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GEOLOGICAL SURVEY

Technique for Estimating the Magnitude and Frequency of Missouri Floods

By

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The opinions, findings, and conclusions expressed in this publication are not necessarily those of the Federal Highway Administration

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Because of renewed interest in this report, it was reissued during 1991.

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FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

The following factors may be used to convert the English units published herein to the International System of Units (SI).

Multiply English units	By	To obtain SI units
	<u>Length</u>	
Feet (ft)	0.3048	Metres (m)
Square miles (mi^2)	2.590	Square kilometres (km^2)
Miles (mi)	1.609	Kilometres (km)
Feet per mile (ft/mi)	0.1893	Metres per kilometre (m/k)
	<u>Flow</u>	
Cubic feet per second (ft^3/s)	0.02832	Cubic metres per second (m^3/s)

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Magnitude and Frequency of Missouri Floods

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ABSTRACT

A technique is presented for estimating the magnitude and frequency of Missouri floods. For 152 gaged sites the magnitudes of floods having recurrence intervals of 2 to 100 years are provided in tables. For ungaged sites, regression relations are presented that allow the estimation of flood magnitudes from a knowledge of the upstream drainage area and the average main-channel slope. The estimating equations are provided in a graphical form for the convenience of the user.

INTRODUCTION

The purpose of this report is to provide techniques for estimating the magnitude and frequency of flooding at sites in Missouri.

Previous reports, Searcy (1955), Patterson (1964), Patterson and Gamble (1968), Matthai (1968), Sandhaus and Skelton (1968), and Skelton and Homyk (1970), have presented methods for estimating flood magnitudes for various recurrence intervals. Each method has been developed on the basis of a limited period of record or sample size and could be used with confidence only for drainage areas greater than 50 mi^2 (130 km^2).

Relationships presented in this report were defined from an expanded data base by detailed analytical techniques and should provide flood estimates of increased reliability.

Because of the need for better definition of flood frequency covering all sizes of drainage areas (0.1 to 14,000 mi^2 or 0.26 to 36,300 km^2) in Missouri, an effort was made to use the limited information collected on small drainage areas (areas less than 10 mi^2) so that when small-area data were included in a statewide data matrix, flood-frequency relationships could be defined for the full range of drainage areas.

A rainfall-runoff model developed by Dawdy, Lichty, and Bergmann (1972) was used to extend short records on small drainage areas so that flood magnitude and frequency with recurrence intervals as high as 100 years could be defined. Flood-frequency curves at each data site, based on synthesized peaks from the rainfall-runoff model for small drainage areas and observed peaks for the larger drainage areas, were defined by fitting the Pearson Type III distribution to the logarithms of the data as recommended by the Hydrology Committee, Water Resources Council (1967), Bulletin 15. Resulting flood magnitudes with recurrence intervals of 2, 5, 10, 25, 50, and 100 years were related to drainage area and average main-channel slope in a regression analysis.

ESTIMATING TECHNIQUE

For ungaged natural floodflow sites, flood magnitudes having recurrence intervals of 2, 5, 10, 25, 50, and 100 years are computed by using appropriate values of the contributing drainage basin size and slope in the equations shown in table 1 or in the graphs of figures 1-6. Drainage area (A) in square miles, can be obtained by planimetering the area contributing surface flows to the site as outlined along the drainage divide on the best available topographic maps. Slope (S) in feet per mile, is the average slope between points 10, and 85 percent of the distance along the main-stream channel from the site to the basin divide. Distance is measured by setting draftsman's dividers at 0.1 mile (0.16 km) spread and stepping along the channel. The main channel is defined above stream junctions as the one draining the largest area. Elevation differences between the 10- and 85-percent points are divided by the distance between the points to evaluate the slope.

Table 1.--Summary of regression equations

Frequency of flood (years)	Magnitude of flood (ft^3/s)	Standard error of estimate (percent)
2---------	$53.5A^{0.851A^{-0.02}}S^{0.356}$	38.6
5----------	$64.0A^{0.886A^{-0.02}}S^{0.450}$	34.7
10----------	$67.6A^{0.905A^{-0.02}}S^{0.500}$	34.5
25----------	$73.7A^{0.924A^{-0.02}}S^{0.542}$	35.0
50----------	$79.8A^{0.926A^{-0.02}}S^{0.560}$	33.3
100----------	$85.1A^{0.934A^{-0.02}}S^{0.576}$	33.3

Example:

Assume design of a hydraulic structure is desired at a point on a stream above which are 200 mi^2 (518 km^2) of drainage. The average main-channel slope is 6 ft/mi (1.14 m/km) and the design frequency desired is 50-year recurrence interval.

1. Solution of equation from table 1.

$$Q_{50}=79.8(200)^{0.926(200)^{-0.02}}(6)^{0.560}$$

$$=18,000\ ft^3/s\ (510\ m^3/s).$$

2. From figure 5, read 200 mi^2 (518 km^2) along the ordinate and over to the 6 ft/mi (1.14 m/km) slope curve. Resulting flood peak,

$$Q_{50}=18,000\ ft^3/s\ (510\ m^3/s).$$

For gaged sites (see figure 7), flood magnitudes having recurrence intervals of 2, 5, 10, 25, 50, and 100 years are shown in table 2. These flood magnitudes were defined by frequency analysis of observed flood records for sites draining greater than 10 mi^2 (26 km^2) and by frequency analysis of partially synthesized records for smaller streams. In general, the values of table 2 will provide the most reliable estimates of future flood characteristics.

Limitations of Equations

The flood-frequency equations in this report may be used to estimate magnitude and frequency of floods on most Missouri streams for drainage areas ranging from 0.1 to 14,000 mi^2 (0.26 to 36,300 km^2), and slopes ranging from 1.0 to 300 ft/mi (0.19 to 56.8 m/km). However, equations are not applicable for basins where manmade changes have appreciably changed the flow regimen or on main stems of the Mississippi River and Missouri River. Flood-frequency relations for the upper Mississippi River are presented by Patterson and Gamble (1968), and for the lower Mississippi River by Patterson (1964). Flood characteristics of the Missouri River below Sioux City, Iowa are presented by Matthai (1968). Equations given in this report do not apply to areas near the mouth of streams draining into larger rivers where backwater effect is experienced. Caution should also be taken when utilizing equations presented here for drainage areas less than 10 mi^2 (26 km^2) which are located in the Lowlands region of Missouri.

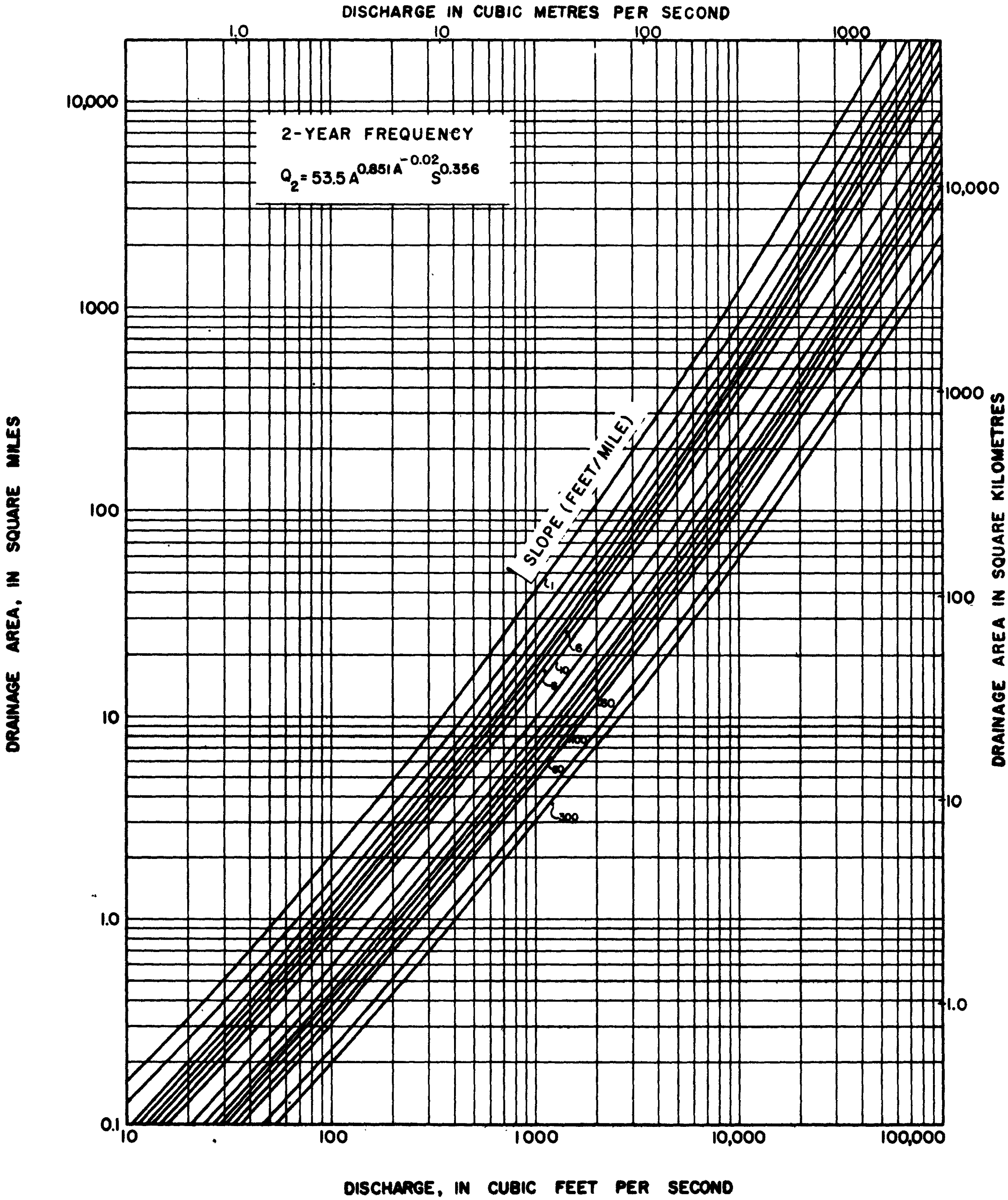

FIGURE 1. Graphical solution of the 2-year equation.

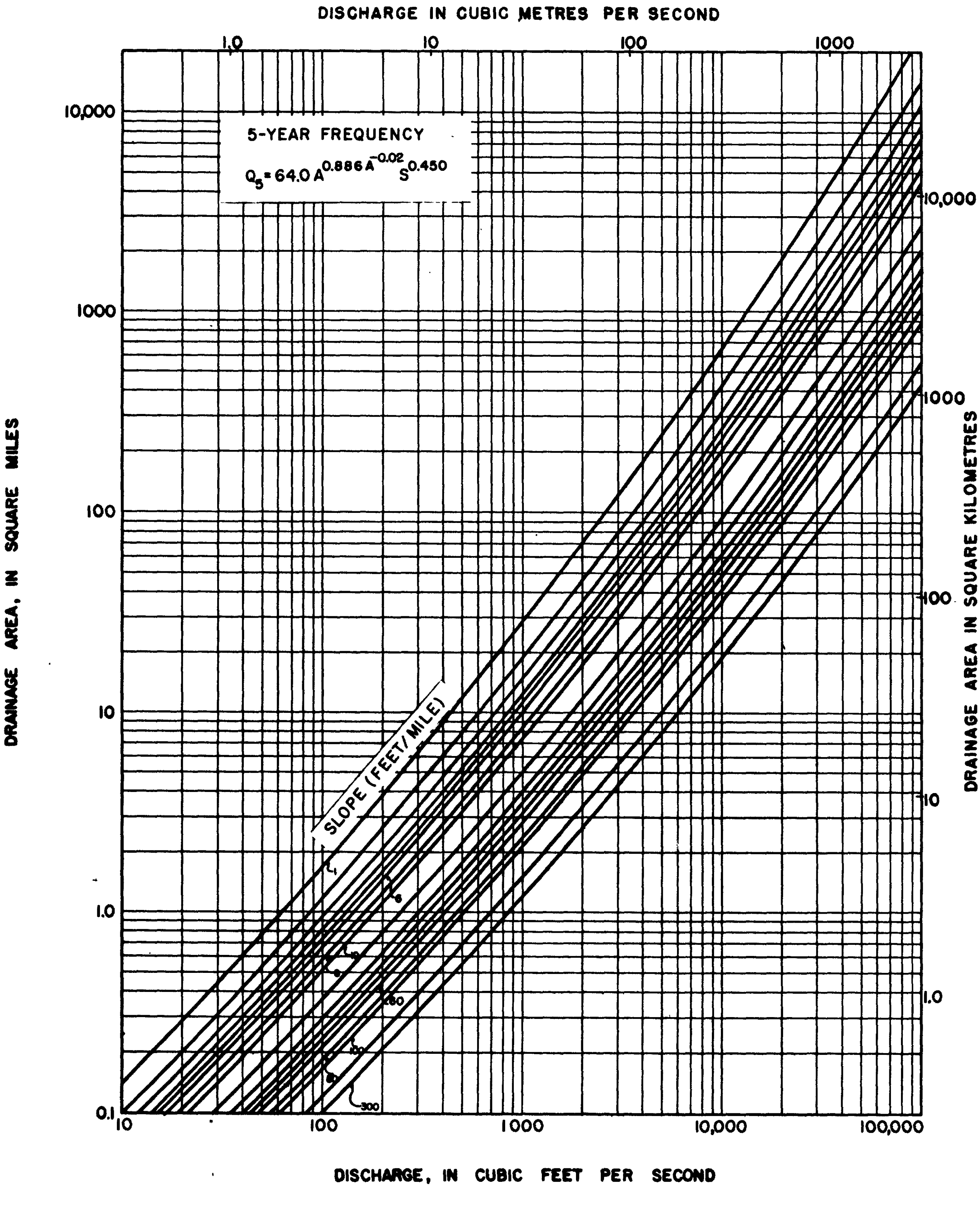

FIGURE 2 Graphical solution of the 5-year equation.

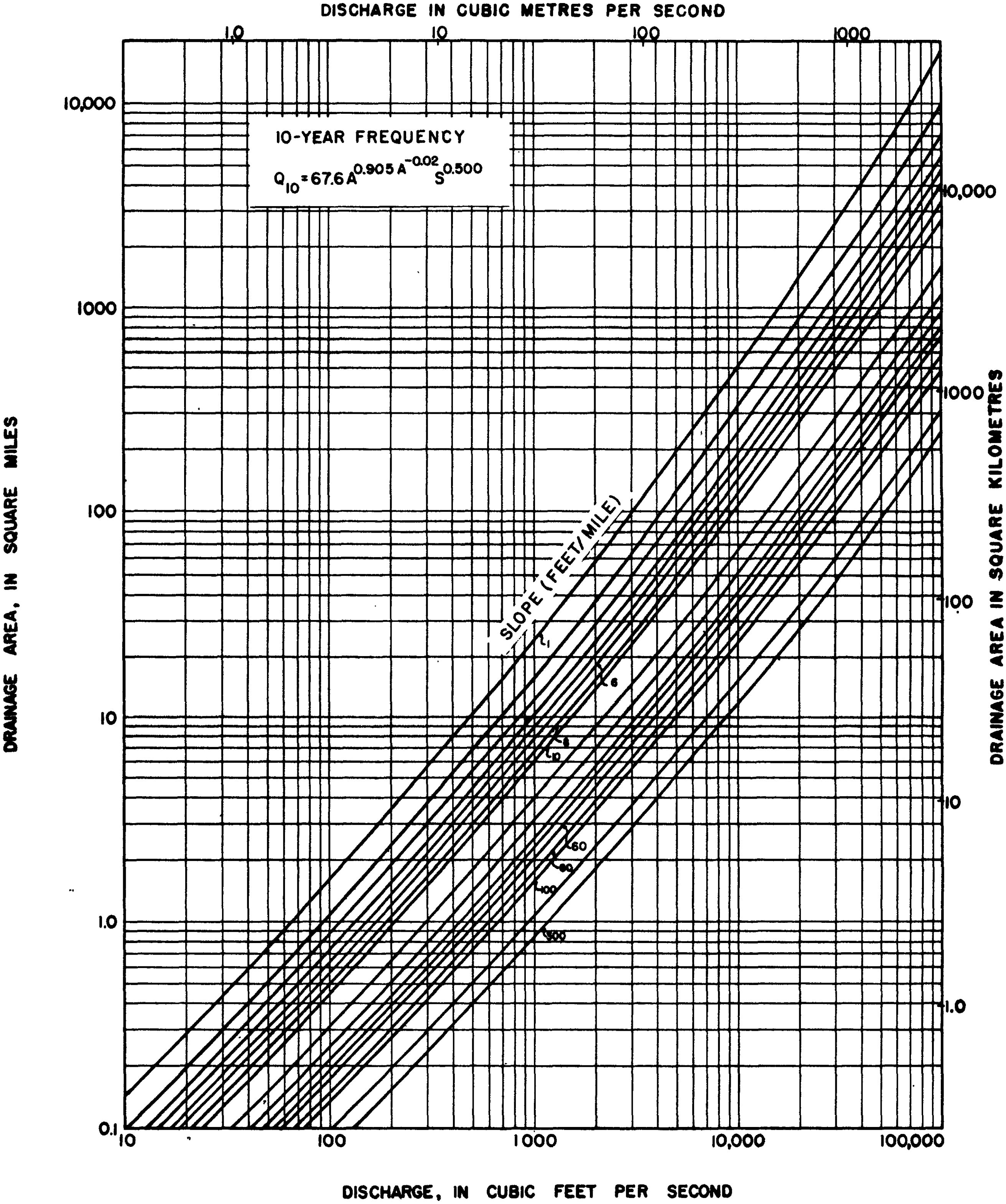

FIGURE 3 Graphical solution of the 10-year equation.

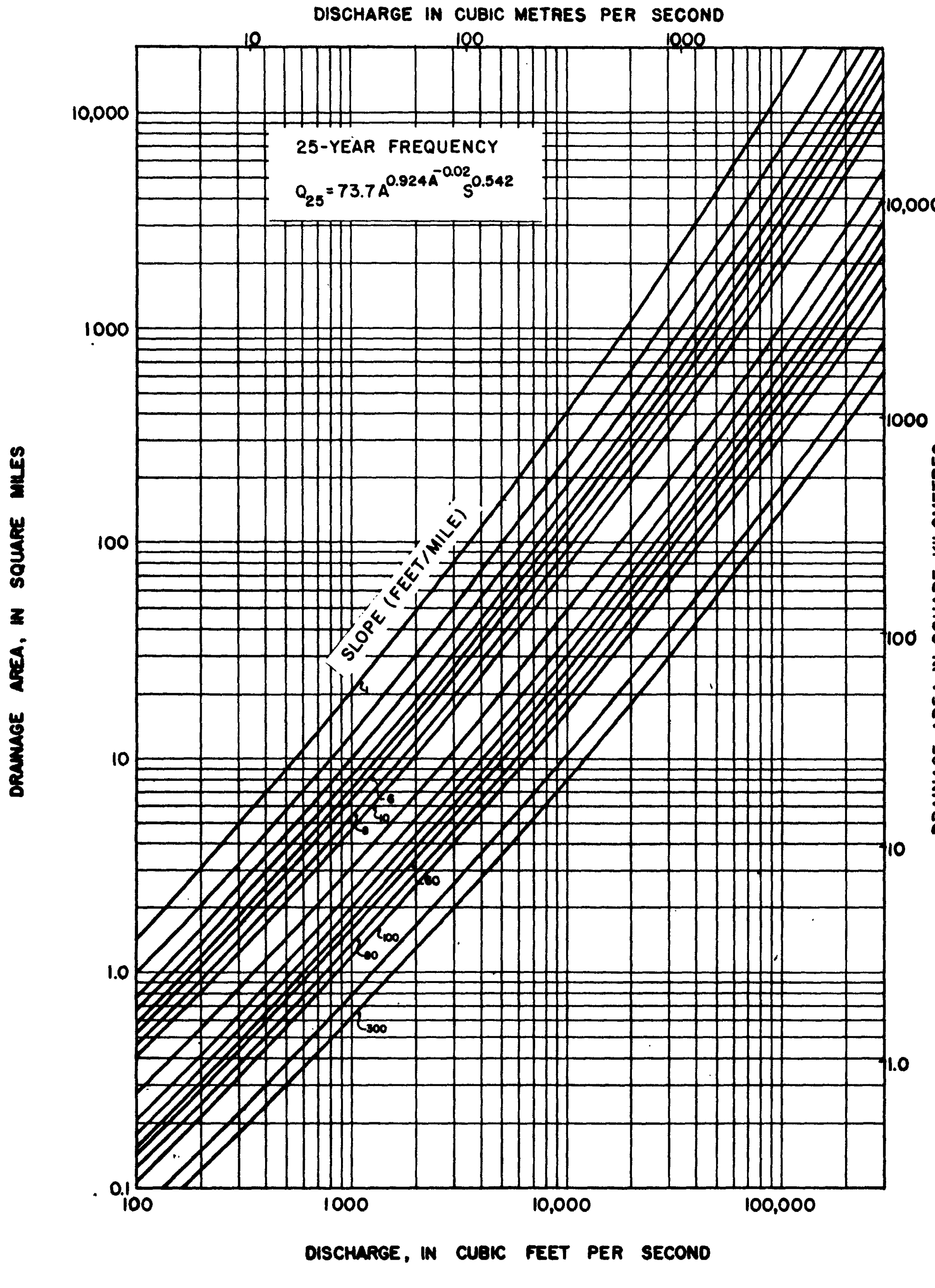

FIGURE 4 Graphical solution of the 25-year equation.

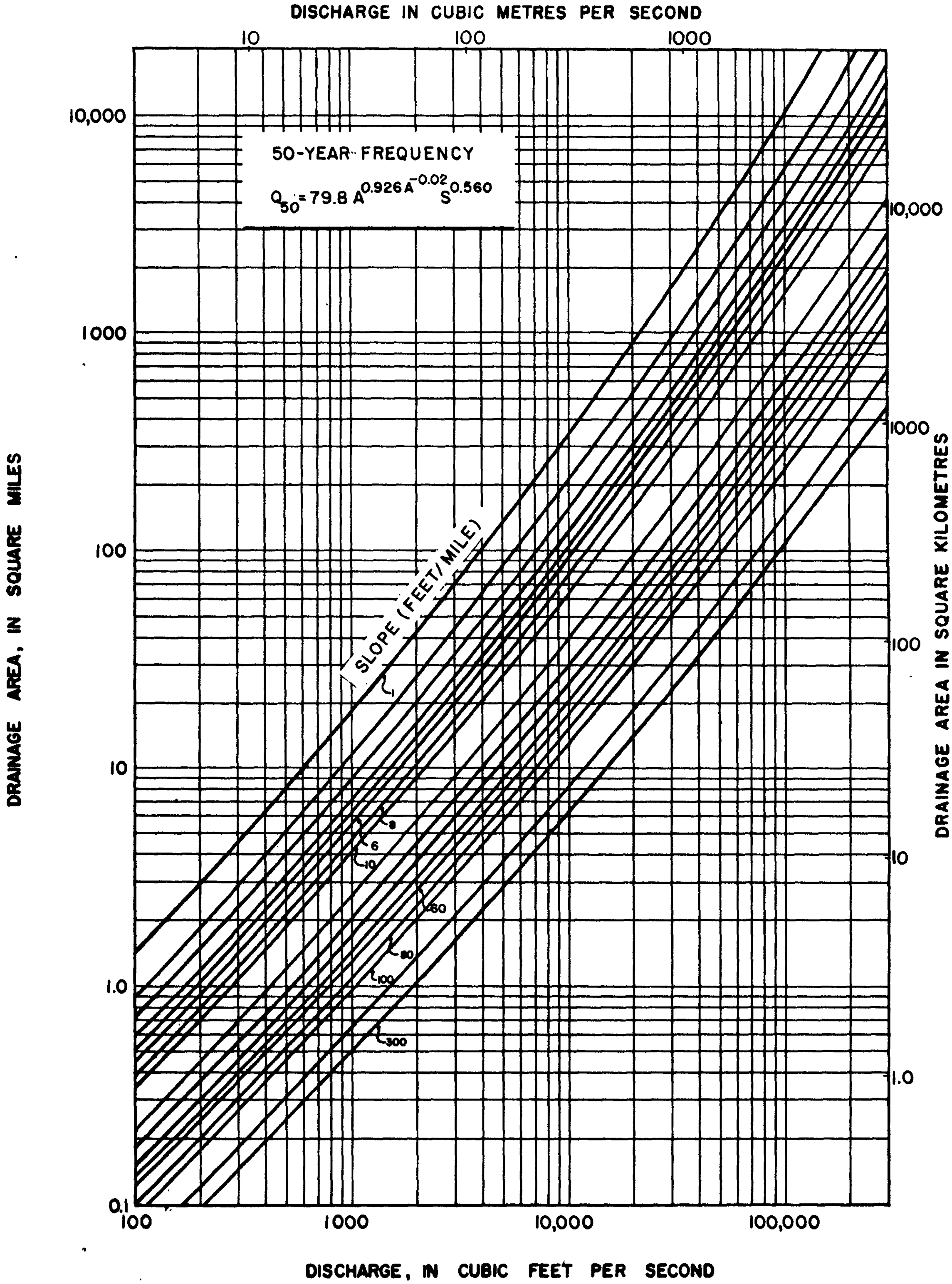

FIGURE 5 Graphical solution of the 50-year equation.

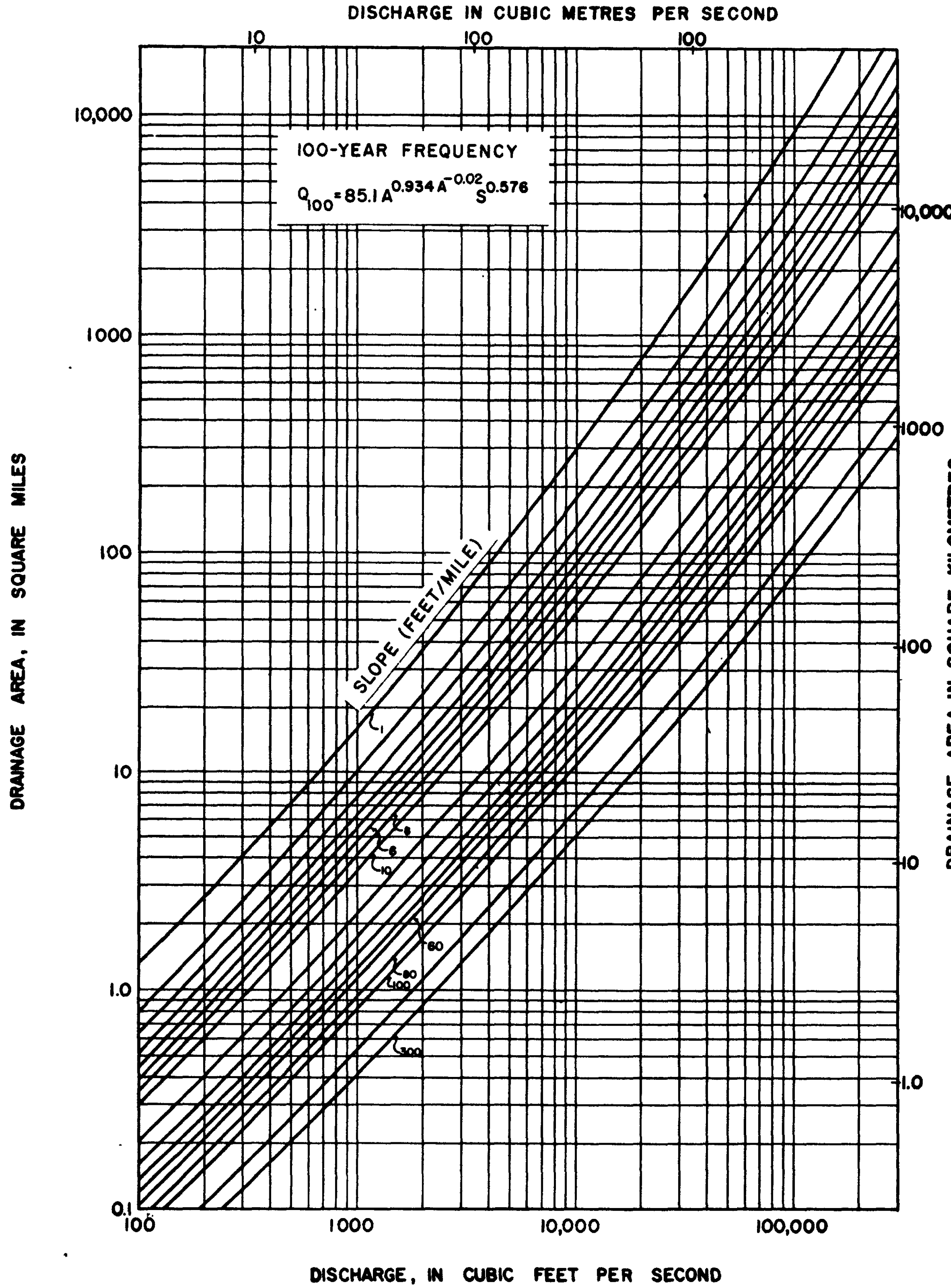

FIGURE 6. Graphical solution of the 100-year equation.

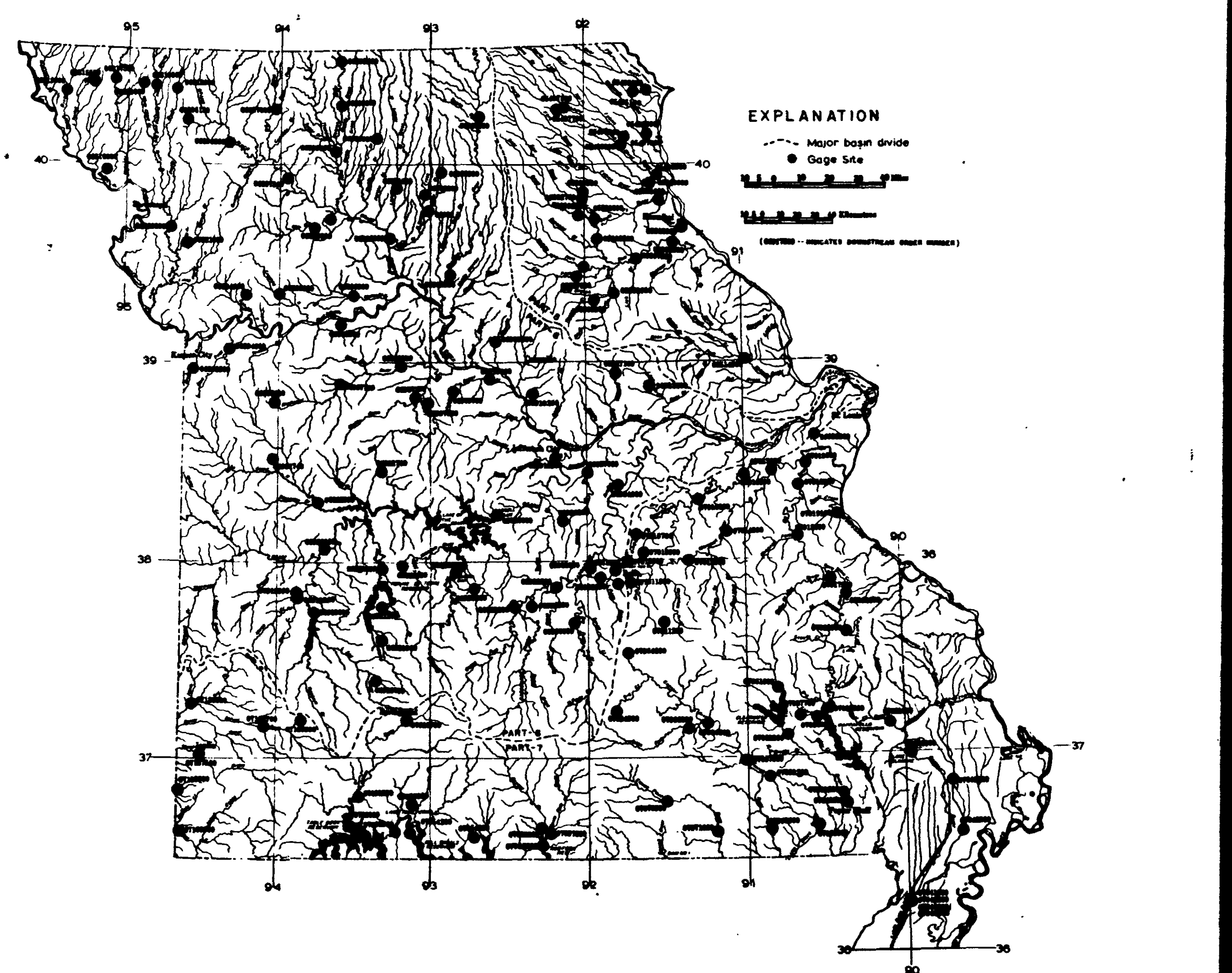

FIGURE 7.-- Location of gaging stations used to determine flood-frequency relationships

Table 2.--Flood-frequency data for streamgaging stations in Missouri

Station number	Station name	Basin characteristic: Area (mi^2)	Basin characteristic: Slope (ft/mi)	Magnitude of flood in cubic feet per second for indicated recurrence interval: 2-year	5-year	10-year	25-year	50-year	100-year
05495000	Fox River at Wayland	400	4.50	6,000	9,950	12,600	15,800	18,200	20,400
05495100	Big Branch tributary near Wayland	0.70	80.8	130	239	317	416	489	561
05496000	Wyconda River above Canton	393	4.50	5,350	8,460	10,500	12,900	14,600	16,200
05497000	North Fabius River at Monticello	452	4.80	7,590	11,400	13,800	16,600	18,500	20,300
05497500	Middle Fabius River near Baring	185	6.80	4,360	6,980	8,720	10,800	12,400	13,900
05497700	Bridge Creek near Baring	2.38	43.2	399	800	860	1,030	1,460	1,650
05498000	Middle Fabius River near Monticello	393	4.10	5,430	7,910	9,430	11,200	12,500	13,600
05498500	North Fabius River near Taylor	930	4.00	11,200	20,100	26,300	34,400	-	-
05500000	South Fabius River near Taylor	620	3.40	7,930	11,600	13,800	16,400	18,200	19,800
05500500	North River near Bethel	58.0	5.00	1,960	3,470	4,520	5,850	6,820	7,780
05501000	North River at Palmyra	373	5.00	9,810	15,200	18,300	22,200	24,900	27,500
05502000	Bear Creek at Hannibal	31.0	15.4	2,330	4,600	6,310	8,590	-	-
05502500	Salt River near Shelbina	481	3.90	6,580	10,100	12,300	15,000	16,800	18,600
05502700	Easdale Branch near Shelbyville	0.71	76.1	399	495	577	689	771	852
05503000	Douglas Creek near Emden	2.64	32.3	693	993	1,190	1,450	1,660	1,870
05503500	Salt River near Hunnewell	626	3.00	7,290	11,000	13,200	15,900	-	-
05505000	South Fork Salt River at Santa Fe	298	3.60	6,370	10,400	13,000	16,200	18,500	20,600
05506000	Youngs Creek near Mexico	67.4	7.50	2,500	4,390	5,710	7,370	8,600	9,790
05506500	Middle Fork Selt River at Paris	365	2.90	5,460	8,840	11,100	13,800	15,700	17,600
05507000	Elk Fork Salt River near Paris	262	3.50	7,380	11,900	14,800	18,400	21,000	23,400
05507500	Salt River near Monroe City	2,230	2.80	28,000	42,100	50,900	61,200	68,400	75,100
05508000	Salt River near New London	2,480	2.50	27,900	40,000	47,300	55,700	61,500	66,800
05514500	Cuivre River near Troy	903	4.60	23,300	39,600	50,600	64,400	74,400	84,000
06813000	Tarkio River at Fairfax	508	4.90	6,320	11,800	15,900	21,700	26,200	31,000
06815550	Staples Branch near Burlington Junction	0.49	61.0	142	316	435	525	586	645
06816000	Mill Creek at Oregon	490	42.3	740	1,600	2,320	3,350	4,190	5,320
06817500	Nodaway River near Burlington Junction	1,240	4.21	12,300	22,600	30,500	41,200	50,000	58,400
06818900	Platte River at Ravenwood	486	4.45	7,430	10,600	12,100	13,600	-	-
06819500	One Hundred and Two River near Maryville	500	5.72	6,800	11,600	15,100	19,600	23,000	26,400
06820000	White Cloud Creek near Maryville	6.06	19.5	729	1,680	2,260	2,820	3,220	3,580
06820500	Platte River near Agency	1,760	3.76	14,000	24,300	31,600	41,300	48,600	56,000
06821000	Jenkins Brench at Gower	272	34.0	638	1,350	1,700	2,120	2,420	2,700
06893500	Blue River at Kansas City	188	12.4	9,360	16,400	21,500	28,000	33,000	38,900
06894000	Little Blue River near Lake City	184	6.26	3,650	6,370	8,290	10,800	12,600	-
06894500	East Fork Fishing River at Excelsior Springs	20	21.9	2,370	5,090	7,330	10,500	13,200	-
06895000	Crooked River near Richmond	159	5.17	4,250	8,480	11,700	16,200	19,600	-
06896000	Wakenda Creek at Carrollton	248	5.27	4,820	6,620	7,690	8,920	9,740	-
06896180	DeMoss Branch near Stanberry	0.38	106	145	207	248	305	345	383
06896500	Thompson Branch near Albany	5.58	30.9	738	1,490	2,020	2,520	2,880	3,220
06897000	East Fork Big Creek near Bethany	95	7.24	2,520	4,380	5,720	7,470	8,800	10,100
06897500	Grand River near Gallatin	2,250	4.11	23,700	37,000	45,800	56,600	64,400	72,000
06897700	Grand River tributary near Utica	1.44	120	392	485	560	665	761	854
06898500	Weldon River near Mercer	246	7.54	11,900	19,900	25,500	32,600	37,800	43,000
06899000	Weldon River at Mill Grove	494	5.05	10,900	19,000	24,600	32,000	37,500	43,000
06899500	Thompson River at Trenton	1,670	3.67	21,900	37,600	48,600	62,900	73,500	84,100
06899700	Shoal Creek near Braymer	391	2.92	7,180	10,800	13,200	21,500	-	-
06900000	Medicine Creek near Galt	225	5.00	5,700	10,600	14,100	18,800	22,400	25,900
06901500	Locust Creek near Linneus	550	4.22	9,200	17,200	23,200	31,200	37,300	43,600

Table 2.--Flood-frequency data for streamgaging stations in Missouri (cont.)

Station number	Station name	Basic characteristic: Area (mi^2)	Basic characteristic: Slope (ft/mi)	Magnitude of flood in cubic feet per second for indicated recurrence interval: 2-year	5-year	10-year	25-year	50-year	100-year
06902000	Grand River near Sumner	6,880	3.15	51,200	83,700	106,000	134,000	154,000	174,000
06902200	West Yellow Creek near Brookfield	135	3.92	2,800	4,560	5,740	-	-	-
06902500	Hamilton Branch near New Boston	2.51	27.0	576	941	1,210	1,580	1,780	1,980
06902800	Onion Branch at St. Catherine	1.04	49.3	231	390	494	623	718	809
06904500	Chariton River at Novinger	1,370	2.63	9,700	15,200	18,800	23,200	26,400	29,400
06905500	Chariton River near Prairie Hill	1,870	2.25	13,400	18,800	22,000	25,800	28,400	30,800
06907000	Lamine River at Clifton City	598	3.60	16,100	27,800	35,700	45,700	52,900	60,000
06907200	Shaver Creek tributary near Clifton City	1.65	46.4	480	887	1,070	1,290	1,450	1,610
06907500	East Branch South Fork Blackwater River near Elm	16.6	22.2	2,220	3,670	4,660	5,890	-	-
06907700	Blackwater River at Valley City	547	5.05	23,600	43,500	58,000	94,000	-	-
06908000	Blackwater River at Blue Lick	1,120	2.50	10,600	18,100	23,200	29,600	34,300	38,900
06908300	Trent Branch near Waverly	0.97	69.2	339	670	890	1,140	1,290	1,430
06909500	Moniteau Creek near Fayette	81	8.47	2,930	4,620	5,700	7,000	7,920	-
06909700	Petite Saline Creek Tributary near Bellair	0.49	78.4	136	191	242	325	408	504
06910000	Petite Saline Creek near Boonville	182	6.35	3,560	5,460	6,660	8,080	9,080	-
06910250	Traxler Branch near Columbia	0.55	119	277	456	564	678	755	825
06910500	Moreau River near Jefferson City	531	4.64	13,400	19,600	23,300	27,600	30,600	-
06918700	Oak Grove Branch near Brighton	1.30	94.2	182	390	567	820	1,020	1,160
06919000	Sac River near Stockton	1,160	4.23	19,600	35,600	47,000	61,600	72,500	83,100
06919200	Sac River tributary near Caplinger Mills	0.14	149	47	70	89	112	127	142
06919500	Cedar Creek near Pleasant View	420	4.78	8,760	15,000	19,200	24,500	28,300	32,000
06920500	Osage River at Osceola	8,220	1.66	41,600	61,700	74,000	88,500	98,500	108,000
06921000	Pomme de Terre River near Bolivar	225	9.00	7,900	11,800	14,200	17,100	22,100	-
06921200	Lindley Creek near Polk	112	11.6	6,820	10,700	14,900	-	-	-
06921500	Pomme de Terre River at Hermitage	655	4.80	19,000	31,000	38,900	48,600	55,500	62,100
06921740	Brushy Creek near Blairstown	1.15	70.8	498	768	959	1,140	1,280	1,400
06922000	South Grand River near Brownington	1,660	2.1	14,600	25,000	32,200	41,200	47,800	54,100
06922700	Chub Creek near Lincoln	2.86	40.3	766	1,360	1,730	2,160	2,430	2,700
06924000	Niangua River near Decaturville	627	4.7	11,700	20,900	27,300	35,600	41,600	47,600
06925200	Starks Creek at Preston	4.18	31	822	1,270	1,530	1,840	2,060	2,330
06925300	Prairie Branch near Decaturville	1.48	84.1	190	310	425	663	850	1,110
06926000	Osage River near Bagnell	14,000	1.2	70,200	95,000	109,000	125,000	136,000	146,000
06926200	Van Cleve Branch near Meta	0.75	95.4	190	310	425	633	850	1,110
06927000	Maries River at Westphalia	257	8.91	11,100	15,100	17,400	20,000	21,700	-
06927100	Doane Branch near Kingdom City	0.54	70.2	111	185	233	293	335	376
06928000	Gasconade River at Hazelgreen	1,250	3.97	23,600	44,800	60,400	80,900	96,200	111,000
06928200	Laquey Branch near Hazelgreen	1.56	87.4	409	860	1,100	1,320	1,490	1,640
06928500	Gasconade River near Waynesville	1,680	3.18	23,400	41,200	53,600	69,200	80,700	91,800
06930000	Big Piney River near Big Piney	560	5.65	11,900	20,600	26,400	33,500	38,500	43,200
06931000	Beaver Creek near Rolla	13.7	39.5	1,920	3,110	3,890	4,850	5,530	-
06931500	Little Beaver Creek near Rolla	6.41	65.6	1,240	2,340	2,430	5,280	6,060	6,800
06932000	Little Piney Creek at Newburg	200	14.0	6,760	13,400	18,200	25,100	30,300	35,400
06933500	Gasconade River at Jerome	2,840	3.01	31,700	55,500	72,000	92,800	108,000	123,000
06934000	Gasconade River near Rich Fountain	3,180	2.68	29,400	48,100	60,400	75,600	86,400	96,700
06935500	Loutre River at Mineola	202	10.4	7,220	11,500	14,400	17,800	20,200	-
06935800	Shotwell Creek near Ellisville	0.81	79.5	365	520	617	755	848	933
07011200	Love Creek near Salem	0.89	106	121	265	370	505	598	671
07011500	Green Acre Branch near Rolla	0.62	82.0	306	509	616	737	818	890
07013000	Meramec River near Steelville	781	6.29	15,400	27,900	36,700	48,100	56,500	64,700

Table 2.--Flood-frequency data for streamgaging stations in Missouri (cont.)

Station number	Station name	Basin characteristic: Area (mi²)	Basin characteristic: Slope (ft/mi)	Magnitude of flood in cubic feet per second for indicated recurrence interval: 2-year	5-year	10-year	25-year	50-year	100-year
07014500	Meramec River near Sullivan	1,475	4.89	18,600	31,800	40,800	52,000	60,000	68,000
07015000	Bourbeuse River near St. James	21.3	34.0	3,440	5,390	6,650	8,150	9,210	-
07015500	Lanes Fork near Rolla	0.22	41.1	71.5	121	152	193	218	240
07015700	Lanes Fork near Vichy	24.1	27.0	3,880	5,740	6,870	8,200	9,120	9,970
07016000	Bourbeuse Rivèr near Spring Bluff	608	3.92	14,900	22,000	26,400	31,500	35,000	38,300
07016500	Bourbeuse River at Union	808	2.76	13,700	20,000	23,900	28,400	31,400	34,300
07017000	Meramec River at Robertsville	2,670	3.83	38,700	62,800	78,700	101,000	-	-
07017500	Dry Branch near Bonne Terre	3.35	48.5	660	1,290	1,700	2,220	2,550	2,820
07018000	Big River near DeSoto	718	4.63	17,100	26,000	31,600	38,200	42,800	-
07018500	Big River at Byrnesville	917	3.36	14,900	22,500	27,300	32,900	36,800	40,500
07019000	Meramec River near Eureka	3,790	3.44	37,000	61,200	77,400	97,400	112,000	125,000
07019100	Murphy Branch near Crystal City	0.44	108	130	221	300	435	572	732
07021000	Castor River at Zalma	423	8.92	11,000	20,600	27,500	36,600	43,300	50,000
07033000	Wolf Creek near Farmington	40.3	19.9	3,410	5,570	7,000	8,740	-	-
07035500	Barnes Creek near Fredericktown	4.03	114	929	2,040	2,850	3,560	4,040	4,510
07037500	St. Francis River near Patterson	956	7.24	32,200	49,800	61,000	74,300	83,700	92,500
07037700	Clark Creek near Piedmont	4.39	63.9	753	1,230	1,680	2,400	2,940	3,500
07038000	Clark Creek at Patterson	37.5	29.4	6,080	8,530	9,990	-	-	-
07041000	Little River ditch 81 near Kennett	111	1.0	1,730	2,660	3,240	3,940	4,420	4,880
07042000	Little River ditch 1 near Kennett	235	1.0	4,070	6,290	7,700	9,380	10,600	11,700
07042500	Little River ditch 251 near Lilbourn	235	2.0	2,520	3,160	3,520	3,900	4,160	4,380
07043000	Castor River at Aquilla	175	0.8	2,230	3,220	3,810	4,500	4,960	5,400
07043500	Little River ditch 1 near Morehouse	450	2.0	5,210	7,080	8,170	9,390	10,200	11,000
07044000	Little River ditch 251 near Kennett	883	1.0	8,850	12,200	14,200	16,500	18,000	19,400
07046000	Little River ditch 259 near Kennett	89	1.0	1,760	2,780	3,430	4,210	4,760	5,290
07050700	James River near Springfield	246	6.5	9,910	17,500	22,800	29,500	-	-
07052500	James River at Galena	987	4.75	18,100	31,100	40,000	51,000	59,300	67,200
07053000	White River near Reeds Spring	3,620	3.53	71,200	114,000	142,000	177,000	-	-
07053500	White River near Branson	4,020	3.36	34,300	76,300	111,000	159,000	19,800	238
07053950	Ingenthron Hollow near Forsyth	0.65	186	197	360	481	598	679	757
07054200	Yandell Branch near Kirbyville	0.33	116	65.1	158	224	318	394	474
07054300	Gray Branch at Lutie	0.23	279	50	97.5	132	178	212	245
07057500	North Fork River near Tecumseh	561	8.29	11,600	19,300	24,500	30,900	35,500	39,900
07058000	Bryant Creek near Tecumseh	570	8.83	12,000	19,400	24,300	30,300	34,600	38,600
07058500	North Fork River at Tecumseh	1,157	8.04	15,700	32,400	45,400	63,000	76,700	-
07061500	Black River near Annapolis	484	10.9	19,200	31,600	39,800	49,900	57,100	64,000
07062500	Black River at Leeper	957	8.52	18,700	38,700	54,300	75,500	92,000	-
07063000	Black River at Poplar Bluff	1,245	6.23	11,000	20,800	28,000	37,400	44,500	51,600
07063200	Pike Creek tributary near Poplar Bluff	0.28	111	124	210	252	305	342	376
07064300	Fudge Hollow near Licking	1.72	68.1	100	360	600	970	1,300	1,620
07064500	Big Creek near Yukon	8.36	53.3	1,750	2,950	3,650	4,510	5,120	5,710
07066000	Jacks Fork at Eminence	398	9.50	10,200	19,700	26,800	36,200	43,300	50,400
07066500	Current River near Eminence	1,272	7.58	22,400	42,800	57,700	77,400	92,200	107,000
07067000	Current River at Van Buren	1,667	5.92	25,900	48,200	64,300	85,300	101,000	116,000
07068000	Current River at Doniphan	2,038	4.75	25,400	45,300	59,400	77,300	90,500	103,000
07068200	North Prong Little Black River at Hunter	1.23	61.7	130	245	355	565	795	1,100
07068500	Little Black River near Fairdealing	187	10.8	6,600	13,400	18,400	25,800	31,200	-
07070500	Eleven Point River near Thomasville	361	13.7	4,900	11,600	17,200	25,300	32,000	-

Table 2.--Flood-frequency data for streamgaging stations in Missouri (cont.)

Station number	Station name	Basin characteristic: Area (mi^2)	Basin characteristic: Slope (ft/mi)	Magnitude of flood in cubic feet per second for indicated recurrence interval: 2-year	5-year	10-year	25-year	50-year	100-year
07071500	Eleven Point River near Bardley	793	10.1	8,880	19,500	28,100	40,200	49,700	56,600
07185500	Stahl Creek near Miller	3.86	41.3	637	1,120	1,140	1,820	2,090	2,340
07185700	Spring River at Larussell	306	9.84	4,980	8,470	10,800	-	-	-
07186000	Spring River near Waco	1,164	6.08	17,100	30,000	38,900	50,200	58,500	66,500
07187000	Shoal Creek above Joplin	410	8.34	8,240	16,800	23,300	32,200	39,000	45,900
07188500	Lost Creek at Seneca	42.0	23.6	843	2,730	4,710	8,020	11,000	-
07198000	Elk River near Tiff City	872	7.09	20,900	41,600	57,400	78,400	94,500	111,000

ANALYSIS

Basic Data

Streamflow and basin characteristics from a network of 152 stations were used in this analysis and are listed in table 2. Their distribution throughout the State is shown in figure 7. The data set does not contain information on small-area stations (drainage areas less than 10 mi^2 [26 km^2]) with flat slopes as experienced in the Lowlands or Bootheel region due to the difficulty in establishing stage-discharge relationships. Drainage area sizes range from 0.1 to 14,000 mi^2 (0.26 to 36,300 km^2).

Determination of Basin Characteristics

Basin characteristics used in describing the magnitude and frequency of flooding are: 1) drainage area (A) which can be described as all contributing drainage upstream from a desired point along a river channel, and 2) average main-channel slope (S). Average main-channel slope was determined from elevations at points 10 and 85 percent of the distance along the channel from the gaging station to the divide.

Determination of Estimating Relations

Relationships developed herein were determined by the step-backward multiple regression technique. Streamflow characteristics (2-, 5-, 10-, 25-, 50-, and 100-year flood) or dependent variables were related to basin characteristics.

First attempts of the regression computation indicated drainage area and average main-channel slope to be significant independent variables in the equation $Q_T = aA^{b_1}S^{b_2}$.

However, a plot of the logarithms of the residual [(log Q_T (observed) - log Q_T (computed)] versus the logarithms of the slope and drainage area indicated nonlinearity.

The basic regression model was again fitted to the array by adjusting the exponent to drainage area based on techniques described by Creager, Justin, and Hinds in their report "Engineering for Dams" (1947). Several attempts were made until the adjustment could be made which would result in the least standard error for the equation $Q_T = aA^{b_1 A^c} S^{b_2}$ and linearity in the area component could be obtained. The same residuals (computed with the adjusted relationship) were plotted on a map of the State to determine any graphic trend. Results showed a random scatter throughout the State thus indicating the relationships to be applicable statewide.

SUMMARY

Techniques for estimating magnitude and frequency of floods at ungaged Missouri streams given in this report utilize the basic linear regression model with adjustments to independent variable components to achieve linearity. Drainage area and slope proved to be significant basin characteristics and were used in defining the relationships. A plot of residuals on a map indicates statewide applicability of the equations.

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