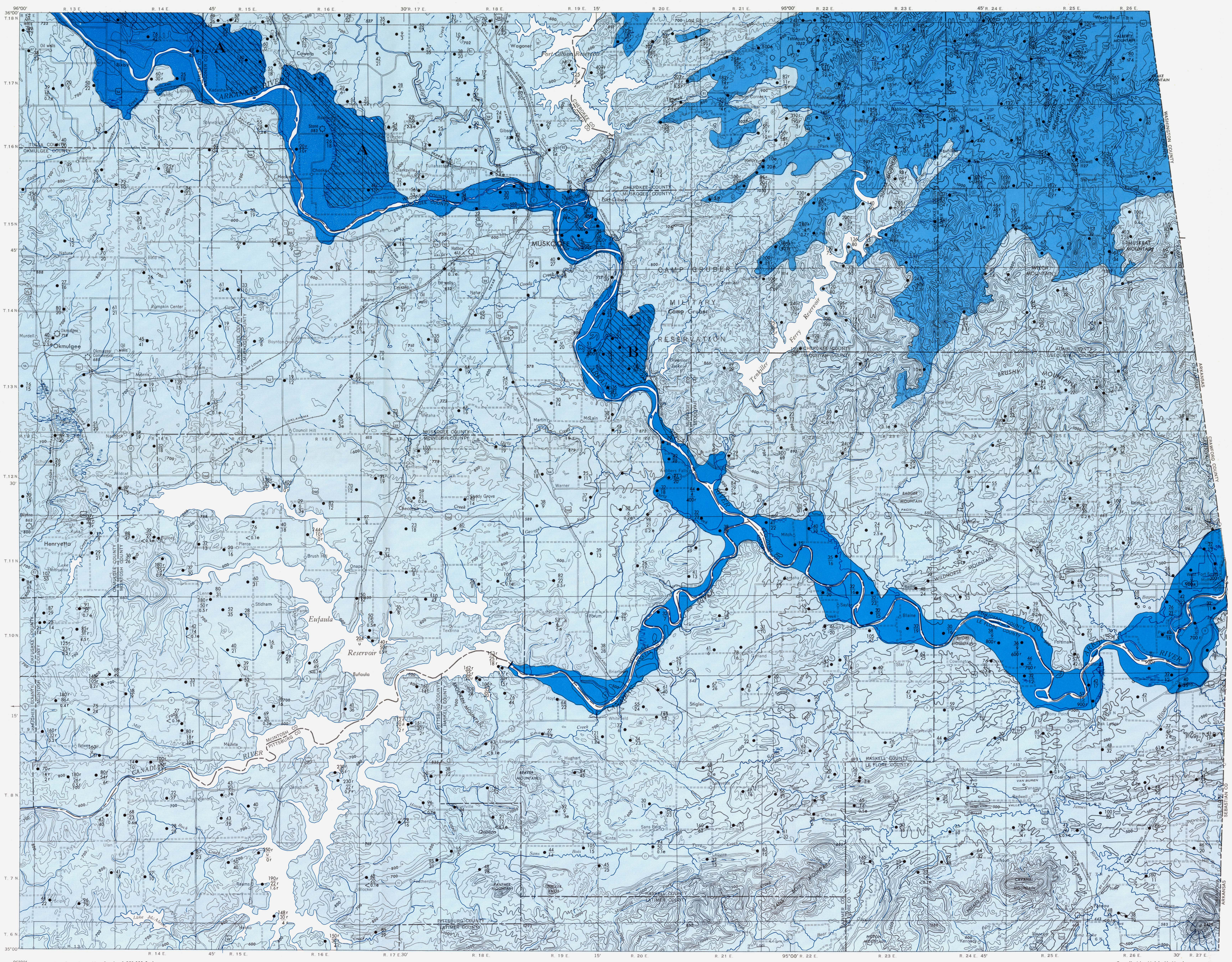


EXPLANATION

Most favorable for ground-water supplies

This area includes alluvium along the Arkansas and Canadian Rivers and some terrace deposits along the Arkansas River. Wells in alluvium along the Arkansas River are reported to yield up to 900 gpm (gallons per minute); larger yields might be obtained locally. Alluvium along the Canadian River is untested, but yields comparable to those from alluvium of the Arkansas River probably could be obtained. Area A, shown by diagonal lines in Tulsa and Wagoner Counties, is underlain by terrace deposits, up to 60 feet thick, that are reported to yield as much as 125 gpm locally. Area B, shown by diagonal lines near Braggs, is also underlain by terrace deposits, up to 90 feet thick, that may yield up to 100 gpm.

Moderately favorable for ground-water supplies

This area is underlain by the Keokuk and Reeds Spring Formations and, in T. 13 N., R. 23 E., by rocks of pre-Mississippian age. Wells in the Keokuk and Reeds Spring Formations are reported to yield as much as 20 gpm and, locally, more. A few springs yield several hundred gallons per minute. Some of the limestones and sandstones, particularly the Burgen Sandstone in T. 13 N., R. 23 E., and in the vicinity of Qualls, are reported to yield up to 20 gpm.

Least favorable for ground-water supplies

The area is underlain by shale, siltstone, and sandstone of Pennsylvanian age and by terrace deposits mainly along the shores of Eufaula Reservoir. Most wells in the shale, siltstone, and sandstone yield only a fraction of a gallon per minute to a few gallons per minute. A few wells are reported to yield as much as 20 gpm. In local areas, terrace deposits along Eufaula Reservoir may yield 10 gpm or possibly more.

• 38/5/1

Well

Upper number is depth of the well in feet; middle number is depth to water in feet below land surface in 1966 and 1967; lower number is yield of the well in gallons per minute. e = estimated value, r = reported value, f = flowing well, + = height of water level above ground level, u = unknown.

• 3e

Spring

Number beside spring symbol is yield in gallons per minute. e = estimated yield. Yield data obtained in 1966.

AVAILABILITY OF GROUND WATER

Information used to determine the availability of ground water was obtained in the field and from other Federal agencies. Information obtained in the field included depth of well, depth to water, and, whenever possible, yield and well-construction data on about 400 wells and yields of 20 representative springs. Records on about 400 additional wells in Adair, Cherokee, McIntosh, and Okmulgee Counties were provided by the U. S. Public Health Service. Similar records of another 200 wells along the shores of Eufaula, Tenkiller Ferry, and Fort Gibson Reservoirs were provided by the U. S. Army Corps of Engineers. Data concerning wells and test holes in the alluvium along the Arkansas River were taken from an open-file report prepared by the U. S. Geological Survey for the U. S. Army Corps of Engineers. To supplement the data on well yields provided by well owners, recovery tests were made on 60 wells.

Ground water in the Fort Smith quadrangle is derived from precipitation falling directly upon the area. The average annual precipitation is about 41 inches; hence, nearly 2,200 acre-feet falls on each square mile each year. Of this amount, an estimated 5 to 25 percent, or about 110 to 550 acre-feet per square mile, enters the soil and seeps downward to become ground water.

The thickness and permeability of the soil and the permeability and storage capacity of the underlying rocks are important factors controlling the amount of water entering the ground-water reservoir. In those parts of the area underlain by shale and similar rocks, the soil is generally thin and poorly permeable so it cannot soak up much water, and rainfall runs off quickly. In some areas where the soil is capable of soaking up large amounts of water, fractures in the underlying rocks can store only relatively small amounts of water; thus, yields from wells penetrating these rocks are small. Although substantiating data are meager, an estimated 20 percent of the wells drilled into such rocks will not yield sufficient amounts of water for domestic use. Of those wells that do yield water, the estimated average yield is about 0.5 gpm (gallons per minute).

In those parts of the area underlain by fractured chert and associated limestone, shown as the Keokuk and Reeds Spring Formations on the geologic map (sheet 1), the soil is stony and permeable, and the underlying rocks contain many interconnected fractures that accept and store large amounts of water. An estimated 95 percent of the wells drilled into these rocks yield enough water for domestic use. Yields greater than 20 gpm have been reported, but the average yield is about 5 gpm. In some places in Adair, Cherokee, and Sequoyah Counties, solution channels are the source of water from limestone below the Keokuk and Reeds Spring Formations. Because these solution channels vary greatly in size and are erratic in distribution, yields, which may differ markedly in wells only a few hundred feet apart, are difficult to predict. Yields from these rocks are reported to be as much as 10 gpm.

In a few places in Adair, Cherokee, and Sequoyah Counties, the Burgen Sandstone is the source of water to wells. These wells are reported to yield as much as 10 gpm, but most yield only about half this amount. Alluvium and, locally, terrace deposits are the most important source of water in the Fort Smith quadrangle because openings in these deposits are more numerous and better connected than in other types of rocks. The lower part of the alluvium along the Arkansas River consists of coarse sand and fine gravel, and, where this material is as much as 15 feet thick, yields of up to 900 gpm have been reported. Similar yields probably could be obtained locally from alluvium along the Canadian River, but substantiating data are not available.

Reports describing ground-water conditions in parts of the Fort Smith quadrangle are listed below:

Motts, W. S., 1963, Water resources of Okmulgee County, *pt. II of* Geology and water resources of Okmulgee County, Oklahoma: Okla. Geol. Survey, Bull. 91, p. 81-123.

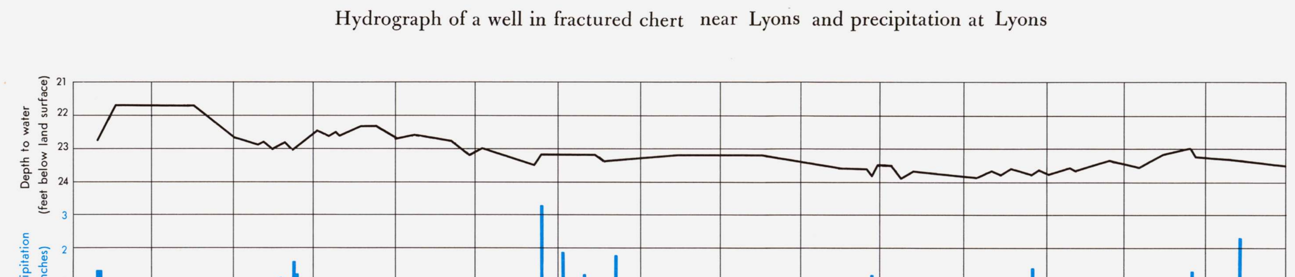
Oakes, M. C., 1952, Geology and mineral resources of Tulsa County, Oklahoma (includes parts of adjacent counties), with section on Oil and gas by G. S. Dille, and Water resources by J. H. Warren: Okla. Geol. Survey, Bull. 69, 234 p.

Schoff, S. L., and Reed, E. W., 1951, Ground-water resources of the Arkansas River flood plain near Fort Gibson, Muskogee County, Oklahoma: Okla. Geol. Survey, Circ. 28, 55 p.

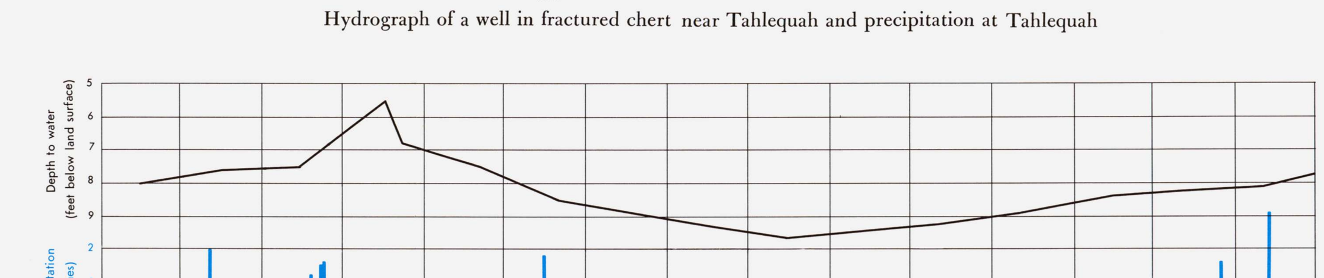
Tanaka, H. H., and Hollowell, J. R., 1966, Hydrology of the alluvium of the Arkansas River, Muskogee, Oklahoma, to Fort Smith, Arkansas: U. S. Geol. Survey, Water-Supply Paper 1809-T, 42 p.

Hydrograph of a well in fractured chert near Lyons and precipitation at Lyons

Hydrograph of a well in fractured chert near Tahlequah and precipitation at Tahlequah



Hydrograph of a well in shale and sandstone near Muskogee and precipitation at Muskogee

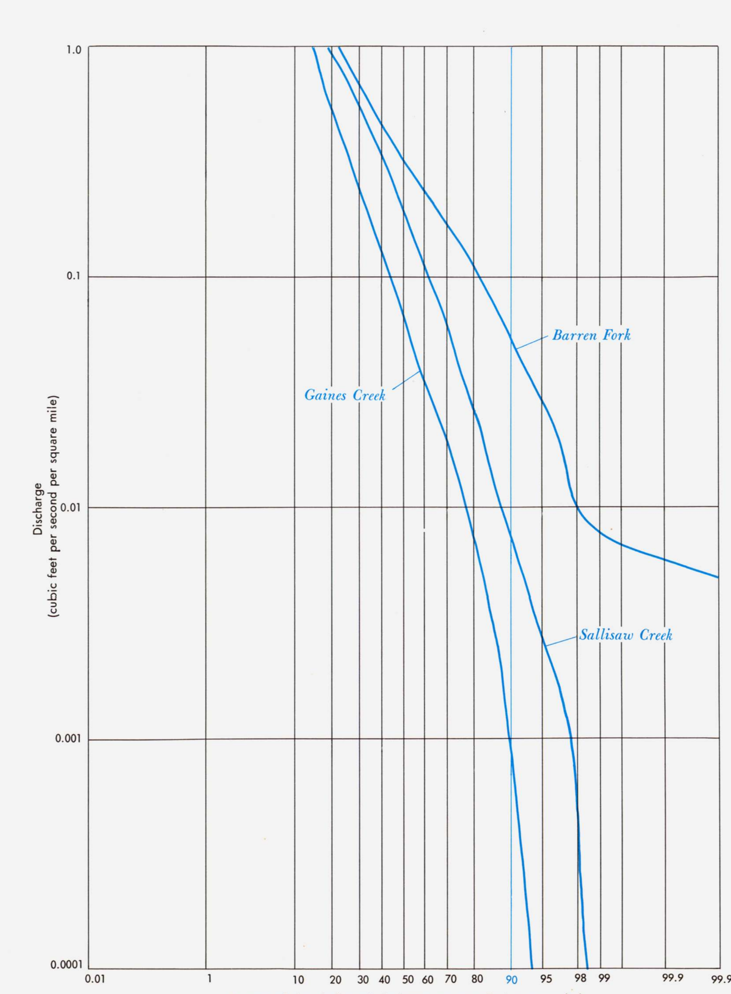


Hydrograph of a well in terrace deposits near Hanna and precipitation at Hanna

Hydrographs Show Seasonal Changes in Water Levels.—Although most rain falls during the spring and summer months, water-level graphs show that most ground-water recharge takes place during late winter and early spring when vegetation is dead or dormant and evaporation and transpiration are at a minimum. Thus water levels, as shown by the hydrographs, are higher in early spring and lower in late spring or early summer. Water levels continue to decline during the summer until late autumn, when they begin to rise as evaporation and transpiration decrease. During the summer months intermittent rains of an inch or so produce only a slight, temporary rise in water levels.

Water levels in fractured and weathered chert rise rapidly in response to rainfall and decline nearly as rapidly, indicating that the permeability of these rocks is sufficient to permit rapid recharge and lateral movement within the ground-water reservoir. The hydrograph of a well in fractured chert at Lyons shows this rapid response. The hydrograph of the well near Tahlequah shows a similar response, but short-term effects are not evident because the well was measured only monthly. In contrast, the water level in a well in shale and sandstone (hydrograph at Muskogee) shows little response to rainfall, suggesting that fractures through which recharge can enter near the well are few or restricted or that the source of recharge is at a considerable distance from the well.

Short-term response to rainfall is not readily apparent in the hydrograph of a 15-foot well in terrace deposits near Hanna because the water level is measured monthly. If continuous or daily measurements were available, response to rainfall probably would be apparent. This hydrograph, however, illustrates the seasonal trend in the water level in these deposits. Hydrographs of water levels in alluvium have similar trends.



Flow Duration Curves of Streams Draining Different Geologic Terranes

Streamflow Duration Curves Provide a Way of Comparing the General Storage Characteristics of Different Rock Types.—During periods of low flow, streams are fed by ground water draining from rocks underlying the stream basins. The figure shows parts of the flow-duration curves for three streams in the Fort Smith quadrangle, each of which drains a different type of geologic terrane. Barren Fork drains an area underlain mostly by the Keokuk and Reeds Spring Formations. The basin of Sallisaw Creek is underlain mainly by Pennsylvanian shale, siltstone, and sandstone, but part of the basin is underlain by Keokuk and Reeds Spring and older formations. Gaines Creek drains an area entirely underlain by Pennsylvanian shale, siltstone, and sandstone.

The steep slope of the duration curve for Gaines Creek shows that the rocks underlying its basin have limited storage capacity and thus cannot provide water to maintain streamflow during dry periods. The slope of the curve for Sallisaw Creek is similar to that for Gaines Creek, but the displacement of the curve to the right is probably largely due to the availability of ground water from the Keokuk and Reeds Spring and older formations that underlie part of the basin. The curve for Barren Fork differs markedly from the other curves because the rocks underlying its basin have a much greater storage capacity and thus can provide water to maintain streamflow during dry periods. The value of the discharge that is equaled or exceeded 90 percent of the time (Q_{90}, taken from the flow-duration curves) is commonly used to compare the effects of basin geology. Q_{90} for Barren Fork is 0.06, which is about 8 times greater than that for Sallisaw Creek (0.008) and 60 times greater than that for Gaines Creek (0.001).

RECONNAISSANCE OF THE WATER RESOURCES OF THE FORT SMITH QUADRANGLE, EAST-CENTRAL OKLAHOMA

Melvin V. Marcher

1969

Cartographers: W. Eunson Jr., Marion E. Clark, and Roy D. Davis, Oklahoma Geological Survey