HYDROLOGY

Precipitation

Precipitation as rainfall averages 41-42" annually, precipitation as snowfall is 12-13" annually, and runoff averages 12" annually (MDNR 1986). The highest runoff is in April-May and the lowest in September, coinciding with seasonal rainfall patterns. Winter snowfall contributes minimally to runoff in the basin, which is primarily rainfall driven (MCWC 1974).

Gauging Stations

The longest running active gauging station in the basin is station 07189000 on the Elk River near Tiff City, Missouri. This gauge records data from a drainage of 872 square miles. It has been in use from October 1939 to present (USGS 1998). Several other gauges have been intermittently used on streams in the basin. Gauge 07188850 on the Elk River at Pineville (1942, 1945, 1947, 1949, 1952, 1962-1965, 1967), gauge 07188870 on Indian Creek at Anderson (1942, 1945, 1947, 1949, 1952, 1962-1965, 1967), gauge 07189100 on Buffalo Creek at Tiff City (1954, 1962-1964, 1967-1975, discontinued partial record station), and gauge 07188500 on Lost Creek at Seneca (1949-1959, 1967-1975; drainage area 42 sq. mi.). Other gauging stations that have been used in the Elk River basin are gauge 07188820 on Little Sugar Creek at Caverna (1967-1975), gauge 07188660 on Mikes Creek at Powell (5/94-5/95), and gauge 07188855 on North Indian Creek near Wanda (5/94-5/95). Groundwater levels were monitored using wells at Longview (1984-1991) and Noel (1984-1991).

Permanent/Intermittent Streams

Funk (1968) listed the Elk River basin as having 169 miles of permanently flowing and 17 miles of intermittently flowing streams with permanent pools in Missouri. The MDNR reported that the Elk River basin in Missouri had 160 miles of classified streams (151 miles of permanently flowing stream, and 9 miles of intermittently flowing streams with permanent pools) (MDNR 1985).

There are 234 third order and larger streams in the Elk River basin with a total stream mileage of 1,115 miles (Table 2). For a more detailed description of stream order, stream mileage, receiving stream, and permanent/intermittent mileage by stream see Appendix A. The permanence/ intermittence of streams usually can be determined from 7.5 minute series topographical maps. Permanent streams are indicated with solid blue lines, and intermittent streams are indicated with dashed blue lines. As of June 1999, several of the topographical maps covering the Elk River basin are only available as provisional editions (draft maps). These provisional maps have all rivers shown as black dashed lines making permanence/intermittence determinations very difficult for many streams. In visiting with personnel of the USGS it was learned that these maps will probably remain provisional maps unless demand increases or some entity comes forward with funding to finish them. Figure 12 displays the topographical maps covering the basin. Losing streams are widespread in the Elk River basin. A losing stream is one where water is "lost," usually into the streambed and becomes groundwater rather than surface water. Losing stream reaches in the Elk River basin are listed in Table 3.

Stream Flow/7-Day Q_2 and Q_{10} Low Flow

On average, in the Missouri portion of the watershed, an area of 5.03 square miles is required to maintain one mile of permanently flowing stream (MDNR 1986). The highest average flows are in April-May, and

Table 2. Number of streams third order and larger and stream mileage by sub-basin for the Elk River basin.

Sub-basin name	Number of streams (≥3 order)	Total stream miles
Lost Creek *	4	50.3
Buffalo Creek	9	72.4
Indian Creek	68	254.1
Elk River + minor tributaries	29	177.6
Big Sugar Creek	84	340.2
Little Sugar Creek	34	170.1
Honey Creek *	6	50.3
Elk River basin (total)	234	1,115.0

***Grand Lake O' the Cherokees watershed sub-basins included in this document.**

Table 3. Losing streams in the Elk River basin in Missouri.

Stream	Receiving Stream	Location T R Sec.		
Little Lost Creek	Lost Creek	25N	33W	25, 26, 27, 28, 36
Second Order Tributary	Little Lost Creek	25N	33W	32, 33, 34
McDougal Branch	Little Lost Creek	24N	33W	8, 17, 18
Buffalo Creek	Elk River	24N	32W	7, 8, 9, 15, 16
Sugar Fork	Buffalo Creek	23N	33W	1, 2, 3
Middle Indian Creek	North Indian Creek	24N	30W	7, 8
Bullskin Creek	Indian Creek	24N	32W	26, 35
Second Order Tributary	Bullskin Creek	24N	32W	26, 23
Middle Indian Creek	North Indian Creek	24N	30W	11, 12
		24N	29W	7
Second Order Tributary	South Indian Creek	24N	29W	31, 32, 33
Second Order Tributary	Middle Indian Creek	24N	29W	7, 8, 9
Second Order Tributary	Beaver Branch	23N	32W	8, 17
Beaver Branch	Indian Creek	23N	32W	30
		23N	33W	36
		22N	33W	1, 12
Unnamed Tributary #28	Bullskin Creek	23N	32W	3, 9
Second Order Tributary	Cave Spring Branch	24N	34W	15, 16, 21
Second Order Tributary	Yarnell Branch	24N	33W	16, 17
Yarnell Branch	Elk River	24N	33W	16, 21, 28
Second Order Tributary	Miser Hollow	21N	31W	16, 21

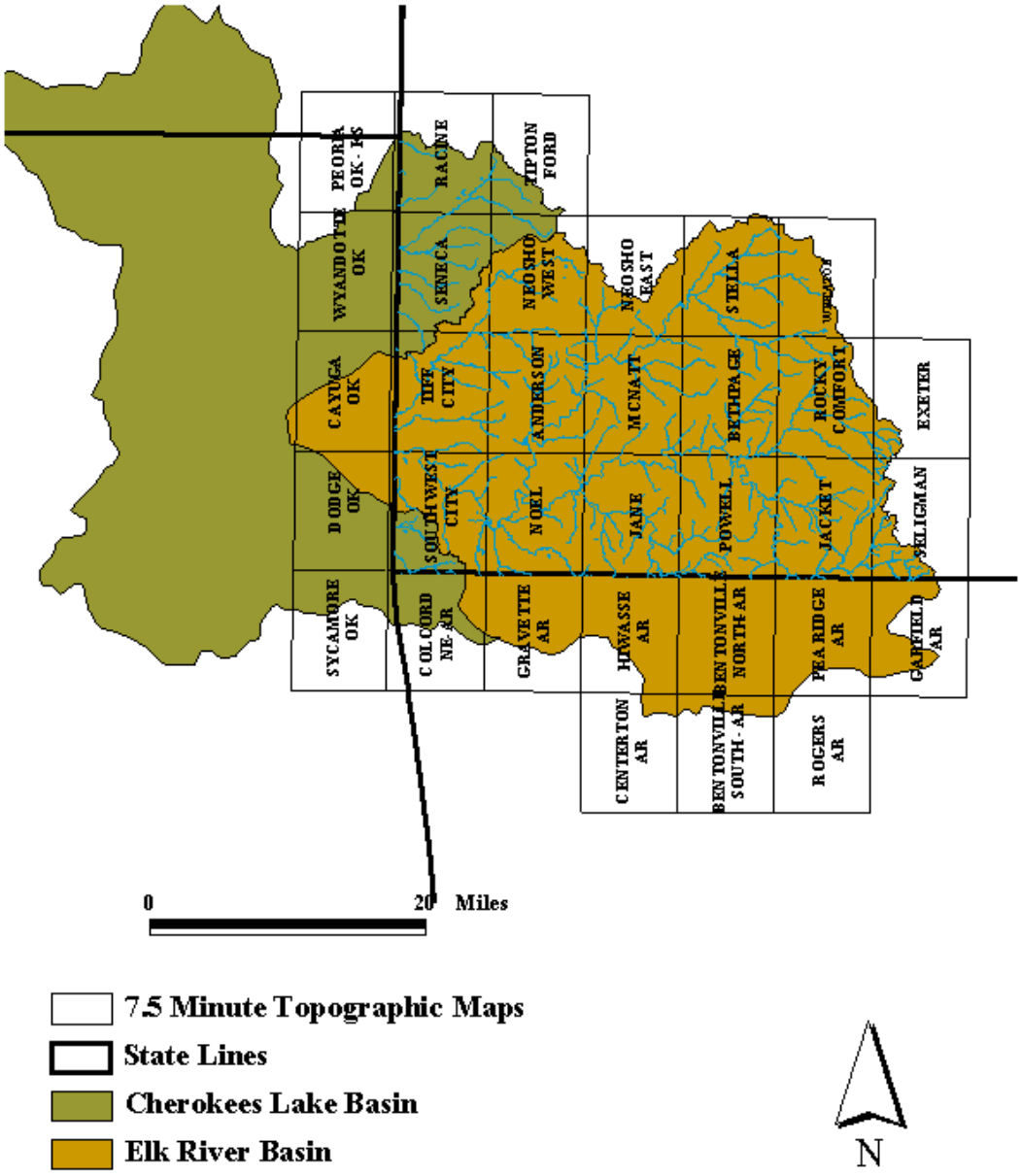
Table 4. Seven-day Q_2 and 7-day Q_{10} low flows for streams in the Elk River basin.

USGS Station No.	Stream	Period of Record	7-Day Q_2 (cfs)	7-Day Q_{10} (cfs)
07188500	Lost Creek at Seneca	1949-1959	6.6	0.9
07188850	Elk River at Pineville	1942,1945, 1947, 1949, 1952, 1962-1965, 1967	41	8.8
07188870	Indian Creek at Anderson	1942, 1945, 1947, 1949, 1952, 1962-1965, 1967	50	15
07189000	Elk River near Tiff City	1940-1966	88	25
07189100	Buffalo Creek at Tiff City	1954, 1962-1964	7.0	0.0

Source: Skelton (1976).

Second Order Tributary	**Missouri Creek**	**21N**	**31W**	**14, 23**
Second Order Tributary	**Missouri Creek**	**21N**	**31W**	**12, 13**
Missouri Creek	**Little Sugar Creek**	**21N**	**31W**	**13, 16, 21, 22, 23, 24**
		21N	**30W**	**16, 17, 18**
Second Order Tributary	**Bear Creek**	**21N**	**30W**	**21**
Bear Creek	**Little Sugar Creek**	**21N**	**30W**	**19, 20, 21, 28, 30**
		21N	**31W**	**35, 36**
Second Order Tributary	**Bear Creek**	**21N**	**31W**	**25, 36**
Big Sugar Creek	**Elk River**	**21N**	**30W**	**1, 2**
		22N	**30W**	**35**

Figure 12. USGS 7.5 minute topographic map coverage for the Elk River basin.



the lowest are for September, coinciding with the pattern of precipitation which is highest in the spring and lowest in the fall (Figure 13). The highest estimated flow in the Elk River was April 19, 1941, when 137,000 cubic feet per second (cfs) was reported near Tiff City (USGS 1998). The lowest recorded flow at this gauging station (07189000) was 5.1 cfs on September 5, 1954 (USGS 1998). Average flow at this station is 835 cfs (USGS 1999a). There is concern about reduced flows from Arkansas into the Missouri portion of the watershed. Decreased flows have the potential to negatively affect water quality and aquatic life in the watershed (Lobb 1998).

Low flows for streams in the Elk River basin are listed in Table 4. The 7-day Q_2 is the minimum flow expected for a seven day period that will occur on average once in two years. The 7-day Q_{10} is the minimum flow expected for a seven day period that will occur on average once in ten years. The lowest flows usually occur in the late summer and fall (August, September, and October). Flows tend to be sustained through dry periods by springs and groundwater. Flow duration curves (Figures 14 and 15) indicate the tendency of stream flow to vary over time. Flows are variable for the Elk River basin, but the ready infiltration of surface water into the groundwater system reduces the magnitude of high flows. The corollary discharge of groundwater during dry periods tends to maintain stream flow. This exchange between groundwater and surface water tends to moderate and maintain more "normal" flows in all but extreme conditions.

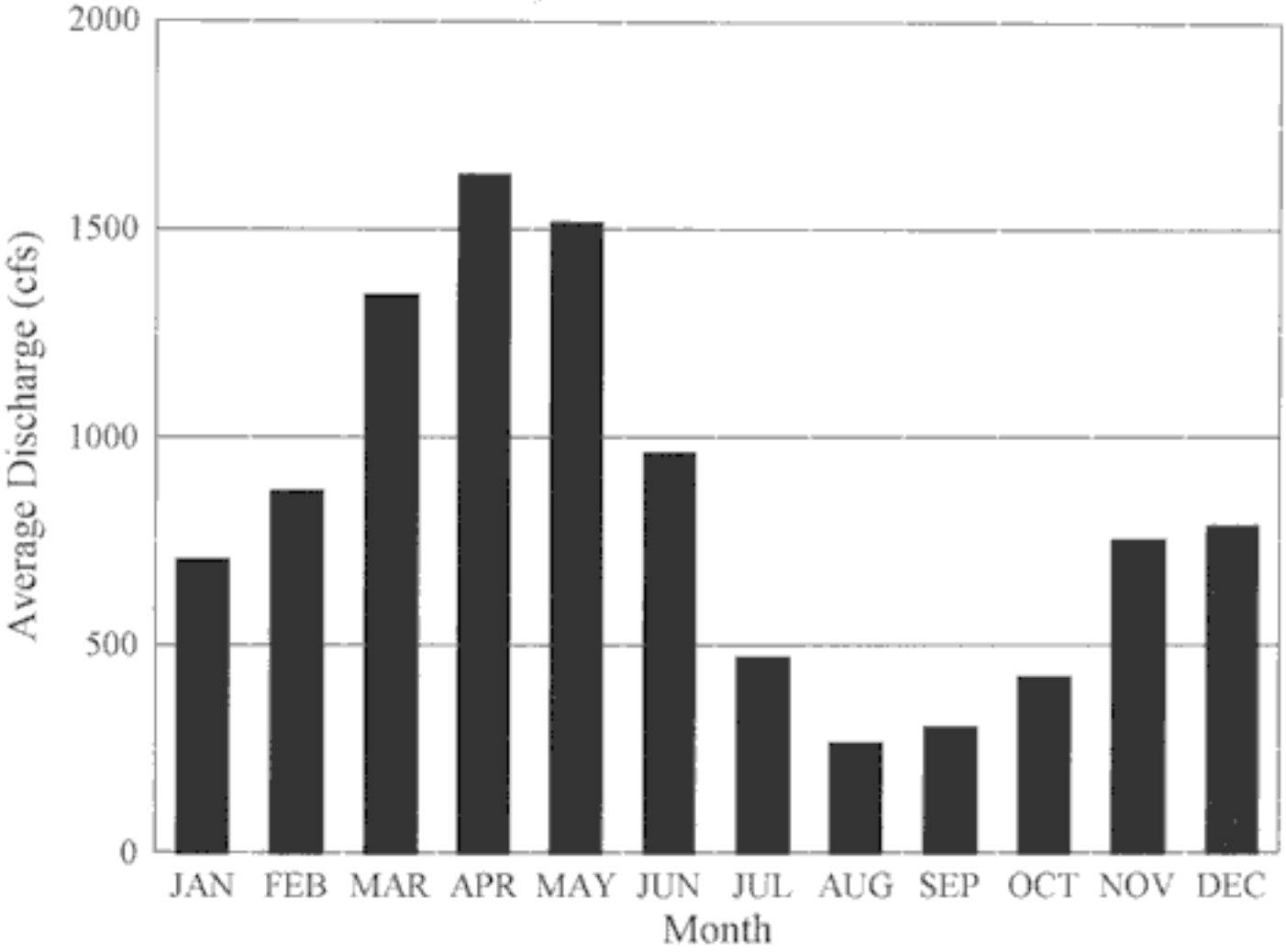
Dam and Hydropower Influences

There are no major dams in the Missouri portion of the basin. The lower Elk River is inundated in Oklahoma by Grand Lake O’ the Cherokees (an impoundment on the Grand [Neosho] River). There are several small to moderate-sized public and private lakes in the basin (Table 5). Due to the soil types and bedrock in the basin, farm ponds are not as numerous as in many other parts of Missouri. Most ponds can be built without permits, and statistics on ponds are usually compiled by county rather than watershed. These factors complicate the acquisition of accurate, up-to-date information on ponds. Concern exists over the effects ponds have on low-flow conditions as they intercept runoff and allow little or no adjustment for maintenance of stream flows. Gordon (1980) reported three small dams on major tributaries and rivers in the Elk River basin. Indian Creek was impounded at McNatt, Missouri, the Elk River at Noel, Missouri, and Little Sugar Creek at Bella Vista, Arkansas. Based on USGS maps that were photo revised in 1982, there were six new impoundments on tributaries of Little Sugar Creek and one new impoundment on Little Sugar Creek in the Bella Vista area. Flows and water quality in the Little Sugar Creek sub-basin could be altered due to these new impoundments.

Table 5. Major lakes in the Elk River basin in Missouri and Arkansas.

Location	Lake Name	Stream(s) Impounded	Surface Acres
Bella Vista, AR	Ann	Pinion Hollow (Tributary of Little Sugar Creek)	112
Bella Vista, AR	Avalon	Tributary of Tanyard Creek	67
Bella Vista, AR	Brittany	Tributary of Pinion Hollow	35
Bella Vista, AR	Loch Lomond	Gordon Hollow, Unnamed #104, Unnamed #105	477
Bella Vista, AR	Norwood	Tributary of Little Sugar Creek	35
Bella Vista, AR	Rayburn	Tributary of Little Sugar Creek	45
Bella Vista, AR	Windsor	Tanyard Creek	220
Noel, MO	Lake St. Clair	Elk River	30
Bella Vista, AR	Bella Vista	Little Sugar Creek	35
Southwest City	Blankenship Park Lake	Honey Creek	2

Figure 13. Average annual discharge for the Elk River basin at gauging station 07189000 near Tiff City, Missouri.



Source: DuCharme and Miller (1996).

Figure 14. Flow duration curve for Lost Creek at gauging station 07188500 near Seneca, Missouri.