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SUSITNA HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114

FLOOD FREQUENCY ANALYSES FOR NATURAL AND WITH-PROJECT CONDITIONS

FINAL REPORT

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SUSITNA JOINT VENTURE

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Report by

Harza-Ebasco Susitna Joint Venture

Prepared for
Alaska Power Authority

Final Report
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NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING
THIS REPORT SHOULD BE DIRECTED TO
THE ALASKA POWER AUTHORITY
SUSITNA PROJECT OFFICE

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1.0 SUMMARY

Flood frequency analyses were made for the Susitna River at Gold Creek, Sunshine and Susitna Station for natural and with-project conditions of Stages I, II and III of the project. The resulting flood peak frequency curves are shown on Exhibits 10, 12 and 14. Tables 2, 5 and 6 also show the flood peaks for the selected recurrence intervals.

Flood frequency curves were derived for the natural conditions for annual, May-June and July-September periods using annual maximum floods in each period. The Watana Reservoir inflow flood hydrographs for the 2-, 5-, 10-, 25- and 50-year recurrence intervals and for annual, May-June and July-September periods were derived by two methods. In the first method, the flood peaks and volumes (1-, 3-, 5-, 10- and 15-day periods) of corresponding recurrence intervals at Gold Creek were transposed to Watana site and the hydrographs were constructed. This was based on the assumption that the floods would originate from the drainage area upstream from the dam site. In the second method, the floods were assumed to originate from the area intervening between Gold Creek and Watana site. Therefore, the flood hydrogaphs of 2-, 5-, 10-, 25- and 50-year recurrence intervals were derived for the intervening area by transposing the flood peaks and volumes of corresponding recurrence intervals, estimated for the area intervening between Cantwell and Gold Creek stream gaging stations. These flood hydrographs were subtracted from the corresponding flood hydrographs at Gold Creek and the residual flows were assumed to represent the Watana inflows.

The two derived sets of hydrographs were routed through the reservoir using operational criteria for Stages I, II and III of the project, discussed under Section 5.2.2 of this report, to obtain with-project outflows from the Watana Reservoir. For the reservoir flood routings, starting reservoir elevations were derived from the "start of the week reservoir elevations" obtained from the weekly reservoir operations study for the period 1950 through 1983 for Case E-VI flow requirements in the License Application of the project. They were assumed to be the median values during the June, May-June, and July-September periods, for annual, May-June and July-September floods, respectively. The median value for June was taken as the starting water surface elevation for annual floods because this is the month in which the annual maximum flood is most likely to occur.

The median reservoir water surface elevations were computed based on the energy demands for the Stage I, Watana (low) operation, for the Stage II Watana (low) - Devil Canyon operation and for the Early Stage III and Late Stage III, Watana (high) - Devil Canyon operation. Based on these elevations, the Watana Reservoir outflows were determined for the selected recurrence intervals, for each flood series and for each stage.

The detailed analyses made for Gold Creek indicated that the with-project Watana outflows using inflows derived by the second method, when combined with the corresponding flood from the intervening area would result in higher flood peaks at Gold Creek for all three stages of the project. The reservoir operation studies for Stages II and III indicated that the Devil Canyon Reservoir will remain near its normal maximum water surface elevation for essentially the entire flood season. Therefore, the flood peaks entering the reservoir would not be significantly attenuated. Thus, the Watana Reservoir outflows (second method) were combined with the flood flows of the corresponding recurrence interval from the intervening areas (between Watana Reservoir and the downstream location of interest) to determine with-project flood peaks at the downstream locations.

The flood peak frequency data indicate a decrease in the difference between the floods peaks for natural and with-project conditions as the distance increases downstream from Gold Creek. This is because of the floods from the tributaries joining the Susitna River downstream from Gold Creek.

The with-project flood-frequency relationships presented in this study, would change in the future if project design or project operation criteria during floods are modified.

2.0 BACKGROUND

With-project flood frequency curves at Gold Creek were developed using results of a weekly Watana/Devil Canyon reservoir operation study based on the energy demands of 2002 and 2010 and were presented in the original License Application for the project (APA, 1983).1/ The purpose of these curves and that for natural conditions was to demonstrate the decrease in the magnitude of floods resulting from project operation. No frequency curves were developed for Sunshine and Susitna Station. These frequency curves were based on results of operation studies using weekly mean flows. Flood peaks may be underestimated by this procedure, indicating a larger attenuation of floods by the reservoirs than would actually occur.

Since the original License Application was filed, the reservoir operation criteria have been modified and the project is now planned to be constructed in three stages instead of two. The assessment of potential project impacts on the Lower Susitna River (between the confluence of the Susitna and Chulitna rivers and Cook Inlet) also has become necessary. Therefore, the flood frequency curves for Gold Creek were re-evaluated and similar curves for Sunshine and Susitna Station were derived (see Exhibit 1 for locations).

1/ Indicates reference at the end of the text.

3.0. SCOPE OF THE STUDY

The major work items of the present study include:

1. Generation of annual, May-June and July-September Watana Reservoir inflow flood hydrographs of various recurrence intervals and for two scenarios. The storms causing the floods were assumed to center upstream from the reservoir in the first scenario and downstream from the reservoir in the second scenario.

2. Routing of the above hydrographs through the reservoir using the most current reservoir operation criteria and starting reservoir elevations representative for Stage I, II and III of the project;

3. Estimation of the annual, May-June and July-September flood peaks from the intervening areas; and

4. Development of annual, May-June and July-September maximum flood peak frequency curves for Gold Creek, Sunshine and Susitna Station for natural and with-project conditions.

4.0 INFLOW FLOOD HYDROGRAPHS FOR WATANA

Two sets of Watana inflow hydrographs were derived for the annual, May-June and July-September periods and for various recurrence intervals. In the first case, it was assumed that the storm causing the flood would center in the drainage area upstream from the Watana damsite. The flow from the area intervening between the dam site and Gold Creek was assumed to be the difference between the respective flood hydrographs at the Watana dam site and Gold Creek. Therefore, the annual, May-June and July-September flood peaks and 3-, 7- and 15-day flood volumes were estimated for the Watana dam site (with a drainage area of about 5,180 square miles) for the recurrence intervals of 2, 5, 10, 25 and 50 years (Table 1) by transposing the corresponding data at Gold Creek (H-E, January 1984). The transposed data were used to develop the flood hydrographs shown on Exhibits 2 through 6. These hydrographs were shaped after the historic flood hydrographs recorded at Gold Creek which had flood peaks and volumes comparable to those shown on Table 1. The selected floods include those of June 1980, July 1981, August 1967, August 1971 and June 1964 which were used to shape the 2-, 5-, 10-, 25- and 50-year floods, respectively. The seasonal flood hydrographs of the same recurrence intervals also were developed for Gold Creek using the flood peaks and flood volumes at Gold Creek and shapes of these historic floods.

For the second case, the storms causing the floods were assumed to center in the area intervening between Watana and Gold Creek and the differences between respective flood hydrographs at Gold Creek and from the intervening area were used as inflows to the Watana Reservoir. The floods of selected recurrence intervals for the area between Watana and Gold Creek were developed from the flood peaks and volumes data for the area between Cantwell and Gold Creek.

The 100-year flood hydrograph was not generated for this study because of uncertainties involved in extension of the flood peak and flood volume frequency curves for return periods much longer than the period of record. The 50-year floods were considered to be large enough to study potential project effects at downstream locations.

5.0 FLOOD FREQUENCY AT GOLD CREEK

5.1 NATURAL CONDITIONS

The flood peak frequency curves for Gold Creek (with a drainage area of about 6,160 square miles) are shown on Exhibit 7 for annual, May-June and July-September periods. The curves were developed using the procedures outlined by the U.S. Water Resources Council (WRC) (WRC, 1981) and the annual maximum instantaneous discharges of the three periods for the water years from 1949 through 1982 (Appendix A). The plotting positions shown on the exhibit were computed using the Weibull's formula, $P=M/(N+1)$, where P is the relative frequency, M is the rank of the flood event in order of magnitude with the events arranged in descending order and N is the number of years of record. The resulting flood peaks for selected recurrence intervals are given in Column 3 of Table 2.

5.2 WITH-PROJECT CONDITIONS

Floods at a location downstream from a major storage reservoir may be caused by a large regulated flood release from the reservoir combined with a relatively small contribution from the area intervening between the reservoir and the location of interest or by a smaller reservoir release combined with a high flood flow from the intervening area. However, as the distance between the reservoir and the downstream location increases, the flood from the intervening area becomes more dominant and the regulation effect of the reservoir becomes less important. For the purpose of this study, two procedures were used to estimate with-project flood peaks at Gold Creek. In the first procedure, the Watana inflow hydrographs determined for the first case in Section 4.0, were routed through the reservoir and the outflow hydrographs were combined with the hydrographs of respective recurrence intervals, from the intervening area (Section 4.0). In the second procedure, the residual inflow hydrographs determined for the second case in Section 4.0

were routed through the reservoir and the outflow hydrographs were combined with the flood hydrographs of respective recurrence intervals from the intervening area.

The with-project flood peaks resulting from the two procedures were compared. For the May-June and annual series, the second procedure generally resulted in larger peaks for a given frequency. This is because the Watana reservoir is capable of storing most of the flood flows and the outflows were essentially constant (equivalent to the average turbine flows) in most of the floods studied. Flood peaks from the intervening area were more significant. For the July-September floods, both procedures gave nearly the same peaks. Therefore, floods estimated by the second procedure were adopted to define with-project flood-frequency relationships.

5.2.1 Floods from Intervening Area

The flood hydrographs for the area intervening between the Watana site and Gold Creek (about 980 square miles) were developed using flood peak and volume (1-, 3-, 5-, 10- and 15-day periods) data of various recurrence intervals. These data were estimated by transposing the flood-peak and volume frequency relationships estimated for the area between Cantwell and Gold Creek (about 2020 square miles). The relationships, shown on Exhibit 8, were developed by using the guidelines of WRC (WRC,1981) and the annual, May-June and July-September maximum daily intervening flows for each of the water years from 1961 through 1972 and of the water years 1981 and 1982 (Appendix A). The intervening flows were computed as differences between the observed flows at Cantwell and Gold Creek. No adjustment was made to the maximum daily intervening flows to obtain the instantaneous intervening flows.

At the two stations, the maximum daily flows generally occurred on days other than those when the annual maximum instantaneous flood occurred. For Gold Creek, the ratio between the annual maximum instantaneous flow and mean flow for the same day varies between 1.01 and 1.08. Thus, the ratios between the maximum instantaneous flow and the maximum daily flow on the day when maximum daily flow occurred are expected to be smaller than this for each of the three series. Therefore, it was decided not to adjust the maximum daily flows (for the intervening area) upward for the maximum instantaneous flows.

Since the 14 years of flood data are not sufficiently long to estimate floods of large recurrence intervals, the procedure recommended in United States Geological Survey Publication 78-129 (USGS 78-129) (Lamke, 1979) was used to develop another set of flood-frequency relationships. The procedure essentially involved the derivation of the relationship by using generalized regression equations. The resulting flood peaks for various recurrence intervals were then adjusted by using the ratio between the floods of 5-year recurrence interval taken from the curve based on observed data (Exhibit 8) and from the regression equation (Lamke, 1979).

The transposition of the resulting flood peak-frequency data for the area between Cantwell and Gold Creek to the area between the Watana dam site and Gold Creek was made by the following relationship:

$$Q = Q_g \left(\frac{A}{A_g}\right)^n \quad \text{......................................} (1)$$

in which:

Q = peak discharge from the area intervening between the Watana dam site and Gold Creek for a given recurrence interval, cfs;

Q_g = peak discharge from the area intervening between Cantwell and Gold Creek for the corresponding recurrence interval, cfs;

A = drainage area between Watana dam site and Gold Creek, square miles;

A_g = drainage area between Cantwell and Gold Creek, square miles; and

n = exponent.

A value of 0.5 was used for "n" as discussed in "Flood Frequency Analysis" by Harza-Ebasco (H-E, January 1984). Table 3 shows the resulting flood peak estimates for the selected recurrence intervals. The flood volume-frequency data were transposed by drainage area ratio.

5.2.2 Watana Reservoir Releases

Watana inflow hydrographs resulting from the two procedures described in Sub-section 5.2, were routed through the reservoir. An in-house reservoir routing program was used to determine the releases from the reservoir. The reservoir was operated using the folowing criteria for the three-stage project:

A. Stage I

1. Normal maximum pool level = 2000 ft

2. Environmental surcharge level = 2014 ft

3. Maximum outlet works capacity = 24,000 cfs

4. Average turbine discharge (cfs) based on weekly reservoir operation study for 1950-1983 period and Case E-VI flow requirements (H-E, December 1985):

May-June	July-September	Annual (For June)
5,900	9,200	8,900

5. Release Criteria

a. When reservoir elevation is less than or equal to 2,000 ft:

release is equal to turbine discharge,

b. When reservoir elevation is between 2000 and 2000.5 ft:
   release is made equal to turbine discharge plus outlet works discharge increased gradually from zero at elevation 2000 to 24,000 cfs at elevation 2000.5 ft,

c. When reservoir elevation is greater than 2000.5 but less than 2014:
   release is made equal to turbine discharge plus 24,000 cfs,

d. When reservoir elevation is equal to 2014 ft: Reservoir level is maintained at 2014 by setting inflow equal to outflow. The outlet works discharge is at full capacity. The inflow in excess of the combined capacity of outlet works and turbines is passed through the spillway.

B. Stage II

1. Normal maximum pool level = 2000 ft

2. Environmental surcharge level = 2014 ft

3. Maximum outlet works capacity = 24,000 cfs

4. Average and maximum turbine discharge (cfs) based on weekly reservoir operation study using streamflow data for the 1950-1983 period and Case E-VI flow requirements (H-E, December 1985) with the assumption that the Watana reservoir will be operated to meet total power demand (no generation at Devil Canyon) when at elevation 2,000 and greater are:

Elevation	May-June	July-September	Annual (For June)
less than 2000	3,400 (avg.)	3,060 (avg.)	2,490 (avg.)
2000 or greater	10,100 (max.)	10,400 (max.)	10,400 (max.)

5. Release Criteria

a. When reservoir elevation is less than 2000 ft:
   release is made equal to average turbine discharge,

b. When reservoir elevation is between 2000 and 2000.5 ft:
   release is made equal to maximum turbine discharge plus outlet works discharge increased gradually from zero at elevation 2000 to 24,000 cfs at elevation 2000.5 ft,

c. When reservoir elevation is greater than 2000.5 but less than 2014:
   release is made equal to maximum turbine discharge plus 24,000 cfs,

d. When reservoir elevation is equal to 2014 ft:
   reservoir level is maintained at 2014 by setting inflow equal to outflow. The outlet works discharge is at full capacity. The inflow excess of the combined capacity of the outlet works and turbines is passed through the spillway.

C. Stage III, Early and Late

1. Normal maximum pool level = 2185 ft

2. Environmental surcharge level = 2193 ft

3. Maximum outlet works discharge = 24,000 cfs

4. Average and maximum turbine discharge (cfs) based on weekly reservoir operation study using streamflow data for the 1950-1983 period and Case E-VI flow requirements (H-E, December 1985) with the assumption that the Watana reservoir will be operated to meet total power demand (no generation at Devil Canyon) when at elevation 2185 and greater are:

Stage	Elevation	May-June	July-September	Annual (For June)
III, Early	less than 2185 2185 or greater	4,130(avg.) 9,900(max.)	3,710(avg.) 9,900(max.)	3,340(avg.) 9,900(max.)
III, Late	less than 2185 2185 or greater	5,820(avg.) 12,500(max.)	5,770(avg.) 12,500(max.)	5,400(avg.) 12,500(max.)

5. Release Criteria

   a. When reservoir elevation is less than 2185 ft:
      release is made equal to average turbine discharge,

   b. When reservoir elevation is between 2185 and 2185.5 ft:
      release is made equal to maximum turbine discharge plus outlet works discharge increased gradually from zero at elevation 2185 to 24,000 cfs at elevation 2185.5 ft,

   c. When reservoir elevation is greater than 2185.5 but less than 2193:

release is made equal to maximum turbine discharge plus 24,000 cfs,

d. When reservoir elevation is equal to 2193 ft: reservoir level is maintained at 2193 by setting inflow equal to outflow. The outlet works discharge is at full capacity. The inflow in excess of the combined capacity of the outlet works and turbines is passed through the spillway.

The above criteria are based on "Dam Safety Criteria" given in a previous report (H-E, February 1985) and in the Amendment to the License Application (APA, 1985). The reservoir volume-elevation curve used in the reservoir routing was that obtained from the License Application Amendment (APA, 1985). The starting reservoir water surface elevations were derived from the "start of the week reservoir elevations" obtained through the weekly reservoir operation study (H-E, December 1985) using streamflow data for the period from 1950 through 1983 (using E-VI environmental flow requirements) and were assumed to be the median values during June, May-June and July-September periods, repectively, for the annual, May-June and July-September floods. The assumption that the annual flood is most likely to occur in the month of June is reasonable because about 60 percent of the historic annual maximum floods occurred in this month (Exhibit 9).

The median reservoir water surface elevations (starting elevations) were computed for the Watana (low) operation for Stage I energy demands, for the Watana (low) - Devil Canyon operation for Stage II energy demands and for the Watana (high) - Devil Canyon operation for early and late Stage III energy demands. Based on the respective starting elevations, the outflows from the Watana Reservoir, which when combined with the flows from the area intervening between Watana and Gold Creek, will provide maximum peaks at Gold Creek, corresponding to the 2-, 5-, 10-, 25- and 50-year recurrence intervals and the Stages I, II and III energy demands were determined through the reservoir routing as shown in Table 4. These flows are essentially constant for a number of days and hence were assumed to travel to Gold Creek, Sunshine and Susitna Station gages without attenuation.

The Watana Reservoir outflows (Table 4) indicate that the seasonal 2-, 5-, 10-, 25- and 50-year floods that would occur in the May-June period would be controlled by the reservoir and the maximum outflow would not exceed the discharge from the turbines. This conclusion remains the same for all stages. This conclusion also is true for the annual flood except that for 25- and 50- year floods, the outlet works would be used for Stage II and Early Stage III, and for the 50-year flood for Stage I conditions.

During the July-September period, the reservoir elevations at the beginning of the flood would generally be higher than for the other periods. Therefore, following the operation criteria described earlier, the use of the outlet works would become necessary during the floods of all selected recurrence intervals under the energy demands for all stages except for Late Stage III. For Late Stage III, Watana Reservoir will have to be operated at lower reservoir elevations to meet the increased energy demand. Under such conditions, the floods of all recurrence intervals would be controlled and outflow would be the same as the average turbine discharge.

5.2.3 Floods at Gold Creek

The flood releases from Watana Reservoir for a given recurrence interval, were combined with the flood of the corresponding recurrence interval from the area intervening between Watana and Gold Creek to determine with-project floods at Gold Creek for the two cases discussed under Sub-section 5.2. Results of the Devil Canyon Reservoir operation studies indicated that the reservoir water surface elevation will remain essentially at its normal maximum throughout the flood season. Therefore, attenuation of flood peaks by Devil Canyon Reservoir was assumed to be insignificant. Since the second procedure resulted in higher with-project flood peaks at Gold Creek, those peaks were adopted. The resulting with-project floods (second procedure) are given in Columns 4 to 7 of Table 2. Exhibit 10 shows the frequency curves for natural and with-project conditions.

6.0 FLOOD FREQUENCY AT SUSITNA STATION

6.1 NATURAL CONDITION

The flood peak data at Susitna Station, with a drainage area of about 19,400 square miles, are available for the water years from 1975 through 1982 (Appendix A). This period is too short to estimate flood peaks of large recurrence intervals. Therefore, the procedure recommended in USGS publication 78-129 (Lamke, 1979) was used to develop the flood frequency curve. The procedure has been discussed briefly under Sub-section 5.2.1. Exhibit 11 shows the flood frequency curve for annual, May-June and July-September periods based on observed data. The plotting positions of the points shown on the curves were computed using Weibull's formula. The adjusted flood frequency curve is shown on Exhibit 12. The flood peaks of selected recurrence intervals are given in Column 3 of Table 5.

6.2 WITH-PROJECT CONDITIONS

The flood peaks for with-project conditions were obtained using the procedure adopted for Gold Creek. That is, the constant release from the Watana Reservoir for a given recurrence interval was added to the flood peak of the corresponding recurrence interval from the area (about 14,220 square miles) intervening between the Watana Reservoir and Susitna Station. The flood peaks for the area between the Watana Reservoir and Susitna Station were derived by transposing the flood frequency relationship estimated for the area (about 13,240 square mile) between Gold Creek and Susitna Station. The relationship was estimated using flood frequency curves based on observed data (Exhibit 13) and the procedure recommended in USGS publication 78-129 (Lamke, 1979) because of the short length of record (for water years from 1975 through 1982). The transposition was made using Equation 1 given in Sub-section 5.2.1 with the values of flood peaks and drainage areas replaced by those between the Watana Reservoir and Susitna Station, and Gold Creek and Susitna Station.

The maximum daily intervening flows used in the frequency analysis were computed by the same method used for the area between Cantwell and Gold Creek. The resulting frequency curves shown on Exhibit 13, were derived using the guidelines of the WRC (WRC, 1981).

The with-project flood frequency curves resulting from the analysis are shown on Exhibit 12. The flood peaks of selected recurrence intervals are given in Columns 4 to 7 of Table 5. The with-project frequency curves are shown for three stages of the project.

7.0 FLOOD FREQUENCY AT SUNSHINE

7.1 NATURAL CONDITION

There are only about 3 years of flow record for Sunshine (drainage area of about 11,100 square miles). These are not sufficient to derive a reliable flood frequency relationship. Therefore, the flood peak frequency relationships developed for Susitna Station for annual, May-June and July-September periods were transposed to this site by Equation 1 given in sub-section 5.2.1 using the appropriate values of flood peaks and drainage areas. A value of 0.5 was used for the exponent "n". The resulting curves for annual, May-June and July-September periods are shown on Exhibit 14. The flood peaks of selected recurrence intervals are given in Column 3 of Table 6.

7.2 WITH PROJECT CONDITIONS

The flood peaks for with-project conditions were estimated using the procedures adopted for Gold Creek and Susitna Station. The intervening area between the Watana Reservoir and Sunshine is about 5,920 square miles. The flood data for the intervening area were estimated by transposing the data for the area between Gold Creek and Susitna Station. The resulting curves for annual, May-June and July-September periods are shown on Exhibit 14, and the flood peaks of selected recurrence intervals are given in Columns 4 to 7 of Table 6 for three stages of the project.

REFERENCES

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Lamke, R.D., Flood Characteristics of Alaskan Streams, 1979: U.S. Geological Survey, Water Resources Investigations 78-129, Anchorage, Alaska.

U.S. Water Resources Council, 1981: Guidelines for Determining Flood Frequency, Bulletin # 17B, Washington D.C.

TABLES

Table 1

FLOOD FREQUENCY DATA AT WATANA[1/]
NATURAL CONDITIONS

	Recurrence Interval (Year)				
	2	5	10	25	50
Annual Series					
Flood Peak, cfs	43,500	57,400	67,000	79,800	89,500
Flood Volume, mean discharge, cfs					
3-day	36,028	47,062	54,485	64,027	71,251
7-day	32,297	41,182	46,910	54,015	59,233
15-day	28,529	35,004	39,049	43,950	47,478
May-June Period					
Flood Peak, cfs	39,000	51,500	60,800	73,800	84,400
Flood Volume, mean discharge, cfs					
3-day	32,188	42,242	49,592	59,732	67,900
7-day	29,114	37,701	43,813	52,043	58,553
15-day	26,036	32,968	37,432	42,969	47,034
July-September Period					
Flood Peak, cfs	34,200	45,700	54,500	67,200	77,800
Flood Volume, mean discharge, cfs					
3-day	28,013	36,783	43,547	53,233	61,341
7-day	25,766	32,521	37,379	43,970	49,210
15-day	23,840	28,728	31,795	35,530	38,227

1/ Source: Harza-Ebasco Susitna Joint Venture, Final Report January, 1984: Flood Frequncy Analysis, Susitna Hydroelectric Project No. 7114, Document No. 474, prepared for Alaska Power Authority.

Table 2

FLOOD PEAK FREQUENCY DATA AT GOLD CREEK
FOR NATURAL AND WITH-PROJECT CONDITIONS

Flood Period	Recurrence Interval (Year)	Natural Flood Peak[1/] (cfs)	Flood Peaks (cfs) With-Project			
			Stage I	Stage II	Stage III	
					Early	Late
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annual	2	48,000	25,600	19,200	20,000	22,100
	5	63,300	33,300	26,900	27,700	29,800
	10	73,700	37,700	31,300	32,100	34,200
	25	87,300	41,600	35,200	36,000	38,100
	50	97,700	46,200	39,600	40,600	42,700
May-June	2	42,500	19,800	17,300	18,000	19,700
	5	56,200	26,800	24,300	25,000	26,700
	10	66,300	30,600	28,100	28,800	30,500
	25	80,500	33,900	31,400	32,100	33,800
	50	92,100	37,900	35,400	36,100	37,800
July-September	2	37,300	36,500	36,500	35,500	15,700
	5	49,800	43,100	43,100	43,100	21,300
	10	59,400	43,500	44,500	43,500	24,000
	25	73,200	44,000	45,000	45,000	26,500
	50	84,800	46,600	47,100	47,300	29,500

1/ From H-E report, January, 1984.

Table 3

FLOOD PEAK FREQUENCY DATA FOR INTERVENING AREAS

		Recurrence Interval, (Year) 2	5	10	25	50
		Flood Peaks, (cfs)				
1. Between Cantwell and Gold Creek						
	Annual	24,000	35,000	41,300	46,900	53,600
	May-June	20,000	30,000	35,400	40,200	45,900
	July-September	14,200	22,200	26,200	29,700	34,000
2. Between Watana and Gold Creek						
	Annual	16,700	24,400	28,800	32,700	37,300
	May-June	13,900	20,900	24,700	28,000	32,000
	July-September	9,890	15,500	18,200	20,700	23,700
3. Between Gold Creek and Susitna Station						
	Annual	149,000	173,000	192,000	212,000	230,000
	May-June	115,000	131,000	146,400	161,000	174,000
	July-September	147,000	172,200	191,000	211,000	229,000
4. Between Watana and Sunshine						
	Annual	99,700	116,000	128,000	142,000	154,000
	May-June	76,900	87,600	97,700	108,000	116,000
	July-September	98,300	115,000	128,000	141,000	153,000
5. Between Watana and Susitna Station						
	Annual	154,000	179,000	199,000	220,000	238,000
	May-June	119,000	136,000	151,000	167,000	180,000
	July-September	152,000	178,000	198,000	219,000	237,000

Table 4

OUTFLOWS AT WATANA RESERVOIR

Case	Stage	Flood Period	Starting Reservoir Elevation (ft)	Recurrence Interval, (Year) 2	5	10	25	50
				Flood Peaks, (cfs)				
1	I	Annual	1919.0	8,900	8,900	8,900	8,900	23,400
		May-June	1885.2	5,900	5,900	5,900	5,900	5,900
		July-September	1993.8	32,600	33,200	33,200	33,200	33,200
1	II	Annual	1922.2	2,490	2,490	2,490	23,400	23,400
		May-June	1882.2	3,440	3,440	3,440	3,440	3,440
		July-September	2000.0	32,600	34,400	34,400	34,400	34,400
1	III	Annual	2140.8	3,340	3,340	3,340	23,400	23,400
	(Early)	May-June	2122.2	4,130	4,130	4,130	4,130	4,130
		July-September	2185.0	31,900	33,900	33,900	33,900	33,900
	III	Annual	2103.7	5,400	5,400	5,400	5,400	5,400
	(Late)	May-June	2085.5	5,820	5,820	5,820	5,820	5,820
		July-September	2159.0	5,770	5,770	5,770	5,770	5,770
2	I	Annual	1919.0	8,900	8,900	8,900	8,900	8,900
		May-June	1885.2	5,900	5,900	5,900	5,900	5,900
		July-September	1993.8	31,100	33,200	33,200	33,200	33,200
2	II	Annual	1922.2	2,490	2,490	2,490	2,490	2,490
		May-June	1882.2	3,400	3,400	3,400	3,400	3,400
		July-September	2000.0	31,100	34,400	34,400	34,400	34,400
2	III	Annual	2140.8	3,340	3,340	3,340	3,340	3,340
	(Early)	May-June	2122.2	4,130	4,130	4,130	4,130	4,130
		July-September	2185.0	30,100	33,900	33,900	33,900	33,900
2	III	Annual	2103.7	5,400	5,400	5,400	5,400	5,400
	(Late)	May-June	2085.5	5,820	5,820	5,820	5,820	5,820
		July-September	2159.0	5,770	5,770	5,770	5,700	5,770

Table 5

FLOOD PEAK FREQUENCY DATA AT SUSITNA STATION
FOR NATURAL AND WITH-PROJECT CONDITIONS

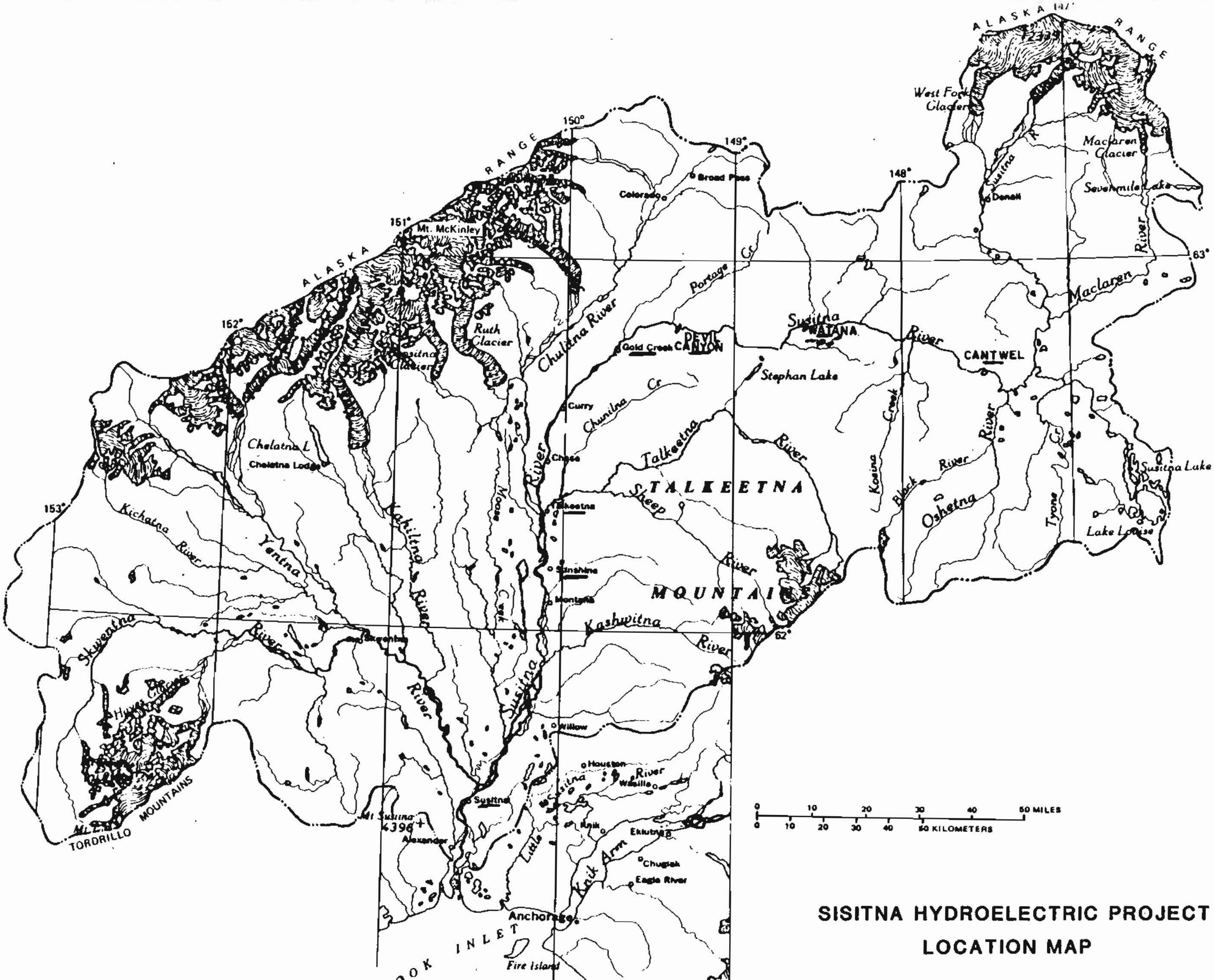
Flood Period	Recurrence Interval (Year)	Natural Flood Peak	Flood Peaks (cfs) With-Project			
			Stage I	Stage II	Stage III	
					Early	Late
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annual	2	189,000	163,000	156,000	157,000	159,000
	5	220,000	188,000	182,000	182,000	185,000
	10	242,000	208,000	201,000	202,000	204,000
	25	264,000	229,000	222,000	223,000	225,000
	50	283,000	247,000	240,000	241,000	243,000
May-June	2	156,000	125,000	122,000	123,000	125,000
	5	179,000	142,000	139,000	140,000	142,000
	10	197,000	157,000	154,000	155,000	157,000
	25	215,000	173,000	170,000	171,000	173,000
	50	230,000	186,000	183,000	184,000	186,000
July-September	2	183,000	183,000	183,000	182,000	158,000
	5	216,000	211,000	212,000	212,000	184,000
	10	238,000	231,000	232,000	232,000	204,000
	25	259,000	252,000	253,000	253,000	225,000
	50	278,000	270,000	271,000	271,000	243,000

Table 6

FLOOD PEAK FREQUENCY DATA AT SUNSHINE
FOR NATURAL AND WITH-PROJECT CONDITIONS

Flood Period	Recurrence Interval (Year)	Natural Flood Peak	Flood Peaks (cfs) With-Project			
			Stage I	Stage II	Stage III	
					Early	Late
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annual	2	143,000	109,000	102,000	103,000	105,000
	5	166,000	125,000	118,000	119,000	121,000
	10	183,000	137,000	130,000	131,000	133,000
	25	200,000	151,000	144,000	145,000	147,000
	50	214,000	163,000	156,000	157,000	159,000
May-June	2	118,000	82,800	80,300	81,000	82,700
	5	135,000	93,500	91,000	91,700	93,400
	10	149,000	104,000	101,000	102,000	104,000
	25	163,000	114,000	111,000	112,000	114,000
	50	174,000	122,000	119,000	120,000	122,000
July-September	2	138,000	129,000	129,000	128,000	104,000
	5	163,000	148,000	149,000	149,000	121,000
	10	180,000	161,000	162,000	162,000	134,000
	25	196,000	174,000	175,000	175,000	147,000
	50	210,000	186,000	187,000	187,000	159,000

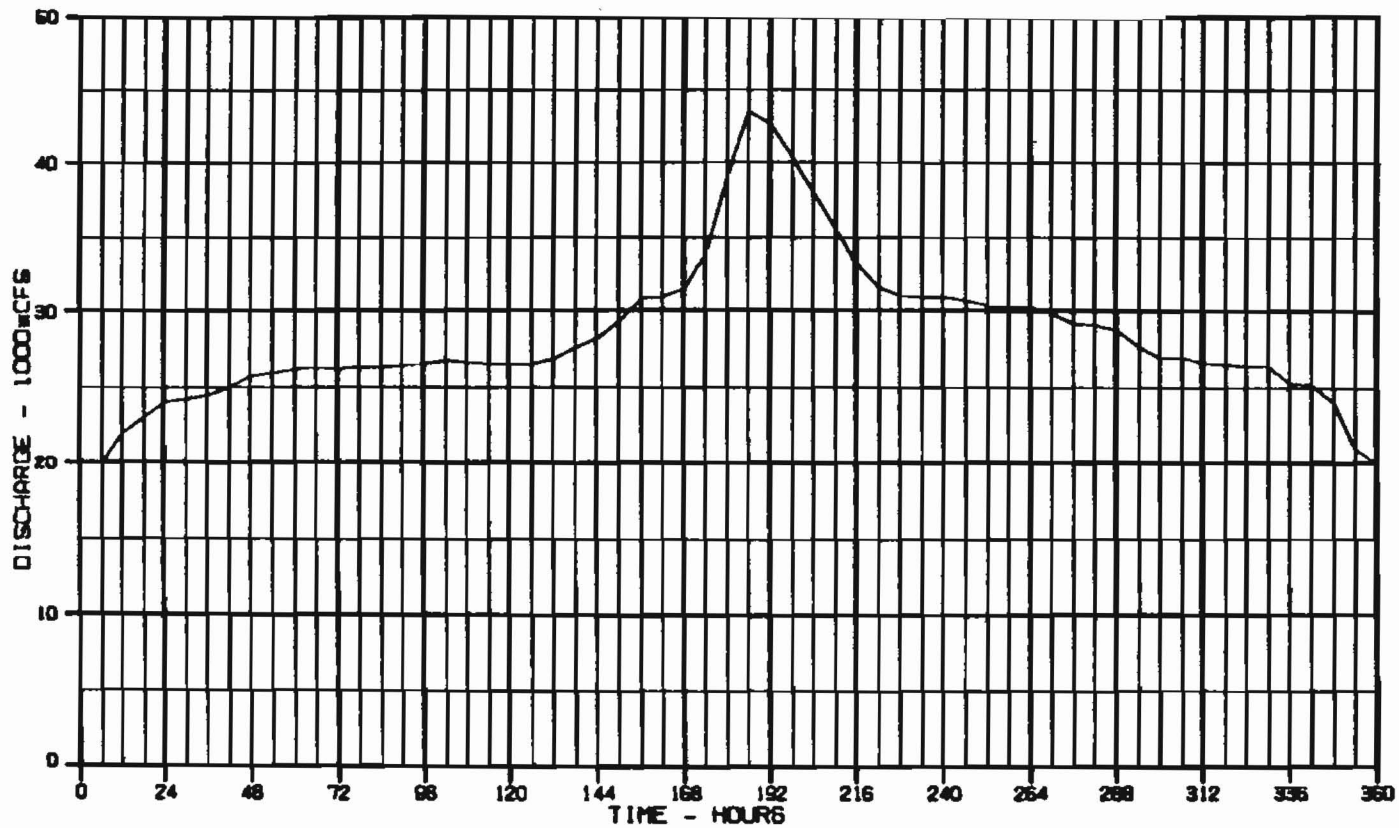
EXHIBITS



SISITNA HYDROELECTRIC PROJECT
LOCATION MAP

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 1



PEAK = 43600 CFS. 16-DAY VOLUME = 0.86*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

SUSITNA PROJECT | HYDROLOGY

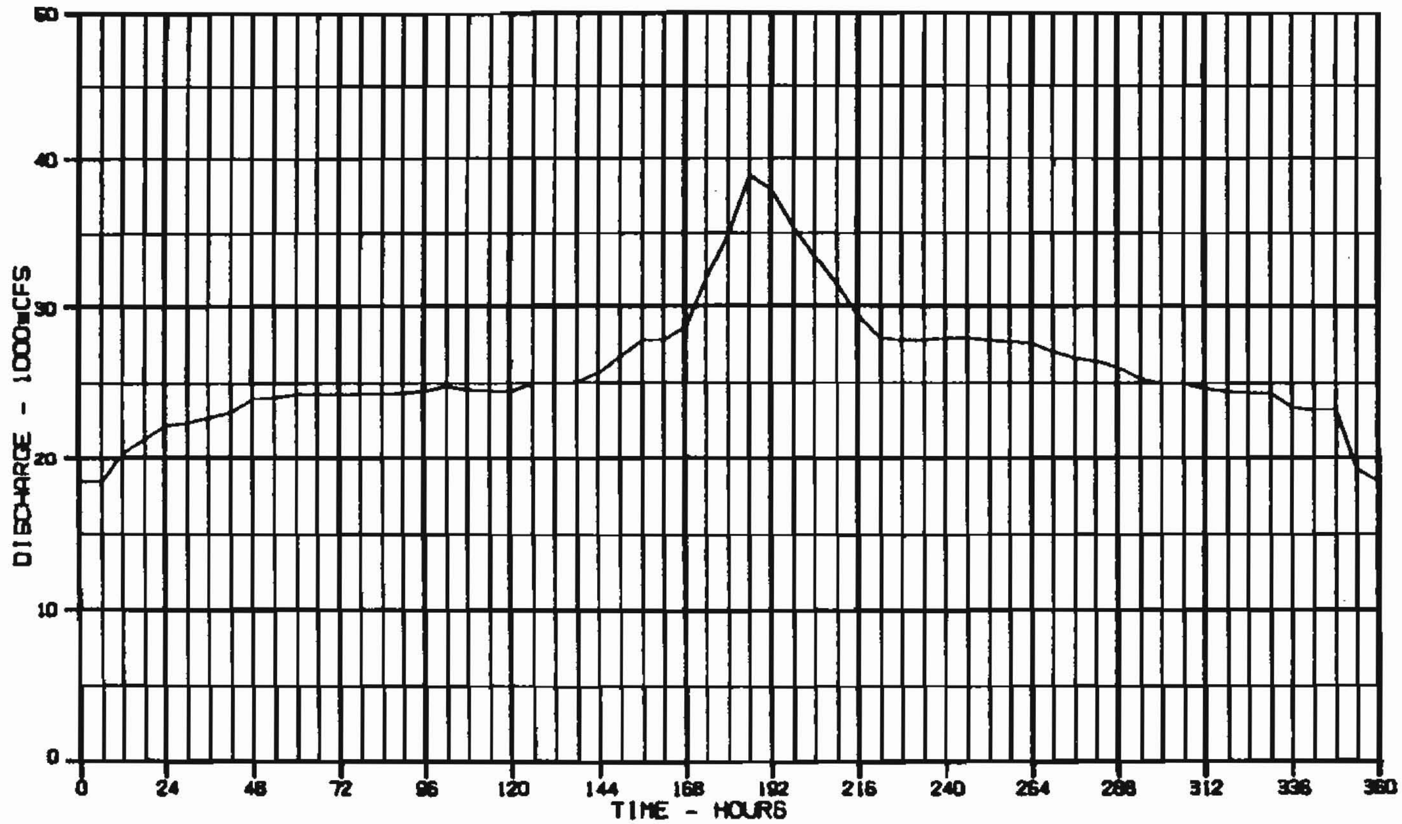
2-YEAR ANNUAL
MAXIMUM FLOOD HYDROGRAPH
AT WATANA

HARZA-EBASCO JOINT VENTURE

42-010-21

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 2
SHEET 1 OF 3



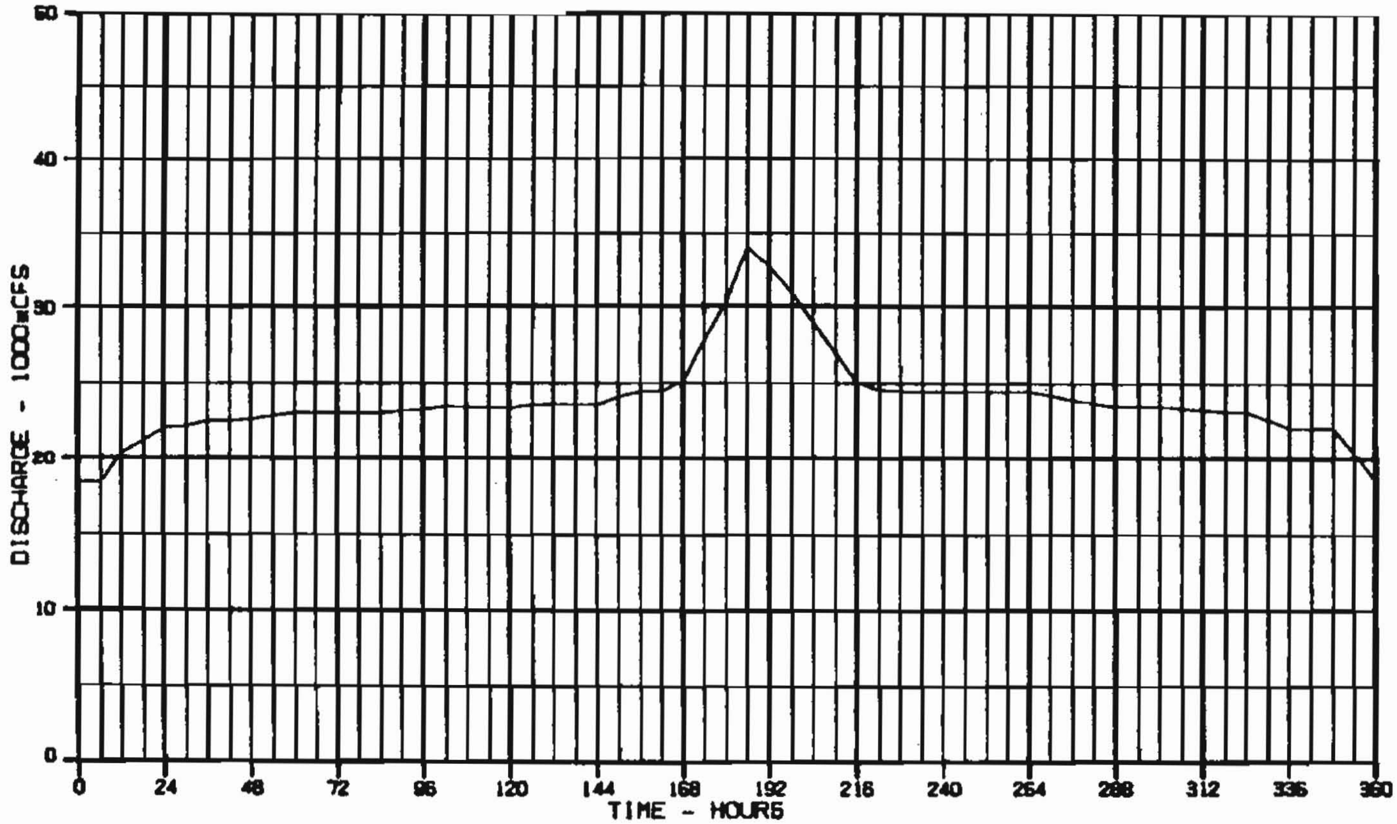
PEAK = 39000 CFS. 15-DAY VOLUME = 0.78*10**6 ACRE-FEET

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	HYDROLOGY
2-YEAR MAY-JUNE MAXIMUM FLOOD HYDROGRAPH AT WATANA	
HARZA-EBASCO JOINT VENTURE	
42-010-21	

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 2

SHEET 2 OF 3



PEAK = 34200 CFS. 16-DAY VOLUME = 0.71*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

SUSITNA PROJECT | HYDROLOGY

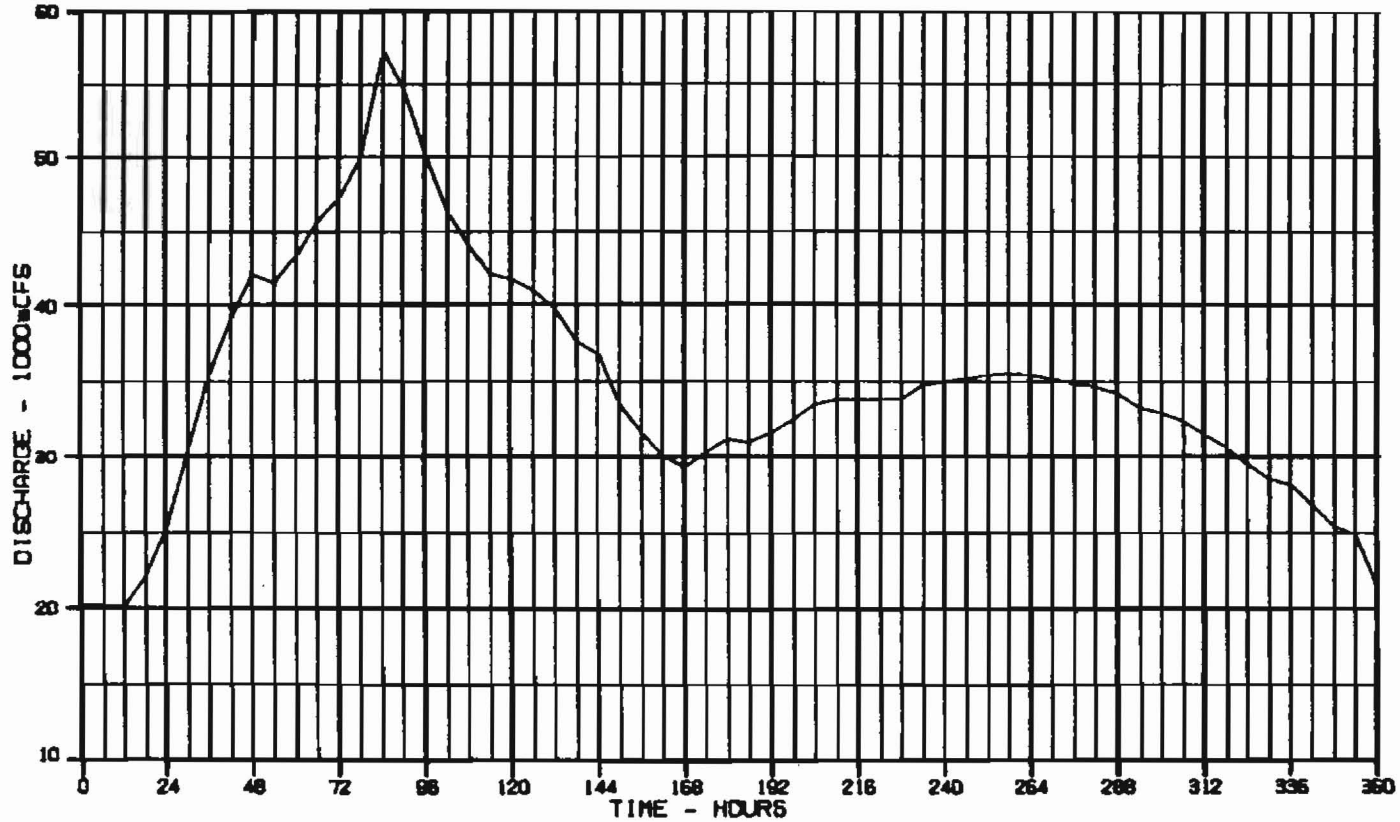
2-YEAR JULY-SEPTEMBER
MAXIMUM FLOOD HYDROGRAPH
AT WATANA

HARZA-EBASCO JOINT VENTURE

42-010-21

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 2
SHEET 3 OF 3

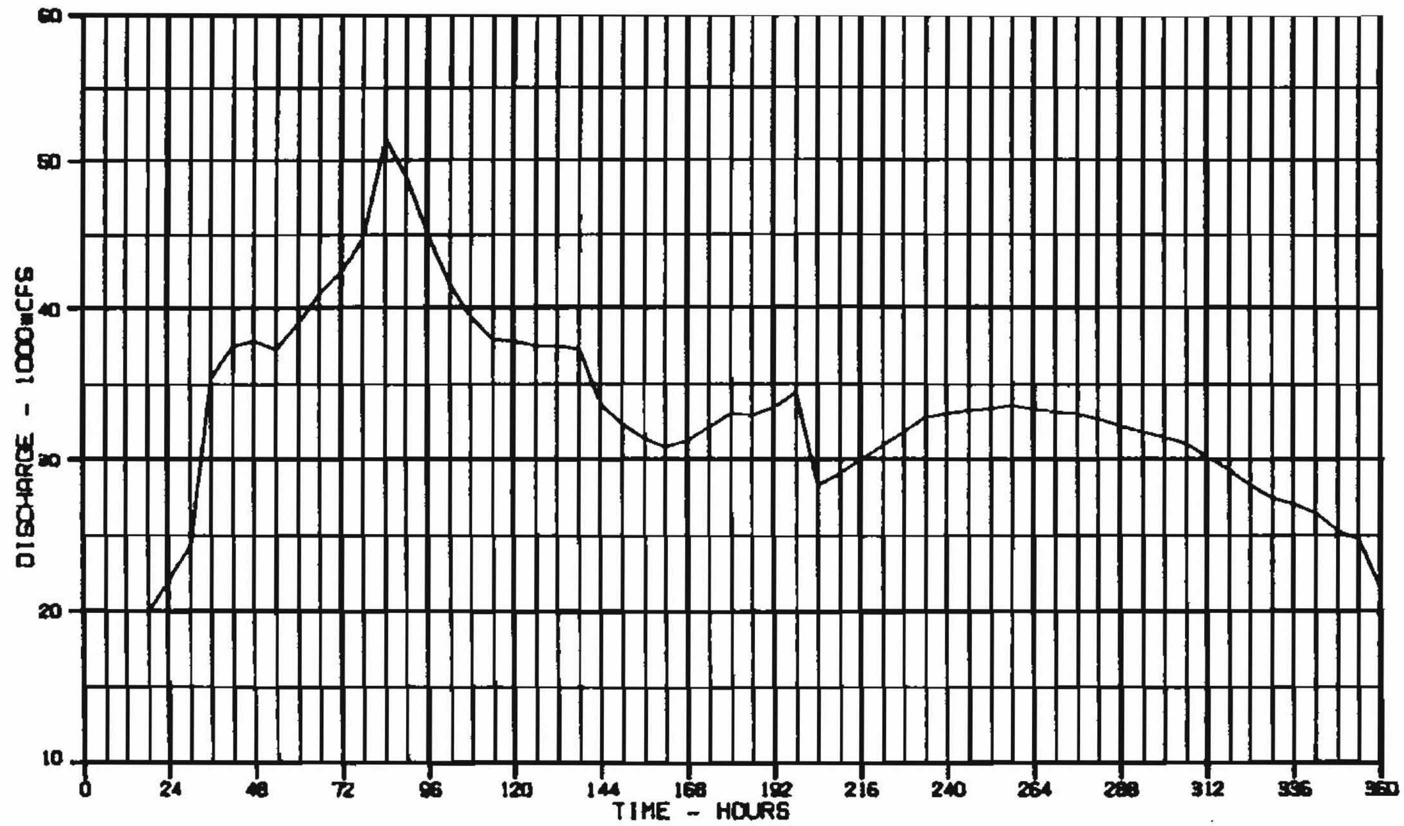


PEAK = 57400 CFS. 16-DAY VOLUME = 1.04*10**6 ACRE-FEET

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	HYDROLOGY	
5-YEAR ANNUAL MAXIMUM FLOOD HYDROGRAPH AT WATANA		
HARZA-EBASCO JOINT VENTURE		
[illegible]	[illegible]	42-010-21

EXHIBIT 3
SHEET 1 OF 3

HARZA-EBASCO SUSITNA JOINT VENTURE



PEAK = 51600 CFS. 15-DAY VOLUME = 0.98*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

SUSITNA PROJECT | HYDROLOGY

5-YEAR MAY-JUNE MAXIMUM FLOOD HYDROGRAPH AT WATANA

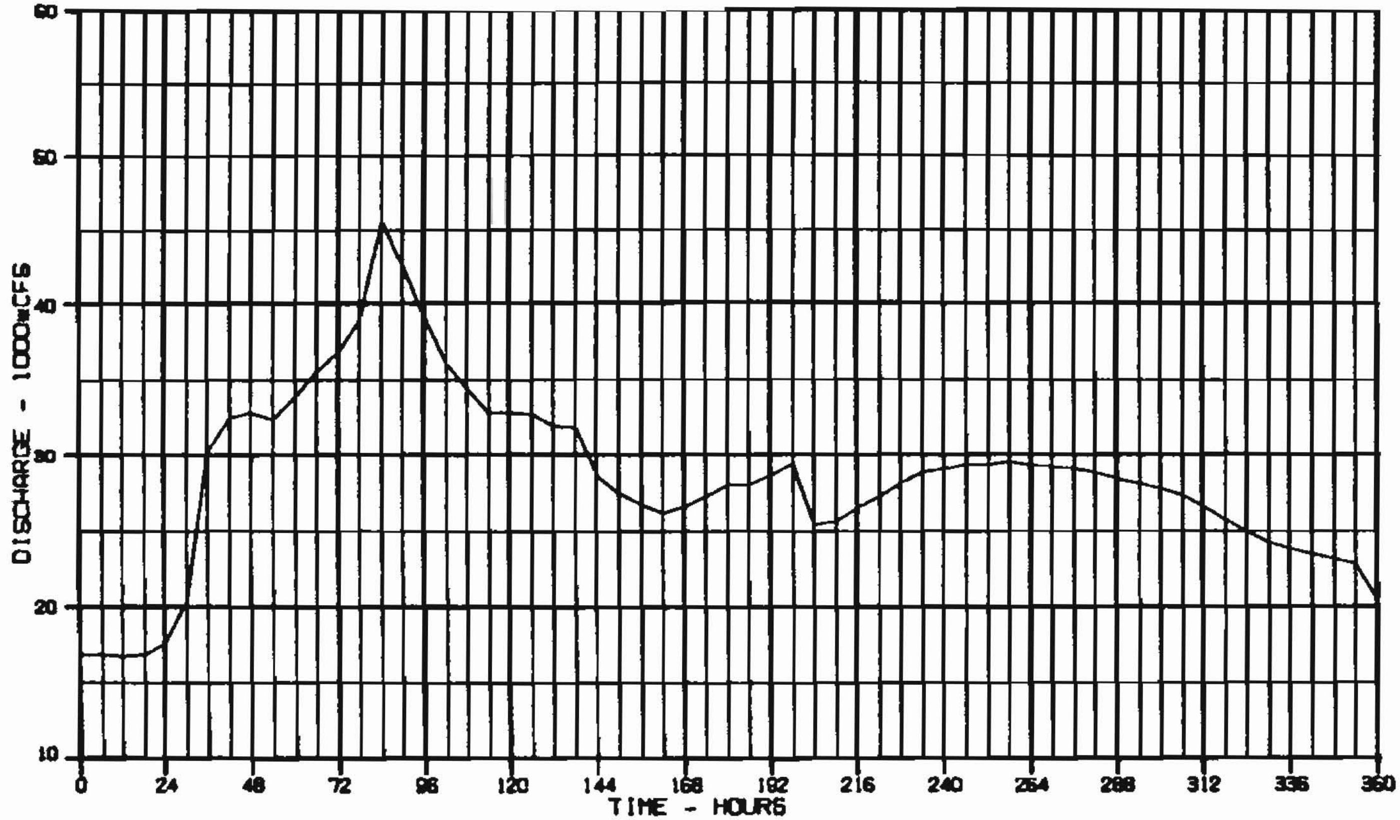
HARZA-EBASCO JOINT VENTURE

42-010-21

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 3

SHEET 2 OF 3



PEAK = 45700 CFS. 15-DAY VOLUME = 0.85*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

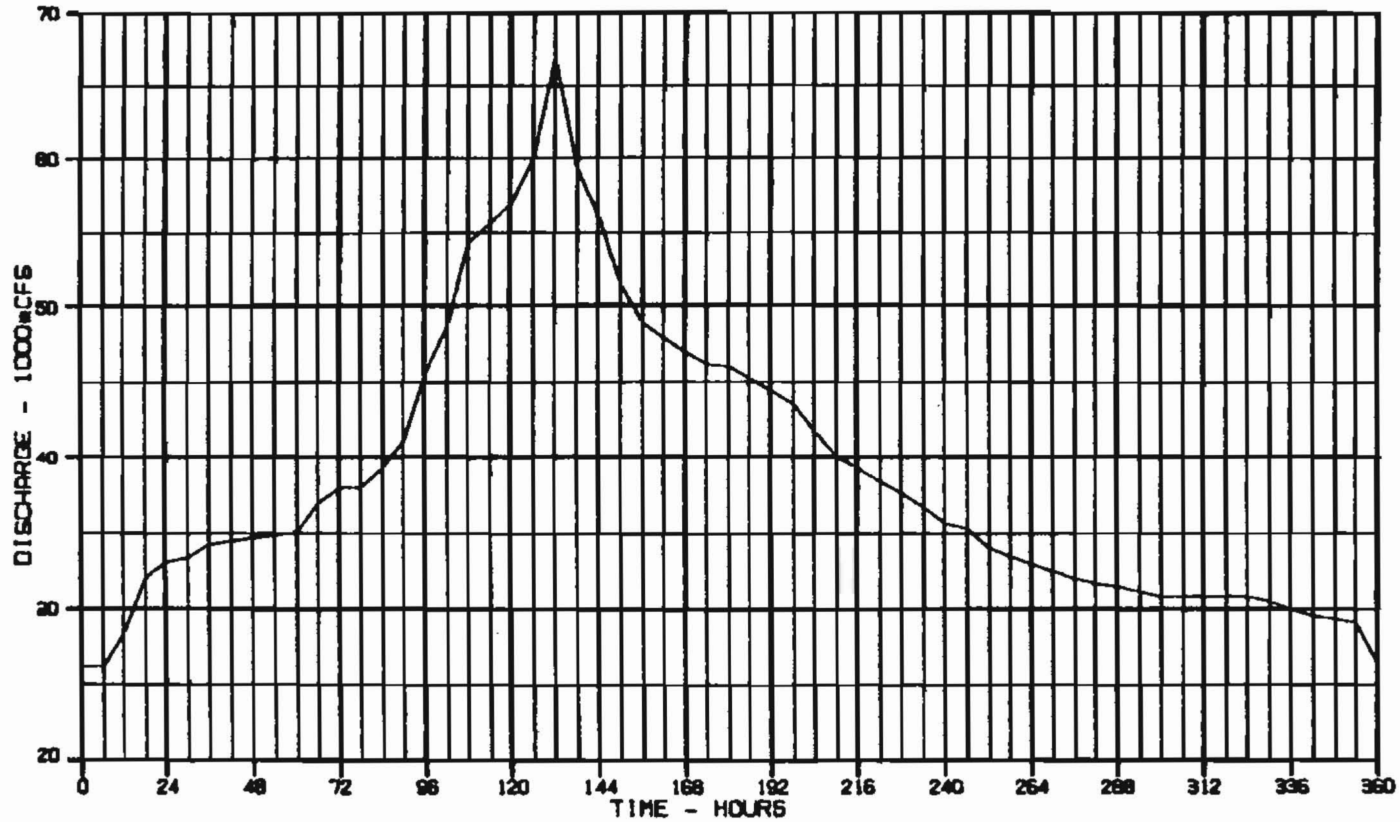
SUSITNA PROJECT | HYDROLOGY

5-YEAR JULY-SEPTEMBER
MAXIMUM FLOOD HYDROGRAPH
AT WATANA

HARZA-EBASCO JOINT VENTURE

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 3
SHEET 3 OF 3



PEAK = 67000 CFS. 16-DAY VOLUME = 1.16*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

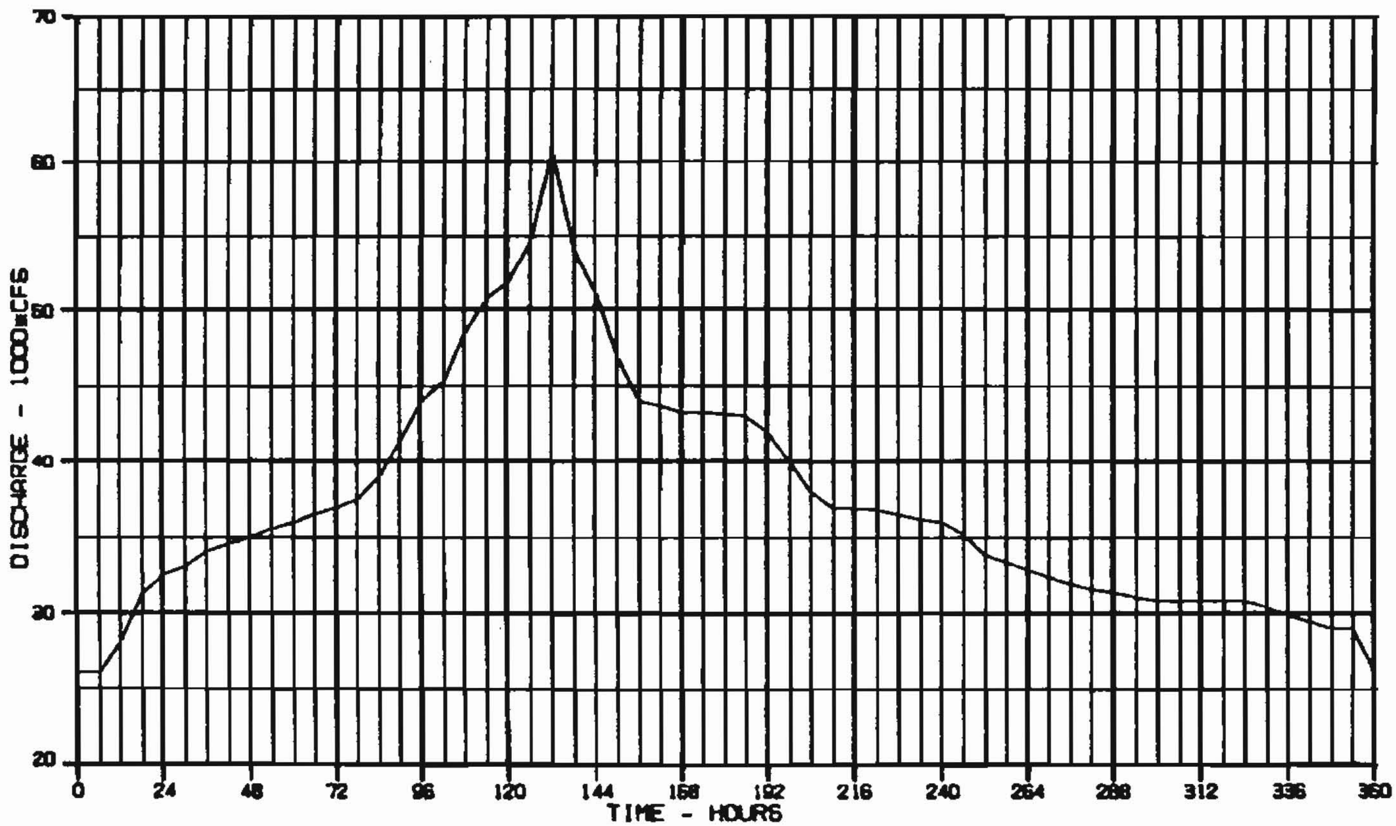
SUSITNA PROJECT | HYDROLOGY

10-YEAR ANNUAL
MAXIMUM FLOOD HYDROGRAPH
AT WATANA

HARZA-EBASCO JOINT VENTURE

EXHIBIT 4
SHEET 1 OF 3

HARZA-EBASCO SUSITNA JOINT VENTURE

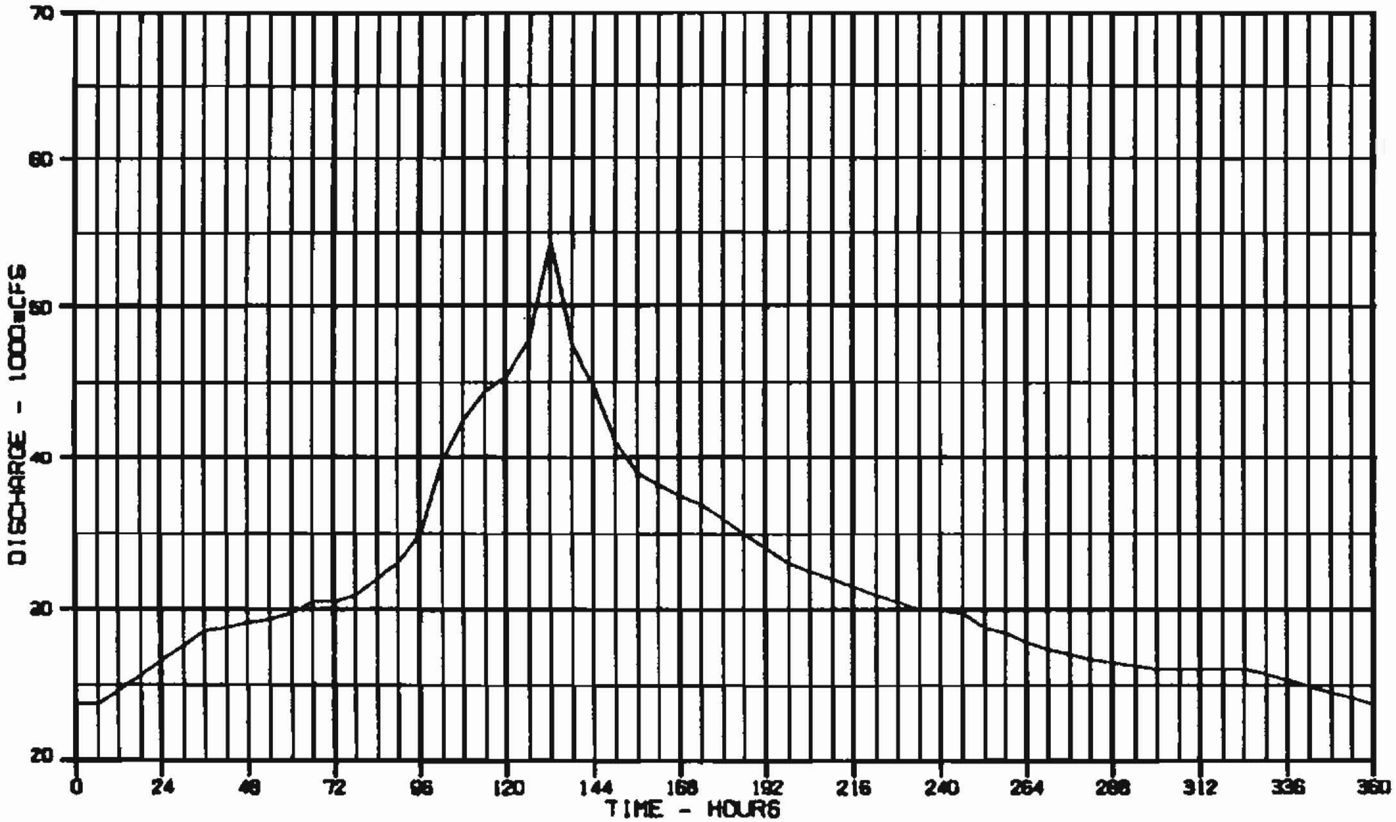


PEAK = 60800 CFS. 15-DAY VOLUME = 1.11*10**6 ACRE-FEET

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	HYDROLOGY
10-YEAR MAY-JUNE MAXIMUM FLOOD HYDROGRAPH AT WATANA	
HARZA-EBASCO JOINT VENTURE	
42-010-21	

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 4
SHEET 2 OF 3



PEAK = 54600 CFS. 15-DAY VOLUME = 0.95*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

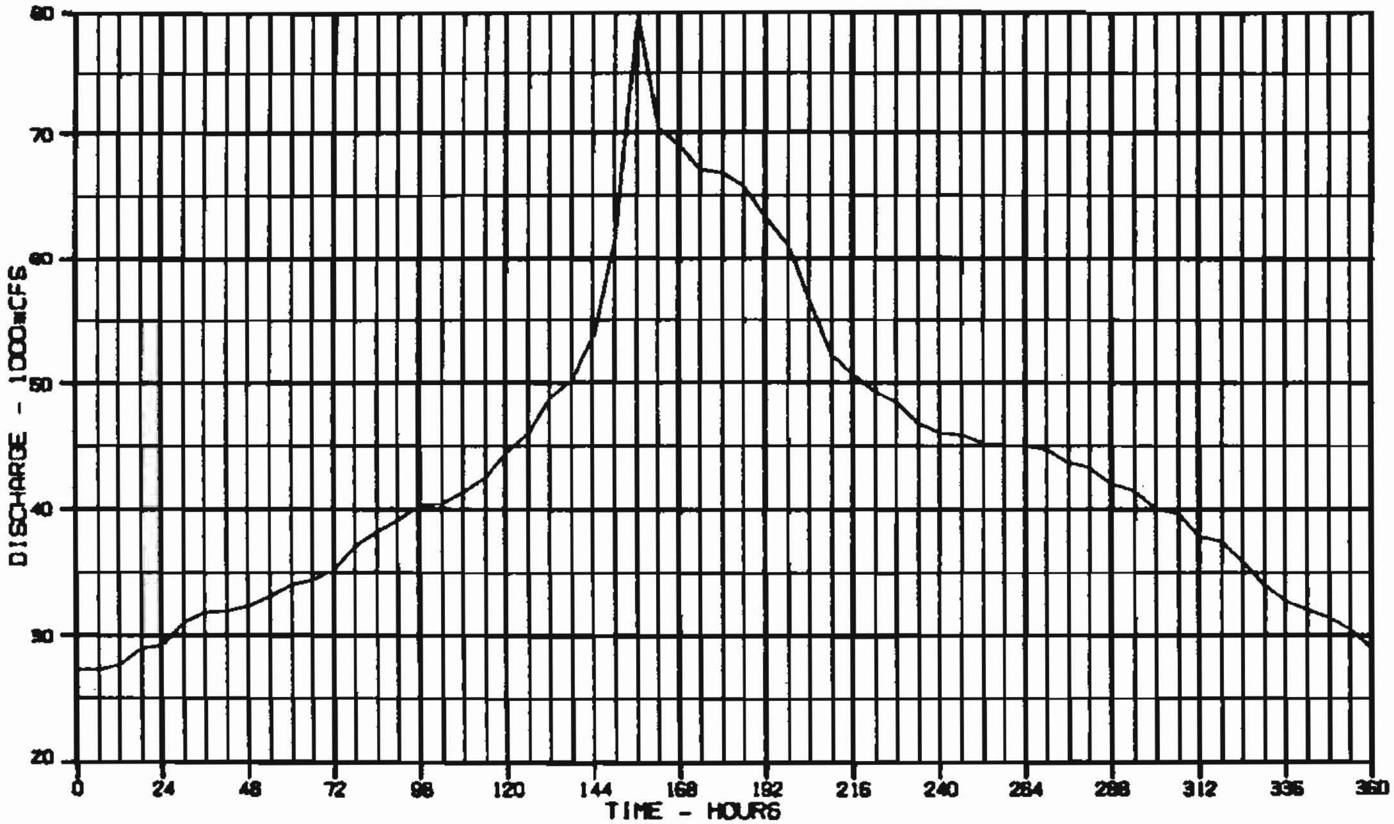
SUSITNA PROJECT | HYDROLOGY

10-YEAR JULY-SEPTEMBER MAXIMUM FLOOD HYDROGRAPH AT WATANA

HARZA-EBASCO JOINT VENTURE

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 4
SHEET 3 OF 3

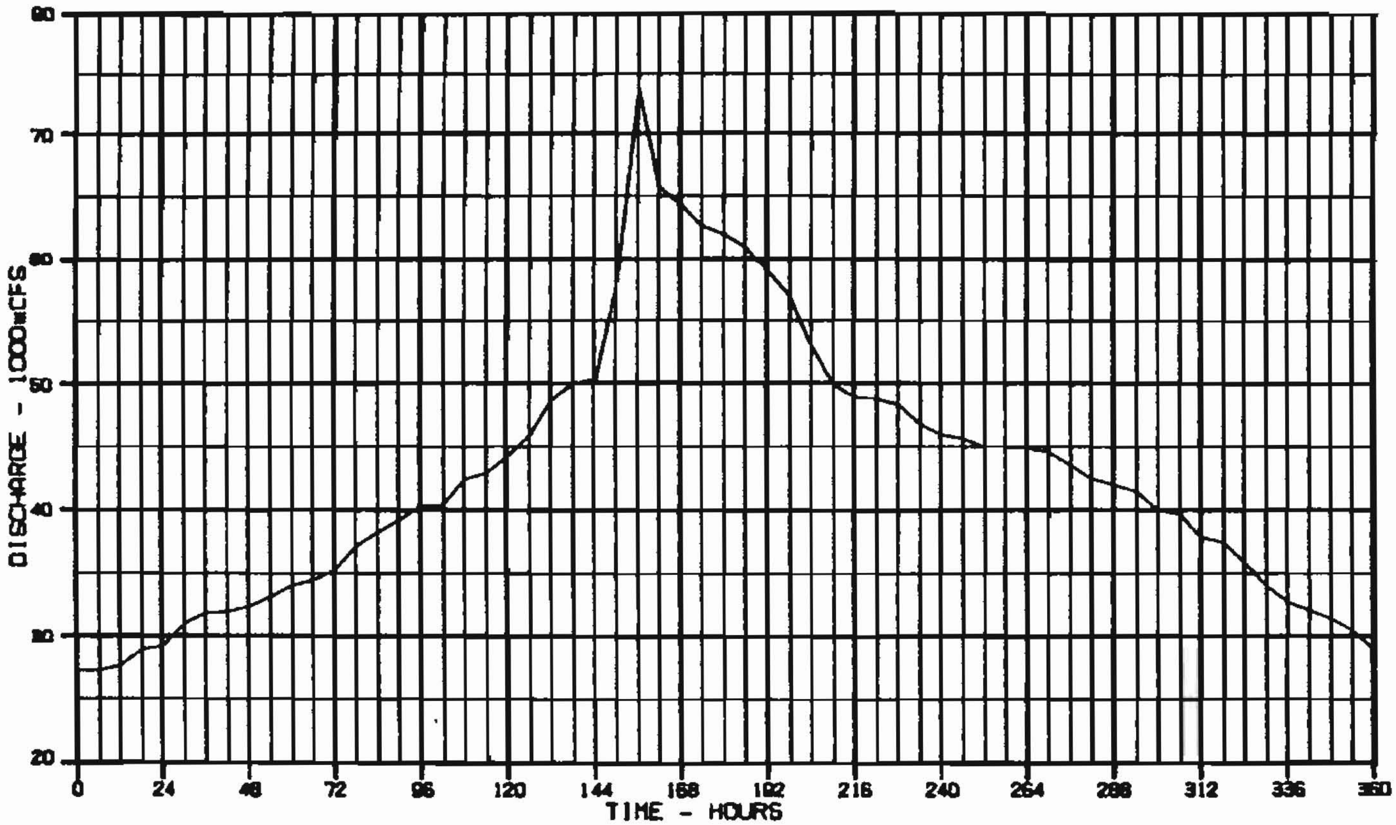


PEAK = 79800 CFS. 16-DAY VOLUME = 1.31*10**6 ACRE-FEET

HARZA-EBASCO SUSITNA JOINT VENTURE

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	HYDROLOGY
25-YEAR ANNUAL MAXIMUM FLOOD HYDROGRAPH AT WATANA	
HARZA-EBASCO JOINT VENTURE	

EXHIBIT 5
SHEET 1 OF 3

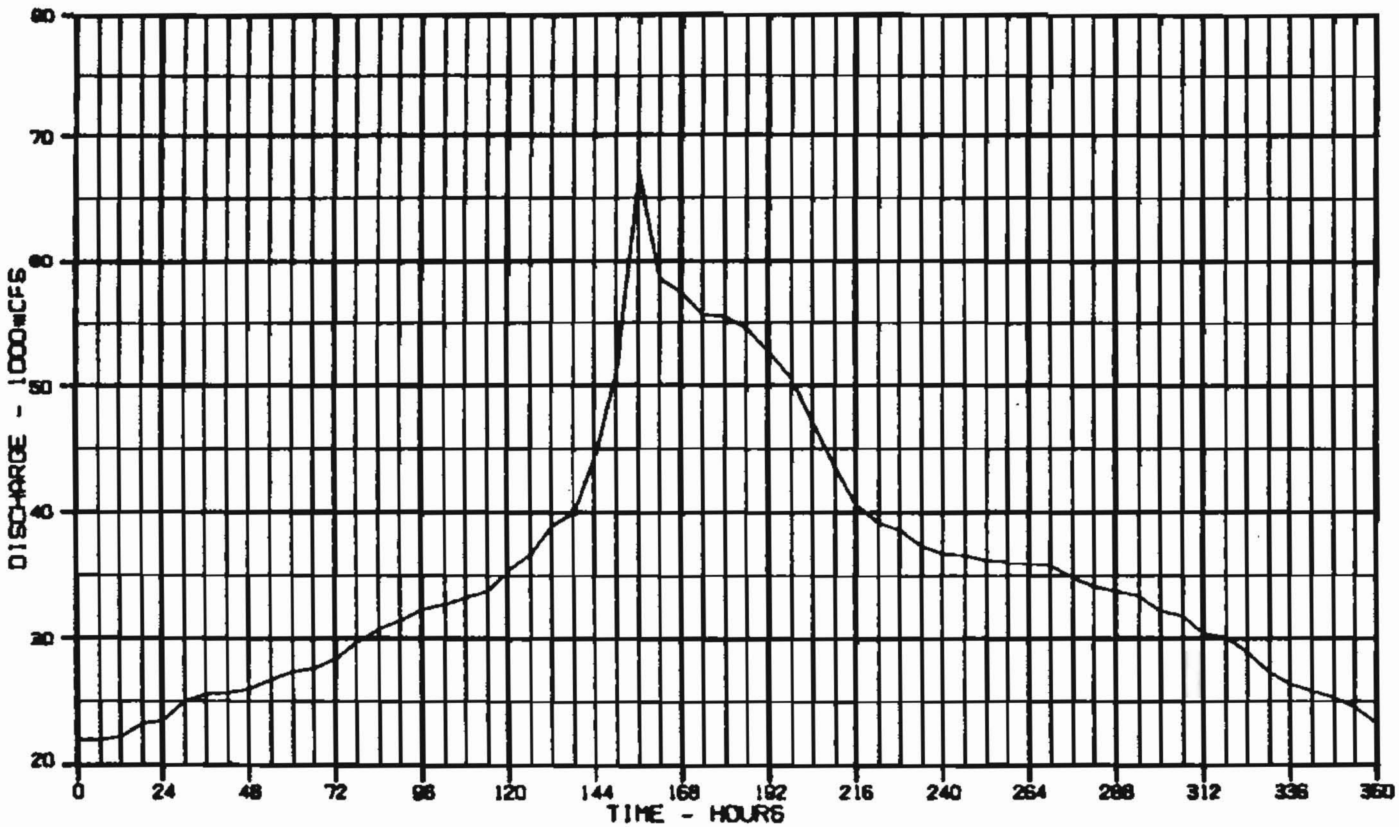


PEAK = 73800 CFS. 15-DAY VOLUME = 1.28*10**6 ACRE-FEET

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	HYDROLOGY
25-YEAR MAY-JUNE MAXIMUM FLOOD HYDROGRAPH AT WATANA	
HARZA-EBASCO JOINT VENTURE	
	42-010-21

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 5
SHEET 2 OF 3



PEAK = 67200 CFS. 15-DAY VOLUME = 1.06*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

SUSITNA PROJECT | HYDROLOGY

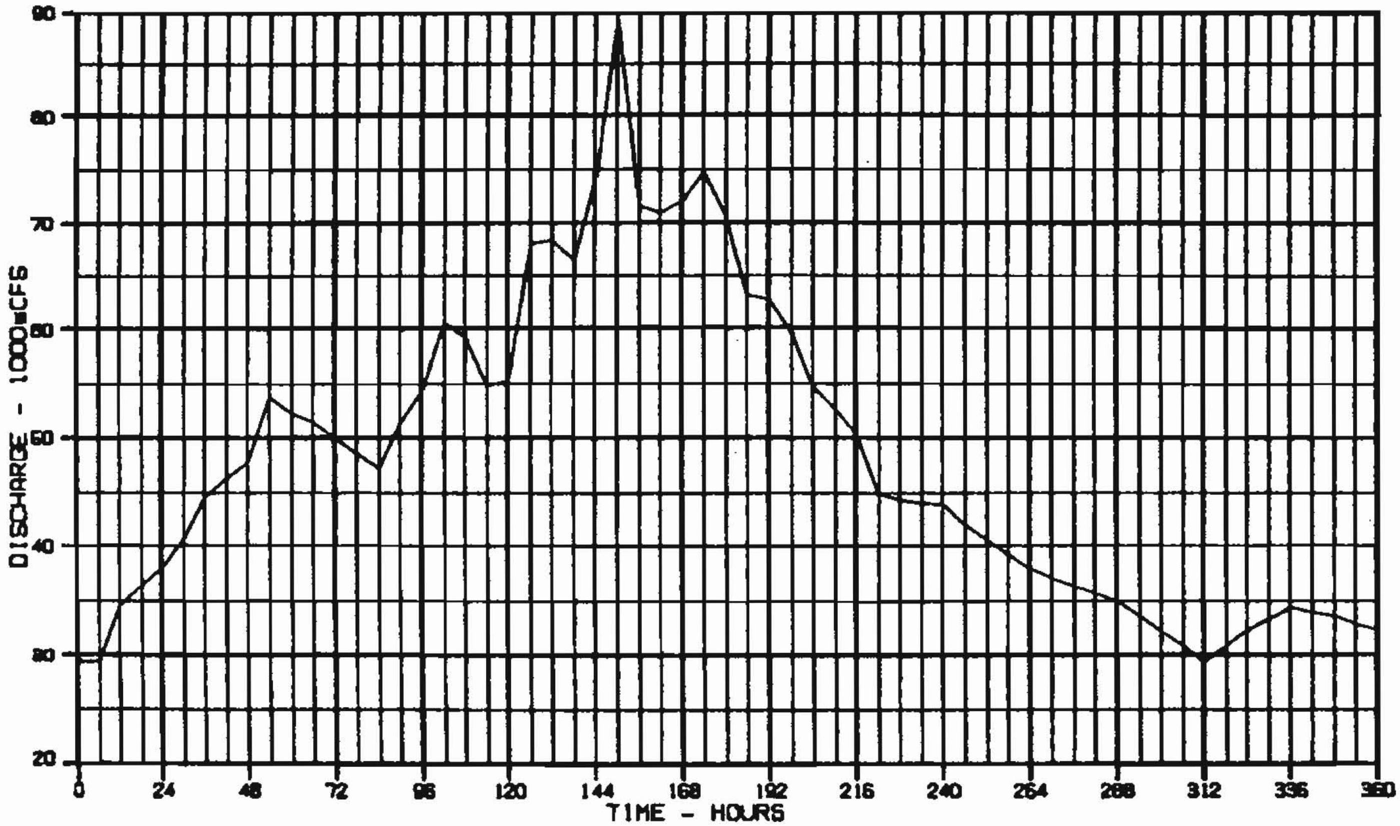
25-YEAR JULY-SEPTEMBER MAXIMUM FLOOD HYDROGRAPH AT WATANA

HARZA-EBASCO JOINT VENTURE

42-010-21

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 5
SHEET 3 OF 3

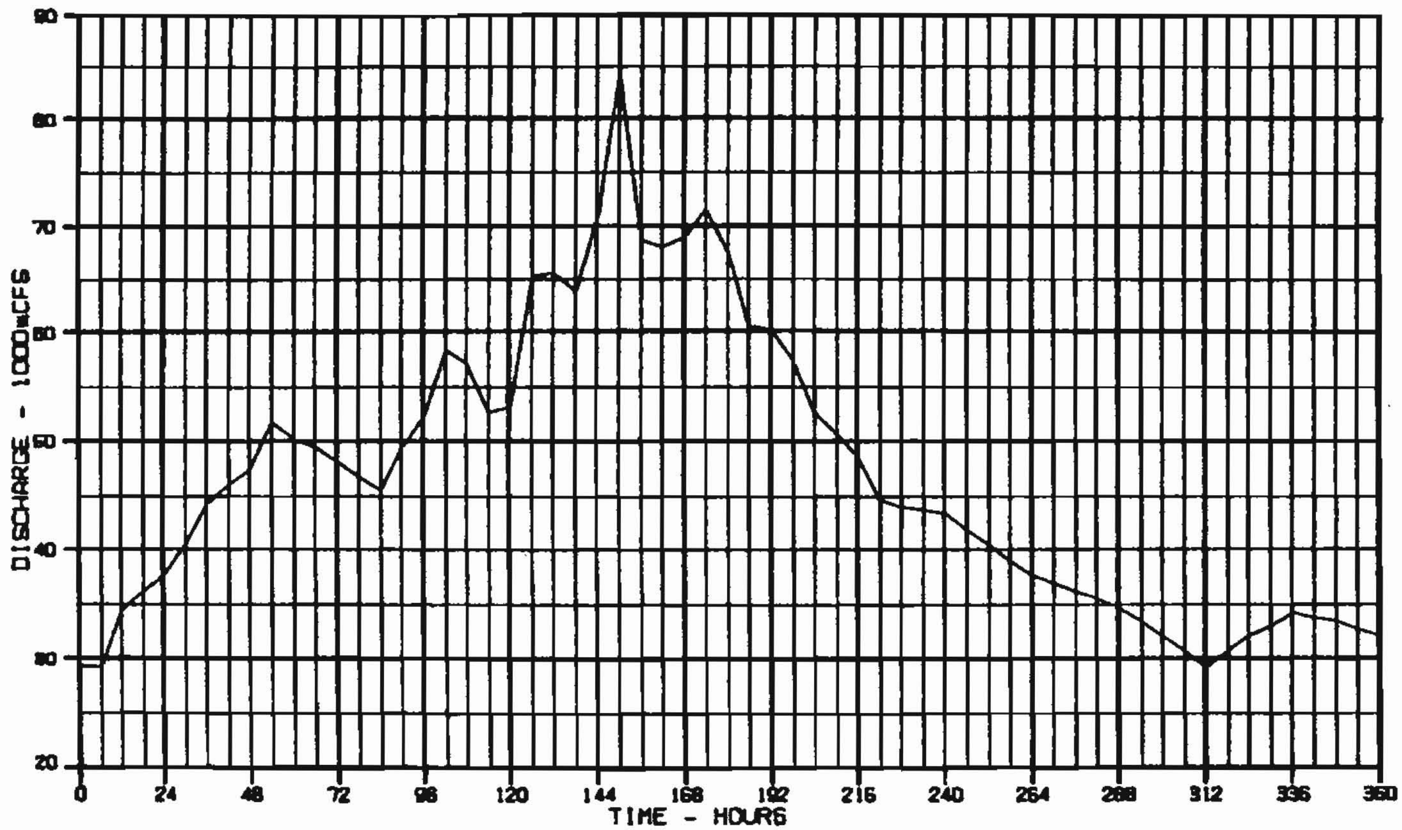


PEAK = 89600 CFS. 15-DAY VOLUME = 1.43*10**6 ACRE-FEET

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	HYDROLOGY
50-YEAR ANNUAL MAXIMUM FLOOD HYDROGRAPH AT WATANA	
HARZA-EBASCO JOINT VENTURE	
[illegible]	42-010-21

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 6
SHEET 1 OF 3



PEAK = 84400 CFS. 15-DAY VOLUME = 1.40*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

SUSITNA PROJECT | HYDROLOGY

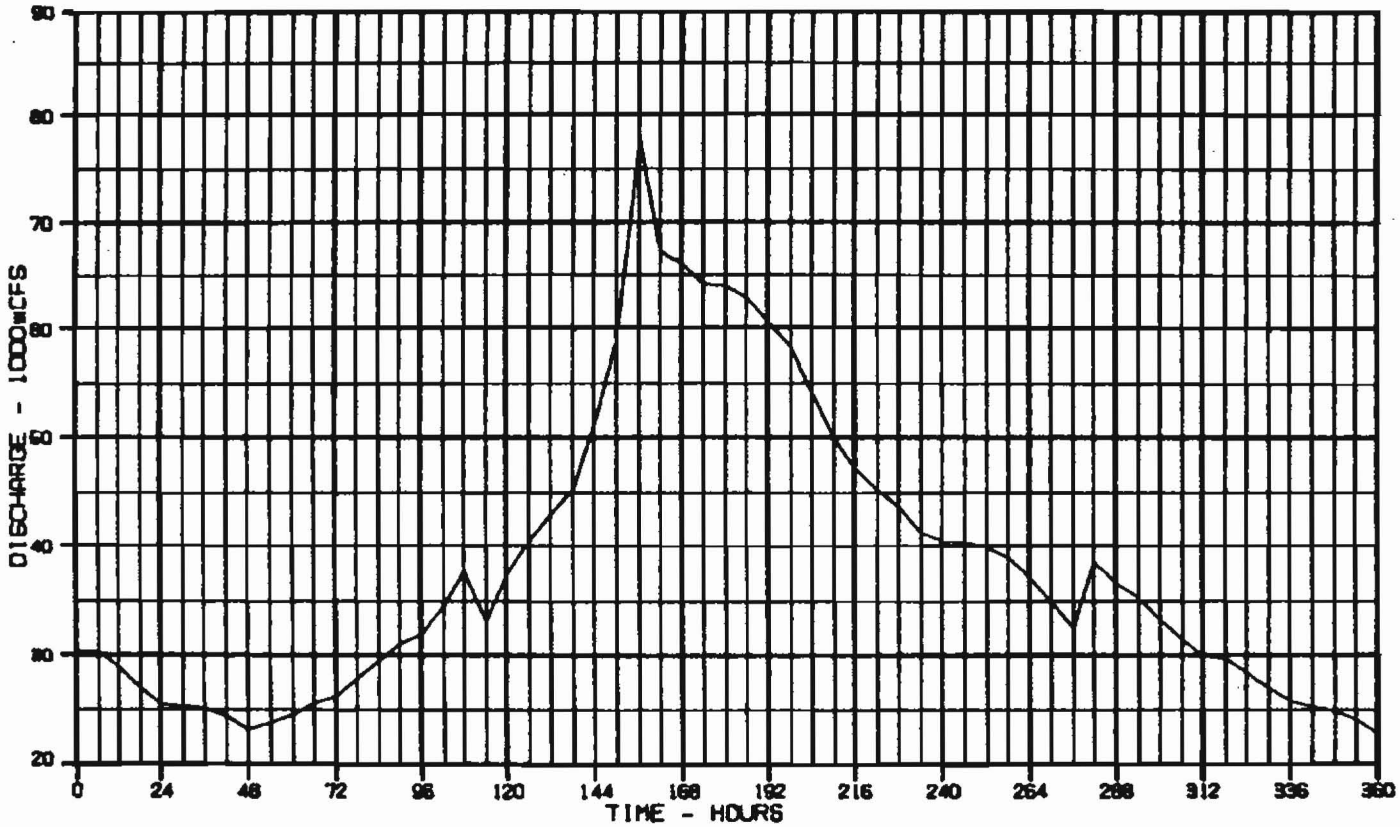
50-YEAR MAY-JUNE MAXIMUM FLOOD HYDROGRAPH AT WATANA

HARZA-EBASCO JOINT VENTURE

4E-010-21

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 6
SHEET 2 OF 3



PEAK = 77800 CFS. 15-DAY VOLUME = 1.14*10**6 ACRE-FEET

ALASKA POWER AUTHORITY

SUSITNA PROJECT | HYDROLOGY

50-YEAR JULY-SEPTEMBER MAXIMUM FLOOD HYDROGRAPH AT WATANA

HARZA-EBASCO JOINT VENTURE

42-010-21

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 6
SHEET 3 OF 3

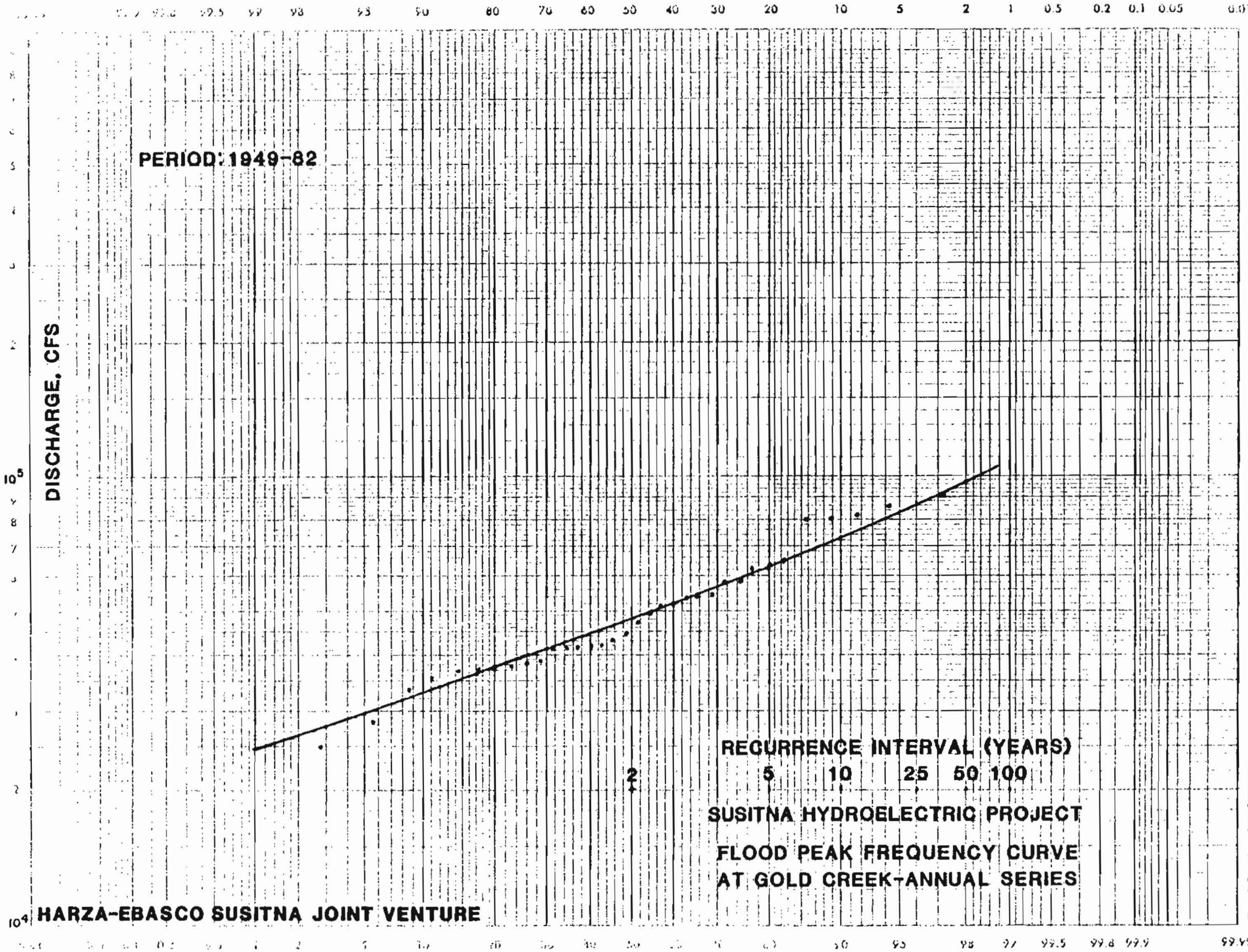


EXHIBIT 7
SHEET 1 OF 3

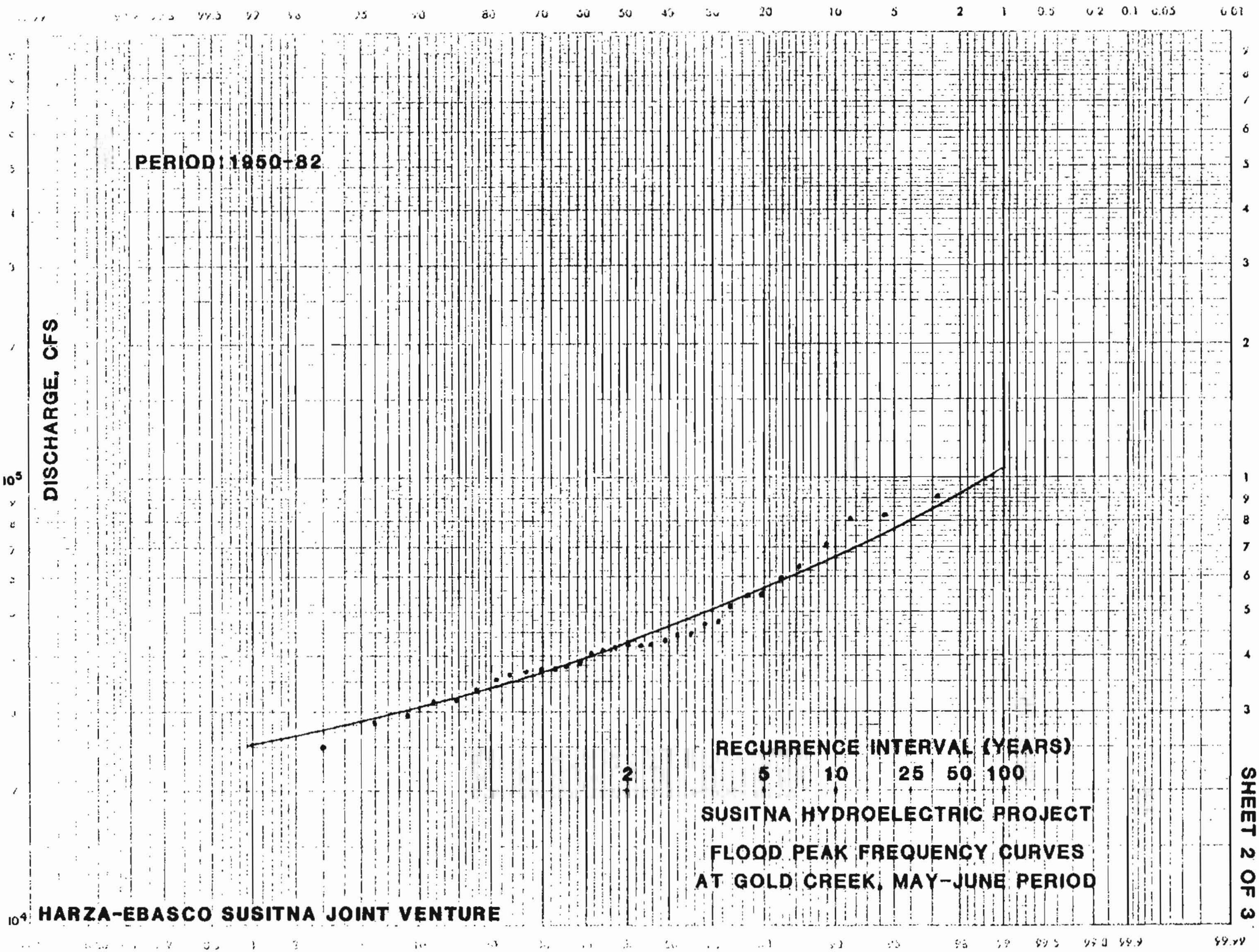
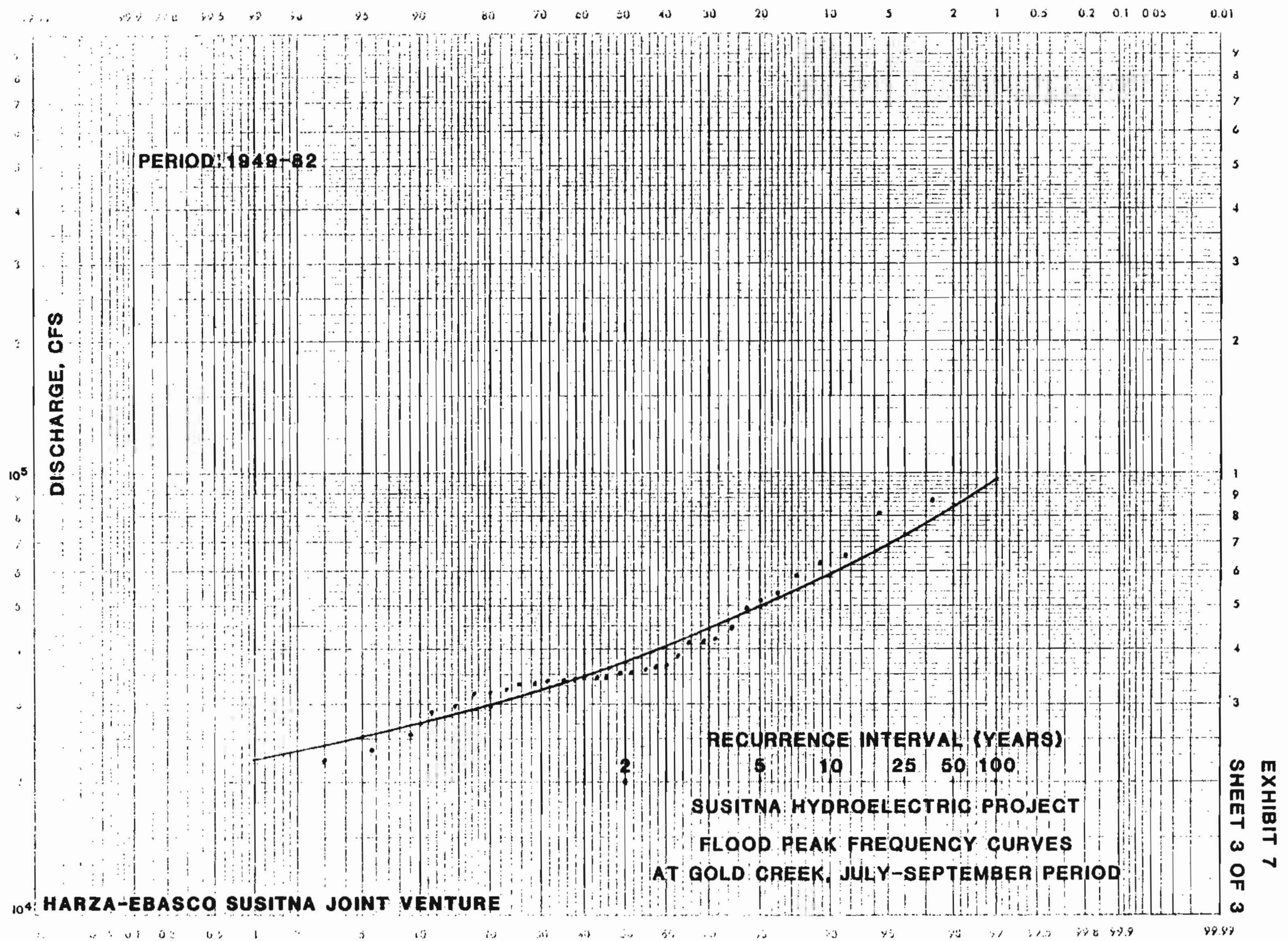


EXHIBIT 7
SHEET 2 OF 3


PERIOD: 1949-82
DISCHARGE, CFS
RECURRENCE INTERVAL (YEARS)
2
5
10
25
50
100
SUSITNA HYDROELECTRIC PROJECT
FLOOD PEAK FREQUENCY CURVES
AT GOLD CREEK, JULY-SEPTEMBER PERIOD
HARZA-EBASCO SUSITNA JOINT VENTURE
EXHIBIT 7
SHEET 3 OF 3

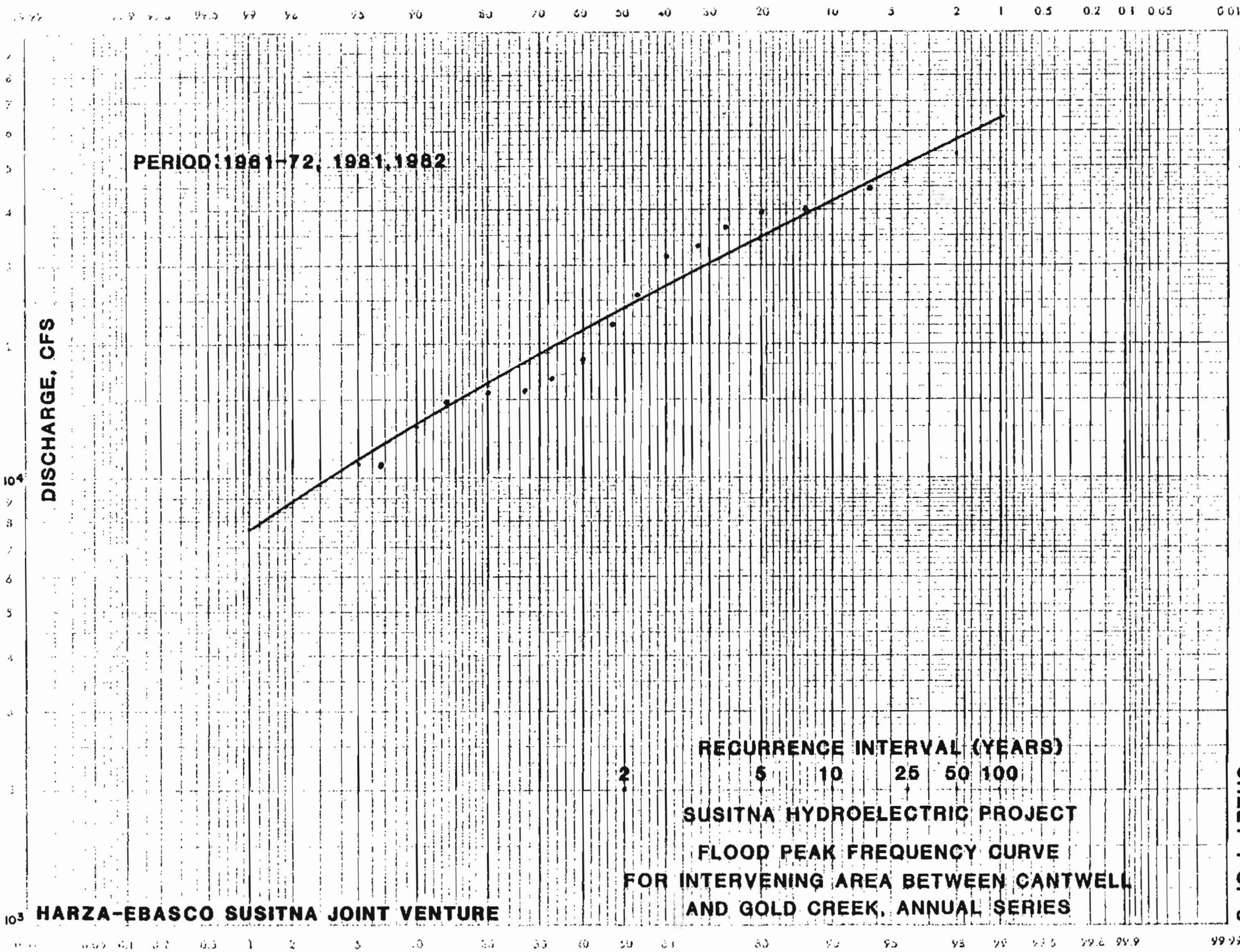


EXHIBIT 8
SHEET 1 OF 3

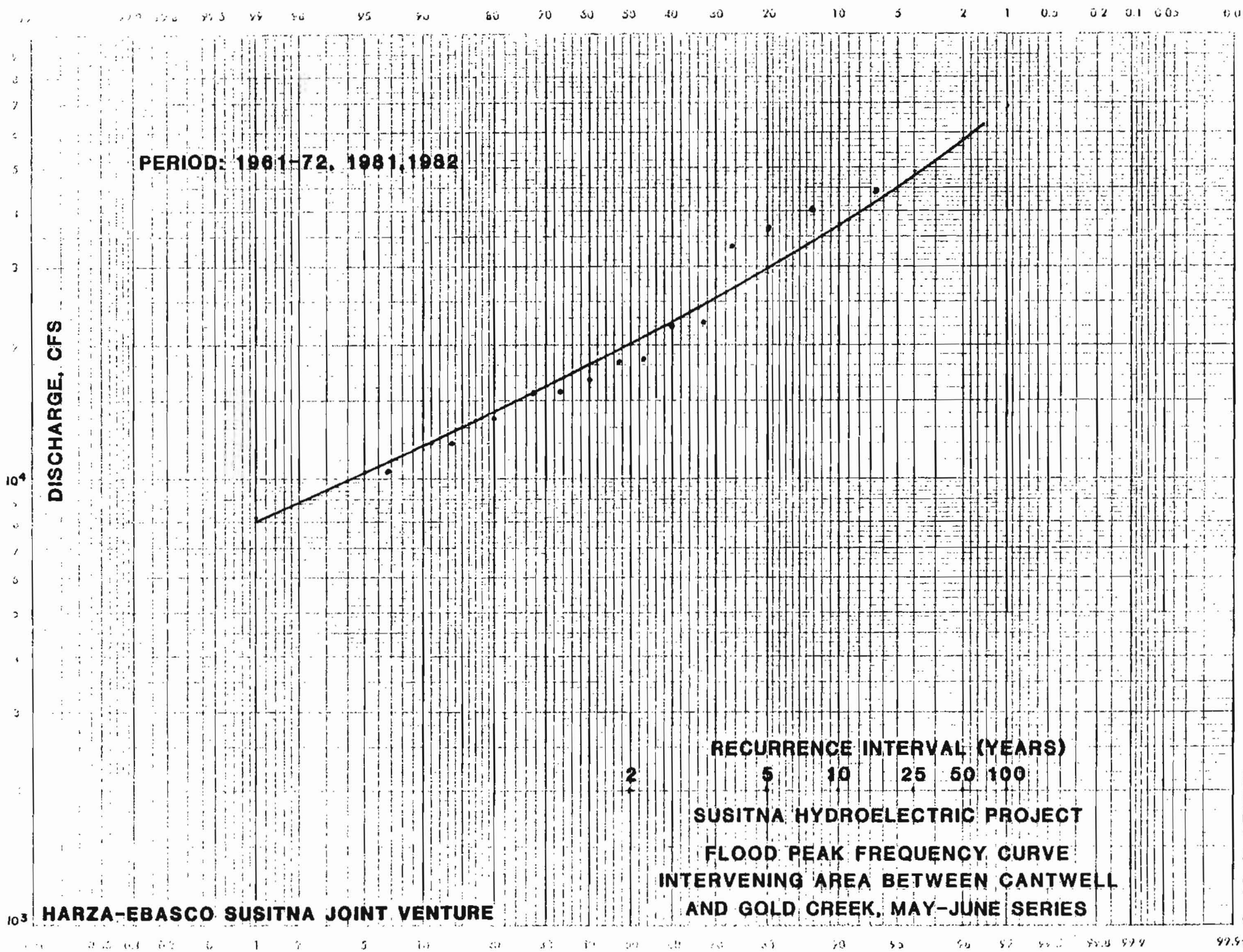


EXHIBIT 8

SHEET 2 OF 3

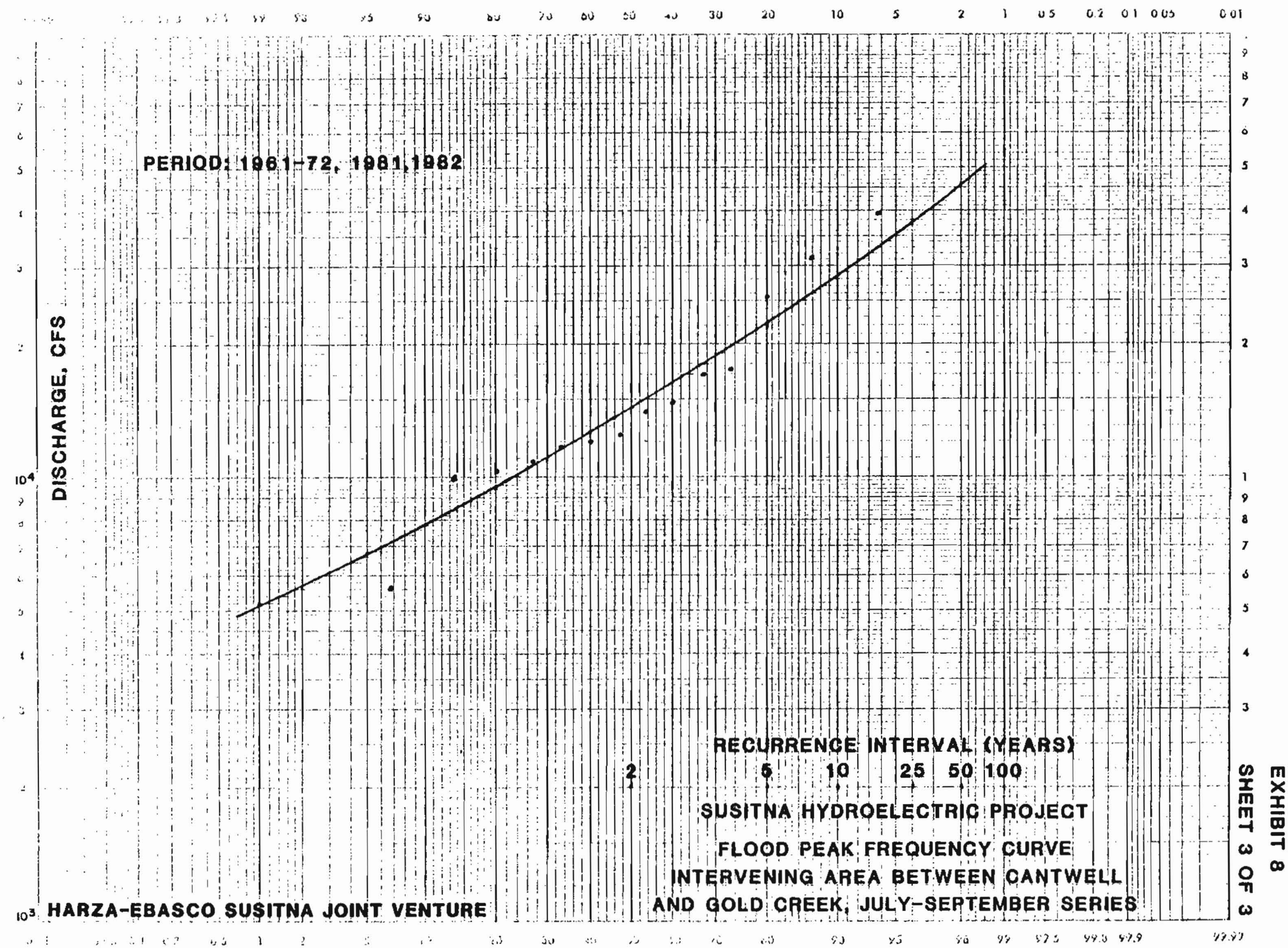
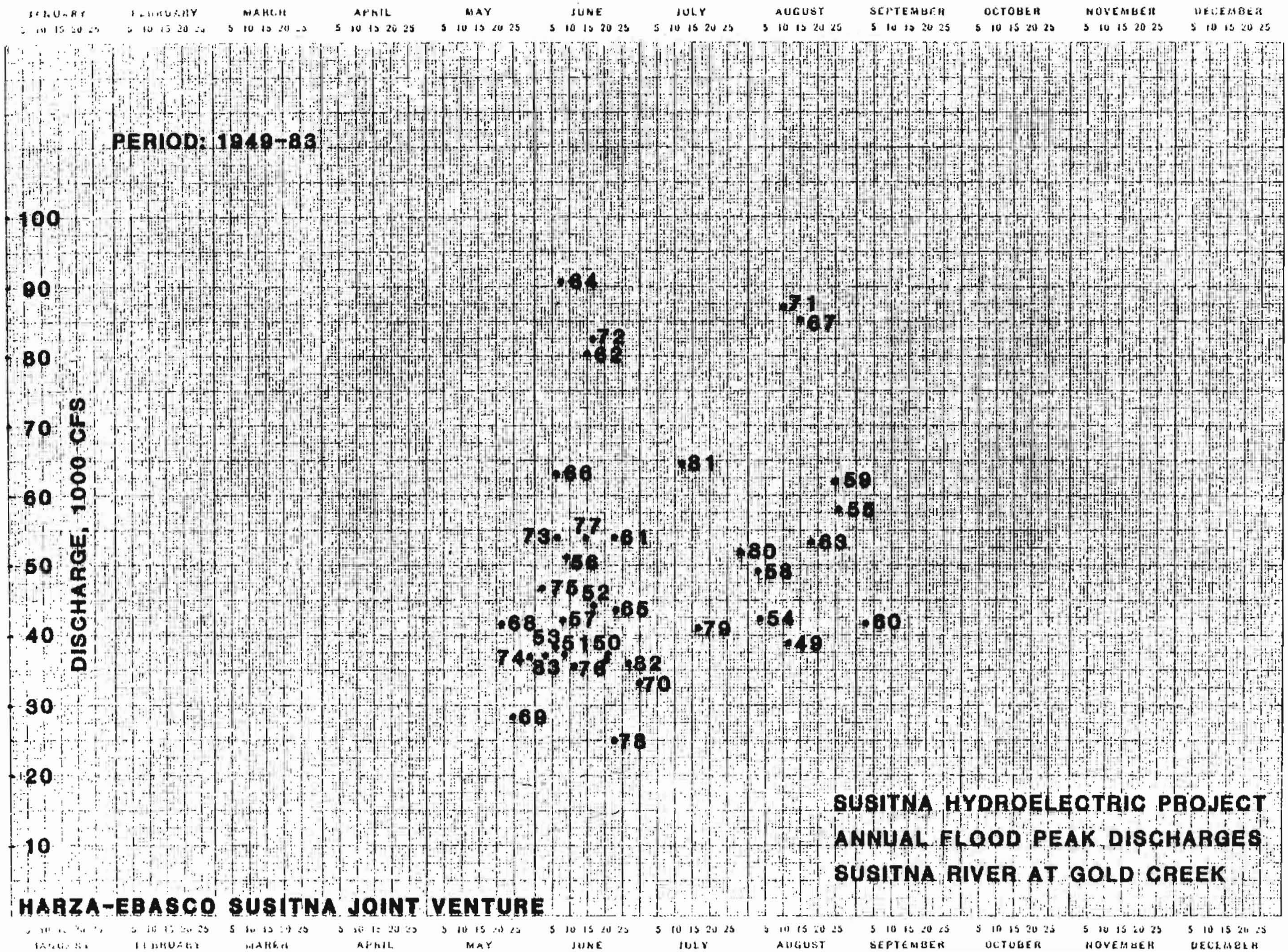
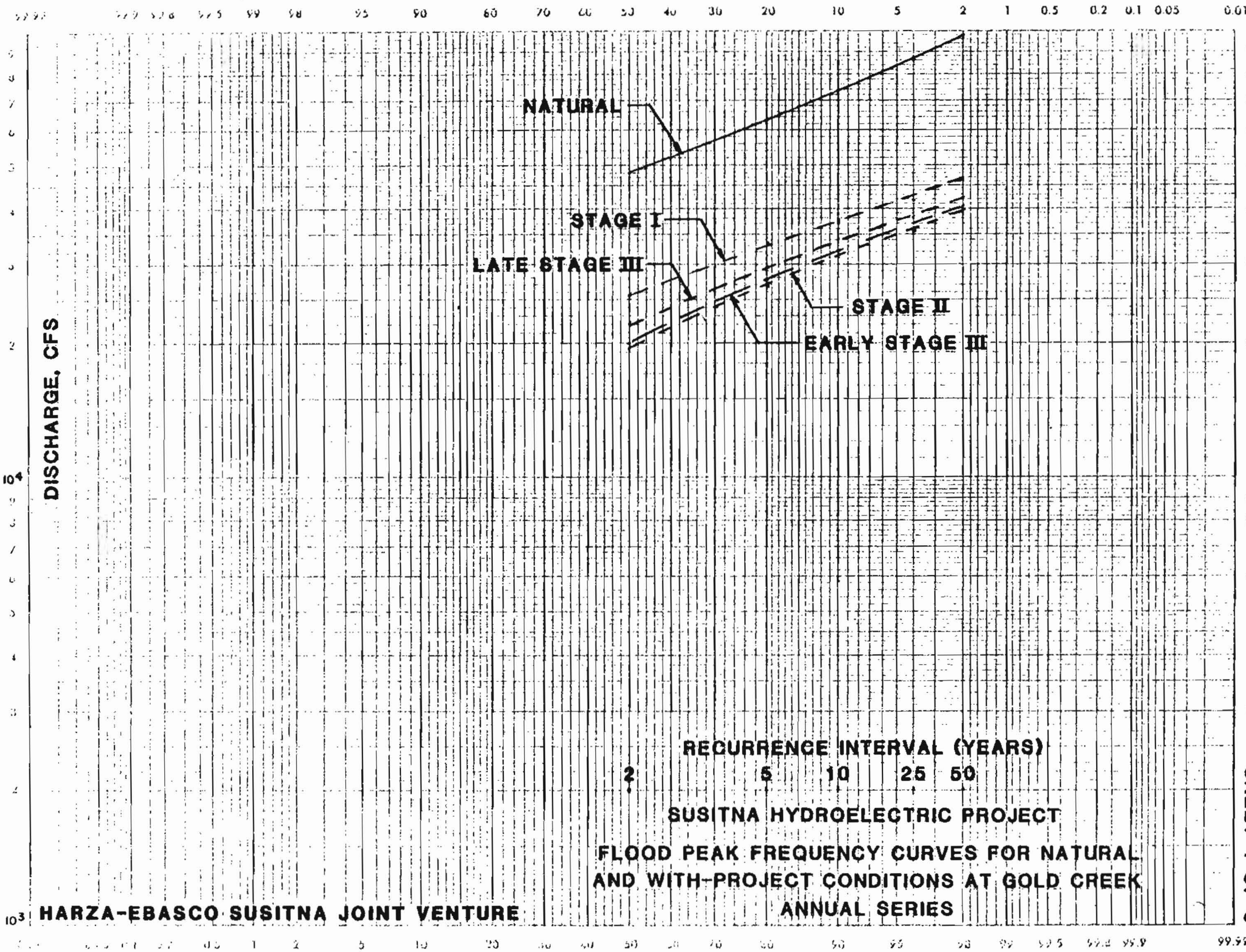

PERIOD: 1961-72, 1981,1982
DISCHARGE, CFS
RECURRENCE INTERVAL (YEARS)
2 5 10 25 50 100
SUSITNA HYDROELECTRIC PROJECT
FLOOD PEAK FREQUENCY CURVE
INTERVENING AREA BETWEEN CANTWELL
AND GOLD CREEK, JULY-SEPTEMBER SERIES
HARZA-EBASCO SUSITNA JOINT VENTURE
EXHIBIT 8
SHEET 3 OF 3

EXHIBIT 9


PERIOD: 1949-83
DISCHARGE, 1000 CFS
100
90
80
70
60
50
40
30
20
10
JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
5 10 15 20 25
64
71
67
72
62
66
81
59
55
73
77
61
63
80
56
58
75
52
65
68
57
54
60
79
53
51
50
49
74
83
76
82
70
69
78
SUSITNA HYDROELECTRIC PROJECT
ANNUAL FLOOD PEAK DISCHARGES
SUSITNA RIVER AT GOLD CREEK
HARZA-EBASCO SUSITNA JOINT VENTURE



SUSITNA HYDROELECTRIC PROJECT

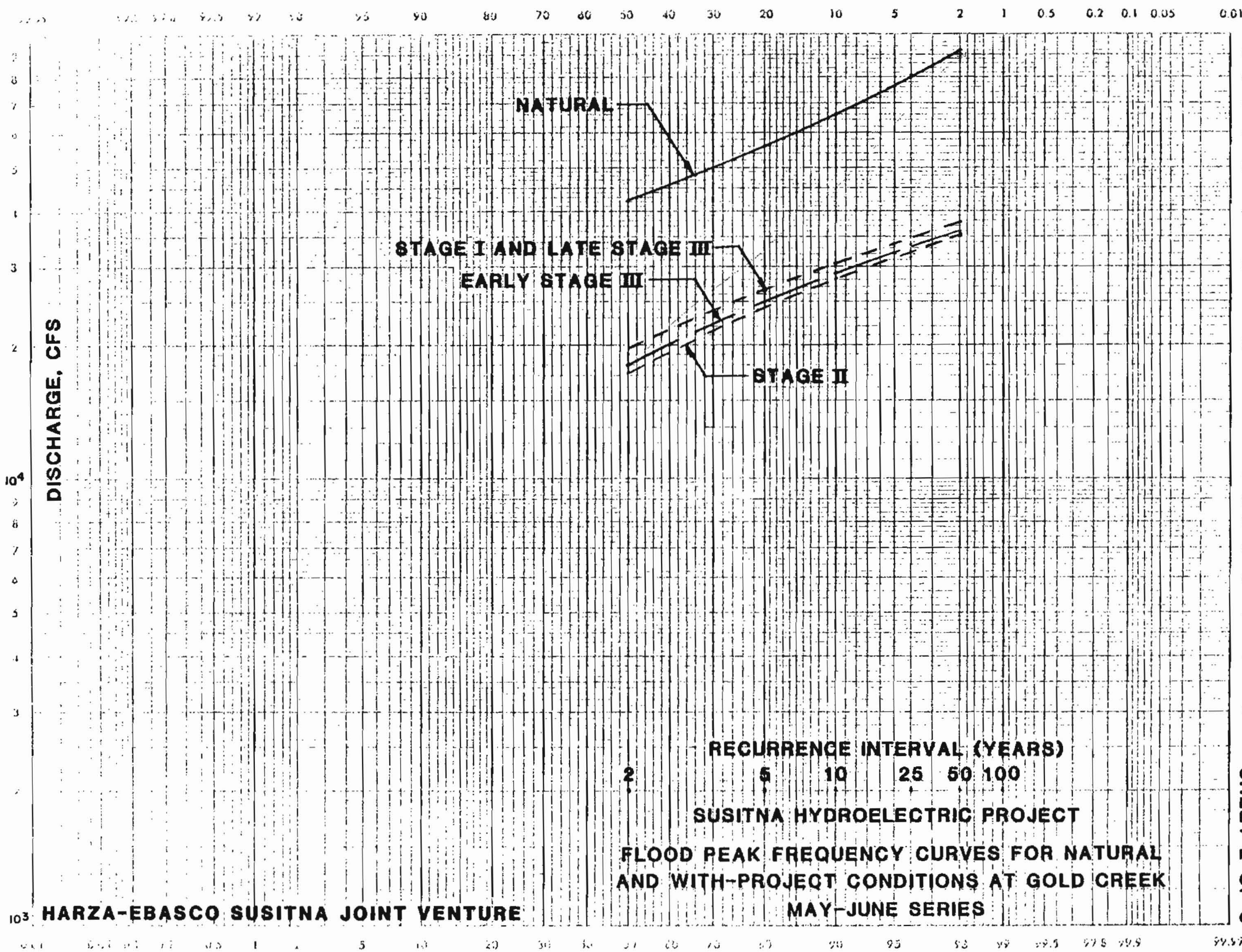
FLOOD PEAK FREQUENCY CURVES FOR NATURAL AND WITH-PROJECT CONDITIONS AT GOLD CREEK

ANNUAL SERIES

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 10
SHEET 1 OF 3

EXHIBIT 10.
SHEET 2 OF 3



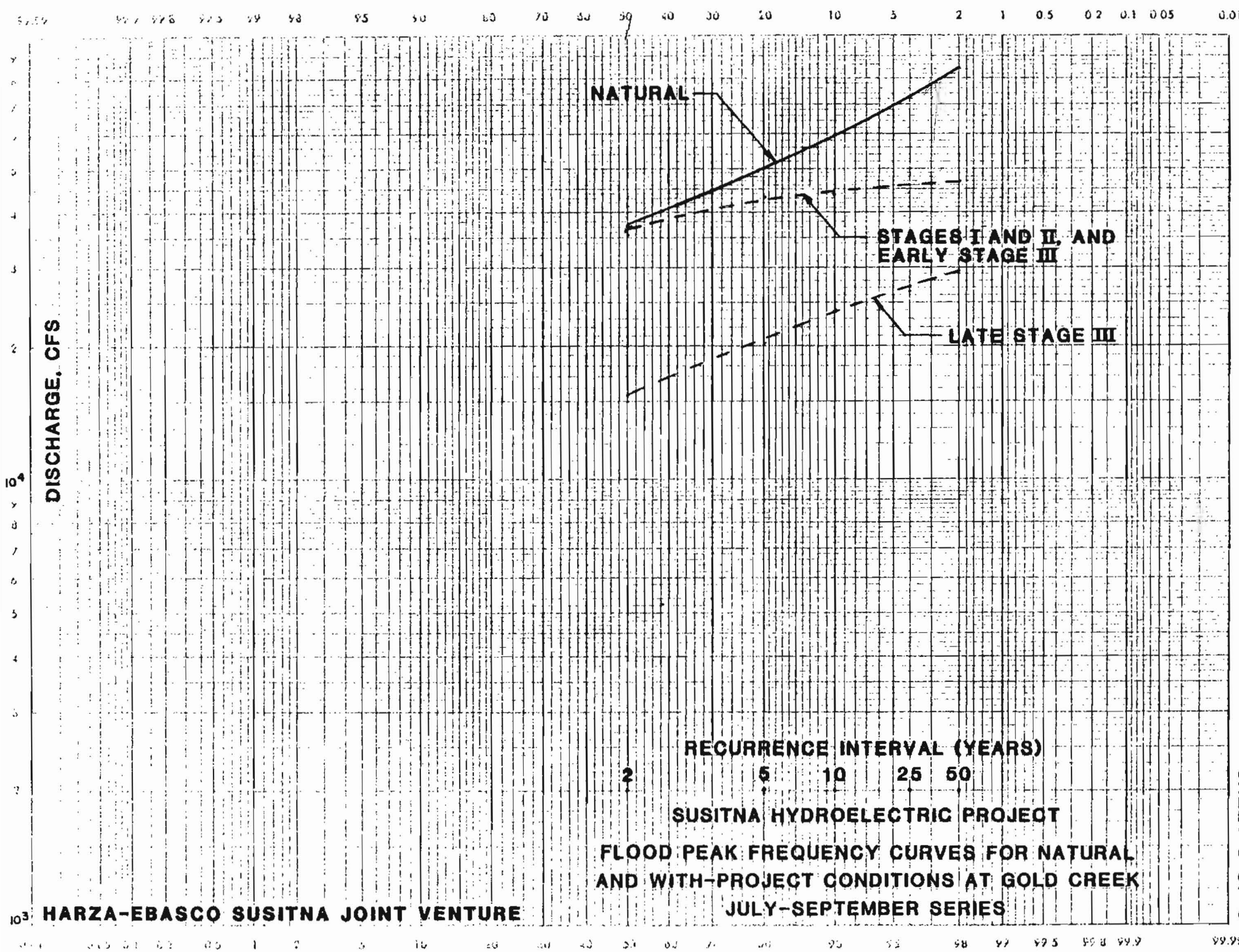
SUSITNA HYDROELECTRIC PROJECT

FLOOD PEAK FREQUENCY CURVES FOR NATURAL AND WITH-PROJECT CONDITIONS AT GOLD CREEK

MAY-JUNE SERIES

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 10
SHEET 3 OF 3



SUSITNA HYDROELECTRIC PROJECT

FLOOD PEAK FREQUENCY CURVES FOR NATURAL AND WITH-PROJECT CONDITIONS AT GOLD CREEK

JULY-SEPTEMBER SERIES

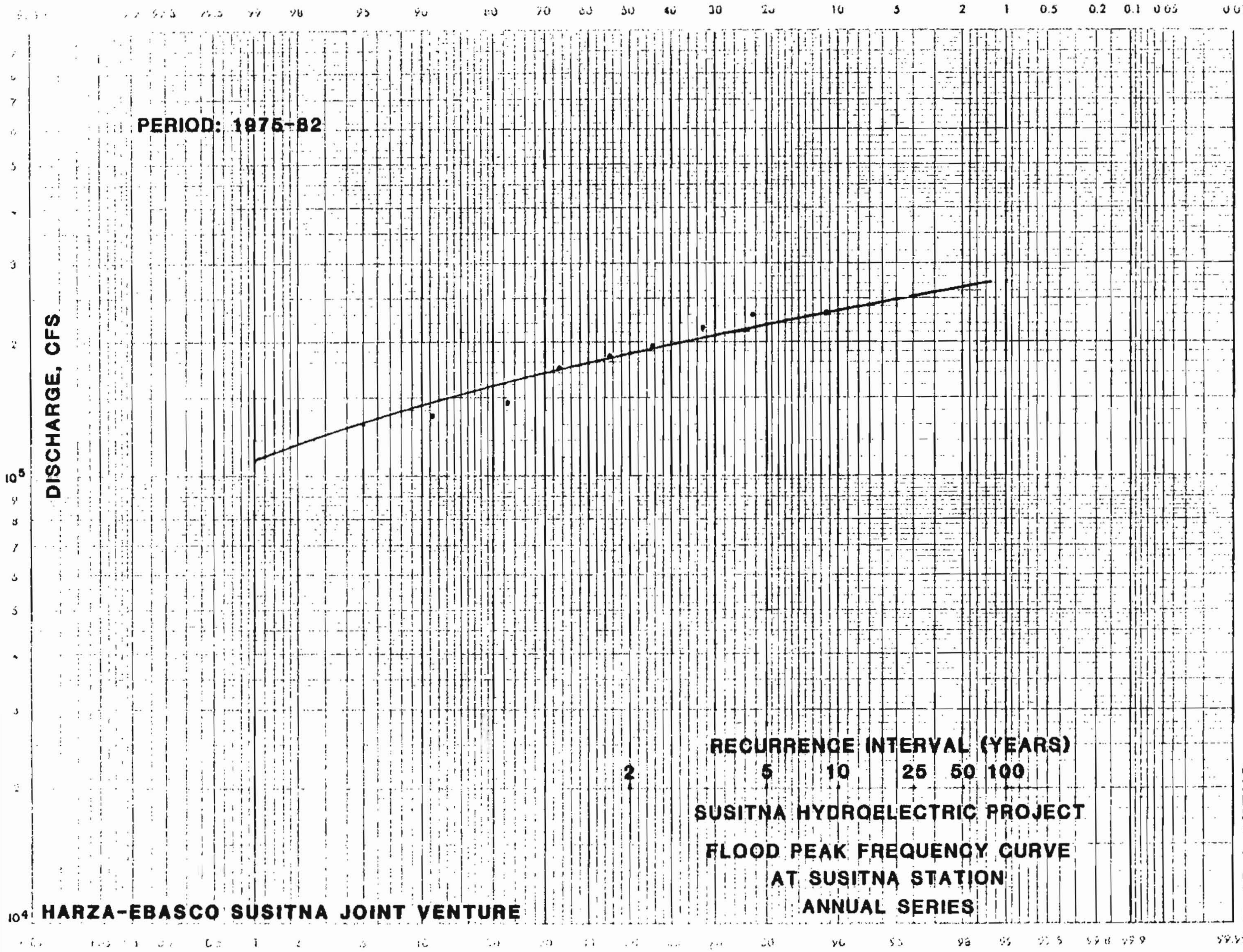


EXHIBIT 11
SHEET 1 OF 3

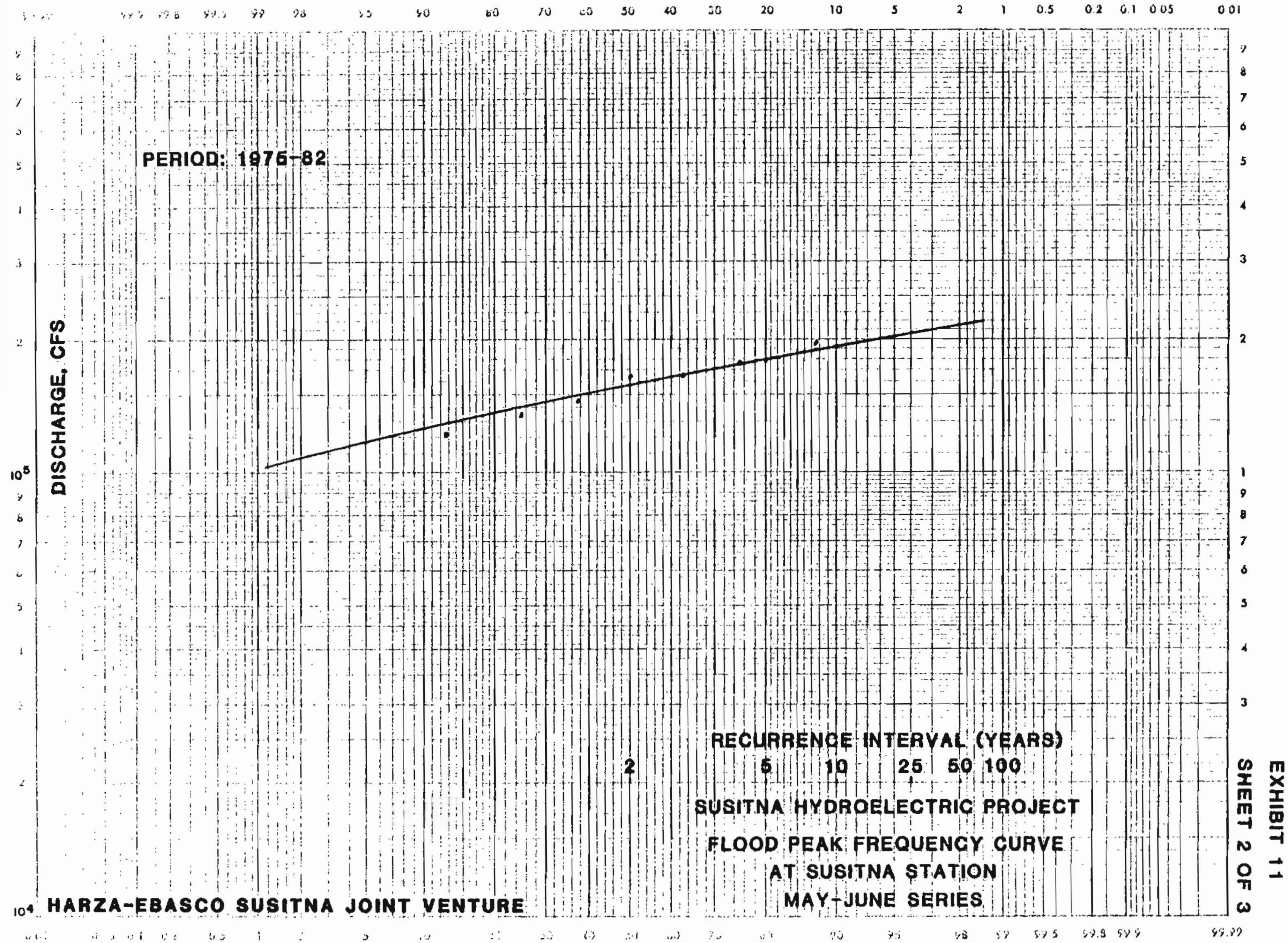
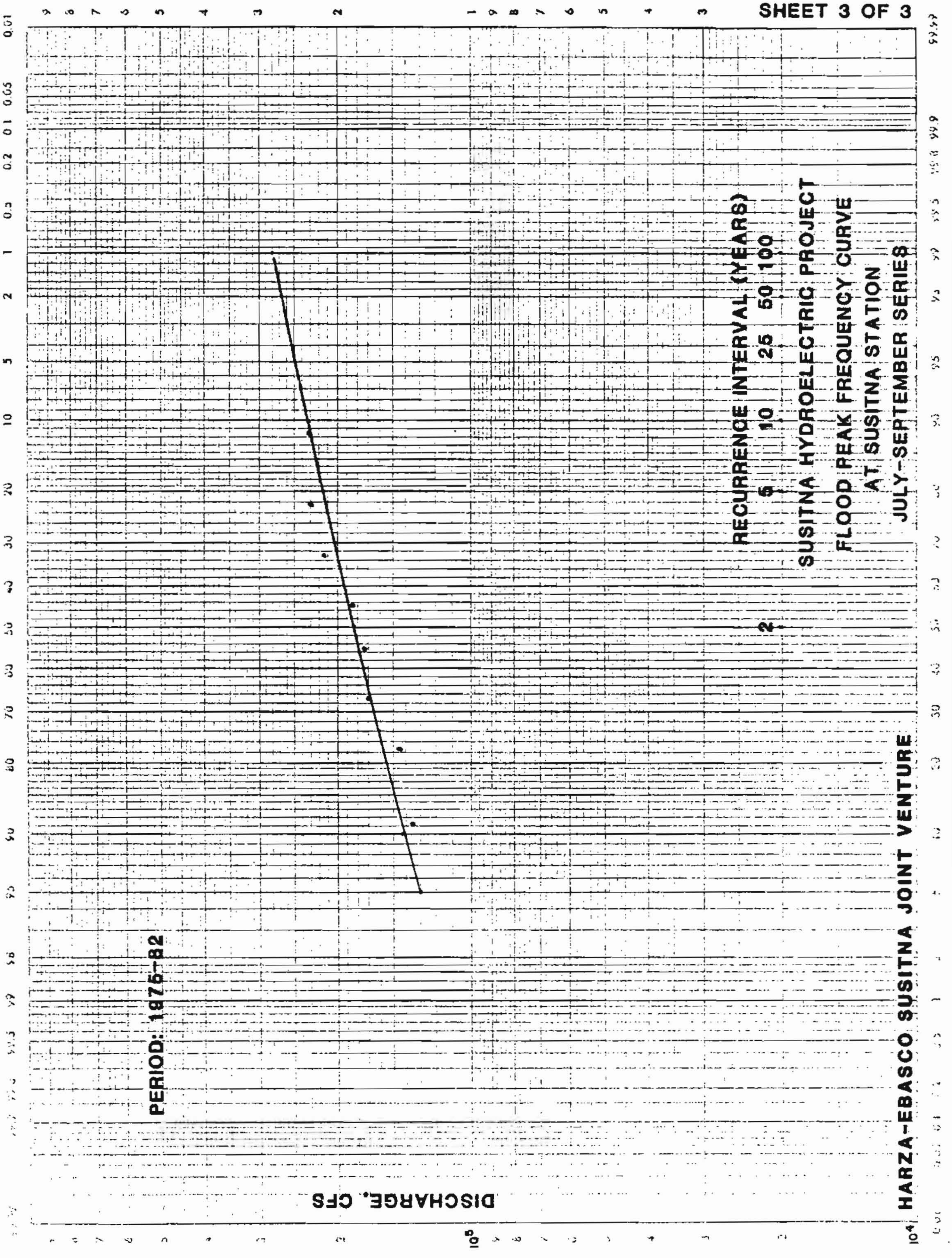

99 98 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
PERIOD: 1975-82
DISCHARGE, CFS
10^5
10^4
RECURRENCE INTERVAL (YEARS)
2 5 10 25 50 100
SUSITNA HYDROELECTRIC PROJECT
FLOOD PEAK FREQUENCY CURVE
AT SUSITNA STATION
MAY-JUNE SERIES
HARZA-EBASCO SUSITNA JOINT VENTURE
EXHIBIT 11
SHEET 2 OF 3

EXHIBIT 11

SHEET 3 OF 3



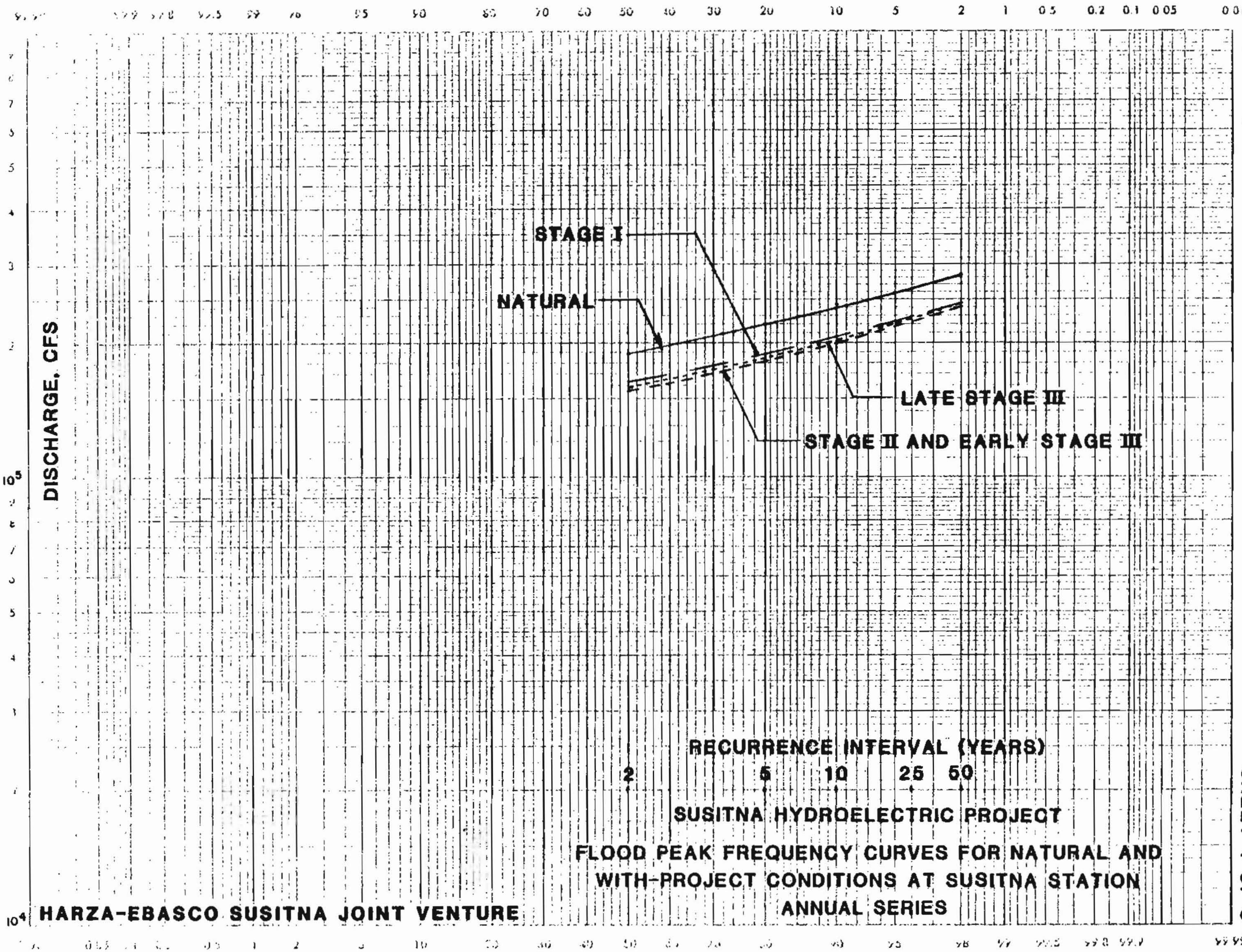
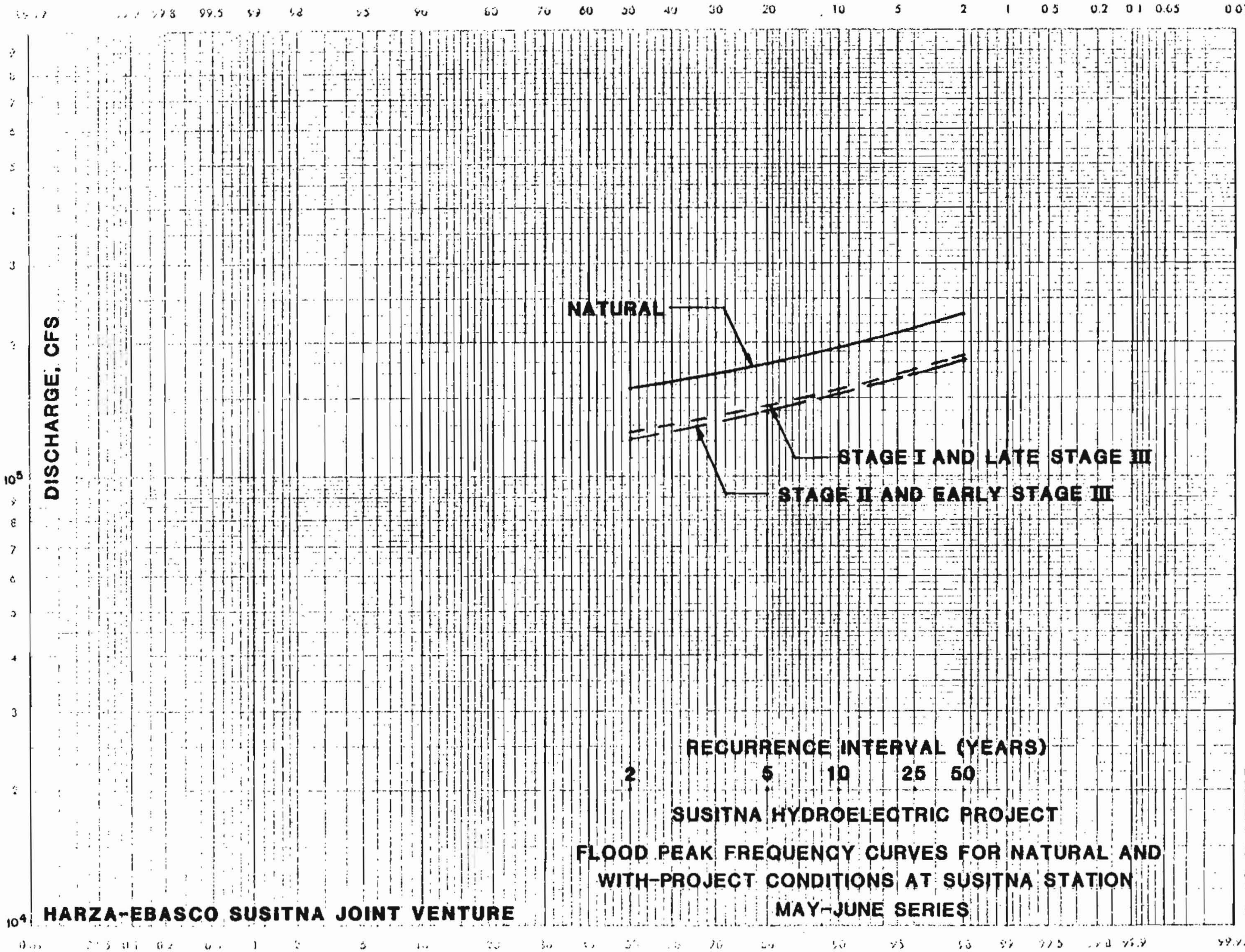


EXHIBIT 12
SHEET 1 OF 3

EXHIBIT 12

SHEET 2 OF 3

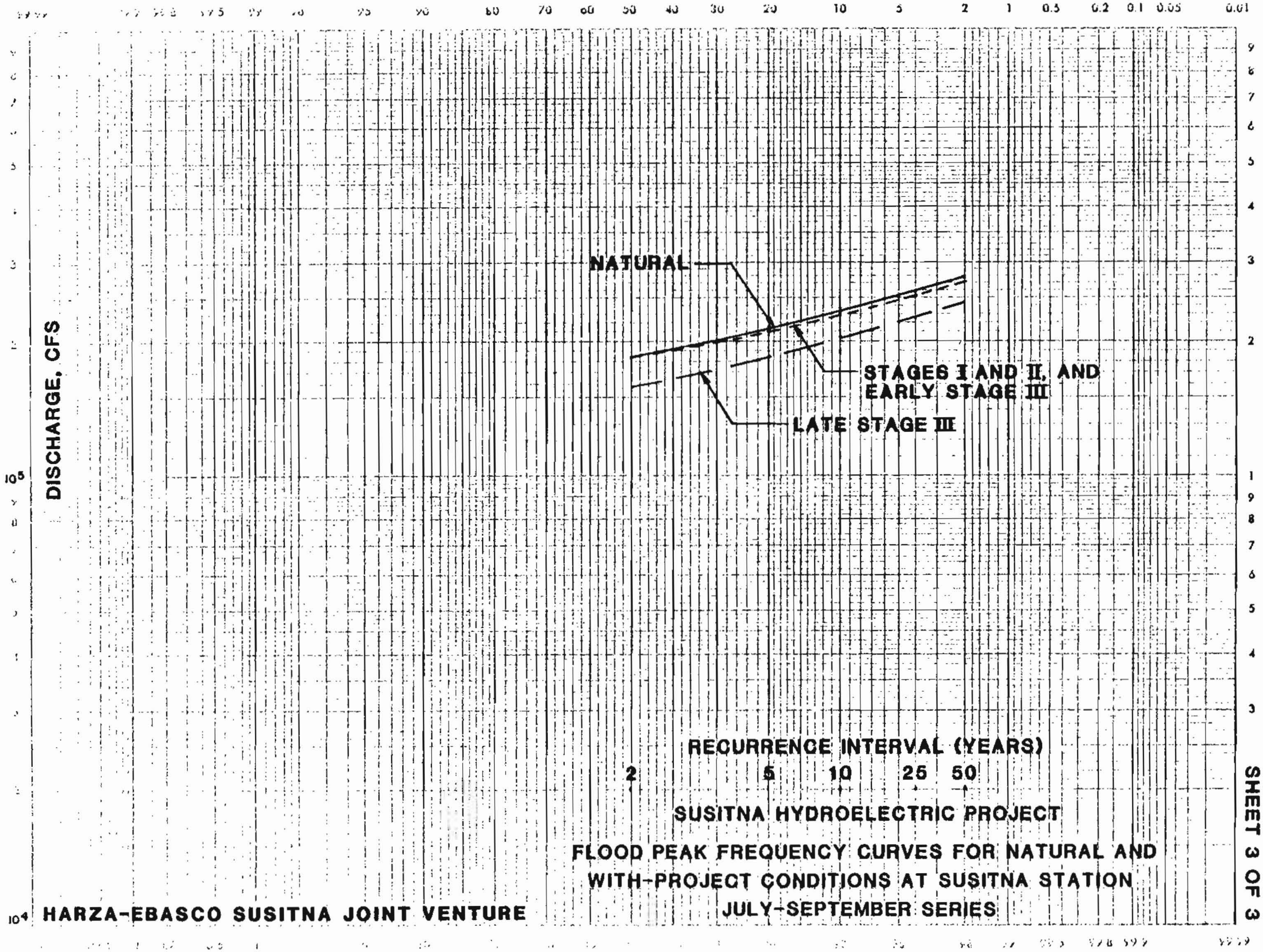


SUSITNA HYDROELECTRIC PROJECT

FLOOD PEAK FREQUENCY CURVES FOR NATURAL AND WITH-PROJECT CONDITIONS AT SUSITNA STATION

MAY-JUNE SERIES

HARZA-EBASCO SUSITNA JOINT VENTURE



SUSITNA HYDROELECTRIC PROJECT

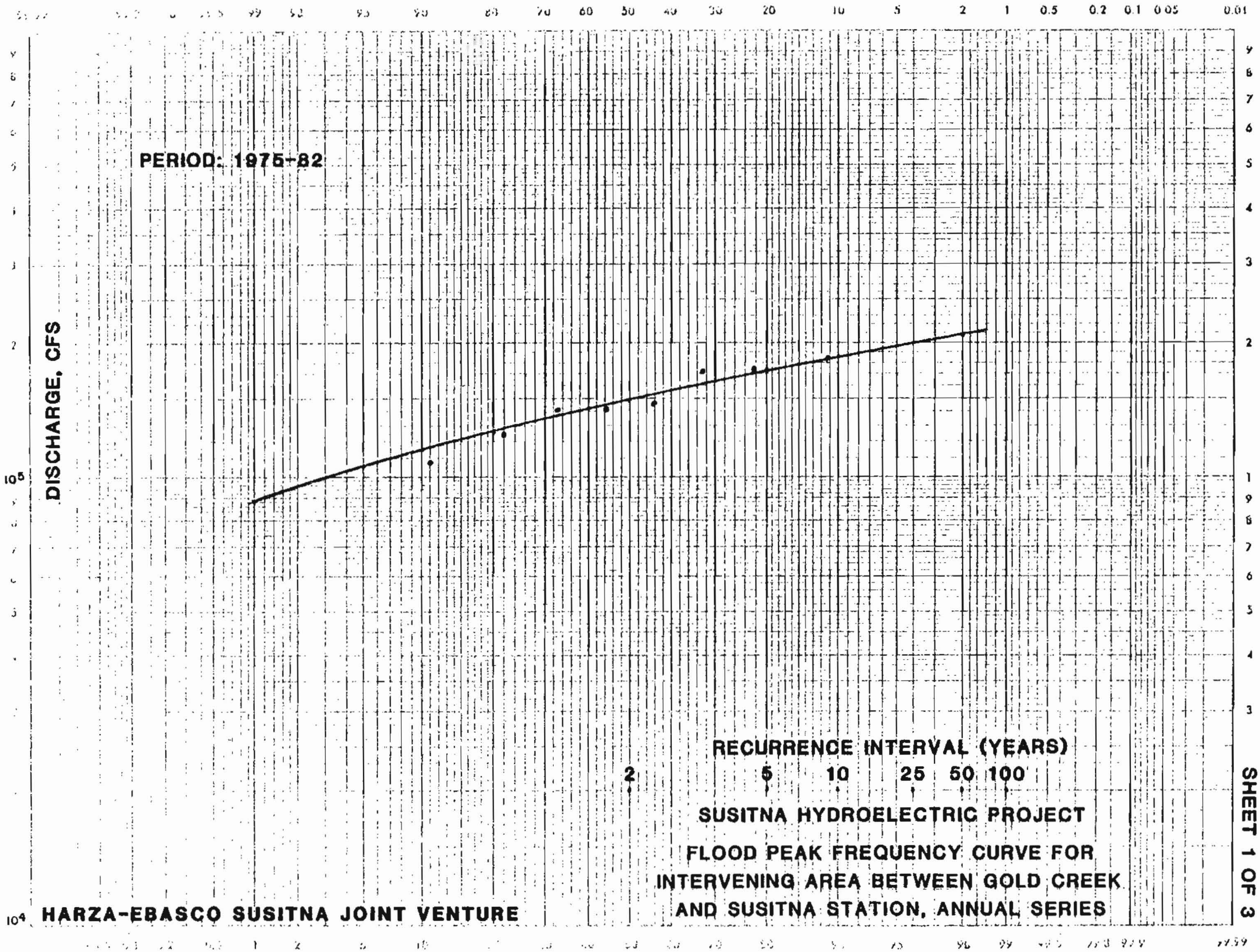
FLOOD PEAK FREQUENCY CURVES FOR NATURAL AND WITH-PROJECT CONDITIONS AT SUSITNA STATION

JULY-SEPTEMBER SERIES

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 12

SHEET 3 OF 3



SUSITNA HYDROELECTRIC PROJECT

FLOOD PEAK FREQUENCY CURVE FOR INTERVENING AREA BETWEEN GOLD CREEK AND SUSITNA STATION, ANNUAL SERIES

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 13
SHEET 1 OF 3

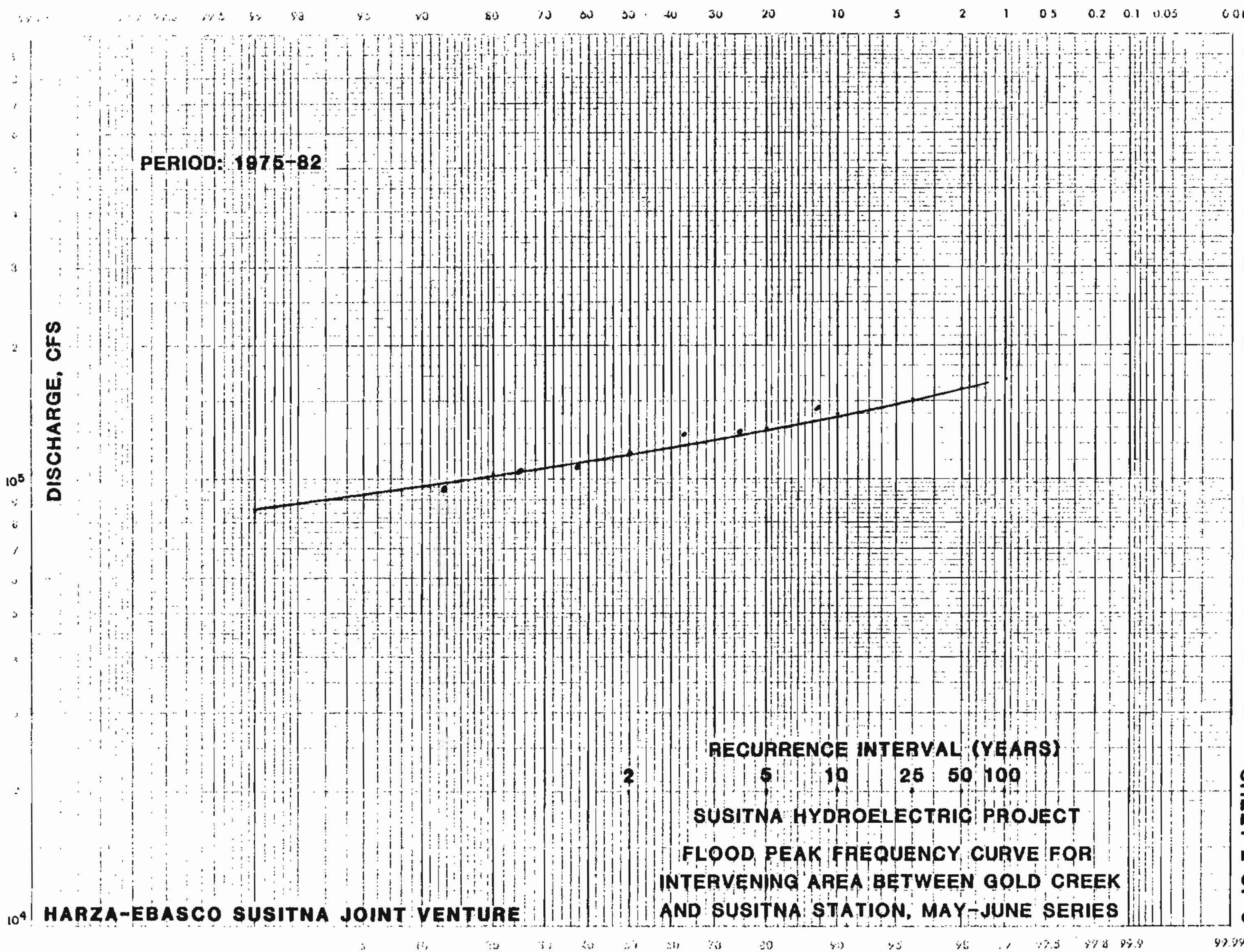


EXHIBIT 13
SHEET 2 OF 3

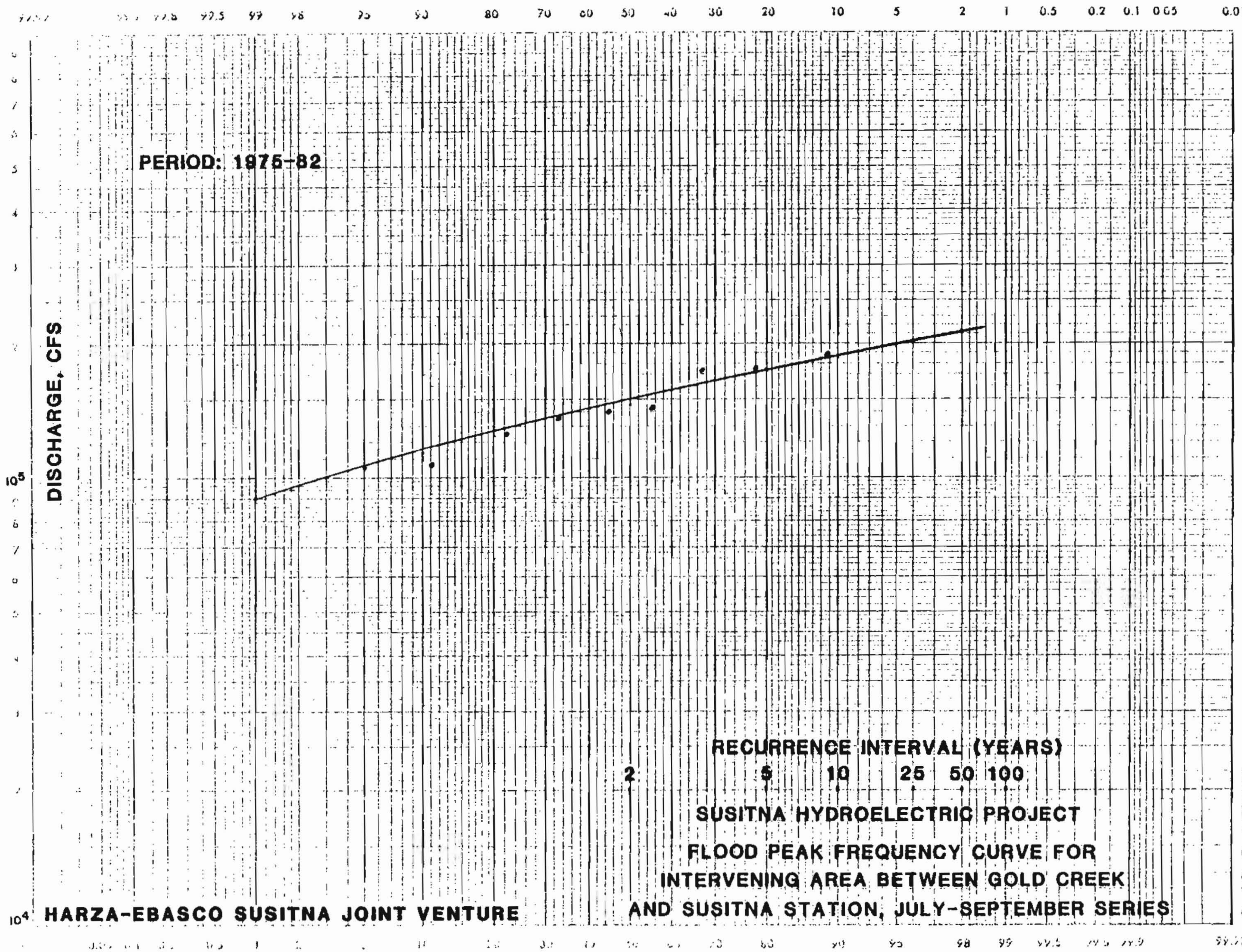
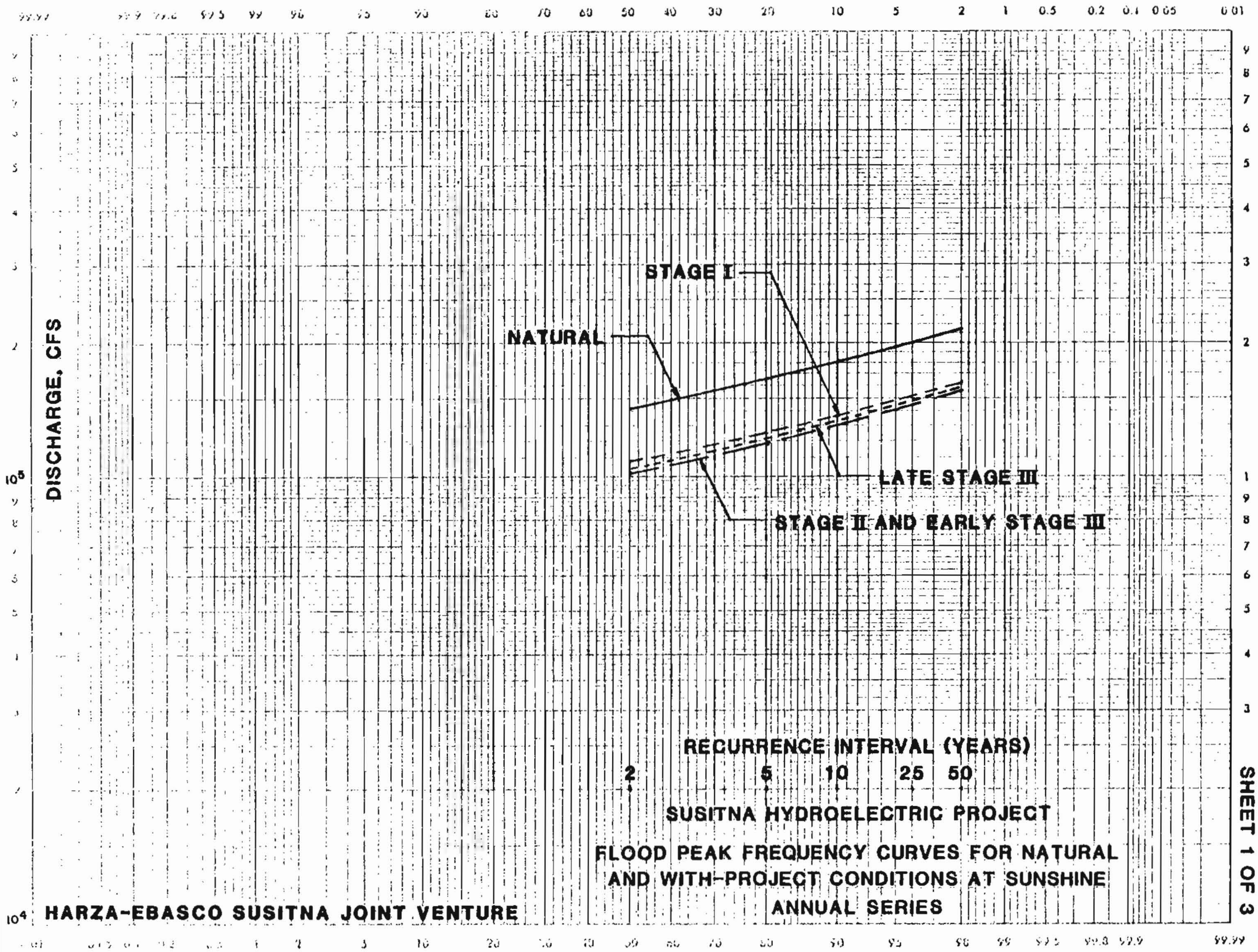
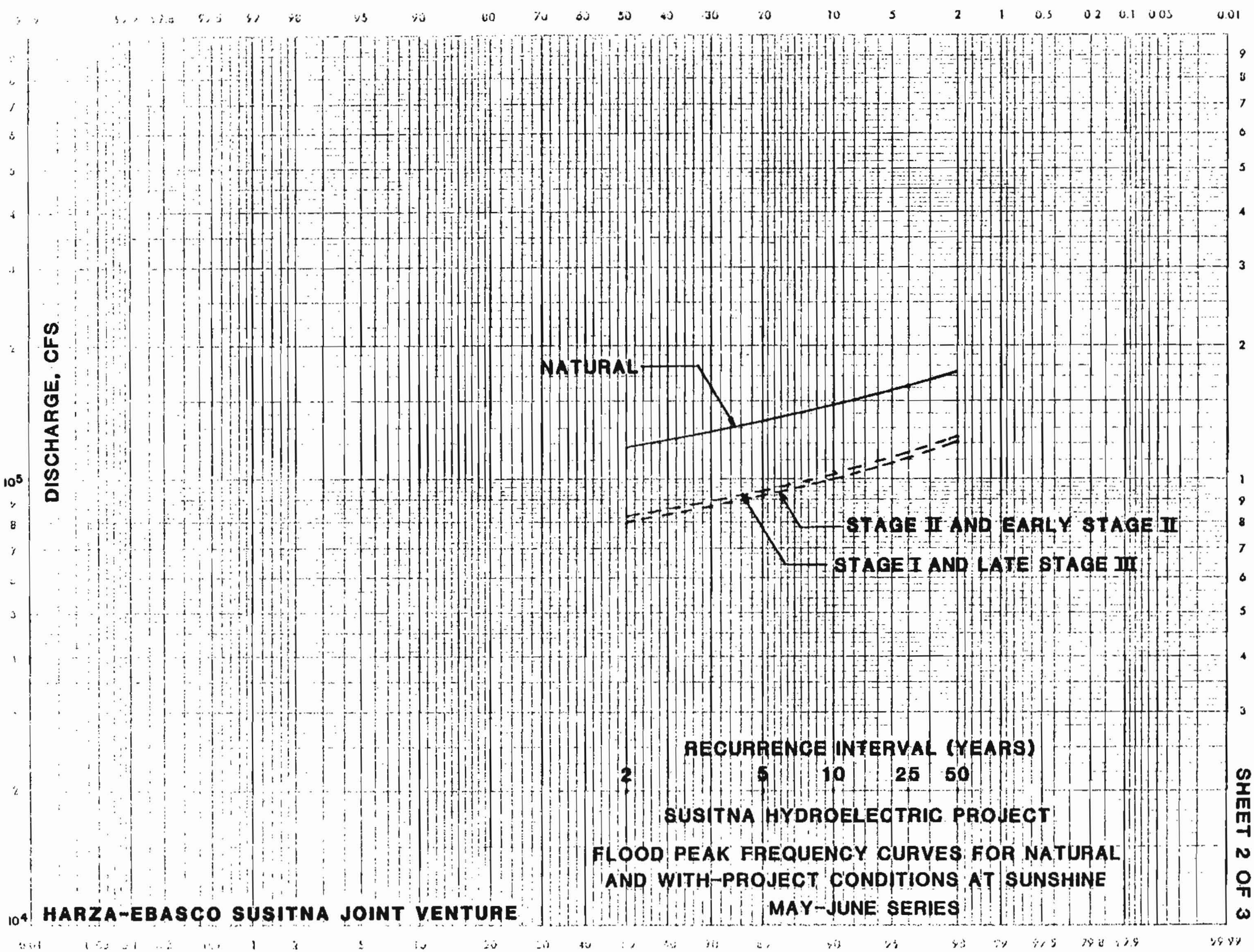


EXHIBIT 13
SHEET 3 OF 3

EXHIBIT 14
SHEET 1 OF 3





SUSITNA HYDROELECTRIC PROJECT

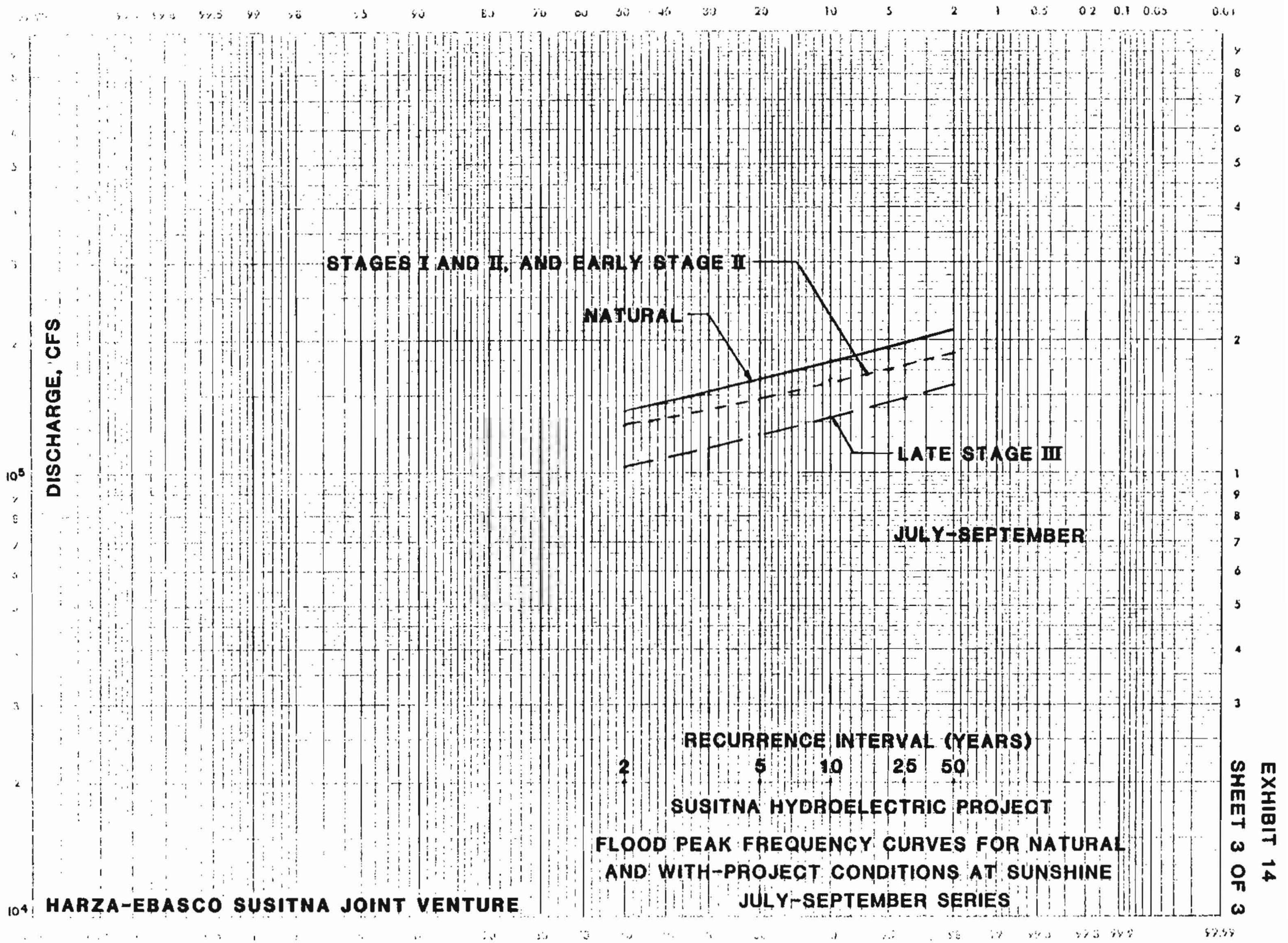
FLOOD PEAK FREQUENCY CURVES FOR NATURAL AND WITH-PROJECT CONDITIONS AT SUNSHINE

MAY-JUNE SERIES

HARZA-EBASCO SUSITNA JOINT VENTURE

EXHIBIT 14

SHEET 2 OF 3



HARZA-EBASCO SUSITNA JOINT VENTURE

SUSITNA HYDROELECTRIC PROJECT

FLOOD PEAK FREQUENCY CURVES FOR NATURAL AND WITH-PROJECT CONDITIONS AT SUNSHINE JULY-SEPTEMBER SERIES

EXHIBIT 14
SHEET 3 OF 3

APPENDIX

APPENDIX A

BASIC DATA USED IN THE STUDY

1 - Instantaneous Flood Peak and Flood Volume Data at Gold Creek

May - June Period

Year	Peak (cfs)	1-day Flow (cfs)	3-day Flow (cfs)	7-day Flow (cfs)	15-day Flow (cfs)
1949	-	-	-	-	-
1950	37,300	34,000	32,067	27,029	24,773
1951	37,400	35,800	32,133	29,814	25,247
1952	44,700	43,300	42,333	39,471	36,620
1953	38,400	37,700	37,233	35,514	31,007
1954	31,900	30,100	29,500	28,514	25,767
1955	40,300	38,000	37,300	35,957	34,567
1956	51,700	51,500	49,900	46,757	40,300
1957	42,200	40,600	39,933	38,386	35,500
1958	29,700	28,000	28,000	28,000	28,000
1959	42,000	39,600	37,167	30,657	27,307
1960	42,400	40,000	35,800	27,886	23,680
1961	59,300	54,000	52,000	42,714	36,767
1962	80,600	79,900	75,233	64,657	53,233
1963	47,700	45,000	42,867	37,114	33,853
1964	90,700	85,900	81,900	75,029	63,467
1965	43,600	39,900	37,367	33,643	27,873
1966	63,600	58,400	56,633	49,171	39,780
1967	41,100	38,800	37,433	34,814	31,520
1968	41,800	39,700	38,933	38,057	36,507
1969	28,400	26,500	24,433	20,514	16,467
1970	33,400	30,800	30,100	26,529	20,627
1971	70,300	66,300	59,000	48,286	38,167
1972	82,600	70,700	65,600	53,547	39,800
1973	54,100	52,800	45,333	40,914	34,560
1974	37,200	33,600	33,233	32,414	29,340
1975	47,300	44,000	42,200	37,114	33,333
1976	35,700	33,300	32,133	29,843	27,920
1977	54,300	52,600	52,200	48,343	41,513
1978	25,000	24,300	23,800	23,129	20,560
1979	36,500	34,400	33,900	32,214	29,353
1980	44,700	43,200	40,267	34,657	31,327
1981	31,800	30,000	25,900	22,771	20,587
1982	37,900	37,000	33,667	29,857	27,867

APPENDIX A

BASIC DATA USED IN THE STUDY

July - September Period

Year	Peak (cfs)	1-day Flow (cfs)	3-day Flow (cfs)	7-day Flow (cfs)	15-day Flow (cfs)
1949	38,700	35,000	34,033	31,943	30,920
1950	34,500	32,500	29,567	26,314	25,407
1951	33,700	31,800	31,467	30,600	27,340
1952	44,500	41,900	41,633	37,843	31,700
1953	29,800	28,000	27,300	26,014	24,053
1954	42,400	41,000	40,333	33,286	28,333
1955	58,100	56,900	53,967	43,071	31,973
1956	34,000	32,000	32,000	32,000	32,000
1957	36,600	34,500	31,267	26,271	24,467
1958	49,600	47,800	45,933	39,257	32,500
1959	62,300	59,700	56,667	49,143	43,293
1960	41,900	40,100	36,200	34,300	30,447
1961	32,100	30,300	27,100	26,114	25,853
1962	34,700	32,700	28,633	27,686	26,840
1963	53,800	44,000	42,333	40,257	39,187
1964	35,200	33,200	29,100	27,114	25,840
1965	38,500	37,700	34,900	31,986	30,120
1966	35,500	33,500	31,367	27,329	25,960
1967	80,200	76,000	69,267	55,386	42,176
1968	34,000	32,000	31,567	29,429	28,387
1969	22,200	20,900	20,200	19,086	17,747
1970	33,500	31,600	29,533	26,543	24,487
1971	87,400	77,700	72,733	57,886	41,693
1972	28,900	27,200	26,300	25,471	25,487
1973	32,400	30,500	29,900	27,800	22,380
1974	28,700	26,300	25,000	21,900	18,840
1975	36,000	33,900	32,533	30,729	28,800
1976	34,000	32,000	30,000	28,571	24,933
1977	32,000	30,000	29,667	27,858	25,080
1978	25,600	24,100	23,267	22,500	21,627
1979	41,300	39,300	34,767	31,886	31,707
1980	51,900	49,700	45,067	37,657	33,733
1981	64,900	60,800	54,533	48,543	42,607
1982	34,500	32,500	30,933	28,114	27,053

APPENDIX A

BASIC DATA USED IN THE STUDY

Annual

Year	Peak (cfs)	1-day Flow (cfs)	3-day Flow (cfs)	7-day Flow (cfs)	15-day Flow (cfs)
1949	38,700	35,000	34,033	31,943	30,920
1950	37,400	34,000	32,067	27,029	25,407
1951	37,400	35,800	32,133	30,600	27,340
1952	44,700	43,300	42,333	39,471	36,620
1953	38,400	37,700	37,233	35,514	31,007
1954	42,400	41,000	40,333	33,286	38,333
1955	58,100	56,900	53,967	43,071	35,520
1956	51,700	51,500	49,900	46,757	40,300
1957	42,200	40,600	39,933	38,386	35,500
1958	49,600	47,800	45,933	39,257	32,500
1959	62,300	59,700	56,667	49,143	43,293
1960	41,900	40,100	36,200	34,300	30,447
1961	59,300	54,000	52,000	42,714	36,767
1962	80,600	79,900	75,233	64,657	53,233
1963	53,800	45,000	42,867	40,257	39,187
1964	90,700	85,900	81,900	75,029	63,467
1965	43,600	39,900	37,367	33,643	31,280
1966	63,600	58,400	56,633	49,171	39,780
1967	80,200	76,000	69,267	55,386	42,187
1968	41,800	39,700	38,933	38,057	36,507
1969	28,400	26,500	24,433	20,514	17,747
1970	33,400	31,500	30,100	26,529	27,107
1971	87,400	77,700	72,733	57,886	41,693
1972	82,600	70,700	65,600	53,547	39,800
1973	54,100	52,800	45,333	40,914	34,560
1974	37,200	33,600	33,233	32,414	29,340
1975	47,300	44,000	52,200	37,114	33,333
1976	35,700	33,300	32,133	29,843	27,920
1977	54,300	52,600	52,200	48,343	41,513
1978	25,600	24,300	23,800	23,129	22,593
1979	41,300	39,300	34,767	32,214	31,707
1980	51,900	49,700	45,067	37,657	33,733
1981	64,900	60,800	54,533	48,543	42,607
1982	37,900	37,000	33,667	29,857	27,867

APPENDIX A

BASIC DATA USED IN THE STUDY

2 - Daily Maximum Intervening Flows Between Cantwell and Gold Creek Stream Gaging Stations

Year	May - June (cfs)	July - September (cfs)	Annual (cfs)
1961	18,300	11,300	18,300
1962	44,200	14,000	44,200
1963	22,000	17,000	22,000
1964	36,800	10,800	36,800
1965	16,800	16,000	16,800
1966	40,100	17,500	40,100
1967	18,400	39,600	39,600
1968	16,600	12,000	16,000
1969	10,500	5,600	10,500
1970	15,800	14,000	15,800
1971	22,300	25,900	25,900
1972	33,100	10,000	33,100
1981	12,000	31,400	31,400
1982	13,800	14,800	14,900

3 - Daily Maxinum Intervening Flows Between Gold Creek and Susitna Station Stream Gaging Stations

Year	May - June (cfs)	July - September (cfs)	Annual (cfs)
1975	102,400	140,400	140,400
1976	109,000	124,500	124,500
1977	144,600	137,000	144,600
1978	95,800	106,400	106,400
1979	128,700	141,400	141,400
1980	127,000	184,800	184,800
1981	106,600	177,400	177,400
1982	113,000	176,000	176,000

4 - Instantaneous Flood Peaks at Susitna Station

Year	May - June (cfs)	July - September (cfs)	Annual (cfs)
1975	165,000	173,000	173,000
1976	134,000	147,000	147,000
1977	197,000	170,000	197,000
1978	121,000	136,000	136,000
1979	162,000	185,000	185,000
1980	177,000	230,000	230,000
1981	135,000	230,000	230,000
1982	145,000	213,000	213,000