# HYDROLOGY



#### **Precipitation**

The Current River Watershed is situated in one of the wetter parts of Missouri, which receives from 32 inches of precipitation in the Northwest to 48 inches in the Southeast of the state (Figure Hy01)(MDNR 1986). Precipitation data based on Easterling et al. (1995) indicates an average annual precipitation of 44.5 inches within the Current River Basin (including the Jacks Fork and Current River Basin in Arkansas) for the period of 1923-1994. Analysis of individual annual precipitation amounts for the previously mentioned period indicate a trend toward increased annual precipitation amounts within the basin (Figure Hy02a). Mean monthly precipitation data for the period indicate that the combined months of April, May, and June receive the most precipitation at 13.46 inches. The combined months of December, January, and February receive the least amount of precipitation at 9.11 inches. May receives the highest mean precipitation amount at 4.91 inches, while February receives the lowest at 2.83 inches (Figure Hy02b).

### **United States Geological Survey Gaging Stations**

The United States Geological Survey (USGS) currently (2000) has two active surface discharge gaging stations within the Current River Watershed (Table Hy01 and Figure Hy01) (USGS 2000a and USGS 2000b). Station <u>07067000</u> (Current River at Van Buren, Mo.) <a href="http://waterdata.usgs.gov/mo/nwis/uv?07067000">http://waterdata.usgs.gov/mo/nwis/uv?07067000</a> is located on the Current River 0.4 miles downstream from Pike Creek (USGS 2000a). The datum of the gage is 442.78 ft above mean sea level (msl). Station 07067000 has been recording continuous discharge data from October 1921 to the present. Station <u>07068000</u> (Current River at Doniphan, Mo.) <a href="http://waterdata.usgs.gov/mo/nwis/uv?07068000">http://waterdata.usgs.gov/mo/nwis/uv?07068000</a> is located

on the Current River 2.5 miles upstream from Briar Creek. The datum of the gage is 321.21 ft above

msl. Station 07068000 has also been recording continuous discharge data from October 1921 to the present.

Historical daily discharge and/or peak flow records exist for an additional 15 continuous surface discharge stations within the watershed with various records available from 1904 to 2001 (<u>Table Hy01</u>). In addition to the water discharge records, the USGS has collected surface water quality records from 10 location within the Current River Watershed (USGS 2000a).

#### Daily Mean Discharge Statistics

Daily mean discharge statistics as well other long term hydrologic trends were determined using data from gage stations 07067000 (Current River at Van Buren, MO), 07067500 (Big Spring near Van Buren, MO), and 07068000 (Current River at Doniphan, MO). These stations have been chosen for analysis because they provide the most comprehensive flow datasets for the Current River Watershed. In addition some statistics are included for station 07068600 (Little Black River at Success, Ar). However station 07068600 is not included in all analysis due to its relatively short period of record (6 years as opposed to greater than 70 years for the other stations).

The annual daily mean discharge of the Current River at Doniphan is 2,815 cubic feet per second (cfs) (USGS 2000a). The highest daily mean discharge at this station is 90,000 cfs, which occurred on March 12, 1935. The lowest daily mean discharge is 852 cfs which occurred on October 8, 1956. Table Hy02 lists annual, highest, and lowest daily mean discharges for four analyzed stations. Annual mean daily discharges for the period 1923-1994 for analyzed stations (not including the Little Black River at Success, Ar.) show possible trends of increased discharges at all three stations (Figure Hy03). These data seem to reflect an increase in annual precipitation during the same time period (Figure Hy02). Analysis of historical discharge data for the period 1923-1994, available through the USGS National Water Information System (NWIS) (2000b), reveals that daily mean discharge has been lowest during the months of August, September, and October and highest during March, April and May (Figure Hy04).

#### Flow Duration

Flow duration curves are useful for determining the variability or flashiness of stream flow as well as how the discharge of a stream is sustained over time. These factors are determined by many variables including climate, watershed land cover/land use, soil type, and topography. Daily flow duration curves have been plotted for USGS surface gage stations on the Current River at Van Buren and Doniphan as well as for stations at Big Spring near Van Buren and the Little Black River at Success, Arkansas using daily flow duration data available from the United States Geological Survey (USGS 2000c) Daily Values Statistical Program (DVSTAT) (Figure Hy05). Slopes of all duration curves are relatively steep at the higher discharges indicating that flood discharges are infrequent or not sustained for long periods of time. In the 10 to 90 percentile range, the curves flatten out considerably for the Current River stations as well as for Big Spring indicating well sustained stream discharges over extended periods of time. This is at least partially attributable to the storage and transport capacity of the karst topography within the watershed and surrounding area. As has been noted in the geology section of this document substantial stream flow from much of the upper portion of the Eleven Point Watershed is lost to the groundwater system. Much of this eventually reemerges in the Current River Watershed most notably at Big Spring.

While base flows are moderately well sustained in the Little Black River (MDNR 1994), it seems, unlike other portions of the Current Watershed, to lack the substantial influence of springs. Only one "spring of note" associated with the Little Black River is mentioned in the MDNR Water Quality Basin Plan (MDNR 1994). This spring has an average discharge of 5 cubic feet per second. In addition, several streams in the lower portion of the Little Black River have been channelized. This has the effect of increasing surface drainage, reducing infiltration to the groundwater system thus reducing the duration of flows. The flow duration curve for the Little Black River indicates flows are not as well sustained as flows for the Current River Stations. While the duration curve for the Little Black River becomes less steep in the 10 to 90 percentile range, it remains substantially steeper than the curves of the Current River and Big Spring (Figure Hy05). However, it is important to note that duration values for the Little Black River are based on available data for the period 1980-1986. While values for the other stations are based on data for the period 1923-1994. Meaningful conclusions can not be made about Little Black River flow duration because of the short period in which data were collected.

Comparison of duration curves for Big Spring and both Current River stations (Little Black River excluded due to lack of data) between the periods 1923-1958 and 1959-1994 show a slight upward shift for all three stations and a slight decrease in slope for Big Spring and the Current River at Doniphan in the 10 to 90 percentile range (Figure Hy06). The Current River at Van Buren appears to have experienced a slight increase in its flow duration curve slope between the 10 to 90 percentile range in the latter time period. The upward shift of the flow duration curve reflects an overall increase in discharge in the latter time period. The changes in the flow duration curve and discharge rates are possibly an indication of changes in precipitation (intensity, amount, seasonal timing, and duration and type i.e. snow, rain, etc.), watershed land cover/land use, and/or changes in the groundwater system. As stated previously, the Current River Basin seems to have experienced an overall increase in average annual precipitation (Figure Hy02). Land cover/land use changes within the watershed have also possibly had an effect on flow duration. The variability of land use/land cover data collection methodology and analysis, as well as the spatial and temporal variability of land cover changes make it difficult to reliably determine actual quantitative land use/land cover changes which have occurred within the watershed for the previously discussed time periods. In addition, a lack of hydrologic data for the late 1800s and very early 1900s leaves to speculation hydrologic trends prior to and through the "timber boom" period. Geologically, possible changes in the karst groundwater system of the area leading to an increased groundwater influence in the watershed may be another explanation. Many factors influence long term changes in stream discharge. Analysis of all factors is beyond the scope of this document. However, further data collection and analysis of hydrologic data will be important for the determination of long term trends within the watershed.

#### 10:90 Ratio

The 10:90 ratio is used as an indicator of discharge variability. It is the ratio of the discharge which is equaled or exceeded 90% of the time. It is useful for determining summer carrying capacity in streams as well as interbasin comparisons. The lower the 10:90 ratio, the lower the variability of flow. The 10:90 ratio for the Current River at Doniphan is 4.1. This is a low value relative to 10:90 values of drainages of similar size within the state (Skelton 1976). This value is similar to 10:90 values from surrounding watersheds (Table Hy03). The relatively low 10:90 ratios of the Current and surrounding watersheds are due in large part to the water storage and release characteristics of the karst geology. It is, however, important to note

that many streams within the area (most of which do not have discharge records) are "losing" in nature and thus will typically exhibit higher 10:90 ratios. An example of this is the Eleven Point River near Thomasville (Station 07070500) which has a drainage area similar in size to that of the Jacks Fork, but which has a high concentration of losing streams and a 10:90 ratio of X:Y. Much of the water which is lost to the ground water system from the Upper Eleven Point River reemerges at Big Spring in the Current River Watershed.

#### Instantaneous Discharge

Table Hy02 lists the highest and lowest instantaneous discharge rates that have occurred at Current River at Van Buren, MO and the Current River at Doniphan, MO. The highest instantaneous peak flow of 125,000 cfs was recorded in 1915 at Van Buren (no USGS gage station existed at Doniphan until 1918). The record instantaneous low flow of 473 cfs was also recorded at Van Buren in 1956.

### 7-day Q2, Q10, Q20 Low Flow and Slope Index

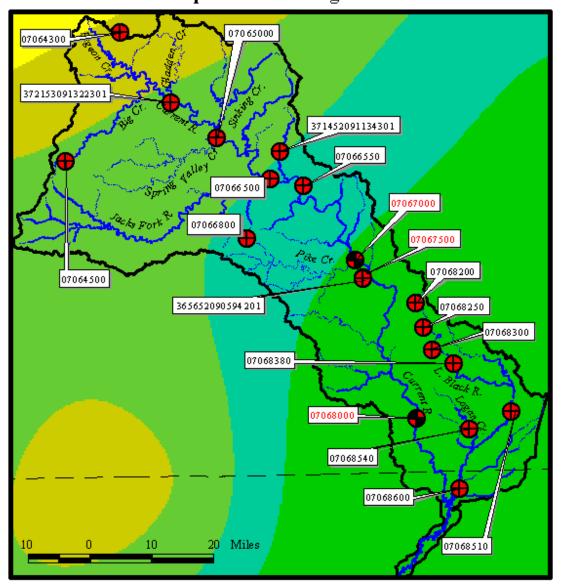
Q2, Q10, and Q20 seven day low flows refer to the lowest 7 day discharges that have a recurrence interval, on average, of 2, 10, and 20 years respectively. Some of the issues which low flow statistics help answer include the relative permanency of a stream and thus the streams ability to support aquatic life, the influence of groundwater in a particular watershed, as well as addressing issues related to effluent discharge. The Current River at Doniphan has seven day Q2, Q10, and Q20 low flow values of approximately 1,170, 940, and 890 cfs, respectively (Skelton 1976). Table Hy04 lists low flow values for additional sites within the Current River Watershed. When analyzed relative to drainage area, these values are 100 times higher than north and west Missouri prairie streams and, in many cases, 2 to 5 times higher than other Ozark streams which, as a basic rule, tend to have the highest sustained low flows in Missouri (Skelton 1976 and MDNR 1994).

The slope index (SI, ratio of the seven day Q2 to Q20) is 1.3 for the Current River at Doniphan for discharge data between 1936 and 1995. This is a low slope index, an indication of low variability in annual low flows. Slope index values for additional Gage Stations are given in Table Hy04.

## Flood Frequency

Magnitudes and frequencies of flooding for the Current River at Doniphan range from 27,300 cfs with a frequency of 2 years to 134,000 cfs for a 100 year frequency (Alexander and Wilson 1995). <u>Table Hy05</u> lists flood frequency estimates for additional selected gage stations within the Current River Watershed.

Figure Hy01. Current River Watershed Precipitation and Gage Stations



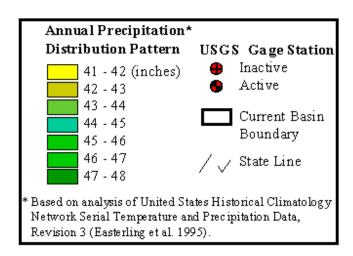




Figure Hy02. (a) Estimated mean annual precipitation amounts and (b) mean monthly precipitation amounts in the Current River Basin for years 1923-1994 based on analysis of Easterling et al. (1995).

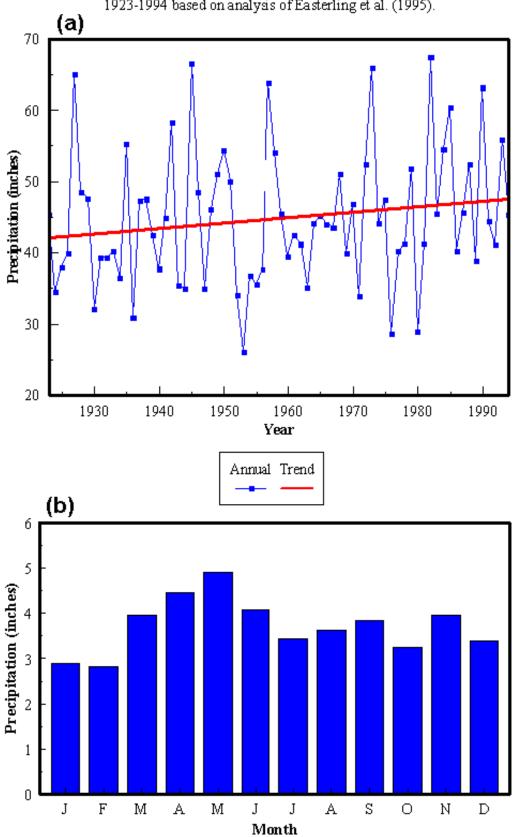


Figure Hy03. Annual mean daily discharge and trend (in red) for selected USGS gage stations within the Current River Watershed for the period 1923-1994 (USGS 2000b).

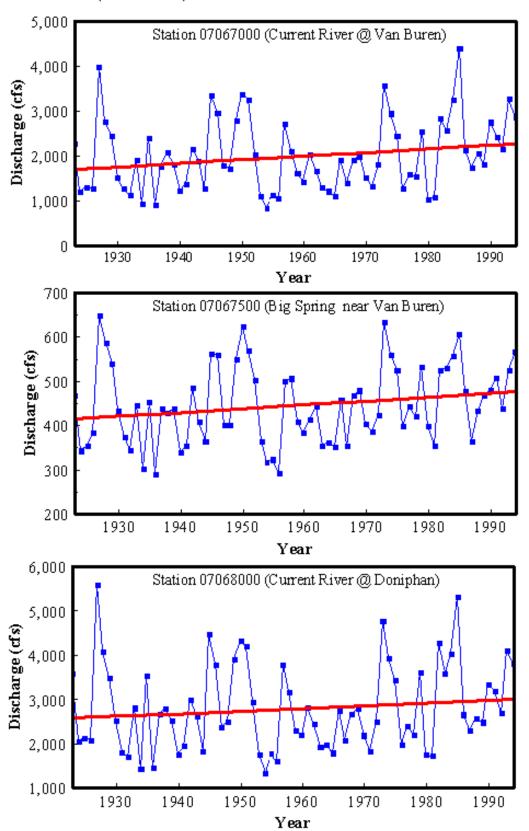


Figure Hy04. Monthly mean daily discharge at selected USGS Gage Stations within the Current River Watershed (USGS 2000b).

# Discharge (cubic feet per second)

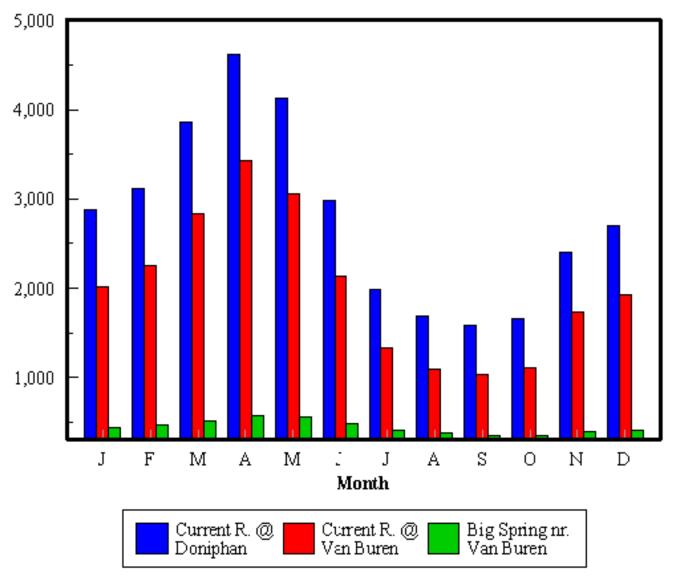


Figure Hy05. Flow duration curves for selected USGS gage stations within the Current River Watershed (USGS 2000c).

# Discharge (cubic feet per second)

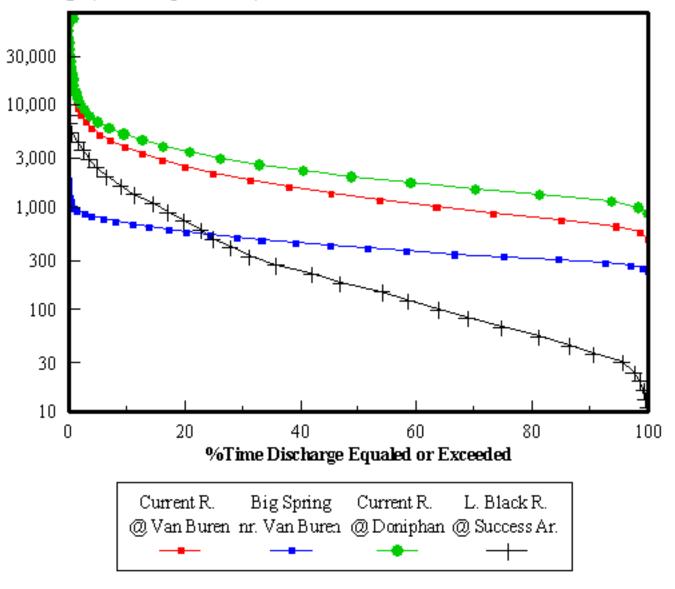


Figure Hy06. Flow duration changes between two time periods (1923-1958 and 1959-1994) at selected USGS Gage Stations within the Current River Watershed (USGS 2000c).

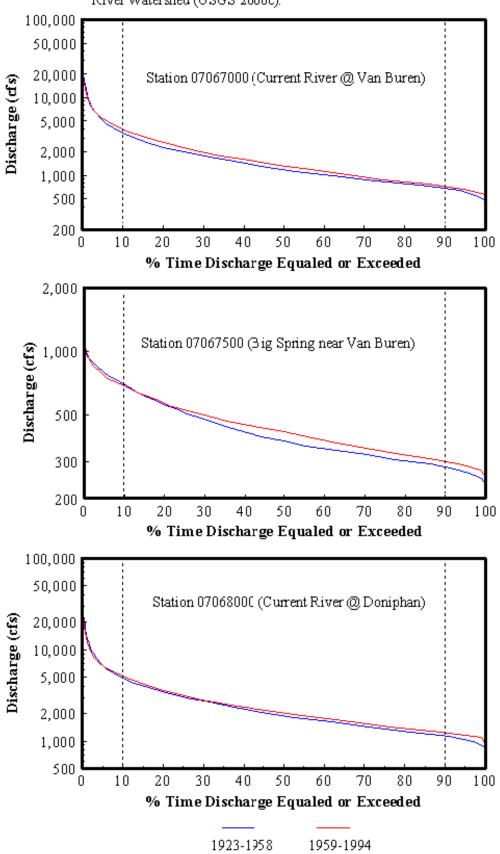


Table Hy01. USGS continuous surface discharge gage stations within the Current River Watershed (USGS 2000a and 2002a). Active stations (as of 2001) are in *green*. Period of record for peak flow measurements is given in parenthesis.

Station #	Station Name	Drainage Area (mi <sup>2</sup> )	Period of Record
07064300	Fudge Hollow near Licking, Mo.	2	1956-1976 (1959-1976)
07064500	Big Creek near Yukon, Mo.	8	1949-1975 (1965-1979)
07065000	Round Spring at Round Spring, Mo.	-	1928-1939 (1965-1979)
07066500	Current River near Eminence, Mo.	1,272	1921-1976 (1904-1975)
07066550	Blue Spring near Eminence, Mo.	-	1970-1971
07066800	Sycamore Creek near Winona, Mo.	1	(1955-1979)
07067000	Current River at Van Buren, Mo.	1,667	1921-2001 (1904-1998)
07067500	Big Spring near Van Buren, Mo.	100	1921-1996, 2000-2001 (1981-1989)
07068000	Current River at Doniphan, Mo.	2,038	1904-2001 (1921-2000)
07068200	N. Prong L. Black River at Hunter, Mo.	1	(1958-1980)
07068250	M. Fork L. Black River at Grandin, Mo.	7	1980-1984 (1981-1983)
07068300	N. Prong L. Black River near Grandin, Mo.	39	1980-1984 (1981-1983)
07068380	Little Black River near Grandin, Mo.	80	1980-1984 (1981-1983)
07068500	Little Black River near Fairdealing, Mo.	297	(1940-1979)
07068510	Little Black River below Fairdealing, Mo.	194	1980-1986 1981-1986
07068540	Logan Creek at Oxly, Mo.	38	1980-1984 (1981-1983)
07068600	Little Black River at Success, Ar.	386	1980-1986 (1981-1986)

Table Hy02. Discharge statistics for United States Geological Survey Discharge Gage Stations within the Current River Watershed (USGS 1987, USGS 1997, USGS 2000a, and USGS 2003) for period of record at each station except for median.

Station	Median	Mean (cfs)	Instant Peak Flow (cfs)	Max (cfs)	Instant Low Flow (cfs)	Min (cfs)
07067000 (Current R. at Van Buren)	1,270	2,006	125,000 8/21/1915	72,000 11/15/1993	473 10/7/1956	476 10/8/1956
07067500 ( Big Spring near Van Buren)	397	447	N/A	2,000 12/3/1982	N/A	236 10/6/1956
07068000 (Current R. at Doniphan)	1,940	2,815	122,000 12/3/1982	90,000 3/12/1935	852 10/8-19/1956	852 10/8/1956
07068600 (Little Black R. at Success, AR)	1 1	487	N/A	8,630 12/5/1982	N/A	11 8/12/1982

**Mean**=Average Daily Discharge

Max=Highest Daily Mean

Min=Lowest Daily Mean

**Med**=Median (Only complete calendar years with daily discharge records used for computation)

N/A=Not Available

Table Hy03. Comparison of 10:90 ratios from the Current River and surrounding watersheds (Skelton 1976).

Station #	Name	Watershed	Drainage Area	10:90
07066000	Jacks Fork at Eminence	Jacks Fork	398	6.8
07057500	North Fork River near Tecumseh	North Fork	561	4.6
07058000	Bryant Creek near Tecumseh	North Fork	570	6.9
07066500	Current River near Eminence	Current	1,272	5.5
07067000	Current River at Van Buren	Current	1,667	5.0
07068000	Current River at Doniphan	Current	2,038	4.1
07070500	Eleven Point River near Thomasville	Eleven Point	361	22.9
07071500	Eleven Point River near Bardley	Eleven Point	793	5.4
06930000	Big Piney River near Big Piney	Big Piney	560	8.3
07061500	Black River near Annapolis	Black River	484	9.1
07061500	Meramec R. near Eureka	Meramec	3,788	12.8

Table Hy04. Low flow calculations for USGS Surface Discharge stations within the Current River Watershed (Skelton 1976). Partial record stations in italics.

Station #	Station Name	Drainage	Q2	Q10	Q20	Slope
		Area (mi <sup>2</sup> )				Index
07064300	Fudge Hollow near Licking, Mo.	2	0	0	0	-
07064400	Montauk Spring at Montauk State Park	-	62.0	46.0	42.0	1.4
07064500	Big Creek near Yukon , Mo.	8	0	0	0	-
07064530	Welch Spring near Akers		95.0	75.0	72.0	1.3
07064555	Pulltite Spring near Round Spring	-	16.0	-	-	-
07064760	Twin Springs near Shannondale	-	10.0	8.4	-	-
07064800	Sinking Creek near Round Spring	-	38.0	28.0	26.0	1.5
07064950	Current River at Round Spring	-	320.0	230.0	220.0	1.5
07065000	Round Spring at Round Spring, Mo.	-	16.0	11.0	10.0	1.6
07066500	Current River near Eminence, Mo.	1,272	512.0	382.0	358.0	1.4
07066550	Blue Spring near Eminence, Mo.	-	78.0	62.0	-	-
07066600	Rocky Creek near Eminence	-	0.1	0	0	-
07066990	Pike Creek at Van Buren	-	1.0	-	-	-
07067000	Current River at Van Buren , Mo.	1,667	700.0	540.0	510.0	1.3
07067500	Big Spring near Van Buren , Mo.	100	290.0	254.0	246.0	1.2
07067680	Cave Spring near Hunter	-	1.6	-	-	-
07067700	Phillips Spring near Van Buren	-	12.0	9.0	-	-
07067900	Tucker Spring near Bennett	-	29.0	-	-	-
07068000	Current River at Doniphan , Mo.	2,038	1,170.0	940.0	890.0	1.3
07068500	Little Black River near Fairdealing,	297	23.0	14.0	12.0	1.9
	Mo.					

Table Hy05. Two to 100 year flood discharges (cubic feet per second) for selected USGS Gage Stations within the Current River Watershed (Alexander and Wilson 1995).

	Recurrence Interval							
Station	(Discharge in cubic feet					per second)		
	2	5	10	25	50	100		
07064300 (Fudge Hollow near								
Licking, Mo.)	124	234	332	489	633	803		
07064500 (Big Creek near								
Yukon, Mo.)	1,840	3,350	4,480	6,020	7,220	8,460		
07066500 (Current River near								
Eminence, Mo.)	23,500	45,500	62,500	85,900	104,000	124,000		
07067000 (Current River at								
Van Buren, Mo.)	26,700	48,900	65,500	87,800	105,000	123,000		
07068000 (Current River								
at Doniphan, Mo.)	27,300	50,700	68,700	93,500	113,000	185,000		
07068500 (Little Black R. near								
Fairdealing, Mo. )	7,220	15,700	23,000	33,800	43,000	52,800		