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WATER SUPPLY OF THE BIRMINGHAM AREA ALABAMA

By W. H. Robinson, J. B. Ivey, and G. A. Billingsley

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PREFACE

This report was prepared to provide information relative to the water resources of one of several of the Nation's centers of industry. The information presented will be of value in the orderly planning for municipal and industrial expansion as well as a guide to the sound development of water supplies related to defense efforts. It was prepared by the U. S. Geological Survey under the technical supervision of the Water Utilization Section of the Technical Coordination Branch and under the direct supervision of Melvin R. Williams, district engineer (Surface Water); Philip E. LaMoreaux, district geologist (Ground Water); and G. A. Billingsley, district chemist (Quality of Water).

Most of the surface-water data for this report have been collected over a period of years by the U. S. Geological Survey in cooperation with the Alabama Geological Survey. Acknowledgment is made to the H. W. Peerson Drilling Co., Birmingham, Ala., whose well records contributed much ground-water information, and to all individuals with whom the geology and ground water of the area were discussed.

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WATER SUPPLY OF THE BIRMINGHAM AREA, ALABAMA

ABSTRACT

Sufficient water is available in the streams of the area surrounding Birmingham to supply any foreseeable demand; however, to utilize these streams impounding reservoirs and rather long supply lines will be required. Moderate supplies of ground water are available from wells, springs, and mines.

The average water use in the area, not including reclaimed and recirculated water, was about 157 mgd during 1951. About 55 mgd was used for domestic or commercial purposes, and 102 mgd was used for industrial purposes. The quantity of water withdrawn would have to be much greater if a considerable amount of reclaimed and recirculated water had not been used. The Birmingham water-supply systems are used at almost full capacity, and plans are being considered by the city to expand its supply greatly.

An estimated 4 mgd of ground water from wells and springs is used for municipal supplies, and 8 mgd is used for industrial purposes. Smaller amounts of ground water are used for irrigation and rural supply. Individual springs in the area are capable of yielding as much as 750 gpm and wells as much as 500 gpm. Some water from worked and abandoned coal and iron mines is used for public and industrial supplies. One of the conclusions reached by the ground-water study is that ground water has not been fully developed in wells and springs of the area and that mine water which would have to be treated for most municipal and industrial purposes is a potential source of water.

Generally, the surface water in the Birmingham area is of better quality than ground water. Surface water is low in dissolved mineral matter and is extremely soft. Some of the streams carry excessive quantities of iron. Village and Valley Creeks carry some surface pollution making the water unsuitable for many uses. Ground water in this area is usually low in color and ranges in temperature from 62° to 72°F. Water from limestone, dolomite, and chert usually is moderately to extremely hard. Calcium, magnesium, and bicarbonate are the predominant constituents. The quantity of iron in ground water from most of the aquifers is low, except from the Pottsville formation. The Floyd shale and the Parkwood formation yield sodium bicarbonate waters high in sulfate and low in calcium, magnesium, chloride, and nitrate. Ground water from the Pottsville formation is more variable in quality than water from other formations in the area. Water samples from the mine shafts yielding from this formation were highly mineralized and extremely hard.

INTRODUCTION

Purpose

Large quantities of water are required in the Birmingham area, principally because of the development of water-using industries in the area. The metropolitan area is so situated that only small quantities of water are available in the immediate vicinity, and in general these easily developed supplies have already been exploited. Thus the development of additional supplies in any appreciable quantities presents a difficult problem, the solution of which will require much planning and a considerable expenditure of money.

The purpose of this report is to provide information on the water resources of the Birmingham area that may be useful for initial guidance in the location or expansion of water facilities for defense and nondefense industries and for the municipalities upon which the industries are dependent.

Information on ground water is limited to the general vicinity and is of interest to the smaller communities and to potential developers of private industrial or commercial supplies requiring moderate quantities. Information on surface water includes records on streams located an appreciable distance from Birmingham. Most of these streams have at some time been considered as a source for additional water for the city. Other units of Government, both State and Federal, also have a potential interest in or plans for the development of these streams; thus the information presented herein will also be of value to them.

Description of Area

Location

The area investigated for water use and supply in this report is that area covered by the city of Birmingham and the surrounding industrial area. In general, the area can be defined as Jefferson County which is in the north-central part of Alabama (pl. 1). It was necessary, because of lack of adequate surface-water supplies nearby, to consider a much larger area in the study of potential surface-water supplies. Surface-water data are presented for selected streams in Jefferson, Shelby, Blount, Walker, and Winston Counties. Ground-water investigations were confined to Jefferson County with special emphasis on the ground-water potential of the main industrial area of Birmingham valley (pl. 2).

Topography

Birmingham valley is 3 to 7 miles wide extending northeastward across Jefferson County. The main valley is divided longitudinally by a low-lying ridge into two parallel flat-bottomed valleys, Jones Valley and Opossum Valley. Birmingham valley is at an elevation of 500 to 600 feet above mean sea level and is slightly higher than the adjoining Warrior Basin and Cahaba Valley. Streams draining the Birmingham valley cut through the valley walls and drain into the Black Warrior River.

The Cahaba Ridges are southeast of Birmingham valley (fig. 1); a series of sharp parallel ridges also extending northeastward across the county. The valleys have steep sides and narrow floors and are drained by the headwaters of the Cahaba River.

The Warrior Basin lies to the west and north of Birmingham valley (fig. 1). The topography ranges from rolling to hilly with the streams of the area occupying steep-sided valleys. Topographic maps are available for much of the area and can be procured from the U. S. Geological Survey or from local agents.

Climate

Since 1896 climatic records in Birmingham have been kept continuously by the U. S. Weather Bureau (U. S. Weather Bureau, 1951). 1/

The climate in the Birmingham area is generally pleasant the year round. There is sunshine about 60 percent of the possible time. The average wind veloc-

1/ See page 53 for list of references cited.

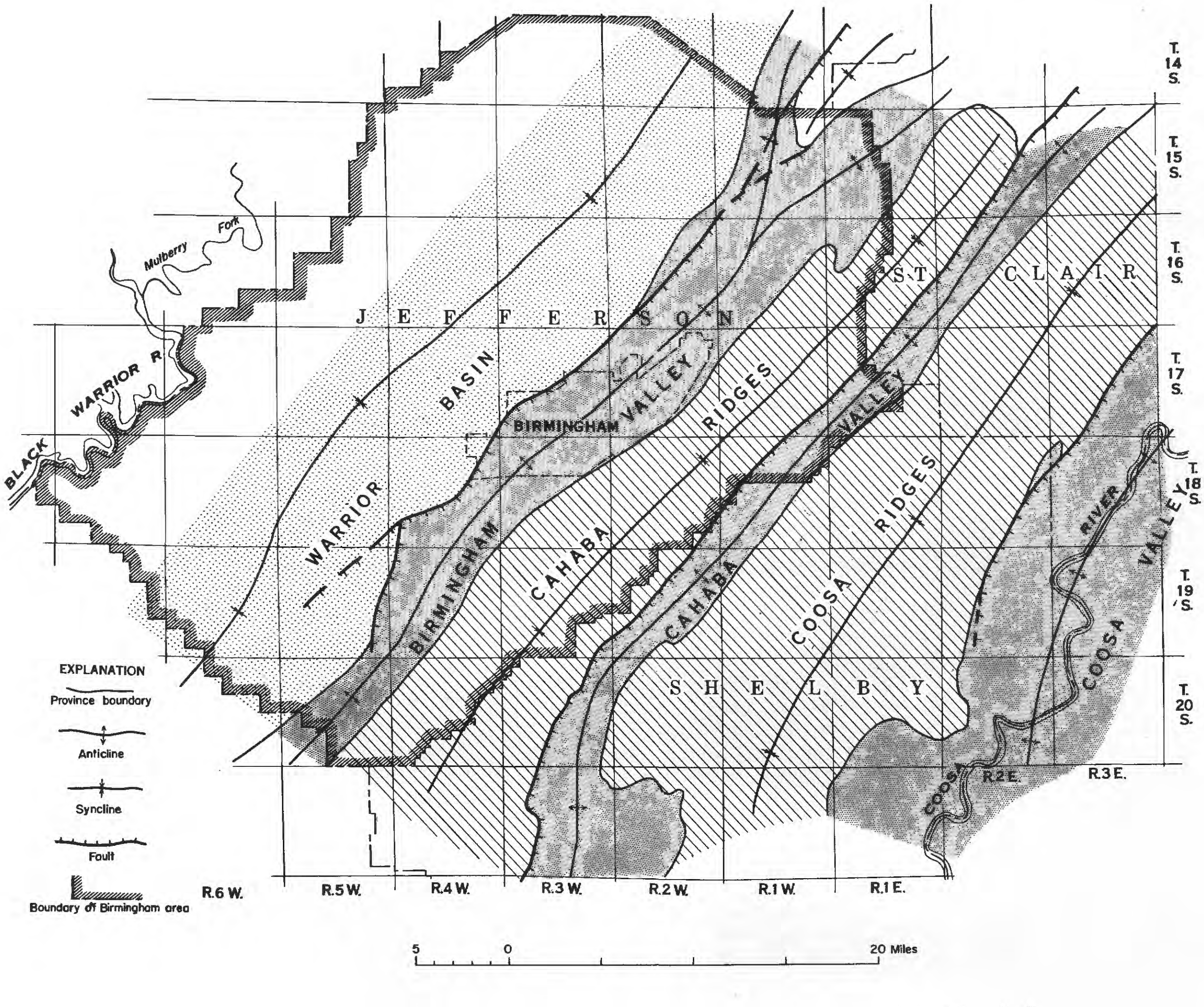

Figure 1.—Generalized physiographic provinces with structural features of the Birmingham area.

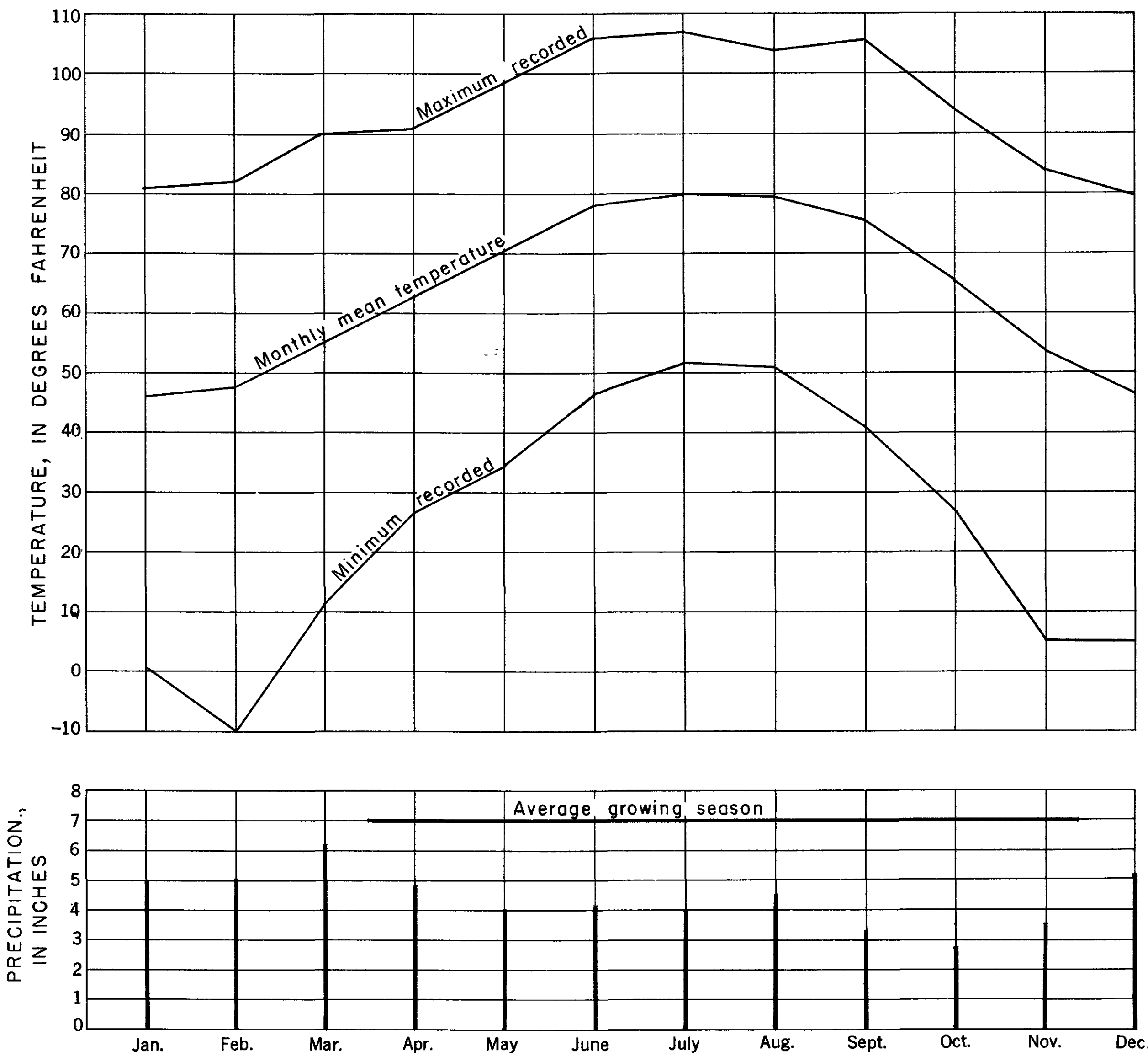

Figure 2.—Temperature and precipitation at Birmingham, 1896-1951.

ity is 7.0 mph with high and low mean monthly velocities of 8.9 and 5.2 mph occurring in March and August, respectively. The average growing season is 239 days; November 10 and March 16 are the average dates of the first and last killing frosts.

Birmingham is in the Eastern Humid climatic division of the United States (U. S. Department of Agriculture, 1941), and heat and cold are more noticeable because of the high relative humidity. There is a difference of 35°F between the high and low mean monthly temperatures of 80°F in July and 45°F in January.

The highest average monthly precipitation of 6.11 inches occurs in March; the lowest average monthly precipitation of 2.76 inches occurs in October. The high mean monthly precipitation for the winter occurs in December and January; the high mean for the summer occurs in July (fig. 2). Most of the precipitation in the Birmingham area falls as rain; January is the only month with a mean monthly snowfall of as much as 1 inch.

Mineral resources

Birmingham is noted for the production of iron and iron products and is often referred to as the "Pittsburgh of the South." Iron ore, coal, dolomite, and limestone, the essential raw materials for making iron, occur nearby; therefore routes from the mines and quarries to the furnaces are short.

Coal, iron ore, and cement, in order of their importance, are the most important mineral resources of the area (U. S. Bureau of Mines, 1951). Limestone is used in the cement industry, and limestone and dolomite are used as fluxing material in the smelting of iron ore. Other minerals produced in the area are sand, gravel, and clay.

Water plays an important role in the development of mineral resources in this area. It is used for washing and concentrating processes at the coal and iron ore mines and pits. Large quantities are used for the manufacture of iron products and in certain phases of the cement industry. Much of the water used in developing mineral resources is available for re-use; however, there is always a loss of part of the water in any industrial process, and this water must be replaced from surface- or ground-water sources.

Coal.—Coal is mined underground and in strip pits in four coal fields in the State. In order of their importance they are the Warrior, Cahaba, Coosa, and Plateau coal fields. The Warrior field covers an area of about 4,000 square miles (Butts, 1926 a). Most of the Warrior field lies within the limits of the area covered by this report and in all or part of Jefferson, Walker, Tuscaloosa, Fayette, Winston, Blount, Cullman, and Lawrence Counties. The Cahaba coal field is the second largest and second most productive in the State. It lies between the Birmingham valley on the northwest and the Cahaba Valley on the southeast, extends about 60 miles southeastward, and averages 5 miles wide. All except the southern quarter of this field lies within the Birmingham area.

The Coosa field is the third largest and third most productive in the State. Most of the field lies in the southeast part of the area of this report in Shelby and St. Clair Counties. Only a small part of the Plateau field lies in the area; it is not an important coal producer.

The coal in the Alabama fields occurs in Carboniferous rocks in the Pottsville formation which consists of sandstone, shale, conglomerate, and coal beds collectively known as the "Coal Measures." The Coal Measures attain a thickness of 2,000 feet in the Warrior field, 9,000 feet in the Cahaba field, and 7,500 feet in the Coosa field.

Jefferson and Walker Counties are the greatest coal producers in the State. In 1948, mines in Jefferson County produced 9.7 million tons of coal from the Warrior and Cahaba fields including 0.3 million tons from strip mines; mines in Walker County produced 5.6 million tons from the Warrior field including 1.1 million tons from strip mines (U. S. Bureau of Mines, 1951).

In 1948, the 484 Alabama mines produced 18.8 million tons of coal of which 1.9 million tons or 10.3 percent were produced by 43 strip pits (U. S. Bureau of Mines, 1951).

Iron ore.—Iron ore is the second most important mineral resource of the Birmingham area. Since the early 1860's when the Confederate Government financially aided the operators (Armes, 1910), the iron industry has grown so rapidly that Alabama was third largest producer of iron ore in the United States in 1949 (U. S. Bureau of Mines, 1951), and fifth largest producer of pig iron in 1950 (Statesman's Yearbook, 1951, p. 592). Most of the iron ore smelted in Birmingham is mined from a seam in the Red Mountain formation which crops out along the crest of the northwest face of Red Mountain. A much smaller amount of residual limonite (brown ore) is stripped from open pits in various parts of the State. Brown ore is produced by several companies which sell the ore to iron smelting companies in Birmingham; the ore is generally mixed with hematite (red ore) for smelting.

Cement.—Cement is the third most valuable mineral product in Alabama (Burchard, 1940, p. 8). Most of the cement produced in the State is manufactured in three plants in Birmingham and one in Leeds.

The raw materials for cement are found in abundance within a few miles of Birmingham. In 1949, the production in Alabama was 9.4 million barrels (376 pounds equals 1 net barrel).

Dolomite and limestone.—Dolomite and limestone are important in the manufacture of pig iron; 832 pounds of fluxing material is required for the production of 1 ton of pig iron (American Society for Metals, 1948, p. 318).

Three of the companies producing pig iron in the Birmingham area operate quarries in the Ketona dolomite; the fourth company, Woodward Iron Co., because of the self-fluxing property of most of the ore it mines, purchases what flux it needs rather than operate a quarry.

The Warsaw limestone is mined in Muscoda No. 5 mine of the Tennessee Coal, Iron, & Railroad Co. This limestone is almost a pure calcium carbonate and usually contains less than 2 percent impurity.

Clay and sand.—Clay and sand are minor mineral resources of the Birmingham area. Refractory clay is available in quantity from coal mines where it occurs as underclay beneath the coal beds. Molding sand is produced from friable parts of the Hartselle sandstone where the bonding agent is weak and the sandstone can be easily crushed.

Development

With the occurrence, in one community, of coal, iron ore, and limestone—the raw materials of the steel industry—it was inevitable that the city grew as it did. From the beginning the development of the city has been tied to the success of the industries developing the resources of the area. In 1871 the site of the city of Birmingham consisted of two section houses.

Each major change of industry brought about a corresponding change in population. The first blast furnace and rolling mills in Birmingham were built in 1880, and with that stimulus the population increased eightfold in the decade from 1880 to 1890. The construction of modern steel mills, about 1905, resulted

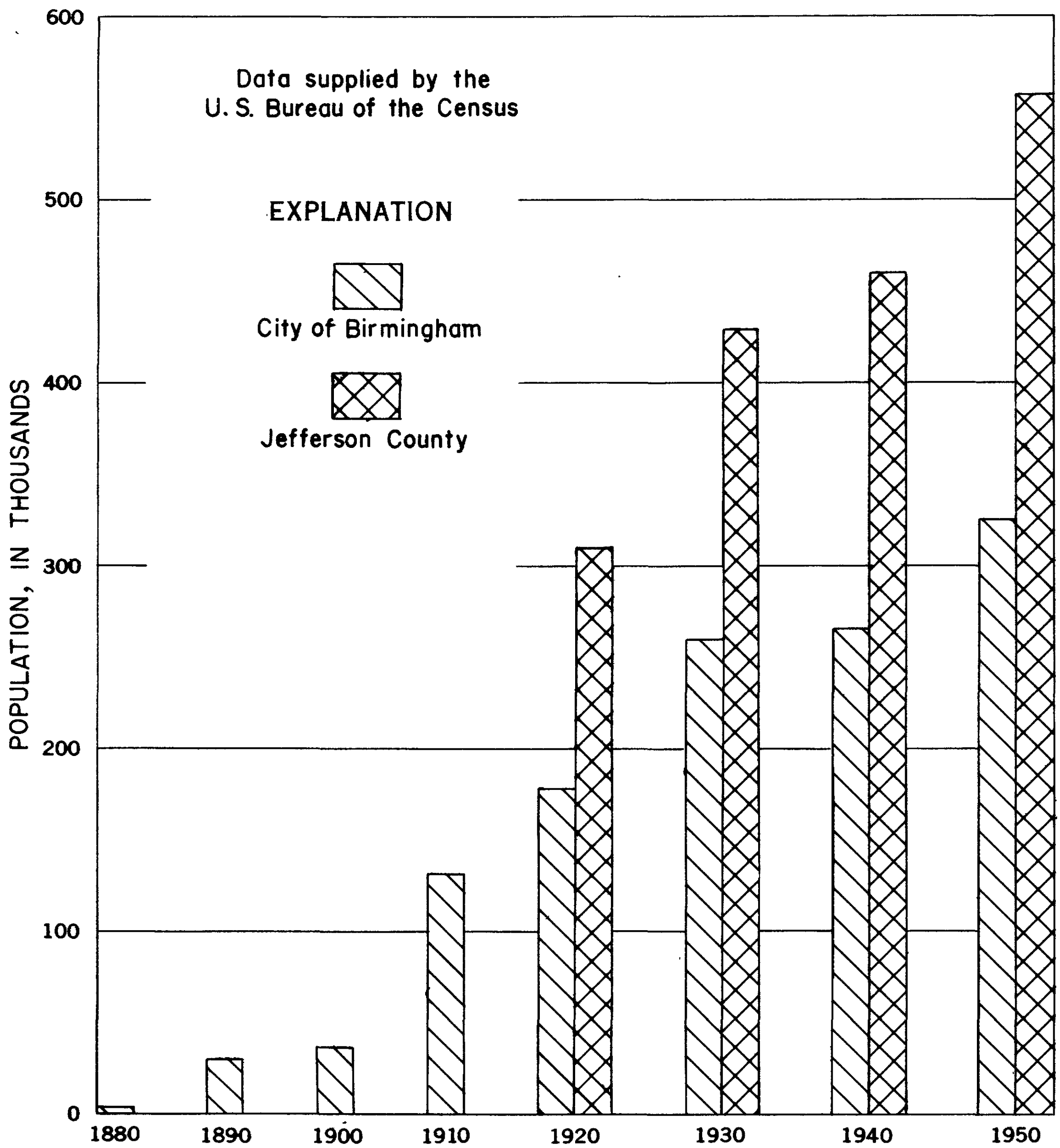

Figure 3.—Growth in population of Birmingham and Jefferson County.

in another sharp increase in population (fig. 3). Jefferson County showed a similar increase in population.

Expansion of the transportation system has kept pace with the industrial development. Today the city is served by 7 major railroads, an adequate system of highways, and the important barge transportation from salt water, at Mobile, up the Tombigbee-Black Warrior River systems to Port Birmingham, 20 miles west of Birmingham.

Heavy iron and related industries are still the backbone of the economy of the area. However, in recent years lighter industries and commercial concerns have increased in number and have developed into an important part of the economy. Industry in the area is concentrated along Jones and Opossum Valleys. Figure 4 shows the concentration of industry as determined from an inspection of aerial photographs.

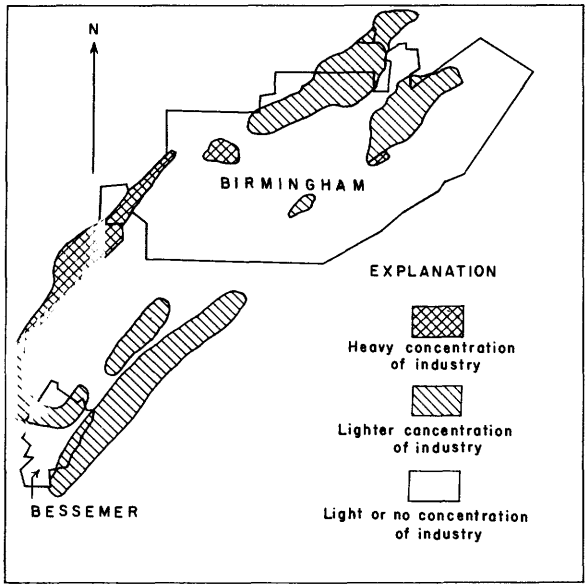

Figure 4.—Industrial concentration in the Birmingham area.

WATER USE AND SUPPLY SYSTEMS

The uses and demands for water are modified or controlled by many factors. Some uses and demands, such as those for household, municipal, and commercial needs, are common to all communities and bear a relation directly to the total population. On the other hand, water for special needs, such as for industry or agriculture,are peculiar to each city or area and do not bear a relation to such indices as population or production. Furthermore, special needs are closely related to quality as well as quantity of water. In the Birmingham area the major special need is water for industry and, more particularly, cooling water for the manufacture of ferrous products.

The importance of the industrial water needs can be readily illustrated by citing some common water requirements for industries in the area. These show a water demand as much as 6,000 gallons for processing

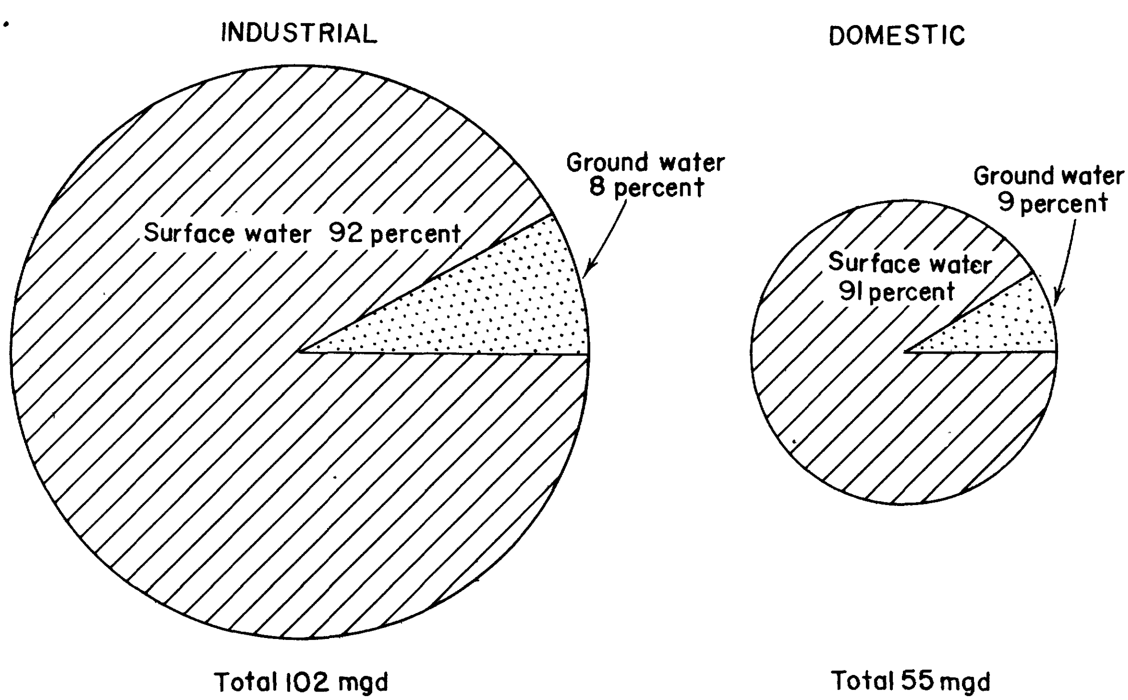

Figure 5.—Water used in the Birmingham area, 1951.

1 ton of coke, 1,400 gallons for smelting 1 ton of pig iron, and 100,000 gallons for manufacturing 1 net ton of rolled steel.

The needs of the population of the area are also substantial. About 460,000 people are served by public water-supply systems; and 100,000 people, mostly in rural areas or communities, are served by private supplies.

Where large quantities of water are required in a single system, surface water has been used as the source of supply; however, a number of smaller communities and industries find it economical to develop ground-water sources which require less expensive installations and treatment. Some industries need water that conforms to certain chemical and physical requirements. These requirements must be considered when selecting the most economical sources of water. Figure 5 shows the relative volume of usage by type and by source.

The following sections describe the water systems, sources of supply, principal uses, and the quality of the various waters.

Public Water Supplies

Birmingham Water Works

This system is municipally owned but was a private company from the date of its organization in 1885 until purchased by the city in 1951. In that year the system served 426,000 people in Birmingham, Bessemer, Homewood, Mountain Brook, Fairfield, Tarrant City,

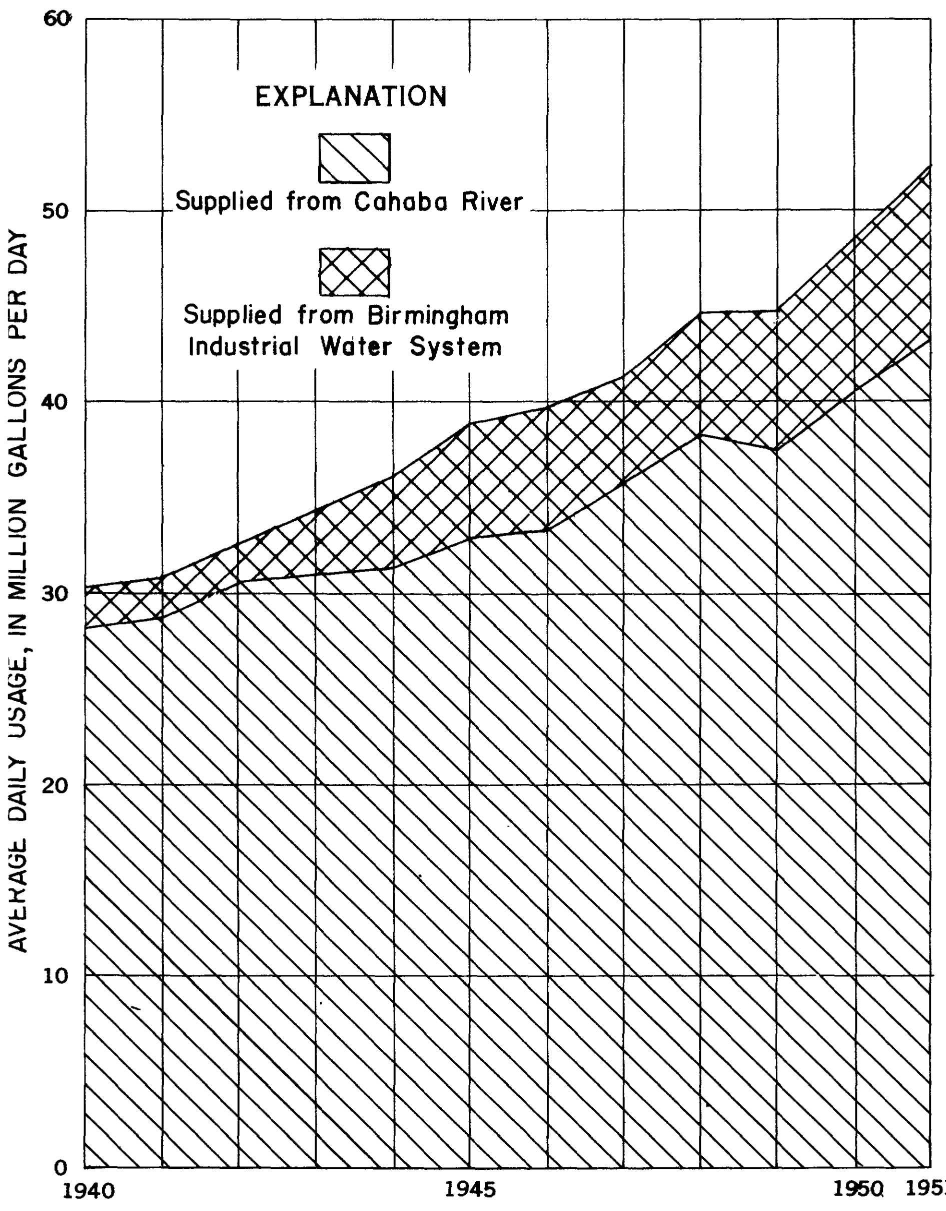

Figure 6.—Average daily water use in the Birmingham area, 1940-51, by Birmingham Water Works.

Graysville, Woodward, and many smaller communities. The company originally developed Fivemile Creek, but it is no longer being used as a source of supply for the city. Since 1891 water has been diverted from the Cahaba River. The dam on Little Cahaba River impounding Lake Purdy was constructed in 1910, and raised to provide additional storage in 1928 and again in 1938. The present capacity is 5.7 billion gallons or 15,300 acre-feet. Water for the city system is obtained below Lake Purdy from a small reservoir formed by a low dam just below the mouth of the Little Cahaba River. The point of diversion is on the Cahaba River and about 2 miles above the mouth of the Little Cahaba River. The filter plant is on Shades Mountain and has a capacity of 55 mgd. The successive steps of treatment consist of sedimentation, prechlorination, coagulation with alum, sedimentation, rapid sand filtration, postchlorination, and lime for adjustment of pH from 8.2 to 8.4.

Birmingham Water Works has obtained additional water from the Birmingham Industrial System since about 1940. Water from that source is treated at the Birmingham Station Filter Plant having a capacity of 12 mgd.

The growth in water use since 1940 and the proportion used from the two sources of supply are shown in figure 6.

There appears to be little opportunity for any substantial increase in diversions from the present developments.

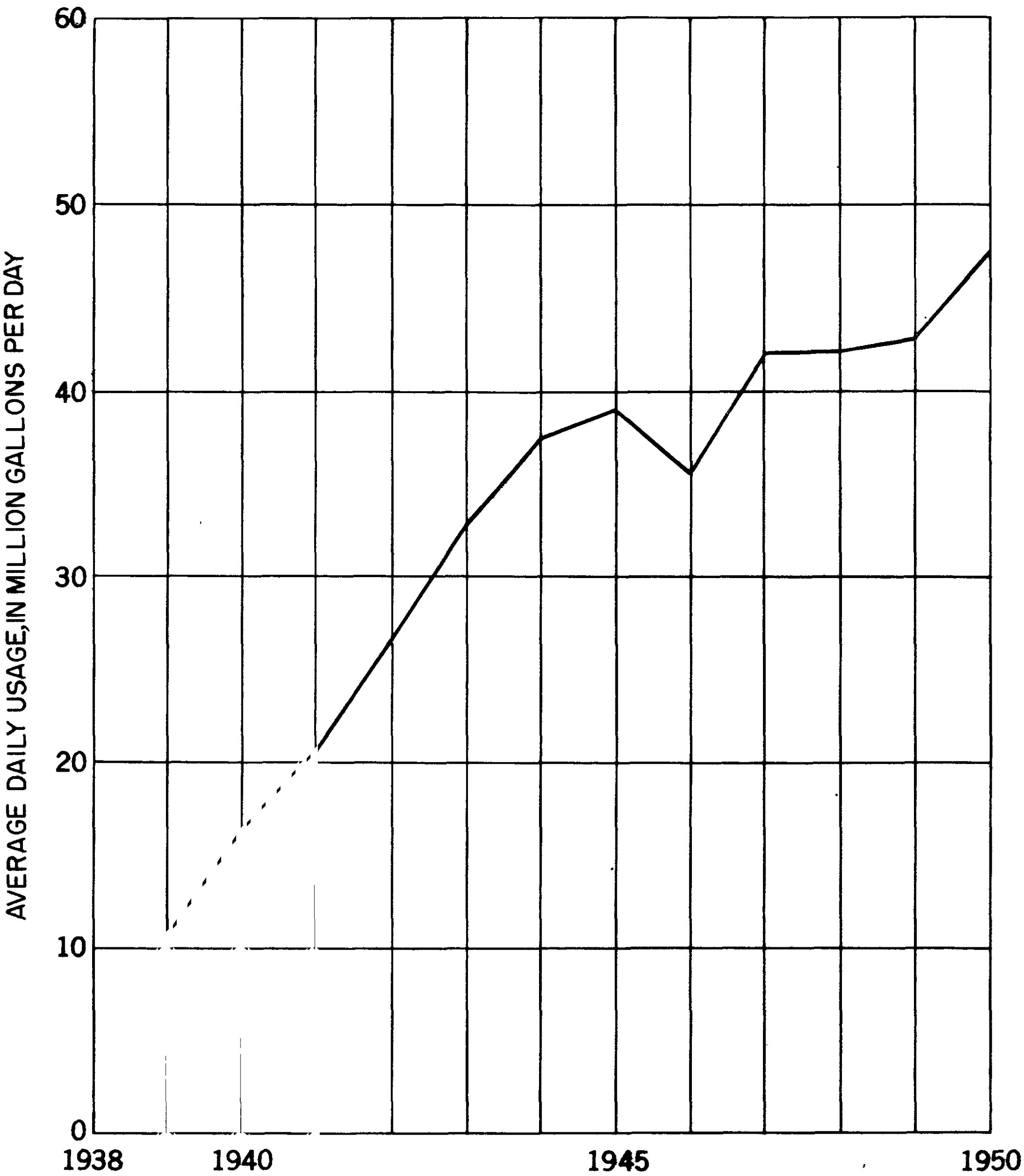

Figure 7.—Average daily water use, 1938-50, by Birmingham Industrial Water System.

Table 1.—Chemical analyses of Birmingham public water supply

[Chemical analyses in parts per million]

	Cahaba River (raw water)	Cahaba River (finished water)	Inland Lake (raw water)	Inland Lake (finished water)
Temperature (F)	69	69	55	57
Date of collection	10/18/51	10/18/51	10/19/51	10/19/51
Silica (SiO_2)	7.8	6.1	5.0	4.5
Iron (Fe)	.06	.06	.07	.03
Manganese (Mn)	.00	.00	.00	.00
Calcium (Ca)	26	27	1.8	9.2
Magnesium (Mg)	5.9	5.7	1.2	1.1
Sodium (Na)	5.1	4.8	2.4	2.9
Potassium (K)	2.0	1.8	1.3	1.1
Bicarbonate (HCO_3)	95	89	9	29
Carbonate (CO_3)	0	0	0	0
Sulfate (SO_4)	16	21	2.9	7.5
Chloride (Cl)	2.8	4.2	2.2	2.2
Fluoride (F)	.2	.2	.3	.1
Nitrate (NO_3)	1.2	1.3	1.6	1.5
Dissolved solids	116	118	26	46
Hardness as $CaCO_3$:				
Total	89	91	9	27
Noncarbonate	11	18	2	4
Specific conductance (micromhos at 25 C)	189	193	29.3	72.6
pH	7.3	7.2	6.2	8.4
Color	7	8	23	7
Turbidity	2	2	1	2

Regular determinations at Shades Mountain treatment plant, 1950

	Alkalinity as $CaCO_3$ (ppm)			pH			Hardness as $CaCO_3$ (ppm)			Turbidity		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Raw water	-	95	22	7.4	7.9	7.0	-	-	-	-	380	15
Finished water	-	105	29	8.3	8.5	8.0	-	100	40	0	0	0

Regular determinations at Birmingham treatment plant, 1950

	Alkalinity as $CaCO_3$ (ppm)			pH			Hardness as $CaCO_3$ (ppm)			Turbidity		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Raw water	12	16	10	7.2	7.3	7.1	12	12	12	-	30	15
Finished water	-	48	19	9.0	9.1	8.9	30	36	24	0	0	0

Birmingham Industrial Water Systems

Inland Reservoir on Blackburn Fork, a tributary of Locust Fork, was constructed in 1938 as a city and Federal works project to supply industrial water to Birmingham. The reservoir has a storage capacity of 60,000 acre-feet. The system in addition to the water supplied to the city of Birmingham supplies 52 industrial customers. Water usage from this system has increased steadily since 1938 (fig. 7).

Estimates of runoff of Blackburn Fork indicate that the maximum dependable supply for a dry year, such as 1941, would be 50 mgd. Not only is the present use of 47 mgd near the limit of the present storage and distribution facilities, but it is near the limit of the generally dependable supply of the Blackburn Fork basin as well.

The water is chlorinated and treated with soda ash.

Quality of Birmingham Public Water Supplies

Water from the Inland Reservoir supply is of better quality than water from the Lake Purdy supply; however, the water from the latter source is low in mineral content and is only moderately hard. (See table 1.) Water from the Inland Reservoir is low in mineral content and is extremely soft. The principal constituents of the Lake Purdy supply are calcium and bicarbonate. Daily records of chemical and physical characteristics of the untreated and treated water are made at the treatment plants (table 1).

Other public systems

Overton.—Overton is a small community about 6 miles east of Birmingham, with a population of about 900. The water supply is drawn from the Cahaba River to a filter plant, owned by Alabama Fuel & Iron Co., which has a capacity of about 86,000 gpd. The water is treated with alum, a light application of soda ash, and is filtered and chlorinated. The pH is generally maintained between 7.2 and 7.4.

Lovick.—Lovick is a small community about 10 miles east of Birmingham, with an estimated population of 145 served by the water system. The water supply is drawn from the Cahaba River to a filter plant, owned by Stephenson Brick Co., which has a capacity of 36,000 gpd. The water is treated with alum, settled, filtered, and chlorinated.

Warrior.—Warrior is a community about 20 miles north of Birmingham. The municipally owned water system draws water from the Locust Fork to a filter plant with a capacity of 150,000 gpd. The water is treated with lime, settled, filtered, and chlorinated.

Roebuck Plaza.—The water works system at Roebuck Plaza, 3½ miles northeast of Birmingham, is owned and operated by Mr. A. J. Grefenkamp.

One well 320 feet deep produces water from the Warsaw limestone and Gasper formation. The well is pumped at the rate of 100 gpm but is capable of a much larger yield. Another previously used well is now used in a standby capacity.

The water contains an excessive amount of iron and is moderately hard. Calcium and bicarbonate are the predominant constituents.

Irondale.—Irondale, with a population of 1,876, is on the northeast side of Birmingham. Water is furnished to the town by a well developed in the Gasper formation and Hartselle sandstone. This well yields about 125 gpm about 18 hours each day, but, according to the driller, it had a capacity of 200 gpm when the well was completed in 1949. A second well, used as a standby, is less than 100 feet from the producing well.

The Gasper formation and Hartselle sandstone yield a water very low in mineral content that is extremely soft (table 18). The water is aerated, treated with Calgon for pH adjustment, and chlorinated. A 172,000-gallon reservoir is at ground level on the lot adjacent to the pump house, and a 75,000-gallon standpipe is three blocks to the northwest on a hill overlooking the town.

Mount Pinson.—Mount Pinson is 12 miles northeast of Birmingham. The waterworks system is owned and operated by a private company; about 185 customers purchase water from the system.

A single well developed in the Ketona dolomite supplies the system. The well is pumped from 2 to 5 hours each day at a rate of 222 gpm, and a daily record is kept of the pumpage. The water has a hardness of 146 ppm, and the dissolved solids are 148 ppm. (See table 18.) It is chlorinated before being pumped into the system.

Center Point.—Center Point is about 6 miles northeast of Birmingham. A water system owned and operated by Mr. George Scott supplies water from one well for the community.

The well is finished in the Copper Ridge dolomite and is pumped at 120 gpm for about 12 hours each day, except when abnormal quantities of water are used during dry weather. The water is low in dissolved solids but is hard (table 18). It is chlorinated before being pumped into the distribution system.

Trussville.—Trussville is about 5 miles northeast of the Birmingham city limits. The Trussville Water Service operates two wells that supply water from the Fort Payne chert and Warsaw limestone for a population of 1,575.

A pumping test indicated that the wells pumping together yielded 336 gpm. The wells are 410 feet apart, and when either well operates alone, a noticeable drawdown is observed in the other one. The analyses show that the water is moderately hard and that the dissolved mineral matter consists largely of calcium and bicarbonate (table 18). The water is aerated, filtered, and chlorinated before it is fed into the distribution system.

Greenwood.—Greenwood is 4.5 miles south of Bessemer. The Greenwood Water Association owns and operates a water system supplied by two wells.

The first well drilled did not produce the quantity of water needed but is used as a standby; the second well yielded 60 gpm. Both wells were developed in the Fort Payne chert and Warsaw limestone. The dissolved mineral matter in water from the operating well consists essentially of calcium, bicarbonate, and sulfate, and is hard (table 18). The water is chlorinated and furnished to about 105 families, and during the school months, to 730 school children.

A water problem developed at Greenwood in 1952. The static water level in the well dropped 111 feet. A study of the ground water at Greenwood indicated that this condition was temporary and the water level would rise to its normal position after sufficient late fall rains replenished the ground-water reservoir.

Newcastle.—Newcastle is 7 miles north of Birmingham in the Warrior coal field. The water system is owned and operated by the Marc Levine Realty Co.

An overflowing well drilled into a flooded mine slope in the Pottsville formation is reportedly pumped at the rate of about 30 gpm. This well was cleaned in 1950 and pumped for 12 hours at a rate of 95 gpm. Except for the excessive amount of iron, the quality of the water is good (table 18). The water is treated with alum and chlorine and is filtered.

Black Diamond.—Black Diamond is a mining community 9 miles southwest of Bessemer in the Warrior coal field. The water system is owned and operated by the Black Diamond Coal Mining Co.

Two 500 gpm horizontal centrifugal pumps are used to pump water from the old Black Diamond mine. One of these pumps is a standby only; the other operates 12 to 24 hours a day. Water is furnished to the mining community and to coal-washing machines.

At this location the Pottsville formation which is the source of water for Black Diamond yields a highly mineralized water that is extremely hard and contains an excessive amount of iron (table 18).

Johns.—Johns is 8 miles west of Bessemer in southern Jefferson County. Three wells owned by the Black Diamond Coal Mining Co. are completed in the Pottsville formation at depths of 60 to 70 feet. There is no central distribution system, but 17 familes have water piped to their homes from the wells.

Blue Creek.—The water system is operated by the Blue Creek Mines at Blue Creek, 7 miles southwest of Bessemer.

Water is taken from an abandoned mine slope near the Blue Creek mines. One pump, which is about 300 feet down the mine slope, is operated about 1 hour each day. The water is chlorinated and pumped to surface reservoirs. About 65 familes use water from this system.

Hammond.—Hammond is a community built around the now abandoned Hammond iron ore mine. This community is less than a mile west of Irondale and obtains water from a system owned and operated by Sloss-Sheffield Steel & Iron Co.

A flowing well drilled more than 50 years ago about half a mile south of Hammond supplies the water system. Water is produced from the Fort Payne chert and Warsaw limestone; the well is constructed with 12-inch casing and is capped. Two 2-inch lines lead off from the well cap. One line leads to a pump house about 15 feet away; the other is open and water flows freely. The pump is reported to supply 30 to 40 gpm to Hammond; the flow from the open line was measured at 58 gpm on September 3, 1952. The quality of water from this well is very similar to that from the Trussville wells. It is a moderately hard calcium bicarbonate type (table 18). The water is chlorinated at the pump house.

Ketona.—Ketona is 6 miles northeast of Birmingham. Water rights to one of the Tarrant Springs have been leased from Jefferson County by Mr. Fred Black for the past 21 years. The spring that supplies water for the community is near a fault along the southeast side of Sand Mountain and probably flows from a fissure in the Ketona dolomite.

Water flows by gravity to a pump house about 600 feet to the southeast where it is chlorinated and pumped into the distribution system. About 250 families are served by this spring.

Trafford.—Trafford is about 4 miles east of Warrior in the northern part of Jefferson County. The water system is municipally owned and operated.

The supply is obtained from one well producing water from the Pottsville formation and serves a population of about 550. The well is pumped about 30 gpm; however, the driller stated that the well could be pumped 60 gpm. The water is aerated, filtered, and chlorinated.

Porter.—Porter is 15 miles northwest of Birmingham near the Black Warrior River. A water system owned and operated by Adams, Rowe, & Norman Coal Co., former operators of the mine at Porter, supplies water to the town.

A well which is completed at a depth of 83 feet in the Pottsville formation supplies about 40 to 50 families in this old mining camp area. It is reported to pump about 16 gpm for 8 hours a day. Water is pumped from the well to a treatment plant a quarter of a mile to the south. At this plant the water is treated with lime, filtered, and chlorinated before being used.

Brookside.—Brookside is 11 miles northwest of Birmingham in the Warrior coal field.

A municipal well completed in the Pottsville formation at 188 feet is reported to pump about 100 gpm. About 200 families are served by the system. Water is aerated, filtered, and chlorinated before being stored in a 100,000-gallon storage tank.

Port Birmingham.—Port Birmingham, on the Black Warrior River, is 20 miles west of Birmingham and is supplied water from a system owned and operated by the Federal Barge Lines.

A single well furnishes water for the port installations, a few families, and river barges. Operators estimate that an average of 150 people are served. The well is in the Pottsville formation and is pumped for 14 hours a day at 65 gpm, the capacity of the filter plant.

Robinwood.—Robinwood is a small community about a mile northeast of Ketona. Water is piped to this community from Caldwell Spring, owned by Mr. J. M. Knight.

The system furnishes untreated water to about 100 families in the community. Except for hardness, which is 154 ppm, the quality of water is good (table 18).

Virginia.—Virginia is a mining community about 9 miles west of Bessemer. The water system supplying the community is owned and operated by the Republic Steel Corp.

Water is pumped from two wells in the Pottsville formation. The total reported production from these wells is about 20 gpm, which supplies about 200 people. The water is filtered and chlorinated.

Raimund.—Raimund is a mining community 1 mile south of Bessemer on Red Mountain. Water from the Edwards Mine of Republic Steel Corp. supplies from 800 to 900 people. Water is pumped up the slope of the mine to a reservoir on the mountain and chlorinated before distribution.

Leeds.—Leeds is a town of 3,306 population, about 15 miles east of Birmingham. The water system, municipally owned and operated, is supplied water from a spring 1 mile northeast of Leeds. The spring is reported to flow 325 gpm from limestone of Ordovician age. In 1952 test drilling was begun to develop a supplemental supply from wells.

Private Industrial Supplies

Most of the private industrial water supplies in the area are developed and used by the iron and steel industry. Other industries use a relatively small amount. Information on private industrial supplies may be incomplete but probably includes most of the major supplies.

Iron and steel

The Tennessee Coal, Iron, & Railway Co. were pioneers in developing industrial water supplies in the area. About 1910, when water supply for the company's Ensley furnaces became acute, the company developed a system to protect themselves against a future shortage of water. The principal part of the system was a dam and impounding reservoir on Village Creek having usable capacity of 1.7 billion gallons. The company's system is the largest privately owned industrial supply in the area. In 1949 the company used an average of 453 mgd of industrial water. About 50 mgd of this was prime water supplied by their own system; another 26 mgd was purchased from the Birmingham Industrial System; and the remaining 377 mgd was recirculated and reclaimed water. The prime water supplied by their system came from two sources: about 0.6 mgd came from mines, and the remainder was drawn from the reservoir on Village Creek.

The National Cast Iron Pipe Co. uses about 360,000 gpd from Fivemile Creek in their foundry.

Ground water has been developed from wells penetrating the Ketona dolomite at the Connors Steel Co. and the Birmingham Stove & Range Co., and from a quarry in the Ketona dolomite at the Sloss-Sheffield Steel & Iron Co. The total withdrawal from the Ketona dolomite for the manufacture of iron and steel is about 3 mgd.

Miscellaneous industrial supplies

Other industrial supplies are from wells and springs in the area and require at least 3 1/3 mgd. These supplies are used for dairies, meat packing, textiles, lumber, cement, railroads, and air conditioning, and for the manufacture of chemicals, ice, and explosives.

Irrigation

Irrigation in Jefferson County, as in other humid areas, is practiced very little except for special crops and for a few pastures. About 50 acres in truck farms and from 100 to 200 acres in pasture are irrigated in Birmingham valley from private wells or from streams. Some individuals and cemeteries have developed wells for watering grass.

It is estimated that not more than 1 mgd of irrigation water is used from privately developed supplies and that use is only during dry periods.

Rural

Parts of rural Jefferson County are densely populated. Many industrial employees live on small tracts of land, which they farm in their spare time. The most densely populated area is close to the industrial communities and thus many rural homes can obtain their water from the community system. Others obtain their supply from wells and springs. An extensive inventory of domestic wells and springs was not made; however, in the rural areas of Jefferson County it is estimated there are 100,000 people who do not obtain their water from public supplies. Assuming an average per capita use of 20 gpd, the estimated domestic use in these areas is 2 mgd.

Summary of Water Use

The total water use in Jefferson County is about 157 mgd (fig. 5). In addition a large percentage of industrial water is reused. The present systems offer little opportunity for furnishing additional supplies in appreciable quantities. Local sources or those nearby are not capable of supplying any large quantity of additional water.

FUTURE WATER DEMANDS

Quantity

Estimating future demands is not within the scope of this report. However, to indicate the relative magnitude of the future demand, attention is called to an estimate made for the city by the J. W. Goodwin Engineering Co. They estimate an average annual increase of about 5 mgd. Thus the indicated increase for each decade is 50 mgd, a very substantial quantity of water. The rate of increase in water use in the period 1941 to 1951 (fig. 8) is not greatly different from the estimated future increase rate.

Quality

The chemical quality of the water used by various industries is so different that it is impossible to establish specifications to fit all of them. Water that may be suitable for one industrial process may be unsuited for another. In general, however, most industries require water free from color, turbidity, and suspended matter, and low in hardness, manganese, and iron.

Unlike waters used by industry, chemical specifications have been accepted generally for waters used domestically. These chemical specifications are independent of any sanitary specifications established for protection of the public health. In 1946 the U. S. Public Health Service established chemical specifications for drinking water used on interstate carriers. Some of the specifications follow:

Lead: Not to exceed 0.1 ppm.
Fluoride: Not to exceed 1.5 ppm.
Iron and manganese together: Not to exceed 0.3 ppm.
Magnesium: Not to exceed 125 ppm.
Chloride: Not to exceed 250 ppm.
Sulfate: Not to exceed 250 ppm.

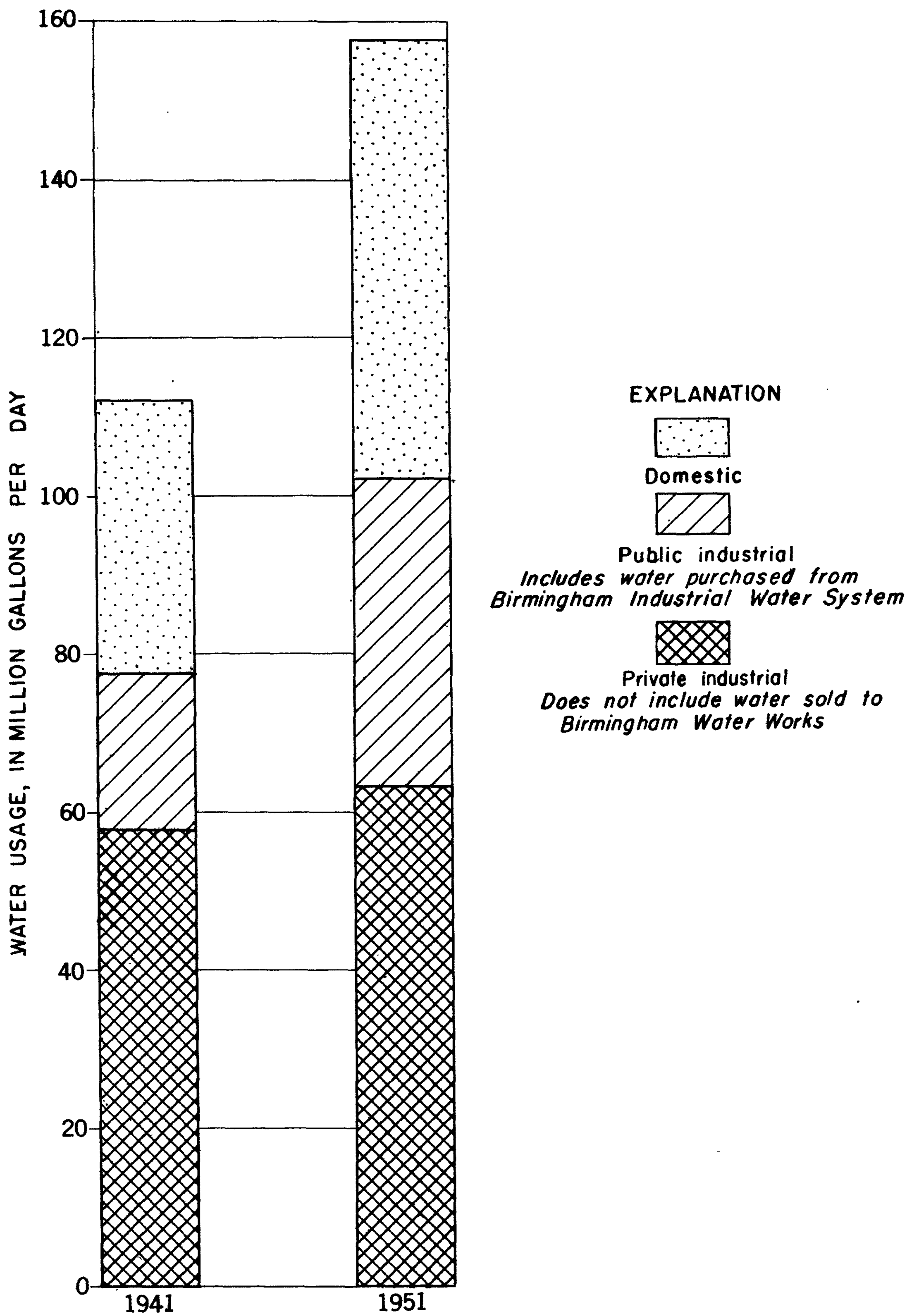

Figure 8.—Trends in water use, 1941-51.

Waters containing less than 500 ppm of dissolved solids generally are satisfactory for most domestic and industrial uses. However, an excessive amount of iron or hardness may cause difficulty in some uses. Waters with more than 1,000 ppm of dissolved solids are likely to include certain constituents that make them unsuitable for domestic or industrial uses.

SOURCES OF WATER

The immediate source of all fresh water is precipitation falling on the surface of the earth. In this area precipitation consists of rainfall and a small amount of snow. Almost all water resulting from precipitation eventually runs off in streams or is returned to the atmosphere by evapotranspiration processes.

A large part of precipitation water seeps down into the ground and becomes subsurface water.

Some of the subsurface water is used by plants and returned to the atmosphere by transpiration. When water percolates into the open spaces of the earth's crust and completely saturates them, it forms a zone of saturation; water in the zone of saturation is called ground water. The upper surface of this zone is referred to as the water table, and a well must penetrate below this surface before it produces water. Where the water table intersects the land surface springs are formed. Ground water is moving most of the time, usually toward some stream channel where, during dry weather, it constitutes most of the flow of streams and rivers. Less than half the water that falls as precipitation runs off in the streams of the area. A large percentage of the runoff occurs immediately following heavy storms and, unless retained in storage reservoirs, is not available for later use. Although surface and ground water are frequently closely related, they are appraised and treated by different methods; thus data on each are given separately in the following sections.

SURFACE WATER

Streamflow Records

Most analyses of streamflow data are made in order to appraise future flow. Past flows are not important except as a guide to what may happen in the future. Normally the assumption is made that future flows will follow the pattern of the past.

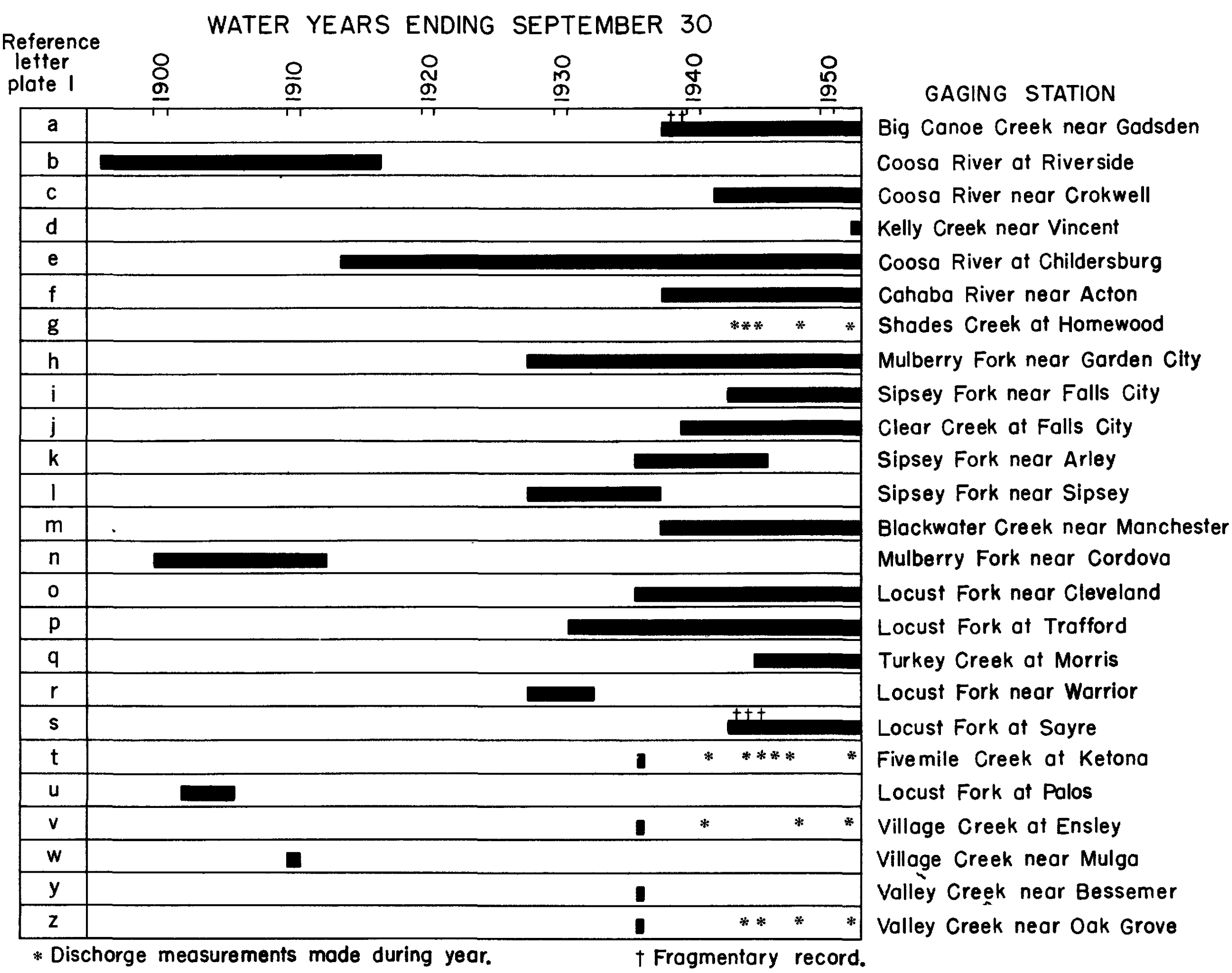

Figure 9.–Duration of published records at gaging stations in the Birmingham area.

Table 2.—Duration of daily flows at gaging stations in the Birmingham area

[Discharge in cubic feet per second per square mile]

Percent of time discharge indicated was equaled or exceeded	Big Canoe Creek near Gadsden		Coosa River near Cropwell		Kelly Creek near Vincent	Mulberry Fork near Garden City
	Water years 1940 to 1951	Water years 1928 to 1951 (estimated)	Water years 1943 to 1951 1/	Water years 1928 to 1951 1/ (estimated)	Water years 1928 to 1950 (estimated)	Water years 1928 to 1951
1	21.1	21.1	10.6	10.6		18.8
2	14.5	14.5	9.08	9.04		12.4
3	11.3	10.9	8.02	7.85		9.5
5	8.00	7.60	6.60	6.42		6.7
7	6.25	5.80	5.60	5.40		5.4
10	4.60	4.30	4.45	4.17		4.2
15	3.11	2.85	3.20	2.90		3.1
20	2.28	2.09	2.40	2.25		2.45
25	1.64	1.58	1.95	1.82		1.91
30	1.22	1.22	1.60	1.51		1.50
40	.725	.800	1.18	1.09		.95
50	.460	.515	.870	.840	0.42	.56
60	.304	.336	.675	.675	.23	.31
70	.206	.228	.540	.540	.11	.165
75	.168	.187	.495	.495	.076	.116
80	.140	.153	.455	.455	.050	.080
85	.112	.126	.414	.410	.033	.054
90	.0920	.102	.380	.365	.021	.036
93	.0815	.0900	.364	.338	.016	.029
95	.0745	.0810	.348	.316	.014	.025
97	.0675	.0730	.328	.288	.011	.0210
98	.0640	.0675	.314	.272	.010	.0189
99	.0600	.0625	.297	.250	.0088	.0160

Percent of time discharge indicated was equaled or exceeded	Sipsey Fork near Falls City		Clear Creek at Falls City		Sipsey Fork near Arley	
	Water years 1944 to 1951	Water years 1928 to 1951 (estimated)	Water years 1940 to 1951	Water years 1928 to 1951 (estimated)	Water years 1937 to 1945	Water years 1928 to 1951 (estimated)
1	18.8	15.8	16.4	17.4	12.8	16.2
2	12.2	10.7	11.1	11.9	9.2	11.2
3	9.3	8.3	8.6	9.3	7.4	8.9
5	6.6	6.0	6.2	6.7	5.5	6.5
7	5.2	4.6	4.95	5.25	4.4	5.1
10	3.95	3.40	3.75	4.00	3.4	3.8
15	2.81	2.40	2.70	2.85	2.35	2.6
20	2.14	1.78	2.08	2.14	1.70	1.93
25	1.67	1.36	1.65	1.74	1.26	1.50
30	1.31	1.10	1.33	1.41	.98	1.18
40	.850	.700	.91	1.00	.62	.78
50	.495	.430	.66	.72	.41	.52
60	.308	.280	.50	.54	.28	.36
70	.204	.186	.375	.405	.198	.245
75	.165	.150	.326	.350	.167	.200
80	.135	.123	.282	.300	.143	.166
85	.109	.100	.244	.256	.123	.138
90	.086	.080	.206	.216	.107	.115
93	.074	.068	.184	.192	.096	.100
95	.065	.060	.169	.175	.088	.092
97	.056	.052	.150	.156	.079	.082
98	.052	.047	.139	.145	.073	.076
99	.047	.042	.125	.130	.066	.070

See footnotes at end of table.

Table 2.—Duration of daily flows at gaging stations in the Birmingham area—Continued

Percent of time discharge indicated was equaled or exceeded	Sipsey Fork near Sipsey		Blackwater Creek near Manchester		Locust Fork near Cleveland	
	Water years 1928 to 1937	Water years 1928 to 1951 (estimated)	Water years 1938 to 1951	Water years 1928 to 1951 (estimated)	Water years 1938 to 1951	Water years 1928 to 1951 (estimated)
1	17.5	16.5	16.2	16.2	18.7	18.7
2	12.0	10.8	12.0	12.0	12.7	12.7
3	9.3	8.4	9.9	9.9	9.9	9.9
5	6.4	6.0	7.5	7.5	7.0	7.0
7	4.9	4.9	6.0	6.0	5.6	5.6
10	3.6	3.7	4.55	4.50	4.4	4.4
15	2.6	2.7	3.30	3.16	3.1	3.2
20	2.05	2.05	2.43	2.33	2.35	2.50
25	1.60	1.60	1.84	1.77	1.80	1.95
30	1.30	1.27	1.42	1.40	1.38	1.48
40	.85	.78	.89	.89	.81	.86
50	.54	.51	.542	.564	.48	.51
60	.33	.33	.345	.364	.286	.310
70	.212	.215	.224	.225	.174	.178
75	.164	.175	.176	.176	.136	.136
80	.127	.140	.141	.141	.102	.102
85	.098	.110	.111	.111	.077	.073
90	.074	.083	.085	.085	.055	.051
93	.061	.069	.071	.071	.043	.038
95	.053	.060	.062	.062	.0355	.0310
97	.043	.049	.052	.052	.0283	.0246
98	.038	.043	.0465	.0465	.0244	.0214
99	.032	.035	.0396	.0396	.0204	.0180

Percent of time discharge indicated was equaled or exceeded	Locust Fork at Trafford	Turkey Creek at Morris		Locust Fork at Sayre
	Water years 1928 to 1951 2/ (estimated)	Water years 1945 to 1951	Water years 1928 to 1951 (estimated)	Water years 1928 to 1951 2/ (estimated)
1	18.4	17.0	14.6	19.2
2	12.1	11.2	10.0	12.5
3	9.50	8.85	7.95	9.5
5	7.00	6.45	5.65	6.8
7	5.60	5.15	4.57	5.2
10	4.35	4.00	3.54	4.0
15	3.10	2.87	2.45	2.8
20	2.35	2.20	1.83	2.1
25	1.85	1.76	1.44	1.62
30	1.41	1.41	1.13	1.25
40	.885	.950	.800	.78
50	.560	.640	.565	.51
60	.360	.450	.416	.33
70	.228	.333	.316	.22
75	.180	.290	.280	.179
80	.141	.255	.250	.147
85	.111	.227	.225	.119
90	.0845	.198	.199	.096
93	.0695	.182	.184	.081
95	.0590	.170	.171	.071
97	.0475	.156	.156	.060
98	.0408	.149	.146	.052
99	.0323	.141	.136	.047

1/Records for 1951 water year adjusted to eliminate effect of regulation from operation of Allatoona Reservoir.
2/Estimated flows at the gage if there had been no diversion or regulation.

Records at gaging stations

Streamflow records of all streams that are probable potential sources of water supply for the area have been compiled and analyzed. These records include streams in the upper Black Warrior River Basin, the upper Cahaba River basin, some streams tributary to the Coosa River, and one station on the Coosa River (pl. 1).

Few records were collected in the area before 1928 (fig. 9), and those collected were of fairly short duration and at places not closely related to later gaging stations. It is probable, however, that the period 1928 to 1951 can be considered a fairly representative period of streamflow as it included periods of drought and floods and years of normal and extremes of runoff. This period (1928-51) was considered to be indicative of expected future flows and was used as the base period for analysis of the records.

This report contains a table of average monthly discharge, a tabulation of daily flow duration data, and a brief description of each gaging station in or near the area.

The further development of appreciable quantities of water from the streams in the area will require holding water in storage for several months or even several years. Monthly average discharges may be used to compute the storage requirements for periods of this length; therefore, the monthly average discharges are an important part of this report.

The duration table shows the percent of the time the daily average streamflow equaled or exceeded the indicated flow. Duration of daily flow data are given for the period of record for each station. If the period of record does not coincide with the base period, 1928-51, values for the base period are also shown. Where necessary, records for short periods were extended to the base period. Thus all records were made to cover the base period.

Duration data are shown in cubic feet per second per square mile of drainage area. Assuming equal yield from all parts of the drainage area, these data may be used to estimate the flow at any place on the stream. For example, information is desired on Locust Fork at a place where the drainage area is 200 square miles. Flow-duration data can be estimated from data on Locust Fork near Cleveland (table 2). A daily flow of 3.6 cfs (200 square miles x .018 cfs) may be expected to be equaled or exceeded 99 percent of the time, and a daily flow of 102 cfs (200 square miles x .51 cfs) may be expected to be equaled or exceeded 50 percent of the time. The estimated flow per square mile for the period 1928-51 was used because that period was more nearly representative of average conditions than the period of record 1938-51.

Care should be exercised in using this method because all parts of most drainage areas do not have equal yields or the same runoff characteristics. (See table 2.)

In general, the possible error increases with an increase in the distance between the gaging station and the places where discharge information is desired.

Big Canoe Creek near Gadsden.—Big Canoe Creek drains a flat valley northeast of Birmingham, which could be considered an extension of Birmingham valley. The stream flows northeastward into the Coosa River.

The gaging station is in the SW¼ sec. 15, T. 13 S., R. 5 E., at bridge on U. S. Highway 11, 5 miles upstream from the mouth and about 50 miles northeast of Birmingham. Discharge records have been collected at this site since January 1938. (See table 3.) The drainage area at the gage is 238 square miles. The average discharge for the 12-year period of record (1939-51) is 447 cfs and for the base period (1928-51) 430 cfs (estimated).

Coosa River near Cropwell.—The Coosa River rises in the mountains of North Georgia. It flows through eastern and central Alabama and its waters eventually reach the Gulf of Mexico by way of the Alabama and Mobile Rivers and Mobile Bay. The river passes east

Table 3.—Monthly and annual discharge, Big Canoe Creek near Gadsden

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1937-38	-	-	-	637	257	1,606	2,207	194	201	532	538	-	-
1938-39	-	-	-	-	1,116	929	533	375	413	303	382	122	-
1939-40	31.1	28.5	54.8	588	1,609	795	412	89.6	295	1,173	82.8	31.0	429
1940-41	26.0	108	307	458	335	437	347	70.2	29.9	370	509	23.3	252
1941-42	19.9	46.9	474	211	1,096	966	166	174	31.2	37.3	236	387	316
1942-43	75.8	39.6	2,470	353	503	1,366	1,061	82.0	34.6	34.7	61.8	26.1	511
1943-44	19.2	23.8	36.9	243	1,313	1,518	1,244	208	50.0	35.0	25.0	74.2	395
1944-45	20.0	25.0	107	508	1,287	945	784	411	111	51.8	44.6	19.5	353
1945-46	64.5	137	592	1,758	2,533	1,149	250	383	153	197	51.8	222	613
1946-47	65.9	213	388	2,168	334	1,147	927	266	160	41.3	34.9	17.8	483
1947-48	20.4	63.5	338	419	1,805	989	1,024	58.8	48.6	66.3	164	34.4	413
1948-49	19.5	2,366	786	2,191	1,597	686	552	340	101	285	112	93.0	754
1949-50	159	127	253	582	639	1,510	234	199	100	549	118	432	409
1950-51	78.1	84.7	290	449	848	1,876	1,014	126	95.6	217	58.4	150	438

Table 4.—Monthly and annual discharge, Kelly Creek near Vincent

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1951-52	-	-	1,282	599	459	1,081	191	40.1	16.3	7.32	114	28.3	-

of Birmingham coming within about 30 miles at the nearest point. Discharge at this point is very nearly the same as the flow at the gaging station at Cropwell.

The gaging station is in the SE1/4 sec. 33, T. 17 S., R. 4 E., at the bridge on State Route 48, 4 miles southeast of Cropwell. Discharge records have been collected at this site since March 1942. The drainage area at the gage is 7,690 square miles. Monthly discharges were computed for the period 1896 to 1942 to show the relation of streamflow for the base period (1928-51) to that for the longer period (1896-1951). Monthly mean discharges for the period 1914-42 were computed on the basis of records for the station at Childersburg (drainage area, 8,390 square miles); and for the period 1896-1914 on the basis of records for the station at Riverside (drainage area, 7,060 square miles).

Average discharge for the period of record (1942-51) is 13,900 cfs. The estimated discharge for the base period (1928-51) is 13,000 cfs and for the longer period (1896-1951) is 13,500 cfs.

Kelly Creek near Vincent.—Kelly Creek drains part of the eastern slopes of the ridge between the Cahaba and Coosa Rivers. The stream flows southeastward into the Coosa River.

The gage is in SW1/4 sec. 24, T. 18 S., R. 2 E., at the bridge on State Route 25, about 6 miles upstream from the mouth of the creek and 26 miles east of Birmingham. Records have been collected at this site since November 1951. (See table 4.) The drainage area at the gaging station is 195 square miles. The estimated average discharge for the period (1928-51) is 300 cfs.

Cahaba River near Acton.—The Cahaba River rises among the Cahaba ridges east of Birmingham and flows southwestward, following their general alinement. The river passes about 8 miles southeast of Birmingham at the nearest point.

The gaging station is in the SE1/4 sec. 23, T. 19 S., R. 3 W., at the bridge on U. S. Highway 31, and 16 miles south of Birmingham. Discharge records have been collected at this site since October 1938. (See table 5.) The drainage area at the gaging station is 229 square miles. Flow is regulated by storage in Lake Purdy (drainage area 44 square miles), and water is diverted above the gage by Birmingham Water Works (drainage area 195 square miles at diversion dam).

Mulberry Fork near Garden City.—The Mulberry Fork is in the headwaters of the Black Warrior River. It rises along the divide between the Black Warrior River and Tennessee River basins north of Birmingham. It flows southwestward to a point 22 miles west of Birmingham where the Black Warrior River is formed by the confluence of Locust Fork and Mulberry Fork.

The gaging station is in the NE1/4 sec. 16, T. 12 S., R. 2 W., at the bridge on U. S. Highway 31, and 32 miles north of Birmingham. Records have been collected at this site since June 1928. (See table 6.) The drainage area at the gage is 365 square miles. The average discharge for the period (1928-51) is 648 cfs.

Sipsey Fork near Falls City.—The Sipsey Fork rises along the divide between the Black Warrior River and Tennessee River basins northwest of Birmingham.

Table 5.—Monthly and annual discharge, Cahaba River near Acton

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1938-39	5.74	20.6	16.9	232	935	745	483	247	263	105	747	93.6	321
1939-40	44.3	33.9	45.7	365	1,342	538	331	160	377	1,236	64.3	6.65	375
1940-41	9.94	30.8	272	282	273	512	350	57.2	9.90	408	812	46.1	257
1941-42	15.9	15.3	212	149	470	781	151	20.0	71.8	157	136	167	194
1942-43	73.9	30.5	1,575	381	247	1,207	793	90.1	13.9	55.9	31.1	14.9	379
1943-44	10.9	13.5	26.2	156	760	1,245	1,277	196	42.1	19.2	13.0	9.81	311
1944-45	2.21	4.47	28.9	244	1,050	701	547	548	34.0	27.9	22.4	8.47	263
1945-46	115	141	479	1,400	1,882	811	182	352	137	398	225	411	537
1946-47	115	231	350	1,610	362	888	747	230	72.7	27.9	65.4	21.7	395
1947-48	14.3	53.8	264	378	1,473	984	742	37.4	11.9	27.8	63.6	13.2	334
1948-49	4.40	1,880	701	1,717	1,568	879	551	444	83.0	25.0	25.2	28.8	652
1949-50	39.8	31.1	108	419	529	651	135	199	59.7	319	93.7	225	233
1950-51	59.2	43.2	166	309	738	1,652	1,018	82.7	35.9	36.3	17.2	127	354

Table 6.–Monthly and annual discharge, Mulberry Fork near Garden City

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1927-28										334	444	557	-
1928-29	134	104	80	1,230	1,140	3,360	894	1,620	166	72.8	20.2	183	752
1929-30	270	3,590	1,060	754	693	1,350	351	1,050	169	104	68.3	84.0	794
1930-31	18.7	316	378	747	659	588	647	158	29.7	49.5	130	5.4	308
1931-32	51.8	94.8	1,850	1,770	2,650	649	-	-	-	1,250	455	112	-
1932-33	1,070	547	3,600	1,000	1,530	949	1,020	587	41	181	81	63	889
1933-34	9.29	22.4	105	889	285	1,643	449	146	583	613	508	59.8	446
1934-35	743	356	416	906	1,091	2,135	1,034	725	124	106	67.5	8.2	642
1935-36	29.8	246	256	2,861	2,122	998	2,050	71.6	36.9	460	162	40.9	772
1936-37	22.7	8.7	161	3,160	1,262	636	999	991	88.8	127	143	127	643
1937-38	248	62.7	194	589	302	1,435	1,943	154	121	459	527	25.5	506
1938-39	6.8	196	122	1,027	3,443	1,304	822	213	772	203	282	134	690
1939-40	19.3	11.6	45.0	353	1,693	1,498	1,072	162	107	1,600	58.5	40.6	552
1940-41	12.6	51.4	192	626	443	714	432	75.6	18.4	546	1,334	63.1	378
1941-42	115	123	816	630	1,130	1,366	276	74.2	32.9	53.3	465	68.0	427
1942-43	38.2	79.9	1,994	704	966	1,855	927	149	88.5	72.8	75.1	117	589
1943-44	9.6	19.2	48.0	380	2,290	2,669	1,583	404	167	57.9	48.4	64.0	638
1944-45	25.4	17.1	208	1,138	1,875	1,588	1,013	491	144	39.4	50.4	14.4	542
1945-46	13.1	67.1	640	2,895	2,862	1,145	502	731	418	683	46.3	378	854
1946-47	84.5	1,206	795	3,046	677	1,468	1,059	348	244	40.8	43.4	21.4	755
1947-48	62.8	180	327	415	3,304	1,283	1,209	131	137	41.5	76.3	10.1	586
1948-49	5.83	1,729	1,267	3,021	2,383	1,217	774	518	482	729	90.5	141	1,021
1949-50	409	333	567	2,200	1,621	2,384	308	260	590	502	216	269	803
1950-51	44.3	70.5	310	990	1,809	2,647	1,450	166	124	268	54.4	71.4	660

Table 7.–Monthly and annual discharge, Sipsey Fork near Falls City

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1943-44	20.1	38.3	76.8	192	1,703	2,548	1,617	556	253	59.7	137	119	605
1944-45	33.5	44.4	273	855	1,791	1,404	865	325	103	58.7	66.5	30.9	479
1945-46	24.7	91.1	508	3,328	2,974	1,033	415	554	232	339	234	536	844
1946-47	121	966	632	2,600	738	1,207	1,382	329	152	50.7	45.2	27.1	688
1947-48	29.0	126	208	182	2,802	1,950	989	194	55.9	46.1	34.5	32.9	545
1948-49	29.8	1,278	750	3,867	1,903	1,254	817	747	778	531	115	275	1,024
1949-50	69.0	87.8	384	2,553	2,060	2,100	411	504	382	305	248	426	789
1950-51	86.0	150	277	879	2,263	2,735	1,151	196	79.7	120	40.4	61.2	660

Table 8.—Monthly and annual discharge, Clear Creek at Falls City

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1939-40	51.6	47.7	67.5	154	604	489	325	121	113	825	82.6	45.7	243
1940-41	42.7	91.1	193	312	180	332	219	65.3	38.6	107	126	29.9	145
1941-42	38.8	52.4	147	139	289	407	132	65.8	41.2	29.8	133	32.2	125
1942-43	25.9	39.1	364	125	240	507	251	94.0	46.3	40.0	39.0	62.3	153
1943-44	24.1	38.5	50.2	112	597	981	698	249	135	57.3	127	125	265
1944-45	36.5	45.2	184	421	767	590	411	197	100	84.5	54.0	38.6	241
1945-46	33.5	78.8	258	1,271	1,135	443	165	202	100	289	112	283	360
1946-47	87.8	427	294	970	303	540	555	191	113	50.7	48.9	30.6	301
1947-48	29.3	105	137	124	1,083	745	399	119	60.7	48.1	42.9	31.4	240
1948-49	27.1	508	373	1,516	773	570	356	278	348	176	92.8	182	431
1949-50	63.8	61.6	207	1,019	941	839	207	218	175	177	112	200	349
1950-51	61.1	91.1	134	330	883	998	507	128	73.7	72.6	35.0	50.1	276

It flows southward and empties into Mulberry Fork 24 miles northwest of Birmingham.

The gaging station is in the NE¼ sec. 33, T. 11 S., R. 7 W., at the bridge on the county highway, 2 ¼ miles upstream from Clear Creek and 44 miles northwest of Birmingham. (See table 7.) Discharge records have been collected at this site since October 1943. The drainage area at the gage is 375 square miles. The average discharge for the 8-year period of record (1943-51) is 704 cfs and for the period (1928-51) 550 cfs (estimated).

Clear Creek at Falls City.—Clear Creek drains the western side of the upper Sipsey Fork basin. The drainage basin has more ground-water storage capacity and a corresponding greater dry-weather flow as compared to other streams in the area.

The gaging station is in the NE¼ sec. 9, T. 12 S., R. 7 W., at the bridge on the county road, 2 miles upstream from the mouth and 43 miles northwest of Birmingham. Discharge records have been collected at this site since October 1939. (See table 8.) The drainage area at the gage is 151 square miles. The average discharge for the 12-year period of record (1939-51) is 261 cfs and for the period (1928-51) 270 cfs (estimated).

Sipsey Fork near Arley.—A gaging station was operated by the U. S. Geological Survey for 10 years in the N½ sec. 19, T. 12 S., R. 6 W., at Duncan Bridge, 3 miles downstream from Clear Creek, about 5 miles downstream from the gage near Falls City, and 39 miles northwest of Birmingham. The drainage area at the gage is 537 square miles.

The average discharge for the 9 complete years of record (1936-45) is 726 cfs and for the period (1928-51) 830 cfs (estimated).

Records of discharge at this site are approximately equal to the combined flow at the gaging stations on Sipsey Fork near Falls City and Clear Creek at Falls City. (See table 9.)

Sipsey Fork near Sipsey.—A gaging station was operated by the U. S. Geological Survey for 9 years (1928-37) (table 10) in the NE¼ sec. 33, T. 13 S., R. 5 W., 5 miles upstream from the mouth, about 18 miles downstream from the station near Arley, and 27 miles northwest of Birmingham. The drainage area at the gage was 1,020 square miles. The average discharge for the 9-year period of record is 1,650 cfs and for the period (1928-51) 1,600 cfs (estimated).

Table 9.—Monthly and annual discharge, Sipsey Fork near Arley

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1935-36					2,446	1,483	2,765	165	55.6	243	147	60.5	
1936-37	55.2	77.1	446	3,363	1,708	933	1,515	1,603	188	165	138	252	867
1937-38	491	202	753	914	679	2,159	2,746	467	580	922	697	98.0	894
1938-39	59.4	248	190	1,518	4,923	1,711	1,465	857	2,017	239	418	180	1,123
1939-40	90.3	93.6	112	376	2,036	1,732	1,242	339	208	2,559	146	78.2	748
1940-41	88.2	212	490	1,067	610	1,142	753	155	66.7	172	268	54.0	423
1941-42	111	124	403	377	1,053	1,415	374	143	76.0	58.7	274	52.8	369
1942-43	47.3	91.1	1,360	310	862	1,803	1,111	267	92.3	84.5	67.8	139	519
1943-44	44.2	76.8	127	304	2,300	3,526	2,315	804	388	117	264	244	869
1944-45	70.0	89.6	457	1,277	2,557	1,992	1,276	522	203	143	120	69.5	720

Table 10.—Monthly and annual discharge, Sipsey Fork near Sipsey

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1928-29	648	687	440	2,670	2,610	9,450	1,740	4,320	533	322	126	451	2,010
1929-30	399	8,380	2,680	1,580	1,490	2,710	903	3,720	a316	a109	327	491	a1,922
1930-31	114	1,270	1,120	1,690	1,740	2,140	2,160	587	153	172	215	562	946
1931-32	49.6	115	3,650	5,070	6,790	1,940	b2,000	b1,000	b500	2,150	525	438	2,020
1932-33	3,890	1,810	8,070	2,400	3,720	2,580	3,040	1,120	241	403	295	266	2,320
1933-34	98.3	129	433	1,472	724	4,101	1,130	398	618	828	365	108	872
1934-35	1,123	461	832	2,088	1,959	5,536	2,117	1,768	496	155	128	43.8	1,394
1935-36	91.8	431	516	4,600	5,479	2,593	5,124	416	79.9	468	260	108	1,663
1936-37	69.0	86.4	549	7,801	3,206	1,888	2,566	3,254	268	210	247	429	1,712

a Revised for this report. b Estimated.

Table 11.—Monthly and annual discharge, Blackwater Creek near Manchester

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1938-39	13.0	45.9	56.4	476	1,598	676	416	305	664	86.8	231	89.1	379
1939-40	36.7	22.6	51.2	236	872	563	436	119	85.5	961	42.3	22.2	286
1940-41	14.2	42.8	147	351	228	406	202	42.1	15.8	72.2	154	17.2	141
1941-42	26.8	39.5	207	183	376	531	140	44.8	19.4	23.5	139	37.0	146
1942-43	14.7	31.5	502	204	339	820	294	74.5	20.2	15.4	15.8	48.1	198
1943-44	7.29	15.5	30.1	104	624	1,069	953	267	73.9	28.7	77.3	74.6	275
1944-45	19.7	22.3	117	483	970	795	461	222	77.1	56.4	87.3	25.5	274
1945-46	23.6	63.8	361	1,517	1,349	544	178	224	98.5	272	171	392	428
1946-47	90.6	631	347	1,334	360	838	600	236	148	35.4	30.3	13.5	389
1947-48	10.2	71.0	144	169	1,342	819	502	90.5	74.3	29.8	15.4	10.8	268
1948-49	11.9	561	733	1,638	974	607	431	253	418	187	51.8	172	501
1949-50	48.9	48.0	220	1,260	1,113	1,091	211	191	139	259	179	389	426
1950-51	44.0	66.2	149	419	1,027	1,125	807	107	53.4	78.8	23.3	30.7	323

Table 12.—Monthly and annual discharge, Locust Fork near Cleveland

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1936-37	-	-	400	3,084	1,108	525	508	1,067	139	92.2	147	45.8	-
1937-38	256	70.0	151	586	345	1,307	2,164	136	211	401	287	26.1	495
1938-39	7.0	144	84.8	709	2,165	1,328	588	224	270	103	232	50.0	481
1939-40	15.0	15.0	30.0	240	1,693	1,129	934	102	127	650	82.4	30.7	415
1940-41	20.0	59.7	286	472	288	361	290	70.4	19.0	236	1,030	50.5	267
1941-42	144	159	753	497	1,091	1,076	214	60.0	40.0	30.0	361	172	380
1942-43	54.1	77.2	2,448	789	1,003	1,465	851	148	96.6	139	58.6	35.9	597
1943-44	10.0	14.0	24.6	225	2,040	2,023	1,294	302	50.7	17.5	21.2	40.1	499
1944-45	18.9	10.5	72.7	718	1,731	1,453	686	338	75.6	43.8	19.4	8.63	423
1945-46	20.4	86.1	573	2,399	2,700	1,369	531	692	191	284	61.0	219	750
1946-47	81.1	966	677	3,158	510	1,261	829	210	112	70.9	30.5	13.8	663
1947-48	6.85	35.1	141	339	2,375	1,123	1,294	75.6	75.1	95.1	68.0	17.8	461
1948-49	12.5	2,123	1,131	2,883	1,986	808	781	445	164	134	30.5	75.5	873
1949-50	123	193	367	1,614	1,265	2,143	310	242	179	609	243	483	646
1950-51	45.4	55.9	356	745	1,122	2,382	1,177	136	191	389	119	66.0	563

Blackwater Creek near Manchester.—Blackwater Creek drains the extreme western part of the upper Black Warrior River Basin. It flows southeastward into Mulberry Fork about 7 miles downstream from Sipsey Fork and 27 miles northwest of Birmingham.

The gaging station is in the SE1/4 sec. 15, T. 13 S., R. 7 W., at the bridge on the county highway, about 18 miles above the mouth of the creek and 37 miles northwest of Birmingham. Discharge records have been collected at the site since October 1938. (See table 11.) The drainage area at the gage is 177 square miles. The average discharge for the 13-year period of record (1938-51) is 310 cfs and for the period (1928-51) 300 cfs (estimated).

Locust Fork near Cleveland.—Locust Fork Black Warrior River rises near the divide between the Black Warrior River and Tennessee River basins to the northeast of Birmingham. It flows southwestward, passing northwest of Birmingham, to its confluence with Mulberry Fork forming the Black Warrior River. Locust Fork passes nearer to Birmingham than any other principal stream in the area, within 14 miles at the closest point.

The gaging station is in the NE1/4 sec. 6, T. 12 S., R. 1 E., at the bridge on State Route 38, and 37 miles northeast of Birmingham. Discharge records have been collected at this site since December 1936. (See table 12.) The drainage area at the gage is 300 square miles. The average discharge for the 14-year period of record (1937-51) is 537 cfs and for the period (1928-51) 530 cfs (estimated).

Locust Fork at Trafford.—The gaging station is in the SW1/4 sec. 9, T. 14 S., R. 2 W., at the county bridge, about 25 miles downstream from the gage near Cleveland and about 21 miles north of Birmingham. Discharge records have been collected at this site since September 1930. (See table 13.) The drainage area at the gage is 622 square miles.

The flow from 70 square miles has been subject to regulation by and diversion from Inland Reservoir on Blackburn Fork since 1938. During periods of low water, all flow from this area is diverted.

The average discharge for the period prior to completion of Inland Reservoir (1930-37) is 1,083 cfs. The average discharge for the base period (1928-51) would have been 1,100 cfs (estimated) if there had not been diversion or regulation.

Turkey Creek at Morris.—Turkey Creek drains part of Birmingham valley about 15 miles north of Birmingham. It flows northwestward into Locust Fork about 10 miles downstream from the gaging station at Trafford.

The gaging station is in the SE1/4 sec. 12, T. 15 S., R. 3 W., at the bridge on U. S. Highway 31, 4 miles upstream from the mouth of the creek and 14 miles north of Birmingham. Discharge records have been

Table 13.—Monthly and annual discharge, Locust Fork at Trafford

[Records for October 1928 to September 1930 were computed from records for station near Warrior. Records for April to June 1932 were computed from records of streams in the Tennessee River basin. Beginning in June 1938, the flow has been affected by storage and diversion from Inland Reservoir on Blackburn Fork. Data are given in cubic feet per second.]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1928-29	116	177	150	1,657	2,302	7,184	1,705	4,174	367	158	124	407	1,547
1929-30	472	7,322	1,412	1,311	1,358	2,614	781	1,376	227	110	115	224	1,437
1930-31	143	1,300	854	1,310	792	825	1,200	179	63.7	88.0	146	36.2	575
1931-32	25.0	41.9	1,840	3,400	4,870	920	1,100	560	250	1,840	580	193	1,300
1932-33	1,180	795	5,300	1,520	2,390	1,700	1,530	629	93	150	155	216	1,300
1933-34	47.5	91.7	200	1,352	602	2,828	549	202	817	807	1,004	176	728
1934-35	2,605	544	755	1,337	1,493	3,679	2,345	1,197	342	83.4	965	32.2	1,211
1935-36	46.5	309	713	4,229	4,475	1,394	2,677	133	37.4	457	470	208	1,250
1936-37	117	49.2	702	6,370	1,941	1,096	1,248	2,157	206	150	335	163	1,214
1937-38	548	158	237	1,007	564	2,656	4,607	405	340	913	718	76.9	1,020
1938-39	25.1	351	195	1,297	3,300	2,348	1,148	326	528	245	500	122	849
1939-40	46.1	55.4	81.9	624	2,929	2,193	1,526	202	247	1,848	133	80.0	823
1940-41	74.0	122	552	1,091	655	1,011	736	165	55.0	481	2,270	118	614
1941-42	198	268	1,230	711	2,493	2,341	510	150	104	65.4	691	262	743
1942-43	98.3	140	4,451	1,443	1,787	3,078	1,677	275	118	171	143	67.0	1,122
1943-44	29.4	41.5	64.0	375	3,193	3,926	2,373	636	157	40.6	73.2	109	908
1944-45	46.5	38.1	178	1,256	3,129	2,567	1,320	768	172	139	73.4	30.6	795
1945-46	45.4	145	823	4,221	5,602	2,667	846	1,022	322	529	133	339	1,367
1946-47	172	1,590	1,172	6,354	916	2,593	1,655	428	223	91.1	92.3	34.5	1,284
1947-48	24.6	97.1	340	693	4,899	2,139	2,559	147	108	128	104	37.6	921
1948-49	36.5	4,556	2,097	6,476	4,133	1,656	1,529	918	316	270	74.8	174	1,837
1949-50	188	285	570	2,564	2,370	4,479	578	429	250	1,147	302	691	1,152
1950-51	81.4	100	534	1,293	2,117	5,287	2,577	284	219	545	156	114	1,105

Table 14.—Monthly and annual discharge, Turkey Creek at Morris

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1943-44				44.0	273	433	298	98.5	43.5	21.7	29.3	17.6	
1944-45	11.7	14.2	27.5	124	396	295	166	98.2	31.1	25.5	17.1	15.8	99.9
1945-46	32.3	66.5	169	487	725	287	74.1	123	70.1	85.3	72.1	57.0	184
1946-47	36.6	151	123	631	130	378	288	145	78.0	27.0	45.0	15.7	171
1947-48	13.8	39.0	99.1	156	506	340	334	45.2	25.9	28.1	29.5	14.2	134
1948-49	12.1	515	253	690	518	340	178	144	44.5	45.3	29.0	34.8	232
1949-50	28.3	24.1	41.7	146	163	427	64.2	51.5	28.2	65.5	37.8	38.1	93.0
1950-51	15.7	19.5	65.6	127	272	513	298	53.7	41.9	66.8	60.9	90.6	135

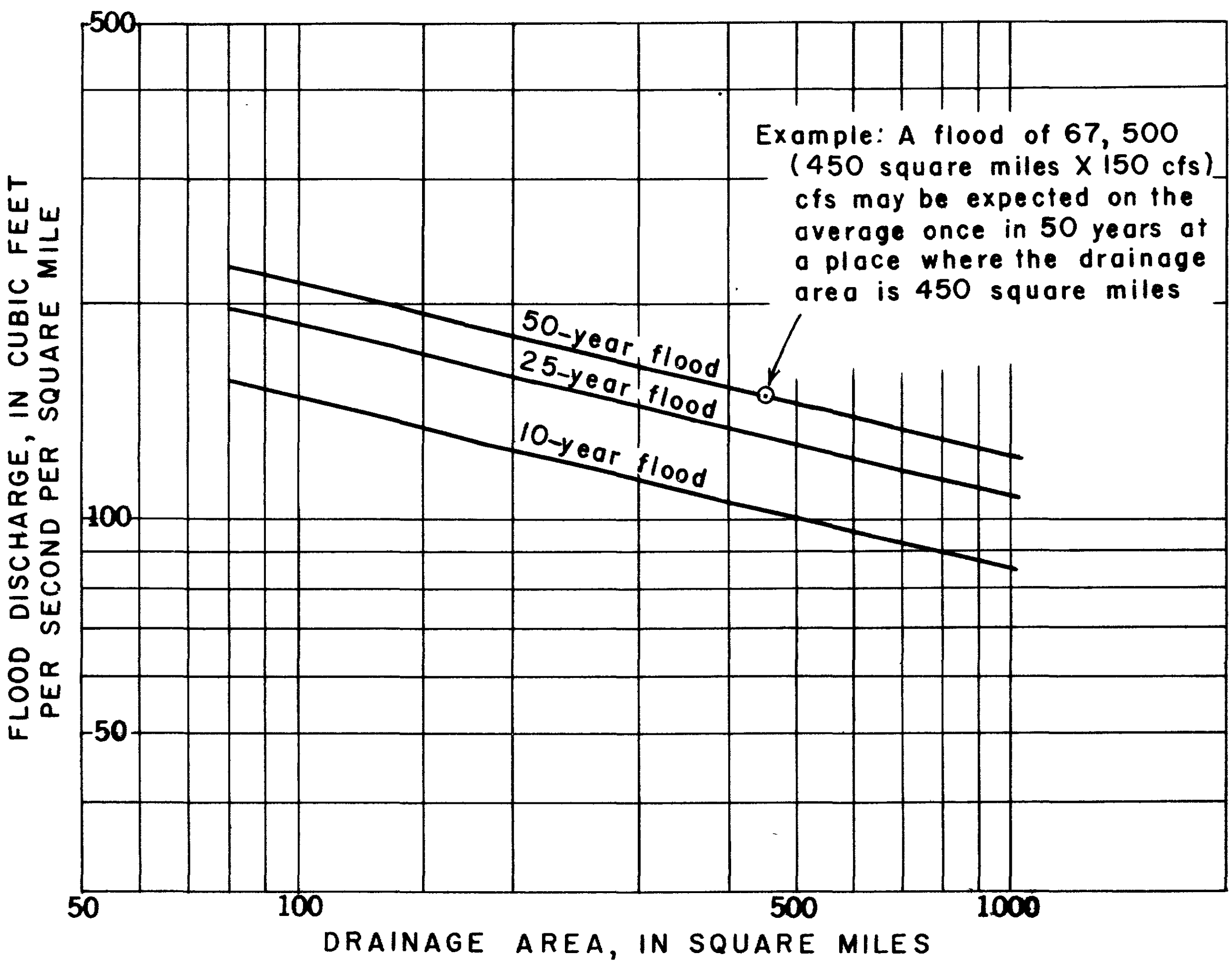

Figure 10.—Flood frequencies in the Black Warrior River Basin, 1928-51.

Table 15.—Monthly and annual discharge, Locust Fork near Warrior

[Cubic feet per second]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1928-29	147	228	190	2,140	2,970	9,280	2,200	5,390	467	200	158	524	1,990
1929-30	604	9,450	1,810	1,680	1,750	3,370	1,000	1,760	288	138	147	284	1,850
1930-31	160	1,680	1,100	1,620	1,000	1,020	1,760	313	87.1	125	211	44.6	757
1931-32	29.8	49.3	2,300	4,470	7,190	1,170							

collected at this site since January 1944. (See table 14.) The drainage area at the gage is 81 square miles. The average discharge for the 7-year period of record (1944-51) is 150 cfs and for the period (1928-51) 120 cfs (estimated). The discharge is believed to include water pumped from mines upstream from the station.

Locust Fork near Warrior.—The gaging station near Warrior was in operation for 3 years. It was located in T. 15 S., R. 4 W., at the county bridge, 9 miles upstream from the gage at Sayre and 16 miles north of Birmingham. The drainage area at the gage is 865 square miles. Records are comparable to those at Sayre. (See table 15.)

Locust Fork at Sayre.—The Locust Fork is gaged at Sayre about 28 miles downstream from the gage at Trafford. The gaging station is in the NW¼ sec. 29, T. 15 S., R. 4 W., at the bridge on the county highway about 16 miles north of Birmingham. Discharge records have been collected at this site since May 1942. (See table 16.) The drainage area at the gage is 885 square miles, 70 square miles of which are subject to regulation and diversion. (See Locust Fork near Trafford.)

The average discharge for the 6-year period of record (1945-51) is 1,701 cfs, uncorrected for diversion and storage. It is estimated that the average runoff for the period (1928-51) would have been 1,400 cfs if there had been no storage or diversion in the drainage basin.

Other streamflow records

Streamflow records are available for some minor streams in the immediate area of Birmingham as follows:

Shades Creek drains Shades Valley to the southeast of Birmingham valley and flows through the residential communities of Mountain Brook and Homewood. Discharge measurements have been made at U. S. Highway 31 and at State Route 149 at irregular intervals since 1943.

Fivemile Creek drains Birmingham valley just north of Birmingham. Daily discharge for the period April-June 1936 was published for the gaging station at the Tarrant City-Ketona highway (drainage area 25.5 square miles). Discharge measurements have been made at two other sites (drainage areas 23 and 19 square miles) at irregular intervals since 1943.

Village Creek drains the northeastern end of Birmingham. Daily discharge for the period April-June 1936 was published for the gaging station at Avenue F in Ensley. Discharge measurements were made at the same site during low water periods in 1945 and 1952.

Valley Creek drains the central and southwestern section of the city. Daily discharge for the period April-June 1936 was published for the gaging station at the county road 19 miles east of Birmingham. Discharge measurements have been made at the same site at irregular intervals since 1944. The Corps of Engineers have made some discharge measurements at this site and have collected daily gage heights.

Floods

Birmingham is not subject to damage from major floods. The distance between the city and a major stream is a disadvantage when considering water supply, but it is a definite advantage when considering hazard from floods. Minor floods on the local streams in the area occur from intense rains.

Rain can fall faster than the local drainage can carry it off, but such floods are of short duration, a few hours at the most, and do not normally cause great damage. Magnitude and frequency of expected floods for larger streams in the area can be estimated. Peirce1/, in his study of flood frequency and magnitude for streams in Alabama, developed a means of computing probable magnitude and frequency of floods on ungaged streams. The curves he developed were based on the combined experience of all streams in and adjacent to Alabama and should be more reliable than curves based on one record alone. The writers believe that Peirce's combined curves should be reliable for estimating floods with a probable frequency up to 50 years. Figure 10 was developed from Peirce's curves for the Black Warrior River basin. It may be used to estimate the probable magnitude of floods having a recurrence interval of 10, 25, and 50 years on any stream in the area. For example, a peak discharge

1/ Peirce, L. B., 1953, Magnitude and frequency of floods in Alabama. [A preliminary study in preparation for the U. S. Geological Survey.]

Table 16.—Monthly and annual discharge, Locust Fork at Sayre

[Cubic feet per second]

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1941-42									136	99.8	737	354	
1942-43	131	188	5,733	1,717	2,174	4,758	2,465	389					
1943-44				567	3,588	5,007	3,070	774	203				
1944-45				1,566	4,195	3,579	1,784	1,081	206				
1945-46	89.4	218	1,233	5,463	7,124	3,533	1,007	1,321	471	866	289	598	1,822
1946-47	270	1,988	1,528	8,224	1,272	3,513	2,412	805	479	152	187	59.8	1,750
1947-48	45.2	155	662	1,048	6,340	2,891	3,498	243	159	173	180	64.3	1,264
1948-49	60.2	5,449	3,291	8,051	5,674	2,297	1,940	1,358	518	467	159	284	2,440
1949-50	209	392	712	3,175	2,948	5,519	810	560	326	1,290	420	823	1,429
1950-51	122	159	685	1,679	2,959	6,608	3,987	436	227	732	270	247	1,501

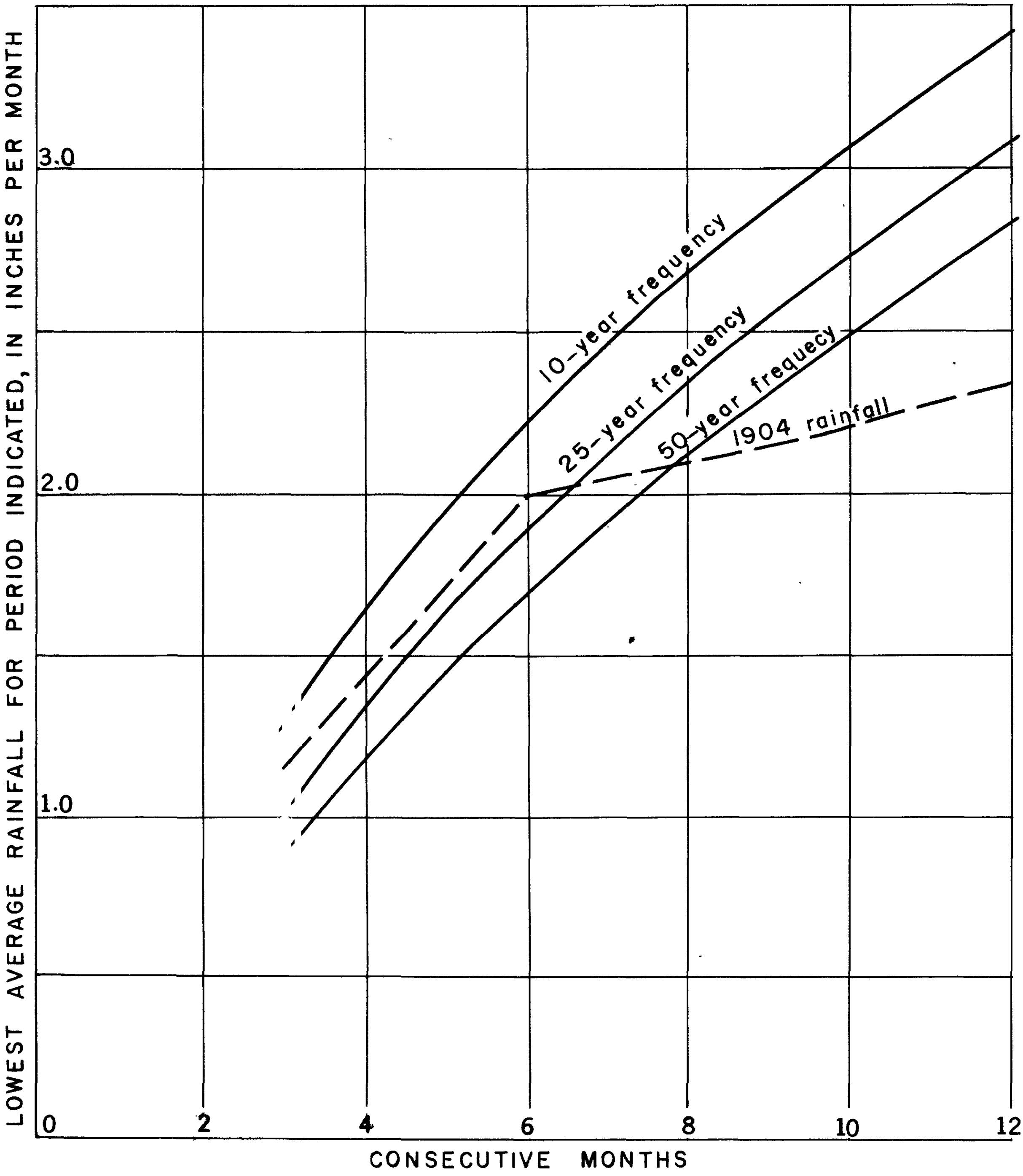

Figure 11.—Drought frequencies (precipitation).

of 67,500 cfs (450 square miles x 150 cfs) may be expected to occur on the average of once in 50 years on any stream in the area where the drainage area is 450 square miles. It should be recognized, however, that the recurrence interval does not imply any regularity of occurrence but is the probable average interval between floods of a given magnitude in a long period of time. Two 50-year floods could conceivably occur in consecutive years or even in the same year.

Knowledge of the magnitude and frequency of floods can be used as an initial guide for the location of industry and in the design of intake or spillway structures. It is seldom economically sound to design hydraulic structures for the computed maximum probable flood or even the maximum flood recorded, unless a failure of such a structure would cause the loss of life or serious property damage. In planning sound design for structures, which do not involve the possible loss of life, the factors of economics and useful life of the structure should be considered. For example: The capacity of a bypass channel used during the construction phases of a project might be designed to pass a 5-year flood, or even a 1-year flood if economical risk is not great; whereas a power plant might be designed for protection against a 50-year flood if considerable damage would be caused by flooding.

Drought

A drought is a deficiency of water. The seriousness of a drought depends upon such factors as the use of the water and the control exercised over the supply. Agricultural droughts, in varying intensities, are experienced nearly every year and can be caused by lack of rain for periods of only a few weeks. On the other hand, the effects of drought on engineering developments do not commonly reach serious proportions until after longer periods of deficient rainfall. If the supply is appreciably controlled by impounding, a critical drought may not develop until there has been a rainfall deficiency for many months or even several years.

During the years 1928-51 fairly severe droughts occurred. However, a much more severe drought occurred in 1904. At that time gaging stations were operated on Mulberry Fork near Cordova and on Locust Fork at Palos. Records for those stations show an annual runoff of less than 7.5 inches as compared to a later annual minimum of 11.5 inches for stations in the upper Black Warrior River Basin. Records of streamflow are not available for a sufficient length of time to appraise the probable frequency of the 1904 drought. Therefore the 1904 drought was appraised using rainfall data (fig. 11). The average rainfall during the 1904 drought has been compared to the average rainfall expected once in 10 years, in 20 years, and in 50 years, as determined from rainfall frequency studies. The 1904 drought became progressively more critical with time. A drought having the magnitude of the 1904 drought after 9 months duration can be expected to reoccur only at long intervals.

Hazen (1951, p. 90) has suggested that a drought having a frequency of once in 20 years is a suitable basis for design. Therefore, the deficient flows of 1904 would not appear to be a suitable basis for design of an impoundment for a municipal supply. Records for the period 1928-51 cannot be evaluated on that basis, but they are probably sufficiently representative to be satisfactory for design.

Quality of Surface Water

All natural waters contain dissolved mineral matter. Water in contact with soils or rocks for only a few hours will dissolve some rock materials. The quantity of dissolved mineral matter in a natural water depends primarily on the type of rock or soil over and through which the water has flowed, and the length of time it has been in contact with the rock or soil. The concentration of mineral matter in a river water is frequently increased by drainage from mines or by the addition of industrial or municipal wastes.

Unlike ground waters, surface waters may change in chemical quality from day to day; therefore, it is desirable to have daily records of chemical analyses at strategically located points within each large river system. Unfortunately, this information is not available in the Birmingham area. Analyses of several samples collected at selected sites during a 3-month period give an indication of the quality of the water. The mineral constituents and physical properties that have a practical bearing on the uses of surface water for most purposes are given in table 17. The samples—except for six previously collected—were obtained during the summer of 1952.

The streams flowing through the outcrop of the Pottsville formation, Floyd shale, and Parkwood formation in the Cahaba River basin carry waters that are more highly mineralized than those in the Coosa River basin, but they are low in dissolved solids, ranging from 68 to 166 ppm. Most of the water samples collected in the Cahaba River basin were moderately hard, the hardness ranging from 33 to 115 ppm.

Streams in the Black Warrior River basin flow through the outcrop of the Pottsville, Copper Ridge, and Ketona dolomite formations. Mulberry Fork near Garden City, Sipsey Fork near Falls City, Sipsey Fork near Sipsey, Blackwater Creek near Manchester, and Locust Fork at Trafford in the upper part of the basin carry waters of good quality. The dissolved solids ranged from 29 to 73 ppm, and hardness ranged from 12 to 50 ppm. Each of the above streams contained excessive quantities of iron. Waters from Turkey Creek at Morris, Fivemile Creek near Ketona, and Locust Fork at Port Birmingham are more concentrated than those in the upper part of the basin, containing considerably more calcium, magnesium, and bicarbonate. The sulfate content of waters from Locust Fork at Port Birmingham is more than from the other streams in this group. Surface pollution has been reported in Village Creek at Ensley and Valley Creek near Oak Grove. The meager data available shows that waters from these two streams are much more concentrated than waters from other streams that were sampled in the area. Most of the waters in the area have very low sodium, potassium, sulfate, and chloride, but, in comparison with other streams in the area, these two streams have abnormally high amounts of these constituents.

The analyses indicated that considerable quantities of iron were being carried in suspension in some of the streams; therefore, it seemed desirable to report

Table 17. –Chemical quality of surface waters in the Birmingham area

[Analyses by U. S. Geological Survey in parts per million]

Index letter plate 1	Source and location	Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe) dissolved[1]	Iron (Fe) precipitated[2]	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25C)	pH	Color
a	Big Canoe Creek near Gadsden	Feb. 23, 1949	877	5.0	0.12	-	17	2.9	5.1		64	6.9	3.5	0.0	1.1	78	54	2	122	8.0	10
	Big Canoe Creek near Gadsden	Oct. 12, 1949	38	5.0	.00	-	31	7.7	1.6	0.6	124	2.3	3.0	.0	1.3	115	109	7	207	7.5	6
	Big Canoe Creek near Gadsden	Sept. 19, 1952	130	7.3	.06	3.5	22	6.2	2.1	1.3	88	8.6	3.8	.1	.4	102	80	8	167	7.2	45
c	Coosa River near Cropwell	Feb. 23, 1949	-	6.6	.05	-	5.0	1.2	8.7		28	6.6	4.0	.1	.8	49	17	0	69.8	7.5	35
	Coosa River near Cropwell	Oct. 11, 1949	-	7.9	.01	-	11	4.5	5.1	.6	56	6.0	4.8	.0	2.7	74	46	0	123	7.2	6
d	Kelley Creek near Vincent	June 23, 1952	12.0	5.4	.11	.44	19	2.4	1.9	.6	68	1.6	2.0	.1	.9	70	57	2	116	7.4	6
	Kelley Creek near Vincent	Aug. 26, 1952	12.0	8.0	.78	.62	13	2.2	2.1	1.4	45	7.2	2.0	.1	1.2	69	42	5	93.6	7.1	70
	Kelley Creek near Vincent	Sept. 19, 1952	30.0	10	.32	1.1	10	2.2	2.1	1.4	41	3.0	2.0	.1	.2	57	34	0	79.8	7.1	45
f	Cahaba River near Acton	Feb. 1, 1949	1,440	6.5	.06	-	7.9	3.3	6.7	.6	26	20	4.0	.0	1.1	68	33	12	103	7.6	10
	Cahaba River near Acton	Sept. 21, 1949	44	6.0	.00	-	28	5.4	2.7	.9	98	6.7	3.0	.0	2.2	105	92	12	183	7.2	6
	Cahaba River near Acton	Sept. 19, 1952	7.0	6.8	.10	.24	26	6.4	2.8	1.8	103	6.2	2.8	.1	.0	104	91	7	174	7.5	6
g	Shades Creek near Homewood	Aug. 25, 1952	7.20	7.6	.07	1.3	35	6.7	6.4	4.4	79	61	4.5	.1	1.5	166	115	50	255	7.3	7
h	Mulberry Fork near Garden City	June 24, 1952	56.0	5.0	.05	.22	9.0	1.2	2.7	.6	33	1.6	3.8	.1	1.4	43	27	0	68.9	7.2	4
	Mulberry Fork near Garden City	Aug. 25, 1952	26.5	5.1	.04	.71	11	1.5	3.0	1.9	40	4.7	3.2	.1	1.2	52	34	1	81.1	7.3	5
	Mulberry Fork near Garden City	Sept. 19, 1952	470	4.2	.33	19	3.8	1.5	3.6	2.9	17	4.9	3.8	.2	1.0	50	16	2	39.7	6.3	22
i	Sipsey Fork near Falls City	June 23, 1952	109	4.2	.14	.32	5.2	1.3	1.6	1.2	21	2.2	2.0	.1	.8	35	18	1	45.3	6.9	18
	Sipsey Fork near Falls City	Aug. 26, 1952	24.4	4.4	.73	.87	4.1	1.8	1.7	1.4	18	2.3	2.2	.1	.9	40	18	3	39.7	7.0	60
	Sipsey Fork near Falls City	Sept. 18, 1952	29.0	5.6	.12	.65	3.5	1.2	2.0	1.6	18	3.2	2.0	.1	.0	32	14	0	38.7	6.9	17
l	Sipsey Fork near Sipsey	June 23, 1952	300	6.2	.26	.49	4.1	1.4	1.7	1.6	17	1.6	2.2	.3	1.0	38	16	2	40.3	6.7	37
	Sipsey Fork near Sipsey	Aug. 26, 1952	69.0	6.0	1.1	1.2	3.3	1.8	1.5	1.6	14	4.1	2.5	.1	1.1	42	16	4	36.4	6.7	60
	Sipsey Fork near Sipsey	Sept. 18, 1952	75.5	5.4	.31	.99	2.7	1.4	2.1	1.6	17	2.0	2.2	.1	.0	29	12	0	36.4	6.8	21
m	Blackwater Creek near Manchester	Sept. 18, 1952	24.0	8.0	.67	1.1	2.9	2.6	2.2	2.1	9	14	2.2	.1	.5	45	18	11	57.3	6.7	38
p	Locust Fork near Trafford	June 24, 1952	125	5.0	.05	.22	9.6	3.1	2.7	1.3	34	10	3.2	.1	1.3	57	37	9	92.2	7.1	5
	Locust Fork near Trafford	Aug. 25, 1952	84.1	4.8	1.2	1.1	9.8	3.1	2.4	2.3	38	8.8	2.5	.1	1.6	73	37	6	88.4	7.2	70
	Locust Fork near Trafford	Sept. 19, 1952	240	4.1	.06	6.0	12	4.8	3.0	2.7	44	14	3.0	.1	.4	69	50	14	112	7.1	25
q	Turkey Creek at Morris	June 24, 1952	24.5	7.0	.11	.72	23	9.1	2.0	2.0	108	5.1	3.2	.1	1.6	113	95	6	187	7.4	18
	Turkey Creek at Morris	Aug. 25, 1952	18.5	7.2	.04	.61	29	13	2.6	1.0	142	7.0	2.8	.1	1.1	134	126	9	230	7.8	7
	Turkey Creek at Morris	Sept. 19, 1952	18.0	7.4	.08	.61	23	14	2.5	1.6	138	5.4	2.5	.0	.3	127	115	2	223	7.6	6
t	Five Mile Creek near Ketona	June 24, 1952	16.8	8.8	.07	1.1	31	14	1.8	1.2	154	3.6	3.0	.1	2.7	144	135	8	247	7.7	6
	Five Mile Creek near Ketona	Aug. 25, 1952	9.79	7.0	.20	.01	33	15	1.8	.8	163	6.3	2.8	.1	2.1	150	144	10	256	8.0	15
	Five Mile Creek near Ketona	Sept. 19, 1952	8.35	7.6	.05	.16	32	17	1.5	1.1	169	2.9	3.0	.1	1.6	150	150	11	259	7.9	6
v	Village Creek at Ensley	Aug. 26, 1952	53.1	11	.12	11	46	14	42	17	128	138	20	1.6	8.1	376	172	68	596	7.0	17
x	Locust Fork at Port Birmingham	June 24, 1952	-	5.0	.02	.41	11	3.8	8.5	2.1	39	23	3.8	.2	2.2	82	43	11	133	7.1	4
z	Valley Creek near Oak Grove	Aug. 26, 1952	121	10	.24	.76	56	12	33	15	62	192	20	1.4	2.0	379	189	138	622	6.5	20
	Valley Creek near Oak Grove	Oct. 1, 1952	114	14	.17	1.3	62	13	57	18	154	178	34	2.8	.3	465	208	82	758	6.9	30

[1] In solution at time of analysis.
[2] Includes iron in suspended materials.

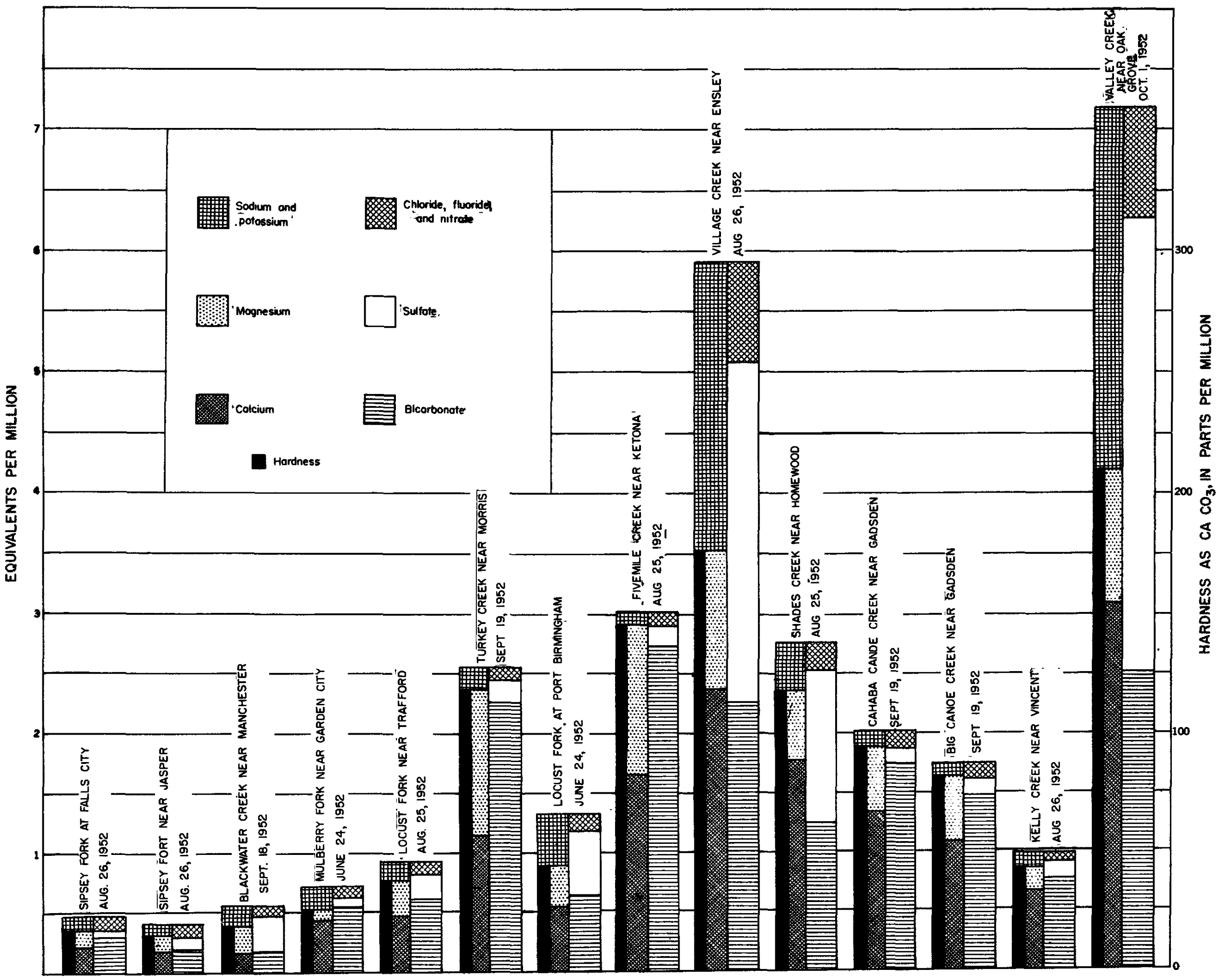

Figure 12.—Composition of selected surface waters in the Birmingham area.

both precipitated iron and iron in solution. Comparison of the mineral constituents in solution for each stream is given in figure 12. The relation of the dissolved solids to the hardness is given in figure 13. Generally, the surface waters in the Birmingham area are of good quality ranging in dissolved solids from 29 to 465 ppm but usually less than 150 ppm. Most of the waters are extremely soft. In the Coosa River basin the waters flow through the outcrops of the Conasuaga limestone and Copper Ridge dolomite formations. The waters of the Coosa River are predominantly the calcium bicarbonate type being low in dissolved solids, and the hardness of five samples ranged from 17 to 109 ppm. One sample collected from Big Canoe Creek near Gadsden contained 3.5 ppm of precipitated iron.

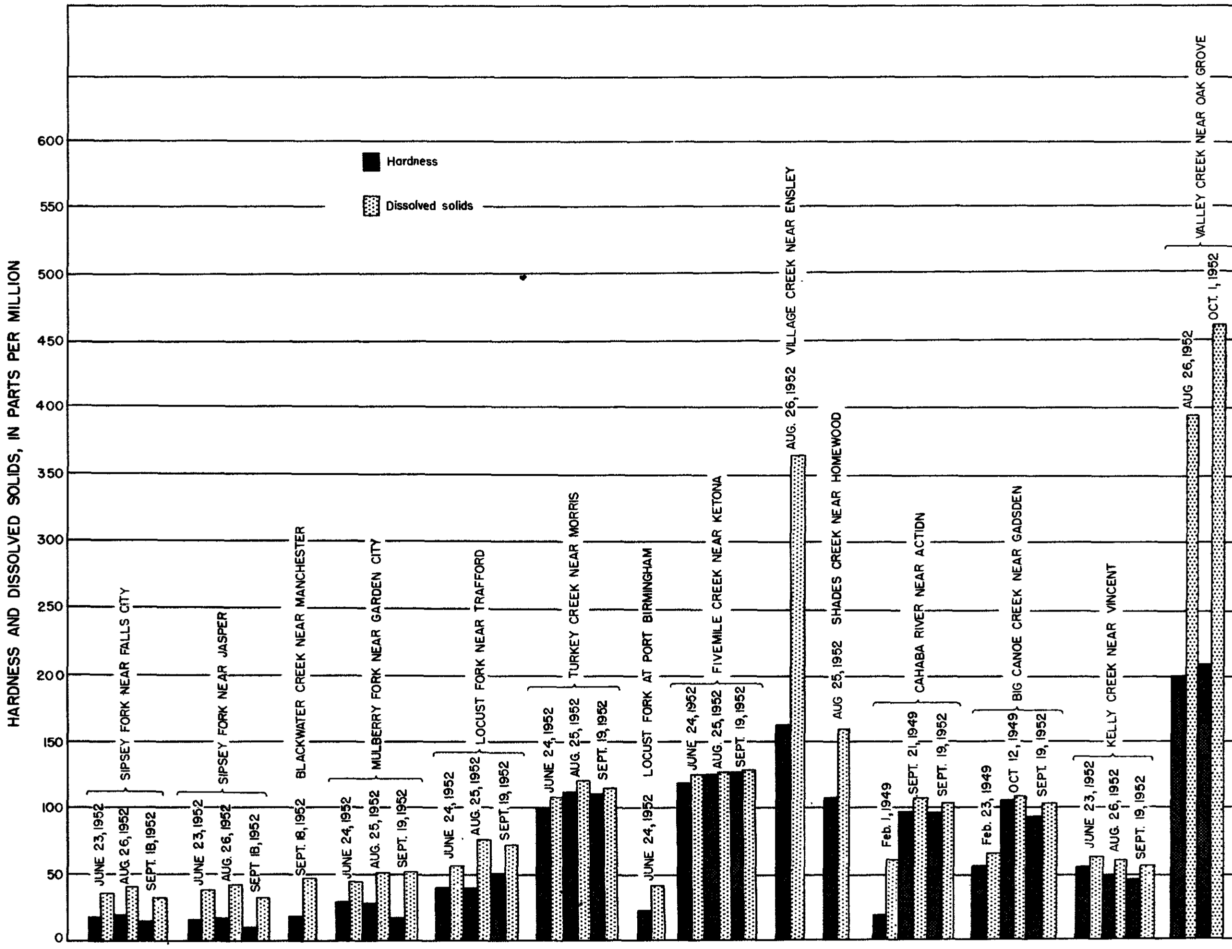

Figure 13.–Relation of hardness to dissolved solids of surface waters in the Birmingham area.

Potential Stream Developments

Information previously presented indicates a need for greatly increased water supplies within a few years and the lack of surface water for developing any large supplies in the immediate vicinity of Birmingham. Records of streamflow show that only the Coosa River, many miles east of Birmingham, has sufficient natural flow at all times to satisfy the growing demand. Besides the distance to that source, there are other important objections to using the Coosa River. Thus an impoundment on one of the headwater streams of the Black Warrior River basin appears to offer the best and perhaps the only source for additional water for the Birmingham area.

The Corps of Engineers and the Federal Power Commission have studied the possibilities for development of the Black Warrior River basin. In connection with their studies, sites believed suitable for constructing dams have been selected. Several of these sites also seem to offer a suitable location for the construction of a reservoir for supplying water to the Birmingham area. Data relating to specific sites are presented to assist in appraising their relative desirability.

Information on streamflows given earlier in this report was presented for the point of collection, that is, for the gaging station. In this section of the report, data will be extended to cover the base period (1928-51) and transferred to the location of the proposed dam. Three curves are presented for the sites proposed by the Corps of Engineers and are as follows:

1. Flow-duration curve: This curve shows the percentage of time that the flow equals or exceeds a given amount.

2. Days of deficient discharge: This curve shows the longest periods of consecutive days or months for which the streamflow was less than the indicated amount.

3. Storage requirements for selected flows: This curve shows the amount of storage capacity needed for an assured flow of various amounts.

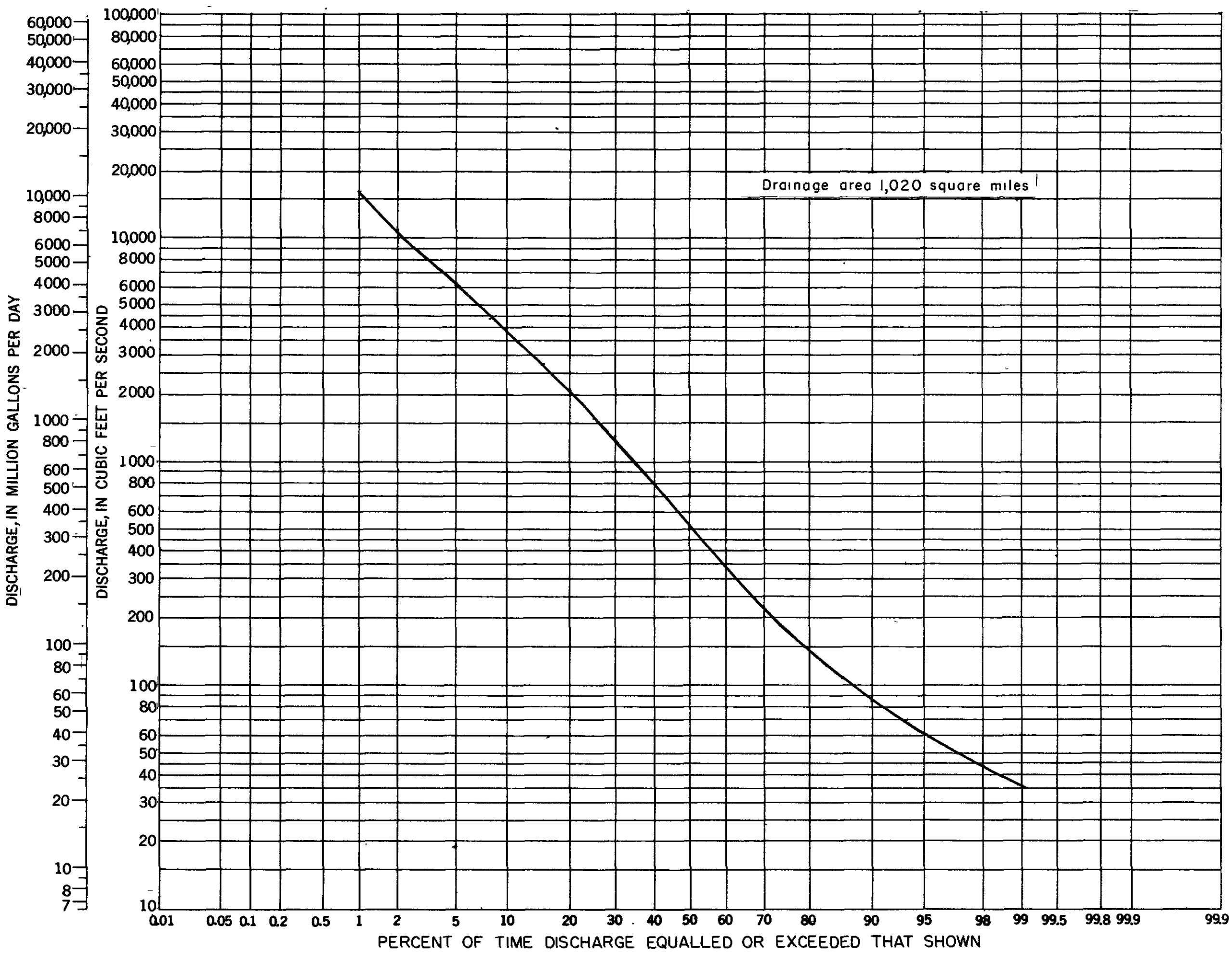

Figure 14.—Duration of daily flows, Sipsey Fork near Sipsey, 1928-51.

Information is presented in these curves which should be of considerable value in preliminary investigations of water-development projects. For example, suppose a flow of 100 cfs (65 mgd) is required from the Locust Fork near Trafford. The flow-duration curve (fig. 20) shows that 77 percent of the time the flow would probably equal or exceed 100 cfs. The curve of maximum period of deficient discharge (fig. 21) shows that 84 consecutive days is the longest period that the flow could reasonably be expected to be less than 100 cfs. If the use were such that it would not be desirable to let the supply fall below 100 cfs for this length of time, storage would have to be provided. The storage curve (fig. 22) shows that 15,000 acre-feet of storage would be required to maintain this flow. If release of water for downstream users is required, the average amount of this release must be added to the required draft to obtain the approximate storage requirements.

The maximum possible development of a stream would utilize the entire flow. Developments to that extent are seldom desirable. However, a substantial degree of developments is desirable if the few good reservoir sites are to be used wisely and efficiently. As a measure of the degree of utilization of the water resources for a proposed development, there is indicated on each storage curve the draft corresponding to 70 percent of the average discharge.

Sipsey Fork

The Sipsey Fork has slightly better low-flow characteristics than most of the streams in the upper Black Warrior River basin, but even it is characterized by extremes in runoff. The stream bed is deeply indented in the sparsely settled rolling country, and in general the land flooded by an impounding reservoir would be comparatively inexpensive.

A dam site has been proposed a short distance below the mouth of Ryan Creek, 34 miles northwest of Birmingham. The flow at the former gaging station on Sipsey Fork near Sipsey is nearly the same as the flow at the dam site. The following curves—flow duration (fig. 14), maximum period of deficient discharge (fig. 15), and storage requirements (fig. 16)—are based on records for the former stations near Sipsey and near Arley, and, for recent years, on the records for the station near Falls City combined with records for Clear Creek at Falls City.

Mulberry Fork

The Mulberry Fork has very little ground-water storage to sustain the flow during dry periods. At Garden City, it has the lowest dry-weather flow per square mile of any gaged stream in the upper Black Warrior River basin.

A dam has been proposed at Hanby Mill, 25 miles northwest of Birmingham. Drainage area at the dam site is 494 square miles. The following curves—flow duration (fig. 17), maximum period of deficient discharge (fig. 18), and storage requirements (fig. 19)—are based on records for the gaging station at Garden City which was in operation for the entire base period (1928-51).

Locust Fork

The Locust Fork has low-flow characteristics which are slightly better than those of Mulberry Fork. The stream is deeply indented and the country rolling. Damage to coal mines in some areas would increase the cost of developing impounding reservoir.

Dam sites at Trafford and at Sayre have been proposed, and data on both sites are presented.

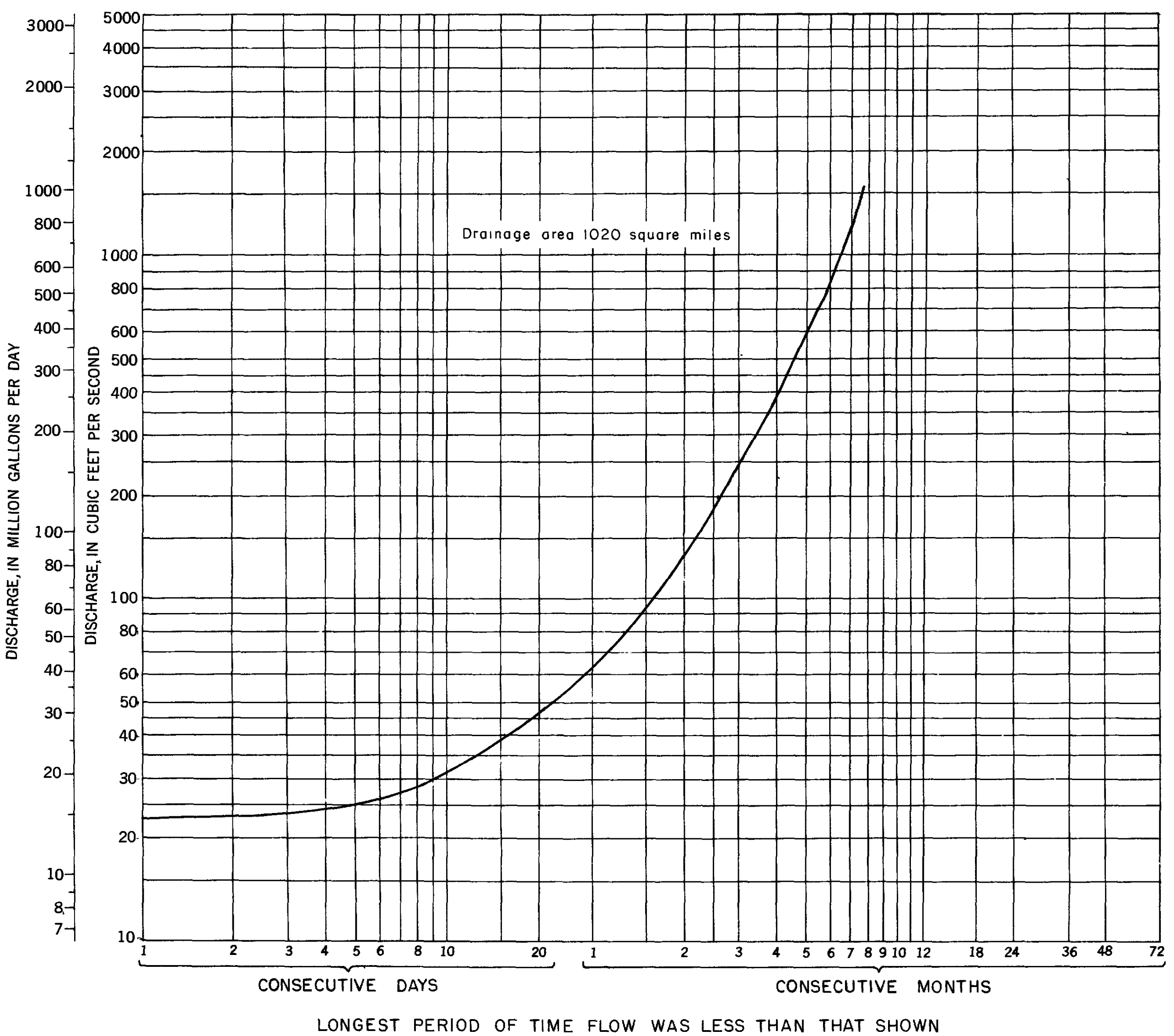

Figure 15.—Discharge available without storage, Sipsey Fork near Sipsey, 1928-51.

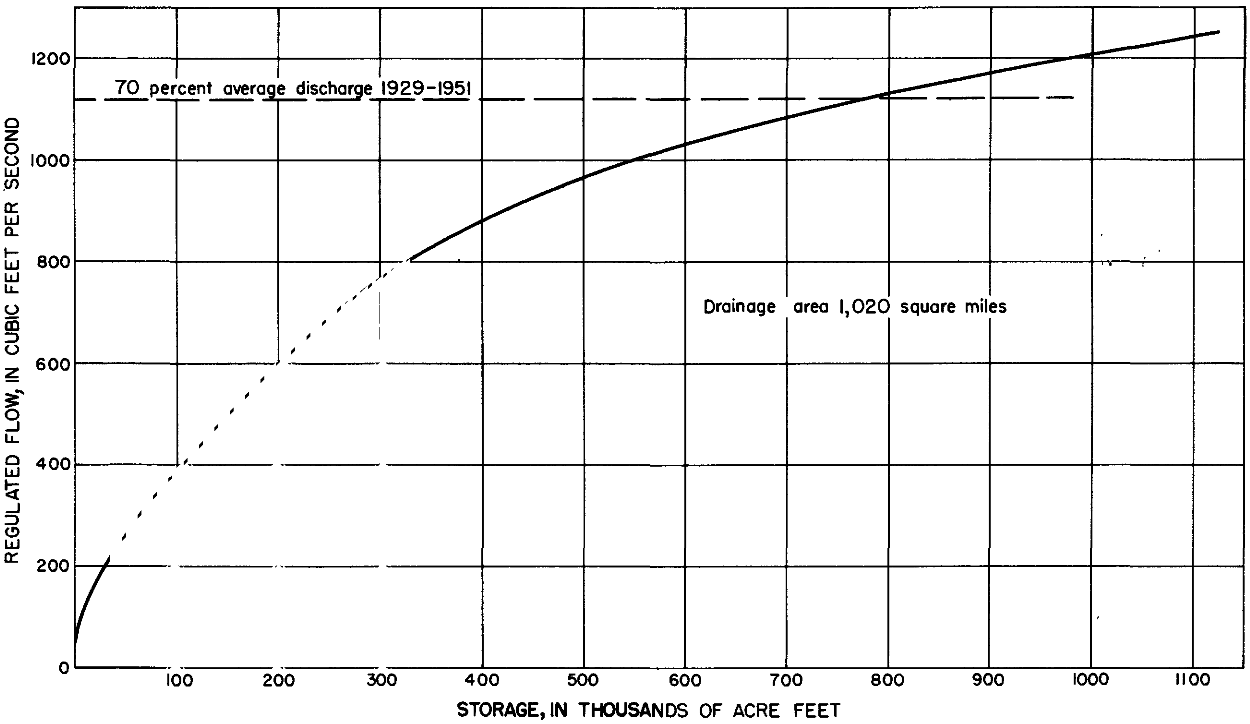

Figure 16.–Storage requirements, **Sipsey Fork** near Sipsey, 1928-51.

Trafford site

Two dam sites near the Trafford gage have been proposed. Streamflow at both sites would, for all practical purposes, be identical to that recorded at the gaging station near Trafford. The following curves – flow duration (fig. 20), maximum period of deficient discharge (fig. 21), and storage requirements (fig. 22)–are based on the record for the Trafford station, and earlier records for the station near Warrior adjusted to equal the flow at Trafford. As previously stated, there has been storage in and diversion from Inland Reservoir on the Blackburn Fork above the dam sites. The curves in figures 20 to 22 were constructed on the basis of no flow being contributed by Blackburn Fork above Inland Reservoir except during periods of high discharge. Therefore, they show the flow available after full use is made of the low flows of Blackburn Fork at Inland Reservoir.

Sayre site.–A dam site near the Sayre gage has been proposed. The curves of flow duration (fig. 23), maximum period of deficient discharge (fig. 24), and storage requirements (fig. 25) show streamflow characteristics at that point. These curves are based on records for stations at Sayre, near Warrior, and at Trafford, combined and adjusted as required to equal the flow at Sayre. As at the Trafford dam site, these curves were constructed on the basis of no low flow being contributed by Blackburn Fork above Inland Reservoir. Therefore, they show the flow available after full use is made of the flows of Blackburn Fork at Inland Reservoir.

Cahaba River

Additional development of the Cahaba River was at one time considered as a possibility. Records are available at the gaging station near Acton, and data are presented for the stream although the prospects for other than a very small increase in use do not seem to be favorable.

The Birmingham Water Works diverts water from a reservoir formed by a diversion dam on the Cahaba River just below the mouth of the Little Cahaba River. The water is pumped from the reservoir a short distance above the mouth of the Little Cahaba River. Lake Purdy (usable capacity 17,400 acre-feet) provides storage on the Little Cahaba River. A considerable part of the flood waters of that river are captured for release during periods of low flow. No storage is developed on the Cahaba River above the diversion dam although the Cahaba is by far the larger stream in the area.

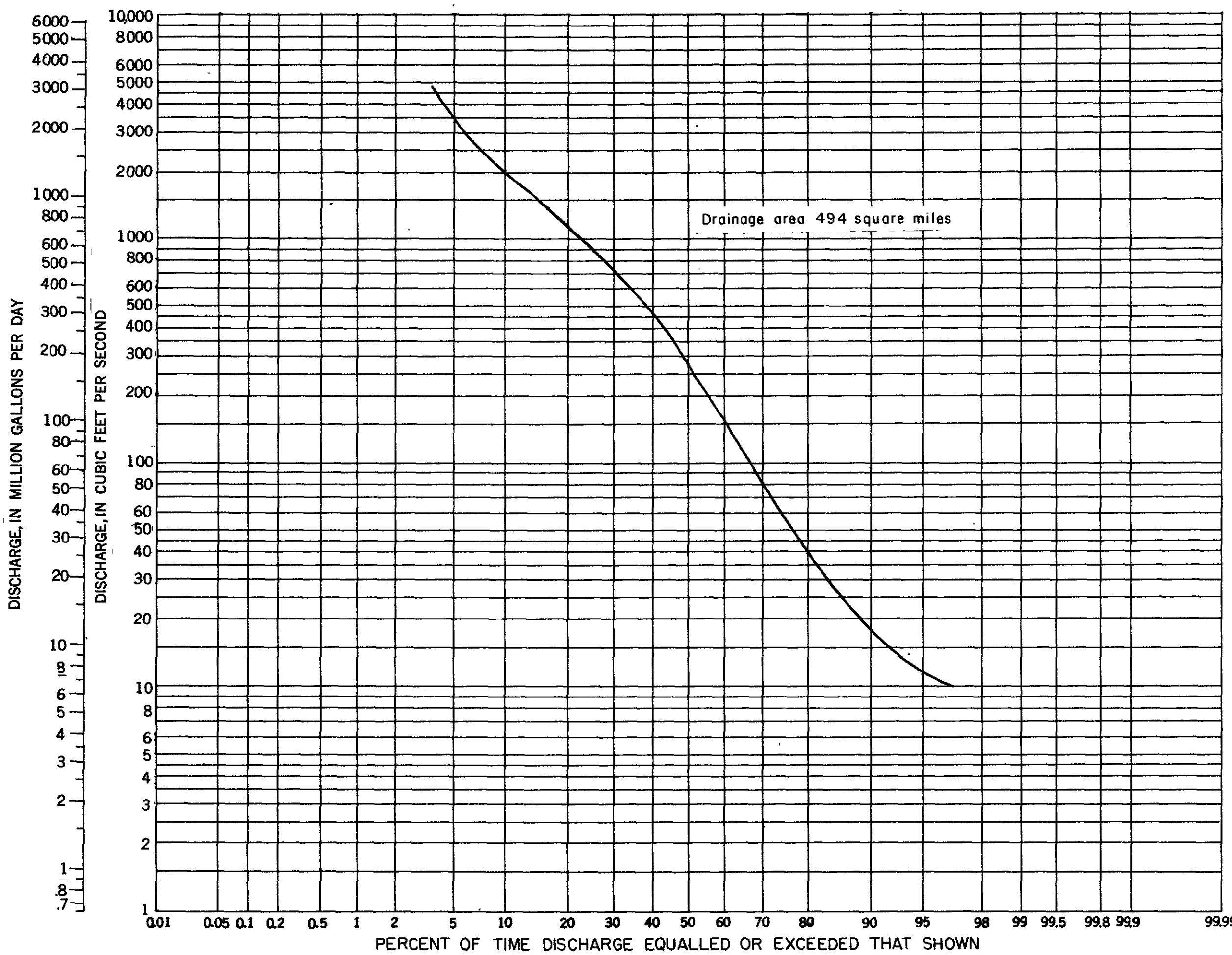

Figure 17.—Duration of daily flows, Mulberry Fork at Hanby Mill dam site, 1928-51.

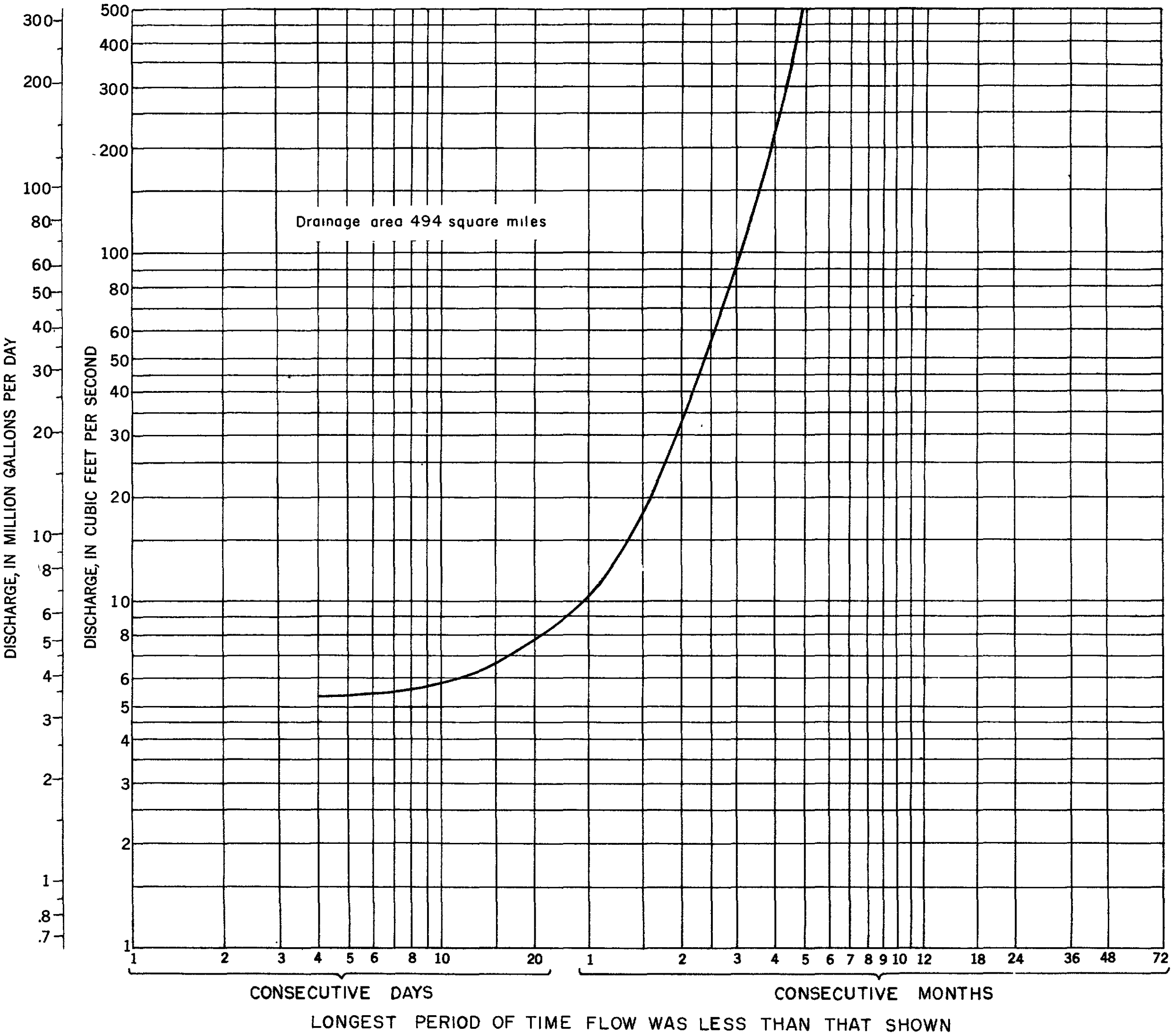

Figure 18.—Discharge available without storage, Mulberry Fork at Hanby Mill dam site, 1928-51.

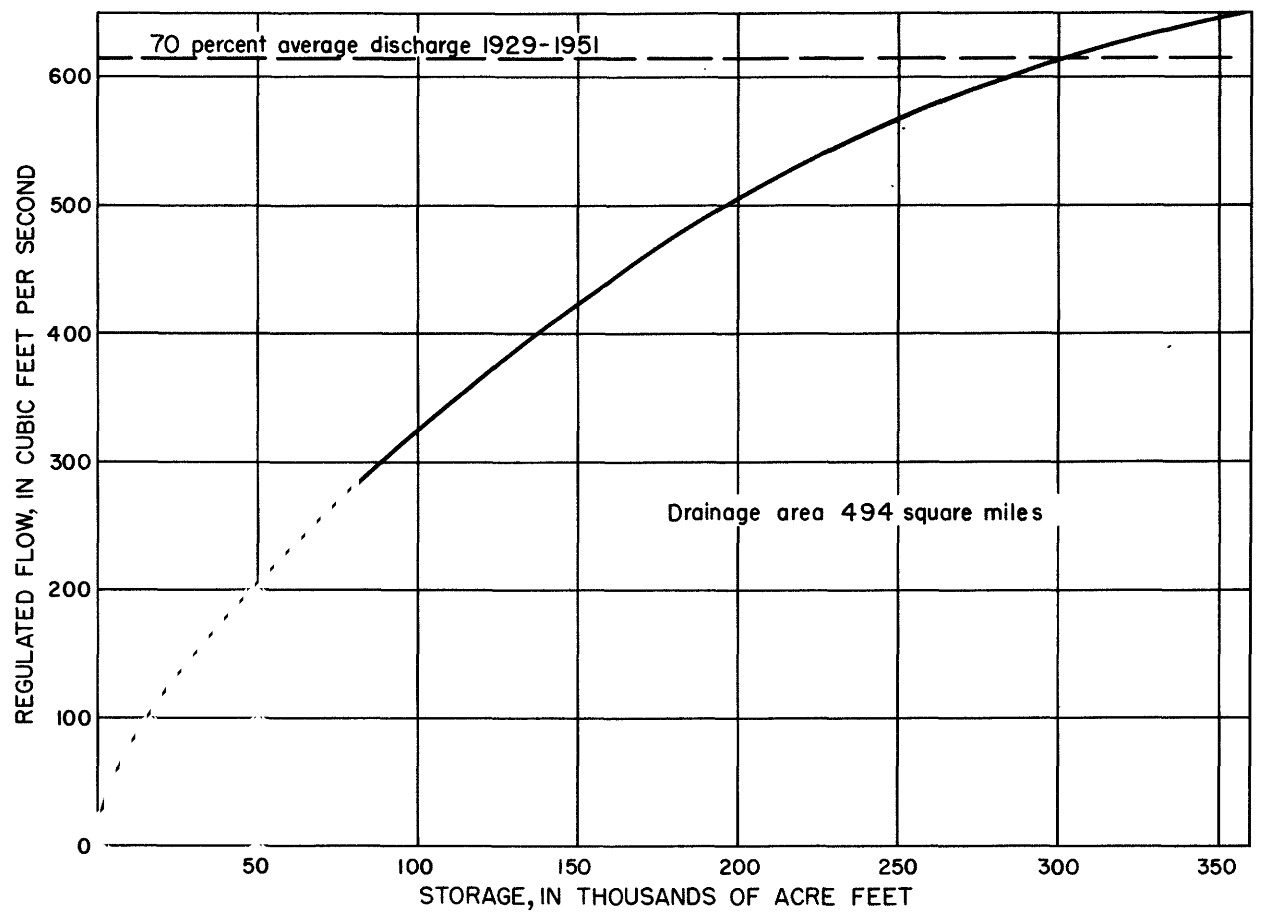

Figure 19.—Storage requirements, Mulberry Fork at Hanby Mill dam site, 1928-51.

Flow at the gaging station at Acton is very nearly equal to the water that passes over the diversion dam. Little or no water is wasted during the summer and fall, but a considerable flow passes the dam during months of heavy precipitation and higher runoff.

Reservoir sites have not been proposed for the Cahaba River. Present developments in the headwaters of the basin preclude the ready development of a reservoir in that area. Thus the opportunity for any substantial increase in storage would seem to be limited to a development at or below the diversion dam. Daily discharge, a storage-requirements curve (fig. 26), and a curve of maximum consecutive days of lowest average discharge (fig. 27) are available for the site at the gaging station near Acton. The storage curve was developed for this site to show the maximum utilization possible at the present point of diversion. It is not implied that a dam at this site is desirable. The same amount of storage at any point upstream would yield less dependable flow at the point of diversion.

The curve of maximum consecutive days of lowest average discharge (fig. 27) has less meaning at this place because it does not represent natural flow. However, it does show that storage for a long period would be required for even a small additional draft.

Coosa River

The unregulated dry-weather flow of the Coosa River is substantially greater than any additional quantity needed in the Birmingham area in the future. Therefore, a reservoir would not be required if diversion from that stream was feasible or desirable. Installation and operating costs created by the distance from the city, the rugged terrain, and the high pumping head are disadvantages which might be sufficient to bar serious consideration of such a proposal.

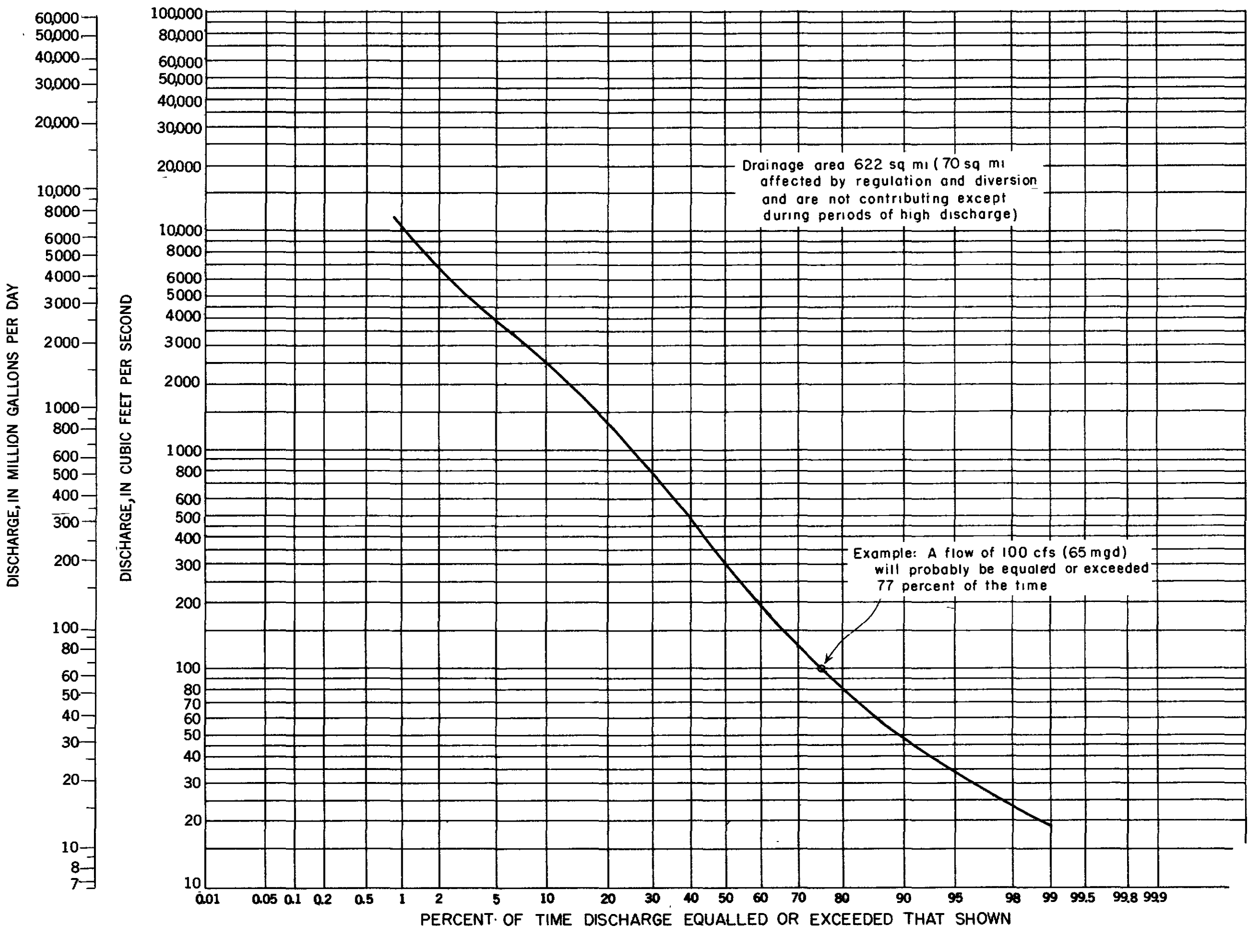

Figure 20.—Duration of daily flows, Locust Fork at Trafford, 1928-51.

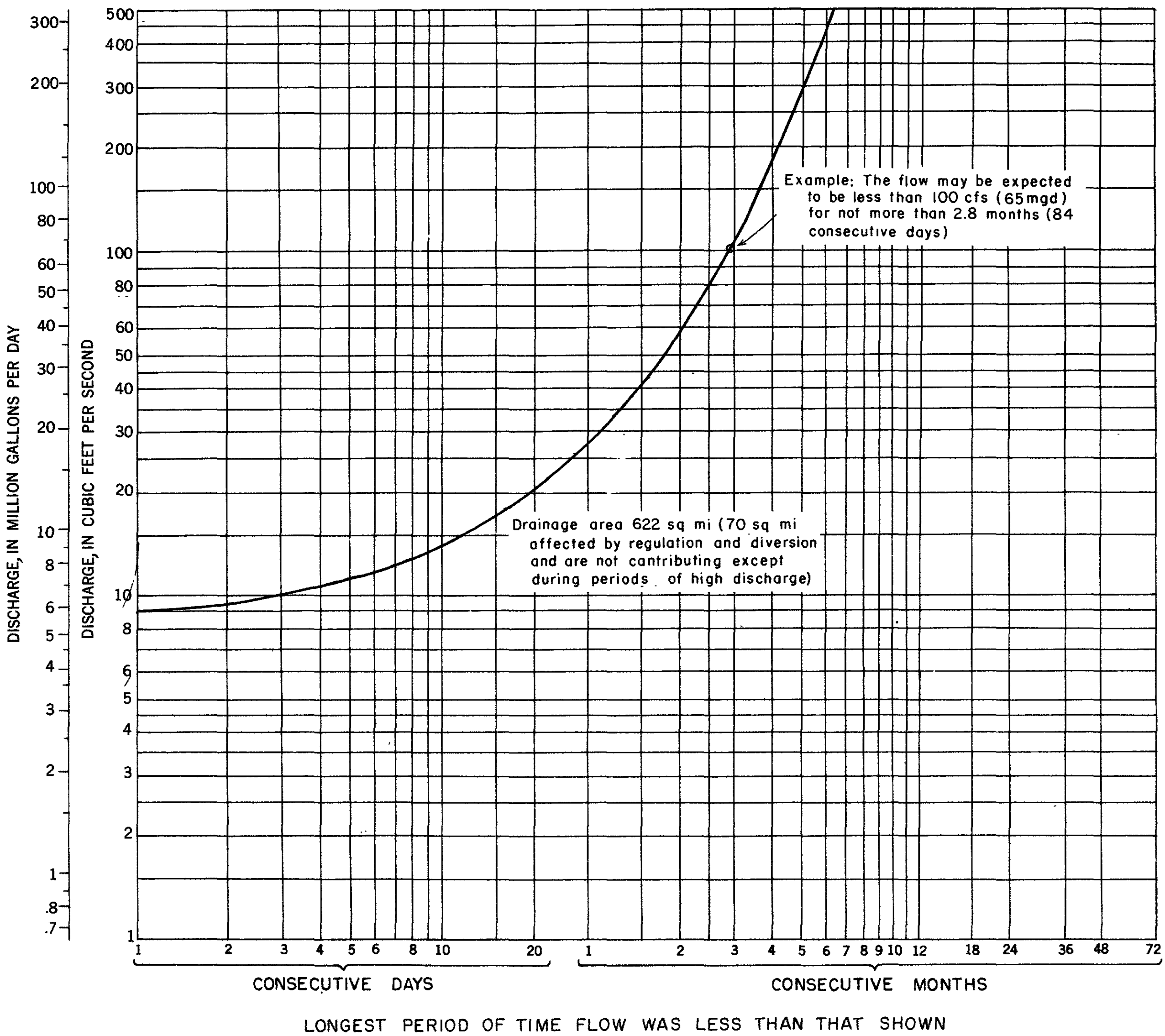

Figure 21.—Discharge available without storage, Locust Fork at Trafford, 1928-51.

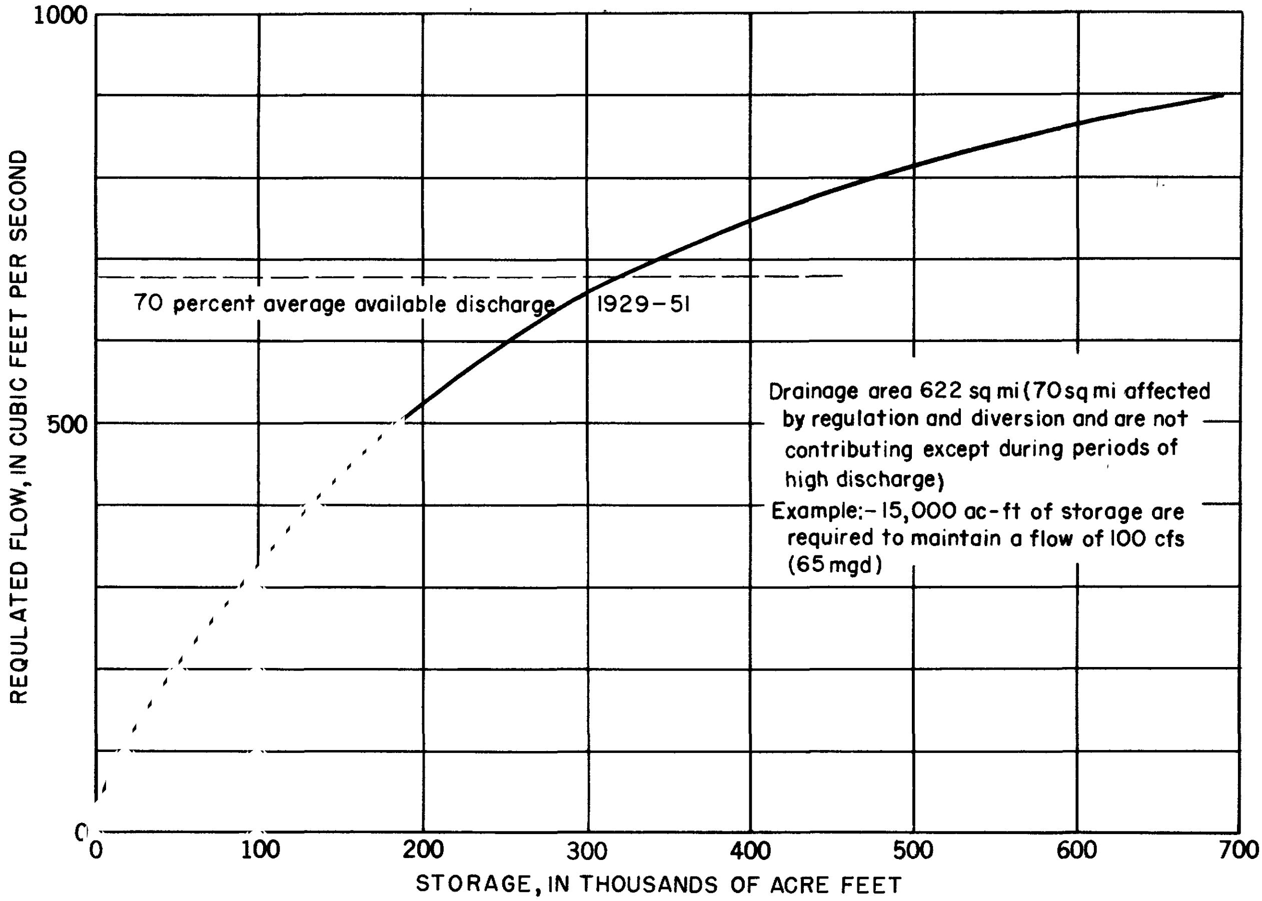

Figure 22.—Storage requirements, Locust Fork at Trafford, 1928-51.

There is an additional adverse factor that is not common to proposed developments in the Black Warrior River basin. All flow diverted from the Coosa River for use in the Birmingham area is later discharged into streams in the Black Warrior River basin. Therefore, any diversion from the Coosa River would not be returned to the river for the benefit of other downstream users. A large amount of diversion would adversely affect the production of power at three hydroelectric developments on the Coosa River and two proposed developments on the Alabama River. To illustrate, a diversion of 100 cfs is equivalent to 3,800 theoretical horsepower at the five plants. Therefore for every 100 cfs diverted, the power production would be reduced by 3,800 theoretical horsepower during periods when all flow is being utilized, which is the condition during a substantial part of the year.

Minor streams

Minor streams near the city while not adequate for development of a large supply do hold some promise for the development of smaller supplies. A discussion of the most important minor streams follows.

Fivemile Creek.—The headwaters of Fivemile Creek are largely supplied from springs; therefore the flow of the stream is better sustained during long periods of no rainfall than the flow of other streams in the area. The lower reaches of the stream below Tarrant City are polluted, but above State Route 38 the water is evidently not greatly polluted. Figure 28 shows the estimated duration of flow of Fivemile Creek at a point about 1 mile upstream from State Route 38 (drainage area about 19 square miles). The flow of

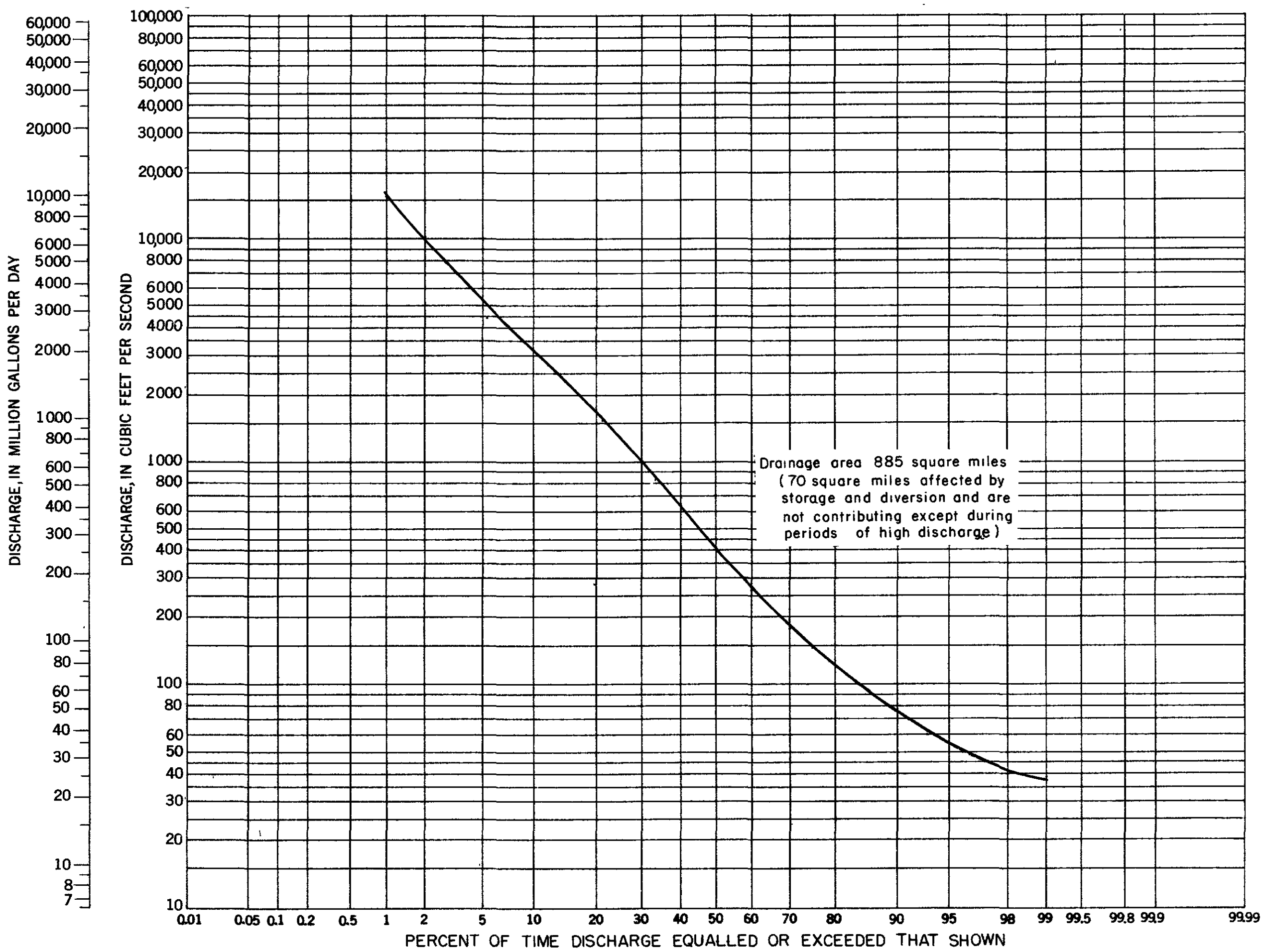

Figure 23.–Duration of daily flows, Locust Fork at Sayre, 1928-51.

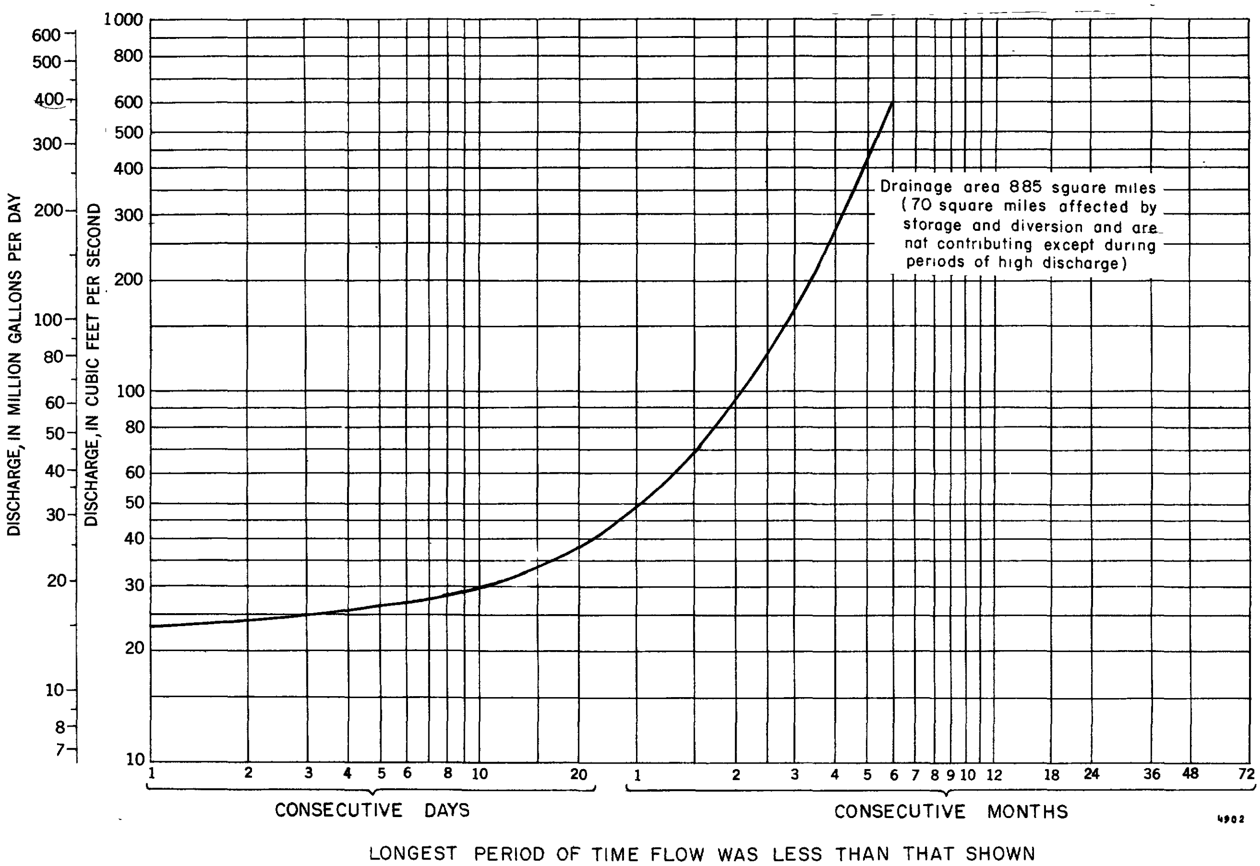

Figure 24.—Discharge available without storage, Locust Fork at Sayre, 1928-51.

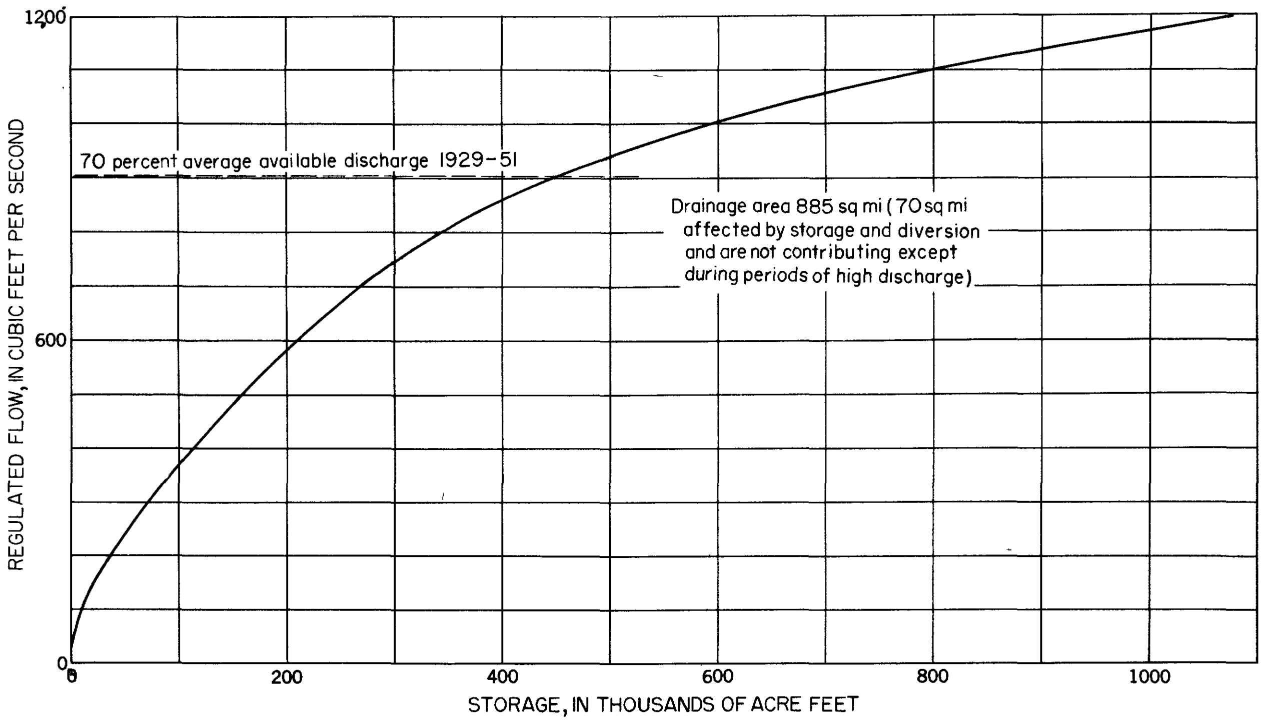

Figure 25.—Storage requirements, Locust Fork at Sayre, 1928-51.

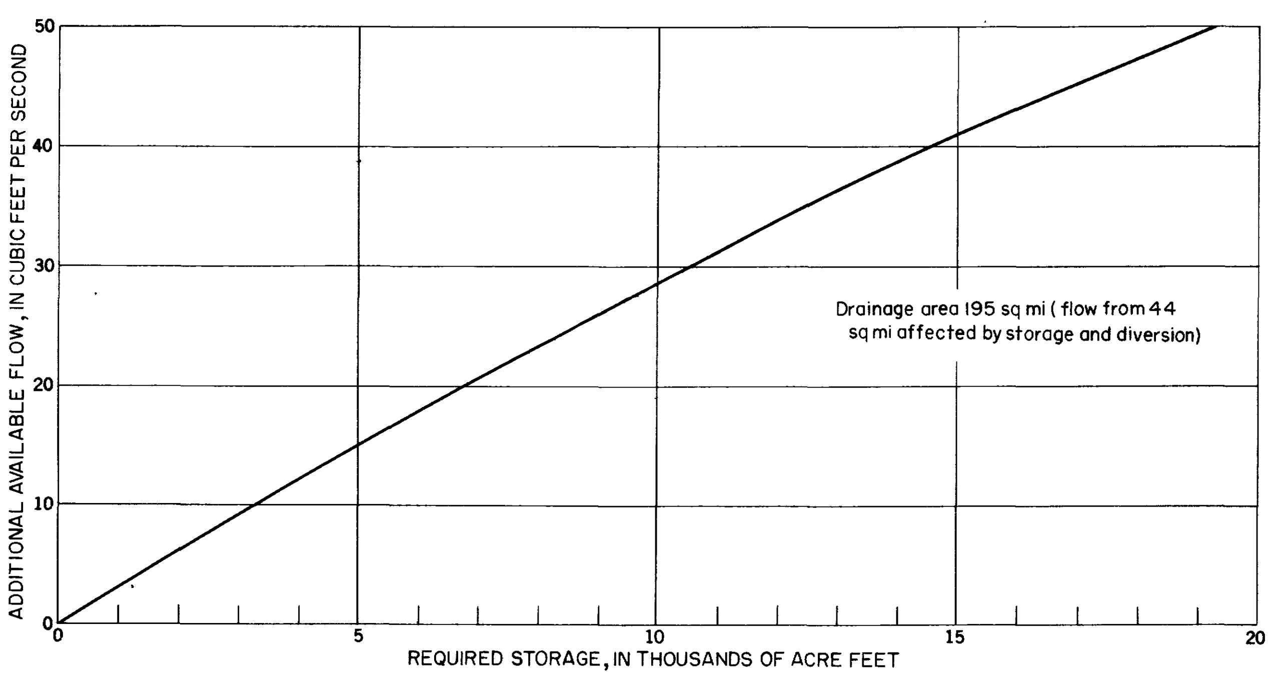

Figure 26.—Storage requirements, Cahaba River near Acton, 1928-51.

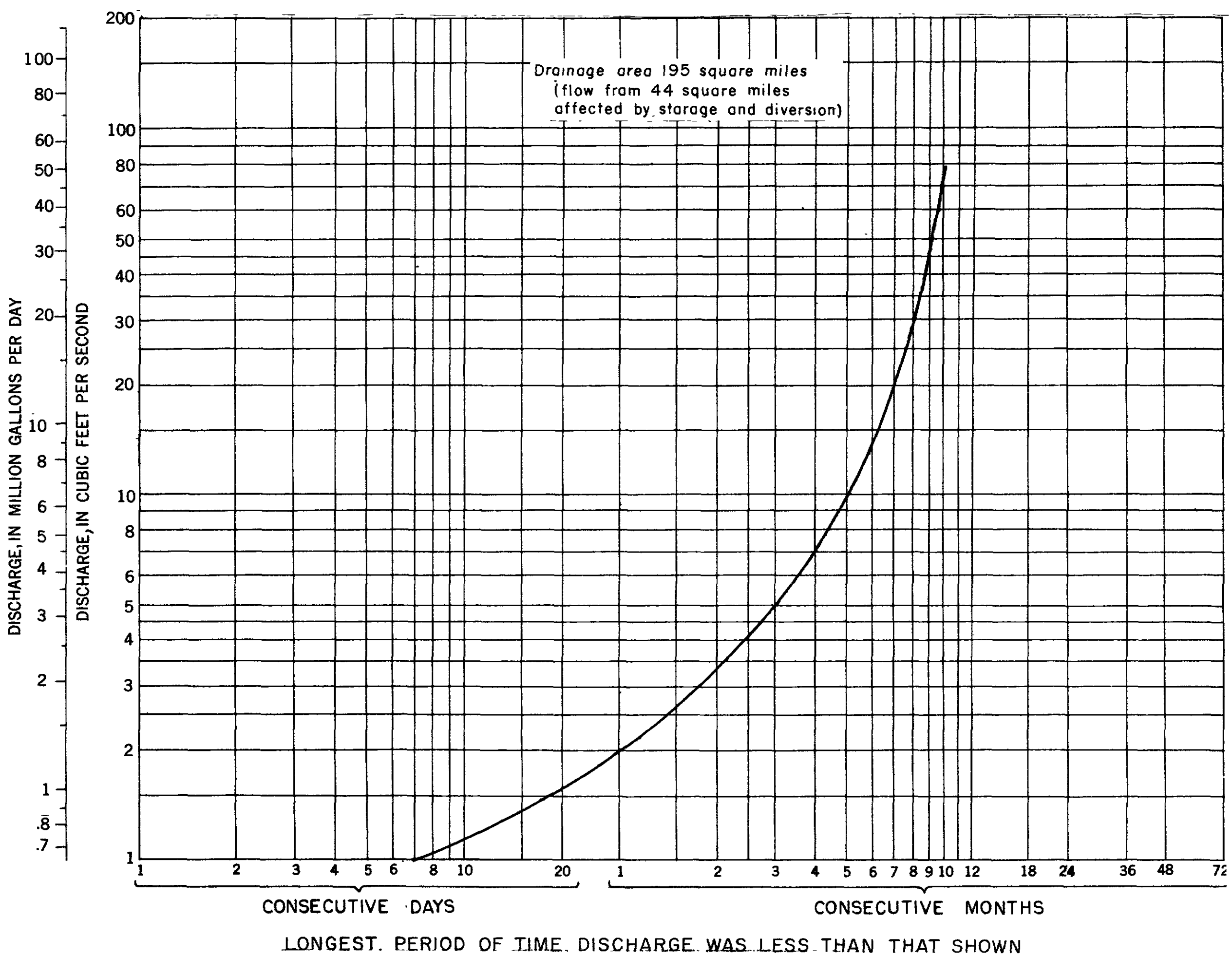

Figure 27.—Maximum number of consecutive days of lowest average discharge, Cahaba River near Acton, 1928-51.

this stream per unit of drainage area varies greatly at different sites because the stream is largely spring fed; therefore the data in figure 28 are not considered closely applicable to other sites.

Shades Creek.—The flow of this stream is not well sustained during long periods of no rainfall. During dry periods the streamflow in the immediate area is so low that the stream cannot be considered as a potential supply of any importance.

Village Creek.—This stream is highly polluted by sewage and industrial wastes. Low-water flow is largely water previously used for cooling in the ferrous industries and its above-normal temperature reflects that use. Further development of this stream for industrial supply does not seem to be feasible.

Valley Creek.—Like Village Creek, this stream is highly polluted and has objectionable odors. The combined flow of both streams includes most of the return flow of the waters diverted into the area. It is probable that this stream is developed to about the maximum extent feasible.

Effect of potential developments on other uses

Each use of water affects in some measure other present or potential users of the same supply. In some places the regulation exercised for one use also provides benefits for other uses and users. In other places the supply is so diminished in either quality or quantity that other present or potential users are adversely affected. In the following paragraphs attention is called to the effect that the possible developments would have on the more important known uses.

The Coosa River.—Diversion from the Coosa River would seriously affect the power produced downstream from the point of diversion. Such diversion would not affect other uses in any great degree.

The Cahaba River.—Additional diversion from the Cahaba River would further reduce the low and medium flow of the stream. Additional diversion would not, however, greatly affect any present or known (proposed) uses downstream.

Tributaries of the Black Warrior River.—Water diverted at the proposed sites would be returned partly by local streams to the Locust Fork. Diversion from storage would tend to increase the dry-weather flow so that downstream users on the Black Warrior River would have a greater amount of water at a critical time, although the total supply might be reduced in quality. Diversion from the Coosa and the Cahaba would also improve the low-water flow of the Black Warrior River. Storage in the Black Warrior River basin or diversion from the Coosa or Cahaba Rivers would be beneficial to navigation as well as to other downstream users.

None of the projects could be depended upon to reduce flood peaks unless flood-control storage was planned as part of the project. Although the control of floods is not generally considered to be greatly needed in the area of the headwater stream, it would be beneficial at and below Tuscaloosa. The control provided in the headwaters would only have moderate effect that far downstream.

The steam-electric power plants at Gorgas, on the Mulberry Fork, use large quantities of water from the Lock 17 pool for cooling condensers. Water diverted from either Mulberry Fork or Sipsey Fork would reduce flow past Gorgas. If the flow past Gorgas were reduced, the efficiency of cooling process of the plants would be reduced during periods of low flow. Conversely, upstream development for water power should improve the conditions by increasing the volume of flow during low-water periods.

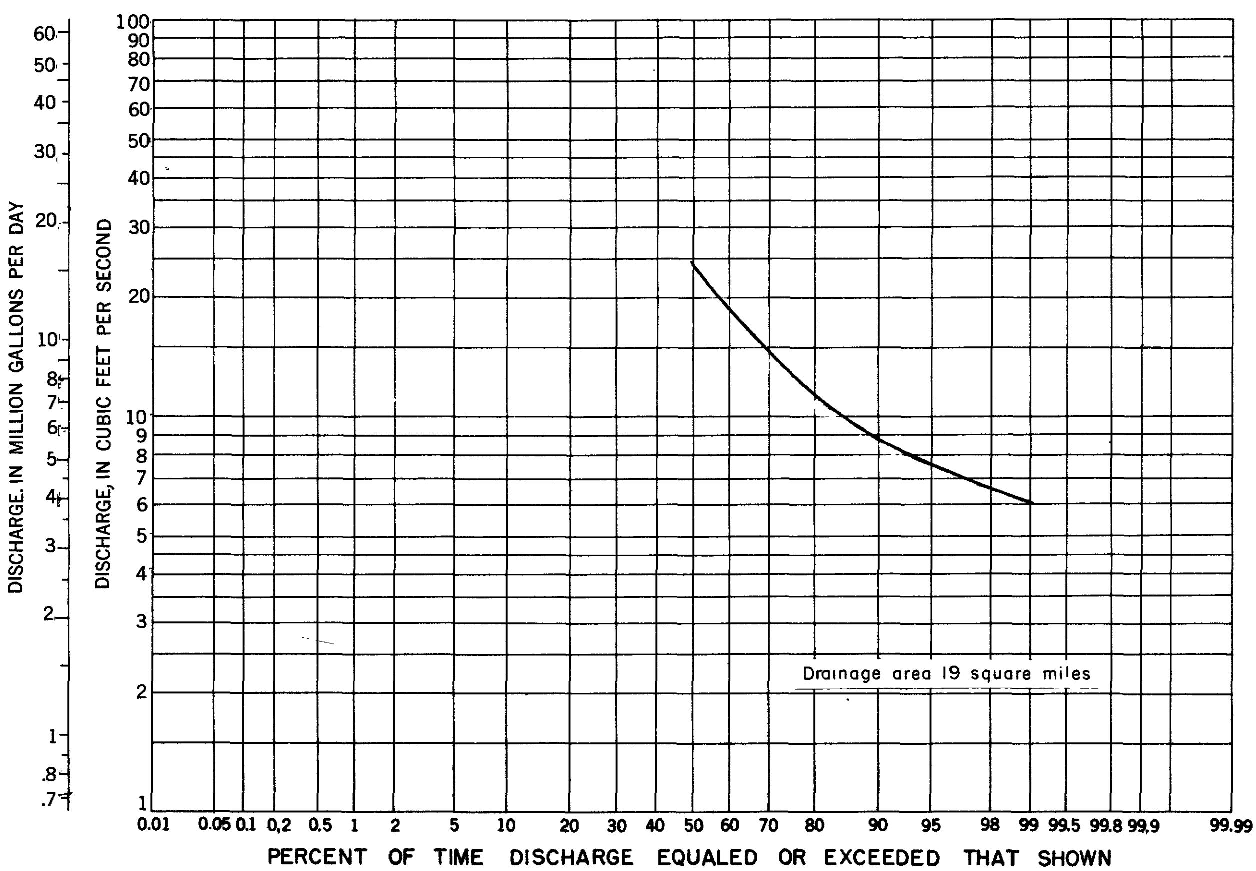

Figure 28.—Estimated duration of daily flows, Fivemile Creek 1 mile upstream from State Route 38.

GROUND WATER

General Principles

Occurrence and storage

Ground water is water that occurs in the zone of saturation below the surface of the earth—the zone where all open spaces in the earth material are filled (saturated) with water. Ground water occurs in the pores, crevices, solution cavities, and other openings formed by weathering and structural stresses on the rocks.

Porosity is the amount or percentage of open spaces or voids in rocks.

Permeability is the ability of porous material to transmit water under pressure. A rock formation may have a high porosity, but, if the pore spaces are small or not connected, it would be difficult, if not impossible, for water to flow through the rocks.

The character and structure of rocks control their porosity and permeability and therefore their ability to contain and yield ground water to wells and springs. In the Birmingham area ground water occurs in pore spaces, along bedding planes, and in fractures in the sandstone; and in solution cavities in limestone and dolomite. Ground water moves under the force of gravity in these rocks along the path of least resistance—the zones of greatest permeability. Rock formations through which ground water is moving in sufficient quantities to supply wells or springs are called aquifers.

Movement

Water-table conditions.—The water table or surface of the zone of saturation is not level or stationary. It varies in slope and height with the topography, the geologic structure, and the rate of withdrawal of water, and with daily, seasonal, and yearly variations in rainfall. Under natural conditions in a year of above-normal rainfall the water table is unusually high and in a drought year it is low.

In the Birmingham area the highest water levels in wells occur during February, March, and April because of the continuous and large amount of recharge to the water table during the heavy winter rains and the low evaporation during cold weather. The lowest water level is usually reached during the latter part of October or early November at the end of the dry fall season.

Artesian conditions.—If water moving laterally in an aquifer passes between and becomes confined above and below by impermeable strata, it is called artesian ground water. The pressure exerted on water in a confined, or artesian, aquifer by the weight of water at higher levels in the same aquifer is known as hydrostatic pressure. When a well penetrates a confined aquifer, the pressure causes the water to rise up the well above the bottom of the overlying confining or impermeable bed. If the land surface is low enough and the artesian pressure great enough, the well will flow. Such a well is called a flowing artesian well. The height that a column of water can be supported by the artesian pressure is called the pressure head. The imaginary surface to which artesian water will rise in tightly cased wells is called the piezometric surface. Water-table and artesian conditions are illustrated in figure 29. Flowing artesian wells can be developed in the Fort Payne chert in the Warsaw limestone and in the Hartselle sandstone beneath Shades Valley.

Recovery from wells and springs

Wells in the Birmingham area are commonly drilled by the cable-tool method. Test drilling is needed in development of a ground-water supply in the area. Test wells are drilled until one or more water-bearing fractures, solution cavities, or other openings are penetrated that will yield an adequate water supply. The depth to which test drilling in the area is carried varies with the kind of underlying formations and the geologic structure.

Pumping in a well lowers the water level, creates a cone of depression (a, b, c, fig. 29), and draws water from the water-bearing formation immediately around the well. The area around the well affected by pumping is known as the area of influence. As the pumping increases or continues, the area of influence becomes larger and the cone of depression deeper until sufficient recharge water is intercepted to balance the amount being pumped. If recharge water is available, the well will continue to yield water; if recharge is inadequate, the well eventually will go dry.

Overpumping of wells in an area causes overlapping cones of depression, progressive decline in water levels, and consequent decline in the pumping yields of wells in the area being depleted. In the Birmingham area muddying of water from wells in limestone sometimes indicates overpumping. The complex network of horizontal and vertical solution cavities in limestone and dolomite weakens the rocks. Where these networks are near the surface and wells drilled,

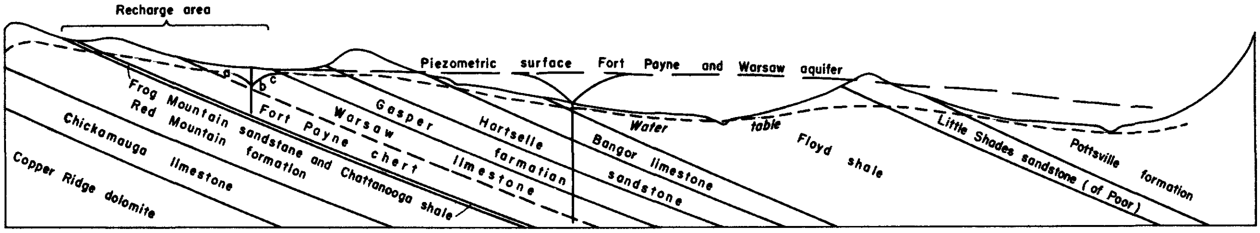

Figure 29.—Diagrammatic section, showing water-table and artesian conditions in the Birmingham area.

into them are overpumped, there is increased velocity of ground-water movement in the area of influence. This increased velocity causes collapse of the rock and clay filling between cavities, and sinkholes are formed at the surface, usually near the well. After the sinkholes have formed, the water is muddied and the yield from wells is usually decreased,owing to blocking of solution cavities.

Wells in the area range from dug wells as much as 50 feet deep that generally yield as much as 25 gpm to deep drilled wells more than 600 feet deep that yield as much as 500 gpm. Industrial and municipal wells usually 6 to 12 inches in diameter have casing set on bedrock, and the hole is drilled into the rock to intersect the water-bearing zones.

Several large springs, such as Caldwell and Tarrant, have been developed for municipal and domestic water supplies. The users of these springs have constructed concrete retaining walls around the springs and roofs over them.

Springs studied for this report ranged in yield from 50 to as much as 750 gpm.

General Geology

Geologic events can be dated by a calendar which geologists call the geologic time scale. Geologic time is divided into four main eras, Proterozoic, Paleozoic, Mesozoic, and Cenozoic. Rocks that crop out in the Birmingham area are of Paleozoic age. Eras are divided into periods. In the Paleozoic era these periods are:

Permian period (youngest)
Pennsylvanian epoch) Carboniferous period
Mississippian epoch)
Devonian period
Silurian period
Ordovician period
Cambrian period (oldest)

Rocks deposited during a geologic period comprise a system of rocks, such as the Carboniferous system and the Ordovician system. The rocks of an epoch make up a series, such as the Pennsylvanian series.

The rock formations exposed in the Birmingham area were deposited in seas. Each time the sea flooded the area sediments were laid down and later cemented and compacted to form rocks. Deposition of these rocks began about 550 million years ago in the Cambrian period and continued until some time during the Pennsylvanian epoch about 220 million years ago. The area was not covered by the sea throughout the 300 million years; evidence of erosion and areas of nondeposition indicate that some areas were dry land while the rest was under water.

The area of this report lies in two physiographic provinces (fig. 1): The Valley and Ridge province in the southeastern third of the area and the Appalachian Plateaus province in the northwestern two-thirds of the area.

Between 185 and 220 million years ago great stresses occurred in the crust of the earth in a belt extending from Newfoundland southwestward to Alabama, where this belt is 25 to 50 miles wide. In Alabama these stresses acted from the southeast, pushing the rocks into great upwarps (anticlines) and downwarps (synclines). Faults formed where the earth's crust fractured and there was movement of the rocks. The stress that warped these rock formations was so great that long faults were formed on the northwest sides of the major anticlines. Older rocks on the southeast were brought upward adjacent to younger rocks on the northwest sides of the faults. The greatest stresses caused folds in what is now the Valley and Ridge province. The Appalachian Plateaus province, a less-disturbed broad syncline, formed to the northwest where the stresses were less intense. As these two physiographic provinces form two natural geologic provinces, the geology of each will be discussed.

The Valley and Ridge province

About the southeastern third of the area of this report lies within the Valley and Ridge province. While the folding of rocks took place, the streams cut downward through the Coosa, Cahaba, and Birmingham anticlines (fig. 1). The Coosa River, Cahaba River and Cahaba Valley Creek, Valley and Village Creeks, and their tributaries eroded through the sandstone, shale, and coal of the Pennsylvanian rocks to the easily eroded underlying limestone, dolomite, and shale exposed in the long valley systems of the area. On either side of the Cahaba anticline (fig. 1) sandstone, shale, and coal beds of the Pottsville formation of Pennsylvanian age were folded into two subdivisions, the Cahaba Ridges and the Coosa Ridges. These rocks were folded into parallel northeast-trending bands. Faulting occurred, and locally the rocks have steep dips. Double and Shades Mountains are examples of sandstone ridges formed by folding of the sandstone and subsequent erosion by streams. Both the Cahaba Ridges and the Coosa Ridges have faults along their southeast boundaries where older rocks have been pushed into contact with the younger Pottsville formation. North of Pinson the Birmingham valley divided; the northwest division formed Murphrees Valley which extends to a point a few miles northeast of Aurora in Etowah County; the southeast part connected with Big Canoe Valley, forming the Birmingham-Big Canoe Valley (Johnston, 1933, p. 15). The Blount Mountain syncline lies between the two extensions of Birmingham valley. Rocks in this syncline are sandstone, shale, and coal beds of the Pottsville formation. Unlike the Cahaba and Coosa Ridges areas, the Blount Mountain syncline has a boundary fault on the northwest side rather than on the southeast side.

The Appalachian Plateaus

The northwestern two-thirds of the area of this report lies northwest of Birmingham valley within the Appalachian Plateaus province. This area is underlain by sandstone, shale, and coal beds of the Pottsville formation. A fault on the southeast side of Sand Mountain separates the Warrior Basin and the Birmingham valley, and the Valley and Ridge and Appalachian Plateaus provinces (fig. 1).

Within the Warrior Basin there are local structural features, such as smaller basins, anticlines, synclines, and faults; however, the rocks in this basin are generally much less folded and faulted than those in the Coosa and Cahaba Ridges areas. The Warrior Basin is drained mainly by the Locust and Mulberry Forks of the Black Warrior River.

The southern part of a prominent anticlinal valley, the Sequatchie, or Browns, Valley, projects into the northeast part of the Warrior Basin, and part of this valley lies within the area of this report. This valley is similar to the Coosa, Cahaba, and Birmingham Valleys.

Water-Bearing Formations

The water-bearing formations in the area of ground-water studies for this report crop out in parallel bands trending northeast (pl. 2). The geologic structure of the area controls the outcrop patterns of the formations, and thereby the areas of recharge of the aquifers.

The main geologic structure is a large anticline, the crest of which has been eroded away, exposing limestone and dolomite in a great valley and sandstone and chert in the adjacent ridges. (See pl. 2.)

The important aquifers are the limestones and dolomites because they contain many fractures and solution cavities and are exposed in Opossum and Jones Valleys under conditions favorable to recharge. Of lesser importance as aquifers are the chert, limestone, and sandstone in Shades Valley and in the ridges adjacent to the valleys.

The general description of the geologic formations and their water-bearing characteristics is based on the reconnaissance study of the geology and occurrence of ground water for this report. The thicknesses of the formations are mostly from Butts (1926 b).

Generally a single water sample from a well is regarded as being representative of the chemical quality of water from the aquifer developed by the well because the concentration of the dissolved minerals in water from a well seldom shows large variations. Samples were collected from 22 wells, 2 springs, and 5 mine shafts to determine the chemical character of the ground-water supplies in the Birmingham area. (See table 18.) The chemical characteristics of the ground waters in the area have been considered pri-

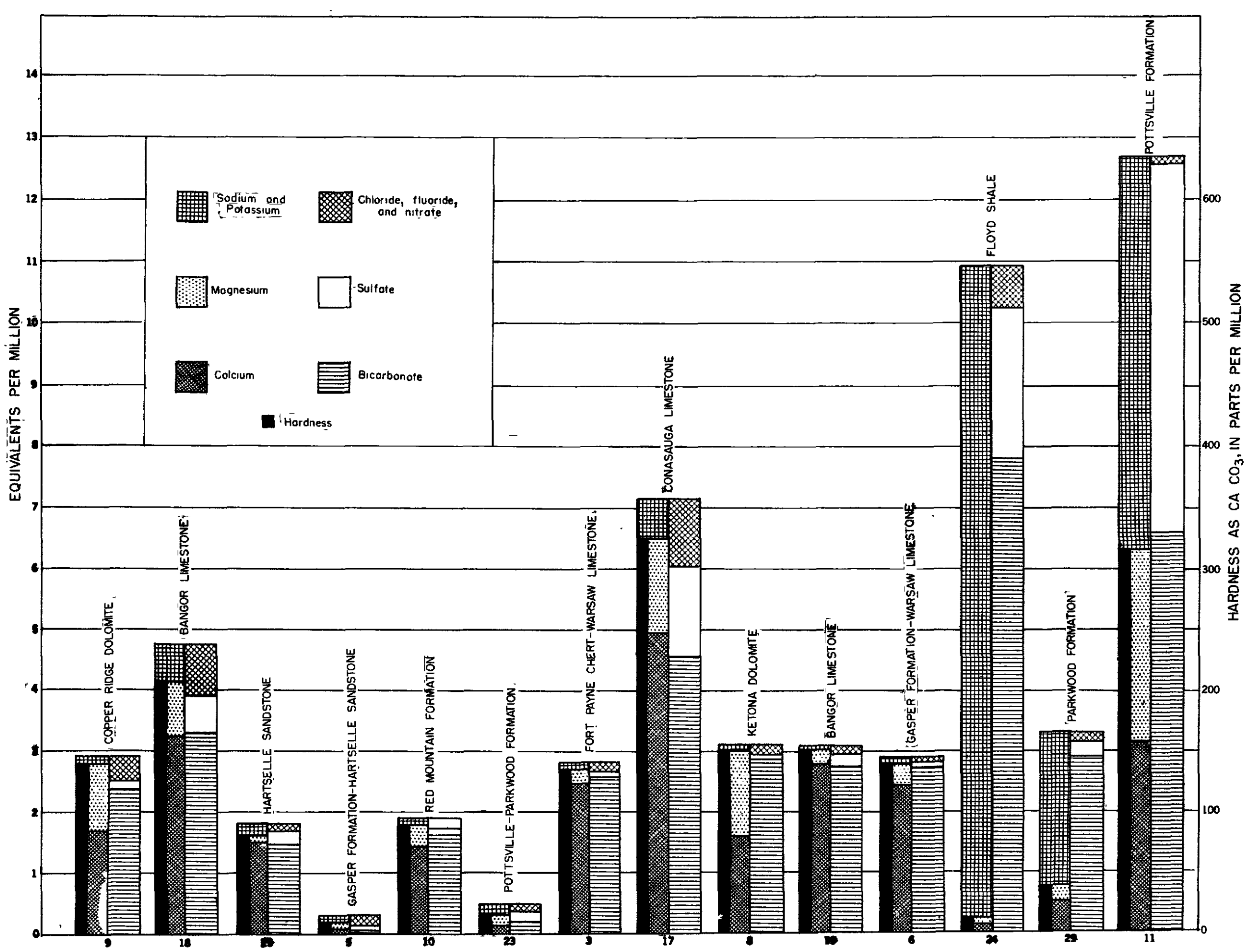

Figure 30.—Composition of selected ground waters in the Birmingham area.

Table 18.–Chemical quality of ground water in the Birmingham area

[Use of well: Ps, public supply; D, domestic; In, industrial; I, irrigation; N, none. Chemical analyses in parts per million]

Index no. plate 1	Location and owner	Use of well	Date of collection	Depth (feet)	Water-bearing formation	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25 C)	pH	Color	Temperature (F)
1	Greenwood - Greenwood.	Ps	Aug. 29, 1952	294	Fort Payne chert and Warsaw limestone.	10	0.75	65	7.2	6.3	1.0	171	45	8.5	0.0	0.4	237	192	52	377	7.5	5	70
2	Center Point - George Scott.	Ps	Aug. 28, 1952	159	Copper Ridge dolomite.	8.4	.02	29	14	.8	.2	145	1.2	2.8	.1	3.4	131	130	11	235	7.6	5	64
3	Trussville - Trussville.	Ps	Aug. 29, 1952	186.5	Fort Payne chert and Warsaw limestone.	5.1	.10	48	2.7	1.5	.7	152	2.2	3.2	.1	.9	143	131	6	245	7.6	5	63
4	Pinson - Wilder Construction Co.	Ps	Sept. 2, 1952	208.5	Ketona dolomite.	8.9	.12	32	16	1.2	.4	166	2.0	2.5	.0	3.2	148	146	10	268	7.6	6	64½
5	Irondale - Irondale.	Ps	Sept. 4, 1952	250	Gasper formation Hartselle sandstone.	8.2	.16	1.6	.9	2.6	.7	4	1.4	4.2	.1	5.1	28	8	4	36.9	5.0	4	64
6	Roebuck Plaza - A. J. Grefenkamp.	Ps	Sept. 17, 1952	320	Gasper formation and Warsaw limestone.	13	2.1	49	3.9	1.9	.8	170	3.4	2.5	.0	1.1	160	138	0	268	7.6	3	67
7	Hammond - (Sloss-Sheffield Steel & Iron Co. well 1).	Ps	Oct. 1, 1952	-	Fort Payne chert	11	.55	43	1.7	2.0	.4	131	2.2	2.2	.0	.7	128	114	7	218	7.5	5	65
8	Caldwell Spring - J. M. Knight (Robinwood supply).	Ps D	Oct. 2, 1952	Spring	Ketona dolomite.	9.7	.47	32	18	1.2	.6	175	1.6	2.8	.1	.5	153	154	10	278	8.0	5	62
9	Harvey Spring.	-	Oct. 1, 1952	Spring	Copper Ridge dolomite.	9.2	.34	34	14	2.0	.6	160	3.7	2.5	.1	3.2	149	142	11	259	7.5	6	62
10	Tel-Hop Drive-In.	Ps	Sept. 4, 1952	118	Red Mountain formation.	9.4	.71	30	3.8	1.2	.5	110	1.5	2.5	.0	.1	103	90	0	177	7.1	5	69
11	Black Diamond (Black Diamond Coal Mining Co.).	Ps	Sept. 17, 1952	Mine shaft	Pottsville formation.	12	1.9	64	38	147	3.8	403	277	3.0	.0	.2	756	316	0	1,090	7.0	6	68
12	Newcastle (Marc Levine Realty Co.).	Ps	Sept. 26, 1952	Mine shaft[1]	Pottsville formation.	14	2.9	24	11	75	3.1	287	28	3.8	.0	.4	305	105	0	491	8.0	5	65
13	Sloss Iron Ore mine (Sloss-Sheffield Steel & Iron Co.).	-	Sept. 8, 1952	Mine shaft[2]	-	17	1.4	17	5.6	1,030	20	1,520	292	550	.9	.7	2,690	66	0	4,250	7.9	45	-
14	Irondale Ice Co.	In	Sept. 3, 1952	210	Bangor limestone.	10	.14	58	3.2	3.4	.6	164	7.0	7.5	.1	8.9	186	158	23	301	7.5	4	64
15	Birmingham Ice & Cold Storage Co.	-	Sept. 26, 1952	-	Conasauga limestone.	11	.11	64	27	26	2.4	246	52	36	.0	20	372	270	69	613	7.3	5	65
16	Connors Steel Co.	In	Oct. 14, 1952	335	Ketona dolomite.	9.8	.68	45	22	3.7	.6	214	12	9.5	.0	5.3	213	203	27	366	7.8	7	65
17	Southern Dairies, Inc.	In	Sept. 2, 1952	440	Conasauga limestone.	11	.81	100	19	20	1.9	281	69	31	.0	17	425	328	98	633	7.2	5	68
18	Homewood Dairy Products Co.	In	Sept. 25, 1952	113	Bangor limestone.	14	.17	66	10	14	1.6	204	27	20	.1	13	281	206	39	448	7.3	6	65
19	W. B. Baker Dairy.	In	Oct. 10, 1952	126	Bangor limestone.	11	.33	55	2.7	2.4	.4	164	9.5	5.2	.0	1.5	169	148	14	278	7.6	5	62
20	Armour & Co. (meat packers).	In	Oct. 3, 1952	310	Conasauga limestone.	11	1.4	96	37	61	1.2	291	91	112	.1	20	582	392	153	963	7.3	5	62
21	Southern Railway System (Ernest Norris Yard).	-	Sept. 23, 1952	295	Hartselle sandstone.	8.8	.47	21	1.6	.8	.6	62	3.6	3.0	.0	1.8	77	59	8	123	6.6	4	63
22	Elmwood Cemetery.	I	Sept. 17, 1952	350	Ketona dolomite Little Shades sandstone of Poor.	10	.19	32	17	2.1	.9	161	1.2	5.2	.0	10	159	150	18	271	7.7	3	68
23	H. J. Tillia.	I	Sept. 19, 1952	175	Parkwood and Pottsville formations.	9.8	2.5	2.8	1.9	3.6	.9	14	5.6	4.0	.0	1.1	37	15	3	69.2	5.6	6	66
24	B. G. Wisenhunt.	D	Sept. 17, 1952	67	Floyd shale.	14	.22	1.4	1.1	242	1.1	[a]473	112	20	2.0	.0	639	8	0	994	8.8	6	-
25	Sloss-Sheffield Steel & Iron Co. flowing well 2.	N	Oct. 9, 1952	-	Warsaw limestone and Hartselle sandstone.	10	.17	31	1.2	2.4	.7	95	6.5	2.8	.1	1.0	103	82	4	161	7.4	5	63
26	Flattop coal mine (Sloss-Sheffield Steel & Iron Co.	N	Oct. 7, 1952	-	Pottsville formation.	18	1.4	112	75	518	5.6	308	1,320	14	.3	3.1	2,220	588	336	2,910	6.9	7	72

Table 18.–Chemical quality of ground water in the Birmingham area–Continued

Index no. plate 1	Location and owner	Use of well	Date of collection	Depth (feet)	Water-bearing formation	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25 C)	pH	Color	Temperature (F)
27	Dolomite coal mine (Woodward Iron Co.).	N	Oct. 9, 1952	Mine shaft[1]	Pottsville formation.	14	.25	111	74	603	8.5	324	1,540	9.0	.5	2.5	2,520	582	316	3,230	7.5	7	[4]68
28	Songo iron ore mine (Woodward Iron Co.).	N	Oct. 11, 1952	Mine shaft[5]	-	14	[6]2.5	13	2.4	67	4.0	[7]166	30	7.0	1.0	6.0	274	42	0	372	8.5	-	67
29	Flowing well, sec. 5, T. 19 S., R. 3 W.	-	Sept. 25, 1952	+1,100	Parkwood formation.	18	1.1	10	2.5	59	1.0	178	11	6.2	.1	.0	200	35	0	309	7.6	7	62

1 Drilled into mine shaft.
2 Sloss iron ore mines 1 and 2 (composite sample).
3 Includes equivalent of 23 ppm of carbonate (CO_3).
4 Not representative.
5 Sample remained turbid for one month. Unable to filter sample.
6 Total iron: 41 ppm.
7 Includes equivalent of 4 ppm of carbonate (CO_3).

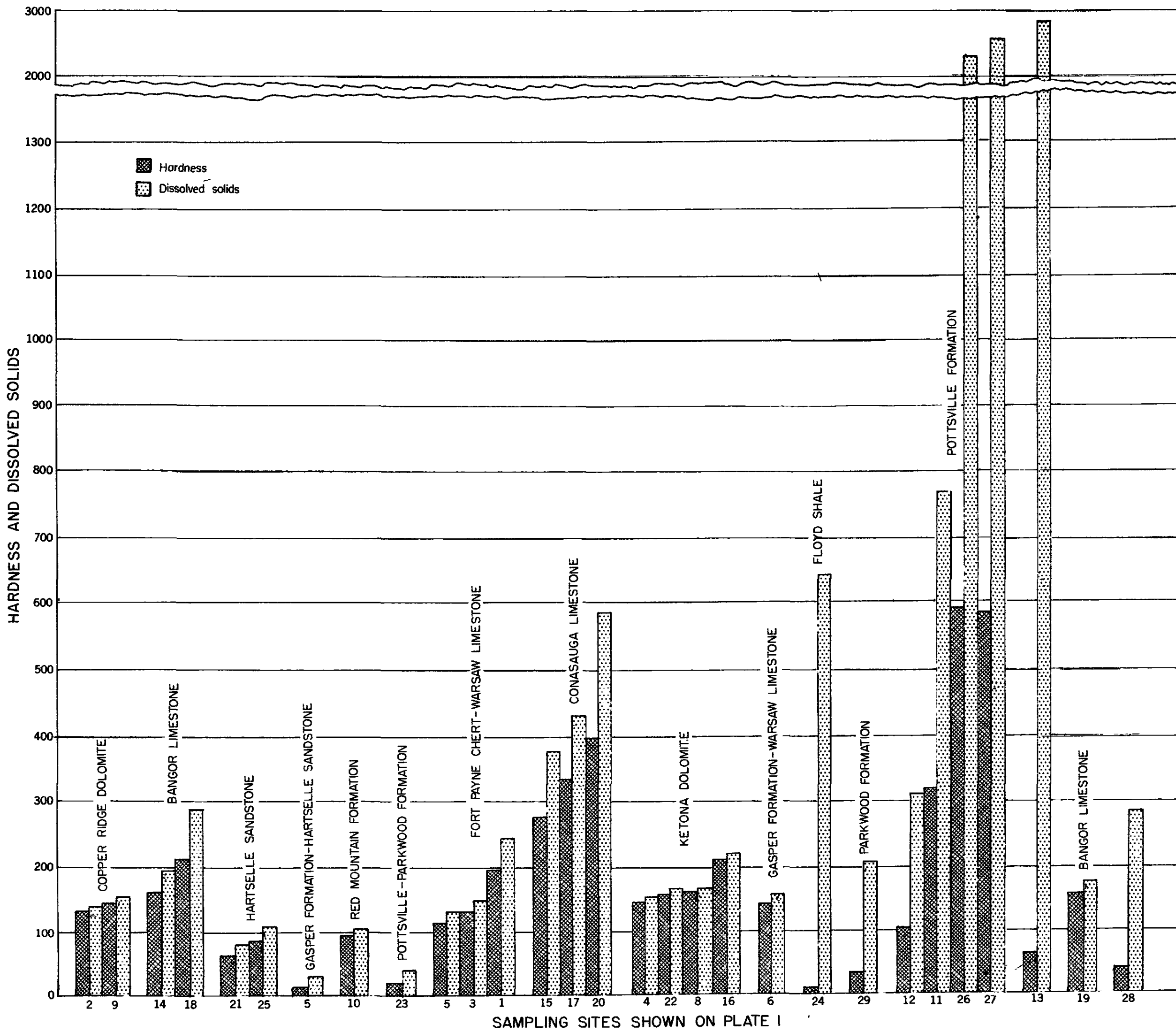

Figure 31.—Relation of hardness to dissolved solids of ground waters in the Birmingham area.

marily in relation to formations from which they are derived. The chemical characteristics of water taken from each water-bearing formation are shown in figure 30. Figure 31 shows the relation of total hardness to dissolved solids of ground waters in the area.

Cambrian system

Conasauga limestone.—The Conasauga limestone crops out in Jones and Opossum Valleys and is about 1,900 feet thick. This limestone is generally dark blue gray and massively bedded, but locally it is thin bedded and shaly. Good exposures of the Conasauga limestone can be seen a mile north of North Birmingham in the Lone Star Cement quarry.

The Conasauga limestone is a good aquifer, and wells are usually productive where extensive systems of solution cavities are penetrated. The Birmingham Ice & Cold Storage Co. at Avenue E and 22d Street South has a well yielding 300 gpm from this limestone. Another well in this aquifer formerly yielded about 200 gpm at the Air Reduction Sales Co. at the southside plant.

Water samples were obtained from three wells in the Conasauga limestone. The concentration of dissolved solids was moderately high, ranging from 372 to 582 ppm; the water was hard, ranging from 270 to 392 ppm. The hardness of the water was principally of a calcium and magnesium bicarbonate type (frequently referred to as temporary hardness), and the sulfate content was high. Each sample contained a larger amount of nitrate than is usually found in most waters, which may indicate pollution. The iron content of the three samples was 0.81, 0.11, and 1.4 ppm.

Cambrian and Ordovician systems

Ketona dolomite.—The Ketona dolomite crops out in Jones and Opossum Valleys. It is generally gray to tan, fine grained, locally dense, and massively bedded. The Ketona dolomite is well exposed at the Dolcito quarry, a mile north of Tarrant City, and is 400 to 600 feet thick in the Birmingham area.

The dolomite is a good aquifer, and wells at the Connors Steel Co., Armour & Co. (north-side plant), and at Elmwood Cemetery are each reported to pump more than 300 gpm from it. The formation is the source of the larger springs in the area that are used for industrial and municipal supply.

Chemical analyses were made of water samples from the Ketona dolomite collected from three wells, 208, 335, and 350 feet deep, and from one spring. The waters were fairly uniform in composition and were lower in mineral content than those from wells tapping the Conasauga limestone. Dissolved solids in the four water samples from the Ketona dolomite ranged from 148 to 213 ppm. The water was hard, 146, 154, 150, and 203 ppm. Samples collected from the Ketona dolomite showed that the water was low in iron, chloride, and sulfate.

Copper Ridge dolomite.—The Copper Ridge dolomite is about 2,000 feet thick. It is a light-gray fine-grained dolomite; in weathered outcrops it contains compact, dense, brittle angular chert. The thick mantle of angular fractured cherty residuum forms an excellent reservoir for ground water and feeds solution cavities in the underlying fresh dolomite. Good exposures of chert of the Copper Ridge dolomite can be seen on the road from Huffman north to Mount Pinson.

This formation is a good aquifer. Some wells developed in the cherty residuum and in solution cavities in the dolomite yield more than 150 gpm.

Two water samples from wells in the Copper Ridge dolomite were analyzed. The two samples had similar mineral contents, dissolved solids (131 and 149 ppm), and hardness (130 and 142 ppm). The quantities of sodium, chloride, sulfate, and iron were low.

Ordovician system

Attalla chert conglomerate member.—The Attalla chert conglomerate member of the Chickamauga limestone is a conglomerate consisting of angular to subangular sand-size to cobble-size chert particles with siliceous cement. It crops out in small scattered patches. Data were not obtained for any wells in this formation.

Chickamauga limestone.—The Chickamauga limestone crops out along Red Mountain from the vicinity of Bessemer northeastward past Irondale. This limestone is about 250 feet thick, light gray to dove colored, fine grained, dense, and hard. It is well exposed in the bluff southeast of Gate City where at one time it was quarried for flux. This limestone is not an important aquifer because of its extremely narrow outcrop and the fact that, where buried, it lies beneath the relatively impervious Red Mountain formation.

Silurian system

Red Mountain formation.—The main exposures of the Red Mountain formation are in Red Mountain. This formation consists of sandstone, shale, and calcareous and siliceous iron-ore beds; it is 200 to 300 feet thick in this area. Most of the iron ore smelted in the furnaces in the Birmingham area is mined or stripped from Red Mountain. This formation is not generally considered a good aquifer because of the relatively large thickness of impervious shale and the prevailing low permeability of the sandstone.

One water sample was collected from the Red Mountain formation from the well at the Tel-Hop Drive-In near Irondale. This sample contained 103 ppm of dissolved solids and had a hardness of 90 ppm. The water was predominantly of the calcium bicarbonate type and was low in sodium, sulfate, and chloride. The iron content (0.71 ppm) was higher than desirable for most uses.

Devonian system

Frog Mountain sandstone.—The Frog Mountain sandstone crops out along Red Mountain above the Red Mountain formation and in some places along west Red Mountain where it has not been removed by faulting and erosion. This sandstone is brown and yellow, fine grained, and massively bedded. The formation is not a good aquifer because the sandstone is well cemented and 22 feet or less in total thickness.

Chattanooga shale.—The Chattanooga shale in the Birmingham area is not more than 1 foot thick. It is varicolored, and clayey in the upper 4 to 5 inches. It is important as a geologic marker to use in test drilling.

Carboniferous system, Mississippian series

Fort Payne chert.—The Fort Payne chert is exposed along Red Mountain and west Red Mountain. The chert is varicolored, commonly iron stained, and thin to medium bedded. Many weathered outcrops contain chert which shows bedding and well-developed solution cavities containing sandy clay filling. Sample logs indicate that the Fort Payne is about 100 feet thick in this area. The Fort Payne chert is a good aquifer and is often developed with the overlying Warsaw limestone. Several wells yield more than 100 gpm of water from these formations. Both formations contain solution cavities and fractures which allow the ready passage of water. The municipal wells at Trussville and Greenwood tap these two formations.

The Fort Payne chert and Warsaw limestone yield waters which predominate in calcium bicarbonate. Other mineral constituents are usually very low. The water samples contained from 128 to 237 ppm of dissolved solids. The quantities of chloride, nitrate, and fluoride were low; the iron was less than 0.80 ppm.

Warsaw limestone.—The Warsaw limestone crops out on the southeast of Red Mountain between the Fort Payne chert and a ridge formed by the Hartselle sandstone. An incomplete exposure of the Warsaw limestone is found in a railroad cut between Irondale and Gate City where it is light gray, coarse grained, crystalline, and thick bedded. Sample logs indicate that the Warsaw is about 100 feet thick in the Birmingham area. This limestone is a good aquifer because of well-developed solution cavities and fractures.

One sample was collected from a well reported to be yielding from both the Gasper formation and the Warsaw limestone. The chemical content of this water sample was similar to that from the Fort Payne and Warsaw formations—it was predominantly of the calcium bicarbonate type, and low in magnesium, sodium, sulfate, chloride, and nitrate. The iron content of the water, however, was above the acceptable limit for municipal use.

Gasper formation.—The Gasper formation crops out above the Warsaw limestone along the southeast slope of Red Mountain. This formation is about 100 feet thick and consists of shale and thin beds of sandstone. A good exposure of the Gasper formation is at Walker Gap where it is a predominantly light-gray sandy massively bedded shale.

In the immediate vicinity of Birmingham the Gasper formation is predominantly shale and is not a good aquifer. Near Roebuck Plaza the Gasper contains beds of limestone with solution cavities in which a well capable of yielding 230 gpm has been developed.

Hartselle sandstone.—The Hartselle sandstone forms a prominent ridge trending northeast from the vicinity of Bessemer past Trussville. This sandstone is 75 to 100 feet thick. It consists of white to tan, locally iron-stained, thin-bedded to massively bedded fine- to medium-grained sandstone. Good exposures of this sandstone may be seen along Sandstone Ridge from Walker Gap to Irondale.

The Hartselle sandstone is a good aquifer where it is friable, and many wells have been developed in this formation. A flowing well yielding water from the Hartselle and the underlying Warsaw limestone has been flowing for more than 50 years. The municipal well at Irondale, capable of yielding 200 gpm, produces from this formation and possibly from the Gasper formation. One of the wells drilled for the Ernest Norris Yard of the Southern Railway System at Irondale was developed in this formation and the Fort Payne and Warsaw formations. This well flowed 50 gpm and has been pumped at 495 gpm.

Water from these three wells was only slightly mineralized and hardness was less than 100 ppm.

Bangor limestone.—The Bangor limestone forms a valley similar to that formed by the Warsaw limestone. The Bangor limestone is 100 to 300 feet thick and is light gray, coarsely crystalline, and thick bedded. It is a good aquifer. A well at the W. B. Baker Dairy on Montevallo Road is capable of yielding 200 gpm, and two wells at the Homewood Dairy Products Co. furnish about 50 and 60 gpm.

Water samples from these three wells showed that this limestone yields typical calcium bicarbonate type water which contains 169 to 281 ppm of dissolved solids. The waters were hard, 148, 158, and 206 ppm. The quantities of magnesium, sodium, sulfate, chloride, and nitrate were low.

Floyd shale.—The Floyd shale is well exposed in road cuts in the vicinity of Bessemer in Shades Valley. Northward this shale grades laterally into the Gasper formation, the Hartselle sandstone, and the Bangor limestone. The Floyd is about 1,200 feet thick and is tan and brown with occasional iron stains. It is flaky and soft, and it contains scattered silty sandstone layers 1 to 2 inches thick.

The shale is not a good aquifer, but many domestic wells yield water from sandstone beds in this formation. The B. G. Wisenhunt well, about a mile south of Muscoda, is reported to be capable of yielding 30 gpm from a sandstone bed in the shale. Water from this formation generally has a strong odor of hydrogen sulfide.

A sample of water from the Floyd shale showed that the water yielded by this formation differs greatly from that of other formations in the area—the water was predominantly of the sodium bicarbonate type with a high sulfate and a low calcium, magnesium, chloride, and nitrate content. The water was extremely soft. It had a fluoride content of 2.0 ppm and a comparatively high amount of dissolved solids, 639 ppm.

Parkwood formation.—The Parkwood formation is exposed along the base of Shades Mountain and occupies the lower part of an escarpment overlooking Shades Valley. This formation consists of about 2,000 feet of sandstone and shale, the shale generally predominating. The shale is dark gray, weathering to various shades of brown, very fine grained, dense, hard, and flaky. It contains scattered sandstone ledges. The sandstone is olive drab, fine grained, and bonded with tough siliceous cement. The Little Shades sandstone (Poor, 1940), 70 to 80 feet thick, lies at the base of the Parkwood (Mississippi Geological Society, 1940). Wells in this formation generally do not yield more than enough water for home use.

The Parkwood formation yields water similar in quality to that of the Floyd shale. It is a sodium bicarbonate type water in which the sulfate exceeds the chloride, and it is low in calcium and magnesium. The sample collected was reported to have a slight odor of hydrogen sulfide. The analysis does not show the iron content to be abnormally high.

Carboniferous system, Pennsylvanian series

Pottsville formation.—The Pottsville formation is exposed at the crest of Shades Mountain and to the southeast. This formation contains several units of conglomerate, sandstone, shale, and coal in the Warrior, Cahaba, and Coosa coal fields where it is 2,600, 9,000, and 7,500 feet thick, respectively.

The sandstones and conglomerates in the Pottsville formation may be considered fair aquifers where weathering has loosened sand grains from their cementing material. The shale beds in this formation are not good aquifers. The H. J. Tillia well on the crest of Shades Mountain, about a quarter of a mile northeast of where U. S. Highway 31 crosses Shades Mountain, was reported by the driller to be capable of producing 165 gpm. This well received water from a sandstone at the bottom of the Pottsville formation and from the Parkwood formation below. It is most probable that the well penetrated a large fissure in the sandstone which is fed by ground water passing through other connecting fissures. Except for the excessive quantity of iron, this well yields water of excellent quality that is extremely soft; however, water samples taken from coal mines were of much poorer quality. (See below.)

Several wells in the Warrior coal field, such as the municipal wells at Brookside and Trafford, are reported to yield 100 gpm or more from the Pottsville. The yield of wells in this formation, however, is extremely variable.

Mines as a source of water

Worked and abandoned coal and iron-ore mines are a potential source of large quantities of ground water. During the active life of the mines this water is pumped to the surface and is used for small public or industrial supplies or is discharged as waste.

Coal mines.—Large areas have been mined out and abandoned in the Warrior coal field and have filled, or are filling up, with water. Several groups of mines have been pumped, or are being pumped, to dewater for mining activities. Water was pumped from one group of mines at a rate of about 5 mgd before it was closed down.

The amount of water available in the mines is not known. The areas that will be mined out in the future will greatly enlarge the storage capacity. Faults and other fractures in the rocks exposed by the mine workings have variable water-bearing characteristics. Detailed studies of the geology and occurrence of ground water in the mine areas would be necessary to determine the quantity of water available.

Water samples collected from the coal mines yielding from the Pottsville formation showed a great variation in quality. Dissolved solids in the samples were 305, 756, 2,220, and 2,520 ppm, and the iron content was 1.9, 2.9, 1.4, and .25 ppm. The waters are predominantly of the sodium bicarbonate and sulfate type. Although the waters contain large quantities of sodium, usually they are extremely hard. As these waters were from coal-mine shafts, the high sulfate concentration was probably derived by the oxidation of the pyrite contained in the coal. The pH of the four samples was 7.0, 8.0, 6.9, and 7.5.

Iron-ore mines.—The general area mined for iron ore extends from the crest of Red Mountain southeastward under Shades Valley and Shades Mountain. This area has not been completely mined out. Several million gallons of water is pumped from the mines each day. Most of this water is pumped into creeks in Shades Valley and Jones Valley, and a small part is used in the mining camps. Water pumped into Valley Creek in Jones Valley is available for industrial uses downstream. The exact amount of water pumped from iron-ore mines was not known at the time of writing this report.

Water in the mines probably is not from the Red Mountain formation, and mining engineers in the area generally assume that water is supplied to the mines through fractures extending from the mines into the water-bearing Fort Payne chert and Warsaw limestone.

A safe estimate indicates that much more than 10 mgd is pumped from the iron-ore mines. The quantity of water available from the ore mines in the future will depend on hydrologic conditions in the aquifers supplying ground water to the mines.

Two water samples were collected from iron-ore mines. The sample collected on the second day of pumping after the Songo mine had been flooded was highly colored and turbid, and it remained turbid for more than a month after collection. Except for the turbidity and the iron content which was 41 ppm, the quality of the water was good. Sodium, bicarbonate, and sulfate were the principal constituents in solution. A composite was made of water samples from Sloss mines 1 and 2. The composite sample contained mostly sodium bicarbonate but had high sulfate and chloride contents.

Potential Development

Aquifers

A reconnaissance survey of the ground water in the Birmingham area indicates that this resource has not been fully developed.

The Ketona dolomite and Conasauga limestone are good aquifers. Wells in these formations yield as much as 350 gpm. Additional wells in these formations could be drilled in the area. The Copper Ridge dolomite would be expected to have yields comparable to the Ketona and Conasauga. The only way to determine whether 350 gpm represents the maximum potential yield of a well in any of these formations is to conduct a test-drilling and test-pumping program. Such a program would determine pumping rates and spacing of wells so that interfering cones of depression could be avoided. The Fort Payne chert and Warsaw limestone together compose an aquifer from which wells yield 180 gpm or more. Additional wells could be developed in these formations. Test drilling and pumping would indicate the best development program for ground-water supplies from this aquifer. The Hartselle sandstone and sandstone in the Pottsville formation generally do not yield large quantities of water. However, the Hartselle alone yields more than 100 gpm to some wells, and a larger amount in combination with other aquifers. The Hartselle can be developed with the Fort Payne and Warsaw formations and the Bangor limestone in many areas. Several wells having yields in excess of 100 gpm have been finished in the Pottsville formation; however, these wells seem to be exceptional. From the information available, most wells in the Pottsville yield less than 60 gpm.

These formations, in order of importance as sources of ground water, are as follows: Ketona dolomite, Conasauga limestone, Copper Ridge dolomite, Fort Payne chert and Warsaw limestone, Hartselle sandstone, and Pottsville formation.

Abandoned coal mines and iron-ore mines in the area contain large quantities of water that is limited in use by its chemical content. Large amounts of water have been pumped from the mines, and they must be considered a potential source of ground water. The most extensive abandoned mines are in the Warrior coal field and in the Red Mountain iron-ore area; little is known of the ground-water potential in mines in the Cahaba and Coosa coal fields. Whether this source of water will ever be developed to any extent, will depend on economic factors.

The best areas for ground-water development are in the outcrop of the Conasauga limestone and Ketona dolomite in Jones and Opossum Valleys. Flowing wells could be drilled in the Fort Payne chert, Warsaw limestone, Hartselle sandstone, and Bangor limestone in Shades Valley. In the part of the valley southeast of Sand Ridge and Sandstone Ridge flowing wells can be developed under favorable topographic conditions. The areas in which mine water could be developed are defined by the extent of abandoned and worked mines.

Quality of ground water in the Birmingham area

Generally the ground waters in the Birmingham area are of poorer quality than the surface waters. Waters from the Conasauga limestone, Ketona dolomite, Copper Ridge dolomite, Fort Payne chert and Warsaw limestone, Bangor limestone, Gasper formation and Warsaw limestone, and Pottsville formation are usually moderately hard to extremely hard; calcium and magnesium bicarbonate are the predominant constituents. In some waters the hardness nearly equals the dissolved solids (fig. 31). Iron is usually low in most of the water-bearing formations; an exception to this is the Pottsville formation. The Floyd shale and the Parkwood formation yield sodium bicarbonate type waters that are high in sulfate and low in calcium, magnesium, chloride, and nitrate. The water from the Pottsville formation is generally characterized by high sodium bicarbonate and sulfate, and it is extremely hard.

WATER LAWS

The State of Alabama exercises some control over pollution of streams but has no laws controlling the use of water and none that requires supervision or approval of water diversion projects. Thus the common-law riparian doctrine is the only one that may be said to govern the use of water in the State.

This doctrine as applied to Alabama recognizes the right of the owner of land that is adjacent to a stream to make reasonable use of the water. He may use it for domestic and household purposes and for watering stock. In most places, also, he is entitled to make such use of it for irrigation as may be reasonable in relation to the similar requirements of riparian landowners. Strictly speaking, he is entitled to have the stream flow along his property undiminished in quantity and unimpaired in quality by upstream uses, but he is obligated to his downstream neighbor in the same way.

The Federal Government, however, has very substantial control over streams in the Birmingham area. This control stems from various powers which the Federal Government has retained for its protection in areas where Federal development programs exist or have been authorized. Thus the development of a major diversion in the Black Warrior River basin, where Federal developments now exist, or in the Coosa River basin, where Federal developments have been authorized, would require the consent of the Federal Government before such a development could be initiated.

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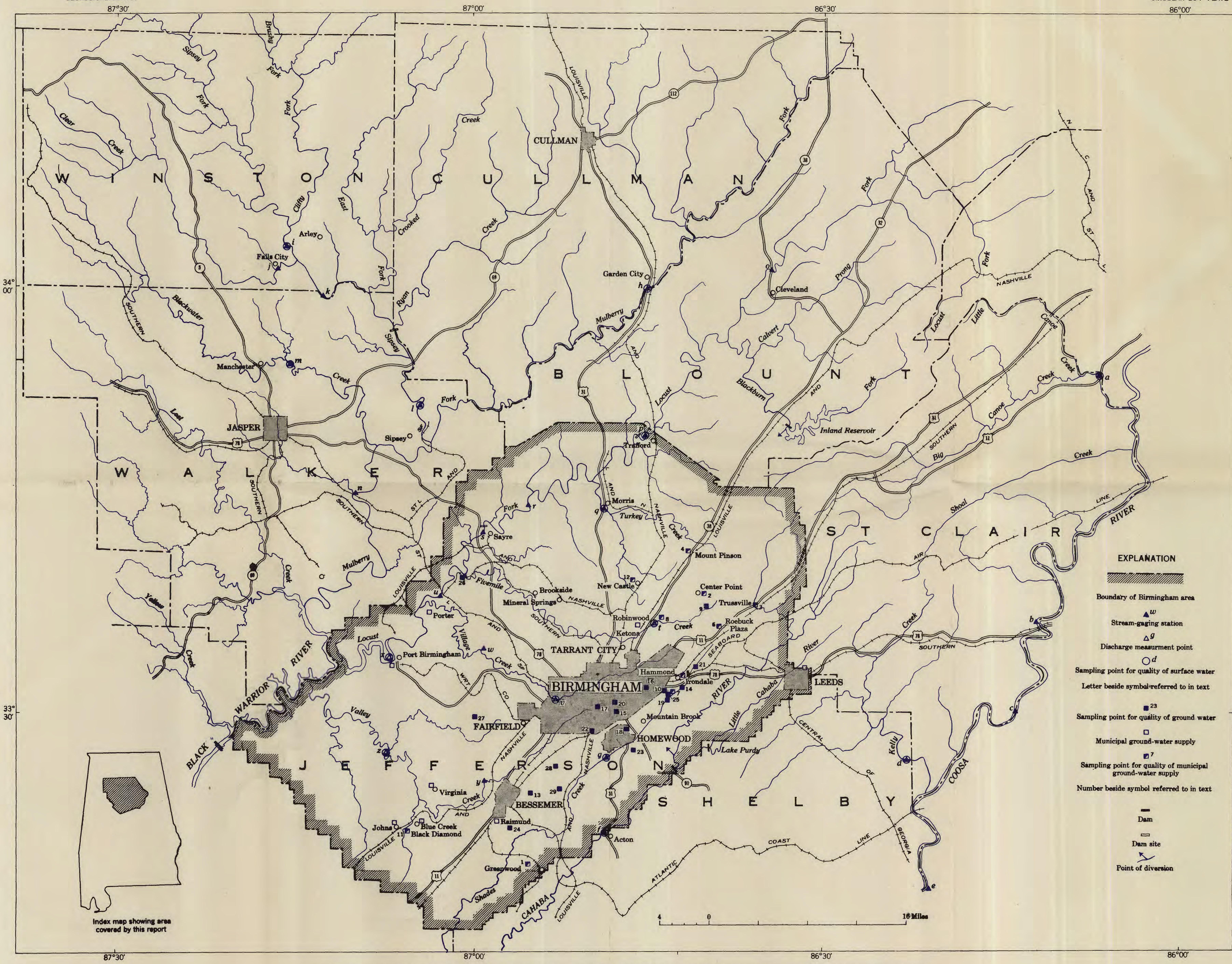
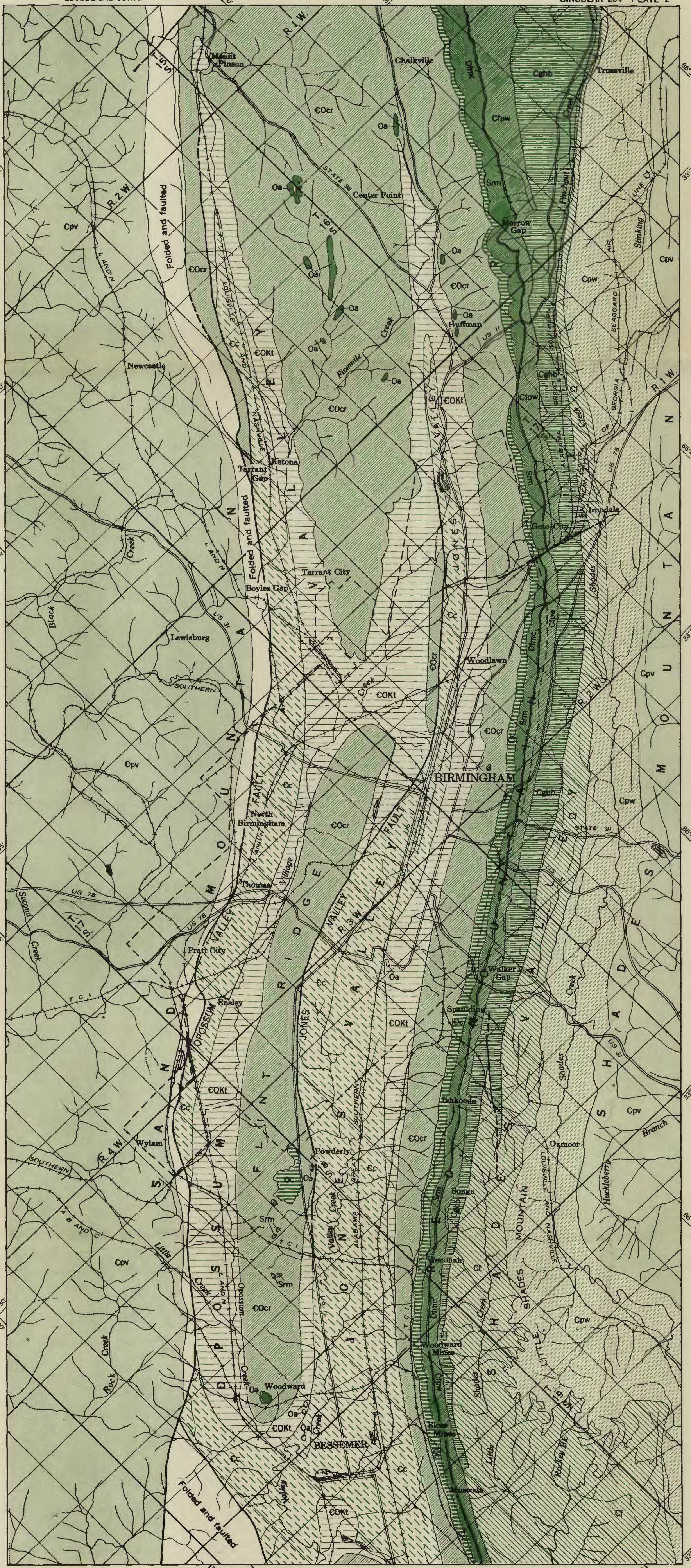


MAP OF THE BIRMINGHAM AREA, ALABAMA, SHOWING SOURCE OF WATER-RESOURCES DATA



Geology modified from Charles Butts

EXPLANATION

SEDIMENTARY ROCKS

CARBONIFEROUS

Pennsylvanian

Cpv — Pottsville formation
Sandstone, shale, coal, and conglomerate. Sandstones are aquifers

Mississippian

Cpw — Parkwood formation
Gray shale and sandstone, with Little Shades sandstone (of Poor) is at base. Poor aquifer

Cf / Cghb — Floyd shale
Shale with scattered sandstone beds.
Between Bessemer and Trussville grades into Cghb, Gasper formation, Hartselle sandstone, and Bangor limestone. Floyd shale is a poor aquifer; Gasper formation alone is a poor aquifer but with Hartselle or Warsaw formation is a good aquifer; Hartselle and Bangor formations are good aquifers

Cfpw — Fort Payne chert and Warsaw limestone
Bedded and fractured chert overlain by cavernous limestone. Good aquifer usually considered as a unit

DEVONIAN

Dfmc — Frog Mountain sandstone and Chattanooga shale
Dense sandstone overlain by thin shale. Not aquifers

SILURIAN

Srm — Red Mountain formation
Sandstone, shale, and iron-ore (hematite) beds. Generally a poor aquifer

ORDOVICIAN

Oc / Oa — Chickamauga limestone
Massive dense limestone with Oa, Attalla chert conglomerate member locally at base. Not developed as an aquifer

CAMBRIAN AND ORDOVICIAN

€Ocr — Copper Ridge dolomite
Cherty dolomite forming very cherty soil. Good aquifer

€OKt — Ketona dolomite
Fine-grained massive dolomite. Good aquifer

CAMBRIAN

€c — Conasauga limestone
Thin-bedded and massive limestone. Good aquifer

Contact

Fault

MAGNETIC NORTH
TRUE NORTH
2½°

APPROXIMATE MEAN DECLINATION 1932

GEOLOGIC MAP OF BIRMINGHAM AREA, ALABAMA