1935

A study of Missouri springs

Harry Cloyd Bolon

A STUDY OF MISSOURI SPRINGS

by

Harry C. Bolon

A

T H E S I S

submitted to the faculty of the

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

D E G R E E O F

CIVIL ENGINEER

Rolla, Mo.

1935

Approved by Joe B Butler

Professor of Civil Engineering

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

PICTURES

INTRODUCTION

This thesis is based upon a study of the large springs of the Ozarks and is designed to answer many of the requests that are being received continually by the Missouri and the United States Geological Surveys. The various studies inculcated in this report are made from a rather limited amount of data available regarding the size, character, and sources of these springs and what they are actually worth to the State of Missouri.

The main body of the thesis is a revised tabulation of data contained in Chapter 3, Volume 20, Missouri Bureau of Geology and Mines, "Water Resources of Missouri 1857-1926" by H. C. Beckman, and includes all records of spring flow collected since September 30, 1926 by the Missouri Geological Survey and Water Resources in cooperation with the Water Resources Branch of the United States Geological Survey and Missouri Game and Fish Department.

IMPORTANCE OF SPRINGS AND THEIR WORTH TO MISSOURI

While there are no actual records of the important part the springs of the Ozark Region played upon the early development of the State of Missouri, it may well be said that they were more attractive to the earlier pioneers than any other natural resource. Although the uses of an individual spring may vary somewhat from one generation to another, the value remains nearly the same, and new fields are continually being found, which cause them to be an important factor in the growth of Missouri and are worthy of considerable study.

The importance and value of the springs can well be studied under five principal phases, namely; recreation, power, water supply, commercial uses, and domestic uses.

Recreation:

Since the completion of the present State highway system and the rapid change in the mode of transportation, the springs of the Ozark Region have rendered an invaluable service to the State of Missouri and will continue to do so. Realizing the worth of these springs, and how well they can be adapted for recreational purposes, the State Game and Fish Department has established ten State Parks which were specially situated at or near a spring and have constructed fish hatcheries at five of these parks for the purpose of propagating game fish to use in stocking the Missouri streams.

The beautiful parks thus formed include some of the scenic wonders of the State and attract thousands of tourists each year, thus

bringing to Missouri an inestimatable amount of revenue through purchases the visitors make during the tourist season. The facilities in Missouri for camping, boating, swimming, and playing of various sports are as good as those in any other State.

C.C.C. Camps are situated at practically all these parks and are making wonderful improvements that will cause the springs to be more attractive than ever before, and will undoubtedly popularize them as much as any other thing.

The State is continually stocking the spring-fed streams with rainbow trout and other game fish and have lured many fishermen to the Ozarks. Therefore, floating down many of the streams has become a popular sport and furnishes the people of Missouri an excellent oppoutunity to enjoy themselves out-of-doors.

Besides the springs furnishing the State several fine recreational centers they also afford pleasure to hundreds of small clubs and families, some of whom have erected many fine mansions, clubhouses, or cottages near many of the privately owned springs.

Power:

The importance of the springs to the earlier pioneers of the Ozarks cannot be more vividly brought to ones attention than by a study of the large number of old mills which were propelled by the power developed from the springs, and for many years played a vital part in the development of the rural communities. The remains of many dams, the skeletons of many mills, and the hundreds of old trails and roads leading to them plainly tell of the invaluable service the springs rendered

to the early Missourians. Of the many springs that have been measured by the Surveys, sixteen still furnish power for some purpose and fourteen others show the remains of old power developments, most of which were grist mills. Doubtless many other small power developments have never been brought to our attention. Several now furnish power for saw mills, some for light plants, and a few are used to operate miscellaneous machinery.

Although the need for the grist mills in the rural sections of the Ozarks has lessened with the increasing accessibility of the different communities, many are still in use and serve as valuable servants to the people living in the more remote parts of the State.

Today, the people of Missouri are realizing the value of the flow from springs in connection with proposed power developments on the rivers which obtain much of their low-water flow directly from the springs. Such are the cases of the proposed developments on the Current and Gasconade rivers and those that may also be feasible on the Eleven Point and North Fork of the White rivers. These rivers derive most of their flow during dry periods from the many large springs that rise within the river basin, thus causing them to be well adapted for power developments with limited storage capacities. The development on the Niangua River near Lebanon would not have been so feasible had it not been for the increased flow from Bennett Spring and several smaller ones.

Very few of the larger springs are well adapted for direct power purposes owing to their being so little above the rivers into which they flow. Two exceptions of this are the large Mammoth Spring

at Mammoth Spring, Arkansas, which is now developed, and the Greer Spring at Greer, Missouri, which could be developed to form a net head of about forty-five feet before entering Eleven Point River.

Water Supply:

No definite data is available regarding the number of families and villages that obtain their water supply directly from the hundreds of large and small springs within Missouri. Practically no single community in southern Missouri is without its spring that furnishes water for either the household or for stock. Many lodges, hotels, and villages rely entirely upon spring flow for their water supply, and practically all use the water without any treatment whatsoever. Many of the deep wells for city supplies in the Ozark Region merely tap the underground caverns which feed the springs and in reality the cities are being supplied with spring water.

During the severe drought period of 1930 to 1934 some of the springs ceased flowing for the first time on record, but many others supplied numerous communities and were very instrumental in relieving the drought conditions that prevailed over the entire region.

Commercial Uses:

Several springs have been commercialized to some extent. Probably the most prominent enterprises are the commercial fish hatcheries which furnish a large supply of rainbow trout and other fish to the city markets and who also sell many to the State and private parties for stocking purposes. A few springs are noted for their health resorts, and others supply the demands for mineral water. The Blue Grass Spring in

St. Louis County near Eureka is equipped with beds for growing water-cress to be marketed in St. Louis and elsewhere. Water-cress is also gathered from many other springs.

Domestic Uses:

Anyone who has ever visited the Ozarks has probably noticed the many spring houses that render an invaluable service to the people of the rural communities. Besides providing cleanliness to the springs, these houses shelter the many articles that are placed in the water to be cooled. Butter, cream, milk, fruits, eggs, and beverages are some of the commodities that are often preserved by the use of the spring house, which serves the rural families almost as well as the modern ice box or refrigerator serves those who live in the cities.

COLLECTION OF SPRING FLOW RECORDS

The flow of some of the larger springs in Missouri has been determined by several agencies and parties from time to time. However, most of the data that has been recorded was obtained only by occasional miscellaneous discharge measurements, made principally by the Missouri Geological Survey and Water Resources in cooperation with the United States Geological Survey, and by Mr. Rodhouse of the Engineering Experiment Station, University of Missouri. These measurements have been very helpful in determining the rank of the springs and have given much other information regarding the character of them.

Miscellaneous Measurements by Mr. T. J. Rodhouse:

Mr. T. J. Rodhouse of the Engineering Experiment Station, University of Missouri, realized the value of the data that could be obtained by making miscellaneous discharge measurements of the springs, and made several during the summers of 1913 and 1914. The results of these measurements were used in this study, and are listed in the tabulations of this report. They add much to the data that has been collected later and are invaluable in determining the variation of flow from year to year by comparing them with recent measurements.

Miscellaneous Measurements by the Missouri and U. S. Geological Surveys:

The Missouri Geological Survey and Water Resources in cooperation with the United States Geological Survey have made miscellaneous discharge measurements of all the springs that have been called to their attention, and have in this manner obtained data regarding the flow

of the larger and more important springs of the Missouri Ozarks. Only one measurement has been made at several places but they give a good indication of the flow in comparison with the other springs. The results of these measurements are also listed in the main body of this report.

Establishment of Gaging Stations:

Staff gages were installed at four of the larger and more accessible springs in 1922, and regular gaging stations were established by the Missouri and United States Geological Surveys. The station on Hahatonka Spring was discontinued September 1926 and the one on Meramec Spring was discontinued October 1928.

The State Game and Fish Department began cooperating with the Missouri and United States Geological Surveys in 1928, and regular gaging stations were established in October and November of that year at Round Spring, Bennett Spring, and Alley Spring State Parks. These three stations, together with the ones established in 1922 at Greer Spring at Greer and Big Spring near Van Buren, are still in operation and the records have been unbroken since their installation, except for short periods of backwater from Current River at Round and Big Springs.

The daily discharges of these seven springs where regular gaging stations are now, or have been established, were computed by the regular method of establishing a stage-discharge rating curve from discharge measurements. From this curve the discharge for any stage could be determined and the gages were usually read once daily with only a few exceptions. The daily discharges thus determined were tabulated

and from them the monthly and yearly average flows were computed. The monthly mean discharges are shown graphically in Figure 1. This chart plainly shows how the records for Greer Spring have been obtained continuously since December 1922, which is the reason for using the records of Greer Spring as the main basis of all the comparative studies of this report. The continuity of the records at this station was possible mainly because of the large amount of fall in the spring branch, thus eliminating all backwater effect from the Eleven Point River.

From Figure 1 it will also be noted that records for Hahatonka and Big Springs were not computed for several months during periods of backwater from Niangua and Current rivers, respectively. If the discharge records were complete and shown on the chart, the Big Spring would show up as being much larger than Greer Spring.

FIGURE 1

CHART SHOWING MONTHLY DISCHARGES OF SEVEN SPRINGS

MEAN MONTHLY FLOW IN CUBIC FEET PER SECOND
By Calander Year

HAHATONKA SPRING AT HAHATONKA

ROUND SPRING AT ROUND SPRING

ALLEY SPRING AT ALLEY

MERAMEC SPRING NEAR ST. JAMES

BENNETT SPRING AT BRICE

GREER SPRING AT GREER

BIG SPRING NEAR VAN BUREN

1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934

DETERMINING THE RANK OF THE LARGER SPRINGS

Regardless of when or where a person introduces the subject of springs, the rank of size in comparison with other springs usually becomes the main topic of discussion. To satisfy many requests and to meet the usual interest in regard to the various springs, the author has made a tabulation of all the records collected by the Missouri and United States Geological Surveys and cooperating parties, and has endeavored to determine the relative mean flows of the larger springs of the Missouri Ozarks.

In making this study the large Mammoth Spring at Mammoth Spring, Arkansas, was included as being in the Missouri Ozark Region, not for the purpose of claiming it to be a Missouri spring, but because it is so near the Missouri-Arkansas State line and very probably derives much of its flow from Missouri. Also this spring is almost always mentioned when one discusses the relative size of the various springs of Missouri.

The lack of measurements on many of the large springs, especially during the wet seasons, make it impossible to determine the relative size of the various ones without making certain assumptions, and then the results of such a study cannot be called much better than an approximation. By studying the various miscellaneous measurements made at the springs where no gaging station has ever been established, it will be seen that many springs were measured only during the very driest years on record. Others were measured only during wet seasons, and several were measured during both wet and dry seasons. Owing to the fact that all the springs were not measured under the same climatical conditions,

it is necessary to make some type of correction instead of making a direct comparison between measured results. Hence, the first and main assumption was to assume that the flow of all the springs had the same variation in flow; that is, when one spring was high, all were high, and when one was low, all were low. Although it is known that this is not an absolute fact, yet it is much better than trying to make a direct comparison of the discharge of one spring measured during a wet season with that of another spring measured during a ~~wet~~ dry season.

As stated before in this report, the record of Greer Spring is the only one which has been unbroken or unaffected by backwater. Also, it was one of the first stations established and forms the longest and best record collected on any single spring. Hence, it was decided to make a direct comparison between the measured flows of each individual spring and the flow recorded for the same period for Greer.

For springs that were measured only by miscellaneous discharge measurements, a list was made of the amount of flow measured during each measurement together with the date. The discharges of Greer Spring for the same days were recorded opposite these measured flows, and the recorded flow during each measurement was divided by the flow of Greer Spring to determine the relation in terms of "per cent of Greer". These percentages were averaged and used to determine the rank of each spring. To more clearly describe the method of computing the percentage the data for Althea Spring near Tecumseh is shown as follows:

Spring	Location	Date	Discharge second-feet	Discharge of Greer	Per cent of Greer
Althea	Tecumseh	Aug. 29, 1926	27	224	12.0
Althea	Tecumseh	Oct. 17, 1932	15.0	145	10.3
Althea	Tecumseh	Aug. 18, 1934	17.8	145	12.3
			Average percentage =		11.8

Figure 2

GRAPHICAL COMPARISON OF OZARK SPRINGS

Average Discharge in Cubic Feet Per Second

500
400
300
200
100

Rank	Spring and County
1	Big Carter
2	Mammoth Fulton (Ark.)
3	Greer Oregon
4	Double Ozark
5	Welch Shannon
6	Bennett Dallas
7	Meramec Phelps
8	Blue Oregon
9	Blue Shannon
10	Alley Shannon
11	Blue Wayne
12	Boiling Pulaski
13	Montauk Dent
14	Hahatonka Camoen
15	Hodgson Mill Ozark
16	Thomasson Mill Oregon
17	Boiling Texas
18	Rockbridge Ozark
19	Pultight Shannon
20	Stone Mill Pulaski
21	Cave Shannon
22	Creasy Pulaski
23	Althea Ozark
24	Keener Butler
25	Coppedge Phelps
26	Prewett Pulaski
27	Round Shannon

From the data recorded above, it can be seen that the flow of Althea Spring varied from 27 to 15.0 second-feet, or 80 per cent, yet the "percentage of Greer" varied only 23 per cent, thus showing a much better comparison by computing the relation between these two springs. The same study was made for each spring that has been measured by miscellaneous measurements only.

For springs where daily discharge records have been obtained, the comparisons were the same except the average discharge for a month, or year, was used instead of the individual days. The data for Round Spring is shown in the following table:

Year ending Sept. 30	Discharge Second-feet	Discharge of Greer	Per cent of Greer
1929	57.9	478	12.1
1930	36.1	387	9.3
1931	32.0	327	11.3
1932	22.0	249	8.9
1933	48.7	363	13.4
1934	18.7	208	9.0

Average percentage = 10.6

The data above also indicates that the relation between the flows of Round and Greer Springs is fairly constant as the "per cent of Greer" varied only 26 per cent from the mean, whereas the yearly mean flows of Round Spring varied from 57.9 to 18.7 second-feet, or over 310 per cent.

By using the Greer Spring records as the basis of comparison, the Althea Spring is shown to be larger than Round Spring, whereas if a direct comparison of measured discharges was made without any regard to the seasonal fluctuations, the flow of Round Spring would have been listed

as 35.9 second-feet against 19.9 second-feet for Althea Spring.

It can also be assumed that if all the springs do vary alike over the same period, then the average flow of any spring can be computed within a fair degree of accuracy by multiplying the "percentage of Greer" by the actual mean discharge of Greer, and the results thus obtained should be much better than to assume that the average of only a few miscellaneous discharge measurements is the actual mean flow of the spring. The average of the three miscellaneous discharge measurements made of Althea Spring is 19.9 second-feet, and the mean discharge of Greer Spring from December 1921 to September 1934 is 363 second-feet. However, if we assume that the springs vary alike and accept the data showing that the flow of Althea Spring is 11.8 per cent of Greer Spring, then the mean flow of Althea Spring can be computed to be 0.118 x 363 = 42.6 cubic feet per second instead of 19.9 second-feet. The larger figure looks very reasonable when we consider that the three measurements were made during the months of August and October, and two of them during the driest periods on record. The discharges shown for each of the 27 springs in Figure 2 were determined by multiplying the "percentage of Greer" by the mean flow of Greer. This indicates the rank in size to the best degree of accuracy that can be obtained from the relatively small amount of data that is available regarding the flow of several of the larger springs.

VARIATION OF SPRING FLOW

Many people are told, and believe, that the flow from the springs are very uniform and merely become slightly turbid during wet seasons or after heavy rains. However, this is usually not true as can be noted by referring to Figure 1. The change in flow is usually slow in comparison to rivers and streams, but there is a distinct variation from day to day, and year to year.

Seasonal Fluctuations:

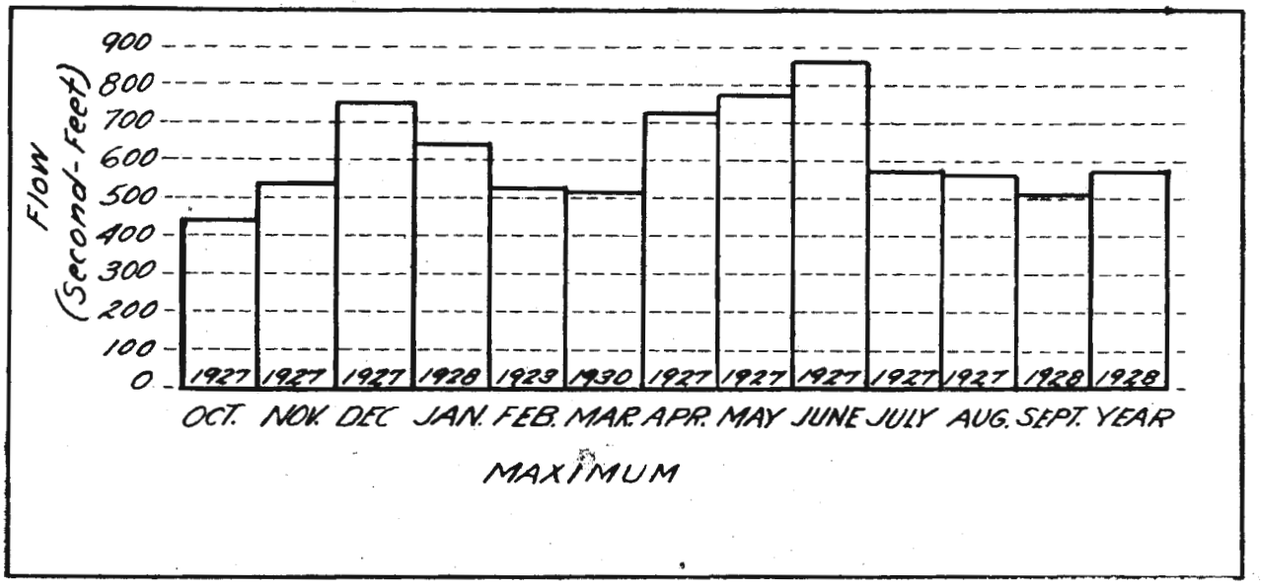
The seasonal variation in the flow of Greer Spring is clearly shown in Figure 3. The chart at the top of the page shows the maximum mean monthly flows, and the maximum yearly mean flow during the period of records, together with the year when each occurred. From this chart, it can be seen that the year of 1927 had eight of the wettest months recorded between December 1921 and September 1934. The chart also indicates that the months of December, April, May, and June had a larger maximum flow than the other months.

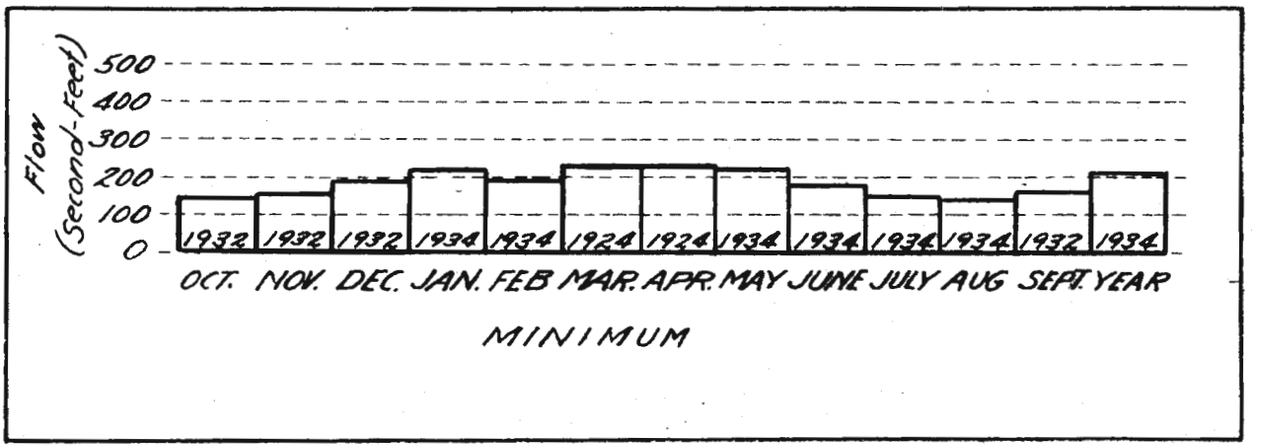
The center chart is a tabulation of the minimum mean monthly flows of Greer Spring and shows that 1932 and 1934 had ten of the smallest monthly mean flows recorded, with 1924 having the smallest recorded for March and April. The year ending September 30, 1934, had the smallest yearly mean flow.

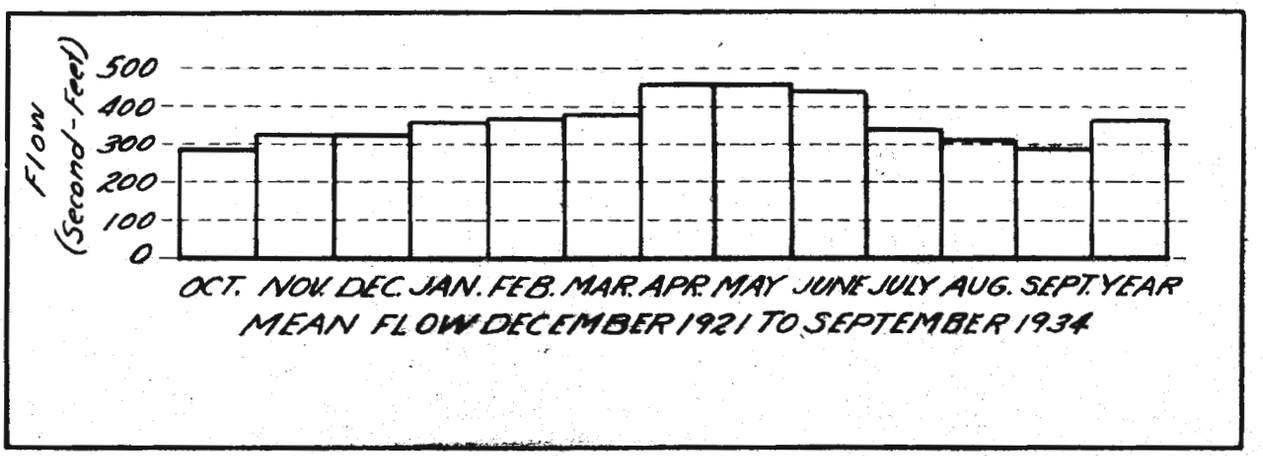
The chart at the bottom of Figure 3 shows the mean monthly flows during the period of records. It indicates that the larger flows occurred during the months of April, May, and June with August, September,

Figure 3

Chart Showing Maximum, Minimum, and Mean Monthly Flow of Greer Spring







and October being the months of the least flow.

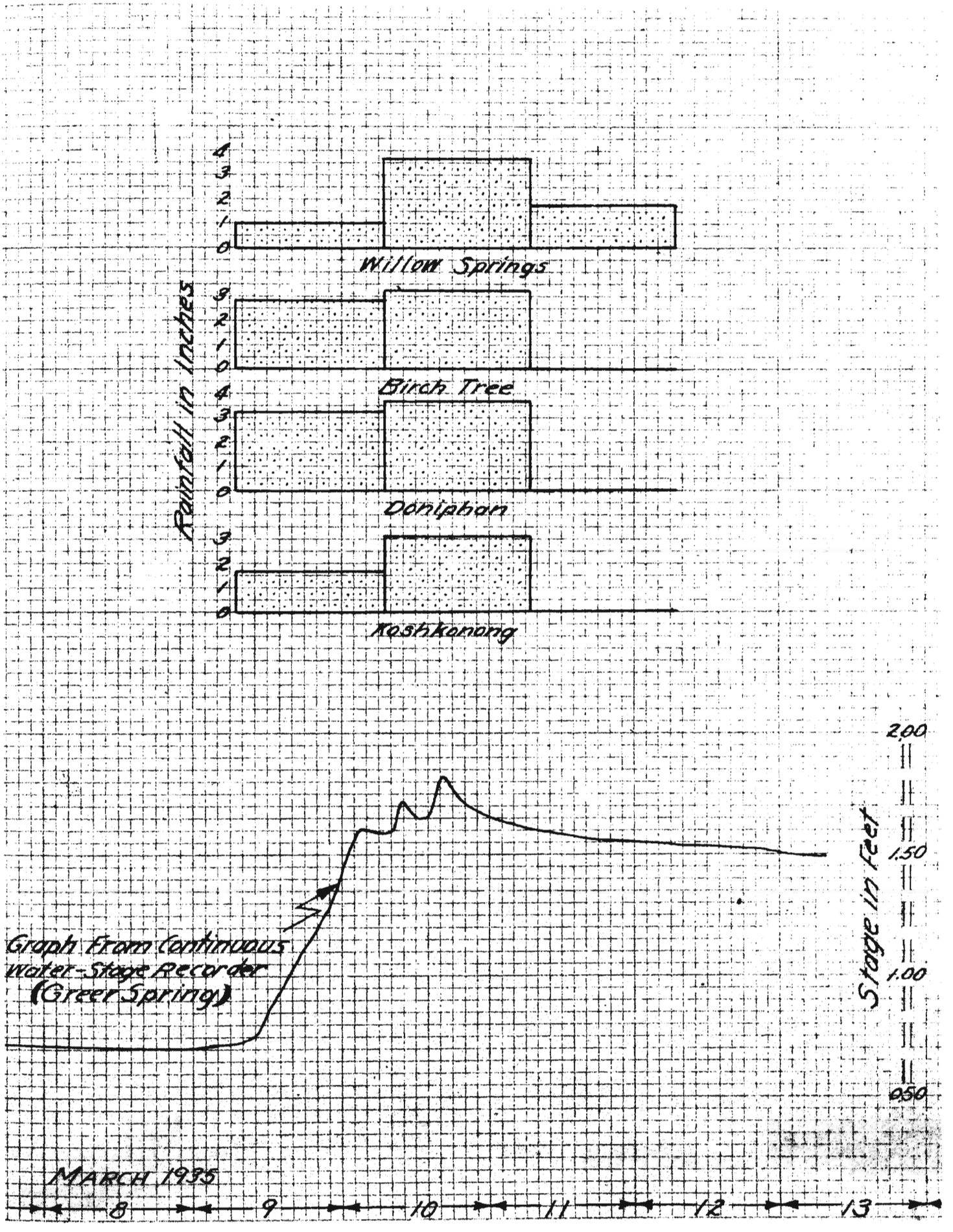
Relation of Rainfall to Spring Flow:

The springs usually increase in flow within a few hours after a heavy rainfall although no definite information was available until after the installation of the automatic water-stage recorder on Greer Spring. The gage readings taken only once daily clearly indicated the change in stage from day to day, but they did not show the irregularities in rate of change during the day. The stage of Greer Spring is not affected by backwater from any river, and the flow is entirely free from surface run-off except what water enters the spring through sinkholes some distance back from the spring outlet.

During the exceptionally heavy rainfall over the Ozark Region March 9 to 12, 1935, the springs throughout the southern part of Missouri showed a marked increase in flow, and Figure 4 clearly shows the effect of rainfall on the stage of Greer Spring. The stage rose from 0.72 foot to 1.82 feet between 6:00 a.m. March 9, and 4:30 p.m. March 10, for an average rate of 0.034 foot per hour. This clearly shows that the stage and flow of springs are affected by rainfall although their range in stage is much smaller than that of rivers and streams. However, local rains may occur that do not cause the flow of nearby springs to increase, depending upon the source of the spring and how much surface water can get into it through sinkholes.

Figure 3

Chart Showing Rainfall near Greer, Missouri and the Effect Upon
The Stage of Greer Spring



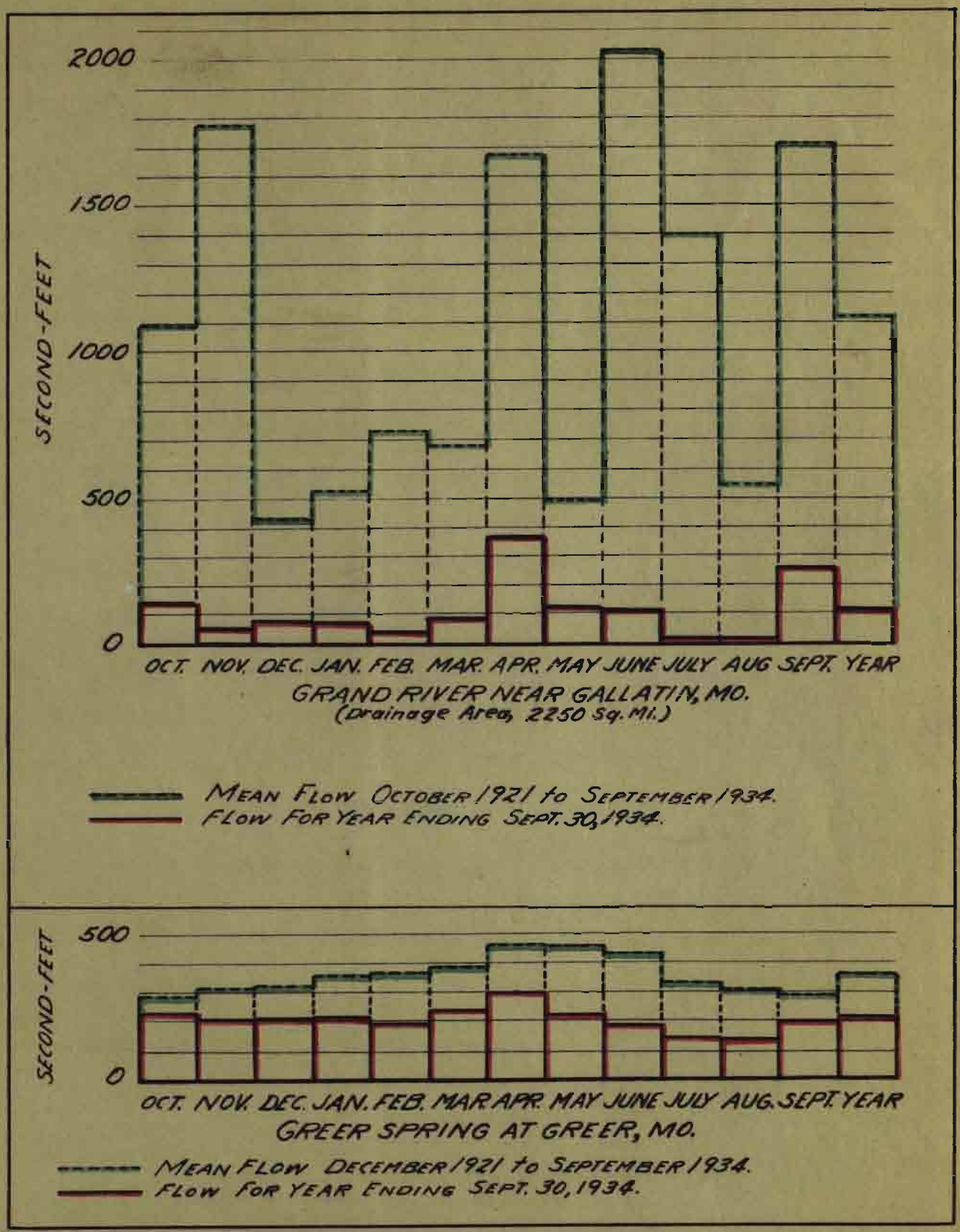
EFFECT OF DROUGHT UPON SPRINGS

The drought during 1934 was probably the most severe recorded within Missouri and caused many rivers and springs to fall much below previous minimums. Many inquiries were made regarding the effect of the drought upon the springs and rivers and Figure 5 is a graphical comparison between the mean monthly flows during the period of records and those recorded during the year ending September 30, 1934, for the stations on Grand River near Gallatin and Greer Spring at Greer. The blue line indicates the mean flow during the period of record for each month of the year, and the red line indicates the flow recorded during 1934. The upper portion of the chart shows that the flow of Grand River during the month of July was only about 1.4 per cent of the average flow during the period of record for that month, whereas the lower portion of the chart shows that the flow of Greer Spring for July was approximately 45 per cent of the average. The flow of Grand River for the entire year was about 8 per cent of the normal while that for Greer Spring was about 60 per cent of the normal.

The records of Grand River near Gallatin, Missouri, were chosen for this comparison because this river derived no part of its flow from springs and also because these records and those of Greer Spring were collected during the same period.

Figure 5

Graph Showing Effect of 1934 Drought Upon the Flow of Greer Spring at Greer and Grand River near Gallatin



UNIFORMITY OF SPRING TEMPERATURES

One often hears of some particular spring as being colder than any other spring in the country, and some are named "Cold Spring" in accordance to this belief. Many others are thought to be as cold as 40 or 50 degrees, but all these beliefs are very contradictory to facts proved by the many temperature observations taken by the Geological Surveys.

Temperature observations have been taken of practically every large spring and of most of the smaller ones. The author has tabulated 102 of these observations, some of which were taken during every month of the year. They represent practically every size and type of spring to be found within the Ozarks, ranging from the smallest to and including Big Spring near Van Buren. The results of these observations are given in Figure 6.

Figure 6

Tabulation of Several Observations of Spring Temperatures

Temp. F.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
60	-	-	-	-	-	1	1	-	-	1	-	-	3
59	2	-	-	1	-	3	-	1	1	3	-	-	11
58	2	2	1	1	-	3	5	9	2	14	1	2	42
57	3	1	1	5	-	-	-	10	-	15	2	-	37
56	-	-	-	-	1	-	-	3	-	3	-	-	7
55	-	-	-	-	-	-	-	-	-	2	-	-	2
Total	7	3	2	7	1	7	6	23	3	38	3	2	102

By studying the table above one can readily see that over one half of the observations were taken during the months of August and October and were, therefore, taken when the flow of the springs were usually near the minimum. However, many of the other observations taken during the other months represent the temperatures during normal stages, but none were taken during extremely high stages or immediately after heavy rains.

The average of all the observations tabulated above is 58.59 degrees Fahrenheit and is within one half of one degree of 77 per cent of all the observations taken, thus showing that the temperatures of all the springs are very uniform and over 95 per cent have temperatures between 56 and 59 degrees Fahrenheit throughout the year when at normal stages. The five observations that do not fall within these limits were very probably taken in the spring branches some distance from the spring and do not represent the actual temperature at the immediate outlet.

RELATION BETWEEN FLOW AND SEA LEVEL ELEVATIONS

Some short studies have been attempted to determine whether or not there is any relation between the flow of springs and the elevation of their outlets. However, the data available is not sufficient for making much of a study of this nature, although it has been concluded that no definite relationship exists. The sea level elevations of the outlets have been very accurately determined for several of the larger springs, but no data is available for many others, and approximate elevations were determined from topographic maps for the remaining springs. Figure 7 is a tabulation of the approximate elevations of many of the springs that have been measured by the Surveys.

Figure 7

Tabulation of Approximate Elevations of Several Springs

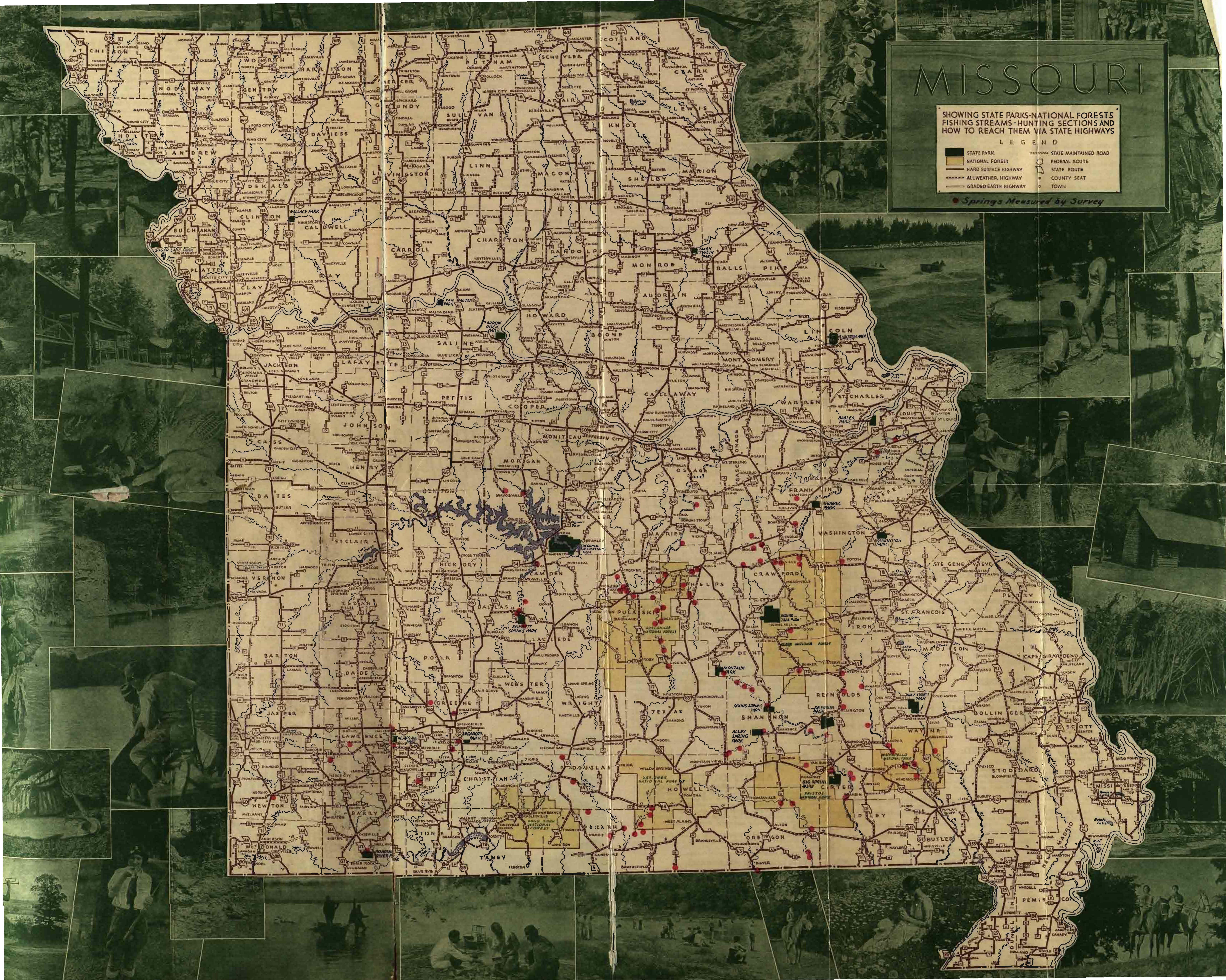
Spring	Town	County	Elevation
Chesapeake	Chesapeake	Lawrence	1181
Clarkson	Pierce City	Lawrence	1178
Big	Mount Vernon	Lawrence	1145
Blue	Battlefield	Greene	1140
Cave	Cedar Grove	Shannon	1075
Big	Neosho	Newton	1045
Lumbee Mill	Halltown	Lawrence	985
Lost	West Plains	Howell	970
BENNETT	Brice	Dallas	866
Piney	Yancy Mill	Phelps	860
Lane	Yancy Mill	Phelps	835
Yancy Mill	Yancy Mill	Phelps	835
Coppedge	Relph	Phelps	830
Wilkins	Newburg	Phelps	820
Cold	Floyd	Washington	818
WELCH	Cedar Grove	Shannon	800

Blue	Eldridge	Laclede	790
Gollahon	Rolla	Phelps	790
MERAMEC	St. James	Phelps	790
McIntosch	Cuba	Crawford	760
Roaring	Fanning	Crawford	750
Kratz	Stanton	Franklin	745
Boylers Mill	Boylers Mill	Morgan	740
Gravois Mill	Gravois Mill	Morgan	736
Blue	Bourbon	Crawford	725
Alley	Alley	Shannon	674
Round	Round Spring	Shannon	666
Hahatonka	Hahatonka	Camden	660
Roaring	Stanton	Franklin	645
GREER	Greer	Oregon	545
BLUE	Eminence	Shannon	540
Blue Grass	Eureka	St. Louis	470
Mill	Mill Spring	Wayne	440
BIG	Van Buren	Carter	431
Leeper	Leeper	Wayne	425

The springs tabulated in capital letters have an average flow of over 100 cubic feet per second, and their position in the table indicates that the large springs also vary in elevation from 431 to 866 feet above mean sea level. However, the Big Spring near Van Buren and Greer Spring at Greer, (two of the largest springs in the Ozarks) are at rather low elevations as may naturally be expected, but with such springs as Bennett, Welch, and Meramec several hundred feet higher, one may conclude that if the elevation has any effect on the flow of these springs, it must be rather small.

LOCATION OF MEASURED SPRINGS

All of the large springs within Missouri are situated in the Ozark Region south of the Missouri River, and most of the larger ones are in the Gasconade, Meramec, Current, Black, North Fork of White, Eleven Point, and Niangua river basins. Current River probably benefits more from spring flow than any other stream although the flow of the other rivers just named is greatly increased by the springs within their basins. Many of these springs are within the National Forest Areas, as shown in Figure 8, which shows the location of the springs measured by the Missouri and U. S. Geological Surveys, and the location of State Parks, highways, streams, counties, and other information regarding the recreational centers of the State, and how to reach them. This map, except for the location of the springs, was prepared and furnished by the State Game and Fish Department.


MISSOURI
SHOWING STATE PARKS-NATIONAL FORESTS FISHING STREAMS-HUNTING SECTIONS AND HOW TO REACH THEM VIA STATE HIGHWAYS
LEGEND
STATE PARK
NATIONAL FOREST
HARD SURFACE HIGHWAY
ALL WEATHER HIGHWAY
GRADED EARTH HIGHWAY
STATE MAINTAINED ROAD
FEDERAL ROUTE
STATE ROUTE
COUNTY SEAT
TOWN
Springs Measured by Survey

LIST OF SPRINGS, WITH DESCRIPTIONS AND STATEMENTS OF MEASURED FLOW

ALLEY SPRING is located in sec. 25, T. 29 N., R. 5 W., at Alley, Shannon County, about 5 miles west of Eminence. It issues from the base of a rocky cliff, flows over an old dam which formerly developed power for a grist mill and empties into Jacks Fork at a distance of about half a mile. The dam forms a small circular lake of clear, blue water. Both the mill and dam are kept repaired and together with the spring are the principal features of the Alley Spring State Park. The spring outlet is about 674.5 feet above mean sea level.

Records of the daily flow of the spring have been collected from October 1928 to date. These records include the occassional run-off from the small creek above the spring outlet. During the period of record the flow was as follows:

	Date	Second-feet	Gallons per day
Maximum	May 1929, 1933	633	409,000,000
Minimum	Dec. 1931, Apr. 1932	56	36,200,000
Average		121	78,200,000

The average monthly and yearly flow in second-feet for climatological years ending September 30 is given in the following table:

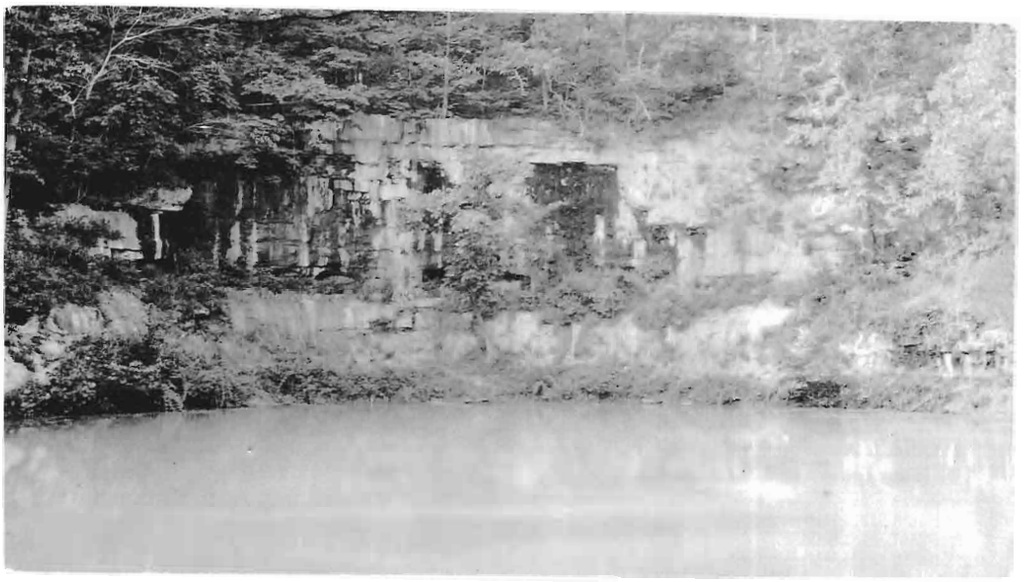
Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Avg.
1929	-	107	151	181	167	193	256	337	262	181	155	119	192
1930	112	125	116	189	202	167	105	111	95	83	77	109	124
1931	120	84	112	78	182	209	174	142	110	85	96	80	121
1932	61	62	65	181	97	92	94	66	71	76	66	60	81
1933	70	79	120	167	86	103	238	322	156	99	83	87	135
1934	78	77	76	79	68	76	88	62	66	61	61	71	72
Avg.	88	89	107	146	134	140	159	173	127	98	90	88	121

ALTHEA SPRING (also called Patrick Spring) is located in sec. 25, T. 23 N., R. 12 W., at Althea, Ozark County, about 5 miles northeast of Tecumseh. It rises in a small depression and was formerly used to operate a mill. It flows into North Fork of White River at a distance of about 600 feet and is privately owned. It is a favorite place for camping. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 29, 1926	27	17,500,000
Oct. 17, 1932	15.0	9,690,000
Aug. 18, 1934	17.8	11,500,000

AMSDEN SPRING (also called Amazon or Amsolen Spring) is located in sec. 19, T. 31 N., R. 1 E., Reynolds County, about 6 miles south of Centerville. The water bubbles up from a gravel bed along a former State highway, and its beautiful surroundings and accessibility causes it to be a favorite place for picnics and camping. The flow on Aug. 1, 1925, was 2.5 second-feet, or 1,620,000 gallons per day.

BARTLETT MILL SPRING is located in sec. 16, T. 36 N., R. 12 W., at Pippin Lodge in Pulaski County, 5 miles northwest of Waynesville. It issues from the foot of a hill, flows 600 feet to a dam 10 feet high where power is developed to operate a grist mill and furnish electric lights to the lodge, and empties into the Gasconade River. The small lake and surroundings make it a very attractive place. Measurements of the flow have been as follows:



Alley Spring at Alley
View of outlet and bluff

Bennett Spring at Brice
Looking downstream at outlet and spring branch

Date	Second-feet	Gallons per day
Aug. 4, 1914	[a]12.2	7,890,000
Sept. 10, 1926	11	7,110,000
Oct. 12, 1932	.31	200,000

[a]Measured by Engineering Experiment Station, University of Missouri.

BEAVER SPRING is located in sec. 34, T. 37 N., R. 5 W., Crawford County, 6 miles west of Steelville. The flow on July 6, 1925, was 0.2 second-foot, or 139,000 gallons per day.

BENNETT SPRING (also called Niangua or Brice Spring) is located in sec. 1, T. 34 N., R. 18 W., Dallas County, half a mile southeast of Brice. It issues from a circular basin about 50 feet in diameter in the bed of Spring Creek, and flows 1½ miles into Niangua River. A dam about half a mile below the spring outlet is used to divert water through the State fish hatchery and to a grist mill. The spring, dam, fish hatchery, beautiful surroundings, and the abundance of rainbow trout are the principal features of the Niangua State Park. The spring outlet is about 866 feet above mean sea level as determined from a topographic map.

The daily flow of the spring from Sept. 9, 1916 to Mar. 31, 1920, was determined by the Engineering Experiment Station, University of Missouri. Daily records have also been obtained from October 1928 to date. These records also include the very occassional surface run-off from an area of 42.4 square miles above the spring. Since October 1928 the record of the flow has been as follows:

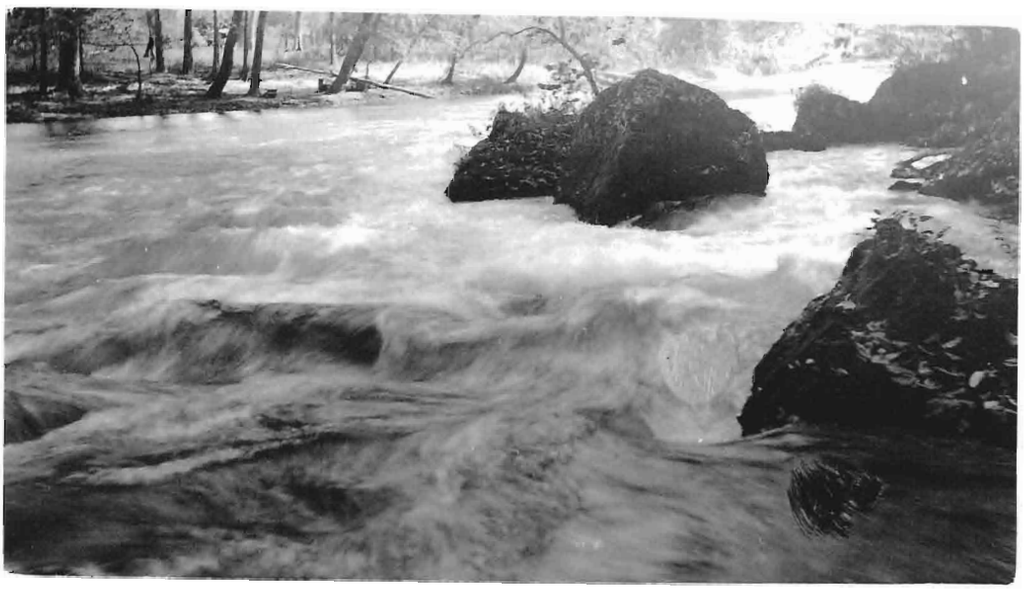
	Date	Second-feet	Gallons per day
Maximum	May 1929	Not determined	--
Minimum	November 1932	75	48,500,000
Average		146	94,400,000

The average monthly and yearly flow in second-feet for climatological years ending September 30 is given in the following table:

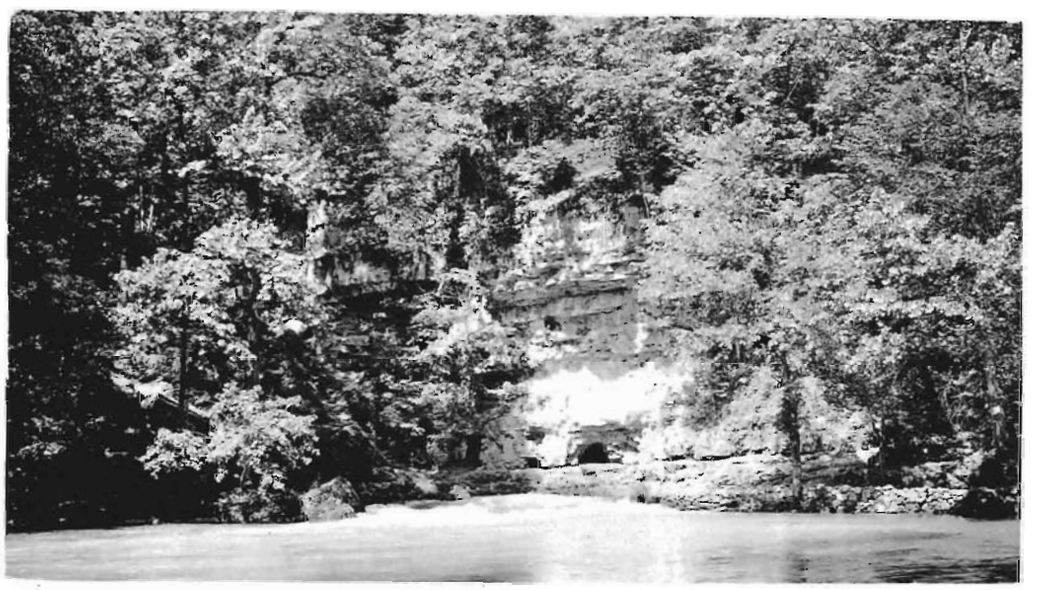
Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Avg.
1929	140	152	149	163	142	204	315	488	214	165	176	139	204
1930	152	142	130	215	218	179	147	127	119	109	100	120	146
1931	97	91	100	89	129	149	141	184	127	115	153	160	128
1932	101	122	135	193	138	131	129	121	182	142	103	94	132
1933	82	82	162	158	131	161	233	410	178	126	113	125	164
1934	143	99	89	90	81	120	126	92	88	80	94	122	102
Avg.	119	115	128	151	140	157	182	237	151	123	123	127	146

BIG SPRING is located in sec. 6, T. 26 N., R. 1 E., Carter County, 4 miles southeast of Van Buren. The clear, cold water gushes from the base of a rocky cliff and hill and flows into Current River at a distance of about 1,000 feet. The spring branch is bordered on one side by a high, rugged, and wooded hill and by an excellent picnic and camping ground on the other. The extreme large volume of clear, sparkling water flowing from the base of the cliff and the picturesque surroundings form the principle features of the Big Spring State Park. It can be reached readily by driving from Van Buren and is visited by thousands of tourists each year. Camp sites and some other accommodations are provided.

As the outlet of the spring is about 431.3 feet above mean sea level, which is only slightly above the normal elevation of Current River, the flow cannot be directly adapted to the development of power.



Big Spring near Van Buren
Looking downstream from outlet



Big Spring near Van Buren
View of outlet and high, rocky bluff

However, owing to the large flow, its study is important in connection with prospective power developments on the river.

This is the largest spring in the State, and so far as can be learned, it is the second largest individual spring in the United States, and is exceeded only by Silver Spring in Florida.

Records of the daily flow of the spring have been collected from January to June 1922 and from April 1923 to date. During these years the flow has been as follows:

	Date	Second-feet	Gallons per day
Maximum	June 1928	1,300	840,000,000
Minimum	August 1934	253	164,000,000

The average monthly and yearly flow in second-feet for climatological years ending September 30 is given in the following table:

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Avg.
1922	-	-	-	358	414	469	460	490	413	-	-	-	-
1923	-	-	-	-	-	-	493	499	413	416	364	347	-
1924	342	330	355	338	349	351	351	371	401	381	346	329	354
1925	300	294	300	296	335	339	338	361	342	304	282	293	315
1926	412	461	477	352	445	533	520	385	358	320	298	278	403
1927	304	442	361	364	558	407	a	a	a	628	a	525	-
1928	476	527	a	568	559	a	a	546	a	a	563	494	-
1929	434	408	495	422	a	598	a	a	583	480	489	413	-
1930	398	439	521	724	661	565	424	426	377	351	335	338	**462**
1931	344	322	340	309	426	487	486	423	345	328	352	345	375
1932	327	325	339	518	427	423	366	317	297	288	288	276	349
1933	271	294	363	563	405	437	678	694	502	394	355	335	**441**
1934	330	327	325	317	303	349	317	300	276	292	272	312	**315**

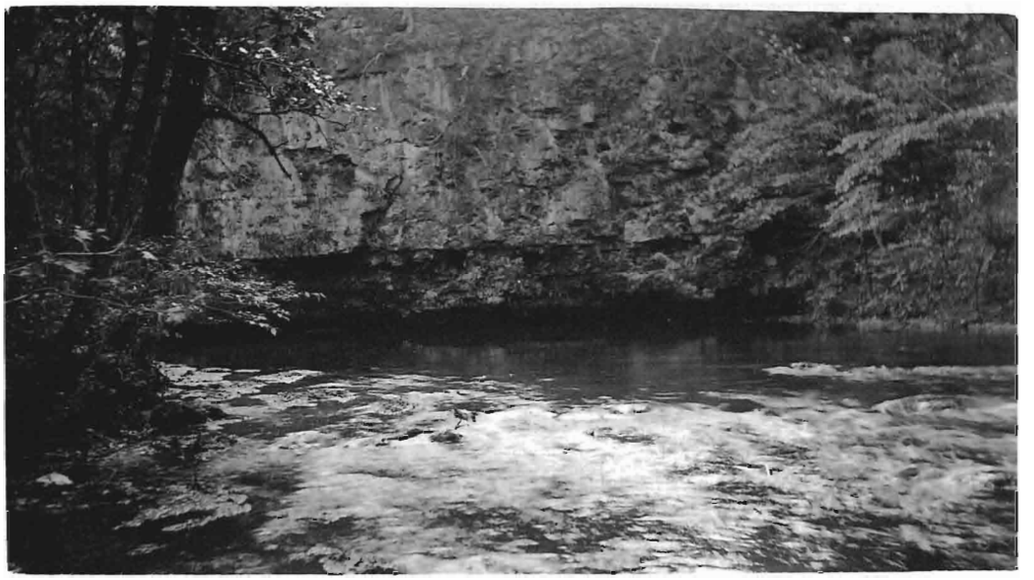
[a]Spring affected by backwater from Current River.

BIG SPRING is located in sec. 2, T. 28 N., R. 27 W., along the Scenic Highway, or River Road in Lawrence County, 4 miles west of Mount Vernon. It issues from the base of a rocky cliff which is known locally as Baptist Hill, and flows into Spring River 200 feet away. Religious conventions are held in a building on the hill, and tourists frequently camp at the spring. The spring outlet is about 1,145 feet above mean sea level as determined from a topographic map. On Sept. 1, 1925, the flow was 8.6 second-feet, or 5,560,000 gallons per day.

BIG SPRING is located in NW¼ sec. 26, T. 25 N., R. 11 W., 400 feet from Big Spring School in Douglas County, 1 mile south of Roosevelt. It issues from the rocks at the base of a hill and flows into Spring Creek at a distance of 60 feet. The spring and its surroundings are very attractive. It can be reached readily by driving and is a favorite place for camping. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Sept. 26, 1927	26.8	17,300,000
Oct. 17, 1932	3.2	2,070,000

BIG SPRING is located in sec. 19, T. 25 N., R. 31 W., at Neosho, Newton County. It issues from the base of a rock bluff in front of the Big Spring Inn near the tourist camp. It has been used at times to furnish water for the City of Neosho. The surroundings are quite attractive. The spring outlet is about 1,045 feet above mean sea level as determined from a topographic map. On Sept. 1, 1925, the



Blue Spring near Eminence
Looking upstream at outlet

Greer Spring near Greer
Looking upstream just below upper outlet

flow was estimated as 1.5 second-feet, or 1,000,000 gallons per day.

BLUE GRASS SPRING is located in NW¼ SW¼ sec. 34, T. 44 N., R. 4 E., St. Louis County, 3¼ miles east of Eureka. The spring issues from beneath a small rock ledge and flows about 300 feet through beds used for growing water-cress, passes under State Highway 66, and empties into Meramec River about half a mile away. The spring outlet is about 470 feet above mean sea level as determined from a topographic map. On Aug. 23, 1934, the flow was 0.1 second-foot, or 64,600 gallons per day.

BLUE SPRING is located in NE¼ sec. 21, T. 29 N., R. 2 W., Shannon County, 12 miles east of Eminence. The water, which has a very deep blue tint, flows with scarcely a ripple from a deep basin at the foot of a rock cliff, then goes swiftly down the spring branch a quarter of a mile and empties into Current River. The spring, with its rugged and wooded surroundings, is one of the most beautiful places in the State, and is owned by a club which has a beautiful lodge nearby. It can be reached readily by driving from Eminence. The spring outlet is about 540 feet above mean sea level. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 1, 1923	133	86,000,000
Oct. 11, 1923	84	54,300,000
June 25, 1929	214	138,000,000
Oct. 10, 1932	62	40,100,000

BLUE SPRING (also called Davidson Spring) is located in sec. 4, T. 27 N., R. 6 E., 2 miles southwest of Kime post office, Wayne County, and 6 miles south of Greenville. It issues from the base of a rock ledge and flows about 300 feet into St. Francis River. The spring and the abundance of pine trees surrounding it makes it a popular place. Tourist cabins are located nearby. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Oct. 30, 1932	48.6	31,400,000
Aug. 15, 1934	46.0	29,700,000

BLUE SPRING is located in SW¼ NW¼ sec. 14, T. 24 N., R. 11 W., at McCabe, Ozark County, and 5 miles southeast of Dora. It issues from the base of a small cliff and flows 50 feet before entering North Fork of White River. The surrounding country is hilly and wooded, which makes it an attractive place. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Nov. 9, 1926	30.0	19,400,000
Oct. 17, 1932	9.5	6,140,000
Aug. 18, 1934	12.3	7,950,000

BLUE SPRING is located in sec. 32, T. 28 N., R. 22 W., Greene County, three miles southeast of Battlefield. It rises in a wooded circular basin surrounded by cultivated fields, flows 300 feet in a winding branch, and empties into James River just above the Blue Spring

bridge. It is a favorite picnic place and can be readily reached by driving. The spring outlet is about 1,140 feet above mean sea level as determined from a topographic map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Oct. 23, 1928	3.3	1,940,000
Oct. 20, 1932	2.0	1,290,000

BLUE SPRING (also called Sweet Spring) is located in sec. 30, T. 36 N., R. 17 W., Laclede County, 6 miles west of Eldridge. It issues from the base of a rocky cliff 150 feet high and flows into the Niangua River about 200 feet away. It is a very scenic place but is rather inaccessible. The spring outlet is about 790 feet above mean sea level as determined from a topographic map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
July 1, 1913	[a]23	14,900,000
Sept. 10, 1925	16	10,300,000
Oct. 20, 1932	11.0	7,110,000

[a]Measured by Engineering Experiment Station, University of Missouri.

BLUE SPRING is located in sec. 2, T. 39 N., R. 3 W., Crawford County, 2 miles southeast of Bourbon. The spring rises in a private park which has conveniences for guests and a fish hatchery. Some large resort buildings and a small zoo are located nearby and add to the attractiveness of the place. The spring outlet is about 725 feet

above mean sea level as determined from a topographic map. The flow on Sept. 3, 1925, was 4.9 second-feet, or ~~316,000~~ 317,000 gallons per day.

BLUE SPRING is located in NW¼ SE¼ sec. 31, T. 28 N., R. 6 W., Shannon County, 7 miles northeast of Mountain View. It issues from a small cave at the base of a rocky cliff about 80 feet high at the edge of Jacks Fork, into which it flows. The surroundings are rugged and the place can be easily reached by driving. Camping facilities are available. Measurements of the flow have been made as follows

Date	Second-feet	Gallons per day
Sept. 25, 1927	7.9	5,110,000
Oct. 16, 1932	2.0	1,290,000

BLUE SPRING is located in sec. 16, T. 22 N., R. 2 W., Oregon County, 14 miles southeast of Alton. It issues from the base of a rocky cliff about 150 feet high, called "The Narrows", which separates Fredricks Fork from Eleven Point River, and flows into the latter stream at a distance of about 1,000 feet. It is a very unique and picturesque place. The spring is not directly adaptable for power purposes. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 12, 1925	67	43,300,000
Oct. 25, 1932	64	41,400,000
Sept. 14, 1933	70	45,200,000
Aug. 17, 1934	59	38,100,000

BLUE SPRING.-- See Shanghai Spring.

BLUE SPRING.-- See McDade Spring.

BOILING SPRING is located in sec. 33, T. 37 N., R. 10 W., Pulaski County, four miles northeast of Hooker. It boils up in the edge of Gasconade River at the base of a high rock bluff about two miles below the mouth of Piney Creek. The spring is submerged when the river is high but is a favorite fishing place at times when the river is low. The flow on Sept. 21, 1923 and Oct. 21, 1932, was 65 second-feet, or 42,000,000 gallons per day.

BOILING SPRING is located in sec. 24, T. 32 N., R. 10 W., Texas County, 8 miles southwest of Licking. It boils up on the wooded bank of Piney Creek and is submerged when the creek is high. It can be reached by driving from Licking although part of the road becomes bad in wet weather. The spring and its surroundings are rather attractive. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 18, 1925	12	7,760,000
Oct. 18, 1932	18	11,600,000
Aug. 14, 1934	31	20,000,000

BOYLERS MILL SPRING is located in sec. 7, T. 41 N., R. 19 W., at Boylers Mill, Morgan County, 14 miles southwest of Versailles. It rises in a lake having an area of about an acre, flows over a dam which formerly was used to develop power to operate a mill, and empties

into Buffalo Creek about a quarter of a mile away. The spring outlet is about 740 feet above mean sea level as determined from a topographic map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Dec. 9, 1926	1.2	775,000
Oct. 14, 1932	1.1	711,000

BOZE MILL SPRING is located in sec. 16, T. 23 N., R. 2 W., Oregon County, about 10 miles east of Alton. It rises in a low swale and flows into Eleven Point River about 500 feet away. The remains of an old dam and water-wheel are still visible near the mouth of the spring branch and were once used to develop power to operate a mill. The place is rather attractive and easily reached by driving from Alton. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 13, 1925	13	8,400,000
Sept. 8, 1931	16.4	10,600,000
Apr. 5, 1932	32.0	20,700,000
Oct. 25, 1932	14.0	9,050,000
Sept. 14, 1933	24.5	15,800,000
Aug. 16, 1934	13.9	8,980,000

BREAKUP SPRING.— See Wilder Spring.

BRICE SPRING.— See Bennett Spring.

BROWN SPRING is located in sec. 12, T. 26 N., R. 24 W., at Brown Spring, Stone County, 12 miles east of Aurora. It flows from an opening at the base of a small cliff, flows over a weir, and empties into Spring Creek. The spring and its surroundings are attractive and at one time a resort stood nearby. The flow on May 8, 1931, was 11 second-feet, or 7,110,000 gallons per day.

BRYANT SPRING is located in sec. 7, T. 27 N., R. 15 W., at Bryant, Douglas County, 6 miles north of Ava. It rises in a marshy lake having an area of about an acre, flows 200 feet in a raceway to a mill which it operates and where it has a fall of 16 feet, and then flows into Bryant Creek at a distance of 300 feet. It is near a good highway, and the place is provided with an attractive camp ground and tourists are welcome. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 27, 1926	1.8	1,160,000
Oct. 18, 1932	.97	627,000

BUBBLING SPRING.-- See Creasy Spring.

CARTER SPRING is located in sec. 34, T. 29 N., R. 2 E., Reynolds County, 7 miles west of Piedmont. The water flows from a hole in a cliff and is used to operate a water-wheel and grindstone. The spring is difficult to reach. The flow on Aug. 1, 1925, was 1.5 second-feet, or 970,000 gallons per day.

CAVE SPRING is located in sec. 4, T. 30 N., R. 23 W., near Pearl, Greene County, 13 miles northwest of Springfield. It issues from a low rock outcrop and flows 200 feet into Asher Creek. The spring is used for a domestic water supply by nearby residents. On Sept. 1, 1925, the flow was estimated as 0.4 second-foot, or 258,000 gallons per day.

CAVE SPRING is located in sec. 28, T. 31 N., R. 5 W., Shannon County, 9 miles southeast of Cedar Grove. It issues from a cave at the base of a rocky cliff 40 feet high and empties into Current River 50 feet away. It is very difficult to reach. The spring outlet is about 1,075 feet above mean sea level as determined from a topographic map. The flow on June 22, 1924, was 72 second-feet, or 46,600,000 gallons per day. This was during a wet season and the measurement, therefore, probably represents nearly the maximum flow.

CAVE SPRING is located in S½ Lot 2 NW¼ sec. 19, T. 26 N., R. 2 E., Carter County, 3½ miles west of Hunter. It issues from a cave, flows over a concrete dam about 5 feet high, which is to be used to develop power, and empties into Current River about three quarters of a mile away. It can be reached by driving from Hunter. On July 26, 1934, the flow was 2.14 second-feet, or 1,380,000 gallons per day.

CHESAPEAKE SPRING is located in SW¼ SW¼ sec. 21, T. 28 N., R. 25 W., at Chesapeake, Lawrence County. It issues from a gravel bed just north of a State highway and is owned by the State Game and Fish Department, which has a large hatchery for propogating game fish. An excellent camping place for tourists is provided by the State. The spring outlet is about 1,180 feet above mean sea level as determined from a topographic map. Measurements of the flow of the main spring combined with that of several small springs rising nearby have been made as follows:

Date	Second-feet	Gallons per day
Aug. 26, 1926	5.6	3,620,000
Oct. 19, 1932	1.6	1,030,000

CLARKSON SPRING is located in SE¼ sec. 17, T. 27 N., R. 28 W., Lawrence County, 7 miles north of Pierce City. It flows from the gravel at the base of a small hill and empties into Center Creek a few hundred feet away. The spring basin is surrounded by a concrete wall. The place is rather inaccessible. The spring outlet is about 1,178 feet above mean sea level as determined from a topographic map. On Sept. 1, 1925, the flow was 7.9 second-feet, or 5,110,000 gallons per day.

COLD SPRING is located in E½ SW¼ sec. 4, T. 37 N., R. 1 E., near Floyd, Washington County, 8 miles northwest of Potosi. It rises near the head of a short hollow and flows down the spring branch which has a fall of about 30 feet in the first one quarter of a mile. The

surroundings are attractive, and the place was formerly used as a trout hatchery. It is now owned by the Cold Spring Club. The spring outlet is about 818 feet above mean sea level as determined from a topographic map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Oct. 8, 1926	3.3	2,130,000
Oct. 12, 1932	.69	446,000

COLLINS SPRING is located in sec. 3, T. 37 N., R. 4 W., one mile southeast of Steelville, Crawford County. The water issues from the gravel inside a concrete spring house, and part of it is pumped to the Collins' estate nearby. On Oct. 11, 1932, the flow was 1.6 second-feet, or 1,030,000 gallons per day.

COLLINS SPRING.-- See Gravois Mills Spring.

CONN SPRING is located in sec. 25, T. 35 N., R. 18 W., Dallas County, one mile northwest of Brice. It issues from a gravel bed about 200 yards from Niangua River. The spring is almost filled with aquatic growth and is often submerged by the river. On Aug. 20, 1932, the flow was 5.1 second-feet, or 3,300,000 gallons per day.

COPPEDGE SPRING (also called Relfe Spring and Freeman Spring) is located in sec. 36, T. 35 N., R. 10 W., at Relfe, Phelps County. The spring issues from the side of a road and flows into Spring Creek a short distance away. The spring is rather low and becomes sub-

merged when the creek is high. The outlet is about 830 feet above mean sea level as determined from a topographic map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Nov. 24, 1923	23	14,900,000
May 26, 1925	29	18,700,000
Sept. 12, 1925	20	12,900,000
Oct. 20, 1932	16.6	10,700,000
Aug. 2, 1934	15.4	9,950,000

CREASY SPRING (also called Bubbling Spring) is located in sec. 16, T. 36 N., R. 12 W., near Pippin Lodge, Pulaski County, 5 miles northwest of Waynesville. It issues from a conical basin about 15 feet in diameter and 8 feet deep and flows quietly into Gasconade River at a distance of 50 feet. The force of the water issuing from the bed of the spring keeps the coarse gravel constantly in motion and forms a very attractive sight. The spring is surrounded by woods and can be reached best by boat from Pippin's Lodge. It is often submerged when the river is high. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 14, 1914	[a]20.6	13,300,000
Sept. 10, 1926	27	17,500,000
Oct. 12, 1932	18.7	12,100,000

[a]Measurement made by the Engineering Experiment Station, University of Missouri.

CRYSTAL SPRING is located in sec. 22, T. 26 N., R. 15 W., at Larissa, Douglas County, 6 miles southeast of Ava. It flows from the base of a hill at the edge of a lake formed by an earth dam. It is used to develop power for lighting a resort nearby. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Sept. 8, 1925	7	4,520,000
Aug. 19, 1934	17.3	11,200,000

DAVIDSON SPRING.— See Blue Spring near Kime.

DOUBLE SPRING is located in NE¼ NE¼ sec. 32, T. 24 N., R. 11 W., Ozark County, 6 miles south of Dora. It issues from the base of a bluff. The water flow divides 50 feet from the outlet, one branch flowing north 700 feet into North Fork of White River and the other south about 1,500 feet into the same stream. It is rather inaccessible owing to rough roads, but is visited by quite a number of people. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 8, 1919	[a]136	87,900,000
Sept. 6, 1924	163	105,000,000
Sept. 7, 1925	82	53,000,000
Aug. 18, 1934	142	91,800,000

[a]Measured by Engineering Experiment Station, University of Missouri.

EBB AND FLOW SPRING is located in NW¼ sec. 35, T. 27 N., R. 6 W., near Rymer's Ranch, Shannon County, 6 miles northwest of Birch Tree. It issues from the base of a high hill and flows into Jacks Fork at a distance of 10 feet. It is used as a water supply for a fishing club and for Rymer's Ranch, a pleasure resort. As its name implies, the spring ebbs and flows at periodic intervals. On July 29, 1923, the flow at the highest stage was partly measured and partly estimated as 22 second-feet, or 14,000,000 gallons per day, and at the lowest stage it was estimated as 5 second-feet, or 3,200,000 gallons per day. A more complete description of this spring is given in Bulletin 1, Volume 7, Missouri School of Mines and Metallurgy, "Ebb and Flow Springs in the Ozarks" by Josiah Bridge.

EVANS SPRING is located in NW¼ sec. 2, T. 37 N., R. 4 W., Crawford County, one mile southeast of Steelville. The water flows from the foot of a rock cliff and is diverted by the use of a dam near the outlet and a flume along the side of a hill to a small power plant about a quarter of a mile away, which is used to furnish electric lights to a nearby estate. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Sept. 26, 1924	5.3	3,430,000
Aug. 6, 1930	2.6	1,680,000
Oct. 11, 1932	.4	259,000

FALLING SPRING is located on line between secs. 17 and 20, T. 36 N., R. 12 W., near Pippin Lodge, Pulaski County, 5 miles northwest of Waynesville. It issues from the side of a wooded hill, flows over an earth and rock dam 8 feet high, and empties into Gasconade River at a distance of 50 feet. The outlet of the spring is about 10 feet above the river. The place can be reached only by walking or by boat from Pippin Lodge. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Sept. 11, 1925	2.3	1,490,000
Sept. 10, 1926	7.4	4,780,000
Oct. 12, 1932	1.4	905,000

FAMOUS BLUE SPRING is located in NW¼ sec. 36, T. 35 N., R. 18 W., Dallas County, one mile west of Brice. It rises in a low swale at the edge of a field and flows into Niangua River 800 feet away. It enters the river just above the mouth of Bennett Spring branch and is submerged when the river is high. On Sept. 2, 1933, the flow was 4.44 second-feet, or 2,870,000 gallons per day.

FREEMAN SPRING.— See Coppedge Spring.

GAINES FORD SPRING (also called Nagogami Spring) is located in NW¼ sec. 35, T. 39 N., R. 9 W., Maries County, 10 miles northwest of Rolla. It issues from the base of a talus slope of a high rock bluff and flows into Gasconade River at a distance of about 500 feet. It

can be reached readily by driving as the road passes between the spring and the bluff. The spring and its rugged surroundings are the principal features of the Nagogami Lodge and the Rolla Country Club. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Apr. 28, 1926	18	11,600,000
June 26, 1932	4.2	2,740,000
Oct. 21, 1932	3.3	2,130,000

GOLLAHON SPRING is located in SW¼ sec. 17, T. 37 N., R. 8 W., Phelps County, 4 miles southwest of Rolla. It rises in the edge of a small field and flows through a narrow ditch to Little Beaver Creek about 70 feet away. It has been excavated to form a pond for propagating fish but has become filled with aquatic growths. It can be easily reached by driving. The spring outlet is about 790 (780) feet above mean sea level as determined from a topographic map. On Apr. 1, 1931, the flow was 0.27 second-foot, or 174,000 gallons per day.

GRAVEL SPRING is located in sec. 4, T. 28 N., R. 1 W., Shannon County, 2 miles northwest of Clear Spring and 10 miles northwest of Van Buren. As its name implies, it issues from the very coarse gravel at the edge of Current River, and is submerged when the river is high. Much of the water enters the river without coming to the surface of the gravel. The very rugged surroundings causes it to be quite inaccessible except by boat. On June 1, 1934, the flow

was roughly estimated as 15 second-feet, or 9,700,000 gallons per day.

GRAVOIS MILL SPRING (also called Collins Spring) is located in sec. 19, T. 41 N., R. 17 W., Morgan County, one mile west of Gravois Mill and 10 miles south of Versailles. It issues from the rock floor of a small rugged ravine and flows 500 feet into several small lakes created by dams. A fish hatchery is located nearby, and the lakes are used for propagating fish. The old grist mill, which stood three quarters of a mile downstream, was flooded by the Lake of the Ozarks. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
May 19, 1926	8.8	5,690,000
Oct. 15, 1932	5.4	3,490,000

GREER SPRING is located in sec. 36, T. 25 N., R. 4 W., Oregon County, one mile north of the village of Greer and 6 miles north of Alton. It has two outlets 300 feet apart, both of which are in a very deep and narrow gorge. At the upper outlet the water flows horizontally from a cave, and the water at the lower outlet boils up in a circular basin in the bed of the stream. The clear, cold water rushes down the branch 1¼ miles, throughout which it falls 46 feet and empties into Eleven Point River. The large volume of clear water dashing down the narrow, rocky valley with its heavily wooded slopes makes a place of very extraordinary beauty and grandeur, and forms one of the scenic gems of the State.

The place is privately owned, but visitors are permitted and can easily reach it by driving from Alton.

The large and uniform flow, combined with the rather large fall in the spring branch and short length of dam necessary to span the valley, makes this a good site for a moderate-sized power development. The lower outlet is about 545 feet above mean sea level.

Records of the daily flow have been collected from December 1921 to date. During this period, the flow has been as follows:

	Date	Second-feet	Gallons per day
Maximum	1927	903	584,000,000
Minimum	August, September 1934	135	87,300,000
Average	----	363	235,000,000

The average monthly and yearly flow in second-feet for climatological years ending September 30 is given in the following table:

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Avg.
1922	-	-	355	284	274	454	681	534	410	390	314	286	402
1923	273	270	236	352	521	500	444	466	507	356	333	300	380
1924	264	239	291	250	244	224	226	316	441	387	328	253	289
1925	210	203	206	221	260	262	264	306	234	173	160	216	226
1926	414	522	394	308	333	375	372	310	278	248	213	227	333
1927	246	377	324	427	433	435	724	776	861	572	563	458	516
1928	442	531	750	648	496	454	707	525	652	539	542	503	566
1929	432	411	398	379	424	452	615	771	673	431	410	341	478
1930	331	360	344	522	492	519	402	476	399	281	269	255	387
1931	285	231	237	224	367	481	450	436	350	299	302	258	327
1932	240	229	246	387	352	318	274	223	199	190	174	157	249
1933	146	154	190	422	323	329	594	677	556	379	316	271	363
1934	231	210	212	217	196	234	301	220	181	149	143	201	208
Avg.	293	320	322	357	363	387	466	464	442	338	313	287	363

Hahatonka Spring at Hahatonka
View of castle and lake

Hahatonka Spring at Hahatonka
View of spring outlet

HAHATONKA SPRING is located in sec. 2, T. 37 N., R. 17 W., at Hahatonka, Camden County. It emerges from the base of a rocky bluff, flows through a narrow, precipitous canyon about 1,000 feet long, and enters directly into the Lake of the Ozarks. The clear, sparkling water in the spring branch and lake, the surrounding rugged country, and the deep wooded valley make this one of the most picturesque and imposing landscapes in the State. The place is widely known for its scenic beauty and is visited by many tourists. The owner of the property maintains cottages, camp grounds, boats, and other conveniences which may be rented by visitors. The spring is flooded when the Niangua River is high. The outlet is 660.22 feet above mean sea level.

Records of the daily flow have been collected from November 1922 to June 1923 and from October 1923 to September 1926. The average monthly flow in second-feet during the periods of records for climatological years ending September 30 is given in the following table:

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1923	-	60.9	57.2	50.3	46.9	59.1	54.6	49.5	75.7	-	-	-
1924	52.8	64.0	a	61.0	77.9	64.8	a	a	a	a	a	88.7
1925	64.3	65.8	a	a	87.8	a	a	85.8	70.4	63.7	64.0	a
1926	90.8	94.6	76.2	63.7	64.5	80.2	95.3	68.0	62.0	56.0	65.5	84.8

[a]Spring affected by backwater from Niangua River.

HAZLETON SPRING is located in sec. 34, T. 33 N., R. 10 W., at Hazleton, Texas County, 8½ miles west of Licking. It rises in a 5-acre pond formed by a dam about 12 feet high in the spring branch, which is used to run a grist mill, and empties into Piney Creek about 500 feet below the mill. The lake is stocked with fish, and the place can be reached readily by driving from Licking. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 18, 1925	4.3	2,780,000
Oct. 18, 1932	4.6	2,970,000
Aug. 14, 1934	7.4	4,780,000

HIGHLEY SPRING is located in sec. 33, T. 32 N., R. 3 W., Dent County, 4 miles southwest of Bunker. It issues from the base of a 30-foot rock ledge and flows 2 miles into Sinking Creek. The flow on Oct. 13, 1932, was 3.5 second-feet, or 2,260,000 gallons per day.

HODGSON MILL SPRING is located in sec. 34, T. 24 N., R. 12 W., Ozark County, near Sycamore. It issues from a rock ledge over which stands a grist mill that utilizes the direct fall of 9 feet. It flows into Bryant Creek at a distance of 600 feet. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 29, 1926	24	15,500,000
Oct. 17, 1932	34.4	22,200,000
Aug. 18, 1934	44.7	28,900,000

HOWES MILL SPRING is located in SW¼ sec. 15, T. 34 N., R. 3 W., at Howes Mill, Dent County, 18 miles east of Salem. It issues from the base of a rocky hill about 50 feet high along State highway 32. A dam across the spring branch forms a small, attractive lake and was formerly used to operate a grist mill. The flow on Oct. 13, 1932, was 8.1 second-feet, or 5,230,000 gallons per day.

JAMES SPRING is located in sec. 36, T. 38 N., R. 3 W., Crawford County, 8 miles east of Steelville. It emerges from several sources in a cultivated field and flows half a mile into Dry Creek. On Oct. 12, 1932, the flow was 2.2 second-feet, or 1,430,000 gallons per day.

JORDAN SPRING is located in W½ NE¼ SW¼ sec. 24, T. 26 N., R. 1 E., Carter County, 3½ miles west of Hunter. It issues from a bed of gravel near the edge of a cultivated field and flows into Current River about half a mile away. It can be reached by driving from Hunter. On July 26, 1934, the flow was 11.8 second-feet, or 7,630,000 gallons per day.

KEENER SPRING is located in sec. 9, T. 26 N., R. 5 E., Butler County, one mile northwest of Keener and 5½ miles south of Williamsville. The water issues from the rocks in several places in a small valley and flows into Black River 600 feet away. The outlet of the spring is several feet above the river, and the remains of an old dam are visible about 150 feet from the mouth of the spring branch. The

LEEPER SPRING is located in sec. 27, T. 28 N., R. 3 E., Wayne County, in Leeper. It bubbles up in a circular concreted basin in the center of the street and flows into Black River about half a mile away. It is used to furnish water to the Ozark Hotel nearby. The spring outlet is about 425 feet above mean sea level as determined from a 20-foot contour map. The flow on Apr. 8, 1932, was 0.17 second-foot, or 109,000 gallons per day.

LORD SPRING is located in SW¼ sec. 28, T. 27 N., R. 5 E., Wayne County, 3 miles east of Williamsville. It issues from the base of a rock ledge, flows into a 5-acre lake, which is formed by a dam across the spring branch, and empties into Black River nearby. On Oct. 30, 1932, the flow was 0.43 second-foot, or 278,000 gallons per day.

LOST SPRING is located in SW¼ NE¼ sec. 26, T. 22 N., R. 9 W., Howell County, about 17 miles southwest of West Plains. The water issues from the bottom of a small concrete box and flows into West Fork of South Fork of Spring River about a mile away. The spring outlet is about 970 feet above mean sea level. On Nov. 21, 1934, the flow was about 0.015 second-foot, or 9,690 gallons per day.

LUMBEE MILL SPRING is located in NW¼ NW¼ sec. 12, T. 29 N., R. 26 W., Lawrence County, 7 miles northwest of Halltown. It issues from several sources within an area of about an acre and flows half a mile into Turnback Creek. The spring outlet is about 985 feet above mean sea level as taken from a 10-foot contour map. On Oct. 19,

1932, the flow was 3.7 second-feet, or 2,390,000 gallons per day.

MCCUBBENS SPRING is located in E½ W½ Lot 1 NW¼ sec. 6, T. 27 N., R. 6 W., Shannon County, 5 miles northeast of Mountain View. It issues from the base of a low rock ledge and flows into Jacks Fork at a distance of a quarter of a mile. The spring branch is in a deep, wooded valley, and the entire surroundings are quite attractive, but are rather inaccessible. On Sept. 25, 1927, the flow was 2.4 second-feet, or 1,550,000 gallons per day, and on Oct. 16, 1932, the flow was 0.78 second-foot, or 413,000 gallons per day.

MCDADE SPRING (also called Blue Spring) is located in sec. 16, T. 39 N., R. 5 W., Crawford County, 5 miles northwest of Cuba. It issues from a break in a small rock flat and flows directly into Brush Creek only a few feet away. It is rather inaccessible but can be reached in dry weather by driving from Cuba. It is surrounded by thick woods, and the place was formerly a favorite spot for rural picnics and gatherings. The flow on Oct. 7, 1934, was estimated as 0.8 second-foot, or 520,000 gallons per day.

MCINTOSCH SPRING is located in NE¼ NE¼ sec. 12, T. 38 N., R. 5 W., Crawford County, about 3 miles south of Cuba. The water issues from the sand in a circular basin surrounded by trees and flows into Pine Creek a few hundred feet away. The spring is near the edge of a cultivated field and was formerly diverted through an open ditch for a distance of about 400 feet to form a small lake

created by an earth dam about 300 more feet down the valley. The water was then diverted by another ditch about 50 feet in length to a point where it was used to operate a water wheel with a total fall of about 15 feet and discharged into the mouth of a large cave. Only a few remains of the former outlay are visible. The outlet of the spring is about 760 feet above mean sea level as determined from a 50-foot contour map. On Feb. 10, 1935, the flow was 1.36 second-feet, or 881,000 gallons per day.

MAMMOTH SPRING is located near line between secs. 5 and 8, T. 21 N., R. 5 W., at Mammoth Spring, Fulton County, Arkansas, just south of the Missouri State line. A dam in the spring branch forms a lake of several acres, and is used to develope hydro-electric power. A Government fish hatchery is located at the spring. On Dec. 11, 1924, the flow was 240 second-feet, or 155,000,000 gallons per day, and on June 11, 1926, it was 310 second-feet, or 200,000,000 gallons per day

As there is often local difference in opinion in regard to the flow of this spring as compared with Big Spring near Van Buren, Mo., and Greer Spring at Greer, Mo., the following table is given to show the comparative flow of the three springs in terms of gallons per day on the dates on which the measurements described above were made:

Date	Big Spring	Mammoth Spring	Greer Spring
Dec. 11, 1924	183,000,000	155,000,000	133,000,000
June 11, 1926	231,000,000	200,000,000	180,000,000

From these figures it appears that Mammoth Spring ranks between Big and Greer Springs in regard to quantity of flow.

MAMMOTH SPRING.— See Prewett Spring.

MARKHAM SPRING is located in sec. 23, T. 27 N., R. 4 E., Wayne County, 3 miles west of Williamsville. It rises in a small natural lake and empties into Black River half a mile away. The place is rather attractive but rather inaccessible. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 3, 1925	7.4	4,780,000
Oct. 29, 1932	6.7	4,330,000
Aug. 15, 1934	7.6	4,910,000

MARTIN'S SPRING is located in sec. 8, T. 37 N., R. 8 W., Phelps County, 3½ miles west of Rolla. It issues from a rock formation inside a stone spring house by the side of State highway 66, and flows about 500 feet before entering Little Beaver Creek. On Mar. 13, 1935, immediately after an unusually heavy rain, the flow was 1.3 second-feet, or 840,000 gallons per day.

MERAMEC SPRING is located in sec. 1, T. 37 N., R. 6 W., Phelps County, 6 miles southeast of St. James. The water issues from a circular basin at the base of a rocky cliff, spreads and falls over an old rock dam, and flows swiftly down the spring branch 1 mile into Meramec River. The clear water bubbling from the basin and rush-

ing over the falls under an arch bridge and down the spring branch, combined with the very picturesque valley and surrounding hills, make this a very scenic place. The spring can be reached readily by driving from St. James. Although the place is privately owned, visitors are welcome during the daytime, and several conveniences are provided for them.

Water power was formerly developed on the spring to serve a nearby iron mine, blast furnace, and grist mill. The remains of the large blast furnace and forge chimneys add much to the scenic value of the place.

A new rustic power plant now develops about forty horsepower which is used to furnish lights, water, and power to the large Meramec Farms dairy buildings and ice plant nearby. The spring outlet is about 790 feet above mean sea level.

Records of the daily flow have been collected from December 1921 to October 1929. During this period the flow has been as follows:

	Date	Second-feet	Gallons per day
Maximum	1927, 1928	650	420,000,000
Minimum	Aug. 1, 1934	[a]56	36,200,000
Average		149	97,300,000

[a] By discharge measurement.

The average monthly and yearly flow in second-feet for climatological years ending September 30 is given in the following table:

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Avg.
1922	-	-	167	119	127	225	309	164	116	115	103	98	-
1923	93	83	100	112	138	205	145	148	168	112	98	89	124
1924	80	78	145	95	133	128	145	154	233	225	169	132	143
1925	103	91	144	114	133	105	144	137	108	103	100	104	115
1926	113	139	117	84	145	165	178	120	91	82	80	80	116
1927	132	174	133	191	180	215	441	296	314	157	143	125	208
1928	174	275	300	152	158	188	299	188	239	153	149	118	199
1929	107	105	109	125	125	170	196	225	204	150	131	102	146
1930	106	-	-	-	-	-	-	-	-	-	-	-	-
Avg.	100	135	152	124	142	175	232	179	184	137	122	106	149

MIDCO SPRING is located in sec. 22, T. 27 N., R. 2 W., at Midco, Carter County, 8 miles west of Van Buren. It issues from the side of a rock bluff 70 feet high and flows into Davis Creek at a distance of half a mile. It can be reached readily by driving. The flow on June 23, 1928 was 2.7 second-feet, or 1,700,000 gallons per day.

MILL SPRING is located in sec. 36, T. 28 N., R. 3 E., at Mill Spring, Wayne County. The water flows from the foot of a rock ledge on the right-of-way of the Missouri Pacific Railroad and is used by the company for locomotives. It is easy to reach by driving. The outlet of the spring is about 440 feet above mean sea level as determined from a 20-foot contour map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Oct. 4, 1922	10	6,460,000
Aug. 2, 1925	11	7,110,000
June 17, 1926	12	7,750,000
Apr. 8, 1932	15	9,690,000
Aug. 14, 1934	9.2	5,930,000

MILLER SPRING is located in sec. 6, T. 34 N., R. 10 W., Pulaski County, 3 miles northeast of Big Piney. It rises in a pool at the base of a high rock bluff, and flows a quarter of a mile into Piney Creek. Owing to the periodic fluctuations in its flow, it is what is known as an "ebb and flow" spring. On Nov. 25, 1923, two measurements of the flow were made by Prof. Josiah Bridge -- at the highest stage the flow was 20 second-feet, or 12,900,000 gallons per day, and at the lowest stage, it was 4.8 second-feet, or 3,100,000 gallons per day. A more complete description of this spring is given in Bulletin 1, Volume 7, Missouri School of Mines and Metallurgy, "Ebb and Flow Springs in the Ozarks", by Josiah Bridge.

MONTAUK SPRING is located in SE$\frac{1}{4}$ sec. 22, T. 32 N., R. 7 W., Dent County, half a mile north of Montauk. The spring has two main branches. The south branch has two mouths 300 feet apart in a gravel bar, and the north one has three mouths; one comes out of the rocks at the base of a hill and the other two out of the gravel at the foot of the hill. The two branches join near Montauk, forming the beginning of Crooked Creek, and the combined flow is used to operate a grist mill. The spring and a fish hatchery nearby are the principal features of Montauk State Park. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Oct. 2, 1923	63	40,700,000
Oct. 13, 1932	46	29,700,000
Aug. 13, 1934	38	24,500,000

NAGOGAMI SPRING.— See Gaines Ford Spring.

NIANGUA SPRING.— See Bennett Spring.

OUSLEY SPRING is located in sec. 10, T. 35 N., R. 10 W., Phelps County, 4 miles northeast of Spring Creek post office. It issues from the base of a high hill and flows 250 feet into Piney Creek. The flow on Oct. 20, 1932, was 0.95 second-foot, or 613,000 gallons per day.

PATRICK SPRING.— See Althea Spring.

PAYDOWN SPRING is located in SW¼ sec. 2, T. 40 N., R. 8 W., Maries County, near Paydown post office, 13 miles northeast of Vienna. It has one main outlet and several small ones in gravel bars within a radius of 300 feet and flows into Gasconade River about 1¼ miles away. The spring formerly supplied power to operate two grist mills about half a mile below the outlets. A new dam near the old mills now forms a lake for recreational purposes. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Sept. 25, 1924	18	11,600,000
Oct. 20, 1932	6.8	4,390,000

PINEY SPRING is located in SW¼ sec. 4, T. 35 N., R. 8 W., Phelps County, 1½ miles southeast of Yancy Mill post office, 14 miles south of Rolla. It emerges from a rock bluff and flows into Piney Creek 500 feet away. The place can be reached best by walking half a mile. The spring outlet is about 860 feet above mean sea level as determined from a 20-foot contour map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
July 24, 1925	5	3,200,000
Oct. 20, 1932	.1	64,000

PHILLIPS SPRING is located in sec. 10, T. 25 N., R. 1 E., Carter County, 12 miles southeast of Van Buren. The water issues from a gravel bar at the base of a rock ledge and empties into Current River at a distance of a quarter of a mile. It is very inaccessible by road, but can be reached readily by boat on Current River, and is a favorite camping place for fishermen. The flow on Aug. 15, 1925, was 8.8 second-feet, or 5,680,000 gallons per day.

PREWETT SPRING (also called Mammoth Spring) is located in sec. 32, T. 34 N., R. 10 W., Pulaski County, 6 miles north of Hazleton, and 14 miles northwest of Licking. It issues from the rocks at the side of a road at the base of a bluff, flows along a cultivated field, and empties into Piney Creek at a distance of half a mile. The rugged surroundings and poor roads make the place quite inaccessible. The outlet of the spring is never flooded by the

river. Measurements of the flow have been made as follows:

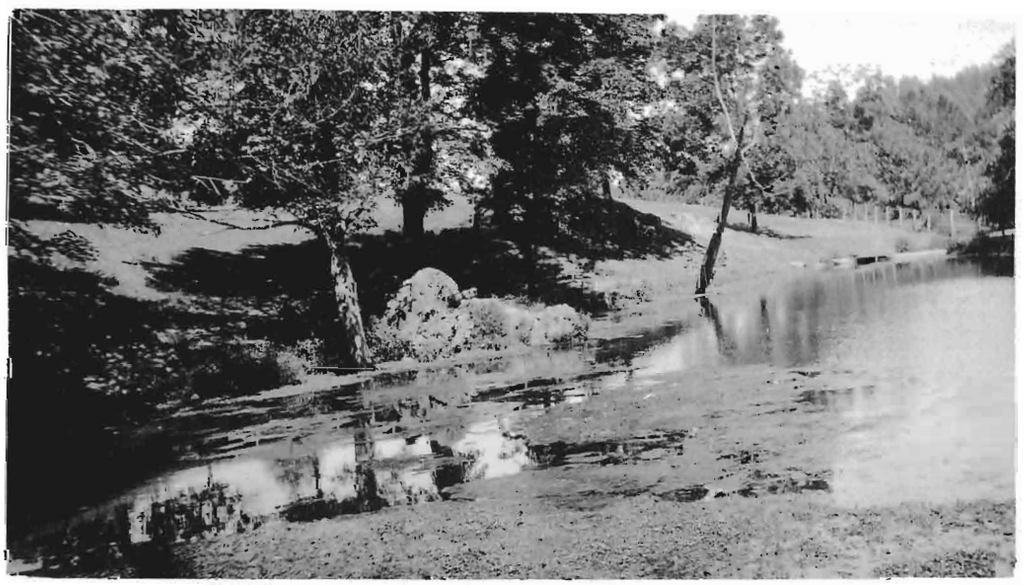
Date	Second-feet	Gallons per day
July 17, 1925	17	11,000,000
Oct. 18, 1932	16.5	10,700,000
Aug. 14, 1934	15.6	10,100,000

PULLTIGHT SPRING is located in NE¼ sec. 4, T. 30 N., R. 5 W., Shannon County, 6 miles northwest of Round Spring, and 14 miles north of Eminence. The water flows from the rocks at the base of a rocky cliff and after passing over three small dams with a combined height of about 10 feet, it empties into Current River 500 feet away. The spring is in a small valley and has a club house nearby. The rugged surroundings make the place rather hard to reach except by boat on Current River. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Oct. 3, 1923	31	20,000,000
June 22, 1924	141	91,000,000
Oct. 14, 1932	5.9	~~38,100,000~~ >3,810,000

RANDOLPH SPRING is located in sec. 20, T. 30 N., R. 1 E., at the side of a highway, Reynolds County, 2½ miles north of Ellington. It rises in a small slough in Dry Creek which empties into Logan Creek. On Aug. 1, 1925, the flow was 1 second-foot or 650,000 gallons per day.

Reed Spring at Centerville
View of waterfall at old mill



Reed Spring at Centerville
Looking downstream at outlet

REEDS SPRING is located in sec. 28, T. 32 N., R. 1 E., Reynolds County, half a mile east of Centerville. It rises in a small basin, which has a dam built across it. From the dam, the water is carried in a small wooden flume to a water-wheel where power is generated to operate a grist mill and was formerly used to furnish lights to Centerville. The water then flows into West Fork of Black River. The place is picturesque and is visited by many people. A pleasure resort is located nearby. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
July 31, 1925	7.5	4,850,000
June 17, 1926	15	9,700,000

RELFE SPRING.— See Coppedge Spring.

ROARING SPRING is located in E½ sec. 19, T. 41 N., R. 1 W., Franklin County, 2 miles east of Stanton. It issues from a cave in a cliff and flows into Meramec River. It is used as a picnic place. The spring outlet is about 645 feet above mean sea level as determined from a 50-foot contour map. On Sept. 3, 1925, the flow was 1 second-foot, or 646,000 gallons per day.

ROARING SPRING is located in sec. 22, T. 38 N., R. 5 W., Crawford County, 3½ miles southeast of Fanning. The water issues from several outlets near the bank of Meramec River. To reach the

place it is necessary to walk three-quarters of a mile from Fox Springs Lodge. On Dec. 1, 1932, the flow was 4.1 second-feet, or 2,650,000 gallons per day.

ROARING RIVER SPRING is located in sec. 27, T. 22 N., R. 27 W., Barry County, 7 miles south of Cassville. The water issues from a cave, and after passing through an artificial lake created by a dam, empties into Roaring River. The spring and State fish hatchery are the principal features of Roaring River State Park. Hydro-electric power is developed to furnish lights to the hatchery and nearby buildings. The entire place with its rugged surroundings is very attractive and lures many tourists. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
July 15, 1923	23	14,900,000
July 16, 1923	28	18,100,000
Oct. 19, 1932	10	6,460,000
July 18, 1934	14.4	9,310,000
Feb. 26, 1935	32.0	20,700,000

ROCKBRIDGE SPRING is located in sec. 5, T. 24 N., R. 13 W., at Rockbridge, Ozark County, 18 miles southeast of Ava. This is really a series of springs which rise in the bed of a lake about 1,500 feet long and 400 feet wide formed by a dam, which develops a head of 9 feet and is used to operate a mill. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 29, 1926	23	14,900,000
Oct. 17, 1932	24	15,500,000

ROCK SPRING is located in T. 43 N., R. 3 E., Jefferson County, 2½ miles southeast of Allenton. It issues from the base of a rock ledge in a small valley and flows into Meramec River about half a mile away. Some summer cottages are located nearby. On Mar. 3, 1935, the flow was estimated as 0.1 second-foot or 65,000 gallons per day.

ROLUFS SPRING is located in sec. 25, T. 37 N., R. 9W W., Phelps County, 1½ miles southeast of Arlington. It issues from the sand in the bottom of "Smith Gorge" and flows into Piney Creek nearby. The flow on Sept. 16, 1931, was 0.24 second-foot, or 155,000 gallons per day.

ROUBIDOUX SPRING (also called Waynesville Spring) is located in sec. 25, T. 36 N., R. 12 W., Pulaski County, half a mile south of Waynesville. The water boils up from the rocks at the edge of a highway, which is protected by a concrete retaining wall and runs between the spring and a high rock cliff. The water flows about 100 feet before entering Roubidoux Creek which submerges the spring when at high stages. The place is very easily reached and is visited by many people. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 11, 1914	[a]12	7,650,000
July 15, 1924	73	47,100,000
Nov. 8, 1931	11	7,100,000
Oct. 12, 1932	5.7	3,680,000
Aug. 3, 1934	5.3	3,420,000
Aug. 18, 1934	[b]159	104,000,000

[a]Measured by Engineering Experiment Station, University of Missouri.

[b]Measured after very heavy rain.

ROUND SPRING is located in sec. 20, T. 30 N., R. 4 W., at Round Spring post office, Shannon County, 10 miles north of Eminence. The spring rises in a circular basin about 80 feet in diameter surrounded by a solid rock ledge about 30 feet high and then flows 80 feet through a cave, emerging at the foot of a small hill. The water then winds its way down a branch and empties into Current River about 1,000 feet away. This unique spring and its beautiful surroundings are the principal features of Round Spring State Park. Floods on the Current River often innundate the spring and part of the park. The place is very easily reached and has one of the most popular picnic grounds in the State.

Records of the flow of the spring have been collected from October 1928 to September 1934. During this period the maximum and minimum flow recorded are as follows:

	Date	Second-feet	Gallons per day
Maximum	May 1933	520	336,000,000
Minimum	August 1934	12	7,760,000

The average monthly and yearly flow in second-feet for climatological years ending September 30 is given in the following table:

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Avg.
1929	-	28.4	35.6	53.8	49.1	57.1	83.8	137	72.7	42.0	48.6	27.6	57.8
1930	28.9	32.1	31.1	73.3	71.9	56.9	28.9	28.8	24.5	20.9	18.0	20.0	36.1
1931	31.9	20.9	25.2	19.3	38.4	67.2	28.3	39.7	27.1	20.0	27.3	19.7	32.0
1932	16.7	19.7	19.9	58.4	24.1	25.9	19.3	16.6	16.5	16.8	15.4	14.7	22.0
1933	21.1	23.0	55.4	64.4	24.4	28.9	95.7	166	37.6	23.0	22.2	19.7	48.7
1934	19.4	19.2	17.6	17.1	15.9	21.5	28.0	17.3	16.8	15.5	12.9	23.1	18.7
Avg.	23.6	23.9	30.8	47.7	37.3	42.9	50.7	67.6	32.5	23.0	24.1	20.8	35.4

SCHLICHT SPRING is located in sec. 30, T. 37 N., R. 12 W., Pulaski County, 7 miles northeast of Waynesville. The water flows from the foot of a 25-foot rock ledge and forms a mill pond which is created by a small dam in the spring branch. Power was formerly developed to operate a grist mill and furnish electric lights. The place is quite inaccessible. On Sept. 12, 1925, the flow was 1.0 second-foot, or 650,000 gallons per day.

SHANGHAI SPRING (also called Blue Spring) is located in SW¼ sec. 24, T. 36 N., R. 11 W., Pulaski County, 7 miles east of Waynesville. It issues from the foot of a high, wooded, and rocky hill and flows about 500 feet into Piney Creek. A private clubhouse is located nearby. The spring outlet is only a few feet above Piney Creek and is submerged when the creek is high. The place is very attractive but is not very well suited for picnics unless they are held within the privately owned grounds. It can be reached readily by

driving three quarters of a mile from State highway 66. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Mar. 24, 1925	22	14,200,000
June 21, 1925	12	7,760,000
June 27, 1932	9.6	6,200,000
Oct. 12, 1932	7.8	5,040,000
Aug. 3, 1934	7.7	4,980,000
Aug. 18, 1934	34.2	22,100,000
Oct. 14, 1934	11.8	7,620,000

SLABTOWN SPRING is located in sec. 15, T. 33 N., R. 10 W., Texas County, 9 miles northwest of Licking. It emerges from the side of a steep, rocky hill, flows over a small rock dam, and empties into Piney Creek about 1,000 feet away. The outlet is never flooded by the creek. The place can be reached by driving from Licking. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
July 21, 1925	13	8,400,000
Oct. 18, 1932	8.7	5,620,000
Aug. 14, 1934	12.6	8,140,000

STONE MILL SPRING is located in sec. 21, T. 35 N., R. 10 W., Pulaski County, 2 miles southwest of Spring Creek post office, and 11 miles southeast of Waynesville. It issues from the base of a rock ledge and flows 100 feet into Piney Creek. A private clubhouse is located nearby. The place and its surroundings are attractive, but it is quite inaccessible. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Sept. 12, 1925	23	14,900,000
Oct. 20, 1932	18.0	11,600,000
Aug. 2, 1934	16.8	10,900,000

SWEET SPRING.-- See Blue Spring near Eldridge.

THOMASSON MILL SPRING is located in sec. 16, T. 22 N., R. 2 W., Oregon County, a quarter of a mile east of a place known as "The Narrows", near the mouth of Fredrick Fork, and 14 miles southeast of Alton. The spring rises in a small lake formed by a dam about 8 feet high where power is occassionally developed to operate a small grist mill, and flows a quarter of a mile into Eleven Point River. The small lake is quite full of aquatic growth, and the surroundings are very attractive and afford an excellent place for picnics and outings. The place can be reached by driving from Alton. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 12, 1925	26	16,800,000
June 10, 1926	50	32,300,000
Oct. 25, 1932	14	9,050,000
Sept. 14, 1933	35	22,600,000
Aug. 17, 1934	23.8	15,400,000

TURNER MILL SPRING is located in sec. 3, T. 24 N., R. 3 W., Oregon County, 10 miles northeast of Alton. The water flows from a cave, is carried 500 feet in a wooden flume to a water wheel which is used to develop power to operate a saw mill, sorgum mill, and flour mill,

Roaring Spring near Cassville
Looking upstream at spring outlet

Welch Spring near Cedar Grove
View of outlet and bluff

and then flows into Eleven Point River. The total fall to the river is about 50 feet. The place is rather inaccessible. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Sept. 8, 1924	2.3	1,500,000
Aug. 13, 1925	2.4	1,600,000
Oct. 25, 1932	1.7	1,100,000

WARNER BAY SPRING is located in sec. 9, T. 31 N., R. 2 E., Reynolds County, 8 miles southeast of Centerville. The water issues from several openings in a cave in a cliff and flows a quarter of a mile before entering Black River. The rugged surroundings are rather picturesque but are quite inaccessible. On July 31, 1925, the flow was 16 second-feet, or 10,300,000 gallons per day.

WAYNESVILLE SPRING.-- See Roubidoux Spring.

WELCH SPRING is located in sec. 14, T. 31 N., R. 6 W., Shannon County, 3 miles southeast of Cedar Grove. The water flows from a cave and is divided by a small concrete dam near the outlet. One branch empties into Current River after flowing about 100 feet. The other flows about 400 feet before entering the same river. The place is very picturesque but is rather difficult to reach by driving. The outlet of the spring is about 800 feet above mean sea level as determined from a 20-foot contour map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Oct. 2, 1923	115	74,300,000
June 22, 1924	331	214,000,000
Oct. 14, 1932	77	49,800,000

WESTOVER SPRING is located in SW¼ SE¼ sec. 14, T. 37 N., R. 3 W., at Westover, Crawford County, 8 miles southeast of Steelville. The water emerges from several sources within an area of about two acres, is diverted by a ditch to a fish hatchery, and empties into Dry Creek. The place can be reached readily by driving from Steelville. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Aug. 23, 1926	13	8,400,000
June 22, 1932	10	6,460,000
Oct. 11, 1932	6.3	4,070,000

WILDER SPRING (also called Breakup Spring) is located in sec. 14, T. 23 N., R. 11 W., on the Kelly-Wilder ranch, Ozark County, 5 miles north of Caulfield. It issues from the base of a low rock bluff in the channel of Spring Creek and during dry weather forms the source of the creek. The place is quite inaccessible, and as it is privately owned, it is not open to the public. Measurements of the flow have been made as follows

Date	Second-feet	Gallons per day
Sept. 5, 1925	6	3,900,000
Aug. 28, 1926	20	12,900,000
Aug. 18, 1934	9.0	5,810,000

WILKINS SPRING is located in S½ SE¼ sec. 17, T. 36 N., R. 9 W., Phelps County, 7 miles southwest of Newburg. It rises in a 2-acre lake formed by an earth dam, flows down the valley 1,000 feet, and empties into Mill Creek. The place is rather attractive and can be quite easily reached by driving from Newburg. The surface of the lake is about 820 feet above mean sea level as determined from a 20-foot contour map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
Jan. 4, 1927	7.2	4,650,000
Oct. 13, 1932	4.8	3,100,000
July 21, 1934	4.3	2,780,000
Aug. 18, 1934	9.1	5,880,000

WINOKA SPRING is located in sec. 15, T. 28 N., R. 21 W., Green County, 1 mile southeast of Galloway. It issues from the side of a wooded hill and flows 300 feet into James River, 200 feet upstream from State highway 65. Winoka Lodge, located nearby, uses the spring for a water supply. The flow on Oct. 20, 1932, was 0.23 second-foot, or 150,000 gallons per day.

YANCY MILL SPRING is located in SW¼ sec. 32, T. 36 N., R. 8 W., at Yancy Mill post office, ~~Crawford~~ Phelps County, 13 miles south of Rolla. The spring bubbles up in a gravel bed, which is surrounded by a rock wall, and flows into a 1-acre lake formed by a concrete dam which was formerly used to operate a grist mill. The water enters Little Piney Creek about 400 feet downstream from the old mill.

It is an excellent camping and picnic place and can be reached readily by driving. The outlet of the spring is about 835 feet above mean sea level as determined from a 20-foot contour map. Measurements of the flow have been made as follows:

Date	Second-feet	Gallons per day
July 24, 1925	1.5	969,000
Oct. 20, 1932	3.0	1,940,000
Aug. 2, 1934	1.0	646,000

ZANONI SPRING is located in sec. 7, T. 23 N., R. 12 W., at Zanoni post office, Ozark County, 9 miles northwest of Gainesville. It issues from the side of a high hill, flows through a flume to an abandoned mill, and empties into Pine Creek at a distance of about half a mile. The flow on Oct. 18, 1932, was estimated as 0.3 second-foot, or 194,000 gallons per day.

ACKNOWLEDGEMENTS

The author is indebted to many for their assistance in obtaining the data.

I wish to acknowledge especially the assistance of Mr. H. C. Beckman, District Engineer, Water Resources Branch of the U. S. Geological Survey.

Dr. H. A. Buehler, State Geologist and Director of the Missouri Geological Survey and Water Resources, Wilbur C. Buford, Commissioner of the Missouri Game and Fish Department, and Mr. Roscoe Nunn, Meteorologist for the United States Weather Bureau, all were very generous in furnishing data from the records of their Departments.

Professor T. J. Rodhouse of the Engineering Experiment Station, University of Missouri made several miscellaneous measurements which are included in this report.

The personell of the District Office of the Water Resources Branch of the United States Geological Survey, Rolla, Missouri, gave very valuable assistance in furnishing suggestions and helping assemble the data. Special acknowledgment is due Mr. W. M. Littlefield and Miss Edythe Mook.

BIBLIOGRAPHY

Climatological Data, U. S. Department of Agriculture.

Water Supply Papers No. 646, 647, 667, 687, 701, 702, 716, 717, 731, 732, 746, 747, U. S. Geological Survey.

Water Resources of Missouri 1857-1926, Vol. 20, Missouri Bureau of Geology and Mines.