Water Power of Indiana.

By W. M. Tucker.

The work of this report is the continuation of the work contained in the Thirty-fifth Annual Report. In this report, the water power of the northern part of the State is treated in about the same manner as the water power of southern Indiana was treated in the thirty-fifth report. The subject is treated in a very preliminary way, with the idea of giving a general view of the water power conditions and possibilities in the north. All the work was done on the St. Joseph and Wabash systems. The Maumee and Kankakee systems have not been investigated. All the field work of this report was done during June, July and August of 1911. During this time the following streams were traversed between the points named, by boat:

River.	*Upper Point.*	*Lower Point.*
Pigeon	Howe	State Line.
Elkhart	Benton	Mouth.
St. Joseph	State Line, E.	State Line, W.
Eel	North Manchester	Mouth.
Tippecanoe	DeLong	Mouth.
Mississinewa	Marion	Mouth.
Wabash	Benton	Logansport.
Wabash	Mouth of Tippecanoe	State Line.

The Pigeon River was traversed on foot and leveled from Howe to Mongo, and also Sugar Creek from Bluff Mills to near its mouth.

The plan of traversing these streams was to ship the boat to the head of the stream and work down stream. The boat was fully equipped for camping, with tent, folding cots, cooking utensils, etc. A level, current meter and other instruments were also carried in the boat. The entire weight of boat and outfit was about 500 pounds. A camp could be quickly established wherever there was work to be done, or when night came on. The writer was assisted in this work by J. C. Clark, a student of civil engineering in Purdue University. Mr. Clark's work was highly commendable and his companionship entirely pleasant. We received many accommodations from chance acquaintances and wish to express our thanks to them. The work of the gage readers has also been highly commendable during the year.

The water power of northern Indiana is much more valuable than that of the southern part. This is due to the natural storage afforded by the numerous lakes and swamps and by the deep deposits of glacial sand and gravel. This is the one important point of difference between the two sections of the State. The dividing line between these sections is the Wabash River. All the northern tributaries of the Wabash, and all the streams which lie north of the Wabash basin have considerable storage. The long belt of small lakes which extends from the northeast corner of the State to Kosciusko County forms an immense storage, and equalizes the flow of all the streams which rise therein. All the streams north of the Wabash, which were traversed during the field work of this report, rise in this belt of lakes. All of the streams show the effect of the lakes by a much more regular discharge than those which do not rise in this region.

The climatic conditions in the northern part of the State are slightly less favorable to water power than in the southern part. The average temperature is several degrees colder, which results in greater interference from ice. Ice interferes with the development of water power in three ways, namely, as ice jams, as anchor ice, and by stopping the flow of the tributaries. Ice jams are caused by floating ice which may form a temporary dam that will rob a site of its water so effectually that no power can be produced for some time. This does not usually last long, but it comes at an unexpected time and is especially troublesome to plants producing power for public use. Even if auxiliary steam power is installed, it could not be started soon enough to keep the power from running low in case of an ice jam. The jam is also dangerous to the exposed works of the site. An ice jam is often responsible for the destruction of a dam or other development.

Anchor ice is the name given to small particles of ice which form in the water just before the stream freezes over. These small particles will collect suddenly on the wheels and gates of a plant in sufficient quantities to completely shut down the power. In case that the anchor ice begins to form on the wheel, the best thing to do is to shut off the water until the stream freezes over. Anchor ice is much less apt to form after the stream has frozen over.

The freezing of tributary streams usually occurs during extremely cold nights. The ripples of the smaller streams freeze entirely to the bottom and the discharge of the stream is entirely stopped. This often causes extremely low discharge on the main stream and it may last for several days.

The rainfall is somewhat lighter on the average in the northern part of the State than in the southern. The difference is about three inches per year. This makes considerable difference in the runoff.

The absence of bed rock formations for dams in the north makes the building of dams more expensive and also a greater risk. Great care must be exercised to prevent undermining where the foundation is of mantle rock.

The conditions which have been discussed in the introduction pertain especially to the St. Joseph system. This system lies mainly in Michigan. In discussing the water power of this system, the tributaries will be treated first and the main stream last.

PIGEON RIVER.

Pigeon River rises in the lake district of Steuben County, south of Angola. It flows west by northwest across Steuben and Lagrange counties, Indiana, and St. Joseph County, Michigan, and empties into the St. Joseph River near the southeast corner of Cass County, Michigan. Its total length is approximately seventy miles, of which the lower fourteen miles are in Michigan.

Pigeon River valley is shallow. The bluffs average about forty feet in height. The average width of the valley is about three-eighths of a mile and is very irregular. The wider parts of the valley are swampy and usually covered with small timber and swamp grasses. At several points the valley narrows to a width of 300 yards or less. These narrows are excellent points for power development.

The basin of Pigeon River lies entirely within the glacial drift, and at no point is bed rock exposed. Its tributaries have their source in the small lakes of southern Lagrange and Steuben counties. The tributaries lie almost entirely south of the main stream, because Fawn River runs parallel to the main stream, about five miles to the north of it. Thus the tributaries to Pigeon River from the north are necessarily small. The abundance of small lakes within the basin tends to make the discharge of the stream fairly constant. The drainage area of Pigeon River basin within Indiana is approximately 350 square miles.

The United States Weather Bureau has three observation stations in or near this drainage basin. The stations are at Angola, Steuben County, at Auburn, Dekalb County, and at Lima, Lagrange County.

TABLE SHOWING THE MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT ANGOLA FOR YEARS 1900-1907.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1900.....	1.37	5.23	2.88	2.21	2.23	4.60	8.02	3.86	1.50	4.35	5.58	0.65	42.48
1901.....	3.19	1.93	3.26	2.54	2.75	4.10	5.95	4.58	0.87	6.15	1.81	3.47	40.60
1902.....	1.10	1.32	4.04	1.20	5.28	8.52	3.64	1.55	4.81	1.77	2.66	4.67	40.56
1903.....	1.59	4.15	1.81	4.20	2.44	3.35	5.66	5.80	3.15	1.91	1.93	3.27	39.26
1904.....	3.96	4.77	7.72	2.71	3.84	1.78	3.15	4.39	2.93	2.54	0.14	1.83	39.76
1905.....	2.15	2.29	2.37	3.67	5.61	4.10	4.13	2.88	4.45	4.42	2.07	1.69	39.83
1906.....	2.64	1.12	2.53	2.60	2.49	5.17	3.81	7.28	2.68	3.15	3.49	4.11	41.07
1907.....	4.01	0.28	3.54	2.95	4.13	2.98	*	*	*	*	*	*	.....
Mean.....	2.50	2.39	3.52	2.77	3.60	4.32	4.91	4 33	2.91	3.47	2.53	2.81	40.06

TABLE SHOWING THE MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT AUBURN FOR YEARS 1900-1910 INCLUSIVE.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1900.....	0.76	5.05	1.89	1.98	2.44	5.61	5.29	3.87	1.39	2.44	4.45	0.45	35.62
1901.....	1.58	1.44	1.15	1.94	2.45	2.87	1.38	3.71	1.30	3.71	1.15	1.57	24.25
1902.....	0.43	0.63	2.73	1.42	3.81	7.84	2.57	0.80	*	*	2.07	2.85	.....
1903.....	1.15	3.89	1.08	4.92	3.04	4.10	2.62	3.50	1.75	2.10	0.93	2.14	31.22
1904.....	4.28	3.75	5.37	2.86	3.10	1.70	1.72	4.92	3.31	1.40	0.13	1.17	33.71
1905.....	2.40	0.96	2.00	3.64	6.35	5.03	3.11	2.91	2.62	2.59	3.62	1.74	36.97
1906.....	1.89	0.78	2.36	2.40	2.94	3.85	3.46	3.99	2.52	2.29	*	3.60	.....
1907.....	4.35	0.19	3.15	1.91	4.95	6.23	5.72	2.01	2 92	2.17	2.44	4.95	43.35
1908.....	*	4.04	2.64	2.37	5.11	0.96	2.80	3.24	0.63	0.44	*	1.58	.....
1909.....	2.95	5.28	1.79	3.59	3.68	5.09	1.69	3.38	2.64	2.40	3.81	2.87	39.17
1910.....	2.53	1.51	0.13	3.03	2.05	0.42	4.33	4.11	3.30	1.30	1.97	2.15	26.83
Mean.....	2.03	2.50	2.21	2.73	3.63	3.97	3.15	3.31	2.24	2.08	2.29	2.29	32.43

*Report missing.

TABLE SHOWING THE MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT LIMA FOR YEARS 1905-1910 INCLUSIVE.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1905.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.85	1.40	.....
1906.....	2.32	0.40	1.99	2.89	3.41	4.99	1.96	2.38	1.74	2.02	3.21	3.33	30.64
1907.....	2.94	0.22	5.03	3.26	4.55	4.87	6.68	2.69	4.07	2.80	1.58	5.30	43.99
1908.....	0.89	4.83	2.63	3.25	6.51	1.30	2.18	2.90	0.91	0.53	2.30	1.15	29.38
1909.....	2.23	4.14	1.74	4.99	5.51	6.94	3.58	6.63	3 21	2.28	4.27	2.60	48.17
1910.....	2.30	1.55	0.73	3.61	3.35	1.81	4.49	1.93	2.76	1.68	2.10	2.18	29.94
Mean.....	2.15	2.15	2.43	3.60	4.76	3.98	3.78	3.31	2.54	1.86	2.53	2.48	36.42

The mean annual rainfall for the Pigeon River basin as shown by these tables is 35.87 inches. The lowest monthly records are in November, 1904, February, 1907, and March, 1910, in which the rainfall was less than .2 inches. These months, however, were preceded and succeeded in each case by a monthly rainfall of 1.5 inches or more, except at Auburn, in November, 1904. Thus the average for any three consecutive months, except in the one case at Auburn, is more than 1.0 inch. A monthly rainfall of 1 inch over 350 square miles would supply a continuous discharge of 313.7 cubic feet per second, if all the water were carried away. How-

ever, since the discharge of the stream in this latitude is usually about one-third of the precipitation within its basin, the discharge of Pigeon River would be slightly more than 100 cubic feet per second for the months of 1 inch rainfall. The average precipitation for the eleven years was 1,129 cubic feet per second, and the average runoff should have been 376.3 cubic feet per second.

The discharge of Pigeon River is very regular because of the storage facilities of the lakes and swamps which it drains. The minimum discharge never reaches as low as 100 cubic feet per second. Two discharge measurements taken at the wagon bridge near Howe, Indiana, on July 11 and 12, show a discharge of 126 and 120 cubic feet per second respectively. At this time the stream was very low, and close observers of it claimed that it was as low as they had ever seen it. Since the stream is considerably larger at the State line than at Howe, the discharge would be correspondingly larger. Since no gage is maintained on this stream, the minimum discharge will be considered as 120 second-feet at Howe and 150 second-feet at the State line.

The profile of Pigeon River is very irregular, which is characteristic of young streams. The fall is greatest near the source and mouth and more gentle in its middle course. The following table shows the profile of the stream as derived from railroad levels.

PROFILE OF PIGEON RIVER.

LOCATION.	Distance, Miles.	Altitude, Feet.	Fall per Mile, Feet.
Source	0	1000	.....
Mongo	32	895	3.28
Ontario	7	865.5	4.21
Howe	3	861	1.5
Seybert	7	834	3.86
State Line	5	813	4.2
Mouth	14	752	4.36

POWER SITES ON PIGEON RIVER.

Within the part of Pigeon River in Indiana which has been investigated by the survey, there are three developed power sites and two which could be easily developed. The developed sites are at Mongo, Ontario, and Scott. The undeveloped sites are one-fourth mile west of the section line between Sections 1 and 2, T. 37 N., R. 10 E., and at the crossing of the L. S. & M. S. Railroad between Seybert and Twin Lake.

Mongo.—This site was first developed and a mill erected in 1831. The dam was built of earth and has not been rebuilt. It is still in

good condition. The gates and spillway have been replaced from time to time. The natural advantages for a dam at this point are not good. The river is wide and the dam is in two sections, separated by an island. It is built on glacial drift. The height of the dam is ten feet and total length about 300 feet. There is a deed reserve for a 10-foot head at this point. The water is conducted by two short races to the wheels.

On the north side of the river the power is used in a flour mill and electric plant. The present mill was built in 1869 and the electric plant installed in the same building recently. There are six wheels in this building, five of which are old style, wood curb, single bucket wheels. The other is a modern Samson Leffel, 35-inch wheel, which is rated at 77.9 H. P. under a head of ten feet.

On the south side of the river the power is used in a sawmill and an elevator. Two wheels are employed in these buildings. They are old style standard Leffel wheels which are improperly installed and are therefore inefficient. They produce ample power for the two plants.

The total power produced at this site was estimated by the owners at 100 H. P., which is approximately the amount that can be produced by a minimum discharge at this point. This power is owned and employed by Hawk Brothers.

Proposed Site in Section 2, T. 37 N., R. 10 E.—Between Mongo and the proposed site in Section 2, the valley is irregular in width and is bordered by considerable swamp land. At present, this land is worthless except for pasture land. The fall between Hawk Brothers' tail race and the proposed site is 18.26 feet. At the quarter section line, west of the section line between Sections 1 and 2, the valley suddenly narrows to a width of 500 feet from bluff to bluff. The bluffs are thirty feet high and are composed entirely of glacial drift. A dam of twelve feet could be constructed at this point, which would submerge about 300 acres of land. With this storage and a minimum discharge of 110 second-feet about 250 H. P. could be produced for a ten-hour day and twelve feet fall. The cost of developing this power would be comparatively small if reasonable options could be secured on the land which would be submerged.

Ontario.—The power site at this point was first developed about 1840. Since its establishment it has been used constantly and has furnished power at various times for a woolen mill, a chair factory, a glove mill, a planing mill, a flour mill, and will operate an electric plant which is now being installed. The dam is situated in a

broad, flat part of the valley. It is seven feet high and approximately 500 feet long. The dam is built of boulders and brush, with concrete abutments. The storage basin covers approximately five acres. The fall from the site in Section 2 to the tail race is 10.5 feet. The mill is situated one-fourth mile below the dam on the south side of the stream. It is a flour mill and was built in 1882. The race is built in glacial drift and is well removed from the stream which bends northward below the dam. During the summer of 1911, the whole site was improved. New concrete abutments, gate and forebay were built and two 45-inch Samson Leffel wheels installed with a joint capacity of 287 H. P. An electric plant was installed in the mill, and the electricity is being used in Lagrange for light and power. The flour mill is also in operation. The head used at the mill is ten feet. The minimum discharge was estimated by a representative of the Leffel Wheel Company from one rough measurement, using the old irregular dam crest as a weir, at 19,000 cubic feet per minute. This discharge would produce a continuous 287 H. P. and a head of ten feet. Careful discharge measurement with a current meter at Howe on July 12, 1911, showed the discharge to be 120 cubic feet per second, which on a head of ten feet will produce 109 H. P. continuously. This discharge was probably near the minimum. However the periods of deficient flow will not occur often and the discharge will usually be sufficient to produce 287 H. P. This power is owned and operated by C. F. Cain, Ontario, Indiana.

Proposed Site in Section 28, T. 38 N., R. 9 E.—Between Ontario and the proposed site in Section 28, the Pigeon River valley is irregular in width. For three miles the stream has little fall and the valley is narrow. After passing Howe, the valley widens and much swamp land appears. In Section 34, T. 38 N., R. 9 E., the stream flows through Pigeon Lake, a body of water one-half mile long and one-eighth mile wide. In Section 28, where the L. S. & M. S. Railroad crosses the stream, the valley narrows to a width of 400 feet. The bluffs are about thirty feet in height. The fall from Ontario is 31.5 feet. A dam twenty feet in height at this point would submerge a large tract of land, not only along Pigeon River but along Buck Creek, which flows into Pigeon Lake from the south and along the tributary from the north which drains Twin Lakes. This storage basin would probably cover five square miles, and would be sufficient to store enough water for dry seasons so that the discharge could be maintained far above the regular minimum. The minimum of 200 second-feet could certainly be

maintained at this point, and practically the whole year the discharge could be held to 250 second-feet. Two hundred second-feet on a 20-foot head would produce 364 H. P. continuously and for a ten-hour day, 700 H. P. could be maintained. The convenience of the L. S. & M. S. Railroad makes this an inviting site for a manufacturing plant. One disadvantageous feature of this site is that the dam site is lower than the railroad bridge and a 20-foot dam would submerge the railroad.

Scott.—Pigeon River again enters swamp land after passing the narrows in Section 28. No favorable site for dam construction occurs between Section 28 and the State line. At Scott, formerly known as Van Buren, is an old power site which is located in a very poorly adapted place. Even at low water in this part of the course, the channel is banked full and the least rise causes it to flood the swamps on either side. In the midst of such conditions, a dam has been constructed and a race leads away to the mill a half mile below. A mill was located at this site about fifty years ago. The present mill was built in 1905. A concrete dam was built in 1907 but proper foundation was not secured and it was undermined and broken out in 1908. At present there is a boulder dam flanked by the remains of the concrete. A head of seven feet is maintained at the mill. Two 56-inch Standard Leffel wheels, each rated at 50 H. P. under seven foot head, are employed. The power is used for grinding and sawing. This power is owned and employed by the firm of Boehmer & Ritzer.

Between Scott and the State line there is no feasible power site. One developed site occurs at White Cloud, Michigan, where the power is used in a paper mill.

Tables showing developed and undeveloped power on Pigeon River in Indiana:

Developed.

Location.	Head. Ft.	Min. Flow, Sec.-Ft.	Min. Power, H. P.
Mongo	10	110	100
Ontario	10	120	109
Scott	7	150	96
Total			305

Undeveloped.

Sec. 2, T. 37 N., R. 10 E.	12	110	120
Sec. 28, T. 38 N., R. 9 E.	20	250	364
Total			484

ELKHART RIVER.

The Elkhart River rises by many small tributaries among the lakes of Noble and southern Lagrange counties. It flows in a general northwestern direction, across Noble and Elkhart counties, and empties into the St. Joseph River at Elkhart. Its total length is approximately seventy miles.

The character of the valley of Elkhart River is much like that of Pigeon River. However, the valley is more distinct and has much less swamp land bordering it than has the Pigeon River valley. Some swamp land occurs between Benton and Goshen, but below Goshen the valley is distinct and no swamp land occurs. The valley lies entirely within glacial drift, and no bed rock is exposed. The glacial drift of this section of the State is heavier than in any other section and is approximately 200 feet deep on the average.

The entire basin of Elkhart River lies within the heavy glacial drift and no rock is exposed. Nearly all the tributaries rise in the small lakes which abound in this region. A group of lakes about Rome City and Walcottville, another south of Albion, and a small group east of Ligonier aggregate an enormous storage in the head waters of the Elkhart and tend to cause the flow to be very regular. The sudden and destructive floods of the streams of similar drainage areas of the southern part of the State are unknown and there is no time, even in the driest seasons, when there is not considerable water flowing in this stream, while streams of similar drainage area in the southern part of the State would entirely cease to flow. The drainage area of the Elkhart River is practically 450 square miles.

United States Weather Bureau maintains but two observation stations within the basin of the Elkhart. These are at Auburn, Dekalp County, and Elkhart, Elkhart County. The stations at Lima, Angola and Winona are near this basin. The records from Angola, Auburn and Lima have been given in the discussion of Pigeon River.

TABLE SHOWING MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT ELKHART FOR YEARS 1902-1910 INCLUSIVE.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1902.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.70	2.10	2.03	.....
1903.....	1.60	1.76	1.18	3.76	1.38	1.36	6.26	4.82	3.72	1.13	1.85	2.18	31.00
1904.....	2.79	3.31	4.22	2.02	2.72	3.75	2.35	3.26	2.43	*	*	*	.....
1905.....	*	*	*	*	6.23	3.14	4.84	4.49	2.64	2.81	2.57	1.49	.....
1906.....	3.29	1.04	2.61	1.97	2.02	3.82	3.89	4.08	1.30	2.12	3.38	4.03	33.55
1907.....	3.17	0.25	4.95	2.91	5.57	3.06	5.34	3.01	3.45	2.53	1.92	3.49	39.65
1908.....	1.79	6.49	3.71	3.60	6.77	2.28	1.62	2.72	1.02	0.17	2.31	1.69	34.17
1909.....	2.12	2.81	1.96	3.20	2.70	5.32	3.51	4.21	2.92	*	4.49	2.77	.....
1910.....	1.57	1.46	0.42	3.40	4.56	1.32	2.94	3.01	5.69	2.49	3.18	2.25	32.29
Mean.....	2.33	2.45	2.72	2.98	3.99	3.01	3.84	3.70	2.90	1.71	2.47	2.49	34.59

*No report.

TABLE SHOWING MONTHLY, ANNUAL, MEAN MONTHLY AND MEAN ANNUAL PRECIPITATION IN INCHES AT WINONA LAKE FOR YEARS 1908-1910 INCLUSIVE.

YEAR.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total Annual.
1908.....	.....	5.13	3.44	a3.72	8.16	0.67	2.77	f2.00	.....	0.16	1.59	1.36	.....
1909.....	2.35	4.85	2.58	4.23	3.47	7.80	3.53	1.67	2.80	2.29	4.55	2.62	42.74
1910.....	2.09	2.11	0.17	3.90	3.86	0.77	1.72	2.48	5.61	1.85	2.22	2.12	28.90
Mean.....	2.22	4.03	2.06	3.95	5.16	3.08	2.67	2.05	4.20	1.43	2.79	2.03	35.67

Letters indicate the number of days missing from monthly record, as *a*, 1; *b*, 2, etc.

These tables show a precipitation of .17 inches at Winona Lake, in March, 1910, and at Elkhart in October, 1908. These are the months of least precipitation. In each case the precipitation of the preceding and succeeding months was sufficient to make an average of more than one inch. Because of the lake storage in this basin, the flow during dry seasons is very regular. If we consider one inch per month over the entire basin, 450 square miles, and consider the discharge to be one-third of the precipitation, it would be 134.4 second-feet continuously. This discharge would produce 12.2 H. P. per foot fall.

A single discharge measurement on the Elkhart, one and on-half miles east of Station 19 on the Elkhart-Goshen Traction line and about five miles above the mouth, showed a discharge of 212.17 second-feet. This measurement was taken July 25, 1911, during comparatively low water. Such a discharge would produce 19.3 H. P. per foot fall continuously.

According to the estimates made by the manager of the Hawks Water Power Company, at Goshen, Indiana, the amount of power which they produce during the minimum flow on a head of sixteen feet for 10 hours per day is 300 H. P. This would be equivalent to 8.33 H. P. per foot fall continuously.

No gage has been established on this stream and the minimum discharge as estimated from the foregoing data is approximately 135 second-feet at the mouth and seldom falling below 200 second-feet. Such a discharge would produce 12 and 18 H. P. per foot fall respectively.

The profile of the Elkhart is somewhat irregular and has the greatest fall in its lower part. The following table shows the profile as derived from the L. S. & M. S. Railroad profile.

PROFILE OF ELKHART RIVER.

LOCATION.	Distance, Miles.	Altitude, Feet.	Fall per Mile, Feet.
Source	0	1000	
Millersburg	35	853	4.20
Benton	6	833	3.33
Goshen	13	774	4.54
Mouth	12	720	4.5

POWER SITES ON THE ELKHART RIVER.

Between Benton and the mouth of the Elkhart River there are four developed power sites and one which it is feasible to develop. The developed sites are at Benton, Baintertown, Goshen and Elkhart. The undeveloped site is between Goshen and Elkhart.

Benton.—One-half mile above the wagon bridge at Benton is the site of an old mill and dam which has been abandoned. The dam was three feet high and a race one-fourth of a mile long increased the head to six feet. The owners of some low-lying land on the backwater brought suit for damage in 1888. The case was decided against the mill owners and the height of the dam was ordered to be reduced by eighteen inches. This reduction made the power useless and it was abandoned. The situation of the power site was very poor. It was located in a wide part of the valley where the banks were very low. It was established about 1850. It is not feasible to redevelop this site.

About one-half mile below the wagon bridge at Benton is a new dam built in 1902 by the Syracuse Power and Light Company. This dam is 130 feet long and 3.86 feet high. It is built of concrete. The backwater reaches a short distance beyond the Benton wagon bridge. After passing the dam the river makes a wide bend toward the south and a race one-half mile long follows the north bluff across this bend. The power house is located at the point where the race re-enters the river. The head on the wheels is eleven feet.

Two Little Giant turbines are employed on this head. Each is rated at 101 H. P. The power is used entirely for the production of electricity which is transmitted to Syracuse and Milford, where it is used for power and light. The power during minimum flow is about 100 H. P. but during the greater part of the year the wheels can be employed to their full capacity. This power is owned and employed by the Syracuse Power and Light Company, of which Mr. J. P. Dolan of Syracuse, Indiana, is the president.

Baintertown.—The old Redden mill site is located in Section 34, R. 6 E., T. 36 N. It has been in continuous operation for about eighty years. The dam is located three-eighths mile above the mill. It is a concrete dam 137 feet long and three and one-half feet high. The backwater from this dam reaches the Wabash Railway bridge in Section 2, R. 6 E., T. 35 N. From the dam, the river makes a wide bend northward and the race leads along the south bluff. The water is divided at the lower end of the race. Part is used in the flour mill of J. D. Redden and part in the saw mill of T. J. Harrington. There are two Little Giant tubines in use in the Redden mill. These wheels are 36 and 42 inches respectively and their capacity is unknown. The head on these wheels is 7 feet. The tail race of this mill has a fall of .63 feet, which could be added to the head by deepening the tail race. The power is employed by J. D. Redden for grinding purposes.

The Harrington mill is situated about 40 rods below the Redden mill. There is one 60-inch old style turbine employed. The head on this wheel is 8.33 feet and a power of 35 H. P. is utilized from it. This mill has been in operation for forty-five years. No supplementary power is used in either of these mills. The estimated minimum discharge at this point is approximately the same as that at Benton and the power should be about 70 H. P. under 7.5 feet head. This power is owned jointly by T. J. Harrington and J. B. Redden of New Paris, Indiana.

Goshen.—The power on the Elkhart River at Goshen was first developed about 1860. The dam is situated about two miles above the point where the power is employed. It is 205 feet long and 14.5 feet high. It is built of concrete and is very substantial. The backwater from this dam reaches three miles and a great storage reservoir is formed by former natural lake basins. The storage is not sufficient for a long continued drought, but could be drawn upon for several days. This storage makes the power at Goshen the most valuable on the Elkhart.

The race skirts the east bluff from the dam to the city where the power is employed by two plants, the Hawks Electric Company produces electricity for lighting Goshen and for motor power. There are two 50-inch Samson Leffel wheels employed in this plant. Each is rated at 300 H. P. under a head of 16 feet. The head at this point was but 14.73 feet when measured by the writer, but both plants were running and the head was lower than usual. This plant was established in 1908. The power is employed by the Hawks Electric Company, Goshen, Indiana.

The Goshen Milling Company employs three wheels under a head of 16 feet. The wheels are one 50-inch Samson Leffel rated at 300 H. P., one 46-inch, rated at 250 H. P. and one 30-inch, rated at 75 H. P. This gives a total rating of 625 H. P. in this plant. The power is employed by the Goshen Milling Company, Goshen, Indiana.

The entire power system is owned by the Hawks Water Power Company and the power is sold to the Hawks Electric Company and the Goshen Milling Company. The minimum power, as estimated by the manager of the Hawks Water Power Company, is 300 H. P. for ten hours per day. He based his estimates upon the amount of electricity produced on the switchboard of the electric plant and upon the amount of coal necessary to do the same amount of work at the mill as is done by water during minimum flow. His estimate is very near the result given by considering the discharge as 33 per cent. of the rainfall during the driest seasons.

Undeveloped Site in Section 14, R. 5 E., T. 37 N.—The elevation of Goshen as given in the profile is at the mouth of the tail race of the Goshen Milling Company plant. Thus the fall from Goshen to the mouth of the Elkhart River is 54 feet. Only 11.09 feet of this fall occurs between the crest of the dam at Elkhart and the mouth of the river. The unemployed fall between Goshen and Elkhart is 42.91 feet. The most feasible point for developing part of this power is in Section 14, R. 5 E., T. 37 N., where a mill has been formerly developed but long ago abandoned. The old dam site cannot be detected now, but the old race depression is still distinct and would greatly lessen the cost of redevelopment. From the point where the old dam was located, the river makes a great bend northward. The race ran along the south bluff for a distance of a mile and re-entered the stream near the mouth of Yellow Creek. The fall between the old dam site and the mouth of Yellow Creek is 7.18 feet. At a point 150 feet above the wagon bridge which

crosses the Elkhart River directly east of Station 19 on the Elkhart-Goshen Traction line and 300 feet above the former dam site, the bluffs approach the river on both sides very closely. A dam 10 feet high and 250 feet long could be constructed at this point. Such a dam would submerge very little land, for the valley is narrow for a long distance above this point. Not more than twenty acres of land would be submerged by this dam. A race one mile long would increase the head to 17 feet. The development of this site would be without great expense and would yield about 300 H. P. continuously.

Elkhart.—The Burrell & Morgan Milling Company dam occurs three-eighths of a mile above the mouth of the Elkhart River. This dam is built of stone, with a concrete apron 20 feet wide. The dam is 167 feet long and 10 feet high. The backwater from the dam reaches about three miles, but there is no storage except the little furnished by the river channel. From near the north end of the dam, the race leads to the mills, which are one-fourth of a mile distant. The head is not increased by the race. The power is employed in Burrel & Morgan's Flour Mill and in the Elkhart Bristol Board and Paper Company's plant. In the flour mill, four 32.5-inch Leffel special wheels are employed. In the paper mill there are four wheels employed, one 56-inch Trump, two 56-inch American, old style, one 37-inch American, modern. The total power at this point during minimum discharge is estimated by the power owners at 150 H. P. under a head of 10 feet. This estimate is approximately the same as those made at the Goshen site and from the weather reports. During low discharge the paper mill uses auxiliary steam and electric power. This power is owned by Burrell & Morgan, Elkhart, and employed by the owners in the flour mill and by the Elkhart Bristol Board and Paper Company in their paper mill.

ST. JOSEPH RIVER.

The St. Joseph River rises in the lake district of south central Michigan and flows southwest into Indiana, where it makes a great bend to the west and then to the north, and finally re-enters Michigan, where it flows into Lake Michigan at St. Joseph. The total length in Indiana is about forty-two miles.

The valley is narrow and from forty to sixty feet deep. There is no swamp land within the valley and no storage is developed in the stream.

The drainage basin lies entirely within glacial drift and no bed rock is exposed. About four hundred lakes varying in size from five square miles to one-eighth of a square mile or less form a great amount of natural storage. The entire drainage area is approximately 4,600 square miles, of which 1,700 are in Indiana.

The discharge of the St. Joseph River is determined from the gaging station which was established on the Leaper bridge at the North Michigan street crossing in South Bend, on July 11 and 12, 1910. The gage is a chain gage and is located on the up-stream hand-rail of the south span of the bridge. The initial point for soundings and current readings is 16 inches along the hand-rail from the inner edge of the iron post on the up-stream side of the south end of the Leaper Bridge. The bridge is on a broad bend in the river, which throws the main current near the north bank. There are no islands or vegetation to interfere with the readings. The current is swift and very steady. During high water, the discharge is between the two bridge abutments except at extremely high stages, when it flows over the levee upon which Michigan street is built south of the bridge. This has not occurred since the gaging station has been established.

The gage is read daily by Mr. J. W. Fisher, chief engineer of the South Bend Water Works Company.

DISCHARGE MEASUREMENTS ON ST. JOSEPH RIVER AT SOUTH BEND, IND., DURING 1910-1911.

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Second-Feet.
July 13 1910	W. M. Tucker	2.20	2,470
February 20 1911	W. M. Tucker	4.05	8,820
April 4 1911	W. M. Tucker	3.05	4,230
July 7 1911	Tucker and Clark	2.25	2,546
July 29 1911	Tucker and Clark	1.85	1,857
July 30 1911	Tucker and Clark	1.15	912

GAGE READINGS ON ST. JOSEPH RIVER AT SOUTH BEND FOR 1910-11.

	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	.....	1.4	1.3	1.6	.....	.....	.....	.....	2.8	1.9	2.8	1.2	2.4
2	.....	2.1	1.5	1.1	.....	.....	.....	.....	2.9	1.4	2.6	1.2	2.1
3	.....	1.8	1.8	1.4	.....	.....	.....	.....	2.4	1.8	2.1	1.6	2.2
4	.....	1.7	1.4	1.5	.....	.....	.....	2.6	2.4	2.1	2.5	1.3	2.1
5	.....	1.8	1.7	1.4	.....	.....	.....	2.0	2.2	2.7	2.4	1.3	1.9
6	.....	1.8	1.4	1.8	.....	.....	.....	2.5	2.2	3.6	2.3	1.6	1.7
7	.....	1.7	2.0	2.0	.....	.....	.....	2.4	2.2	3.2	1.3	1.4	1.8
8	.....	1.5	2.0	1.9	.....	.....	.....	2.4	2.1	2.9	2.0	2.2	1.5
9	.....	2.1	1.9	1.3	.....	.....	.....	2.3	2.0	2.8	1.4	2.6	1.5
10	.....	2.0	1.9	1.6	.....	.....	.....	1.7	2.0	2.6	2.0	2.1	1.7
11	.....	1.9	1.5	1.9	.....	.....	.....	2.1	2.0	2.4	1.6	1.3	1.6
12	.....	2.0	1.8	1.7	.....	.....	.....	2.3	1.9	2.6	1.3	b	1.7
13	3.0	1.5	1.9	1.7	.....	.....	.....	2.7	2.1	2.5	1.1	2.2	1.8
14	1.9	1.4	1.9	1.6	.....	.....	.....	2.0	2.8	2.6	1.2	1.6	1.2
15	2.0	1.0	1.8	1.6	.....	.....	.....	4.0	2.7	2.6	1.6	1.7	1.4
16	1.9	1.7	2.0	1.1	.....	.....	.....	3.8	2.5	2.5	1.7	1.6	1.4
17	1.4	1.7	1.9	1.5	.....	.....	.....	3.7	2.5	2.8	1.5	1.7	1.5
18	1.9	1.8	1.6	1.7	.....	.....	.....	4.0	2.3	2.7	1.7	1.4	1.5
19	2.0	2.0	1.6	1.4	.....	.....	.....	4.6	2.2	2.7	1.5	1.2	1.4
20	2.1	1.4	2.0	1.5	.....	.....	.....	4.5	2.2	3.5	1.5	1.3	1.4
21	1.7	1.4	1.7	1.8	.....	.....	.....	3.9	2.1	4.7	1.2	1.4	1.3
22	2.2	1.4	1.7	1.8	.....	.....	.....	3.7	2.0	4.2	1.4	1.4	1.4
23	1.9	1.5	1.8	1.2	.....	.....	.....	3.4	1.9	4.0	1.2	1.6	1.7
24	1.4	1.2	1.9	a	.....	.....	.....	3.2	1.8	3.9	1.6	1.7	1.5
25	1.3	1.5	1.1	.....	.....	.....	.....	3.1	1.8	3.6	1.3	1.4	1.6
26	1.7	2.0	1.9	.....	.....	.....	.....	3.1	1.7	3.3	1.1	2.7	1.6
27	2.0	1.5	1.9	.....	.....	.....	.....	3.1	1.9	3.1	1.2	3.2	1.6
28	1.8	1.3	1.7	.....	.....	.....	.....	2.9	2.0	2.9	1.0	2.9	1.5
29	1.9	1.1	1.4	.....	.....	.....	.....	.....	2.0	2.8	1.0	2.9	1.3
30	1.6	1.9	1.7	.....	.....	.....	.....	.....	1.9	2.5	1.4	2.7	1.7
31	1.5	1.7	.....	.....	.....	.....	.....	.....	1.9	.....	1.6	.....	1.6

a Chain stolen and replaced February 4.
b No report.

RATING TABLE FOR ST. JOSEPH RIVER AT SOUTH BEND, IND., FOR 1910-11.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.0	760	2.0	2,110	3.0	4,140	4.0	8,490
1.1	873	2.1	2,280	3.1	4,430	4.1	9,200
1.2	988	2.2	2,460	3.2	4,760	4.2	9,965
1.3	1,105	2.3	2,640	3.3	5,110	4.3	10,780
1.4	1,227	2.4	2,825	3.4	5,475	4.4	11,650
1.5	1,365	2.5	3,020	3.5	5,870	4.5	12,570
1.6	1,495	2.6	3,225	3.6	6,300	4.6	13,540
1.7	1,640	2.7	3,440	3.7	6,770	4.7	14,560
1.8	1,790	2.8	3,670	3.8	7,280		
1.9	1,950	2.9	3,900	3.9	7,850		

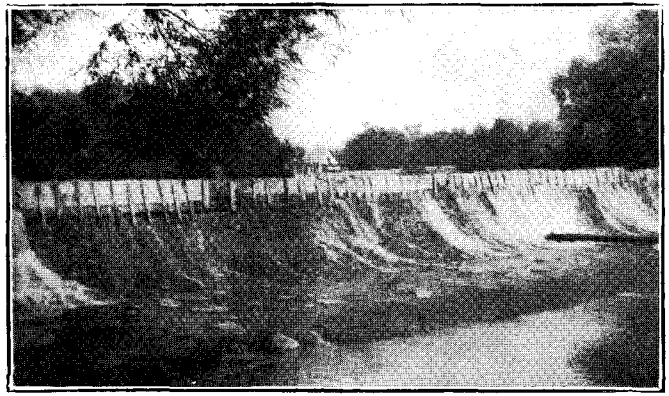
From the above data, which shows the lowest gage height to have been one foot, the smallest discharge was 767 second-feet. The gage was read each day at 6:00 o'clock a. m. with the idea that at that time the river would have filled all the storage above the several dams which are located between South Bend and Elkhart, and would have resumed the natural flow by overflow over the dams. Mr. Fisher expressed the idea, after a year's observation, that this was not the case, but that the discharge at that time of

the day was less than normal. To ascertain the real condition, gage readings were taken every hour for 24 hours, from 6 a. m. July 28 to 6 a. m. July 29. The results are shown in the following tables:

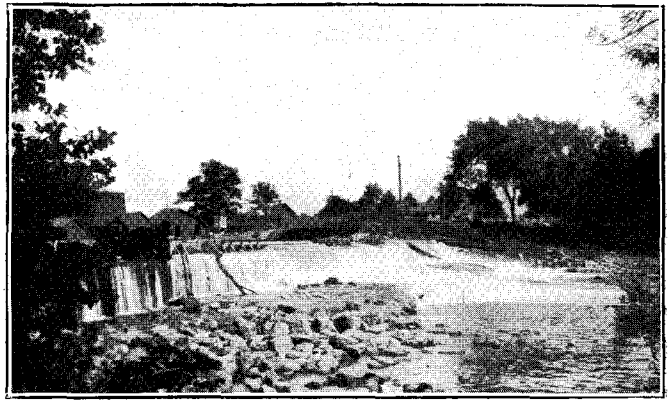
A. M.	July 28.
6:00	1.5
7:00	1.75
8:00	2.25
9:00	2.3
10:00	2.3
11:00	2.3
12:00	2.3
P. M.	
1:00	1.6
2:00	1.9
3:00	2.0
4:00	2.0
5:00	2.6
6:00	2.9
7:00	2.8
8:00	2.0
9:00	1.6
10:00	1.6
11:00	1.55
12:00	1.5

A. M.	July 29.
1:00	1.4
2:00	1.3
3:00	1.2
4:00	1.25
5:00	1.35
6:00	1.3

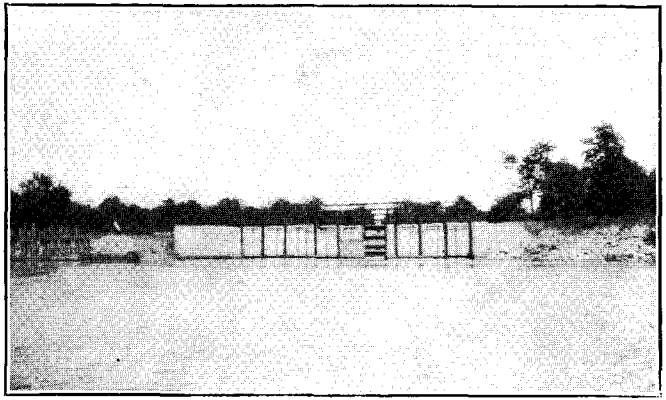
When the discharges for these twenty-five gage heights are taken from the rated table and averaged, the average is found to be 19.91 second-feet. Such a discharge is represented in the rating table by a gage height of 1.925 feet, which is more than .5 feet higher than the average (1.4 feet) of the two 6:00 o'clock a. m. readings. This demonstration corresponds to Mr. Fisher's idea, but is insufficient to prove the exact error. An average result of several such demonstrations could be taken as a correcting factor. It is safe to conclude, however, that the discharge is shown by the gage height is somewhat low. During the time which this station has been in operation, there has probably been no day in which the average discharge has not been below 1,000 second-feet. The estimated discharge at Elkhart, above the mouth of the Elkhart River, is .6 as great as that at South Bend. The profile of the St. Joseph in Indiana shows a fairly regular fall, which varies from 1.99 below South Bend to 2.93 between Elkhart and Mishawaka. The following table shows the profile of the St. Joseph River in Indiana:



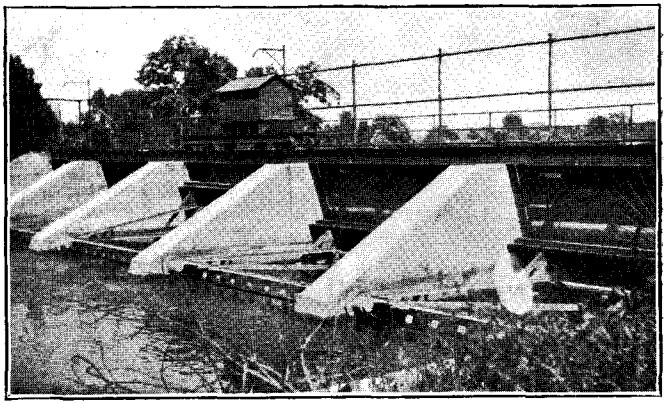
Elkhart River dam at Elkhart. Flashboards used to raise head during low water.



St. Joseph River dam at Elkhart. Flashboards broken and destroyed by flood and drift.



Gates at Goshen dam. Notice height of banks. Dam is to the left of this picture.



Gates at Mishawaka dam.

VIEWS ON ELKHART AND ST. JOSEPH RIVERS.

Location.	Estimated Distance, Miles.	Altitude, Feet.	Fall per Mile, Feet.
Upper State Line	0	750.51	2.03
Elkhart River Mouth	15	720.01	2.03
Mishawaka (below dam)	12	684.82	2.93
South Bend (below dam)	6	671.98	2.14
Lower State Line	9	654.00	1.99

Power Sites on the St. Joseph River.

Within Indiana, there are four developed power sites and one undeveloped site. The developed sites are at Elkhart, Twin Branch, Mishawaka and South Bend. The undeveloped site is at the lower State line.

Elkhart.—The Elkhart power site is situated in Elkhart, 2,500 feet above the mouth of the Elkhart River, 800 feet above the mouth of the Constantine River, and immediately above the Johnson street crossing. The dam is built of wood, with stone abutment and concrete apron. The dam and apron are in poor condition. The dam is 295 feet long and 12.17 feet high. The water is separated and some is used on the north and some on the south side. It is used to produce electricity, which is fed into the system of the Indiana Michigan Electric Company.

This site is owned by the Indiana Michigan Electric Company, whose headquarters are at South Bend. The dam will be replaced during 1912 by a modern concrete dam, and the power concentrated into one plant. The head will be about 15 feet and probably 18 feet. The minimum continuous discharge at this point is approximately 600 second-feet, which will produce 818 H. P. continuously under a head of 15 feet. At normal stages of the river, a power of 1,500 H. P. can be produced at this point.

Twin Branch.—The Twin Branch dam and power station is located about four miles above Mishawaka. The dam is built of solid concrete. It is 408 feet long and 23.2 feet high. The backwater from this dam reaches almost to the mouth of Elkhart River. The power plant is built entirely of concrete and is located at the south end of the dam. Twenty-seven wheels are installed, with a capacity of 250 H. P. each. The minimum discharge at this point is 750 second-feet, which produces about 1,600 H. P. under a head of 23 feet. This is the largest and best installed power station in Indiana. It is owned and operated by the Indiana Michigan Electric Company. The power is used entirely for the production of electricity, which is fed into the system of the company.

The Indiana Michigan Electric Company has water power sites in Michigan, of which the largest is at Barrien Springs, near Buchanan. The power from all the stations operated by the company is used entirely for the development of electricity, and this is fed into one system. The electric power is then sold to manufacturing concerns. The following table gives the principal purchasers and the amount of power furnished each, so far as known:

Traction Lines:
Goshen to twenty miles north of Benton Harbor, Michigan.
South Bend to Michigan City.
All local street car service in Elkhart, Goshen, South Bend, Benton Harbor and St. Joseph.
All electric power in South Bend except Singer's, Oliver's and Birdsell's.

Mishawaka Woolen Co	1,500 H. P.
Rubber Regenerating Co., Elkhart	500 H. P.
L. S. & M. S. Ry. Shops, Elkhart	500 H. P.
Elkhart Paper Co	1,000 H. P.

Besides the water power which is used by this company, they are producing 8,000 H. P., auxiliary steam power, and are now developing 7,000 H. P. more.

Mishawaka.—The Mishawaka dam is located within the city of Mishawaka. It is the oldest dam on the St. Joseph River. It is built of wood in three sections, and has a total length of 305 feet. It is 9.95 feet high. The backwater from this dam reaches the tail race of the Twin Branch plant. This power is owned by the Mishawaka Hydraulic Company, which sells the power to local manufacturing companies. There are two races leading away from this dam. The race on the north side leads into the plant of the Mishawaka Rubber Regenerating Company where 600 H. P. is produced on a head of 10 feet. There are six horizontal Trump wheels with a rating of 100 H. P. each. The power is used continuously. The race on the south side of the river furnishes water to five plants. The Mishawaka Water Works Company employs 100 H. P. continuously. They have one wheel and a head of 10 feet. The Ripple Milling Company employs 60 H. P. The head is 10 feet and the power is produced on a single wheel. The Mishawaka Plow Company employs 60 H. P. from one wheel under a head of 10 feet. The Perkins Windmill Company employs 75 H. P. from one wheel under a head of 11 feet. The Mishawaka Woolen Manufacturing Company has four wheels installed. The sizes of these

wheels are 66 inches, 61 inches and two 56 inches. The total capacity of these wheels is 700 H. P. under a head of 11 feet.

The total rating of wheels gives an aggregate of 1,595 H. P. This is more power than can be produced during the minimum discharge of the stream. The minimum discharge at this point sometimes reaches 750 second-feet. This discharge would produce 682 H. P. on a fall of 10 feet. During the greater part of the year, however, the discharge is sufficient to produce the rated power at this site.

South Bend.—The power station at South Bend is usually known as the Oliver dam. However, the power is not controlled by the Oliver Company, but is governed by grants and is controlled by the city of South Bend. The dam is located in the city of South Bend. It is 200 feet long and 11 feet high. It is constructed of wood, with concrete abutment. The backwater of this dam reaches the tail race of the Mishawaka Woolen Manufacturing Company. The water is divided by grants, equally on the east and west sides.

The eastern half is divided under fourteen grants, and the amount of power allowed in each grant is specifically stated. The following table shows the firms, the number of each grant, and the amount of water as specified in each grant.

Firm.	Grant Number.	Amount, Sec.-Ft.
Manufacturer's Plant and Power Co.....	1	42.91 cubic feet.
Knoblock & Gintz Milling Co.....	2	77.23 cubic feet.
Stephenson Mfg. Co.....	3	51.49 cubic feet.
Stephenson Mfg. Co.....	4	68.65 cubic feet.
LaSalle Paper Co.....	5	60.05 cubic feet.
Miller	6	85.81 cubic feet.
Manufacturer's Plant and Power Co.....	7	40.00 cubic feet.
South Bend Toy Mfg. Co.....	8	51.49 cubic feet.
Manufacturer's Plant and Power Co.....	9	51.49 cubic feet.
F. P. Nicely.....	10	102.98 cubic feet.
South Bend Woolen Co.....	11	68.65 cubic feet.
South Bend Woolen Co.....	12	51.49 cubic feet.
Stephenson Mfg. Co.....	13	.....
Stephenson Mfg. Co.....	14	343.24 cubic feet.

The conditions of the grants are that in case of deficient discharge the supply is first discontinued to No. 14, then to No. 13, etc. The lowest discharges have made it necessary to discontinue the supply to No. 8. All this water is employed on heads varying from 11 to 13 feet. Since in any case a second-foot of water on a head of 11 feet produces a horse-power, the amount of water supplied by each grant can be considered as the same number of horse-

power. The first seven grants aggregate a discharge of 426.14 second-feet, and this would indicate that the minimum discharge at this point is 852.28 second-feet. This corresponds very closely to the minimum discharge as given in the data collected from the gage at Leaper bridge.

The western half of the water is owned by the Oliver Company, known as the South Bend Manufacturing Company, and by the city of South Bend. The Oliver Company owns 85 per cent. and the city 15 per cent. The city employes the 15 per cent. in the city water works plant. Three 54-inch Samson Leffel wheels are employed under a head of 11 feet. The minimum power produced is about 75 H. P.

The Oliver Company employs twelve 68-inch Samson Leffel wheels, each rated at 295 H. P. under 11 feet head. The minimum power produced is about 400 H. P. and the maximum about 1,800 H. P. The power is used to generate electricity which is used for power and light in the Oliver Chilled Plow Works, the Oliver Hotel, J. D. Oliver's residence and Geo. Ford's residence.

The city of South Bend employs an inspector, whose duty is to enforce the conditions of the several grants of this system.

Lower State Line.—The power site on the lower State line is undeveloped. It is in control of the Indiana-Michigan Electric Company. This company has options upon the land which would be affected by the development of the site. A dam 12 feet high would pond the water to the South Bend city limits and to the mouths of the large sewers from the city. The 12-foot dam would not interfere with the city sewage discharge during low stages of the river, but in high stages the height and distance of backwater from a dam are greatly increased. Such a condition would seriously interfere with the city sewage discharge and would result in litigations which make the proposition practically worthless. The electric company has considered a collapsible dam which could be lowered during high stage until the backwater would be under control. However, no steps toward development of this site have been taken at the present time. The development of this site would be of great benefit to the electric company, for the power is needed during seasons of low discharge, and is not needed during seasons of high discharge for it can be supplied by the other plants during such times.

THE WABASH RIVER SYSTEM.

This report has to do with that part of the Wabash River system which lies above the intersection of the Wabash River and the State line, 14.6 miles below Terre Haute. The system drains an area of 12,200 square miles, which lies in a broad curve across north central Indiana between the basins of Kankakee, St. Joseph and Maumee rivers on the north, and of White and Whitewater rivers on the south.

The basin is entirely within the Wisconsin glacial drift area except that portion which lies below the north line of Vigo County. The drift is much heavier in the northern part of the basin than in the southern part. The northern tributaries, Tippecanoe and Eel rivers, rise in the lake regions of Kosciusko and Noble counties, while the main stream and the southern tributaries have no lakes within their basins.

As a whole the Wabash system lies near bed rock. Many exposures occur in the stream beds. The main stream lies in the Silurian formation from its source to the west line of Cass County, in the Devonian to Lafayette, in the Mississipian to Covington, and in the Pennsylvanian to the State line. The Mississinewa and Eel rivers lie entirely in the Silurian. The Tippecanoe is in the Silurian formation to Norway, three miles north of Monticello, where it enters the Devonian. The rest of its course is in the Devonian. Sugar Creek rises in the Devonian, enters the Mississippian near Thorntown, Boone County, and the Pennsylvanian directly north of Annapolis, Parke County.

The mean annual rainfall in the Wabash River basin for the past eleven years was 38.12 inches. The lowest annual rainfall during that period was in 1901 when the average for the Wabash basin was 30.63 inches. The highest yearly record was in 1909, with an average of 47.16 inches. The monthly precipitation in this basin has been very irregular. The highest monthly average for all the stations within the Wabash basin and those closely adjoining was in June, 1902, when 8.35 inches occurred. The low record was in March, 1910, with .195 inches. These figures are based on the records from twenty-five stations as given by the United States Weather Bureau.

The forests of the Wabash River basin are practically negligible. A hundred years ago the forests covered 90 per cent. of this vast area and now the areas covered by forest in the form of wood lots will not aggregate 10 per cent. of the whole area. Even the forests which do remain are thin and made up entirely of second growth

timber. Of the magnificent walnut, maple, poplar, beech, hickory and gum trees which grew here a hundred years ago, all are gone. Some were used, but most of them were destroyed. The destruction of the forests also greatly reduced the water power possibilities along the Wabash. In fact, the irregularity of the stream flow is largely due to the depletion of the forests, and this irregularity is so great that the water power of the Wabash River is practically worthless. Mr. F. A. Bryan, general manager of the Indiana-Michign Electric Company, probably the best authority in Indiana on the subject of water power, says that he would not give $10,000 for all the water power on the Wabash.

In discussing the power conditions of the Wabash River system, the northern tributaries will be considered first, followed by the southern tributaries, and finally the main stream.

EEL RIVER.

Eel River rises by several branches in the lake district of southern Noble, northern Whitley, and northwestern Allen counties. It flows in a general southwest direction, across Whitley, Wabash, Miami and Cass counties, and debouches into the Wabash River at Logansport, Indiana. Its total length is approximately 110 miles.

The valley is young and has little bottom land. The bluffs are from 30 to 75 feet in height. The valley lies entirely within glacial drift and does not touch bed rock until within nine miles of the mouth. At Adamsboro, the stream first touches bed rock and a rapid is formed. This rapid is wide and shallow. It is about one-fourth mile in length, with a total fall of six feet. From this point to the mouth, the stream flows on bed rock much of the way.

The drainage basin of Eel River is long and narrow. The tributaries are short and those that do not rise in lakes are intermitten streams. Three small tributaries which debouch in Wabash County rise in small lakes of southern Kosciusko. The tributaries near the source of the stream rise in the lakes of southern Noble County. The storage offered by these lakes makes the discharge regular. The drainage area of Eel River is 777 square miles.

On July 14 and 15, 1910, a gaging station was established on the bridge which crosses Eel River on Third street, Logansport. It is a chain gage, and is located on the down stream hand-rail of the south span of the bridge. The length of the chain from the end of the weight to the first marker is 18 feet 6.7 inches. The gage is read once each day by H. J. Kruck of the Logansport Water Works Company. The stream is straight for 500 feet above this station,

and a similar distance below. The channel is about 360 feet wide between the bridge abutments. Two piers divide the channel into three parts. The depth is fairly regular. The bed of the stream is of sand, which is deposited at the head of the backwater from Uhl's mill dam. The backwater reaches a short distance above the station, but the current is regular and steadily down stream. The bed has not changed perceptibly during the years since the gage was established. All the water must pass between the bridge abutments except during extremely high water, when the north bank overflows. The initial point for soundings is three and one-half feet from the north end of the down stream hand-rail. The discharge and gage readings from this station appear in the following table:

DISCHARGE MEASUREMENTS ON EEL RIVER AT LOGANSPORT, IND., FOR 1910-11.

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
July 15 1910	W. M. Tucker	2.8	207.16
Aug. 12 1910	W. M. Tucker	2.4	125.33
Feb. 21 1911	W. M. Tucker	3.6	1,390 2
April 15 1911	W. M. Tucker	3.9	2,147.89
July 5 1911	Tucker and Clark	2.9	263.28

GAGE READINGS ON EEL RIVER AT LOGANSPORT, IND., FROM JULY 16, 1910, TO JULY 15, 1911.

	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	.....	2.5	2.7	2.8	2.8	2.8a	3.2	3.4	3.0	3.0	3.4	3.2	2.9
2	.....	2.3	2.7	2.9	2.8	2.8	3.3	3.3	3.0	3.0	3.4	3.1	2.9
3	.....	2.6	2.7	2.8	2.6	2.8	4.0	3.2	3.0	3.0	3.2	2.9	2.9
4	.....	2.7	2.8	2.8	2.6	2.8	b	3.2	3.0	3.1	3.1	3.0	2.9
5	.....	2.5	3.0	3.1	2.8	2.8	b	3.1	3.0	3.7	3.1	3.2	2.9
6	.....	2.6	3.5	3.1	2.8	2.8	b	3.1	2.9	3.9	3.1	3.0	2.9
7	.....	2.8	3.3	3.1	2.7	2.8	b	3.1	2.9	3.6	3.0	3.0	2.9
8	.....	2.7	3.1	3.1	2.7	2.8	b	3.0	2.9	3.3	2.9	2.9	2.9
9	.....	2.6	2.9	3.0	2.6	2.8	b	2.9	2.9	3.2	2.9	2.9	2.9
10	.....	2.6	3.0	2.9	2.6	2.8	b	2.9	2.9	3.1	2.9	2.8	2.8
11	.....	2.5	2.9	2.8	2.7	2.8	b	2.8	2.9	3.0	2.9	2.8	2.7
12	.....	2.4	2.8	2.8	2.6	2.8	b	3.0	3.0	3.0	2.9	2.8	2.7
13	.....	2.7	3.2	2.8	2.9	2.8	b	3.0	3.0	3.1	2.9	2.8	2.7
14	.....	2.8	3.6	2.8	2.9	2.8	b	3.3	3.0	3.9	2.9	2.8	2.6
15	.....	2.5	3.2	2.8	2.7	2.8	b	4.7	2.9	3.9	2.8	2.8	2.7
16	2.8	2.6	3.0	2.9	2.7	2.8	b	4.3	2.9	3.5	2.8	2.8	.....
17	2.9	2.7	2.9	2.8	2.6	2.8	b	4.1	3.0	3.4	2.8	2.9	.....
18	2.8	2.7	3.0	2.8	2.7	2.8	b	4.0	3.0	3.2	2.8	2.9	.....
19	2.8	2.6	2.9	2.8	2.7	2.8	b	4.0	3.0	3.9	2.8	2.9	.....
20	2.7	2.7	3.0	2.8	2.9	2.8	b	3.9	3.0	4.4	2.8	2.8	.....
21	2.7	2.8	2.9	2.8	2.8	2.8	b	3.6	3.0	4.2	2.8	2.8	.....
22	2.7	2.8	2.8	2.8	2.8	2.8	b	3.3	2.9	3.9	2.8	2.7	.....
23	2.7	2.8	2.8	2.9	2.8	2.8	b	3.3	2.9	3.9	3.0	2.7	.....
24	2.8	2.9	2.9	2.9	2.8	2.8	b	3.1	2.9	3.7	3.0	2.9	.....
25	2.5	2.8	3.3	2.9	2.8	2.8	2.9	3.1	2.9	3.3	2.9	2.9	.....
26	2.5	2.8	3.2	2.5	2.8	2.8	2.9	3.1	3.0	3.2	2.8	4.3	.....
27	2.7	2.8	3.1	2.6	2.9	2.8	3.1	3.1	3.0	3.1	2.8	3.8	.....
28	2.6	2.8	2.9	2.7	2.8	2.9	3.8	3.1	3.0	3.1	2.8	3.5	.....
29	2.7	2.7	2.7	2.7	2.8	3.2	4.0	.....	3.0	3.2	2.8	3.2	.....
30	2.8	2.6	2.8	2.9	2.9	3.1	4.0	.....	3.0	3.2	2.8	2.9	.....
31	2.7	2.7	.....	2.6	.....	3.1	3.6	.....	2.9	.....	3.0	.....	.....

a Ice conditions during all of December. Ice ½ to 6 inches thick. Water over ice on Dec. 29 30 and 31.
b No record.

RATING TABLE FOR EEL RIVER AT LOGANSPORT, IND., FOR 1910–11.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge. Sec.-Ft.
2.3	115	3.0	332	3.7	1,645	4.4	3,395
2.4	125	3.1	425	3.8	1,895	4.5	3,645
2.5	137	3.2	550	3.9	2,145	4.6	3,895
2.6	155	3.3	720	4.0	2,395	4.7	4,145
2.7	178	3.4	925	4.1	2,645		
2.8	210	3.5	1,155	4.2	2,895		
2.9	260	3.6	1,395	4.3	3,145		

Since the gaging station from which this data is taken is in the backwater from the Uhl dam, the manipulation of the water at the mill has considerable effect upon the data. When the gage stands at 2.7 feet the water is just at the crest of the dam. Whenever the gage registers lower than that, the head is being pulled down at the mill. The gage is read about 7:00 a. m. each day and it is probable that the head has been reduced on some days at the time of reading. From the data it seems that minimum continuous discharge is about 150 second-feet and the maximum is over 4,000 second-feet. A discharge of from 200 to 300 second-feet occurred most of the year.

The profile of Eel River is very irregular and shows the greatest fall near its mouth. After the stream bed crosses the edge of the hard Niagara limestone at Adamsboro, it has heavy fall to its mouth. The following table shows the profile of the river.

PROFILE OF EEL RIVER.

LOCATION.	Estimated Distance.	Altitude Above Sea Level.	Fall Per Mile, Inches.
Source	0	900	
North Manchester	50	732	44.64
Laketon	9	715	22.66
Stockdale	9	701	18.66
Chili	9	682	25.33
Denver	4	671	33.00
Mexico	5	653	43.20
Hoover	7	629	41.14
Adamsboro	6	617	28.00
Mouth	9	574	57.33

POWER SITES ON EEL RIVER.

There are eight developed power sites on Eel River and six intervening points where power could be conveniently developed. The developed sites are at North Manchester, Laketon, Roann, Chili, Mexico and two in Logansport. The undeveloped sites are between North Manchester and Laketon, between Roann and Chili,

and Chili and Mexico, between Mexico and Adamsboro, and two between Adamsboro and Logansport.

North Manchester.—The power site at North Manchester was first developed about sixty years ago. The present mill was built in 1874. The dam is 130 feet long, between abutments, and 5.7 feet high. It is built of wood. There is a charter for a 6-foot head at this point. The mill is 300 feet below the dam, and the head race carries the water to the mill where it is used on three wheels —one 48-inch American, one 54-inch American, one 61-inch Standard Leffel. The minimum amount of power which is produced at this point for twelve-hour day is about 60 H. P. The minimum discharge is about 75 cubic feet per second. The power is used entirely for milling purposes and no auxiliary power is employed. This power is owned and operated by the North Manchester Milling Company, of which Allen Dohner is manager.

Power Site Between North Manchester and Laketon.—The fall from the tail race at North Manchester to the tail race at Laketon is 17 feet. The Laketon dam is 5.5 high. This leaves 11.5 fall which is not employed. The water of Eel River valley is such that power on a low head can be installed at almost any point. The point at which this power could be developed must be above the backwater of the Laketon dam. This backwater reaches about 1.5 miles above the dam. In Section 11, T. 29 N., R. 6 E., near the north line of the section is a point at which the dam would have to be located to employ this power. A 6-foot dam would produce 60 H. P. for a twelve-hour day at this point.

Laketon.—In Section 10, T. 29 N., R. 6 E., the river makes a bend towards the south. The bend is a mile in length, but the distance between the ends of the bend is but one-fourth of a mile. The land enclosed in this bend is low. In 1854 a dam was built at the upper end of this bend and a race constructed across the bend. A mill was built where the race intersected the river below. Since that time the power has been used continually at this site. The present mill was built in 1900, and the present dam was built three years later. The mill is a frame building of two stories, and is in excellent condition. The dam is built of concrete. It is 125 feet long and 5.5 feet high. The charter grant is for a 6-foot dam. The head is increased 2.5 feet by the race. Two 40-inch American, and one 40-inch Standard Leffel wheels are employed. The minimum discharge at this point is about 100 second-feet and a minimum of 75 H. P. is produced. This power is owned by Thos. E. Mitchell and employed by Arthur D. Hughes in the manufacture

of flour mill machinery. The power is not employed to its full capacity. This little plant is well situated and the water can be placed under absolute control. It is within one mile of the junction of the Erie and Vandalia railroads and is in every way suitable for a small manufacturing enterprise.

The fall from the tail race of the Laketon mill to the tail race of the Roann mill is 11.5 feet. The head at the Roann mill is five feet. This leaves 6.5 feet unaccounted for, but it cannot be developed profitably because of the backwater. A head of four feet could be developed but would not be profitable.

Roann.—This power site is situated one mile west of Roann at Stockdale, which is one of those pioneer towns that has lost everything except its name and water-power. The first mill was built on this site in 1840, and the present one in 1859. In spite of its age, it is in good repair. The dam is built of wood, and the south end was broken by ice during the winter of 1910-11. The breach has been patched with boulders and a new concrete dam will be built soon. The dam is 206 feet long and 4.6 feet high. The dam is connected at the north end with an excellent concrete forebay. The flumes are also of concrete. Two 35-inch and one 30-inch Samson Leffel wheels are employed. The head on the wheels is five feet. The combined power produced by these wheels is estimated at 75 H. P. No auxiliary power is used and there is never a lack of water. Because of the extremely low head used, the power is often diminished by backwater. The power is used for grinding only. It is owned and employed by James M. Deck.

Power Site Between Stockdale and Chili.—The fall from the tail race at Stockdale to the tail race at Chili is 19 feet. The head employed at Chili is five feet. This leaves 14 feet fall which is unemployed. The backwater from the dam at Chili reaches approximately two miles. One and five-tenths miles above the head of this backwater is the site of a former dam which is now entirely destroyed. An abrupt fall of three feet still occurs at this point, which is on the line between Section 16 and Section 21, T. 28 N., R. 5. E. This site could be redeveloped with a head of seven feet. The dam would be 200 feet long. This site is one mile due south of Pettysville on the Vandalia Railroad.

Chili.—This site was first improved during the early history of this part of the State. The present mill was built before 1873. The present dam was built in 1891. It is a wood dam 198 feet long and 4.5 feet high. This dam is built upon piles driven into the gravel. The dam will be replaced soon by another wood dam. During the

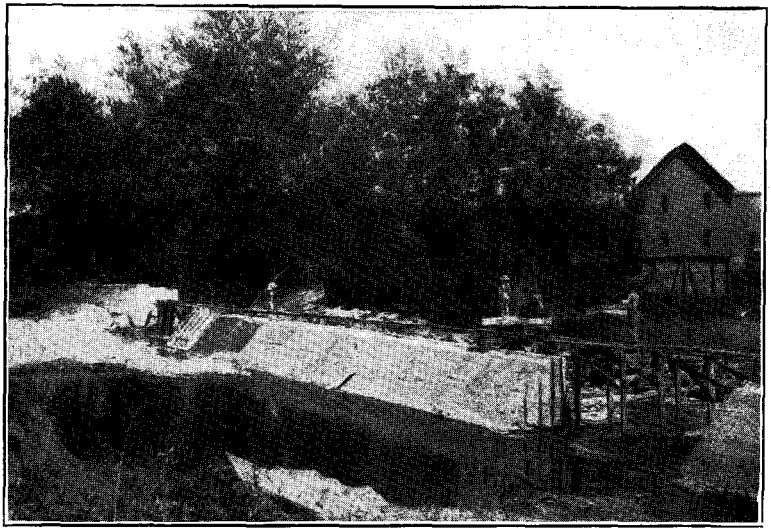
summer of 1911, a concrete abutment and gates were built upon the north end of the dam. A race 300 feet long leads to the mill. Two 48-inch wheels are employed under a head of five feet. The minimum power produced at this point is about 70 H. P. The power is used for operating a flour mill and elevator combined. It is owned and employed by the heirs of Jacob Myers.

Power Site Between Chili and Mexico.—The fall from the tail race at Chili to the tail race at Mexico is 29 feet. The head employed at Mexico is seven feet. This leaves 22 feet of unemployed fall between these two points. The best point for developing this power is near the line between Sections 20 and 29, T. 28 N., R. 4 E. The bluffs approach the river at this point, and a head of two feet could be developed. This would injure a few acres of land above the dam which would increase the cost of development. This site is 1.5 miles from Denver and one-fourth of a mile from the Vandalia Railway.

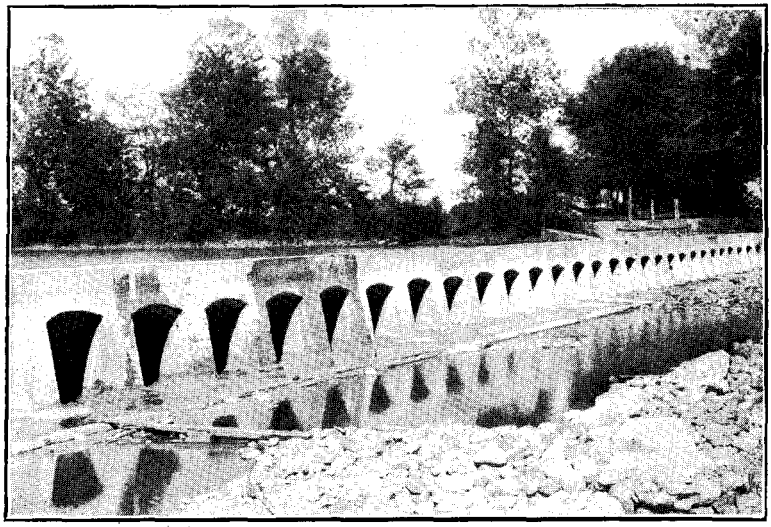
Mexico.—This is an old power site, but its history is unknown. The present mill was built in 1900 and the present dam in 1910. This dam is one of the best constructed dams in the State. It is built entirely of reinforced concrete and its foundation on hard pan. The base of the dam is on an average of four feet thick and 14 feet wide. The dam proper has a 9-foot base which leaves an apron of five feet. The height is six feet from the base. The lower face of the dam is perpendicular for 1.5 feet and has a 1-foot brace slant in the remaining 4.5 feet. This slant also serves to break the fall of the water. The crest is two feet wide and the upstream face has a regular slant at an angle of 45 degrees. The concrete is reinforced every two feet by three-fourths inch steel bars corrugated every inch. The dam is built in sections of 12 feet with expansion joints between. The length of the dam between abutments is 242 feet.

A short race at the east end of the dam leads to the mill where three 48-inch Standard Leffel wheels are employed. The head on the wheels is seven feet. The power is estimated at 300 H. P. at normal flow. The minimum discharge at this point is estimated at 100 second-feet which would produce 63 H. P. on seven feet fall. The power is used for milling only. The mill and power are owned by C. H. Black and operated by R. E. Zinn, who has it leased.

Power Site Between Mexico and Adamsboro.—The fall between Mexico and Adamsboro is 36 feet, of which seven are occupied by the Adamsboro site. Most of the remaining 29 feet occur between Hoover and Mexico. Two heavy ripples occur in Section 6,



View of the dam at Mexico during construction (from above).



View of the dam at Mexico (from below).

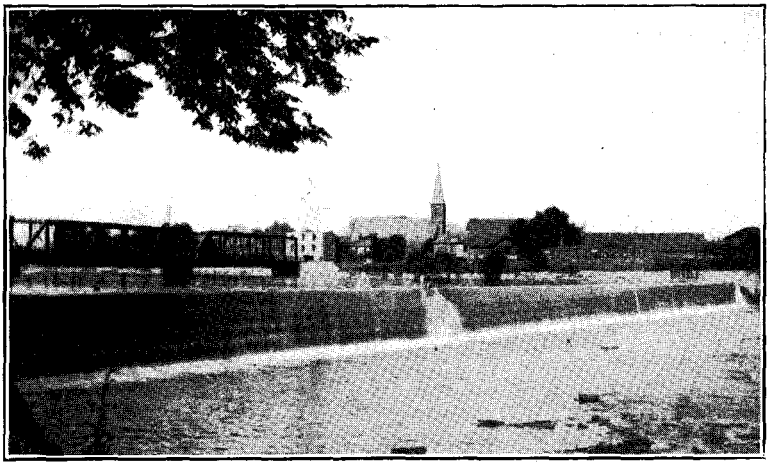
R. 4 E., T. 27 N., and in Section 2, R. 3. E., T. 27 N. Seven feet head could be developed at the ripple in Section 2. The dam would be 200 feet long. The minimum discharge at this point would never fall below 100 second-feet. This would produce 63 H. P. on a head of seven feet. The normal discharge would produce approximately 300 H. P. at this point. It is probable that more of the surplus fall could be utilized between this point and Adamsboro, but no feasible dam site has been selected.

Adamsboro.—The Adamsboro dam is built upon solid limestone. It is an old dam and in poor condition. The leakage is greater than the amount of water which is used. The dam is 311 feet long and 4.09 feet high. A race one-half mile in length leads to an old mill, where the power is used for grinding. The power is not used continually and is often idle for long periods. This site is ideal for a well developed plant. The solid rock foundation makes the construction of a dam very simple. A heavy fall below the dam and above the mill adds 3.5 feet to the head. A dam seven feet high could be constructed at this point which would give a head of 10.5 feet at the mill. The race is in fair condition. It is on the west side of the river. With a minimum of 100 second-feet at this point, a power of 95 H. P. would be produced, while a normal discharge would furnish 350 H. P.

Two Power Sites Between Adamsboro and Logansport.—The fall between Adamsboro and the mouth of Eel River is 43 feet. Of this fall 11 feet are employed by the Uhl site and 11.25 feet by the Logansport Water Works and Electric Company's site. There is a loss of three feet between these sites and below the Uhl site. This leaves 17.75 feet between the tail race at Adamsboro and the backwater from the Water Works and Electric Company's site. This could all be developed at two sites with a fall of seven feet each. One of these would be located in Section 21, R. 2 E., T. 27 N., and the other at the head of the backwater from the Water Works and Electric Company's dam. Both these dams would have bed rock foundations. The power produced at these two sites would be about 100 H. P. each at minimum discharge and 300 H. P. at normal discharge.

Logansport Waterworks and Electric Company.—The dam of this plant is situated near the intersection of Tenth street and Eel River in Logansport. This site was first developed about eighty years ago. The present dam was constructed in 1854. The plant of the Logansport Waterworks Company was built in 1876, and that of the Logansport Electric Company in 1895. They stand immedi-

ately adjoining each other on the river bank, 300 feet below the dam. The dam is 340 feet long and seven feet high. It is a wood dam and is in good repair when its age is taken into consideration. It is located on solid limestone immediately above a fall of four feet. The backwater from this dam reaches about two miles, but there is no storage except that in the direct stream channel. A short race built of limestone leads to the plants. The Waterworks Company uses three wheels under a head of 11 feet 4 inches. There are two 48-inch Dowling wheels each rated at 106 H. P. and one 54-inch Dayton wheel rated at 136 H. P. The Electric Company employs two 48-inch Dowling wheels each rated at 106 H. P. The Waterworks Company uses all the power during low discharges



The Dennis Uhl & Co's. dam at mouth of Eel River.

and has supplementary steam power. The power is used entirely for pumping in the Waterworks Company. The power at minimum discharge is 106 H. P. at this point but should be much higher. A minimum discharge of 150 second-feet under a head of 11 feet 4 inches will produce 154.5 H. P. This power is owned by the Logansport Waterworks Company.

Dennis Uhl & Company.—About one and a half miles below the Logansport Waterworks Company's tail race, and within 250 feet of the mouth of Eel River, occurs the dam of Dennis Uhl & Co. The first dam was built in 1858, about one-half mile further up stream, and races carried the water to the plants. The present dam was built in 1897-98. It is built of wood on a concrete base which is anchored to bed rock. It is 385 feet long and 11 feet high. The

backwater from this dam reaches the tail race of the Logansport Waterworks Company's site. The water is employed from both ends of the dam. On the west, a short race leads to the flouring mill and elevator of Dennis Uhl & Co. This mill was built in 1858. Two modern American and two old Dolan wheels are employed in this plant under a head of 11 feet. The combined power rating of these wheels is about 500 H. P. The power is used entirely for milling purposes. No auxiliary power is employed. The tail race of this plant is at the mouth of Eel River.

On the east end of the dam, the Majestic Knitting Company employs one modern American wheel rated at 150 H. P. This wheel is not employed during reduced discharge.

The minimum discharge at this point is about 150 second-feet, which under a head of 11 feet will produce 150 H. P. Backwater from the Wabash River in flood stage is a serious handicap to this power. This handicap is seldom and of short duration, but is uncontrollable while it lasts. This power is owned by Dennis Uhl & Co.

TIPPECANOE RIVER.

The Tippecanoe River rises among the lakes of Noble, Whitley and Kosciusko counties. It is a very crooked stream and flows in a general westward direction to the northeastern corner of Pulaski County and then in a general southward direction to its mouth in Tippecanoe County. It is about 166 miles in length.

The valley contains much swamp land in its upper parts, but below DeLong, little swamp land occurs. The valley is narrow and the bluffs low in the middle course. The level upland at DeLong is about 30 feet above the river, at Monterey 16 feet, at Ora 23 feet, and at Winamac 32 feet. At Monticello the bluffs are 67 feet high, and at Oakdale 100 feet. This is approximately the maximum depth of the valley. The upper and middle courses of the valley lie entirely in glacial drift. It first touches bed rock at Norway, three miles above Monticello. In this part of its course the stream crosses the Cincinnati anticline, whose surface formation in this locality is the hard Niagara limestone. After touching bed rock at Norway, it is near the rock throughout the rest of its course and rock exposures are frequent. The banks below Norway are usually high and there is little overflow.

The basin of Tippecanoe River embraces almost all of White, Pulaski and Fulton counties, half of Kosciusko, and small portions of several other counties. The entire drainage area is about

1,900 square miles. It is overlaid entirely with glacial drift and many small glacial lakes occur in the northern and eastern parts of the basin. There are no large tributaries, but most of the tributaries drain either lakes or swamps and for this reason have a more or less continuous discharge.

No gage has been established by the State department on the Tippecanoe River, but a gage was maintained by the United States Geological Survey at Spring boro, five miles west of Delphi, during parts of the years 1903-06 inclusive. The data from this gaging station gives a good idea of the discharge of the stream. The following data is taken direct from the U. S. G. S. Water Supply and Irrigation papers:

Tippecanoe River at Springboro.—"This station was established March 14, 1903, by George E. Waesche. The station is located at the highway bridge at Springboro, Ind. The nearest railroad station is Delphi, five miles east of Springboro. The standard chain gage is located on the second span from the east bank, one panel length beyond the center of the span. The length of the chain from the end of the weight to the marker is 25.66 feet. The gage is read once each day by Lois Imler. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is the face of the east abutment. The channel is straight for about 1,600 feet above and about 2,000 feet below the station. Its width at ordinary stages is 350 feet, broken by two piers, and at high water is 510 feet, broken by three piers. Both banks are high and can not overflow to any considerable extent. The bed of the stream is rocky and rough; the current is swift. The bench mark is the head of an anchor bolt in the east abutment; it is the outside anchor of the downstream truss. Its elevation above the zero of the gage is 22.25 feet.

The observations at this station during 1903 have been made under the direction of E. Johnson, Jr., district hydrographer.

DISCHARGE MEASUREMENTS OF TIPPECANOE RIVER AT SPRINGBORO, IND., IN 1903.

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
March 16	G. E. Waesche	4.73	3,448
May 18	G. E. Waesche	3.00	747
June 22	G. E. Waesche	2.87	662
July 17	E. C. Murphy	3.03	892
August 14	E. Johnson	2.75	584
September 30	L. R. Stockman	3.05	704
November 11	L. R. Stockman	3.03	653
December 29	E. Johnson Jr	4.00	a1,083

a Partly frozen.

MEAN DAILY GAGE HEIGHT IN FEET OF TIPPECANOE RIVER AT SPRINGBORO, IND., FOR 1903.

DAY.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.50	3.82	3.42	2.78	2.99	2.94	3.10	3.08	3.10
2	.....	3.50	3.80	3.42	4.20	3.00	3.53	3.20	3.06	3.09
3	.....	3.72	3.73	3.28	7.03	3.03	3.40	3.40	3.09	3.08
4	.....	4.94	3.65	3.16	7.07	3.11	3.32	3.50	3.10	3.10
5	.....	5.54	3.57	3.50	7.18	2.99	3.28	3.47	3.09	3.12
6	.....	5.37	3.52	4.15	6.40	3.16	3.02	3.54	3.08	3.18
7	.....	5.00	3.49	4.59	5.54	3.07	2.90	3.70	3.06	3.22
8	.....	4.64	3.43	4.63	5.05	.....	2.88	3.90	3.05	3.28
9	.....	4.18	3.36	4.12	4.50	2.96	2.70	4.17	3.04	3.26
10	.....	4.21	3.32	3.77	4.10	2.98	2.81	4.07	3.02	3.24
11	.....	5.25	3.24	3.67	3.88	2.99	2.87	4.00	3.03	3.21
12	.....	6.69	3.20	3.26	3.76	3.00	2.94	3.93	3.10	3.20
13	.....	8.55	3.18	3.28	3.56	2.80	2.80	3.87	3.09	3.29
14	5.18	9.65	3.16	3.16	3.40	2.77	2.90	3.81	3.05	3.95
15	4.90	9.30	3.13	3.09	3.27	2.73	3.20	3.74	*a*	4.15
16	4.75	8.53	3.10	3.04	3.15	2.84	3.60	3.67	*a*	*b*
17	4.58	7.86	3.09	3.02	3.07	2.85	3.70	3.63	*a*	*b*
18	4.58	7.10	3.04	3.00	3.10	2.82	3.79	3.58	*a*	*b*
19	4.52	6.02	2.99	2.93	3.66	2.81	3.83	3.40	*a*	*b*
20	4.35	4.89	2.95	2.96	4.00	2.84	3.60	3.39	*a*	4.20
21	4.54	5.30	2.93	2.98	3.87	2.86	3.50	3.38	*a*	4.18
22	4.40	4.85	2.99	2.87	3.45	2.85	*c*	3.36	3.02	4.16
23	4.22	4.62	3.10	2.93	3.30	2.83	*c*	3.35	3.05	4.14
24	3.97	4.47	3.28	2.96	3.14	2.81	*c*	3.34	3.08	4.15
25	3.87	4.33	3.72	2.92	3.10	3.01	*c*	3.31	3.07	4.13
26	3.88	4.47	4.05	2.87	3.05	2.94	*c*	3.25	3.05	4.17
27	3.82	4.38	4.08	2.93	2.97	2.96	*c*	3.24	3.04	4.16
28	3.78	4.14	3.80	2.86	2.93	2.97	*c*	3.20	3.07	4.15
29	3.70	4.05	3.70	2.83	2.91	2.98	*c*	3.19	3.09	4.14
30	3.60	3.90	3.54	2.82	2.94	3.01	3.05	3.14	3.11	4.13
31	3.50	.....	3.38	.....	2.96	2.97	.....	3.09	.....	4.13

a Gage reader absent. *b* Frozen. *c* Gage stolen.

RATING TABLE FOR TIPPECANOE RIVER AT SPRINGBORO, IND., FROM MARCH 14 TO DECEMBER 31, 1903.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
2.7	551	4.0	1,987	5.3	4,230	7.2	7,650
2.8	611	4.1	2,151	5.4	4,410	7.4	8,010
2.9	680	4.2	2,320	5.5	4,590	7.6	8,370
3.0	758	4.3	2,490	5.6	4,770	7.8	8,730
3.1	845	4.4	2,660	5.7	4,950	8.0	9,090
3.2	940	4.5	2,830	5.8	5,130	8.5	9,990
3.3	1,043	4.6	3,000	5.9	5,310	9.0	10,890
3.4	1,154	4.7	3,170	6.0	5,490	9.5	11,790
3.5	1,273	4.8	3,345	6.2	5,850	10.0	12,690
3.6	1,400	4.9	3,520	6.4	6,210	10.5	13,590
3.7	1,535	5.0	3,695	6.6	6,570	11.0	14,490
3.8	1,678	5.1	3,870	6.8	6,930		
3.9	1,829	5.2	4,050	7.0	7,290		

DISCHARGE MEASUREMENTS OF TIPPECANOE RIVER NEAR DELPHI, IND., IN 1904.

DATE.	Hydrographer.	Width, Feet.	Area of Section, Sq. Ft.	Mean Velocity, Ft. per Sec.	Gage Height, Feet.	Discharge, Sec.-Ft.
January 23	F. W. Hanna	448	2,404	4.10	8.48	9,863
March 2*a*	F. W. Hanna	466	3,920	2.55	13.00	10,010
March 28	F. W. Hanna	449	2,560	4.78	8.80	12,240
May 2	Hanna and Johnson	343	917	4.04	4.95	3,708
June 18	F. W. Hanna	253	328	2.12	2.98	694
July 23	Hanna and Johnson	238	292	1.83	2.92	534
August 22	F. W. Hanna	255	370	2.38	3.20	882
September 13	F. W. Hanna	241	278	1.62	2.85	451
October 22	F. W. Hanna	249	273	1.77	2.90	484
November 5	F. W. Hanna	240	266	1.49	2.86	396

a Ice jam.

MEAN DAILY GAGE HEIGHT IN FEET OF TIPPECANOE RIVER NEAR DELPHI, IND., FOR 1904.

DAY.	Jan.a	Feb.a	Mar.a	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.a
1	.....	.....	14.60	9.55	6.59	4.25	3.49	2.85	2.93	3.10	2.83	2.83
2	.....	.....	13.44	9.43	5.07	4.21	3.37	2.82	2.90	3.07	2.82	2.82
3	.....	.....	13.21	8.49	4.80	3.87	3.21	2.80	2.87	3.05	2.84	2.80
4	.....	.....	12.90	8.34	5.60	3.74	3.09	2.81	2.86	3.00	2.84	2.80
5	.....	.....	12.37	8.21	5.12	3.65	3.17	2.81	2.84	2.95	2.85	2.91
6	4.10	8.25	12.25	8.03	4.96	3.61	3.22	2.77	2.85	2.91	2.85	2.96
7	.....	.....	12.80	7.95	4.72	3.40	3.75	2.75	2.83	2.90	2.84	2.97
8	3.80	.....	13.20	8.20	4.57	3.45	4.03	2.73	2.83	2.93	2.80	2.98
9	.....	.....	12.47	8.75	4.35	3.49	4.40	2.73	2.84	3.00	2.85	3.00
10	.....	.....	7.05	8.15	4.05	3.52	4.37	2.72	2.85	3.07	2.87	3.02
11	.....	.....	7.00	7.75	4.00	3.43	4.26	2.71	2.85	3.05	2.86	3.00
12	.....	.....	6.95	7.08	3.93	3.18	4.20	2.69	2.84	3.00	2.85	2.99
13	.....	7.85	6.90	5.53	3.84	3.17	4.17	2.74	2.81	3.00	2.86	2.98
14	.....	.....	7.00	4.98	3.89	3.13	3.98	2.73	3.00	2.98	2.84	.....
15	.....	.....	6.87	5.02	3.91	3.13	3.96	2.72	2.98	2.97	2.87	.....
16	3.85	.....	6.77	5.17	3.89	3.12	3.71	2.71	3.01	3.03	2.89	.....
17	.....	.....	7.00	5.17	3.85	3.54	3.55	2.78	3.05	3.00	2.88	3.04
18	.....	.....	7.20	5.14	4.01	3.27	3.47	2.80	3.21	2.97	2.86	.....
19	.....	.....	7.23	5.12	3.99	3.20	3.38	2.81	3.10	2.95	2.86	.....
20	4.75	8.20	7.10	5.09	3.95	3.16	3.30	2.90	3.05	2.92	2.85	.....
21	11.05	.....	7.15	4.98	3.90	3.10	3.21	3.05	3.00	2.90	2.83	.....
22	11.25	.....	7.77	4.91	3.81	3.09	3.00	3.35	2.98	2.98	2.80	.....
23	10.95	.....	8.10	4.67	3.70	3.07	2.95	3.42	2.97	2.95	2.85	3.05
24	.....	.....	8.54	4.47	3.64	3.06	2.91	3.40	2.95	2.94	.....	3.09
25	.....	.....	8.92	4.01	3.73	3.00	2.90	3.35	2.93	2.97	.....	3.12
26	.....	.....	11.20	5.80	3.72	2.96	2.90	3.28	3.10	2.95	.....	.....
27	15.00	8.20	9.41	7.03	3.71	3.00	2.99	3.18	3.15	2.92	.....	.....
28	.....	.....	7.94	6.70	3.70	3.83	2.98	2.98	3.23	2.81	.....	.....
29	.....	15.20	7.02	6.35	3.60	3.71	2.93	3.00	3.20	2.85	2.84	.....
30	7.25	.....	6.76	6.10	3.74	3.79	2.91	2.93	3.16	2.85	2.83	3.05
31	.....	.....	8.90	.....	4.20	.....	2.89	2.90	.....	2.84	.....	.....

a Frozen January 1 to March 9 and December 14 to 31.

RATING TABLE FOR TIPPECANOE RIVER NEAR DELPHI, IND., FROM JANUARY 1 TO DECEMBER 31, 1904.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
2.7	280	3.8	1,770	4.9	3,640	7.0	8,110
2.8	390	3.9	1,930	5.0	3,830	7.5	9,220
2.9	510	4.0	2,090	5.2	4,230	8.0	10,370
3.0	630	4.1	2,250	6.4	4,650	8.5	11,520
3.1	760	4.2	2,410	5.6	5,070	9.0	12,670
3.2	890	4.3	2,580	5.8	5,490	9.5	13,820
3.3	1,030	4.4	2,750	6.0	5,910	10.0	14,970
3.4	1,170	4.5	2,920	6.2	6,350	10.5	16,120
3.5	1,320	4.6	3,090	6.4	6,790	11.0	17,270
3.6	1,470	4.7	3,270	6.6	7,230	12.0	19,570
3.7	1,620	4.8	3,450	6.8	7,670	13.0	21,870

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.8 feet and 8.8 feet. The table has been extended beyond these limits. Above gage height 7.4 feet the rating curve is a tangent, the difference being 230 per tenth.

DISCHARGE MEASUREMENTS OF TIPPECANOE RIVER NEAR DELPHI, IND., IN 1905.

DATE.	Hydrographer.	Width, Feet.	Area of Section, Sq. Ft.	Mean Velocity, Ft. per Sec.	Gage Height, Feet.	Discharge, Sec.-Ft.
March 21	S. K. Clapp	319	713	3.9	4.25	2,782
May 27	M. S. Brennan	325	682	3.23	4.29	2,203
June 13	S. K. Clapp	285	672	3.66	4.30	2,459
July 14	S. K. Clapp	272	617	3.44	4.10	2,120
August 24	M. S. Brennan	256	294	1.89	2.98	556
October 5	M. S. Bernnan	251	276	1.76	2.98	486

DAILY GAGE HEIGHT IN FEET OF TIPPECANOE RIVER NEAR DELPHI, IND., FOR 1905.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.04	.....	7.8	4.1	7.9	4.4	3.4	3.35	3.9	3.02	3.25	4.4
2	3.08	.....	6.9	4.0	7.8	4.2	3.35	3.3	3.5	3.09	3.25	4.4
3	3.09	.....	6.1	3.95	7.8	4.0	3.3	3.3	3.6	3.08	3.2	4.25
4	3.08	3.06	5.9	3.7	7.6	3.95	3.25	3.25	3.75	3.04	3.2	4.2
5	3.06	.....	5.7	3.65	7.4	3.9	3.15	3.15	3.7	3.02	3.15	4.0
6	3.03	.....	5.6	3.6	7.3	3.85	3.15	3.06	3.55	3.0	3.8	3.85
7	3.0	.....	5.5	3.5	7.2	3.75	3.25	3.0	3.45	2.98	4.1	3.8
8	3.0	.....	5.4	3.55	6.8	3.75	3.25	3.0	3.35	2.98	4.0	3.7
9	.....	.....	5.1	3.55	6.8	3.9	3.2	2.98	3.15	2.97	3.95	3.65
10	.....	.....	4.7	3.55	6.5	4.0	3.3	2.98	3.1	2.96	3.95	3.55
11	.....	3.1	4.1	3.5	5.6	4.5	3.7	2.97	3.09	2.96	3.9	3.5
12	.....	.....	4.1	3.5	10.1	4.3	4.3	2.99	3.06	2.95	3.9	3.45
13	.....	.....	4.05	3.7	9.4	4.4	4.1	3.0	3.1	2.94	3.8	3.45
14	3.0	.....	4.05	3.9	10.2	4.4	4.0	3.09	3.3	2.93	3.7	3.65
15	.....	.....	4.2	3.85	10.0	4.4	3.9	3.2	3.25	2.91	3.6	3.6
16	.....	.....	4.2	3.85	9.8	4.3	3.7	3.45	3.15	2.9	3.5	3.5
17	.....	.....	4.2	3.8	8.9	5.0	3.6	3.3	3.15	2.9	3.35	3.45
18	.....	3.12	4.2	3.75	7.6	5.6	3.45	3.15	3.15	3.15	3.35	3.4
19	.....	.....	4.1	5.2	6.5	5.0	3.45	3.15	3.1	4.4	3.3	3.4
20	.....	3.1	4.1	7.0	4.8	4.3	3.35	3.45	3.1	4.4	3.3	3.25
21	3.03	.....	4.05	6.1	4.8	4.2	3.25	3.4	3.09	4.3	3.3	3.3
22	.....	.....	4.1	6.0	4.7	4.3	3.2	3.35	3.08	4.1	3.3	3.4
23	.....	.....	4.3	6.0	4.7	4.05	3.2	3.3	3.1	4.0	3.25	4.8
24	.....	.....	4.3	6.59	4.6	3.85	3.15	3.25	3.1	3.95	3.25	4.65
25	.....	3.15	4.2	5.8	4.6	3.7	3.1	3.25	3.09	3.85	3.2	4.2
26	.....	.....	4.2	5.5	4.4	3.6	3.07	3.2	3.08	3.8	3.15	3.9
27	.....	.....	4.2	5.4	4.4	3.65	3.05	3.15	3.06	3.6	3.1	3.9
28	3.1	.....	4.1	7.8	4.4	3.7	3.02	3.08	3.05	3.35	3.1	3.85
29	.....	.....	4.1	8.0	4.5	3.5	3.35	3.01	3.04	3.3	4.3	3.35
30	.....	.....	4.2	7.9	4.5	3.45	3.65	2.95	3.03	3.3	4.4	3.8
31	.....	4.90	4.1	.....	4.7	.....	3.4	2.98	.....	3.25	.....	3.75

NOTE.—There were ice conditions during January and February. From January 9 to February 11 the river was frozen over except for a narrow channel near the west bank. February 12–28 river frozen entirely across. Gage heights are to surface of water in hole in ice. The following comparative readings were also made:

DATE.	Water Surface, Feet.	Top of Ice, Feet.	Thickness of Ice, Feet.
January 14	3.0	2.9	0.3
January 21	3.03	3.03	.35
January 28	3.1	3.12	.5
February 4	3.06	.....	.5
February 11	3.1	3.12	1.0
February 18	3.12	3.12	1.0
February 25	3.15	3.19	1.0

STATION RATING TABLE FOR TIPPECANOE RIVER NEAR DELPHI, IND., FROM JANUARY 1, 1904, TO DECEMBER 31, 1905.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
2.70	280	4.20	2,410	5.70	5,280	8.40	11,290
2.80	390	4.30	2,580	5.80	5,490	8.60	11,750
2.90	510	4.40	2,750	5.90	5,700	8.80	12,210
3.00	630	4.50	2,920	6.00	5,910	9.00	12,670
3.10	760	4.60	3,090	6.20	6,350	9.20	13,130
3.20	890	4.70	3,270	6.40	6,790	9.40	13,590
3.30	1,030	4.80	3,450	6.60	7,230	9.60	14,050
3.40	1,170	4.90	3,640	6.80	7,670	9.80	14,510
3.50	1,320	5.00	3,830	7.00	8,110	10.00	14,970
3.60	1,470	5.10	4,030	7.20	8,550	10.50	16,120
3.70	1,620	5.20	4,230	7.40	8,990	11.00	17,270
3.80	1,770	5.30	4,440	7.60	9,450	11.50	18,420
3.90	1,930	5.40	4,650	7.80	9,910	12.00	19,570
4.00	2,090	5.50	4,860	8.00	10,370	12.50	20,720
4.10	2,250	5.60	5,070	8.20	10,830	13.00	21,870

NOTE.—The above table is applicable only for open-channel conditions. It is based on 23 discharge measurements made during 1903–1905. It is not very well defined.

DISCHARGE MEASUREMENTS OF TIPPECANOE RIVER AT DELPHI, IND., IN 1906.

DATE.	Hydrographer.	Width, Feet.	Area of Section, Sq. Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
February 10*a*	Brennan and Kriegsman	272	522	3.86	1,450
March 10	E. F. Kriegsman	335	790	4.74	3,320
April 3	E. F. Kriegsman	325	779	4.62	3,090
May 9	E. F. Kriegsman	257	361	3.27	962

a Slush and cake ice running.

DAILY GAGE HEIGHT IN FEET OF TIPPECANOE RIVER NEAR DELPHI, IND., FOR 1906.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	3.75	5.17	4.18	5.47	3.49	3.1	3.0
2	3.73	4.8	4.76	5.25	3.45	3.04	3.02
3	3.7	4.2	5.34	4.97	3.57	3.0	3.0
4	3.72	4.16	5.27	4.63	3.51	2.99	2.99
5	3.78	4.09	5.21	4.37	3.44	2.97	2.97
6	3.74	4.02	4.99	4.6	3.43	3.04	2.96
7	3.69	3.96	4.96	4.5	3.4	3.0	2.94
8	3.66	3.93	4.89	4.42	3.33	2.95	2.9
9	3.61	3.9	4.83	5.7	3.27	3.1	2.88
10	3.58	3.87	4.82	5.27	3.25	3.08	2.85
11	3.55	3.84	4.79	5.06	3.21	3.11	2.84
12	3.52	3.81	4.76	4.89	3.19	3.32	2.87
13	3.47	3.78	4.72	4.56	3.22	3.26	2.9
14	3.43	3.76	4.68	4.63	3.18	3.17	2.81
15	3.57	3.68	4.66	5.17	3.16	3.13	2.85
16	3.51	3.64	4.59	4.95	3.15	3.1	2.98
17	3.48	3.61	4.37	4.8	3.14	3.04	2.97
18	3.46	3.66	4.19	4.67	3.11	3.0	2.9
19	3.42	3.64	3.94	4.43	3.09	2.99	2.84
20	4.73	3.6	3.88	4.37	3.08	3.0	2.82
21	5.8	3.57	3.75	4.19	3.05	2.95	.....
22	6.12	3.52	3.73	4.0	3.03	2.96	.....
23	6.36	3.48	3.7	3.96	3.1	2.94	.....
24	6.39	3.45	3.75	3.91	3.15	2.93	.....
25	6.3	4.4	3.78	3.84	3.13	2.93	.....
26	6.15	4.33	4.12	3.76	3.11	2.9	.....
27	6.1	4.28	6.18	3.65	3.07	2.87	.....
28	6.0	4.21	6.0	3.6	3.05	2.85	.....
29	5.85	.....	5.94	3.57	3.03	2.95	.....
30	5.57	.....	5.86	3.53	3.1	3.02	.....
31	5.25	.....	5.71	.....	3.15	.....	.....

NOTE.—Flow slightly affected by ice conditions February 5 to 10.

RATING TABLE FOR TIPPECANOE RIVER NEAR DELPHI, IND., FOR 1904 TO 1906.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
2.80	390	3.70	1,620	4.60	3,090	5.50	4,860
2.90	510	3.80	1,770	4.70	3,270	5.60	5,070
3.00	630	3.90	1,930	4.80	3,450	5.70	5,280
3.10	760	4.00	2,090	4.90	3,640	5.80	5,490
3.20	890	4.10	2,250	5.00	3,830	5.90	5,700
3.30	1,030	4.20	2,410	5.10	4,030	6.00	5,910
3.40	1,170	4.30	2,580	5.20	4,230	6.20	6,350
3.50	1,320	4.40	2,750	5.30	4,440	6.40	6,790
3.60	1,470	4.50	2,920	5.40	4,650		

NOTE.—The above table is applicable only for open-channel conditions. It is based on 28 discharge measurements made during 1903 to 1906. It is well defined.

From the preceding data the minimum discharge is found to be 269 second-feet, and to have occured on August 12, 1904. The lowest in 1903 was 600 second-feet on July 1; in 1905, 510 second-feet on October 16 and 17; and in 1906, 400 second-feet on July 14. This data leads to the conclusion that a discharge of about 300 second-feet could be taken as a safe minimum.

The United States Weather Bureau shows the slightest rainfall for the time during which this gage record was kept to have been in November, 1904, when the mean monthly precipitation for northern Indiana was but .23 inch. During this month, however, the discharge at Springboro did not fall below 390 second-feet. The mean monthly rainfall for July, 1904, was 3.46 inches in northern Indiana, and in August was 3.17 inches, which is a normal rainfall in each case. A problem presents itself as to the reason for the discharge being so low on August 12 and remaining so high throughout November. The answer is unknown and cannot be derived from the data. The natural storage produced by the lakes would keep the discharge up during drought, but why the discharge should fall so low in August, when 30 per cent. of the precipitation in the Tippecanoe basin would have given a continuous discharge of over 1,200 second-feet, while the maximum discharge, which was on the 23d, was only 1,200 second-feet, according to the gage readings, is a point which cannot be accounted for except by the conclusion that the data in one or the other case is incorrect. It seems very probable that the gage readings are low because the rainfall data is collected from twenty-one stations and the error at any one station would be divided by twenty-one in striking the mean, and it is unlikely that twenty-one people reading rain gages should make an error which would be very large in the average. For these reasons the minimum discharge is estimated to be somewhat higher than the data shows on August 21, 1904.

The profile of the Tippecanoe River is peculiar in that the fall in the upper course is much less than in the lower course. The greatest fall occurs in the vicinity of Monticello. This is due to the fact that the stream flows over the Cincinnati anticline in northern White County and has been unable to cut through the hard rock at Norway. The Wabash River has been deepening its valley at the mouth of the Tippecanoe faster than the Tippecanoe could deepen its valley in the vicinity of Norway. The result of this condition is a gradually increasing fall in the lower course of the stream. The following table shows the profile of the river.

PROFILE OF TIPPECANOE RIVER.

LOCATION.	Estimated Distance, Miles.	Altitude, Feet.	Fall per Mile, Inches.
Source	0	950	
De Long	80	711	20.85
Monterey	7	703	13.71
Ora	5	698	12.00
Winamac	15	678	16.00
Monticello	31	599	30.58
Oakdale	11	563	37.09
Springboro	8	544	28.50
Mouth	9	524	26.66

POWER SITES ON THE TIPPECANOE RIVER.

The Tippecanoe River is without doubt the best power stream in Indiana, except the St. Joseph. Its minimum discharge is greater than that of either fork of White River or of the Wabash at Cicott Street bridge in Logansport, which is below the mouth of Eel River. The broad valley flats along the Wabash and White rivers are also distinct disadvantages when compared to the Tippecanoe, which has high banks and little bottom land except in the last ten miles of its course. That part of the Tippecanoe which lies between Winamac and the mouth is the part which is well adapted for power development. In spite of the advantages for power development, there are but two developed sites on the entire stream below De-Long. These sites are at Pulaski and Monticello. The development of power above Pulaski is not feasible. The current in this part of the stream is sluggish but steady. There are no ponds and the bed of the stream is composed of pure white sand, which is extremely beautiful under the water. There are no bowlders and no bed rock. There is little timber drift in this part of the stream, and on the whole it is a stream ideally adapted to pleasure trips.

Pulaski.—The dam at Pulaski was built about 1860 and has not been rebuilt. The present mill was built at the same time. The dam is built of wood and brush. It is in very bad repair and at least half the water goes through it when the discharge is small enough that none goes over. It is 418 feet long and four feet high. The backwater from this dam reaches nearly three miles. The race leads from the west end of the dam to the mill, one-fourth of a mile below. The head at the mill is five feet. Three wheels are employed under this head, one 48-inch and one 35-inch Little Giant, and one 30-inch Standard Leffel. These wheels produce about 75 H. P. The owners say that there would never be lack of water to

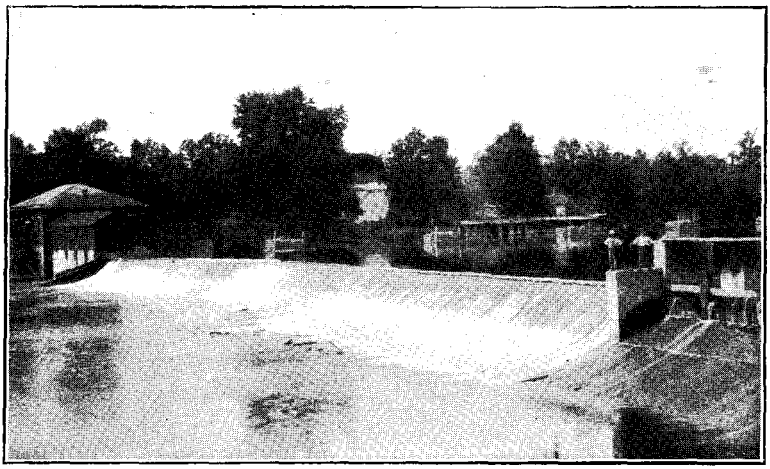
produce 75 H. P. if the dam were in good condition. This would indicate a minimum discharge of 165 second-feet at this point. The power is used entirely for grinding and all the power is not needed to run the mill. Much of it is wasted, besides the waste through the dam. It is safe to say that the minimum discharge here is not less than 200 second-feet. If the old dam were replaced by a new dam, with a head of eight feet at the mill, and modern wheels installed, a power of 145 H. P. could be produced continually and the installation should be on a 300 H. P. basis. That much power could be produced for eight months of the driest year. This power is owned and employed by C. N. Niedham and S. March.

There is little choice of location for power sites between Pulaski and Monticello. The character of the stream is similar throughout. Long reaches are separated by abrupt gravel ripples. The banks occasionally approach a little nearer to each other and are at some points slightly higher than at others. However, at no place are these peculiarities pronounced enough to be of great importance. The fall from Winamac to Monticello below the dam is 79 feet. About eight feet of this is occupied by the Monticello site and six feet by the Pulaski site. This leaves 65 feet of undeveloped fall between Winamac and Monticello. Ten feet of this should be developed at Norway. The rest of this fall could be developed on low heads, but no particular sites have been selected as superior to others.

Norway.—The first exposure of bed rock on the Tippecanoe occurs at Norway. It is Niagara, and is very hard. There is an abrupt ripple over this exposure with a fall of 2.7 feet. A dam could be located above this ripple with a head of eight feet. Such a dam has been in existence at this point and the race is still in good repair. The race adds 2.7 feet to the head at the dam. A dam eight feet high would injure about 20 acres of low lying land on the east side of the river in Section 16, T. 27 N., R. 3 west. If the minimum discharge at this point be considered 250 second-feet, a continuous power of 230 H. P. could be produced on a head of 10 feet.

Tippecanoe Electric and Power Company.—The dam of this plant is located about 100 yards below the point where the Tippecanoe crosses the line between Sections 27 and 34, T. 27 N., R. 3 W. It is at the northeast corner of Monticello. There has been a dam at this point for over fifty years. The power was formerly used in a woolen mill, and later in a flour mill. At present the power is used to produce electricity. The dam is 320 feet

long and 8.55 feet high. It is built of wood with concrete apron and abutments. The foundation is upon gravel, which makes it very unstable. Considerable trouble has been caused already by undermining below the dam. The dam is well constructed. The electric plant is situated on the west end of the dam. Four 50-inch wheels, each with a rating of 100 H. P. under eight feet head are installed. These wheels are not properly installed and do not produce their rated power. The discharge below the draft tube is restricted so that the water is forced out, which accounts for the loss of power. The four wheels produce about 300 H. P. when in full operation. The river discharge is insufficient to run the four wheels during low water, but has never failed to run two to their



Dam and power plant of the Tippecanoe Electric and Power Co., Monticello, Ind.

capacity. Thus, the minimum power produced at this point has not been below 150 H. P. This would indicate that the minimum discharge does not go below 210 second-feet. There has never been a time when there was not waste when only two wheels were running, so that the discharge is probably at the least 250 second-feet. The electric plant is a model concern of its kind. It is run continuously and furnishes the motor power and light for Monticello. Steam auxiliary power is used during low discharge. This power is owned and operated by the Tippecanoe Electric and Power Company, of which D. J. Oglesby is superintendent.

Tioga.—Tioga is the name of a point on the river at the southeast corner of Monticello, about two and one-half miles by the river

below the Tippecanoe Electric and Power Company plant, and in Section 3, T. 26 N., R. 3 W. The river makes a great bend eastward between these two sites. The fall from the tail water of the electric plant to the wagon bridge at Tioga is 13.04 feet. One hundred and fifty feet above the wagon bridge is the remnant of an old dam and evidences of an old mill are still visible on the east side of the stream. The river flows against the west bluff, which is about 80 feet high at this point. The east bank is about 25 feet high. The stream is about 350 feet wide. The bed is composed of gravel, but bed rock is said to be within a few feet of the surface. This is probably true, because the river flows on bed rock about one-fourth of a mile above Tioga. This site could be developed with a head of 10 feet without interference to the electric plant. The control of this site and much of the power below this point is in the hands of a corporation, known as the Tippecanoe Hydraulic Company. This company is holding the rights as an investment.

Power Site in Section 22, T. 26 N., R. 3 W.

In Section 22, the river is flowing south by east and bends suddenly to a southwestward direction. On this bend the river flows against the east bluff, which rises abruptly about 30 feet and then slopes gradually to a height of 70 or 80 feet. The west bank is about 25 feet high and slopes immediately into the west bluff, which approaches within an eighth of a mile of the river. After the river has turned southwestward, a remnant of the east bluff forms a long, gradually lowering ridge along the southeast side of it. Back of this ridge is a low bottom field. A dam constructed on this bend and a race cut through the ridge would make an excellent power site, for the water would be under absolute control. The race would skirt the east bluff towards the southeast and re-enter the river at a point in the exact center of the south line of Section 22. The race would be one-half mile long, but would be easily constructed after the cut through the previously mentioned ridge had been made. The cut would be about 250 feet long and the depth would be governed by the height of the dam. If the Tioga site were developed, the height of this dam would be limited to 10 feet. This height is an estimate, because no levels were run over this part of the river. However, if the Tioga site were not developed, a dam of 15 or even 20 feet could be constructed here. There is practically no low land above this site. The race would re-enter the river one and one-half miles below the dam and would add five feet

to the head. The power at this point at minimum discharge, 250 second-feet, would be 23 H. P. per foot head. The farm upon which this site is located belongs to Martin Baum.

Oakdale.—Oakdale is the name of a small summer resort in Section 33, T. 26 N., R. 3 W. A water power mill was previously located at this point and part of the old dam still remains. Below the old dam is a considerable ripple. The entire fall over the dam and ripple is 6.38 feet. The old dam was located at a point where the banks are low and the stream bed very wide. Immediately below the ripple the river flows against the west bluff and the east bank is about 12 feet high. A dam at this point would be about 400 feet long. There is no bed rock in the stream at this point. A head of eight feet could be maintained here and a minimum power of 200 H. P. produced.

Springboro.—Springboro is located five miles west of Delphi, near the southwest corner of Section 26, T. 25 N, R. 3 W. The fall from Oakdale to this point is 19 feet. A heavy ripple occurs at Springboro with a fall of approximately four feet. This is a bowlder ripple and no bed rock is exposed. At the foot of this ripple the banks are high. A dam 10 feet high and 500 feet long could be constructed here without damage to low land. Such a dam would produce 273 H. P. when the discharge is 300 second-feet.

The fall from this point to the mouth is 20 feet, and no plan for developing this power seems feasible. The banks of the river become lower and more bottom land occurs in this part of the valley. Back-water from the Wabash River would be a serious handicap to development in this part of the stream. The Wabash River fluctuates a great deal because its headwaters and southern tributaries have no storage. Any rise in this river would diminish the fall between Springboro and the mouth by the amount of the rise.

If the group of sites which have been mentioned were developed by one management, supplemented by steam power and fed into one system, the enterprise should be profitable. The development of the several sites would improve each individual site by the increased storage and water control.

SUGAR CREEK.

A discussion of Sugar Creek will be found on page 75 of the Thirty-fifth Annual Report. This stream was investigated again during the summer of 1911. The estimated discharge was found to be too high. The former estimate was made from one current reading and the statements of men who were acquainted with the stream as to the comparative stages which it presented. Upon the second visit the stream was found to be very low, indeed. A discharge measurement, made on August 21, 1911, at the Shades of Death, where the former measurement was taken, showed a discharge of but 17.62 second-feet. The profile of the stream was determined and is given in the following table:

PROFILE OF SUGAR CREEK.

LOCATION.	Distance, Miles.	Altitude, Feet.	Fall per Mile, Feet.
Source	0	1000	.....
Bluff Mill	60	565	7.25
Pleasantview	5	543	4.4
Narrows	8	502	5.12
Mouth	13	459	3.31

A site which could be easily developed is in Section 18, T. 17 N., R. 6 W. The stream flows through a gorge of Mansfield sandstone. The gorge is 100 feet wide and 60 feet deep. The bed of the stream is on bed rock. The stream falls 16.76 feet from the Pleasant View site to this site, and the fall from this site to the Narrows is 23.78 feet. Thus this site could be developed with a head of 15 feet without interference with either of the sites mentioned in the Thirty-fifth Annual Report. The valley above this site is narrow and not more than five acres of cultivated land would be submerged by this development.

The valley widens below this site and there is considerable low land between it and the Narrows. A development of 20 feet at the Narrows would submerge about 20 acres of cultivated land.

When the extreme irregularity of discharge of this stream is considered, it is plain that the power is not feasible for continuous use. Not only is the low discharge a menace, but also the stages are dangerous. Sugar Creek is very wild during high water because of the narrow valley through which it flows. The fact that each of the sites which have been discussed offer locations for power houses above the danger line of floods and the ease with which dam construction can be carried on in each case are favorable to development. No sites for development were located below the Narrows.

MISSISSINEWA RIVER.

The Mississinewa River rises in Darke County, Ohio, flows westward through Randolph County, Indiana, bends to the northwest in Delaware County, and flows in that general direction through Delaware, Grant, Wabash and Miami counties, to its mouth, one and one-half miles east of Peru. It is a very crooked stream and has no large tributaries. It has a total length of 105 miles, practically all of which is in Indiana.

The valley of this stream lies between two glacial moraines left by the Erie glacier. It is entirely within glacial drift, but below Marion continually touches and is excavated into bed rock in many places. At Marion, the valley is about 40 feet deep and becomes gradually deeper toward the mouth. The greatest depth is about 100 feet. The width is variable. Broad bottoms are succeeded by gorges and narrows. The limestone gorges which occur in northern Grant County are the most picturesque in Indiana and the bottom land in Miami County is not surpassed by bottom land anywhere.

The basin of the Mississinewa River is long and narrow. It is bounded by the Salamonie Basin on the north and by White River Basin on the south. The devides between these basins are formed by the glacial moraines which have been previously mentioned. The tributaries are short and about evenly divided on north and south. No natural storage occurs in this basin, since the land has been systematically drained and the forests removed. The absence of wooded land in this basin is particularly noticeable. This is due to the gas boom, at which time the forests were practically all destroyed because it was thought that there would be no wood needed for fuel in the future. Before the land was artificially drained there was considerable natural storage caused by the irregular relief of the glacial drift. This did not take the form of lakes nor even swamps, but was poorly drained land. This land is now perfectly drained by tile. The entire drainage area of this stream is approximately 900 square miles.

The discharge of the Mississinewa River is very irregular. A gaging station has been maintained at Peoria since 1910 and the data which has accumulated will be given. This gage was established on July 6, 7, and 8, 1910. It is located five miles southeast of Peru, Indiana. A discussion of this gage is given on page 76 of the Thirty-fifth Annual Report. This gage is based on one bench mark, which is a wire nail in the north side of a small hackberry tree. The nail is about five inches from the ground. The

tree stands 37 feet southwest of the upper end of the gage. It is beside a large bowlder and has a woven wire fence attached to it. The bench mark is 18.69 feet above the 0 of the gage.

DISCHARGE MEASUREMENTS ON MISSISSINEWA RIVER AT PEORIA DURING 1910-11.

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
July 8, 1910	W. M. Tucker	1.0	65.49
April 5, 1911	W. M. Tucker	4.6	3191.48
June 23, 1911	Tucker and Clark	1.8	183.34
June 26, 1911	Tucker and Clark	1.9	202.76

GAGE READINGS ON MISSISSINEWA RIVER AT PEORIA FROM JULY 8, 1910, TO JULY 7, 1911.

DAY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	.....	1.1	1.0	1.7	1.3	3.0	4.7	4.2	2.3	2.0	3.7	1.2	1.5
2	.....	1.1	1.0	1.5	1.3	2.8	4.5	3.6	2.2	2.0	2.9	1.2	1.5
3	.....	1.0	1.0	1.4	1.2	2.4	4.5	3.4	2.1	2.0	2.8	1.2	1.9
4	.....	1.0	1.0	1.4	1.2	2.2	4.3	3.1	2.0	2.1	2.1	1.2	1.3
5	.....	1.0	1.3	1.3	1.2	2.0	4.0	3.0	2.0	2.1	2.2	1.2	1.3
6	.....	1.0	1.7	1.3	1.2	2.9	3.4	2.8	1.9	5.3	2.2	1.6	1.3
7	.....	1.0	1.7	6.6	1.2	2.8	3.0	2.8	1.8	5.2	2.3	2.5	1.3
8	1.0	1.0	1.5	8.4	1.2	1.7	2.9	2.8	1.9	4.8	2.0	2.5	.....
9	1.0	1.0	1.6	7.8	1.1	1.7	2.8	2.7	1.9	4.0	2.4	2.1	.....
10	1.0	1.0	1.6	7.8	1.1	1.7	2.8	2.7	2.2	3.6	2.4	2.0	.....
11	1.1	1.0	1.6	7.4	1.1	1.7	2.7	2.7	2.8	3.1	2.2	1.7	.....
12	1.0	1.0	1.5	6.4	1.1	1.8	2.7	2.5	3.2	2.6	2.2	1.7	.....
13	1.0	1.1	2.1	4.9	1.1	1.8	2.6	2.4	2.8	2.4	2.0	1.7	.....
14	1.0	1.1	2.0	3.2	1.1	1.7	2.7	2.8	2.5	3.2	2.0	1.4	.....
15	1.0	1.1	2.0	2.1	1.1	1.7	2.9	3.8	2.3	4.6	2.0	1.4	.....
16	1.0	1.1	2.1	1.8	1.1	1.6	5.0	3.7	2.1	4.4	2.0	1.3	.....
17	1.0	1.1	2.2	1.8	1.1	1.6	6.4	3.3	2.1	2.7	1.7	1.3	.....
18	1.1	1.0	2.3	1.7	1.1	1.6	5.6	3.2	2.1	2.3	1.7	1.1	.....
19	1.0	1.0	2.3	1.7	1.1	1.5	4.9	3.0	2.1	2.0	1.8	1.1	.....
20	1.0	1.0	2.3	1.6	1.1	1.5	4.4	2.9	2.2	3.8	1.8	1.4	.....
21	1.0	1.0	2.3	1.6	1.1	1.5	4.1	2.8	2.2	3.8	1.6	1.4	.....
22	1.1	1.0	2.3	1.6	1.1	1.5	3.8	2.6	2.1	3.5	1.6	1.5	.....
23	1.0	1.0	2.2	1.5	1.1	1.6	3.4	2.5	2.0	3.7	1.6	1.8	.....
24	1.0	1.0	2.2	1.5	1.1	1.6	3.6	2.4	2.0	3.2	1.5	1.6	.....
25	1.1	1.0	2.2	1.5	1.1	1.6	3.0	2.4	1.9	2.3	1.4	2.2	.....
26	1.0	1.1	2.1	1.5	1.1	1.6	2.8	2.4	1.9	2.1	1.4	1.9	.....
27	1.0	1.2	2.1	1.5	1.1	1.6	3.4	2.3	2.1	1.8	1.4	1.7	.....
28	1.0	1.1	2.0	1.5	1.5	1.9	7.1	2.3	2.0	1.5	1.4	1.6	.....
29	1.0	1.1	2.0	1.4	2.9	2.8	7.0	.....	1.9	1.5	1.4	1.6	.....
30	1.0	1.0	1.8	1.4	3.3	5.0	6.6	.....	2.0	2.2	1.2	1.5	.....
31	1.1	1.0	.....	1.4	.....	4.8	5.0	.....	2.1	.....	1.2	.....	.....

RATING TABLE FOR MISSISSINEWA RIVER AT PEORIA FOR 1910-11.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.0	66	1.9	204	2.8	557	3.7	1,583
1.1	77	2.0	227	2.9	629	3.8	1,743
1.2	89	2.1	252	3.0	711	3.9	1,910
1.3	102	2.2	280	3.1	804	4.0	2,083
1.4	116	2.3	312	3.2	908	4.1	2,261
1.5	131	2.4	349	3.3	1,023	4.2	2,443
1.6	147	2.5	391	3.4	1,149	4.3	2,628
1.7	164	2.6	439	3.5	1,285	4.4	2,815
1.8	183	2.7	494	3.6	1,430	4.5	3,003
						4.6	3,191

From this data it is evident that there are long periods during the year in which the discharge is less than 100 second-feet. The minimum discharge is 66 second-feet. This discharge will produce six H. P. per foot fall. The entire fall from Marion to the mouth of the river is 148 feet. If this entire fall covering 30 miles could be developed, the minimum discharge would yield less than 888 H. P. because the discharge is less at any point above Peoria and much less at Marion.

The profile of the Mississinewa has not been determined. The elevations at Marion and at the mouth were determined and the fall estimated in the various parts between these two points. The elevation at Marion is 781 feet above sea level and at the mouth 633 feet. The fall averages 4.93 feet per mile.

Power Sites on the Mississinewa River.

There are three developed power sites on this stream between Marion and the mouth. One is one mile below Marion, another in Section 9, T. 25 N., R 7 E., and the other in Section 26, T. 26 N., R. 6 E. These sites are known as Charles' Mill, Conner's Mill, and Pearson's Mill, respectively. Another site was developed until the winter of 1910-11, when the dam was destroyed by ice. This site was at Peoria and was known as the Peoria Mill. There are points where power could be developed but with the deficient discharge it is not considered to be profitable. Some of these points will be discussed, however.

Charles' Mill.—This mill is located in the extreme north end of Marion, about one mile from the business section. This site was first developed about 1840. It has been owned by the Charles family for fifty years. The dam is 320 feet long and six feet high. It is built of stone and wood. About 200 feet of the eastern end is built of limestone and is in excellent condition. The remainder is built of wood and is fast falling into decay. The forebay is at the east end of the dam and is built of limestone. The dam and forebay are built upon solid limestone. Three wheels are employed, one 84-inch wheel rated at 45 H. P., one 54-inch wheel rated at 35 H. P., and one 54-inch wheel rated at 25 H. P. These are all old-style wheels. Fifty H. P. is developed at this site for eight months of the year. It is supplemented by electric power during low discharge. The river is practically intermittent in this part of its course. The power is used entirely for milling purposes.

Conner's Mill.—This site is naturally ideally located. The bluffs of the stream converge until they are 300 feet apart. They rise abruptly from the river. They are composed of limestone, as is also the bed of the stream. A dam 30 feet in height could be constructed here but would submerge a great deal of low land. This dam is about forty years old. It is built of wood and is in fair condition. It is 250 feet long and five feet high. The power is employed in a flour mill and in a sawmill. There is one 48-inch wheel in the sawmill. The power developed by this wheel is not known. It is employed by S. B. Kennedy. In the flour mill there are three wheels employed, one 48-inch, one 40-inch and one 38-inch. The rating of these wheels is unknown. This power is employed by Alec Lindsay. The power produced at this site is not more than 25 H. P. during minimum discharge.

Power Site at Joel Garst Farm.—When the river enters Wabash County it becomes more crooked and has several large incised meanders. One of these meanders begins where the river first touches the range line between Ranges 6 and 7 E. The river crosses into R. 6 E., but immediately returns to R. 7 E. It then makes a great bend northeastward and after flowing for two miles has returned to a point about three-fourths of a mile northwest of the point where it first touched Range 6. Between these points lies a depression which is so low that the southeast end must be leveed to keep the flood water from flowing across and injuring the field. At a point immediately below the southeast end of this depression, the river is flowing on bed rock, a shaly, thin-bedded limestone. The fall by river from the upper to lower end of the depression is 5.37 feet. A mill was formerly located in this depression and used the power. The water was conducted across in a race. A six-foot dam, 150 feet in length, could be constructed on the limestone foundation and the race be reconstructed. This would produce a fall of 11 feet. This site is on the farm of Joel Garst.

Pearson's Mill.—At the point where the depression re-enters the river the backwater from the Pearson dam begins. The pond is two miles long. The dam is situated on a solid rock foundation and has a rock bluff 40 feet high for its south abutment. The dam is 183 feet long and four feet, 10 inches high. The bank on the north end of the dam is about 10 feet high above the pond. The mill is located on this bank, in a very pretty park. The land rises gradually to 40 or 50 feet above the river in a quarter of a mile. In the mill are two wheels. One is used for mill purposes and is

rated at 20 H. P. The other is used to produce electricity, which is used in lighting the park grounds. The park is used for a summer resort. The power is owned and employed by Richard Pearson.

Power Site in Section 29, T. 26 N., R. 6 E.—This site is about three miles below Somerset. The fall below Pearson's Mill to this point is about 15 feet. The river flows through a narrow, the sides and bed of which are solid limestone. The east bluff rises abruptly for 60 feet, and on the west the solid rock slopes upward to a height of 20 feet within a distance of 75 feet. The river is about 125 feet wide and an average of 12 feet deep. A 12-foot dam at this point would back the water beyond Somerset. The location for a plant on the west side is ideal. With a head of 12 feet, about 100 H. P. could be produced except in very low water, when about 60 H. P. would be available.

Site in Section 14, T. 26 N., R. 5 E.—Below the previous site the river flows through narrows and short canyons. At Redbridge is an old dam which is almost obliterated. It produces a fall of three feet, but is not used. The location is poor for development, for the stream is wide and the dam is on a bend of the stream. In Section 14, the bluffs approach the river until a dam 200 feet long and 15 feet high would retain the water. The stream bed is of solid rock. A power plant could be well located on the west side of the stream at this point. This site is near the ford, which is a short distance above the head of the Peoria mill pond. Fifteen feet head would produce about 100 H. P. during minimum flow, and more during most of the year.

Peoria Mill.—The Peoria Mill was operated by water until the winter of 1910-11, when the dam was destroyed by high water and ice. The dam had been built during the previous summer. A dam was built of bowlders which was covered and filled by cement. The apron was light and extended but two feet below the dam. The dam was three feet high. When the ice went out in December, 1910, it broke the apron and the water undermined the dam and it broke in three places. A race 500 feet long added two feet to the head. On the head of five feet, about 40 H. P. was produced for 12 hours per day. This site is owned by H. F. Whisler.

No sites occur below this point which are feasible for development. The fall from Peoria to the mouth is approximately 15 feet.

THE WABASH RIVER.

The Wabash River rises in the Grand Reservoir, an artificial lake, at Celina, Mercer County, Ohio. It crosses the State line into Indiana near the northeast corner of Jay County and flows in a northwest direction to Huntington, through Adams, Wells and Huntington counties. At Huntington it turns westward and flows in that direction, bearing slightly southward to Logansport, through Huntington, Wabash, Miami and Cass counties. At Logansport it turns toward the southwest and flows in that direction to Covington, through Cass, Carroll, Tippecanoe, and between Warren and Fountain counties. At Covington it bends southward and flows in that direction, bearing toward the west to the State line in Vigo County, between Fountain and Parke counties on the east and Vermillion County on the west and through Vigo County. From this point it forms the west line of Indiana to its mouth. The entire length of the part which lies entirely in Indiana is 320 miles. In this course are the mouths of several large tributaries. The Little Wabash, at Huntington; the Salamonie, near Lagro; the Mississinewa, near Peru; the Eel, at Logansport; the Tippecanoe, near Delphi; the Wildcat, near Lafayette, and Sugar Creek, near Newport, are the largest of these. The main branch from Celina, Ohio, to Huntington, Indiana, is very much like the Mississinewa in its characteristics. It flows between two glacial moraines and the tributaries are small. It runs through glacial drift in this part of its course, although it touches bed rock frequently.

The valley below Markle is everywhere characterized by broad valley flats. The width varies from one-half mile in the upper course to six miles at Terre Haute. The banks are composed of river sediment and usually very low. The bluffs vary in height from 50 feet at Markle to 100 feet or more throughout its course below Wabash.

The drainage basin is a broadly curved, unsymmetrical section of land stretching across the north central part of the State. The main branch and the southern tributaries have no natural storage facilities. The northern tributaries rise in the lake regions of the Saginaw glacier. The effect of these streams is to make the discharge more regular below Logansport and Delphi. Above Logansport, the discharge is very irregular. The drainage area above Terre Haute is 12,200 square miles, and above Logansport, including Eel River basin, is 3,163 square miles.

The United States Geological Survey maintained a gage at Lo-

gansport from April 27, 1903, to July 8, 1906. The following data is taken from the United States Water Supply Papers:

WABASH RIVER AT LOGANSPORT, INDIANA.*

This station was established April 27, 1903, by Geo. E. Waesche. It is located at the Cicott Street bridge, about 1 mile from the center of the city of Logansport, 1¾ miles from the Wabash Railroad station, 1½ miles from the Pennsylvania station, four blocks from the street car line, and 1,000 feet below the mouth of Eel River. The standard chain gage is placed on the second span of the bridge, at the third panel from the second pier, and is supported by the bridge pins, and is between the lower chord bars. It is reached through a trap door in the floor planks of the bridge. The distance from the end of the weight to the marker is 20.78 feet. The gage is read once each day by C. B. Woodruff. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is the back wall of the bridge seat for the north abutment. The channel is nearly straight for 1,000 feet above and for 1,500 feet below the station. The distance between abutments is 550 feet, and the channel is broken by three bridge piers. The right bank is high and is not subject to overflow at the bridge. The left bank is submerged only at extreme high water. The bed of the stream is covered with small bowlders and is rough. The stream is shallow and the current is never sluggish. Benchmark No. 1 is the top of the north abutment, under the fourth board of the downstream sidewalk. Its elevation is 18.814 feet above gage datum. From Pennsylvania Railroad levels its elevation above sea level has been found to be 591 feet. Bench mark No. 2 is the top of the third course of masonry from the top of the north abutment. Its elevation above the zero of the gage is 15.31 feet.

The observations at this station during 1903 have been made under the direction of E. Johnson, Jr., district hydrographer.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT LOGANSPORT, IND., IN 1903.*

DATE.	Hydrographer.	Gage Height. Feet.	Discharge, Sec.-Ft.
April 27	Geo. E. Waesche	2.50	2,367
June 8	Geo. E. Waesche	4.55	7,180
June 16	Geo. E. Waesche	?	1,444
July 8	Geo. E. Waesche	2.30	1,358
July 16	E. C. Murphy	1.54	719
August 15	E. Johnson Jr	1.35	418
September 30	L. R. Stockman	1.30	349
November 10	L. R. Stockman	1.38	452
December 28	E. Johnson Jr	2.75	1,285

*Water-supply paper U. S. Geol. Survey, No. 98, page 225.

MEAN DAILY GAGE HEIGHT IN FEET OF WABASH RIVER AT LOGANSPORT, IND., FOR 1903.*

DAY.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.15	2.30	1.55	1.70	1.70	.....	.....	1.30
2	.....	2.10	2.25	10.15	1.60	1.70	.....	.....	1.30
3	.....	.....	2.70	7.25	1.50	1.70	*a*	.....	1.40
4	.....	2.00	2.50	4.80	1.60	1.70	.....	.....	1.50
5	.....	2.00	3.25	3.65	1.60	1.70	.....	.....	1.60
6	.....	1.95	4.15	3.00	1.55	1.92	.....	.....	1.70
7	.....	1.90	5.50	2.55	1.55	1.72	.....	.....	1.50
8	.....	1.90	.....	2.30	1.50	1.72	.....	.....	1.45
9	.....	1.90	4.30	2.15	1.45	1.70	.....	.....	1.40
10	.....	.....	3.65	2.00	1.40	1.40	*a*	1.40	1.40
11	.....	1.80	3.10	1.90	1.40	1.40	.....	1.40	1.85
12	.....	1.80	2.65	1.95	1.35	1.35	.....	1.40	1.85
13	.....	1.80	2.40	1.90	1.35	1.35	.....	1.40	2.40
14	.....	1.75	2.25	1.25	1.35	1.40	.....	1.40	2.90
15	.....	1.75	2.10	1.70	1.35	1.40	.....	1.40	2.90
16	.....	1.75	1.95	1.60	1.45	1.40	.....	1.50	2.90
17	.....	.....	1.85	1.60	1.40	1.40	*a*	1.50	2.70
18	.....	1.70	1.80	1.75	1.40	1.40	.....	1.80	2.40
19	.....	1.65	1.80	1.85	1.30	1.40	.....	1.60	2.40
20	.....	1.65	1.75	1.85	1.35	*a*	.....	1.40	2.40
21	.....	1.60	1.70	1.80	1.35	.....	.....	1.50	2.70
22	.....	1.65	1.80	1.70	1.30	.....	.....	1.50	2.90
23	.....	1.70	2.05	1.80	1.30	.....	.....	1.40	2.80
24	.....	2.15	2.20	1.75	1.30	.....	*a*	1.40	2.70
25	.....	2.80	2.00	1.70	1.30	.....	.....	1.40	2.70
26	.....	2.70	1.85	1.70	1.30	.....	.....	1.40	2.70
27	2.50	3.00	1.75	1.70	1.35	.....	.....	1.40	2.80
28	2.40	3.60	1.70	1.60	1.90	.....	.....	1.40	2.75
29	2.30	3.30	1.60	1.60	2.10	.....	.....	1.40	2.68
30	2.20	2.85	1.60	1.65	1.90	.....	.....	1.30	2.60
31	.....	2.60	.....	1.70	1.70	.....	.....	.....	2.53

*Water-supply paper U. S. Geol. Survey, No. 98, page 226. *a*Observer absent.

RATING TABLE FOR WABASH RIVER AT LOGANSPORT, IND., FROM APRIL 27 TO DECEMBER 31, 1903.*

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.3	380	2.6	1,990	4.8	8,100	8.0	22,780
1.4	460	2.7	2,170	5.0	8,890	8.5	25,130
1.5	550	2.8	2,360	5.2	8,720	9.0	27,480
1.6	650	2.9	2,560	5.4	10,590	9.5	29,830
1.7	750	3.0	2,770	5.6	11,500	10.0	32,180
1.8	860	3.2	3,200	5.8	12,440	10.5	34,530
1.9	980	3.4	3,670	6.0	13,380	11.0	36,880
2.0	1,100	3.6	4,180	6.2	14,320	11.5	39,230
2.1	1,230	3.8	4,740	6.4	15,260	12.0	41,580
2.2	1,370	4.0	5,340	6.6	16,200	12.5	43,930
2.3	1,510	4.2	5,970	6.8	17,140	13.0	46,280
2.4	1,660	4.4	6,640	7.0	18,080	.....	.....
2.5	1,820	4.6	7,350	7.5	20,430	.....	.....

*Water-supply paper U. S. Geol. Survey, No. 98, page 226.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT LOGANSPORT, IND., IN 1904.*

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
1904.			
January 22*b*	F. W. Hanna	13.11	46,660
March 2*c*	F. W. Hanna	8.20	23,660
March 29*c*	F. W. Hanna	10.50	32,480
May 3	F. W. Hanna and Johnson	2.98	3,744
June 17	F. W. Hanna	1.66	878
July 21	F. W. Hanna	1.76	920
August 23	F. W. Hanna	1.50	723
September 14	F. W. Hanna	1.48	542
October 21	F. W. Hanna	1.30	401
November 4	F. W. Hanna	1.27	379

*Water Supply Paper U. S. Geol. Survey, No. 128, page 84.

MEAN DAILY GAGE HEIGHT IN FEET OF WABASH RIVER AT LOGANSPORT, IND., FOR 1904.*

DAY.	Jan.a	Feb.a	Mar.a	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.a
1	2.53	3.10	9.90	12.22	3.75	2.90	1.80	1.30	1.30	1.35	.....	1.30
2	2.50	3.00	7.88	13.00	3.25	3.00	1.73	1.30	1.33	1.35	1.22	1.35
3	2.33	2.30	7.65	13.02	2.95	3.00	1.75	1.35	1.27	1.30	1.25	1.45
4	2.23	2.50	7.88	11.06	2.75	2.90	1.68	1.33	1.21	1.29	1.27	1.22
5	2.23	2.50	7.30	7.65	2.58	2.70	1.79	1.30	1.25	1.26	1.23	1.28
6	2.20	3.00	6.50	5.73	2.50	2.40	1.90	1.35	1.30	1.25	1.25	1.22
7	2.20	10.20	8.19	4.88	2.40	2.30	3.10	1.29	1.24	1.28	1.27	1.22
8	2.15	9.65	7.35	4.45	2.30	2.20	5.12	1.29	1.20	1.35	1.27	1.28
9	2.15	7.90	5.83	4.70	2.30	2.00	4.95	1.32	1.25	1.45	1.22	1.25
10	2.15	6.35	5.00	4.95	2.35	1.90	4.71	1.25	1.25	1.46	1.30	1.18
11	2.15	5.60	5.00	4.70	2.25	1.90	4.43	1.25	1.25	1.46	1.30	1.31
12	2.10	5.10	5.15	4.68	2.13	1.82	4.14	1.24	1.25	1.45	1.30	1.20
13	2.10	4.20	.....	4.30	2.10	1.78	3.53	1.20	1.26	1.45	1.30	1.40
14	2.20	3.60	4.20	3.90	.....	1.73	2.99	1.25	1.48	1.40	1.31	.....
15	2.20	2.70	3.70	3.60	.....	1.70	2.69	1.21	1.41	1.37	1.31	.....
16	2.15	2.50	3.42	3.33	2.00	1.70	2.50	1.25	1.25	1.35	1.25	.....
17	2.15	2.30	3.45	3.15	1.95	1.65	2.00	1.25	1.30	1.35	1.31	.....
18	2.20	2.34	5.40	2.90	2.00	1.73	1.99	1.25	1.41	1.29	1.30	.....
19	2.25	2.38	6.75	2.90	2.15	1.75	1.85	1.25	1.49	1.28	1.30	.....
20	2.60	2.10	7.00	2.63	2.40	1.90	1.81	1.50	1.49	1.25	1.33	.....
21	10.85	2.25	6.20	2.52	2.40	2.56	1.78	1.61	1.51	1.30	1.35	.....
22	13.19	2.21	8.30	2.48	2.35	3.30	1.65	1.76	1.39	1.30	1.35	.....
23	12.55	2.35	8.10	2.85	2.43	3.15	1.65	1.50	1.37	1.30	1.30	1.31
24	10.00	3.50	6.68	2.15	2.40	2.97	1.61	1.45	1.37	1.30	1.28	1.35
25	7.45	4.80	6.85	2.60	2.40	2.49	1.55	1.40	1.40	1.30	1.31	1.41
26	6.00	4.50	13.45	7.05	2.75	2.20	1.53	1.29	1.56	1.30	1.30	1.50
27	4.75	3.70	14.84	7.12	2.70	2.00	1.53	1.30	1.50	1.30	1.30	1.73
28	4.38	3.88	13.05	5.90	2.53	1.93	1.50	1.27	1.56	1.24	1.34	.....
29	4.00	9.22	10.32	5.25	2.40	1.87	1.50	1.30	1.46	1.22	1.30	4.12
30	3.70	.....	7.50	4.50	2.43	1.80	1.41	1.33	1.40	1.22	1.28	3.95
31	3.50	.....	9.10	.....	2.55	.....	1.39	1.34	.....	.....	.....	3.41

*Water Supply Paper U. S. Geol. Survey, No. 128, page 85.
aIce conditions from January 1 to March 3 and December 14 to 31, 1904.

RATING TABLE FOR WABASH RIVER AT LOGANSPORT, IND., FROM JANUARY 1 TO DECEMBER 31, 1904.*

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.2	260	2.5	2,540	4.2	7,380	8.0	22,770
1.3	360	2.6	2,770	4.4	8,050	8.5	25,060
1.4	480	2.7	3,010	4.6	8,730	9.0	27,410
1.5	620	2.8	3,260	4.8	9,430	9.5	29,790
1.6	770	2.9	3,510	5.0	10,140	10.0	32,200
1.7	930	3.0	3,770	5.2	10,880	10.5	34,650
1.8	1,100	3.1	4,030	5.4	11,640	11.0	37,130
1.9	1,280	3.2	4,300	5.6	12,420	12.0	42,130
2.0	1,470	3.3	4,580	5.8	13,220	13.0	47,130
2.1	1,670	3.4	4,870	6.0	14,040	14.0	52,130
2.2	1,880	3.6	5,460	6.5	16,170	15.0	57,130
2.3	2,090	3.8	6,080	7.0	18,320	.....	.....
2.4	2,310	4.0	6,720	7.5	20,520	.....	.....

*Water Supply Paper U. S. Geol. Survey, No. 128, page 85.

The preceding table is applicable only for open-channel conditions. It is based upon 19 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.3 feet and 8.2 feet. The table has been extended beyond these limits. Above gage height 10.7 feet the rating curve is a tangent the difference being 500 per tenth.*

*Water Supply Paper U. S. Geol. Survey, No. 128, page 86.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT LOGANSPORT, IND., IN 1905.*

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
March 21	S. K. Clapp	3.75	5,450
May 27	M. S. Brennan	2.22	1,700
June 14	S. K. Clapp	3.79	5,480
July 14	S. K. Clapp	2.75	2,436
August 23	M. S. Brennan	1.95	1,100
September 4	M. S. Brennan	1.74	748

*Water Supply Paper U. S. Geol. Survey, No. 169, page 75.

DAILY GAGE HEIGHT IN FEET OF WABASH RIVER AT LOGANSPORT, IND., FOR 1905.*

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.95	.....	6.12	4.82	4.25	3.14	1.67	1.40	1.63	1.48	1.60	4.50
2	2.42	.....	5.88	4.25	3.70	2.88	1.70	1.40	1.72	1.55	1.63	4.05
3	2.20	2.15	5.55	3.45	3.20	2.70	1.70	1.36	1.75	1.60	1.58	3.68
4	2.00	.....	5.20	2.93	2.68	2.52	1.62	1.25	1.75	1.65	1.55	3.60
5	1.90	.....	4.60	2.60	2.55	2.40	1.62	1.35	1.60	1.89	1.60	3.50
6	1.85	.....	4.35	2.40	2.80	5.10	1.63	1.58	1.55	1.87	2.00	3.10
7	1.90	.....	3.95	2.28	3.40	4.00	1.63	2.45	1.50	1.80	2.35	2.84
8	.....	.....	3.70	2.20	3.39	3.55	1.63	2.17	1.45	1.75	2.50	2.58
9	.....	2.10	3.85	2.15	2.95	3.22	1.63	1.80	1.42	1.65	2.39	2.48
10	.....	.....	4.00	2.10	2.73	3.23	1.70	1.70	1.42	1.60	2.33	2.40
11	.....	.....	3.86	2.05	3.80	3.78	2.25	1.53	1.50	1.60	2.20	2.30
12	2.70	.....	3.60	2.05	10.50	3.78	3.17	1.45	1.49	1.54	2.05	2.25
13	.....	.....	3.10	2.05	10.05	3.80	2.95	1.40	3.33	1.50	1.85	2.22
14	.....	.....	2.85	2.00	8.45	3.72	2.63	1.49	3.48	1.50	1.81	2.15
15	.....	.....	2.70	2.00	7.10	3.33	2.40	1.77	2.90	1.45	1.80	2.10
16	.....	2.20	2.50	1.95	6.12	3.00	2.30	1.90	2.83	1.42	1.78	1.99
17	.....	.....	2.85	1.90	5.10	2.85	2.10	1.70	3.58	1.40	1.75	2.10
18	3.00	.....	3.40	1.86	4.50	2.68	1.92	2.30	4.42	2.13	1.70	2.05
19	.....	.....	3.60	1.86	3.88	2.65	1.91	2.56	3.78	2.45	1.70	2.00
20	.....	.....	3.60	1.88	3.50	2.60	1.75	2.70	3.28	2.30	1.65	1.90
21	.....	.....	3.71	5.65	3.23	2.40	1.99	2.43	3.00	2.20	1.58	2.80
22	.....	.....	3.47	6.45	2.85	2.72	1.73	2.21	2.80	2.05	1.55	4.65
23	.....	2.23	3.10	5.98	2.60	2.60	1.68	1.99	2.00	2.00	1.63	4.58
24	.....	.....	3.00	5.15	2.45	2.30	1.50	2.00	2.20	1.85	1.62	4.10
25	2.25	.....	3.58	4.48	2.30	2.19	1.50	2.57	2.00	1.80	1.59	3.60
26	.....	.....	3.45	3.75	2.25	2.19	1.43	2.60	1.80	1.78	1.60	3.20
27	.....	7.90	2.95	4.65	2.20	2.15	1.40	2.30	1.80	1.70	1.58	2.90
28	.....	6.45	2.65	4.12	2.15	2.00	1.37	1.98	1.70	1.65	1 93	2.63
29	.....	.....	2.45	5.55	2.10	1.88	1.40	1.82	1.55	1.60	5.80	2.60
30	.....	.....	2.50	4.95	2.25	1.78	1.40	1.72	1.50	1.53	6.10	2.75
31	.....	.....	5.32	.....	2.61	.....	1.43	1.55	.....	1.60	.....	3.00

*Water Supply Paper U. S. Geol. Survey, No. 169, page 75.

NOTE.—Gage heights interpolated March 2, 9, November 16, and December 7. Ice conditions January 1 to February 27. From January 12 to February 27 river was entirely frozen across. Gage was read to the surface of the water in a hole in the ice.

STATION RATING TABLE FOR WABASH RIVER AT LOGANSPORT, IND., FROM JANUARY 1 TO DECEMBER 31, 1905.*

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.20	330	2.30	1,805	3.40	4,440	4.50	7,700
1.30	360	2.40	2,010	3.50	4,715	4.60	8,020
1.40	420	2.50	2,225	3.60	4,995	4.70	8,340
1.50	510	2.60	2,445	3.70	5,280	4.80	8,670
1.60	630	2.70	2,675	3.80	5,570	4.90	9,000
1.70	770	2.80	2,910	3.90	5,865	5.00	9,340
1.80	920	2.90	3,150	4.00	6,160	5.20	10,020
1.90	1,080	3.00	3,395	4.10	6,460	5.40	10,720
2.00	1,250	3.10	3,645	4.20	6,760	5.60	11,430
2.10	1,425	3.20	3,905	4.30	7,070	5.80	12,160
2.20	1,610	3.30	4,170	4.40	7,380	6.00	12,910

*Water Supply Paper U. S. Geol. Survey, No. 169, page 76.

NOTE.—The above table is applicable only for open channel conditions. It is based on discharge measurements made during 1903–1905. It is well defined between gage heights 1.2 and 4.00 feet. The table has been extended beyond these limits. Above 6 feet the discharge is estimated, being based on three high-water measurements of 1904.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT LOGANSPORT, IND., IN 1906.*

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
February 9a	Bernnan and Kriegsman	2.02	1,270
March 10	E. F. Kriegsman	2.78	3,010
April 3	E. F. Kriegsman	5.42	11,800
May 10	E. F. Kriegsman	1.72	1,070

*Water Supply Paper U. S. Geol. Survey, No. 205, page 60.

DAILY GAGE HEIGHT, IN FEET, OF WABASH RIVER AT LOGANSPORT, IND., FOR 1906.*

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	2.73	2.58	2.08	7.90	1.90	1.72	1.52
2	2.57	1.40	1.88	6.85	2.40	1.66	1.55
3	2.48	1.18	2.48	5.60	1.90	1.66	1.60
4	2.38	1.58	3.83	4.85	1.90	1.70	1.60
5	4.88	1.88	3.30	3.90	1.80	1.70	1.75
6	4.43	2.03	2.93	3.80	1.80	1.72	1.87
7	3.88	2.03	2.78	3.60	1.76	1.70	1.75
8	3.20	2.06	2.70	4.40	1.72	1.50	1.75
9	2.63	1.97	.....	6.70	1.76	2.70	1.69
10	2.00	1.88	2.78	7.15	1.73	2.40	1.60
11	2.18	1.83	2.68	5.90	1.66	2.06	1.86
12	2.38	1.78	2.58	4.85	1.65	1.80	1.80
13	2.18	1.83	2.53	4.80	1.60	1.86	1.83
14	2.15	1.88	2.41	4.70	1.72	1.80	1.82
15	2.08	2.08	2.28	5.90	1.72	1.76	1.80
16	2.68	2.18	2.23	5.25	1.80	1.72	1.80
17	2.88	2.23	2.18	3.80	1.68	1.70	1.80
18	3.18	1.88	2.08	3.40	1.60	1.72	1.80
19	3.08	1.73	1.93	3.30	1.60	1.66	1.80
20	2.88	1.78	1.98	2.86	1.40	1.60	1.80
21	3.88	1.78	1.98	.....	1.43	1.60	1.80
22	8.21	1.83	2.03	2.60	1.53	1.72	1.80
23	6.88	1.78	2.08	2.40	1.52	1.36	1.78
24	5.88	1.88	1.88	2.30	1.56	.....	.....
25	4.88	2.08	1.88	2.20	1.76	1.19	.....
26	4.13	2.38	1.98	2.20	1.50	1.19	.....
27	3.88	2.71	8.48	2.20	1.50	1.30	.....
28	3.68	2.58	9.03	2.10	1.60	1.37	.....
29	3.03	.....	8.38	2.15	1.44	1.40	.....
30	2.88	.....	8.18	2.10	1.47	1.57	.....
31	.....	.....	8.03	.....	1.84	.....	.....

*Water Supply Paper U. S. Geol. Survey, No. 205, page 61.

RATING TABLE FOR WABASH RIVER AT LOGANSPORT, IND., FOR 1906.

Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.
1.20	310	2.30	1,900	3.40	4,690	5.00	9,770
1.30	400	2.40	2,110	3.50	4,980	5.20	10,480
1.40	500	2.50	2,330	3.60	5,270	5.40	11,210
1.50	610	2.60	2,560	3.70	5,570	5.60	11,950
1.60	730	2.70	2,800	3.80	5,870	5.80	12,710
1.70	860	2.80	3,050	3.90	6,170	6.00	13,500
1.80	1,000	2.90	3,310	4.00	6,480	7.00	17,600
1.90	1,160	3.00	3,580	4.20	7,110	8.00	22,100
2.00	1,330	3.10	3,850	4.40	7,750	9.00	26,800
2.10	1,510	3.20	4,130	4.60	8,410	9.10	27,280
2.20	1,700	3.30	4,410	4.80	9,080	.....	.....

NOTE.—The above table is applicable only for open channel conditions. It is based on discharge measurements made during 1903 to 1906. It is well defined.

On July 16, 17, 18, 1910, a gaging station was established by the writer on the Cicott Street bridge in Logansport. A discussion of this gage is given on page 77 of the Thirty-fifth Annual Report. The following data has been collected at this station:

DISCHARGE MEASUREMENTS ON WABASH RIVER AT LOGANSPORT, IND., FOR 1910-11.

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec. Ft.
July 18, 1910	W. M. Tucker	5.4	442.72
April 15, 1911	W. M. Tucker	9.0	8,865.96
July 6, 1911	Tucker and Clark	5.6	545.23

These three readings are not sufficient data to formulate a rating table, but taken with the United States Geological Survey rating tables shows that the base of this gage is approximately 4.1 feet lower than the base of the United States Geological Survey gage was. Thus the gage readings can be used with the United States Geological Survey rating tables if 4.1 feet be subtracted from the gage reading in each case and the discharge for that gage height be taken from the rating table.

CURRENT READINGS ON WABASH RIVER AT LOGANSPORT, IND., FROM JULY 18, 1910, TO JULY 17, 1911, INCLUSIVE.

DAY.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	.....	5.2	5.3	5.9	5.4	8.3	9.0	9.9	6.5	6.0	7.7	6.1	5.9
2	.....	5.2	5.2	5.8	5.4	8.1	9.4	8.0	6.4	6.0	8.1	6.1	5.8
3	.....	5.2	5.2	5.7	5.5	7.5	e	7.9	6.4	6.0	7.2	6.1	5.7
4	.....	5.2	5.3	5.8	5.6	6.0	e	7.9	6.3	6.3	6.8	6.1	5.6
5	.....	5.2	5.4	5.9	5.8	5.8	e	7.8	6.2	10.2	6.6	6.1	5.6
6	.....	5.2	6.0	6.0	5.8	5.7	e	7.7	6.1	10.6	6.3	6.2	5.6
7	.....	5.1	6.4	6.2	5.8	5.7	e	7.6	6.1	9.3	6.2	6.2	5.5
8	.....	5.1	6.2	10.3	5.7	5.7	e	7.5	6.1	8.7	6.2	6.3	5.4
9	.....	5.1	5.9	10.6	5.7	5.8	e	7.3	6.0	7.9	6.2	6.0	5.4
10	.....	5.1	5.9	9.5	5.7	5.9	e	6.4	6.0	7.9	6.2	6.9	5.4
11	.....	5.1	5.8	9.4	5.6	5.9	e	6.6	6.2	6.2	6.2	5.8	5.5
12	.....	5.1	5.8	8.5	5.6	5.8	e	6.4	6.3	6.7	6.2	5.6	5.4
13	.....	5.1	6.3	7.9	5.6	5.8	e	6.6	6.9	6.8	6.2	5.6	5.4
14	.....	5.1	7.2	7.5	5.5	5.6	e	6.7	6.5	8.0	6.1	5.6	5.4
15	.....	5.1	6.6	7.3	5.5	5.6	e	9.2	6.3	8.9	6.1	5.6	5.4
16	.....	5.1	6.5	6.0	5.5	5.5	e	10.7	6.2	8.6	5.9	5.7	5.4
17	.....	5.1	6.2	5.9	5.5	5.5	e	9.0	6.1	8.1	5.7	6.1	5.6
18	5.4	5.2	6.1	5.9	5.4	5.5	e	8.5	6.2	7.3	5.8	6.1	.....
19	5.3	5.2	6.2	5.7	5.4	5.5	e	8.5	6.1	7.2	5.8	6.1	.....
20	5.3	5.5	6.1	5.7	5.3	5.5	e	8.2	6.0	10.0	5.8	6.1	.....
21	5.3	5.6	6.1	5.7	5.3	5.6	e	8.1	5.9	10.1	5.9	5.7	.....
22	5.2	5.5	6.0	5.6	5.3	5.7	e	8.0	5.9	9.3	5.9	5.8	.....
23	5.2	5.5	6.0	5.7	5.3	5.8	7.0	7.2	5.9	8.6	5.9	5.9	.....
24	5.2	5.5	6.0	5.7	5.4	6.0	6.8	7.0	5.9	8.8	5.8	6.0	.....
25	5.2	5.5	6.0	5.5	5.4	5.8	6.7	6.8	5.9	7.2	5.7	6.1	.....
26	5.2	5.5	6.2	5.6	5.4	5.8	6.6	6.7	5.9	7.2	5.6	7.6	.....
27	5.2	5.5	6.2	5.6	5.5	5.8	7.4	6.6	6.0	7.2	5.6	6.9	.....
28	5.2	5.4	6.1	5.5	5.5	7.3	11.9	6.5	6.0	7.2	5.6	6.0	.....
29	5.4	5.3	6.0	5.5	8.4	8.1	11.7	.....	6.0	7.1	5.6	6.0	.....
30	5.4	5.3	5.9	5.5	8.8	9.0	11.5	.....	6.0	7.0	5.5	5.9	.....
31	5.2	5.3	.....	5.4	.....	9.0	11.3	.....	6.0	.....	5.5	.....	.....

eNo records taken.

From the foregoing data, a fair idea of the discharge of the stream can be gained. The lowest discharge in 1903 was 345 second-feet on July 14, and the highest about 33,000 second-feet on July 2. The lowest discharge in 1904 was 260 second-feet on August 13, and September 8, and the highest was 56,140 on March 27. In 1905, the lowest discharge was 345 second-feet on August 4, and the highest was 56,140 second-feet on March 27. In 1905, the lowest discharge was 345 second-feet, on August 4, and the highest estimated at 33,750 second-feet on May 12. In 1906, the lowest was 294 second-feet, on February 3, and the highest 26,900 second-feet on March 28. In 1910-11, the lowest was less than 310 second-feet, from August 7 to August 17, 1910, and the highest 21,200 second-feet on January 28, 1911. This shows the high discharge to be practically one hundred times the low discharge. Since this station is situated one mile below the mouth of Eel River, the discharge from it must be subtracted in each case to determine the discharge of the Wabash above the junction of the two streams. The discharge of Eel River is not known for the years prior to 1910 and 1911. Between August 7 and 17, 1910, it is found from the data of the Third Street Gaging Station to have varied from 125 second-feet to 210 second-feet, which indicates that the discharge on the Wabash was less than 100 second-feet during part of this time. On January 28, 1911, the discharge of Eel River was 1,895 second-feet, which indicates that the discharge of the Wabash was 19,305 second-feet. Thus the maximum discharge of the Wabash at the mouth of Eel River is approximately two hundred times the minimum. The United States Geological Survey maintained a gage on the Wabash River at Terre Haute, Indiana, from February 25, 1905, to July 20, 1906. The following data is taken from the United States Water Supply Papers:

WABASH RIVER AT TERRE HAUTE, IND.*

This station was established February 25, 1905. It is located at the Vandalia Line railway bridge near the city waterworks. There are no tributaries nor any islands, falls or dams in the river near the station.

The channel is practically straight for 700 feet above and below the station. There is a considerable angle of approach on the right bank, but practically none at the left bank. The right bank is comparatively low and alluvial, but is protected by a levee that does not overflow. The left bank is high, covered with buildings and does not overflow. All of the water passes between the abutments of the bridge. The bed of the stream is composed of hard permanent material, is clean of vegetation, and always consists of but one channel. The current has a medium-swift velocity at low stages.

* Water Supply Paper, U. S. Geol. Survey, No. 169, page 77.

Discharge measurements are made from the downstream lower chord of the bridge. The initial point for soundings is the center of the truss pin through the left end of the downstream lower chord of the left span of the bridge.

A standard chain gage is fastened to the downstream side of the bridge on the first span from the left bank; length of chain, 42.97 feet. During 1905 the gage was read by Albert Shewmaker. The gage is referred to bench marks as follows: (1) The Terre Haute city bench mark at the northeast corner of First and Chestnut streets; elevation 0.33 feet. (2) The southeast corner of the left abutment of the Vandalia Line railway bridge; elevation 36.40 feet. (3) The base of the railroad rail immediately opposite the pulley at the gage box; elevation 42.51 feet. Elevations refer to the datum of the gage. This is 0.33 foot below the city datum, which is 438.72 feet above mean sea level.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT TERRE HAUTE, IND., IN 1905.*

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec. Ft.
May 12	M. S. Brennan	6.90	15,750
June 25	M. S. Brennan	3.74	7,367
July 29	M. S. Brennan	1.42	2,648
August 25	M. S. Brennan	2.00	3,700
September 11	M. S. Brennan	1.81	3,311
October 15	M. S. Brennan	1.00	2,066

*Water Supply Paper U. S. Geol. Survey, No. 169, page 77.

DAILY GAGE HEIGHT, IN FEET, OF WABASH RIVER AT TERRE HAUTE, IND., FOR 1905.**

DAY.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	13.7	5.1	8.6	6.4	2.2	1.72	1.5	1.42	1.9	9.55
2	.....	14.3	7.0	8.0	6.2	2.02	1.58	1.75	1.4	1.82	9.85
3	.....	14.4	7.2	6.7	6.6	2.88	1.38	1.75	1.3	1.85	8.62
4	.....	14.7	6.2	5.8	5.2	3.8	1.28	1.6	1.22	1.8	7.05
5	.....	15.0	5.2	5.3	4.6	2.78	1.22	1.85	1.18	1.88	6.02
6	.....	13.3	4.4	4.9	4.05	2.48	1.15	1.95	1.18	2.85	5.88
7	.....	10.6	3.9	4.7	4.7	2.28	1.3	1.88	1.18	3.4	5.3
8	.....	9.0	3.6	4.5	6.0	1.98	1.22	1.7	1.32	3.9	4.88
9	.....	8.2	3.3	4.9	5.6	2.35	1.48	1.5	1.3	3.98	4.4
10	.....	7.3	3.1	5.6	4.9	2.58	1.82	1.4	1.28	3.88	4.05
11	.....	6.6	3.0	5.3	4.6	4.0	1.68	1.92	1.18	3.62	3.8
12	.....	6.5	3.05	6.8	4.7	4.75	1.45	3.0	1.1	3.32	3.62
13	.....	6.2	3.1	12.7	5.2	4.25	1.28	3.1	1.02	3.05	3.42
14	.....	5.6	2.95	14.1	5.4	4.4	1.52	2.72	1.0	3.75	3.18
15	.....	5.0	2.72	15.1	5.1	4.4	2.62	2.4	1.0	2.52	2.85
16	.....	4.6	2.55	16.3	5.0	3.85	2.8	3.32	.95	2.38	2.65
17	.....	4.3	2.4	17.0	4.6	3.4	2.62	3.95	.9	2.22	2.48
18	.....	4.0	2.32	16.8	4.2	3.0	2.55	4.6	2.0	2.12	2.52
19	.....	4.35	2.15	15.7	4.8	2.68	2.25	5.0	3.4	2.02	2.55
20	.....	5.1	2.02	12.8	5.4	2.75	2.1	5.1	4.15	1.92	2.48
21	.....	5.6	2.82	9.5	7.3	4.6	2.38	4.8	4.92	1.82	2.62
22	.....	5.6	5.9	7.8	4.8	3.4	2.58	4.2	4.68	1.75	3.2
23	.....	5.5	9.2	6.6	4.1	2.65	a2.15	3.6	4.12	1.65	4.9
24	.....	5.3	10.9	5.7	3.9	2.28	1.72	3.2	3.68	1.65	7.08
25	.....	4.8	10.6	5.0	3.7	1.98	1.68	2.72	3.3	1.6	7.4
26	9.7	4.8	9.4	4.6	3.3	1.78	1.78	2.32	2.95	1.65	6.7
27	12.3	5.0	8.4	4.3	2.9	1.6	2.1	2.05	2.7	1.58	6.0
28	11.3	5.0	7.5	4.1	2.65	1.5	2.38	1.8	2.45	1.42	5.3
29	.....	4.5	8.0	3.9	2.5	1.42	2.3	1.68	2.2	2.1	4.9
30	.....	4.1	8.2	6.7	2.4	1.78	2.02	1.5	1.12	8.0	4.5
31	.....	4.5	.....	7.1	.....	1.68	1.75	.....	1.95	.....	4.48

aGage height interpolated.
**Water Supply Paper U. S. Geol. Survey, No. 169, page 78.

STATION RATING TABLE FOR WABASH RIVER AT TERRE HAUTE, IND., FROM FEBRUARY 25 TO DECEMBER 31, 1905.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
0.90	1,945	2.50	4,670	4.20	8,430	7.40	17,200
1.00	2,065	2.60	4,870	4.40	8,910	7.60	17,800
1.10	2,195	2.70	5,080	4.60	9,390	7.80	18,400
1.20	2,335	2.80	5,290	4.80	9,890	8.00	19,000
1.30	2,485	2.90	5,505	5.00	10,400	8.20	19,600
1.40	2,643	3.00	5,720	5.20	10,920	8.40	20,300
1.50	2,808	3.10	5,940	5.40	11,450	8.60	21,000
1.60	2,978	3.20	6,160	5.60	11,990	8.80	21,700
1.70	3,152	3.30	6,380	5.80	12,540	9.00	22,400
1.80	3,330	3.40	6,605	6.00	13,100	9.50	24,150
1.90	3,513	3.50	6,830	6.20	13,660	10.00	25,900
2.00	3,700	3.60	7,055	6.40	14,240	10.50	27,800
2.10	3,890	3.70	7,280	6.60	14,820	11.00	29,800
2.20	4,080	3.80	7,510	6.80	15,400	11.50	31,800
2.30	4,275	3.90	7,740	7.00	16,000	12.00	33,800
2.40	4,470	4.00	7,970	7.20	16,600		

NOTE.—The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1905. It is well defined between gage heights 1 foot and 4 feet. The table has been extended beyond these limits, being based on one measurement at 6.9 feet and also on well-defined area and mean-velocity curves to 12 feet. Above this point the curve is more uncertain as the river overflows.

DISCHARGE MEASUREMENTS OF WABASH RIVER AT TERRE HAUTE, IND., IN 1906.

DATE.	Hydrographer.	Width, Feet.	Area of Section, Sq. Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
February 16[a]	Brennan and Kriegsman	482	3,790	4.40	6,710
March 28	E. F. Kriegsman	606	10,700	15.84	40,600
March 31	E. F. Kriegsman	714	13,000	19.20	62,800
April 18	E. F. Kriegsman	580	8,520	12.02	25,500
April 19	E. F. Kriegsman	564	7,740	10.80	22,200
April 20	E. F. Kriegsman	557	6,790	9.30	19,300
April 20	E. F. Kriegsman	557	6,650	8.92	18,200
April 21	E. F. Kriegsman	552	6,210	7.95	16,800
April 21	E. F. Kriegsman	549	5,950	7.65	16,200
April 23	E. F. Kriegsman	541	5,190	6.35	13,200
June 9	E. F. Kriegsman	535	4,500	4.98	11,400

[a] Partial ice conditions.

DAILY GAGE HEIGHT, IN FEET, OF WABASH RIVER AT TERRE HAUTE, IND., FOR 1906.

DAY	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	4.68	8.22	5.02	19.8	3.88	5.72	1.08
2	4.72	7.28	4.88	19.22	3.8	4.22	1.22
3	4.85	6.0	7.38	18.45	3.78	3.5	1.35
4	5.88	5.88	9.9	17.7	3.75	2.88	1.32
5	6.5	5.15	10.78	16.8	3.78	2.88	1.38
6	7.35	4.55	10.48	15.22	3.52	3.2	1.7
7	7.85	2.45	9.28	12.9	3.3	3.12	1.72
8	7.18	2.35	8.48	10.75	3.1	2.52	1.62
9	5.82	2.7	8.3	14.22	2.95	4.22	1.6
10	4.78	2.78	8.18	15.02	2.9	5.55	1.52
11	3.85	2.92	7.82	15.1	2.82	4.52	1.42
12	4.02	3.02	7.28	15.3	2.72	4.08	1.35
13	3.62	3.2	6.75	15.42	2.62	3.38	1.32
14	3.58	3.72	6.38	14.95	2.52	2.92	1.32
15	3.55	4.42	5.98	12.85	2.45	2.6	1.25
16	3.75	4.15	5.58	12.52	2.35	2.32	1.22
17	3.82	3.4	5.28	12.75	2.28	2.12	1.4
18	3.88	3.12	4.98	12.25	2.15	1.98	1.75
19	3.95	3.6	4.82	10.7	2.12	1.82	1.7
20	4.65	4.02	4.55	9.1	2.08	1.75	1.42
21	5.72	4.2	4.35	7.9	2.02	1.75	.....
22	13.68	3.78	4.42	6.95	1.92	1.7	.....
23	15.95	3.82	4.6	6.28	1.9	1.68	.....
24	16.82	3.78	4.52	5.72	1.85	1.6	.....
25	17.12	4.18	4.48	5.38	1.9	1.5	.....
26	17.38	5.0	6.35	5.05	1.98	1.42	.....
27	17.22	5.22	14.28	4.78	1.9	1.3	.....
28	16.25	5.3	15.88	4.48	2.12	1.28	.....
29	14.12	.....	16.42	4.25	2.08	1.2	.....
30	11.18	.....	17.02	4.05	1.88	1.15	.....
31	9.3	.....	18.95	.....	4.32	.....	.....

NOTE.—Ice gorge at railroad bridge, a short distance above the gaging section, February 7 to 18. The flow at the gaging section was probably affected by ice on only February 15 and 16.

RATING TABLE FOR WABASH RIVER AT TERRE HAUTE, IND., FOR 1905 AND 1906.

Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.	Gage Height, Feet.	Discharge, Sec.-Ft.
1.00	2,050	2.50	4,510	4.00	7,620	7.00	14,700
1.10	2,180	2.60	4,700	4.20	8,060	8.00	17,200
1.20	2,320	2.70	4,900	4.40	8,500	9.00	19,800
1.30	2,460	2.80	5,100	4.60	8,940	10.00	22,500
1.40	2,610	2.90	5,300	4.80	9,380	11.00	25,300
1.50	2,770	3.00	5,500	5.00	9,830	12.00	28,400
1.60	2,940	3.10	5,700	5.20	10,300	13.00	31,800
1.70	3,110	3.20	5,900	5.40	10,780	14.00	35,500
1.80	3,280	3.30	6,100	5.60	11,260	15.00	39,500
1.90	3,450	3.40	6,310	5.80	11,740	16.00	43,700
2.00	3,620	3.50	6,520	6.00	12,220	17.00	48,100
2.10	3,790	3.60	6,740	6.20	12,700	18.00	52,700
2.20	3,970	3.70	6,960	6.40	13,200	19.00	57,400
2.30	4,150	3.80	7,180	6.60	13,700	20.00	62,100
2.40	4,330	3.90	7,400	6.80	14,200		

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1905 and 1906. It is well defined.

On July 21 and 22, 1910, the writer visited the Terre Haute waterworks station and found that daily gage readings had been kept at that point since 1901. These gage readings were secured through the kindness of Mr. Taylor, chief engineer of the Terre Haute Water Works Company, and will be given in this report. Two current readings were taken from the Wabash avenue bridge

in Terre Haute, and these will be used with the readings of the United States Geological Survey to determine a rating table to accompany the gage readings:

DISCHARGE MEASUREMENTS ON WABASH RIVER AT TERRE HAUTE, IND., FROM 1905 TO 1911.

DATE.	Hydrographer.	Gage Height, Feet.	Discharge, Sec.-Ft.
May 12, 1905	M. S. Brennan	6.00	15,750
June 25, 1905	M. S. Brennan	2.84	7,367
July 29, 1905	M. S. Brennan	.52	2,648
August 25, 1905	M. S. Brennan	1.10	3,700
September 11, 1905	M. S. Brennan	.10	2,066
February 16,*a* 1906	Brennan and Kriegsman	3.50	6,710
March 28, 1906	E. F. Kriegsman	14.94	40,600
March 31, 1906	E. F. Kriegsman	18.30	62,800
April 18, 1906	E. F. Kriegsman	11.12	25,500
April 19, 1906	E. F. Kriegsman	9.90	22,200
April 20, 1906	E. F. Kriegsman	8.40	19,300
April 20, 1906	E. F. Kriegsman	8.02	18,200
April 21, 1906	E. F. Kriegsman	7.05	16,800
April 21, 1906	E. F. Kriegsman	6.75	16,200
April 23, 1906	E. F. Kriegsman	5.45	13,200
June 9, 1906	E. F. Kriegsman	4.08	11,400
July 23, 1910	W. M. Tucker	.67	2,962
August 28, 1911	Tucker and Clark	.25	2,249

a Partial ice conditions.

NOTE.—The readings taken by Messrs. Brennan and Kriegsman were based on the government gage which was placed .9 ft lower than the waterworks gage. Thus the reduction of each gage reading by .9 ft. gives data for a rating table for the waterworks gage. The reduction has been made in this table.

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1901.

DAY.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.0	3.7	1.4	1.3	1.5	1.0	1.2
2	6.0	3.0	1.4	1.3	1.5	1.0	1.2
3	5.0	2.8	1.5	1.5	1.5	1.2	1.2
4	4.0	2.5	1.5	1.5	1.5	1.2	1.2
5	3.5	3.0	1.5	1.5	1.5	1.2	1.2
6	4.0	2.0	1.5	1.5	1.5	1.2	1.2
7	6.0	2.0	1.5	1.5	1.5	1.3	1.2
8	4.5	1.8	1.5	1.5	1.5	1.3	1.2
9	4.0	1.5	1.5	1.5	1.5	1.3	1.2
10	3.5	1.0	1.5	1.5	1.5	1.3	1.0
11	3.0	1.0	1.5	1.5	1.5	1.5	1.0
12	2.5	.5	1.5	1.5	1.5	1.3	1.0
13	2.0	.0	1.5	1.5	1.0	1.3	.9
14	1.8	.0	1.5	1.5	1.0	1.3	3.5
15	1.5	.0	1.5	1.5	1.2	1.3	6.7
16	1.5	.5	1.5	1.5	2.0	1.3	6.0
17	1.5	.8	1.5	1.5	2.5	1.3	*a*
18	1.5	.8	1.5	1.5	2.3	1.3	*a*
19	1.5	1.0	1.5	1.5	1.8	1.3	*a*
20	1.0	1.0	1.3	1.5	1.3	1.3	*a*
21	1.5	1.0	1.3	1.5	1.0	1.3	5.0
22	4.0	1.0	1.3	1.5	.5	1.3	5.3
23	5.5	1.0	1.3	1.5	.5	1.2	5.5
24	10.0	1.3	1.3	1.5	.0	1.2	6.0
25	7.0	1.3	1.3	1.5	.0	1.2	6.0
26	5.5	1.3	1.3	1.5	.5	1.2	6.3
27	8.0	1.3	1.3	1.5	.5	1.2	6.3
28	6.0	1.3	1.3	1.5	.7	1.2	6.3
29	5.0	1.3	1.3	1.5	.8	1.2	6.5
30	4.5	1.4	1.3	1.5	1.0	1.2	6.5
31	.....	1.4	1.3	.....	1.0	.....	6.3

a Ice conditions.

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1902.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.3	1.5	10.0	8.7	2.7	1.7	15.5	3.8	.6	5.0	1.0	4.0
2	6.0	1.5	12.0	8.5	2.5	2.0	17.0	3.5	.6	5.0	1.0	4.4
3	6.0	1.5	12.5	9.0	2.3	5.5	18.7	5.3	.4	5.0	1.0	6.0
4	6.0	1.5	10.0	8.0	1.8	4.7	19.1	5.0	.4	5.5	1.0	7.0
5	6.0	1.5	8.0	6.5	1.5	5.5	18.9	4.0	.4	6.7	1.2	7.8
6	5.8	1.5	5.5	5.5	2.0	7.0	18.2	5.0	.8	7.3	1.3	8.4
7	5.5	1.5	5.0	5.3	3.0	6.3	17.4	4.3	.8	7.8	1.7	8.6
8	5.0	1.5	4.5	5.0	3.0	6.7	16.2	4.0	.8	8.5	2.3	7.3
9	4.5	1.5	5.7	4.4	3.3	6.7	15.0	3.6	.6	8.3	3.2	6.0
10	3.5	1.5	5.9	4.0	3.0	8.0	11.2	3.2	.4	7.0	3.2	5.0
11	3.0	1.5	5.5	3.8	2.7	8.0	8.8	3.0	.4	5.8	3.0	4.5
12	2.5	1.5	5.7	3.5	2.3	6.3	7.6	2.6	.2	4.5	3.9	5.3
13	2.0	1.5	7.0	3.3	1.8	6.3	6.4	2.3	1.0	4.0	4.0	5.8
14	1.5	1.5	8.2	3.0	1.5	5.5	5.4	2.3	.5	5.8	3.8	6.5
15	1.0	1.5	8.5	2.8	1.2	5.3	4.6	2.6	.4	4.5	3.7	5.7
16	1.0	1.5	8.2	2.5	1.0	5.2	4.0	2.8	.4	4.0	3.4	7.8
17	.5	1.5	8.7	2.0	.8	5.8	3.7	2.7	.4	3.8	3.4	8.9
18	.5	1.5	8.3	2.0	.7	5.8	3.3	2.8	.4	3.0	3.7	9.0
19	.0	1.5	8.0	1.7	.5	5.5	3.2	2.3	.4	2.8	4.2	9.8
20	.5	1.5	7.0	1.5	.3	4.8	4.2	2.6	.3	2.5	5.0	10.2
21	.8	1.5	6.0	1.5	1.0	3.6	4.8	2.8	.3	2.3	5.7	12.3
22	1.0	1.5	5.0	1.5	2.3	2.5	5.8	2.8	.3	2.7	5.3	14.5
23	1.5	1.5	4.5	1.3	3.2	2.0	5.7	2.6	.3	2.7	4.8	15.2
24	2.0	1.5	4.2	1.2	2.7	1.7	5.5	2.3	.3	2.6	4.3	15.5
25	2.0	1.5	3.7	1.2	2.5	1.5	4.6	2.0	2.0	2.2	3.8	15.8
26	2.0	1.2	3.5	1.2	4.0	1.5	4.4	1.6	3.8	1.8	3.4	16.0
27	2.0	.0	3.3	1.0	4.2	1.7	3.6	1.2	2.8	1.5	3.3	15.1
28	1.5	5.0	3.0	1.0	4.0	1.8	3.2	1.2	4.0	1.5	3.4	14.0
29	1.5	.....	4.3	1.0	3.3	5.0	3.2	1.0	5.0	1.4	2.8	10.0
30	1.5	.....	6.0	1.3	2.7	13.5	3.8	.8	3.5	1.3	3.5	8.0
31	1.5	.....	6.3	.....	1.9	.....	3.8	.8	.....	1.2	.....	7.0

GAGE READINGS AT TERRE HAUTE WATERWORKS STATION ON WABASH RIVER FOR 1903.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.0	14.5	15.0	3.8	5.2	5.5	1.8	1.2	1.5	—.1	—.4	—.3
2	5.5	15.2	15.8	3.4	4.7	5.0	1.5	1.0	1.7	—.1	—.5	—.3
3	6.3	15.5	16.0	3.4	4.7	4.7	1.5	1.0	1.7	—.1	—.5	—.3
4	7.7	15.7	17.0	6.5	4.2	5.7	5.5	1.0	1.5	—.1	—.6	—.4
5	8.0	15.8	18.0	9.0	3.9	5.5	9.8	5.0	1.0	.1	—.6	—.4
6	8.5	15.8	18.7	10.8	3.8	5.8	9.7	4.3	.8	.2	—.5	—.4
7	9.0	15.8	18.2	12.5	3.3	7.5	7.8	3.0	.8	.1	—.5	—.4
8	8.5	15.9	17.5	12.7	3.1	8.8	6.2	2.0	.7	.4	—.5	—.5
9	8.0	15.7	17.2	12.0	2.8	9.3	5.0	1.7	.7	.5	—.6	—.5
10	6.5	15.0	16.6	10.3	2.8	9.0	4.0	1.6	.4	1.0	—.6	—.5
11	3.5	13.5	16.7	8.8	2.7	7.8	3.7	1.4	.3	1.5	—.6	—.5
12	3.0	14.0	16.7	11.7	2.6	6.5	3.7	1.3	.1	1.7	—.6	—.6
13	2.7	14.3	16.2	13.5	2.4	5.5	3.8	1.3	.0	1.7	—.5	—.5
14	2.5	15.9	15.4	15.7	2.2	4.0	3.3	1.1	.0	1.5	—.5	—.5
15	2.5	16.7	15.0	18.0	2.3	3.5	2.0	.8	.0	1.0	—.4	—.5
16	2.2	17.3	13.5	19.5	2.3	3.0	2.0	.8	—.5	.7	—.4	—.2
17	2.7	17.3	13.3	20.0	2.3	2.5	1.8	.7	—.2	.5	—.4	1.0
18	4.3	16.9	12.4	19.8	2.1	2.3	1.8	.5	.0	.3	—.2	1.3
19	4.6	15.2	10.4	19.2	1.9	2.0	1.7	.4	.0	.3	—.1	1.6
20	4.7	11.0	9.4	18.2	1.8	2.0	1.6	.4	—.3	.2	—.2	1.6
21	4.0	8.2	8.7	16.6	1.7	2.0	1.6	.3	—.3	.1	—.0	2.7
22	4.2	7.1	8.2	14.0	5.5	2.2	1.8	.2	—.4	.0	—.1	3.0
23	3.5	6.6	7.6	11.3	7.7	2.1	1.8	.2	—.4	.0	.0	3.6
24	3.4	6.8	7.2	9.0	4.5	2.3	1.8	0.0	—.3	—.1	.0	3.5
25	3.3	7.0	6.3	7.9	4.0	2.3	1.7	.0	—.3	—.1	—.1	3.6
26	3.1	6.5	5.6	7.3	4.3	2.3	1.6	—.1	—.3	—.2	—.1	4.0
27	3.2	7.1	5.3	7.2	4.5	2.3	1.4	—.2	—.2	—.2	—.2	4.0
28	5.3	12.8	5.2	6.8	5.3	2.2	1.3	—.3	—.1	—.3	—.3	3.8
29	8.0	.....	4.8	6.3	5.6	2.0	1.3	2.0	.0	—.3	—.3	3.5
30	14.0	.....	4.4	5.8	5.7	1.8	1.3	1.8	.0	—.3	—.3	3.5
31	14.3	.....	4.2	.....	6.0	.....	1.3	1.5	.....	—.4	.....	3.5

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1904.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.3	9.0	12.8	23.1	14 3	3 9	2.0	.3	.6	1.8	—.3	—.5
2	2 3	7.5	14.7	23.7	12.7	4.0	2.3	.0	.5	1.5	—.3	—.5
3	2.5	6.5	15.8	23.1	10.3	4.0	2.0	.0	.0	.8	— 4	—.5
4	2.0	6.0	17.2	22.6	8.3	4.0	2.0	—.1	.0	.8	—.4	—.6
5	2.0	5 0	17.8	22.0	7.1	3.9	1.9	— 1	—.2	.7	—.3	—.6
6	1.7	4.7	17.5	21.3	6.1	3.8	2.3	—.2	—.3	.5	—.3	—.6
7	1.5	12.0	17 3	20.3	5.9	3.8	3.6	—.3	—.4	.4	—.3	—.6
8	1.5	15.6	17.0	19.2	5.7	3.5	9.7	—.3	—.5	.3	—.3	—.7
9	1.3	16.7	16.9	17 8	5.5	3.3	19.4	—.3	—.6	.3	—.3	—.7
10	1.3	17.1	16.7	16.4	5.5	3.0	9.8	—.3	.2	.2	—.3	—.7
11	1.2	17.3	16.6	15.3	5.4	3.0	8.8	—.3	.3	.2	—.3	—.7
12	1.0	17.4	16.3	14.8	5.3	2.5	8.0	—.4	.3	.3	—.3	—.7
13	1.0	16.6	15.3	14.2	4.8	2.2	7.8	—.4	.3	.4	—.3	—.8
14	.7	14.0	13.5	13 5	4.0	2.2	6.8	—.5	.3	.7	—.3	—.8
15	.7	10.4	12.0	12.0	4.0	2.0	5.7	—.5	.2	.6	—.3	—.9
16	.6	7.2	10.4	10.8	3.9	1.8	4.5	—.6	.2	.4	—.3	—.9
17	.7	6.3	9.0	9.5	3.9	1.9	4.0	—.6	.1	.3	—.3	—.9
18	.7	5.1	12.3	8.7	3.8	1.9	3.7	—.7	.5	.3	—.3	—.9
19	.6	4.0	13.5	7.8	3.7	1.9	3.0	—.6	.4	.2	—.3	—.9
20	1.0	3 3	13.8	7.1	3.6	2.0	3.0	—.4	.4	.2	—.3	—1.0
21	4.1	3.0	14 3	6 5	3.7	1.9	2.3	3.8	.3	—.1	—.3	—1.0
22	15.5	4.5	14 8	6.1	4.0	2.1	1.8	2.8	.3	—.2	—.3	—1.0
23	17.3	4.8	16.3	6.0	4.0	2.2	1.7	2.2	.3	—.2	—.4	—1.0
24	19.0	6.5	17.3	5.7	4.4	3.0	1.5	1 8	.3	—.3	—.4	—.7
25	20.2	6.8	17.8	5.8	4.3	3.7	1 3	1.8	.3	—.3	—.4	.0
26	20.6	6.8	19.9	9.6	4.1	3.7	1.0	1.5	.6	—.3	—.4	.2
27	20 5	6.9	25.1	13.0	4.1	3.0	1.0	1 3	1.5	—.3	—.4	.5
28	20.0	6.9	24.9	13 9	4.1	2.6	.7	1.0	1.7	—.3	—.5	.2
29	18.3	9.5	24.0	14.3	4.0	2.2	.7	1.0	2.3	—.3	—.5	.2
30	16.0	.....	23.3	14.5	4.0	1.9	.7	.7	2.4	— 3	—.5	.3
31	12.5	.....	22 8	.....	4.0	.....	.5	.6	.....	—.3	.....	.3

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1905.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.5	.7	13.5	3 8	8.2	5.6	1.3	.9	.7	.7	.8	8.5
2	.7	.3	14.0	5.8	7.8	5.6	1.3	.8	.7	.5	.8	9.2
3	.7	.3	14.5	6 0	6.7	5.8	1.4	.8	1.0	.5	.7	8.2
4	.0	.2	14.5	5.2	5.5	5.0	3.5	.8	.8	.4	.6	6.5
5	.0	.2	15.2	4.8	4.8	4.2	1.5	.7	.8	.3	.6	5.0
6	.0	.2	14 0	4.2	4.4	5.2	1.3	.6	.9	.3	2.0	5.0
7	.2	.2	11.2	3.2	4.2	5.4	1.2	.6	1.0	.3	2.5	4.7
8	.3	.3	9.1	2.7	3.8	4.8	1.0	.4	.8	.3	3.0	4.0
9	.4	.3	8.2	2.2	4.0	4.8	1.2	.4	.7	.3	3.0	3.8
10	.5	.3	7.5	1.8	4.8	4.0	1.5	1.0	.7	.3	2.9	3.3
11	.5	.5	6.7	1.8	4.8	5.7	1.9	.8	1.0	.0	2.8	3.0
12	1.0	.5	6.3	1.7	4.6	5.6	4.0	.8	2.0	.0	2.5	2.8
13	1.1	.7	6.0	1.9	10.8	4.1	3.3	.6	2.5	.0	2.3	2.8
14	2.0	.7	5.5	1.7	13.6	4.4	5.4	.5	2.0	.0	1.9	2.6
15	1.8	.7	4.8	1.5	14.7	4.3	4.3	1.2	1.6	.0	1.8	2.3
16	1.7	.7	4.0	1.3	15.9	4.1	3.0	2.0	2.3	.0	1.7	2.0
17	1.6	.8	3.5	1.2	16.9	3.8	2.8	1.8	2.8	.2	1.6	1.8
18	1.6	.8	3.0	1.0	17.0	3.3	2.3	1.7	3.7	.2	1.4	1.7
19	1.8	.8	3.0	.6	16.2	3.4	2.0	1.5	4.2	2.7	1.3	1.7
20	1.8	.8	3.0	.8	13.6	4.3	1.7	1.2	4.2	3.0	1.0	1.6
21	1.8	.8	5.0	1.1	10.0	7.0	3.7	1.5	4.0	4.0	.8	1.6
22	2.0	.8	4.8	3.8	7.8	4.3	3.0	1.5	3.5	4.0	.8	2.0
23	2.0	.5	4.8	6.9	6.1	3.2	2.0	1.8	2.8	3.5	.8	3.5
24	1.7	3.7	4.7	10.2	5.1	2.8	1.6	1.5	2.3	3.0	.8	6.0
25	2.0	5.0	4.4	10.3	4.3	2.8	1.3	1.2	2.0	2.5	.7	6.8
26	2.0	7.0	4.2	9.3	3.8	2.4	1.1	.8	1.7	2.2	.7	6.0
27	1.7	11.0	4.2	8.3	3.5	2.0	.8	.8	1.2	2.0	.7	5.3
28	.9	11.5	4.3	7.2	3.3	1.8	.7	1.3	1.0	1.7	.7	4.7
29	.9	.....	3.8	7.3	3.1	1.6	.5	1.5	.7	1.5	.6	4.0
30	.8	.....	3.3	7.7	3.9	1.5	.4	1.3	.7	1.2	6.7	3.8
31	.7	.....	3.3	.....	7.7	.....	.3	.8	.....	1.0	.....	3.8

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1906.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	7.5	4.2	19.0	3.0	5.5	.3	—.3	.8	.0	—.5	3.6
2	3.9	6.7	4.0	18.6	3.0	3.7	.3	—.3	.5	.0	—.5	3.1
3	4.0	5.7	5.8	17.8	3.0	2.8	.4	—.3	.3	.7	—.3	2.8
4	5.0	5.0	8.8	17.1	3.0	2.0	.3	—.3	.2	.7	—.3	2.6
5	5.5	4.7	10.0	16.2	3.0	2.0	.3	—.3	.0	.7	—.3	2.4
6	6.3	3.8	9.9	15.0	2.8	1.8	.7	—.3	—.2	.8	—.3	4.1
7	7.0	2.7	8.8	12.5	2.8	2.5	.8	—.3	—.3	.6	—.3	9.3
8	6.8	1.5	7.8	10.8	2.8	1.8	.8	—.2	—.3	.3	—.3	10.3
9	5.7	1.5	7.5	13.0	2.8	1.9	.7	.3	—.3	.1	—.2	11.3
10	4.5	1.3	7.3	14.0	2.3	5.0	.6	.3	—.3	—.1	—.2	11.0
11	3.7	1.2	7.0	14.0	2.0	4.0	.6	.3	—.3	—.1	—.2	9.8
12	3.7	1.2	6.5	14.2	1.8	3.5	.5	.7	—.4	—.3	—.2	8.7
13	3.5	1.3	6.0	14.5	1.8	2.8	.5	.5	—.3	—.3	—.2	7.8
14	2.7	2.0	5.5	14.4	1.7	2.0	.5	.4	—.3	—.3	—.2	6.3
15	2.7	3.7	5.3	13.0	1.7	1.8	.4	.2	—.4	—.5	—.2	8.0
16	3.0	3.2	4.8	11.5	1.5	1.5	.4	.0	—.4	—.5	—.2	10.2
17	3.0	2.7	4.5	11.8	1.3	1.3	.4	—.2	—.4	—.5	—.2	10.6
18	2.8	1.8	4.0	11.8	1.3	1.2	.6	—.2	—.5	—.5	—.2	10.8
19	3.0	2.3	3.8	10.2	1.3	1.1	.8	.2	—.5	—.4	.0	10.0
20	3.7	3.0	3.8	8.7	1.2	.8	.7	.0	—.5	—.4	.0	8.7
21	4.0	3.7	3.6	7.5	1.0	.8	.7	.5	—.5	—.4	1.5	7.0
22	11.5	3.0	3.4	6.6	1.0	.8	1.5	.4	—.5	—.4	.5	5.8
23	14.9	3.0	3.7	5.7	1.0	.8	.9	.4	—.3	—.5	8.8	5.0
24	16.0	3.0	3.7	5.0	1.0	.7	.7	.6	—.2	—.5	10.0	4.0
25	16.3	3.0	3.7	4.7	1.0	.6	.2	1.0	—.3	—.5	9.3	3.0
26	16.7	4.0	4.3	4.3	1.0	.5	.0	1.0	—.3	—.5	8.3	3.0
27	16.7	4.3	12.5	3.8	1.2	.5	.0	1.0	—.3	—.5	7.0	2.9
28	15.0	4.5	15.0	3.7	1.3	.4	—.1	1.8	—.4	—.5	5.5	3.0
29	13.8	.....	15.7	3.5	1.3	.3	—.2	1.6	—.4	—.5	4.6	3.0
30	11.0	.....	16.0	3.3	1.0	.3	—.2	1.0	—.2	—.5	3.8	3.0
31	8.8	.....	17.4	.....	2.0	.....	—.2	.8	.....	—.5	.....	5.5

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1907.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.9	7.3	2.8	12.8	3.4	7.5	4.5	2.4	1.2	.8	.3	1.3
2	9.8	6.5	2.8	12.8	4.0	11.3	3.7	2.3	2.0	.8	.7	1.3
3	12.2	6.5	3.0	11.6	5.0	13.0	3.0	2.0	2.9	1.0	1.1	.9
4	15.0	5.5	3.2	9.3	5.0	13.3	2.8	2.0	2.8	2.9	1.1	.8
5	16.0	4.8	3.7	7.7	4.9	13.8	2.4	2.0	2.3	3.6	2.2	.6
6	16.3	3.7	3.8	6.7	4.3	14.0	2.3	2.2	1.9	3.5	2.8	.6
7	16.2	3.5	3.7	5.8	3.0	14.0	2.0	2.3	1.3	2.9	2.8	.5
8	16.2	3.5	3.5	5.7	3.7	13.7	2.0	4.0	1.3	2.8	2.5	.4
9	17.3	3.5	3.3	5.5	3.9	12.7	2.2	3.9	1.3	2.7	2.0	.5
10	17.5	3.5	3.2	5.2	3.8	11.0	2.2	3.0	1.7	2.1	1.9	1.1
11	17.4	3.8	3.2	4.9	3.8	9.5	2.9	2.8	1.5	1.9	1.7	1.2
12	17.2	3.8	4.0	4.8	3.5	8.9	4.2	2.3	1.2	1.8	1.3	2.3
13	16.3	3.8	10.5	4.5	3.4	7.9	5.4	2.1	1.0	1.3	1.0	3.5
14	16.0	3.8	14.3	4.3	3.2	6.9	6.9	2.0	.9	1.2	.9	3.9
15	15.0	4.0	15.2	4.0	3.0	6.0	6.9	1.8	.7	1.0	.8	3.8
16	14.6	4.0	16.3	4.0	3.0	6.0	6.7	1.7	.7	.8	.8	3.3
17	15.0	4.0	16.7	3.9	2.9	5.8	6.0	1.7	.7	.8	.8	2.8
18	15.7	4.0	17.1	3.9	2.8	5.3	10.5	2.7	.5	.8	.8	2.8
19	16.4	4.4	17.3	3.8	2.8	4.8	12.2	2.8	.4	.7	.7	2.8
20	18.7	4.7	16.8	3.7	2.8	4.8	12.2	2.3	.3	.7	.7	2.7
21	21.2	4.7	15.7	3.3	2.8	4.5	10.0	2.0	.3	.7	1.0	2.3
22	24.0	4.5	13.8	3.1	2.1	4.3	7.9	1.9	1.8	.7	1.2	2.0
23	24.6	4.0	11.7	3.0	2.0	4.8	6.4	1.9	2.0	.6	1.3	2.3
24	23.3	3.5	9.6	3.0	1.9	4.9	5.6	1.7	1.8	.6	1.7	4.5
25	21.2	3.2	8.1	3.0	4.0	5.4	4.9	1.3	1.5	.6	2.0	5.3
26	20.0	3.0	7.2	2.9	4.8	6.3	4.0	1.2	1.2	+.6	2.0	8.5
27	19.8	3.0	6.3	2.9	6.7	7.0	3.6	1.0	.8	+.6	1.8	10.0
28	15.0	3.0	6.1	2.9	7.3	6.7	3.3	1.1	.7	+.6	1.7	11.5
29	11.5	.....	7.0	2.9	7.0	6.0	3.3	.8	.7	+.7	1.5	13.8
30	8.6	.....	9.9	3.0	6.7	5.2	2.9	.8	.6	+.4	1.5	14.9
31	7.3	.....	11.8	.....	5.8	.....	2.6	.8	.....	.3	.....	15.5

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1908.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16.5	2.7	12.8	9.4	7.0	5.8	1.7	1.0	.9	—.1	—.3	.3
2	17.3	2.0	15.0	11.2	6.6	5.5	1.6	.8	.0	—.2	—.3	.3
3	17.3	1.7	16.4	10.5	5.8	5.5	1.5	.8	.0	—.2	—.3	.3
4	16.8	1.4	17.3	8.9	7.0	5.0	1.6	.2	—.1	—.2	—.3	.3
5	15.8	2.0	17.4	7.8	11.2	4.7	1.5	.2	—.2	—.2	—.3	.3
6	14.1	7.5	18.6	7.8	13.5	3.5	1.5	.2	—.2	—.2	—.3	.3
7	11.6	8.8	19.0	7.0	15 5	3.5	1.7	.2	—.2	—.2	—.3	.3
8	9.3	8.3	19.3	7.5	18.7	2.8	2.0	.3	—.2	—.2	—.3	.3
9	7.8	8.3	20.9	12.0	19.5	2.8	1.9	.3	—.2	—.2	—.3	.2
10	6.8	7.0	22.8	13.0	20.0	2.8	1.7	.4	—.2	—.2	—.3	.2
11	6.0	7.0	22.8	13.9	19.2	2.7	1.3	.3	—.2	—.2	—.3	.2
12	6.3	8.0	21.8	14.5	18.3	2.5	1.3	.3	—.2	—.2	—.3	.2
13	9.2	12.3	20.5	14.6	18.1	2.8	1.1	.3	—.2	—.3	—.3	.2
14	10.4	12.8	19.3	14.6	18.2	2.7	1.0	.3	—.2	—.3	—.3	.2
15	10.7	14.5	18.2	13.8	18.0	2.5	1.0	1.7	—.2	—.3	—.3	.2
16	10.7	15.9	16.8	11.8	17.9	2.5	1.0	2.8	—.2	—.3	—.3	.2
17	9.7	17.0	15.2	9.5	17.8	2.3	1.0	2.0	—.2	—.3	—.3	.2
18	8.1	17.7	13.5	8.4	17.6	2.3	1.0	1.6	—.2	—.3	—.3	.2
19	6.8	18.3	11.9	7.8	17.0	2.0	.9	1.0	—.2	—.3	—.3	.2
20	6.0	18.8	13.7	7.3	16.8	2.3	.8	.8	—.2	—.3	—.3	.2
21	5.3	18.0	14.5	6.8	16.3	2.5	1.5	.7	—.2	—.3	—.3	.2
22	5.2	16.8	15.1	6.0	15.8	2.0	1.0	.5	—.2	—.3	—.3	.2
23	5.1	14.5	15.8	5.7	15.0	1.9	1.0	.4	—.2	—.3	—.3	.2
24	4.8	11.3	16.5	6.0	13.0	1.9	1.0	.4	—.2	—.3	—.3	.2
25	4.7	9.7	16.7	7.9	10.5	2.0	1.3	.3	—.2	—.3	—.3	.2
26	4.2	13.6	15.9	9.1	8.8	2.2	2.3	.6	—.2	—.3	.3	.2
27	4.5	14.3	14.0	8.8	7.9	2.0	2.0	.6	—.2	—.3	.3	.2
28	4.3	14.0	11.0	7.9	7.5	1.8	1.8	.7	—.1	—.3	.3	.2
29	3.9	13.5	9.7	7.7	7.0	1.8	1.8	.7	—.1	—.3	.3	.2
30	3.5	.....	9.0	7.0	6.4	1.7	1.5	.8	—.2	—.3	.3	.2
31	2.5	.....	9.4	.....	6.0	.....	1.3	.8	.....	—.3	.....	.2

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1909.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.2	1.1	17.7	5.3	11.0	7.9	6.0	2.0	1.0	2.0	1.8	4.6
2	.2	1.1	17.0	4.7	13.0	6.7	5.0	2.0	1.0	1.0	1.8	4.1
3	.2	.9	16.4	4.1	13.5	5.9	4.2	1.9	.9	.8	1.5	3.9
4	.2	.9	14.2	3.8	14.2	7.8	3.6	1.8	.8	.8	1.4	3.5
5	.2	.9	10.8	3.4	15.0	10.2	3.0	2.2	.8	.7	1.3	3.1
6	.2	2.3	8.3	3.3	14.9	11.2	3.0	2.0	.7	.7	1.1	3.5
7	.0	2.8	6.8	10.2	13.7	11.3	6.5	1.8	.7	.7	1.1	3.7
8	.0	3.0	5.0	14.0	10.8	10.0	5.9	1.5	.7	.7	1.1	3.5
9	.0	3.7	7.2	14.4	10.0	8.3	5.0	1.3	.9	.5	1.0	Ice
10	.0	4.0	9.8	14.8	11.0	9.2	4.7	.9	.7	.5	1.0	Ice
11	.0	4.0	8.8	15.0	10.8	11.2	3.8	.9	.5	.3	1.0	1.0
12	.0	4.2	9.0	15.1	10.8	12.4	4.1	.9	.5	.2	1.0	2.0
13	.0	4.7	10.3	14.4	11.2	13.8	8.2	2.2	.9	.2	1.0	5.0
14	.0	4.3	10.2	13.8	11.2	15.0	11.0	4.0	.9	.2	1.3	8.9
15	.0	6.4	8.8	14.8	10.3	15.0	10.7	3.9	.7	.0	1.3	10.8
16	.0	7.7	7.2	13.6	9.0	13.7	8.8	3.5	.8	.0	1.3	12.3
17	.0	7.0	6.0	12.3	7.8	11.0	7.1	3.0	.6	.0	1.5	13.0
18	.0	6.0	5.0	9.8	7.3	10.9	5.8	2.5	.6	.3	2.3	12.8
19	.0	6.5	4.7	8.2	6.7	8.3	6.3	2.3	.6	.2	3.4	11.0
20	.0	11.2	4.1	7.2	5.8	6.7	7.0	2.0	.5	.2	3.5	Ice
21	.0	13.0	4.0	6.7	4.8	5.7	6.3	1.8	.5	.3	3.5	Ice
22	.1	13.7	4.0	8.0	4.3	4.8	5.0	1.7	.5	.2	3.3	Ice
23	.8	14.3	4.0	9.6	3.8	4.2	4.3	1.5	.7	.7	5.4	2.0
24	.9	15.1	3.9	9.1	3.5	4.0	3.5	1.2	2.2	1.0	7.2	2.0
25	.8	16.3	3.9	7.9	3.3	2.8	2.9	.8	4.3	1.3	9.8	2.0
26	.8	16.9	3.9	6.8	3 3	11.0	2.5	1.2	4.7	2.0	11.0	1.5
27	.9	17.5	4.9	5.8	4.7	12.4	2.3	2.0	4.1	3.0	10.8	2.0
28	.9	17.7	6.6	5.8	8.5	11.0	2.0	1.5	3.3	3.3	9 0	2.0
29	1.1	.....	6.9	4.8	10.0	10.0	1.9	1.2	2.7	2.9	7.2	*
30	1.1	.....	6.9	4.8	9.3	7.8	1.8	.9	2.0	2.3	6.5	2.0
31	1.1	.....	6.0	.....	8.8	.....	1.7	.8	.....	2.0	.....	2.3

*No record.

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1910.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.3	7.0	14.8	1.9	4.0	2.7	.7	—.2	—.2	.8	.3	1.0
2	2.3	6.0	15.5	1.8	3.7	2.5	.5	—.3	—.3	.8	.3	1.0
3	2.3	5.5	16 0	1.8	4.5	2.3	.3	—.3	—.3	.7	.2	1.0
4	2.5	5.3	16.3	1.8	5.2	2.0	1.0	—.3	—.3	.8	.2	1.0
5	2.5	6.0	16.5	1.8	4.7	1.8	.9	—.3	—.3	1.9	.2	1.5
6	2.7	7.2	16.3	1.8	4.6	1.8	.8	—.3	+.2	4.8	.2	.8
7	2.7	6.5	15.5	1.8	4.3	1.8	.5	—.3	4 3	3.3	.2	.8
8	2.7	5.5	14.5	1.8	4.3	1.7	.5	—.3	2.8	3.0	.2	.7
9	2.7	4.8	12.5	1.8	4.1	1.5	.4	—.3	4.7	2.8	.2	.3
10	4.9	4.3	10.7	1.8	3.8	1.3	.4	—.3	4.7	4.2	.2	.3
11	4.3	4.0	8.8	1.8	3.3	1.3	.3	—.3	3.0	6.3	.2	.3
12	3.8	3.8	7.5	1.7	3.7	1.0	.5	—.3	2.0	6.0	.2	.3
13	6.0	3.3	6.5	1.7	3.8	.9	1.0	—.3	1.6	4.8	.2	.3
14	12.0	2.8	5.8	1.6	3.4	.8	.6	—.4	1.3	3.5	.0	.3
15	12.5	2.7	5.3	1.5	2.8	.8	.4	—.4	1.0	2.8	.0	.3
16	13 2	2.7	4.9	1.7	2.5	.7	2.0	—.4	1.0	2.0	.0	.3
17	13.5	3.0	4.5	1.8	2.3	.6	5.7	—.4	1.7	1.8	.0	.3
18	14.7	3.0	4.0	1.8	2.3	.5	4.5	—.3	1.5	1.2	.0	.3
19	17.5	2.7	3.8	1.9	2.0	.4	2.8	—.3	1.2	1.0	.0	.3
20	18.5	2.7	3.7	2.0	1.8	.4	2.0	—.3	1.0	.9	.0	.3
21	17.5	5.0	3.4	2.5	1.5	.3	1.5	—.3	1.2	.8	.0	.0
22	19.0	4.3	3.1	3.7	3.0	.3	1.0	—.3	1.1	.8	.0	.0
23	19.3	4.9	3.0	4.8	5.8	.3	.7	—.3	1.0	.7	.0	.0
24	18.8	5.0	2.9	4.6	4.5	.3	.5	—.3	.9	.7	.0	.0
25	17.8	4.0	2.8	4.2	5.7	.2	.4	.2	.8	.6	.0	.0
26	16.5	4.3	2.8	4.2	5.6	.1	.3	.2	.8	.5	.0	.0
27	14.5	8.0	2.6	4.0	5.0	.1	.2	.1	.8	.5	.0	.0
28	11.0	14.5	2.5	3.8	4.0	.5	.2	.1	.8	.4	1.7	.0
29	9.7	.....	2.3	3.8	3.3	1.0	.0	.0	.8	.4	1.8	4.2
30	9.7	.....	2.2	4.0	3.0	.8	.0	—.1	.8	.3	1.2	8.2
31	7.8	.....	2.0	.....	2.8	.....	.0	—.1	.....	.3	.....	6.0

GAGE READINGS ON WABASH RIVER AT TERRE HAUTE WATERWORKS STATION FOR 1911.

DAY.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.3	13.6	4.9	2.5	4.3	.6	1.8	—.3	.....	.....	.....	.....
2	8.8	13.6	3.8	2.2	4.3	.6	1.5	—.3	.....	.....	.....	.....
3	9.0	12.3	3.5	4.0	4.8	.8	1.2	—.3	.....	.....	.....	.....
4	7.3	9.5	3.3	4.2	5.2	1.0	.8	—.3	.....	.....	.....	.....
5	7.0	7.7	2.9	6.7	5.0	1.0	.7	—.3	.....	.....	.....	.....
6	4.5	6.7	2.8	7.7	4.3	1.2	.5	—.3	.....	.....	.....	.....
7	4.0	6.5	2.8	8.7	3.8	1.0	.4	—.3	.....	.....	.....	.....
8	3.0	5.8	5.4	10.3	3.0	1.0	.4	—.3	.....	.....	.....	.....
9	7.0	5.1	5.0	9.8	2.8	1.0	.3	—.3	.....	.....	.....	.....
10	7.0	4.6	4.7	8.0	2.7	.8	.3	—.4	.....	.....	.....	.....
11	6.5	4.0	4.5	6.5	2.5	.8	.3	—.4	.....	.....	.....	.....
12	6.3	3.3	4.1	5.3	2.3	.8	.2	—.4	.....	.....	.....	.....
13	3.3	3.3	3.8	5.0	2.0	.8	.3	—.5	.....	.....	.....	.....
14	5.0	3.5	3.8	10.0	1.8	.5	.2	—.5	.....	.....	.....	.....
15	9.5	4.0	3.8	12.4	1.7	.3	.0	—.5	.....	.....	.....	.....
16	11.5	5.5	3.8	11.9	1.6	.2	.0	—.5	.....	.....	.....	.....
17	12.0	9.0	3.8	10.4	1.4	.2	—.1	—.1	.....	.....	.....	.....
18	11.3	10.4	3.8	10.0	1.3	.2	—.2	—.3	.....	.....	.....	.....
19	8.9	10.0	3.2	8.5	1.2	.2	—.1	—.3	.....	.....	.....	.....
20	6.5	9.8	3.0	9.5	1.3	.2	.0	—.3	.....	.....	.....	.....
21	5.3	9.8	2.8	8.7	1.4	.3	—.2	—.3	.....	.....	.....	.....
22	5.3	9.2	2.5	9.0	1.0	.5	.0	—.3	.....	.....	.....	.....
23	5.0	8.0	2.2	10.3	1.3	.5	—.2	—.3	.....	.....	.....	.....
24	4.3	6.5	2.0	9.5	1.3	.4	—.2	—.3	.....	.....	.....	.....
25	3.9	5.8	1.7	8.0	1.3	.4	—.3	—.3	.....	.....	.....	.....
26	4.0	5.0	1.7	7.7	1.2	.4	—.3	—.3	.....	.....	.....	.....
27	4.5	4.8	1.5	5.7	1.3	.4	—.3	—.3	.....	.....	.....	.....
28	9.5	4.3	2.0	5.0	1.0	.7	—.3	—.3	.....	.....	.....	.....
29	12.0	.....	2.0	4.7	.8	2.0	—.3	—.3	.....	.....	.....	.....
30	13.0	.....	2.3	4.3	.8	2.2	—.3	.....	.....	.....	.....	.....
31	13.5	.....	2.5	.....	.7	.....	—.3	.....	.....	.....	.....	.....

RATING TABLE FOR WABASH RIVER AT TERRE HAUTE, IND., FOR 1901-11 INCLUSIVE.

Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.	Gage Height, Feet.	Discharge, Sec. Ft.
0.0	1,930	1.5	4,330	3.0	7,400	5.9	14,200
0.1	2,050	1.6	4,510	3.1	7,620	6.1	14,700
0.2	2,180	1.7	4,700	3.3	8,060	7.1	17,200
0.3	2,320	1 8	4,900	3.5	8,500	8.1	19,800
0.4	2,460	1.9	5,100	3.7	8,940	9.1	22,500
0.5	2,610	2.0	5,300	3.9	9,380	10.1	25,300
0.6	2,770	2.1	5,500	4.1	9,830	11.1	28,400
0.7	2,940	2.2	5,700	4.3	10,300	12.1	31.800
0.8	3,110	2.3	5,900	4 5	10,780	13.1	35,500
0.9	3,280	2.4	6,100	4.7	11,260	14.1	39,500
1.0	3,450	2.5	6,310	4.9	11,740	15.1	43,700
1.1	3,620	2.6	6,520	5.1	12,220	16.1	48,100
1.2	3,790	2.7	6,740	5.3	12,700	17.1	52,700
1.3	3,970	2.8	6,960	5.5	13,200	18.1	57,400
1.4	4,150	2.9	7,180	5.7	13,700	19.1	62,100

The data contained in these tables gives a very good idea of the nature of the river at Terre Haute. The data is not entirely accurate. The readings were recorded in the Terre Haute Waterworks record as feet and inches. The inches were reduced to tenths by letting each equal the nearest tenth. However, the error due to this cause is small. An examination of this data shows that the Wabash is a very erratic river. The following table shows some striking features:

TABLE SHOWING ANNUAL FLUCTUATIONS OF WABASH RIVER AT TERRE HAUTE AND RATIO BETWEEN MAXIMUM AND MINIMUM DISCHARGE.

YEAR.	MINIMUM.		MAXIMUM.		
	Date.	Discharge, Sec.-Ft.	Date.	Discharge, Sec.-Ft.	Times Minimum.
1901	October 24	1,930	June 24	25,000	13
1902	February 27	1,930	July 4	62,100	32
1903	November 4	1,200	April 17	66,330	55
1904	December 20	900	March 27	90,300	100
1905	January 4	1,930	May 18	52,000	26
a	October 17	1,920	May 17	50,000	.....
1906	October 15	1,300	April 1	61,630	47
a	July 1	2,160	April 2	61,200	.....
1907	September 20	2,320	January 23	87,950	37
1908	October 13	1,530	March 10	79,490	52
1909	January 7	1,930	February 28	55,520	29
1910	August 14	1,410	January 23	63,040	45
1911	August 13	1,300	February 1	37,500	21

a U. S. G. S. data.

This table shows the maximum annual discharge to have occurred twice in each of the first four months and once in each of the next three during the past eleven years. The minimum discharge is also distributed among seven months with October three,

August and January two each, and September, November, December and February one each. The lowest ratio between the minimum and maximum discharge of any year in which complete data is recorded is 1 to 26 in 1905 and in the previous year the ratio was 1 to 100. Both the absolute minimum and maximum discharges occurred in 1904. The profile of the Wabash shows a much more uniform gradient than any of the smaller streams of the State. The fall is slight throughout its course. The profile is taken from Water Supply and Irrigation Paper No. 169, U. S. Geological Survey, page 74. Several of the altitudes have been checked by the writer:

TABLE OF ALTITUDES AND DISTANCES ALONG WABASH RIVER.

LOCATION.	Estimated Distance, Miles.	Altitude, Feet.	Fall Per Mile, Inches.
Source	0.0	1,000.0	0.0
Huntington	100.0	699.0	36.0
Mouth of Salamonie River	15.0	667.0	25.6
Mouth of Mississinewa River	20.0	633.0	20.4
Logansport	20.0	583.0	30.0
Lafayette	50.0	506.0	18.5
Attica	25.0	487.0	9.1
Covington	20.0	470.0	10.2
Terre Haute	55.0	447.7	4.9
State Line	14.6	440.6	5.8
Hutsonville, Ill	29.0	424.6	6.6
Vincennes	46.4	398.8	6.7
Mouth of White River	32.5	376.5	8.2
Grayville, Ill	28.0	365.0	4.9
Mouth of Little Wabash River	46.0	323.0	11.0
Mouth of Wabash River	16.0	311.0	9.0

POWER SITES ON WABASH RIVER.

But one power site is now in use on the part of the Wabash River which has been investigated. This site is at Markle. It has been developed about fifty years. The dam is part concrete and part wood. The wood is being replaced by concrete in sections. The dam is 212 feet long, including the forebay, and six feet high. The head on August 31 was but 4.5 feet, due to a slight rise of the river. The dam is situated on limestone. The mill is situated on the north end of the dam. Three wheels are employed, one 20, one 15, and one 12 H. P. They are all old style wheels. The power is used entirely for mill purposes. It is very inconstant and is supplemented by steam power. This power is owned and operated by A. R. Thomas and Son.

Site One Mile Below Markle.—At a point one mile below Markle is an old wood and brush dam. It is 200 feet long and two feet

high. It was built thirty-five years ago. A race leads to the mill which is one-fourth mile down stream on the north side. The race increases the head to six feet. The mill is fast falling into decay. Two wheels have been in use at this mill and are still used occasionally during the winter for grinding feed. The mill was abandoned because of long seasons of insufficient water for operation. The site is owned by Jacob Hite.

Logansport.—A stone dam is located at Logansport at the east line of the city. It is a stone dam 700 feet long and six feet high. It is situated on bed rock and is in first class condition. The water from this dam has been used on the south side of the river but is not used at the present time. The interference of low and high water make the site practically worthless. This site is owned by the Standard Oil Company.

It is not feasible to develop power upon the Wabash River in any part which has been investigated. The features which make it impracticable are: the irregular discharge, wide valley, low banks, and slight fall. The only point in favor of development is the presence of solid rock in the bed. This does not occur in the lower part of the course. The only plan which the writer can suggest for the development and control of this stream is a series of high dams which would flood the lowlands and develop storage. With the present low price of coal and the high price of Wabash bottom land, such an enterprise is entirely out of the question. However, at some remote period when the coal is exhausted, the Wabash may be harnessed on a grand scale.