

Appendix H
River Flow Data Summaries

River Flow Data Summary for Lower Rouge Subwatershed

4/14/00

Introduction (Table 1 and Figure 1)

Continuous river flow data in the Lower Rouge Subwatershed include historic USGS data and data collected by the RPO with USGS assistance, beginning in 1994. A summary of all available continuous flow data is presented in Table 1. A map and table including all river flow measurement locations in the Lower Rouge Subwatershed have been provided separately.

To aid in interpreting flow data impacted by wet weather events, long-term precipitation totals from Detroit Metropolitan Airport are shown in Figure 1. The annual precipitation totals include hail, sleet, snow, etc. expressed as equivalent inches of water. Annual average precipitation is 32.3 inches for the period of 1959 through 1997.

Historic USGS Data (Attachment 1)

The USGS has operated a stream gage on the Lower Rouge at John Daly Road (US1) continuously since 1948, in addition to recording annual peak flows for 3 years in the early 1930's. Attachment 1 includes a table for gage US1 with the following information for each year of gage operation:

1. Lowest daily average flow (cfs)
2. Annual average flow (cfs)
3. Annual average volume (expressed as inches over the upstream watershed)
4. No. of events with instantaneous peak flow rate exceeding a gage-specific threshold
5. Date and flow rate (cfs) of highest instantaneous peak flow recorded

In addition, bar charts are included in Attachment 1 for items 1, 2 and 4 to show long-term trends in the data. Each plot includes the actual data for each year as well as a trend line, which is calculated as a seven-year moving average. The lowest daily average flow typically represents the "driest" dry weather day of each year, when river flows are mainly comprised of groundwater recharge and point source inputs. The annual average flow represents dry and wet weather conditions, as it represents the annual volume of flow measured at the gage converted to cfs. The number of event peaks above a threshold shows how the watershed is responding to significant wet weather events.

The following observations can be made from the historic USGS data:

- The lowest daily average flow has averaged 1 to 2 cfs until 1996 when it jumped to around 25 cfs as the Ypsilanti Community Utilities Authority (YCUA) waste water treatment plant (WWTP) in Ypsilanti Township began discharging all its effluent to the Lower Rouge River. The WWTP effluent enters the Lower Rouge River just east of Beck Road.

- For the last 15 years, the annual flow at this gage averaged 60 cfs (0.72 cfs/sq mi) until the YCUA discharge caused a significant increase beginning in 1996. The highest annual average flow of 107 cfs occurred in 1998, the last year of data available. Between 1959 and 1979 the annual average flow increased from 40 to 60 cfs while the trend of annual average precipitation was fairly constant.
- The highest flow recorded at this gage was 3,600 cfs on June 26, 1968. There is no clear increasing or decreasing trend in the peak flow data over the years where precipitation data are available.

Recent RPO Data (Figure 2 and Table 2)

Beginning in 1994, the RPO has measured stream flow during one or more monitoring seasons at four sites in the Lower Rouge Subwatershed. Flow measurements were based on measured water level and stream rating curves. Stream rating curves developed over only one or two years can have significant uncertainty at very low and very high flow conditions that can skew the computation of an average flow. Therefore, the RPO data are best summarized using median stream flow values. Median stream flow is that flow rate which is exceeded 50 percent of the year, which typically represents a flow at the upper end of the dry weather flow regime.

The results for the May through September period each year are shown as a bar chart with stream flow normalized by dividing by the drainage area. Data for each RPO gage are shown along with data from USGS gage US1 for the same period.

The following observations can be made from the RPO and USGS data:

- The impact of the YCUA discharge is evidenced by the significant increase in flows from 1994-95 to later years.
- Of the years monitored, the highest median flow occurred in the 1997 monitoring season.

Attachment 1

Historic Flow Data Summary for Lower Rouge River at John Daly Road (US1)

Figure 1
Detroit Metro Airport
Annual Precipitation Totals

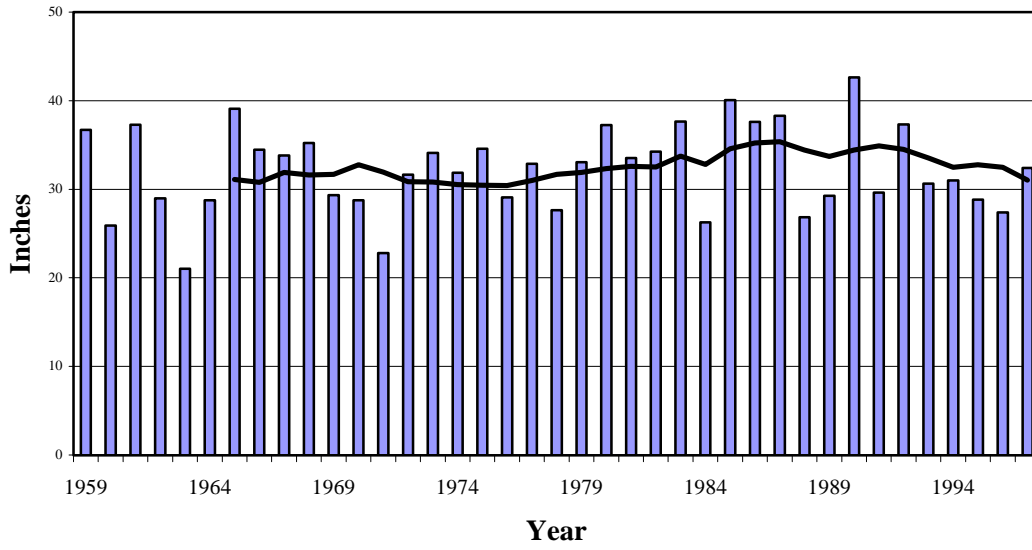


Figure 2
Lower Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

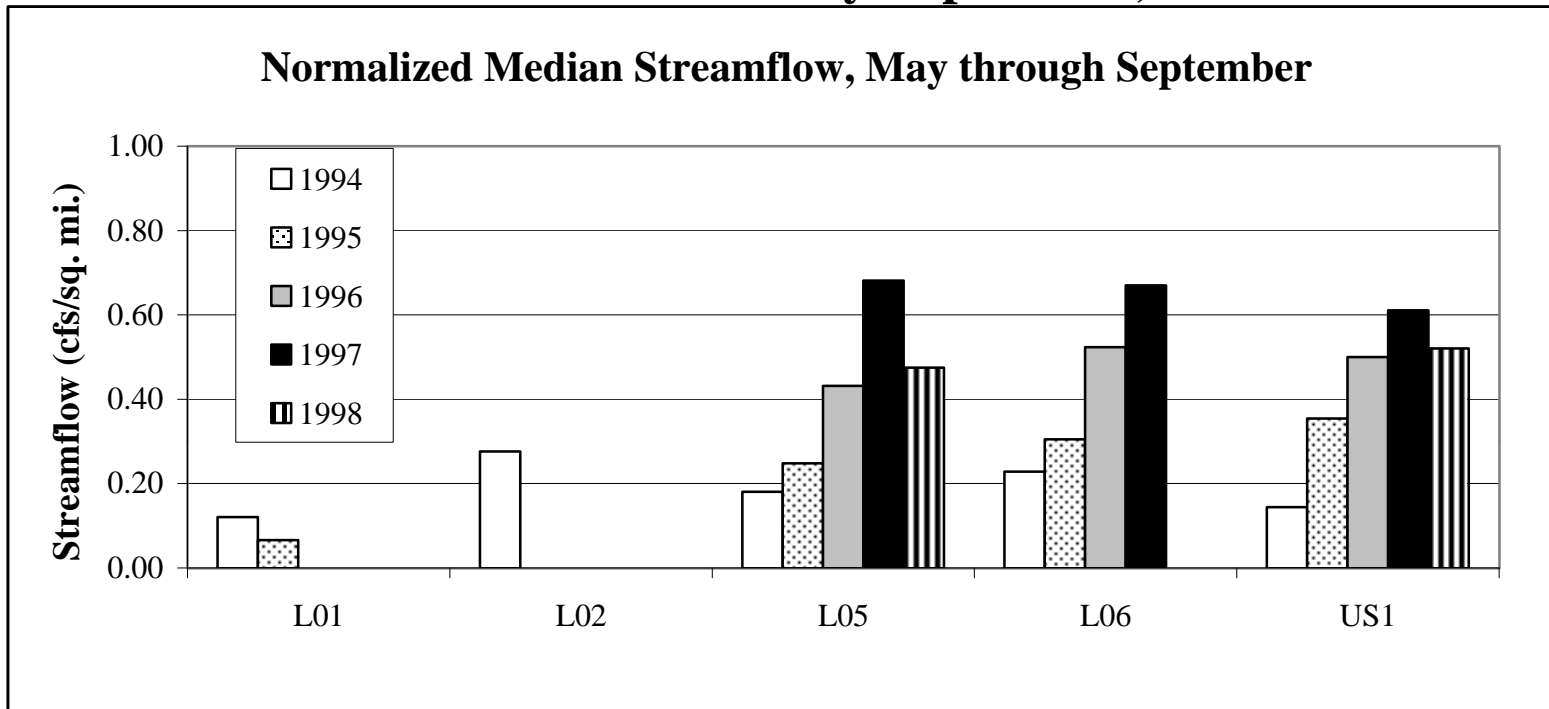


Table 1
Upper Storm Water Management Areas
Summary of Historic and RPO Continuous Flow Measurements

Type of Flow Measurement	Year	Months of Operation	Measurement Locations				
			U03	U04	U05	U22	US3
Historic USGS Data	WY* 1959-present	Year Round					
Recent RPO Data	1994	Apr/May - Oct/Nov					
	1995	Apr/May - Oct/Nov					
	1996	Apr/May - Oct/Nov					
	1997	Apr/May - Oct/Nov					
	1998	Year Round (except U22)					
	1999	Year Round					

* WY = Water Year (e.g. WY 1961 is Oct. 1960 - Sept. 1961)

Table 2
Upper Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

Site	Drainage Area* (sq mi)	Median Streamflow (cfs)					Normalized Median Streamflow (cfs/sq mi)				
		1994	1995	1996	1997	1998	1994	1995	1996	1997	1998
U03	35.2		7.5	8.2				0.21	0.23		
U04	36.1	15.9					0.44				
U05	60.6	27.4	34.2	34.7	**	18.6	0.45	0.57	0.57		0.31
U22	25.4					8.2					0.32
US3	17.5	8.8	9.5	13.3	12.2	6.4	0.50	0.54	0.76	0.70	0.37

* Drainage areas are approximate (within 5% of actual)

** Flows not reliable due to unstable rating curve.

Attachment 1

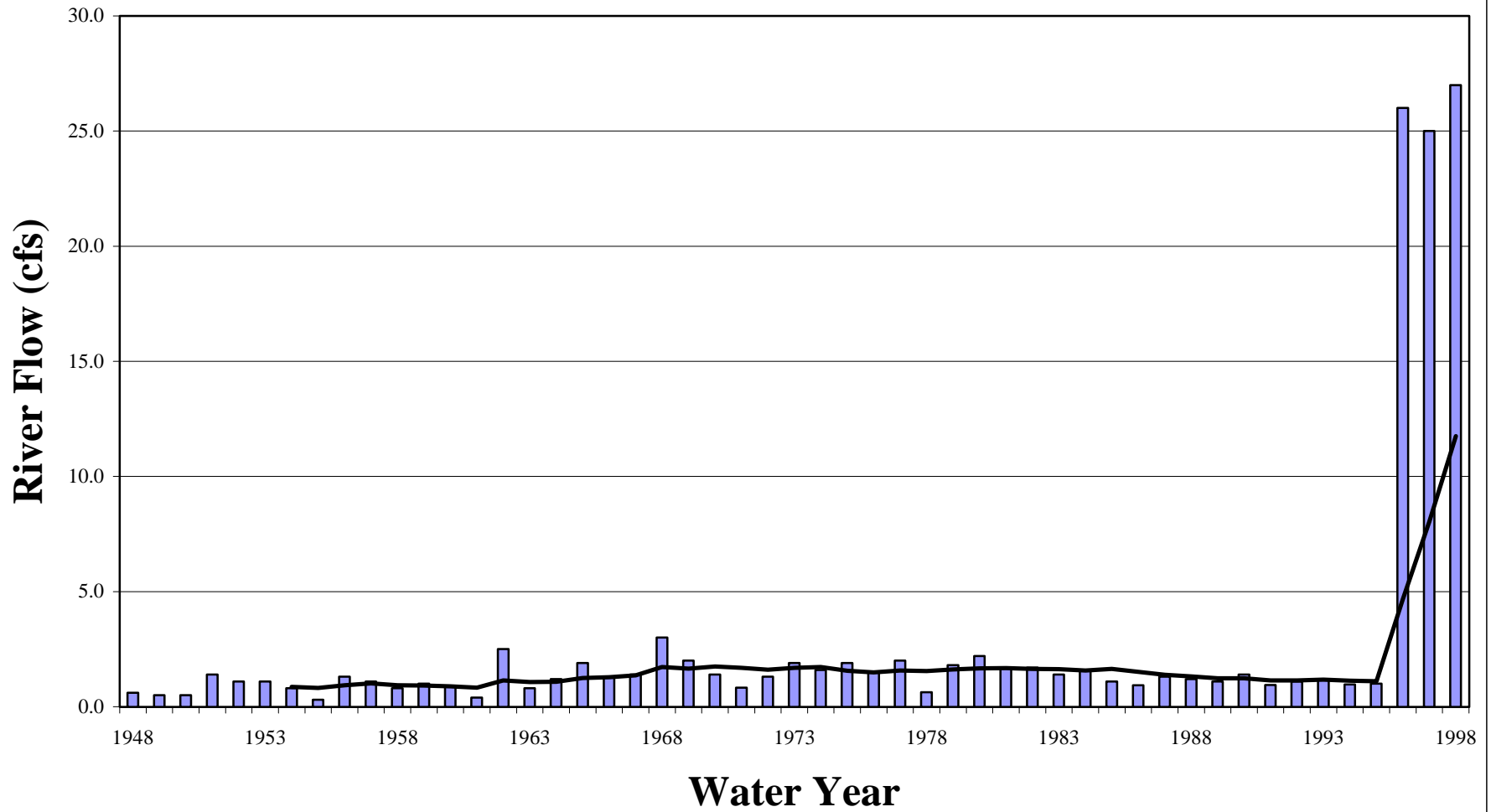
Historic Flow Data Summary For Lower Rouge River at John Daly Road (US1)

Historic Flow Data Summary
Lower Rouge River at John Daly Rd. (US1)

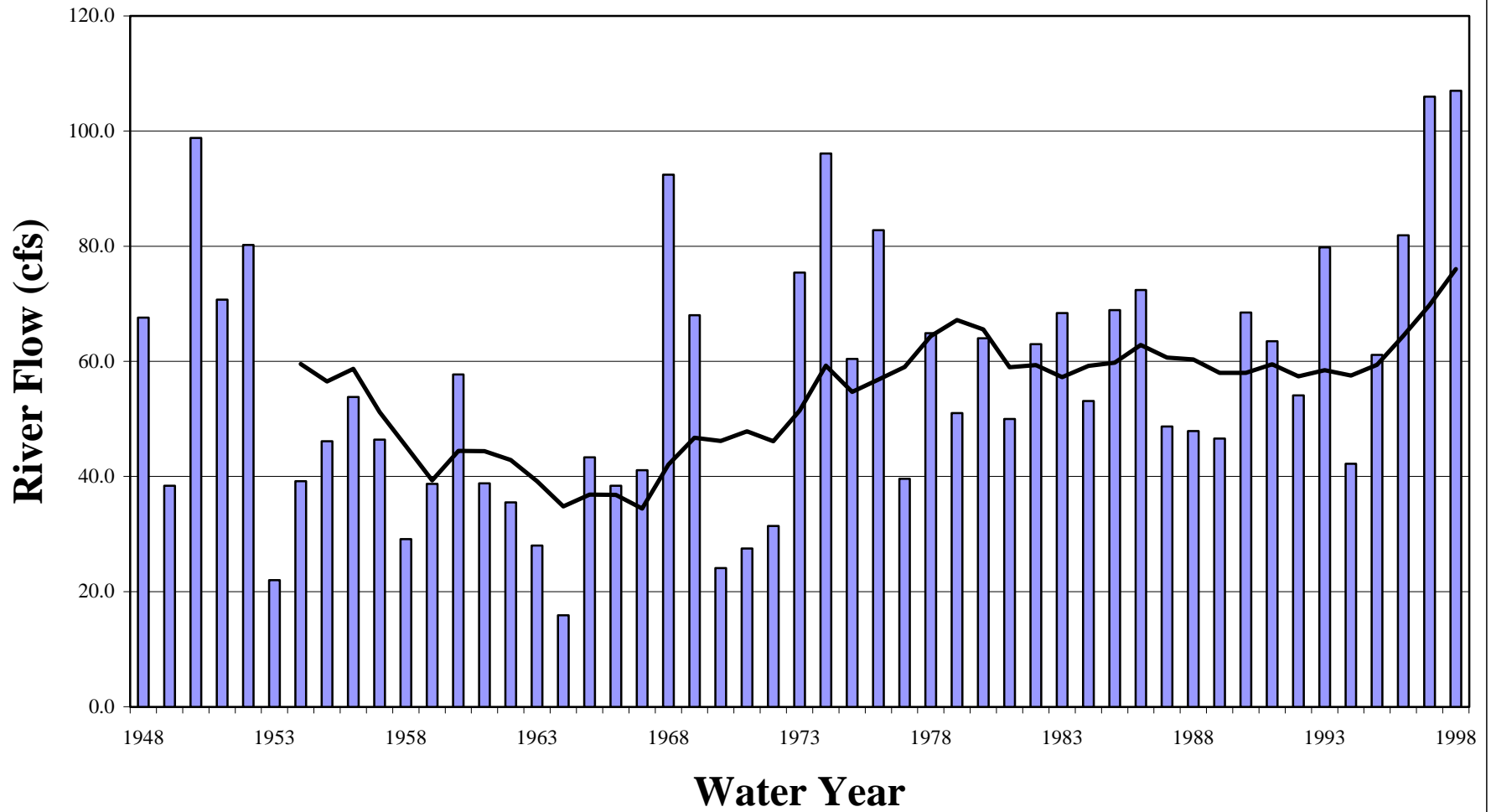
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 900 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1931	N/A	N/A	N/A	N/A	6/30/31	178
1932	N/A	N/A	N/A	N/A	2/12/32	725
1933	N/A	N/A	N/A	N/A	5/1/33	1,400
1948	0.6	67.6	11.1	4	5/11/48	2,920
1949	0.5	38.4	6.3	2	2/15/49	1,980
1950	0.5	98.8	16.2	8	4/4/50	3,120
1951	1.4	70.7	11.6	3	12/8/50	1,290
1952	1.1	80.2	13.1	7	1/20/52	1,630
1953	1.1	22.0	3.6	0	3/4/53	840
1954	0.8	39.2	6.4	2	3/26/54	2,790
1955	0.3	46.1	7.5	2	1/6/55	1,020
1956	1.3	53.8	8.8	1	4/30/56	2,460
1957	1.1	46.4	7.6	2	4/6/57	964
1958	0.8	29.1	4.8	1	12/21/57	949
1959	1.0	38.7	6.3	2	4/3/59	1,280
1960	0.9	57.7	9.4	2	6/18/60	1,010
1961	0.4	38.8	6.3	1	4/26/61	2,330
1962	2.5	35.5	5.8	1	3/12/62	1,860
1963	0.8	28.0	4.6	0	5/10/63	612
1964	1.2	15.9	2.6	0	8/11/64	590
1965	1.9	43.3	7.1	3	3/5/65	1,830
1966	1.3	38.4	6.3	1	12/25/65	1,720
1967	1.4	41.1	6.7	0	4/3/67	830
1968	3.0	92.4	15.1	4	6/26/68	3,600
1969	2.0	68.0	11.1	2	1/30/69	1,640
1970	1.4	24.1	3.9	0	3/5/70	646
1971	0.8	27.5	4.5	1	2/20/71	1,010
1972	1.3	31.4	5.1	0	4/17/72	838
1973	1.9	75.4	12.3	0	3/12/73	865
1974	1.6	96.1	15.7	6	2/23/74	1,420
1975	1.9	60.4	9.9	4	2/25/75	1,140
1976	1.5	82.8	13.5	4	2/17/76	1,910
1977	2.0	39.6	6.5	1	4/26/77	1,220
1978	0.6	64.9	10.6	1	3/22/78	1,540
1979	1.8	51.0	8.3	1	4/14/79	2,700
1980	2.2	64.0	10.5	3	4/5/80	1,260
1981	1.7	50.0	8.2	1	2/19/81	1,110
1982	1.7	63.0	10.3	2	3/14/82	1,550
1983	1.4	68.4	11.2	1	5/2/83	1,750
1984	1.6	53.1	8.7	1	3/22/84	1,310
1985	1.1	68.9	11.3	3	2/24/85	2,320
1986	0.9	72.4	11.8	2	3/11/86	1,160
1987	1.3	48.7	8.0	0	6/21/87	798
1988	1.2	47.9	7.8	1	12/16/87	977
1989	1.1	46.6	7.6	0	5/31/89	687
1990	1.4	68.5	11.2	2	2/23/90	2,230
1991	0.9	63.5	10.4	2	12/30/90	1,850
1992	1.1	54.1	8.8	0	4/25/92	682
1993	1.2	79.8	13.0	2	1/5/93	1,880
1994	1.0	42.2	6.9	0	3/22/94	774
1995	1.0	61.1	10.0	1	6/29/95	1,120
1996	26.0	81.9	13.4	1	5/10/96	1,470
1997	25.0	106.0	17.3	3	2/22/97	1,820
1998	27.0	107.0	17.5	5	2/18/98	2,500

* Based on approximate drainage area of 83.2 square miles.

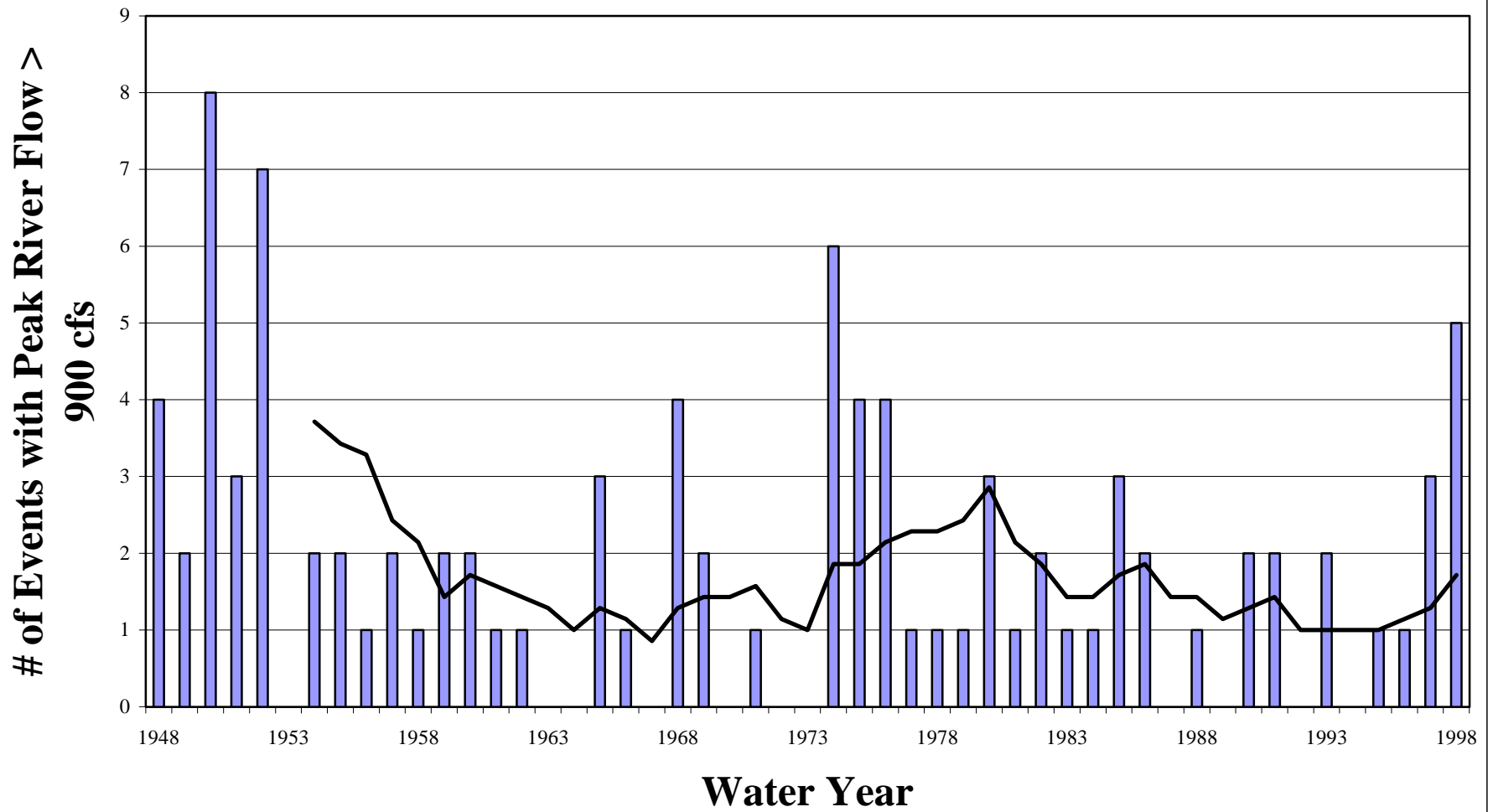
Low Flow Trend Lower Rouge River @ John Daly Rd. (US1)



Average Flow Trend Lower Rouge River @ John Daly Rd. (US1)



Peak Flow Trend Lower Rouge River @ John Daly Rd. (US1)



River Flow Data Summary for Main 1 & 2 Rouge Subwatershed

4/14/00

Introduction (Table 1 and Figure 1)

Continuous river flow data in the Main 1 & 2 Rouge Subwatershed include historic USGS data and data collected by the RPO with USGS assistance, beginning in 1994. A summary of all available continuous flow data is presented in Table 1. A map and table including all river flow measurement locations in the Main 1 & 2 Rouge Subwatershed have been provided separately.

To aid in interpreting flow data impacted by wet weather events, long-term precipitation totals from Detroit Metropolitan Airport are shown in Figure 1. The annual precipitation totals include hail, sleet, snow, etc. expressed as equivalent inches of water. Annual average precipitation is 32.3 inches for the period of 1959 through 1997.

Historic USGS Data (Attachment 1)

The USGS has operated three stream gages in the Main 1 & 2 Rouge since the 1950's as listed below.

- Main Rouge River at Maple Road (US4) – beginning in 1951
- Main Rouge River at Beech Road (US5) – beginning in 1959
- Evans Ditch at Nine Mile Road (US6) – beginning in 1959

Attachment 1 includes a table for each of the three gages with the following information for each year of gage operation:

1. Lowest daily average flow (cfs)
2. Annual average flow (cfs)
3. Annual average volume (expressed as inches over the upstream watershed)
4. No. of events with instantaneous peak flow rate exceeding a gage-specific threshold
5. Date and flow rate (cfs) of highest instantaneous peak flow recorded

In addition, for each gage, bar charts are included in Attachment 1 for items 1, 2 and 4 to show long-term trends in the data. Each plot includes the actual data for each year as well as a trend line, which is calculated as a seven-year moving average. The lowest daily average flow typically represents the “driest” dry weather day of each year, when river flows are mainly comprised of groundwater recharge and point source inputs. The annual average flow represents dry and wet weather conditions, as it represents the annual volume of flow measured at the gage converted to cfs. The number of event peaks above a threshold shows how the watershed is responding to significant wet weather events.

The following observations can be made from the historic USGS data:

Main Rouge River at Maple Road (US4)

- The lowest daily average flow has increased significantly over the years. The lowest daily average flows in the 1960's averaged around 1 cfs compared to an average of more than 5 cfs in recent years.
- For the last 15 years, the annual flow at this gage has averaged 27 cfs (0.82 cfs/sq mi). The highest annual average flow of 36 cfs occurred in 1968. Between 1959 and 1998, the annual average stream flow increased from around 11 to 28 cfs while the trend of annual average precipitation was fairly constant.
- The highest recorded flow at this gage was 1,390 cfs on June 26, 1968. There is a definite increasing trend in the number of events with peak flows greater than 180 cfs. From 1959 to 1998, the frequency of such events increased from two to six times per year while the trend of annual average precipitation was fairly constant.

Main Rouge River at Beech Road (US5)

- The lowest daily average flow has increased significantly over the years. The lowest daily average flows in the 1960's averaged 2.5 cfs compared to an average of more than 15 cfs in recent years.
- For the last 15 years, the annual flow at this gage has averaged 85 cfs (0.97 cfs/sq mi). The highest annual average flow of 105 cfs occurred in 1993. Between 1959 and 1998, the annual average stream flow increased from around 40 cfs to 90 cfs while the trend of annual average precipitation was fairly constant.
- The highest recorded flow at this gage was 4,900 cfs on June 26, 1968. There is a definite increasing trend in the number of events with peak flows greater than 700 cfs. From 1959 to 1998, the frequency of such events increased from 1.5 to more than six times per year while the trend of annual average precipitation was fairly constant.

Evans Ditch at Nine Mile Road (US6)

- The lowest daily average flow has increased somewhat over the years. The lowest daily average flows in the 1960's averaged 0.4 cfs compared to an average of 1.1 cfs in recent years.
- For the last 15 years, the annual flow at this gage has averaged 10 cfs (1.06 cfs/sq mi). The highest annual average flow of 17 cfs occurred in 1968. Between 1959 and 1998, the annual average stream flow increased from around 5 cfs to 10 cfs while the trend of annual average precipitation was fairly constant.
- The highest recorded flow at this gage was 1,200 cfs on October 1, 1981. There is a definite increasing trend in the number of events with peak flows greater than 400 cfs. From 1959 to 1998, the frequency of such events increased from less than once per year to five times per year while the trend of annual average precipitation was fairly constant.

Recent RPO Data (Figure 2 and Table 2)

Beginning in 1994, the RPO has measured stream flow during one or more monitoring seasons at three sites in or just outside the Main 1 & 2 Rouge Subwatershed. Flow measurements were based on measured water level and stream rating curves. Stream rating curves developed over only one or two years can have significant uncertainty at very low and very high flow conditions that can skew the computation of an average flow. Therefore, the RPO data are best summarized using median stream flow values. Median stream flow is that flow rate which is exceeded 50 percent of the year, which typically represents a flow at the upper end of the dry weather flow regime.

The results for the May through September period each year are shown as a bar chart with stream flow normalized by dividing by the drainage area. Data for each RPO gage are shown along with data from the three USGS gages for the same period.

The following observations can be made from the RPO and USGS data:

- The highest median stream flow occurred in the 1996 or 1997 monitoring season while the lowest occurred in 1998.
- The normalized median stream flow for the only tributary measured, Evans Ditch (US6), is lower than all the other main branch flow measurement locations.

Attachment 1

Historic Flow Data Summary For Main Rouge River at Maple Road (US4) Main Rouge River at Beech Road (US5) Evans Ditch at Nine Mile Road (US6)

Figure 1
Detroit Metro Airport
Annual Precipitation Totals

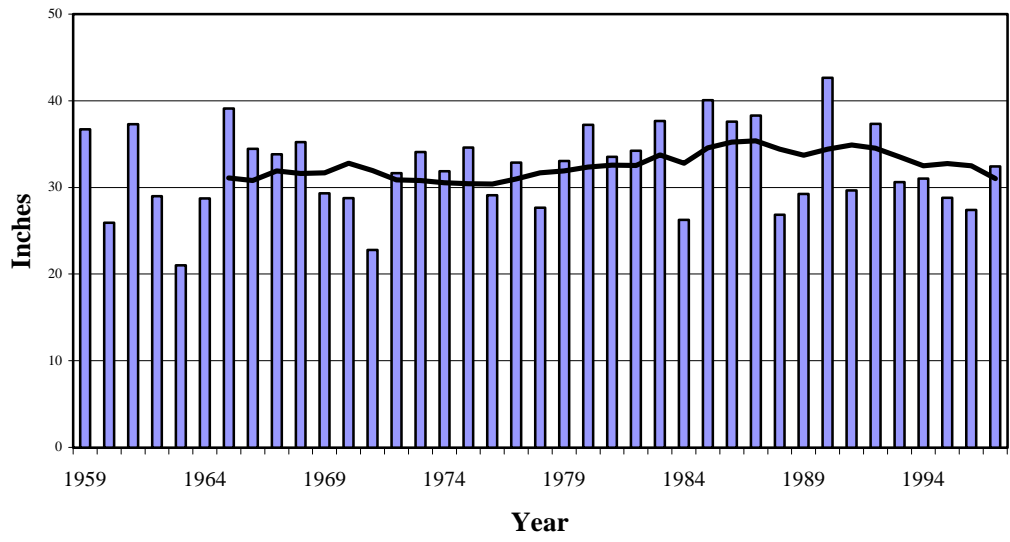


Figure 2
Main 1 & 2 Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

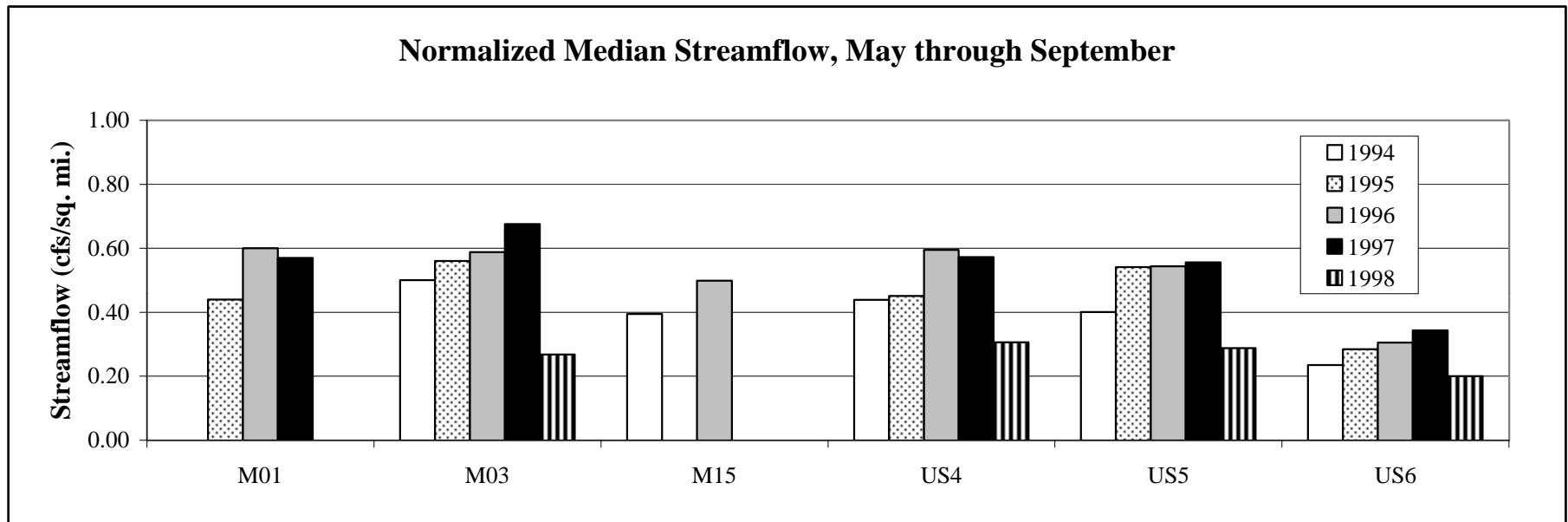


Table 1
Main 1 & 2 Storm Water Management Areas
Summary of Historic and RPO Continuous Flow Measurements

Type of Flow Measurement	Year	Months of Operation	Measurement Locations						
			M01	M03	M15	US4	US5	US6	
Historic USGS Data	WY* 1951-1958	Year Round							
	WY* 1959-present	Year Round							
Recent RPO Data	1994	Apr/May - Oct/Nov							
	1995	Apr/May - Oct/Nov							
	1996	Apr/May - Oct/Nov							
	1997	Apr/May - Oct/Nov							
	1998	Apr/May - Oct/Nov							
	1999								

* WY = Water Year (e.g. WY 1961 is Oct. 1960 - Sept. 1961)

Table 2
Main 1 & 2 Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

Site	Drainage Area* (sq mi)	Median Streamflow (cfs)					Normalized Median Streamflow (cfs/sq mi)				
		1994	1995	1996	1997	1998	1994	1995	1996	1997	1998
M01	10.0	**	4.4	6.0	5.7			0.44	0.60	0.57	
M03	38.0	19.0	21.3	22.4	25.7	10.2	0.50	0.56	0.59	0.68	0.27
M15	105.0	41.4	**	52.4			0.39		0.50		
US4	33.3	14.6	15.0	19.8	19.1	10.2	0.44	0.45	0.59	0.57	0.31
US5	87.9	35.2	47.5	47.8	48.9	25.3	0.40	0.54	0.54	0.56	0.29
US6	9.5	2.2	2.7	2.9	3.3	1.9	0.23	0.28	0.31	0.34	0.20

* Drainage areas are approximate (within 5% of actual)

** Flows not reliable due to unstable rating curve.

Attachment 1

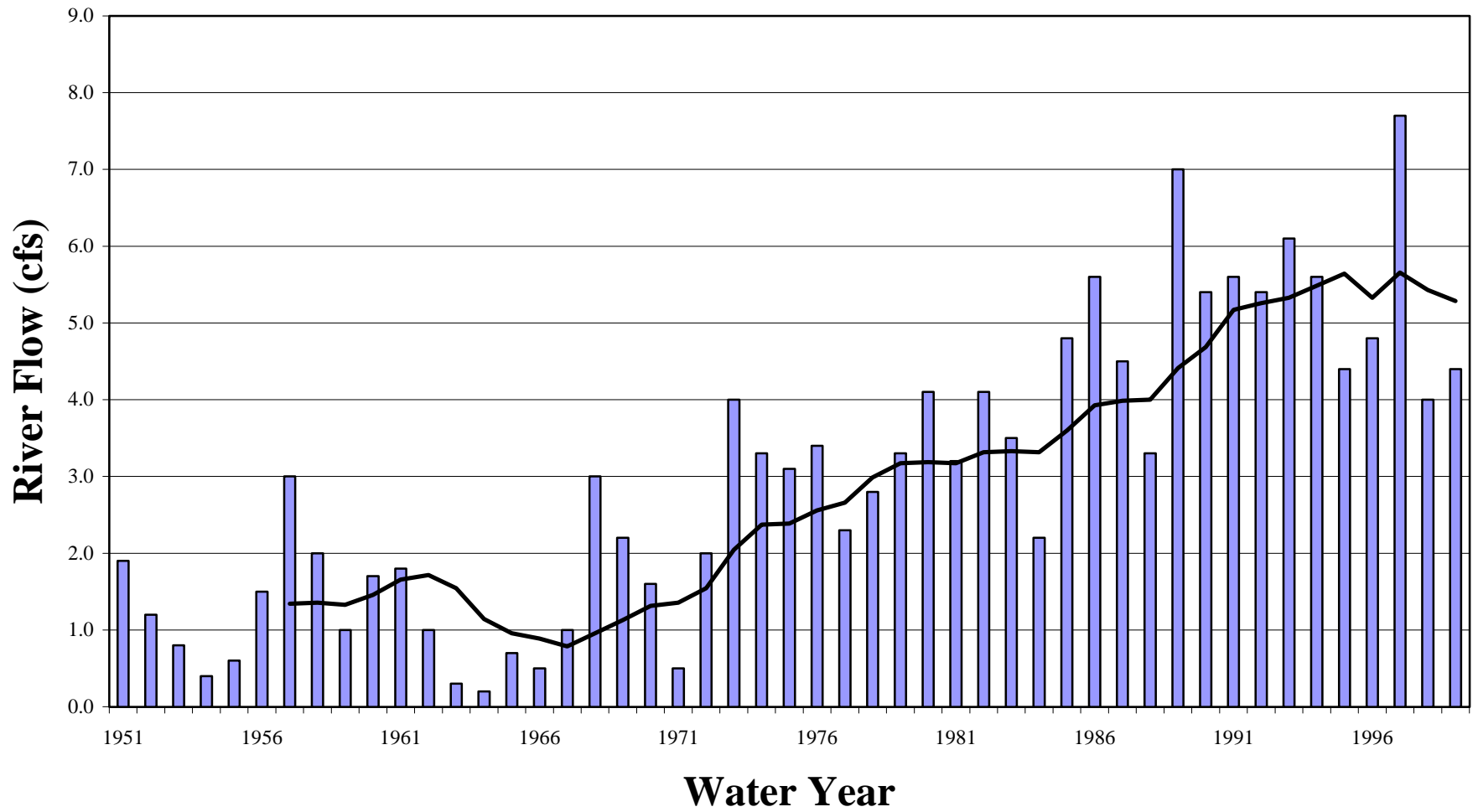
Historic Flow Data Summary For Main Rouge River at Maple Road (US4) Main Rouge River at Beech Road (US5) Evans Ditch at Nine Mile Road (US6)

Historic Flow Data Summary
Main Rouge River @ Maple Rd. (US4)

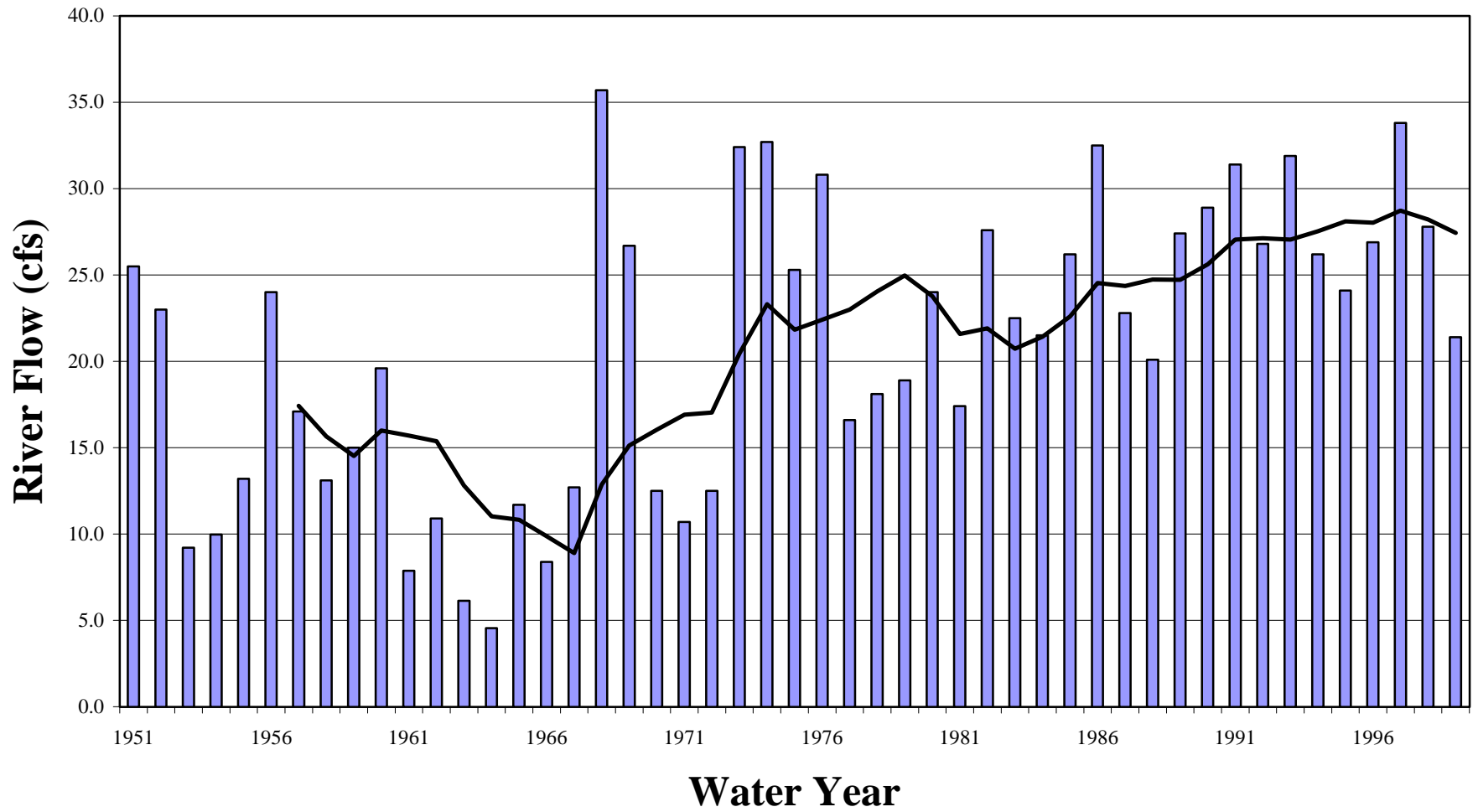
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 180 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1951	1.9	25.5	10.4	4	12/7/50	320
1952	1.2	23.0	9.4	3	3/11/52	370
1953	0.8	9.2	3.8	0	3/4/53	92
1954	0.4	10.0	4.1	2	3/25/54	244
1955	0.6	13.2	5.4	0	10/3/54	170
1956	1.5	24.0	9.8	8	4/29/56	700
1957	3.0	17.1	7.0	2	7/8/57	488
1958	2.0	13.1	5.4	1	12/20/57	193
1959	1.0	15.0	6.1	5	3/6/59	446
1960	1.7	19.6	8.0	2	3/28/60	313
1961	1.8	7.9	3.2	1	4/25/61	184
1962	1.0	10.9	4.5	2	3/12/62	624
1963	0.3	6.1	2.5	1	6/9/63	252
1964	0.2	4.6	1.9	0	6/19/64	117
1965	0.7	11.7	4.8	2	2/10/65	608
1966	0.5	8.4	3.4	1	12/25/65	200
1967	1.0	12.7	5.2	0	7/19/67	168
1968	3.0	35.7	14.6	7	6/26/68	1,390
1969	2.2	26.7	10.9	7	7/4/69	557
1970	1.6	12.5	5.1	1	3/4/70	194
1971	0.5	10.7	4.4	0	2/20/71	130
1972	2.0	12.5	5.1	2	3/14/72	357
1973	4.0	32.4	13.2	9	6/26/73	474
1974	3.3	32.7	13.4	9	3/5/74	390
1975	3.1	25.3	10.3	5	4/19/75	593
1976	3.4	30.8	12.6	6	5/7/76	419
1977	2.3	16.6	6.8	4	4/2/77	476
1978	2.8	18.1	7.4	1	3/21/78	251
1979	3.3	18.9	7.7	3	4/14/79	426
1980	4.1	24.0	9.8	5	3/17/80	413
1981	3.2	17.4	7.1	1	2/18/81	220
1982	4.1	27.6	11.3	5	10/1/81	1,050
1983	3.5	22.5	9.2	2	5/2/83	575
1984	2.2	21.5	8.8	4	3/16/84	381
1985	4.8	26.2	10.7	5	2/23/85	475
1986	5.6	32.5	13.3	11	9/27/86	531
1987	4.5	22.8	9.3	2	6/21/87	192
1988	3.3	20.1	8.2	3	12/15/87	359
1989	7.0	27.4	11.2	6	6/21/89	900
1990	5.4	28.9	11.8	6	2/22/90	457
1991	5.6	31.4	12.8	7	5/26/91	664
1992	5.4	26.8	10.9	5	9/7/92	290
1993	6.1	31.9	13.0	7	1/4/93	428
1994	5.6	26.2	10.7	10	6/26/94	582
1995	4.4	24.1	9.8	3	3/7/95	312
1996	4.8	26.9	11.0	6	6/18/96	1,070
1997	7.7	33.8	13.8	9	5/19/97	626
1998	4.0	27.8	11.4	6	8/6/98	769
1999	4.4	21.4	8.7			

* Based on approximate drainage area of 33.3 square miles.

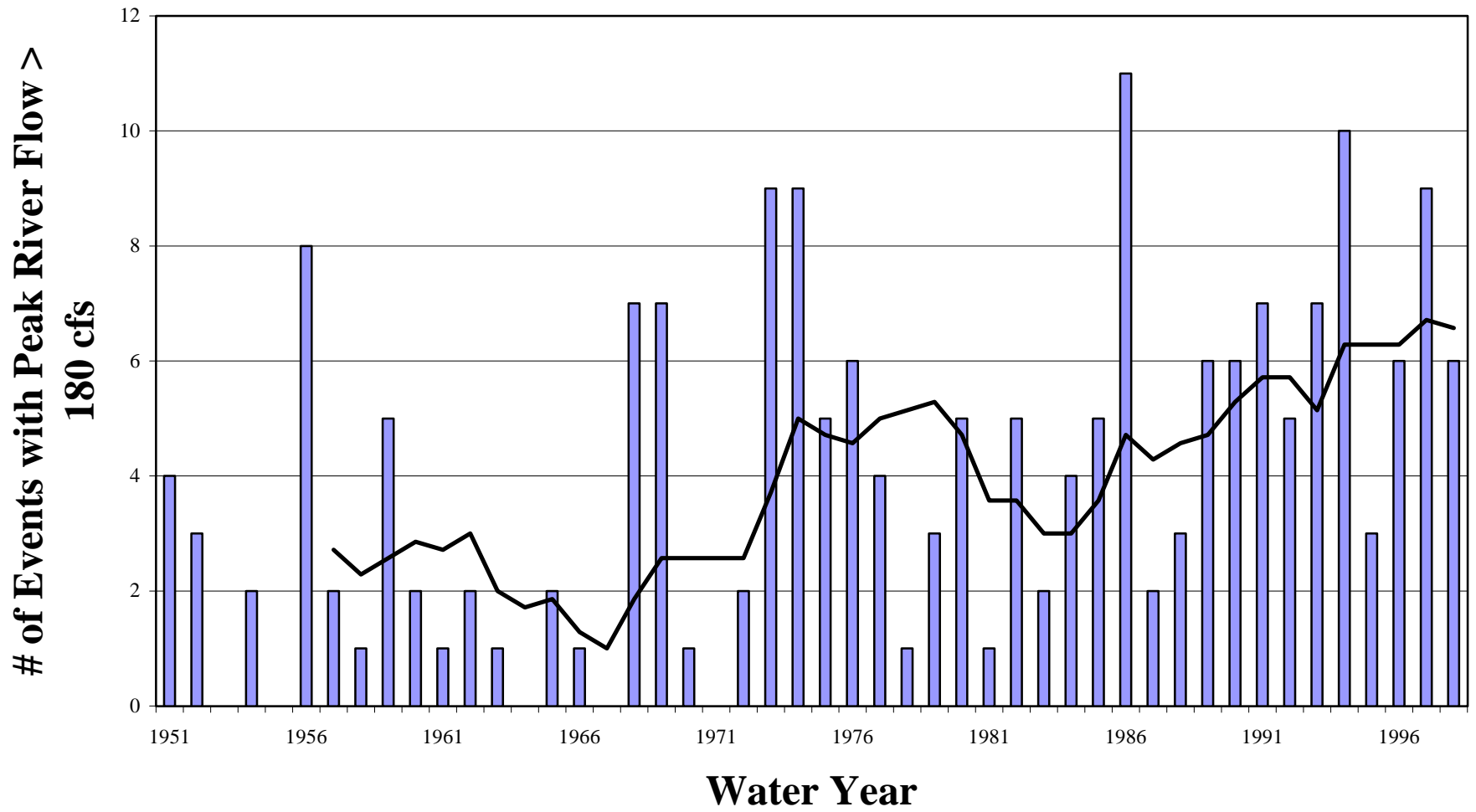
Low Flow Trend Main Rouge River @ Maple Rd. (US4)



Average Flow Trend Main Rouge River @ Maple Rd. (US4)



Peak Flow Trend Main Rouge River @ Maple Rd. (US4)

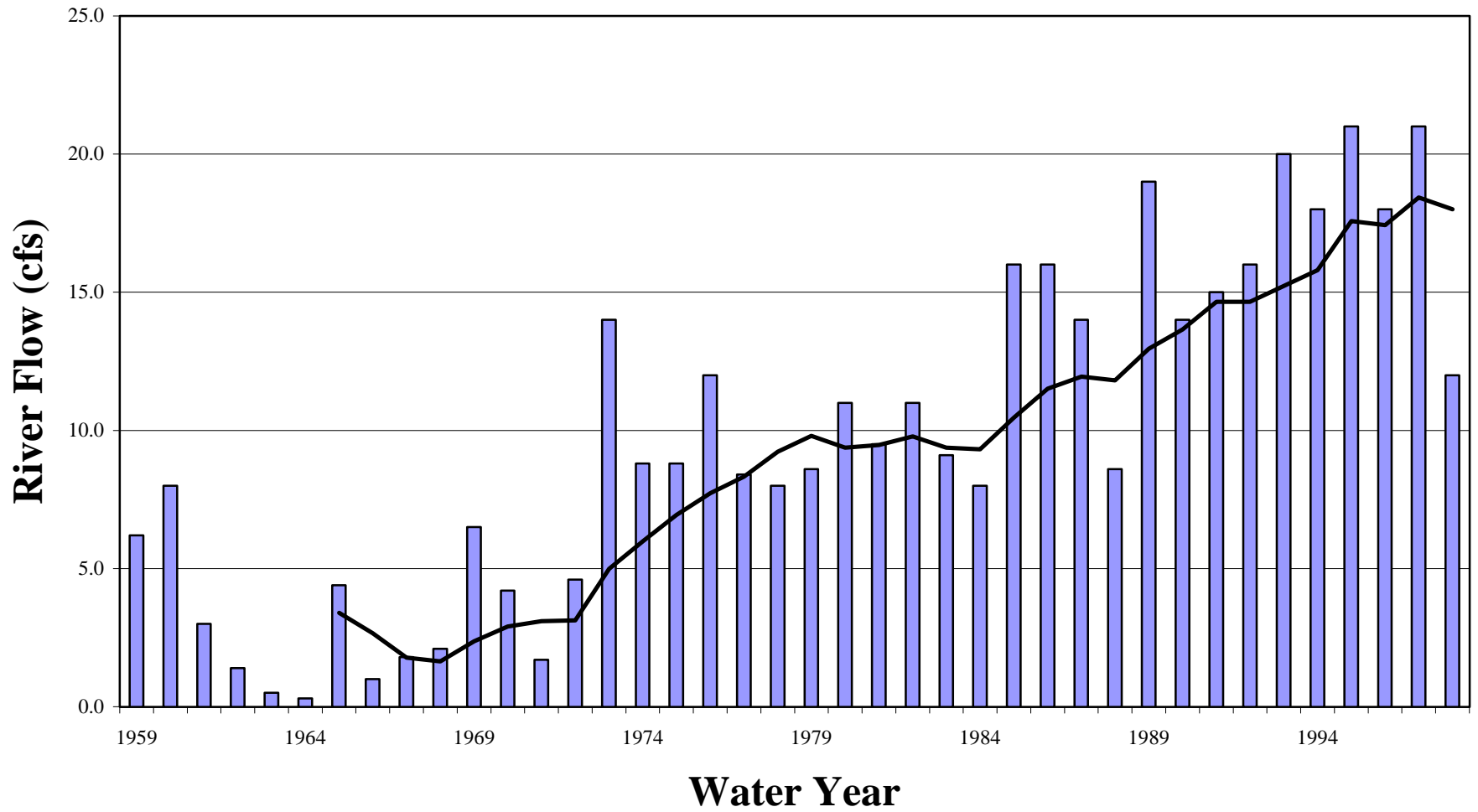


Historic Flow Data Summary Main Rouge River @ Beech Rd. (US5)

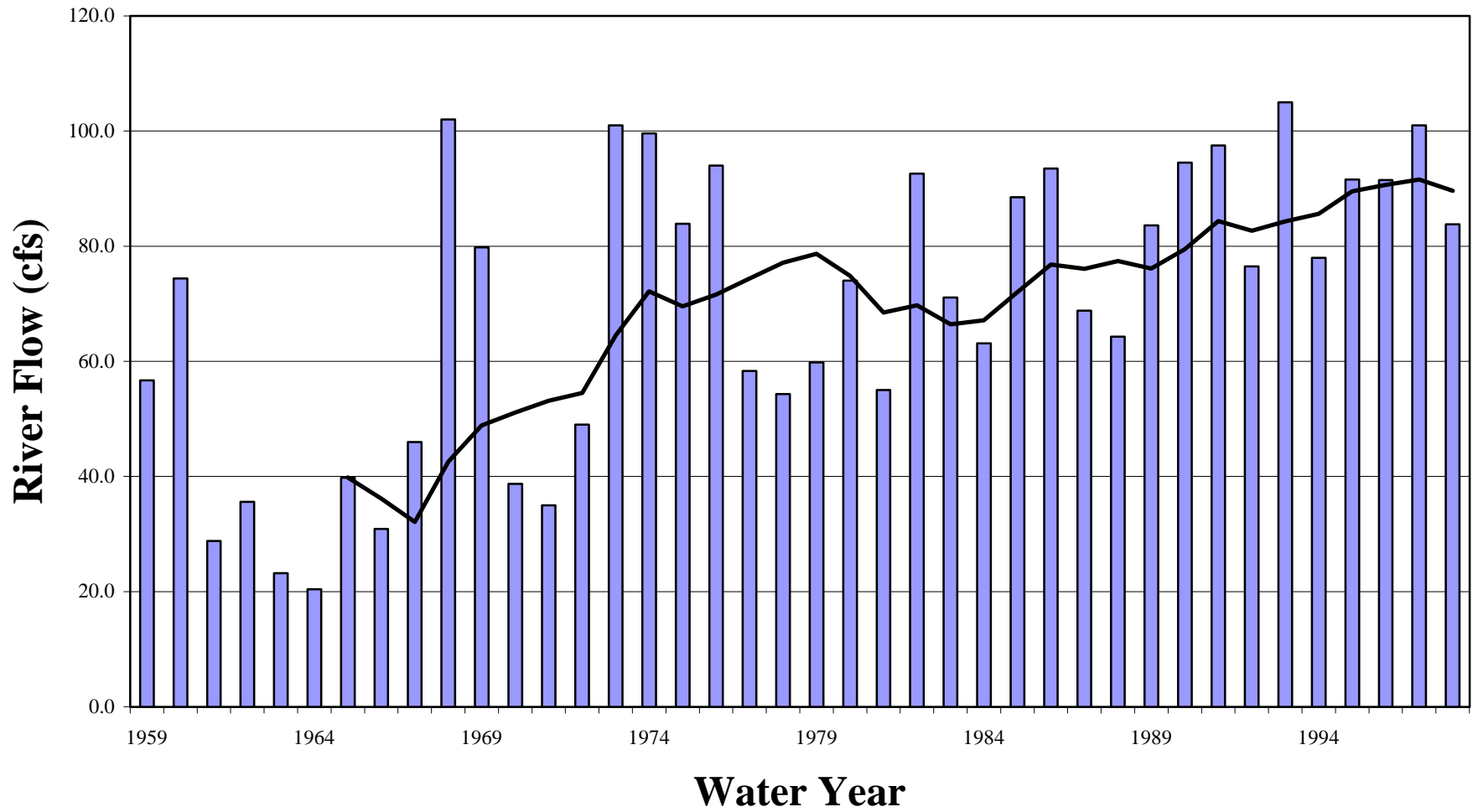
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 700 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1959	6.2	56.7	8.8	2	3/6/59	1,200
1960	8.0	74.4	11.5	5	6/17/60	1,140
1961	3.0	28.8	4.5	1	4/25/61	787
1962	1.4	35.6	5.5	1	3/12/62	1,200
1963	0.5	23.2	3.6	0	5/10/63	569
1964	0.3	20.4	3.2	0	4/29/64	447
1965	4.4	39.8	6.2	2	2/10/65	2,030
1966	1.0	30.9	4.8	1	12/25/65	1,250
1967	1.8	46.0	7.1	0	6/8/67	641
1968	2.1	102.0	15.8	7	6/26/68	4,900
1969	6.5	79.8	12.3	6	1/30/69	1,360
1970	4.2	38.7	6.0	0	3/4/70	570
1971	1.7	35.0	5.4	2	2/20/71	800
1972	4.6	49.0	7.6	4	3/14/72	1,420
1973	14.0	101.0	15.6	6	6/27/73	1,530
1974	8.8	99.6	15.4	8	4/4/74	1,350
1975	8.8	83.9	13.0	6	4/19/75	1,790
1976	12.0	94.0	14.5	6	5/7/76	1,470
1977	8.4	58.3	9.0	5	4/3/77	1,440
1978	8.0	54.3	8.4	1	3/22/78	912
1979	8.6	59.8	9.3	2	4/14/79	1,640
1980	11.0	74.0	11.4	5	4/4/80	1,140
1981	9.5	55.0	8.5	0	2/19/81	600
1982	11.0	92.6	14.3	5	10/1/81	4,400
1983	9.1	71.1	11.0	2	5/2/83	1,900
1984	8.0	63.1	9.8	4	3/16/84	1,400
1985	16.0	88.5	13.7	5	2/24/85	1,830
1986	16.0	93.5	14.5	8	9/23/86	1,180
1987	14.0	68.8	10.6	2	10/3/86	984
1988	8.6	64.3	9.9	4	12/15/87	1,320
1989	19.0	83.6	12.9	8	6/21/89	2,740
1990	14.0	94.5	14.6	7	2/22/90	1,800
1991	15.0	97.5	15.1	7	5/26/91	2,000
1992	16.0	76.5	11.8	1	7/15/92	742
1993	20.0	105.0	16.2	6	1/4/93	1,460
1994	18.0	78.0	12.1	8	3/21/94	1,290
1995	21.0	91.6	14.2	9	8/3/95	1,180
1996	18.0	91.5	14.2	6	6/19/96	2,250
1997	21.0	101.0	15.6	8	7/3/97	1,550
1998	12.0	83.8	13.0	6	8/6/98	2,430

* Based on approximate drainage area of 87.9 square miles.

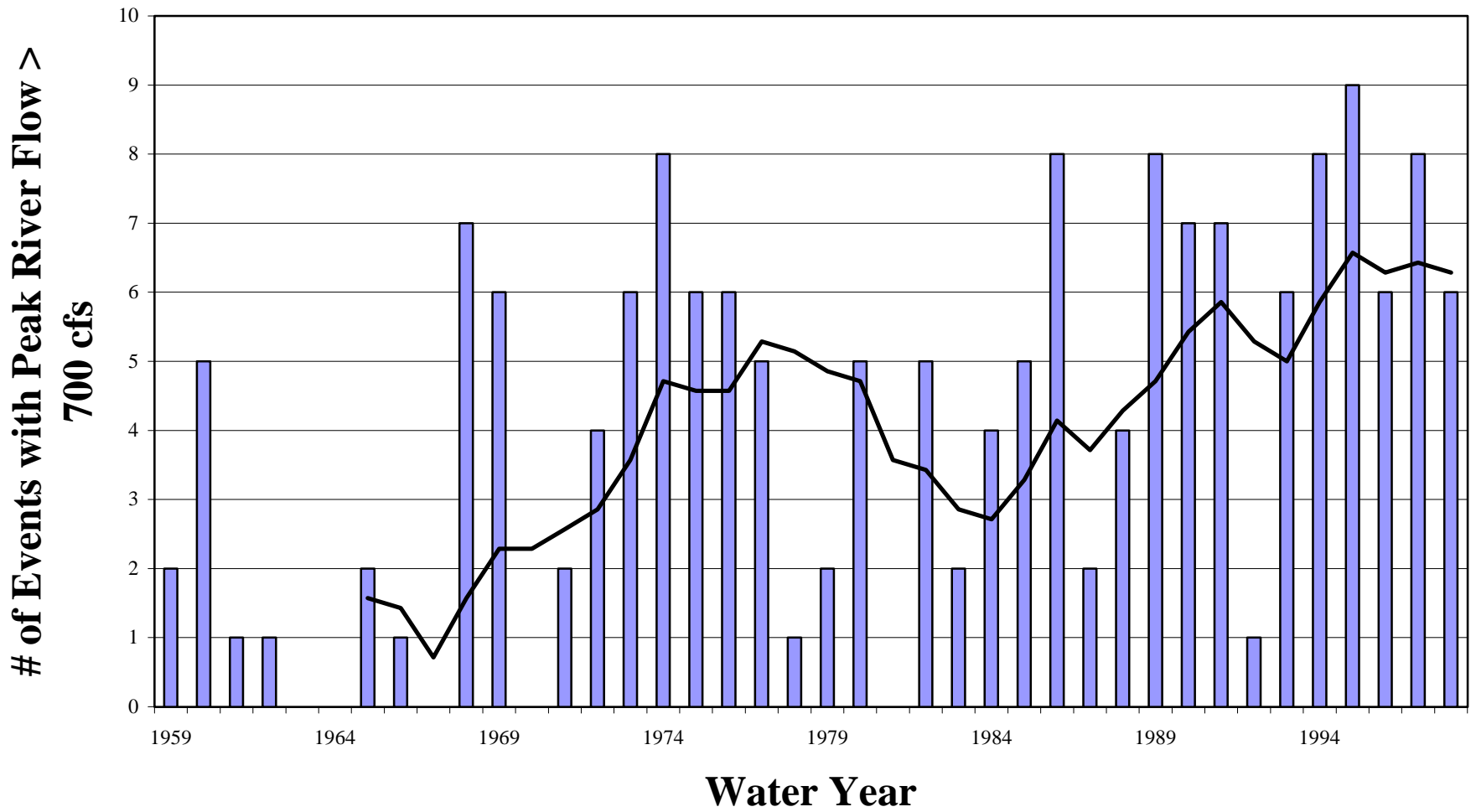
Low Flow Trend Main Rouge River @ Beech Rd. (US5)



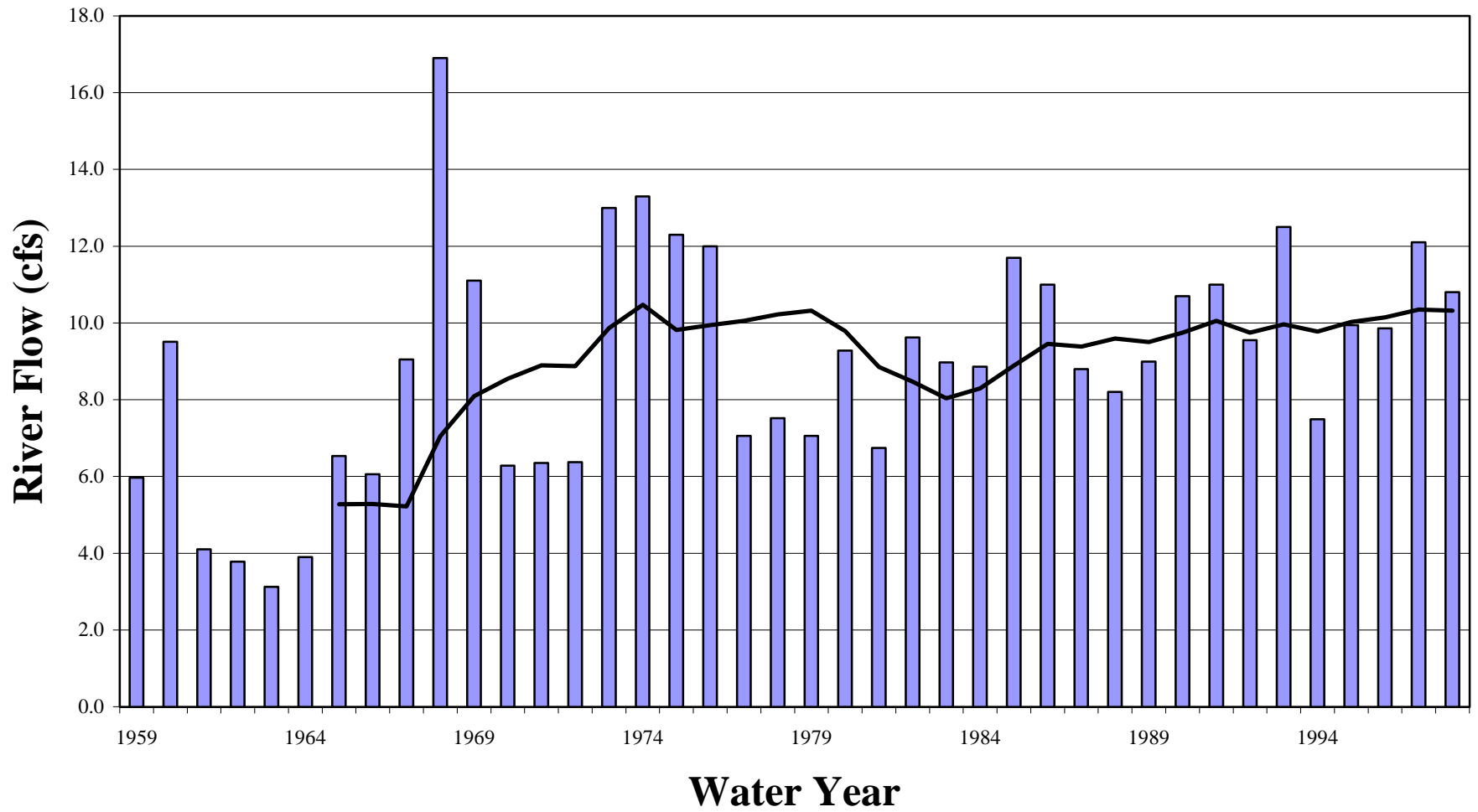
Average Flow Trend Main Rouge River @ Beech Rd. (US5)



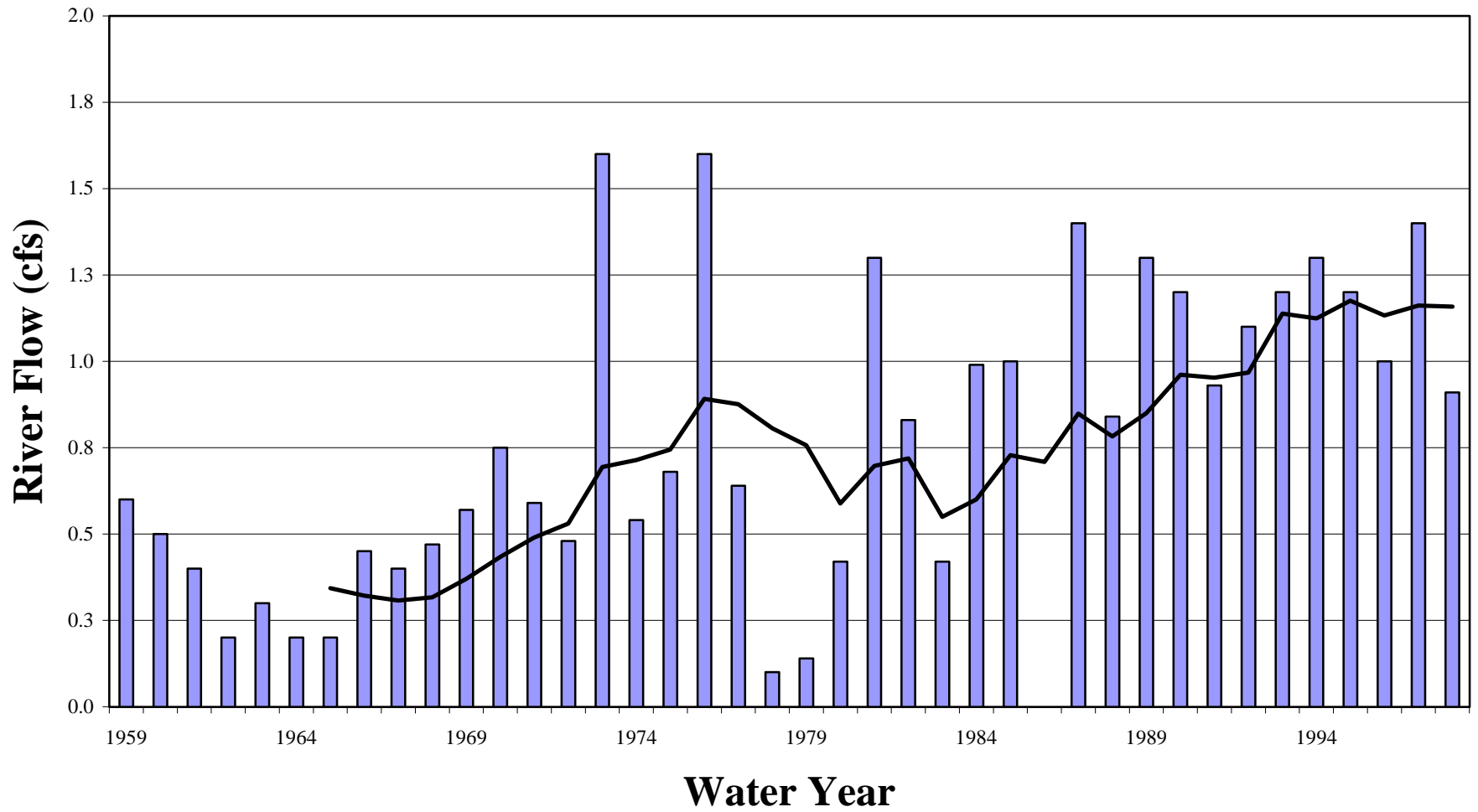
Peak Flow Trend Main Rouge River @ Beech Rd. (US5)



Average Flow Trend Evans Ditch @ Nine Mile Rd. (US6)



Low Flow Trend Evans Ditch @ Nine Mile Rd. (US6)



River Flow Data Summary for Main 3 & 4 Rouge Subwatershed

4/14/00

Introduction (Table 1 and Figure 1)

Continuous river flow data in the Main 3 & 4 Rouge Subwatershed include historic USGS data and data collected by the RPO with USGS assistance, beginning in 1994. A summary of all available continuous flow data is presented in Table 1. A map and table including all river flow measurement locations in the Main 3 & 4 Rouge Subwatershed have been provided separately.

To aid in interpreting flow data impacted by wet weather events, long-term precipitation totals from Detroit Metropolitan Airport are shown in Figure 1. The annual precipitation totals include hail, sleet, snow, etc. expressed as equivalent inches of water. Annual average precipitation is 32.3 inches for the period of 1959 through 1997.

Historic USGS Data (Attachment 1)

The USGS has operated one stream gages in the Main 3 & 4 Rouge since 1931, and two stream gages just upstream since 1959. The three gages are listed below.

- Main Rouge River at Beech Road (US5) – beginning in 1959
- Evans Ditch at Nine Mile Road (US6) – beginning in 1959
- Main Rouge River at Plymouth Road (US7) – beginning in 1931

Attachment 1 includes a table for each of the three gages with the following information for each year of gage operation:

1. Lowest daily average flow (cfs)
2. Annual average flow (cfs)
3. Annual average volume (expressed as inches over the upstream watershed)
4. No. of events with instantaneous peak flow rate exceeding a gage-specific threshold
5. Date and flow rate (cfs) of highest instantaneous peak flow recorded

In addition, for each gage, bar charts are included in Attachment 1 for items 1, 2 and 4 to show long-term trends in the data. Each plot includes the actual data for each year as well as a trend line, which is calculated as a seven-year moving average. The lowest daily average flow typically represents the “driest” dry weather day of each year, when river flows are mainly comprised of groundwater recharge and point source inputs. The annual average flow represents dry and wet weather conditions, as it represents the annual volume of flow measured at the gage converted to cfs. The number of event peaks above a threshold shows how the watershed is responding to significant wet weather events.

The following observations can be made from the historic USGS data:

Main Rouge River at Beech Road (US5)

- The lowest daily average flow has increased significantly over the years. The lowest daily average flows in the 1960's averaged 2.5 cfs compared to an average of more than 15 cfs in recent years.
- For the last 15 years, the annual flow at this gage has averaged 85 cfs (0.97 cfs/sq mi). The highest annual average flow of 105 cfs occurred in 1993. Between 1959 and 1998, the annual average stream flow increased from around 40 cfs to 90 cfs while the trend of annual average precipitation was fairly constant.
- The highest recorded flow at this gage was 4,900 cfs on June 26, 1968. There is a definite increasing trend in the number of events with peak flows greater than 700 cfs. From 1959 to 1998, the frequency of such events increased from 1.5 to more than six times per year while the trend of annual average precipitation was fairly constant.

Evans Ditch at Nine Mile Road (US6)

- The lowest daily average flow has increased somewhat over the years. The lowest daily average flows in the 1960's averaged 0.4 cfs compared to an average of 1.1 cfs in recent years.
- For the last 15 years, the annual flow at this gage has averaged 10 cfs (1.06 cfs/sq mi). The highest annual average flow of 17 cfs occurred in 1968. Between 1959 and 1998, the annual average stream flow increased from around 5 cfs to 10 cfs while the trend of annual average precipitation was fairly constant.
- The highest recorded flow at this gage was 1,200 cfs on October 1, 1981. There is a definite increasing trend in the number of events with peak flows greater than 400 cfs. From 1959 to 1998, the frequency of such events increased from less than once per year to five times per year while the trend of annual average precipitation was fairly constant.

Main Rouge River at Plymouth Road (US7)

- The lowest daily average flow has increased somewhat over the years. The lowest daily average flows in the 1930's averaged 7 cfs compared to an average of more than 25 cfs in recent years.
- For the last 15 years, the annual flow at this gage has averaged around 160 cfs (0.85 cfs/sq mi). The highest annual average flow of 222 cfs occurred in 1968. Between 1959 and 1998, the annual average stream flow increased from around 100 cfs to 170 cfs while the trend of annual average precipitation was fairly constant.
- The highest recorded flow at this gage was 13,000 cfs in April, 1947. There is somewhat of an increasing trend in the number of events with peak flows greater than 1,200 cfs. From 1959 to 1998, the frequency of such events increased from three to 4.5 times per year while the trend of annual average precipitation was fairly constant.

Recent RPO Data (Figure 2 and Table 2)

Beginning in 1994, the RPO has measured stream flow during one or more monitoring seasons at five sites in or just outside the Main 3 & 4 Rouge Subwatershed. Flow measurements were based on measured water level and stream rating curves. Stream rating curves developed over only one or two years can have significant uncertainty at very low and very high flow conditions that can skew the computation of an average flow. Therefore, the RPO data are best summarized using median stream flow values. Median stream flow is that flow rate which is exceeded 50 percent of the year, which typically represents a flow at the upper end of the dry weather flow regime.

The results for the May through September period each year are shown as a bar chart with stream flow normalized by dividing by the drainage area. Data for each RPO gage are shown along with data from the three USGS gages for the same period.

The following observations can be made from the RPO and USGS data:

- The highest median stream flow occurred in the 1996 or 1997 monitoring season while the lowest occurred in 1998, except for site L05 which was impacted by the YCUA discharge beginning in 1996.
- The normalized median stream flow for Evans Ditch (US6) is lower than all the other flow measurement locations.

Attachment 1

Historic Flow Data Summary for Main Rouge River at Beech Road (US5) Evans Ditch at Nine Mile Road (US6) Main Rouge River at Plymouth Road (US7)

Figure 1
Detroit Metro Airport
Annual Precipitation Totals

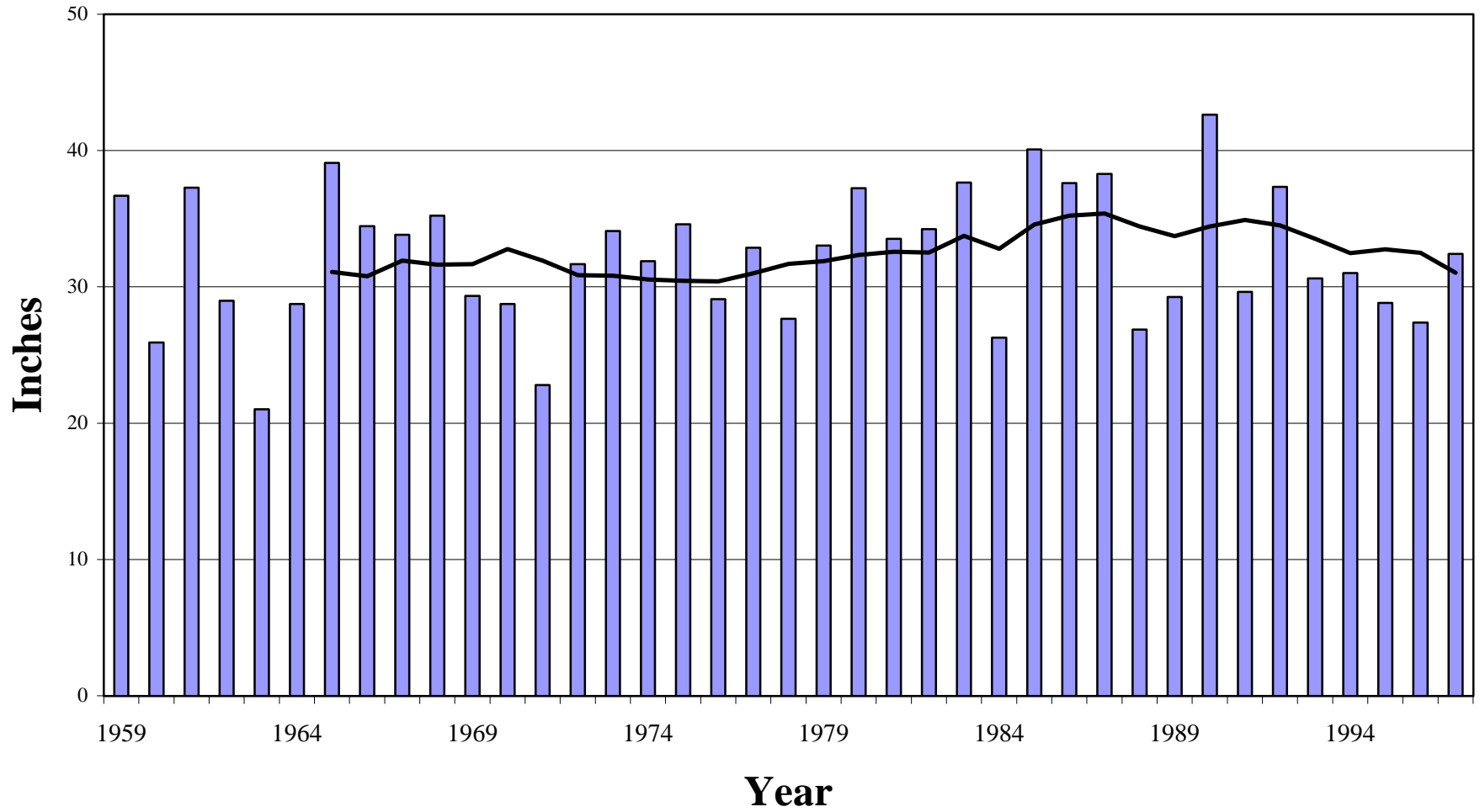


Figure 2
Main 3 & 4 Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

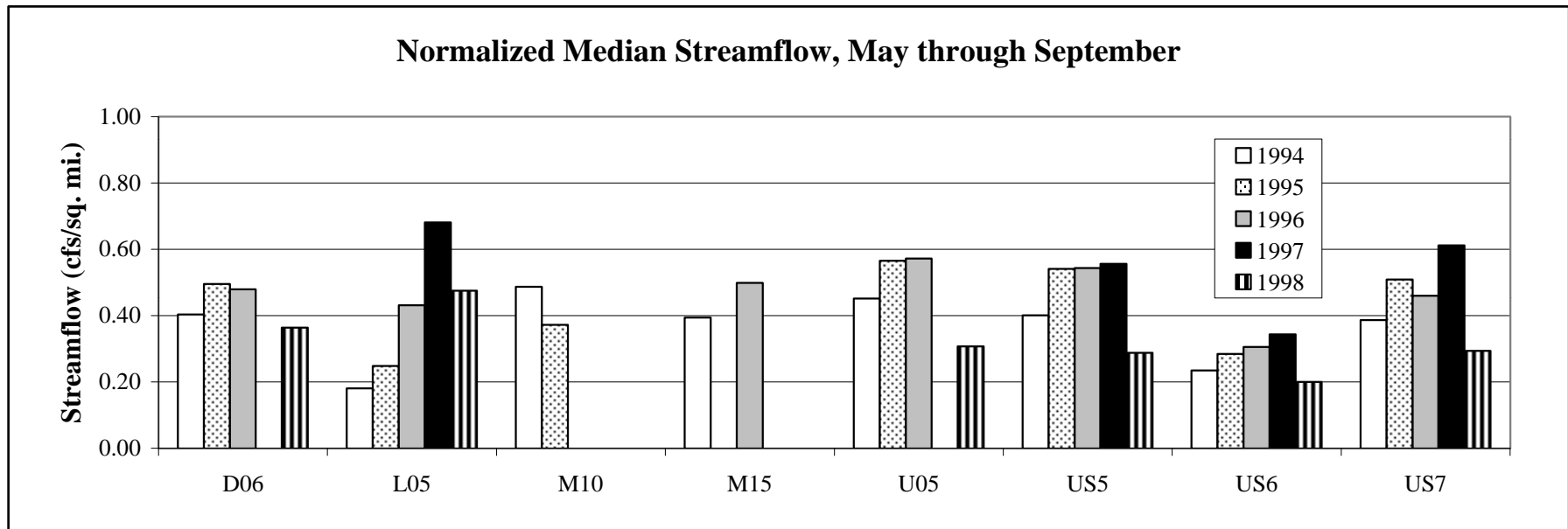


Table 1
Main 3 & 4 Storm Water Management Areas
Summary of Historic and RPO Continuous Flow Measurements

Type of Flow Measurement	Year	Months of Operation	Measurement Locations									
			D06	L05	M10	M15	U05	US5	US6	US7		
Historic USGS Data	WY* 1931-1958	Year Round										
	WY* 1959-present	Year Round										
Recent RPO Data	1994	Apr/May - Oct/Nov										
	1995	Apr/May - Oct/Nov										
	1996	Apr/May - Oct/Nov										
	1997	Apr/May - Oct/Nov										
	1998	Apr/May - Oct/Nov										
	1999	Apr/May - Oct/Nov										

* WY = Water Year (e.g. WY 1961 is Oct. 1960 - Sept. 1961)

Table 2
Main 3 & 4 Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

Site	Drainage Area* (sq mi)	Median Streamflow (cfs)					Normalized Median Streamflow (cfs/sq mi)				
		1994	1995	1996	1997	1998	1994	1995	1996	1997	1998
D06	109.4	44.2	54.2	52.4	**	39.8	0.40	0.50	0.48		0.36
L05	87.4	15.8	21.7	37.7	59.5	41.5	0.18	0.25	0.43	0.68	0.47
M10	299.4	145.8	111.3				0.49	0.37			
M15	105.0	41.4	**	52.4			0.39		0.50		
U05	60.6	27.4	34.2	34.7	**	18.6	0.45	0.57	0.57		0.31
US5	87.9	35.2	47.5	47.8	48.9	25.3	0.40	0.54	0.54	0.56	0.29
US6	9.5	2.2	2.7	2.9	3.3	1.9	0.23	0.28	0.31	0.34	0.20
US7	187.0	72.3	95.2	86.0	114.4	54.9	0.39	0.51	0.46	0.61	0.29

* Drainage areas are approximate (within 5% of actual)

** Flows not reliable due to unstable rating curve.

Attachment 1

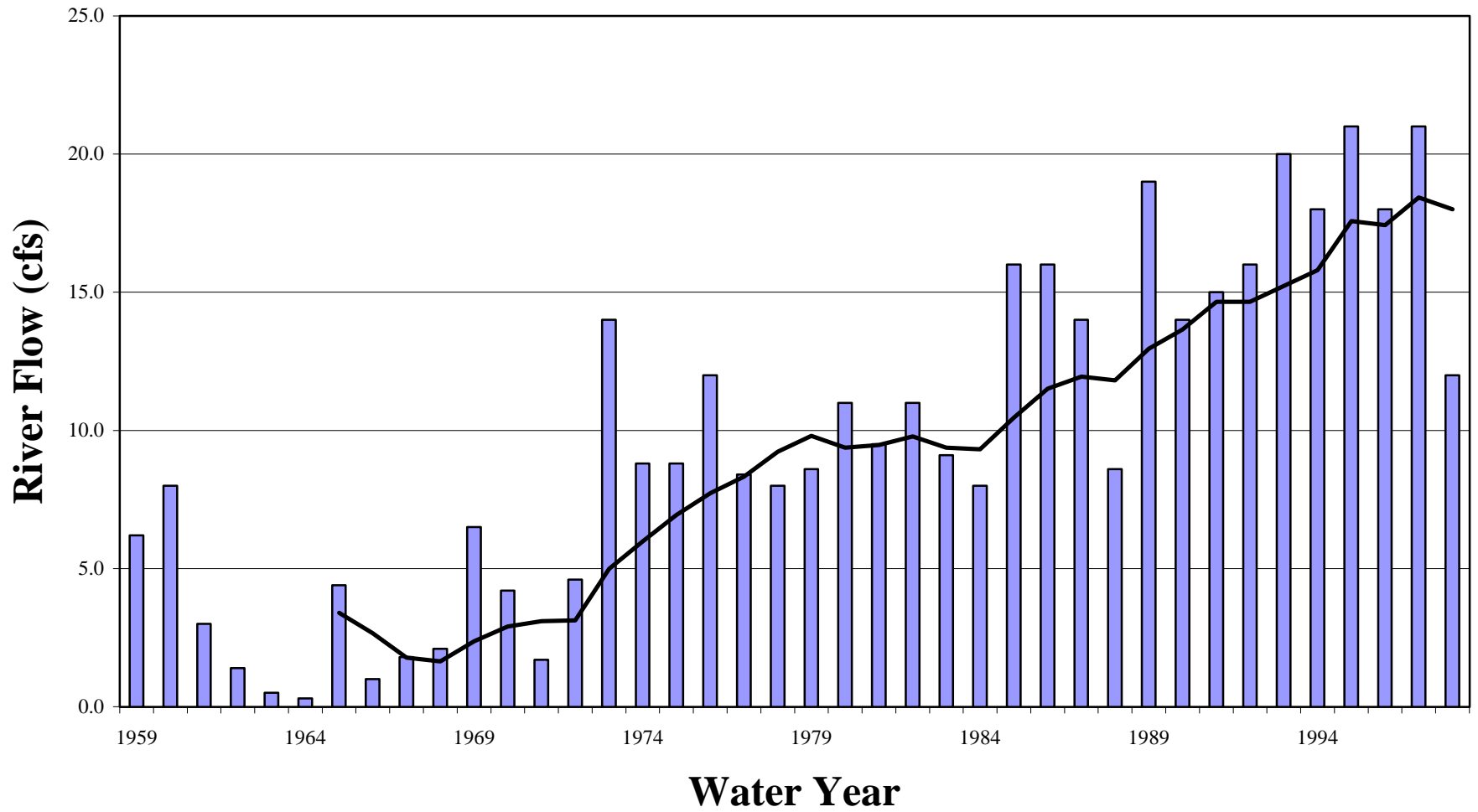
Historic Flow Data Summary For Main Rouge River at Beech Road (US5) Evans Ditch at Nine Mile Road (US6) Main Rouge River at Plymouth Road (US7)

Historic Flow Data Summary
Main Rouge River @ Beech Rd. (US5)

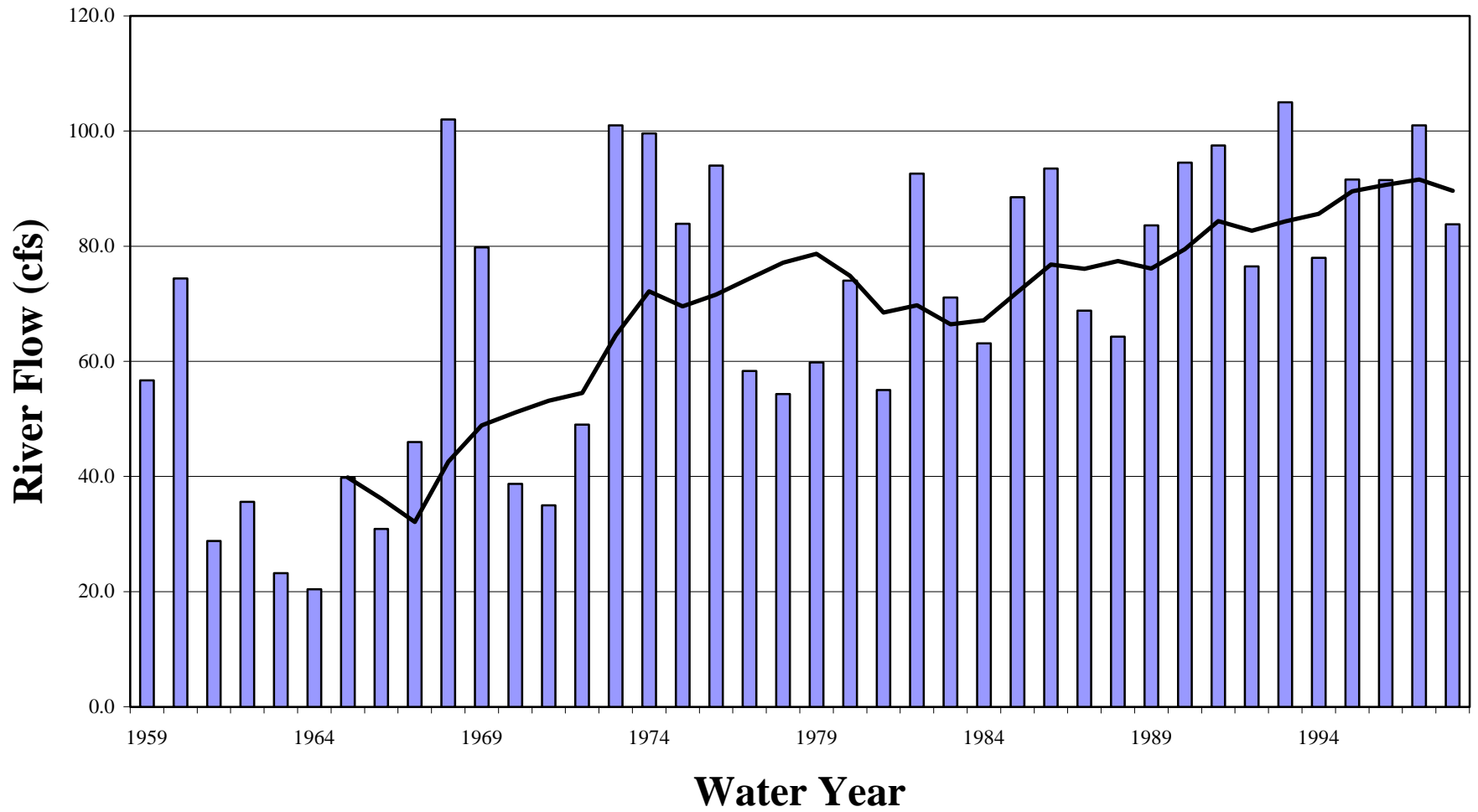
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 700 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1959	6.2	56.7	8.8	2	3/6/59	1,200
1960	8.0	74.4	11.5	5	6/17/60	1,140
1961	3.0	28.8	4.5	1	4/25/61	787
1962	1.4	35.6	5.5	1	3/12/62	1,200
1963	0.5	23.2	3.6	0	5/10/63	569
1964	0.3	20.4	3.2	0	4/29/64	447
1965	4.4	39.8	6.2	2	2/10/65	2,030
1966	1.0	30.9	4.8	1	12/25/65	1,250
1967	1.8	46.0	7.1	0	6/8/67	641
1968	2.1	102.0	15.8	7	6/26/68	4,900
1969	6.5	79.8	12.3	6	1/30/69	1,360
1970	4.2	38.7	6.0	0	3/4/70	570
1971	1.7	35.0	5.4	2	2/20/71	800
1972	4.6	49.0	7.6	4	3/14/72	1,420
1973	14.0	101.0	15.6	6	6/27/73	1,530
1974	8.8	99.6	15.4	8	4/4/74	1,350
1975	8.8	83.9	13.0	6	4/19/75	1,790
1976	12.0	94.0	14.5	6	5/7/76	1,470
1977	8.4	58.3	9.0	5	4/3/77	1,440
1978	8.0	54.3	8.4	1	3/22/78	912
1979	8.6	59.8	9.3	2	4/14/79	1,640
1980	11.0	74.0	11.4	5	4/4/80	1,140
1981	9.5	55.0	8.5	0	2/19/81	600
1982	11.0	92.6	14.3	5	10/1/81	4,400
1983	9.1	71.1	11.0	2	5/2/83	1,900
1984	8.0	63.1	9.8	4	3/16/84	1,400
1985	16.0	88.5	13.7	5	2/24/85	1,830
1986	16.0	93.5	14.5	8	9/23/86	1,180
1987	14.0	68.8	10.6	2	10/3/86	984
1988	8.6	64.3	9.9	4	12/15/87	1,320
1989	19.0	83.6	12.9	8	6/21/89	2,740
1990	14.0	94.5	14.6	7	2/22/90	1,800
1991	15.0	97.5	15.1	7	5/26/91	2,000
1992	16.0	76.5	11.8	1	7/15/92	742
1993	20.0	105.0	16.2	6	1/4/93	1,460
1994	18.0	78.0	12.1	8	3/21/94	1,290
1995	21.0	91.6	14.2	9	8/3/95	1,180
1996	18.0	91.5	14.2	6	6/19/96	2,250
1997	21.0	101.0	15.6	8	7/3/97	1,550
1998	12.0	83.8	13.0	6	8/6/98	2,430

* Based on approximate drainage area of 87.9 square miles.

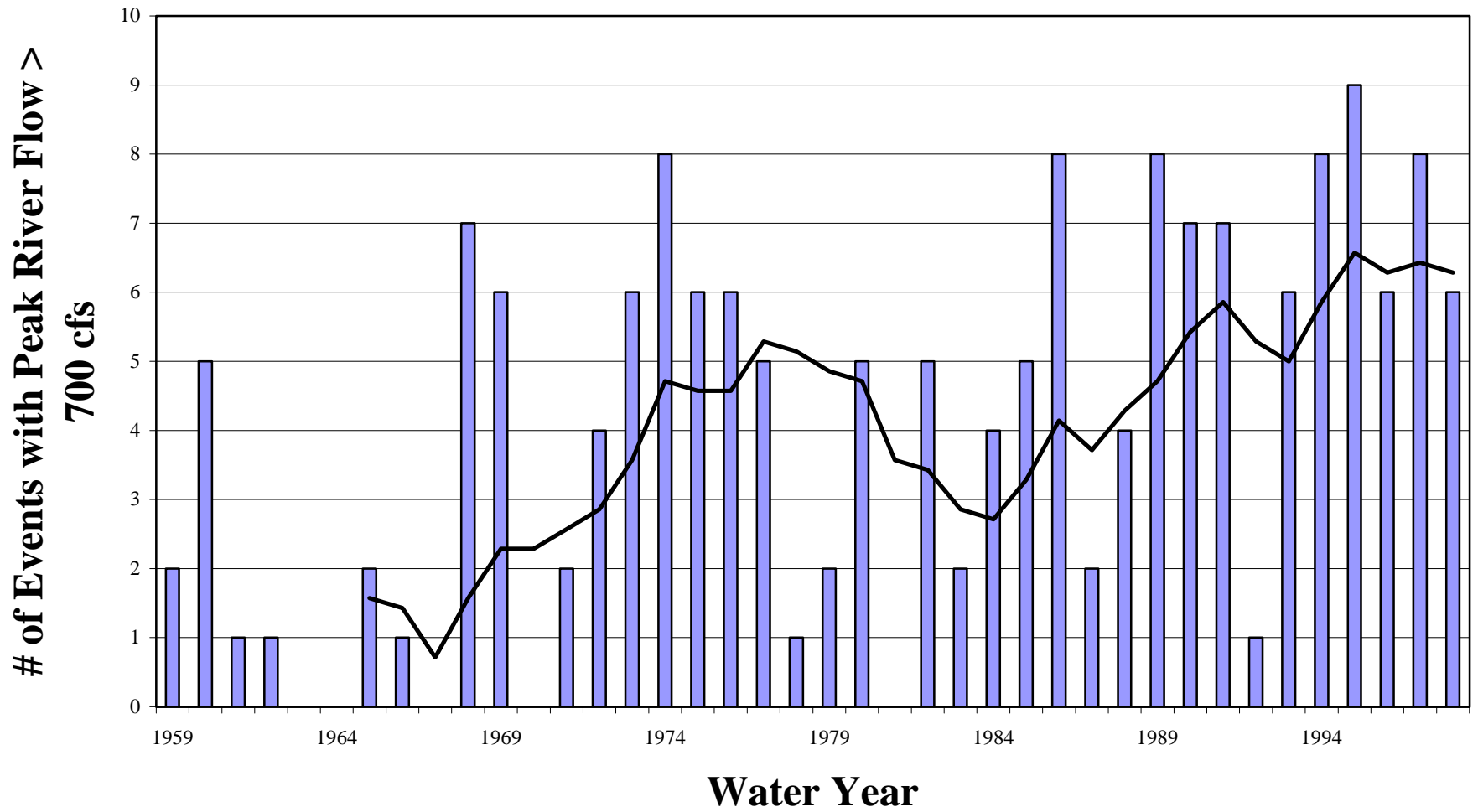
Low Flow Trend Main Rouge River @ Beech Rd. (US5)



Average Flow Trend Main Rouge River @ Beech Rd. (US5)



Peak Flow Trend Main Rouge River @ Beech Rd. (US5)

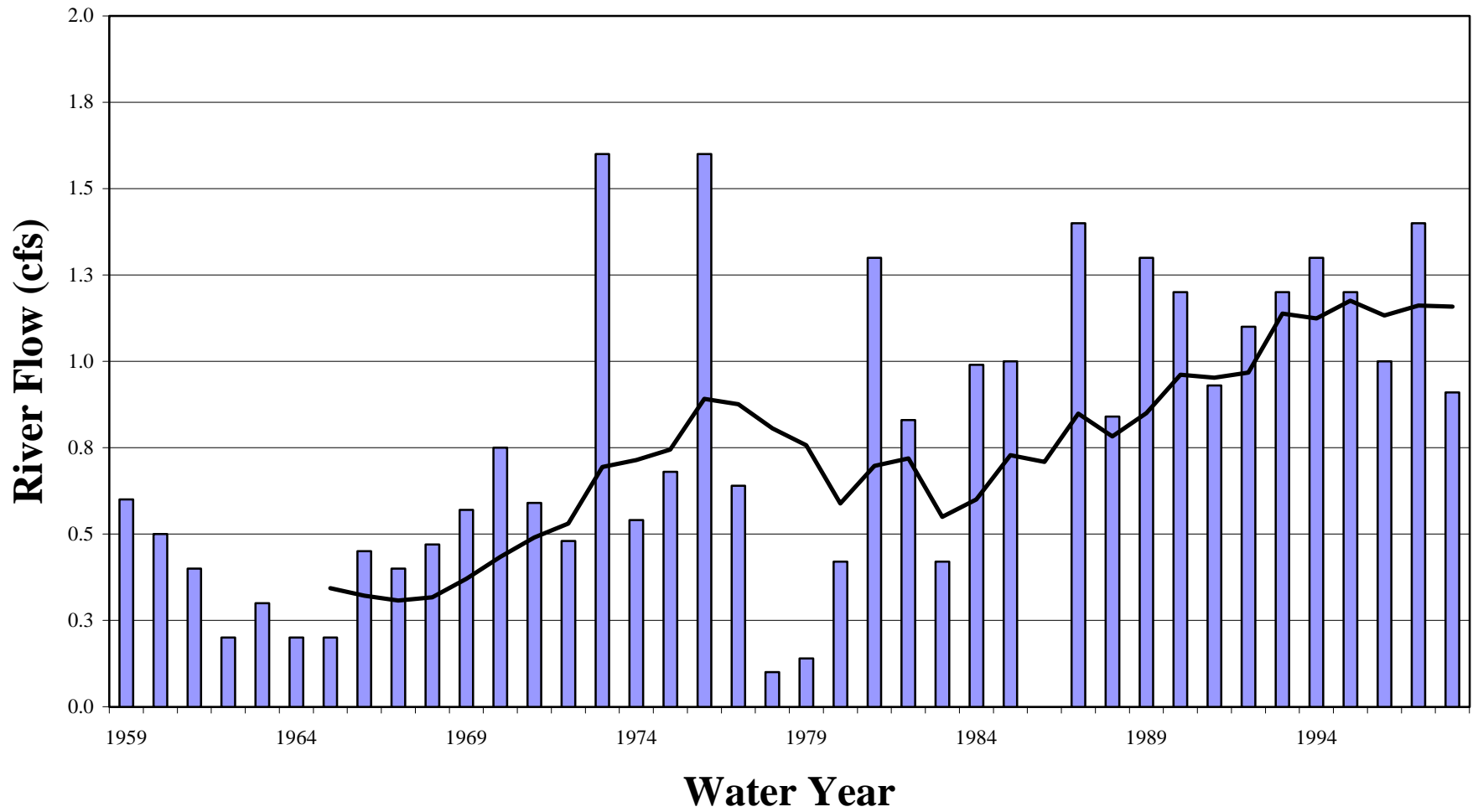


Historic Flow Data Summary
Evans Ditch @ Nine Mile Rd. (US6)

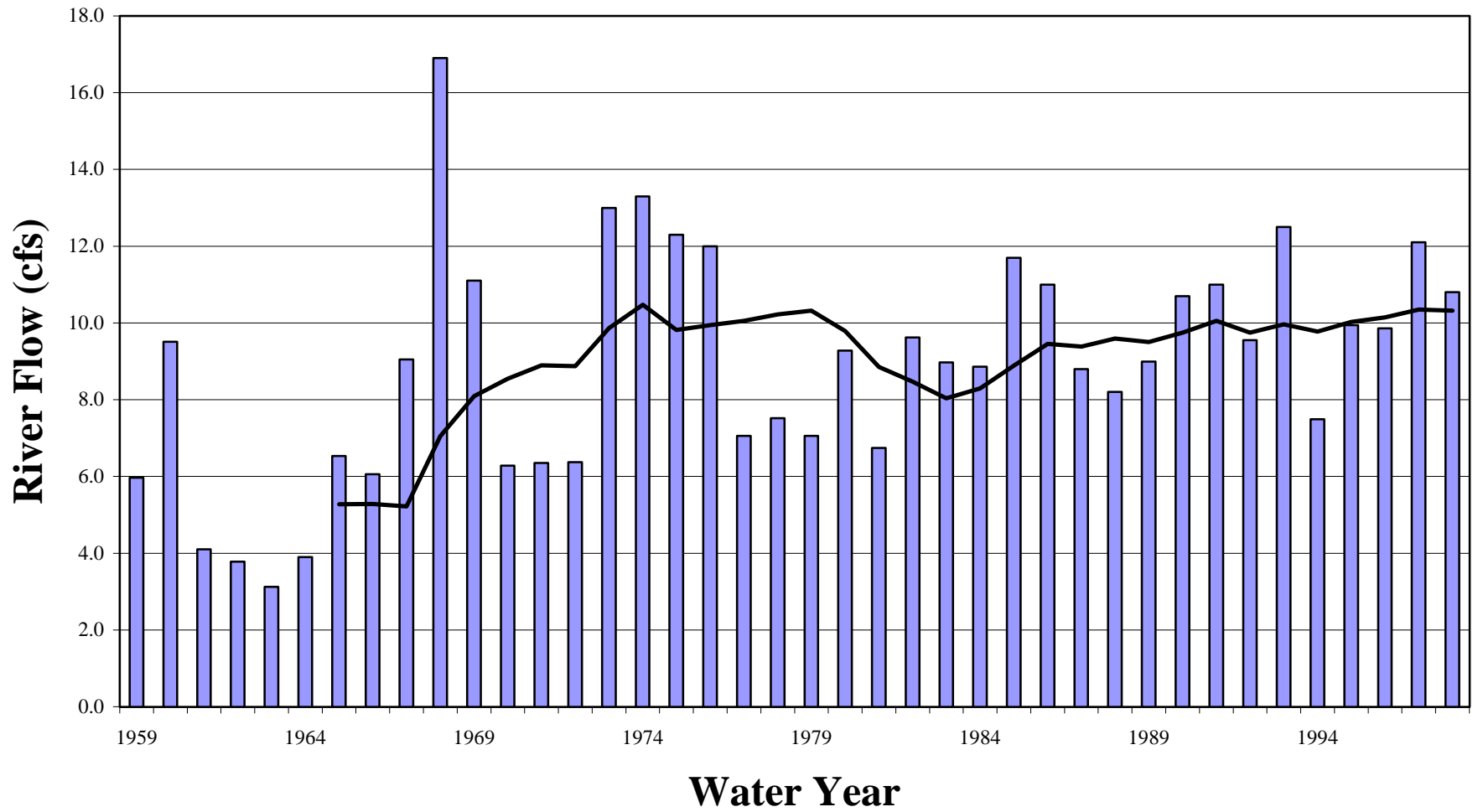
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 400 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1959	0.6	6.0	8.6	0	3/6/59	233
1960	0.5	9.5	13.6	0	6/14/60	370
1961	0.4	4.1	5.9	0	4/25/61	228
1962	0.2	3.8	5.4	0	3/12/62	210
1963	0.3	3.1	4.5	0	6/10/63	208
1964	0.2	3.9	5.6	0	8/11/64	176
1965	0.2	6.5	9.4	2	2/10/65	527
1966	0.5	6.1	8.7	0	12/25/65	354
1967	0.4	9.1	13.0	1	6/28/67	403
1968	0.5	16.9	24.2	6	6/25/68	903
1969	0.6	11.1	15.9	1	7/4/69	484
1970	0.8	6.3	9.0	0	3/4/70	243
1971	0.6	6.4	9.1	1	2/19/71	415
1972	0.5	6.4	9.1	2	3/14/72	463
1973	1.6	13.0	18.6	1	6/26/73	670
1974	0.5	13.3	19.1	1	1/27/74	495
1975	0.7	12.3	17.6	0	4/19/75	348
1976	1.6	12.0	17.2	4	7/25/76	688
1977	0.6	7.1	10.1	2	4/2/77	516
1978	0.1	7.5	10.8	0	5/30/78	283
1979	0.1	7.1	10.1	2	4/14/79	598
1980	0.4	9.3	13.3	4	4/4/80	582
1981	1.3	6.7	9.7	0	7/28/81	317
1982	0.8	9.6	13.8	4	10/1/81	1,200
1983	0.4	9.0	12.9	2	5/2/83	644
1984	1.0	8.9	12.7	5	8/18/84	627
1985	1.0	11.7	16.8	5	5/31/85	614
1986	0.0	11.0	15.8	4	7/8/86	580
1987	1.4	8.8	12.6	4	6/21/87	480
1988	0.8	8.2	11.8	3	12/15/87	579
1989	1.3	9.0	12.9	2	10/18/88	416
1990	1.2	10.7	15.3	3	9/7/90	555
1991	0.9	11.0	15.8	4	5/26/91	686
1992	1.1	9.6	13.7	4	7/31/92	545
1993	1.2	12.5	17.9	4	1/4/93	595
1994	1.3	7.5	10.7	4	6/13/94	564
1995	1.2	9.9	14.2	6	8/3/95	754
1996	1.0	9.9	14.1	5	6/12/96	704
1997	1.4	12.1	17.3	6	7/2/97	828
1998	0.9	10.8	15.5	6	8/6/98	962

* Based on approximate drainage area of 9.49 square miles.

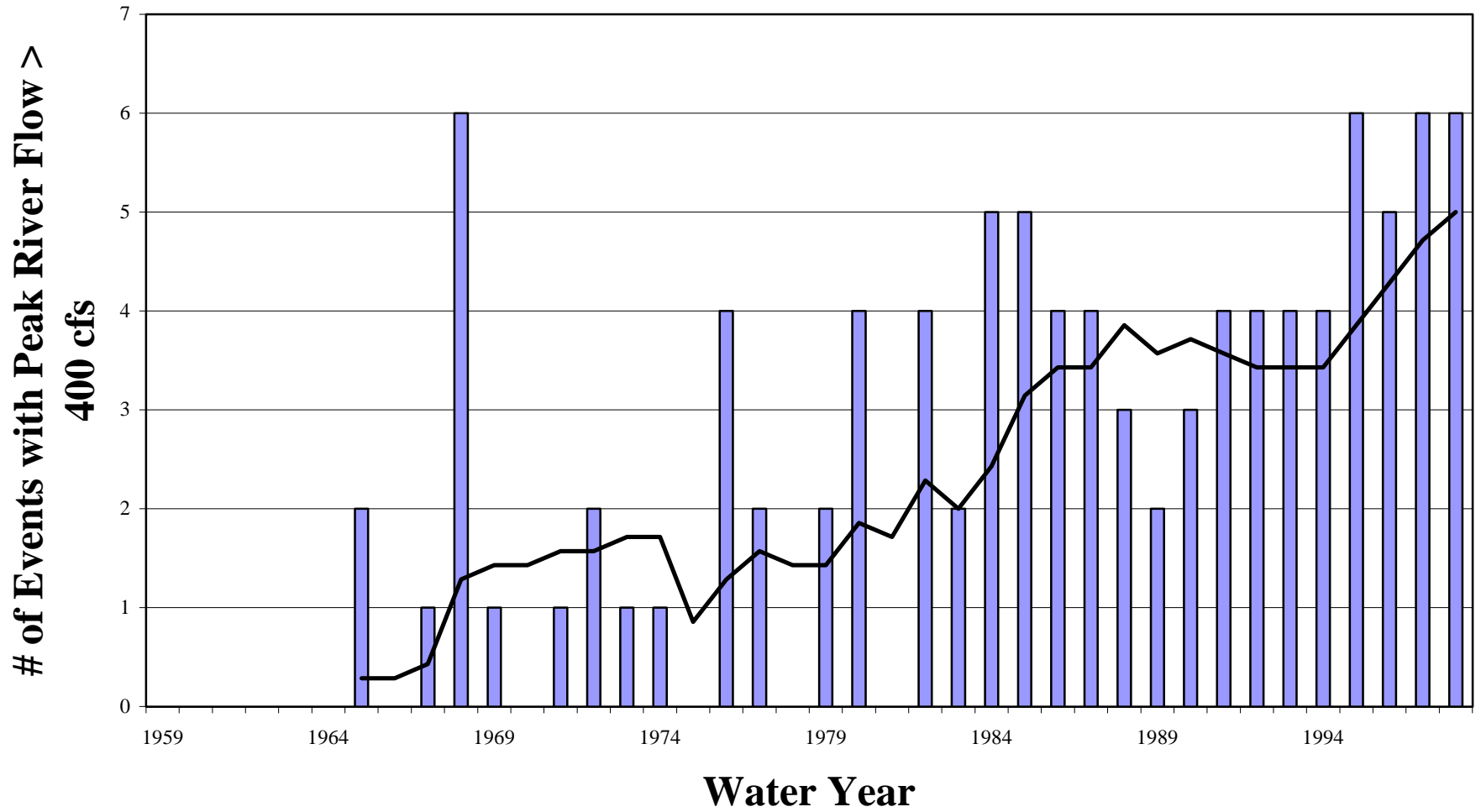
Low Flow Trend Evans Ditch @ Nine Mile Rd. (US6)



Average Flow Trend Evans Ditch @ Nine Mile Rd. (US6)



Peak Flow Trend Evans Ditch @ Nine Mile Rd. (US6)



Historic Flow Data Summary
Main Rouge River @ Plymouth Rd. (US7)

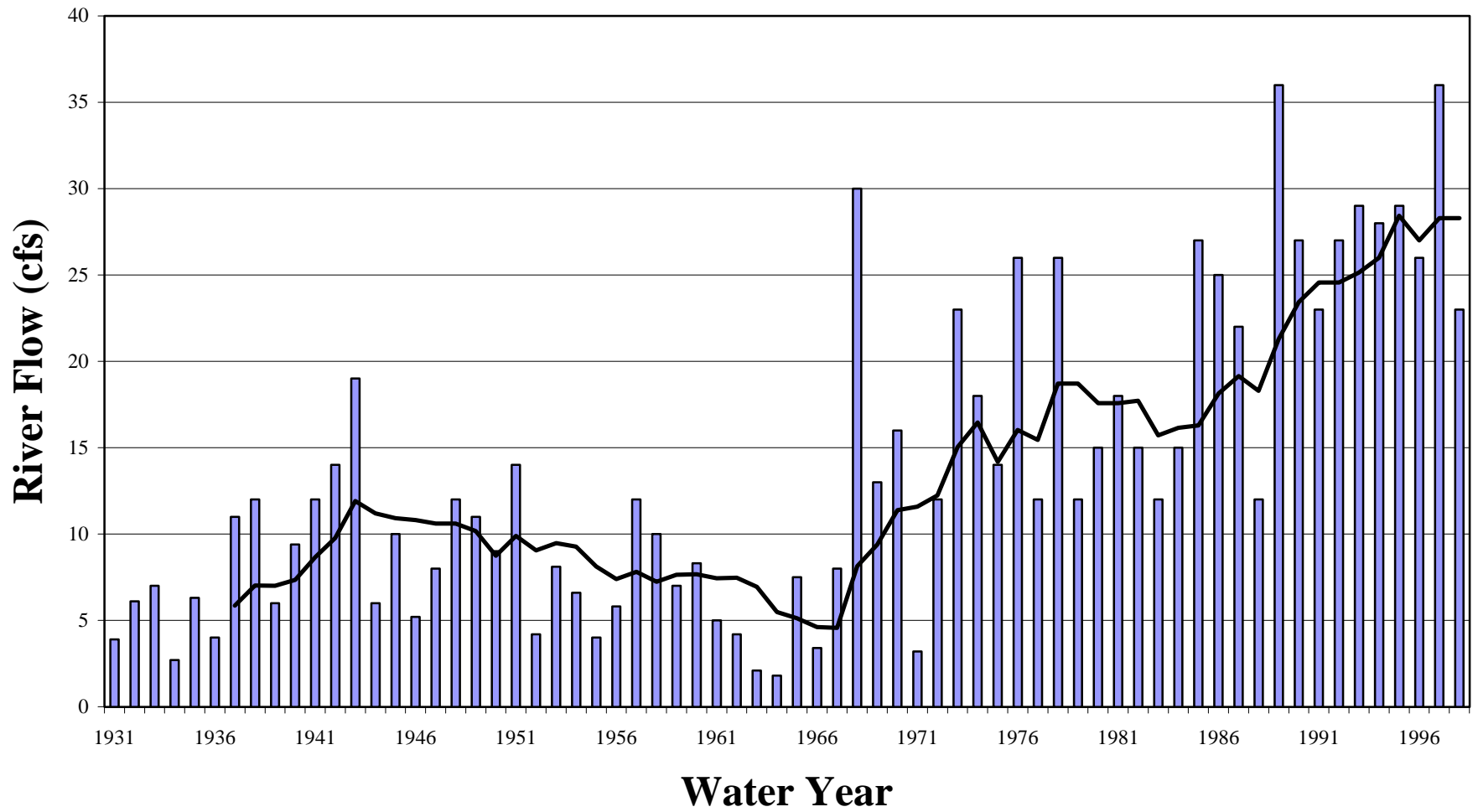
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 1200 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1931	3.9	25.7	1.9	0	3/28/31	152
1932	6.1	81.3	5.9	N/A	5/27/32	1,720
1933	7.0	125.0	9.1	N/A	5/1/33	3,840
1934	2.7	46.4	3.4	N/A	4/2/34	1,650
1935	6.3	53.4	3.9	0	3/11/35	760
1936	4.0	59.7	4.3	0	3/5/36	800
1937	11.0	114.0	8.3	N/A	4/22/37	1,440
1938	12.0	121.0	8.8	N/A	2/14/38	2,680
1939	6.0	124.0	9.0	N/A	2/20/39	6,140
1940	9.4	66.1	4.8	0	3/30/40	850
1941	12.0	86.4	6.3	0	12/30/40	1,100
1942	14.0	79.2	5.8	N/A	3/17/42	1,300
1943	19.0	203.0	14.8	N/A	5/12/43	4,210
1944	6.0	73.6	5.4	0	3/16/44	920
1945	10.0	91.1	6.6	N/A	5/18/45	4,000
1946	5.2	89.8	6.5	0	6/18/46	1,090
1947	8.0	201.0	14.6	N/A	4/5/47	13,000
1948	12.0	173.0	12.6	2	5/10/48	6,130
1949	11.0	105.0	7.6	2	2/15/49	2,420
1950	9.0	201.0	14.6	5	4/4/50	3,640
1951	14.0	154.0	11.2	3	12/8/50	1,880
1952	4.2	160.0	11.6	5	3/11/52	2,040
1953	8.1	69.7	5.1	0	5/31/53	960
1954	6.6	87.1	6.3	2	3/26/54	3,080
1955	4.0	112.0	8.1	2	10/4/54	1,510
1956	5.8	166.0	12.1	5	4/29/56	4,240
1957	12.0	136.0	9.9	5	7/9/57	4,030
1958	10.0	88.4	6.4	1	12/20/57	1,380
1959	7.0	101.0	7.3	2	3/6/59	1,880
1960	8.3	144.0	10.5	5	6/17/60	2,140
1961	5.0	62.2	4.5	1	4/25/61	1,690
1962	4.2	74.4	5.4	2	3/13/62	2,750
1963	2.1	54.1	3.9	1	6/10/63	1,260
1964	1.8	43.9	3.2	0	4/29/64	824
1965	7.5	85.8	6.2	2	2/10/65	2,610

Historic Flow Data Summary (continued)
Main Rouge River @ Plymouth Rd. (US7)

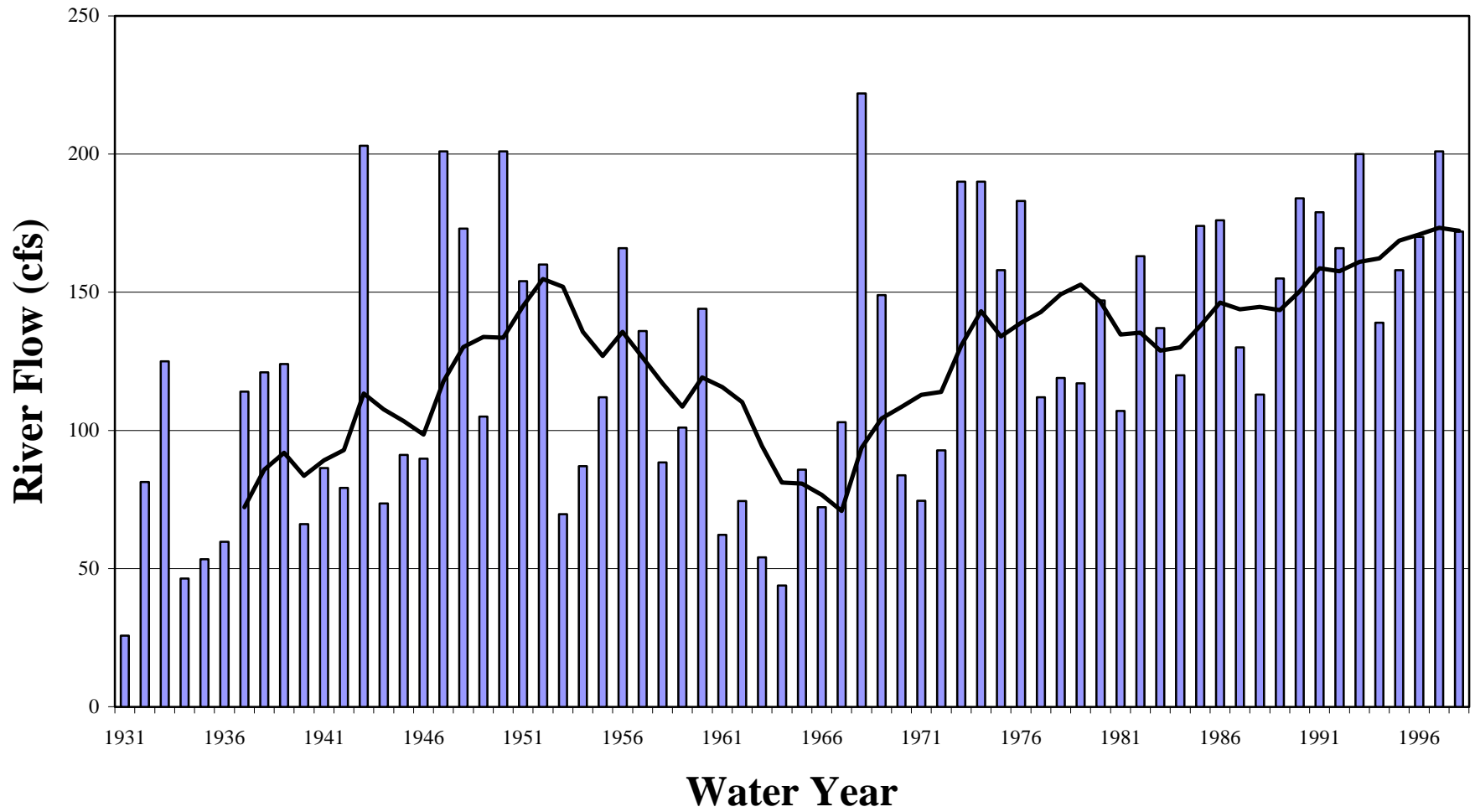
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 1200 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1966	3.4	72.2	5.5	1	12/25/65	1,820
1967	8.0	103.0	7.8	3	6/8/67	1,520
1968	30.0	222.0	16.9	6	6/26/68	7,300
1969	13.0	149.0	11.3	7	1/30/69	1,990
1970	16.0	83.8	6.4	2	3/4/70	1,480
1971	3.2	74.5	5.7	1	2/20/71	1,520
1972	12.0	92.8	7.1	2	3/14/72	1,620
1973	23.0	190.0	14.4	6	6/27/73	2,300
1974	18.0	190.0	14.4	7	4/4/74	1,980
1975	14.0	158.0	12.0	6	9/1/75	2,710
1976	26.0	183.0	13.9	6	7/29/76	3,330
1977	12.0	112.0	8.5	5	4/26/77	2,440
1978	26.0	119.0	9.0	2	3/21/78	1,460
1979	12.0	117.0	8.9	3	4/14/79	2,640
1980	15.0	147.0	11.2	4	8/3/80	1,920
1981	18.0	107.0	8.1	2	2/19/81	1,310
1982	15.0	163.0	12.4	3	10/1/81	6,830
1983	12.0	137.0	10.4	2	5/2/83	3,440
1984	15.0	120.0	9.1	3	3/21/84	2,200
1985	27.0	174.0	13.2	5	2/24/85	3,420
1986	25.0	176.0	13.4	8	3/11/86	1,700
1987	22.0	130.0	9.9	2	6/21/87	1,840
1988	12.0	113.0	8.6	1	12/16/87	1,790
1989	36.0	155.0	11.8	6	6/22/89	3,750
1990	27.0	184.0	14.0	3	2/23/90	3,810
1991	23.0	179.0	13.6	5	5/26/91	3,740
1992	27.0	166.0	12.6	2	7/15/92	1,530
1993	29.0	200.0	15.2	5	1/5/93	2,730
1994	28.0	139.0	10.6	5	3/22/94	1,670
1995	29.0	158.0	12.0	5	8/4/95	1,560
1996	26.0	170.0	12.9	4	6/19/96	2,610
1997	36.0	201.0	15.3	6	7/3/97	2,720
1998	23.0	172.0	13.1	4	8/6/98	3,500

* Based on approximate drainage area of 187 square miles.

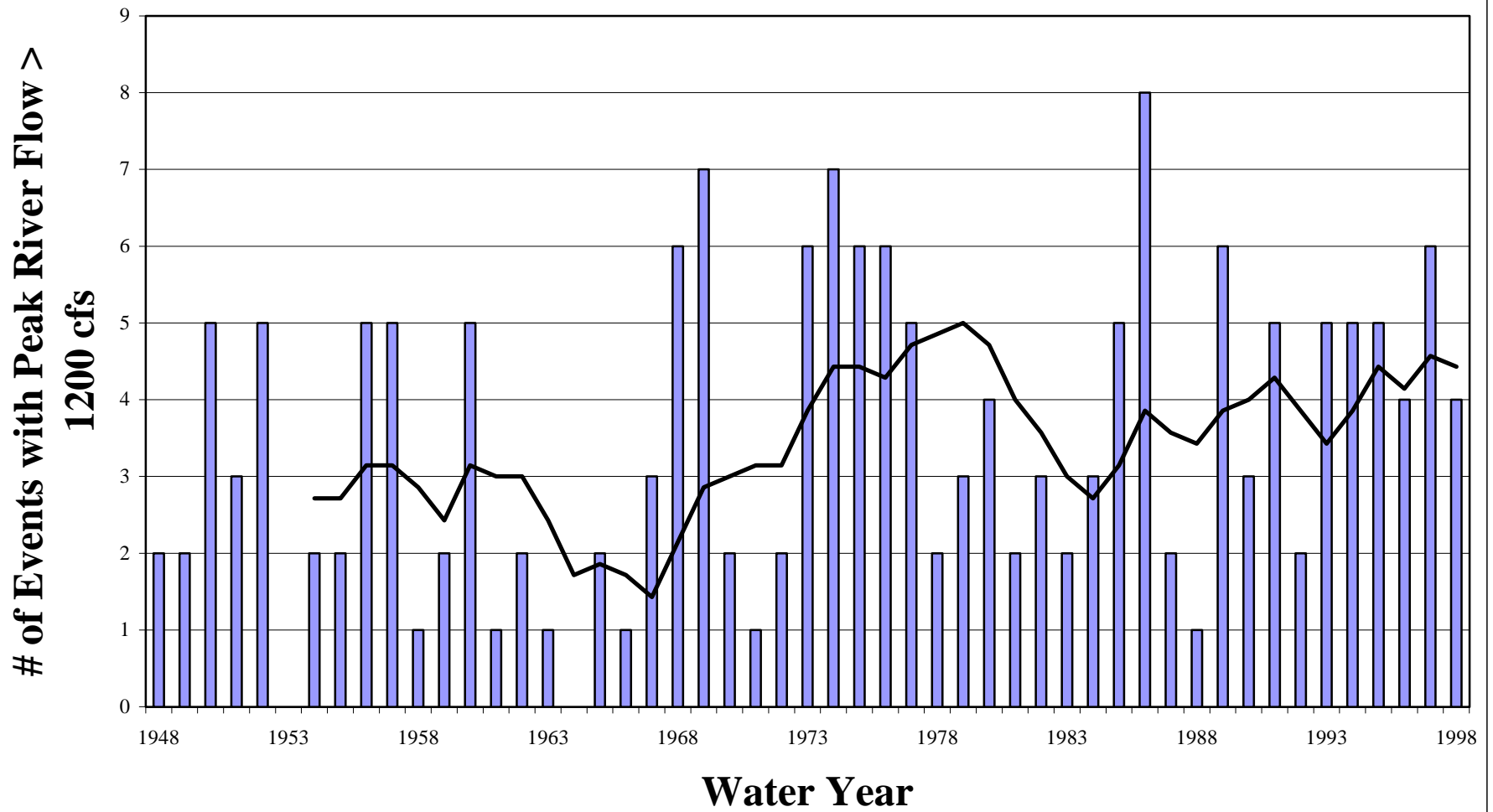
Low Flow Trend Main Rouge River at Plymouth Rd. (US7)



Average Flow Trend Main Rouge River @ Plymouth Rd. (US7)



Peak Flow Trend Main Rouge River at Plymouth Rd. (US7)



River Flow Data Summary for Middle Rouge Subwatershed

4/14/00

Introduction (Table 1 and Figure 1)

Continuous river flow data in the Middle Rouge Subwatershed include historic USGS data and data collected by the RPO with USGS assistance, beginning in 1994. A summary of all available continuous flow data is presented in Table 1. A map and table including all river flow measurement locations in the Middle Rouge Subwatershed have been provided separately.

To aid in interpreting flow data impacted by wet weather events, long-term precipitation totals from Detroit Metropolitan Airport are shown in Figure 1. The annual precipitation totals include hail, sleet, snow, etc. expressed as equivalent inches of water. Annual average precipitation is 32.3 inches for the period of 1959 through 1997.

Historic USGS Data (Attachment 1)

The USGS has operated a stream gage on the Middle Rouge River at Inkster Road (US2) continuously since 1948, in addition to 3 years of operation in the early 1930's. Attachment 1 includes a table for gage US2 with the following information for each year of gage operation:

1. Lowest daily average flow (cfs)
2. Annual average flow (cfs)
3. Annual average volume (expressed as inches over the upstream watershed)
4. No. of events with instantaneous peak flow rate exceeding a gage-specific threshold
5. Date and flow rate (cfs) of highest instantaneous peak flow recorded

In addition, bar charts are included in Attachment 1 for items 1, 2 and 4 to show long-term trends in the data. Each plot includes the actual data for each year as well as a trend line, which is calculated as a seven-year moving average. The lowest daily average flow typically represents the "driest" dry weather day of each year, when river flows are mainly comprised of groundwater recharge and point source inputs. The annual average flow represents dry and wet weather conditions, as it represents the annual volume of flow measured at the gage converted to cfs. The number of event peaks above a threshold shows how the watershed is responding to significant wet weather events.

The following observations can be made from the historic USGS data:

- The lowest daily average flow has varied significantly over the years with a definite increasing trend. The lowest daily average flows in the 1930's were below 3 cfs compared to an average of 21 cfs over the last ten years. The large drop in lowest daily average flow from 1997 to 1998 may have been partly due to the dewatering of Newburgh Lake.
- For the last 15 years, the annual flow at this gage has averaged 96 cfs (0.96 cfs/sq mi). The highest annual average flow of 133 cfs occurred in 1976. Between 1959 and 1998, the annual average stream flow increased from around 50 to 100 cfs while the trend of annual average precipitation was fairly constant.

- The highest recorded flow at this gage was 2,330 cfs on June 26, 1968. There is no clear increasing or decreasing trend in the number of events with peak flows greater than 700 cfs.

Recent RPO Data (Figure 2 and Table 2)

Beginning in 1994, the RPO has measured stream flow during one or more monitoring seasons at six sites in the Middle Rouge Subwatershed. Flow measurements were based on measured water level and stream rating curves. Stream rating curves developed over only one or two years can have significant uncertainty at very low and very high flow conditions that can skew the computation of an average flow. Therefore, the RPO data are best summarized using median stream flow values. Median stream flow is that flow rate which is exceeded 50 percent of the year, which typically represents a flow at the upper end of the dry weather flow regime.

The results for the May through September period each year are shown as a bar chart with stream flow normalized by dividing by the drainage area. Data for each RPO gage are shown along with data from USGS gage US2 for the same period.

The following observations can be made from the RPO and USGS data:

- Based on the USGS site, the highest median stream flow occurred in the 1997 monitoring season while the lowest occurred in 1994 and 1998.
- The normalized median stream flow values on the main branch of the Middle Rouge are generally higher than for upstream tributaries (D02 and D03), which may be in part to the storage provided in the impoundments.

Attachment 1

Historic Flow Data Summary For Middle Rouge River at Inkster Road (US2)

Figure 1
Detroit Metro Airport
Annual Precipitation Totals

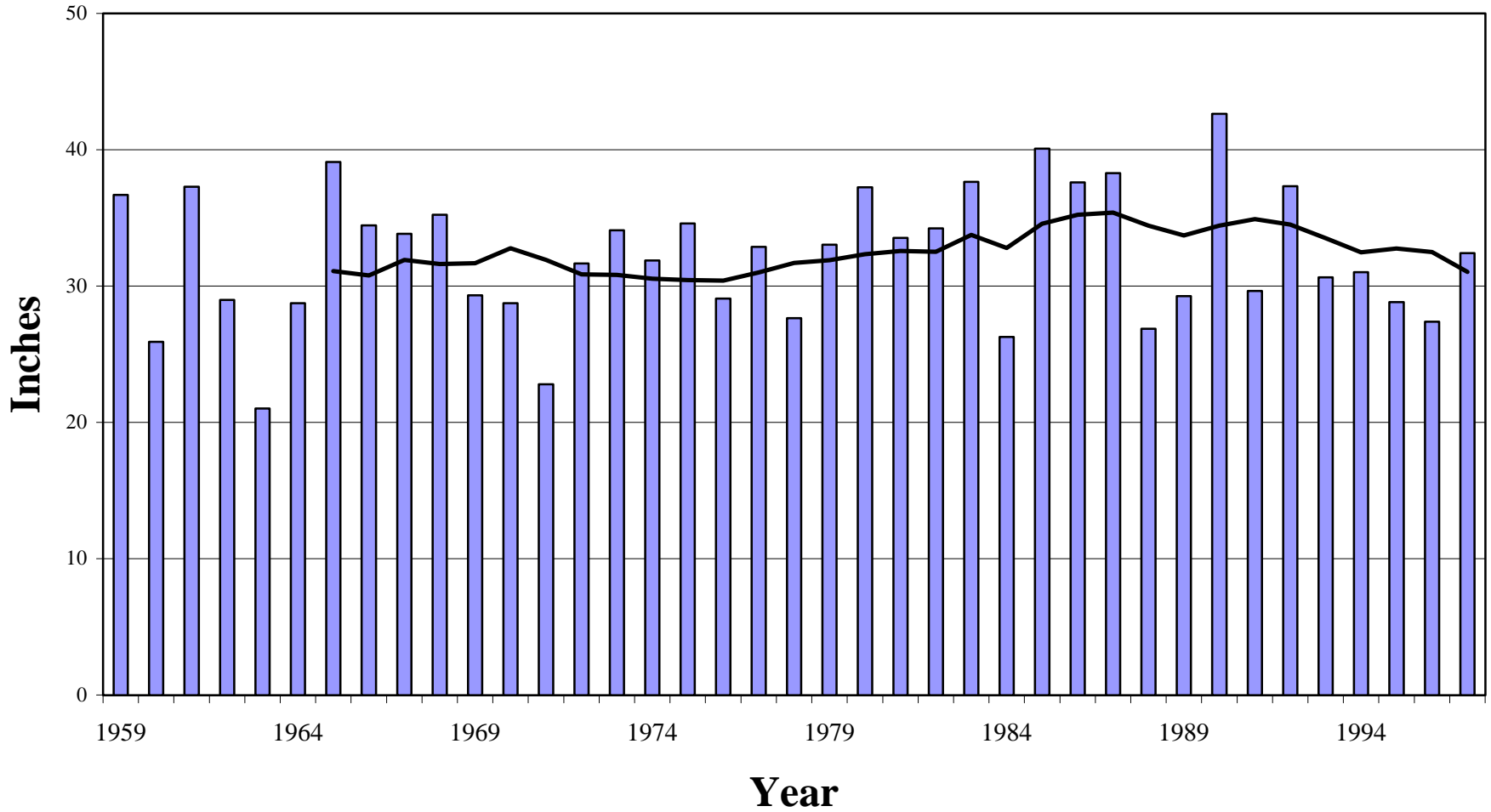


Figure 2
Middle Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

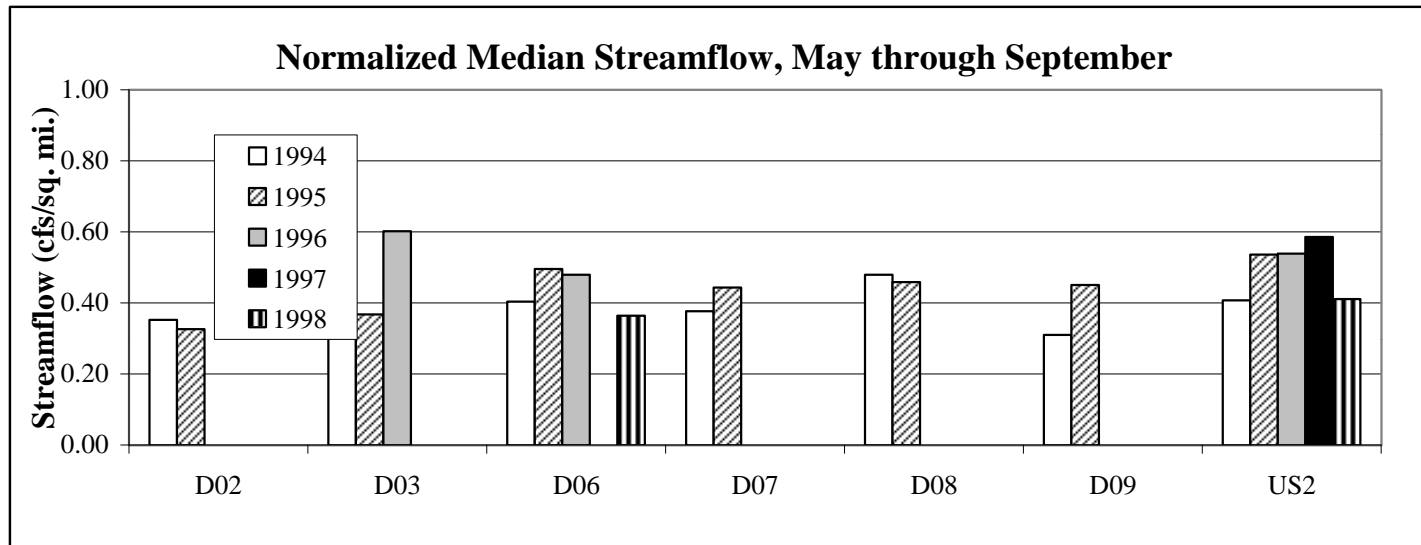


Table 1
Middle Storm Water Management Areas
Summary of Historic and RPO Continuous Flow Measurements

Type of Flow Measurement	Year	Months of Operation	Measurement Locations							
			D02	D03	D06	D07	D08	D09	US2	
Historic USGS Data	WY* 1931-33, 1948-present	Year Round								
Recent RPO Data	1994	Apr/May - Oct/Nov								
	1995	Apr/May - Oct/Nov								
	1996	Apr/May - Oct/Nov								
	1997	Apr/May - Oct/Nov								
	1998	Year Round								
	1999	Year Round								

* WY = Water Year (e.g. WY 1961 is Oct. 1960 - Sept. 1961)

Table 2
Middle Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

Site	Drainage Area* (sq mi)	Median Streamflow (cfs)					Normalized Median Streamflow (cfs/sq mi)				
		1994	1995	1996	1997	1998	1994	1995	1996	1997	1998
D02	19.0	6.7	6.2				0.35	0.33			
D03	25.6	8.1	9.4	15.4			0.32	0.37	0.60		
D06	109.4	44.2	54.2	52.4	**	39.8	0.40	0.50	0.48		0.36
D07	95.7	36.0	42.4				0.38	0.44			
D08	56.5	27.1	25.9				0.48	0.46			
D09	65.9	20.4	29.7				0.31	0.45			
US2	99.9	40.7	53.6	53.8	58.5	41.0	0.41	0.54	0.54	0.59	0.41

* Drainage areas are approximate (within 5% of actual)

** Flows not reliable due to unstable rating curve.

Attachment 1

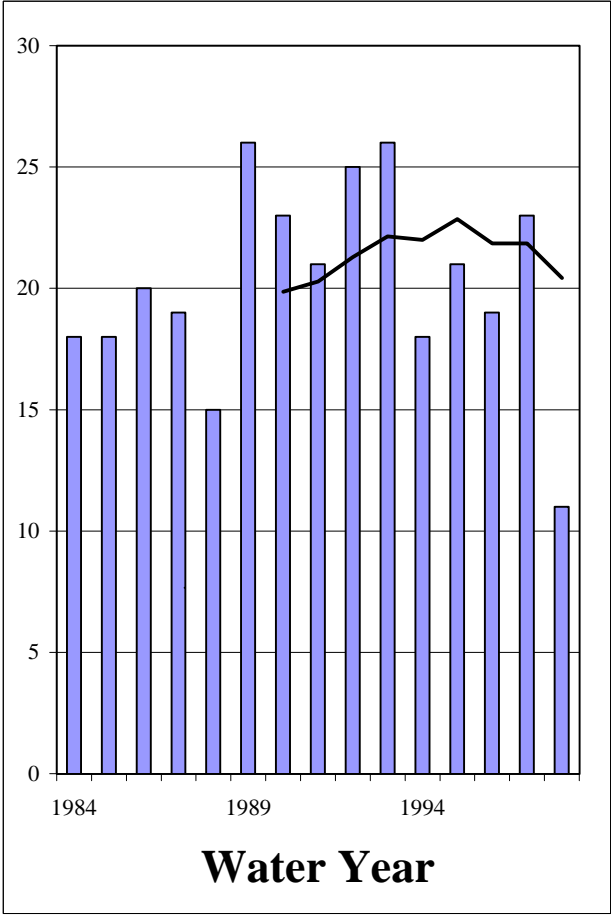
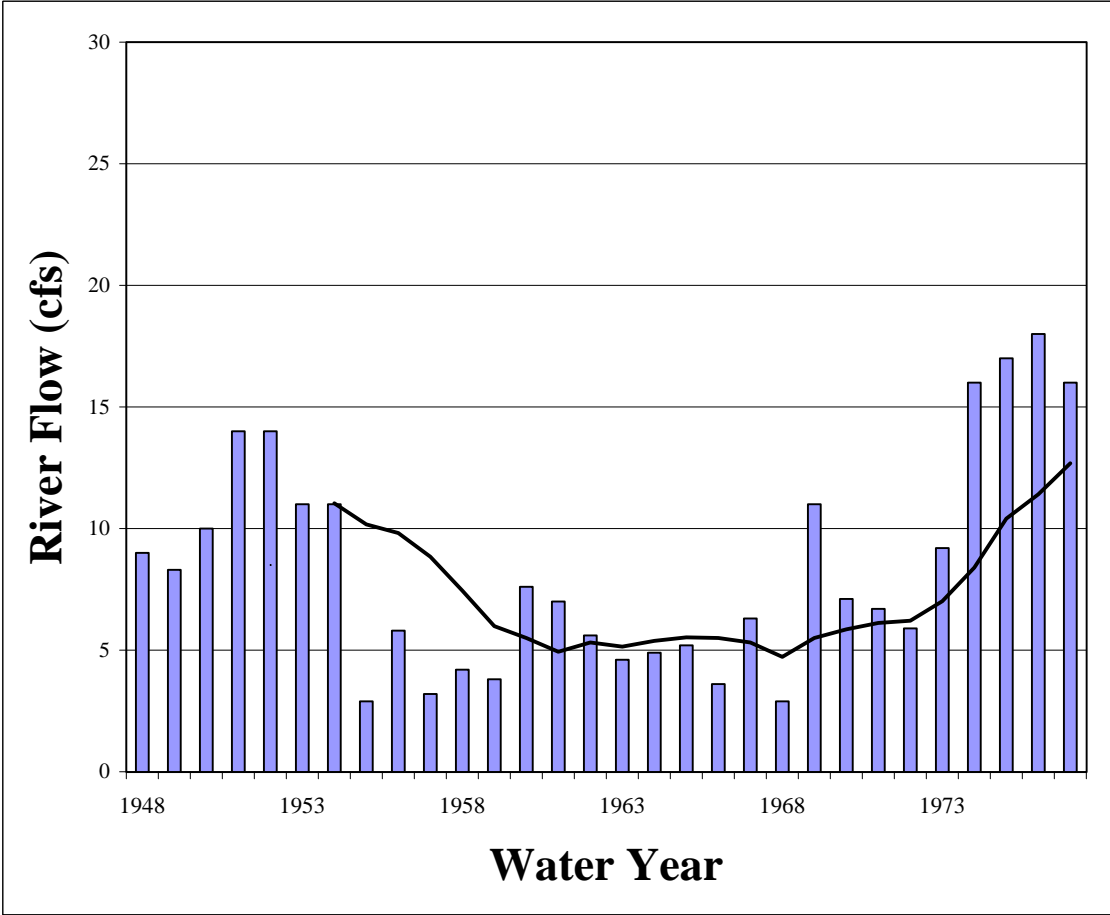
Historic Flow Data Summary For Middle Rouge River at Inkster Road (US2)

**Historic Flow Data Summary
Middle Rouge River at Inkster Rd. (US2)**

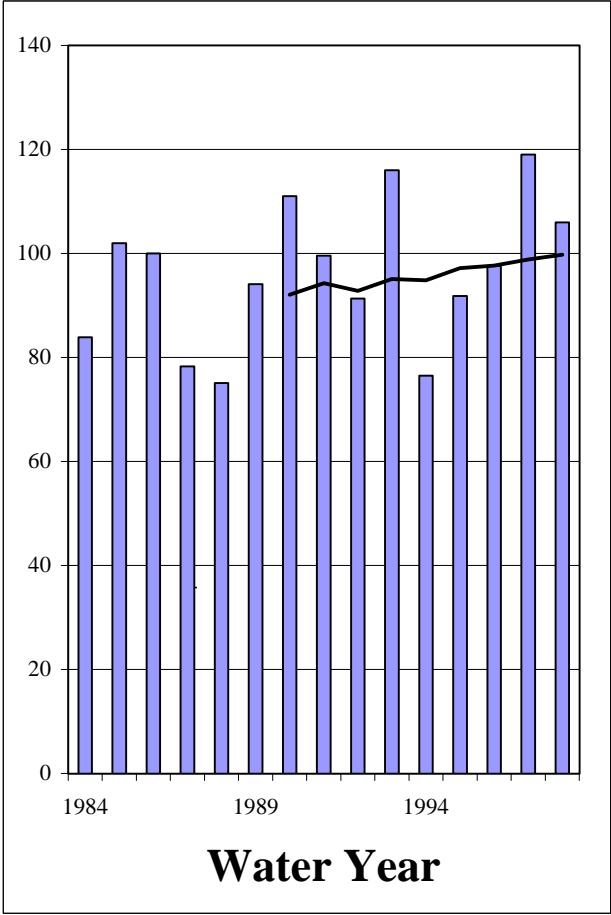
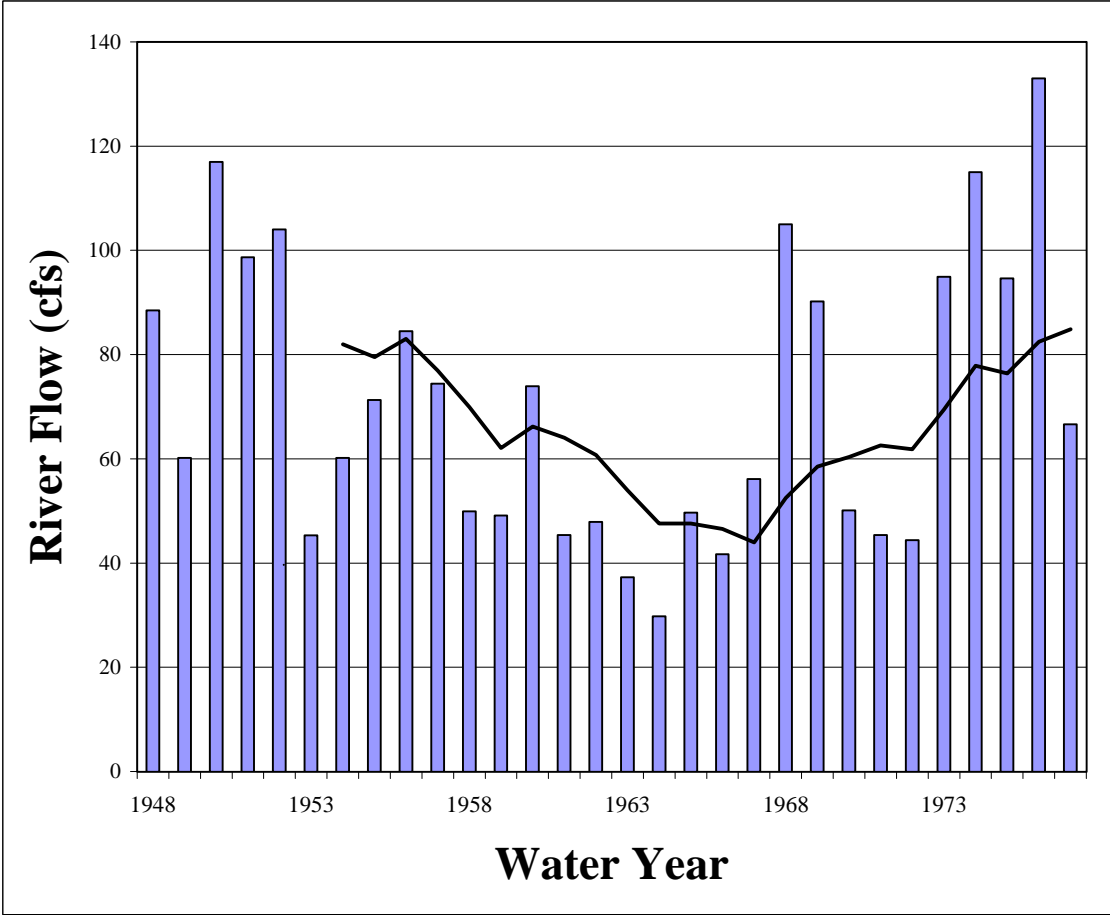
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 700 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1931	1.4	20.8	2.8	0	3/29/31	76
1932	1.6	51.3	7.0	1	5/27/32	780
1933	2.4	81.0	11.0	1	5/1/33	1,420
1948	9.0	88.5	12.0	2	5/10/48	2,150
1949	8.3	60.2	8.2	2	2/15/49	1,200
1950	10.0	117.0	15.9	2	4/4/50	1,960
1951	14.0	98.7	13.4	4	12/8/50	1,060
1952	14.0	104.0	14.2	5	3/11/52	1,060
1953	11.0	45.3	6.2	0	3/4/53	470
1954	11.0	60.2	8.2	2	3/25/54	1,720
1955	2.9	71.3	9.7	0	1/6/55	615
1956	5.8	84.5	11.5	4	4/29/56	1,840
1957	3.2	74.4	10.1	3	7/8/57	1,210
1958	4.2	49.9	6.8	1	12/20/57	814
1959	3.8	49.1	6.7	2	3/7/59	1,090
1960	7.6	73.9	10.1	2	6/17/60	1,040
1961	7.0	45.4	6.2	1	4/25/61	1,020
1962	5.6	47.9	6.5	2	3/12/62	1,500
1963	4.6	37.3	5.1	1	6/10/63	798
1964	4.9	29.8	4.1	0	4/22/64	484
1965	5.2	49.7	6.8	2	2/10/65	1,540
1966	3.6	41.7	5.7	1	12/25/65	900
1967	6.3	56.1	7.6	0	7/19/67	591
1968	2.9	105.0	14.3	4	6/26/68	2,330
1969	11.0	90.2	12.3	2	1/30/69	1,030
1970	7.1	50.1	6.8	0	3/5/70	669
1971	6.7	45.4	6.2	1	2/20/71	871
1972	5.9	44.4	6.0	1	4/16/72	742
1973	9.2	94.9	12.9	0	12/31/72	619
1974	16.0	115.0	15.7	6	4/4/74	945
1975	17.0	94.6	12.9	5	9/1/75	1,120
1976	18.0	133.0	18.1	6	5/7/76	1,670
1977	16.0	66.6	9.1	1	4/25/77	1,060
1978				N/A	5/31/78	790
1979				N/A	4/14/79	1,970
1980				N/A	4/4/80	944
1981				N/A	9/4/81	1,320
1982				N/A	10/1/81	1,970
1983				N/A	5/2/83	1,930
1984	18.0	83.9	11.4	2	3/21/84	1,110
1985	18.0	102.0	13.9	2	2/24/85	1,620
1986	20.0	100.0	13.6	3	3/11/86	1,150
1987	19.0	78.3	10.7	2	6/21/87	1,000
1988	15.0	75.1	10.2	1	12/16/87	802
1989	26.0	94.1	12.8	1	6/22/89	1,480
1990	23.0	111.0	15.1	2	2/23/90	1,670
1991	21.0	99.6	13.6	3	5/26/91	1,010
1992	25.0	91.3	12.4	0	4/25/92	658
1993	26.0	116.0	15.8	2	1/5/93	1,460
1994	18.0	76.5	10.4	2	8/13/94	1,220
1995	21.0	91.8	12.5	1	6/29/95	885
1996	19.0	97.6	13.3	3	5/10/96	965
1997	23.0	119.0	16.2	4	2/22/97	1,140
1998	11.0	106.0	14.4	3	2/18/98	1,490

* Based on approximate drainage area of 99.9 square miles.

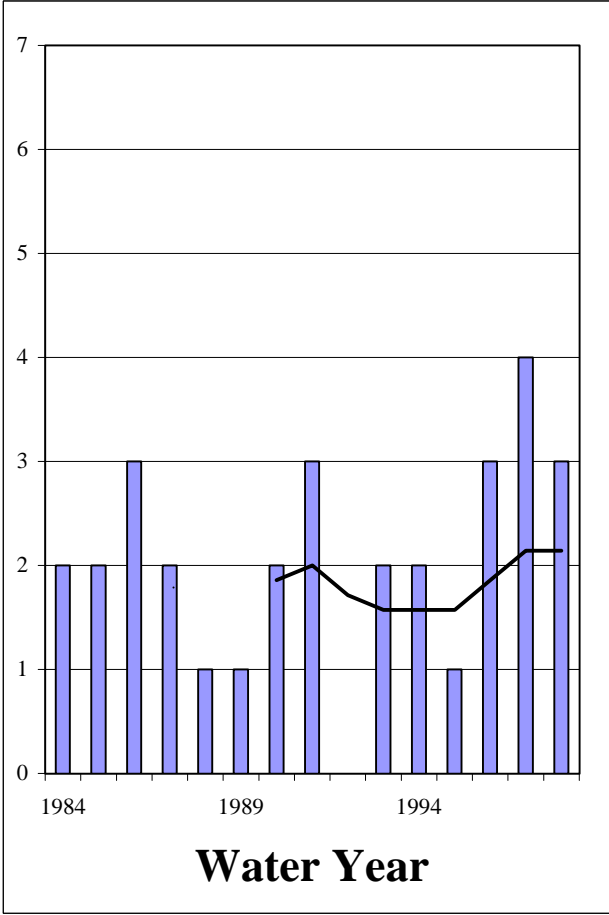
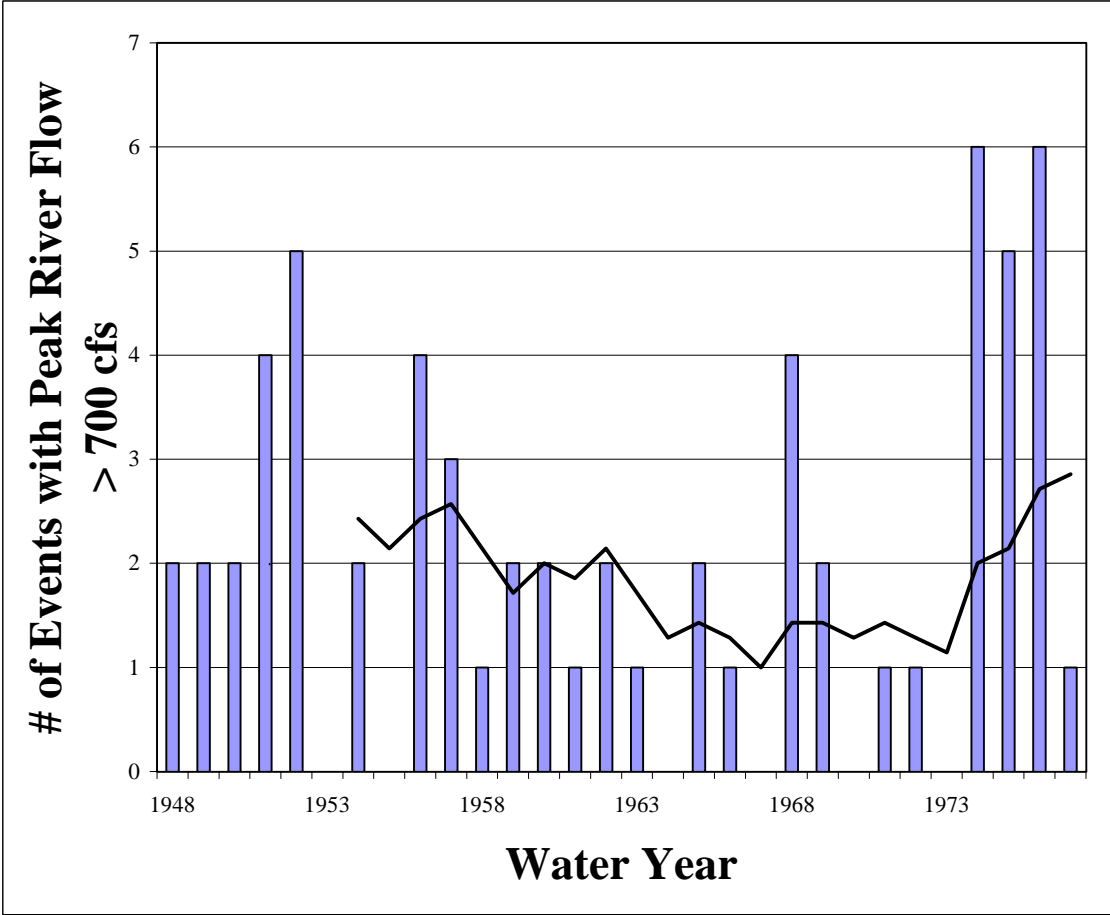
Low Flow Trend Middle Rouge River @ Inkster Rd. (US2)



Average Flow Trend Middle Rouge River @ Inkster Rd. (US2)



Peak Flow Trend Middle Rouge River @ Inkster Rd. (US2)



River Flow Data Summary for Upper Rouge Subwatershed

4/14/00

Introduction (Table 1 and Figure 1)

Continuous river flow data in the Upper Rouge Subwatershed include historic USGS data and data collected by the RPO with USGS assistance, beginning in 1994. A summary of all available continuous flow data is presented in Table 1. A map and table including all river flow measurement locations in the Upper Rouge Subwatershed have been provided separately.

To aid in interpreting flow data impacted by wet weather events, long-term precipitation totals from Detroit Metropolitan Airport are shown in Figure 1. The annual precipitation totals include hail, sleet, snow, etc. expressed as equivalent inches of water. Annual average precipitation is 32.3 inches for the period of 1959 through 1997.

Historic USGS Data (Attachment 1)

The USGS has operated a stream gage on the Upper Rouge at Shiawassee Road (US3) continuously since 1959. Attachment 1 includes a table for gage US3 with the following information for each year of gage operation:

1. Lowest daily average flow (cfs)
2. Annual average flow (cfs)
3. Annual average volume (expressed as inches over the upstream watershed)
4. No. of events with instantaneous peak flow rate exceeding a gage-specific threshold
5. Date and flow rate (cfs) of highest instantaneous peak flow recorded

In addition, bar charts are included in Attachment 1 for items 1, 2 and 4 to show long-term trends in the data. Each plot includes the actual data for each year as well as a trend line, which is calculated as a seven-year moving average. The lowest daily average flow typically represents the “driest” dry weather day of each year, when river flows are mainly comprised of groundwater recharge and point source inputs. The annual average flow represents dry and wet weather conditions, as it represents the annual volume of flow measured at the gage converted to cfs. The number of event peaks above a threshold shows how the watershed is responding to significant wet weather events.

The following observations can be made from the historic USGS data:

- The lowest daily average flow has increased significantly over the years. The lowest daily average flows in the 1960’s averaged less than 1 cfs compared to an average of 4 cfs in recent years.

- For the last 15 years, the annual flow at this gage has averaged 18 cfs (1.0 cfs/sq mi). The highest annual average flow of 23 cfs occurred in 1997. Between 1959 and 1998, the annual average stream flow increased from around 8 to 19 cfs while the trend of annual average precipitation was fairly constant.
- The highest recorded flow at this gage was 1,500 cfs on June 25, 1968. There is no clear increasing or decreasing trend in the number of events with peak flows greater than 700 cfs. There is a definite trend of increasing frequency for events with peak flows in excess of 120 cfs. From 1959 to 1998, the frequency of such events increased from two to eight times per year while the trend of annual average precipitation was fairly constant.

Recent RPO Data (Figure 2 and Table 2)

Beginning in 1994, the RPO has measured stream flow during one or more monitoring seasons at four sites in the Upper Rouge Subwatershed. Flow measurements were based on measured water level and stream rating curves. Stream rating curves developed over only one or two years can have significant uncertainty at very low and very high flow conditions that can skew the computation of an average flow. Therefore, the RPO data are best summarized using median stream flow values. Median stream flow is that flow rate which is exceeded 50 percent of the year, which typically represents a flow at the upper end of the dry weather flow regime.

The results for the May through September period each year are shown as a bar chart with stream flow normalized by dividing by the drainage area. Data for each RPO gage are shown along with data from USGS gage US3 for the same period.

The following observations can be made from the RPO and USGS data:

- The highest median stream flow occurred in the 1996 monitoring season while the lowest occurred in 1998.
- The normalized median stream flow on the Bell Branch at Inkster Road is significantly lower than at other sites.

Attachment 1

Historic Flow Data Summary For Upper Rouge River at Shiawasse Road (US3)

Figure 1
Detroit Metro Airport
Annual Precipitation Totals

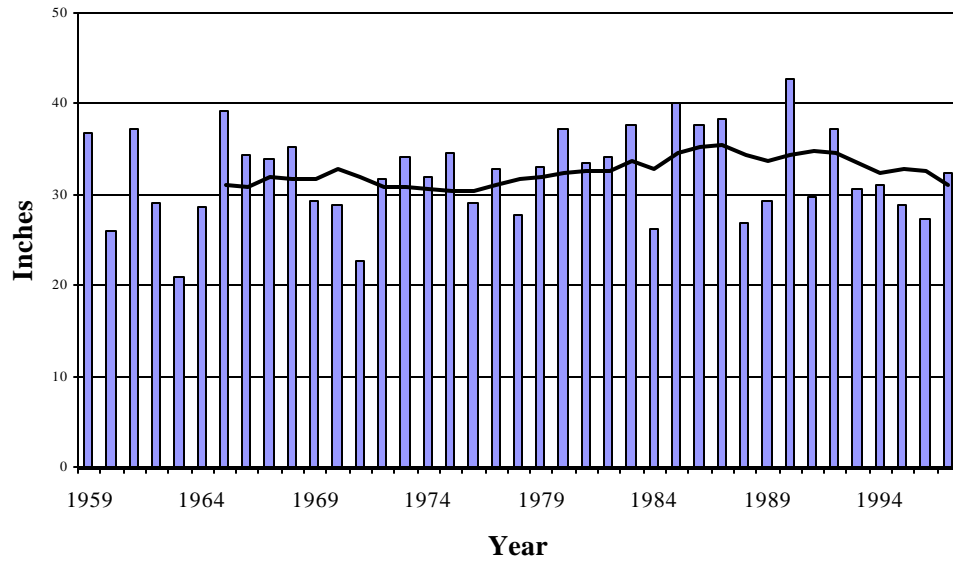


Figure 2
Upper Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

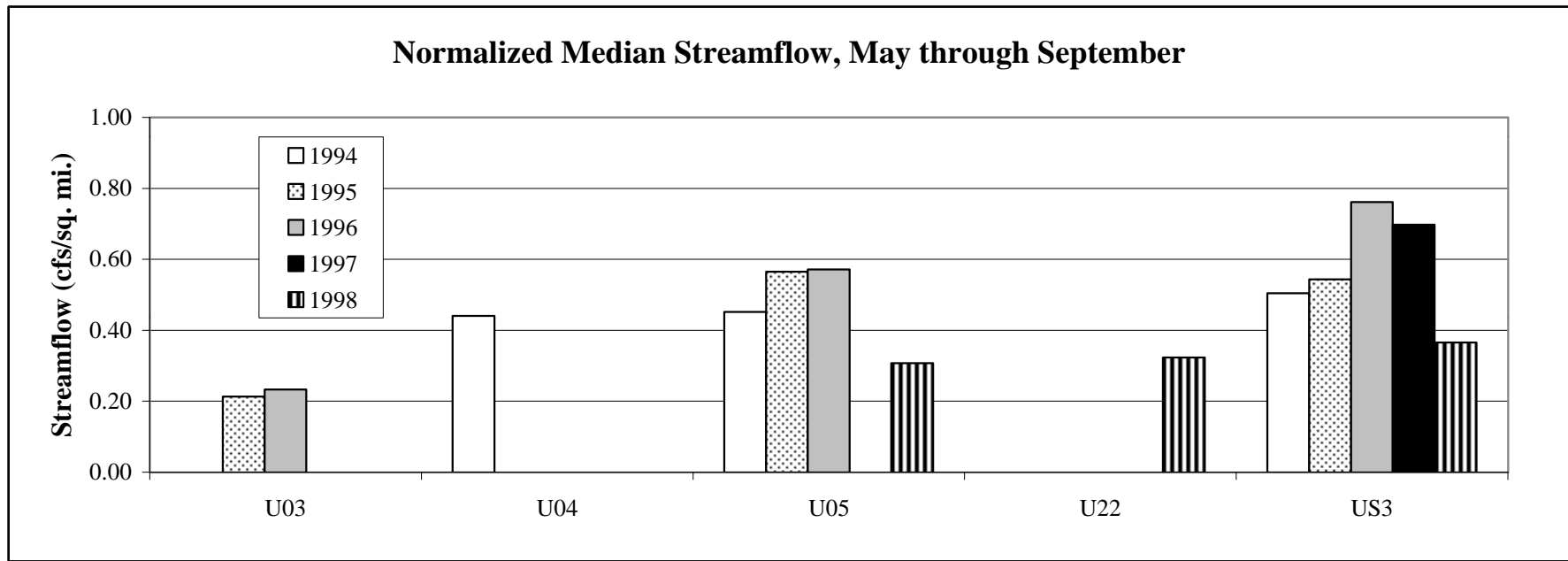


Table 1
Upper Storm Water Management Areas
Summary of Historic and RPO Continuous Flow Measurements

Type of Flow Measurement	Year	Months of Operation	Measurement Locations				
			U03	U04	U05	U22	US3
Historic USGS Data	WY* 1959-present	Year Round					
Recent RPO Data	1994	Apr/May - Oct/Nov					
	1995	Apr/May - Oct/Nov					
	1996	Apr/May - Oct/Nov					
	1997	Apr/May - Oct/Nov					
	1998	Year Round (except U22)					
	1999	Year Round					

* WY = Water Year (e.g. WY 1961 is Oct. 1960 - Sept. 1961)

Table 2
Upper Rouge Storm Water Management Area
Median Streamflow for May-September, 1994-1998

Site	Drainage Area* (sq mi)	Median Streamflow (cfs)					Normalized Median Streamflow (cfs/sq mi)				
		1994	1995	1996	1997	1998	1994	1995	1996	1997	1998
U03	35.2		7.5	8.2				0.21	0.23		
U04	36.1	15.9					0.44				
U05	60.6	27.4	34.2	34.7	**	18.6	0.45	0.57	0.57		0.31
U22	25.4					8.2					0.32
US3	17.5	8.8	9.5	13.3	12.2	6.4	0.50	0.54	0.76	0.70	0.37

* Drainage areas are approximate (within 5% of actual)

** Flows not reliable due to unstable rating curve.

Attachment 1

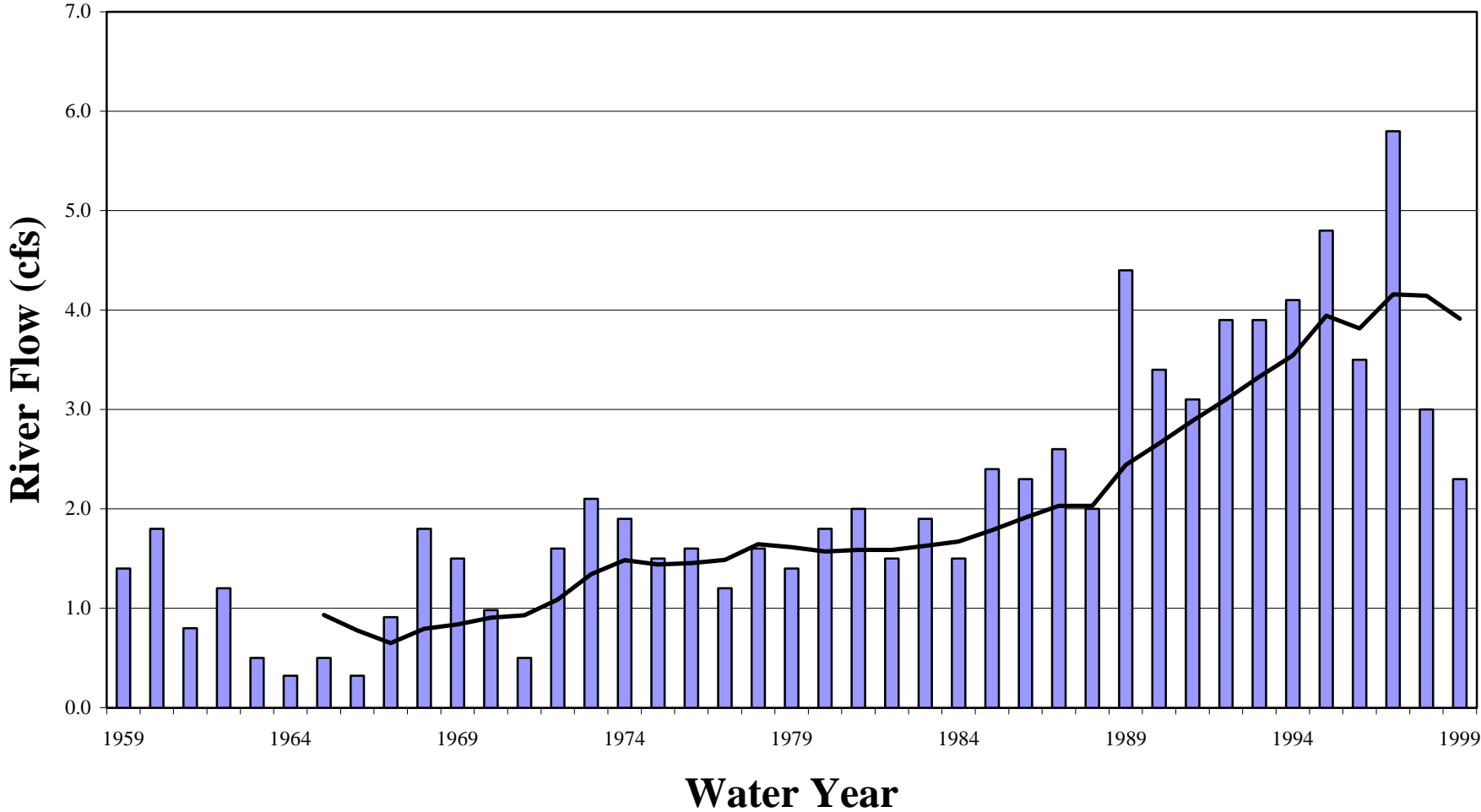
Historic Flow Data Summary For Upper Rouge at Shiawassee Road (US3)

Historic Flow Data Summary
Upper Rouge River @ Shiawassee Rd. (US3)

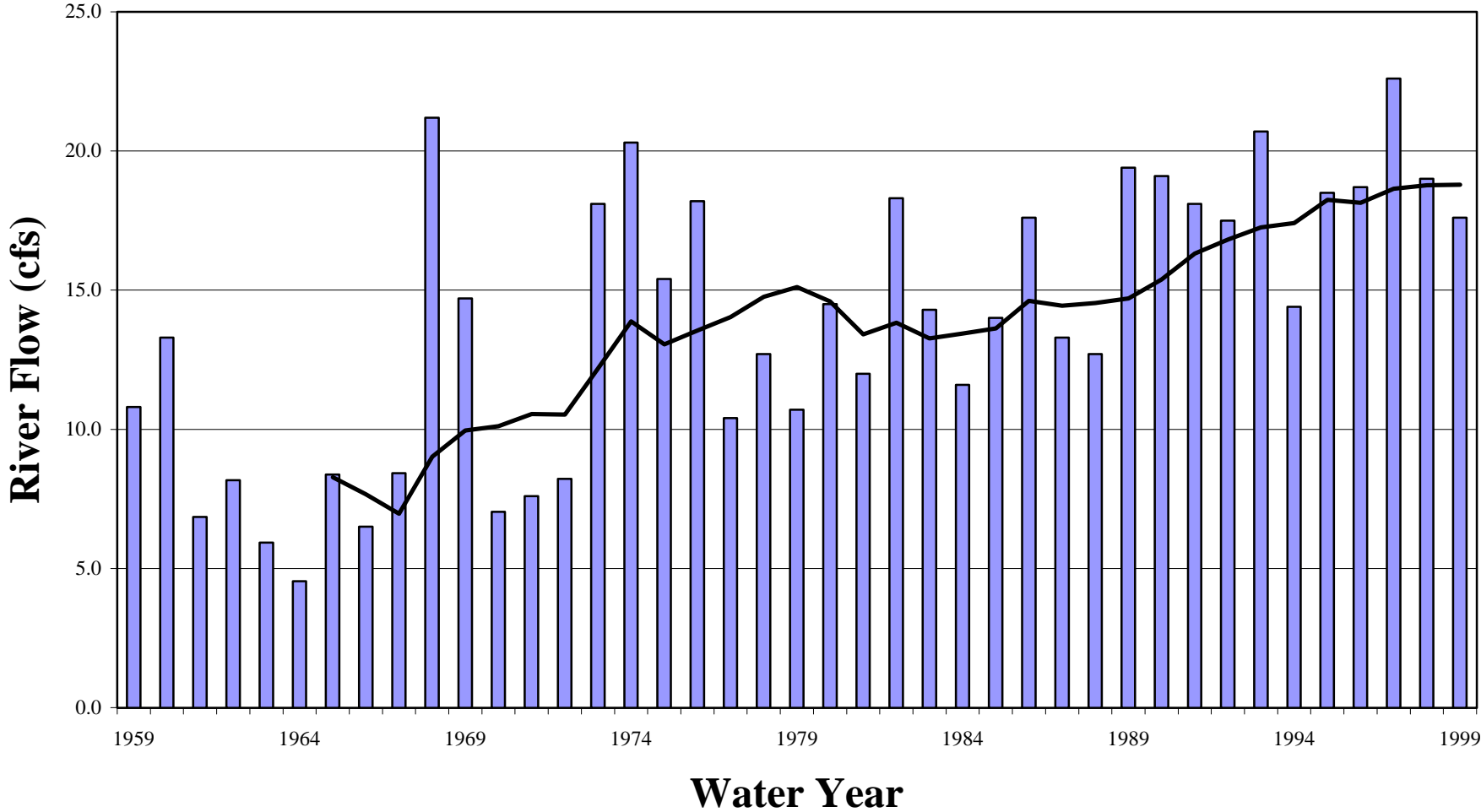
Water Year (Oct-Sep)	Lowest Daily Average Flow (cfs)	Annual Average Flow (cfs)	Annual Average Volume* (in)	No. of Events with Peak Flow Greater Than 120 cfs	Highest Peak Flow Recorded in Year	
					Date	(cfs)
1959	1.4	10.8	8.4	3	4/2/59	326
1960	1.8	13.3	10.3	3	6/16/60	287
1961	0.8	6.9	5.3	1	4/25/61	174
1962	1.2	8.2	6.3	2	3/12/62	400
1963	0.5	5.9	4.6	0	2/26/63	96
1964	0.3	4.5	3.5	0	4/30/64	75
1965	0.5	8.4	6.5	2	2/10/65	665
1966	0.3	6.5	5.1	1	12/25/65	182
1967	0.9	8.4	6.5	0	4/3/67	108
1968	1.8	21.2	16.5	7	6/25/68	1,500
1969	1.5	14.7	11.4	4	1/30/69	287
1970	1.0	7.0	5.5	0	3/4/70	90
1971	0.5	7.6	5.9	3	2/20/71	260
1972	1.6	8.2	6.4	3	3/14/72	220
1973	2.1	18.1	14.1	4	12/30/72	252
1974	1.9	20.3	15.8	10	3/5/74	345
1975	1.5	15.4	12.0	7	4/19/75	458
1976	1.6	18.2	14.1	8	5/6/76	349
1977	1.2	10.4	8.1	6	4/2/77	315
1978	1.6	12.7	9.9	4	3/21/78	210
1979	1.4	10.7	8.3	2	4/14/79	363
1980	1.8	14.5	11.3	4	3/17/80	330
1981	2.0	12.0	9.3	3	2/18/81	200
1982	1.5	18.3	14.2	5	10/1/81	878
1983	1.9	14.3	11.1	2	5/2/83	518
1984	1.5	11.6	9.0	4	3/16/84	275
1985	2.4	14.0	10.9	5	2/23/85	430
1986	2.3	17.6	13.7	9	7/9/86	281
1987	2.6	13.3	10.3	3	6/22/87	166
1988	2.0	12.7	9.9	3	12/15/87	176
1989	4.4	19.4	15.1	9	6/21/89	885
1990	3.4	19.1	14.8	5	2/22/90	412
1991	3.1	18.1	14.1	6	8/19/91	614
1992	3.9	17.5	13.6	6	7/14/92	239
1993	3.9	20.7	16.1	8	11/12/92	321
1994	4.1	14.4	11.2	6	3/21/94	264
1995	4.8	18.5	14.4	9	10/1/94	269
1996	3.5	18.7	14.5	7	6/18/96	548
1997	5.8	22.6	17.6	12	2/21/97	368
1998	3.0	19.0	14.8	7	8/6/98	633
1999	2.3	17.6	13.7			

* Based on approximate drainage area of 17.5 square miles.

Low Flow Trend
Upper Rouge River @ Shiawassee Rd. (US3)



Average Flow Trend Upper Rouge River @ Shiawassee Rd. (US3)



Peak Flow Trend Upper Rouge River @ Shiawassee Rd. (US3)

