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# **an examination of the statistics of maximum mean daily floods**

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## SUMMARY

The purpose of the study was to ascertain to what extent five, ten, fifteen and twenty-five-year averages of the annual mean daily floods approach forty-year averages and to investigate trends in these short-term statistics.

The short-term averages oscillate about the forty-year mean, seldom becoming, statistically speaking, significantly different from the forty-year mean. The ten-year averages show a declining tendency through the 1930's and 1940's with an increase in the 1950's and a slight decrease in the 1960's.

Some streams show much less variation in averages than others, and this appears to be related to location rather than stream size.

## INTRODUCTION

The object of this study was to ascertain to what extent five, ten, fifteen and twenty-five year averages of annual mean daily floods approach forty-year averages and to investigate trends in these short-term statistics.

For this study, the annual maximum mean daily floods for twenty-six streams in British Columbia are analyzed in five, ten, fifteen, twenty-five and forty-year periods from 1930 to 1969. If a short period can be found in which the averages are statistically similar to the long-term average, then this period may be of value in regionalization studies. If trends are found, these will be of value in assessing the records of other streams for which short periods of record are available.

## PROCEDURE

The annual maximum mean daily floods for this study were provided by a report entitled, "*Magnitude of Floods in British Columbia*". As these data have three significant figures, results have been rounded to three figures. The majority of stations selected for this study were stations recording natural flow except as noted in Table 1. The locations of the stations are shown in Figure 1.

The forty-year period from 1930 to 1969 was the longest period with the largest number of stations having continuous records. Also it was desirable to compare the averages on a common basis, i.e., a common forty-year period. At six stations, one or two years were missing. In these cases, 1929 or 1970 data were added to bring the length of record to forty years. (See Table 1).

For Station 08LF051, Thompson River near Spences Bridge, the five-year period, 1925-1929, was substituted for 1930-1934 since two consecutive years, 1932-1933, were missing.

A computer program listed in Appendix 1 was used to calculate the average, standard deviation, coefficient of variation and the maximum and minimum floods for five, ten, fifteen, twenty-five and forty-year periods, with average referring to the arithmetic average. In addition, the ratios of the short-term averages to the long-term, i.e., forty-year averages, were produced. The results for the ratios of ten-year average to forty-year average are shown in Figures 2 to 5. The skew calculation should be disregarded in this study, as forty years is too short an interval to produce a meaningful value. (See Appendix 3). The program was written in Fortran IV and run on an IBM 360.

A criterion was required to establish whether or not the short-term and the long-term averages are statistically similar. The development of the criterion is provided in Appendix 2. At a 5 per cent level of significance, the ten-year and forty-year average floods were similar if,

$$0.90 \leq \text{RAFL} \leq 1.10.$$

RAFL is the ratio of the short-term average to the long-term average. While the twenty-five-year and forty-year averages were similar if,

$$0.93 \leq \text{RAFL} \leq 1.07.$$

## RESULTS

A graphical demonstration of selected results of the study is shown in Figures 2 to 12. In Figures 2 to 5, ten-year averages are selected because they demonstrate the essential trends. These figures are intended for demonstration of each stream's time variation, not for stream-to-stream comparison. The statistics shown in Figures 6 to 12 are selected to represent the general areas of the Province covered by the study.

The numerical values for all the stations in the study are presented in Tables 2 to 27. The units of floods are cfs.

For the Columbia River at Nicholson the forty-year, 1930-1969, average (15200) was compared with the sixty-seven-year, 1903-1969, average (15500) as a check on the forty-year period, 1930-1969. These values are statistically similar. 1930-1969 appears to be a reasonable base period, i.e., representative of the flow recording history in British Columbia.

### (a) Five-Year Averages

As shown in Figures 6 to 12, there is more variation in five-year averages than in longer-term averages; in general, for most streams, 1960-1964 and 1965-1969 averages are closest to the long-term averages. The general pattern is decreasing averages through the '30's and early '40's with increases in the late '40's and '50's and decreases again in the '60's. Considerable variation in five-year average floods is shown even for large streams; for example, the Fraser River at Hope, Figure 9.

### (b) Ten-Year Averages

The ratios of the ten-year average to the forty-year average, RAFL, are plotted in Figures 2 to 5, for each stream in decades 1930-1939, 1940-1949, 1950-1959 and



1960-1969. The limits within which the ten-year average may be considered statistically similar to the long-term average are indicated by dashed lines. In the decades 1930-1939 and 1940-1949 no stream has significantly higher than average flood and several are significantly lower. In the decades 1950-1959 and 1960-1969 no stream has significantly lower-than-average flood and of the four decades, 1960-1969 has most streams with averages similar to the forty-year average flood.

(c) Fifteen-Year Averages

Three fifteen-year periods were considered: 1930-1944, 1945-1959 and 1955-1969. The 1930-1944 averages are all lower than the forty-year average and the 1945-1959 and 1955-1969 averages are all higher.

(d) Twenty-Five-Year Averages

The twenty-five-year averages for 1930-1954 are all lower than, but in general, statistically similar to the forty-year average, according to the criterion developed in Appendix 2. Only the Columbia at Nicholson, Bull at Wardner and Okanagan at Okanagan Falls have significantly lower values and the Okanagan is highly regulated. Further, the twenty-five and forty-year values of standard deviation and maximum and minimum floods are similar. Therefore the information content in this twenty-five-year record and the forty-year record appears similar, at least for the statistics over the period in the study.

However, the twenty-five-year averages for 1945-1969 show fourteen streams with averages significantly greater than the forty-year average. This period is apparently largely controlled or weighted by the higher-than-average floods in the late '40's and '50's. The information content in this twenty-five-year period appears different than that of the forty-year period.

To investigate the information content of twenty-five and forty-year statistics in an analytical manner, Figure 13 was plotted. The analysis behind Figure 13 is contained in "Accuracy of Streamflow Characteristics" by Clayton H. Hardison, 1969. In general, the relative standard error of the mean is reduced by one per cent when the record is extended from twenty-five to forty years with a coefficient of variation of 0.25. This is shown for two streams, the Bull River near Wardner, Figure 14, reduction in relative standard error 1.5%, CV = 0.30; and Lillooet River near Pemberton, Figure 15, reduction in standard error 0.5%, CV = 0.21. The relative standard error of the mean is given by:

$$\frac{100 \cdot SD}{\bar{x} \cdot \sqrt{N}}$$

in which  $\bar{x}$  is the mean, SD is the standard deviation and N is the number of events. However, care must be taken in the selection of the twenty-five-year period, as witnessed by the results of this study.

Figure 13 shows that the higher the coefficient of variation the longer the record must be to achieve a given relative standard error.

The streams of coastal and northern areas of the Province are not represented in this study and results should not be extrapolated to these areas. The streams that have been covered have a similar time variation in average values for different geographical areas as witnessed in Figures 2 to 5. Some streams, such as the Lillooet near Pemberton, the Bulkley at Quick and the Chilko at Redstone, show relatively little variation in average flood when compared with streams in the south-eastern area.

APPENDIX 1 - PROGRAM LISTING

\$COMPILE

```

REAL*8 STATN
INTEGER YEAR(150),DATE(150)
REAL MAXFL,MINFL
DIMENSION DIFF(2000),DIFF2(2000),DIFF3(2000)
DIMENSION FK(200),S(200)
DIMENSION FLOW(150),FLOWT(150),FLOWR(150),NSAMP(10),CJ(150)
DIMENSION MONTH(150)
DIMENSION AVGFL(10,15),RAFL(10,15)
C ** NS THE NUMBER OF SAMPLES
C ** NY THE NUMBER OF YEARS
C ** KBW BANDWIDTH OF THE FILTERING PROCESS IN YEARS
C ** NSAMP SIZE OF SAMPLE
301 READ(5,103,END=9) NS,NY,KBW
103 FORMAT(3I6)
WRITE(6,250) NY
250 FORMAT(1H1,'NY ',I5)
NK=NS-1
READ(5,104)(NSAMP(K),K=1,NK)
104 FORMAT(10I6)
NSAMP(NS)=NY
WRITE(6,251)(NSAMP(J),J=1,NS)
251 FORMAT(10X,'NSAMP ',10I10)
DO 5 I=1,NY
READ(5,222) STATN,MONTH(I),DATE(I),YEAR(I),FLOW(I)
222 FORMAT(A8,A4,I2,I5,F7.0)
WRITE(6,223) STATN,MONTH(I),DATE(I),YEAR(I),FLOW(I)
223 FORMAT(10X,'STATN,MONTH,DATE,YEAR,FLOW ',A8,A4,I2,I5,F7.0)
5 CONTINUE
105 FORMAT(F10.0,I8)
WRITE(6,206)
206 FORMAT(1HC,4X,'YEAR',16X,'AVGFL',8X,'STNDEV',8X,'COEFF VAR',
110X,'SKEW',6X,'MAX FLOW',8X,'MIN FLOW')
DO 65 KK=1,NS
DO 66 J=1,15
AVGFL(KK,J)=0.
RAFL(KK,J)=0.
66 CONTINUE
65 CONTINUE
DO 55 KK=1,NS
KJ=1
NTOT=NSAMP(KK)
K1=1
K2=NSAMP(KK)
7 SDIFF2=0.
SDIFF3=0.
SFLOW=0.
DO 6 I=K1,K2
DIFF(I)=0.
DIFF2(I)=0.
DIFF3(I)=0.
SFLOW=FLOW(I)+SFLOW
6 CONTINUE
AVGFL(KK,KJ)=SFLOW/NTOT
DO 40 I=K1,K2
DIFF(I)=FLOW(I)-AVGFL(KK,KJ)
DIFF2(I)=DIFF(I)**2
SDIFF2=DIFF2(I)+SDIFF2
DIFF3(I)=DIFF(I)**3
SDIFF3=DIFF3(I)+SDIFF3

```

```

40    CONTINUE
      STNDEV=SQRT(SDIFF2/(NTOT-1))
      SKEW=(NTOT**2)*SDIFF3/(NTOT*(NTOT-1)*(NTOT-2)*STNDEV**3)
      CV=STNDEV/AVGFL(KK,KJ)
C ** PUT THE FLOW SEQUENCE INTO A TEMPORARY ARRAY FLOWR
      DO 50 I=K1,K2
        FLOWR(I)=FLOW(I)
50    CONTINUE
C ** SORT FLOWS INTO DESCENDING ORDER
      DO 31 J=K1,K2
        DO 30 I=K1,K2
          IF(FLOWR(J).LE.FLOWR(I)) GO TO 30
          FLOWT(J)=FLOWR(J)
          FLOWT(I)=FLOWR(I)
          FLOWR(J)=FLOWT(I)
          FLOWR(I)=FLOWT(J)
30    CONTINUE
31    CONTINUE
      MAXFL=FLOWR(K1)
      MINFL=FLOWR(K2)
      WRITE(6,201) YEAR(K1),YEAR(K2),AVGFL(KK,KJ),STNDEV,CV,SKEW,MAXFL
1,MINFL
      K1=K1+NSAMP(KK)
      K2=K2+NSAMP(KK)
      KJ=KJ+1
      IF(K2.LE.NY) GO TO 7
55    CONTINUE
201  FORMAT(1H0,2I8,2F14.0,2F14.3,2F14.0)
      DO 60 KK=1,NS
        DO 61 J=1,15
          RAFL(KK,J)=AVGFL(KK,J)/AVGFL(NS,1)
          IF(RAFL(KK,J).LE.0.) GO TO 61
          WRITE(6,202) KK,J,RAFL(KK,J)
202  FORMAT(1H0,'KK ',J ',RAFL ',2I5,F10.4)
61    CONTINUE
60    CONTINUE
      GO TO 301
9     STOP
      END

```

## APPENDIX 2

### DEVELOPMENT OF CRITERION FOR STATISTICAL

#### SIMILARITY OF AVERAGE VALUES

By the Central Limit Theorem, if a random variable  $x$  has a distribution with mean  $\mu$  and standard deviation  $\sigma$  for which the first two moments exist, then  $t = (\bar{x} - \mu) * \frac{n}{\sigma}$  has a distribution which approaches the standard normal distribution as  $n$  the sample size becomes infinite. A standard normal distribution is a normal distribution with mean = 0. and standard deviation = 1.

The following statistical criterion is developed under the assumptions that:

1. Flow is a random variable with a distribution for which the first two moments exist;
2. The forty-year average flow and standard deviation approximate  $\mu$  and  $\sigma$ ;
3.  $n = 10$  and  $n = 25$  are sufficiently large samples for the Central Limit Theorem to apply.

For a 5% level of significance  $t = (\bar{x} - \mu) * \frac{n}{\sigma}$  must be less than or equal to 1.64 for statistical similarity of  $\bar{x}$  and  $\mu$ . In this case,  $\bar{x}$  is the sample mean,  $\mu$  is the population mean,  $\sigma$  is the variance of population and  $n$  is the size of the sample.

Let  $\mu$  be the forty-year average  
 $\bar{x}$  be the short-term average, i.e.,  
 ten-year average or  
 twenty-five-year average  
 $\sigma$  be the forty-year standard deviation  
 CV be the coefficient of variation,  $\frac{\sigma}{\mu}$

$$\text{RAFL} = \frac{\bar{x}}{\mu}$$

$$t = \left| \frac{\bar{x} - \mu}{\sigma} \right| * \sqrt{n} \leq 1.64$$

$$= \left| \frac{\frac{\bar{x}}{\mu} - 1}{\frac{\sigma}{\mu}} \right| * \sqrt{n} \leq 1.64$$

$$= \left| \text{RAFL} - 1 \right| \leq \frac{1.64}{\sqrt{n}} * \text{CV}$$

CV is 0.24, an average value for the streams considered  
 in this study, so with  $n = 10$

$$\left| \text{RAFL} - 1 \right| \leq 0.10$$

or  $0.90 \leq \text{RAFL} \leq 1.10$

$$\text{For } n = 25, \quad 0.93 \leq \text{RAFL} \leq 1.07$$

### APPENDIX 3

#### REPORT ON RESULTS FROM A COMPUTER PROGRAM

#### TO SAMPLE FLOW SEQUENCES

##### Object:

To examine the effects of sample size on the average, standard deviation, and skew coefficient of a sample from a known non-normal population.

##### Procedure:

To generate a known non-normal population, a density curve of flood peak discharge was adopted from Methods of Flow Frequency Analysis - Notes on Hydrologic Activities Bulletin No.13, April 1966. This curve, when carefully traced on graph paper, provided the relative frequencies of various peak flows. Flows in the population were arbitrarily taken to range from 25 CFS to 1600 CFS in 25 CFS increments, with the size of the population taken to be 1000.

The number of each of the flows was found by multiplying the relative frequency of that flow by 1000. Then this number was distributed randomly in the 1000 occurrence array. For example, for a flow of 25 CFS,  $1000 \times 0.003$  or three occurrences were located at positions 319, 414 and 947. The position was found by the generation of a random number between 0. and 1. from a uniform distribution, University of British Columbia, Random Number Generators. This number was multiplied by 1000 and if the location so generated was found to be empty, the flow was entered. If the location was not empty, the procedure was repeated until an empty position was found.

When the array was complete, 30 samples of each of 25, 50, 75 and 100 consecutive occurrences were drawn and the average, standard distribution and skew coefficient were calculated. The draws were performed by generating a random number between 1 and 1000, as previously described. This number provided the entry point for the sample.

The routine for calculation of average, standard deviation and skew coefficient was checked on data from Formulae and Tables for Computing and Plotting Drought Frequency Curves, Technical Bulletin No.8, Inland Waters Branch, 1967.

Results:

The results of the samples are summarized in the following table:

Sampl- -ing Period	No. of Samples	Avg. Avg. Flow	Max. Avg. Flow	Min. Avg. Flow	Avg. S.D.	Max. S.D.	Min. S.D.	Avg. Skew	Max. Skew	Min. Skew
25	30	391	501	313	245	323	155	0.84	1.34	0.24
50	30	393	464	320	249	313	188	0.99	1.53	0.37
75	30	398	457	339	254	295	210	0.96	1.44	0.50
100	30	397	446	347	248	294	207	0.94	1.23	0.53
Popula- tion	-	397			255			1.02		

This table indicates that:

1. The skew coefficient cannot be estimated reliably from samples of 100 years or less;
2. Increasing the length of the sampling period does decrease the range from maximum to minimum value of the statistical parameters with the decrease being comparatively low from 75 to 100. On this basis a 75-year or 75-occurrence sample would appear to contain almost as much information as the 100-year sample from the point of view of estimating average and standard deviation.

However, these are results for a specific case and statistical tests have not been performed to decide whether the 100-year statistics are statistically similar to the 75-year statistics.



## REFERENCES

1. *"Magnitude of Floods in British Columbia"*  
Water Survey of Canada, Vancouver  
May, 1972.
  
2. *"Accuracy of Streamflow Characteristics"*  
Clayton H. Hardison  
United States Department of the Interior  
Geological Survey  
Water Resources Division  
1969

T A B L E S

1. Alphabetical Listing of Stations in Study

Annual Mean Daily Flood Statistics

2.	08NA002	Columbia River at Nicholson
2-A.	08NA002	Columbia River at Nicholson
3.	08NE049	Columbia River at Birchbank
4.	08NG005	Kootenay River at Wardner
5.	08NG042	Kootenay River at Newgate
6.	08NH021	Kootenai River at Porthill
7.	08NG002	Bull River near Wardner
8.	08NK012	Elk River at Stanley Park
9.	08NH006	Moyie River at Eastport
10.	08NH032	Boundary Creek near Porthill
11.	08NJ013	Slocan River near Crescent Valley
12.	08NE010	Pend Oreille River at International Boundary
13.	08NP001	Flathead River at Flathead
14.	08NN013	Kettle River near Ferry
15.	08NM002	Okanagan River at Okanagan Falls
16.	08NL022	Similkameen River near Nighthawk
17.	08MF005	Fraser River at Hope
18.	08JE001	Stuart River near Fort St. James
19.	08KH001	Quesnel River at Likely
20.	08KH003	Cariboo River below Kangaroo Creek
21.	08MA001	Chilko River near Redstone
22.	08LF051	Thompson River near Spences Bridge
23.	08LB064	North Thompson River at McLure
24.	08LE069	South Thompson River at Monte Creek
25.	08LD001	Adams River near Squilax
26.	08MG005	Lillooet River near Pemberton
27.	08EE004	Bulkley River at Quick

## EXPLANATION OF THE QUANTITIES IN THE TABLES

1. The Years of Record are the number of events (N) in the Period of Record.

2. The Average of Annual Mean Daily Floods is the arithmetic average, given by,

$$\frac{\sum_{i=1}^N \text{FLOOD } i}{N},$$

where FLOOD is the maximum mean daily flow of the *i*th year. As the units of the individual floods are cubic feet per second (cfs), the units of Average of Annual Mean Daily Floods are also cfs.

3. The Ratio to 40 Year Average refers to the short-term average - for example, a particular 5-year average flood - divided by the 40-year average flood.

4. The Standard Deviation over a period is equal to

$$\sqrt{\frac{\sum_{i=1}^N (\text{FLOOD } i - \text{AVERAGE FLOOD})^2}{(N-1)}}$$

Where the AVERAGE FLOOD is the average over the period of record under consideration. The units are cfs.

5. The Coefficient of Variation is the ratio of the standard deviation to the average. This ratio is dimensionless.

6. For the period under consideration the highest and lowest maximum mean daily flow are shown. The units are cfs.

7. Statistical similarity is determined on the basis of the criteria developed in Appendix 2.

TABLE 1 - ALPHABETICAL LISTING OF STATIONS IN STUDY

<u>Station Name</u>	<u>Flow</u>	<u>Missing</u>	<u>In "Magnitude of Floods in B.C." Refer to:</u>	
			<u>Table</u>	<u>Page</u>
Adams River near Squilax		1938, 1946	25	227
Boundary Creek near Porthill			10	88
Bulkley River at Quick		1930	27	325
Bull River near Wardner	M		7	76
Cariboo River below Kangaroo Creek		1958, 1965	20	182
Chilko River near Redstone			21	188
Columbia River at Nicholson			2	32
Columbia River at Birchbank	M		3	41
Elk River at Stanley Park	M		8	82
Flathead River at Flathead			13	101
Fraser River at Hope	M		17	156
Kettle River near Ferry			14	106
Kootenai River at Porthill			6	66
Kootenay River at Newgate		1930	5	65
Kootenay River at Wardner			4	64
Lillooet River near Pemberton			26	288
Moyie River at Eastport			9	87
North Thompson River at McLure			23	210
Okanagan River at Okanagan Falls	M		15	112
Pend Oreille River at International	M		12	100
Quesnel River at Likely		1937	19	178
Similkameen River near Nighthawk			16	135
Slocan River at Crescent Valley			11	98
Stuart River near Fort St. James		1932	18	172
South Thompson River at Monte Creek			24	226
Thompson River near Spences Bridge		1932, 1933	22	206

M - Flow Modified in some manner; for details consult Tables.

TABLE 2 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NA002 - Columbia River at Nicholson

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Lowest Flood Flood	
5	1930-1934	14600	0.96	2710	0.186	17200	10400
	1935-1939	12900	0.85	2740	0.211	17200	10000
	1940-1944	11300	0.74	2940	0.261	14700	8400
	1945-1949	13200	0.87	4080	0.310	19400	9300
	1950-1954	17000	1.12	3350	0.197	20800	12000
	1955-1959	18800	1.23	2330	0.124	21600	15500
	1960-1964	16900	1.11	3240	0.191	22500	14300
	1965-1969	17000	1.12	3170	0.186	21100	13600
10	1930-1939	13800	0.90*	2710	0.197	17200	10000
	1940-1949	12200	0.80	3500	0.286	19400	8400
	1950-1959	17900	1.18	2870	0.160	21600	12000
	1960-1969	17000	1.12	3020	0.178	22500	13600
15	1930-1944	12900	0.85	2940	0.227	17200	8400
	1945-1959	16300	1.07	3920	0.240	21600	9300
	1955-1969	17600	1.16	3380	0.192	22500	13600
25	1930-1954	13800	0.90	3520	0.255	20800	8400
	1945-1969	15900	1.04*	3704	0.233	22500	9300
40	1930-1969	15200	1.00	3740	0.246	22500	8400

\* Statistically similar to forty-year average

Drainage Area: 2570 square miles

TABLE 2-A - FIVE, TEN, FIFTEEN, TWENTY-FIVE, FORTY AND SIXTY-SEVEN-YEAR  
ANNUAL MEAN DAILY FLOOD STATISTICS

Station 08NA002 - Columbia River at Nicholson

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 67-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1903-1907	15700	1.02	3850	0.245	20800	10800
	1908-1912	15800	1.02	2940	0.186	18500	11600
	1913-1917	17600	1.13	5010	0.285	23700	10600
	1918-1922	17400	1.12	3790	0.218	21500	13100
	1923-1927	13900	0.89	3630	0.261	18300	10200
	1928-1932	13700	0.88	2110	0.154	15600	10400
	1933-1937	14000	0.90	2870	0.206	17200	10000
	1938-1942	12500	0.78	3430	0.274	17200	8510
	1943-1947	11800	0.76	2760	0.234	14500	8400
	1948-1952	15500	0.99	4330	0.280	19400	9860
	1953-1957	19200	1.21	2270	0.118	21600	16200
	1958-1962	17500	1.13	3310	0.189	22500	14300
1963-1967	16100	1.04	3030	0.188	21100	13600	
10	1903-1912	15800	1.02	3230	0.205	20800	10800
	1913-1922	17500	1.23	4190	0.240	23700	10600
	1923-1932	13800	0.89	2800	0.203	18300	10200
	1933-1942	13200	0.86	3080	0.233	17200	8510
	1943-1952	13600	0.88	3940	0.289	19400	8400
	1953-1962	18400	1.19	2830	0.154	22500	14300
15	1903-1917	16400	1.06	3820	0.234	23700	10600
	1918-1932	15000	0.97	3500	0.233	21500	10200
	1933-1947	12800	0.83	2960	0.232	17200	8400
	1948-1962	17400	1.12	3530	0.203	22500	9860

TABLE 2-A (Continued)

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 67-Year Average	Standard Deviation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
25	1903-1927	16100	1.04	3810	0.237	23700	10200
	1928-1952	13500	0.87	3190	0.236	19400	8400
	1943-1967	15900	1.03	3510	0.221	22500	8400
40	1903-1942	15100	0.97	3460	0.229	23700	8510
	1928-1967	15000	0.95	3380	0.225	22500	8400
67	1903-1969	15500	1.00	3710	0.239	23700	8400

TABLE 3 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NE049 - Columbia River at Birchbank

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	242000	0.96	48800	0.202	288000	189000
	1935-1939	229000	0.91	38800	0.169	271000	183000
	1940-1944	184000	0.73	26500	0.144	207000	152000
	1945-1949	256000	1.02	68500	0.268	369000	198000
	1950-1954	269000	1.07	51100	0.190	325000	220000
	1955-1959	300000	1.19	28400	0.095	332000	260000
	1960-1964	276000	1.10	60000	0.217	375000	236000
	1965-1969	259000	1.03	50000	0.194	345000	215000
10	1930-1939	236000	0.94*	42100	0.179	288000	183000
	1940-1949	220000	0.87	62100	0.282	369000	152000
	1950-1959	285000	1.13	42300	0.149	332000	220000
	1960-1969	267000	1.06*	53000	0.198	375000	215000
15	1930-1944	218000	0.87	44600	0.204	288000	152000
	1945-1959	275000	1.09	51900	0.188	369000	198000
	1955-1969	278000	1.10	60900	0.219	375000	215000
25	1930-1954	236000	0.94*	53700	0.228	369000	152000
	1945-1969	272000	1.08	62300	0.229	375000	198000
40	1930-1969	252000	1.00	55000	0.219	375000	152000

\* Statistically similar to 40-year average

Drainage Area: 34000 square miles

Storage since 1931 Corra Linn Dam  
Storage since 1967 Duncan Dam  
Storage since 1968 Hugh Keenleyside Dam



TABLE 4 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NG005 - Kootenay River at Wardner

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	42200	1.01	13000	0.307	60600	25900
	1935-1939	35100	0.84	7760	0.221	47600	28400
	1940-1944	30100	0.72	10700	0.355	43500	17900
	1945-1949	44500	1.06	12500	0.280	64200	33000
	1950-1954	44000	1.05	7320	0.166	52900	32600
	1955-1959	47700	1.14	10100	0.211	56400	32400
	1960-1964	43600	1.04	10000	0.229	61100	36800
	1965-1969	48200	1.15	2680	0.056	51700	44300
10	1930-1939	38700	0.92*	10800	0.278	60600	25900
	1940-1949	37300	0.89	13300	0.358	64200	17900
	1950-1959	45800	1.09*	8520	0.186	56400	32400
	1960-1969	45900	1.10*	7310	0.159	61100	36800
15	1930-1944	35800	0.85	11200	0.312	60600	17900
	1945-1959	45400	1.08	9570	0.211	64200	32400
	1955-1969	46500	1.11	8560	0.184	61100	32400
25	1930-1954	39200	0.94*	11200	0.286	64200	17900
	1945-1969	45600	1.08	9580	0.210	64200	32400
40	1930-1969	41900	1.00	10600	0.254	64200	17900

\* Statistically similar to 40-year average

Drainage Area: 5200 square miles

TABLE 5 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NG042 - Kootenay River at Newgate

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1931-1935	56400	0.97	18100	0.321	80000	32700
	1936-1940	47300	0.81	12900	0.274	68800	37200
	1941-1945	39900	0.69	14300	0.358	57100	23300
	1946-1950	68700	1.18	18300	0.266	97900	48100
	1951-1955	63300	1.09	13400	0.212	74200	40100
	1956-1960	62600	1.08	16900	0.270	89800	45600
	1961-1965	63900	1.10	17500	0.273	90300	46800
	1966-1970	63000	1.08	7730	0.123	70400	50200
10	1931-1940	51800	0.89	15600	0.301	80000	32700
	1941-1950	54300	0.93*	21700	0.400	97900	23300
	1951-1960	63000	1.08*	14400	0.229	89800	40100
	1961-1970	63500	1.09*	12700	0.201	90300	46800
15	1931-1945	47800	0.82	15800	0.330	80000	23300
	1946-1960	64900	1.11	15400	0.237	97900	40100
	1956-1970	63100	1.09	15300	0.242	90300	45600
25	1931-1955	55100	0.94*	17800	0.323	97900	23300
	1946-1970	64300	1.11	16100	0.250	97900	40100
40	1931-1970	58100	1.00	16700	0.286	97900	23300

\* Statistically similar to 40-year average

Drainage Area: 7660 square miles

TABLE 6 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NH021 - Kootenai River at Porthill

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	74600	0.94	17700	0.238	93200	52000
	1935-1939	65100	0.83	16100	0.247	91100	51100
	1940-1944	55400	0.70	20200	0.365	81900	33300
	1945-1949	89700	1.14	22600	0.252	125000	62300
	1950-1954	86500	1.10	11800	0.137	102000	71200
	1955-1959	91900	1.16	13300	0.145	114000	81100
	1960-1964	83100	1.05	22500	0.271	117000	63700
	1965-1969	85500	1.08	10100	0.118	98300	75200
10	1930-1939	69900	0.89	16700	0.239	93200	51100
	1940-1949	72500	0.92*	27100	0.374	125000	33300
	1950-1959	89200	1.13	12200	0.137	114000	71200
	1960-1969	84300	1.07*	16500	0.196	117000	63700
15	1930-1944	65000	0.82	18600	0.286	93200	33300
	1945-1959	89400	1.13	15600	0.174	125000	62300
	1955-1969	86800	1.10	17400	0.200	117000	63700
25	1930-1954	74300	0.94*	21100	0.284	125000	33300
	1945-1969	87300	1.11	18200	0.208	125000	62300
40	1930-1969	79000	1.00	19900	0.253	125000	33300

\* Statistically similar to 40-year average

Drainage Area: 13700 square miles

TABLE 7 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NG002 - Bull River near Wardner

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Lowest Flood Flood	
5	1930-1934	6690	0.90	2000	0.300	9790	4310
	1935-1939	6130	0.82	1630	0.265	8590	4590
	1940-1944	4860	0.65	1180	0.242	6620	3390
	1945-1949	7780	1.05	2580	0.331	12200	5760
	1950-1954	8270	1.11	1520	0.184	10100	6000
	1955-1959	8410	1.13	2210	0.263	11900	6270
	1960-1964	8370	1.13	3000	0.359	13300	5730
	1965-1969	8970	1.21	682	0.076	9750	8170
10	1930-1939	6410	0.86	1750	0.272	9790	4310
	1940-1949	6320	0.85	2440	0.385	12200	3390
	1950-1959	8340	1.12	1790	0.215	11900	6000
	1960-1969	8670	1.17	2080	0.240	13300	5730
15	1930-1944	5890	0.79	1710	0.290	9790	3390
	1945-1959	8150	1.10	2010	0.246	12200	5760
	1955-1969	8580	1.15	2390	0.278	13300	5730
25	1930-1954	6740	0.91	2090	0.309	12200	3390
	1945-1969	8360	1.13	2420	0.290	13300	5730
40	1930-1969	7430	1.00	2240	0.301	13300	3390

\* Statistically similar to 40-year average

Drainage Area: 578 square miles

Pondage since 1922 - Aberfeldie Power Plant

TABLE 8 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NK012 - Elk River at Stanley Park

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	14300	1.09	4530	0.318	19900	7950
	1935-1939	11300	0.86	5580	0.493	20900	7260
	1940-1944	9380	0.72	4730	0.505	16900	5140
	1945-1949	13400	1.02	4730	0.354	21200	9400
	1950-1954	14600	1.12	3340	0.228	18300	9540
	1955-1959	14600	1.12	4920	0.337	22100	10200
	1960-1964	1400	1.07	4900	0.350	20100	8640
	1965-1969	13100	1.00	1450	0.111	14700	11200
10	1930-1939	12800	0.98*	5040	0.394	20900	7260
	1940-1949	11400	0.87	4940	0.434	21200	5140
	1950-1959	14600	1.12	3960	0.271	22100	9540
	1960-1969	13600	1.04*	3440	0.254	20100	8640
15	1930-1944	11600	0.89	5050	0.433	20900	5140
	1945-1959	14200	1.09	4110	0.289	22100	9400
	1955-1969	13900	1.07	3700	0.266	22100	8640
25	1930-1954	12600	0.96*	4690	0.373	21200	5140
	1945-1969	13900	1.07*	3840	0.276	22100	8640
40	1930-1969	13000	1.00	4390	0.335	22100	5140

\* Statistically similar to 40-year average

Drainage Area: 1370 square miles

Pondage since 1924 - Elko Power Plant

Records before 1945 obtained from Station No. 08NK001, Elk River at Elko

TABLE 9 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NH006 - Moyie River at Eastport

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	4460	0.85	1420	0.317	6100	2800
	1935-1939	4040	0.77	1020	0.252	5740	3220
	1940-1944	3720	0.71	1790	0.481	5660	1420
	1945-1949	5950	1.13	1400	0.235	7790	3930
	1950-1954	6330	1.21	1590	0.251	8930	4690
	1955-1959	5940	1.13	1720	0.289	8870	4430
	1960-1964	5590	1.07	1700	0.304	8050	3840
	1965-1969	5870	1.12	1210	0.206	7200	4560
10	1930-1939	4250	0.81	1180	0.278	6100	2800
	1940-1949	4830	0.92*	1920	0.396	7790	1420
	1950-1959	6140	1.17	1570	0.256	8930	4430
	1960-1969	5730	1.09*	1400	0.244	8050	3840
15	1930-1944	4080	0.78	1370	0.337	6100	1420
	1945-1959	6070	1.16	1470	0.242	8930	3930
	1955-1969	5800	1.11	1680	0.290	8870	3840
25	1930-1954	4900	0.93*	1710	0.349	8930	1420
	1945-1969	5930	1.14	1650	0.278	8930	3840
40	1930-1969	5220	1.00	1650	0.316	8930	1420

\* Statistically similar to 40-year average

Drainage Area: 570 square miles

TABLE 10 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NH032 - Boundary Creek near Porthill

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
5	1930-1934	1450	0.92	502	0.346	2080	799
	1935-1939	1390	0.88	323	0.233	1920	1100
	1940-1944	1210	0.76	357	0.296	1500	645
	1945-1949	1690	1.06	248	0.147	2040	1400
	1950-1954	1620	1.02	242	0.149	2000	1410
	1955-1959	1850	1.17	324	0.175	2340	1580
	1960-1964	1630	1.02	484	0.297	2440	1200
	1965-1969	1850	1.17	409	0.222	2480	1500
10	1930-1939	1420	0.90*	399	0.281	2080	799
	1940-1949	1450	0.91*	385	0.266	2040	645
	1950-1959	1740	1.09*	295	0.170	2340	1410
	1960-1969	1740	1.09*	438	0.252	2480	1200
15	1930-1944	1350	0.85	387	0.287	2080	645
	1945-1959	1720	1.08	273	0.159	2340	1400
	1955-1969	1780	1.12	443	0.249	2480	1200
25	1930-1954	1470	0.93*	362	0.246	2080	645
	1945-1969	1730	1.09	370	0.214	2480	1200
40	1930-1969	1590	1.00	399	0.251	2480	645

\* Statistically similar to 40-year average

Drainage Area: 97 square miles

TABLE 11 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NJ013 - Slocan River near Crescent Valley

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	14600	0.94	5090	0.349	21600	9250
	1935-1939	13700	0.88	2130	0.159	16400	11100
	1940-1944	11200	0.72	2610	0.234	13900	7930
	1945-1949	16300	1.06	4620	0.283	24100	12500
	1950-1954	15300	0.99	1920	0.126	17400	12900
	1955-1959	18300	1.18	2910	0.159	21600	14900
	1960-1964	16900	1.09	4560	0.269	24300	13700
	1965-1969	17500	1.13	3600	0.206	22200	14100
10	1930-1939	14100	0.91*	3710	0.262	21600	9250
	1940-1949	13800	0.89	4450	0.323	24100	7930
	1950-1959	16800	1.09*	2810	0.168	21600	12900
	1960-1969	17200	1.11	3890	0.226	24300	13700
15	1930-1944	13100	0.85	3580	0.272	21600	7930
	1945-1959	16600	1.08	3350	0.202	24100	12500
	1955-1969	17600	1.13	4240	0.241	24300	13700
25	1930-1954	14200	0.92	3680	0.259	24100	7930
	1945-1969	16900	1.09	4010	0.237	24300	12500
40	1930-1969	15500	1.00	3930	0.254	24300	7930

\* Statistically similar to 40-year average

Drainage Area: 1270 square miles



TABLE 12 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NE010 - Pend Oreille River at International Boundary

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	86400	0.96	36200	0.419	137000	50900
	1935-1939	81100	0.90	13800	0.171	96500	59900
	1940-1944	60000	0.67	28400	0.474	103000	32000
	1945-1949	110000	1.23	36000	0.327	171000	79500
	1950-1954	107000	1.19	13500	0.126	128000	91500
	1955-1959	102000	1.14	17700	0.174	130000	81000
	1960-1964	90400	1.01	28100	0.311	122000	57900
	1965-1969	80600	0.90	21900	0.271	110000	53800
10	1930-1939	83700	0.93*	26000	0.310	137000	50900
	1940-1949	85000	0.94*	40300	0.475	171000	32000
	1950-1959	104000	1.16	15100	0.145	130000	81000
	1960-1969	85500	0.95*	24300	0.284	122000	53800
15	1930-1944	75800	0.85	28300	0.373	137000	32000
	1945-1959	106000	1.19	22900	0.216	171000	79500
	1955-1969	91000	1.01	25400	0.279	130000	53800
25	1930-1954	88900	0.99*	31300	0.352	171000	32000
	1945-1969	98000	1.09	26300	0.268	171000	53800
40	1930-1969	89600	1.00	28200	0.315	171000	32000

\* Statistically similar to 40-year average

Drainage Area: 25200 square miles

Storage since 1939 - Upstream U.S. Dams

TABLE 13 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NP001 - Flathead River at Flathead

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
5	1930-1934	6940	0.93	2240	0.323	10100	4560
	1935-1939	6650	0.90	1680	0.252	8950	5030
	1940-1944	4730	0.64	1730	0.366	6220	2780
	1945-1949	8650	1.16	3530	0.407	14600	5470
	1950-1954	7570	1.02	2560	0.338	11200	4400
	1955-1959	8830	1.19	2200	0.249	12500	6900
	1960-1964	8730	1.17	3930	0.451	13500	4610
	1965-1969	7340	0.99	1450	0.197	9600	6000
10	1930-1939	6790	0.91*	1870	0.276	10100	4560
	1940-1949	6690	0.90*	3340	0.499	14600	2780
	1950-1959	8200	1.10*	2340	0.286	12500	4400
	1960-1969	8030	1.08*	2890	0.359	13500	4610
15	1930-1944	6100	0.82	2030	0.333	10100	2780
	1945-1959	8350	1.12	2670	0.320	14600	4400
	1955-1969	8300	1.11	2760	0.331	13500	4610
25	1930-1954	6910	0.93*	2590	0.375	14600	2780
	1945-1969	8220	1.11	2990	0.364	14600	4400
40	1930-1969	7430	1.00	2660	0.358	14600	2780

\* Statistically similar to 40-year average

Drainage Area: 450 square miles

TABLE 14 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NN013 - Kettle River near Ferry

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	9810	0.83	3080	0.314	13800	5490
	1935-1939	10400	0.88	1030	0.098	11500	8900
	1940-1944	10200	0.87	4340	0.424	17900	7550
	1945-1949	13700	1.16	4180	0.305	20300	8850
	1950-1954	13200	1.12	1680	0.127	15000	11100
	1955-1959	14200	1.20	2150	0.152	16900	12000
	1960-1964	11300	0.95	2040	0.181	13600	8700
	1965-1969	11500	0.97	2890	0.251	14100	7200
10	1930-1939	10100	0.86	2190	0.216	13800	5490
	1940-1949	12000	1.02*	4410	0.368	20300	7550
	1950-1959	13700	1.16	1880	0.138	16900	11100
	1960-1969	11400	0.97*	2360	0.207	14100	7200
15	1930-1944	10200	0.86	2910	0.286	17900	5490
	1945-1959	13700	1.16	2700	0.197	20300	8850
	1955-1969	12300	1.05	2690	0.219	16900	7200
25	1930-1954	11500	0.97*	3330	0.290	20300	5490
	1945-1969	12800	1.08	2930	0.229	20300	7200
40	1930-1969	11800	1.00	3070	0.260	20300	5490

\* Statistically similar to 40-year average

Drainage Area: 2220 square miles

TABLE 15 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NM002 - Okanagan River at Okanagan Falls

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
5	1930-1934	796	0.68	499	0.627	1300	146
	1935-1939	984	0.84	269	0.273	1240	532
	1940-1944	787	0.67	360	0.457	1280	263
	1945-1949	1230	1.05	320	0.260	1530	689
	1950-1954	1260	1.08	201	0.160	1440	944
	1955-1959	1750	1.50	598	0.342	2560	1030
	1960-1964	1180	1.01	525	0.455	1790	348
	1965-1969	1370	1.17	528	0.387	1730	455
10	1930-1939	890	0.76	391	0.439	1300	146
	1940-1949	1010	0.86	397	0.394	1530	263
	1950-1959	1500	1.29	493	0.328	2560	944
	1960-1969	1270	1.09*	506	0.397	1790	348
15	1930-1944	856	0.73	371	0.434	1300	146
	1945-1959	1410	1.21	451	0.319	2560	689
	1955-1969	1430	1.23	564	0.451	2560	348
25	1930-1954	1010	0.86	376	0.372	1530	146
	1945-1969	1360	1.16	436	0.366	2560	348
40	1930-1969	1170	1.00	494	0.423	2560	146

\* Statistically similar to 40-year average

Drainage Area: 2650 square miles

Flow regulated since 1915 - Okanagan Lake Dam

Flow regulated Skaha Lake Dam

TABLE 16 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08NL022 - Similkameen River near Nighthawk

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	14900	0.87	8130	0.547	26400	8300
	1935-1939	14600	0.85	4540	0.312	21600	10000
	1940-1944	10800	0.63	5650	0.523	19300	4750
	1945-1949	22400	1.32	9980	0.445	38100	14300
	1950-1954	19800	1.16	5930	0.299	28900	14000
	1955-1959	21900	1.28	4910	0.225	28000	15000
	1960-1964	16700	0.98	4850	0.289	22300	12100
	1965-1969	15500	0.91	4000	0.258	20800	9600
10	1930-1939	14700	0.86	6210	0.422	26400	8300
	1940-1949	16600	0.97*	9790	0.590	38100	4750
	1950-1959	20900	1.22	5240	0.251	28900	14000
	1960-1969	16100	0.94*	4240	0.263	22300	9600
15	1930-1944	13400	0.79	6130	0.457	26400	4750
	1945-1959	21400	1.25	6830	0.320	38100	14000
	1955-1969	18000	1.05	5130	0.284	28000	9600
25	1930-1954	16500	0.97*	7740	0.469	38100	4750
	1945-1969	19300	1.13	6480	0.335	38100	9600
40	1930-1969	17100	1.00	6850	0.401	38100	4750

\* Statistically similar to 40-year average

Drainage Area: 3550 square miles

TABLE 17 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08MF005 - Fraser River at Hope

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	295000	0.95	23100	0.078	328000	269000
	1935-1939	288000	0.93	51300	0.178	375000	241000
	1940-1944	233000	0.75	35300	0.151	267000	181000
	1945-1949	351000	1.14	106000	0.303	536000	276000
	1950-1954	319000	1.03	71700	0.225	440000	255000
	1955-1959	351000	1.14	37200	0.106	400000	299000
	1960-1964	327000	1.06	52500	0.161	408000	272000
	1965-1969	310000	1.00	42900	0.138	382000	276000
10	1930-1939	291000	0.94*	37700	0.129	375000	241000
	1940-1949	292000	0.95*	97000	0.332	536000	181000
	1950-1959	335000	1.08*	56500	0.169	444000	255000
	1960-1969	319000	1.03*	46000	0.145	408000	272000
15	1930-1944	272000	0.88	45500	0.167	375000	181000
	1945-1959	340000	1.10	73100	0.215	536000	255000
	1955-1969	329000	1.07	54800	0.166	408000	272000
25	1930-1954	297000	0.96*	71000	0.239	536000	181000
	1945-1969	331000	1.07*	76200	0.230	536000	255000
40	1930-1969	309000	1.00	63800	0.206	536000	181000

\* Statistically similar to 40-year average

Drainage Area: 83700 square miles

Storage and diversion since 1952 - Kenny Dam and Kemano Power Plant

TABLE 18 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08JE001 - Stuart River near Fort St. James

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1935	10300	0.93	2800	0.272	13600	6240
	1936-1940	10200	0.92	2440	0.240	13300	7690
	1941-1945	7580	0.68	1040	0.138	9230	6370
	1946-1950	11200	0.92	1520	0.136	13800	9800
	1951-1955	12300	1.11	3050	0.249	15100	7740
	1956-1960	12800	1.15	3720	0.291	16000	7590
	1961-1965	11700	1.05	3740	0.321	17700	8200
	1966-1970	12900	1.16	2730	0.212	15800	9900
10	1930-1940	10200	0.92*	2470	0.242	13600	6240
	1941-1950	9400	0.85	2270	0.242	13800	6370
	1951-1960	12500	1.13	3220	0.257	16000	7590
	1961-1970	12300	1.11	3160	0.257	17700	8200
15	1930-1945	9340	0.84	2430	0.260	13600	6240
	1946-1960	12100	1.09	2780	0.230	16000	7590
	1956-1970	12500	1.12	3430	0.274	15800	7590
25	1930-1955	10300	0.93*	2630	0.256	15100	6240
	1946-1970	12200	1.10	3450	0.282	17700	7590
40	1930-1970	11100	1.00	3020	0.272	17700	6240

\* Statistically similar to 40-year average

Drainage Area: 5400 square miles

TABLE 19 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08KH001 - Quesnel River at Likely

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1930-1934	14200	1.04	3410	0.240	18900	11400
	1935-1940	13300	0.97	4520	0.339	20400	9400
	1941-1945	9420	0.69	931	0.099	10800	8390
	1946-1950	14500	1.06	2300	0.159	17500	11900
	1951-1955	13400	0.98	3250	0.243	18300	9730
	1956-1960	14800	1.08	1960	0.133	17500	12200
	1961-1965	15300	1.12	2260	0.148	18700	12400
	1966-1970	14600	1.07	2910	0.199	18900	11700
10	1930-1940	13700	1.01*	3800	0.276	20400	9400
	1941-1950	11900	0.87	3140	0.263	17500	8390
	1951-1960	14100	1.03*	2630	0.187	18300	9730
	1961-1970	15000	1.09*	2480	0.166	18900	11700
15	1930-1945	12300	0.90	3740	0.304	20400	8390
	1946-1960	14200	1.04	2450	0.172	18300	9730
	1956-1970	14900	1.09	2800	0.188	18900	11700
25	1930-1955	13000	0.95*	3410	0.263	20400	8390
	1946-1970	14500	1.06*	3000	0.207	18900	9730
40	1930-1970	13700	1.00	3140	0.229	20400	8390

\* Statistically similar to 40-year average

Drainage Area: 2330 square miles



TABLE 20 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08KH003 - Cariboo River below Kangaroo Creek

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
5	1929-1933	13500	0.99	1440	0.107	14600	11400
	1934-1938	14200	1.05	3680	0.258	20200	10600
	1939-1943	11700	0.86	3280	0.281	16300	7190
	1944-1948	13200	0.97	3930	0.298	19800	9750
	1949-1953	13200	0.97	1340	0.101	15100	11600
	1954-1959	15300	1.12	3380	0.221	18700	11600
	1960-1964	13900	1.03	2570	0.184	17900	11100
	1966-1970	13700	1.01	2970	0.217	16700	9670
10	1929-1938	13900	1.02*	2660	0.192	20200	10600
	1939-1948	12400	0.92*	3510	0.282	19800	7190
	1949-1959	14200	1.05*	2660	0.187	18700	11600
	1960-1970	13800	1.02*	2620	0.190	17900	9670
15	1929-1943	13100	0.97	2960	0.226	20200	7190
	1944-1959	13900	1.02	3040	0.219	19800	9750
	1954-1970	14300	1.05	3010	0.210	18700	9670
25	1929-1953	13200	0.97*	2830	0.215	20200	7190
	1944-1970	13900	1.02*	2880	0.204	19800	9670
40	1929-1970	13600	1.00	2860	0.211	20200	7190

\* Statistically similar to 40-year average

Drainage Area: 1310 square miles

TABLE 21 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08MA001 - Chilko River near Redstone

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
5	1930-1934	10000	0.92	525	0.052	10600	9270
	1935-1939	11000	1.01	1290	0.117	13200	9930
	1940-1944	11000	1.01	1500	0.137	12800	8960
	1945-1949	10000	0.92	3100	0.310	15400	7520
	1950-1954	11300	1.03	3150	0.280	16800	9000
	1955-1959	11300	1.03	1710	0.151	13500	8920
	1960-1964	10500	0.97	1130	0.108	12200	9380
	1965-1969	12000	1.10	2030	0.170	14000	9640
10	1930-1939	10500	0.97*	1060	0.101	13200	9270
	1940-1949	10500	0.97*	2360	0.224	15400	7520
	1950-1959	11300	1.04*	2390	0.212	16800	8920
	1960-1969	11200	1.03*	1730	0.154	14000	9380
15	1930-1944	10700	0.98	1200	0.112	13200	8960
	1945-1959	10900	1.00	2610	0.240	16800	7520
	1955-1969	11300	1.04	1660	0.147	14000	8920
25	1930-1954	10700	0.98*	2060	0.193	16800	7520
	1945-1969	11000	1.01*	2300	0.210	16800	7520
40	1930-1969	10900	1.00	1920	0.177	16800	7520

\* Statistically similar to 40-year average

Drainage Area: 3230 square miles

TABLE 22 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08LF051 - Thompson River near Spences Bridge

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	Lowest Flood
5	1925-1929	99600	1.00	27900	0.280	134000	60300
	1935-1939	95900	0.96	17500	0.182	124000	81900
	1940-1944	80000	0.80	6490	0.081	86400	70700
	1945-1949	107000	1.07	23800	0.223	146000	89300
	1950-1954	99100	0.99	13400	0.135	117000	85500
	1955-1959	114000	1.14	13300	0.116	126000	94900
	1960-1964	102000	1.02	20200	0.198	124000	75000
	1965-1969	101000	1.01	13200	0.130	122000	86900
10	1925-1939	97700	0.98*	22100	0.226	134000	60300
	1940-1949	93400	0.94*	21700	0.232	146000	70700
	1950-1959	106000	1.07*	14800	0.139	126000	85500
	1960-1969	101000	1.02*	16100	0.158	124000	75000
15	1925-1944	91800	0.92	20000	0.218	134000	60300
	1945-1959	107000	1.07	17400	0.163	146000	85500
	1955-1969	105000	1.06	17500	0.167	126000	75000
25	1925-1954	96200	0.97*	20000	0.206	146000	60300
	1945-1969	105000	1.06*	18900	0.180	146000	75000
40	1925-1969	99700	1.00	18800	0.189	146000	60300

\* Statistically similar to 40-year average

Drainage Area: 21600 square miles

Records before 1952 obtained from: Station No. 08LF022 - Thompson River  
at Spences Bridge

TABLE 23 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08LB064 - North Thompson River at McLure

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood	For the Period Lowest Flood
5	1930-1934	60500	0.95	4220	0.070	64800	55100
	1935-1939	59700	0.94	12900	0.216	82500	50600
	1940-1944	51400	0.81	10200	0.199	62900	43200
	1945-1949	66000	1.04	16700	0.253	93200	51100
	1950-1954	64100	1.01	8510	0.133	74900	54200
	1955-1959	75200	1.19	14400	0.191	96800	58000
	1960-1964	67800	1.07	11200	0.165	77600	51300
	1965-1969	63100	0.99	7960	0.126	74000	53600
10	1930-1939	60100	0.95*	9060	0.151	82500	50600
	1940-1949	58700	0.92*	15100	0.258	93200	43200
	1950-1959	69700	1.10*	12600	0.180	96800	54200
	1960-1969	65500	1.03*	9500	0.145	77600	51300
15	1930-1944	57200	0.90	10000	0.175	82500	43200
	1945-1959	68500	1.08	13600	0.198	96800	51100
	1955-1969	68700	1.08	12500	0.182	96800	51300
25	1930-1954	60400	0.95*	11500	0.191	93200	43200
	1945-1969	67200	1.06*	13200	0.197	96800	51100
40	1930-1969	63500	1.00	12200	0.192	96800	43200

\*Statistically similar to 40-year average

Drainage Area: 7870 square miles

Records of before 1960 obtained from Station No. 08LB022, North Thompson River near Barriere

Note that Station No. 08LB064 includes the Barriere River

TABLE 24 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08LE069 - South Thompson River at Monte Creek

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period Highest Flood    Lowest Flood	
5	1930-1934	34200	0.97	9800	0.286	47400	22900
	1935-1939	35200	1.00	8400	0.238	46500	25800
	1940-1944	26500	0.75	3080	0.116	29300	22400
	1945-1949	40600	1.15	10200	0.251	56700	33000
	1950-1954	36600	1.04	5240	0.143	43600	30000
	1955-1959	38700	1.10	2800	0.072	43500	36600
	1960-1964	35500	1.00	7390	0.208	43600	26100
	1965-1969	35400	1.00	3120	0.088	40800	33100
10	1930-1939	34700	0.98*	8600	0.248	47400	22900
	1940-1949	33600	0.95*	10300	0.306	56700	22400
	1950-1959	37700	1.07*	4110	0.109	43600	30000
	1960-1969	35400	1.00*	5350	0.151	43600	26100
15	1930-1944	32000	0.91	8130	0.254	47400	22400
	1945-1959	38600	1.09	6520	0.169	56700	30000
	1955-1969	36500	1.03	5320	0.146	43600	26100
25	1930-1954	34600	0.98*	8550	0.247	56700	22400
	1945-1969	37300	1.06*	6750	0.182	56700	26100
40	1930-1969	35300	1.00	7360	0.208	56700	22400

\* Statistically similar to 40-year average

Drainage Area: 6340 square miles

Records before 1959 obtained from Station No. 08LE031, South Thompson River  
at Chase

TABLE 25 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08LD001 - Adams River near Squilax

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
5	1929-1933	8250	0.99	878	0.106	9430	7160
	1934-1939	8370	1.00	1940	0.232	11700	6770
	1940-1944	6640	0.80	736	0.111	7590	5580
	1945-1950	9460	1.13	2390	0.252	13100	6890
	1951-1955	8640	1.03	868	0.101	10100	7800
	1956-1960	9030	1.08	967	0.107	10100	7820
	1961-1965	8170	0.98	1650	0.202	10100	6160
	1966-1970	8310	0.99	1040	0.125	9660	7040
10	1929-1939	8310	0.99*	1420	0.171	11700	6770
	1940-1950	8050	0.96*	2230	0.277	13100	5580
	1951-1960	8830	1.06*	890	0.101	10100	7800
	1961-1970	8240	0.99*	1300	0.158	10100	6160
15	1929-1944	7760	0.93	1450	0.188	11700	5580
	1945-1960	9040	1.08	1500	0.165	13100	6890
	1956-1970	8500	1.02	1440	0.169	10100	6160
25	1929-1955	8270	0.99*	1670	0.202	13100	5580
	1945-1970	8720	1.04*	1400	0.161	13100	6160
40	1929-1970	8360	1.00	1510	0.180	13100	5580

\* Statistically similar to 40-year average

Drainage Area: 1200 square miles

TABLE 26 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08MG005 - Lillooet River near Pemberton

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Deviation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
5	1930-1934	15600	0.85	1680	0.108	17500	13400
	1935-1939	17600	0.96	2060	0.117	20600	15100
	1940-1944	19800	1.08	6980	0.352	31800	14300
	1945-1949	17900	0.98	2900	0.162	22000	13800
	1950-1954	17700	0.97	1400	0.079	19900	16400
	1955-1959	20600	1.12	2780	0.135	25300	18000
	1960-1964	16400	0.90	3490	0.212	20400	13200
	1965-1969	20700	1.13	5240	0.253	27900	14600
10	1930-1939	16600	0.91*	2070	0.125	20600	13400
	1940-1949	18900	1.03*	5140	0.272	31800	13800
	1950-1959	19100	1.05*	2560	0.134	25300	16400
	1960-1969	18600	1.02*	4770	0.257	27900	13200
15	1930-1944	17700	0.97	4380	0.248	31800	13400
	1945-1959	18700	1.02	2640	0.141	25300	13800
	1955-1969	19200	1.05	4570	0.238	27900	13200
25	1930-1954	17700	0.97*	3600	0.203	31800	13400
	1945-1969	18700	1.02*	3740	0.200	27900	13200
40	1930-1969	18300	1.00	3860	0.211	31800	13200

\* Statistically similar to 40-year average

Drainage Area: 800 square miles

TABLE 27 - FIVE, TEN, FIFTEEN, TWENTY-FIVE AND FORTY-YEAR ANNUAL  
MEAN DAILY FLOOD STATISTICS

Station 08EE004 - Bulkley River at Quick

Years of Record	Period of Record	Average of Annual Mean Daily Floods	Ratio to 40-Year Average	Standard Variation	Coefficient of Variation	For the Period	
						Highest Flood	Lowest Flood
5	1931-1935	21500	1.03	8140	0.379	30100	13000
	1936-1940	21500	1.03	4040	0.187	28500	18000
	1941-1945	16200	0.77	5810	0.359	24400	10300
	1946-1950	21600	1.03	5650	0.262	31600	18000
	1951-1955	20700	0.99	4260	0.206	23700	13200
	1956-1960	20700	0.99	4240	0.205	24900	15900
	1961-1965	22600	1.08	5270	0.233	29900	17600
	1966-1970	22000	1.05	5380	0.245	30400	16200
10	1931-1940	21500	1.03*	6060	0.282	30100	13000
	1941-1950	18900	0.90*	6100	0.323	31600	10300
	1951-1960	20700	0.99*	4010	0.193	24900	13200
	1961-1970	22300	1.07*	5030	0.226	30400	16200
15	1931-1945	19700	0.94	6320	0.320	30100	10300
	1946-1960	21000	1.00	4430	0.211	31600	13200
	1956-1970	21800	1.05	4880	0.224	30400	15900
25	1931-1955	20300	0.97*	5670	0.280	31600	10300
	1946-1970	21500	1.03*	4880	0.227	31600	13200
40	1931-1970	20800	1.00	5310	0.255	31600	10300

\* Statistically similar to 40-year average

Drainage Area: 2800 square miles



## FIGURES

1. Map of British Columbia indicating locations of Stations used in the Study.  
Ratios of Ten-Year Average Flood to Forty-Year Average for:
  2. 1930 - 1939
  3. 1940 - 1949
  4. 1950 - 1959
  5. 1960 - 1969Averages and Standard Deviations of Annual Mean Daily Floods for:
  6. 08NE049 Columbia River at Birchbank
  7. 08NG042 Kootenay River at Newgate
  8. 08NG002 Bull River near Wardner
  9. 08MF005 Fraser River at Hope
  10. 08LB064 North Thompson River at McLure
  11. 08MG005 Lillooet River near Pemberton
  12. 08EE004 Bulkley River at Quick
13. Relative Standard Error of Average and Standard Deviation as a Function of Length of Record and Coefficient of Variation.
14. Relative Standard Error of Estimate of the Mean as a Function of Length of Record for Station No. 08NG002 - Bull River near Wardner.
15. Relative Standard Error of Estimate of the Mean as a Function of Length of Record for Station No. 08MG005 - Lillooet River at Pemberton.

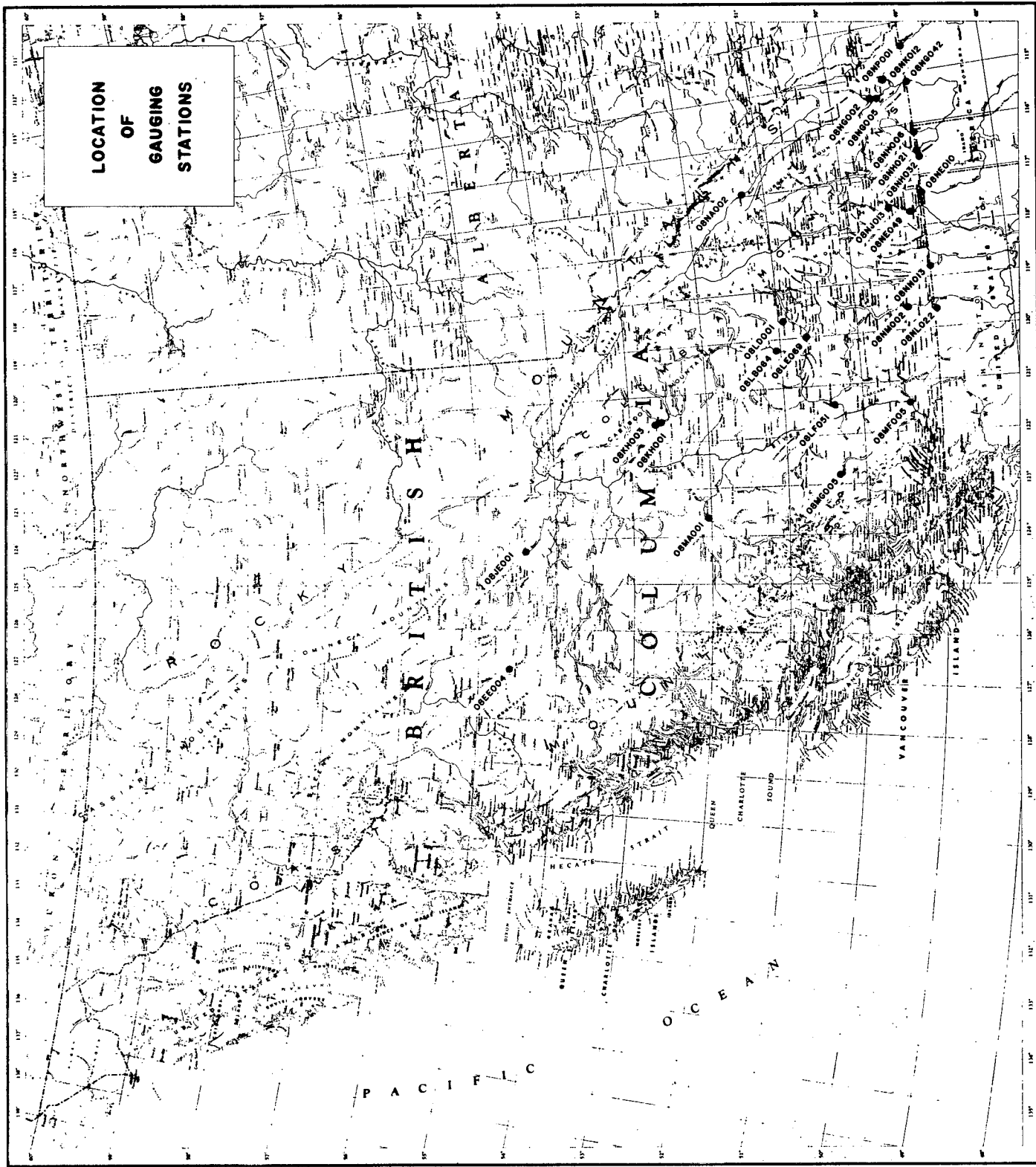


FIGURE 1

RATIO OF  
10 YEAR AVERAGE FLOOD TO 40 YEAR AVERAGE FLOOD  
FOR 1930 — 1939

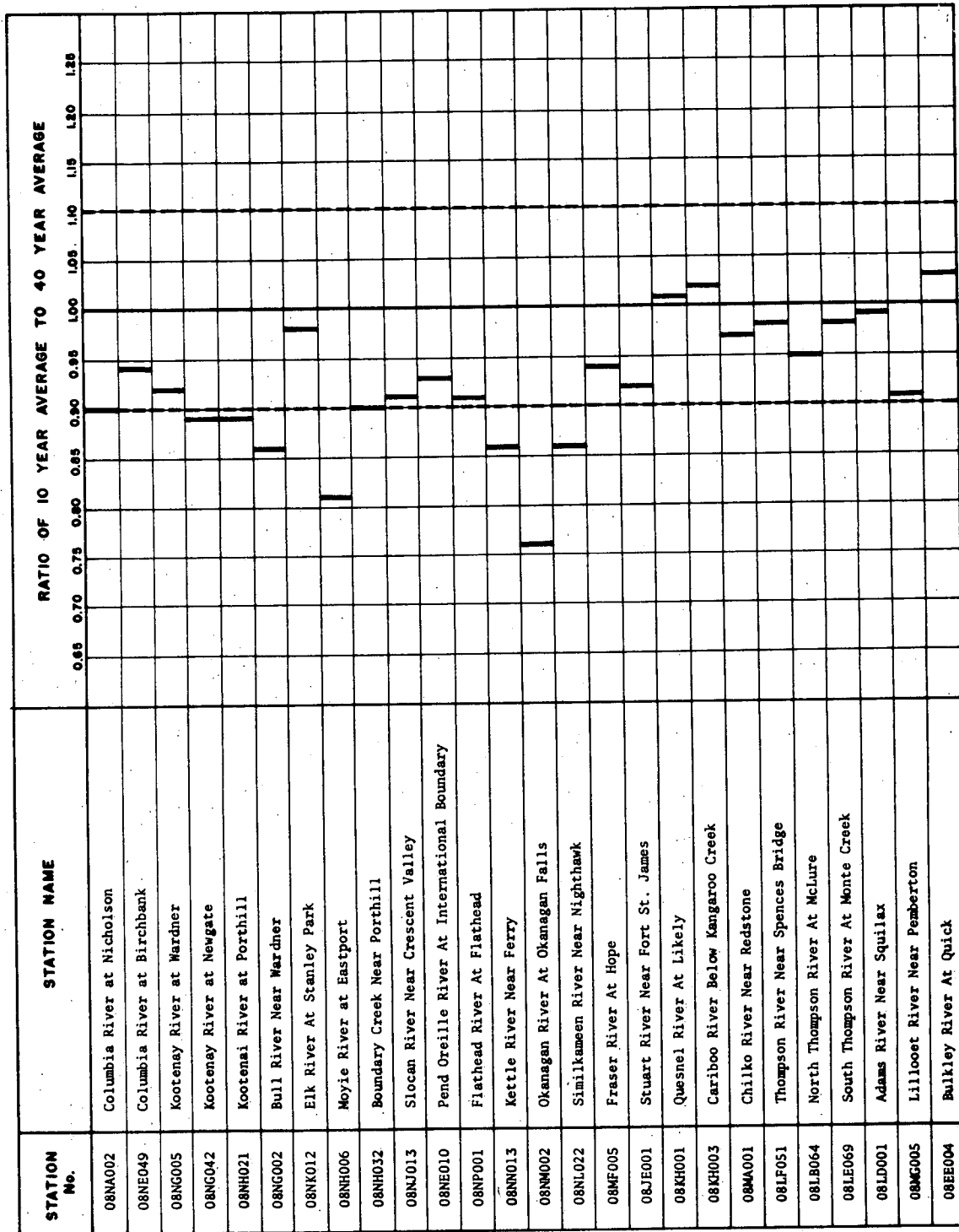


FIGURE 2

RATIO OF  
10 YEAR AVERAGE FLOOD TO 40 YEAR AVERAGE FLOOD  
FOR 1940 — 1949

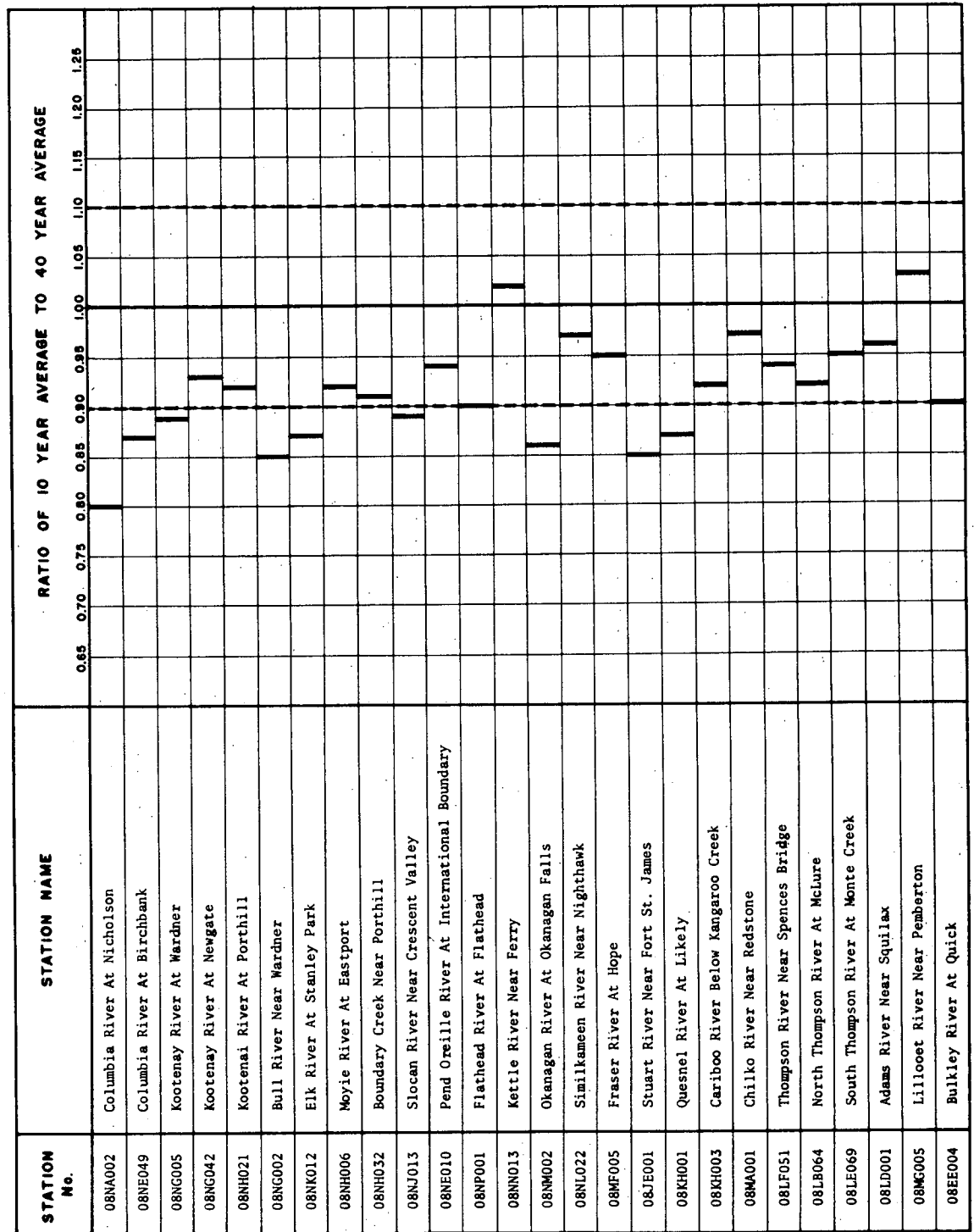


FIGURE 3

**RATIO OF  
10 YEAR AVERAGE FLOOD TO 40 YEAR AVERAGE FLOOD  
FOR 1950 — 1959**

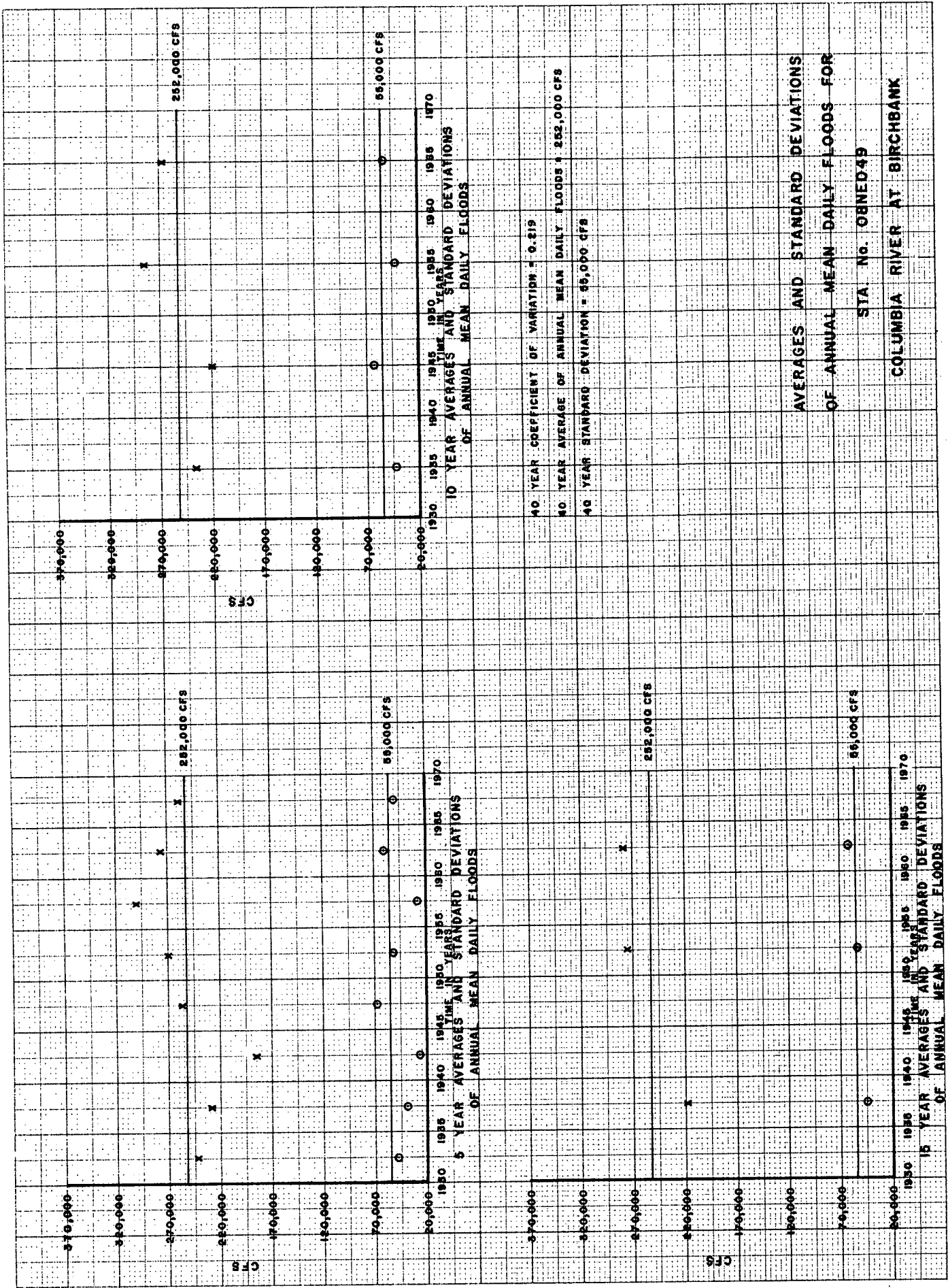
STATION No.	STATION NAME	RATIO OF 10 YEAR AVERAGE TO 40 YEAR AVERAGE												
		0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25
08NA002	Columbia River At Nicholson													
08NE049	Columbia River At Birchbank													
08NG005	Kootenay River At Wardner													
08NG042	Kootenay River At Newgate													
08NH021	Kootenai River At Porthill													
08NG002	Bull River Near Wardner													
08NK012	Elk River At Stanley Park													
08NH006	Moyie River At Eastport													
08NH032	Boundary Creek Near Porthill													
08NJ013	Slocan River Near Crescent Valley													
08NE010	Pend Oreille River At International Boundary													
08NP001	Flathead River At Flathead													
08NN013	Kettle River Near Ferry													
08NM002	Okanagan River At Okanagan Falls													
08NL022	Similkameen River Near Nighthawk													
08MF005	Fraser River At Hope													
08JE001	Stuart River Near Fort St. James													
08KH001	Quesnel River At Likely													
08KH003	Cariboo River Below Kangaroo Creek													
08MA001	Chilko River Near Redstone													
08LF051	Thompson River Near Spences Bridge													
08LB064	North Thompson River At McLure													
08LE069	South Thompson River At Monte Creek													
08LD001	Adams River Near Squilax													
08MG005	Lillooet River Near Pemberton													
08EE004	Bulkley River At Quick													

FIGURE 4

**RATIO OF  
10 YEAR AVERAGE FLOOD TO 40 YEAR AVERAGE FLOOD  
FOR 1960 — 1969**

STATION No.	STATION NAME	RATIO OF 10 YEAR AVERAGE TO 40 YEAR AVERAGE												
		0.85	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25
08NA002	Columbia River At Nicholson													
08NE049	Columbia River At Birchbank													
08NG005	Kootenay River At Wardner													
08NG042	Kootenay River At Newgate													
08NH021	Kootenai River At Porthill													
08NG002	Bull River Near Wardner													
08NK012	Elk River At Stanley Park													
08NH006	Moyie River At Eastport													
08NH022	Boundary Creek Near Porthill													
08NJ013	Slocan River Near Crescent Valley													
08NE010	Pend Oreille River At International Boundary													
08NP001	Flathead River At Flathead													
08NN013	Kettle River Near Ferry													
08NM002	Okanagan River At Okanagan Falls													
08NL022	Similkameen River Near Nighthawk													
08NF005	Fraser River At Hope													
08JE001	Stuart River Near Fort St. James													
08KH001	Quesnel River At Likely													
08KH003	Cariboo River Below Kangaroo Creek													
08MA001	Chilko River Near Redstone													
08LF051	Thompson River Near Spences Bridge													
08LB064	North Thompson River At McLure													
08LE069	South Thompson River At Monte Creek													
08LD001	Adams River Near Squilax													
08MG005	Lillooet River Near Pemberton													
08EE004	Bulkley River At Quick													

**FIGURE 5**



AVERAGES AND STANDARD DEVIATIONS  
OF ANNUAL MEAN DAILY FLOODS FOR  
STA. No. 08NED49  
COLUMBIA RIVER AT BIRCHBANK

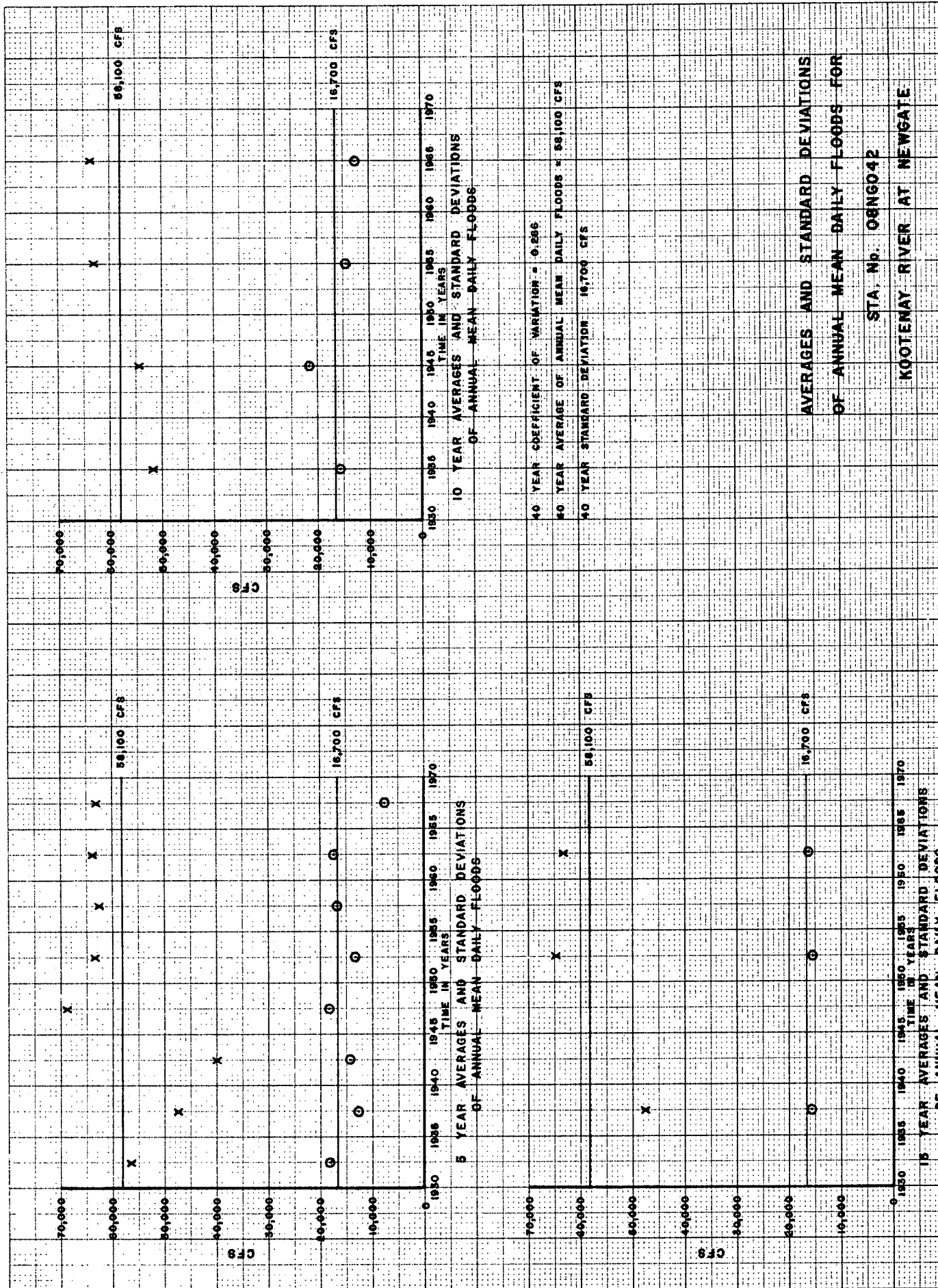
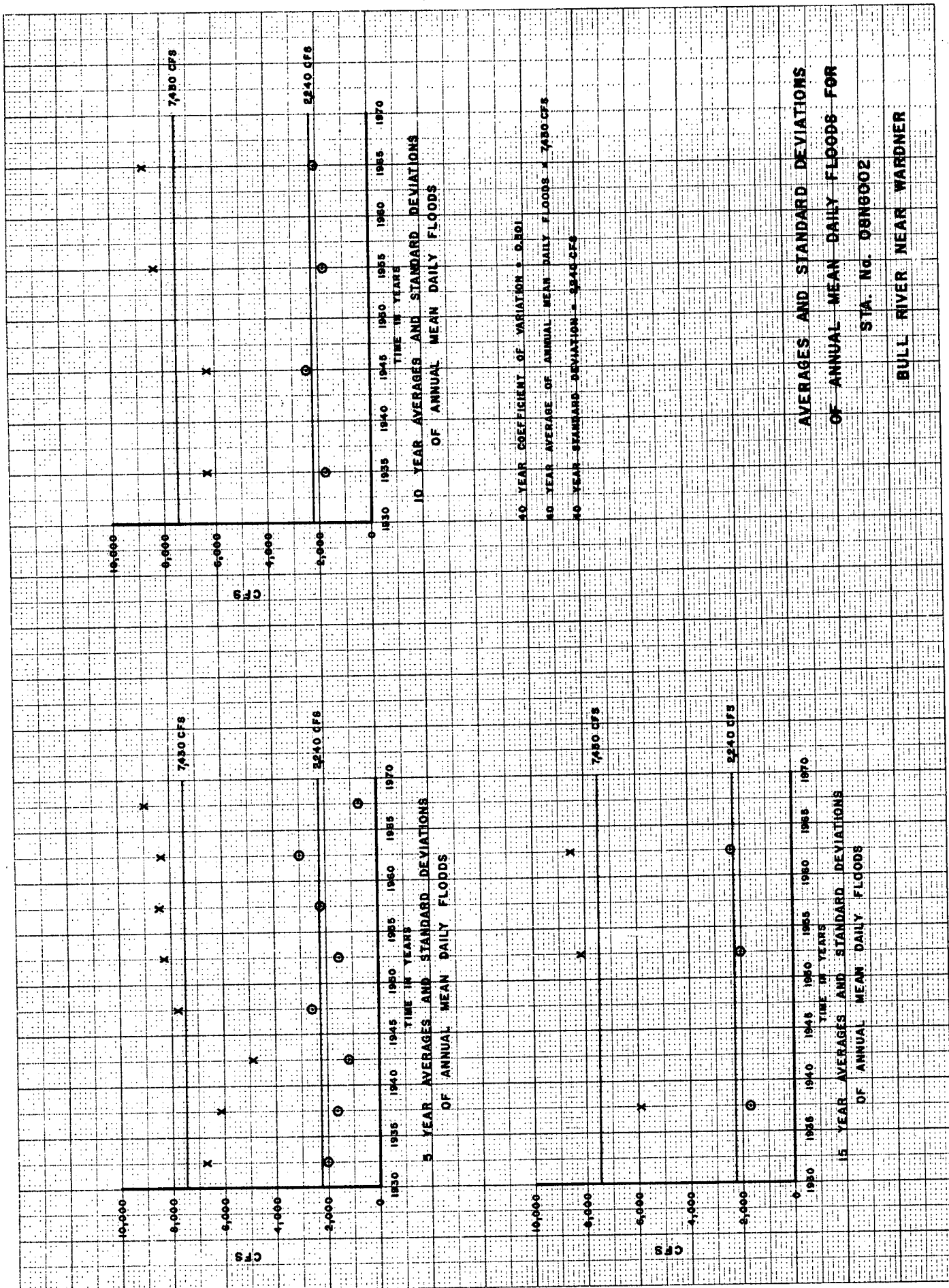


FIGURE 7





**AVERAGES AND STANDARD DEVIATIONS OF ANNUAL MEAN DAILY FLOODS FOR BULL RIVER NEAR WARDNER**

STA. NO. 08N6002

BULL RIVER NEAR WARDNER

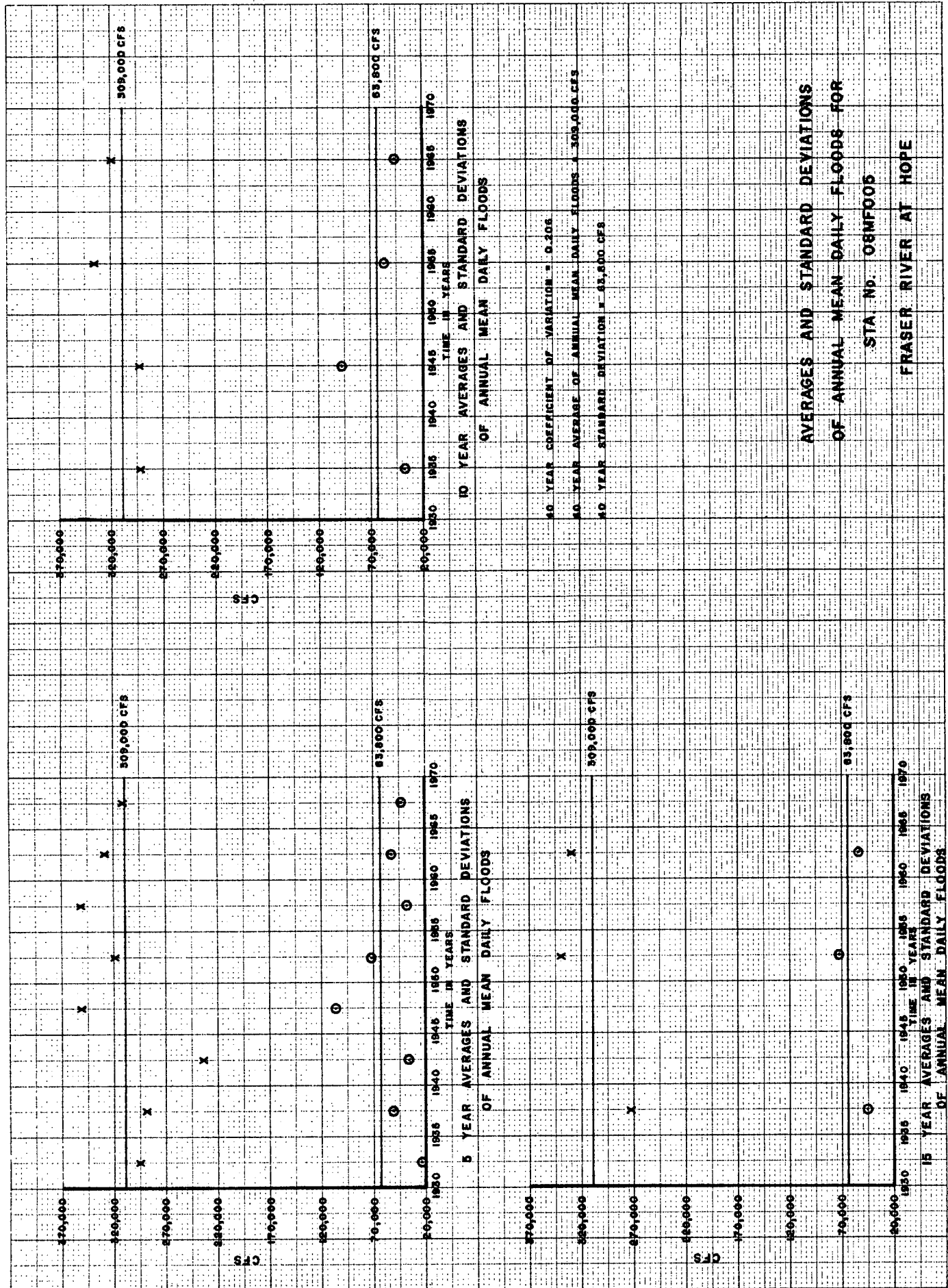
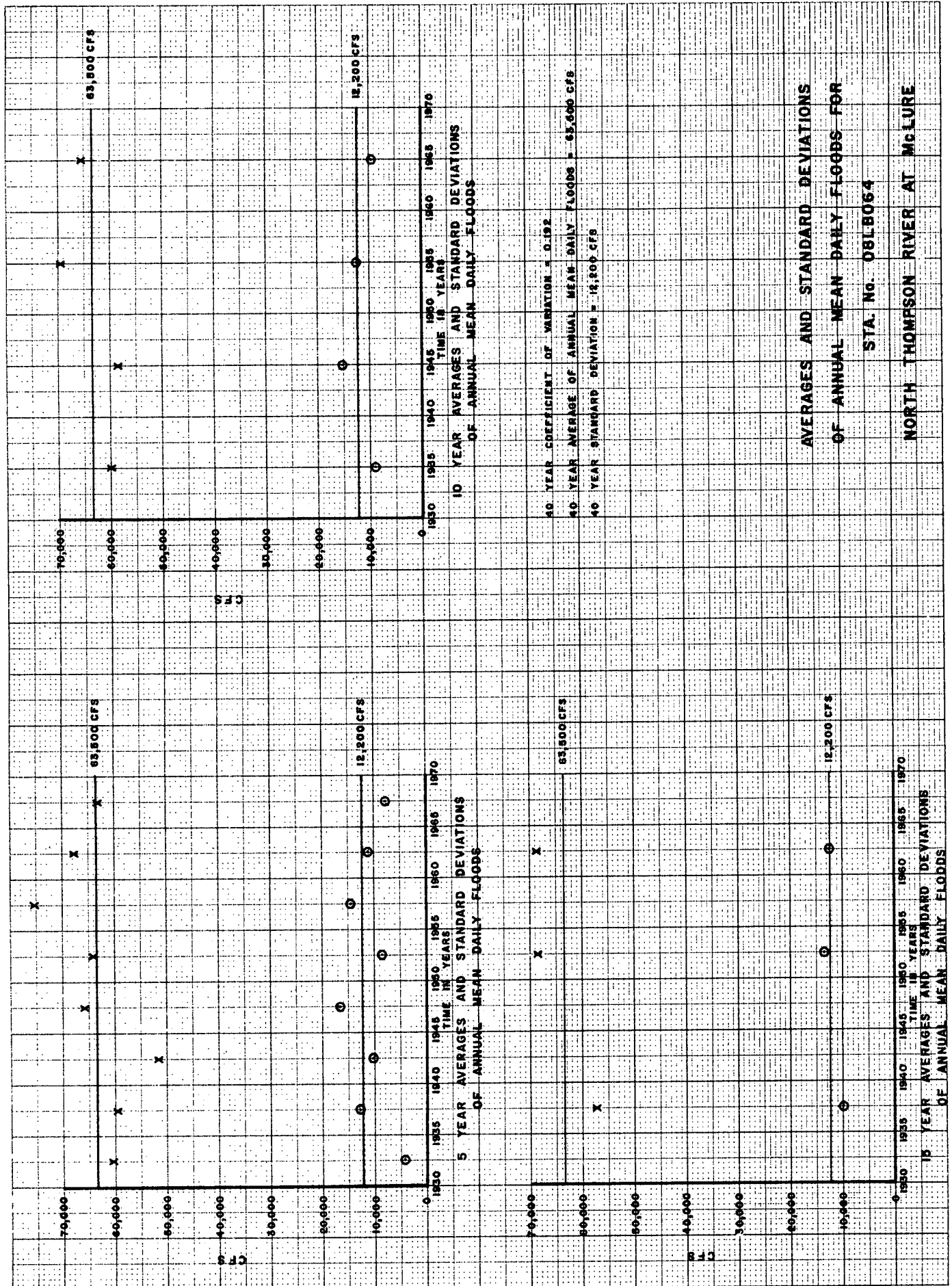


FIGURE 9



**AVERAGES AND STANDARD DEVIATIONS OF ANNUAL MEAN DAILY FLOODS FOR**

**STA. No. 08LB054**

**NORTH THOMPSON RIVER AT MCLURE**

**FIGURE 10**

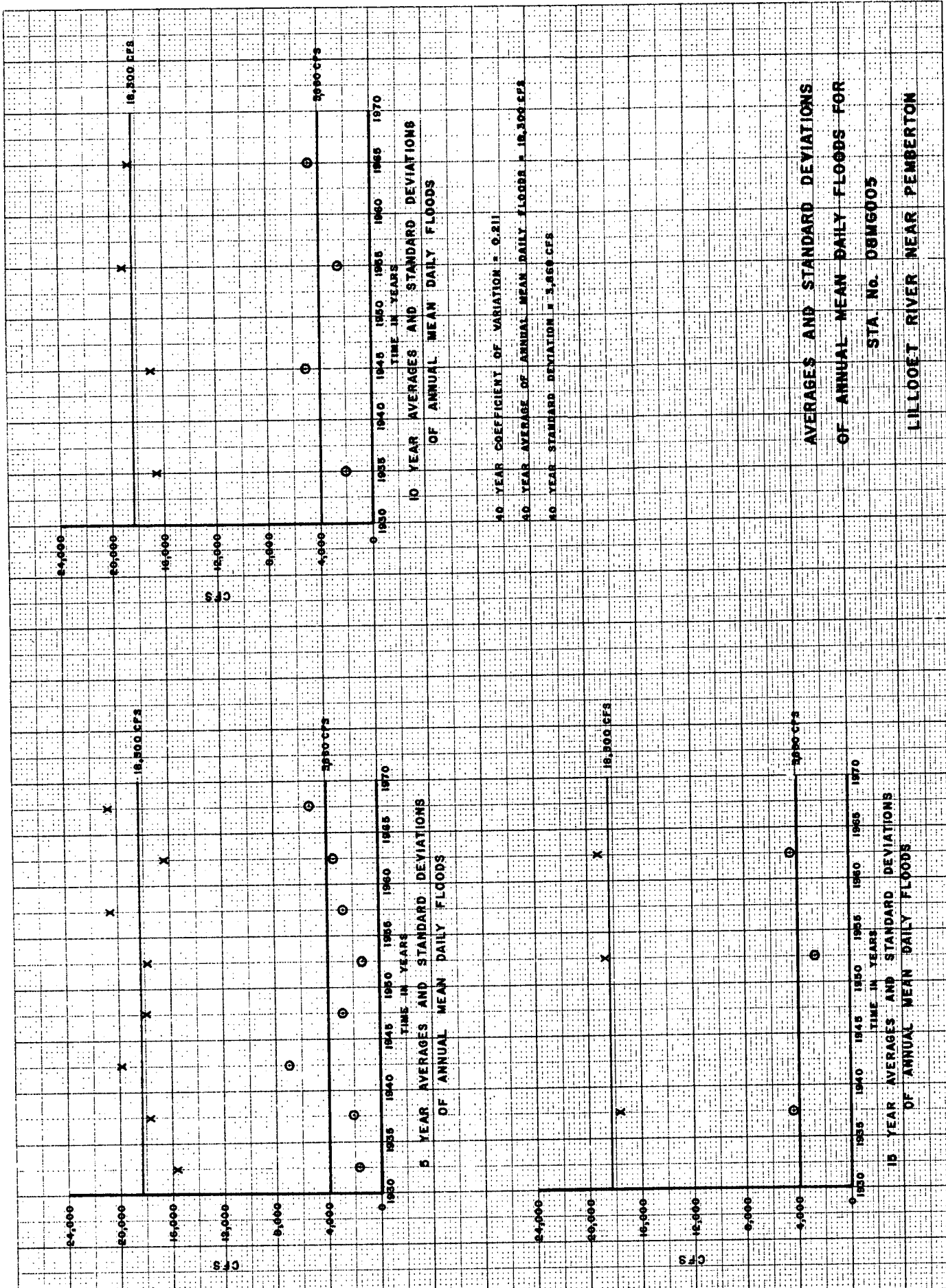
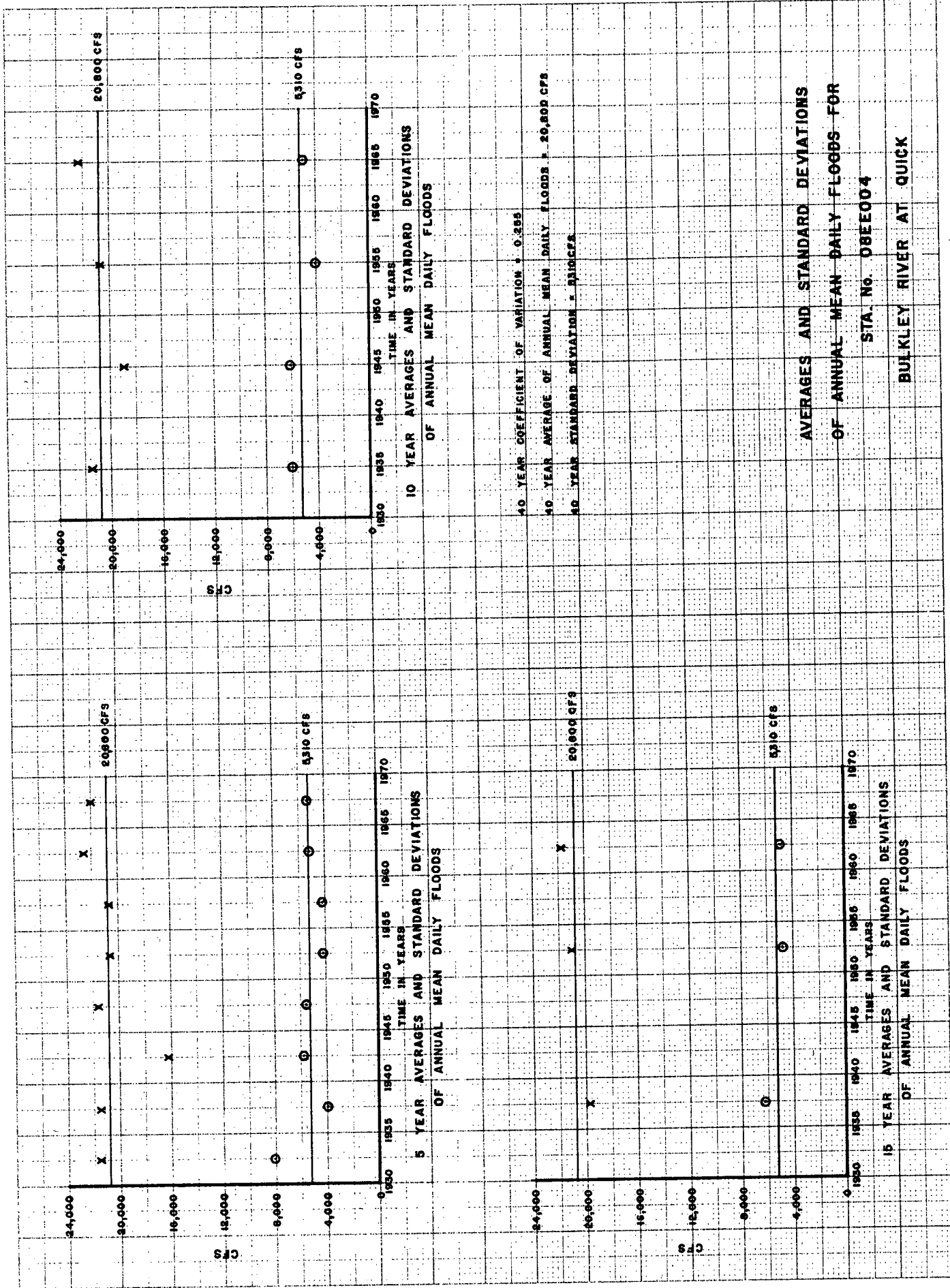


FIGURE 11



AVERAGES AND STANDARD DEVIATIONS  
OF ANNUAL MEAN DAILY FLOODS FOR  
STA. No. 0BEE004  
BULKLEY RIVER AT QUICK

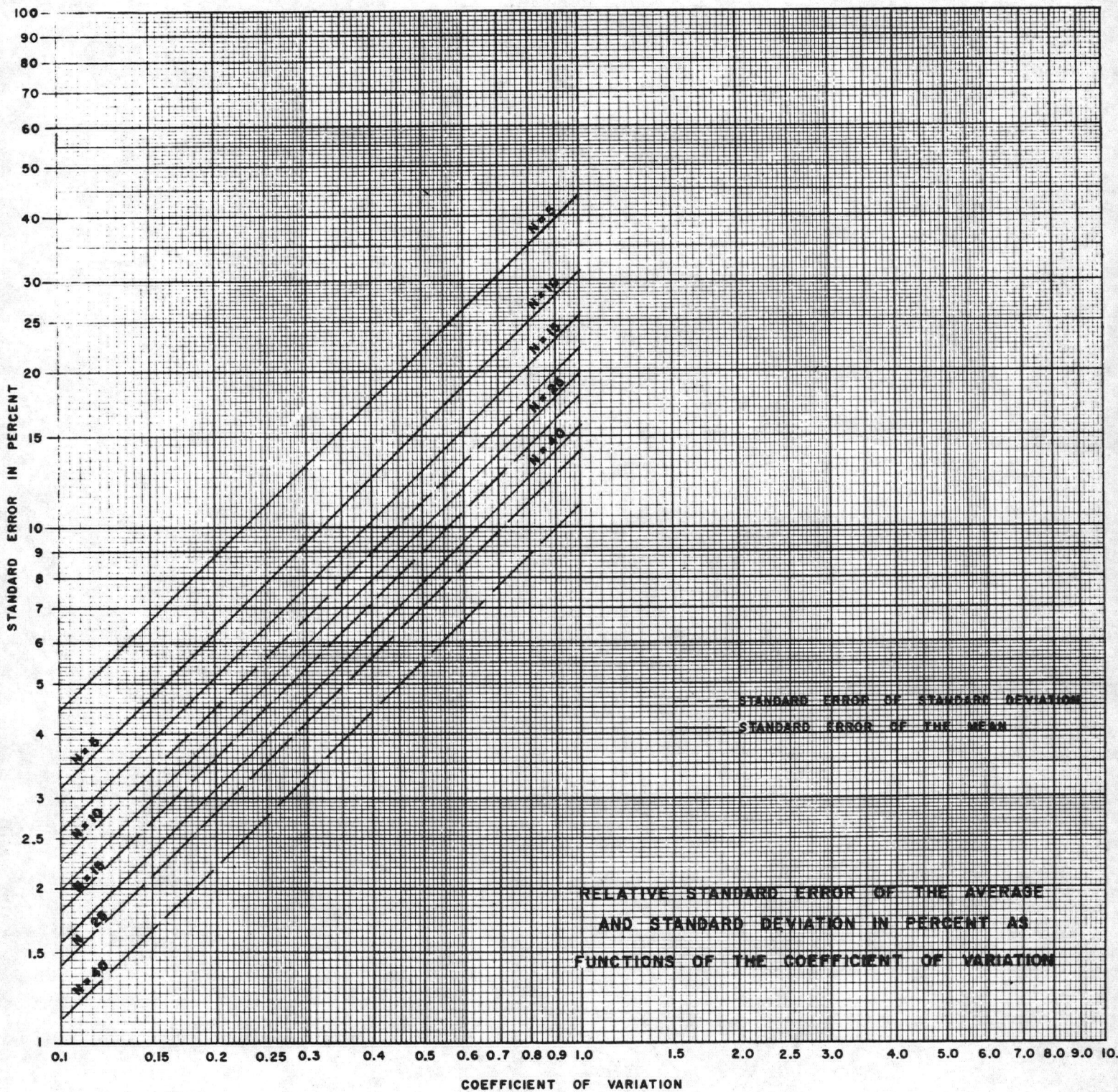
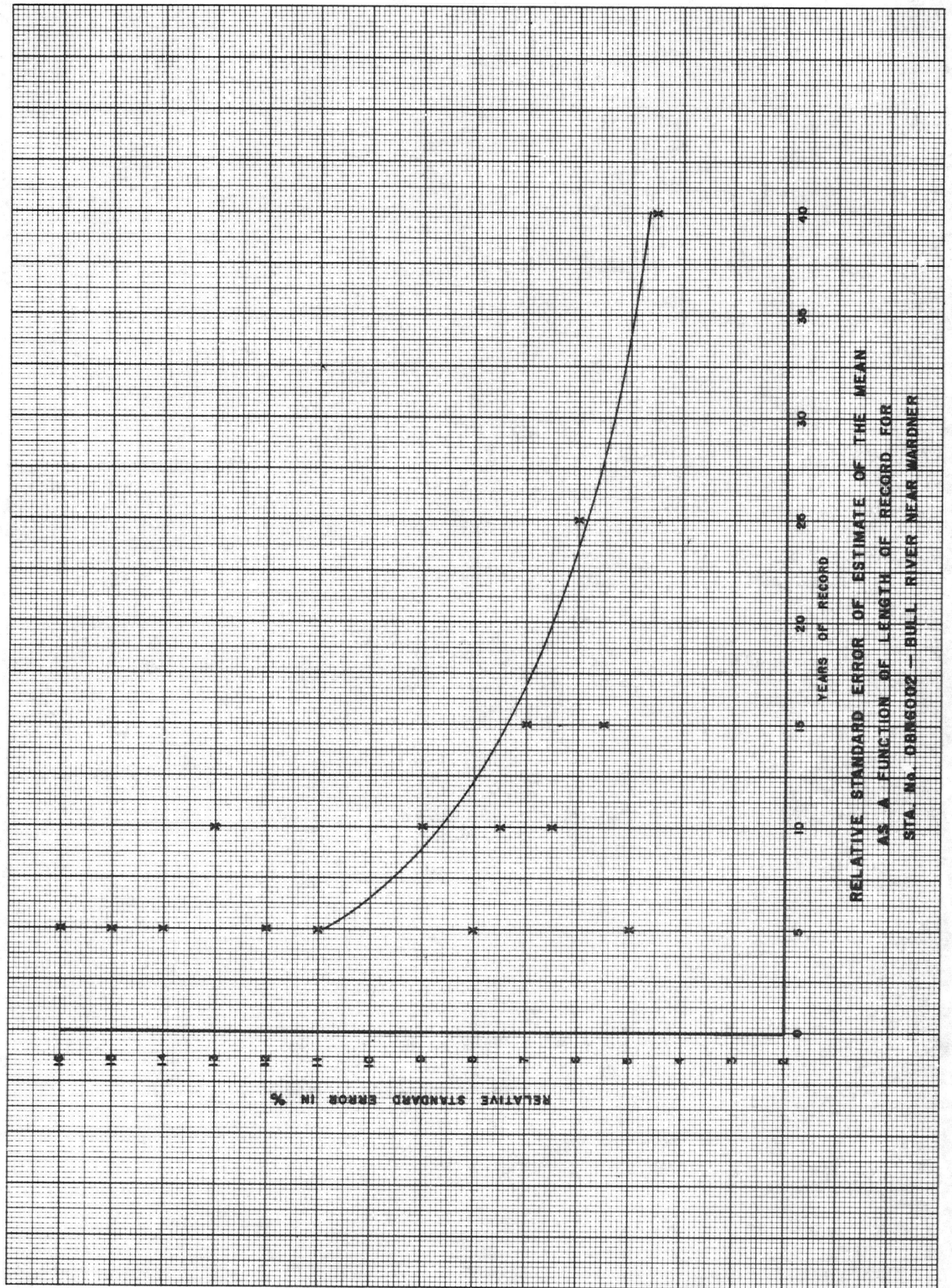


FIGURE 13



RELATIVE STANDARD ERROR OF ESTIMATE OF THE MEAN  
 AS A FUNCTION OF LENGTH OF RECORD FOR  
 STA. No. 08N6002 -- BULL RIVER NEAR WARDNER

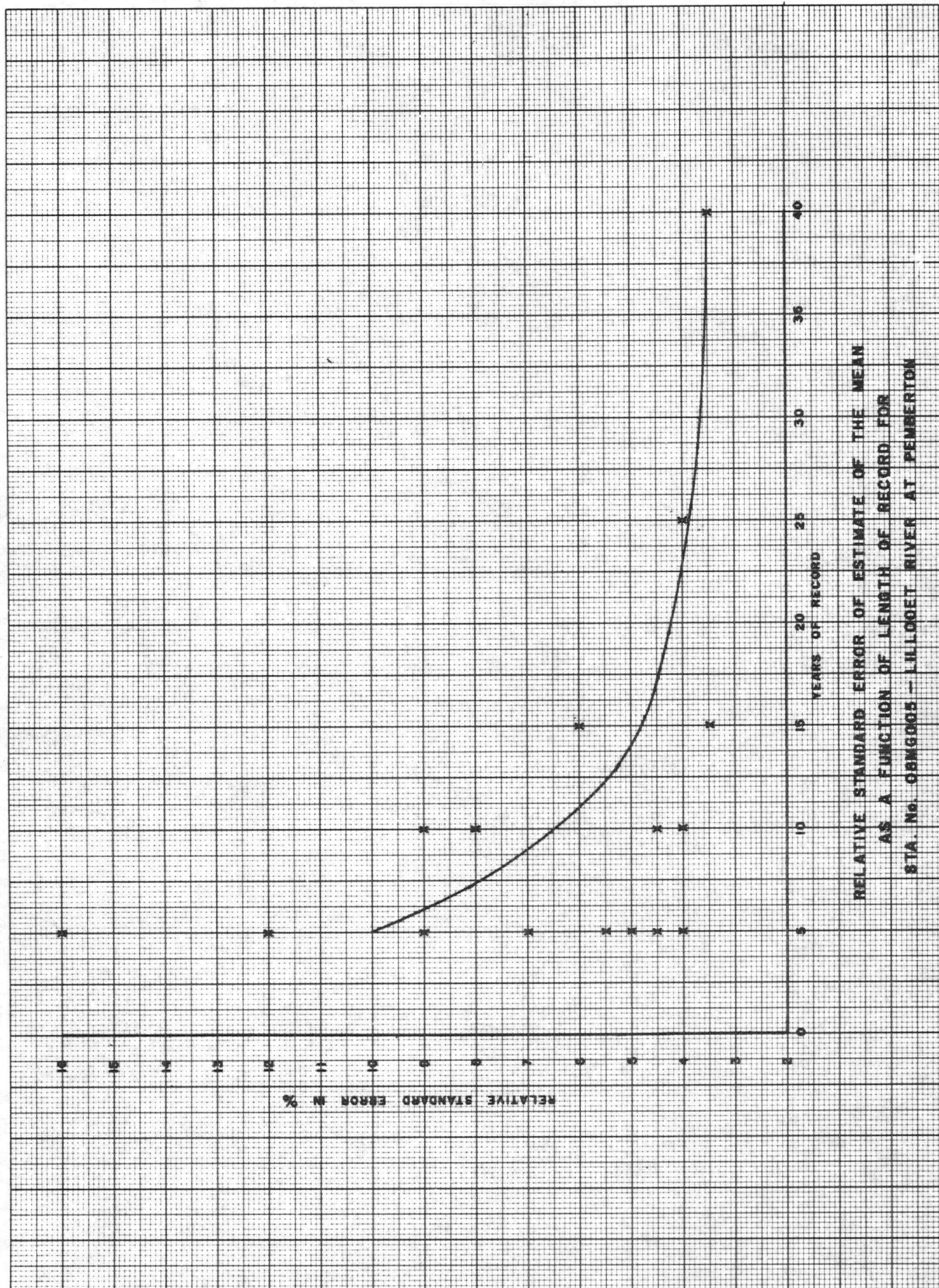


FIGURE 15