HYDROLOGY

Precipitation

A National Weather Service Station in Willow Springs, measuring precipitation since 1924, indicates an average annual precipitation of 45 inches, with very little change throughout the period of record (Figure Hy01)(USDC 1995; Owenby and Ezell 1992). The Eleven Point Watershed is situated in one of the wetter parts of the state. The greatest amount of precipitation occurs during the spring months of March, April, and May. Precipitation is lowest in the winter months of December, January, and February.

USGS Gage Stations

The United States Geological Survey (USGS) has two active gage stations within the Eleven Point Watershed (USGS 1996 and USGS 1998). Station #07071000 is located at Greer Spring, 300 feet from the lower outlet spring, and 1 mile upstream from the Eleven Point River. It has been recording water stage data from August 1904 to the present and water quality data periodically from 1968 to the present. Gage station #07071500 (http://mo.water.usgs.gov/rt-cgi/gen_stn_pg?station=07071500) is located 7.0 miles southwest of Bardley in Oregon county, at the Highway 160 Bridge. Water stage data has been recorded from October 1921 to the present. Water quality data was recorded periodically at this station from 1968 to the present (USGS 1996). Historical water stage records exist from ten other gaging stations positioned throughout the Eleven Point Watershed (Table Hy01 and Figure Hy02).

Average Daily and Peak Discharge

Long-term flow data exists for three locations throughout the Eleven Point Watershed, the two operational gage stations discussed earlier and the Eleven Point River near Thomasville. The mean daily discharge at gage station #07070500 on the Eleven Point River near Thomasville from 1951-1976 was 101 cubic feet per second (cfs) (USGS 1995). The average daily discharge at the Greer Spring Branch Gage for the last 73 years was 342 cfs. The average daily discharge at the gage station near Bardley for the last 73 years was 781 cfs. Stream flow at all stations was lowest during the months of August, September, and October and highest during April and May (Figures Hy03,Hy04, and Hy05). Table Hy02 lists the highest and lowest instantaneous flow rates that have occurred at each of the above sites during the period of gaging record.

7-day Q2, Q10, and Q20 Low Flow and Slope Indices

Seven day low flow statistics were computed for the three areas that had long term gaging station records (Table Hy03). The Eleven Point River near Thomasville has seven day Q2, Q10, and Q20 low flow values of 7.2, 4.1, and 3.4 cubic feet per second (cfs), respectively. These are extremely low flow rates when one considers that this site drains 361 square miles (36% of the watershed), yet another indicator of the number of losing stream reaches in this portion of the watershed.

Slope indices (SI, ratio of the seven day Q2 to Q20) were calculated for the Eleven Point River near Thomasville and also for the Eleven Point River near Bardley. The SI were 2.1 near Thomasville and 1.5 near Bardley. The slope index near Bardley is slightly lower than that at Thomasville. One possible reason for such a low slope index near Bardley would be the influence of springs on maintaining stable low flows. Both stations had extremely low slope indices, an indication of low variability in annual low flows.

Duration of Daily Flows and Mean Annual Discharge

Flow duration curves are useful for inter/intra watershed comparisons of discharges. Daily flow duration data was compared to determine if the Eleven Point River has become more or less susceptible to flooding and or drying in recent years. Figures Hy06 and Hy07 illustrate the duration of flows from 1922 through 1958 and 1959 through 1994 for the Eleven Point River near Bardley and Greer Spring Branch respectively. The flow duration curves from the latter time period have made an upward shift to higher discharges. The upward shift of the flow duration curve reflects, in part, an overall increase in discharge in the latter time period. The changes in the flow duration curve and discharge rates are an indication of possible changes in precipitation, land use, and/or spring output.

Changes in the amount, intensity, seasonal timing, and/or duration of precipitation could impact discharge. Although the amount and seasonal timing of precipitation (at least at Willow Springs and Alton) have remained relatively stable since 1922, data on intensity and duration of precipitation is unavailable; however, it is unlikely that the change in discharge on Greer Spring Branch is linked to precipitation.

Land use practices can significantly alter flow duration and discharge. A change in land use from pasture or clear-cut to timber can slow the rate of surface runoff, alter the ratio of surface to subsurface flow, and reduce over bank flow velocities. Land use practices have changed considerably over the two time periods mentioned. As described in preceeding sections, the earlier time period was characterized by massive clearcutting, row crop conversion to pasture, and burning. A large portion of this disrupted land has returned to timber (Jacobson and Primm 1994) This would decrease the flashiness of the river as noted by the extended durations at any particular flow rate.

In the Eleven Point Watershed, ground water contributes significantly to the overall river water supply. Table Ge03 lists the names, locations, and measured discharges of springs referenced in Springs of Missouri (Vineyard and Feder 1974). The Eleven Point River Watershed is characterized by karst topography and a complex aquifer system. Alterations in the aquifer and subsequent changes in the supply of ground water could significantly change stream discharge and flow duration. Although Figure Hy07 shows an increase in discharge from Greer Spring Branch in recent years, at present, we have no way of determining whether this increase has been caused by a change in land use (i.e. surface/subsurface water flow) or a possible alteration in the aquifer system (i.e. collapse).

10:90 Ratio

The 10:90 ratio refers to the ratio of the flow rate equaled or exceeded 10% of the time to the flow rate equaled or exceeded 90% of the time. The 10:90 ratio for the Eleven Point River near Thomasville and Bardley is 31:1 and 5:1 respectively. The Eleven Point River near Thomasville has a high 10:90 ratio, an indication of highly variable flows. A high 10:90 ratio would be expected at Thomasville since much of the watershed at this point is in pasture and stream channels are composed of intermittent and losing stream reaches. In addition, the flow of the river near Thomasville is influenced to a great extent by precipitation and to a lesser extent by spring flow. In contrast to the Eleven Point River near Thomasville, near Bardley the Eleven Point River has a low 10:90 ratio, indicative of low variable flows. Flow of the river near Bardley is highly regulated by spring flow. As a result, the river near Bardley maintains a relatively stable flow rate throughout the year.

Flood Frequency

Table Hy04 shows the frequency and magnitude of flooding at two locations (Thomasville and Bardley) on the Eleven Point River. Flooding magnitude for the Eleven Point Watershed is comparable to other Ozark watersheds of similar size.

Figure Hy01. Mean monthly precipitation at Willow Springs for two time periods.

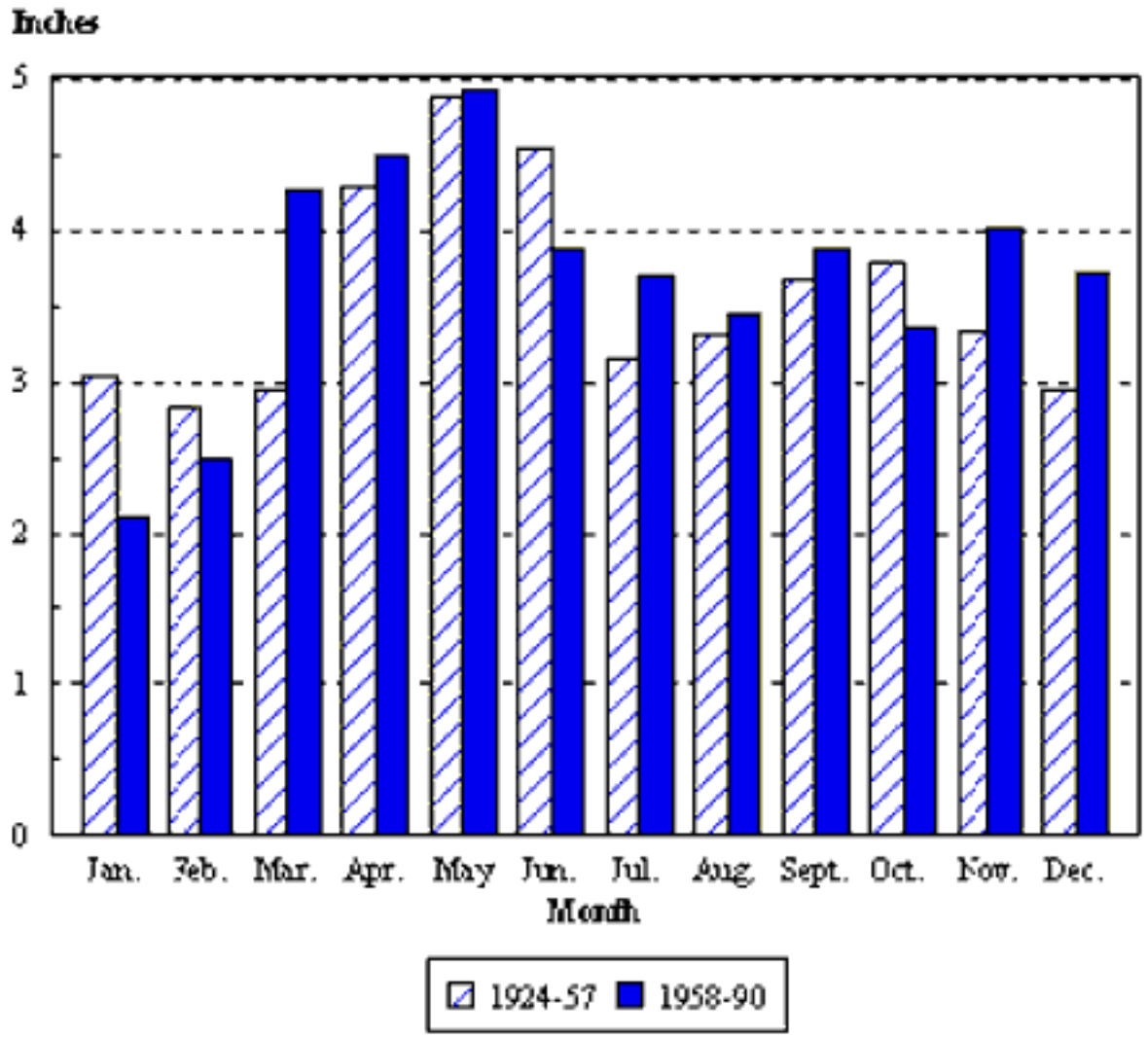

Figure Hy02.

Eleven Point Watershed

Surface Water Gage Stations

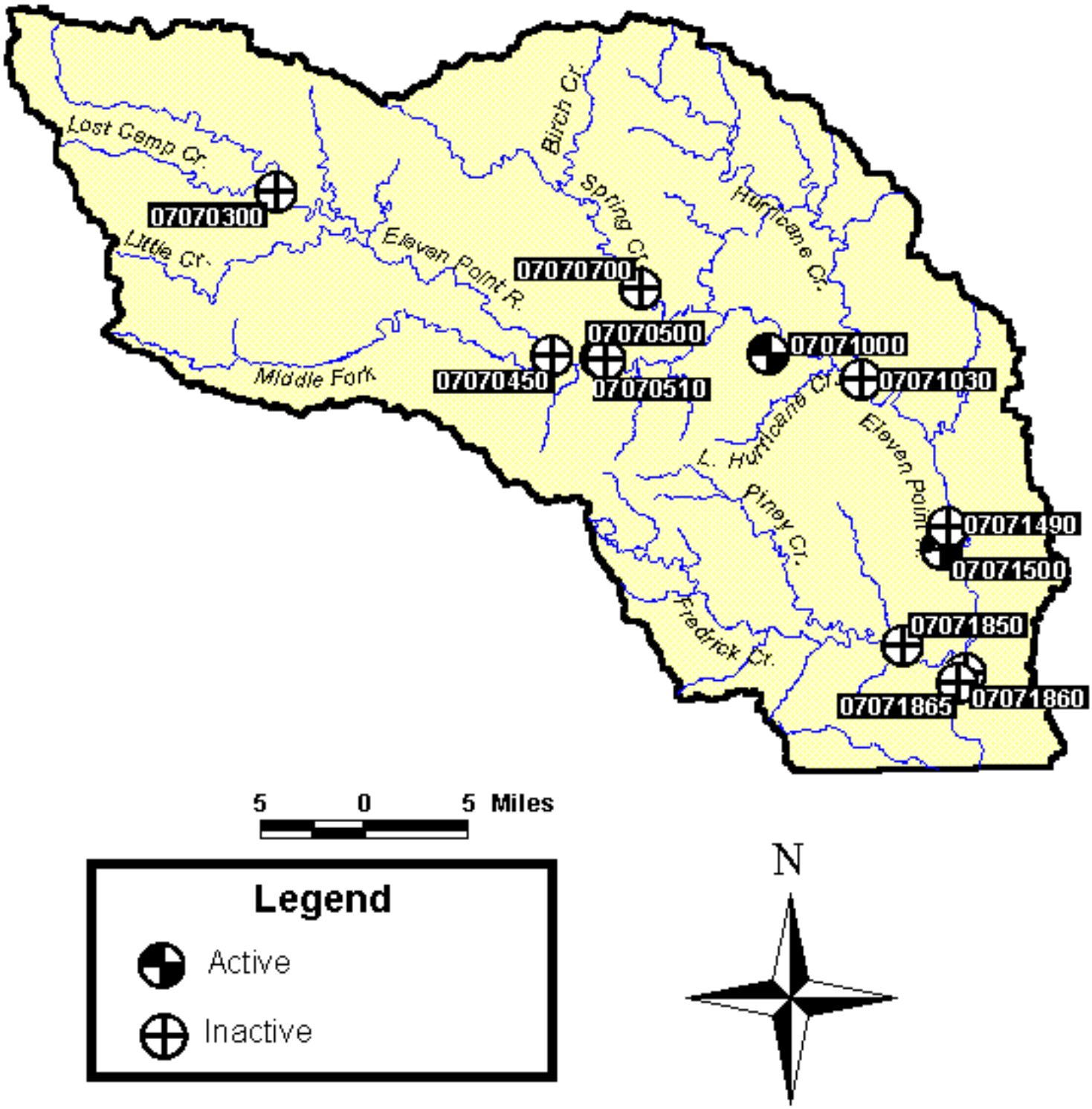

Figure Hy03. Monthly maximum, minimum, and mean flows for station 07071000-Greer Spring Branch at Greer, MO 1922-1994 (USGS 1995).

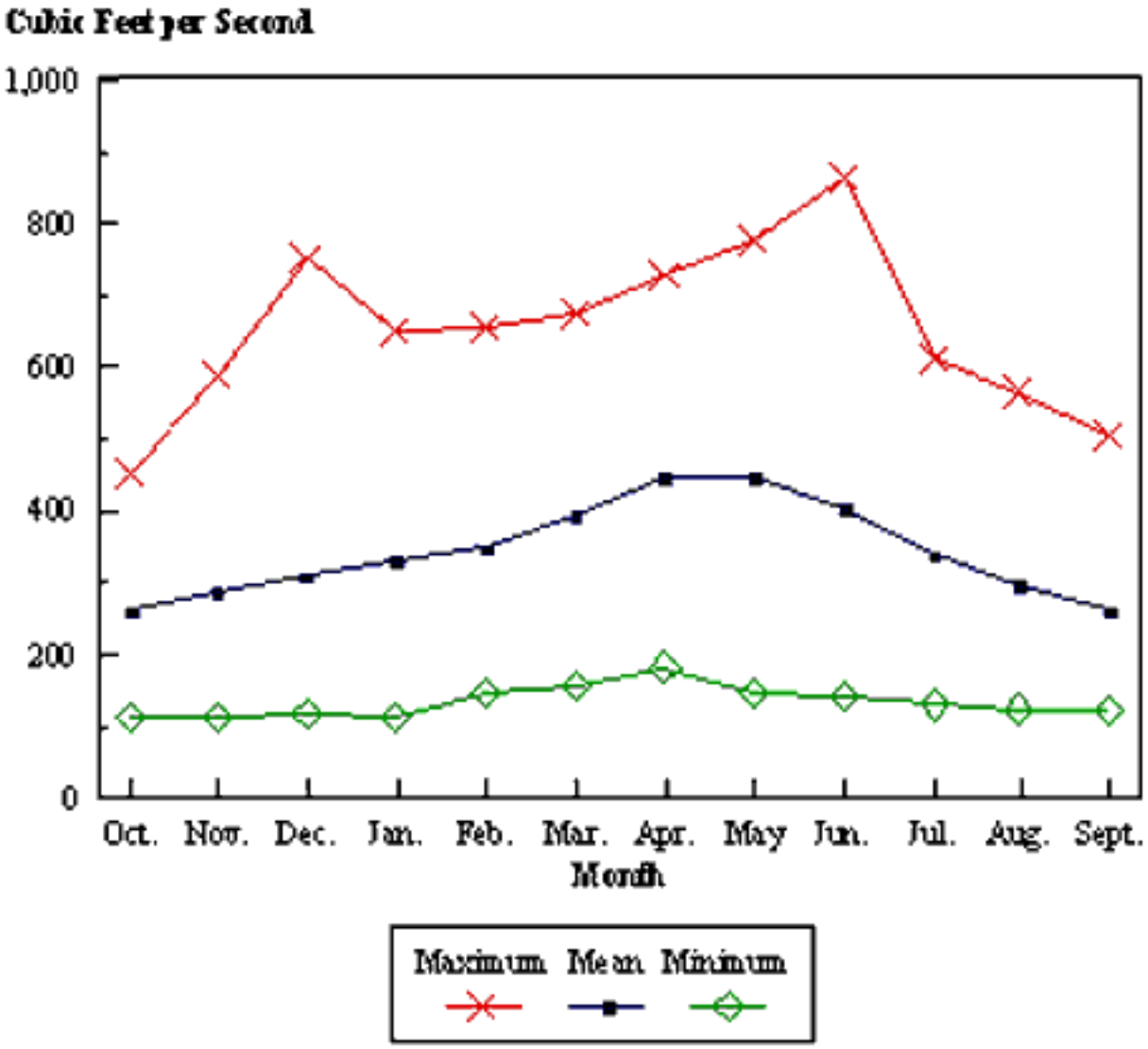

Figure Hy04. Monthly maximum, minimum, and mean flows for station 07071500-Eleven Point River near Bardley 1922-1994 (USGS 1955).

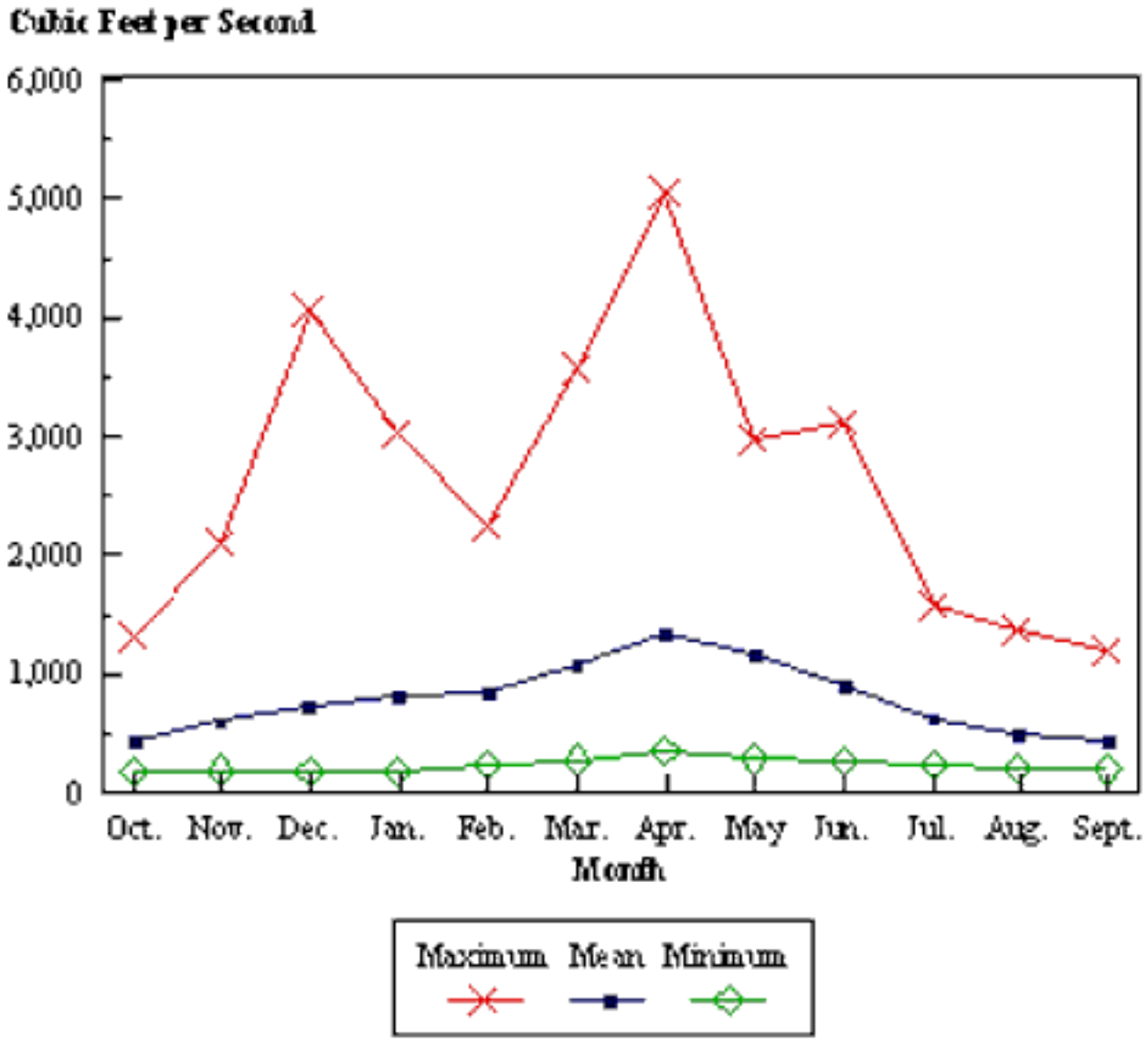

Figure H05. Monthly maximum, minimum, and mean flows for station 07070500-Eleven Point River near Thomasville 1951-1977 (USGS 1996).

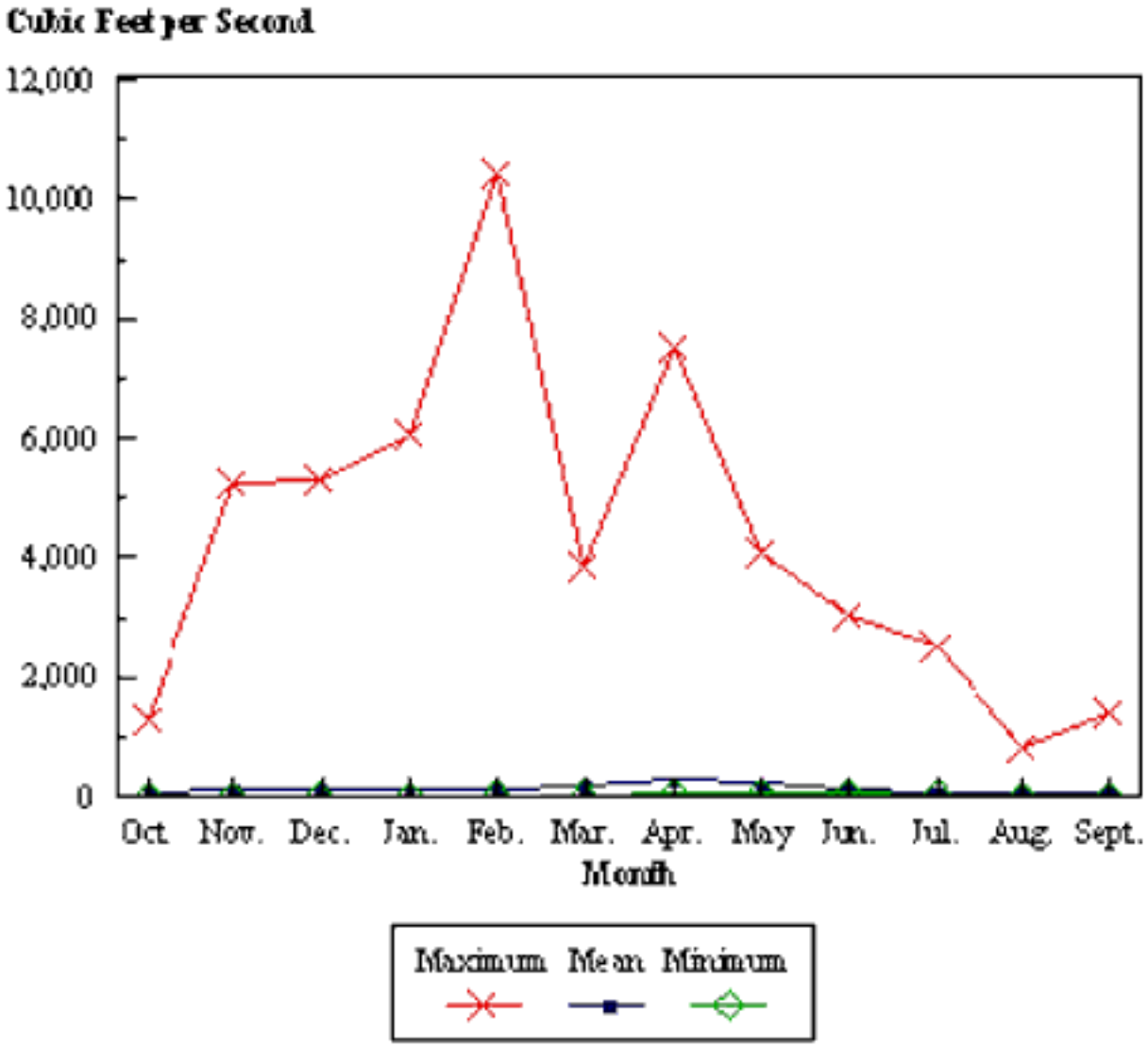

Figure Hy06. Flow duration changes between two time periods for the Eleven Point River near Bardley (USGS 1995).

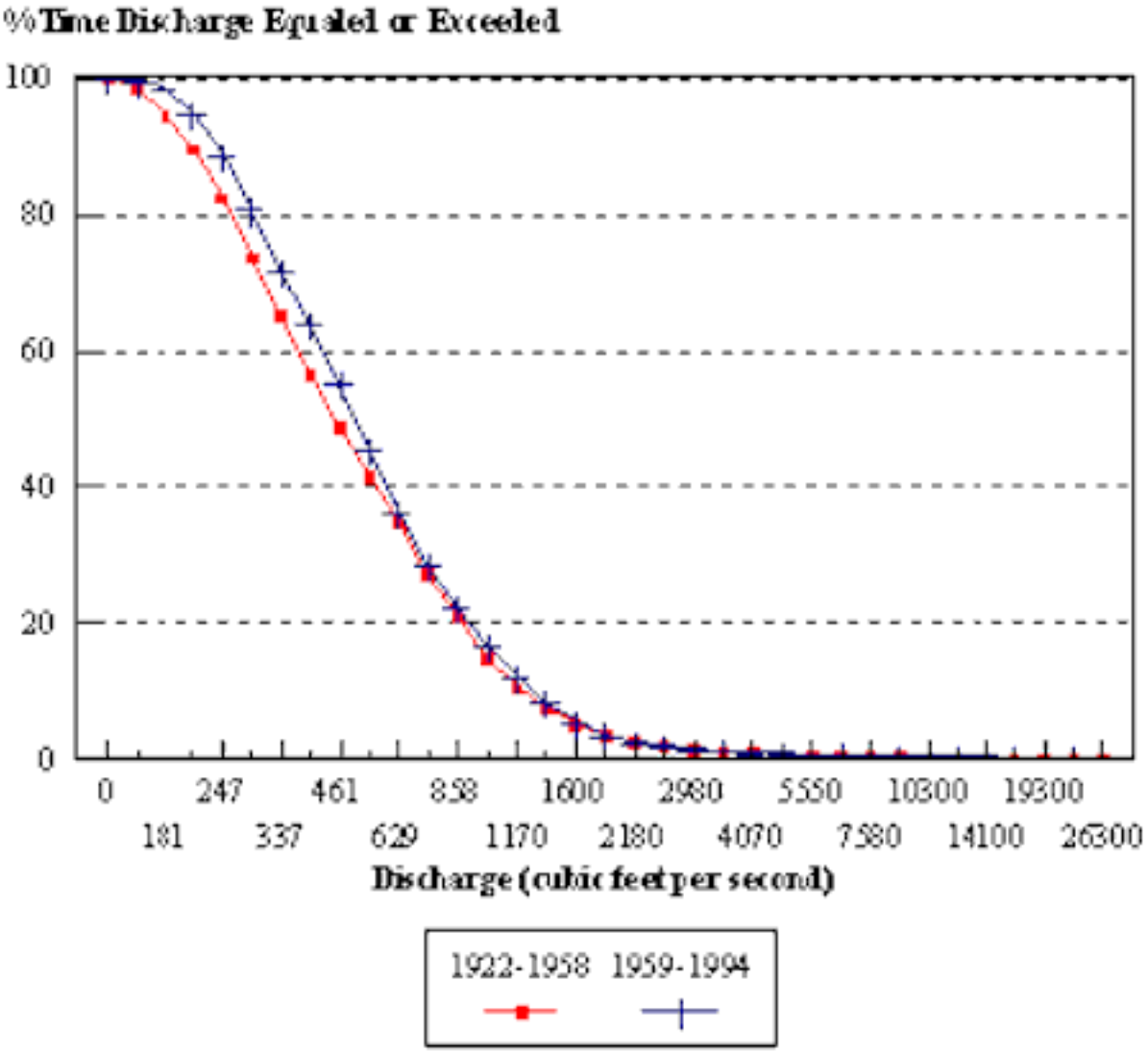

Figure Hy07. Flow duration changes between two time periods for the Greer Spring (USGS 1995).

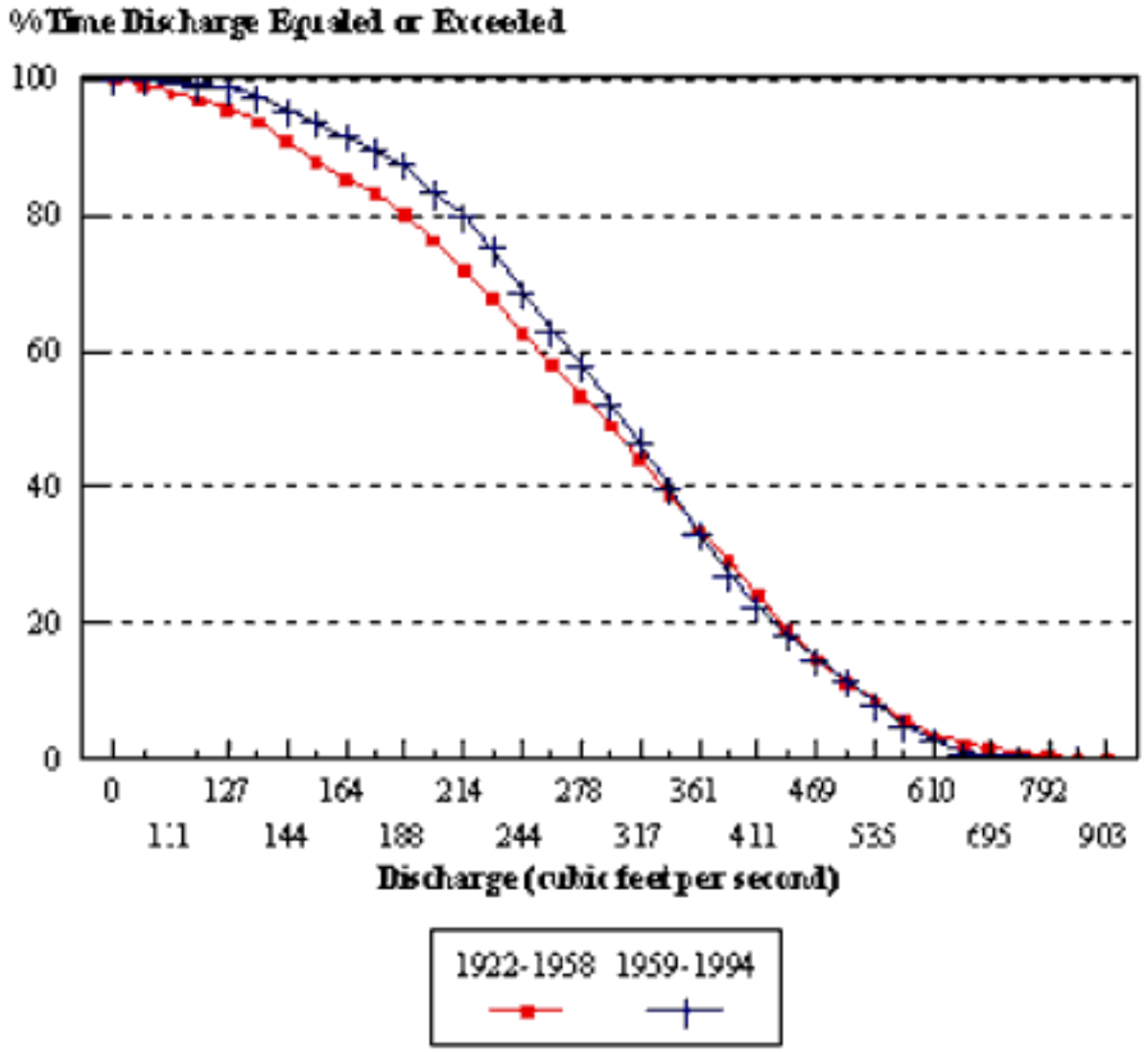

Table Hy01. Gage stations in the Eleven Point Watershed (MDNR 1984, USGS 1994 and 1997).

Station Number	Station Name	Location	Period of Record
07070300	Eleven Point River near Mountain View	Howell County NE,NE,Sec.25,T26N,R8W	1964-1966
07070450	Eleven Point River at Thomasville	Oregon County SW,Sec.32,T25N,R5W	1942-1943 1945-1946 1951 1962-1967
07070500	Eleven Point River near Thomasville	Oregon County NE,NE,Sec.3,T24N,R5W	1951-1972
07070510	Posey Spring near Thomasville	Oregon County NE,NE,Sec.3,T24N,R5W	1950-1956 1958-1959 1961-1963
07070700	Spring Creek near Thomasville	Oregon County SW,Sec.13,T25N,R5W	1969-1970
07071000	Greer Spring at Greer	Oregon County SE,SW,Sec.36,T25N,R4W	1904 1921-1997
07071030	Turner Mill Spring near Alton	Oregon County NE,SE,Sec.3,T24N,R3W	1924-1925 1932-1936 1966-1967
07071490	Boze Mill Spring near Bardley	Oregon County SE,SE,Sec.9,T23N,R2W	1925 1931-1934 1936-1964 1966-1967
07071500	Eleven Point River near Bardley	Oregon County NE,SE,Sec.17,T23N,R2W	1922-1997
07071850	Fredrick Creek near Myrtle	OregonCountyNE, Sec.12,T22N,R3W	1969-1971

07071860	**Thomasson Mill (Morgan) Spring near Alton**	**Oregon County NW,Sec.16,T22N,R2W**	**1925-1926 1932-1936 1963-1967**
07071865	**Blue Spring near Alton**	**Oregon County SE,Sec.16,T22N,R2W**	**1925 1932-1936 1942-1964 1966-1967 1971**

Table Hy02. Highest and lowest instantaneous discharges and date of occurrence at three gage stations within the Eleven Point Watershed (USGS 1995).

Station Number	Station Name	Period of Record	Highest Instantaneous Flow and Date of Occurrence	Lowest Instantaneous Flow and Date of Occurrence
07070500	Eleven Point R near Thomasville	1951-1976	10,400 cfs February, 1966	3.0 cfs Sept. 1954
07071000	Greer Spring near Greer	1921-1994	1,770 cfs December, 1982	104 cfs Nov.1956
07071500	Eleven Point R. near Bardley	1921-1994	49,800 cfs December, 1982	152 cfs Jan. 1956

Table Hy03. Seven-day low-flow discharges for 2, 10, and 20 year recurrence intervals, as well as (Q2/Q20) slope indices for the Eleven Point River (USGS 1995).

Station Number	Station Name	Period of Record	Q2 (cfs)	Q10 (cfs)	Q20 (cfs)	Slope Index (Q2/Q20)
07070500	Eleven Point R. near Thomasville	1951-1976	7.2	4.1	3.4	2.1
07071000	Greer Spring near Greer	1921-1994	184	122	119	1.5
07071500	Eleven Point R. near Bardley	1921-1994	270	185	178	1.5

Table Hy04. Two-500 year flood discharges at two United States Geological Survey (USGS) Stations within the Eleven Point Watershed (Alexander and Wilson 1995).

Station	Recurrence Interval						
-	2	5	10	25	50	100	500
Eleven Point Near Thomasville	6,070	10,900	14,700	19,800	23,800	28,100	38,600
Eleven Point Near Bardley	9,250	20,000	28,600	40,300	49,500	58,800	80,600