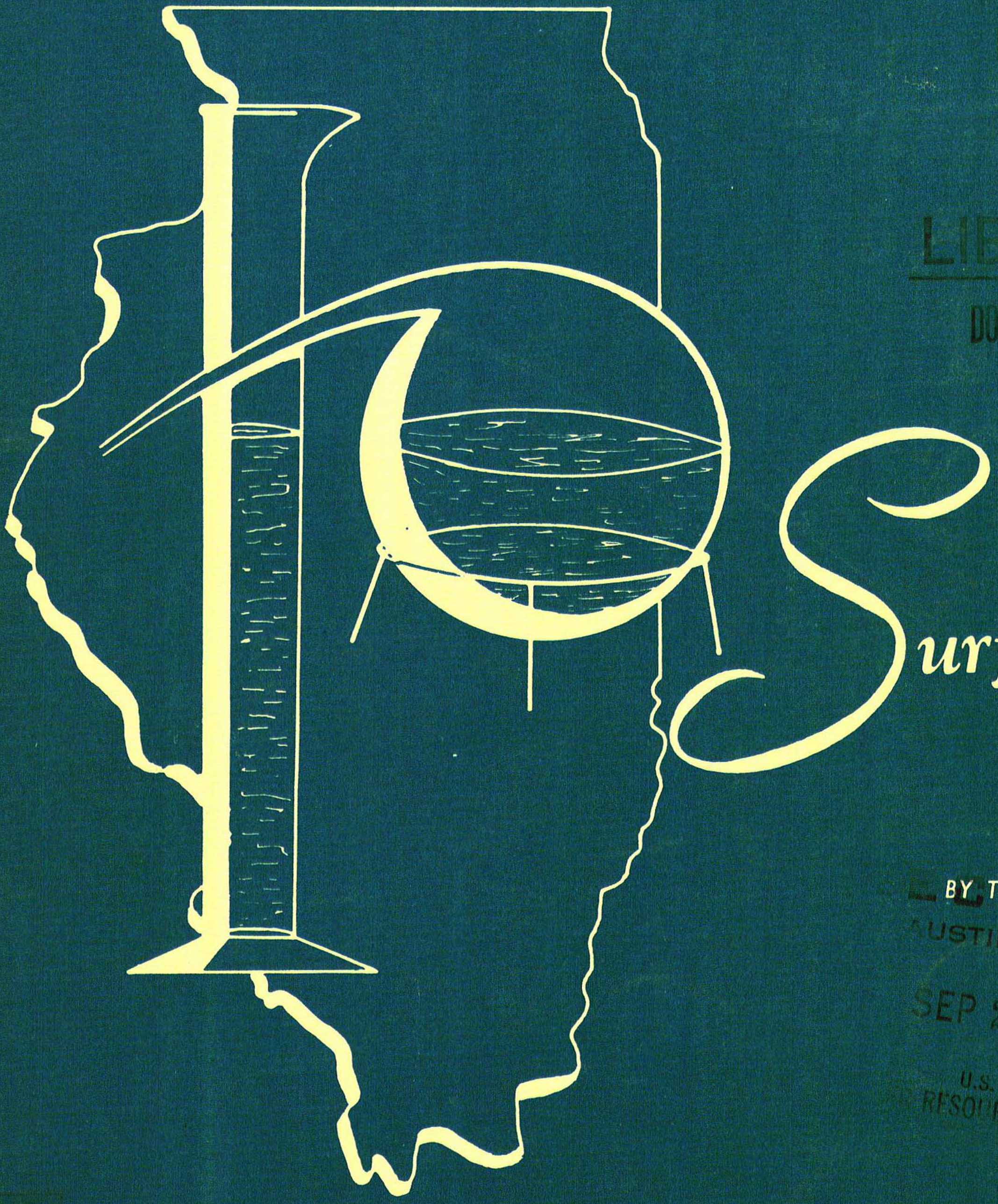
BULLETIN 45

STATE OF ILLINOIS
WILLIAM G. STRATTON, Governor

DEPARTMENT OF REGISTRATION AND EDUCATION
VERA M. BINKS, Director



Quality of Surface Waters in Illinois

BY T. E. LARSON AND B. O. LARSON

ILLINOIS STATE WATER SURVEY
WILLIAM C. ACKERMANN, Chief

URBANA
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ABSTRACT

Owing to continuously increasing needs for water and the limited available ground water in some areas of Illinois, demand for water in the future will of necessity be obtained in progressively larger amounts from surface' water resources.

This bulletin provides data on water quality in 19 streams at 21 sampling locations and at 2 locations on Crab Orchard Lake, the largest artificial lake in Illinois. Over 1200 samples have been analysed for 14 to 16 constituents in each. A tabulation of the quality determinations for each of the streams and for Crab Orchard Lake are included with temperature and flow data in the Appendix.

The water samples were analysed for all the usual mineral constituents, but not all constituents were used to compare the quality of water in the various streams for this bulletin. Probability charts were prepared to include long-term average flow, temperature, turbidity, hardness, alkalinity, total dissolved minerals, and the ratio of alkalinity to total dissolved minerals at the 23 sampling locations. Only the above characteristics were treated statistically in this bulletin because they are generally considered the best criteria of suitability for various uses.

No attempt has been made to convert the data for the purpose of indicating the quality ranges that might be expected from a reservoir. The quality of stored water is less variable and depends upon the length of time the reservoir has been in operation as well as the amount or percentage of runoff stored.

An important section of this bulletin concerns a post-mortem statistical analysis and discussion to indicate the significance, and reliability of the sampling program and data.

ACKNOWLEDGMENTS

The data assembled herein were obtained under the administrative direction of Dr. A. M. Buswell, Chief of the State Water Survey to September, 1955, and William C. Ackermann, Chief of the State Water Survey beginning May 195(5. All of the chemical analyses were made by members of the Chemistry Section under the supervision of Orville Vogel, Robert King, and Laurel Henley during various periods. Much of the basic preparation of the log-probability duration curves was done by Clarence Crozier, Engineering Assistant, during the summer of 1956.

The writers are especially indebted to J. H. Morgan, District Engineer for Illinois, Water Resources Division of U. S. Geological Survey, and his field staff who collected most of the water samples. The District Office at Champaign, Illinois, also provided the instantaneous discharges and the unpublished duration curves for the selected periods of daily flow that were used in this study.

Grateful acknowledgment is due Mr. F. F. Schrader, U. S. Geological Survey District Engineer at Louisville, Kentucky, and Mr. A. S. Curtis, engineer-in-charge at Paducah, Kentucky, for collection of the Wabash River samples at Mt. Carmel, Illinois, and the Ohio River at Metropolis, Illinois. Similarly, appreciation is due V. R. Bennion, U. S. Geological Survey District Engineer at Iowa City, Iowa, and Mr. C. Herlofson, Hydraulic Engineer, Union Electric Co., Keokuk, for collection of Mississippi River samples at Keokuk, Iowa; Harry C. Bolon, U. S. Geological Survey District Engineer, Rolla, Missouri, and J. C. Berkenbosch, engineer-in-charge at St. Louis, Missouri, for collection of Mississippi River samples at Thebes, Illinois. Mr. E. E. Crawford, Project Manager, Crab Orchard National Wild Life Refuge, Carterville, Illinois, provided samples from Crab Orchard Lake, and his cooperation is greatly appreciated.

Special acknowledgment is due Dr. James C. Neill for the statistical study of sampling aspects and the preparation of the chapter on this subject. The thoughtful appraisal given this work, and other chapters in the bulletin, by Mr. William Mitchell of the Champaign District Office of the U. S. Geological Survey has' been of great value and is sincerely appreciated.

Particular acknowledgment is due the patience and contributions of the Water Survey staff; particularly to Dr. A. M. Buswell and Mr. W; C. Ackermann for guidance, Mr. Orville Vogel of the Peoria Laboratory for assembly of the Illinois River data, Mr. Robert Russell for careful and artful drafting, and many others whose help is no less appreciated by oversight.

INTRODUCTION

Water is a ,most important commodity to the progress of a state and the welfare of its people. In the northern part of Illinois, except, for the area immediately adjacent to Lake Michigan, industry and municipalities depend almost wholly on subsurface water for their supplies. Conversely, in the southern part of the state, surface supplies are the major source. These supplies are obtained almost entirely from impounding reservoirs and major rivers.

All surface water is dependent on precipitation. "In Illinois the average annual precipitation is equivalent to about 100 billion gallons per day, and of this amount only about 24 per cent is measured as runoff. The remainder is lost through evapotranspiration or by percolation intn the ground. Only about one-third of the 24 billion gallons per day average runoff is used for urban and industrial purposes.

"Illinois has large' resources of surface water. At the northeast corner lies Lake Michigan; the Mississippi River borders the western side, and the Wabash and Ohio border the eastern and southern sides. Next in importance is the Illinois River which has its flow augmented by an average daily diversion from Lake Michigan of 1500 second feet. The Rock River, Fox River, Sangamon River, and several smaller rivers, plus approximately 500 lakes and reservoirs, complete the surface water resources for the state."[(1)]

A comparison of surface and ground-water use in the State of Illinois is pertinent. The total ground-water withdrawal for industrial use is estimated to be 258 million gallons per day. Municipal ground-water withdrawal totals 153 million gallons per day of which it is estimated that, at some locations, as high as 42 per cent is routed to industry for plant and air-conditioning uses. Most of this ground water is considered to be consumed since it is not returned to the source from which it was taken. The 13 principal industries using surface water have a daily pumpage of 1,753 million gallons with approximately 150 million gallons being classified as consumed and 1,603 million gallons as non-consumed. In addition electric-power generating plants use surface water for cooling, pumping a total of 5,927 million gallons daily. Stand-by and municipal plants raise this total to approximately 6,000 million gallons per day. Most of this water is circulated once through the condensers and returned to the source, the water consumed being estimated at less than 0.3 per cent.

There are 11 hydroelectric plants in Illinois and two at state lines for which Illinois is accountable for one half the output. These plants require nearly 21,000 million gallons of water per day which is considered to be non-consumed.

During the 10-year period ending in 1950, the major industries increased their total water requirements. For example, the food industries increased their demands by 38 per cent and aircraft by 82 per cent. Also new industries during this same period caused an increase of 12 per cent in water use. As time goes on, demands for water resources of Illinois can be expected to increase.

Generally for most subsurface water, a single chemical analysis gives a representative sample of the type of water which can be obtained from any given well. However, the quality of the water in a stream varies almost continuously, and hence, any conclusion as to quality must be based upon a series of samples obtained under a systematic sampling program.

When planning a development for municipal, agricultural, industrial, or other purposes, it is not always sufficient to know whether or not the supply is potable. It is often necessary to know the amount and kind of minerals the water contains. With this knowledge, adequate plans can be made for treating the water for the intended uses.

The turbidity, mineral quality, and temperature data provide the design engineer with the essential water quality information for his needs. The time-frequency of high turbidities is as important to the design engineer as the time-frequency of low flows. The time-frequency data provide information suitable for up to 90 per cent and permit supplemental treatment with higher alum dosage or coagulant aids for exceptional periods beyond the physical limits of the treatment capacity.

The first analysis of the mineral quality of Illinois streams was made in 1906-07. The U. S. Geological Survey arranged for the collection of daily samples at 27 points on 17 rivers and reservoirs in Illinois in cooperation with the State Water Survey, the State Geological Survey, and the University of Illinois Engineering Experiment Station. Mineral analyses were made on 10-day composites in the Water Survey laboratory. Samples were obtained from four reservoirs and 13 streams including the

Mississippi River. Twenty-three sampling stations were used on these 13 streams. A complete discussion of the 1906-07 analysis can be found in the U. S. Geological Survey Water Supply Paper 239.[2] Some of these data were analysed and the results compared with data on the quality of the streams included in this bulletin.

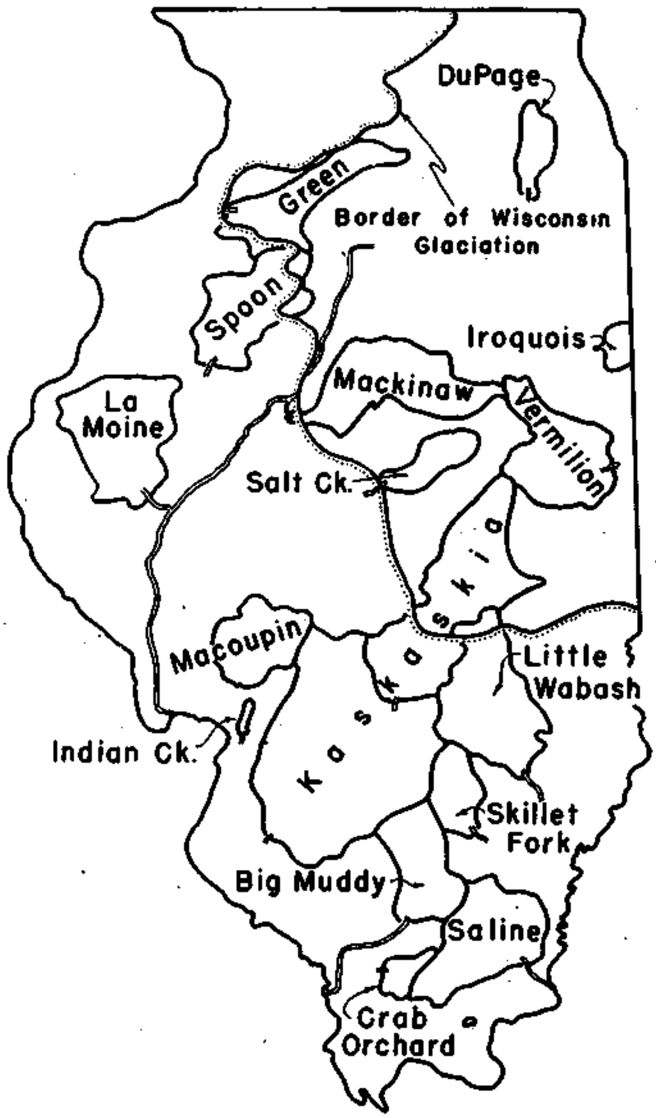

FIGURE 1 WATERSHEDS FOR STREAMS SAMPLED FOR MINERAL ANALYSIS

COLLECTION OF SAMPLES

The present surface water study of the mineral quality of 10 Illinois streams (Fig. 1) for five-year periods was inaugurated in 1945 by the State Water Survey with the cooperation of the U. S. Geological Survey, District Office, Champaign, Illinois.

With few exceptions, all samples were collected by U. S. Geological Survey field engineers on scheduled visits to gaging stations. Without such cooperation, the cost of sampling would have been prohibitive. One gallon glass containers were used and shipped or delivered to the Water Survey laboratory with data on location, gage height, time, day, temperature, and appropriate remarks on condition's of ice, flood, etc.

Upon completion of the first sampling program in 1950, samples were collected from 10 additional streams by the U. S. Geological Survey District Offices in Champaign, Illinois; Louisville, Kentucky; and St. Louis, Missouri; beginning in October 1950 and terminating July 1955. Samples were also submitted from two points on Crab Orchard Lake, near Carterville, Illinois.

Samples from the Illinois River were obtained near the Upper River Bridge from 1941-1950 and at the Cedar Street Bridge from 1951-1956 by the State Water Survey at Peoria. Samples were obtained daily from October 1951 to June 1952; every other day to October 1952; daily again until May 13, 1953; every other day to October 1953; daily to June 1954; every other day to November 17, 1954; daily through May 12, 1955; and every other day to complete the testing program. Samples at other stations were collected approximately at four to five week intervals, without regard to flow, with a total of between 50 and 65 samples being collected during the five-year period. A complete mineral analysis was made for each of these individual samples.

PROCEDURES FOR PRESENTATION OF DATA

It is believed that a more complete and useful description of data can be obtained by presenting frequency of occurrences than by presenting only extremes and averages. Consequently, frequency of occurrence methods were applied in the expression of quality as well as availability of water. The adaptation of the log-probability system of coordinates for graphical illustration, as demonstrated by Mitchell for flow-duration curves, was considered appropriate.

Some of the advantages of this system described by Mitchell are less obvious when applied to mineral quality data because they are presented on a compressed log scale. However, clarity of the frequency of occurrence as well as the variability in quality are immediately apparent. Severe skewness, or deviations from a normal distribution about the mean, is also apparent when the frequency of occurrence curve is not a straight line.

It is also hoped that the singular use of frequency analysis techniques in the present study may recommend its use in other investigations of water quality.

Flow duration curves on log-probability paper were reproduced or obtained directly from the U. S. Geological Survey. The data used are from average daily flow records for the indicated period of record. The data for instantaneous discharge are presented in a similar manner together with the long-term flow-duration curves to show the representative sampling correlation.

Turbidity, as obtained from the monthly samples, is also presented on these charts with a line drawn through those points that fall between the 10 per cent and 90 per cent time values. Although as a general rule, the higher concentrations of turbidity and the higher discharge rate occur at about the same time and with similar frequency, the corresponding turbidities and discharge rates are not necessarily related.

In a similar manner, the total dissolved minerals content, the hardness, the alkalinity, and the ratio of alkalinity to total dissolved minerals are indicated with the percentage scale reversed since the concentration of the minerals, in general, decreases as the discharge rate increases.

In preparation of the duration curves for flow, turbidity, temperature, and the above-mentioned minerals, the values in each category were arranged in classes dependent upon magnitude as described by Mitchell.[3] Determination was then made of the proportion of time during which flow or mineral concentration was equal to or greater than the lower limit of each class. Class intervals were selected to give about 30 well-distributed points on the duration curves. The extremes were chosen to include only the maximum and minimum values for the period of record considered. Class limits were determined as follows: On semi-logarithmic paper the minimum value of the specific category was plotted at 1 on the linear scale, and the maximum values at 30. These two points were connected with a straight line. The boundaries between the classes were chosen at abscissas of 0.5, 1.5, 2.5, etc., to 30.5.

Tabulations of the dat'a for each sampling period were made as exemplified in Table 1 for turbidity for the La Moine River. Entries in the body of the table represent the number of times in each month that the turbidity was less than shown in the second column but equal to or greater than shown on the preceding line of column two. Therefore, the total column represents. the number of times there existed a sample within these limits. When these values are summed upward from the bottom and the sum recorded on the line above, the summation column becomes a distribution of occurrence. The last column shows occurrences as a per cent of the total number of occurrences during the period.

TABLE 1

FREQUENCY OF OCCURRENCES OF TURBIDITY AT INDICATED VALUES FOR 49 SAMPLES COLLECTED FROM LA MOINE RIVER AT RIPLEY

No.	Turbidity	January	February	March	April	May	June	July	August	September	October	November	December	Total	Summation	Per Cent of Time
1	.86													0	49	100
2	1.16	x												1	48	97.9
3	1.60													0	48	97.9
4	2.20													0	48	97.9
5	3.05													0	48	97.9
6	4.20													0	48	97.9
7	5.80	x												1	47	96.
8	7.90													0	47	96.
9	11.0													0	47	96.
10	15.0												x	1	46	93.9
1	20.5			x					xx		x			4	42	85.8
2	28.2	x		x	x								x	4	38	77.5
3	39.0										xx	xx		4	34	69.4
4	54.0						x			x	x		xx	5	29	59.1
5	64.0													0	29	59.1
6	101	x	x			x	xx	x	xx	x	x			10	19	38.8
7	140											x		1	18	36.7
8	190				x	x								2	16	32.6
9	265		x						x			x		3	13	26.5
20	362						x			x				2	11	22.4
1	500													0	11	22.4
2	680			x	x		x	x						4	7	14.3
3	950		xx					x						3	4	8.17
4	1300			x										1	3	6.12
5	1790							x						1	2	4.09
6	2430					x								1	1	2.04
7	3320													0	1	2.04
8	4600													0	1	2.04
9	6300													0	1	2.04
30	8700													0	1	2.04
1	12000				x									1	0	---
	Totals	4	4	4	4	3	5	4	5	3	5	4	4	49		

Logarithmic-probability paper is used in order to present the data in a convenient form. The ordinate is a logarithmic scale and shows the discharge in second feet per square mile, temperature in degrees Fahrenheit, and chemical ingredients in parts per million. The abscissa is the probability scale with frequency expressed as a per cent of occurrences equal to or more (or less) than the specified value.

In presenting the data, the actual measured amounts are indicated for the values between 0 and 10 per cent and between 90 and 100 per cent of occurrences and a best-fit curve was not continued through these points. The minimum values in each category are omitted since they would occur 100 per cent of the time, and cannot be indicated. The upper and lower 10 per cent values are presented as actual amounts due to the relatively small total number of samples (50 to 60), and they are considered therefore as less representative of the probable occurrence.

It is inherent in the collection of data that maximum and minimum figures only approximately represent the extremes, since they represent only such values as have been recorded for the number of samples collected during a given period. If more frequent samples had been collected or the collection period extended, new maximum and minimum figures might be obtained. However, with the number of samples collected within the period, excellent assurance of the reliability of the median value is apparent and a reasonable assurance is provided for the values of the data for 10 per cent to 90 per cent occurrence.

The average daily flow and the instantaneous flow are expressed in cubic feet per second per square mile to eliminate the variation due to size of the drainage area and to emphasize the similarity - or dissimilarity of the streams.

Representativeness of Observation Period

It is assumed that sampling representativeness is indicated by the relation of distribution of flows at the time of sampling to the distribution of average daily flows established from long-term records by the U. S. Geological Survey. It will be noted that the shape of distribution is generally quite similar although for a number of streams, the median flow often deviates somewhat from that indicated by the long-term records. This trend is due to the deviation of rainfall, during the period of collection, from normal rainfall as established by long-term

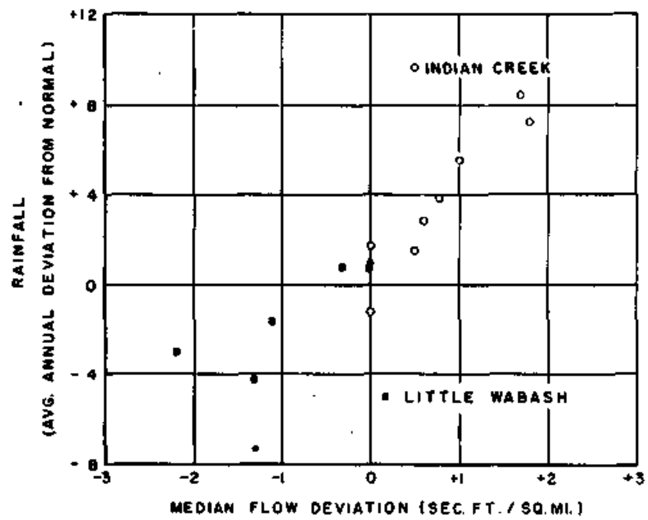

FIGURE 2 RELATION OF DEVIATION IN RAINFALL FROM NORMAL TO DEVIATION IN MEDIAN STREAM FLOW FROM NORMAL

records. From Figure 2, it appears that the deviations in flow are directly associated with deviations in rainfall during the sampling periods. Close examination of the duration curves, which do not appear to be in line with most of the records, have indicated that, for instance at Indian Creek, the high flows as well as the low flows during the sample period were very much above normal, although the median flow was not. Also, the small deviation of the median flow at the Little Wabash sampling point does not reflect the more extensive deviations during the high and low periods. This general relationship with rainfall concerns only over-all averages and medians and is therefore no more than indicative of a trend.

HYDROLOGIC AND PHYSIOGRAPHIC RELATIONS

Relation of Quality to Stream Flow

Although the probability distribution curves for quality appear to be related to the stream flow by this manner of presentation, this trend is true only in a general sense. The higher concentrations of turbidity and the higher discharge rates do occur in general at about the same time and with similar frequency. However, the corresponding turbidities and flow rates are not necessarily at identical frequencies, as indicated by data for the Little Wabash River (Fig. 3). Also, it will be noted that

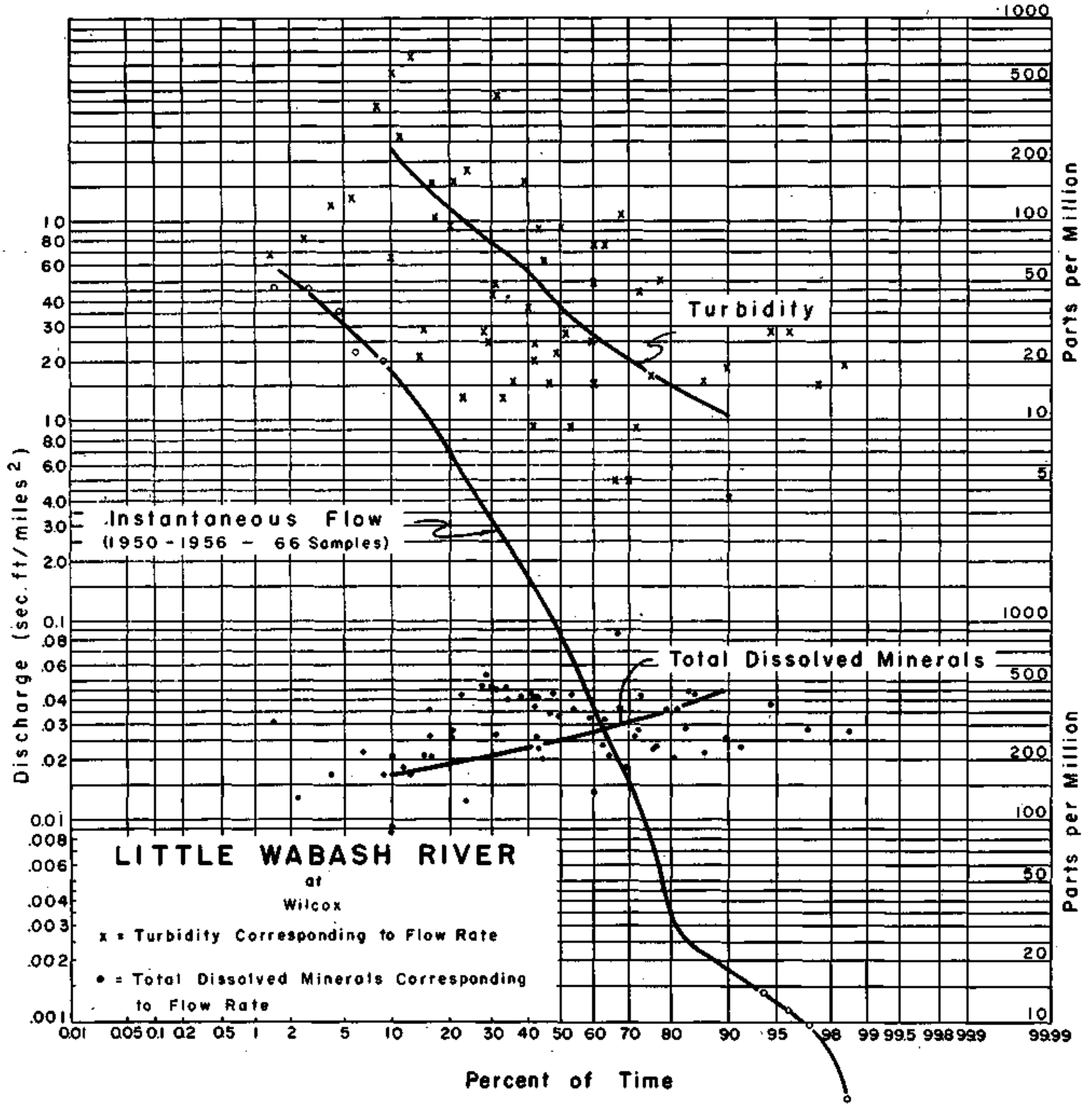

FIGURE 3 CORRESPONDING RECORDED TURBIDITY AND DISSOLVED MINERALS TO RECORDED FLOW RATE FOR LITTLE WABASH RIVER

the total dissolved minerals, as indicated, as well as the alkalinity and hardness are not directly related to the corresponding flow rates. Here again, the relation is general and not specific. In other words, a measure of the total mineral content is not an exact indicator of the flow rate, nor is the flow rate a specific indicator of the mineral content that may be present at the time. It should, of course, be obvious that this specificity is not to be expected, owing to the many variables concerned with the mineral quality of any water and with stream flow.

Relation of Watershed Area and Physiography

It was recognized, upon inspection of the data, that for the streams as a whole, there was little or no relation between watershed size and variability in stream flow or water quality. This trend is divergent from the general conception that variability of stream flow is related to watershed area, but it is not incompatible. It may be considered normal for stream flow and quality to be more highly variable near the source than downstream since 1) for increasingly small watersheds, there is greater probability for less rainfall and runoff, 2) there is less probability for sustained ground-water contribution from small watersheds than from large watersheds, and 3) tributaries tend to become integrated and equalize the flows and qualities. A large tributary, however, can markedly change the flow and quality of water in the main stream.

For the Illinois watersheds of 37 to 5,220 square miles discussed here, area size appears to have so little influence that it must be considered inconsequential. The flow and quality obtained from the source of each tributary, as well as for the integrated main stream, must be dependent on the physiography of the respective watershed. The recorded data for the streams have been compared on this basis.

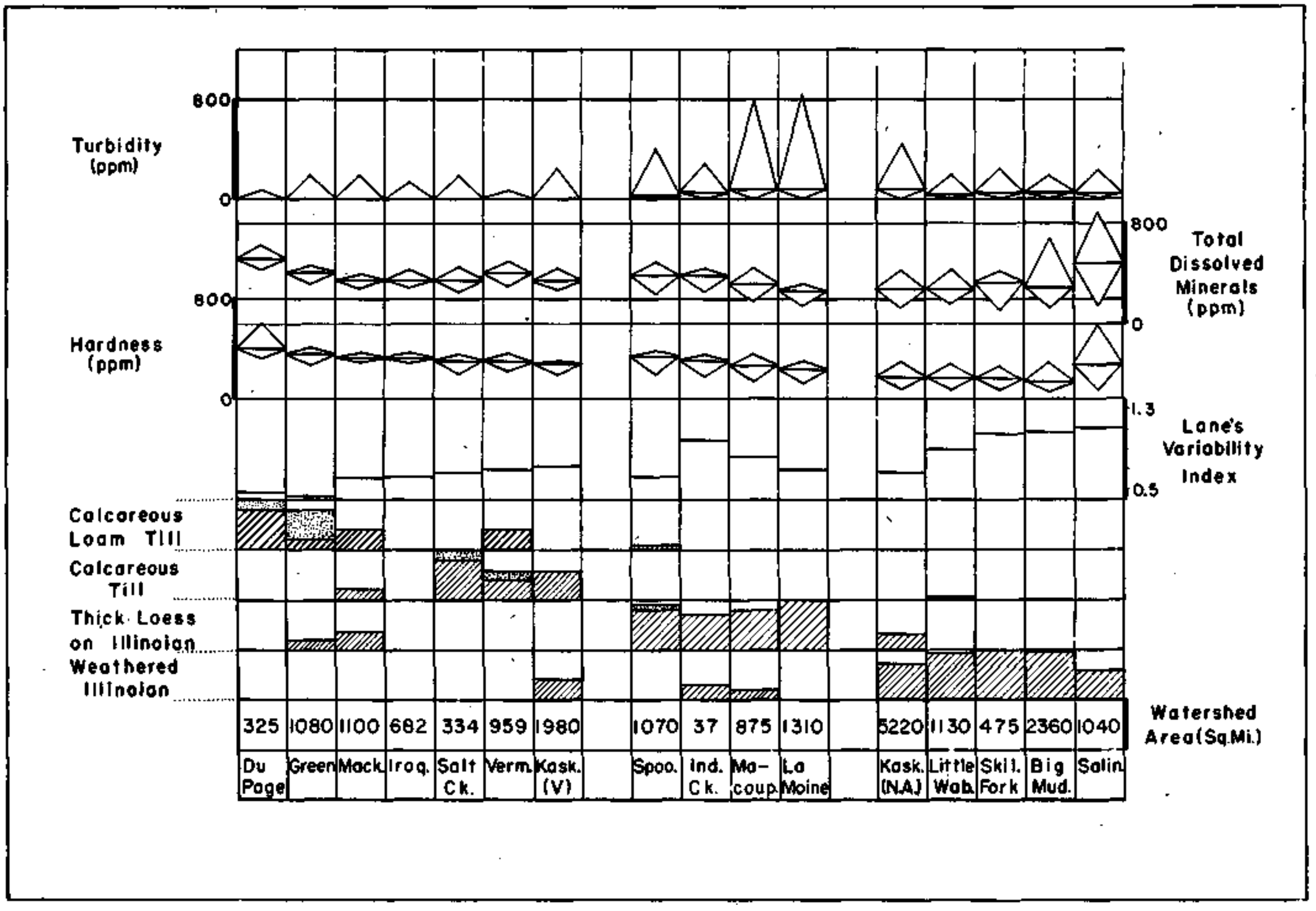

FIGURE 4 RELATION OF WATER QUALITY TO WATERSHED AREA AND PHYSIOGRAPHY

Figure 4 shows for each internal stream, the watershed areas and the general soil classifications as published by the University of Illinois Agronomy Department,[4] Lane's variability index^ calculated for each stream from long-term daily flow records, the hardness, total dissolved minerals, and turbidity. The data for hardness, minerals, and turbidity are ranked according to the median, and the lower and upper 10 per cent values of the determinations. Estimates of the percentage of soil classifications in each watershed were made by overlaying each watershed on the soil association map. These estimates were grouped according to the dominate parent material and are listed in Table 2. Where appreciable outwash, terrace and lake bed sediments (Soil Association R) were evident, this area percentage was included with the surrounding parent material.

The watersheds were then listed in the order of:

1. Calcareous loam till of Wisconsin glacial under 0-3 feet of loess (C, D, E, F, and R)
2. Calcareous till of Wisconsin glacial age under 0-5 feet of loess (H, I and R)
3. Weathered till of Illinoian glacial age under 5-9 feet of loess (J, K, L, M, and R)
4. Weathered till of thin Illinoian glacial age under 0-5 feet of loess (N, 0, P)

TABLE 2

PERCENTAGE ESTIMATES OF PRINCIPAL SOIL CLASSIFICATIONS IN EACH WATERSHED

	Wisconsin		Illinois		Outwash	Acid Soils
Soil Association	CDEF	HI	JKLM	NOP	X	Z
Du Page River	90				10	
Green River	25		15		60	
Iroquois River	--	--	--	--	--	--
Mackinaw River	35	30	35			
Salt Creek	5	80			15	
Kaskaskia River (Vandalia)		60		40		
Vermilion River	40	40			20	
Spoon River	10		80		10	
Indian Creek			75	25		
Macoupin Creek			85	15		
La Moine River			55	45		
Kaskaskia River (New Athens)		35		60		5
Little Wabash River		5		95		
Skillet Fork				100		
Big Muddy River				85		15
Saline River				60		30

These physiographic classifications are indicated in Figure 4 with data on stream flow, turbidity and mineral quality.

Northern Illinois. The variability in stream flow is low in northern Illinois streams, such as the Du Page and Green Rivers, where physiographic conditions are conducive to high underground storage capacity and contribution of ground water to sustain stream flow during low flow periods. This same physiography is responsible for the relatively low variability in mineral content and composition. The soil classifications indicate that the subsoil of the watersheds is calcareous glacial till of Wisconsin age. Ground waters are very hard and surface runoff is also exposed to the richly mineralized soil of recent glacial origin.

Central Illinois. Farther south in the lower two-thirds of the Wisconsin glacial area, a trend exists toward a somewhat greater variability in stream flow with lesser ground-water contribution for the Mackinaw, Iroquois, Salt, Vermilion, and upper Kaskaskia streams.

Soil classifications indicate a somewhat thicker loess of 0-5 feet on calcareous till subsoil. The lesser ground-water contribution results in a slight, general decrease in hardness toward the southern end of the Wisconsin glacial boundary.

Southern Illinois. Continuing southward through the area where the Wisconsin glacial deposits are absent, the physiography dictates greater variability of stream flow. The lower Kaskaskia at New Athens is influenced by the contributions from the Wisconsin drift in the upper third of its watershed above Shelbyville. The variability in flow for the other streams increases from the Little Wabash to the Skillet Fork, the Big Muddy, and Saline Rivers.

Soil classifications show a weathered till subsoil of the older Illinoian glacial period. The subsoils are of very fine texture and are permeated very slowly. Thus, the subsoil ground-water contributions are negligible, and in fact the available ground-water is virtually non-existent toward the southern end of the state.

Greater variability in mineral composition is evident in these streams, and a general decrease in hardness is noted. Bedrock seepage may be a factor in mineralization. At least one flowing salt well is known to exist in the Saline watershed. This well and others may contribute to the high mineral content and hardness. Since the character of the mineralization in these streams is also highly variable, occasional high mineralization in the Big Muddy as well as the Saline may also be due to mine wastes or brine spills at the oil fields.

Western Illinois. In the western part of the state, although there is no general trend, the variability of flow and the mineral composition may be considered as intermediate between the results observed in the Wisconsin glacial watersheds of the north and the thin leached Illinoian watersheds in the south. Thick loess of 5 to more than 8 feet covers weathered Illinoian or Kansan till.

It is notable that a greater turbidity is evident particularly from the La Moine, Macoupin and Spoon River watersheds. By way of postulation this turbidity may be attributed to the recognized thick loess deposits often exceeding 8 feet in this western part of the state. The high turbidities are also noted to a lesser extent in the Kaskaskia waters nearby, particularly at New Athens.

From the standpoint of treatment, turbidity is of appreciable significance to the water plant operator. From the standpoint of reservoir sedimentation, however, turbidity which is determined empirically by the *transmittance of light,* is not considered as significant as suspended solids. Suspended solids are determined as the *weight* of the suspended matter in the water. It is entirely possible that the suspended solids in the waters of the western part of the state are no greater than elsewhere but are more finely divided and are, therefore, more resistant to the passage of light.

Crab Orchard Lake. The samples collected at two points in Crab Orchard Lake (Figs. 47, 48) are of related interest in the physiographic correlation. The data illustrate that 1) the relatively low dissolved minerals are a result of a watershed with 30 per cent consisting of thin loess on thin weathered glacial deposit and 70 per cent thin loess on bedrock, 2) a low variability in quality due to blending by storage, and 3) a low proportion of alkalinity in the dissolved minerals. The latter may possibly be due in part to mine drainage.

The low mineral content of surface waters from watersheds in the unglaciated area in extreme southern Illinois has been further demonstrated by isolated samples from Lake Glendale, which has a watershed of less than two square miles consisting entirely of thin loess on bedrock. These samples and others from ponds in the vicinity were noted to have a total dissolved mineral content of 50-70 ppm.

These observations tend, therefore, to complete the range of quality—from waters of relatively high mineral content and hardness from areas of recent glacial origin in northern Illinois to waters of very low mineral content from areas of no glaciation in southern Illinois. There are notable divergences resulting from thick loess deposits on the western side of the state and from brine spills, acid mine wastes, and flowing salt wells in other isolated areas.

As a result of the relation established between quality and dominant parent material in the soil associations, the quality of waters from other watersheds may be estimated.

ANALYTICAL METHODS

All analyses were made according to Standard Methods of Water Analysis, 9th Edition. [6] All samples were carbonated with dry ice prior to filtration and analysis. In general, the following selected procedures were used.

Determination	Symbol	Procedure
Iron	Fe	Ortho phenanthroline (colorimetric)
Manganese	Mn	Periodate (colorimetric)
Boron	B	Carmine (colorimetric)
Fluoride	F	Scott-Sanchis (colorimetric)
Calcium	Ca	Permanganate titration (volumetric)
Magnesium	Mg	Pyrophosphate (gravimetric)
Ammonium	NH_4	Distillation and Nessleriation (colorimetric)
Sodium	Na	by difference
Silica	SiO_2	Molybdate (colorimetric)
Chloride	Cl	Mohr (volumetric)
Nitrate	NO_3	Reduction distillation and Nessleriation (colorimetric)
Sulphate	SO_4	Barium Sulfate (gravimetric)
Alkalinity	(as $CaCO_3$)	Methyl Orange (volumetric)
Hardness	(as $CaCO_3$)	by calculation
Total dissolved minerals	TDM	by conductivity (gravimetric)

No results on taste and order are reported.

The results are expressed in parts per million (ppm), a term which refers to pounds per million pounds of water, or grams per 1000 liters of water, or milligrams per liter. Such results can be converted by grains per gallon (gpg) by dividing by the factor 17.2. The parts per million results can be converted to equivalents per million (milliequivalents per liter) by dividing by the equivalent weight of the particular ion.

The results for hardness and alkalinity are expressed in equivalent terms of calcium carbonate (as $CaCO_3$). Since the pH of nearly all samples was less than eight, no carbonate alkalinity existed and alkalinity represents a measure of the bicarbonate ion concentration (as CaCO,). Non-carbonate hardness (as CaCO,) can be calculated by subtracting alkalinity from hardness.

Boron was not determined on samples collected before 1954. Fluorides were seldom determined before 1952.

SIGNIFICANCE OF MINERALS

The importance of water quality is presented in the following discussion which indicates the significance of each of the chemical determinations mentioned in the report.

Turbidity

Turbidity is an empirical measure of insoluble particles, such as clay, silt, or microscopic organisms, which are suspended in water and interfere with light transmission. It is not synonymous or equivalent to a gravimetric measurement of "suspended matter."

The Public Health Service Drinking Water Standards[7] state that the turbidity of water shall not exceed 10 ppm. One or two ppm may be detected by eye in a glass of water. All public water supplies in Illinois from rivers or reservoirs are filtered to remove turbidity and improve the effectiveness of disinfection.

Total Dissolved Minerals

The "total dissolved minerals" represents the dissolved mineral matter in the sample, as determined by evaporation of a filtered sample or by multiplying the specific conductivity at 25°C by an empirical conversion factor of 0.564.

Dissolved mineral ingredients in water originate by the solution of the chloride, nitrate, sulfate, and carbonate salts of calcium, magnesium, ammonium, and sodium. However, in solution, the component parts of each salt exist in the water as separate entities and bear no relation to the original combination.

Water with a high mineral content may have a salty or brackish taste of an intensity which depends on the concentration and the kind of minerals in solution. The Public Health Service Drinking Water Standards[7] state that water should not contain more than 500 ppm total dissolved minerals, but if such water is not. available 1000 ppm may be permitted. A mineralization of 1000 ppm can be faintly tasted. Several municipalities in Illinois use waters of 1500 to 2000 ppm dissolved minerals. Waters of 3000 and 4000 ppm can hardly be called palatable, and at 5000 or 6000 ppm, even livestock do not do very well although they can survive. At about 12,000 ppm or 1.2 per cent, the water is injurious and would cause death if used continuously. Sea water contains 3.4 per cent dissolved minerals. In the range of 500 to 2000 ppm, the taste factor is one to which the public may become accustomed to such a point that if a change from 1500 ppm to 500 ppm water is experienced it would again become necesrsary to become accustomed to the 500 ppm water.

In water that is heated, certain minerals become less soluble and form a scale or sludge. Continuous passage (not recirculation) of water through a closed heating unit will cause an accumulation of the deposition. On evaporation of water by exposure in an open container or dripping faucet, drinking fountain, cooling tower or tea kettle, the mineral content increases proportionally to the evaporation and exceeds its solubility to the point where it deposits as a scale. Some combinations of ingredients are less soluble and deposit before others.

Hardness

Hard water is caused primarily by the presence of calcium and magnesium in the water. The distinction between hard and soft water is a relative one. Municipalities accustomed to water of 250 ppm consider Lake Michigan water (130 ppm) to be soft, whereas municipalities supplied by softened water of 50 to 75 ppm hardness consider Lake Michigan water to be hard. In turn, individuals, who are accustomed to home zeolite-softened water of 0 to 10 ppm hardness or to rain water, consider 50 to 75 ppm to be classed as hard water.

The effects of hard water are numerous and very few are advantageous. Hard water is responsible for the formation of scale in boilers and hot water heaters. The formation of scale due to hardness results from the fact that the solubility of the calcium carbonate and sulfate salts and of magnesium hydroxide is greatly lowered at increased temperatures.

If an appreciable proportion of the hardness is non-carbonate hardness, the scale will be very hard and difficult to remove. If little or none of the hardness is non-carbonate, that is, if all of the hardness is present as carbonate hardness, the scale will be soft and sludgy. In either case, the scale formed in furnace coils or in hot water coils is a distinct nuisance, and may reduce the rate of heat transfer to such an extent that the metal can become burned by over-heating.

Chemical treatment of water used in boilers for the production of steam and power is a common practice and is, in most cases, an economic necessity.

The effect of hard water on soap and soap products is well known to everyone. The insoluble calcium and magnesium soaps which are formed with hard water combine with the dirt removed from the laundry, redepositing it on the clothes causing a gray rather than clean white appearance. Dishes and glassware rinsed in hard water show an accumulating white deposit which can be unsanitary as well as unsightly. Hair washed and rinsed with hard water becomes sticky and stiff.

Highly mineralized water of 2000 ppm or more total dissolved minerals, although soft with respect to calcium and magnesium content, often behaves as hard water when soap is used for washing or laundry purposes. The salt content prevents sufficient solution of soap to provide an effective cleaning concentration.

The State Water Survey in conjunction with the University of Illinois conducted a survey of soap consumption in four municipalities in 1929.[8] The results were published in 1930 and the following table indicates the cost and the pounds of soap used per capita at these municipalities. This table also indicates the average cost of soap products in 1947 which was about 80 per cent greater than in 1930.

City	Total Hardness of Water Supply	Annual per Capita Soap Consumption	Annual per Capita Cost of Soap, Year 1930	1947
	ppm	pounds	dollars	
Superior, Wisconsin	45	29.23	3.75	6.75
Bloomington, Illinois	70	32.13	4.48	8.06
Urbana-Champaign, Illinois	298	39.89	5.98	10.67
Chicago Heights, Illinois	555	45.78	7.50	13.50

Municipal softening of hard water from 300 ppm to 90 ppm costs approximately 65 cents to a dollar per capita per year. Home water-softeners which can reduce the hardness to zero for a supply having a hardness of 300 ppm, may vary in cost from 7 to 15 dollars per capita per year, depending on the proportion of water softened.

The introduction of, synthetic detergents has been highly beneficial for use with most hard waters. Such detergents have a distinct advantage over soaps in that they do not form an insoluble scum with the minerals in hard water, hence none is wasted. However, no synthetic detergent has been devised which has universal application, both from the standpoint of water quality and from the standpoint of purpose of use.

Iron and Manganese

Iron and manganese are determined on unfiltered samples, and the results therefore represent the total iron in the sample including that which may be a portion of the clay or soil turbidity. There is no accurate method of distinguishing between the natural, dissolved iron and that resulting from the presence of suspended matter in shipped samples.

The presence of 0.3 ppm iron and manganese is sufficient to cause staining. For river supplies, iron and manganese are usually removed by the coagulation and filtration required for turbidity removal.

Nitrates

Excessive nitrate concentrations in water may cause "blue babies" when such water is used in the preparation of infant feeding formulas. Serious cases of methemoglobinemea in adults have also been attributed to this. An upper safe limit has tentatively been set at 44 ppm (as NO,) by the National Research Council.[10] At least one supply in Illinois, however, contains more than 80 ppm and has been in use for a number of years with no reported difficulty. This subject is under constant consideration by the State Department of Public Health.

Chloride and Sulfate

The presence of high chloride and sulfate concentrations is a direct indication of high total dissolved minerals. Chloride and sulfate salts are generally quite soluble in water at normal temperatures, although the solubility of calcium sulfate at temperatures approaching boiling reduces to the point where all of the calcium and sulfate are not compatible in solution. The incompatibility of calcium and sulfate at elevated temperatures is not as great as the incompatibility of calcium and carbonate.

High chloride and/or sulfate in waters of high mineral content is responsible for greater electrical conductivity. This in turn enhances corrosive properties of water, particularly with respect to iron when coupled with copper-bearing metals.

Chlorides are detectable by taste when present in concentrations of 400 to 500 ppm.

Alkalinity

Alkalinity is a measure of bicarbonate salts. In most waters in Illinois, the alkalinity is in the range of 200 to 400 ppm, and in general is associated with 20 to 50 ppm free carbon dioxide. The free carbon dioxide is usually present in an amount no more than necessary to maintain the solubility of calcium in these waters.

Alkalinity in ground-waters is responsible for the presence and formation of carbonates which, being incompatible with calcium in water, forms a precipitate of lime or calcium carbonate upon heating. The change from bicarbonate to carbonate takes place on loss of carbon dioxide. Such loss occurs when free carbon dioxide in the water escapes to the air either on standing, exposed to air, or when the temperature is elevated, thereby driving out the free carbon dioxide in the water.

Waters softened by zeolite will produce excessive quantities of carbon dioxide in steam and the corrosion resulting therefrom can be a major problem in condensate return lines. The removal of carbon dioxide by aeration is of limited benefit for almost all Illinois waters since the removal of some carbon dioxide only causes the formation of an additional quantity of free carbon dioxide by the conversion of bicarbonates to carbonates and free carbon dioxide.

Alkalinity to Total Dissolved Minerals

Alkalinity, a measure of bicarbonate salts, is considered a mild inhibitor to corrosion whereas chloride and sulfate salts are considered corrosion accelerators. The ratio of alkalinity to total dissolved minerals serves as a basic indicator of corrosivity which may be modified by the quantitative presence of scale-forming constituents such as calcium. The calcium carbonate solubility balance is established by control of pH, a measure of hydrogen ion concentration.

As a general rule, water of low ratio, 0.9-0.7, would be increasingly corrosive and water of a ratio of 0.6 or less, severely corrosive.

Dissolved oxygen, a gas present in all normal river waters is a corrosive agent. Its removal, if economical, would further reduce the corrosivity of any corrosive water.

The presence of calcium is an inhibitor and its solubility in a water of a given alkalinity is governed or controlled by pH adjustment. The closer the approach to or slight excess of its limited solubility, the greater the inhibition that might be expected. For a highly inhibited water, high velocity improves inhibition, whereas for a relatively corrosive water, high velocity increases corrosion. Increase in temperature decreases solubility of calcium in waters of alkalinity above 500-100 ppm.

Irrigation

The United States Salinity Laboratory[11] classifies water suitability for irrigation purposes according to four hazards: salinity, sodium, boron, bicarbonate. The salinity and the sodium hazards are given first consideration with boron and other toxic ingredients as contributing factors. The limiting concentrations are for general guidance. Rainfall, drought, drainage, and crop and management practices must be considered.

Total Dissolved Minerals (Salinity). A water with total dissolved minerals of less than about 150 ppm can be used for irrigation for most crops on most soils, whereas a water of 1500 ppm total dissolved minerals is not suitable for irrigation under ordinary conditions. No water reported in this publication appears to correspond to the latter classification.

Sodium. It is reported[11] that the sodium adsorption ratio is more significant for interpreting water quality than per cent sodium since it is related more directly to adsorptions of sodium by the soil. It can be calculated by converting ppm to epm (milliequivalents per liter) and dividing 1.4 epm sodium by the square root of epm hardness. Roughly this is equal to 1.4 (TDM minus hardness) in ppm divided by the square root of the hardness in ppm. The low sodium waters having a ratio less than 10 can be used on almost all soils whereas a very high sodium water with a ratio greater than 26 is generally unsatisfactory for irrigation.

Boron. The degree to which boron is a hazard to plant growth is dependent on the sensitivity of various crops, shown in Table 3. Limits ranging from excellent to unsuitable have been prepared for crops which are sensitive, semi-tolerant, and tolerant. Of all the samples analysed for boron, only rare exceptions indicated a concentration in in excess of 0.3 ppm.

TABLE 3

PERMISSIBLE LIMITS (ppm) OF BORON IN IRRIGATION WATERS

Grade	Sensitive Crops	Semitolerant Crops	Tolerant Crops
Excellent	0.00-0.33	0.00-0.67	0.00-1.00
Good	0.33-0.67	0.67-1.33	1.00-2.00
Permissible	0.67-1.00	1.33-2.00	2.00-3.00
Doubtful	1.00-1.25	2.00-2.50	3.00-3.75
Unsuitable	over 1.25	over 2.50	over 3.75

Bicarbonate. When bicarbonate is present in water used for irrigation, it causes soils to become alkaline as a result of that portion of the total bicarbonate concentration which might combine with sodium on evaporation of the water. The sodium carbonate residue resulting from evaporation is alkaline, as evaporation approaches the point where the sodium carbonate is dry, and likewise when a slight amount of moisture or dew causes re-solution of the sodium carbonate.

A standard calculation is made in water analysis for the carbonate and non-carbonate hardness. The non-carbonate hardness is calculated by subtracting the alkalinity, a measure of bicarbonate ions, from the hardness, a measure of the sum of the calcium and magnesium ions — both of which are expressed (as $CaCO_3$).

All hardness up to and equivalent to the alkalinity is carbonate hardness. All hardness in excess of an equivalent of alkalinity is non-carbonate hardness. If the alkalinity exceeds the hardness, the negative non-carbonate hardness, as obtained by subtracting the hardness from the alkalinity to calculate the non-carbonate hardness, is sodium alkalinity or sodium carbonate as obtained in the residue by evaporation of the water.

Therefore, the greater the sodium alkalinity, the greater the tendency for soil to become alkaline. The sodium alkalinity is equivalent to the common calculation of negative non-carbonate hardness. It is this sodium alkalinity, or residual sodium carbonate after calcium and magnesium carbonate have been, precipitated, that is the limiting-portion of the bicarbonate concentration in irrigation water or significant in water quality for irrigation.

Water Treatment

Water from any of the sources described in this report can be treated for any specific use, the cost and amortization being the controlling economic factors. No discussion will be entered here on limits and treatments for various uses since the range is wide within each particular field or industry.

SAMPLING ASPECTS

To evaluate the sampling program and the data collected, it is necessary to submit the data to statistical analysis. Two questions, of many that may be asked, are paramount. How well do the samples for the period of collection represent the water quality at the sampling station during the period of observation, and how well does the sampling period represent the long-term range of variability of the stream flow? An approach to these questions, posed of necessity by the sampling plan, is made in this section of the report.

Although it is shown in this section that the sampling program adequately represents the long-term time-distribution of the stream flow and that the median quality represents, with reasonable accuracy, the true value, it has been indicated elsewhere (p. 16) that there is no specific relation between stream flow and the mineral quality

Introduction

Knowledge of variables is based primarily on a portion from the aggregate of all possible samples over an infinite period of time.* In statistical analysis, sampling generally denotes a plan of repeated action in obtaining a portion of the aggregate. The mathematical model, selected for a repetitious operation in the selection of portions, is designed to permit predictions about the frequency with which certain results can be expected.

The frequency of the repetitious operation depends to a considerable extent upon the variance of the aggregate and the degree of accuracy which will be acceptable and is limited by the cost of the operation. Furthermore, the sampling plan should be designed and administered so as to produce an unbiased estimate of the parameters of the aggregate.

Statistical theory and experience has provided several sampling plans for consideration. Among these, random, stratified random, and systematic will be discussed briefly.

A *random* sampling procedure permits the selection of a number of observations out of the total aggregate in a manner that allows each observation an equal chance of being chosen. This plan is good unless the investigator has reason to believe the aggregate may be composed of sub-groups.

*This expression is used in this report to represent "population" or 'universe" as normally used in statistical literature.

In case the aggregate is composed of sub-groups, a purely random sample may be misleading since chance can allow unequal weight to be given to the various groups. This weakness can be alleviated by dividing the aggregate into homogeneous groups and obtaining a random portion* of observations from each group. This is a *stratified random* sampling plan.

In a *systematic* sampling plan, the first observation is chosen at random from the first "k" items and every k*th* item thereafter is automatically designated to complete the observations. Since this sampling plan in which one observation is selected from each group, in effect introduces a stratification into the aggregate, it might be expected to approach the precision of a stratified random sampling plan with one random observation per group. The differance lies in the fact that the systematic plan selects observations from the same relative position within each group, whereas the stratified random plan selects a random observation within each group.

In an investigation of stream flow and water quality, it is reasonable to expect that a seasonal variation could be present. Consequently, stratified random and systematic sampling plans would be preferred over a random plan.

For this investigation, one observation per month was chosen as regularly as possible during the sampling period to represent the aggregate. This sampling plan probably resembles both the stratified random sampling plan with one observation chosen somewhat at random within each month and a systematic sampling plan with one observation per month.

TABLE 4

ALKALINITY OBSERVATIONS AT SALT CREEK
Data in Parts per Million

	Water Year				
Month	1950-1951	1951-1952	1952-1953	1953-1954	Sum
10	268	268	300	280	1116
11	308	140	320	304	1072
12	280	276	276	288	1120
1	204	268	240	320	1032
2	44	244	208	232	728
3	236	172	160	272	840
4	220	204	212	204	840
5	169*	180	88	264	701
6	256	256	195*	88	795
7	260	284	252	292	1088
8	270	280	256	180	986
9	283*	284	316	272	1155
Sum	2798	2856	2823	2996	11473
Avg.	233.2	238.0	235.2	249.7	239

* estimated values

*The term "portion" is used for the statistical "sample" in order to avoid confusion with the use of sample in chemical analysis.

Significance of Number of Observations

Mineral Quality. An evaluation of the sample obtained in the monthly sampling for water quality is illustrated with the alkalinity observations for four water years at Rowell, Illinois on Salt Creek. Since there were too many missing observations in the fifth year, only four years of records were used. The data are presented in Table 4.

A reliable estimate of the average of concentrations of specific mineral ingredients in streams is the primary purpose of sampling for water quality. Users of the analytical data base their operations on the average values and make suitable allowances in design for variations from the average. A reliable index for predicting immediate changes in quality is not known at present, but it is of interest to know the frequency of deviations of various magnitude from the average. Therefore, an estimate of the variability of water quality would also be pertinent.

Evidence of whether the quality varies significantly from year to year and within a year can be obtained from an analysis of variance (variation). Prior to performing an analysis of variance, a test of normality should be made. A coefficient of skewness, g, a measure of conformity to the normal distribution, was computed by the following equation:

$$g = \frac{(X - \bar{x})^3}{Ns^3} \qquad (1)$$

where X is an individual alkalinity observation, x is the average, N is the total number of observations, and s is the standard deviation of the observations. The computed coefficient for this example of Salt Creek at Rowell was -0.12. The small negative value for g indicates there is a slight excess in the number of items greater than x. If g had been zero, symmetry would have been demonstrated. Since g was not zero, a test of significance was made to determine evidence as to whether the skewness coefficient is greater than expected in random sampling of normally distributed aggregates. The t-test is applicable in this test of significance. The t-value is computed from the following formula:

$$t = g/s_g \qquad (2)$$

where s_g is the standard error for the skewness coefficient and is determined by:

$$s_g = \sqrt{6N(N-1) / (N-2)(N+1)(N+2)} \qquad (3)$$

Application of formulas (2) and (3) gives a t-value of 0.40 which is not significant because it is considerably less than the 1.96 which would be required for significance at the 95 per cent confidence level.

A summary of the analysis of variance is presented in Table 5. The ratio of mean square for years and mean square for error and the ratio for months and error are 0.18 and 1.94 respectively. These "F" ratios are not significant since they are less than required for significance at the 95 per cent confidence level. On the basis of this analysis it is concluded that the alkalinity observations varied at random about their mean of 239 during the four year sampling period.

TABLE 5

ANALYSIS OF VARIANCE OF ALKALINITY OBSERVATIONS

Source of Variation	Deg. of Freedom	Sum Square	Mean Square	F Ratio
Total	44*	182,265		
Years	3	1,954	651	.18
Months	11	74,874	6,807	1.94
Error	30	105,437	3,515	

* Three degrees of freedom were deducted from a total of 47 for the three estimates in Table 4.

The manner in which the observations were collected resembled a stratified random sampling plan. By arbitrarily placing two successive months together to form separate groups in this plan, it is possible to consider the plan as a stratified random plan with two observations from each group. This permits estimation of variation within groups. However, it should be noted that the selection of two observations for each group was not strictly random since the observation times were subject to the convenience of the observer.

An estimate of the variance for a stratified random sample was computed for each year as well as for all four years. On the basis of the analysis of variance it seemed reasonable to suppose that the variance has the same value in all groups. A pooled estimate of this common variance was computed from the following formula:

$$s^2 = \frac{\sum_{j=1}^{m} \sum_{i=1}^{n_k} (y_{ij} - \bar{y}_j)^2}{n - m} \qquad (4)$$

where s^2 is the sample variance, y_{ij} is the *ith* observation in the *jth* group, $\bar{y}_j$ is the average of the observations in the *jth* group, n_k is the number of observations in the *jth* group, n is the total number of observations and m is the number of groups. Standard deviations (square root of the variance) are presented in column 2, Table 6, for each water year and for several longer periods of time.

TABLE 6

STANDARD DEVIATIONS AND ESTIMATED NUMBER OF OBSERVATIONS REQUIRED FOR 5 PER CENT ACCURACY FOR THE MEAN VALUE WITH 95 PER CENT CONFIDENCE LEVEL

Period	Standard Deviation (s)	Total Observations (n_e)	Observations per group
1950-51	62.6	157	26.2
1951-52	44.9	78	13.0
1952-53	46.7	88	14.5
1953-54	63.6	164	27.3
1950-52	54.0	94	7.8
1950-53	51.7	80	4.4
1950-54	54.9	87	3.6
5 years	54.9	85	2.8
7 years	54.9	83	2.0
10 years	54.9	81	1.4

An estimate of the total number of observations, that would be required for estimating the true mean alkalinity with ±5 per cent can be computed from the following formula:

$$n_e = \frac{t^2}{d^2} \sum \left[\frac{\left(\frac{N_m}{N}\right)^2 s^2}{\frac{n_m}{n}} \right] \qquad (5)$$

where t is the value of the normal deviate corresponding to the desired confidence probability, d is the absolute value of the arbitrarily chosen error which the investigator is willing to accept, the ratio N /N is the proportion of the total aggregate of days included in each group, i.e. 60/365 for a one year period.

The ratio n_m/n is the proportion of the total number of observations which was taken from each group, i.e., 2/12 for a one year period, and s is the pooled estimate of the variance. In the application of the above formula, a value of 12 for d (approximately 5 per cent of 239) and values of t for the 95 per cent confidence level were substituted. The formula yielded n_e values in column three of Table 6.

The estimated number of samples per groups of two months is listed in the last column of the table. It will be noted that sampling over an increasing period of time requires fewer observations per month. The estimate of four observations per group for 5 per cent accuracy is twice as many as were taken in the investigation.

Using the four year mean and variance, the number of observations required over periods of five, seven and ten years was computed and shown in the last two rows of Table 3. The computations suggest that a seven year sampling period with one observation per month would be required to obtain an alkalinity mean value accurate to 5 per cent.

The error to be expected with the 53 observations at Rowell over a five year period can be approached by substituting 53 for n_e in (5) and computing d. This computation suggests an error of approximately 15 parts per million or 6.3 per cent.

Stream Flow

Some idea of the accuracy of the instantaneous observations of stream flow can be obtained from a comparison of die single instantaneous stream flow with the corresponding mean daily stream flow. . Theoretically, the *instantaneous flow observations* should deviate at random about the *mean daily values,* that is, the average of the instantaneous observations should be a good estimate of the average of the corresponding daily mean flows. A graphical comparison of the instantaneous flow with the daily mean flow (Figure 5) suggests the above reasoning is accurate and that the deviations are small.

These graphs suggest that the flow duration curve from instantaneous observations should be representative of the curve constructed from mean daily flows except for high flow periods. It may be further inferred, in view of the general stability of daily stream flow, that the sample duration curve is a good estimate of the daily mean flow curve from the total number of daily observations.

The above hypothesis was examined for the Salt Creek watershed. A coefficient of variation of 5.04 for the instantaneous flow observations suggested that the actual flow values were considerably skewed and therefore not normally distributed. The flow observations were transformed to logarithms since it has been generally recognized that logarithms of stream flows have a tendency to be normally distributed. The coefficient of skewness for the logarithms was computed by equation (1), where X in this case is a logarithm of an individual flow observation, and s is the standard deviation of the logarithm of flow. -The computed value for g was +0.34. The positive value for g indicates there is still an excess in the number of items less than x.

Application of formulas (2) and (3), however, gives a t-value of 1.04 which is considerably less than 1.96 which is required for significance at the 95 percent level and well within the realm of chance variation. For practical purposes the logarithm of stream flow in Salt Creek can be regarded as normally distributed.

The line of best fit on the log-probability scale is established by the antilogarithm of average logarithmic flow at 50 per cent occurrence and the antilogarithm of the logarithmic flow at one standard deviation (34 per cent) on either side of the median. The line through these points is theoretically the best estimate of the desired frequency relation. Probability curves were determined in this mariner for the five water years 1950 through 1955 from 53 daily mean flow values, and from all the population of daily mean flow values. These three lines are shown in Figure 5. Data points for the instantaneous and corresponding daily mean flows are also shown. Confidence lines are based on the instantaneous flow curve.

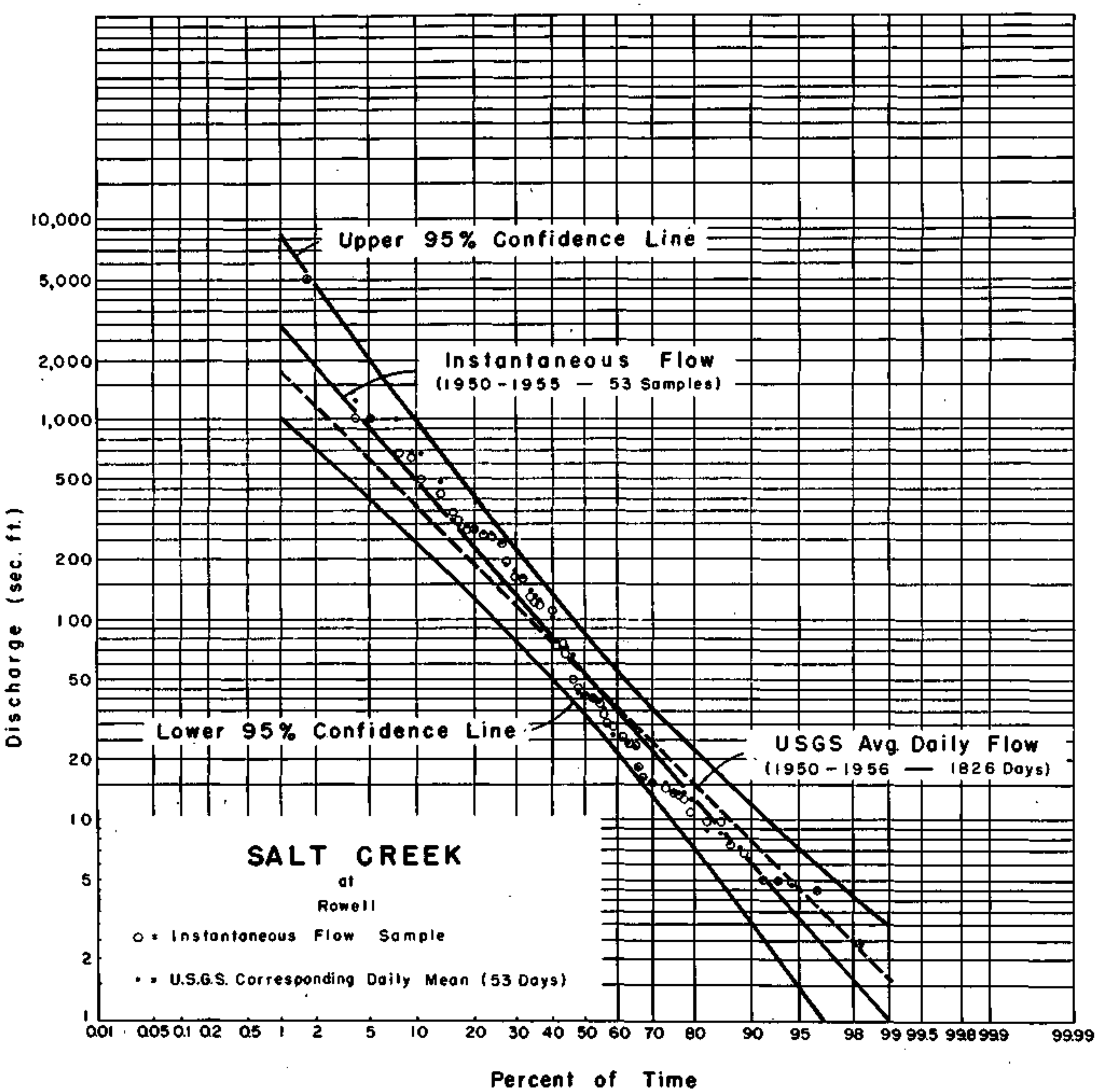

FIGURE 5 CONFIDENCE LIMITS FOR INSTANTANEOUS FLOW BASED ON DAILY MEAN FLOW RECORDS

For the period of October 1, 1950, to September 30, 1955, it appears that the instantaneous flow observations permit the construction of a representative probability curve. The assumption of the logarithmic-probability distribution should be more justified over a longer period of time since a severe drought began in June of 1952 and extended through the winter of 1956. Many small flow values associated with the drought are a factor in the positive skewness of the data.

It is evident from Figure 5 that the instantaneous curve was an excellent estimate of the corresponding mean daily curve, as was mentioned earlier in the discussion. However, these curves deviate considerably from that established from 1826 daily observations during the same period. Although this deviation is not significant at the median flow it is appreciable at high and low flow frequencies.

Retrospect

The preceding examples of representative accuracy only begin to cover the range of evaluations which could be applied to the tabulated Appendix. Time and available funds, however, limit this important phase of study at this time.

Of particular interest is the design of an adequate water sampling program. This design must be approached from the standpoint of being representative of long-term data on stream flow and from the standpoint of accuracy in representation of the mean and variability of mineral quality. Both have been partially evaluated for the data obtained at one stream. Certain inadequacies have been noted for both. The extent to which greater precision is necessary or desired is perhaps open to question and is certainly limited by economics.

Median Accuracy. With one sample per month from Salt Creek at Rowell, it was shown that seven years of stratified random sampling would be necessary for a 5 per cent accuracy in the median alkalinity. An equivalent accuracy could have been obtained by 81 stratified samples in 10 years or 85 in five years. On the other hand, for the 53 samples collected (seven missing) over a five-year period, an estimated accuracy of 6.3 per cent was obtained. If no samples were missing, the accuracy may have been estimated as 5.9 per cent. If sampling were limited to four years, the accuracy would be 6.6 per cent. With the controlling basis of one sample per month, it would appear that accuracy is improved from 6.6 to 5.9 per cent by extending the sampling program by 20 per cent from 4 years to 5 years, and from 5.9 to 5.0 per cent by further extending the program by 40 per cent from five to seven years.

In view of the noted influence of deviations from normal rainfall (Figure 2) on the median flow for the instantaneous samples, there is further question of the need or desirability for either a more frequent or an extended sampling program unless it approaches that for long term gaging stations.

Variability. The accuracy of the median value, however, does not represent the accuracy of the variability of the quality. Further treatment of this phase of the program result is necessary.

Further treatment of the data for the other streams is also necessary since the calculated accuracy of the median value of alkalinity for Salt Creek may not be representative of that which might be calculated for the Green River where the stream flow as well as the mineral quality are less variable than for Salt Creek. Nor may the calculated accuracy be representative for the southern streams, Big Muddy, Skillet Fork, and Saline, where both stream flow and quality are very highly variable.

Skewness. The statistical treatment is further complicated by the following observation. Data for alkalinity at Salt Creek were found to conform to the normal distribution, i.e. the variability was similar for values above the median and below the median. However, this was not found to be true for the instantaneous or the average daily flow measurements. It was necessary to convert the flow data to logarithms in order that the effect of skewness be eliminated and thus permit further computation on accuracy.

Preliminary computations on hardness at Salt Creek also indicate the presence of skewness of the observed values about the mean. Converting these values to their respective logarithms did not eliminate this non-conformity as with the stream flow. This complication dictates that additional study will be necessary to eliminate the effects of skewness before computations on accuracy can be made.

Summary. There is need for evaluation of sampling programs, and the very preliminary approach presented here shows methods by which it could be accomplished. A true evaluation of any quality data should first demand a well planned sampling program and include a final summary of the perennial accuracy of median values as well as of the variations noted from these median values.

It should be a pertinent part of the collection of such data to make periodic calculations during the period of collection to determine the point where considerable additional sampling and analysis will but slightly improve the accuracy.

With due respect to the inadequacies of the sampling program and evaluation thereof, the immediate value of publishing the available data takes precedence in this publication.

SUMMARIES OF DATA

The following summaries for each sampling point provide a description of the watershed, its area, and the elevation of the gage zero. Deviations from normal rainfall are indicated for the period of collection. Discharge and quality data are summarized and depicted graphically.

The summaries are arranged in the order of bordering rivers, and internally from north to south in accord with the physiographic features as discussed for Figure 4.

MISSISSIPPI RIVER AT THEBES

The Mississippi River drainage area upstream from Cairo, near Thebes, includes 43,410 square miles of area in Illinois. The Mississippi forms the Illinois-Iowa and the Illinois-Missouri borders, and most of the primary streams in Illinois empty into it. The elevation of the gage zero at Thebes is 299.93 feet above mean sea level (1929 adjustment) and the total drainage area at Thebes is 717,200 square miles.

In the northern part of the Mississippi basin, the earlier formations are covered by sheets of unconsolidated material brought from the north by the ice sheets that invaded this territory during the latter part of the glacial period. The line bordering the southern limit of these deposits of sand, gravel, and clay runs through the northern part of Montana east and then south across the Dakotas, follows the Missouri River across Missouri, and crosses the Mississippi River near St. Louis. It includes nearly all of Illinois, crosses Indiana, Ohio, and takes in a small corner of northwestern Pennsylvania. A small section in southwestern Wisconsin, northwestern Illinois, and southeastern Minnesota has no drift covering. In Indiana, Ohio, Illinois, and eastern and southern Wisconsin, the drift is mostly derived from limestone and, therefore, partakes the essential characteristics of lime rock. In northern Minnesota, Iowa, and Missouri a similar condition is found. In northern Wisconsin and eastern Minnesota, on the other hand, the drift is derived mostly from crystalline rocks and, therefore, partakes the essential characteristics of quartzites and similar rocks. The western fringe through northern Montana and the Dakotas is derived partly from cretaceous material, that is, limestone and calcareous shales which contain more soluble material than the eastern limestone.

The long-term flow data for the Mississippi River at Thebes are not included in this report inasmuch as duration curves had not been previously prepared. The U. S. Geological Survey at St. Louis has unpublished daily discharge data for Thebes available for the period April 1941 to September 1955.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 6 and 7.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 0.5 sec ft per sq mi and was not less than 0.1 sec ft per sq mi with a median flow of 0.18 sec ft per sq mi. The minimum average daily flow of record was 45,000 sec ft on February 6, 1951.

The turbidity was not less than 55 ppm and not more than 750 ppm for the central 80 per cent of the time, with a median of 240 ppm. This compares with a median turbidity of 700 ppm in 1906-07 on 36 ten-day composites of daily samples collected at Chester.

The reported temperature was over 80°F for 10 per cent and over 70°F for 40 per cent of the time. It was below 50°F for 40 per cent and below 40°F for less than 10 per cent of the time.

The following table indicates maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	45	120	215
Hardness (as $CaCO_3$)	ppm	85	190	300
Total Dissolved Minerals	ppm	130	290	430

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.5, ranging from 0.42 to 0.55, for the central 80 per cent of the time.

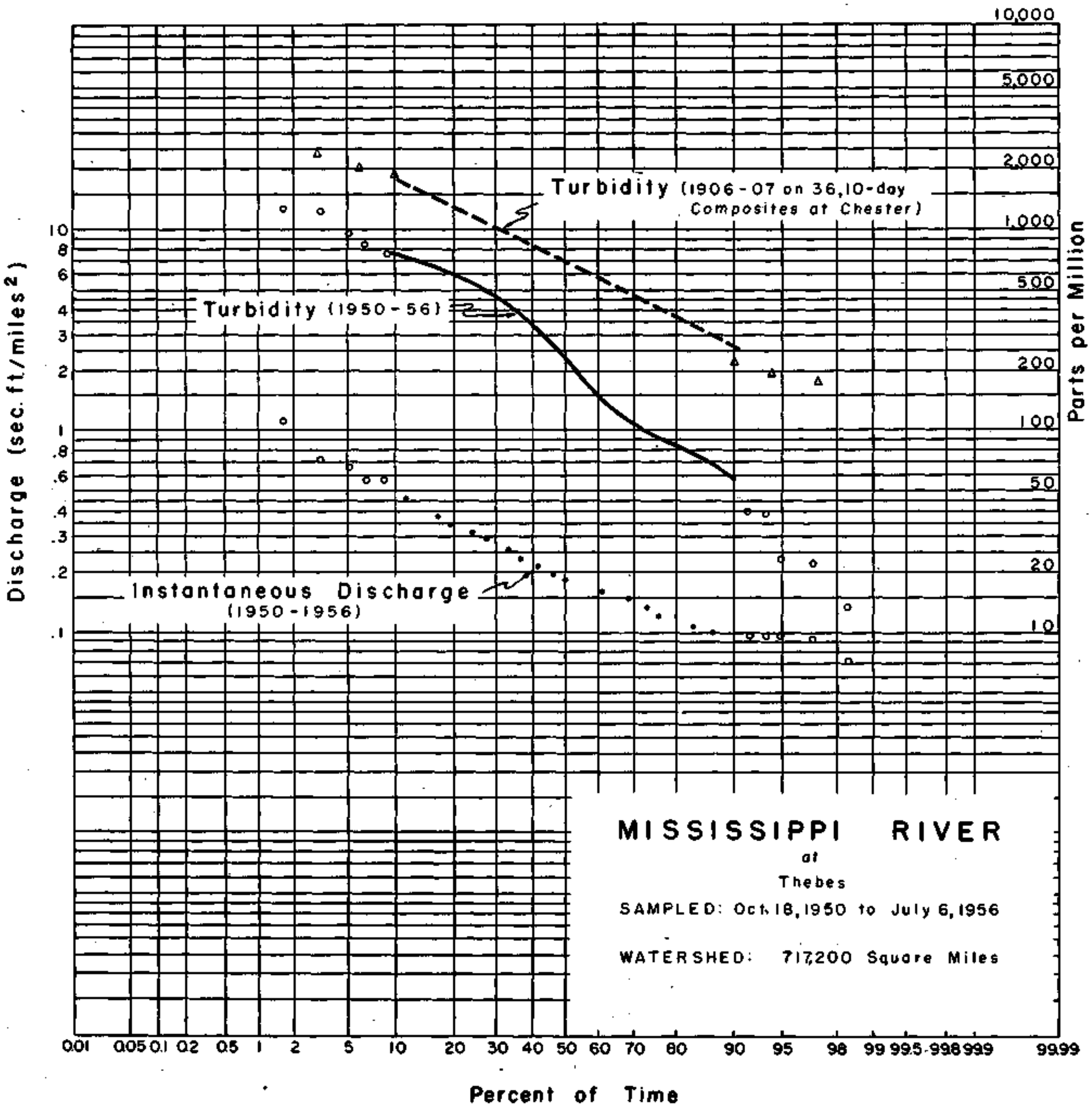

FIGURE 6 MISSISSIPPI RIVER AT THEBES, DISCHARGE

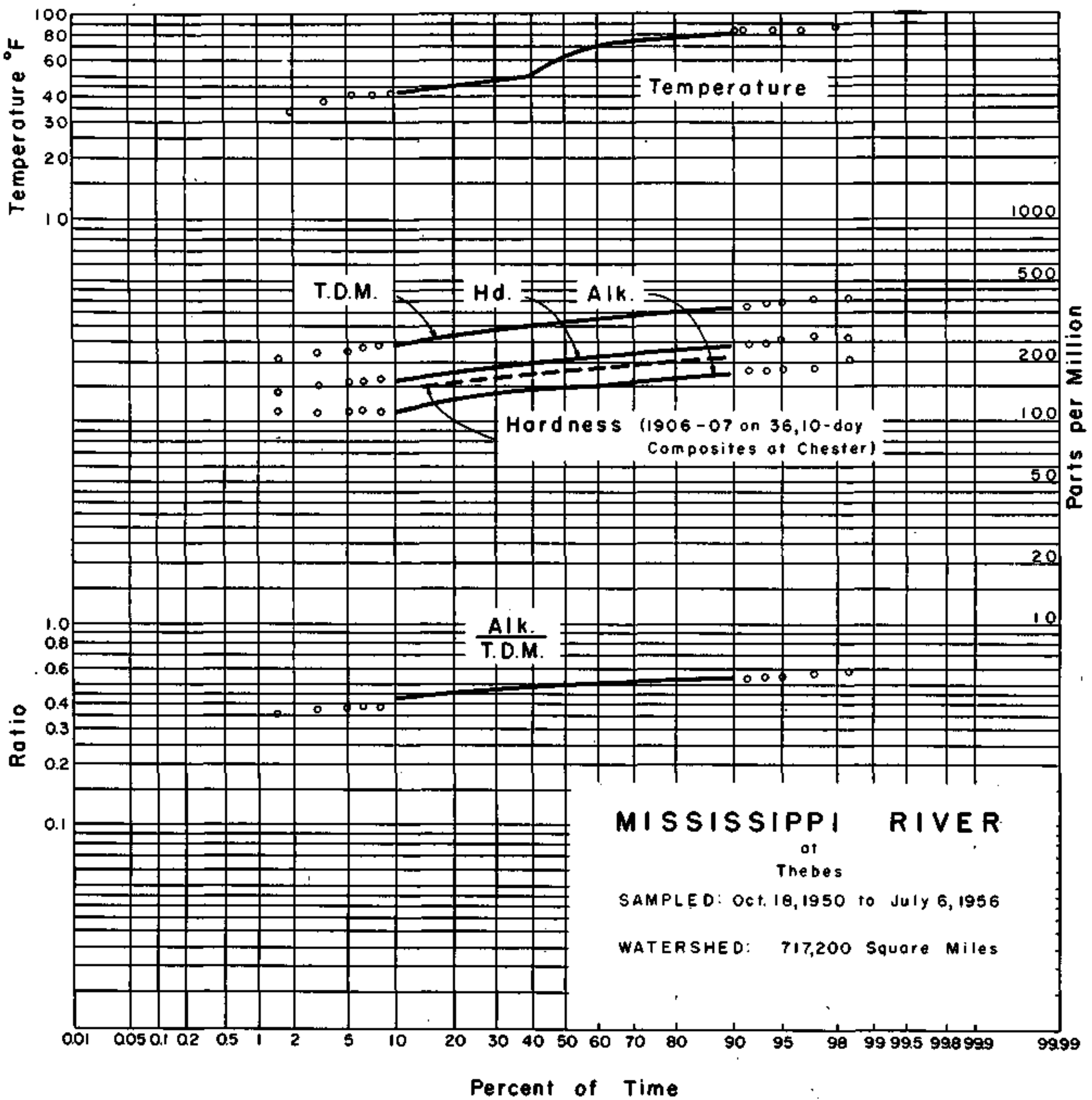

FIGURE 7 MISSISSIPPI RIVER AT THEBES, QUALITY

MISSISSIPPI RIVER AT KEOKUK, IOWA

The drainage area for the Mississippi River [13] upstream from Keokuk is 119,000 square miles and includes Rock River in Illinois, Wisconsin River in Wisconsin, and Cedar River in Iowa. The basin is covered with unconsolidated material deposited by glaciers with the exception of a minor area in northwestern Illinois, southwestern Wisconsin, northeastern Iowa, and southeastern Minnesota where there is no drift covering. The drift is largely derived from limestone, except for the northern Wisconsin and eastern Minnesota area where it is derived mostly from crystalline rocks.

Daily flow data are available for 1940-42 [14] and 1942-50. [15] Records prior to 1940 are now being compiled for publication by the U. S. Geological Survey. The elevation of the gage zero is 477.41 ft above mean sea level. Flow duration curves from long-term data have not been prepared.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 8 and 9.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 1.0 sec ft per sq mi and was not less than 0.22 sec ft per sq mi with a median flow of 0.5 sec ft per sq mi. The minimum average daily flow of record was 5000 sec ft.

The turbidity was not less than 6 ppm and not more than 225 ppm for the central 80 per cent of the time with a median of 35 ppm.

The reported temperature was over 80°F for 10 per cent and over 70°F for 25 per cent of the time. It was below 50°F for 45 per cent and below 40°F for 25 per cent of the time.

The following table indicates maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	100	140	155
Hardness (as $CaCO_3$)	ppm	135	165	190
Total Dissolved Minerals	ppm	165	200	235

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.68, ranging from 0.59 to 0.78, for the central 80 per cent of the time.

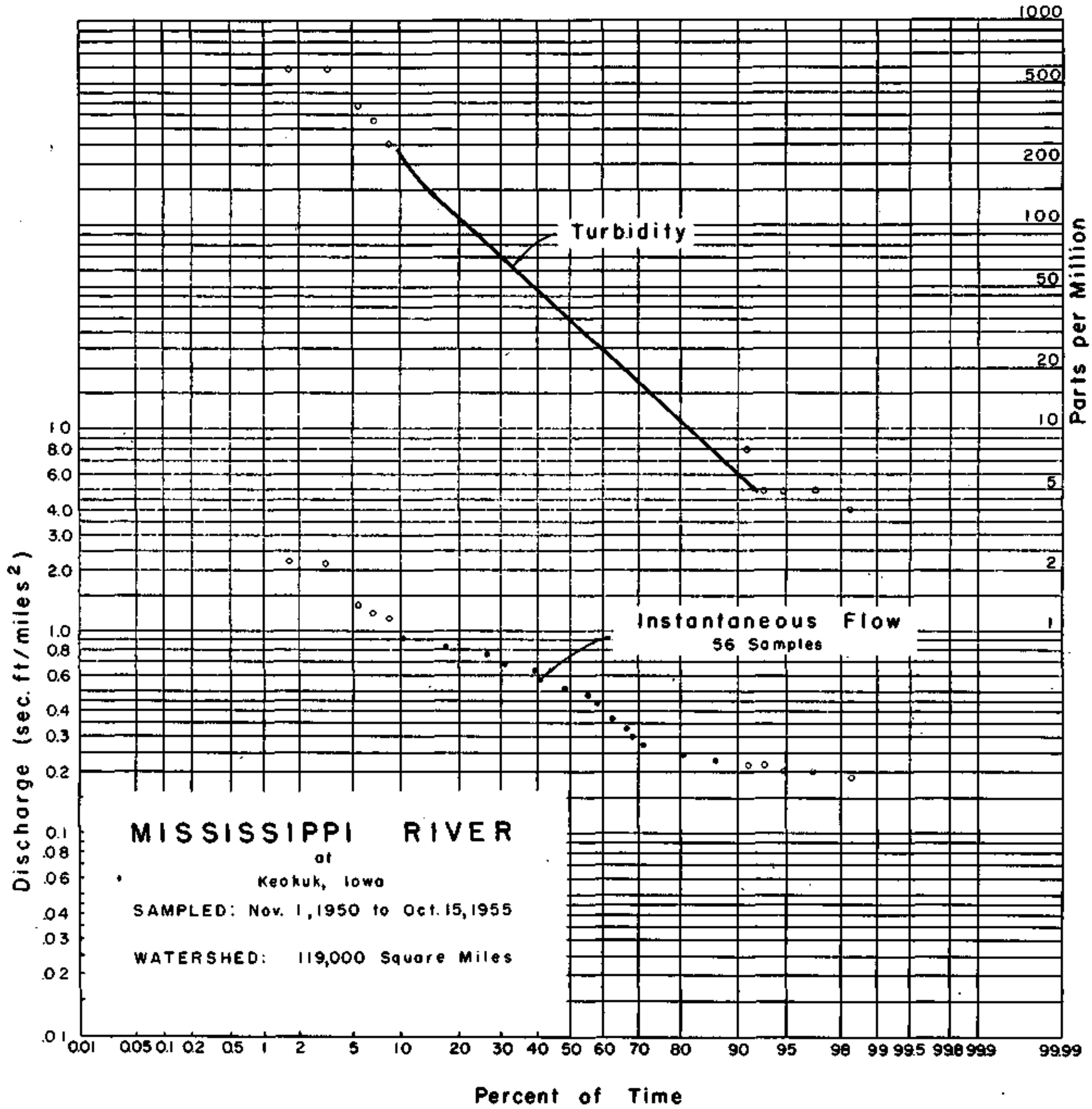

FIGURE 8 MISSISSIPPI RIVER AT KEOKUK, IOWA, DISCHARGE

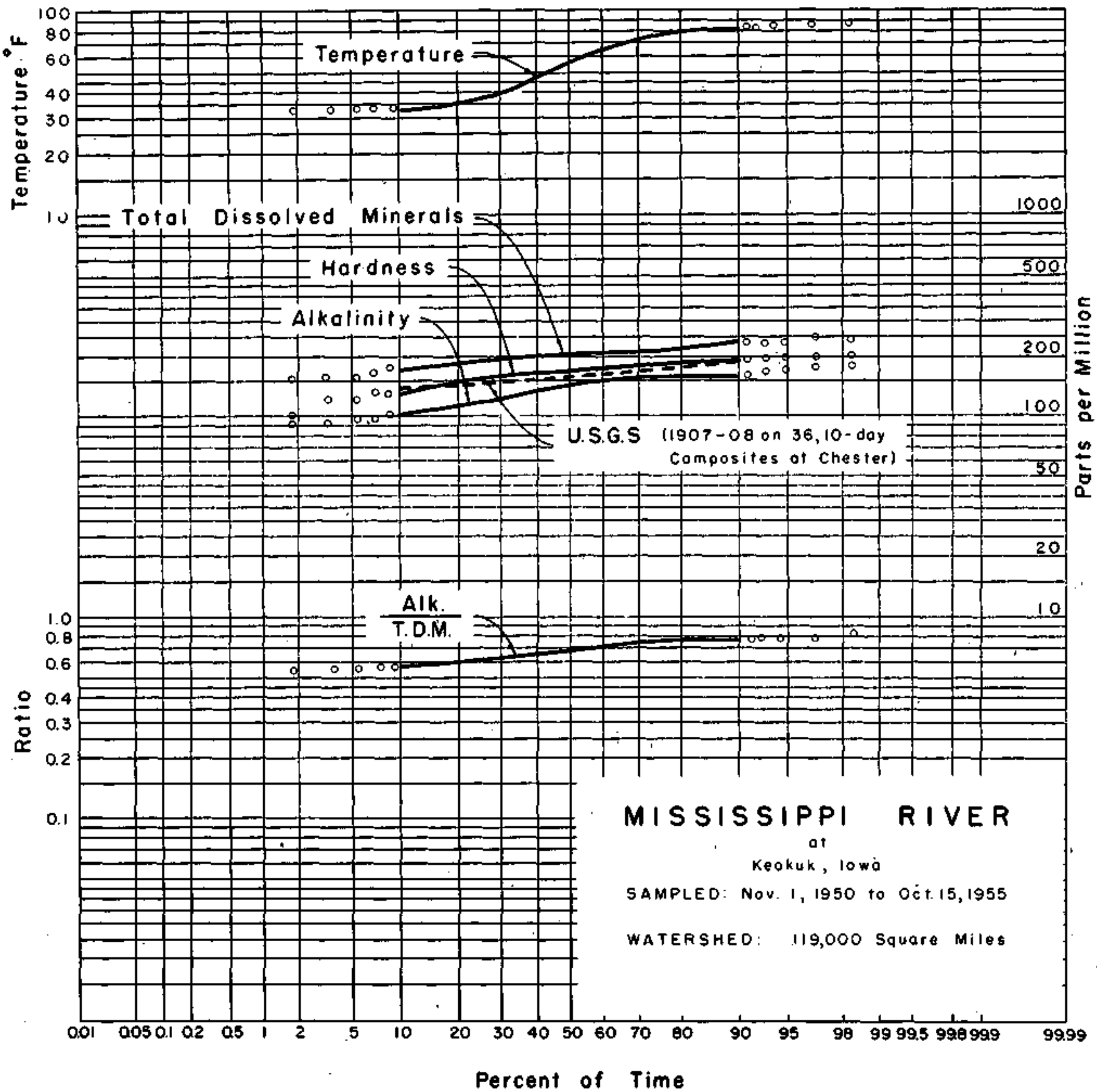

FIGURE 9 MISSISSIPPI RIVER AT KEOKUK, IOWA, QUALITY

OHIO RIVER AT METROPOLIS

Upstream from Metropolis, the Ohio River[16] has a total drainage area of 203,000 square miles, of which 800 square miles drain parts of Hardin, Pope, Johnson, Massac, and Pulaski Counties in Illinois. Its valley is wide throughout, averaging from two to five miles. The elevation of the gage zero at Metropolis is 276.27 feet above mean sea level. For 130 miles, the Ohio River constitutes the Illinois-Kentucky boundary line and flows into the Mississippi River at Cairo, 37 miles downstream from Metropolis.

The three major physical divisions of the basin are the Appalachian Highlands in the east, the Interior Plateau in the southwest and the Interior Plains in the northwest. Limestones and shales are the most common bedrocks of the basin.

Within the Illinois portion of the Ohio River basin, the bottom land soil is mostly light-colored, or a yellow-gray, with non-calcareous subsoil. Inland beyond the bottom lands, are hilly forest, orchard, and pasture soils, particularly in Hardin and Pope Counties, and to a lesser degree, in Massac and Pulaski Counties.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 10 and 11.

Instantaneous flow measurements for samples collected during 1950-56 were reasonably similar to those indicated by the average daily flow records during 1929-45.[17]

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 3.0 sec ft per sq mi and was not less than 0.3 sec ft per sq mi with a median flow of 0.9 sec ft per sq mi. The minimum average daily flow of record was 20,600 sec ft on October 8, 1941.

The turbidity was not less than 7 ppm and not more than 125 ppm for the central 80 per cent of the time, with a median of 25 ppm.

Temperature was not recorded with sufficient frequency to provide an adequate analysis.

The following table indicates maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent 10	50	90
Alkalinity (as $CaCO_3$)	ppm	50	70	95
Hardness (as $CaCO_3$)	ppm	90	120	145
Total Dissolved Minerals	ppm	125	170	210

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.4, ranging from 0.3 to 0.5, for the central 80 per cent of the time.

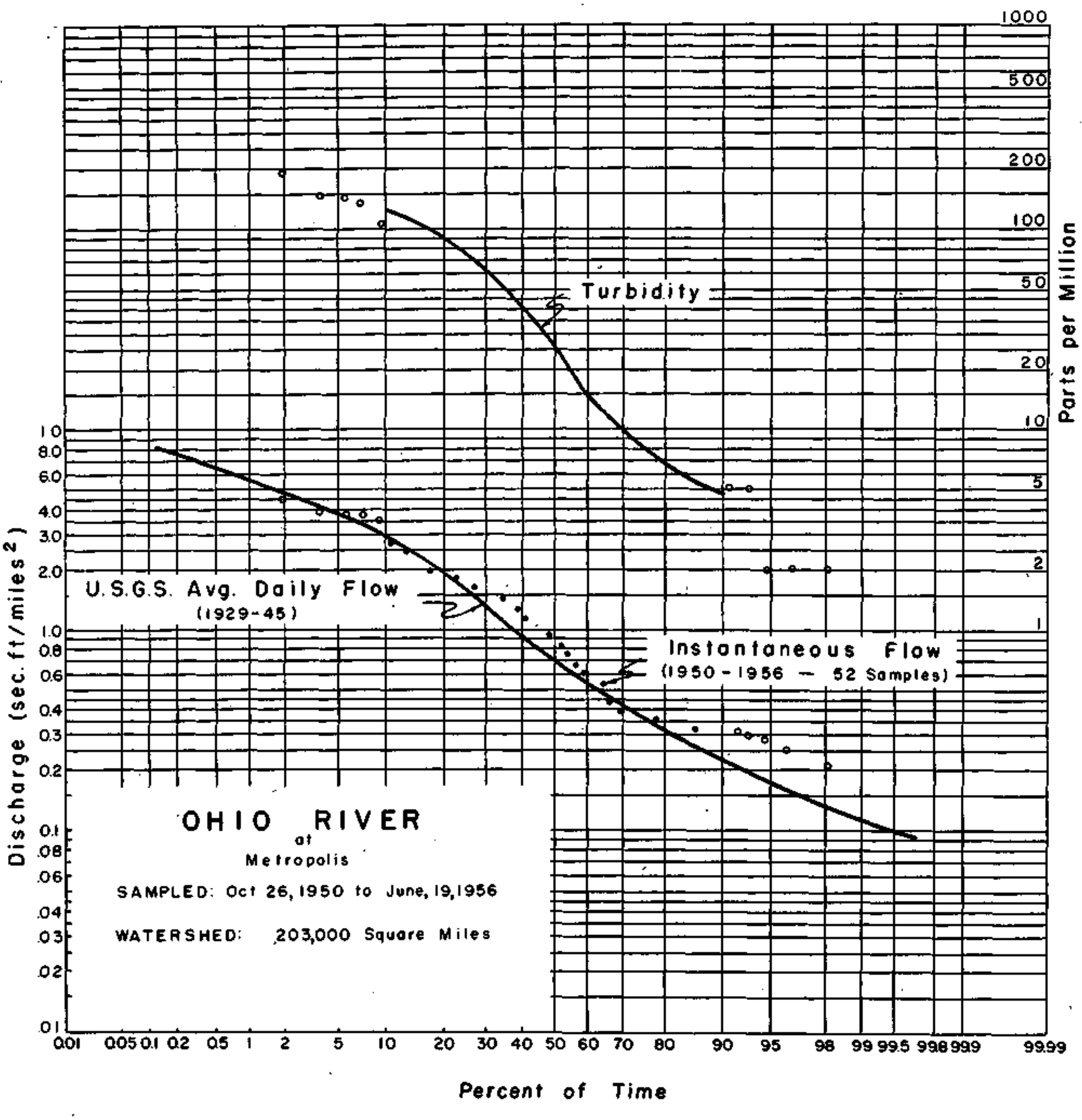

FIGURE 10 OHIO RIVER AT METROPOLIS, DISCHARGE

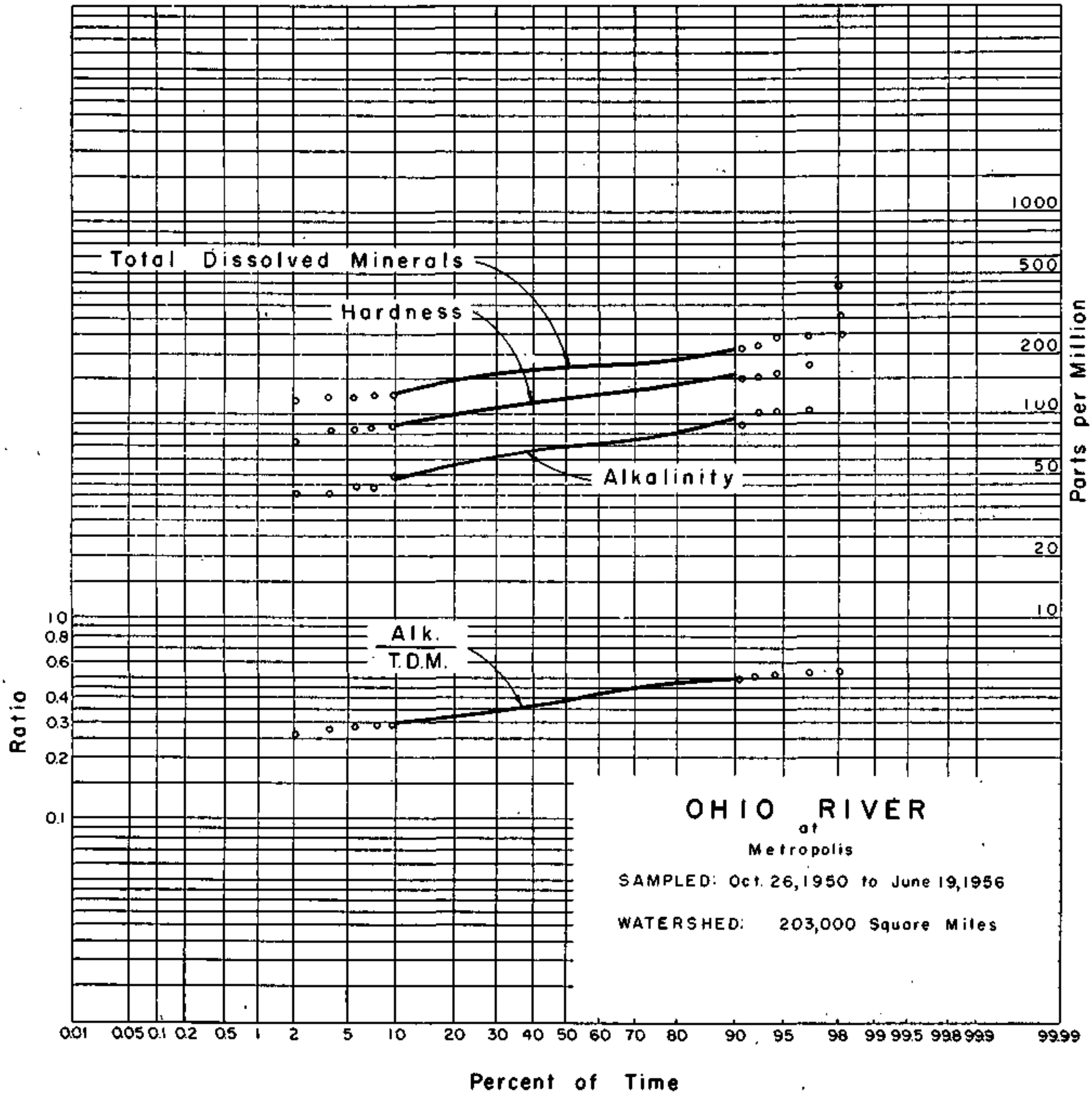

FIGURE 11 OHIO RIVER AT METROPOLIS, QUALITY

WABASH RIVER AT MT. CARMEL

The Wabash River rises in northern Indiana and flows in a southwesterly direction. For 200 miles, its winding course forms the boundary between Illinois and Indiana from Clark County south to a point ten miles north of Shawneetown where it joins the Ohio. Upstream from Mt. Carmel, the Wabash has a total drainage area of 28,600 square miles of which approximately 4,976 square miles are in Illinois

The principal tributaries in Illinois are the Vermilion, Embarrass, and Little Wabash Rivers. The elevation of the gage zero at Mt. Carmel is 371.63 feet above mean sea level.

The valley of the Wabash is several miles wide, with elevations varying from 850 feet above mean sea level in the" extreme north to less than 400 feet in the south.

The whole basin is covered by glacial drift deposits of varying depth. Rock strata immediately underlying the drift are carboniferous except for narrow areas of the Quaternary age which parallel stream beds.

The soil in the northern half is dark, the subsoil varying from a heavy calcareous to an open, non-calcareous composition. There are areas of brownish yellow clay in Vermilion County, around Danville, in the northeast portion of Clark County, the southeast portion of Edgar County, and the southeast portion of Coles County. The soil in the southern half of the basin is almost entirely gray, with an impervious, non-calcareous subsoil.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 12 and 13.

Instantaneous flow measurements for samples collected during 1950-56 were reasonably similar to those indicated by the average daily flow records during 1928-45.[17]

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 2.0 sec ft per sq mi and was not less than 0.14 sec ft per sq mi with a median flow of 0.5 sec ft per sq mi. The minimum average daily flow of record was 1,620 sec ft on September 27, 28, 30, 1941.

The turbidity was not less than 13 ppm and not more than 300 ppm for the central 80 per cent of the time, with a median of 28 ppm.

Temperature was not reported with sufficient frequency to provide an adequate analysis.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	125	180	225
Hardness (as $CaCO_3$)	ppm	165	245	305
Total Dissolved Minerals	ppm	220	305	390

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.57, ranging from. 0.51 to 0.68, for the central 80 per cent of the time.

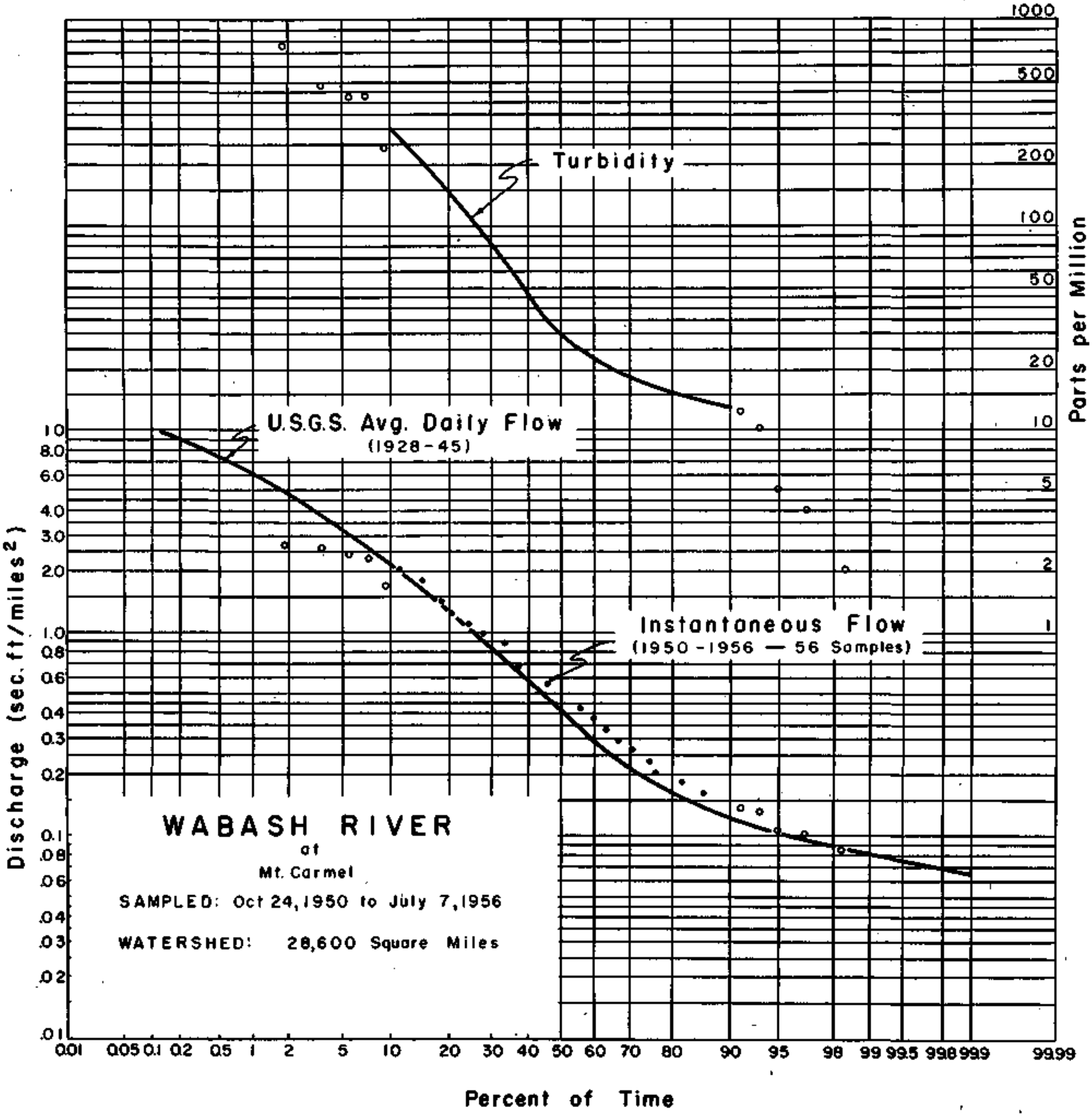

FIGURE 12 WABASH RIVER AT MT. CARMEL, DISCHARGE

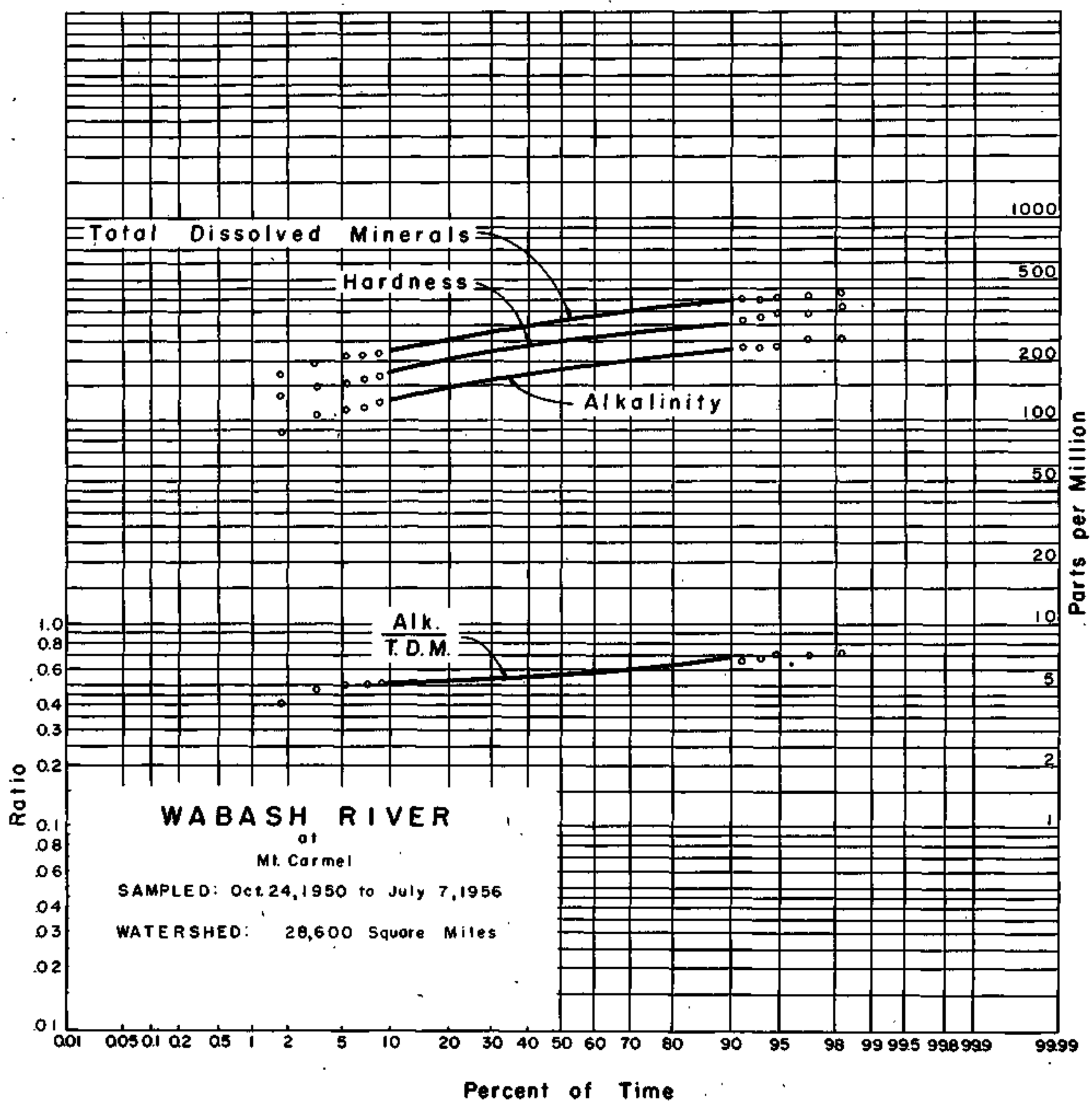

FIGURE 13 WABASH RIVER AT MT. CARMEL, QUALITY

ILLINOIS RIVER AT PEORIA

The Illinois River, the principal stream within the boundaries of Illinois, is formed by the junction of the Kankakee and Des Plaines Rivers in Grundy County. It flows west and then southwest to Meredosia and south to Grafton in Jersey County where it empties into the Mississippi River. The total length of the Illinois River basin from north to south is 385 miles and the total drainage area is 21,910 square miles. This drainage area includes that part of Wisconsin through which the Fox and Des Plaines Rivers flow and that part of Indiana drained by the Kankakee. The principal tributaries of the upper Illinois, that is, above Peoria, include the Vermilion, Fox, Des Plaines, and Kankakee Rivers.

The upper Illinois lies in a glacial valley that was once part of the Mississippi Sea bed, and the basin is characterized by a gently rolling topography. The course of the river is entirely through deposits of Illinoian drift except for about 15 miles between Lemont and Joliet and 40 miles between Morris and Peru, where the rock strata have been eroded. From a line through Harvard, McHenry County, passing about five miles west of Aurora and 15 miles west of Kankakee, the entire eastern portion of the basin is underlain with Silurian rock. A strip of Ordovician rock, approximately five miles wide, parallels this stratum to the west. The upper half of this basin above La Salle is Dolomite and the lower half is Carboniferous limestone and clay, with the east-west portion of the Illinois River roughly forming the dividing line between these two strata. Near Joliet and in the center of the basin, the soil is dark, with a heavy calcareous subsoil, sandy loam, and sand separating these areas. Near Spring Valley, the subsoil is non-calcareous. Above Peoria, the soil is mainly dark with non-calcareous subsoils.

From Ottawa west for about 28 miles, the valley is well defined and is about one and one-half, miles wide. For the next 60 miles, it increases in width from three to six miles and is bordered by rather high bluffs. Below Starved Rock, the Illinois is a slow moving, turbid river with an average fall of less than one-tenth of a foot per mile.

A tabulation of data may be found in the Appendix. The quality data for the period 1945-50 are graphically summarized in Figure 14.

Instantaneous flow records were not obtained at this sampling point at the Upper River Bridge. Average daily flow records are available at Kingston Mines from October 1939 to the present. Average discharge for the 14 years, 1939 to 1952, was 14,560 sec ft.

The turbidity, was not less than 10 ppm and not more than 100 ppm for the central 80 per cent of the time.

The reported temperature was 80°F or more for 10 per cent and over 70°F for 20 per cent of the time. It was below 50°F for 40 per cent and below 40°F for 30 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	115	145	180
Hardness (as $CaCO_3$)	ppm	200	250	300
Total Dissolved Minerals	ppm	275	340	395

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.43, ranging from 0.36 to 0.49, for the central 80 per cent of the time.

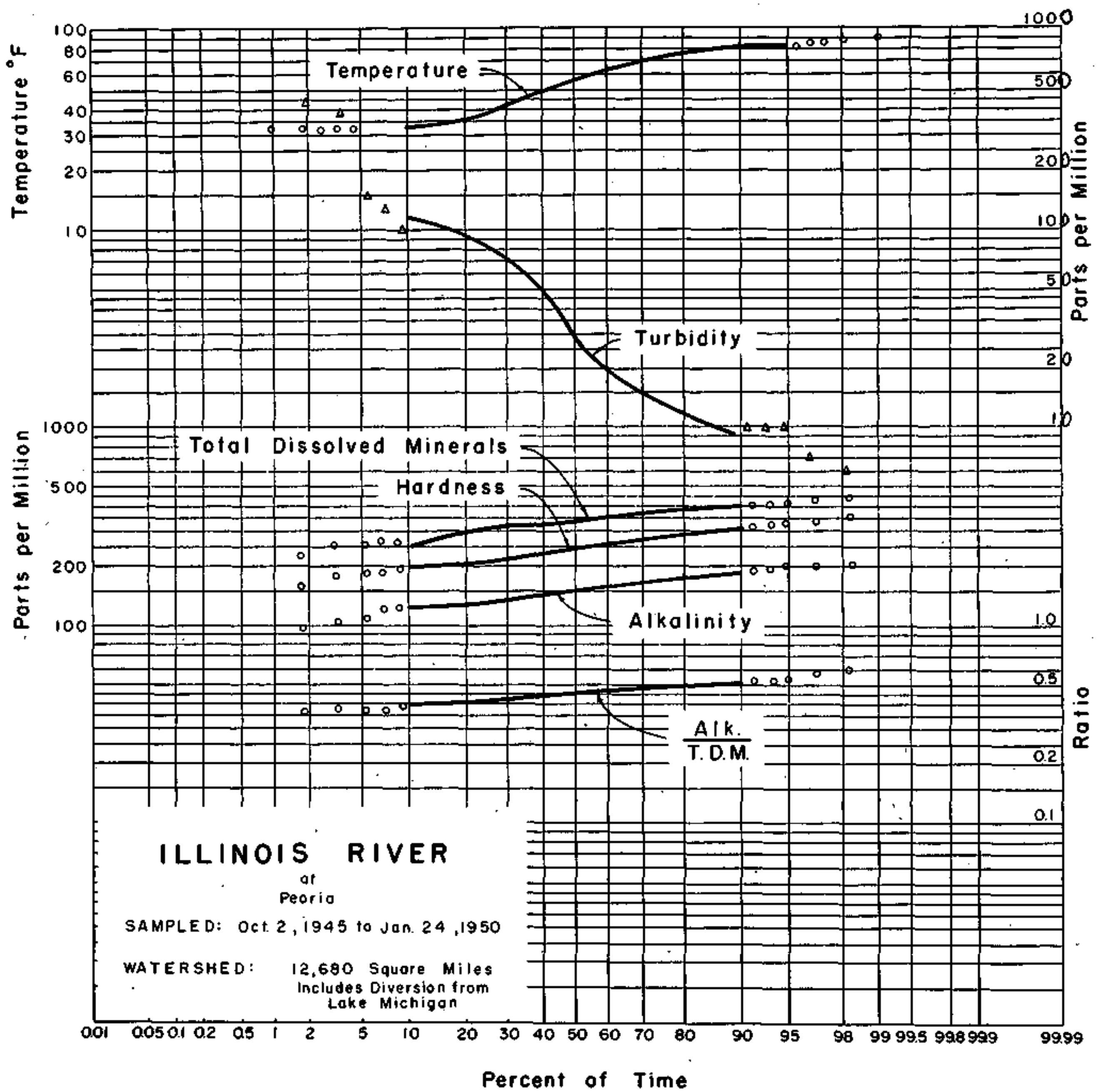

FIGURE 14 ILLINOIS RIVER AT PEORIA, QUALITY

DU PAGE RIVER AT TROY

The Du Page River rises in the northern part of Du Page County as two branches which join in the northern portion of Will County north of Plainfield. The combined flow continues in a southerly direction until it empties into the Des Plaines River near Channahon. The drainage area to Troy, Will County, is 325 square miles. The elevation of the gage zero is approximately 565 ft above mean sea level.

The Du Page basin is in Wisconsin drift starting in the Wheaton Morainal country and entering the Kankakee Plain Section of the Central Lowland Province.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 15 and 16.

Instantaneous flow measurements for samples collected during 1945-50 were reasonably similar to those indicated by the average daily flow records during 1941-49.[17] Rainfall at Troy during the period of collection was 4.47 inches above the normal, based on the period 1900-44, and the average annual departure was 0.90 inches. This departure compares with a deviation of 0.00 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 1.45 sec ft per sq mi and was not less than 0.11 sec ft per sq mi, with a median flow of 0.3 sec ft per sq mi. The minimum average daily flow of record was 2 sec ft on several occasions in 1953 and 1954.

The turbidity was not less than 2 ppm and not more than 80 ppm for the central 80 per cent of the time, with a median of 20 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 20 per cent of the time. It was below 50°F for 40 per cent and below 40 F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	180	245	280
Hardness (as $CaCO_3$)	ppm	330	400	460
Total Dissolved Minerals	ppm	430	520	620

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.44, ranging from 0.40 to 0.49, for the central 80 per cent of the time.

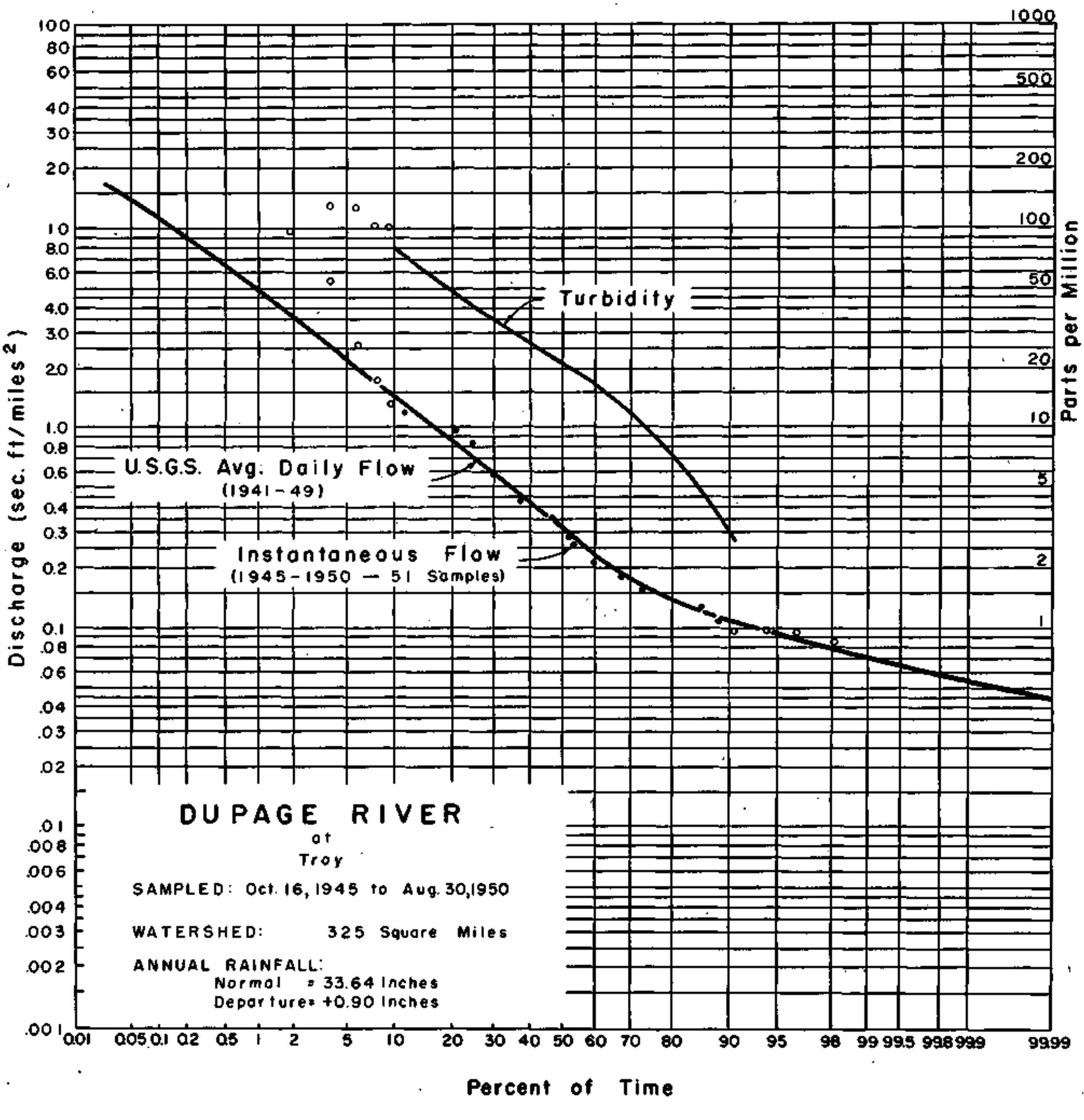

FIGURE 15 DU PAGE RIVER AT TROY, DISCHARGE

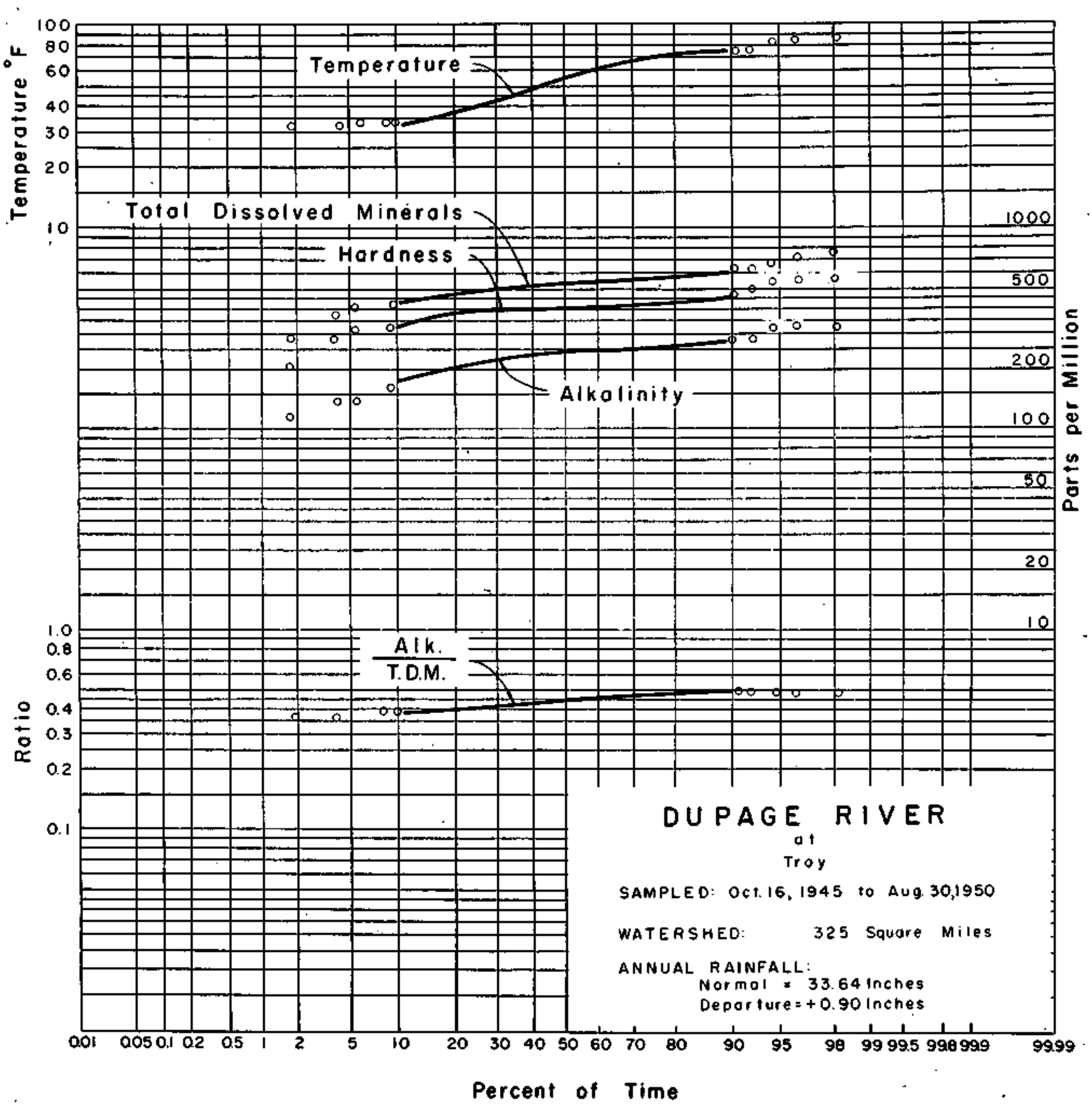

FIGURE 16 DU PAGE RIVER AT TROY, QUALITY

GREEN RIVER AT GENESEO

The Green River [20, 22] begins in Lee County and flows in a southwesterly direction through Lee, Bureau, and Henry Counties, joining the Rock River in the northern portion of Henry County.

The maximum altitude is about 980 feet. Elevation of the gage zero at Geneseo is 580.66 feet above mean sea level. Mud Creek, the principal tributary, enters from the south about 10 miles upstream from Geneseo.

The Green River basin lies in the Green River Lowland of the Central Lowland Province. The river is 93 miles long and flows through gently rolling country for its entire length. Sandy loam prevails in the central portion of the watershed which covers 1,080 square miles upstream from Geneseo. In the southern portions of Henry and Bureau Counties is a dark soil with a non-calcareous subsoil.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 17 and 18.

Instantaneous flow measurements for samples collected during 1945-50 were appreciably greater than those indicated by the average daily flow records during 1937-49. Rainfall at four raingage stations during the period of sampling averaged 3.95 inches above normal, based on the period 1900-44, and the average annual departure was +0.79 inches. This departure compares with a deviation of -0.02 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 1.5 sec ft per sq mi and was not less than 0.12 sec ft per sq mi, with a median flow of 0.30 sec ft per sq mi. The minimum average daily flow of record was 27 sec ft on January 2, 1940.

The turbidity was not less than 7 ppm and not more than 200 ppm for the central 80 per cent of the time, with a median of 40 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 20 per cent of the time. It was below 50°F for 35 per cent and below 40°F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	180	240	255
Hardness (as $CaCO_3$)	ppm	260	350	390
Total Dissolved Minerals	ppm	340	410	450

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.59, ranging from 0.53 to 0.60, for the central 80 per cent of the time.

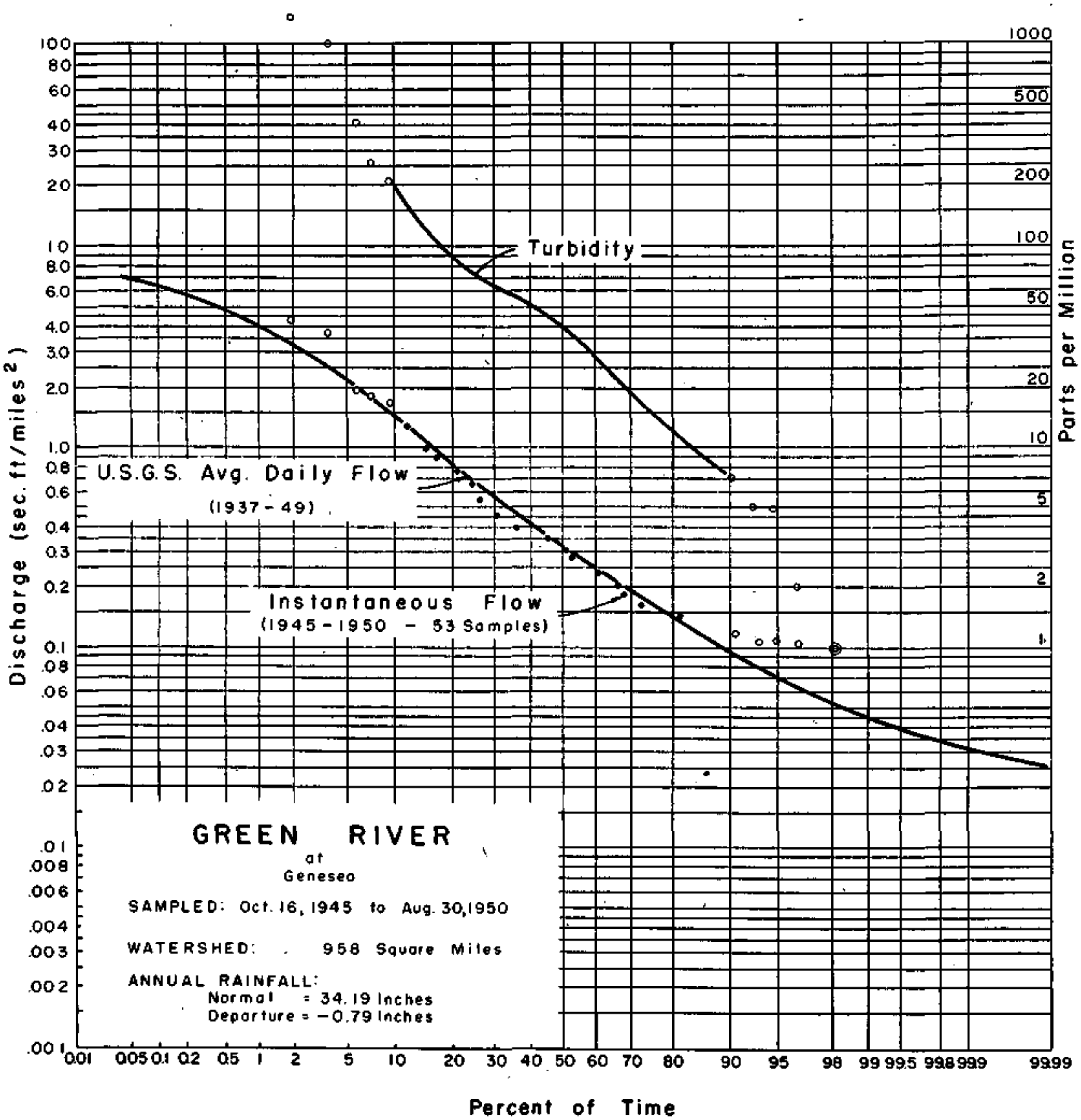

FIGURE 17 GREEN RIVER AT GENESEO, DISCHARGE

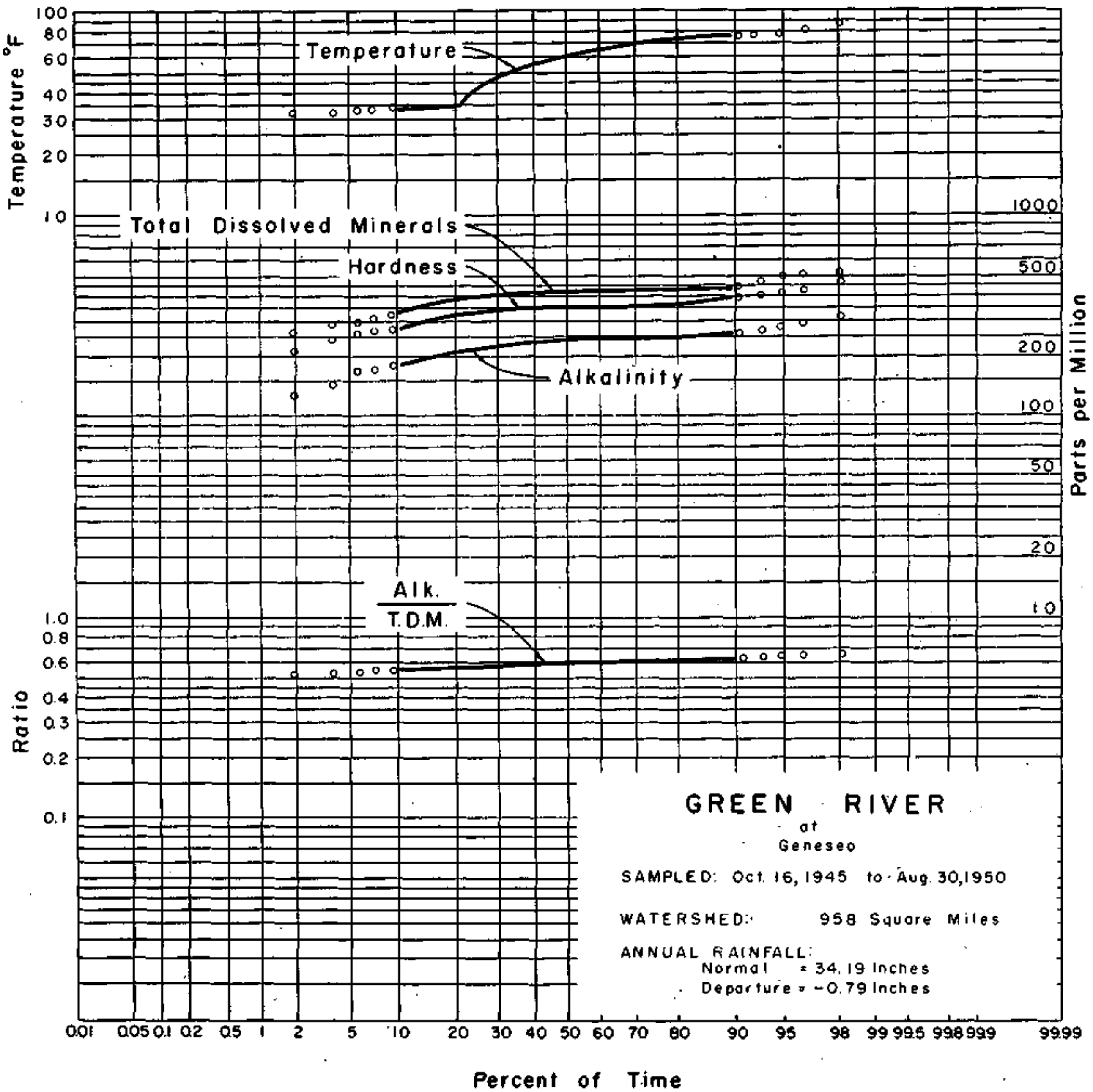

FIGURE 18 GREEN RIVER AT GENESEO, QUALITY

MACKINAW RIVER AT GREEN VALLEY

The Mackinaw River begins in Ford County and flows west through a well defined valley to a point south of Sand Prairie and then turns and flows north, emptying into the Illinois River about four miles south of Pekin. The total length of the Mackinaw is 112 miles and the river has a drainage area of 1,160 square miles. The length from the source to the gaging station at Green Valley is approximately 100 miles and the drainage area above this station is 1,100 square miles. The principal tributaries are Panther Creek, Walnut Creek, and Money Creek. The elevation of the gage zero at Green Valley is 479.10 feet above mean sea level.

The basin lies almost completely in the Bloomington Ridged Plain of the Central Lowland Province. Bordering the Mackinaw River throughout its course are brownish gray soils with non-calcareous subsoils. There are also scattered flat areas with impervious subsoils. Except for the area near the junction with the Illinois River, dark soils with non-calcareous subsoils occur with almost complete exclusion of other types.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 19 and 20.

Instantaneous flow measurements for samples collected during 1950-56 were reasonably similar to those indicated by the average daily flow records during 1922-45.[17] Rainfall at Gridley during the period of collection was 10.72 inches above normal, based on the period 1900-44, and the average annual departure was +1.86 inches. This departure compares with a deviation of 0.00 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 1.2 sec ft per sq mi and was not less than 0.05 sec ft per sq mi, with a median flow of 0.23 sec ft per sq mi. The minimum average daily flow of record was 17 sec ft on October 26-27, 1940.

The turbidity was not less than 6 ppm and not more than 200 ppm for the central 80 per cent of the time, with a median of 25 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 20 per cent of the time. It was below 50°F for 50 per cent and below 40°F for 30 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	180	260	310
Hardness (as $CaCO_3$)	ppm	250	320	350
Total Dissolved Minerals	ppm	300	360	390

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.70, ranging from 0.63 to 0.82, for the central 80 per cent of the time.

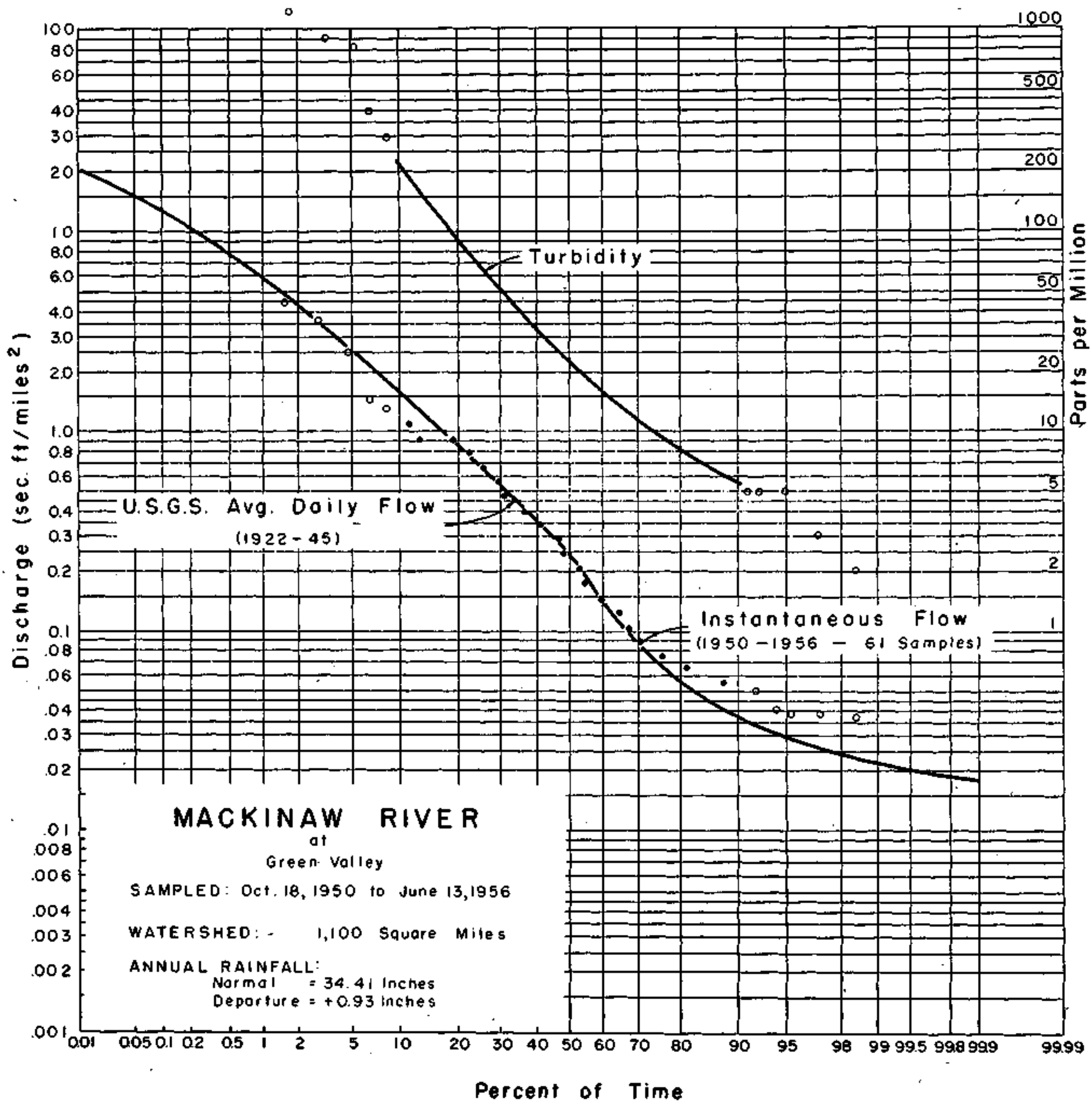

FIGURE 19 MACKINAW RIVER AT GREEN VALLEY, DISCHARGE

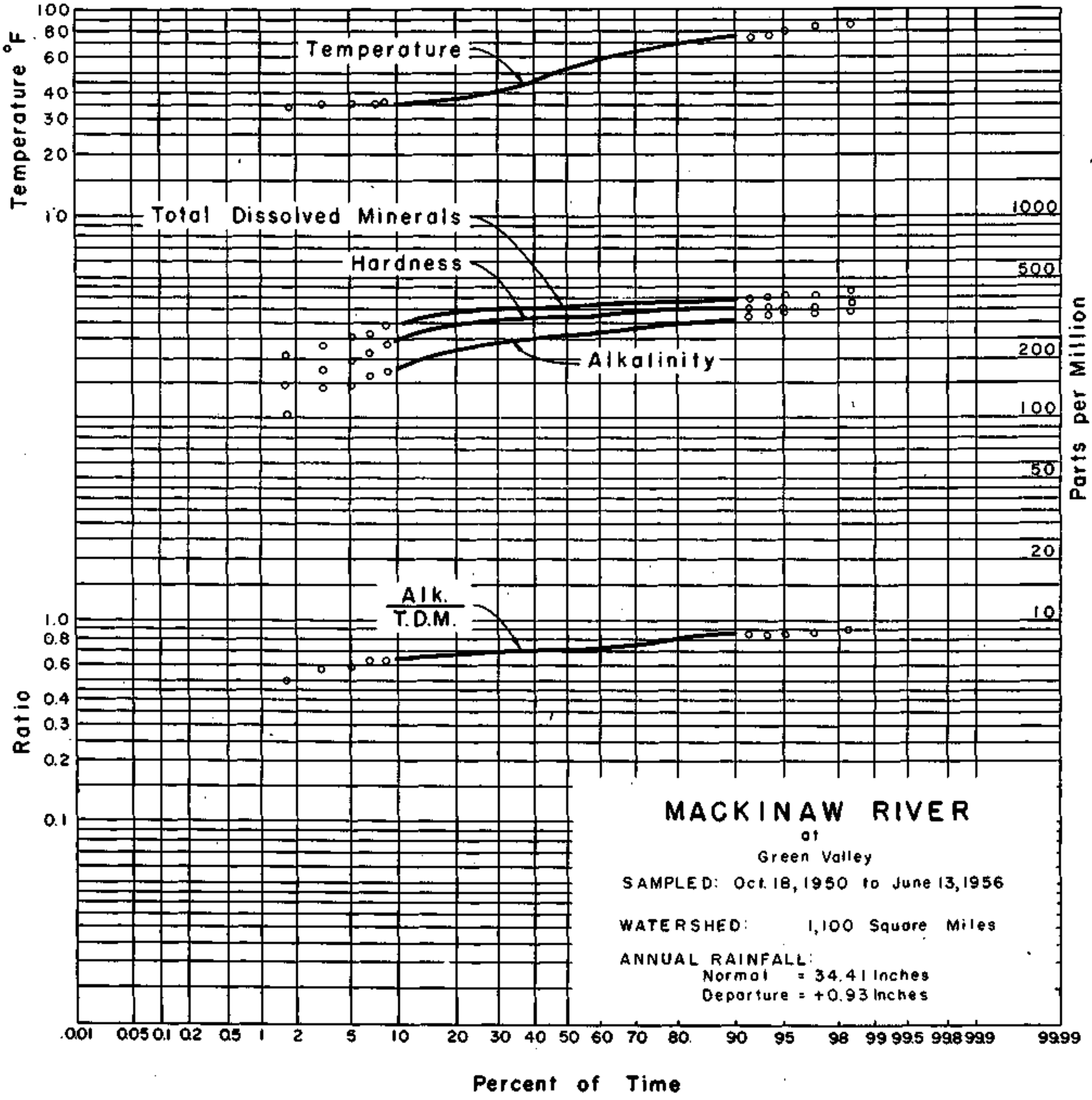

FIGURE 20 MACKINAW RIVER AT GREEN VALLEY, QUALITY

IROQUOIS RIVER AT IROQUOIS

The Iroquois River [23, 20] rises near Medoryville, Jasper County, Indiana. 'It flows southwesterly into Iroquois County, Illinois, then westerly to Watseka after which it turns north to its junction with • the Kankakee River at Aroma, Kankakee County. About half the length of 85 miles lies in Illinois. The Iroquois River drains about 2,180 square miles. Approximately 48 miles of the length is above the town of Iroquois and the drainage area to this point is 682 square miles.

The Iroquois basin lies almost completely in the Kankakee Plain of the Central Lowland Province in Illinois and in the Till Plains Section in Indiana.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 21 and 22.

Instantaneous flow measurements for samples collected during 1950-56 were reasonably similar to those indicated by the average daily flow records during 1945-50. [17] Rainfall at Watseka during the period of collection was 8.92 inches above the normal, based on the period 1900-44, and the average annual departure was +1.55 inches. This departure compares with a deviation of 0.05 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 1.5 sec ft per sq mi and was not less than 0.06 sec ft per sq mi, with a median flow of 0.35 sec ft per sq mi. The minimum average daily flow of record was 13 sec ft on September 19, 1948.

The turbidity was not less than 6 ppm and not more than 150 ppm for the central 80 per cent of the time, with a median of 40 ppm.

The reported temperature was over 80 F for less than 10 per cent and over 70°F for 25 per cent of the time. It was below 50 F for 50 per cent and and below 40°F for 30 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
. for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	150	200	220
Hardness (as $CaCO_3$)	ppm	245	320	350
Total Dissolved Minerals	ppm	300	370	440

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.55, ranging from 0.45 to 0.60, for the central 80 per cent of the time.

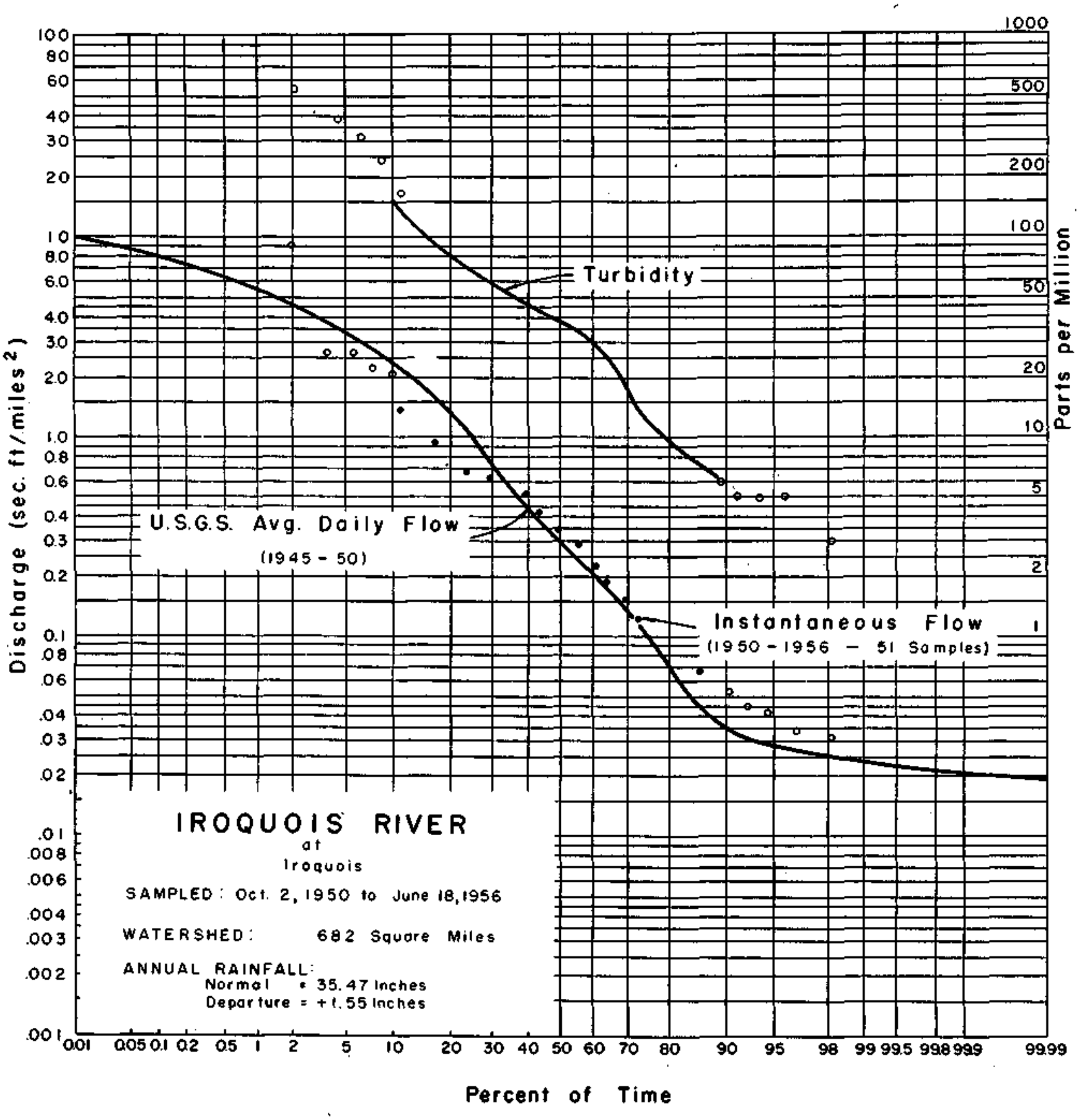

FIGURE 21 IROQUOIS RIVER AT IROQUOIS, DISCHARGE

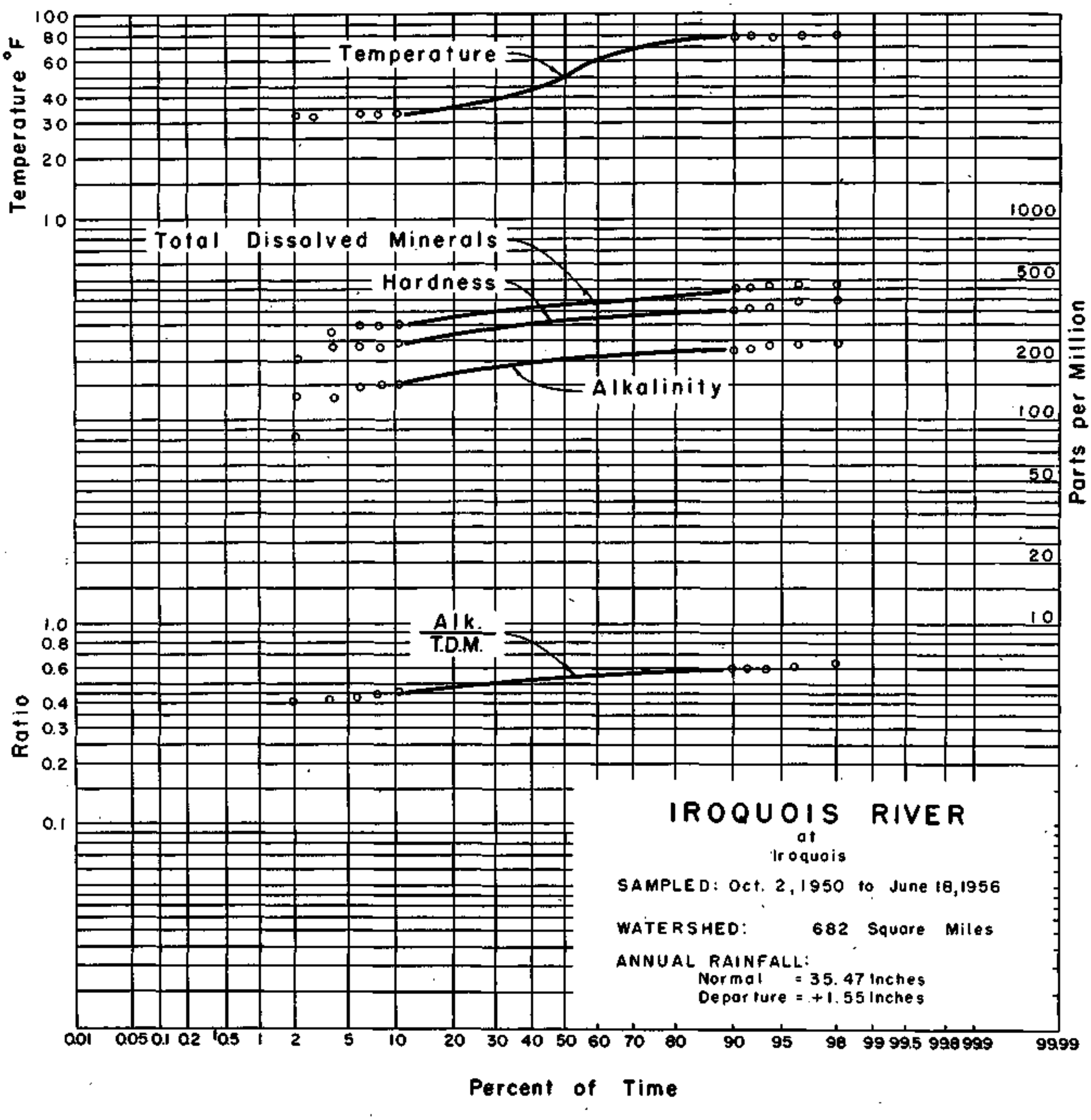

FIGURE 22 IROQUOIS RIVER AT IROQUOIS, QUALITY

SALT CREEK AT ROWELL

Salt Creek rises in the southeast quarter of McLean County and flows southwest about 35 miles through rolling country. It then turns west and continues through typical prairie to its confluence with the Sangamon, some eight miles southwest of Mason City. For five miles before joining the Sangamon, it flows through straightened channels. Salt Creek is 92 miles long and drains 1,803 square miles. The main tributaries are Sugar Creek, Kickapoo Creek, and Lake Fork. Three hundred and thirty-four square miles of this area are upstream of Rowell. The elevation of the gage zero at Rowell is 610.00 feet above mean sea level.

The soil in Salt Creek bottom lands is mainly brownish yellow, with non-calcareous subsoils. Over the remainder of the basin, most of the soil is dark with a heavy, non-calcareous subsoil. This dark type is well suited to cultivation of corn, wheat, and oats, which are the chief crops. Salt Creek lies in the Bloomington Ridged Plain of the Central Lowland Province.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 23 and 24.

Instantaneous flow measurements for samples collected during 1950-56 were appreciably lower than those indicated by the average daily flow records during 1943-50.[17] Rainfall at Clinton during the period of collection[21] was 16.91 inches below normal, based on the period 1900-44, and the average annual departure was -2.95 inches. This departure compares with a deviation of -0.22 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 1.5 sec ft per sq mi and was not less than 0.22 sec ft per sq mi, with a median flow of 0.14 sec ft per sq mi. The minimum average daily flow of record was 5.2 sec ft on August 12-17, 1944.

The turbidity was not less than 4 ppm and not more than 200 ppm for the central 80 per cent of the time, with a median of 16 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 15 per cent of the time. It was below 50°F for 50 per cent and below 40°F for 35 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	160	255	310
Hardness (as $CaCO_3$)	ppm	200	300	360
Total Dissolved Minerals	ppm	250	360	450

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.70, ranging from 0.60 to 0.75, for the central 80 per cent of the time.

Since the rainfall and discharge during the period of sampling were lower than normal, it might be deduced that the normal turbidity may be deduced that the normal turbidity may be somewhat greater and the concentrations of the mineral components somewhat less than recorded.

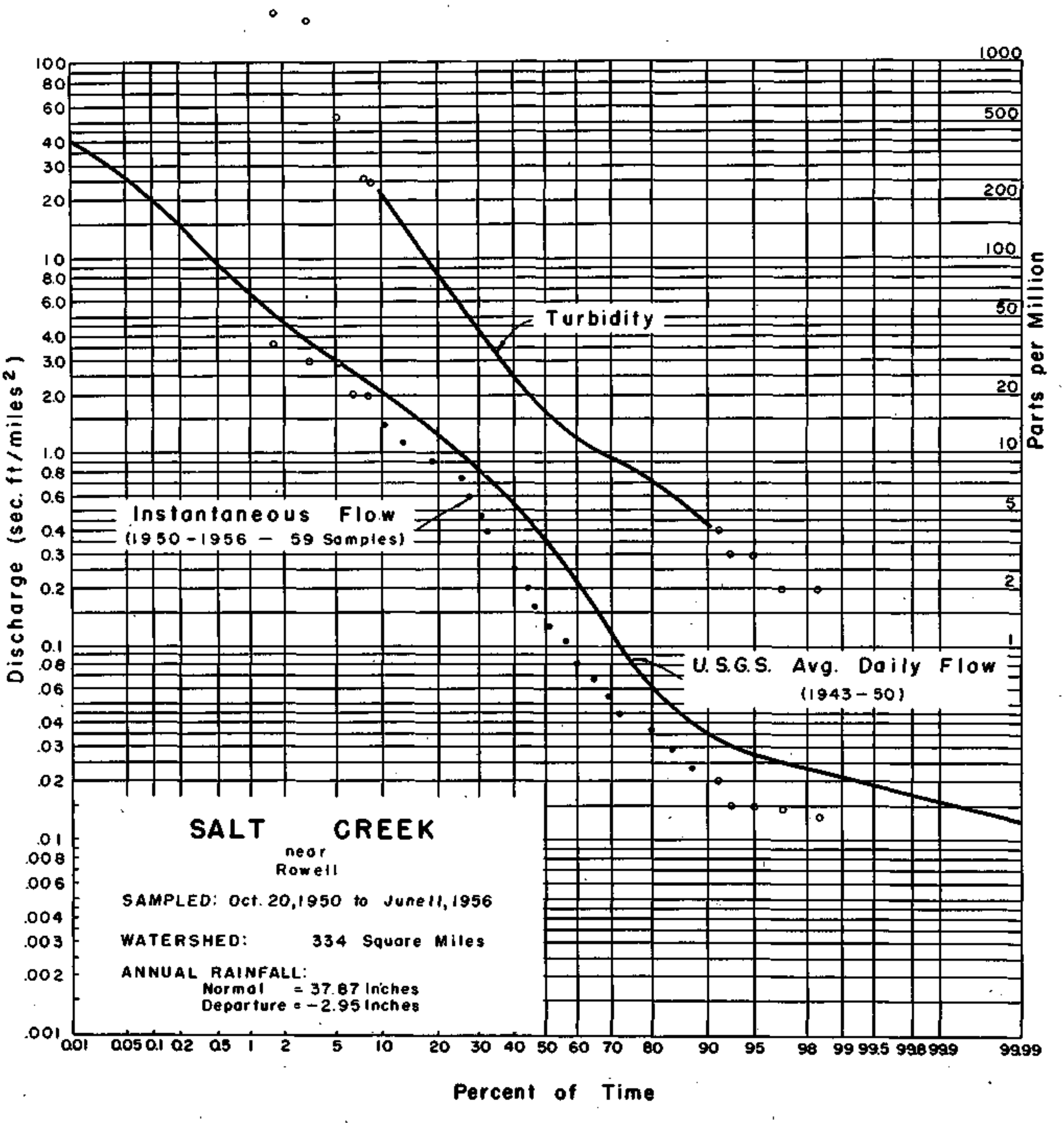

FIGURE 23 SALT CREEK NEAR ROWELL, DISCHARGE

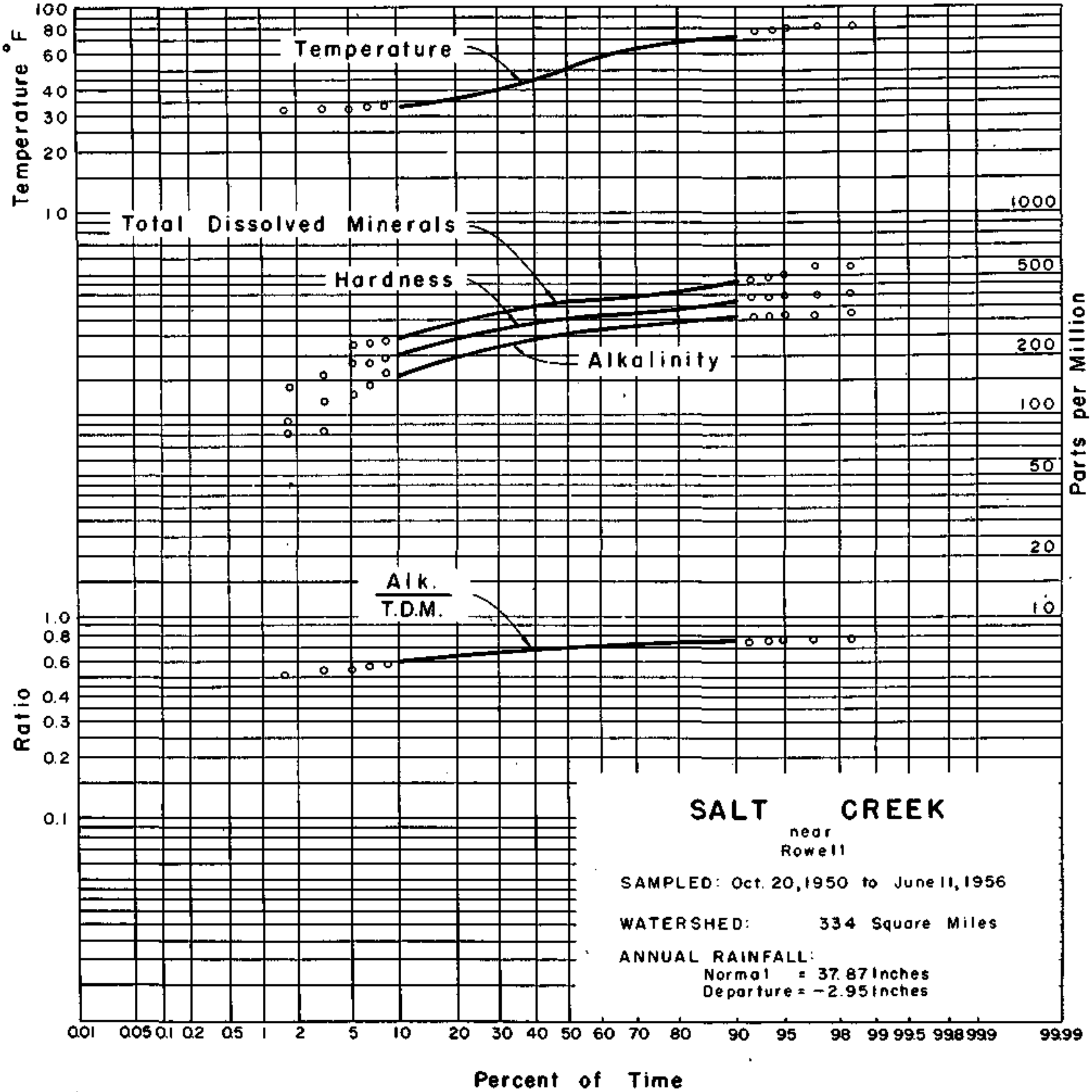

FIGURE 24 SALT CREEK NEAR ROWELL, QUALITY

VERMILION RIVER AT CATLIN

The Vermilion River [25] rises in Ford County and flows southeast, crossing the state line at Danville on its way to join the Wabash. Seventy-two miles of its course are in Illinois. Principal tributaries are Salt Fork and Middle Fork.

There are 1,378 square miles of the Vermilion watershed within the Wabash basin. Nine hundred fifty-nine square miles of this drainage area are upstream from Catlin. The elevation of the gage zero at Catlin is 527.02 feet above mean sea level. The topography is characterized by comparatively level tablelands, the river flowing through a narrow, well defined valley. The soils are nearly all dark and highly productive.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 25 and 26.

Instantaneous flow measurements for samples collected during 1950-56 were appreciably greater than those indicated by the average daily flow records during 1941-50. [17] Rainfall at Urbana and Danville during the period of collection [21] was respectively 18.92 and 0.58 inches below normal, based on the period 1900-44, and the average annual departure was -9.75 inches. This departure compares with a deviation of -0.105 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 2.0 sec ft per sq mi and was not less than 0.025 sec ft per sq mi, with a median flow of 0.24 sec ft per sq mi. The minimum average daily flow of record was 9.5 sec ft on September 17, 1940.

The turbidity was not less than 4 ppm and not more than 80 ppm for the central 80 per cent of the time, with a median of 14 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 30 per cent of the time. It was below 50°F for 45 per cent and below 40°F for 20 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	130	235	300
Hardness (as $CaCO_3$)	ppm	230	300	350
Total Dissolved Minerals	ppm	300	400	550

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.58, ranging from 0.50 to 0.65, for the central 80 per cent of the time.

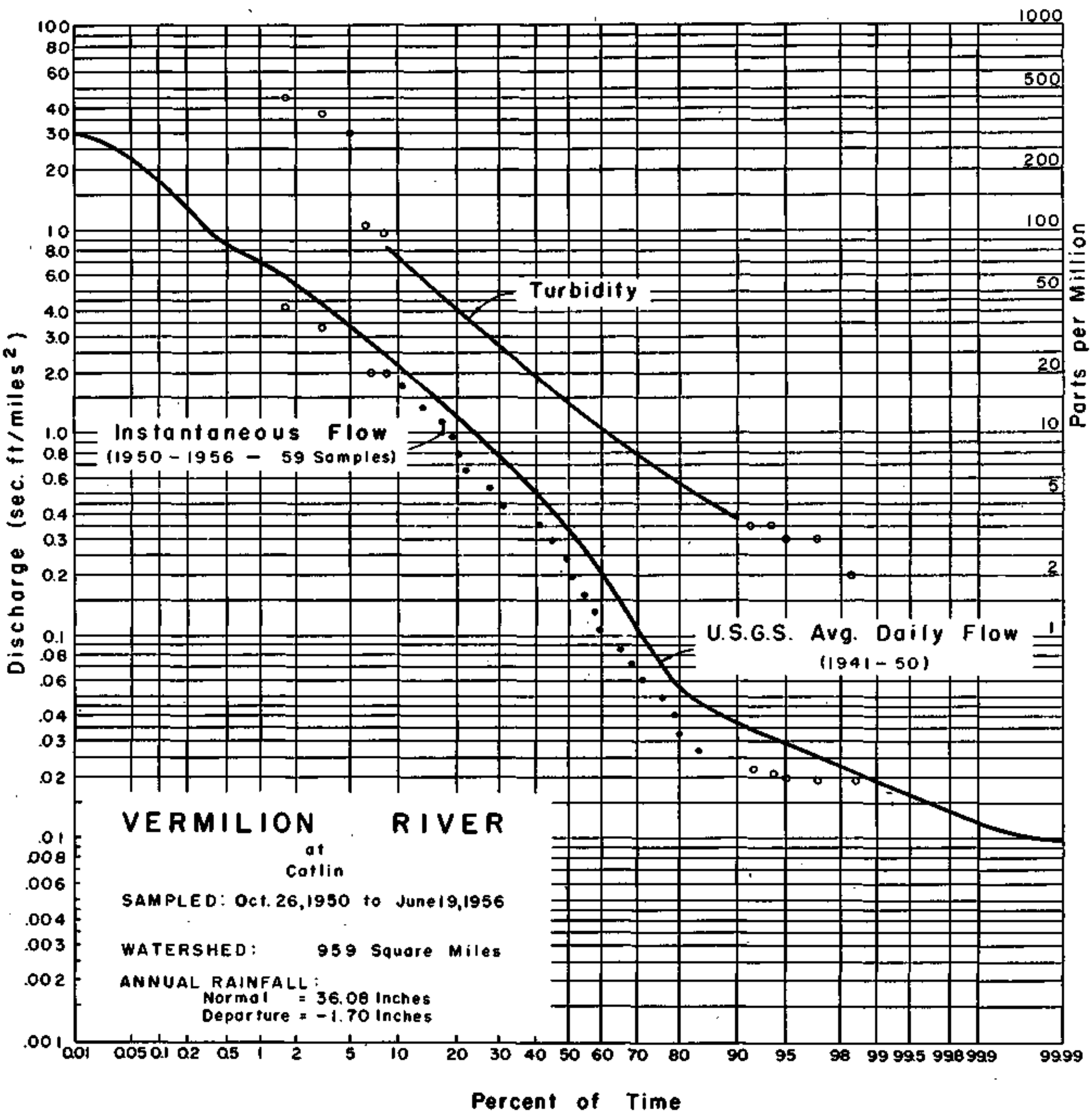

FIGURE 25 VERMILION RIVER AT CATLIN, DISCHARGE

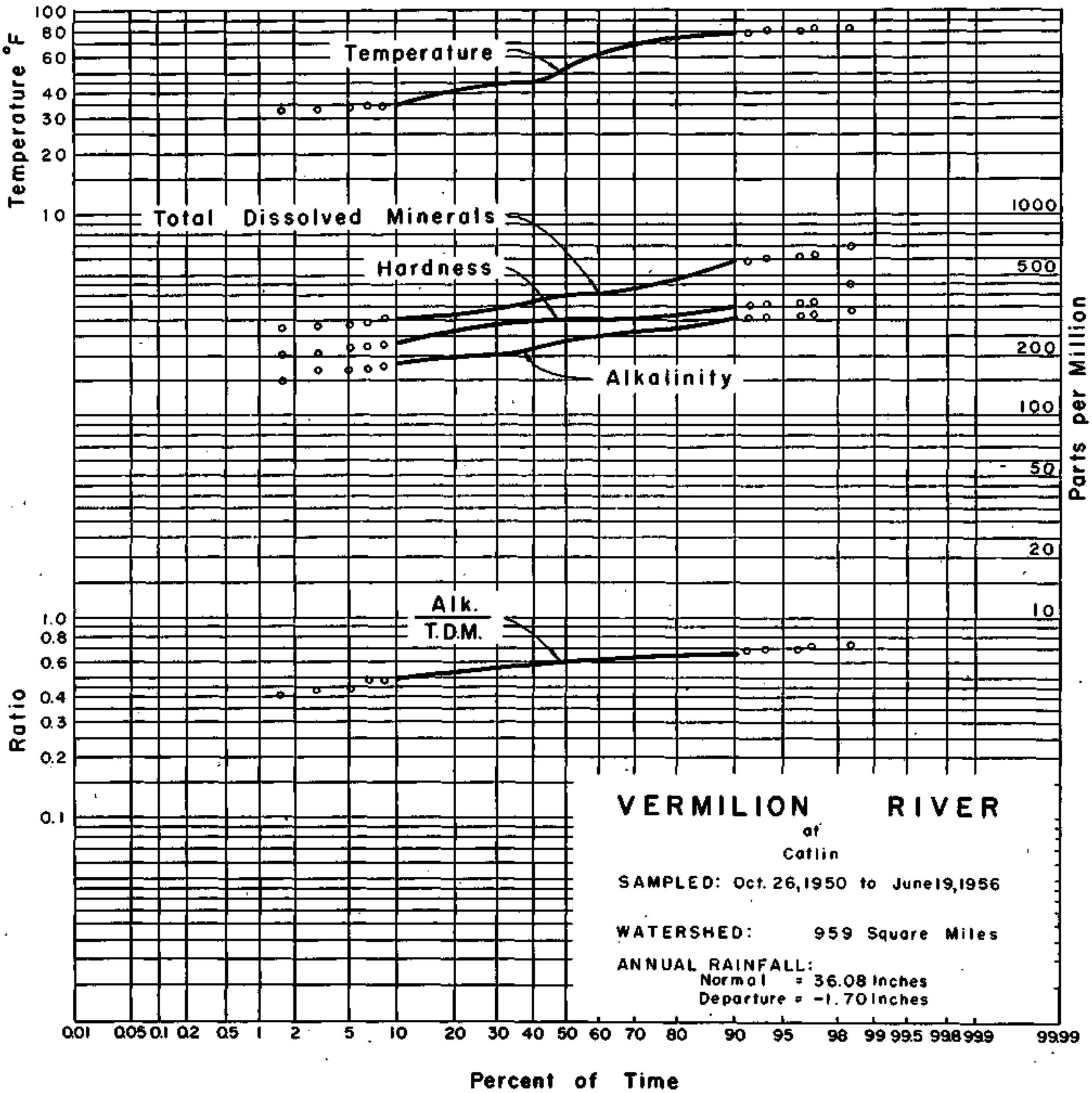

FIGURE 26 VERMILION RIVER AT CATLIN, QUALITY

KASKASKIA RIVER AT VANDALIA

The Kaskaskia River [26, 27] rises in the geographical center of Champaign County. Above the gaging station at Vandalia in Fayette County, it flows in a southwesterly direction through Douglas, Coles, Moultrie, Shelby, and Washington Counties.

The gaging station at Vandalia is 161 miles north of the mouth and 159. miles south of the source of the Kaskaskia River. Above Vandalia the drainage area is 1,980 square miles. The principal tributaries are Becks Creek, Wolf Creek, and the West Okaw River.

The valley is entirely a plains region of typically flat or gently rolling prairies. The valley was once covered with glacial drift and the streams have not only cut into it but through it to bedrock in some places. The drift contains silty, sandy, pebbly, and bouldery clay known as till of Wisconsin age and varies in thickness from a few feet to 300 feet. Above the drift is a mantle of wind blown loess. Bedrock of limestone, sandstone and shale is below the glacial drift. In the valley above Vandalia, the loess varies from zero to seventy inches. The underlying Wisconsin till which has been leached only slightly is permeable to water and calcareous.

The basin starts in the Bloomington Ridged Plain and lies predominantly in the Springfield Plain which is located in the Central Lowland Province. The upper half of the valley is comparatively flat. Moderately eroded areas exist through the central and northern sections of the basin. The bottom land soils in the upper basin are from recent loess or till of the Wisconsin age.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 27 and 28.

Instantaneous flow measurements for samples collected during 1950-56 were appreciably less than those indicated by the average daily flow records during 1909-12 and 1915-45. [17] Rainfall at Pana, Urbana, and Windsor during the -period of collection[21] was respectively 20.06, 19.99, and 30.06 inches below normal, based on the period 1900-44, and the average annual departure was -4.25 inches. This departure compares with a deviation of -0.14 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 1.0 sec ft per sq mi and was not less than 0.01 sec ft per sq mi, with a median flow of 0.12 sec ft per sq mi. The minimum average daily flow of record was 3.5 sec ft on August 22, 1911.

The turbidity was not less than 10 ppm and not more than 250 ppm for the central 80 per cent of the time, with a median of 28 ppm.

The reported temperature was over 80°F for 10 per cent and over 70°F for 20 per cent of the time. It was below 50°F for 45 per cent and below 40°F for 30 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	140	220	260
Hardness (as $CaCO_3$)	ppm	200	280	305
Total Dissolved Minerals	ppm	280	340	450

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.61, ranging from 0.45 to 0.75, for the central 80 per cent of the time.

Since the rainfall and discharge during the period of sampling was lower than normal, it might be deduced that the normal turbidity may be somewhat higher and the concentrations of the mineral components somewhat lower than recorded.

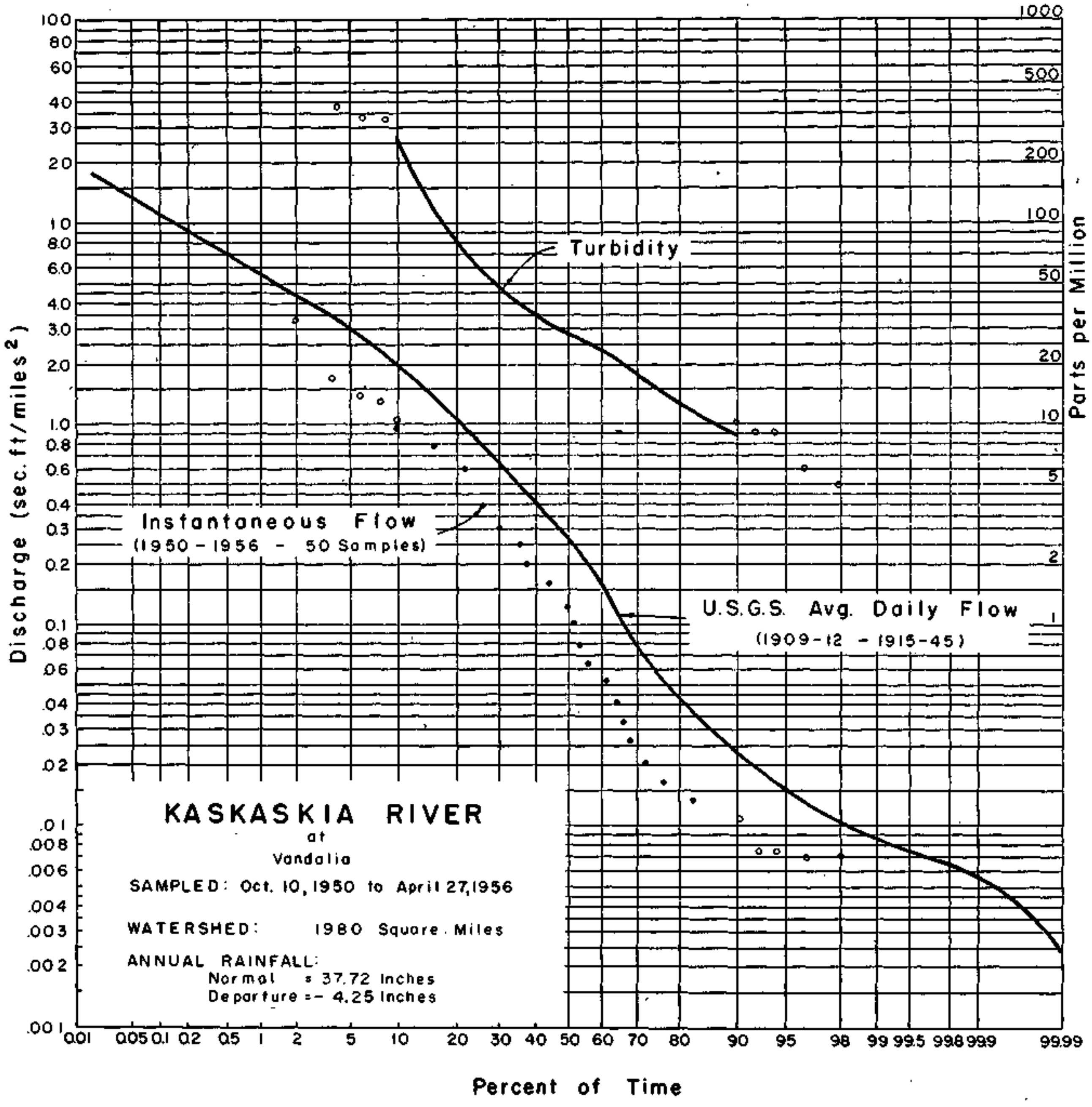

FIGURE 27 KASKASKIA RIVER AT VANDALIA, DISCHARGE

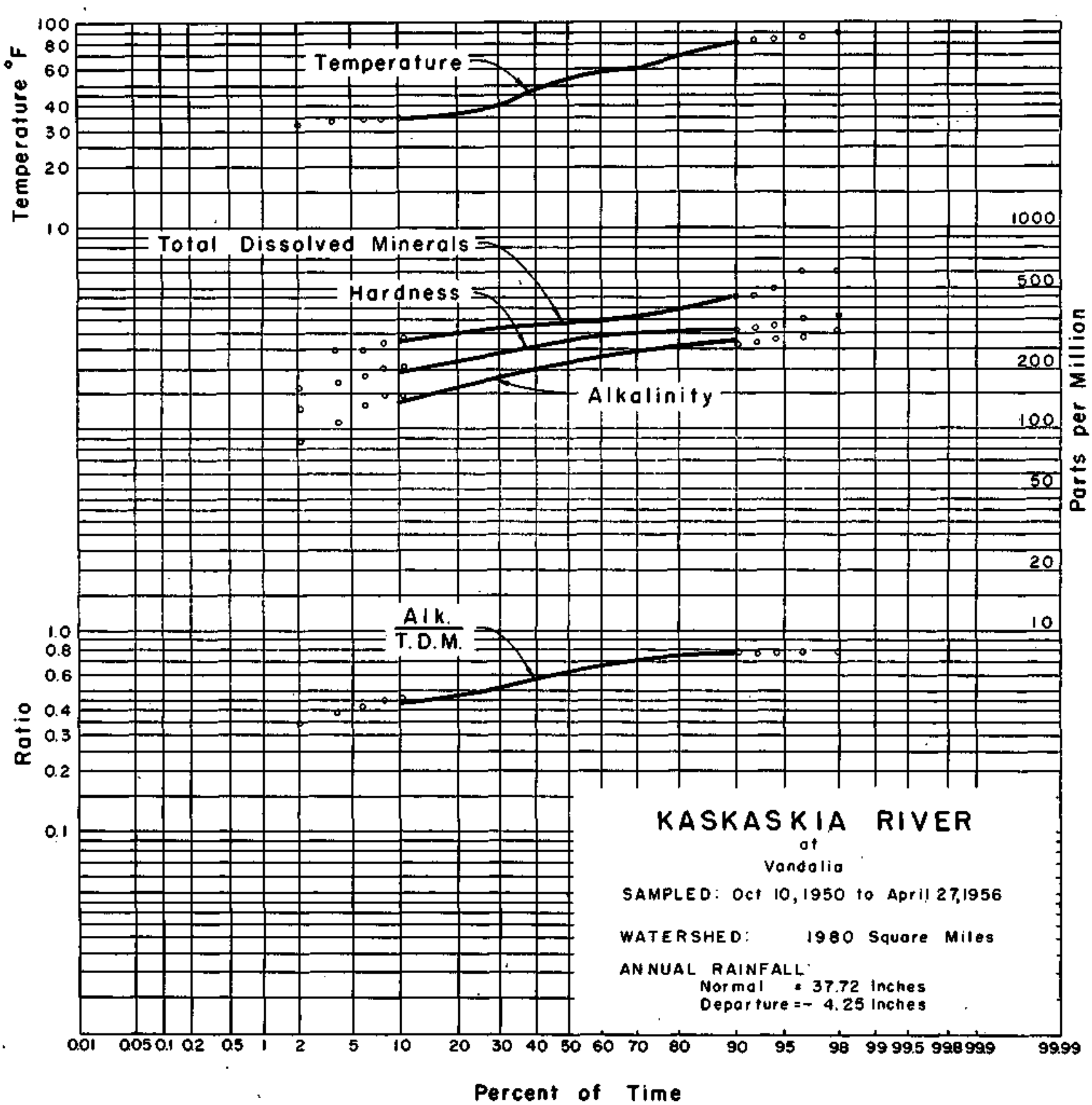

FIGURE 28 KASKASKIA RIVER AT VANDALIA, QUALITY

KASKASKIA RIVER AT NEW ATHENS

The Kaskaskia River rises in the geographical center of Champaign County, flows in a southwesterly direction through Douglas, Coles, Moultrie, Shelby, Washington, Fayette, Clinton, St. Clair, and Monroe Counties and empties into the Mississippi River seven miles north of Chester in Randolph County. Its 320-mile course is extremely winding and irregular, and the fall throughout this distance is only about 390 feet. The length of the basin is approximately 180 miles and its greatest width is about 55 miles. The land on both sides of the river is exceptionally flat, although definite bluffs occur where the stream has cut through glacial eminences and terraces. The soils are generally deep gray loam though sandy soils are not uncommon.

Upstream from New Athens the drainage area is 5,220 square miles. The elevation of the gage ' zero at New Athens is 359.90 feet above mean sea level.

Of its numerous tributaries, the principal ones are the East Fork, Big, Crooked, Hurricane, Shoal, Plum, Elkhorn, Silver, and Sugar Creeks. They are fairly evenly distributed throughout the territory and may be rated nearly equal in importance.

The basin starts in the Bloomington Ridged Plain, lies predominately in the Springfield Plain, and expires in the Mount Vernon Hill country. The entire basin is located in the Central Lowland Province. This area is rough and hilly in the southwest, but the northeastern part is comparatively level. The altitude varies from 384 feet above sea level in the southwest to 740 feet in the northeast. There are evidences of moderate sheet erosion, with occasional gullies in the southwestern portion, and gullies occur frequently in the extreme west. Moderately eroded areas are scattered through the central and northern sections.

All of the bottom lands, covering approximately 187,420 acres, are subject to frequent overflow. Nearly every year, minor floods cause crop damage.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 29 and 30.

Instantaneous flow measurements for samples collected during 1945-50 were appreciably greater than those indicated by the average daily flow records during 1909-12, 1915-21, and 1936-45.[17] Rainfall during the period of collection [21] from five of the six rain-gage stations ranged from 21-50 inches above normal, based on the period 1900-44, and the average annual departure for the six stations was +5.55 inches. This departure compares with a deviation of +0.22 sec ft per sq mi in the median flow of the sampling period from the long-term median flow. ,

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 3.3 sec ft per sq mi and was not less than 0.07 sec ft per sq mi, with a median flow of 0.45 sec ft per sq mi. The minimum average daily flow of record, unaffected by backwater, was 61 sec ft on September 26, 1936.

The turbidity was not less than 40 ppm and not more than 450 ppm for the central 80 per cent of the time, with a median of 110 ppm.

The reported temperature was over 80°F for 10 per cent and over 70°F for 25 per cent of the time. It was below 50°F for 40 per cent and below 40°F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time;

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	45	120	215
Hardness (as $CaCO_3$)	ppm	85	190	300
Total Dissolved Minerals	ppm	130	290	430

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.45, ranging from 0.27 to 0.59, for the central 80 per cent of the time.

Since ' the rainfall and discharge during the period of sampling were higher than normal, it might be deduced that the normal turbidity may be somewhat lower and the concentrations of the mineral components somewhat greater than recorded.

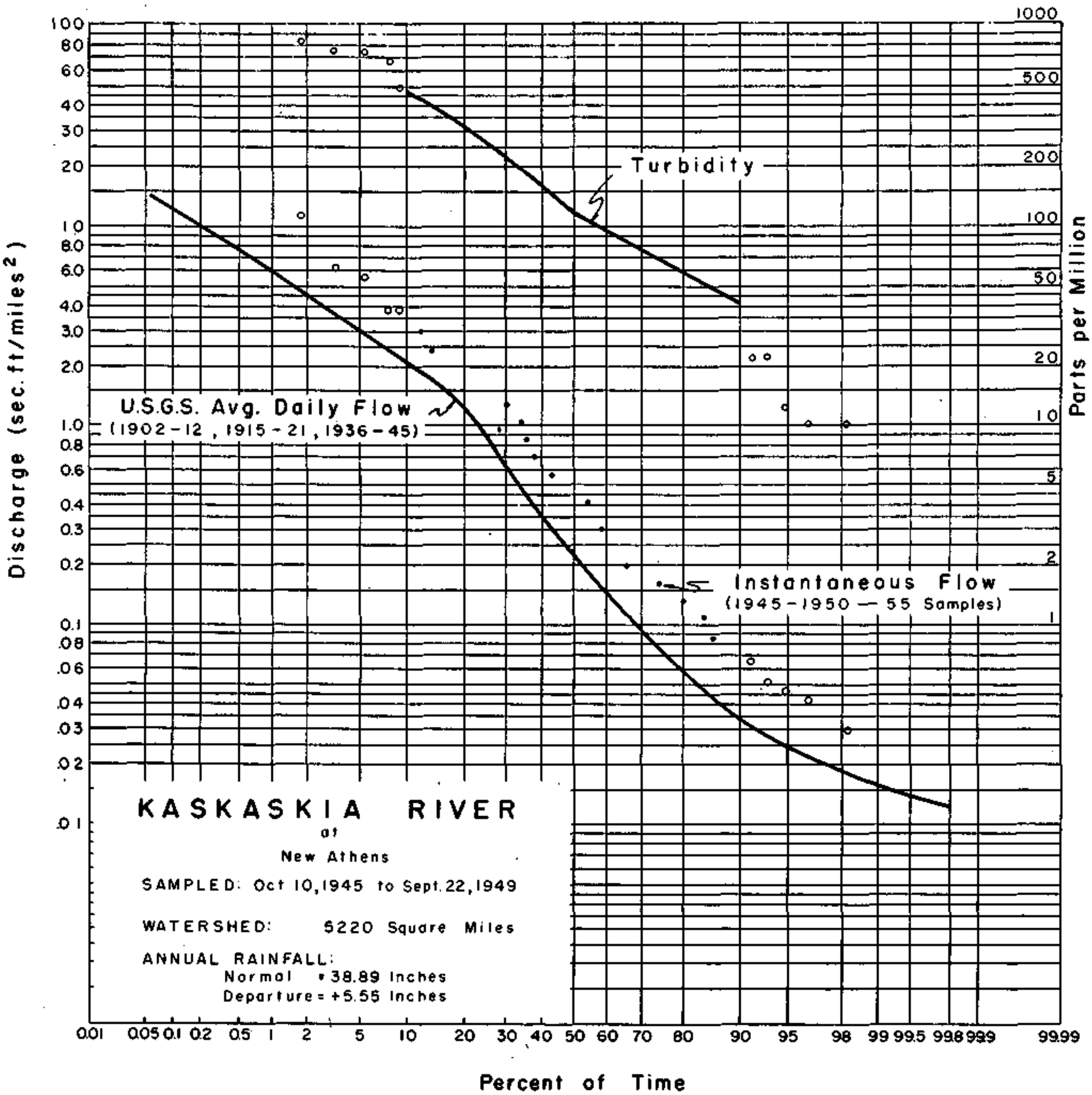

FIGURE 29 KASKASKIA RIVER AT NEW ATHENS, DISCHARGE

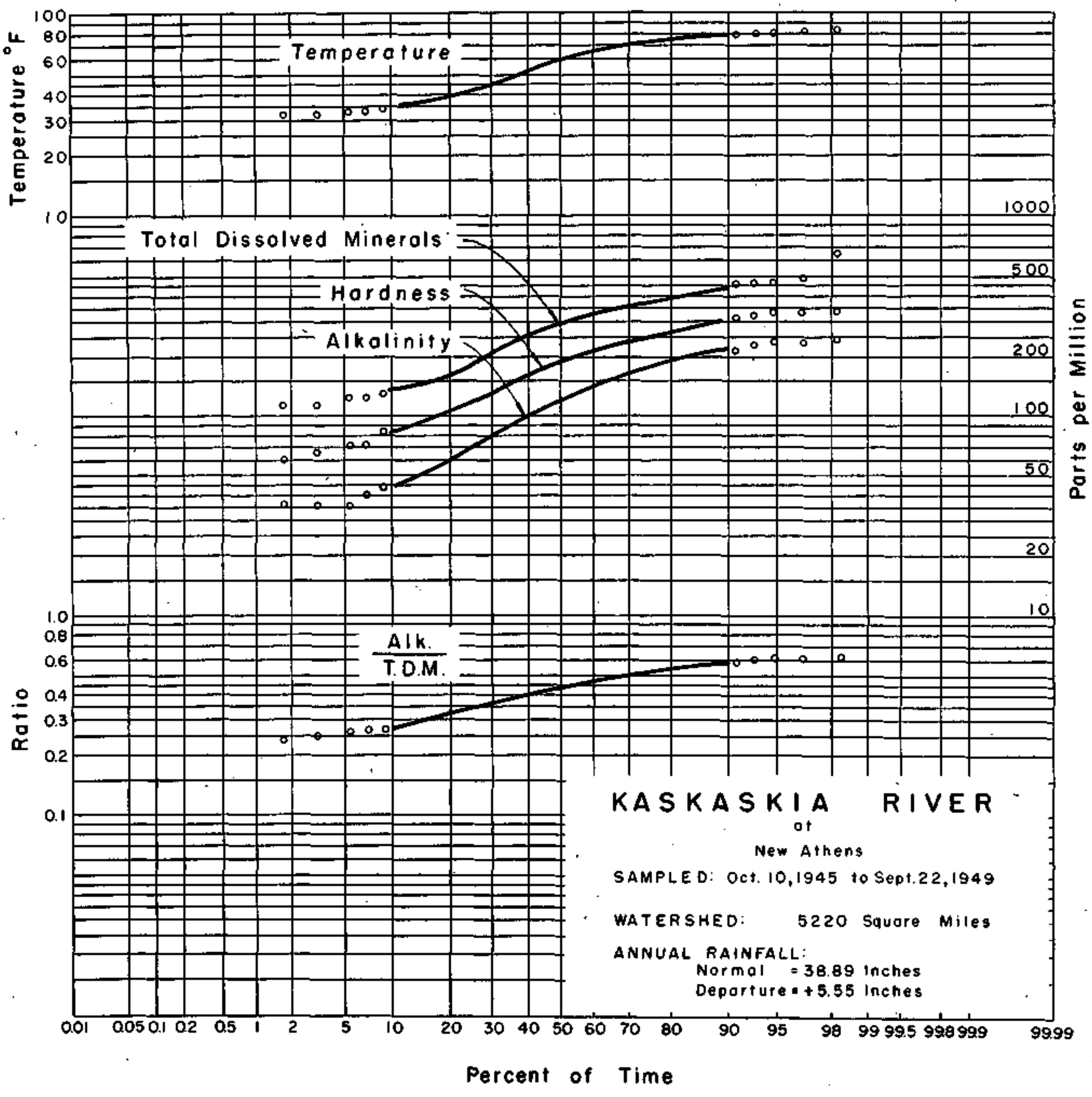

FIGURE 30 KASKASKIA RIVER AT NEW ATHENS, QUALITY

SPOON RIVER AT LONDON MILLS

The east fork of Spoon River rises near Neponset and flows south. The west fork rises near Kewanee, Henry County, and flows west for six miles, then south to join the east fork near Modena. The two branches of the Spoon River then flow nearly parallel to the Illinois River through rolling country for about 50 miles to London Mills. The gaging station at London Mills is 78.5 miles from the source and the elevation of the gage zero at this station is 508.97 feet above mean sea level. The drainage basin has an area of 1,070 square miles. The Spoon River occasionally floods large areas of its bottom lands. Spoon River has a total length of 115 miles to the Illinois River and a drainage area of 1,790 square miles.

The basin lies in the Galesburg Plain of the Central Lowland Province which includes the western segment of the Illinois drift sheet. The till plain is level to undulatory with a few morainic ridges and is in a late youthful stage of erosion. The Illinoian drift is generally thick and is underlain by extensive Kansas and Nebraskan deposits. Adjacent to the Spoon River, in Stark and Knox Counties, are large areas of brownish yellow-gray soils underlain with non-calcareous subsoils.

There are deep and strip coal mines in Henry, Knox, and Stark Counties.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 31 and 32.

Instantaneous flow measurements for samples collected during 1945-50 were reasonably close to those indicated by the average daily flow records during 1943-49. [17] Rainfall at four rain gage stations during the period of collection was from 6.32 inches above normal to 24.09 inches below normal, based on the period 1900-44, and the average annual departure was -1.12 inches. This departure compares with a deviation of 0.00 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 1.0 sec ft per sq mi and was not less than 0.04 sec ft per sq mi, with a median flow of 0.17 sec ft per sq mi. The minimum average daily flow of record was 13 sec ft on September 20, 1947.

The turbidity was not less than 18 ppm and not more than 400 ppm for the central 80 per cent of the time, with a median of 35 ppm.

The reported temperature was over 80°F for 10 per cent and over 70°F for 25 per cent of the time. It was below 50°F for 40 per cent and below 40 F for 35 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	130	230	270
Hardness (as $CaCO_3$)	ppm	190	310	370
Total Dissolved Minerals	ppm	230	390	490

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.55, ranging from 0.50 to 0.65, for the central' 80 per cent of the time.

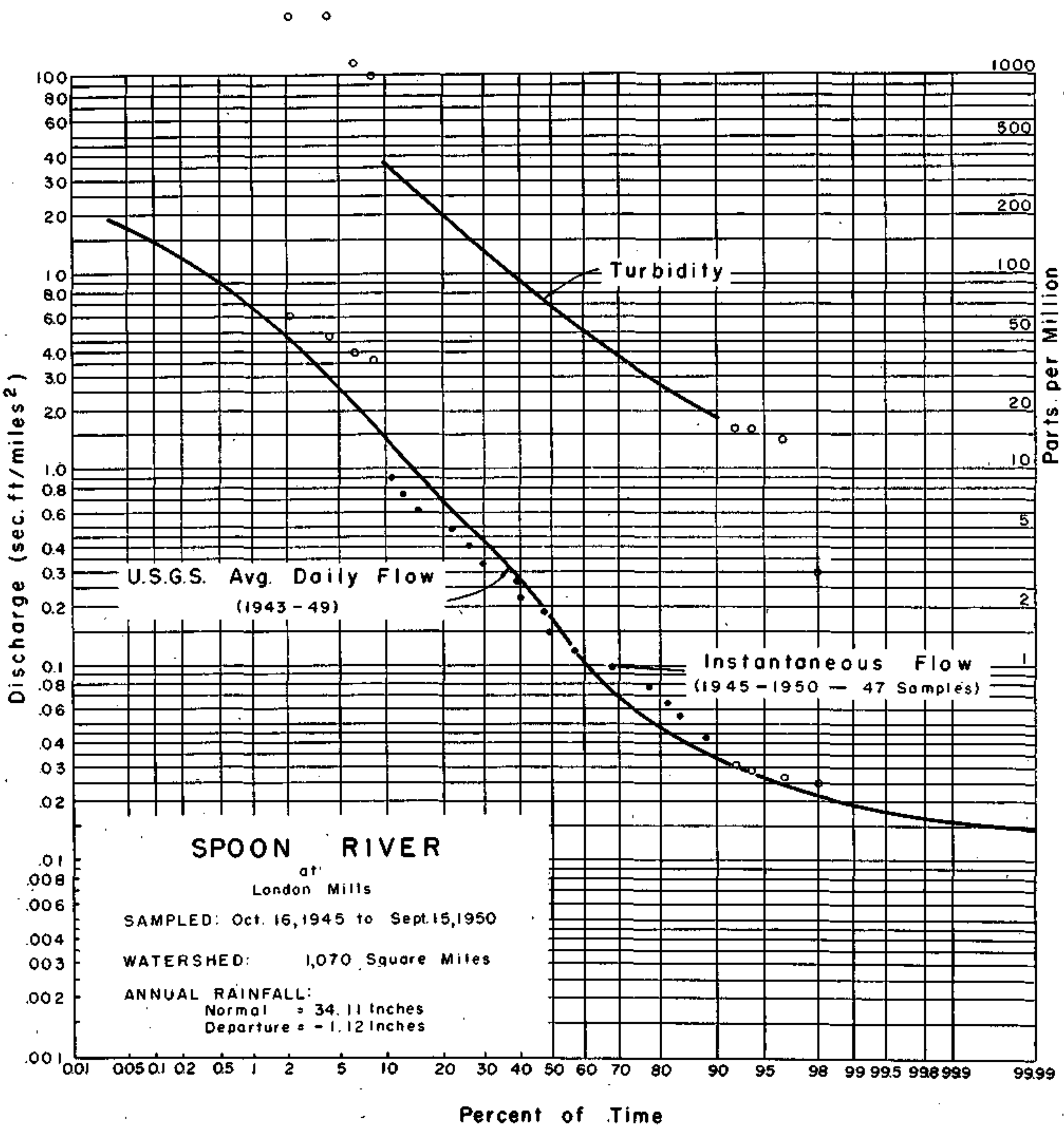

FIGURE 31 SPOON RIVER AT LONDON MILLS, DISCHARGE

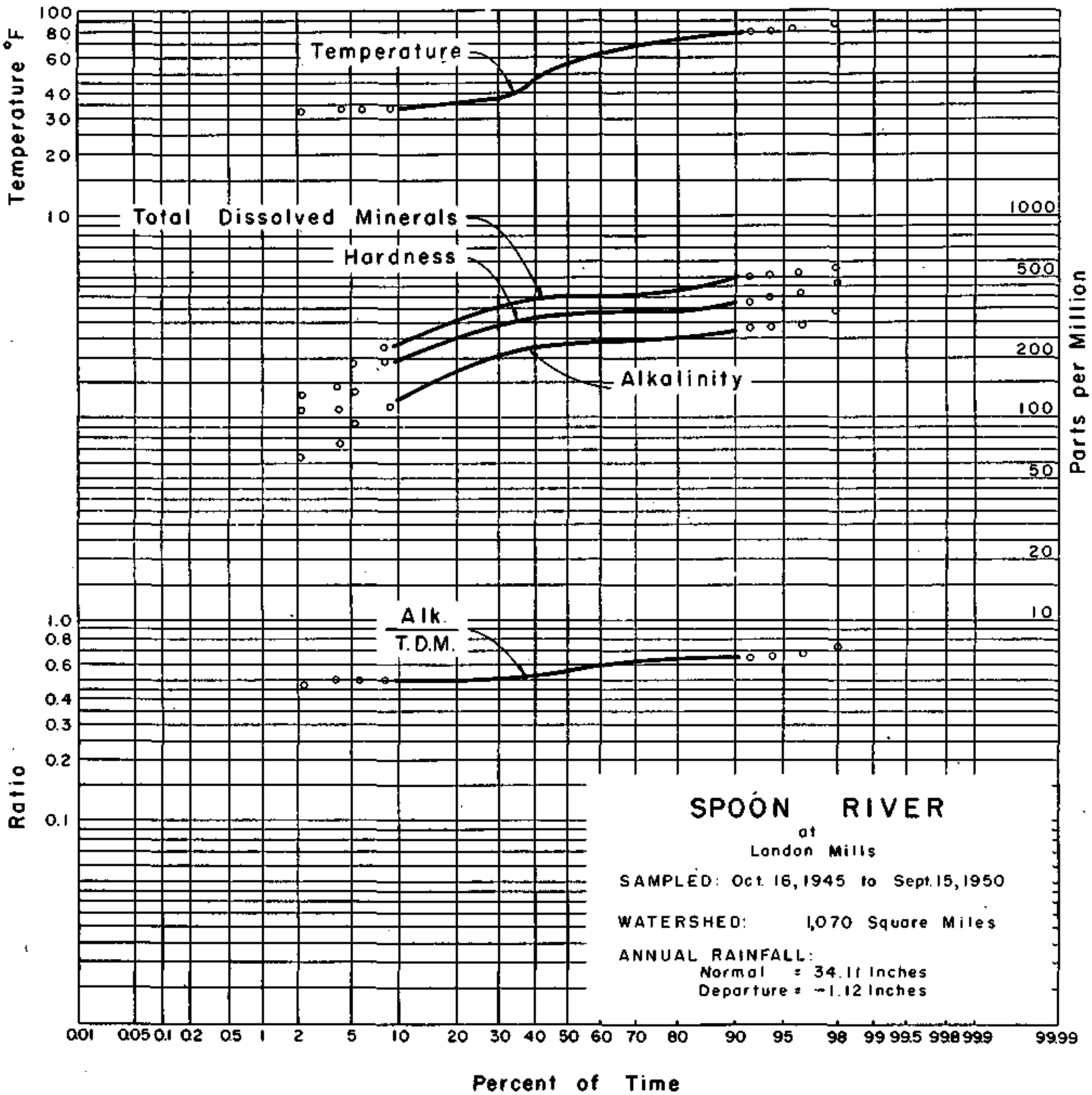

FIGURE 32 SPOON RIVER AT LONDON MILLS, QUALITY

LA MOINE RIVER AT RIPLEY

The La Moine River [19, 28] rises in the hills, bordering the Mississippi River in Henderson and Hancock Counties, and flows approximately 86 miles through rolling country to Ripley. Its valley varies in width from a quarter of a mile to two miles. There are three principal tributaries: Camp Creek, East Fork, and Troublesome Creek. The elevation of the gage zero at Ripley is 431.1 feet above mean sea level and the drainage area is 1,310 square miles. The La Moine River has a total length of 97 miles to the Illinois River and drains an area of 1,341 square miles.

The basin lies in the Galesburg Plain of the Central Lowland Province. The most prevalent soil is brownish yellow-gray. The subsoil is a non-calcareous material. There are scattered flat areas with impervious subsoils and also several areas of dark soils with non-calcareous subsoils.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 33 and 34.

Instantaneous flow measurements for samples collected during 1945-50 were reasonably close to those indicated by the average daily flow records during 1922-45 with the exception of the very high and very low flows. Rainfall at La Harpe and Macomb during the period of collection [21] was respectively 12.05 and 4.24 inches above the normal, based on the period 1900-44, and the average annual departure was +1.63 inches. This departure compares with a deviation of 0.00 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 2.5 sec ft per sq mi and was not less than 0.04 sec ft per sq mi, with a median flow of 0.18 sec ft per sq mi. The minimum average daily flow of record was 6.4 sec ft on September 23, 1940.

The turbidity was not less than 20 ppm and not more than 900 ppm for the central 80 per cent of the time, with a median of 75 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 20 per cent of the time. It was below 50°F for 45 per cent and below 40°F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	70	165	210
Hardness (as $CaCO_3$)	ppm	110	230	290
Total Dissolved Minerals	ppm	150	270	300

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.59, ranging from 0.48 to 0.72, for the central 80 per cent of the time.

Since the rainfall and discharge during the period of sampling were somewhat higher than the normal, it might be deduced that the normal turbidity may be somewhat lower and the concentrations of the mineral components somewhat greater than recorded.

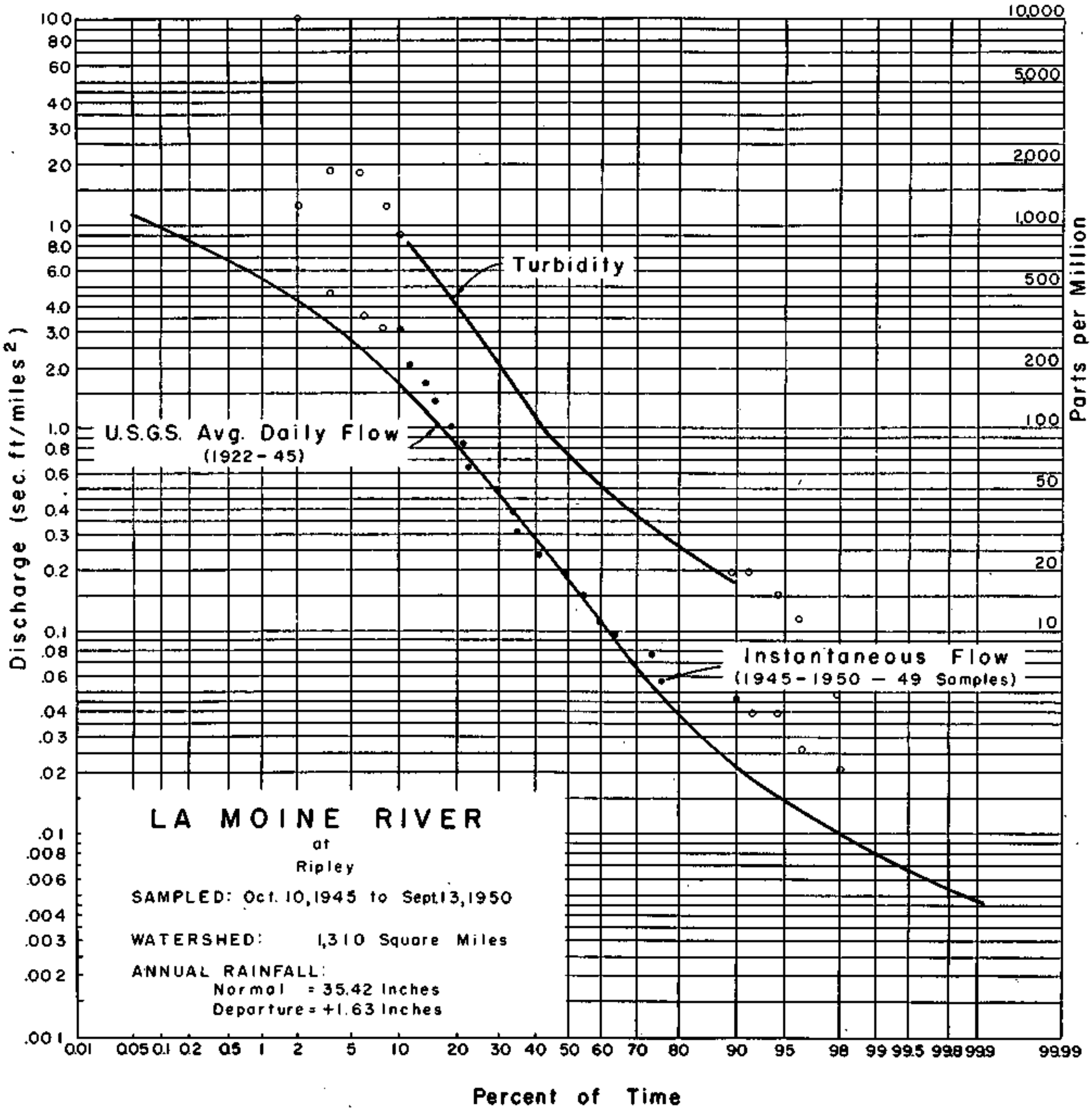

FIGURE 33 LA MOINE RIVER AT RIPLEY, DISCHARGE

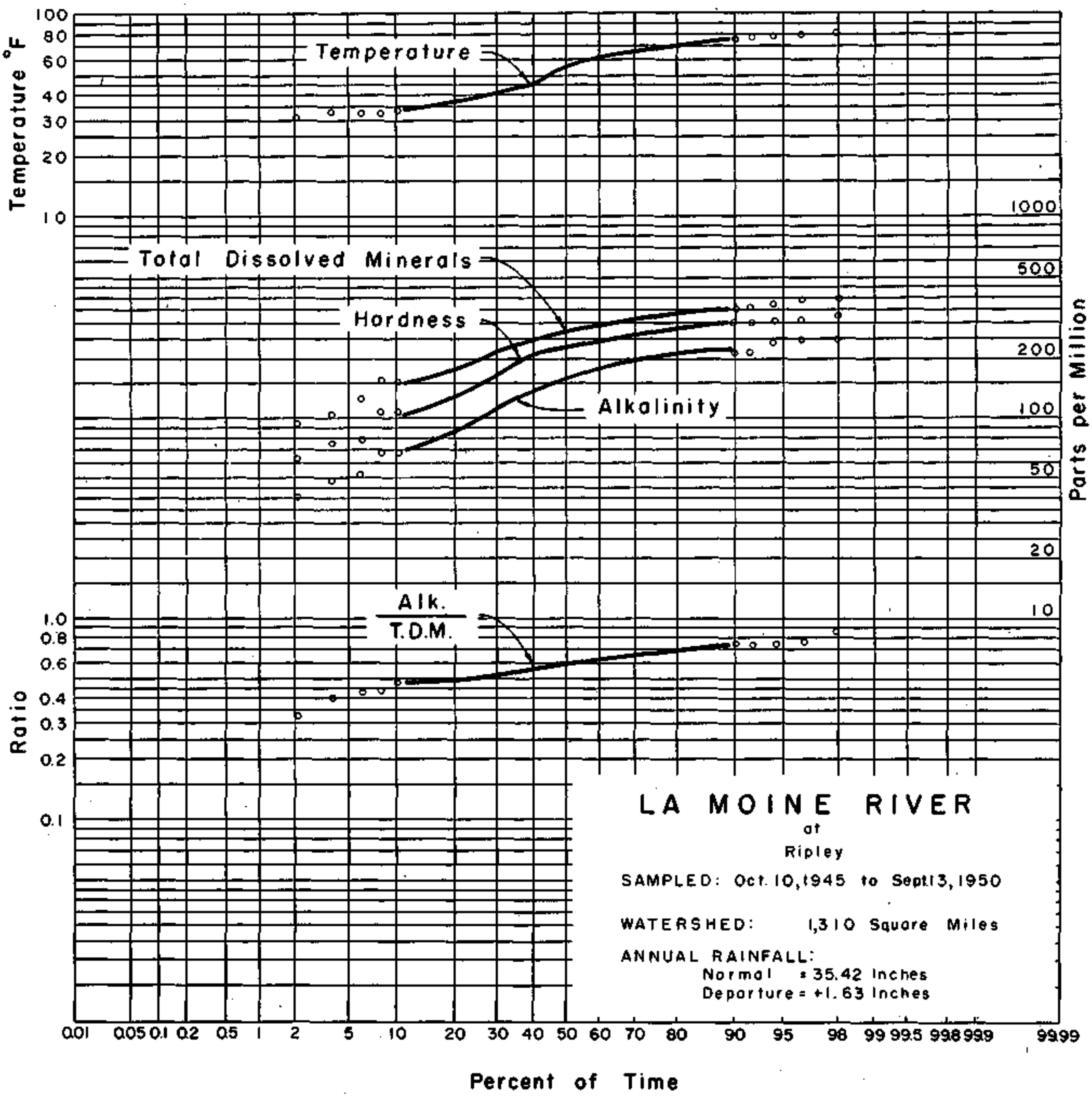

FIGURE 34 LA MOINE RIVER AT RIPLEY, QUALITY

MACOUPIN CREEK AT KANE

Macoupin Creek, which rises in northern Montgomery County, is 90 miles long and drains an area of 957 square miles. From its source to the gaging station near Kane, it is approximately 74 miles in length and has a drainage area of 875 square miles. Macoupin Creek runs generally southwest through a low valley varying from one to three miles in width. The stream winds through the hills bordering the Illinois River for ten miles before flowing into the Illinois near Titus. The main tributaries are Taylor Creek, Otter Creek, and Hurricane Creek. The elevation of the gage zero near Kane is 426.77 feet above mean sea level.

The basin lies in the Springfield Plain of the Central Lowland Province. In the northern and eastern portions of the watershed, the most important, soils are of a dark color and have heavy non-calcareous subsoils. To the east and south, dark soils with impervious subsoils, and to the north and east, dark soils with non-calcareous subsoils extend in irregular directions. The predominant soils of the entire watershed are the brownish yellow-gray, having non-calcareous subsoils. Flat areas with impervious subsoils are more or less characteristic of these areas.

A tabulation of data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 35 and 36.

Instantaneous flow measurements for samples collected during 1945-50 were appreciably greater than those indicated by the average daily flow records during 1928-33 and 1941-45.[17] Rainfall at Medora and Carlinville during the period of collection [21] was respectively 18.65 and 10.25 inches above normal, based on the period 1900-44, and the average annual departure was +2.90 inches. This departure compares with a deviation of +0.06 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 2.0 sec ft per sq mi and was not less than 0.015 sec ft per sq mi, with a median flow of 0.18 sec ft per sq mi. The minimum average daily flow of record was 1.0 sec ft on September 29, and October 3, 5, and 15, 1922.

The turbidity was not less than 15 ppm and not more than 800 ppm for the central 80 per cent of the time, with a median of 70 ppm.

The reported temperature was over 80°F for 10 per cent and over 70 F for 25 per cent of the time. It was below 50°F for 40 per cent and below 40°F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	80	200	250
Hardness (as $CaCO_3$)	ppm	130	260	345
Total Dissolved Minerals	ppm	180	320	430

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.55, ranging from 0.45 to 0.70, for the central 80 per cent of the time.

Since the rainfall and discharge during the period of sampling were somewhat higher than normal, it might be deduced that the normal turbidity may be somewhat lower and the concentrations of the mineral components somewhat greater than recorded.

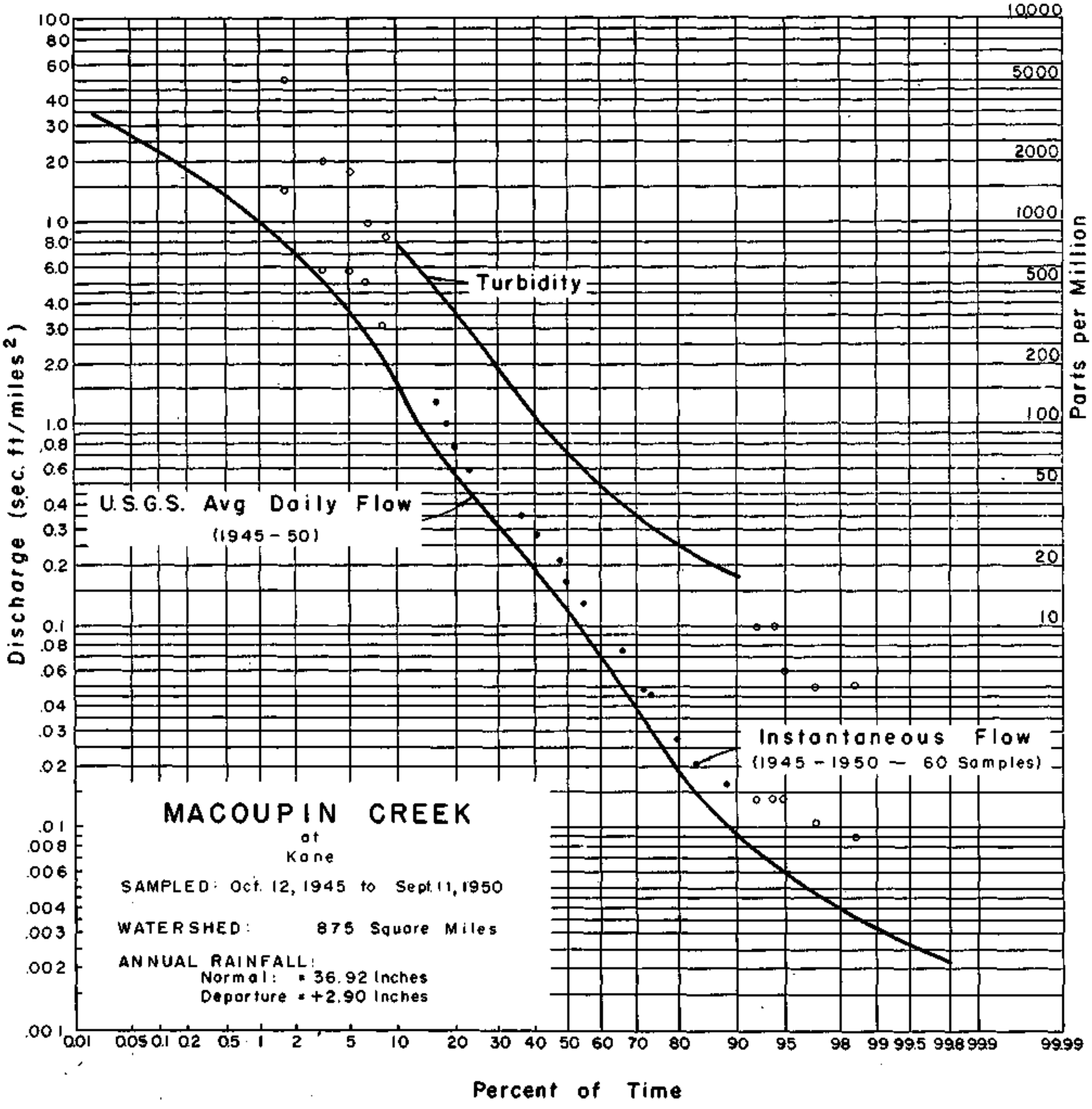

FIGURE 35 MACOUPIN CREEK NEAR KANE, DISCHARGE

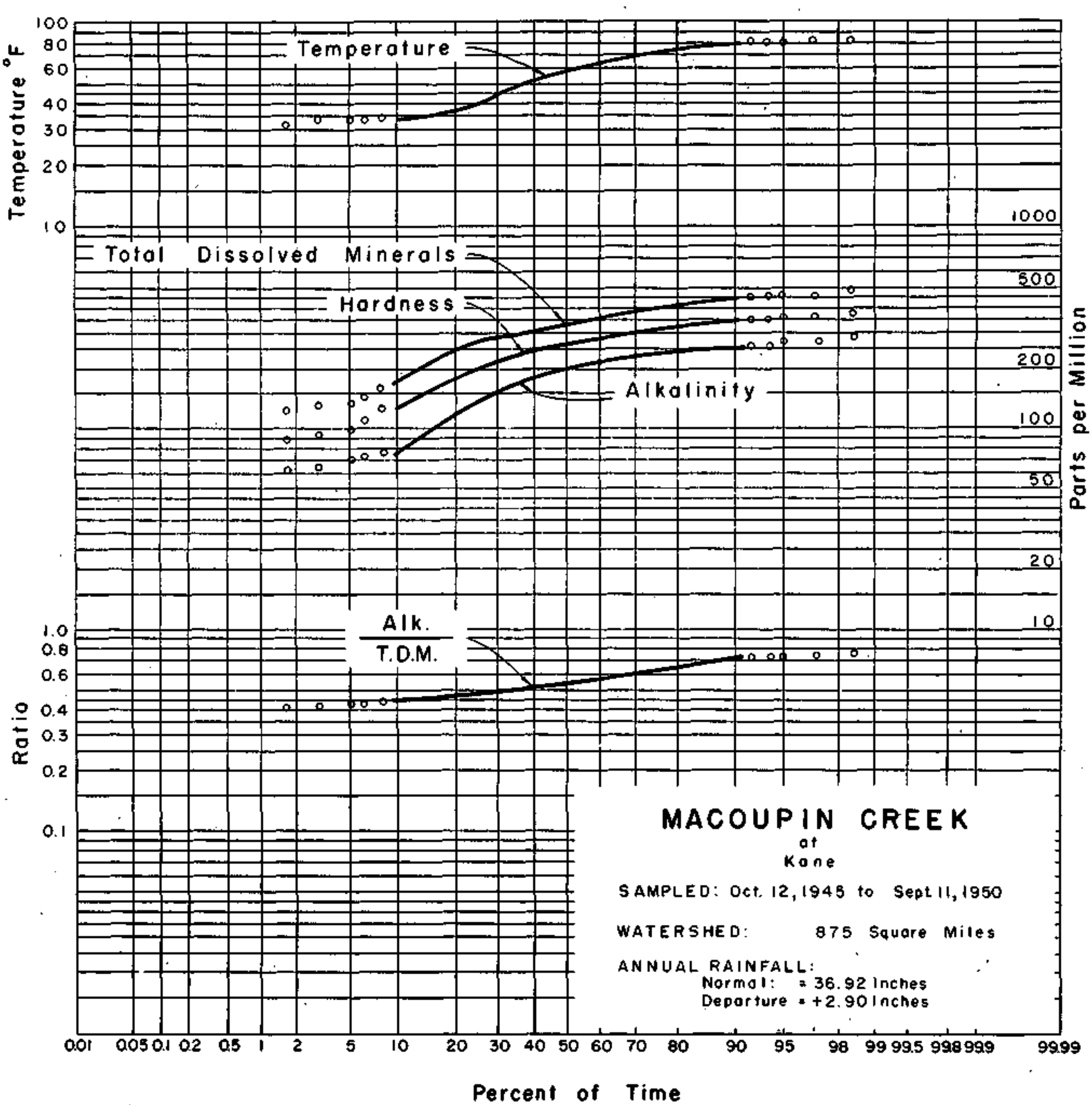

FIGURE 36 MACOUPIN CREEK NEAR KANE, QUALITY

INDIAN CREEK AT WANDA

Indian Creek [28] rises near Bunker Hill in Macoupin County. It flows in a southerly direction and empties into the Cahokia Creek and Diversion Channel and then into the Mississippi River. Above Wanda, the drainage area is 37 square miles. The elevation of the gage zero at Wanda is 431.52 feet above mean sea level.

The watershed lies in the Springfield Plain Section of the Central Lowland Province. In general, the soils are dark, and flat areas with impervious subsoils are more or less characteristic.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 37 and 38.

Instantaneous flow measurements for samples collected during 1945-50 were somewhat greater than those indicated by the average daily flow records during 1941-49.

Rainfall at Edwardsville during the period of collection [21] was 48.21 inches above normal, based on the period 1900-44, and the average annual departure was +9.64 inches. The departure compares with a deviation of 0.05 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 0.8 sec ft per sq mi and was not less than 0.01 sec ft per sq mi, with a median flow of 0.15 sec ft per sq mi. The minimum average daily flow of record was 0.0 sec ft for a number of days in 1940-41, 1944, 1948, 1953-54.

The turbidity was not less than 12 ppm and not more than 250 ppm for the central 80 per cent of the time, with a median of 52 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 25 per cent of the time. It was below 50°F for 45 per cent and below 40°F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	125	210	245
Hardness (as $CaCO_3$)	ppm	180	300	350
Total Dissolved Minerals	ppm	250	380	430

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.51, ranging from 0.45 to 0.65, for the central 80 per cent of the time.

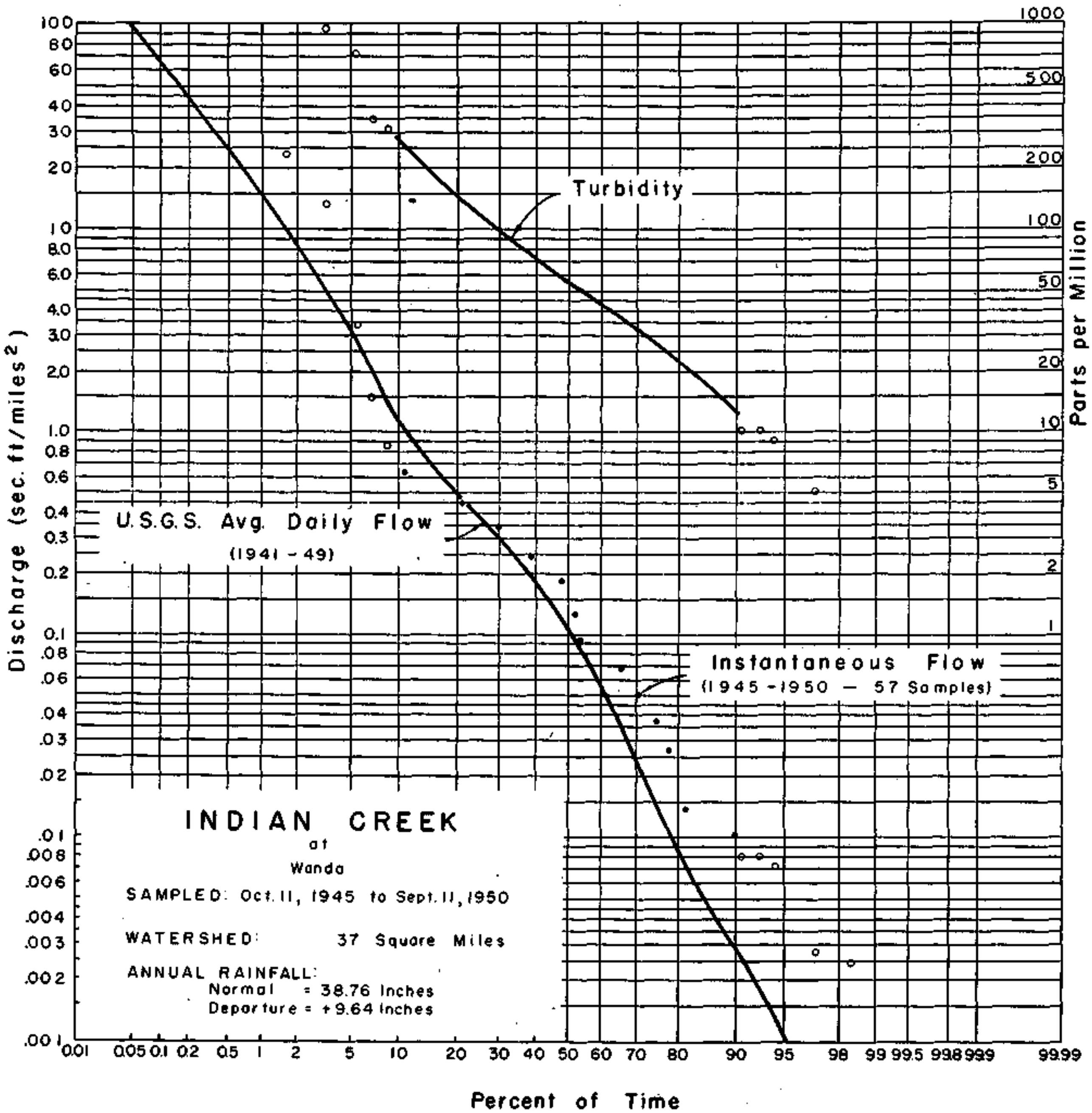

FIGURE 37 INDIAN CREEK AT WANDA, DISCHARGE

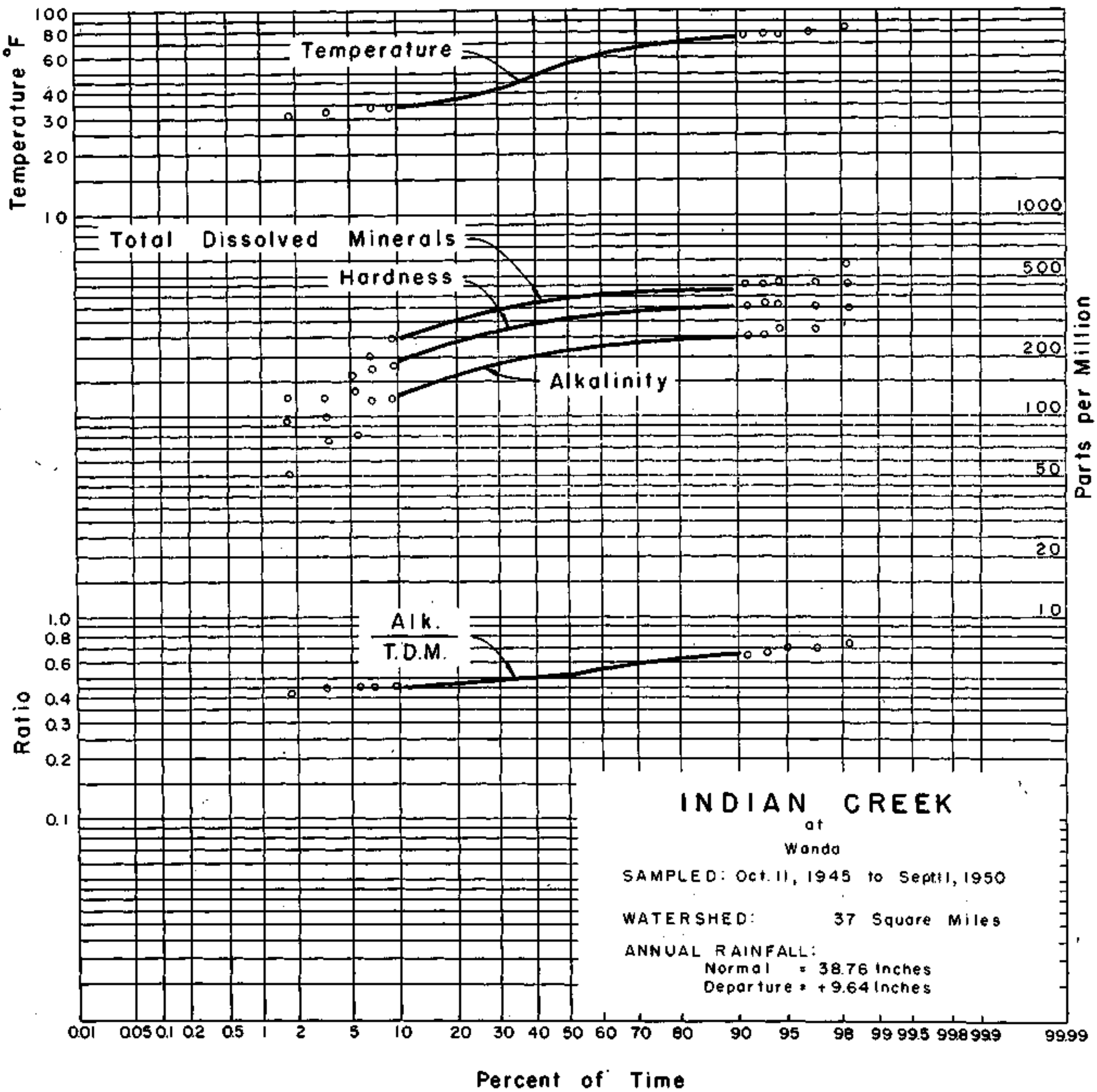

FIGURE 38 INDIAN CREEK AT WANDA, QUALITY

LITTLE WABASH RIVER AT WILCOX

The Little Wabash River[25] originates in the foothills of Moultrie, Douglas, and Coles Counties; flows south for 160 miles through the southern half of the Wabash basin, and empties into the Wabash near the southern boundary line of White County. Its main tributaries, omitting Skillet Fork which is discussed separately, are Elm Creek and Muddy Creek. The topography of the watershed, which has an area of 2,237 square miles, is rolling in the upper reaches but flattens as the river enters the Wabash valley.

The soil in the watershed of the Little Wabash is almost entirely gray with a moisture-resisting, non-calcareous subsoil which is strongly acid. Productiveness is relatively low, and drainage presents a problem on the level areas because the subsoil is too tight to permit adequate under-drainage. Erosion is difficult to control on the rolling land.

This report is concerned with the upstream .1,130 square miles of drainage area and upstream 65 miles of river. The elevation of the gage zero at Wilxox is 392.29 feet above mean sea level.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 39 and *40.*

Instantaneous flow measurements for samples collected during 1950-56 were reasonably similar to those indicated by the average daily flow records during 1930-45 [17] except for very low flows which occurred with apparent greater frequency. Rainfall at Effingham and Newton during the period of collection was respectively 27.42 and 30.50 inches below normal, based on the period 1900-44, and the average annual departure was -5.05 inches. This departure compares with a deviation of 0.00 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 2.0 sec ft per sq mi and was not less than 0.002 sec ft per sq mi, with a median flow of 0.085 sec ft per sq mi. The minimum average daily flow of record was 0.09 sec ft on October 30, 1944.

The turbidity was not less than 10 ppm and not more than 200 ppm for the central 80 per cent of the time, with a median of 35 ppm.

The reported temperature was over 80°F for 10 per cent and over 70 F for 30 per cent of the time. It was below 50°F for 55 per cent and below 40°F for 30 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and. total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	60	105	195
Hardness (as $CaCO_3$)	ppm	90	175	285
Total Dissolved Minerals	ppm	170	290	445

The median proportion of alkalinity to total dissolved minerals for individual samples was *0.4,* ranging from 0.25 to 0.55, for the central 80 per cent of the time.

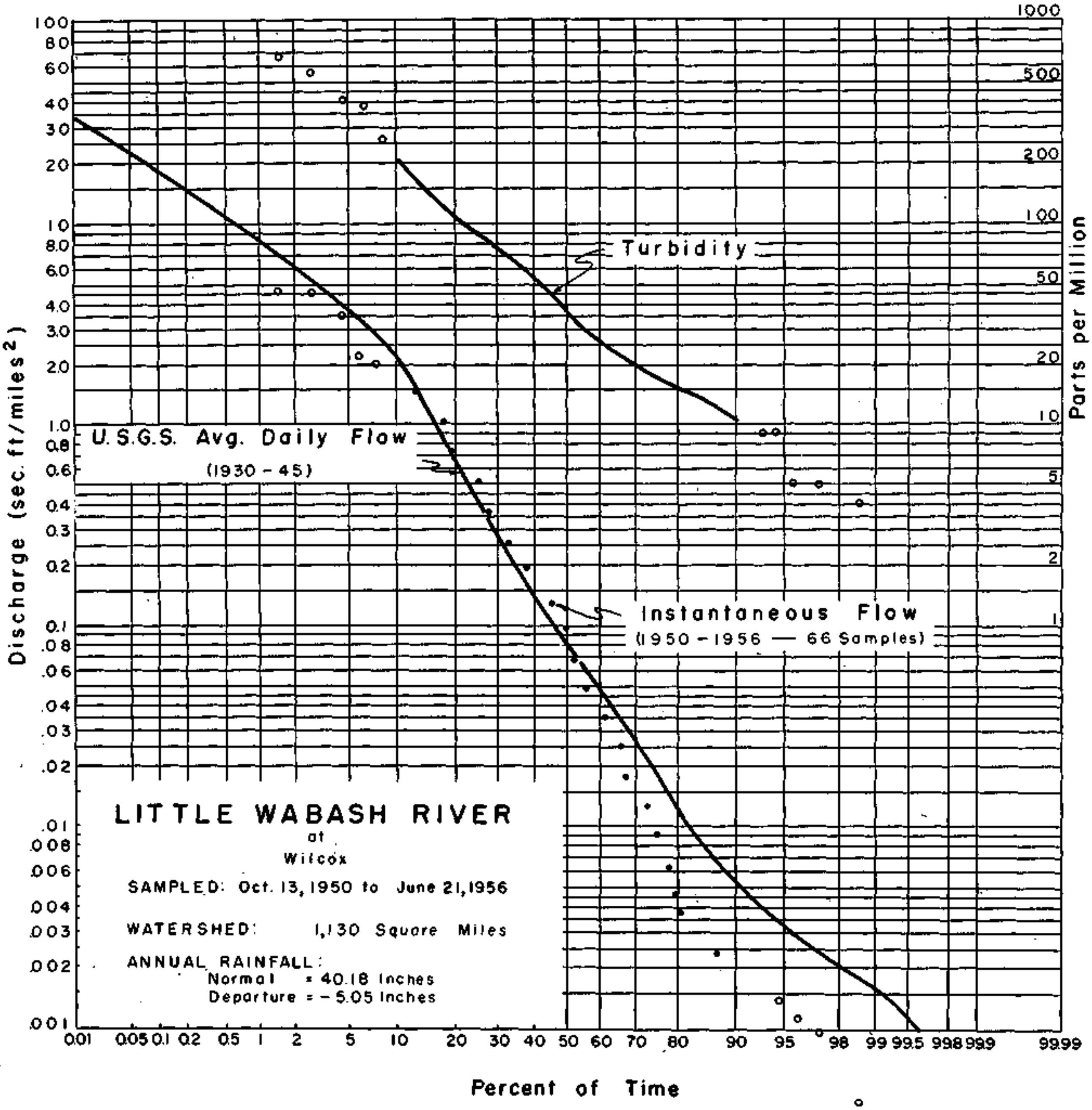

FIGURE 39 LITTLE WABASH RIVER AT WILCOX, DISCHARGE

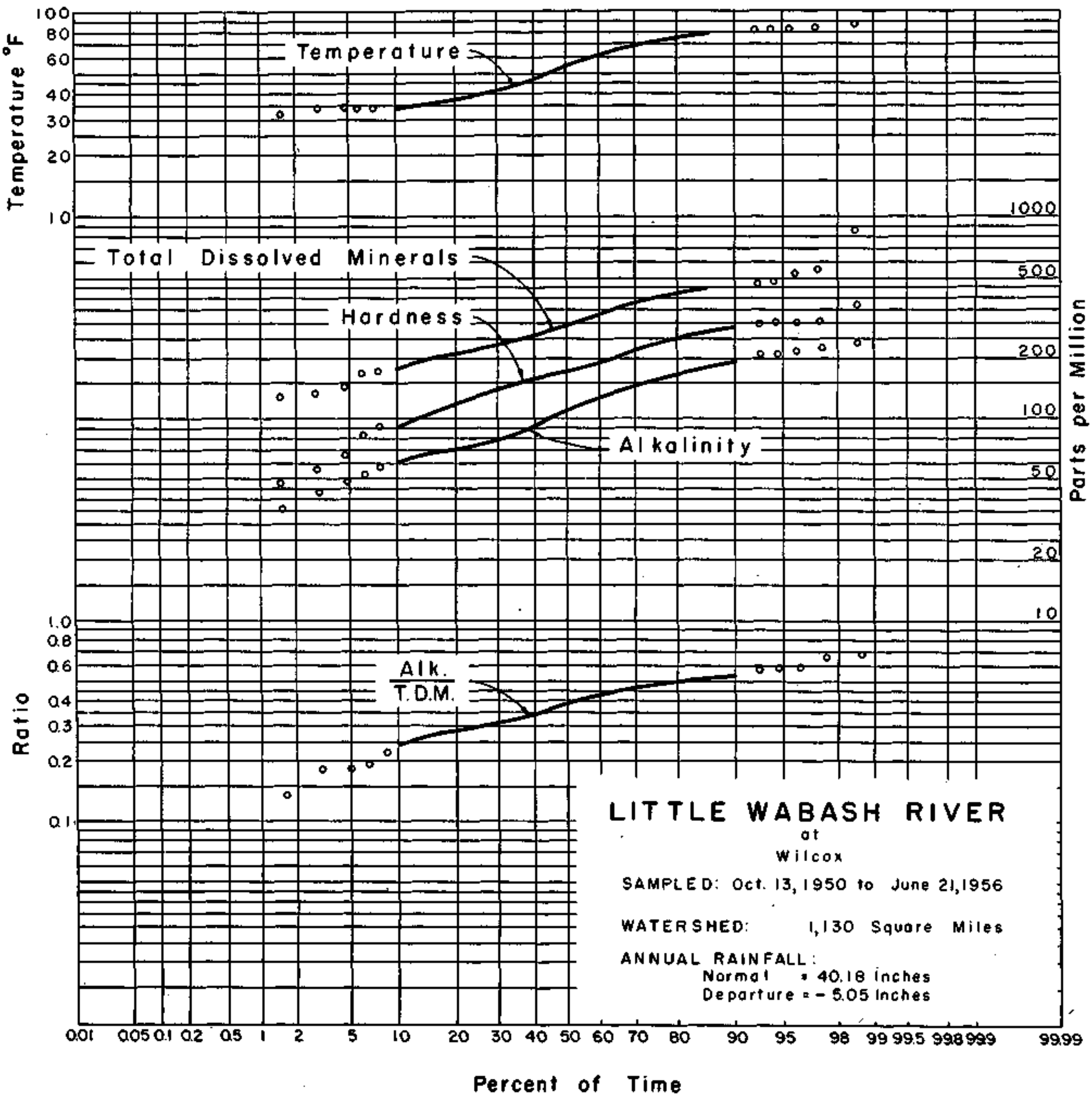

FIGURE 40 LITTLE WABASH RIVER AT WILCOX, QUALITY

SKILLET FORK AT WAYNE CITY

Skillet Fork,[25] a tributary of the Little Wabash, rises in the northern portion of Clay and Marion Counties. It flows southeast for 78 miles and empties into the Little Wabash River in White County. The Skillet Fork watershed, with an area of 1,047 square miles, is in the southernmost part of the Little Wabash basin. This report deals with 475 square miles of drainage and 43 miles of river upstream from Wayne City. The elevation of the gage zero at Wayne City is 383.15 feet above mean sea level.

The topography is slightly rolling in the extreme upper reaches but comparatively flat in most of the remaining area. The soil like that adjacent to the Little Wabash is almost entirely gray with a moisture-resisting, non-calcareous subsoil.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 41 and 42.

Instantaneous flow measurements for samples collected during 1945-50 were appreciably greater than those indicated by the average daily flow records during the period 1909-12, 1915-21, and 1929-45.[17] Rainfall at Wayne City during the period of collection was 19.13 inches above the normal, based on the period 1900-44, and the average annual departure was +3.83 inches. This compares with a deviation of +0.08 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80, per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 4.0 sec ft per sq mi and was not less than 0.02 sec ft per sq mi, with a median flow of 0.13 sec ft per sq mi. The minimum average daily flow of record was 0.00 sec ft for a number of days in 1909, 1911, 1934, 1954.

The turbidity was not less than 20 ppm and not more than 260 ppm for the central 80 per cent of the time, with a median of 60 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 20 per cent of the time. It was below 50°F for 40 per cent and and below 40°F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	17	58	100
Hardness (as $CaCO_3$)	ppm	60	170	255
Total Dissolved Minerals	ppm	110	350	430

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.2, ranging from 0.12 to 0.38, for the central 80 per cent of the time.

Since the rainfall and discharge during the period of sampling were higher than normal, it might be deduced that the normal turbidity may be somewhat lower and the concentrations of the mineral components somewhat greater than recorded.

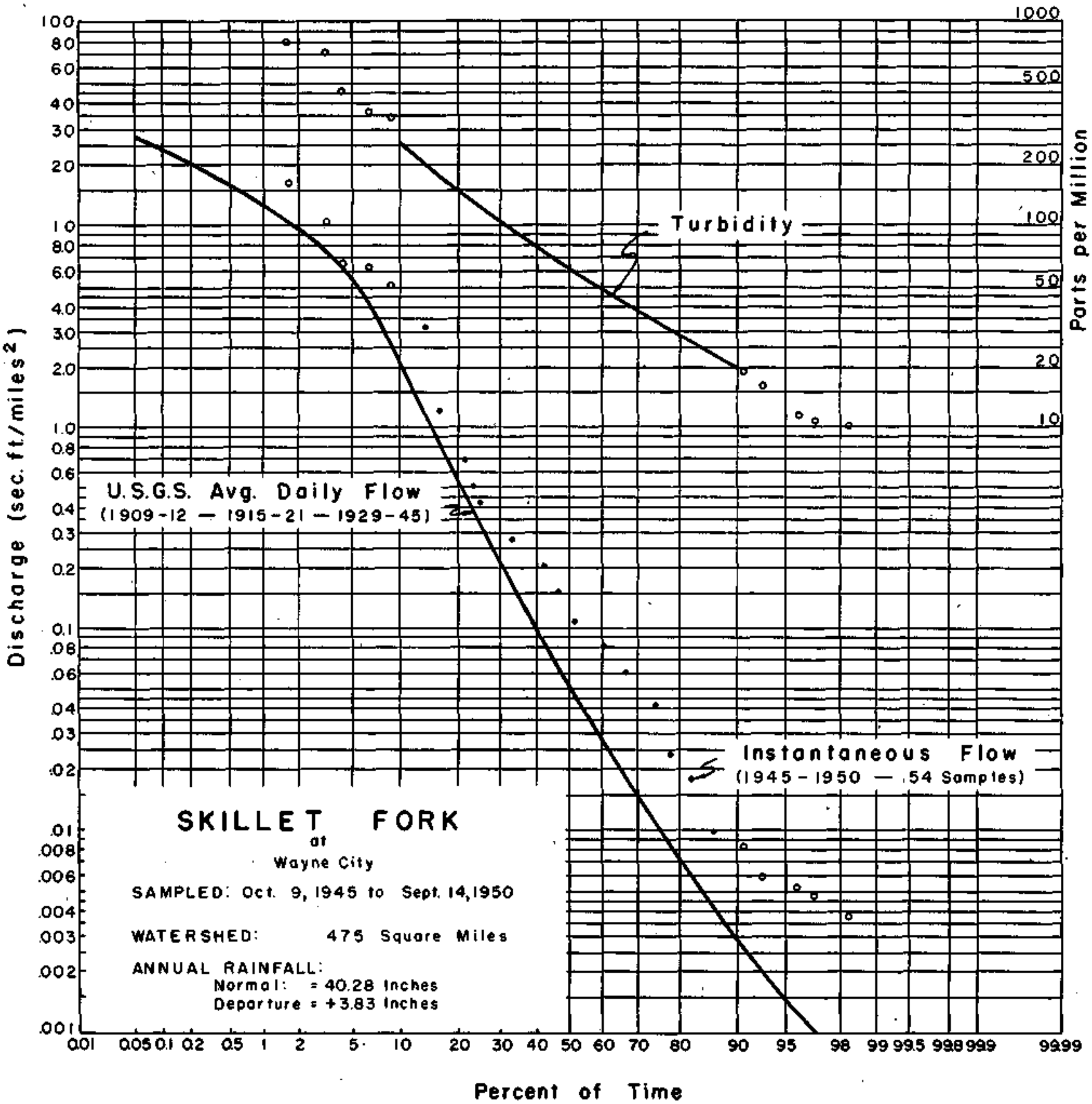

FIGURE 41 SKILLET FORK AT WAYNE CITY, DISCHARGE

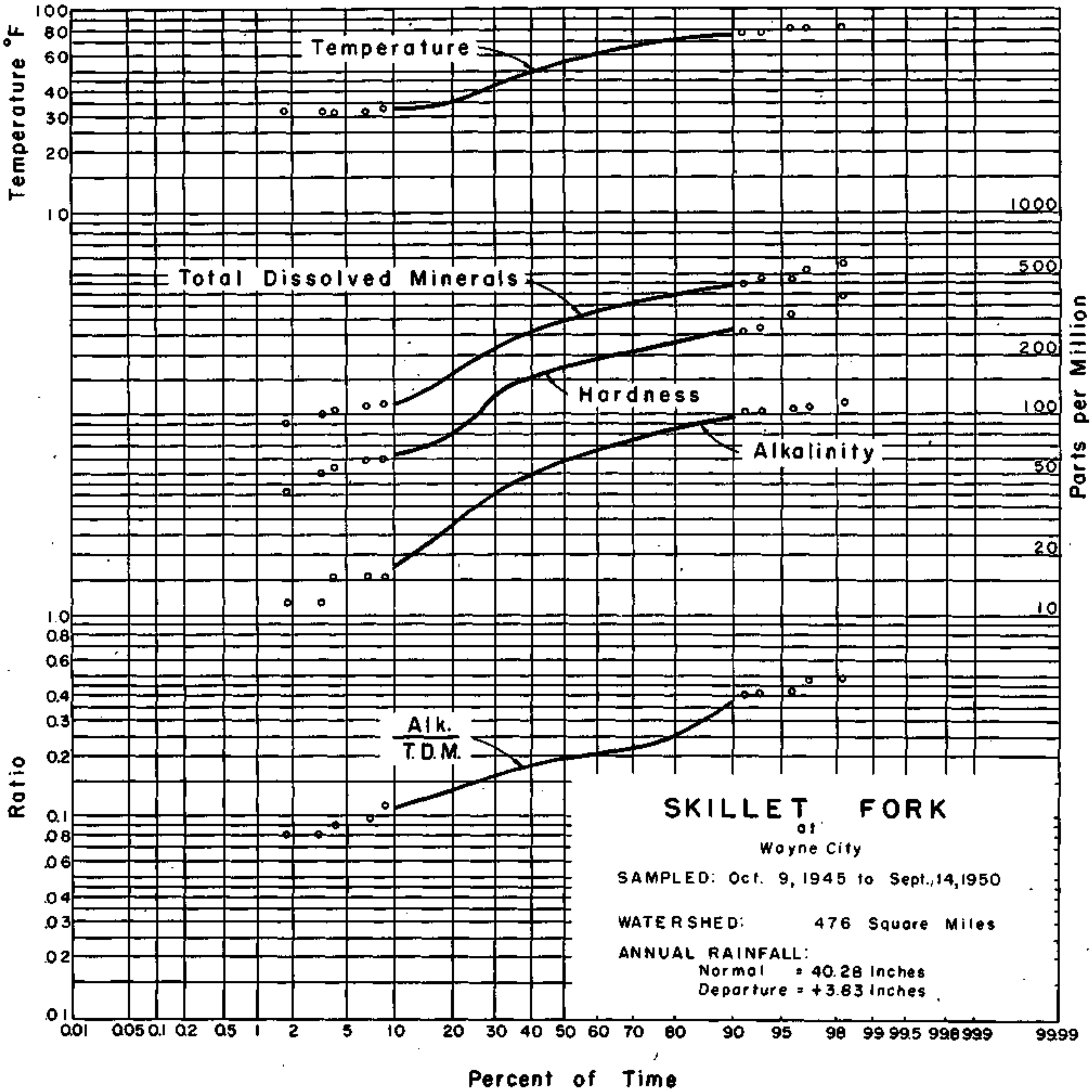

FIGURE 42 SKILLET FORK AT WAYNE CITY, QUALITY

BIG MUDDY RIVER AT PLUMFIELD

The Big Muddy River rises in the northwestern part of Jefferson County, flows southward to the mouth of Pond Creek, southwesterly to a point about five miles west of Murphysboro, and thence southward to its junction with the Mississippi River about 40 miles north of Cairo. It is 111 miles long, with Little Muddy River, Middle Fork, Craborchard Creek, Beaucoup Creek, Kinkaid Creek and Pond Creek as the principal tributaries. The elevation of the gage zero at Plumfield is 358.30 feet above mean sea level. At this station the drainage area is 741 square miles.

The basin lies in the Mount Vernon Hill country of the Central Lowland Province. The entire area lies in a pre-glacial valley, with the rock structure classification as follows: parallel to the Mississippi and extending to the bluffs, the formation is Quaternary, interrupted for a short distance below Cape Girardeau by an outthrust of older rock. The bluffs are Devonian. Extending eastward beyond the bluffs, the formation of the entire watershed is Carboniferous shale and limestone, except in the area forming the bottom lands of the basin where it is of Quaternary origin. Throughout the entire area a thin loess overlies deposits of Illinois drift, which is strongly leached. On the lowlands, weathering developed the drift into a plastic, slowly permeable material known as gumbotil.

In general the topography is rugged. The channels of the rivers are very crooked, and the bottom lands are frequently overflowed. A considerable portion of this area is wet throughout the year and cannot be cultivated.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 43 and 44.

Instantaneous flow. measurements for samples collected during 1945-50 were appreciably greater than those indicated by the average daily flow records during the periods 1909-12 and 1915-45.[17] Rainfall at Mt. Vernon and Benton during the period of collection[21] was respectively 43.73 and 40.80 inches above normal, based on the period 1900-44, and the average annual departure was +8.45 inches. This departure compares with a deviation of 0.17 sec ft per sq mi in the median flow of the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 5.8 sec ft per sq mi and was not less than 0.014 sec ft per sq mi, with a median flow of 0.26 sec ft per sq mi. The minimum average daily flow of record was 0.00 sec ft at times in 1914, 1936, 1940-41.

The turbidity was not less than 30 ppm and not more than 190 ppm for the central 80 per cent of the time, with a median of 80 ppm.

The reported temperature was over 80°F for 10 per cent and over 70°F for 25 per cent of the time. It was below 50°F for 35 per cent and below 40°F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	8	33	68
Hardness (as $CaCO_3$)	ppm	60	145	300
Total Dissolved Minerals	ppm	140	300	700

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.095, ranging from 0.045 to 0.2, for the central 80 per cent of the time.

Since the rainfall and discharge during the period of sampling was higher than normal, it might be deduced that the normal turbidity may be somewhat lower.

It should be noted that the mineral content at this sampling point appears to be far different from that of other streams sampled in Illinois, with the exception of the Saline River at Junction. It is not only highly variable in total dissolved minerals but also in hardness. The particularly noticeable characteristic is the very low proportion of alkalinity to total dissolved minerals. The range of alkalinity is far below that of other streams.

If the equivalents of sulfate are added to the equivalents of alkalinity, the totals are very close to the equivalents of hardness. This may be an indication of the presence of acid mine waste or drainage in this watershed during the period of sample collection. A great variability of chloride is also noted, the salt content being recorded as high as 500 ppm (as NaCl) for the sample collected October 2, 1946.

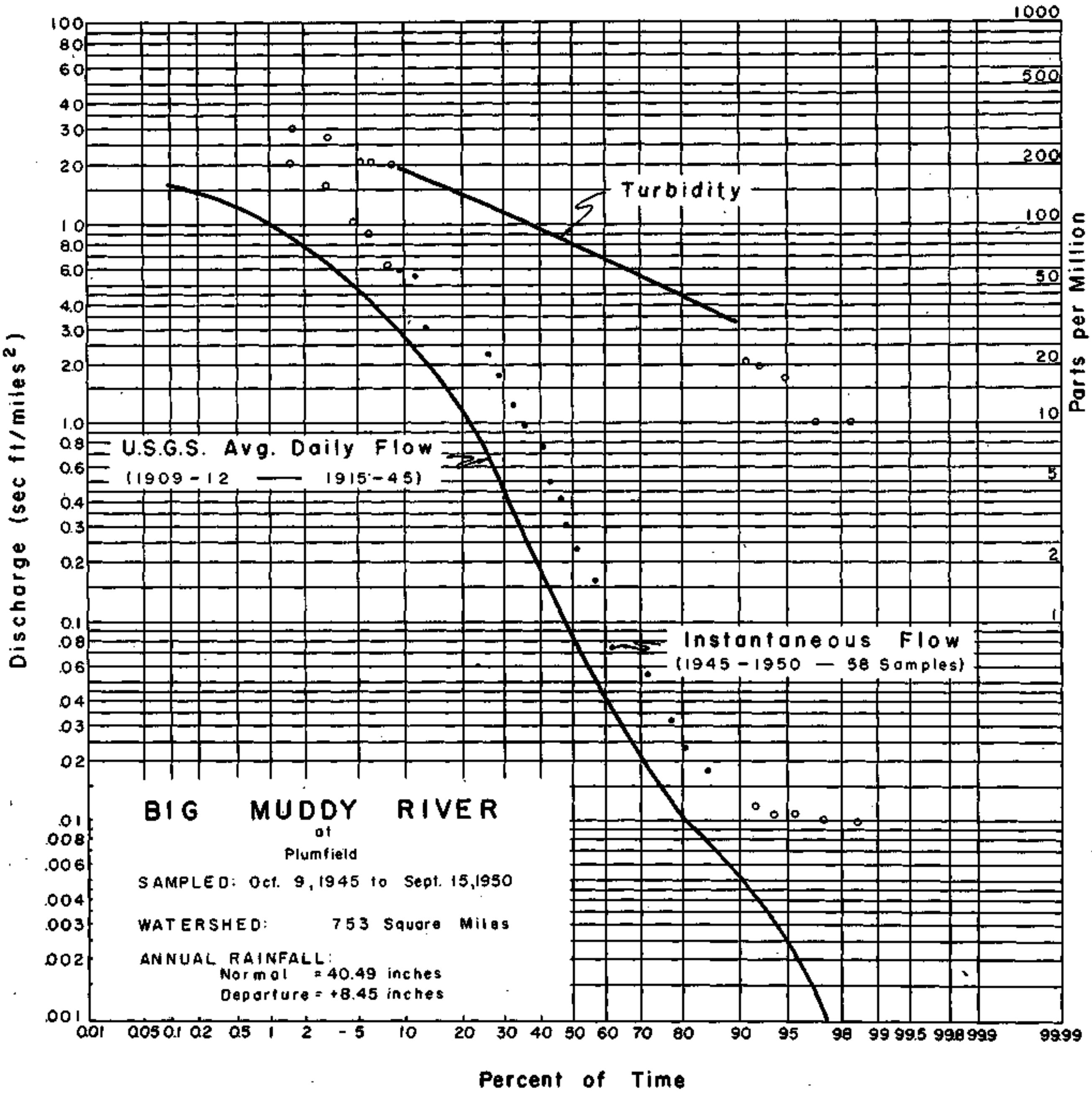

FIGURE 43 BIG MUDDY AT PLUMFIELD, DISCHARGE

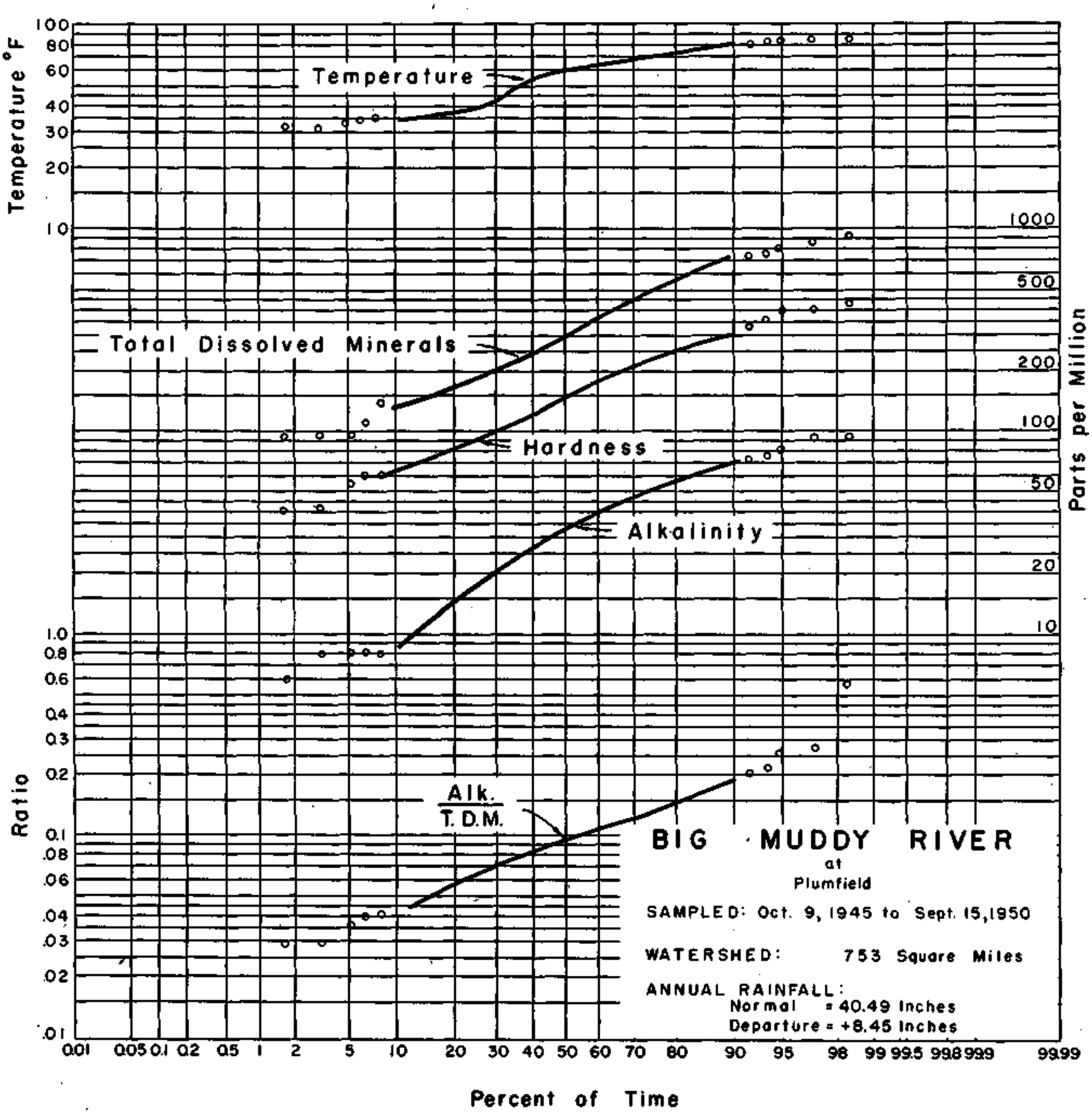

FIGURE 44 BIG MUDDY AT PLUMFIELD, QUALITY

SALINE RIVER AT JUNCTION

The Saline River which is 62 miles long and drains 1,268 square miles, is formed by three main tributaries: the North Fork, Middle Fork, and South Fork. There are 1,040 square miles of drainage area upstream from Junction, Illinois. The elevation of the gage zero at this point is 320.40 feet above mean sea level. The North Fork rises in central Hamilton County and flows south through a flat plain, emptying into the Saline about one mile east of Equality. Rising in the northeast quarter of Williamson County, the Middle Fork flows southeast through a wide, flat valley and joins the Saline about five miles north of Somerset. The South Fork originates in the south central part of Williamson County and flows eastward through the southern portion of Williamson and Saline Counties to its confluence with the Middle Fork, north of Somerset. From its source to a point about two miles northeast of Bolton, the South Fork flows through rolling country. The valley then widens and the river winds between isolated small hill's for some eight miles until the valleys of these streams merge about six miles above the confluence of the South and Middle Forks.

From the confluence of the Middle Fork and South Fork, the Saline flows northeast to a point near Equality, where the North Fork joins, and then, turning southeast, the river empties into the Ohio about ten miles south of Shawneetown. South of the Saline River, the region is very hilly; but to the north, including the North Fork watershed, it is generally flat.

The flat lands north of the Saline are mainly of yellowish-gray soil with a non-calcareous subsoil. Most of Gallatin County consists of sandy loam and sand with areas of swamp. The watershed is largely confined to the Mount Vernon Hill country, however, the river discharges into the Ohio in the Shawnee Hills Section. The whole watershed lies in the Central Lowland Province.

A tabulation of the data may be found in the Appendix. The discharge and quality data are graphically summarized in Figures 45 and 46.

Instantaneous flow measurements for samples collected during 1945-50 were appreciably greater than those indicated by the average daily flow records during 1940-48. [17] Rainfall at McLeansboro and Junction during the period of collection [21] was respectively 47.52 and 24.78 inches above normal, based on the period 1900-44, and the average annual departure was +7.23 inches. This departure compares with a deviation of +0.17 sec ft per sq mi in the median flow for the sampling period from the long-term median flow.

For 80 per cent of the time in the region between 10 and 90 per cent, the flow did not exceed 4.0 sec ft per sq mi and was not less than 0.02 sec ft per sq mi, with a median flow of 0.26 sec ft per sq mi. The minimum average daily flow of record during non-backwater periods was 0.9 sec ft on September 22-23, 1944.

The turbidity was not less than 25 ppm and not more than 225 ppm for the central 80 per cent of the time, with a median of 55 ppm.

The reported temperature was over 80°F for less than 10 per cent and over 70°F for 25 per cent of the time. It was below 50°F for 35 per cent and below 40°F for 20 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Alkalinity (as $CaCO_3$)	ppm	25	70	150
Hardness (as $CaCO_3$)	ppm	80	270	600
Total Dissolved Minerals	ppm	150	500	900

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.15, ranging from 0.08 to 0.27, for the central 80 per cent of the time.

The quality of water from the Saline River at Junction is highly variable and the proportion of ionic components was not uniform throughout the range of total dissolved solids. The mineral composition is affected by backwater from the Ohio River, by drainage from active and inactive coal mines and strip mines, and by possible brines from oil fields and flowing salt wells in the drainage area. The maximum total dissolved minerals were noted to be 1,592 ppm on June 28, 1948.

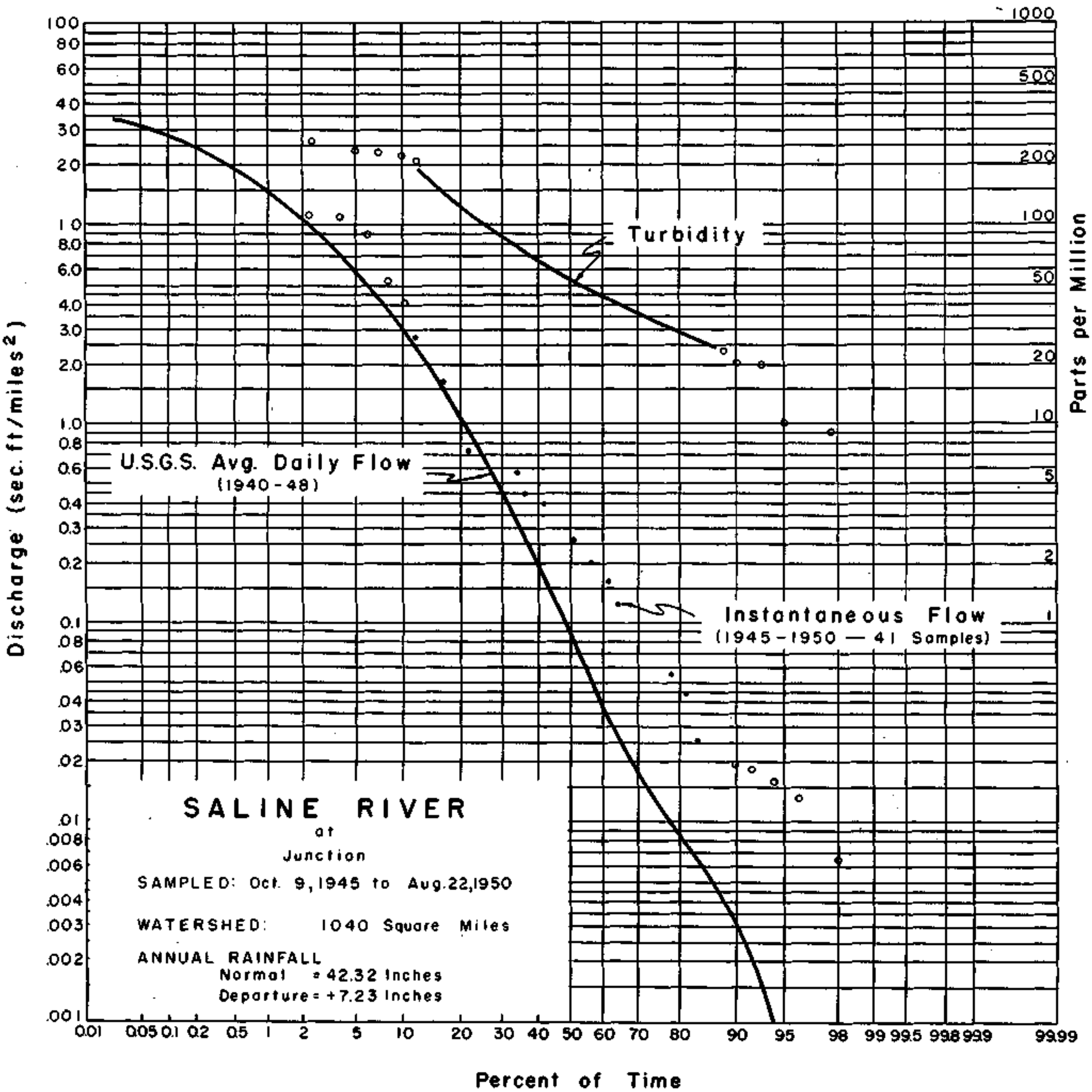

FIGURE 45 SALINE RIVER AT JUNCTION, DISCHARGE

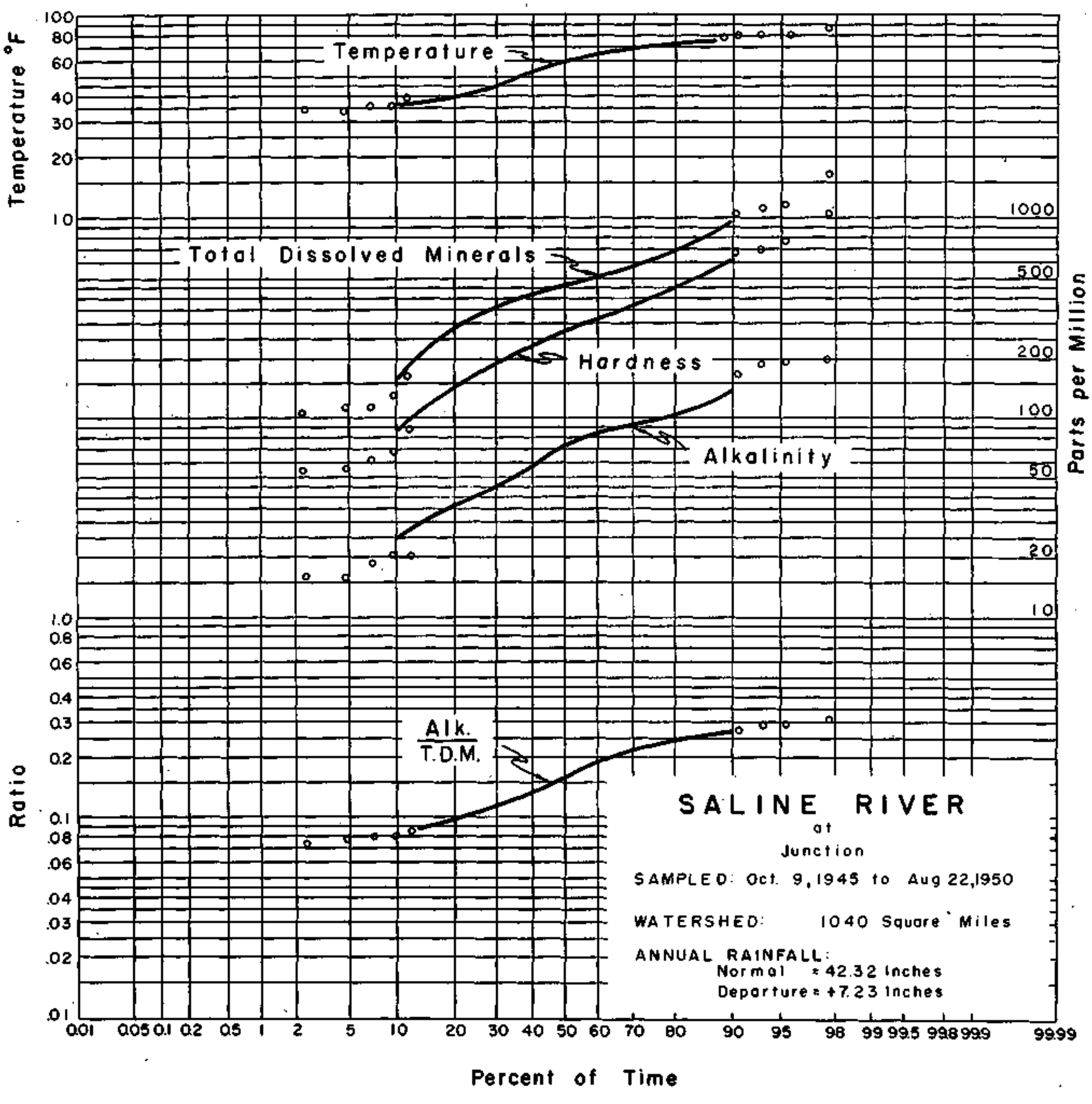

FIGURE 46 SALINE RIVER AT JUNCTION, QUALITY

CRAB ORCHARD LAKE AT WOLF CREEK AND STATION R5

Crab Orchard Lake is the largest man-made lake in Illinois. It was constructed in the late 1930's for recreational and water supply uses.

The major portion of Crab Orchard Lake watershed is in Williamson County but it extends on the south into Union and Johnson Counties and on the west into Jackson County. The total land area of the watershed, excluding lakes, is 118,137 acres or 184.59 square miles.

The northern portion of the watershed is in the glaciated Mt. Vernon Hill Country and the southern portion is in the unglaciated Shawnee Hills Section. In general, the southern portion has greater elevation and rougher topography than the northern part.

Loess cover from which most of the upland soils developed (except those on very steep slopes) is thickest in the southwest part of the watershed and thinnest in the northeast part. Actual loess thicknesses on gently sloping, uneroded areas vary from about 150 inches in the southwest to about *40* inches in the northeast part of the watershed. The northern portion of the watershed was glaciated and in this area the loess is underlain by leached glacial till of Illinoian age. The southwestern part of the watershed, in general, was not glaciated although it is evident in many places, especially near the northern boundary, that the glacier extended into many of the major valleys. In general, the loess in the southwestern part is underlain either by a residual soil, developed from the weathering of sandstone bedrock or by sandstone bedrock itself.

The lake is approximately nine miles long extending in an easterly direction from the dam. It varies in width from about one and one-half miles in the western part to about one-half mile at the easternmost end. • About two miles upstream from the dam, two major sidearms with widths of one-half to three-quarters of a mile extend northward from the lake for about two miles. About six miles upstream from the main dam, another major arm about three-quarters of a mile wide extends about four miles directly southward. This arm of the lake is fed by two major streams, Little Grassy Creek and Big Grassy Creek. About six miles upstream from the dam, Wolf Creek, a major tributary, enters the lake from the south. The main drainage area above the lake is to the east and is drained by Craborchard Creek proper.

The dam is of earth-fill construction with rock riprap on the upstream face. It is 3,000 feet in length and has a maximum height of 50 feet above the elevation of the stream bed of the former Craborchard Creek. The top of the dam is at elevation 415 feet above mean sea level and is 12 feet in width. The dam has a 3:1 and 2.5:1 slope on the upstream face and a 2:1 slope on the downstream face. The spillway is located at the south end of the dam where the bedrock outcrops. The concrete spillway has a length of 450 feet and a crest elevation of 405 feet above mean sea level.

Samples were collected at Wolf Creek Road Bridge, somewhat more than half the length of the lake east from the dam, and at Station R5, approximately one and one-half miles north-northeast from the spillway.

A tabulation of the data may be found in the Appendix. The quality data are graphically summarized in Figures 47 and 48.

The turbidity was not less than 5 ppm and not more than 10 ppm for the central 80 per cent of the time, with a median of 25 ppm at Station R5. It was not less than 11 ppm and not more than 50 ppm, with a median of 26 ppm at Wolf Creek Road Bridge.

The reported temperature at both sampling points was over 80°F for 15 per cent and over 70°F for 30 per cent of the time. It was below 50°F for 40 per cent and below 40°F for 25 per cent of the time.

The following table indicates the maximum concentrations in parts per million of alkalinity, hardness, and total dissolved minerals for 10, 50, and 90 per cent of the time.

Maximum Concentrations
for Indicated Per Cent of Time

		Per Cent		
		10	50	90
Wolf Creek Road Bridge				
Alkalinity (as $CaCO_3$)	ppm	22	42	55
Hardness (as $CaCO_3$)	ppm	100	120	140
Total Dissolved Minerals	ppm	180	210	240
Station R5				
Alkalinity (as $CaCO_3$)	ppm	20	35	50
Hardness (as $CaCO_3$)	ppm	82	97	120
Total Dissolved Minerals	ppm	150	165	220

The median proportion of alkalinity to total dissolved minerals for individual samples was 0.2, ranging from 0.1 to 0.25, for the central 80 per cent of the time at Wolf Creek Road Bridge.

The mineral quality of Crab Orchard Lake water reflects primarily two aspects of the area. The relatively low concentrations indicate a watershed that has been heavily leached by age. A similar condition exists at Lake Glendale where the total dissolved minerals are about 40 ppm. Secondly, by comparison with the quality of samples collected from rivers in this report, the variability in the range of total dissolved minerals is much less due to storage and blending of inflow with stored water.

It will also be noted that the mineralization is somewhat greater at the eastern end of the lake and that such mineralization at the western end was approached only for 35 per cent of the samples.

Iron and manganese were noted to be present in more than desirable concentration (0.3 ppm) in all samples.

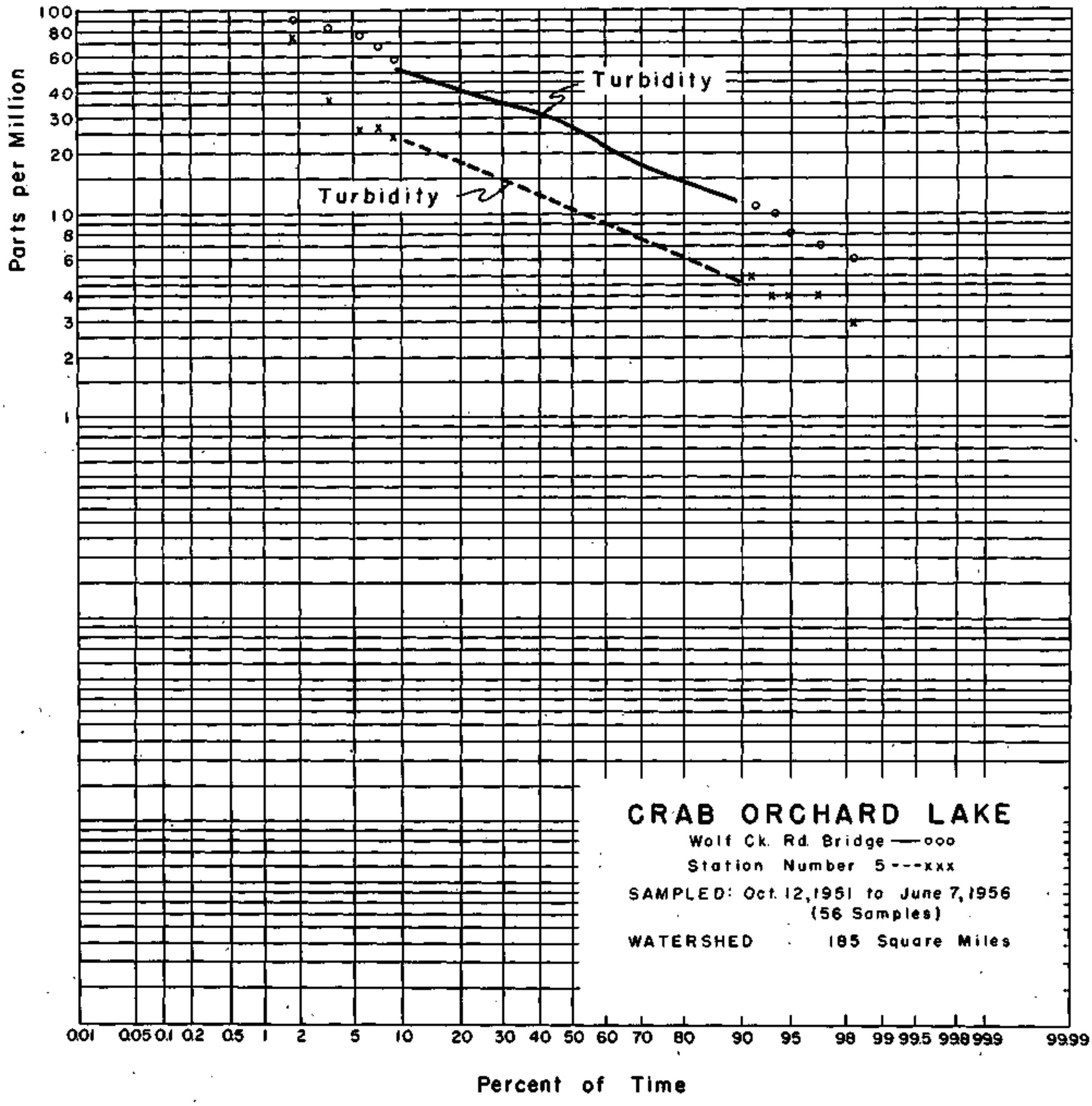

FIGURE 47 CRAB ORCHARD LAKE, WOLF CREEK AND STATION R5, TURBIDITY

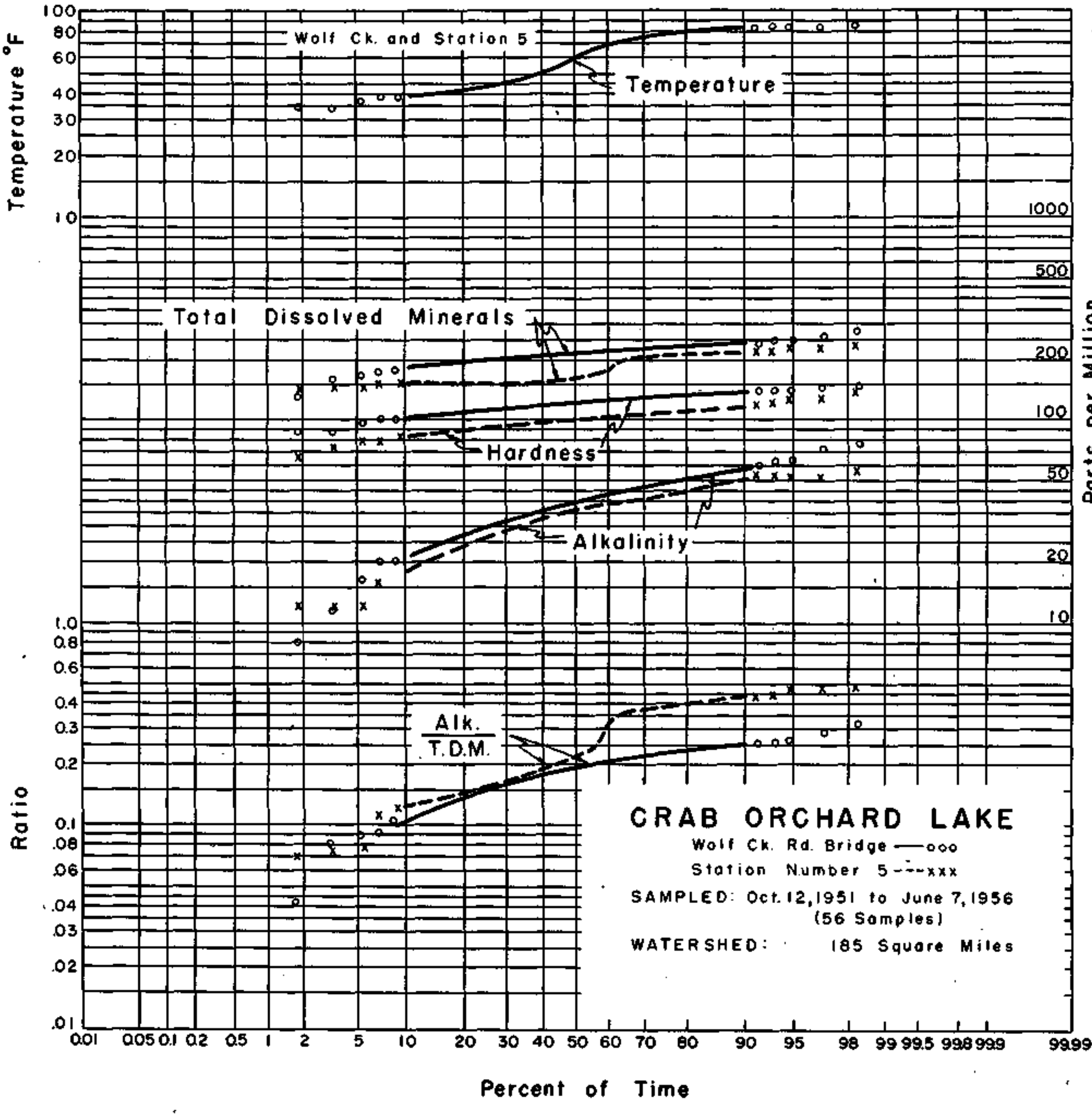

FIGURE 48 CRAB ORCHARD LAKE, WOLF CREEK AND STATION RS, QUALITY

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APPENDIX

All chemical data in parts per million

Date	Discharge	Laboratory Number	Temperature	Turbidity	Iron	Manganese	Fluoride	Boron	Silica	Chloride	Sulfate	Nitrate	Ammonium	Calcium	Magnesium	Sodium	Alkalinity (bicarbonate)	Total Hardness	Total Dissolved Minerals
	ft. sec.		°F		Fe	Mn	F	B	SiO_2	Cl	SO_4	NO_3	NH_4	Ca	Mg	Na	--(as $CaCO_3$)--		
1950																			
10-18	103,000	123421	65	685	13.0	1.1			15.3	14	75.7	4.9	T	55.4	13.4	28	152	194	317
11- 8	86,000	123582	53.5	259	5.0	0.6			15.8	18	119.3	3.5	0.2	65.1	18.7	33	160	240	369
1951																			
1- 9	101,000	124122	33	102	4.0	0.3			17.8	23	102.9	7.6	T	58.4	18.9	38	160	223	360
2-15	119,000	124410		149	7.7	0.5			12.6	16	61.5	5.7	0.1	40.8	14.4	19	112	162	238
3-13	303,000	124705	38	512	15.5	1.1			16.1	8	46.3	6.1	0.0	42.7	11.6	10	112	155	223
4-15	413,000	124887	46	763	30.8	2.4			14.4	10	46.3	5.8	0.2	47.6	12.1	11	128	169	235
5- 9		125366	58	743	28.4	1.8			23.8	9	42.6	7.8	T	46.1	10.7	13	124	160	225
6-13	410,000	125601	70	846	51.0	2.9			15.7	10	61.9	6.1	0.0	61.3	7.8	28	156	186	284
7-24	802,000	126000	81	380	13.6	0.5			16.8	7	31.5	1.0	T	41.6	6.9	13	116	133	201
9-12	344,000	126468	73.7	685	23.3	0.6			13.9	10	45.5	4.4	T	46.1	4.8	20	120	141	237
10-10	228,000	126667	65	306	10.6	0.9			13.5	16	73.4	5.1	T	57.4	11.4	26	156	263	299
11-15	305,000	127030	45	220	10.5	1.3			16.3	11	71.6	4.6	0.1	54.9	16.6	13	140	206	283
1952																			
1-10	156,000	127450	34	59	2.1	0.3	0.3		14.2	18	71.4	7.8	0.3	59.0	21.0	11	152	234	319
3-20	480,000	128250	47	685	25.0	1.9	0.3		12.4	8	53.9	9.3	0.1	44.6	12.3	13	116	162	213
3-12	308,000	128251	47	167	6.1	0.6	0.3		13.2	11	67.9	6.8	T	49.6	14.7	22	140	185	274
4-16	547,000	128480		500	20.0	1.8	0.2		11.0	8	76.5	6.6	0.1	50.1	14.5	16	124	185	259
6-11	198,000	129028	80.5	600	19.9	1.6	0.3		15.2	12	77.1	5.7	T	67.0	15.8	25	184	233	430
6-25	257,000	129099	82.2	372	11.1	0.9	0.3		32.0	9	79.0	6.0	T	57.2	16.5	24	164	211	318
7-30	162,000	129593		296	8.6	0.5	0.2		15.4	10	59.7	5.2	T	52.7	15.5	13	144	186	271
8- 6	149,000	129660	81	136	5.2	0.3	0.3		18.0	12	58.4	4.3	0.0	51.2	16.3	20	156	195	278
9-10	125,000	130229	75.5	661	19.3	1.3			13.3	11	60.9	4.0	T	45.7	12.0	12	108	164	242
10-30	74,000	130337		136	6.8	0.3	0.3		10.9	19	109.6	2.5	T	57.9	19.2	36	160	224	351
12- 3	84,300	130660		186	5.8	0.3			10.6	21	94.6	3.0	T	57.2	18.1	37	168	218	347
1953																			
1-19	69,500	131031	41	28	2.1	T			11.0	20	88.0	4.9	0.1	63.7	22.9	24	184	254	342
3- 4	179,000	131346		460	14.4	0.8	0.3		10.3	14	61.7	6.2	0.1	41.5	15.0	18	116	166	242
4- 8	337,000	131690		694	26.1	1.3	0.3		12.1	8	65.6	7.3	T	48.0	13.7	12	116	176	242

5-23	242,000	131976	46	431	15.7	0.9	0.3		9.9	10	90.5	3.9	0.1	58.5	16.1	23	152	213	310
6- 9	170,000	132217	81	343	9.3	0.7	0.4		8.8	16	91.8	1.1	T	58.6	18.5	30	168	222	339
7- 2	227,000	132407	85	685	52.8	2.8	0.5		14.1	10	134.3	5.4	0.0	65.6	19.0	44	180	242	414
8- 5	128,000	132642	82	95	3.5	0.3	0.3		13.3	13	64.6	2.0	T	46.5	17.6	16	136	189	281
9- 3	118,000	132828	80	76	1.8	0.3	0.3		9.9	15	72.7	2.8	T	48.0	16.6	29	152	188	283
10-14	67,500	133175	66	84	3.6	0.2	0.2		6.4	18	118.9	2.0	0.1	58.1	19.3	43	168	225	383
11-10	70.000	133391	72	91	3.7	0.3	0.3		7.0	17	111.1	1.7	T	57.5	19.1	40	168	223	384
12- 9	71,100	133607	46	14	2.3	T	0.3		7.1	21	74.9	3.5	0.1	55.5	21.4	29	180	227	333
1954																			
2-10	52,800	133982	48	27	2.2	0.1	0.3		11.4	26	91.9	6.2	T	64.2	20.7	44	204	246	403
3-10	79,000	134192	48	167	6.4	0.5	0.5		9.9	20	97.0	3.8	0.4	58.0	17.8	37	168	219	365
4-21	139,000	134673	49	455	11.0	0.5	0.4		8.8	14	86.4	6.9	T	54.8	21.0	18	148	224	325
5- 4	211,000	134888	52	1240	11.0	1.4	0.2		7.6	12	85.5	6.9	T	57.0	17.8	20	148	216	317
6-16	194,000	135070	72	1200	25.0	1.3		T	10.1	12	71.5	8.4	T	55	3.1	48	156	150	308
7- 7	239,000	135263	82	750	T	0.9	0.4	0.2	12.6	6	45.7	8.2	T	47.2	19.0	0	132	196	238
8-10	114,000	135635	78	102	T	0.3	0.4	0.3	9.2	15	112.3	2.8	T	50.9	17.1	38	140	198	348
9-22	120,000	135489	66	263	1.4	0.1	0.7	0.0	6.5	12	71.2	3.1	T	48.6	15.4	20	136	185	269
10- 4	113,000	136203	48	119	T	0.3	0.3	0.0	10.9	11	75.9	4.2	T	52.3	17.9	10	128	204	274
12- 7	92,000	136518	41	13	0.1	0.3	0.3	0.0	20.0	16	71.6	1.8	T	55.8	19.2	12	148	219	284
1955																			
2- 8	69,900	136898	42	44	2.8	0.1	0.3	0.0	11.6	17	80.9	4.2	0.0	66.5	23.1	12	176	262	323
5-10	137,000	137641	70	145	5.0	0.4	0.1	0.0	8.6	9	90.3	5.0	T	58.3	15.1	29	160	208	312
6-15	177,000	137915	62	500	8.6	1.2	0.2	0.0	7.0	14	80.8	3.1	T	46.4	18.5	24	140	192	285
7- 7	129,000	138105	71	950	18.0	1.6	0.1	0.0	9.6	15	64.0	3.4	0.2	50.9	15.3	16	136	191	262
8- 4	82,900	138357	81	112	7.0	0.4	0.3		14.4	16	111.5	5.1	T	53.8	18.6	35	144	211	354
9- 2	109,000	138606	67	60	2.0	0.2	0.2	0.1	7.4	17	101.2	3.8	T	51.4	19.2	33	148	208	322
10- 5	103,000	138779	62	201	1.1	T	0.2	0.1	7.2	19	95.2	4.1	T	46.9	16.3	37	136	185	318
11- 2	82,100	139003	52	84	3.4	0.4	0.2	0.0	7.2	19	105.5	4.5	T	58.8	16.8	32	144	216	335
12- 1	52,900	139211	44	45	1.9	0.1	0.2	0.4	7.4	22	79.4	5.4	T	54.8	18.3	34	168	212	331
1956																			
2-15	69,700	139892		600	19.0	1.9	0.2	0.2	9.5	20	66.4	4.2	0.8	43.0	17.1	34	152	178	291
2-29	88,200	139960	41	242	7.9	0.7	0.3	0.0	9.5	24	80.0	7.7	T	53.4	17.8	26	140	207	323
4-14	113,000	140301	49	86	3.8	0.5	0.3	0.1	5.4	15	75.3	4.7	0.1	48.0	18.3	26	148	195	276
5- 1	188,000	140545	52	80	2.8	0.5	0.2	0.0	11.1	13	66.4	4.4	0.1	46.5	15.1	15	120	179	302
6- 1	144,000	140739	69	119	6.3	0.5	0.2	0.0	6.7	16	90.1	5.2	0.1	51.5	17.7	25	136	202	296
7- 6	146,000	140981	71	198	8.2	0.2	0.1	0.0	7.5	14	89.1	3.6	0.1	47.3	16.9	27	132	188	302

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) —(as $CaCO_3$)—	Total Hardness —(as $CaCO_3$)—	Total Dissolved Minerals
1950																			
11- 1	22,400	123817	60.5	28	0.6	0.2			8.1	8	27.2	0.2	T	42.0	17.1	5	148	176	205
12- 1	17,700	123816	32.9	18	0.4	0.1			6.1	8	24.1	0.2	0.1	44.6	18.5	4	160	188	215
1951																			
1- 2	25,600	124004	32.5	4	0.6	0.1			11.3	7	24.5	4.8	0.5	46.1	17.1		148	186	212
2- 1	23,700	124510	32.2	5	0.4	0.1			16.8	2	22.0	5.2	0.0	43.7	16.1	5	156	176	205
3- 2	140,800	124566	33.5	214	7.1	0.8			13.0	10	19.5	6.4	0.2	32.4	10.3	11	108	123	168
4- 2	157,700	124860	33.5	277	9.7	0.7			14.0	8	21.6	7.5	T	32.9	10.4	3	92	125	156
5- 1	258,600	125153	58.5	298	10.0	0.7			14.6	6	28.8	8.1	T	37.3	9.6	4	96	133	177
6- 1	102,500	125442	70.5	136	5.7	0.6			7.0	6	37.6	4.2	0.1	40.2	13.9	6	120	158	195
7- 2	93,700	125735	74.5	73	3.2	0.3			12.7	7	36.6	5.3	T	47.0	13.6	12	148	174	232
8- 1	101,500	126091	81.5	90	4.0	0.0			17.5	6	23.0	4.7	0.0	39.3	13.2	2	120	153	180
9- 5	64,500	126356	72.5	63	3.9	0.0			15.3	6	25.5	3.8	0.0	40.8	15.2	2	132	165	191
10- 1	76,700	126630	59.7	51	3.0	0.0			15.7	7	25.1	3.4	T	37.6	13.5	4	120	150	179
11- 1	80,200	126908	47.5	49	2.9	0.0	0.3		15.5	4	30.4	5.0	T	43.1	14.1	7	140	166	200
11-30	70,100	127145	34.7	18	1.8	0.0	0.2		16.0	6	24.5	4.4	0.1	42.0	14.3	2	132	164	197
12-31	47,400	127426	32.1	3	0.4	0.0	0.2		21.6	5	28.2	5.1	0.1	49.0	17.8	3	164	196	230
1952																			
2- 1	62,600	127655	32.4	12	1.4	0.0	0.2		15.0	6	32.5	7.7	T	44.3	17.1	5	144	181	226
2-29	56,400	128008	36.4	5	0.6	0.0	0.2		15.0	5	30.6	5.2	0.3	46.6	17.6	6	160	189	232
3-31	103,800	128315	44.5	44	2.3	0.1	0.2		16.8	4	31.1	8.5	T	40.2	17.6	2	132	173	203
5- 1	248,500	128682	61.0	89	4.6	0.3			10.9	4	25.9	6.1	T	34.2	8.4	6	96	120	156
6- 2	66,400	128938	68.5	56	2.4	0.5	0.2		8.9	4	40.5	4.3	T	45.0	14.4		120	172	216
7- 1	77,000	129178	83.5	70	5.4	0.2	0.3		10.7	5	32.1	5.3	T	43.4	17.0	5	144	189	199
8- 1	92,400	129576	79	38	2.7	T	0.1		16.0	5	26.3	2.9	T	39.0	16.2	1	128	164	177
9-11	47,700	129901	74	21	1.0	0.0	0.2		10.5	4	21.4	1.9	0.1	35.1	14.9		120	149	180
10- 2	29,900	130070	67	16	1.0	0.0	0.2		7.3	6	24.5	0.5	T	37.3	16.8	4	136	163	172
11- 3	27,000	130368	48.5	8	0.5	0.0			2.6	7	22.8	1.2	T	38.3	16.6	7	144	164	177
12- 1	31,200	130620	35	9	0.8	0.1	0.2		6.4	7	23.2	2.5	T	41.0	15.2	9	148	165	199
12- 4	32,600	130627	40	34	1.0					15	51.2						148	196	240

1953																			
1- 2	35,000	130845	32.5	9	0.4	0.0			8.1	7	23.4	3.3	0.2	43.9	19.0	4	160	188	210
2- 2	29,400	131049		5	0.5	T			9.2	5	23.2	4.9	0.1	43.8	18.5	1	152	186	217
2-27	77,700	131302		321	8.8	0.4	0.3		9.2	6	21.8	3.9	0.7	29.0	11.2	1	88	119	151
4- 2	137,200	131635		161	5.8	0.2	0.2		11.7	5	29.6	7.5	T	33.0	10.8	8	100	127	168
5- 1	85,700	131889	53.8	32	0.1	0.1	0.2		5.9	5	33.3	2.6	0.1	37.1	13.7	1	108	149	166
6- 1	85,500	132148	73.0	89	4.1	0.3	0.3		3.3	5	48.1	1.4	0.2	43.4	16.3	2	120	176	209
7- 1	92,300	132402	82.0	113	4.5	0.4	0.5		10.8	3	38.1	3.8	0.1	42.4	16.4	1	132	173	223
7-31	80,300	132640	84.9	32	1.4	0.0	0.3		12.0	5	31.4	2.2	T	38.6	15.7	T	120	161	203
9- 2	61,900	132827	81.9	21	0.7	0.1	0.2		10.5	5	25.2	1.6	0.0	40.1	16.7	5	136	169	203
10- 1	25,100	133062	67.8	20	0.6	0.2	0.3		7.2	6	33.7	0.8	0.1	41.2	17.7	12	156	175	232
11- 2	25,500	133336	54.1	13	0.6	T	0.2		1.9	6	32.5	0.3	T	41.7	17.8	8	152	178	221
12- 1	32,100	133505	38.8	15	0.7	T	0.2		1.9	8	24.9	1.3	0.2	40.6	18.1	8	156	176	204
12-31	28,800	133693	32.6	8	0.4	0.0	0.3		6.1	9	22.4	2.2	0.3	44.5	17.5	12	172	184	227
1954																			
2- 2	26,200	133932	32.8	8	0.4	0.0	0.1	T	7.3	9	25.7	2.8	0.1	45.9	0.0	12	176	191	237
4- 2	56,400	134439	42.6	26	1.0	0.3	0.3	T	2.3	7	24.0	1.1	0.1	41.5	16.2	4	144	171	208
5- 4	100,900	134784	55.5	590	0.1	0.6	0.3	0.1	10.4	6	40.5	4.8	T	42.2	14.1	9	128	164	224
6- 2	98,200	134986	64.8	590	0.2	0.5	0.3	0.1	5.8	6	26.9	2.6	0.2	31.5	4.9	14	92	99	148
7- 1	144,600	135215	80.8	388	0.1	0.5	0.2	0.2	11.2	5	21.0	4.5	T	30.4	2.6	30	120	86	181
9- 1	50,500	135700	78.2	81	0.1	T	0.3	0.0	7.3	7	20.2	2.8	T	34.0	13.2	8	124	140	182
11- 1	58,800	136204	46.5	62	0.2	0.4	0.3	0.0	11.3	10	29.8	3.2	T	38.1	15.5	6	124	159	184
12- 1	42,100	136384	38.5	24	0.1	0.2	0.2	0.0	10.5	8	27.8	2.0	0.1	41.6	18.8	1	140	181	205
1955																			
1- 1	42,000	136655	32.4	11	0.6	T	0.2	0.2	9.8	8	29.4	2.6	T	43.5	16.2	6	144	176	212
2- 4	30,700	136896	32.4	8	0.4	0.0	0.1	0.2	12.6	10	29.2	2.0	0.0	48.9	18.7	7	168	200	227
4- 1	60,300	137358	40.6	29	1.0	0.1	0.1	0.2	11.4	9	27.8	2.1	T	43.0	15.1	6	140	170	190
5- 2	97,800	137599	63.4	114	3.5	0.2	0.0	0.0	7.4	7	28.6	3.4	T	41.0	14.7	1	124	163	173
6- 2	53,400	137863	70.2	55	2.2	0.2	0.2	0.0	2.8	8	30.2	2.6	T	43.0	18.6	4	148	184	202
7- 1	29,800	138096	77.5	35	1.4	0.1	0.1	0.0	8.3	7	25.3	2.8	0.1	39.0	15.2	1	124	160	170
9- 2	35,800	138553	75.0	20	0.7	0.1	0.1	0.1	3.6	8	23.5	2.1	T	36.6	15.6	6	132	156	187
10-15	23,800	138883	59.2	35	0.7	0.1	0.1	0.2	6.1	8	21.0	3.3	T	38.6	19.0	T	140	175	186

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) —(as $CaCO_3$)—	Total Hardness	Total Dissolved Minerals
1950																			
11-13	306,000	123581		56	3.3	0.2			8.3	24	84.1	5.0	T	40.1	10.9	22	68	145	239
12- 1	389,000	123783		186	5.1	0.1			11.7	13	42.8	4.1	0.1	40.1	9.5	6	88	140	187
1951																			
1-24	692,000	124235	38	93	5.5	0.3			9.9	9	29.2	3.1	T	26.5	4.9	6	56	87	123
3- 2	767,000	124567		94	4.0	0.3			10.1	8	37.8	4.0	T	29.0	6.1	11	68	88	141
4- 3	736,000	124861		36	3.1	0.3			10.4	10	47.5	3.0	T	35.4	7.5	12	80	120	171
5-10	320,000	125237		16	1.4	0.1			8.5	14	8.5	3.0	T	37.3	8.2	14	72	127	201
6-20	215,000	125596		2	0.3	T			4.4	13	48.5	1.9	T	32.5	4.4	14	60	100	149
7-27	142,000	125973		9	0.6	0.0			9.9	12	38.3	3.0	T	40.4	8.3		76	135	151
9- 4	69,400	126357		8	0.6	0.1			1.9	16	44.8	1.5	0.0	38.8	9.5	8	84	136	170
10- 1	62,000	126577		8	0.6	0.1			2.7	15	43.4	1.6	T	35.2	7.1	14	80	117	175
11-27	117,000	126911		14	1.1	0.3	0.3		3.4	17	49.2	3.5	T	40.1	6.4	17	88	127	191
12-10	542,000	127267		143	7.0	1.2			7.6	15	49.4	4.7	0.0	32.1	6.2	12	56	106	167
1952																			
1-14	774,000	127699		69	4.8	0.3			7.8	8	40.5	5.7	T	27.2	0.3	8	44	84	127
2- 8	895,000	127746		94	6.5	0.5	0.2		7.4	6	40.7	4.5	0.1	25.3	4.5	5	40	82	125
3-11	454,000	128482		104	6.2	0.3	0.2		7.0	10	57.6	4.9	0.1	40.2	10.9	5	80	146	188
4-14	390,000	128483		64	3.7	0.2	0.2		7.1	8	46.7	5.0	T	37.7	9.2	5	80	132	180
5-22	227,000	128842		21	1.3	0.5	0.2		5.6	15	69.7	4.1	0.1	38.9	8.3	11	60	132	202
9- 2	63,700	129988		7	0.6	0.1	0.3		2.0	11	33.7	1.3	0.0	27.0	6.7	7	60	95	117
6-27	163,000	129132		16	1.0	0.0	0.3		15.2	10	46.3	4.9	T	40.9	10.9	8	100	148	185
10- 6	56,900	130239		5	0.4	0.1	0.3		2.4	20	51.4	2.2	T	34.7	8.2	16	72	121	190
11-14	39,300	130565		2	0.5		0.3		3.1	31	39.5	0.2		32.5	5.8	16	56	106	158
1953																			
1-15	384,000	130898		83	6.4	0.6	0.3		4.3	20	42.6	5.1	0.0	35.4	6.6	10	60	116	174
2-24	446,000	131303		109	6.5	0.5	0.2		6.6	8	29.4	4.6	T	28.0	0.7	13	56	73	135
4-15	302,000	131760		40	3.2	0.2	0.2		6.0	11	47.3	4.1	T	31.5	8.1	5	56	112	147
5- 5	330,000	131977		34	2.7	0.1	0.2		5.6	13	53.5	3.4	T	35.0	8.8	8	64	124	168
7-15	79,000	132516		26	1.6	T	0.1		8.6	12	32.9	6.4	T	30.7	5.8	11	68	101	164

8-14	83,200	132719		15	0.4	0.1	0.1		3.1	4	46.6	1.8	0.1	34.6	9.2	7	84	125	183
9-21	63,100	133061		5	0.3	0.1	0.3		2.9	16	34.7	2.1	T	25.8	8.2	19	80	98	168
11- 2	42,700	133310		5	0.3	0.1	0.3		0.8	21	42.4	0.6	0.1	34.0	8.3	18	84	119	199
11-30	51,100	133522		2	T	0.1	0.2		1.4	24	45.1	0.9	T	37.6	9.1	14	80	132	185
1954																			
1- 4	76,200	133716		8	0.2	0.0	0.3	T	3.0	32	67.5	3.8	0.2	41.7	9.6	23	76	144	235
2- 9	119,000	133985		51	2.0	0.3	0.2	T	8.2	14	42.6	6.0	T	31.2	5.5	15	64	101	170
3-17	212,000	134288		91	2.8	0.2	0.4	T	6.1	13	59.2	0.1	0.1	16.7	5.7	23	36	65	156
4-21	313,000	134657		83	0.1	0.3	0.4	T	9.6	14	53.8	7.4	T	36.5	7.9	9	68	124	179
5-24	132,000	135154		21	T	0.1	0.2	0.1	5.2	14	54.5	4.6	T	33.2	10.8	6	60	127	187
7- 1	68,500	135489		7	T	0.1	0.4	T	4.0	15	42.0	2.3	T	30.2	8.5	11	68	111	170
8- 2	68,100	135742		7	0.0	0.1	0.2	0.2	9.2	15	59.4	2.4	T	31.2	7.8	9	44	110	156
9- 7	60,600	135737		2	T	0.1	0.2	T	1.7	19	50.8	2.8	T	29.1	7.2	13	48	103	180
11-23	72,700	136345		7	T	T	0.1	0.1	6.4	20	30.6	1.8	T	33.7	8.2	4	64	118	154
12-30	256,000	136724		101	4.0	0.2	0.2	0.0	5.0	17	42.2	2.7	0.1	30.8	8.8	2	48	113	161
1955																			
1- 3	336,000	136594		16	0.2	0.1	0.1	0.0	25.3	28	90.1	2.8	T	84.5	22.2	35	244	303	442
1-25	174,000	136897		46	2.4	T	0.2	0.2	4.4	15	27.6	1.6	0.0	28.4	7.0	1	52	100	113
7-26	111,000	138281		52	1.7	0.1	0.1	0.1	4.0	17	41.8	3.6	T	40.5	12.2	11	104	152	194
9- 1	72,200	138603		7	0.3	T	0.1	0.0	3.1	19	39.7	3.3	T	32.6	7.5	14	72	113	154
10- 3	84,400	138780		43	1.7	0.8	0.2	0.0	1.8	24	62.9	2.4	0.1	36.6	8.8	19	68	128	212
11- 7	107,000	139135		20	1.1	0.1	0.3	0.0	3.7	26	41.8	7.3	T	45.9	10.8	5	84	160	217
12-13	175,000	139295		29	0.8	0.1	0.1	0.3	4.5	19	35.2	3.8	T	34.1	7.2	12	76	115	166
1956																			
1-24	70,800	139650		9	0.3	0.3	0.1	0.0	4.1	25	59.9	6.3	T	45.9	14.1	16	104	173	222
3-21	715,000	140248		131	6.1	0.7	0.2	0.1	6.4	9	42.0	3.8	T	23.8	9.3	1	40	98	122
5- 1	275,000	140471		145	3.5	0.3	0.1	0.0	6.6	14	58.0	3.3	0.1	34.4	10.3	10	68	129	186
6-13	272,000	140835	74	36	3.0	0.1	0.2	0.0	7.2	11	56.4	5.9	T	35.6	10.6	8	72	133	192
7- 3	227,000	140924		55	1.5	0.7	0.1	0.0	8.9	12	39.7	2.8	T	34.8	8.6	5	72	123	168

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) —(as $CaCO_3$)—	Total Hardness	Total Dissolved Minerals
1950																			
10-24	9,720	123490	58	16	0.4	T			19.0	16	63.0	5.5	0.4	77.2	18.6	21	224	270	362
11-28	73,900	123731	31	122	5.3	0.2			14.3	9	44.8	8.4	0.1	57.6	16.5	4	156	212	251
1951																			
1- 3	22,700	124020	46	28	1.2	0.2			13.7	9	49.4	2.2	0.3	76.2	21.4	1	216	279	311
2-15	58,100	124444	30	121	19.9	0.4			8.8	10	43.0	6.7	T	42.7	13.1	8	116	161	210
3-13	54,900	124684		107	4.4	0.3			11.4	13	61.3	7.1	0.0	57.0	15.4	9	140	207	265
4-17	76,000	125002		43	1.9	0.2			11.4	7	44.8	7.5	0.1	49.0	11.7	10	132	171	217
5-22	19,400	125367		27	1.9	0.2			11.7	10	51.4	6.4	0.1	71.8	19.7	9	208	261	300
not recorded		121822		228		0.6			11.7	9	38.0	2.0	T	13.9	4.9	6	16	55	105
7-11	29,700	125874		479	28.2	1.3			17.4	9	55.5	6.0	0.0	58.8	14.1	14	160	205	268
8- 7	10,200	126198		36	2.4	0.2			9.8	19	52.0	1.9	T	69.0	21.5	10	282	261	283
9-11	5,790	126358		16	1.3	0.2			10.9	19	59.7	4.2	T	72.9	23.3	10	208	278	330
10-17	4,280	126910		13	1.3	0.5	0.3		5.1	22	67.9	3.3	T	69.8	22.8	20	208	269	335
11-26	32,500	127174		125	5.7	0.9	0.3		10.0	11	50.6	5.2	0.1	37.1	13.5	14	108	149	213
12-18	53,200	127265		40	2.3	0.2	off color		12.5	13	65.0	8.2	T	67.6	20.0	4	168	251	310
1952																			
1-28	62,400	127696		230	9.4	1.0	0.2		9.0	7	42.8	6.3	T	43.0	10.6	9	112	151	194
3- 3	25,100	128009		16	1.4	0.2	0.2		11.1	21	67.1	8.9	T	72.9	23.5	12	200	279	335
4- 4	46,800	128481		79	2.8	0.2	0.1		14.0	14	61.5	8.2	T	63.0	22.1	6	172	248	303
6-16	31,900	129055		125	5.8	0.5	0.1		5.5	10	58.6	5.3	T	65.5	22.2	3	184	255	290
7-21	10,800	129602		29	1.3	0.1	0.2		1.1	12	59.4	3.9	T	64.4	21.8	10	192	251	303
8-25	7,220	129790		16	1.0	0.2	0.2		11.0	15	75.0	3.5	T	61.3	23.6	16	180	247	323
9-30	6,200	130240		17	1.3	0.3	0.2		7.5	15	52.5	4.5	T	61.4	20.0	7	172	236	286
11- 4	3,910	130367		10	0.5	0.2	0.3		4.3	21	75.7	2.5	0.1	70.0	25.9	20	216	282	351
12- 8	8,530	130644		12	1.0	0.6	0.3		7.2	32	119.1	6.8	0.0	79.5	34.2	16	200	340	425
1953																			
1-12	15,500	130862		91	3.6	0.3	0.2		8.4	12	57.2	5.7	T	59.8	15.3	13	160	213	265
3- 2	18,400	131304		64	2.6	0.1	0.2		8.2	10	52.0	8.6	T	58.0	17.8	6	156	218	249
4- 2	38,100	131627		127	5.9	0.2	0.2		8.3	14	61.7	8.2	T	59.0	18.0	8	148	222	276

5- 1	25,300	131978	24	2.0	0.1	0.3		8.7	7	44.2	4.1	T	51.8	16.4	3	144	198	229
6- 1	30,300	132131	131	6.3	0.3			8.4	12	49.0	11.8	0.1	59.7	17.7	7	160	222	265
8- 3	65,400	132720	17	0.9	0.2	0.2		3.4	11	48.1	1.5	0.0	76.2	15.2	1	188	253	280
9- 1	3,730	132819	15	0.6	1.4	0.1		5.3	13	62.8	0.0	0.3	60.4	26.6	12	204	260	320
10- 2	2,420	133059	15	0.6	0.3	0.2		5.5	25	69.4	0.7	0.3	65.8	27.1	23	216	276	375
11- 2	sample arrived broken																	
12-10	2,920	133521	4	0.2	0.2	0.2		1.9	29	90.9	2.0	0.3	77.2	29.2	23	228	314	396
12-28	2,450	133717	2	0.3	0.1	0.2	0.1	5.9	27	79.0	3.6	0.4	79.5	27.0	29	252	310	398
1954																		
2- 8	5,700	133986	26	0.9	0.2	0.2	T	6.9	20	80.8	8.1	T	64.7	18.8	26	176	239	351
3- 9	7,420	134315	5	0.6	T	0.3	T	6.0	18	82.8	10.3	T	74.2	19.0	19	184	264	360
4-19	25,200	134616	225	5.3	0.2	0.4	T	11.0	14	67.8	13.4	0.1	69.4	17.4	7	160	245	298
5-17	9,060	134878	30	1.3	0.3	0.4	0.1	3.1	14	48.7	2.7	0.1	61.4	20.8	1	168	239	280
6-28	5,630	135156	28	T	0.1	0.3	T	2.0	15	64.8	1.9	T	53.5	25.3	6	160	238	299
8- 2	3,060	135488	17	T	0.1	0.3	T	4.6	24	59.5	1.2	0.1	54.2	25.2	21	188	239	327
9-22	unknown	135744	12	T	0.2	0.4	0.0	4.1	16	75.7	1.8	0.1	53.9	23.2	13	156	230	303
10-18	13,900	136086	420	0.2	0.9	0.5	0.5	9.0	13	54.1	8.4	T	62.1	13.2	2	132	210	235
11-15	4,400	136346	26	T	0.1	0.4	0.0	8.7	27	96.5	1.1	0.1	90.0	24.2	20	228	325	415
1955																		
1-25	11,200	136815	20	0.1	0.0	0.1	0.0	9.6	19	90.2	7.1	T	83.0	24.6	5	192	308	382
3- 3	47,200	137099	420	18.1	0.7	0.3	0.0	6.5	12	42.0	2.7	0.0	37.2	9.7	8	88	133	177
5-10	14,800	137836	41	2.2	0.1	0.0	0.0	4.9	19	70.6	6.2	T	85.0	25.7	12	224	363	391
6- 7	13,600	137837	60	2.4	0.2	0.0	0.0	6.7	17	60.3	6.3	T	68.7	21.4	11	192	260	313
7-25	17,500	138284	96	3.0	0.3	0.2	not run	10.7	16	47.3	11.1	T	57.8	18.3	6	152	219	269
8-22	4,800	138539	20	0.3	0.2	0.2	0.2	4.2	22	65.8	4.2	T	57.8	25.2	14	176	248	309
9-27	4,980	138712	25	1.1	0.3	0.1	0.3	2.8	61	70.1	2.3	0.3	51.9	19.5	43	144	210	357
10-31	8,160	138989	13	1.0	0.1	0.2	0.0	11.3	26	79.0	6.5	0.1	82.5	25.0	19	228	310	405
12- 1	23,200	139228	24	1.5	0.1	0.1	0.0	11.1	21	72.6	11.0	0.1	73.6	22.5	21	208	277	358
1956																		
1-10	7,580	139529	2	0.3	0.1	0.1	0.3	8.5	23	78.8	7.0	0.3	91.4	27.2	14	252	341	390
2-21	67,000	140334	750	9.8	1.0	0.1	0.2	7.2	11	56.0	11.2	T	44.0	14.4	14	116	169	235
4-24	19,000	140421	36	2.3	0.2	0.1	0.1	6.7	10	55.7	5.3	0.1	71.6	20.4	12	212	263	316
5-22	15,300	140656	42	2.5	0.1	0.1	0.0	10.5	17	73.2	8.5	0.1	77.1	22.9	9	200	287	362
7-11	18,600	141029	116	6.0	0.3	0.1	0.2	8.4	9	39.9	7.5	T	59.9	16.9	6	172	220	265

Date	Discharge	Laboratory Number	Temperature	Turbidity	Iron	Manganese	Fluoride	Boron	Silica	Chloride	Sulfate	Nitrate	Ammonium	Calcium	Magnesium	Sodium	Alkalinity (bicarbonate)	Total Hardness	Total Dissolved Minerals
	ft. sec.		°F		Fe	Mn	F	B	SiO_2	Cl	SO_4	NO_3	NH_4	Ca	Mg	Na	--(as $CaCO_3$)--		
1945																			
10- 2		104420	57	100	1.3					16	85.4	7.9	0.7	50.6	20.8		140	213	287
10-30		104658	56	20	1.1					22	113.8	13.9	0.2	66.2	25.1		164	270	364
12- 4		104972	39	30	1.4					25	118.9	17.4	0.1	69.6	25.8		178	281	371
1946																			
1-15		105277	35.5	100	6.0					8	68.9	10.5	0.8	48.5	17.1		120	192	258
1-29		105375	35.5	20	1.3					17	115.2	11.7	1.6	74.0	28.4		180	303	356
3- 5		105759	45	100	3.0					19	100.2	8.9	1.8	65.1	21.3		164	248	338
4- 2		106028	59	20	1.2					11	107.0	1.5	T	72.7	29.1		188	303	334
4-30		106358	59	10	0.6					24	118.5	10.6	T	74.5	26.0		172	294	372
5-28		106583	64.5	10	0.8					17	87.2	9.0	1.0	63.5	23.2		172	255	313
6-25		106880	72	100	1.0					12	64.6	15.8	T	49.7	18.2		112	200	252
7-30		107257	77	T	0.3					27	93.2	8.4	0.1	56.6	23.3		152	239	319
8-27		107512	71	50	0.4					35	83.3	8.6	0.8	67.2	19.1		128	248	303
10- 1		107810	61	100	0.5					31	85.2	7.6	1.4	49.5	19.1		124	203	300
10-29		108129	59.5	20	0.4					31	88.9	6.4		58.1	21.2		128	234	323
12- 3		108503	38	100	1.6					31	112.9	6.7	3.1	60.7	22.7		172	247	390
1947																			
1- 8		108812	36	10	0.9					37	141.1	10.6	4.9	66.2	31.1		160	295	413
1-28		109030	34	10	2.9					23	110.7	10.6	2.0	66.2	25.9		164	274	348
3- 5		109468	34	40	0.8					29	111.5	6.7	4.2	72.0	24.2		168	281	376
4- 2		109790	42	100	2.1					18	109.4	15.6	1.2	64.2	24.2		140	261	354
5- 6		110197	58	100	0.9					13	106.8	14.3	0.6	65.6	25.1		152	269	335
6- 3		110513	59	40	1.3					16	102.4	12.3	0.3	67.3	27.5		152	283	324
7-15		111042	79	10	0.7					22	110.0	8.6	0.1	65.9	27.5		164	279	345
8-12		111475	84.5	20	1.6					35	104.0	9.5	0.2	50.7	23.7		128	225	343
9- 2		111721	78	10	0.8					28	74.1	10.5	0.1	70.4	5.1		116	197	295
10- 1		112082	56	50	1.4					34	95.4	13.2	0.2	64.8	11.8		132	211	327
10-28		112368	64.5	10	0.8					36	102.6	17.2	0.2	57.1	22.3		124	236	342
12- 2		112756	36	100	1.4					32	122.4			70.0	24.9		168	278	383

1948													
1- 6	113075	32	100	1.5	28	112.9	6.6		72.0	25.9	196	288	432
1-29	113335	32	10	0.7	32	139.7	39.8	0.4	83.5	32.8	180	346	484
3- 2	113648	36	430	7.7	16	79.2	7.5	2.2	50.4	16.4	112	187	255
3-23	113904	48	380	7.8	10	62.5	8.5	1.0	34.6	17.3	92	158	205
5- 4	114543	60.5	100	1.4	20	126.5	10.6	1.1	81.0	29.1	180	324	391
6- 2	114899	73	40	1.6	18				74.0	26.6	172	296	344
6-29	115125	77	70	1.3	30	107.6	5.6	2.8	62.2	23.1	156	252	344
8- 3	115484	75	30	0.7	23	89.7	11.2	0.1	56.6	20.4	144	226	298
8-31	115727	79.5	30	5.8	27	82.3	8.7		49.1	20.4	116	208	282
9-28	115947	65	15	0.3	33	90.5	8.3		56.6	15.9	120	208	327
11- 5	116347	59	13	0.7	41	97.9	9.5	2.3	62.3	19.3	128	236	343
11-30	116580	41	42	1.0	42	113.3	5.9		63.4	21.1	152	246	388
1949													
1- 4	116943	36	33	1.4	39	125.1	2.7	5.2	70.4	23.7	168	275	400
2- 1	117177	32	92	2.5	16	103.3	12.9	1.5	60.5	21.1	128	239	299
3- 1	117493	33	125	3.8	10	74.3	12.2	0.1	41.5	15.3	92	168	254
4- 5	117734	51	63	2.3	22	153.7	7.8	2.3	83.1	24.1	164	308	397
5- 3	118122	64.5	28	1.0	23	143.6	10.2	0.1	71.0	28.1	160	295	388
5-31	118355	68.5	16	0.8	22	109.6	10.9	T	53.3	25.1	124	238	308
7- 5	118765	87	7	0.5	27	101.4	8.6	T	57.6	24.2	128	245	309
7-27	118978	81	15	0.9	29	91.9	11.5	0.1	60.8	19.3	120	233	300
9- 6	119276	72	16	0.5	31	92.8	9.8		57.2	17.2	116	215	303
10- 4	119523	63.5	11	0.7	33	95.9	13.9	0.1	59.0	18.2	112	224	326
11- 1	119808	47	6	0.5	32	103.1	14.9	T	66.2	21.5	136	255	344
12-20	120386	37.5	20	1.3	37	116.8	20.9	T	70.5	21.6	140	266	374
1950													
1-24	P-35	34	145	0.1	11	90.9			65.1	18.7	120	241	279

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness	Total Dissolved Minerals
1945																			
10-16	150	104547	49	20	0.6	0.0			11.0	13	179.4	12.8	0.1	104.4	47.9	4	252	458	535
11-28	566	104966	40	100	2.3	0.1			11.5	12	156.9	11.7	T	89.1	42.5	4	216	397	487
1946																			
1- 7	1,730	105241	39	100	3.7	0.0			10.0	5	79.6	15.5	0.2	49.6	19.8	4	112	206	280
2- 3	134	105547	33	10	0.1	T			13.0	17	210.2	38.5	T	111.4	53.3	22	272	498	616
3- 1	188	105764	41	27	0.8	0.0			9.0	12	111.9	12.0	0.1	87.3	41.7	3	224	390	472
4- 1	241	106075	54	25	0.4	0.1			10.0	10	168.7	13.8	T	96.1	43.9	5	232	421	495
5- 7	120	106431	56	25	0.2	0.1			4.0	18	193.6	5.5	0.1	91.7	48.7	10	240	430	535
6- 8	65	106739	68	10	0.2	0.1			7.1	21	186.4	7.3	0.2	98.1	51.2	28	288	456	586
7- 8	55	107009	70	25	0.3	T			10.1	18	175.7	3.5	0.2	88.3	46.5	25	256	413	543
9-13	28	107690	62	5	0.9	0.0			5.0	47	159.0	0.9	0.1	82.6	46.2	46	264	396	547
10- 4	23	107908	56	25	0.2	0.1			3.3	27	176.3	0.2	0.1	84.2	53.6	23	260	431	540
11- 2	47	108178	56	25	0.3	0.0			10.9	28	181.2	3.4	0.2	87.6	44.2	39	256	401	550
12- 6	42	108642	36	0	0.2	0.0			6.7	25	185.7	11.0	0.2	95.1	47.5	29	260	434	577
1947																			
1- 9	54*	108902	40	T	0.1	0.0			14.3	27	207.6	10.5	1.6	103.3	52.0	35	288	472	634
2- 5	70*	109195	32	2	0.1	0.0			12.8	26	235.3	15.4	0.8	122.0	60.6	29	324	554	688
3- 7	108	109519	34	7	0.3	T			12.3	26	186.2	8.9	1.3	90.6	44.8	20	220	411	530
4-12	829	109979	46	121	3.4	0.3			14.4	10	150.2	29.1	0.2	78.6	33.1	0	140	333	414
5-15	265	110336	58	17	0.5	0.0			9.9	12	179.8	13.9	0.1	92.6	41.8	14	220	404	498
6-13	375	110662	61	58	1.7	0.0			14.4	11	158.8	15.9	T	89.9	41.8	2	208	397	463
7-17	137	111127	86	36	1.4	T			14.4	18	158.8	12.6	T	89.3	42.5	16	232	398	490
8-15	65	111563	79	15	0.7	0.1			10.6	21	152.4	5.0	T	84.3	42.9	20	240	388	496
10- 5	44	112150	72	27	0.6	0.1			4.1	26	166.4	2.8	0.1	71.4	48.0	22	212	376	471
11-14	72	112567	36	25	0.3	0.1			17.4	28	198.3	14.6	T	99.4	49.1	33	264	451	589
12- 8	335	112966	37	55	1.6	0.0			10.6	12	188.2	25.8	T	100.6	40.3	13	212	418	519
1948																			
1-23	47*	113251	33	0	0.2	0.1			11.3	31	236.3	14.3	0.7	122.1	61.3	4	332	558	718
2-27	281	113623	41	100	2.5	0.2			12.6	15	147.5	10.3	0.9	75.8	31.8	9	160	320	405

3-21	3,180	113885	52	450	11.5	T	11.6	7	58.6	13.9	T	40.6	12.7	6	84	154	206
4-21	180	114370	62	20	0.5	0.0	8.4	17	191.5	9.1	T	97.8	45.4	9	220	432	527
5-20	461	114912	50	27	0.9	0.1	13.7	14	164.6	17.0	T	93.7	40.3	2	200	400	491
7- 7	101	115249	74	77	1.7	0.1	19.2	21	185.5	10.6	T	101.4	46.5	19	256	445	560
8- 5	44	115486	75	15	0.2	0.1	3.0	28	170.7	2.2	0.1	80.3	46.2	31	240	391	506
8-28	31	115700	82	50	4.6	0.0	20.7	40	176.1	3.2	4.3	106.9	48.5	16	272	467	629
9-22	31	115901	72	39	0.9	0.0	10.6	38	154.1	4.3	0.1	84.9	45.2	34	256	399	532
10-19	31	116217	47	0	0.1	0.1	3.1	48	186.4	4.3	0.1	87.5	50.9	48	268	428	606
11-22	47	116549	38	6	0.3	0.0	8.4	52	204.1	9.5	0.1	95.6	47.8	54	260	436	629
12-28	40*	116887	32	7	0.1	0.0	12.8	57	252.0	11.2	0.7	121.1	59.1	52	328	546	764
1949																	
2-28	364	117447	32	45	1.8	0.1	16.4	14	145.0	13.1	0.1	72.8	27.1	4	144	294	384
3-16	170	117608	33	2	0.4	0.1	12.2	18	177.9	11.5	0.5	90.4	41.2	17	216	396	544
4-18	332	117975	43	16	1.2	0.1	8.4	16	173.6	13.8	T	93.9	39.4	15	216	397	502
5-16	83	118250	64	12	0.6	0.0	6.9	32	184.3	3.3	T	103.7	48.5	17	256	459	565
6-13	54	118502	76	13	0.6	0.0	10.4	36	181.7	0.2	0.1	97.3	48.6	35	280	444	582
7-21	86	118928	81	21	0.7	0.1	7.3	30	150.0	3.9	0.1	82.9	41.5	14	208	378	446
9- 8	34	119275	65	9	0.4	0.1	9.3	52	168.9	0.5	0.1	93.6	24.9	79	260	337	588
10-20	36	119678	62	6	0.4	0.1	10.6	50	180.0	3.2	T	103.4	46.7	38	272	451	602
12-21	116	120279	41	25	1.1	T	13.9	27	145.8	19.1	T	78.9	32.7	17	164	332	455
1950																	
4-20	398	121452	48	28	1.1	0.2	13.7	13	164.4	16.1	T	81.7	41.6	11	196	375	476
5-11	332	121658	61	51	2.3	0.1	14.0	13	154.9	13.3	T	84.8	37.9	14	208	368	469
6-27	275	122239	74	127	6.3	0.1	16.7	12	138.9	15.5	T	92.8	38.9	8	236	392	482
7-26	126	122547	79	9	0.3	0.1	16.4	16	154.5	10.3	T	87.5	43.4	21	252	398	530
8-22	64	122871	77	13	0.6	0.0	10.8	29	167.4	5.4	0.0	86.6	47.9	32	264	414	546
8-30	72	122873	76	31	0.8	0.1	8.3	33	158.8	5.7	0.0	83.7	44.3	35	252	392	534

* under ice effect

Date	Discharge	Laboratory Number	Temperature	Turbidity	Iron	Manganese	Fluoride	Boron	Silica	Chloride	Sulfate	Nitrate	Ammonium	Calcium	Magnesium	Sodium	Alkalinity (bicarbonate)	Total Hardness	Total Dissolved Minerals
	ft. sec.		°F		Fe	Mn	F	B	SiO_2	Cl	SO_4	NO_3	NH_4	Ca	Mg	Na	--(as $CaCO_3$)--		
1945																			
10- 8	451	104471	70	40	1.4	0.3			15.0	5	108.2	6.2	0.1	90.1	33.3	1	240	363	402
11- 1	258	104673	69	10	0.7	0.1			13.3	5	110.7	3.3	0.1	87.3	34.5	2	240	360	398
1946																			
1-15	1,800	105276	52	86	3.1	0.3			12.5	4	95.4	12.6	0.2	78.1	26.9	6	204	296	356
2-18	648	105582	52	205	5.8	0.4			15.0	6	101.6	6.9	0.1	80.5	30.0	2	210	325	364
3- 6	3,460	105784	61	1000	69.5	2.3			9.5	3	48.5	10.6	0.4	47.2	15.4	2	124	182	206
3-29	1,090	106008	71	65	3.1	0.3			15.0	6	102.4	10.1	0.0	92.4	34.8	0	252	374	413
5-27	642	106613	78	55	4.3	0.1			16.7	7	87.2	7.6	0.1	77.6	29.1	8	224	314	387
7- 5		106928		110	6.2	0.4			18.3	8	107.0	8.7	0.2	92.1	33.6	0	240	369	417
8-23	225	107477	82	71	2.2	0.2			19.6	8	87.8	3.2	0.1	77.6	23.4	5	196	290	353
10-24	134	108078	72	32	1.1	0.2			27.7	6	119.5	2.0	0.1	63.9	22.6	2	232	253	443
11-20	295	108414	60	53	1.4	0.2			19.6	8	115.9	4.1	0.2	97.6	35.2	1	256	389	435
12-16	349	108658	54	65	0.1	0.2			18.5	4	115.4	6.0	0.2	91.0	35.3	1	244	381	417
1947																			
1- 7	151	108815	51	80	0.3	0.3			19.4	5	131.9	1.6	0.2	103.2	37.7	4	276	413	464
2- 5	210*	109137	33	23	1.4	0.3			19.9	6	142.1	4.6	0.2	115.2	43.0	1	308	465	510
4- 7	4,100	109874	42	250	4.6	1.5			14.0	5	65.8	16.5	0.2	62.1	17.4	1	140	227	273
6- 6	1,720	110606	66	400	16.2	0.6			14.8	4	72.2	12.0	0.1	64.2	22.3	1	164	257	295
7-25	310	111272	67	27	2.0	0.0			21.8	5	108.0	3.4	T	89.1	35.4	1	248	369	427
8-28	120	111720	76	16	1.8	0.1			22.8	4	105.9	2.9	0.1	81.7	32.0	1	220	336	401
9-22	921	111967	62	190	6.3	0.6			16.4	3	77.5	8.8	0.1	51.0	18.8	1	116	205	254
10-16	144	112224	62	40	1.1	0.1			24.9	6	103.7	2.8	T	83.0	31.9	6	232	339	420
12-17	211	112945	34	T	0.7				16.7	3	141.1			105.7	37.7	9	288	420	512
1948																			
1-14	130*	113224	32	5	0.2	0.2			19.2	8	131.2	0.1		103.6	26.9	21	268	370	498
2- 4	95	113388	32	0	0.5				18.1	4	115.0	4.4		86.4	32.8	10	244	353	434
3- 9	355*	113779	32	47	2.3				17.1	6	104.3	7.3		77.8	29.4	7	208	317	400
4-12	463	114226	53	36	2.0				19.9	8		5.1		95.7	34.4		236	383	424
5- 5	357	114696	62	58	2.1				15.6	6	95.2	8.2		78.4	31.1	1	212	325	386

6- 2	225	115100	71	20	1.6	T	19.2	3	112.7			85.8	37.3	1	248	370	442
7- 7	142	115210	73	20	0.9	0.2	25.1	5	95.4			79.9	40.1	7	232	326	406
8-12	174	115560	74		1.0	0.1	16.3	4	110.3	1.6	0.2	89.6	34.0	1	244	364	416
9- 8	118	115769	67	68	2.0	0.2	14.9	6	99.1	2.0	0.1	77.2	30.4	1	208	318	366
10-13	99	116124	54	10	0.4	0.1	15.7	7	122.3	0.8	0.1	87.9	34.1	4	232	360	415
11-17	120	116492	43	9	0.5	0.2	17.4	6	108.2	2.0	0.2	86.6	28.8	3	220	335	401
12-15	134	116752	36	15	0.6	0.2	17.8	6	111.1	2.2	0.2	83.3	27.3	15	228	321	393
1949																	
1-12	625	117039	32.5	7	0.6	0.2	19.7	5	96.3	4.8	0.2	81.4	28.0	4	216	319	376
2- 8	224	117266	33	2	0.7	0.3	21.4	5	104.1	2.8	0.2	87.3	30.6	4	236	344	404
3- 2	1,280	117446	33	39	2.8	0.2	16.3	5	87.4	9.0	0.2	71.8	22.1	3	172	270	310
4- 5	813	117789	51	41	2.6	0.3	17.4	5	110.7	8.0	0.3	93.4	33.0	1	244	369	449
5- 3	386	118121	60	36	3.6	0.1	18.5	4	104.5	3.3	T	89.0	30.5	4	240	348	421
5-30	218	118354	61	45	2.0	0.0	22.0	5	101.2	3.3	T	91.4	31.4	0	244	358	399
7- 9	375	118766		1340	51.7	3.0	16.1	15	90.5	4.7	T	74.1	27.8	5	192	300	342
8- 5	129	119059	72	17	0.3	0.1	13.7	13	104.1	0.2	0.1	84.8	35.6	5	244	358	413
9- 9	102	119383	64	12	0.7	0.1	16.3	6	116.0	0.2	T	89.7	35.2	0	240	368	420
10- 8	155	119572	66	45	2.1	0.1	17.9	7	111.3	2.2	T	82.0	29.2	1	200	325	391
11- 9	102	119901	53	5	0.4	0.3	19.2	5	107.2	1.7	T	92.9	30.0	0	236	356	407
12- 9	134	120161	32	9	1.2	0.4	29.8	5	106.6	4.0	T	94.5	30.9	1	244	363	416
1950																	
2- 3	367*	120764	33	16	0.8	0.1	22.0	5	119.9	9.8		100.5	34.9	1	256	395	444
3- 9	1,150	121007	33	121	3.7	0.0	15.7	5	74.8	13.3	0.0	65.1	22.5	2	164	250	317
3-31	806	121340	45	52	5.0	0.2	19.7	6	112.9	11.6	T	97.2	33.3		244	380	427
5- 4	1,560	121588	59	132	5.4	0.4	16.4	4	105.9	13.5	0.1	94.2	27.8	0	224	350	396
6- 9	425	121862	74	78	1.6	0.1	17.3	7	94.3	7.6	T	83.4	32.5	5	240	344	423
7-13	320	122391	76	49	3.8	T	10.8	4	109.4	0.7	0.2	87.6	34.8	2	248	362	399
8-11	234	122741	74	94				5	103.7						220	318	368
9- 9	97	122955	70	13	0.6	0.1	15.1	5	120.4	1.1	T	88.5	34.0	11	252	362	428

* estimated, ice effect

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness	Total Dissolved Minerals
1950																			
10-18	89	123305	63	5	0.4	0.2			12.5	8	37.6	0.2	0.1	66.3	33.2	18	292	303	350
11-14	78	123605	39.5	13	0.5	0.1	0.2		13.5	9	42.8	1.5	0.3	80.6	35.9	4	300	349	370
12-14	84	123873	36	1	0.6	0.1			16.1	10	48.5	4.9	T	80.7	32.5	6	280	336	375
1951																			
1-17	244	124128	37	5	0.4	0.2			26.9	9	54.5	7.8	T	77.0	32.3	8	268	326	374
2- 7	1,580	124305	33	174	10.9	0.5			10.3	9	41.1	7.8	0.3	35.4	14.5	8	104	148	210
3-16	507	124677	36.2	19	1.1	0.0			14.9	7	59.4	10.5	0.0	73.7	28.4	3	228	301	339
4-12	4,820	124922	41.5	805	41.5	14.2			11.6	6	36.0	11.0	0.1	50.0	14.2	7	144	184	235
5-17	1,010	125290	67.5	36	3.0	0.2			12.9	6	61.1	18.0	T	73.9	29.0	1	220	305	342
6-18	427	125597	74.5	47	3.2	0.2			12.7	8	52.9	12.7	0.1	72.5	28.1	1	224	297	340
7-19	1,320	125943	75.5	90	10.0	0.2			15.3	8	52.7	12.9	0.0	78.4	28.9	3	244	315	348
8-10	346	126081	69.5	37	2.7	0.2			12.5	11	48.1	6.7	T	75.7	31.1	3	254	317	329
10- 4	106	126560	69	14	1.1	0.2	0.2		9.6	15	44.0	1.5	0.1	75.9	33.4	13	288	328	386
11-30	531	127131	41																
1952																			
1-18	978	127545	41	88	2.2	0.4	0.1		11.9	5	61.1	13.1	T	73.9	32.2	4	244	317	341
3- 5	760	128046	34.5	18	1.1	0.1	0.1		15.7	5	70.1	11.9	0.1	74.4	33.1	3	240	322	357
4- 1	1,180	128286	51.5	56	2.6	0.1	0.1		10.2	7	64.8	16.5	0.2	75.9	32.2	0	232	323	355
4-18	2,670	128501	55	121	5.1	0.7	0.1		15.8	4	63.4	19.8	T	73.4	30.5	1	224	309	341
5-13	722	128720	55	2	0.7	T	0.1		12.2	7	63.1	15.0	T	77.9	32.5	5	252	329	374
6-10	926	128971	74	295	9.4	0.8	0.2		10.5	5	52.9	18.9	T	67.0	28.3	1	208	284	307
7- 2	752	129179	79.5	91	4.8	0.3	0.2		19.0	5	54.9	15.5	0.1	78.4	32.4	3	260	330	357
8- 5	151	129592	74	15	0.8	0.1	0.2		11.7	10	44.2	3.5	T	70.5	33.0	12	276	312	357
9-30	66	130062		28	1.3	0.3	0.2		18.4	9	33.1	3.6	T	79.7	35.6	4	304	346	375
10-21	59	130241	47	9	0.7	0.3	0.1		14.0	11	33.1	3.4	T	79.5	34.5	16	324	341	390
11-13	55	130461	47.5	12	1.5	0.3	0.1		12.4	8	34.1	2.5	T	79.5	36.7	14	332	350	395
12- 9	83	130673	44	7	0.8	0.4	0.1		13.0	15	43.4	3.2	T	78.0	35.8	5	284	343	376
1953																			
1-13	95	130899	39.5	5	0.8	0.3	0.1		12.1	12	53.1	4.1	0.0	80.2	37.0	12	304	353	400
2-10	176	131104	39.5	5	0.6	0.2	0.1		7.6	10	59.0	6.2	T	74.1	34.6	4	256	328	352

3-11	354	131429	44	24	1.3	0.1	0.2		6.5	8	70.1	9.6	0.1	71.0	32.8	7	236	312	343
4-15	900	131731	50.5	32	1.9	T	0.2		8.3	6	65.2	16.5	T	72.0	31.6	2	224	310	340
5-19	415	132008	64.5	10	0.6	0.0	0.2		6.5	6	64.0	10.3	T	70.1	34.1	4	240	316	351
6-29	230	132411	84	275	7.2	0.5	0.3		10.1	7	54.5	9.7	0.0	68.6	30.4	8	240	296	345
8- 6	176	132686	74.5	19	1.2	0.2	0.2		9.3	7	47.8	3.9	T	69.2	35.1	8	272	317	355
9-16	55	132945	61	10	0.6	0.3	0.1		11.4	9	34.6	1.6	0.2	75.6	35.4	16	320	335	376
10-15	40	133174	55.5	11	0.5	0.3	0.3		13.0	6	26.1	2.2	0.0	80.6	36.2	9	332	351	374
11-12	42	133390	46	15	1.0	0.3	0.1		12.6	6	26.9	2.1	T	81.6	35.6	6	328	352	388
12- 8	66	133552	41	11	0.9	0.2	0.2		11.6	8	39.1	1.8	0.2	71.9	34.2	8	284	321	349
<u>1954</u>																			
2- 3	131	133931	35.5	135	2.3	0.0	0.1	0.1	8.3	7	42.7	5.8	0.6	46.9	19.0	12	164	196	258
3-16	494	134269	36.5	390	3.6	0.5	0.2	T	8.6	8	265.8	23.6	T	60.5	25.8	8	176	257	338
4-12	3,860	134609	54.5	1200	23.0	0.3	0.1	0.0	8.1	6	44.4	18.4	T	52.5	18.9	3	148	212	263
5-18	387	134883	62	5	0.6	0.1	0.4	T	5.5	10	62.5	2.0	T	72.0	32.9	1	236	315	324
6-29	225	135171	76	21	T	0.1	0.2	0.1	11.4	8	56.4	12.4	T	80.5	35.5	4	276	347	388
8-17	700	135604	72	183	T	0.5	0.4	0.2	14.1	7	45.9	6.6	T	81.6	29.4	0	256	325	352
9-14	68	135830	65.5	33	T	0.3	0.1	0.2	4.0	8	39.1	2.0	T	67.0	33.4	11	276	305	341
10- 7	304		59																
11-23	144	136344	42.5	44	T	0.2	0.1	0.1	10.7	13	53.3	4.9	0.1	68.0	28.6	10	232	288	322
12-10	144	136513	34	9	T	0.1	0.1	0.0	10.2	11	59.9	8.2	T	79.7	38.4	7	288	357	393
<u>1955</u>																			
2- 9	443	136981	35	21	1.0	T	0.1	0.2	7.5	10	65.4	9.7	T	75.8	32.6	2	244	324	353
2-24	1,350	137123	37	97	5.7	0.2	0.1	0.0	7.9	9	63.5	13.6	T	70.9	29.7	5	220	300	346
3-31	968	137329	48.5	36	1.9	0.1	0.1	0.0	6.8	10	65.2	11.3	T	76.1	32.5	T	236	324	350
5-18	968	137735	65.5	55	2.9	0.1	0.1	0.0	9.3	9	64.6	25.0	T	81.0	32.8	1	240	338	405
6-14	1,410	137905	61.5	99	3.2	0.2	0.0	0.0	12.0	7	63.8	21.7	T	78.1	33.0	0	236	332	384
7-29	95	138359	86	13	0.3	0.1	0.1	0.1	25.9	10	41.3	1.9	T	64.7	29.5	12	252	284	357
10- 6	364	138884	64.5	900	25.0	0.1	0.1	0.2	6.6	13	19.5	5.6	T	33.6	12.4	8	108	135	155
10-31	138	138986	49	109	2.3	0.3	0.1	0.2	7.3	12	42.6	3.5	T	53.4	24.9	12	196	236	290
12-21	42	139351	35	3	0.8	0.5	0.1	0.2	16.5	15	40.9	2.6	T	84.0	40.4	14	344	376	430
<u>1956</u>																			
1-10	44	139572	35.5	5	1.0	0.4	0.1	0.0	9.6	16	42.4	3.3	T	71.6	38.5	16	304	338	365
2- 7	40	139748	41.5	9	1.3	0.4	0.0	0.0	8.8	17	39.7	1.4	0.3	77.6	38.7	11	312	353	371
3-15	104	140078	45	24	0.6	0.3	0.1	0.0	21.2	13	58.4	7.9	T	78.1	33.9	11	272	335	393
4- 5	65	140275	60	14	0.7	0.4	0.1	0.1	3.9	14	53.9	1.4	0.1	69.0	39.5	5	284	335	382
5- 9	247	140629	64.5	45	1.3	0.1	0.1	0.0	15.6	10	73.0	17.2	T	80.5	35.8	7	260	349	385
6-13	171	140837	74.5	40	1.3	0.1	0.1	0.1	7.5	10	46.7	12.1	0.1	72.5	34.6	2	256	324	346

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) —(as $CaCO_3$)—	Total Hardness	Total Dissolved Minerals
1950																			
10- 2	188	123141	68	47	2.8	0.0			16.8	5	94.6	3.0	T	90.0	19.4	13	226	305	375
11-21	510	123655	39	43	0.9	T			14.0	7	86.2	5.9	T	83.6	22.6	1	200	302	359
12-15	300*	123925	33	9	0.8	0.0			17.7	7	102.9	8.5	0.1	94.2	23.4	5	220	332	409
1951																			
3- 9	798	124683	42	104	3.0	0.3			12.4	8	81.2	12.5	0.0	71.7	20.0		156	262	315
4- 5	1,420	124920	46	13	0.6	0.0			11.7	9	81.0	15.7	T	73.2	19.4	5	164	263	330
5-10	418	125236	56.5	109	3.9	0.3			10.2	8	75.1	10.8	T	76.1	21.7	1	184	280	318
6- 8	227	125482	66	89	4.0	0.4			13.9	8	71.8	10.4	T	76.4	22.6	5	200	284	336
7-10	6,460	125814	72	388	7.4	0.4			7.1	4	12.5	5.2	0.0	20.6	4.1	5	56	69	93
8-17	167	126172	69.5	48	2.4	0.1			15.2	11	71.2	4.6	T	79.3	22.1	5	208	289	323
10- 4	42	126629	69	33	2.6	0.2	0.5		12.8	10	96.7	2.9	T	83.5	23.0	14	216	304	370
11-19	1,520	126998	31	9	0.6	0.0	0.2		12.4	6	86.4	13.2	0.1	77.2	22.8		176	284	327
12-28	390*	127429	32	T	0.3	0.0	0.3		11.9	6	87.2	7.4	T	84.2	23.0		200	305	339
1952																			
2-20	531	127904	39	T	0.5	0.0			8.9	9	83.9	10.8	T	79.9	21.6	7	196	289	338
3-26	914	128237	42	6	0.5	0.0	0.2		8.6	8	83.1	12.9	0.1	76.9	24.2		184	292	316
4-28	1,870	128577	59.5	25	0.9	0.0	0.2		9.4	6	67.1	15.9	T	64.0	17.9	5	152	234	295
5-28	1,800	128869	61	39	0.1	0.1	0.2		16.7	6	57.0	18.0	0.1	63.0	18.2	1	152	233	275
6-24	1,210	129084	78	39	0.2	0.0	0.2		29.0	7	70.6	14.1	T	76.4	20.4	7	196	275	346
7-18	100	129336	80	39	0.1	0.2	0.3		12.7	9	78.2	4.7	T	78.5	22.7	7	208	290	334
8-25	80	129803	71	71	2.0	0.0	0.2		16.8	10	105.9	3.5	T	90.7	24.1	4	208	326	396
9- 8	36	129874	75	50	2.3	0.2	0.3		14.2	9	102.6	2.7	T	86.2	24.8	9	216	318	386
10-21	32	130274	44	16	0.6	0.0	0.3		20.8	14	104.1	1.9	0.1	82.5	25.4	10	204	311	389
11-10	32	130449	45	10	0.4	0.1			13.9	15	100.6	0.6	T	86.8	25.4	11	220	323	384
12-22	85	130764	35.5	5	0.5	0.0	0.3		8.5	11	129.2	3.3	0.0	93.5	24.9	7	200	337	415
1953																			
1-20	275	130934	34.8	3	0.4	0.0			8.7	13	135.9	11.3	0.1	91.0	23.9	7	172	326	415
2-18	246	131257	34.5	5	0.4	0.0	0.2		9.4	12	119.5	10.2	0.1	90.0	25.8	8	200	331	394
4-14	512		49.2																

6-18	288	132347	76.5	115	4.5	0.2	0.4		18.7	10	78.8	14.7	T	82.6	23.9		224	305	390
8-20	29	132755	72.5	84	2.0	0.6	0.3		10.9	10	90.6	1.8	0.0	82.6	24.2	1	232	306	384
11-11	19	133338	40	42	1.3	0.2	0.2		11.1	8	101.2	1.8	T	82.7	23.6	14	216	304	380
1954																			
1-29	420	133911	32.1	305	4.5	0.0	0.2	T	7.0	6	51.6	10.7	0.2	36.9	9.6	10	84	132	204
2-24	155	134143	43.2	35	1.4	0.2	0.4	T	10.0	12	164.8	10.4	0.1	100.6	25.4	8	176	356	467
3-22	229	134483	41.2	18	0.9	0.2	0.4	T	7.3	9	120.0	9.3	0.1	82.2	22.2	4	160	296	361
4-26	618	134733	62.5	240	2.2	0.2	0.3	T	11.9	11	91.6	21.5	T	77.6	22.4	3	164	286	354
5-24	114	134974	66.7	75	3.8	0.3	0.4	T	6.4	13	100.6	8.1	T	84.0	26.2	7	204	318	379
6-22	598	135158	77.4	560	10.4	0.3	0.3	0.1	8.6	10	64.0	22.8	T	62.7	20.3	1	144	240	299
7-29	36	135440	79.9	52	T	0.0	0.3	T	8.2	13	103.3	2.9	0.1	84.2	20.5	21	212	295	417
8-31	75	135709	70.0	76	0.1	T	0.4	0.1	11.7	10	67.9	5.8	0.0	71.4	23.5	6	200	275	355
10- 7	140		59.3																
12-13	73	136509	33.0	10	T	0.1	0.3	0.1	10.0	16	133.0	2.6	0.0	110.0	29.5	1	236	396	452
1955																			
1-17	439	136777	33.1	5	0.3	T	0.2	0.2	9.8	14	123.8	14.9	T	97.4	29.1	1	204	363	419
6- 6	348	137849	69.2	54	2.2	0.1	0.1	0.0	9.9	13	98.3	12.2	T	90.9	27.3	1	212	340	412
7-12	120	138150	78.3	45	1.6	0.2	0.3	not run	11.8	13	89.3	15.2	T	82.0	25.1	6	196	308	384
8-23	23	138514	76.3	60	1.4	0.4	0.1	0.2	12.3	17	91.1	3.7	0.1	85.0	26.9	10	224	323	404
11- 8	190	139049	none	2	0.2	T	0.2	0.0	12.7	17	122.8	14.3	0.1	96.8	27.8	14	224	357	465
12-12	97	139296	32.6	T	0.1	T	0.1	0.0	12.5	18	126.1	10.0	T	103.3	30.5	9	240	384	473
1956																			
1-18	76	sample received frozen - broken bottle																	
2-13	795	139756	34	14	0.8	0.1	0.1	0.0	7.9	13	77.8	17.7	T	63.2	17.9	5	128	232	298
3-20	398	140130	38.5	12	0.4	0.1	0.2	0.0	6.8	15	105.9	16.9	T	88.4	27.3	5	200	334	397
4-23	83	140441	49.5	28	1.1	0.2	0.2	0.0	4.2	15	101.6	6.2	0.1	85.9	28.7	8	220	333	411
5-21	389	140680	63	48	2.5	0.1	0.2	0.0	8.5	15	100.6	16.4	T	90.5	26.9	8	216	337	397
6-18	213	140850	78	105	4.4	0.2	0.2	0.0	10.2	15	90.1	16.6	0.4	85.9	24.8	8	208	317	387

* backwater from ice

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness	Total Dissolved Minerals
1950																			
10-20	16	123335	59	20	0.4	0.2			9.4	15	43.8	2.1	T	69.3	32.3	14	268	307	351
11- 6	17	123536	46	7	1.0	0.2			11.9	18	41.8	3.1	T	76.7	35.5	19	308	338	400
12- 4	49	123797	33	9	1.0	0.1			14.0	13	46.1	4.5	T	78.2	34.2	6	280	336	379
1951																			
1- 8	240*	124102	32	9	0.8	0.1			14.9	7	46.1	13.5	T	60.4	25.1	8	204	255	299
2-20	474	124445	36	542	25.2	0.7			10.8	5	20.0	9.6	T	16.2	7.1	5	44	70	109
3-27	258	124798	42	3	0.6	0.1			14.2	8	48.3	10.6	0.0	69.3	28.7	7	236	292	336
4-25	308	125062	54	16	0.7	0.2			9.6	8	51.0	15.7	T	68.4	29.2	3	220	291	314
6-14	118	125541	66	43	2.4	0.2			26.1	7	47.1	13.2	0.0	72.5	27.4	14	256	294	362
7-16	272	125875	72	51	4.9	0.2			16.8	6	44.8	13.5	T	77.4	29.2	6	260	314	355
8-23	40	126218	65	13	0.9	0.1			16.3	16	41.8	3.6	0.1	71.4	30.7	16	270	304	351
10- 2	29	126559	64	9	1.3	0.2			10.5	17	43.0	2.8	T	70.9	32.1	14	268	310	369
11-14	1,000	126974	52	254	8.2	1.2	0.2		11.5	3	32.5	8.0	T	43.1	17.9	1	140	182	224
12-12	117	127213	35	3	0.4	0.2	0.1		14.0	8	52.7	7.2	0.1	79.7	33.2	5	276	336	375
1952																			
1-11	160	127463	33.5	6	0.4	0.1	0.1		19.2	6	49.4	10.4	T	76.9	33.4	3	268	330	357
2-18	262	127865	36.5	2	0.5	0.1	0.1		16.2	6	50.8	12.5	T	72.9	31.9	1	244	314	329
3-20	1,230	128173	46	96	3.8	T	0.1		12.4	5	45.5	16.4	0.1	52.1		7	172	224	264
4-17	1,000	128429	55.5	32	1.9	0.1	0.1		11.1	5	46.3	19.2	0.1	64.0	26.4	2	204	269	300
5-27	677	128845	63	210	6.3	0.5			11.9	4	36.8	17.4	0.1	56.0	19.9	7	180	222	264
6-19	275	129036	76	93	4.1	0.4	0.2		19.3	7	45.0	18.0	T	75.5	31.0	5	256	317	350
7-21	66	129355	81	19	1.7	0.2	0.1		19.2	8	45.5	6.4	T	76.6	33.2	9	284	328	366
8-29	15	129802	74	16	0.8	0.1	0.2		11.8	17	45.7	3.5	T	69.0	32.3	22	280	306	376
9- 8	13	129828	66	11	0.3	0.1	0.3		11.7	25	42.8	3.3	0.0	68.1	34.2	25	284	311	385
9-22	14	129977	66	20	1.2	0.2	0.2		8.5	25	34.8	5.1	T	60.6	28.8	30	260	270	351
10-24	10	130273	46	10	0.5	0.3	0.2		12.6	33	47.9	6.2	T	71.2	34.3	38	300	319	427
11-12	13	130408	41.5	9	0.4	T	0.2		16.3	25	45.5	3.7	T	71.7	35.1	38	320	324	429
12-20	30	130757	38.6	6	0.5	0.2	0.2		8.8	27	64.2	8.7	0.0	68.6	31.6	40	276	302	425
1953																			
1-23	37	130968	26.3	2	0.5	0.1	0.1		6.4	14	53.3	4.5	T	69.4	31.2	8	240	302	336

2-21	193	131245	38.2	248	5.9	0.8	0.2		5.3	9	52.9	5.0	0.1	58.1	26.8	11	208	255	290
3-21	671	131524	48.3	51	1.9	0.1	0.2		9.9	6	54.9	20.4	T	55.0	22.9	5	160	232	275
4-25	168	131829	60.2	11	0.6	0.1	0.2		4.1	7	55.3	10.8	0.1	62.5	28.8	6	212	275	297
5-23	338	132050	59.4	1700	68.2	2.0	0.2		5.9	3	28.0	6.8	0.1	31.1	9.9	3	88	119	139
7-13	127	132475	72.7	66	3.2	0.2	0.2		11.0	6	46.6	13.1	T	71.6	29.2	9	252	299	373
8- 8	45	132656	71.3	23	1.1	0.1	0.2		9.0	11	46.1	4.5	T	67.3	31.0	13	256	296	350
9-28	5	133008	63.0	21	0.7	0.4	0.1		13.0	46	66.3	14.6	T	69.4	34.3	67	316	315	493
10-12	4	133092	58.5	11	0.6	0.2	0.1		13.9	44	112.9	7.5	T	72.1	36.6	62	280	331	551
11-10	7	133337	41	8	0.6	0.6	0.2		14.8	36	100.6	8.1	T	74.4	39.4	54	304	348	542
12-10	12	133535	39	5	0.5	0.1	0.1		12.1	31	61.5	4.1	0.3	69.4	34.5	38	288	316	452
1954																			
1- 8	11*	133718	34	2	0.3	0.1	0.2	0.3	9.5	35	64.0	2.1	0.8	72.8	36.7	47	320	333	459
2- 8	24	133991	33.5	4	0.6	0.1	0.1	0.1	9.0	10	52.5	10.3	T	61.6	23.2	32	232	249	349
3- 8	23	134166	39	8	0.5	0.2	0.3	T	7.8	23	50.8	1.4	0.5	66.1	34.6	23	272	308	399
4- 7	114	134479	59.5	210	4.1	0.5	0.3	T	4.9	8	49.3	4.2	T	57.4	26.2	9	204	251	312
5-10	40	134822	55	8	0.7	0.2	0.0	T	6.0	12	55.1	6.6	T	72.7	31.2	16	264	310	358
6- 9	421	135018	75	1800	31.0	1.5	0.3	0.3	8.3	5	25.1	14.1	0.1	35.8	1.1	17	88	94	160
7-12	7	135292	82	31	T	0.3	0.4	0.4	6.9	22	38.5	5.0	T	71.5	22.2	44	292	271	408
8-16	10	135585	77	126	0.1	0.4	0.3	0.3	6.4	33	33.7	8.4	0.1	44.2	20.2	34	180	194	297
9- 7	2	135736	75.5	53	T	0.5	0.4	0.4	9.3	40	32.7	9.1	T	56.3	28.8	51	272	260	407
11-16	5	136314	48.6	16	0.1	0.1	0.4	0.3	13.4	37	40.3	3.3	T	70.4	33.9	69	320	315	468
12-13	7	136570	34.7	4	0.5	0.1	0.0	0.0	11.6	44	36.8	4.8	T	74.3	37.8	40	324	341	481
1955																			
1-11	73	136732	34.9	18	0.7	0.1	0.2	0.0	9.6	26	68.3	11.2	T	74.3	32.3	11	228	319	397
2-15	26*	137290	32	11	0.8	0.2	0.0	0.2	6.6	15	50.0	6.0	T	61.8	27.2	11	212	267	295
5-24	73	137779	56	67	2.8	0.2	0.1	0.1	10.0	11	52.7	6.1	T	65.7	31.9	9	240	295	322
7-20	34	138280	80	194	6.1	0.4	0.1	0.0	10.1	13	31.1	5.7	0.1	45.9	20.6	9	164	200	234
8-19	5	138569	79	16	0.5	0.2	0.1	0.5	10.2	34	39.7	4.9	T	71.6	34.5	41	316	321	445
11-21	22		36.5																
1956																			
1-13	18	139578	33.5	8	0.7	0.3	0.2	0.0	7.3	29	52.0	6.7	T	75.6	39.5	30	316	352	428
2-20	348	139893	34	172	3.6	0.2	0.1	0.1	7.7	7	43.2	13.9	0.1	42.5	18.2	4	124	182	230
3-23	52	140132	45	11	0.5	0.3	0.1	0.0	2.3	12	58.6	7.6	T	70.1	36.1	13	268	324	377
6- 4	388	140755	61.5	62	3.4	0.1	0.1	0.0	11.1	11	56.8	19.5	0.1	77.1	30.8	6	244	320	396
6-11	130	140816	74.5	55	2.9	T	0.2	0.0	11.6	10	61.9	19.1	0.1	82.1	33.5	10	272	343	399

* backwater from ice

Date	Discharge	Laboratory Number	Temperature	Turbidity	Iron	Manganese	Fluoride	Boron	Silica	Chloride	Sulfate	Nitrate	Ammonium	Calcium	Magnesium	Sodium	Alkalinity (bicarbonate)	Total Hardness	Total Dissolved Minerals
	ft. sec.		°F		Fe	Mn	F	B	SiO_2	Cl	SO_4	NO_3	NH_4	Ca	Mg	Na	--(as $CaCO_3$)--		
1950																			
10-26	196	123381	51	5	0.4	0.0	0.3		10.8	12	64.0	8.4	T	76.7	31.8	13	260	323	383
11-30	379	123730	34	2	0.1	0.1			16.1	6	71.6	8.9	0.2	79.2	34.7	0	252	341	376
12-22	390*	123974	32	5	0.7	0.1			14.9	10	67.1	15.2	0.0	81.7	30.8	10	256	331	399
1951																			
2-27	1,910	124511	45	59	3.0	0.3			11.7	3	50.0	14.6	0.0	54.5	21.6	7	172	226	282
3-22	1,290	124727	41	24	0.9	0.3			14.1	8	59.2	18.4	0.0	69.2	27.8	0	200	288	321
5- 2	775	125143	69	16	0.9	0.1			12.6	7	64.4	17.8	T	69.8	27.3	6	208	287	331
6-11	602	125483	72	106	4.3	0.1			17.4	6	58.2	23.7	0.0	61.7	25.1	8	188	258	319
7-17	1,880	125854	76.5	367	26.4	0.4			12.8	6	44.0	10.4	0.0	57.8	20.3	5	176	228	279
11-16	1,920	126975	45	33	2.1	0.3			12.5	6	54.5	14.5	T	70.8	27.3	7	228	290	324
12-28	560*	127296	33	6	0.4	0.0	0.1		10.7	10	62.3	13.6	0.1	68.8	28.4	10	220	289	328
1952																			
1-15	1,460	127449	45	24	1.7	0.2			8.9	6	54.7	14.6	T	69.3	28.4	5	224	290	326
2-12	1,110	127744	41	5	0.9	T	0.1		9.3	6	58.0	17.1	T	68.4	27.7	5	212	285	317
3-12	3,990	128072	43	300	10.7	1.2			8.7	5	47.5	16.8	0.1	55.8	22.2	5	172	231	275
4-15	3,180	128398	47	43	2.2	T	0.2		10.6	5	53.5	20.5	T	62.0	27.4	3	196	268	307
5-14	404	128721	61	9	0.5	0.0	0.1		5.2	9	66.4	16.3	T	70.4	30.5	10	228	302	354
6-17	1,240	129009	80	96	8.5	0.5	0.2		11.5	13	118.7	21.2	T	75.0	31.0	22	204	315	420
7-17	241	129335	79	30	1.4	0.1	0.3		11.6	10	38.9	10.2	0.0	49.3	20.9	3	152	209	232
8-22	55	129709	76	20	1.4	0.0	0.3		16.8	38	64.6	4.4	T	65.9	28.9	63	248	284	436
9- 8	29	129829	77	15	1.3	0.0	0.5		10.2	52	71.0	4.0	T	71.6	35.4	58	300	325	480
10- 9	25	130128	53	13	0.6	0.0	0.6		11.1	72	69.9	7.4	T	72.2	33.7	80	312	219	528
11-10	40	130399	45	8	0.7				12.7	60	66.6	12.1	0.3	69.2	31.9	46	292	304	487
12- 8	67	130659	43	5	0.5	0.0			14.5	32	86.8	19.3	T	70.6	29.5	47	248	298	445
1953																			
1-15	99	130900	38	12	0.6				8.9	49	75.7	12.1		59.5	24.9	49	200	252	395
2-20	136	131244	40.5	5	0.3	0.0	0.3		8.3	22	80.6	11.0	0.2	69.9	31.6	20	224	305	381
3-19	3,160	131439	47.5	67	3.4	0.2	0.2		14.1	6	60.3	20.2	0.1	56.0	23.5	1	152	237	277
4-22	429	131800	57	9	0.8	0.1	0.2		4.4	10	69.1	17.4	T	65.5	28.7	6	196	282	317

5-27	417	132065	74	9	0.7	T	0.2		6.0	15	65.3	12.6	0.1	62.2	27.1	18	208	267	333
6-17	114	132228	78	10	0.9	T	0.4		15.4	320	61.7	8.9	0.1	65.0	29.7	38	252	284	388
7-13	301	132467	75.5	36	1.9	0.1	0.2		14.4	10	62.6	16.2	T	73.5	29.4	25	268	305	391
8-18	44	132730	77	4	0.3	0.1	0.3		8.1	29	76.1	1.2	0.4	64.3	29.5	42	252	282	408
9-16	20	132918	67.5	9	0.2	0.1	0.1		10.1	34	218.2	3.4	0.2	89.8	53.8	63	304	445	697
10-14	21	133138	55	12	0.5	0.1	0.3		9.5	50	122.2	5.2	0.1	78.2	42.3	77	336	369	612
11- 9	24	133309	42.5	7	0.4	T	0.1		14.9	55	86.6	5.6	0.4	72.4	34.4	68	300	323	544
12-21	26	133627	35	3	0.1	T	0.3		13.6	71	102.6	20.2	T	75.4	36.7	85	300	340	604
1954																			
1-26	54*	133850	35	12	0.8	0.1	0.1	0.2	12.4	73	141.5	19.3	0.9	60.7	29.7	113	256	274	611
2-24	34	134069	44.5	4	0.3	T	0.3	0.4	16.7	76	77.3	14.3	0.3	60.7	30.9	86	268	279	536
3-23	70	134295	43	22	0.3	0.1	0.3	0.2	10.4	41	112.6	8.9	0.1	54.7	33.8	52	208	276	470
4-27	332	134697	72	26	1.3	0.1	0.4	0.2	6.0	22	82.0	15.2	0.1	67.5	26.8	24	204	280	392
5-25	73	134909	70	5	0.5	0.1	0.1	0.3	3.3	44	69.7	16.4	T	65.9	31.4	41	240	299	417
6-23	82	135124	84	39	1.2	0.2	0.2	0.4	17.2	25	58.6	10.3	0.1	67.8	7.0	67	240	198	406
7-19	19	135360	86.5	16	T	0.2	0.4	0.3	9.7	48	91.5	2.3	0.1	66.2	22.5	80	268	258	505
8-26	28	135646	80	63	0.4	0.4	0.1	0.4	10.6	25	63.8	6.1	T	44.2	21.6	38	176	200	314
9-21	13	135799	68.7	38	0.1	0.0	0.5	0.3	7.6	50	44.6	1.3	T	62.3	32.9	55	292	291	469
10-27	24	136105	55	37	T	0.1	0.2	0.2	11.9	38	71.0	8.6	0.1	54.9	22.9	42	188	232	366
11-23	18	136377	41.6	11	T	0.1	0.7	0.4	8.1	62	76.1	4.9	T	75.3	34.6	73	320	331	560
1955																			
1- 4	89	136611	39	13	0.7	0.2	0.5	0.1	12.7	66	76.9	10.3	T	64.5	31.1	63	244	289	503
2- 9	100*		32																
3-10	440	137133	48.3	14	0.9	0.0	0.0	0.0	6.5	18	81.5	16.0	T	72.6	30.7	11	208	308	365
4-25	695	137642	58	51	1.9	0.1	0.1	0.0	7.1	14	80.4	17.8	T	73.6	30.6	3	200	310	344
5-16	590	137754	66	23	1.0	0.1	0.1	0.0	7.8	23	86.2	11.4	T	73.6	31.7	15	216	315	418
6-23	368	138097	74	53	2.2	0.1	0.2	0.0	16.7	11	71.4	15.3	0.1	81.0	32.0	2	236	334	368
9-21	18	139082	73.5	16	1.1	0.2	0.4	0.1	8.8	76	84.7	4.8	T	74.1	36.1	81	312	334	573
11-30	240	139173	33.5	5	0.5	0.1	0.3	0.0	7.8	20	91.3	26.9	0.1	83.0	37.2	13	244	361	418
12-28	142	139360	33	1	0.1	0.1	0.2	0.4	9.1	28	89.3	20.4	T	74.6	32.8	29	236	322	429
1956																			
1-12	101	139538	33.5	3	0.2	T	0.3	0.2	4.2	39	91.3	24.2	T	84.0	37.1	40	280	363	491
2-27	1,510	140110	41.5	34	1.3	0.2	0.2	0.0	10.2	12	73.2	22.3	T	64.2	28.3	8	184	277	340
3-21	373	140131	45	7	T	T	0.2	0.0	2.8	17	89.5	18.3	T	77.6	32.7	9	216	329	377
4-26	158	140623	54	16	0.4	0.3	0.2	0.0	6.4	18	50.6	3.8	0.1	74.6	38.2	17	300	344	410
5-22	162	140635	74	5	0.3	0.1	0.2	0.0	2.4	28	86.4	10.3	0.1	71.6	35.1	27	244	323	414
6-19	325	140851	76	434	9.1	0.5	0.2	0.0	7.9	14	63.6	13.4	T	58.2	22.9	10	164	240	306

* backwater from ice

Date	Discharge	Laboratory Number	Temperature	Turbidity	Iron	Manganese	Fluoride	Boron	Silica	Chloride	Sulfate	Nitrate	Ammonium	Calcium	Magnesium	Sodium	Alkalinity (bicarbonate)	Total Hardness	Total Dissolved Minerals
	ft. sec.		°F		Fe	Mn	F	B	SiO_2	Cl	SO_4	NO_3	NH_4	Ca	Mg	Na	--(as $CaCO_3$)--		
1950																			
10-10	584	123225	60	50	3.0	0.2	0.3		16.1	14	44.2	3.6	T	63.9	23.5	19	228	256	330
10-31	180	123468	61	25	1.1	0.2			13.5	13	45.5	2.1	0.0	75.7	31.4	13	28	319	361
12-10	1,080		31.5														280		
1951																			
1- 9	2,110	124236	32	93	5.1	0.3			15.1	9	41.3	10.5	0.1	54.0	21.3	10	180	223	268
2-16	6,540	124409	34	372	10.8	0.8			9.4	9	37.8	6.7	T	29.5	12.3	10	88	125	159
4-27	1,520	125072	59.5	27	1.8	0.2			11.7	4	59.0	12.2	T	70.3	30.2	2	228	300	325
5-10	1,280	125238	61	43	2.2	0.2			10.6	14	50.4	12.7	T	65.5	26.8	9	212	274	319
6-11	329	125501	73																
7-30	1,230	125999	79.6	326	11.7	0.5			13.3	9	27.6	7.6	T	50.0	18.9	6	168	203	249
9-18	255	126504	67	13	1.4	0.1			9.1	17	39.3	2.6	0.0	66.5	26.4	2	212	275	286
10-16	82	126757	64	13	1.8	0.7	0.2		6.1	18	38.5	1.9	T	69.8	29.9	14	260	298	347
11-13	2,580	126976	51	240	9.8	1.6	0.2		9.3	29	53.9	4.2	T	43.1	18.3	30	148	184	279
12-13	652	127266	36	10	0.7	0.2	0.2		14.3	26	61.9	7.0	T	72.8	30.8	19	244	309	368
1952																			
1-21	1,470	127589	41	37	1.2	0.3	0.1		10.5	12	54.3	12.9	T	67.4	30.4	7	224	294	339
2-18	1,530	127903	39	15	1.5	0.2	0.1		10.4	15	56.6	12.5	T	68.8	30.5	13	236	297	346
4- 8	3,260	128377	48	74	3.1		0.2		11.5	10	55.3	11.9	T	54.1	24.2	8	172	235	284
5-21	762	128820	58.2	330	8.4	0.9	0.2		7.3	11	40.1	11.9	0.1	50.6	19.3	9	160	206	245
6-25	2,900	129100	81	703	20.5	1.2	0.2		10.6	2	13.4	8.0	T	24.2	9.6		76	100	100
8- 1	130	129533		22	1.6	0.2	0.1		13.6	13	38.5	1.9	T	57.8	30.2		232	269	298
8-26	60	129768	76	28	1.3	0.4	0.2		8.9	12	36.4	2.4	T	65.9	28.7	12	252	283	331
9-25	36	129989	64.5	30	1.2	0.5	0.2		15.2	16	34.4	2.5	T	57.9	23.2	17	216	240	305
10-16	22	130200	55	28	1.0	0.8	0.1		8.6	18	36.4	3.9	T	68.7	30.1	14	260	296	346
11-10	28	130450	46	30	1.3	0.9	0.2		12.8	23	40.3	3.5	T	71.6	29.6	25	276	300	388
12-16	44	130765	33.5	5	0.9	0.4	0.1		10.4	97	66.0	2.3	T	70.4	30.4	64	232	301	489
1953																			
1-25	95	130969	36.3	9	0.9	0.4	0.1		4.5	62	97.9	2.5	T	69.1	32.0	44	208	305	433
2-24	260	131256	39.5	220	5.3	0.3	0.3		6.6	41	79.0	3.0	0.2	48.7	21.8	30	136	212	324

4-20	970	131823	47.5	13	0.9	0.1	0.2		8.8	25	71.6	11.8	T	65.5	28.8	17	200	283	347
8-26	37	132820	77	10	0.8	0.1	0.1		6.4	16	36.2	2.0	T	66.3	31.4	14	264	295	340
9-28	15	133060	69.5	21	0.9	0.7	0.2		8.3	15	34.3	3.6	T	66.4	30.1	14	260	289	358
10-29	24	133256	54	16	0.8	0.1	0.1		8.3	14	36.2	2.4	T	67.1	26.8	13	248	278	344
11-16	15	133392	49.5	26	0.9	0.5	0.1		11.6	22	31.7	1.6	0.3	68.9	28.2	19	264	288	353
1954																			
1-19	22	133824	34.5	6	0.6	0.4	0.2		5.6	35	53.7	0.8	0.4	70.0	33.4	44	304	313	448
3-16	27	134411	44.5	19	0.8	1.3	0.2	T	3.9	68	146.7	1.7	T	60.3	24.7	122	268	253	608
5-10	114	134821	61	54	2.0	0.5	0.2	0.1	5.2	47	89.5	3.4	T	63.4	24.7	61	180	210	410
6-14	361	135083	83.6	36	3.8	0.3	0.5	0.2	4.1	18	67.1	7.8	T	57.8	6.3	40	156	171	290
7-20	14	135441	87.9	26	T	0.7	0.2	T	4.9	28	60.8	3.8	T	61.3	18.1	47	224	228	377
8-17	27	135654	82.7	38	0.2	0.5	0.2	0.1	1.3	27	68.9	3.5	T	59.7	30.4	27	220	275	357
9-13	10	135768	71.5	24	T	0.4	0.2	0.0	9.4	30	57.0	5.5	T	60.2	19.9	21	172	233	346
10-18	78	136090	53.9	84	0.1	0.0	0.3	0.6	6.8	25	94.2	1.5	0.3	53.4	16.3	19	108	201	311
12- 2	14	136385	39	216	T	0.3	0.1	0.2	10.5	47	72.6	1.8	T	72.3	24.6	3	196	282	353
12-31	50	136572	40	16	0.7	0.3	0.1	0.1	6.2	45	109.2	0.6	0.6	75.8	24.9	33	188	297	416
1955																			
2-11	110*	136980	34	43	1.3	0.1	0.3	0.0	6.6	75	114.6	5.4	0.3	72.3	26.0	43	152	288	450
8- 5	385	138389	85.1	55	1.0	0.1	0.1	0.1	10.6	20	42.6	11.5	0.1	48.6	23.0	25	188	216	329
9-29	26		55.2	bottle cracked - - broke															
10-27	214	138934	57.5	20	1.0	0.1	0.1	0.1	10.2	24	66.9	11.0	T	76.1	30.0	12	228	314	374
12- 6	440	139227	34.7	12	0.5	0.1	0.1	0.0	8.6	43	80.8	19.3	T	82.5	34.3	24	240	348	442
12-26	251	139370	35.7	2	0.5	0.1	0.4	0.2	15.4	66	139.3	11.4	T	84.0	35.6	71	264	357	593
1956																			
2-20	1,520	139874	37.7	190	5.9	0.1	0.1	0.3	8.4	23	60.1	20.8	0.1	60.8	23.0	6	148	247	311
3-22	590	140133	46.2	9	1.0	0.2	0.1	0.0	5.9	30	80.8	18.6	T	77.6	31.3	11	204	323	384
4-27	556	140452	59.5	77	3.6	0.5	0.1	0.0	5.4	48	97.3	4.5	0.1	59.1	26.6	32	156	258	397

* complete ice cover; discharge estimated

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness	Total Dissolved Minerals
1945																			
10-10	2,820	104513	58	200	4.7	0.6			12.5	41	48.3	7.0	0.1	44.0	16.9	20	108	180	258
11-17	2,820	104829	51	309	4.6	0.5			11.5	37	81.3	3.8	T	50.6	21.2	26	130	214	325
12-19	815[a]	105136	32.5	10	0.8	0.3			13.0	42	92.4	7.9	0.1	79.4	33.0	33	244	334	451
1946																			
1-21	8,670	105331	34	60	1.9	T			11.5	11	58.4	9.8	T	45.1	18.7	10	128	190	252
3- 5	2,740	105803	50	100	3.5	0.4			13.0	30	84.5	10.3	T	65.9	26.5	24	188	274	364
4-11	1,240	106164	59	43	1.4	0.5			10.0	36	95.2	6.9	T	71.8	31.9	28	216	311	404
5-15	17,100	106481	61	108	1.5	0.1			15.9	13	41.6	7.3	0.1	26.3	11.7	12	72	114	175
6-11	6,910	106804	73	158	3.0	T			13.3	14	42.8	5.9	0.1	42.3	17.3	11	132	177	235
7- 8	1,030	107057	81	118	2.3	0.3			18.3	21	46.1	14.3	0.1	66.7	25.0	14	212	270	344
8- 3	713	107334	80.5	260	0.5	0.7			16.1	17	42.4	6.9	T	53.1	21.1	10	168	219	281
9- 3	948	107600	68.5	100	0.6	0.6			17.8	23	50.8	4.9	T	64.5	21.7	18	200	251	320
10- 8	264	107949	65.5	70	2.1	0.4			14.2	63	56.0	1.4	0.2	72.4	25.2	44	232	285	410
11-14	17,100	108313	51	85	4.0	0.1			13.6	20	34.8	1.6	0.1	20.4	5.1	20	50	72	145
12- 2	3,380	108609	39	110	2.4	0.1			14.4	22	75.3	5.2	0.2	40.0	17.5	22	108	172	264
1947																			
1-10	2,830[b]	108903	32	130	2.6	0.7			14.9	32	85.6	5.5	0.3	54.1	21.5	25	140	224	325
2- 8	8,600	109157	32	270	4.7	0.4			15.3	14	53.3	7.7	0.1	34.6	13.2	14	92	141	215
3- 4	1,050	109536	36	5	0.8	0.4			16.3	57	91.3	6.7	0.2	79.6	32.0	38	232	331	460
5- 8	15,300	110231	59	245	2.0	0.4			12.6	12	44.2	6.9	0.1	35.7	12.7	8	92	142	203
6-13	5,400[c]	110725	74	480	11.2	0.6			13.5	9	28.4	6.4	T	31.1	11.5	5	88	125	159
7- 7	10,500	111043	71	240	4.6	0.2			11.8	16	29.6	5.0	T	26.4	8.0	11	66	99	148
8-13	445	111521	73	96	1.7	0.4			14.1	62	50.4	3.4	T	57.4	27.1	40	200	255	362
9-12	220	111857	67	58	1.9	0.6			14.7	66	31.3	3.5	T	43.1	15.3	34	116	171	293
10- 7	146	112121	63.8	71	1.9	0.7			13.5	114	46.1	2.6	T	53.0	21.6	58	138	222	428
11- 3	1,050	112506	57	240	4.6	0.4			11.7	87	50.4	2.2	T	34.4	12.9	56	84	139	316
12- 1	340	112853	38.5	57	2.2	0.5			15.6	196	88.7	1.8	0.2	66.2	27.8	115	160	280	629
1948																			
1-15	1,440	113187	33.5	93	1.9	0.3			13.2	50	80.4	10.0	0.1	57.4	24.7	30	148	245	373

2- 2	426	113443	35	10	2.1	0.6	15.3	71	81.7	8.5	0.3	77.6	31.2	43	224	323	478
3- 3	7,060[d]	113688	41	425	19.0	0.0	12.6	18	62.7	6.4	T	30.9	7.2	28	72	107	220
4- 2	31,700[d]	114069	50	212	4.2	T	10.4	8	32.3	3.0	0.2	15.0	5.4	14	44	60	124
5-17	6,630[d]	114766	64	300	11.6	1.0	9.6	36	61.5	8.5	0.1	38.4	14.1	31	100	154	260
6- 8	2,560	114970	71.5	817	14.9	1.3	9.6	109	43.6	4.4	0.1	34.3	9.2	64	60	124	322
7- 9	2,100[b]	115215	80	400	7.1	0.8	13.5	34	35.0	14.6	T	45.8	16.6	17	124	183	252
8-18	640	115622	78	81	2.5	0.3	12.2	47	52.5	2.7	T	60.8	23.4	29	188	248	360
9-28	156	115988	64	50	1.6	0.9	14.4	45	42.0	0.4	0.3	53.3	15.0	41	176	194	315
10-28	240	116345	54.5	54	2.6	0.6	11.6	151	47.7	2.1	0.1	50.5	19.3	76	108	206	449
1949																	
1-12	15,900	117041	40	174	4.0	0.2	11.6	14	42.6	9.0	0.1	21.9	6.7	12	40	83	153
2- 3	28,600	117300	33	103	2.9	0.5	8.4	8	38.3	8.0	T	21.4	7.5	4	36	85	112
3-25	6,080[d]	117819	52	179	5.8	0.8	11.8	24	76.9	4.5	T	42.2	14.4	22	96	165	269
4- 9	7,420[d]	117821	47	84	3.5	0.5	14.0	16	66.7	7.3	0.1	56.1	21.6	4	140	229	284
5-11	948	118200	68.5	22	0.2	0.3	8.6	28	82.3	3.1	T	70.6	28.2	22	212	292	374
6-27	2,060[d]	118725	78	743	29.6	2.0	12.3	22	30.2	4.5	T	29.3	7.6	19	80	105	193
7-15	2,740[d]	118926	68	740	17.3	0.5	11.7	21	19.4	3.5	0.1	18.5	4.5	11	36	65	130
8-17	775	119159	82	99	2.6	0.3	12.6	98	33.5	3.1	0.1	37.7	13.8	47	76	148	322
9-18	3,170	119385	66	473	10.6	0.9	8.7	19	33.5	2.2	0.1	24.8	2.1	13	36	71	127
11-14	872	119913	55.5	22	1.4	0.3	19.7	30	66.0	5.6	T	75.0	27.3	13	212	300	375
11-29	604	120219	43	12	1.8	0.4	14.3	56	84.5	0.3	0.3	74.9	34.4	24	216	329	433
1950																	
1- 9	59,300[d]	120446	45	380	6.3	0.4	9.2	8	28.8	3.5	T	17.1	3.6	10	36	58	92
2- 2	14,600	120666	37.5	183	3.4	0.1	11.7	12	42.6	5.1	T	32.7	10.3	1	60	124	167
3-11	6,850[d]	120962	42	71	2.1	T	17.4	20	63.1	10.5	T	55.5	21.6	18	160	228	303
4-14	10,700[d]	121407	50.5	256	2.2	0.0	12.5	17	48.8	7.5	0.0	30.2	11.2	5	52	122	166
5- 6	3,140[d]	121655	63	76	3.7	0.1	13.1	21	76.7	6.5	T	55.6	22.6	18	156	232	312
6-19	7,000[d]	121954	76	652	0.7	0.8	10.2	9	31.4	4.2	T	22.3	6.9	6	48	84	135
7-10	4,050	122390	74	470	11.2	0.6	10.8	3	17.5	4.4	0.1	22.3	7.3	1	64	86	113
7-31	852[d]	122559	78	64	2.6	0.4	19.4	27	40.7	7.9	T	59.8	23.7	17	196	247	324
9-22	526	123065	72.5	54	1.8	0.0	16.2	28	47.5	3.0	T	48.2	17.0	22	148	191	276

a - affected by ice b - affected by changing stage c - based on means d - adjusted for backwater

Date	Discharge ft., sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness	Total Dissolved Minerals
1945																			
10-16	112	104520	50	20	0.7	0.3			11.0	16	105.5	6.7	0.1	88.1	35.6	7	244	367	408
11-16	158	104832	43	435	7.9	0.5			13.5	14	76.7	6.3	0.0	61.5	22.6	14	172	247	309
11-27	207	104967	33	320	5.5	0.5			11.0	14	97.3	8.9	T	81.6	32.2	12	236	337	409
1946																			
2- 1	235	105411	35	34	0.8	0.5			312.5	11	95.2	5.9	0.3	91.3	35.1	6	268	373	424
2-28	335	105703	34	77	2.1	0.2			10.5	7	83.5	6.8	0.2	59.2	22.6	6	152	246	299
4- 1	632	106073	58	94	3.0	0.4			10.5	7	80.0	11.9	T	81.2	30.9	0	228	330	362
5- 1	256	106411	60	25	0.5	T			7.4	9	80.6	6.4	T	74.8	33.6	7	240	326	375
6- 1	332	106622	65	115	3.2	0.3			13.5	9	71.2	10.0	0.1	79.3	31.7	10	256	329	374
6-20	4,180	106844		1000	25.6	1.9			12.5	6	44.4	14.7	0.2	23.5	17.0	5	132	188	219
6-28	647	106926	81	250	9.7	0.4			16.3	4	76.9	17.2	0.1	82.7	30.1	6	244	331	370
8- 3	85	107353	73	20	0.5	T			8.5	14	90.7	2.0	0.1	73.1	32.8	14	232	317	377
9-11	54	107699	73	47	1.5	0.3			8.1	22	107.4	2.1	T	68.7	31.8	27	216	302	413
10- 2	19	107857	59	100	0.9	0.6			3.0	24	146.9	0.6	0.1	83.0	36.0	29	232	356	468
11-22	96	108434	38.5	65	0.8	0.3			15.0	16	129.4	6.5	0.2	89.4	35.9	14	240	371	457
1947																			
1- 6	63	108862	34	2	0.2	0.2			14.7	20	124.7	7.7	0.4	95.6	41.4	19	288	409	498
2-11	170*	109220		65	2.9	0.5			16.3	12	103.7	13.3	0.3	95.3	33.1	18	280	375	462
5-23	688	110435	61	100	7.9	0.2			14.3	10	76.7	13.5		78.4	31.7	5	232	326	368
6-16	950	110770	62.5	100	6.9	1.2			17.4	10	74.5	17.2		83.1	32.6	11	260	344	394
7-31	202	111324	80	100	6.5	0.7			15.8	8	73.2	10.2		71.8	26.2	4	200	287	338
8-23	45	111631	84.5	16	0.9	0.1				16	83.7			70.4	30.4	17	228	303	384
10-21	28	112327	63	34	1.5	0.2			9.1	27	112.5			81.4	33.4	30	252	343	436
11-17	130	112623	39	55	1.6	0.4				23	109.8			72.8	30.0	23	208	307	380
12-17	114	112967	34	14	0.4	0.2			15.6	17	128.4	11.6	T	92.3	35.4	20	252	376	492
1948																			
1-22	72	113260	34	3	0.2	0.2			15.3	19	124.7	9.1	T	115.1	44.8	18	348	472	554
2-19	3,840	113542	33	2000	40.3	T			9.4	4	43.0	0.7	0.8	28.6	9.8	0	64	112	130
3- 5	319	113682	32	248	6.6	0.3			19.6	11	86.8	9.1	0.4	56.1	23.4	21	172	237	336

4- 5	505	114099	54	62	2.3	0.2	27.1	10	86.4	12.3	0.1	82.9	25.8	15	232	314	394
5-31	117	114897	68	53	1.4		7.2	16	85.4	4.0		75.5	34.6	13	244	333	400
6-22	106	115119	72	47	1.4		9.7	17	97.7	2.0		68.1	30.2	28	228	296	400
7-19	100	115397	80	260	7.9			8	47.1	7.5		65.1	17.8	8	188	237	254
8-22	55	115665	81	68	4.2	0.4	6.3	8	109.2	1.0	0.3	70.6	25.1	4	164	280	315
10- 5	30	116043	55	50	1.2	0.5	5.8	17	104.5	0.6	0.3	72.3	25.8	26	212	287	406
10-29	34	116314	55	25	1.1	0.2	9.7	41	131.4	0.3	0.2	89.6	34.2	38	252	365	504
11-21	88	116544	42	39	1.3	0.0	9.3	40	114.0	2.3	0.1	77.7	31.4	37	228	324	452
12-17	106	116820	34	81	3.3	0.6	6.7	28	111.5	3.3	0.2	74.5	30.0	29	216	310	431
1949																	
1-22	395*	117115	33	32	1.2	0.4	15.3	10	91.7	11.9	0.6	78.3	27.1	8	212	308	360
2-14	5,120	117298	35	281	7.3	1.0	4.7	5	21.2	5.8	0.1	14.6	3.8	0	20	52	66
4-24	454	117938	59	31	1.4	0.0	6.8	9	86.6	6.3	T	75.3	30.1	9	224	313	375
5-27	104	118327	67	93	3.2	0.0	18.1	17	87.8	6.0	T	84.5	33.0	15	260	347	409
7-23	1,180	118980	67	1130	63.4	5.0	11.7	9	27.1	4.4	0.1	38.0	9.5	2	96	134	185
11-19	26	119974	39	19	0.8	0.2	11.6	45	116.6	0.2	0.2	96.4	37.1	33	280	394	523
1950																	
1-18	639	120517	32	220	6.8	0.5	11.0	8	66.6	13.1	0.1	51.3	18.1	0	112	203	234
2-21	340*	120861	32	168	6.3	0.4	13.7	8	91.1	11.3	T	73.9	25.7	4	184	290	352
6-16	6,480	121973	74	2000	79.3	3.5	10.7	1	30.2	5.4	T	29.3	8.7	2	76	110	139
7-28	420	122610	72	38	1.7	0.1	21.3	8	92.4	9.2	0.0	81.2	32.4	11	244	336	396
8-25	146	122814	76.5	16	0.5	0.1	7.6	10	101.2	0.4	0.0	74.9	34.3	16	244	329	400
9-15	112	122969	62.5	161	4.9	0.2	8.2	8	81.7	3.2	T	53.0	21.4	16	156	221	291

* under ice effect

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness	Total Dissolved Minerals
1945																			
10-10	226	104510	52	20	1.3	0.4			14.5	6	53.5	7.5	0.1	55.8	19.7	0	152	221	267
11- 8	99	104744	57	30	1.9	0.3			16.0	10	68.9	1.5	T	73.2	26.9	2	212	294	320
12- 2	164	104982	38	44	0.7	0.0			12.8	10	88.9	5.2	T	71.6	25.8	12	200	285	368
1946																			
1- 5	4,580	105240	31	100	30.8	0.0			9.5	3	34.8	4.9	0.2	20.7	6.2	6	48	78	128
1-31	258	105412	35	25	0.6	0.4			13.0	7	75.5	5.7	0.2	71.6	27.5	2	204	292	326
2-28	389	105702	39	220	4.0	0.2			11.0	7	69.7	8.6	0.2	66.1	24.5	7	192	266	304
3-27	1,190	106074	58	520	10.3	0.5			13.0	4	74.5	11.9	0.1	52.9	19.3	4	128	212	253
4-30	280	106410	56	25	0.8	0.2			20.3	9	113.1	4.5	0.0	70.3	27.8	20	200	291	377
5-31	302	106623	68	73	1.8	0.2			15.4	9	71.8	8.5	0.1	67.4	27.5	9	208	282	343
6-27	658	106927	76	305	8.6	0.4			18.4	12	48.1	13.9	T	52.5	20.5	7	152	216	252
8-10	569	107352	68	100	17.4	0.9			11.6	13	32.1	5.1	0.1	31.3	8.2	9	76	111	151
9-12	105	107698	70	290	6.3	0.1			10.1	4	27.8	2.9	T	34.4	10.7	6	106	130	153
10- 4	34	107856	56	100	1.3	0.3			5.2	8	35.8	2.2	0.1	57.7	18.0	1	172	219	230
11-14	668	108319	45	240	4.1	0.6			14.9	4	57.2	8.5	0.1	48.6	16.3	3	124	189	239
1947																			
1- 7	273	108861	36	5	0.5	0.4			18.5	8	78.2	8.1	0.3	72.6	29.5	7	220	303	360
2-19	231	109289	33	690	50.4	3.3			15.0	7	75.3	7.5	0.3	62.0	22.4	8	172	247	300
3- 8	190	109528	36.5	16	0.7	0.2			16.1	8	74.7	6.9	0.3	72.8	26.5	3	204	291	337
5-19	1,680	110434	64	1800	48.4	1.5			11.5	5	43.8	6.0	0.1	35.1	12.8	1	86	141	177
6- 9	16,400	110663	74	100	26.0	4.2			11.6	5	22.8	6.7		18.4	4.1	6	68	63	94
7-30	503	111323	80	100	11.3	2.7			17.7	7	45.9	10.5		67.6	20.3	4	196	253	306
8-21	72	111630	84	20	1.3	0.2			14.1	9	44.6	2.3		70.4	23.7	7	228	275	298
10-22	16	112328	61.5	33	1.1	0.5			15.8	7	38.5			78.5	21.4	0	244	286	330
11-18	118	112624	39	114	4.0	0.9				8	86.4			51.4	20.6	9	132	214	250
12-16	123	112968	34	49	1.1	0.2			15.3	7	66.0	12.8	T	52.6	15.9	11	132	197	278
1948																			
1-26	51	113286	33	T	0.5	0.4			18.6	14	77.8	10.9	0.1	79.8	29.9	12	240	323	392
3- 3	2,530	113681	33	1268	12.7	0.3			11.9	6	59.0	10.4	0.7	31.3	9.3	0	40	117	163

4- 7	4,170	114100	57	10240	400.0	3.0	13.1	7	51.4	6.8	0.6	40.3	10.0	11	100	143	202
6- 1	116	114898	69	45	1.5		13.0	9	57.0	2.6		69.5	25.8	0	212	281	324
6-25	377	115118	74	608	21.8		9.0	7	51.2	7.2		35.5	12.4	0	92	141	206
7-24	1,980	115396	74	1767	22.6			4	23.2	6.3		60.7	10.7	1	164	196	196
8-16	148	115664	72	100	2.3	0.2	16.2	8	45.3	3.3	T	68.3	22.9	3	212	267	308
9-28	62	116044	61	100	3.5	1.1	12.6	3	30.0	4.3	T	36.4	10.9	3	104	136	184
10-25	91	116313	51	32	1.6	0.5	18.6	9	41.1	1.5	0.2	60.3	19.2	8	192	230	272
11-17	59	116543	45.5	39	1.6	0.4	16.3	11	42.4	2.8	0.1	57.1	21.1	4	176	230	270
12-14	51	116821	38	13	1.1	0.6	13.6	13	54.7	3.3	T	67.3	24.2	12	216	268	322
1949																	
2-21	6,080	117355	42	900		1.0	7.7	4	19.1	1.9	0.1	17.2	2.1	7	40	52	93
3-17	340	117607	44	21	1.8	0.4	14.7	5	84.3	7.0	0.2	69.7	23.6	11	196	272	349
4-18	872	117937	44	186	8.8	0.5	12.7	6	77.3	5.5	0.1	52.5	17.1	11	132	202	270
5-23	208	118328	68	163	5.1	0.0	12.8	8	86.0	3.5	T	65.7	24.2	7	176	264	320
6-23	112	118638	78	88	2.8	0.3	16.9	5	42.6	T	T	49.7	16.1	0	140	191	234
7-21	540	118979	67	846	47.6	2.3	12.2	8	31.7	3.5	T	32.7	8.6	5	80	118	166
8-25	67	119195	65	204	6.1	0.3	11.8	5	25.1	3.6	0.2	29.7	8.7	0	76	111	158
10-13	41	119596	60	54	2.0	1.2	15.3	15	55.1	2.7	0.1	58.6	19.5	2	152	227	266
12-19	66	120277	36	26	2.4	0.6	14.9	14	70.3	2.8	T	72.9	23.8	8	204	281	345
1950																	
2-23	643*	120862	32	96	4.2	0.4	14.4	6	89.5	8.6	T	56.9	21.6	4	132	232	270
4-29	3,710*	121589	44	590	11.8	0.8	14.3	2	43.8	8.3	0.1	33.6	9.4	0	68	127	169
7-19	4,090	122408	73	641	21.6	1.0	13.0	2	19.1	3.5	T	21.8	5.0	1	52	75	104
8-26	74	122815	78	22	1.2	0.2	15.7	6	43.0	1.9	0.0	57.9	21.0	9	196	231	273
9-13	72	122968	65	48	0.2	0.3	13.2	7	42.8	0.1	0.1	59.8	24.6	11	220	251	300

* affected by backwater from Illinois River

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) —(as $CaCO_3$)—	Total Hardness	Total Dissolved Minerals
1945																			
10-12	104	104509	55	20	1.5	0.3			13.0	8	80.4	5.3	0.1	68.1	23.8	12	196	269	334
11-19	130	104831	48	109	2.6	0.3			13.3	7	91.9	4.1	T	68.9	28.6	10	202	290	359
12-17	56*	105139	33	10	0.9	0.8			15.5	9	121.2	4.9	0.2	89.9	35.9	27	288	372	482
1946																			
1-22	230	105335	33	92	5.1	0.4			13.5	8	113.5	8.9	0.2	75.1	30.6	21	224	314	390
2-15	5,050	105549	33	700	19.9	0.9			9.5	6	55.1	3.5	0.1	33.3	11.6	4	70	131	163
3- 4	279	105802	51	82	3.2	0.3			12.5	11	123.0	7.6	0.1	81.7	32.1	21	232	337	437
4-12	159	106166	49	25	0.9	0.3			19.0	9	122.8	2.8	T	82.3	36.9	19	256	358	441
5-16	1,580	106484	64	700	24.4	1.6			14.2	4	77.3	7.1	0.1	52.2	20.2	8	140	214	273
6-17	59	106807	81	56	1.3	0.5			14.9	14	82.1	2.2	T	68.2	29.5	14	216	292	344
7-12	16	107056	77	62	0.5	1.3			17.1	8	63.4	5.1	0.4	73.7	25.0	19	248	288	358
8- 1	19	107330	82.5	45	1.0	0.7			15.8	5	50.8	1.1	0.2	63.6	19.5	4	188	240	286
9- 6	68	107601	72	100	0.6	0.6			15.3	6	65.6	0.4	0.2	68.9	23.8	7	208	271	336
10-14	15	107946	59	25	1.5	1.8			17.9	7	42.2	0.1	0.1	71.1	23.8	5	232	276	308
11- 5	12,400	108312	55	180	4.7	0.2			14.2	3	23.9	3.0	0.1	18.9	4.7	7	52	67	110
12- 9	257	108607	51	85	2.8	0.3			16.3	6	114.0	5.0	0.2	78.4	33.5	9	224	334	393
1947																			
1- 7	200	108906	32	33	1.2	0.3			17.7	8	123.4	7.7	0.1	81.0	34.4	14	228	344	433
2- 3	706	109160	36	51	14.5	0.9			14.6	7	97.7	9.8	0.1	87.1	25.2	21	248	322	438
3-10	127	109534	37	30	1.5	0.5			13.3	9	136.6	3.8	0.1	84.0	36.3	16	236	359	444
4- 7	1,730	109942	54.5	230	40.4	0.7			14.4	7	90.1	6.8	0.1	52.2	17.6	T	124	203	289
5- 1	2,670	110230	62	280	19.1	1.1			11.8	5	66.2	4.8	0.1	40.0	13.3	6	88	155	215
6-13	323	110726	72	210	7.6	0.5			17.9	5	80.4	8.1	T	65.7	24.4	13	196	265	348
7- 2	4,920	111044	74	975	15.0	0.9			13.0	4	30.0	5.5	0.1	25.3	7.0	5	62	92	126
8- 5	31	111522	72	62	1.5	1.5			20.7	5	57.8	2.2	T	73.6	27.3	13	256	297	342
9- 2	9	111858	64	52	2.1	3.0			34.0	7	47.9	2.2	T	66.8	25.6	1	212	272	323
10- 5	8	112123	63	72	1.6	2.3			14.9	4	45.7	2.4	T	60.7	22.9	4	200	246	287
11- 8	12	112509	44.5	37	1.5	1.2			14.6	6	51.8	2.4	T	58.4	21.4	14	200	234	299
12- 9	33	112854	36	82	2.0	0.5			14.9	7	75.5	0.1	T	62.0	25.0	5	180	258	328

1948																	
1-12	34	113188	39.5	100	1.8	0.5	13.9	7	96.5	6.2	0.3	58.5	24.1	12	156	246	316
2- 9	7	113440	31	10	0.9	3.2	17.7	11	93.6	4.2	1.1	83.8	33.3	20	276	347	440
3- 1	373	113687	44	2000	67.0	1.9	12.6	7	91.1	6.3	T	63.2	22.2	10	160	249	333
4-16	408	114274	57	194	6.3	0.3	14.2	7	105.1	5.9	T	61.4	23.7	11	152	251	319
5-18	918	114768	66	500	9.4	1.0	14.3	6	73.0	5.6	T	46.5	14.7	5	100	177	248
6- 8	87	114972	77.5	430	15.3	0.7	11.7	3	50.6	3.8	0.1	43.5	14.4	5	120	169	226
7-10	71	115218	80	5000	121.0	4.4	25.1	6	53.7	3.8	0.3	55.8	21.0	1	160	226	270
8-20	393	115638	80	454	18.1	1.1	9.4	3	26.1	2.6	0.1	27.9	6.7	3	72	98	133
9-30	12	115987	71	20	0.8	1.7	16.1	6	44.8	1.2	0.1	66.0	19.5	16	224	246	306
10-15	12	116149	51	25	0.8	1.6	15.3	6	42.0	0.2	0.2	65.5	23.4	7	224	260	313
11-24	37	116548	37	6	0.6	0.7	15.3	1	94.4	2.7	0.2	69.9	26.2	8	200	283	361
12-15	224	116754	52.5	358	0.5	0.9	11.0	9	90.9	4.2	0.2	65.8	21.7	18	184	254	335
1949																	
1-13	1,440	117089	37.5	186	6.6	0.5	13.5	5	76.1	7.7	0.4	40.2	14.3	9	88	160	210
2-25	2,610	117411	41	600		0.8	14.2	5	71.2	7.8	0.1	41.6	12.9	14	100	157	227
3- 9	337	117550	42	32	1.7	0.3	16.4	9	112.5	6.6	0.2	77.5	28.7	16	212	312	408
4-21	187	118029	49	5	0.3	0.1	14.3	8	126.3	1.9	0.1	79.4	31.1	15	216	327	449
5-16	76	118231	71	47	0.5	0.4	16.8	6	81.0	3.7	T	66.6	23.6	8	184	264	312
6-14	137	118529	68	485	14.1	1.4	15.3	7	63.1	3.5	T	54.6	19.1	2	140	215	265
6-30	574	118727	80	846	38.8	3.0	11.2	15	35.4	4.1	T	34.1	9.5	11	88	125	168
8- 2	494	119023	74	1800	104.9	3.0	9.5	8	22.4	1.9	0.3	22.9	7.5	14	84	88	130
9- 6	15	119274	75	24	0.5	1.6	17.9	7	50.8	0.4	0.2	72.3	23.5	10	236	278	329
10- 7	1,990	119598	62	365	10.7	0.4	11.4	8	35.0	4.5	0.2	31.8	7.8	1	64	112	142
11- 7	94	119899	57	5	0.8	0.2	18.8	7	94.0	3.6	T	85.0	30.6	10	248	338	407
12- 9	40	120155	34	5	1.2	0.6	34.5	8	104.5	2.1	T	85.4	34.3	16	268	355	451
1950																	
1-10	4,390	120448	39	678	25.5	1.5	10.6	4	48.3	6.9	T	35.7	11.7		76	138	160
2- 1	406	120667	36	47	0.5	0.4	17.9	8	104.7	8.2	0.0	67.8	29.7	22	212	292	401
3- 9	312	120964	36	17	1.3		18.3	11	118.7	8.0	0.0	82.2	32.8	14	224	340	422
4-13	513	121408	49.5	169	4.6	0.0	15.0	12	110.5	10.3	0.0	67.1	27.7	16	176	317	375
5- 4	247	121590	66	19	1.0	0.2	11.3	7	126.9	1.8	0.0	79.7	31.7	22	220	329	416
6- 8	68	121958	78.5	37	1.7	1.1	28.3	6	101.0	4.1	T	81.3	27.3	13	228	316	419
7- 7	58	122291	71	44	2.5	0.3	18.3	6	68.7	2.9	T	60.6	24.6	14	200	253	325
8- 1	20	122560	77.5	45	1.9	1.3	17.8	8	58.0	2.6	T	71.2	24.4	17	240	278	345
9-11	14	122954	69.5	42	1.3	0.9	12.3	4	48.3	0.5	0.2	59.3	17.7	12	192	221	271

*affected by ice

Date	Discharge	Laboratory Number	Temperature	Turbidity	Iron	Manganese	Fluoride	Boron	Silica	Chloride	Sulfate	Nitrate	Ammonium	Calcium	Magnesium	Sodium	Alkalinity (bicarbonate)	Total Hardness	Total Dissolved Minerals
	ft. sec.		°F		Fe	Mn	F	B	SiO_2	Cl	SO_4	NO_3	NH_4	Ca	Mg	Na	--(as $CaCO_3$)--		
1945																			
10-11	5.3	104511	56	30	1.2	0.2			15.0	6	102.9	5.4	0.1	70.7	31.2	6	198	306	374
11-18	3.2	104830	48	25	0.8	0.3			18.5	7	108.4	3.0	0.0	72.4	33.2	9	212	318	395
12-18	1.4	105137	33	10	0.3	0.1			18.0	9	150.8	6.3	0.1	103.1	49.1	31	352	460	582
1946																			
1-20	14.6	105332	34	33	0.1	0.3			13.5	8	125.1	6.1	0.1	72.5	33.6	18	212	320	409
2-13	860	105546	40	2000	92.4	0.5			11.0	3	36.0	2.7	0.6	22.7	8.5	T	50	92	124
3- 4	10	105801	54	27	0.7	0.2			13.5	7	133.9	6.3	T	80.6	38.1	19	244	358	451
4-11	7	106165	49	25	0.3	0.3			8.0	7	131.4	3.5	0.1	77.1	39.5	19	248	356	426
5-16	12.2	106485	63	105	1.6	0.3			17.8	9	124.7	6.9	T	68.9	34.6	24	220	315	426
6-17	1.9	106805	82.3	108	2.5	T			15.1	8	102.4	4.0	T	68.7	34.0	15	224	312	406
7-11	.26	107059	79.5	61	1.1	0.8			12.5	7	84.5	2.9	0.1	74.2	33.9	13	252	325	384
8- 1	.09	107331	79.5	46	1.1	0.9			14.8	5	64.0	1.2	0.3	59.0	23.9	7	188	246	300
9- 6	2	107603	74	30	0.4	0.2			15.7	6	94.2	2.8	0.1	73.7	34.8	10	240	328	385
10- 7	.39	107948	61	75	0.5	0.3			16.3	6	80.0	1.3	0.2	80.0	37.7	2	268	356	386
11- 4	55	108310	57	130	4.1	0.3			20.4	5	89.5	6.0	0.1	55.5	22.5	13	156	232	302
12- 9	18.2	108606	52	65	0.5	0.2			16.7	5	121.4	4.7	0.1	76.4	35.8	12	228	338	414
1947																			
1- 6	9.7	108905	32	30	0.5	0.2			19.2	8	135.6	5.2	0.2	81.7	37.7	22	252	360	474
2- 3	20	109158	34	51	3.2	0.2			19.2	8	123.0	8.0	0.1	75.7	32.1	17	212	322	411
3-10	8.3	109535	35	29	0.8	0.3			12.9	6	124.0	3.9	0.1	69.2	32.2	14	196	306	383
4- 7	30	109943	50	205	3.7	0.3			17.6	7	118.9	7.9	0.1	68.2	27.8	18	184	285	393
5- 5	20	110232	57	185	1.5	0.2			18.5	6	124.9	4.9	0.1	70.7	33.3	18	212	314	402
6-13	2.8	110722	70	70	1.2	0.2			14.4	7	123.4	4.1	T	76.4	38.8	11	232	351	425
7- 2	19*	111048	69	233	5.6	0.5			23.2	6	87.2	9.6	0.1	54.8	20.9	9	136	223	292
9-16	.3*	111859		140	3.6	2.1			17.3	6	45.3	4.3	0.1	55.4	27.2	7	208	251	291
10- 5	.09	112120	68	90	2.0	1.2			14.1	3	45.5	3.2	0.1	41.4	18.0	4	132	178	199
11- 8	.19	112510	48	98	2.1	1.0			18.5	6	83.1	2.6	T	53.7	22.8	11	156	229	293
12- 9	.81	112855	38	56	1.4	0.4			16.9	6	106.8	3.6	T	68.4	31.0	11	200	299	385

1948																	
1-12	3.4	113191	38.5	T	0.3	0.3	16.9	8	125.1	7.0	0.1	73.7	27.4	21	196	297	415
2- 9	.53	113437	31.5	T	0.2	0.5	17.8	8	122.8	5.4	T	84.9	35.5	23	264	359	479
2-27	14.2	113689	46	98	2.6	0.3	19.7	8	125.7	6.7	T	66.7	26.5	23	176	276	386
5-18	8.8	114767	65	90	1.4	0.4	18.3	8	138.0	9.2	T	72.9	30.4	20	188	308	428
6- 8	1.2	114973	75.5	110	2.9	0.9	13.3	8	76.1	5.1	0.3	55.0	23.3	7	160	233	298
7-10	1.2	115216	76	132	2.5	1.0	19.4	5	76.9	4.6	0.1	58.0	21.6	9	164	234	318
8-19	2	115631	77	279	6.7	0.5	10.1	6	40.7	3.0	T	33.1	11.8	1	80	132	164
10- 4	.10	115989	57	100	1.7	1.8	14.8	6	67.5	0.5	T	70.4	27.1	16	244	288	376
10-13	.78	116150	54.5	190	2.4	0.4	14.4	7	57.2	2.9	0.2	41.1	16.1	10	120	169	249
11-24	3.5	116547	35	5	0.4	0.4	18.4	6	109.4	3.8	0.1	69.1	30.5	12	200	299	369
12-15	9.4	116753	55	306	6.8	0.9	10.2	8	106.3	2.2	0.0	158.4	22.7	20	160	240	335
1949																	
1-13	32	117090	37.5	35	1.4	0.0	18.3	7	116.2	8.1	0.2	62.6	25.7	13	156	265	340
2-11	18.6	117299	38	27	1.2	0.4	17.4	6	109.3	6.7	0.1	67.9	30.0	6	180	293	361
3- 9	12.6	117551	43	11	0.4	0.2	15.7	8	133.1	5.5	T	77.7	34.6	21	228	337	437
4-21	8	118030	51	19	1.0	0.4	14.7	8	141.5	1.7	T	76.5	35.1	20	220	336	455
5-16	2.7	118230	69	34	0.3	0.4	19.2	7	111.5	3.3	T	79.9	37.1	7	240	352	394
6-14	2.5	118528	69	66	5.7	0.6	16.1	8	96.9	3.5	T	85.0	33.9	10	232	352	406
6-30	18.6	118726	79	343	6.7	0.7	17.9	8	63.6	3.2	T	44.9	15.4	13	124	176	253
8- 2	115	119021	71	950	52.7	7.1	10.4	9	24.7	0.4	0.5	22.9	7.5	11	76	89	125
9- 6	.30	119273	76	13	0.7	1.0	16.2	7	59.6	1.3	0.4	69.9	25.2	17	240	276	349
10-10	2.2	119597	73	40	1.5	0.0	18.4	9	73.6	4.5	0.1	53.1	20.5	10	148	218	271
11- 7	3.2	119900	49	9	0.8	0.2	17.4	6	109.6	1.8	T	78.0	35.2	8	232	340	394
12- 9	1.3	120154	29	2	0.4	0.2	18.5	7	117.7	1.2	T	82.1	36.9	11	248	358	439
1950																	
1- 9	406	120447	40	710	24.9	1.6	9.2	3	40.7	6.1	T	26.1	7.5	3	52	97	124
2- 1	15	120665	37	10	0.8	0.2	23.8	6	126.3	8.3	T	82.4	34.4	8	220	349	432
3- 9	8.7	120963	34	46	0.1		19.3	10	128.8	7.5	0.0	81.7	24.4	15	224	346	429
4-13	16.3	121409	47.5	33	1.1	0.3	20.2	14	124.4	7.5	0.0	76.2	32.7	19	212	325	410
5- 4	11.8	121591	69	15	1.4	0.2	15.3	7	133.1	3.6	0.0	77.9	32.7	19	220	330	431
6- 8	4.1	121957	75	41	2.1	0.3	21.4	8	103.7	6.8	T	73.9	31.2	14	220	314	405
7- 7	1.2	122290	72.5	47	2.4	0.7	17.1	8	85.8	3.7	T	66.3	30.7	11	212	292	365
8- 1	.81	122558	78	40	1.0	0.7	16.4	7	77.6	3.4	T	68.2	34.9	12	248	314	382
9-11	2.2	122953	73	106	2.6	0.5	17.4	6	59.2	3.3	0.1	49.9	19.8	27	192	206	312

* estimated

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) —(as $CaCO_3$)—	Total Hardness —(as $CaCO_3$)—	Total Dissolved Minerals
1950																			
10-13	136	123283		15	0.6	0.2			15.3	15	61.7	0.3	T	68.3	25.6	15	224	276	341
11-20	2290	123656	47	372	4.6	0.0			11.0	32	38.7	0.4	0.1	21.0	7.2	22	44	82	165
12-13	421	123881	32	28	1.5	0.3			16.0	71	112.1	3.7	T	65.6	25.0	52	160	267	462
1951																			
1-18	3970	124144	38	117	3.6	0.2			13.5	12	45.9	6.8	T	25.0	9.5	11	56	102	172
2-14	5260	124376	32	68	2.6	0.3			7.9	18	33.3	2.1	0.2	15.7	4.0	10	36	56	130
3-15	5140	124728	35	80	8.2	0.6			12.3	9	67.7	18.0	0.0	67.3	26.1	6	192	276	322
4-12	2520	124921	46	138	4.0	0.5			10.6	29	58.6	2.6	0.1	29.1	10.8	27	72	118	221
5-16	174	125289	67	20	2.2	0.4			9.7	53	96.3	2.0	0.1	67.9	28.2	37	192	286	410
6-26	330	125671	75.5	404	9.9	1.0			9.0	60	50.2	5.5	0.0	32.3	11.2	41	76	127	272
7-26	540	125972	80	183	6.6	0.3			9.4	10	21.2	2.2	T	20.6	3.6	16	64	67	132
9-11	34	126426	71.5	13	1.3	0.2			9.6	53	32.1	2.7	T	39.7	14.0	30	112	157	243
10- 9	17	126639	56	5	1.0	0.2	0.3		10.3	38	44.8	0.8	T	42.6	15.1	24	120	179	265
11- 9	347	126909	34.5	47	3.2	0.8	0.3		9.4	184	43.8	1.0	0.2	37.1	11.0	106	64	139	450
12- 4	722	127153	49.5	156	5.2	0.8	0.1		11.8	74	71.4	2.3	0.2	30.7	13.7	46	52	133	286
1952																			
1- 7	1360	127428	34.3	21	1.5	0.3			11.8	31	84.5	3.7	T	37.1	16.7	26	84	162	262
1-31	1830	127656	33.5	260	6.4	0.6			10	15	49.8	6.2	T	28.1	9.6	17	68	110	182
3- 6	403	128045	37	24	1.8	0.8			8.4	91	172.4	1.5	0.1	66.5	32.8	72	148	301	543
4- 4	1370	128313	51.5	208	9.3	0.8			8.6	88	76.5	2.7	T	41.2	16.2	63	100	170	359
4-28	262	128596	66	16	1.3	0.3	0.1		9.3	42	101.0	1.6	T	63	26.6	43	196	267	400
6-17	187	129054	79	91	4.0	0.6			12.4	37	42.0	5.3	T	40.8	14.6	21	108	162	252
7-23	43	129394	83	76	4.5	0.2	0.2		14.3	12	21.8	2.6	0.0	26.9	9.5	7	80	107	140
8-13	9.5	129661	77	17	0.8	0.2	0.2		15.7	32	26.1	0.5	T	38.0	13.8	26	136	152	235
9-22	190	129990	65.5	36	2.0	0.4	0.2		11.8	84	46.5	.13	T	58.9	23.0	45	172	242	380
10-13	2.5	130201	60	16	1.3	0.2	0.2		12.8	22	35.8	0.5	T	38.8	10.8	23	124	142	222
11-19	14	130515	53	9	1.4	0.3	0.2		18.0	55	30.9	0.5	0.0	43.9	17.1	32	140	181	280
12-12	41	130758	41	49	2.0	0.4			9.2	125	67.9	2.4	T	48.4	18.7	80	124	199	432
1953																			
1-20	25	130947	38.2	5	1.3	0.3	0.3		4.8	385	101.4	2.0	0.1	62.0	29.2	207	80	275	863
2-25	220	131255	39.5	151	4.0	0.3	0.3		6.5	89	111.1	4.0	0.3	50.2	22.6	59	104	219	414
4- 8	595	131682		126	5.3	0.4			9.3	99	106.8	4.1	T	48.0	22.6	57	84	213	425

5-19	2050	132027	63.5	66	6.8	0.1	0.3		10.4	26	54.3	1.8	0.1	28.6	12.6	18	68	123	217
7- 6	30	132432	83.0	77	3.7	0.3	0.3		9.9	24	35.3	5.3	T	28.1	10.4	21	84	113	211
7-29	20	132594	83.9	105	5.2	0.2	0.3		8.8	15	30.8	4.0	0.1	22.3	8.5	19	76	91	173
8-19	4.4	132756	71.5	34	1.3	0.3	0.2		7.4	19	28.6	0.5	0.0	37.6	12.3	24	140	145	204
9-16	1.3	132917	70.5	15	0.5	0.3	0.1		4.9	49	30.7	0.1	0.1	43.8	17.8	36	160	183	291
10-12	.5	133176	55.5	16	0.0	0.4	0.1		6.7	45	25.1	0.3	T	47.4	18.2	30	168	193	285
11-13	1.1	133389	44.5	16	1.2	1.0	0.2		9.6	79	26.5	0.2	T	51.3	20.2	48	176	212	370
12-15	2.9	133628	36.0	16	1.8	0.4	0.2	T	10.3	118	35.2	0.2	T	59.0	22.3	60	168	240	437
1954																			
1-18	1.6	133825	34.0	4	0.7	0.1			11.0	59	47.5	0.7	T	56.4	22.5	48	204	234	386
2-15	3.2	134047	53.0	15	1.3	0.1	0.3	T	8.0	24	74.6	0.1	0.3	46.1	22.1	17	132	207	291
3-15	3.8	134289	45.0	20	0.9	0.2	0.4	0.1	3.3	120	57.3	6.2	0.1	47.2	16.7	64	92	187	366
4-13	5.9	134600	58.5	10	0.7	0.3	0.4	T	1.9	40	84.5	0.1	T	51.8	17.7	41	148	203	352
5-10	34	134863	58	77	3.5	0.5	0.5	0.1	7.6	45	75.8	4.4	T	43.8	16.2	34	104	176	317
6-17	2.6	135069	86.5	27	1.1	0.8	0.5	T	5.8	100	63.3	0.2	0.2	52.7	15.3	77	156	195	423
7-26	.3	135442	84	19	T	0.8	0.4	T	5.0	52	23.2	0.2	0.2	38.9	14.1	33	132	158	249
8-17	2.0	135602		29	0.1	0.6	0.3	0.4	8.0	68	13.0	0.9	T	25.4	8.8	40	76	100	237
9-27	20.0	135839	69.5	77	0.6	0.5	0.1	0.0	7.8	52	23.2	1.0	0.1	22.3	8.9	25	48	93	187
10-27	1980	136126	45	550	0.4	0.6	0.2	0.2	5.3	17	17.5	2.0	0.2	14.1	3.1	12	32	48	87
11-18	2.3	136304	52	28	0.6	0.2	0.3	0.2	7.8	56	59.0	0.3	0.6	20.0	10.7	58	80	94	254
12-17	3.2		35																
1955																			
1-27	14	136832	34	44	3.5	0.3	0.1	0.2	17.3	120	93.2	1.4	T	64.1	20.9	54	96	247	418
2-18	48	137046	36	25	1.5	0.2	0.2	0.0	6.7	78	78.1	2.9	T	36.2	15.0	47	60	152	330
3-31	290	137352	69.5	40	1.9	0.2	0.0	0.1	11.0	89	118.7	2.8	T	59.8	22.8	74	152	244	465
5- 5	119	137588	71	22	1.0	0.1	0.1	0.0	10.9	53	105.5	5.6	0.1	77.6	28.4	32	192	311	435
5-26	99	137773	74	90	2.5	0.2	0.3	0.0	5.3	54	67.5	1.5	T	47.9	20.0	28	116	202	331
6-23	78	137973	78	27	0.8	0.2	0.1	0.1	12.0	47	86.2	5.3	0.1	76.1	27.6	30	208	304	430
7-28	156	138358	78	90	3.8	0.5	0.2	0.0	19.8	43	32.3	2.5	0.1	51.4	14.5	3	100	188	229
8-23	8.6	138529	78	51	1.6	0.3	0.2	0.1	9.6	30	29.4	4.7	T	37.5	11.5	20	108	142	237
10-14	142	138882	62	60	1.4	0.2	0.1	0.1	26.1	22	34.4	3.3	T	29.1	14.1	10	84	131	203
11-21	1140	139123	44	100	2.4	0.5	0.1	0.0	12.2	33	57.4	0.9	0.1	10.4	4.9	55	60	46	207
12-15	72	139303	34	9	0.2	0.5	0.1	0.2	15.1	54	87.4	5.6	T	63.7	23.6	29	148	257	369
1956																			
1-12	42	139571	38	15	1.1	1.0	0.0	0.0	9.5	81	121.2	4.8	T	84.5	36.3	53	232	361	554
2- 9	1210	139757	38	156	4.0	0.1	0.1	0.0	8.4	23	61.7	9.1	0.2	31.1	13.3	18	68	133	209
3-21	780	140118	44	93	2.8	0.3	0.2	0.0	9.7	30	67.7	4.8	0.1	41.5	16.6	18	96	173	260
4-13	382	140333	45	43	2.5	0.5	0.1	0.3	9.8	67	124.2	4.5	T	67.5	28.3	47	160	286	472
5-18	173	140636	66	24	0.9	0.3	0.1	0.0	2.3	46	93.2	1.0	0.2	67.5	30.4	33	204	294	408
6-21	1700	140852	78	652	13.0	1.2	0.2	0.1	8.3	16	44.4	4.1	T	33.1	12.4	2	80	134	168

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness	Total Dissolved Minerals
1945																			
10- 9	25	104508	55	30	3.2	0.3			14.5	12	91.7	3.6	0.1	29.2	14.1	10	38	131	215
11-16	214	104834	47	112	2.4	0.0			13.0	17	123.4	2.0	0.1	33.5	15.8	21	40	149	267
12-12	31	105085	34	33	2.2	0.5			13.0	24	225.9	2.7	T	57.4	28.8	41	80	272	443
1946																			
1-17	132	105333	33	52	2.3	0.5			13.5	13	151.4	2.6	0.1	36.5	19.4	21	40	172	301
2- 6	1120	105548	44.4	700	12.8	0.8			10.0	20	164.1	6.3	T	36.7	20.7	24	26	178	318
3- 7	146	105805	54	68	2.8	0.6			11.0	31	191.1	1.7	0.1	48.3	24.9	40	66	224	394
4- 3	41	106167	71	51	1.9	0.6			10.0	22	208.6	1.1	T	55.0	30.4	36	92	263	433
5- 7	2910	106483	63	95	2.2	0.6			15.1	5	61.5	2.3	T	15.9	7.9	10	24	74	132
6-17	11	106803	81	56	1.9	0.6			17.9	18	151.4	2.8	0.1	43.3	18.7	40	86	185	334
7-10	4.5	107055	81	52	4.6	0.4			16.1	21	73.8	3.7	0.1	37.4	15.5	26	104	158	253
8- 5	2.8	107335	81	80	0.2	0.5			11.5	12	33.9	0.2	0.1	23.0	8.9	6	56	94	147
9- 4	39	107602	66	60	2.2	0.4			11.5	36	94.2	2.0	T	32.5	17.8	21	50	155	255
10- 9	1.2	107947	64	60	0.6	0.3			14.6	26	57.6	0.1	0.1	38.0	14.6	26	116	155	244
11- 8	76	108314	52	65	2.2	0.6			37.0	23	139.7	1.3	0.1	38.1	17.1	21	53	166	327
12- 5	50	108610	43	30	1.9	0.2			16.2	29	204.9	4.6	0.1	48.5	28.1	38	62	237	407
1947																			
1- 9	149	108904	30	42	1.2	0.4			15.3	40	192.7	2.4	0.1	44.4	24.0	44	48	210	406
2- 6	112	109159	32	76	2.0	0.6			17.4	17	148.9	2.6	0.1	41.1	21.0	24	60	189	303
3- 6	35	109533	32.5	11	1.0	0.9			15.2	38	252.8	1.4	0.2	95.2	37.1	14	104	391	531
4-10	505	109945	56.5	140	2.7	0.5			14.9	13	160.4	2.6	0.1	42.7	19.8	21	48	189	321
5- 7	109	110233	57	47	2.4	0.5			16.1	14	149.3	1.1	0.1	41.8	19.7	25	66	186	310
6-10	56	110723	77	75	2.3	0.3			14.9	15	160.0	2.6	T	44.6	23.7	24	72	209	340
7- 9	24	111045	68.5	140	3.8	0.6			18.5	14	91.9	3.3	T	32.1	14.0	19	62	138	244
8- 7	2.2	111520	74.5	37	0.7	0.8			14.2	41	61.7	1.6	0.1	44.9	16.3	25	112	180	275
9- 4	47	111860	65.5	290	5.7	0.5			11.2	24	27.6	2.7	0.1	14.7	5.4	12	22	59	115
9-30	6.6	112122	58	115	3.3	0.4			12.3	15	40.7	2.5	T	17.8	9.0	7	32	82	139
11- 5	39	112508	54	80	2.1	0.7			12.8	162	74.2	0.5	T	32.2	15.3	92	38	144	412
12- 3	19	112856	40	29	1.9	0.2			16.0	21	226.3	T	T	50.8	28.9	37	62	246	432

1948																	
1- 2	7800	113189	36.5	450	8.8	0.7	8.1	4	35.8	2.4	T	10.3	2.8	4	2	38	79
2- 5	17.3	113439	32	10	1.1	1.4	17.4	44	254.6	0.7	0.2	73.5	29.9	60	112	307	563
3- 8	524	113725	43	100	2.2	0.5	14.4	17	199.3	1.4	T	43.6	24.5	34	52	210	390
5-12	70	114764	65	158	2.5	0.7	12.6	72	175.9	2.8	T	50.5	25.0	63	80	230	469
6- 5	4.5	114971	73.5	67	3.3	1.1	11.3	28	125.1	0.7	0.1	47.5	21.9	30	104	209	329
9- 2	1.8	115991	53	30	2.4	0.7	13.5	14	21.6	1.5	0.2	30.1	7.5	19	84	106	175
11- 4	2060 *	116346	65	150	4.3	0.4	11.1	9	34.4	0.5	0.1	15.0	5.4	2	16	60	198
12- 3	60	116700	33	18	2.1	0.6	15.7	36	212.7	1.1	0.5	53.3	30.1	38	68	258	425
1949																	
1-12	2050 *	117038	40	343	7.3	0.8	9.6	5	43.8	1.8	T	15.1	5.8	5	20	62	99
1-31	2400 *	117170	32	104	2.5	0.7	10.4	10	45.5	5.1	0.1	15.7	5.5	9	16	62	113
3- 2	97	117496	37	18	1.7	0.5	14.0	27	212.5	1.6	0.1	52.0	26.8	40	68	240	430
4- 6	111	117822	53	43	2.8	0.9	16.3	30	145.6	0.8	0.1	44.3	21.4	29	68	199	345
5-12	445 *	118202	63	254	1.3	0.7	11.7	15	121.6	2.2	0.1	35.3	14.6	20	40	146	239
6- 3	6.6	118527	77	51	3.2	0.8	18.4	31	121.6	1.9	T	49.7	23.5	18	88	221	340
7-14	27	118927	74	116	3.4	0.2	11.2	25	56.0	4.1	0.1	25.4	7.9	17	36	96	159
8-20	163	119160	71	789	17.7	1.4	6.1	22	30.9	1.8	0.4	10.9	3.4	16	12	42	92
10- 4	3.9	119573	62	12	1.1	0.2	17.6	18	93.8	0.5	T	38.8	15.7	16	72	162	257
10-12	2960 *	119601	64	171	5.5	0.0	10.7	16	34.4	1.7	0.3	11.9	6.0	7	12	55	121
11-16	35	119927	44	2	1.4	0.2	16.9	69	180.8	0.3	0.1	61.1	27.7	49	88	267	473
12-16	165	120253	34	36	2.0	0.4	17.7	20	146.7	2.0	T	47.7	20.1	13	48	202	293
1950																	
2- 3	302	120710	36	33	1.9	0.4	18.1	44	150.6	1.1	T	43.2	21.2	31	44	195	351
3- 9	78	120961	38	16	1.2	0.1	15.2	23	175.6	1.5	0.1	51.0	26.8	31	88	238	385
4- 5	4990	121341	49.5	360	7.7	0.6	8.6	4	38.7	2.5	T	12.0	5.0	6	16	50	107
5-12	2360 *	121654	61	80	3.2	0.3	11.8	12	58.0	0.6	T	20.3	7.5	15	36	82	156
6-19	26	121956	76	39	2.2	0.5	14.9	23	94.0	2.3	T	36.7	17.2	28	92	163	278
7-20	2.5	122436	76	34	2.7	1.0	15.8	22	46.9	0.4	T	33.6	12.9	18	96	137	227
9-14	11	123003	65.5	38	1.4	0.2	14.0	21	97.9	0.8	0.0	29.7	15.6	25	60	139	250

* = adjusted for changing stage

Date	Discharge	Laboratory Number	Temperature	Turbidity	Iron	Manganese	Fluoride	Boron	Silica	Chloride	Sulfate	Nitrate	Ammonium	Calcium	Magnesium	Sodium	Alkalinity (bicarbonate)	Total Hardness	Total Dissolved Minerals
	ft. sec.		°F		Fe	Mn	F	B	SiO_2	Cl	SO_4	NO_3	NH_4	Ca	Mg	Na	--(as $CaCO_3$)--		
1945																			
10- 9	403	104512	57	40	2.4	0.8			13.0	45	82.9	2.0	0.2	27.6	9.4	23	8	108	221
11-15	1750	104833	51	110	2.1	0.6			12.5	19	94.2	0.1	0.0	23.3	9.8	19	16	99	190
12-20	32	105138	33	10	0.7	1.4			14.5	113	307.7	4.7	0.9	76.3	35.9	94	64	338	717
1946																			
1-18	1680	105334	36	58	2.0	0.4			14.5	29	109.2	2.3	0.2	25.9	11.2	25	10	111	233
2-11	657	105545	40	120	1.8	0.6			11.0	45	154.7	3.0	T	37.8	15.5	35	8	159	323
3- 6	175	105804	56	105	2.1	1.0			11.0	57	231.0	3.3	T	53.1	25.4	59	42	238	475
4- 9	56	106163	61	205	2.0	1.0			8.5	83	251.6	3.6	T	63.9	33.1	69	64	296	558
5-14	4560	106482	59	95	1.9	0.1			11.8	10	52.7	2.5	0.1	14.2	5.8	13	18	60	139
6-13	40	106806	83	122	3.7	0.1			15.1	41	91.5	5.0	T	31.4	12.6	23	24	130	242
7- 9	3.7	107058	84	102	0.4	2.7			12.6	150	201.6	2.9	0.1	65.9	26.1	102	74	273	600
8- 5	16.2	107332	78	112	0.1	1.6			10.3	91	129.0	4.7	T	40.0	16.5	66	44	168	403
9- 4	682	107604	67	40	2.8	2.4			11.4	30	50.6	0.7	0.7	23.2	10.5	12	34	101	170
10- 2	8.7	107950	64.5	41	0.8	3.2			9.9	305	179.6	7.7	0.9	105.0	32.5	122	40	397	793
11- 8	109	108311	57	100	4.6	1.2			14.8	107	156.9	2.7	1.0	48.9	18.9	67	32	200	427
12- 4	111	108608	36	32	1.0	0.4			15.1	68	191.7	1.9	0.1	45.5	22.1	54	26	205	413
1947																			
1- 9	317	108907	32	47	0.9	0.9			16.0	66	209.0	2.6	0.6	47.5	23.5	56	26	216	441
2- 6	1290	bottle broken																	
3- 5	51	109532	35	10	0.9	1.4			14.4	184	327.7	2.7	1.9	100.0	42.5	116	80	425	847
4- 9	1770	109944	53	135	2.6	0.4			14.0	29	123.6	2.6	0.2	28.4	12.2	35	26	122	264
5- 7	863	110234	59	48	2.0	0.8			12.9	31	106.3	1.2	0.2	30.1	12.2	28	48	126	245
6- 3	1030	110724	65	190	4.7	0.7			9.2	14	78.6	2.7	T	18.3	8.1	14	6	79	147
7- 8	560	111046	72	93	3.0	0.4			15.2	28	67.7	2.7	0.1	21.4	6.8	18	10	82	185
8-12	13.0	111519	72	133	2.0	1.6			17.7	110	180.4	4.7	T	57.8	25.6	87	92	250	550
9-11	11.1	111856	84	97	0.3	0.6			10.0	71	65.8	5.3	T	25.7	11.3	50	46	111	267
10- 1	8.0	112124	58.5	112	2.2	1.5			8.6	78	131.6	7.6	T	43.9	18.8	72	36	188	416
11- 4	151	112507	55	125	2.8	1.0			12.3	71	133.9	2.8	1.9	34.3	14.4	50	18	145	329
12- 3	46	112852	38.5	37	1.2	0.7			14.9	93	228.1	2.3	0.5	55.6	26.1	74	38	247	521

1948																	
1- 8	4260	113190	37.5	140	4.0	0.5	11.6	17	59.2	2.5	T	15.0	5.4	15	4	60	139
2- 4	52	113438	32	10	0.7	1.8	16.1	206	330.8	4.2	2.4	101.2	33.4	138	60	391	901
3- 4	1840	113690	41	75	1.8	0.3	14.4	33	132.5	2.2	T	37.3	13.8	20	8	150	276
4-14	1990	114276	57	122	8.7	0.6	11.3	22	89.9	2.4	T	22.4	8.1	25	18	90	182
5-13	233	114765	64	195	3.1	1.4	9.7	162	244.4	5.6	0.1	66.4	27.1	116	64	278	666
6- 6	16	114974	81	45	2.0	1.3	10.2	124	191.3	1.1	0.6	59.7	26.4	86	72	258	539
7- 8	52	115217	79.5	55	2.2	1.4	10.3	115	192.3	9.2	T	77.4	17.9	89	92	267	562
8-15	19.2	115603	83	45	1.3	1.1	14.0	69	99.6	5.8	T	40.9	14.4	42	48	162	309
9-28	7.3	115990	63	50	0.9	1.2	8.1	265	99.6	2.7	0.4	51.4	14.5	152	56	188	653
11- 1	9.5	116344	52	73	2.8	1.3	9.4	139	89.3	6.9	0.7	45.0	14.4	76	48	176	425
12- 8	548	116699	34	51	2.0	0.9	15.2	65	211.1	1.9	0.5	51.4	23.8	54	32	227	441
1949																	
1-11	4280	117040	42	95	3.2	0.3	11.5	20	61.7	6.4	0.2	18.8	4.4	16	40	65	159
1-29	11500	117169	35	179	4.2	0.8	6.7	7	26.7	5.1	0.1	12.7	1.9	3	40	40	69
3- 2	180	117495	40	21	1.5	0.8	14.3	101	229.4	1.7	0.3	56.7	24.4	80	36	242	550
3-29	8000	117820	61	291	10.2	0.8	8.0	7	35.2	4.9	0.3	9.7	3.9	11	16	41	95
5-11	112	118201	68	63	0.4	1.2	9.9	225	232.4	3.1	T	84.7	34.7	123	60	354	747
6- 8	46	118530	74	49	1.6	1.3	9.1	118	227.3	20.2	T	74.8	28.8	91	32	306	668
8- 1	11.1	119022	68	101	2.4	1.0	10.5	43	60.3	6.5	T	25.8	9.2	40	60	102	219
9-14	846	119386	67	174	4.9	0.6	5.5	50	39.7	3.3	0.2	23.3	6.0	22	16	83	169
10-13	3390	119602	68	17	0.7	0.0	13.0	20	43.6	0.4	0.1	16.9	4.1	12	12	61	110
11-15	175	119912	56	19	1.5	2.0	16.3	111	293.1	1.4	T	79.0	32.9	73	28	333	666
12-15	2980	120252	38	99	4.1	0.4	73.0	26	74.5	0.5	T	20.6	9.4	19	16	90	176
1950																	
1- 6	14700	120449	44	208	5.3	0.3	9.0	6	31.3	2.5	0.2	10.6	3.6	8	16	42	93
2- 3	2980	120709	37.5	69	2.1	0.3	12.0	18	75.3	.8	T	21.1	6.8	14	8	81	175
3-16	1710	121008	40	109	1.6	0.0	11.1	26	89.3	3.3	0.0	7.0	10.4	42	20	60	202
4- 5	6740	121342	52	188	5.4	0.3	8.3	8	47.5	1.6	T	14.5	4.6	9	12	56	95
5-10	1400	121656	64	269	11.0	1.1	9.9	20	71.4	1.3	T	21.8	9.4	16	24	93	166
6-19	42	121955	79.5	127	3.6	1.2	9.7	53	98.2	4.0	T	33.2	12.6	37	36	135	277
7-13	19.2	122389	77.5	143	6.2	1.1	12.5	51	63.1	3.2	T	23.7	10.4	30	28	102	205
7-31	8.7	122561	79	41	1.2	1.1	12.3	74	96.7	4.8	T	35.5	13.3	61	68	144	318
9-15	268	123002	66	50	2.5	0.9	15.3	71	115.2	2.4	T	37.5	13.7	52	42	150	352

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness --(as $CaCO_3$)--	Total Dissolved Minerals TDS
1945																			
10- 9	607	104522	60.5		0.9	1.6			12.0	25	182.7	4.1	0.2	53.8	30.6	22	80	260	406
10-30	63	104674	55	10	1.1	0.7			12.0	68	322.1	2.3	0.1	80.4	51.0	54	92	411	679
12- 3	298	104968	41	38	1.1	0.0			12.5	31	182.0	1.9	T	52.1	28.0	36	88	245	418
1946																			
1- 4	356	105187	34	20	0.8	0.9			11.0	25	164.4	3.9	0.3	47.2	26.3	25	72	226	365
1-31	395	105458	35	20	0.8	0.1			10.5	33	206.1	3.0	0.2	57.0	32.9	28	76	278	448
3- 5	530	105800	53	28	0.7	1.5			10.0	45	212.9	2.1	0.2	58.5	31.7	45	88	277	484
4- 2	negligible	106072	66	62	1.2	1.3			9.0	48	210.6	2.6	0.1	51.4	24.9	45	40	231	414
6- 4	1430	106653	61	220	5.4	0.3			10.9	14	35.2	3.4	0.0	16.4	5.0	15	36	62	120
7-11	290	107031	80	50	2.7	0.3			7.6	83	503.6	2.3	0.3	108.1	74.0	79	104	575	951
8- 2	19	107333	80	44	0.9	1.7			10.2	29	177.9	3.2	T	48.5	23.9	22	40	219	354
9- 4	52	107674	70	65	0.1	2.6			10.2	21	446.4	1.9	0.1	93.2	64.4	35	80	498	722
9-20	14	107769	66	25	0.8	2.0			13.0	72	554.8	0.9	0.2	122.6	86.4	61	116	662	1019
11- 5	121	108196	60	92	3.1	1.8			11.5	88	190.7	1.9	0.2	52.7	23.7	65	48	230	464
12- 3	228	108580	42	32	1.3	1.3			14.9	41	210.6	3.6	0.1	64.0	32.7	31	82	295	460
1947																			
1- 2	2260	108943	35	261	7.1	0.7			11.0	20	97.9	2.9	0.1	31.2	15.9	20	54	144	246
5-31	4220	109841	46	230	6.2	0.6			11.4	12	81.9	3.2	0.2	20.0	8.8	16	18	87	169
5- 6	negligible	110213	66	40	1.5	0.6			14.9	14	109.6	1.9	0.3	30.7	15.7	18	46	142	250
6- 9	-195	110653	74	138	4.5	1.0			14.1	23	126.7	4.0	T	34.8	18.5	19	36	163	278
7-24	23	111273	78	74	3.3	4.0			13.5	64	643.1	3.2	0.1	134.8	85.0	74	88	687	1121
8-22	6.8	111665	87	55	7.1	6.7			11.9	78	679.2	2.4	0.1	154.9	91.5	73	104	764	1190
9-22	750	112085	70	95	2.2	3.6			10.2	23	366.1	3.4	0.1	74.6	43.1	32	16	362	559
12- 1	71	112802	38	35	3.1	1.7			15.2	98	321.0	2.0	0.3	74.8	41.6	79	58	358	690
1948																			
1- 5	9260	113185	34	225	7.7	0.7			10.6	7	43.2	1.6	0.1	12.6	6.1	3	8	57	105
2- 9	366	113667	33	23	19.1	1.7			12.0	30	204.9	3.3	0.2	48.4	26.4	28	32	230	396
3-15	633	113888	47	160	5.6	1.2			9.0	43	213.1	2.9	T	55.8	29.9	45	76	263	452
4-14	11500	114371	52	210	8.8	0.4			8.6	5	29.6	3.4	T	11.3	5.4	5	20	51	82

6-28	187	115209	70	55	2.9	4.0	11.3	95	978.3	2.2	T	184.3	141.3	105	116	1042	1592
10-11	6.6	116218	62	30	0.5	0.8	20.4	55	246.4	0.7	0.2	93.0	47.4	45	192	428	655
1949																	
4-11	318	117883	56	28	1.5	1.4	12.8	36	279.5	1.6	T	69.3	43.7	36	88	353	528
5-20	46	118295	72	51	1.7	0.0	10.2	57	315.7	1.5	T	95.1	53.6	55	168	459	713
6-20	100	118682	79	79	2.0	0.3	17.8	131	80.6	3.1	T	46.3	17.5	81	92	188	466
8-29	218	119260	72	216	6.8	0.4	7.2	230	40.5	3.0	0.2	20.3	3.9	14	20	67	131
10- 3	20	119521	60	39	1.3	1.9	12.2	94	218.5	3.1	T	59.6	30.9	58	40	276	513
11- 7	104	119865	44	9	.5	1.7	16.6	49	322.5	1.2	T	90.5	53.6	43	136	447	683
12- 5	66	120070	42	9	.7	1.0	21.1	59	317.0	1.8	0.0	106.5	56.8	43	180	500	740
1950																	
1-11	11400	120495	38	71	2.0	0.3	8.0	7	53.3	2.1	0.2	14.8	4.3	13	16	55	115
3- 6	2640	120916	41	70	2.2	0.3	11.5	15	122.0	2.3	0.1	42.0	18.3	8	48	180	248
3-20	1690	121043	42	41	2.2	1.0	15.1	30	201.8	2.1	0.0	52.1	30.8	26	60	257	406
4-24	176	121520	66	48	1.3	2.3	12.6	56	404.6	2.0	T	151.8	34.6	46	120	522	807
7-10	17	122474	78	36	0.6	1.2	15.3	82	266.6	2.4	0.0	86.0	56.3	72	184	422	695
8-22	168	122810	67	84	5.9	1.0	13.3	26	100.4	2.6	T	34.6	15.4	26	64	150	267

CRAB ORCHARD LAKE near Carterville at Wolf Creek Road Bridge

Date	Discharge	Laboratory Number	Temperature	Turbidity	Iron	Manganese	Fluoride	Boron	Silica	Chloride	Sulfate	Nitrate	Ammonium	Calcium	Magnesium	Sodium	Alkalinity (bicarbonate)	Total Hardness	Total Dissolved Minerals
Date	ft. sec.		°F		Fe	Mn	F	B	SiO_2	Cl	SO_4	NO_3	NH_4	Ca	Mg	Na	—(as $CaCO_3$)—		
1951																			
10-12		126665	63	30	1.4	1.0				13	110.7						36	119	197
11-27		127057	41.5	47	3.1	1.8				8	110.7						8	115	188
12-10		127215	44	43	2.1	1.6				8	110.6						24	115	187
1952																			
6- 9		127425	38	21	1.8	1.2				8	118.1						8	129	201
2-13		127742	43	36	4.0	1.0				9	125.5						16	119	199
3-19		128145	49	91	4.2	0.9				5	73.6						12	88	132
4-18		128484	58	43	1.9	0.6				6	109.2						20	101	173
6- 5		128937	79.5	13	0.8	0.6				8	111.5						32	113	193
7-16		129333	79	42	2.0	10.0				9	100.4						36	118	195
9-11		129900	80	6	1.2	0.5				10	112.7						44	122	217
10- 9		130150	64	27	1.4	1.4				10	112.3						48	132	215
11-14		130492	50	30	1.4	1.0				14	121.2						48	136	234
12- 9		130675	50	15	1.0	0.9				13	117.7						40	126	221
1953																			
1-12		130861	34	22	0.9	0.7				13	114.4						36	132	209
2-10		131088	43	30	1.2	0.7				13	113.1						32	120	204
3- 6		131348	50	68	1.7	1.6				14	121.6						28	124	220
4- 8		131660		48	1.4	1.7				9	130.6						24	136	219
6- 8		132175	82	30	1.1	1.2				10	109.8						32	112	192
5- 8		131916	67	16	0.9	1.2				11	137.6						20	136	225
7- 9		132458	84	25	2.4	1.2				9	108						44	128	209
8- 6		132639	84	38	3.5	1.5				11	103						76	118	235
9-14		132916	71	40	1.3	1.7				14	105.7						60	128	242
10-15		133139	66	27	1.0	0.9				14	110.8						56	122	242
11- 6		133339	52	18	1.0	0.5				12	117.8						72	144	276
12- 9		133536	49	16	0.6	0.3				13	119.0						56	140	224

1954										
1- 8	133719	40	8	0.5	0.2	13	114.8	56	124	240
2-15	133989	48.5	19	1.0	0.3	6	105.5	52	116	204
3- 9	134178	42	16	0.7	0.3	12	105.3	32	116	205
4-20	134617	66	12	0.7	0.2	13	109.0	48	136	209
5-14	134847	68	19	1.5	0.7	14	115.1	48	140	217
6- 9	135017	77	20	0.9	0.9	15	113.2	52	140	223
7- 9	135264	83	36	2.9	1.2	13	107.6	56	132	222
8-16	135568	82	32	0.9	1.2	15	108.2	64	128	225
9- 8	135722	81	22	1.2	0.8	13	107.8	64	120	258
10- 7	135914	72	36	1.9	0.4	15	108.8	52	120	216
11-16	136273	56	4	0.2	T	28	110.0	44	128	222
12- 7	136427	38	18	0.8	T	17	106.8	32	148	221
1955										
1-10	136723	41	47	3.0	T	18	92.4	48	112	201
2-14	137048	34	11	0.5	0.1	16	92.6	44	116	192
3- 4	137126	55	59	3.1	0.4	19	95.2	40	108	192
4- 7	137368	55	84	3.4	0.5	7	64.0	20	88	120
5- 9	137604	68	41	1.8	0.6	10	84.3	32	88	161
6- 6	137819	75	28	1.3	0.6	11	89.5	36	118	166
7- 8	138107	85	26	0.8	0.6	11	79.8	40	100	206
8-11	138419	84	15	0.9	0.6	11	84.1	44	96	191
9-12	138605	76	39	3.1	1.6	11	99.6	52	124	230
10-10	138804	68	39	0.8	1.2	12	92.4	48	108	199
11- 8	139045	47	7	0.4	0.4	14	102.4	48	120	224
12-11	139287	36	11	0.5	0.4	17	89.1	48	104	202
1956										
1-11	139540	34	16	0.4	0.1	18	86.4	48	112	196
2- 6	139717	39	32	1.1	0.6	13	82.3	40	116	189
3-12	140033	46	77	1.8	0.8	10	94.6	24	100	178
4- 5	140260	65	36	1.1	0.5	11	106.1	24	124	211
5- 7	140502	70	9	0.6	0.2	11	109.0	32	140	223
6- 7	140756	78	16	0.9	0.6	14	118.3	40	132	240

Date	Discharge ft. sec.	Laboratory Number	Temperature °F	Turbidity	Iron Fe	Manganese Mn	Fluoride F	Boron B	Silica SiO_2	Chloride Cl	Sulfate SO_4	Nitrate NO_3	Ammonium NH_4	Calcium Ca	Magnesium Mg	Sodium Na	Alkalinity (bicarbonate) --(as $CaCO_3$)--	Total Hardness --(as $CaCO_3$)--	Total Dissolved Minerals
1951																			
10-12		126666	65	5	0.4	0.1	0.3		0.9	9	83.5	8.0	T	22.3	9.3	16	28	94	174
11-27		127058	42	8	0.6	0.9	0.3		1.7	5	79.6	0.9	0.1	22.3	7.6	16	32	88	159
12-10		127214	44	8	0.5	0.5	0.3		4.4	7	86.2	0.6	0.2	21.8	8.3	9	8	89	162
1952																			
1- 9		127424	38	9	0.7	0.8	0.2		5.6	5	86.8	1.0	0.2	21.3	9.1	12	20	91	163
2-13		127743	42.5	22	1.5	0.6			5.5	7	90.5	1.9	0.1	20.9	7.2	22	24	82	168
3-19		128144	47	26	2.0	0.6			3.8	8	88.9	1.6	0.1	20.3	6.7	18	12	79	158
4-18		128485	56.5	18	0.8	0.2	0.2		0.9	5	80.4	0.6	0.2	18.8	4.6	19	16	66	140
6- 5		128936	80.5	7	0.5	0.2	0.2		1.7	6	81.0	0.4	0.2	18.6	5.0	21	20	67	140
7-16		129334	77.3	5	0.4	0.2	0.2		3.5	6	76.1	2.4	T	19.8	7.0	18	28	78	146
9-11		129899	82	10	0.8	0.4	0.3		2.3	7	83.1	2.7	0.0	21.5	9.2	14	24	92	153
10- 9		130149	65	36	0.9	2.0	0.3		3.9	8	82.5	2.4	T	22.1	9.2	16	28	93	161
11-14		130491	50.5	15	0.6	1.6	0.5		3.3	8	87.8	2.4	0.1	21.6	9.7	16	24	94	160
12- 9		130674	50	19	0.5	0.8	0.3		1.5	7	87.0	2.2	0.1	20.7	9.6	16	24	92	174
1953																			
1-12		130860	35	9	0.4	0.4	0.3		0.5	7	82.3	1.3	0.0	20.2	9.2	17	28	88	155
2-10		131089	42.5	5	0.3	0.2	0.3		1.4	8	86.0	1.9	T	20.7	8.3	19	24	86	165
3- 6		131347	47	9	0.6	0.1	0.3		1.5	8	82.7	1.5	0.1	20.5	8.6	14	20	87	151
4- 8		131659		16	1.1	0.4	0.4		2.2	6	86.2	2.2	0.1	19.0	10.4	10	12	90	153
5- 8		131915	66	15	0.7	0.2	0.3		2.2	7	89.5	1.0	0.1	21.2	9.9	15	24	94	160
6- 8		132174	83	10	0.9	0.4	0.2		2.3	12	93.2	2.8	0.1	23.7	9.5	14	12	98	198
7- 9		132459	83.5	8	0.5	0.5	0.2		5.1	9	96.9	1.1	T	23.7	0.91	19	32	104	217
8- 6		132641	83	16	0.5	0.4	0.3		9.4	10	93.8	1.1	T	23.9	11.6	21	40	107	215
9-14		132919	73	26	0.5	1.4	0.2		1.8	13	97.4	0.4	0.3	25.7	12.0	26	52	114	209
10-15		133140	64	12	0.4	0.8	0.4		1.1	12	100.8	0.3	0.1	25.6	11.4	25	44	111	210
11- 6		133340	54	14	0.4	0.4	0.1		1.1	9	98.1	1.5	T	24.9	12.9	18	40	116	192
12- 9		133537	48	7	0.5	0.2	0.3		1.2	10	103.7	0.1	0.1	26.8	13.0	21	44	121	215

1954																		
1- 8	133720	40	4	0.3	0.0	0.3		0.9	11	100.6	1.2	0.1	27.5	12.1	21	44	119	204
2-15	133988	48	16	1.0	0.2	0.2		1.2	11	104.7	0.5	0.2	26.2	11.2	29	52	112	225
3- 9	134177	43	4	0.5	0.1	0.4		1.4	11	101.6	0.1	0.2	23.7	10.3	31	48	102	212
4-20	134615	66	6	0.8	0.2	0.3		0.7	11	99.8	0.2	0.2	25.7	12.0	23	44	114	226
5- 9	135016	76	8	0.6	0.3	0.4		1.3	10	99.2	0.6	0.1	27.4	1.2	39	40	74	204
5-14	134848	67	2	0.1	0.2	0.2		0.7	11	102.9	0.1	0.3	29.4	12.3	21	48	124	209
7- 9	135265	84	5	0.6	0.4	0.4		1.9	12	100.6	0.3	0.3	27.7	15.1	17	48	132	220
8-16	135569	82	7	0.4	0.2	0.3		0.9	12	100.6	0.3	0.1	26.9	12.8	26	56	120	219
9- 8	135721	81	8	0.4	0.3	0.5		1.5	11	100.2	0.5	0.1	28.6	13.8	20	52	128	223
10- 7	135915	72	16	0.8	0.6	0.1		1.2	12	99.6	0.2	T	27.2	11.8	24	48	117	204
11- 8	136211	50	8	T	0.2	0.4		0.9	15	102.0	0.9	0.2	24.0	12.2	30	48	110	202
12- 7	136426	40	14	T	0.1	0.2		1.0	14	101.6	1.2	0.1	27.4	12.0	24	44	118	208
1955																		
1-10	136722	41	10	0.4	0.0	0.2		1.3	14	94.2	0.5	T	26.4	12.3	25	52	117	233
2-14	137047	34	3	0.4	0.0	0.3		1.9	13	96.5	0.9	T	24.9	14.3	21	48	122	211
3- 4	137127	52	12	0.9	0.0	0.3		1.5	14	93.3	0.3	0.1	24.8	10.6	24	40	106	191
4- 7	137367	52	24	1.3	0.1	0.2		2.3	11	78.4	0.8	0.1	25.2	9.6	14	36	103	161
5- 9	137603	68	18	2.3	T	0.1		2.6	10	74.1	1.6	0.2	20.7	9.1	16	32	90	145
6- 6	137820	76	10	0.5	0.1	0.2		2.9	7	69.3	0.3	0.2	23.7	8.6	10	36	95	151
7- 8	138106	85	73	1.2	0.1	0.2		2.0	9	65.0	1.5	0.3	21.2	9.1	15	44	91	159
8-11	138420	84	16	1.4	0.5	0.1		2.6	9	69.5	3.9	T	22.7	8.5	15	36	92	177
9-12	138604	77	6	1.0	0.4	0.2		3.8	9	72.4	2.1	0.4	23.7	10.6	14	44	103	155
10-10	138803	68	14	0.6	0.8	0.1		2.8	10	75.9	2.1	T	22.7	9.7	15	36	97	160
11- 8	139044	48	14	0.6	0.7	0.2		2.8	10	72.8	2.4	T	22.2	9.2	20	44	94	166
12-11	139288	36	4	0.2	0.4	0.2		3.3	9	74.7	2.5	T	21.7	10.5	16	40	98	166
1956																		
1-11	139539	34	5	0.2	0.3	0.1		1.7	7	77.1	2.2	T	23.7	11.4	12	40	107	165
2- 6	139718	39	5	0.2	0.1	0.1		1.5	10	73.8	1.2	0.1	23.7	10.9	14	44	105	156
3-12	140032	47	17	0.6	0.1	0.3	0.0	1.6	10	71.4	1.8	T	23.7	9.2	11	32	98	151
4- 5	140261	62	24	0.5	0.1	0.1	0.2	0.4	10	70.3	1.6	0.1	19.4	9.7	16	36	89	154
5- 7	140503	69	14	0.7	0.2	0.1	0.0	1.1	10	75.3	2.4	0.1	23.3	10.4	9	28	102	149
6- 7	140757	77	20	1.5	0.2	0.2	0.0	1.7	11	76.7	1.3	0.2	22.6	10.2	15	36	99	181