

Figure 1.--Physiographic areas in Arkansas. (From Fenneman, 1946).

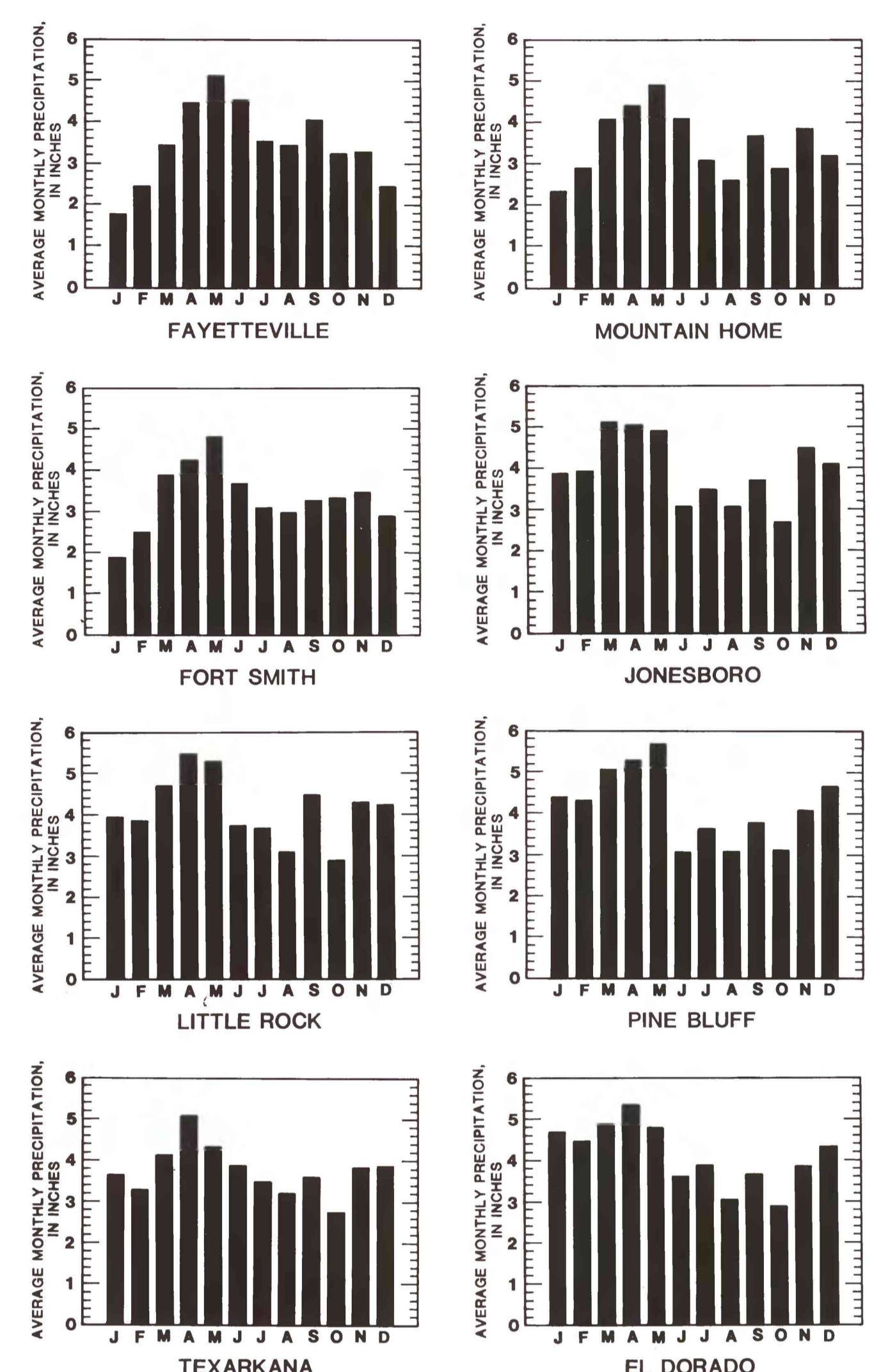


Figure 2.--Average monthly precipitation for selected cities in Arkansas (1951-81). (Data from U.S. Department of Commerce, 1952-81).

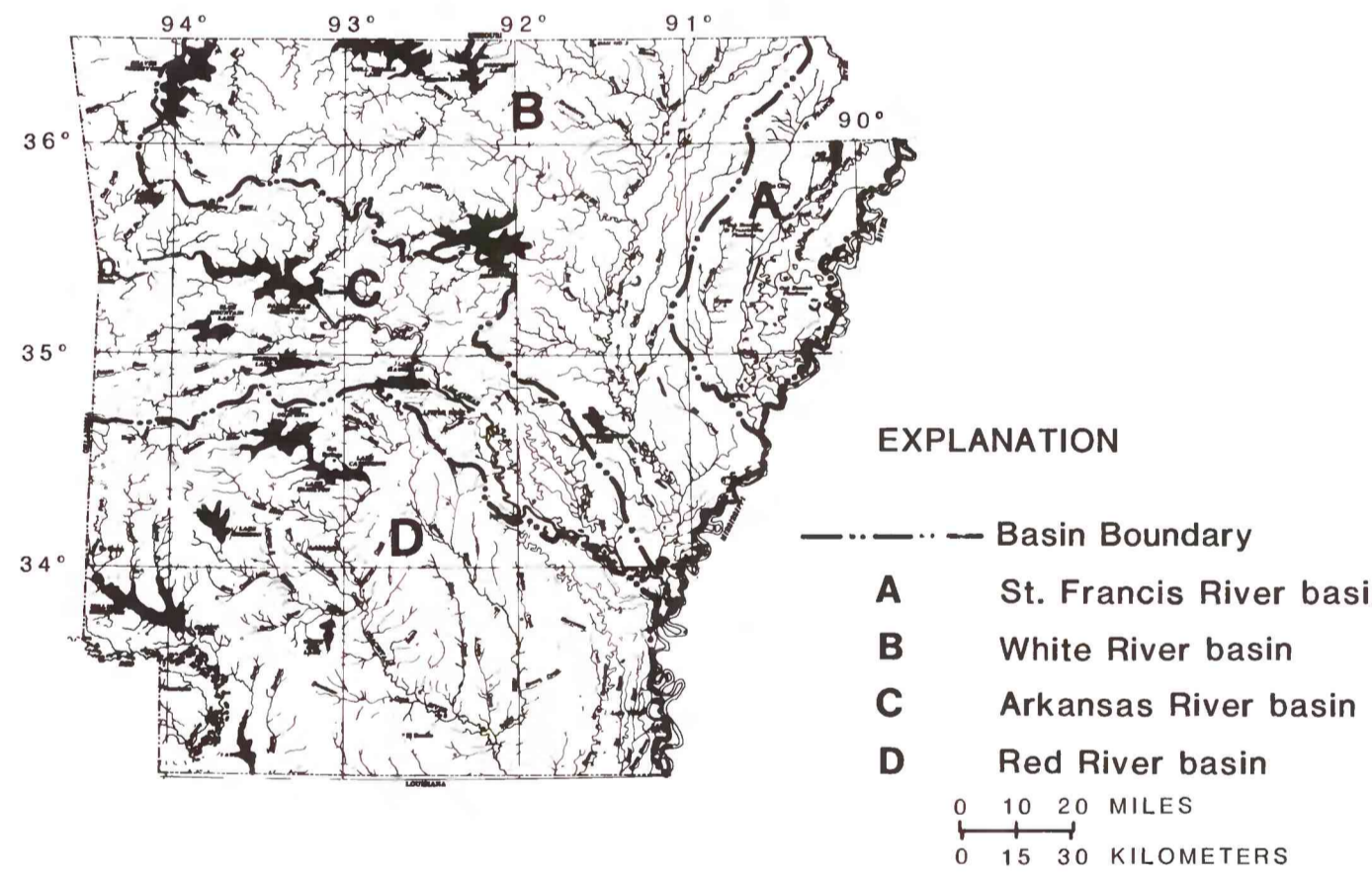


Figure 3.--Major river basins in Arkansas.

INTRODUCTION

Water is an important resource that is normally plentiful in the State of Arkansas. Future demands for freshwater require that hydrologic studies be undertaken to define the occurrence and availability of this resource to permit proper planning and management. Annual precipitation and runoff represents the upper limit of the water potentially available for development and consequently forms a convenient base for many hydrologic investigations. This report was prepared to show the distribution of the average annual precipitation and runoff patterns in Arkansas. It was done as part of the U.S. Geological Survey's Central Midwest Regional Aquifer Systems Analysis (Jorgensen and Signor, 1981), a large scale study that includes parts of nine states. The study is one of several that are designed to increase basic knowledge of the flow regime and hydrologic properties of major aquifer systems in the United States.

No detailed precipitation and runoff maps for Arkansas have been published by the U.S. Geological Survey. Langbein (1949) and Busby (1966) developed runoff maps for the whole United States. Hedman and others (in press) developed precipitation and runoff maps of the Ozark region which included parts of northern Arkansas. Patterson (1971) included a small precipitation map of Arkansas in his flood study report but it only included data for the same year. This report includes detailed maps of average annual precipitation and runoff in Arkansas for 1951-80 and illustrates the close relation between the two.

Arkansas comprises about 53,100 square miles and on the basis of land surface and underlying rock formations is divided diagonally into two areas of approximately the same size. The northwestern half of the State is known as the Interior Highlands and the southeastern half is part of the Coastal Plain (Fenneman, 1946) (fig. 1).

The Interior Highlands region is physiographically divided into three areas: the Ozark Plateau in northern Arkansas, with rugged mountains up to 2,400 feet above sea level and geologic units consisting of mostly limestone, dolomite, sandstone and shale; the Arkansas Valley in the vicinity of the Arkansas River with a gently undulating low altitude plain and geologic units consisting of sandstones and shales; and the Ouachita Mountains of southwestern Arkansas composed of numerous ridges with peaks as high as 2,800 feet and geologic units consisting mostly of shale and sandstone.

The Coastal Plain region is divided into two areas: the Mississippi Alluvial Plain in the eastern part of the State is level to gently rolling with altitudes ranging from 100 to 300 feet above sea level and the West Gulf Coastal Plain extending across the southern part of the State is rolling to slightly hilly with altitudes up to 700 feet. The geologic material of this region consists of deposits of clay, silt, sand and gravel.

For those who use the International System (SI) of measurement rather than the inch-pound system, inches may be converted to millimeters by using the multiplication factor 25.4 and feet may be converted to meters by using the multiplication factor 3.281.

ANNUAL PRECIPITATION

Precipitation in Arkansas is normally abundant and well distributed throughout the year. Most of the State's precipitation falls as rain, though snow does occur primarily in the northwest. Precipitation during the same spring and summer is predominantly of the thunderstorm type with periods of general rains during the rest of the year. Generally, April and May are the wettest months in Arkansas. January and February are generally the driest months in the northwest quarter of Arkansas with October generally the driest month in the rest of the State (fig. 2). The average number of days with measurable precipitation is about 100 per year (U.S. Department of Commerce, 1976).

Average annual precipitation for 1951-80 in Arkansas is about 49 inches. It ranges from a low of slightly less than 40 inches in the western Arkansas Valley region to a high of 59 inches in the central Ouachita Mountains (table 1). Annual precipitation amounts are a reflection of both geographic location and local orographic influences. In general, precipitation increases from the northwestern part of the State to the southeast. Precipitation is greater in southeast Arkansas because of its proximity to the oceanic moisture source of the Gulf of Mexico. Local orographic influences causes variations from the geographic pattern as precipitation is highest in the Ouachita Mountains.

The map of average annual precipitation was prepared by calculating the average annual precipitation in inches for each weather station in Arkansas using 1951-80 climatological data from the U.S. Department of Commerce. Some stations were not in operation for the full 30 year period, so the average precipitation for the available period was used. This adjustment was made by multiplying the average precipitation at the shorter-term station by the ratio that the precipitation during this period at a nearby long-term station bore to the precipitation during the 30 year period (1951-80). Only those stations with less than 25 years of record were adjusted (see footnote, table 1). These data then were plotted on a map at the station location and lines of equal average annual precipitation were drawn.

ANNUAL RUNOFF

Runoff is water that drains from the land into creek or river channels and appears as a flow of water in surface streams. It occurs chiefly as a residual of precipitation, after the demands of evapotranspiration and ground-water recharge have been defined.

Runoff can also be defined as the total volume of water discharged in a stream divided by the drainage area of that stream. The collected flow from a drainage basin, as measured at gauging stations, is expressed on the map in inches of water per year and represents the average depth over the basin. In these terms, the map is directly useful to facilitate comparisons with other basins and with precipitation.

Arkansas exhibits a wide range of runoff characteristics that are related to climate, topography and geology. Average annual runoff (table 2) ranges from a low of about 11.3 inches in the western Arkansas Valley basin (refer to figure 3 for basin boundaries) to a high of about 33.8 inches in the northwestern Red River basin in Arkansas and averages about 17 inches statewide. The area of lowest annual runoff in the western Arkansas River basin coincides with the area of low annual precipitation, generally undulating low elevation topography and surface geology consisting of mostly weathered limestone and sandstone. Because of these conditions runoff is less, slower to leave the basin and more water is recharged to the ground-water system or lost through evapotranspiration. The area of highest annual runoff exists in an area of high precipitation, steep mountain gradients and surface geology predominantly of shale. These conditions are favorable for rapid runoff which allows the water to leave the basin before it has the opportunity to evapotranspire or recharge the ground-water system.

The map of average annual runoff was based entirely on streamflow data for selected gauging stations, using the same period of record as precipitation (1951-80). Most stations either were not operated during this entire 30 year period or they had some form of regulation take place prior to 1980. These stations which had less than 25 years of record were adjusted by comparing a nearby station with similar surface geology, precipitation amounts and drainage area size. Adjustments were made to the runoff values by multiplying the average runoff at the shorter-term station by the ratio that the runoff during this period at the nearby long-term station bore to the runoff during the 30 year period (1951-80) (Langbein, 1949). For those streams with regulation by reservoirs, the period prior to regulation was used. These average runoff values at each of the selected stations were plotted in the center of the contributing drainage area for that basin. Lines of equal average annual runoff were then drawn to show the runoff at the place of origin rather than at the point of measurement.

Table 1.--Average annual precipitation (1951-80)

(Data calculated from U.S. Department of Commerce, 1952-81)

Map no.	Station name	Years of record	Average annual precipitation (inches)
NORTHWEST ARKANSAS			
1	Bentonville	29	43.16
2	Berryville	24	44.96
3	Buffalo Tower	30	47.96
4	Deer	5	46.67
5	Eureka Springs	24	43.34
6	Fayetteville FAMP	30	43.90
7	Fayetteville Experimental Station	30	42.92
8	Gravette	29	42.85
9	Green Forest	28	42.07
10	Harrison	19	46.61
11	Huntville	17	40.94
12	Jasper	30	45.56
13	Lead Hill	30	41.17
14	Ozell	30	47.71
15	Siloam Springs	30	43.26
CENTRAL ARKANSAS			
16	Calico Rock	30	43.61
17	Clinton	28	50.75
18	Damascus	27	51.54
19	Evening Shade	28	46.23
20	Gilbert	30	42.18
21	Greers Ferry Dam	20	45.34
22	Hamoth Spring	28	43.19
23	Marshall	27	41.90
24	Nelbourne	27	44.83
25	Mountain Home JMW	27	42.08
26	Mountain Home Corps	28	42.86
27	Mountain View	29	47.85
28	Selen	23	46.77
29	Shirley	28	46.56
30	Wailville	25	45.04
NORTHEAST ARKANSAS			
31	Alfalfa	28	47.55
32	Bateville Livestock	30	45.12
33	Bateville Lock	29	46.63
34	and Dam	29	48.33
35	Black Rock	30	46.51
36	Bytchville	27	49.01
37	Corning	29	46.47
38	Georgetown	30	49.02
39	Georgetown	30	47.62
40	Keiser	21	46.71
41	Newport	29	49.22
42	Paragould	29	48.43
43	Pocahontas	30	47.62
44	Saint Francis	30	46.36
45	Searcy	30	51.75
WEST-CENTRAL ARKANSAS			
46	Abbott	29	40.72
47	Aly	30	49.43
48	Big Fork	30	56.73
49	Blue Mountain Dam	14	48.39
50	Booneville	28	43.83
51	Clarksville	27	46.22
52	Cove	28	52.65
53	Danville	30	46.56
54	Dardanelle	30	48.91
55	Fort Smith WSO AP	30	39.92
56	Fort Smith Water	29	48.04
57	Gravelly	30	47.37
58	Greenwood	30	43.42
59	Hector	30	46.75
60	Mena	28	52.03
61	Nulberry	30	46.56
62	Natural Dam	18	47.96
63	Ozark	30	43.16
64	Paragould	30	51.56
65	Parks	30	44.70
66	Ratcliff	28	39.39
67	Russellville	30	44.82
68	Subiaco	30	44.72
69	Walton	30	44.72
CENTRAL ARKANSAS			
70	Alum Fork	29	52.33
71	Benton	30	52.27
72	Bismark	15	48.65
73	Blakely Mountain Dam	27	53.90
74	Bonerdale	15	49.30
75	Cabot	30	48.06
76	Conroy	30	48.99
77	Crystal Valley	30	47.96
78	Hot Springs	29	55.25
79	Jonesville	30	49.68
80	Lake Manumelle	30	51.22
81	Leola	30	51.22
82	Little Rock	30	49.21
83	Malvern	30	54.16
84	Morrilton	27	45.80
85	Marion	28	45.58
86	North Little Rock	4	45.124
87	Oden	30	54.09
88	Perry	16	49.91
89	Sheridan	29	53.84
EAST-CENTRAL ARKANSAS			
90	Arkansas Post	17	49.31
91	Augusta	30	49.13
92	Briarcliff Tower	28	48.28
93	Clarendon	23	48.44
94	Des Arc	30	50.96
95	Helena	28	50.72
96	Keo	30	47.88
97	Madison	28	50.35
98	Marionna	30	50.89
99	Saint Charles	30	50.51
100	Stuttgart	30	50.89
101	Stuttgart WSE	29	48.61
102	West Memphis	18	49.86
103	Wynne	28	49.54
SOUTHWEST ARKANSAS			
104	Antoine	29	50.94
105	Ashdown	23	49.23
106	Athens	29	55.83
107	Daisy	23	46.62
108	Dehusen	30	50.39
109	Dierks	21	45.97
110	Glenwood	28	55.65
111	Hope	30	51.18
112	Hopper	30	56.75
113	Horatio	30	49.21
114	Landley	28	49.00
115	Mount Ida	30	53.70
116	Murreesboro	10	48.04
117	Narrows Dam	19	49.17
118	Nashville Experimental Station	29	53.01
119	Nathan	29	52.04
120	Newhope	29	54.96
121	Osborne	29	51.16
122	Okay	30	49.18
123	Pine Ridge	30	51.72
124	Stamps	30	50.82
125	Texaskane	30	45.24
126	Wahita	16	48.16
SOUTH-CENTRAL ARKANSAS			
127	Anity	30	56.17
128	Arkadelphia	30	51.11
129	Bluff City	30	51.25
130	Boughton	29	50.60
131	Canon	29	50.17
132	El Dorado	30	49.11
133	Fordyce	25	50.23
134	Gardou	30	51.30
135	Hamolia	29	50.33
136	Morohay Lock &	30	50.79
137	Moxy Grove	15	48.02
138	Prescott	30	53.36
139	Sparks	30	49.67
140	Saylor	30	47.51
141	Warren	27	50.71
SOUTHEAST ARKANSAS			
142	Arkansas City	30	51.81
143	Crossett	30	54.75
144	Hamblin	30	51.90
145	Dumas	30	50.89
146	Eudora	18	49.58
147	Hamburg	28	48.47
148	Monticello	30	52.53
149	Pine Bluff	30	50.27
150	Stamps	30	49.36
151	Robber	21	48.02
152	Star City	25	50.53

* Precipitation value adjusted for the 30 year period 1951-80

Table 2.--Average annual runoff (1951-80)

(Data calculated from U.S. Geological Survey 1954-62, 1962-65, 1966-75, 1976-82)

Map no.	Station no.	Station name	Period of record	Average annual runoff (inches)
ST. FRANCIS RIVER BASIN				
1	0704942	Anguille River near Galt	1971-80	422.55
WHITE RIVER BASIN				
2	0705050	Kings River near Berryville	1951-74	115.02
3	0704900	Har Eagle Creek near Hindaville	1952-70	113.81
4	0704860	White River near Fayetteville	1964-80	118.19
5	0704800	West Fork White River at Greenland	1951-80	16.52
6	0705600	Buffalo River near St. Joe	1951-80	15.96
7	0705700	Buffalo River near Rush	1951-69	114.30
8	0706070	North Sylamore Creek near Fifty Six	1966-80	112.52
9	0705700	Middle Fork Little Red River at Shirley	1951-80	20.24
10	0707530	South Fork Little Red River at Clinton	1962-80	420.71
11	0706700	Little Red River near Heber Springs	1951-59	123.41
12	0707300	Strawberry River near Evening Shade	1951-78	12.47
13	0707300	Pinney Fork at Evening Shade	1951-80	11.85
14	0707400	Strawberry River near Poughkeepsie	1951-80	13.74
15	0707200	Eleven Point River near Ravenden Springs	1951-80	13.29
16	0706890	Fourche River above Pocahontas	1964-70	116.33
17	0706900	Spring River at Imboden	1951-80	15.17
18	0707380	Cache River at Egypt	1965-80	116.68
19	0707500	Cache River at	1951-74	17.06
20	0707700	Patterson Bayou DeWitt at Norton	1951-76	15.67
21	0707650	Bayou DeWitt at Norton	1951-76	116.44
22	0707800	Bebe	1951-53	419.12
23	0707950	Big Creek at Poplar Grove	1971-80	21.92
ARKANSAS RIVER BASIN				
24	07195800	Flint Creek at Springfield	1962-80	112.78
25	07195000	Osage Creek near Elm Springs	1951-74	112.28
26	07196900	Baron Fork at Dutch Mills	1959-80	111.33
27	07249500	Osage Creek near Lee Creek	1951-69	113.37
28	07250000	Lee Creek near Van Buren	1951-80	15.51
29	07251500	Frog Bayou at Rudy	1951-69	113.88
ARKANSAS RIVER BASIN				
30	07252000	Hulberry River near Hulberry	1951-80	18.46
31	07249400	James Fork near Hackett	1959-80	111.71
32	07247000	PotEAU River at Caithron	1951-80	13.56
33	07258500	Petit Jean River near Booneville	1951-80	13.35
34	07260000	White Creek at Walnut	1951-74	115.63
35	07261500	Fourche LaPave near Gravelly	1951-80	16.26
36	07257000	Big Piney Creek near Dover	1951-80	19.75
37	07257500	Illinois Bayou near Sootville	1951-69	118.64
38	07263000	South Fourche LaPave near Hollis	1951-80	17.65
39	07261000	Galton Creek near Guy	1955-80	23.61
RED RIVER BASIN				
40	07356000	Ouachita River near Mount Ida	1951-80	21.56
41	07356500	South Fork Ouachita River at Mount Ida	1951-69	118.25
42	07340300	Conasaot River near Underwood	1968-80	133.79
43	07359800	Cado River near Aletine	1951-69	211.24
44	07341000	Saline River near Herkes	1951-74	122.44
45	073			