.350
T. B. M. 112	Is 3½ miles below New Haven, 1,640 feet below sign post marked "Kent ½ mile," 1,257 feet below milepost 64, 262 feet above farm crossing, bluff side of track, 9 feet from center and 6 inches below top of rail; being highest point in square cut in natural ledge.	27.4586	90.088
P. B. M. 58	Is 2$\frac{7}{16}$ miles below New Haven, 2,713 feet below milepost 65, west side of coulee, at south right of way fence, 32 feet from center of track, 3 feet west of intersection of north and south rail fence with right of way fence; being copper bolt in B. M. stone.	27.9234	91.613
Top of cap	Over P. B. M. 58.	29.1617	95.676
T. B. M. 113	Is 2¾ miles below New Haven, 2,156 feet below milepost 65, on bluff side of track, 6 feet from center; being highest point in square cut on imbedded stone.	27.5082	90.251
P. B. M. 59	Is 1½ miles below New Haven, near center of siding, 633 feet from west head block, on bluff side of track, 9 feet from center and 3½ feet above the rail; being center of punch mark in copper bolt leaded horizontally into natural ledge.	29.1258	95.558
T. B. M. 114	Is 1½ miles below New Haven, 636 feet below west head block of siding, on bluff side of track, 9 feet from center and 1½ feet above the rail; being the highest point in square cut on natural ledge and marked 'U. S.,' in large letters facing the track.	28.5082	93.532

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 60=[illegible]	Is in New Haven, at west side, 5 feet from doorway of three-story brick building now owned by Mr. W. G. Warenken, on corner of Olive street and rail oad; being copper bolt in B. M. stone.	27.5977	90.544
Top of cap.........	Over P. B. M. 60 (the cap is about even with the top of the sidewalk).	28.8383	94.615
T. P. M. 115...... New Haven.	Is in New Haven, on three-story brick building owned by Mr. W. G. Warenken, corner of Olive street and railroad, on north side of building, 2.5 feet from northwest corner, being the highest point in square cut on top of water table.	29.2050	95.818
T. B. M. 116	Is in New Haven, 492 feet above the depot, on north end of east abutment of railroad culvert; being the highest point in square cut into bridge seat course of masonry, 14 inches from north end, and 25 inches from west face of stone.	28.0607	92.063
P. B. M. 61	Is $1\frac{3}{4}$ miles above New Haven, 100 feet below lower side of coulée, at point where river and bluff meet, 25 feet below center of arch culvert, on bluff side of track, 14 feet from center and $3\frac{1}{2}$ feet above grade; being center of punch mark in copper bolt leaded horizontally into vertical ledge.	30.2883	99.372
T. B. M. 118.......	Is $1\frac{7}{8}$ miles below Etlah, at point where river comes back to the bluff, 1,827 feet below milepost 69, at upper end of sidehill rock cut, on south wall of arch culvert, over center of arch; being highest point in square.	28.7838	94.436
P. B. M. 62	Is $1\frac{3}{4}$ miles below Etlah, 948 feet below mile post 69, 879 feet above stone arch culvert on west side of coulee, at south right-of-way fence, 32 feet from center of track; being copper bolt in B. M. stone.	28.1909	92.491
Top of cap........	Over P. B. M. 62	29.4308	96.558
T. B. M. 119	Is 6,168 feet below Etlah Station, 2,010 feet above milepost 69, on south end of west wall of open culvert; being the highest point in square.	28.9800	95.080
T. B. M. 120	Is 2,372 feet below depot at Etlah, about 328 feet below head-block at east end of siding, 380 feet above mile post 70, on bluff side of track, 8 feet from center, being highest point in square cut on imbedded rock.	28.9378	94.941
U. S. C. S. B. M. XIV.	Is 1,060 feet below depot at Etlah, on north end of east abutment of double track open culvert "F_2" and marked in small letters U S / I □ M / XIV	29.1554	95.655
T. B. M. 121	Is 656 feet above depot at Etlah, on south side of track, about 75 feet from center, opposite road crossing; being spike in east root of stump.	28.4023	93.184
P. B. M. 63 [illegible]... Etlah.	Is 672 feet above depot at Etlah, 60 feet west of road crossing, 40 feet south of track, in corner of fence made by right-of-way fence and fence on west side of public road; being copper bolt in B. M. stone.	29.7898	97.736
Top of cap.........	over P. B. M. 63	31.0320	101.812
T. B. M. 122	Is one mile above Etlah, 1,850 feet below small iron bridge, 225 feet below post marked "Water station one mile," on bluff side of track 8 feet from center, on same elevation as rail; being highest point in squarecut on large imbedded piece of ledge, about 6 inches from edge.	29.5285	96.879
T. B. M. 123 old R. R. B. M.	Is about $1\frac{3}{8}$ miles above Etlah, on south end of east abutment, bridge seat course, of iron bridge across Berger Creek; being highest point in square found on northeast quarter of cross and marked B. ⊡ M.	28.3888	93.140
T. B. M. 125	Is $2\frac{1}{4}$ miles below Berger, 1,584 feet below milepost 73, at farm crossing, on bluff side of track, 23 feet from center and 2 feet above rail; being highest point in square cut on natural ledge.	29.7975	97.762
P. B. M. 64..........	Is $2\frac{1}{4}$ miles below Berger 1,535 feet below milepost 73, 60 feet above farm crossing, about 75 feet south of Missouri Pacific track, at foot of hill, 5 feet south of east end of gate on private road; being copper bolt in B. M. stone.	30.6564	100.580
Top of cap	Over P. B. M. 64..	31.8884	104.622
T. B. M. 126	Is $2\frac{1}{16}$ miles below Berger, 682 feet below milepost 73, at lower end of rock cut, on bluff side of track, 10 feet from center and 1 foot below top of rail; being highest point in square cut on natural ledge.	29.0941	95.454
P. B. M. 65	Is $2\frac{1}{16}$ miles below Berger, 604 feet below milepost 73, 165 feet above farm crossing on west side of wide coulée at lower end of sidehill work, on bluff side of track 13 feet from center and 4 feet above the rail, 15 inches west of drill scar; being center of punch mark in copper bolt leaded horizontally into vertical ledge.	30.8671	101.271

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
T. B. M. 127	Is 1 mile below Berger, 990 feet above post marked "One mile to station," on 3.5 foot white oak, 25 feet east of small field and 105 feet south of railroad on west side of small ravine; being top of spike in north root.	31.2597	102.559
U. S. C. S. B. M. XV, Berger.	Is in Berger, on east side of Main street and north of Missouri Pacific Rys., 3.3 feet north of southwest corner of Mrs. M. M. Schaub's house; being bottom surface of square cavity cut into top of a stone post 6 inches square planted in the ground and marked U. S. B. □ M.	29.9041	98.112
P. B. M. 66 = 29	Is in Berger, in southwest corner of Mrs. Schaub's yard, 8 feet west of house, 16 feet north of south fence line, and 5 feet east from west fence line; being copper bolt in B. M. stone.	28.7356	94.278
Top of cap	Over P. B. M. 66	29.9723	98.335
T. B. M. 128	Is one mile above Berger, 475 feet below bridge "F_3," on bluff side of track, 4 feet from rail and about 1 foot below grade; being highest point in square cut on imbedded rock.	29.6940	97.422
P. B. M. 67	Is $4\frac{1}{10}$ miles below Hermann depot, [illegible],870 feet above bridge over Little Berger Creek, 2,395 feet below post set on county line at road crossing, on upper side of small valley, at foot of bluff just outside of right-of-way fence, on south side of track, 56 feet from center and 2 feet east of gate, on land owned by Charley Burns; being copper bolt in B. M. stone.	28.6127	93.874
Top of cap	Over P. B. M. 67	29.8520	97.940
T. B. M. 129	Is $4\frac{1}{10}$ miles below depot at Hermann, 2,277 feet below post set on county line, at lower end of bluff, 110 feet above road crossing, on south side of track, 8 feet from center on level with rail; being highest point in square cut on natural ledge and marked U. □ S.	29.8468	97.923
T. B. M. 130	Is $3\frac{1}{4}$ miles below depot at Hermann, 2,526 feet above sign-board on county line, on bluff side of track, $7\frac{1}{2}$ feet from center and 18 inches above rail; being highest point in square cut on imbedded stone, and marked U. S. in large letters.	30.9058	101.398
P. B. M. 68	Is $1\frac{1}{2}$ miles below depot at Hermann, at lower side of wide valley, 1,115 feet above road crossing, 66 feet below wooded point of bluff, on bluff side of the track 50 feet from center, on land of Tobias Larcer; being copper bolt in B. M. stone.	29.7045	97.456
Top of cap	Over P. B. M. 68	30.9398	101.509
T. B. M. 132	Is 8,809 feet below depot at Hermann, at lower side of small coulee, on river side of Missouri Pacific track, 11.5 feet from center, in stone over center of stone culvert; being the highest point in square.	29.9654	98.312
P. B. M. 69	Is 2,290 feet below depot at Hermann, 338 feet below upper end of bluff, opposite watchman's house on river bank, 425 feet below road crossing, on bluff side of track 17 feet from center and 4 feet above rail, 8 inches west of drill scar in rock face of cut; being center of punch mark in copper bolt leaded horizontally into natural ledge.	32.0563	105.173
T. B. M. 133	Is 2,297 feet below depot at Hermann, 31 feet below P. B. M. 69, 6 inches below base of rail; being highest point in square cut on natural ledge at foot of vertical face of bluff.	30.7963	101.039
P. B. M. 70 = 31	Is in Hermann, in lot of August Wholts, on north side of Front street, 450 feet below railroad bridge over Frame Creek and about 140 feet south of railroad; being copper bolt in B. M. stone.	29.6591	97.308
Top of cap	Over P. B. M. 70	30.8930	101.356
P. B. M. 71	Is in Hermann, on north end of east abutment of bridge over Frame Creek, on northwest corner of bridge seat, 5 feet below the track and [illegible] inches from either face of corner stone; being the top of copper bolt leaded vertically.	29.6044	97.128
U. S. C. S. B. M. N_3 Hermann.	Is in Hermann, 15 inches east of northeast corner of stone foundation of White House hotel; being the center of a cross cut into vertical face of foundation, and marked U S B + M N_3 1888	32.3103	106.006
T. B. M. 135	Is in Hermann, on north side of White House hotel, on northeast corner of lower step of east entrance, 8 feet west of northeast corner of building; being the highest point in square.	32.0743	105.232
P. B. M. 72 = old B. M. 50.	Is at point of bluff at upper end of Hermann, 1,148 feet above depot, at lower end of rock cut, on bluff side of track, 10 feet from center and 1 foot above grade, 6 feet west of cattle-guard fence; being horizontal furrow in copper bolt leaded horizontally into natural ledge.	31.5883	103.637

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
P. B. M. 73	Is 1¼ miles above Hermann, 164 feet above post marked "One mile to station," in southeast corner of Wm. Streker s garden, 7 feet east of northeast corner of house and about 110 feet south of railroad track; being copper bolt in B. M. stone.	33.3687	109.478
Top of cap	Over P. B. M. 73	34.6083	113.545
T. B. M. 136	Is 1¼ miles above Hermann, 358 feet above post marked "One mile to station," on south end of east abutment of small bridge, on top course of masonry, 10 inches from each face; being the highest point in square, marked U. □ S.	31.5464	103.500
T. B. M. 137	Is 2,215 feet below bridge "F_4" Missouri Pacific Rwy., 919 feet below small bridge, at lower side of small coulee, bluff side of track 22 feet from center, about 1 foot above grade; being the highest point in square on rock marked U. □ S.	33.0534	108.444
P. B. M. 74	Is 2 miles above Hermann on north end of east abutment of bridge "F_4," on second course of masonry from top, 10 inches from north end of stone; being top of copper bolt leaded vertically.	31.4463	103.171
U. S. C. S. B. M. XVI. Coles Creek.	Is on north end of east abutment of bridge over Coles Creek; being bottom surface of square cavity in top course of masonry marked U □ S B M	33.3501	109.417
T. B. M. 139	Is 3 miles below Gasconade Bridge, 3,143 feet above bridge over Coles Creek, 413 feet below small open culvert, on bluff side of track 9 feet from center, 6 inches above grade; being highest point in square on imbedded rock marked U. □ S.	34.0924	111.853
T. B. M. 141	Is 1¾ miles below Gasconade Bridge, on north end west abutment of small bridge, about 500 feet above prominent sand stone point in bluff; being highest point in square.	33.5344	110.022
P. B. M. 75=¾²	Is 2¼ miles below Gasconade Bridge, 46 feet east of arch culvert, 3,458 feet below milepost 86, at west fence of Frank Berke's garden (inside) and about 70 feet south from Missouri Pacific Rwy. track; being copper bolt in B. M. Stone.	33.5516	110.078
Top of cap	Over P. B. M. 75	34.7894	114.140
T. B. M. 140	Is 2¼ miles below Gasconade Bridge, 3,419 feet below milepost 86, on east end of south wall of stone arch culvert near Frank Berke's house on southeast corner of large sand stone; being the highest point in square.	31.4437	103.162
P. B. M. 76	Is 1½ miles below Gasconade Bridge, at lower side of coulee and in front of John Uffelman's house, on bluff side of track 31 feet from the center, 10 feet south of right of way fence, 1 foot west of rail fence running south over the bluff; being copper bolt in B. M. stone.	32.6793	107.217
Top of cap	Over P. B. M. 76	33.9151	111.271
T. B. M. 142=Old R. R. B. M.	Is 7,628 feet below Gasconade Bridge, on north end of stone culvert under Missouri Pacific Rwy., near north-west corner; being the highest point in square formed on one angle of a cross and marked B. ⊡ M.	31.9557	104.842
T. B. M. 143	Is 4,265 feet below bridge across the Gasconade River, 300 feet above milepost 87, Missouri Pacific Rwy., 200 feet below signpost marked "Station 1 mile," 7 feet below small boxdrain under track, on projecting rock 1 foot above grade, 11.8 feet from center, on bluff side of track; being highest point in square.	34.3198	112.599
T. B. M. 144, Gasconade survey B. M. of 1879.	Is in Gasconade, on south end of first pier from east end of bridge across the Gasconade River; being the highest point of spherical knob cut in stone, 4½ feet from south corner of stone and marked B. M. 6 inches away from point.	33.5662	110.126
U. S. C. S. B. M. XVII.	Is in Gasconade, on middle pier of bridge across the Gasconade River, on south side of track, 6 inches from south end of pier; being bottom surface of a square cavity, marked U. □ S. B. M.	33.5947	110.220
P. B. M. 77	Is in Gasconade, on north end of first pier from the west end of bridge across the Gasconade River, 6 inches south of north end of pier; being top of copper bolt leaded vertically.	33.5628	110.115
U. S. C. S. B. M., XVIII. Gasconade.	Is in Gasconade, at southeast corner of J. Walter's house, south side, 2 feet from the corner, 200 feet south of east end of station house; being the bottom surface of a square cavity cut into the top of a limestone post 6 inches square, set into the ground and marked U. □ S. B. M.	34.5299	113.288

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
T. B. M. 145	Is 1¼ miles above Gasconade, 620 feet above post marked, "1 mile to water tank," on bluff side of track 6.5 feet from center and 3 inches above rail; being highest point in square cut on natural ledge and marked U.□S.	34.3268	112.622
T. B. M. 146	Is 1½ miles above Gasconade, 33 feet below post marked, "1 mile to station," on east end of south wall of culvert; being the highest point in square.	31.6918	103.977
P. B. M. 78=$\frac{23}{1}$	Is 1½ miles above Gasconade, 78 feet above post marked, "1 mile to station," inside of north fence of Nicholas Wolz's dooryard, 157 feet from center of track and 10 feet east of small yard gate; being copper bolt in B. M. stone.	34.5433	113.332
Top of cap	Over P. B. M. 78	35.7808	117.392
P. B. M. 79	Is 2 miles above Gasconade, near upper side of coulee, on south end of west abutment, in bridge seat course of bridge "F. G." on Missouri Pacific Rwy., 7 feet from center of track; being top of copper bolt leaded vertically into stone.	33.5336	110.019
T. B. M. 148	Is 1¾ miles below Morrison, on north end of east abutment of bridge "G," on north end of bridge seat about 1 foot from corner of stone; being the highest point in square.	33.4235	109.658
T. B. M. 149=Old R. R. B. M.	Is 4,855 feet below depot at Morrison, on north end of east abutment of culvert; being the highest point in square formed on northeast quarter of cross and marked B.┼□M.	33.9943	111.531
P. B. M. 80	Is 1,008 feet below Morrison depot 869 feet above lower head block of siding, on point of bluff at lower side of coulee and 275 feet below whistle post, 35 feet south of siding, 2 feet north of right-of-way fence, opposite a two story frame house standing 400 feet north of track; being copper bolt in B. M. stone.	34.6929	113.823
Top of cap	Over P. B. M. 80	35.9308	117.884
P. B. M. 81	Is 1,427 feet below Morrison, 115 feet below whistle post, 150 feet above point of bluff and small coulee, on bluff side of Missouri Pacific Rwy. track, 12 feet from center of siding and 4 feet above grade; being center of punch mark in copper bolt leaded horizontally into vertical face of natural ledge.	36.0907	118.408
T. B. M. 150	Is 1,427 feet below Morrison depot, 115 feet below whistle post, at upper side of first coulee below station, 140 feet above point of bluff, on bluff side of track, 12 feet from center of siding, on same elevation as base of rail; being highest point in square cut on natural ledge, 3 feet east of P. B. M. 80.	34.9875	114.790
U. S. C. S. B. M. XIX. Morrison.	Is in Morrison, on north side of foundation, near northeast corner of H. Brinkhotters & Co.'s grain elevator standing on south side of track, about 150 feet west of depot; being the bottom surface of a square cavity, marked U.□S. B.□M.	34.6647	113.730
T. B. M. 151	Is 4,593 feet above Morrison, on west wall of open culvert over wagon road, on second course of masonry from top, south side of Missouri Pacific track; being highest point in square, 20 inches from south corner and 9 inches from east face of stone.	34.0822	111.819
P. B. M. 82	Is 1½ miles above Morrison, 1,427 feet above milepost 94, at west end of only bare spot of bluff in vicinity, on bluff side of track, 13 feet from center and about 3 feet above grade; being center of punch mark in copper bolt leaded horizontally into natural ledge.	36.5688	119.978
P. B. M. 83=$\frac{24}{1}$	Is 2¼ miles above Morrison, 1,542 feet below milepost 95, 50 feet west of bridge "H I" over road, at south fence of Missouri Pacific right of way, 21 feet from center of track, at foot of bluff, on west side of coulee; being copper bolt in B. M. stone.	36.3090	119.125
Top of cap	Over P. B. M. 83	37.5458	123.183
T. B. M. 153	Is 2½ miles above Morrison, 1,597 feet below milepost 95, on south end of east abutment of small bridge "H I" over road; being highest point in square on top stone of wing wall.	36.4162	119.477
T. B. M. 154	Is 4½ miles below Chamois, 3,228 feet below mile post 96, Missouri Pacific Rwy., on east end of south wall of stone arch culvert, being highest point in square.	35.1958	115.473
T. B. M. 155	Is 3 miles below Chamois, 105 feet below lower head block of Portage siding, Missouri Pacific Rwy in center of stone at north end of west abutment of bridge "I"; being highest point in square marked U.□S.	35.5140	116.516
P. B. M. 84 Portage.	Is 2¼ miles below Chamois, 275 feet above upper head block of Portage siding, 15 feet below small bridge, on bluff side of track, 45 feet from the center; being copper bolt in B. M. stone.	34.8114	114.211
Top of cap	Over P. B. M. 84.	36.0494	118.274

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 157	Is on right bank, 1⅜ miles below Chamois, Osage County, Mo., 360 feet above milepost 98, Missouri Pacific Rwy., 85 feet above signboard marked "Portage 1 mile," on bluff side of track, 12 feet from center and 3 feet above grade. It is 246 feet below upper end of side hill cut; being highest point in square cut on projecting point of natural ledge.	38.3996	125.984
T. B. M. 158	Is ⅞ mile below Chamois depot, 410 feet above road crossing, 60 feet above milepost 99, 70 feet below sign marked "Yard Limits," on extreme north end of west abutment of small bridge, 2 feet from north edge of stone, 20 feet from center of track; being highest point in square, cut on masonry.	36.1642	118.650
P. B. M. 85	Is in Chamois, in south end of stone doorstep at east door of saloon on southwest corner of Maine and Pacific streets; being top of copper bolt leaded vertically.	37.8772	124.270
P. B. M. 86 = $^{23}_{1}$ Chamois.	Is in Chamois, 544 feet north of railroad station, in southwest corner of lot to brick residence owned by William Cochran, on east side of Main street; being copper bolt in B. M. stone.	35.5654	116.685
Top of cap	Over P. B. M. 86	36.8083	120.763
U. S. C. S. B. M. O_3	Is in Chamois, on stone doorstep at side door of two-story brick saloon on northwest corner of Maine and Pacific streets; being bottom surface of square cavity marked U. S. B. M. O_3 1888.	37.3765	122.628
T. B. M. 160. = old R. R. B. M.	Is 2 miles above Chamois, 480 feet below milepost 102, at north end of east abutment of bridge "K;" being highest point in square formed on angle of cross and marked U. S. B. M.	37.0337	121.503
P. B. M. 87	Is 1⅛ miles below Deer Creek, 3 miles above Chamois, on lower side of coulée, 20 feet from foot of bluff, 35 feet from center of track, in angle of fence formed by right-of-way fence turning south over bluff; being copper bolt in B. M. stone.	37.5224	123.106
Top of cap	Over P. B. M. 87	38.7603	127.187
T. B. M. 161	Is 30 feet west of P. B. M. 87; being highest point in square cut on large stone.	38.9854	127.906
P. B. M. 88	Is about 3¼ miles above Chamois Depot, 1 mile below Deer Creek, opposite center of large coulée 200 feet above log house 200 feet south of railroad, on north end of west abutment of small bridge over road, on fourth course of stone below bridge seat; being top of copper bolt leaded vertically.	36.2349	118.882
P. B. M. 89. = old B. M. 74.	Is 1½ miles below St. Aubert Station Depot, on south end of east abutment of bridge over Deer Creek, at lower side of wide coulée; being horizontal furrow in copper bolt leaded horizontally into first course of masonry below bridge seat course.	35.4122	116.18
T. B. M. 163	Is 1½ miles below St. Aubert Station Depot, on south end of east abutment of iron bridge over Deer Creek, at lower side of wide coulée; being highest point in square cut on end projecting stone on course next above bridge seat course.	36.4401	119.55
T. B. M. 164	Is ⅝ mile below St. Aubert Station Depot 235 feet below head-block of siding, bluff side of Missouri Pacific track, 15 feet from center; being highest point in square on projecting ledge.	38.6002	126.64
P. B. M. 90 = $^{26}_{1}$ St. Aubert.	Is in St. Aubert, on northwest corner of Main and Morrow streets, inside of fence, 300 feet from depot; being copper bolt in B. M. stone.	38.6324	126.74
Top of cap	Over P. B. M. 90	39.8744	130.8
U. S. C. S. B. M. XX.	Is in St. Aubert, on south end of east abutment of bridge No. 25; being bottom surface of square cavity marked U. S. B. M.	38.1499	125.1
P. B. M. 91 Shipley Landing	Is at Shipley Landing, 250 feet below bridge 27, at foot of west end of bluff east side of coulée, at fence corner, 1⅓ feet inside of right of way; being copper bolt in B. M. stone.	37.9814	124.61
Top of cap	Over P. B. M. 91	39.2200	128.67
T. B. M. 167	Is at Shipley Landing, 1⅜ miles below Isbell on north end of east abutment of bridge No. 27; being highest point in square marked U. S.	39.5069	129.61
T. B. M. 168	Is 1,800 feet below east end of Loose Creek Bridge, at upper end of first cut below bridge, bluff side of track, 10 feet from center and 2 feet above grade; being highest point in square cut on projecting point of ledge, with letters "U. S." cut on vertical face below the bench.	40.5924	133.17

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
U. S. C. S. B. M. XXII destroyed. Loose Creek.	Is 1,640 feet below Isbell Depot, on north end of east abutment of iron bridge over Loose Creek, 2 feet from west face and 6 inches from north end of abutment; being bottom surface of square cavity marked U. S. B. M.	38.4794	126.246
P. B. M. 92=[illegible] Isbell.	Is at Isbell, 295 feet below center of depot, 300 feet above runway to stock yards, bluff side of track, 35 feet from center, 1½ feet north of right-of-way fence; being copper bolt in B. M. stone.	35.7974	117.446
Top of cap	Over P. B. M. 92	37.0309	121.493
P. B. M. 93	Is at Isbell, 165 feet above depot, 60 feet above lower end of cut, 15 feet above head block of siding, bluff side Missouri Pacific track, 11.4 feet from center and 3 feet above grade; being center of punch mark in copper bolt leaded horizontally into natural ledge.	41.1460	134.975
T. B. M. 169	Is at Isbell, 165 feet above west end of depot, 60 feet above lower end of cut, 15 feet above head block of siding on bluff side of Missouri Pacific track, 10.8 feet from center; being highest point in square cut on natural ledge at about the elevation of grade.	40.3412	132.354
T. B. M. 170	Is 1 mile above Isbell Depot, 245 feet below bare face of ledge, 1,030 feet above sign "Station one mile," on bluff side of track, 9.5 feet from center; being highest point in square cut on point of projecting ledge, 2 feet above grade and marked U. S.	41.8228	137.215
T. B. M. 171=old R. R. B. M.	Is about 2½ miles below Bonnots Mill, on northwest corner of east abutment of small bridge opposite center of coulée; being highest point in square formed on south-east angle of cross and marked B. M.	39.0990	128.279
P. B. M. 94	Is 1¾ miles below Bonnots Mill Depot, at upper side of coulee, bluff side of Missouri Pacific track, 60 feet from center, 30 feet above bridge "N_2" on top of projecting ridge, 20 feet south of south right-of-way fence; being copper bolt in B. M. stone.	37.1024	121.728
Top of cap	Over P. B. M. 94	38.3378	125.781
T. B. M. 172	Is in same locality as P. B. M. 94, on south end of west abutment to bridge "N_2" at upper side of coulée; being highest point in square cut on third course of stone from top.	38.2139	125.375
T. B. M. 173	Is ¾ miles below Bonnots Mill Depot, on river side of Missouri Pacific track, 11 feet from center, in a small thorough cut; being highest point in square cut on imbedded stone.	40.1502	131.728
T. B. M. 174	Is at Bonnots Mill, 65 feet east of door of depot and 10 feet south of center of siding; being highest point in square cut on top of foundation at northeast corner of warehouse.	40.3911	132.518
U. S. C. S. B. M. P_3 Bonnots Mill.	Is at Bonnots Mill, 92 feet south of railroad track, at northwest corner of brick store owned by Mrs. L. Bonnot; being bottom surface of square cavity cut in top of water-table, which is marked U. S. B. M. P_3 1888.	42.2442	138.598
T. B. M. 175=old R. R. B. M.	Is in Bonnots Mill, on south end of east abutment to bridge No. "P."; being highest point in square formed on angle of cross, marked B. M.	39.8137	130.623
P. B. M. 95=[illegible]	Is in Bonnots Mill, 700 feet west of station, 210 feet west of bridge No. "P," 45 feet above mill and on opposite side of track, on line with north right-of-way fence; being copper bolt in B. M. stone.	36.1777	118.694
Top of cap	Over P. B. M. 95.	37.4167	122.759
T. B. M. 178=old B. M. 81.	Is 2¾ miles below east end of Osage Bridge, on northwest stone column to bridge No. 29 over Evans Creek, Missouri Pacific Railway, being highest point in base of "U" cut on southwest corner of capstone.	39.8558	130.761
T. B. M. 177=old B. M. 80.	Is near T. B. M. 178, in column at northeast corner of bridge No. 29; being highest point in square cut on northeast corner of capstone, and marked U. S.	39.8796	130.840
P. B. M. 96	Is 1½ miles above Bonnots Mill, 815 feet above bridge No. 29, 250 feet above point of bluff, on bluff side of track, 9.2 feet from center and 2 feet above grade; being center of punch mark in copper bolt leaded horizontally.	41.1255	134.927
T. B. M. 179	Is 2½ miles below east end of Osage Bridge, 295 feet above milepost 114, on downstream abutment of small bridge on end of second course of stone from top next to river, 14 feet from center of track; being highest point in square marked U. S.	39.2558	128.728
P. B. M. 97	Is 1¾ miles below Osage City, 45 feet below bridge "P_2," on bluff side of Missouri Pacific track, 43 feet from center, 3 feet outside of right of way fence; being copper bolt in B. M. stone.	38.2560	125.513

Descriptions and elevations of precise level bench marks, etc.—**Continued.**

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M. 97	39.4977	129.587
T. B. M. 180 = old R. R. B. M.	Is 1⅞ miles below Osage City, on north end of east abutment of bridge "P_2" Missouri Pacific Railway; being highest point in square formed on one angle of cross marked B. M. U. S.	39.6918	130.221
P. B. M. 98	Is at Osage City, on north end of east abutment of iron railroad bridge over the Osage River, 16 inches from north end and 9 inches from west face of abutment; being top of copper bolt leaded vertically into coping.	40.5373	132.998
T. B. M. 182 — old R. R. B. M.	Is on south end of east abutment of iron bridge over Osage River; being highest point at extreme southeast corner of coping stone, and marked B. M.	40.5427	133.015
P. B. M. 99 Osage City.	Is in Osage City, 60 feet below depot, on line with north side of same, on line of fence running east from depot, 12 feet south of center of siding, 55 feet above west end of ice house; being copper bolt in B. M. stone.	40.9451	134.336
Top of cap	Over P. B. M. 99	42.1842	138.401
U. S. C. S. B. M. XXIV.	Is in Osage City, on north side of railroad track, in front of Russler's Hotel, at southwest corner of front door yard and on line with west side of house, 1 foot north of fence line; being bottom surface of square cavity cut into top face of stone monument 6 inches square, and projecting above ground about 3 inches, and marked U. S. B. M.	40.5935	133.182
T. B. M. 183	Is in Osage City on west side of upper water tank, on top of wall, near middle, forming foundation for tank, and 8.8 feet from the south side of the tank; being highest point in square.	42.4452	139.257
T. B. M. 184, old R. R. B. M.	Is ¾ mile above Osage City, on east abutment of small bridge, 8 inches from face of abutment and 3 feet from north end; being highest point in square formed on one angle of cross marked B. M.	44.1698	144.915
T. B. M. 185	Is about 1¾ miles above Osage City, 262 feet below post marked "One mile to station," on bluff side of track, 5 feet inside of right of way; being top of spike in north root of a 2-foot black oak.	42.1737	139.351
U. S. C. S. B. M. XXV.	Is 2 miles above Osage City, at southwest corner of west abutment of bridge across Rising Creek; being bottom surface of square cavity, 1 inch square, marked U. S. B. M.	43.7669	143.593
P. B. M. 100 — [illegible]. Ewings Landing.	Is at upper end of U. S. boat yard, at west end of pond, 100 feet east of northeast corner of field, on line of prolongation of south road fence and about 400 feet from river; being copper bolt in B. M. stone.	39.1271	128.371
Top of cap	Over P. B. M. 100	40.3713	132.453
T. B. M. 186	Is 35 feet west of P. B. M. 100; being top of spike in west root of a 2 foot walnut.	40.0160	131.287
T. B. M. 187	Is five-eighths of a mile below Ewing Station, 918 feet above bridge over Rising Creek, 82 feet above mile-post 119, on river side of track, 20 feet outside of right of way; being top of spike in a 2-foot black oak.	44.1618	144.889
T. B. M. 188	Is 935 feet below upper head block at Ewings Siding, 655 feet below north and south lane, 125 feet below center head block, 6 feet south of south fence of lane running along south of track; being top of spike in a 2½-foot white oak.	47.5310	155.943
U. S. C. S. B. M. XXVI. Moreau River.	Is on north end of east abutment of railroad bridge over Moreau River; being bottom surface of square cavity cut in capstone and marked U. S. B. M.	52.0857	170.886
P. B. M. 101	Is at east end of Missouri Pacific tunnel, 3½ miles below Jefferson City depot, on south side of Missouri Pacific track and 4 feet above rail; being center of punch mark in copper bolt leaded horizontally into natural ledge.	51.0378	167.448
P. B. M. 102	Is 3½ miles below Jefferson City depot, 656 feet above mouth of Missouri Pacific tunnel, at lower end of short cut, on south side of Missouri Pacific track 39 feet from center, 239 feet below small open stone culvert; being copper bolt in B. M. stone.	47.9677	157.376
Top of cap	Over P. B. M. 102	49.2048	161.434
T. B. M. 190	Is 3½ miles below Jefferson City depot, 1,233 feet above tunnel, at lower end of side-hill cut, on bluff side of Missouri Pacific track 15 feet from center; being highest point in square cut on natural ledge.	48.0473	157.637
T. B. M. 191	Is 2¾ miles below Jefferson City, on north end of east abutment of bridge No. P_3, 1½ feet from both end and side of stone; being highest point in square marked U. S.	43.5326	142.825

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
T. B. M. 192	Is 1¾ miles below depot at Jefferson City at lower side of wide center, on south end of east abutment of bridge 34, over stream; marked B. M.	43.5373	142.840
P. B. M. 103	Is 1¾ miles below Jefferson City, 225 feet above bridge 34, where T. B. M. 192 is located, at large opening in bluff, on a high bench of ground, 35 feet from track on bluff side, 75 feet from a 10 inch white oak, blazed, and 13 feet north of south right of way fence; being copper bolt in B. M. stone.	40.9013	134.192
Top of cap	Over P. B. M. 103	42.1392	138.253
T. B. M. 193 = Old B. M. 88.	Is at Jefferson City, about 7,000 feet below capitol building, on southwest corner of coping of east abutment of small bridge of Missouri Pacific Railway.	43.5940	143.026
P. B. M. 104	Is three-fourths of a mile below Jefferson City depot, 125 feet above bridge and heavy stone work under track, 60 feet above point of bluff on upper side of coulee, at lower edge of large rock face of bluff, 10.2 feet from center of track 2.6 feet above grade; being center of punch mark in copper bolt leaded horizontally.	44.2959	145.329
T. B. M. 194	Is directly opposite P. B. M. 104, about 50 feet above extreme end of ledge; being highest point in square cut on ledge about level with grade of track.	43.4048	142.406
T. B. M. 195	Is in Jefferson City, at the southwest corner of Jefferson and West Water streets, 10 feet from the northeast corner of stone building, on top of rounding curb stone; being highest point in square.	43.1526	141.578
T. B. M. 196, Gauge B. M. 1st.	Is in Jefferson City, at the foot of Jefferson street, on Lohman's warehouse, on east end of east door sill.	43.2908	142.031
U. S. C. S. B. M. XXVII.	Is on top of east stone wall around capitol grounds north of the east main entrance to grounds, 8 inches south of the first incline of the top surface of wall; being the bottom surface of a square cavity one-fourth of an inch deep marked U. S. C. & G. S. B. M.	58.6883	192.549
U. S. C. S. B. M. in capitol.	Is in Jefferson City, at the northeast corner of capitol building, on the east face of the second course of stone from the ground, 10 inches from corner and 2 feet above ground, marked U. S. C. & G. S. B. M. on stone directly under cross.	65.1990	214.894
City B. M	Is in Jefferson City, at the southeast corner of Jefferson and High streets on door stone at the northeast entrance to Merchants Bank building, on northeast corner of stone, outside of pillar and next to sidewalk, marked ✝.	68.1791	223.688
Jefferson City datum.	Is taken as a point 200 feet below city B. M		23.688
T. B. M. 197	Is in Jefferson City on circular step in front of main entrance to capitol, on second step from the bottom, about 45 degrees around from north end of step, in center of the 5th stone from the north end; being highest point in square, marked U. S.	65.3087	214.269
P. B. M. 105	Is in Jefferson City, at the northeast corner of inclosure of capitol grounds in north face of stone corner column, in center of third course of stone from bottom; being center punch mark in copper bolt leaded horizontally.	44.5836	146.273
P. B. M. 106 = Old B. M. 90 (a). Jefferson City.	Is in Jefferson City in rock cut under Capitol Hill on south side of Missouri Pacific track, about 3 feet above grade; being horizontal furrow in copper bolt.	43.8207	143.770
T. B. M. 199	Is in Jefferson City, just above the west side of capitol grounds, on Missouri Pacific Railway, stone culvert No. 320, on northeast corner of wing wall, on north side of track; being highest point in square cut in top of stone.	43.0780	141.333
T. B. M. 198 = Old B. M. 90, (C)—Gauge B. M. 2nd.	Is in Jefferson City in same culvert as T. B. M. 199, 325 feet west of west end of capitol grounds, 20 feet east of foot of arch on north face of culvert, 0.2 foot below the top of eleventh course of masonry from top; being knob cut on projection of rock.	39.1036	128.284
Lower gauge	In Jefferson City, is at culvert where T. B. M. 199 and T. B. M. 198 are located, being a staff gauge in poor condition; elevation of its zero.	0.0576	0.189
T. B. M. 200	Is in Jefferson City at upper Ferry Landing, opposite W. J. Lemp's St. Louis Beer depot, 52 feet west of the southwest corner of warehouse of the Dalle Milling Co., formerly pork house; being highest point of square cut on natural ledge.	43.8979	144.023
T. M. 201 = Old B. M. 90 (*b*). gauge B. M. P. H.	Is near T. B. M. 200, 100 feet west of Dalle Milling Co.'s warehouse, 50 feet north of the Missouri Pacific Railway track, on vertical ledge of rock nearest the river, in an old cellar, 2 feet above ground; being knob cut on projection of ledge.	40.1407	131.696

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Upper gauge......	In Jefferson City, is just above T. B. M. 201 P. H., which is an inclined gauge, elevation of its zero.	+0.0678	+0.222
P. B. M. 107 $= {}^{30}_{1}$...	Is in Jefferson City, in the east corner of the fourth block above Capitol Square, opposite the Ferry Landing and 280 feet from the river, just below Lemp's St. Louis Beer depot; being copper bolt in B. M. stone.	42.6136	139.810
Top of cap.........	Over P. B. M. 107.	43.8514	143.871
T. B. M. 202.......	Is 282 feet west of city limit of Jefferson City, 60 feet below east end of pump house of waterworks, 275 feet above sign, "Jefferson City, one mile," 100 feet above head block of siding, and 6 feet south from center of siding; being square in point of ledge 1 foot above grade.	44.7230	146.730
P. B. M. 108.......	Is $2\frac{3}{4}$ miles above depot at Jefferson City, 197 feet below Missouri Pacific stone culvert, at point of bluff on lower side of coulee, on right of way at south fence, 35 feet south of center of track; being copper bolt in B. M. stone.	42.4416	139.245
Top of cap.........	Over P. B. M. 108.	43.6804	143.310
T. B. M. 203 = Old B. M.	Is on lower abutment of same culvert with T. B. M. 204, on north end at side of top course of stone; being southeast angle of cross.	42.9630	140.956
T. B. M. 204.......	Is on south end of stone culvert arched with brick, 197 feet above P. B. M. 108 on south end of culvert, on point of cap stone, being highest point in square marked U. □ S.	43.4774	142.644
P. B. M. 109.......	Is $\frac{3}{4}$ mile below Gray's Creek, 150 feet above upper end of long tangent above Jefferson City, 30 feet above telegraph pole bearing mile sign 128, 12.5 feet from track center, 492 feet below large rocks at upper end of riprap bank, 45 feet below a triangulation point, 4 feet above ground and $1\frac{1}{2}$ feet above grade of track; being center of punch mark in copper bolt leaded into vertical face of ledge.	45.6648	149.820
T. B. M. 205.......	Is directly under P. B. M. 109, on bluff side of track 12 feet from center, $1\frac{1}{2}$ feet below grade, on natural ledge; being highest point in square.	44.7409	146.789
T. B. M. 206.......	Is on line of Missouri Pacific Railway, 410 feet below mouth of Gray's Creek, 150 feet below whistle post, 15 feet below stone drain under track, on bluff side, 10 feet from center and 1 foot below grade; being square on point of ledge marked U. S. on face of rock just above.	44.8486	147.142
T. B. M. 207, old R. R. B. M. Grays Creek.	Is on west abutment of iron bridge across Gray's Creek, on downstream side of abutment; being highest point in square.	43.6916	143.346
P. B. M. 110 $= {}^{31}_{1}$....	Is about 2 miles above Jefferson City, 1,166 feet N. 87° 30′ W. (mag.) of west end of Missouri Pacific bridge over Gray's Creek, about 88 feet below gate to pasture at foot of bluff, on north side of wagon road in field, 10 feet from fence; being copper bolt in B. M. stone.	45.7789	150.195
Top of cap.........	Over P. B. M. 110	47.0217	154.272
T. B. M. 208.......	Is 23 feet below P. B. M. 110, on north side of wagon road in field, 10 feet from fence; being spike in north root of a lone sycamore.	46.6013	152.893
T. B. M. 209.......	Is 4,260 feet above mouth of Gray's Creek, on right bank of slough, at rocky point of bluff projecting into slough about on center of main point of exposed ledge on upper side; being square on natural ledge 18 inches back from upper quarter of break.	38.8840	127.573
T. B. M. 213.......	Is 65 feet below P. B. M. 112, on natural ledge at base of rock point; being highest point in square marked U. □ S.	42.4825	139.379
P. B. M. 111.......	Is 98 feet below P. B. M. 112, $2\frac{1}{2}$ feet above surface of ground on north face of bluff; being center of punch mark in copper bolt leaded horizontally.	43.2028	141.743
P. B. M. 112.......	Is about $2\frac{1}{4}$ miles above mouth of Gray's Creek, where extreme east road crossing bottom north and south opposite Claysville reaches bluff, on south side of wagon road, 144 feet west of gate and 285 feet east of Canaan Cole's house, at foot of bluff, 1 foot from vertical ledge; being copper bolt in B. M. stone.	41.6072	136.508
Top of cap.........	Over P. B. M. 112	42.8447	140.568
P. B. M. 113 $= {}^{32}_{1}$....	Is at foot of bluff opposite Claysville, at west fence of section line road between Secs. 19 and 20, T. 45, R. 12 W., 1,172 feet south of northeast corner of section 19, on land of F. Martin, 110 feet south of gate where road enters pasture, 10 feet west of wagon road; being copper bolt in B. M. stone.	45.5580	149.470
Top of cap.........	Over P. B. M. 113	46.7968	153.534
T. B. M. 216.......	Is 49 feet north of P. B. M. 113, 62 feet south of gate where road enters pasture by roadside; being spike in north root of a 16-inch hickory.	43.8972	144.021
T. B. M. 218....... Stanley's Landing.	Is 655 feet above Stanley's Landing, at foot of bluff directly across road from a 3-foot elm at side of road; being highest point in square cut on rock.	42.9647	140.962

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
T. B. M. 219	Is ¼ of a mile above head of Stanley Island and 1,310 feet below a very large vertical rock standing on side of bluff on river bank; being a spike in root of an elm.	43.3222	142.168
P. B. M. 114 Sugar Loaf Rock.	Is at Sugar Loaf Rock, which stands on the side of the bluff about 50 feet from river bank; it is in the northeast face of the rock, 7 feet above the level of a bench below rock, and 2 feet above ground at face of rock; being center of punch mark in copper bolt leaded horizontally.	47.5203	155.908
P. B. M. 115	Is 4½ miles below Marion, Mo., 2⅓ miles below Bull Rock, ½ mile above Sugar Loaf Rock, 82 feet back from river at mouth of small ravine, 24 feet east of bed of small stream; being copper bolt in B. M. stone.	43.0718	141.313
Top of cap	Over P. B. M. 115	44.3090	145.372
T. B. M. 220	Is very near P. B. M. 115; being highest point in square cut on projecting point of natural ledge.	41.7138	136.700
T. B. M. 222	Is 1 mile below Bull Rock, 1¾ miles above Sugar Loaf Rock, 1,475 feet above mouth of Meadow Creek, 50 feet back from river bank; being top of spike in root of 18-inch elm.	43.4766	142.641
T. B. M. 223	Is ¾ mile below Bull Rock, on upper one of three large conspicuous rocks on bank (the only ones near); being highest point in square cut on northwest corner, marked U □ S.	41.1548	135.024
P. B. M. 116 Bull Rock.	Is in west face of Bull Rock, a very prominent pinnacle rock, aobut 50 feet high, at edge of water, 10 feet north of edge of bluff, 25 feet above long narrow shoulder, upon which is T. B. M. 224, and 15 feet below south end of projecting ridge of rock; being center of punch mark in copper bolt. (This rock is incorrectly called "Sugar Loaf Rock" on map, survey of 1878.)	42.9212	140.819
P. B. M. 117	Is 40 feet west of west face of Bull Rock, on top of bench 20 feet north and 30 feet west of foot of upper slope; being copper bolt in B. M. stone.	48.2683	158.362
Top of cap	Over P. B. M. 117	49.5057	162.422
T. B. M. 224	Is 2⅓ miles below Marion, on west side of Bull Rock, at about the elevation of high water; being highest point in square cut on shoulder of rock and marked U. □ S.	42.1071	138.148
T. B. M. 225	Is 2¼ miles below Marion, ½ mile above Bull Rock, at point of bluff, on upper one of several large flat pieces of rock lying on the bank at an angle of about 45° with the horizontal; being highest point in square cut at about the center of the top surface of rock.	41.1535	135.019
T. B. M. 226	Is 1⅔ miles below Marion, 1⅓ miles above Bull Rock, 159 feet below mouth of Mud Creek, on river side of wagon road, at lower side of coulee, at foot of bluff; being highest point in square cut on small projecting point of natural ledge.	43.7184	143.434
T. B. M. 227	Is 1 mile below Marion, at mouth of small coulee, where road turns up bluff, at foot of bluff, west side of road, opposite Mr. Banshausen's land; being top of spike in root of stump of sugar maple 5 feet high.	45.0459	147.790
T. B. M. 228	Is about 1,860 feet below Marion, 30 feet west of west fence of wagon road, on south side of creek, 15 feet from bank, on land owned by James Hickman and about 400 feet from his house; being top of spike in 2-foot bur oak.	43.8114	143.740
P. B. M. 118 = [illegible] Marion.	Is in Marion, 475 feet from river, in northwest corner of lot No. 30, belonging to T. W. Glenn, just outside of Mr. Glenn's yard, 40 feet from his house, at south fence of road running back from store at landing, where lane runs south in front of Mr. Glenn's house; being copper bolt in B. M. stone.	48.8890	160.398
Top of cap	Over P. B. M. 118	50.1297	164.469
T. B. M. 229	Is at landing at Marion, at mouth of small ravine in front of store; being top of spike in north root of 2½ foot sycamore.	42.6996	140.092
P. B. M. 119	Is 1,705 feet above mouth of small ravine at Marion, 59 feet above northwest corner of prominent vertical ledge, and in the continuation of this ledge, 3 feet above high-water mark; being center of punch mark in copper bolt leaded horizontally.	44.8338	147.094
T. B. M. 230	Is at Marion, 39 feet from upper end of vertical ledge of rock at water's edge, 1,705 feet above landing; being highest point in square cut on oval bowlder in water, 12 feet from water's edge at stage, 10 feet below high water.	40.4073	132.571
T. B. M. 232	Is 1½ miles above Marion, at mouth of Moniteau Creek, on lower one of two large projecting rocks overhanging bank; being highest point in square.	42.8419	140.559
T. B. M. 234	Is about 2¼ miles above Marion, opposite H. M. Murphy's skiff ferry over Moniteau Creek, 1¼ miles above its mouth, 20 feet east from center of road leading to Marion; being top of spike in a 14-inch box elder.	45.5372	149.402

Descriptions and elevations of precise level bench marks, etc.—**Continued.**

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 120	Is on west side of road, nearly opposite T. B. M. 234, 65 feet south of small ravine on right bank of Moniteau Creek, 98 feet above Murphy's skiff ferry, on field side of wire fence, 10 feet south of gate across private road from Hickman's house to main road to Marion; being copper plate in B. M. stone.	46.3952	152.217
Top of cap	Over P. B. M. 120	47.6361	156.288
T. B. M. 235	Is 1⅜ miles above mouth of Moniteau Creek and 1,640 feet east from same, at cross fence between Rosemeller's land above and Murphy's land below; being top of spike in peach tree.	45.0198	147.704
T. B. M. 236	Is about 1¼ miles below Sandy Hook Landing, on C. F. Rosemeller's land, ⅜ mile south of his house, 30 feet from foot of bluff, 16 feet below fence running at right angles to bluff separating pasture from field; being highest point in square cut on imbedded rock and marked U. □ S.	45.8843	150.540
P. B. M. 121	Is 4 miles above Marion, ⅞ mile below Sandy Hook Landing, on west side of Factory Creek, opposite T. B. M. 237, in east face of semicircular ledge of rock next to creek; being center of punch mark in copper bolt leaded horizontally.	44.8842	147.260
T. B. M. 237	Is ⅞ mile below Sandy Hook Landing, 490 feet below C. F. Rosemeller's house, on left bank of Factory Creek; being top of spike in root of 2-foot elm, upon which is hung a gate across the road running from Sandy Hook to the bottom.	45.1490	148.128
P. B. M. 122=Ψ Sandy Hook.	Is at Sandy Hook Landing, 300 feet west of road running south from landing and on north side of road running west over bluff, 3 feet south of southeast corner of William Gentzsch's front door yard; being copper bolt in B. M. stone.	51.0757	167.573
Top of cap	Over P. B. M. 122	52.3166	171.644
T. B. M. 239	Is at Sandy Hook Landing, on south side of road leading west up bluff, 200 feet west from where it branches north to landing, 175 feet east of east side of William Gentzsch's yard; being top of spike in west root of 30-inch sycamore.	48.0715	157.716
P. B. M. 123	Is 2,953 feet below Cook's Landing, 1,800 feet above Sandy Hook Landing, at lower end of bottom, 25 feet north of a point at which a stratum of rock projects out 10 feet from face of bluff, directly under a small projection 10 feet below its top; being center of punch mark in copper bolt leaded horizontally into natural ledge one foot above ground.	46.6785	153.146
T. B. M. 240	Is 8 feet north of P. B. M. 123 and 12 feet from vertical face of bluff; being highest point in square on imbedded rock.	45.3638	148.833
T. B. M. 241	Is ⅛ mile below Geigers Landing, 1,017 feet below small creek, 75 feet above lower end of large rock bank at foot of bluff; being highest point in square cut on projecting point of ledge and marked U. □ S.	43.8184	143.762
P. B. M. 124 Geigers Landing.	Is at Geigers Landing, on south side of road running west from landing up coulee, about 500 feet from river, at northeast corner of S. V. Cook's shed, at east side of corncrib, 1 foot north of shed; being copper bolt in B. M. stone.	51.1116	167.690
Top of cap	Over P. B. M. 124	52.3488	171.750
P. B. M. 125	Is at Geigers Landing, 60 feet north of T. B. M. 242, in projecting point of rock ledge 10 feet high by 8 feet wide; being center of punch mark in copper bolt leaded horizontally.	49.3315	161.850
T. B. M. 242	Is at Geigers Landing, 380 feet above road running west up coulee, between road running parallel to river and bluff, 50 feet from river, 10 feet from bluff, 60 feet south of 2-foot hickory standing at foot of bluff, opposite point of ledge in which copper bolt is placed; being highest point in square cut on top of round imbedded rock and marked U. □ S.	47.6298	156.267
T. B. M. 243	Is 1,722 feet above Geigers Landing, on river side of farm road, 14 feet from foot of bluff, 16 feet below a ditch; being highest point in square cut in large, rough rock and marked U. □ S.	48.1612	158.010
P. B. M. 126=Ψ	Is 3 miles below Wolf Point, 1 mile below upper end of bottom opposite Providence, at mouth of coulee, 150 feet southeast of small frame house on land owned by Mr. Jackson, at east corner of small granary, 1½ feet from building, 25 feet south of fence line; being copper bolt in B. M. stone.	50.3791	165.287
Top of cap	Over P. B. M. 126	51.6185	169.354
T. B. M. 247	Is about 2 miles below Wolf Point, ¼ mile below head of bottom opposite Providence, 30 feet from bank of river, at end of obscure lane, near lower fence; being top of spike in large sycamore.	47.2197	154.922

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
T. B. M. 249	Is ½ mile below Wolf Point, 40 feet from river bank, 33 feet north from top of high bank of Little Spice Creek; being top of spike in stump.	47.7063	156.518
P. B. M. 127—Wolf Point.	Is at Wolf Point, at northwest corner of Musick & Redford's general merchandise store, 3 feet from corner of building; being copper bolt in B. M. stone.	52.8841	173.506
Top of cap	Over P. B. M. 127	54.1246	177.576
T. B. M. 250	Is at Wolf Point, on southeast corner of chimney on east side of Mr. Redford's house; being highest point in square cut on bottom course of stone.	51.0288	167.419
P. B. M. 128	Is at Wolf Point, 75 feet above lower end of exposed ledge, 25 feet above level of bottom land, 3½ feet north of a point directly under end of fence running back over bluff; being center of punch mark in copper bolt leaded horizontally into vertical face of ledge, 2 feet above ground.	58.6135	192.303
P. B. M. 129	Is at Mount Vernon Landing, 1,148 feet below mouth of Petite Saline Creek, 24 feet south of bank of small stream, 184 feet above its mouth on slope of hill; being copper bolt in B. M. stone.	53.0757	174.135
Top of cap	Over P. B. M. 129	54.3119	178.190
T. B. M. 253	Is 984 feet below mouth of Petite Saline Creek, 92 feet above wheat shed at Mount Vernon Landing, 20 feet towards river from vertical ledge of rock; being highest point in square cut on natural ledge and marked U. [illegible] S.	46.1106	151.283
P. B. M. 130 Mount Vernon.	Is 964 feet below mouth of Petite Saline Creek, 112 feet above wheat shed at Mount Vernon Landing; being center of punch mark in copper bolt leaded horizontally into northeast face of natural ledge having vertical exposure of about 10 feet.	49.5489	162.563
T. B. M. 255	Is one mile above mouth of Petite Saline Creek, at Whists or Pixleys Landing, at northeast corner of barnyard next to house occupied by D. Giles on land owned by Mr. Bruce; being top of spike in west root of elm.	49.4538	162.251
T. B. M. 256	Is 2¼ miles above the mouth of Petite Saline Creek, 1¼ miles above Whists Landing, about 1,705 feet below main road, at edge of cornfield by side of farm road; being top of spike in 3-foot cottonwood.	48.2318	158.242
T. B. M. 257	Is about 5½ miles below Overton, nearly opposite middle of Terrapin Island, at forks of road, on river side of road running parallel to river, 25 feet from center and in line with upper side of road running back to bluff; being top of a spike in northwest root of a 2-foot black walnut.	50.7456	166.490
T. B. M. 258	Is about 9 feet south of P. B. M. 131; being top of spike in west root of triple honey locust.	52.4949	172.229
P. B. M. 131	Is nearly opposite middle of Terrapin Island, on land owned by H. H. Woolrich, at fence separating pasture and cultivated field, 338 feet east of road leading south through the bluffs. It is 1,460 feet S. 61° 45′ W. (mag.) from northeast corner of southeast quarter of the southeast quarter sec. 23, T. 48, R. 15 W.; being copper bolt in B. M. stone.	51.5888	169.256
Top of cap	Over P. B. M. 131	52.8308	173.331
T. B. M. 259	Is about 5 miles below Overton, a little above a point opposite the middle of Terrapin Island, 1,640 feet above forks of road, 1½ miles south from river (along road) on river side of road, at edge of high bank along Terrapin Island Chute, behind willow bar; being top of spike in a 2 foot cottonwood, which is the north one of three in a row.	49.1964	162.391
T. B. M. 260	Is opposite a point about 3¼ miles below Overton by river, about 2,295 feet south from river bank, at west side of road in front of log house on farm owned by J. H. Hall, Joe Combs, and Marshall Rusk; being top of spike in east root of elm.	49.5556	162.586
P. B. M. 132	Is in southwest corner of John Campbell's dooryard, near T. B. M. 262; being copper bolt in B. M. stone.	49.7935	163.366
Top of cap	Over P. B. M. 132	51.0308	167.425
T. B. M. 262	Is 3 miles below point opposite Rocheport, 2,460 feet west (along road) from river; being top of spike in stump in southwest corner of John Campbell's dooryard.	51.0432	167.466
P. B. M. 133	Is 350 feet west of T. B. M. 265, on W. E. Clayton's land, at south fence of small meadow at foot of bluff, 880 feet S. 11° 45′ E. (mag.) from center sec. 5, T. 48, R. 15 W.; being copper bolt in B. M. stone.	54.7044	179.478
Top of cap	Over P. B. M. 133	55.9470	183.555
T. B. M. 265	Is in middle of main road running south from Overton, 2 miles from the town, 350 feet east of P. B. M. 133, at foot of bluff; being top of spike in north root of a 2-foot black walnut.	53.2446	174.688

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
P. B. M. 134	Is about 9 miles below Boonville, 1 mile above road running across bottom toward Rocheport, 175 feet above west side of county road running to river, 187 feet below conspicuous cave in side of high rock bluff, two-thirds of the way up; being center of punch mark in copper bolt leaded horizontally into face of rock bluff 30 inches above ground.	53.5772	175.780
P. B. M. 135	Is 1⅝ miles below Elliotts Landing, ⅞ mile below head of large bottom back of slough, 1¼ miles above road running north across the bottom toward the river, 100 feet east of high vertical rock ledge, 20 feet from foot of bluff, on line with rail fence, 25 feet below small creek from spring, 6 feet east of a 2-foot slippery elm blazed; being copper bolt in B. M. stone.	53.0138	173.931
Top of cap..........	Over P. B. M. 135	54.2512	177.991
T. B. M. 268	Is about ⅞ mile below Elliotts Landing, at lower side of meadow on south bank of small creek, 100 feet from vertical rock bluff; being top of spike in 30-inch elm.	53.4528	175.372
P. B. M. 136	Is at Elliotts Landing, 108 feet below wooden warehouse; being center of punch mark in copper bolt leaded horizontally into face of solid rock bluff, about 2¼ feet above ground.	55.2368	181.225
P. B. M. 137=$\frac{32}{1}$, Elliotts Landing,	Is at Elliotts Landing, at head of Diana Island, about 6.2 miles below Boonville, in the northeast corner of orchard and 1,060 feet S. 45° W. (mag.) from house owned by J. E. Elliott, 575 feet back from the river, 82 feet southwest from wagon bridge over small creek, at southeast corner of yard surrounding a log house, on west side of wagon road; being copper bolt in B. M. stone.	56.2026	184.394
Top of cap..........	Over P. B. M. 137	57.4400	188.453
T. B. M. 270	Is about ⅞ mile above Elliotts Landing, on edge of river bank, on west side of road leading out from coulee down to boat landing; being top of spike in south root of 2-foot sycamore.	51.2251	168.063
T. B. M. 271	Is 1 mile below foot of Franklin Island, on point of bluff 705 feet below small creek, at lower side of coulee, about ½ mile below vertical rock ledge, at top of vertical rock bank on projecting point of ledge, about 2 feet below standard high water; being highest point in square marked U. [] S.	49.8484	163.546
P. B. M. 138	Is 3.8 miles below Boonville, opposite foot of Franklin Island, 100 feet below small creek, in rock ledge forming high-water bank, 3 feet above surface of ground, 40 feet from low-water shore line; being center of punch mark in copper bolt leaded horizontally into natural ledge.	52.3202	171.656
T. B. M. 272	Is 3.8 miles below Boonville, opposite foot of Franklin Island, in same locality as P. B. M. 138; 75 feet above mouth of small creek, near river bank; being top of spike in root of cottonwood.	52.4055	171.936
P. B. M. 139	Is 3⅓ miles below Boonville, ⅞ mile above foot of Franklin Island, 590 feet above very prominent point of vertical ledge of rock, 30 feet below very small stream, at foot of bluff about 1 foot above mean high water; being copper bolt in B. M. stone.	51.2828	168.252
Top of cap..........	Over P. B. M. 139..	52.5259	172.331
T. B. M. 276........	Is 1⅝ miles below Main street, Boonville, at lower end of bottom where bluff comes back to river, 1,720 feet below Marietta Creek, 328 feet above head of chute, 65 feet above a spring at base of rock; being highest point in square cut on natural ledge, and marked U. S. on face of ledge 1 foot above point.	52.3497	171.753
P. B. M. 140 =$\frac{40}{1}$....	Is 1¼ miles below Main street, Boonville, on upper side of coulee, near mouth of Marietta Creek, 25 feet above wagon road running up coulee, on bottom land at foot of bench of bluff, near a group of small elms, on land owned by Mr. Storm; being copper bolt in B. M. stone.	53.0510	174.053
Top of cap..........	Over P. B. M. 140..	54.2874	178.110
T. B. M. 277........	Is 1¼ miles below Main street, Boonville, at upper side of coulee, near mouth of Marietta Creek, 125 feet from river and 50 feet from foot of bluff, on bluff side of wagon road; being top of spike in an 18-inch elm.	52.6251	172.656
T. B. M. 279........	Is in Boonville, on west side of Main street, between Levee and Water streets, on southeast corner of stone monument, 29 inches by 5 inches, on top marked high water 1844; being highest point in square cut on top of stone.	56.6795	185.958

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
High-water mark, 1844.	Is on same stone as T. B. M. 279, being center of mark parallel to and 6 inches below top of stone, cut across its east face. The stone has been disturbed, and its mark is no longer horizontal. The middle of the line was taken as the high-water mark. The stone is marked on top High water mark. ; and on the east face June 1st, A. D. 1844.	56.5016	185.374
P. B. M. 144=Old B. M. 121.	Is in Boonville on river side of abutment to Missouri Kansas and Texas R. R. bridge, north of Missouri Pacific track, at about the middle of the north face, 2 feet below surface of ground, 5 feet below point of arrow cut in stone; being center of punch mark in copper bolt leaded horizontally.	52.7941	173.211
U. S. Signal Service gauge.	Is in Boonville, on first pier from right bank of Missouri, Kansas, and Texas Railroad bridge, downstream end, south side; being staff gauge cut in rock reading to feet and tenths. Elevation of its zero.	46.4297	152.330
High water, 1844...	Is in Boonville, on downstream end of first pier from right bank of Missouri, Kansas and Texas R. R. bridge, being center of horizontal line of black paint thus: —44 (line is not perfectly horizontal.) East end of line at nose of pier was taken.	56.4384	185.167
U. S. gauge at Boonville.	Is standard wire cable gauge on Missouri, Kansas and Texas bridge. Elevation of its zero.	+0.0249	+0.082
P. B. M. 141.......	Is in Boonville, at northwest corner of a three-story brick building occupied by Boonville Flouring Mills owned by C. W. and J. Sombast, facing levee, 200 feet east of Main street, on north face of top corner stone of foundation, 6 inches east of corner and 3.5 feet above ground; being centre of punch mark in copper bolt leaded horizontally.	55.7436	182.887
P. B. M. 142=40½ Boonville........	Is in Boonville, Mo. on west side of Main street between Levee and Water streets, 1 foot west of stone curbing at lower edge of stone marking high water 1844; being copper bolt in B. M. stone.	55.5386	182.215
Top of cap........	Over P. B. M. 142......................................	56.7860	186.287
T. B. M. 280.......	Is on shore pier at south end of Missouri, Kansas and Texas R. R. bridge at Boonville, on downstream end of pier, on side of downstream pedestal next to track, and almost in line with north edge of bed plate; being highest point in square cut on coping.	60.1307	197.281
P. B. M. 143.......	Is in shore pier at south end of Missouri, Kansas and Texas R. R. bridge at Boonville, 21½ inches west of bed plate, 168 inches northwest from northwest corner of stone wall, 22 inches south of north side of pier and 32¾ inches from west end; being copper bolt leaded vertically into coping stone.	60.1320	197.285
P. B. M. 145.......	Is in shore pier at north end of Missouri, Kansas and Texas R. R. bridge across the Missouri River at Boonville, in upstream end of pier, 14½ inches from northwest corner of bed plate and 1½ inches north of a point in line with north edge of same, 15 inches from west and 50 inches from south bevel edge of pier; being top of copper bolt leaded vertically into coping stone.	59.2648	194.440
P. B. M. 146.......	Is about ½ mile west of Franklin Station 902 feet north west of second bend in road after crossing Missouri, Kansas and Texas R. R. on line with south fence of east and west branch road, 50 feet east of fence corner on opposite side of road and 6 inches east of east fence of north-and-south Boonville road, on land owned by Joseph B. Baker; being copper bolt in B. M. stone	54.8371	179.913
Top of cap........	Over P. B. M. 146	56.0793	183.989
T. B. M. 282.......	Is top of spike in foot of broken sycamore tree, 50 feet south-east of P. B. M. 146.	56.0678	183.951
T. B. M. 283.......	Is 1½ miles above Franklin, 195 feet south of a point directly in front of Mr. Brown Chancellor's house, 52 feet south from corner of fence, 3 feet west of west fence of wagon road; being top of spike in root of a 30-inch leaning oak.	54.9635	180.328
P. B. M. 147=4½ (new position).	Is 3 miles above Boonville, at point where road running south branches off from east-and-west road, 58 feet above a point directly in front of Mrs. Kate Chancellor's house, 49 feet below point opposite east end of barn; being copper bolt in B. M. stone.	55.7767	182.996
Top of cap.........	Over P. B. M. 147......................................	57.0125	187.051
T. B. M. 286.......	Is 4½ miles above Boonville, 2,920 feet below road running southeast to river, 820 feet below two large lone cotton woods by roadside, on small knoll on bluff side of road; being highest point in square cut on flat embedded rock.	57.8298	189.732

Descriptions and elevations of precise level bench marks, etc.—**Continued.**

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 148	Is 5¼ miles above Boonville bridge, at lower end of Kings Lake, 2,130 feet above branch road running across bottoms to river, opposite W. E. Saddler's house on river side of road leading to Boonville and on line with road fence along John Tinsley's land, between an elm above, and a honey locust below; being copper bolt in B. M. stone.	56.9686	186.907
Top of cap	Over P. B. M. 148	58.2077	190.972
T. B. M. 287	Is 5¼ miles above Boonville bridge, on east side of wagon road, 50 feet below ice house on land owned by W. E. Saddler; being top of spike in south root of 2-foot honey locust.	58.6279	192.350
T. B. M. 288	Is about 6¼ miles above Boonville, on east side of Natchez Lake, 108 feet below road leading up bluff to L. H. Hayter's house, 82 feet above a shed by roadside, bluff side of wagon road, 15 feet from center; being top of spike in southwest root of a 3-foot honey locust.	57.1344	187.450
T. B. M. 289	Is 5¾ miles below Lisbon, 7¼ miles above Boonville, 125 feet above a point directly in front of Steve Cooper's house, on bluff side of wagon road, 25 feet from center and 12 feet from rail fence; being top of spike in 28-inch walnut.	59.7501	196.032
P. B. M. 149	Is 5½ miles below Lisbon, 1 mile below branch road leading west, 900 feet south of house occupied by Ed Smith (owned by Clark Bros.), 125 feet south of fence running east over bluff, 50 feet north of large elm, on east side of road next to Steve Cooper's land; being copper bolt in B. M. stone.	58.2371	191.068
Top of cap	Over P. B. M. 149	59.4744	195.128
T. B. M. 290	Is 5½ miles below Lisbon, 1 mile below branch road leading west, at point where road comes to bluff after crossing mouth of large coulee near P. B. M. 149, at west side of wagon road to Boonville; being top of spike in root of 30-inch burr oak.	58.5702	192.161
T. B. M. 291	Is 4½ miles below Lisbon, on east side of wagon road leading to Boonville and 98 feet south of branch road leading west; being top of spike in west root of a large sycamore.	59.2874	194.514
P. B. M. 150	Is about 4 miles below Lisbon, 1,610 feet above branch road leading west, 252 feet north of east-and-west fence, 20 feet east of center of road leading to Boonville and 2½ feet above grade of same; being top of copper bolt leaded vertically into projecting ledge 6 inches back from vertical face.	57.5319	188.754
P. B. M. 151—4¾	Is 3½ miles below Lisbon, 2,000 feet north of schoolhouse, district No. 4, 430 feet north of Fairbanks' weighing scales, 275 feet southeast of John Step's house, 230 feet east from wagon road; being copper bolt in B. M. stone.	62.8772	206.292
Top of cap	Over P. B. M. 151	64.1161	210.357
T. B. M. 294	Is 3½ miles below Lisbon, 2,130 feet above school house, district No. 4, on Boonville road, at foot of bluff; being top of spike in 18-inch lime tree in John Step's front yard.	58.9137	193.288
T. B. M. 295	Is 2¼ miles below Lisbon, 590 feet below William Marshall's barn at mouth of coulee, 145 feet below large rock lying by roadside at foot of bluff, on east side of wagon road leading to Boonville; being highest point in square on inclined embedded rock and marked U. □ S.	57.5826	188.921
T. B. M. 296	Is ⅞ mile below Lisbon, 490 feet above mouth of small creek, on river side of wagon road, 12 feet from river bank and 16 feet from fence; being top of spike in a 30-inch slippery elm.	59.0120	193.611
P. B. M. 152—4¾	Is 2,295 feet below Lisbon, 1,310 feet below creek at lower end of town, 133 feet above fence corner, on river side of wagon road, 59 feet from center, 15 feet from river bank, at east side of large imbedded rock; being copper bolt in B. M. stone.	61.1809	200.727
Top of cap	Over P. B. M. 152	62.4207	204.794
T. B. M. 297	Is 2,295 feet below Lisbon, 1,310 feet below creek at lower end of town, 50 feet west of wagon road, 20 feet east of river, 33 feet north of P. B. M. 152, 8 feet southwest of blazed elm; being highest point in square cut on natural ledge and marked U. □ S. on west face of ledge.	62.4627	204.932
T. B. M. 298 Lisbon.	Is in Lisbon, on rocky point of high bank extending out into river directly opposite center of town; being top of spike in northeast root of 30-inch walnut.	63.2896	207.645
T. B. M. 299	Is ⅜ mile above Lisbon, 300 feet from river, 245 feet above first creek above Lisbon, on east edge of large cottonwood grove, on river side of wagon road, 40 feet from center; being top of spike in east root of blazed cottonwood.	57.7509	189.473
P. B. M. 153	Is 1 mile above Lisbon, 2,050 feet above first bridge over creek above Lisbon, 60 feet above a point directly east of and across slough from John McCorkle's log barn or shed, on east side of wagon road, 2 feet above surface of ground; being center of punch mark on copper bolt leaded horizontally into natural ledge.	58.9696	193.472

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
T. B. M. 300	Is 1 mile above Lisbon, 2,050 feet above first bridge over creek above Lisbon, 460 feet north of prominent rock point, east side of wagon road, 50 feet south of south end of small coulee, and 1 foot above ground; being highest point in square cant on natural ledge.	58.3899	191.570
P. B. M. 154 = $\frac{4}{5}$	Is 1$\frac{1}{4}$ miles above Lisbon, $\frac{3}{4}$ mile above the second highway bridge above Lisbon, $\frac{1}{4}$ mile below John W. Goe's log house, which stand by road, 275 feet below prominent point of rock bluff, by rail fence on west side of wagon road; being copper bolt in B. M. stone.	56.9527	186.854
Top of cap	Over P. B. M. 154	58.1766	190.870
T. B. M. 301	Is 275 feet above P. B. M. 154, on east side of wagon road, at prominent point of rock bluff, on natural ledge; being highest point in a square marked U. S.	58.3739	191.517
T. B. M. 302	Is 2$\frac{1}{4}$ miles above Lisbon, 616 feet above John W. Goe's house, about 50 feet above small stream flowing from spring on the east side of point of bluff, on the upper side of small couleè, on east side of wagon road, on natural ledge; being highest point in square, marked U. S.	59.1302	193.999
T. B. M. 303	Is 3$\frac{1}{10}$ miles above Lisbon, 3,000 feet below highway bridge over Richland Creek, on the west side and 8 feet from wagon road and 9 feet from fence; being highest point in square on large flat rock, marked U. S.	61.5248	201.855
T. B. M. 304	Is 1$\frac{7}{8}$ miles below Bluffport, $\frac{1}{2}$ mile below Mrs. J. Cropp's house, at the upper side of a small creek 40 feet east of black walnut standing on the west side of road, at east roadside; being a square on imbedded rock.	60.3165	197.891
P. B. M. 155	Is about 1 mile above Richland Creek, on line of wagon road above and 230 feet in direct line from house of Mrs. Blanche Cropp, and 230 feet above small stream, at the upper side of couleè, opposite a point 8 feet below the lower outcropping of ledge; being a copper bolt in B. M. stone.	60.3915	198.137
Top of cap	Over P. B. M. 155	61.6300	202.200
P. B. M. 156	Is about 1$\frac{1}{2}$ miles below Bluffport, 95 feet above P. B. M. 155, 87 feet above end of bare bluff, 3$\frac{1}{2}$ feet above ground, on east side of wagon road; being center of punch mark in copper bolt leaded horizontally in face of ledge.	62.8906	206.336
T. B. M. 305	Is in the same locality as P. B. M. 155, 230 feet above Mrs. Blanche Cropp's house, 260 feet above creek and 35 feet above the lower end of bare ledge, 1$\frac{1}{2}$ feet above surface of ground; being the highest point in square on natural ledge.	62.5094	205.085
T. B. M. 306	Is $\frac{1}{2}$ mile below Bluffport, $\frac{5}{8}$ of a mile below Miller Brothers' sawmill, and 328 feet above J. F. Moberly's house, where wagon road leaves the river bank going south, at foot of bluff by fence at side of road, 55 feet from the river; being spike in base of a 30-inch hackberry.	62.7396	205.840
T. B. M. 307. Bluffport.	Is in Bluffport, 3$\frac{1}{2}$ miles below Glasgow, 655 feet below Miller Brothers' sawmill, 360 feet below C. W. Miller's house, 6 feet back from river bank and 20 feet from wagon road; being pike in the south root of a 38-inch oak.	62.8634	206.246
P. B. M. 157 = $\frac{4}{6}$ Hurricane Creek.	Is on left bank, 2 miles below Glasgow, 175 feet above the mouth of the first creek below Hurricane Creek, on level spot of ground just back of fence at foot of bluff, 20 feet from river bank, and 40 feet below the lower end of high rock ledge; being a copper bolt in B. M. stone.	60.0734	197.093
Top of cap	Over P. B. M. 157	61.3117	201.156
T. B. M. 313	Is 1,720 feet below the railroad bridge at Glasgow, about 300 feet above point where river strikes bluff, 200 feet east of river, and 2 feet east of board fence; being spike in the west root of a 2-foot red elm.	60.6204	198.888
T. B. M. 309	Is about 50 feet above P. B. M. 157, 29$\frac{1}{2}$ feet above the lower extremity of sandstone ledge, under twin lime tree, on natural ledge 3 inches back of face; being highest point in square.	60.0257	196.936
P. B. M. 159 = $\frac{4}{7}$	Is in Glasgow, Mo., at the west side of the second pier from the east abutment of the Chicago and Alton Railroad Bridge, opposite center of pier and 2 feet from its face; being copper bolt in B. M. stone.	62.2381	204.195
Top of cap	Over P. B. M. 159	63.4744	208.252
P. B. M. 160 Glasgow.	Is in Glasgow, in the first lowland pier, just below wagon road at the east end of the Chicago and Alton Railroad Bridge, in the first course of stone under capstone, in east face, 10 inches north of southeast corner of pier, 6 feet above ground; being center of punch mark in copper bolt leaded horizontally.	68.2552	223.936
T. B. M. 314	Is in Glasgow, at the Chicago and Alton Railroad Bridge, at the base of same pier as P. B. M. 160, in the center of south face, 3 feet east of the southwest corner of pier, on projecting stone, at about the same elevation as the surface of ground; being highest point in square.	65.8880	216.170

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Fe
U. S. gauge	At Glasgow is on the downstream side of the Chicago and Alton Railroad Bridge; being a standard wire-cable gauge elevation of its zero.	+0.0781	+(
T. B. M. 315=Old B. M. 141 (a)	Gauge B. M. in Glasgow is on top of ridge-joint between the columns of the third pier from the east abutment of the Chicago and Alton Railroad Bridge.	61.0846	200
P. B. M. 161	Is opposite Glasgow, Mo., on the Chicago and Alton Railroad Bridge, on the first high double pier from the right bank, at the west end of high truss, on down stream end and top of pier, 17 inches from the southeast corner of bed plate and just south of anchor bolt, 7½ inches from either beveled edge at the southeast corner of pier; being top of copper bolt leaded vertically.	76.2102	250
P. B. M. 158=Y	Is on the right bank three-quarters of a mile below the west abutment of Glasgow Bridge and 1,960 feet from river bank and 1,960 feet south from the Chicago and Alton Railroad tracks, in south fence of road in front of house, 195 feet east of a 2-foot oak tree; being copper bolt in B. M. stone.	62.4379	204
Top of cap	Over P. B. M. 158	63.6761	208
T. B. M. 316	Is about 195 feet west of P. B. M. 158, in east root of a white-oak tree 2 feet in diameter, standing in center of road; being top of spike.	61.9465	203
T. B. M. 318	Is about 2 miles west of Glasgow on the line of the Chicago and Alton Railroad track, 125 feet north of center at the upper end of siding, 150 feet below F. J. Snitzmier's house; being a spike in west root of a 3-foot black walnut.	62.6834	205
T. B. M. 319	Is on line of the Chicago and Alton track, 3¼ miles west of Glasgow, at Estell's Crossing, in front of Mr. Testerman's house, at the southeast corner of scales; being spike in timber.	61.8736	202
P. B. M. 162	Is 2 miles south of Cambridge, Mo., and 5 miles west of Glasgow, where wagon road crosses the Chicago and Alton Railroad track just as it enters bluffs going west, about three-eighths of a mile from the river bank, 47.5 feet south from the center of track, on west side of wagon road, at corner of fence; being copper bolt in B. M. stone.	64.5502	211
Top of cap	Over P. B. M. 162	65.7901	215
T. B. M. 322	Is 1¾ miles below Cambridge, Mo., about 20 feet south of the south right-of-way fence of the Chicago and Alton Railway, and 1,770 feet west of the road crossing where railroad enters the bluffs, at lower end of cut, opposite whistle post; being spike in root of a 13-inch oak.	69.2018	227
T. B. M. 323	Is about 1 mile below Cambridge Landing, 15 feet south of small creek crossing road, 60 feet east of east road fence; being a spike in the west root of a 30-inch oak.	64.3798	211
T. B. M. 324	Is 2,755 feet below the landing at Cambridge, at east side of wagon road, 90 feet east of east bank of creek, on line with the south side of bridge over creek, at the upper point of the first woods below Cambridge and 100 feet from top of river bank; being spike in the west root of a 30-inch post oak.	63.0798	206
P. B. M. 163 Cambridge.	Is in Cambridge, Mo., on the east side of warehouse of W. D. Woolridge, near river end, 4.4 feet south, of the north corner and 3 feet above ground; being center of punch mark in copper bolt leaded horizontally.	68.3425	224
T. B. M. 325	Is in Cambridge on same warehouse as P. B. M. 163, at east side, 10 feet south from its north end, on projecting course of stone; being highest point in square.	67.7039	222
P. B. M. 164=Y	Is in Cambridge, Mo., 623 feet above the landing at foot of Main street, on a low point of bluff just above spring, 245 feet west of fence, 15 feet above elevation of bottom land; being copper bolt in B. M. stone.	65.2588	214
Top of cap	Over P. B. M. 164	66.4947	218
T. B. M. 326	Is 82 feet west of P. B. M. 164, on the east side of small ravine, on a natural ledge of rock; being highest point in square marked U □ S.	66.3848	217
T. B. M. 328	Is about 1½ miles above Cambridge, on ridge between two sloughs, 60 feet from the west bank of the east slough and 1,050 feet above highway bridge over creek; being spike in the east root of a lone black walnut 26 inches in diameter.	62.8400	206
P. B. M. 165	Is 2¼ miles below Salt Creek, about ¾ mile from the bank of the river, on old river bank, 150 feet west of bank of large slough, on west side of wagon road to Cambridge in line with fence, on land of Judge Gillum, across slough and 490 feet from his house, 180 feet south of the exceedingly large cottonwood tree 9 feet in diameter; being copper bolt in B. M. stone.	62.7419	205

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M. 165	63.9791	209.907
T. B. M. 329	Is in same locality as P. B. M. 165, 180 feet above it; being a spike in the lone cottonwood tree 9 feet in diameter.	64.6473	212.099
T. B. M. 330	Is 2 miles below New Frankfort, 400 feet west of a group of apple trees, 200 feet from river bank, 820 feet northwest of John Conche's house on Gillum's land; being spike in root of a honey locust.	63.4777	208.262
T. B. M. 331 Salt Creek.	Is 10 feet from west bank of Salt Creek, ⅝ mile below New Frankfort and 50 feet above its mouth; being spike in south root of a 30-inch elm.	63.5146	208.383
P. B. M. 166=4/9 New Frankfort.	Is at the upper end of New Frankfort, 885 feet south of river bank, 213 feet north of point where road running west turns north, 65 feet south of and across road from house of R. M. Elliott, 2 feet west of the west fence and 300 feet south of center of bridge over small creek; being copper bolt in B. M. stone.	64.8781	212.856
Top of cap	Over P. B. M. 166	66.1209	216.934
T. B. M. 332	Is directly across road from P. B. M. 166, on a row of maple trees in front of Mr. Elliott's house; being spike in root of fifth tree south of gate.	66.2292	217.289
T. B. M. 333	Is at New Frankfort, 275 feet above the Ferry Landing, 50 feet from river bank, between river and road; being spike in the uppermost one of a group of cottonwood trees.	63.8797	209.581
T. B. M. 334	Is 1 mile above the Ferry Landing at New Frankfort, in the northwest corner of timber lot, 25 feet south of road fence, 100 feet from old river bank; being spike in the west root of a 30-inch elm.	64.1749	210.550
T. B. M. 335	Is 1½ miles above New Frankfort, 500 feet above the upper edge of first timber, 400 feet from river bank, on land owned by the widow Kerns; being spike in root of a large hickory in field.	64.1182	210.363
T. B. M. 336	Is 2⅝ miles above New Frankfort, ⅜ mile from river and ¼ mile from foot of bluff, ¾ mile below Mr. Campbell's house and ½ mile west of J. A. Harman's house, on land owned by Wood Gillam, 100 feet north of east-and-west fence on south side of field; being spike in root of a tall lone cottonwood 3 feet in diameter.	65.3805	214.505
P. B. M. 167	Is 3 miles above New Frankfort, at old site of sawmill, where old road running west along foot of bluff turns south over the bluff and from which point a lane runs north about ½ mile to Mr. Campbell's house, 328 feet above prominent ledge of rock, on north side of road and east side of lane; being copper bolt in B. M. stone.	64.9406	213.062
Top of cap	Over P. B. M. 167	66.1768	217.118
T. B. M. 337	Is in vicinity of P. B. M. 167, at foot of bluff, on south side of road opposite the site of old sawmill, 180 feet east of lane running north to Mr. Campbell's house and about 164 feet above prominent ledge of rock; being spike in root of a broken elm, 18 inches in diameter.	66.5029	218.187
T. B. M. 339 Graves Creek.	Is about ⅝ mile above the mouth of Graves Creek on its left bank; being spike in the east root of an elm, 30 inches in diameter.	65.7529	215.727
T. B. M. 340	Is at the foot of bluff ½ mile above where Graves Creek comes out of bluff, on land of Harmon Huff, at north side of orchard and south edge of woods, in fifth row of apple trees from east fence of orchard; being spike in south root of apple tree.	71.7838	235.513
P. B. M. 168=4/9	Is opposite Buckhorn Point at foot of bluff 98 feet west of line between sections 27 and 28 T. 53, R. 20 W. on land of Samuel Wood, north of barn on top of bluff, 3 feet south of east and west fence running along foot of bluff, 820 feet east of the "old mulberry corner;" being copper bolt in B. M. stone.	65.9879	216.498
Top of cap	Over P. B. M. 168	67.2292	220.570
T. B. M. 342	Is about 700 feet west of P. B. M. 168,115 feet east of "old mulberry corner," on top of old river bank at foot of bluff, 40 feet north of east and west fence past P. B. M. 168 on land of Samuel Wood; being spike in root of a 2-foot lime.	67.2424	220.614
T. B. M. 344 Cromwell.	Is on Cromwell Point, 1,640 feet south of the mouth of Salt Creek, 8 feet west of fence between two fields; being spike in the south root of a lone 20-inch elm.	66.7730	219.074
P. B. M. 169	Is on Cromwell Point at foot of Brunswick Island, ⅜ mile north of Mr. Downing's house, above mouth of creek, below bridge where road between Downing and Andy Campbell crosses creek, 22 feet south of high bank, 18 feet north of gate, on the west side of fence, at the northwest corner of Cyrus Downing's field, where road leaves creek and enters field; being copper bolt in B. M. stone.	66.9048	219.506
Top of cap	Over P. B. M. 169	68.1446	223.574

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 170=$\frac{51}{Y}$	Is opposite the mouth of Grand River, 20 feet west of the southwest corner of the NE. ¼ of NE. ¼ sec. 24, T. 53, R. 21 W. on the south side of the east and west lane between Mr. White's house, on the west and Mr. Sullivan's house on the east, 130 feet west of large blazed elm at edge of woods on north and field on south, 49 feet south from a small elm blazed; being copper bolt in B. M. stone.	67.5291	221.554
Top of cap	Over P. B. M. 170	68.7684	225.620
T. B. M. 349	Is 419 feet east of P. B. M. 171 about 65 feet west of T. W. Wood's house, 3 feet north of south road fence; being spike in root of a lone cottonwood, 26 inches in diameter.	68.9895	226.346
P. B. M. 171=$\frac{52}{Y}$	Is opposite De Witt, Mo., on line running east and west through center of section 22, T. 53, R. 21 W., 60 feet west of ¼ post between sections 22 and 23 about 820 feet west of S. W. Wood's house at south road fence; being copper bolt in B. M. stone.	67.7800	222.377
Top of cap	Over P. B. M. 171	69.0161	226.433
T. B. M. 351	Is opposite De Witt, Mo., on the west edge of north and south road about 1⅜ miles south of where it reaches the river bank and 1⅛ miles north of Mr. Davenport's two-story frame dwelling; being highest point of a bent wire spike in root of a lone 30-inch sycamore.	69.3173	227.421
P. B. M. 172	Is 2½ miles below Miami, Mo., in the southeast corner of Miami and De Witt road, where the road turns north, 459 feet south of Mr. Davenport's two 1-story frame house, 5 feet south of east-and-west fence between Davenport's and Wilson's fields, 1 foot east of the east-road fence; being top of copper bolt in B. M. stone.	68.5809	225.005
Top of cap	Over P. B. M. 172	69.8224	229.078
T. B. M. 352	Is 15 feet west of P. B. M. 172, 459 feet south of Mr. Davenport's large white two-story frame house; being spike in north root of a 16-inch black walnut.	69.5609	228.220
T. B. M. 353	Is 2 miles below Miami, Mo., ½ mile north of corner at foot of bluff where the highway turns north, in large yard west of farm house, ¼ mile south of point where road turns east, and 98 feet east of east side of road; being spike in the west root of a 30-inch elm.	69.4862	227.975
T. B. M. 354=Old B. M. 154.	Is 3,280 feet below the landing at Miami, 1,064 feet below mouth of creek, at lower end of rocky shore and 20 feet south of edge of road; being nail in root of a 2½ foot sugar maple.	71.8287	235.660
T. B. M. 355	Is at the lower side of Miami, Mo., ½ mile along shore below the steamboat landing, 820 feet below mouth of creek, on the north side of wagon road, where road comes to river; being spike in the north root of an elm 30 inches in diameter standing near the river bank.	70.5984	231.624
P. B. M. 173	Is about 1,640 feet below the flouring mill at Miami, 295 feet above upper bank of creek, 5½ feet above surface and 6 feet from edge of water at a medium stage, in face of ledge; being center of punch mark in copper bolt leaded horizontally.	69.6983	228.671
T. B. M. 357=B. M. "C." of 1878.	Is on east side of road from landing to town, on west bank of small stream 25 feet from river bank at Smith & Boyer's warehouse; being top of knob chiseled in rock ledge. It is said to be of the same elevation as high water of 1881.	70.8579	232.475
P. B. M. 175 Miami.	Is in Miami, at the Ferry Landing, on the west side of street, 40 feet from river, at the northeast corner of flouring mill of J. G. Guthrie; being copper bolt in B. M. stone.	70.4282	231.066
Top of cap	Over P. B. M. 175	71.6716	235.145
T. B. M. 358	Is in Miami, Mo., at same place as P. B. M. 175, on foundation of brick flouring mill owned by J. G. Guthrie, at its northeast corner; being highest point in square.	71.5911	234.881
P. B. M. 176	Is 2,885 feet above the present landing at Miami, 295 feet above creek at old Miami Ferry Landing, 4 feet above surface of water at a medium stage and 7 feet from shore, in west face of rock; being center of punch mark in copper bolt leaded horizontally.	69.2279	227.128
T. B. M. 359	Is in the same locality as P. B. M. 176, 130 feet below it, about 1 foot above surface of ground and 3 feet from shore at medium stage; being highest point in square cut on natural ledge, marked U. ⊔ S.	68.4688	224.637
T. B. M. 360	Is ¾ mile above Miami, 2,950 feet below the creek which is outlet to Lake Teteseau, at foot of bluff, 15 feet from river, 34.5 feet below path running over bluff to Miami, on largest bowlder in this vicinity; being square cut on top of shoulder at its base, on river side, marked U. ⊔ S.	72.2563	237.064

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 361	Is about 1½ miles above Miami, on the east bank of small stream, the outlet of Teteseau Lake, about half way between the mouth of this creek and point where wagon road turns up the bluff, west of cultivated ground, 25 feet from fence; being spike in root of a 2-foot sycamore.	71.6852	235.190
P. B. M. 177=$\frac{54}{1}$	Is 2¾ miles above Miami, where the road running to Laynesville leaves the bluff, 65 feet E. 10° N. of small bridge where road crosses discharge ditch, 230 feet above the southeast corner of field, about 20 feet west of center of road and 60 feet from foot of bluff, being copper bolt in B. M. stone.	70.0417	229.798
Top of cap	Over P. B. M. 177	71.2846	233.876
T. B. M. 362	Is 2½ miles above Miami, where the wagon road from Laynesville reaches bluff, about 30 feet from foot of bluff; being spike in the west root of a 20-inch elm.	71.3145	233.974
T. B. M. 364	Is about 1 mile south of the east end of Millers Island, and 3½ miles above Miami, 505 feet below house of B. F. Smith, at south edge of wagon road where road follows the old river bank; being spike in the root of an elm.	72.4259	237.620
P. B. M. 178	Is south of the center of Teteseau Bend, about 1,700 feet from the river, at the east side of Jos. Hilderbrand's yard, 125 feet north of house, 80 feet east of east road fence and 40 feet south of south farm lane fence; being top of copper bolt in B. M. stone.	71.2296	233.695
Top of cap	Over P. B. M. 178	72.4613	237.736
T. B. M. 367	Is in the same locality as P. B. M. 178, on east side of road, in north part of Jos. Hilderbrand's yard, 50 feet from center of road, 10 feet south from the south side of farm lane, in south root of a 14-inch oak; being the highest point of a bent wire spike.	72.1656	236.766
T. B. M. 369	Is at the upper part of Teteseau Bend, about 2½ miles below Laynesville, 770 feet below Richard Hilderbrand's sawmill, on river side of road, 15 feet from center, where the road turns south away from the river; being nail in 30-inch cottonwood stump.	73.6086	241.500
T. B. M. 371	Is 1½ miles below Laynesville, on the south side of wagon road, in the northwest corner of lot owned by George Nye, 100 feet below house of I. H. Legg; being spike in the north root of a 2-foot black walnut.	73.9067	242.478
T. B. M. 372	Is 1 mile below Laynesville, Mo., on south side of road to Miami; being spike in the east root of a 30 inch lime.	74.1725	243.350
T. B. M, 373 Laynesville.	Is in Laynesville, on the west side of road going south out of town, in yard in front of old frame house, 245 feet above east-and-west road running past the post-office to river; being spike in root of a 10-inch black walnut.	73.2585	240.352
P. B. M. 179=$\frac{45}{2}$	Is in Saline County, Mo., 1 mile southeast of Laynesville, at north fence of road between townships 51 and 52, 4,379 feet west of the southeast corner of section 33, T. 52, R. 22 W., and 120 feet east of bridge over Davies Lake; being top of copper bolt in B. M. stone set 3 feet below surface of ground.	72.5047	237.878
Top of cap	Over P. B. M. 179	73.7453	241.949
T. B. M. 374	Is 1½ miles by road above Laynesville, N. 15° W. of Mr. B. F. Rutherford's house, 195 feet below lane leading to same, on north side of wagon road, being a spike in south root of a 30-inch twin sycamore.	73.7062	241.820
T. B. M. 375	Is ⅝ mile below Malta Bend Landing, on south side of road, 1,610 feet above large gate across same, on a high black walnut stump; being top of spike driven to surface.	75.0054	246.083
P. B. M. 180 Malta Bend Landing.	Is at Malta Bend Landing, 300 feet west of house occupied by S. Hugh, in west line of road, on land owned by Charles Von Stone; being copper bolt in B. M. stone.	72.7512	238.687
Top of cap	Over P. B. M. 189	73.9916	242.757
T. B. M. 377	Is ⅝ mile above Malta Bend Landing, 984 feet west of east edge of very dense woods, on the south side of wagon road; being spike in root of a boxelder 24 inches in diameter.	74.1559	243.296
T. B. M. 378	Is 1½ miles east of bridge over outlet to swamps, 25 feet west of outlet to Grand Pass Lake, and ¼ of a mile east of Mr. Ayer's residence, 150 feet west of point where wagon road turns south away from river; being spike in the southwest root of a 6-foot cottonwood.	74.2510	243.608
P. B. M. 181	Is 2 miles above Malta Bend Landing, in front of Grand Pass Lake, ¾ mile back from present river bank, 360 feet back from road that follows old river bank, in Fred Ayer's front yard, 18 feet from its northwest corner and 6 inches south from front fence, 6 feet above small gate, and 72 feet from the northwest corner of house; being copper bolt in B. M. stone.	73.4572	241.004
Top of cap	Over P. B. M. 181	74.6959	245.067

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
T. B. M. 381	Is 3$\frac{1}{4}$ miles above Malta Bend Landing, on old river bank, about 1,960 feet from present bank, where highway bridge crosses the outlet from lakes, 25 feet south of stream, at north edge of woods; being spike in the south root of a 22-inch boxelder.	74.6157	244.804
T. B. M. 382	Is 1 mile north of Grand Pass Lake, on north and south road, in field 20 feet west of the west highway fence, 770 feet south of J. Y. Chrisman's one-story frame house, by cross-rail fence; being spike in 14-inch elm.	74.8392	245.538
P. B. M. 182=$\frac{86}{1}$	Is about 5$\frac{3}{4}$ miles below Waverly, 158 feet east of point in road in front of house owned by S. H. Moore now occupied by John Plattern, 4 feet north of south fence of section line road between sections 5 and 8, T. 51, R. 23 W., 1,106 feet west of southeast corner of sec. 5; being copper bolt in B. M. stone 3 feet underground.	74.7797	245.342
Top of cap	Over P. B. M., 182	76.0233	249.422
T. B. M. 384	Is near P. B. M. 182, on road running east and west, about one half mile north of "lakes," on north side of wagon road, by John Plattern's barnyard fence; being top of spike in 30-inch elm.	75.7114	248.399
T. B. M. 386	Is about 3 miles below Waverly, 1 mile north of railroad track, at the intersection of north-and-south road running past the west end of Gilham's Lake, with east-and-west road, in the southeast corner of woods just west of land owned by Mrs. Callihan, on line with west side of north-and-south road; being top of spike in east root of 3-foot black walnut.	76.7398	251.774
T. B. M. 387	Is on the east side of wagon road, at the west end of Gilham's Lake, 1,310 feet north of Missouri Pacific track; being top of spike in the west root of 30-inch black walnut.	75.6759	248.283
P. B. M. 183	Is 3 miles below Waverly, Mo., at foot of bluff, 147 feet from center of track, at west side of wagon road, 1 foot east of fence south of the west end of Gilham's Lake, 230 feet from bridge No. 62 and 219 feet from west cattle guard at road crossing Missouri Pacific track; being copper bolt in B. M. stone.	79.3806	260.438
Top of cap	Over P. B. M. 183	80.6203	264.505
T. B. M. 388	Is in the vicinity of P. B. M. 183, 60 feet north from Missouri Pacific track at road crossing, at east edge of wagon road; being top of spike in 2-foot elm.	76.8422	252.109
T. B. M. 389	Is 1$\frac{3}{4}$ miles below Waverly, Mo., 738 feet west of line between Lafayette and Saline counties, 230 feet above bridge No. 59, on river side of track, 15 feet from center; being highest point in square cut in rock.	78.8126	258.574
P. B. M. 184=$\frac{87}{1}$	Is 1$\frac{1}{2}$ miles below Waverly, Mo., 984 feet north of track, on land owned by Charles Walton, in corner of field, 177 feet, S. 59° 30′ E. (Mag). from a point on section line between sections 12 and 13, T. 51 R. 24 W., which point is 460 feet west of $\frac{1}{4}$ post between said sections; being top of copper bolt in B. M. stone.	74.9313	245.840
Top of cap	Over P. B. M. 184	76.1724	249.912
T. B. M. 390=old B. M. 175.	Is 1 mile below Waverly, 50 feet from river bank, at upper edge of timber; being top of spike in south root of 2.7 foot elm stump.	76.4675	250.880
T. B. M. 392	Is $\frac{5}{8}$ mile below Waverly depot and 770 feet below highway crossing, on bluff side of Missouri Pacific track, 12 feet from center; being highest point in square cut on a rock.	81.0565	265.936
T. B. M. 185=$\frac{88}{1}$ Waverly.	Is in Waverly, Mo., about $\frac{1}{2}$ mile below depot, 60 feet south of Missouri Pacific track, in northwest corner of lot owned by W. Milnor, 20 feet south of north line of lot and 10 inches east of west fence; being copper bolt in B. M. stone.	82.6584	271.192
Top of cap	Over P. B. M. 185	83.9058	275.284
T. B. M. 394	Is in same corner of field as P. B. M. 185; being top of spike in west root of large elm.	82.7848	271.606
Gauge	At Waverly is at foot of road running down bluff from the town and crossing track just below depot. It is an inclined staff gauge. Elevation of its zero.	60.0683	197.076
P. B. M. 186	Is one mile above Waverly on east end of bridge No. 55, Missouri Pacific Railway, on south end of bridge seat stone, 6 inches west from retaining wall and 8 inches back from face of bridge seat stone; being top of copper bolt leaded vertically.	78.9518	259.031
T. B. M. 396	Is near P. B. M. 186, on north end east abutment of same bridge, 9 inches east of northwest corner, and 8 inches back from face; being highest point in square cut on cap stone of retaining wall and marked U. □ S.	80.3677	263.676
P. B. M. 187	Is 1$\frac{1}{2}$ miles above Waverly, on south end of east abutment bridge east course of bridge No. 54, Missouri Pacific Railway, 6 inches west of retaining wall and 6 inches back from face; being top of copper bolt leaded vertically.	79.8273	261.903

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 397	Is near P. B. M. 187, on north end of same abutment, 14 inches east from northwest corner of stone and 3 inches back from face; being highest point in square marked U. □ S.	80.3714	263.688
P. B. M. 188	Is about 1⅙ miles above Waverly, Mo., 10.5 feet east of the east end of bridge No. 52, on south side Missouri Pacific track and 30 feet from bank of small stream, 3.3 feet east of 10-inch elm, at foot of bluff, on flat spot of ground; being copper bolt in B. M. stone.	79.0434	261.300
Top of cap	Over P. B. M. 188	80.8788	265.353
T. B. M. 398	Is 3.3 feet west of P. B. M. 188; being top of spike in root of 10-inch elm.	80.5906	264.407
T. B. M. 399	Is about 2¼ miles above Waverly, Mo., on Missouri Pacific Railway bridge No. 51, on first bent from east end; being top of drift bolt over pile at the north end of cap.	80.2438	263.269
P. B. M. 189=$^{49}_{1}$	Is 4 miles above Waverly, 2¼ miles below Edwards, 50 feet above bridge 47, Missouri Pacific Rwy., bluff side of track, 100 feet from center and 40 feet northeast of a cluster of six lime trees (blazed).	86.6082	284.150
Top of cap	Over P. B. M. 189	87.8479	288.217
P. B. M. 190	Is 1¼ miles below Edwards, Mo., at point of bluff, 738 feet below bridge No. 46, Missouri Pacific Rwy., on south side of track, 12.4 feet from center and 3.9 feet above grade; being the center of punch mark in copper bolt leaded horizontally into natural ledge.	83.4110	273.661
T. B. M. 402	Is 1¼ miles below Edwards, 785 feet below bridge No. 46, on south side of track 10 feet from center; being highest point in square cut on natural ledge.	82.8768	271.908
P. B. M. 191	Is at Edwards, Mo., in north face of foundation of old mill, 33 inches west of east window and 3 feet below top of foundation; being center of punch mark in copper bolt leaded horizontally.	82.1962	269.675
P. B. M. 192. Edwards.	Is at Edwards, Mo., 730 feet below depot, 130 feet north of northwest corner of Edward's mill, 154 feet southeast of railroad bridge No. 42, 95 feet SSW, of lower head-dock of siding, 33 feet above road crossing, 72 feet south of center of Missouri Pacific track, and 1½ feet north of south right-of-way fence; being copper bolt in B. M. stone.	79.5628	261.035
Top of cap	Over P. B. M. 192	80.8061	265.114
T. B. M. 403	Is 620 feet below depot at Edwards, 45 feet below bank of small creek under bridge No. 42, Missouri Pacific Rwy., on south side of track 59 feet from center; being highest point in square cut on imbedded rock.	80.7711	264.999
P. B. M. 193=$^{59}_{1}$	Is 2 miles below Dover depot, 164 feet south of Missouri Pacific track, in NW¼. of SE¼. of Sec. 9, T. 51, R. 25 W., in W. D. Ballard's yard, between house and well, in line with north side of house and 14 feet from the northwest corner; being copper bolt in B. M. stone.	81.5390	267.519
Top of cap	Over P. B. M. 193	82.7785	271.586
T. B. M. 407	Is about 2⅜ miles below Dover, ¾ miles below water tank, 574 feet below bridge No. 35, bluff side of Missouri Pacific track 29 feet from center; being highest point in square cut on rock.	81.5564	267.576
T. B. M. 408	Is 1½ miles below Dover, on stone foundation of water tank, at the southeast corner; being highest point in square.	82.2124	269.728
T. B. M. 409	Is 3,100 feet below Dover, Mo., at lower end of bridge 33; being top of spike in south end of cap over pile.	80.7282	264.859
T. B. M. 194. Dover.	Is at Dover, 39 feet west from the road crossing, at the southeast corner of depot platform, 48.5 feet east of the east end of depot, on south side of track 12 feet from center; being copper bolt in B. M. stone.	80.4469	263.936
Top of cap	Over P. B. M. 194	81.6869	268.004
P. B. M. 195=$^{71}_{1}$. Berlin.	Is in Berlin, Mo., 580 feet N. 87° W. from Y. E. Gray's brick house on bluff, on bluff side of track 145 feet from center, 425 feet below bridge No. 26, and 1,030 feet above bridge No. 27; being copper bolt in B. M. stone.	82.0227	269.106
Top of cap	Over P. B. M. 195	83.2583	273.160
P. B. M. 196	Is in Berlin, in south end of east stone abutment to bridge No. 26, 3 feet below grade of track; being top of copper bolt leaded vertically.	82.7916	271.628
T. B. M. 411	Is very close to P. B. M. 196, on south end of west abutment; being highest point in square marked U. □ S.	83.4183	273.685
P. B. M. 197	Is 1 mile below Northrup, Mo., on south end of west pier of iron bridge No. 25 across Big Tabo Creek, in line with west side of pedestal, one foot south of same; being copper bolt leaded vertically.	81.8869	268.660
T. B. M. 412. Tabo Creek.	Is near P. B. M. 197, on south end of east pier; being highest point in square marked U. □ S.	82.1482	269.518
P. B. M. 198. Northrup.	Is 1,460 feet above section house at Northrup, Mo., 328 feet below east bank of side hill cut, on bluff side of track 75 feet from center; being copper bolt in B. M. stone.	84.0020	275.600

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation Meters.	Elevation Fe[et]
Top of cap	Over P. B. M. 198	85. 2377	27
T. B. M. 415	Is about seven-eighths mile above section house at Northrup, 1,785 feet below Missouri Pacific bridge No. 22, 288 feet below sign "station one mile," on sandstone ledge; being highest point in square.	84. 8286	27
P. B. M. 199=$^{62}_{1}$	Is 5¼ miles below Lexington, Mo., near the center of wide bottom land 1¼ miles below point where bluff leaves river, in the northeast corner of northwest ¼ of northwest ¼ of Sec. 29, 639 feet south of the Missouri Pacific track, 100 feet southwest of the southwest corner of a small log-house owned by Wm. Mayfield, 2 feet west of a north and south fence; being copper bolt in B. M. stone.	80, 1792	26
Top of cap	Over P. B. M. 199	81. 4240	26
T. B. M. 419	Is 4¼ miles below Lexington, Mo., 820 feet above end of bridge No. 21, Missouri Pacific Railway, and about 325 feet above end of long side-hill cut, on bluff side of track 12 feet from center; being highest point in square cut in natural ledge.	85. 8911	28
P. B. M. 200	Is 3¼ miles below Lexington, Mo., on south end of west abutment, bridge seat course, of Missouri Pacific Rwy., bridge No. 19, 9 inches east of retaining wall, and 14 inches north from face; being top of copper bolt leaded vertically.	86. 2875	28
T. B. M. 420	Is about 3 miles below Lexington, Mo., at Missouri Pacific Rwy. bridge No. 17, on north end of west abutment, in northwest corner of coping stone; being highest point in square cut on rock and marked U. □ S.	88. 7585	29
P. B. M. 201	Is about 2¾ miles below Lexington, Mo., about in middle of 1,200 foot tangent on Missouri Pacific track, at foot of bluff, 32.8 feet from track center, 150 feet below bridge No. 15, on east side of small coulee and 8 feet south of right-of-way fence; being copper bolt in B. M. stone.	87. 0702	28
Top of cap	Over P. B. M. 201	88. 3108	29
T. B. M. 421	Is 150 feet below P. B. M. 201, 300 feet below bridge No. 15, at foot of bluff, 75 feet from track center; being top of spike in north root of a 14-inch hickory.	88. 6642	29
P. B. M. 202	Is about 2¼ miles below foot of Pine street, Lexington, Mo., on south side of west abutment of bridge No. 14, Missouri Pacific Rwy., on bridge seat course, 8 inches from retaining wall and 8 inches from face; being top of copper bolt leaded vertically.	86. 0799	28
T. B. M. 422	Is 1¼ miles below foot of Pine street, Lexington, 540 feet below head block of switch to coal mine, 15 feet north of Missouri Pacific track, near river bank, on large imbedded bowlder being highest point in square.	84. 4986	27
P. B. M. 203=$^{63}_{1}$	Is in lower part of Lexington, 1,770 feet below Missouri Pacific bridge No. 8, at foot of Pine street, 130 feet from the northeast end of Missouri Pacific bridge No. 10, on bluff side of track, by wire fence; being copper bolt in B. M. stone.	83. 7174	27
Top of cap	Over P. B. M. 203	84. 9574	27
Gauge	At Lexington is 1,968 feet below foot of Pine street, 82 feet above house of J. S. Walters; being an inclined staff gauge elevation of its zero.	60. 9791	20
T. B. M. 423	Is 98 feet above inclined gauge, 1,900 feet below Missouri Pacific bridge No. 8, at foot of Pine street, 180 feet above J. S. Walter's house, 262 feet below Missouri Pacific bridge No. 10, on bluff side of track, 40 feet from center; being highest point in square cut on rock.	85. 0974	27
P.B.M. 204 Lexington.	Is in Lexington, Mo., at the foot of Pine street, in north face of retaining wall, 13 feet west of the east end and 30 feet below center of stream running over top of this wall; it is in the third course of masonry from top, 3.3 feet below same; being center of punch mark in copper bolt leaded horizontally.	83. 6602	27
T. B. M. 424	Is in Lexington, 1 foot lower and 1 foot further down stream than P. B. M. 204; being highest point in square cut on top of fourth course of masonry from top, in retaining wall.	83. 4072	27
P. B. M. 205=Old B. M. 190.	Is in Lexington, Mo., in point of bluff on west side of Pine street, 210 feet from river and 19.5 feet west of west fence along Pine street; being horizontal furrow in copper bolt leaded horizontally into natural ledge.	93. 4366	30
T. B. M. 425=Old B. M. 191.	Is 1¼ miles above Ferry landing at Lexington, 655 feet above city limits, at north end of rock arch bridge over Graham's Creek, directly over arch, near top of parapet wall, on top at the southeast corner of cut rock inscribed Crum and Hackett, 1858. A cross is cut in the south face (road side) of the stone, which at the intersection is 1 inch below the bench.	86. 2873	28

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	Elevation. Feet.
P.B.M. 206	Is on same bridge as Old B. M. 191, between the two branches of the Missouri Pacific track, 2,345 feet below the Junction depot, 40 feet west from the east end of wall, on north face, 4½ feet above ground, and 3 feet below coping stone, 30.5 inches east from center of arch; being center of punch mark in copper bolt leaded horizontally.	85.4440	280.331
P.B.M. 207	Is about 2¼ miles above the ferry landing at Lexington, 410 feet below siding to J. C. McGrew's coal mine, 150 feet below house occupied by Edward Rosewell on land owned by Reed and Taylor families, directly opposite small bridge on wagon road and culvert on railroad, on bluff side of track, 80 feet from center, and 25 feet from wagon road; being copper bolt in B. M. stone.	85.1027	279.211
Top of cap	Over P. B. M. 207	86.3434	283.282
T.B.M. 427	Is 1,195 feet below mile post 248, 175 feet above J. C. McGrew's coal mine No. 2, at end of siding for mine, just outside of right of way, on bluff side of track; being top of spike in root of 18-inch oak.	87.7268	287.820
P.B.M. 208	Is 2¼ miles below Wellington, Mo., 1,605 feet below the east end of Missouri Pacific bridge No. 145, over Little Sny Creek, ½ mile above the mouth of slough at foot of Wolf Island, 490 feet north of forks of road, at foot of hill, on roadside, 10 feet northeast of a lone red oak 20 inches in diameter, 4 feet from corner of field and 62 feet east of track center; being copper bolt in B. M. stone.	86.4110	283.503
Top of cap	Over P. B. M. 208	87.6438	287.548
T.B.M. 429, Old B. M. 194.	Is 2 miles below Wellington, Mo., on the line of the Missouri Pacific Rwy., opposite bridge No. 145, 328 feet below mile post 249, at the northeast corner of the east abutment of wagon bridge over Little Sny Creek; being + cut in top of stone.	86.3216	283.210
P. B. M. 209=$\frac{84}{Y}$ Wellington.	Is 1,950 feet below Wellington mill, 1,655 feet above west end of Missouri Pacific bridge No. 149 over Big Sny Creek, 250 feet above bridge No. 150, 55 feet above upper end of coal dump, at point of bluff where bluff recedes, 35 feet south of center of Missouri Pacific tracks; being copper bolt in B. M. stone.	88.4422	290.167
Top of cap	Over P. B. M. 209	89.6858	294.248
T.B.M. 430	Is 80 feet below P. B. M. 209, just outside of south right-of-way fence; being top of spike in 32-inch elm.	88.4718	290.264
P.B.M. 210	Is in Wellington, Mo., 400 feet below the depot, at the northeast corner of mill 5 inches south from the corner, and 25 inches above ground; being center of punch mark in copper bolt leaded horizontally.	92.3873	303.111
T.B.M. 431	Is in Wellington, 400 feet below depot, at the southeast corner of mill, being highest point in square cut on stone 2 inches above ground and marked U. [] S.	93.2149	305.826
T.B.M. 432	Is ¾ mile above Wellington, Mo., at the upper end of bridge, No. 155, on bluff side of track, 30 feet from center; being top of spike in north root of a 30-inch elm.	97.6533	320.388
P.B.M. 211	Is 3,600 feet below Waterloo, 226 feet above coal mine of Mr. Hartmann, 30 feet west of gate through which road leads from coal mine up the bluff, 10 feet north of wagon road, directly north of a one-story frame house on edge of bluff, 62 feet south from Missouri Pacific track center, 2 feet outside of right of way; being copper bolt in B. M. stone.	86.0867	282.439
Top of cap	Over P. B. M. 211	87.3224	286.493
T.B.M. 433	Is about 80 feet below P. B. M. 211, 338 feet below head block of switch to coal mine, 44 feet above the mine, 10 feet outside of north right-of-way fence; being top of spike in south root of a 26-inch elm.	85.8991	281.824
T.B.M. 434 Waterloo.	Is 1½ miles below Napoleon, 2,050 feet above depot at Waterloo, 1,245 feet above road crossing, 1,555 feet above mile post 254, 30 feet outside of right of way, on bluff side of track; being top of spike in 13-inch sycamore.	88.3945	290.011
P.B.M. 212=$\frac{4}{Y}$ Napoleon.	Is at Napoleon, Mo., 220 feet south of depot, at foot of bluff, 90 feet east of small creek under trestle No. 161, Missouri Pacific Rwy., and about 75 feet south of wagon road; being copper bolt in B. M. stone.	89.4674	293.531
Top of cap	Over P. B. M. 212	90.7081	297.601
T.B.M. 435	Is 1,060 feet above the depot at Napoleon, 520 feet above trestle No. 161, 230 feet below center of old flour mill and same distance below mile post 256, 32 feet south from center of Missouri Pacific track; being top of spike in root of 18-inch walnut.	92.0716	302.075
T.B.M. 436	Is about 1 mile above Napoleon, 1,840 feet below house of F. P. Ellis, 10 feet east of east end of open culvert, and 8 feet south of center of Missouri Pacific track; being highest point in square cut on natural ledge.	93.5646	306.973

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 213	Is 2 miles above Napoleon, Mo., 390 feet below the line between Jackson and Lafayette counties, 150 feet below farm crossing, 1,400 feet below bridge 164, 72 feet in direct line from bridge 163, 59 feet south of center of track, on point of land between old Lexington and Napoleon roads owned by Mr. Johnson, 8.6 feet northeast from an elm tree 30 inches in diameter; being copper bolt in B. M. stone.	89.4036	2
Top of cap	Over P. B. M. 213	90.6407	29
T. B. M. 437	Is 1¼ miles below Levasy, Mo., 137 feet below the east line of Jackson County, 260 feet above trestle No. 163, Missouri Pacific Rwy., 90 feet above farm crossing, on north side of track, at right-of-way fence; being top of spike in base of 2-foot elm.	88.9751	29
T. B. M. 439	Is ¾ mile below Levasy, 1,410 feet below road crossing, 60 feet below whistle post, 245 feet above farm crossing, on river side Missouri Pacific track, 60 feet from center, at the lower end of a row of elms; being top of spike in root of 14-inch elm.	89.9959	2
T. B. M. 440 Levasy.	Is in Levasy, Mo., 50 feet east of J. C. McGrew's grain elevator, at the south side of yard, owned by Mrs. Anna B. Hays, 60 feet north of center Missouri Pacific track; being top of a 6-inch spike in south root of 3-foot cottonwood.	89.8014	2
T. B. M. 442	Is about 1¾ miles south of Matthews Landing, and ¼ mile below F. W. Schwester's house, about 350 feet south of branch road running west up bluff, 1.3 feet west of west fence; being top of spike in north root of 14-inch elm.	91.4000	3
P. B. M. 214=$\frac{4}{4}$	Is about 2 miles below Sibley Bridge, at Matthews Landing, 390 feet south of river bank, in southwest corner of young orchard, 202 feet west from southwest corner of D. O'Donnell's house, at the east side of north and south road and on north side of lane leading past house; being copper bolt in B. M. stone.	90.6844	2
Top of cap	Over P. B. M. 214	91.9246	3
T. B. M. 444	Is at Matthews Landing, in center of north and south road at point where road comes to river, between the houses of Isaiah Johnson and D. O'Donnell; being top of spike in top of 30-inch oak stump about 18 inches high.	92.5403	3
T. B. M. 445, old bench 210. Matthews Landing.	Is at Matthews Landing, 2 miles below Sibley Bridge, on the house of D. O'Donnell, east side of road, at the northwest corner of foundation; being the highest point in square cut on northwest quarter of cross.	92.6311	3
T. B. M. 446	Is 1½ miles below Sibley Bridge and ½ mile above Matthews Landing, 50 feet from river and 75 feet from foot of bluff, 200 feet above an old log house and 15 feet north from wagon road; being top of spike in south root of 18-inch pin oak.	93.0567	3
T. B. M. 447	Is 1 mile below Sibley Bridge, 590 feet below the one-story house occupied by Mr. Faris, 50 feet back from river bank, on east bank of small ravine, at mouth of which a large spring is flowing; being top of spike in south root of a 3-foot bur oak.	96.0737	3
T. B. M. 448	Is ¾ mile below the Santa Fe R. R. Bridge at Sibley, 55 feet south from top of right bank in front of orchard, 570 feet below farm house and 210 feet above the lower barn, 35 feet north of wagon road and 20 feet south of a small log house or corncrib; being top of a spike in south root of 14-inch black walnut.	90.5109	2
P. B. M. 215	Is 1 mile below station at Sibley, Mo., at the south end of Santa Fe Bridge, across the river, 108 feet back from top of river bank, at foot of bluff, 75 feet east and 23 feet north of the northwest corner of land pier; being copper bolt in B. M. stone.	91.9997	3
Top of cap	Over P. B. M. 215	93.2350	3
P. B. M. 216	Is at Sibley, Mo., on right bank in land pier of the Santa Fe Bridge, at the top and southwest corner of pier, 6 inches back from each beveled edge; being top of copper bolt leaded vertically.	101.4760	3
T. B. M. 449	Is on top of bank, upstream side of south end of Sibley Bridge, 98 feet west of track center, 106 feet north of Andrew Brown's one-story frame house at right-of-way fence; being top of spike in east root of a 14-inch oak.	109.5116	3
T. B. M. 450 New Sibley.	Is at New Sibley, 350 feet west of bridge No. 596, Atchison, Topeka and Santa Fe Rwy., 360 feet east of depot and 40 feet above road crossing, on top of bluff, 15 feet from brink, 110 feet north of center of track; being top of spike in root of 18-inch white oak.	111.7810	3

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 451	Is about ¾ mile above New Sibley, 1,850 feet east of wagon bridge No. 600 over track, 210 feet east of Santa Fe R. R. Bridge No. 599, on the east side of coulee at upper end of cut, on river side of track, 35 feet from center; being top of spike in west root of white oak stump.	105.6402	346.592
T. B. M. 452	Is on lower point of bottom land above Sibley, about ½ mile north of railroad track, on the east bank of stream that flows under bridge No. 599, 100 feet north of wagon road at foot of bluff and small bridge; being top of spike in west root of 3-foot oak.	92.1450	302.316
P. B. M. 217	Is on bottom land just above Sibley, 2,800 feet north of bridge over small creek at foot of bluff, where T. B. M. 452 is located, 400 feet south of Keller and Angel's house. 360 feet north of small box culvert and road running east through field at east edge of brush on the west side of north and south county road, 1½ feet east of fence; being top of cap over old B. M. $\frac{45}{1}$.	89.9898	295.245
T. B. M. 454	Is about 1¾ miles above New Sibley, 2,345 feet above Highway bridge No. 600, over railroad track through cut, 410 feet above farm crossing, and 1,170 feet below mile post 433, 30 feet north of center of Santa Fe track; being top of spike in charred stump.	96.9194	317.980
P. B. M. 218	Is near the river on line of Santa Fe railroad, about 2¾ miles above New Sibley, on line with center of road running up bluff, 125 feet below Auld's sawmill, opposite the upper end of bridge No. 603, just above wing fence, bluff side of track 30 feet from center; being copper bolt in B. M. stone.	91.3948	299.854
Top of cap	Over P. B. M. 218	92.6279	303.900
T. B. M. 456	Is where railroad comes to river, 3 miles above New Sibley, at Auld's sawmill siding, about 1,115 feet above P. B. M. 218, below upper head block of siding, on river side of track 30 feet from center; being top of spike in large oak stump.	92.8957	304.779
T. B. M. 457	Is 3¾ miles above New Sibley, at the first point of bluff above Auld's sawmill, at upper end of cut, 30 feet below mile post 435, on bluff side of track, 25 feet from center, and 3 feet above grade; being highest point in square cut on large rock in side of slope, and marked U. S.	97.0239	318.323
T. B. M. 458	Is 705 feet below east end of railroad bridge No. 605 over Little Blue River, 230 feet below mile post 436, 20 feet north from center of track: being highest point in square cut on a rock at foot of bank, and marked U. S.	92.6676	304.030
P. B. M. 219 = $\frac{42}{1}$	Is on right bank, opposite Missouri City, five-eighths mile above the Santa Fé bridge, over the Little Blue River, 2,295 feet above road crossing, 820 feet north of railroad track, on the north side of wagon road, about 2 feet inside of Mr. Sullivan's field, about 200 feet above a small one-story house on south side of road and 30 feet below two small plum trees growing close together on the north side of road; being copper bolt in B. M. stone.	92.4221	303.225
Top of cap	Over P. B. M. 219	93.6650	307.302
T. B. M. 459	Is 1½ miles below Atherton, 3,015 feet above highway crossing on section line, 75 feet below mile post 437, at north side of 4-foot fill on track, 15 feet from center; being top of spike in low stump.	92.9424	304.932
T. B. M. 460	Is three-fourths mile below Atherton, 885 feet above farm crossing, 275 feet above the small railroad trestle No. 606, 30 feet below edge of field in the southwest corner of triangular point of woods, on north side of Santa Fe track, 12 feet outside of right of way; being top of spike in 18-inch doublepin oak.	94.9424	311.494
P. B. M. 220 Atherton.	Is in Atherton, Mo., 1,185 feet below depot, 245 feet below section house, 328 feet above road crossing, 215 feet below lowest head block of siding and 49 feet below tool house, directly opposite and northwest from Joseph Sample's house, 49 feet north from center of track at south side of right-of-way fence; being copper bolt in B. M. stone.	96.2744	315.864
Top of cap	Over P. B. M. 220	97.5114	319.922
T. B. M. 463	Is 1 mile below head of Blue Mills Island, 1⅛ miles above Atherton, 328 feet above road crossing, opposite bridge No. 607 Atchison, Topeka and Sante Fe Railroad, 75 feet north of center, on west bank of small creek; being top of spike in the west base of 18 inch sycamore.	95.4831	313.268
P. B. M. 221	Is near old B. M. 227, about 1⅛ miles below Blue Mills Landing, 2¼ miles above Atherton, 328 feet south from Santa Fe track, 200 feet west of section line, on land owned by George Hendrick, 35 feet east from levee, near creek from spring and path leading down from Mr. Hendrick's house, on small point of bluff 10 feet above level of bottom land; being copper bolt in B. M. stone.	98.6274	323.584

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.
Top of cap	Over P. B. M. 221	99.8602
T. B. M. 464 = Old B. M. 227	Is opposite the head of Blue Mills Island, about 250 feet north of railroad track, 100 feet southwest from Fred. Schrank's one-story log house; being top of spike in north root of 2-foot black walnut.	95.3916
T. B. M. 465	Is at Blue Mills Landing, 1,330 feet below railroad bridge No. 609, in small railroad cut, 72 feet below old mill at the Ferry Landing to which the road leads, and 115 feet above road crossing, 7 feet north from center of track; being highest point in square cut on natural ledge and marked U. □ S.	101.8388
T. B. M. 466 = Old B. M. 33 of 1878.	Is at Blue Mills Landing, on the river bank at the northeast corner of old mill (now gone), on the top of a ledge of rock 14 inches from the north edge and 3 inches from east edge, marked +.	97.3100
T. B. M. 467 = Old B. M. 228. Blue Mills Landing.	Is at Blue Mills Landing, at the northeast corner of site of old mill, in the river face of ledge of rock, 7.1 feet below the top and 6.5 feet from the east face of ledge; being center of cavity from which horizontal copper bolt had been extracted.	94.8112
T. B. M. 468	Is $1\frac{1}{10}$ miles below Courtney Station, 1,310 feet below mile-post, 443,740 feet below lower end of earth cut, 518 feet above west end of railroad trestle No. 610, at top of river bank, 22 feet from track center; being top of spike in root of an oak stump 20 inches in diameter.	98.7322
P. B. M. 222	Is at Courtney, Jackson County, Mo., 12 feet east of southeast corner, on line with south side of depot, in the southwest corner of plat of ground at angle in platform; being copper bolt in B. M. stone.	97.3551
Top of cap	Over P. B. M. 222	98.5867
T. B. M. 469	Is at Courtney, 1,135 feet below depot, in front of stock yard, 24 feet below lower end of car scales, 30 feet north from center of main track; being top of spike in most easterly of three piles.	99.1850
T. B. M. 470	Is five-eighths mile above Courtney Station, 1,400 feet above highway crossing, on first curve above town, 15 feet below sign, "Station," at foot of bluff, 10 feet from center of track, on white, imbedded rock; being highest point in square, marked U. □ S.	100.1819
T. B. M. 471	Is $1\frac{1}{4}$ miles below pump house of Independence Water Works, and ½ mile below road crossing, at old Wayne Landing on bluff side of track, 20 feet from center; being highest point in square cut on projecting point of natural ledge and marked U. □ S.	103.7949
T. B. M. 472	Is 16 feet above P. B. M. 223, 150 feet below road crossing, on river side of track, 55 feet from center, on the nearest of group of three cottonwoods; being top of spike in root.	101.7724
P. B. M. 223 = [illegible] Wayne.	Is at old Wayne Landing, ½ mile below pump house of Independence Water Works, 82 feet below group of cottonwoods, on river side of track, 80 feet from center, on south edge of wagon road, 39 feet below old stone wall foundation standing at right angles to track; being copper bolt in B. M. stone.	97.3400
Top of cap	Over P. B. M. 223	98.5813
P. B. M. 224	Is in Wayne between railroad track and the river at the southwest corner of pump house of Independence Water Works, on the south face, 5 inches east of the west corner, 65 inches above ground; being center of punch mark in copper bolt leaded horizontally.	101.4933
P. B. M. 225	Is about 2,460 feet below Santa Fe bridge No. 616 over Rock Creek, and 525 feet above bridge No. 615, between two small ravines which are about 850 feet apart, 48 feet south from center of track, and 2 feet north of right-of-way fence; being copper bolt in B. M. stone.	102.1171
Top of cap	Over P. B. M. 225	103.3532
T. B. M. 474	Is 2,165 feet below Santa Fe bridge No. 616 over Rock Creek, 40 feet below farm crossing, 40 feet south from center of track; being top of spike in root of 15-inch lime.	102.7868
P. B. M. 226. Rock Creek.	Is about $2\frac{1}{4}$ miles above Independence, Mo., at the crossing of A. T. and S. Fe and Mo. P. tracks, at foot of iron post of Santa Fe bridge standing between Missouri Pacific, and K. C. and Ind. tracks; being top of anchor bolt through northwest corner of shoe. The letters U. S. are cut into east pedestal, one on each side of nut to anchor bolt.	100.5822
P. B. M. 227. Big Blue River.	Is on the right bank of Big Blue River, near its mouth, 98 feet up that stream from the south end of Missouri Pacific Railroad bridge No. 69, upon pier of which bridge is located U. S. C. & G. S. B. M. LVIII. It is 2 feet outside of right-of-way fence and 18.5 feet back from the top of bank of Big Blue River.	97.9719

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M. 227	99.2093	325.493
U. S. C. S. B. M. LVIII.	Is 5½ miles below Grand Avenue Depot at Kansas City, Mo., on south abutment of Missouri Pacific bridge No. 69, over the Big Blue River, on the southwest corner, above the bridge seat; being bottom surface of square cavity cut in masonry and marked U S □ B M.	102.0088	334.875
T. B. M. 475	Is 4½ miles below Grand Avenue Depot at Kansas City, Mo., 1 mile above Big Blue River, ⅞ mile above telegraph station, 1,835 feet below Chicago, Milwaukee and St. Paul Railway, and Missouri Pacific Railway crossing, in pasture on north side of track, 60 feet from center, 20 feet outside of right of way; being top of spike in root of 18-inch elm.	99.7267	327.190
T. B. M. 476	Is about 4½ miles below Hannibal Bridge at Kansas City, 4,265 feet below Tile Works, 1,400 feet above road crossing, 60 feet north of center of north one of two Missouri Pacific tracks; being top of spike in south root of 40-inch elm.	100.2248	328.824
P. B. M. 228 = $\frac{41}{1}$ ...	Is about 3½ miles below Hannibal Bridge, ⅝ mile southeast of Cresent Elevator, about 2,295 feet north of tile factory, at northwest corner of intersection of two country roads, 120 feet S. 65° W. of Lizzie Wright's house; being copper bolt in B. M. stone.	97.8868	321.154
Top of cap	Over P. B. M. 228	99.1274	325.224
T. B. M. 478 = Old B. M. 240.	Is in Kansas City, Mo., 1¾ miles below the Hannibal Bridge, at the Kansas City Distillery, at northwest corner of one-story brick fermenting house, 2.5 feet east of corner on top of the stone foundation; being the highest point in the northeast angle of cross.	100.2078	328.769
T. B. M. 479	Is in Kansas City, Mo., 1 mile below the Hannibal Bridge, at the northeast corner of Zenith Mills, on top of foundation; being the highest point in square. This is in the same place as old B. M. 241, the masonry upon which that was located having been replaced.	102.1436	335.120
P. B. M. 229	Is in Kansas City, Mo., ⅞ mile below the Hannibal Bridge. 60 feet north from the Chicago and Alton track, on the south side of the retort room of gas works, in water table 50 inches west of the southeast corner; being top of copper bolt leaded vertically.	102.3098	335.665
T. B. M. 480 = Old B. M. 242.	Is in Kansas City, Mo., on the northwest corner of First and Main streets, at the southeast corner of the three-story brick occupied by the Pabst Brewing Company; being a cross cut in top of stone step. This bench was partly destroyed and a new point was taken instead on the same surface 2 inches nearer the river, between two parallel lines cut in the stone.	107.6223	353,095
P. B. M. 230 = $\frac{73}{1}$	Is in Kansas City, Mo., 50 feet east of the shore pier of the Hannibal Bridge and 10 feet from river bank; being copper bolt in B. M. stone.	101.4593	332.875
Top of cap	Over P. B. M. 230	102.7038	336.958
U. S. C. and G. S. B. M.	Was top of cap over old pipe over old P. B. M. $\frac{73}{1}$. This pipe was replaced by a similar pipe with flange at bottom.	102.7058	336.964
P. B. M. 231 = Old B. M. 244.	Is on the Hannibal Bridge, over the Missouri River at Kansas City, Mo., on the east face of first pier north from south abutment; being point of arrowhead engraved in the stone and marked $\ggg\xrightarrow[\text{1844}]{\text{High Water}}$. It was connected with by U. S. C. S. precise levels.	104.0555	341.392
Kansas City datum.	Is 32.03 feet below the arrowhead described above, and was, when assumed, supposed to coincide with low water in the Missouri River.	....	309.362
P. B. M. 232 = Old B. M. 243. Kansas City.	Is in Kansas City, Mo., in north face of south abutment of Hannibal Bridge near east end of abutment; being horizontal furrow in copper bolt (connected with by U. S. C. S.).	104.2152	341.916
T. B. M. 481	Is directly under P. B. M. 232, at northeast corner of abutment; being highest point in square cut on projecting stone.	103.4352	339.358
U. S. gauge	At Kansas City, is a wire cable gauge on the south span of the Hannibal Bridge. Elevation of its zero.	+0.0742	+0.244
P. B. M. 233	Is in Kansas City, Mo., at the foot of Fourth street, in stone pier of wagon bridge over tracks, the south face of the north one of two small piers on river side of Missouri Pacific main track, 5 feet above ground and 9½ inches back from the southwest corner of pier; being center of punch mark in copper bolt leaded horizontally.	102.8089	337.302

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation	
		Meters.	F
T. B. M. 482	Is in the same locality as P. B. M. 233, at the northwest one of three iron struts forming a rectangle with the south one of two small piers on river side of track, on top of cap stone supporting this strut; being highest point in square.	101.9420	3
P. B. M. 234	Is in Kansas City, Kans., on the southeast corner of James street and Lyon avenue, in the stone foundation of Police Station No. 2, on James Street face, 22½ inches from its northwest corner in second course of stone from top, 3½ feet above sidewalk, being center of punch mark in copper bolt leaded horizontally.	103.6118	3
T. B. M. 483	Is in Kansas City, Kans., on the southeast corner of James street and Lyon avenue, in front of Police Station No. 2, on the east side of James street, 23.5 feet south from the northwest corner of sidewalk; being highest point in square cut on curbstone and marked U. □ S.	102.3460	3
P. B. M. 235 Kaw River.	Is on the left bank of Kaw River, in the same pier as T. B. M. 484, in west face, 7.2 feet south of north corner, in third course of masonry from ground, 2 feet below grade of Missouri Pacific track; being center of punch mark in copper bolt leaded horizontally.	100.0816	3
T. B. M. 484	Is on the left bank of the Kaw River, at the third bridge above the mouth, over which the cable cars cross, on the first pier east of the west abutment, on west face of pier at north corner; being highest point in square cut on top of projection of second course of stone above ground and marked U. □ S.	99.5502	3
T. B. M. 485 = Old B. M. 248.	Is in Kansas City, Kans., on the northeast corner of Third street and Wyandotte avenue, on the south face, next to the southwest corner of a two-story brick, on the outer edge, next to corner stone pillar of iron doorsill.	111.0557	3
T. B. M. 486 = City B. M. Kansas City, Kans.	Is at the northwest corner of Third street and Minnesota avenue; being top north nut in rim of hydrant. (The elevation of this bench above the old city datum is 51.46 feet; above the new datum is 364.94 feet.)	111.3204	3
T. B. M. 485	Is in Kansas City, Kans., between the Missouri Pacific and Kansas City, Wyandotte and Northwestern Railway tracks, 460 feet below their crossing, at the southeast corner of old gas factory, on top of foundation; being highest point in square.	106.4787	3
P. B. M. 236	Is at the upper end of Kansas City, Kans., 300 feet below the K. T. Brick Works, opposite the lower head block of switch, 50 feet east from center of track by right-of-way fence; being copper bolt in B. M. stone.	102.4877	3
Top of cap	Over P. B. M. 236	103.7260	3
T. B. M. 488	Is in same locality as P. B. M. 236, 855 feet above mile post 287 and crossing, 160 feet below K. T. Brick Works, between the main track and switch of the Missouri Pacific Railway; being top of spike in large hub.	103.8330	3
T. B. M. 489	Is 147 feet below the lower head block of Ramapo Siding, on river side of track 75 feet from center, on large lone green elm snag standing 20 feet high; being top of spike in south root.	100.5148	3
P. B. M. 237	Is in the west side of Kansas City and Wyandotte waterworks pump house, between two windows, 1 foot north of south one, 14 feet south of the northwest corner of wall and 4.3 feet above ground, being the center of punch mark in copper bolt leaded horizontally.	103.3515	3
T. B. M. 490	Is opposite Kansas City and Wyandotte water works pump house, 195 feet below milepost 289, 100 feet above head block of waterworks siding, on bluff side of track, 60 feet from center; being top of spike in root of 18-inch slippery elm.	103.4948	3
T. B. M. 491	Is 17.4 feet below P. B. M. 238, on river side of track 75 feet from center and about 200 feet from river bank being top of spike in cedar stump.	103.7594	3
P. B. M. 238	Is about ½ mile below old town of Quindaro, 2,295 feet above Kansas City and Wyandotte waterworks pump house, 285 feet below bridge No. 73½, on river side of track, 80 feet from center; being copper bolt in B. M. stone.	101.6265	3
Top of cap	Over P. B. M. 238.	102.8670	3
T. B. M. 492	Is 1¼ miles above Kansas City waterworks, 738 feet above old town of Quindaro, 1,705 feet below bridge No. 74½, 900 feet above bridge No. 74, on bluff side of Missouri Pacific track, 7 feet from center; being highest point in square cut on natural ledge.	109.6755	3
P. B. M. 239 Nearman.	Is ½ mile below Nearman Station, 1⅞ miles above Quindaro, Kans., directly opposite Parkville, 275 feet below road crossing, on line with west side of road running north toward Parkville, 50 feet north of track center; being copper bolt in B. M. stone.	101.7677	3

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M. 239.	102.9994	337.928
T. B. M. 493	Is about 98 feet above P. B. M. 239, on opposite side of railroad track, 35 feet from center of same, and 164 feet below road crossing; being top of spike in root of 12-inch black walnut.	103.8338	340.065
T. B. M. 494	Is ¾ mile above Nearman Station, Kans., 1,200 feet below road crossing, 829 feet above another road crossing, by large ditch, 610 feet below milepost 293, and 140 feet above fence separating field from woods, on bluff side of track 40 feet from center and 25 feet outside of right-of-way; being top of spike in south root of 28-inch elm.	102.5181	336.349
P. B. M. 240	Is 2¼ miles below Pomeroy, Kans., at the first small stream 1,630 feet below water tank, 2,145 feet above road crossing, on southwest corner of east abutment of railroad bridge. A small wagon bridge spans the hollow a little higher up the bluff. It is top of copper bolt leaded vertically.	105.0486	344.651
T. B. M. 495	Is at the same bridge as P. B. M. 240, on the northwest corner of top stone of east abutment; being highest point in square marked U□S.	105.0486	344.651
P. B. M. 241	Is 1¾ miles below Pomeroy, Kans., directly opposite the center of water tank and 25 feet north from center of track; being copper bolt in B. M. stone.	104.4700	342.752
Top of cap	Over P. B. M. 241	105.7065	346.809
T. B. M. 496	Is 1¾ miles below Pomeroy, Kans., in the northwest pile of water-tank foundation, 10 feet south from Missouri Pacific track; being top of spike.	105.3809	345.741
T. B. M. 497	Is 2,990 feet below Pomeroy, Kans., 82 feet above whistle post, on river bank 60 feet east of Missouri Pacific track; being top of spike in 10-inch sycamore.	102.8497	337.436
P. B. M. 242. Pomeroy.	Is in Pomeroy, Kans., in foundation of F. H. Betton's house, the first residence on the west side of street running south from depot, in the northeast face of foundation under bow window on the east end of house, in center of stone in second course of masonry from top; being center of punch mark in copper bolt leaded horizontally.	110.2530	361.726
P. B. M. 243	Is in Pomeroy, Kans., about 195 feet south of depot, in northeast corner of lot owned by I. C. Henderson, in which the old post-office building stands, 18 feet south of the southeast corner of the post-office and 2 feet from angle of stone wall; being copper bolt in B. M. stone.	103.6420	340.036
Top of cap	Over P. B. M. 243	104.8750	344.081
T. B. M. 498	Is in Pomeroy, Kans., 18 feet south of east end of wagon bridge over small stream just below depot, 2 feet from right bank of stream and 8 feet below level of road; being top of spike in 8-inch maple stump.	102.3668	335.852
P. B. M. 244 = old B. M. 260.	Is five-eighths of a mile above Pomeroy, 960 feet above east end of trestle over Marshall Creek, 125 feet from river, 75 feet south from railroad, and 21 feet above grade of same; being center of cavity in disintegrated rock ledge from which the copper bolt had been extracted.	109.9485	360.727
T. B. M. 499	Is five-eighths of a mile above Pomeroy, Kans., 1,810 feet above mile post 296, 655 feet above end of railroad bridge over Marshall Creek on bluff side of track, 8 feet from center; being highest point in square cut on rock.	103.8047	340.570
T. B. M. 500	Is one-half of a mile below Connors, Kans., 60 feet above whistle post on bluff side of track, 40 feet from center; being top of spike in black walnut stump.	105.0173	344.548
P. B. M. 245 = $\frac{18}{Y}$	Is at Connors, Kans., 350 feet east of railroad depot, on river side of track, 240 feet from center, in the northwest corner of lot owned by Mr. Maxwell, and 15 feet northeast from the north corner of Eli Davis's house; being copper bolt in B. M. stone.	104.0440	341.355
Top of cap	Over P. B. M. 245	105.2854	345.428
P. B. M. 246 Conners City.	Is in Connors, Kans., in foundation wall at the southeast corner of public schoolhouse on its east face, 6 inches north from corner and 20 inches above ground; being center of punch mark in copper bolt leaded horizontally.	109.2888	358.562
T. B. M. 501	Is at Conners, Kans., east of depot and west of Ben Stagger's house, on line of its south side; being a spike in west root of a large black walnut stump.	105.3616	345.678
T. B. M. 502	Is one-half mile above Connors Station, in front of Mr. Kirkpatrick's house, 100 feet west from center of track, on the north one of two large sycamore trees blazed on the west side; being top of spike in root.	104.0808	341.475
T. B. M. 503	Is about 1¼ miles above Connors, Kans., 1,400 feet below mile post 300, 918 feet above iron bridge over Island Creek, 800 feet above line between Leavenworth and Wyandotte counties, 190 feet above farm crossing on land owned by Mr. Russell, a little above center of coulee, 45 feet west of track center; being top of spike in a 15-inch black walnut.	105.5162	346.185

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation. Meters.	F
T. B. M. 504	Is 380 feet below P. B. M. 247, 60 feet east of track center; being top of spike in stump.	104.6318	34
P. B. M. 247	Is about 2¼ miles above Connors, Kans., 1,265 feet below first road crossing below Pope's Siding, 1,315 feet below Bridge No. 79, over small creek, and 220 feet above center of small bridge where the Gillman or bottom road turns east away from the track (Mr. E. Piper and Mr. Tull live on this road about one-half mile east of track). It is 33 feet west of track center, on line of right of way; being copper bolt in B. M. stone.	104.3529	34
Top of cap	Over P. B. M. 247	105.5873	34
T. B. M. 505	Is about one-half mile below Pope's Siding, on the north side of a large coulee, in the upper edge of Ike Williams' land, 1,640 feet below lower head block of the siding, 1,670 feet above center of Bridge No. 79, 35 feet north of center of road running up the bluff, at foot of bluff, 50 feet west of center of track; being top of spike in south root of an 18-inch elm.	105.0004	34
T. B. M. 506 Popes.	Is at Popes Station, Kans., Missouri Pacific Railway, 720 feet above mile post 302, 443 feet above Mr. Pope's house, 394 feet above upper head block of siding on east end of upper abutment of small culvert; being highest point in square marked U. □ S.	106.2574	34
T. B. M. 507	Is 2¼ miles below Leavenworth Junction, 1,600 feet below mile post 303, 755 feet below Missouri Pacific Bridge 81, 720 feet below Martin Cancannon's house; being top of spike in charred red-oak stump, 6 feet west of west right-of-way fence.	106.5733	34
P. B. M. 248 = $\frac{77}{1}$	Is 2 miles below Leavenworth Junction, Kans., opposite foot of Spar Island, 970 feet above mile post 303, 1,610 feet above railroad trestle No. 81, on second bench of bluff from foot, 120 feet from Missouri Pacific track; being top of copper bolt in B. M. stone.	117.7227	38
Top of cap	Over P. B. M. 248	118.9657	39
T. B. M. 509 = old B. M. 266. Delaware.	Is 1¼ miles below Leavenworth Junction, 1,685 feet below pump-house for State prison, 260 feet below Thomas Gibson's stone house on bluff, on bluff end of stone-arch culvert, directly over and 1.6 feet above the center of the keystone; being highest point in northwest angle of cross cut on projecting stone and marked □. (Very soft stone; point not permanent.)	106.5038	34
T. B. M. 510	Is seven-eighths of a mile below Leavenworth Junction, 715 feet below Bridge No. 81½, 508 feet above pump house for State prison, on bluff side of Missouri Pacific track, 55 feet from center; being top of spike in 15-inch sycamore.	104.4987	34
P. B. M. 249; Leavenworth Junction.	Is at Leavenworth Junction, Kans., 93 feet above center of depot, 100 feet above head block at Junction, 18 feet east of center of track, 29.5 feet above lower head block of siding; being copper bolt in B. M. stone.	104.6024	34
Top of cap	Over P. B. M. 249	105.8413	34
T. B. M. 511	Is 200 feet above depot at Leavenworth Junction, on river side of track, 40 feet from center; being top of spike in root of 4-foot cottonwood stump. (Old B. M. 267 was on this tree, but had rotted out.)	105.7563	34
T. B. M. 512	Is 1,820 feet above depot at Leavenworth Junction, 492 feet below upper head block of siding at upper side of path leading up bluff, bluff side of track 40 feet from center; being top of spike in west root of 16-inch sycamore.	105.6235	34
T. B. M. 513	Is 2¾ miles below Leavenworth depot, 230 feet above small coulee, 246 feet above bridge on bluff side of track, 12.5 feet from center; being highest point in square cut in flat piece of ledge about 2 feet below grade of track and marked U. □ S.	106.6784	34
T. B. M. 514	Is 1¾ miles below Leavenworth depot, 820 feet above coal mine, 39 feet below whistle post, on bluff side Missouri Pacific track, 8 feet from center, at foot of side-hill cut; being highest point in square cut on imbedded rock and marked U. □ S.	108.9025	35
P. B. M. 250 = $\frac{78}{1}$	Is on shelf of bluff, 1¼ miles below Leavenworth depot, opposite East Leavenworth, on lower side of small ravine, 200 feet from river and 20 feet west from center of siding leading to coal mine; being copper bolt in B. M. stone.	120.2861	39
Top of cap	Over P. B. M. 250	121.5252	39
T. B. M. 515	Is seven-eighths of a mile below Leavenworth depot, 344 feet above runway to coal mine over tracks, on bluff side of Union Pacific track, 7 feet from center, at foot of side-hill cut; being highest point in square cut in well-imbedded rock.	107.9325	35

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P.B.M. 251	Is in Leavenworth, on north side of the Great Western Stove Company's brick building, one block south of Union depot, 3.4 feet west from northeast corner and 5 feet above ground; being center of punch marks in copper bolt leaded horizontally.	112.3640	368.654
P.B.M. 252	Is in Leavenworth, Kans., in brick building occupied by Rohlfing Bros., grocers, on southeast corner of Third and Cherokee streets, on west end of stone window sill, Cherokee street side; being top of copper bolt leaded vertically.	113.8386	373.490
T.B.M. 516 = old B.M. 270.	Is in Leavenworth, Kans., at riverward foot of arch forming main entrance to north side of old Union depot; being cross cut in top of water table.	108.4823	355.916
City datum	At Leavenworth is 23.83 feet below T.B.M. 516.		332.086
P.B.M. 253 Leavenworth.	Is in Leavenworth, in retaining wall at northeast corner of Main and Cherokee streets, 59 feet north of south end of wall, 78 feet south of south end of depot; being center of punch mark in copper bolt leaded horizontally into fourth course of masonry above ground.	110.2643	361.763
T.B.M. 517	Is in Leavenworth, on east side of Union depot, on south end of doorstep to first door south of main entrance; being highest point in square marked U.□S.	109.1685	358.168
T.B.M. 518	Is 1½ of a mile above Leavenworth Depot, 85 feet below mile-post 310, 500 feet above coal mine, 8 feet below head block of switch, on bluff side of Chicago, St. Paul and Kansas City track, 7 feet from center and on level with grade of same; being highest point in square cut on imbedded rock.	111.3252	365.244
T.B.M. 519 = old B.M. 271. (?)	Is ⅝ of a mile below Chicago, Rock Island and Pacific Bridge at Fort Leavenworth, at foot of bluff; being top of spike in root of large cottonwood.	106.9602	350.922
P.B.M. 254 = 7?	Is 30 feet below south face of west abutment of Chicago, Rock Island and Pacific Bridge at Fort Leavenworth, 27 feet from center of Missouri Pacific track, and 8 feet above grade; being copper bolt in B.M. stone.	114.1720	374.583
Top of cap	Over P.B.M. 254	115.4173	378.669
P.B.M. 255	Is in west abutment of Chicago, Rock Island and Pacific Bridge at Fort Leavenworth, in south side 3.5 feet back from east face; being center punch mark in copper bolt leaded horizontally into fourth course of masonry above ground at southeast corner.	114.3108	375.039
T.B.M. 520	Is at southeast corner of west abutment of Chicago, Rock Island and Pacific Bridge at Fort Leavenworth, 12 feet from center of Missouri Pacific track on same level; being highest point in square cut on inclined rock and marked U.□S.	112.3592	368.636
T.B.M. 521 = gauge B.M.	Is on southeast corner of west abutment of Chicago, Rock Island and Pacific bridge at Fort Leavenworth, on second course of masonry from ground and 26 inches north of south face; being bottom surface of a notch cut in top of stone.	113.4361	372.169
U.S. Gauge	At Fort Leavenworth is a wire cable gauge on west span of Chicago, Rock Island and Pacific Bridge. Elevation of its zero.	−0.1168	−0.383
P.B.M. 256 Fort Leavenworth.	Is in Fort Leavenworth at northeast corner of Government stone ice house on river bank, 7 inches west from east face, and 5.2 feet above ground; being center of punch mark in copper bolt leaded horizontally into building.	110.4992	362.534
P.B.M. 257	Is ¾ of a mile above Fort Leavenworth, 1¼ miles above Chicago, Rock Island and Pacific Railway Bridge across Missouri River, 525 feet below wagon road crossing, 505 feet below center of bridge across small creek at lower edge of wagon road, 150 feet below point of bluff, on bluff side of track, 28 feet from center; being copper bolt in B.M. stone.	109.6894	359.876
Top of cap	Over P.B.M. 257	110.9292	363.944
T.B.M. 523 = an old B.M.	Is ⅞ of a mile above Fort Leavenworth, 540 feet below road crossing, 520 feet below bridge across small creek, on bluff side of track 30 feet from center; being top of spike in east root of 36-inch elm.	110.6147	362.912
T.B.M. 524	Is 1⅜ miles above Chicago, Rock Island and Pacific Railway Bridge at Fort Leavenworth, about 1,180 feet below stone quarries, on bluff side of track 60 feet from center; being top of spike in root of 20-inch elm at point of bluff	110.0033	360.906
P.B.M. 258 = 8?	Is about 2¼ miles above Chicago, Rock Island and Pacific Bridge at Fort Leavenworth, 350 feet above lower head block of Wade Siding, on bluff side of track, 2 feet inside of right-of-way fence; being copper bolt in B.M. stone.	108.4223	355.719
Top of cap	Over P.B.M. 258	109.6655	359.798

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Fee[illegible]
T. B. M. 525	Is 613 feet above lower head-block of Wade Siding, 2¼ miles above Chicago, Rock Island and Pacific Bridge at Fort Leavenworth, 262 feet above P. B. M. 258, on river side of track, 30 feet from center; being highest point in square cut on rock at top of river bank.	109.8087	360.[illegible]
T. B. M. 526	Is about 2¼ miles above Fort Leavenworth Station, 1,968 feet above upper head-block at Wade Siding, 1,555 feet above mile post 314, which stands at a road crossing, river side of track 20 feet from center; being top of spike in a charred stump.	110.3397	362.[illegible]
P. B. M. 259	Is 1¾ miles below Kickapoo, Kans., 9 feet above upper end of bridge No. 95 over Salt Creek, Missouri Pacific Railway, on bluff side of track 24 feet from center; being copper bolt in B. M. stone.	109.8263	360.[illegible]
Top of cap	Over P. B. M. 259	111.0627	364.[illegible]
T. B. M. 528	Is 1¼ miles below Kickapoo, Kans., 1,245 feet above mile post 315, 2,885 feet above center of iron bridge No. 95 over Salt Creek, 45 feet from south foot of rocky point of bluff, bluff side of track 85 feet from center; being top of spike in root of black walnut.	110.4302	362.[illegible]
P. B. M. 260	Is ½ mile below Kickapoo, Kans., 885 feet below trestle, 1,035 feet above mile post 316, 85 feet above upper end of small bridge over drain for cut, on bluff side of track 9.7 feet from center and 2.5 feet above grade; being center of punch mark in copper bolt leaded horizontally into face of natural ledge.	116.1374	381.[illegible]
T. B. M. 529 = Old B. M. 278.	Is 912 feet below west end of trestle at Kickapoo, Kans., on bluff side of track 7.5 feet from center and 3.5 feet above grade, 10 feet above P. B. M. 260; being horizontal furrow in copper bolt leaded horizontally into northwest exposure of cut rock.	116.2618	381.[illegible]
T. B. M. 530	Is ½ mile below Kickapoo, Kans., 880 feet below lower end of trestle, 1,035 feet above mile post 316, 100 feet above small bridge, bluff side of track 10 feet from center, on level with grade; being highest point in square cut on natural ledge.	115.6912	379.[illegible]
P. B. M. 261 = $^{9}_{1}$ Kickapoo.	Is at Kickapoo, Kans., on upper side of small ravine, 30 feet from vertical bank of small stream, bluff side of track, 80 feet from center; George Sharp's house bears S. 88° W. (Mag.) 130 feet distant; copper bolt in B. M. stone.	118.2398	387.9[illegible]
Top of cap	Over P. B. M. 261	119.4780	391.99[illegible]
T. B. M. 531	Is at Kickapoo, Kans., opposite upper end of bridge No. 96, Missouri Pacific Railway bluff side of track 15 feet from center and 4 feet below grade; being highest point in square cut on natural ledge with letters U S cut on vertical face of ledge just below the bench.	116.9156	383.58[illegible]
T. B. M. 532	Is about ½ mile above the depot at Kickapoo, 524 feet below mile post 317, 193 feet below head-block of switch, on river side of track 40 feet from center; being top of spike in 18-inch elm.	118.8849	390.046
P. B. M. 262	Is 1½ miles below Oak Mills, Kans., 70 feet below center of railroad bridge over small creek coming out of valley, on bluff side of track, 3 feet east from wire fence directly opposite south point of bluff; being copper bolt in B. M. stone.	110.0321	361.001
Top of cap	Over P. B. M. 262	111.2633	365.040
T. B. M. 533	Is 1½ miles below Oak Mills, Kans., 975 feet above Mile Post 318, 152 feet below center of railroad bridge over creek coming out of valley, on bluff side of track 50 feet from center; being top of spike in north root of 15-inch elm.	110.6306	362.964
T. B. M. 534	Is 1⅜ miles below depot at Oak Mills, at lower edge of woods, river side of track 75 feet from center; being top of spike in 2-foot elm.	109.4900	359.222
P. B. M. 263	Is in Oak Mills, in northwest side of stone building facing the northeast, 65 feet southeast of John Davitz's store, 6 feet above ground and 8 inches from front face of building; being center of punch mark in copper bolt leaded horizontally.	114.8281	376.736
P. B. M. 264 = $^{8}_{1}{}^{2}$ Oak Mills.	Is at Oak Mills in John Davitz's front yard, 19 feet below his store and 2 feet inside of tight board fence; being copper bolt in B. M. stone.	111.9977	367.450
Top of cap	Over P. B. M. 264	113.2369	371.515
T. B. M. 537	Is 1⅜ miles above Oak Mills, 735 feet above Missouri Pacific Railway Bridge No. 98 over Little Walnut Creek, on bluff side of track 62 feet from center; being top of spike driven in shoulder cut about one foot above ground in a 13-inch black walnut.	113.6110	372.743
P. B. M. 265	Is 2¼ miles above Oak Mills, ⅞ mile above Little Walnut Creek, 180 feet below railroad bridge No. 99, 16 feet towards the river from wagon road running parallel to river, near forks in the road, on bluff side of track 65 feet from center; being copper bolt in B. M. stone.	113.3600	371.919

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M. 265	114.5908	375.958
T. B. M. 538	Is 2¼ miles above Oak Mills, ⅞ mile above Little Walnut Creek, 180 feet below railroad bridge No. 99, on bluff side of track 65 feet from center; being top of spike in root of 6-inch elm.	114.2910	374.974
T. B. M. 539=old B. M.	Is about 2¾ miles above Oak Mills, ⅝ mile below Mr. Silk's house, 105 feet above mile post 323, on river side of track 40 feet from center, at upper edge of small strip of timber; being top of large spike in 22-inch elm.	112.4520	368.941
T. B. M. 540	Is about 3 miles above Oak Mills, 413 feet below Joseph Silk's house, 16 feet above whistle post, on bluff side of track 12 feet from center; being highest point in square cut on imbedded rock and marked U □ S.	113.4918	372.352
P. B. M. 266=32/Y Walnut Creek.	Is about 5¾ miles below Atchison, Kans., 30 feet below lower end of iron bridge across Walnut Creek, on bluff side of track 68 feet from center and 45 feet north of T. B. M. 541; being copper bolt in B. M. stone.	113.1337	371.177
Top of cap	Over P. B. M. 266	114.3607	375.202
T. B. M. 541	Is 5¼ miles below Union Depot at Atchison, 75 feet below end of iron bridge across Walnut Creek, on bluff side of track 65 feet from center; being top of spike in north root of 30-inch elm.	114.5305	375.760
T. B. M. 542	Is 4¼ miles below Union Depot at Atchison, 242 feet below milepost 328, 742 feet below south end of railroad bridge No. 103 on bluff side of track 14 feet from center and 15 feet east of wagonroad; being highest point in square cut on imbedded rock.	114.1885	374.638
P. B. M. 267	Is at prominent point 3 miles below Union depot at Atchison, 130 feet below mile post 327, on bluff side track, 59 feet from center, 10 feet above grade, 16 feet toward river from wagon road, and 8 feet southeast of 10-inch crab apple; being copper bolt in B. M. stone.	116.6550	382.730
Top of cap	Over P. B. M. 267	117.8931	386.792
T. B. M. 543	Is about 3 miles below Union depot at Atchison, 985 feet above railroad bridge No. 104 over small creek, 108 feet below mile post 327, on bluff side of track, 15 feet from center; being highest point in square cut on rock and marked U □ S.	114.8599	376.775
P. B. M. 268=old B. M. 287.	Is about 1¾ miles below Union depot at Atchison, 1,900 feet below Bridge No. 106 over creek, just below ice house, on west side of track, 35 feet from center; being horizontal furrow in copper bolt leaded horizontally into natural ledge.	117.5740	385.745
T. B. M. 545	Is 1¼ miles below Union depot at Atchison, 165 feet below Bridge No. 106, on bluff side of track, 60 feet from center; being top of spike in oak stump.	114.4475	375.487
T. B. M. 546	Is in lower end of Atchison, 655 feet above lowest head block of sidings, 328 feet below brick works, river side of track, 50 feet from center and 30 feet west from edge of river bank; being top of spike in west root of lone elm 2 feet in diameter.	113.7400	373.166
P. B. M. 269=31/Y	Is in Atchison, on west side of Gillespie street, 710 feet south of its intersection with Park street, at foot of bluff and 35 feet west of bank of White Clay Creek; being top of copper bolt leaded vertically into natural ledge about 4 feet below surface of ground and surmounted by an iron pipe.	117.3190	384.908
Top of cap	Over P. B. M. 269	118.5449	388.930
T. B. M. 548. Atchison City B. M.	Is on Miller's Hotel on southeast corner of Third and Commercial streets, on Commercial street side, 15 inches back from Third street side; being highest point in square cut in water table and marked U □ S.	118.3184	388.187
Atchison datum	41.59 feet below city B. M		346.597
P. B. M. 270	Is in Atchison, at northeast corner of Fifth and Santa Fe streets, in the southwest corner of tower at south entrance of First Presbyterian Church; being center of punch mark in copper bolt leaded horizontally into second course of stone from ground.	129.8177	425.915
T. B. M. 549	Is in Atchison, on northeast corner of Fifth and Santa Fe streets; being highest point in square cut in curbstone, 1 foot east of east building line, and marked U □ S.	129.0768	423.484
T. B. M. 550=old gauge B. M.	Is in Atchison, on northeast corner of west abutment of Atchison Bridge; being highest point in square formed on southwest angle of cross, thus .	115.1104	377.662
U. S. gauge	At Atchison, is wire-cable gauge on west span of bridge. Elevation of its zero.	+0.0797	+0.262
P. B. M. 271	Is in Atchison, in southeast corner of Burlington and Missouri River Railroad freight depot, 41 inches west from corner and 2 inches from south face of water table; being top of copper bolt leaded vertically.	117.4180	385.233
P. B. M. 272	Is in north end of east abutment of Atchison Bridge across Missouri River, in top course of masonry, northwest corner, 5 inches from either bevel edge of stone; being top of copper bolt leaded vertically.	116.6790	382.812

Descriptions and elevations of precise level bench marks, etc.—**Continued.**

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 551	Is in north retaining wall of east abutment of Atchison Bridge, on second course of masonry from top; being highest point in square marked U. □ S.	117.1556	384.372
T. B. M. 552 Winthrop.	Is seven-eighths of a mile up track from east end of Atchison Bridge, three-quarters of a mile below water tank, five-eighths of a mile below railroad crossing, 2,165 feet below Kansas City, St. Joseph and Council Bluffs Junction, 1,640 feet below Winthrop; being top of spike in root of a 2-foot elm.	114.0245	374.099
P. B. M. 273 — $\frac{54}{2}$	Is 1½ miles east of East Atchison, one-half mile south of Kansas City R. R. track, on section line 325 feet south of section corner 19, 20, 29, 30, T. 55 N., R. 37 W., and 325 feet south of wagon road; being copper bolt in B. M. stone.	112.6485	369.585
Top of cap	Over P. B. M. 273	113.8777	373.618
T. B. M. 553	Is 1½ miles east of East Atchison, Mo., near section line between sections 29 and 30, and about 450 feet south of section corner 19, 20, 29, and 30, T. 55 N., R. 37 W.; being top of spike in 2½-foot elm.	113.9213	373.761
T. B. M. 554	Is one-half mile above railroad crossing opposite Atchison, just north of marsh at upper edge of Mud Lake, 75 feet from track, in yard to house owned by Jacob Cook; being top of spike in 30-inch elm.	114.2868	374.960
P. B. M. 274	Is about 2 miles below Rushville, Mo., three-quarters mile above water tank, one-half mile above Mud Lake, in northwest corner of field owned by Jasper Allison, due south of house occupied by S. H. Fisher, owned by Mrs. Osborne; being copper bolt in B. M. stone.	114.3173	375.060
Top of cap	Over P. B. M. 274	115.5490	379.101
T. B. M. 555	Is 1 mile above railroad crossing, opposite Atchison, opposite farm-road crossing, 140 feet south from Chicago, Rock Island and Pacific Rwy., on farm owned by Jasper Allison; being top of spike in root of large elm standing at upper edge of road.	115.6404	379.401
T. B. M. 556	Is about 1 mile below Rushville, Mo., 630 feet above Bridge No. 30 on Chicago, Rock Island and Pacific Rwy., 615 feet above farm crossing, midway between Kansas City, St. Joseph and Council Bluffs, and St. Joseph and Santa Fe Rwys; being top of spike in east root of first large sycamore stump below Rushville.	114.3106	375.038
T. B. M. 557	Is 754 feet below Chicago, Rock Island and Pacific depot at Rushville, opposite center of Bridge No. 190 on above road, 744 feet above junction of this road with its branch line, on bluff side of track, 40 feet from center; being top of spike in south root of west one of two willow trees 14 inches in diameter.	118.7842	389.715
P. B. M. 275 — $\frac{55}{3}$ Rushville.	Is at point of bluff at south side of Rushville, one-quarter mile above junction of Chicago, Rock Island and Pacific Rwy., 98 feet below road crossing in same road, 20 feet up the side of bluff from large lone elm, on which T. B. M. 558 is located; being copper bolt in B. M. stone.	119.8447	393.195
Top of cap	Over P. B. M. 275	121.0740	397.228
T. B. M. 558	Is on large lone elm 30 inches in diameter, near P. B. M. 275; being top of spike in root	118.7498	389.603
T. B. M. 560	Is 1¼ miles above Rushville, [illegible]5 feet above Mr. William Howard's brick house, [illegible] feet east of east fence of wagon road on bluff side of track, about opposite P. T. of curve; being top of spike in 20-inch [illegible]m.	119.1280	390.843
T. B. M. 561	Is 1¾ miles above Rushville, 515 feet [illegible] Norris road crossing, [illegible]ver side Missouri Pacific track, 45 feet from center, 5 feet outside of right-of-way fence, opposite P. C.; being top of spike in 2-foot walnut.	117.2151	384.567
P. B. M. 276 — [illegible]	Is about [illegible] m[illegible] below Hall's Station, on bluff side of track, where railroad comes to the bluff at [illegible] corner of bluff road and road to Hall's, in line [illegible]h Hall's road, where it crosses the tracks opposite Bridge 186 on Santa Fe R. R., about 80 feet from T. B. M. 562, 23 feet northwest from a 30 inch elm, 17 feet north from [illegible] 20 inch elm, and 16 feet S. 15° E. of a large black walnut; being copper bolt in B. M. stone at an elevation of about 15 feet above the bottom land.	119.7401	392.832
Top of cap	Over P. B. M. 276	120.9720	396.893
T. B. M. 562	Is about 2 miles below Hall's, in same locality as P. B. M. 276, at a point where bluffs come to railroad at the corner of bluff and Hall's roads at foot of bluff; being top of spike in north root of [illegible] el[illegible] fee[illegible] in diameter.	117.4461	385.325
T. B. M. 277 Hall's.	Is at Hall's Station, about [illegible]85 feet above T. B. M. 566, 1,590 feet above [illegible] station and [illegible]10 feet above the upper head b[illegible]k of Missouri Pac[illegible]ing, 98 feet above small bridge and 82 feet above the north end of w[illegible]ng fence, on the north side of track, on right of way [illegible] line with telegraph poles; being copper bolt in B. M. stone.	117,3340	384.958

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M. 277	118.5712	389.016
T. B. M. 566	Is at the upper end of Hall's, one quarter mile above the depot, 125 feet above upper head block of Missouri Pacific siding, 60 feet north from center of same, on north side of wagon road; being top of spike in south root of a 40 inch elm.	118.6856	389.392
P. B. M. 278 = $\frac{87}{2}$ Kenmoor.	Is in the northeast corner of section 28, T. 56 N., R. 36 W., 2,000 feet northeast of Kenmoor Station and about 250 feet northeast of house of Warren Samuels, about 240 feet above T. B. M. 569; being copper bolt in B. M. stone.	123.3438	404.675
Top of cap	Over P. B. M. 278	124.5725	408.706
T. B. M. 570	Is one-half mile above Kenmoor. 900 feet above farm crossing, on river side of tracks, 33 feet from center of Missouri Pacific track at fence; being top spike in south root of 30-inch elm.	119.5084	392.091
T. B. M. 571	Is about 1¾ miles above Kenmoor, 590 feet above Bridge No. 43 J A, Missouri Pacific Rwy., 15 feet from the northeast corner of Mr. John Mead's yard; being a spike in the east root of a 28-inch black walnut.	120.6505	395.838
P. B. M. 279	Is 6¾ miles below St. Joseph, Mo., 1¾ miles below Lakes Siding, near T. B. M. 573, in the southwest corner of dooryard owned by A. Roche, at east side of wagon road and about 100 feet east from Chicago, Rock Island and Pacific track; being copper bolt in B. M. stone.	119.5482	392.222
Top of cap	Over P. B. M. 279	120.7908	396.299
T. B. M. 573	Is about one-half mile above Horseshoe Lake, 114 feet east from center of Rock Island track, near southwest corner of dooryard of house occupied by N. Bozarth and owned by A. Roche; being top of spike in west base of 3½-foot elm.	120.7159	396.053
P. B. M. 280 = $\frac{89}{2}$	Is on left bank of Missouri River, 4¾ miles below Hannibal and St. Joseph Railway Bridge, about one-half mile east of the railroad, near quarter post on the north side of sec. 12, T. 56 N., R. 36 W., 304 feet southeast of Nelson Hawley's house, in the highway, at east fence; being copper bolt in B. M. stone.	125.5879	412.037
Top of cap	Over P. B. M. 280	126.8142	416.061
T. B. M. 575	Is about 350 feet north of P. B. M. 280, nearly midway between Nelson Hawley's and Frank Jones's houses, at high point of ground at west side of road, at fence; being top of spike in east root of honey locust.	125.0972	410.428
T. B. M. 576	Is about 2¼ miles below St. George, at Bridge No. 181 of the Kansas City, St. Joseph and Council Bluffs Railway, on stump of pile at the upper northwest side of bridge, one foot above surface of ground; being top of spike.	122.6674	402.456
T. B. M. 577	Is 1½ miles below St. George, at lower end of Bridge 39 J.B., under center of track; being top of spike in stump of a pile 14 inches in diameter projecting 2 feet above surface of ground.	125.0088	410.138
P. B. M. 281 St. George.	Is in St. George, Mo., on east side of railroad track, in southwest corner of yard to hotel owned by Nick Byrnes, on Missouri Avenue, 18 feet west of southwest corner of hotel porch; being copper bolt in B. M. stone.	125.3334	411.202
Top of cap	Over P. B. M. 281	126.5679	415.253
T. B. M. 579	Is in St. George, on east side of St. Joseph Stockyards Exchange Building, on stone doorstep of south door; being highest point in square cut on south end of step and marked U. S.	124.4682	408.364
T. B. M. 580	Is at the southern part of St. Joseph, Mo., on the southwest corner of Fifth and Cedar streets, on brick building of the Water Gas Company, on the south window sill on Fifth street, 8 inches south of the south side of the window; being the highest point in square marked U. S.	125.9720	413.297
P. B. M. 282	Is in St. Joseph, in the north end of the east pier of the Hannibal and St. Joseph R. R. Bridge across Missouri River, being the pier at east end of draw, 15 inches north of bed plates and in line with the west row of bolts through plate, 2 feet south from the north edge of pier; being copper bolt leaded vertically.	124.1268	407.244
T. B. M. 582 = Old B. M. 313.	Is same as B. M. 34 (1879), at southwest corner of Fourth street and railroad, on Henry Krugg's packing house, at the northeast corner of foundation, on the west side of arched entrance; being outer end of cross, thus: ☐;	125.0983	410.431
U. S. gauge	At St. Joseph, is a wire-cable gauge on the east span of Hannibal and St. Joseph R. R. Bridge. Elevation of its zero.	− 0.0747	−0.245
T. B. M. 583 = Old B. M. 312.	Is on the east pier of Hannibal and St. Joseph Bridge at St. Joseph, 126 feet south of north edge of coping pier; being highest point in southwest angle of crossed marked ☐	124.8775	409.707
P. B. M. 283 = $\frac{89}{3}$	Is in south end of St. Joseph, Mo., at northeast corner of Duncan and Bartlett streets, about 1,100 feet east of east end of Hannibal and St. Joseph Bridge; being copper bolt in B. M. stone.	124.0320	406.933

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	F
Top of cap	Over P. B. M. 283	125.2580	41
P. B. M. 284	Is in St. Joseph, on west side of Union depot, in window sill of second window south of south entrance to waiting room, 4½ inches back from vertical face of sill and 7 inches north of south end; being top of copper bolt leaded vertically.	127.8096	41
T. B. M. 584	Is in St. Joseph, on west side of Union depot, on north end of stone doorstep of door to barber shop, being first door north of passage way through building; being highest point in square.	126.9232	41
P. B. M. 285 St. Joseph.	Is in St. Joseph, at the southeast corner of Edmond and Eighth streets, on the northeast corner of post-office building, 12 feet west from corner, on windowsill of window just east of entrance on Edmond street, 8 inches west from east end of sill; being copper bolt leaded vertically.	140.6132	46
P. B. M. 286	Is in St. Joseph, at southeast corner of Felix and South Second streets, in the northwest corner of city hall, 1 foot east of corner of building on Felix street and 5 feet above side walk; being center of punch mark in copper bolt leaded horizontally.	130.5072	42
T. B. M. 585	Is near P. B. M. 286, on water table at northwest corner of city hall; being highest point in notch.	129.2635	42
City datum	Of St. Joseph, is 23.832 feet below T. B. M. 585		40
T. B. M. 586	Is in St. Joseph, at upper end of town, on southwest corner of Francis street, and just east of north end of Kansas City, St. Joseph and Council Bluffs depot; being highest point in square cut on curb stone and marked U. ▢ S.	126.5034	41
P. B. M. 287 = 89½ U. S. boat yard.	Is at United States boat yard above St. Joseph, one-eighth of a mile above Mr. Duprée's house, just behind top of revetment, near the north line of sec. 1, T. 57 N., R. 36 W., about 800 feet east of the northwest corner of the section. It is 16 feet north from the north line of ways and 85 feet west of west end, 196 feet below track of ways; being copper bolt in B. M. stone.	123.0735	40
Top of cap	Over P. B. M. 287	124.2941	40
T. B. M. 588	Is on south side of Upper French Bottom Road, 3,280 feet west from railroad track, 65 feet west from end of lane leading from Chas. Huncey's house; being top of spike in south root of a 30-inch elm.	123.1603	40
P. B. M. 288	Is 2¾ miles above St. Joseph, at foot of bluff, 48 feet from center of track, at east right-of-way fence, and on line with the fence on north side of Upper French Bottom Road, 15 feet south of small railroad bridge; being copper bolt in B. M. stone.	121.7375	39
Top of cap	Over P. B. M. 288	122.9708	40
T. B. M. 589	Is near P. B. M. 288, 100 feet below small railroad bridge at foot of bluff, 70 feet east from track center, 27 feet from east right-of-way fence, on a small rock lying midway between two large rocks; being highest point in square marked U. ▢ S.	124.0244	40
P. B. M. 289	Is about 3¼ miles above St. Joseph, at pump house of water works, on west side of pump room, 18 feet north from southwest corner, 10 feet north from door, 35 feet south from tall chimney, on south end of stone window sill, 1½ inches back from west face; being copper bolt leaded vertically.	125.0111	41
P. B. M. 290 = ??	Is 3¾ miles above St. Joseph, 720 feet above pump house of St. Joseph water works, at foot of bluff, 70 feet from center of Kansas City, St. Joseph and Council Bluffs track, 20 feet east of east right-of-way fence; being copper bolt in B. M. stone.	124.0640	40
Top of cap	Over P. B. M. 290	125.2516	4

APPENDIX A 6.

ANNUAL REPORT OF MR. JAMES A. PAIGE, ASSISTANT ENGINEER, 1893.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., December 31, 18

SIR: I have the honor to report as follows on the field work of the precise l ing operations in my charge between Sioux City, Iowa, and St. Joseph, Mo., d the summer of 1892:

On April 9, I received instructions from you to go to Council Bluffs, Iowa, o ize two precise level field parties, which were to be quartered on a quarter boat pared for the purpose, then lying at the Council Bluffs U. S. boat yard, to pr thence in tow of the U. S. snag boat *James B. McPherson* to Sioux City, Iowa, and from there carry a line of precise levels down the east bank of the Missouri River to St. Joseph, Mo.

Field work began April 18 and ended at St. Joseph September 22, 1892.

The quarter boat was barge No. 12, provided with a tent 50 by 14 feet, a description and plan of which with slight modifications is given on page 3746 (and inset) Report of the Chief of Engineers U. S. Army for 1891.

The organization of the force was: James A. Paige, leveller; S. W. Shinkle, recorder; 2 rodmen, 2 umbrella men; O. H. B. Turner, leveller; N. E. Ferguson, recorder; 2 rodmen, 2 umbrella men, 1 cook, and 1 waiter, making a total of 14 men.

On June 19 Mr. Ferguson left the work, and Rodman George F. Bird succeeded him as recorder.

The route prescribed was that of the Sioux City and Pacific and the Chicago and Northwestern railways from Sioux City to Council Bluffs, thence to St. Joseph by the Kansas City, St. Joseph and Council Bluffs Railway.

It was decided that the levels should start about 5 miles above Sioux City, at the crossing of the Chicago, Milwaukee and St. Paul Railway over the Big Sioux River.

The line of levels began at this point at P. B. M. 1 and ended at U. S. boat yard at St. Joseph at P. B. M. 112 (B. M. 89½ Wellman).

At Council Bluffs a line of levels was carried across the river to Omaha, where three precise bench marks were established.

During the summer of 1890 a system of bench marks was established between Sioux City and Leavenworth.

Some of these bench-mark lines extended to the railroads on the east side of the river.

Whenever these outer bench marks were established along the railroads or within a half mile thereof, connection was made with them, and they were incorporated in the precise bench-mark system.

Also when two consecutive bench marks thus connected with were more than 3 miles apart, another bench mark was established between them.

The old pattern of bench marks, which has been described in previous reports, was modified, in that a cast-iron flange or flat ring, 10 inches in outer diameter, was added; it being slipped over the pipe, the lower end of which was expanded to hold the flange in place. The flange thus rests just above the top surface of the stone, and tends to prevent the pipe being pulled out of the ground or otherwise moved. This form of pipe and flange was used to replace the old pipe when any of the "Wellman" bench marks were connected with and when new bench marks were set.

Bench marks, consisting of copper bolts three-eighths of an inch in diameter and set with lead, were also established in bridge piers and brick or stone buildings whenever the structure was considered reliable.

In moving the quarter boat the usual method of hand power with sweeps was used in handling her.

While moving from Hentons, Iowa, on July 13, during extreme high water, the quarter boat was drawn on a sand bar by side currents and grounded, 5 miles above Plattsmouth, Nebr. Unfortunately, about this time the water began falling, and before the boat could be pulled off with the force and means at hand, the river had gone down so that she was soon left high on the sand. By your instructions the quarter boat was left temporarily in charge of a watchman, and the field work continued southward, the surveying parties being quartered at boarding houses along the line. The quarter boat was subsequently floated by a force sent from Omaha by Division Engineer Potter, and brought down to a point opposite Bartlett, Iowa, and the surveying party returned to her July 21.

This work was at a disadvantage on account of the route of the levels lying in general so far from the river; much time was taken in the morning and evening in going to and from work.

In precise leveling operations this is the best time of the day for instrumental work.

It was found economical to quarter Mr. Turner's field party at hotels at Whiting, Missouri Valley, Hamburg, and Bigelow, when the work was in those vicinities.

At the beginning of the season the necessary instruments and tools and a portion of the subsistence stores were received at Council Bluffs from Charles F. Potter, division engineer, and the property was turned over to S. Waters Fox, division engineer, at St. Joseph, at the close of the season on September 26, 1892.

On the next day, with Assistant O. H. B. Turner, I reported to you at St. Louis for further duty in reducing the field notes, and have been so engaged till the present time.

The field computations were reported to you in tabulated form for each week ending Saturday night. The plane of reference was the same as that of B. M. $\frac{1}{3}{}^{3}$ at Sioux City, elevation of which is 692.846 feet. (See report of Chief of Engineers, U. S. A., for 1891, p. 3817.)

The work of the season is indebted to Assistant Turner for his usual valuable services.

The kinds of instruments used and their various constants, the methods employed and results obtained, and certain statistical data, together with the theoretical features of the work, will form subjects for discussion with the final office reduction when it is completed.

The following is a summary of work done:

Line leveled and checked .... miles..	247.3
Precise bench marks (stone and pipe), set	64
Precise bench marks (copper bolts), set	18
Old bench marks (stone and pipe), connected with, and pipe replaced by new,	25
Other engineer bench marks connected with	4
City bench marks connected with	1

Very respectfully, your obedient servant,

JAMES A. PAIGE,
Assistant Engineer.

First Lieut. J. C. SANFORD,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

REPORT OF MR. JAMES A. PAIGE, ASSISTANT ENGINEER, ON LEVEL VIALS USED, SIOUX CITY TO ST. JOSEPH, 1892.

BALTIMORE, MD., *July 4, 1893.*

SIR: Referring to the level vials, Nos. 9 and 12, in use on this work, they have an angular value per division of 3.55 seconds and 4.58 seconds, respectively, and which, in common with other vials, change some from season to season. These two vials are very poor instruments for this kind of work. The fluid appears to stick at times, and its movement is not uniform with the movement of the micrometer screw.

Since the field season from Sioux City to St. Joseph ended, I have used, on a line 102 miles long, a level vial (value 3 seconds) furnished by a different manufacturer, and there is no comparison between the two dealers' precise leveling vials.

Many lines on the Sioux City-St. Joseph work had to be leveled more than twice; and, while a constant appears in the results, I am satisfied the trouble was in the tubes used.

In the 102 miles above named where a different vial was used, but one line had to be leveled more than twice.

The limit of discrepancy was the same in both cases.

These two Kern vials, Nos. 9 and 12, are not fit for precise leveling, and they should be discarded; or better, they should be condemned and destroyed, so that precise levelers in the future may not have the vexation and annoyance due to using them, or have their work vitiated by them.

For a few dollars they can be replaced by instruments that are precise in fact as well as in name.

I do not know wherein the defect lies. Possibly the fluid in the vials has undergone some change with age. Probably the cause of the trouble is the manner in which the interior surfaces of the glasses were ground.

Very respectfully, your obedient servant,

JAMES A. PAIGE,
Assistant Engineer.

First Lieut. J. C. SANFORD,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

TABULATION OF PRECISE LEVEL RESULTS, SIOUX CITY, IOWA, TO ST. JOSEPH, MO., 1892.

In the table of results, column 1 gives the bench mark T. B. M., signifying temporary bench mark, and P. B. M., signifying precise level bench mark.

Column 2 gives the bench mark from which that in column 1 was determined.

Column 3 gives length of stretch in meters.

Column 4 contains the distances in kilometers from initial bench mark.

Column 5 gives the direction in which the line was leveled. S is for south or direct line. N is for north or reverse line.

Column 6 gives successive differences of elevation in millimeters between bench marks and the mean of such determinations.

Column 7 gives the residuals found by subtracting each determination from the mean.

Column 8 gives the discrepancy between direct line and the mean, and is the algebraic sum of the residuals.

Column 9 gives the discrepancy between reverse line and the mean, and is the algebraic sum of the residuals.

Column 10 gives the probable error, *r*, of the mean in column 5.

Column 11 gives the probable error, R, of the mean elevation of each bench mark as computed from the beginning of the section.

Column 12 gives the total rod correction as computed from initial bench mark.

Column 13 gives the elevation in meters of all bench marks referred to St. Louis Directrix.

Column 14 gives the elevation in feet of all bench marks referred to St. Louis Directrix.

Column 15 gives the elevation in feet of all old bench marks connected with referred to St. Louis Directrix.

Column 16 gives the discrepancy in feet of old bench marks.

Column 17 gives the initial of each observer: P. is for Assistant James A. Paige; T. is for Assistant O. H. B. Turner; S. is for Recorder S. W. Shinkle; B. is for Recorder George F. Bird.

Bench marks marked with an asterisk (*) are not in the main line. The value of the meter used is 3.2808693 feet.

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V		r	R	Rod cor.	Elevation above St. Louis City Directrix.			Discrepancy.	Obs.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	Km.		Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.				Feet.	
P. B. M. 399												209.1785	686.287			
T. B. M. 973	P. B. M. 399	52	.05	S	+2,915.0	+0.5	+0.5	—0.5	0.3	0.3	—0.6	212.0934	695.851			P.
				N	+2,916.0	—0.5										
				Mean	+2,915.5											
*Top of cap, P. B. M. 399	T. B. M. 973	35		S	—1,694.7	+0.2			0.1	0.1	—0.3	210.3902	690.292			T.
				N	—1,694.3	—0.2										
				Mean	—1,694.5											
*P. B. M. 398	T. B. M. 973	91		S	—1,540.7	—0.3			0.2	0.4	—0.3	210.5527	690.796			T.
				N	—1,541.3	+0.3										
				Mean	—1,541.0											
*Top of cap, P. B. M. 398	T. B. M. 973	91		S	— 318.7	0.0			0.0	0.3	—0.5	211.7748	694.805			T.
				N	— 318.7	0.0										
				Mean	— 318.7											
T. B. M. 972 + A	T. B. M. 973	1,062	1.71	S	—1,464.7	+2.8	+2.6	—2.6	1.0	1.0	—0.3	210.6318	691.055			P.
				N	—1,459.3	—2.6										
				N	—1,461.7	—0.2										
				Mean	—1,461.9											
T. B. M. 971	T. B. M. 972 + A	995	2.71	S	+ 27.0	+7.7	+5.8	—5.9	2.0	2.3	—0.3	210.6665	691.169			P.
				N	+ 34.7	0.0										
				S	+ 36.0	—1.3										
				N	+ 41.3	—6.6										
				Mean	+ 34.7											
T. B. M. 970	T. B. M. 971	796	3.51	S	— 222.2	—1.7	+4.1	—4.2	1.1	2.5	—0.3	210.4426	690.435			P.
				N	— 225.6	+1.7										
				Mean	— 223.9											

*P. B. M. 397	T. B. M. 970	36	....	N.....	−663.2	−0.5	....	....	0.1	2.5	−0.1	209.7791	688.258	....	....	T.
				S.....	−663.8	+0.1										
				N.....	−663.7	0.0										
				S.....	−664.1	+0.4										
				Mean.	−663.7											
*Top of cap, P. B. M. 397.	T. B. M. 970	37	....	N.....	+559.3	−0.2	....	....	0.1	2.5	−0.4	211.0016	692.209	....	....	T.
				S.....	+558.9	+0.2										
				Mean.	+559.1											
T. B. M. 969 + A	T. B. M. 970	1,090	4.60	S.....	+3,515.6	+0.6	+4.7	−4.7	0.4	2.5	−1.0	213.9581	701.969	....	....	T.
				N.....	+3,516.7	−0.5										
				Mean.	+3,516.2											
T. B. M. 968 + A	T. B. M. 969 + A...	1,316	5.91	S.....	+8,732.5	+2.8	+6.8	−6.8	1.5	3.0	−2.7	222.6917	730.622	....	....	T.
				N.....	+8,741.7	−6.4										
				S.....	+8,733.8	+1.5										
				N.....	+8,733.1	+2.2										
				Mean.	+8,735.3											
T. B. M. 967 + A	T. B. M. 968 + A...	1,666	7.58	S.....	−4,725.4	+7.7	+10.6	−10.6	2.0	3.6	−1.8	217.9749	715.147	....	....	T.
				N.....	−4,711.3	−6.4										
				N.....	−4,716.5	−1.2										
				S.....	−4,717.7	0.0										
				Mean.	−4,717.7											
T. B. M. 966	T. B. M. 967 + A...	1,238	8.82	N.....	−5,708.9	−1.3	+11.9	−11.9	0.9	3.7	−0.6	212.2659	696.417	....	....	T.
				S.....	−5,711.5	+1.3										
				Mean.	−5,710.2											
*P. B. M. 396 = 143 .... Sioux City.	T. B. M. 966	44	....	N.....	−702.3	+0.1	....	....	0.1	3.7	−0.5	211.5638	694.113	692.846	−1.267	T.
				S.....	−702.0	−0.2										
				Mean.	−702.2											
*Top of cap, P. B. M. 396 = 143.	T. B. M. 966	44	....	S.....	+522.7	+0.3	....	....	0.2	3.7	−0.7	212.7888	698.132	....	....	T.
				N.....	+523.3	−0.3										
				Mean.	+523.0											
*B. M. "A"	T. B. M. 966	59	....	S.....	+810.6	+0.2	....	....	0.1	3.7	−0.8	213.0765	699.076	....	....	T.
				N.....	+810.9	−0.1										
				Mean.	+810.8											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 965	T. B. M. 966	1,188	10.00	S	—1,501.4	—1.0	+10.9	—10.9	0.7	3.7	—0.3	210.7638	691.488	....	....	T.
				N	—1,503.4	+1.0										
				Mean	—1,502.4											
T. B. M. 964	T. B. M. 965	1,098	11.10	S	—420.0	—0.4	+11.2	—11.2	0.3	3.8	—0.2	210.3435	690.110	....	....	T.
				N	—420.0	—0.4										
				S	—421.3	+0.9										
				Mean	—420.4											
T. B. M. 963	T. B. M. 964	1,221	12.22	S	+146.6	—1.4	+ 9.8	— 9.8	0.9	3.9	—0.3	210.4886	690.586	....	....	T.
				N	+143.8	+1.4										
				Mean	+145.2											
*Top of cap, P. B. M. 395	T. B. M. 963	222	....	N	—2,612.3	—0.5	....	....	0.3	3.9	+0.2	207.8763	682.015	....	....	P.
				S	—2,613.3	+0.5										
				Mean	—2,612.8											
*P. B. M. 394	Top of cap, P. B. M. 395.	61	....	N	+3,523.0	—0.5	....	....	0.3	3.9	—0.4	211.3982	693.570	....	....	P.
				S	+3,521.7	+0.8										
				S	+3,522.7	—0.2										
				Mean	+3,522.5											
*P. B. M. 393	T. B. M. 963	44	....	N	—1,418.8	+0.4	....	....	0.2	3.9	0.0	209.0705	685.933	....	....	P.
				S	—1,418.0	—0.4										
				N	—1,418.3	—0.1										
				Mean	—1,418.4											
*Top of cap, P. B. M. 393	T. B. M. 963	44	....	S	—191.7	+0.2	....	....	0.1	3.9	—0.2	210.2972	689.958	....	....	P.
				N	—191.3	—0.2										
				Mean	—191.5											

T. B. M. 962	T. B. M. 963	1,013	13.34	S N	+6,468.3 +6,472.0	+1.9 —1.8	+11.7	—11.0	1.3	4.1	—1.0	210.9575	711.809			P.
				Mean	+6,470.2											
T. B. M. 961	T. B. M. 962	1,108	14.44	S N	—6,654.7 —6,654.9	+0.3 —0.4	+12.0	—12.0	0.2	4.1	—0.2	210.3045	689.982			P.
				Mean	—6,654.4											
T. B. M. 960	T. B. M. 961	1,178	15.62	S N	—1,651.3 —1,643.3	+8.9 +0.9	+14.7	—14.6	1.6	4.4	+0.1	208.6624	684.594			T.
				S N S N	—1,637.0 —1,639.7 —1,647.0 —1,636.3	—5.4 —2.7 +4.6 —6.1										P.
				Mean	—1,642.4											
*P. B. M. 392	T. B. M. 960	22		S N	—1,117.7 —1,117.0	+0.3 —0.4			0.2	4.4	+0.3	207.5453	680.929			P.
				Mean	—1,117.4											
* Top of cap, P. B. M. 392	T. B. M. 960	22		S N	+107.0 +106.3	—0.4 +0.3			0.2	4.4	+0.1	208.7690	684.944			P.
				Mean	+106.6											
T. B. M. 959	T. B. M. 960	968	16.50	S N	—412.7 —411.0	+0.9 —0.8	+15.6	—15.4	0.6	4.4	+0.2	208.2507	683.243			P.
				Mean	—411.8											
T. B. M. 958 + A	T. B. M. 959	378	16.96	S N	—43.2 —42.5	+0.4 —0.3	+16.0	—15.7	0.2	4.4	+0.2	208.2079	683.103			P.
				Mean	—42.8											
T. B. M. 957	T. B. M. 958 + A	384	17.35	S N	+30.7 +30.2	—0.3 +0.2	+15.7	—15.5	0.2	4.4	+0.2	208.2383	683.203			P.
				Mean	+30.4											
T. B. M. 956	T. B. M. 957	1,588	18.94	S N	—198.2 —197.5	+0.4 —0.3	+16.1	—15.8	0.2	4.4	+0.2	208.0405	682.554			P.
				Mean	—197.8											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. M. B. 955	T. B. M. 956	936	19.87	S	—1,181.9	+0.9	+17.0	—16.7	0.6	4.5	+0.5	206.8598	678.680	....	....	P.
				N	—1,180.1	—0.9										
				Mean	—1,181.0											
*P. B. M. 391 $^{1}_{3}{}^{2}$ Sargent's Bluff.	T. B. M. 955	310	....	N	—161.3	+0.3	....	....	0.2	4.5	+0.5	206.6988	678.152	676.957	—1.195	P.
				S	—160.7	—0.3										
				Mean	—161.0											
*Top of cap P. B. M. 391 = $^{1}_{3}{}^{2}$	T. B. M. 955	309	....	N	+1,056.0	—0.5	....	....	0.3	4.5	+0.3	207.9151	682.142	....	....	P.
				S	+1,055.0	+0.5										
				Mean	+1,055.5											
T. B. M. 954	T. B. M. 955	1,446	21.32	S	—596.3	+1.3	+18.3	—18.1	0.0	4.6	+0.6	206.2649	676.728	....	....	T.
				N	—593.6	—1.4										
				Mean	—595.0											
T. B. M. 953+A	T. B. M. 954	1,318	22.64	S	+485.0	+1.4	+19.7	—19.5	0.9	4.7	+0.5	206.7512	678.324	....	....	T.
				N	+487.8	—1.4										
				Mean	+486.4											
T. B. M. 952	T. B. M. 953+A	1,076	23.71	S	—281.6	+2.0	+21.7	—21.5	1.3	4.8	+0.5	206.4716	677.406	....	....	T.
				N	—277.6	—2.0										
				Mean	—279.6											
T. B. M. 951+A	T. B. M. 952	1,057	24.77	S	—353.0	+4.8	+24.4	—24.3	1.7	5.1	+0.6	206.1235	676.264	....	....	T.
				N	—344.5	—3.7										
				S	—347.1	—1.1										
				Mean	—348.2											
*P. B. M. 390	T. B. M. 951+A	12	....	S	—957.0	—0.1	....	....	0.1	5.1	+0.8	205.1666	673.125	....	....	T.
				N	—957.2	+0.1										
				Mean	—957.1											

*Top of cap P. M. B. 390.	T. B. M. 951+A	12	....	S N	+267.2 +266.8	−0.2 +0.2	....	....	0.1	5.1	+0.6	206.3005	677.140	....	....	T.
				Mean.	+267.0											
T. B. M. 950	T. B. M. 951+A	704	25.47	S N	+306.2 +305.0	−0.6 +0.6	+23.8	−23.7	0.4	5.1	+0.6	206.4291	677.267	....	....	P.
				Mean.	+305.6											
T. B. M. 949+A	T. B. M. 950	1,118	26.59	S N	−1,291.5 −1,289.5	+1.0 −1.0	+24.8	−24.7	0.7	5.2	+0.8	205.1388	673.034	....	....	P.
				Mean.	−1,290.5											
T. B. M. 948+A	T. B. M. 949+A	1,460	28.05	N S	+577.8 +580.2	+1.2 −1.2	+23.6	−23.5	0.8	5.2	+0.7	205.7178	674.983	....	....	P.
				Mean.	+579.0											
*P. B. M. 389	T. B. M. 948+A	138	....	S N S	−462.0 −463.7 −463.2	−1.0 +0.7 +0.2	....	....	0.3	5.3	+0.8	205.2548	673.414	....	....	P.
				Mean.	−463.0											
*Top of cap P. B. M. 389.	T. B. M. 948+A	138	....	S N	+758.0 +759.0	+0.5 −0.5	....	....	0.3	5.3	+0.5	206.4760	677.421	....	....	P.
				Mean.	+758.5											
T. B. M. 947	T. B. M. 948+A	1,755	29.81	N S N S	−963.3 −953.0 −959.2 −962.5	+3.8 −6.5 −0.3 +3.0	+21.8	−21.8	1.0	5.5	+0.9	204.7584	671.786	....	....	P.
				Mean.	−959.5											
T. B. M. 946	T. B. M. 947	858	30.66	N S N S	−607.3 −601.3 −604.7 −602.0	+3.5 −2.5 +0.9 −1.8	+19.6	−19.6	0.9	5.6	+1.0	204.1547	669.805	....	....	P.
				Mean	−603.8											
T. B. M. 945	T. B. M. 946	1,126	31.79	N S N S	+86.0 +91.0 +92.3 +94.7	+5.0 0.0 −1.3 −3.7	+17.8	−17.9	1.2	5.7	+1.0	204.2457	670.103	....	....	P.
				Mean.	+91.0											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 944+A	T. B. M. 945	1,055	32.85	N.....	−214.5	−1.2	+16.9	−16.9	1.3	5.8	+1.0	204.0300	669.396	....	....	P.
				S.....	−218.7	+3.0										
				N.....	−218.8	+3.1										
				S.....	−210.9	−4.8										
				Mean.	−215.7											
*P. B. M. 388 .... Salix.	T. B. M. 944+A ..	136	....	S.....	−862.8	+0.4	....	....	0.3	5.8	+1.2	203.1678	666.567	....	....	T.
				N.....	−862.0	−0.4										
				Mean.	−862.4											
*Top of cap, P. B. M. 388.	T. B. M. 944+A ..	136	....	N.....	+357.8	−0.3	....	....	0.2	5.8	+1.0	204.3875	670.569	....	....	T.
				S.....	+357.2	+0.3										
				Mean.	+357.5											
T. B. M. 943+A	T. B. M. 944+A ..	518	33.36	N.....	+166.7	−1.9	+17.7	−17.7	0.5	5.9	+1.0	204.1948	669.936	....	....	T.
				S.....	+163.2	+1.6										
				S.....	+164.7	+0.1										
				N.....	+164.5	+0.3										
				Mean.	+164.8											
T. B. M. 942+A	T. B. M. 943+A ..	1,182	34.55	N.....	−1,003.2	−2.0	+19.7	−19.7	1.3	6.0	+1.2	203.1898	666.639	....	....	T.
				S.....	−1,007.2	+2.0										
				Mean.	−1,005.2											
T. B. M. 941+A	T. B. M. 942+A ..	1,075	35.62	N.....	−172.7	−5.8	+23.5	−23.5	1.3	6.1	+1.2	203.0113	666.054	....	....	T.
				S.....	−184.8	+6.3										
				S.....	−181.7	+3.2										
				N.....	−174.9	−3.6										
				S.....	−180.3	+1.8										
				N.....	−176.5	−2.9										
				Mean.	−178.5											

T. B. M. 940+A	T. B. M. 941+A ..	1,013	36.63	N	—979.8	—7.1	+25.0	—25.0	1.7	6.4	+1.4	202.0946	662.816	....	....	T.
				S	—995.0	+8.1										
				S	—986.8	—0.1										
				N	—990.9	+4.0										
				Mean .	—986.9											
*P. B. M. 387	T. B. M. 940+A ..	17	....	S	—961.0	+0.1	....	....	0.1	6.4	+1.6	201.0689	659.664	....	....	T.
				N	—960.8	—0.1										
				Mean .	—960.9											
*Top of cap P. B. M. 387.	T. B. M 940+A ..	17	....	S	+266.2	—0.2	....	....	0.2	6.4	+1.4	202.2906	663.680	....	....	T.
				N	+265.7	+0.3										
				Mean	+266.0											
T. B. M. 939+A	T. B. M. 940+A ..	808	37.44	N	—59.5	+2.1	+23.1	—23.1	0.7	6.4	+1.4	201.9672	662.628	....	....	T.
				S	—55.4	—2.0										
				N	—59.2	+1.8										
				S	—55.7	—1.7										
				Mean .	—57.4											
T. B. M. 938+A	T. B. M. 939+A ..	1,587	39.03	N	—255.1	+2.4	+20.7	—20.7	1.6	6.6	+1.5	201.7146	661.799	....	....	T.
				S	—250.3	—2.4										
				Mean .	—252.7											
T. B. M. 937+A	T. B. M. 938+A ..	1,470	40.50	N	—83.6	—0.6	+21.3	—21.3	0.4	6.6	+1.5	201.6304	661.523	....	....	T.
				S	—84.8	+0.6										
				Mean .	—84.2											
*P. B. M. 386=¹⁄₃²	T. B. M. 937+A ..	72	....	S	—1,239.4	—0.2	....	....	0.1	6.6	+1.8	200.3911	657.457	656.092	—1.365	T.
				N	—1,239.7	+0.1										
				Mean .	—1,239.6											
*Top of cap P. B. M. 386=¹⁄₃²	T. B. M. 937+A ..	72	....	S	—19.4	+0.2	....	....	0.2	6.6	+1.5	201.6112	661.460	....	....	T.
				N	—18.9	—0.3										
				Mean .	—19.2											
T. B. M. 936+A	T. B. M. 937+A ..	1,186	41.68	N	+516.7	+2.0	+19.3	—19.3	1.3	6.7	+1.4	202.1490	663.224	....	....	T.
				S	+520.7	—2.0										
				Mean .	+518.7											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	*r*	*R*	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 935+A	T. B. M. 936+A	1,025	42.71	N	—690.2	—2.0	+21.4	—21.3	1.4	6.9	+1.5	201.4569	660.954			T.
				S	—694.3	+2.1										
				Mean	—692.2											
*P. B. M. 385 Sloan.	T. B. M. 936+A	664		N	+372.6	+0.6			0.4	6.9	+1.3	202.5221	664.449			T.
				S	+373.9	—0.7										
				Mean	+373.2											
*P. B. M. 384	T. B. M. 935+A	35		S	—1,540.5	+0.1			0.1	6.9	+1.9	199.9169	655.901			P.
				N	—1,540.2	—0.2										
				Mean	—1,540.4											
*Top of Cap P. B. M. 384	T. B. M. 935+A	35		S	—319.4	—0.6			0.4	6.9	+1.6	201.1370	659.904			P.
				N	—320.7	+0.7										
				Mean	—320.0											
T. B. M. 934	T. B. M. 935+A	1,004	43.71	S	—383.0	—4.0	+21.9	—21.9	1.3	7.0	+1.6	201.0700	659.684			P.
				N	—387.5	+0.5										
				S	—392.0	+5.0										
				N	—385.3	—1.7										
				Mean	—387.0											
T. B. M. 933	T. B. M. 934	1,240	44.95	S	—1,212.7	—1.3	+20.6	—20.7	0.8	7.1	+1.9	199.8563	655.702			P.
				N	—1,215.2	+1.2										
				Mean	—1,214.0											
T. B. M. 932+A	T. B. M. 933	901	45.86	S	+126.6	—1.0	+19.6	—19.8	0.6	7.1	+1.8	199.9818	656.114			P.
				N	+124.7	+0.9										
				Mean	+125.6											

T. B. M. 931	T. B. M. 932 + A...	1,066	46.94	S..... N..... Mean.	—397.8 —398.8 —397.8	—0.5 +0.5	+19.1	—19.3	0.9	7.1	+1.9	199.5841	654.809	....	....	P.
*P. B. M. 383=$\frac{1}{3}$a	T. B. M. 931	96	....	S..... N..... Mean.	—1,260.3 —1,270.3 —1,269.8	—0.5 +0.5	....	....	0.3	7.1	+3.2	198.8146	650.644	649.827	—1.317	P.
*Top of Cap P. B. M. 383=$\frac{1}{3}$a	T. B. M. 931.......	96	....	S..... N..... Mean.	—31.7 —31.0 —31.4	+0.3 —0.4	....	....	0.2	7.1	+1.9	199.5527	654.706	....	....	P.
T. B. M. 930 + A.........	T. B. M. 931	1,004	47.94	S..... N..... Mean.	—240.7 —242.3 —241.5	—0.8 +0.8	+18.8	—18.5	0.5	7.1	+2.0	199.3427	654.017	....	....	P.
T. B. M. 929	T. B. M. 930 + A...	99[illegible]	48.94	S..... N..... N..... S..... Mean.	+277.3 +271.8 +277.1 +276.6 +275.7	—1.6 +3.9 —1.4 —0.9	+17.1	—17.2	0.0	7.2	+1.9	199.6183	654.922	....	....	P. T.
T. B. M. 928	T. B. M. 929	549	49.49	S..... N..... S..... N..... Mean	—220.3 —216.7 —221.0 —219.7 —219.4	+0.9 —2.7 +1.6 +0.3	+18.3	—18.4	0.6	7.2	+2.0	199.3990	654.202	....	....	P.
T. B. M. 927	T. B. M. 928	1,003	50.50	N..... S..... Mean.	—149.2 —153.2 —151.2	—2.0 +2.0	+20.3	—20.4	1.3	7.3	+2.0	199.2478	653.706	....	....	T.
T. B. M. 926+A	T. B. M. 927	1,164	51.66	N..... S..... Mean.	—673.3 —675.2 —674.2	—0.9 +1.0	+21.3	—21.3	0.6	7.3	+2.1	198.5737	651.494	....	....	T.
*P. B. M. 382	T. B. M. 926 + A...	20	....	S..... N..... Mean.	—989.3 —989.0 —989.2	+0.1 —0.2	....	....	0.1	7.5	+2.3	197.5847	648.250	....	....	T.

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1893—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Top of Cap P. B. M. 382.	T. B. M. 926 + A	20	....	S	+234.8	0.0	....	....	0.0	7.3	+2.1	198.8085	652.265	....	....	T.
				N	+234.7	+0.1										
				Mean	+234.8											
T. B. M. 925	T. B. M. 926 + A	831	52.49	N	−227.0	−3.2	+21.2	−21.2	0.8	7.4	+2.2	108.3436	650.739	....	....	T.
				S	−231.3	+1.1										
				N	−231.0	+0.8										
				S	−226.5	−3.7										
				N	−233.0	+2.8										
				S	−232.4	+2.2										
				Mean	−230.2											
T. B. M. 924	T. B. M. 925	1,112	53.60	N	−770.0	−1.8	+23.1	−23.0	1.2	7.5	+2.3	197.5719	648.208	....	....	T.
				S	−773.7	+1.9										
				Mean	−771.8											
T. B. M. 923+A	T. B. M. 924	1,148	54.75	N	−302.3	+1.6	+21.5	−21.4	1.1	7.5	+2.4	197.2713	647.221	....	....	T.
				S	−299.1	−1.6										
				Mean	−300.7											
T. B. M. 922+A	T. B. M. 923+A	1,108	55.86	N	+133.3	−0.3	+21.8	−21.7	0.2	7.5	+2.4	197.4043	647.658	....	....	T.
				S	+132.7	+0.3										
				Mean	+133.0											
*P. B. M. 381 Whiting.	T. B. M. 922+A	23	....	S	−854.8	−0.2	....	....	0.2	7.5	+2.5	196.5494	644.853	....	....	T.
				N	−855.3	+0.3										
				Mean	−855.0											
*Top of Cap P. B. M. 381	T. B. M. 922+A	23	....	S	+386.2	0.0	....	....	0.0	7.5	+2.3	197.7004	648.924	....	....	T.
				N	+386.3	−0.1										
				Mean	+386.2											

T. B. M. 921	T. B. M. 922+A	1,252	57.11	S	—100.7	+0.6	+22.4	—22.3	0.4	7.6	+2.4	197.2952	647.300			T.
				N	—100.5	—0.6										
				Mean	—100.1											
T. B. M. 920	T. B. M. 921	958	58.07	S	—865.3	—1.4	+21.0	—21.0	0.9	7.6	+2.6	196.4288	644.457			T.
				N	—867.9	+1.3										
				Mean	—866.6											
T. B. M. 919+A	T. B. M. 920	678	58.75	S	—249.5	+1.6	+22.6	—22.6	1.1	7.7	+2.6	196.1809	645.044			T.
				N	—246.3	—1.6										
				Mean	—247.9											
T. B. M. 918+A	T. B. M. 919+A	1,206	59.96	N	—12.6	+0.4	+19.9	—19.9	1.1	7.8	+2.6	196.1687	643.604			T.
				S	—6.5	—5.7										
				N	—16.1	+3.9										
				S	—11.4	—0.8										
				N	—14.3	+2.1										
				Mean	—12.2											
*P. B. M. 380	T. B. M. 918+A	94		S	—1,411.5	—0.5			0.3	7.8	+2.9	194.7570	638.972			T.
				N	—1,412.5	+0.5										
				Mean	—1,412.0											
*Top of Cap P. B. M. 380	T. B. M. 918+A	94		S	—185.5	+0.1			0.0	7.8	+2.6	195.9833	642.996			T.
				N	—185.4	0.0										
				Mean	—185.4											
T. B. M. 917+A	T. B. M. 918+A	1,310	61.26	N	—150.2	—0.1	+20.7	—20.7	0.4	7.8	+2.6	196.0184	643.111			T.
				S	—151.4	+1.1										
				N	—149.4	—0.9										
				Mean	—150.3											
T. B. M. 916	T. B. M. 917+A	1 054	62.32	N	—308.2	—0.8	+21.5	—21.5	0.5	7.8	+2.7	195.7095	642.097			P.
				S	—309.8	+0.8										
				Mean	—309.0											
T. B. M. 915+A	T. B. M. 916	978	63.30	N	—213.2	—1.2	+22.8	—22.7	0.8	7.8	+2.7	195.4951	641.394			P.
				S	—215.7	+1.3										
				Mean	—214.4											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 914	T. B. M. 915+A	994	64.29	N	—630.0	+1.2	+21.5	—21.5	0.8	7.9	+2.9	194.8665	639.332			P.
				S	—627.5	—1.3										
				Mean	—628.8											
*P. B. M. 379	T. B. M. 914	54		S	—1,007.3	0.0			0.0	7.9	+3.1	193.8594	636.027			P.
				N	—1,007.3	0.0										
				Mean	—1,007.3											
*Top of Cap P. B. M. 379	T. B. M. 914	54		S	+212.0	—0.2			0.1	7.9	+2.8	195.0782	640.026			P.
				N	+211.7	+0.1										
				Mean	+211.8											
T. B. M. 913	T. B. M. 914	1,391	65.68	S	—112.3	—3.1	+19.6	—19.6	1.1	8.0	+2.9	194.7511	638.953			P.
				N	—118.0	+2.6										
				S	—116.0	+0.6										
				Mean	—115.4											
T. B. M. 912	T. B. M. 913	1,128	66.81	N	—212.0	—0.8	+20.5	—20.4	0.6	8.0	+2.9	194.5383	638.255			P.
				S	—213.7	+0.9										
				Mean	—212.8											
T. B. M. 911	T. B. M. 912	1,386	68.20	N	—311.3	+2.2	+18.8	—18.2	1.5	8.1	+3.0	194.2293	637.241			P.
				S	—306.9	—2.2										
				Mean	—309.1											
*T. B. M. 910	T. B. M. 911	438		S	+222.3	+1.3			0.9	8.2	+2.9	194.4528	637.974			P.
				N	+225.0	—1.4										
				Mean	+223.6											

*P. B. M. 378=$\frac{1}{8}$a .... Onawa.	T. B. M. 910	152	....	S	—775.7	+0.2	....	....	0.1	8.2	+3.1	193.0775	635.431	634.810	—1.121	P.
				N	—775.3	—0.2										
				Mean .	—775.5											
*Top of cap P. B. M. 378 = $\frac{1}{3}$a.	T. B. M. 910	152	....	S	+463.3	+0.7	....	....	0.5	8.2	+2.9	194.9168	639.497	....	....	P.
				N	+464.7	—0.7										
				Mean .	+464.0											
*P. B. M. 377	T. B. M. 911	414	....	N	+904.3	—0.7	....	....	0.4	8.1	+2.8	195.1327	640.205	....	....	P.
				S	+903.0	+0.6										
				Mean .	+903.6											
T. B. M. 909	T. B. M. 911	1,136	69.34	S	+2.3	+1.3	+19.6	—19.6	0.9	8.2	+3.0	194.2329	637.253	....	....	P.
				N	+5.0	—1.4										
				Mean .	+3.6											
T. B. M. 908	T. B. M. 909	1,211	70.55	S	—204.7	+1.7	+21.3	—21.3	1.1	8.2	+3.0	194.0299	636.587	....	....	P.
				N	—201.3	—1.7										
				Mean .	—203.0											
T. B. M. 907+A	T. B. M. 908	1,018	71.56	S	—488.8	—0.6	+20.7	—20.7	0.4	8.3	=3.1	193.5406	634.981	....	....	P.
				N	—490.0	+0.6										
				Mean .	—489.4											
*P. B. M. 376	T. B. M. 907+A ...	106	....	S	—826.0	—0.2	....	....	0.1	8.3	+3.3	192.7146	632.271	....	....	P.
				N	—826.3	+0.1										
				Mean .	—826.2											
*Top of cap P. B. M. 376.	T. B. M. 907+A ...	105	....	S	+400.0	—0.4	....	....	0.2	8.3	+3.1	193.9402	636.292	....	....	P.
				N	+399.3	+0.3										
				Mean .	+399.6											
T. B. M. 906	T. B. M. 907+A ...	638	72.20	N	—77.8	+0.5	+20.2	—20.2	0.3	8.3	+3.1	193.4633	634.728	....	....	P.
				S	—76.8	—0.5										
				Mean .	—77.3											
T. B. M. 905	T. B. M. 906	924	73.18	N	—272.7	—0.9	+21.2	—21.1	0.6	8.3	+3.2	193.1898	633.830	....	....	P.
				S	—274.6	+1.0										
				Mean .	—273.6											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals. =V.	Σ V. Direct line.	Σ V. Reverse line.	*r*	*R*	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 904	T. B. M. 905	1,083	74.21	S N N S	+11.0 +16.0 +18.3 +19.0	+5.1 +0.1 —2.2 —2.9	+22.3	—22.2	1.2	8.4	+3.2	193.2059	633.883			P.
				Mean	+16.1											
*P. B. M. 375	T. B. M. 904	120		S N	—1,177.3 —1,178.3	—0.5 +0.5			0.3	8.4	+3.4	192.0283	630.020			P.
				Mean	—1,177.8											
*Top of cap P. B. M. 375.	T. B. M. 904	121		S N	+48.3 +49.0	+0.3 —0.4			0.2	8.4	+3.2	193.2545	634.043			P.
				Mean	+48.6											
T. B. M. 903	T. B. M. 904	1,319	75.53	N S	—1,073.3 —1,071.0	+1.1 —1.2	+21.1	—21.1	0.8	8.4	+3.4	192.1339	630.366			P.
				Mean	—1,072.2											
T. B. M. 902+A	T. B. M. 903	1,310	76.84	S N	—570.3 —574.2	—1.9 +2.0	+19.2	—19.1	1.3	8.5	+3.5	191.5618	628.489			P.
				Mean	—572.2											
T. B. M. 901+A	T. B. M. 902+A	919	77.76	S N	+115.8 +118.1	+1.2 —1.1	+20.4	—20.2	0.8	8.5	+3.5	191.6788	628.873			P.
				Mean	+117.0											
T. B. M. 900+A	T. B. M. 901+A	853	78.61	S N	—19.2 —18.0	+0.6 —0.6	+21.0	—20.8	0.4	8.5	+3.5	191.6602	628.812			T.
				Mean	—18.6											

*P. B. M. 374=[illegible]	T. B. M. 900+A	147	....	S	−1, 170. 2	−0. 6	....	....	0. 4	8. 6	+3. 7	190. 4996	624. 971	623. 716	−1. 255	T.
				N	−1, 171. 4	+0. 6										
				Mean	−1, 170. 8											
*Top of cap P. B. M. 374 =[illegible]	T. B. M. 900+A	147	....	S	+45. 6	+0. 4	....	....	0. 4	8. 6	+3. 5	191. 7062	628. 963	....	....	T.
				N	+47. 8	−1. 8										
				S	+45. 8	+0. 2										
				N	+45. 0	+1. 0										
				Mean	+46. 0											
T. B. M. 899	T. B. M. 900+A	1, 084	79. 64	S	−624. 5	−0. 7	+20. 8	−20. 0	0. 5	8. 6	+3. 6	191. 0351	626. 761	....	....	T.
				N	−626. 0	+0. 8										
				Mean	−625. 2											
T. B. M. 898+A	T. B. M. 899	1, 137	80. 78	S	−509. 6	−1. 4	+18. 0	−17. 7	1. 4	8. 7	+3. 7	190. 5242	625. 085	....	....	T.
				N	−517. 2	+6. 2										
				S	−507. 9	−3. 1										
				N	−509. 5	−1. 5										
				Mean	−511. 0											
T. B. M. 897+A	T. B. M. 898+A	1, 042	81. 82	S	+110. 4	−2. 0	+16. 0	−15. 6	1. 4	8. 8	+3. 7	190. 6326	625. 441	....	....	T.
				N	+106. 3	+2. 1										
				Mean	+108. 4											
*P. B. M. 373	T. B. M. 897+A	50	....	S	−1, 089. 5	0. 0	....	....	0. 0	8. 8	+3. 9	189. 5433	621. 867	....	....	T.
				N	−1, 089. 5	0. 0										
				Mean	−1, 089. 5											
*Top of cap P. B. M. 373	T. B. M. 897+A	50	....	S	+130. 8	0. 0	....	....	0. 0	8. 8	+3. 7	190. 7634	625. 870	....	....	T.
				N	+130. 9	−0. 1										
				Mean	+130. 8											
T. B. M. 896+A	T. B. M. 897+A	1, 247	83. 07	S	−159. 9	+1. 2	+17. 4	−17. 0	0. 9	8. 8	+3. 7	190, 4730	624. 920	....	....	T.
				N	−154. 8	−3. 9										
				N	−159. 8	+1. 1										
				S	−160. 3	+1. 6										
				Mean	−158. 7											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 895	T. B. M. 896+A	918	83.99	S	+99.2	−4.6	+15.6	−15.3	1.1	8.9	+3.7	190.5685	625.230			T.
				N	+92.2	+2.4										
				S	+93.6	+1.0										
				N	+93.5	+1.1										
				Mean	+94.6											
T. B. M. 894	T. B. M. 895	883	84.87	N	−290.9	+0.8	+14.8	−14.5	0.5	8.9	+3.8	190.2785	624.279			T.
				S	−289.3	−0.8										
				Mean	−290.1											
T. B. M. 893+A	T. B. M. 894	1,032	85.90	N	+283.6	−1.8	+16.6	−16.3	1.2	9.0	+3.7	190.5602	625.203			T.
				S	+280.0	+1.8										
				Mean	+281.8											
*Top of cap P. B. M. 372 =$\frac{132}{4}$.	T. B. M. 893+A	76		N	−1,691.8	−0.4			0.3	9.0	+4.1	188.8692	619.655			T.
				S	−1,690.9	+0.5										
				Mean	−1,691.4											
*P. B. M. 371	T. B. M. 893+A	19		S	−1,934.2	+0.4			0.3	9.0	+4.1	188.6260	618.857			T.
				N	−1,935.0	−0.4										
				Mean	−1,934.6											
*Top of cap P. B. M. 371	T. B. M. 893+A	19		S	−713.4	−0.2			0.2	9.0	+3.9	189.8468	622.863			T.
				N	−713.9	+0.3										
				Mean	−713.6											
T. B. M. 892	T. B. M. 893+A	1,068	86.97	S	+183.0	+1.5	+18.1	−17.8	1.0	9.1	+3.7	190.7447	625.808			T.
				N	+186.0	−1.5										
				Mean	+184.5											

T. B. M 891+A	T. B. M. 892	644	87.62	S	−143.2	−0.1	+18.0	−17.7	0.1	9.1	+8.7	190.6014	625.388	....	....	T.
				N	−143.4	+0.1										
				Mean	−143.3											
T. B. M. 890	T. B. M. 891+A ...	1,202	88.82	N	−617.2	−2.0	+20.1	+19.7	1.4	9.2	+3.8	189.9823	623.307	....	....	P.
				S	−621.3	+2.1										
				Mean	−619.2											
T. B. M. 889	T. B. M. 890	1,038	89.86	N	−325.7	+0.5	+19.6	−19.2	0.3	9.2	+3.9	189.6572	622.240	....	....	P.
				S	−324.7	−0.5										
				Mean	−325.2											
*P. B. M. 370............	T. B. M. 889	15	....	S	−1,708.7	−0.1	....	....	0.1	9.2	+4.2	187.9487	616.635	....	....	P.
				N	−1,709.0	+0.2										
				Mean	−1,708.8											
*Top of cap. P. B. M 370.	T. B. M. 889	15	....	S	−488.0	+0.4	....	....	0.2	9.2	+4.0	189.1697	620.641	....	....	P.
				N	−487.3	−0.3										
				Mean	−487.6											
T. B. M. 888	T. B. M. 889	818	90.67	N	−338.7	−0.1	+19.8	−19.3	0.1	9.2	+4.0	189.3185	621.129	....	....	P.
				S	−339.0	+0.2										
				Mean	−338.8											
T. B. M. 887	T. B. M. 888	234	90.91	S	+170.7	−0.8	+20.3	−19.9	0.4	9.2	+3.9	189.4883	621.686	....	....	P.
				N	+170.3	−0.4										
				S	+168.0	+1.9										
				N	+170.7	−0.8										
				Mean	+169.9											
T. B. M. 886	T. B. M. 887	1,146	92.05	S	+932.3	−0.8	+19.5	−19.1	0.5	9.2	+3.8	190.4197	624.742	....	....	P.
				N	+930.7	+0.8										
				Mean	+931.5											
T. B. M. 885	T. B. M. 886	960	93.01	S	−1,051.0	+1.0	+20.5	−20.1	0.7	9.2	+4.0	189.3699	621.298	....	....	P.
				N	−1,049.0	−1.0										
				Mean	−1,050.0											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 884	T. B. M. 885	780	93.79	S	+446.3	−0.8	+19.7	−19.3	0.5	9.2	+3.9	189.8153	622.759	....	....	P.
				N	+444.7	+0.8										
				Mean	+445.5											
*P. B. M. 369=[illegible] River Sioux.	T. B. M. 884	81	....	S	−936.0	+0.2	....	....	0.1	9.2	+4.1	188.8797	619.690	618.558	−1.132	P.
				N	−935.7	−0.1										
				Mean	−935.8											
*Top of cap, P. B. M. 369=[illegible].	T. B. M. 881	82	....	S	+283.0	0.0	....	....	0.0	9.2	+3.8	190.0982	623.687	....	....	P.
				N	+283.0	0.0										
				Mean	+283.0											
T. B. M. 883	T. B. M. 884	1,296	95.09	N	−180.3	+0.3	+19.4	−19.0	0.2	9.2	+3.9	189.6353	622.160	....	....	P.
				S	−179.7	−0.3										
				Mean	−180.0											
T. B. M. 882	T. B. M. 883	986	96.08	S	+499.3	+1.9	+21.3	−20.9	1.3	9.3	+3.8	190.1364	623.813	....	....	P.
				N	+503.1	−1.9										
				Mean	+501.2											
T. B. M. 881+A	T. B. M. 882	1,098	97.17	S	−2,216.5	+0.1	+21.4	−21.1	0.1	9.3	+4.3	187.9205	616.543	....	....	P.
				N	−2,216.2	−0.2										
				Mean	−2,216.4											
***P. B. M. 368**	**T. B. M. 881+A**	**137**	....	**S**	**−912.5**	**0.0**	....	....	0.0	9.3	+4.4	187.0081	613.549	....	....	T.
				N	**−912.5**	**0.0**										
				Mean	**−912.5**											
***Top of cap, P. B. M. 368.**	**T. B. M. 881+A**	**136**	....	**S**	**+308.6**	−0.6	....	....	0.4	9.3	+4.2	188.2284	617.553	....	....	T.
				N	**+307.5**	+0.5										
				Mean	**+308.0**											

T. B. M. 880	T. B. M. 881+A ...	1,280	98.45	S	—579.4	+3.2	+21.8	—21.6	1.0	9.4	+4.4	187.3444	614.652	....	....	T.
				N.....	—578.5	—2.7										
				S	—573.8	—2.4										
				N.....	—577.9	+1.7										
				Mean.	—576.2											
T. B. M. 879	T. B. M. 880	1,211	99.66	S	—389.7	—1.1	+20.7	—20.4	0.8	9.4	+4.4	186.9536	613.370	....	....	T.
				N.....	—392.0	+1.2										
				Mean.	—390.8											
T. B. M. 878	T. B. M. 879	1,086	100.70	S	+192.3	—0.5	+20.2	—19.9	0.3	9.4	+4.4	187.1454	614.000	....	....	P.
				N.....	+191.3	+0.5										
				Mean.	+191.8											
*P. B. M. 367=$\frac{1}{2}$°	T. B. M. 878	132	....	S	—1,769.3	—0.5	....	....	0.3	9.4	+4.8	185.3760	608.194	607.081	—1.113	P.
				N.....	—1,770.3	+0.5										
				Mean.	—1,769.8											
*Top of cap, P. B. M. 367= $\frac{1\,30}{2}$	T. B. M. 878	132	....	S	—552.7	+0.3	....	....	0.2	9.4	+4.5	186.5931	612.188	....	....	P.
				N.....	—552.0	—0.4										
				Mean.	—552.4											
T. B. M. 877	T. B. M. 878	998	101.70	S	—445.3	—0.2	+20.0	—19.6	0.1	9.4	+4.5	186.7000	612.538	....	....	P.
				N.....	—445.7	+0.2										
				Mean.	—445.5											
T. B. M. 876+A	T. B. M. 877	618	102.32	S	—2.5	+0.6	+20.6	—20.2	0.4	9.4	+4.5	186.6981	612.532	....	....	P.
				N.....	—1.3	—0.6										
				Mean.	—1.9											
T. B. M. 875	T. B. M. 876+A ...	984	103.30	S	—252.3	+0.5	+21.1	—20.7	0.3	9.4	+4.5	186.4463	611.706	....	....	P.
				N.....	—251.3	—0.5										
				Mean.	—251.8											
*P. B. M. 366	T. B. M. 875	68	....	S	—616.3	—0.5	....	....	0.3	9.4	+4.7	185.8297	609.683	....	....	P.
				N.....	—617.2	+0.4										
				Mean.	—616.8											
*Top of cap, P. B. M. 366	T. B. M. 875	68	....	S	+604.0	—0.5	....	....	0.3	9.4	+4.4	187.0497	613.686	....	....	P.
				N.....	+603.0	+0.5										
				Mean.	+603.5											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	≥ V. Direct line.	≥ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common level.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 874	T. B. M. 875	625	103.92	S	+779.9	−0.7	+20.4	−20.1	0.4	9.4	+4.4	187.2254	614.262	....	....	P.
				N	+778.6	+0.6										
				Mean	+779.2											
*P. B. M. 365 Mondamin.	T. B. M. 874	76	....	S	−469.3	+0.1	....	....	0.1	9.4	+4.5	186.7563	612.723	....	....	P.
				N	−469.0	−0.2										
				Mean	−469.2											
T. B. M. 873+A	T. B. M. 874	926	104.85	S	−2,209.8	−0.7	+19.7	−19.4	0.5	9.5	+4.8	185.0153	607.011	....	....	P.
				N	−2,211.2	+0.7										
				Mean	−2,210.5											
T. B. M. 872	T. B. M. 873+A	1,138	105.99	S	−273.4	0.0	+19.7	−19.3	0.0	9.5	+4.9	184.7420	606.114	....	....	T.
				N	−273.5	+0.1										
				Mean	−273.4											
T. B. M. 871	T. B. M. 872	1,126	107.12	S	−244.3	−2.1	+17.6	−17.2	1.4	9.6	+4.9	184.4956	605.306	....	....	T.
				N	−248.5	+2.1										
				Mean	−246.4											
*P. B. M. 364	T. B. M. 871	29	....	S	−1,169.4	+0.2	....	....	0.1	9.6	+5.2	183.3267	601.471	....	....	T.
				N	−1,169.0	−0.2										
				Mean	−1,169.2											
*Top of cap, P. B. M. 364	T. B. M. 871	29	....	S	+55.3	−0.1	....	....	0.1	9.6	+4.9	184.5508	605.487	....	....	T.
				N	+55.0	+0.2										
				Mean	+55.2											
T. B. M. 870+A	T. B. M. 871	932	108.05	S	+32.3	0.0	+17.6	−17.2	0.0	9.6	+4.9	184.5279	605.412	....	....	T.
				N	+32.3	0.0										
				Mean	+32.3											

T. B. M. 869	T. B. M. 870 + A	1,118	109.16	S	+64.0	+1.4	+19.0	−18.7	1.0	9.6	+4.9	184.5933	605.626	T.
				N	+66.9	−1.5								
				Mean	+65.4									
T. B. M. 868 + A	T. B. M. 869	1,290	110.46	S	−455.0	−1.4	+17.6	−17.8	0.9	9.6	+5.0	184.1370	604.129	P.
				N	−457.8	+1.4								
				Mean	−456.4									
T. B. M. 867	T. B. M. 868 + A	678	111.13	N	−178.7	+1.1	+16.4	−16.2	0.8	9.7	+5.0	183.9594	603.547	T.
				S	−176.4	−1.2								
				Mean	−177.6									
T. B. M. 866	T. B. M. 867	981	112.12	N	−1,063.8	+2.8	+14.9	−14.8	0.7	9.7	+5.3	182.8987	600.067	T.
				S	−1,059.4	−1.6								
				N	−1,061.1	+0.1								
				S	−1,059.7	−1.3								
				Mean	−1,061.0									
*P. B. M. 363	T. B. M. 866	85	....	S	−696.0	0.0	....	....	0.0	9.7	+5.4	182.2028	597.784	T.
				N	−696.0	0.0								
				Mean	−696.0									
*Top of cap. P. B. M. 363	T. B. M. 866	85	....	S	+527.0	−0.4	....	....	0.2	9.7	+5.2	183.4252	601.794	T.
				N	+526.3	+0.3								
				Mean	+526.6									
T. B. M. 865	T. B. M. 866	542	112.66	N	−79.3	−1.5	+16.4	−16.3	1.0	9.8	+5.3	182.8178	599.802	T.
				S	−82.3	+1.5								
				Mean	−80.8									
T. B. M. 864	T. B. M. 865	559	113.21	N	+182.7	−1.0	+17.4	−17.3	0.7	9.8	+5.2	182.9995	600.397	P.
				S	+180.7	+1.0								
				Mean	+181.7									
T. B. M. 863	T. B. M. 864	700	113.91	N	−17.3	−0.4	+17.8	−17.7	0.3	9.8	+5.2	182.9818	600.339	P.
				S	−18.1	+0.4								
				Mean	−17.7									
T. B. M. 862 + A	T. B. M. 863	598	114.51	N	−6.3	+0.4	+17.4	−17.3	0.3	9.8	+5.2	182.9759	600.320	P.
				S	−5.5	−0.4								
				Mean	−5.9									

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	*r*	*R*	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Former by common level.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 861	T. B. M. 862 + A	740	115.25	N	−360.9	+0.8	+16.6	−16.5	0.5	9.8	+5.3	182.6159	599.139	....	....	P.
				S	−359.3	−0.8										
				Mean	−360.1											
*P. B. M. 362	T. B. M. 861	16	....	S	−835.3	0.0	....	....	0.0	9.8	+5.5	181.7808	596.399	....	....	T.
				N	−835.3	0.0										
				Mean	−835.3											
*Top of cap, P. B. M. 362	T. B. M. 861	16	....	S	+382.0	−0.2	....	....	0.1	9.8	+5.2	182.9976	600.391	....	....	T.
				N	+381.7	+0.1										
				Mean	+381.8											
T. B. M. 860	T. B. M. 861	1,145	116.40	N	−572.8	0.0	+16.6	−16.5	0.0	9.8	+5.4	182.0432	597.260	....	....	P.
				S	−572.7	−0.1										
				Mean	−572.8											
T. B. M. 859 + A	T. B. M. 860	1,081	117.48	N	+73.4	+0.8	+15.7	−15.7	0.6	9.8	+5.4	182.1174	597.503	....	....	P.
				S	+75.1	−0.9										
				Mean	+74.2											
T. B. M. 858	T. B. M. 859 + A	1,002	118.48	N	+592.7	+0.9	+14.9	−14.8	0.6	9.8	+5.3	182.7109	599.451	....	....	P.
				S	+594.4	−0.8										
				Mean	+593.6											
*P. B. M. 361	T. B. M. 858	25	....	S	−1,985.0	−0.4	....	....	0.2	9.8	+5.7	180.7259	592.938	....	....	P.
				N	−1,985.7	+0.3										
				Mean	−1,985.4											
*Top of cap, P. B. M. 361	T. B. M. 858	25	....	S	−761.7	−0.3	....	....	0.2	9.8	+5.4	181.9490	596.951	....	....	P.
				N	−762.2	+0.2										
				Mean	−762.0											

T. B. M. 857	T. B. M. 858	1,868	119.85	N	—985.3	—0.5	+15.4	—15.8	0.8	9.8	+5.5	181.7253	596.217			P.
				S	—986.3	+0.5										
				Mean	—985.8											
T. B. M. 856 + A	T. B. M. 857	1,116	120.96	N	—855.1	+2.3	+13.1	—13.0	1.6	10.0	+5.7	180.8727	593.420			P.
				S	—850.5	—2.3										
				Mean	—852.8											
T. B. M. 855	T. B. M. 856 + A	432	121.40	N	+1,004.0	+0.8	+12.2	—12.2	0.6	10.0	+5.5	181.8773	596.716			P.
				S	+1,005.7	—0.9										
				Mean	+1,004.8											
*P. B. M. 360=½z California Junction.	T. B. M. 855	78		S	—2,011.7	0.0			0.0	10.0	+5.9	179.8660	590.117	588.833	—1.184	P.
				N	—2,011.7	0.0										
				Mean	—2,011.7											
*Top of cap, P. B. M. 360 =½z.	T. B. M. 855	79		S	—790.3	0.0			0.0	10.0	+5.6	181.0871	594.123			P.
				N	—790.3	0.0										
				Mean	—790.3											
T. B. M. 854	T. B. M. 855	1,074	122.47	S	—923.4	—0.4	+11.8	—11.7	0.3	10.0	+5.6	180.9536	593.685			P.
				N	—924.3	+0.5										
				Mean	—923.8											
T. B. M. 853	T. B. M. 854	1,005	123.47	S	—380.8	+0.7	+12.5	—12.4	0.5	10.0	+5.7	180.5736	592.438			P.
				N	—379.4	—0.7										
				Mean	—380.1											
T. B. M. 852	T. B. M. 853	942	124.42	N	+469.0	—0.8	+13.3	—13.2	0.5	10.0	+5.6	181.0417	593.974			P.
				S	+467.4	+0.8										
				Mean	+468.2											
T. B. M. 851	T. B. M. 852	972	125.39	S	—95.3	—0.9	+12.4	—12.4	0.6	10.0	+5.6	180.9455	593.659			P.
				N	—97.0	+0.8										
				Mean	—96.2											
*T. B. M. 359	T. B. M. 851	128		S	—1,338.4	0.0			0.0	10.0	+5.9	179.6074	589.268			P.
				N	—1,338.4	0.0										
				Mean	—1,338.4											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	*r*	*R*	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Top of cap, P. B. M. 359.	T. B. M. 851	128	....	S	−113.1	−0.7	....	....	0.4	10.0	+5.7	180.8318	593.286	....	....	P.
				N	−114.4	+0.6										
				Mean	−113.8											
T. B. M. 850	T. B. M. 851	808	126.20	S	+41.2	+1.0	+13.4	−13.3	0.6	10.1	+5.6	180.9877	593.797	....	....	P.
				N	+43.1	−0.9										
				Mean	+42.2											
T. B. M. 849+A	T. B. M. 850	1,208	127.40	S	−1,070.4	+1.6	+15.0	−15.0	1.1	10.1	+5.9	179.9192	590.291	....	....	P.
				N	−1,067.1	−1.7										
				Mean	−1,068.8											
T. B. M. 848	T. B. M. 849 + A	827	128.23	S	+717.3	+1.7	+16.7	−16.7	1.1	10.2	+5.7	180.6380	592.650	....	....	T.
				N	+720.7	−1.7										
				Mean	+719.0											
T. B. M. 847	T. B. M. 848	1,012	129.24	S	−1,666.3	+0.6	+17.3	−17.3	0.4	10.2	+6.0	178.9726	587.186	....	....	T.
				N	−1,665.1	−0.6										
				Mean	−1,665.7											
T. B. M. 846	T. B. M. 847	186	129.43	S	+1,137.3	+0.3	+17.6	−17.7	0.2	10.2	+5.8	180.1100	590.917	....	....	T.
				N	+1,138.0	−0.4										
				Mean	+1,137.6											
*P. B. M. 358 Missouri Valley.	T. B. M. 846	396	....	S	+965.0	−2.3	....	....	0.6	10.2	+5.6	181.0725	594.075	....	....	T.
				N	+962.0	+0.7										
				S	+963.2	−0.5										
				N	+960.7	+2.0										
				Mean	+962.7											

T. B. M. 845	T. B. M. 846	880	130.31	S	−290.9	−5.7	+15.2	−15.2	1.8	10.3	+5.9	179.8145	589.948	....	....	T.
				N	−299.3	+2.7										
				S	−297.4	+0.8										
				N	−298.9	+2.3										
				Mean	−296.6											
T. B. M. 844 + A	T. B. M. 845	973	131.28	S	−311.5	+0.1	+13.4	−13.4	1.4	10.4	+6.0	179.0033	587.286	....	....	T.
				N	−317.1	+5.7										
				S	−307.6	−3.8										
				N	−309.2	−2.2										
				Mean	−311.4											
T. B. M. 843	T. B. M. 844 + A	761	132.04	S	+228.1	+0.1	+13.5	−13.6	0.1	10.4	+6.0	179.2314	588.085	....	....	T.
				N	+228.4	−0.2										
				Mean	+228.2											
T. B. M. 842	T. B. M. 843	1,078	133.12	S	−267.0	+0.8	+14.3	−14.4	0.5	10.4	+6.0	178.9650	587.161	....	....	T.
				N	−265.4	−0.8										
				Mean	−266.2											
*P. B. M. 357	T. B. M. 842	20	....	S	−1,386.3	−0.2	....	....	0.1	10.4	+6.3	177.5790	582.614	....	....	T.
				N	−1,386.7	+0.2										
				Mean	−1,386.5											
*Top of cap, P. B. M. 357	T. B. M. 842	20	....	S	−164.0	+0.4	....	....	0.2	10.4	+6.1	178.8017	586.625	....	....	T.
				N	−163.3	−0.3										
				Mean	−163.6											
T. B. M. 841	T. B. M. 842	1,076	134.20	S	−517.7	+0.1	+14.4	−14.5	0.1	10.4	+6.1	178.4477	585.464	....	....	T.
				N	−517.5	−0.1										
				Mean	−517.6											
T. B. M. 840	T. B. M. 841	938	135.19	S	+123.0	−1.8	+12.6	−12.6	1.2	10.4	+6.1	178.5689	585.861	....	....	T.
				N	+119.3	+1.9										
				Mean	+121.2											
T. B. M. 839	T. B. M. 840	1,021	136.22	S	+1,793.6	−0.8	+11.8	−11.8	0.5	10.5	+5.8	180.3614	591.742	....	....	T.
				N	+1,792.0	+0.8										
				Mean	+1,792.8											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 356 Loveland.	T. B. M. 839	230	....	S	—1,223.0	+0.2	....	....	0.1	10.5	+6.0	179.1388	587.731	....	....	T.
				N	—1,222.7	—0.1										
				Mean	—1,222.8											
T. B. M. 838 + A	T. B. M. 839	1,089	137.30	S	+1,258.5	—1.8	+10.8	—10.8	1.8	10.6	+5.5	181.6178	595.864	....	....	T.
				N	+1,263.0	—6.3										
				S	+1,252.5	+4.2										
				N	+1,247.0	+9.7										
				N	+1,257.1	—0.4										
				S	+1,262.0	—5.3										
				Mean	+1,256.7											
T. B. M. 837	T. B. M. 838 + A	996	138.30	N	—863.5	+0.9	+10.0	— 9.9	0.6	10.6	+5.7	180.7554	593.035	....	....	T.
				S	—861.8	—0.8										
				Mean	—862.6											
T. B. M. 836	T. B. M. 837	1,092	139.39	N	—203.7	+1.0	+ 9.0	— 8.9	0.7	10.7	+5.7	180.5527	592.370	....	....	T.
				S	—201.7	—1.0										
				Mean	—202.7											
T. B. M. 835	T. B. M. 836	940	140.33	S	—944.3	—1.6	+ 7.4	— 7.3	1.1	10.7	+5.9	179.6070	589.267	....	....	T.
				N	—947.5	+1.6										
				Mean	—945.9											
*P. B. M. 355	T. B. M. 835	58	....	S	—313.2	+0.7	....	....	0.2	10.7	+6.0	179.2946	588.242	....	....	T.
				N	—311.9	—0.6										
				S	—312.6	+0.1										
				N	—312.2	—0.3										
				Mean	—312.5											

*Top of cap, P. B. M. 355.	T. B. M. 835	58	....	S	+912.9	−1.3	....	....	0.3	10.7	+5.7	183.8194	588.281	....	....	T.
				N	+912.1	+0.5										
				S	+911.8	+0.8										
				N	+912.8	−0.2										
				Mean.	+912.6											
T. B. M. 834	T. B. M. 835	1,008	141.84	N	−1,116.0	−0.5	+ 7.3	− 7.3	0.2	10.7	+6.1	178.4907	585.605	....	....	T.
				S	−1,116.4	−0.1										
				N	−1,117.0	+0.5										
				Mean.	−1,116.5											
T. B. M. 833	T. B. M. 834	1,192	142.53	S	+902.2	−1.2	+ 6.1	− 6.2	0.8	10.7	+6.0	179.2916	588.560	....	....	T.
				N	+899.9	+1.1										
				Mean.	+901.0											
T. B. M. 832	T. B. M. 833	1,016	143.55	N	+1,884.7	−3.8	+ 7.9	− 8.0	9	10.8	+5.6	181.2721	594.730	....	....	T.
				S	+1,879.0	+1.9										
				N	+1,883.7	+0.2										
				S	+1,879.3	+1.6										
				Mean.	+1,880.9											
*P. B. M. 354 .... Honey Creek.	T. B. M. 832	80	....	S	−709.3	−0.3	....	....	0.2	10.8	+5.7	180.5626	542.402	....	....	P.
				N	−710.0	+0.4										
				Mean.	−709.6											
T. B. M. 831	T. B. M. 832	1,070	144.62	S	−3,398.6	−4.2	+ 4.9	− 5.0	1.3	10.9	+6.3	177.8700	583.568	....	....	P.
				N	−3,407.5	+4.7										
				S	−3,401.1	−1.7										
				N	−3,404.2	+1.4										
				Mean.	−3,402.8											
T. B. M. 830	T. B. M. 831	1,110	145.73	S	+650.4	−1.6	+ 1.6	− 1.6	1.4	10.9	+6.1	178.5186	585.696	....	....	P.
				N	+646.4	+2.4										
				S	+653.9	−4.9										
				N	+644.3	+4.5										
				Mean.	+648.8											
T. B. M. 829	T. B. M. 830	926	146.65	N	−551.5	+5.5	− 0.2	+ 0.2	1.9	11.1	+6.2	177.9727	583.905	....	....	P.
				S	−543.6	−2.4										
				N	−542.8	−3.2										
				Mean.	−546.0											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	*r*	*R*	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 353	T. B. M. 829	37	....	S	−67.8	−0.2	....	....	0.1	11.1	+6.3	177.9048	583.682	....	....	P.
				N	−68.1	+0.1										
				Mean .	−68.0											
*Top of cap, P. B. M. 353.	T. B. M. 829	37	....	S	+1,154.6	−0.5	....	....	0.3	11.1	+6.0	179.1266	587.691	....	....	P.
				N	+1,153.6	+0.5										
				Mean .	+1,154.1											
T. B. M. 828+A	T. B. M. 829	1,130	147.78	S	−623.7	−0.7	−0.9	+1.0	0.5	11.1	+6.4	177.3485	581.857	....	....	P.
				N	−625.2	+0.8										
				Mean .	−624.4											
T. B. M. 827	T. B. M. 828+A	1,176	148.96	N	−459.3	+1.5	−2.4	+2.5	1.0	11.2	+6.5	176.8908	580.356	....	....	T.
				S	−456.3	−1.5										
				Mean .	−457.8											
T. B. M. 826+A	T. B. M. 827	1,184	150.14	N	−407.4	+0.6	−3.0	+3.1	0.4	11.2	+6.5	176.4840	579.021	....	....	T.
				S	−406.2	−0.6										
				Mean .	−406.8											
T. B. M. 825	T. B. M. 826+A	1,088	151.23	N	−105.5	−0.2	−2.8	+2.9	0.1	11.2	+6.6	176.3784	578.674	....	....	T.
				S	−105.9	+0.2										
				Mean .	−105.7											
T. M. B. 824+A	T. B. M. 825	1,144	152.38	N	+458.5	−0.3	−2.6	+2.6	0.2	11.2	+6.5	176.8365	580.177	....	....	T.
				S	+458.0	+0.2										
				Mean .	+458.2											
*P. B. M. 352 Crescent.	T. B. M. 824+A	122	....	S	−1,269.3	+0.1	....	....	0.0	11.2	−6.7	175.5675	576.014	....	....	T.
				N	−1,269.2	0.0										
				Mean .	−1,269.2											

*Top of cap, P. B. M. 352.	T. B. M. 824+A ...	122	....	S	—44.7	+0.5	....	....	0.3	11.2	+6.5	176.7023	580.032	....	....	T.
				N	—43.8	—0.4										
				Mean .	—44.2											
T. B. M. 823	T. B. M. 824+A ...	1,186	153.56	N	—858.7	—1.5	—1.0	+1.1	1.0	11.2	+6.6	175.9764	577.356	....	....	T.
				S	—861.8	+1.6										
				Mean .	—860.2											
T. B. M. 822	T. B. M. 823	942	154.50	N	—422.6	+3.0	—3.9	+3.8	1.1	11.3	+6.7	175.5569	575.979	....	....	T.
				S	—416.7	—2.9										
				N	—422.3	+2.7	....	....	....	....	....	....	....	....	....	P.
				S	—416.7	—2.9										
				Mean .	—419.6											
T. B. M. 821	T. B. M. 822	968	155.47	N	+83.4	+3.9	—6.3	+6.2	1.1	11.3	+6.7	175.6442	576.266	....	....	T.
				S	+88.0	—0.7										
				S	+91.4	—4.1										
				N	+86.3	+1.0	....	....	....	....	....	....	....	....	....	P.
				Mean .	+87.3											
*P. B. M. 351	T. B. M. 821	73	....	S	—507.3	—0.2	....	....	0.1	11.3	+6.8	175.0468	574.306	....	....	P.
				N	—507.7	+0.2										
				Mean .	—507.5											
*Top of cap, P. B. M. 351.	T. B. M. 821	73	....	S	+626.7	—0.2	....	....	0.1	11.3	+6.6	176.2706	578.321	....	....	P.
				N	+626.3	+0.2										
				Mean .	+626.5											
T. B. M. 820	T. B. M. 821	1,246	156.72	S	—1,401.7	—1.3	—7.6	+7.5	0.9	11.4	+7.0	174.2415	571.064	....	....	P.
				N	—1,404.3	+1.3										
				Mean .	—1,403.0											
T. B. M. 819	T. B. M. 820	940	157.66	S	+54.3	+0.5	—7.1	+7.0	0.3	11.4	+7.0	174.2963	571.843	....	....	P.
				N	+55.3	—0.5										
				Mean .	+54.8											
T. B. M. 818	T. B. M. 819	972	158.63	S	+3,387.0	+0.5	—6.6	+6.5	0.3	11.4	+6.3	177.6831	582.955	....	....	P.
				N	+3,388.0	—0.5										
				Mean .	+3,387.5											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 350	T. B. M. 818	203		S	+65.6	+0.8			0.5	11.4	+6.3	177.7495	583.173			P.
				N	+67.2	−0.8										
				Mean	+66.4											
*Top of cap, P. B. M. 350	T. B. M. 818	203		S	+1,288.2	−0.5			0.3	11.4	+6.0	178.9705	587.179			P.
				N	+1,287.2	+0.5										
				Mean	+1,287.7											
T. B. M. 817	T. B. M. 818	996	159.63	S	+428.8	+1.0	−5.6	+5.6	0.6	11.4	+6.2	178.1128	584.365			P.
				N	+430.7	−0.9										
				Mean	+429.8											
T. B. M. 816	T. B. M. 817	1,379	161.00	S	−4,110.3	−4.6	−5.7	+5.7	1.5	11.5	+7.0	173.9987	570.867			P.
				N	−4,118.0	+3.1										
				S	−4,119.3	+4.4										
				N	−4,112.0	−2.9										
				Mean	−4,114.9											
*T. B. M. 815	T. B. M. 816	304		N	−1,984.3	+0.1			0.1	11.5	+7.4	172.0149	564.358			S.
				S	−1,984.0	−0.2										
				Mean	−1,984.2											
*T. B. M. 814	T. B. M. 815	660		N	+385.7	+1.4			0.5	11.5	+7.4	172.4020	565.628			S.
				N	+388.4	−1.3										
				S	+387.3	−0.2										
				Mean	+387.1											
*T. B. M. 813	T. B. M. 814	959		S	+244.7	−1.3			0.9	11.6	+7.3	172.6453	566.427			P.
				N	+242.0	+1.4										
				Mean	+243.4											

*P. B. M. 349=$\frac{1}{11}$. Council Bluffs.	T. B. M. 813	92	....	S	−1,072.0	+0.4	....	....	0.2	11.6	+7.5	171.5739	562.912	562.154	−0.758	S.
				N	−1,071.3	−0.3										
				Mean .	−1,071.6											
*Top of cap, P. B. M. 349=$\frac{1}{11}$.	T. B. M. 813	92	....	S	+153.0	+0.2	....	....	0.1	11.6	+7.3	172.7985	566.929	....	....	S.
				N	+153.3	−0.1										
				Mean .	+153.2											
T. B. M. 812+A	T. B. M. 816	908	162.00	S	−420.8	−0.9	−6.6	+6.7	0.6	11.5	+7.1	173.5776	569.485	....	....	P.
				N	−422.2	+1.0										
				Mean .	−421.2											
T. B. M. 811	T. B. M. 812+A	1,114	163.12	S	+1,771.2	−5.2	−8.2	+8.3	1.2	11.6	+6.8	175.3433	575.278	....	....	T.
				N	+1,764.7	+1.3										
				N	+1,764.0	+2.0										
				S	+1,764.0	+2.0										
				Mean .	+1,766.0											
T. B. M. 810	T. B. M. 811	787	163.90	S	−1,189.0	−1.6	−8.4	+8.5	1.0	11.6	+7.0	174.1529	571.373	....	....	T.
				N	−1,194.0	+3.4										
				S	−1,191.7	+1.1										
				N	−1,187.5	−3.1										
				Mean .	−1,190.6											
*T. B. M. 809	T. B. M. 810	884	....	S	+2,413.0	+0.8	....	....	0.6	11.6	+6.5	176.5662	579.291	....	....	T.
				N	+2,414.7	−0.9										
				Mean .	+2,413.8											
*P. B. M. 348=$\frac{1}{11}$	T. B. M. 809	84	....	S	−428.0	−0.4	....	....	0.2	11.0	+6.6	176.1379	577.885	577.156	−0.729	T.
				N	−428.7	+0.3										
				Mean .	−428.4											
*Top of cap, P. B. M. 348=$\frac{1}{11}$.	T. B. M. 809	84	....	S	+796.3	+0.2	....	....	0.1	11.6	+6.4	177.3626	581.904	....	....	T.
				N	+796.7	−0.2										
				Mean .	+796.5											
T. B. M. 808+A	T. B. M. 810	962	164.87	S	−1,872.8	−1.4	−9.8	+9.9	0.9	11.6	+7.4	172.2791	565.225	....	....	T.
				N	−1,875.6	+1.4										
				Mean .	−1,874.2											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*T. B. M. 807	T. B. M. 808+A	526	....	S	+907.4	−1.3	....	....	0.9	11.6	+7.2	173.1850	568.197	....	....	P.
				N	+904.8	+1.3										
				Mean	+906.1											
*P. B. M. 347	T. B. M. 807	854	....	S	+1,799.7	+4.1	....	....	1.4	11.7	+6.8	174.9884	574.114	....	....	P.
				N	+1,805.4	−1.6										
				S	+1,806.5	−2.7										
				Mean	+1,803.8											
*T. B. M. 806	P. B. M. 347	536	....	S	−2,267.7	+0.7	....	....	0.5	11.7	+7.3	172.7219	566.678	....	....	P.
				N	−2,266.3	−0.7										
				Mean	−2,267.0											
*T. B. M. 805	T. B. M. 806	1,005	....	S	+4,541.5	−4.8	....	....	1.6	11.8	+6.4	177.2577	581.559	....	....	P.
				N	+4,534.3	+2.4										
				S	+4,534.3	+2.4										
				Mean	+4,536.7											
*T. B. M. 804	T. B. M. 805	608	....	N	+3,632.3	+1.0	....	....	0.7	11.9	+5.7	180.8903	593.477	....	....	P.
				S	+3,634.3	−1.0										
				Mean	+3,633.3											
*T. B. M. 803	T. B. M. 804	236	....	S	+991.7	−0.4	....	....	0.3	11.9	+5.5	181.8814	596.729	....	....	P.
				N	+990.9	+0.4										
				Mean	+991.3											
*T. B. M. 802	T. B. M. 803	1,008	....	S	+6,493.5	−0.9	....	....	0.6	11.9	+4.2	188.3727	618.026	....	....	P.
				N	+6,491.7	+0.9										
				Mean	+6,492.6											

*T. B. M. 801	T. B. M. 802	534	....	S	—435.2	—0.6	....	....	0.4	11.9	+4.2	187.9869	616.596	....	....	P.
				N	—436.3	+0.5										
				N	—436.0	+0.2										
				Mean .	—435.8											
*T. B. M. 800	T. B. M. 801	162	....	N	—16,543.7	+2.5	....	....	0.6	11.9	+7.6	171.3991	562.338	....	....	P.
				S	—16,540.9	—0.3										
				N	—16,541.3	+0.1	....	....	....	....	....	....	....	....	....	S.
				S	—16,539.0	—2.2										
				Mean .	—16,541.2											
*P. B. M. 346=Gauge B. M., Omaha.	T. B. M. 800	19	....	S	—959.7	—0.1	....	....	0.1	11.9	+7.7	170.4394	559.189	558.486	—0.703	P.
				N	—960.0	+0.2										
				Mean .	—959.8											
*Top of cap, P. B. M. 346.	T. B. M. 800	19	....	S	+249.0	+0.2	....	....	0.1	11.9	+7.5	171.6484	563.156	....	....	P.
				N	+249.3	—0.1										
				Mean .	+249.2											
*P. B. M. 345	T. B. M. 800	1,102	....	S	+2,039.3	—0.9	....	....	0.6	11.9	+7.1	173.4370	569.024	....	....	T.
				N	+2,037.6	+0.8										
				Mean .	+2,038.4											
*"City Bench," Omaha.	P. B. M. 345	1,031	....	S	+18,136.6	—0.6	....	....	1.5	12.0	+3.5	191.5694	628.514	....	....	T.
				S	+18,139.4	—3.4										
				N	+18,132.0	+4.0										
				Mean .	+18,136.0											
*P. B. M. 344	"City Bench," Omaha.	24	....	S	—316.0	—0.2	....	....	0.1	12.0	+3.6	191.2533	627.477	....	....	P.
				N	—316.3	+0.1										
				Mean .	—316.2											
T. B. M. 799	T. B. M. 808+A	1,092	165.96	S	—93.7	+1.4	—8.4	+8.5	0.9	11.7	+7.4	172.1868	564.922	....	....	T.
				N	—90.9	—1.4										
				Mean .	—92.3											
T. B. M. 798+A	T. B. M. 799	778	166.74	S	—257.1	—2.6	—11.1	+11.1	1.0	11.7	+7.5	171.9272	564.071	....	....	T.
				N	—263.0	+3.3										
				S	—257.0	—2.7										
				N	—261.7	+2.0										
				Mean .	—259.7											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 343	T. B. M. 798+A	77	....	S	+1,362.2	+0.8	....	....	0.2	11.7	+7.2	173.2899	568.542	....	....	T.
				N	+1,363.3	−0.3										
				S	+1,363.2	−0.2										
				N	+1,363.8	−0.8										
				S	+1,361.5	+1.5										
				N	+1,363.5	−0.5										
				S	+1,362.7	+0.3										
				N	+1,363.7	−0.7										
				Mean	+1,363.0											
T. B. M. 797	T. B. M. 798+A	801	167.54	S	−13.3	−1.7	−12.8	+12.8	1.1	11.8	+7.5	171.9122	564.021	....	....	T.
				N	−16.7	+1.7										
				Mean	−15.0											
T. B. M. 796+A	T. B. M. 797	1,164	168.70	S	−121.0	+0.4	−12.4	+12.4	0.3	11.8	+7.5	171.7916	563.626	....	....	T.
				N	−120.2	−0.4										
				Mean	−120.6											
T. B. M. 795	T. B. M. 796+A	562	169.26	N	−125.5	+0.1	−12.5	+12.5	0.1	11.8	+7.5	171.6662	563.214	....	....	T.
				S	−125.3	−0.1										
				Mean	−125.4											
T. B. M. 794	T. B. M. 795	762	170.02	N	+314.0	−1.2	−11.3	+11.3	0.8	11.8	+7.4	171.9789	564.240	....	....	T.
				S	+311.6	+1.2										
				Mean	+312.8											
T. B. M. 793	T. B. M. 794	1,096	171.12	N	−295.7	+1.4	−12.7	+12.7	0.9	11.8	+7.5	171.6847	563.275	....	....	T.
				S	−292.9	−1.4										
				Mean	−294.3											

*P. B. M. 342	T. B. M. 793	20	....	S	−1,610.7	+0.3	....	....	0.2	11.8	+7.8	170.0746	557.903	....	....	T.
				N	−1,610.0	−0.4										
				Mean .	−1,610.4											
*Top of cap, P. B. M. 342.	T. B. M. 793	20	....	S	−388.0	+0.2	....	....	0.1	11.8	+7.6	171.2970	562.003	....	....	T.
				N	−387.7	−0.1										
				Mean .	−387.8											
T. B. M. 792	T. B. M. 793	1,020	172.14	S	−143.7	−1.4	−13.6	+13.6	1.4	11.9	+7.5	171.5396	562.790	....	....	T.
				N	−150.8	+5.7										
				S	−144.7	−0.4										
				N	−141.2	−3.9										
				Mean .	−145.1											
T. B. M. 791	T. B. M. 792	1,081	173.22	S	−526.2	−4.4	−16.6	+16.6	1.6	12.0	+7.6	171.0091	561.059	....	....	T.
				N	−534.6	+4.0										
				S	−531.0	+0.4										
				Mean .	−530.6											
T. B. M. 790	T. B. M. 791	607	173.83	N	−317.7	+1.3	−18.0	+17.9	0.9	12.1	+7.7	170.6928	560.021	....	....	P.
				S	−315.0	−1.4										
				Mean .	−316.4											
T. B. M. 789	T. B. M. 790	605	174.44	N	+344.7	−2.1	−16.9	+16.8	0.6	12,1	+7.6	171.0353	561.144	....	....	P.
				S	+340.3	+2.3										
				N	+342.7	−0.1										
				S	+342.7	−0.1										
				Mean .	+342.6											
T. B. M. 788+A	T. B. M. 789	814	175.25	N	−368.2	+0.2	−17.2	+17.0	0.2	12.1	+7.7	170.6674	559.937	....	....	P.
				S	−367.7	−0.3										
				Mean .	−368.0											
*P.B.M.341 Island Park.	T. B. M. 788+A	53	....	S	−1,432.8	+0.3	....	....	0.2	12.1	+8.0	169.2352	555.239	....	....	P.
				N	−1,432.2	−0.3										
				Mean .	−1,432.5											
* Top of cap, P. B. M. 341.	T. B. M. 788+A	53	....	S	−207.0	+0.2	....	....	0.1	12.1	+7.7	170.4606	559.259	....	....	P.
				N	−206.7	−0.1										
				Mean .	−206.8											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Red cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 787	T. B. M. 788+A	1,059	176.31	S	−119.3	−0.5	−17.7	+17.4	0.3	12.1	+7.7	170.5476	559.544	....	....	P.
				N	−120.2	+0.4										
				Mean	−119.8											
T. B. M. 786	T. B. M. 787	870	177.18	S	−107.7	0.0	−17.7	+17.4	0.0	12.1	+7.7	170.4399	559.191	....	....	P.
				N	−107.7	0.0										
				Mean	−107.7											
T. B. M. 785	T. B. M. 786	860	178.04	N	−372.3	+1.1	−18.9	+18.5	0.8	12.1	+7.8	170.0688	557.974	....	....	P.
				S	−370.0	−1.2										
				Mean	−371.2											
T. B. M. 784	T. B. M. 785	714	178.75	N	−68.2	−3.0	−18.7	+18.3	0.9	12.1	+7.8	169.9976	557.740	....	....	P.
				S	−72.8	+1.6										
				N	−73.7	+2.5										
				S	−69.9	−1.3										
				Mean	−71.2											
T. B. M. 783	T. B. M. 784	944	179.70	N	+811.0	+0.3	−19.0	+18.6	0.2	12.1	+7.7	170.8088	560.401	....	....	P.
				S	+811.6	−0.3										
				Mean	+811.3											
*P. B. M. 340	T. B. M. 783	29	....	S	−1,181.3	+0.1	....	....	0.1	12.1	+7.9	169.6278	556.527	....	....	P.
				N	−1,181.0	−0.2										
				Mean	−1,181.2											
*Top of cap, P. B. M. 340	T. B. M. 783	29	....	S	+41.7	+0.1	....	....	0.1	12.1	+7.7	170.8506	560.538	....	....	P.
				N	+42.0	−0.2										
				Mean	+41.8											

T. B. M. 782	T. B. M. 783	1,117	180.81	N.....	−1,123.0	−1.0	−18.1	+17.6	0.6	12.2	+7.9	169.6850	556.714	....	....	P.
				S.....	−1,124.9	+0.9										
				Mean.	−1,124.0											
T. B. M. 781+A	T. B. M. 782	1,079	181.89	N.....	−1,429.8	+1.8	−19.8	+19.4	1.2	12.2	+8.2	168.2573	552.030	....	....	P.
				S.....	−1,426.3	−1.7										
				Mean.	−1,428.0											
T. B. M. 780	T. B. M. 781+A ...	1,132	183.02	N.....	+147.5	+0.1	−19.9	+19.5	0.1	12.2	+8.2	168.4049	552.514	....	....	P.
				S.....	+147.7	−0.1										
				Mean.	+147.6											
T. B. M. 779	T. B. M. 780	810	183.84	N.....	+929.0	+3.6	−20.2	+19.8	1.0	12.8	+8.0	169.3378	555.574	....	....	P.
				S.....	+934.3	−1.7										
				S.....	+931.6	+1.0										
				N.....	+935.7	−3.1										
				Mean.	+932.6											
*P. B. M. 339 .... Hentons.	T. B. M. 779	141	....	S.....	−1,785.9	+0.7	....	....	0.4	12.3	+8.3	167.5524	549.718	....	....	P.
				N.....	−1,784.6	−0.6										
				Mean.	−1,785.2											
*Top of cap, P. B. M. 339.	T. B. M. 779	141	....	S.....	−562.9	+0.1	....	....	0.1	12.3	+8.1	168.7746	553.727	....	....	P.
				N.....	−562.6	−0.2										
				Mean.	−562.8											
T. B. M. 778	T. B. M. 779	1.042	184.88	S.....	−1,539.4	+1.2	−19.0	+18.6	0.8	12.3	+8.3	167.7994	550.528	....	....	T.
				N.....	−1,537.0	−1.2										
				Mean.	−1,538.2											
T. B. M. 777+A	T. B. M. 778	1.094	185.97	S.....	+115.0	+1.2	−17.8	+17.5	0.8	12.3	+8.3	167.9156	550.909	....	....	T.
				N.....	+117.3	−1.1										
				Mean.	+116.2											
T. B. M. 776	T. B. M. 777+A...	996	186.97	S.....	−276.8	−0.4	−18.2	+17.8	0.2	12.3	+8.3	167.6384	550.000	....	....	T.
				N.....	−277.5	+0.3										
				Mean.	−277.2											
T. B. M. 775	T. B. M. 776	1.097	188.06	S.....	−441.0	+1.6	−16.6	+16.1	1.1	12.4	+8.4	167.1991	548.558	....	....	T.
				N.....	−437.7	−1.7										
				Mean.	−439.4											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Red cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 338	T. B. M. 775	24	....	S	−936.0	−0.4	....	....	0.2	12.4	+8.6	166.2629	545.487	....	....	T.
				N	−936.7	+0.3										
				Mean	−936.4											
*Top of cap, P. B. M. 838	T. B. M. 775	24	....	S	+291.3	0.0	....	....	0.0	12.4	+8.3	167.4903	549.514	....	....	T.
				N	+291.3	0.0										
				Mean	+291.3											
T. B. M. 774+A	T. B. M. 775	931	189.00	S	−808.2	−2.6	−17.9	+17.5	0.6	12.4	+8.6	166.3885	545.899	....	....	T.
				N	−812.6	+1.8										
				S	−810.8	0.0										
				N	−811.8	+1.0										
				Mean	−810.8											
T. B. M. 773	T. B. M. 774 + A	984	189.98	S	−27.2	−2.0	−19.9	+19.6	1.4	12.4	+8.6	166.3593	545.803	....	....	T.
				N	−31.3	+2.1										
				Mean	−29.2											
T. B. M. 772	T. B. M. 773	992	190.97	S	−438.0	+1.1	−21.1	+20.9	1.4	12.5	+8.7	165.9225	544.370	....	....	T.
				N	−442.4	+5.5										
				S	−433.3	−3.6										
				N	−434.0	−2.9										
				Mean	−436.9											
T. B. M. 771	T. B. M. 772	736	191.71	S	−29.6	−1.0	−22.1	+22.0	0.7	12.5	+8.7	165.8919	544.270	....	....	T.
				N	−31.7	+1.1										
				Mean	−30.6											
*P. B. M. 837	T. B. M. 771	80	....	S	−580.3	+0.5	....	....	0.8	12.5	+8.8	165.3122	542.368	....	....	T.
				N	−579.3	−0.5										
				Mean	−579.8											

*Top of cap, P. B. M. 337.	T. B. M. 771	30	....	S	+642.7	0.0	....	....	0.0	12.5	+8.5	166.5344	546.378	....	....	T.
				N	+642.7	0.0										
				Mean .	+642.7											
T. B. M. 770+A	T. B. M. 771	1,030	192.74	S	+62.1	−1.1	−23.0	+23.0	1.1	12.6	+8.6	165.9528	544.470	....	....	T.
				N	+56.3	+4.7										
				N	+63.8	−2.8										
				S	+61.7	−0.7										
				Mean .	+61.0											
T. B. M. 769	T. B. M. 770 + A...	1,030	193.77	S	−1,071.0	−0.4	−23.4	+23.2	0.2	12.6	+8.9	164.8817	540.955	....	....	T.
				N	−1,071.7	+0.3										
				Mean .	−1,071.4											
T. B. M. 768+A	T. B. M. 769	634	194.40	S	+95.5	−0.9	−24.3	+24.1	0.6	12.6	+8.8	164.9762	541.265	....	....	T.
				N	+93.7	+0.9										
				Mean .	+94.6											
* P. B. M. 336 = ¹⁄₃ᶻ	T. B. M. 768 + A...	920	....	S	−1,301.2	−1.0	....	....	0.7	12.6	+9.1	163.6743	536.994	536.400	−0.585	T.
				N	−1,303.3	+1.1										
				Mean .	−1,302.2											
* Top of cap, P. B. M. 336 = ¹⁄₃ᶻ.	T. B. M. 768 + A...	920	....	S	−76.2	−1.0	....	....	0.7	12.6	+8.9	164.8991	541.012	....	....	T.
				N	−78.3	+1.1										
				Mean .	−77.2											
T. B. M. 767	T. B. M. 768 + A...	1056	195.46	S	+1,060.3	−1.3	−25.6	+25.3	0.8	12.6	+8.6	166.0350	544.739	....	....	T.
				N	+1,057.8	+1.2										
				Mean .	+1,059.0											
T. B. M. 766	T. B. M. 767	798	196.26	S	−1,422.4	−1.0	−26.6	+26.4	0.7	12.7	+8.9	164.6119	540.070	....	....	P.
				N	−1,424.5	+1.1										
				Mean .	−1,423.4											
T. B. M. 765	T. B. M. 766	1,104	197.36	S	−775.1	−1.1	−27.7	+27.4	0.7	12.7	+9.1	163.8359	537.524	....	....	P.
				N	−777.2	+1.0										
				Mean .	−776.2											
T. B. M. 764	T. B. M. 765	1,108	198.47	S	−25.5	−1.9	−29.6	+20.2	1.2	12.7	+9.1	163.8085	537.434	....	....	P.
				N	−29.2	+1.8										
				Mean .	−27.4											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 335, Haynies Siding	T. B. M. 764	42	....	S	−692.6	0.0	....	....	0.0	12.7	+9.2	163.1160	535.162	....	....	P.
				N	−692.6	0.0										
				Mean	−692.6											
*Top of cap, P. B. M. 335	T. B. M. 764	42	....	S	+530.4	+0.2	....	....	0.1	12.7	+9.0	164.3300	539.175	....	....	P.
				N	+530.8	−0.2										
				Mean	+530.6											
T. B. M. 763	T. B. M. 764	842	199.31	S	−399.3	−1.7	−31.3	+31.0	1.2	12.8	+9.2	163.4076	536.119	....	....	T.
				N	−402.8	+1.8										
				Mean	−401.0											
T. B. M. 762+A	T. B. M. 763	1,078	200.39	S	−714.7	−1.3	−32.6	+32.2	0.8	12.8	+9.3	162.6917	533.770	....	....	T.
				N	−717.2	+1.2										
				Mean	−716.0											
T. B. M. 761	T. B. M. 762+A	1,077	201.46	N	−504.2	+1.2	−33.9	+33.4	0.8	12.8	+9.4	162.1888	532.120	....	....	T.
				S	−501.7	−1.3										
				Mean	−503.0											
T. B. M. 760	T. B. M. 761	1,020	202.48	S	−81.3	−0.2	−34.1	+33.6	0.1	12.8	+9.4	162.1073	531.853	....	....	T. S.
				N	−81.7	+0.2										
				Mean	−81.5											
*T. B. M. 759	T. B. M. 760	336	....	N	+1,229.7	+0.1	....	....	0.1	12.8	+9.2	163.3369	535.887	....	....	S.
				S	+1,230.0	−0.2										
				Mean	+1,229.8											
P. B. M. 334=¹⁄₃	T. B. M. 759	29	....	S	−1,184.7	−0.3	....	....	0.2	12.8	+9.4	162.1521	532.000	531.639	−0.361	S.
				N	−1,185.3	+0.3										
				Mean	−1,185.0											

*Top of cap, P. B. M. 334=[illegible]	T. B. M. 759	28	....	S	+36.3	0.0	....	....	0.0	12.8	+9.2	163.2733	536.006	....	....	S.
				N	+36.3	0.0										
				Mean	+36.3											
T. B. M. 758	T. B. M. 700	727	203.21	S	+329.3	+0.5	—33.6	+33.1	0.3	12.8	+9.4	162.4871	532.935	....	....	T.
				N	+330.3	—0.5										
				Mean	+329.8											
T. B. M. 757	T. B. M. 758	1,199	204.41	N	—100.9	—0.7	—32.8	+32.4	0.5	12.9	+9.4	162.3855	532.602	....	....	T.
				S	—102.4	+0.8										
				Mean	—101.6											
T. B. M. 756	T. B. M. 757	1,071	205.48	N	+25.0	—3.1	—30.7	+30.3	1.4	12.9	+0.4	162.3584	532.677	....	....	T.
				S	+20.8	+2.1										
				Mean	+22.9											
* P. B. M. 333	T. B. M. 756	15	....	S	—1,120.0	+0.2	....	....	0.1	12.9	+9.6	161.2388	529.003	....	....	T.
				N	—1,119.6	—0.2										
				Mean	—1,119.8											
*Top of cap, P. B. M. 333.	T. B. M. 756	15	....	S	+105.0	0.0	....	....	0.0	12.9	+9.3	162.4633	538.021	....	....	T.
				N	+105.0	0.0										
				Mean	+105.0											
T. B. M. 755	T. B. M. 756	1,088	206.57	N	—161.7	+2.3	—32.2	+31.8	1.2	13.0	+9.4	162.1900	532.154	....	....	T.
				S	—154.1	—5.3										
				N	—160.9	+0.6										
				S	—161.6	+2.2										
				Mean	—159.4											
T. B. M. 754	T. B. M. 755	1,100	207.67	N	+819.0	+0.8	—33.0	+32.6	0.5	13.0	+9.2	163.0186	534.843	....	....	T.
				S	+820.6	—0.8										
				Mean	+819.8											
T. B. M. 753	T. B. M. 754	982	208.65	N	—1,086.7	+0.3	—33.4	+32.9	0.2	13.0	+9.5	167.9325	531.279	....	....	T.
				S	—1,086.0	—0.4	....	....	....	....	....	....	....	....	....	P.
				Mean	—1,086.4											
T. B. M. 752	T. B. M. 753	914	209.56	S	—714.1	—1.3	—34.7	+34.2	0.9	13.0	+9.6	161.2172	528.933	....	....	P.
				N	—716.7	+1.3										
				Mean	—715.4											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 332	T. B. M. 752	53	....	S	—976.0	—0.5	....	....	0.3	13.0	+9.8	160.2409	525.729	....	....	S.
				N	—977.0	+0.5										
				Mean .	—976.5											
*Top of cap, P. B. M. 332	T. B. M. 752	53	....	S	+247.3	+0.3	....	....	0.2	13.0	+9.5	161.4647	529.745	....	....	S.
				N	+248.0	—0.4										
				Mean .	+247.6											
T. B. M. 751 + A	T. B. M. 752	895	210.46	S	—150.8	+0.5	—34.2	+33.7	0.3	13.0	+9.6	161.0669	528.439	....	....	P.
				N	—149.8	—0.5										
				Mean .	—150.3											
T. B. M. 750	T. B. M. 751 + A	1,091	211.55	S	—684.0	—1.6	—35.8	+35.3	1.1	13.1	+9.8	160.3815	526.191	....	....	P.
				N	—687.2	+1.6										
				Mean .	—685.6											
T. B. M. 749	T. B. M. 750	1,024	212.58	S	—400.3	—2.9	—40.2	+39.7	1.8	13.2	+9.8	159.9783	524.868	....	....	P.
				N	—406.7	+3.5										
				S	—397.3	—5.9										
				N	—408.7	+5.5										
				Mean .	—403.2											
T. B. M. 748 + A	T. B. M. 749	636	213.21	S	+586.8	—0.8	—41.0	+40.5	0.5	13.2	+9.7	160.5642	526.790	....	....	P.
				N	+585.2	+0.8										
				Mean .	+586.0											
*P. B. M. 331	T. B. M. 748 + A	21	....	S	—756.5	0.0	....	....	0.0	13.2	+9.9	159.8079	524.309	....	....	P.
				N	—756.5	0.0										
				Mean .	—756.5											

*Top of cap, P. B. M. 331	T. B. M. 748 + A ..	21	....	S	+467.7	+0.1	....	....	0.1	13.2	+9.6	161.0319	528.325	....	....	P.
				N	+468.0	−0.2										
				Mean .	+467.8											
T. B. M. 747	T. B. M. 748 + A ..	886	214.10	N	−221.5	−0.9	−40.2	+39.6	0.6	13.2	+9.8	160.3419	526.061	....	....	P.
				S	−223.2	+0.8										
				Mean .	−222.4											
T. B. M. 746	T. B. M. 747.......	574	214.67	N	+65.7	+2.0	−41.2	+40.6	0.7	13.2	+9.8	160.4096	526.283	....	....	T.
				S	+69.0	−1.3										
				N	+68.3	−0.6										
				Mean .	+67.7											
*T. B. M. 745	T. B. M. 746.......	514	215.18	S	−1,557.4	+1.2	−42.4	+41.8	0.8	13.3	+10.1	158.8537	521.178	....	....	T.
				N	−1,555.0	−1.2										
				Mean .	−1,556.2											
T. B. M. 744	T. B. M. 745.......	1,056	216.24	S	+112.3	−4.5	−43.7	+43.1	1.5	13.3	+10.0	158.9614	521.532	....	....	T.
				N	+106.0	+1.8										
				S	+105.0	+2.8										
				Mean .	+107.8											
T. B. M. 743	T. B. M. 744.......	830	217.07	S	−369.6	+1.4	−42.3	+41.6	1.0	13.4	+10.1	158.5933	520.324	....	....	T.
				N	−366.7	−1.5										
				Mean .	−368.2											
* T. B. M. 742............	T. B. M. 743.......	721	....	S	+303.8	+1.4	....	....	0.9	13.4	+10.1	158.8985	521.825	....	....	T.
				N	+306.7	−1.5										
				Mean .	+305.2											
* P. B. M. 330 = $^1_3{}^4$......	T. B. M. 742.......	21	....	S	−774.7	0.0	....	....	0.0	13.4	+10.2	158.1239	518.784	518.576	−0.208	T.
				N	−774.7	0.0										
				Mean .	−774.7											
*Top of cap, P. B. M. 330 = $^1_3{}^4$.	T. B. M. 742.......	21	....	S	+442.0	0.0	....	....	0.0	13.4	+10.0	159.3404	522.775	....	....	T.
				N	+442.0	0.0										
				Mean .	+442.0											
T. B. M. 741.	T. B. M. 743.......	1,165	218.24	N	−368.0	+0.5	−42.8	+42.1	0.3	13.4	+10.2	158.2259	519.118	....	....	T.
				S	−367.0	−0.5										
				Mean .	−367.5											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	*r*	*R*	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 740	T. B. M. 741	1,076	219.31	N	−10.3	+7.9	−44.4	+43.7	1.9	13.5	+10.2	158.2235	519.111	....	....	T.
				S	−2.3	−0.1										
				N	+2.3	−4.7										
				S	+0.7	−3.1										
				Mean	−2.4											
T. B. M. 739	T. B. M. 740	1,085	220.40	N	−492.0	+3.9	−45.7	+45.0	1.3	13.6	+10.3	157.7355	517.510	....	....	T.
				S	−486.3	−1.8										
				N	−485.9	−2.2										
				Mean	−488.1											
T. B. M. 738	T. B. M. 739	1,092	221.49	N	−97.3	−0.3	−45.3	+44.7	0.2	13.6	+10.3	157.6379	517.189	....	....	T.
				S	−98.0	+0.4										
				Mean	−97.6											
T. B. M. 737	T. B. M. 738	1,141	222.63	N	−252.7	+0.5	−45.9	+45.2	0.4	13.6	+10.4	157.3858	516.362	....	....	T.
				S	−251.6	−0.6										
				Mean	−252.2											
*P. B. M. 329	T. B. M. 737	30	....	S	−841.0	+0.2	....	....	0.1	13.6	+10.5	156.5451	513.604	....	....	T.
				N	−840.7	−0.1										
				Mean	−840.8											
*Top of cap, P. B. M. 329. Percival	T. B. M. 737	30	....	S	+387.0	+0.2	....	....	0.1	13.6	+10.3	157.7729	517.632	....	....	T.
				N	+387.3	−0.1										
				Mean	+387.2											
T. B. M. 736+A	T. B. M. 737	1,005	223.64	N	−588.8	−0.2	−45.6	+45.0	0.2	13.6	+10.5	156.7969	514.430	....	....	P.
				S	−589.3	+0.3										
				Mean	−589.0											

T. B. M. 735	T. B. M. 736+A	996	224.63	S	+16.9	−0.6	−46.2	+45.6	0.4	13.6	+10.5	156.8132	514.484	....	....	P.
				N	+15.7	+0.6										
				Mean	+16.3											
T. B. M. 734	T. B. M. 735	902	225.54	S	−620.1	−3.4	−47.0	+40.4	0.9	13.6	+10.6	156.1808	512.438	....	....	P.
				N	−626.1	+2.6										
				S	−625.3	+1.8										
				N	−622.6	−0.9										
				Mean	−623.5											
T. B. M. 733+A	T. B. M. 734	982	226.52	S	−154.3	+0.1	−46.9	+46.4	0.0	13.6	+10.6	156.0356	511.982	....	....	P.
				N	−154.2	0.0										
				Mean	−154.2											
T. B. M. 732+A	T. B. M. 733+A	941	227.46	S	−1,408.3	−1.4	−48.3	+47.8	0.9	13.7	+10.9	154.0262	507.308	....	....	P.
				N	−1,411.1	+1.4										
				Mean	−1,409.7											
P. B. M. 328	T. B. M. 732+A	350	227.81	S	+77.2	−0.8	−49.1	+48.5	0.5	13.7	+10.9	154.7026	507.559	....	....	P.
				N	+75.7	+0.7										
				Mean	+76.4											
*Top of cap, P. B. M. 328.	P. B. M. 328	85	....	S	+1,226.7	−0.5	....	....	0.3	13.7	+10.6	155.9285	511.581	....	....	P.
				N	+1,225.7	+0.5										
				Mean	+1,226.2											
T. B. M. 731	P. B. M. 328	1,096	228.90	S	+136.7	−2.0	−51.1	+50.5	1.3	13.7	+10.9	154.8373	508.001	....	....	P.
				N	+132.7	+2.0										
				Mean	+134.7											
T. B. M. 730+A	T. B. M. 731	1,010	229.91	S	+143.3	−2.3	−53.5	+52.9	0.9	13.8	+10.8	154.9782	508.463	....	....	P.
				N	+137.6	+3.4										
				S	+143.6	−2.6										
				N	+139.6	+1.4										
				Mean	+141.0											
T. B. M. 729+A	T. B. M. 730+A	1,022	230.94	N	−266.0	−0.1	−53.4	+52.8	0.1	13.8	+10.9	154.7122	507.591	....	....	S.
				S	−266.2	+0.1										
				Mean	−266.1											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direc-tion.	Difference of elevation.	Resid-uals = V.	Σ V: Direct line.	Σ V: Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix: Meters.	Elevation above St. Louis City Directrix: Feet.	Elevation above St. Louis City Directrix: Former by common levels.	Dis-crep-ancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 728	T. B. M. 729+A	1,032	231.97	N	—302.2	—1.4	—52.1	+51.4	0.9	13.8	+11.0	154.4087	506.595	....	....	P.
				S	—304.9	+1.3										
				Mean	—303.6											
*P. B. M. 327	T. B. M. 728	89	....	S	+140.0	0.0	....	....	0.0	13.8	+10.9	154.5486	507.054	....	....	P.
				N	+140.0	0.0										
				Mean	+140.0											
*Top of cap, P. B. M. 327	T. B. M. 728	89	....	S	+1,366.0	+0.5	....	....	0.3	13.8	+10.7	155.7749	511.077	....	....	P.
				N	+1,367.0	—0.5										
				Mean	+1,366.5											
T. B. M. 727+A	T. B. M. 728	1,106	233.07	N	—463.7	+1.3	—53.4	+52.7	0.9	13.8	+11.0	153.9463	505.078	....	....	P.
				S	—461.1	—1.3										
				Mean	—462.4											
T. B. M. 726	T. B. M. 727+A	1,009	234.08	N	+143.4	+3.5	—54.8	+54.1	1.2	13.9	+11,0	154.0932	505.560	....	....	P.
				S	+148.8	—1.9										
				N	+148.5	—1.6										
				Mean	+146.9											
T. B. M. 725+A	T. B. M. 726	1,014	235.10	N	—9.6	—0.6	—54.3	+53.5	0.4	13.9	+11.0	154.0830	505.526	....	....	P.
				S	—10.7	+0.5										
				Mean	—10.2											
*P. B. M. 326	T. B. M. 725+A	80	....	N	—691.3	0.0	....	....	0.0	13.9	+11.2	153.3919	503.259	....	....	P.
				S	—691.3	0,0										
				Mean	—691.3											

*Top of cap, P. B. M. 326.	T. B. M. 725+A ...	80	....	S	+535.3	—0.1	....	....	0.0	13.9	+10.9	154.6181	507.282	....	....	P.
				N	+535.2	0.0										
				Mean .	+535.2											
T. B. M. 724	T. B. M. 725+A ...	1,092	236.19	S	—1,126.6	+2.0	—52.8	+51.5	1.8	13.9	+11.2	152.9580	501.887	....	....	T.
				N	—1,122.6	—2.0										
				Mean .	—1,124.6											
T. B. M. 723	T. B. M. 724	1,094	237.28	S	—702.1	+3.7	—50.6	+49.8	1.2	14.0	+11.4	152.2604	499.546	....	....	T.
				N	—696.2	—2.2										
				S	—697.0	—1.4										
				Mean .	—698.4											
T. B. M. 722	T. B. M. 723	1,098	238.38	S	—176.6	—0.8	—51.4	+50.6	0.5	14.0	+11.4	152.0830	498.964	....	....	T.
				N	—178.2	+0.8										
				Mean .	—177.4											
T. B. M. 721	T. B. M. 722	277	238.66	S	—227.0	—0.5	—51.9	+51.1	0.3	14.0	+11.5	151.8556	498.218	....	....	T.
				N	—228.0	+0.5										
				Mean .	—227.5											
*P. B. M. 325=¹⁄₂².	T. B. M. 721	60	....	S	—1,620.0	—0.2	....	....	0.1	14.0	+11.8	150.2357	492.904	493.023	+0.119	T.
				N	—1,620.3	+0.1										
				Mean .	—1,620.2											
*Top of cap, P. B. M. 325=¹⁄₂².	T. B. M. 721	60	....	S	—404.3	+0.5	....	....	0.3	14.0	+11.5	151.4518	496.894	....	....	T.
				N	—403.3	—0.5										
				Mean .	—403.8											
T. B. M. 720	P. B. M. 721	1,102	239.76	S	—1,356.6	—0.4	—52.3	+51.4	0.2	14.0	+11.7	150.4988	493.767	....	....	T.
				N	—1,357.3	+0.3										
				Mean .	—1,357.0											
T. B. M. 719+A	T. B. M. 720	1,082	240.84	S	+833.8	+0.6	—51.7	+50.8	0.4	14.0	+11.6	151.3331	496.504	....	....	T.
				N	+835.0	—0.6										
				Mean .	834.4											
T. B. M. 718	T. B. M. 719+A ...	1,010	241.85	S	—276.0	0.0	—51.7	+50.8	0.0	14.0	+11.6	151.0571	495.599	....	....	T.
				N	—276.0	0.0										
				Mean .	—276.0											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 717+A	T. B. M. 718	1,084	242.94	S	−1,432.2	−1.8	−53.5	+52.5	1.2	14.1	+11.92	149.6234	490.895	....	....	T.
				N.....	−1,435.7	+1.7										
				Mean .	−1,434.0											
T. B. M. 716	T. B. M. 717+A ...	1,079	244.02	N.....	+178.6	+1.9	−55.4	+54.4	1.3	14.1	+11.9	149.8039	491.487	....	....	T.
				S	+182.4	−1.9										
				Mean .	+180.5											
* P. B. M. 324	T. B. M. 716	95	....	S	−336.8	0.0	....	....	0.0	14.1	+11.9	149.4071	490.382	....	....	T.
				N.....	−336.8	0.0										
				Mean .	−336.8											
* Top of cap, P. B. M. 324.	T. B. M. 716	95	....	S	+891.9	−0.5	....	....	0.3	14.1	+11.7	150.6951	494.411	....	....	T.
				N.....	+890.9	+0.5										
				Mean .	+891.4											
T. B. M. 715	T. B. M. 716	718	244.73	N.....	+1,993.8	−1.1	−54.3	+53.3	0.7	14.1	+11.5	151.7962	498.023	....	....	T.
				S	+1,991.6	+1.1										
				Mean .	+1,992.7											
T. B. M. 714	T. B. M. 715	636	245.37	S	−1,235.5	+0.2	−54.1	+53.1	0.1	14.1	+11.7	150.5614	493.972	....	....	T.
				N.....	−1,234.8	−0.2										
				Mean .	−1,235.0											
T. B. M. 713	T. B. M. 714	1,100	246.47	S	−544.3	−0.8	−54.9	+53.9	0.5	14.1	+11.8	150.0164	492.184	....	....	T.
				N.....	−545.9	+0.8										
				Mean .	−545.1											
T. B. M. 712	T. B. M. 713	922	247.39	S	+110.1	+0.1	−54.8	+53.7	0.1	14.1	+11.8	150.1266	492.546	....	....	T.
				N.....	+110.4	−0.2										
				Mean .	+110.2											

T. B. M. 711	T. B. M. 712	908	248.39	N..... S.....	+1,608.0 +1,605.7	—1.2 +1.1	—53.7	+52.5	0.8	14.2	+11.5	151.7331	497.816	....	....	T.
				Mean.	+1,606.8											
* P. B. M. 323	T. B. M. 711	91	....	S..... N.....	—650.1 —651.1	—0.5 +0.5	....	....	0.8	14.2	+11.6	151.0626	496.682	....	....	T.
				Mean.	—650.6											
T. B. M. 710	T. B. M. 711	1,086	249.48	N..... S.....	—158.5 —156.1	+1.2 —1.2	—54.9	+53.7	0.8	14.2	+11.5	151.5758	497.300	....	....	T.
				Mean.	—157.3											
T. B. M. 709	T. B. M. 710	1,072	250.55	N..... S..... N.....	—1,608.6 —1,602.6 —1,605.4	+3.1 —2.9 —0.1	—57.1	+55.9	1.2	14.2	+11.8	149.9706	492.034	....	....	T.
				Mean.	—1,605.5											
T. B. M. 708 + A	T. B. M. 709	1,096	251.64	N..... S..... N.....	—687.5 —681.0 —683.0	+3.7 —2.8 —0.8	—59.2	+58.0	1.8	14.3	+12.0	149.2870	489.791	....	....	T.
				Mean.	—683.8											
T. B. M. 707	T. B. M. 708 + A	946	252.59	N..... S.....	+128.9 +132.3	+1.7 —1.7	—60.9	+59.7	1.2	14.4	+12.0	149.4176	490.220	....	....	P.
				Mean.	+130.6											
Top of cap, P. B. M. 322	T. B. M. 707	1,120	253.71	N..... S.....	+841.3 +842.9	+0.8 —0.8	—61.7	+60.5	0.5	14.4	+11.8	150.2595	492.982	....	....	P.
				Mean.	+842.1											
* P. B. M. 322	Top of cap, P. B. M. 322.	102	....	N..... S.....	—1,226.7 —1,227.0	—0.1 +0.2	....	....	0.1	14.4	+12.0	149.0329	488.957	....	....	P.
				Mean.	—1,226.8											
T. B. M. 706 + A	Top of cap, P. B. M. 322.	1,217	254.93	N..... S.....	—1,405.3 —1,404.5	+0.4 —0.4	—62.1	+60.9	0.3	14.4	+12.1	148.8549	488.373	....	....	P.
				Mean.	—1,404.9											
T. B. M. 705	T. B. M. 706 + A	976	255.90	N..... S.....	+680.0 +680.3	+0.2 —0.1	—62.2	+61.1	0.1	14.4	+11.9	149.5349	490.604	....	....	P.
				Mean.	+680.2											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 704	T. B. M. 705	1,222	257.13	N	−195.0	+0.6	−62.9	+61.7	0.4	14.4	+12.0	149.3406	489.967	....	....	P.
				S	−193.7	−0.7										
				Mean	−194.4											
T. B. M. 703 + A	T. B. M. 704	1,134	258.26	N	−1,292.0	−1.0	−61.9	+60.7	0.7	14.4	+12.2	148.0478	485.725	....	....	P.
				S	−1,294.0	+1.0										
				Mean	−1,293.0											
* P. B. M. 321 Watson.	T. B. M. 703 + A	34	....	S	−1,264.2	−0.2	....	....	0.2	14.4	+12.5	146.7837	481.578	....	....	P.
				N	−1,264.7	+0.3										
				Mean	−1,264.4											
* Top of cap, P. B. M. 321	T. B. M. 703 + A	34	....	S	−40.9	−0.1	....	....	0.1	14.4	+12.2	148.0068	485.591	....	....	P.
				N	−41.1	+0.1										
				Mean	−41.0											
* T. B. M. 702	T. B. M. 703 + A	824	....	S	+203.8	−0.3	....	....	0.2	14.4	+12.2	148.2513	486.393	....	....	P.
				N	+203.2	+0.3										
				Mean	+203.5											
* P. B. M. 320 [illegible]	T. B. M. 702	146	....	S	−813.8	−0.5	....	....	0.4	14.4	+12.4	147.4372	483.722	484.002	+0.280	P.
				N	−815.4	+1.1										
				S	−813.8	−0.5										
				Mean	−814.8											
* Top of cap, P. B. M. 320 = [illegible].	T. B. M. 702	146	....	S	+408.2	−0.3	....	....	0.2	14.4	+12.1	148.6591	487.731	....	....	P.
				N	+407.6	+0.3										
				Mean	+407.9											

T. B. M. 701	T. B. M. 703 + A	1,174	259.44	S	—1,137.1	—1.5	—68.4	+62.2	1.0	14.4	+12.5	146.9005	481.991	....	....	P.
				N	—1,140.1	+1.5										
				Mean	—1,138.6											
T. B. M. 700 + A	T. B. M. 701	1,046	260.48	S	—464.6	—1.0	—64.4	+63.1	0.6	14.4	+12.5	146.4439	480.463	....	....	P.
				N	—466.5	+0.9										
				Mean	—465.6											
Top of cap, P. B. M. 319	T. B. M. 700 + A	1,193	261.67	S	+94.7	+0.9	—63.5	+62.2	0.6	14.4	+12.5	146.5395	480.777	....	....	P.
				N	+96.5	—0.9										
				Mean	+95.6											
* P. B. M. 319	Top of cap, P. B. M. 319	28	....	N	—1,228.3	+0.3	....	....	0.2	14.4	+12.8	145.3118	476.749	....	....	P.
				S	—1,227.7	—0.3										
				Mean	—1,228.0											
T. B. M. 699	Top of cap, P. B. M. 319.	906	262.58	S	—219.8	+0.7	—62.8	+61.5	0.5	14.5	+12.6	146.3205	480.058	....	....	P.
				N	—218.4	—0.7										
				Mean	—219.1											
T. B. M. 698	T. B. M. 699	1,088	263.67	S	—125.0	—2.2	—65.1	+63.8	1.1	14.5	+12.6	146.1033	479.641	....	....	T.
				N	—130.3	+3.1										
				S	—126.3	—0.9										
				Mean	—127.2											
T. B. M. 697	T. B. M. 698	1,096	264.76	S	+25.6	—2.7	—67.0	+65.7	0.9	14.5	+12.6	146.2162	477.716	....	....	T.
				N	+19.0	+3.9										
				S	+24.0	—1.1										
				N	+23.0	—0.1										
				Mean	+22.9											
T. B. M. 696	T. B. M. 697	970	265.73	S	—533.9	+1.3	—65.7	+64.4	0.9	14.6	+12.7	145.6837	477.969	....	....	S.
				N	—531.3	—1.3										
				Mean	—532.6											
T. B. M. 695 + A	T. B. M. 696	958	266.69	S	—49.1	—1.5	—67.2	+65.8	1.0	14.6	+12.7	145.6331	477.803	....	....	S.
				N	—52.0	+1.4										
				Mean	—50.6											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*P. B. M. 318=19a, Phelps.	T. B. M. 695+A...	45	....	S.....	−974.3	+0.1	....	....	0.1	14.6	+12.9	144.6591	474.608	474.872	+0.264	P.
				N.....	−974.1	−0.1										
				Mean.	−974.2											
*Top of cap, P. B. M. 318=19a.	T. B. M. 695+A...	45	....	S.....	+248.9	0.0	....	....	0.0	14.6	+12.7	145.8820	478.620	....	....	P.
				N.....	+248.9	0.0										
				Mean.	+248.9											
T. B. M. 694	T. B. M. 695+A...	1 078	267.77	N.....	−457.2	−0.4	−66.7	+65.4	0.3	14.6	+12.8	145.1756	476.302	....	....	P.
				S.....	−458.1	+0.5										
				Mean.	−457.6											
T. B. M. 693+A	T. B. M. 694	1,172	268.94	S.....	+269.6	−0.8	−67.5	+66.1	0.5	14.6	+12.7	145.4443	477.184	....	....	P.
				N.....	+268.1	+0.7										
				Mean.	+268.8											
T. B. M. 692	T. B. M. 693+A...	1,172	270.11	S.....	−327.5	+0.9	−66.6	+65.3	0.6	14.6	+12.8	145.1178	476.113	....	....	P.
				N.....	−325.8	−0.8										
				Mean.	−326.6											
*P. B. M. 317............	T. B. M. 692	89	....	S.....	−1,368.6	−1.3	....	....	0.3	14.6	+13.1	143.7482	471.619	....	....	
				N.....	−1,369.6	−0.3										
				S.....	−1,370.9	+1.0										P.
				N.....	−1,370.6	+0.7										
				Mean.	−1,369.9											
*Top of cap, P. B. M. 317.	T. B. M. 692	88	....	S.....	−142.0	+0.1	....	....	0.1	14.6	+12.8	144.9750	475.644	....	....	P.
				N.....	−142.6	−0.2										
				Mean.	−142.8											

T. B. M. 691	T. B. M. 692	1,156	271.27	S	−820.3	+0.2	−66.4	+65.1	0.1	14.6	+13.0	144.2979	473.423			P.
				N	−819.9	−0.2										
				Mean	−820.1											
T. B. M. 690	T. B. M. 691	1,055	272.82	N	+738.0	+0.2	−67.5	+66.3	1.4	14.7	+12.8	145.0359	475.814			T.
				S	+744.1	−5.9										
				N	+736.0	+2.2										
				S	+734.6	+3.6										
				Mean	+738.2											
T. B. M. 689	T. B. M. 690	1,095	273.42	S	−1,504.2	+2.0	−65.5	+64.4	1.3	14.7	+13.1	143.5340	470.916			T.
				N	−1,500.3	−1.9										
				Mean	−1,502.2											
T. B. M. 688	T. B. M. 689	1,100	274.52	S	+414.4	+1.6	−63.9	+63.8	1.1	14.8	+13.0	143.9490	472.281			T.
				N	+417.6	−1.6										
				Mean	+416.0											
T. B. M. 687	T. B. M. 688	914	275.43	S	−194.3	+3.6	−63.2	+62.1	1.2	14.8	+13.1	143.7593	471.655			T.
				N	−189.8	−0.9										
				S	−188.1	−2.6										
				Mean	−190.7											
* P. B. M. 316	T. B. M. 687	74		S	−588.9	0.0			0.0	14.8	+13.2	143.1705	469.724			T.
				N	−588.9	0.0										
				Mean	−588.9											
*Top of cap, P.B.M. 316	T. B. M. 687	74		S	+637.1	+0.3			0.2	14.8	+13.0	144.3966	473.746			T.
				N	+637.7	−0.3										
				Mean	637.4											
T. B. M. 686	T. B. M. 687	634	276.07	S	−241.7	+0.5	−62.7	+61.7	0.3	14.8	+13.1	143.5181	470.864			T.
				N	−240.8	−0.4										
				Mean	−241.2											
T. B. M. 685	T. B. M. 686	1,137	277.20	N	−336.0	−1.2	−61.6	+60.5	0.8	14.8	+13.2	143.1810	469.758			P.
				S	−338.3	+1.1										
				Mean	−337.2											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1893—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 684	T. B. M. 685	691	277.89	S	—193.7	—1.1	—62.7	+61.7	0.8	14.8	+13.2	142.9862	469.119	....	....	P.
				N	—196.0	+1.2										
				Mean	—194.8											
P. B. M. 315	T. B. M. 684	808	278.70	N	+415.0	+1.8	—64.6	+63.5	1.3	14.9	+13.2	143.4030	470.487	....	....	P.
				S	+418.7	—1.9										
				Mean	+416.8											
T. B. M. 683	P. B. M. 315	708	279.41	N	—614.4	+3.4	—65.1	+64.0	1.2	15.0	+13.3	142.7921	468.482	....	....	P.
				S	—610.3	—0.7										
				N	—608.3	—2.7										
				Mean	—611.0											
T. B. M. 682	T. B. M. 683	1,066	280.48	N	—885.3	+1.0	—66.1	+65.0	0.7	15.0	+13.5	141.9080	465.582	....	....	P.
				S	—883.3	—1.0										
				Mean	—884.3											
Top of cap, P. B. M. 314, Nishnabotna.	T. B. M. 682	977	281.45	S	—515.7	0.0	—66.1	+65.0	0.0	15.0	+13.6	141.3924	463.890	....	....	P.
				N	—515.7	0.0										
				Mean	—515.7											
*P. B. M. 314	Top of cap, P.B.M. 314.	24	....	S	—1,225.7	+0.2	....	....	0.1	15.0	+13.8	140.1671	459.870	....	....	P.
				N	—1,225.3	—0.2										
				Mean	—1,225.5											
T. B. M. 681 + A	Top of cap, P.B.M. 314.	448	281.90	N	—457.0	+1.0	—67.1	+66.0	0.7	15.0	+13.6	140.9364	462.394	....	....	T.
				S	—455.0	—1.0										
				Mean	—456.0											

T. B. M. 680	T. B. M. 681 + A.	997	282.90	S	+109.5	—0.9	—68.0	+66.9	0.6	15.0	+13.6	141.0450	462.750	....	....	T.
				N	+107.7	+0.9										
				Mean.	+108.6											
T. B. M. 679	T. B. M. 680	1,046	283.95	N	+224.4	+4.6	—70.7	+69.7	1.6	15.1	+13.6	141.2740	463.503	....	....	T.
				S	+232.7	—3.7										
				N	+229.9	—0.9										
				Mean.	+229.0											
T. B. M. 678	T. B. M. 679	1,068	285.01	N	+226.0	+1.8	—72.6	+71.5	1.2	15.1	+13.5	141.5017	464.240	....	....	T.
				S	+229.7	—1.9										
				Mean.	+227.8											
*P. B. M. 313	T. B. M. 678	33	....	S	—932.0	0.0	....	....	0.0	15.1	+13.7	140.5099	461.191	....	....	T.
				N	—932.0	0.0										
				Mean.	—932.0											
*Top of cap, P. B. M. 313.	T. B. M. 678	33	....	S	+289.3	+0.3	....	....	0.2	15.1	+13.5	141.7913	465.109	....	....	T.
				N	+290.0	—0.4										
				Mean.	+289.6											
T. B. M. 677	T. B. M. 678	1,087	286.10	N	—687.7	+1.9	—75.2	+74.1	1.1	15.2	+13.7	140.8161	461.999	....	....	T.
				S	—681.7	—4.1										
				N	—689.0	+3.2										
				S	—684.6	—1.2										
				Mean.	—685.8											
T. B. M. 676 + A	T. B. M. 677	1,082	287.18	N	—590.3	—0.3	—75.0	+73.8	0.2	15.2	+13.8	140.2250	460.062	....	....	T.
				S	—590.8	+0.2										
				Mean.	—590.6											
P. B. M. 312 .... Corning.	T. B. M. 676 + A.	1,024	283.21	N	+617.8	—4.0	—74.3	+73.1	1.4	15.2	+13.7	140.8393	462.075	....	....	P.
				S	+612.8	+1.0										
				N	+610.7	+3.1										
				Mean.	+613.8											
T. B. M. 675	P. B. M. 312	834	289.04	S	—789.7	+0.2	—74.1	+72.9	0.1	15.2	+13.8	140,0409	459.485	....	....	P.
				N	—789.3	—0.2										
				Mean.	—789.5											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 674	T. B. M. 675	822	289.86	N	+425.3	−0.3	−73.7	+72.6	0.2	15.2	+13.7	140.4748	460.880	....	....	P.
				S	+424.6	+0.4										
				Mean	+425.0											
T. B. M. 673	T. B. M. 674	965	290.82	S	−72.7	−0.3	−74.0	+73.0	0.2	15.2	+13.8	140.4019	460.640	....	....	P.
				N	−73.4	+0.4										
				Mean	−73.0											
T. B. M. 672 + A	T. B. M. 673	884	291.71	N	−1,178.7	−0.7	−73.3	+72.3	0.5	15.3	+14.0	139.2227	456.771	....	....	P.
				S	−1,180.1	+0.7										
				Mean	−1,179.4											
*P. B. M. 311	T. B. M. 672 + A	28	....	S	−845.0	−0.2	....	....	0.2	15.3	+14.2	138.3777	453.999	....	....	P.
				N	−845.5	+0.3										
				Mean	−845.2											
*Top of cap, P.B.M. 311	T. B. M. 672 + A	28	....	S	+382.8	−0.4	....	....	0.3	15.3	+13.9	139.6050	458.026	....	....	P.
				N	+382.0	+0.4										
				Mean	+382.4											
T. B. M. 671	T. B. M. 672 + A	1,033	292.74	S	−531.0	−1.2	−74.5	+73.4	0.8	15.3	+14.1	138.6906	455.026	....	....	P.
				N	−533.3	+1.1										
				Mean	−532.2											
T. B. M. 670	T. B. M. 671	710	293.45	S	+0.2	+0.6	−73.9	+72.9	0.4	15.3	+14.1	138.6914	455.028	....	....	P.
				N	+1.3	−0.5										
				Mean	+0.8											

T. B. M. 669 + A	T. B. M. 670	564	294.02	S	—341.1	+3.7	—73.1	+72.2	0.9	15.8	+14.2	138.3541	453.922	....	....	P.
				N	—337.4	0.0										
				S	—335.2	—2.2	....	....	....	....	....	....	....	....	....	S.
				N	—336.0	—1.4										
				Mean	—337.4											
T. B. M. 668	T. B. M. 669 + A	831	294.85	S	—388.8	—3.5	—74.5	+73.6	0.8	15.8	+14.2	137.9618	452.635	....	....	P.
				N	—393.3	+1.0										
				S	—393.0	+0.7										
				N	—394.0	+1.7										
				Mean	—392.3											
T. B. M. 667 + A	T. B. M. 668	896	295.74	S	+860.2	+0.8	—73.7	+72.7	0.6	15.3	+14.1	138.8227	455.459	....	....	P.
				N	+861.9	—0.9										
				Mean	+861.0											
T. B. M. 666	T. B. M. 667 + A	682	296.42	S	—128.2	+0.4	—73.3	+72.4	0.2	15.3	+14.1	138.6049	455.040	....	....	P.
				N	—127.5	—0.3										
				Mean	—127.8											
P. B. M. 310	T. B. M. 666	706	297.13	S	—492.7	+0.7	—72.6	+71.8	0.4	15.4	+14.2	138.2030	453.426	....	....	P.
				N	—491.4	—0.6										
				Mean	—492.0											
T. B. M. 665	P. B. M. 310	996	298.13	S	+160.0	+0.3	—72.3	+71.5	0.2	15.4	+14.2	138.3633	453.952	....	....	P.
				N	+160.6	—0.3										
				Mean	+160.3											
* P. B. M. 309	T. B. M. 665	92	....	S	+861.7	—0.3	....	....	0.2	15.4	+14.3	137.5014	451.124	....	....	S.
				N	+862.3	+0.3										
				Mean	—862.0											
*Top of cap, P. B. M. 309	T. B. M. 665	92	....	S	+361.7	0.0	....	....	0.0	15.4	+14.1	138.7249	455.138	....	....	S.
				N	+361.7	0.0										
				Mean	+361.7											
T. B. M. 664	T. B. M. 665	1,032	299.16	N	—812.6	+2.2	—74.5	+73.7	1.0	15.4	+14.3	137.5530	451.293	....	....	T.
				S	—807.4	—3.0										
				N	—811.1	+0.7										
				Mean	—810.4											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V.		r	R	Rod cor.	Elevation above St. Louis City Directrix.			Discrepancy.	Obs.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 663	T. B. M. 664	1,073	300.23	N.....	—115.3	—1.8	—72.6	+71.8	0.8	15.4	+14.4	137.4360	450.910	....	....	T.
				S.....	—118.7	+1.6										
				N.....	—115.0	—2.1										
				S.....	—119.3	+2.2										
				Mean.	—117.1											
P B M. 308	T. B. M. 663	39	....	S.....	+3.6	+0.2	....	....	0.1	15.4	+14.4	137.4398	450.922	....	....	T.
				N.....	+4.0	—0.2										
				Mean.	+3.8											
T. B. M. 662 + A.........	T. B. M. 663	909	301.14	N.....	—316.2	—1.4	—71.1	+70.4	1.0	15.4	+14.4	137.1184	449.868	....	....	T.
				S.....	—319.1	+1.5										
				Mean.	—317.6											
T. B. M. 661	T. B. M. 662 + A...	916	302.06	N.....	+1,182.4	+1.5	—72.5	+71.9	0.6	15.5	+14.2	138.3021	453.751	....	....	T.
				S.....	+1,180.6	—2.7										
				N.....	+1,182.4	+1.5										
				S.....	+1,184.1	—0.2										
				Mean.	+1,183.9											
T. B. M. 660	T. B. M. 661	1,098	303.15	N.....	—2,477.6	+5.4	—74.2	+73.7	1.2	15.5	+14.7	135.8304	445.642	....	....	T.
				S.....	—2,471.3	—0.9										
				S.....	—2,469.6	—2.6										
				N.....	—2,470.3	—1.9										
				Mean.	—2,472.2											
T. B. M. 659 + A.........	T. B. M. 660	1,001	304.16	N.....	+130.5	+1.7	—75.8	+75.4	1.1	15.5	+14.6	135.9625	446.075	....	....	T.
				S.....	+133.8	—1.6										
				Mean.	+132.2											

T. B. M. 658	T. B. M. 659+A	1,009	305.17	N S	−128.5 −125.5	+1.5 −1.5	−77.3	+76.9	1.0	15.6	+14.7	135.8356	445.659	....	....	T.
				Mean	−127.0											
*P. B. M. 307	T. B. M. 658	28	....	S N	−579.0 −580.3	−0.6 +0.7	....	....	0.4	15.6	+14.8	136.2561	443.758	....	....	T.
				Mean	−579.6											
*Top of cap P. B. M. 307	T. B. M. 658	28	....	N S	+650.0 +650.0	0.0 0.0	....	....	0.0	15.6	+14.5	136.4854	447.791	....	....	T.
				Mean	+650.0											
T. B. M. 657	T. B. M. 658	1,110	306.28	N S	+66.0 +67.8	+0.9 −0.9	−78.2	+77.8	0.6	15.6	+14.7	135.9025	445.878	....	....	T.
				Mean	+66.9											
T. B. M. 656+A	T. B. M. 657	1,097	307.38	N S N	−375.5 −371.0 −372.1	+2.6 −1.9 −0.8	−79.6	+79.2	0.9	15.6	+14.7	135.5296	444.655	....	....	T.
				Mean	−372.9											
T. B. M. 655	T. B. M. 656+A	1,082	308.46	N S	+124.4 +124.5	0.0 −0.1	−79.7	+79.2	0.1	15.6	+14.7	135.6540	445.063	....	....	T.
				Mean	+124.4											
T. B. M. 654	T. B. M. 655	1,082	309.55	N S	+521.3 +523.0	+0.9 −0.8	−80.5	+80.1	0.6	15.6	+14.6	136.1761	446.776	....	....	T.
				Mean	+522.2											
*P. B. M. 306 Bigelow.	T. B. M. 654	78	....	S N	−1,594.7 −1,593.7	+0.5 −0.5	....	....	0.3	15.6	+14.9	134.5822	441.547	....	....	T.
				Mean	−1,594.2											
*Top of cap P. B. M. 306	T. B. M. 654	78	....	S N	−366.7 −366.7	0.0 0.0	....	....	0.0	15.6	+14.7	135.8095	445.573	....	....	T.
				Mean	−366.7											
T. B. M. 653	T. B. M. 654	1 094	310.64	S N	−224.7 −223.6	+0.5 −0.6	−80.0	+79.5	0.4	15.6	+14.6	135.9519	446.040	....	....	T.
				Mean	−224.2											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 652	T. B. M. 653	1,094	311.73	S	—1,626.7	—0.3	—80.3	+79.8	0.2	15.6	+15.0	134.3253	440.744	....	....	T.
				N	—1,627.3	+0.3										
				Mean .	—1,627.0											
T. B. M. 651 +A	T. B. M. 652	1,081	312.82	S	—137.7	—1.0	—81.3	+80.8	0.7	15.6	+15.0	134.1866	440.249	....	....	T.
				N	—139.7	+1.0										
				Mean .	—138.7											
T. B. M. 650	T. B. M. 651 +A ...	696	313.51	S	—459.7	+1.2	—80.1	+79.6	0.8	15.7	+15.1	133.7282	438.745	....	....	T.
				N	—457.3	—1.2										
				Mean .	—458.5											
*P. B. M. 305	T. B. M. 650	95	....	N	—1,099.8	0.0	....	....	0.0	15.7	+15.3	132.6286	435.137	....	....	T.
				S	—1,099.8	0.0										
				Mean .	—1,099.8											
*Top of cap P. B. M. 305.	T. B. M. 650	95	....	S	+125.2	—0.4	....	....	0.2	15.7	+15.1	133.8530	439.154	....	....	T.
				N	+124.5	+0.3										
				Mean .	+124.8											
T. B. M. 649	T. B. M. 650	906	314.42	S	—309.6	+1.2	—78.9	+78.4	0.8	15.7	+15.2	133.4199	437.733	....	....	T.
				N	—307.2	—1.2										
				Mean .	—308.4											
T. B. M. 648 +A	T. B. M. 649	392	314.81	N	—146.5	+1.0	—79.9	+79.4	0.7	15.7	+15.2	133.2744	437.256	....	....	P.
				S	—144.5	—1.0										
				Mean .	—145.5											

T. B. M. 658	T. B. M. 659+A	1,000	305.17	N	−128.5	+1.5	−77.3	+76.9	1.0	15.6	+14.7	135.8356	445.659	....	....	T.
				S	−125.5	−1.5										
				Mean	−127.0											
*P. B. M. 307	T. B. M. 658	23	....	S	−579.0	−0.6	....	....	0.4	15.6	+14.8	135.2561	443.758	....	....	T.
				N	−580.3	+0.7										
				Mean	−579.6											
*Top of cap P. B. M. 307	T. B. M. 658	23	....	N	+650.0	0.0	....	....	0.0	15.6	+14.5	136.4854	447.791	....	....	T.
				S	+650.0	0.0										
				Mean	+650.0											
T. B. M. 657	T. B. M. 658	1,110	306.28	N	+66.0	+0.9	−78.2	+77.8	0.6	15.6	+14.7	135.9025	445.878	....	....	T.
				S	+67.8	−0.9										
				Mean	+66.9											
T. B. M. 656+A	T. B. M. 657	1,097	307.38	N	−375.5	+2.6	−79.6	+79.2	0.9	15.6	+14.7	135.5296	444.655	....	....	T.
				S	−371.0	−1.9										
				N	−372.1	−0.8										
				Mean	−372.9											
T. B. M. 655	T. B. M. 656+A	1,082	308.46	N	+124.4	0.0	−79.7	+79.2	0.1	15.0	+14.7	135.6540	445.063	....	....	T.
				S	+124.5	−0.1										
				Mean	+124.4											
T. B. M. 654	T. B. M. 655	1,082	309.55	N	+521.3	+0.9	−80.5	+80.1	0.6	15.0	+14.6	136.1761	446.776	....	....	T.
				S	+523.0	−0.8										
				Mean	+522.2											
*P. B. M. 306 Bigelow.	T. B. M. 654	78	....	S	−1,594.7	+0.5	....	....	0.3	15.6	+14.9	134.5822	441.547	....	....	T.
				N	−1,593.7	−0.5										
				Mean	−1,591.2											
*Top of cap P. B. M. 306	T. B. M. 654	78	....	S	−366.7	0.0	....	....	0.0	15.6	+14.7	135.8095	445.573	....	....	T.
				N	−366.7	0.0										
				Mean	−366.7											
T. B. M. 653	T. B. M. 654	1 094	310.64	S	−224.7	+0.5	−80.0	+79.5	0.4	15.6	+14.6	135.9519	446.040	....	....	T.
				N	−223.6	−0.6										
				Mean	−224.2											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV.		r	R	Rod cor.	Elevation above St. Louis City Directrix.			Discrepancy.	Obs.
						Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
	Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 653	1,094	311.73	S	—1,626.7	—0.3	—80.3	+79.8	0.2	15.6	+15.0	134.3253	440.744	....	....	T.
			N	—1,627.3	+0.3										
			Mean .	—1,627.0											
T. B. M. 652	1,081	312.82	S	—137.7	—1.0	—81.3	+80.8	0.7	15.6	+15.0	134.1866	440.249	....	....	T.
			N	—139.7	+1.0										
			Mean .	—138.7											
T. B. M. 651 + A ...	696	313.51	S	—459.7	+1.2	—80.1	+79.6	0.8	15.7	+15.1	133.7282	438.745	....	....	T.
			N	—457.3	—1.2										
			Mean .	—458.5											
T. B. M. 650	95	....	N	—1,099.8	0.0	....	....	0.0	15.7	+15.3	132.6286	435.137	....	....	T.
			S	—1,099.8	0.0										
			Mean .	—1,099.8											
T. B. M. 650	95	....	S	+125.2	—0.4	....	....	0.2	15.7	+15.1	133.8530	439.154	....	....	T.
			N	+124.5	+0.3										
			Mean .	+124.8											
T. B. M. 650	906	314.42	S	—309.6	+1.2	—78.9	+78.4	0.8	15.7	+15.2	133.4199	437.733	....	....	T.
			N	—307.2	—1.2										
			Mean .	—308.4											
				—146.5	+1.0	—79.9	+79.4	0.7	15.7	+15.2	133.2744	437.256	....	....	P.
				[illegible]	—1.0										

T. B. M. 647	T. B. M. 648 + A..	944	315.75	N.....	+272.2	—0.6	—79.8	+78.8	0.4	15.7	+15.1	133.5459	438.147	....	....	P.
				S.....	+271.0	+0.6										
				Mean.	+271.6											
P. B. M. 304 .... Napier.	T. B. M. 647	993	316.75	N.....	—1,388.3	+4.0	—81.5	+81.0	0.9	15.7	+15.4	132.1619	433.606	....	....	P.
				S.....	—1,379.0	—5.3										
				N.....	—1,386.0	+1.7										
				S.....	—1,382.0	—2.8										
				N.....	—1,385.3	+1.0										
				S.....	—1,385.3	+1.0										
				Mean.	—1,384.3											
*Top of cap. P. B. M. 304	P. B. M. 304	68	....	S.....	+1,231.7	—0.1	....	....	0.1	15.7	+15.2	133.3933	437.646	....	....	P.
				N.....	+1,231.0	+0.6										
				N.....	+1,232.0	—0.4										
				S.....	+1,231.7	—0.1										
				Mean.	+1,231.6											
T. B. M. 646	P. B. M. 304	1,092	317.84	S.....	+1,454.7	+1.1	—80.4	+79.8	0.8	15.8	+15.1	133.6174	438.381	....	....	P.
				N.....	+1,457.0	—1.2										
				Mean.	+1,455.8											
T. B. M. 645	T. B. M. 646	1,096	318.93	S.....	+1,114.6	—0.2	—80.6	+79.9	0.1	15.8	+14.9	134.7316	442.037	....	....	T.
				N.....	+1,114.3	+0.1										
				Mean.	+1,114.4											
T. B. M. 644	T B. M. 645	1,084	320.02	S.....	—664.6	—1.8	—82.4	+81.7	1.2	15.8	+15.0	134.0653	439.851	....	....	T.
				N.....	—668.2	+1.8										
				Mean.	—666.4											
T. B. M. 643............	T. B. M. 644	1,097	321.11	S.....	—497.3	—0.4	—82.8	+82.1	0.3	15.8	+15.1	133.5677	438.218	....	....	T.
				N.....	—498.1	+0.4										
				Mean.	—497.7											
T. B. M. 642	T. B. M. 643	1,003	322.12	S.....	+1,254.3	—0.5	—83.3	+82.5	0.3	15.8	+14.9	134.8213	442.331	....	....	T.
				N.....	+1,253.4	+0.4										
				Mean.	+1,253.8											
*P. B. M. 303	T. B. M. 642	42	....	S.....	—1,768.3	—0.2	....	....	0.1	15.8	+15.2	133.0531	436.530	....	....	T.
				N.....	—1,768.7	+0.2										
				Mean.	—1,768.5											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Top of cap, P. B. M. 303	T. B. M. 642	42	....	S	−544.0	−0.2	....	....	0.1	15.8	+15.0	134.2772	440.546	....	....	T.
				N	−544.3	+0.1										
				Mean .	−544.2											
T. B. M. 641	T. B. M. 642	981	323.10	N	−1,819.7	−1.9	−81.3	+80.6	1.3	15.9	+15.2	133.0000	436.356	....	....	T.
				S	−1,823.6	+2.0										
				Mean .	−1,821.6											
T. B. M. 640	T. B. M. 641	732	323.83	N	−1,577.7	0.0	−81.3	+80.6	0.0	15.9	+15.6	131.4227	431.181	....	....	T.
				S	−1,577.7	0.0										
				Mean .	−1,577.7											
T. B. M. 639	T. B. M. 640	1,096	324.93	N	+2,644.3	+2.1	−83.5	+82.7	1.5	15.9	+15.0	134.0685	439.861	....	....	T.
				S	+2,648.6	−2.2										
				Mean .	+2,646.4											
T. B. M. 638	T. B. M. 639	1,077	326.01	N	+563.0	+2.8	−85.2	+84.3	0.8	15.9	+14.9	134.6342	441.717	....	....	T.
				S	+568.8	−3.0										
				S	+566.2	−0.4										
				N	+565.4	+0.4										
				Mean .	+565.8											
*P. B. M. 302 .... Forest City.	T. B. M. 638	44	....	S	+1,131.7	+0.3	....	....	0.2	15.9	+14.7	135.7660	445.431	....	....	P.
				N	+1,132.4	−0.4										
				Mean .	+1,132.0											
T. B. M. 637	T. B. M. 638	1,063	327.07	S	−2,411.0	+3.3	−84.2	+83.3	1.3	16.0	+15.4	132.2270	433.820	....	....	P.
				N	−2,403.0	−4.7										
				S	−2,406.3	−1.4										
				N	−2,410.4	+2.7										
				Mean .	−2,407.7											

T. B. M. 636	T. B. M. 637	738	327.81	S	−464.3	−1.5	−85.7	+84.8	1.0	16.0	+15.5	131.7613	432.202	....	....	P.
				N	−467.3	+1.5										
				Mean .	−465.8											
T. B. M. 635	T. B. M. 636	738	328.55	S	+1,286.0	+3.4	−84.2	+83.8	1.0	16.1	+15.2	133.0504	436.521	....	....	P.
				N	+1,293.0	−3.6										
				S	+1,289.7	−0.3										
				N	+1,288.7	+0.7										
				Mean .	+1,289.4											
T. B. M. 634	T. B. M. 635	518	329.06	N	+1,779.3	+0.7	−84.9	+84.0	0.5	16.1	+14.9	134.8301	442.360	....	....	P.
				S	+1,780.7	−0.7										
				Mean .	+1,780.0											
*T. B. M. 633	T. B. M. 634	117	....	S	+1,045.3	−0.1	....	....	0.1	16.1	+14.7	135.8751	445.788	....	....	P.
				N	+1,045.0	+0.2										
				Mean .	+1,045.2											
*P. B. M. 301=$\frac{24}{3}$	T. B. M. 633	88	....	N	+973.0	+0.2	....	....	0.1	16.1	+14.5	136.8481	448.981	449.024	+0.043	P.
				S	+973.3	−0.1										
				Mean .	+973.2											
*Top of cap, P. B. M. 301=$\frac{24}{3}$.	T. B. M. 633	88	....	S	+2,183.3	+0.3	....	....	0.2	16.1	+14.2	138.0582	452.951	....	....	P.
				N	+2,184.0	−0.4										
				Mean .	+2,183.6											
T. B. M. 632	T. B. M. 634	675	329.74	S	−412.9	+0.6	−84.3	+83.4	0.4	16.1	+15.0	134.4179	441.008	....	....	P.
				N	−411.7	−0.6										
				Mean .	−412.3											
T. B. M. 631	T. B. M. 632	719	330.46	S	−1,259.9	+0.2	−84.1	+83.2	0.1	16.1	+15.2	133.1584	436.875	....	....	P.
				N	−1,259.5	−0.2										
				Mean .	−1,259.7											
T. B. M. 630	T. B. M. 631	1,089	331.55	S	−58.0	−0.2	−84.3	+83.3	0.1	16.1	+15.2	133.1002	436.684	....	....	T.
				N	−58.3	+0.1										
				Mean .	−58.2											
T. B. M. 629	T. B. M. 630	1,107	332.65	N	−1,574.3	−0.5	−83.7	+82.8	0.4	16.1	+15.5	131.5257	431.519	....	....	T.
				S	−1,575.4	+0.6										
				Mean .	−1,574.8											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*T. B. M. 628	T. B. M. 629	94	....	S	+877.8	0.0	....	....	0.0	16.1	+15.4	132.4034	434.398	....	....	T.
				N	+877.8	0.0										
				Mean	+877.8											
*P. B. M. 300=$\frac{25}{3}$	T. B. M. 628	16	....	S	+69.3	0.0	....	....	0.0	16.1	+15.3	132.4726	434.625	434 781	+0.156	T.
				N	+69.3	0.0										
				Mean	+69.3											
*Top of cap, P. B. M. 300=$\frac{25}{3}$.	T. B. M. 628	16	....	S	+1,282.3	+0.3	....	....	0.2	16.1	+15.1	133.6857	438.605	....	....	T.
				N	+1,282.9	−0.3										
				Mean	+1,282.6											
T. B. M. 627	T. B. M. 629	452	333.10	N	−1,683.7	+0.1	−83.7	+82.9	0.0	16.1	+15.9	129.8425	425.996	....	....	T.
				S	−1,683.6	0.0										
				Mean	−1,683.6											
T. B. M. 626	T. B. M. 627	1,099	334.20	N	−100.7	−1.5	−82.2	+81.4	1.0	16.1	+15.9	129.7403	425.661	....	....	T.
				S	−103.7	+1.5										
				Mean	−102.2											
T. B. M. 625	T. B. M. 626	1,092	335.30	N	+2,550.3	+0.5	−82.8	+81.9	0.4	16.1	+15.4	132.2906	434.028	....	....	T.
				S	+2,551.4	−0.6										
				Mean	+2,550.8											
*P. B. M. 299	T. B. M. 625	25	....	S	−746.0	−0.2	....	....	0.1	16.1	+15.5	131.5445	431.580	....	....	P.
				N	−746.3	+0.1										
				Mean	−746.2											
*Top of cap, P. B. M. 299.	T. B. M. 625	25	....	S	+484.3	+0.3	....	....	0.2	16.1	+15.3	132.7751	435.618	....	....	P.
				N	+485.0	−0.4										
				Mean	+484.6											

*T. B. M. 624	T. B. M. 625	984	336.25	S ..... N ..... S ..... N ..... Mean .	−1,147.0 −1,154.1 −1,155.7 −1,151.8 −1,152.0	−5.0 +2.1 +3.7 −0.7	−83.4	+82.6	1.3	16.2	+15.6	131.1388	430.240	....	....	P.
T. B. M. 623	T. B. M. 624	936	337.22	S ..... N ..... Mean .	−339.5 −341.8 −340.6	−1.1 +1.2	−84.5	+83.8	0.8	16.2	+15.7	130.7983	429.132	....	....	P.
T. B. M. 622	T. B. M. 623	1,076	338.29	S ..... N ..... Mean .	−2,062.0 −2,066.3 −2,064.2	−2.2 +2.1	−86.7	+85.9	1.5	16.3	+16.1	128.7245	422.361	....	....	P.
T. B. M. 621	T. B. M. 622	869	338.96	S ..... N ..... Mean .	+4,343.7 +4,346.6 +4,345.2	+1.5 −1.4	−85.2	+84.5	1.0	16.3	+15.2	133.0788	436.614	....	....	P.
*P. B. M. 298=$\frac{4}{3}$........	T. B. M. 621	17	....	S ..... N ..... Mean .	+1,356.0 +1,355.7 +1,355.8	−0.2 +0.1	....	....	0.1	16.3	+15.0	134.4344	441.062	441.185	+0.123	P.
*Top of cap, P. B. M. 298=$\frac{4}{3}$.	T. B. M. 621	17	....	S ..... N ..... Mean .	+2,561.0 +2,560.7 +2,560.8	−0.2 +0.1	....	....	0.1	16.3	+14.7	135.6391	445.014	....	....	P.
T. B. M. 620	T. B. M. 621	953	339.92	S ..... N ..... S ..... N ..... Mean .	−2,810.3 −2,807.1 −2,806.3 −2,811.7 −2,808.8	+1.5 −1.7 −2.5 +2.9	−85.7	+85.1	0.9	16.3	+15.8	130.2706	427.401	....	....	P.
T. B. M. 619	T. B. M. 620	1,092	341.01	S ..... N ..... Mean .	−1,432.6 −1,431.7 −1,432.2	+0.4 −0.5	−85.3	+84.6	0.8	16.3	+16.1	128.8387	422.703	....	....	T.
T. B. M. 618	T. B. M. 619	1,090	342.10	S ..... N ..... Mean .	+416.7 +419.0 +417.8	+1.1 −1.2	−84.2	+83.4	0.8	16.4	+16.0	129.2564	424.073	....	....	T.

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	ΣV. Direct line.	ΣV. Reverse line.	r	R	Rod cor.	Elevation above St. Louis City Directrix. Meters.	Elevation above St. Louis City Directrix. Feet.	Elevation above St. Louis City Directrix. Former by common levels.	Discrepancy.	Obs.
		Meters.	Km.		Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.				Feet.	
*T. B. M. 617	T. B. M. 618	89	....	S N	+161.3 +161.0	−0.1 +0.2	....	....	0.1	16.4	+16.0	129.4176	424.602	....	....	T.
				Mean	+161.2											
*P. B. M. 297	T. B. M. 617	28	....	S N	+270.7 +270.4	−0.1 +0.2	....	....	0.1	16.4	+15.9	129.6881	425.490	....	....	T.
				Mean	+270.6											
*Top of cap, P. B. M. 297.	T. B. M. 617	28	....	S N	+1,476.4 +1,476.7	+0.2 −0.1	....	....	0.1	16.4	+15.7	130.8939	429.446	....	....	T.
				Mean	+1,476.6											
T. B. M. 616	T. B. M. 618	790	342.89	N S N S	−1,254.0 −1,249.9 −1,256.0 −1,256.3	0.0 −4.1 +2.0 +2.3	−85.1	+84.4	1.0	16.4	1+6.2	128.0026	419.960	....	....	T.
				Mean	−1,254.0											
T. B. M. 615	T. B. M. 616	1,096	343.98	N S	+1,069.7 +1,073.0	+1.7 −1.6	−86.7	+86.1	1.1	16.4	+16.0	129.0738	423.474	....	....	T.
				Mean	+1,071.4											
P. B. M. 296=$\frac{23}{3}$	T. B. M. 615	1,044	345.03	N S N S	+2,136.3 +2,142.0 +2,133.5 +2,138.0	+1.1 −4.6 +3.9 −0.6	−89.3	+88.6	1.2	16.5	+15.6	131.2108	430.485	430.622	+0.137	T.
				Mean	+2,137.4											
*Top of cap, P. B. M. 296=$\frac{9}{2}$.	P. B. M. 296=$\frac{23}{3}$	40	....	S N S N	+1,211.3 +1,209.7 +1,210.0 +1,210.7	−0.9 +0.7 +0.4 −0.3	....	....	0.2	16.5	+15.4	132.4210	434.456	....	....	T.
				Mean	+1,210.4											

T. B. M. 614	P. B. M. 296=$\frac{34}{4}$	1,064	346.09	S	+1,631.7	+0.5	—88.8	+88.1	0.8	16.5	+15.8	132.8427	435.840	....	P.
				N	+1,632.7	—0.5									
				Mean	+1,632.2										
T. B. M. 613	T. B. M. 614	1,016	347.11	S	—2,010.5	+1.3	—87.5	+88.9	0.8	16.5	+15.8	130.2340	427.281	....	P.
				N	—2,608.0	—1.2									
				Mean	—2,609.2										
T. B. M. 612	T. B. M. 613	850	347.96	S	—1,885.4	+1.4	—86.1	+85.4	1.0	16.5	+16.2	128.8504	421.101	....	P.
				N	—1,882.5	—1.5									
				Mean	—1,884.0										
P. B. M. 295	T. B. M. 612	756	348.71	S	—679.9	—5.6	—88.4	+87.7	1.4	16.6	+16.3	127.6650	418.852	....	P.
				N	—686.0	+0.5									
				S	—686.5	+1.0									
				N	—689.6	+4.1									
				Mean	—685.5										
T. B. M. 611	P. B. M. 295	1,086	349.80	S	—122.7	—1.3	—89.7	+89.0	0.9	16.6	+16.3	127.5410	418.445	....	T.
				N	—125.3	+1.3									
				Mean	—124.0										
T. B. M. 610	T. B. M. 611	1,001	350.89	S	—114.7	+0.5	—89.2	+88.5	0.3	16.6	+16.4	127.4269	418.071	....	T.
				N	—113.7	—0.5									
				Mean	—114.2										
T. B. M. 609	T. B. M. 610	1,029	351.98	S	+26.4	—1.7	—92.4	+91.7	1.1	16.6	+16.3	127.4515	418.152	....	T.
				N	+19.9	+4.8									
				S	+25.7	—1.0									
				S	+26.7	—2.0	....	....	....	....	....	....	....	....	P.
				Mean	+24.7										
T. B. M. 608	T. B. M. 609	1,062	353.04	S	+3.7	+1.9	—90.5	+89.8	1.3	16.7	+16.3	127.4571	418.170	....	P.
				N	+7.5	—1.9									
				Mean	+5.6										
P. B. M. 294=$\frac{33}{5}$	T. B. M. 608	151	....	S	+627.2	+0.5	....	....	0.3	16.7	+16.2	128.0847	420.229	420.431	+0.202	P.
				N	+628.2	—0.5									
				Mean	+627.7										

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V.		r	R	Rod cor.	Elevation above St. Louis City Directrix.			Discrepancy.	Obs.
							Direct line.	Reverse line.				Meters.	Feet.	Former by common levels.		
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
*Top of cap, P. B. M. 294=$\frac{2}{3}$.	T. B. M. 608	151	....	S	+1,837.9	+0.1	....	....	0.1	16.7	+16.0	129.2948	424.199	....	....	P.
				N	+1,838.2	—0.2										
				Mean .	+1,838.0											
T. B. M. 607	T. B. M. 608	530	353.57	N	—852.7	+0.7	—91.1	+90.5	0.4	16.7	+16.5	126.6053	415.375	....	....	P.
				S	—851.4	—0.6										
				Mean .	—852.0											
T. B. M. 606	T. B. M. 607	760	354.33	N	+212.9	+2.5	—93.4	+92.8	0.9	16.7	+16.5	126.8207	416.082	....	....	P.
				S	+218.1	—2.7										
				N	+213.4	+2.0										
				S	+217.4	—2.0										
				Mean .	+215.4											
T. B. M. 605	T. B. M. 606	1,067	355.40	N	+1,311.6	+0.8	—94.3	+93.6	0.6	16.7	+16.2	128.1328	420.387	....	....	P.
				S	+1,313.3	—0.9										
				Mean .	+1,312.4											
T. B. M. 604	T. B. M. 605	1,074	356.48	N	—1,130.7	—0.1	—94.1	+93.5	0.1	16.7	+16.4	127.0022	416.678	....	....	P.
				S	—1,131.0	+0.2										
				Mean .	—1,130.8											
*P. B. M. 293	T. B. M. 604	25	....	S	—844.0	—0.1	....	....	0.1	16.7	+16.6	126.1583	413.909	....	....	P.
				N	—844.2	+0.1										
				Mean .	—844.1											
*Top of cap, P. B. M. 293.	T. B. M. 604	25	....	S	+381.3	—0.1	....	....	0.1	16.7	+16.4	127.8834	417.928	....	....	P.
				N	+381.0	+0.2										
				Mean .	+381.2											

T. B. M. 603	T. B. M. 604	1,077	357.55	S.....	—612.5	+2.0	—92.1	+91.5	1.3	16.8	+16.6	126.3919	414.675	....	....	T.
				N.....	—608.5	—2.0										
				Mean.	—610.5											
T. B. M. 602	T. B. M. 603	917	358.47	S.....	—877.9	+4.3	—91.0	+90.4	1.3	16.8	+16.7	125.5184	411.810	....	....	T.
				N.....	—869.6	—4.0										
				S.....	—871.5	—2.1										
				N.....	—876.3	+1.7										
				Mean.	—873.6											
T. B. M. 601	T. B. M. 602	1,096	359.57	S.....	+237.6	—1.0	—92.0	+91.5	0.7	16.9	+16.7	125.7550	412.586	....	....	T.
				N.....	+235.5	+1.1										
				Mean.	+236.6											
T. B. M. 600	T. B. M. 601	270	359.84	S.....	+797.8	+1.0	—91.0	+90.5	0.7	16.9	+16.5	126.5536	415.206	....	....	T.
				N.....	+799.8	—1.0										
				Mean.	+798.8											
*P. B. M. 292=⁹⁄₁	T. B. M. 600	59	....	S.....	+496.8	0.0	....	....	0.0	16.9	+16.4	127.0503	416.835	417.034	+0.199	T.
				N.....	+496.8	0.0										
				Mean.	+496.8											
*Top of cap, P. B. M. 292=⁹⁄₁.	T. B. M. 600	59	....	S.....	+1,707.8	+1.0	....	....	0.2	16.9	+16.2	128.2621	420.811	....	....	T.
				N.....	+1,709.1	—0.3										
				S.....	+1,709.4	—0.6										
				N.....	+1,708.8	0.0										
				Mean.	+1,708.8											
T. B. M. 599	T. B. M. 600	1,090	360.93	S.....	—1,179.7	0.0	—91.0	+90.5	0.0	16.9	+16.8	125.3742	411.336	....	....	T.
				N.....	—1,179.7	0.0										
				Mean.	—1,179.7											
T. B. M. 598	T. B. M. 599	1,100	302.03	S.....	+1,030.1	+0.7	—90.3	+89.9	0.4	16.9	+16.6	126.4048	414.718	....	....	T.
				N.....	+1,031.4	—0.6										
				Mean.	+1,030.8											
T. B. M. 597	T. B. M. 598	770	362.80	N.....	—1,512.0	+0.5	—90.8	+90.4	0.3	16.9	+16.9	124.8936	409.760	....	....	T.
				S.....	—1,511.0	—0.5										
				Mean.	—1,511.5											

Tabulation of precise level results, Sioux City, Iowa, to St. Joseph, Mo., 1892—Continued.

Bench mark.	Determined from—	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals =V.	Σ V. Direct line.	Σ V. Reverse line.	r	R	Rod cor.	Elevation above St. Louis city Directrix. Meters.	Feet.	Former by common levels.	Discrepancy.	Obs.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*				*Feet.*	
T. B. M. 596	T. B. M. 597	915	363.72	N S	+2,281.3 +2,281.0	−0.1 +0.2	−90.6	+90.3	0.1	16.9	+16.4	127.1743	417.242	....	....	T.
				Mean	+2,281.2											
*P. B. M. 291	T. B. M. 596	59	....	S N	+1,453.7 +1,453.3	−0.2 +0.2	....	....	0.1	16.9	+16.1	128.6275	422.010	....	....	B.
				Mean	+1,453.5											
*Top of cap, P.B.M.291	T. B. M. 596	59	....	S N	+2,679.3 +2,679.7	+0.2 −0.2	....	....	0.1	16.9	+15.9	129.8533	426.032	....	....	B.
				Mean	+2,679.5											
T. B. M. 595	T. B. M. 596	1,104	364.82	N S	−2,407.0 −2,406.7	+0.2 −0.1	−90.7	+90.5	0.1	16.9	+16.9	124.7680	409.348	....	....	T.
				Mean	−2,406.8											
T. B. M. 594	T. B. M. 595	922	365.74	S N	−66.4 −69.6	−1.6 +1.6	−92.3	+92.1	1.1	16.9	+16.9	124.7000	409.124	....	....	P.
				Mean	−68.0											
*P. B. M. 290=$\frac{29}{2}$	T. B. M. 594	39	....	S N	−638.4 −638.7	−0.2 +0.1	....	....	0.1	16.9	+17.0	124.0615	407,030	407.182	+0.152	P.
				Mean	−638.6											
*Top of cap, P. B. M. 290=$\frac{29}{2}$.	T. B. M. 594	39	....	S N	+549.7 +550.0	+0.1 −0.2	....	....	0.1	16.9	+16.8	125.2497	410.928	....	....	P.
				Mean	+549.8											
P. B. M. 289, O. W. F.	T. B. M. 594	264	366.01	S N	+310.5 +312.7	+1.1 −1.1	−91.2	+91.0	0.7	16.9	+16.8	125.0115	410.146	....	....	P.
				Mean	+311.6											

T.B.M. 593	P. B. M. 289	1,293	367.30	S	−2,123.0	−0.3	−91.5	+91.3	0.2	16.9	+17.3	122.8887	403.182	....	....	P.
				N	−2,123.6	+0.3										
				Mean	−2,123.3											
T.B.M. 592	T. B. M. 593	836	368.14	S	−562.0	+1.0	−90.5	+90.3	0.7	16.9	+17.4	122.3278	401.242	....	....	P.
				N	−560.0	−1.0										
				Mean	−561.0											
T.B.M. 591	T. B. M. 592	843	368.98	S	+1,480.3	−1.0	−91.5	+91.3	0.7	17.0	+17.1	123.8068	406.194	....	....	P.
				N	+1,478.3	+1.0										
				Mean	+1,479.3											
T.B.M. 590	T. B. M. 591	556	369.54	S	−170.4	−0.8	−92.3	+92.0	0.5	17.0	+17.1	123.6356	405.632	....	....	P.
				N	−171.9	+0.7										
				Mean	−171.2											
*P. B. M. 287, O. W. F. = 89½. St. Joseph.	T. B. M. 590	84	....	S	−562.3	+0.1	....	....	0.1	17.0	+17.2	123.0735	403.788	403.900	+0.112	P.
				N	−562.0	−0.2										
				Mean	−562.2											
*Top of cap, P. B. M. 287 = 89½.	T. B. M. 590	84	....	S	+665.0	+0.2	....	....	0.1	17.0	+17.0	124.3007	407.814	....	....	P.
				N	+665.3	−0.1										
				Mean	+665.2											

DESCRIPTIONS AND ELEVATIONS OF PRECISE LEVEL BENCH MARKS BETWEEN THE UNITED STATES BOAT YARD ABOVE ST. JOSEPH AND SIOUX CITY.

All elevations are given in both meters and feet, and refer to St. Louis City Directrix as zero. The elevation of this above Biloxi sea level is 412.731 feet.

A P. B. M. is a precise bench mark that is set to be practically permanent.

A T. B. M. is a precise bench mark, generally of not as permanent a nature as a P. B. M.

All P. B. Ms, excepting 385, which is a cross cut on stone doorsill, are (1) top of copper bolts set in the regulation "B. M. stone," 18 inches by 18 inches by 4 inches, 3½ feet under ground, over and concentric with which is set an iron pipe 4 feet long, provided with a flange at the bottom 10 inches in outer diameter, and cap at top terminating in a rounded knob, which is also taken as a P. B. M.; or (2) top of copper bolt set vertically in the masonry of structures or of natural ledges, nearly flush with the surface; or (3) the center of copper bolts three-eighths inch in diameter, leaded horizontally in the masonry of structures or of natural ledge about one-eighth inch deeper than the surface of rock. In case 1 the top surface of flat stone is marked "B. M.", and the cap surmounting pipe is molded with the inscription "Missouri River Commission." In cases 2 and 3 there is no mark excepting the bolt. But seven T. B. Ms are described, one a cross on a bridge seat, one a ringbolt, and five on trees—two spikes and three nails—all more or less blazed.

The value of the meter used is 3.2808693 feet.

Number.	Description.	Elevation.	
		Meters.	Feet.
T. B. M. 591	Is 1,640 feet east of the United States boat yard above St. Joseph, Mo., and 164 feet from the river bank, being a nail in a 20-inch elm tree.	123.8068	406.194
P. B. M. 291	Is about 4½ miles south from the depot at Amazonia, Andrew County, Mo.; 1,650 feet northward from Bridge 7, section 14; 2,605 feet south of milepost 73, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track, being copper bolt in B. M. stone.	128.6275	422.010
Top of cap	Over P. B. M. 291	129.8533	426.032
P. B. M. 292 = $\frac{91}{3}$	Is about 1¾ miles south of the depot at Amazonia, 436 feet northeast of the north end of the truss of the railway bridge over Dillon Creek, and 328 feet east, measured along public road from the Kansas City, St. Joseph and Council Bluffs Rwy. track, being copper bolt in B. M. stone.	127.0503	416.835
Top of cap	Over P. B. M. 292	128.2621	420.811
P. B. M. 293	Is 1,270 feet west of the depot at Amazonia, 46 feet north from the Kansas City, St. Joseph and Council Bluffs Rwy. track, and 10 feet west of the west fence of public road, being copper bolt in B. M. stone.	126.1583	413.909
Top of cap	Over P. B. M. 293	127.3834	417.926
P. B. M. 294 = $\frac{92}{3}$	Is about 2¼ miles west of Amazonia, 492 feet north of the Kansas City, St. Joseph and Council Bluffs Rwy. track, 156 feet southeast of Lewis Payne's, dwelling, and 40 feet south of an 18-inch sugar-maple tree; being copper bolt in B. M. stone.	128.0847	420.229
Top of cap	Over P. B. M. 294	129.2948	424.199
P. B. M. 295	Is about one-third mile west of depot at Nodaway, Andrew County, Mo., in top of coping forming the bridge seat of the southwest corner of the Kansas City, St. Joseph and Council Bluffs Rwy. bridge over Nodaway River, and 0.85 feet east of the bed plate under the inclined end post of the bridge; being top of copper bolt leaded vertically in stone.	127.6650	418.853
P. B. M. 296 = $\frac{93}{3}$	Is about 2¼ miles west of the railway bridge over Nodaway River, in Holt County, Mo., on land of Shirley heirs, 361 feet east of milepost 84, 164 feet northwest of Bridge 4, section 17, 102 feet north of the Kansas City, St. Joseph and Council Bluffs Rwy. track, on a small knoll about 10 feet high; being copper bolt in B. M. stone.	131.2108	430.485
Top of cap	Over P. B. M. 296	132.4210	434.456
P. B. M. 297	Is about 1⅓ miles east of the depot at Forbes, Holt County, Mo., 666 feet east of M. Sipes' dwelling, 33 feet north of Kansas City, St. Joseph and Council Bluffs Rwy. track, and 16 feet south of wagon road; being copper bolt in B. M. stone.	129.6881	425.496
Top of cap	Over P. B. M. 297	130.8939	429.446
P. B. M. 298 = $\frac{94}{3}$	Is 1,424 feet west from depot at Forbes, and 45 feet north of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	134.4344	441.062
Top of cap	Over P. B. M. 298	135.6391	445.034

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 299	Is about 2 miles south of the depot at Curzons, Holt County, Mo., 55 feet from center of public road and railroad crossing, 190 feet west from J. B. Payne's house, occupied by B. F. Martin, and 45 feet west of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	131.5445	431.580
Top of cap	Over P. B. M. 299	132.7751	435.618
P. B. M. 300=$\frac{25}{3}$	Is 2,860 feet south of the east end of the siding at Curzons, 435 feet southeast of Mrs. Comls' house, 125 feet north of the Kansas City, St. Joseph and Council Bluffs Rwy. track, and about 6 feet above the level of the road; being copper bolt in B. M. stone.	132.4726	434.625
Top of cap	Over P. B. M. 300	133.6857	438.605
T. B. M. 632	Is about 2 miles south of Forest City, Holt County, Mo., at railroad bridge No. 4, over Mill Creek; being a cross cut on the northwest corner of the south bridge seat.	134.4179	441.008
P. B. M. 301=$\frac{25}{3}$	Is $1\frac{1}{2}$ miles southeast of Forest City, 600 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track at foot of bluffs, 50 feet west of W. T. Davies' house; being copper bolt in B. M. stone.	136.8481	448.981
Top of cap	Over P. B. M. 301	138.0582	452.951
P. B. M. 302	Is in Forest City, at the southeast corner of Grand avenue and B street, 8 feet from the northwest corner of store building owned by G. W. Quick, in top surface of water table flush with door sill; being top of copper bolt leaded vertically in stone.	135.7660	445.431
P. B. M. 303	Is about $2\frac{1}{4}$ miles north of the depot at Forest City, 1,076 feet north of milepost 98, 144 feet north of railway bridge No. 3, over Kinzie Creek, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	133.0531	436.530
Top of cap	Over P. B. M. 303	134.2772	440.546
P. B. M. 304	Is 627 feet south of the depot at Napier, Holt County, Mo., 287 feet south of the head block of the B. and M., and the Kansas City, St. Joseph and Council Bluffs Rwy.'s junction, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	132.1619	433.606
Top of cap	Over P. B. M. 304	133.3933	437.646
P. B. M. 305	Is about $2\frac{1}{4}$ miles south of Bigelow, Holt County, Mo., 2,713 feet north of milepost 103, 1,998 feet north of a public road crossing, and 44 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	132.6286	435.137
Top of cap	Over P. B. M. 305	133.8530	439.154
P. B. M. 306	Is in Bigelow, in Peter Nelson's lot, 249 feet northeast of the northeast corner of the railway water tank; being copper bolt in B. M. stone.	134.5822	441.547
Top of cap	Over P. B. M. 306	135.8095	445.573
P. B. M. 307	Is 13,957 feet north of the depot at Bigelow, opposite a curve to right in track going south; the tangent towards Bigelow, if prolonged northward, would pass through the B. M. It is 43 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	135.2561	443.758
Top of cap	Over P. B. M. 307	136.4854	447.791
P. B. M. 308	Is about $1\frac{3}{4}$ miles south of the depot at Craig, Holt County, Mo., in top of the west end of the north pier of the Kansas City, St. Joseph and Council Bluffs Rwy. bridge over the "County Ditch," 1.42 feet from the south face of the stone and 1.08 feet east of the bedplate under the inclined end post; being top of copper bolt leaded vertically in stone.	137.4398	450.922
P. B. M. 309	Is 1,726 feet south of the depot at Craig, 153 feet south of a section tool house, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	137.5014	451.124
Top of cap	Over P. B. M. 309	138.7249	455.138
P. B. M. 310	Is one-quarter mile north of depot at Craig, in the pedestal block forming the bridge seat under the southwest inclined end post of the Kansas City, St. Joseph and Council Bluffs Rwy. bridge over Tarkio Creek, and 0.62 feet from the southeast corner of the stone; being top of copper bolt leaded vertically in stone.	138.2030	453.426
P. B. M. 311	Is about 2 miles south of the depot at Corning, Holt County, Mo., 38 feet south of a public road crossing, 74 feet southeast of south cattle guard, 16 feet south of milepost 117, and 45 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	138.3777	453.999
Top of cap	Over P. B. M. 311	139.6050	458.026

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation	
		Meters.	F
P. B. M. 312	Is in Corning, 459 feet north of the depot, in water table under south window in west wall of Danker Bros.' one-story brick building on east side of East street; being top of copper bolt leaded vertically in stone.	140.8393	4
P. B. M. 313	Is about 2¼ miles north of depot at Corning, 525 feet north of milepost 121 and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	140.5699	4
Top of cap	Over P. B. M. 313	141.7913	4
P. B. M. 314	Is at Nishnabotna, Atchison County, Mo., in the northwest corner of R. E. Christian's orchard, 810 feet south of the depot and 52 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being bolt copper in B. M. stone.	140.1671	4
Top of cap	Over P. B. M. 314	141.3924	4
P. B. M. 315	Is 1¼ miles north of depot at Nishnabotna, in top of pedestal block forming the bridge seat, under the northeast inclined end post of the Kansas City, St. Joseph and Council Bluffs Rwy. bridge over Nishnabotna River, 0.66 feet south of the north face of the pedestal, and 0.56 foot from the west face of the stone, being top of a copper bolt leaded vertically in stone, and projecting 0.02 feet above the surface of the stone.	143.4030	4
P. B. M. 316	Is about 2 miles south of depot at Langdon, Atchison County, Mo., 525 feet north of mile post 127, adjacent to land of Frederick Meyerkorth and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	143.1705	4
Top of cap	Over P. B. M. 316	144.3966	47
P. B. M. 317	Is 2 miles south of depot at Phelps, Atchison County, Mo., 3,120 feet south of a road crossing 2,861 feet north of railway bridge No. 3, section 26, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	143.7482	47
Top of cap	Over P. B. M. 317	144.9750	4
P. B. M. 318=${}^{1}_{9}{}^{a}$	Is at Phelps, in the northeast corner of the Methodist churchyard and 33 feet from the northeast corner of the church; being copper bolt in B. M. stone.	144.6591	4
Top of cap	Over P. B. M. 318	145.8820	4
P. B. M. 319	Is 2½ miles south of the depot at Watson, Atchison County, Mo., 102 feet south of the south end of a farm gate. 233 feet southwest of a dwelling, and 43 feet east of the Kansas City, St. Joseph and Council Bluff Rwy. track; being copper bolt in B. M. stone.	145.3118	4
Top of cap	Over P. B. M. 319	146.5395	4
P. B. M. 320=${}^{1}_{9}{}^{r}$	Is ½-mile west of Watson, in the southwest corner of barnyard on the estate of Hay's heirs and 27 feet north of the northeast corner of the southeast quarter of section 4, T. 65 N., R. 42 W.; being copper bolt in B. M. stone.	147.4372	4
Top of cap	Over P. B. M. 320	148.6591	4
P. B. M. 321	Is 722 feet south of the depot at Watson, 39 feet south of a public road crossing, and 47 feet east of Kansas City, St. Joseph and Council Bluff Rwy. track; being copper bolt in B. M. stone.	146.7837	4
Top of cap	Over P. B. M. 321	148.0068	4
P. B. M. 322	Is about 2¾ miles north of the depot at Watson, about 656 feet north of Joseph Kometzer's house, 92 feet south of a jog in the east right-of-way fence, and 34 feet east of the Kansas City, St. Joseph and Council Bluff Rwy. track; being copper bolt in B. M. stone.	149.0329	4
Top of cap	Over P. B. M. 322	150.2595	4
P. B. M. 323	Is about 1¼ miles south of the depot at Hamburg, Iowa, in the pedestal block forming the bridge seat at the west end of the south pier of the Kansas City, St. Joseph and Council Bluffs Rwy. bridge over the Nishnabotna River in Atchison County, Mo., and 0.67 feet south of the south edge of the bedplate under the inclined end post, and 10 feet west of the track center; being copper bolt leaded vertically in stone.	151.0826	4
P. B. M. 324	Is 1,998 feet north of the depot at Hamburg, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	149.4671	4
Top of cap	Over P. B. M. 324	150.6951	4
P. B. M. 325=${}^{1}_{4}{}^{e}$	Is about 3¾ miles north of Hamburg, in the southeast corner of W. H. Frake's dooryard, 46 feet southeast of the southeast corner of Frake's dwelling, and 52 feet southwest of the southwest corner of a schoolhouse, and about 328 feet west of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	150.2357	4
Top of cap	Over P. B. M. 325	151.4518	4

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P.B.M. 326	Is about 1¼ miles south of depot at Nebraska City Junction, Fremont County, Iowa, 384 feet west of house occupied by Johnson Gibson, 35 feet north of the north end of a farm gate, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	153. 3919	503. 259
Top of cap	Over P. B. M. 326	154. 6181	507. 282
P.B.M. 327	Is 3,884 feet north of the depot at Nebraska City Junction and 45 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track, on a sand knoll; being copper bolt in B. M. stone.	154. 5486	507. 054
Top of cap	Over P. B. M. 327	155. 7749	511. 077
P.B.M. 328	Is about 3 miles south of depot at Percival, Fremont County, Iowa, 18 feet north of a farm gate, 627 feet north of a road crossing, and 45 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	154. 7026	507. 559
Top of cap	Over P. B. M. 328	155. 9285	511. 581
P.B.M. 329	Is 784 feet north of the center of the depot at Percival and 46 feet east of Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	156. 5451	513. 604
Top of cap	Over P. B. M. 329	157. 7729	517. 632
P.B.M. 330=$\frac{114}{3}$	Is about 1¼ miles southwest of depot at McPaul, Fremont County, Iowa, 656 feet north and 26 feet west of the southeast corner of the southwest quarter of sec. 5, T. 69 N., R. 42 W., on land of William Woods, and is 3 feet west of a hedge on west side of public road; being copper bolt in B. M. stone.	158. 1239	518. 784
Top of cap	Over P. B. M. 330	159. 3404	522. 775
P.B.M. 331	Is 4,941 feet north of McPaul Depot, 46 feet south of center of a public road, 13 feet south of a fence corner, and 48 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	159. 8079	524. 309
Top of cap	Over P. B. M. 331	161. 0319	528. 325
P.B.M. 332	Is 6,532 feet south of the depot at Bartlett, Fremont County, Iowa, 1,214 feet south of L. M. Gannon's house, 82 feet east of center of public road and 45 feet west of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	160. 2409	525. 729
Top of cap	Over P. B. M. 332	161. 4647	529. 745
P.B.M. 333	Is in Mills County, Iowa, 6,480 feet north of the depot at Bartlett, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	161. 2388	529. 003
Top of cap	Over P. B. M. 333	162. 4633	533. 021
P.B.M. 334=$\frac{148}{3}$	Is about 2¼ miles south of Haynies Siding, Mills County, Iowa, on east side of a public road, on land of Bruce Collier, about 984 feet south of Thomas Collier's house, and 1,099 feet west of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	162. 1521	532. 000
Top of cap	Over P. B. M. 334	163. 3732	536. 006
P.B.M. 335	Is at Haynies Siding, 174 feet northwest of the south head block, 43 feet south of a fence corner of west right of way fence, and 45 feet west of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	163. 1160	535. 162
Top of cap	Over P. B. M. 335	164. 3390	539. 175
P.B.M. 336=$\frac{131}{3}$	Is about 1½ miles southwest of Pacific Junction, Mills County, Iowa, on land owned by Charles Kroon, 32 feet east and 51 feet south of the northwest corner of the northeast quarter of the northeast quarter of sec. 32, T. 72 N., R. 42 W.; being copper bolt in B. M. stone.	163. 6743	536. 994
Top of cap	Over P. B. M. 336	164. 8991	541. 012
P.B.M. 337	Is 4,455 feet north of the railway crossing at Pacific Junction, 1,151 feet south of the railway bridge over the old channel of Keg Creek, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	165. 3122	542. 308
Top of cap	Over P. B. M. 337	166. 5344	546. 378
P.B.M. 338	Is about 2¼ miles south of Hentons Depot, Mills County, Iowa, on section line between sec. 5 and 8, T. 72 N., R. 43 W., 308 feet east of the quarter-section corner, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; land on the east side belongs to J. Martin; being copper bolt in B. M. stone.	166. 2629	545. 487
Top of cap	Over P. B. M. 338	167. 4903	549. 514
P.B.M. 339	Is at Hentons Station, in the northeast corner of James Meisner's dooryard, 3 feet from each fence and 259 feet northeast of the depot; being copper bolt in B. M. stone.	167. 5524	549. 718
Top of cap	Over P. B. M. 339	168. 7746	553. 727

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 340	Is about 2¼ miles north of depot at Hentons, 741 feet south of bridge No. 11, section No. 38, 427 feet west of Hans Schroeder's house, and 43 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	169.6278	556.527
Top of cap	Over P. B. M., 340	170.8506	560.538
P. B. M. 341	Is 1,148 feet south of depot at Island Park, Pottawattamie County, Iowa, 164 feet south of a public road crossing, and 46 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	169.2352	555.239
Top of cap	Over P. B. M. 341	170.4606	559.239
P. B. M. 342	Is about 4 miles southeast of the Kansas City, St. Joseph and Council Bluffs depot at Council Bluffs, 615 feet south of railway bridge over Mosquito Creek, and 49 feet east of the Kansas City, St. Joseph and Council Bluffs Rwy. track; being copper bolt in B. M. stone.	170.0746	557.993
Top of cap	Over P. B. M. 342	171.2970	562.003
P. B. M. 343	Is at Council Bluffs, in the stone doorsill of the Chicago, Milwaukee and St. Paul Rwy. roundhouse, 0.33 feet from east side of door frame and same from front face of sill, and is 8 feet from the southwest corner of the building; being top of copper bolt leaded vertically in stone.	173.2899	568.542
City B. M., Omaha	Is at the southeast corner of the post-office building at Fifteenth and Dodge streets; being top of small projection on top surface of the third course of stone above the sidewalk.	191.5694	628.514
P. B. M. 344	Is at Omaha, on the upper surface of the water table of the post-office building, corner of Fifteenth and Dodge streets, and 5.71 feet east of the southwest corner of the building; being top of a copper bolt leaded vertically in stone.	191.2533	627.477
P. B. M. 345	Is in Omaha, in the top of the pedestal block supporting the first iron post on north side and west of the cylindrical piers at the west end of the Omaha and Council Bluffs wagon bridge being top of copper bolt leaded vertically in stone.	173.4370	569.024
P.B.M. 346 = gauge B. M.	Is at Omaha, 59 feet south of the south cylindrical pier next to the river, 137 feet southeast of the south cylindrical pier next to the approach abutment at west end of the Union Pacific Rwy. Bridge over the Missouri River and 39 feet east of the east switch track of the Burlington and Missouri River Rwy.; being copper bolt in B. M. stone.	170.4394	559.189
Top of cap	Over P. B. M. 346	171.6484	563.156
T. B. M. 804	Is near Omaha, 3.976 feet east of the east portal of the Union Pacific Rwy. Bridge over the Missouri River, midway between the two tracks of the Union Pacific Rwy.; being a cross cut on top of a stone post.	180.8903	593.477
P. B. M. 347	Is in the Council Bluffs Union Depot, in window sill of the second window west of the northeast corner of the depot, 0.39 feet from the east jamb and 0.33 feet from the face of the sill; being top of a copper bolt leaded vertically in stone.	174.9884	574.114
P. B. M. 348 = $\frac{1}{2}^{1}$	Is in Council Bluffs, in the southwest corner of the court-house yard, 3 feet from the west fence and 3 feet from the south fence; being copper bolt in B. M. stone.	176.1379	577.885
Top of cap	Over P. B. M. 348	177.3626	581.904
P. B. M. 349 = $\frac{1}{2}^{2}$	Is at Council Bluffs, 197 feet above the upper end of the ways of the United States boat yard, 112 feet from the river bank and 3 feet from the northwest corner of the boat-yard storehouse; being copper bolt in B. M. stone.	171.5739	562.912
Top of cap	Over P. B. M. 349	172.7985	566.929
P. B. M. 350	Is about 4 miles above Council Bluffs, 62 feet south of the south end of bridge No. 1066, 404 feet north of milepost 4, and 28 feet east of the Chicago and Northwestern Rwy. track; being copper bolt in B. M. stone.	177.7495	583.173
Top of cap	Over P. B. M. 350	178.9705	587.179
P. B. M., 351	Is about 6 miles north of Council Bluffs Union Depot, 630 feet north of the shore end of the upper Government dike, 367 feet north of the south end of bridge No. 1043, and 16 feet west of the Chicago and Northwestern Rwy. track; being copper bolt in B. M. stone.	175.0468	574.306
Top of cap	Over P. B. M. 351	176.2706	578.321
P. B. M. 352	Is at Crescent, Pottawattamie County, Iowa, 183 feet south of the depot, 15 feet east of the Chicago and Northwestern Rwy. track, and is in a small park belonging to the railway company; being copper bolt in B. M. stone.	175.5675	576.014
Top of cap	Over P. B. M. 352	176.7923	580.032
P. B. M. 353	Is about 1¾ miles south of Honey Creek depot, Pottawattamie County, Iowa, 112 feet north of the north end of railway bridge No. 1007, 1,936 feet south of milepost 12, and 49 feet east of the Chicago and Northwestern Rwy. track; being copper bolt in B. M. stone.	177.9048	583.682

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M. 353	179. 1266	587. 691
P. B. M. 354	Is near Honey Creek depot, in the west end of the south bridge seat of the plate-girder bridge No. 998 over Honey Creek and 4 feet west of the south end of the west girder; being top of a copper bolt leaded vertically.	180. 5626	592. 402
P. B. M. 355	Is 2 miles north of Honey Creek depot, 2,730 feet south of milepost 16 and 46 feet east of the Chicago and Northwestern Rwy. track; being copper bolt in B. M. stone.	179. 2946	588. 242
Top of cap	Over P. B. M. 355	180. 5194	592. 261
P. B. M. 356	Is at Loveland, Pottawattamie County, Iowa, on the southwest corner of the Chicago and Northwestern Rwy. Bridge, No 979, over Boyer Creek, 0.33 feet east of the bed-plate under the inclined end post, and 2.5 feet from the north edge of the abutment; being top of a copper bolt leaded vertically in stone of abutment.	179. 1388	587. 731
P. B. M. 357	Is about 2½ miles south of Missouri Valley, Harrison County, Iowa, 300 feet south of the south end of railway bridge No. 978, 90 feet south of milepost 20, and 46 feet east of the Chicago and Northwestern Rwy. track; being copper bolt in B. M. stone.	177. 5790	582. 614
Top of cap	Over P. B. M. 357	178. 8017	586. 625
P. B. M. 358	Is in Missouri Valley, at the northwest corner of Second and Erie streets; being center of copper bolt leaded horizontally into the southeast corner of Kreder's billiard hall. It is 7½ inches west of the east face of the building and 1.23 feet above the sidewalk.	181. 0725	594. 075
P. B. M. 359	Is about 3 miles west of Missouri Valley, 335 feet east of the east end of railway bridge No. 4, 886 feet west of milepost 3, and 47 feet north of Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	179. 6074	589. 268
Top of cap	Over P. B. M. 359	180. 8318	593. 286
P. B. M. 360 = [illegible]	Is 758 feet east of the depot at California Junction, Harrison County, Iowa, in the northwest corner of A. W. Smith's orchard, 3 feet from each fence, and 56 feet south of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	179. 8660	590. 117
Top of cap	Over P. M. B. 360	181. 0871	594. 128
P. B. M. 361	Is about 1¾ miles north of California Junction depot, 70 feet south of a public road crossing, and 44 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	180. 7259	592. 933
Top of cap	Over P. B. M. 361	181. 9490	596. 951
P. B. M. 362	Is ¾ of a mile south of Modale, Harrison County, Iowa, 195 feet north of railway bridge No. 10, and 46 feet east of Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	181. 7808	596. 399
Top of cap	Over P. B. M. 362	182. 9976	600. 391
P. B. M. 363	Is about 1 mile north of Modale, 2,320 feet north of milepost 11, 60 feet south of highway crossing, and 46 feet east of Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	182. 2028	597. 784
Top of cap	Over P. B. M. 363	183. 4252	601. 794
P. B. M. 364	Is 2 miles south of Mondamin, Harrison County, Iowa, 7 feet west of the west right-of-way fence, and 54 feet west of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	183. 3267	601. 471
Top of cap	Over P. B. M. 364	184. 5508	605. 487
P. B. M. 365	Is in Mondamin, 246 feet east of the Sioux City and Pacific Rwy. track; being center of copper bolt leaded horizontally in center of a sandstone block in southwest corner of brick building occupied by D. Ganet & Co. and 0.71 feet from the west wall of building.	186. 7563	612. 723
P. B. M. 366	Is 2,238 feet north of Mondamin depot, 889 feet south of public road crossing, 33 feet south of mile post 17, and 46 feet east of Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	185. 8297	609. 683
Top of cap	Over P. B. M. 366	187. 0497	613. 686
P. B. M. 367 = [illegible]	Is about 2¼ miles north of Mondamin, 246 feet north of public road crossing, 299 feet north of dwelling of Joseph Krummel, and 105 feet east of Sioux City and Pacific Rwy. track, and is in corner of field; being copper bolt in B. M. stone.	185. 3760	608. 194
Top of cap	Over P. B. M. 367	186. 5931	612. 188
P. B. M. 368	Is about 2½ miles south of River Sioux depot, Harrison County, Iowa, 3,553 feet north of milepost 20, and 51 feet east of Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	187. 0081	613. 549
Top of cap	Over P. B. M. 368	188. 2284	617. 553
P. B. M. 369 = [illegible]	Is 1,260 feet south of River Sioux depot, 541 feet south of milepost 23, and 45 feet east of Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	188. 8797	619. 690

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M., 369	190. 0982	623. 687
P. B. M. 370	Is about 2½ miles north of River Sioux depot, 1,634 feet north of milepost 25, and 47 feet east of Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	187. 9487	616. 635
Top of cap	Over P. B. M. 370	189. 1697	620. 641
P. B. M. 371	Is about 4½ miles south of Blencoe, Monona County, Iowa, 165 feet south and 92 feet east of P. B. M. 372, 1,345 feet south of milepost 28, and 46 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	188. 6260	618. 857
Top of cap	Over P. B. M. 371	189. 8468	622. 863
P. B. M. 372=$\frac{1\,3\,2}{4}$	Is about 4½ miles south of Blencoe, 1,148 feet south of milepost 28, and 46 feet west of Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.		
Top of cap	Over P. B. M. 372	188. 8692	619. 655
P. B. M. 373	Is about 1¾ miles south of Blencoe, 1,483 feet north of milepost 30, 1,305 feet south of railway bridge No. 25, and 46 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	189. 5433	621. 867
Top of cap	Over P. B. M. 373	190. 7634	625. 870
P. B. M. 374=$\frac{1\,2\,3}{4}$	Is 623 feet north of the depot at Blencoe, 525 feet west of the Sioux City and Pacific Rwy. track, 25 feet north and 58 feet east of the northeast corner of Isaac Fleener's house; being copper bolt in B. M. stone.	190. 4896	624. 971
Top of cap	Over P. B. M. 374	191. 7062	628. 963
P. B. M. 375	Is about 4 miles south of Onawa Depot, Monona County, Iowa, 44 feet east of Sioux City and Pacific Rwy. track, on line with south side of E. S. Cody's farmhouse, and 259 feet east of same; being copper bolt in B. M. stone.	192. 0283	630. 020
Top of cap	Over P. B. M. 375	193. 2545	634. 043
T. B. M. 905	Is 3,511 feet north of milepost 35, 49 feet west of track, and opposite farmhouse; being nail in root of a 6-inch box-elder tree.	193. 1898	633. 830
P. B. M. 376	Is about 2¼ miles south of Onawa, 1,585 feet south of milepost 37, 1,056 feet south of east and west road crossing, and 45 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	192. 7146	632. 271
Top of cap	Over P. B. M. 376	193. 9402	636. 292
P. B. M. 377	Is at Onawa, at the Iowa avenue entrance of the court-house, 1.12 feet from the face of sill, and 0.43 feet from the west jamb; being top of copper bolt leaded vertically in west end of stone doorsill.	195. 1327	640. 205
P. B. M. 378=$\frac{1\,3\,4}{4}$	Is in Onawa, in the northwest corner of the German Lutheran Churchyard, corner of Granite and Maple streets, 3 feet from the alley fence, and 3 feet from the southwest corner of a stable; being copper bolt in B. M. stone.	193. 6775	635. 431
Top of cap	Over P. B. M. 378	194. 9168	639. 497
T. B. M. 911	Is 1,047 feet north of Onawa Depot, and 43 feet west of track; being spike in root of a 20-inch cottonwood tree.	194. 2293	637. 241
P. B. M. 379	Is about 2¼ miles north of Onawa Depot, 810 feet north of milepost 41, 180 feet north of the north end of railway bridge No. 40, and 44 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	193. 8594	636. 627
Top of cap	Over P. B. M. 379	195. 0782	640. 026
P. B. M. 380	Is about 2⅔ miles of south of Whiting Depot, Monona County, Iowa, 958 feet south of milepost 44, 46 feet east of the Sioux City and Pacific Rwy. track, 3 feet from east right of way fence, and 6 feet south of the south fence of road crossing; being copper bolt in B. M. stone.	194. 7570	638. 972
Top of cap	Over P. B. M. 380	195. 9833	642. 996
P. B. M. 381	Is 1,050 feet south of Whiting Depot, 66 feet south of the south head block at Whiting, and 46 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	196. 5494	644. 853
Top of cap	Over P. B. M. 381	197. 7904	648. 924
P. B. M. 382	Is about 2½ miles north of Whiting Depot, 282 feet south of milepost 49, 46 feet east of the Sioux City and Pacific Rwy. track, and opposite Daley's dwelling; being copper bolt in B. M. stone.	197. 5847	648. 250
Top of cap	Over P. B. M. 382	198. 8085	652. 265
P. B. M. 383=$\frac{1\,3\,1}{4}$	Is about 3 miles south of Sloan Depot, in Monona County, Iowa, 1,345 feet south of milepost 52, and 47 feet west of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	198. 3146	650. 644
Top of cap	Over P. B. M. 383	199. 5527	654. 706
P. B. M. 384	Is 1,335 feet south of Sloan Depot, 47 feet west of the Sioux City and Pacific Rwy. track, and 3 feet south of the south side of an east and west public road; being copper bolt in B. M. stone.	199. 9169	655. 901
Top of cap	Over P. B. M. 384	201. 1370	659. 904

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
P. B. M. 385	Is on the corner of Fourth and Evans streets, Sloan; being cross cut on the northeast corner of stone doorsill of the State Bank.	202.5221	664.449
P. B. 386=$\frac{2}{2}^{8}$	Is 5,256 feet north of Sloan Depot, 879 feet south of milepost 56, and 49 feet west of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	200.3911	657.457
Top of cap	Over P. B. M. 386	201.6112	661.460
P. B. M. 387	Is about 2¼ miles south of Salix Depot, Woodbury County, Iowa, 240 feet south of a farm crossing, and 40 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	201.0639	659.664
Top of cap	Over P. B. M. 387	202.2906	663.689
P. B. M. 388	Is 1,270 feet south of Salix Depot, 144 feet north of south head block at Salix siding, and 46 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone. This bench mark was formerly B. M. $\frac{1}{2}^{2}$. It had been established in a low swampy place, and also had been disturbed. It was taken up and reëstablished as described above.	203.1678	666.567
Top of cap	Over P. B. M. 388	204.3875	670.569
T. B. M. 946	Is about 1½ miles north of Salix Depot, 98 feet south of milepost 62, 60 feet east of the Sioux City and Pacific Rwy. track; being spike in root of a 30-inch cottonwood.	204.1547	669.805
P. B. M. 389	Is about 2¾ miles north of Salix Depot, 623 feet north of a road crossing, 361 feet north of C. W. Wheeler's house, 47 feet east of the Sioux City and Pacific Rwy. track, and is on the south side of the old river bed; being copper bolt in B. M. stone.	205.2548	673.414
Top of cap	Over P. B. M. 389	206.4760	677.421
P. B. M. 390	Is about 2¾ miles south of Sargent's Bluff Depot, Woodbury County, Iowa, 1,900 feet south of milepost 66, 656 feet north of a road crossing, 1,352 feet north of Louis Godferson's house, and 46 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	205.1666	673.125
Top of cap	Over P. B. M. 390	206.3905	677.140
P. B. M. 391=$\frac{1}{4}^{2}$	Is in Sargent's Bluff, in lot 1, block 2, 10 feet from the southwest corner of E. T. Berry's house, and 52 feet from the northwest corner of Tenth and Walnut streets; being copper bolt in B. M. stone.	206.6988	678.152
Top of cap	Over P. B. M. 391	207.9151	682.142
P. B. M. 392	Is about 3 miles north of Sargent's Bluff, 47 feet east of the Sioux City and Pacific Rwy. track, 1,476 feet south of a road crossing, and about 2 feet west of east right of way fence; being copper bolt in B. M. stone.	207.5452	680.929
Top of cap	Over P. B. M. 392	208.7690	684.944
T. B. M. 961	Is 1¼ miles below the Missouri River Bridge, at Sioux City, Iowa, about 656 feet south of railway bridge No. 56, about 558 feet from a farmhouse, and is in woods 60 feet west of the Sioux City and Pacific Rwy. track; being a spike in root of a 15-inch elm tree.	210.3045	689.982
P. B. M. 393	Is in Sioux City, 558 feet south of the Missouri River Bridge, 148 feet north of railway bridge No. 60, and is 20 feet east of the Sioux City and Pacific Rwy. track; being copper bolt in B. M. stone.	209.0705	685.933
Top of cap	Over P. B. M. 393	210.2972	689.958
P. B. M. 394	Is in Sioux City, in the northwest corner of the east pier of the Missouri River Bridge, 2 feet above the ground; being center of copper bolt leaded horizontally into the seventeenth course of masonry below the coping course.	211.3982	693.570
P. B. M. 395; gauge B. M.	Is in Sioux City, 103 feet west of the west side of the eastern or shore pier of the Missouri River Bridge, and almost vertically under the north truss of the east span, and is 69 feet west of the Sioux City and Pacific Rwy. track, being copper bolt in B. M. stone.	....	....
Top of cap	Over P. B. M. 395	207.8763	682.015
P. B. M. 396=$\frac{1}{2}^{3}$	Is in Sioux City, in the southwest corner of the court-house yard, 72 feet from the southwest corner of the court-house and 135 feet from the southeast corner of the same; being copper bolt in B. M. stone.	211.5638	694.113
Top of cap	Over P. B. M. 396	212.7888	698.132
T. B. M. 966	Is in Sioux City, about 39 feet north of the northeast corner of Fifth and Pierce streets; being top of ring bolt set vertically in sidewalk stone.	212.2659	696.417
T. B. M. 970	Is 108 feet west of P. B. M. 397, and 39 feet west of Chicago, Milwaukee and St. Paul Rwy. track; being railroad spike in root of a 12-inch ash tree.	210.4426	690.435
P. B. M. 397	Is about 3½ miles above Sioux City and about one-fourth mile north of the Electric Rwy. power-house at Riverside Park, and 121 feet north of north head block, and is at foot of bluff, 52 feet east of the Chicago, Milwaukee and St. Paul Rwy. track; being copper bolt in B. M. stone.	209.7791	688.258

Descriptions and elevations of precise level bench marks, etc.—Continued.

Number.	Description.	Elevation.	
		Meters.	Feet.
Top of cap	Over P. B. M. 397	211.0016	692.269
T. B. M. 971	Is about 3¼ miles above Sioux City, 174 feet north of north head block at Riverside Park, 69 feet west of the Chicago, Milwaukee and St. Paul Rwy. track, and 10 feet east of the Electric Rwy. track; being spike in root of a 15-inch post oak tree.	210.6065	691.169
P. B. M. 398	Is about 6 miles above Sioux City, 515 feet south of the south end of the railway bridge over Big Sioux River, and 3 feet east of the west right of way fence; being copper bolt in B. M. stone.	210.5527	690.796
Top of cap	Over P. B. M. 398	211.7748	694.805
T. B. M. 973	Is about 246 feet south of the Chicago, Milwaukee and St. Paul Rwy. bridge over Big Sioux River, and 30 feet east of track; being railroad spike in root of a 12-inch maple tree.	212.0934	695.851
P. B. M. 399	Is about 6 miles above Sioux City on land of Mrs. Rose Pacquette, 50 feet west of Chicago, Milwaukee and St. Paul Rwy. track, 190 feet south of the south end of the railway bridge over the Big Sioux River, and about 5 feet west of the right-of-way fence; being copper bolt in B. M. stone.	209.1785	686.287
Top of cap	Over P. B. M. 399	210.3992	690.292

APPENDIX A 7.

ANNUAL REPORT OF MR. O. H. B. TURNER, ASSISTANT ENGINEER, 1893.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., July 6, 1893.

SIR: I have the honor to report on field operations of special precise level survey under my charge.

In accordance with your instructions I left St. Louis May 19 for Blair, Nebr., to organize a precise level party to connect gauge bench marks with precise level line, which was run from Sioux City to mouth of river last season.

I arrived at Blair, Nebr., on the morning of the 21st, having stopped at Omaha to get men, and the entire party reported the same evening.

The organization of the party was as follows: O. H. B. Turner, leveler, E. J. Thomas, recorder, two rodmen, two axmen. Work began on the morning of the 23d and continued without interruption until the 27th of June, when the work was completed at Dewitt, Mo.

The party was to subsist at hotels and farmhouses, and to use railroads for transportation.

The work consisted of running a duplicate line of precise levels from gauge bench marks to the nearest precise level bench mark. As the gauges were on opposite sides of river from precise bench marks, it was necessary to cross river with levels. At five places the levels were run over railroad bridges, and at two others river crossings were made.

The gauge bench marks connected with were at following places and in order named: Blair, Nebr., Plattsmouth, Nebr., Nebraska City, Nebr., Brownville, Nebr., Rulo, Nebr., Randolph Bridge and Dewitt, Mo.

At Brownville, Nebr., on account of the river being very wide, nearly 1 mile, a crossing was made to a willow bar, 750 meters, then ran over bar to channel on right of bar, and another crossing was made of about 200 meters.

In making a river crossing with one instrument it is necessary to have a cloudy day, so that change in refraction may be a minimum.

In this crossing the morning was very cloudy, threatening rain, and the change in refraction was small, so that there was a range of only 6 millimeters in the four complete results taken on each bank.

The manner in which the river crossing was made is as follows:

Having chosen a place suitable for making the crossing, temporary bench marks were set on either bank, recorder and one rodman crossed to opposite bank with one rod and target; target used was made of cardboard, 4 inches wide by 5 inches long, tacked upon a strip of wood; it had a white bar 10 millimeters in width, through the center of which was a single black line; the target, after being set each time, was read and recorded by the recorder.

The readings were taken in the following order, namely: Telescope normal, level direct, level reversed, telescope inverted, level direct, level reversed. In each observation the position of level bubble was kept in center and four complete results taken on each bank.

At Dewitt, Mo., another crossing was made of 580 meters; the day was cloudy and a very fair crossing was made.

At Blair, Nebr., Plattsmouth, Nebr., Nebraska City, Nebr., Rulo, Nebr., and at Randolph, Mo., the lines of levels were crossed over bridges, varying in length, including trestles, from 400 meters to 2,400 meters.

At these bridges the levels had to be run up and down embankments about 50 feet in height, which required about two-thirds of a day for each bridge, and lengths of stretches were less than 200 meters each.

Below is a brief summary of work done:

Line leveled and checked .... miles	32.0
River crossings made	2
River crossings, on railroad bridges	5
Old B. Ms., connected with	23
P. B. Ms., established	7

The cost per mile, exclusive of transportation of party and express of instruments, was about \$23; total cost per mile, including all expenses of party from time of leaving St. Louis till it returned, was \$28.

A much better showing could be made where the work was continuous, as five days were lost in moving party seven times.

Out of a total of thirty-five days in field, there were eleven days, including Sundays, on which no work was done, so that there were only twenty-four days on which the party did any work.

The probable error per kilometer is 0.64 millimeter.

No line was run more than twice, and with one exception all closed well within the limit, $3^{mm} \sqrt{2 \text{ x distance in kilometers}}$.

Instrument used was Kern level No. 5, with vial No. 5, which is an excellent vial for this work.

Vial No. 12 was used last season on similar work, and many lines had to be rerun on account of the level vial being wholly unfit for precise work.

The value of one division was 4.58 seconds, while vial No. 5 has a value of only 2.23 seconds.

Very respectfully, your obedient servant,

O. H. B. TURNER,
Assistant Engineer.

First Lieut. J. C. SANFORD,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

Tables giving the values of instrumental constants.

INEQUALITY OF TELESCOPE RINGS.

No. of telescope.	Date of observation.	Dates to be used between.	Value of P′ in seconds.	Correction in millimeters per meter.	Me valu P′ in onds seas
2	Apr. 17, 1892	....	—3.51	—0.017	......
2	Oct. 3, 1892	....	—0.80	—0.003	......
2	....	April 17 to September 26, 1892	....	....	—2
5	Apr. 17, 1892	....	—3.52	—0.017	......
5	Oct. 3, 1892	....	—3.52	—0.017	......
5	....	April 17 to September 26, 1892	....	....	—3

ANGLE IN ONE DIVISION OF LEVEL TUBE.

No. of tube.	Date of observation.	Dates to be used between.	Seconds in one division.	Subtends 1 millimeter at meters—	Mean onds one d sion seas
9	Apr. 18, 1892	....	3.74	55.20	......
9	Oct. 24, 1892	....	3.37	61.25	......
9	....	During whole season	....	....	3
12	Apr. 19, 1892	......do	....	....	4

LENGTHS OF "A," RODS XIV, XV, XVI, AND XVII.

No. of rod.	Date of measurement.	Dates to be used between.	Distance from first gradient to foot of spur.
			Millimeters.
XIV	Apr. 23, 1892	During whole season	44.10
XVII	....do	......do	44.10
XV	Apr. 27, 1892	......do	44.20
XVI	....do	......do	44.20

ROD CORRECTION.

No. of rod.	Date of measurement.	Dates to be used between.
XIV	Dec. 7, 1892	During whole season..................................
XV	....do	......do..
XVI	....do	......do..
XVII	....do	......do..

Mean length of the four rods used = 2,999.31.
Mean length of the meter used = 999.77.

APPENDIX A 8.

ANNUAL REPORT OF MR. A. H. BLAISDELL, ASSISTANT ENGINEER, 1893.

OFFICE MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1893.

SIR: I have the honor to submit the following report on the water gauges maintained by the Missouri River Commission during the fiscal year ending June 30, 1893.

The following table gives the location of each gauge in miles above the mouth of the river, as measured on the low-water channel line of 1890, its character, and time maintained during the year:

Location of gauge.	Character of gauge.	Miles above mouth.	Months maintained during year.
St. Charles, Mo	Bridge, cable	28.06	12
Hermann, Mo*	Shore, inclined	103.3	12
Cole Creek, Mo	do	107.1	12
Ewings Landing, Mo	Shore, cable	143.8	12
Jefferson City, Mo	Shore, inclined	151.3	12
Boonville, Mo	Bridge, cable	205.8	12
Glasgow, Mo	do	237.5	12
DeWitt, Mo	Shore, cable	267.2	12
Waverly, Mo	Shore, inclined	299.1	12
Lexington, Mo	do	322.0	12
Sibley, Mo	Bridge, cable	350.0	12
Randolph, Mo	do	386.7	2
Kansas City, Mo	do	390.7	12
Leavenworth, Kans	Shore, vertical	421.8	2
Ft. Leavenworth Bridge, Kansas	Bridge, cable	424.0	12
Atchison, Kans	do	447.8	12
St. Joseph, Mo	do	479.0	12
St. Joseph Waterworks	Shore, vertical	488.7	2
White Cloud, Kans	do	525.4	2
Rulo, Nebr	Bridge, cable	537.5	12
Brownville, Nebr	Shore, cable	577.6	12
Nebraska City, Nebr	Bridge, cable	607.7	12
Plattsmouth Bridge, Nebraska	do	633.6	12
Omaha, Nebr	do	659.1	12
Blair, Nebr	do	694.6	12
Sioux City Bridge, Iowa	do	805.7	12
Sioux City (Perry Creek), Iowa	Shore, vertical	807.4	2
Townsend, Mont	Bridge, cable	....	12

*Weather Bureau gauge (corrected).

The gauges which were maintained only two months were those which had been temporarily reëstablished in May, 1892, for comparison of the extreme high water of that year with those of 1881 and 1883.

At gauge stations above White Cloud, Kans., the flood of 1892 had not reached its maximum until near the middle of July; and these gauges were continued until August 31, at which date the river had fallen to about its normal fall stage.

The inspection of the gauges has been in charge of Mr. L. P. Butler, assistant engineer, who has made three thorough tours of inspection between St. Charles and Sioux City; in addition to this, he was charged with other work connected with the measurement of bridges, the gathering of commercial statistics, and the erection of new gauges and pilot-bulletin signs.

It was found necessary during the month of September to entirely renew the inclined shore gauges at Jefferson City, Waverly, and Lexington.

At the present time the gauges are all in good condition; but the one at DeWitt—a shore-cable gauge—will doubtless have to be renewed during the next year, on account of caving banks.

Acting under your orders, pilot-bulletin signs have been established at all the regular gauge stations between the mouth of the river and Kansas City.

Randolph Bridge having just been made a regular gauge and bulletin station, makes the total number of bulletins maintained eleven.

At stations where high bridges have been built—St. Charles, Glasgow, Sibley, and Randolph—two bulletins, which are attached to the bridge structure, are exhibited, one showing upstream and the other downstream.

The Kansas City Bridge has one single bulletin showing downstream; all the other bulletins are exhibited from the shore.

Drawings of the bulletins are shown on the accompanying plate.

The figures and letters of the bulletins are white on a black backgrounc painted on a cold rolled steel plate of No. 16, B. W. gauge.

The plates of the shore bulletins, and also of that on the Kansas City Br 30 inches high by 24 inches wide.

The bridge bulletin signs are of two sizes. Those on the upstream sid inches high by 40 inches wide; those on the lower side are 42 inches hig inches wide.

The bulletins are changed every morning in accordance with the forenoon reading, and exhibit the stage of water in feet and tenths of a foot, and by t minal letters R., F., S., indicate whether the stage is a rising, falling, or stati one.

The shore bulletins have a framework made of T and angle iron. The T posts are firmly incased at their lower ends for a depth of 3 feet in a cedar cas. feet long, which is buried in the ground, and the structure is further brace struts.

The bridge bulletins have a framework of bar and angle iron, the constructio which is readily understood from the drawing. The weight of the bulletin is s ported on the eye bars or lower chord of the bridge, to which it is attached by ho bolts. Braces, either of iron or wood, are carried back to a stringer or guard ra and a platform is laid to the bulletin frame for the safety and convenience of tl observer.

In authorizing the gauge-bulletin service, the commission had decided that th stages exhibited by the bulletins should be as nearly as possible the same as those published daily by the Weather Bureau. To accomplish this result, it was found that the zero to which the bulletin would have to be referred was 5.1 feet below a mean of the navigable low waters, usually occurring in early November of each year. This stage was accordingly made the zero of the bulletins.

At Kansas City, the record of the bulletin and the Weather Bureau agree.

At Boonville, the Weather Bureau should record a stage one-tenth foot higher than the bulletin.

At Cole Creek, 3.6 miles above Hermann, the bulletin shows a relatively higher stage than the Weather-Bureau gauge at Hermann, but it agrees more nearly with the old Signal Service-gauge at Hermann previous to 1886.

The zero of the Hermann Signal Service-gauge has varied from an elevation of 67.21 feet in 1886 to 71.1 feet in 1890; the latter elevation is now used.

A mean of the navigable low waters at Hermann for fourteen years appears, from the various records on file, to be 73.5 feet.

The bridge bulletins also give by simple subtraction the clear headway available under the bridges for passing steamboats; the elevations of the lowest point of superstructure of the bridges and the water surface being known.

By your direction, printed cards explanatory of the bulletin service, and giving data for ascertaining the clear headway under bridges up to and including Kansas City, have been issued to the owners, masters, and pilots of steamboats navigating the Missouri River.

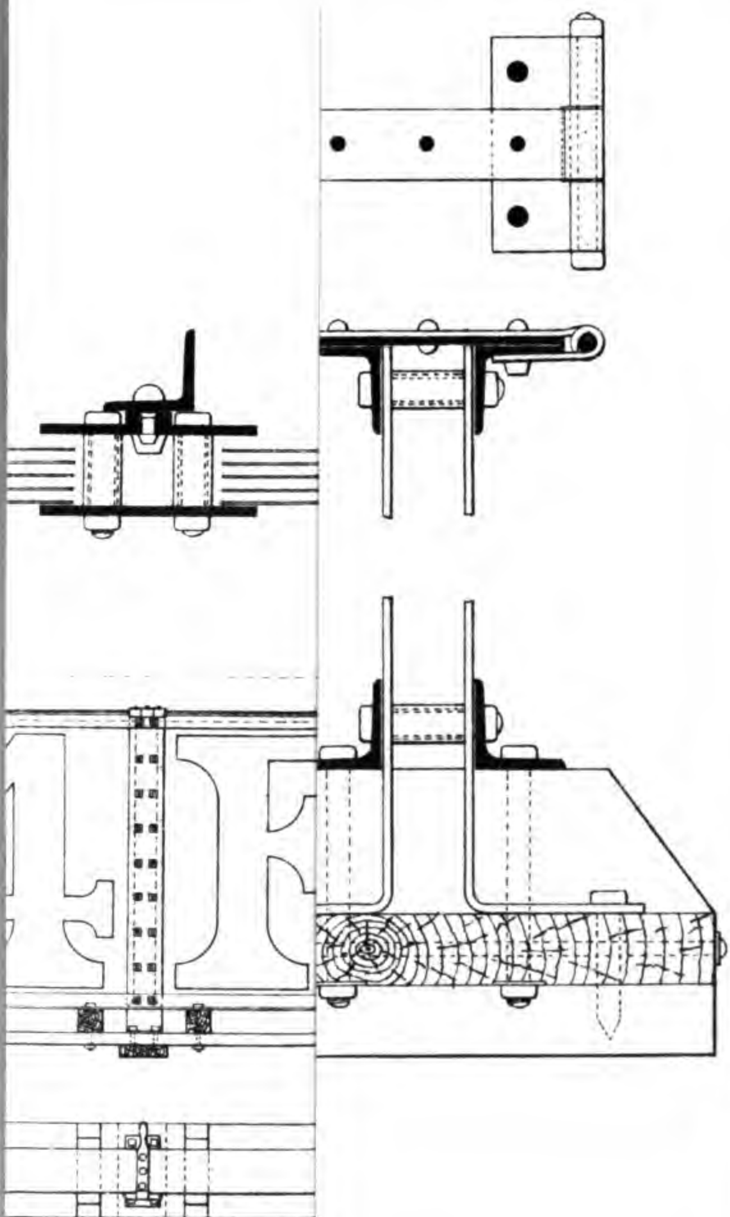
The work of the precise-level parties, which has just been completed, shows that the records of all the gauges on the river must receive corrections, varying in amount.

The corrections from old to new elevations at each gauge appear to be as follows:

	Feet.		Feet.
Sioux City (Perry Creek)	+1.259	Leavenworth	+0.094
Sioux City Bridge	+1.27	Kansas City	+0.209
Blair	+0.433	Randolph	+0.131
Omaha	+0.703	Sibley	+0.143
Plattsmouth	+0.552	Lexington	+0.015
Plattsmouth Bridge	+0.548	Waverly	+0.252
Nebraska City	+0.056	DeWitt	+1.620
Brownville	—0.319	Glasgow	+0.254
Rulo	—0.187	Boonville	+0.228
White Cloud	—0.082	Jefferson City	+0.206
St. Joseph Waterworks	—0.132	Ewings Landing	+0.103
St. Joseph	—0.137	Cole Creek	+0.109
Atchison	—0.021	Hermann	+0.135
Fort Leavenworth	—0.070	St. Charles	+0.082
Fort Leavenworth Bridge	—0.070		

As soon as it can be conveniently and satisfactorily done, it is proposed to change all the gauges so as to read correct elevations above the St. Louis Directrix, as determined by the precise-level line.

No change has been made in the methods heretofore adopted for the permanent preservation of the gauge records; trial hydrographs are kept platted up to date, from which errors of reading are detected.



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3. of A. H. Blaisdell, Ass't. Engr.

Permanent hydrographs are platted from the yearly cards, which are prepared with great care from a comparison of the weekly records, the observer's gauge book and the results of the inspection and testing of the gauges.

Means of the two daily readings of the gauges have been prepared; and, after applying the corrections found necessary by the line of precise levels, the records for the years 1890–1892, which have not yet been published, will be ready for the printer's hands.

Very respectfully, your obedient servant,

A. H. BLAISDELL,
Assistant Engineer.

First Lieut. J. C. SANFORD,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

APPENDIX B.

ANNUAL REPORT OF MR. S. WATERS FOX, DIVISION ENGINEER, OMAHA DIVISION, 1893.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER,
Hermann, Mo., June 30, 1893.

COLONEL: I have the honor to submit herewith a report of the operations under my charge on the Omaha division of the Missouri River during the fiscal year ending June 30, 1893.

A map of the river in the vicinity of Council Bluffs, Iowa, compiled from surveys of November, 1890, and May, 1893, accompanies the report.

The Omaha division was assigned to my charge, by your direction, in a letter from the chief clerk, dated St. Louis, Mo., September 30, 1892, two days after the death of Mr. Charles F. Potter, division engineer, previously in charge. In compliance therewith I proceeded to Omaha, arriving October 3, 1892, and took charge of the property and work. The operations in progress at that time were the repair and launching of the fleet, for which authority was given Mr. Potter in your letter dated July 23, 1892; revetment construction in Council Bluffs Bend, and miscellaneous work incident thereto, as authorized by Mr. Potter's project, dated August 19, 1892, and approved September 8, 1892, for the expenditure of the $30,000 allotted for repair and completion of revetment in vicinity of Council Bluffs, Iowa.

Prior to October 3, and from July 1, 1892, the records show the force to have been occupied as follows, viz:

Measurements were taken to determine the elevations of the lowest points of the superstructures of the channel spans of the bridges across the Missouri River at Sioux City, Blair, Omaha (Union Pacific and Omaha and Council Bluffs), and at Plattsmouth. This work was ordered verbally June 28, 1892, by the secretary of the Commission, and the report thereon was submitted to him under date of July 28, 1892.

In accordance with a telegram and letter from the secretary, dated at St. Louis, Mo., July 5, 1892, a party was sent to float and deliver to Mr. Paige, assistant engineer, in charge of a precise-level party, a quarter boat grounded on a bar near Plattsmouth and left there by him in charge of a watchman. The boat was delivered to Mr. Paige, July 21, at a landing about 2 miles below "Calumet Point."

A survey of Florence Lake, July 11 and 12, during a stage of water that was four-tenths of a foot below the maximum of that season, was made the subject of a special report to you on July 23.

The work of repairing the fleet referred to above was begun July 27. The procuring of brush by hired labor, for use in revetment construction, was begun September 9.

The sinking of anchorage piles was begun September 10. The rock ballast for the revetment extension and repairs was purchased September 10, in open market, at two dollars and twenty-four cents ($2.24) per cubic yard, to be delivered on the bank at points of expenditure.

The repair and launching operations and revetment construction were continued after I took charge, in accordance with the approved plan.

Revetment construction and repairs.—The weaving of mattress was begun October 11, with one party, at the downstream side of the launching ways. I afterwards learned that the way frontage was unprotected, and ordered a woven mattress placed there, lapping the old work above and the new below. A second party began work October 25 at a point about 800 feet above the head of the revetment constructed in 1891.

Weaving was finished November 16; 3,040 linear feet were woven, of an average width of 70 feet, the lower end lapping the revetment of 1891 (see the accompanying map A–B).

Brush cutting was finished November 5; the total quantity procured was 1,113 cords. The sinking of piles for shore anchorage was finished October 11; 271 piles were sunk, with a jet, to an average penetration of 18.21 feet.

Hydraulic grading for the upper bank work began Ooctober 19 and was finished November 21; 2,601 linear feet of bank were graded, involving the removal of 8,776 cubic yards of earth.

The character of earth composing the bank was such, in places, that the grade made by the jet required some surfacing with scrapers and shovels. The ballasting of mattress and upper bank was begun October 26 and finished November 30; 4,073 cubic yards of rock were thus expended.

The cost of this work is shown in item in the following table:

Cost exhibit in detail of 3,040 linear feet of revetment at Council Bluffs, Iowa, 1892.

Classification and extent.		Cost per unit.	Cost of each item.	Cost per linear foot.	Total cost.
Procuring 1,113 cords of willow brush, viz:					
Stumpage, 842 cords		$0.1867	$157.20		
Cutting		.3376	375.75		
Binding:					
Labor	$203.50				
Material	55.60				
		.2328	259.10		
Loading wagons, 270 cords		.1765	47.62		
Hauling		.8670	964.95		
Barging		.2998	333.68		
Subsistence		.6631	738.06		
Superintendence, foreman, and timekeeper		.2660	296.16		
Towing by hand		.1386	154.37		
(1,059 cords used in revetment.)					
		2.9891	3,326.89	$1.0413	$3,165.45
Hydraulic grading 8,776 cubic yards of earth, viz:					
Labor		.0793	696.23		
Subsistence		.0266	233.43		
Fuel		.0420	368.60		
		.1479	1,298.26	.4270	1,298.26
Weaving 3,040 linear feet of mattress, viz:					
Labor		.5867	1,783.71		
Subsistence		.2594	788.57		
		.8461	2,572.28	.8461	2,572.28
Anchoring 3,040 linear feet of mattress, viz:					
Labor		.0759	230.65		
Subsistence		.0172	52.57		
Material:					
60,250 feet 3-8 inch strand	$762.49				
3,453 feet 3-4 inch cable	164.80				
148 "Nier" anchors	22.50				
		.3124	949.79		
		.4055	1,233.01	.4055	1,233.01
Sinking 271 anchor piles:					
Labor		1.1312	306.57		
Subsistence		.9514	162.70		
Fuel		.6082	114.00		
Material, 271 piles		3.4000	920.40		
		6.0908	1,503.67	.4946	1,503.67
Ballasting 3,040 linear feet of mattress, viz:					
Material, 1,370 cubic yards of rock		2.24	3,068.80		
Labor, placing		.3659	501.37		
Subsistence		.1476	202.28		
		2.7535	3,772.45	1.2409	3,772.45
Ballasting 3,040 linear feet upper bank, viz:					
Material, 2,703 cubic yards of rock		2.24	6,054.72		
Labor, placing		.2398	648.10		
Subsistence, placing		.1409	380.82		
		2.6207	7,083.64	2.3301	7,083.64
Total		....	....	6.7856	20,6[illegible].76

Bill of cost of 3,040 linear feet of revetment, Council Bluffs, Iowa, 1892.

Classification and extent:	
1,059 cords of willow brush at works, at $2.9891	$3,165.45
4,073 cubic yards of rock at works, at $2.24	9,123.52
160 piles at works, at $3.7753	604.05
111 piles, paid for on allotment for 1889	316.35
60,250 linear feet, $\frac{3}{8}$-inch strand, at $0.01265	762.49
3,453 linear feet, $\frac{3}{4}$-inch cable, at $0.0477	164.80
148 "Nier" anchors, at $0.1513	22.50
Labor and subsistence:	
Weaving	2,572.28
Anchoring	283.22
Ballasting	1,732.57
Labor, subsistence, and fuel, hydraulic grading	1,298.26
Labor, subsistence, and fuel, driving anchor piling	583.27
Total	20,628.76

Miscellaneous data and elements of cost exhibit at Council Bluffs, Iowa, 1892.

Classification and extent:	
Linear feet of mattress made	3,040
Square feet of mattress made	212,800
Square feet of upper bank revetted	82,080
Total cost	$20,628.76
Cost per linear foot of work	6.7856
Cost per square (100 square feet) mattress work	5.7551
Cost per square (100 square feet) upper bank work	10.2110

The repairs to the 1891 revetment in the vicinity of the pumping station were finished December 6, 1892. The deposit left by the June rise on the upper bank was graded off and the ballast reinforced with 306 cubic yards of rock. This rock was broken up with hammers and packed into the interstices of the old ballast; the area thus treated was 1,347.8 square yards.

Bill of cost, repairing revetment near pump-house, Council Bluffs, Iowa.

Classification and extent.	Cost of each item.	Total cost.
Labor:		
Grading deposit off of old revetment	$67.00	
Placing 306 cubic yards of rock	94.32	
		$161.32
Material:		
306 cubic yards of rock	685.44	
Fuel	22.80	
		708.24
Total		869.56

The construction of two pile dikes in the pocket (shown at C on the map) above the boat yard, was begun December 28, 1892, and finished January 25, 1893. Forty-one white oak piles were driven to an average penetration of 23.73 feet. The dikes extended from the shore out 60 feet and 80 feet, respectively, their outer, or stream ends, being about on a line chording the pocket. As they projected beyond the revetment mattress, it was necessary to protect their outer ends with foot mattresses. These mats, containing 5,697 square feet, were woven on the ice and sunk in place with 150 cubic yards of rock.

The cost of the dikes is shown in item in the following table:

Bill of cost of pile-dike construction at Council Bluffs, Iowa, 1892 and 1893.

Classification and extent.	Cost of each item.	Total cost.
Labor:		
Driving 41 piles	$433.47	
Placing wales and braces	97.47	
Weaving foot mattress, 5,697 square feet	111.46	
Sinking and ballasting same	178.50	
Making shore connections	63.36	
		$884.26
Material:		
41 white oak piles	344.49	
5,944⅔ feet, B. M., wales and braces, white oak and yellow pine	162.40	
1,568 pounds drift-bolt iron	35.62	
54 cords of willow brush	161.41	
274 cubic yards of rock ballast (paid for on allotments for 1889 and 1891)	142.41	
2,050 feet of ⅜-inch strand	25.43	
176 bushels coal	33.37	
		905.13
Plant, rental of steam hoist, and leads with 3,000-pound ram	127.50	
		127.50
Total		1,916.89

These dikes were so badly damaged by the ice when it moved out in the spring, that they were unable to withstand the April flood; all of the upper one and a portion of the lower one were taken out.

Under date of April 10, 1893, Assistant Jones reported a break, 450 feet long, in the old revetment just below the dikes.

The matter was reported to you, and authority obtained for repairing it by the construction of new revetment. Work was begun April 18 and finished May 25. Four hundred and eighty-one linear feet of bank were graded, involving the removal of 1,261 cubic yards of earth. Five hundred and twenty-seven linear feet of mattress, averaging 65 feet wide, were woven. Seven hundred and forty-six cubic yards of rock were expended in ballasting the mattress and upper bank; this material was purchased in open market for $1.95 per cubic yard, delivered on the bank at the point of expenditure. The brush used, 121.42 cords, was procured by hired labor at a cost of $2.57 per cord on the work.

The location of this work is shown on the accompanying map, from point C, 481 feet downstream.

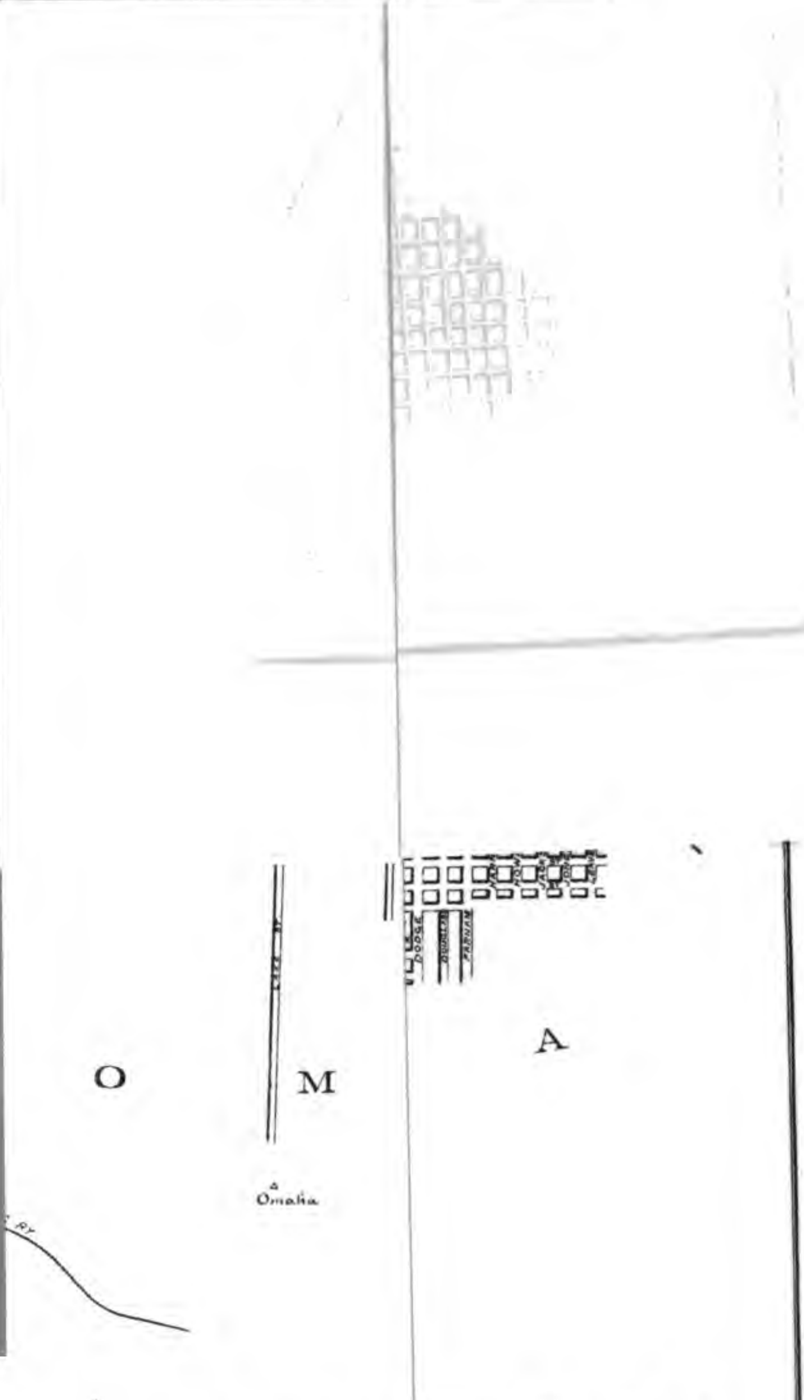
The cost is shown in item in the following table, viz:

Bill of cost repairing 481 linear feet of revetment at Council Bluffs, Iowa.

Classification and extent.	Cost of each item.	Total cost.
Labor:		
Procuring 121.42 cords of willow brush at works	$312.00	
Hydraulic grading (1,261 cubic yards)	106.45	
Weaving 34,255 square feet of mattress	355.12	
Sinking and ballasting same	70.17	
Ballasting upper bank	165.90	
		$1,009.64
Material:		
7,700 linear feet, ⅜-inch strand	97.44	
545 linear feet ⅝-inch cable	22.55	
746 cubic yards rock	1,453.90	
		1,573.89
Total		2,583.53

In the latter part of April, 1893, the old revetment above the gumbo point (see accompanying map, D–C) began to show signs of failure; but, as there were no funds available, it could not be repaired.

Under date of May 29, I submitted to you a report on the condition of the work on the reach, with a project and estimates for its repair and maintenance.



To accompany an Waters Fox, Div. Eng'r.

Eng 93.

Care of and repairs to plant.—Up to the time that I took charge of the work in October, 1892, 11 hulls had been repaired and 14 launched. The character of the repairs was such as was thought necessary to make the pieces serviceable for that season only. In accordance with verbal instructions from the Secretary, arrangements were then made for the extensive repair of all hulls that required it.

October 15 a raft of four large barges was started down the river for St. Joseph; the balance of the fleet afloat, consisting of fifteen hulls, was pulled out and placed on the ways after the revetment construction had been finished, November 16 to 28, 1892. Preparatory to pulling these hulls out, the launching ways had to be extended under water. The repairs to hulls were carried on all winter and until April 25, 1893, when they were finished, and the force of carpenters and calkers discharged.

Seven of the brush and stone barges (25 by 100 feet) and one of the small barges (16 by 65 feet) were practically rebuilt. All of the decayed timbers were taken out; on one piece this left only the bottom.

The other pieces required and were given but slight repairs. It was proposed to outfit hydraulic grader No. 1 with a set of pile leads and a B-Cram steam hammer, for use as a pile-driver on the Kansas City division, and, in order that the weight involved in the pile-driving apparatus might be carried without distress to the hull, a set of hog chains and braces were put on her. The pile leads for the outfit were made at the yard.

A general movement and breaking up of the ice in the river on the Omaha Reach occurred March 10, 1893. Launching operations began ten days thereafter; the entire fleet, consisting of 33 hulls, was launched by April 21. The removal of launching and storage ways and their supports was begun April 12 and by May 25 had been finished, and the material loaded on barges for transportation down the river. The entire field force, except the watchman in care of the fleet, was then discharged. The Omaha office was closed by May 31 and the records sent to the Hermann office.

The cost of these operations is shown in the following table:

Bill of cost repairing ways pulling boats, repairing and launching hulls, and removing storage ways at Council Bluffs, Iowa, 1892 and 1893.

Classification and extent.	Cost of each item.	Total cost.
Repairing launching ways:		
Sinking 25 piles	$77.20	
Carpentering	406.08	
Labor	87.07	
Subsistence	65.50	
		$635.85
Material:		
Lumber, piles, nails, etc	147.45	
Supplies, fuel	38.00	
		185.45
Pulling boats (14 hulls):		
Labor and subsistence	376.75	
Teaming	151.20	
		527.95
Repairing hulls (labor, repairs proper):		
Carpentering	9,799.44	
Calking	3,347.24	
Assisting carpenters	1,370.47	
Teaming	163.10	
Subsistence	1,613.85	
		16,294.10
Material:		
Plant material, lumber, oakum, iron, etc	3,113.00	
Plant purchased, tools, etc	10.60	
Supplies, fuel, oil, paints, tallow, etc	316.89	
		3,440.49
Launching 42 hulls:		
Labor and subsistence	1,076.78	
Teaming	444.90	
		1,521.68
Removing storage ways:		
Labor and subsistence	1,374.57	
Teaming	209.65	
		1,584.22
Total		24,189.74

The movement of the Omaha fleet down the river was effected by the steamers *Alert* and *Gasconade*, except one lot of 7 small hulls, which was rafted down. The *Alert* took away 16 hulls in 3 tows; the first one April 13, the last June 3; the *Gasconade* took 4 hulls in 2 tows; the first one June 9, the last one June 19.

Miscellaneous.—In accordance with instructions from the Secretary, dated at St. Louis, January 26, 1893, some special measurements were made of the waterways, batter of piers, and depths of trusses on the bridges across the Missouri River at Nebraska City, Plattsmouth, Omaha (Union Pacific and Omaha and Council Bluffs), Blair, and Sioux City. .

A drawing of these bridges, showing the data asked for, was prepared and a tracing of it sent to the Secretary with a letter dated March 1, 1893.

A survey of the river to show the location of the new revetment constructed and the interstate bridge now in process of erection was made May 16, 1893.

Sioux City Reach.—No work was done on this reach. Assistant Jones made an inspection on the 26th instant of the nine dikes constructed there under your direction in the spring of 1889, and reports all of them intact and in good condition. The accretion formed by them extends from the main shore to their stream ends, is quite uniform, and of an average height of about 1½ feet below standard high water. It is covered almost entirely with a dense growth of willows about a year old.

A revetment is in process of construction by the Chicago, St. Paul, Minneapolis and Omaha Railroad Company on the right bank. On the 26th instant 2,300 lineal feet of it had been finished. The upper end of it is at a point 3,750 feet above the Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge. It was stated by the foreman at the work that a dike, extending 50 feet into the stream, will be constructed at the head of the revetment.

I am, colonel, very respectfully, your obedient servant,

S. WATERS FOX,
Division Engineer.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

APPENDIX C.

ANNUAL REPORT OF MR. S. WATERS FOX, DIVISION ENGINEER, ST. JOSEPH DIVISION, 1893.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER,
Hermann, Mo., June 30, 1893.

COLONEL: I have the honor to submit the following report of the operations under my charge on the St. Joseph division of the Missouri River, during the fiscal year ending June 30, 1893:

Nebraska City Reach.—No work was done on the Nebraska City Reach. The revetment constructed in 1889 and 1890 is intact and in good condition.

Rulo Reach.—A project with estimates, for the continuation of the work undertaken by the commission on the Rulo Reach was prepared in accordance with the instructions contained in your letter dated July 25, and submitted under date of July 29. No funds were allotted, however, and no work was done. A number of small breaks show in the upper bank work of the revetment constructed during the spring of 1890.

St. Joseph Reach.—Operations on the St. Joseph Reach consisted in revetment repairs in Bon Ton and Belmont Bends; pile dike construction in Belmont Bend; the care and repair of plant, and other work incident to the removal of all plant down the river.

The completion of the six short spur dikes, authorized at the foot of Belmont Bend, and that were begun in June, 1892, was effected July 8; twenty-five piles were driven and braced, and 2,551 square feet of foot mattresses were woven and ballasted. This work practically exhausted the funds; the force was disbanded, and the fleet left in charge of two watchmen. These dikes are shown on the accompanying map of the river at Belmont Bend—the first six below the point A.

A project, with estimates, for the continuation of the work undertaken by the Commission on the St. Joseph Reach was prepared, in accordance with your instructions of July 25, and submitted under date of July 29.

In brief, it provided for extension of the upper system of dikes in the Kansas Chute, at a cost of $11,802; for revetment repairs in Bon Ton and Belmont bends, a cost of $6,660 and $32,431, respectively; and for revetment repairs in Elwood Bend, at a cost of $31,178. In the item of $32,431 for repairs in Belmont Bend, provision was made for the construction of a system of fourteen spur dikes, aggregating 3,610 linear feet, the object for which these dikes were projected being to fair out the shore line, or to mask the pocket formed at the lower end of the bend to an alignment tangential to the general trend of the Elwood revetment.

I was notified August 18, 1892, that an allotment of $30,000 had been made by the Commission, and was instructed to prepare a project for its expenditure. The revised project was submitted August 23 and approved September 8, 1892. It provided for the repairs to the revetments in Bon Ton and Belmont bends, as specified in my project dated July 29, 1892, and for the expenditure of the balance of the money in the protection of the bank exposed to the river in the gap between the Belmont and Elwood revetments by a continuation of the system of short spur dikes then in place, the dikes to be of such lengths that a line through their outer ends should be fair with the trends of the revetted shore line above and below.

Measures were taken immediately after receipt of notice of approval of project for its execution. A quarry was opened September 10 in the Missouri Bluffs, about a mile above the head of Bon Ton Bend, and operated until November 16. The total product from the quarry was 11,346.36 cubic yards of rock ballast, at an average cost of 67¼ cents per cubic yard, loaded on barges. Brush cutting was begun September 16 and carried on, at several different localities, until November 12. The total product was 1,474 cords of willow brush, at an average cost of $1.41 per cord, bound and loaded on barges.

Bon Ton Bend.—Revetment repairs in Bon Ton Bend began September 16 and were finished November 16; a delay of eighteen days was occasioned by the nonarrival of strand used in mattress construction.

One thousand two hundred and twenty linear feet of bank were graded with a jet, involving the removal of 8,288 cubic yards of earth. One thousand one hundred and seventy-nine and one-half linear feet, or 47,894 square feet, of mattress were woven in two pieces. Eight breaks, aggregating 655 linear feet of bank, were repaired by regrading and fairing out the slope with brush and then ballasting well with rock. The cost of this work is shown in item in the following table:

Bill of cost of repairs to revetment in Bon Ton Bend, 1892.

Classification and extent:	
416 cords of brush on works at points of expenditure	$627.27
5,920 pounds wire strand, ⅜-inch, at $0.0405 per pound	239.76
4,296 cubic yards of rock on works at points of expenditure	3,026.24
Labor, viz, anchorage	17.50
Labor and subsistence, viz:	
Weaving	451.18
Ballasting	1,201.28
Labor, fuel, and subsistence, viz, hydraulic grading	227.94
Total cost, exclusive of administration, care and repair of plant	5,791.17

Belmont Bend.—Revetment repairs in Belmont Bend began October 1 and were finished November 21; 1,441 linear feet of bank, containing 3,629 cubic yards of earth were graded with a jet; 88 linear feet, or 5,456 square feet of mattress were woven in one piece. Fifteen small breaks aggregating 739 linear feet of bank were repaired in the same manner as similar ones in Bon Ton Bend. In the latter part of March, 1893, a break in the upper bank work, 150 feet long, at a point a short distance above the system of dikes, was repaired in the same way. And again in April, at a point just below this break, one of the same character and about the same extent was repaired. The cost of these repairs in item is shown in the following table:

Bill of cost of repairs to revetment in Belmont Bend, 1892.

Classification and extent:	
169 cords of brush on works at points of expenditure	$302.38
11,137 pounds of wire strand, ⅜-inch, at $0.0405 per pound	451.05
6,297.86 cubic yards of rock on works at points of expenditure	4,791.21
Labor, viz, weaving	25.00
Labor and subsistence, viz, ballasting	1,815.47
Labor, fuel, and subsistence, viz, hydraulic grading	396.38
Total cost, exclusive of administration, care and repair of plant	7,781.49

The construction of the seven new dikes and reënforcement of the six dikes referred to above (see accompanying map, between A and B) was begun October 6; owing to a failure in delivery of wales and braces, work on them was suspended November 27.

Operations were resumed December 29, and the dikes were completed, with the exception of placing the curtains, by January 31. April 3 to April 10, after the ice in the river had moved out, the curtains were put on.

Three hundred and ninety-five piles in all were driven to an average penetration of 19.44 feet; the maximum and minimum penetrations were 29 feet and 10 feet, respectively.

Thirty-nine of the piles were driven to reënforce the old dikes, making three-row dikes of them. All of the new dikes were three-row work with oak and heart long-leaf pine wales and braces. Sixty-seven thousand nine hundred and ninety square feet of foot mattresses were woven, and 229½ cubic yards of rock expended in sinking them.

The following table shows in item the cost of the entire system of thirteen dikes:

Bill of cost of construction, reënforcement, and extension of dikes in Belmont Bend, 1892 and 1893.

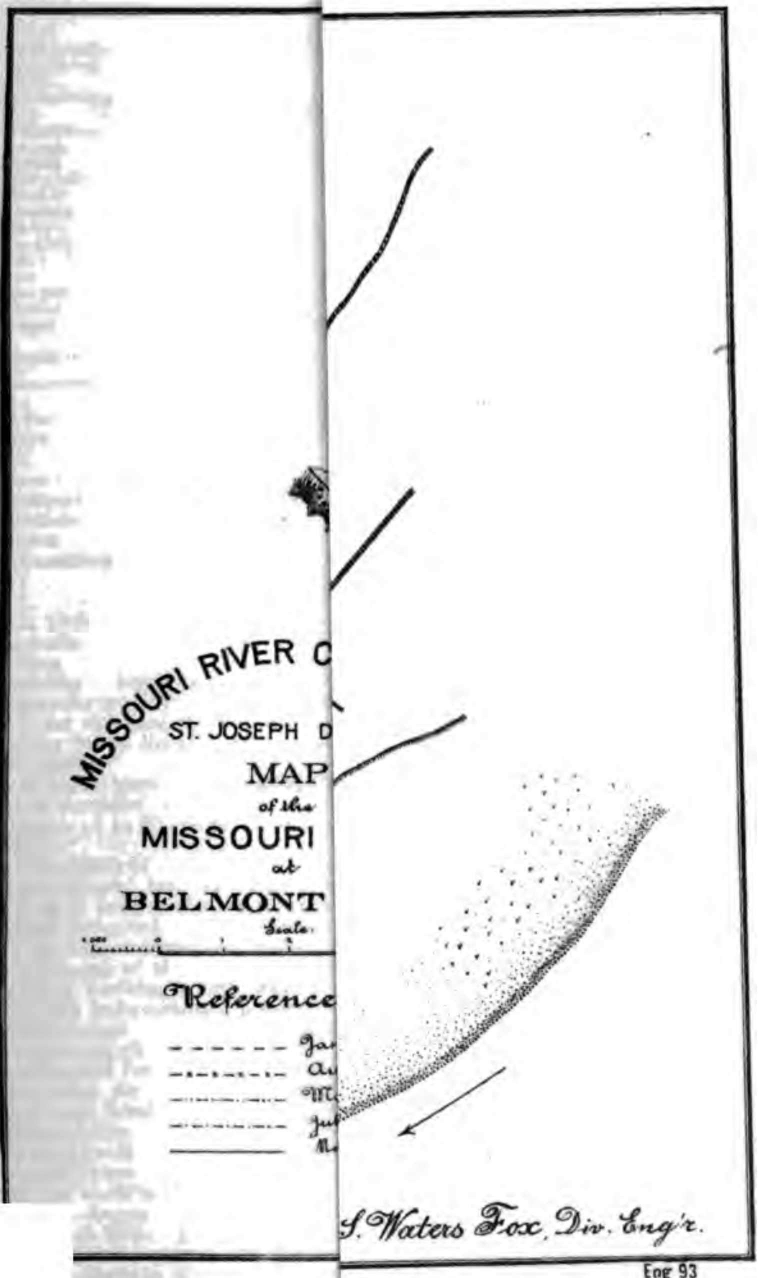
Classification and extent:	
889 cords of willow brush on the works at points of expenditure	$1,141.54
21 wagon loads of poles on the works at points of expenditure	33.25
633 cubic yards of rock on the works at points of expenditure	589.61
119½ cubic yards of rock on the works, at $1.2025 per cubic yard	143.70
16,687 pounds of wire strand, ⅜-inch, at $0.0405 per pound	675.82
313 oak piles, loading and transporting from East Atchinson, Mo	596.44
128 cottonwood piles, at $3.0187 per pile	386.40
32,711 feet, B. M., yellow pine lumber, at $18.1883 per M	594.96
5,378 pounds of drift bolt iron, ⅝-inch, at $0.02215 per pound	119.13
Labor, viz:	
Ballasting	211.86
Making curtains	36.00
Labor and subsistence, viz:	
Weaving foot mat	867.98
Waling and bracing	828.80
Labor, fuel, and subsistence, viz:	
Sinking and driving piling	1,212.06
Hydraulic grading	47.20
Total cost, exclusive of administration, care and repair of plant	7,484.75

Care of and repairs to plant, launching and pulling out hulls.—In accordance with the instructions contained in your letter dated July 23, 1892, measures were at once taken for putting in working order and launching the fleet under my charge at St. Joseph.

An estimate of the cost of the repairs, amounting to $5,800, was submitted June 30.

The repairs and launching of the fleet needed on the St. Joseph Reach were finished October 6, 1892. Twenty-five hulls were repaired and thirteen were launched. The repairs included, besides the usual work of recalking and the removal of badly decayed timbers, new canvas on the roofs of quarter boats Nos. 1 and 5, and pile sinkers Nos. 7 and 13; patching and painting roofs of graders Nos. 6 and 7; the painting of cabins, and putting new chimneys on pile sinkers as well as the painting of all the hulls. October 27, a raft of four 100-foot barges which left Omaha October 15 was received at St. Joseph. The expense of the trip was $373.06. The pulling out of the fleet and placing the hulls on storage ways for the winter began November 8 and were finished November 27. Thirty hulls were taken out.

Active repairs of plant for the current season were begun March 9, 1893, and launching of hulls March 13. By April 14 the entire fleet of thirty-seven pieces had been repaired and launched (these repairs consisted simply of calking and deck repairs); the yard ways and supports were removed and loaded on barges for transportation down the river. Nine hundred and seventy-two piles were pulled, at an average cost of 7 cents per pile. The steamer *Thetis* was dismantled, the machinery and all serviceable parts taken off; the hull was launched and sunk in a deep eddy just below the boat yard.



MISSOURI RIVER C
ST. JOSEPH D
MAP
of the
MISSOURI
at
BELMONT
Scale
Reference
S. Waters Fox, Div. Eng'r.

Eng 93

Cost exhibit of care of, repairs to, and launching of hulls at St. Joseph, Mo., from July 1, 1892, to June 30, 1893.

Class.	Designation.	Amount.	Total.
Labor, viz:			
Care of plant	Watching boats and other property	$1,713.40	$1,713.40
Carpentering		1,507.92	
Calking		1,281.00	
Blacksmithing		58.45	
Labor	Repairs proper	573.37	
Machinist		137.17	
Teaming		84.30	
Painting		396.12	4,038.33
Pulling out boats			858.53
Launching boats			911.48
Wrecking "Thetis"			51.67
Repairs to "Sabrina"			25.83
Removing boat ways			663.26
Material:			
Plant material	Lumber, oakum, iron, etc	882.98	
Plant purchased	Tools, rope, etc	1,388.97	
Supplies	Oil, paint, tallow, nails	788.06	3,060.01
Subsistence	Labor, stores, and supplies		2,092.00
Grand total			13,414.51

Tow boat service.—The towing and handling of floating plant were done by the U.S. steamers *Alert* and *Sabrina*. The former reported at St. Joseph for duty September 7, 1892, and continued in service on the reach until November 1, when she left for Jefferson City with instructions to report there for further orders to Division Engineer Samuel H. Yonge. The steamer *Sabrina* arrived at St. Joseph from Jefferson City October 31, 1892, and continued in service until she was put on the ways, November 27, 1892. She was put in commission again March 21, 1893, and after doing some handling incident to the Belmont revetment repairs was engaged in moving plant from St. Joseph to Kansas City. She cleared with her first tow for that point April 1, 1893. The *Alert* was also used in this latter service, arriving at St. Joseph April 2, 1893, and clearing the following day with a tow for Kansas City. The last of the hulls on the St. Joseph Division were taken in tow for Kansas City by the *Alert* May 25, 1893.

A transfer of headquarters to Hermann, Mo., for the works under my charge having been effected November 19, 1892, the force at St. Joseph was reduced to a minimum needed for the care of plant and regular clerical duties. The office was removed November 30 to Room A, German American Bank building, and was finally closed May 31, 1893.

In the latter part of April, 1893, the dikes in Belmont Bend were swept away and the bank between the Belmont and Elwood revetments exposed. The accompanying map shows (A to B) the extent of the bank erosion up to the date of the survey, May 19, 1893.

An inspection of the map and of the cross sections taken before and after the dikes went out shows: 1st, that there was a heavy scour of the bed of the river all along from A to B, such as always occurs at the foot of a hook-shaped bend during a rise; the scour extended nearly, if not quite, to the limit of penetration given the dike piles; 2d, that the mattress, from the point A down to the dikes, settled to such an extent because of the scour as to expose the bank there to erosion, and thus was initiated a flanking action, which, once begun under the existing conditions, must of necessity have resulted in the destruction of the dikes.

In accordance with your instructions I prepared and submitted, under date of May 27, a report on the condition of the works on the St. Joseph Reach, and a project with estimates for their maintenance and repair.

It provided for the reinforcement with rock ballast of the upper bank work on the Belmont Bend revetment from its present terminus, 4,500 feet upstream and for the construction of 3,550 linear feet of new revetment (see map A to B), connecting the Belmont and Elwood works. The conditions of flow there now are such that it is thought there will be no difficulty in the shore line as proposed. The estimated cost of the work is $30,000.

Surveys.—August 22 to 27, 1892, twenty-two partial sections were sounded at the lower end of Belmont Bend to secure data for pile-dike estimates and to learn the position of the mattress constructed in 1891. May 16 to 19, 1893, a hydrographic survey was made in the same vicinity to determine the probable causes of failure of the dikes and to furnish information for a project for the protection of the bank exposed.

The cost of the first survey was $20.90; the latter, $41.55.

Atchison Reach.—No work was done on the Atchison Reach.

As was anticipated, considerable damage has been done by the Doniphan Cut-off. A. J. Spahr, in command of the steamer *Alert*, passed over the reach with a tow June 6, and makes the following report as to its condition: The main flow coming through the new channel in the cut-off impinged directly against the right or Kansas bank at the head of the Atchison Island chute and is causing a rapid erosion there. Considerable water was flowing through the chute, and the indications were that the flow would increase and possibly soon become the main channel of the river.

From the head of Atchison Island a crossing was made to the main left bank at Mud Lake. The revetment, from that point 3,300 feet downstream, constructed by railroad companies in the winter of 1887 and 1888, has been practically destroyed. A deep bight has formed in the shore line just above the system of dikes constructed by the Commission in 1889. The main channel passed between the upper railroad dike and the shore. This gives a direction to the flow which delivers the main current against the right bank at the roundhouse, a sufficient distance above the Atchison Bridge to make the passage through the draw span easy and safe.

Further loss of improvement works on the reach seems inevitable, unless the main flow of the river should quickly find its way through the Atchison chute, a contingency which I regard as very doubtful.

I am, colonel, very respectfully, your obedient servant,

S. WATERS FOX,
Division Engineer.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

APPENDIX D.

ANNUAL REPORT OF MR. S. WATERS FOX, DIVISION ENGINEER, KANSAS CITY DIVISION, FROM JANUARY, 1893.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER,
Hermann, Mo., June 30, 1893.

COLONEL: I have the honor to submit herewith a report of the operations under my charge on the Kansas City division of the Missouri River during the fiscal year ending June 30, 1893.

In accordance with your instructions that I should relieve Mr. Samuel H. Yonge of the charge of Kansas City division, I met him by appointment at the office in Kansas City January 6, 1893, and the transfer of the office, records, and other property pertaining to that division was effected several days thereafter.

As a result of a reconnaissance of the reach made at that time Mr. Yonge prepared and submitted, under date of January 12, a revised project for the expenditure of the funds available ($20,000). Under date of February 9, 1893, I received from you a copy of the revised project with the information that it had been approved.

In brief, it provided for the expenditure of as much of the allotment then available on the works situated below the Hannibal and St. Joseph Railway Bridge as would be necessary to place them in serviceable condition, and to apply the balance of the allotment to reinforcing the Little Platte dikes and to repair the Kaw Bend revetment. The work specified below the bridge was the extension of Dike I about 100 feet; the reconstruction of Dikes VII and VIII out to the old line of rectification; the repair of the breaks, aggregating then some 700 or 800 feet, in East Bottoms revetment; the reinforcing of all the Kansas City and Harlem dikes by placing pile buttresses under their stream ends; the repair of the breach in the single-row part of Dike III, and the repair of the slight break at the head of the Harlem revetment.

Measures were at once taken with a view of carrying out this project to completion as early in the spring as possible.

With the exception of a lot of 82 white oak piles stored at Harlem, there was no material or plant on the Kansas City division.

The material, excepting brush, needed for the proposed repairs to the dikes in Little Platte Bend, and for all of the projected repairs below the Hannibal and St. Joseph Bridge, was purchased in open market for delivery on or before March 20.

The launching of the floating plant at the Omaha and St. Joseph boat yards, which was to be used in the work, was begun as soon as the ice in the river at those points had moved out.

The U. S. S. *Alert* and *Sabrina* were put into service moving the plant down to Kansas City. The former left Jefferson City for St. Joseph March 26. She delivered the first tow of hulls at Kansas City April 4. The *Sabrina* was put in commission March 21, and delivered her first tow of three hulls at Kansas City April 2.

The *Sabrina* delivered her last tow at Kansas City May 16, and was then ordered to Gasconade, with a tow of three barges, for service on that division.

The *Alert* delivered her last tow at Kansas City June 8, and then began the delivery of the plant from Kansas City to Gasconade. The steamer *Gasconade* delivered two tows at Kansas City from Omaha; the first one June 11, the second June 23; she was then put in service delivering plant from there to Gasconade.

Up to June 30, 1893, 57 hulls had been delivered at Kansas City, as follows, viz:

By steamer *Alert* 18 hulls, aggregating 1,550 tons, from Omaha, and 9 hulls, aggregating 712.5 tons, from St. Joseph. The cost of this service was $6,494.04, or $0.01013 per ton-mile.

By steamer *Sabrina*, 26 hulls, aggregating 1,855 tons, were delivered from St. Joseph, at a cost of $1,297.17, or $0.00738 per ton-mile.

By steamer *Gasconade*, 4 hulls, aggregating 540 tons, from Omaha, at a cost of $1,268.18, or $0.00625 per ton-mile.

Before sufficient plant and materials for carrying on work had been accumulated, the April rise came on, and damaged the works below the bridge to such an extent that a revision of project became necessary. The shore line of the main left bank of the river above the Harlem revetment was subjected to erosion that resulted in the loss of about 120 feet of that work, and threatened further loss. The breaks in the East Bottoms revetment were enlarged until they aggregated 1,600 feet in length.

A revised project was submitted, under date of April 28, which provided for the repair of the East Bottoms revetment and the extension of the Harlem revetment upstream about 1,000 feet, or as far as there was depth of water sufficient for construction purposes, and its extension downstream about 300 feet, to protect the shore end of Dike X; the balance of funds, if any remained, to be expended in reinforcing the Kansas City and Harlem dikes.

This project was approved.

East Bottoms repairs.—The weaving of mattress in East Bottoms was begun April 25 and finished May 11. The total length of mattress woven was 1,491 feet, of an average width of 74.4 feet (see accompanying map, C–D and E–F).

Three breaks, aggregating 250 linear feet in length, were repaired by regrading the bank, fairing out the slope with brush, and ballasting well with rock. Hydraulic grading of the upper bank was begun April 24 and finished May 16; the total length of bank graded was 1,200 feet, the total quantity of earth thus removed 6,315 cubic yards. The driving of anchorage piles was begun May 2 and finished May 16; 150 piles were driven to an average penetration of 17 feet. The ballasting of mattress and upper bank was finished May 31; 2,731.86 cubic yards of rock were thus expended.

Harlem revetment extension.—The weaving of mattress on the Harlem side was begun May 5 at a point 875 feet above the head, at that time, of the old Harlem revetment. Nine hundred linear feet of mattress, of average width of 68.9 feet, were woven by May 17, the lower end lapping the old work 25 feet (see accompanying map, A–B). Hydraulic grading for this work was begun May 5 and finished May 13. Eight hundred and seventy-four linear feet of bank, involving the removal of 4,922 cubic yards of earth, were graded. The driving of anchorage piles was begun May 17 and finished May 27. Seventy-four piles were driven to an average penetration of 17 feet. Owing to shoal water, 11 piles could not be driven. The ballasting of mattress and upper bank was finished May 31; 1,603.69 cubic yards of rock were thus expended.

The following is a statement of the cost of these works, viz:

Bill of cost, repairing 250 linear feet of revetment, East Bottoms, 1893.

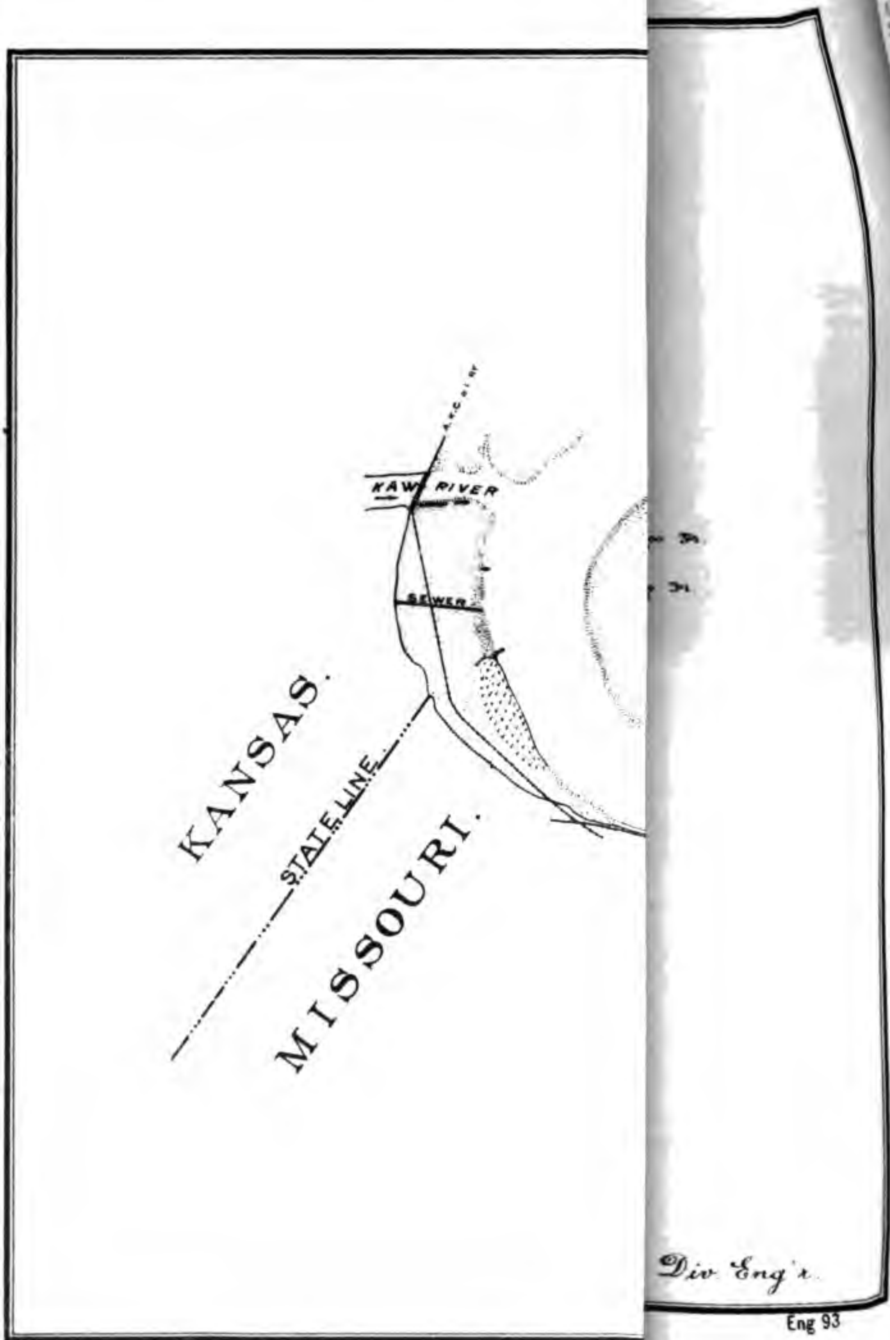
Classification and extent:	
To labor, subsistence, and fuel, hydraulic grading, 374 cubic yards	$13.36
To labor and subsistence, procuring and placing brush	55.23
To labor and subsistence, placing 250 cubic yards of rock	55.77
To material, 250 cubic yards of rock	317.92
Total	442.28

Cost exhibit in detail of 2,391 linear feet of revetment at Harlem and East Bottom.

Classification and extent.		Cost per unit.	Cost of each item.	Cost per linear foot.	To
Procuring 1,162 cords of willow brush, viz:					
Stumpage		$0.1000	$116.20		
Cutting		.4202	488.27		
Binding:					
Labor	$228.81				
Material	40.71				
		.2319	269.52		
Loading and unloading wagons		.2016	234.28		
Hauling		.3666	425.93		
Loading brush barges		.2320	269.62		
Towage:					
Steamer Gasconade	185.28				
Fuel	10.30				
		.1685	195.58		
		1.7208	1,999.40	$0.8362	$
Procuring 4,338.55 cubic yards of rock, viz:					
Purchase of 2,661.55 cubic yards, at 83 cents	2,209.09				
Labor, loading barges	610.14				
Subsistence	117.38				
		1.1033	2,936.61		
Purchase of 1,677 cubic yards on barges		.8400	1,408.68	....	....
Towage, 4,338.55 cubic yards:					
Steamer Gasconade	691.80				
Fuel	38.62				
		.1684	730.42	....	....
4,088.55 cubic yards used on revetment		2.1117	5,075.71	1.9898	
Weaving 2,391 linear feet of mattress, viz:					
Labor		.4893	1,169.90		
Subsistence		.0982	234.74		
		.5875	1,404.64	.5875	
Anchoring 2,391 linear feet of mattress, viz:					
Labor		0.0823	196.72		
Subsistence		.0188	44.97		
Strand $\frac{3}{8}$-inch, 44,537 linear feet		.0118	525.54		
Cable, $1\frac{1}{4}$-inch, second hand, 19,280 pounds		.0100	192.80		
		.1229	960.03	.4015	
Hydraulic grading, 10,863 cubic yards, viz:					
Labor		.0266	289.21		
Subsistence		.0045	48.26		
Fuel		.0060	65.56		
		.0371	403.03	.1685	
Driving anchor piling (224), viz:					
Labor		1.3857	310.40		
Subsistence		.2927	65.57		
Fuel		.1735	38.88		
Material, 224 piles, at $2.10	$470.40				
Labor, loading on barges	22.90				
Towage:		2.2022	493.30		
Steamer Gasconade	77.17				
Fuel	4.26				
		.3635	81.43		
		4.4176	989.58	.4139	
Placing 4,088.55 cubic yards of rock, viz:					
Labor		.1752	716.36		
Subsistence		.0479	196.08		
		.2231	912.44	.3816	
Total				4.7790	1

Miscellaneous data and elements of cost exhibit at Harlem and East Bottoms.

Classification and extent:		
Linear feet of mattress made		
Square feet of mattress made		1
Total cost		$11.
Cost per linear foot of mattress		$
Cost per square (100 square feet)		$
Meals issued to work (number)		
Subsistence, cost per capita per diem:		
Labor	$0.0897	
Stores	0.2759	


KAW RIVER
SEWER
KANSAS.
STATE LINE
MISSOURI.
Div. Eng'r.

)f 2,391 linear feet of revetment at Harlem and East Bottoms, 1893.

nd extent:	
of willow brush at works, at $1.7208	$1,999.40
)ic yards of rock at works	4.757.79
rood piles, at 2.5657	574.73
ir feet of ⅜-inch galvanized wire strand, at .0118	525.54
ıds, 1¼-inch, second-hand, cable, at .01	192.80
subsistence:	
ıg	1,404.64
age	241.69
ing	912.44
ɪistence, and fuel:	
ılic grading	403.03
ʒ anchor piling	414.85
t, exclusive of administration, care and repair of plant	11,426.91

ed on these works was obtained by hired labor. The rock was pur market, 2,661.55 cubic yards at 83 cents per cubic yard on the bank, yards at 84 cents per cubic yard in wagons on barges. The towboat formed by the steamer *Gasconade* of Hermann, Mo., which was char- urpose at a rate of $35 per day for the steamer and crew. She was in each from April 15 to May 31.

th estimates of cost, for repair and maintenance of the works on the ;le Platte Bend to Randolph Bridge was prepared in accordance with ns, and submitted under date of May 29.

ɪic survey of the reach from the mouth of the Kansas River to the ge was made in the latter part of May, to show changes of flow and the work done, as well as for the use of the Commission in the estab- arbor line on the reach (a tracing from the map made of this survey e report). Subsequently, in June, some work was done in the field with the municipal engineers of the two cities, to tie or reference established by the Commission to known fixed points in those cities. reach to a scale of 1 inch = 250 feet, showing the harbor line and ɔints in the streets of Kansas City, Mo., and Kansas City, Kans., was ubmitted with my letter dated June 19, 1893.

;ity office was closed June 30, 1893. At that time there were 28 hulls ;ottoms awaiting transportation to Gasconade.

ɔnel, very respectfully, your obedient servant,

S. WATERS FOX,
Division Engineer.

HAS. R. SUTER,
)f Engineers, U. S. A.,
President Missouri River Commission.

APPENDIX E.

ʀT OF MR. SAMUEL H. YONGE, DIVISION ENGINEER, KANSAS CITY [VISION, TO JANUARY, 1893, AND OSAGE DIVISION, 1893.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER,
Jefferson City, Mo., July 1, 1893.

ɪave the honor to submit my report of the operations conducted under he work of improving the Missouri River on Kansas City Division, sion of First Reach during the fiscal year ending June 30, 1893, as

MAINTENANCE OF WORKS IN THE VICINITY OF KANSAS CITY, MO.

ınt belonging to the work of improving the Missouri River in the sas City, Mo., was transferred to the First Reach in the fall of 1891, provement were constructed during the part of the fiscal year that ınder my charge.

ɪ were made of obstructions at several of the bridges in the vicinity , Mo., viz: at the Union Pacific Railway Bridge and the Riverview

Bridge across the Kansas River, in August and December, 1892, respectively, and at the Hannibal and St. Joseph Railroad Bridge across the Missouri River, in December, 1892.

The examinations at the two former bridges were made to determine if the owners of the bridges had complied with the orders of the honorable the Secretary of War, by removing the obstructions they had placed in the river under the bridges, and at the latter bridge on account of the complaint of Hale Chapman, master of the steamboat *Krata*, employed in towing sand at Kansas City, that the railroad company had placed false works across the channel of the river for the purpose of erecting a new draw span.

The river was closed by ice and all navigation suspended a short time after the latter examination was made.

A low-water survey was made in November, 1892, of the reach between Lower Kaw Bend and Randolph Bridge.

The expenditures on account of the above examinations and survey, including rent of office and traveling expenses, amounts to $688.65.

The improvement works in the vicinity of Kansas City, Mo., were transferred to Division Engineer S. Waters Fox, January 6, 1893.

SYSTEMATIC IMPROVEMENT IN THE FIRST REACH.

Projects.—During the fiscal year ending June 30, 1892, ten of the dikes proposed in the original project of April 16, 1891, viz, Nos. 1, 2, 3, 9, 10, 11, 13, 13A, 13B, and 14 were nearly completed. Five other dikes, viz, 16 and 17, belonging to the same project, and O, P, Q of the project of February 9, 1892, were begun, as described in my last annual report. No great progress, however, was made on the five dikes last named, on account of the high stage of water that prevailed after March 30.

There still remained to be constructed at the close of the last fiscal year, to complete approved projects, the whole of Dikes 18, 19, 20, 21, and 22, and the greater parts of 16, 17, P, and Q on the left bank, and all of Dikes 17a, 18a, and 19a on the the right bank.

Under date of July 11, 1892, a plan was submitted for constructing three dikes at the foot of Cedar Island, viz, Y, Y^I, and Y^{II}, for the purpose of preventing a flow at high stages of water along the Callaway County shore through the breaches made in the incomplete parts of Dikes 1, 2, and 3 during the flood of May, 1892; also for reënforcing the latter dikes. I was notified by you on July 13 of the Commission's approval of this plan.

Under date of August 19, 1892, a project was submitted for protecting Murrays Bend by a revetment 15,000 feet long. The objects of the revetment were to prevent the dikes at Cedar City from being flanked by the erosion of the bend, and to maintain a stable regimen in the bend and in the reach below it. I was notified by you August 20 of the approval of this project by the Commission, and also of the part of the project of February 9, 1892, covering the construction of Dikes A, B, C, D, and E, at Cedar City, and was directed by you to proceed with the construction of these works as opportunity offered.

The construction of two earth dams, one across the head of the old bed of Cedar Creek, the other across the head of Cedar Island Slough, was also authorized about the same time. The former dam was made necessary by the river having cut into Cedar Creek, which formerly emptied into the Missouri River at Cedar City, thereby rendering a cut-off possible through the old creek bed between the upper part of Murrays Bend and the shore end of the Cedar City dikes; the latter to cut off the flow of river water around Cedar Island and behind Dikes P and Q.

Under date of March 21, 1893, a revised project for extending the works of improvement to △ Isbell, below Hords Crossing, was submitted. It was proposed in this project to modify that of February 17, 1892, below Dike 17, by training the river on two long tangents connected at their intersection by a short swing, the upper tangent to extend to Côte Sans Dessein Bluff, the lower one from Côte Sans Dessein to the bluff contact immediately above Isbell; also to shut out the flow of the Missouri River into Osage Chute by a brush and stone dam extending 2 or 3 feet above S. L. W. The changes made necessary in the plans of the dikes by the above modification of project consisted of extending Dikes 17a, 18a, and 19a 1,000 feet in the aggregate, and of making Dikes 19, 20, 21, and 22, which had not been carried as far as the proposed new lines of rectification, 2,500 feet shorter in the aggregate than originally designed.

The new works proposed in the project of March 21, 1893, consisted of 21 dikes, with a total length of 39,830 feet, a mattress dam about 2,900 feet long between the head of Dodds Island and Osage Point, and 4,800 linear feet of revetment. Of the latter work, 3,000 feet was proposed for protecting that length of bank on the north side of the river opposite and below Bonnots Mill, and 1,800 feet along the front of the material yard at Bonnots Mill.

Under date of March 22, 1893, a preliminary project and estimate of cost of completing the systematic improvement of the river to the bluff contact at Portland, Mo., was submitted.

As the construction of the revetment at Bonnots Mill was an immediate necessity, to prevent the material yard from being washed away, your approval for proceeding with that work was given in your letter of April 14. I was also directed by you, about the same time, to extend Dikes 17A, 18A, and 19A in accordance with the project of March 21, 1893.

Under date of June 3, I was authorized by you to construct the following works, viz, Dikes 27, 28, 29, 34, 35, 36, 33a, 34a, 35a, 36a; also the outer parts of Dikes 24, 25, and 26.

DIKE CONSTRUCTION.

Dike 1.—The river had fallen sufficiently by July 20 to allow field operations to be resumed, and the work of reconstructing the part of Dike 1 which had been breached during the high water of the preceding May was begun. This work consisted of constructing about 1,340 feet of 3-row dike about 30 feet above the line of the old dike and parallel to it. The new part of the dike is connected with the serviceable part of the old work and laps it about 20 feet. This dike was entirely completed August 22, at which time the river had fallen to such an extent that the plant was removed with great difficulty.

During the progress of the work large quantities of straw, which had been thrown into the river by farmers threshing wheat, accumulated under and in front of the foot mat. This caused a scour to set in under the mat, and increased the surface exposed to the current, so as to make it necessary on several occasions to suspend mat weaving and sink the mat to prevent its being torn loose from the mooring piles.

Gravel beds were frequently encountered in pile sinking, which made that work difficult.

On the completion of Dike 1, one working party was moved to Dikes P and Q, and the other to the sites of Y′ and Y″.

Before very much had been accomplished on these dikes work had to be suspended and the plant moved away, as the dikes had become inaccessible to the steamboats on account of shoal water on the crossings.

Dike P.—Pile-sinking at Dike P was begun August 6, and the construction of the dike proceeded with till August 20, when the plant had to be removed.

The length of the dike constructed is 338 feet; it is situated 30 feet above the old work, which it laps 100 feet.

The pile-sinking was difficult on account of quicksand and pockets of gravel.

Dike Q.—When work was resumed at Dike Q on August 4 the water in front of the old work for a distance of 200 feet was found to be too shallow to float the pile-sinker. It was therefore necessary to leave a gap of that length across which the foot mat was constructed. The dike was extended 500 feet and a wing constructed at its extremity. On August 24 work had to be suspended and the plant removed from the dike for reasons given above.

Work was resumed in the 200-foot gap April 14. Before the gap could be closed, however, the pile-sinker had to be removed on account of a rapid fall of the river. Pile-sinking for extending the dike was then begun, but before much progress was made a violent storm occurred, in which the pile-sinker, whose hull was old and unseaworthy, was swamped and sunk.

As the other serviceable pile-sinkers were engaged on other dikes, work was suspended and the party sent to Bonnots Mill to construct a revetment in front of the material yard.

Work was resumed at Q June 3. By June 9, the gap was closed and the dike extended about 265 feet. At this time work was interrupted for two days by high water, after which the dike was extended about 370 feet. As the stage of water was not low enough to carry the dike any further without placing it at too high an elevation, a wing was constructed and work suspended June 17. Pile-driving on the outer 200 feet of this dike was very hard, and a number of the oak piles were split in driving.

Dike Y′.—The length of Dike Y′ completed is 262 feet. The piles at the shore end of the dike for a distance of 82 feet could not be sunk, as the water was too shallow to float a pile-sinker. Work was begun August 9 and discontinued August 20, for the same reasons as at Dikes P and Q.

In the early part of December the screening was attached to the dike and the foot mat extended to the top of the main bank and ballasted.

Dike Y″.—Work at this dike was begun August 4 and discontinued August 22, after 414 feet of the dike was constructed.

As the height of the piles above the foot mat near the shore end for a distance of about 200 feet was over 20 feet, a set of longitudinal and transverse braces were attached to the piles just above the water line. This work was done and the screening attached to the piles in December.

When it became impossible to proceed further with the above dikes, the construction of Dikes 17, 18, 19, 20, 21, 22, also 17a, 18a, and 19a, was taken up and proceeded with as opportunity offered or circumstances permitted till field operations were suspended on account of winter.

The construction of these dikes could not be proceeded with continuously, as it was frequently interrupted by having to move the plant from one dike to another on account of deep water and swift currents, or to suspend work on a dike temporarily to avoid closing the steamboat channel, or to delay pile-sinking until the Cram hammer was available from some other dike for driving piles into gravel beds. Considerable time was lost and expense incurred on account of the steamboats or the barges loaded with construction material getting aground and having to transfer the material to other barges, or by having to get the barges to the dikes by hand.

Dike 17.—The work of extending Dike 17, of which 120 feet had been constructed during the last fiscal year, was begun August 18. The first two bents of piles were driven with the Cram hammer, on account of the foot mat, constructed last year, extending beyond the pile structure.

The piles for the rest of the dike, excepting the outer 150 feet, which were driven with the Cram hammer, were sunk with the water jet.

The penetrations obtained with the sinker for the first 500 feet were satisfactory; beyond that point the sinking was slow and difficult on account of having to penetrate pockets of gravel. As some of the piles were not given sufficient penetrations by the pile-sinker, the Cram hammer was used for driving them down.

There were three intermissions in the construction of this dike, viz: From August 24 to 30, on account of having to use the pile-sinker at Dike 18; from September 1 to September 7, on account of the dike having been carried to the steamboat channel, which could not be crossed without closing navigation, and from September 20 to September 23, on account of having to wait till the Cram hammer was available from other work. Pile-driving was completed September 26, and the dike entirely completed October 6. The progress of the work was slow, on account of the difficulty of getting barges with material to the dike. Most of the barges had to be warped by hand through crooked channels, and often got aground, making it necessary to transfer the material to other barges.

Dike 18.—Dike 18 was begun August 20. Work was suspended August 24, as the pile-sinker was required at Dike 19A. Work was resumed August 27 and continued till August 31, when it was again suspended, as any further extension of the dike would have carried it across the steamboat channel. Work was resumed September 8, and the dike carried to within about 50 feet of the line of rectification, where it had to be stopped, on account of reaching shallow water. About 200 feet at the shore end of the dike was constructed with four rows of piles; this part of the dike was also strengthened by a system of braces near the water line.

In carrying on the pile-sinking at Dike 18, pockets of gravel were occasionally encountered; good penetrations, however, were generally obtained. The progress of the work on this dike was slow, on account of the same difficulties being experienced in getting plant and material to the dike as at 17.

Dike 19.—Pile-sinking was begun at Dike 19 September 2, and continued till September 6, but as penetrations of only 15 feet could be given with the pile-sinker, on account of gravel and clay, the piles put in by the sinker were driven down by the Cram hammer, and further work was suspended till October 15, when pile-driving was resumed with the Cram hammer.

Pile-driving was finished October 21, and the dike finally completed for a length of 183 feet November 29. The outer 146 feet of this part of the dike has four rows of piles, and has an extra set of braces similar to Dike 18. The dike could not be extended in the fall any further on account of its running into shallow water.

Work was resumed May 29, 1893. By June 3 the piles were driven and the foot mat woven and sunk for 190 feet. Work had then to be suspended on account of a sudden rise in the river, which allowed only sufficient time to attach temporary bracing to the piles.

Pile-driving was resumed June 16 and completed June 21. The dike was completed, excepting a part of the screening, June 24. This latter work could not be completed on account of a sudden rise in the river.

Dike 20.—The construction of Dike 20 was begun August 16, but had to be suspended August 23, as sufficient penetrations could not be obtained with the pile-sinker. Work was resumed October 22 with the Cram hammer, and 290 feet of the dike completed November 1. It was not extended any further, as navigation would thereby have been obstructed. The outer 260 feet of this work is constructed with four rows of piles.

Dike 21.—The piles on Dike 21 were driven with the Cram hammer, it being found impossible to get proper penetrations with the water jet on account of gravel, clay, and wreck heaps.

The dike was begun September 16; work suspended September 21, and resumed September 27. About 500 feet of dike, except the screening, was completed by October 21. The outer 350 feet of the dike consists of four rows of piles. The shore end, for a distance of 72 feet, consists of crib work, as piles could not be driven on account of a flat foreshore. The dike was not constructed full length, as it would have crossed the steamboat channel and closed navigation. The screening was attached before operations were suspended in the winter. When the river opened in February, the outer end of the dike was exposed to the full force of the ice, and 135 feet of the pile structure, adjacent to the wing, was broken down. The breach was repaired between March 15 and April 4, the work being interrupted by heavy-running ice and stormy weather.

Dike 22.—This dike was begun August 22, and by September 10 was completed for a length of 1,062 feet. The pile-sinking was hard and slow on account of gravel.

Dike 17a.—All of the piles in Dike 17a were driven with the Cram hammer, excepting for 162 feet next to shore, where bed rock was exposed or slightly covered with sand and gravel. This part of the dike consists of pile bents, which were braced and then lowered from the leads of a pile-sinker to the rock bottom.

The bents were subsequently anchored by filling in with loose stone to a stage of about 3 feet above S. L. W. Pile-driving was begun September 7 and was completed September 15. The other work on the dike was carried on intermittently, when the plant could be spared from other dikes. The dike was finally completed to the point proposed in the amended project of February 17, 1892, December 15.

During the breaking up of the ice in February, 1893, 13 piles were broken off at the stream end of the dike. This damage was repaired early in March. The deep water and rapid current at the stream end of the dike prevented its being extended in the spring, as proposed in the project of March 21, 1893.

Dike 18a.—The bottom at Dike 18a is similar to that at Dike 17a. Pile-driving was begun with the Cram hammer August 25, and was carried on till August 31, when an attempt was made to put in piles with a sinker. As penetrations of only 17 to 18 feet, however, could be obtained by this means, the Cram hammer was moved to the dike September 3 and the driving completed September 6. Seventy-five feet of the shore end consist of framed bents, which were constructed and filled around with stone in the same manner as at Dike 17a. The dike was completed December 6 as far as proposed in the project of February 17, 1892.

The work of extending this dike in accordance with the project of March 21, 1893, was begun May 22. Deep water and the swift current at the end of the dike made it necessary to place the extension 90 feet above the old work, with a lap of 72 feet.

By May 26 the piles were driven for about 100 feet of the extension, and a 2-row dike, connecting it with the old work, constructed. Further work was then prevented by the river rising over the piles.

Dike 19a.—Pile-driving with the Cram hammer was begun at 19a August 18, and continued till August 25, when the hammer was removed to one of the other dikes, where the driving was more difficult. Pile-sinking was then begun and carried on for two days, the dike being carried to the steamboat channel.

By September 28 the channel had widened, so that the dike could be extended about 200 feet farther. Pile-sinking was accordingly resumed, and continued till October 5. When the snag boat reached this dike on her way down the river, October 16, the channel left outside of the dike was barely wide enough to allow her to pass. The dike was finally completed, for a length of 581 feet November 19.

Work was resumed May 11 and continued till May 27, when it had to be suspended on account of the river rising over the dike. During this period 609 feet of dike was constructed. The new work laps the old about 56 feet, and was placed 86 feet above it, as the depth of water at the end of the work constructed in the fall was too great to allow a direct connection being made.

The old and new work were connected by a 2-row dike. At the time operations were suspended there was no opportunity, on account of the suddenness of the rise, for constructing a wing. By June 15 the river had fallen several feet, and this was done.

In the meanwhile, however, the outer 75 feet of piling was bent over by an accumulation of driftwood.

No further work was done at the dike up to June 30 on account of a channel 30 feet deep having been scoured out at its extremity, and also as it was not considered advisable to extend the dike without at the same time extending 17a and 18a, which was not feasible, on account of the depth of the water, being 43 feet at the former and 30 feet at the latter.

Dike 13.—The outer 135 feet of Dike 13 could not be constructed during the fiscal year of 1892 on account of shallow water. The bar was washed away during the high water of 1892, and in the early part of September the water was low enough to allow the dike to be extended. Work was begun September 8, the dike carried to the line of rectification, and a wing constructed under the stream end. The dike was completed October 11.

Dike 13a.—The repairs made to Dike 13a consisted in reconstructing about 200 feet at the stream end. A wing 50 feet long was also constructed. Work was begun September 8, and the dike completed September 21, excepting the screening, which was attached in October.

Dike 13b.—As it was impossible to get a pile-sinker to the shore behind Dike 13b, to extend the pile structure back to where the bank had been eroded during the flood of May, 1892, the gap was closed by stretching two three-fourths inch cables 10 feet apart in the same vertical plane between the dike and a deadman placed on the top of the main bank opposite and above the former end of the dike (see Plate IX).

The usual screening was attached to the cables. A mattress 45 feet wide was laid in front of the screening and one 12 feet wide behind it, the edges of the mattress adjacent to the lower cable being wired to it. One end of the mattress was extended up the shore, to prevent flanking from bank erosion, and the other over the foot mat of the dike. The above repairs were made between November 10 and 16.

About 100 feet at the stream end of this dike was constructed to close a breach of 66 feet made during the flood of May, 1892. The new work laps the old 17 feet at each end. It was begun September 9 and completed September 16.

On completing the above repairs one of the construction parties was moved to Cedar City, and the construction of the Cedar City group begun.

The greater parts of Dikes B and C extend across a shore bar, which is not entirely submerged excepting at a stage of nearly standard high water. For this reason only about one-sixth of B and two-thirds of C could be entirely completed during the fall. The entire foot mat of both dikes, however, extending to the main bank, was constructed and ballasted before work was suspended on account of winter.

Dike B.—Pile-sinking on Dike B was begun at the outer edge of the sand bar September 17, and completed to the stream end of the dike, a distance of 331 feet, September 30. This part of the dike was entirely completed October 7. It was subsequently decided to construct the remainder of the foot mat across the bar to the main bank, a distance of 1,470 feet. The mat was begun November 21 and completed December 10. As barges loaded with material could not be brought closer to the bar than 175 feet, the brush had to be carried by hand for that distance, loaded on wagons and hauled out on the line of the dike. The stone was landed 1¼ miles above the dike, from which point it was hauled on wagons to the foot mat.

The foot mat was thoroughly ballasted and its upper edge anchored by cast-iron disks buried 5 feet below the surface of the ground.

Pile-sinking was resumed March 22, but was constantly interrupted and delayed by having to move the Cram hammer or the pile-sinkers from the dike to prevent their getting aground. After June 10, the river was not high enough to carry on pile-sinking, and there still remains 368 feet of the dike for which the pile-driving, bracing, and screening have to be constructed.

Dike C.—Pile-sinking was begun September 16 and completed for 1,204 feet of dike October 18. About ten days were lost on account of the dealers furnishing piling not keeping up the supply of that material. The dike was completed for the above distance, excepting the screening, October 22.

The foot mat was subsequently extended to the main bank. The brush and stone for the mat were gotten to the dike in the same manner as at B. Pile sinking and driving were resumed in the latter part of March. This work was frequently interrupted and delayed by having to move the plant from the dike on account of fluctuations in the stage of water. The dike was completed, with the exception of 75 feet at the shore end, June 15. After this date no work could be done on account of the water at the dike being too shallow to float a sinker. The pile-sinking on this dike was hard and slow, as pockets of gravel were frequently encountered.

Dike D.—The construction of Dike D was commenced March 30, and was proceeded with almost continuously till the dike was completed May 21.

The part of the dike lying across the deepest part of the old channel into Cedar City Chute is constructed with four and five rows of piles. This became necessary, as during the progress of the work this part of the dike, which had been constructed with three rows of piles, began to careen.

Most of the piles on this dike were sunk with pile-sinkers.

The methods employed in constructing dike work during this year's operations were essentially the same as those followed last year. The only departure of any importance in the details of construction described in my last annual report was made for the higher parts of some of the dikes across channels which were in process of being closed. In these cases the foot mat was made slightly wider, four or five rows of piles used instead of three, and extra bracing attached to the piles about midway between the ground and the top of dike.

During the opening of the river in February the ice piled up over the tops of some of the dikes, without doing them any injury. The damage sustained at the outer ends of Dikes 17a and 21 was caused by immense cakes of heavy floating ice, having in two instances areas of over 20 acres, shearing off or breaking down the piles. With this exception and that of 75 feet of dike bent over at the end of Dike 19a, described above, no loss of dike work was sustained.

A résumé of pile-driving and pile-sinking for the whole year is given in the following table. This table does not include mooring piles, of which 461 were sunk and driven:

Number or letter of dike.	Number of piles, average penetration, and method of sinking.			
	Water jet.		Cram hammer.	
	Number.	Average penetration.	Number.	Average penetration.
1	469	20.8	....	....
13	60	22.0	....	....
13a	92	20.4	....	....
13b	49	19.5	....	....
17a	....	....	*117	17.6
18a	8	18.0	†197	20.9
19a	142	19.8	‡259	22.2
17	300	20.2	§71	22.3
18	339	20.3	24	23.1
19	48	21.5	205	23.0
20	18	19.7	121	22.1
21	....	....	250	21.5
22	386	18.4	....	....
P	138	20.0	....	....
Q	261	19.2	181	23.3
B	416	21.3	76	24.7
C	503	19.7	84	22.8
D	591	21.5	75	23.1
Y'	103	21.9	....	....
Y"	151	21.2	....	....
Total	4,077	20.3	1,660	22.2

* Twenty-four piles driven to bed rock.
† Thirty piles driven to bed rock.
‡ Eight piles sunk to refusal by sinker, afterwards driven down by Cram hammer.
§ Five piles sunk to refusal by sinker, afterwards driven down by Cram hammer.

It will be noticed that the Cram hammer was used to greater or less extent for driving piles on most of the dikes. In some cases its use was indispensable.

The hulls of all the old pile-sinkers used in carrying on operations in the spring were almost unfit for service, and the new hulls now nearing completion will have to be used on future work.

In conducting operations in the fall it was sometimes impossible to get enough laborers to make the working parties fully efficient.

Notwithstanding the uncommon difficulties that were encountered, the time lost in moving plant, and the going into effect of the eight-hour law, 17,122 feet of dike and 4,700 feet of revetment were completed and 630 feet of dike partly constructed.

The following table shows the extent of dike work completed:

Group.	Number or letter of dike.	Lengths in feet. 2-row.	3-row.	4-row.	5-row.	Totals. In dike.	In gro
Cedar City	B	*49	1,443	....	....	1,492	
	C	*50	1,667	....	....	1,717	
	D	*58	1,727	147	58	1,990	
Total	....	157	4,837	147	58	....	5
Cedar Island	P	*49	338	....	....	387	
	Q	†252	1,231	....	....	1,483	
Total	....	301	1,569	....	....	....	1
Cedar Slough	Y′	*44	262	....	....	306	
	Y″	*43	414	....	....	457	
Total	....	87	676	....	....	....	
Group I	1	....	1,337	....	....	1,337	
Total	....	....	1,337	....	....	....	
Harlans Island	13	*51	135	....	....	186	
	13A	*50	218	....	....	268	
	13B	....	126	....	....	126	
Total	....	101	479	....	....	....	
Barkersville	17	*60	1,034	....	....	1,094	
	18	....	760	198	....	958	
	19	‡133	559	146	....	838	
	20	‡116	30	260	....	406	
	21	*56	154	346	....	556	
	22	*49	1,062	....	....	1,111	
Total	....	414	3,599	950	....	....	
Osage	17A	§119	356	....	....	475	
	18A	‖114	515	....	....	629	
	19A	¶116	1,190	....	....	1,306	
Total	....	349	2,061	....	....	....	
Total	....	....	....	....	....	....	1

* Wing.
† Two wings = 101 feet, and 151 feet main dike.
‡ Two wings.
§ 59 feet wing.
‖ 61 feet wing.
¶ 86 feet connection between old and new work, and 30 feet wing.

The details of the cost and extent of each class of dike work constructed du the year are contained in the following statements:

Detailed statement of driving dike piles.

Letter or number of dike.	Extent of work—number of piles.	Quantities of material. Native-oak piles.	White-oak piles.	Coal.	Cost. Material.	Labor and subsistence.	Tot
		Lin. feet.	*Lin. feet.*	*Bushels.*			
B	76	3,126	....	225	$369.60	$192.46	$5
C	84	3,218	....	280	385.87	154.05	5
D	75	1,390	1,780	122	458.08	140.22	5
Q	181	7,076	....	170	798.75	201.97	1,0
17a	119	1,960	2,526	239	656.02	296.06	9
18a	200	5,296	2,410	187.25	998.89	313.38	1,3
19a	251	9,508	....	417.67	1,094.39	463.81	1,5
17	66	230	1,988	99	361.72	73.40	4
18	24	976	....	50	113.14	52.23	1
19	205	6,204	1,642	380.5	994.83	234.65	1,2
20	121	5,234	....	275.25	607.50	183.96	
21	250	10,686	....	606	1,245.23	580.06	1,8
Totals	1,652	54,904	10,346	3,051.67	8,084.02	2,886.25	10,

Average cost per pile = $6.64+.

Detailed statement of sinking dike piles.

Letter or number of dike.	Extent of work—number of piles.	Quantities of material.						Cost.		
		Native-oak piles.	White-oak piles.	Cotton-wood piles.	Coal.	8 by ⅜-inch spikes.	7 by ⅜-inch spikes.	Material.	Labor and subsistence.	Total.
		Lin. ft.	*Lin. ft.*	*Lin. ft.*	*Bush.*	*Pounds.*	*Pounds.*			
B	416	11, 228	1, 510	....	765	317	113	$1, 580. 78	$741. 22	$2, 322. 00
C	503	15, 950	1, 539	....	867	44	313	2, 115. 86	1, 003. 66	3, 119. 52
D	594	20, 932	966	....	790	419	....	2, 563. 42	837. 63	3, 401. 05
P	138	5, 060	....	....	160	....	82	577. 69	268. 90	846. 59
Q	261	8, 676	....	....	269	7	134	989. 93	439. 55	1, 429. 48
Y′	103	3, 628	....	....	127	....	30	414. 79	150. 80	565. 59
Y″	151	5, 650	....	....	200	....	55	646. 44	187. 53	833. 97
1	469	16, 267	....	90	510	....	475	1, 872. 48	601. 60	2, 474. 08
13	60	450	1, 482	....	50	....	45	298. 91	45. 76	344. 67
13a	92	780	2, 513	....	85	....	79	508. 81	145. 56	654. 37
13b	49	....	1, 916	....	50	....	36	320. 08	64. 47	384. 55
16a	8	306	....	....	25	5	2	36. 69	47. 87	84. 56
16a	150	5, 387	....	....	226	50	56	621. 64	256. 63	878. 27
17	305	10, 007	256	....	203	25	110	1, 181. 93	344. 48	1, 526. 41
18	339	11, 905	....	....	222	25	125	1, 340. 70	407. 56	1, 748. 26
19	48	1, 794	....	....	35	10	10	202. 13	70. 35	272. 48
20	18	701	....	....	96	....	11	88. 26	122. 33	210. 59
22	386	13, 001	....	....	355	....	296	1, 480. 34	474. 50	1, 954. 84
Total	4, 090	131, 822	10, 182	90	5, 035	902	1, 972	16, 840. 88	6, 210. 40	23, 051. 28

Average cost per pile = $5.06+.

Detailed statement of driving mooring piles.

Letter or number of dike.	Extent of work—number of piles.	Quantities of material.			Cost.		
		Native-oak piles.	White-oak piles.	Coal.	Material.	Labor and subsistence	Total.
		Linear ft.	*Linear ft.*	*Bushels.*			
D	2	....	80	3	$13. 42	$10. 40	$23. 82
17a	1	42	....	10	5. 74	5. 33	11. 07
19a	1	36	....	2. 5	4. 26	4. 60	8. 86
19	9	330	....	28	38. 92	54. 08	93. 00
20	5	198	....	25	24. 61	17. 75	42. 36
21	5	190	....	10	22. 06	17. 25	39. 31
Total	23	796	80	73. 5	109. 01	109. 41	218. 42

Average cost per pile = $9.50—.

Detailed statement of sinking mooring piles.

Letter or number of dike.	Extent of work—number of piles.	Quantities.					Cost.		
		Native-oak piles.	Cotton-wood piles.	Coal.	7 by ⅜ inch spikes.	8 by ⅜ inch spikes.	Material.	Labor and subsistence.	Total.
		Lin. ft.	*Lin. ft.*	*Bush.*	*Lbs.*	*Lbs.*			
[illegible]	12	362	....	18	6	....	$42. 06	$49. 57	$91. 63
[illegible]	28	854	....	35	17	....	98. 48	73. 31	171. 79
[illegible]	59	2, 042	....	150	....	41	242. 80	127. 37	370. 17
[illegible]	7	236	....	5	5	....	26. 71	19. 29	46. 00
[illegible]	46	1, 490	40	62	12	3	176. 00	157. 73	333. 73
[illegible]	12	....	374	40	5	....	46. 49	30. 38	76. 87
[illegible]	12	34	402	25	5	....	51. 70	70. 88	122. 58
[illegible]	42	....	1, 346	85	15	....	160. 65	136. 71	297. 36
[illegible]	5	152	....	14	5	....	18. 45	8. 86	27. 31
[illegible]	8	367	....	5	5	....	41. 14	30. 98	72. 12
[illegible]	4	146	....	2	2	....	16. 36	40. 08	56. 44
[illegible]	8	84	212	45	1	....	32. 54	91. 95	124. 49
[illegible]	32	642	486	85	....	15	135. 05	114. 67	249. 72
[illegible]	47	958	643	120	7	10	191. 42	190. 50	381. 92
[illegible]	35	576	582	48	3	2	134. 15	73. 71	207. 86
[illegible]	32	802	288	52	5	1	126. 61	100. 74	227. 35
[illegible]	18	506	118	15	2	5	70. 83	62. 01	132. 84
[illegible]	10	408	....	35	6	....	49. 03	56. 01	105. 04
21	11	360	36	10	4	....	44. 93	37. 95	82. 88
22	22	668	....	27. 75	7	....	76. 90	108. 15	185. 05
Total	450	10, 637	4, 527	878. 75	112	77	1, 782. 30	1, 580. 85	3, 363. 15

Average cost per mile = $7. 47+.

Detailed statement of weaving foot mat.

Letter or number of dike.	Extent of work.	Quantities of material.				Cost.	
		Brush.	⅜-inch wire cable.	No. 10 wire.	¾-inch wire cable.	Material.	Labor and subsistence.
	Square feet.	*Cords.*	*Feet.*	*Pounds.*	*Pounds*		
B	100,450	644	10,700	235	....	$1,438.84	$1,152.04
C	113,984	670.5	9,250	103	....	1,473.59	1,160.48
D	140,993	1,055.8	16,850	280	....	2,348.29	1,743.35
P	23,304	167	2,300	....	....	366.18	297.49
Q	87,305	580.33	8,400	....	....	1,276.85	846.85
Y′	24,711	152	2,600	....	....	338.68	281.33
Y″	26,174	188	3,200	....	....	418.73	231.68
1	78,646	689.1	22,750	....	....	1,651.99	905.16
13	14,537	85	700	....	....	181.38	168.64
13A	20,599	125	800	....	....	264.30	292.00
13B	20,755	124.5	1,600	60	350	287.63	309.01
17A	22,892	138	2,900	....	....	313.22	321.80
18A	35,018	248.67	5,850	35	....	572.14	289.76
19A	84,185	567.84	14,600	35	....	1,318.29	864.60
17	63,270	420.25	7,450	62	....	941.09	722.28
18	58,928	368	6,015	63	....	818.94	754.95
19	57,977	360	5,500	....	....	795.14	770.66
20	34,028	206	3,325	....	....	456.89	425.71
21	44,070	287	3,800	....	....	627.69	494.18
22	60,025	358	5,050	....	....	786.27	684.14
Total	1,111,851	7,434.99	133,640	873	350	16,676.13	12,716.11

Average cost per 100 square feet = $2.64.

Detailed statement of sinking foot mat.

Letter or number of dike.	Extent of work.	Quantities of material.	Cost.	
		Stone.	Material.	Labor and subsistence.
	Square feet.	*Cubic yards.*		
B	100,450	533.9	$517.74	$898.46
C	113,984	680.8	660.20	447.28
D	140,993	1,706.62	1,654.98	743.10
P	23,304	183	177.46	38.61
Q	87,305	521.8	506.01	257.54
Y′	24,711	200	193.95	115.45
Y″	26,174	295	286.07	68.06
1	78,646	906	878.58	293.90
13	14,537	68.35	66.28	30.57
13A	20,599	102	98.91	42.94
13B	15,695	214.73	208.23	168.53
17A	22,892	317	307.41	148.93
18A	35,018	325.46	315.61	204.39
19A	78,535	727	705.00	257.10
17	63,270	587.5	569.72	256.85
18	58,928	573	555.66	333.65
19	57,977	569.7	552.46	178.93
20	34,028	398	385.96	148.06
21	44,070	619	600.27	292.57
22	60,025	612	593.48	178.28
Total	1,101,141	10,140.86	9,833.98	5,103.20

Average cost per 100 square feet = $1.36.

Detailed statement of bracing dikes.

Letter or number of dike.	Extent of work.	Quantities of material.					Cost.		
		$\frac{3}{4}$-inch square iron.	8 by $\frac{3}{8}$-inch spikes.	7 by $\frac{3}{8}$-inch spikes.	Native oak piling.	Lumber.	Material.	Labor and subsistence.	Total.
	Lin. ft.	*Pounds.*	*Pounds.*	*Pounds.*	*Lin. ft.*	*Feet B. M.*			
B	1,492	3,330	446	....	....	42,888	$1,071.68	$486.07	$1,557.75
C	1,717	3,770	495	....	....	50,952	1,268.60	559.22	1,827.82
D	1,990	4,839	604	....	360	59,934	1,540.52	334.83	1,875.35
P	387	860	145	....	....	11,992	298.74	135.47	434.21
Q	1,483	2,825	440	....	....	37,744	942.23	898.86	1,841.09
Y′	306	370	140	....	....	8,604	210.32	203.59	413.91
Y″	457	1,010	235	....	210	13,948	372.46	131.65	504.11
I	1,337	2,386	410	....	....	38,720	955.35	438.02	1,393.37
13	186	364	35	....	....	4,840	120.32	48.99	169.31
13A	268	404	175	....	....	7,944	196.57	77.68	274.25
13B	126	130	100	....	....	4,116	100.50	38.97	139.47
17A	549	638	130	10	....	9,752	242.29	144.98	387.27
18A	819	850	117	....	....	17,074	429.55	227.12	656.67
19A	1,306	2,916	455	....	....	36,966	926.38	460.76	1,387.14
17	1,094	1,790	279	....	....	33,972	830.13	311.97	1,142.10
18	958	1,780	255	....	200	30,022	759.80	315.39	1,075.19
19	838	2,504	281	65	180	24,080	636.73	307.90	944.63
20	406	1,320	75	....	270	14,834	401.78	196.45	598.23
21	770	2,420	364	....	720	26,014	739.70	476.17	1,215.87
22	1,111	2,600	330	....	....	33,300	831.98	328.60	1,160.58
Total	17,600	37,100	5,511	75	1,940	508,296	12,875.63	5,622.69	18,498.32

Average cost per linear foot = $1.05 +.

Detailed statement of lashing dikes.

Letter or number of dike.	Extent of work.	Quantity of material.	Cost.		
		$\frac{3}{8}$-inch wire cable.	Material.	Labor and subsistence.	Total.
	Linear ft.	*Feet.*			
B	1,492	12,800	$136.09	$95.36	$231.45
C	1,717	8,600	91.44	62.37	153.81
D	1,990	15,950	169.58	151.17	320.75
P	387	1,500	15.95	23.66	39.61
Q	1,483	5,900	62.73	56.53	119.26
Y′	306	1,400	14.88	16.35	31.23
Y″	457	2,200	23.39	13.70	37.09
I	1,337	5,400	57.41	60.88	118.29
13	186	700	7.44	11.82	19.26
13A	268	1,200	12.76	4.18	16.94
13B	126	600	6.38	3.25	9.63
17A	549	2,075	22.06	33.64	55.70
18A	629	2,250	23.92	10.04	33.96
19A	1,306	7,075	76.28	38.92	115.20
17	1,094	5,850	62.20	36.16	98.36
18	958	4,235	45.03	50.85	95.88
19	838	4,760	50.60	66.25	116.85
20	406	2,790	29.66	24.21	53.87
21	770	4,525	48.11	75.16	123.27
22	1,111	6,250	66.45	27.70	94.15
Total	17,410	96,100	1,022.36	862.20	1,884.56

Average cost per linear foot = $0.11.

Detailed statement of screening dikes.

Letter or number of dike.	Extent of work.	Quantities of material.								Cos[t]	
		8 by 3/8-inch spikes	7 by 3/8-inch spikes	30d wire nails.	20d wire nails.	Lumber.	Brush.	5/8-inch wire cable.	3/4-inch wire cable.	Material.	Lab[or] and s[ub]sisten[ce]
	Lin. ft.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Ft. B. M.*	*Cords.*	*Feet.*	*Lbs.*		
B	1,492	......	20	162	124	567	55	......	......	$133.09	$114.
C	1,717	47	50	316	136	1,814	48.8	......	......	155.24	350.
D	2,000	36	......	209	150	1,133	76.5	......	......	192.31	252.
Q	1,589	50	......	100	50	2,403	39	......	......	140.36	217.
Y′	316	15	......	90	......	453	8	......	......	29.39	39.
Y″	467	35	......	155	......	1,043	16	......	......	61.48	151.
1	1,337	40	......	......	235	2,130	41	......	......	139.98	211.
2	150	......	......	150	......	......	13.5	......	......	31.20	67.
13	186	20	......	85	......	385	10	......	......	31.90	29.
13A	268	20	......	75	......	453	9	......	......	31.20	31.
13B	259	55	......	115	......	249	10	200	130	37.66	69.
17A	559	53	......	150	......	771	16	......	......	55.51	88.
18A	639	34	......	160	......	1,201	31	......	......	95.93	101.
19A	1,276	74	50	345	......	2,970	46	......	......	174.37	250.
17	1,097	59	......	370	......	1,473	48	......	......	142.63	211.
18	958	103	......	45	200	2,403	30	......	......	125.59	188.
19	183	38	......	65	......	907	11	......	......	46.03	82.
20	290	40	......	95	......	1,360	17	......	......	69.58	28.
21	748	72	......	233	......	997	40	......	......	112.31	225.
22	1,111	......	......	200	......	2,743	35	......	......	139.96	195.
Total.	16,742	791	120	3,120	895	25,455	600.8	200	130	1,945.72	2,908.

Average cost per linear foot = $0.29—.

Detailed statement of framing bents.

Letter or number of dike.	Extent of work.	Quantities of material.								Co[st]	
		Native oak piles.	Stone.	5/8-inch wire cable.	Lumber.	Coal.	5/8-inch square iron.	8 by 3/8-inch spikes.	7 by 3/8-inch spikes.	Material.	Lab[or] an[d] subs[is]ten[ce]
	Feet.	*Feet.*	*Cu. yds.*	*Feet.*	*Ft B. M.*	*Bu.*	*Lbs.*	*Lbs.*	*Lbs.*		
17A	162	690	512.27	1,500	5,540	160	600	200	25	$752.68	$148.
18A	130	720	651.27	800	3,918	85	200	80	......	825.71	137.
Total	292	1,410	1,163.54	2,300	9,458	245	800	280	25	1,578.39	285.

Average cost per linear foot = $6.38 +.

Résumé of cost of dike construction in Osage Division, first reach, for fiscal y[ear ending] June 30, 1893.

Dike B	$9,019.82
C	10,060.02
D	13,524.22
P	2,246.15
Q	7,469.57
Y′	2,085.89
Y″	2,714.85
1	8,364.39
2	99.00
13	1,068.53
13A	1,778.91
13B	1,670.42
17A	3,667.57
18A	4,878.95
19A	7,898.50
17	6,253.51
18	6,089,38
19	5,215.45
20	3,315.76
21	5,639.41
22	5,972.61
Total net cost	$1[illegible]

Administration	$3,587.22	
Office and incidental expenses	5,819.56	
Current care and repair of plant in service	10,646.29	
Steamboat service	5,695.94	
Towboat service	10,334.20	
Surveys	7,593.12	
		$43,676.33
Total cost of dike construction		152,710.24

The total extent of dike entirely completed, reduced to 3-row dike, amounts to 17,057 linear feet.

By deducting the cost of incomplete dike, amounting to $1,277.38, from the total cost of dike construction given above, the net cost and total cost per linear foot of 3-row dike are determined to be $6.32 and $8.95, respectively.

Results of dike work.—The stage of water during the spring and June rises has not been high enough to get the best results from the dikes. Accretions of greater or less extent have formed behind most of the new dikes, and those behind the old dikes have in some cases been built up to a higher elevation. These deposits consist principally of very fine silt.

The rectified channel that was formed last year between Dikes 1 and 14 has been maintained and extended down to Dike 18, and the indications are that during the approaching season of low water the main steamboat channel will lie between Dodds Island and Barkersville, and that the flow into Osage Chute will be reduced and possibly entirely shut off. The channel on June 1 in this locality is shown on Plate I.

The Cedar City group of dikes has reduced the flow into Cedar City Chute to some extent. Above a half stage, however, a large volume of water still enters the chute between the tow-head opposite Jefferson City and the end of Dike D, the upper end of the tow-head having cut away as the dike was extended.

In connection with these dikes the Cedar Creek Dam has shut off the flow of the river, when above a half stage, through the old creek bed, which was formerly instrumental in keeping open the chute.

Extensive accretions have formed behind Dikes P, Q, Y', and Y''. The parts of the two latter that were constructed have, to a great extent, served the purpose for which they were designed.

The embankment across the head of Cedar Island Slough has greatly assisted in the attainment of the same object by preventing the river from flowing through the slough.

The changes in cross section on the reach under improvement are illustrated by Plates II, III, IV, V, VI, VII, and VIII.

For reasons stated in my last annual report the sections sounded about half way between dikes are used for this purpose instead of those on the lines of the dikes. An exception to this rule, however, is made in the section shown with Dikes 20–19A. These sections were sounded on the line of the dikes, as the effect of the contraction works above, in causing the river to scour a new channel through the sand bar in front of Barkersville is not so marked below the dikes.

The section of June 16, 1893 (Plate VIII), shows the scour at the end of Dike 19A in the spring, resulting from extending it across the channel leading into Osage Chute, also the scour that occurred during the rise in the latter part of May, immediately after the dike was again extended.

The accretions behind Dikes 1, 2, and 3 have been leveled off and become more uniform, but have not built up to any extent, as the stage of water has not been at any time higher than 2½ feet below S. H. W.

The same may be said of Harlans Chute, the stage at which a flow through the chute begins being about the same as last year, viz, 115 feet on the Ewing gauge.

The accretions behind Dikes 9, 10, and 11 have built up slightly, and their contours have become more uniform.

The width of the rectified channel in front of these dikes is unchanged, as no appreciable erosion of the tow-head has occurred. Very extensive deposits have been made between Dikes 13 and 18, also between 17A and 19A. The dikes at and below Barkersville have had a good effect in changing the direction of flow, but their full effect will not be felt till they are completed and a high stage of water of some duration occurs.

The results of channel rectification accomplished by the dikes constructed this year are shown in detail in Table I. This table also contains the results during the year of dikes constructed last year.

Table II is compiled from Table I, and shows the percentage of change of area in the rectified channel.

Table III furnished interesting data on the filling in of the rectified channel as the river declines from a high to a low stage, also the dimensions of the rectified channel for different stages.

The length of the improved reach on which the observations for this data made is 2 miles, and extends from Dike 1 to Dike 14.

It will be noticed that all sections in this table for the early part of Nove show an increase of channel area from scour. This effect was produced by a 1.45 feet which occurred between October 25 and 28.

TABLE I.—*Areas of cross sections of the Missouri River in the vicinity of the constructed in Osage Division, First Reach, from soundings made during the year ending June 30, 1893; also areas of scour and fill resulting from the dike*

Section.	Date.	Gauge.	Areas below standard high water = 122 feet.			Fill or scour behind dikes.		Fill or s rectifie nel.
			Behind dikes.	In rectified channel.	Total.	Since last date.	Total.	Since last date.
		Feet.	Sq. feet.	Sq. feet.	Sq. feet.	Sq. feet.	Sq. feet.	Sq. feet.
Dike B[1]	July 13, 1892	117.95	23,075	24,037	47,112			
Do	Oct. 12, 1892	107.50	20,900	24,912	45,812	+ 2,175	+ 2,175	− 875
Do	Nov. 5, 1892	108.00	21,825	25,487	47,312	− 925	+ 1,250	− 575
Do	May 13, 1893	115.85	20,280	27,032	47,312	+ 1,545	+ 2,705	−1,545
Do	June 3, 1893	118.30	16,880	24,000	40,880	+ 3,400	+ 6,195	+3,032
Do	June 8, 1893	118.70	18,400	24,320	42,720	− 1,520	+ 4,675	− 320
Dike C[1]	July 13, 1892	117.95	30,057	18,532	48,589			
Do	Oct. 13, 1892	107.40	32,145	20,455	52,600	− 2,088	− 2,088	−1,923
Do	Nov. 5, 1892	108	32,145	19,641	51,786	0	− 2,088	+ 814
Do	May 13, 1893	115.85	21,840	23,500	45,340	+10,305	+ 8,217	−3,859
Do	May 22, 1893	112.10	22,400	24,520	46,920	− 560	+ 7,657	−1,020
Do	June 3, 1893	118.30	20,400	23,800	44,200	+ 2,000	+ 9,657	+ 720
Do	June 8, 1893	118.70	19,280	23,820	43,100	+ 1,120	+10,777	− 20
Dike D[1]	July 13, 1892	117.95	27,400	22,688	50,088			
Do	Oct. 13, 1892	107.40	29,000	21,430	50,430	− 1,600	− 1,600	+1,258
Do	Nov. 5, 1892	108	27,040	22,000	49,040	+ 1,960	+ 360	− 570
Do	May 6, 1893	116	27,280	23,080	50,360	− 240	+ 120	−1,080
Do	May 22, 1893	112.10	28,920	24,480	53,400	− 1,640	− 1,520	−1,400
Do	June 3, 1893	118.30	23,840	24,800	48,640	+ 5,080	+ 3,560	− 320
Do	June 8, 1893	118.70	24,000	25,360	49,360	− 160	+ 3,400	− 560
Dike 1[1]	June 15, 1892	117.45	21,409	30,968	52,377			
Do	July 9, 1892	118.80	23,575	26,525	50,100	− 2,166	− 2,166	+4,443
Do	July 18, 1892	118.30	30,513	29,587	60,100	− 6,938	− 9,104	−3,062
Do	Aug. 4, 1892	113.75	29,467	25,913	55,380	+ 1,046	− 8,058	+3,674
Do	Aug. 13, 1892	111.80	29,461	27,825	57,286	+ 6	− 8,052	−1,912
Do	Aug. 20, 1892	110.70	30,081	27,275	57,356	− 620	− 8,672	+ 550
Do	Oct. 8, 1892	107.70	30,081	25,200	55,281	0	− 8,672	+2,075
Do	Nov. 1, 1892	108.30	30,081	26,337	56,418	0	− 8,672	−1,137
Do	Dec. 7, 1892	107.70	30,081	25,087	55,168	0	− 8,672	+1,250
Do	May 3, 1893	118.10	18,160	31,200	49,360	+11,921	+ 3,249	−6,113
Do	May 19, 1893	113.45	18,000	29,520	47,520	+ 160	+ 3,409	+1,680
Do	May 29, 1893	116.80	19,880	27,460	47,340	− 1,880	+ 1,530	+2,060
Do	June 6, 1893	117.80	21,520	29,880	51,400	− 1,640	+ 111	−2,420
Do	June 19, 1893	113.25	20,960	30,320	51,280	+ 560	+ 449	− 440
Dike 2[1]	July 9, 1892	118.80	12,600	27,367	39,967			
Do	July 18, 1892	118.30	15,838	25,706	41,544	− 3,238	− 3,238	+1,661
Do	Aug. 4, 1892	113.75	11,660	24,604	36,264	+ 4,178	+ 940	+1,102
Do	Aug. 13, 1892	111.80	11,660	25,050	36,710	0	+ 940	− 446
Do	Aug. 20, 1892	110.70	11,660	24,800	36,460	0	+ 940	+ 250
Do	Oct. 11, 1892	107.55	11,660	23,117	34,777	0	+ 940	+1,683
Do	Nov. 1, 1892	108.30	11,660	23,550	35,210	0	+ 940	− 433
Do	Nov. 30, 1892	107.60	11,660	22,005	33,665	0	+ 940	+1,545
Do	May 3, 1893	118.10	15,725	29,695	45,420	− 4,065	− 3,125	−7,690
Do	May 20, 1893	112.80	15,750	27,090	42,840	− 25	− 3,150	+2,605
Do	June 5, 1893	117.10	15,980	28,620	44,600	− 230	− 3,380	−1,530
Dike 3[1]	June 15, 1893	117.45	18,149	28,677	46,896			
Do	July 9, 1893	118.80	15,250	26,700	41,950	+ 2,899	+ 2,899	+1,977
Do	July 18, 1893	118.30	14,850	24,233	39,083	+ 400	+ 3,299	+2,407
Do	Aug. 4, 1892	113.75	13,480	25,978	39,458	+ 1,370	+ 4,669	−1,745
Do	Aug. 13, 1892	111.80	13,480	24,447	37,927	0	+ 4,669	+1,531
Do	Aug. 20, 1892	110.70	13,480	23,433	36,912	0	+ 4,669	+1,014
Do	Oct. 11, 1892	107.55	13,480	23,488	36,968	0	+ 4,669	− 55
Do	Nov. 30, 1892	107.60	13,480	22,450	35,930	0	+ 4,669	+1,038
Do	May 4, 1893	117.55	13,360	30,560	43,920	+ 120	+ 4,789	−8,110
Do	May 20, 1893	112.80	13,360	26,880	40,240	0	+ 4,789	+3,680
Do	June 5, 1893	117.10	13,560	28,840	42,400	− 200	+ 4,589	−1,960
Dike 9[1]	June 16, 1892	117.35	4,424	28,598	33,022			
Do	July 8, 1892	118.95	4,840	28,000	32,840	− 416	− 416	+ 598
Do	July 19, 1892	117.75	4,275	28,654	32,929	+ 565	+ 149	− 654
Do	Aug. 5, 1892	113.35	3,975	28,033	32,008	+ 300	+ 449	+ 621
Do	Aug. 13, 1892	111.75	5,040	27,050	32,090	− 1,065	− 616	+ 983
Do	Aug. 20, 1892	110.70	5,260	26,000	31,260	− 220	− 836	+1,050
Do	Oct. 8, 1892	107.70	5,550	23,280	28,830	− 290	− 1,126	+2,720

Areas of cross sections of the Missouri River in the vicinity of the dikes constructed in Osage Division, First Reach, etc.—Continued.

Date.	Gauge.	Areas below standard high water=122 feet.			Fill or scour behind dikes.		Fill or scour in rectified channel.	
		Behind dikes.	In rectified channel.	Total.	Since last date.	Total.	Since last date.	Total.
	Feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*
Nov. 5, 1892	108	4,825	23,300	28,125	+ 725	— 401	— 20	+5,298
Nov. 29, 1892	107.70	4,700	22,025	26,725	+ 125	— 276	+1,275	+6,573
May 4, 1893	117.55	2,830	28,272	31,102	+ 1,870	+ 1,594	—6,247	+ 326
May 20, 1893	112.80	3,400	27,360	30,760	— 570	+ 1,024	+ 912	+1,238
June 5, 1893	117.10	3,280	25,440	28,720	+ 120	+ 1,144	+1,920	+3,158
June 16, 1892	117.35	5,609	27,650	33,259	....	....	....	....
July 8, 1892	118.95	5,867	33,551	39,418	— 258	— 258	—5,901	—5,901
July 19, 1892	117.75	5,250	33,458	38,708	+ 617	+ 359	+ 93	—5,808
Aug. 5, 1892	113.55	4,425	31,958	36,383	+ 825	+ 1,184	+1,500	—4,308
Aug. 13, 1892	111.75	5,075	31,025	36,100	— 650	+ 534	+ 933	—3,375
Aug. 20, 1892	110.70	5,000	31,105	36,105	+ 75	+ 609	— 80	—3,455
Oct. 8, 1892	107.70	4,660	29,400	34,060	+ 340	+ 949	+1,705	—1,750
Nov. 5, 1892	107.95	4,580	27,920	32,500	+ 80	+ 1,029	+1,480	— 270
Nov. 29, 1892	107.65	4,590	28,033	32,623	— 10	+ 1,019	— 113	— 383
May 4, 1893	117.55	3,225	27,120	30,345	+ 1,365	+ 2,384	+ 913	+ 530
May 20, 1893	112.80	4,080	27,800	31,880	— 855	+ 1,529	— 680	— 150
June 5, 1893	117.10	4,160	24,000	28,160	— 80	+ 1,449	+3,800	+3,650
June 8, 1892	119.45	12,245	27,255	39,500	....	....	....	....
July 8, 1892	118.95	11,700	31,350	43,050	+ 545	+ 545	—4,095	—4,095
July 19, 1892	117.75	10,625	31,343	41,968	+ 1,075	+ 1,620	+ 7	—4,088
Aug. 5, 1892	113.55	8,674	30,872	39,546	+ 1,951	+ 3,571	+ 471	—3,617
Aug. 13, 1892	111.75	7,618	28,920	36,538	+ 1,056	+ 4,627	+1,952	—1,665
Aug. 20, 1892	110.70	7,575	29,000	36,575	+ 43	+ 4,670	— 80	+1,745
Oct. 8, 1892	107.70	7,325	27,565	34,890	+ 250	+ 4,920	+1,435	— 310
Nov. 5, 1892	107.95	7,100	25,563	32,663	+ 225	+ 5,145	+2,002	+1,692
Nov. 29, 1892	107.65	7,250	25,588	32,838	— 150	+ 4,995	— 25	+1,667
May 20, 1893	112.80	6,985	31,880	38,865	+ 265	+ 5,260	—6,202	—4,625
June 5, 1893	117.10	6,200	26,800	33,000	+ 785	+ 6,045	+5,080	+ 455
June 9, 1892	118.50	8,906	29,724	38,630	....	....	....	....
July 19, 1892	117.75	10,188	29,253	39,441	— 1,282	— 1,282	+ 471	+ 471
Aug. 5, 1892	113.55	10,082	28,047	38,129	+ 106	— 1,176	+1,206	+1,077
Aug. 13, 1892	111.75	11,175	29,492	40,667	— 1,093	— 2,269	—1,445	+ 232
Aug. 20, 1892	110.70	10,630	30,020	40,650	+ 545	— 1,724	— 528	— 296
Oct. 7, 1892	107.70	11,150	27,127	38,277	— 520	— 2,244	+2,893	+2,597
Nov. 8, 1892	107.90	10,995	28,052	39,047	+ 155	— 2,089	— 925	+1,672
Nov. 29, 1892	107.70	11,100	27,293	38,393	— 105	— 2,194	+ 759	+2,431
Apr. 28, 1893	117.30	9,270	29,240	38,510	+ 1,830	— 364	—1,947	+ 484
May 20, 1893	112.80	9,900	29,520	39,420	— 630	— 994	— 280	+ 204
June 2, 1893	118.65	8,080	29,680	37,688	+ 1,820	+ 826	— 160	+ 44
June 9, 1892	118.50	15,168	27,650	42,818	....	....	....	....
July 20, 1892	117.35	12,260	28,174	40,434	+ 2,908	+ 2,908	— 524	— 524
Aug. 13, 1892	111.75	11,835	26,900	38,735	+ 425	+ 3,333	+1,274	+ 750
Aug. 20, 1892	110.70	12,335	26,000	38,335	— 500	+ 2,833	+ 900	+1,650
Oct. 7, 1892	107.70	11,785	24,700	36,485	+ 550	+ 3,383	+1,300	+2,950
Nov. 8, 1892	107.90	11,635	24,900	36,535	+ 150	+ 3,533	— 200	+2,750
Nov. 29, 1892	107.70	11,085	24,475	35,560	+ 550	+ 4,083	+ 425	+3,175
Apr. 28, 1893	117.30	9,680	27,240	36,920	+ 1,405	+ 5,488	—2,765	+ 410
May 18, 1893	114.05	10,080	28,720	38,800	— 400	+ 5,088	—1,480	—1,070
June 2, 1893	118.65	9,520	27,960	37,480	+ 560	+ 5,648	— 760	— 310
June 16, 1892	117.35	9,875	27,413	37,288	....	....	....	....
July 20, 1892	117.35	10,475	28,795	39,270	— 600	— 600	—1,382	—1,382
Aug. 13, 1892	111.75	10,537	27,953	38,490	— 62	— 662	+ 842	— 540
Aug. 20, 1892	110.70	10,425	27,115	37,540	+ 112	— 550	+ 838	+ 298
Oct. 7, 1892	107.70	10,685	26,123	36,808	— 260	— 810	+ 992	+1,290
Nov. 8, 1892	107.90	10,660	26,860	37,520	+ 25	— 785	— 737	+ 553
Dec. 2, 1892	107.25	10,300	24,678	34,978	+ 360	— 425	+2,182	+2,735
Apr. 28, 1893	117.30	9,065	26,072	35,137	+ 1,235	+ 810	—1,394	+1,341
May 18, 1893	114.05	9,760	26,455	36,215	— 695	+ 115	— 383	+ 958
June 2, 1893	118.65	9,080	28,560	37,640	+ 680	+ 795	—2,105	—1,147
June 14, 1892	117.35	14,378	28,045	42,423	....	....	....	....
July 20, 1892	117.35	13,135	30,757	43,892	+ 1,243	+ 1,243	—2,712	—2,712
Aug. 13, 1892	111.75	13,432	29,562	42,994	— 297	+ 946	+1,195	—1,517
Aug. 20, 1892	110.70	13,345	28,585	41,930	+ 87	+ 1,033	+ 977	— 540
Oct. 7, 1892	107.70	12,720	26,180	38,900	+ 625	+ 1,658	+2,405	+1,865
Nov. 8, 1892	107.90	13,545	25,750	39,295	— 825	+ 833	+ 430	+2,295
Dec. 2, 1892	107.25	12,500	26,570	39,070	+ 1,045	+ 1,878	— 820	+1,475
Apr. 20, 1893	116.70	12,740	27,920	40,660	— 240	+ 1,638	—1,350	+ 125
June 2, 1893	118.65	10,060	26,515	36,575	+ 2,680	+ 4,318	+1,405	+1,530
July 20, 1892	117.35	17,507	28,199	45,706	....	....	....	....
Oct. 8, 1892	107.70	15,995	26,492	42,487	+ 1,512	+ 1,512	+1,707	+1,707
Nov. 8, 1892	107.90	16,282	27,545	43,827	— 287	+ 1,225	—1,053	+ 650
Dec. 2, 1892	107.25	15,995	26,790	42,785	+ 287	+ 1,512	+ 755	+1,409
Apr. 29, 1893	116.70	14,680	27,160	41,840	+ 1,315	+ 2,827	— 370	+1,039
May 16, 1893	115.20	13,600	26,415	40,015	+ 1,080	+ 3,907	+ 745	+1,789
June 9, 1893	118.10	12,160	27,680	39,840	+ 1,440	+ 5,347	—1,265	+ 519

TABLE I.—*Areas of cross sections of the Missouri River in the vicini constructed in Osage Division, First Reach, etc.*—Continue

Section.	Date.	Gauge.	Areas below standard high water=122 feet.			Fill or scour behind dikes.	
			Behind dikes.	In rectified channel.	Total.	Since last date.	Total.
		Feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*
Dike 17[1]	July 20, 1892	117.35	18,135	28,385	46,520	....	....
Do	Oct. 8, 1892	107.70	17,585	28,965	46,550	+ 550	+ 550
Do	Nov. 8, 1892	107.90	20,162	30,646	50,808	— 2,577	— 2,027
Do	Dec. 2, 1892	107.25	17,247	28,803	46,050	+ 2,915	888
Do	Apr. 24, 1893	116.15	12,217	32,317	44,534	+ 5,030	+ 5,918
Do	May 16, 1893	115.20	9,320	33,200	42,520	+ 2,897	+ 8,815
Do	June 9, 1893	118.10	8,960	33,760	42,720	+ 360	+ 9,175
Dike 18[1]-17A[1]	July 20, 1892	117.35	25,680	21,280	46,960	....	....
Do	Oct. 8, 1892	107.70	25,400	18,960	44,360	+ 280	+ 280
Do	Nov. 8, 1892	107.90	26,480	22,640	49,100	— 1,080	— 800
Do	Dec. 5, 1892	106.75	24,720	21,100	45,880	+ 1,760	+ 960
Do	Apr. 24, 1893	116.15	21,360	28,240	49,600	+ 3,360	+ 4,320
Do	May 16, 1893	115.20	19,240	27,000	46,240	+ 2,120	+ 6,440
Do	June 9, 1893	118.10	17,920	27,280	45,200	+ 1,320	+ 7,760

TABLE II.

Section.	Period of observation.		Increase in channel area.	Remarks
	From—	To—		
			Per cent.	
Dike B[1]	July 13, 1892	June 8, 1893	1.2	By deepening channel.
Dike C[1]	....do	....do	28.5	Do.
Dike D[1]	....do	....do	11.7	Do.
Dike 1[1]	June 15, 1892	June 19, 1893	22.1	The areas of some of th vicinity of dikes cons are not as large this y stage of water has not to cause as great a sco
Dike 2[1]	July 9, 1892	June 5, 1893	4.5	
Dike 3[1]	June 15, 1892	....do	0.5	
Dike 9[1]	June 16, 1892	....do	—11	
Dike 10[1]	....do	....do	—13.2	
Dike 11[1]	June 8, 1892	....do	— 1.6	
Dike 13[1]	June 9, 1892	June 2, 1893	— 0.1	
Dike 13A[1]	....do	....do	1.1	
Dike 13B[1]	June 16, 1892	....do	4.2	
Dike 14	June 14, 1892	....do	— 5.4	
Dike 16[1]	July 20, 1892	June 9, 1893	— 1.1	
Dike 17[1]	....do	....do	18.8	By deepening channel.
Dike 18[1]-17A[1]	....do	....do	28.2	Do.

TABLE III.—*Areas and dimensions of cross sections of rectified chann stages.*

Section.	Date.	Gauge.	Rectified channel below standard high water=122 feet.				Dimensions tified chan s	
			Area = A.	Fill or scour since last date.	Total fill back = a.	Per cent of section filled back $=\frac{a}{A}$.	Width.	Me dep
		Feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*		*Feet.*	*Fe*
Dike 1[1]	May 26, 1892	121.95	27,211	....	....	....	1,275	21
Do	July 9, 1892	118.80	26,525	+ 686	+ 686	2.5	1,270	17
Do	Aug. 4, 1892	113.75	25,913	+ 612	+1,298	4.7	1,225	12
Do	Aug. 13, 1892	111.80	27,825	—1,912	— 614	—2.2	1,090	14
Do	Aug. 20, 1892	110.70	27,275	+ 550	— 65	—0.2	1,040	12
Do	Oct. 8, 1892	107.70	25,200	+2,075	+2,011	7.3	1,005	8
Do	Nov. 1, 1892	108.30	26,337	—1,137	+ 874	3.2	1,005	10
Do	Dec. 7, 1892	107.70	25,007	+1,250	+2,124	7.7	1,000	8

TABLE III.—*Areas and dimensions of cross sections of rectified channel for different stages*—Continued.

Section.	Date.	Gauge.	Rectified channel below standard high water=122 feet.				Dimensions and areas of rectified channel for different stages.			
			Area=A.	Fill or scour since last date.	Total fill back=a.	Per cent of section filled back =a/A	Width.	Mean depth.	Maximum depth.	Area.
		Feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*		*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*
Dike 2'	July 9, 1892	118.80	27,367	....	....	....	1,250	20.4	36	23,520
Do.......	July 18, 1892	118.30	25,706	+1,661	+1,661	6.7	1,200	16.4	34.5	21,655
Do.......	Aug. 4, 1892	113.75	24,604	+1,102	+2,763	10.9	920	17	36.5	15,600
Do.......	Aug. 10, 1892	111.80	25,050	— 446	+2,317	8.4	900	15.5	27	13,960
Do.......	Aug. 20, 1892	110.70	24,800	+ 250	+2,567	9.3	905	14	24	12,720
Do.......	Oct. 11, 1892	107.55	23,117	+1,683	+4,250	15.5	925	9	18	8,280
Do.......	Nov. 1, 1892	108.30	23,550	— 433	+3,817	13.9	940	9.5	14.5	8,920
Do.......	Nov. 30, 1892	107.60	22,000	+1,545	+5,362	19.6	925	7.4	12	6,880
Dike 3'	May 26, 1892	121.95	26,800	....	....	....	1,200	22.3	37.5	26,740
Do.......	July 9, 1892	118.80	26,700	+ 100	+ 100	.3	1,175	19.6	34.5	23,040
Do.......	July 18, 1892	118.30	24,233	+2,467	+2,567	9.6	1,175	17.7	35.5	20,800
Do.......	Aug. 4, 1892	113.75	25,978	—1,745	+ 822	3.4	855	20.4	34.5	17,440
Do.......	Aug. 13, 1892	111.80	24,475	+1,531	+2,353	8.7	810	17	26	13,840
Do.......	Aug. 20, 1892	110.70	23,433	+1,014	+3,367	12.5	800	15	22	12,000
Do.......	Oct. 11, 1892	107.55	23,488	— 55	+3,312	12.4	850	10.6	14	9,000
Do.......	Nov. 30, 1892	107.60	22,450	+1,038	+4,350	16.2	910	8.3	11	7,600
Dike 9'	June 8, 1892	119.45	30,045	....	....	....	1,050	26	30	27,450
Do.......	June 16, 1892	117.35	28,598	+1,447	+1,447	4.8	1,100	21.5	29	23,576
Do.......	July 8, 1892	118.95	28,000	+ 598	+2,045	6.8	1,100	22.5	33	24,760
Do.......	July 19, 1892	117.75	28,654	— 654	+1,391	4.6	1,080	22	37	21,074
Do.......	Aug. 5, 1892	113.55	28,023	+ 621	+2,012	6.7	1,050	18	33	18,738
Do.......	Aug. 13, 1892	111.75	27,050	+ 983	+2,995	9.9	1,000	16.5	30	15,761
Do.......	Aug. 20, 1892	110.70	26,000	+1,050	+4,045	13	910	14.5	27	13,200
Do.......	Oct. 8, 1892	107.70	23,280	+2,720	+6,765	22.5	710	12	19.5	8,640
Do.......	Nov. 5, 1892	108	23,300	— 20	+6,745	22.3	700	11	19.5	8,030
Do.......	Nov. 29, 1892	107.70	22,025	+1,275	+8,020	26.7	710	10	19	7,120
Dike 10'	July 8, 1892	118.95	33,551	....	....	....	1,020	24.5	29	25,040
Do.......	July 19, 1892	117.75	33,458	+ 93	+ 93	3	1,020	24.1	31	24,640
Do.......	Aug. 5, 1892	113.55	31,958	+1,500	+1,593	4.8	1,020	17.9	28	18,260
Do.......	Aug. 13, 1892	111.75	31,025	+ 933	+2,526	7.5	1,000	16.4	25	16,360
Do.......	Aug. 20, 1892	110.70	31,105	— 80	+2,446	7.3	1,000	15.5	24	15,520
Do.......	Oct. 8, 1892	107.70	29,400	+1,705	+4,151	12.4	1,000	10.1	19	10,080
Do.......	Nov. 5, 1892	107.95	27,920	+1,480	+5,631	16.8	1,000	8.9	19	8,880
Do.......	Nov. 29, 1892	107.65	28,033	— 113	+5,518	16.4	1,000	8.8	19	8,800
Dike 11	July 8, 1892	118.95	31,350	....	....	....	1,195	23.5	31.5	28,160
Do	July 19, 1892	117.75	31,343	+ 7	+ 7	02	1,185	22.5	32	26,800
Do	Aug. 5, 1892	113.55	30,872	+ 471	+ 478	1.5	1,175	18	36	21,440
Do	Aug. 13, 1892	111.75	28,920	+1,952	+2,430	7.7	1,150	15.5	26	17,640
Do	Aug. 20, 1892	110.70	29,000	— 80	+2,350	7.5	1,125	15	24	16,710
Do	Oct. 8, 1892	107.70	27,565	+1,435	+3,785	12.1	1,100	12	23	12,070
Do	Nov. 5, 1892	107.95	25,563	+2,002	+5,787	18.5	1,100	9.3	21	10,240
Do	Nov. 29, 1892	107.65	25,588	— 25	+5,762	18.4	1,105	9	24	9,920
Dike 13'	May 26, 1892	121.95	31,758	....	....	....	1,225	25	27.5	31,700
Do	July 19, 1892	117.75	29,253	+2,505	+2,505	7.9	1,220	19.5	22	23,520
Do	Aug. 5, 1892	113.55	28,047	+1,206	+3,711	11.7	1,170	15	19	17,800
Do	Aug. 13, 1892	111.75	29,492	—1,445	+2,266	7	1,240	12.5	17.5	15,360
Do	Aug. 20, 1892	110.70	30,020	— 528	+1,738	5.5	1,240	12.5	17.5	15,480
Do	Oct. 7, 1892	107.70	27,127	+2,893	+4,631	14.6	1,225	8	13.5	9,600
Do	Nov. 8, 1892	107.90	28,052	— 925	+3,706	11.7	1,230	9	14.5	11,000
Do	Nov. 29, 1892	107.70	27,293	+ 759	+4,465	14	1,200	8	11.5	9,520
Dike 13A	May 26, 1892	121.95	27,492	....	....	....	1,145	24	29	27,450
Do	July 20, 1892	117.35	28,174	— 682	— 682	—2.4	1,140	20.3	28	23,160
Do	Aug. 13, 1892	111.75	26,900	+1,274	+ 592	2.1	1,120	13.7	21	15,400
Do	Aug. 20, 1892	110.70	26,000	+ 900	+1,492	5.4	1,110	11.7	21	13,080
Do	Oct. 7, 1892	107.70	24,700	+1,300	+2,792	10.2	1,105	7.6	11	8,400
Do	Nov. 8, 1892	107.90	24,900	— 200	+2,592	9.4	1,110	8.2	13	9,160
Do	Nov. 29, 1892	107.70	24,475	+ 425	+3,017	11	1,115	8.1	11.5	9,000
Dike 13B'	May 26, 1892	121.95	29,278	....	....	....	1,110	26.3	13	29,223
Do	July 20, 1892	117.35	28,795	+ 483	+ 483	1.6	1,085	22	29	24,000
Do	Aug. 13, 1892	111.75	27,953	+ 832	+1,225	4.2	1,060	16.3	25.5	17,325
Do	Aug. 20, 1892	110.70	27,115	+ 838	+2,163	7.4	1,050	14.5	23	15,225
Do	Oct. 7, 1892	107.70	26,123	+ 992	+3,155	10.7	1,045	11.8	19.5	10,640
Do	Nov. 8, 1892	107.90	26,860	— 737	+2,418	8.2	1,035	11.2	19.5	11,640
Do	Dec. 2, 1892	107.25	24,678	+2,182	+4,600	16.7	1,030	8.5	17	8,760
Dike 14	May 26, 1892	121.95	29,151	....	....	....	1,080	27	32	29,100
Do	July 20, 1892	117.25	30,757	—1,606	—1,606	—5.5	1,055	24.3	32	25,640
Do	Aug. 13, 1892	111.75	29,562	+1,195	— 411	—1.4	1,010	18	30	18,840
Do	Aug. 20, 1892	110.70	28,585	+ 977	+ 566	2.9	1,050	16	29	16,920
Do	Oct. 7, 1892	107.70	26,180	+2,405	2,971	10.2	1,070	10.5	26.5	11,280
Do	Nov. 8, 1892	107.90	25,750	+ 430	+3,401	11.7	1,025	10.9	28	11,160
Do	Dec. 2, 1892	107.25	26,570	— 820	+2,581	8.8	1,025	11.1	26	12,240

The rectified channel referred to in this table is the waterway between end of dike and opposite bank. In the case of sections 9′, 10′, and 11′, the opposite bank is the south side of the towhead.

REVETMENT WORK.

Murrays Bend revetment.—The construction of revetment in Murrays Bend was begun October 24 and was proceeded with continuously till November 29, when operations were discontinued on account of having to lay up the plant for the winter. The head of the revetment is in Cedar Creek, 250 feet from its mouth. The length of the revetment along the river is 3,250 feet.

The width of the mattress varies from 65 to 70 feet, with its shore edge extending about 2 feet above standard low water. The bank in Cedar Creek and about 175 feet of the river bank were graded with shovels, and the remainder of the river bank with one of the hydraulic pile sinkers.

When the plant was removed, in the latter part of November, for storing it for the winter, there still remained, to complete the revetment, about 95,000 square feet of upper bank to be ballasted. This work was carried on during the winter and was completed February 20.

The greater part of the stone used for the revetment was hauled to the river bank from the Callaway County bluffs, a distance of 1 mile; the remainder was transported on barges from Jefferson City and from the mouth of Moreau Creek.

The following statement shows the extent and cost of each class of work and quantities of material used:

Class and extent of work and quantities of material.	Prices of material.	Cost of each class of work.	Total.
Sinking 292 anchor piles:			
Labor and subsistence		$227.31	
7,008 linear feet of piling	$0.1102	772.28	
90 pounds 7 by ⅜-inch spikes	.02707	2.44	
120 bushels of coal	.1116	13.39	
			$1,015.40
Weaving 231,421 square feet of mattress:			
Labor and subsistence		1,659.03	
1,479.5 cords of brush	2.04631	3,027.52	
56,300 feet ⅜-inch wire cable	.010632	598.58	
4,000 pounds ⅜-inch wire cable	.04	160.00	
			5,445.13
Sinking 231,421 square feet of mattress:			
Labor and subsistence		390.06	
1,489.2 cubic yards of stone	.9674	1,444.14	
			1,834.20
Grading bank with shovels:			
Labor and subsistence		372.02	
			372.02
Grading bank with hydraulic pile sinker, 4,240 cubic yards:			
Labor and subsistence		343.17	
545 bushels coal	.1116	60.82	
			403.99
Ballasting 119,000 square feet, 3,500 linear feet, with stone:			
Labor and subsistence		693.77	
4,490.77 cubic yards of stone	.96971	4,354.88	
			5,048.65
Miscellaneous:			
Administration		464.52	
Office and incidental expenses		661.00	
Steamboat service		737.58	
Towboat service		1,338.20	
Care and repair of plant in service		1,378.58	
Surveys		983.25	
			5,563.13
Total			19,682.53

Cost per linear foot, $5.6235—.

Bonnots Mill revetment.—The head of the Bonnots Mill revetment is situated in the mouth of the small creek flowing through the village. Its length is 1,200 feet.

Mattress work was begun April 28, and completed May 8. The width of the mattress is about 62 feet, 50 feet of which is below the low-water contour. The grading was done with one of the hydraulic pile-sinkers, and was completed May 10.

As the grading was carried on while the river was above a midstage, the bank could not be given a uniform slope from top to bottom, and in some places it is steeper than 1 on 2½.

The ballasting of the upper bank was completed May 29. In constructing this work the anchor piles and transverse cables were placed 20 feet apart and a three-eighth inch cable used in the selvage edge of the mattress. In other respects the revetment is the same as the standard revetment.

The following statement shows the cost and extent of the work:

Class and extent of work and quantities of material	Prices of material.	Cost of each class of work.	Total.
Making 60 anchor piles:			
Labor and subsistence		$109.51	
1,894 linear feet piling	$0.1102	208.72	
70 bushels coal	.1116	7.81	
15 pounds of 8 by ⅜-inch spikes	.0250	.38	
			$326.42
Weaving 75,177 square feet of mattress:			
Labor and subsistence		633.47	
445.84 cords of brush	2.4631	912.33	
14,000 feet ⅜-inch wire cable	.010632	148.85	
			1,694.65
Sinking 75,177 square feet of mattress:			
Labor and subsistence		217.37	
419 cubic yards of stone	.96974	406.32	
			623.69
Grading 1,620 cubic yards:			
Labor and subsistence		61.24	
65 bushels of coal	.1116	7.25	
			68.49
Ballasting 35,468 square feet of upper bank with stone:			
Labor and subsistence		258.21	
1,275.7 cubic yards of stone	.96974	1,237.10	
			1,495.31
Miscellaneous:			
Administration		138.48	
Office and incidental expenses		197.05	
Steamboat service		219.84	
Towboat service		398.93	
Care of plant in service		410.97	
Surveys		293.38	
			1,658.65
Total			5,867.21

Cost per linear foot, $4.8893.

MISCELLANEOUS WORKS.

Cedar Creek Dam.—This dam is situated across the old bed of Cedar Creek, about 3,000 feet below the head of Murrays Bend revetment, which protects it from being flanked by the river.

The dam is an earth embankment formed of material taken from the bed of the creek by means of slip scrapers. It is 218 feet long, and contains about 2,000 cubic yards. It has a top width of 10 feet, side slopes of 1 on 1½, and is about 1½ feet above the level of the banks of the creek. It was constructed between October 31 and November 16. After the spring rains it was found necessary to do some further filling to make the dam perfectly secure. The total cost of this dam amounts to $628.19.

Cedar Slough Dam.—This dam is similar to the one across Cedar Creek. It is 585 feet long, and contains about 2,500 cubic yards of earth. It was constructed between November 15 and 30. The exterior slope of the embankment is faced with bundles of brush ballasted with stone. In the early part of June the embankment was raised slightly, and the slopes faired up by filling in with earth. The cost of this dam amounts to $634.81.

Removing Tatum Rock.—This rock was situated in Osage Chute, about 800 feet above Bonnots Island. It was sunk about 3 feet below standard low water, and contained about 5 cubic yards. Several holes were drilled in the rock during the winter of 1891 and 1892, but before the drilling could be completed an ice gorge caused the river to rise to such an extent that work had to be suspended. During the winter of 1892 and 1893 the drilling was completed and the rock entirely removed by blasting. The cost of removing the rock amounts to $52.42.

PROCURING CONSTRUCTION MATERIALS.

The materials used for constructing works of improvement on Osage Division during the fiscal year were purchased in the open market, excepting the willow brush and a small quantity of stone, which were procured by hired labor.

The quantities of construction materials which were procured and used during the year's operations, and their average cost per unit, are given in the following statement:

Material.	Quantity procured.	Quantity used.	Cost per unit.
Willow brush .... cords..	9,349	9,985	$2.[illegible]
Stone rip-rap .... cubic yards..	19,133	18,997	[illegible]
Native oak piles .... linear feet..	179,938	216,825	[illegible]
White oak piles .... do....	47,022	20,608	[illegible]
Cypress piles .... do....	29,998	....	[illegible]
Assorted sizes of yellow pine lumber for bracing ..... feet, B. M..	270,337	570,952	[illegible]
⅞-inch square iron .... pounds..	28,283	40,656	[illegible]
⅝-inch wire cable .... feet..	257,000	302,000	[illegible]
8-inch by ⅜-inch spikes .... pounds..	8,600	7,576	[illegible]
7-inch by ⅜-inch spikes .... do....	2,200	2,585	[illegible]
20-penny wire nails .... do....	2,000	945	[illegible]
30-penny wire nails .... do....	3,500	3,165	[illegible]

One hundred and fifty-one thousand and nineteen linear feet of the native oak piling were delivered on barges at the works, 10,530 feet at Lamine River, 12,538 feet at Chariton River, and 5,850 feet at Gasconade River.

The pine lumber and white oak piles were delivered at Jefferson City, Mo., and Bonnots Mill, Mo., and the cypress piles at Bonnots Mill.

Of the stone, 3,813 cubic yards were delivered on the river bank in Murrays Bend, 4,525 yards on barges at Jefferson City, Mo., 7,931 yards at the mouth of Moreau Creek, 1,277 yards at Bonnots Mill, 451 yards at Cedar Island, and 1,136 yards procured by hired labor.

The total value of construction material on hand at this date amounts to $20,508.89.

During the winter of 1892 and 1893 specifications were prepared and bids received for furnishing a supply of cypress piles and pine lumber for future dike construction. As there appeared, however, to be some doubt about another appropriation being made by Congress, the final arrangements for purchasing the materials were not made till March 10.

A tract of land was rented at Bonnots Mill, Mo., and arranged for storing materials received either by railroad or river.

For convenient and economical handling of material received by railroad, a side track was laid from the main line of the Missouri Pacific Railway along the whole length of the yard and a spur track constructed between the side track and the river bank for delivering coal from cars on barges. These conveniences could not be had in conducting former operations, on account of there not being any suitable site for a yard available in the immediate vicinity of where work was being carried on, and, in consequence, a large number of barges intended for transporting material had to be used for storage.

STEAMBOAT SERVICE.

The following steamers were used for transporting material and moving plant during the fiscal year, viz: The towboats *Wm. Stone* and *Jennie Gilchrist*, and the steamers *Sabrina*, *Melusina*, and *Doris*.

The *Stone* was employed principally for towing material from more distant points, and for moving heavy plant from one part of the work to another. During the winter she was laid up under Dike 19. When operations were resumed in the spring she was employed, till June 10, in towing brush from points between Providence, Mo., and Jefferson City, and piles from the Chariton and Lamine rivers. Between June 10 and 24 repairs were made to her furnaces and new stacks erected. On the latter date the boat was transferred to Division Engineer S. W. Fox, to assist in towing plant from Kansas City, Mo., to Gasconade, Mo.

During the fall of 1892, after September 15, the water on most of the crossings between the brush patches and the work was too shallow for the *Stone*, and it became necessary, in order to keep the construction parties supplied with brush and other materials, to charter a towboat of lighter draft. The necessary authority being obtained, the towboat *Jennie Gilchrist* was chartered October 4, at the rate of $50 per diem without fuel. This boat was used in towing brush and other material till November 30, when she was returned to her owners.

The steamer *Sabrina*, belonging to the St. Joseph division, was employed for towing and moving plant for one of the construction parties till October 23, when she was returned to St. Joseph.

After the *Melusina* received her new boiler, in the latter part of July, she was employed continuously during the year's operations, towing material for one or both f the construction parties, moving plant, and towing barges loaded with lumber for lant repairs from Jefferson City to the boat yard.

The repairs to the steamer *Doris*, which were begun in June, 1892, were completed nd the boat put in commission October 5. After this date she was used for light owing. The boat was hauled out on the ways in June, 1893, for the purpose of aking some necessary alterations in her hull.

The cost of the service rendered by the different steamers is as follows: *Wm. Stone*, 5,846.33; *Jennie Gilchrist*, $3,577.32; *Melusina*, $5,617.59; *Sabrina*, $2,031.66; *Doris*, ,018.79, total, $40,091.69. Besides these expenses, coal to the value of $55.80 was urnished the snag boat, and to the value of $320.22 to the towboat *Alert*.

CONSTRUCTION, REPAIR, AND CARE OF PLANT.

Plant construction.—The plant constructed during the year consists of a mill with ood-working machinery, two single-deck quarter boats and one office quarter boat.

The mill is one-story frame structure, 60 by 30 feet, with a half-pitch gable roof. he roof and the upper half of the sides are covered with corrugated iron. The achinery is placed on pile foundations slightly above the level of the ground. The pper part of the building serves the purpose of a mold loft.

The equipment of the mill consists of one No. 3 Mississippi planer, one rip saw, ne cut-off saw, one band saw, and a turning lathe. The motive power is a 30-horse ower engine, with one 10 by 16 inch cylinder. The construction of the mill was egun in the early part of October, and was completed December 5. It has proved o be a very valuable accession to the plant, in saving time and expense in dressing nd sawing the lumber for construction and repair of plant. The mill has in conection with it a steam box, a dry kiln constructed out of old lumber, and a water nk for supplying water to the force employed at the boat yard.

The two quarter boats were designed for the use of the brush party employed in ocuring brush. The hulls are of the same dimensions, viz, 100 feet long, 20 feet am, by 4½ feet deep, with guards 3 feet wide. The sides and bottom are 2½ inches ick. The hulls are constructed entirely of long-leaf yellow pine.

The cabins are 82 feet by 18 feet, one-story high, built of short-leaf yellow pine mber, with shingle roofs having a one-half pitch. As the hulls are of light conruction, they are held in shape by two 1¼-inch hog chains.

The cabin of one of the boats is arranged for sleeping quarters; that of the other r mess hall, storage, kitchen, and office. The boats accommodate 85 men.

The office boat consists of a framed hull 114 feet long by 25 feet beam by 5½ feet ep, strengthened by 1¼-inch hog chains. The hull of the boat is completed, but, account of delays in receiving lumber, very little work has been done on the cabin. e boat will accommodate all of the office employés of the work, who have hitherto en quartered on several small boats.

A part of the lumber and other materials required for ten 100 foot barges was ceived, but not sufficient to begin their construction.

The work of repairing and constructing plant could not be proceeded with as pidly as desired on account of lumber dealers failing to furnish lumber on time. onsiderable delay was also caused by having to wait till a great deal of lumber, jected for not conforming to specifications, could be replaced.

The quantities of materials used for construction and repair of plant are as folws:

hite oak lumber...feet, B. M..	282,035	Candle wicking.......pounds..	105
ong-leaf yellow pine lumber, feet, B. M....................	273,732	Metallic paint.............do....	900
ort-leaf yellow pine lumber, feet, B. M......................	97,114	Red lead..................do....	475
hite pine lumber.. feet, B. M..	28,107	White lead................do....	3,250
press lumber..........do....	1,419	Assorted sizes of iron....do....	57,993
kum...............pounds..	11,200	Nails.......................do....	14,310
		Spikes.....................do....	31,880

The greater part of the plant material was delivered free on board cars at Jefferon City, Mo., where it was loaded on barges, transported to the boat yard, and loaded. During the winter, while navigation was suspended, the materials had be hauled by wagons to the boat yard from Ewings Switch and Jefferson City. e rehandling of materials has added greatly to the cost of plant construction and pairs. The construction and repairs of plant were carried on at the boat yard at vings. The force employed on this work was quartered in the cabins of two old ush quarter boats, and in temporary quarters, constructed out of old lumber in 91, which were repaired and enlarged.

Repairs to plant.—The repairs made to plant during the year were very extensive, volving in some cases entire reconstruction. The principal repairs made are as llows, viz: To machine boat No. 1, bottom, rakes, and three lower gunwales strakes renewed; a new shingle roof laid; the fantail platform rebuilt; hull streng ened by $1\frac{1}{4}$-inch hog chains, and outside of boat painted. To two double-deck qu ter boats, Nos. 3 and 6, the bottom, rakes, and two lower gunwale strakes renew the windows on the lower deck enlarged; new floor laid in mess halls; the h strengthened by $1\frac{1}{4}$-inch log chains; a new guard added at the bottom of the fe ers, and the outside of hulls and cabin painted. To six pile-sinkers, new hulls both pump and cross boats constructed and made 18 inches deeper, and the cr boats 10 feet longer than the old hulls; cabins removed from the old hulls, placed the new ones, and repaired; four sets of tower leads, 52 feet high, framed, and one erected; new smokestacks provided, and all the machinery overhauled and pla in first-class condition. To hydraulic grader No. 8, gunwales repaired with gr ing pieces, and the hull strengthened, for using a Cram hammer driver, by $1\frac{1}{4}$-in hog chains; gunwales of ten barges sheathed for a height of $3\frac{1}{2}$ feet from the botto the decks of five of the barges covered with 2-inch pine decking; extra stanch placed in the holds of the barges; most of the cavils and timber heads renew extensive repairs of a miscellaneous character made to gunwales, head blocks, bottoms, and the barges thoroughly calked. To 64-four foot barges, the gunw of 12 barges sheathed with 2-inch pine for a height of $2\frac{1}{2}$ feet from the bottom, other repairs of a miscellaneous character made to the gunwales and bottoms. the steamer *Melusina*, a new double-drum steam capstan set up, and the old loco tive boiler replaced by a new boiler with ten 6-inch flues. To the steamer *Sab* a new skylight framed and erected. To the steamer *Doris*, a wooden hull, 65 by by 4 feet deep, and a cabin constructed; a double-drum steam capstan set up; the locomotive boiler replaced by a new steel boiler with ten 6-inch flues; the en thoroughly repaired and fitted with a longer shaft. This latter change was m necessary by the greater beam of the new hull.

As the draft of the boat proved to be too great for full efficiency, her hull lengthened 11 feet 8 inches and her depth at the midship section increased inches.

The changes in the hull made it necessary to change the position of the boiler to make other minor changes.

Two sets of tower leads 46 feet high, that were framed during the last fiscal y were erected in July and August on the hulls of two of the old cross boats 27 skiffs reconstructed.

Numerous repairs incidental to conducting work were also made to nearly the plant, besides a great variety of other repair work which was necessary to the plant in good working condition.

Care of plant.—At the beginning of the fiscal year the floating plant belongin this division consisted of 70 pieces, as follows: 1 machine boat, 2 double-d quarter boats, 2 single-deck quarter boats, 1 steamer, *Melusina*, 3 hydraulic gra (on one of which the Cram hammer was mounted), 1 six-lead pile-sinker, 1 th lead pile-sinker, 6 old-style pile-sinkers with derrick and platform, 36 100-foot bar 11 64-foot barges, 3 64-foot barges with quarters, 2 mattress boats, and 1 unser able steamer, *Doris*.

During the high stage of water in the summer of 1892 most of the fleet laid up in ordinary at Boggs Creek, $1\frac{1}{2}$ miles below Jefferson City. As soon as stage of water declined sufficiently the plant was placed in service as rapidl construction parties could be organized.

It was made impossible to complete the storage ways at the boatyard in the of 1891, on account of the failure of the lumber-dealers to furnish all the lu ordered for that purpose, as explained in my last annual report. The lumber be subsequently received, this work was taken up in the fall of 1892 and a set tracks 600 feet long constructed. The inclined part of the ways had also reconstructed and extended 320 feet to the new low-water shore line, as during high water the old ways were buried under the accretions formed by Dike 9, be which they were situated. This work was very difficult, on account of the ac tions being very soft mud, which in some places would not support the weight a man.

At the close of the season's operations 49 pieces were taken out of the river laid up on the ways. The remaining 21 pieces had to be left in the river, account of its being closed by ice before the work of storing the boats coul completed. During the winter the ice was kept cut from around the plant lyin the river, and other precautions taken for its safety. The river opened and the went out February 18 without injury to any of the plant. The launching of plant was begun in the latter part of February, and was proceeded with as rap as repairs were completed and the hulls calked. It was practically comp May 5.

During the launching of the plant in April several sharp rises of the river occu After each of the rises the lower part of the ways was buried under a deposit of which had to be washed away by the towboat before launching could be resu

To Accompany Annual

Plate II.

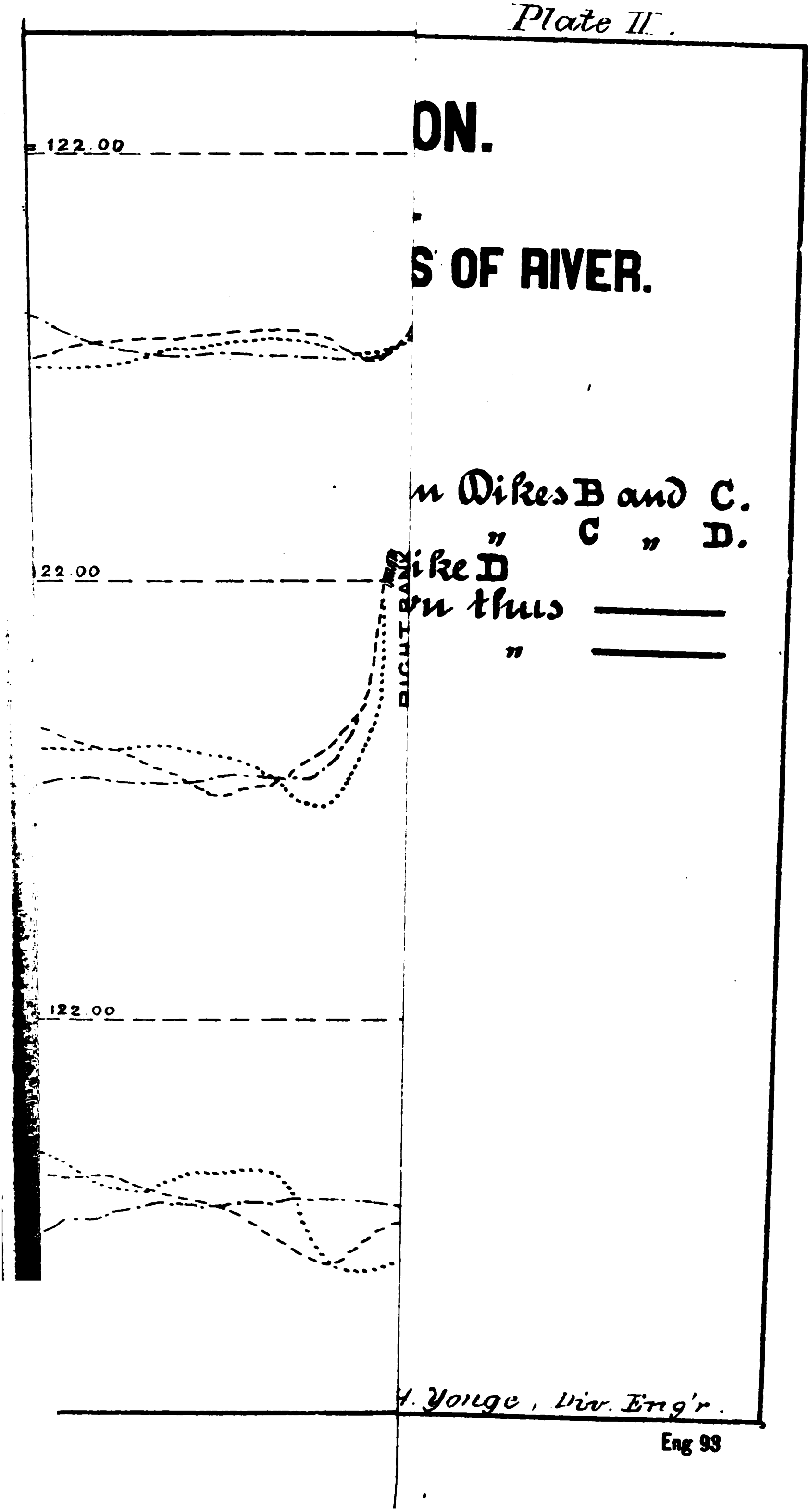


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PLATE III

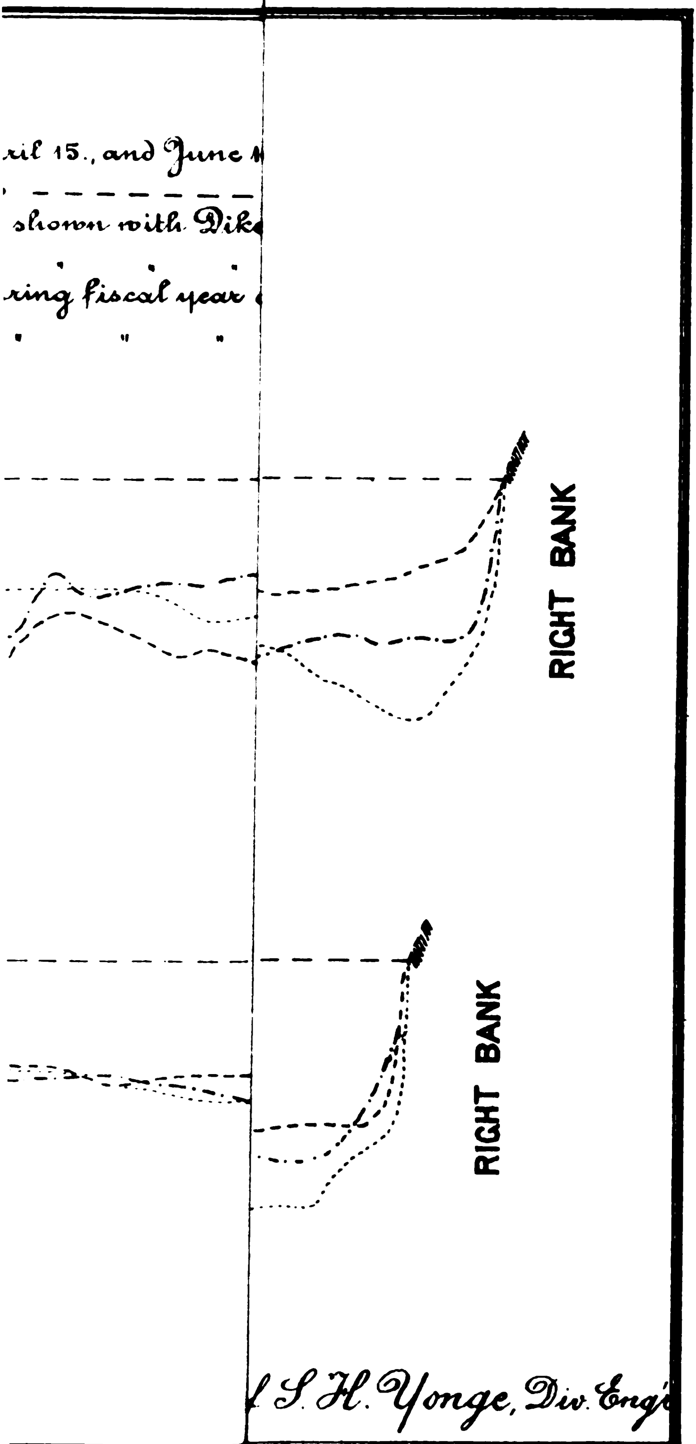

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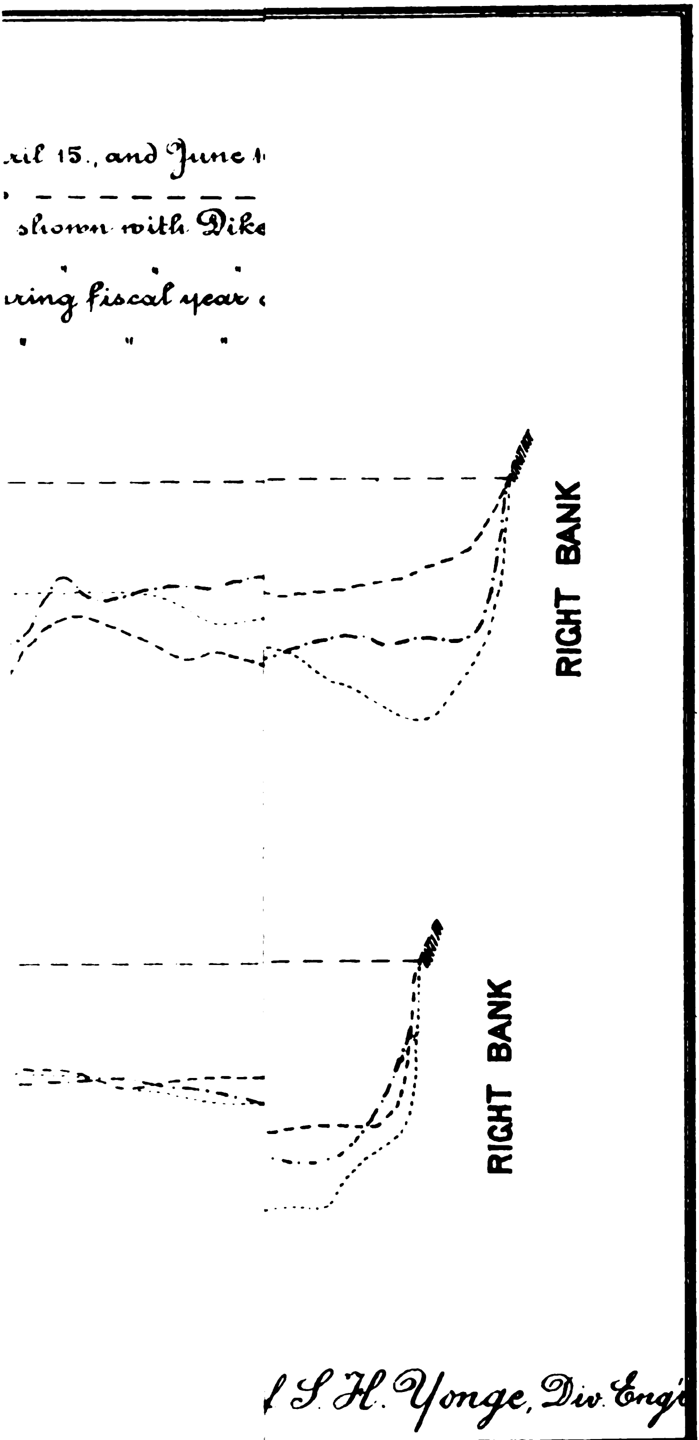
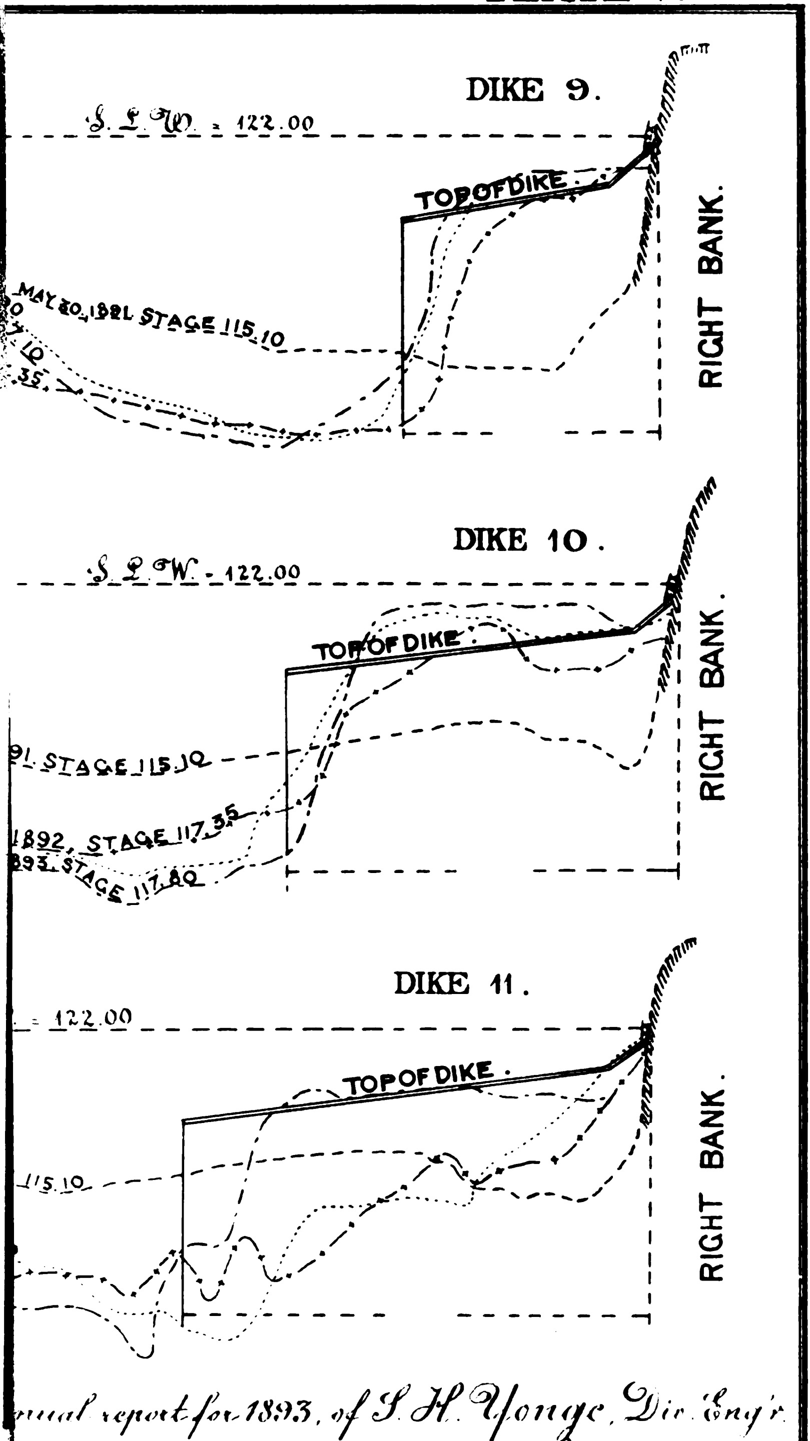
PLATE III



ril 15., and June 1
shown with Dike
ring fiscal year
RIGHT BANK
RIGHT BANK
S. H. Yonge, Div. Engi

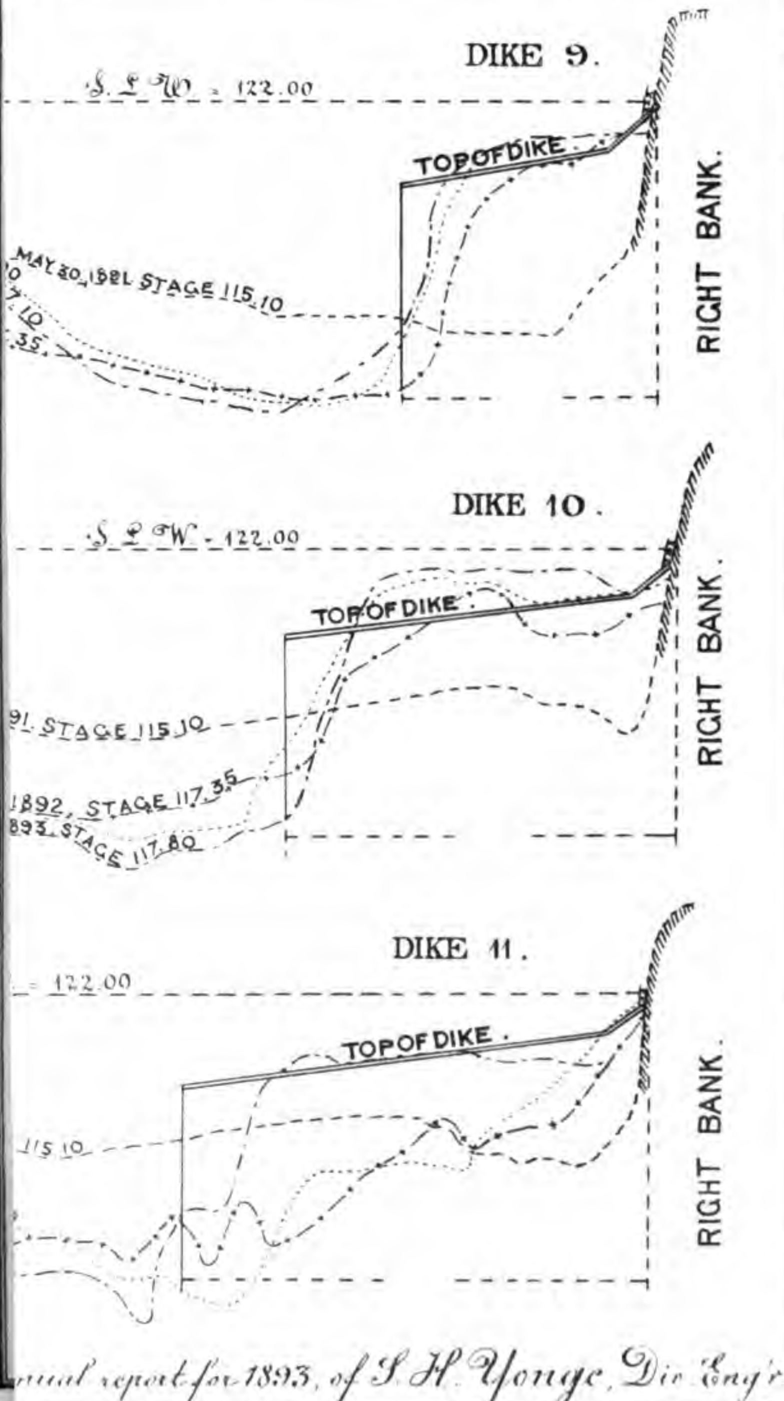
PLATE V.



nual report for 1893, of S. H. Yonge, Div. Eng'r.

Eng 93

PLATE V.



nual report for 1893, of S. H. Yonge, Div. Eng'r

PLATE VII

ON.

H.

ns of River.

500 Feet

40 Feet

N.B.

Cross-S 17, and 18-17A, shown thus - - - - -

" *S 19-18A*, " " - - - - -

" " " " " ....

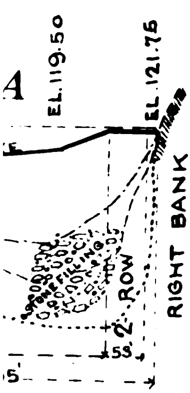
Other c between Dikes 17 and 18.

" " " *18 and 19.*

" " " *19 and 20.*

Dikes shown thus ═══════

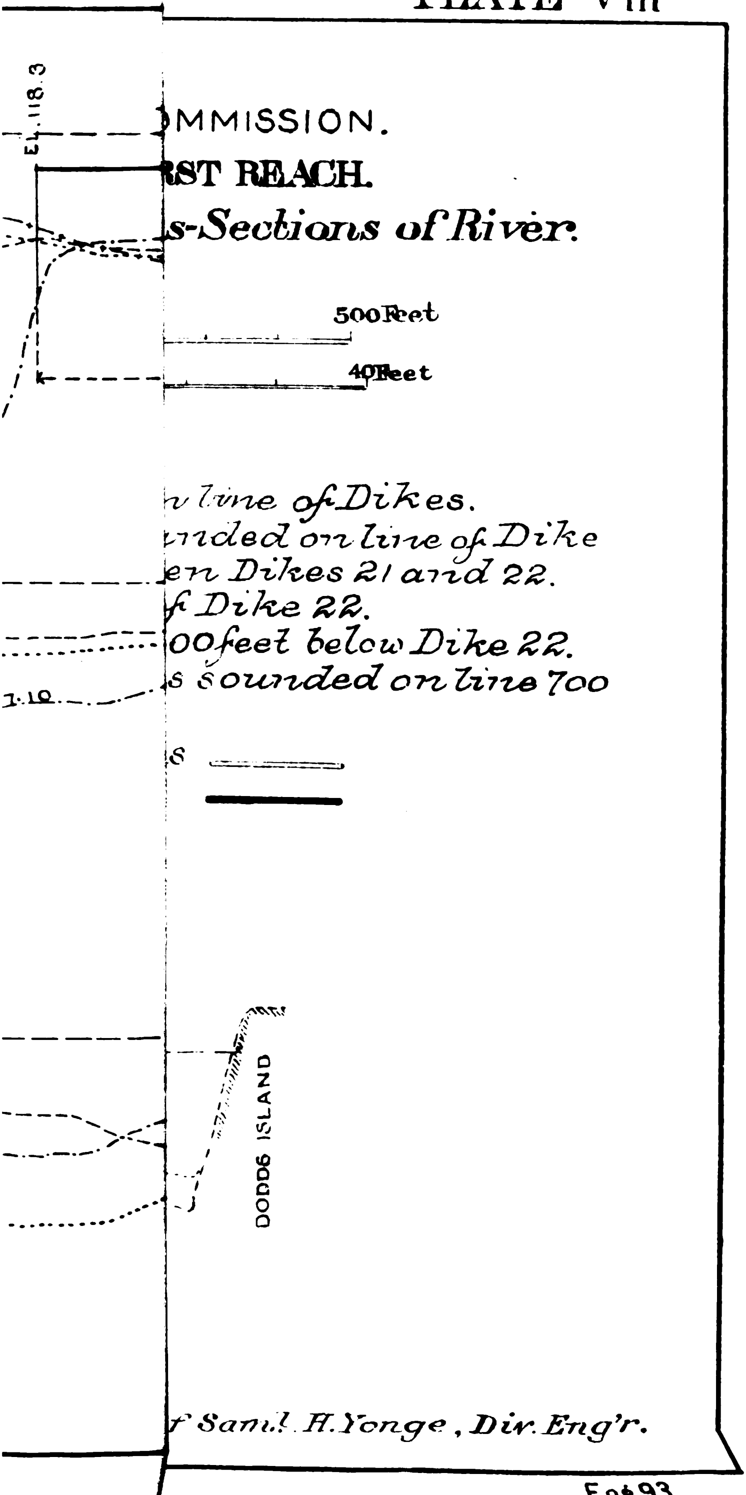
" " " ━━━━━━━



aml. H. Yonge, Div. Eng'r.

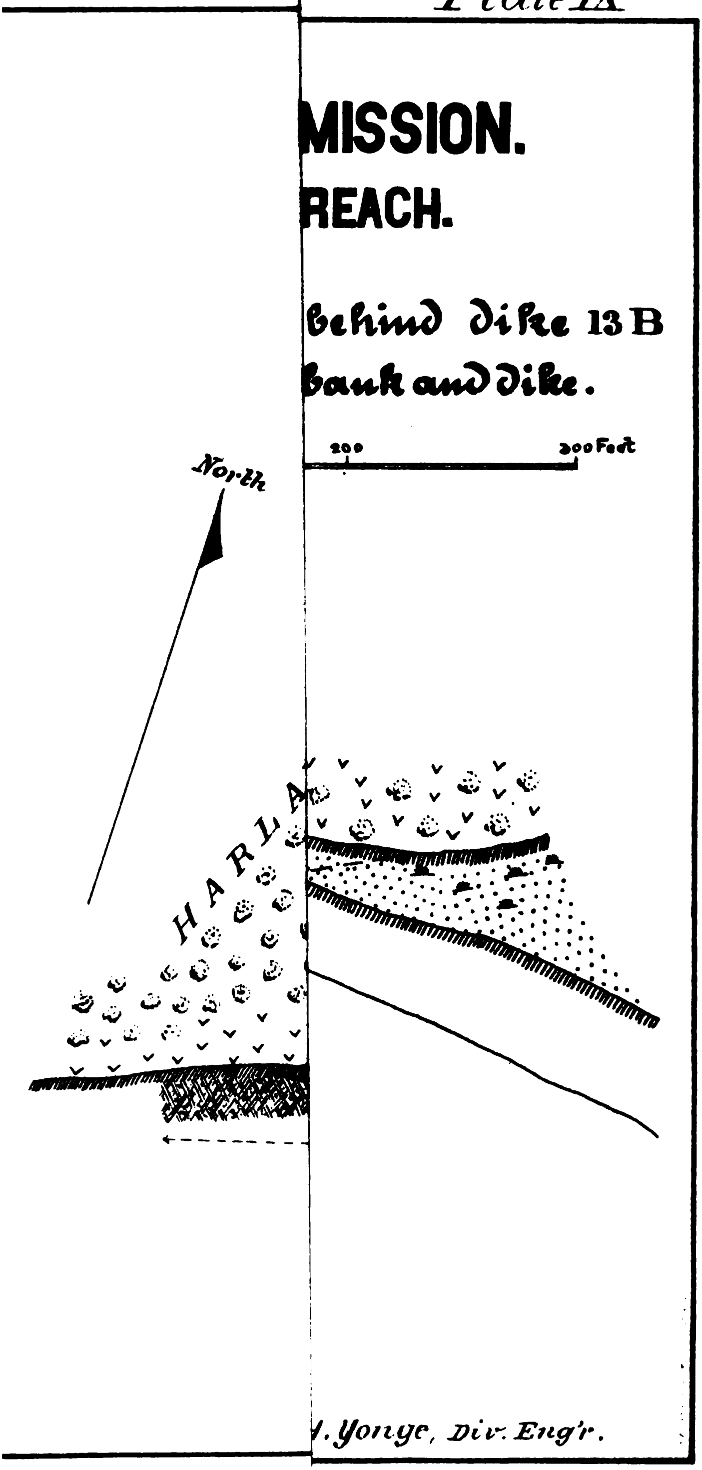
Eng 93

PLATE VIII



Eng. 93.

Plate IX



Eng. 93

lriving for 8 lines of new tracks, 700 feet long, made necessary by the the number of pieces of plant, was begun in May, and 337 piles driven. ving statement shows the expenditures during the fiscal year on account

Statement of expenditures on account of plant.

	Labor.	Material.	Total.
plant:			
edeck quarter boats	$4,135.94	$1,670.46	$5,806.40
s	2,068.45	1,141.34	3,209.79
king mill	1,203.72	609.09	1,872.81
at Bonnot's mill-material yard	787.43		787.43
ıg plank, etc	439.82	164.93	604.75
			12,281.18
nt:			
and repairing quarters and erecting temporary s for plant material, etc	658.60	581.67	1,240.27
cting steamer Doris	4,104.20	2,735.20	6,839.40
old pile-sinkers	239.73		239.73
w hulls for pile-sinkers	21,002.69	6,883.70	27,886.39
r-leads for four pile-sinkers	1,773.97	777.92	2,551.89
machine boat No. 1	2,784.11	1,049.60	3,833.71
quarter boats Nos. 3 and 6	4,767.07	1,979.00	6,746.07
barges	5,334.06	1,145.96	6,480.02
10 100 foot barges	1,001.28	335.41	1,336.69
12 64-foot barges	589.57	203.19	792.76
steamer Melusina	468.88	1,381.84	1,850.72
and altering grader No. 8 for Cram hammer-driver.	852.35	153.22	1,005.57
cting skiffs	1,232.35	189.26	1,421.61
ng steamer Doris	1,573.87	314.43	1,888.30
igging pile-sinkers, barge lines, lashings, etc		3,041.29	3,041.29
nd sundry repairs		1,747.85	1,747.85
steam hose		898.33	898.33
pairs	4,627.06	4,386.91	9,013.97
			78,814.57
buildings for storing plant and material	677.97	453.69	1,131.66
nken grader and sinker machinery	185.86		185.86
ng and extending ways	6,849.98	4,743.74	11,593.72
et on ways	2,575.00	137.53	2,712.53
fleet	2,118.30	101.01	2,219.31
e around boats, pulling drift, watching, and general lant	13,723.21		13,723.21
ckle for storing boats		1,073.05	1,073.05
and fire grenades, waste, coal oil, and miscellaneous		1,604.54	1,604.54
			34,243.88
chased:			
king machinery for mill			2,960.64
m hammer and hoisting engine			1,454.25
nges, heating stoves, and mess utensils			1,130.70
ors, wheelbarrows, weighing scales, timber trucks, ll tools			703.85
re-extinguisher			38.50
			6,287.94
ation			4,778.92
incidental expenses			5,622.82
service			7,592.00
rvice			13,775.00
			163,396.31

of plant material on hand amounts to $13,757.72.

SURVEYS.

ding of cross sections on ranges normal to the direction of the lines of at and between dikes that were constructed or in course of construc- those w... construction has been approved but not begun, has been ing the year.

Several measurements of discharge have also been made and a few series of slope levels observed.

A low-water survey of the reach of river between Stanley Island and the Gasconade River was made during the fall of 1892.

The above work was carried on by a party which was also employed in giving lines and levels for dikes under construction and in making measurements of work constructed. The cost of this service, including the plotting of field notes and making maps and tracing, amounts to $8,869.75.

I have been assisted in conducting the operations referred to in this report by assistants R. H. Bacot, A. H. Weber, and R. A. Crawford, in charge of construction parties; by assistant S. W. Benedict, in charge of surveys and hydrographic work, and by Mr. Morris Rosenbach in making up pay rolls and accounts.

Very respectfully, your obedient servant,

SAML. H. YONGE,
Division Engineer.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

APPENDIX F.

ANNUAL REPORT OF MR. S. WATERS FOX, DIVISION ENGINEER, GASCONADE DIVISION, 1893.

MISSOURI RIVER COMMISSION,
OFFICE OF DIVISION ENGINEER,
Hermann, Mo., June 30, 1893.

COLONEL: I have the honor to submit the following report of the operations under my charge on the Gasconade division of the Missouri River during the fiscal year ending June 30, 1893, viz:

Operations on this division consisted in hydrographic survey work; the establishment of headquarters (for this and other works under my charge) at Hermann, Mo.; the establishment of a boatyard at Gasconade, Mo., with storage and launching ways, storage yards and sheds for construction materials, plant, and supplies, railroad terminal facilities, workshops and quarters, and steam wood-working plant; the construction of telephone line from Hermann, Mo., to Gasconade, Mo.; the preparation of designs for and construction of new floating plant; the construction of revetment; the preparation of a project for the improvement of the river from Little Tavern Creek to Rhineland Landing, and miscellaneous work incident thereto.

The following illustrations accompany the report, viz:

A map (Plate I) of that portion of the river embraced in the project for improvement, showing proposed rectification, the location of the boatyard, and the revetment (A-B) constructed during the current season; a photograph taken June 2, 1893, looking upstream from the lower end of the revetment, showing the revetment, some of the new floating plant, and the yard; a drawing (Plate II) of boatyard showing the arrangement of ways, location of buildings, track, and levees.

On the 18th of August, 1892, you informed me verbally that the Gasconade division of the Missouri River, extending from the mouth of the Gasconade River to Washington, Mo., had been assigned to my charge; subsequently, by your instructions of March 8, 1893, the upper limit of the division was extended to Little Tavern Creek; that the floating plant then in my care at Omaha and St. Joseph would finally be concentrated on the Gasconade division; and that such new plant as would be required in the contemplated annual expenditure of funds for improvement work on that division should be designed at once, with a view of having it in readiness for service by July 1, 1893.

August 28 to September 3 I made a trip over the division on the U. S. Steamer *Alert* and selected Hermann, Mo., as the most suitable place for the location of an office and the strip of bottom land to the north of Gasconade as the only suitable place for a boatyard.

Survey.—In accordance with your instructions, a hydrographic survey of the river from Gasconade to New Haven was made October 1 to December 31. Subsequently, March 13 to April 6, the survey was extended to Little Tavern Creek. A map of the survey was made in pencil to a scale of 1 inch to 1,000 feet, and forwarded May to the St. Louis office for completion in ink and reduction to a scale of 1 inch to 2,000 feet. The soundings were platted, for easy comparison with subsequent soundings, on cross-section paper.

The space east of the mill and north of the quarters has been reserved for use as a ipyard in the construction of hulls.

The natural surface of the ground in the yard was quite uneven and subject to erflow, the highest ground being 21.5 feet above S. L. W. and 1.3 feet below the od of 1892. On this account the low places in that portion of the yard used most ere filled up, and the system of levees shown on the plate was built. The location d height of the levees are such that the spur track outside of the yard will be procted against overflow to a stage of 97 feet, and that portion of the yard inclosed them to a stage of 101 feet, which is 0.2 feet above extreme high water. The cost filling the depressions in the yard was $532.60; the cost of the levees was $1,117.90; e total cubic yards of earth embankment in the levee is 5,558.

A two-wire telephone line, connecting the field office in the quarters at the boatard with the Hermann office, was erected March 7 to May 6, and equipped with telphone instruments. The length of the line is 7.32 miles. The cost is shown in ppendix, Exhibit C.

Boat construction.—The construction of the boats and skiffs authorized was begun December as soon as sufficient material had been accumulated at the yard, and ontinued with a force commensurate with the rate of delivery thereafter to the end f the fiscal year. The following was the status of the work at that time, viz: 39 hree-pair-oared skiffs were finished; no work had been done on the one-pair-oared kiffs as the materials for them had not yet arrived.

Four mattress boats had been finished with the exception of the ways and kevels and their outfits of capstans. They were launched June 15, 16, and 17; the other five were in various stages of completion.

The two quarter boats for brush parties were finished, outfitted, and launched June 24. The hulls of three cross-boats for pile sinkers were finished and launched, one of them June 24, and the other June 26. The hulls of three pile sinker machine boats were finished and launched June 27, 28, and 30, respectively.

Three of the six lead towers were erected in the yard, and practically finished except placing some of the tie rods and bolts and painting them. The two Cram hammer leads, to be built at the yards, were finished except painting. The office and supply boat, launched June 24, was practically finished, except some inside work by the painters. The lines of the new steam tenders had been laid down, the molds made, and the lumber and hardware purchased, but as delivery of the materials had not been made, nothing further could be done. The lines of the new hull for the *Thetis* had been laid down, the molds made, a bill of materials gotten out and sent to market.

The high price, scarcity, and difficulty of securing, within a reasonable or definite length of time, upland-grown white oak, for boat construction, suggested the use of the Oregon or Douglas fir. The office boat, the small quarter boats, and the mattress boats were built almost exclusively of fir. The use of this material was an innovation in boat construction on the Missouri River, and some difficulty was experienced with it at first, chiefly in bending it. With proper steaming and careful handling, however, it bends well in one direction, and with great care can be formed in almost any way that is possible with oak. In all other respects, except that of hardness, it seems better adapted to the service than the oak which is furnished. It is very much cheaper. Two other important features are that it may be gotten promptly, and of any desired length. Oak was used in the construction of the other hulls; redwood and cypress in skiff construction.

Revetment construction.—The protection of the right bank of the river in the vicinity of Gasconade, by the construction of 3,210 linear feet of revetment (see accompanying map A—B), was begun in accordance with your instructions, April 4, and finished, with the exception of about 200 feet of upper bank work, June 30. Three thousand two hundred and sixty linear feet, or 2,811,626 square feet of mattress were woven in three pieces, of an average width of 86.38 feet. The brush used in this work, 1,781 cords, was purchased in open market as follows, viz: 660.1 cords at $1.50 per cord, and 1,120.9 cords at $1.25 per cord, delivered on the work at points of expenditure. The rock ballast was procured by hired labor from a quarry in the bluffs on the right bank of the Gasconade River, about three-fourths of a mile above its mouth. The cost of the revetment is shown in Appendix, Exhibits D, E, and F.

Towboat service.—The handling of floating plant on the reach, incident to revetment construction, was performed by the steamers *Gasconade*, *Pin Oak*, and *Sabrina*. The *Gasconade* was employed under a charter of $30 per day for the boat and crew to April 10. From that time until May 26, when the *Sabrina* arrived with a tow of three 100-foot barges from Kansas City, the work was done by the *Pin Oak*. It consisted simply in handling rock barges, when required, between the quarry and the revetment work. She was paid for the service at an average rate of $3.23 per barge, or $0.001,922 per ton-mile.

On March 22 the steamer *Wm. Stone* delivered at Gasconade two mattress boats from the Osage division for use in the construction of the boat-yard revetment. On

April 11 she delivered from the Osage division two brush and stone barges for use on the same work. March 31 she delivered a tow at Gasconade from Bushberg, consisting of the following pieces, viz: One barge, 25 by 100 feet, loaded with coal; one barge, 16 by 65 feet, loaded with old machinery and scrap-iron; three pile-sinker machine boats, and two small survey quarter boats with outfits.

As stated in the reports for the other divisions, the steamers *Alert*, *Sabrina*, and *Gasconade* were employed in towing plant from Omaha and St. Joseph to Kansas City, the two former during the entire season, the latter since June 1.

The delivery of the fleet from Kansas City to Gasconade was taken part in by those three steamers, the steamer *Wm. Stone* and a rafting party. The *Sabrina* made one tow, as stated above, consisting of three hulls, leaving Kansas City May 21 and arriving at Gasconade May 26. The *Alert* left Kansas City with her first tow of six hulls for Gasconade June 10. She was laid up at Jefferson City from June 14 to June 21, repairing damage to her chimneys sustained by running against a ferry cable across the river at Rulo, Nebr. On June 29 she arrived at Gasconade with a second tow of ten hulls, and cleared the same day for Kansas City with two mat-boats in tow, to be left at Ewings Landing.

The *Gasconade* left Kansas City with her first tow of four 100-foot barges June 24, and arrived at Gasconade June 26. She then made a round trip between Gasconade and Ewings Landing, to return to Division Engineer Yonge two 100-foot barges loaned for use on this division, and to bring back a small barge and boiler. She cleared for Kansas City for another tow June 28.

June 7 I was informed that the steamer *Wm. Stone* had been placed under my orders for duty in the same service. I wired instructions that day to proceed, without delay, to Kansas City for a tow. She started June 24, the interim having been devoted to the renewal of her chimneys. She left Kansas City June 28 with a tow of six hulls. After her arrival at Gasconade she will be sent to Bushberg, in accordance with the instructions contained in your letter dated June 23, for a tow of the new barges.

Repairs and alterations of plant.—The two mattress boats received March 22 from the Osage division were overhauled, provided with aprons, reel racks and reels, fair-leaders, etc. The entire tow received March 31 from Bushberg was practically unserviceable; the deck of the large barge had broken through in a number of places; the hull of one of the pile-sinkers and that of the survey quarter-boat *Pappoose* had been crushed in, and one corner, about 6 feet each way, of the cabin of the latter had been carried away. A force was at once employed putting the pieces in condition for service. Two of the pile sinkers were overhauled, and arranged and outfitted for use as hydraulic graders. The other sinker was dismantled, and the hull used to carry a set of leads and special apparatus for driving the anchor piles for the revetment. The quarter-boat *Pappoose* was repaired, and the cabin remodeled for use as a dining room and kitchen for the quarry force of 40 men. The cabin of the other small quarter-boat (No. 25) was taken off the hull, placed on land at a point convenient of access to the quarry, and remodeled for use as sleeping quarters by the quarry force. The cost of these repairs is shown in Appendix, Exhibit G.

Project for improvement.—In accordance with your instructions, I prepared and submitted to you, under date of May 27, a project, with estimates of cost amounting to $358,850, for the improvement of the river from Little Tavern Creek to Rhineland Landing.

The accompanying map, reduced by pantagraph, to a scale of 1 inch to 2,000 feet from the original, shows the location of the proposed improvement works and rectification. The project contemplates, by means of pile dikes and revetments of the standard types approved by the Commission, the concentration and confinement of the low-water flow of the river to a width of 1,100 feet between the lines, as shown.

I am, colonel, very respectfully, your obedient servant,

S. WATERS FOX,
Division Engineer.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission

List of exhibits forming appendix accompanying the foregoing report.

Exhibit A.—Cost in item of shop and quarters.
Exhibit B.—Cost in item of steam planing and sawmill.
Exhibit C.—Cost in item of telephone.
Exhibit D.—Cost in item of revetment.
Exhibit E.—Miscellaneous data and elements of cost of revetment.
Exhibit F.—Bill of cost of revetment.

pace east of the mill and north of the quarters has been reserved for use as a :d in the construction of hulls.
ıatural surface of the ground in the yard was quite uneven and subject to w, the highest ground being 21.5 feet above S. L. W. and 1.3 feet below the ! 1892. On this account the low places in that portion of the yard used most lled up, and the system of levees shown on the plate was built. The location ght of the levees are such that the spur track outside of the yard will be pro- against overflow to a stage of 97 feet, and that portion of the yard inclosed n to a stage of 101 feet, which is 0.2 feet above extreme high water. The cost g the depressions in the yard was $532.60; the cost of the levees was $1,117.90; al cubic yards of earth embankment in the levee is 5,558.
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construction.—The construction of the boats and skiffs authorized was begun ember as soon as sufficient material had been accumulated at the yard, and ıed with a force commensurate with the rate of delivery thereafter to the end fiscal year. The following was the status of the work at that time, viz: 39 ›air-oared skiffs were finished; no work had been done on the one-pair-oared s the materials for them had not yet arrived.
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two quarter boats for brush parties were finished, outfitted, and launched 4. The hulls of three cross-boats for pile sinkers were finished and launched, them June 24, and the other June 26. The hulls of three pile sinker machine were finished and launched June 27, 28, and 30, respectively.
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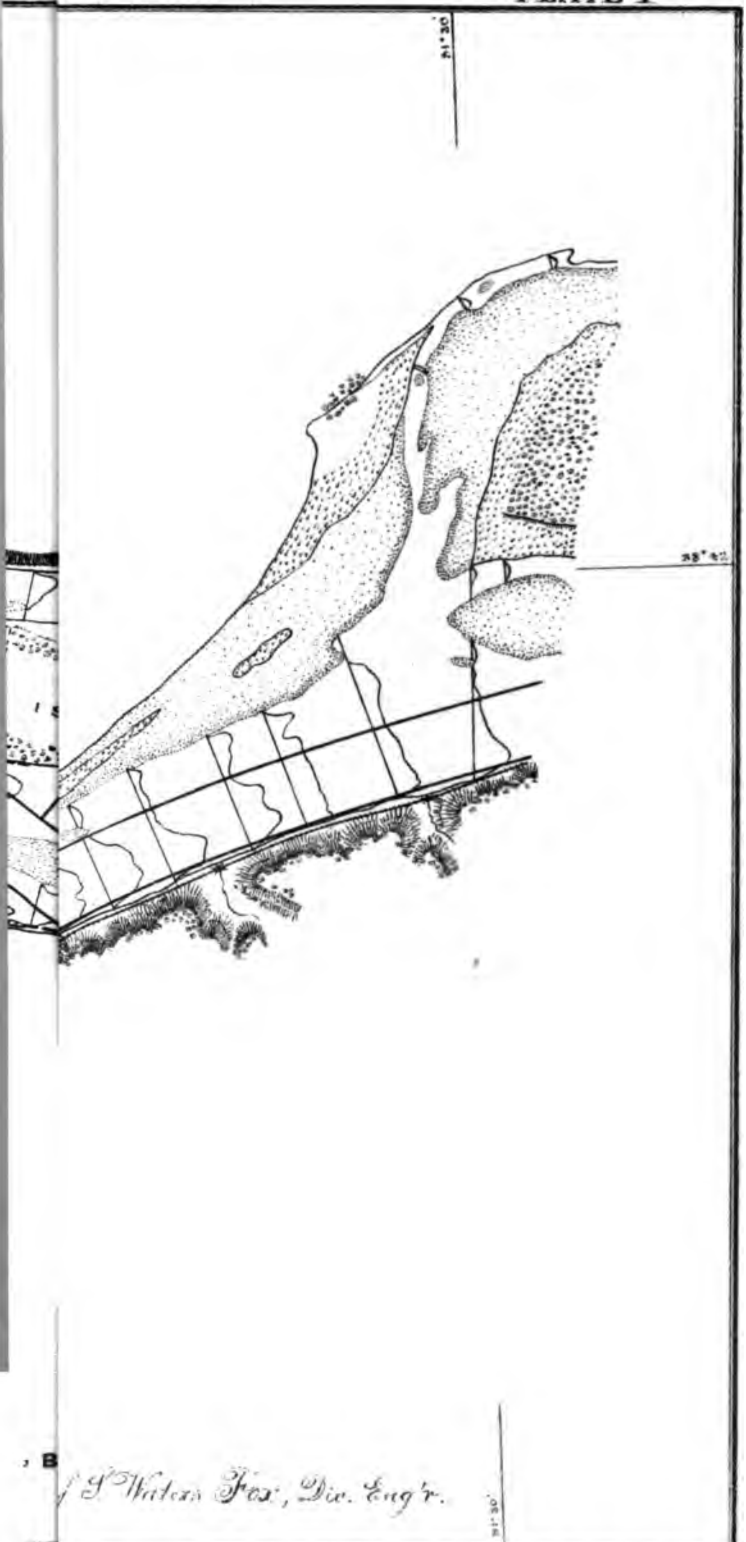
high price, scarcity, and difficulty of securing, within a reasonable or definite of time, upland-grown white oak, for boat construction, suggested the use of egon or Douglas fir. The office boat, the small quarter boats, and the mattress were built almost exclusively of fir. The use of this material was an innova- boat construction on the Missouri River, and some difficulty was experienced at first, chiefly in bending it. With proper steaming and careful handling, er, it bends well in one direction, and with great care can be formed in almost y that is possible with oak. In all other respects, except that of hardness, it better adapted to the service than the oak which is furnished. It is very much r. Two other important features are that it may be gotten promptly, and of sired length. Oak was used in the construction of the other hulls; redwood press in skiff construction.
ment construction.—The protection of the right bank of the river in the vicin- Gasconade, by the construction of 3,210 linear feet of revetment (see accompa- nap A—B), was begun in accordance with your instructions, April 4, and fin- with the exception of about 200 feet of upper bank work, June 30. Three nd two hundred and sixty linear feet, or 2,811,626 square feet of mattress were in three pieces, of an average width of 86.38 feet. The brush used in this ,781 cords, was purchased in open market as follows, viz: 660.1 cords at $1.50 rd, and 1,120.9 cords at $1.25 per cord, delivered on the work at points of iture. The rock ballast was procured by hired labor from a quarry in the n the right bank of the Gasconade River, about three-fourths of a mile above ıth. The cost of the revetment is shown in Appendix, Exhibits D, E, and F.
oat service.—The handling of floating plant on the reach, incident to revet- onstruction, was performed by the steamers *Gasconade*, *Pin Oak*, and *Sabrina*. *sconade* was employed under a charter of $30 per day for the boat and crew il 10. From that time until May 26, when the *Sabrina* arrived with a tow of 00-foot barges from Kansas City, the work was done by the *Pin Oak*. It con- simply in handling rock barges, when required, between the quarry and the ent work. She was paid for the service at an average rate of $3.23 per barge,)1,922 per ton-mile.
larch 22 the steamer *Wm. Stone* delivered at Gasconade two mattress boats ıe Osage division for use in the construction of the boat-yard revetment. On

EXHIBIT D.—*Cost in detail of 3,210 linear feet of revetment at Gasconade, Mo.,*

Classification and extent.	Cost per unit.	Cost of each item.	Cost per linear foot.	Tot
Procuring 1,781 cords of willow brush, viz:				
660.1 cords purchased, delivered on work	$1.50	$990.15		
1,120.9 cords purchased, delivered on work	1.25	1,401.12		
Binding material	.0174	31.06		
	....	2,422.33	$0.7546	$
Procuring 8,187 cubic yards of rock, viz:				
Quarry privilege	.01	81.87		
Stripping, 2,497 cubic yards	.3365	840.24		
Quarrying	.2033	1,664.42		
Barging	.1363	1,115.97		
Handling and piling	.0341	280.00		
Supplies, powder, fuse, dynamite, and caps	.0233	191.05		
Subsistence	.0974	797.66		
Towage, labor, fuel, and subsistence	.1427	1,168.35		
	....	6,139.56	1.9126	
Weaving 3,260 linear feet of mattress, viz:				
Labor	.4393	1,432.31		
Subsistence	.1496	487.95		
	.5889	1,920.26	.5982	
Anchoring 3,260 linear feet of mattress, viz:				
Labor	.1436	468.16		
Subsistence	.0491	160.32		
Strand, ⅜", 29,066 pounds, at $0.037121 per pound	.3309	1,078.97		
Cable, 1¼", 46,843 pounds, at $0.005 per pound	.0718	234.21		
	.5954	1,941.66	.6049	
Hydraulic grading, 11,735 cubic yards, viz:				
Labor	.0338	396.99		
Subsistence	.0081	95.31		
Fuel	.0082	96.15		
	.0501	588.45	.1833	
Sinking and driving anchor piling, viz:				
Labor	.7508	251.54		
Subsistence	.0226	75.94		
Material, 335 piles	2.00	670.00		
	2.7734	997.48	.3107	
Placing 8,187 cubic yards of rock, viz:				
Labor	.1420	1,162.45		
Subsistence	.0484	396.70		
	.1904	1,559.15	.4858	
Total			4.8501	1

EXHIBIT E.—*Miscellaneous data and elements of cost exhibit, Gasconade, Mo.,*

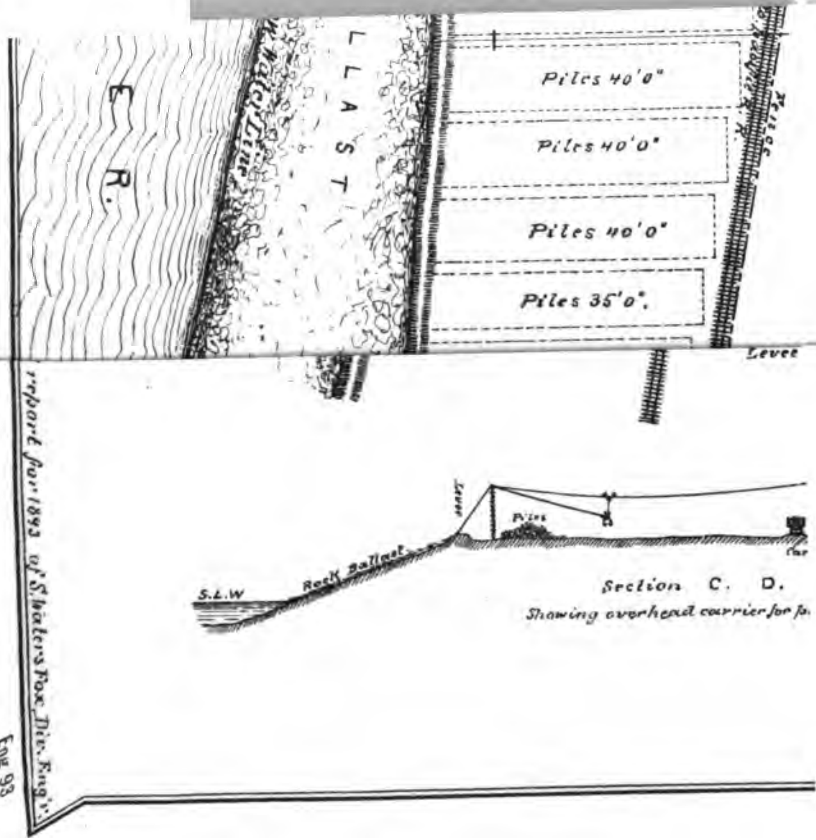
Classification and extent:
- Linear feet of revetment
- Linear feet of mattress
- Square feet of mattress 2
- Average width
- Total cost $15,
- Cost per linear foot of revetment .... $
- Cost per square (100 square feet)
- Meals issued to workmen (number)
- Subsistence, cost per capita per diem .... $



81°30'
33°42'
81°30'
, B
J. S. Waters Fox, Div. Eng'r.

MISSOURI RIVER COMMISSION.—GASCONADE DIVISION.

Looking upstream from the lower end of the revetment, showing the revetment, some of the new floating plant, and the yard, June 29, 1893.


Piles 40'0"
Piles 40'0"
Piles 40'0"
Piles 35'0".
Fence
Levee
L L A S T
E R.
Section C. D.
Showing overhead carrier for p.
Levee
Piles
Rock Ballast
S.L.W
report for 1893 of S. Waters Fox, Div. Eng'r.

HIBIT F.—*Bill of cost of 3,210 linear feet of revetment at Gasconade, Mo., 1893.*

ification and extent:	
60.1 cords of brush delivered on work, at $1.50 per cord	$990.15
.120.9 cords of brush delivered on work, at $1.25 per cord	1,401.12
70½ pounds of binding wire, No. 18, at $3.20 per cwt	31.06
9,066 pounds of wire strand, ⅜-inch, at $0.037121 per pound	1,078.97
6,843 pounds of cable, second-hand, 1¼-inch, at $0.005 per pound	234.21
35 cottonwood piles, at $2 each	670.00
,187 cubic yards of rock, viz:	
Quarry privilege	81.87
Quarry supplies, powder, fuse, etc	191.05
8,187 cubic yards procured by hired labor	4,698.29
.abor and subsistence:	
Ballasting	1,559.15
Weaving	1,920.26
Anchoring	628.48
.abor, fuel, and subsistence:	
Hydraulic grading	588.45
Sinking and driving anchor piling	327.43
Towage	1,168.35
Total cost, exclusive of administration, care, and repair of plant	15,568.89

APPENDIX A A A.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.

[Reported under section 2, river and harbor act of 1884, and section 4, river and harbor act of 1886.]

(1) REPORT OF CAPT. THOS. L. CASEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New York, August 10, 1893.

GENERAL: I have the honor to transmit herewith a report on "occupation or injury to piers," etc., to accompany my annual report for the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

THOS. L. CASEY,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

DIKES.

SOUTH RIVER, NEW JERSEY.

The Sayre and Fisher Company and Wm. F. Fisher have occupied portions of dikes in the canal for several years. They have brickyards in the rear of the dikes; have filled in out to them, using the dikes as a bulkhead and landing for loading and unloading cargoes. No damage or injury has been done the dikes as yet. Sayre and Fisher applied for a permit to make this use of the dike in 1888, but owing to dispute as to title to the land, none was granted.

CANARSIE BAY, NEW YORK.

In 1881 a permit was granted one B. B. Remsen to construct a frame building on the end of the north dike, he agreeing to protect the dike from trespassing fishermen. The building had been used for the sale of intoxicants, and consequently was the means of drawing trespassers instead of being a protection. This permit was revoked September 2, 1892, and the occupant notified September 15, 1892, to vacate the dike, removing the building therefrom within seven days from that date, which was accordingly complied with.

PASSAIC RIVER, NEW JERSEY.

The injury worked to the dike in Newark Bay by the contractors of the Jersey City, Newark and Western Railroad Company in violation of section 9 of the river and harbor act of September 19, 1890, reported in Annual Report for 1892, was reported to the United States attorney for the district of New Jersey September 12, 1892, in compliance with Department instructions of September 7, 1892, and no information has as yet been received as to what action, if any, has been taken in the matter.

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(2) REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Washington D. C., July 10, 1893.

GENERAL: In accordance with General Orders No. 6, Headquarters, Corps of Engineers, Washington, June 1, 1887, and General Orders No. 9, from the same headquarters, dated June 26, 1888, I have the honor to submit the following report of all cases in which piers, breakwaters, locks and dams, or other structures or works built or made by the United States in aid of commerce or navigation in this district, are used, occupied or injured by a corporation or an individual, and the extent and mode of such use, occupation or injury.

OCCUPANCY OF THE POTOMAC FLATS BELONGING TO THE WORKS OF IMPROVEMENT OF THE POTOMAC RIVER, AT WASHINGTON, DISTRICT OF COLUMBIA.

Henry Lyles, Henry S. McGlue, Louis M. Goodrick, Valentine Ruebsam, and John B. Lord, all residents of Washington, are in the habit, and have been for some years past, of using a portion of the land reclaimed by filling in by the Goverment in carrying on its improvement of the Potomac River, for the purpose of carrying on a traffic in building-sand. The sand is brought in scows through the sewer canal crossing the flats near the foot of Seventeenth street NW., and piled up on the land alongside the canal and thence removed by carts to various points of delivery in the city. In addition, the last-named person, John B. Lord, builds barges, scows, etc., on the banks of the small tidal eservoir on the flats, hauling his building materials through the large nd the small tidal reservoirs and their connecting channels.

As all this is in direct violation of section 9 of the river and harbor ict of September 19, 1890, a report in accordance with section 11 of the same act, giving the information to the United States district attorney, vas made July 18, 1892.

H. Clay Jones, of Alexandria, Va., has built a small wharf or landng partly on ground belonging to the Potomac River improvement and ibutting on the tidal reservoir, in order to facilitate the loading of vesels with manure. This was also reported to the United States District Attorney April 4, 1893.

On June 26, 1893, a letter was addressed to the United States Disrict Attorney requesting information as to the status of these cases, but up to date no answer has been received.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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(3) REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

The only additional information received during the fiscal year ending June 30, 1893, concerning the occupation of, trespass upon, or injury to public works in charge of this office, is as follows:

1. A fence owned by Mr. L. F. Allien, of Bay View, Tex., projected on the Government property at Morgan Point. Mr. Allien was notified to remove this fence by November 30, 1892, which he did.

2. A portion of the residence of Mr. J. J. Atkinson projected about 15 feet upon the Government ground at Morgan Point. Notice was served on him to remove house by December 31, 1892. This was done.

3. A wharf belonging to Mr. L. F. Allien was built on the right bank of Morgan Canal, thus obstructing a navigable water of the United States. Mr. Allien was notified to remove wharf by November 30, 1892, and was given permission to build a new wharf off the reservation, which he did.

4. On August 24, 1892, the steam tug *Juno*, Capt. L. F. Folk, having a dredge in tow, collided with the revetment at Morgan Canal, and damaged it by splitting one of the square piling. The matter was reported to the Chief of Engineers, U. S. A., Washington, D. C., and to the United States District Attorney at Paris, Tex., on September 5, 1892.

Submitted in compliance with Special Order No. 9, Headquarters, Corps of Engineers, June 26, 1888.

A. M. MILLER,
Major, Corps of Engineers.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 1, 1893.

(4) REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, September 2, 1893.

GENERAL: In reply to Department letter of August 30, 1893, I have the honor to report that the only instance in the district in my charge of occupancy of and injury to public works by corporations and individuals is as follows:

LOCK NO. 3, GREEN RIVER, KENTUCKY.

A. J. Craig is occupying about 1¼ acres of the United States land on abutment side of river.

The matter has been reported to the United States Attorney for Kentucky.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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(5) REPORT OF MAJ. WILLIAM LUDLOW, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 17, 1893.

GENERAL: Complying with General Orders No. 9, of June 26, 1893, I have the honor to report with reference to the works in my charge that there are no cases of use or occupation of Government works in aid of commerce or navigation during the past fiscal year, with the following exception:

The act of July 13, 1892, in appropriating for the harbor of St. Joseph, contains the following:

> The Cincinnati, Wabash and Michigan Railroad Company, owners of the land abutting on the north side of Saint Joseph River and harbor, shall have the right to load and unload freight over the east three hundred feet of the wing dam or wall constructed at the entrance to Benton Harbor Canal, in the harbor of Saint Joseph, Michigan, under such regulations and orders as may be approved by the Secretary of War; said right to be at any time revocable by him or Congress, after 20 days' notice to said company; and in consideration thereof the said railroad company shall, at their own proper cost and expense, rebuild, repair, renew, and protect the said three hundred feet of wing dam; all such rebuilding, repairs, and renewals to be done under the direction of the Chief of Engineers of the United States Army.

The Cincinnati, Wabash and Michigan Railroad is now a division of the Cleveland, Cincinnati, Chicago and St. Louis Railway system, commonly designated "The Big Four."

The company has in part availed itself of the privilege accorded, and proposes presently to complete the work. The plans for rebuilding, etc., were submitted December 29, 1892, and after certain modifications had been made at my suggestion, were approved by the Chief of Engineers under date of January 27, 1893.

The known instances of injury done to works in my charge are as follows:

1. Portage Lake, August 18, 1892.—The schooner *Cuba* ran into the end of the north pier, breaking off the horns and four upper channel wale timbers, and injuring the decking.

2. Muskegon Harbor, October 28, 1892.—Schooner *Ralph Campbell*

at 2 a. m. in rough weather, struck the south pier about 100 e the end, and tore away a considerable portion of the elevated :ing to the light-house.

e harbor and date.—Schooner *Nellie Hammond* entering at ith violent sea, struck first one pier, and rebounding struck '. The injury to piers was not material, but the schooner and subsequently raised.

kegon, November 21, 1892.—Schooner *Minerva* entering in a t gale struck the end of the north pier, cutting through the ıbers and the upper six courses of the end wall.

r of the additional cribs to be built this season, immediate ere not deemed necessary.

ɜ of these cases of collision did the facts indicate special fault ɪrt of the vessels.

ry respectfully,

WILLIAM LUDLOW,
Major, Corps of Engineers,
Bvt. Lieut. Col., U. S. A.

·en. THOMAS L. CASEY,
hief of Engineers, U. S. A.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., September 2, 1893.

·AL: In accordance with section 4 of the river and harbor act ɪt 5, 1886, the General Orders No, 9, Headquarters Corps of s, June 26, 1888, I have the honor to report the following ere "piers, breakwaters, etc.," under my charge "have been ıpied, or injured by a corporation or individual" during the r ending June 30, 1893.

DS OCCUPIED BY U. S. LIGHT-HOUSE ESTABLISHMENT.

nited States Light-House Establishment occupies as site for ıer's dwelling a portion of the St. Marys Falls Canal grounds, ɔy 200 feet, extending from the south bank of the canal to eet in the city of Sault Ste. Marie, Mich., and just west of the meridian of Michigan, the authority for this occupation being f Secretary of War William C. Endicott dated March 25, 1885, g terminable at pleasure of the War Department; also the end of the southwest canal pier, by a light house, and a por- ɪe northwest pier by a range light; authority by act of Con- ed March 3, 1879.

ited States Light-House Establishment also occupies the lower ɪr ends of the west pier of the St. Clair Flats Ship Canal by ses. Authority by acts of Congress dated July 28, 1866, and 1871.

CY OF PUBLIC LANDS, ETC., BELONGING TO THE RESERVATION OF ST. MARYS FALLS CANAL, MICHIGAN.

the fiscal year ending June 30, 1893, the reservation has been as reported in my annual report for 1891, printed on p. 3868 *et seq.*, of the Annual Report of the Chief of Engineers for 1891. In addition, the following new cases of occupancy have occurred:

1. By the Edison Sault Electric Company by an embankment dam. The authority for this occupation is a "revocable license" to the Edison Sault Electric Company, a corporation existing under the laws of the State of Michigan, to construct and maintain a dam in the St. Marys River Rapids, adjacent to the property of the Edison Sault Electric Company, at Sault Ste. Marie and extending into the river to a point half the distance from the shore to Islands Nos. 1 and 2, granted by Acting Secretary of War L. A. Grant on the 13th day of August, 1892.

2. By the city of Sault Ste. Marie, Mich., by an intake pipe for water supply. The authority for this occupation is a "revocable license" to the city of Sault Ste. Marie, a municipal corporation existing under the laws of the State of Michigan, to lay a new intake pipe from Pump House to 200 feet above upper end of South West pier (Lock of 1881) and nearly parallel to said pier, granted by Secretary of War Daniel S. Lamont on the 21st day of March, 1893.

INJURIES TO PIERS, ETC., OF ST. CLAIR FLATS CANAL, MICHIGAN.

On April 20, 1893, the steam barge *Phillip Minch*, bound down, sheered, and ran into the east pier, doing $147.95 damage.

On June 19, 1893, the steamer *Saginaw Valley* sheered and ran into west pier, doing $97.86 damage.

No further use, occupation, or injury to works in my charge than these above reported, are known to have occurred during the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

O. M. POE,
Colonel, Corps of Engineers,
Bvt. Brig. General, U. S. A.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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(7) REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., July 21, 1893.

GENERAL: In accordance with circular letter, Department Headquarters, August 15, 1892, I have to report that the Delaware, Lackawanna and Western Railroad are in unlawful possession of the North United States Pier at Buffalo, N. Y. This matter has been repeatedly reported upon by my predecessors, and the status at present is that the assistant United States District Attorney, in whose hands the matter is for report, has recommended to the Attorney-General that the United States seize and hold this pier by force until the railroad company bring suit to quiet the title.

There is no other case of the occupation by individuals or corporations of property belonging to the United States in the district under my charge.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(8) REPORT OF MAJ. T. H. HANDBURY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, September 7, 1893.

GENERAL: To comply with the requirements of General Order No. 9, Headquarters Corps of Engineers, U. S. A., June 26, 1888, I have the honor to report that there are no structures or works built by the United States in aid of commerce or navigation on any of the rivers or harbors in my charge that were used, occupied, or injured by a corporation or an individual during the fiscal year ending June 30, 1893, excepting that under authority of act of Congress approved March 3, 1891, the State of Oregon was permitted to enter upon the Government grounds at Cascade Locks, and build and operate thereon a portage railroad.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX B B B.

MAINTENANCE AND REPAIRS OF WASHINGTON AQUEDUCT—INCREASING THE WATER SUPPLY OF WASHINGTON, DISTRICT OF COLUMBIA—ERECTION OF FISHWAYS AT GREAT FALLS.

REPORT OF COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

1. Washington Aqueduct.
2. Increasing the water supply of Washington, D. C.
3. Erection of fishways at Great Falls.

OFFICE OF THE WASHINGTON AQUEDUCT,
Washington, D. C., June 30, 1893.

GENERAL: I have the honor to transmit herewith report of operations for the following works in my charge for the fiscal year ending June 30, 1893, viz:

Washington Aqueduct.
Increasing the water supply of Washington, D. C.
Erection of fishways at Great Falls.

Very respectfully, your obedient servant,

GEORGE H. ELLIOT,
Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

B B B 1.

WASHINGTON AQUEDUCT.

Appropriations for the Washington Aqueduct are applied to the improvement, the maintenance, and repair of those portions of the Washington water supply, other than the tunnel from the distributing reservoir to the new reservoir near Howard University, that have been placed under the supervision of the Chief of Engineers. The works include the masonry dam, 2,877 feet long, extending from the Maryland to the Virginia shore at Great Falls of the Potomac, 14 miles west of Washington; the works at Great Falls for regulating the supply of the conduit; the conduit from Great Falls, 9 feet in diameter; the three reservoirs, viz, the receiving (or Dalecarlia) reservoir, about 4½ miles west of the city, the distributing reservoir, about 2 miles west of the city, and the high-service reservoir in Georgetown for the supply of the higher portions of that city; the mains by which the water is carried from the reservoirs and delivered into the city's distributing system, and the bridges for supporting the mains across Rock Creek.

The following statement exhibits the condition of the acqueduct and its accessory works and the operations of the last fiscal year.

THE DAM AND OTHER WORKS AT GREAT FALLS.

No damage has been done to the masonry dam at Great Falls during the last fiscal year, and it is in excellent condition. Some of the riprap back of the dam that was carried away by ice in previous fiscal years was not replaced during the last year by reason of the inadequacy of the appropriation for preservation and repair, and the pressure of more immediately important work.

In July the bed of the river in front of the conduit mouth having been shoaled so much by deposits as to interfere with the proper supply to the conduit at low stages of the river, about 70 cubic yards of material were excavated in increasing the depth of the river bottom at this place by 18 inches.

Several times during the past winter the screen at the mouth of the conduit was in danger of being obstructed by ice to such a degree as to interfere with the supply to the city, but the watchman and his assistants succeeded in preventing any serious results.

Estimates for the protection of the inlet to the aqueduct at Great Falls, for the construction of a storehouse at the same place, and for the protection of the conduit at Wasteweir No. 1, near Great Falls, will be found in the list of estimates appended hereto, and explanations of the same will be found farther on in this report under the title "Explanations of Estimates."

THE CONDUIT AND THE CONDUIT ROAD.

The conduit.—The conduit between Great Falls and Wasteweir No. 2, which is in Tunnel No. 4 near Dalecarlia reservoir, was flushed several times during the year; that is to say, the flow from the conduit into the distributing reservoir was shut off, and all the gates at Great Falls being opened the entire flow of the conduit was turned through the two waste gates that are in the dam of Wasteweir No. 2, by which means a rapid flow through the conduit of about 5 feet per second is produced.

An estimate of $11,000 was included in my last annual estimates for removing the thirty years' accumulation of deposits in the conduit, which I found in my inspection of September, 1891, to be about 15,500 cubic yards; but this estimate has not yet been acted on by Congress. The deposits in Tunnel No. 4, and the 9-foot by-conduit at the Dalecarlia reservoir, have been pretty well cleaned out in the last two years by means of the small general appropriations for repairs; but as this appropriation is barely sufficient for the most urgent work required for controlling the supply of water to the city and the maintenance of the aqueduct system, including the conduit, the reservoirs, and the 21 miles of 48-inch and other mains in the city, these appropriations can not be relied on to complete the expensive work of removing the deposits by hand, and all I can expect to do until the appropriation shall be granted is, by means of flushing, to prevent further accumulation. This requires, however, the wastage of a large quantity of water that during the low stages of the river can not be spared.

The culverts under the aqueduct, of which there are 26 between Great Falls and the distributing reservoir, were kept clear of the material that is washed into them in severe storms. A number of bowlders that had been carried in this way into Culvert 25 were used in constructing a wall on the side of the stream that flows through the culvert.

An experiment was made on June 20 to find the value of C in the Chezy formula $V = C\sqrt{R.\ I.}$ for the 9-foot conduit between the Dalecarlia and the distributing reservoir. The head of water on the crown of the arch in this portion of the conduit is about 4 feet.

The elevations of the water were taken for this purpose at the upper one of the 4 ventilators just below the Dalecarlia reservoir, and in the influent gatehouse at the distributing reservoir, these elevations being referred to the elevations of the masonry at these points, as shown in Gen. Meigs's plans of the aqueduct. The difference of elevation found was .5901 of a foot. The horizontal distance is 9,490 feet. The hydraulic slope, or I, was therefore $\frac{.5901}{9490} = .00006218$.

The amount of water consumed and wasted in the city was measured at the distributing reservoir at the same hour the next day and was found to be at the rate of 2,362,918 gallons per hour or 87.73 cubic feet per second. The sectional area of the 9-foot conduit is 63.617 square feet, but as there is about 6 inches of deposit in the bottom, the sectional area of the waterway may be assumed to be 62.247 square feet. Assuming that the same quantity of water passed through the conduit at the same time on June 20, (which was no doubt essentially true) we find the mean velocity through the conduit to have been 1.409 feet per second. Then, as the value of R for the reduced section of the conduit is 2.214 feet, we have $C = \frac{1.409}{\sqrt{2.214 \times .00006218}} = 120$. This is smaller than I anticipated, but after a careful leveling and horizontal measurement between the ends of the section of the conduit under trial, it appears to be correct.

On an application of Mr. J. P. Clark, that Congress be urged to provide for the removal of wasteweir No. 3, and the waste gate under the weir, a careful survey was made of the land and water courses in the vicinity of the weir. A report thereon was made and the Secretary of War decided on January 7 that Congress should not be asked to take any action in the matter; that the War Department should continue to use the weir where it is, in the same manner that it has been using it since the construction of the aqueduct, a period of about thirty-five years. If, however, Mr. Clark, as owner of the adjoining land over which the waste water from the weir is drained, should make application to have the Government lay a pipe through the land by means of which the water from the wasteweir and gate could be carried off, his application would receive due consideration by the Department.

It having been found that when the stop timbers at the influent gate house at the distributing reservoir were put down for the purpose of shutting off from the reservoir the water from Great Falls before commencing the periodic measurement of the daily consumption and waste in the city, the water in the conduit above was abnormally raised and to a height that might endanger the conduit, directions were given the division watchman always to open the waste gate in the dam of wastewEir No. 3 in time to prevent the water in the conduit from rising at that point above elevation (146.4) which is 1.4 feet above the lip of the weir.

A wooden flume 16 feet long by 10 feet wide was constructed for the purpose of preventing the wearing of the banks of the stream into which is discharged the outflow from wasteweir No. 3, and the gate under the weir.

The Conduit road.—The Conduit road between the Dalecarlia (receiving) reservoir and the distributing reservoir has been repaired during the year. About 850 cubic yards of flint rock, which is by far the best and most durable material that can be obtained for Macadam pavement in the vicinity of the road, was crushed and put on the road commencing at the south line of the Dalecarlia reservoir lands and running 4,007 feet toward the distributing reservoir, or to a point a short distance this side of culvert No. 24. The stone was put on about 4 inches deep and about 12 feet wide, and rolled as well as possible with the roller belonging to the aqueduct, but this roller is not heavy enough and a heavier one was obtained from the District government. The road at the southeast end of the distributing reservoir extending from the auxiliary gate house to a point opposite the air-valve on the 48-inch main was also thoroughly repaired with flint stone the full width of the road. The repairs of the last year are the most extensive that the Conduit road has had for many years. It is to be regretted that the annual appropriation for the aqueduct does not permit greater expenditures for this purpose. Most of the flint rock was obtained from a quarry on the Maddox farm, near culvert No. 25, at a cost of 20 cents per cubic yard in the quarry; but the quarry was exhausted, and this kind of rock is getting to be scarce along the line of the conduit between the two reservoirs. Below culvert No. 24, a considerable length of the road was repaired with broken bluestone.

The further side of Dalecarlia Hill, which is quite steep, is the portion of the Conduit road most difficult to keep in good order, by reason of the habit of the drivers of heavy teams of chaining their wheels in descending the hill. I have recently caused it to be graded preparatory to laying a Macadam pavement early in the next fiscal year.

About 700 feet of substantial fencing on the sides of the Conduit road near the Dalecarlia reservoir was made during the year.

In my last annual report I mentioned the damage to the Conduit road by reason of the earth and clay washed upon it from the newly excavated streets above the road. The locality from which most of the trouble arises is a subdivision of White Haven, and as the streets in this subdivision have been accepted by the city I requested the Commissioners on March 14 to take the necessary measures to prevent it, which can be done at an expense of about $250. The Commissioners could not spare the funds for that purpose at the time, but promised to remedy the evil as soon as possible.

Estimates for the removal of deposits in the conduit; for raising the masonry casings of the manholes along the line of the conduit, and for commencing the work of widening the Macadam pavement of the Conduit road, by widening the pavement of the road between the two reservoirs, will be found in the list of estimates appended hereto, and explanations of the same will be found further on in this report under the title "Explanations of Estimates."

THE RESERVOIRS.

Improving the Dalecarlia (receiving) reservoir.—By an act of Congress approved by the President on the 3d of March, 1893, an appropriation commencing the improvement of the Dalecarlia (receiving) reservoir s made in the following terms:

owards improving the receiving reservoir by the works required for cutting off drainage into it of polluted waters and sewage from the surrounding country, the purchase or condemnation of the small amount of land required for the pur- e, and for the excavation necessary at the head of the reservoir, sixty thousand lars; *Provided*, That the whole cost of the work shall not exceed the sum of one dred and fifty thousand dollars; to be done by contract or otherwise as the Sec- ry of War may determine.

'he following is a description of the watershed of the reservoir, and approved project for the expenditure of the foregoing appropria- l:

'rom East Creek around to the south connection (see accompany- plat marked M) the land around the reservoir is public land per- ning to the reservoir, and with a slight exception the outer margin the watershed in this direction is on this land, so that no polluted inage water can enter the reservoir from this direction.

'rom the south connection to the spillway the margin of the reser- r is mainly occupied by the dam of the reservoir.

'rom the spillway to the shaded area of land marked B the land ublic land and no drainage water can enter the reservoir.

t is proposed to purchase or condemn, as authorized by the act, the ided area of land marked B, so that no polluted drainage water will er the reservoir from this direction.

'rom the north connection to the site of the dam (see plat M) which s proposed to construct across Little Falls Branch, the entrance of drainage water into the reservoir is guarded against by the condi- ns imposed upon the Metropolitan Southern Railroad Company by Secretary of War under the requirements of the act of Congress of rch 3, 1891, granting a right of way through the reservoir lands his railway, which conditions were accepted by the railroad com- y.

'he object to be accomplished by the works of improvement is there- to exclude from the reservoir all the drainage water that now runs it from the three streams known as East Creek, Mill Creek, and tle Falls Branch (See plats M and N herewith), and also the water t falls directly into the reservoir from the land lying contiguous to reservoir and between these streams.

'he watershed of the three streams is shown on plat N, which is a uction from the map of the environs of Washington, which was pre- ed from original surveys in the Engineer Department. The major tion of it is, as will be observed, in Maryland, and is altogether an icultural, grazing, and wooded land. The portion that is within the trict of Columbia is mainly agricultural and grazing land, but on eastern border are the village of Tennallytown and the new village Chevy Chase. Further suburban improvements may be expected ng the Loughboro and Rockville roads in the vicinity of this der, but the major portion of the area of the watershed within the trict, with the exception of scattered farm houses and villas, will btless remain unbuilt upon.

'he watershed of East Creek as shown on the plat contains 224 acres; watershed of Mill Creek contains 886 acres; and the watershed of le Falls Branch contains 2,712 acres. The combined watershed, drainage from which is to be provided for in the works contem- ed by the act of March 3, 1893, may therefore be assumed to have area of 3822 acres.

Having found the areas of the three subsidiary watersheds and combined area of the entire watershed, it has been necessary to m a careful estimate of the maximum amount of water that ma expected to flow from these areas.

I have made this estimate from the well-known Burkli-Ziegler mula, which is considered as better adapted to this country than other, and have tested the results by the rule followed by our i eminent hydraulic engineers.

1. *The Burkli-Ziegler formula.*—The formula is—

$$Q = f.\,r.\left(\frac{S}{A}\right)^{\frac{1}{4}}, \text{ in which}$$

Q is the quantity in cubic feet dischared per acre per second.

f is a variable coefficient, increasing from 0.25 for purely rural tricts to 0.75 for areas closely built over.

r is the rate of rainfall in inches per hour during heaviest rain.

S is the average slope of the watershed in feet per 1000 feet, and A is the number of acres in the watershed.

The value of f.—Considering the present condition of the waters and its future prospects, I think that 0.40 would be a large, but unreasonable value to assume for f.

The value of r.—I have assumed 1.5 for the value of r. There been recorded instances of higher rates of rainfall in inches per h but as it is the invariable rule that they are for very short period time too short for concentration of flow from a surface of nearly 4 acres, I think these instances need not be considered. Through the k ness of Prof. Harrington, chief of the Weather Bureau, I have furnished with a table of the amounts and the durations of the h falls, and the amounts and durations and rates per hour in inch the maximum falls, as recorded by the automatic rain gauges at Washington office of the Weather Bureau and its predecessor the nal Office, in all the heavy storms that, with the exception of the 1879, occurred from June 10, 1876, to November, 1892. A copy of interesting record will be found in an appendix to this report. I compiled from it the following table:

Table of heavy falls of rain of one hour or more than one hour, at Washington, D. C. June 10, 1876, to November 18, 1892, showing duration and rate per hour in inc

Date.	Duration.		Rate per hour.	Date.	Duration.		R
	Hr.	*min.*	*Inches.*		*Hr.*	*min.*	*I*
Oct. 23, 1876	1	50	0.97	Oct. 29, 1885	1	00	
June 21, 1877	1	30	1.09	Mar. 31, 1886	1	00	
Oct. 4, 1877	1	00	1.20	June 22, 1886	1	00	
Nov. 24, 1877	1	15	.64	July 26, 1886	1	00	
Mar. 12, 1878	1	30	.53	July 1, 1889	1	22	
Oct. 23, 1878	1	00	.70	Sept. 17, 1889	1	00	
Apr. 29, 1880	1	00	.25	Aug. 1, 1890	1	00	
June 15, 1880	8	00	.25	Oct. 23, 1890	4	00	
Aug. 3, 1880	1	00	.54	May 3, 1891	1	07	
Dec. 22, 1881	1	00	.20	May 26, 1892	1	30	
Sept. 24, 1883	1	00	.42	Sept. 23, 1892	1	00	

It will be found from this table that there was, during the fi and a half years covered by the record, no rainfall lasting one ho more that had as high a rate of fall as 1½ inches per hour, and th only four storms was there a rainfall lasting one hour or more that as high a rate as 1 inch per hour.

ble from which the above table has been compiled also shows
r short (rarely more than a few minutes) are the periods of the
bursts of rain or "downpours" which are from time to time
ed in newspapers.

lue of S.—The value of S may be safely taken at 100.

ing in the formula the foregoing values of *f*, *r*, and S, and the
the subsidiary watersheds in acres, I find that the maximum
es of water in cubic feet that may be expected to be discharged
watersheds are as follows:

	Cubic feet per second.
k	110
:	308
ls Branch	714
l	1,132

rule adopted by Mr. Alphonse Fteley, engineer of the Croton
et, and also by the engineers of the Boston waterworks, for
ng the capacity of spillways or waste channels required for
off surplus waters, in the highest freshets, is to provide for a
of water that would be equivalent to 6 inches in depth in
our hours from the entire watershed.

B. Francis, in giving his views as to the sufficiency of a pro-
r a flood discharge, and referring to the great storm in the
cut Valley in 1869, said:

ie maximum rate of flow for this watershed would be in such a case I have
of estimating with precision. It is clear that it would be less than the
ich the rain fell, but combination of circumstances appear to be possible
t may approach it during part of the storm; and, to be on the safe side, I
w equivalent to 6 inches in depth in twenty-four hours from the whole
should be provided for. This is between three and four times the esti-
r in the great freshet of March, 1876, above referred to.
omputed approximately the capacity of the proposed arrangements in these
he discharge of surplus water and find that in each case it equals or exceeds
ty above suggested, and I therefore conclude that ample provision is made.

ile would give the following discharges from the three water-

	Cubic feet per second.
k	57
	224
s Branch	682
l	963

ubic feet less than given by the Burkli-Ziegler formula.

fore conclude that if our drainage works are planned so as to
for the amount of water that, according to the Burkli-Ziegler
will be discharged in the heaviest rainfalls—that is to say, from
eek, Mill Creek, and Little Falls Branch, 110, 308, and 714
t per second respectively, or 1,132 cubic feet per second from
e watershed—these works will have abundant capacity.

ld remark that the principal differences between the volumes
arge found by the Burkli-Ziegler formula and the volumes
the rule just mentioned are in the cases of the small areas,
ula giving, as it should, larger rates per acre for these areas
large ones. If we use in the formula the acreage of the entire
ed, we find the volume of discharge from it to be 922 cubic feet
d, which differs from the volume of discharge found by the
Ir. Francis by only 41 cubic feet per second.

To show that the assumed volume of discharge, 1,132 cubic feet per second, is beyond all doubt an ample one, I have compiled the following:

Rainfalls exceeding 3 inches in twenty-four hours at the Dalecarlia (receiving) reservoir and at the distributing reservoir of the Washington Aqueduct system, as collected in the rain gauges kept at these reservoirs.

[The record includes the period May 17, 1877—May 18, 1893.]

Date.	Dalecarlia (receiving) reservoir.	Distributing reservoir.	Date.	Dalecarlia (receiving) reservoir.	Distributing reservoir.
	Inches.	*Inches.*		*Inches.*	*Inches.*
Oct. 6, 1877	3.60		Sept. 17, 1888		[illegible]
Oct. 7, 1877		4.15	Apr. 27, 1889	3.37	[illegible]
Oct. 23, 1878	3.52		June 1, 1889	5.07	[illegible]
May 23, 1886		3.04	July 31, 1889	3.01	
June 23, 1886		3.07			

The dams across East Creek, Mill Creek, and Little Falls Branch, and the works between these streams.—It is proposed to construct dams across East Creek, Mill Creek, and Little Falls Branch, in approximately the positions shown on plat M; an open and paved channel from East Creek around the reservoir to a point on Mill Creek above its dam, and a similar channel from Mill Creek around to the mouth of a short tunnel that will carry into Little Falls Branch above its dam the combined waters of East Creek and Mill Creek, as well as the water which now falls directly into the reservoir from the land contiguous to the reservoir, between Mill Creek and the lower mouth of this tunnel.

A special provision is to be made for diverting from the reservoir by means of small paved ditches the water discharged from all of that part of the little peninsula lying between the lower end of the reservoir and Little Falls Branch, that is, outside the portion this peninsula that must be purchased or condemned.

The foregoing works, of which I will submit detailed plans and estimates as soon as the necessary survey can be completed, will carry all of the drainage water that is to be disposed of, except the water of Little Falls Branch into this branch.

The receiving shaft or well and the outlet tunnel.—The following are the plans and estimates of the cost of the shaft or well in the valley of Little Falls Branch that is to receive all of the drainage of the watershed, and also plans and estimates of cost of the outlet tunnel.

The well is to be on the right bank of Little Falls Branch above its dam at the point marked *k* (see plat M), where there is firm ground underlaid by rock. It is to be 10 feet in diameter when lined, and its coping is to be at or about the elevation of 143 feet above datum. (The top of the dam is to be 157 feet above datum, and the normal height of water in the reservoir is 146.5 feet above datum.) The depth of the well is to be about 56 feet. It is to be lined with brick backed by concrete. From above the water-cushion that I propose to provide at the bottom of the well there will be run under Dalecarlia Hill and below tunnel No. 4, of the Washington Aqueduct a tunnel whose portal on the southerly side of the hill will be near the outer end of the tunnel leading from wasteweir No. 2, which is in aqueduct tunnel No. 4. From the portal, which will be at a lower level than the mouth of the tunnel leading from wasteweir No. 2, an open channel will conduct the drainage water to the stream, the lower portion of Little Falls Branch, that will carry it down to the Potomac.

h the drainage outlet tunnel will be laid a brick circular con- ritrified brick invert of which will be laid on concrete. The ween the arch and the top and sides of the tunnel will be solidly with rubble stone laid in mortar.

nduit will be 7 feet in diameter and have a grade of 0.0031, ot in 100 feet.

isons have governed me in fixing this grade:

ll pass the drainage tunnel as far under aqueduct tunnel No. ticable. From the north connection for a distance of 163 feet tunnel No. 4 is lined with brick and for a farther distance it is lined with rubble stone of not very good quality, but , from within a few feet of the point of crossing below the aque- el of the line of the drainage tunnel, the aqueduct tunnel is It is a great misfortune that General Meigs did not com- ie aqueduct tunnel No. 4, for, although the rock is fairly good, hen I emptied the conduit between Great Falls and the dis- reservoir and inspected it in September, 1891, that there have ral slides from the roof and sides of the tunnel. A serious ever occurs, will block up the tunnel and cut off the supply of he city, but it is too late to line it now. This can only be a duplicate conduit from Great Falls (which will doubtless perhaps twenty years hence, be deemed necessary for the he supply as well as for its increase) has been constructed.

avation of the drainage tunnel through Dalecarlia Hill and aqueduct tunnel will be a delicate operation. The blasting former in such a manner as not to produce shocks and jars supported roof of the latter will have to be done with the are and caution on the part of all concerned. Else we may ave falls of rock into the aqueduct tunnel, but the opening of aks through some of the numerous seams that exist every- the rock. Such leaks, if large, not only would interfere add to, the expense of the excavation of the lower (the drain- el, but they might be an irreparable damage to the upper (the tunnel through the difficulty of finding (by lantern light and ort periods of time during which the supply to the distribut- oir can be interrupted without seriously impairing the head y mains) the sources of the leaks in this unlined tunnel. I ention that all parts of the aqueduct tunnel are under pres- s roof is several feet lower than the level of the water in the ng reservoir.

a grade of 0.0031 the velocity of the water in the conduit full will be about 10 feet per second. This will be the condi- e conduit when the discharge from the entire watershed will bic feet per second, and this will obtain so rarely that abrasion ert by sand and pebbles carried along by the water need not

ld that in Washington there has not been found any abrasion of sewers, when made of vitrified brick, from velocities as as 16 feet per second.

he well is supplied with less water than enough to make the ist full, the velocities will be less than 10 feet per second, but es the velocities through the conduit will be sufficient to pre- odgment of any detritus that is likely to be carried into the

he quantity of water that in storms now produces a depth of n the weir of the spillway (which is, under existing conditions the only escape from the reservoir of the discharge from the water shed), the depth of water in the conduit will be as represented in section 2, on plat M. The velocity in this case will be 8.1 feet per second. Storms that produce this depth of water on the weir of the spillway are very infrequent, and do not, on an average, occur more than three or four times a year. There is no doubt then as to the capacity of the conduit to carry the amount of water discharged from the watershed in ordinary storms, or of the safety of the lining of the drainage tunnel from abrasion, and the main question is, will it carry the amount that will be discharged in the greatest flood and freshet that is liable to occur and under the circumstances most favorable for producing the highest percentage of discharge? This quantity, as we have seen, is 1,132 cubic feet per second. Before the water could be damned up in the valley of Little Falls Branch (and the two other valleys) and above the well to a height sufficient to allow the water to pass over the dams into the reservoir, it would have to have a head over the lower mouth of the outlet conduit of 59.3 feet.

There are no formulas that are specially adapted to conduits under pressure and running with high velocities. Kutter's general formula* with his value of $n=0.013$ for brickwork, gives 1,680 cubic feet of flow per second under this head, and the general formula of Chezy† with the value of 135.75 for the coefficient C, which, in the experiments on the Sudbury conduit at Boston (which was not under pressure), was found to correspond to the hydraulic mean radius of a 7-foot circular conduit, gives 1,776 cubic feet per second.

I have recently obtained the actual value of C in the Chezy formula for that portion of the Washington Aqueduct that lies between the Dalecarlia and distributing reservoirs. This portion of the aqueduct is in a fairly good condition, but there is a small amount of sediment in the bottom, say an average of 6 to 8 inches in depth. It is under a pressure of about 4 feet at the crown of the arch and the velocity is small, about 1.4 feet per second. Making allowance for the portion of the section occupied by sediment, the value of C was found to be 120. With this value of C in the formula it gives 1,570 cubic feet per second as the amount that the outlet tunnel would carry before the water behind the dam would overrun the dam.

I have not trusted, however, to any of these formulas for finding the capacity of the outlet conduit under the extreme case of having to carry 1,132 cubic feet of water per second, in which case the velocity would be about 30 feet per second, but have found the required area of conduit section by means of the formula used to determine the flow of pipes under pressure‡ with a coefficient (31.8) adapted to a roughness of interior corresponding to ordinary smooth brickwork. This formula

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$$^*V=\left(\frac{41.6+\frac{1.811}{n}+\frac{0.00281}{I}}{1+\left(41.6+\frac{0.00281}{I}\right)\frac{n}{\sqrt{R}}}\right)\sqrt{R.I.}$$

in which V is the mean velocity per second in feet; R is the hydraulic mean radius; n is the coefficient of roughness, and I is the fall in feet per foot.

† $V=C\sqrt{R.I.}$ in which V is the velocity per second in feet; C is a coefficient; R the hydraulic mean radius; and I is the fall in feet per foot.

‡ $Q=C\left(\frac{hd^5}{l}\right)^{\frac{1}{2}}$, in which Q is the number of cubic feet per second; C is the coefficient of roughness; h is the head in feet; d is the diameter in feet, and l is the length in feet.

,150 cubic feet per second as the flow through the conduit that obtain before the water would overrun the dam, and 154.1 feet ation of the water above datum, or about 3 feet below the top of m when the flow through the conduit would, in case of the extreme probable discharge from the watershed that I have supposed, be ubic feet per second.

not consider, therefore, that 7 feet for the diameter of the con- ould be excessive, and one much smaller could not be constructed ically.

mate of cost.—A careful estimate of cost of the receiving shaft or he drainage conduit and the open cut at its mouth, allowing 10 t for contingencies, gives $50,686. The remainder of the $60,000 riated by the act of March 3, 1893, will be required for the pur- r condemnation of the small parcels of land and the purchase of chinery necessary for the work.

two plats that accompanied the project are appended to this and are as follows:

an of the reservoir, marked M, showing the works herein de- l.

at of the watershed of the reservoir marked N.

ccount of the delicacy of the work of blasting out the drainage through Dalecarlia Hill under the aqueduct tunnel, it will be ary to do the work required by this project by days' work, and s authorized by the act, has been approved by the Secretary of In order to complete by this method within the fiscal year the liture of the appropriation (which is a fiscal year appropriation) also be necessary to commence work as soon as practicable after ney will become available; that is to say, the 1st of July. It so probably be necessary to carry on the work night and day, g three shifts of eight hours each.

he end of the fiscal year, in addition to the surveys required for ns of the main drainage tunnel and the receiving shaft in the of Little Falls Branch which have been completed, the sur- quired for the plans of the open channels and the short drain- nnel which is to be excavated through the peninsula lying n the reservoir and Little Falls Branch, have been nearly com- , and a contract has been made with the Ingersoll-Sergeant Drill ny, of New York, for the compressor and other machinery required excavation of the tunnels.

hoped that the remaining $90,000 of the $150,000 contemplated gress as the entire cost of this work, which is so important to strict of Columbia, will be voted at its next session.

RK AT THE RESERVOIRS DURING THE LAST FISCAL YEAR.

rvey and plan for carrying off the drainage from the underground chambers at the distributing reservoir was made during the year. esent outlet for this drainage is through a valley through private hich has recently been bought by a syndicate and laid off into . It is liable to be stopped up at any time by the filling up of lley, and in case of stoppage it would cause the spring water in ound around and above the arches (that now flows freely into the chambers through openings made for the purpose) to submerge in valves and prevent the regulation of the supply of water to y. It is proposed to lay during the next year, if money can be for the purpose, an 8-inch iron pipe from the present outlet of the drain, along and inside the southeastern boundary line of the United States land, a distance of about 500 feet, thence across private land to the canal, a distance of about 300 feet.

The raising of the walls around the south connection of the Dalecarlia (receiving) reservoir to prevent an undue strain on the conduit in floods was completed by placing the coping thereon.

A masonry chamber for the valve on the blow-off from the by-conduit at the spillway from the same reservoir was constructed of stone.

A traveling crane was made and put up at the influent gatehouse of the distributing reservoir, for use in handling the heavy stop timbers when the monthly measurements of water consumed and wasted in the city are made, and on other occasions when the flow into the reservoir is interrupted.

A plat showing the 7-foot conduit and the connections of the mains at the east end of the distributing reservoir is herewith.

Estimates for completion of the works of improvement of the Dalecarlia (receiving) reservoir and purchase of land appropriated for by the act of March 3, 1893; for lowering the height of the cross dam at the distributing reservoir; for cleaning out the distributing reservoir, and for widening and deepening the spillway at the Dalecarlia (receiving) reservoir, will be found in the list of estimates appended hereto, and explanations of the same will be found further on in this report under the title "Explanations of estimates."

THE MAINS.

The trunk mains that lead from the distributing reservoir and supply the distributing system of street mains were, as a general rule, laid by the United States, and are under the care of this office. The aggregate length of these mains is about 21 miles. The distributing mains were laid by the District of Columbia, and are under the care of the Commissioners of the District.

There have been three breaks in the trunk mains during the last fiscal year. One of them was in the old 30-inch main in New Jersey avenue at K street. When it was uncovered a crack 35 inches long was found in the top of the main, commencing at the spigot end of the 30-inch by 12-inch cross at this point. This leak had been repaired many years ago, but the patch used had given way and the break had extended. A new patch was skillfully put on and secured by 4 heavy wrought-iron bands by Mr. Ferguson, the aqueduct valve tender and machinist, without turning off the water from the main. One of the others was on the 30-inch main at East Capitol and Third streets, and the third was on the 48-inch main at Thirty-second and M streets. Both made it necessary to shut off the water and empty the mains, and were the result of the unprecedented cold weather of the last winter, in which the frost penetrated the ground more than 4 feet, and were caused, not by breaks in the mains themselves, but in two of the vacuum valves connected with them that I provided at all the summits for use when necessary to empty the mains. These valves are in iron boxes or casings, the covers of which are in the surface of the street. The cases had all been carefully packed with a nonconducting material for the protection of the valves, but the great severity of the cold was too much for it. Before another winter I intend to protect all of these vacuum valves by another method, which, while it will be inexpensive and not interfere with ready access to the valves in case of sudden necessity, will certainly be reliable and efficient.

[T]he casings of the 20-inch blow-off from the 48-inch main just above [th]e Foundry Branch culvert under the Canal Road, and the 30-inch blow-[off] from the same main near College Pond, were protected by paving [ar]ound the casings.

A serious accident occurred on the 18th of March by the breaking [of] the stem of the 30-inch blow-off valve at Foundry Branch. Fortu[na]tely, at the instant of the breaking of the stem, the valve was shut, else [th]e distributing reservoir, or a large part of it, would have been drained [in]to the river before the flow could have been stopped. The renewal [of] this stem, which is a heavy gun-metal casting in the form of a screw [an]d weighing about 150 pounds, required the emptying of the 30-inch [an]d 12-inch mains between the distributing reservoir and Georgetown [t]wice, once in order to get out the broken stem for a pattern, and again [to] put in the new one.

The lines of the trunk mains have been carefully inspected and [wa]tched monthly, and the valves have been regularly oiled and cleaned [du]ring the year.

An estimate for inserting efficient air valves and blow-off valves in [th]e old 30-inch and 36-inch mains will be found in the list of estimates, [an]d explanations of the same will be found farther on in this report [u]nder the title, "Explanations of estimates."

THE AQUEDUCT LANDS.

The survey of the boundary lines of the aqueduct lands, both in the [D]istrict of Columbia and in Maryland, which was commenced in the [fi]scal year 1890–'91, was continued, but not much was done during the [y]ear. Boundary stones suitably marked were planted at all the angles, [ex]cept two, that were not already marked, from the Dalecarlia (receiv[in]g) reservoir to above Cabin John Bridge.

By an act of Congress approved by the President on the 14th of July, [18]92, the Attorney-General, the Secretary of War, and engineer com[m]issioner of the District of Columbia were empowered to select from [th]e lands in the District of Columbia belonging to the United States a [sit]e for a girls' reform school. Under the decision of the commission [a] tract containing 19.39 acres, and comprising nearly the whole of the [re]servoir land lying between the Conduit road and the Little Falls [ro]ad, was surveyed and exscinded from the reservoir lands for this pur[po]se.

During the year the Metropolitan Southern Railroad Company [se]lected and surveyed its route through the lands of the Dalecarlia [(re]ceiving) reservoir, as authorized in the following act of Congress, [ap]proved by the President on the 3d of March, 1891:

[B]e *it enacted by the Senate and House of Representatives of the United States of America [in] Congress assembled*, That the Metropolitan Southern Railroad Company is hereby [au]thorized to construct its road across the grounds of the United States forming a [pa]rt of the grounds of the receiving reservoir in Montgomery County, in the State [of] Maryland, north of the northeast boundary line of the District of Columbia, and [for] that purpose said company is hereby granted a width of sixty feet, at grade, and [su]ch additional width as it may require for slopes of cuttings and embankments, [ac]ross said grounds for its right of way through the grounds aforesaid: *Provided*, [th]at the location and plans of said road through said grounds shall be approved by [th]e Secretary of War before the commencement of any work on said grounds, and [th]e work of construction and the operating of said road shall be subject to such reg[ula]tions as he may prescribe; and the damages for the use and occupation of the [rig]ht of way herein granted shall be fixed by a board of three Army officers appointed [by] the Secretary of War, and the payment of said damages so fixed shall be a condition [pr]ecedent to the exercise of the rights by this act granted, which are to terminate [at] the pleasure of the Secretary of War in case of persistent neglect by said com[pa]ny, or by its *successors, to comply* with the regulations aforesaid.

The location and plans of the road were submitted by the company and approved by the Secretary of War on the 25th of January, 1893, and the regulations concerning the work of construction and the operating of the road were prescribed by him on the same date. These regulations, which had previously (December 6, 1892) been accepted by the company, are as follows:

Regulations respecting the construction and the operating of the Metropolitan Southern Railroad through the lands of the United States, in Montgomery County, Maryland, pertaining to the receiving reservoir, by virtue of an act of Congress approved by the President of the United States on the 3rd of March, 1891.

1. In that part of its route where the Metropolitan Southern Railroad, shown in the plan of Parcel No. 1 of the plans of the railroad and between said parcel and the railway tunnel is not in cutting, substantial retaining walls shall be constructed by the railroad company between the reservoir and the railroad to such height, not less than the height of the roadbed, as will, with paved gutters behind them, be sufficient to catch and lead alongside the railroad and away from the reservoir, all the drainage from the roadbed, the land pertaining thereto, and the land behind it, either southward through the railroad tunnel or northward to the small stream that is to be crossed by the railroad near station No. 317 of the plans of the railroad. The retaining walls shall be kept in good order by said railroad company and its successors.

2. Paved drainage gutters shall be constructed by said railroad company behind the above-mentioned walls and across the railroad bridge and through the tunnel and cuttings, of ample size for the above purpose, and they shall always be kept by said railroad company and its successors in good order and free from obstructions. No drainage water shall ever be permitted by said railroad company or its successors to flow from or across the roadbed or the lands pertaining thereto, or the land behind it, into the reservoir.

3. The crossing of the conduit, between Parcels Nos. 1 and 2 shall be made by a substantial iron or steel bridge of not less than fifty (50) feet span, the abutments of which shall not be less than twenty-five (25) feet from the middle line of the conduit measured on the middle line of the railroad, and the said railroad company shall have the right, subject to the act of March 3, 1891, to maintain said bridge over said conduit. No part of said bridge between the abutments shall be less than nine (9) feet above the surface of the ground as it lies over the conduit, and no deposit of any material shall be made by said railroad company or its successors between the abutments.

4. No dumping or deposit of any material shall be made by said railroad company on the land of the United States outside the boundaries of the land ceded to said company. If any other deposits of material shall interfere with access by wagons and carts to the "north connection" of the reservoir, a convenient wagon road thereto shall be graded by said railroad company to the satisfaction of the engineer officer in charge of the Washington aqueduct. Efficient means shall be provided by said railroad company for preventing any leakage through the bridge, and all drainage and washing of earth upon the space between the abutments of the bridge and upon the land of the United States near the north connection not ceded by the United States to said company.

5. A substantial fence ten (10) feet high shall be constructed by said railroad company between the railroad and the reservoir from the Government line near station No. 317 to the Government line near the mouth of the tunnel. The design, the location, and the construction of the fence shall be subject to the approval of the engineer officer in charge of the Washington aqueduct, and it shall be painted and kept in good order and repair by said railroad company and its successors. The employés and servants of said railroad company and its successors shall not be allowed access to or to cross the United States lands around the reservoir.

6. In all blasting in the construction of the railroad, and especially in the railroad tunnel under Dalecarlia hill, great care shall be used by said railroad company and its agents not to injure the tunnels 4 and 5 of the Washington aqueduct, and for all damage done to these tunnels by such blasting, said railroad company and its successors shall be responsible, and said railroad company and its successors shall make good all damages to the conduit, tunnels, and other property of the United States by said company and its successors, and by its and their agents.

7. All of the slopes of railroad cuttings and embankments within view from the reservoir shall be sodded and kept in good order and repair by said railroad company and its successors.

8. No claim shall ever be made by said railroad company or its successors for any damage done to the railroad and its appurtenances either in the vicinity of or below

ceiving reservoir by the water from the reservoir or the Washington aqueduct, e water of Little Falls Branch in time of freshets at any time or under any cir-stances.

Stone monuments properly marked and of a design to be approved by the engi-officer in charge of the Washington aqueduct shall be planted by said rail-company at all the angles of the land conveyed by the United States to said pany before commencing work on said land, and the said monuments are to be tained in place and in good order by said company and its successors.

. The railroad bridges crossing the streams on the land ceded by the United s to said railroad company and the bridge near station No. 317 of the plans of ailroad shall be strong and substantial, and shall be maintained in good order id company and its successors. The waterways under the bridges shall be of le size to carry the water of these streams under all circumstances, and said oad company and its successors shall keep said waterways free and unobstructed.

. The said railroad company shall provide convenient bridges or paved crossings agons over the railroad whenever and wherever they may be deemed necessary he engineer officer in charge of the Washington aqueduct, and it and its succes-shall maintain the same in good order.

. The said railroad company shall suitably pave and keep in repair the floor of ulvert near station No. 317 of the plans of said railroad, and shall construct and in repair a paved gutter through this culvert of ample size to carry the water e stream that is to flow through the culvert. Both the floor of the culvert and gutter are to be kept free of obstruction by said railroad company and its suc-rs.

. The said railroad company shall construct, and it and its successors shall main-at its and their own expense, a substantial post and rail fence on the boundary of the property ceded by the United States, but this requirement shall only y to the boundaries between the lands ceded and the lands that remain the prop-of the United States.

. Before commencing work on the lands ceded by the United States, the Metro-an Southern Railroad Company shall deposit with the Treasurer of the United es, to the credit of the Washington aqueduct, the sum of one thousand five hun-(1,500) dollars, for the purpose of making good to the United States the cost of inspection of the operations of said company as the Secretary of War may con-necessary for the protection of the Washington aqueduct and its appurtenances, the said company shall deposit as aforesaid such further sums as the said Secre-may require. The said moneys shall be disbursed like other moneys appropri-for the Washington aqueduct, and whatever may remain of said deposits after completion of said railroad through said lands, shall be returned to the said pany with an account of their disbursement in detail.

. If the United States shall at any time desire to construct an additional waste from the Washington aqueduct, and a channel for the discharge from said e weir through that parcel of United States land which is southwest of Dalecar-lill and projects from the aqueduct lands between boundary stones W. A. 19-B W. A. 22-B, then the said Metropolitan Southern Railroad Company or its suc-rs shall, on the demand of the Secretary of War, construct and maintain at its eir own expense, a suitable and substantial iron or masonry railway bridge over channel on such plans as may be approved by the said Secretary.

The Secretary of War may make such changes in these regulations and such tional regulations as he from time to time may consider necessary.

y authority of the Secretary of War a board of officers, consisting ieut. Col. Elliot and Majs. Oswald H. Ernst and Charles E. L. B. is, corps of engineers, was directed by the Chief of Engineers on 20th of December, 1892, to appraise the damages for the use and pation of the right of way granted to the road by the above act. board recommended an assessment of $4,300, which was paid by company and deposited in the Treasury by me on the 14th of Janu-1893.

n reference from the Department, a report was made on an appli-on to the Secretary of War by the Commissioners of the District of mbia, to enter upon a strip of land 60 feet in width extending from distributing reservoir to the New Cut road, for the purpose of con-cting water mains in connection with the work of extending the service system of the District of Columbia. This land had been lemned by the United States for the Washington aqueduct in 1883.

In compliance with a Department order, a report was made on the occupations of land pertaining to the Washington Aqueduct under revocable licenses or other authority.

THE BRIDGES.

With the exception of the wooden bridge over the spillway from the Dalecarlia (receiving) Reservoir the bridges are generally in good condition, except in respect of their pavements. There are some small leaks in the conduit in its passage through Cabin John Bridge, which are shown by drippings into the chambers in the abutments and from the arch, but they can not be repaired before an appropriation is made for removing the accumulation of deposits in the conduit.

The roadway over bridge No. 4 (Cabin John Bridge) was temporarily repaired by filling the holes in the asphalt pavement with broken stone and earth, but this only made the bridge passable, and the pavement of this bridge, as well as that of bridge No. 3 (Griffith's Park Bridge), is still in very bad condition.

The wooden bridge over the spillway at the Dalecarlia (receiving) Reservoir was repaired.

An entire renewal of the wooden superstructure of the Pennsylvania Avenue Bridge over Rock Creek was made dgring the year, at an expense of $1,300. Twenty-five thousand feet B. M. of lumber were used in the work. Heretofore, in relaying the flooring, oak has been used, but by reason of urgent demands on the small appropriation for maintenance and repair for other necessary work on the aqueduct, and as an experiment, the best quality of yellow pine was used for the new flooring.

A large quantity of ice that, in the exceptional cold of the last winter, had formed in the chambers of the abutments of Cabin John Bridge was removed.

Estimates for repaving the worn-out asphalt floors of bridges Nos. [illegible] and 5 (Cabin John and Griffith's Park bridges) with granite blocks [illegible] vitrified bricks, and for replacing the wooden bridge over the spillway at the Dalecarlia (receiving) Reservoir by a stone structure commensurate in durability and appearance with the other bridges on the line [illegible] the aqueduct, will be found in the list of estimates appended here[illegible] and explanations of the same will be found further on in this report under the title "Explanations of estimates."

MEASUREMENT OF HOURLY SUPPLY.

Hourly and total flow from the distributing reservoir for the twenty-four hours ending at 8 a. m., June 22, 1893.

[City temperature, in the shade, at 2 p. m., June 21, 90°.]

Date.	Outflow per hour.	Date.	Outflow per hour.
June 21—	*Gallons.*	June 21—	*Gallons.*
From 8 a. m. to 9 a. m	2,369,705	From 10 p. m. to 11 p. m	1,504,[illegible]
From 9 a. m. to 10 a. m	2,226,974	From 11 p. m. to 12 midnight	1,50[illegible]
From 10 a. m. to 11 a. m	2,362,918	June 22—	
From 11 a. m. to 12 noon	1,943,210	From 12 midnight to 1 a. m	1,[illegible]
From 12 noon to 1 p. m	2,218,005	From 1 a. m. to 2 a. m	1,[illegible]
From 1 p. m. to 2 p. m	2,214,855	From 2 a. m. to 3 a. m	1,[illegible]
From 2 p. m. to 3 p. m	2,349,828	From 3 a. m. to 4 a. m	1,[illegible]
From 3 p. m. to 4 p. m	1,932,666	From 4 a. m. to 5 a. m	1,[illegible]
From 4 p. m. to 5 p. m	2,205,644	From 5 a. m. to 6 a. m	2,[illegible]
From 5 p. m. to 6 p. m	2,340,256	From 6 a. m. to 7 a. m	2,[illegible]
From 6 p. m. to 7 p. m	1,924,703	From 7 a. m. to 8 a. m	2,[illegible]
From 7 p. m. to 8 p. m	2,061,362		
From 8 p. m. to 9 p. m	1,780,543	Total	46,727,[illegible]
From 9 p. m. to 10 p. m	1,917,516		

[Mea]surements of the consumption and waste of water in the city and condition of the water in the last fiscal year.

Date.	Gallons.	Date.	Gallons.
[W]ednesday, July 20, 1892	40, 942, 822	Wednesday, Nov. 30, 1892	40, 637, 987
[W]ednesday, Aug. 31, 1892	42, 362, 581	Thursday, Mar. 30, 1893	38, 446, 932
[Tu]esday, Sept. 27, 1892	44, 532, 627	Wednesday, May 3, 1893	38, 900, 453
[Th]ursday, Oct. 27, 1892	41, 433, 272	Thursday, June 22, 1893	46, 727, 108

It will have been observed that the measurement for the day ending [a]t 7 a. m. on September 27 showed the consumption and waste to have [a]mounted to 44,532,627 gallons. This was the largest measurement of [th]e daily supply to Washington and Georgetown ever made, and it was [ac]counted for by the extra flushing of the street mains by the District [au]thorities on account of the cholera excitement, and the presence in [th]e city of the Grand Army of the Republic, but the measurement for [th]e day ending at 8 a. m., June 22, of this year exceeded it, and was [46],727,108 gallons.

It will also have been observed that the dates of measuring the con[s]umption and waste of water in the city during the last fiscal year were [q]uite irregular. The reason for this was that I deemed it best during [th]e unusually protracted low stage of the Potomac last summer and fall, [an]d also when the water in the river was very muddy, not to lower [u]nnecessarily the head of water in the distributing reservoir.

No complaints as to the condition of the water, except in respect of [it]s turbidity, have been made during the year.

Statements of the condition of the water in the distributing reservoir [a]s it is supplied to the mains leading to the city after passing through [th]e reservoir have been furnished monthly to the Museum of Hygiene [of] the Navy Department since June, 1891, at the request of the medical [d]irector in charge.

[Co]nsumption and waste of water in the city, as measured annually in the latter part of June of each year, from 1874 to 1893, both inclusive.

Year.	Gallons.	Year.	Gallons.	Year.	Gallons.
[illegible]	17, 554, 848	1881	26, 525, 901	1888	29, 115, 774
[illegible]	21, 000, 000	1882	29, 727, 864	1889	27, 708, 779
[illegible]	24, 177, 797	1883	24, 314, 715	1890*	35, 541, 845
[illegible]	23, 252, 932	1884	24, 827, 113	1891	38, 594, 743
[illegible]	24, 885, 945	1885	25, 219, 194	1892	41, 161, 780
[illegible]	25, 947, 642	1886	25, 542, 476	1893	46, 727, 108
[illegible]	25, 740, 138	1887	26, 878, 424		

* Forty-eight inch main added to the supply.

MISCELLANEOUS.

[I]n addition to the foregoing work of the last fiscal year stated under [the] appropriate headings, the telephone line between the head of the [aq]ueduct at Great Falls, the reservoirs, and this office has been fre[qu]ently repaired. Considerable damage has been done by lightning [du]ring the year. On the 4th of June several poles near Great Falls [we]re destroyed, and the instruments in the dwelling of the watchman [of] that division of the aqueduct were greatly damaged. On account [of] the frequency of damages by lightning to the aqueduct telephones connecting this office with the reservoirs and the works at Great Falls, lightning arresters were purchased for all of the stations.

In October I inspected the quarry and land near Seneca, Md., belonging to the Washington Aqueduct.

Repairs were made during the year to the dwellings of the watchmen gate keepers, the aqueduct office, its stable, and fences.

New rain gauges, furnished for the purpose by the Weather Bureau, were set at the reservoirs and at Great Falls.

An iron railing was put up around the south connection of the Dalecarlia Reservoir for the security of the watchman in the execution of his duties in icy weather.

The survey required for my project for the improvement of this reservoir, under the act of March 3, 1893, was commenced on June 1, and a small frame building to serve for a shelter for the surveying party in storms and the storage of instruments was put up on the top of Dalecarlia Hill over aqueduct tunnel No. 4.

Negotiations were commenced for the purchase of a portion of several parcels of the land that is to be acquired under the act just mentioned, and an advertisement with specifications for a contract for drilling plant was issued.

Superintendent R. C. Smead, Chief Clerk Simon Newton, Valve tender and Machinist Thomas Ferguson, and other employés of the aqueduct have been faithful in the performance of their responsible duties. Mr. Thomas Sullivan, Mr. John Halloran, and Mr. Daniel Harrington, for many years watchmen gate-keepers at Great Falls and at the Dalecarlia (receiving) and distributing reservoirs, in addition to their other duties, have skillfully and energetically acted as foremen of laborers engaged on the works of repair of their respective divisions of the aqueduct.

On reference from the Chief of Engineers, a report was made on a claim pending in the Court of Claims of Thomas B. Coyle against the United States.

On reference from the Chief of Engineers, reports on the following bills introduced in the Fifty-second Congress, second session, have been made by me during the fiscal year:

H. R. 9733, to incorporate the East End Electric Railway Company of the District of Columbia.

H. R. 10085, to authorize the Washington and Chesapeake Beach Railway Company to extend its railroad into and within the District of Columbia.

S. 3808, amending the charter of the Maryland and Washington Railway Company.

During the last fiscal year revocable licenses have been granted by the Secretary of War, under certain provisions and conditions, as follows:

To The Potomac Electric Company to run its wires (overhead) across the Conduit road for the purpose of supplying electricity for lighting houses north of the distributing reservoir.

To the District of Columbia to construct and maintain an electric line across the Conduit road and lands belonging to the United States, and to lay a pipe from its pump house to the south connection of the Dalecarlia reservoir, with a branch into the reservoir for use whenever the south connection may be empty, in order to furnish an electric and water supply to the Girls' Reform School.

To Mr. Albert Dowling to construct and maintain a neat fence on the lands of the United States pertaining to the Conduit road, said fence extend from a point on the boundary of said lands, near his hotel led "The River View," thence along the top of the embankment ır said hotel to the Conduit road; and to erect and maintain a tering trough for public use in the space on said lands between his el and the Conduit road.

'o Mr. Edward Baltzley to lay, maintain, and use a drain pipe across Conduit road strip of land, forming a part of the Washington ueduct Reservation, at or near stone 79 of the Washington Aque- ;t, in Glen Echo, Maryland.

EXPLANATIONS OF ESTIMATES.

:t is my duty to call especial attention to several works that are gently needed. Most of them were mentioned in my last annual ort, and in several previous reports, but have not yet been acted on Congress.

Improving the receiving, or Dalecarlia, reservoir.—One of the most neficial appropriations ever made for the Washington Aqueduct ice its completion in 1863 was the appropriation of $60,000 made at last session of Congress for "improving the receiving reservoir the works required for cutting off the drainage into it of polluted aters and sewage from the surrounding country, for the purchase or ndemnation of the small amount of land required for the purpose, d for the excavation necessary at the head of the reservoir," with the ovisions that the whole cost of the work shall not exceed $150,000, d that the work should be done by contract or otherwise, as the Sec- tary of War may determine.

This reservoir has a capacity of about 170,000,000 of gallons.

It was contemplated by Gen. Meigs in his design of the aqueduct, at the Potomac water flowing from Great Falls through the conduit. ould always pass through this long and comparatively narrow reser- ir for the purpose of settling the water before entering the distrib- ng (the lower) reservoir, when the river is turbid, which it often is, d the reservoir was so constructed by making an inlet chamber at upper end and an outlet chamber at its lower end. These cham- 's are known as the north and south connections, and communicate h the main conduit.

t was also designed that the receiving reservoir should collect and l to the supply the water flowing from the watershed of the reser- r, an area of about 4,000 acres; and the combined waters were sup- ed from this reservoir to the distributing reservoir and thence to city from the time of the completion of the former reservoir (nearly ty years ago) until 1888. At this time so many complaints had been de of the bad quality of the water, which was attributed to fertiliz- ; and other deleterious substances carried into the reservoir from cultivated and grazing lands of its watershed, and to the sewage Tennallytown (to which that of the village of Chevy Chase, which is o on the watershed, has since been added), that the reservoir was 'own out of service, and no use has been made of it, except on the 'e occasions when the conduit has been emptied and the supply from eat Falls has been suspended for the purpose of inspection of the erior of the conduit and for cleaning it.

The utility, however, of the receiving reservoir for settling purposes d for storage (the distributing reservoir has at most only about four ys' supply for the city) led to the project for its improvement by the works required for excluding all the water from its watershed that I have already described in this report under the title "The Reservoirs."

That part of the project that relates to the shaft in the valley of Little Falls Branch, into which shaft all the water of the watershed is to be collected, and also the main drainage tunnel under Dalecarlia Hill from the bottom of the shaft, has been approved by the Chief of Engineers. The appropriation of March 3, 1893, will be sufficient to execute this part of the work and to pay for several small parcels of land required to be purchased or condemned for it. Work will be commenced as soon after July 1, the date on which the appropriation will become available, as possible. The appropriation will be exhausted by July 1, 1894. The remainder ($90,000) of the sum of $150,000, to which the cost of the entire work was limited in the act of March 3, 1893, will be required for the execution of the remainder of the entire project, viz, the dams across the three streams that enter the reservoir; the excavation and paving of the open channels (about 1 mile in aggregate length) that are to pass around the reservoir and behind the dams to Little Falls Branch; to pay for the remainder of the land required to be purchased or condemned, and to do the excavation necessary at the head of the reservoir.

I should add that if it should be decided at sometime in the future, following the examples presented by the large cities of Europe, to filter the Potomac water, it will be indispensable, in order to save a great part of the cost of the maintenance of the filters, to "settle" the water as much as possible before it enters the filters, and the receiving reservoir will then be available, and even necessary, for this purpose, for the reason that the filtration works must be at or near the lower (the distributing) reservoir, and there is no place other than the receiving reservoir that is suitable for the settling basin, which must, of course, be above the filtration works.

Widening the Macadam pavement of the Conduit road.—The present Macadam pavement of the Conduit road was only made wide enough (about 12 feet) to prevent the earth covering of the arch of the masonry conduit under the road from being cut through by travel in spring and at other times when the ground is softened by rain. The travel on the road in good weather, and especially on Sundays and other holidays, has increased so enormously that collisions are frequent. Wrecks of vehicles are often seen along the sides of the road on Mondays, and there is constantly danger of serious accidents by collision on the narrow pavement of this road.

The greater portion of the Conduit road is beyond the District line, but it and the strip of land through which it passes belong entirely to the United States. It is almost the only, if not quite the only, road out of the city that has not been spoiled for driving purposes by street railways. It is one of the most picturesque roads in the country, extending far up into Maryland amid the fine scenery along the Potomac, and it is the only route to the city that is available for a large number of the farmers of Montgomery County. Congress has refused to allow the road or any part of the strip of land referred to to be occupied for railroad purposes, and in its charter for a railway on private land south of the Conduit road and parallel to it (that of the Washington and Great Falls Electric Railway) the marring of the beauties of the road was carefully guarded against, and the construction of more than one line of railway near the Conduit road was prohibited.

The Macadam pavement (see sketch herewith) should be widened to a width of 30 feet. The depth of the new portions should be 13 inches, cluding 8 inches of large stone, 4 inches of small broken stone, and 1 ch of binder. There should be a wide paved gutter and a line of ade trees (preferably alternate lindens and tulip poplars) on each de of the road, and the slopes of embankments should everywhere be dded. This plan will require the widening of the roadbed at several laces by adding to the width of the embankments over the culverts at pass under the aqueduct, by cutting away embankments on the pper side of the road, and by filling on its lower side.

I estimate that the cost of the work required for that part of the road at lies between the auxiliary gatehouse at the distributing reser- ir and the foot of Dalecarlia hill, a distance of 13,200 feet, or about miles, will be $34,500, and an estimate for it is submitted in the list estimates. The remaining distance to Cabin John Bridge, which is e limit of the major part of the travel at present, is about 3 miles. It ll probably not be necessary to extend the improvement of the road yond this point for several years.

In addition to widening the pavement of the Conduit road as herein oposed, a width of 100 feet, or such other width as may be necessary, each side of the road should be purchased or condemned for the pur- se of parking it, and with the additional object of controlling the ad abutting on the road and excluding the liquor saloons that now ist and are increasing, and to which many of the collisions on the ad are doubtless attributable.

I may remark that when the late Gen. Meigs constructed the Wash- gton Aqueduct (it was commenced in 1853 and essentially finished in 63) there was no road along it or in its vicinity, and the only road om Washington to Great Falls was via the Rockville road and the River" road which ran and now runs from Tennallytown to the Falls, it the route over the conduit being shorter and (until the hills around e Falls are reached) comparatively level,* it soon attracted travel and has been constantly increasing.

Raising the masonry casings of the manholes along the line of the aque- ct.—When the water in the distributing reservoir is at its normal ight of 146 feet above datum, there is a pressure of something over 4 t of water at the crown of the conduit arch where the conduit enters e reservoir, and the water in the conduit is backed up and the crown the arch is under pressure about as far up as Bridge No. 3, or Grif- h's Park Bridge, the bridge next above Cabin John Bridge. I found en I uncovered the manholes along the line of the conduit for use in inspection of its interior from Great Falls to the distributing reser- r in September, 1891, that the tops of several of the casings of the nholes below this point are below the gradient or slope of the water, that when the manholes are uncovered it is found above the man- le covers, and in some instances more than a foot in depth above em. No harm has thus far resulted from this state of affairs, but the ings of the manholes wherever necessary (I have a record of them) uld be raised above the gradient, so as to prevent the soakage of the ound around the manholes. An estimate, of $600 for this work is sub- tted.

Lowering the height of the cross dam in the distributing reservoir.—The er reservoir (the distributing reservoir) is divided about halfway tween the influent and effluent gatehouses by a cross dam, in the ddle of the length of which is a narrow cut lined with masonry,

* The road has essentially the same grade as the conduit beneath it, viz, 9½ inches the mile; or, more accurately, 9 inches in 5,000 feet, or .00015.

through which all the water on its way to the effluent gatehouse, where it enters the mains, must pass.

The draft through this cut is so strong that the major part of the water is drawn straight from the influent gatehouse, which is in an angle of the upper division (the settling division), to the cut, so that when the water is turbid it does not diffuse itself through the whole body of water in this division (110,000,000 gallons) as it should in order that the greatest amount of settling be done.

Neither is the water after it passes through the cut properly distributed through the lower division, which contains about 60,000,000 gallons, for the reason that the draft from the cut to the head of the mains leading to the city from the lower end of the division is so strong that the water all passes in a comparatively narrow stream straight to these mains, so that it also gets very little chance to settle in this division.

Now, as the upper portion of any body of water not quite free of turbidity and in the process of settling is the clearest, if the top of the dam be lowered far enough to allow only a thin sheet (at the present rate of consumption it would be about an inch deep) of water to pass over the dam, as was Gen. Meigs's design, we should have in each division a very effective additional means of clarifying the aqueduct water, and I believe that this improvement in the distributing reservoir being made, and the receiving reservoir being improved as has been provided for in the act of March 3, 1893, there would be but rarely, if any, complaint of muddy water.

I estimate the cost of this improvement at the distributing reservoir by lowering the cross dam at $12,500.

Protection of the inlet to the conduit at Great Falls.—The bank of the Chesapeake and Ohio Canal, which runs parallel to the Potomac at Great Falls, and about 150 feet from it, is about 16½ feet higher than the uncovered chamber, just above the Maryland end of the aqueduct dam, that forms the inlet from the river to the conduit.

In the flood of November, 1877, which rose at Great Falls to the height of 160 feet above the datum of the aqueduct, or 12 feet higher than the crest of the dam, the canal bank at a point opposite the inlet was washed down to the river and a part of it into the inlet. I quote from the annual report of the aqueduct for 1878:

> The masonry forming the arch of the feeder was uncovered from a point near the middle of the canal to the mouth of the feeder, a distance of 150 feet. The chamber at the head of the aqueduct was filled with stones that had formed the slope wall of the canal, and the aqueduct feeder for a distance of 300 feet was filled with débris to depths varying from 3 to 6 feet, so as to entirely stop the flow of water during the ordinary low stages of the river.

In the still higher flood of June, 1889, *which rose to the height of 16 feet over the aqueduct dam*, the canal bank was again washed down to the river, but fortunately the damage did not occur immediately opposite the inlet to the conduit, but from 200 to 400 feet higher up, so that the major part of the débris being left on the margin of the river and a part of it being carried over the dam, not so much filling of the inlet to the conduit was done, but, as in the flood of 1877, it was partially obstructed.

The annual report of the aqueduct for 1889 says:

> The banks of the Chesapeake and Ohio Canal above and below the mouth of the conduit were carried away and that opposite the conduit was threatened. A number of men were kept at work on this bank during the freshet, and it is believed that had it not been for the energetic work of this force and the widening and strengthening of the bank at this locality in April, great damages would have occurred at the mouth of the conduit.

:t will be observed that in the freshet of 1877 not only the inlet umber, but the conduit itself was filled with débris to a depth of from o 6 feet *for a distance of 300 feet in from its mouth*, but the water in river being at a high stage, there was still waterway enough in the iduit above the débris to enable the supply to the city to be kept up. d a complete closure of the mouth of the conduit occurred, with 12 16 feet of water over it, there would have been no possible way, with torrent raging over the mouth, to remove the obstruction before river subsided, and the water supply to the city would have been off.

:here is no more important part of our system of water supply to be efully guarded than the head of the conduit at Great Falls, and in ler to avert dangers like those of 1877 and 1889, to which the water pply is liable in every freshet, a masonry wall should be built ween the river and the canal bank, rising a few feet higher than the ter, and extending upriver from the mouth of the conduit as far as limit of the Government land, and thence at about a right angle l still on the Government land to the shore of the river. I estimate cost of this wall at $5,000.

Storage yard.—I have provided supplies for use in case of breaks in 48-inch and other mains, comprising sections of pipe, curves, crosses, lucers, sleeves, etc., a heavy wagon for hauling them where needed, ing jacks, and efficient pumps; also machinery for lowering the pipes the trenches, and the implements and material required for handling d calking.

A portion of these supplies has been placed in a yard which I have anged on the public land at the distributing reservoir, for use in the intry portions of the routes of the mains, and the remainder for use the city portions of these routes has been placed in a portion of enty-seventh street, near M Street Bridge, which has been loaned the purpose by the District government until the street is wanted improvement.

As we shall not be able, probably, to retain this place, except for a rt time, a permanent yard in the city should be purchased for use a storage yard. It should be near this office and at or near the de of the street, so that the heavy castings and machinery required repairs can be quickly gotten out.

believe that a suitable lot can be obtained by purchase, or if need by condemnation, for $10,000, and I recommend an appropriation of amount for the purpose.

Cleaning the bottom of the distributing reservoir.—The sedimentary osits of about twenty years, within which time the distributing ervoir has not been cleaned out, have raised the botton of its upper ision (the settling division) about 9 inches and of the lower division ut 4 inches.

These deposits have diminished the capacity of the reservoir about 0,000 gallons, and, although it is probable that these deposits, which mostly clay, are not deleterious to the water, they should be removed soon as an appropriation can be obtained for the purpose. It would uire the removal of about 39,500 cubic yards, the estimated cost of ich, at 35 cents per cubic yard, is $13,825.

Widening and deepening the spillway at the Dalecarlia (receiving) Reser-.—The overflow weir at the head of the spillway was constructed in 5. It is 75 feet long, 27½ feet wide, with side walls 3 feet above the line of the reservoir. It is immediately over the by-conduit, and is ed with stone. The channel of the spillway below this weir has never been completed, and the waterway is not sufficiently large to carry off the overflow from the reservoir fast enough to keep it below the top of the side walls in exceptionally heavy storms. In such cases the earth covering of the conduit at the ends of the overflow weir is liable to be washed away and the by-conduit and the supply of water to the city endangered. I estimate that the work will cost $2,000.

Repaving Bridge No. 3 (Griffith's Park Bridge) and Bridge No. 4 (Cabin John Bridge).—The floors of these bridges were paved several years ago with asphalt, which is almost completely worn out. For the safety of the conduit, which is carried across these bridges beneath their floors, they should be repaved, and as the travel over them is very great and is confined to a width of only 16 feet, it is very destructive to the floors. I therefore propose to repave them with granite blocks or vitrified brick. This work will cost about $5,000.

Storehouse at Great Falls.—There is no place for storage of the public property at Great Falls or for cement and other materials required when any work of construction or repairs is going on on that division of the aqueduct. A storehouse is urgently needed, and I propose to erect one about 40 by 20 feet in size, at a cost of about $1,500. The Chesapeake and Ohio Canal is now in operation, and the stone for the walls can be cheaply obtained from the Government quarry at Seneca, a short distance above the falls.

Protection of the Conduit at Wasteweir No. 1.—The masonry at wasteweir No. 1, which is at the mouth of a tunnel outlet from the side of tunnel No. 1, near Great Falls, has never been completed, and by reason of this the head of water in the conduit can not always be maintained as high as is necessary. The mouth of this tunnel outlet needs also a protection in the form of a heavy iron grating against the indraft of logs and other driftwood into the conduit in freshets, which endangers the conduit and the supply of water to the city. In my inspection, in September, 1891, of the interior of the conduit between Great Falls and the distributing reservoir there was found in the conduit, below wasteweir No. 1, a telegraph pole which must have been drawn into tunnel No. 1 through the side tunnel referred to during the great flood of 1889, when the river rose 75 feet at this place and overflowed the mouth of the outlet tunnel. The cost of this work will be about $5,000.

Inserting air valves and blow-off valves in the 30-inch and 36-inch mains.—In respect of this estimate I beg leave to quote from my annual report of 1890, as follows:

> It is important that more efficient facilities be provided for emptying and filling the old mains in case of accident, and of making connections from main to main.
>
> In either case a section of the main must be cut out and a new piece inserted, but before this can be done the main valve, at whatever distance on either side, must be shut, and the section of the main between these two valves, generally more than a mile long, must be emptied of its water. The time required for emptying depends not only on the sizes of the blow-offs in the valleys crossed by the mains, but also on the sizes of the air valves provided at the summits, for the water can not, of course, in any case be gotten out of a main any faster than the air required to take its place can be gotten in.
>
> In making the connections at New Jersey avenue and L street between the 36-inch main and the 24-inch by-pass, on the night of the 14th of April last, more than five hours were consumed in freeing the main of water, owing to insufficient blow-offs and air valves in the 36-inch main, and the refilling of the main after the connection had been made was so much prolonged by the want of proper valves for the egress of the air that it was nearly noon of the next day before the charging of the main was completed.
>
> Similar delays occurred at each of the numerous connections between the mains that were made after the 48-inch main was completed, and I was in each case obliged,

etting the air into the mains for emptying and out of them for filling them again h water, to have recourse not only to fire hydrants, but to the service-pipe spigots private houses in the vicinities of these connections.

These delays are very expensive, night work costing about double the tes of day work, and the danger in case of fire in the district cut from its supply of water is so great that large air valves and blow-valves should be placed on both the 30 and 36 inch mains as soon as appropriation can be obtained for the purpose. A patented device, which I have obtained the details since the date of the report referred , very much reduces the time required for inserting these valves, as ell as their cost, and, what is very important, it enables the work to done while the mains are under their ordinary pressure. The cost inserting the required blow-off and air valves in the 36 and 30-inch ains will be about $6,250.

Removal of the accumulation of deposits in the conduit.—As stated in last annual report, my inspection of the interior of the conduit from eat Falls to the distributing reservoir, in September, 1891, showed an cumulation of about 15,500 cubic yards of clayey deposits in the con-it throughout its entire length between these points of about 12 les. These deposits, which diminish the capacity of the conduit, ould be removed as soon as money can be obtained for the purpose. r the reason that the supply of water to the city must be interrupted ile the work of removal is going on, a large part of it must be done at ght. It will, therefore, be a tedious and expensive operation, and it n not be accomplished by means of the small annual appropriations maintenance and repair. I include in my estimates an item of $14,000 the removal of the deposits in the conduit, and this, if granted, uld enable the entire conduit to be thoroughly cleaned out in one ar.

Rebuilding the bridge over the spillway at the Dalecarlia (receiving) ervoir.—The Conduit Road Bridge over the spillway at the Dalecar-(receiving) Reservoir and just beyond the District line is a wooden dge on trestles that was built many years ago. The travel over the dge is very heavy, it is decaying, and, in order to prevent accidents quent repairs are necessary.

This bridge, which is of short span, should be replaced by a masonry dge of an architecture commensurate with Cabin John Bridge and other masonry bridge next higher up the line of the aqueduct riffith's Park Bridge), and I include an estimate of $18,000 for it in annual estimates.

Deepening the distributing reservoir.—The present bottom of the tributing reservoir being at reference 135 above the aqueduct um, and the flow line of the reservoir being at reference 146 above s datum, the available depth of water is 11 feet.

t has often been recommended in former annual reports that the th be increased 13 feet, or to reference 122, the depth of the axes of four 48-inch connections between the screen house and the gate mber.

This would increase the storage capacity of the reservoir from about ,000,000 gallons to about 290,000,000 gallons, and add to the cool-s of the water and also to its purity, for, unlike the receiving reser-r, which is nearly surrounded by woods, the distributing reservoir ully exposed to winds, and the waves are sometimes so great as to turb the bottom and make the water roily.

Should this be done bermes of 10 feet in width should be left at the t of the present slope walls protecting the sides of the reservoir, the tops of these bermes should be paved, and the deepened portions of the sides should be protected by slope walls of dry rubble masonry 12 inches thick, laid on a broken-stone lining 6 inches thick. The cost of the work will be about $290,000.

I consider the work of deepening this reservoir to be of very great importance for the reasons given, and it should be done as soon as appropriations can be obtained for it, but as the improvement of the quality of the aqueduct water, the increase of storage, capacity above the heads of our mains, the protection of the aqueduct, and other works herein mentioned are of more importance at this time, I have not included it in the estimates for the next fiscal year.*

Raising the height of the dam at Great Falls.—During the last summer and fall the Potomac at Great Falls was at a lower stage than has ever before been known within the memory of the oldest inhabitant. On 72 days the gauge above the dam showed a depth of water on the dam of only about 7 inches, and on five days it showed but 6 inches. The crown of the conduit arch at Great Falls is 151 feet above datum and the crest of the dam is 148 feet above datum. The conduit was therefore (in respect of its diameter) only about three-fourths full at its head. A similar deficiency now obtains every year during the time of low water at Great Falls and at such times, the weather being usually hot and dry and the consumption and waste in the city greatly increased, I have found ever since I laid the 48-inch main that the height of the dam is not sufficient during a considerable portion of every year to enable the conduit to deliver into the distributing reservoir as much water as is now consumed and wasted in the city, *and at the same time keep up the head in the mains to 146 feet above datum, which is necessary for the supply by gravity of the high northern portions of the city and of Capitol Hill.* The only remedy for this deficiency† which reduces pressures everywhere in the city and is annually increasing, is one that must be made before any further steps are taken for increasing the supply from the distributing reservoir, either by the tunnel to the new reservoir near Howard University, or by another main. It is the raising the height of the dam at Great Falls. In other words, before providing additional means of supplying to the city more water *from* the distributing reservoir, it will be necessary to be able to send more water from Great Falls *into* this reservoir.

The following is an estimate of the cost of raising the height of the dam:

2,134 cubic yards of stone masonry, at $35	$74,690
3,333 cubic yards of riprap, at $2	6,666
Damages on account of flooding of land and other damages	12,000
Total	93,356
Add 10 per cent for contingencies	9,336
	102,692

This work might properly be done at once, and it will soon have to be done, but there are so many things that are immediately necessary for the protection of the aqueduct and for other works herein mentioned,

* The late Gen. Meigs, in one of his frequent notes respecting the aqueduct, in which up to his death on the 2d of January, 1892, he continued to retain the deepest interest, called my attention to the care that would be required, whenever the distributing reservoir is deepened, not to cause leaks by uncovering and cutting into the uptilted and more or less dislocated gneiss formation that he found to underlie some portions of the reservoir.

† Except the enactment of a law requiring the use of meters by all consumers of Potomac water.

r the completion of the improvement of the Dalecarlia (receiv- :voir, I do not include an estimate for it in the estimates for fiscal year.*

PROVISIONS OF LAW IN RESPECT OF APPROPRIATIONS FOR THE AQUEDUCT.

w the statement of reasons for this provisions which was con- my last annual report. In my judgment the desired provision 3 in the law is of the utmost importance.

priations for the aqueduct are now fiscal year appropriations, : availability terminates on the 30th of June of each year. r appropriations are delayed there is liable to be a time in the t of every other fiscal year during which, should a break occur either in the city or in the country this side of the distribut- voir or in the conduit, or should any disaster occur at the res- at Great Falls, there is no money available for repairs.

appropriations for the aqueduct should be made available iended some of the less urgent repairs toward the end of the ld be postponed until the next appropriation should become , so that there would always be money in hand for repairing the mains or other works of repair.

in one of the city's old and decayed street mains or in one of reds of small service pipes that cross the route of the 48-inch instance, by undermining it, may cause it to break and the of water that would be discharged on the street, especially in levels of the route, would be so enormous that the property ı the lives of citizens in the vicinity of the break might be ed.†

en, in the cases of delay in the passage of the regular appropriation bills, provisions are made for the expenditures of the Government, considerable time after the beginning of the fiscal year elapse before official informa- ı only would warrant expenditures under these provisions of law) reaches officers.‡

8th of July, 1892, in blowing off the 30-inch main at Foundry the heavy bronze sleeve through which the valve stem works y fractured, so that the valve could not be moved before a new uld be cast and turned. The regular appropriation bill had been passed by Congress. I had only information from news-

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:rease of height for which this estimate is made is 2.5 feet, which would lam to reference (150.5). This would be required in order to enable the at its summer flow of, say, 6 inches over the dam to completely fill the its head. I find among the interesting and instructive notes that I received le Gen. Meigs and have carefully filed for the information of the officers in rge of the aqueduct, one dated March 1, 1891, of which the following is : "The original design was to set the lip of the dam at the Great Falls at of 150 feet above tide, for which height all the profiles and wasteweirs The back filling over the conduit would now allow a height of water higher than the dam to flow safely through the conduit, and, if needed, ot or two and corresponding widening of the embankments would fit the o convey, with increased height of dam lip, a very much increased flow of ie city.

:rnal pressure on our mains at some portions of their routes is about 43 :he square inch. This great pressure will be better appreciated if it be it is nearly 40 tons to the running foot of 48-inch main.

'k on the aqueduct was suspended in July of last year until the 15th of , on which date the first official information reached me that tempo- sion had been made by Congress on the 30th of June for the expenditures 'ernment.

papers that temporary provision had been made for the expenditures of the Government and I had no money to my credit for the repair of the valve.

Fortunately the valve happened to be shut at the instant when the accident occurred, else it would have wasted into the Potomac the water in the distributing reservoir at the rate of about 2,000,000 gallons per hour at a time when, on account of the low stage of water in the river, we had none whatever to spare.

And in case of appropriations for specific works like those I have recommended it is sometimes not advantageous, either in respect of economy or the quality of the work, to oblige the work to be fully completed at the end of the fiscal year.

Sometimes, by reason of the late date at which appropriations become available, or of the weather, or of the condition of the river, the work can not be fully completed within this time without hurrying it so much as to be detrimental to the interests of the Government.

I do not know of any appropriations that more require to be made available until expended, like appropriations for river and harbor improvements, light-houses, etc., than appropriations for the Washington Aqueduct. I urgently recommend, therefore, that it be done, and that the following clause be attached to the next appropriations for the aqueduct and be made to operate on all future appropriations for it:

Provided, That the appropriations for the Washington Aqueduct for the fiscal year ending June 30, 1895, and thereafter until otherwise provided by law, shall not be considered as fiscal-year appropriations, but they shall be available until expended; and the Secretary of War shall apply the moneys so appropriated in carrying on the works by contract or days' labor as he may find most economical and advantageous to the Government.

DESIRED INCREASE IN THE ANNUAL APPROPRIATION FOR MAINTENANCE, PRESERVATION, AND REPAIR OF THE AQUEDUCT, AND THE RESERVOIRS, MAINS, ROADS, ETC., CONNECTED THEREWITH.

While works that have cost $565,000 have recently been added to the aqueduct system by the laying of more than 8 miles of 48-inch and other large water mains under the act of March 2, 1889, with their numerous valve chambers, main valves, air-valves, blow-off valves, and other adjuncts, all of which have to be carefully watched and kept in repair, there has been no increase in the appropriation for maintenance and repair of the aqueduct.

It has been for many years and is now $20,000, and it proves entirely inadequate for keeping in repair the long line of works, including the dam at Great Falls, the conduit, the Conduit road (which is paved for the protection of the conduit), the reservoirs, the gatehouses, the fences of the aqueduct and Conduit road lands, the dwellings of the watchmen of the different divisions, and the more than 20 miles of trunk mains in the city supplying the distributing system of the District of Columbia, besides paying the salaries of the watchmen and other employés.

Twenty-one thousand dollars was asked for in my last annual estimates, and it is again asked for. It is not a large sum to provide for the annual maintenance and repairs of works that have cost more than $4,000,000, and I could expend much more in works of preservation and repair that would be for the best interests of the Government.

Money statement.

1892, balance unexpended	$2,238.51	
; appropriated by act approved July 14, 1892	20,000.00	
; appropriated by act approved March 3, 1893	80,000.00	
		$102,238.51
ber 9, 1892, amount deposited with the Treasurer United ı, being balance of appropriation of March 3, 1891	2.49	
, 1893, amount expended during fiscal year	21,431.01	
		21,433.50
1893, balance unexpended		80,805.01
1893, outstanding liabilities		805.01
1893, balance available		*80,000.00

ESTIMATES.

estimates of appropriations that should be made for the year ; June 30, 1895, are as follows, and I again urgently recommend ıe provision of law suggested in this report be attached to the ppropriations for the reasons stated:

ıpleting the improvement of the receiving (or Dalecarlia) reservoir e works required for cutting off the drainage into it of polluted water ewage from the surrounding country, for completing the purchase ıdemnation of the small amount of land required for the purpose, and :cavation necessary at the head of the reservoir	$90,000
ımencing the widening of the Macadam pavement of the Conduit road feet by widening that portion of the road that lies between the lower f the distributing reservoir and the receiving (or Dalecarlia) reser- widening the road and the embankments over the culverts on the f the aqueduct where necessary for this purpose, making the neces- hanges in the drainage, and the planting of shade trees	34,500
ering the height of the cross dam at the distributing reservoir	12,500
tecting the inlet to the aqueduct at Great Falls	5,000
chase or condemnation of a site for a storage yard	10,000
ıning out the distributing reservoir	13,825
ening and deepening the channel from the spillway at the receiving ılecarlia) reservoir	2,000
aving Griffith's Park and Cabin John bridges	5,000
·ehouse at Great Falls	1,500
tecting the conduit at wasteweir No. 1, near Great Falls	5,000
ırting air valves and blow-off valves in the 36-inch and 30-inch mains	6,250
ıoving the accumulation of deposits in the conduit	14,000
uilding the bridge over the channel from the spillway at the receiv- ır Dalecarlia) reservoir	18,000
ing the height of the masonry casings of the conduit manholes where ;ary	600
intenance and repairs of the aqueduct, and the reservoirs, mains, , etc., connected therewith	21,000

maintenance and repair of the aqueduct, $20,000; for commencing the im- ent of the receiving reservoir, $60,000.

Condition of water at Great Falls, Dalecarlia (receiving), reservoir and distributing re voir, and height of water over dam at Great Falls for each day in the year.

[The height of water on the dam at Great Falls varied during the year from a minimum of .47 foo November 1, 1892, to a maximum of 4.7 feet on May 6, 1893.]

Day of month.	Condition of water.			Height of water over dam at Great Falls, feet.	Condition of water.			Height of water over dam at Great Falls, feet.	Condition of water.			Height of water over dam at Great Falls, feet.	Condition of water.			Height of water over
	Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.		Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.		Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.		Great Falls.	Receiving reservoir, south connection.	Distributing reservoir, effluent gatehouse.	
	July, 1892.				August, 1892.				September, 1892.				October, 1892.			
1	2	36	6	1.00	25	31	18	.70	36	36	36	.60	36	17	36	
2	2	36	5	1.00	26	34	22	.70	36	36	36	.60	36	20	36	
3	7	24	4	.90	7	30	28	.70	36	36	36	.60	36	34	36	
4	1	28	4	1.00	8	27	26	.80	36	36	36	.60	36	36	36	
5	1	28	4	1.00	7	29	26	1.00	36	36	36	.60	36	36	36	
6	1	18	3	.90	7	30	28	.90	36	36	36	.60	36	36	36	
7	2	25	3	.80	5	30	30	.80	36	36	36	.60	36	36	36	
8	4	32	3	.90	10	34	28	.80	36	36	36	.60	36	36	36	
9	4	32	3	.80	25	36	28	.70	36	36	36	.60	36	36	36	
10	4	36	3	.80	33	36	30	.70	36	36	36	.60	36	36	36	
11	10	36	4	.70	33	36	36	.70	36	36	36	.60	36	36	36	
12	11	36	9	.70	36	36	36	.70	36	36	36	.60	36	36	36	
13	22	36	8	.70	26	36	36	.60	36	36	36	.60	36	36	36	
14	26	36	12	.70	28	36	36	.60	36	36	36	.60	36	36	36	
15	8	36	18	.70	32	36	36	.60	1	36	36	1.70	36	36	36	
16	9	36	22	1.70	36	36	36	.60	1	36	15	1.00	36	36	36	
17	12	7	22	.70	36	36	36	.60	2	36	7	1.00	36	36	36	
18	29	12	24	.70	36	36	36	.60	5	36	4	.80	36	36	36	
19	33	14	26	(*)	36	36	36	.60	8	36	3	.70	36	36	36	
20	36	19	36	(*)	36	36	36	.60	16	36	4	.70	36	36	36	
21	36	19	18	(*)	36	36	36	.60	20	36	6	.60	36	36	36	
22	36	20	13	.60	36	36	36	.60	23	36	7	.60	36	36	36	
23	36	14	15	.70	36	36	36	.60	28	36	10	.70	36	36	36	
24	36	22	36	.70	36	36	36	.60	26	8	12	.70	36	36	36	
25	36	28	36	.70	6	36	36	.60	32	12	16	.70	36	36	36	
26	36	36	36	.70	36	36	36	.60	34	14	18	.70	31	36	36	
27	10	36	36	.70	36	36	36	.60	36	9	21	.70	36	36	36	
28	1	36	36	.80	36	36	36	.60	36	7	20	.70	36	36	36	
29	4	36	22	.70	36	36	36	.60	36	11	24	.70	36	36	36	
30	8	36	10	.70	36	36	36	.60	36	16	31	.60	36	36	36	
31	10	36	11	.80	36	36	36	.60	.....	.....	.....	.....	36	36	36	

Day of month.	November, 1892.				December, 1892.				January, 1893.				February, 1893			
1	36	36	36	.50	30	33	22	.80	36	36	36	.80	4	36	27	
2	36	36	36	.50	30	34	36	.80	4	36	36	.90	2	36	10	
3	36	36	36	.50	31	36	36	.70	3	36	16	.90	3	36	7	
4	36	36	36	.60	32	36	36	.70	5	36	7	.80	5	36	5	
5	36	36	36	.60	32	36	36	.70	3	36	6	.80	8	36	4	
6	36	36	36	.60	33	36	36	.70	6	36	4	.90	6	26	5	
7	36	36	36	.60	36	36	36	.70	9	36	5	.90	4	36	7	
8	36	36	36	.60	36	36	36	.70	11	36	7	.80	4	36	8	
9	36	36	36	.60	36	36	36	.70	15	36	9	.80	6	36	10	
10	36	36	36	.60	36	36	36	.70	18	36	12	.70	4	36	10	
11	36	30	36	.70	36	36	36	.70	27	36	18	.70	1	36	9	
12	36	36	36	.70	36	36	36	.70	30	36	20	.80	1	36	6	
13	36	36	36	.70	36	36	36	.70	33	36	30	.80	1	36	5	
14	36	36	36	.70	6	36	36	.80	36	36	36	.80	1	36	4	
15	36	36	36	.70	5	36	36	1	36	36	36	.80	1	36	3	
16	36	36	36	80	3	36	30	1.20	36	36	36	.80	1	36	4	
17	36	36	36	.80	2	36	14	1.70	36	36	36	.80	1	30	4	
18	36	36	36	.70	2	36	12	1.40	36	36	36	.90	1	24	4	
19	7	36	36	.80	3	36	10	1.30	36	36	36	.90	1	27	4	
20	3	20	36	1	3	36	7	1.20	36	36	36	.90	2	15	4	
21	2	15	36	1.10	3	36	6	1.20	36	36	36	.80	3	16	3	
22	3	14	15	1.20	5	36	5	1.20	36	36	36	.80	4	21	4	
23	4	12	10	1.20	7	36	6	1.10	36	36	36	.80	5	21	5	
24	10	17	7	1	11	36	7	.80	36	36	36	.80	8	26	5	
25	6	21	7	.90	11	36	12	.70	36	36	36	.80	4	21	5	
26	8	22	10	.80	12	36	15	.70	36	36	36	.80	7	26	5	
27	9	27	12	.80	13	36	15	.70	36	36	36	.70	11	26	5	
28	16	30	15	.80	20	36	19	.70	10	36	36	.70	12	29	7	
29	26	32	16	.80	30	36	23	.70	15	36	36	.70	.....	.....	.....	
30	27	32	17	.80	36	36	25	.70	8	36	36	.70	.....	.....	.....	
31	.....	.....	.....	.....	36	36	36	.70	6	36	30	.80	.....	.....	.....	

* Water shut off from conduit and the gauge could not be read on those days.

dition of water at Great Falls, Dalecarlia (receiving), reservoir and distributing reservoir, etc.—Continued.

Condition of water. Great Falls.	Condition of water. Receiving reservoir, south connection.	Condition of water. Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	Condition of water. Great Falls.	Condition of water. Receiving reservoir, south connection.	Condition of water. Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	Condition of water. Great Falls.	Condition of water. Receiving reservoir, south connection.	Condition of water. Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.	Condition of water. Great Falls.	Condition of water. Receiving reservoir, south connection.	Condition of water. Distributing reservoir, effluent gatehouse.	Height of water over dam at Great Falls, feet.
March, 1893.				April, 1893.				May, 1893.				June, 1893.			
2	26	9	1.60	36	36	36	1	12	36	18	1.50	29	36	36	1.10
2	26	10	1.70	36	36	36	.90	13	36	32	(*)	29	36	36	1.10
2	22	7	1.90	36	36	36	.90	10	36	23	1.60	30	36	36	1.10
2	20	6	1.80	36	36	36	.80	1	36	13	2.30	23	36	36	1.20
4	8	5	1.80	36	36	36	.80	1	6	10	4.60	2	36	36	1.70
6	7		1.80	36	36	36	.80	1	5	5	4.70	1	36	25	1.70
8	10		1.70	36	36	36	.80	1	5	5	3.40	1	36	15	1.80
9	9		1.60	36	36	36	.80	1	6	8	2.80	1	32	15	1.70
10	10		1.50	36	36	36	.80	2	6	4	2.20	2	29	5	1.60
1	8		2.30	36	36	36	.80	3	7	4	(*)	5	33	4	1.30
1	9		2.80	36	36	36	.80	9	8	7	1.70	8	36	4	1.20
1	6		2.60	36	36	36	.80	13	6	7	1.60	13	36	6	1.10
2	7	3	2.30	36	36	36	1.20	14	15	10	1.50	10	36	9	1.10
2	8	4	2.10	10	36	36	1.20	9	27	12	1.40	11	36	13	1
4	9	4	1.90		36	36	1.40	12	27	14	1.40	23	36	20	1
5	9	4	1.90	1	36	36	1.60	14	32	19	1.30	26	36	28	.90
7	12	5	1.60	1	36	26	1.50	2	32	22	1.60	28	36	36	.80
9	10	9	1.50	3	36	9	1.50	2	34	20	1.50	30	36	36	.80
20	13	9	1 40	6	36	7	1.40	5	36	16	1.40	32	36	36	.80
22	16	9	1.40	6	36	4	1.20	15	36	16	1.30	36	36	36	.80
19	17	14	1.30	6	36	5	1.50	21	36	7	1.30	36	36	36	.80
24		18	1.20	1	36	12	2	21	36	27	1.30	36	36	36	.80
24	24	25	1 20	1	36	7	2	22	36	36	1.50	1	36	36	.90
27	27	26	1.20	2	36	4	1.90	14	36	36	1.60	2	36	7	.80
29	24	30	1.10	6	36	4	1.70	12	36	36	1.50	4	36	4	.80
30	27	28	1.10	6	36	4	1.60	8	36	36	1.30	18	36	6	.80
30	28	36	1.10	7	36	5	1.50	6	36	30	1.30	23	36	9	.80
31	29	36	1.10		36	8	1.40	10	36	28	1.20	30	36	14	.70
34	30	36	1.10	14	36	11	1.40	19	36	28	1.10	30	36	20	.70
36	34	36	1.10	14	36	16	1.50	22	36	30	1.10	32	36	26	.70
36	36	36	1		......	......	......	27	36	26	1.10	......	......	......	......

*Water shut off from conduit and the gauge could not be read on these days.

ber of days during the fiscal year 1892–'93, on which the water was clear or turbid at the places indicated.

Place.	Clear.	Slightly turbid.	Turbid.	Very turbid.
Falls	186	14	51	114
arlia (receiving) reservoir	309	21	23	12
ibuting reservoir	205	30	43	87

'E.—In determining the condition of the water a metallic tube with glass ends is used. This is with water, and the distance at which a ball immersed in the water can be seen from one of the s noted. When it can be seen at a distance of from 22 to 36 inches, inclusive, it is considered from 15 to 21 inches, slightly turbid; from 8 to 14 inches, turbid, and from 0 to 7 inches, very l.

Daily gauge pressures at the office of the Washington Aqueduct at 9 o'clock a. m.

Month.	Main.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Average.
1892.	*Inch.*																																
	30	32	32	32	32	33	32	33	32	32	33	32	32	32	32	32	32	32	32	32	32	32	32	32	33	32	32	32	32	32	32	32	32.13
July	36	33	33	33	33	33	33	34	33	33	32	33	33	33	33	33	33	33	33	33	32	32	33	33	33	33	33	33	33	33	33	33	32.93
	48	37	37½	37	37½	37½	37	37½	37	37½	37½	37	37	37	37	37½	37	37	37½	37½	36	36	36	36	36	36	36	36	37	37	37	37	36.89
	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
August	36	33	33	33	33	33	33	33	33	33	33	33	33	33	33	32	33	32	33	33	32	32	32	32	32	33	33	33	33	33	33	32	32.77
	48	37	37½	37	37½	37½	37½	37	37½	37½	37	37	37	37	37	37	37	36	37	37½	37½	37	37	37	37	37	37	37	37	37	37	36	37.06
	30	32	32	32	32	32	32	32	32	32	31	32	32	32	32	32	32	32	32	31	32	31	31	32	31	32	31	31	31	31	31	....	31.67
September	36	32	32	32	32	32	32	32	32	32	31	32	32	32	32	32	32	32	32	31	32	31	32	32	31	32	31	31	31	31	31	....	31.70
	48	36	36	36	36	36	37	37	37	37	37	37	37	37	37	37	37	37	37	36	37	37	37	37	36½	37	36	36	36	36½	37	....	36.66
	30	31	31	30	31	31	31	31	31	31	31	31	31	32	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
October	36	31	31	30	31	31	31	31	31	31	31	31	31	32	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	36	36	36	37	37	37	36½	35½	36	37	37	37	36	37	37	37	37	36½	37	36	37	37	37	37	37	37	36	36	36	37½	37½	36.66
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
November	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	37	37	37	37	37½	37½	37½	37½	37	37½	37½	37½	37½	37	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37	37	37½	....	37.37
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	(*)	31	31	31	31	31	(*)	31
December	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	32	32	(*)	31.07
	48	37½	36	37½	37½	37½	37½	37	37½	37½	37½	37½	37½	37	37	37	37½	37½	37½	37½	37½	37½	37	37	37	37	37	37	37	37	37	37	37.22
1893.																																	
	30	31	31	31	31	31	31	31	31	31	(*)	31	31	31	31	(*)	(*)	31	(*)	(*)	(*)	(*)	(*)	(*)	31	31	31	31	31	31	31	31	31
January	36	32	32	32	31	31	31	31	31	31	31	(*)	(*)	31	31	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	31	31	31	31	31	31	31	31	31.15
	48	37	37	37	36½	37	37	36	37	37	37	36	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	36.77
	30	31	31	31	31	31	31	31	31	31	31	32	32	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	....	....	31.07
February	36	31	31	31	31	31	31	31	31	31	31	32	32	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	....	....	31.07
	48	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	36	37½	37	37½	37	37½	37	37	37½	37½	37½	37	....	....	....	37.17
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
March	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	37½	37½	37½	38	37½	37½	38	37½	37½	37½	38	38	38	38	37½	37½	37½	38	38	37½	38	37½	37½	37½	38	38	38	37½	38	37	37½	37.69
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
April	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	37½	38	37½	38	37½	37½	37½	37½	37½	38	38	38	38	38	38	37½	38	37½	37½	38	37½	38	38	38	38	37½	37½	37½	38	37½	....	37.75
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
May	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	34	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	38	38	37½	37½	37½	37½	38	38	38	37½	37½	37½	37½	37½	37½	37½	37½	38	38	37½	38	37½	38	37½	37½	37½	38	37½	38	38	38	37.71
	30	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
June	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	38	38	38	38	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	37½	38	37½	37½	37½	36	37½	37	37	37½	37	37	37	37	....	37.43

* Gauges frozen.

s of greatest intensity from June 10, 1876, to November 18, 1892, as recorded by
c gauges at the United States Signal Service and Weather Bureau, Washington,

	Total fall.		Heavy fall.			Maximum fall.		
	Amount.	Duration.	Amount.	Duration.	Rate per hour.	Amount.	Duration.	Rate per hour.
	Inches.	*Hrs. Min.*	*Inches.*	*Hrs. Min.*	*Inches.*	*Inches.*	*Min.*	*Inches.*
....	2.03	1 00	1.98	0 40	2.97	1.98	40	2.97
....	4.12	12 00	.45	0 30	.90	.10	03	2.00
....	.52	1 30	.43	0 11	2.35	.20	02	6.00
....	2.16	5 13	1.78	1 50	.97	.60	18	2.00
....	2.08	17 18	.76	0 32	1.43	.06	01	3.60
....	2.17	6 25	1.65	1 30	1.09	.10	02	3.00
....	1.03	8 22	.50	0 12	2.50	.14	02	4.20
....	.63	0 53	.63	0 53	.71	.07	01	4.20
....	2.34	2 50	1.45	0 30	2.90	.15	02	4.20
....	.80	0 38	.40	0 12	2.00	.10	01	6.00
....	3.98	4 10	1.20	1 00	1.20	.15	03	3.00
....	2.83	20 10	.80	1 15	.64	.20	08	1.50
....	2.60	16 48	.80	1 30	.53	.10	02	3.00
....	.82	0 15	.82	0 15	3.28	.06	01	3.60
....	4.09	23 00	.50	0 30	1.00	.20	10	1.20
....	.42	0 18	.20	0 06	2.00	.09	02	2.70
....	.80	0 42	.80	0 42	1.14	.07	01	4.20
....	4.25	24 00	.90	0 30	1.80	.30	06	3.00
....	.64	1 42	.43	0 24	1.07	.20	05	2.40
....	2.15	4 50	2.05	0 45	2.73	.40	04	6.00
....	3.40	12 30	.70	1 00	.70	.20	04	3.00
....	2.23	15 90	.20	0 34	.22	.10	06	1.00
*								
....	2.14	19 25	.25	1 00	.25	.10	10	.60
....	1.40	1 12	.38	0 12	1.90	.11	02	3.30
....	2.26	14 89	2.03	8 00	.25	(†)	(†)	(†)
....	1.79	16 15	.54	1 00	.54	.10	06	1.00
....	.65	1 55	.26	0 10	1.56	.06	01	3.60
....	2.89	24 00	.20	0 50	.24	.10	15	0.40
....	2.59	1 38	1.58	0 36	2.63	.80	12	4.02
....	.88	0 40	.88	0 40	1.32	.30	06	3.00
....	2.12	24 00	.20	1 00	.20	.10	10	.60
....	1.11	3 52	.80	0 23	2.09	.40	07	3.42
....	2.00	4 46	.87	0 43	1.21	.10	03	1.98
....	1.53	2 15	1.16	0 30	2.32	.20	03	3.96
....	.96	0 40	.86	0 24	2.15	.10	03	3.00
....	.53	0 47	.53	0 47	.68	.07	01	4.20
....	1.13	2 20	.48	0 12	2.40	.20	03	3.96
....	2.20	22 13	.33	0 13	1.52	.10	02	3.00
....	.95	0 42	.95	0 42	1.36	.20	03	3.96
....	.74	0 28	.55	0 18	1.83	.20	04	3.00
....	1.34	0 40	.30	0 06	3.00	.07	01	4.20
....	1.98	15 49	.42	1 00	.42	.08	02	2.40
....	2.21	16 00	.47	0 15	1.88	.14	02	4.20
....	2.41	10 33	.50	0 36	.83	.10	03	2.00
....	3.45	24 00	.49	0 20	1.47	.10	03	2.00
....	2.05	7 49	.85	0 30	1.70	.08	01	4.80
....	.78	1 47	.60	0 25	1.44	.09	01	5.40
....	1.85	24 00	.30	0 28	.64	.11	03	2.20
....	1.52	2 05	.85	0 42	1.21	.10	03	2.00

* The record for 1879 not available. † No sheet.

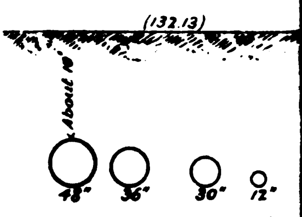
Rain storms of greatest intensity, etc., Washington, D. C.—Contin

Date.	Total fall.		Heavy fall.			Maxim	
	Amount.	Duration.	Amount.	Duration.	Rate per hour.	Amount.	Dur
1885.	*Inches.*	*Hrs. Min.*	*Inches.*	*Hrs. Min.*	*Inches.*	*Inches.*	*M*
June 28	.95	7 50	.54	0 35	.93	.06	
Aug. 3	1.92	24 00	.30	0 11	1.64	.08	
Aug. 23	.67	0 25	.67	0 25	1.61		
Oct. 29	2.69	15 15	.85	1 00	.85	.20	
1886.							
Mar. 31	2.57	24 00	.65	1 00	.65	.20	
May 8	3.50	23 05	.30	0 17	1.06	.20	
June 22	4.16	5 45	.65	1 00	.65	.06	
July 15	1.62	4 40	.74	0 30	1.48	.15	
July 21	1.63	6 10	.48	0 18	1.60	.10	
July 26	3.25	5 35	1.16	1 00	1.16	.20	
1887.							
Aug. 11	.76	0 25	.76	0 25	1.82	.10	
Sept. 12	.66	0 28	.66	0 28	1.41	.09	
1888.							
June 14	.40	0 25	.25	0 06	2.50	.05	
June 23	.69	1 14	.65	0 30	1.30	.10	
July 10	3.03	15 25	1.03	0 25	2.47	.20	
Aug. 21	.89	3 45	.60	0 12	3.00	.20	
Sept. 16	1.60	4 39	1.20	0 22	3.27	1.20	
1889.							
Apr. 6	2.23	13 40	.25	0 45	.33	.05	
Apr. 26	3.21	24 00	(*)	(*)	(*)	(*)	(
May 31	2.98	24 00	.35	0 30	.70	.05	
July 1	1.50	8 25	.75	1 22	.55	.30	
July 15	.59	0 35	.30	0 05	3.60	.30	
July 31	3.18	23 30	.60	0 30	1.20	.25	
Aug. 6	1.17	3 45	.66	0 12	3.30	.35	
Aug. 9	.60	0 25	.30	0 05	3.60	.30	
Sept. 17	1.10	5 39	.30	1 00	.30	.09	
1890.							
Apr. 4	.65	8 00	.22	0 35	.38	.15	
May 20	.81	2 25	.48	0 12	2.40	.20	
June 12	.65	2 27	.50	0 15	2.00	.25	
July 2	.96	2 00	.66	0 12	3.30	.30	
Aug. 1	1.83	6 03	1.13	1 00	1.13	.30	
Sept. 11	1.25	6 30	.41	0 17	1.52	.25	
Oct. 23	3.39	24 00	1.30	4 00	.32	.05	
1891.							
Jan. 22	1.36	8 00	.36	0 25	.86	.10	
Apr. 11	1.73	24 00	.70	0 42	1.00	.23	
May 3	.57	4 30	.30	1 07	.27	.15	
June 21	1.63	13 15	.60	0 18	2.00	.30	
July 15	1.22	2 04	.60	0 20	1.80	.40	
Sept. 5	1.74	24 00	.40	0 14	1.71	.25	
Oct. 19	1.10	7 57	.66	0 25	1.58	.28	
Dec. 7	.85	19 15				.10	
1892.							
Apr. 22	.87					.15	
May 26	1.25	4 55	.65	1 30	.43	.24	
June 23	.40	2 36	.21	0 05	2.52	.21	
July 14	1.46	2 32	.60	0 35	1.03	.32	
Aug. 5	.64	2 35	.30	0 30	.60	.15	
Sept. 23	1.49	14 10	.55	1 00	.55	.20	
Nov. 18	.72	5 18	.30	0 50	.36	.10	

* No hourly record.

Scale of Plan.

Scale of Sections.



Section on line G.H.

...accompany annual report for 1893.

Geo. H. Elliot,
Colonel of Engineers U.S.A.

Appropriations made for the Washington Aqueduct, with the dates of acts for the same.

Date.	Amount.	Date.	Amount.	Date.	Amount.
September 30, 1850	$500	July 15, 1870 *b*	$120,822	March 3, 1883	$20,000
August 31, 1852 *a*	5,000	March 3, 1871	114,196	July 5, 1884	20,000
March 3, 1853	100,000	June 10, 1872	70,555	February 25, 1885	20,000
March 3, 1855	250,000	January 23, 1873	14,000	July 9, 1886	20,000
August 18, 1856	250,000	March 3, 1873 *c*	43,600	March 3, 1887	20,000
March 3, 1857	1,000,000	June 23, 1874 *d*	36,400	July 18, 1888 *h*	20,000
June 12, 1858	800,000	March 3, 1875	26,000	March 2, 1889 *i*	20,000
June 25, 1860	500,000	July 31, 1876	22,000	August 6, 1890 *j*	25,500
July 4, 1864	150,000	March 3, 1877	15,000	March 3, 1891 *k*	20,000
July 28, 1866	142,584	June 20, 1878	15,000	July 14, 1892	20,000
December 20, 1866	12,000	March 3, 1879 *e*	20,000	March 3, 1893	80,000
March 2, 1867	20,000	June 4, 1880 *f*	20,000		
July 25, 1868	52,500	March 3, 1881	20,000	Total	4,150,657
March 3, 1869	25,000	July 1, 1882 *g*	20,000		

NOTE.—Reverted to the Treasury: (*a*) $2.81, (*b*) $46.25, (*c*) $560.87, (*d*) 35 cents, (*e*) $1,109.87, (*f*) $381.06, (*g*) $1,354.17, (*h*) $2,266.34, (*i*) $4.12, (*j*) $5,500, (*k*) $2.49; total, $11,228.33. Since 1878 one-half of the amounts appropriated have been contributed by the United States and the other half by the District of Columbia.

B B B 2.

INCREASING THE WATER SUPPLY OF WASHINGTON, DISTRICT OF COLUMBIA.

This work was commenced under an appropriation made in the act of Congress approved July 15, 1882.

The plan consisted of raising the dam in the Maryland channel at the Great Falls of the Potomac to an elevation of 148 feet above mean tide at the Washington navy-yard and its extension at that height across Conn's Island and the Virginia Channel of the river; extending the Washington Aqueduct from the distributing reservoir above Georgetown to the site selected for the new reservoir near Howard University by a tunnel 20,696.3 feet long; constructing at the tunnel outlet a new reservoir of about 300,000,000 gallons capacity, and connecting this reservoir by a new line of large mains with the existing system of water mains in the city of Washington.

All operations on this project are suspended, and no work has been done under it during the year.

The channel on the east side of the reservoir, which has been damaged by heavy rain, was repaired in August, and a strong bulkhead was built with a flume leading from behind it into the great sewer that passes around the reservoir. The paving of the ditch at this point was laid in cement, and it is hoped that future damage at this troublesome place will be avoided.

The necessary repairs were made to the watchman's house at the reservoir during September and October.

A new protection over the top of the Fayette street air shaft was made in November.

Stone was hauled, by permission, by the District of Columbia from Champlain avenue shaft for repairs of roads.

A deed of Frederick Wetzel to the United States for land near the distributing reservoir, dated April 26, 1890, with quitclaim deed of Margaret A. Wetzel, dated May 2, 1890, was recorded on January 18, in the land records of the District of Columbia.

The following provisions were incorporated in the act making appropriations for the District of Columbia, approved by the President March 3, 1893.

That notwithstanding the limitation prescribed by the acts of Congress approved July fifteenth, eighteen hundred and eighty-two, and February twenty-six, eighteen hundred and eighty-five, the Secretary of War be, and he is hereby, authorized to pay to Thomas Ready the sum of four hundred and seventy dollars and ninety cents out of the unexpended balance of the appropriation of fifty-one thousand three hundred and seventy dollars to pay for land to extend aqueduct, made by the act entitled "An act to increase the water supply of the city of Washington, and for other purposes," approved July fifteenth, eighteen hundred and eighty-two, which sum shall be in full for the appraised value of land owned by the said Thomas Ready and taken by the United States for the requirements and purposes of that act: *Provided*, That no payment hereunder shall be made until the Attorney-General shall have decided that an absolute title to the premises shall vest in the United States.

A watchman has been employed during the year at the new reservoir. His duties have included the guarding the stone at the mouths of all the shafts except the one at Foundry Branch, which is under the care of the watchman at the distributing reservoir.

The following is a list of the appropriations for this work, with date of act for the same:

July 15, 1882	$1,485,279.30
July 7, 1884	87,500.00
March 3, 1885	87,500.00
March 26, 1886	5,000.00
August 4, 1886	555,000.00
March 30, 1888	355,000.00
Total	2,575,279.30

Money statement.

Title of appropriation.	July 1, 1892, balance unexpended.	June 30, 1893, amount expended during fiscal year.	July 1, 1893, balance unexpended and available.
Land to extend aqueduct	$24,930.49	$2.75	$24,927.74
Extension of aqueduct	272,103.89	4.08	272,099.81
Main connections	1,989.18		1,989.18
Land for reservoir	173.09		173.09
Constructing reservoir and gate house	81,581.32	973.42	80,607.90
Water rights and land to extend dam at Great Falls	44,882.04		44,882.04
Completion and extension of dam at Great Falls	4,605.52		4,605.52
Aggregate	430,325.53	980.25	429,345.28

No estimate for further appropriation is submitted.

B B B 3.

ERECTION OF FISHWAYS AT GREAT FALLS.

At the commencement of the fiscal year no work was in progress.

Sections 4, 5, and 6 of the fishways at Great Falls were completed at the date of my last Annual Report, and there remained to complete the plans of the Commissioner of Fish and Fisheries sections 1, 2 and 3.

Under a ruling concerning the act of July 15, 1882, providing for the construction of these fishways, the Secretary of War decided that the engineer officer in charge should be held responsible only for the proper protection of the Aqueduct Dam at Great Falls and the disbursement of the funds appropriated, the Commissioner of Fish and Fisheries being responsible under the act for the plans and specifications of the fishways and their execution.

By the act of Congress approved by the President August 5, 1892, an appropriation of $15,000 was made for this work. Proposals were advertised for October 17, and the contract, which was awarded to Mr. Isaac H. Hathaway, of Philadelphia, Pa., the lowest bidder, was entered into November 23.

During August and September a surveyor and three men were employed on a survey for the purpose of enabling the Commissioner of Fish and Fisheries to make the construction plans for sections 1, 2 and 3, and also for an additional work desired by him, viz, a permanent dam between sections 1 and 2.

Upon application by the contractor, and with the authority of the Chief of Engineers, the time for the completion of the contract was extended one month.

Sections 2 and 3 of the fishways and part of the permanent deflecting dam have been completed, but there remains to be done the completion of this dam and the construction of section 1.

The Commissioner of Fish and Fisheries is of the opinion that an additional sum of $7,890 will be required to complete the work, and requests that an estimate for it be submitted. His letter to me is as follows:

> I have to request that you include in your estimates for the ensuing fiscal year an item of $7,890 for the completion of the Great Falls Fishways. The additional appropriation asked for is made necessary, first, by reason of an increased cost of sections 2 and 3 over and above the estimate; second, by reason of the construction of a permanent deflecting dam which was found essential for the better protection of the fishways, and to obtain control of the water supply to the same; third, for the reason that a sufficiently large amount is included to cover the work of cleaning out the river bed between the fishways, and to construct a tool shed with small office. And, lastly, to provide a small fund with which to repair any damage to the fishways from the effects of the spring freshets before the completion of the permanent deflecting dam.

The appropriations for this work to date are as follows:

Act of July 15, 1882	$50,000
Act of February 1, 1888	25,000
Act of August 5, 1892	15,000

Money statement.

July 1, 1892, balance unexpended	$47.89	
Amount appropriated by act approved August 5, 1892	15,000.00	
		15,047.89
June 30, 1893, amount expended during the year		10,546.60
July 1, 1893, balance unexpended		4,501.29
July 1, 1893, outstanding liabilities		4,469.27
July 1, 1893, balance available		32.02
Amount deemed necessary by the Commissioner of Fish and Fisheries for the completion of the work		7,890.00

Abstract of proposals for construction of fishways at Great Falls of the Potomac; received in response to advertisement dated October 17, 1892, and opened November 8, 1892, by Lieut. Col. George H. Elliot, Corps of Engineers.

Estimated quantities.	No. 1.—Proposal of Isaac H. Hathaway, Philadelphia, Pa.	No. 2.—Proposal of John E. Lyons, Washington, D. C.
Earth excavation, 65 cubic yards	$0.80	$0.25
Solid rock excavation, 80 cubic yards	3.50	4.00
Bowlder excavation, 15 cubic yards	3.00	4.00
Concrete masonry, 325 cubic yards	6.50	8.00
Riprap 140 cubic yards	2.00	2.00
Superstructure section 2	2,800.00	3,808.50
Superstructure section 3	2,660.00	3,808.00
Rubblestone masonry, section 1, 51 cubic yards	10.00	12.50
Timber and lumber, section 1, 5,000 feet B. M.	65.00	180.00
Cast-iron section 1, 900 pounds	.08	.11
Wrought-iron and steel, section 1, 440 pounds	.10	.14
Rubblestone masonry, not including section 1, 43 cubic yards	6.00	12.50
Coping stone masonry, 24 cubic yards	45.00	70.00
Timber and lumber, not including section 1, 14,500 feet B. M.	50.00	73.00
Wrought-iron and steel, not including section 1, 8,200 pounds	.08	.12
Total bids	11,899.50	16,367.85

Contract awarded to Isaac H. Hathaway.

APPENDIX C C C.

IMPROVEMENT AND CARE OF PUBLIC BUILDINGS AND GROUNDS IN THE DISTRICT OF COLUMBIA—WASHINGTON MONUMENT.

REPORT OF COL. JOHN M. WILSON, U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

OFFICE OF PUBLIC BUILDINGS AND GROUNDS,
Washington, D. C., July 8, 1893.

GENERAL: I have the honor to submit the following report of operations upon Public Buildings and Grounds under the Chief of Engineers during the fiscal year ending June 30, 1893.

I relieved Col. O. H. Ernst, U. S. A., Major, Corps of Engineers, of the charge of this office March 31, 1893.

In addition to these duties I am a member of the Light-House Board and in charge of the erection of a monument to mark the birthplace of Washington and of an iron pile wharf at the mouth of Bridge Creek, Virginia.

THE IMPROVEMENT OF THE PUBLIC GROUNDS IN THE DISTRICT OF COLUMBIA.

While all persons justly concede the utility and value to the Capital of the Nation of the system of parks and public spaces at the intersection of its streets and avenues and the important relation they bear to the health and welfare of the citizens, many of whom from the requirements of official duties must reside here nearly continuously during the year, the many indirect yet not less valuable agencies extending from them in promoting the mental growth and cultivating a love for horticulture, arboriculture, and floriculture among our people, who congregate here from all sections of our country, do not seem to be fully understood or appreciated.

Prior to the commencement of the improvement of the Smithsonian Grounds in 1851 by that celebrated landscape architect and gardener, Mr. A. J. Downing, it is believed that few extensive park improvements were contemplated or had been made in any American city.

Now many of our largest cities have within their limits extensive and highly improved public parks, the expenditures therefor in some instances approximating to millions of dollars. However large the cost has been, the benefits accruing therefrom have invariably amply repaid the labor and expense.

Increased revenues have been derived from taxation caused by the rapid increase in value of adjacent lands and from the handsome and costly buildings usually erected in the immediate vicinity of the parks.

The effect upon the health and morals of the people benefited by these improvements has been of the most marked and beneficial character.

In the opening paragraph of a recent publication, Washington has been described as follows:

> Washington is in a double sense the Capital city.
>
> It is the Capital of one of the foremost nations of the earth and it is first in beauty and attractiveness among all the cities of the American continent. It is in many respects the most interesting city in America, and to it thousands of tourists make pilgrimages from all parts of the world.

If this language is too strong, and Washington is not the most beautiful and attractive city in America, surely as the Capital city it should be made so, and the parks and park places so freely distributed through it by the wise foresight of the great man who laid it out, and which are conceded to form one of its chief attractions, should be maintained in the very highest condition of improvement.

This can only be done by liberal appropriations from Congress for their support, as they are the exclusive property of the United States.

The improved reservations of the Government, comprising the public grounds, have been mainly created under the direction of the Chief of Engineers, U. S. Army, the officers detailed for the duties having been most earnestly, ably, and efficiently assisted by Mr. George H. Brown, the Public Gardener, whose taste, skill, intelligence, and untiring industry have been freely and promptly devoted to this beautiful work.

Mr. Downing designed extensive improvements, but his death prevented him from executing them. Under his direction Lafayette Park was improved and planted and a portion of the Smithsonian Grounds beautified; he formulated plans and projected minor improvements of other parks, which were subsequently partly adopted.

During the period between the death of Mr. Downing, in 1852, and the assignment in 1867 of the control of the public grounds to the Chief of Engineers no improvements of any importance were made except those around the Agricultural Department. Since 1867 all of the prominent parks and park places, with the exceptions noted in the foregoing, have been improved under the direction of the Chief of Engineers, U. S. Army, with the limited appropriations made by Congress for that purpose. How well the task has been accomplished, how carefully the funds have been used, the many compliments paid to Washington on her park system by her sister cities and by distinguished visitors from abroad abundantly testify.

It is also conceded that our parks, by the manner the improvements are maintained, evidence more care than is generally exercised in such work except where large expenditures are made. This is encouraging in view of the fact that it is believed that a less amount per acre is expended in their care and maintenance than in any other locality where similar park systems are maintained. This condition of affairs is, in some measure, due to the great care exercised by the Government in making expenditures for the purchase of materials and for payment for superintendence, labor, etc. It is a notable fact that the Government has been apparently fortunate in securing good materials and very good service in all work connected with the parks. Unfortunately, for the next fiscal year the appropriations for this very important work have been reduced, and while there is every evidence that what has been done is fully appreciated, it is feared that the great work yet to be accomplished is not fully realized. It is earnestly hoped that the Congress soon to convene will evince that interest in our beautiful parks that their importance demands, and that sufficient funds may be allotted to push to speedy completion projected and necessary improvements in a manner commensurate with their importance, not only for the purpose of adorning the Capital city in which all citizens have a just pride, but to furnish an example of simple landscape gardening and park ornamentatio that will have a direct influence in aiding in elevating the taste of all visitors, and that may eventually lead to the transformation into beautiful parks of many pieces of waste ground adjacent to the cities of our country.

With these facts before me I respectfully submit the following report of work done during the year, with suggestions for improvements which I deem necessary:

GROUNDS NORTH OF THE EXECUTIVE MANSION.

These grounds include those within the iron fence north of the White House. During the year they have been maintained in excellent condition; lawns have been mown, flower beds have been planted with flowering bulbs and with summer and autumn flowering and foliage plants; trees and shrubs have been pruned, and about 92 square yards of the asphalt pavement repaired; the hydrants near the north balcony were moved, so as to be more accessible in case of fire; the fountain has been placed in good condition, and some repairs made to the old iron hurdle fence leading from the north side of the mansion to the steps opposite the Treasury Department.

It is suggested that the old rubble masonry wall, capped with a worn-down sandstone coping and surmounted by an old iron railing, bounding the grounds of the Executive Mansion on its north front, along the principal avenue of the city, should be removed, and give place to a more substantial and more ornamental structure more in keeping with its prominent location and surroundings; for many years it kept company with an old, uneven small, flagstone pavement which, in the march of progress, has been removed and replaced by a smooth granolithic pavement.

The sidewalk approaches for pedestrians to the mansion, bordering the main roadway, which are surfaced with uneven, worn-down, old flag pavement, should be removed and replaced with a granolithic pavement. The old, worn-out, hurdle wire fence between the Executive Mansion and the steps leading down to the fountain opposite the Treasury Department building, should be removed and replaced with a more suitable and more ornamental iron fence.

GROUNDS SOUTH OF THE EXECUTIVE MANSION.

These grounds include not only those attached to the Executive Mansion but the entire reservation south of the White House, the Treasury, and the State, War and Navy building, north of B street, between Fifteenth and Seventeenth streets.

During the year the main roads have been repaired, raked, and rolled compactly, using for this purpose about 332 cubic yards of gravel. The roads were well watered during the summer season in order to keep down the dust. All paths, gutters, drain traps, etc., were kept clean and in good repair.

All lawns, covering an area of about 40 acres, were mown several times and maintained in good order; those portions of the lawn surfaces upon which the grass was destroyed during the occupation of this reservation by the Grand Army of the Republic in September, 1892, were spaded and harrowed, covered with compost, seeded down, and eventually restored to their original beauty. All trees and shrubs were pruned, mulched, and maintained in good order. In the Executive Mansion grounds additions were made to the trees and shrubbery, and handsome ornamental flower beds were laid out and planted.

The display of fireworks near the monument on the night of March 6, and the children's annual Easter festival in the White House grounds on Easter Monday, while not causing any great damage, necessitated more or less extra labor in restoring the grounds to their original beauty.

The south grounds of the Mansion should be highly improved; the high mounds should be graded and shaped, the gravel walks removed and replaced with artificial stone or granolithic pavements, curbed, and provided with ample drainage so as to be in good condition for travel at all seasons; the northern portion of the grounds outside the iron fence, fronting the State, War and Navy building and the Treasury Department, should be highly improved; the Treasury Department photograph gallery and greenhouses should be removed; bedding plants for use of the Treasury Department could be provided at the propagating gardens if deemed necessary.

The White House stable should be moved from the grounds fronting the State Department, where it is manifestly out of place, and the park generally should receive such further improvement as is needed by the construction of asphalt walks to replace the gravel walks now in place; additional walks are required for public travel through these grounds, increased water supply for irrigation, and increased drainage facilities.

WASHINGTON NATIONAL MONUMENT.

Every effort has been made during the year to maintain the monument and its machinery in good condition.

Vandals continue to give annoyance by occasionally chipping pieces either from the outside or from the memorial stones in the inner walls, while some insist upon writing their names upon the white marble; whenever detected these thoughtless persons are arrested and punished.

The elevator and all the machinery connected therewith has been carefully and critically inspected monthly by an expert from the Otis Elevator Company, and pronounced in excellent condition; weekly inspections are made by the principal steam engineer and machinist at the monument and daily tests of the safety appliances of the elevator car are made by the employés before starting to convey passengers to the top.

It is believed that the elevator is as safe as it is possible for man to make it, and every effort is made to prevent accident; should an accident ever occur it will result from something which it was impossible to foresee.

All the iron work in the elevator drum pit has been painted with red lead, the drum given a coat of plumbago and oil, the outside hand rope of the elevator given a coat of red lead, and a portion of the iron work between the top and bottom of the shaft repainted. A new leather belt has been placed upon the elevator engine, all old oil cups replaced with new lubricating cups, a new set of governor brasses put on, and other minor repairs made.

The boilers were thoroughly cleaned, subjected to a cold-water test of 125 pounds, and all tubes, seams, and rivets found tight; all steam valves were repacked; new tubes were placed in the feed-water heater in boiler house and the heater connected; the fronts of the boilers were given a coat of asphaltum and the interior of the boiler house was whitewashed; new joints were made from time to time as required on the main steam pipe in the tunnel between the boiler and engine houses, and the brick saddles supporting this pipe were reset. The exhaust pipe through the tunnel was repainted, the main steam pipe in the vertical tunnel near engine room recovered with felt and canvas, and the small engine which runs the dynamo was overhauled and repaired several times. This little engine is in very bad condition, is liable at any time to become useless, and should be replaced by a new one as soon as practicable.

The roof and spouting of the boiler house was repaired, the gutters repainted, and minor repairs were made to the plumbing in the lodge.

The monument was open to visitors daily during the year, except on Sundays and holidays and with the exception of one day in August, 1892, three days in November, 1892, and two days in May, 1893, when repairs and improvements were in progress; the elevator was in operation whenever the monument was open.

There were 186,327 visitors to the top of the monument during the year, of which number 108,281 made the ascent in the elevator and 78,046 by the stairway, making 799,502 persons who have visited the top since the shaft was opened to the public October 9, 1888.

There were a greater number of visitors to the monument during the month of September, 1892, than during any month since the shaft was opened to the public; during the week of the Grand Army of the Republic encampment, September 19 to 24, there were more than 30,000 visitors to the top, and the custodian estimates that at least 20,000 more entered the shaft and passed out without ascending.

WASHINGTON MONUMENT GROUNDS.

In this extensive park, covering an area of about 78 acres, is located the Washington Monument, one of the chief attractions of the city. It is destined to be the Mecca of many visitors from all sections of the country in the future; already nearly 1,000,000 people have visited the monument since it was opened to the public five years ago. During the year every effort has been made to maintain the improved portion of the grounds in as good order as possible and to continue the improvement of other portions so far as the limited funds available would admit. Lawns have been frequently mown and about 8 tons of hay secured for use of the public animals belonging to this office. The main roads have been repaired, raked, and rolled, using for this purpose about 270 cubic yards of gravel; all gutters and drain traps have been maintained in clean condition and a number of washouts repaired in the mound around the monument.

The old plank walk from the lodge to the monument was removed, the ground sown with grass seed and rolled, and a new plank walk, 800 feet long and 6 feet wide, laid from Fourteenth street to the monument. The plank walk from the entrance at Fifteenth and B streets was repaired and the gravel margins of the asphalt walks dressed with fresh gravel and rolled.

The manhole over the sewer near Fifteenth and B streets was raised to grade and a new frame and grating placed upon it; about 800 cubic yards of clay were received for use upon the unimproved portion of the reservation.

The north section of this park, which was occupied by temporary buildings erected in September for the Grand Army of the Republic, was carefully policed after the close of the encampment and a large amount of trash collected and burned; the grass in this section was destroyed, and it will be necessary to plow, enrich, and again seed down this area. About 400 feet of 2 inch water pipe has been introduced into the park for irrigating purposes; seven large flower beds have been prepared and planted with ornamental flowering and foliage plants.

By the act of Congress approved August 30, 1890, the officer in charge of public grounds was authorized to set aside a portion of the public grounds for a children's playground, under regulations to be prescribed by him; the southern portion of this park was at once set aside for this purpose, but no regulations were prescribed, as there were no means of carrying them out, no watchmen or policemen having been authorized, and the services of the one watchman on duty at the monument being needed there to protect the structure from acts of vandalism.

Just complaints have been received that the lawns are being destroyed, trees injured, and that the children's playground is overrun by vicious and improper persons; this office has been requested to take action to relieve the grounds of such characters, and has been obliged to call on the District police for assistance.

If Congress deems it best to continue the privileges extended by the act of August 30, 1890, then rules and regulations should be prepared assigning certain grounds for young children, other portions for base ball, tennis, football, etc., and there should be regular watchmen on duty at all hours, not simply for eight hours of the day, whose duty should be to prevent improper characters from interfering with the amusements and to see that all proper regulations are thoroughly enforced.

In the further improvement of this important reservation, it is desired to provide, as soon as possible, suitable approaches to the monument, as direct as practicable with the contour of the grounds, and to otherwise improve the park in accordance with plans, the main features of which were approved six years ago. An appropriation of $10,000 was requested as a sum that could be readily expended in this direction during the present fiscal year, but only $2,000 was appropriated; this will unfortunately retard the progress of this important work, as the sum available is barely sufficient to maintain in sightly condition 30 acres of lawns already defaced by trespassers and by baseball players, etc., and to maintain in good condition for travel nearly 6 acres of gravel road and walk surfaces and several miles of paved stone gutters with their connecting drain lodges, outlet drains, etc.

These park grounds, including on their borders the grounds occupied by the U. S. Fish Commission, the propagating gardens, and the Bureau of Engraving and Printing, as stated in the foregoing, cover an area of about 78 acres; they present rolling surfaces with pleasing contours, the stately shaft of the Washington Monument rising from the principal knoll near the river front. The main features of the plan prepared for its improvement, only a few of which have been carried out, are the construction of substantial driveways, over as easy grades as the contour of the grounds will admit, approaching the monument and from thence connecting with the roads of adjoining parks and the surrounding streets; to construct substantial walks with the view of affording the traveling public all necessary facilities for approach to the monument in as nearly direct lines of travel as may be practicable over the undulating lawns and to connect with other walks and roads which will be carried generally through the park in the direction of the propagating gardens, the U. S. Fish Commission lakes, and other points of interest.

The planting will be mainly confined to providing suitable park embellishment and shade for the roadways and walks through the grounds; the roadways near the monumental shaft will be appropriately furnished with groupings of low-growing trees of ornamental character, and in the vicinity of the monument, chiefly at the termination of roads and walks, simple groupings of dwarf flowering shrubs will be planted.

Flower beds will be laid out in the triangles formed by the road and walk intersections, and a few on the lawns at the monument. A parterre will be constructed around the lodge, and it is purposed to construct in a suitable location in the grounds, a large tropical lily pond, with numerous ornamental fountain jets, which will be heated in the spring by means of steam pipes placed in the basin for which the exhaust steam from the monument will be utilized, and which, it is believed, will be a great attraction to the visitors to the park. It is earnestly recommended that the electric-light system inaugurated in 1889 in the grounds south of the White House be extended throughout this park; there is now no method of artificial illumination between B street and the propagating gardens south of the monument, between Fourteenth and Seventeenth streets, and in the interest of morality and for the protection of persons necessarily crossing these grounds at night, lights are absolutely necessary; an estimate for electric lights is submitted with this report.

PROPAGATING GARDENS, INCLUDING THE GREENHOUSES AND NURSERY.

Extensive repairs were made to the various greenhouses during the year and the large and valuable collection of plants was maintained in good condition; all furnaces, boilers, flues, and coal cellars were cleaned, hot-water pipes repaired and packed where necessary, and a large amount of shelving placed in position in the autumn for use in plant propagation, and taken down and stored in the spring when the plants were placed in the parks.

The shops and storehouses were repaired and yellow-washed and the roofs of the three storehouses were covered with felt and painted; considerable miscellaneous work was accomplished in constructing and repairing cold frames, repairing roofs, constructing water tanks and plant boxes, repairing tin gutters and down spouts, laying brick walks in greenhouses, etc. Nearly 500,000 bedding plants, covering about 300 varieties, were propagated for spring planting in the public grounds, and particular attention was given to chrysanthemums for autumn bloom; in the autumn 8,132 plants, consisting of roses, smilax, carnations, begonias, heliotrope, geraniums, and pansies, and 20,577 bulbs, consisting of hyacinths, freesia, lilies, tulips, narcissus, and lilies of the valley, were planted for winter forcing and early spring bloom; 47,610 bulbs were purchased and planted for decorating the public grounds.

The nursery grounds were maintained in good condition; roads and walks were raked, repaired, and rolled, lawns mown and gutters and drain traps cleaned; all shrubbery was properly trimmed, transplanted where necessary, and unserviceable trees, etc., removed; 18,100 cuttings of flowering shrubs were set out in beds; about 500 trees and shrubs were lifted and used in the ornamentation of various parks throughout the city.

In the spring about 10,000 tuberoses and 7,000 carnations were set out and about 40,000 bulbs brought in from parks were planted in order to properly ripen for next season. About 10,000 ornamental foliage and flowering plants were set out in May within and in front of the nursery for ornamental purposes.

The old brick tanks for growing water lilies for the fountain basins were repaired and one new tank 60 feet by 12 feet was constructed.

On Sunday, March 26, the brush on the river flats on west side of nursery was set on fire and the flames extended to the nursery fence, burning about 60 feet before it could be extinguished by the watchmen on duty. Extensive improvements can well be made at these gardens; nearly 500,000 plants are annually propagated at the greenhouses for use in the summer and autumn decoration of the public parks; the beautiful water lilies and other aquatic plants used in many of the fountain basins are also propagated here.

The various structures are serviceable for the purposes for which they are used, and have been mainly erected by our own workmen at comparatively cheap cost; they are without ornamentation of any kind, and are maintained in repair by a small annual appropriation of $2,000; the buildings should be increased in number; a large palm house and a subtropical plant house are especially needed; greenhouse pits and cold frames are also required for the purpose of growing hardy herbaceous perennials, no plantings of which of any magnitude have as yet been made in any of the parks or other public gardens in Washington.

The nursery grounds of the gardens, exclusive of the ground occupied by the greenhouses, storehouses, sheds, roads, and walks, cover an area of about 4 acres, one-third of which is occupied by greenhouse plantings for stock and hardy rose grounds; the remaining portion is thickly planted with young trees and hardy flowering shrubs, set out in rows ready for transplanting when required; this area is not sufficiently large to supply the tree and shrub plantings of the park extensions of the public grounds, and purchases are made of the varieties and character needed from commercial nurseries, and wherever they can be found to supply deficiencies. It is hoped that in the near future, when the work of filling the Potomac flats near the propagating gardens is completed, that the nursery grounds may be extended so as to furnish abundant room for the purposes for which they are intended.

I am frequently in receipt of requests for the loan of plants from the gardens for the use of churches, fairs, festivals, etc., and demands are constantly made for flowering and decorative plants for private purposes.

I have been obliged to decline all such requests, as either the loan or gift of any plants would be in violation of the following extract from the act of Congress approved June 20, 1878:

> *Provided*, That hereafter such trees, shrubs, and plants shall be propagated at the greenhouses and nursery as are suitable for planting in the public reservations, to which purpose only the productions of the greenhouses and nursery shall be applied.

After the annual spring planting in the parks is completed it sometimes happens that there is a small surplus of bedding plants on hand; these are divided among such public reservations or institutions as

Fort Myer, Marine Barracks, State, War, and Navy building, fire department, for vases outside of public buildings, and also to hospitals in the city which receive Government aid.

SMITHSONIAN PARK GROUNDS.

This large park, located on the "Mall," nearly midway between the President's grounds and the United States Capitol grounds, and midway between the business sections of north and south Washington, is one of the popular park resorts of the city.

It contains within its boundaries the Smithsonian Institution, the National Museum, and the Army Medical Museum, all of which attract many visitors.

The area of the park is about 58 acres, the greater portion of which is laid out in lawn surfaces, a little over 9 acres being devoted to roads and walks. During the year the improvement of the park has been continued and it has been maintained in good order.

Gravel roads and walks have been repaired, raked, and rolled, lawns mown, trees and shrubs pruned, and gutters and traps cleaned; 605½ square yards of asphalt roadway pavement have been laid upon the gravel roadways northeast of the Museum building and 266 square yards of asphalt footwalks laid upon paths leading towards the Museum; repairs were made to the old asphalt walks, covering an area of 101½ square yards; about 140 square yards of sod was used in sodding along new asphalt walks and repairing trespass paths. A portion of the roadway near the small observatory building south of the Smithsonian Institution was transferred into a lawn at the request of the Secretary of the Institution on account of the disturbance caused by passing vehicles to delicate instruments in the observatory.

In the autumn flower beds were planted with bulbs which, after blooming in the spring, were removed and replaced with summer decorative plants. The extensive lawns of this park are planted with a great variety of deciduous and evergreen trees, many of them being the largest and most perfect of their kind to be found in park planting in the United States.

The roads are subjected to heavy and continuous travel; they are not only thoroughfares connecting the streets of north and south Washington, but they are direct routes to the principal city markets, the center market, the hay, straw, and grain markets. On the public space just north of the park is the hucksters' market, and the débris from this place, which is blown or thrown into the park, entails a great deal of additional labor to maintain it in sightly condition.

On account of the constant passage of teams, many of them heavily laden, over the gravel roads it has been somewhat difficult to maintain them in good condition for travel, especially during the winter season.

In the autumn of 1886 the main roadway from Seventh street to the north front of the Museum building was covered with asphalt pavement, and year by year, so far as available funds would admit, this has been continued, until now out of an area of about 45,000 square yards of road and walk surfaces over 15,000 square yards are of asphalt.

Unfortunately the limited funds available for the fiscal year 1893–'94 will not admit of any appreciable extension of this work.

The lawn surfaces of this park need renovation, and after the completion of the roadways this important portion of the reservation will be renewed and beautified.

HENRY AND SEATON PARKS.

These two parks have an aggregate area of about 34 acres, mainly laid out in lawn surfaces, the planting of which has not as yet been completed; about 3 acres only are covered by gravel road and walk surfaces. They extend from the Smithsonian grounds to the Botanical Gardens, which in their turn adjoin the United States Capitol grounds and complete the chain of parks extending from the Executive Mansion to the Capitol.

The beauty of the parks is somewhat marred by the depot and tracks of the Baltimore and Potomac Railroad lying between them; a mound has been constructed bordering the depot and a section of the tracks, which if carried to completion and planted as designed, with a thick belt of suitable trees and shrubs, will screen the objectionable features from the west section of the park; to complete this mound and provide water pipes for irrigation and drainage pipes for its watershed will cost about $2,500. During the year lawns were mown, gravel roads and walks repaired, raked, and rolled, gutters and drain traps cleaned, a few dead trees removed, lawns resodded or sown with grass seed where winter killed or injured by tresspassers, trees and shrubs pruned, and a large flower bed prepared and planted in front of the building occupied by the Commissioner of Fisheries.

The main roadway leading to the bridge over Sixth street was thoroughly repaired, about 150 cubic yards of gravel being used. At the close of the year the grounds were in comparatively good condition, but the system of asphalt roads and walks commenced in the Smithsonian Park should be extended throughout the reservations and the mound west of the depot should be completed without further delay.

RESERVATIONS NORTH OF PENNSYLVANIA AVENUE AND WEST OF CAPITOL.

This division of the city embraces all the public reservations located between First and Twenty-eighth streets west and B street and Florida avenue north, the majority of which are in an advanced condition of improvement and require the constant attention of a force of skilled laborers employed for their proper maintenance.

It includes the highly improved parks known as Washington Circle, Rawlins Square, Du Pont Circle, Scott Circle, Lafayette Square, Franklin Square, Farragut Square, McPherson Square, Mount Vernon Square, Iowa Circle, Thomas Circle, Judiciary Square, and a number of other smaller, but highly improved, reservations. During the year lawns have been properly mown, seeded down, or sodded where winter killed, watered during the dry season, and their margins edged and trimmed; the gutters and drain lodges have been cleaned; trees and shrubs have been pruned and cultivated, and the young trees and shrubs and flower beds watered during dry season; new trees and shrubs were planted and beds of ornamental foliage, flowering and tropical plants set out; snow and ice removed from paths through and around the parks during the winter. This is a part of the regular annual work necessarily mentioned in the reports.

The asphalt walks in Lafayette, Franklin, Farragut, and Mount Vernon squares were repaired and resurfaced over an area of 1,072 square yards; in Judiciary Square 233 square yards of new asphalt roadway and 253 square yards of new walks were laid; all the gravel roads and paths in all reservations were repaired and maintained in good order.

All vases were filled with handsome plants and water lilies were planted and goldfish placed in fountain basins.

In Lafayette Square the gun carriages around the Jackson statue were painted and the statue and marble pedestal were cleaned; repairs were made to the lodge; the foundation intention for the Lafayette statue was covered with a group of tropical plants, making a most graceful addition to this beautiful park.

In Franklin Square some unsightly shrubs and evergreens were removed, and in response to a petition from a number of prominent citizens living in the vicinity the large aspen poplars on the southern border of the park were extensively pruned and the old unsightly and decaying trees on the sidewalk removed.

In Judiciary Square the lodge house and the plumbing connected therewith received considerable repairs and the rubbish left after the removal of the temporary structures connected with the inauguration ball was removed and necessary repairs made to lawns, etc.

In Reservation No. 133, on Connecticut avenue, trees were planted near the sidewalk.

Four small unimproved reservations known as Nos. 127, 128, 134, and 148, and situated on New Hampshire, Vermont, and Rhode Island avenues, were improved during the year. These were graded, surfaced with soil, and sown down in grass seed; Nos. 127, 128, and 134 were planted with shrubbery and flower beds laid out; walks were laid out in No. 127 and ornamental trees planted; post and chain fences were erected around Nos. 134 and 148.

During October, 1892, the work of improvement of the circle then known as Hancock Circle, at the intersection of New Hampshire avenue, Sixteenth and U streets, was commenced, but was discontinued upon information from the Engineer Commissioner of the District of Columbia that it was the intention of the Commissioners to abandon the circle in conformity with the terms of the sundry civil bill approved August 5, 1892, which provides:

That the circle at the intersection of Sixteenth street and New Hampshire avenue known as Hancock Circle be, and the same is hereby, transferred to and located at or near the intersection of Sixteenth street extended and Morris street, the location and dimensions of said circle to be as shown in a map on file in the office of the Commissioners of the District of Columbia.

The Commissioners were at once informed by letter of October 18, 1892, that this office relinquished all responsibility for the care of the abandoned circle.

Much work is still required in this beautiful section of the city; the parks should all be surrounded by granite curbings; all walks and roads should be of asphalt; the roads should have curbings and be properly drained; this is particularly true of Judiciary Park, which covers an area of about 20 acres, and the gravel roads of which are almost as much traveled as those of the adjacent streets and equally subject to wear from heavily-loaded teams, rendering it very difficult to maintain them in good condition for travel during the winter. The first cost of asphalt roads and granite curbings would of course be approximately large, but the subsequent saving in the cost of their maintenance would in the course of a few years more than compensate for the original outlay.

In all the parks the lawn, tree, and shrub plantings should be well cared for and maintained in the highest degree of excellence. This will necessitate from time to time not only considerable trimming but the removal of occasional trees and shrubs where too thickly planted, to secure future benefits not apparent to the casual observer.

Fountains should be constructed where possible with handsome jets and with basing filled during the summer season with aquatic plants.

RESERVATIONS EAST AND SOUTH OF THE CAPITOL.

This division of the city includes within its limits the highly-improved reservations known as Lincoln, Garfield, Folger, Stanton, and Marion parks.

In all of these parks, as well as in a number of smaller, improved reservations, the lawns were mown and seeded or sodded where winter-killed; all roads and paths were raked, repaired, and rolled, trees and shrubs pruned and watered, flower beds planted, and during the winter snow and ice removed from paths, so far as funds would admit. In Garfield Park considerable attention was given toward continuing the drainage system.

One drain trap and 233 linear feet of cobblestone gutter 2 feet wide were constructed; 550 feet of ditches were opened and 122 feet of 6-inch terra-cotta pipe and 428 feet of 2-inch drain tile pipe were placed in position and properly covered with broken stone and sod.

The ground in the west section of the park occupied by the temporary buildings and tents erected during the encampment of the Grand Army of the Republic in September, 1892, was raked, cleaned, rubbish removed, and the whole covered with compost, the work being done at the expense of this department.

At *Marion Park* the roadway entrances, covering an area of 620 square feet, were paved and cobblestone gutters 324 feet long and 2½ feet wide were constructed.

At *Lincoln Park* the middle north entrance was improved by extending the gravel path from the post and chain fence to the sidewalk and constructing brick gutters on both sides.

Repairs were made to the lodge, including its plumbing.

In *Stanton Park* brick gutters were constructed on each side of the gravel paths at the Fifth street entrance, north side, and at the northwest entrance from Massachusetts avenue.

Minor improvements were made to a number of smaller reservations throughout this section of the city.

It will be observed that the two parks named after our martyred Presidents are located in this section of the city.

Lincoln Park was practically completed in 1875, and at that time it was anticipated that a colossal statue or a historical column would be erected in the center of the park, and an oval space was provided for its site. In raising the grade of this space to form an ornamental mound a long-stemmed sapling, found growing very close to its center, was allowed to remain and the earth filled around it to a depth of nearly 6 feet; to-day this sapling is a large, wide-spreading tree, one of the best specimens of the oriental plane tree in the city of Washington. This park attracts great attention; it contains the Lincoln emancipation statue, and its paths should be asphalted and an annual appropriation of $1,000 made for its improvement and care.

The final improvements projected for the decoration of Garfield Park, covering an area of about 24 acres, are nearing completion; during September, 1892, the occupation of these park grounds for quarters for the Grand Army of the Republic caused an increased expenditure in their maintenance; the lawn surfaces were much injured and the gravel roads much cut up by the passage of heavy teams; these damages have been repaired. The main gravel road through this park leading to Virginia avenue is used as a thoroughfare for heavy teams, which renders it difficult to maintain it in good condition during the winter season.

It is regretted that the reduced appropriations for the ensuing fiscal year will prevent the continuance of any extensive improvements, the amount available being not more than sufficient to maintain in good order the roads, walks, gutters, drains, lawn surfaces, trees, shrubs, and other improvements.

Stanton, Folger, and Marion parks are highly improved, planted with choice specimens of trees and shrubs and laid out with gravel paths; there are fountains in Stanton and Folger parks, and Stanton Park contains the bronze equestrian statue of General Greene; the gravel walks in these reservations should be covered with asphalt.

In addition to these parks there are 28 small public spaces which have been partly improved and planted, and about 100 similar spaces at the intersections of streets and avenues yet unimproved.

The increased prosperity of this section of our city and the large number of private improvements in progress demand that still more attention be given to beautifying the public spaces, and increased appropriations are earnestly recommended for this purpose.

RESERVATIONS OCCUPIED FOR THE INAUGURAL CEREMONIES, MARCH 4, 1893, AND FOR THE TWENTY-SIXTH NATIONAL ENCAMPMENT OF THE GRAND ARMY OF THE REPUBLIC IN SEPTEMBER, 1892.

Under the authority conveyed by the joint resolution of Congress approved January 26, 1893, permits were granted by the War Department in February to the executive committee on the inaugural ceremonies to occupy certain reservations on Pennsylvania avenue between Seventh and Seventeenth streets NW., certain spaces around the Pension Office building in Judiciary Square, to construct a grand stand along the grounds north of the Executive Mansion with a board walk leading from the Mansion to the stand, and to display fireworks in the Monument grounds. Under these permits stands were erected in reservations 30, 31, 32, 33, and 34 on Pennsylvania avenue, between Seventh and Fourteenth streets, along the Pennsylvania avenue front of Lafayette Square, and on the north front of the Executive Mansion; large poles with framework for fireworks were erected on the Monument grounds; covered board approaches were constructed at the north, south, and west entrances of the Pension building and a large wooden building erected at its northwest corner for use as a kitchen; a temporary wooden building was constructed on reservation 34, at Pennsylvania avenue and Seventh street, and used as a photographic establishment.

The stands and other temporary structures were removed within a few days after March 4 by the executive committee.

In the District of Columbia appropriation bill, approved July 14, 1892, the Secretary of War was authorized "to grant permits for the use of any reservation or other public space in the city of Washington for reunion or camp purposes connected with such encampment." (Twenty-six National Encampment, Grand Army of the Republic.)

Under this authority permits were granted by the War Department on July 28 for occupying the Monument grounds for camp purposes and for erecting stands at certain reservations on Pennsylvania avenue between Seventh and Twenty-first streets, and on August 4 for occupying Garfield Park and Reservation No. 101 for camp purposes, and the grounds south of the Executive Mansion for reunion purposes; during August and September, 10 large wooden buildings and a number of tents were erected in Garfield Park; 9 large wooden buildings for sleeping quarters, 1 for mess house, 1 for cook house, 1 for wash-house, and 6 other buildings and 3 tents for other purposes were erected in the Monument grounds. In the grounds south of the Executive Mansion the committee erected a grand stand, a flag staff and tower, a full size model of the battleship *Kearsarge*, 5 wooden platforms, 654 tents, and 21 large poles for electric lights.

Tents were pitched in Reservation 101 and occupied as quarters.

Stands for viewing the parade were erected along the Pennsylvania avenue fronts of Reservations 30, 31, 32, and 33 and Lafayette Square; a large tent for use as a lunch room was placed upon Reservation No. 32, and on September 14, by authority of the War Department, the use of Judiciary Square was authorized for "camp-fire" purposes and a stand erected; at a later date, by similar authority, one of the Grand Army posts was allowed to camp in this park.

The stands, tents, etc., were all removed from the Pennsylvania avenue reservations by the close of September and the temporary structures upon other portions of the public grounds had all been removed by the early part of November. More or less damage was done to the lawns in the parks, particularly in the grounds south of the Executive Mansion, in Garfield Park, and at the Monument; these damages, except where the buildings were erected in the Monument grounds, were all repaired before the close of the spring of 1893.

SETTEES, TOOLS, MANURE, CONSTRUCTION AND REPAIR OF POST AND CHAIN FENCES, AND REMOVING SNOW AND ICE.

Repairs were made to the park settees so far as funds would admit; 213 settees were repaired and about 300 painted; a large number of settees now on hand require immediate repair and the appropriation for 1894 will be used for this purpose.

Repairs were made to lawn mowers, wheelbarrows, and miscellaneous tools; edge tools were sharpened and put in good order, and new tools purchased from time to time when necessary.

About 1,100 cubic yards of manure, 600 cubic yards of soil, and 266 cubic yards of potting sod were purchased.

About 1,500 cubic yards of compost were prepared and used in top-dressing the lawns of various parks, in mulching trees and shrubs, and enriching flower beds; a quantity of guano was used in preparing a compost, which was sown upon the lawns of the Smithsonian grounds; potting compost was also made for use in growing plants in the green-houses.

Iron post-and-chain fences were erected around the following reservations: No. 134, intersection of Rhode Island avenue and M street; No. 148, intersection of Vermont avenue and Tenth street; No. 51, intersection of Pennsylvania avenue and Twelfth street SE.

Repairs were made to a number of post and chain fences where necessary.

A large number of iron post caps which had been broken or stolen by mischievous boys were replaced with new caps.

The snow and ice was promptly removed from the paths and sidewalks through and around various reservations up to the 18th of February, when the appropriation of $1,200 made for the purpose became exhausted; a deficiency appropriation of $500 was made by the act of March 3, and the snow which fell afterwards was promptly removed.

The necessity for a larger annual appropriation for removing snow and ice has long been evident, and it is earnestly recommended that $1,500 be appropriated for the next year. Should we have an open winter any unexpended balance would be returned to the Treasury.

WATER PIPES AND FIRE PLUGS, AND CARE AND REPAIR OF FOUNTAINS.

Repairs were made to water pipes as required. In the autumn the water was shut off from the various parks, the hose valves removed and stored at the nursery grounds; in the spring these valves were replaced in the parks.

Two hundred and twenty-one feet of 4-inch water main was laid in Garfield Park and connected with the public main in New Jersey avenue and with smaller service pipes in the grounds, and an old 4-inch valve was removed and replaced by a new one and a brick man hole constructed.

An additional line of 2-inch water pipe 85 feet long was laid in the nursery grounds and 6 1¼-inch stand pipes for hose valves placed therein; 135 feet of 1-inch water pipe was also laid in these grounds and two stand pipes with three-quarter-inch hose bibbs placed thereon; 400 feet of 2-inch galvanized iron water pipe with outlets for two hose valves was laid in the Monument grounds, and 153 feet with similar outlets in the Smithsonian grounds.

The necessary pipe was laid and connections made with street mains for introducing water into reservations Nos. 127 and 128 on New Hampshire avenue. Repairs were made to the stand pipes and hose valves in Mount Vernon Square.

Two old fire plugs at the north portico of the Executive Mansion and 1 old fire plug at the south portico were removed and replaced with new fire hydrants of improved pattern; 2 improved street washers were placed at the north portico; the fish traps through which water enters the grounds of the Executive Mansion were thoroughly cleaned, the old perforated plates and broken wire nettings replaced with new netting, thus admitting a greater flow of water and increasing the pressure at the fire hydrants.

A new 3-inch valve was placed on the water main supplying Seaton Park.

There are 23 fountains with basins in charge of this office, located as follows:

Executive Mansion grounds, 3; Lincoln Square, 2; Stanton Square, 2; Rawlins square, 2; and 1 each in Folger Square, Judiciary Square, Mount Vernon Square, Franklin Square, Iowa Circle, and the reservations at Massachusetts avenue and Twentieth street, New York avenue and Third street, New York avenue and Tenth street, Pennsylvania avenue and Ninth street, Pennsylvania avenue and Thirteenth street, Pennsylvania avenue and Nineteenth street, Pennsylvania avenue and Twenty-first street, Pennsylvania avenue and Twenty-eighth street, and Deleware avenue and First street east. With a few exceptions the jets are of a very simple character.

There are 25 drinking fountains in the various parks.

Repairs were made to the various drinking fountains and cups and chains renewed.

The fountain basins were properly cleaned from time to time and thoroughly repaired before water was turned on in the spring; the large fountains in Mount Vernon Square and at Pennsylvania avenue and Twenty-eighth street were painted. In the autumn the water was turned off from the fountains, the jets removed and stored at the nursery shops; these jets were repaired where necessary during the winter and replaced upon the fountains in the spring.

PAINTING WATCHMEN'S LODGES, IRON FENCES, VASES, LAMPS, AND LAMP-POSTS.

There are nine watchmen's lodges, 406 lamp-posts, 18 vases, a large number of post and chain fences, the high iron fences around the Executive Mansion, and the iron fences around the greenhouses and nurseries under charge of this office. For painting all of these Congress appropriated $500 at its last session; the result will be that much necessary painting must this year be omitted. It is earnestly recommended that the sum of $1,500 be allotted for this work during the next fiscal year.

During the past year the following have been painted: The roofs of 6 lodges, the iron fence around the Executive Mansion grounds, the post-and-chain fences around Dupont Circle, Mount Vernon Square, and around 12 smaller reservations, the fence around the Jackson statue, and 47 lamp-posts, 50 lanterns and 8 drinking fountains in various reservations. All the watchmen's lodges, the lamp-posts, vases, most of the post-and-chain fences, and the remaining high iron fences should be repainted during the fiscal year 1894-'95.

LIGHTING THE PUBLIC GROUNDS.

The usual attention has been paid to the gas lamps in the various parks during the year, and the lanterns maintained in as good repair as possible.

The grounds immediately south of the Executive Mansion have been illuminated by arc electric lights.

The 8 gas lamps in Marion Park, which were erected in 1886, were provided with burners and lighted for the first time in June, 1893. There are in all 404 ordinary gas lamps, with 445 burners, and 2 arc gas lamps belonging to this department; of this number 108 burners in lamps on the sidewalks of the reservations are lighted at the expense of the District government.

The number of lamps not connected with meters, burning during the year and paid for by this department, was as follows:

	Single burners.
July 1, 1892, to February 28, 1893	309
March 1, 1893, to May 31, 1893	253
Month of June, 1893	261

Each of these lamps burned about 3,000 hours and consumed about 18,000 cubic feet of gas; in addition to these there are 71 burners within the Executive Mansion grounds connected with the meters of the mansion.

There are quite a number of lanterns in the Smithsonian grounds in such bad condition as to be beyond repair, and which must be replaced with new ones.

It is earnestly recommended that the system of electric lights now in operation upon many of the streets and avenues of the city of Washington be gradually extended to the public grounds; with the gas lamps now in use in the parks the illumination is far from satisfactory, and in the interest of morality, as well as the welfare of those visiting and passing through the parks after dark, it is desired to make them as brilliant as possible at night.

Estimates are submitted with this report for arc electric lights in Lafayette, Franklin, and the Monument parks; in the future the system can be extended to the Smithsonian and the other parks on the "Mall."

EXECUTIVE MANSION, GREENHOUSES, AND GROUNDS.

In addition to the usual care extended to the mansion and its furniture, the following work has been accomplished during the year:

A pavement of Neufchatel mastic has been laid upon the old brick pavement of the areas at the north, east, and west sides of the mansion, and upon the old brick walk on south side, and a granolithic curb has been constructed along portions of the border of the latter walk.

Neufchatel mastic floors were laid under the south portico, in the 3 small rooms and the passageway under north portico, and in the furnace room in the basement.

The old hot-water heating apparatus in the furnace room was torn out and rebuilt with alterations and additions, including new boiler, tank, and connections.

In two rooms in the basement the old brick and wooden floors and the wooden washboards were taken up, the ground disinfected, new floors of Neufchatel mastic laid on foundations of Portland cement concrete, new cement washboards constructed, and new wooden floors laid over the mastic.

The partitions that had been removed in one of these rooms were replaced, the plastering in both rooms repaired, the walls and ceilings calcimined, the woodwork repainted, and the hearths relaid with new brick.

Repairs were made to the ranges in the kitchen and pantry; the walls and ceilings of the main corridor on the first floor were repainted and redecorated; the chandeliers and electric-light fixtures in the mansion were cleaned, and the metal parts of the 4 crystal chandeliers in the corridor on first floor were replated with silver, and 2 large candelabra were replated in gold.

Hot-water radiators were placed in the large north bathroom and in one of the small bedrooms; the walls and ceiling of the small kitchen were calcimined, and those under floor of north portico were repaired and calcimined.

The large water filter in the basement was taken apart, repacked, and some new parts put in.

The portions of the stone balustrade, cornice, coping, etc., of the roof of the mansion, which were destroyed during a violent storm in November, 1891, were restored during the year; the work consisted in setting 25 new balusters and 35 feet of new coping on east side of roof balustrade and repairing the main cornice on that front, setting necessary new coping, lintels, etc., on the east portico, and repairing roof and ceiling of the portico.

Two storerooms were constructed in the area outside of west door to basement corridor, and these, together with the partitions, doors, frames, and the large ice box at the west basement entrance, the ceiling of east portico, and the closets in watchmen's lodge were painted.

The stone balustrade and the chimneys on the roof were repointed.

Necessary attention was paid to the plumbing of the mansion, which was carefully tested, and to the gas fixtures and electric lights, and additional electric lights placed in position.

The tin roof covering and down spouts of east portico were repaired.

The side walls in the southeast bedroom, second floor, were repapered; new carpets were laid in the southwest bedroom and private dining room, and new matting in the lower main corridor and in three rooms on the second floor and in the elevator hall and car.

New lace curtains were placed in one bed chamber, some furniture reupholstered, and the floor of one room finished in hard oil.

The two northwest bedrooms, second floor, in which the scarlet fever had occurred, were dismantled, disinfected, walls scraped, carpets, bedding, etc., destroyed; the work of disinfection was done under the direction of the health officer of the District of Columbia.

These two rooms were subsequently repapered, repainted, refurnished, and placed in complete order for occupancy.

The floor of main bathroom on north front, which was concreted and tiled two years ago, gave evidence of gradual and dangerous settling; an iron beam was placed under the floor in the middle, the floor slightly raised by the use of jackscrews, and the danger overcome; the beam was boxed in, painted, and a border of neat paper placed around it; it rests in the solid walls immediately under the ceiling of the small reception room on parlor floor.

In the autumn the carpets were relaid and curtains rehung, and in the spring the carpets, amounting to about 3,000 yards, were taken up and cleaned, curtains taken down and laundried, and the house placed in summer costume.

The exterior of the mansion and some of the apartments on the first floor were appropriately decorated during the period of the Grand Army of the Republic encampment, and the exterior of the mansion draped in mourning from January 19 to February 17, upon the occasion of the death of ex-President Hayes.

The stone columns at the entrance to the grounds from Pennsylvania avenue, the bases of the columns at the north front portico, and the coping of the iron railing at the north front were painted. Some minor repairs were made to the stable.

Considerable repairs were made to the greenhouses. All boilers, furnaces, stoves, etc., were cleaned, repaired, and put in as good order as possible.

The old superstructures of the small rose house and of the camelia house were taken down and new iron, wood, and glass superstructures erected; all the other greenhouses were overhauled and placed in as good condition as funds would admit. It was hoped that the old wooden superstructure of the greenhouse south of the camelia house could be replaced with an iron one this year, and an estimate of $1,500 was submitted for this purpose; only $1,000 was appropriated, and every effort to have the necessary work done for that sum has failed.

A pavement of Neufchatel mastic was laid upon the old pavement of the passageway under south side of conservatory and on the floor of the potting house, and a pavement of Portland cement laid in the passageway under middle of conservatory; the stone columns supporting conservatory were repaired, the plastering of walls renewed where necessary, and the columns, walls, and ceilings under the main structure were whitewashed.

Necessary attention was given to the large collection of plants in the conservatory and greenhouses and a catalogue prepared. A large number of plants suitable for bedding were propagated and about 16,250 spring flowering bulbs were purchased for the greenhouses and grounds.

The grounds attached to the mansion were maintained in excellent condition; the old flower beds around the fountains were sodded over and 14 new beds laid out; in the autumn 43 flower beds were planted with hyacinths, tulips, crocuses, and spring plants, over 44,000 bulbs and 3,000 hardy plants having been used for this purpose; 3,000 crocus bulbs were planted in the grass on the hillsides; in the early summer the bulbs were removed and replaced with flowering and foliage plants.

The basins of fountains were planted with water lilies for summer bloom.

Trees, shrubs, and vines were pruned and lawns seeded or sodded as was deemed necessary.

It again becomes my duty to call attention to the fact that the Chief Magistrate of our country should no longer be obliged to have his private residence and office under the same roof; surely he is entitled to the same privacy in his home life as any other citizen, and it is sincerely hoped that either office rooms may be found for him in the Treasury or the State, War, and Navy building, or that Congress will take such steps as are necessary to erect a suitable office building at an early day.

Efforts heretofore made to enlarge the mansion have failed, and I invite attention to the suggestions made in the annual report submitted by me in 1889, at the close of my last tour of duty in this office, wherein I suggested that a structure suitable for office purposes might be erected within the White House grounds on the site of the greenhouses opposite the State, War, and Navy building. This Executive office could be connected by a corridor with the main building, and would be of great assistance in caring for the large crowds during the winter evening receptions.

The conservatory and greenhouses, the woodwork of which, as a rule, is old and decaying, could be rebuilt on the east side of the mansion, opposite the Treasury. A picture gallery might be built opening from the East room and thence into a handsome conservatory arranged with a winter garden.

The portion of the White House now used for the President's home life is entirely too small, and it is earnestly hoped that the office will be transferred during the coming spring to the Treasury or State, War, and Navy building, the present rooms abandoned as offices, and the whole mansion used for what it was evidently originally intended, the home of the Chief Executive of the nation.

An estimate is submitted for redecorating and refurnishing these rooms as bedrooms as soon as the office is transferred.

TELEGRAPH CONNECTING THE CAPITOL WITH THE DEPARTMENTS AND GOVERNMENT PRINTING OFFICE.

The telegraph lines now under control of this office are as follows:

The line of overhead wires consists of 78 poles, covering a distance of about 3½ miles, with a length of about 8 miles of wire. This line, starting from the State, War, and Navy building, runs to the Executive Mansion, thence to the Treasury Department, thence to G street, thence to Eighth street, thence to H street, thence to North Capitol street, and thence to the Capitol. Connected with it is one running from the Treasury Department along Fourteenth street to the Bureau of Engraving and Printing, and one down Fifth street to the Pension building.

There is about 500 feet of 13-conductor Patterson cable running from the cable pole in the Capitol grounds into the basement of the Senate, and 250 feet of 20-conductor cable running from the cable pole on the corner of Seventeenth and G streets into the State, War, and Navy building.

The underground cable laid by the Standard Underground Cable Company of Pittsburg, in October, 1883, under permit granted for experimental purposes, and afterwards purchased by the Government in accordance with an act of Congress, has been useless for telegraphic operations since the winter of 1891-'92, owing to the manner in which it was laid, being without any protection from the picks, etc., of workmen in the streets. The cable was laid about 12 or 15 inches below the surface of the ground in a wooden box filled with sand. After two or three years the boxing decayed and was no longer a protection. When a workman began to dig up the streets and stuck a pick into the cable it was quickly covered up without giving notice of the damage done, and soon the dampness would show the defect. As there were no manholes for testing, it was impossible to discover the fault without digging up the streets at considerable expense. The underground line was therefore abandoned.

During the past year the main battery in this office and the local batteries and instruments in the various departments have been maintained in good condition. Obstructions of all kinds were removed from the overhead lines as soon as possible and all breaks repaired. The entire line was carefully examined, 11 decayed poles replaced with new ones, new cross-arms put up, and slack wire cut out.

About 1½ miles of old wire was removed and replaced with new No. 12 galvanized iron wire and No. 12 copper conductor weatherproof wire. This weatherproof wire was run through trees along the line, and was most useful during the past winter.

The telegraph office in the Department of Justice was moved during the year, new wires run, and connections made. The old fixtures and wire on the Post-Office Department were removed and replaced with new. The wires on roofs of Government Printing Office, Interior Department, Department of Justice, Treasury Department, Agricultural Department, Second Auditor's Office, and War Department were carefully overhauled, repairs made, and new fixtures put up where necessary.

The cable boxes were overhauled and the cables in the basement of the Capitol reset where they had become loose.

The instruments removed from the tables of the operators in the Senate and House of Representatives at the close of the session in the summer of 1892 were cleaned, repaired, and reset prior to the opening of Congress in December, 1892, and again removed and stored in this office upon the final adjournment of the Senate and House of Representatives.

The telegraph office in the War Department was moved, wires run, and necessary connections made.

Attention is again respectfully invited to the fact that it is becoming more and more difficult to operate the overhead telegraph system, owing to the trees along the line gradually growing up into the wires and interrupting the currents, particularly during wet and windy weather. The necessity for either replacing the present poles with taller ones, or replacing the overhead wires with the modern system of underground cable, is so apparent that argument in its favor is unnecessary.

An estimate for an underground cable and an alternate estimate for an overhead line with high poles are submitted with this report; the underground estimate is for a conduit with manholes on each square for testing for defects and for repairs when necessary.

Should Congress adopt the high overhead line, authority should appear in the law making the appropriation, to continue the line on the south side of G street, between Ninth and Eleventh streets NW.; at present the line crosses to the north side of the street at Eleventh and G, and continues on that side for two squares; as the lines of the Western Union are on the north side it will be difficult, if not impossible, to raise our lines above the trees without crossing to the south side.

SURVEYING AND DRAFTING.

The time of the only draftsman allowed this office is mainly taken up with the care of the old records of the city of Washington.

He is required to be in his office the greater portion of each day to exhibit these records to those interested, and is frequently summoned to produce them in the courts.

He has located and plotted the positions of water pipes and drain pipes laid in the public grounds during the year, has surveyed a number of small reservations, and has been engaged in preparing a complete list of all reservations belonging to the United States in the District of Columbia, under charge of the Chief of Engineers.

During the month of May he made soundings and borings on the proposed line of the new wharf to be built at Wakefield, Va.

As stated in my annual report for 1889, Mr. Stewart, the draftsman, informs me that in his investigation of the old records he can find no satisfactory evidence to show that the United States has ever received payment or granted deeds in fee for 20 entire squares and about 2,000 lots in different parts of the city of Washington. My report on this subject, dated February 19, 1889, was submitted to the United States Senate by the Secretary of War on February 25, 1889, inviting the attention of Congress to its importance and to the recommendation that provision be made for the employment of a clerk with a view to complete and exhaustive investigation of the subject.

It is again earnestly recommended that Congress shall authorize the employment of a clerk to take charge of these old records, and thus permit the only draftsman allowed this office to attend to his legitimate duties.

NUMBER AND AREA OF RESERVATIONS, AND NUMBER OF STATUES.

Condition, number, and area of reservations.

Description.	Number.	Area.
		Acres.
Total number of reservations	302	403.60
Reservations highly improved	86	247
Reservations partially improved	40	107
Reservations unimproved	170	49
Unimproved reservations occupied for turnouts and sidings by the Baltimore and Potomac Railroad, by authority of act of Congress, approved January 19, 1891	5	0.55
Unimproved reservations occupied by railroad track to Washington navy-yard, by authority of act of Congress, approved March 2, 1889	1	0.05

The following reservations claimed as property of the United Stat are now occupied, it is believed, in violation of law:

Reservations Nos. 101, 118, and 175, by the Baltimore and Potom Railroad Company.

Reservation No. 201, by the Baltimore and Ohio Railroad Compan

Reservation No. 116, by the Central Union Mission, as a place of w ship.

Reservation No. 163, by the Bethany Chapel of the New York A nue Presbyterian congregation.

Reservation No. 305, by a party who built a frame house thereon 1888; this case is now in the hands of the United States district att ney for the District of Columbia.

Reservation No. 323 is occupied as a lumber yard by a party w claims to rent from a gentleman in Port Deposit, Md.

During the coming year I propose to give this subject of the reser tions careful study, and in my next annual report to submit a detail list of public parks and spaces with their areas and locations.

There are 13 statues in the public grounds under the charge of t office, as follows:

Washington, Greene, Jackson, Lincoln, Scott, Farragut, Thom Dupont, Rawlins, McPherson, Garfield, Henry, and Lafayette; these are in good condition.

It is anticipated that within the next two years statues will erected to the memory of Generals Sheridan, Hancock, and Logan.

Estimates for the fiscal year ending June 30, 1895.

Salaries of employés, public buildings and grounds, etc.:	
One office clerk	$1,600
One messenger	840
One public gardener	2,000
One clerk in charge of old public records of Washington City	1,500
One clerk	1,400
One electrician and telegraph lineman	1,080
Overseers, draftsmen, foremen, gardeners, mechanics, and laborers	35,000
One captain of the watch	1,200
One day watchman in Lafayette square	660
One day watchman in Franklin square	660
Two day watchmen in Smithsonian grounds, at $660 each	1,320
Two night watchmen in Smithsonian grounds, at $720 each	1,440
One day watchmam in Judiciary square	660
One night watchman in Judiciary square	720
One day watchman at Lincoln square and adjacent reservations	660
One day watchman at Iowa circle	660
One day watchman at Thomas circle and neighboring reservations	660
One day watchman at Washington circle and neighboring reservations	660
One day watchman at Dupont circle and neighboring reservations	660
One day watchman at McPherson and Farragut squares	660
One day watchman at Stanton square and neighboring reservations	660
Two day watchmen at Henry (Armory) and Seaton squares, at $660 each	1,320
One night watchman at Henry (Armory) and Seaton squares	720
One day watchman at Mount Vernon square and adjacent reservations	660
One day watchman at grounds south of the Executive Mansion	660
One watchman for greenhouses and nursery	660
One day watchman for Marion square, Folger square, and adjacent reservations	660

Salaries of employés, public buildings and grounds, etc.—Cont'd.		
One day watchman at Garfield park	$660	
One night watchman at Garfield park	720	
One day watchman at Rawlins square and adjacent reservations	660	
		$61,420
Contingent expenses public buildings and grounds		500
Improvement and care of public grounds:		
Improvement of grounds north of Executive Mansion	1,000	
Improvement and maintenance of grounds south of Execuiive Mansion	4,000	
Ordinary care of greenhouses and nursery	2,000	
Ordinary care of Lafayette square	1,000	
Ordinary care of Franklin square	1,000	
Ordinary care of Lincoln square	1,000	
Care and improvement of Monument grounds	10,000	
Continuing improvement of reservation No. 17 and site of old canal northwest of same	5,000	
Construction and repair of post-and-chain fences, repair of high iron fences, and constructing stone coping about reservations	1,500	
Manure and hauling same	5,000	
Painting watchmen's lodges, iron fences, vases, lamps, and lamp-posts	1,500	
Purchase and repair of seats	1,000	
Purchase and repair of tools	2,000	
Trees, tree and plant stakes, labels, lime, whitewashing, and stock for nursery	3,000	
Removing snow and ice	1,500	
Flower pots, twine, baskets, wire, splints, moss, and lycopodium	1,000	
Care, construction and repair of fountains	1,500	
Abating nuisances	500	
Improvement, care, and maintenance of various reservations	20,000	
Improvement, maintenance, and care of Smithsonian grounds, etc	8,000	
Improvement, care, and maintenance of Judiciary square	7,000	
Granite curbing about Franklin square	5,000	
Laying asphalt walks in various reservations	5,000	
Improvement and care of Henry and Seaton parks	5,000	
Constructing an ornamental fountain in Lafayette square upon the site originally selected for the Lafayette statue	4,000	
Replacing the old flagging pavement of the sidewalks in the grounds north of the Executive Mansion by a granolithic pavement	2,500.00	
Construction of a large greenhouse at the propagating gardens, for palms and tropical plants of large growth, needed for tropical bedding, etc., in the public parks during the summer months	6,000.00	
Improvement of Howard University Park (Reservation No. 246)	5,000.00	
Laying an asphalt pavement upon the roadway east and south of the State, War and Navy Department Building	15,000.00	
For lodges for park watchmen in Stanton, Mount Vernon, Iowa, Dupont, Thomas, McPherson, and Folger reservations, at $500 each	3,500.00	
		129,500.00
Care of, repairs, fuel, etc., Executive Mansion:		
Care, repair and refurnishing Executive Masion, to be expended by contract or otherwise, as the President may determine	30,000.00	
Fuel for Executive Mansion, greenhouses, and stable	3,000.00	
Care and necessary repair of greenhouses	5,000.00	
Renewing the superstructure of one greenhouse connected with the Executive Mansion	1,500.00	
Repairs to conservatory, Executive Mansion	2,000.00	
For portrait, and frame for same, of Hon. Benjamin Harrison, ex-President of the United States	2,500.00	
		44,000.00

Lighting the Executive Mansion and the public grounds:		
Gas; pay of lamplighters, gas-fitters and laborers; purchase, erection, and repair of lamps and lamp-posts; purchase of matches, and repairs of all kinds; fuel and lights for office and office stable, for watchmen's lodges, and for greenhouses at the nursery: *Provided,* That for each 6-foot burner not connected with a meter in the lamps on the public grounds, no more than $21.50 shall be paid per lamp for gas, including lighting, cleaning, and keeping the lamps in repair, under any expenditure provided for in this act; and said lamps shall burn not less than 3,000 hours per annum; and authority is hereby given to substitute other illuminating material for the same or less price, and to use so much of the sum hereby appropriated as may be necessary for that purpose	**$15,000.00**	
Electric lights for 365 nights, from 7 posts, at 40 cents per light per night, $2.80 per night	**1,022.00**	
Lighting the monument grounds with electric lights:		
For 6,642 feet 5-inch terra cotta pipe laid complete with manholes, at 60 cent per foot	**3,985.20**	
For 18 iron poles, complete in position, at $19.50 per pole	**351.00**	
Lighting Lafayette park with electric lights:		
For 1,305 feet 5-inch terra cotta pipe laid complete with manholes, at 60 cents per foot	**783.00**	
For 6 iron poles complete in position, at $19.50 per pole	**117.00**	
Lighting Franklin park with electric lights:		
For 1,442 feet 5-inch terra cotta pipe laid complete, with manholes, at 60 cents per foot	**865.20**	
For 9 iron poles complete in position, at $19.50 per pole	**175.50**	
For lighting for 365 nights, 33 arc electric lights in the monument grounds, Lafayette and Franklin parks, at 50 cents per light per night	**6,022.50**	
		$28,321.[illegible]
Repairs to water pipes and fire plugs:		
Repairing and extending water pipes, purchase of apparatus for cleaning them, purchase of hose, and for cleaning the springs and repairing and renewing the pipes of the same that supply the Capitol, the Executive Mansion, and the building for the State, War, and Navy Departments		5,000.00
Telegraph to connect the Capitol with the Departments and the Government Printing Office:		
Replacing the present system of wires with a duplicate 6-conductor underground cable, being a total distance of about 6,625 linear feet	31,000.00	
(An alternative estimate, amounting to $1,600, is also submitted for replacing the present poles with new and taller poles, and if an appropriation for that purpose be made it should be accompanied by authority to erect the poles.)		
Care and repair of existing lines	1,500.00	
		32,500.00
Total		301,241.[illegible]

Washington monument, elevator, electric lights, and machinery connected threwith.

The following estimate for operating the elevator, the electric lights, and machinery connected therewith for the fiscal year ending June 30, 1895, is submitted:

One custodian, at $100 per month	$1,200
One steam engineer, at $90 per month	1,080
One assistant steam engineer, at $70 per month	840
One fireman, at $60 per month	720
One assistant fireman, at $60 per month	720
One conductor of elevator car, at $75 per month	900
One attendant on floor, at $60 per month	720
One attendant on top floor, at $60 per month	720
Three night and day watchmen, at $60 per month, each	2,160
For one new engine complete in position, to replace the old engine which runs the dynamo for the electric lights	650

Fuel, lights, oil, waste, packing, tools, matches, paints, brushes, brooms, lanterns, rope, nails, screws, lead, electric lights, heating apparatus, oil stoves for elevator car and upper and lower floors, repairs to engines, boilers, dynamo, elevator, and repairs of all kinds connected with the monument and machinery, and purchase of all necessary articles for keeping the monument, machinery, elevator, and electric-light plant in good order.....	$3,600
Total..	13,310

As some of the foregoing estimates are larger than the amounts heretofore appropriated, and as others are for new work, it is deemed advisable to submit the following brief explanation in reference thereto:

First.—One public gardener, $2,000. I have asked for an increase in the salary of the public gardener, a position now so satisfactorily filled by Mr. George H. Brown. The duties of the office require that the gentleman who fills it shall be thoroughly skilled in the culture of trees, shrubs, and plants, and shall have a practical knowledge of civil engineering as applied to landscape gardening. Mr. Brown combines these attributes, to which he adds taste, industry, and integrity. His duties take him from one end of the city to the other. He is directly responsible for the care of the valuable collection of plants in the propagating garden, and superintends the propagation of plants that are annually raised for the public grounds, which this year numbered about 500,000.

Second.—One clerk in charge of old public records of Washington City, $1,500. These records include maps, deeds, record books, letters, etc., from the organization of the original board of commissioners, near the close of the last century, up to 1867, when the duties were turned over to the Chief of Engineers. They are constantly examined by attorneys and others interested in lands in Washington, and the person in charge of them is frequently required to produce them in courts; to index them properly, to be able to turn at once to the details of any question raised, requires familiarity with every paper. This work has for the last few years been intrusted to the only draftsman allowed this office, and during the past year at least one-fourth of his time has been actually employed on this duty. It is desirable that this appropriation be made in order that the draftsman may be permitted to attend to the necessary and legitimate duties of his office.

Third.—One clerk, $1,400. Of late years the office work has increased to such an extent that to properly perform it has required continuous work at night and on Sundays and holidays. This is a hardship, and as a remedy an appropriation for an additional clerk is recommended.

Fourth.—For one telegraph lineman, $1,080. The telegraph system under charge of this office includes about 8 miles of overhead wire. There are eighteen offices connected with these lines, the main battery being at this office. The lineman is constantly engaged in the care of the main and local batteries and such necessary repairs and extensions as a system of wires of this kind requires. He is industrious, efficient, and capable, and has won the confidence of all with whom he has come in contact by faithful attention to his duties.

Fifth.—An increase in the appropriation for overseers, foremen, etc., is suggested; as the city of Washington is spreading to the north, east, and west, the area of improved reservations must be increased to keep pace with private enterprise, and the small increase requested will be of the utmost advantage in continuing the ornamentation of spaces now entirely unimproved.

Sixth.—An estimate for a captain of the watch is submitted and recommended. Such an officer is much needed in order that the park watchmen may be under proper supervision.

Seventh.—Estimates for a day watchman for Marion and Folger squares and adjacent reservations, and for a day watchman for Garfield Park, are submitted and recommended. Marion and Folger squares contain an aggregate area of about 3 acres, and Garfield Park contains an area of about 24 acres. They are highly improved, and the necessity for providing watchmen for their care is apparent.

Eighth.—An estimate is submitted for a day watchman at Rawlins Square and adjacent reservations. Rawlins Square is a large, highly improved park on New York avenue, between Eighteenth and Nineteenth streets. It is about seven squares from Washington Circle and there are several highly improved reservations just north of it on Pennsylvania avenue.

It is frequented to a large extent by the people living south and east of the reservation.

Ninth.—An estimate is submitted for $1,000 for the ordinary care of Lincoln Park, situated in the extreme eastern section of the city and covering an area of over 6 acres. It is highly improved, contains the bronze "Emancipation statue," and is visited by a large number of people. Numerous important improvements have been made in the private property in its vicinity, and a large number of well-built dwellings constructed during the past two years.

Tenth.—For the care and improvement of the Monument grounds, $10,000. It is desirable that this important improvement should progress more rapidly than heretofore. The amount ($2,000) appropriated for 1894 will be sufficient merely to maintain the park in its present condition, and will not admit of any improvements in the unfinished portions of the grounds.

Eleventh.—For painting watchmen's lodges, iron fences, vases, lamps, and lamp-posts, $1,500 is requested. There are 8 watchmen's lodges, a number of post and chain fences, 18 vases, over 400 lamp-posts, and the iron fence around the Executive Mansion, all of which should be painted in 1894–'95.

Twelfth.—For trees, tree and plant stakes, etc., and stock for nursery, $3,000 is asked in place of the $2,000 last granted. The larger sum is the amount appropriated annually for more than twelve years, ending June 30, 1892.

Thirteenth.—For removing snow and ice, the sum of $1,500 is asked. The sum usually granted, viz, $1,200, is generally sufficient but sometimes is not. The latter was the case during the last fiscal year, as mentioned in my annual report.

Fourteenth.—Twenty thousand dollars is asked for improvement, care, and maintenance of various reservations, in place of the $10,000 granted this year. It is proposed to improve as many as possible of the unimproved reservations; each year from one to five are added to the list of improved reservations, and if the funds now requested become available, eight or ten can be added during the fiscal year ending June 30, 1895. As reservations are thus improved the expense of the care of the whole is slightly increased, for the improvements must be maintained.

Fifteenth.—For the Smithsonian grounds $8,000 is asked, and for Judiciary Square $7,000, in place of $2,500 and $3,000 granted this year. The increased amounts can be profitably expended during the fiscal year ending June 30, 1895, in the improvement of those parks.

Sixteenth.—For placing granite curbing about Franklin Square $5,000 is asked. The beauty of this handsome park will be greatly enhanced by placing around it a granite curbing similar to those used around parks of the same style in the larger cities elsewhere.

Seventeenth.—For laying asphalt walks in various reservations, $5,000. It is proposed to replace with first-class asphalt walks the gravel paths in Washington Circle, Mount Vernon Square, Executive Mansion grounds (south side), Lincoln Square, Stanton Square, Folger Square, Marion Square, Henry and Seaton parks, and to renew those in Farragut Square. In the late fall, winter, and early spring these walks are muddy, and pedestrians seek the lawns, which are thus destroyed by trespassers. The amount of these paths which it is proposed to lay is about 3,500 square yards. Each autumn it becomes necessary to put down plank walks, which must again be removed in the spring. If asphalt walks are laid the annual expense incident to plank walks will be avoided.

Eighteenth.—For improvement, care, and maintenance of Henry (Armory) and Seaton parks, $5,000. These reservations, extending from Seventh street to the Botanic Gardens, cover an area of 34 acres, with road and walk surfaces of over 10,000 square yards. They are in an advanced state of improvement. Their beauty has been marred by the depot and tracks of the Baltimore and Potomac Railroad. A mound has been constructed around the depot, upon which it is intended to plant trees and shrubs, so that in time the depot will be hidden partially from view. The materials for this mound have thus far been obtained free of expense to the United States, and it is now proposed to grade the mound and to seed and plant it. The funds requested are needed for this purpose and for the care of roads, lawns, gutters, etc., and laying out additional paths.

Nineteenth.—For constructing an ornamental fountain in Lafayette Square, upon the site originally selected for the Lafayette statue, $4,000. This space is on the Pennsylvania avenue side of the square, directly opposite the Executive Mansion. The old foundation made for the pedestal of the statue can not be removed without considerable expense, but can be utilized for the foundation of a basin for an ornamental fountain, for the erection of which this estimate is submitted.

Twentieth.—For replacing the old flagging pavement of the sidewalks in the grounds north of the Executive Mansion by a granolithic pavement, $2,500. These sidewalks lead from the entrance gates on Pennsylvania avenue to the north front of the Executive Mansion. The old flagging at present composing them is in bad condition and should be replaced by a granolithic pavement.

Twenty-first.—An estimate amounting to $6,000 is also submitted for constructing a large greenhouse at the propagating gardens for palms and subtropical plants. The greenhouse structures now existing at the gardens are of small size and not of sufficient capacity to accommodate that class of plants.

Twenty-second.—An estimate amounting to $5,000 is submitted for improving Reservation No. 246, known as Howard University Park. This park contains an area of about 11½ acres and is unimproved.

Twenty-third.—An estimate amounting to $15,000 is submitted for laying an asphalt pavement upon the roadway east and south of the State, War, and Navy Departments building. The present gravel roadway is objectionable both in wet and dry weather.

Twenty-fourth—For lodges for park watchmen in Stanton, Mount Vernon, Iowa, Dupont, Thomas, McPherson, and Folger reservations, at $500, each, $3,500. The watchmen in these reservations are exposed to the inclemency of the weather at all seasons of the year. Rain or shine, hot or cold, night or day, year in and out they must be at their stations and take shelter, when necessary, either under a tree or in such a dwelling or store as will offer its hospitality. The dictates of humanity call for this appropriation.

Twenty-fifth.—An increase in the appropriation for care, etc., of the Executive Mansion is requested; the building should be repainted inside and out; much of the furniture needs to be reupholstered; new carpets are necessary and it is desired to change the office rooms into bed rooms and use the entire mansion simply for the home of the President of the United States.

Twenty-sixth.—The sum of $1,500 is required for renewing the superstructure of one of the greenhouses connected with the Executive Mansion. The present structure is weak and should be rebuilt at the earliest opportunity. This estimate was submitted last year but only $1,000 was appropriated; as a proper superstructure could not be built for that sum, the money will not be used and will revert to the Treasury. Two thousand dollars is requested for repair of the conservatory; the structure is old, in bad condition, and requires continual repairs and patching to preserve the splendid collection of plants it contains.

Twenty-seventh.—For portrait of ex-President Harrison and frame for portrait, $2,500.

This sum was appropriated for the portrait of ex-President Harrison's immediate predecessor.

The Executive Mansion now contains the portraits of all the ex-Presidents of the United States except President Harrison.

Twenty-eighth.—The appropriation requested for lighting Executive Mansion and public grounds, and which is in excess of that made last year, is deemed very necessary in order to extend the electric light system through the Monument grounds, now entirely without illumination, and to change the system in Lafayette and Franklin parks from gas to electric lights; in the interest of morality, as well as for the protection of persons visiting or passing through the parks after dark, it is desirable to make them as light as possible at night.

Twenty-ninth.—The estimate for repairs to waterpipes and fireplugs has been increased from $2,500 to $5,000. The sources of the spring which supplies the United States Capitol with water were much impared by the excavations made in connection with the construction of the large reservoir near the Howard University for the increase of the city's supply of Potomac water, which has resulted in diminishing the pressure at the Capitol. It is proposed to use the additional amount requested in making connection with the strongest springs in the vicinity and in overhauling and repairing the old pipe line and renewing such portions of it as may be found unserviceable.

Thirtieth.—An estimate is again submitted for replacing the overhead wires between the Capitol and the departments with a duplicate underground six-wire cable. The growth of the trees on the sidewalks renders it absolutely necessary, in order to maintain telegraphic communication over these wires, either to erect at once taller poles at a cost of about $1,600, or to lay an underground cable at a cost of $31,000. It appears to be the will of Congress that no more overhead wires shall be placed in this city (see District of Columbia appropriation act of July 18, 1888); otherwise I should recommend the appropriation of the smaller amount.

Thirty-first.—I recommend that the salaries of the two steam engineers at the Washington Monument be increased from $80 and $60 to $90 and $70 per month, respectively. The duties of these two men are of great importance. Upon their efficiency and intelligence depend, to a great extent, the lives of those who use the elevator. The increase asked is small and the men deserve it. I also recommend that the pay of the two firemen be placed at $60 per month each. That is the rate allowed firemen in the Executive Departments and there appears to be no reason why the firemen at the Monument should receive less.

The item for fuel, lights, oil, waste, repairs, etc., should be increased from $3,000 to $3,600 for the purpose of painting the ironwork in the interior of the monument, and an item is added for a new engine for the electric light system to replace the old one which is in bad condition and constantly breaking down.

In submitting these estimates I earnestly recommend that the various items under the heading of "improvement and care of public grounds" be aggregated under one head, and while each item of work shall be named, the whole shall be covered by a general sum of $129,500.00, not a specific sum for each item; this is done in other Departments of the Government, particularly the Quartermaster's Department of the Army; it saves quite an amount of clerical labor by permitting the preparation of accounts under one heading, rather than under about thirty; moreover, it permits small balances which might be saved from one item to be used in some other equally necessary and important work.

This recommendation is based strictly upon business principles, and is for the purpose of reducing clerical labor and expediting the progress of the work.

On the afternoon of June 30, during the closing hours of the fiscal year, I was directed to assume charge of all public buildings, rented or otherwise, occupied by the War Department, or any of its bureaus or offices in the District of Columbia, so far as their preservation, care, and safety are concerned.

This additional duty will be assumed at once, and if necessary a separate report rendered in reference thereto.

Financial statement for fiscal year ending June 30, 1893.

Title of appropriation.	Year.	Available at beginning of fiscal year.	Expended during fiscal year.	Unexpended balance to revert to the Treasury.
Improvement and care of public grounds	1893	*$52,950.00	$52,349.44	$600.56
Repairs, fuel, etc., Executive Mansion	1893	30,000.00	29,956.52	43.48
Lighting, etc., Executive Mansion etc	1893	15,022.00	14,892.24	129.76
Repairs to waterpipes and fireplugs	1893	2,500.00	2,481.55	18.45
Telegraph to connect the Capitol with the Departments and Government Printing Office.	1893	1,500.00	1,500.00	....
Contingent expenses public buildings and grounds under Chief Engineer.	1893	500.00	499.28	.72
Salaries of employés public buildings and grounds under Chief Engineer.	1893	49 060.00	49,052.95	7.05
Care and maintenance of Washington Monument	1893	11,520.00	11,517.57	2.43

*Of this amount $500 was not available until March 3, 1893, having been appropriated by deficiency appropriation act approved that date.

In again assuming the duties of this office, after an absence of nearly four years, I must express my gratification at finding Mr. George H. Brown, the energetic, reliable, and skillful public gardener, and Mr.

E. F. Concklin, the faithful, untiring, careful and attentive chief clerk, still on duty in this department.

To these two gentlemen I am again indebted for most valuable and loyal assistance in the discharge of my official duties.

I am, general, very respectfully, your obedient servant,

JOHN M. WILSON,
Lieut. Col., Corps of Engineers,
Colonel, U. S. Army.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX DDD.

NORTHERN AND NORTHWESTERN LAKES—SURVEYS—CORRECTING ENGRAVED PLATES—PRINTING AND ISSUING OF CHARTS.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS, BVT. BRIG. GEN., U. S. A., FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 11, 1893.

SIR: I have the honor to transmit herewith, in duplicate, my annual report on the "issue of the published charts of the Northern and Northwestern Lakes and surveys, made for the purpose of keeping these charts up to date," for the fiscal year ending June 30, 1893. * * *

Very respectfully, your obedient servant,

O. M. POE,
Colonel, Corps of Engineers, Bvt. Brig. Gen., U. S. A.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

DDD 1.

NORTHERN AND NORTHWESTERN LAKES—SURVEYS—CORRECTING ENGRAVED PLATES—PRINTING AND ISSUING OF CHARTS.

The sundry civil act of August 5, 1892, appropriated the following amounts for the fiscal year ending June 30, 1893:

Survey of Northern and Northwestern Lakes.—For printing and issuing charts for use of navigators and electrotyping plates for chart printing, two thousand dollars.

For surveys, additions to, and correcting engraved plates, five thousand dollars.

Under the first item the issuing of charts has been done in Detroit, Mich., from this office, the rest of the work required being attended to by the office of the Chief of Engineers in Washington. During the fiscal year nearly all charts have been sold at the uniform price of 20 cents each. A few special lithographic charts have been sold for 10, 5, and 4 cents each, and some charts have been issued free of charge for the official use of Government agents applying for them.

The following table shows the extent of this business:

Issue of the charts of the Northern and Northwestern Lakes during the fiscal year ending June 30, 1893.

Description.	Number.	Total.
On hand July 1, 1892	5,173	
Received during year	6,503	
		11,676
Issued to United States vessels and officials, etc	382	
Destroyed, worthless, not showing corrections to date	655	
Sold at 20 cents each	6,347	
Sold at 10 cents each	18	
Sold at 5 cents each	5	
Sold at 4 cents each	5	
		7,412
On hand July 1, 1893	....	4,264

The sum of $1,271.65 was turned into the Treasury from sale of charts.

Total number of charts distributed to July 1, 1892	186,987
Distributed, etc., during fiscal year	7,412
Total distributed to July 1, 1893	194,399

Under the second item of the above appropriation a number of charts have had corrections and additions made upon them in this office, and have been forwarded to Washington in order that the necessary changes might be made upon the engraved plates.

The following charts have been amended in this office:

	Scale.
River Saint Marie, No. 1	1 : 40,000
River Saint Marie, No. 2	1 : 40,000
East Neebish Rapids, River Saint Marie	1 : 15,000
Straits of Mackinac	1 : 120,000
Beaver Island Group, Lake Michigan	1 : 120,000
Coast Chart No. 6, Lake Erie	1 : 80,000
Coast Chart No. 7, Lake Erie	1 : 80,000
Detroit River, No. 56	1 : 40,000
Lake Michigan, Coast Chart No. 8	1 : 80,000
Lake Michigan, Coast Chart No. 9	1 : 80,000
Saginaw River	1 : 10,000

The information embodied in the above charts was derived from the best available sources of information. This work has been seriously impeded by lack of sufficient funds. The work is essential, however, if the charts are to be used for navigating the lakes.

RESURVEY ST. MARYS RIVER.

The charts of St. Marys River are based on surveys made in 1853 and 1857. When these surveys were made the maximum draft of vessels was from 9½ to 12 feet. With the completion of the ship channel connecting the waters of the Great Lakes, the maximum draft of vessels will soon approximate to 20 feet.

The methods followed in the earlier surveys, especially the hydrographic work, while accurate enough for the needs of the time, were not in all cases sufficiently accurate when the needs of a 20-foot navigation are to be provided for. In addition, changes both artificial and natural have taken place. Consequently the resurvey of certain localities is or will be a necessity.

In conformity with this general plan a resurvey of St. Marys River was commenced in May, 1892, at an estimated cost of $64,080. Work was suspended on June 30, 1892, on account of the exhaustion of funds available.

Under an allotment of $4,000, subsequently increased to $4,325, work was resumed in January, 1893. This allotment was so small it was determined to confine the work for this fiscal year to the requisite astronomical determinations and the extension of the triangulation.

Contracts.

Contractor.	For—	Entered into.	Remarks.
The Richmond & Backus Co	Stationery	Apr. 27, 1893	In force.
P. M. Church & Co	Hardware, ship chandlery, etc.	....do	Do.
Prenzlauer Bros	Groceries	....do	Do.
Andrew Hotton	Meats	....do	Do.

OPERATIONS DURING THE FISCAL YEAR.

Astronomical work.—A field observatory has been constructed at Sault Ste. Marie, Mich., on land belonging to the United States. The astronomical instruments and electrical apparatus necessary for the determination of latitude and longitude have been placed in position. These instruments had not been in use for a good many years, so a great number of small repairs and the recalibration of all the instruments were necessary. The observatory was not complete and ready for astronomical determination until about June 1.

A fundamental determination of latitude has been made, consisting of about four nights' observations of about 25 pairs of stars a night. About 100 pairs in all.

Everything at this observatory is now in readiness for the determination of longitude.

Triangulation.—Eight primary stations have been definitely and four approximately selected.

Six triangulation stations have been built, one 64 feet in height, and from 12 to 15 lines of sight cut.

Computations.—The computations of the length of the "Soo" Base measured last year by Mr. O. B. Wheeler, assistant engineer, have been made. The computations of the line of precise levels, run last year from Sault Ste. Marie to Bay Mills, Mich., are nearly completed.

PROPOSED ORDER OF WORK.

The allotment for the fiscal year ending June 30, 1893 having been but $4,000, subsequently increased to $4,325, and the allotment for the following year being in the neighborhood of $20,000, the former allotment has been mainly spent in preparatory work with a view to pushing the field operations after July 1, 1893, when the larger amount becomes available.

With the new allotment an effort is to be made to accomplish enough field work for one new chart. A scheme for charting the river was therefore made and is as follows:

Chart No. 1, St. Marys River; scale, 1:40,000, Détour Passage to Winter Point Range.
Chart No. 2, St. Marys River; scale, 1:40,000, Pilot Island Range to west end St. Marys Falls Canal.
Chart No. 3, St. Marys River; scale, 1:40,000, east end St. Marys Falls Canal to about 15 miles northwest of Point Iroquois light-house.
White Fish Bay; scale, 1:80,000, St. Marys Falls Canal to Whitefish Point and Mamainse.

The field work that can be quickest completed is that for Chart No. 3. The required topography is less than for any one of the other charts, the triangulation can be finished sooner in this direction, and in addition this reach is much less conveniently shown in the old charts than any other part of the river.

It is proposed also to employ a draftsman to compile existing hydrography of the river, using the river-improvement surveys, and all other reliable information. This compilation will show where new hydrography is necessary, and the additional information needed can be obtained by sounding through the ice next winter. This will prevent unnecessary duplication of work.

ESTIMATE (RESURVEY ST. MARYS RIVER).

The approved estimate for the resurvey of St. Marys River is $64,080, of which $40,000 can be profitably expended during fiscal year ending June 30, 1895.

The resurvey of St. Marys River has been under the local charge of First Lieut. Charles S. Riché, Corps of Engineers, U. S. Army, and the details of this work will be found in his report appended hereto.

Estimate for the fiscal year ending June 30, 1895.

For printing and issuing charts for the use of navigators and electrotyping copper plates for chart printing	$3, 00[illegible]
For surveys and other expenses connected with correcting and extending the charts of the northern and northwestern lakes, exclusive of resurvey of St. Marys River	10, 0[illegible]
Resurvey St. Marys River	40, 0[illegible]
Total	53, 0[illegible]

Money statement.

RESURVEY ST. MARYS RIVER, MICHIGAN.

Allotted, September 8, 1892, $4,000; April 8, $100; May 5, $325; June 3, 1893, $175	$4, 60[illegible]
June 30, 1893, amount expended during fiscal year	2, 61[illegible]
July 1, 1893, balance unexpended	1, 98[illegible]
July 1, 1893, outstanding liabilities	1, 98[illegible]
Amount (estimated) required for completion of existing project	40, 00[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1895	40, 00[illegible]

Dates and amounts of appropriations for survey of northern and northwestern lakes.

March 3, 1841	$15,000
May 18, 1842	20,000
March 1, 1843	30,000
June 17, 1844	20,000
March 3, 1845	20,000
August 8, 1846	25,000
August 12, 1848	25,000
March 3, 1849	10,000
September 28, 1850	25,000
March 3, 1851	25,000
August 30, 1852	25,000
March 3, 1853	50,000
August 5, 1854	50,000
March 3, 1855	50,000
August 30, 1856	50,000
March 3, 1857	50,000
June 12, 1858	75,000
March 3, 1859	75,000
June 21, 1860	75,000
March 2, 1861	75,100
July 5, 1862	105,000
February 9, 1863	106,879
July 2, 1864	100,000
February 28, 1865	125,000
June 12, 1866	50,000
March 2, 1867	77,500
March 2, 1868	77,500
July 20, 1868	$75,000
March 3, 1869	100,000
July 15, 1870	100,000
March 3, 1871	175,000
June 10, 1872	175,000
March 3, 1873	175,000
June 23, 1874	175,000
March 3, 1875	150,000
July 31, 1876 (not including $16,000 applied to survey Mississippi River)	84,600
March 3, 1877 (not including $25,000 applied to survey Mississippi River and including $9,500 received from sale of steamers)	94,500
June 20, 1878 (not including $49,500 applied to survey of Mississippi River)	49,500
March 3, 1879	85,000
June 16, 1880	40,000
March 3, 1881	18,000
August 17, 1882	12,000
March 3, 1883	3,000
Total	2,942,879

Dates and amounts of appropriations for survey of northern and northwestern lakes.

Printing and issue of charts for use of navigators and electrotyping copper plates for chart printing:

July 7, 1884	$3,000
March 3, 1885	3,000
August 4, 1886	2,000
March 3, 1887	2,000
October 2, 1888	2,000
March 2, 1889	2,000
August 30, 1890	2,000
March 3, 1891	2,000
August 5, 1892	2,000
March 3, 1893	2,000
Total	22,000

Dates and amounts of appropriations for survey of northern and northwestern lakes.

Surveys and additions to and correcting engraved plates:

March 2, 1889	$5,000
August 30, 1890	10,000
March 3, 1891	10,000
August 5, 1892	5,000
March 3, 1893	25,000
Total	55,000

Abstract of bids for furnishing supplies for survey of Northern and Northwestern lakes; received and opened April 7, 1893, in accordance with advertisement dated March 23, 1893.

No.	Name and address of bidder.	Stationery, approximate total.	Hardware, ship chandlery, etc., approximate total.	Groceries, approximate total.	Lumber, approximate total.	Meats, vegetables, etc., approximate total.
1	The Richmond & Backus Co., Detroit, Mich	*$115.08				
2	J. L. Hudson, Detroit, Mich	112.10				
1	P. M. Church & Co., Sault Ste. Marie, Mich		*$301.12			
2	Ferguson Hardware Co., Sault Ste. Marie, Mich		302.66			
1	Prenzlauer Bros., Sault Ste. Marie, Mich			*$246.68		
2	P. C. Keliher, Sault Ste. Marie, Mich			249.23		
3	G. & R. McMillan & Co., Detroit, Mich			257.10		
4	David Wallace, Detroit, Mich			259.94		
5	Otto Suppe & Co., Sault Ste. Marie, Mich			265.44		
1	G. K. Gustin & Co., Ann Arbor, Mich				†$54.00	
1	Andrew Hotton, Sault Ste. Marie, Mich					‡$303.60

* Recommended for acceptance.
† To be withdrawn in case contract for lumber for operating and care, St. Mary's Falls canal is not awarded to them. Withdrawn; this being the case.
‡ Bid for meats only. Recommended for acceptance.

REPORT OF LIEUT. CHARLES S. RICHÉ, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., July 4, 1893.

SIR: I have the honor to submit the following report of operations of the survey of the Northern and Northwestern lakes, resurvey of St. Marys River for the fiscal year ending June 30, 1893:

An allotment of $4,000 having been made for this survey from the general appropriation of $5,000 which had been made by Congress for the entire chain of lakes, I received orders to proceed to Sault Ste. Marie, Mich., and take immediate charge of the work.

The work done during the closing months of the preceding fiscal year, under the immediate direction of Assistant Engineer O. B. Wheeler, had consisted in the measurement of a 2-mile base line, known as the "Soo" base; the selection of sites for five triangulation stations adjacent thereto, reading the angles of the first quadrilateral off the base; the determination of an astronomical azimuth and the running of a line of precise levels from Sault Ste. Marie to Bay Mills. In addition some hydrographic work was done by Assistant Engineer Joseph Ripley in the vicinity of Sailors Encampment.

This work having been well started, was obliged to stop on June 30, 1892, owing to the provision of law that renders appropriations unavailable after the close of the fiscal year to which they relate, and owing to the fact that the new appropriation was not made until over a month later, after the parties employed upon the work had been disbanded. This rendered it practically impossible to do any more field work during the last and best portion of the season of 1892.

As the available allotment was so small it was determined to confine the work to the requisite astronomical determinations and to the extension of the triangulation, and the results accomplished are as follows:

ASTRONOMICAL WORK.

The first work done was the erection of a small field observatory in Sault Ste. Marie, Mich. This was built during the coldest part of the winter, and forms an ell of the United States Engineer Office. Having a door communicating with the office it is practically a room of the latter, and will always receive the same care as the rest of the building. In addition, being on Government land it can be kept permanently, and will always be a useful point for comparisons of longitude and other work of this character pertaining to the various surveys of the Engineer Department.

For purposes of permanency the two astronomical piers in the observatory were made of masonry laid in cement and capped with a block of cut stone. Each stands on a separate foundation from the rest of the building and makes a very stable support for its instrument.

It was found that the astronomical instruments needed a number of minor repairs to put them in first-class condition. When issued from the engineer depot last year they had been sent to Messrs. F. E. Brandis & Sons, of Brooklyn, N. Y., for repair, and their work proved to have been very incomplete. The two levels of the astronomical transit needed refilling badly, as the shortest length of bubble at a temperature of +32° F. was longer than the tube. These were refilled here. The striding level of the zenith telescope was broken in transit, and while this was doubtless due to carelessness on the part of the express company it could undoubtedly have been avoided by greater care in packing. Messrs. Brandis asked $40 for repairing this level. Messrs. Buff & Berger, of Boston, repaired it very satisfactorily for $22. Only three vertical and one horizontal threads were found in the transit, and there was no evidence that more had been inserted. This necessitated the sending away of the eyepiece of the instrument to have the proper number of threads put in. Other minor defects had to be corrected in like manner, and much delay was caused thereby.

The instruments were calibrated as rapidly as possible under the circumstances. Values of one division of the various levels were found by the level-trier at various temperatures. The inequality of pivots of the transit were determined. The value of a division of the side level of the zenith telescope was determined in terms of the micrometer, it having also been determined by level-trier, and the value of one turn of the micrometer of this instrument was determined by observations on Polaris. The electrical apparatus needed for longitude work was purchased and installed, and a sidereal clock was obtained from the engineer depot, but it was not until about June 1 that the observatory could be considered complete in its appointments and ready for the work for which it was needed.

The Western Union Telegraph Company very kindly put at our disposal a continuous wire connecting the observatory here with that at the University of Michigan at Ann Arbor, charging nothing therefor, the only proviso being that the Government should pay any increased expense that might be entailed. This liberality has very greatly facilitated the work, and the uniform courtesy of the company's officials has been fully appreciated.

Difficulty has been experienced in the longitude work, owing mainly to trouble with the action of the magnets at Ann Arbor. Prof. Asaph Hall, jr., who is observing at that point, has suggested and carried out several changes which will improve matters in this respect, and the determination of longitude will shortly be finished.

A fundamental determination of latitude has been made, consisting of four nights' observations of about twenty-five pairs of stars a night; about a hundred pairs in all. In view of the fact, however, that the latitude has recently been proved to be a variable quantity, the variations following some as yet unknown law or laws, it has been decided to continue latitude observations for as long a period as possible, and in addition to observe continuously for azimuth. Should the pole move in an orbit, therefore, as is supposed, these observations would enable this orbit and the laws governing it to be determined, and would enable corrections to be obtained to reduce the latitude and azimuth at any locality to their mean positions. This work, of course, can not be begun until the longitude work is finished. A permanent azimuth mark, however, has been established on a primary triangulation station about 5 miles from the observatory and close to the meridian line through it, so that everything is in readiness for this work as soon as it is practicable to begin the observations. Such arrangements have been made that the cost of this work to the United States will be nominal.

A detailed report of the astronomical work can not well be submitted until the fundamental observations have been finished and the continuous observations are in progress. Such a report is, therefore, deferred for the present. I desire, however, to express my appreciation of the services rendered by Assistant Engineer F. C. Shenehon, who has acted as recorder during the observations and has assisted in many other ways; and also by Inspector L. Fleming, who without extra compensation, has performed the duties of telegraph operator during the longitude work, in addition to his regular duties in connection with the improvement of St. Marys River. I am also indebted to the latter for valuable suggestions and assistance in regard to the management of the chronograph and other electrical apparatus used.

PLANNING TRIANGULATION.

On April 18, 1893, Assistant Engineer Fred Morley reported for duty on the resurvey of St. Marys River, and was duly assigned to the work of planning triangulation. He informed himself as fully as possible in regard to previous wo about the end of April went into the field. By the close of the fiscal year definitely selected eight primary stations and approximately selected fou Almost all of the problems that presented themselves have been solved; ab only difficulty now apparent being the connection back of △ Mamainse with gantua. I do not anticipate any more serious trouble with this connectio has already been met and overcome, and can only emphasize Mr. Morley's mendation as to the advisability of making this connection. It will probably us to dispense with an extra base line, and will give us a complete chain of t tion around Lake Superior.

The work accomplished by Mr. Morley is well shown in the sketch su herewith. When it is considered that this is the result of practically b months' work during weather that was ordinarily too hazy or smoky to great distance, further commendation of Mr. Morley's zeal and energy seems u sary.

In Mr. Morley's report, appended hereto, marked A, will be found a description of the work done and results obtained in this direction.

BUILDING STATIONS.

On April 26, 1893, Assistant Engineer Glen E. Balch reported for duty duly assigned to the work of building stations for the triangulation. He or a party and prepared a camp outfit, cutting a number of lines of sight prior ing into camp. On May 14 the entire party went into the field, and by the the fiscal year six triangulation stations had been built, one 64 feet in hei from twelve to fifteen lines of sight cut. The stations built last year were r and put in good condition for use, and reference stones were set at all of the s

The recent eight-hour law has somewhat retarded this work. Mr. Balch h very energetic and has accomplished a great deal with the time at his d His report is appended hereto marked B, and reference is made to it for information and for an approximate description of the stations already con

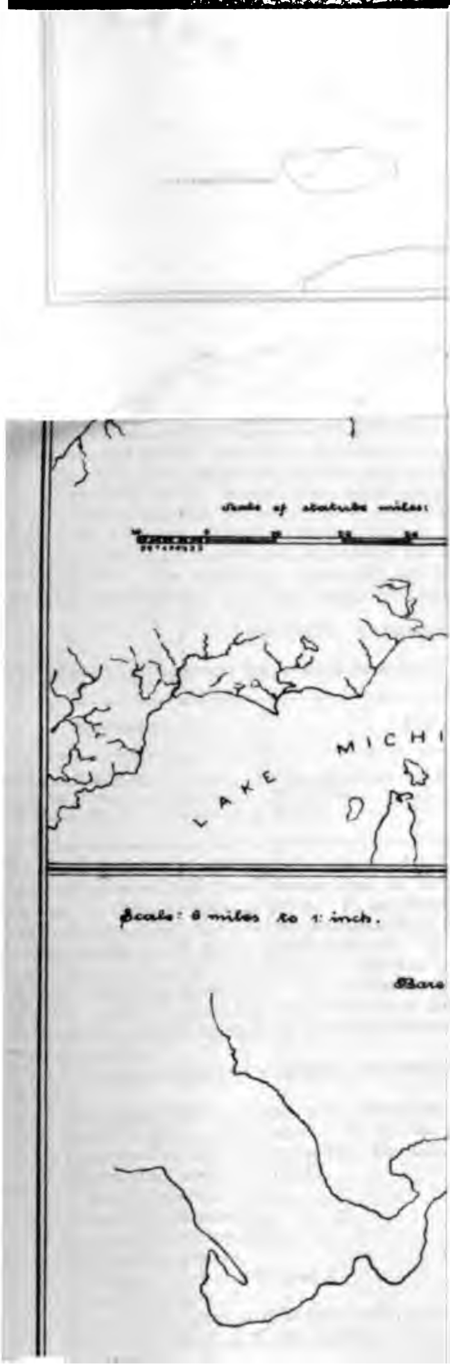
OFFICE WORK, ETC.

The allotment being so small, it was considered inadvisable to measure an until more money was available. It was also considered the part of economy, time and money, not to begin occupying any of the stations until enough had been completed to avoid as far as possible the necessity of occupying tion more than once. In addition, the shortness of the base line rendered n a gradual development to the sized triangles required for the primary syst the number of stations adjacent to the base has been greatly increased i quence. The completion of these stations was therefore necessary before e cal measurement of angles could begin. Hence, when Assistant Enginee Haskell reported for duty on May 2, 1893, and was assigned to the work uring angles, he was instructed not to take the field prior to July 1. Up to t of the fiscal year, therefore, he has been engaged mainly in office work. He the theodolites, etc., in good condition, has calibrated them, has made the c tions of the length of the "Soo" base measured last year by Assistant Eng B. Wheeler, and has nearly completed the computations of the line of preci run last year from Sault Ste. Marie to Bay Mills. In addition, he has assi Morley in part of his work in White Fish Bay, where it was necessary to tak the Troughton and Simms theodolites to determine the direction of the lon Iroquois, △ Kings Mountain. Assistant Engineer Haskell's report is a hereto, marked C; and his computation of "Soo" base is also appended, ma

Assistant Engineer von Schon reported for duty June 12, 1893, and has been in preparing camp outfits, etc., for two topographical parties. In additio checked Mr. Haskell's computations and has compiled and plotted the terti angulation stations and bench marks located along St. Marys River betwe Iroquois and Little Rapids. At the close of the fiscal year he was ready to t field with a topographical party as soon as the requisite instruments shou been received. His report is appended, marked E.

PROPOSED WORK.

The allotment for the fiscal year ending June 30, 1893, having been but $4,(sequently increased to $4,325, and the allotment for the following year bein neighborhood of $20,000, the former allotment has been mainly spent in prep work with a view to pushing the field operations after July 1, 1893, when th amount becomes available.



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With the new allotment an effort is to be made to accomplish enough field work for one new chart. A scheme for charting the river was therefore made, and is as follows:

Chart No. 1, St. Marys River; scale, 1:40,000, Detour Passage to Winter Point Range.

Chart No. 2, St. Marys River; scale, 1:40,000; Pilot I. Range to west end St. Marys Falls Canal.

Chart No. 3, St. Marys River; scale, 1:40,000; east end St. Marys Falls Canal to about 15 miles northwest Point Iroquois Light.

White Fish Bay; scale, 1:80,000; St. Marys Falls Canal to Whitefish Point and Mamainse.

The field work that can be quickest completed is that for Chart No. 3. The required topography is less than for any one of the other charts, the triangulation can be finished sooner in this direction, and, in addition, this reach is much less conveniently shown in the old charts than any other part of the river.

With a view to completing the field work for this chart, the triangulation will be pushed northward to the Lake Superior connection, and a topographical party will be employed on each side of the river, and will work westward and northward from Sault Ste. Marie until the limits of the chart are reached.

It is proposed also to employ a draftsman to compile existing hydrography of the river, using the river improvement surveys, and all other reliable information. This compilation will show where new hydrography is necessary, and the additional information needed can be obtained by sounding through the ice next winter. This will prevent unnecessary duplication of work.

It is hoped that all field work necessary for Chart No. 3 can be done under the new allotment. The drafting, engraving, and printing of the chart would, of course, have to be provided for by a later appropriation.

CONTRACTS, EXPENDITURES, ETC.

The following contracts have been in force during the fiscal year.

Contractor.	For—	Date.	Remarks.
P. M. Church & Co	Ship chandlery and hardware	Apr. 27, 1893	In force.
Prenzlauer Bros	Groceries	....do	Do.
Andrew Hotton	Meats	....do	Do.

An effort was made to obtain contracts for lumber, vegetables, and milk, but no bids were received for these items, and, in consequence, they have to be procured from time to time in open market. In addition, many articles of the same nature as those under contract have to be purchased in the same way owing to their not having been enumerated in the specifications. The specifications were prepared before the new appropriation was made, and it was impossible to foresee just what would be required during the season. In addition, the survey had to be started fresh with pratically nothing available except some of the instruments, and it was also impossible on that account to tell in advance what subsequent experience alone could prove necessary.

The following articles of engineer property have been received during the fiscal year, viz:

The Lake Survey level-trier—since returned.
Bond & Sons astronomical clock, No. 256.
Lukens sidereal chronometer, No. 141.
The Bailey switch board.
1 binocular field glass.
1 aneroid barometer.
3 prismatic compasses.
2 pocket sextants.
1 Gurley level and tripod.
2 leveling rods.
2 surveying chains (100 feet and pins).
2 trivets (for T. & S. theodolites, Nos. 1 and 3).
1 telescope.
2 hand levels (reflecting).
1 box sounding relay (150 ohms) with key on base.
1 relay (5 ohms).
4 relays (50 ohms).
2 telegraph keys.
7 two-point switches.
7 gravity cells (Daniell).

The following statement shows the expenditures during the fiscal year and the work to which they pertain:

Allotted	$4,325

Expended.

Astronomical work	$760.40
Planning triangulation	869.51
Building stations	1,680.86
Measuring angles	22.20
Topography	41.00
Office work	505.00
Contingencies	101.15
Outstanding liabilities	344.88
Total	4,325.00

ESTIMATES.

For the continuation of work on the resurvey of St. Marys River, $40,000 can be profitably expended during the fiscal year ending June 30, 1895. This is for field work and office computations alone, and does not include the final drafting of charts, nor does it include other work of like character elsewhere on the lakes. If this amount were appropriated to be available until expended, as is done for other work under the Engineer Department, a great saving both in time and money could be effected for the Government, and work would not have to stop in the best part of the season as is now often the case. This method of appropriation has worked so well in the river and harbor work of the Corps of Engineers, that it would seem very desirable to have it applied generally to all surveys made by the Engineer Department.

The amount of the estimate, $40,000, is small in comparison to the advantages which would result to the enormous traffic of St. Marys River, by the early publication of new charts showing the channels to be run and the dangers to be avoided in the difficult navigation of this portion of the greatest commercial waterway of the world.

In conclusion, I desire to express my appreciation of the many courtesies received from the engineers and others employed upon river and harbor works in this locality. I am especially indebted to Assistant Engineer E. S. Wheeler for many valuable suggestions concerning the work.

Very respectfully, your obedient servant,

CHARLES S. RICHÉ,
First Lieut., Corps of Engineers, U. S. A.

Col. O. M. POE,
Corps of Engineers, U. S. Army.

A.

REPORT OF MR. FRED MORLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., July 1, 1893.

SIR: I have the honor to submit the following report of the work done to date in planning the primary triangulation connecting the Lake Survey triangulation in the east end of Lake Superior with that in the Mackinac Straits and northern end of Lake Huron, this work having been assigned to me by your letter of April 19, 1893.

In accordance with Gen. Poe's instructions, dated April 8, I reported at his office in Detroit on Monday, April 17. After obtaining such information relative to the work already done by Assistant Engineer O. B. Wheeler on the resurvey of the St. Marys River during the fiscal year ending June 30, 1892, as was on record in the Detroit office, I proceeded to Sault Ste. Marie, Mich., where, on April 18, I reported to you in person in compliance with the instructions from Gen. Poe dated April 17, 1893.

The following stations had been located and marked by Mr. Wheeler: A station at the upper and one at the lower end of a 2-mile base line—the "Soo" base—situated on Portage avenue in this city, the former or westerly base station being near the inction of Portage avenue and Bingham street, and the latter or easterly station eing on Portage avenue, near the Little Rapids; a station on the Ashmun Street ill 1½ miles southerly from west base and a station in Canada 3 miles northeasterly om west base, forming with the base stations the first quadrilateral; a station on ugar Island, about 3½ miles east of east base and a station on Rankin Mountain in anada, about 7 miles northeast of this city, forming with the two first stations off ie base a second quadrilateral, and a station on Larks Ridge, about 2 miles southest of New Fort Brady.

Preparatory to continuing the work of locating triangulation stations and of eveloping and extending a system of triangulation both to the north and south om the measured base line, the above-named stations, excepting the one on Sugar sland which was visited later, were visited by me during the first ten days after my rival in this city. Tracings and maps were also made or procured and other information and data collected as aids in prosecuting the work.

Iroquois Point on the American side and Gros Cap on the Canadian side—two mmanding ridges or promontories at the entrance to St. Marys River from White sh Bay—were visited and examined during the last week of April and the former lected as the more favorable site for a primary station.

Within the last week a secondary station has been selected on Gros Cap, and the ie Iroquois-Gros Cap across the head of St. Marys River will form the line of connection between the triangulation system now planning and the tertiary system of angles already nearly completed by Assistant Engineer Joseph Ripley along the eater portion of the St. Marys River. In the lower reach of the river this tertiary stem of triangles will again be connected with the primary triangulation system.

During the first week in May a number of peaks in MacDonald Township in the cinity of the eastern shore of Lake George were examined, but none of them found vorable as station points for a rapid enlargement to primary triangles. The nountains" on St. Joseph Island were also visited and the westerly peak of a short nge was selected as a most favorable site for a station. This is an important stan, as not less than 12 primary directions will be read from it. The mountain is sy of access and the station or scaffolding to be erected will not be high.

An examination was next made of that tract of country known as the sand hills ing between the meridian and Mackinac roads, and extending from 12 to 20 miles uth of this city. A station site was selected 3 miles south and 3½ miles west of onaldson post-office. Owing to the general flatness and timbered condition of the untry and the distance of adjacent stations a considerable height will here be given the station scaffolding, to get above the timber, thus avoiding the expensive outng of long lines and the payment of timber damages.

The next locality visited was that known as "the mountain," about 5 miles south Pickford, Mich., the range extending nearly east and west. On this mountain nge the approximate location for two stations has been chosen. The westerly one ill be about 4 miles south and 8 miles west of Pickford. The easterly one will obably be about 5 miles south and 3 miles east of the same place and therefore out 11 miles east of the former. It is expected that these two stations will form quadrilateral with two stations yet to be selected, one on Bois Blanc Island and e other the Lake Survey station at Fort Holmes on Mackinac Island, if it can be entified. If it can not be identified, a new station in its vicinity will be chosen. om stations on these two islands it will be easy to extend the system, either rough the quadrilaterals and triangles used by the Lake Survey or, *more directly*, the Mackinac base line situated on the southern shore of the Straits of Mackinac, ith its western terminus on McGulpin Point. The ends of this base appear from e records to have been well marked and it is confidently expected to identify em.

Following the above locations, the country south and east of Stalwart post-office as traversed, the examination extending to within 9 miles of Detour. The general aracter of all this region is flat. It is mostly covered with tall timber. On a mestone ridge east and north of Gatesville an approximate location of a station as selected. This station will not be distant from the river, and will be seen from ie easterly station on "the mountains," and from the station selected on St. Joseph land.

Two prominent peaks in Canada nearly east of this city, respectively about 5 and miles distant from the east shore of Lake George, were visited on May 23 and 24. hese are commanding peaks, and the more easterly one, which has been selected a site for a station, is most happily situated for extending the main triangulation stem northward, and for locating a station southerly on the north shore of Drumond Island. This peak is in Coffin additional concession 4, and probably 4 and 5. he station scaffolding to be erected here will not be high.

Toward the last of May a partial examination for a station site was made in the cinity of Detour, and an approximate location determined upon. Harbor Island id the northern and eastern portions of Drummond Islands were visited. The latter is heavily wooded and comparatively flat, with few rises of land above the general elevation of the island. The selection of a station or stations anywhere in the interior of the island would require the erection of high scaffolding, or necessitate extensive cutting. A site for a station was therefore chosen on the extreme northwesterly point of the island, about 3 miles northeast of Harbor Island. This station, the one at Detour, and the one in the vicinity of Gatesville, are the only stations outside of the direct chain of quadrilaterals as planned to connect the Lake Survey triangulation on the east end of Lake Superior with that at the Straits of Mackinac. These three stations, taken in connection with the station on St. Joseph Island, cover the lower portion of the St. Marys River and the numerous islands in the channel between St. Joseph and Drummond islands. From them a reduction to the secondary and tertiary systems can easily be effected.

On June 20, I proceeded to Goulais River and on the following day went to the summit of a mountain known as Kings Mountain situated near the southwest corner of Tupper Township, Canada. Other mountains west and southwest of Kings Mountain were visited, but were found of insufficient height. Before, however, selecting Kings Mountain as a station point it was necessary to make sure that it could be seen from station Iroquois, 28 miles distant, and either from the station located by Mr. Wheeler on Rankin Mountain 17 miles distant, or from the station located by me on the peak in Coffin Additional, 30 miles distant. A range of mountains on the south side of Goulais River intervenes between the last two named stations and Kings Mountain and the line from Iroquois to Kings Mountain passes over Gros Cap. On account of the distance between stations and other causes a very favorable condition of the atmosphere was necessary for testing the intervisibility of these points. The protracted hazy and smoky atmospheric condition gave no favorable opportunity for making a test. An attempt was made at night by placing lights at Iroquois station and at the station on Rankin Mountain in the hope that they could be seen at Kings Mountain. The trial was made on three successive nights, but the unfavorable condition of the atmosphere and the smallness of the largest available lights rendered these efforts unsuccessful. The unfavorable weather continuing, two temporary points were selected—one on the south end of Parisian Island and the other at Goulais Point—from each of which stations Iroquois and Kings Mountain were visible, and the angles measured by Assistant Engineer E. E. Haskell at each of these points to the other, to Kings Mountain and to Iroquois. The direction of the line from Iroquois to Kings Mountain was thence determined. A rain having cleared the atmosphere, station Iroquois was occupied, when it was found that Kings Mountain was plainly visible over Gros Cap. I have since visited the peak in Coffin Additional, Canada, and am confident that Kings Mountain is visible from it. It is not essential that Rankin Mountain should also be visible from Kings Mountain; Kings Mountain has therefore been selected as a primary triangulation station. Very little work will be required to prepare this peak for occupation by the observer of the angles.

Mamainse—the last station determined by the Lake Survey on the east coast of Lake Superior—is about 22 miles distant from Kings Mountain to the northwest across Bachewauaung Bay and will doubtless be visible from the latter. It is yet to be visited and identified.

If, of the Lake Survey stations on the east coast of Lake Superior, Mamainse alone is included in the present primary triangulation system, but one more station, namely, on White Fish Point, remains to be located in order to complete the northern connection. If Gargantua, the next Lake Survey station north of Mamainse, as well as Mamainse, is connected with, an additional station or two will need to be erected, probably in Canada to the north and east of Mamainse. By connecting with both Gargantua and Mamainse a continuous and unbroken triangulation system will be completed around Lake Superior. We strongly recommend that the present connection be so made as to secure, if possible, so desirable a result. If only Mamainse is connected with, it will be advisable to measure a base line as near the northern end of the present work as may be.

By locating a station on Parisian Island and using it in connection with Mamainse and primary stations on White Fish Point and King's Mountain the first reduction from the primary to the secondary system will be easily effected. The line from White Fish Point to Parisian Island will then form a base for still further reduction. It is proposed to locate, as soon as may be, such of the secondary stations in White Fish and adjacent bays as will be read to from the primary stations, so that these stations need be occupied by the observer but once.

A station has been located on a bare rock in Canada on the southeast quarter of Section 15, Korah Township, about 5 miles northwesterly from this city. This station, while being of some service in expanding from the "Soo" base, is principally useful in locating the government astronomical observatory station in this city in connection with the other stations. No cutting of timber and no scaffolding is required at this place.

An azimuth mark has been located in Canada 5 miles almost directly north of the observatory. It is expected that the position of this mark and of the observatory itself will be determined in the same manner as though they were regular stations in the triangulation system and thus be made a part of it.

The general plan, therefore, is to identify if possible the east and west base stations of the Mackinac base line on the south shore of the straits of Mackinac and to remeasure it. This base is about 4 miles long. Then from this base to project a series of quadrilaterals northward up the St. Marys River and across White Fish Bay, and to connect this system with the Lake Survey station Mamainse, or with Mamainse and Gargantua on the east coast of Lake Superior, where another base may be measured. If that plan be carried out the 2-mile "Soo" base will serve as an intermediate and check base.

From the above description of work already done and from the progress map herewith submitted, it will be seen that eight primary stations have been located definitely and four approximately, so that to practically complete the primary triangulation contemplated three stations have yet to be located, namely, one at White Fish Point, one at Bois Blanc Island, and one on Mackinac Island, or the old station at Fort Holmes identified.

Very respectfully, your obedient servant,

FRED MORLEY,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. Army.

B.

REPORT OF MR. GLEN E. BALCH, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault St. Marie, Mich., July 1, 1893.

SIR: I have the honor to submit the following report of the work under my charge up to June 30, 1893:

I reported here for duty April 26, 1893, and being assigned to the work of building stations, at once began organizing a party and getting a camp outfit.

Work began on the 1st of May with two carpenters at work on camp boxes, tables, etc., and four laborers and self in the field clearing lines between the stations built in 1892.

The following lines were cleared during the next two weeks: △ Ste. Marie, Ontario, to △ Rankin Mountain, △ Mirron, Sugar Island to Hill east of Lake George, △ Mirron to △ Larke, △ Mirron to Point Iroquois, △ Mirron to △ East Base, and △ Mirron to △ Ste. Marie, Ontario.

On May 14 the party, consisting of two carpenters, four laborers, cook, and teamster, with team, went into camp on the hill southwest of Point Iroquois, where a 32-foot observing station was built on the highest point.

The observing station built consists of a very rigid tripod, placed over the Geodetic Point, and around this tripod a scaffold is built with a platform about 42 inches below the top of the tripod and a railing about level with the top.

The plans for observing stations, as described by Mr. Charles O. Boutelle in Appendix No. 10, Report for 1882 of the Coast and Geodetic Survey, were followed very closely.

The timber around the △ at Iroquois was cut till the horizon was clear in all directions.

May 21 camp was moved to the NE. ¼ of sec. 23, T. 47 N., R. 1 W. △ Larke, a 64-foot station, was erected here on the summit of a stony ridge. This station was made of sawed timber and was high enough to avoid all cutting.

Camp was next moved to △ East Base, near Little Rapids, where a 23-foot station was built of round balsam timber with bark removed.

While this station was being built two trips were made to △ Mirron, on Sugar Island, where two reference stones were set, and line from △ Mirron to △ Rankin Mountain cut. A trip was made to Rankin Mountain, where Mr. O. B. Wheeler located a station in 1892, a wire nail set in the solid rock to the east of the old mining road up to the mountain. A little cutting was done on the south and west.

△ Ste. Marie was also visited, the tripod raised a little and strengthened, and reference stones set under fence on east side of field.

From East Base the party moved across the St. Marys River into Canada to section 13, Korak Township, Ontario, where an azimuth mark was built in the highway near the center of the section.

A 32-foot station was built at this point with a stone column over the Geodetic Point beginning 3 feet below the surface and rising 7 feet above it, with the top arranged for a light.

While at this camp a 3-foot tripod was made and carried to the top of a "Bare Rock" in the southeast quarter of section 15, Korak Township, Ontario, where "Bare Rock" is located. The station point is a one-half inch hole drilled in about 5 inches. A line was cut from this △ to Azimuth.

It was necessary to pay for the timber cut for the station and in clearing this line. The observatory at the United States Engineer Office is visible without cutting.

Three other lines should be cut from Azimuth to Rankin Mountain, Mirron, and Larke, all of which may have to be paid for.

The line from Bare Rock to △ Mirron was also cleared, some very heavy cutting on Sugar Island being needed.

A △ was built under Mr. Morley's direction on Gros Cap on a rock bluff on west side and the timber cut to Parisian Island, Iroquois, Bay Mills, Round Island, and till a large part of the shore line on the Canadian side of the river was visible.

June 30 camp was moved to sec. 33, T. 45 N., R. 1 W., where an 80-foot station is to be built on land belonging to Mr. Thomas Duke.

In connection with this report I respectfully submit the following description of the triangulation stations on the Lake Survey as they now stand.

STATION WEST BASE.

△West Base is located at the intersection of Portage avenue and Bingham street, 8.43 feet north of the inner edge of the north rail of the street car track and 2 feet west of the fence line on east side of Bingham street.

The Geodetic Point consists of a three-eighths-inch brass rod with cross on top set in top of stone 18 by 18 by 6 inches. Stone has letters U. S. L. S. cut on top and is set 3½ feet below surface. A 4 by 4 inch post is set 6 inches below surface and carries a nail exactly over the Geodetic Point. There is a sewer manhole about 13 feet southwest of station point.

Two reference stones, 2 feet long with tops dressed to 4 inches, and with letters U. S. cut on side facing station, have been set on south edge of Portage avenue.

One is set about 2 feet west of the northeast corner of the high school fence, and 77.6 feet from nail over Geodetic Point. The second stone is about 25 feet east of the northwest corner of Fort Brady garden fence and 50.4 feet from nail over Geodetic Point. Distance between stones, 92.7 feet; all measurements made to center of stones. The two reference stones make an angle at the station point of 90° 7′.

The stations visible from West Base are East Base, Soo, and Ste. Marie. The line to the last one was cleared in 1892.

STATION EAST BASE.

△East Base is on the south side of Portage avenue and east of water power embankment on land belonging to the Methodist mission claim, and 10,500 feet from West Base.

The Geodetic Point is a three-eighths-inch brass rod set in top of stone 18 by 18 by 6 inches. Stone is set 3 feet below surface and has a wall of cement 10 inches in diameter built up a foot above stone to keep out water. Wall is filled in with packed earth and covered with flat stone. Surface point is a nail in top of 4 by 4 inch post 2.97 feet above Geodetic Point.

Four reference stones consisting of ordinary field stones, with crosses on top and letters U. S. on side facing station, were set as follows: First in line with spire of Catholic Church, second 90°, third 180°, fourth 270°, and all have the crosses 50 feet from nail over Geodetic Point.

There is an observing station at this △ made of round balsam timber with bark removed. The platform is about 23 feet from surface of ground. Stations in sight from East Base are Ste. Marie, Rankin Mountain, Mirron, Soo, West Base, Bare Rock.

There were two lines that had to be cleared, one to △ Soo cleared in 1892 and one to Mirron cut this year.

STATION SOO.

△ Soo is located on high land to southwest of Ryans brickyard about 550 feet west of the center of Mackinac road and about 200 feet south of center of Sixth avenue.

Geodetic Point stone and surface mark same as at West Base. Two reference stones 2 feet long with tops dressed to 4 inches, and letters U. S. on side facing station set on south line of Sixth avenue. First stone on line with spire of Catholic church, Sault Ste. Marie, Mich. and cross on top of stone is 203 feet from nail over Geodetic Point, second stone makes an angle at the station with the first stone of 60°, and cross is 170.7 feet from nail over Geodetic Point. Distance between crosses on reference stones 189 feet.

A 6-foot tripod is placed at this station, and a small hut built around and over it, just as it was used by Mr. O. B. Wheeler, in 1892.

The stations in sight from △ Soo are Bare Rock, West Base, Rankin Mountain, Ste. Marie, East Base, Mirron, and Larke.

Lines to East Base and Mirron were cleared in 1892, but were partly overgrown.

STATION STE. MARIE, ONTARIO.

△ Ste. Marie is located on Park Lot No. 4, Third Concession, township of Sainte Marie, City of Sault Ste. Marie, Ontario. It is in the center of a cultivated field nearly north of dwelling house. Geodetic Point same as at West Base and 3¼ feet below surface.

Reference stones 2 feet long, with tops dressed to 4 inches and letters U. S. on side facing station and crosses on top, have been set under fence line on east side of field.

First on line between △ Ste. Marie and △ Rankin Mountain and 736.5 feet northeast of Geodetic Point.

Second at angle of 61° to south and 567.8 feet from Geodetic Point. Distance between centers of two stones 704.2 feet. A nail in the foot of a triple oak tree bears south 25° 45′ east 47.8 feet from Geodetic Point.

The observing station built in 1892 has a platform 17 feet above surface of ground and is made of black-oak timber.

Stations in sight from △ Ste. Marie are East Base, Larke, Soo, West Base, Iroquois, Rankin Mountain, and Mirron.

Line from Ste. Marie to West Base was cleared in 1892. The lines from Ste. Marie to Rankin Mountain and Mirron have been cut this year.

STATION MIRRON.

△ Mirron is located on the south side of the main east and west road on Sugar Island, 21.7 feet south of the line between the stakes on the southeast and southwest corners of Mr. Mirron's 40 acres, 561.75 feet east of stake at southwest corner and 758.45 feet west of stake at southeast corner of said 40 acres. Geodetic Point is same as at West Base and 3¼ feet below surface. Surface-mark is a nail in cedar post 6 inches in diameter.

Reference stones are two stones 2 feet long, with tops dressed to 4 inches and letters U. S. on side facing station. First stone bears N. 1° 15′ E. 50 feet; second stone N. 86° 15′ W. 50.4 feet; distance between stones, 69.1 feet.

The observing station was built in 1892, of round balsam timber, with platform 54 feet high. A few changes were made this year at Mr. Haskell's suggestion.

Stations in sight are Larke, Soo, Iroquois, East Base, Ste. Marie, Bare Rock, Rankin Mountain, and hill beyond Lake George.

Lines have been cut from Mirron to all the above stations.

STATION RANKIN MOUNTAIN.

△ Rankin Mountain is situated on a high cap of the mountain, north of the road to Garden River and east of the old Mining Road up the mountain.

Geodetic Point is a 4-inch wire nail set in the top of the solid rock which rises above all the rest. A single pine, 18 inches in diameter, stands on the same ridge about 200 feet west of △.

Stations visible are Mirron, East Base, Ste. Marie, Soo, Larke, Iroquois, and Bare Rock.

STATION LARKE.

△ Larke is situated on the summit of a ridge in the northeast quarter of the northeast quarter of section 23, Township 47 north, range 1 west.

Geodetic Point same as West Base and 3.3 feet below surface. Surface mark is a nail in maple stake 6 inches diameter.

Reference stones are four field stones with letters U. S. on side and cross on top, set as follows:

First in line with spire of St. Marys Church, second at angle of 90°, third at angle of 180°, and fourth at angle of 270°. Crosses on all are 50 feet from surface mark.

The observing station is 64 feet high, made of sawed timber.

Stations in sight are Iroquois, Bare Rock, Soo, Rankin Mountain, Ste. Marie, and Mirron.

STATION IROQUOIS.

△ Iroquois is located on the east end of the highest ridge on Iroquois Point. Bearing from light-house S. 57° W. about 5 miles from Bay Mills.

Geodetic Point is a three-eighths inch hole in a stone 2 feet by 6 by 6 inches set 4½ feet below surface.

Reference stones are 2 feet long, tops dressed to 4 inches, with letters U. S. cut in side.

First stone set N. 12° 45′ E. in line with Parisian Island and 50 feet from station point; second stone S. 84° 30′ E. and 50 feet from station point.

Observing station is 32 feet high and made of round balsam timber with bark removed.

Stations in sight are Gros Cap, Bare Rock, Rankin Mountain, Mirron, and Larke. Lines cut to all above stations.

STATION AZIMUTH.

△ Azimuth is near the center of section 13 Korak Township, Ontario, and in the Peoples Road.

Geodetic Point is a three-eighths-inch hole drilled in top of stone 2 feet by 6 by 6 inches, and set 4½ feet below surface. A stone pier 2 feet square at the base and 1 foot square on top begins 3 feet below the surface and rises 7 feet above, directly over the Geodetic Point. The top of this pier is fitted for a light, an iron box with a circular aperture being bolted on top. The observing station is 32 feet high, and built of round balsam timber with bark removed.

Two reference stones 2 feet long with tops dressed to 4 inches square, letters U. S. on side, and crosses cut on top, have been set.

First bearing S. 35° W. 69.4 feet from station, near west edge of road; second, S. 34° 10′ E. 69.1 feet from station, near east edge of road.

The two stones are 79 feet apart. Nail in foot of 10-inch balsam N. 84° 25′ E. 82.4 feet from station point and 78 feet from second reference stone.

BARE ROCK.

△ Bare Rock is on a large stone ledge in the southeast quarter of section 15, Kor Township, Ontario.

Geodetic Point is a half-inch hole drilled in top of solid rock about 5 inches dee

Crosses are cut on projecting rocks around station as follows: N. 25.6 feet, to t east 59.9 feet, to southwest 35.6 feet, and to the west 26.15 feet.

A 3-foot tripod was placed over this station and anchored with stones.

Stations visible are Rankin Mountain, Azimuth, Mirron, East Base, Soo, Lark and Iroquois. Ste. Marie can be seen by cutting line. Cutting had to be done Rankin Mountain, Azimuth, and Mirron.

GROS CAP.

△ Gros Cap is on a rock bluff on west edge of Gros Cap Mountain.

Geodetic Point is a one-half inch hole drilled into a point of rock which projects slightly in a hollow of a ledge.

A 3-foot tripod was placed here with separate tripod for flag over it.

Stations visible are Iroquois and the ones to be made on White Fish Point an Parisian Island.

Very respectfully, your obedient servant,

GLEN E. BALCH,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. Army.

C.

REPORT OF MR. E. E. HASKELL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., July 1, 1893.

SIR: I have the honor to submit the following report of work accomplished during the months of May and June, the period of the fiscal year 1893 that I have been employed on the survey of the Northern and Northwestern lakes, resurvey of St. Marys River:

In compliance with my engagement for this work, I reported to Col. O. M. Poe,

›f Engineers, at Detroit, Mich., on May 1, when I received orders from him to l to Sault Ste. Marie, Mich., and report to you for duty in connection with the ıentioned. In accordance therewith I arrived here May 2 and reported to ı the afternoon of that date, since when I have been working under your :tions of May 4.

e instructions assigned to me the work of measuring the angles of the pririangulation of the river, specifying that owing to the reduced state of the riation I would not be able to take the field with a party before July 1, and the meantime my duties would be confined to such preliminary work in the y of Sault Ste. Marie as would best serve the interests of the survey. I was :ed to make a careful examination of the two Troughton and Simms theodo- ›s. 1 and 3, with a view to their use in the field, to make a reduction of and a upon the measurement of the "Soo" base, to reduce the line of precise levels, ite. Marie to Bay Mills, and to select a suitable cross section for a gauging of the St. Marys River, as well as to execute several minor pieces of work I will not enumerate here.

:cordance with these instructions I have made a careful examination of the oughton and Simms theodolites Nos. 1 and 3. Some slight repairs, such as ng lost screws in some of the reading microscopes, were found necessary. repairs have been made under my direction by a mechanic in the employ of al office and the instruments are now in perfect working condition.

value of one division of the striding level and of the vertical circle level of : these instruments has been determined. For this determination a level-trier ed, it being placed on one of the stone piers in the new observatory. The ations are very satisfactory and the values obtained agree very closely with ues determined for these instruments when they were used by the old Lake '. The results of my determination will be found with the office records.

measurement of the Soo base made by Mr. O. B. Wheeler, assistant engineer, ri River Commission, in June, 1892, has been reduced and a report upon it ed for publication. This report was transmitted to you on June 28.

base was measured with a 300-foot steel tape and the precision attained— ›le error of 1 in 1,160,000 parts—makes it another example of the value of long n determining the length of base lines.

computation of the line of precise levels run by Messrs. E. J. Thomas and A. ›eler, in June, 1892, between B. M. "A" on the canal lock of 1881, at Sault Ste. and the water guage at Bay Mills is nearly finished and will be transmitted '.

ıe constants of the precise level—Kern No. 2—used in running this line had ›n determined in some time, and as the instrument had not been used to speak ng the year intervening, it was thought best to make a determination of them e their values in the present computations. This determination has there- en made and the results used. The notes with their reductions will be found he office records.

ould here be noted that Mr. Thomas in his field report on this line of levels, 123 of the Report of the Chief of Engineers for 1892, gives B. M. "F" as his g point. B. M. "F" was on the old State lock of 1855 and was destroyed in 1890 hat lock was torn out to give place to the lock now building. B. M. "F" had ›ferred to B. M. "A," which is on the lock finished in 1881, the elevation of which 2 feet lower than the old elevation of B. M. "F." B. M. "A" is the one on Mr. Thomas started his work, hence the zero of the water gauge at Bay Mills ‹a Bay) as given in his report should be corrected by the difference in the on of these benches given above.

ı a view to selecting a gauging station I have made an examination of the ı this vicinity and would recommend a cross section about three-quarters of below the foot of the rapids. At this point the current runs fair with the ›l which is quite uniform in both depth and width for a reach of half a mile e. A series of gaugings made at this point for the period of year would be ıt value and of great scientific interest as well. These gaugings need not be lischarges, but say from 4 to 6 per month, in accordance with the weather ions prevailing over Lake Superior, or at times covering rapid changes in the vel.

interval June 15 to 23 inclusive, was spent in the field in assisting Mr. Morley rmining the intervisibility of the stations Iroquois, Kings Mountain, points d in the present scheme of the triangulation connecting the old work of the ırvey in the eastern end of Lake Superior with their work in the Straits of ıac.

ldition to the above some little time has been spent in the field and some time on minor pieces of office work. Among these may be mentioned the ng in placing the reference stones of the two base stations and making a description of these stations for the report upon the base line, as also some work in connection with the adjustment of the instruments in the observatory.

Very respectfully, your obedient servant,

E. E. HASKELL,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. Army.

D.

REPORT OF MR. E. E. HASKELL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., June 23, 1893.

SIR: I have the honor to submit herewith the reduction and the results of the measurements of the Soo base.

This base is located on Portage avenue in Sault Ste. Marie, Mich. It is approximately 2 miles in length and runs eastward from a point at the intersection of Bingham street with Portage avenue. It was measured by Mr. O. B. Wheeler, assistant engineer, Missouri River Commission, assisted by Assistant Engineers E. B. Wheeler, G. E. Balch, A. O. Wheeler, E. J. Thomas, A. Mangelsdorf, and G. R. Snover. Steel tape No. III belonging to the Missouri River Commission was used. The method of supporting and stretching it was the same as employed by Mr. Wheeler in his Missouri River work, and is fully described by him in the reports of the Missouri River Commission for the years 1886 and 1887.

The tape was standardized by comparing it with a 299-foot tape belonging to the Mississippi River Commission, which in turn had been standardized by running it over the Olney base.* The constants of it are: Length at 62° Fahrenheit, 16 pounds pull and supported every 30 feet = 300′.02396.

Coefficient of expansion = 0.00000691.

Expansion for 1° Fahrenheit = 0.002073.

Dimensions expressed in inches: Thickness, 0.0250; breadth, 0.1217; area of cross-section, 0.003042.

Weight of 1 foot length of the tape = 0.009867 pounds.†

The thermometers used for getting the temperature of the tape were Nos. 5103 and 5114 F., belonging to the Missouri River Commission, and No. 5167 F., belonging to Mr. E. S. Wheeler, assistant engineer in charge of river and harbor improvements at the local office. The corrections to Nos. 5103 and 5114 are published in the report of the Chief of Engineers for 1890, p. 3402, and are zero at the temperatures of the measurements. The corrections to No. 5167 were determined by the U. S. Signal Service in March, 1890, and are here appended.

Table of corrections for thermometer No. 5167.

Scale readings.	Corrections.	Scale readings.	Corrections.	Scale readings.	Corrections.
°	°	°	°	°	°
−22	−.10	+32	−.10	+82	−.12
− 8	−.06	42	−.13	92	−.12
+ 2	−.12	52	−.14	102	−.12
+12	−.02	62	−.11	112	−.24
+22	−.03	72	−.14	....	....

NOTE.—The — sign indicates that the correction is to be subtracted from the reading given by the thermometer.

Three measurements of the base were made all on the same day, June 2, 1892, and proceeded in the same direction, namely, from △ east base westward. The first measurement was made between the hours of 3 and 5 p. m., the second between the hours of 7 and 8:20 p m., and the third between the hours of 9 and 10:30 p. m.

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* See reports of the Missouri River Commission for 1886 and 1887, being Appendix Z Z to the Annual Report of the Chief of Engineers, U. S. Army, for 1887. For the measurement of the Olney base see Professional Papers, Corps of Engineers, U. S. Army, No. 24, Chapters VIII, IX, and XII.

† Computed from the known weight of a similar tape.

uations expressing these measurements are:

< 300′.02396—0′.5672+0′.5831—0′.0051—0′.0427=10500′.8067
< 300′.02396—0′.8976+0′.9513—0′.0051—0′.0427=10500.8445
< 300′.02396—1′.2515+1′.2632—0′.0051—0′.0427=10500.8025

rst term is number of tapes multiplied by length of tape at 62° F.
is temperature correction to reduce 35 tapes, at tape temperature, to

s distance between mark on zinc 35 and △ west base.
is the correction for the omission of one supporting stake in each of
hs.
correction for inclination of tape.
f the three measurements=10500′.8179 which is taken as the true
robable error of this result from the individual results is ±0′.009 or
arts of the base.
f the base expressed in meters = 3200.6199 ± 0.0027.
n to reduce to sea level is 0.2940 feet = 0.0896 meters, the mean ele-
ase line being 599.95 feet (182.86 meters) as determined by a line of
uplicate from B. M. "A" at canal lock, the elevation of which is 605.872
eters) above sea level. The length of the base therefore reduced to
00.5239 feet = 3200.5303 meters.

TABLE No. 1.—*Temperatures of the "Soo" Base.*

First measurement.				Second measurement.				Third measurement.			
June 2, 892— p.m.	Thermometers.			June 2, 1892— p.m.	Thermometers.			June 2, 1892— p.m.	Thermometers.		
	5103	5167	5114		5103	5167	5114		5103	5167	5114
h. m.	°	°	°	*h. m.*	°	°	°	*h. m.*	°	°	°
3 06	54.2	54.1	54.2	7 01	51.0	50.8	50.7	9 04	43.8	43.9	44.1
3 13	54.4	54.2	53.7	7 03	51.1	50.4	51.4	9 07	44.0	43.0	44.8
3 17	54.0	54.3	53.9	7 06	50.2	50.4	50.5	9 09	44.5	44.5	43.8
3 21	54.0	53.5	52.6	7 09	51.0	50.3	49.5	9 11	45.0	44.5	44.9
3 26	53.7	53.8	54.0	7 11	50.5	50.4	51.0	9 14	44.5	44.4	44.7
3 31	53.6	54.2	54.0	7 13	50.0	50.5	50.5	9 18	44.0	44.2	44.5
3 35	53.7	54.2	53.7	7 15	49.3	49.4	50.0	9 20	44.5	44.0	44.1
3 39	53.6	53.2	54.5	7 17	49.0	49.1	49.0	9 22	44.5	44.7	44.5
3 44	53.5	53.2	54.3	7 19	49.6	49.7	49.5	9 25	44.1	43.8	44.8
3 47	53.4	53.2	53.9	7 21	50.3	49.6	49.7	9 27	44.8	44.2	44.7
3 49	53.5	53.6	53.6	7 23	49.9	49.7	50.3	9 29	45.2	44.7	44.5
3 52	5[illegible].7	54.2	53.8	7 25	49.0	49.5	50.2	9 31	44.5	44.7	44.4
3 55	54.2	53.8	54.2	7 27	49.3	48.9	49.5	9 33	45.0	44.6	44.4
3 57	54.3	54.0	54.7	7 20	50.2	49.4	49.6	9 35	45.0	44.8	44.7
4 00	54.0	54.0	54.5	7 31	50.5	50.1	50.5	9-38	44.6	45.3	44.8
4 04	53.8	53.2	54.2	7 33	50.5	49.9	50.1	9 40	44.8	45.1	44.7
4 07	54.0	53.8	53.8	7 35	48.8	49.2	50.4	9 42	45.3	44.7	45.0
4 09	53.8	53.9	54.6	7 37	49.5	49.3	49.0	9 45	45.6	44.8	44.8
4 13	52.5	52.3	54.5	7 39	49.4	49.0	49.5	9 47	45.0	44.8	45.4
4 16	53.3	52.6	53.7	7 41	49.3	49.4	49.1	9 49	44.8	44.8	44.5
4 21	53.5	52.9	53.9	7 43	49.0	48.0	48.4	9 52	44.5	44.4	45.3
4 25	54.1	53.8	53.9	7 45	49.7	48.7	47.6	9 55	45.0	44.0	44.7
4 29	54.5	54.7	54.6	7 48	49.0	49.2	49.0	9 57	45.7	44.9	45.1
4 32	54.5	54.0	54.2	7 50	48.5	48.7	49.5	9 59	45.0	44.8	45.0
4 35	54.5	54.5	55.0	7 53	49.2	49.0	48.7	10 01	45.0	44.9	44.8
4 38	54.8	54.1	54.5	7 55	50.0	49.2	49.5	10 04	44.7	44.7	44.7
4 40	54.8	55.1	55.3	7 57	50.1	49.6	49.8	10 08	45.3	44.9	44.7
4 44	55.0	55.2	55.0	7 59	50.2	49.6	50.4	10 10	45.3	45.4	45.7
4 48	55.0	54.8	55.0	8 02	50.5	49.4	50.3	10 13	45.4	45.0	45.0
4 50	55.5	54.9	55.2	8 04	50.3	50.2	50.1	10 15	45.2	45.0	45.0
4 54	55.4	55.0	55.7	8 07	49.8	48.8	49.5	10 17	45.0	44.7	45.0
4 57	55.0	54.6	55.1	8 09	49.5	49.1	49.0	10 20	45.8	45.5	44.6
5 00	55.0	54.8	55.5	8 13	49.7	49.2	49.5	10 23	45.6	45.6	45.5
5 03	55.0	55.0	55.7	8 16	49.8	49.1	49.9	10 26	45.9	45.8	45.6
5 07	55.5	55.2	55.6	8 18	49.0	48.7	49.7	10 28	45.5	45.2	45.0
.....	54.209	54.054	54.417	......	49.793	49.471	49.757	......	44.926	44.680	44.780
.....	±0.0	—.134	±0.0	......	±0.0	—.137	±0.0	......	±0.0	—.133	±0.0
.....	54.209	53.920	54.417	......	49.793	49.334	49.757	......	44.926	44.547	44.780
.....		54.182		......		49.628		......		44.751.	
.....		62.000		......		62.000		......		62.000	
.....		7.818		......		12.372		......		17.249	

TABLE NO. 2.—*The "Soo" Base. Correction for inclination of tape.*

Tape length.	Difference in elevation of zincs.		Mean =h.	h^2.	$\frac{h^2}{2L}$.
	First levels.	Second levels.			
	Feet.	*Feet.*	*Feet.*		
E. base to 1	−1.77	−1.77	1.77	3.13	.0052
1 to 2	+0.66	+0.66	0.66	.44	.0007
2 to 3	+0.07	+0.07	0.07	.00	.0000
3 to 4	+0.68	+0.67	0.68	.46	.0008
4 to 5	−0.14	−0.14	0.14	.02	.0000
5 to 6	−0.07	−0.11	0.09	.01	.0000
6 to 7	+1.29	+1.35	1.32	1.74	.0029
7 to 8	+2.03	+2.05	2.04	4.16	.0069
8 to 9	+1.84	+1.86	1.85	3.42	.0057
9 to 10	+1.11	+1.12	1.12	1.25	.0021
10 to 11	+0.40	+0.44	0.42	.18	.0003
11 to 12	+0.66	+0.68	0.67	.45	.0008
12 to 13	+0.54	+0.55	0.54	.29	.0005
13 to 14	+0.39	+0.37	0.38	.14	.0002
14 to 15	+0.68	+0.68	0.68	.46	.0008
15 to 16	+0.53	+0.57	0.55	.30	.0005
16 to 17	+0.16	+0.08	0.12	.01	.0000
17 to 18	−0.46	−0.46	0.46	.21	.0004
18 to 19	+0.16	+0.19	0.18	.03	.0000
19 to 20	+1.87	+1.93	1.90	3.61	.0060
20 to 21	+0.38	+0.37	0.38	.14	.0002
21 to 22	+0.40	+0.36	0.38	.14	.0002
22 to 23	+0.43	+0.45	0.44	.19	.0003
23 to 24	+0.80	+0.81	0.80	.64	.0011
24 to 25	+0.46	+0.44	0.45	.20	.0003
25 to 26	+0.94	+0.96	0.95	.90	.0015
26 to 27	+1.00	−0.94	0.97	.94	.0016
27 to 28	+0.59	(*)	0.59	.35	.0006
28 to 29	+0.43	....	0.43	.18	.0003
29 to 30	+0.08	....	0.08	.01	.0000
30 to 31	+0.51	....	0.51	.26	.0004
31 to 32	+0.78	....	0.78	.61	.0010
32 to 33	+0.75	....	0.75	.56	.0009
33 to 34	−0.25	....	0.25	.06	.0001
34 to 35	−0.52	....	0.52	.27	.0004
					.0427

*Stakes 28 to 34, inclusive, were disturbed previous to the running of the second line of levels, the line, however, checked on zinc 35, within 0.04 of a foot.

TABLE NO. 3.—*The "Soo" Base. Measurement of the zincs.*

No. of tape.	First and second measurements.	First and third measurements.	No. of tape.	First and second measurements.	First and third measurements.
1	.10	.26	19	2.15	4.43
2	.18	.53	20	2.22	4.62
3	.27	.75	21	2.41	4.82
4	.35	.98	22	2.52	5.04
5	.46	1.12	23	2.70	5.30
6	.62	1.42	24	2.81	5.51
7	.72	1.62	25	2.96	5.78
8	.84	1.84	26	3.07	6.00
9	.94	2.09	27	3.23	6.26
10	1.07	2.37	28	3.36	6.52
11	1.19	2.63	29	3.46	6.72
12	1.33	2.93	30	3.61	6.94
13	1.49	3.15	31	3.74	7.20
14	1.58	3.34	32	3.91	7.46
15	1.70	3.57	33	4.06	7.70
16	1.80	3.77	34	4.24	7.94
17	1.94	4.02	35	4.42	8.16
18	2.06	4.24			

The first measurement is taken as the standard, and the difference recorded as corrected to the second and third measurements. There were no "set ups" or "set backs."

Thirty-five tape lengths fell short, or to the eastward of a △ west base: In the first measurement 7 inches; in the second measurement 11.42 inches; in the third measurement 15.16 inches.

DESCRIPTION OF THE BASE STATIONS.

Station west base is at the intersection of Portage avenue and Bingham street, and is marked by a cross in the end of a three-eighths-inch brass bolt set in the center of a stone that is 18 inches square and 4 inches deep, buried 3.7 feet under ground. A surface mark over this stone would be on a line parallel with and about 2 feet west of the fence on the eastern side of Bingham street, 77.3 feet northeast of the hydrant standing near the southwest corner of the streets, 8.3 feet north of the north rail of the street-car track, and 13 feet easterly from the center of the sewer manhole. Two reference stones of limestone, with dressed tops and marked U. S. on the side facing the station, are placed as follows: The first one under the Portage avenue fence of the High School grounds about 2 feet west from the corner of Bingham street. The second stone is on the same side of Portage avenue, 92.7 feet east of the first one, 24.5 feet east of the street corner, under the street fence. The angle at the station between these two stones is 90°, and the distance to the first one is 77.6 feet and to the second one 50.4 feet. The following angles were also measured to objects in the vicinity: From St. Marys (Catholic) church spire to the second stone 46° 28′; from the second stone to the court-house flag staff, 48° 32′; from the court-house flag staff to the high-school flag staff, 12° 30′; from the high-school flag staff to the first stone, 29° 5′, and from the first stone to the apex of the tallest tower of the International Hotel in Sault Ste. Marie, Ontario, Canada, 118° 44′.

Station east base is approximately 2 miles east of △ west base. It is near the fence line on the south side of the road—Portage avenue extended—720 feet east of the bridge over the canal outlet and 415 feet from the river bank, measured on a line at right angles with the road. It is marked the same as station west base, the stone being buried 3.5 feet under ground. To keep back the water, which gave some trouble in plumbing down to the cross in the bolt, a wall of cement was built around the mark. This wall is about one foot in height, and incloses a circular area about 10 inches in diameter. The surface mark was a nail in the end of a 4-inch by 4-inch scantling, the top of which came just flush with the surface of the ground. Four bowlders, with the letters U. S. and a cross cut in them, were placed for surface reference stones. They are 90° apart, and distant 50 feet each from the station, the first one being on the line from the station to St. Marys Church spire. The following angles were also read to distant objects: From St. Marys Church spire to the Catholic church spire in Sault Ste. Marie, Ontario, Canada, 31° 00′; from the Catholic church spire (in Canada) to Shingwauk Chapel belfry (in Canada) 78° 46′, and from Shingwauk Chapel belfry to △ Mirron, on Sugar Island, 47° 49′.

Very respectfully, your obedient servant,

E. E. HASKELL,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. A.

E.—REPORT OF MR. H. VON SCHON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., July 1, 1893.

SIR: I have the honor to submit herewith my annual report for the fiscal year ending June 30, 1893:

Having been assigned to duty with the Lake survey on June 10, 1893, by Col. O. M. Poe, Corps of Engineers, I reported to you at this office on June 12, 1893, and in pursuance of your instructions of June 13, 1893, took charge of the organizing and equipping of two field corps to be ready to enter upon the topographical part of the resurvey of the St. Marys River on or about July 1, 1893.

This work has consisted in (1) the compilation and platting from available data of the tertiary triangulation stations and bench marks located along the St. Marys River between Point Iroquois and Little Rapids; (2) the construction of tools and camp furniture, such as stadia rods, camp chests, and tables; (3) the procuring of the material and utensils for camp equipment; and (4) the engagement of the required personnel, namely, recorders, rodmen, cooks, and carpenter.

All this work has progressed satisfactorily, and is nearly completed.

Very respectfully, your obedient servant,

H. VON SCHON,
Assistant Engineer.

First Lieut. CHARLES S. RICHÉ,
Corps of Engineers, U. S. A.

DDD 2.

MEASUREMENT OF DISCHARGE OF NIAGARA RIVER.

REPORT OF MAJ. ERNEST H. RUFFNER, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., July 6, 1893.

GENERAL: There are fowarded herewith the annual reports for the year ending June 30, 1893, * * * on the measurement of the discharge of the Niagara River, in 1891 and 1892. * * *

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. J. C. QUINTUS, INSPECTOR.

UNITED STATES ENGINEER OFFICE,
Erie, Pa., November 8, 1892.

MAJOR: I would respectfully submit the following report on the measurement of the discharge of the Niagara River, New York, made during April and May, 1892:

This series of measurements was supplemental to the series of December, 1891, and this report is therefore made supplemental to the report on the first series submitted in February, 1892. In the table of discharges and on the plat accompanying this report the results of both series of observations are, however, incorporated.

A narrative report of the field work is given in my reports of operations for April and May, 1892, on file at the United States Engineer Office, Buffalo, N. Y., and need not be repeated here. The field party was made up as follows: J. C. Quintus in charge; G. W. Ulrich, recorder; one leadsman; two boatmen, and the steam tug *J. F. Behn.*

THE DISCHARGE CROSS-SECTIONS.

The discharge observations were taken over the Black Rock section, as described in the first report and shown in the sketch on its accompanying plat, and over a section 600 feet below it, designated as the Lower Black Rock section. The Black Rock section was identical with the original section, all range targets, monuments, gauges, etc., being found intact. The Lower Black Rock section was established in order to check the measurements on the Black Rock section, and also to secure a section with a uniform river bottom. The cross-sections were sounded and measured by the methods employed for the first series. The soundings over the Black Rock section agreed very closely with those of the first series, and no change was made in the area of the section excepting a change of 55 square feet in the partial area for Station 800. The two sections are shown on the accompanying plat, the Black Rock section being revised as above noted.

WATER GAUGES.

The local gauge on the draw pier of the International Bridge, used during the first series of measurements, was found intact and used during this series. The local gauge height was observed at the beginning and close of velocity observations. The United States gauge at Buffalo, showing the level of Lake Erie, was observed daily, every hour from 8 a. m. to 4 p. m.

During this series of discharge measurements the level of Lake Erie was gradually rising—from 1.5 feet below mean lake level, very low stage, to about mean lake level.

METHOD OF TAKING VELOCITY OBSERVATIONS.

The observations for current velocities were made in the same manner as in the first series. The same current meter, Price No. 36, was used. The method is described in the first report.

OBSERVATIONS OBTAINED.

The field party began fitting out for the work on April 25 and had the plant in working order on the tug on the 28th. The measurement of discharges was begun on the 29th, the plan of operation being to obtain a complete set of velocity observations at six-tenths depth, daily, at each of the 16 velocity stations distributed over the cross-section, from bank to bank, together with observations of velocities in verticals, at 5-feet intervals, from surface to bottom, at each station, soundings at each station, and observations for river slope.

On May 1 the tug was ordered to other work, and, owing to delays thereon by unfavorable weather, did not return to the discharge station until May 10, excepting for a few hours on May 7, when a set of velocity observations were obtained. On May 10 observations were resumed and carried on daily until May 28, when, the money allotment being exhausted, the field work was closed and the party disbanded.

The following table shows the number and extent of the velocity observations obtained:

Observations of current velocities.

Date.	Velocity at $\frac{6}{10}$ depth.	Velocities in verticals.	Which section.	Remarks.
1892.				
Apr. 29	16 stations	None	Black Rock	
Apr. 30	....do	8 stations, over stream	......do	
May 7	....do	None*	......do	No time for observing verticals.
10	....do	8 stations, over stream	......do	
11	....do	......do	......do	
12	....do	None	......do	Fog shut out ranges.
13	....do	8 stations, over stream	......do	
14	....do	......do	......do	
16	....do	9 stations, over stream	Lower Black Rock	
18	15 stations.*	15 stations, over stream	......do	
19	....do	2 stations, over stream	......do	Rain and fog obscured ranges.
20	....do	15 stations, over stream	......do	
23	16 stations	16 stations, over stream	Black Rock	
24	15 stations	15 stations, over stream	Lower Black Rock	
25	....do	10 stations, over stream	......do	Fog shut out ranges.
26	....do	15 stations, over stream	......do	
27	....do	15 stations, over stream	......do	
28	....do	10 stations, over stream	......do	

*Station 200 could not be occupied, as there was not sufficient water for tug.

On May 17 special observations were made for determining the relation between velocities at the end meter stations and velocities between the end meter station and the river banks on the lower section, as follows: At two points between station 300 and right bank; at three points between station 1688 and left bank.

Meter ratings were obtained as follows: April 28, Price meter No. 36, 21 observations, base line, 150 feet, in still water. April 29, Price meter No. 36, 34 observations, base line, 150 feet, in still water. May 4, Price meter No. 36, 60 observations, base line, 150 feet, in still water. May 17, Price meter No. 36, 46 observations, base line, 150 feet, in still water.

Slope observations were obtained as follows: May 3, 4, 5, 6, 7, 9, 10, 12, 18, 20, 23—11 observations.

Soundings were taken over the discharge sections, soundings about 25 feet apart, and each sounding located by transit, as follows: May 14, Black Rock section, two sets of soundings across stream. May 14, Lower Black Rock section, two sets of soundings across stream. May 17, Lower Black Rock section, two sets of soundings across stream.

REDUCTION OF OBSERVATIONS.

For the computation and reduction of river discharges the same processes and methods were employed as for the first series and as described in the first report.

The meter coefficients for converting the revolutions of the meter wheel to velocity in feet per second were determined from the rating observations by the formation and solution of normal equations by the method of least squares. The results are given in the following table:

Date.	No. of observations.	Range of observed velocities.	Meter coefficients.		Meter.	Remarks.
			a.	b.		
1892.		*Ft. per sec.*				
Apr. 28	20	2.5—7.3	4.239	+0.000	Price No. 36 ..	Still-water rating, base line, 150 feet.
29	34	2.1—6.7	4.256	+0.061	....do	Do.
May 4	49	1.7—7.7	4.046	+0.207	....do	Do.
17	43	2.0—8.0	4.130	+0.067	....do	Still-water rating, base line, 300 feet.
Means.	....	....	4.168	+0.084		

April 29, meter wheel started by hand, ran 283 seconds before coming to rest. May 27, meter wheel started by hand, ran 320 seconds before coming to rest. The meter was oiled daily before using.

The meter (Price No. 36) used during the entire series of observations was not injured in any way, nor were any of its adjustments changed. The four ratings may therefore be regarded as having equal weight in determining the meter coefficients. The arithmetical mean has therefore been adopted in the discharge computations, the equation for converting revolutions of meter per second into velocity in feet per second being:

Velocity in feet per second = 4.168 revolutions per second + 0.084.

The method employed in computing the discharges is fully explained in the report on the first series of observations. All of the discharge values are based upon the velocities observed at six-tenths depths, the investigation of the velocities observed in verticals at each meter station proving that the mean velocities are located at, or very nearly at, that depth.

For determining the velocities to be applied to the two end areas, the coefficients determined by special observation between the end meter stations and the shores during the first series of observations were used for the Black Rock section. Coefficients derived from the similar special observations made on May 17 were applied to the end areas on the Lower Black Rock section. All of the discharges having been computed by the prescribed form, the tabulation of results was compiled as given in the accompanying table of discharges.

In order to make the table as complete as possible the results obtained during the first series of observations are incorporated in the table and the discharges arranged in the order of local gauge heights. It will be noted on comparison with the table in the report of the first series, that slight differences occur in the values of discharges for the first series. The average difference in corresponding discharge values is about 1 per cent; the maximum difference being about 2¾ per cent and only three values showing a difference of 2 per cent or over. The reason for changing the discharge values, although the changes can have no weight on general results, is this: In the computation of results as given in the first table, the mean of the several meter ratings was not used for computing velocities, as the meter was supposed to have undergone changes in rate between ratings. A system of adjusted values for the meter coëfficients was therefore used, as described in the first report. The more extensive knowledge of the meter gained during its use on the second series of observations, and the close agreement between the means of the two series of ratings, leads to the opinion that the arithmetical mean of the three ratings of the first series would be a more consistent value to adopt. The discharge values of the first series have therefore been revised and adopted as given in the table; being based upon the arithmetical mean of the three ratings of December 9, 11, and 26, 1891. The small percentage difference goes to show that small discrepancies in the determination of meter coëfficients have but little effect on final discharge values.

The wind velocities at Buffalo, N. Y., during the time of velocity observations given in the table, are compiled from data furnished by the United States Weather Bureau. It is a question whether the local winds, at the discharge sections, had any effect on the river currents. Such effects, if any, must have been very slight. The water surface was at no time more than "choppy" and never disturbed so as to appreciably affect the meter.

The table of discharges may be regarded as the summary of the two series of discharge observations.

Date.	Local gauge.			Buffalo gauge.				Width of section.	Mean depth.	Area of section.		Mean velocity (feet per second).	Discharge (cubic feet per second).	Wind at Buffalo.	Remarks.
	At beginning of observation.	At close of observation.	Mean.	At beginning of observation.	At hour intervals during observation.	At close of observation.	Mean.			Datum at gauge =0.0.	Water.				
	Feet.	Feet.	Feet.	Feet.		Feet.	Feet.	Feet.	Feet.	Sq. feet.	Sq. feet.				
Dec. 24, 1891..	0.000	—0.100	—0.050	—3.2	Not taken	—2.7	—2.95	1,883.4	21.7	40,935	40,841	4.031	164,648	NE. 11-12....	B. R. section.
14, 1891 .	0.800	0.500	0.650	—1.8	......do	—1.9	—1.85	1,896.5	22.2	40,935	42,162	4.550	191,822	SW.13, NE.3.	Do.
21, 1891..	0.800	0.670	0.735	—1.7	......do	—1.8	—1.75	1,898.3	22.3	40,935	42,315	4.573	193,522	SE. 5, E. 11 ..	Do.
19, 1891..	0.830	0.750	0.790	—1.7	......do	—1.9	—1.80	1,899.5	22.3	40,935	42,449	4.623	196,252	SW. 4 3	Do.
11, 1891..	0.830	0.750	0.790	—1.5	......do	—1.6	—1.55	1,899.5	22.3	40,935	42,449	4.557	193,448	W. 8-11	Do.
20, 1891..	0.750	0.920	0.835	—1.8	......do	—1.7	—1.75	1,900.1	22.4	40,935	42,506	4.739	201,433	S. 9-10........	Do.
28, 1891..	1.000	0.900	0.950	—1.6	......do	—1.6	—1.60	1,902.3	22.5	40,935	42,734	4.711	201,320	SE. 5-6	Do.
25, 1891..	0.960	0.960	0.960	—1.6	......do	—1.7	—1.65	1,902.7	22.5	40,935	42,752	4.716	201,612	SW. 8-5	B. R. section, 8 stations across stream.
22, 1891..	1.170	1.080	1.125	—1.5	......do	—1.4	—1.45	1,905.4	22.6	40,935	43,077	4.842	208,597	S. 19½, SW.25.	B. R. section.
Apr. 30, 1892..	1.010	1.250	1.130	—1.7	—1.4, —1.4, —1.5.......	—1.2	—1.40	1,905.4	22.6	40,990	43,132	4.817	207,775	N. 6, SW. 10 .	Do.
29, 1892..	1.300	1.330	1.315	—1.2	—1.1, —1.1	—1.1	—1.13	1,908.9	22.7	40,990	43,492	4.875	212,024	SW. 10-17	Do.
Dec. 10, 1891..	1.330	1.330	1.330	—0.4	Not taken	—0.6	—0.50	1,909.1	22.7	40,935	43,458	5.024	218,353	SW. 26½-21 ..	Do.
May 10, 1892..	1.330	1.330	1.330	—0.9	—0.9, —1.0, —0.8.......	—1.1	—0.93	1,909.1	22.8	40,990	43,513	5.059	220,121	NE. 12, E. 14.	Do.
Dec. 12, 1891..	1.420	1.380	1.400	—1.4	Not taken	—1.0	—1.20	1,910.7	22.8	40,935	43,592	5.073	221,158	SW. 24, W. 23½.	Do.
May 19, 1892..	1.500	1.625	1.562	—0.7	—1.1, —0.8............	—0.3	—0.80	1,833.7	22.8	38,952	41,781	5.102	213,180	SE. 15	L. B. R. section.
18, 1892..	1.500	1.667	1.584	—0.9	—0.8, —0.8, —0.7.......	—0.8	—0.79	1,834.0	22.8	38,952	41,826	5.201	217,550	E. 7-14	Do.
14, 1892..	1.583	1.583	1.583	—0.7	—0.8, —0.9, —0.9.......	—0.8	—0.84	1,913.0	22.9	40,990	43,991	4.963	218,330	S. 4-6.........	B. R. section.
13, 1892..	1.737	1.625	1.681	—0.6	—0.7, —0.7, —0.5.......	—0.7	—0.64	1,914.9	23.0	40,990	44,132	5.066	223,561	S. 7, SW. 11-3.	Do.
11, 1892..	1.708	1.667	1.688	+0.8	+0.4, +0.5............	+0.9	+0.58	1,915.0	23.0	40,990	44,199	5.112	225,886	SW. 15-14 ...	Do.
7, 1892..	1.800	1.700	1.750	—0.8	—0.9....................	—0.8	—0.85	1,916.9	23.1	40,990	44,316	4.941	218,988	NW. 2-11....	Do.
12, 1892..	1.833	1.833	1.833	—0.5	—0.6....................	—0.6	—0.58	1,918.4	23.2	40,990	44,480	5.052	224,715	SW. 7-9	Do.
16, 1892..	1.750	1.917	1.833	—0.6	—0.6, —0.5, —0.5.......	—0.2	—0.50	1,837.0	23.0	38,952	42,282	5.206	220,121	W. 18-12	L. B. R. section,
Dec. 16, 1891..	1.750	1.920	1.835	—0.4	Not taken	—0.2	—0.30	1,918.4	23.2	40,935	44,419	5.054	224,485	W. 15½-18....	B. R. section.
May 20, 1892..	2.250	1.667	1.959	+0.5	+0.1, —0.2, —0.7, —0.9.	—0.9	—0.38	1,838.7	23.1	38,952	42,511	5.278	224,360	S. W. 24-14 ..	L. B. R. section.
25, 1892..	2.000	2.000	2.000	—0.1	—0.2, —0.3, —0.3.......	—0.2	—0.24	1,839.0	23.2	38,952	42,590	5.306	225,989	SW. 12-11 ...	L. B. R. section, 8 stations across stream.
23, 1892..	1.917	2.083	2.000	—0.2	—0.2, —0.1............	—0.2	—0.17	1,921.5	23.3	40,990	44,795	5.351	239,677	NE. 4, NW. 5.	B. R. section.
27, 1892..	2.125	2.083	2.104	0.0	—0.3, —0.3, —0.3, —0.3.	—0.8	—0.27	1,840.5	23.2	38,952	42,776	5.290	226,264	W. 13, NW. 18.	L. B. R. section.
26, 1892..	2.042	2.250	2.146	—0.3	—0.3, —0.1, +0.1, 0.0..	0.0	—0.09	1,840.8	23.3	38,952	42,859	5.424	232,448	SW. 12-15 ...	Do.
28, 1892..	2.208	2.167	2.188	0.0	—0.1, 0.0, 0.0..........	—0.1	—0.04	1,842.0	23.3	38,952	42,937	5.392	231,513	SW. 4, W. 11.	Do.
24, 1892..	2.208	2.375	2.292	—0.1	0.0, +0.2, +0.3, +0.1..	+0.4	+0.15	1,843.5	23.3	38,952	43,122	5.491	236,762	SW. 13-24 ...	Do.

On the accompanying plat are shown the cross-section areas, mean veloc discharges, as given in the table, plotted to local gauge. The "smooth curve charge drawn on the plat is the computed curve based upon the discharge valu plotted. The curve is derived from thirty equations, of the form, $y=S+Tx+$ etc., formed from the observed discharges. The computations were made by method of least squares and normal equations solved by the Gauss method of su tution. The equation of the curve of river discharge, as determined, is:

$$\text{Discharge}=166000+43702x-6182x^2, \text{ etc.}$$

in which, x=local gauge height in feet and tenths.

In order to determine the relation between the local gauge and the Buffalo g denoting the level of Lake Erie, the mean gauge heights, covering the same spa time on both gauges, during the time occupied in observing for discharge, plotted as shown in the drawing. These mean gauge heights are given in th charge table. The curve shown is the computed "smooth curve" of gauge rel based upon the mean gauge heights as plotted. The curve is derived from t equations, formed from the mean observed gauge heights, solved by the same me as employed for the discharge curve.

The equation of gauge relation, as determined, is:

$$\text{Local gauge height}=2.087+0.624x-0.046x^2, \text{ etc.}$$

in which, x=Buffalo gauge height in feet and tenths, + or —, above or below Zero of Buffalo gauge=mean level of Lake Erie.

From these two equations the mean river discharge can be computed; the B gauge height being known.

In connection with the discharge observations, velocities in the verticals surface to bottom, at each of the velocity stations, were taken immediately aft observation of velocity at sixth-tenth depth, as described in the report of the series. The object of these observations was to prove, if possible, the gen accepted theory that the six-tenth depth velocities are the mean velocities stream. The observations of velocities in verticals were taken as often as pra ble. At the velocity stations on the Black Rock Section, complete sets were obt on four days at the even-numbered stations and on three days at the odd-num stations; on the Lower Black Rock Section, six to nine complete sets were obt at all of the velocity stations. The mean of these observations, for each st were plotted as shown on the accompanying plat, in terms of meter revolutio second, to the depth regarded as unity. In each case the "smooth curve" of v ties in the vertical was computed from the mean observed velocities, as plotte computations being based upon from three to ten observation equations, acc to depth. Normal equations were formed by the method of least squares and s by the Gauss method of substitution. The mean velocity of each curve wa determined and plotted on its curve as shown.

The following table shows the values and locations on the curves of the mean velocities of the computed curves, the differences between these means and the corresponding mean observed velocities at six-tenths depth, and the differences in partial and total discharges resulting from the differences in mean velocity values.

BLACK ROCK SECTION.

Velocity station.	Range of local gauge.	Mean depth.	No. of sets observed velocities.	Mean velocities. By computed curve.	Mean velocities. Observed at $\frac{6}{10}$ depth.	Mean velocities. Difference in revolutions per second.	Mean velocities. Difference in feet per second.	Difference in partial discharge.	Location mean velocity on curve.
		Feet.		*Rev. per sec.*	*Rev. per sec.*			*Cubic feet.*	*Depth.*
200	1.1-2.0	9.35	4	.693	.669	+.024	+0.184	+166	.467
300	1.6-2.0	9.35	3	.806	.797	+.009	+0.122	+101	.500
400	1.1-2.0	30.0	4	1.112	1.120	−.008	−0.117	−417	.557
500	1.6-2.0	36.0	3	1.115	1.088	+.027	+0.196	+746	.561
600	1.1-2.0	41.0	4	1.539	1.533	+.006	+0.109	+457	.648
700	1.6-2.0	39.5	3	1.450	1.450	.000	0.000	000	.673
800	1.1-2.0	43.5	4	1.490	1.462	+.028	+0.201	+824	.609
900	1.6-2.0	45.0	3	1.457	1.411	+.046	+0.276	+1,171	.586
1,000	1.1-2.0	40.0	4	1.170	1.184	−.014	−0.142	−524	.678
1,100	1.6-2.0	35.0	3	1.192	1.205	−.013	−0.138	−487	.624
1,200	1.1-2.0	25.0	4	1.036	1.056	−.020	−0.167	−414	.623
1,300	1.6-2.0	19.5	3	1.089	1.099	−.010	−0.126	−248	.505
1,400	1.1-2.0	17.0	4	1.001	1.001	.000	−0.000	000	.500
1,500	1.6-2.0	13.0	3	1.001	.989	+.012	+0.134	+179	.600
1,600	1.1-2.0	10.0	4	.967	.919	+.048	+0.284	+312	.538
1,688	1.3-2.0	9.0	2	.911	.873	+.038	+0.242	+214	.518
Difference on total discharge of 223,000								+2,080	M.5804
Percentage difference								+0.9	

LOWER BLACK ROCK SECTION.

300	1.6-2.3	9.0	6	.804	.788	+.016	+0.151	+168	.557
400	1.6-2.3	33.0	7	1.180	1.200	−.020	−0.167	−460	.639
500	1.6-2.3	36.0	7	1.178	1.167	+.011	+0.130	+514	.594
600	1.6-2.3	37.5	8	1.565	1.577	−.012	−0.134	−656	.625
700	1.6-2.3	36.5	7	1.514	1.527	−.013	−0.138	−516	.641
800	1.6-2.3	37.0	8	1.527	1.525	+.002	+0.092	+339	.615
900	1.6-2.3	33.0	6	1.518	1.529	−.011	−0.130	−459	.630
1,000	1.6-2.3	30.5	7	1.308	1.321	−.013	−0.138	−439	.639
1,100	1.6-2.3	29.0	6	1.226	1.253	−.027	−0.196	−557	.638
1,200	1.6-2.3	26.0	7	1.239	1.233	+.006	+0.109	+280	.607
1,300	1.6-2.3	23.0	7	.995	.971	+.024	+0.184	+437	.570
1,400	1.6-2.3	22.5	9	1.088	1.066	+.022	+0.176	+410	.566
1,500	1.6-2.3	15.5	6	.970	.936	+.034	+0.226	+376	.600
1,600	1.6-2.3	12.0	7	.963	.948	+.015	+0.146	+139	.583
1,688	1.6-2.3	11.5	6	.833	.805	+.028	+0.201	+221	.504
Differences in total discharge of 223,000								−232	M.601
Percentage difference insignificant.									

As shown, the mean location of the mean velocity across the stream is at .58 depth on the Black Rock section, and the results would indicate that the velocity values obtained at six-tenths depth would be a trifle smaller than the curve means. The discharge difference is consistent therewith, the discharge based upon the curve means being about 1 per cent greater than that based upon mean six-tenths depth velocities.

On the lower Black Rock section the mean location of the mean velocity across the stream is at .60 depth, and the results would indicate that the velocity values should agree. The practically insignificant difference in discharges is consistent therewith.

From the foregoing results it may be fairly inferred that the river discharges based upon six-tenths depth velocities are reasonably exact.

The slope observations made in connection with this series of discharge measurements were more extended and made under much more favorable circumstances than those made in connection with the first series. The observations were taken, as shown in the following table, along the right bank—along Squaw Island. Slope stakes were set, one near the head of the island, one at the International Bridge, and one on the lower discharge section. The elevations of the stakes were carefully determined by three lines of levels. The slope readings were taken simultaneously on the three stakes and only at times when the water level could be closely measured on the stakes.

Date.	Local gauge.	Which river bank.	Distance above Black Rock Section.	Distance below Black Rock Section.	Total distance.	Difference in elevation.	Slope, per foot.
1892.	*Ft.*		*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*
May 3	1.20	Right	3,273	600	3,873	0.475	.000118
4	1.67	...do	3,273	600	3,873	0.599	.000155
5	0.96	...do	3,273	600	3,873	0.516	.000133
6	1.30	...do	3,273	600	3,873	0.475	.000123
7	1.58	...do	3,273	600	3,873	0.558	.000144
9	1.33	...do	3,273	600	3,873	0.474	.000123
10	1.33	...do	3,273	600	3,873	0.535	.000138
12	1.96	...do	3,273	600	3,873	0.558	.000144
18	1.67	...do	3,273	600	3,873	0.557	.000144
20	1.50	...do	1,010	600	1,610	0.213	.000132
23	2.04	...do	1,010	600	1,610	0.220	.000137
Mean							.000136

This gives a slope of 0.718 feet per mile. This result is well in accord with the slope implied by the hydraulic conditions.

The difference between the level of the Erie Canal and the river, at the canal lock at Black Rock, almost exactly on the line of the Black Rock discharge section, was measured on May 9 and 20 and found to be 5.0 feet. The level of the canal at this point is, practically, the level of Lake Erie. The distance from the lock to the head of the river is about 4 miles. The average slope would, therefore, be about 1.25 feet per mile; but the greater part of the fall of 5 feet occurs in the second and third miles of river from the lake.

REMARKS.

On the plat of the first series of observations the discharge of December 16, 1891, is marked doubtful—occurs at local gauge height 1.83 feet. The observations at and above this gauge height during the second series prove this result to be reasonable and, in fact, very close to the mean discharge value, as determined by the computed curve.

The gauge readings on the two gauges during the first series suggested that mean lake level was equivalent to a local gauge height of about 2.1 feet. The equation of gauge relation, based upon the observations of both series, gives 2.087 feet on the local gauge as a mean determination of the equivalent to mean lake level.

* * * * * * *

Very respectfully, your obedient servant,

J. C. QUINTUS,
Inspector.

Maj. E. H. RUFFNER,
Corps of Engineers, U. S. A.

* * * * * * *

It is true that the mean discharge curve is based upon a limited number of observations, but it is not probable that a greater number of observations would materially affect the values of the mean discharges within the limits covered. The maximum variation in the measured discharges for the same height is about 7 per cent at gauge height of 2.0 feet. In no other instance, for approximately equal gauge heights, does the variation in discharge exceed 4 per cent. It is not probable that the variation would ever exceed 10 per cent.

The mean discharge at mean lake level, as determined by the equation, is 230,280 cubic feet per second. It is to be regretted that the lake level during the time of observation did not reach well above mean lake, for the equation will not give fairly approximate results for higher levels than the extremes observed. A discussion of the equation indicates that between gauge heights 0.0 feet and 1.0 feet, the discharge increment for a change of 1 foot is about 37,500 cubic feet per second; between 1.0

and 2.0 feet the discharge increment for a change of 1 foot is reduced to 25,000 cubic feet per second and diminishes rapidly. At a local gauge height, 3.0 feet, equivalent to +1.9 feet on the Buffalo gauge, the equation indicates a discharge of 241,468 cubic feet per second. At this stage the river has reached the level of its bank on the Squaw Island side, at the discharge sections, and the lower end of the island is flooded. A maximum discharge of about 243,500 cubic feet per second is indicated at a local gauge height, 3.5 feet, equivalent to Buffalo gauge height +3.0 (?) feet. At a local gauge height of 4.0 feet, equivalent to Buffalo gauge height +5.0 (?) feet, the equation indicates a discharge of 241,896 cubic feet per second. From this point the equation gives decreasing discharges. In the absence of observed values, which would have great weight in determining the discharge curve above mean lake level, it is evident that this equation, determined by rigid mathematical computation, will not give value at high levels consistent with the hydraulic principles involved in river discharge.

The discharge values obtained during the two series of observations cover less than one-half of the range of the local gauge. With the exception of one observation at extreme low water values are wanting at the extremes of high and low water. These values would have the greatest weight in determining the complete curve of discharge. The data at hand for determining a probable curve of discharge for all stages is, therefore, very limited.

A probable curve of discharge, based upon the means of discharges measured on the two sections, is shown on the accompanying plat. Its equation is:

Probable discharge $= 170,000+28,000x+1,000\ x^2$, etc., in which $x =$ local gauge height.

This equation gives a discharge at mean lake level of 232,800 cubic feet per second. A discussion of the equation gives the following results:

Buffalo gauge.	Local gauge.	Discharge.	Discharge increment.
Feet.	*Feet.*	*Cubic feet.*	
—2.80	0.0	170,000	
—1.50	1.0	199,000	29,000
—0.20	2.0	230,000	31,000
+1.80	3.0	263,000	33,000
+(*)	4.0	298,000	35,000
—2.0	0.66	188,915	
—1.0	1.42	211,776	22,861
0.0	2.09	232,800	21,024
+1.0	2.67	251,889	19,089

* Probably between 4 and 5 feet.

The equation of gauge relation can not be safely applied beyond the limits of observation. More extended observations are necessary to determine this relation at high levels.

The results indicate that near mean lake level the discharge increment is about 21,000 cubic feet per second, for a change of 1 foot on the Buffalo gauge, or in level of Lake Erie.

The meter ratings for the first series, as applied to the computation of discharges for that series, are as follows:

Date.	No. of observations.	Range of observed velocities.	Meter coefficients.		Meter.	Remarks.
		Ft. per sec.	*a.*	*b.*		
1891.						
Dec. 9...	16	2.5 to 11	4.204	+0.059	Price No. 36...	Still water, base 100 feet.
11...	26	1.3 to 8.5	4.252	+0.163	....do	Still water, base 145 feet.
26...	24	2 to 7	4.057	+0.061	....do	Do.
Mean..			4.171	+0.094		

NOTE.—December 11, meter started by hand ran 185 seconds before coming to rest; December 17, meter started by hand ran 242 seconds before coming to rest; December 27, meter started by hand ran 277 seconds before coming to rest.

The meter was oiled daily before using.

Velocity, in feet per second=4.171 rev. per sec. +0.094.

Respectfully submitted,

J. C. QUINTUS,
Inspector.

Maj. E. H. RUFFNER,
Corps of Engineers, U. S. A.

D D D 3.

RESURVEY OF THE LAKE FRONT AT CHICAGO, ILL.

REPORT OF CAPT. WILLIAM L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., April 27, 1893.

GENERAL: I have the honor to forward by express to-day in a separate package—

(1) A general map* of the survey of the Lake front, Chicago, Ill., from Diversey street to the Indiana State line, numbered 1 of the series, Nos. 2 and 3 having been heretofore forwarded.

(2) There is also inclosed with this map a plan* of the triangulation, with descriptions of stations, lengths and azimuths of bases and sides of triangles for such uses in correcting existing charts as may be desired to make of these data.

There is also inclosed herewith a copy of the report of Assistant L. M. Mann, who made the survey, which gives a full description of the methods of survey, with an appendix including the information given upon the triangulation sheet, with other valuable data in tabular form.

* * * * * * *

I am, sir, very respectfully, your obedient servant,

W. L. MARSHALL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. L. M. MANN, ASSISTANT ENGINEER.

CHICAGO, ILL., *April 17, 1893.*

CAPTAIN: I have the honor to report as follows respecting the survey of the Lake Front, Chicago, Ill., made during the summer of 1892.

The survey party consisted of one transitman, a recorder, a leadsman and two rodmen, besides the engineer and steersman of the steam launch. During about two months a second transitman was employed.

After several days spent in preparing tools, adjusting instruments, etc., and putting the launch in condition for service, actual work in the field was commenced April 25.

The survey was first intended to locate the shore line from the Chicago Harbor to the Calumet Harbor and to make a close hydrographic survey from Thirty-fifth street to the south limit of Jackson Park, about 4 miles. This was afterwards extended in both directions until a close hydrographic survey was made from Diversey street to the Indiana State line, 16 miles in extent.

A triangulation system was evolved starting from a measured base line on the exterior breakwater. By the extraordinary advantage of the water-works cribs in the lake and the Auditorium Tower, about 200 feet high, an excellent system was developed along the comparatively straight shore, without going far inland. The Auditorium and 4-mile crib form a common side to a set of independent triangles running up to the Calumet Harbor. From the Hyde Park Inner Crib and Sixty-eighth street base, a secondary system was carried to the Indiana State line. The Outer Hyde Park Crib was not in place until towards the close of the survey and could therefore not be utilized.

The system contains forty-five triangles, including four quadrilaterals and three base lines. The base lines were measured with a 100-foot steel tape with a spring balance attachment. The first base, B-B', on the exterior breakwater, resulted in a

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* Omitted.

mean length of 5407.872 feet from four measurements, the greatest difference between two measurements being 0.3 feet, and the greatest difference from the mean is 0.155 foot. The second base, C–C′, was measured on the easterly breakwater and resulted in a mean of 3,956.94 feet from four measurements; calculated from the first base and triangulation it is 3,957.25 feet. The third base, C B–C B′, is the base used by the city, and measured 2,738.46 feet; its calculated length is 2,739.06 feet.

All the angles of the triangles were measured with a Nickel & Strassberger plain transit, 6-inch limb, reading to 30 seconds. Four repetitions were obtained, reducing the error to 7½ seconds. The majority of the triangles were closed within 4 seconds; 271 sets of angles were read and 239 azimuths were observed.

The shore line and details, such as piers, slips, buildings and city landmarks, were taken up by stadia. The azimuth was carried forward and connection obtained and checked at each triangulation point possible. This work was done with a "Patten" transmit, reading to 1 minute. A stadia rod graduated to 0.05 feet was used, excepting between stadia points, when a target rod reading to thousandths of a foot was used. During the progress of this work sounding points were established by stadia, from which, afterwards, the sounding lines were run in the lake. By this means the sounding lines could all be run parallel to each other, the azimuth to some prominent object or triangulation point having been obtained at each sounding point.

The distance between sounding points varied according to the importance of the area to be covered. The stadia work between the Chicago Harbor and Jackson Park was much impeded by moving railroad trains and smoke; 2,129 stadia readings were taken and 307 sounding stations were established.

The lake soundings were taken either with a pole graduated to feet and tenths or a lead line tagged every foot. The pole was 20 feet long and used to 18 feet depths, beyond which the lead line was used. The soundings were taken from a small steam launch, 37 feet long with 7 feet beam. The sounding lines from Diversey street south to the Illinois Steel Company's pier were run about on an easterly course, but from the latter point to the Indiana State line, on account of the decided change in the shore line, were run parallel to the north pier of Calumet Harbor. Lines were generally run 400 feet apart to 30 feet depths, excepting from Chicago avenue to Diversey street they were 600 feet apart. South of the Outer Harbor to Sixty-eighth street, intermediates, half way between the long lines, were run to 15-feet depths, to more closely determine any changes along the shore. Where shoals were encountered, lines were concentrated to 200 feet apart, as between Forty-seventh and Fifty-first streets and between Seventy-fourth and Cheltenham Place, and 100 feet apart to cover Cheltenham Shoal between Eightieth and Eighty-third streets. For 1,600 feet on either side of Calumet Harbor, lines 400 feet apart were carried out to 40 feet depths, with intermediates 100 feet and 200 feet apart to 30 feet depths. Radial lines to cover the mouths of Chicago and Calumet harbors, and at the end of the Illinois Central pier at Twelfth street, were run. Soundings were also taken in the Lincoln Park Lagoon, around the Illinois Central piers and in the Illinois Steel Company's harbor.

The method of locating the soundings was by means of two transits. One transit was placed over a sounding point and the boat kept on line by flag signals; the steersman was also assisted by a compass, which at the same time was a check on the direction. The other transit was placed over some convenient triangulation point, giving good angles, and angles to every fourth sounding with the pole and every third sounding with the lead were measured. The recorder in the boat raised a flag just before the sounding to be located was taken; the soundings thus located were marked by a cross. The soundings were taken uninterruptedly and the boat run as fast as convenient to the leadsman. Counter signals were given to prevent errors, and at the end of every line the number of marked soundings were signaled to the transitman to check the same number of angles recorded by him. Time of each run was also kept and recorded. The gauge was recorded five times daily, and soundings reduced to the Chicago city datum.

The shoals were located and re-sounded very carefully by means of buoys. In this case both transits were placed over triangulation points and buoys and soundings located by intersection. The buoys were placed in deep water, generally 25 feet surrounding the shoal; they were distinguished by different arrangements of red, white and blue flags. After being set the colors were checked by numbering the buoys in the following manner: The boat starting at No. 1 moved around in succession while both transitmen were taking shots, a signal being given at each buoy. Soundings were taken at each buoy, and on as many cross lines as possible between buoys. Signals were given before starting each line and about every third sounding was located. Cheltenham Shoal was sounded by lines running from shore 100 feet apart. The following table gives the number of buoys set at each shoal and number of soundings taken:

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Name.	Number of buoys.	Number of soundings.
Oakland Shoal	12	1,093
Morgan Shoal	20	1,744
Hyde Park Inner Shoal	15	518
Hyde Park Outer Shoal	9	220
South Shore Shoal	13	898
Clarke Point Shoal	14	1,466
Cheltenham Shoal	None.	511
Total	83	6,450

Soundings were only taken in comparatively calm weather; 42,478 soundings were taken on 331 regular lines, and 15,584 angles were read to locate the same. Only 8,665 soundings are shown on Chart No. 1, being one-fifth of the total number taken.

An observation for azimuth was obtained on the base CB–CB′, Lake Front Park, and repeated observations for magnetic declination, which resulted in a mean of 3° 49′ 51″ east.

The survey was very materially delayed by the exceedingly bad weather during last summer and the smoky atmosphere around Chicago. May and June were the rainiest months on record in the U. S. Weather Bureau, there being twenty-five and twenty-six rainy days, respectively, during those months. During westerly winds, when the water was smooth, the lake and shore was obscured by smoke, and during easterly winds, when the atmosphere was clear, if the wind was strong, the water was rough.

This report is accompanied by a plot of the triangulation system on a scale of 1:10000, giving the calculated lengths of the sides of the triangles, their azimuths, and a detailed description of the triangulation points. Also tables of the corrected angles; the lengths and azimuths of the sides; a table of distances between prominent points; sailing distances by the three channels between the southeast corner of the Columbian Pier, Chicago Harbor, and the northeast corner of the Casino Pier, Jackson Park; and a table giving general details of shoals and channels.

Very respectfully, your obedient servant.

L. M. MANN,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

exterior
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balance attachment. The firs

Shoals and Channels.

Name.	Area at datum.			Soundings at datum.				Physical character.	Remarks.
	6-foot contour.	12-foot contour.	15-foot contour.	Least feet.	Mean. 6 feet.	Mean. 12 feet.	Mean. 15 feet.		
	Acres.	*Acres.*	*Acres.*						
1. Oakland Shoal	......	11.9	......	9.4	......	11.0	......	Rock.	
2. Morgan Shoal. I, I	0.29	......	......	......	5.9				
2. Morgan Shoal. I, II	0.05	29.4	......	3.9	5.9	8.2	......	Rock	I is nearest shore.
2. Morgan Shoal. I, III	1.84	......	......	......	5.1				
	2.18								
2. Morgan Shoal. II	......	0.5	......	8.6	......	10.4	......		
2. Morgan Shoal. III	......	4.9	......	7.2	......	9.1	......		
Total	......	34.8							
3. Hyde Park Shoal (inner). I	......	......	0.94	13.6	......	......	14.2		
3. Hyde Park Shoal (inner). II	......	......	0.11	12.7	......	......	14.0	Rock.	
Total	......	......	1.05						
		Sq. ft							
4. Hyde Park Shoal (outer)	......	300	0.52	11.7	......	......	13.5	Rock.	
		Acres.							
5. South Park Shoal	......	4.4	10.02	9.3	......	11.0	12.3	Rock.	
6. Clarke Point Shoal. I	......	4.3	......	6.2	......	10.5	......		This is virtually a reef extending from outcroppings which occur along the shore.
6. Clarke Point Shoal. II	......	12.5	......	6.9	......	9.6	......		
6. Clarke Point Shoal. III	......	4.3	......	8.1	......	10.1	......	Rock	
6. Clarke Point Shoal. IV	......	0.7	......	10.7	......	11.1	......		
6. Clarke Point Shoal. V	......	0.2	......	10.6	......	11.4	......		
Total	......	22.0							
7. Cheltenham Shoal	......	17.3	......	6.2	......	9.3	......	Rock.	
8. Calumet Bar	......	......	......	19.2	......	......	*20.5	Sand.	

* Mean inside 21 feet contour.

Channels.

Name.	Location.	Width at datum.	Mean depth at datum.	Remarks.
		Feet.	*Feet.*	
Main Channel	Between Inner and Outer Hyde Park Shoals.	4,915	29.6	Between 15-foot contours.
Morgan Channel	Between Morgan Shoal and Morgan Pier.	200	13.1	Between 12-foot contours.
Hyde Park Channel	Between Morgan Shoal and Inner Hyde Park Shoal.	2,320	24.3	Between 12 and 15 foot contours.
Cheltenham Channel	Channel inside of Cheltenham and Clarke Point Shoal.	375 530	13.3 13.9	Between 12-foot contours.

NOTE.—Mean level of Lake Michigan for 33 years = 1.9 feet above datum.

Sailing distances from southeast corner Columbian Pier to northeast corner of Casino Pier.

Route.	Distance.	Description.	True bearing.
	Feet.		
By Morgan Channel and south entrance to outer harbor.	3,720	Southeast corner Columbian Pier to point opposite northeast corner of Illinois Central Pier (Twelfth street).	S. 9° 17′ E.
	19,250	Thence opposite Forty-third-street depot	S. 19° 39′ E.
	14,550	Thence to northeast corner Casino Pier	S. 31° 21′ E.
	37,520	=7.1 miles.	
By Hyde Park Channel and east entrance to outer harbor.	2,850	Southeast corner Columbian Pier to point outside of east entrance.*	S. 81° 01′ E.
	26,050	Thence to middle of Hyde Park Channel to point opposite Forty-seventh street.	S. 23° 19′ E.
	9,975	Thence to northeast corner Casino Pier	S. 8° 49′ E.
	38,875	=7.4 miles.	
By Main Channel and east entrance to outer harbor.	2,850	Southeast corner Columbian Pier to point outside of east entrance*.	S. 81° 01′ E.
	27,910	Thence to middle of Main Channel to point opposite Forty-seventh street.	S. 31° 16′ E.
	10,275	Thence to northeast corner Casino Pier	S. 14° 51′ W.
	41,035	=7.8 miles.	

* Point in range with Chicago Beacon (north pier) and westerly end of exterior breakwater.

Table of distances.

[These measurements are all in a direct line.]

From—	To—	Distance.
		Miles.
Four-mile crib	Auditorium tower	4.1
Do	Temporary crib (2½ miles)	1.5
Do	Chicago Avenue crib	3.2
Do	Hyde Park inner crib	6.3
Do	Hyde Park outer crib	6.0
Do	Chicago harbor beacon	3.4
Do	East entrance of outer harbor	3.5
Do	Calumet beacon	9.6
Chicago harbor beacon	do	11.5
East entrance of outer harbor	do	10.7
Do	Hyde Park inner crib	7.4
Calumet beacon	do	3.3

Table of corrected angles.

Angle.	Magnitude.	Angle.	Magnitude.	Angle.	Magnitude.
	° ′ ″		° ′ ″		° ′ ″
B A B′	60 11 31.25	B B′ S	59 16 40.00	A D C	43 59 38.75
C A D	54 48 50.00	B B′ C	65 25 46.87	A D E	99 28 18.75
D A E	27 35 48.75	C B B′	58 47 46.87	A D G	69 18 02.81
E A G	83 32 23.83	A C D	81 11 31.25	A D S	39 50 37.50
D A G	55 56 34.68	B C B	55 46 26.26	C D C′	20 01 00.00
B A S	32 46 12.55	C′ C D	58 24 00.00	G D I	57 06 53.70
B A S	27 25 18.70	C′ C F	41 47 16.25	G D K	57 37 37.50
S A U	41 46 42.50	C′ C CB	41 12 07.92	G D K′	55 34 43.12
S A V	67 40 15.00	C′ C′ D	101 35 00.00	A d Water Tower	41 15 43.44
S A W	84 05 36.25	C′ C′ F	86 31 38.75	A E D	52 55 52.50
T A U	27 57 38.75	F C′ H	66 27 18.75	A E G	45 47 16.53
D A S	54 17 41.25	C C′ CB	95 48 17.92	G E L	51 38 11.25
Water Tower A-D	83 13 20.94	CB C′ CB′	34 11 01.25	G E M	64 39 03.75
A B E	71 53 57.50	C CB C′	42 58 34.16	G E L	49 39 15.00
A B S	128 09 33.75	C′ CB C$\overline{B}$′	94 09 35.00	G E N	74 28 26.25
B′ B S	56 15 36.25	C′ CB′ CB	51 39 23.75	G E O	81 31 37.50
A B′ B	47 54 31.25			G E P	90 12 16.25
A B S	107 11 11.25				

[redacted]

Table of corrected angles—Continued.

Angle.	Magnitude.
	° ′ ″
G E Q	95 45 59.77
G E R	98 03 10.21
G E X	98 27 30.94
G E B	70 28 35.00
G E B (new)	93 31 42.81
B (new) E NB	8 50 51.12
G E NB	84 40 56.04
C F C′	51 41 05.00
C′ F H	67 33 07.50
A G D	54 45 22.51
A G E	50 40 19.83
D G I	66 58 20.10
D G K	67 09 00.00
D G K′	64 02 10.32
E G L	68 15 11.25
E G L′	67 58 15.00
E G M	65 51 26.25
E G N	64 22 56.25
E G O	63 42 07.50
E G P	61 51 53.75
E G Q	60 12 54.14
E G R	59 17 10.52
E G X	59 47 38.44
E G B	61 10 53.75
E G B (new)	54 33 28.75
E G NB	63 39 43.86
B (new) G NB	9 06 18.24
F H C′	45 59 33.75

Angle.	Magnitude.
	° ′ ″
D I G	75 54 46.20
D K G	55 13 22.50
D K′ G	60 23 06.56
E L G	60 06 37.50
E L′ G	62 22 30.00
E M G	49 29 30.00
E N G	41 08 37.50
E O G	34 46 15.00
E P G	27 55 50.00
E Q G	24 01 06.09
E R G	22 30 39.27
E X G	21 44 50.62
A S B	24 25 07.55
A S B′	40 02 36.20
A S D	85 51 41.25
B S B′	61 27 43.75
A S U	81 57 12.50
A S V	69 14 18.75
A S W	66 14 36.25
A T U	82 49 38.75
A U S	56 16 05.00
A U T	69 12 42.50
A V S	43 05 26.25
A W S	29 39 47.50
E B G	46 20 31.25
A—Water Tower—D	55 30 55.62
E NB B (new)	52 03 12.10

Angle.	Magnitude.
	° ′ ″
B (new) NB X	83 03 14.46
G NB E	31 39 20.10
B (new) NB Ashley	100 14 18.46
X NB Ashley	17 11 04.00
G NB B (new)	83 42 35.72
NB X B (new)	21 40 00.27
B (new) X Ashley	110 21 30.66
Ashley X A (new)	53 42 39.07
Indiana X Ashley	59 50 53.75
NB X Ashley	88 41 30.39
SOUTH CHICAGO.	
G B (new) E	31 54 48.44
NB B (new) E	119 05 56.78
X B (new) NB	75 16 45.27
X B (new) Ashley	14 15 30.27
Ashley B (new) NB	61 01 15.00
NB B (new) G	87 11 06.04
X Ashley B (new)	55 22 59.07
X Ashley A (new)	75 02 55.00
Indiana Ashley X	87 56 48.12
B (new) Ashley NB	18 44 26.54
NB Ashley X	74 07 25.61
X A (new) Ashley	51 14 25.93
X Indiana Ashley	32 12 18.13

Azimuths and lengths of sides of triangles.

Side.	Length.	Azimuth.	General location of △ points.
	Feet.	° ′ ″	
A-D	13,694.09	166 13 21.67	A, at Chicago avenue, W. W. crib.
A-E	16,928.40	138 37 32.92	D, at temporary crib (2½ miles).
A-G	15,685.14	222 09 56.35	E, at 4-mile crib.
B-A	4,624.96	13 05 44.22	G, at Auditorium tower.
B-B′ (measured)	5,407.87	301 11 46.72	B, at east end of base on exterior breakwater.
B′-A	5,924.02	73 17 15.47	B′, at west end of base on exterior breakwater.
C-A	9,625.22	41 02 11.67	C, at north end of base on easterly breakwater.
C-B	5,948.29	62 23 59.85	C′, at south end of base on easterly breakwater.
C-B′	5,594.31	6 37 33.59	
C-D	11,325.53	122 13 42.92	
C-F	5,033.92	222 24 59.17	F, opposite foot of Adams street.
C′-C	3,957.25	0 37 42.92	(Measured = 3956.94).
C′-CB	3,823.57	264 48 25.00	CB, north end of city base, Lake Front Park.
C′-D	9,846.01	102 12 42.92	
C′-F	3,360.04	274 06 04.17	
C′-H	4,318.37	207 38 45.42	H, at east end of Illinois Central pier, Twelfth street.
CB-C	5,774.62	41 49 50.84	
CB′-CB	2,739.06	358 58 00.00	CB′, south end of city base, Lake Front Park.
CB′-C′	4,862.25	50 37 23.75	
D-E	7,950.44	85 41 40.42	
D-G	13,891.55	276 55 18.86	
D-I	13,181.01	239 48 25.16	I, opposite foot of Twenty-second street.
D-K	15,585.29	219 17 41.36	K, opposite Thirty-first Street Depot.
D-K′	14,306.18	221 20 35.74	K′, on Illinois Central pier, between Twenty-ninth and Thirtieth streets.
E-B (new)	33,512.93	179 18 33.57	B (new), on Hyde Park inner crib.
E-B	26,824.28	202 21 41.38	B, end of Morgan pier, Fifty-first street.
E-L	23,206.70	221 12 05.13	L, opposite Oakland Depot, Thirty-ninth street.
E-L′	22,751.67	223 11 01.38	L′, on Fleishman's pier, Thirty-eighth street.
E-M	20,090.16	208 11 12.63	M, opposite Kenwood Depot, Forty-seventh street
E-N	29,801.60	198 21 50.13	N, end of pier foot of Fifty-fifth street.
E-NB	37,133.82	188 09 20.34	
E-O	34,184.00	191 18 38.88	O, on Casino pier, Jackson Park.
E-P	40,939.49	182 38 00.13	P, on pier, foot of Seventy-sixth street.
E-Q	46,367.45	177 04 16.61	Q, east end of pier, Cheltenham, Eighty-third street.
E-R	48,524.47	174 47 06.17	R, east end of Illinois Steel Company's pier.
E-X	50,721.37	174 22 45.44	

Azimuths and lengths of sides of triangles—Continued.

Side.	Length.	Azimuth.	General location of △ points.
	Feet.	° ′ ″	
F-H	4, 283. 48	161 39 11. 67	
G-E	21, 745. 59	92 50 16. 38	
G-I	8, 642. 28	163 53 38. 96	
G-K	14, 283. 99	164 04 18. 86	
G-K′	13, 181. 06	160 57 20. 18	
G-L	19, 666. 34	161 05 27. 63	
G-L′	18, 705. 87	160 48 31. 38	
G-M	25, 847. 12	158 41 42. 63	
G-N	31, 844. 45	157 13 12. 63	
G-N̄B	41, 256. 69	156 30 00. 24	
G-O	37, 714. 23	156 32 23. 88	
G-P	46, 424. 86	154 42 10. 13	
G-Q	53, 154. 77	153 03 10. 52	
G-R	55, 884. 97	152 07 26. 90	
G-X	58, 051. 79	152 37 54. 82	
G-B (new)	41, 057. 18	147 23 45. 13	
G-B	28, 329. 04	156 01 10. 13	
NB-X	17, 122. 61	143 15 50. 52	NB, north end of city base-line at Sixty-eighth street.
S-A	8, 796. 69	40 31 02. 92	
S-B	5, 152. 27	94 56 10. 47	S, east end of north pier, Chicago Harbor.
S-B′	4, 983. 93	0 28 26. 72	
S-D	11, 149. 09	126 22 44. 17	
S-U	7, 047. 26	318 33 50. 42	U, at Division street.
S-V	11, 911. 04	331 16 44. 17	V, opposite Grant monument.
S-W	17, 680. 29	334 16 26. 67	W, east end of pier, Diversey street.
T-A	9, 868. 72	54 20 06. 67	T, foot of Indiana street.
T-U	4, 949. 32	331 30 27. 92	
U-A	10, 473, 32	82 17 45. 42	
V-A	12, 040. 43	108 11 17. 92	
W-A	16, 268. 52	124 36 39. 17	
Water tower-A	10, 956. 62	69 26 42. 61	Water tower, Chicago avenue.
Water tower-D	16, 497. 32	124 57 38. 23	
Ashley-A (new)	5, 436. 54	129 37 15. 13	Ashley, on Counselman's elevator, South Chicago.
Ashley-B (new)	20, 020. 46	359 11 21. 06	
Ashley-NB	17, 797. 21	340 26 54. 52	
Ashley-Indiana	8, 533. 82	142 31 08. 25	Indiana, at Indiana State monument.
Ashley-X	5, 259. 49	54 34 20. 13	X, Calumet Beacon, north pier.
B (new)-NB	6, 536. 37	240 12 36. 06	
B (new)-X	17, 573. 87	164 55 50. 79	
X-A (new)	6, 516. 40	180 51 41. 06	A(new), on pier off Ninety-ninth street.
X-Indiana	9, 862. 17	174 43 26. 38	

D D D 4.

SURVEY OF SHOAL OFF THE MOUTH OF NIAGARA RIVER.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., June 7, 1893.

GENERAL: I have the honor to submit the following report upon a shoal said to exist about 3 miles north of Fort Niagara, in Lake Ontario.

In July, 1892, a letter was addressed to the Superintendent of the United States Life Saving Service by the United States collector of customs at the Suspension Bridge, New York, reporting that the steam barge *Rhoda Emily* had grounded on a shoal about 2¾ miles north of Fort Niagara, in Lake Ontario, on the 28th of June preceding, and had been obliged to throw off her deck load of coal in order to float. The letter stated that the water on the shoal was about 11 feet deep, although the chart called for 13 feet at that point. The letter stated further that other vessels had grounded on this same shoal. The letter was received in due course by the Chief of Engineers and transmitted to me for report. Finally an allotment of $200 was made to defray the necessary expenses of a survey. Owing to the pressure of other work I was obliged to postpone the survey until the present season. The work has just been completed by Assistant Engineer Judson, and his report is transmitted herewith.

It appears from the records of this office that the American steam barge *Rhoda Emily*, 875 tons, gross measurement, left Oswego June 27, 1892, bound for Chicago, with a cargo of 925 tons of coal; she was drawing 14 feet of water; it was on the next day that she grounded on the 13-foot shoal.

It appears from the evidence submitted in Mr. Judson's report that the shoal upon which this vessel took ground is accurately shown upon the Lake Survey chart. The top of this shoal as he found it was about 200 feet across and had at the time of his examination about 14 feet of water over it. It should be noted that the present level of the water in the lake is about 1 foot higher than the level to which the soundings on the Lake Survey chart are referred. The depth of 13 feet given on the chart is therefore the proper one. The level of the water at the time that the *Rhoda Emily* was aground was about a foot and a half below the present stage; this would indicate about 12½ feet of water on the shoal. The vessel, as before stated, was drawing 14 feet, and they report 11 feet of water.

There is another point that was developed by Mr. Judson's examination which renders the exact depth of water upon this shoal at any given time quite unimportant. A careful examination of the shoal by a properly constructed specimen dredge, which brings up good size samples of the bottom, showed that the shoal was formed of coarse sand, and not of rock as described on the chart. This sand-bar, being undoubtedly formed by conflicting currents in the lake and river, could hardly be expected to be perfectly stable in form or in height; therefore the variation of 2 or 3 feet in the amount of water upon it, occurring in a comparatively short time, would not be unreasonable, but would be quite what ought to be expected. A careful and quite extended examination failed to reveal any other shoal in the vicinity.

It would seem very desirable, inasmuch as this shoal is a considerable distance from the shore, and close to the track of vessels bound from Lake Ontario ports to the upper lakes, that it should be properly marked by an easily recognizable buoy.

This examination does not reveal anything which would call for a change in the existing chart other than the change of word "rocky" to "sand" in describing the shoal.

Respectfully submitted.

DAN C. KINGMAN,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. WILLIAM PIERSON JUDSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., June 5, 1893.

SIR: I have the honor to report having located the shoal off the mouth of the Niagara River, upon which the steamer *Rhoda Emily* grounded on June 28, 1892, and to state that it is found to be the same one already shown upon the lake survey charts as the "13-foot Shoal."

The grounding of this and of other steamers upon this shoal, which lies 3 miles off shore near the course of vessels bound from American ports to the Welland Canal, has been due to the lack of a buoy upon it, and not to any omission in the charts.

The details of the examination are as follows:

No useful bearings or ranges were given by the captain of the *Rhoda Emily* in reporting the shoal. It was therefore necessary to depend upon local authorities for information as to the general position of the steamer when grounded.

United States Deputy Collector Tower, of Youngstown, and Canadian Deputy Collector Sando, of Niagara-on-the-Lake, were each very courteous and took the greatest pains to give aid by finding the more reliable of the fishermen and boatmen who were familiar with the locality and who had taken ranges of the steamer's position when grounded. The Canadian deputy collector was specially efficient in helping in every way.

Of course the most diverse opinions were expressed as to the distance offshore, varying from 2 miles off to 3 miles off. Some of the ranges were vague, but several were stated in such terms as to inspire confidence. For instance, one boatmen said that from his boat-house door on the Canadian side, the steamer ranged just clear of the northwest corner of Fort Niagara; another that from a certain point on the Canadian shore the range was over the northwest corner of the Fort wharf.

An intelligent American, long known to this office and considered reliable, stated that the steamer was not visible from the Youngstown street, and that he went with two other citizens (who were also consulted) to the cupola upon the hotel Eldorado, whence the steamer was in range over the cupola of a certain building at Fort Niagara, that the two others then took a boat and went out to the steamer and talked with her captain.

The captain of the American steamer *Annie Owen* also visited the steamer when aground, and knew the general direction and distance which he ran to reach her. He also stated that in February and March, 1893, the unusually heavy ice which ran out of the Niagara River grounded upon the shoal spots in the lake outside, forming ice islands which remained some time. The largest one he recognized as occupying the same position as the steamer had done, and of this ice island he took an accurate range as being upon the line of the west parade wall of Fort Niagara.

All of these ranges agreed in converging upon the same general locality, which is about 3 miles offshore—so far off that the details of points on shore could not be distinguished.

Taking on shore the compass bearings of the lines which passed through Fort Niagara and then going out on the lake and turning back the same bearings to the fort (whose buildings make it conspicuous at a distance) it was easy to place buoys which filled the conditions of the various ranges given by the fishermen and others. The buoys were so placed as to inclose an area about one-third of a mile square, within which area was then found a shoal corresponding in form and depths with the peculiar conditions said to exist around the *Rhoda Emily* when aground.

The two gentlemen before referred to, who talked with the captain of the steamer, said that she was aground on 12 feet depth forward, and 22 feet depth at her stern. The crown of the shoal as now found is about 200 feet in diameter, and has 14 feet depth of water, sloping off abruptly in a northeast direction to 23½ feet at 200 feet distance. The fact that the stage of water in the lake is now 1½ feet higher than when the *Rhoda Emily* was aground, and 1 foot higher than the stage to which the published charts refer, makes these depths agree closely. The surrounding area for a half a mile was then swept by an iron sounding-pole held at a depth of 18 to 20 feet, and no other shoals were found, except such as are also already shown upon the lake survey chart.

Being thus satisfied that this was the shoal sought, it was then located on the map by sextant angles taken to three restored lake survey stations on shore at which 40-foot poles had previously been put up, each having a large white flag and a 3-foot bright tin cone. Two of these stations were in Canada, 4 miles and 1½ miles west of Fort Niagara, and one was 1 mile east of Fort Niagara on the American shore. The location thus made upon the large original sheet of $\frac{1}{10000}$ scale obtained from the office of the Chief of Engineers, coincided with the outer shoal which is there shown, and which is described on the published charts as "the 13-foot shoal."

The only particular in which the completeness of the original survey-sheet was not fully confirmed by this examination was in the character of the material forming the shoal. This is there stated to be "rocky." The form and location would lead one to expect this, and examination with the usual lead-line might lead to this opinion.

The present survey was made with an iron and wood sounding rod, 30 feet in length, carried continuously step by step along the bottom while the boat was in motion. The depths and the character of the material were thus made certain at every foot of progress. Nothing but hard sand was found upon the shoal or anywhere near it. In addition to this, a specimen sounding-dredge, devised by the writer, was freely used at various points in depths from 11 to 30 feet, and at each sounding thus made the cups were brought up solidly filled with 20 cubic inches of the material, which in every case consisted of yellow sand of varying degrees of fineness, mixed with the small shell-fish which are said to be the white-fish food. About one-quarter of a cubic foot of the sand accompanies this report.

The formation and maintenance of this sand bar, 3 miles in the open lake, may be accounted for by the fact that at this point is the eddy formed by the meeting of the Niagara River current of two or more miles per hour, with the back current of the lake which trends westward along the shore to the mouth of the river. If the material had proved to be rocky, it was expected to recover some of the deck-load of coal which was thrown over by the *Rhoda Emily*, and which the specimen dredge would have readily brought up; but the smooth surface of the sand-bank offered no place in which the coal could be expected to lodge without being at once buried, and no coal was found.

Other steamers besides the *Rhoda Emily* have struck this shoal. It lies within a half a mile of the direct path of steamers from American ports to and from the Welland Canal. Its position being unmarked and its danger well known, all steamers go several miles out of their course to avoid it. No place on Lake Ontario more needs a first-class bell buoy, and every vessel man who has spoken of the subject has expressed a most earnest desire that the shoal should be marked.

As per accompanying vouchers, the total cost of the survey, including travel expenses, was $107.61.

I am, very respectfully, your obedient servant,

WM. PIERSON JUDSON,
Assistant Engineer.

Capt. DAN. C. KINGMAN,
Corps of Engineers, U. S. A.

D D D 5.

ANNUAL WATER LEVELS OF THE NORTHERN AND NORTHWESTERN LAKES.

Tri-daily observations were made at Charlotte, N. Y., and at Oswego, N. Y., on Lake Ontario, from July 1, 1892, to June 30, 1893; at Erie Harbor, Pa., and at Cleveland, Ohio, on Lake Erie, from July 1, 1892, to June 30, 1893; at Milwaukee, Wis., on Lake Michigan, from July 1, 1892, to June 30, 1893; and daily observations at Escanaba, Mich., on Green Bay, from July 1, 1892, to June 30, 1893. At the last-named place observations were not made from December 17, 1892, to April 26, 1893.

Daily observations were made at Sand Beach, Mich., on Lake Huron, and at Sault Ste. Marie and Marquette, Mich., on Lake Superior, from July 1, 1892, to June 30, 1893.

The accompanying table is a continuation of that published in the Annual Report of the Chief of Engineers for 1892, Part IV, p. 3430:

Monthly mean of water levels for the several stations below the planes of reference adopted in 1876.

Stations.	1892.						1893.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Charlotte	2.87	2.93	3.22	3.64	3.96	4.05	4.06	4.38	4.00	3.31	2.08	1.81
Oswego	2.78	2.86	3,06	3.50	3.77	3.90	4.23	4.34	3.86	3.11	1.94	1.73
Erie	1.64	2.02	2.37	2.76	3.11	3.21	3.73	3.76	3.49	2.84	1.90	1.74
Cleveland	1.73	2.08	2.40	2.96	3.29	3.56	3.94	3.86	3.64	2.91	2.07	1.88
Milwaukee	3.842	3.758	3.964	4.203	4.467	4.743	4.754	4.612	4.504	4.044	3.736	3.409
Escanaba	4.221	4.185	4.368	4.637	4.643	4.949	......	......	......	4.390	4.247	3.814
Sand Beach	4.30	3.81	3.98	4.19	4.52	4.76	5.01	5.06	4.98	4.60	3.97	3.22
Marquette	3.56	3,44	3.39	3.40	3.66	3.94	4.22	4.31	4.26	4.16	3.06	3.14
Sault Ste. Marie	3.320	3.309	3.251	3.360	3.637	3.919	4.171	4.369	4.355	4.111	3.535	3.003

WATER LEVEL OF LAKE ONTARIO.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., July 10, 1893.

GENERAL: I have the honor to transmit herewith my annual report for the fiscal year ending June 30, 1893, for the following works in my charge: Water level on Lake Ontario.

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

DAN C. KINGMAN,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

WATER LEVEL OF LAKE ONTARIO.

Permanent gauges are established at Oswego Harbor and at Charlotte Harbor (at the mouth of the Genesee River), and each has been read three times per day during the year. They show the lake level to have been lower than is usual at similar dates throughout the year.

OSWEGO GAUGE.

This gauge was established in 1837 by the United States engineer at Oswego at plane of extreme low water. The lake level has several times since been at this plane, but never below it.

The gauge is cut on the harbor face of the stone pier at the foot of West Third street, and is indicated by an iron plate cut to feet and tenths and bolted beside it.

The zero of the gauge is referred to the top of an iron bolt in top of masonry of old Government stone pier, .05 feet from east face of pier, 3½ feet north of its intersection by the cribwork wharf, foot of the United States reservation at the foot of West Third street, Oswego, marked U. S. B. M. This B. M. is 7.75 feet above zero of gauge. The zero of gauge on plane of extreme low water is 244.21 feet above mean tide at New York (see p. 609, Prof. Papers 24). Readings were taken daily at 7 a. m., 1 p. m., and 6. p. m., with observations of direction and force of wind. The daily means were taken and a mean of three taken as a monthly mean.

Oswego monthly mean above extreme low-water level.

1892.	Feet.	1893.	Feet.
July	2.20	January	0.75
August	2.12	February	0.64
September	1.92	March	1.12
October	1.48	April	1.87
November	1.21	May	3.04
December	1.08	June	3.25

Oswego monthly means below plane of reference for Lake Ontario water levels.

1892.	Feet.	1893.	Feet.
July	2.78	January	4.23
August	2.86	February	4.34
September	3.06	March	3.86
October	3.50	April	3.11
November	3.77	May	1.94
December	3.90	June	1.73

CHARLOTTE GAUGE.

The gauge at Charlotte Harbor was established by the Lake Survey and is described in the Report of 1876 and in Professional Papers No. 24.

The zero was lowered 4.5 feet in 1883 to coincide with the zero of the Oswego gauge at plane of extreme low water, and since that date all readings have given heights above extreme low-water level.

The zero is referred to a B. M. on the upper side of the water table of the old (now disused) light-house at Charlotte, at the south-southeast angle east of the south window, which B. M. is at 283.23 feet above mean tide at New York and 39.02 feet above the zero of the gauge, which zero is 244.21 feet above mean tide at New York.

The gauge is cut in feet and tenths in a wrought-iron plate and is bolted to an oak pile at the northeast angle of the west abutments of the R. W. and O. R. R. drawbridge at Charlotte.

Readings are taken daily at 7 a. m., 1 p. m., and 7. p. m., with observation of direction and force of wind.

The daily means were taken and a mean of these as the monthly mean.

Charlotte monthly mean above extreme low-water level.

1892.	Feet.	1893.	Feet.
July	2.11	January	.92
August	2.05	February	.60
September	1.76	March	.98
October	1.34	April	1.67
November	1.02	May	2.90
December	.93	June	3.17

Charlotte monthly means below plane of reference for Lake Ontario water levels.

1892.	Feet.	1893.	Feet.
July	2.87	January	4.06
August	2.93	February	4.38
September	3.22	March	4.00
October	3.64	April	3.31
November	3.96	May	2.08
December	4.05	June	1.81

WATER LEVEL OF LAKE MICHIGAN

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 11, 1893.

GENERAL: I have the honor to forward the accompanying plate,* on which is continued the water-level curve on Lake Michigan for the fiscal year ending June 30, 1893, and to inclose a letter from Mr. W. H.

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* Omitted.

Hearding, assistant engineer, giving the monthly mean water levels during the year.

The monthly reports* of observers at Milwaukee, Wis., and Escanaba Mich., during the year are also transmitted herewith.

Very respectfully, your obedient servant,

JAMES F. GREGORY,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, June 30, 1893.

SIR: I have the honor to submit the accompanying profile of water-level curves on Lake Michigan, with monthly reports of observers reduced to plane of reference. The tri-daily observations of the water gauge established by the United States Lake Survey at the foot of Poplar street, Milwaukee, have been continued without interruption during the fiscal year ending this date. The observations were discontinued at Escanaba from December 17, 1892, to April 26, 1893.

The following are records of the monthly levels in feet and decimals of feet at Milwaukee and Escanaba below the established plane of reference, the zero of the gauge at Milwaukee being 0.61 feet above plane of reference, and the zero of gauge at Escanaba, Mich., being taken at 0.76 feet above the same plane:

Observation stations.	1892.						1893.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
Milwaukee	3.842	3.758	3.964	4.203	4.467	4.743	4.754	4.612	4.504	4.044	3.736	3.409
Escanaba	4.221	4.185	4.368	4.637	4.643	4.949*	.....	......	......	4.390†	4.247	3.814

*1st to 17th. †26th to 30th.

Respectfully submitted,

W. H. HEARDING,
Assistant Engineer.

Maj. JAS. F. GREGORY,
Corps of Engineers, U. S. Army.

D D D 6.

WATER GAUGE AT OGDENSBURG, NEW YORK.

REPORT OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., March 24, 1893.

GENERAL: I have the honor to inclose herewith the tabulation, in duplicate, called for by your letter of the 13th instant, being the record of water gauge at Ogdensburg, N. Y., from 1869 to 1874, and from 1883 to 1892, inclusive, with the exception of the year 1888; and, as directed, all readings are reduced to refer to the present zero.

* * * * * * *

Very respectfully, your obedient servant,

SMITH S. LEACH,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Record of water gauge at Ogdensburg, N. Y.

[The standard gauge is cut on the retaining wall of the light-house inclosure. Its zero is near local low water. The doorsill of light house reads 6.75 feet on the gauge.]

1869.

[Readings of gauge above zero in feet.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	1.5	1.9	1.5	1.6	1.2	1.2
2	1.5	1.7	2	1.5	1.6	1.3	1.2
3	1.5	1.6	2	1.5	1.6	1.3	1.2
4	1.4	1.6	1.9	1.5	1.5	1.2	1.6
5	1.5	1.5	1.9	1.4	1.5	1.2	1.3
6	1.5	1.7	1.9	1.3	1.5	1.2	1.1
7	1.5	1.7	1.8	1.3	1.5	1.1	1.3
8	1.4	1.6	1.9	1.4	1.5	1.1	1.3
9	1.4	1.7	1.9	1.4	1.5	1.2	1.6
10	1.4	1.7	1.8	1.4	1.7	1.1	1.5
11	1.9	1.8	1.8	1.4	1.7	1	1.3
12	1.5	1.7	1.5	1.4	1.7	1	1.1
13	1.5	1.7	1.8	1.5	1.7	0.7	1.1
14	1.6	1.5	1.8	1.5	1.6	0.7	1
15	1.8	1.9	1.9	1.6	1.5	0.7	1
16	1.7	1.9	1.9	1.6	1.3	0.7	1.1
17	1.6	1.9	1.7	1.6	1.4	0.7	1.5
18	1.5	1.7	1.8	1.6	1.5	1	1.2
19	1.6	1.6	1.8	1.6	1.6	0.7	1.6
20	1.6	1.7	1.7	1.6	1.7	1.9	1.2
21	1.4	2	1.8	1.6	1.6	1	1.3
22	1.6	2	1.8	1.6	1.3	0.8	1.3
23	1.6	2	1.7	1.6	1.3	0.7	2.4
24	1.6	2	1.8	1.7	1.3	1.1	1.6
25	1.6	1.9	1.7	1.6	1.4	1.2	1.6
26	1.5	1.8	1.7	1.6	1.2	1.1	1.4
27	1.6	2	1.7	1.6	1.1	1.1	1.6
28	1.6	1.9	1.7	1.6	1.2	1.3	1.6
29	1.7	1.9	1.7	1.6	1.2	1.2	1.6
30	1.5	2	1.5	1.7	1.1	1.6	2
31	....	2	1.5	....	1.1	....	1.8

1870.

[Readings of gauge above zero in feet.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	1.9	1.6	1.7	3.5	3.0	2.4	2.7	2.0	1.3	0.8	1.6
2	—0.1	1.8	1.7	1.9	3.5	3.0	2.7	2.4	2.0	1.3	1.1	1.2
3	3.7	1.8	1.7	1.9	3.5	3.0	2.8	2.5	1.8	1.2	1.0	0.5
4	1.9	1.6	1.4	1.5	3.4	2.9	2.8	2.7	1.9	1.0	1.2	0.8
5	1.8	1.9	1.6	2.0	3.3	3.0	2.8	2.6	1.2	1.1	1.0	0.1
6	2.1	1.8	1.5	2.2	3.3	3.0	2.8	2.6	1.4	1.0	1.3	0.3
7	1.6	1.8	1.5	2.3	3.3	3.0	2.7	2.4	1.9	1.1	1.5	0.5
8	1.5	1.6	1.6	2.4	3.3	3.0	2.8	2.6	1.7	1.2	1.2	0.4
9	1.6	1.8	1.6	2.4	3.2	2.8	2.9	2.6	1.9	1.2	1.3	0.3
10	1.5.	1.8	1.4	2.4	3.2	2.8	2.8	2.6	1.5	1.4	1.4	1.0
11	1.4	1.5	1.5	2.5	3.2	2.8	2.6	2.5	1.5	1.5	1.2	0.2
12	1.6	2.2	1.4	2.6	3.1	2.9	2.8	2.5	1.6	1.3	1.1	0.0
13	1.1	1.7	1.4	2.6	3.3	3.0	2.9	2.4	1.5	1.6	1.2	0.9
14	1.3	1.7	1.5	2.8	3.2	3.0	2.8	2.8	1.7	1.5	0.6	1.6
15	1.8	1.6	1.5	2.2	3.4	3.0	2.8	2.4	1.7	1.4	0.7	1.9
16	1.5	1.6	1.2	2.7	3.5	3.0	2.8	2.5	1.2	1.7	0.6	0.4
17	1.7	1.6	1.5	2.7	3.0	3.0	2.7	2.5	1.5	1.5	1.1	1.3
18	1.8	1.9	1.6	2.7	3.4	3.1	2.7	2.3	1.5	—0.5	1.1	1.0
19	1.8	1.8	1.6	2.7	3.4	3.2	2.6	2.4	1.5	1.2	1.2	1.0
20	1.8	1.7	1.6	3.0	3.3	3.1	2.7	2.3	1.5	1.4	0.8	1.2
21	1.7	1.8	1.6	3.2	2.9	3.1	2.7	2.5	1.5	1.6	0.9	1.5
22	1.7	1.9	1.6	3.3	3.0	3.1	2.5	2.3	1.6	1.7	0.1	1.4
23	1.9	1.8	1.7	3.3	3.3	3.1	2.7	2.2	1.6	1.1	0.1	1.0
24	1.7	1.6	1.6	3.3	3.5	3.1	2.8	2.0	1.4	1.2	0.9	......
25	1.9	1.8	1.5	3.3	3.4	3.0	2.9	2.3	1.4	1.3	1.2	......
26	1.8	1.7	1.4	3.7	3.0	2.9	2.6	2.0	1.4	1.1	1.5	......
27	1.9	1.2	1.1	3.4	2.9	3.0	2.6	2.0	1.4	1.1	1.2	......
28	1.9	1.6	1.5	4.0	2.9	3.0	2.6	2.0	1.4	1.2	0.3	......
29	1.9	......	1.6	3.5	3.1	2.9	2.7	2.1	1.4	1.2	1.4	......
30	1.7	......	1.7	3.5	3.1	2.2	2.7	2.3	1.3	1.5	1.3	......
31	1.9	......	1.6	......	3.0	......	2.8	2.3	......	0.9	......	......

Record of water gauge at Ogdensburg, N. Y.—Continued.

1871.

[Readings of gauge above zero in feet.]

Date.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	1.5	1.6	1.6	1.1	1.0	....	0.4
2	....	1.3	1.6	....	1.1	0.9	0.4	0.3
3	....	0.9	1.5	1.3	1.2	....	0.7	—0.2
4	....	0.6	....	1.3	1.4	1.0	0.8	0.4
5	....	0.9	1.2	1.1	1.4	1.0	0.8	....
6	....	1.7	1.5	1.0	....	1.1	0.5	—0.3
7	....	....	1.9	1.1	1.0	0.6	0.6	—0.2
8	....	0.8	1.9	1.6	1.6	0.7	....	—0.2
9	....	1.0	1.9	....	1.0	0.9	1.0	—0.3
10	....	0.9	1.7	1.5	1.3	....	0.8	—0.1
11	....	1.8	....	1.5	1.2	0.9	0.6	0.0
12	1.8	1.5	1.9	1.4	0.7	0.8	0.1	....
13	1.5	1.6	2.2	1.8	....	0.5	0.4	—0.6
14	1.3	....	1.9	1.9	0.7	0.5	0.6	—0.4
15	1.2	1.3	1.5	1.7	0.9	0.6	....	—1.0
16	....	1.7	1.8	....	1.3	0.7	0.2	—0.3
17	1.1	1.2	1.6	1.3	0.9	....	0.6	—0.2
18	1.1	1.2	....	1.7	1.8	0.5	0.3	—0.3
19	1.0	1.9	1.6	1.6	1.0	0.5	0.9	....
20	1.2	1.8	1.7	1.5	....	0.5	0.0	0.3
21	1.2	....	1.5	1.4	0.5	0.4	0.5	—0.4
22	1.5	1.5	1.7	1.3	0.8	0.5	....	—0.5
23	....	1.5	1.3	....	0.9	0.9	0.2	—0.2
24	1.5	1.7	1.5	1.5	1.0	....	—0.3	—0.1
25	1.1	1.8	....	1.2	0.8	0.4	—0.4	—0.2
26	0.9	1.9	1.6	1.2	0.9	0.5	—0.1	....
27	0.9	1.5	1.6	1.4	....	0.8	0.3	—0.7
28	1.2	....	1.7	1.1	0.8	0.8	0.2	—0.8
29	1.0	1.0	1.2	1.0	0.6	0.9	....	....
30	....	1.6	1.8	....	1.0	0.5	—0.1	....
31	....	1.4	....	1.0	1.0	....	—0.2	....

1872.

[Readings of gauge above zero in feet.]

Day.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	....	—0.5	—0.3	0.1	0.0	....	—0.2	—0.9
2	....	—0.2	0.0	0.4	—0.1	0.0	—0.4	—0.7
3	....	—0.1	—0.4	0.0	—0.1	—0.1	—0.2	....
4	....	—0.3	—0.4	0.2	....	0.1	—0.3	—0.6
5	....	....	—0.4	0.3	0.1	0.1	—0.3	—0.6
6	....	—0.3	0.0	0.2	0.1	0.2	....	—0.1
7	....	—0.3	—0.1	....	0.3	0.2	—0.6	—0.3
8	....	—0.4	—0.1	0.2	0.2	....	—0.6	—0.4
9	....	—0.4	....	0.3	0.1	—0.5	—0.5	—0.4
10	....	—0.4	0.2	0.2	0.3	0.1	—0.4	....
11	....	—0.3	0.5	0.1	....	0.1	—0.6	—0.6
12	....	....	0.3	0.3	—0.1	0.1	—0.7	—0.5
13	....	—0.5	0.2	—0.3	—0.1	0.6	....	—0.5
14	....	—0.5	0.5	....	—0.2	0.3	—0.7	—0.5
15	—1.2	—0.5	0.2	0.2	0.1	....	—0.2	0.5
16	—1.0	—0.5	....	0.2	—0.1	—0.2	—0.6	0.1
17	—1.0	—0.6	0.3	0.1	0.2	—0.3	—0.7	....
18	—0.7	0.5	0.1	0.0	....	—0.2	—0.4	—0.5
19	—0.4	....	0.2	0.0	0.0	—0.2	—0.4	—0.7
20	—0.8	—0.3	0.3	0.3	—0.1	—0.3	....	....
21	....	—0.3	0.3	....	0.1	—0.1	—0.2	....
22	0.0	—0.5	0.1	—0.2	0.1	....	—0.3	....
23	0.4	—0.4	....	0.2	0.0	—0.6	—0.5	....
24	—0.5	—0.1	0.2	0.3	0.1	—0.3	—0.6	....
25	—0.2	0.0	0.2	0.3	....	0.0	—1.0	....
26	0.2	....	0.1	0.3	0.0	—0.2	—1.1	....
27	—0.7	—0.3	0.1	0.0	—0.1	0.2	....	....
28	....	—0.2	0.2	....	—0.1	—0.3	—0.9	....
29	—0.5	—0.2	0.2	0.1	0.0	....	—0.8	....
30	—0.5	—0.3	....	0.0	0.1	0.2	—0.8	....
31	....	—0.5	....	0.0	0.1	....	—0.6	....

Record of water gauge at Ogdensburg, N. Y.—Continued.

1873.

[Readings of gauge above zero, in feet.]

Day.	Apr.	May.	June.	July.	Day.	Apr.	May.	June.	July.
1	....	1.5	1.6	1.4	17	0.8	1.4	1.6	1.5
2	....	1.1	1.6	1.5	18	1.0	1.4	1.7	1.3
3	....	1.0	1.4	1.8	19	0.7	1.5	1.8	1.6
4	....	1.3	1.4	1.5	20	....	1.5	1.9	1.6
5	....	1.3	1.6	1.9	21	1.2	1.6	1.8	1.6
6	....	1.3	1.5	1.8	22	1.2	1.6	1.6	1.6
7	....	1.2	1.5	1.8	23	1.3	1.6	1.5	1.8
8	....	1.2	1.5	1.5	24	1.4	1.9	1.5	1.4
9	....	1.2	1.4	1.5	25	1.4	1.8	1.4	2.2
10	....	1.9	1.4	1.5	26	1.5	1.6	1.4	1.5
11	....	1.8	1.5	1.6	27	1.5	1.8	1.8	1.5
12	....	1.7	1.5	1.5	28	1.4	2.2	1.4	1.3
13	....	1.0	1.6	1.5	29	1.3	1.8	1.4	1.4
14	1.2	1.9	1.6	1.8	30	1.5	1.3	1.4	1.4
15	0.8	1.7	1.6	1.4	31	....	1.7	....	1.4
16	0.8	1.4	1.5	1.6					

1874.

[Readings of gauge above zero, in feet.]

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1	......	1.8	1.4	12	......	1.6	0.9	23	1.7	1.5	......
2	......	1.8	1.1	13	......	1.4	1.0	24	1.7	1.4	......
3	......	1.6	1.2	14	......	1.4	1.0	25	1.7	1.4	......
4	......	1.7	1.1	15	......	1.3	1.0	26	1.7	1.4	......
5	......	1.6	1.1	16	2.0	1.4	0.9	27	1.6	1.4	......
6	......	1.7	1.0	17	1.7	1.6	0.8	28	1.3	1.5	......
7	......	1.6	1.0	18	1.8	1.6	0.9	29	1.6	1.3	......
8	......	1.7	1.0	19	1.6	1.6	0.8	30	1.6	1.2	......
9	......	1.6	1.0	20	1.6	1.7	0.9	31	1.8	1.3	......
10	......	1.6	1.0	21	1.7	1.5	1.0				
11	......	1.6	0.9	22	1.6	1.6	......				

1883.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1	....	2.1	2.0	1.7	17	1.2	2.2	1.9	1.0
2	....	2.2	1.9	1.7	18	1.4	2.1	1.7	....
3	....	1.7	2.0	1.7	19	1.9	2.0	1.7	....
4	....	1.7	2.3	1.6	20	1.7	1.8	1.8	....
5	....	1.9	1.9	1.6	21	1.7	1.8	1.7	....
6	....	1.7	2.1	1.6	22	1.7	1.9	1.7	....
7	....	1.9	2.0	1.6	23	1.6	1.7	1.7	....
8	1.2	1.7	1.9	1.6	24	1.6	1.8	1.7	....
9	1.2	1.6	1.9	1.6	25	1.5	1.9	1.6	....
10	....	1.7	1.7	1.6	26	1.6	1.9	1.6	....
11	1.6	1.9	1.7	1.6	27	1.7	1.9	1.6	....
12	1.6	2.0	1.7	1.4	28	1.7	1.9	1.6	....
13	1.6	1.9	1.6	1.2	29	1.8	1.9	1.5	....
14	1.6	1.9	1.8	1.5	30	1.4	2.1	1.7	....
15	1.4	1.9	1.7	1.5	31	....	2.2	1.7	....
16	1.5	2.0	1.7	1.1					

Record of water gauge at Ogdensburg, N. Y.—Continued.

1884.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.0	1.5	1.5	0.6	17		1.9	1.3	0.7	
2		2.1	1.1		0.7	18		1.5	1.2	0.5	
3		2.0	1.4	1.0	0.6	19		1.6		0.4	
4		1.9	1.7	0.1	0.9	20		1.7	1.7	0.6	
5		1.9		1.9	0.5	21			1.1	0.9	
6		2.0	1.6	1.1	0.2	22		1.5	1.7	0.1	
7			1.3	2.0		23		1.3	1.4		
8		1.8	1.4	0.9	1.0	24		1.8	1.3	1.1	
9		1.7	1.3		0.8	25		1.5	1.4	1.0	
10		1.7	1.5	0.9	0.8	26		1.5		1.0	
11		2.0	1.6	1.0	1.0	27	2.0	1.8	1.4	1.0	
12		1.8		0.8	0.1	28	1.9		1.3	0.6	
13		1.5	1.3	1.4	0.3	29	1.9	1.7	0.8	0.9	
14			1.3	1.1		30	2.0	1.5	0.9		
15		1.7	1.3	0.5		31			0.8		
16		2.3	1.5								

1885.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		1.8	1.8			1.6	
2		1.6	2.0			1.6	1.4
3		1.6	2.0			1.5	1.7
4		1.5					1.5
5		1.3				1.6	1.5
6		1.6				1.5	1.5
7						1.5	
8		1.8				1.5	
9		1.9				1.5	
10		2.0				1.6	
11		1.7					
12		1.7				1.0	
13		1.9				1.2	
14						1.3	
15		1.7				1.5	
16		1.9			1.8	1.5	
17		2.0			1.6	1.5	
18		2.0			1.8		
19		1.9			1.8	1.1	
20		1.8				1.6	
21	1.5				1.9	1.4	
22	1.5	2.5			1.8	1.5	
23	1.5					1.4	
24		2.1			1.9	1.5	
25	1.6	2.0			1.9		
26	1.7	2.0			2.0	1.5	
27	1.6	2.0				1.5	
28	1.5				1.7	1.2	
29	1.5	1.9			1.6	1.2	
30	1.5	1.8			1.9	1.0	
31						1.5	

1886.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	Nov.	Dec.	Day.	Nov.	Dec.
1		1.1	25	1.0	
2		1.8	26	1.3	
3		1.4	27	1.0	
22	1.0		29	1.6	
23	1.0		30	1.0	
24	1.6				

Record of water gauge at Ogdensburg, N. Y.—Continued.

1887.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	Apr.	May.	June.	July.	Aug.	Day.	Apr.	May.	June.	July.	Aug.
1	......	......	2.4	2.4	1.8	17	......	2.6	2.3	......	1.8
2	......	2.2	2.4	2.5	1.9	18	......	2.6	2.3	2.1	1.8
3	......	2.5	2.7	......	2.0	19	......	2.6	......	2.1	2.1
4	......	2.6	2.5	......	2.0	20	......	2.5	2.4	2.2	1.9
5	......	2.4	......	2.5	2.0	21	......	2.5	2.5	2.0	......
6	......	2.4	2.5	2.5	2.2	22	......	......	2.5	2.2	......
7	......	2.5	2.4	2.5	......	23	......	2.8	2.5	2.2	......
8	......	......	2.5	2.4	2.1	24	......	2.7	2.5	......	......
9	......	2.5	2.4	2.4	1.9	25	......	2.6	2.5	2.1	......
10	......	2.6	2.4	......	2.0	26	......	2.6	......	2.2	......
11	......	2.4	2.4	2.4	2.1	27	......	2.5	2.3	2.2	......
12	......	2.5	......	2.5	......	28	2.2	2.3	2.4	1.0	......
13	......	2.4	2.6	2.4	2.0	29	2.0	......	2.4	2.0	......
14	......	2.5	2.2	2.4	......	30	2.3	2.4	2.5	2.0	......
15	......	......	2.5	2.3	2.0	31	......	2.5	......	......	......
16	......	2.6	2.6	2.4	1.9						

1889.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	Oct.	Nov.	Day.	Oct.	Nov.	Day.	Oct.	Nov.	Day.	Oct.	Nov.
1	......	0.3	9	......	0.2	17	......	......	25	......	0.2
2	......	0.4	10	......	......	18	......	0.1	26	......	0.2
3	......	......	11	......	0.2	19	......	—0.1	27	......	0.1
4	......	0.7	12	......	0.2	20	......	0.1	28	0.2	......
5	......	0.7	13	......	0.1	21	......	0.4	29	0.2	......
6	......	0.8	14	......	0.4	22	......	0.1	30	0.3	......
7	......	0.9	15	......	0.2	23	......	0.1	31	0.3	......
8	......	0.3	16	......	0.1	24	......	......			

1890.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	1.8	......	2.3	1.9	1.2	17	2.4	2.6	2.5	......	1.0
2	1.8	1.7	2.5	1.8	1.5	18	......	2.6	2.2	1.4	1.2
3	2.0	1.7	2.5	......	1.1	19	2.5	2.6	2.1	1.3	1.2
4	......	2.0	......	1.8	1.0	20	2.0	2.7	......	1.2	1.6
5	1.5	2.1	2.6	1.8	1.2	21	2.0	2.6	2.0	1.2	......
6	1.9	2.1	......	1.8	1.1	22	1.8	......	2.1	1.5	1.2
7	2.2	2.6	2.5	1.7	......	23	2.1	2.6	2.2	1.2	1.5
8	1.8	......	2.6	1.8	......	24	1.9	2.5	2.2	......	1.2
9	2.0	2.4	2.7	1.8	......	25	......	2.4	2.0	1.3	1.4
10	1.5	2.4	2.5	......	......	26	2.2	2.4	2.1	1.3	1.3
11	......	2.5	2.4	1.5	......	27	2.1	2.4	......	1.3	1.2
12	1.9	2.5	2.4	1.4	......	28	2.0	2.4	2.0	1.2	......
13	1.6	2.5	......	1.5	......	29	1.8	......	2.1	1.2	1.0
14	1.9	2.2	2.5	1.5	......	30	2.0	......	2.3	1.5	1.1
15	2.0	......	2.6	1.5	1.2	31	2.0	......	2.5	......	......
16	2.1	2.4	2.4	1.4	1.1						

Record of water gauge at Ogdensburg, N. Y.—Continued.

1891.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	1.0	0.6	0.2	0.1	....	—1.0
2	....	0.9	....	0.1	—0.1	—0.5	—0.9
3	1.4	0.9	0.5	0.2	—0.2	—0.7	—1.0
4	1.3	....	0.5	0.1	....	—0.6	—0.9
5	1.2	....	0.5	—0.1	0.1	—0.6	0.3
6	1.2	1.1	0.5	....	—0.1	—0.6	....
7	....	1.0	0.6	0.1	—0.3	—0.6	—0.9
8	1.5	0.9	0.4	0.0	—0.1	....	—0.4
9	1.1	0.9	....	0.2	—0.1	—0.7	—0.2
10	1.1	0.9	0.5	0.2	0.1	—0.8	—1.0
11	1.5	0.9	0.6	0.0	....	—0.8	—0.9
12	1.1	....	0.6	0.1	—0.5	—0.8	—0.9
13	1.1	1.1	0.5	....	—0.5	—0.8	....
14	....	1.0	0.5	0.0	—0.5	—1.0	....
15	1.3	1.2	0.5	0.0	—0.2	....	....
16	1.2	1.0	....	0.1	—0.2	—0.6	....
17	0.9	0.9	0.5	0.2	—0.4	0.2	....
18	1.0	0.7	0.4	0.6	....	—0.5	....
19	0.9	....	0.1	—0.1	—0.5	—0.6	....
20	1.0	0.5	0.5	....	—0.6	—0.8	....
21	....	0.6	0.5	0.0	—0.5	—1.0	....
22	1.1	0.6	0.5	—0.1	—0.5	....	....
23	1.2	0.7	....	0.0	—0.5	—0.9	....
24	1.0	0.8	0.1	0.1	—0.5	0.6	....
25	1.0	0.8	0.6	0.1	....	—0.7	....
26	0.9	....	0.3	—0.1	—0.6	—1.1	....
27	0.6	0.7	0.2	....	—0.5	—0.3	....
28	....	0.8	0.6	0.1	—0.6	—0.9	....
29	0.9	0.7	0.3	0.2	—0.6	....	....
30	0.6	0.7	....	—0.1	—0.6	—0.8	....
31	....	0.7	0.1	....	—0.4	....	....

1892.

[Mean of tridaily readings of gauge above zero, in feet.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	....	0.5	0.5	0.7	—0.1	—0.8	—0.3
2	....	0.6	0.5	0.6	....	—0.8	—0.4
3	....	....	0.6	0.7	0.4	—0.3	—0.5
4	....	0.7	0.7	....	0.0	—0.3	....
5	....	0.5	0.6	0.8	0.0	—0.4	—0.4
6	....	0.5	0.7	0.9	0.1	....	—0.4
7	—0.2	0.6	....	0.7	0.4	0.0	—0.4
8	—0.1	0.6	0.5	0.5	0.3	—0.1	—0.3
9	0.0	0.6	0.7	0.5	....	—0.2	—0.2
10	—0.1	....	0.6	0.5	0.0	—0.2	—0.3
11	0.2	0.6	0.6	....	—0.1	—0.2	....
12	....	0.6	0.3	0.7	—0.2	—0.1	—0.2
13	0.3	0.7	0.5	0.6	0.0	....	0.0
14	0.4	0.6	....	1.2	0.1	0.1	0.0
15	0.0	0.6	0.5	0.8	0.1	—0.4	0.0
16	0.2	0.6	0.6	0.8	....	—0.2	—0.2
17	—0.2	....	0.6	0.6	0.0	—0.3	—0.5
18	0.0	0.9	0.6	....	—0.1	—0.2	....
19	....	0.7	0.6	0.5	0.1	0.0	....
20	0.4	0.6	0.2	0.3	0.0	....	....
21	0.1	0.7	....	0.2	0.0	0.1	....
22	0.4	0.6	0.5	0.3	0.1	—0.1	....
23	0.3	0.6	0.4	0.4	....	—0.2	....
24	0.3	....	0.6	0.3	0.0	—0.1	....
25	0.4	0.6	0.3	....	0.0	—0.2	....
26	....	0.7	0.2	0.7	—0.2	—0.4	....
27	0.1	0.6	0.3	0.5	—0.1	....	....
28	0.1	0.7	....	0.5	0.0	—0.7	....
29	0.3	0.8	0.3	0.3	0.1	—0.6	....
30	0.5	0.5	0.4	0.6	....	—0.4	....
31	....	....	1.1	....	0.1	....	....

APPENDIX E E E.

CONSTRUCTION AND IMPROVEMENT OF ROADS AND BRIDGES IN THE YELLOWSTONE NATIONAL PARK.

REPORT OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., July 6, 1893.

GENERAL: I have the honor to submit herewith my report of operations for the improvement of Yellowstone National Park during the fiscal year ending June 30, 1893.

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

The project for this work was adopted in 1883, when the control was placed in the hands of officers of the Corps of Engineers, and consists in the construction and maintenance of about 225 miles of road, with the necessary bridges, culverts, etc. The roads embraced in the project commence at Gardiner, at the north boundary line of the Park, thence to Mammoth Hot Springs; thence to Upper Geyser Basin, passing through Norris Geyser and Lower Geyser Basins; thence to the outlet of Yellowstone Lake via Shoshone Lake and the west arm of Yellowstone Lake, crossing the continental divide of the Rocky Mountains twice; thence to Yanceys, via the Falls and Grand Canyon of the Yellowstone River; thence to Mammoth Hot Springs, completing the so-called belt road, with a circuit of about 145 miles. In addition, there are projected a road from the west boundary line of the Park, passing through Lower Geyser Basin and continued easterly to intersect the road along the Yellowstone River to the Falls; a road from Norris Geyser Basin to the Falls of the Yellowstone; a road from Yanceys to the east boundary line of the Park, and a number of short branch roads and trails from the above-named roads to objects of interest off the main line of travel; in all, 225 miles of new road, about 20 large and 50 small bridges, with many culverts, etc. Estimated cost, as revised in 1889 by my predecessor, $444,779.42.

The act of Congress approved March 3, 1891, changed the project of the part of the belt line between Lower Geyser Basin and Yellowstone Lake by requiring the road to be built "by the shortest practicable route" from Fountain Geyser to the thumb of the Yellowstone Lake. This change did not materially affect the cost.

The act of Congress approved August 5, 1892, appropriated $45,000, and provided "that fifteen thousand dollars of this amount, or so much thereof as may be necessary may be expended, in the discretion of the Secretary of War, for the construction of a road from the Upper Geyser Basin to a point on Snake River where it crosses the southern boundary of the park."

Construing this act as the wish of Congress to modify the project by adding thereto some 33½ miles of projected road, the estimated cost of my predecessor will be considerably increased. A detailed estimate is not now given, as experience has demonstrated that all the estimates heretofore made have been too low, and it is the intention to submit to the Chief of Engineers at an early date a new estimate of the cost of completing the project. The question of repairs has not yet been included in the estimates, although about 20 per cent of the appropriations have been expended in this way.

It may suffice, for the present, to state that the expenditures to June 30, 1893, have been $373,779.42 and the project for plain dirt roads is not one-half completed.

At the beginning of the year the roads that were open to travel and averaging in fairly good condition were: (1) The road from Gardiner to Mammoth Hot Springs, Norris, Lower, and Upper Geyser Basins; (2) the road from Norris Geyser Basin to the Falls of the Yellowstone; (3) the road from Upper Geyser Basin to the Falls of the Yellowstone via Yellowstone Lake and outlet. There were also in use the two roads known as the Madison Canyon road and Howard trail from the western boundary line of the Park to Lower Geyser Basin, where they joined, and their continuation as one road to the road from Yellowstone Lake outlet to the falls.

Total amount expended to June 30, 1892, including outstanding liabilities, $334,779.42.

WORK DONE.

The close of the last fiscal year found all work practically suspended for lack of funds, and as the new appropriation came so late, there was but a short season for operations. Full details of the work accomplished during the season will be found in the report of Lieut. Chittenden, herewith. The operations consisted mainly in making new road at Mammoth Hot Springs, Norris, Gibbon Canyon, and Grand Canyon, in completion of old roads at various points, and in extensive repairs. In the spring of 1893 a contract was entered into with Oscar Swanson for completing a wagon trail to the south boundary of the Park and repair parties were placed early in the field to insure a good condition of the roads as soon as the snow went off. Snow remained on the roads much later than usual, and these parties had to shovel their way through it for considerable distances. It may be necessary to submit estimates for clearing a portion of the roads from snow which blocks them up during the month of June. As a result of these operations the whole road system presented itself for the season's traffic in excellent condition.

Amount expended during fiscal year ending June 30, 1893, including outstanding liabilities, $39,000.

REVISED PROJECT.

The approved project as modified by my predecessor calls for an expenditure of $444,779.42 on 225 miles of road, including bridges. This was based upon an estimated cost of $2,000 per mile. In my report of operations for November, 1892, an analysis of the past expenditures is presented which shows that the average cost per mile, including repairs prior to 1891, was $3,300. This completed 60.9 miles of road out of a total of 225. The cost of repairs and maintenance should come out of the $201,898.69 expended on this mileage, but it is apparent that a revision of the estimate can not be longer deferred.

An extract from the report above alluded to is herewith submitted, and a new project will be duly prepared based thereon:

"A map* is submitted herewith showing (1) the location of the various points of interest in the Park which are to be reached by roads under the approved project; (2) the various stages of completion of these roads; (3) the work done during the present season; (4) the work under the project which remains to be done.

The project covers (1) four approaches, one from each boundary; (2) a belt line through the principal centers of interest; (3) side roads and bridle paths to points of minor interest.

APPROACHES.

The approaches are as follows: (1) From Mammoth Hot Springs to north boundary, distance, 5 miles; this is complete; (2) From belt line at Yanceys to east boundary, distance, 30 miles; (3) From belt line at Thumb to south boundary, distance, 33⅓ miles; (4) From belt line at Lower Firehole to west boundary, distance, 15 miles. Whole mileage of approaches, 83⅓ miles; approaches unfinished, 78⅓ miles.

BELT LINE.

There are seven principal centers of interest in the Park. They are: Mammoth Hot Springs, Norris Geyser Basin, Firehole Geyser Basin, West Thumb of Yellowstone Lake, Yellowstone Lake outlet, the Grand Canyon, the fossil forests near Yanceys. A cross road from Norris to the Grand Canyon makes a secondary belt which is now in use, and which will facilitate the distribution of supplies after the main belt is completed.

The mileage of this part of the system is:

	Miles.
Mammoth to Norris	20
Norris to Firehole Geyser Basin (Fountain Hotel)	22
Fountain Hotel to Upper Geyser Basin	12
Upper Geyser Basin to Thumb	19.1
Thumb to lake outlet	18.4
Lake outlet to Grand Canyon	17
Grand Canyon to Yanceys	23
Yanceys to Mammoth	22
Cross road from Norris to Grand Canyon	11.5
Belt mileage	165

Of this the following is not yet completed:

	Miles.
Between Norris and Fountain	7
Canyon to Yanceys	23
Yanceys to Mammoth	22
Total	52

* Printed in Annual Report of the Chief of Engineers for 1892.

SIDE ROADS AND BRIDLE PATHS.

At nearly all the principal centers, and at many points between them, there are outlying objects of interest which can only be reached by short side roads and bridle paths. These may be approximately recited:

	Miles.
Mammoth Hot Springs to the Great Canyon and falls of the Middle Gardiner River	3
Mammoth Hot Springs to the summit of Mount Evarts	3
Mammoth Hot Springs to and around the formation	1
At Norris Geyser Basin	1
To Gibbon Paint Pots	1
At Lower Geyser Basin	5
At Upper Geyser Basin	5
To Natural Bridge	2
To Sulphur Mountain	2
At Grand Canyon	5
To summit of Mount Washburn	2
To Fossil Forests	5
To Madison Lake and Shoshone Geyser Basin	15
Whole mileage	50

Of this 1 mile is finished around formation at Mammoth Hot Springs. I estimate as follows for the completion of this unfinished mileage:

To south boundary, 33½ miles, at $3,000	$100,000
To east boundary, 30 miles, at $2,500	75,000
To west boundary, 15 miles, at $3,000	45,000
Between Gibbon Canyon and Fountain, 7 miles, at $2,500	17,500
Grand Canyon to Yanceys, 23 miles, at $3,000	69,000
Yanceys to Mammoth, 22 miles, at $2,500	55,000
130 miles, main road	361,500

For the side roads it will be sufficient under the present project to simply make them passable for vehicles. That is to say, clear them of trees, stumps, roots, rocks, etc.; make cuts in steep side slopes; make provision for escape of water, but do no grading where it can be avoided. For the bridle paths these can be opened from time to time by the repair party, and no estimate is necessary for them. We then have—

Mammoth to Middle Gardiner, 3 miles, at $1,000	$3,000
Mammoth to Mount Evarts, 3 miles, at $500	1,500
At Norris, 1 mile	800
At Gibbon, 1 mile	800
At Lower Geyser Basin, 5 miles, at $1,000	5,000
At Upper Geyser Basin, 5 miles, at $1,000	5,000
To Natural Bridge, 2 miles, at 1,000	2,000
To Sulphur Mountain, 2 miles, at $500	1,000
At Grand Canyon, 5 miles, at $2,000	10,000
To Mount Washburn, 2 miles, at $1,000	2,000
To Fossil Forests, 5 miles, at $500	2,500
To Shoshone Geyser Basin, 15 miles, at $800	12,000
35 miles of side road	45,600

SUMMARY OF WORK REMAINING TO BE DONE.

135 miles of main road	$361,500
35 miles of side road	33,600
Total	395,100

The foregoing figures are largely in excess of anything previously submitted, but previous estimates have been too low. Capt. Kingman estimated the cost of this road work at $1,000 per mile; Maj. Allen raised it to $2,000 per mile; I have carried along the general estimates on the latter basis until such time as I could be able to base figures on my own work. The foregoing figures are based upon the following comparisons between the total mileage and the total expenditures:

Up to June 30, 1891, there had been expended in all upon the project $201,898.69, completing 60.9 miles; cost per mile, $3,300. Between June 15 and September 15, 1891, there was expended $132,980.73, completing substantially 44 miles and opening 53 miles to stage traffic. Of this mileage, 7.5 miles was done by contract for $34,805.25; cost per mile, $4,640.70. The remaining 36.5 miles were done by day's labor. The whole sum expended on this, including road work, repairs, large purchases of new plant, superintendence, etc., was $98,175.48; cost per mile, $2,690.

It is to be particularly noted that the 7.5 miles of contract work was almost wholly in open valley country and presented no difficulties whatever.

Summary.

Cost per mile prior to 1891, by day's labor	$3,300.00
Cost per mile in 1891, by day's labor	2,690.00
Cost per mile in 1891 by contract	4,640.70
Total expenditure up to June 30, 1893	$379,779.42
Miles of road completed, including maintenance and repairs	127.5
Additional mileage required to complete the project	170
Estimated cost of completion, exclusive of repairs and maintenance	$395,100
Estimated cost of repairs and maintenance, per mile per year	200

It is impossible to separate the item of repairs with any reasonable precision. It has often happened that the work of one season has opened stretches of road but has not finished them. In subsequent years these stretches would be completed by the parties engaged upon repairs, and the records do not show how much of the work of repair parties has been applied to each of these two items. I have made considerable effort to do this, and have had special blanks furnished so as to make it easy for foremen to keep the record; but the results during my administration are not enough.

An approximate statement will be as follows:

Whole expenditure to June 30, 1893	$379,779.42
Expended on new work	306,766.39
Expended on repairs	73,013.03
Total	379,779.42

It may be assumed that of the amount shown above as for repairs, about $13,000 was applied to completing unfinished work, which would give us:

Whole expenditure on construction up to June 30, 1893	$319,766.39
Whole expenditure on repairs	60,013.03
Total	379,779.42

It will be safe to assume that the cost of repairs on these dirt roads in the mountains will be in excess of that on roads elsewhere. There is considerable recorded matter on this subject, from which I estimate that it will cost not less than $200 per mile per year to keep these roads in repair. It will be necessary in the near future to surface the greater portion of the main roads with gravel. It would be much better to do it with broken stone, but it is not considered advisable to discuss such a project at present."

ABSTRACT OF ALLOTMENTS AND APPROPRIATIONS.

ALLOTMENTS.

Under the appropriation of—	
1883	$23,570.03
1884	23,000.02
1885	23,209.37

APPROPRIATIONS.

By act approved—	
August 4, 1886	20,000.00
March 3, 1887	20,000.00
October 2, 1888	25,000.00
March 2, 1889	50,000.00
August 30, 1890	75,000.00
March 3, 1891	75,000.00
August 5, 1892	45,000.00
March 3, 1893	30,000.00
	409,779.42

Money statement.

July 1, 1892, balance unexpended		$94.92
Amount appropriated by act approved August 5, 1892		45,000.00
Amount appropriated by act approved March 3, 1893		30,000.00
		75,094.92
June 30, 1893, amount expended during fiscal year		36,284.46
July 1, 1893, balance unexpended		38,810.46
July 1, 1893, outstanding liabilities	$2,810.46	
July 1, 1893, amount covered by uncompleted contracts	6,000.00	
		8,810.46
July 1, 1893, balance available		30,000.00
Amount (estimated) required for completion of existing project		*130,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1895		†150,000.00

Abstract of proposals for clearing and grubbing site for wagon road in Yellowstone National Park, opened at St. Paul, Minn., April 10, 1893, by Maj. W. A. Jones, Corps of Engineers, U. S. Army.

	No. 1. Albert L. Love, Livingston, Mont.	No. 2. Geo. T. Young, Livingston, Mont.	No. 3. Oscar Swanson, Kibbey, Mont.‡
For clearing and grubbing where the debris is to be burned on the ground ... per acre..	$350.00	$375.00	$125.00
For clearing and grubbing where the debris is to be hauled off the roadway ... per acre..	390.00	350.00	100.00
For clearing and grubbing where the debris is to be piled and burned in the autumn ... per acre..	410.00	375.00	135.00
For logs cut as specified in par. 39 of specifications, per 1,000 feet, B. M	3.00	5.00	5.00
For corduroy poles cut as specified in par. 39 of specifications, each	.15	.05	.05

‡ Accepted.

REPORT OF LIEUT. H. M. CHITTENDEN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., January 24, 1893.

MAJOR: I have the honor to submit herewith my report of operations in the Yellowstone National Park during the past season.

The annual appropriation became available August 5, 1892. The sum of $45,000

* According to estimate made in 1889, which was too low.

† Twenty thousand dollars for repairs and maintenance and $130,000 for construction of new roads.

was appropriated: "*Provided*, That fifteen thousand dollars of this amount, or so much thereof as may be necessary may be expended, in the discretion of the Secretary of War, for the construction of a road from the Upper Geyser Basin to a point on Snake River where it crosses the southern boundary of the park."

The project for the season's work, previously submitted, was approved, so far as related to the expenditure of the $30,000, immediately upon the passage of the act. A separate project for the expenditure of the $15,000 devoting only $7,500 to the purpose mentioned in the proviso was not approved until too late to undertake operations in that part of the Park during the current season. But the $7,500 withdrawn from the special allotment and added to the general improvement fund enabled us to continue operations much later than we could otherwise have done.

The organization of a working force was begun as soon as it was known that the appropriation was available. Teams were hired in open market and our first supplies were purchased by the same method because the extreme shortness of the season made it unadvisable to await the issue of proposals. The teams were obtained wherever they could be found, generally in numbers of three or four from a single party.

The organization for the summer's work consisted of the following parties:

Under foremen Mitchell Askey, A. C. Wells, and W. C. Wyatt, parties consisting each of: 1 foreman, 1 subforeman, 1 blacksmith, 1 cook, and an average of about 30 men and 10 teams.

Under foreman Henrie, a general repair party consisting of 1 subforeman and carpenter, 1 cook, 17 laborers, 5 teams.

Under foreman J. H. Sohl a bridge construction party consisting of 1 foreman, 3 carpenters, 1 cook, 8 laborers, 2 teams.

Under A. O. Powell, assistant engineer from this office, a survey party consisting of 1 assistant engineer, 1 transitman, 1 leveler, 1 rodman, 2 chainmen, 2 stadiamen, 1 cook, 1 team, 1 saddle horse.

The work under Foreman Askey was mainly done along the Yellowstone River, consisting of road completion, general repairs, and graveling, particularly at Trout and Antelope Creeks, Alum Creek, and the stretch of road along the cut bank about a mile north of Alum Creek. After the completion of this work the opening of about a mile of new road was begun along the rapids of the Yellowstone to replace the bad stretch of old road which passes through the fields at some distance back from the river. This work was carefully laid out by Mr. Powell and will form probably the finest piece of work from a professional point of view, as it certainly will be the most interesting scenic route hitherto constructed. Commencing at that point of the river where it breaks into the extremely picturesque rapids which extend for half a mile above the falls, the road leaves the river just opposite the brink of the falls, forming a fitting introduction to the general scenery of the Grand Canyon. On this piece of road will be the largest bridge yet constructed in the Park. Its length is 180 feet and greatest height about 52 feet. It crosses the inlet of a small, and generally dry, tributary of the Yellowstone. It is built on a gradient of 3 feet to 100. It is composed of three decks on the plan of ordinary railroad bridges. The proper sizes of timbers have been carefully computed and the cost of the whole estimated. It will require approximately 70 M feet of lumber, a part of which we have from last year's supply, and will cost, complete, about $1,500. The only work so far done upon it is the building of the foundation to a point above high-water mark, and the hauling of about 20 M feet of lumber to the ground. It will take but little work in addition to the completion of the bridge to make this piece of road available.

The existing very poor wagon road to Inspiration Point was extended half a mile by an exceedingly interesting road, which touches at two or three points on the brink of the canyon and terminates immediately at the Point.

The short piece of road, about 100 yards, just south of Cascade Creek Bridge was carefully repaired. This has been probably the worst piece of road in the Park whenever the weather has been wet. The soil is very peculiar and drainage seems to be scarcely any help, the ground at once absorbing all water that falls upon it. About 150 feet of this road was covered with hand-broken stone to a depth of about 9 inches, the bottom layer being composed of pieces about 5 by 4 inches and the top layer of cubes averaging about 2½ inches with a thin covering of fine material. The other half of the road was covered with 18-foot corduroy poles well covered with gravel. The ditch was very carefully cleared out and revetted, and inclined poles were placed across it and imbedded in the bank to prevent careless drivers from running into it. The broken stone was taken from the roadside just across the Cascade Creek Bridge and served the important end of clearing out and widening the side hill cut at that point.

There was considerable additional general repair work done in this vicinity.

The work under Foreman Wells was mainly done on the road from the Firehole River to the West Thumb of the Yellowstone Lake. In Spring Creek Canyon the road was extensively improved and the creek well cleaned out. The work was efficiently done, although additional expenditure can be made there to advantage.

Over the Continental Divide and down the east slope of the mountains considerable work was done, consisting of widening, elevating, and draining the road where it was barely opened up last year. Along the east fork of Heron Creek a small amount of work was done designed to control the stream that flows along the roadside during the melting of the snow in May and June.

Upon the completion of this work Foreman Wells moved his camp to the vicinity of Excelsior Geyser and commenced work on the new road that is to pass through the Great Fountain Geyser Basin. But little work was done at this point, only about three-fourths of a mile road being opened up. The party then moved to the vicinity of the Fountain Hotel and did considerable work in graveling the long stretch of road across the swampy plain just north of the hotel.

Foreman Wyatt did work at two points, near Norris Geyser Basin and in the Gibbon Canyon. The work at Norris consisted in cutting out the exceedingly difficult Norris Hill, which had become so badly washed as to be in need of immediate reconstruction. The work was executed in the least satisfactory and most expensive manner of any during the season. The crew was especially unfortunate in having a large proportion of inefficient help which the exigencies of the work had compelled us to accept. It took some time to weed out the worthless laborers and replace them by others, and the loss thus occasioned fell principally upon this part of the work. The Norris cut-off is an important work. It shortens the old route by about a quarter of a mile in a distance of 2 miles, at the same time avoiding two of the worst hills in the Park. The real gain can be seen from the fact that even in the present imperfect condition of the work the saving of time to stage coaches is twenty minutes in a distance which now takes but ten minutes to traverse.

The work at Gibbon Canyon is even more important than that at Norris. It avoids probably the steepest and hardest single hill in the Park, replacing it by a maximum grade of only 3 per cent without lengthening the route.

The work under Foreman Henrie was exclusively repair work. He passed over the whole line of the old road from Mammoth Hot Springs to Cooke City, clearing out stones, evening up sideling places, putting in culverts, and replacing the bridge over the East Fork of the Yellowstone, which was washed out last June. The party then repaired the hill road at Virginia Cascade and on Blanden Hill, where it was badly washed. Going from this point to the Gibbon Canyon, the party remained there till the end of the month doing general repair work, and was then consolidated with Askey's party at the Grand Canyon.

The bridge crew under Foreman Sohl built six substantial bridges, 2 over the Gibbon River, 3 over the Firehole above Upper Basin, and 1 small bridge across a tributary of the latter river. The average span of these bridges is about 40 feet and the average cost, including proportion of all outside expenses, is a little over $400. A large part of the timber and the decking for two of the bridges were hewn on the ground, as the amount of lumber required did not justify the use of the sawmill.

The survey work included the unsurveyed portion of the mountain road, the whole lake shore and river divisions and the new work at Norris and in the Gibbon Canyon. In addition to this, Mr. Powell, who had charge of the work, rendered valuable assistance in selecting the locations already referred to for the new road near the Grand Canyon.

From the 25th of September to the 12th of November considerable work was done in graveling the hill roads in the vicinity of Mammoth Hot Springs.

The season's work was executed under considerable difficulties, which arose principally from the necessity of organizing a force in too short a time to permit of careful selection. There are always many floating laborers or tramps (for that is what they really are) who want to go through the Park and who seize the opportunity offered by the Government work to get into the Park and out again at no expense. They are utterly useless as laborers, and it is not easy, without taking greater precautions than our limited time permits, to exclude them. All the laborers are generally poorly supplied with clothing and bedding, and find the frosty nights in the mountains too severe to get along with, and consequently they generally remain but a little while. The problem of getting efficient help for the work in the National Park is the most serious one we have to deal with.

Below is a statement of expenditures upon the various portions of the work, including all payments and liabilities to December 31, 1892:

Statement of expenditures.

From monthly money statement.

Cash payments for—	
August	$340.16
September	7,628.51
October	20,694.34
November	2,902.67
December	871.57
Outstanding December 31, 1892	780.35
	33,217.60

Apportionment of expenditures.

Team hire	$10,754.84
Labor	11,972.00
Subsistence	4,711.97
Mileage and travel	1,353.30
Freight, expressage, etc	204.50
Telegrams	105.97
Material	1,837.58
St. Paul office	1,664.00
Miscellaneous	613.44
	33,217.60

Apportioning expenditures among various working parties.

Designation of party.	Labor.	Team hire.	Board.	Miscellaneous.	Total.
Wells	$2,825.66	$2,391.29	$1,261.10	$1,364.31	$7,842.36
Askey	2,893.94	2,489.97	1,215.03	1,389.81	7,988.75
Wyatt	2,761.25	1,892.64	1,028.46	1,196.78	6,879.13
Sohl	640.08	1,088.44	224.50	411.29	2,364.31
Henrie	896.20	913.13	315.63	447.52	2,572.48
Survey	447.75	138.50	139.59	152.86	878.70
Office	1,507.12	693.50	235.53	513.06	2,949.21
Transportation		1,147.37	292.13	303.16	1,742.66
Total	11,972.00	10,754.84	4,711.97	5,778.79	33,217.60

Apportionment of expenditures among various portions of work.

New work at Mammoth Hot Springs (side roads)	$449.06
New work at Norris	4,238.18
New work in Gibbon Canyon	3,742.44
New work near Excelsior Geyser	473.53
New work near Upper Falls of Yellowstone	1,807.43
New work at Inspiration Point	323.41
General repairs and road completion in Spring Creek Canyon	3,411.97
General repairs and road completion near Continental Divide	1,829.63
General repairs and road completion on East Fork Heron Creek	921.97
General repairs and road completion along Yellowstone River and Lake	4,612.96
General repairs and graveling between Mammoth Hot Springs and Cooke Creek	1,708.11
General repairs and graveling in Gibbon Canyon	940.77
General repairs and graveling at Virginia Cascade and Blanden Hill	346.82
General repairs and graveling in vicinity of Mammoth Hot Springs	1,407.55
General repairs and graveling near Fountain Hotel	1,635.81
General repairs and graveling near Grand Canyon	1,043.89
Broken-stone work on Cascade Creek Hill	319.79
Corduroy work at Cascade Creek Hill	128.64
Bridge work on Gibbon and Firehole rivers	2,498.17
Bridge foundation above Upper Falls of Yellowstone	281.43
Bridge drawings and estimates	72.91
Survey of roads	1,023.23
	33,217.60

The work for next season should first include—in addition to regular repairs—a completion of the work begun this season at Norris, Gibbon Canyon, Fountain Geyser Basin, Upper Falls of the Yellowstone, and at Inspiration Point. It should further include special repairs on the road between Upper Geyser Basin and the mouth of Spring Creek, the opening of a driveway among the principal points of interest at the Upper Geyser Basin, and a repair of the old road from the Lower Basin to the west boundary of the Park. This, of course, does not include the work to be done between the Yellowstone Lake and the south boundary.

After the close of the tourist season I made a statistical investigation on a small scale designed to ascertain the views of the traveling public as to what will most contribute to the enjoyment of a tour of the National Park. I was led to examine this question from the fact that the hotel company, which has been seeking an electric railway franchise in the Park, had endeavored to obtain, during the summer, the signatures of all tourists who favored an electric line as a means of transportation. Of course such an expression, being entirely one-sided, could form no fair criterion as to the actual state of opinion upon the subject. For the purpose of obtaining a fair expression upon this point, and incidentally to show how little foundation there is for the opinion entertained in certain quarters that the Park road-work is practically completed, as well as to get the general impression of visitors upon the importance of the Park as a national pleasuring ground, I selected the name of one tourist for each day of the tourist season, covering all conditions of climate and travel, and sent to each the following questions: (1) What was the principal drawback to the enjoyment of your tour of the Park? (2) From the experience of your own tour would you advise your friends to visit the Park? (3) Assuming that there were a complete system of thoroughly macadamized or graveled roads in the Park, so constructed as largely to eliminate the mud and dust nuisance, and in which there should be no hills so steep that teams could not ascend them at a trot; and assuming also that there were a well-equipped electric railway covering substantially the same route; by which method would you prefer to make a tour of the Park: by coach or by car?

The names selected were in all cases those of strangers to myself, and were chosen from all sections of the country in order that the answers might form as fair a basis of general opinion as possible.

Of the one hundred and twenty letters sent out about twenty failed to reach their destination, owing to the defective post-office address taken from the hotel register. The answers to the rest were full and complete, quite beyond my expectation, and were the best possible proof of the deep interest which all who have seen the National Park take in that reservation. The answers nearly always contained the additional views of other members of the particular party to which the person addressed belonged, so that the aggregate of answers considerably exceeded the number of letters sent out. The tabulated result is as follows:

Answer to first question: Condition of roads, 97; hotel accommodations, 26; transportation accommodations, 17; miscellaneous, 21; no drawback whatever, 24; no answer to question, 4.

Answers to second question: Yes, 111; no, 2; no answer, 4.

Answers to third question: By coach, 117; by car, 29.

The above answers show (1) that to the great majority of tourists the present imperfect condition of the roads, the steepness of hills, presence of mud or dust, roughness of the way, are the principal drawbacks to the enjoyment of the Park. (2) That the wonders of the Yellowstone National Park more than offset the often serious discomforts of travel. The expression of opinion upon this point was practically unanimous. (3) That tourists, by a majority of five to one, object to the introduction of electric railways into the Park. It must be stated, however, that the answers to this question were in many cases conditional upon the existence of roads such as are described in the question. It is quite certain that if the choice had been between an electric line and our *present* roads the vote would have been in favor of the former.

It was the third question that elicited the most interesting comments upon the Park. Many of the writers insisted at length upon the importance of keeping the Park free from corporate encroachment of any kind, especially in the introduction of any form of railroad. The use of stage coaches was considered a desirable feature of the tour. In fact, those who favored the car were in most cases those who lacked either time or physical strength for the slower and rougher method of carriage.

The whole inquiry emphasizes the importance of securing a thorough system of macadamized roads for the Park and of keeping it free from anything like railroad encroachment.

I desire to mention in closing this report the frequent assistance in the execution of the season's work rendered by Capt. Anderson, Sixth U. S. Cavalry, superintendent of the Park, and Capt. Scott, of the same regiment, also stationed there.

Very respectfully, your obedient servant,

HIRAM M. CHITTENDEN,
First Lieutenant of Engineers.

Maj. W. A. JONES,
Corps of Engineers, St. Paul, Minn.

APPENDIX F F F.

EXPLORATIONS AND SURVEYS IN MILITARY DEPARTMENTS.

F F F 1.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE MISSOURI.

ANNUAL REPORT OF LIEUT. CASSIUS E. GILLETTE, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

ENGINEER OFFICE,
HEADQUARTERS DEPARTMENT OF THE MISSOURI,
Chicago, Ill., July 19, 1893.

SIR: I have the honor to submit the following report as engineer officer of this department for the year ending June 30, 1893.

One general service clerk has been employed in the office.

The rifle range at Fort Sheridan, Ill., was resurveyed and levels taken for the purpose of improving the grade of the range.

The office work has consisted in the preparation of maps and tracings for the use of the department commander and other officers connected with these headquarters. During the year there have been prepared 9 original drawings, 38 tracings, 5 maps mounted and corrected to date, besides sundry sketches.

The office has had no facilities for making blue prints, but had to depend on the Quartermaster Department for those supplied. About 100 blue prints were furnished for the ceremonies connected with the dedication of the World's Fair Grounds in October, 1892.

Very respectfully, your obedient servant,

CASSIUS E. GILLETTE,
First Lieut., Corps of Engineers,
Engineer Officer, Dept. Missouri.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

F F F 2.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE COLUMBIA.

REPORT OF MAJ. TULLY McCREA, FIFTH UNITED STATES ARTILLERY, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

ENGINEER OFFICE,
HEADQUARTERS DEPARTMENT OF THE COLUMBIA,
Vancouver Barracks, Wash., July 8, 1893.

SIR: I have the honor to submit the following report of the operations of this office for the fiscal year ending June 30, 1893.

FIELD WORK.

There being no funds in this office whatever, very little field work could be accomplished.

The lines of the United States public land survey through the Vancouver Barracks Military Reservation have been retraced and the section and quarter section corners permanently marked with stone monuments.

OFFICE WORK.

The office work has consisted in the revision of the military map of this department, from the latest Land Office and post route maps, and other official data. Much new topographical matter has been added to northern Idaho and Washington from maps and information furnished by Mr. N. D. Miller, chief engineer of the Great Northern Railway. The preparation of maps for the use of troops in the field at the scene of the mining disturbances in the Cœur d'Alene mining district. The preparation of various reports in relation to matters referred to this office for information and action. Map drawing, tracing, solar printing, map mounting, and other routine work pertaining to this office, as follows:

Maps and plans drawn	8
Tracings for issue and office files	11
Solar prints	82
Negatives	8
Maps colored	200
Maps mounted on linen	123
Maps issued	95

Five hundred copies of the revised map of this department, edition of 1892, were received from the office of the Chief of Engineers, and are being issued as called for.

General Service Clerk Charles A. Homan has been on duty as topographer and draftsman since date of last report.

There has been no funds available for the use of this office during the year.

The Quartermaster's Department has kindly furnished the drawing material necessary for carrying on the work of this office.

Very respectfully, your obedient servant,

TULLY McCREA,
Major, Fifth Artillery, Acting Engineer Officer.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

F F F 3.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE PLATTE.

REPORT OF CAPTAIN CHARLES A. WORDEN, SEVENTH INFANTRY, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

ENGINEER OFFICE,
HEADQUARTERS DEPARTMENT OF THE PLATTE,
Omaha, Nebr., July 1, 1893.

SIR: I have the honor to submit the following annual report of operations of the Engineer Office, headquarters Department of the Platte, for the fiscal year ending June 30, 1893:

On the 28th of August, 1892, I visited Fort Sidney, Nebr., by order of the department commander, and marked out on the military reservation, in accordance with the terms of the act of Congress approved June 10, 1892, 20 acres of said reservation, to be used by the city of Sidney, Nebr., as a cemetery.

A map of the Department of the Platte and adjacent territory east of the 103d meridian was completed in this office January 23, 1893. This map was reproduced and published by the Office of the Chief of Engineers, U. S. Army, and 300 copies of it were furnished this office for distribution. Army officers in this and other military departments, county surveyors, railroad officials, postmasters, and others who furnished information used in its compilation, have been supplied with copies of the map. Up to date about 150 copies have been distributed in compliance with requests.

Work has been continued on the revision of the map of the western portion of this department.

Numerous maps have been mounted on cloth; tracings and blue prints have been made; note books, instruments, and drawings have been supplied to the various posts in this department whenever requested.

Very respectfully, your obedient servant,

CHAS. A. WORDEN,
Captain, Seventh Infantry, Acting Engineer Officer.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

F F F 4.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF CALIFORNIA.

ANNUAL REPORT OF LIEUTENANT CHARLES G. LYMAN, SECOND CAVALRY, A. D. C., FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

ENGINEER OFFICE,
HEADQUARTERS DEPARTMENT OF CALIFORNIA,
San Francisco, Cal., July 29, 1893.

SIR: I have the honor to submit herewith the following report of operations for the fiscal year ending June 30, 1893:

Since rendering the report for the last fiscal year I have been in charge of this office, and C. Winstanley, general service clerk, has been continuously on duty as topographer and draftsman.

The office work has involved the preparation of original drawings, tracing, and blue prints of maps, etc., for use at these headquarters and at posts in the department; distribution of maps, and the care and preservation of the surveying and astronomical instruments in store.

Maps have been prepared, mounted, and colored to supply the different offices at these headquarters, and such assistance as has been called for by the officers at posts has been rendered.

Instruments have been furnished to the different posts, to troops in the field, and to the Quartermaster's Department, when required.

No field work of any importance has been entered into during the year.

Very respectfully, your obedient servant,

CHAS. G. LYMAN,

Second Lieutenant, Second Cavalry, A. D. C., in charge of office.

Brig. Gen. THOMAS L. CASEY,

Chief of Engineers, U. S. A.

INDEX.

[The references in Roman are to part (or volume), and those in Arabic to page.]

A.

C.

D.

E.

F.

H.

I.

J.

M.

N.

O.

P.

Q.

R.

T.

U.

V.

W.