Appendix C:
Hydrologic and Hydraulic Analyses

Green and Barren Rivers Locks and Dams - Disposition Study

HYDROLOGY AND HYDRAULICS
APPENDIX B

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Green and Barren Rivers Locks and Dams - Disposition Study

HYDROLOGY AND HYDRAULICS
APPENDIX C

History

The Barren River, a tributary of the Green River, and the Green River, a tributary of the Ohio River, have been used for commercial navigation purposes since the mid 1700's. The first structural improvements to aid navigation were constructed in the 1830's with additional improvements built periodically since that time. Green River Lock and Dam 6 and Barren River Lock and Dam 1, were the most upstream in a series of navigation structures constructed from the mouth of Green River. Each project was constructed to maintain a minimum six foot navigation channel.

Green River Lock and Dam 1 - Original construction 1835-1840, new lock placed in operation June 18,1956
Green River Lock and Dam 2 - Old lock and dam rebuilt 1893-1895, new lock placed in operation May 25, 1956
Green River Lock and Dam 3 - Original construction 1833-1836
Green River Lock and Dam 4 - Original construction 1834-1839, dam was breached May 24, 1965 and closed to traffic
Green River Lock and Dam 5 - Old lock placed in operation January 17, 1900, new lock placed in operation December 22, 1934, deactivated August 31, 1951
Green River Lock and Dam 6 - Original construction 1904-1905, deactivated August 31, 1951
Barren River Lock and Dam 1 - Original construction 1841, new lock placed in operation September 17, 1934, closed to navigation with breach of Green River Lock and Dam 4

General Study Purpose

This report was prepared by the Louisville District, Corps of Engineers (COE) under the authority of Section 216 of the Flood Control Act of 1970. The intent of this analysis was to identify low flow duration and a range of frequency water surface elevations for existing conditions, with Green River Dams 3 through 6 and Barren River Dam 1 removed and various combinations of leave-in-place and removal alternatives.

Portions of the Green River valley subject to flooding by the Green and Barren Rivers are addressed in this appendix. The properties in the Green River and Barren River floodplain, although largely undeveloped at present, are inundated almost annually by floodwaters. These open areas are coming under increasing development pressures as the growth in the Green River valley progresses. However, usage during low flow periods, thereby lower water surface elevations, are also addressed in this appendix and may be more germane to this study.

Basin Characteristics

The headwaters of the Green River begin in central Kentucky in Lincoln County and generally flow westward for 370 miles to its confluence with the Ohio River at river mile 784. In the headwater area, the stream slope is about four feet per mile and drops to a gradient of about 0.25 feet per mile in the extreme lower reaches of the stream. The overall average stream slope is about two feet per mile.

Major tributaries of the Green River include Rough, Barren, and Nolin Rivers, all located in the south central portion of the state. The total drainage area of the Green River basin is 9,230 square miles.

The headwaters of the Barren River begin in north central Tennessee and generally flow northwestward for approximately 140 miles to its confluence with Green River at river mile 149.5. In the headwater area, the stream slope is about three feet per mile and drops to a gradient of about one foot per mile in the extreme lower reaches of the stream. The overall average stream slope is about 1.6 feet per mile.

Pertinent drainage areas within the study limits are shown in Table 1. A significant amount of karst topography lies within the Green River drainage basin and does not contribute directly to surface runoff.

TABLE 1

GREEN RIVER BASIN DRAINAGE AREAS

STREAM AND LOCATION	MILES ABOVE MOUTH	DRAINAGE AREA (Square Miles)	
Green River at Green River Lake	305.7	682	(0.6)
Green River at Munfordsville	225.9	1,673	(176)
Green River at Mammoth Cave	197.2	1,983	(444)
Green River above Nolin River	183.5	2,031	(463)
Nolin River at Nolin River Lake	7.8	703	(223)
Nolin River at Kyrock	7.4	707	(223)
Nolin River at mouth	0.0	727	(223)
Green River including Nolin River	183.5	2,758	(686)
Green River at Brownsville at Lock and Dam 6	181.7	2,762	(687)
Green River at Naker / Glenmore at Lock and Dam 5	168.1	3,001	(697)
Green River above Barren River	149.5	3,140	(703)
Barren river at Barren River Lake	79.2	942	(77)
Barren River at Bowling Green	37.6	1,849	(487)
Barren River at Greencastle at Lock and Dam 1	15.0	1,968	(568)
Barren River at mouth	0.0	2,264	(656)
Green River including Barren River	149.5	5,404	(1,359)
Green River at Woodbury at Lock and Dam 4	149.1	5,404	(1,359)
Green River at Rochester at Lock and Dam 3	108.5	6,142	(1,380)
Green River above Rough River	71.3	6,431	(1,401)
Rough River at Rough River Lake	89.4	454	(107)
Rough River at mouth	0.0	1,081	(134)
Green River including Rough River	71.3	7,512	(1,534)
Green River at Calhoun at Lock and Dam 2	63.3	7,566	(1,534)
Green River including Pond River	55.1	8,423	(1,568)
Green River at Spottsville at Lock and Dam 1	9.1	9,183	(1,576)
Green River at mouth	0.0	9,230	(1,576)

( ) non-contributing drainage area - karst topography

Historic Floods

Generally, the Green River basin flood season extends from early winter through late spring. High water occurs almost annually in the Green River basin and in many years multiple flood events have been observed. Highwater marks were set for a number of floods since 1913 with the January 1937 and the March 1962 events being major floods in the study reach. Plates 1 through 3 show selected Green River highwater profiles of a number of floods in the basin. Plate 4 presents selected Barren River highwater profiles and Plate 5 presents selected Nolin River highwater profiles. (It should be noted that the highwater profiles were last revised in 1972).

Projects Affecting the Study Area

A system of flood control reservoirs were constructed by the U.S. Army Corps of Engineers on the Green River and three of its main tributaries to reduce flood damage in the basin. These projects, the drainage area they control and the date they were put into operation are as follows:

Rough River Lake, 454 square miles, (December 1960)
Nolin River Lake, 703 square miles, (March 1963)
Barren River Lake, 942 square miles, (May 1964)
Green River Lake, 682 square miles, (February 1969)

It is estimated that Nolin and Green River Lakes would combine to reduce a flood equal to that of January 1937 by about 9 feet at Lock 6, Brownsville, Kentucky, and all four Corps projects would combine for an estimated 2.3 foot reduction at Lock 2, Calhoun, Kentucky. Significant flood reductions will dissipate downstream of Lock 2 at a point where the contributing influence of the Ohio River backwater dominates.

Gaged Flow Data

Numerous U.S. Geological Survey (USGS) gaging stations have been maintained in the study reach of the Green and Barren Rivers. The USGS gaging stations records provided stage and discharge data. Flood peak data were extracted from the period of record for each gaging station and were the basis for computing the percent chance exceedence flood events presented in this report. Table 2 lists the period of record observed annual peaks for the available gaging stations. These data are actual recorded peak values and not homogeneous as they contain both natural and modified (pre and post Green, Nolin, Barren and Rough River Lakes) values. Funding to keep gaging stations in operation is limited and is reflected in discontinuance at several sites.

TABLE 2

ANNUAL PEAKS - DISCHARGE AND STAGE

GREEN RIVER AT MUNFORDVILLE, KY.

Drainage Area = 1,673 sq. mi. Gage Datum = 451.70 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
1/__/13	67,000	54.00	2/1/57	31,600	36.94
12/19/15	39,500	40.80	11/21/57	36,500	39.40
1/7/17	31,400	35.60	1/23/59	23,000	31.34
1/31/18	28,500	33.20	11/28/59	13,500	21.17
1/3/19	31,500	35.70	3/1/61	18,400	26.91
1/11/20	36,300	39.50	3/1/62	76,800	57.72
3/11/21	23,000	18.20	3/8/63	23,500	31.86
3/25/22	21,400	26.70	3/11/64	43,900	42.95
12/10/24	37,800	40.00	3/31/65	25,400	33.33
1/24/26	19,200	24.60	2/15/66	15,900	24.16
2/24/27	37,000	39.60	3/8/67	33,700	37.83
6/11/28	24,100	29.20	4/6/68	37,700	39.83
3/1/29	26,800	31.50	*4/19/69*	*12,700*	*20.14*
2/6/1930	16,300	21.80	*4/3/70*	*24,500*	*32.70*
3/30/31	12,000	17.45	*12/23/70*	*17,900*	*26.31*
1/31/32	37,600	39.90	*2/26/72*	*23,800*	*32.08*
1/24/33	31,600	35.70	*12/10/72*	*25,000*	*33.10*
3/6/34	30,900	35.10	*1/12/74*	*45,000*	*43.48*
1/22/35	44,900	43.40	*3/14/75*	*49,500*	*45.76*
3/28/36	23,400	28.50	*3/31/76*	*21,500*	*29.98*
1/23/37	60,000	50.40	*3/13/77*	*18,300*	*26.75*
3/7/38	15,600	22.40	*12/6/77*	*21,300*	*29.81*
2/6/39	30,100	34.50	*12/10/78*	*61,500*	*51.89*
4/2/40	21,700	28.60	*6/8/81*	*22,200*	*30.58*
7/20/41	15,300	23.03	*9/3/82*	*23,500*	*31.75*
4/11/42	19,800	27.74	*5/17/83*	*31,500*	*36.60*
1/1/43	40,500	41.20	*5/8/84*	*65,300*	*53.78*
4/14/44	20,300	28.49	*11/20/84*	*18,600*	*27.04*
1/3/45	36,100	38.65	*2/18/86*	*14,700*	*22.62*
1/10/46	19,600	27.24	*3/1/87*	*23,400*	*31.73*
5/23/47	21,000	28.41	*1/21/88*	*18,500*	*27.90*
4/15/48	43,700	42.42	*2/16/89*	*44,700*	*43.00*
2/17/49	45,900	43.34	*2/5/90*	*28,100*	*32.16*
1/8/50	42,900	42.45	*12/19/90*	*27,500*	*31.01*
1/16/51	22,400	30.78	*12/4/91*	*20,300*	*27.30*
3/25/52	56,100	48.31	*2/22/93*	*13,300*	*20.07*
5/21/53	23,300	31.67	*3/11/94*	*35,000*	*39.64*
4/18/54	16,800	25.08	*5/20/95*	*34,400*	*39.18*
03/24/55	35,000	38.64	*12/8/96*	*16,200*	*23.14*
2/20/56	36,300	39.29	*3/3/97*	*40,600*	*43.30*

TABLE 2 (Continued)

GREEN RIVER AT MUNFORDVILLE, KY. (Continued)

Drainage Area = 1,673 sq. mi. Gage Datum = 451.70 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
4/17/98	*22400*	*28.5*	*12/1/04*	*20300*	*25.27*
1/10/99	*23200*	*29.16*	*9/24/06*	*21500*	*27.68*
3/21/00	*18700*	*25.01*	*1/8/07*	*15500*	*21.50*
12/17/00	*17300*	*23.45*	*4/5/08*	*24800*	*30.50*
3/21/02	*22200*	*28.29*	*1/29/09*	*27200*	*32.65*
2/17/03	*27700*	*32.99*	*5/4/10*	*56900*	*51.88*
2/7/04	*22600*	*28.66*	*4/13/11*	*29700*	*34.68*

Green River Lake placed in operation beginning February 1969

GREEN RIVER AT MAMMOTH CAVE, KY.

Drainage Area = 1,983 sq. mi. Gage Datum = 420.52 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
1913	----	50.5	1/2/43	41,700	38.1
1935	51,600	42.6	4/14/44	21,600	24.5
3/28/36	23,400	26.5	1/4/45	35,700	34.6
1/24/37	75,000	52.0	2/16/46	20,200	23.4
3/7/38	15,300	19.8	5/23/47	20,100	23.3
2/6/39	29,800	31.7	4/16/48	45,200	40.1
4/4/40	20,000	23.5	2/18/49	51,400	43.0
7/21/41	15,200	19.2	1/9/50	49,200	42.0
4/12/42	21,300	24.3		Discontinued	

Green River Lake placed in operation beginning February 1969

TABLE 2 (Continued)

NOLIN RIVER AT KYROCK, KY.

Drainage Area = 703 sq. mi. Gage Datum = 400.0(NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
4/27/31	3,390		*3/6/77*	*5,680*	
1/30/32	22,700		*12/27/77*	*7,860*	
3/3/40	10,500		*12/26/78*	*11,200*	
7/19/41	4,540		*10/18/79*	*7,160*	
4/9/42	7,360		*5/26/81*	*4,380*	
3/20/43	8,800		*9/9/82*	*7,180*	
4/11/44	6,820		*5/27/83*	*10,300*	
3/1/45	10,600		*5/21/84*	*8,480*	
2/15/46	8,850		*1/21/85*	*10,000*	
1/2/47	8,940		*12/2/85*	*4,650*	
2/13/48	14,700		*12/12/86*	*4,950*	
2/17/49	11,700		*1/8/88*	*4,970*	
12/13/49	13,600		*3/17/89*	*10,100*	
5/9/61	12,600	43.95	*2/27/90*	*8,710*	
2/27/62	12,600	59.27	*1/26/91*	*7660*	*37.23*
3/23/63	*9,120*	*38.27*	*7/8/92*	*5,860*	*34.82*
3/26/64	*9,620*	*40.06*	*2/27/93*	*5,020*	*33.89*
12/1/64	*13,100*	*42.70*	*3/5/94*	*6030*	*42.93*
2/25/66	*5,640*	*32.91*	*6/1/95*	*7290*	*43.05*
5/23/67	*6,980*	*39.17*	*6/18/96*	*4260*	*32.37*
6/5/68	*5,520*	*41.19*	*3/27/97*	*6910*	*49.52*
2/5/69	*4,790*	*33.70*	*1/13/98*	*4010*	*32.22*
5/7/70	*8,220*	*39.58*	*2/5/99*	*4230*	*29.21*
3/24/71	*9,540*	*38.37*	*2/26/00*	*3660*	*29.05*
3/13/72	*9,990*	*41.40*	*2/22/01*	*5440*	*28.87*
7/24/73	*6,200*	*36.60*	*5/1/02*	*5480*	*29.05*
12/6/73	*10,100*		*5/12/03*	*6200*	*34.94*
4/7/75	*8,420*		*6/9/04*	*7560*	*37.2*
3/3/76	*6,790*			Discontinued	

Nolin River Lake placed in operation beginning March 1963

TABLE 2 (Continued)

GREEN RIVER AT LOCK 6, BROWNSVILLE, KY.

Drainage Area = 2,762 sq. mi. Gage Datum = 413.03 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
1/20/07	34,000	25.3	1/9/50	55,900	33.40
2/16/08	28,000	20.0	3/25/52	66,900	37.15
2/26/09	45,900	31.2	5/20/53	32,500	22.85
6/13/10	31,000	22.0	4/19/54	20,400	16.57
5/2/11	49,400	32.6	3/26/55	38,100	27.82
4/4/12	34,800	26.0	2/3/56	44,000	30.10
1/10/13	103,000	42.8	2/2/57	38,000	27.52
5/7/14	30,600	21.8	11/21/57	55,300	34.15
2/3/15	33,200	24.4	1/24/59	33,700	23.48
12/19/15	51,300	33.0	1/16/60	19,000	16.05
1/7/17	38,600	27.1	3/8/61	32,900	23.07
1/31/18	29,800	21.1	3/2/62	90,200	41.85
1/4/19	61,000	35.6	*3/8/63*	*27,200*	*19.84*
1/11/20	52,900	33.2	*3/12/64*	*46,300*	*30.6*
4/2/21	19,100	16.1	*3/31/65*	*32,700*	*22.96*
2/23/22	33,200	23.6	*2/14/66*	*18,900*	*16.02*
2/5/23	42,100	29.0	*3/9/67*	*35,700*	*25.04*
1/5/24	36,800	26.2	*4/7/68*	*39,300*	*26.95*
12/11/24	39,000	27.4	*4/20/69*	*16,200*	*15.12*
1/24/26	34,000	24.0	*4/4/70*	*27,200*	*19.82*
1/24/27	55,700	34.3	*12/24/70*	*21,700*	*17.20*
6/11/28	32,900	23.4	*2/27/72*	*30,500*	*21.77*
2/28/29	32,600	23.1	*12/11/72*	*30,200*	*22.63*
2/6/30	23,200	17.6	*1/13/74*	*48,500*	*31.50*
3/30/31	12,000	14.2	*3/15/75*	*53,000*	*33.12*
2/1/32	47,700	30.8	*3/31/76*	*26,100*	*20.12*
1/24/33	35,900	25.6	*3/14/77*	*20,600*	*17.05*
3/6/34	32,900	23.1	*1/27/78*	*25,500*	*19.66*
1/23/35	55,000	33.7	*12/11/78*	*70,100*	*37.26*
4/9/36	29,300	20.8	*12/15/79*	*26,500*	*20.37*
1/24/37	120,000	44.94	*6/9/81*	*26,000*	*20.00*
3/16/38	19,400	16.20	*9/4/82*	*24,800*	*19.24*
2/3/39	35,600	26.10	*5/19/83*	*37,000*	*26.44*
4/22/40	25,100	18.48	*5/9/84*	*73,000*	
7/20/41	17,700	15.83	*11/20/84*	*20,900*	*17.16*
4/11/42	26,400	19.55	*2/19/86*	*18,400*	
3/22/43	45,500	29.13	*3/2/87*	*28,800*	*21.81*
4/13/44	25,900	19.16	*1/21/88*	*23,000*	*18.32*
3/8/45	39,800	26.00	*2/17/89*	*59,500*	*34.03*
2/16/46	28,700	20.28	*2/6/90*	*31,100*	*21.92*
1/5/47	25,600	18.75	*2/20/91*	*31,100*	*21.96*
4/16/48	47,800	30.65		Discontinued	
2/18/49	57,000	33.74			

Green River Lake placed in operation beginning February 1969 and Nolin River Lake placed in operation beginning March 1963.

TABLE 2 (Continued)

BARREN RIVER NEAR FINNEY, KY.

Drainage Area = 940 sq. mi. Gage Datum = 400.00 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
4/10/42	16,400	96.50	*2/4/74*	*4,980*	*87.98*
12/31/42	23,500	99.50	*4/6/75*	*6,360*	*90.24*
3/1/44	20,500	98.33	*2/4/76*	*5,080*	*88.11*
1/1/45	49,400		*3/2/77*	*8,160*	*88.20*
1/8/46	43,800		*12/14/77*	*4,590*	*88.01*
5/22/47	17,900	97.18	*1/30/79*	*7,150*	*91.00*
2/14/48	51,800		*2/7/80*	*5,220*	*87.75*
6/17/49	42,800		*6/19/81*	*3,250*	*87.10*
1/6/50	38,700		*3/9/82*	*3,950*	*92.95*
6/16/61	14,100	95.75	*5/24/83*	*4,380*	*86.98*
2/27/62	78,000		*12/11/83*	*5,000*	*87.86*
3/14/63	8,460	91.84	*11/18/84*	*4,030*	*86.77*
3/10/64	*7,410*	*90.68*	*2/27/86*	*3,560*	*85.61*
12/7/64	*5,440*	*88.20*	*12/11/86*	*4,540*	*87.21*
1/10/66	*4,590*	*86.98*	*1/27/88*	*3,990*	*86.50*
3/23/67	*6,080*	*89.20*	*4/12/89*	*5,130*	*87.75*
12/2/67	*3,420*	*85.69*	*2/10/90*	*4,890*	*87.20*
2/14/69	*3,690*	*85.70*	*3/22/91*	*5,340*	*87.83*
5/8/70	*4,140*	*86.97*	*1/7/92*	*4,170*	*86.18*
3/6/71	*4,300*	*87.11*	*2/23/93*	*3,290*	*84.86*
2/28/72	*6,060*	*89.18*	*4/11/94*	*7,470*	*90.66*
5/10/73	*4,860*	*87.85*		Discontinued	

Barren River Lake placed in operation beginning March 1964

TABLE 2 (Continued)

BARREN RIVER AT BOWLING GREEN, KY.

Drainage Area = 1,848 sq. mi. Gage Datum = 409.83 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
1/8/13		52.20	*2/14/66*	*12,700*	*21.82*
1937		46.00	*3/7/67*	*22,700*	*29.61*
8/2/38	22,500	28.80	*4/5/68*	*29,000*	*33.65*
2/5/39	27,600	32.00	*6/24/69*	*59,000*	*41.67*
4/2/40	20,600	27.37	*12/30/69*	*23,300*	*29.37*
7/5/41	11,900	20.40	*8/4/71*	*11,400*	*20.56*
4/11/42	23,000	29.10	*1/29/72*	*19,400*	*26.24*
3/21/43	32,300	34.70	*12/10/72*	*19,600*	*29.37*
3/1/44	26,100	31.10	*1/11/74*	*29,900*	*29.37*
1/2/45	51,100	39.40	*3/13/75*	*62,400*	*29.37*
1/10/46	38,800	36.30	*3/30/76*	*22,500*	*28.76*
5/23/47	20,000	27.01	*3/5/77*	*18,400*	*25.73*
2/15/48	53,000	39.82	*12/6/77*	*17,500*	*25.50*
6/18/49	35,000	35.10	*12/9/78*	*48,900*	*39.47*
1/7/50	51,600	39.65	*12/14/79*	*19,400*	*26.57*
2/14/51	21,800	28.52	*6/7/81*	*21,400*	*27.76*
3/24/52	77,400	44.63	*2/10/82*	*14,000*	*23.69*
5/20/53	19,500	26.93	*5/20/83*	*42,000*	*37.04*
4/19/54	19,200	26.50	*5/8/84*	*41,400*	*37.15*
3/23/55	55,100	40.46	*11/19/84*	*16,300*	*24.38*
2/19/56	38,000	36.73	*2/18/86*		*20.91*
1/30/57	66,100	42.07	*3/1/87*	*20,400*	*28.12*
11/20/57	30,700	34.32	*1/20/88*	*17,600*	*26.14*
1/23/59	21,300	28.06	*2/22/89*	*35,400*	*34.02*
6/29/60	19,400	26.35	*2/4/90*	*28,000*	*31.34*
6/16/61	19,200	26.65	*12/23/90*	*23,900*	*30.86*
2/28/62	85,000	49.55	*12/3/91*	*24,200*	*29.64*
3/6/63	18,300	25.96	*2/22/93*	*8,290*	*16.12*
3/11/64	*24,000*	*30.04*	*4/12/94*	*32,300*	*33.24*
2/12/65	*20,200*	*26.88*		Discontinued	

Barren River Lake placed in operation beginning March 1964

TABLE 2 (Continued)

GREEN RIVER AT LOCK 4, WOODBURY, KY.

Drainage Area = 5,403 sq. mi. Gage Datum = 389.17 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
1/11/13		38.50	*3/31/65*	*54,000*	*25.69*
1/25/37	205,000	43.10	*3/14/66*	*38,700*	*17.88*
8/2/38	39,900	20.20	*3/7/67*	*55,300*	*24.54*
2/6/39	66,200	29.30	*4/7/68*	*60,400*	*26.49*
4/22/40	44,600	21.60	*6/25/69*	*56,500*	*24.60*
7/19/41	22,500	13.12	*4/3/70*	*48,900*	*22.22*
4/12/42	48,700	23.05	*12/23/70*	*37,500*	*18.17*
3/23/43	73,700	30.16	*1/29/72*	*45,400*	*21.71*
3/3/44	46,800	21.54	*12/11/72*	*50,600*	*23.88*
1/4/45	74,100	29.30	*1/13/74*	*72,300*	*29.72*
1/12/46	53,000	24.79	*3/15/75*	*86,100*	*42.15*
1/5/47	45,800	21.88	*3/31/76*	*49,500*	*22.46*
2/17/48	87,400	31.30	*3/6/77*	*43,800*	*19.82*
2/18/49	72,700	30.65	*1/27/78*	*45,000*	
1/8/50	84,900	33.07	*12/11/78*	*102,000*	*34.07*
1/17/51	58,600	27.02	*12/15/79*	*45,300*	*21.19*
3/26/52	106,000	34.20	*6/8/81*	*44,800*	*20.71*
5/21/53	51,700	24.90	*1/24/82*	*40,900*	*19.00*
4/19/54	34,900	19.35	*5/21/83*	*70,700*	*29.62*
3/25/55	72,000	31.25	*5/9/84*	*101,000*	*34.15*
2/21/56	65,800	30.55	*11/20/84*	*39,000*	*27.74*
2/1/57	77,400	30.88	*2/19/86*	*36,000*	*25.68*
11/21/57	80,500	31.81	*3/2/87*	*51,700*	*33.38*
1/24/59	48,700	23.66	*1/22/88*	*49,500*	*30.25*
7/1/60	36,800	19.87	*2/17/89*	*92,300*	*42.95*
3/9/61	52,600	25.68	*2/5/90*	*53,400*	*33.72*
2/2/62	161,000	37.94	*12/20/90*	*51,900*	*34.66*
3/7/63	*41,300*	*21.35*	*12/4/91*	*45,600*	*31.20*
3/11/64	*69,800*	*30.15*		Discontinued	

Green River Lake placed in operation beginning February 1969, Nolin River Lake placed in operation beginning March 1963 and Barren River Lake placed in operation beginning March 1964.

TABLE 2 (Continued)

GREEN RIVER AT PARADISE, KY.

Drainage Area = 6,182 sq. mi. Gage Datum = 363.19 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
4/22/40	42,500		*4/2/76*	*46,000*	*26.16*
1/27/41	20,800		*3/7/77*	*38,200*	*23.86*
4/14/42	45,600		*1/29/78*	*44,000*	*24.96*
3/25/43	63,300		*12/13/78*	*75,700*	*36.01*
3/4/44	40,100		*12/16/79*	*39,700*	*25.94*
3/7/45	63,200		*6/9/81*	*40,100*	*23.62*
1/13/46	46,000		*12/6/91*	*39,700*	*22.81*
1/7/47	40,900		*3/5/93*	*25,500*	*17.02*
2/20/48	60,400		*3/14/94*	*46,800*	*28.14*
2/23/49	72,200		*5/23/95*	*48,800*	*30.15*
1/14/50	89,300		*3/9/96*	*31,600*	*20.86*
3/11/61	52,400	31.55	*3/7/97*	*86,300*	*37.63*
3/5/62	107,000	40.46	*6/12/98*	*39000*	*22.46*
3/8/63	*43,500*	*27.73*	*1/26/99*	*51200*	*26.92*
3/12/64	*65,400*	*55.67*	*2/19/00*	*29400*	*17.85*
4/1/65	*58,100*	*30.18*	*2/18/01*	*34200*	*19.62*
2/15/66	*38,900*	*24.23*	*3/23/02*	*44600*	*25.04*
3/11/67	*52,700*	*28.59*	*2/21/03*	*42700*	
4/9/68	*56,700*	*30.27*	*2/9/04*	*41400*	*22.25*
6/27/69	*53,400*	*28.11*	*9/1/05*	*40800*	*21.11*
4/5/70	*43,400*	*26.38*	*1/26/06*	*35600*	*19.85*
2/24/71	*41,100*	*25.88*	*1/9/07*	*33500*	*18.6*
2/27/72	*46,300*	*27.73*	*4/7/08*	*50100*	*27.78*
12/12/72	*46,200*	*28.30*	*2/1/09*	*47800*	*24.21*
1/14/74	*59,300*	*31.88*	*5/8/2010*	*61600*	*35.01*
3/17/75	*65,700*	*33.66*	*4/30/2011*	*54800*	*31.12*

Green River Lake placed in operation beginning February 1969, Nolin River Lake placed in operation beginning March 1963 and Barren River Lake placed in operation beginning March 1964.

TABLE 2 (Continued)

ROUGH RIVER AT FALLS OF ROUGH, KY.

Drainage Area = 504 sq. mi. Gage Datum = 420.94 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
1/12/13		28.96	*2/22/71*	*4,750*	*21.84*
3/29/05		28.93	*2/24/72*	*4,770*	*21.87*
03/00/35		29.31	*12/8/72*	*4,100*	*20.48*
1/25/37		34.06	*1/11/74*	*3,480*	*18.42*
2/16/49	11,400	28.20	*3/29/75*	*4,020*	*20.20*
1/14/50	12,400	28.87	*1/26/76*	*3,080*	*16.84*
1/16/51	10,900	27.85	*3/4/77*	*3,280*	*17.62*
3/23/52	11,600	28.32	*12/5/77*	*5,400*	*22.76*
3/5/53	8,060	25.95	*12/4/78*	*5,440*	*22.82*
4/16/54	3,000	17.06	*1/30/80*	*3,740*	*19.24*
3/23/55	7,140	25.08	*5/19/81*	*3,770*	*19.34*
2/4/56	8,840	26.49	*2/9/82*	*3,360*	*17.91*
5/24/57	10,500	27.59	*5/3/83*	*6,000*	*23.01*
11/19/57	4,900	24.38	*5/7/84*	*5,850*	*23.47*
1/21/59	6,620	24.52	*12/21/84*	*4,040*	*20.19*
1/15/60	*4,130*	*20.38*	*2/2/86*	*3,100*	*16.92*
5/8/61	*5,130*	*21.44*	*2/28/87*	*2,840*	*15.90*
2/27/62	*3,230*	*16.78*	*1/20/88*	*5,250*	*22.52*
3/5/63	*4,170*	*19.67*	*2/14/89*	*6,150*	*23.92*
3/9/64	*8,320*	*26.13*	*2/16/90*	*7,890*	*25.64*
12/11/64	*2,730*	*15.59*	*12/18/90*	*5,030*	*21.47*
2/10/66	*3,660*	*18.20*	*3/19/92*	*3,470*	*17.42*
5/14/67	*5,620*	*22.69*	*5/4/93*	*3,310*	*17.03*
4/4/68	*4,160*	*18.84*	*2/4/94*	*2,800*	*15.00*
4/18/69	*3,910*	*18.35*		Discontinued	
4/2/70	*4,020*	*20.45*			

Rough River Lake placed in operation beginning October 1959.

TABLE 2 (Continued)

GREEN RIVER AT LOCK 2, CALHOUN, KY.

Drainage Area = 7,564 sq. mi. Gage Datum = 353.95 (NGVD)

Date	Discharge in CFS	Stage in Feet	Date	Discharge in CFS	Stage in Feet
1913		36.8	*2/24/71*	*41,000*	*26.30*
4/27/31	28,100	15.4	*3/1/72*	*45,000*	*27.87*
2/6/32	80,000	32.2	*12/14/72*	*45,700*	*28.30*
1/30/33	59,100	29.4	*1/18/74*	*54,500*	*30.01*
3/10/34	51,100	27.1	*3/20/75*	*58,700*	*31.14*
4/7/35	73,300	32.9	*4/2/76*	*46,300*	*27.57*
4/15/36	53,000	30.1	*3/7/77*	*40,800*	*22.97*
1/27/37	208,000	43.7	*1/30/78*	*42,600*	*25.37*
8/4/38	44,500	25.1	*12/15/78*	*73,800*	*32.47*
2/11/39	72,900	32.9	*12/17/79*	*43,800*	*26.36*
4/25/40	49,300	29.2	*6/11/81*	*40,000*	*23.05*
1/27/41	23,600	14.1	*1/26/82*	*40,000*	*23.55*
4/15/42	46,400	27.3	*5/5/83*	*62,000*	*31.48*
3/27/43	67,600	32.3	*5/14/84*	*78,200*	*32.40*
4/17/44	40,100	25.6	*12/22/84*	*43,600*	
3/8/45	70,900	33.6	*2/21/86*	*32,800*	*20.01*
2/19/46	51,700	29.2	*3/4/87*	*44,300*	*23.99*
1/8/47	41,200	24.3	*1/24/88*	*48,000*	*22.87*
2/22/48	57,000	30.3	*2/21/89*	*80,000*	*33.37*
2/24/49	71,300	32.3	*2/15/90*	*51,500*	*29.42*
1/16/50	86,300	36.3	*12/26/90*	*50,900*	*29.84*
1/21/51	63,400	32.0	*12/6/91*	*40,500*	*20.56*
3/31/52	72,000	32.5	*3/5/93*	*32,000*	*19.31*
5/26/53	48,000	28.5	*3/15/94*	*45,300*	*27.54*
4/21/54	36,900	20.4	*5/23/95*	*53,400*	*29.66*
3/29/55	66,800	32.2	*3/9/96*	*38,500*	*24.00*
2/25/56	67,000	32.6	*3/7/97*	*86,000*	*34.37*
2/8/57	54,600	30.7	*4/21/98*	*44200*	*23.91*
11/27/57	59,600	31.1	*1/27/99*	*49300*	*27.47*
1/27/59	42,200	28.2	*2/21/00*	*31900*	*21.83*
7/3/60	*41,400*	*22.65*	*2/19/01*	*38000*	*19.43*
3/12/61	*52,700*	*30.52*	*3/23/02*	*47800*	*27.01*
2/8/62	*106,000*	*33.97*	*2/24/03*	*48500*	*27.93*
3/18/63	*42,600*	*28.93*	*2/9/04*	*40700*	*22.16*
3/13/64	*80,300*	*33.96*	*12/11/04*	*41100*	*20.91*
4/3/65	*47,800*	*28.87*	*1/26/06*	*37200*	*20.43*
2/15/66	*39,700*	*25.23*	*1/10/07*	*35100*	*22.19*
3/13/67	*44,900*	*28.81*	*4/8/08*	*53000*	*28.56*
4/11/68	*50,000*	*28.25*	*2/2/09*	*45700*	*24.51*
6/27/69	*46,900*	*24.09*	*5/9/10*	*70400*	*31.46*
4/6/70	*42,100*	*26.63*	*5/4/11*	*76900*	*34.04*

Green River Lake placed in operation beginning February 1969, Nolin River Lake placed in operation beginning March 1963, Barren River Lake placed in operation beginning March 1964 and Rough River Lake placed in operation beginning October 1959.

Climate Data

The National Oceanic and Atmospheric Administration Weather Service (NOAA) maintains year round surveillance of weather conditions for the study area at its various climate collection stations. Flood warning and anticipated weather conditions are issued to city / county officials, radio / television stations and the local press for further dissemination to the residents of the area.

Similar to the USGS stream gaging program, funding is limited and some climate stations have been discontinued in recent years. However, new technology such as NEXRAD radar provides rainfall information for the predicting of anticipated flooding, but the historic preservation of this information is still in the developmental stage.

The NOAA climate stations at Bowling Green, Ky. and Henderson, Ky. are near the study extremes and were selected as being representative of the study reach. The following temperature and precipitation data was extracted from the Midwestern Climate Center Internet web site.

a. Recorded Temperature Data

The climate within the study area varies with moderately warm summers and cool winters with an average temperature of about 36 degrees Fahrenheit in the winter and 76 degrees Fahrenheit in the summer.

Bowling Green, Kentucky (Averages: 1961-1990 Extremes: 1893-1996)

	Averages			Daily Extremes				Mean Extremes			
	Max	Min	Mean	High	Date	Low	Date	High	Year	Low	Year
Annual	67.5	46.0	56.8	113	7/28/30	-21	1/23/63	62.7	1921	55.0	1958
Winter	45.4	26.4	36.0	83	2/28/18	-21	1/23/63	47.7	1932	28.3	1978
Spring	68.0	45.4	56.7	100	5/28/11	-6	3/5/60	62.9	1921	51.5	1960
Summer	87.1	65.1	76.1	113	7/28/30	39	6/13/03	82.4	1936	73.0	1967
Fall	69.6	47.0	58.3	105	9/7/25	-7	11/25/50	66.7	1931	52.9	1976

Henderson, Kentucky (Averages: 1961-1990 Extremes: 1896-1996)

	Averages			Daily Extremes				Mean Extremes			
	Max	Min	Mean	High	Date	Low	Date	High	Year	Low	Year
Annual	67.3	46.4	56.9	113	7/13/36	-20	1/19/94	67.0	1931	55.0	1947
Winter	44.1	26.3	35.2	80	2/13/62	-20	1/19/94	45.4	1932	26.7	1936
Spring	68.0	46.2	57.1	97	5/31/34	-4	3/6/60	61.7	1977	51.7	1960
Summer	87.2	65.1	76.2	113	7/13/36	41	6/2/56	84.1	1936	72.7	1946
Fall	69.9	48.0	59.0	104	9/8/39	-5	11/25/50	65.3	1931	53.5	1976

b. Recorded Precipitation Data

The rainfall within the study area is generally evenly distributed throughout the year with extremes, maximum or minimums, occurring during any season of any given year.

Bowling Green, Kentucky (Averages: 1961-1990 Extremes: 1893-1996)

	Total Precipitation							Snow		
	Mean	High	Year	Low	Year	1-Day Max	Date	Mean	High	Year
Annual	50.93	76.56	1979	30.50	1930	11.02	4/29/37	12.8	49.8	1960
Winter	12.98	30.12	1950	5.45	1963	6.15	12/7/24	11.0	34.7	1978
Spring	14.36	25.58	1983	5.87	1900	11.02	4/29/37	1.4	32.0	1960
Summer	12.42	19.56	1938	5.22	1952	5.69	6/23/69	0.0	0.0	-
Fall	11.17	22.39	1921	2.82	1963	6.02	9/13/79	0.4	8.0	1966

Henderson, Kentucky (Averages: 1961-1990 Extremes: 1896-1996)

	Total Precipitation							Snow		
	Mean	High	Year	Low	Year	1-Day Max	Date	Mean	High	Year
Annual	44.80	71.01	1950	28.25	1963	6.33	3/11/35	15.9	39.5	1978
Winter	9.80	28.22	1950	3.68	1977	4.28	12/30/32	12.4	35.5	1985
Spring	13.62	27.27	1983	4.61	1941	6.33	3/11/35	2.8	21.5	1960
Summer	11.05	19.00	1950	2.13	1936	5.02	7/10/65	0.0	0.0	-
Fall	10.33	22.43	1984	2.47	1963	4.72	9/24/84	0.7	8.5	1958

Hydrologic and Hydraulic Analysis

This report will provide current modified (indicating the benefits of the upstream COE lake operation) flood frequency and flow duration profiles for the Green River and Barren River study reach from which water surface elevations could be used as the basis of further analysis. To develop water surface profiles two main elements are required. Frequency or duration discharge values must be developed and the stream physical geometry must be established to which the flow values will be applied.

a. Development of Flood Frequency Discharges.

Natural peak discharge-frequency values for the Green River and Barren River were developed from period of record data for gaged locations on the respective streams. Data modified by operational periods for Green, Nolin, Barren, and Rough River Lakes were returned to natural conditions and included in the natural data analyses.

Final existing condition (modified) discharge-frequency curves were developed through paper operation, October, 1939 through September, 1980 for the four lake projects. Resultant lake holdouts (developed from 12-hour storage differences in each lake) were routed through each gage location to determine the modified peak discharge events. The final modified discharge-frequency values for the Green River and Barren River study reach were based on the "paper operation" period and actual lake operation period. Pertinent discharge values were selected from the relationship developed using these gages. Determination of the final frequency-

discharge relationships were made using Bulletin No. 17B criterion and considered omission of low and high outliers, weighting with a generalized skew, and historically adjusting the data where possible.

The flood frequency discharges for the USGS gages located at Paradise, Munfordville, Calhoun, and Kyrock, Kentucky were updated from the original report to include the latest available annual peak flow data from USGS. As all of the other gages in the study area were discontinued prior to 1997, they did not require an update. While the inclusion of these extra data points did alter the flood frequency discharges at all four gages, none were changed by more than 5%. Because of this, it was determined that an update of the hydraulic analysis using these discharges was not necessary, as significant changes to water surface elevations would not be expected. By the same logic, stage frequency curves would not be expected to change drastically and were not updated. The natural and modified discharge and stage frequency curves, and the record upon which they were based, are shown on Plates 6 through 21 for the USGS gaging stations within the study reach.

b. Surveyed Cross-Sections and Mapping

Surveyed natural cross-sections were obtained at uniform intervals from top of bank to top of bank; bridge geometry was field surveyed. Overbank areas were added to the surveyed data and additional cross-sections estimated using the best available mapping.

The best available mapping for the study area is USGS quadrangle sheets having a scale of 1"=2000' with 10-foot or 20-foot contour intervals. This large scale and contour interval together with estimated stream geometry below the map water surface, in some locations, limits the degree of accuracy presented as the final product.

c. Hydraulic Analyses

Analyses of the hydraulic characteristics for the streams studied were carried out to provide estimates of the water surface elevations of selected recurrence intervals.

Roughness coefficients (Manning's n) were developed from field inspection and known roughness values for comparable streams in adjacent watersheds. In addition, 1950, 1962, and 1974 flood highwater marks were reproduced in order to verify the roughness values for the Green River. Similarly, the 1957 flood highwater marks were used for Barren River. The present study used roughness coefficients ranging from 0.030-0.065 for the channel and 0.055-0.085 for overbanks (Green River) and 0.035-0.048 for the channel and 0.050-0.075 for overbanks (Barren River).

Water surface profiles of selected discharge magnitude, existing conditions and with various dams removed, were computed using the HEC-2 step-backwater computer program. The starting water surface elevations were computed by the slope/area method. Profiles were drawn showing the computed water surface elevations of the selected discharge values and are presented on Plates 22 through 30. The hydraulic analyses for this study are based on unobstructed flow. The water surface elevations shown on the profiles are thus considered valid

only if hydraulic structures remain unobstructed, operate properly, and do not fail. All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD).

During floods, debris collecting on bridges could decrease their carrying capacity and cause greater water depths (backwater effect) upstream of these structures. Since the occurrence and amount of debris are indeterminate factors, only the physical characteristics of the structures were considered in preparing selected water surface profiles. Similarly, the maps of flooded areas show the backwater effect of obstructive bridges and culverts, but do not reflect increased water surface elevation that could be caused by debris collection against the structures, or by deposition of silt in the stream channel under structures. None of the bridges in the study area are significantly restrictive to flows of the flows studied. However, the approaches to most of these bridges are at a low elevation and subject to flooding and therefore impassable. The Green River or the Barren River lock and dam structures have little or no effect on larger flood water surface profiles.

Water velocities during floods depend largely on the size and shape of the cross sections, conditions of the stream, and the bed slope, all of which vary on different streams and at different locations on the same stream.

d. Discharge / Elevation Duration

Flow duration is a measure of the range and variability of stream flows. Usually presented as a graph of volume flow rate (discharge in cubic feet pre second) versus percent of time that flows are greater than, or equal to, a selected flow during the period of record studied.

Duration curves were developed for the USGS gaging stations Green River at Munfordville, Brownsville at Lock 6, Woodbury at Lock 4, Calhoun at Lock 4, Nolin River at Kyrock and Barren River at Bowling Green. The period of record, modified by Green River, Barren River, Nolin River and Rough River Lakes, for each site was analyzed. Each mean daily discharge value was placed in ascending order, individual number of occurrences tabulated, then the percent of occurrence versus total days in the period of record was computed. Flow duration values for Green River Lock 6 were translated upstream to the Mammoth Cave gaging station and downstream from Bowling Green to the Barren River Lock 1 site by the drainage-area relationship method. Table 3 presents annual discharge duration values for the published USGS gaging stations within the study area.

TABLE 3

DISCHARGE DURATION
(IN CUBIC FEET PER SECOND)

ANNUAL

Gaging Station	Period of Record	Drainage Area (sq. mi.)	100 %	90 %	70 %	50 %	25 %	10 %	5 %	1 %
Munfordville	1970-1990	1,673	157	300	695	1,550	4,430	7,120	9,010	18,500
Kyrock	1964-1990	707	0*	43*	233	470	1,170	2,660	4,540	7,770
Brownsville	1964-1990	2,762	190	589	1,240	2,290	6,400	12,400	15,500	25,300
Bowling Green	1965-1990	1,849	75	288	719	1,990	4,310	6,040	7,100	12,500
Woodbury	1964-1990	5,404	356	1,130	2,580	5,200	12,800	22,600	29,200	48,200
Calhoun	1962-1990	7,566	455	1,390	3,250	6,490	16,700	31,100	39,400	52,500

TABLE 3 (Continued)

AUGUST

Gaging Station	Period of Record	Drainage Area (sq. mi.)	99 %	90 %	70 %	50 %	25 %	10 %	5 %	1 %
Munfordville	1970-1990	1,673	167	235	299	421	729	3,070	4,590	7,190
Kyrock	1964-1990	707	0*	12*	95	181	317	596	863	2,690
Brownsville	1964-1990	2,762	195	389	545	726	1,350	3,340	6,140	12,500
Bowling Green	1965-1990	1,849	93	163	242	410	978	3,110	3,800	5,550
Woodbury	1964-1990	5,404	360	719	1,040	1,500	3,070	6,320	8,980	21,600
Calhoun	1962-1990	7,566	449	850	1,200	1,880	3,810	6,880	10,900	21,500

(*) Minimum design outflow from Nolin River Lake is 50 cfs. However, special maintenance operations have required short periods of zero outflow and are reflected in these discharge duration computations.

Best-fit discharge versus water surface elevation rating curves were developed from USGS rating curves and/or the HEC-2 computer model for the Green River Lock 6, Mammoth Cave (at mile 197) and Nolin River at Kyrock sites. Estimated, existing condition and with Dam 6 removed, discharge versus water surface elevation rating curves are presented on Plates 31 through 33. Estimated flow duration water surface elevation profiles, existing condition and with various lock and dams in place and/or removed, are presented on Plates 23 through 30.

Annual elevation duration curves, (percent of time a selected water surface elevation is equaled or exceeded versus the selected water surface elevation) for the Green River Lock 6, Mammoth Cave (at mile 197) and Nolin River at Kyrock sites, are presented on Plates 34 through 36. Existing condition curves and with Green River dam 6 removed curves are shown on each Plate. In addition, discharge duration curves based on annual and August flows, are furnished for each published gaging station within the study reach on Plates 37 through 42.

Table 4 presents representative elevation duration values that can be derived from the Green River at Mammoth Cave duration curve.

TABLE 4

GREEN RIVER AT MAMMOTH CAVE - MILE 197

ELEVATION DURATION DATA

Percent of Time an Elevation is Equaled or Exceeded	Estimated Water Surface Elevation in Feet (NGVD) Existing Condition	Dam 6 Removed
100 %	421.4	417.1
90 %	422.3	418.9
80 %	423.0	420.2
70 %	423.9	421.6
60 %	425.1	423.1
50 %	426.7	425.2
40 %	429.1	427.9
30 %	432.8	432.0
20 %	436.3	435.7
10 %	440.4	440.1

e. Elevation Hydrographs

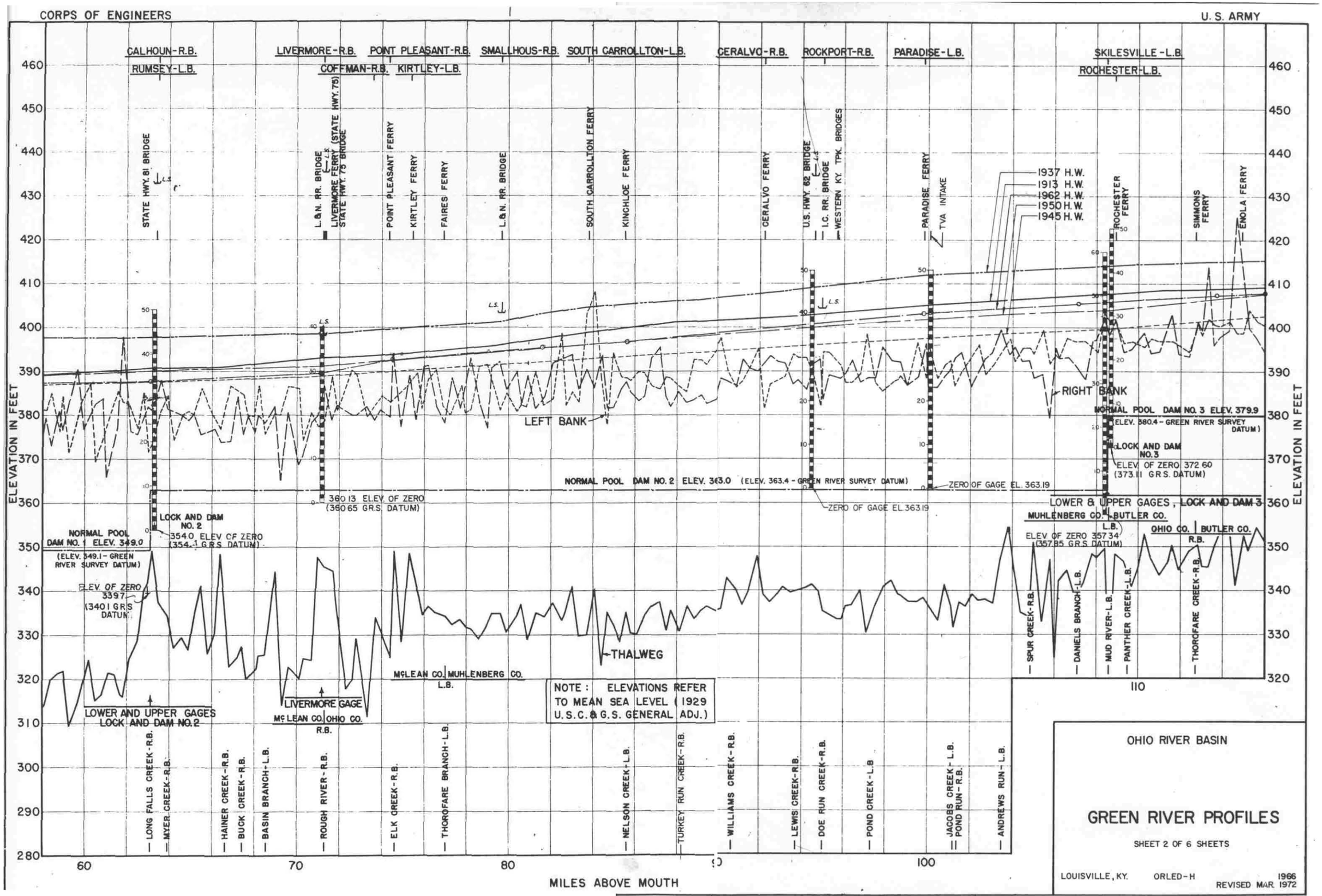
Elevation hydrographs, water surface elevation versus time, were developed from observed mean daily discharge values applied to the adopted elevation versus discharge rating curves (Plates 31 and 33). The selected presentation includes data from the Green River at Brownsville and Nolin River at Kyrock USGS gages. These data include existing conditions and the Dam 6 removed scenario. Brownsville data is shown on Plates 43 through 48 and Kyrock data on Plates 49 through 55.

Nolin River Lake Tailwater

Examination of elevation hydrographs, Plates 49 through 55, for the Nolin River Lake tailwater (Nolin River at Kyrock) revealed that there were possibly nine occurrences in 25 years (1969 through 1993) when the increase in tailwater velocities, at the beginning of a Nolin Lake release, would be more severe with Dam 6 removed than under existing conditions. During these occurrences, the tailwater elevation may increase by 13 feet in one day, compared to 7 feet under existing lake operation and river conditions. This change in tailwater fluctuations would cause a temporary increase in velocities, increasing the tendency for stream bank failures in the stream reach immediately downstream of Nolin Dam. This tendency could be reduced by a lengthened time that Nolin Lake releases are increased from minimum release to bank-full.

No modification of the stilling basin would be required because it was designed to meet maximum release requirements when backwater from Lock and Dam 6 was not a factor. Since the tailwater area has already been protected with grouted rip-rap, significant bank caving is unlikely.

Examination of elevation hydrographs for Green River at Brownsville (Lock and Dam 6), Plates 43 through 48 revealed that there were possibly three occurrences in 23 years (1969 through 1991) when drawdown after a flood release from Nolin River Lake would be more severe with Dam 6 removed. However, these occurrences could also be alleviated by avoiding sudden reductions in Nolin River Lake releases. Possible bank caving would be too rare to estimate cost of repair on an annual basis.


CORPS OF ENGINEERS
U. S. ARMY
CALHOUN-R.B.
RUMSEY-L.B.
LIVERMORE-R.B.
COFFMAN-R.B.
POINT PLEASANT-R.B.
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SMALLHOUS-R.B.
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CERALVO-R.B.
ROCKPORT-R.B.
PARADISE-L.B.
SKILESVILLE-L.B.
ROCHESTER-L.B.
STATE HWY. 81 BRIDGE
L.&N. RR. BRIDGE
LIVERMORE FERRY (STATE HWY. 75)
STATE HWY. 75 BRIDGE
POINT PLEASANT FERRY
KIRTLEY FERRY
FAIRES FERRY
L.&N. RR. BRIDGE
SOUTH CARROLLTON FERRY
KINCHLOE FERRY
CERALVO FERRY
U.S. HWY. 62 BRIDGE
I.C. RR. BRIDGE
WESTERN KY. TPK. BRIDGES
PARADISE FERRY
TVA INTAKE
ROCHESTER FERRY
SIMMONS FERRY
ENOLA FERRY
1937 H.W.
1913 H.W.
1962 H.W.
1950 H.W.
1945 H.W.
RIGHT BANK
LEFT BANK
NORMAL POOL DAM NO. 3 ELEV. 379.9
(ELEV. 380.4 - GREEN RIVER SURVEY DATUM)
LOCK AND DAM NO. 3
ELEV. OF ZERO 372.60
(373.11 G.R.S. DATUM)
NORMAL POOL DAM NO. 2 ELEV. 363.0 (ELEV. 363.4 - GREEN RIVER SURVEY DATUM)
ZERO OF GAGE EL. 363.19
ZERO OF GAGE EL. 363.19
LOWER & UPPER GAGES, LOCK AND DAM 3
MUHLENBERG CO. | BUTLER CO. L.B.
ELEV. OF ZERO 357.34
(357.85 G.R.S. DATUM)
OHIO CO. | BUTLER CO. R.B.
360.13 ELEV. OF ZERO
(360.65 G.R.S. DATUM)
LOCK AND DAM NO. 2
354.0 ELEV. OF ZERO
(354.1 G.R.S. DATUM)
NORMAL POOL DAM NO. 1 ELEV. 349.0
(ELEV. 349.1 - GREEN RIVER SURVEY DATUM)
ELEV. OF ZERO 339.7
(340.1 G.R.S. DATUM)
THALWEG
McLEAN CO. | MUHLENBERG CO. L.B.
LOWER AND UPPER GAGES LOCK AND DAM NO. 2
LIVERMORE GAGE
McLEAN CO. | OHIO CO. R.B.
NOTE: ELEVATIONS REFER TO MEAN SEA LEVEL (1929 U.S.C.&G.S. GENERAL ADJ.)
LONG FALLS CREEK-R.B.
MYER CREEK-R.B.
HAINER CREEK-R.B.
BUCK CREEK-R.B.
BASIN BRANCH-L.B.
ROUGH RIVER-R.B.
ELK CREEK-R.B.
THOROFARE BRANCH-L.B.
NELSON CREEK-L.B.
TURKEY RUN CREEK-R.B.
WILLIAMS CREEK-R.B.
LEWIS CREEK-R.B.
DOE RUN CREEK-R.B.
POND CREEK-L.B.
JACOBS CREEK-L.B.
POND RUN-R.B.
ANDREWS RUN-L.B.
SPUR CREEK-R.B.
DANIELS BRANCH-L.B.
MUD RIVER-L.B.
PANTHER CREEK-L.B.
THOROFARE CREEK-R.B.
ELEVATION IN FEET
MILES ABOVE MOUTH
OHIO RIVER BASIN
GREEN RIVER PROFILES
SHEET 2 OF 6 SHEETS
LOUISVILLE, KY. ORLED-H 1966
REVISED MAR. 1972

PLATE 1

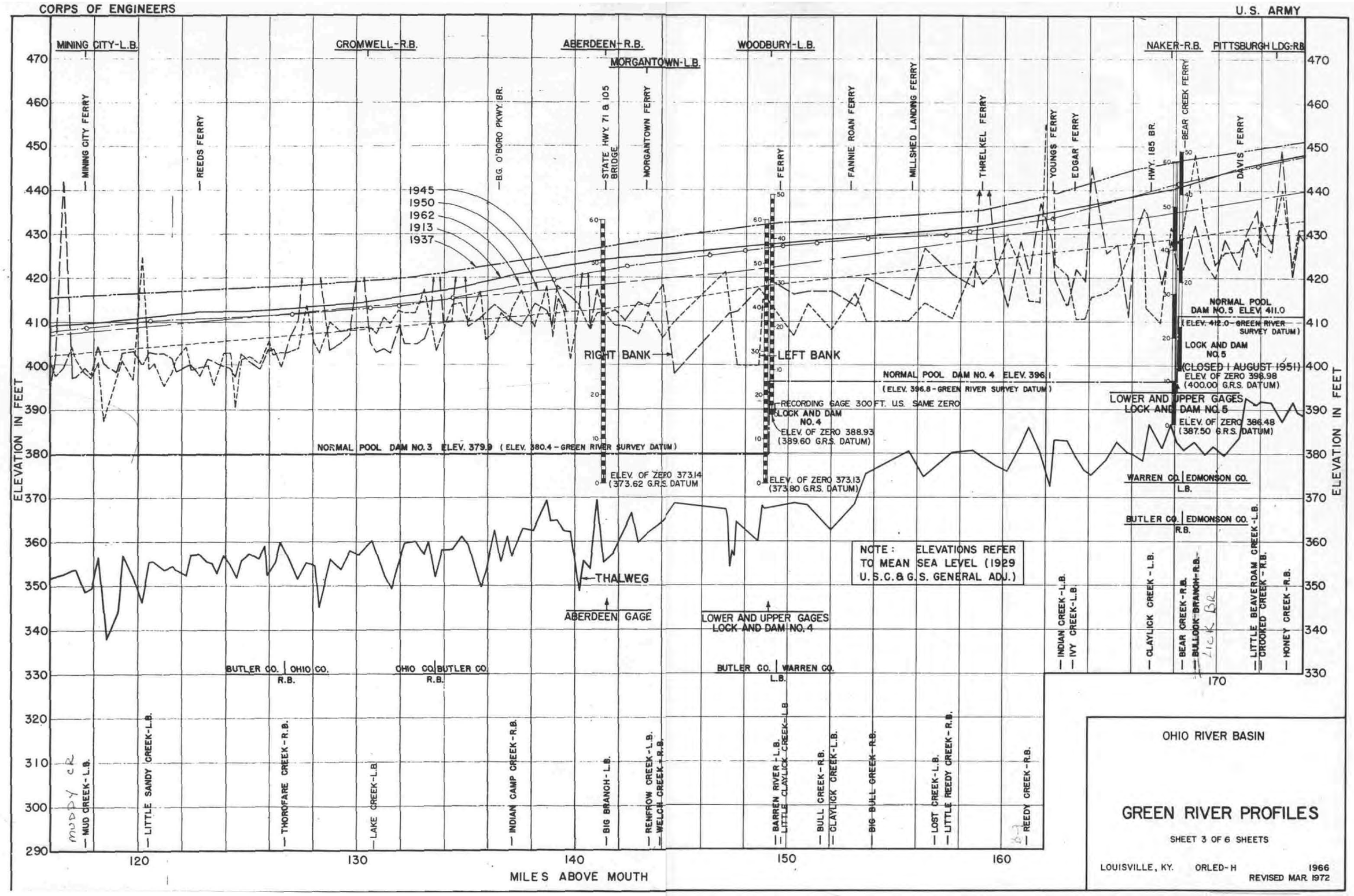
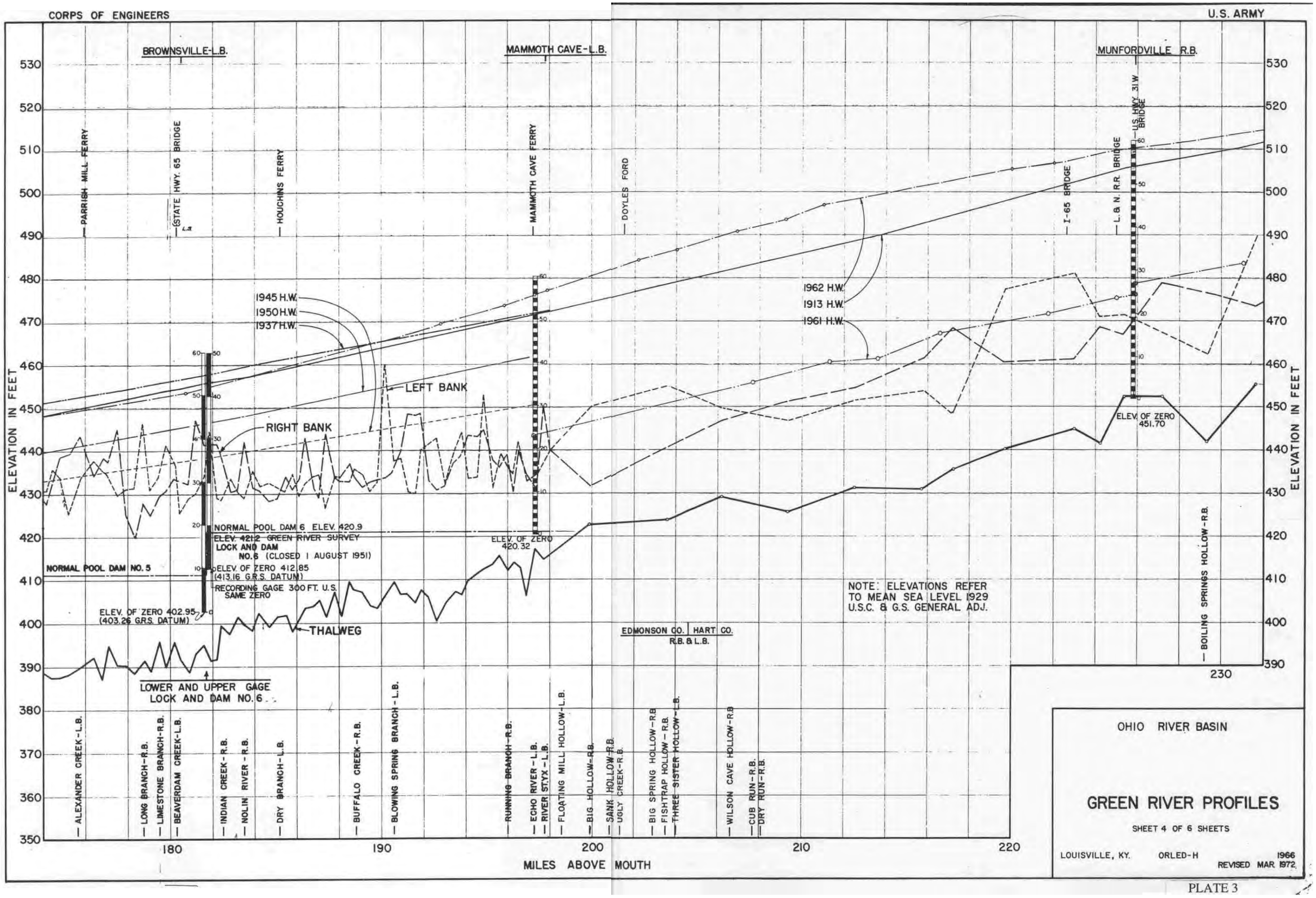
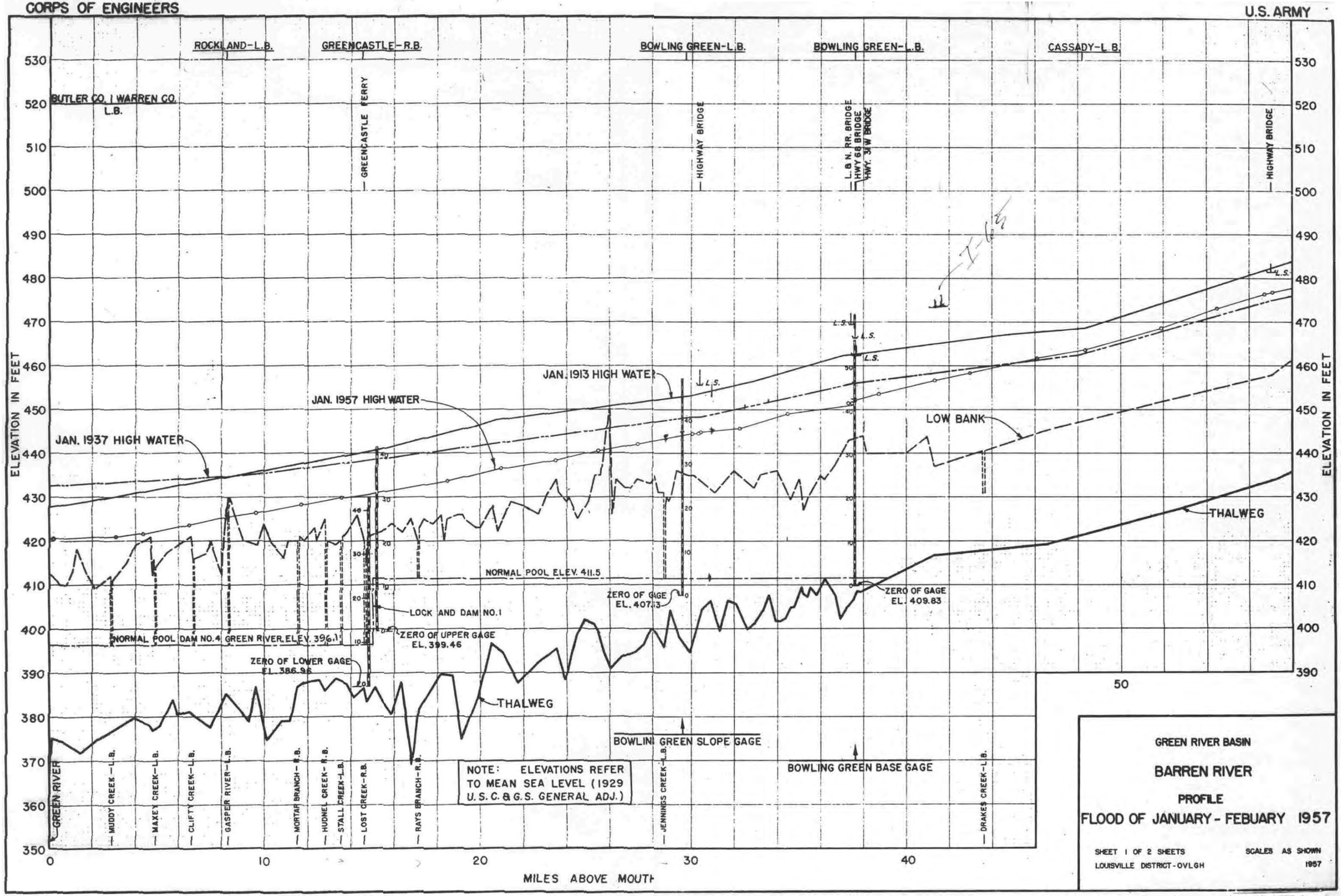

CORPS OF ENGINEERS
U.S. ARMY
MINING CITY-L.B.
CROMWELL-R.B.
ABERDEEN-R.B.
MORGANTOWN-L.B.
WOODBURY-L.B.
NAKER-R.B.
PITTSBURGH LDG-R.B.
MINING CITY FERRY
REEDS FERRY
B.G. O'BORO PKWY. BR.
STATE HWY. 71 & 105 BRIDGE
MORGANTOWN FERRY
FERRY
FANNIE ROAN FERRY
MILLSHED LANDING FERRY
THRELKEL FERRY
YOUNGS FERRY
EDGAR FERRY
HWY. 185 BR.
BEAR CREEK FERRY
DAVIS FERRY
1945
1950
1962
1913
1937
RIGHT BANK
LEFT BANK
NORMAL POOL DAM NO. 3 ELEV. 379.9 (ELEV. 380.4 - GREEN RIVER SURVEY DATUM)
ELEV. OF ZERO 373.14 (373.62 G.R.S. DATUM
ELEV. OF ZERO 373.13 (373.80 G.R.S. DATUM)
RECORDING GAGE 300 FT. U.S. SAME ZERO
LOCK AND DAM NO. 4
ELEV. OF ZERO 388.93 (389.60 G.R.S. DATUM)
NORMAL POOL DAM NO. 4 ELEV. 396.1
(ELEV. 396.8 - GREEN RIVER SURVEY DATUM)
NORMAL POOL DAM NO. 5 ELEV. 411.0
(ELEV. 412.0 - GREEN RIVER SURVEY DATUM)
LOCK AND DAM NO. 5
(CLOSED 1 AUGUST 1951)
ELEV. OF ZERO 398.98 (400.00 G.R.S. DATUM)
LOWER AND UPPER GAGES LOCK AND DAM NO. 5
ELEV. OF ZERO 386.48 (387.50 G.R.S. DATUM)
WARREN CO. | EDMONSON CO. L.B.
BUTLER CO. | EDMONSON CO. R.B.
NOTE: ELEVATIONS REFER TO MEAN SEA LEVEL (1929 U.S.C.&G.S. GENERAL ADJ.)
THALWEG
ABERDEEN GAGE
LOWER AND UPPER GAGES LOCK AND DAM NO. 4
BUTLER CO. | OHIO CO. R.B.
OHIO CO. | BUTLER CO. R.B.
BUTLER CO. | WARREN CO. L.B.
MUDDY CR
MUD CREEK-L.B.
LITTLE SANDY CREEK-L.B.
THOROFARE CREEK-R.B.
LAKE CREEK-L.B.
INDIAN CAMP CREEK-R.B.
BIG BRANCH-L.B.
RENFROW CREEK-L.B.
WELCH CREEK-R.B.
BARREN RIVER-L.B.
LITTLE CLAYLICK CREEK-L.B.
BULL CREEK-R.B.
CLAYLICK CREEK-L.B.
BIG BULL CREEK-R.B.
LOST CREEK-L.B.
LITTLE REEDY CREEK-R.B.
REEDY CREEK-R.B.
INDIAN CREEK-L.B.
IVY CREEK-L.B.
CLAYLICK CREEK-L.B.
BEAR CREEK-R.B.
BULLOCK BRANCH-R.B.
LICK BR
LITTLE BEAVERDAM CREEK-L.B.
CROOKED CREEK-R.B.
HONEY CREEK-R.B.
ELEVATION IN FEET
MILES ABOVE MOUTH
OHIO RIVER BASIN
GREEN RIVER PROFILES
SHEET 3 OF 6 SHEETS
LOUISVILLE, KY. ORLED-H 1966
REVISED MAR. 1972

PLATE 2


CORPS OF ENGINEERS
U.S. ARMY
BROWNSVILLE-L.B.
MAMMOTH CAVE-L.B.
MUNFORDVILLE R.B.
PARRISH MILL FERRY
STATE HWY. 65 BRIDGE
HOUCHINS FERRY
MAMMOTH CAVE FERRY
DOYLES FORD
I-65 BRIDGE
L. & N. R.R. BRIDGE
U.S. HWY. 31 W. BRIDGE
1945 H.W.
1950 H.W.
1937 H.W.
1962 H.W.
1913 H.W.
1961 H.W.
LEFT BANK
RIGHT BANK
ELEV. OF ZERO 451.70
NORMAL POOL DAM 6 ELEV. 420.9
ELEV. 421.2 GREEN RIVER SURVEY
LOCK AND DAM NO.6 (CLOSED 1 AUGUST 1951)
ELEV. OF ZERO 420.32
NORMAL POOL DAM NO. 5
ELEV. OF ZERO 412.85 (413.16 G.R.S. DATUM)
RECORDING GAGE 300 FT. U.S. SAME ZERO
ELEV. OF ZERO 402.95 (403.26 G.R.S. DATUM)
THALWEG
NOTE: ELEVATIONS REFER TO MEAN SEA LEVEL 1929 U.S.C. & G.S. GENERAL ADJ.
EDMONSON CO. | HART CO.
R.B. & L.B.
LOWER AND UPPER GAGE LOCK AND DAM NO.6
ALEXANDER CREEK-L.B.
LONG BRANCH-R.B.
LIMESTONE BRANCH-R.B.
BEAVERDAM CREEK-L.B.
INDIAN CREEK-R.B.
NOLIN RIVER-R.B.
DRY BRANCH-L.B.
BUFFALO CREEK-R.B.
BLOWING SPRING BRANCH-L.B.
RUNNING BRANCH-R.B.
ECHO RIVER-L.B.
RIVER STYX-L.B.
FLOATING MILL HOLLOW-L.B.
BIG HOLLOW-R.B.
SANK HOLLOW-R.B.
UGLY CREEK-R.B.
BIG SPRING HOLLOW-R.B.
FISHTRAP HOLLOW-R.B.
THREE SISTER HOLLOW-L.B.
WILSON CAVE HOLLOW-R.B.
CUB RUN-R.B.
DRY RUN-R.B.
BOILING SPRINGS HOLLOW-R.B.
ELEVATION IN FEET
MILES ABOVE MOUTH
OHIO RIVER BASIN
GREEN RIVER PROFILES
SHEET 4 OF 6 SHEETS
LOUISVILLE, KY. ORLED-H 1966
REVISED MAR 1972

CORPS OF ENGINEERS

U.S. ARMY



GREEN RIVER BASIN

BARREN RIVER

PROFILE

FLOOD OF JANUARY - FEBUARY 1957

SHEET 1 OF 2 SHEETS

SCALES AS SHOWN

LOUISVILLE DISTRICT - OVLGH

1957

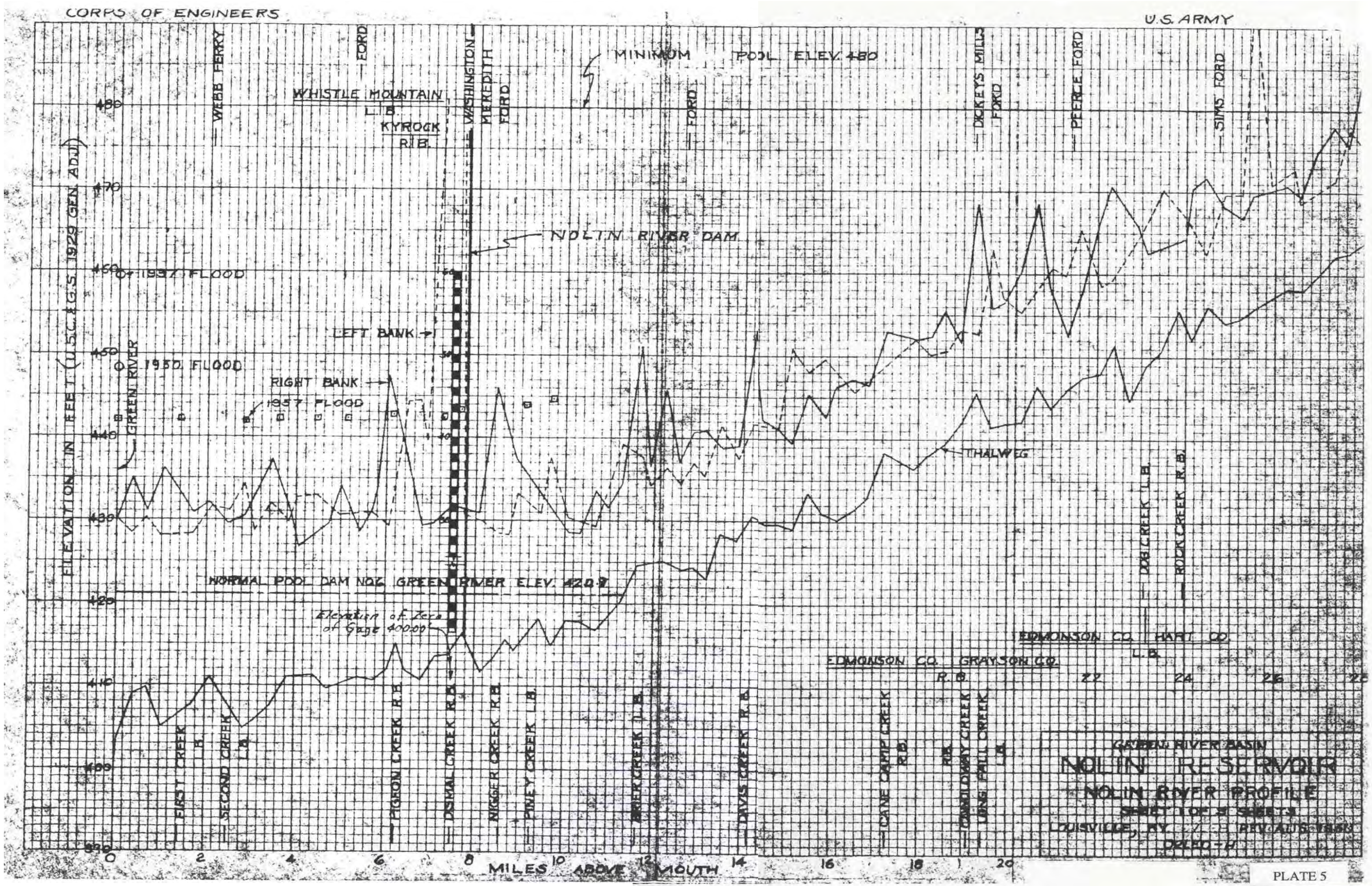

CORPS OF ENGINEERS
U.S. ARMY
MINIMUM POOL ELEV. 480
WEBB FERRY
FORD
WHISTLE MOUNTAIN L.B.
KYROCK R.B.
WASHINGTON
MEREDITH FORD
FORD
DICKEYS MILLS FORD
PEERCE FORD
SIMS FORD
NOLIN RIVER DAM
1937 FLOOD
LEFT BANK
1950 FLOOD
RIGHT BANK
1957 FLOOD
GREEN RIVER
THALWEG
DOG CREEK L.B.
ROCK CREEK R.B.
NORMAL POOL DAM NO. 6 GREEN RIVER ELEV. 420.0
Elevation of Zero of Gage 400.00'
EDMONSON CO. HART CO.
L.B.
EDMONSON CO. GRAYSON CO.
R.B.
FIRST CREEK R.B.
SECOND CREEK L.B.
PIGEON CREEK R.B.
DISMAL CREEK R.B.
NIGGER CREEK R.B.
PINEY CREEK L.B.
BRIER CREEK L.B.
DAVIS CREEK R.B.
CANE CAMP CREEK R.B.
R.B.
LONG FALL CREEK L.B.
ELEVATION IN FEET (U.S.C.&G.S. 1929 GEN. ADJ.)
MILES ABOVE MOUTH
GREEN RIVER BASIN
NOLIN RESERVOIR
NOLIN RIVER PROFILE
SHEET 1 OF 3 SHEETS
LOUISVILLE, KY.
REV. AUG. 1960
D-4-10-H

PLATE 5

GREEN RIVER AT MUNFORDVILLE, KY

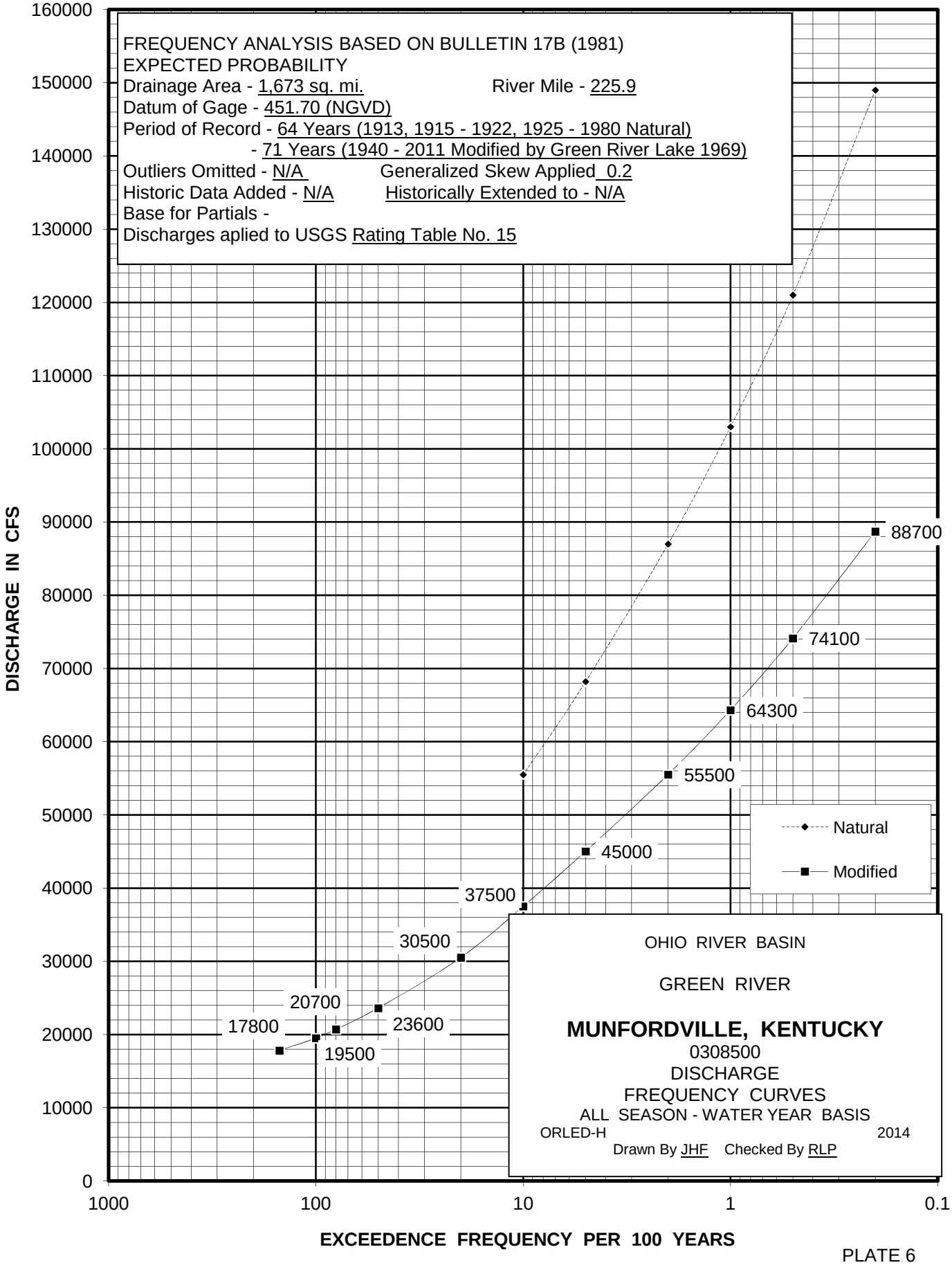


PLATE 6

GREEN RIVER AT MUNFORDVILLE, KY.

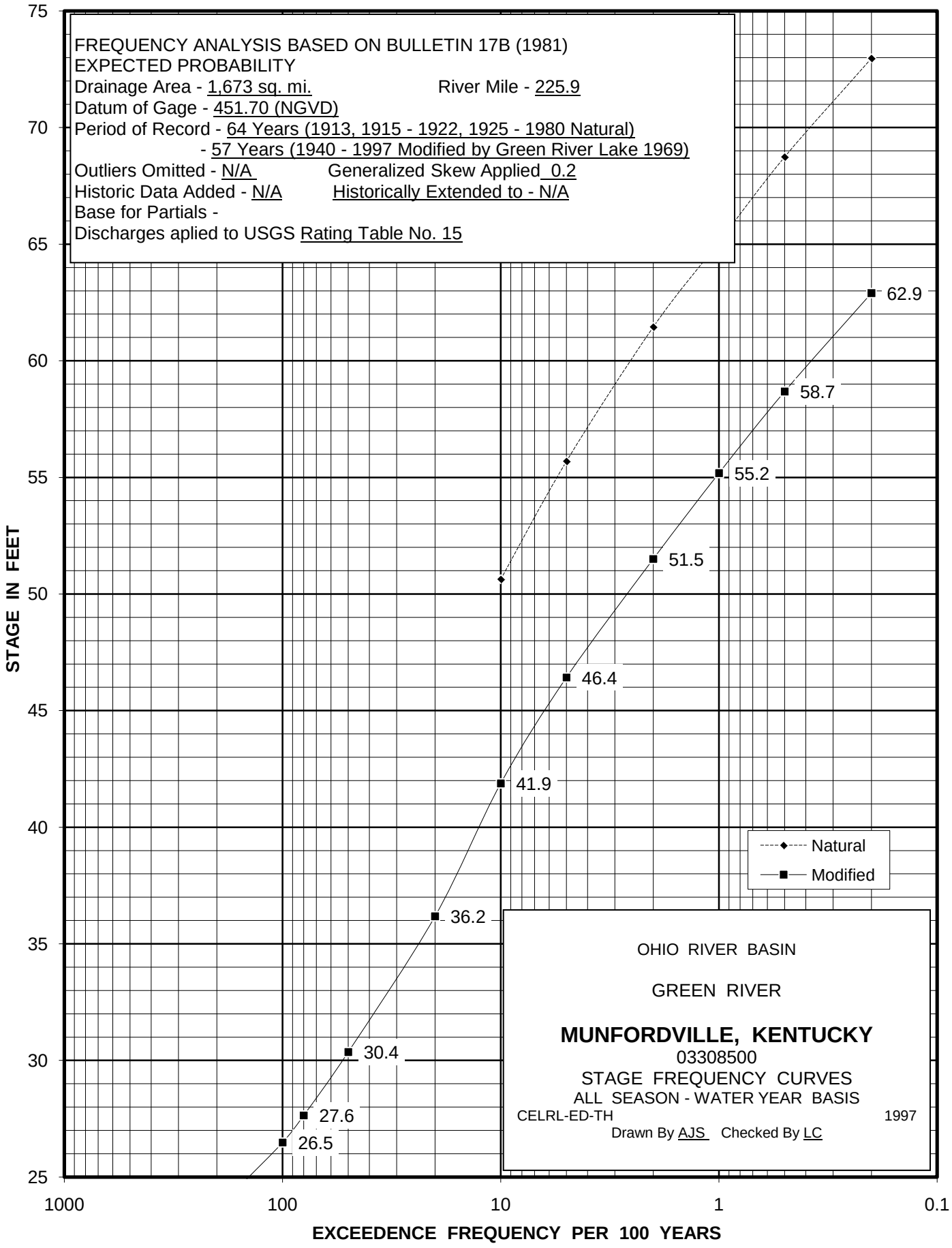


PLATE 7

NOLIN RIVER AT KYROCK, KY.

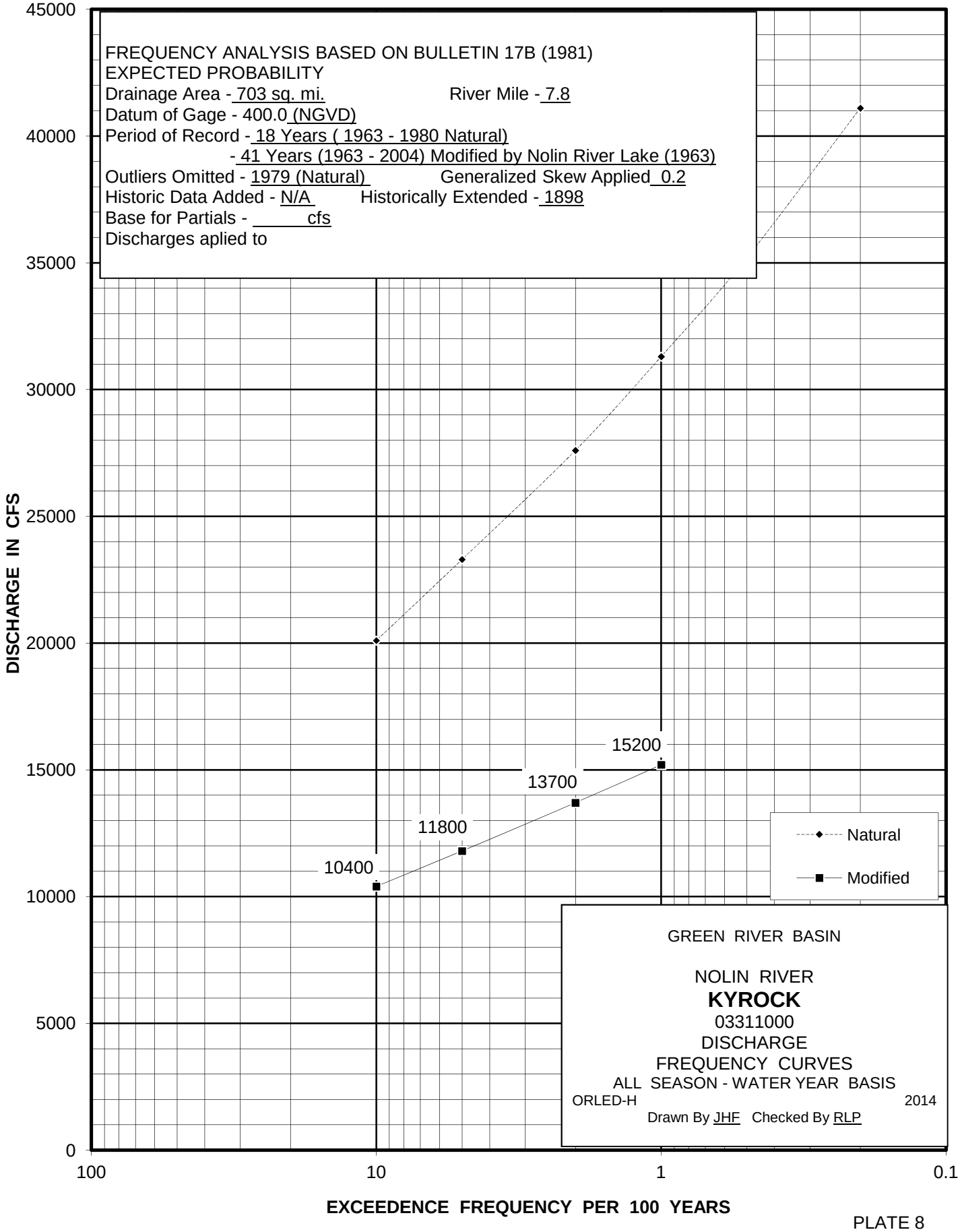
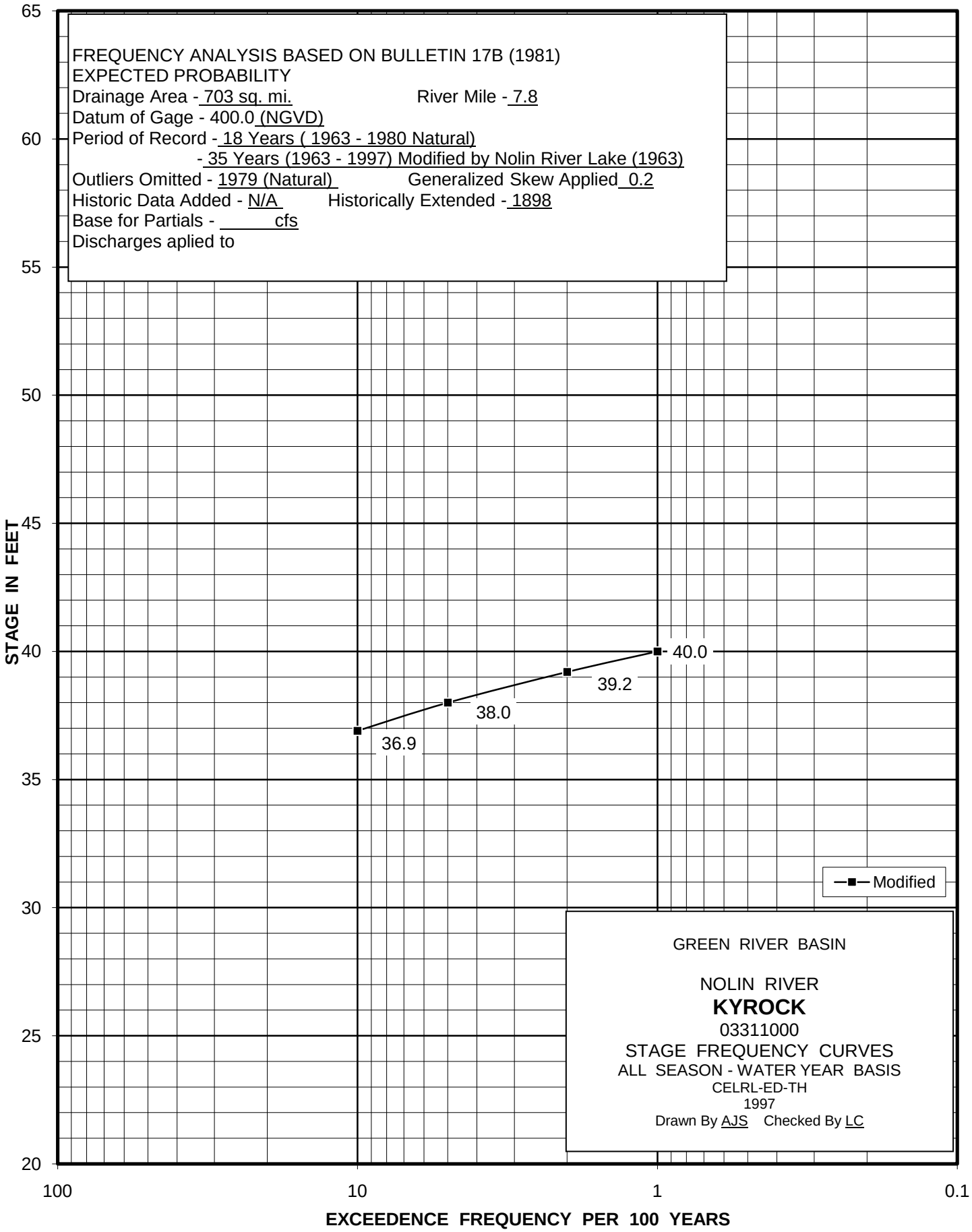
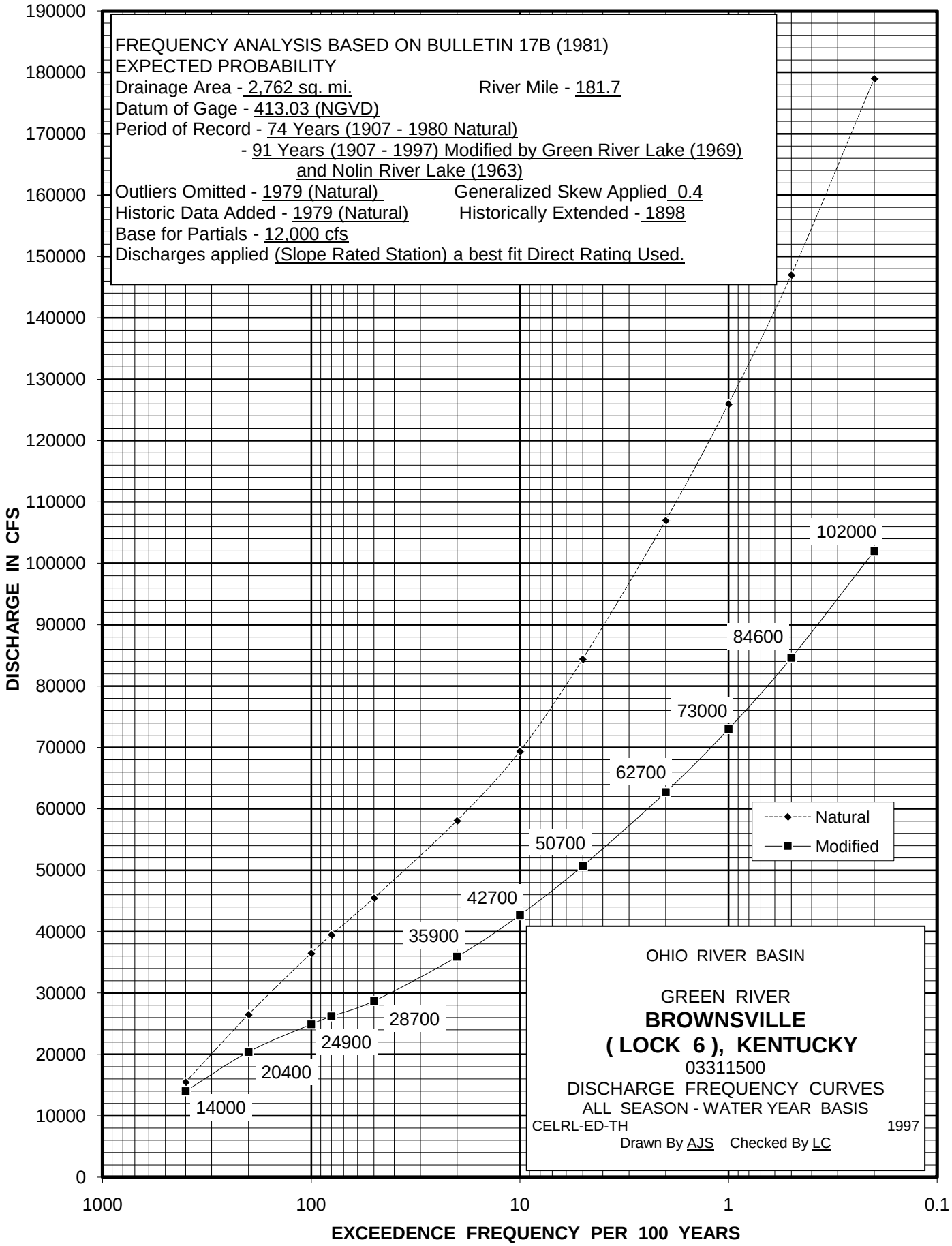


PLATE 8

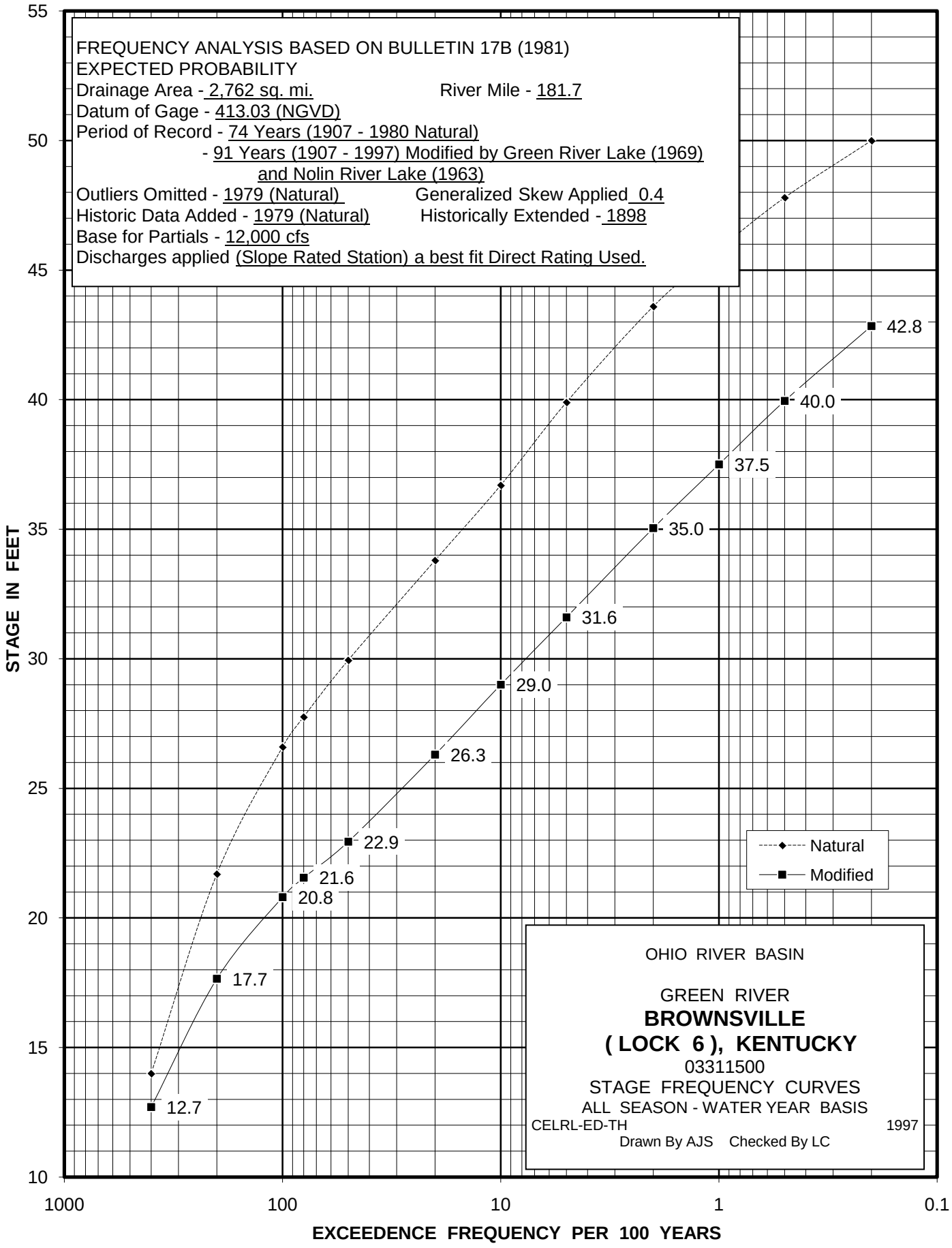
NOILN RIVER AT KYROCK, KY.



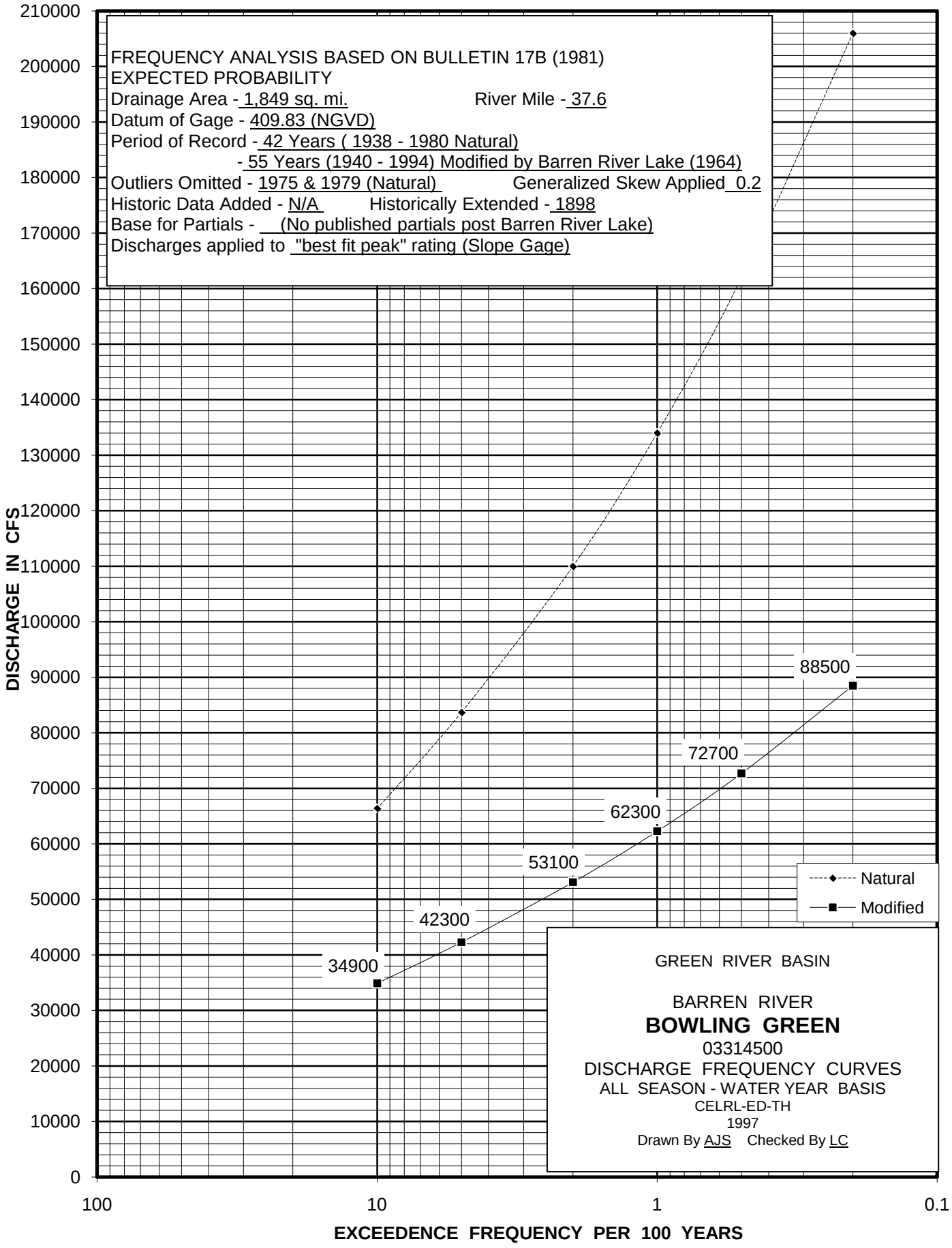
GREEN RIVER AT BROWNSVILLE (LOCK 6), KY.



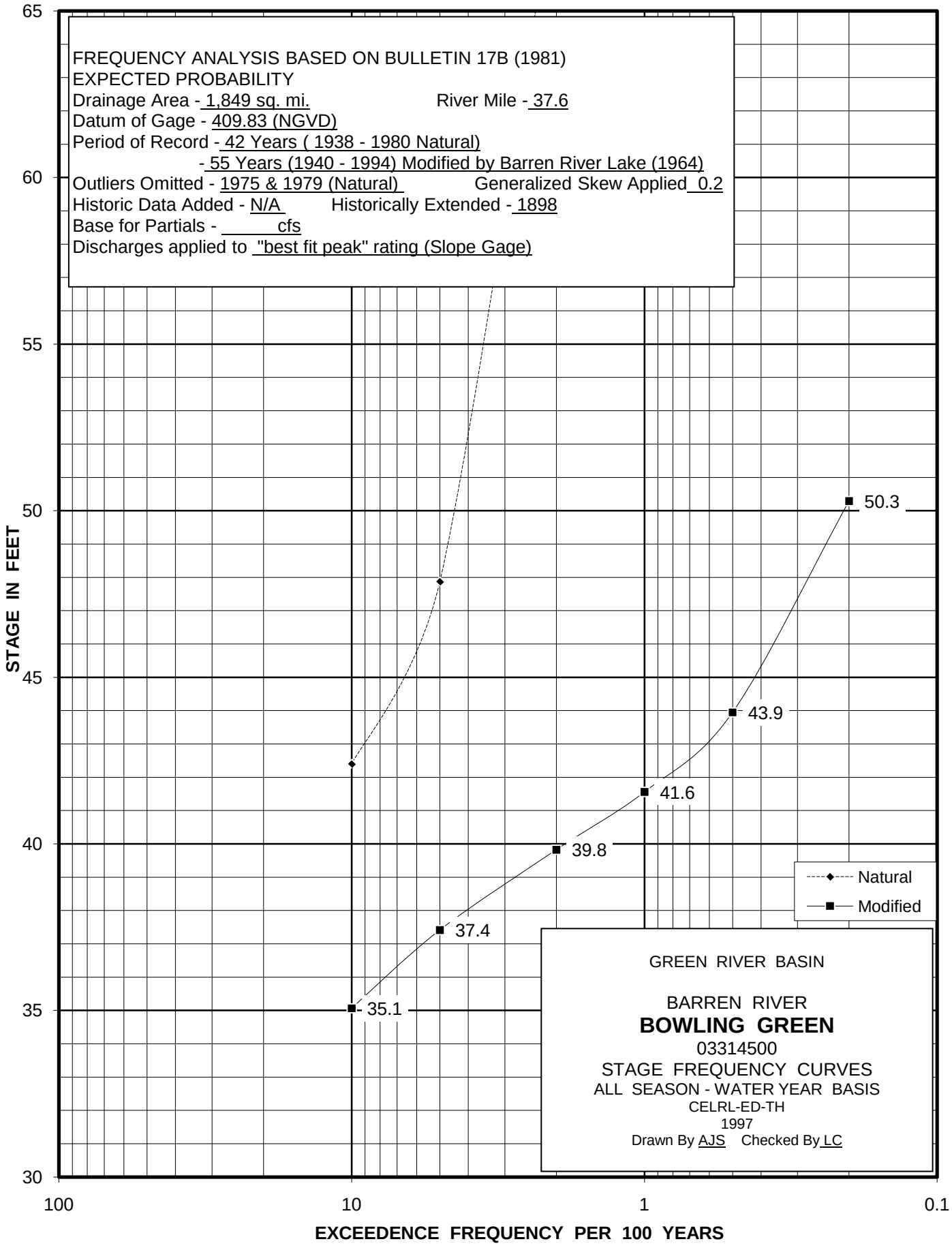
GREEN RIVER AT BROWNSVILLE (LOCK 6), KY.



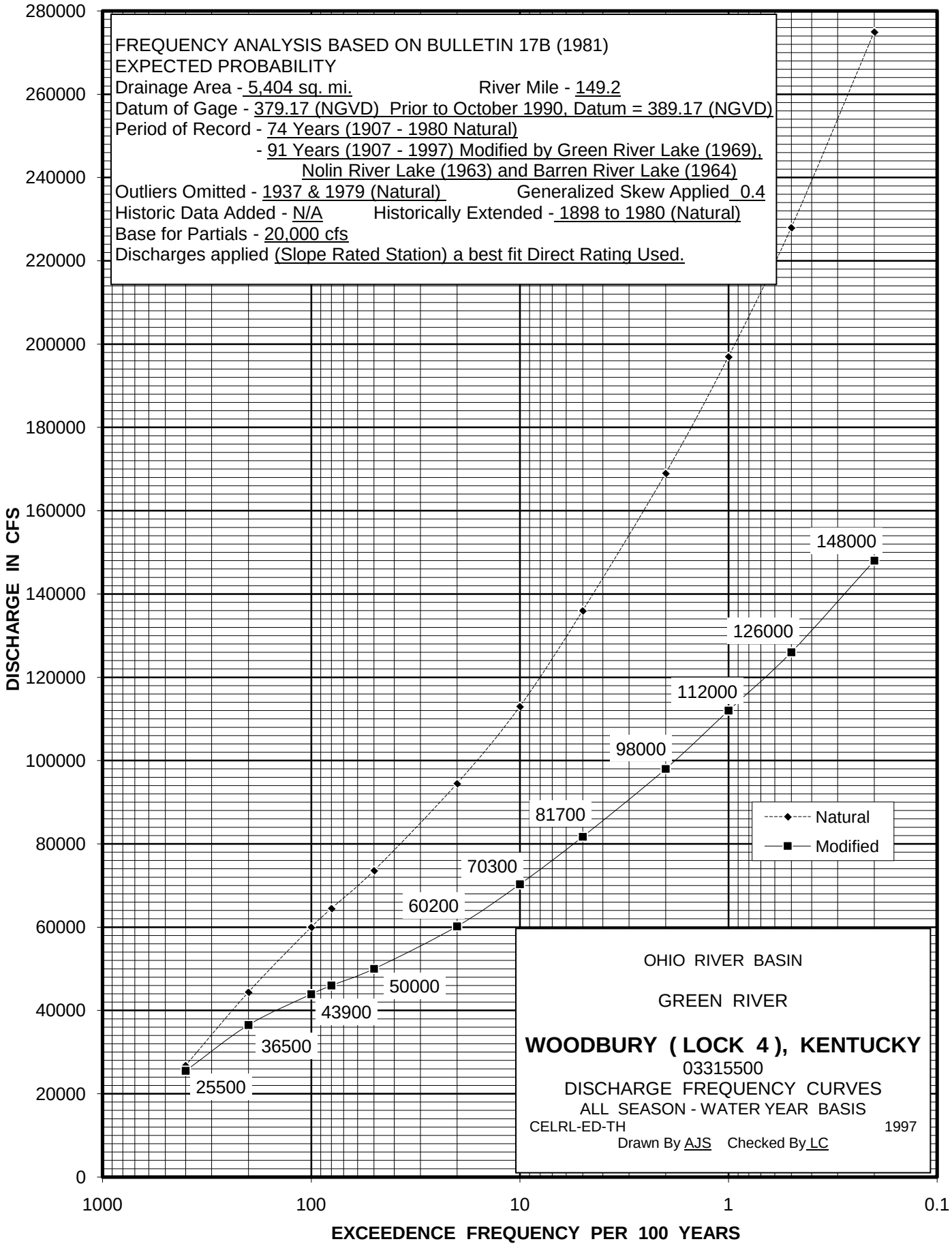
BARREN RIVER AT BOWLING GREEN, KY.



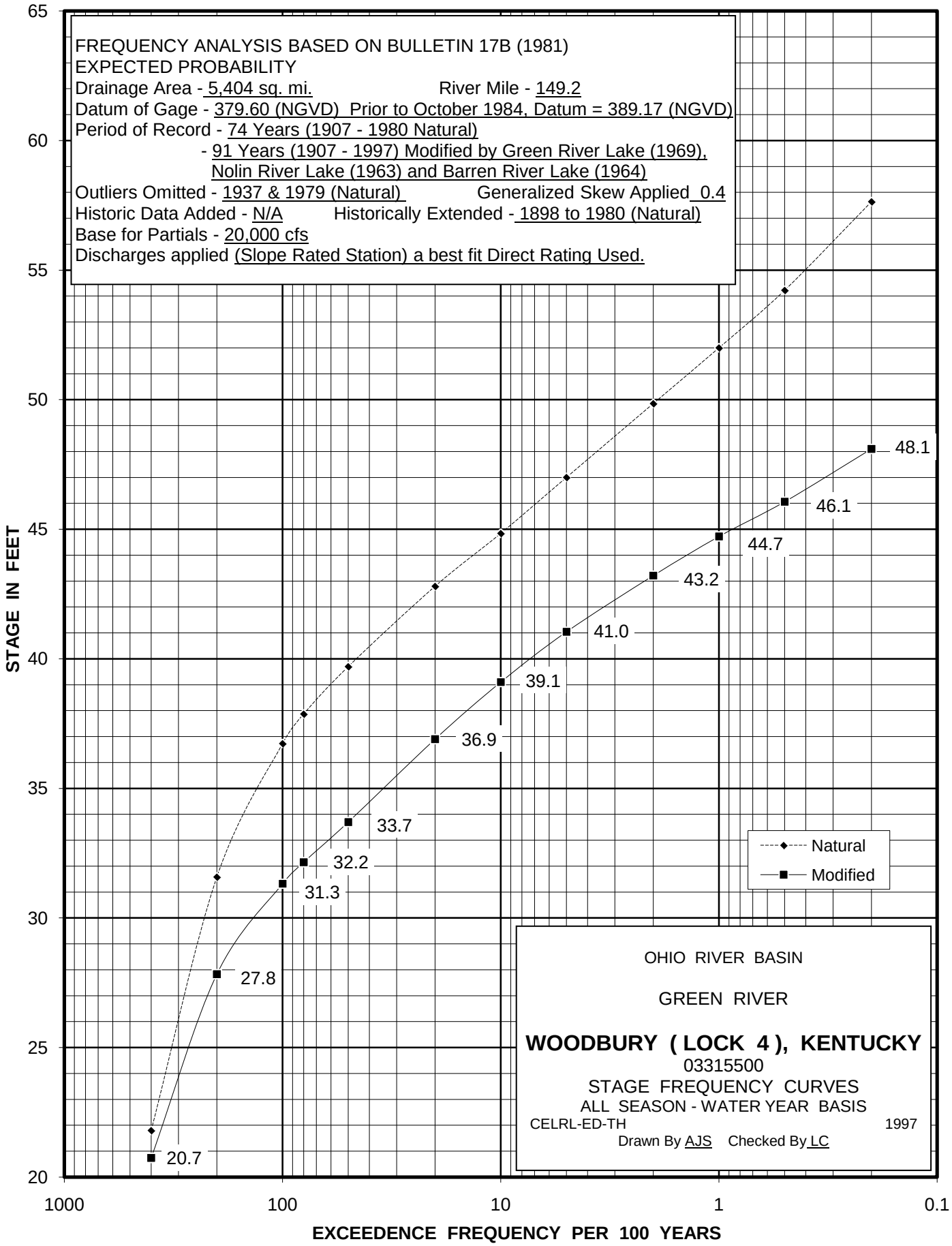
BARREN RIVER AT BOWLING GREEN, KY.



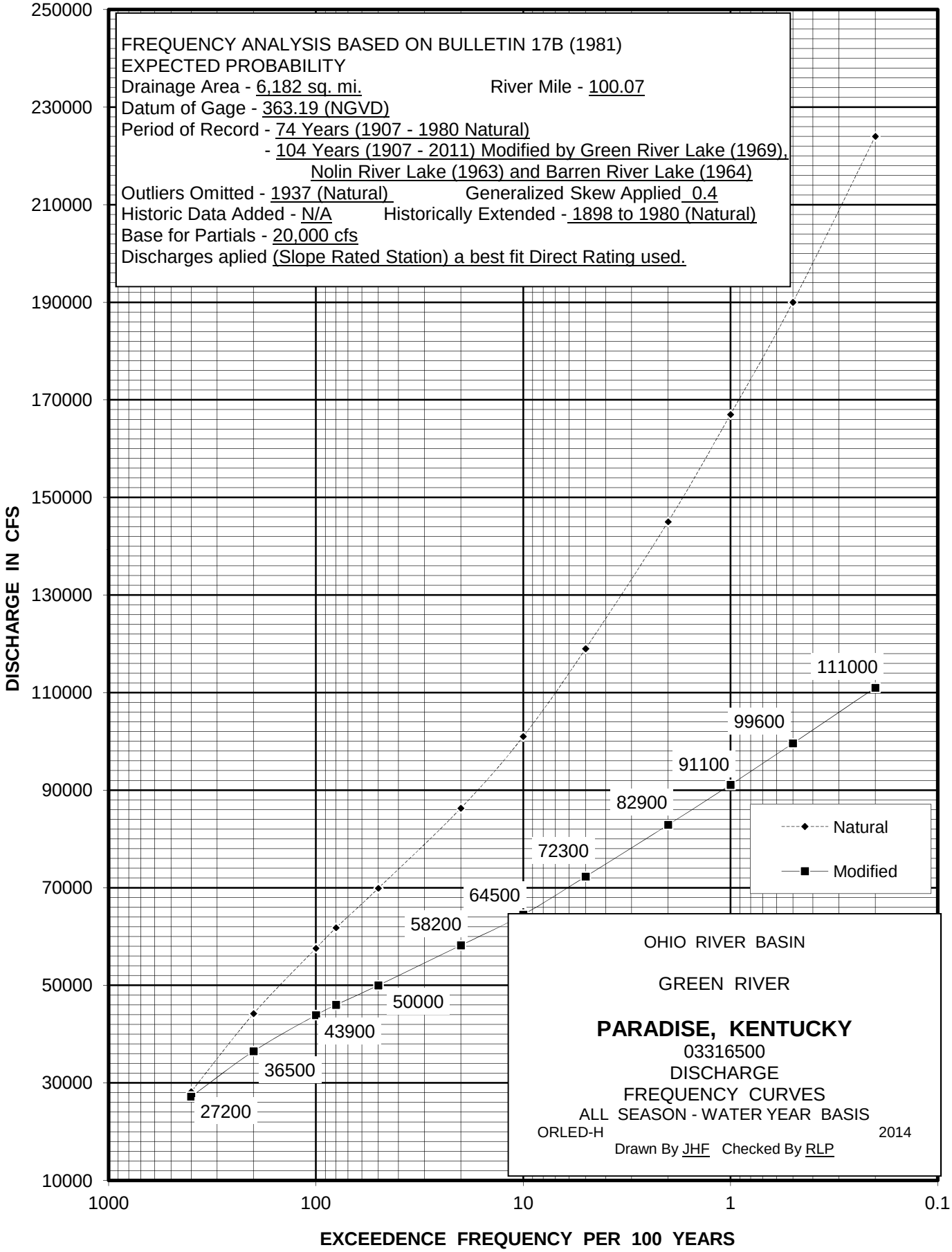
GREEN RIVER AT WOODBURY (LOCK 4), KY.



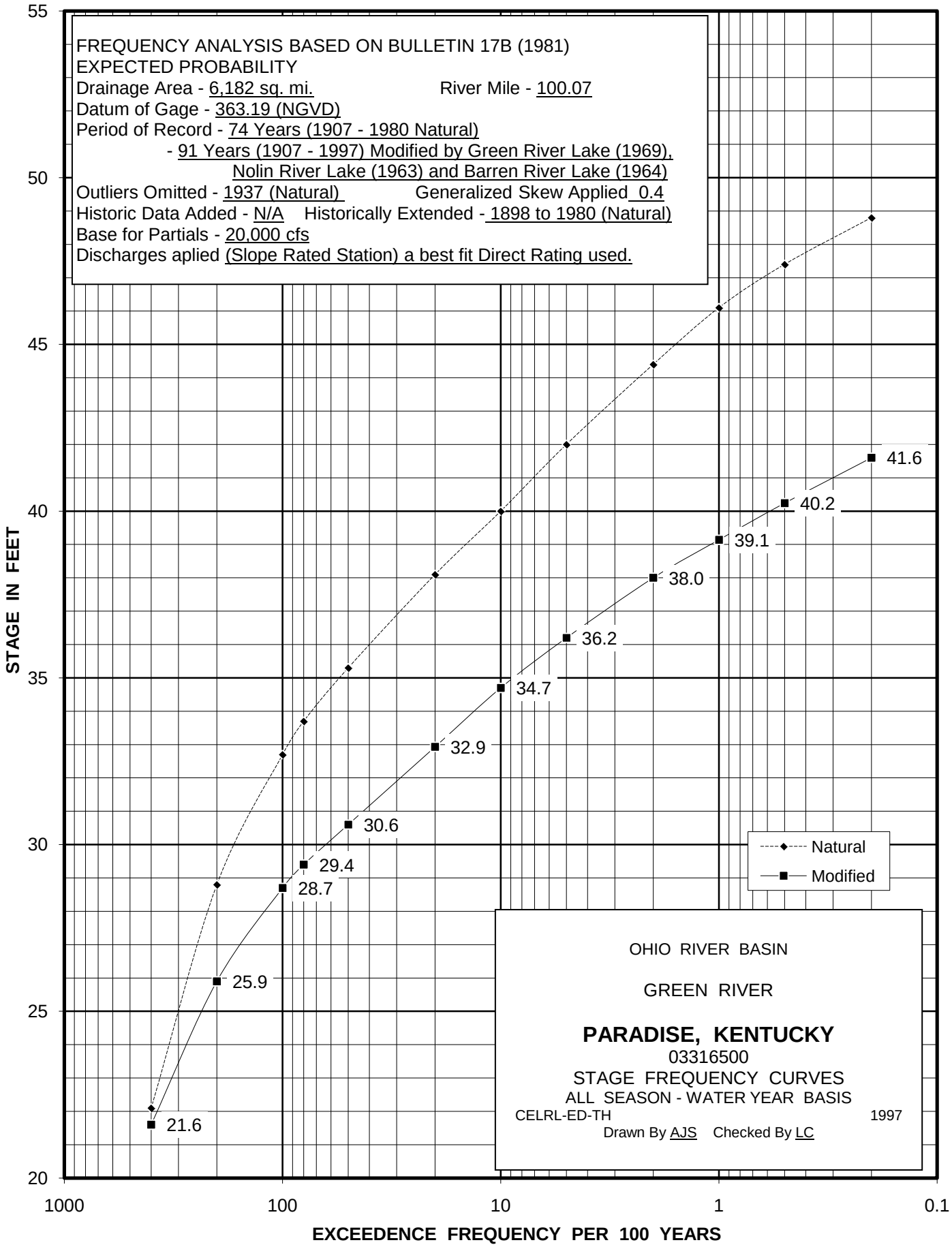
GREEN RIVER AT WOODBURY (LOCK 4), KY.



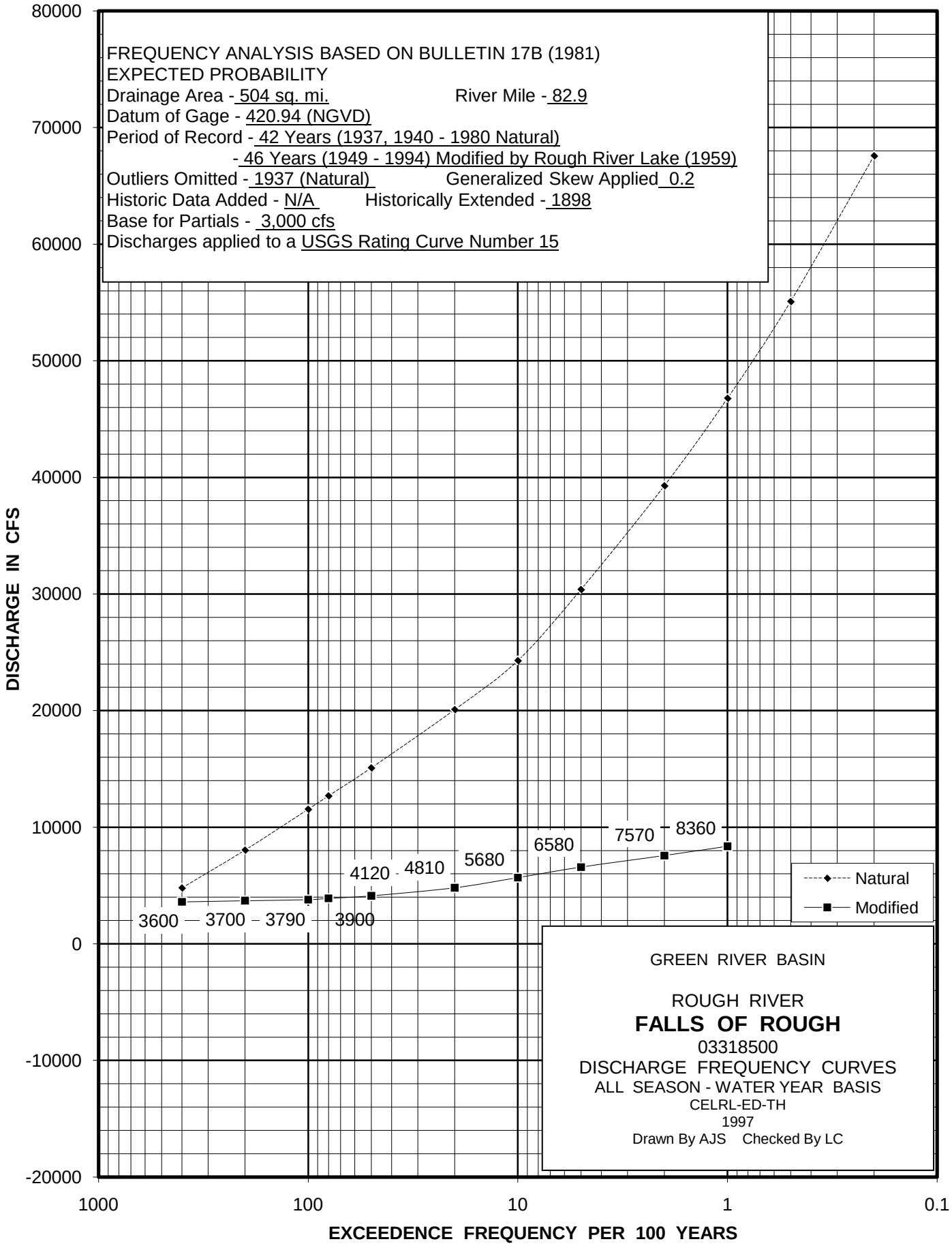
GREEN RIVER AT PARADISE, KY.



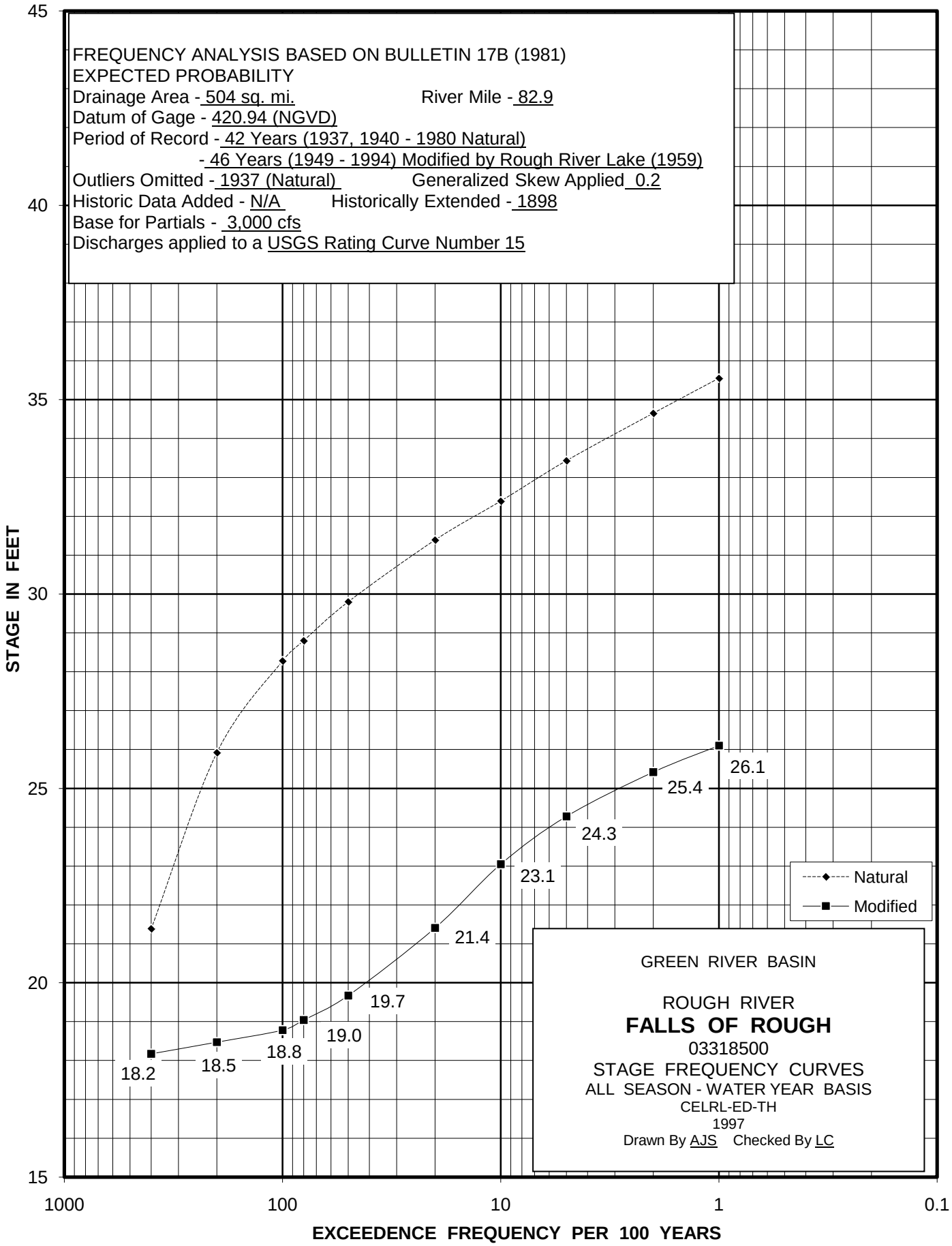
GREEN RIVER AT PARADISE, KY.



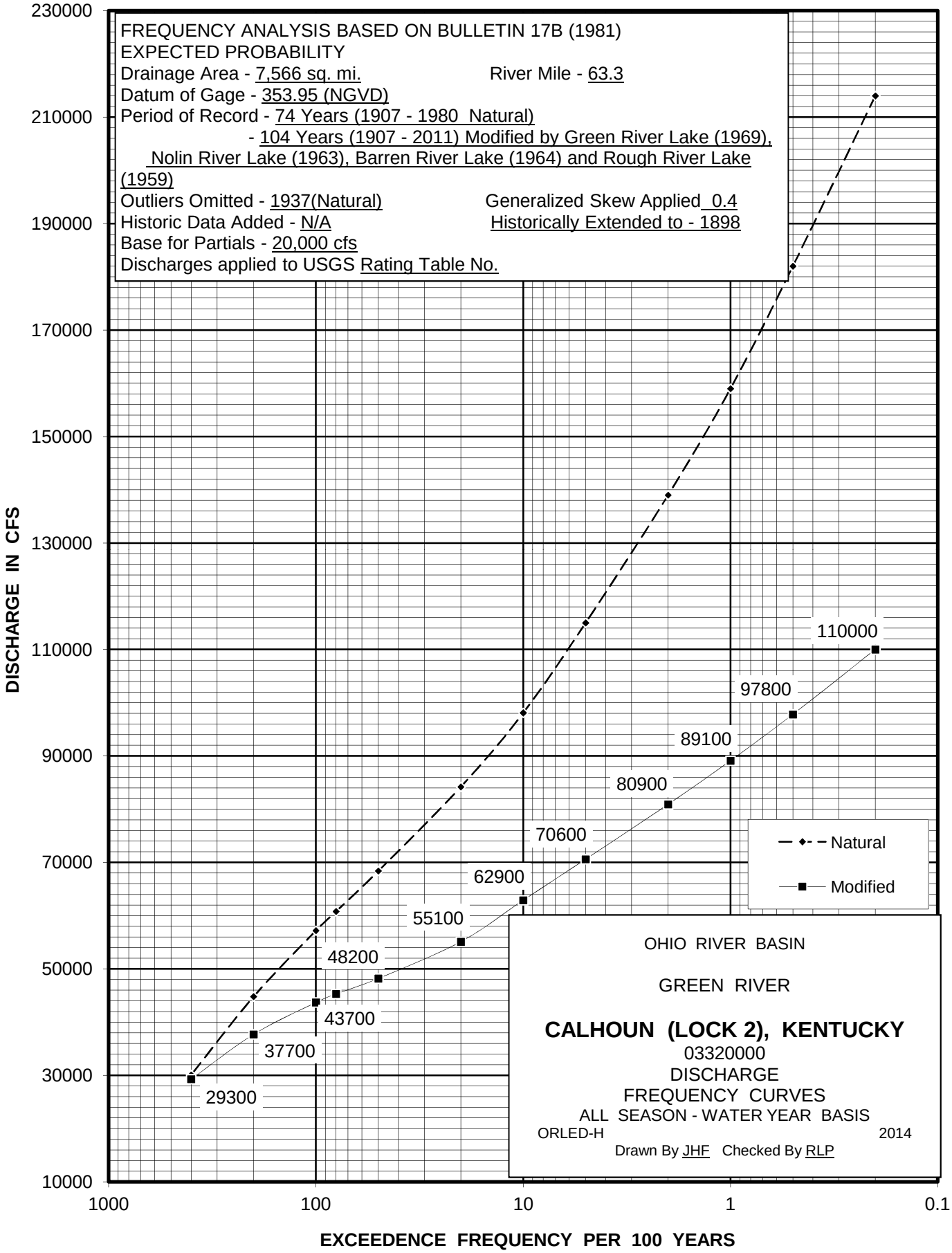
ROUGH RIVER AT FALLS OF ROUGH, KY.



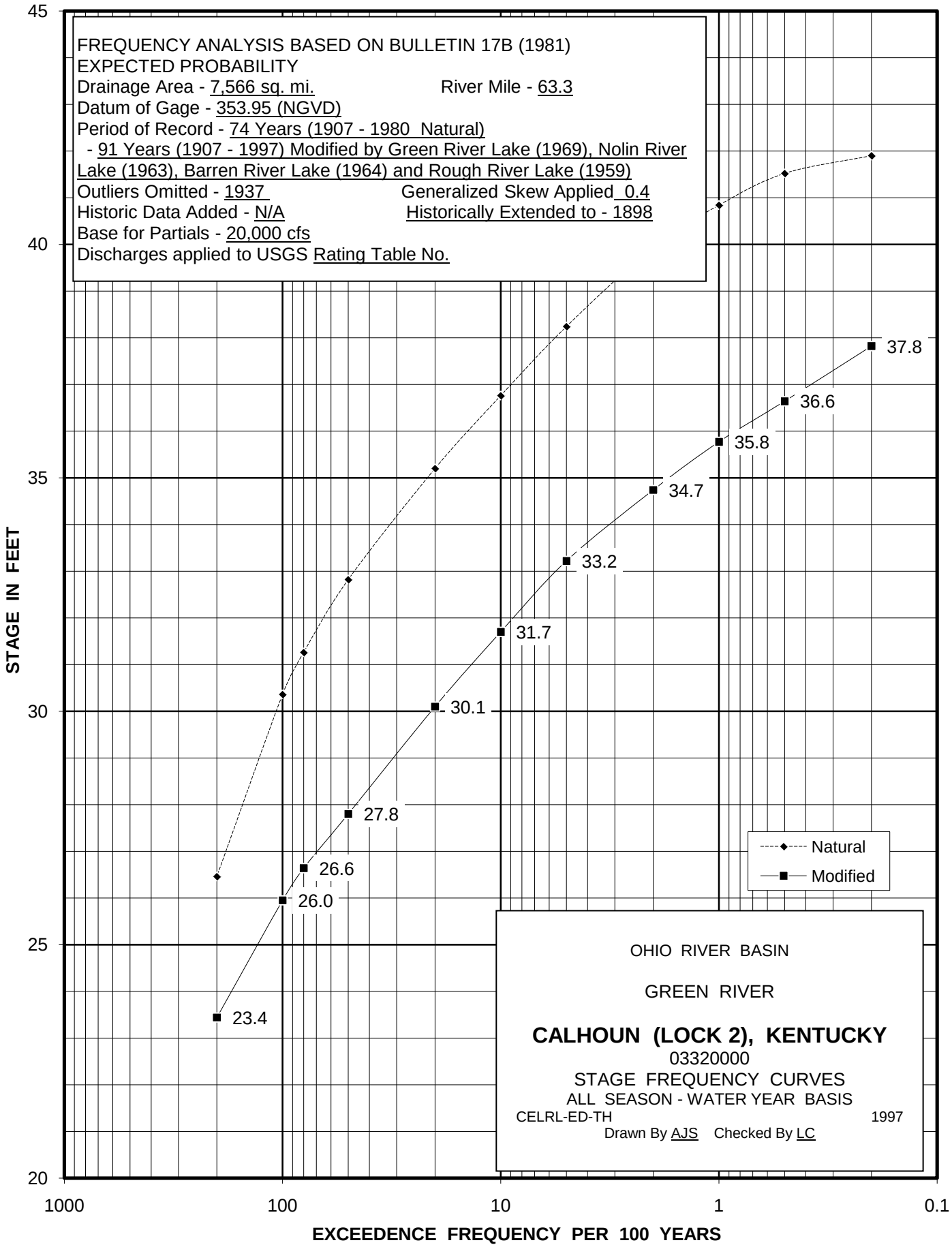
ROUGH RIVER AT FALLS OF ROUGH, KY.



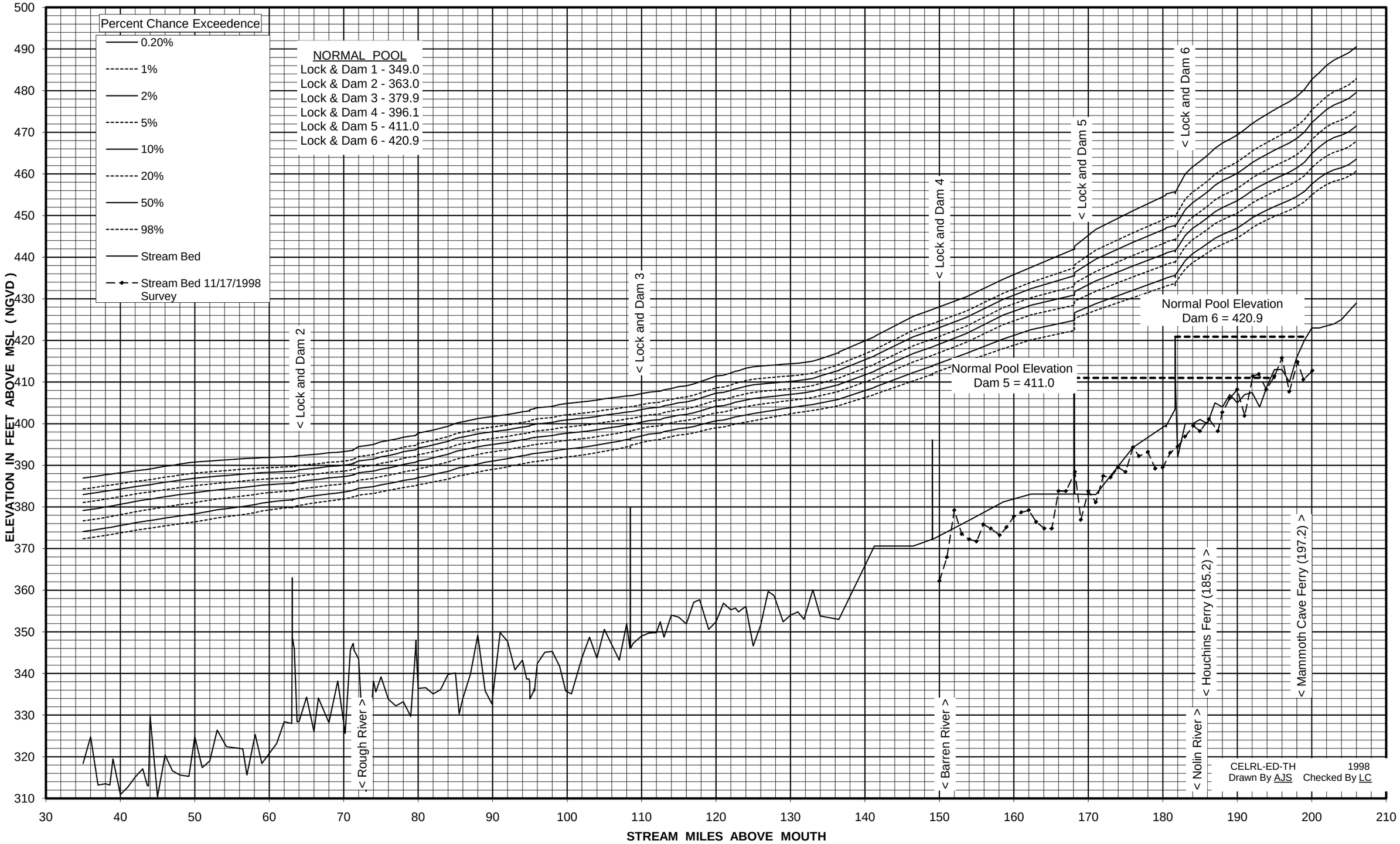
GREEN RIVER AT CALHOUN (LOCK 2), KY



GREEN RIVER AT CALHOUN (LOCK 2), KY.



GREEN RIVER - KENTUCKY
EXISTING CONDITION -- PERCENT CHANCE EXCEEDENCE FLOODS



BARREN RIVER - KENTUCKY

EXISTING CONDITIONS - PERCENT CHANCE EXCEEDENCE FLOODS

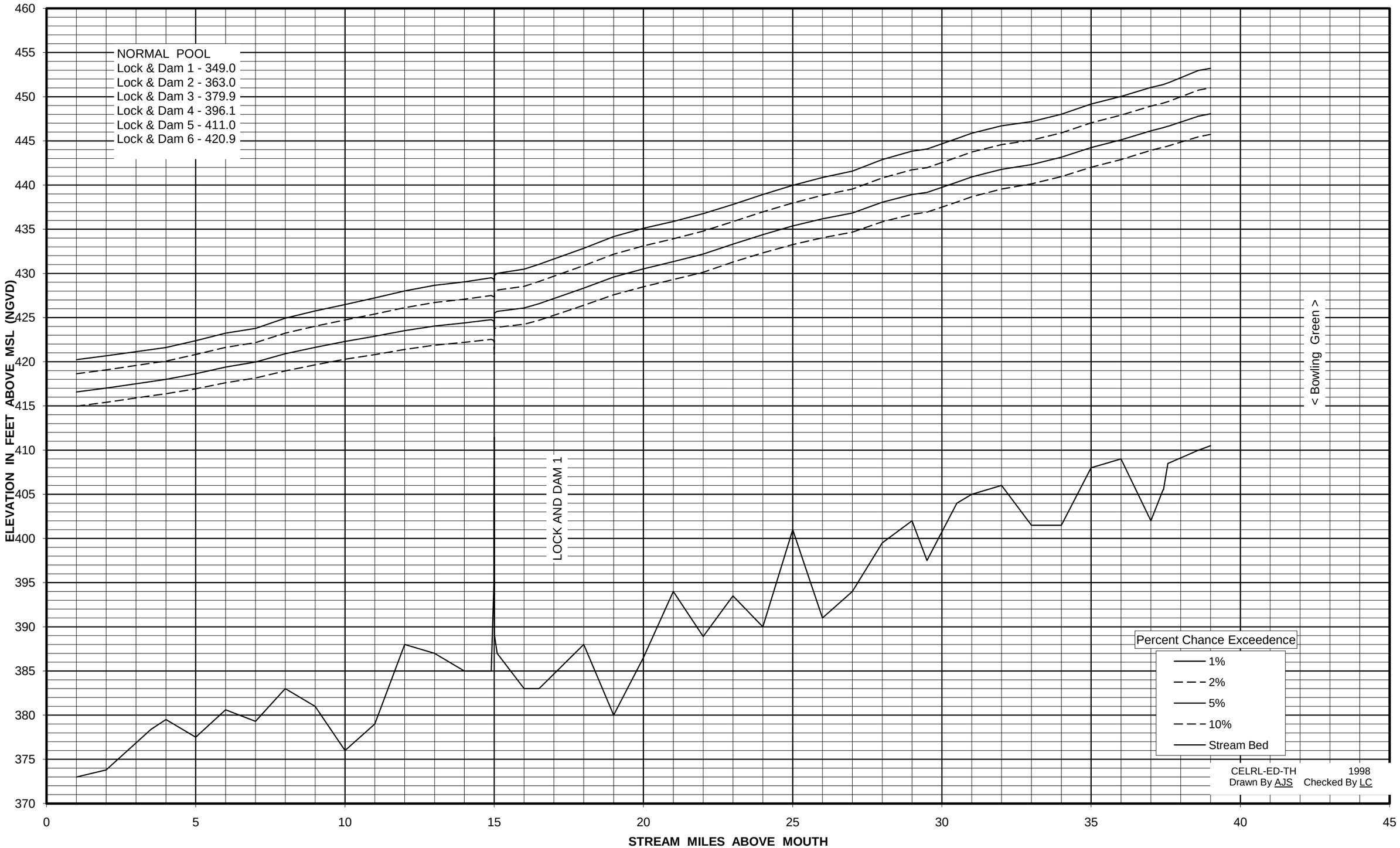
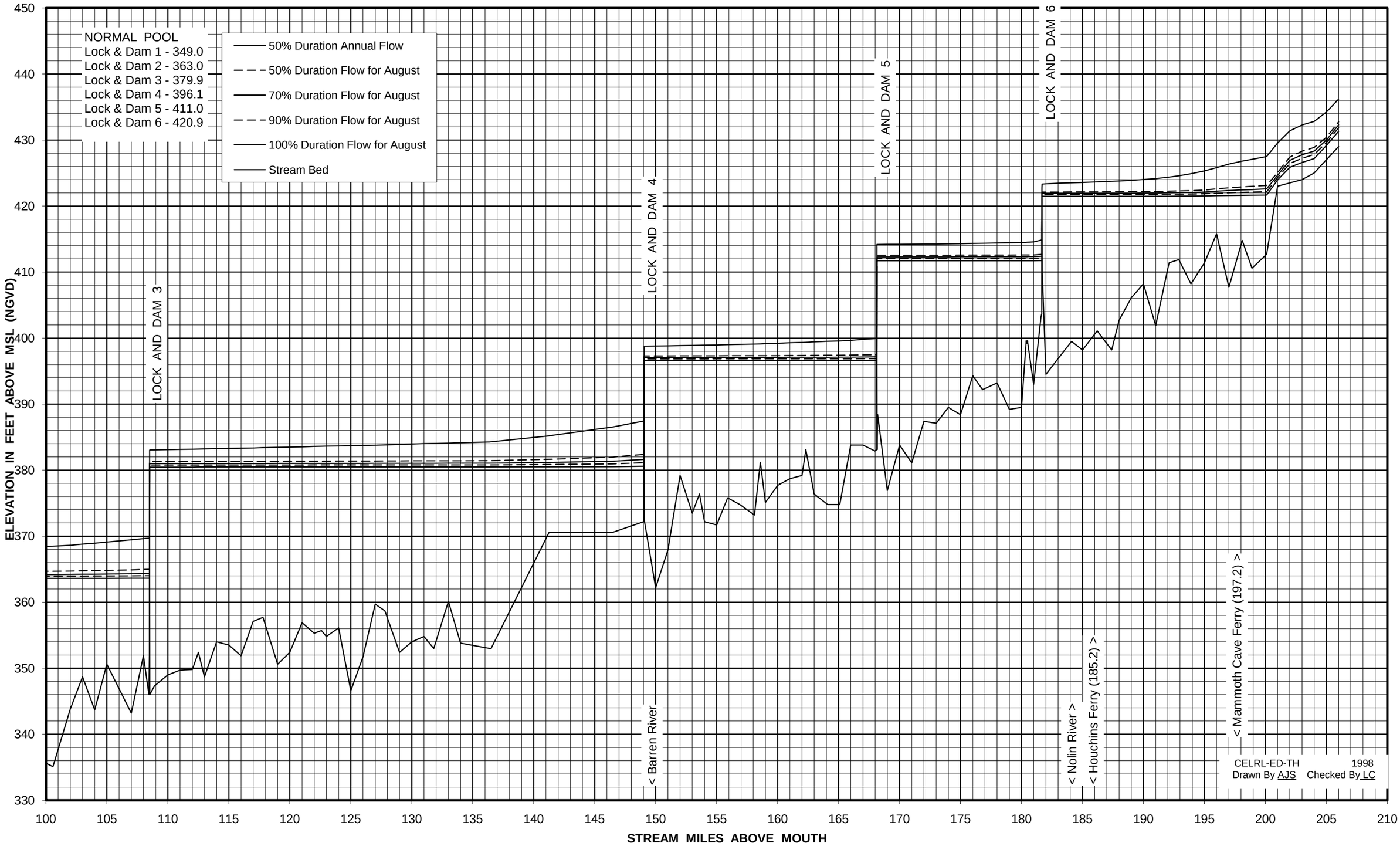


PLATE 22 (b)

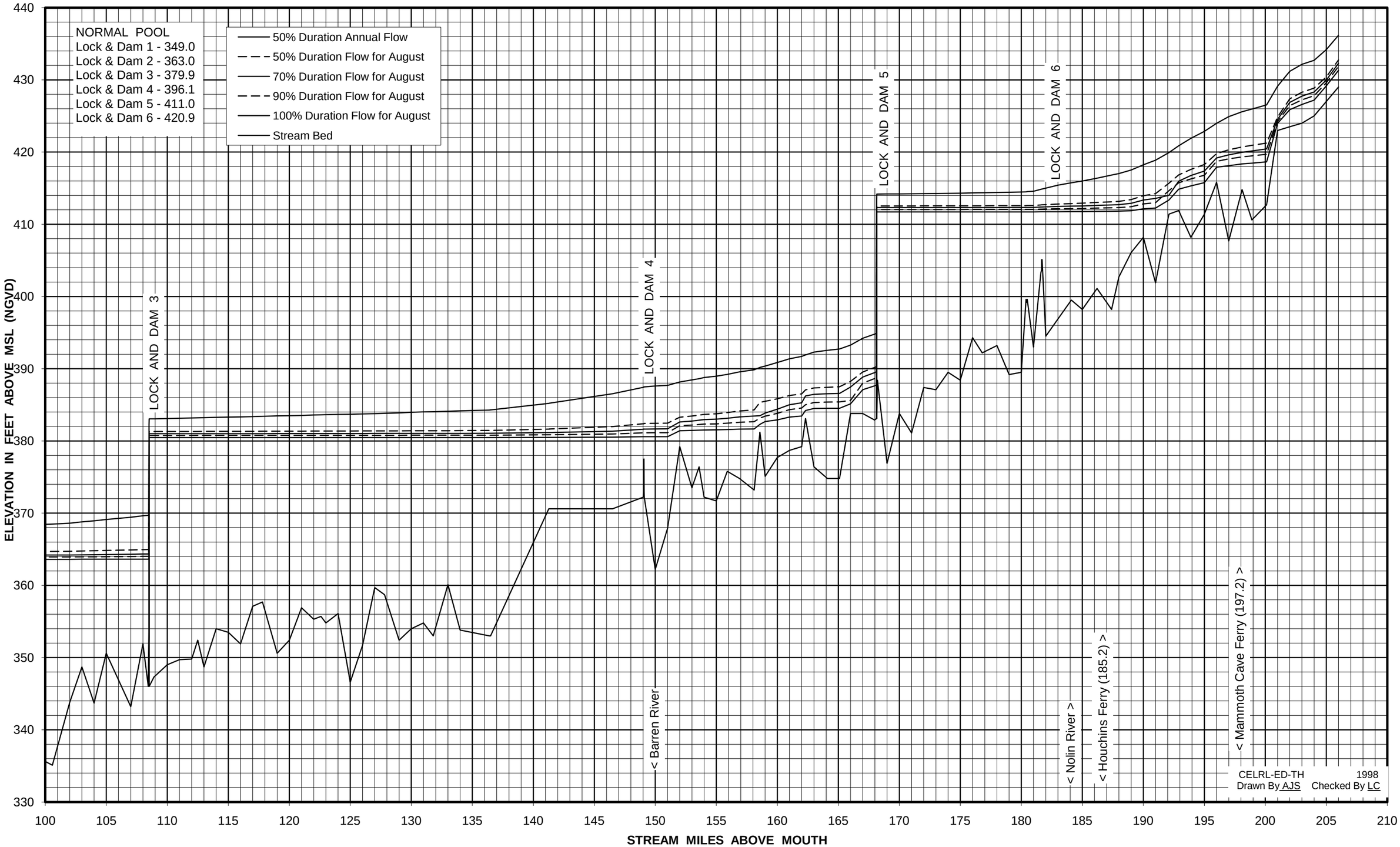
GREEN RIVER - KENTUCKY

DESIGN CONDITIONS - ALL LOCKS AND DAMS IN PLACE



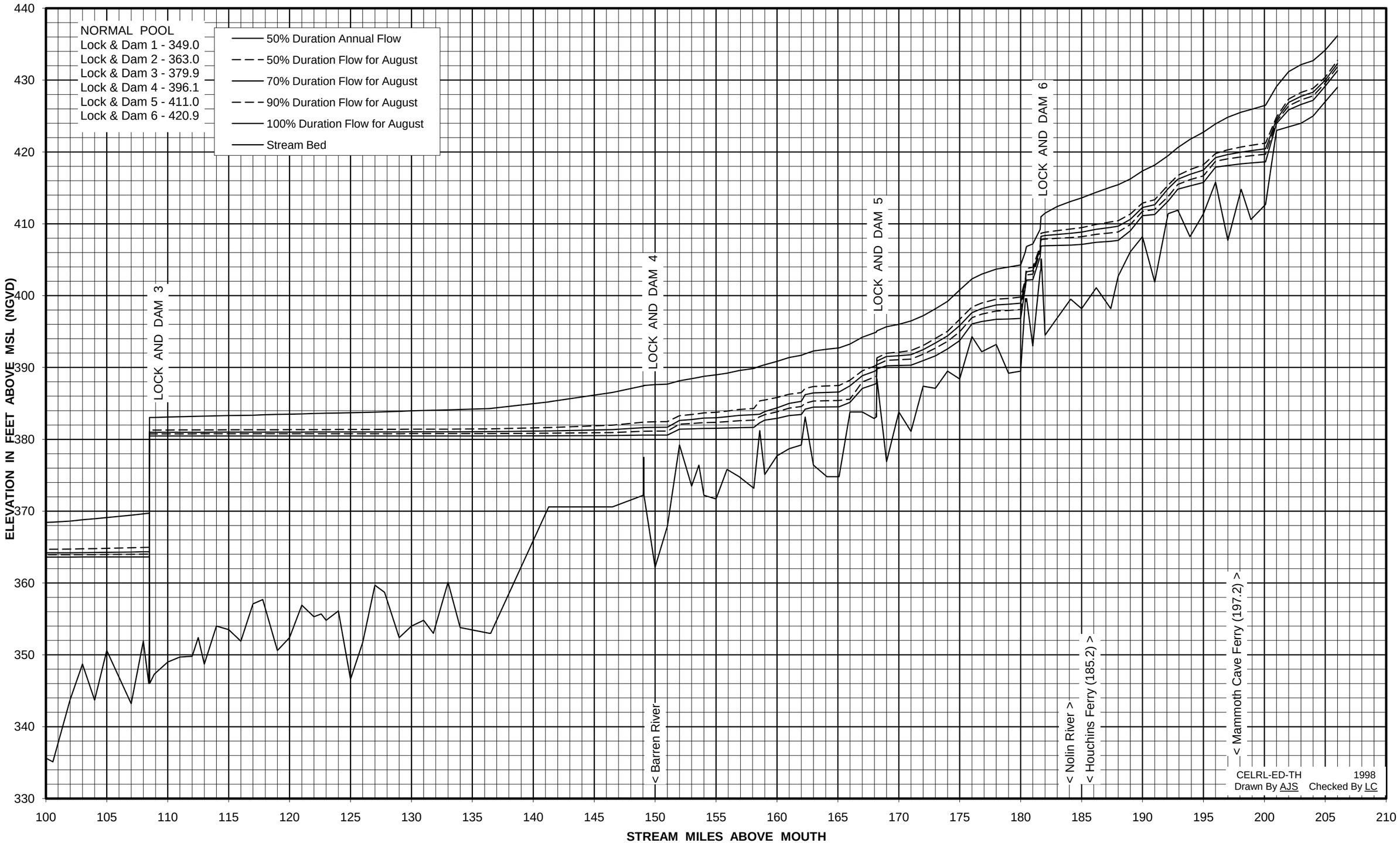
GREEN RIVER - KENTUCKY
ESTIMATED EXISTING CONDITIONS (DAM 4 DETERIORATED)

GREEN RIVER - KENTUCKY
DAM 4 DETERIORATED AND DAM 6 REMOVED



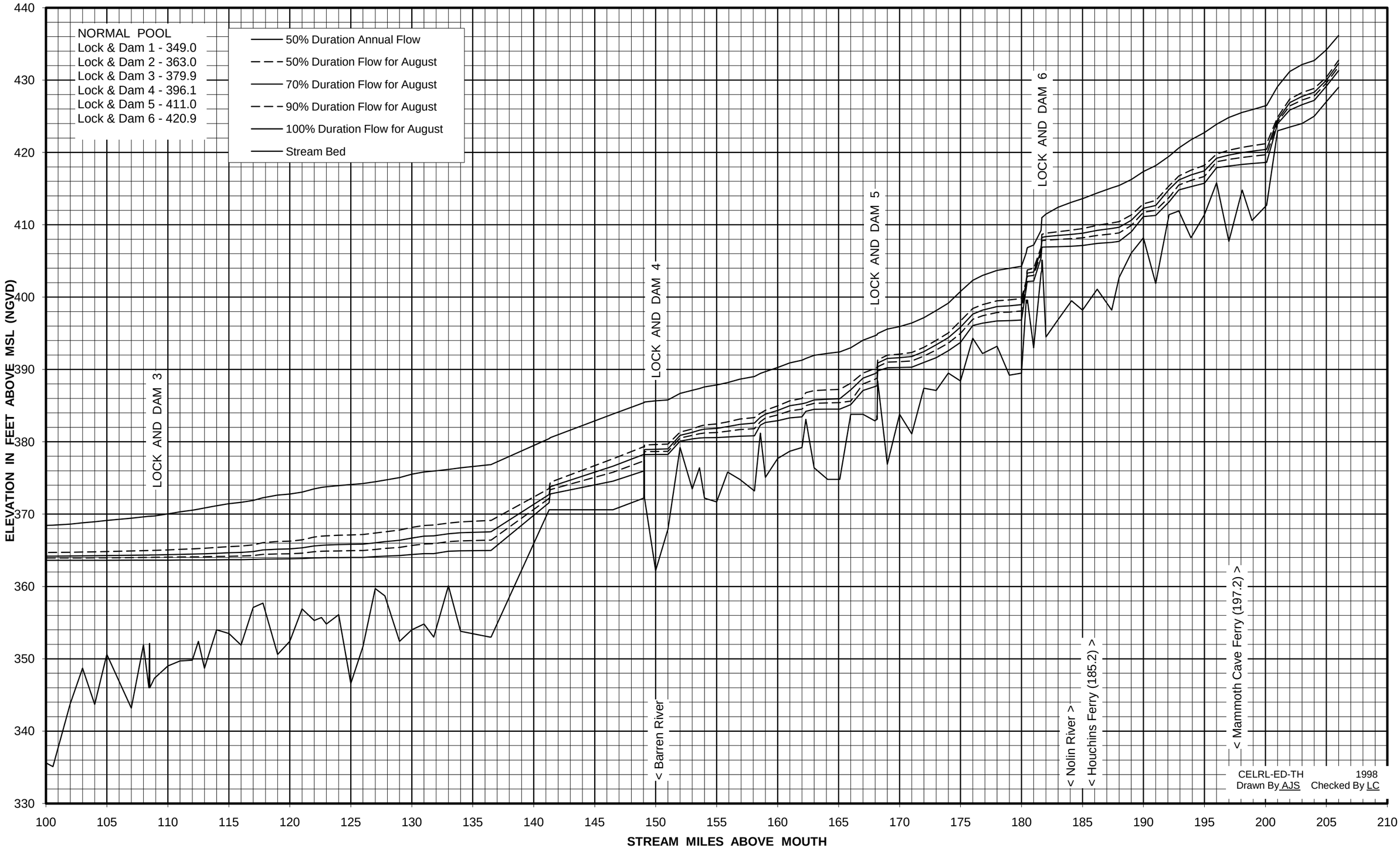
GREEN RIVER - KENTUCKY

DAM 4 DETERIORATED, DAM 5 AND 6 REMOVED



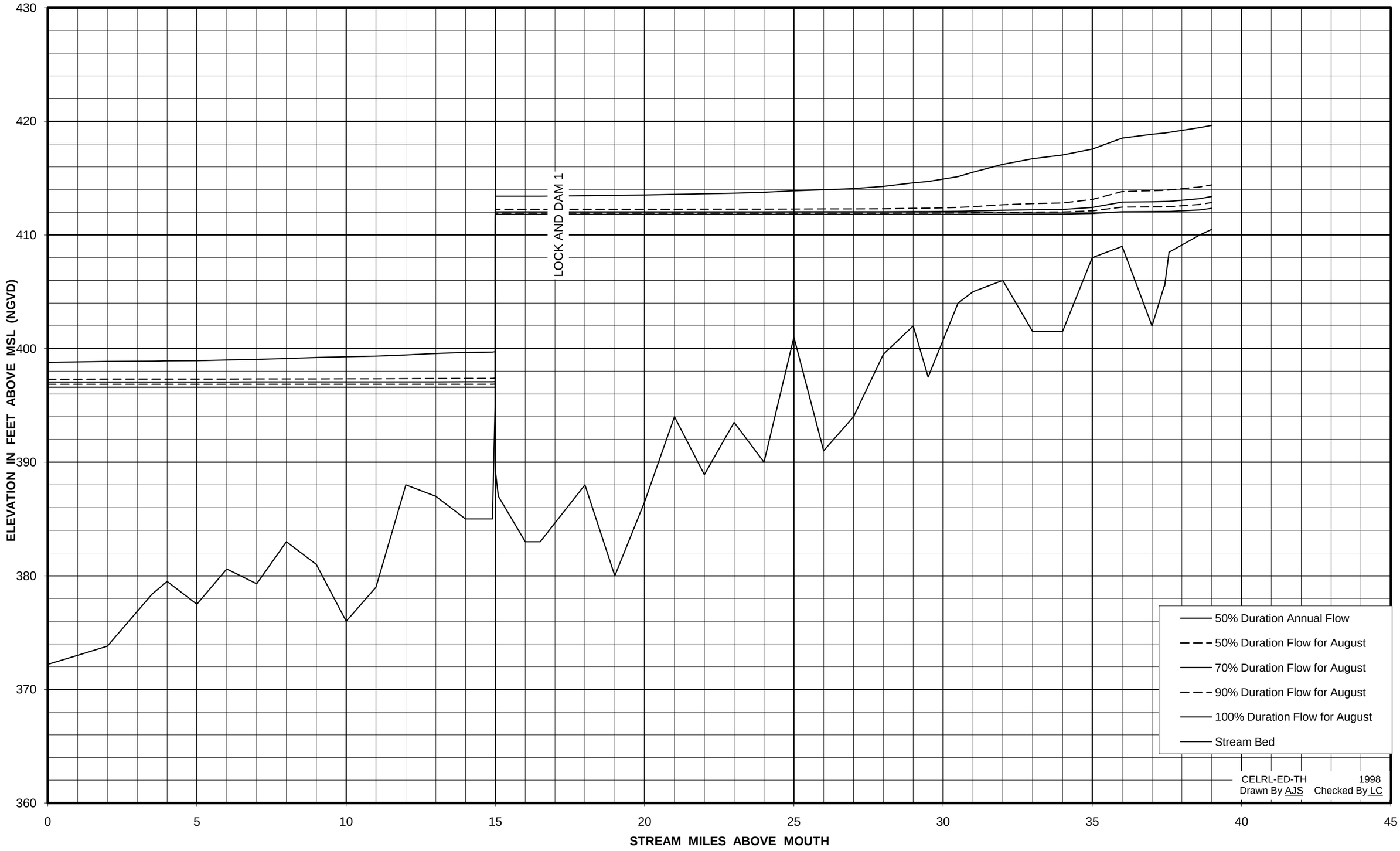
GREEN RIVER - KENTUCKY

DAM 4 DETERIORATED, DAM 3, 5 AND 6 REMOVED

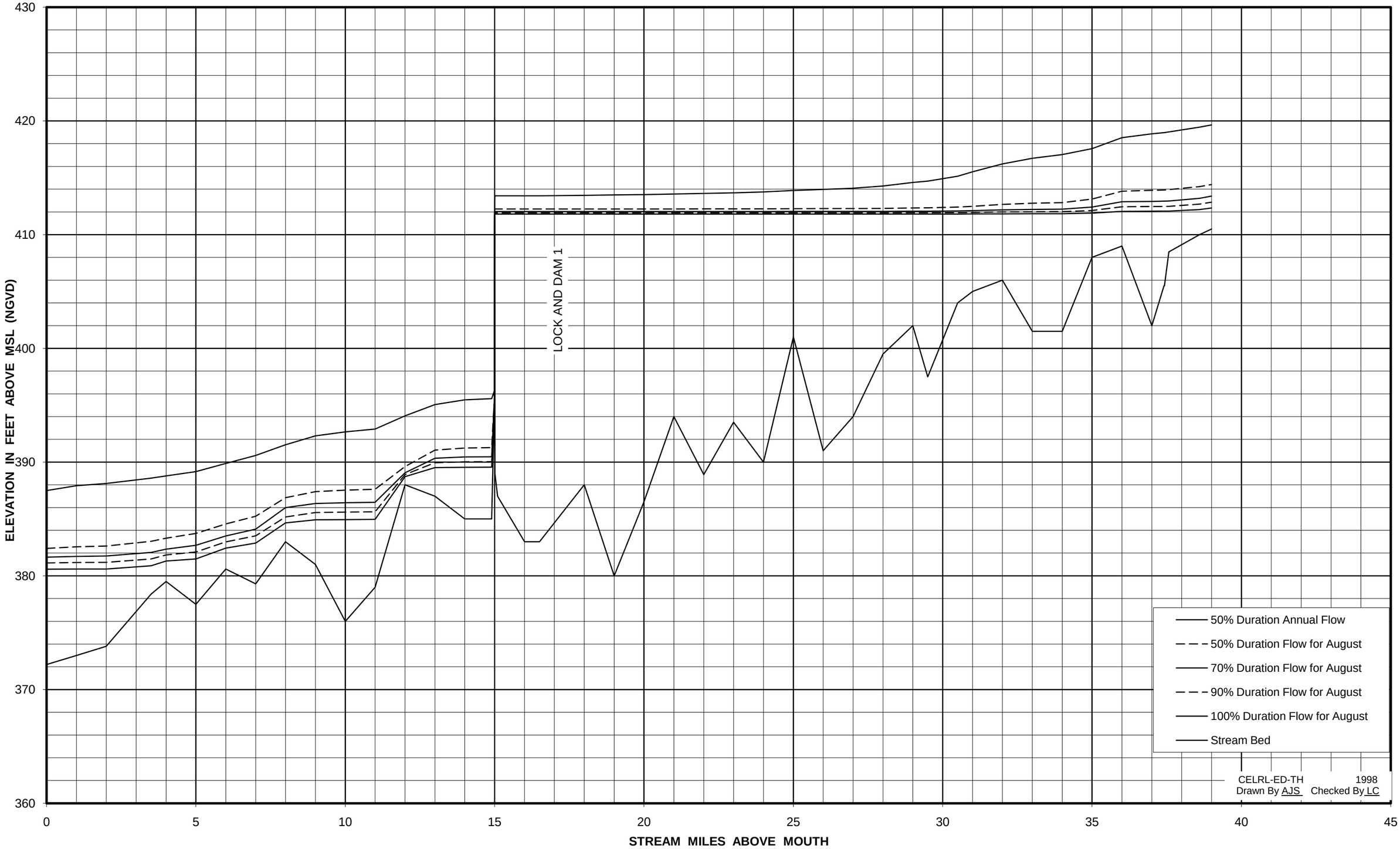


BARREN RIVER - KENTUCKY

DESIGN CONDITIONS - ALL LOCKS AND DAMS IN PLACE

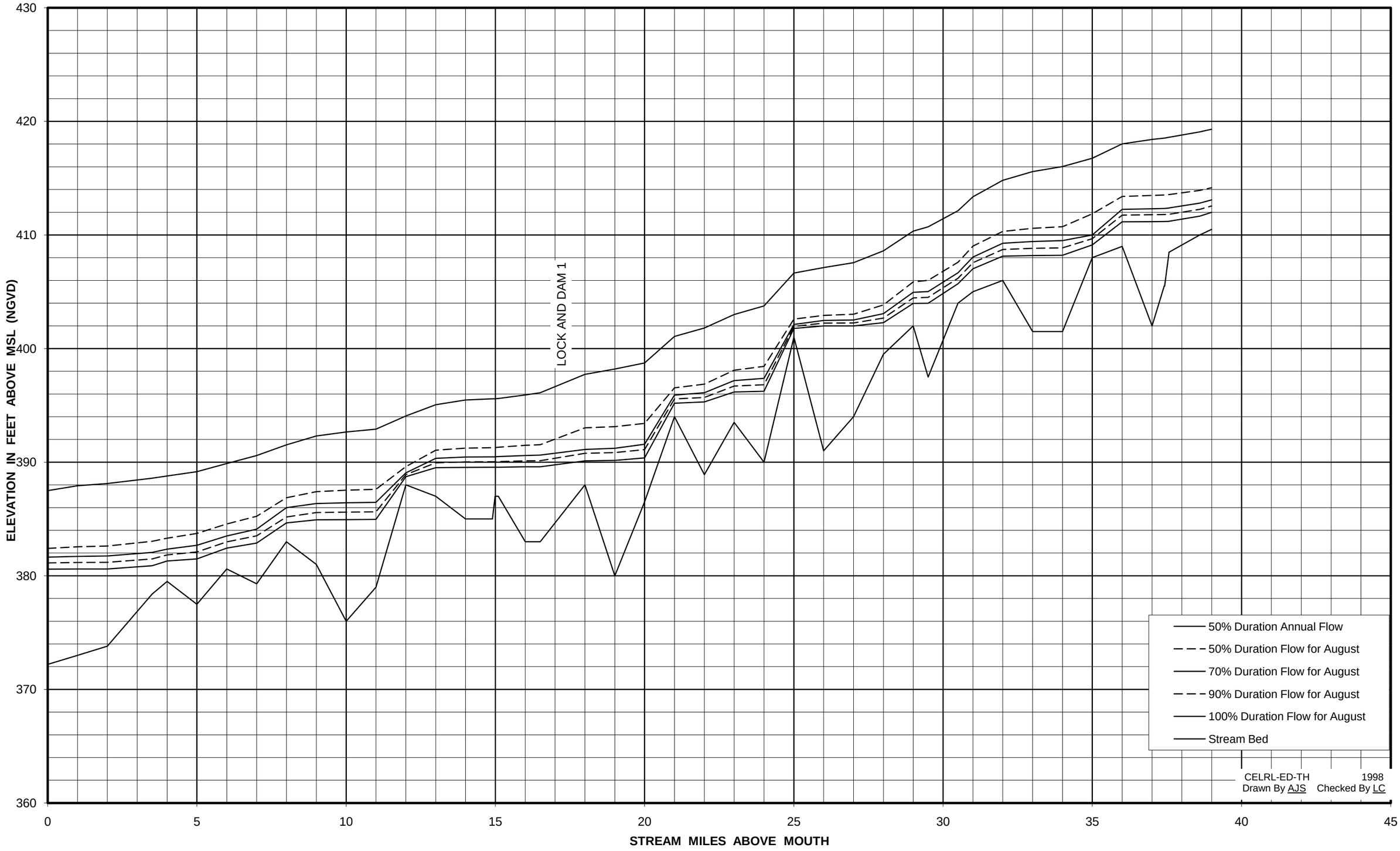


BARREN RIVER - KENTUCKY
ESTIMATED EXISTING CONDITIONS (GREEN RIVER DAM 4 DETERIORATED)

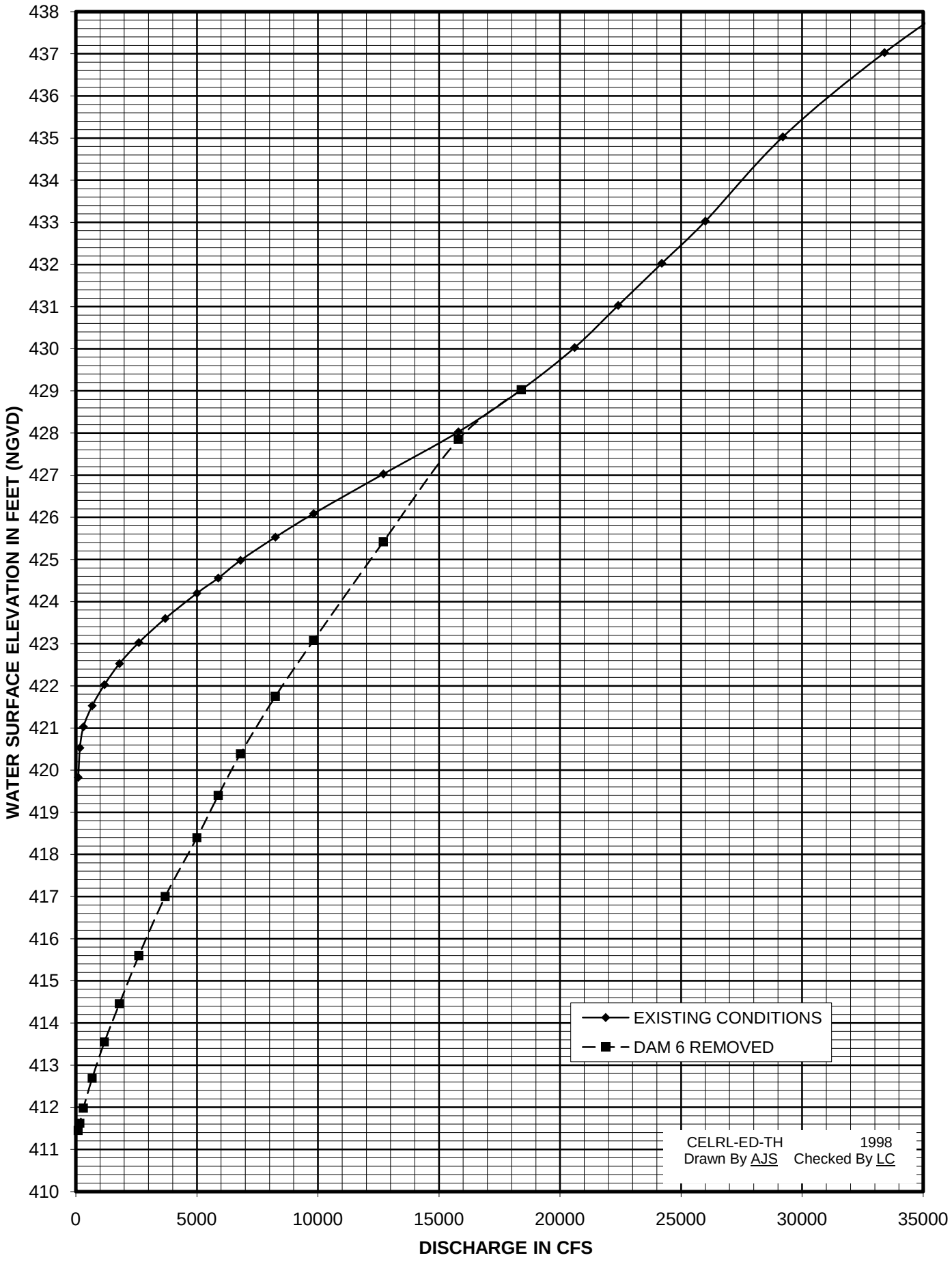


BARREN RIVER - KENTUCKY

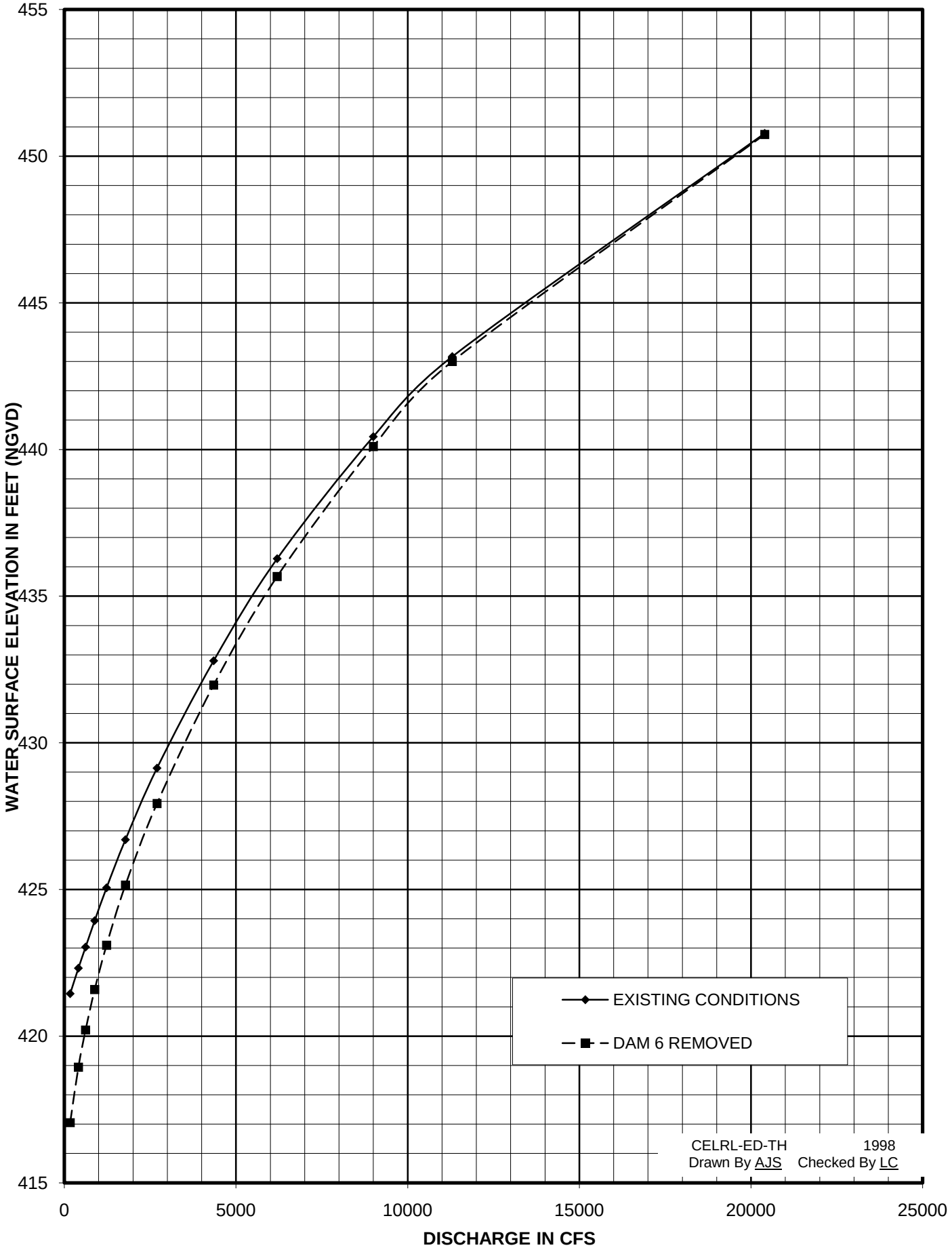
GREEN RIVER DAM 4 DETERIORATED AND BARREN RIVER DAM 1 REMOVED



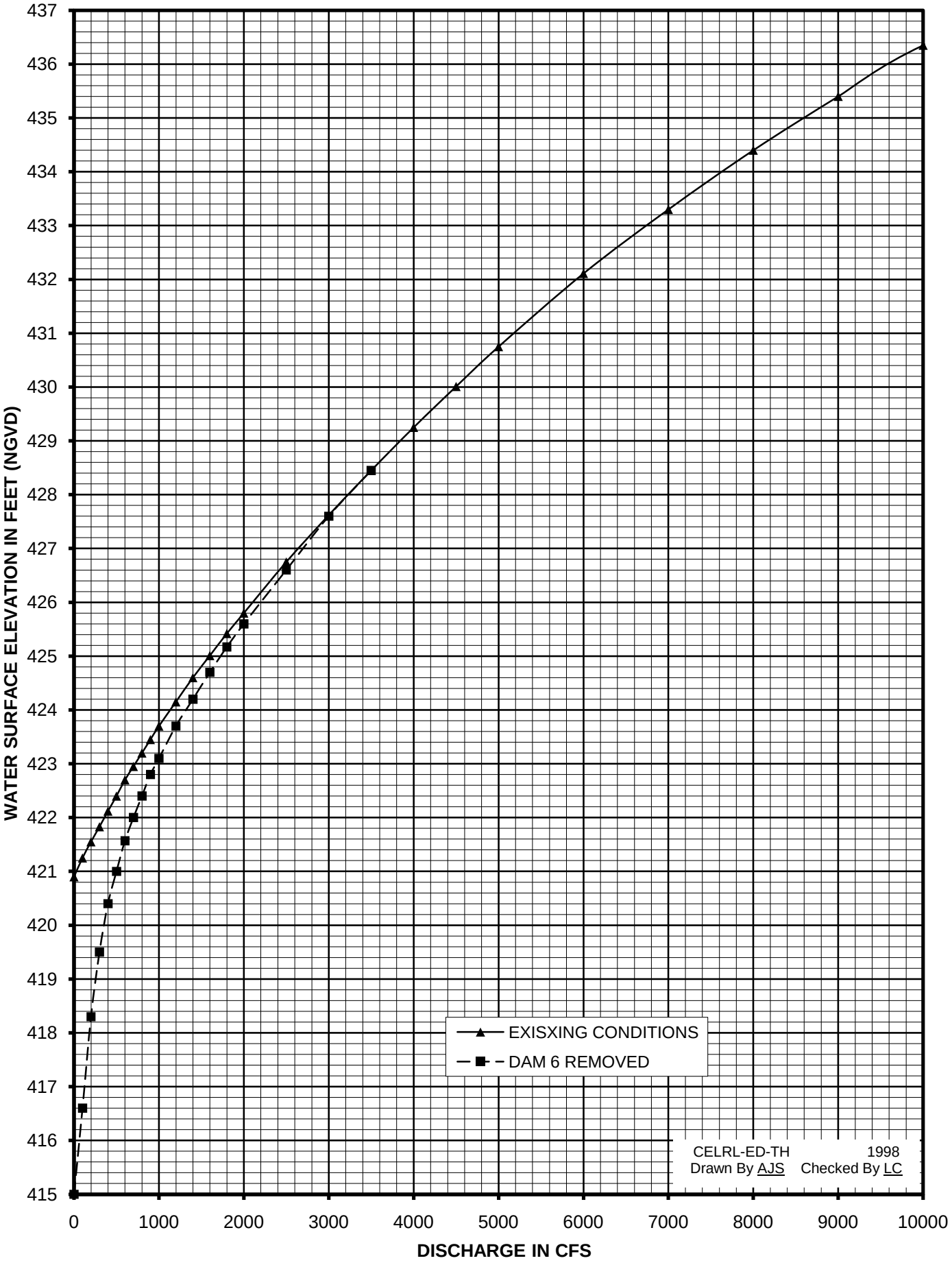
GREEN RIVER AT BROWNSVILLE - LOCK AND DAM 6



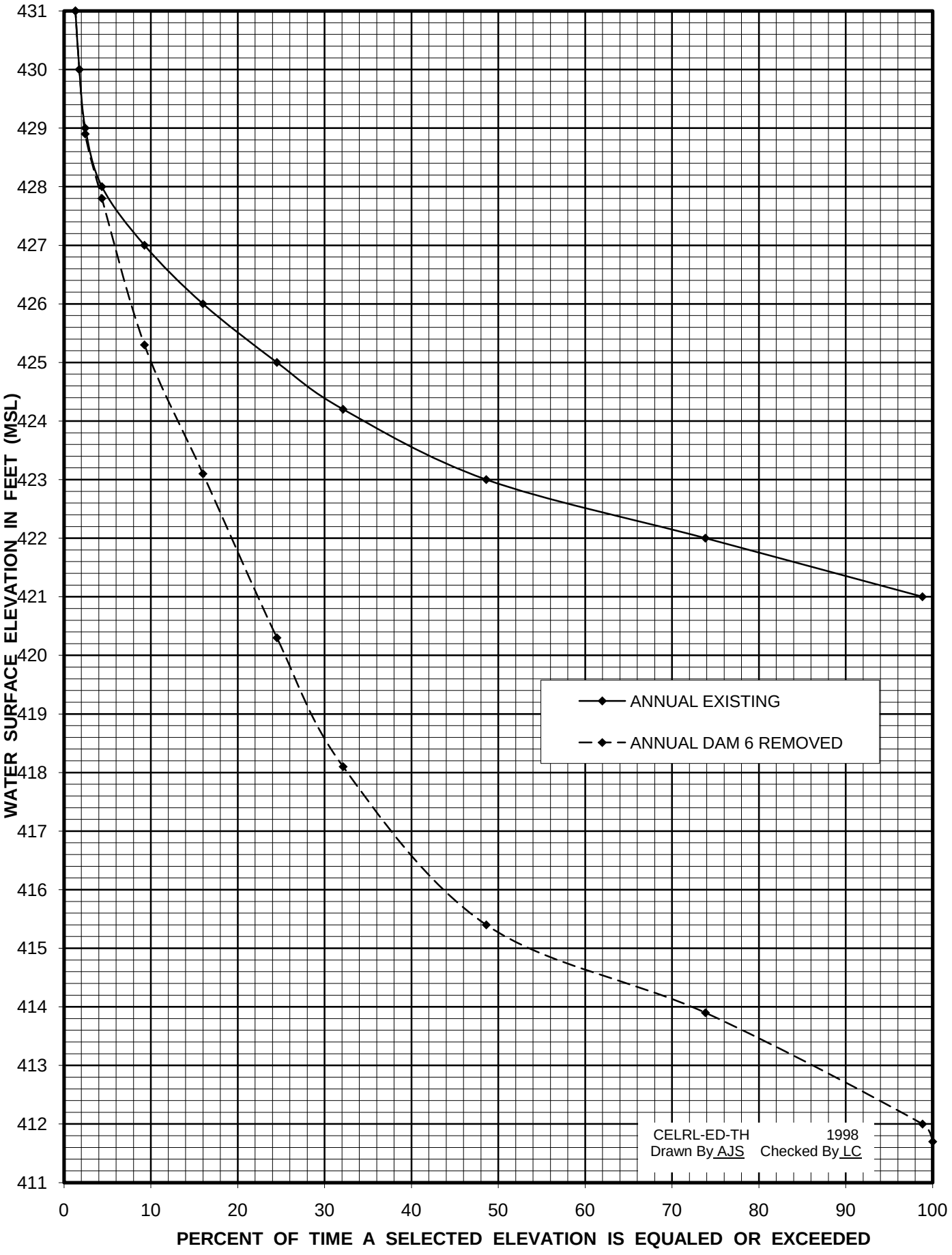
GREEN RIVER AT MILE 197 - HYPOTHETICAL GAGE
(MAMMOTH CAVE AREA)



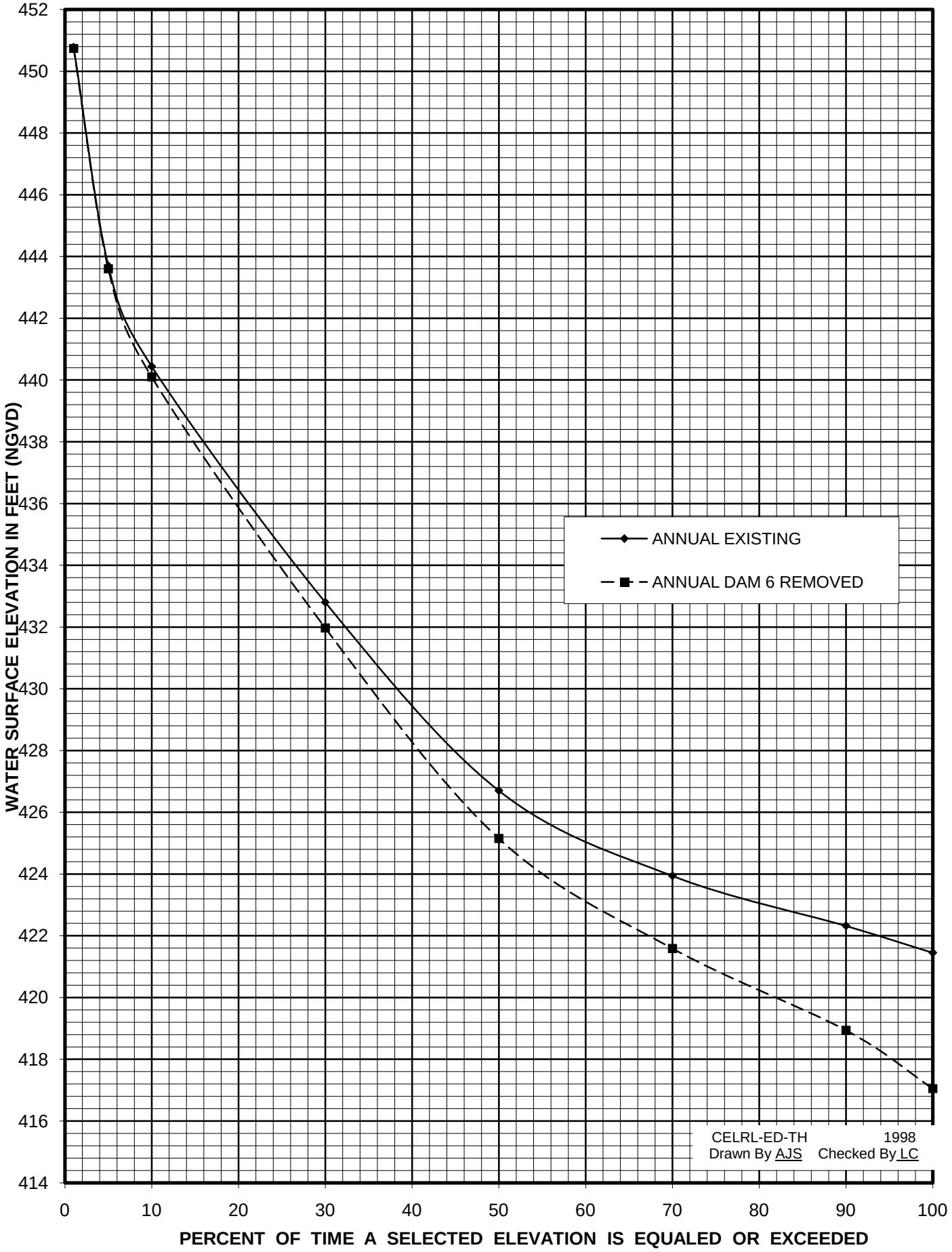
NOLIN RIVER AT KYROCK



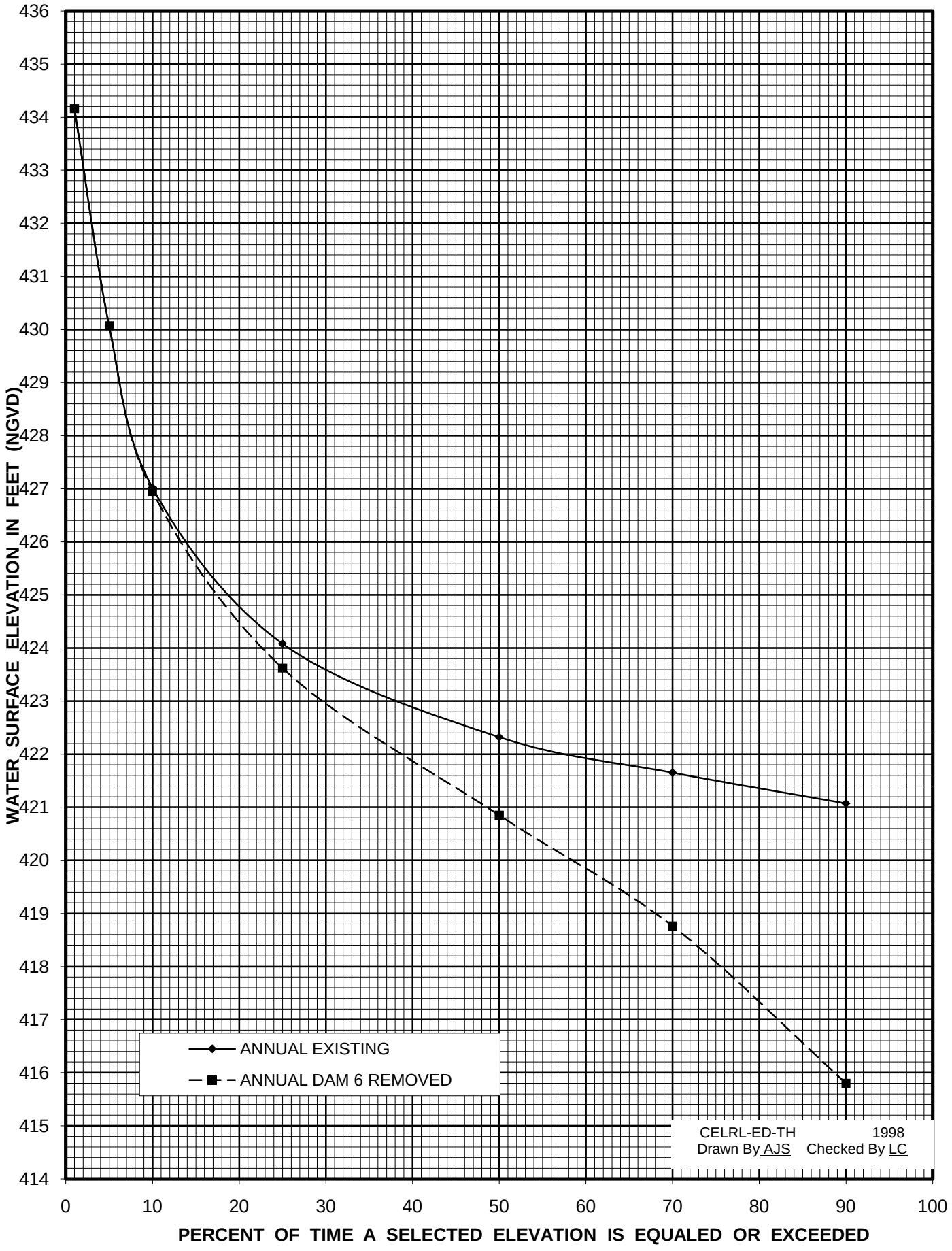
GREEN RIVER AT BROWNSVILLE - LOCK AND DAM 6
ELEVATION DURATION



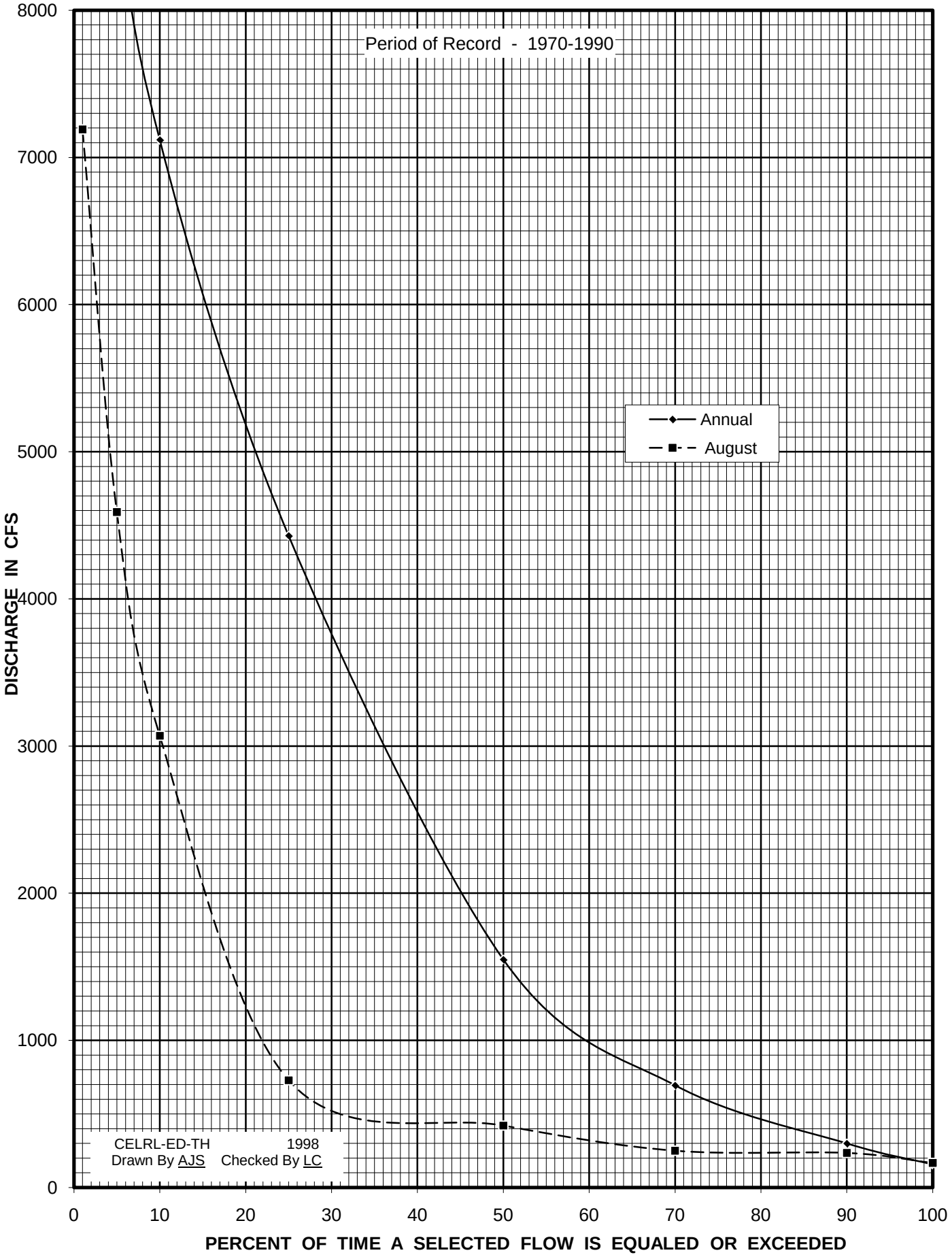
GREEN RIVER AT MILE 197 - HYPOTHETICAL GAGE
ELEVATION DURATION - (MAMMOTH CAVE AREA)



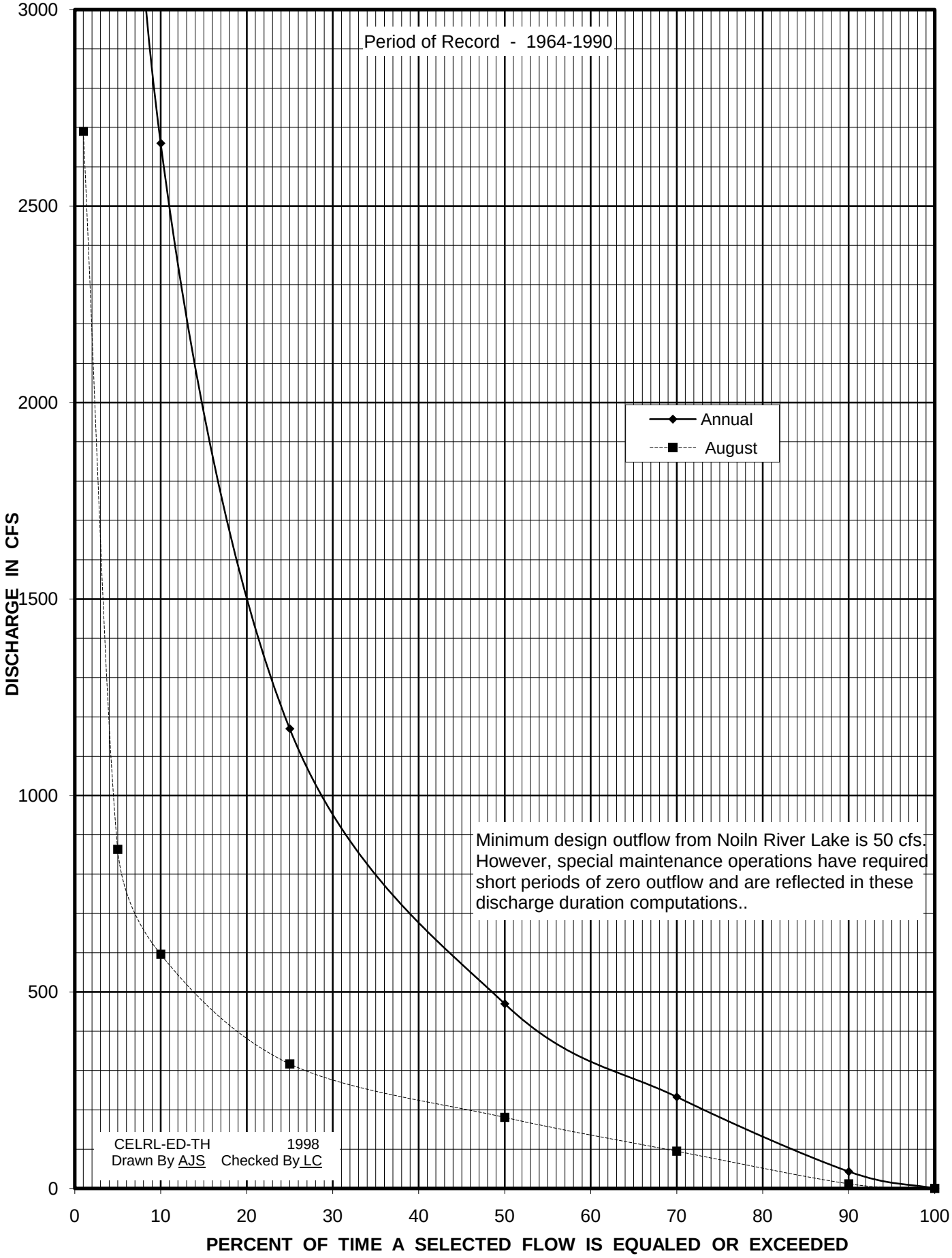
NOILN RIVER AT KYROCK, KENTUCKY
ELEVATION DURATION



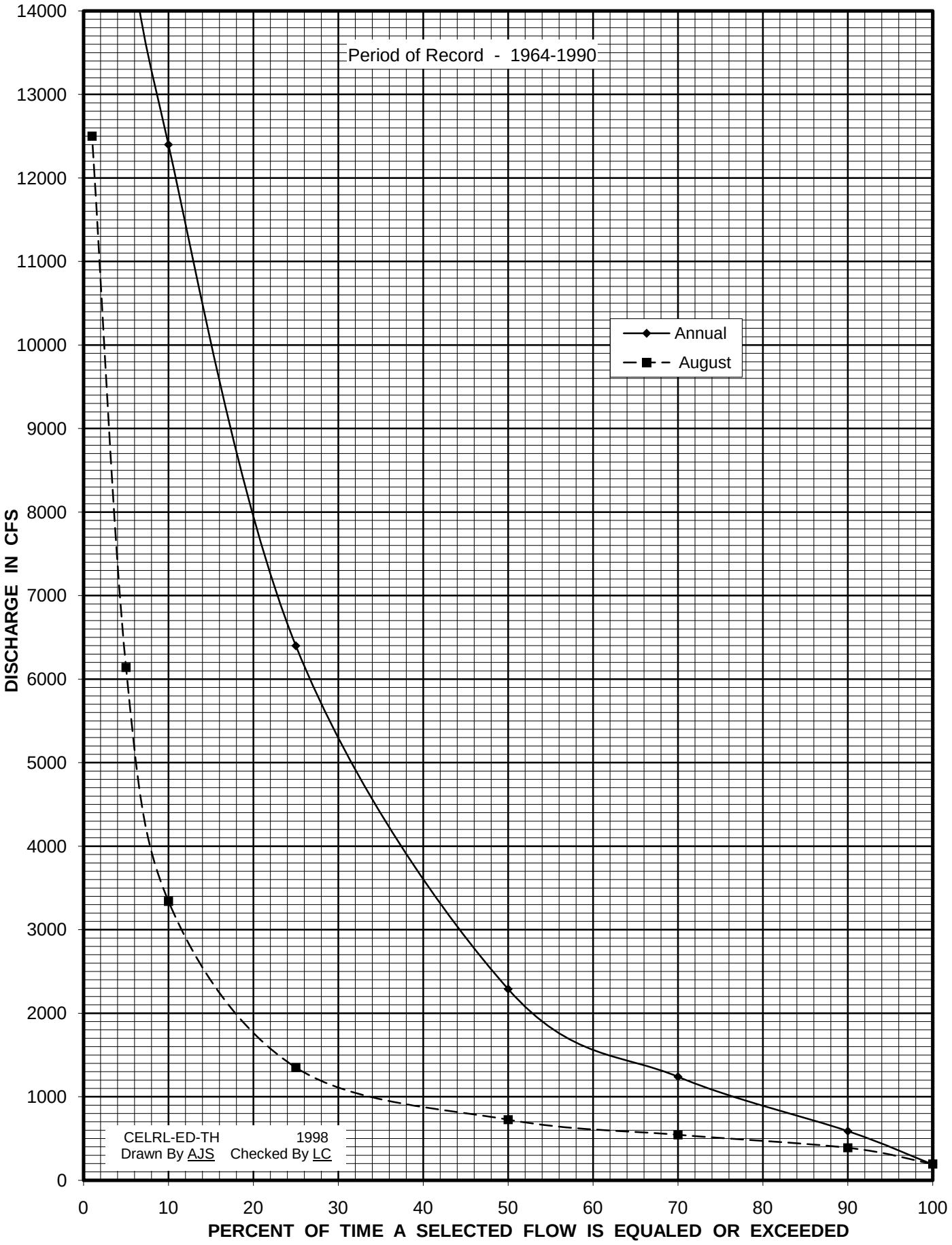
GREEN RIVER AT MUNFORDVILLE, KENTUCKY
DISCHARGE DURATION



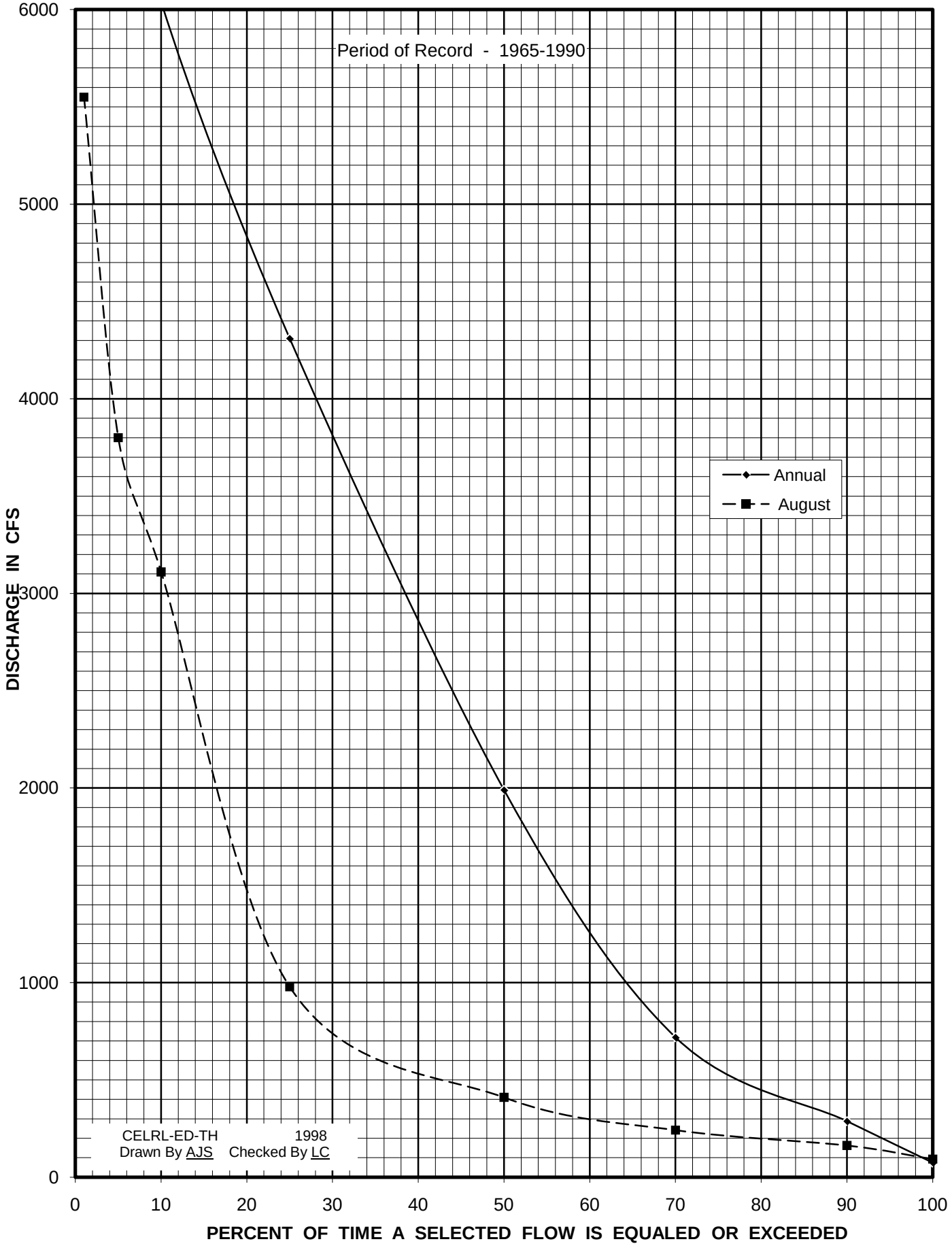
NOILN RIVER AT KYROCK, KENTUCKY
DISCHARGE DURATION



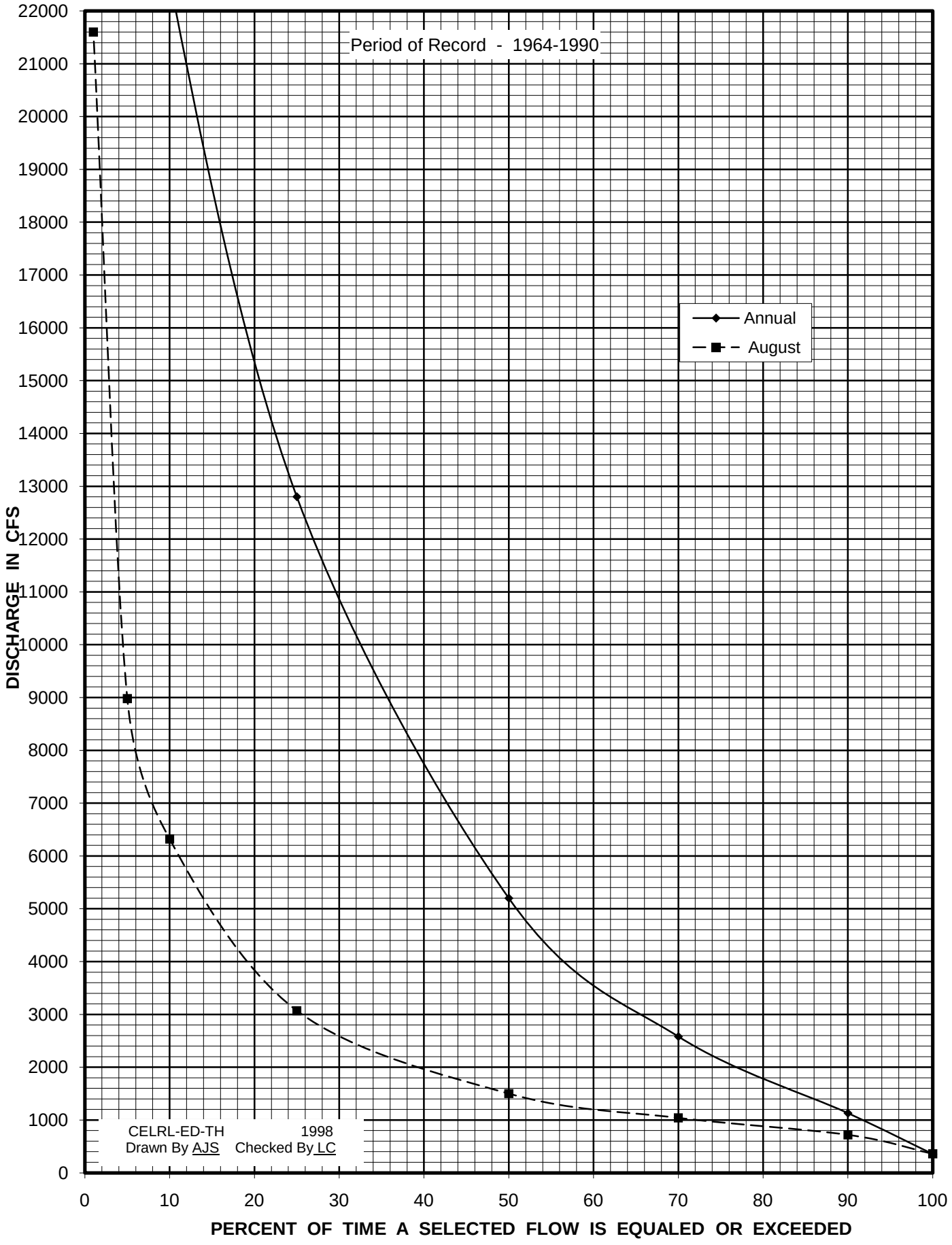
GREEN RIVER AT BROWNSVILLE - LOCK 6, KENTUCKY
DISCHARGE DURATION



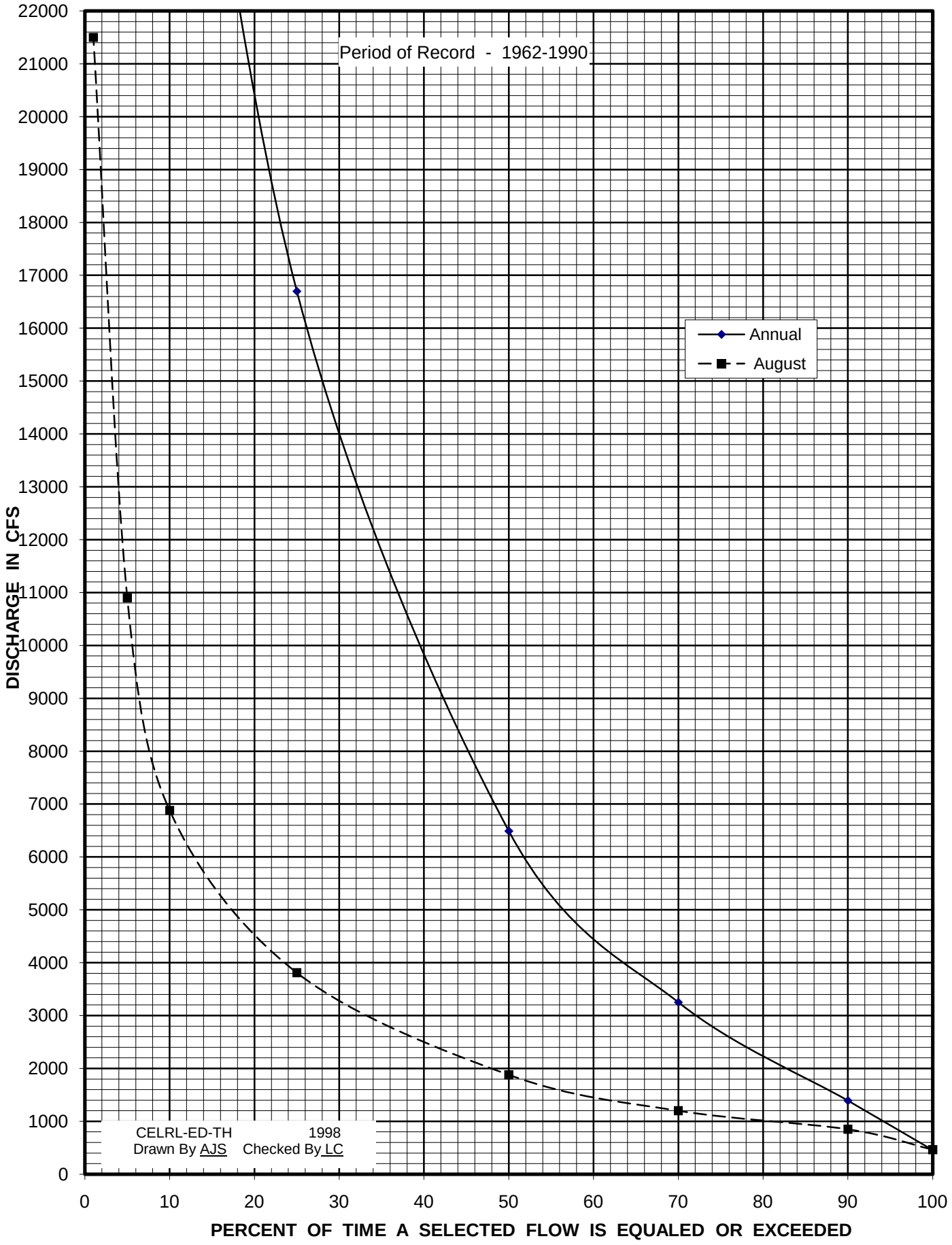
BARREN RIVER AT BOWLING GREEN, KENTUCKY
DISCHARGE DURATION

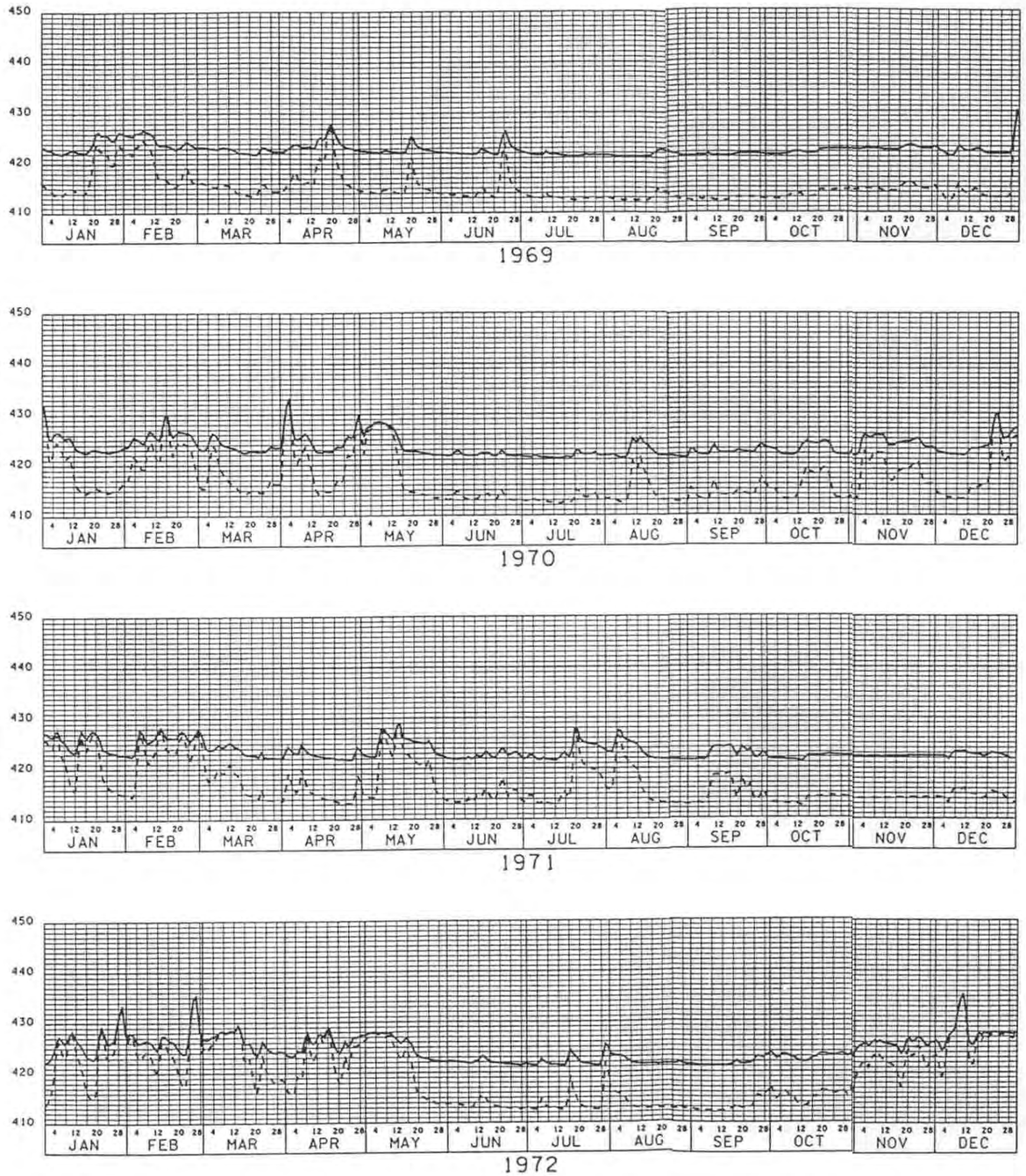


GREEN RIVER AT WOODBURY - LOCK 4, KENTUCKY
DISCHARGE DURATION



GREEN RIVER AT CALHOUN - LOCK 2, KENTUCKY
DISCHARGE DURATION





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——————— **EXISTING CONDITION**

- - - - - - - - - - **DAM REMOVED**

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GREEN RIVER
BROWNSVILLE, KY

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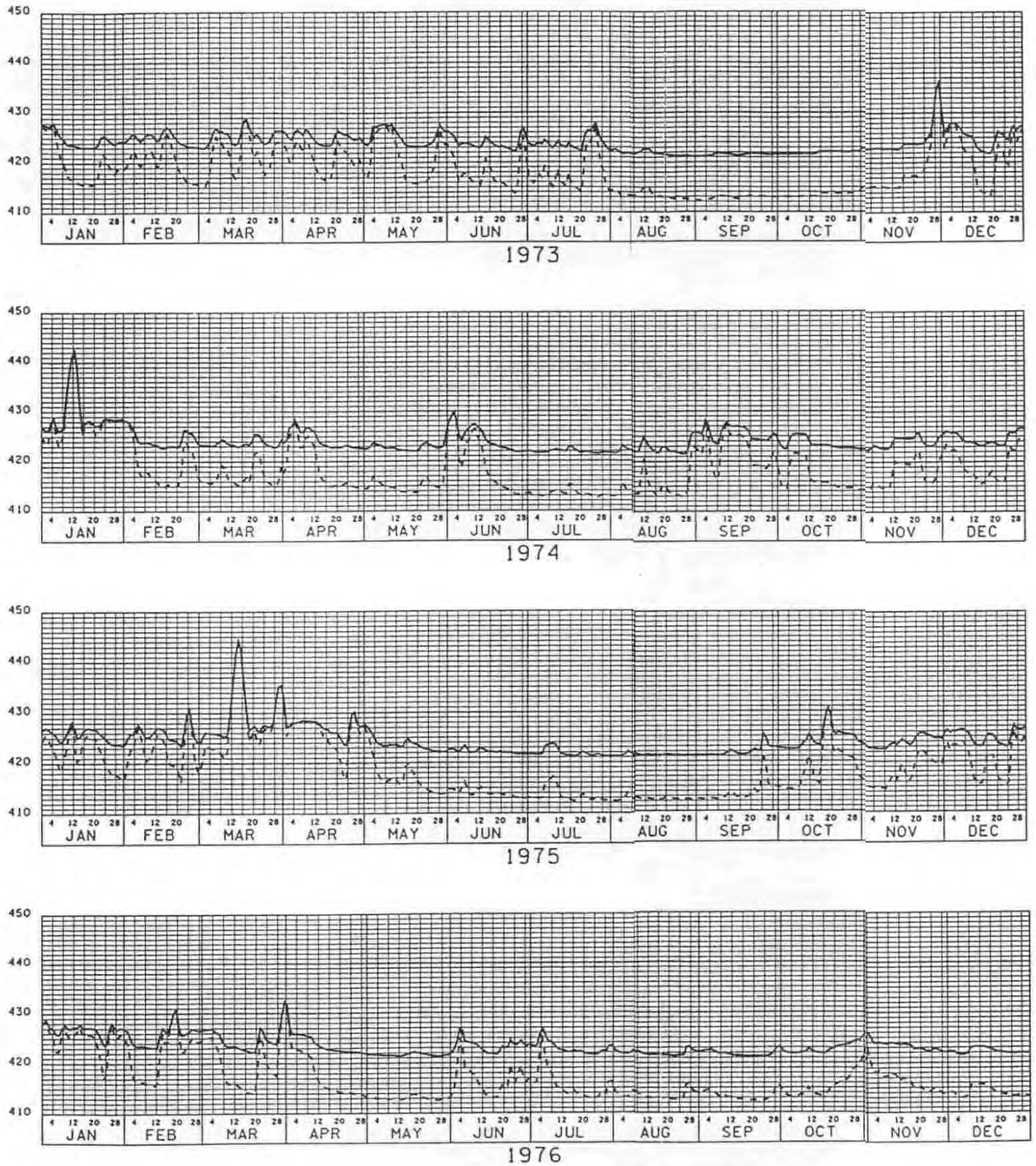

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GREEN RIVER
BROWNSVILLE, KY

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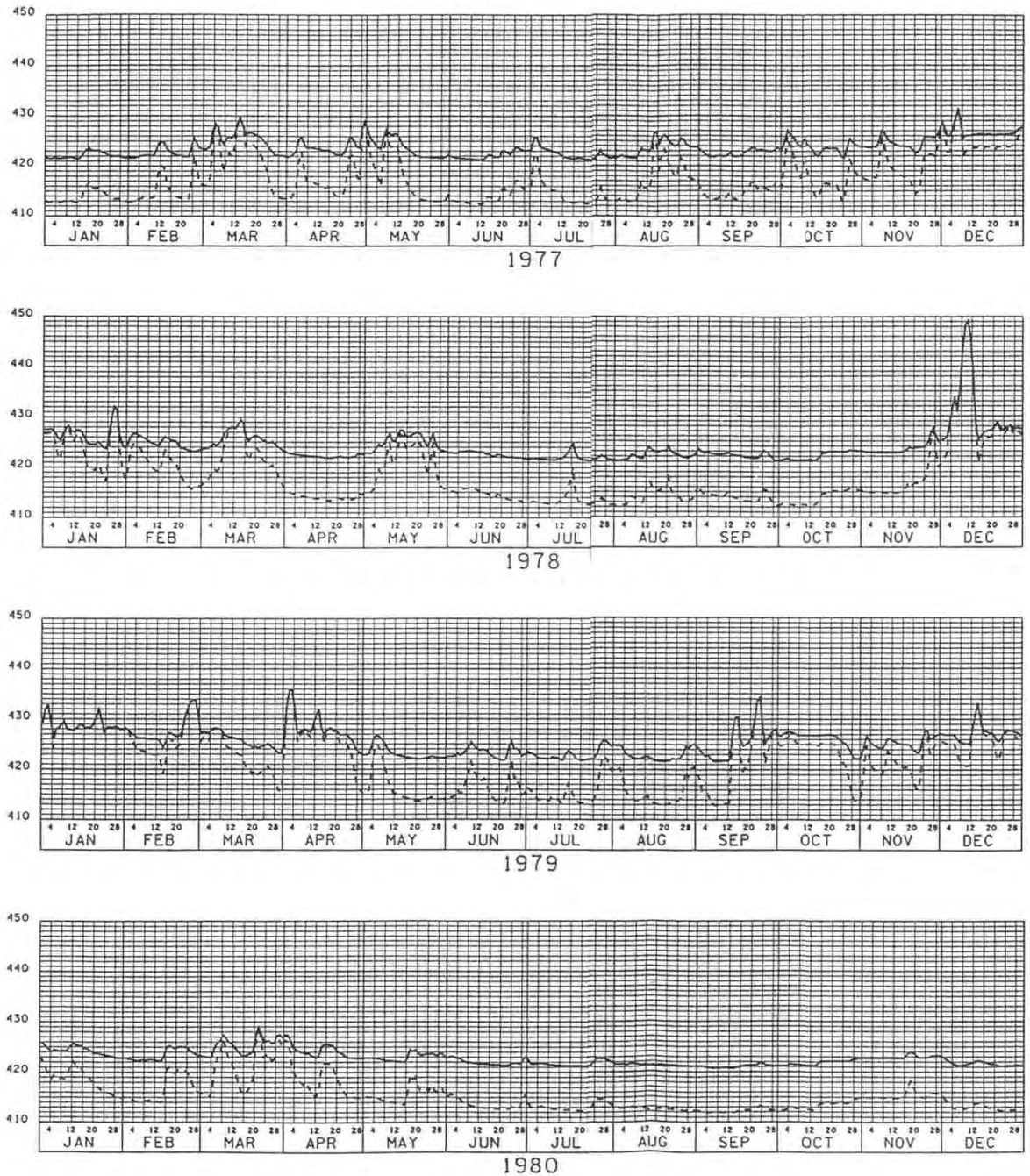

LEGEND:

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GREEN RIVER
BROWNSVILLE, KY

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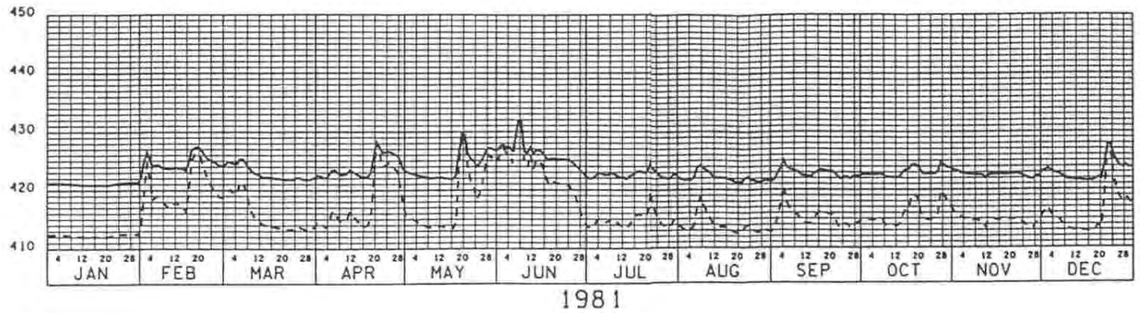

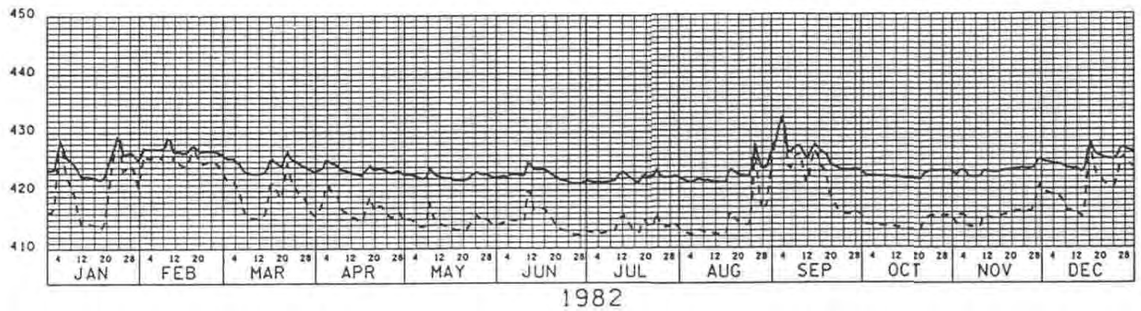

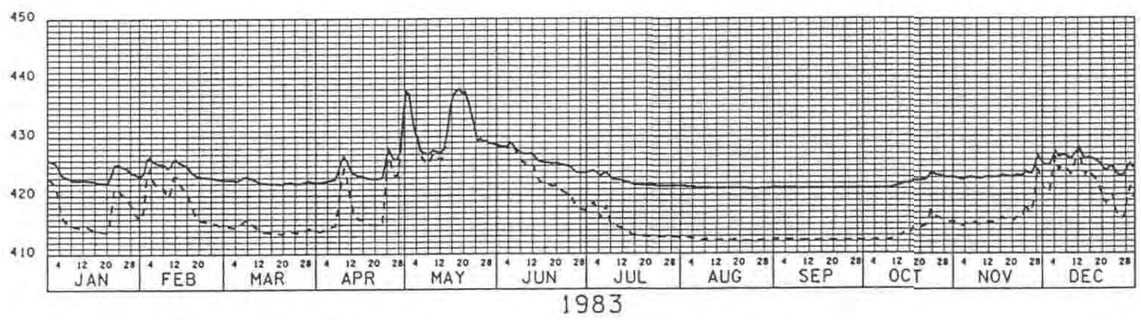

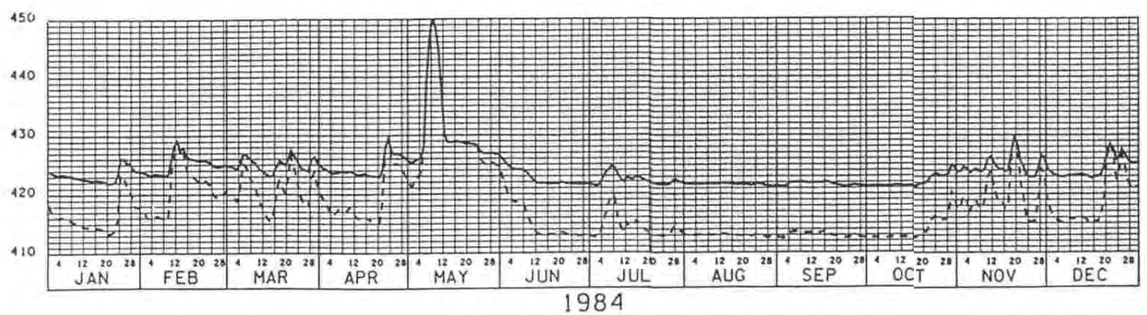

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BROWNSVILLE, KY

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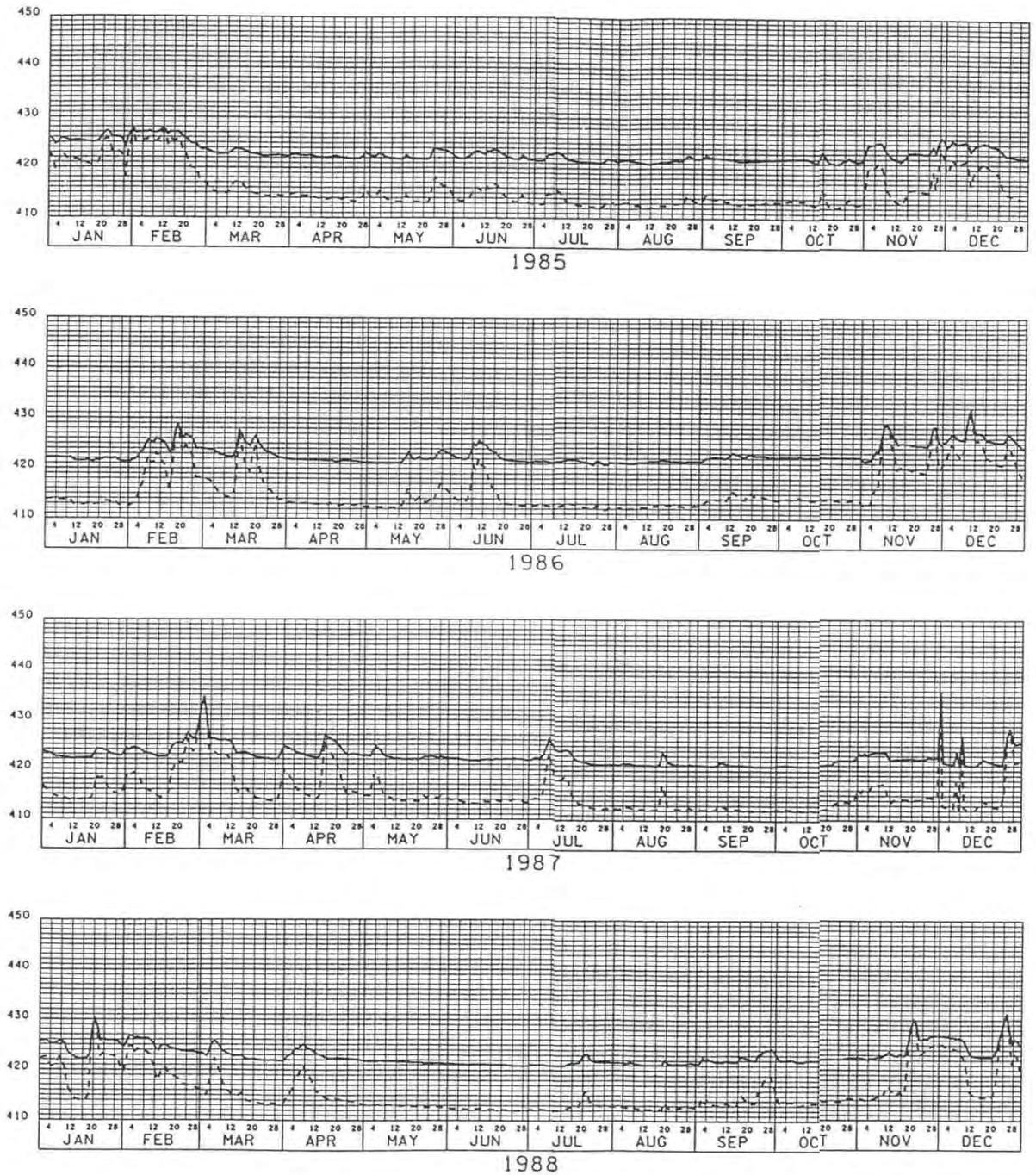
PLATE 46



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GREEN RIVER
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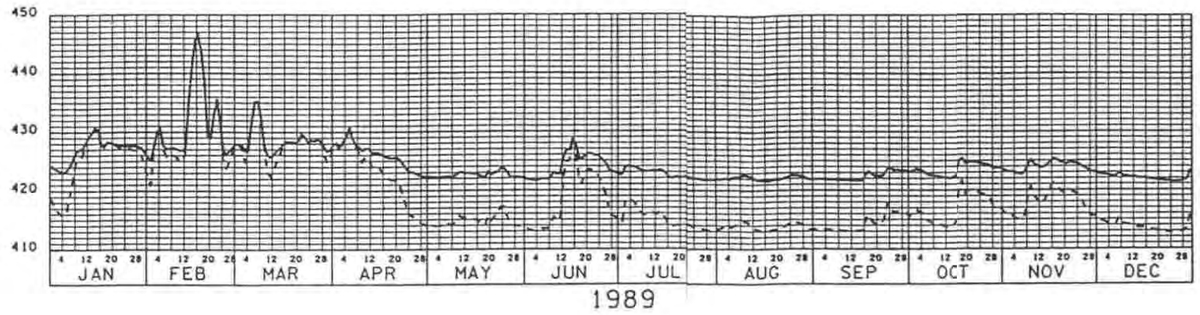

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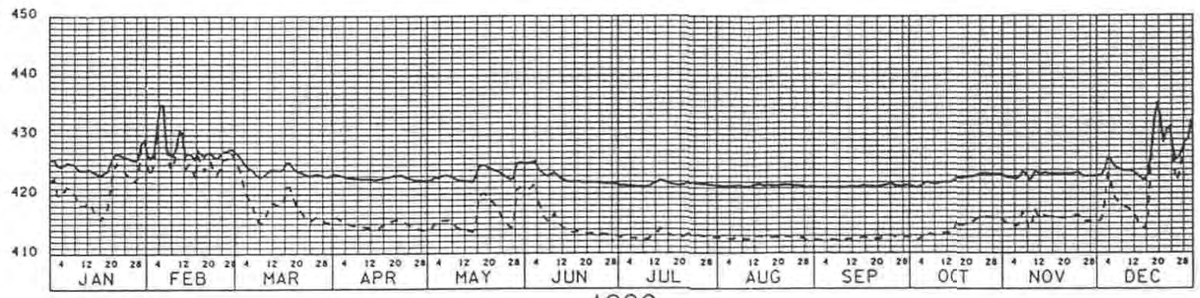

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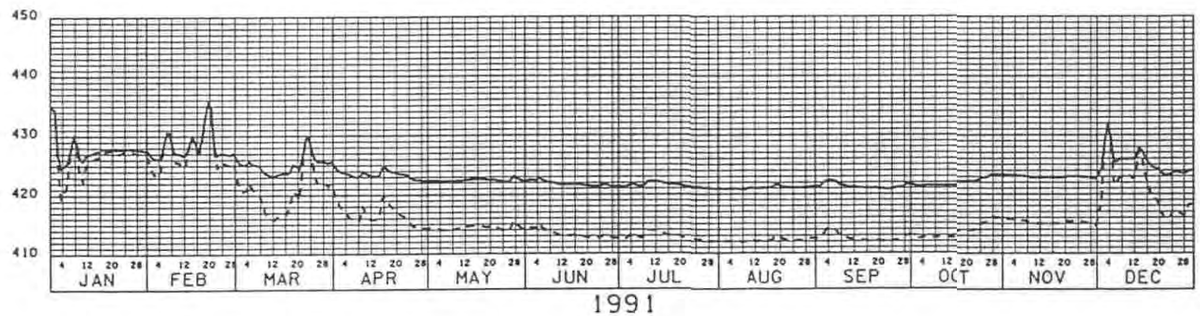

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LEGEND:

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GREEN RIVER
BROWNSVILLE, KY

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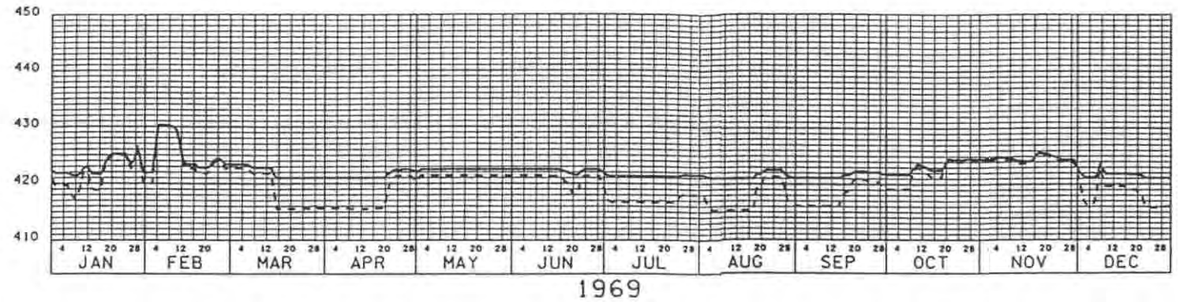
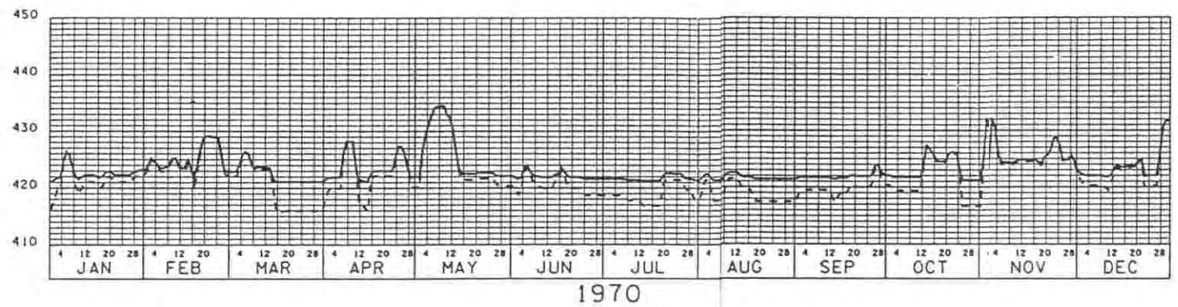
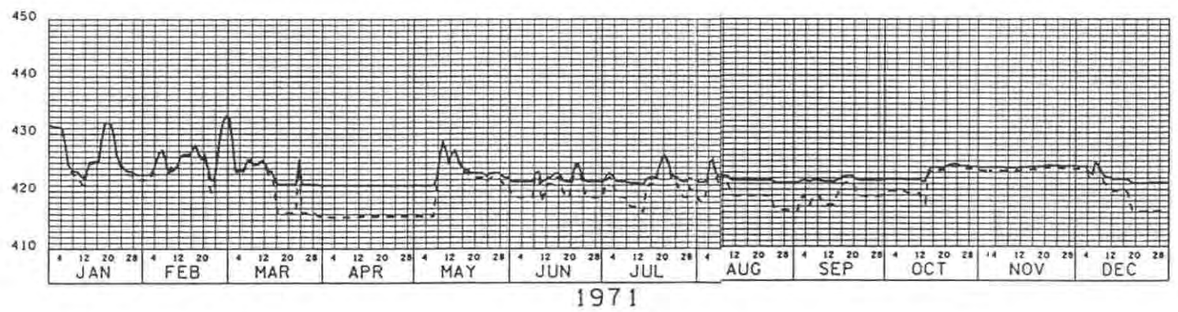
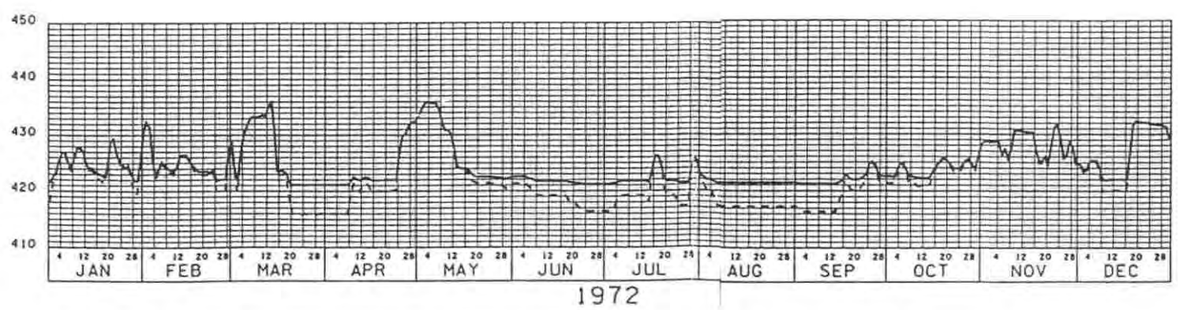
DATE: 28-Aug-96 01









LEGEND:

——————— **EXISTING CONDITION**

- - - - - - - - - - - **DAM REMOVED**

Revisions			
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LOUISVILLE, KENTUCKY

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US Army Corps of Engineers

NOLIN RIVER
KYROCK, KY

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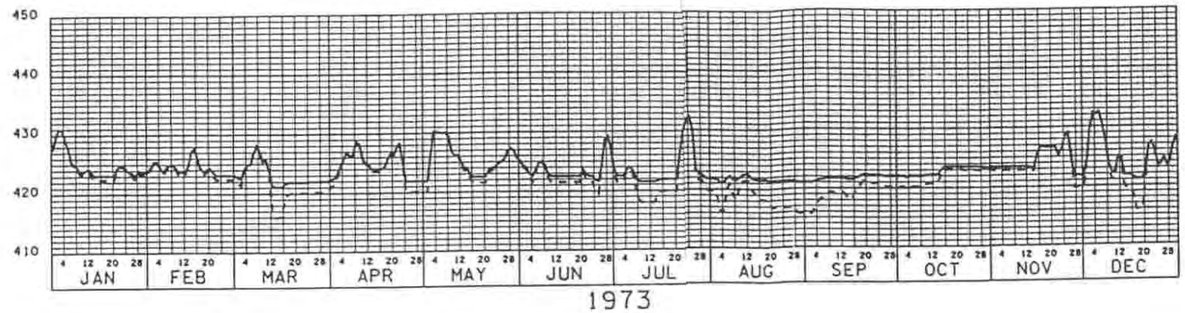
Sheet reference numbers
Sheet ___ of ___

FILE: C:*hydro*NOLRV.DGN
DATE: 28-Aug-96 08:30



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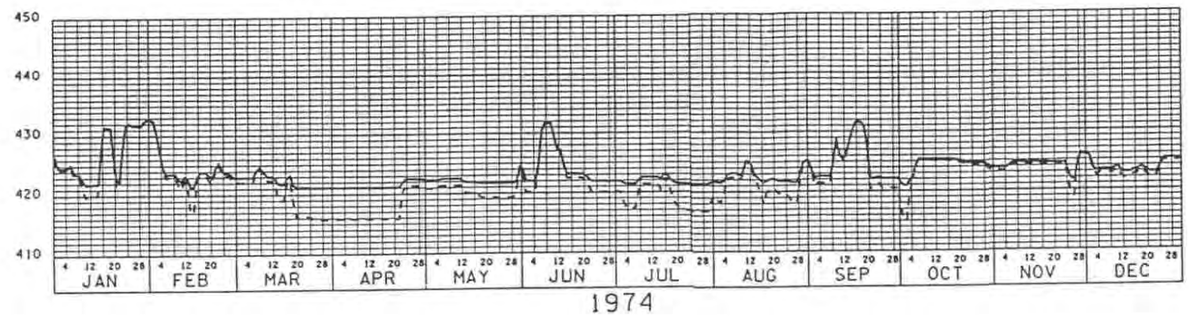

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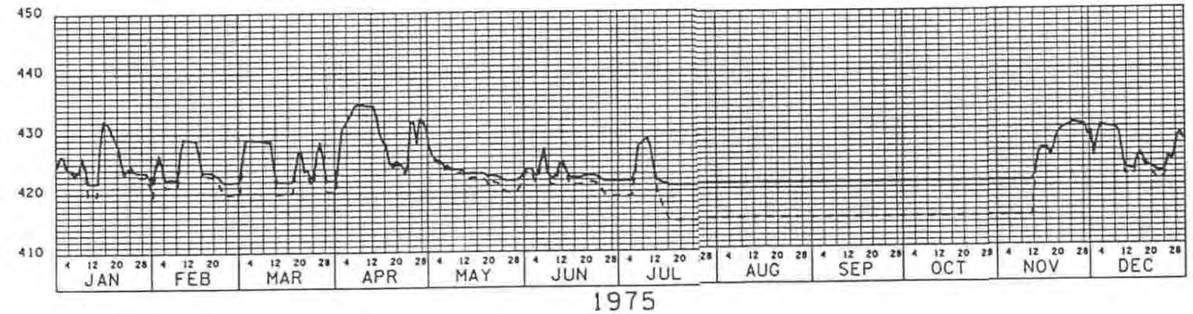

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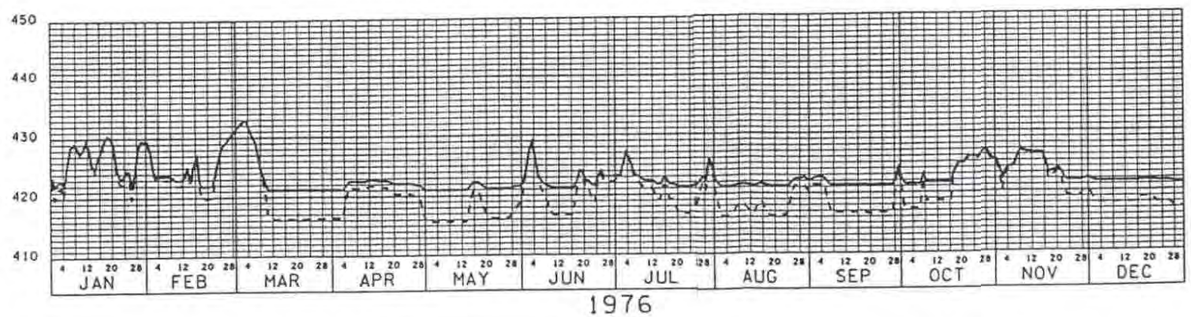

1976

LEGEND:

——————— **EXISTING CONDITION**

- - - - - - - - - - **DAM REMOVED**

Revisions			
Symbol	Descriptions	Date	Approved

U.S.ARMY ENGINEER DISTRICT
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LOUISVILLE, KENTUCKY

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Checked by:
Reviewed by:
Approved by:

NOLIN RIVER
KYROCK, KY

Scale:
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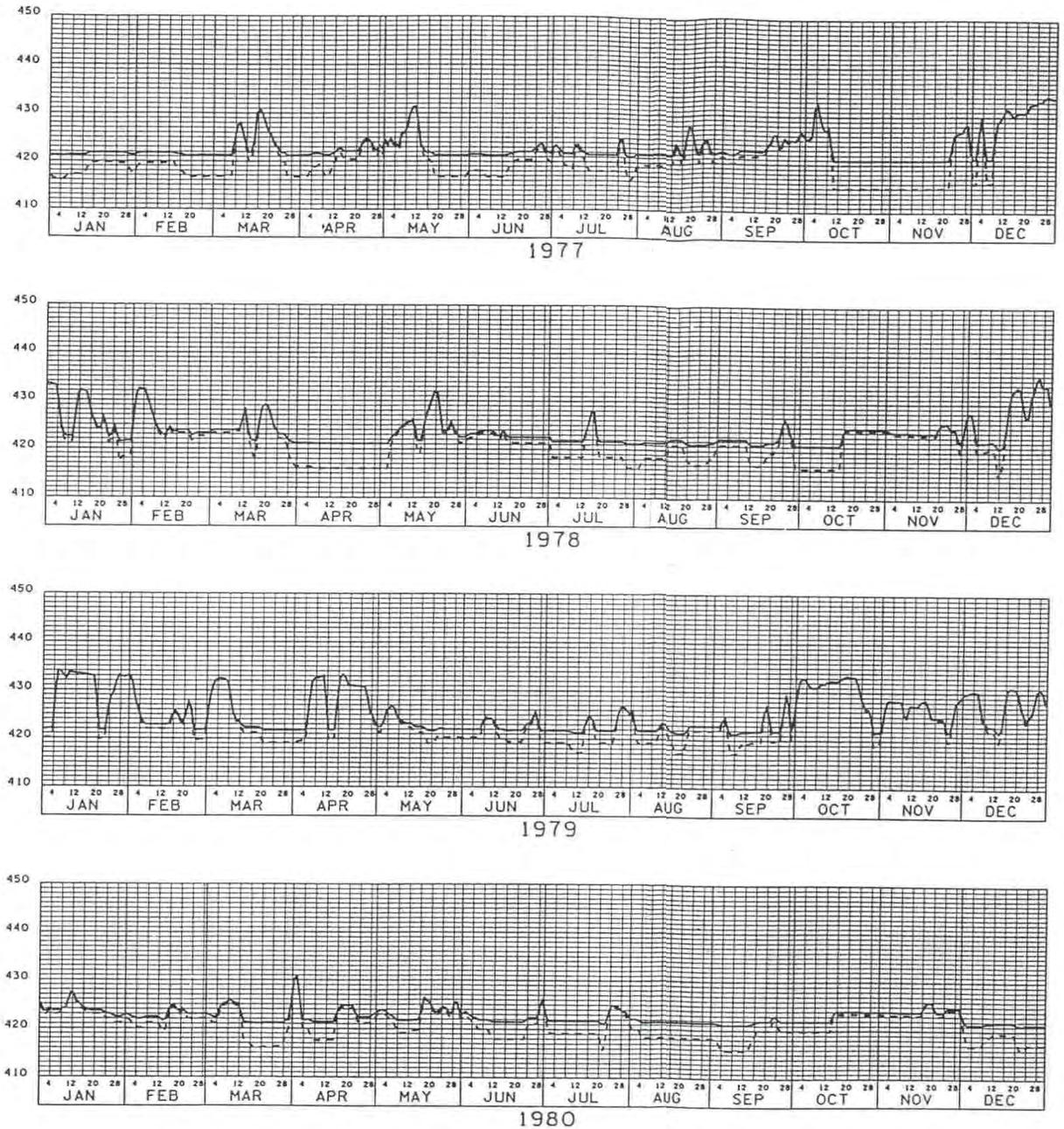
Drawing Code:
Sheet reference numbers:
Sheet ___ of ___

FILE: C:*hydro*NOLRV.DC
DATE: 28-Aug-96 08:30

PLATE 50



LEGEND:

——————— **EXISTING CONDITION**

- - - - - - - - - - - **DAM REMOVED**

Revisions			
Symbol	Descriptions	Date	Approved

U.S.ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

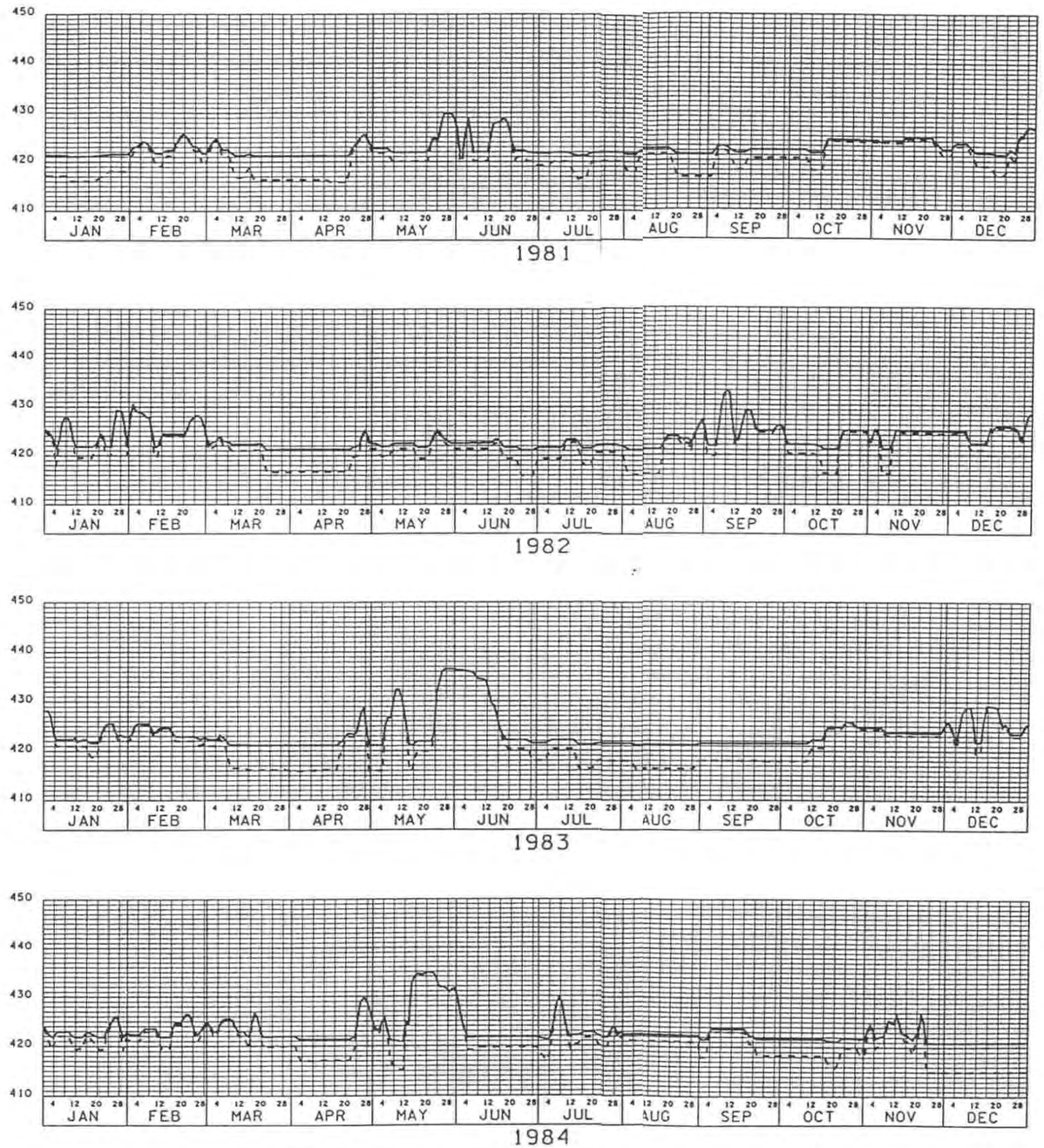
US Army Corps of Engineers

Designed by:
Drawn by:
Checked by:
Reviewed by:
Approved by:

NOLIN RIVER
KYROCK, KY

Scale:
Date:
Drawing Codes:
Sheet Reference numbers:
Sheet ____ of ____

FILE: C:*hydro*NOLRV.
DATE: 28-Aug-96 08:



LEGEND:

——————— **EXISTING CONDITION**

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Revisions			
Symbol	Descriptions	Date	Approved

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KYROCK, KY

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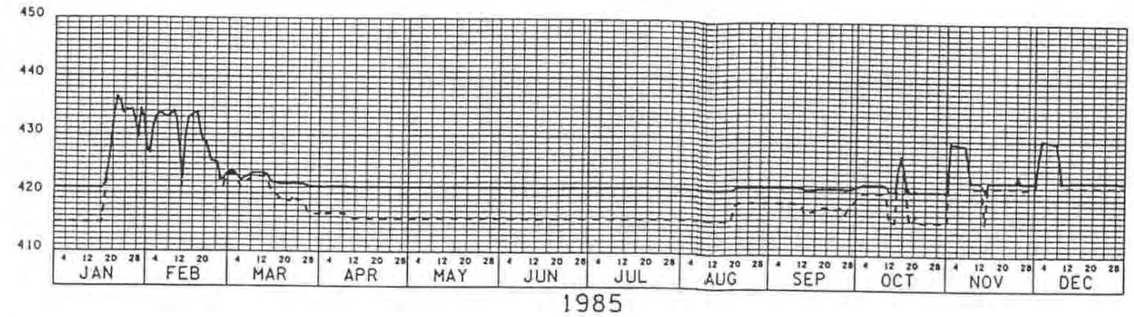
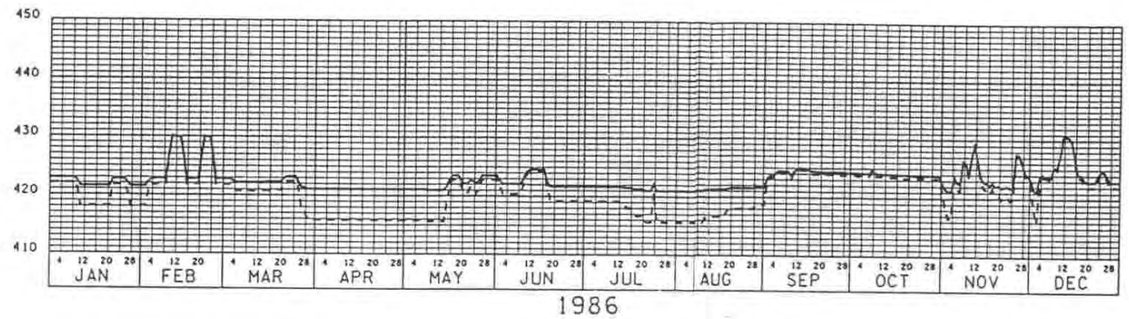
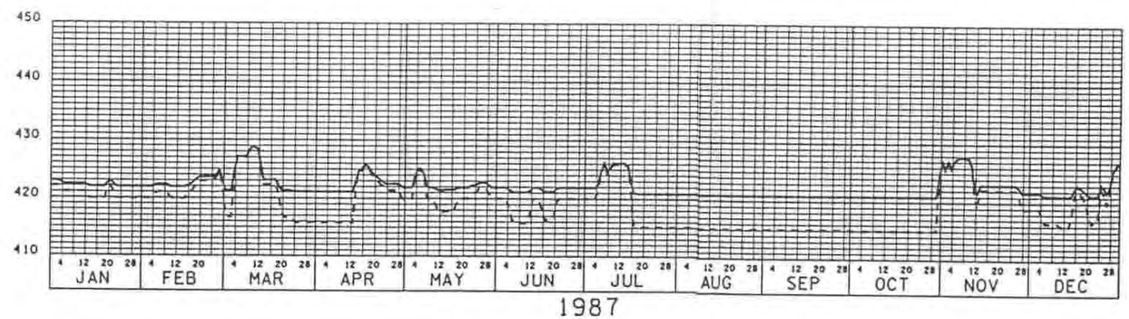
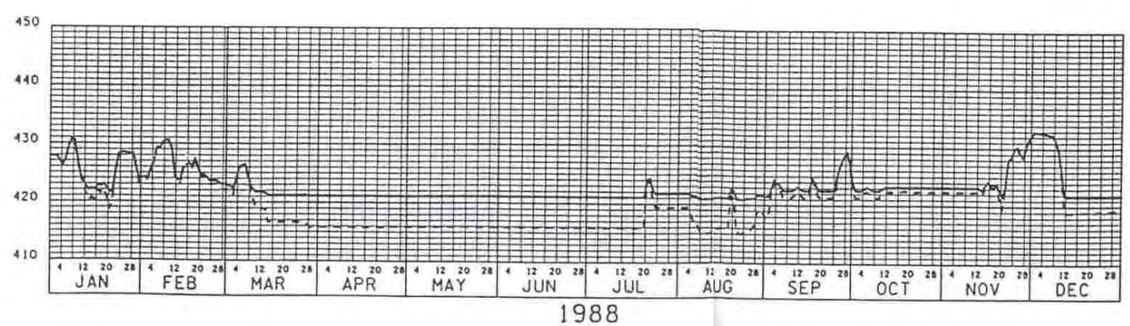
Date:
Drawing Code:
Sheet reference (number):
Sheet ___ of ___

FILE: C:*hydro*NOLRV.DGN
DATE: 28-Aug-96 08:30









LEGEND:

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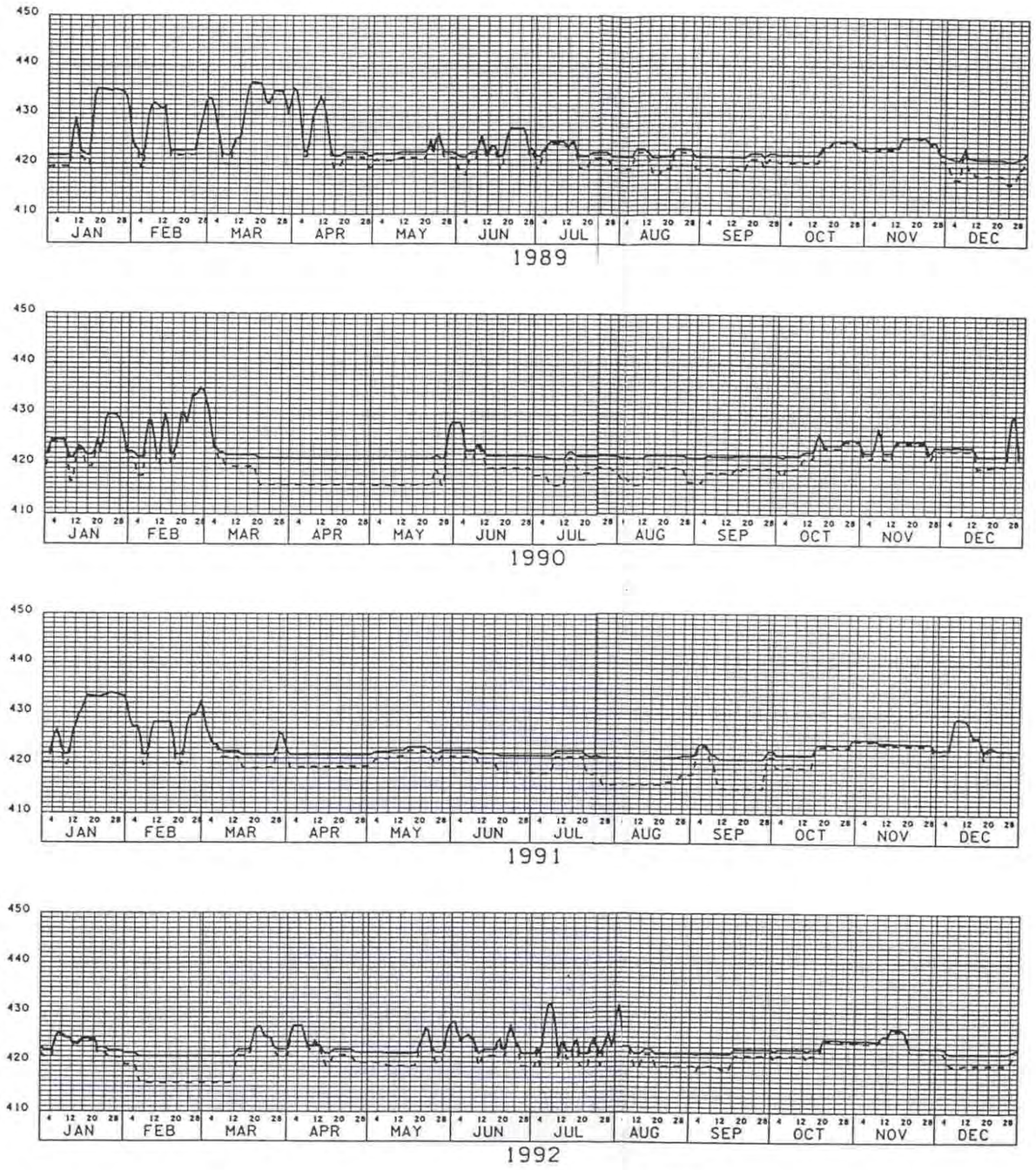
DATE: 28-Aug-96 C

PLATE 53



LEGEND:

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Revisions			
Symbol	Descriptions	Date	Approved

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Scale:
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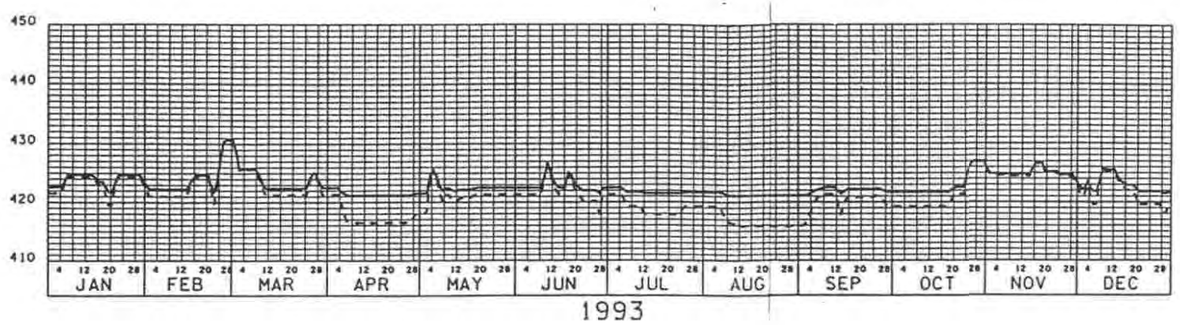
FILE: C:*hydro*NOLPV.DGN
DATE: 28-Aug-96 01



LEGEND:

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Sheet reference number:
Sheet ___ of ___

FILE: C:*hydro*NO
DATE: 28-Aug-96