

APPENDIX D

STATISTICAL ANALYSIS

MAIN VALLEY OKANAGAN RIVERS

APPENDIX D

STATISTICAL ANALYSIS MAIN VALLEY OKANAGAN RIVER

D.1 INTRODUCTION

The study period extending from April 1921 to March 1971 includes several droughts, the major one occurring in the period 1929 to 1931 as well as the 1928 and 1948 floods. It is known that the 1894 flood exceeded both these according to limited historical data as did the 1972 flood. Unfortunately, time did not permit the rerun of the computer modelling (completed three years ago) to include the 1972 data. Thus, while the study period does include several droughts of one to three years duration, it may be somewhat deficient with respect to an adequate sampling of high runoff. These facts should be born in mind in a study of the various tables and graphs which follow.

The tables and graphs listed in Table D.1 indicate the various types of analysis that have been undertaken which can be classified as follows:

- a) Annual Available Flows at Various Probability Levels and Dependable Flows
- b) Representative Monthly Flows Hydrographs
- c) Monthly Flow Frequency Curves

The various statistical analysis which follow with the exception of the discharges at Oroville are based on the results from computer print-outs which are available in Technical Supplement III. This model was developed to simulate as closely as possible the probable operation of the Okanagan Flood Control Works (constructed during 1950 to 1956) over the historic period 1921 to 1970 assuming present day (1970) water requirements.

D.2 ANNUAL AVAILABLE FLOWS AT VARIOUS PROBABILITY LEVELS

A table and accompanying graph (on the same sheet) show the annual inflows or discharges equalled or exceeded 50, 80, 90 and 95% of the time.

- D.3 GROSS HISTORIC INFLOW TO OKANAGAN LAKE BASIN (Figure D.I) is the closest estimate that has been made of the total yield of the basin. The median inflow or inflow equalled or exceeded 50% of the time is 664 kilo acre-feet compared to 396 kilo acre feet at the 95% level. The gross inflow has been determined by adding to the historic inflow to Okanagan Lake the estimated historic consumptive use and the evaporation from Okanagan Lake. The former has been estimated primarily from irrigation water use over the 50 year study period as outlined in Appendix C while the latter is detailed in Appendix A.

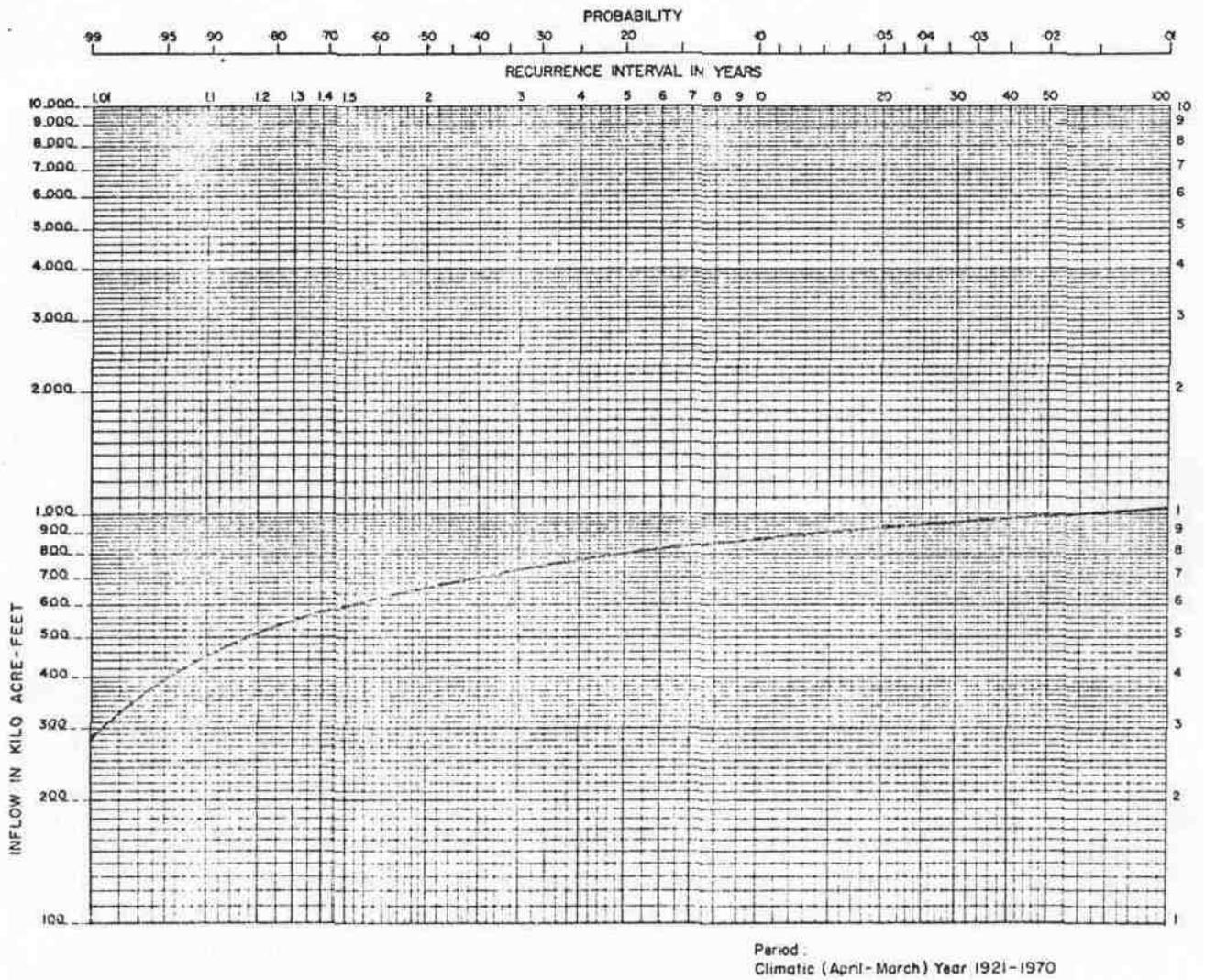
TABLE D.1

LIST OF STATISTICAL DATA DERIVED FOR MAINSTEM SYSTEM BASED ON 50 YEARS
OF RECORDS AND COMPUTER MODEL RESULTS

Type of Analysis	Basic Data Used	Table No.	Figure No.	Remarks
Annual Dependable Yield Tables	Gross Historic Inflows Okanagan Lake Net Historic Inflows Okanagan Lake Net Modified (1970 Development) Inflow Okanagan Lake Simulated Discharge Okanagan River at Penticton Simulated Discharge Okanagan River at Oliver Historic Discharge Okanagan River at Oroville Comparison Dependable Discharge Okanagan River at Okanagan Falls (1929-58) with Penticton (1921-70)	D.2 D.3 D.4 D.5 D.6 D.7 D.8		
Annual Frequency Curves and Tables	Gross Historic Inflow Okanagan Lake Basin Net Historic Inflow Okanagan Lake Basin Net Modified (1970 Development) Inflow Okanagan Lake Average Simulated Discharge Okanagan River at Penticton Average Simulated Discharge Okanagan River at Oliver Historic Discharge Okanagan River at Oroville	D.9 D.10 D.11 D.12 D.13 D.14	D.1 D.2 D.3 D.4 D.5 D.6	Table Included With Figure
Monthly Frequency Hydrographs and Tables	Gross Historic Inflow Okanagan Lake Basin Net Historic Inflow Okanagan Lake Basin Net Modified (1970 Development) Inflows Okanagan Lake Simulated Discharges Okanagan River at Penticton Simulated Discharges Okanagan River at Oliver Historic Discharges Okanagan River at Oroville	D.15 D.16 D.17 D.18 D.19 D.20	D.7 D.8 D.9 D.10 D.11 D.12	Table Included With Figure
Monthly Flow Frequency Curves	Gross Historic Inflows Okanagan Lake Basin Net Historic Inflows Okanagan Lake Basin Net Modified (1970 Development) Inflow Okanagan Lake Simulated Discharge Okanagan River at Penticton Simulated Discharge Okanagan River at Oliver Historic Discharge Okanagan River at Oroville		D.13 D.14 D.15 D.16 D.17 D.18	

TABLE OF ANNUAL AVAILABLE FLOWS AT VARIOUS PROBABILITY LEVELS

FLOW UNIT	Mean Flow	FLOW EQUALLED OR EXCEEDED IN PERCENT OF TIME			
		50 Median Flow	80	90	95
K. A. F.	664.0	664.0	526.9	455.3	396.2



FREQUENCY CURVE,
ANNUAL GROSS HISTORIC INFLOW, OKANAGAN LAKE BASIN

Figure D.1

D.4 ANNUAL NET HISTORIC INFLOW TO OKANAGAN LAKE BASIN (Figure D.2) is the

gross historic inflow to Okanagan Lake Basin less the evaporation losses from Okanagan Lake in each of the 50 years of the study period (April 1921 to March 1971 inclusive). This is the water available within the drainage basin north of the Okanagan Lake Dam based on the last 50 years of record (1921 to 1970)

D.5 ANNUAL NET MODIFIED (1970 DEVELOPMENT) INFLOW TO OKANAGAN LAKE (Figure D.3)

is the gross inflow less evaporation from Okanagan Lake as well as the present day consumptive use within the tributaries and from Okanagan Lake for use within this portion of the basin.

The three classifications of annual inflow north of Okanagan Lake Dam described above are compared with respect to the dependable yield over one to ten year consecutive years as well as the 50 year period in Tables D.2, D.3 and D.4.

Thus, it can be seen that the gross historic inflow to Okanagan Lake Basin was 1117.2 kilo acre-feet (3 X 372.4) during the 1929-31 drought which reduces to 234.3 kilo acre-feet (3 X 78.1) in Table D.4 after allowing for consumptive use under present day development north of Penticton and evaporation from Okanagan Lake.

For those concerned with the total runoff within the Basin (exclusive of natural tributary losses) the gross inflows to Okanagan Lake Basin provides the best estimates to date. However, to the water manager who is concerned with the net water available from Okanagan Lake after allowing for existing withdrawals upstream of Okanagan Lake Dam the net modified (1970 development) inflow to Okanagan Lake provides the most realistic data.

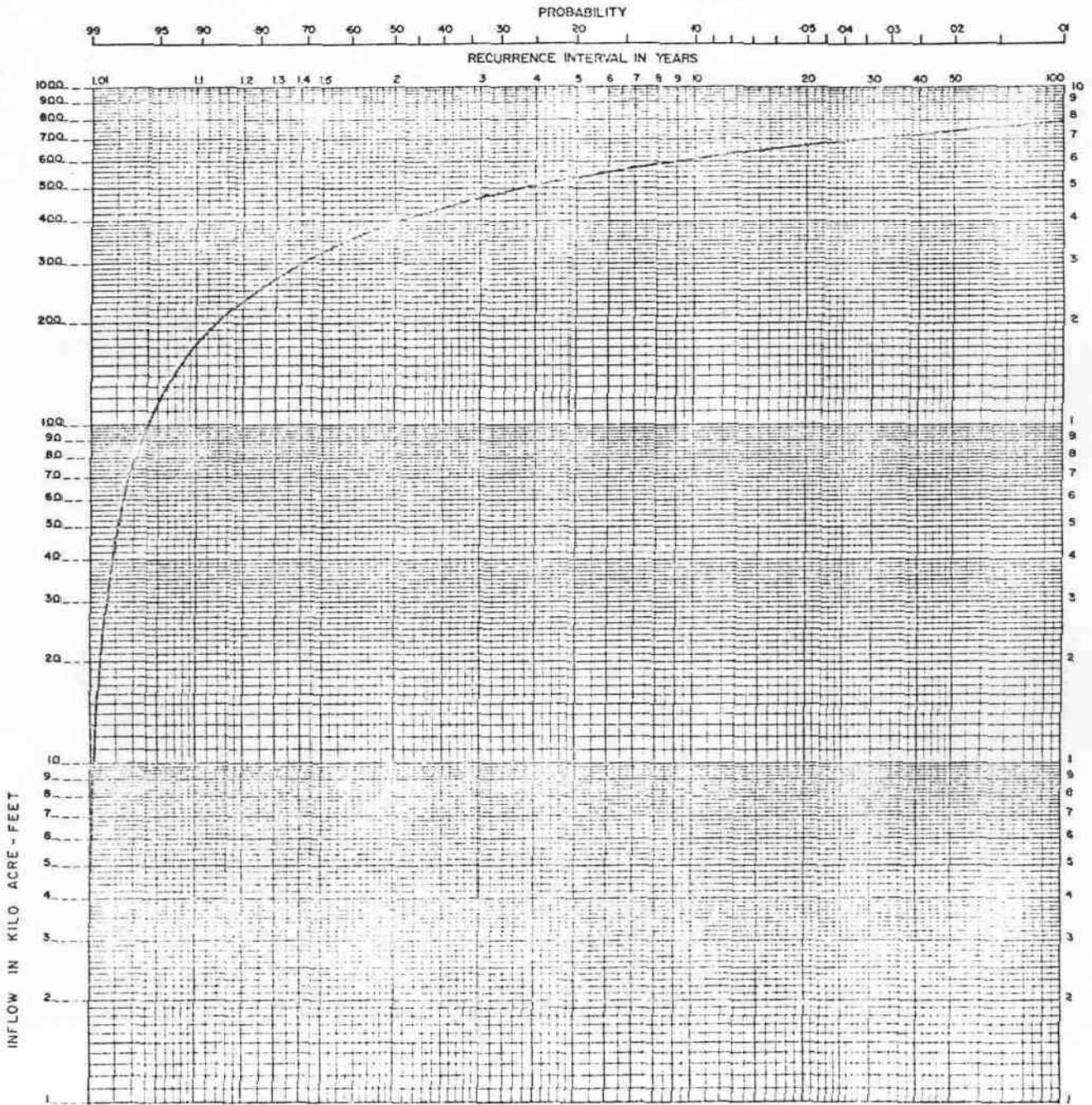
D.6 ANNUAL SIMULATED DISCHARGES OKANAGAN RIVER (Figures D.4 to D.6)

An analysis of the simulated discharges obtained from the computer model are shown for Penticton and Oliver in Table D.5 and D.6 respectively. It is evident that there is little difference in the three year drought flows of 230 cfs at Penticton compared to 259 at Oliver.

The dependable yield at Oroville shown in Table D.7 are based on historic flows for the period 1943 to 1970 are not directly comparable to the above mentioned simulated flows. Moreover, these flows do not include the critical low flow years in the 1920's and early 1930's so evident in Tables D.2 to D.6.

TABLE OF ANNUAL AVAILABLE FLOWS AT VARIOUS PROBABILITY LEVELS

FLOW UNIT	Mean Flow	FLOW EQUALLED OR EXCEEDED IN PERCENT OF TIME			
		50 Median Flow	80	90	95
K.A.F.	397.3	397.3	255.2	180.9	119.7



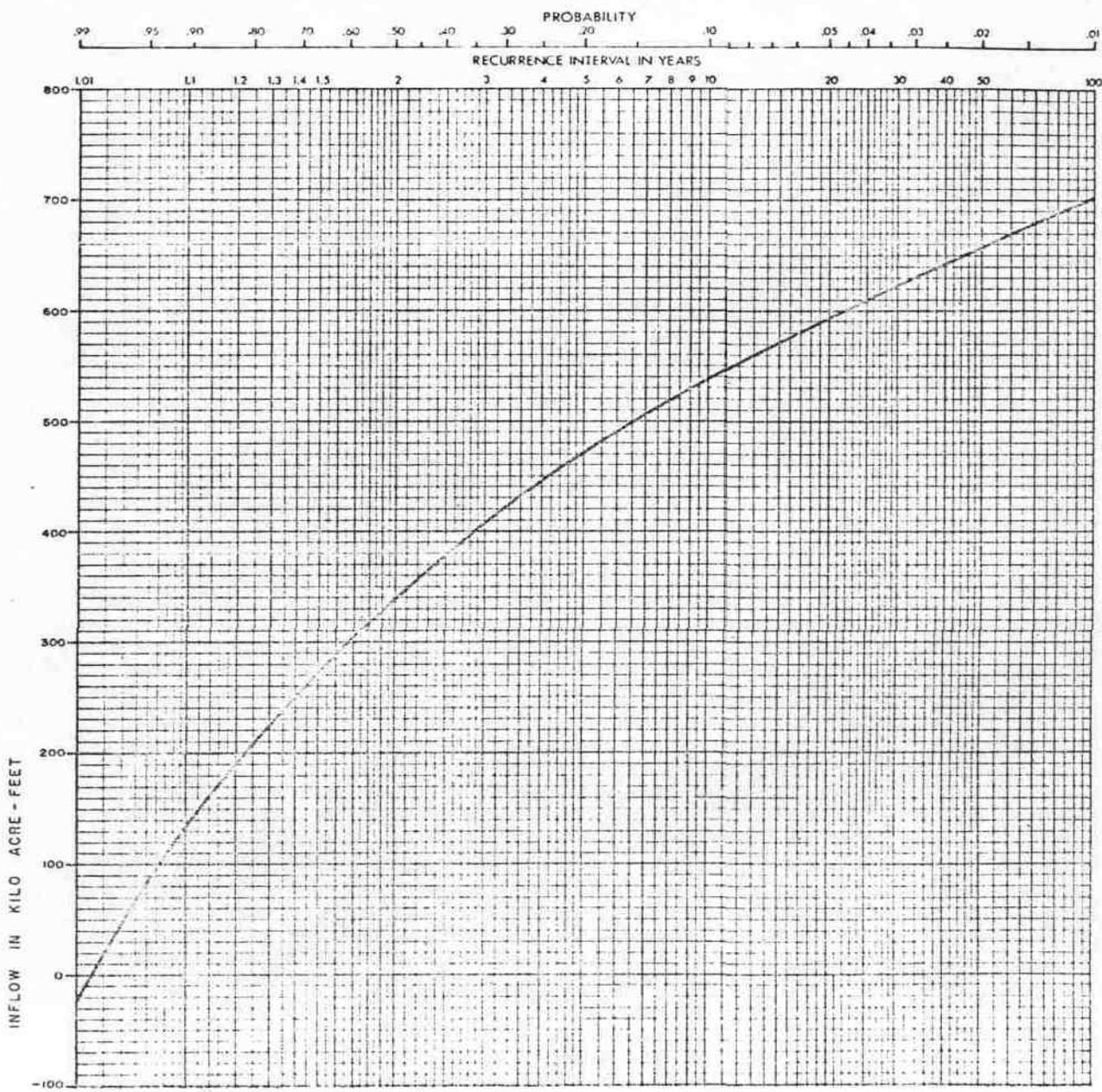
Period:
Climatic (April-March) Year 1921-1970

FREQUENCY CURVE, ANNUAL NET HISTORIC INFLOW, OKANAGAN LAKE
BASIN

Figure D.2

TABLE OF ANNUAL AVAILABLE FLOWS AT VARIOUS PROBABILITY LEVELS

FLOW UNIT	Mean Flow	FLOW EQUALLED OR EXCEEDED IN PERCENT OF TIME			
		50 Median Flow	80	90	95
K A F	339.7	339.7	208.9	140.6	84.2



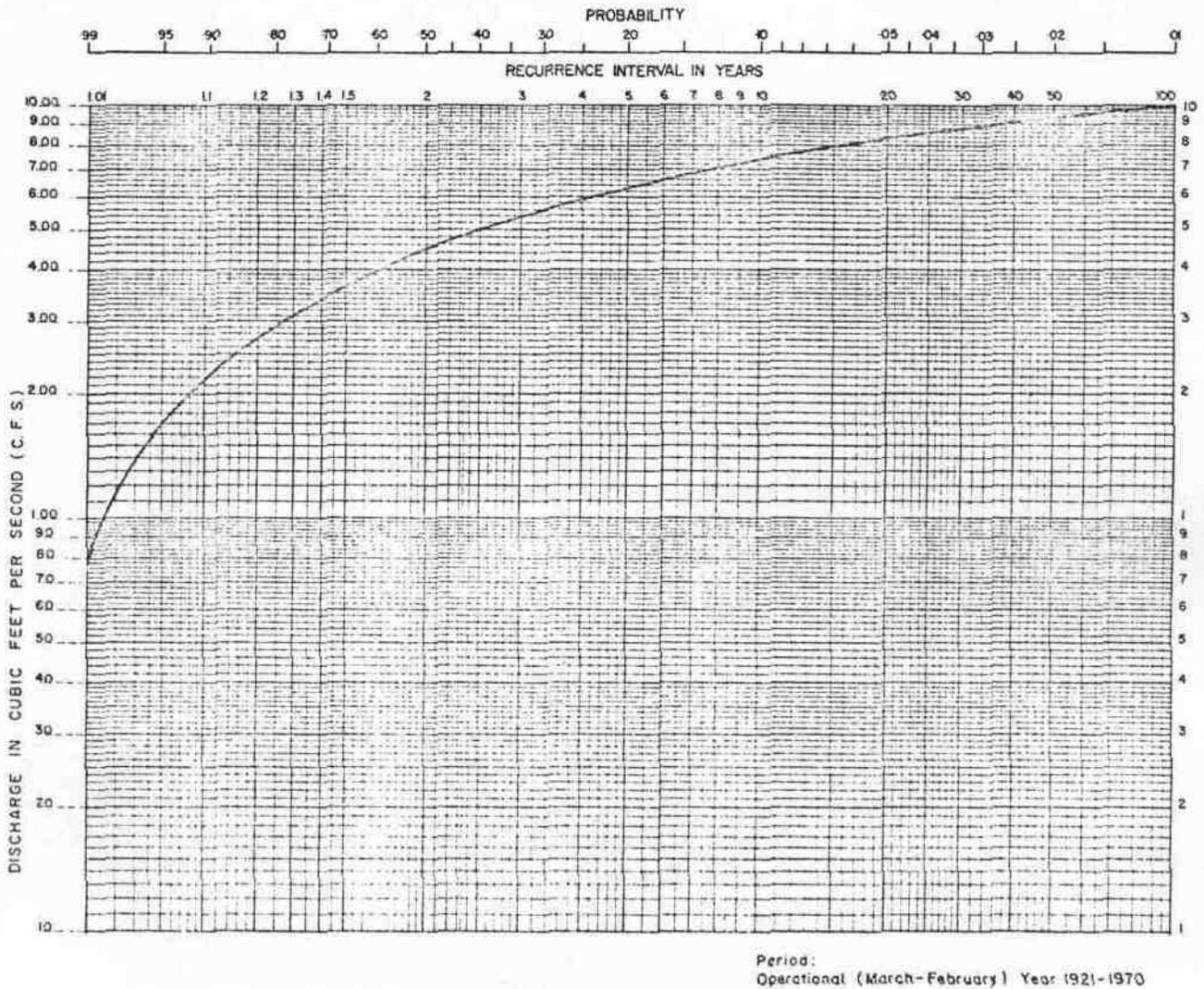
Period: Climatic (April - March) Year 1921-1970

FREQUENCY CURVE,
ANNUAL NET MODIFIED (1970 DEVELOPMENT) INFLOW, OKANAGAN LAKE

Figure D.3

TABLE OF ANNUAL AVAILABLE FLOWS AT VARIOUS PROBABILITY LEVELS

FLOW UNIT	Mean Flow	FLOW EQUALLED OR EXCEEDED IN PERCENT OF TIME			
		50 Median Flow	80	90	95
C. F. S.	466.0	449.5	296.0	224.8	170.3
K. A. F.	337.4	325.4	214.3	162.4	123.3

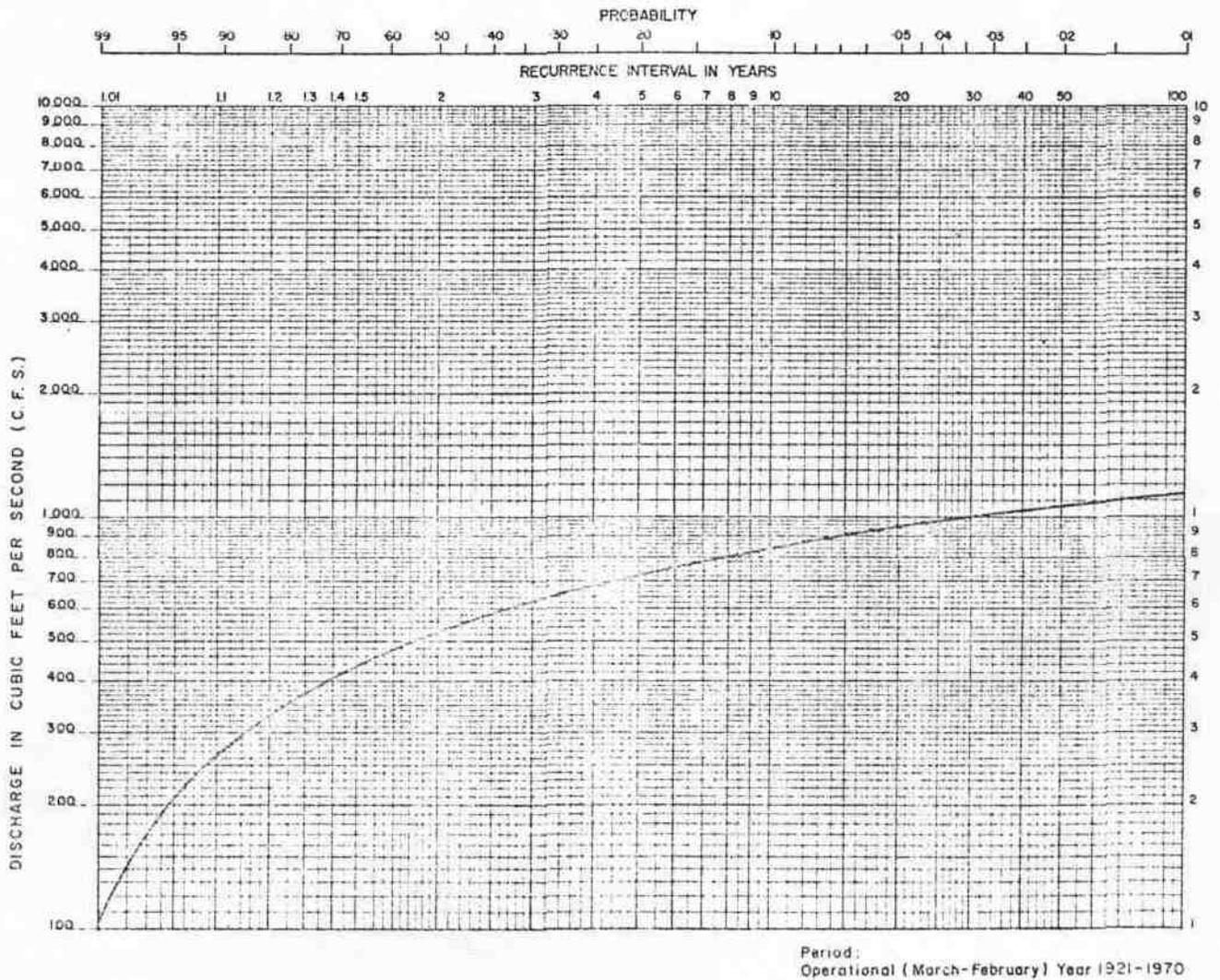


FREQUENCY CURVE,
AVERAGE SIMULATED DISCHARGE , OKANAGAN RIVER AT PENTICTON

Figure D.4

TABLE OF ANNUAL AVAILABLE FLOWS AT VARIOUS PROBABILITY LEVELS

FLOW UNIT	Mean Flow	FLOW EQUALLED OR EXCEEDED IN PERCENT OF TIME			
		50 Median Flow	80	90	95
C.F.S.	548.5	529.6	353.9	272.3	209.9
K.A.F.	397.1	383.4	256.2	197.1	152.0

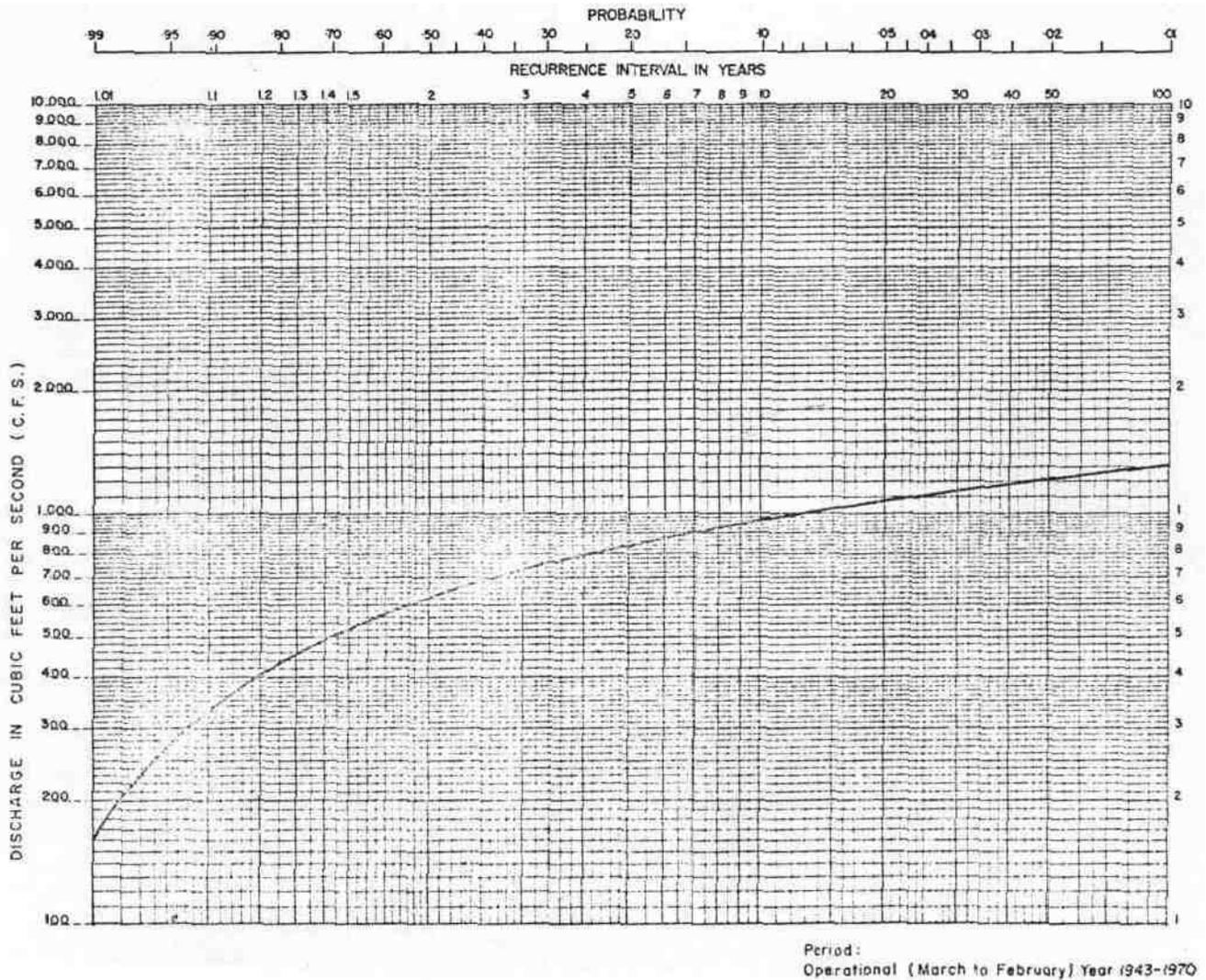


FREQUENCY CURVE, AVERAGE SIMULATED DISCHARGE , OKANAGAN RIVER AT OLIVER

Figure D.5

TABLE OF ANNUAL AVAILABLE FLOWS AT VARIOUS PROBABILITY LEVELS

FLOW UNIT	Mean Flow	FLOW EQUALLED OR EXCEEDED IN PERCENT OF TIME			
		50 Median Flow	80	90	95
C.F.S.	646	625	433	345	276
K.A.F.	467.7	452.5	313.5	249.8	199.8



FREQUENCY CURVE, ANNUAL HISTORIC DISCHARGE, OKANAGAN RIVER AT OROVILLE, WASH.

Figure D.6

TABLE D.2

Dependable Yield

Annual Gross Historic Inflow in Kaf.
 Okanagan Lake Basin
 Period: Climatic (April-March) Year 1921-1970 (50 Years)

No. of Consecutive Years of Minimum Average Annual Inflow	Inclusive Years	Minimum Average Annual Inflow For Period Indicated (Kaf.)	Percent of Period Mean
1	1931	352.7	53.1
2	1930-1931	361.6	54.5
3	1929-1931	372.4	56.1
4	1929-1932	448.2	67.5
5	1922-1926	530.5	79.9
6	1926-1931	526.3	79.3
7	1925-1931	531.0	80.0
8	1924-1931	518.8	78.1
9	1924-1932	536.3	80.8
10	1922-1931	543.8	81.9
50	1921-1970	664.0	100.0

TABLE D.3

Dependable Yield

Annual Net Historic Inflow (Water Available) in Kaf.
 Okanagan Lake Basin
 Period: Climatic (April - March) Year 1921-1970 (50 Years)

No. of Consecutive Years of Minimum Average Annual Inflow	Inclusive Years	Minimum Average Annual Inflow For Period Indicated (Kaf.)	Percent of Period Mean
1	1931	96.2	24.2
2	1930-1931	97.2	24.5
3	1929-1931	106.0	26.7
4	1929-1932	182.5	45.9
5	1922-1926	255.4	64.3
6	1926-1931	258.3	65.0
7	1925-1931	259.1	65.2
8	1924-1931	246.1	61.9
9	1924-1932	264.6	66.6
10	1922-1931	272.6	68.6
50	1921-1970	397.3	100.0

TABL
E

D.4

Dependable Yield

Annual Net Modified (1970 Development) Historic Inflow in Kaf.
 Okanagan Lake Basin
 Period: Climatic (April-March) Year 1921-1970

No. of Consecutive Years of Minimum Average Annual Inflow	Inclusive Years	Minimum Average Annual Inflow For Period Indicated (Kaf.)	Period of Period Mean
1	1931	68.6	20.2
2	1930-1931	69.5	20.5
3	1929-1931	78.1	23.0
4	1929-1932	144.4	42.5
5	1922-1926	208.7	61.4
6	1926-1931	216.9	63.9
7	1925-1931	216.9	63.9
8	1926-1931	205.3	60.4
9	1924-1932	220.7	65.0
10	1922-1931	227.2	66.9
50	1921-1970	339.7	100.0

TABLE D.5

Dependable Yield

Annual Simulated Discharge in cfs
 Okanagan River at Penticton
 Period: Operational (March-February) Year 1921-1970 (50 Years)

No. of Consecutive Years of Minimum Average Annual Discharge	Inclusive Years	Minimum Average Annual Discharge (cfs)	Percent of Period Mean
1	1943	222	47.6
2	1929-1930	228	48.9
3	1930-1932	230	49.4
4	1929-1932	229	49.1
5	1929-1933	282	60.5
6	1922-1927	316	67.8
7	1926-1932	332	71.2
8	1925-1932	320	70.8
9	1924-1932	311	66.7
10	1923-1932	324	69.5
50	1921-1970	466	100.0

TABLE D.6

Dependable Yield

Annual Simulated Discharge in cfs

Okanagan River at Oliver

Period: Operational (March-February) Year 1921-1970 (50 Years)

No. of Consecutive Years of Minimum Average Annual Discharge	Inclusive Years	Minimum Average Annual Discharge (cfs)	Percent of Period Mean
1	1943	257	46.9
2	1930-1931	258	47.1
3	1929-1931	259	47.3
4	1929-1932	272	49.6
5	1929-1933	340	62.0
6	1922-1927	375	68.4
7	1925-1931	389	71.0
8	1924-1931	375	68.4
9	1924-1932	368	67.2
10	1923-1932	385	70.3
50	1921-1970	548	100.0

TABLE D.7

Dependable Yield

Annual Historic Discharge in cfs

Okanagan River at Oroville, Washington

Period: Operational (March-February) Year 1943-1970 (28 Years)

No. of Consecutive Years of Minimum Average Annual Discharge	Inclusive Years	Minimum Average Annual Discharge For Period Indicated (cfs)	Percent of Period Mean
1	1963	265	41.0
2	1962-1963	365	56.5
3	1961-1963	426	65.9
4	1960-1963	446	69.0
5	1966-1970	458	70.9
6	1962-1967	482	74.6
7	1961-1967	491	76.0
8	1963-1970	491	76.0
9	1962-1970	488	75.5
10	1961-1970	494	76.5
28	1943-1970	646	100.0

An interesting comparison within the Okanagan River is the discharges determined at Okanagan Falls, as shown in Water Resources Appendix V volume I prepared by the Pacific Northwest River Basin Commission, April, 1970.

The following is taken in part from Table 87 of that publication representing the dependable yield at Okanagan Falls for the period 1929-1958 based on historic records. In the two right hand columns are shown the simulated discharges at Penticton and their percentage of the long-term mean based on 50 years of record.

TABLE D.8
COMPARISON DEPENDABLE YIELD, OKANAGAN RIVER AT
OKANAGAN FALLS AND PENTICTON

Consecutive Years of Lowest Mean Flow	OKANAGAN FALLS			PENTICTON	
	Inclusive Years	Lowest Mean Flow (CFS)	Percent of 1929-58 Mean	Lowest Mean Flow (CFS)	Percent of 1921-70 Mean
1	1931	52.2	9.5	222	47.6
2	1930-31	67.4	12.3	228	48.9
3	1930-32	150.7	27.4	230	49.4
4	1930-33	264.6	48.2	220	49.1
5	1929-33	345.9	63.0	282	60.5
6	1939-44	377.2	68.7	316	67.8
7	1939-45	393.9	71.7	332	71.2
8	1938-45	414.0	75.4	320	70.8
9	1937-45	429.0	78.1	311	66.7
10	1936-45	449.0	81.8	324	69.5
30	1929-58	549.0	100.0		
50				466	100.0

The records for Okanagan Falls extending from 1929-1958 cover a period during which storage on Okanagan Lake varied within the range of two to three feet and drawdown below this range was not physically possible until 1956 when the present dam was constructed. This is reflected in the Okanagan Falls records in which the lowest mean flow for the three year drought was 151 cfs compared to 230 cfs at Penticton. Even without an allowance for inflow between Penticton and Okanagan Falls the dependable discharges in this reach of the river have increased by some 50% with the present dam.

D.7 REPRESENTATIVE MONTHLY FLOWS (HYDROGRAPHS) (Figures D.7 to D.12 inclusive)

These figures include the following data with respect to inflows and discharges.

- a) Maximum monthly flows.
- b) Monthly flows occurring in the record flood year of 1948.
- c) Monthly flows equal or exceeding those occurring 20% of the time.
- d) Median flows (occur 50% of time).
- e) Monthly flows equal or less than those occurring 80% of the time.
- f) Monthly flows occurring in the record drought year of 1931.
- g) Minimum monthly flows.

The representative monthly hydrographs plotted for the above conditions have omitted the mean flow because of its close agreement with the median flows. It will be noted that even under the monthly Gross Basin Inflow (Table of Figure D.7) that minor negative inflows occur indicating that the estimated evaporation losses of from 200,000 to 300,000 acre-feet on Okanagan Lake are probably somewhat low. Negative inflows occur often in the monthly net historic inflows and are greatest under the modified inflows where the Gross Basin Inflow has been reduced by 1970 consumptive use and evaporation losses. The statistical curves that accompany the various tables are for the most part self explanatory.

D.8 MONTHLY FLOW FREQUENCY CURVES (Figures D.13 to D.18 inclusive)

It will be noted that frequency curves showing monthly high and low flows for duration periods of 1, 3, 7 and 12 months have been shown together using a special graph paper. These graphs show the character of the extreme flow conditions in comparison with the mean flow.

These graphs for the three types of inflows for the Okanagan Basin Area have relatively uniform curves as would be expected because of limited modification by man compared to the very large natural losses in this portion of the study area.

The historic discharges of Oroville, also show uniform curves in contrast to the heavy regulation under the simulated flow condition for the discharges at Penticton and Oliver. This is particularly true for the low, flow one month curves.

D.9 GENERAL REMARKS

The additional data which have become available since this study was completed for the years 1970, 1971 and 1972 which appear to be representative of a drought, average and wet year, respectively will in the future provide

more accurate monitoring of hydrologic conditions particularly in the tributaries. It is fortunate that the newly established hydrometric and meteorological stations have been available to monitor these extreme conditions which have occurred in a relatively short period of time.

D.10 TRIBUTARY STATISTICAL ANALYSIS

Statistical analysis of tributary discharges have been limited to natural flows at the mouths since these are the only locations where 50 years of record have been derived based primarily on the inflow to Okanagan Lake and River. Apart from this additional stream flow data in the tributaries has been limited to eight selected tributaries to Okanagan Lake where upstream discharges have been derived at a number of use points and location for dry, average and wet year conditions. Thus, with the exception of the flows at the mouths of the tributaries and at a few hydrometric stations upstream only three years of derived discharges are available which are not nearly sufficient to carry out statistical analysis.

The natural flows of the various streams at their mouths listed in Table D.21 will be found in Technical Supplement No. 3 in the form of computer print-out sheets. On the last page for each creek listing of the monthly flows classified according to 100% exceedance, 90% exceedance, etc., will be found. In addition to the various creeks certain additional low lying areas near Okanagan Lake or River which discharges directly to the main lake and river system have been similarly analyzed. The various creeks and low areas are shown in Figure D.19.

TRIBUTARIES IN THE OKANAGAN BASIN UPSTREAM

OF OROVILLE, WASHINGTON

- Notes: 1. See Figure D.19 For Location
 2. See Technical Supplement 3 for Basic Data and Statistical Analysis.

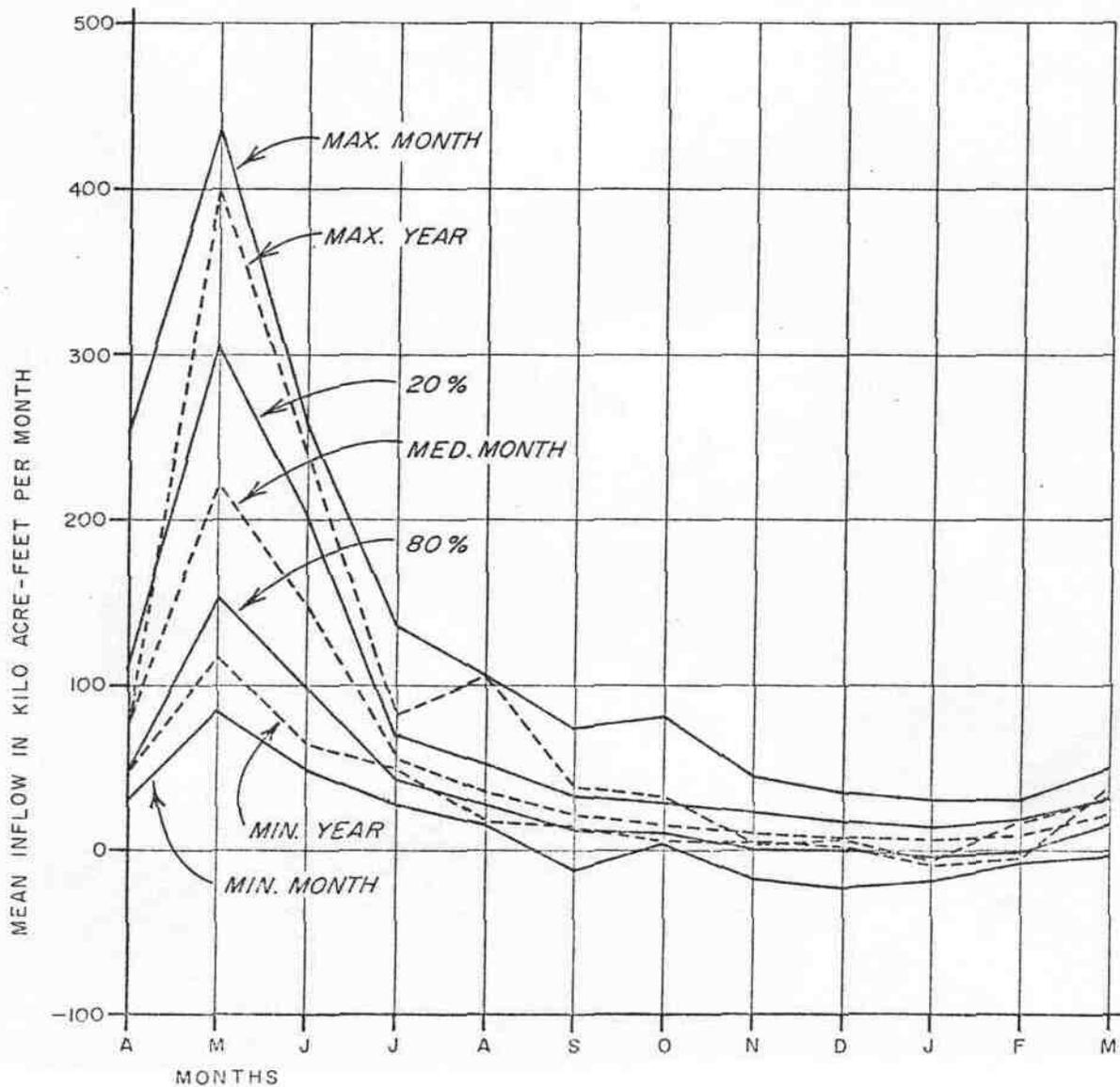
	DISCHARGES AVAILABLE		Page No. (Technical Supplement 3)
	50 Years Derived Record At Mouth Only (Natural Discharge)	50 Years Derived Record At Mouth Plus 3 Years Derived Record Upstream Natural and Simulated Flows	
<u>Okanagan Lake Tributaries</u>			
Bellevue Creek	X		347
Deep Creek	X		330
Equesis Creek	X	X	332
Eneas Creek	X		351
Irish Creek	X		331
Kelowna Creek	X	X	340
Lambly Creek	X		339
McDougall Creek	X		342
Mission Creek	X	X	343
Naramata Creek	X		350
Nashito Creek	X		333
Peachland Creek	X	X	346
Penticton Creek	X	X	352
Powers Creek	X	X	341
Shorts Creek	X		337
Trepanier Creek	X		344
Trout Creek	X	X	349
Vernon Creek	X	X	336
Whiteman Creek	X		335
Low Area 6	X		348
Low Area 7	X		345
Low Area 8	X		338
Low Area 9	X		334
<u>Okanagan River Tributaries</u>			
Ellis Creek	X		355
Marron Creek	X		358
McLean Creek	X		357
Park Hill Creek	X		360
Shingle Creek	X		354
Shuttleworth Creek	X		359
Testalinden Creek	X		365
Vaseux Creek	X		361
Wolf Cub Creek			363
Low Lying Area 2	X		364
Low Lying Area 3	X		362
Low Lying Area 4	X		356
Low Lying Area 5	X		353

TABLE OF REPRESENTATIVE MONTHLY FLOWS

MONTHLY GROSS HISTORIC INFLOW IN KAF./NO., OKANAGAN LAKE BASIN, PERIOD: CLIMATIC (APRIL-MARCH) YEAR 1921-1970 (50 YEARS)

Inflow	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total	Mean
Max. month	252.9	437.7	259.6	136.3	106.7	74.3	81.8	46.2	35.8	29.8	30.7	50.6	1542.4	128.5
Max. year (1948)	75.6	507.5	253.2	81.1	106.7	39.8	33.9	2.6	6.5	-4.6	17.3	51.8	1041.2	86.8
20% month	107.0	501.3	204.7	70.3	53.2	33.4	28.8	23.1	17.1	14.1	18.4	32.1	916.5	75.5
Mean month	77.4	226.0	152.4	60.3	40.1	24.5	20.5	11.7	6.9	6.9	10.0	24.9	663.6	55.3
50% or median mo.	75.4	221.6	148.7	55.8	36.6	21.1	16.6	10.3	9.3	6.6	10.6	24.4	637.0	53.1
80% month	45.9	152.5	98.5	43.1	28.7	12.6	11.0	0.3	0.0	-2.1	-1.0	16.8	406.3	33.9
Min. year (1931)	45.5	118.4	65.7	50.5	14.4	14.8	6.4	4.4	3.6	-7.3	-6.5	38.3	352.7	29.4
Min. month	28.3	84.8	48.4	28.3	17.1	-11.2	2.4	-17.5	-21.7	-19.7	-7.4	3.7	135.5	11.3

Note: 20%, 50%, and 80% Months Inflows indicate flows equalled or exceeded 20, 50, 80 percent of time obtained from the empirical probability plotting position by the Weibull formula.



MONTHLY GROSS HISTORIC INFLOW, OKANAGAN LAKE BASIN

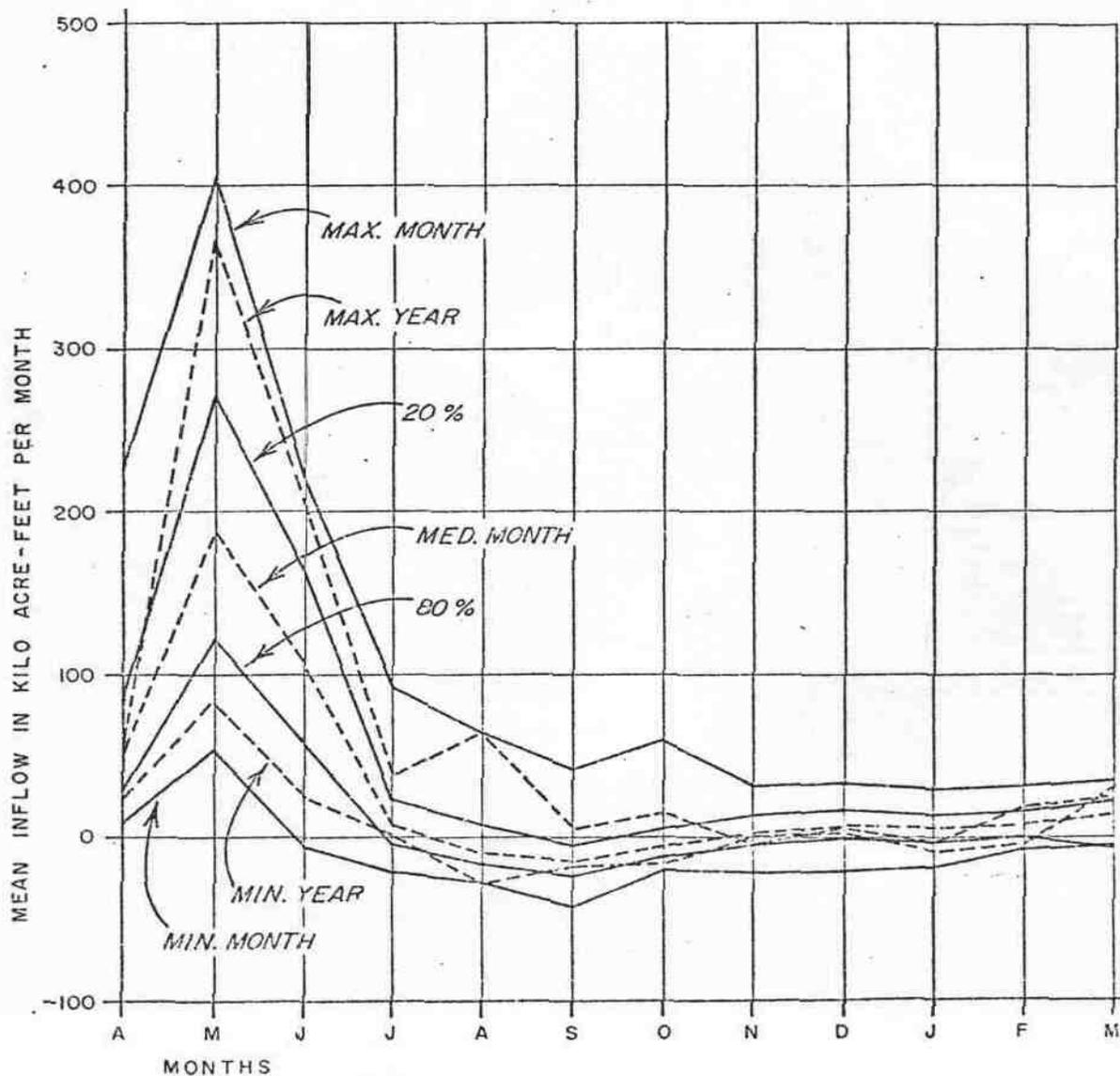
Figure D.7

TABLE OF REPRESENTATIVE MONTHLY FLOWS

MONTHLY NET HISTORIC INFLOW IN KAF./MO., OKANAGAN LAKE BASIN, PERIOD: CLIMATIC (APRIL-MARCH) YEAR 1921-1970 (50 YEARS)

Inflow	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total	Mean
Max. month	223.4	402.2	220.5	92.4	66.4	41.2	59.4	31.3	33.7	29.8	30.6	36.6	1267.5	105.6
Max. year (1948)	56.8	368.0	208.2	38.4	66.4	6.7	15.1	-5.3	6.3	-4.6	17.3	23.7	796.8	66.4
70% month	85.6	270.6	165.6	23.7	8.3	-3.8	6.4	13.5	15.8	13.4	14.5	21.5	633.1	52.8
Mean month	55.7	194.1	112.2	12.9	-5.1	-10.7	-1.6	4.0	7.4	6.3	7.4	14.6	397.2	33.1
50% or median mo.	51.1	189.1	107.2	6.0	-9.6	-13.8	-5.1	3.0	8.1	6.4	8.8	13.9	367.1	30.6
80% month	27.1	120.6	58.2	-3.0	-16.5	-22.9	-11.9	-5.5	-0.4	-2.1	-0.1	7.9	151.6	12.6
Min. year (1931)	23.1	84.1	26.6	1.9	-27.8	-18.3	-14.8	1.1	3.6	-7.3	-6.5	30.7	96.4	8.0
Min. month	9.5	52.8	5.7	-20.3	-27.8	-43.1	-19.8	-22.0	-21.7	-19.7	-7.4	-4.4	-118.2	-9.4

Note: 20%, 50%, and 80% Months Inflows indicate flows equalled or exceeded 20, 50, or 80 percent of time obtained from the empirical probability plotting position by the Weibull formula.



MONTHLY NET HISTORIC INFLOW, OKANAGAN LAKE BASIN

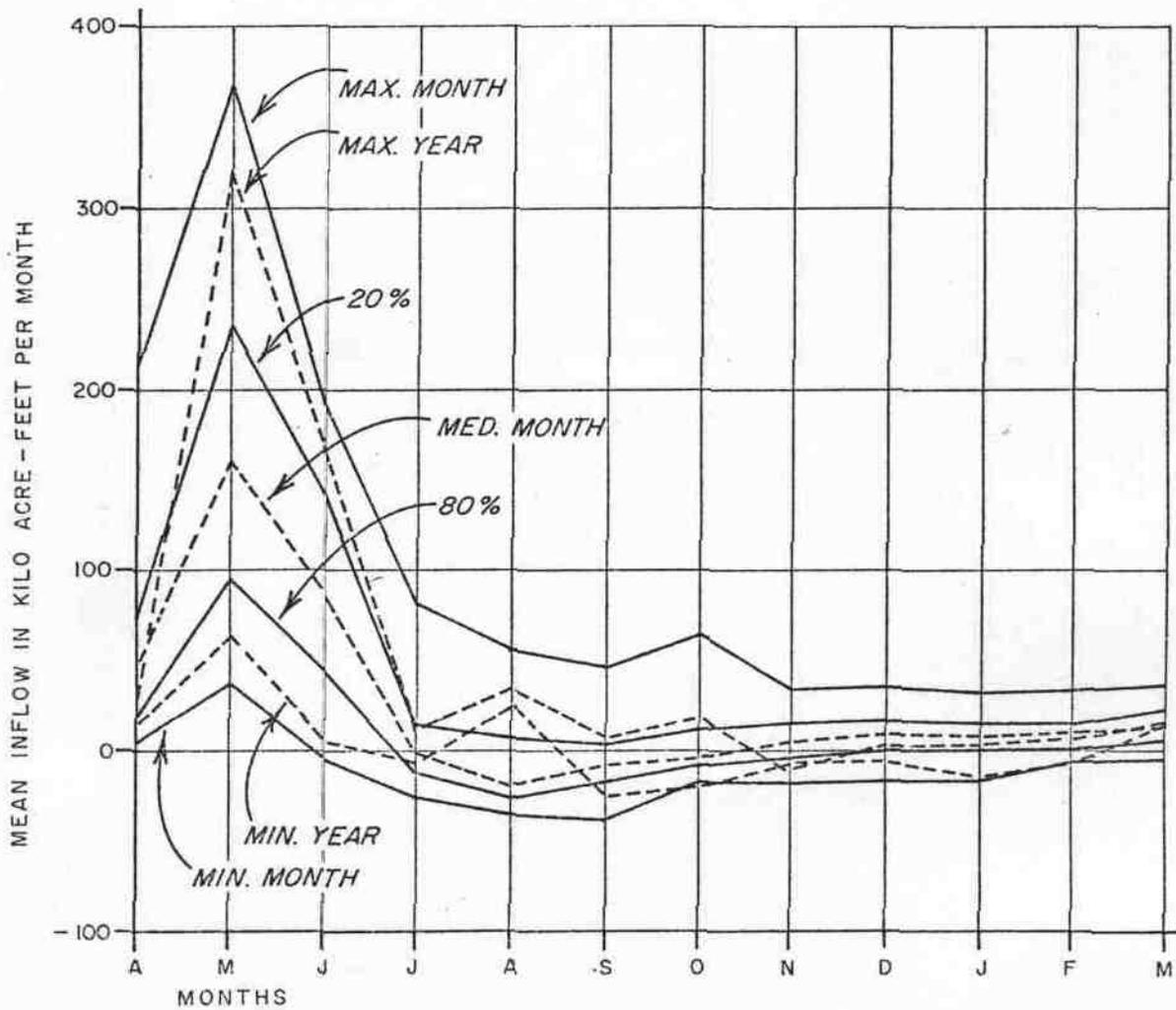
Figure D.8

TABLE OF REPRESENTATIVE MONTHLY FLOWS

MONTHLY NET MODIFIED (1970 DEV.) INFLOW IN KAF./MO., OKANAGAN LAKE, PERIOD: CLIMATIC (APRIL-MARCH) YEAR 1921-1970 (50 YEARS)

Inflow	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total	Mean
Max. month	211.1	306.8	193.1	81.1	55.8	47.7	64.9	34.1	36.4	32.9	33.4	38.7	1196.0	99.7
Max. year (1948)	26.9	318.2	169.6	12.8	33.3	8.6	18.1	-10.1	2.8	-7.4	8.0	17.8	598.6	50.0
20% month	71.8	236.2	143.0	15.4	0.7	2.3	11.8	16.6	18.5	16.1	16.6	23.8	550.0	45.8
Mean month	45.6	164.5	92.0	3.4	-14.0	-5.2	2.9	6.3	9.7	8.8	9.6	16.2	339.8	28.3
50% or median mo.	42.2	159.2	89.1	-2.1	-17.9	-8.6	-4.4	5.4	10.2	9.1	11.5	15.6	294.0	24.5
80% month	18.8	95.6	44.9	-11.8	-25.7	-17.6	-8.4	-3.2	0.8	0.6	1.5	8.8	104.3	8.7
Min. year (1931)	16.0	65.2	6.5	-4.5	34.6	-25.6	-19.7	-3.8	-5.5	-15.1	-6.9	16.1	-9.5	-0.8
Min. month	4.6	38.1	-3.9	-25.4	-35.1	-38.0	-17.6	-19.3	-18.9	-17.0	-6.2	-3.1	-141.8	-11.8

Note: 20%, 50%, and 80% Months inflows indicate flows equalled or exceeded 20, 50, or 80 percent of time obtained from the empirical probability plotting position by the Weibull formula.



MONTHLY NET MODIFIED (1970 DEVELOPMENT) INFLOW, OKANAGAN LAKE

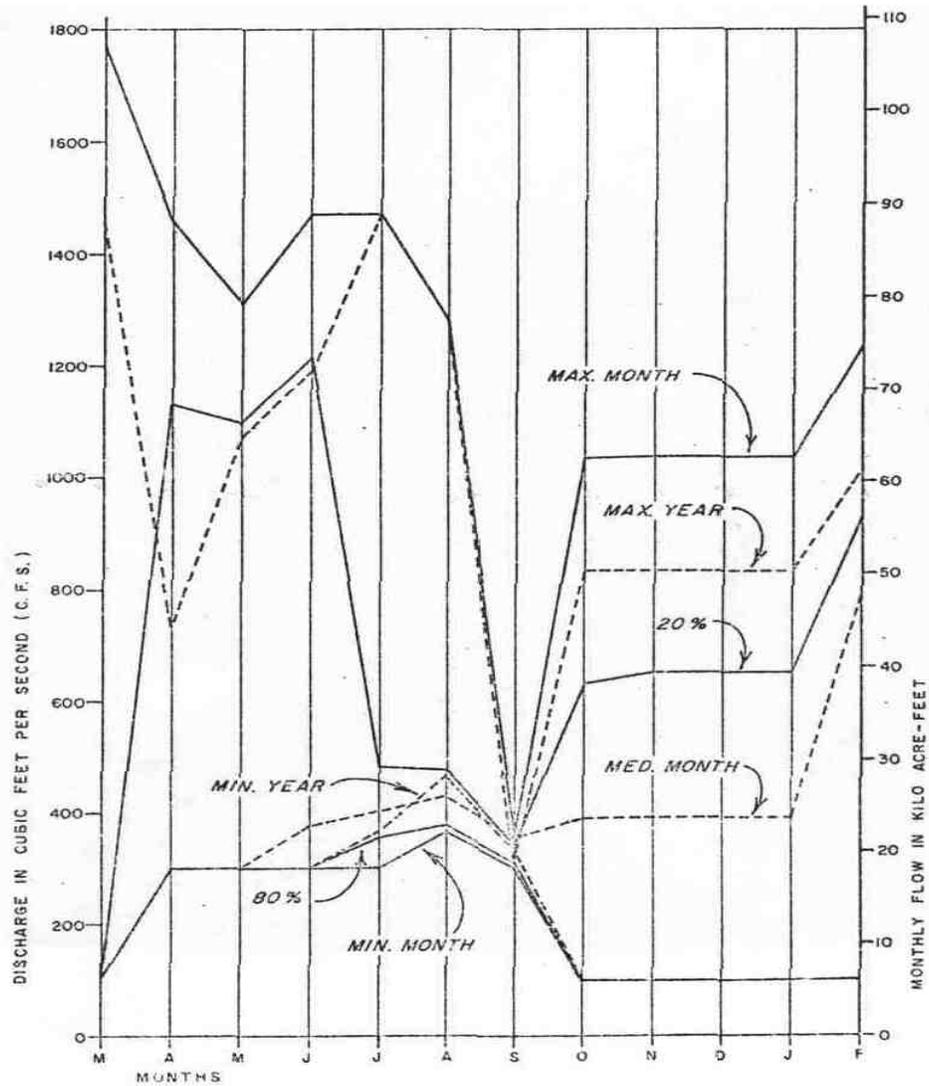
Figure D.9

TABLE OF REPRESENTATIVE MONTHLY FLOWS

MONTHLY 'NULL' DISCHARGE IN CFS, OKANAGAN RIVER AT PENTICTON, PERIOD: OPERATIONAL (MARCH-FEBRUARY) YEAR 1921-1970 (50 YEARS)

Discharge	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Total	Mean
Max. month	1770.0	1459.5	1311.0	1470.0	1475.0	1283.7	356.4	1037.3	1037.3	1037.3	1037.3	1232.1	14502.5	1206.5
Max. year (1948)	1434.5	710.8	1063.7	1193.9	1470.0	1253.7	350.0	854.2	854.2	854.2	854.2	1011.3	11843.7	987.0
20% month	100.0	1120.5	1097.1	1210.5	482.9	478.8	347.4	833.2	648.7	648.7	648.7	650.2	8353.2	690.1
Mean month	207.1	563.4	559.9	863.5	516.4	454.8	320.9	420.3	420.5	420.5	420.5	602.9	5583.9	465.3
50% or median mo.	100.0	359.0	300.0	375.9	401.7	429.0	330.2	390.1	390.3	390.3	390.3	785.1	4583.1	381.9
80% month	100.0	100.0	300.0	300.0	367.8	377.7	310.6	100.0	100.0	100.0	100.0	100.0	2546.1	212.2
Min. year (1943)	100.0	300.0	300.0	300.0	365.2	465.5	336.8	100.0	100.0	100.0	100.0	100.0	2667.3	222.3
Min. month	100.0	300.0	300.0	300.0	300.0	364.4	300.0	100.0	100.0	100.0	100.0	100.0	2464.4	205.4

Note: 20%, 50%, & 80% Months Discharges indicate flows equalled or exceeded 20, 50, or 80 percent of time obtained from the empirical probability plotting position by the Weibull formula.



MONTHLY

SIMULATED DISCHARGE, OKANAGAN RIVER AT PENTICTON

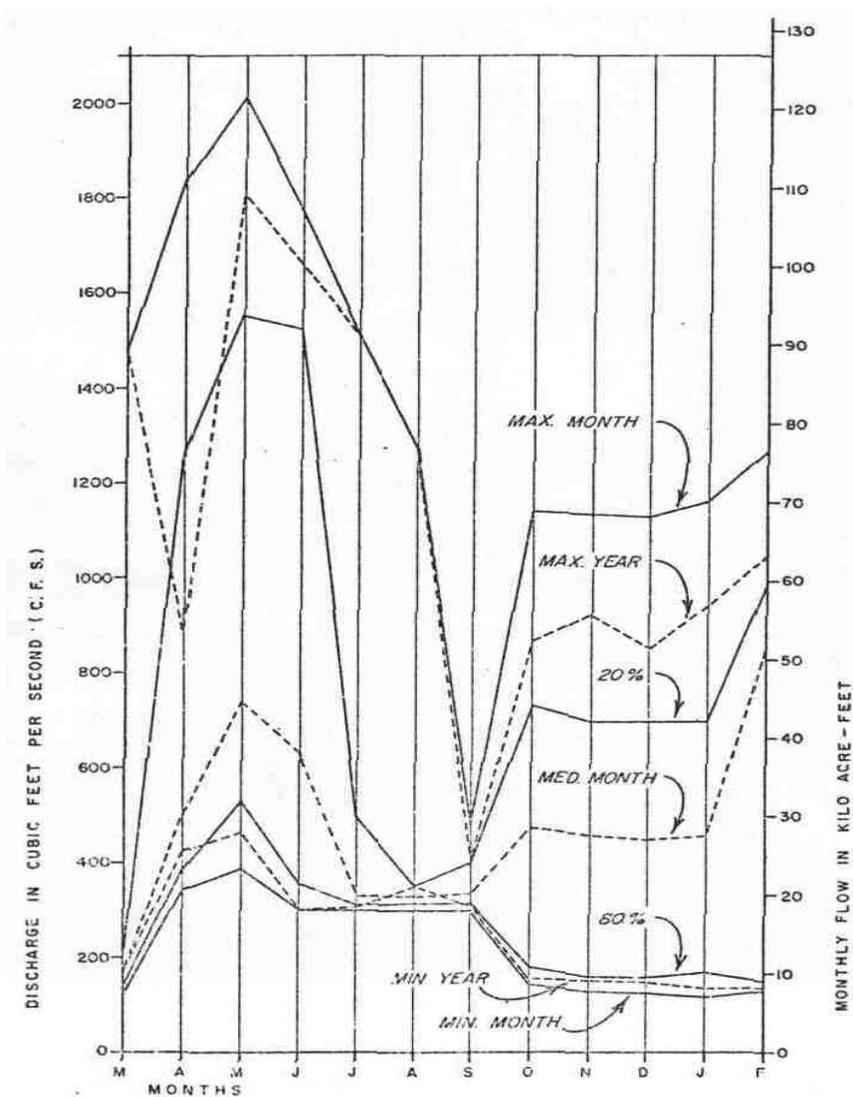
Figure D.10

TABLE OF REPRESENTATIVE MONTHLY FLOWS

MONTHLY 'NULL' DISCHARGE IN CFS, OKANAGAN RIVER AT OLIVER, PERIOD: OPERATIONAL (MARCH-FEBRUARY) YEAR 1921-1970 (50 YEARS)

Discharge	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Total	Mean
Max. month	1478.0	1825.5	2009.3	1777.9	1513.7	1277.4	480.4	1141.5	1136.2	1127.2	1160.4	1271.5	16 299.0	1350.7
Max. year (1945)	1478.0	1825.5	2009.3	1777.9	1513.7	1277.4	480.4	1141.5	1136.2	1127.2	1160.4	1271.5	16 299.0	1350.7
20% month	215.4	1216.8	1516.0	1525.6	501.1	353.1	402.2	729.7	697.0	698.5	698.4	991.9	9 025.6	472.1
Mean month	263.4	722.7	961.1	841.5	474.8	361.1	354.0	492.9	483.8	480.2	480.1	658.2	6 560.8	348.4
50% or median mo.	173.2	502.0	737.3	632.5	330.2	328.2	354.7	477.6	460.6	451.6	457.0	847.9	5 736.8	478.1
80% month	111.6	360.9	525.9	356.0	311.2	315.0	315.8	182.1	162.4	158.5	166.7	149.4	3 165.3	263.8
Min. year (1931)	173.2	424.7	464.6	304.7	312.8	353.1	311.1	158.9	555.8	151.7	136.9	137.8	3 087.6	257.3
Min. month	118.5	325.7	548.4	304.7	300.1	300.1	302.5	145.7	127.6	125.2	117.0	132.8	2 628.6	224.0

Note: 20%, 50%, & 80% Months Discharges indicate flows equalled or exceeded 20, 50, or 80 percent of time obtained from the empirical probability plotting position by the Weibull formula.



MONTHLY

SIMULATED

DISCHARGE, OKANAGAN RIVER AT OLIVER

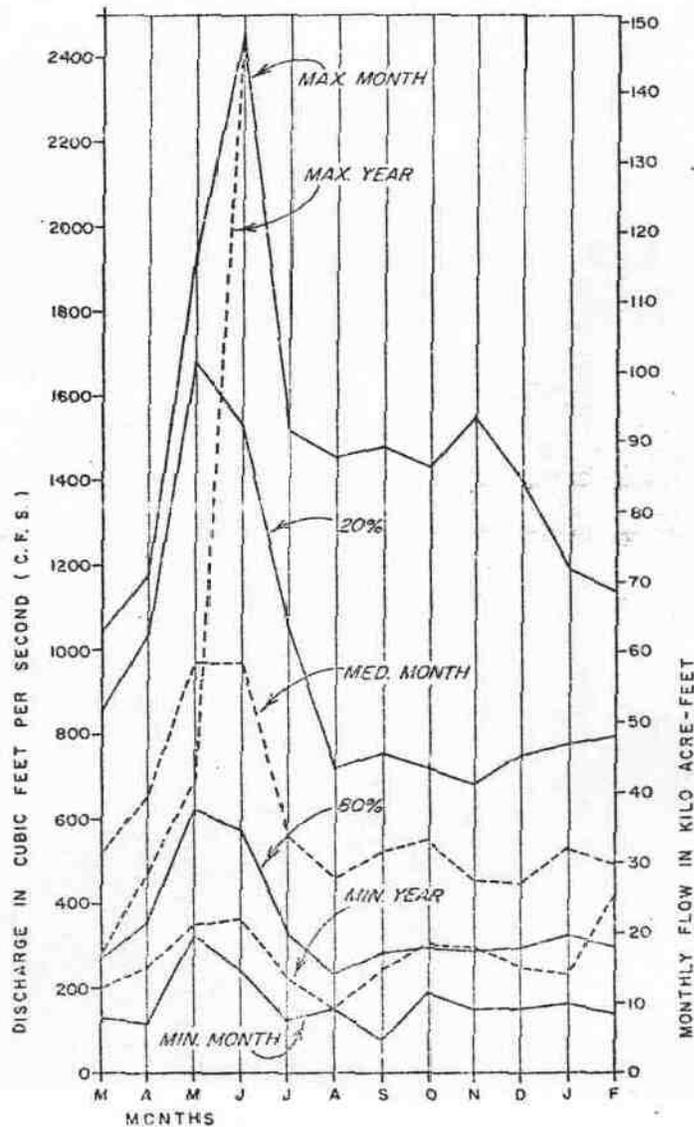
Figure D.11

TABLE OF REPRESENTATIVE MONTHLY FLOWS

MONTHLY HISTORIC DISCHARGE IN CFS, OKANAGAN RIVER AT OROVILLE, WASHINGTON, PERIOD: OPERATIONAL (MARCH-FEBRUARY) YEAR 1943-1970 (28 YEARS)

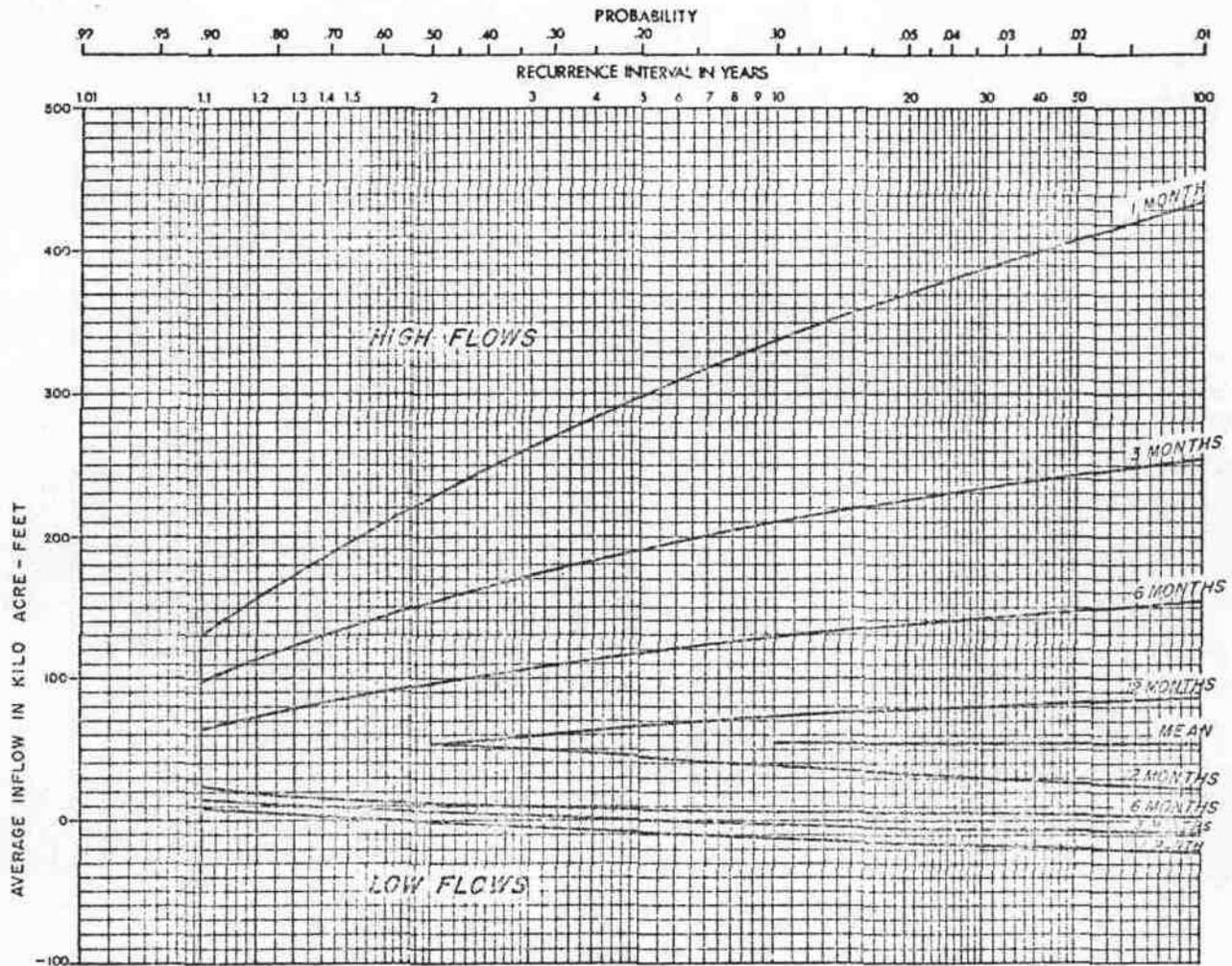
Discharge	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Total	Mean
Max. month	1040	1180	1930	2451	1522	1456	1482	1430	1551	1404	1190	1139	17 774	1481
Max. year (1943)	274	475	691	2451	1599	1456	1482	1430	1551	1404	1190	1139	15 057	1253
20% month	855	1056	1643	1535	1072	720	706	701	681	749	774	794	11 374	944
Mean month	553	670	1062	1089	657	305	575	549	577	530	541	535	7 749	626
50% or median month	516	655	970	960	564	460	576	551	457	451	531	496	7 145	595
80% month	268	355	635	575	330	233	234	294	266	294	326	297	4 165	347
Min. year (1962)	202	247	349	262	225	150	214	203	205	247	235	423	3 180	265
Min. month	130	115	323	243	126	150	52	158	148	229	162	141	1 957	163

Note: 20%, 50%, & 80% Months Discharges indicate flows equalled or exceeded 20, 50, or 80 percent of time obtained from the probability plotting position by the Weibull formula.



MONTHLY HISTORIC DISCHARGE, OKANAGAN RIVER AT OROVILLE. WASH.

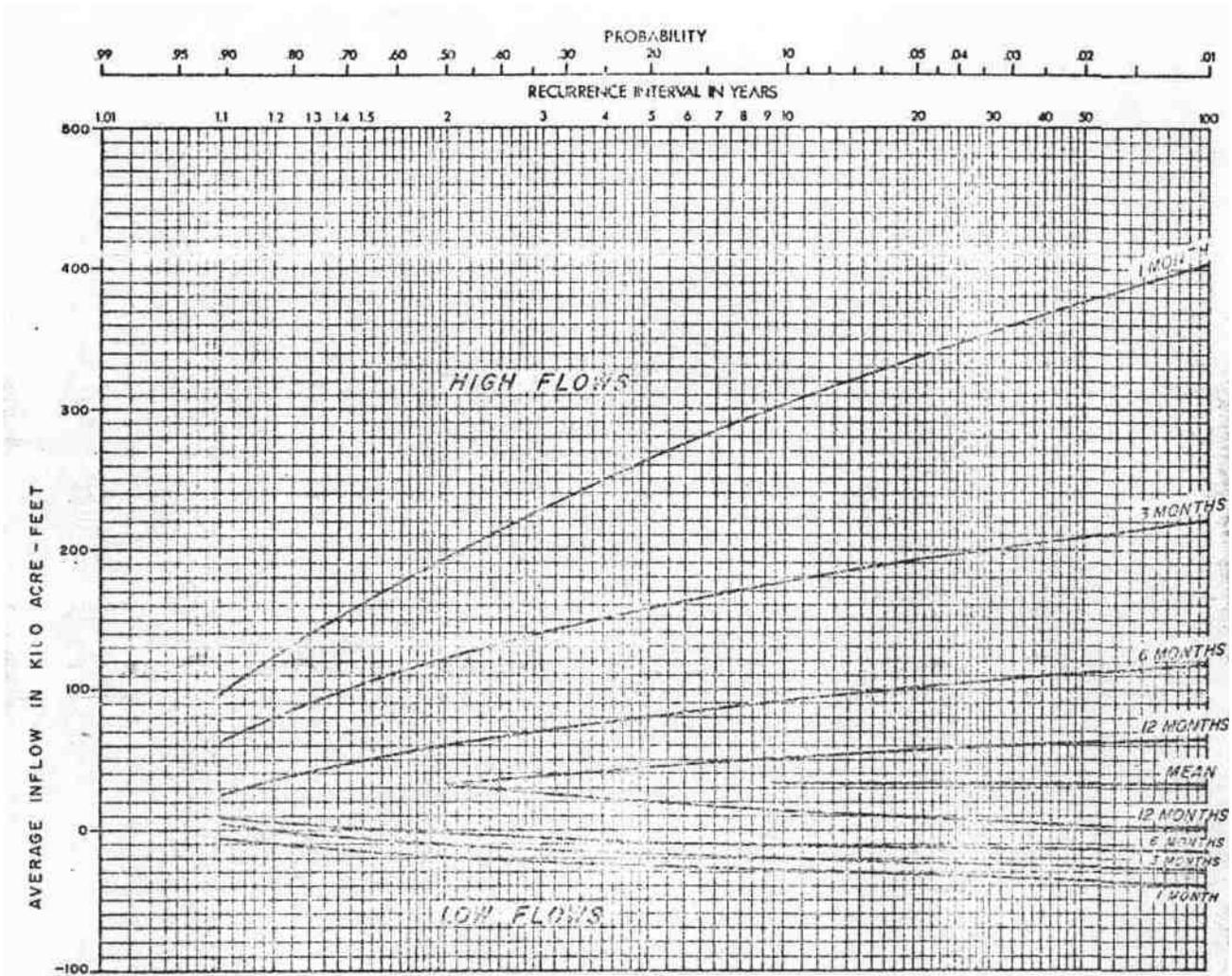
Figure D.12



Period:
Climatic (April-March) Year 1921-1970

FREQUENCY CURVES,
AVERAGE GROSS HISTORIC INFLOWS OF INDICATED CONSECUTIVE MONTHS,
OKANAGAN LAKE BASIN

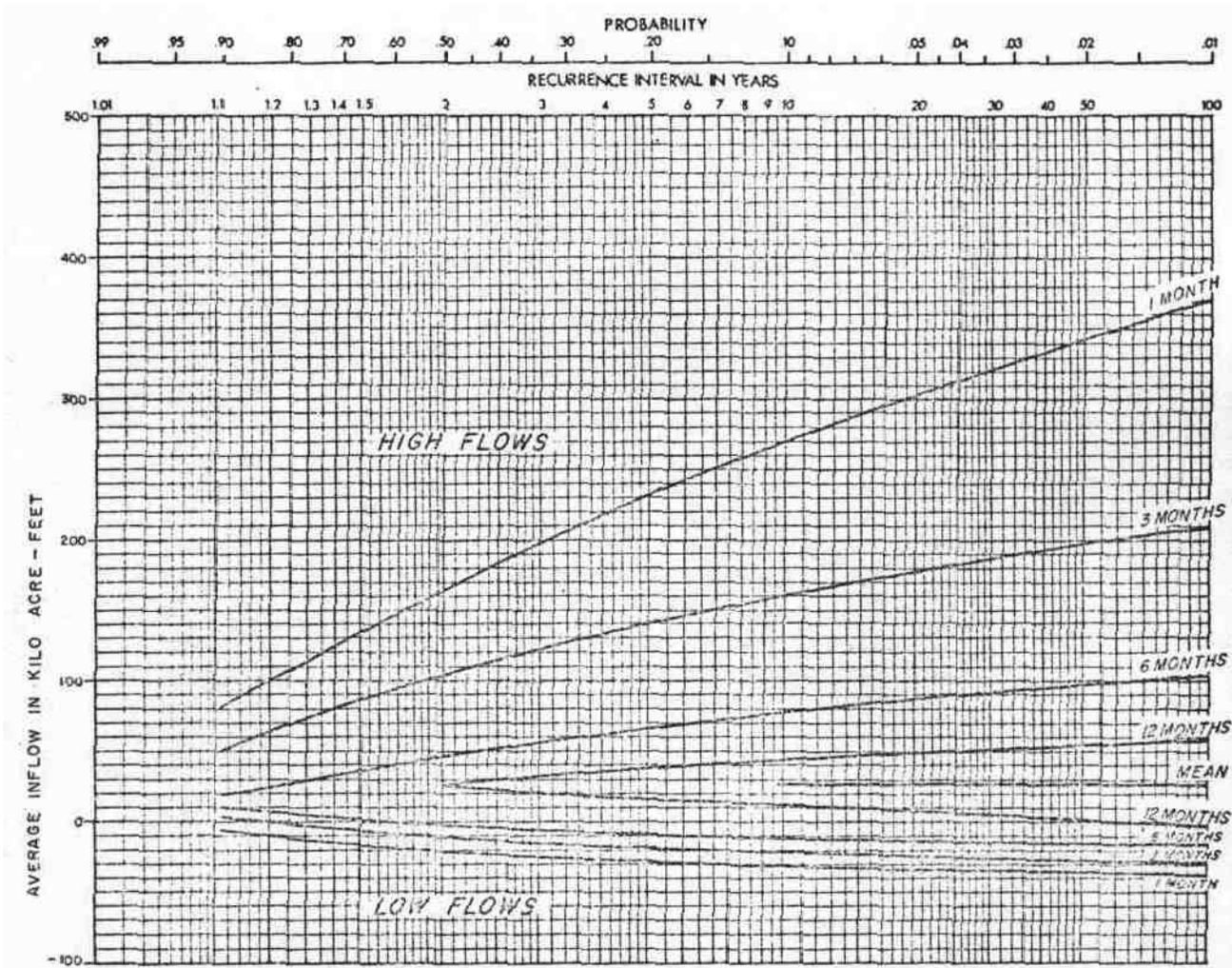
Figure D.13



Period:
 Climatic (April - March) Year 1921-1970

FREQUENCY CURVES,
 AVERAGE NET HISTORIC INFLOWS OF INDICATED CONSECUTIVE MONTHS,
 OKANAGAN LAKE BASIN

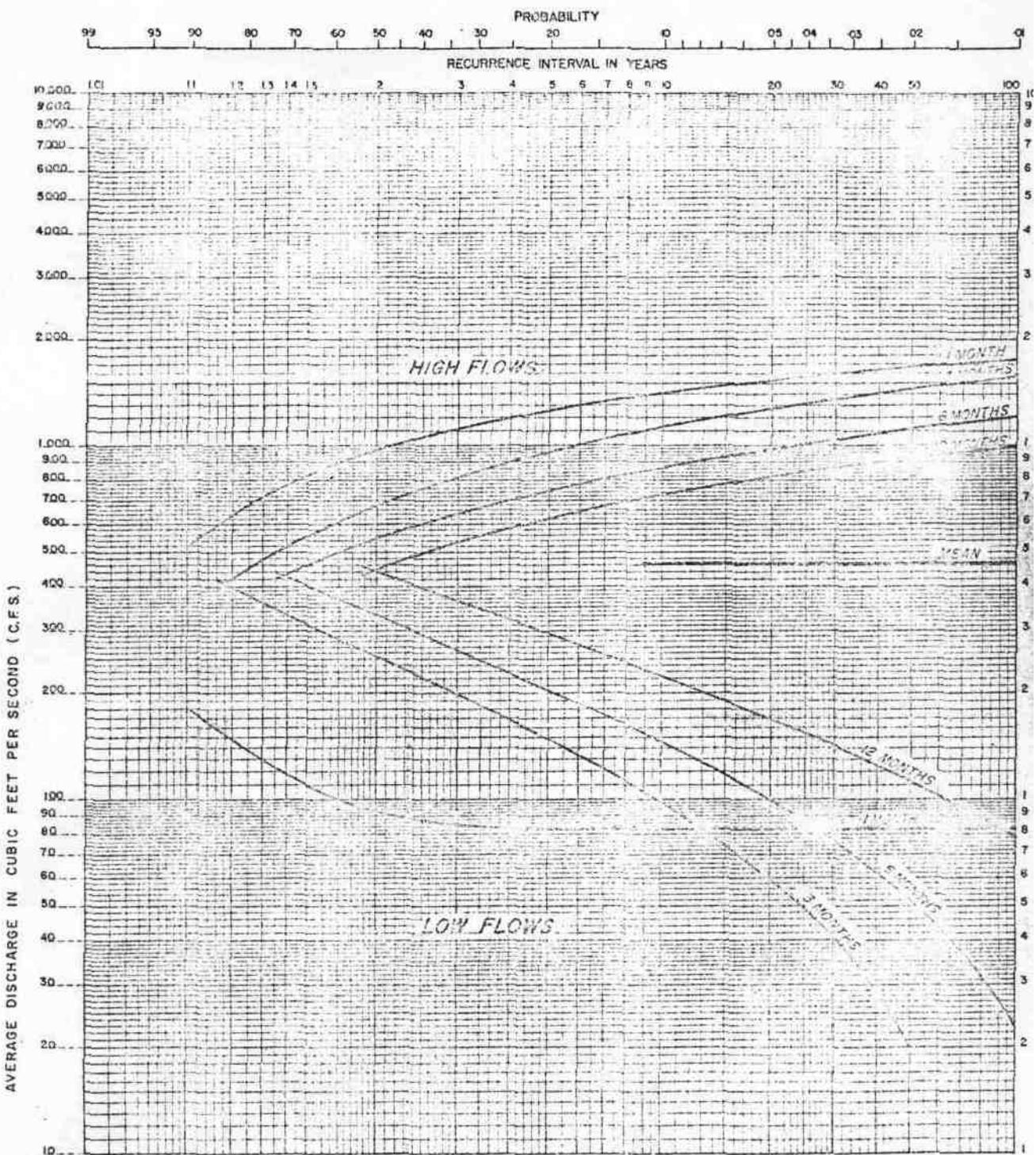
Figure D.14



Period:
 Climatic (April-March) Year 1921-1970

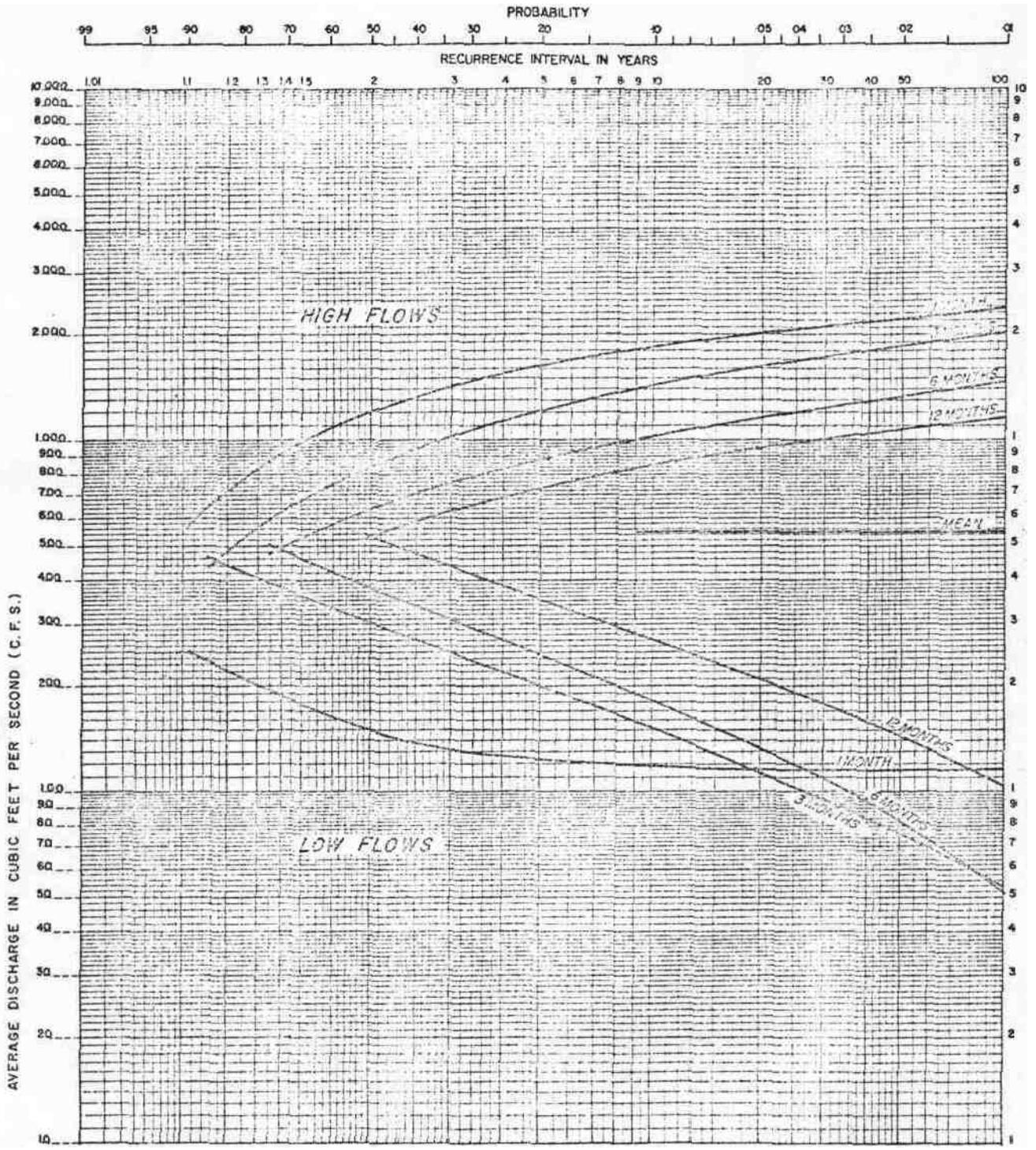
FREQUENCY CURVES,
 AVERAGE NET MODIFIED (1970 DEV.) INFLOW OF INDICATED CONSECUTIVE MONTHS,
 OKANAGAN LAKE

Figure D.15



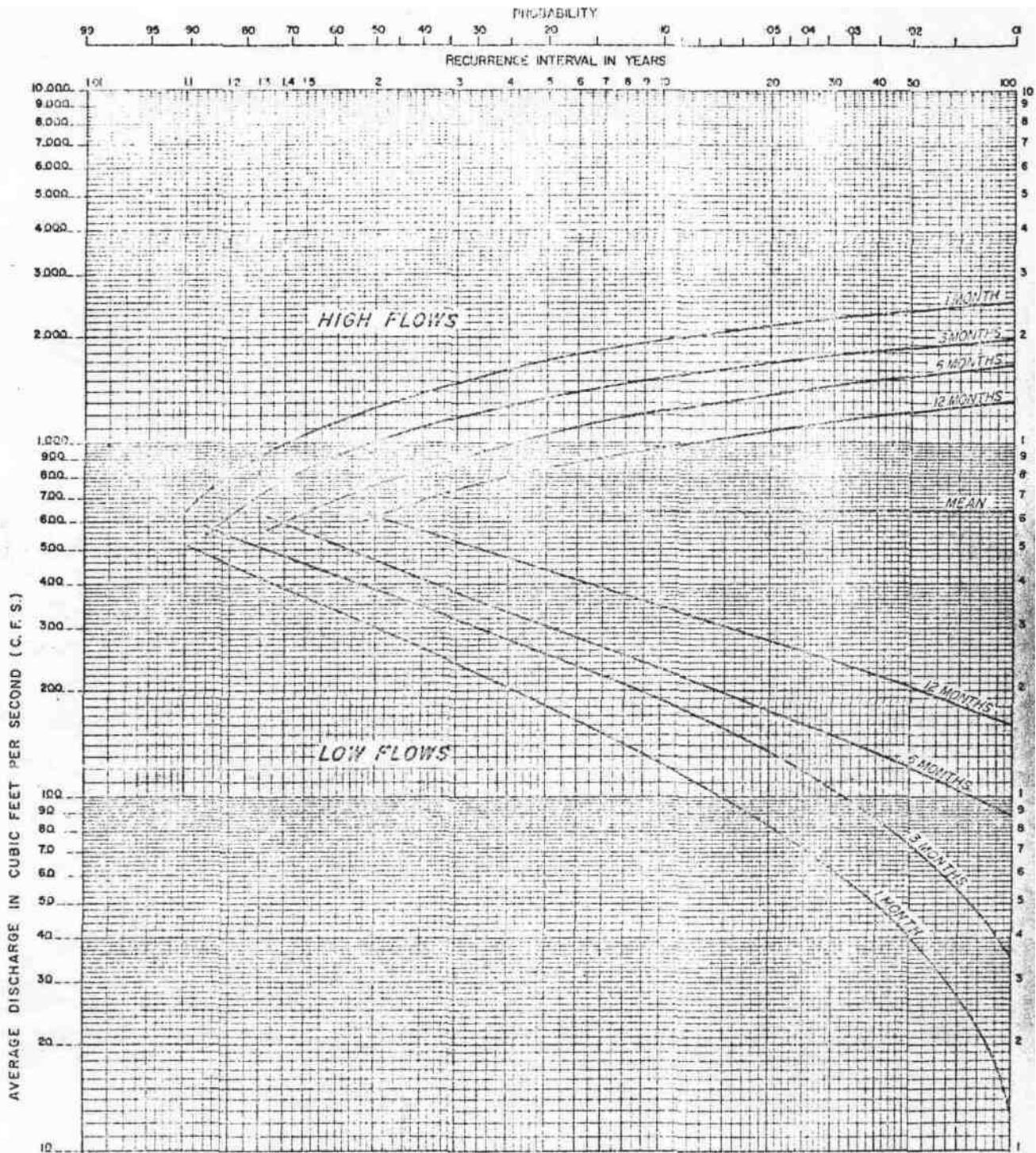
Period:
 Operational (March- February) Year 1921-1970
 FREQUENCY CURVES,
 AVERAGE SIMULATED DISCHARGES OF INDICATED CONSECUTIVE MONTHS,
 OKANAGAN RIVER AT PENTICTON

Figure D.16



Period:
 Operational (March-February) Year 1921-1970
 FREQUENCY CURVES,
 AVERAGE SIMULATED DISCHARGES OF INDICATED CONSECUTIVE
 MONTHS, OKANAGAN RIVER AT OLIVER

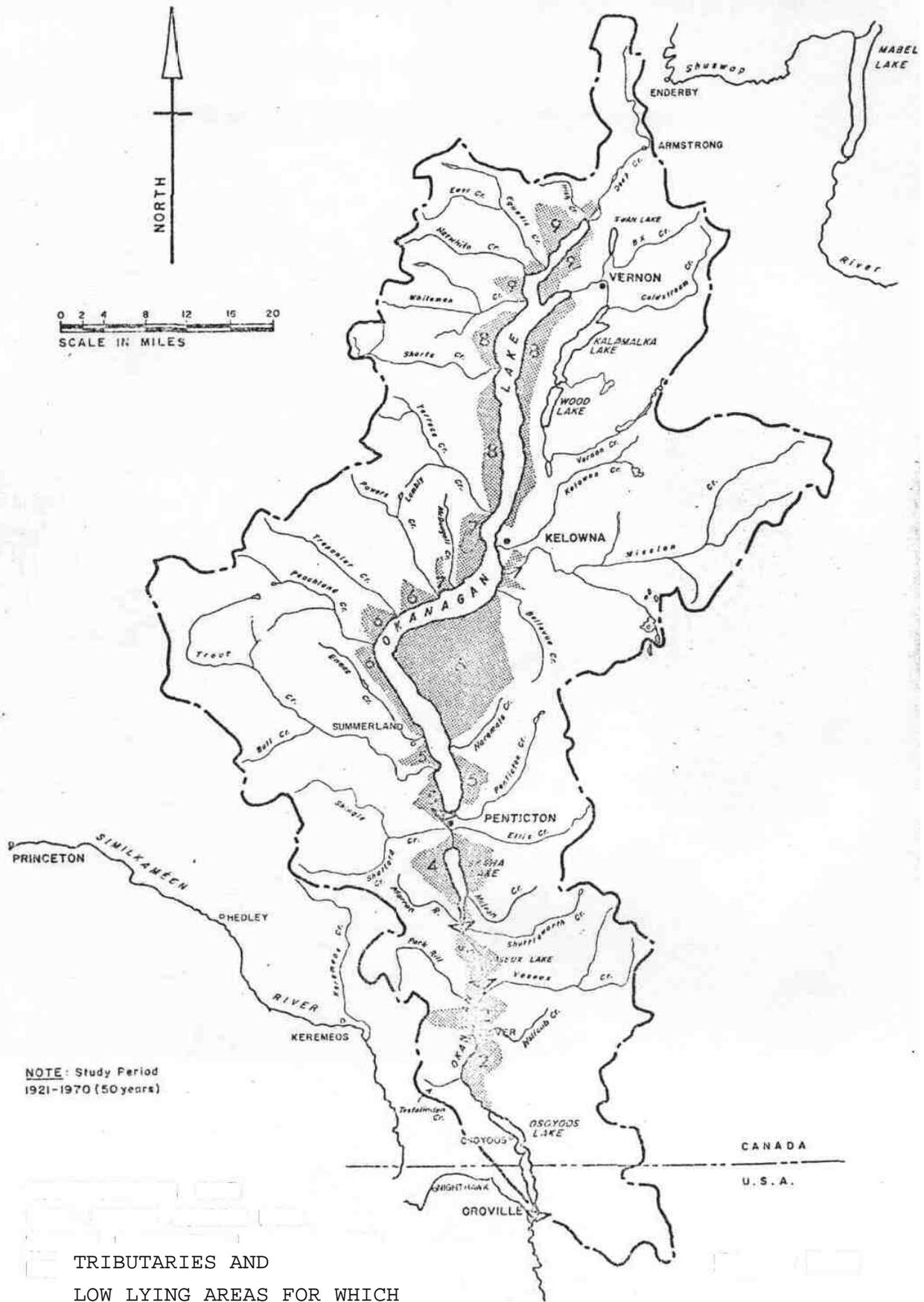
Figure D.17



Period:
Operational (March-February) Year 1943-1970

FREQUENCY CURVES,
AVERAGE HISTORIC DISCHARGES OF INDICATED CONSECUTIVE MONTHS,
OKANAGAN RIVER AT OROVILLE, WASH.

Figure D.18



NOTE: Study Period
1921-1970 (50 years)

TRIBUTARIES AND
LOW LYING AREAS FOR WHICH
MONTHLY DISCHARGES DERIVED
BY COMPUTER MODEL

Figure D.19