

SUSITNA RIVER ICE PROCESSES: NATURAL CONDITIONS AND
PROJECTED EFFECTS OF HYDROELECTRIC DEVELOPMENT

VOLUME II

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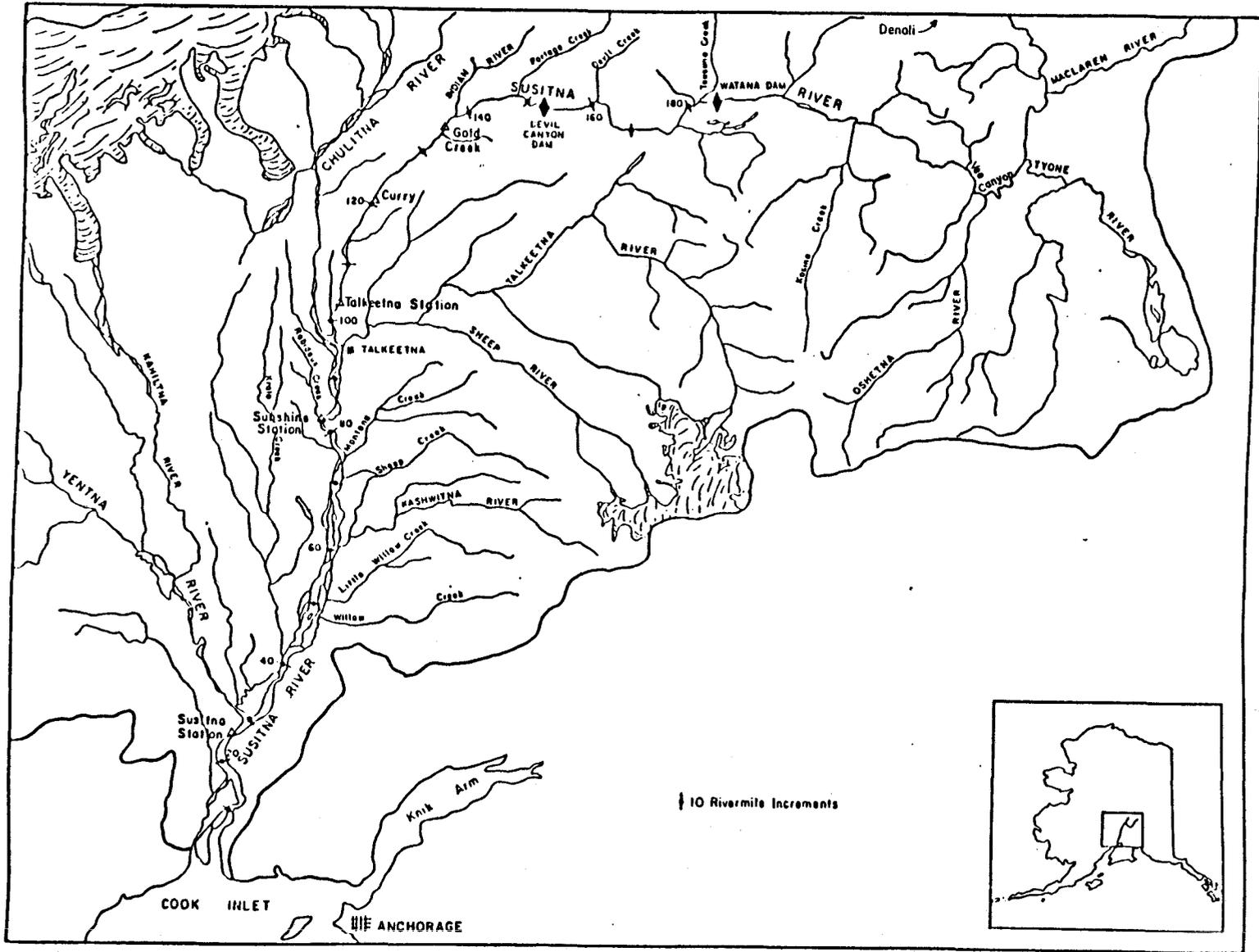


Figure 1. Map of the Susitna basin study region.

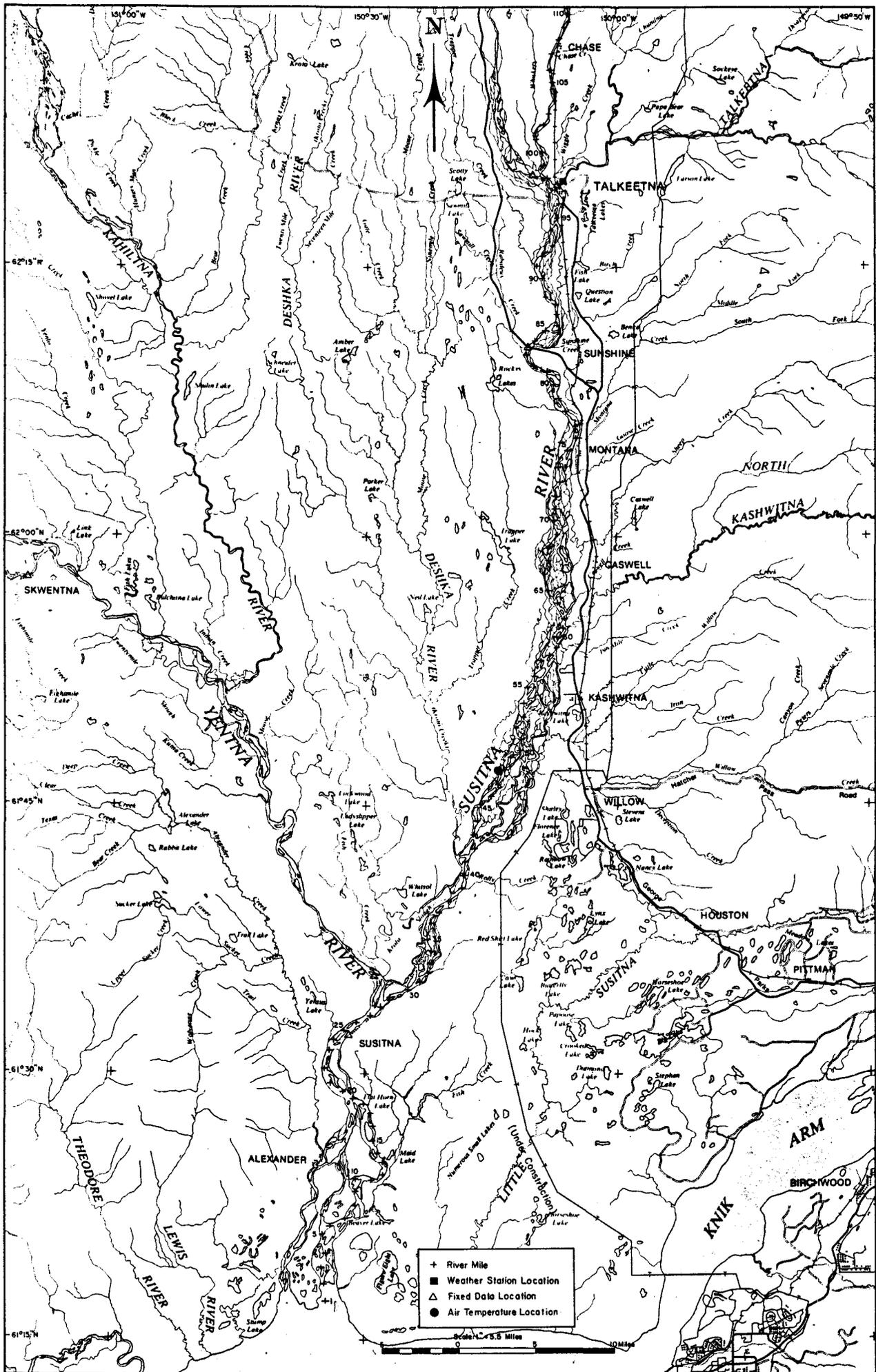


Figure 2. Lower River

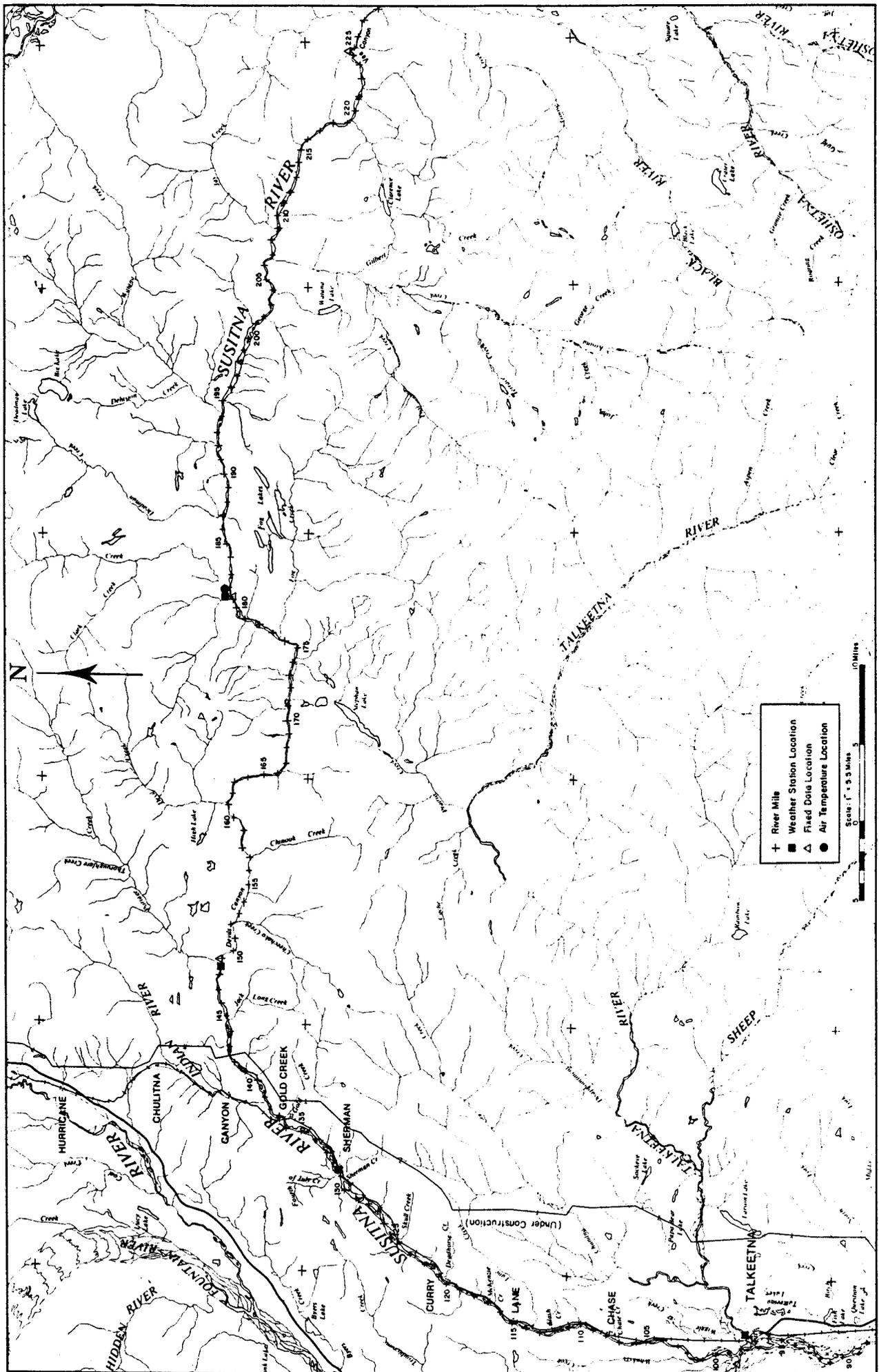


Figure 3. Middle River

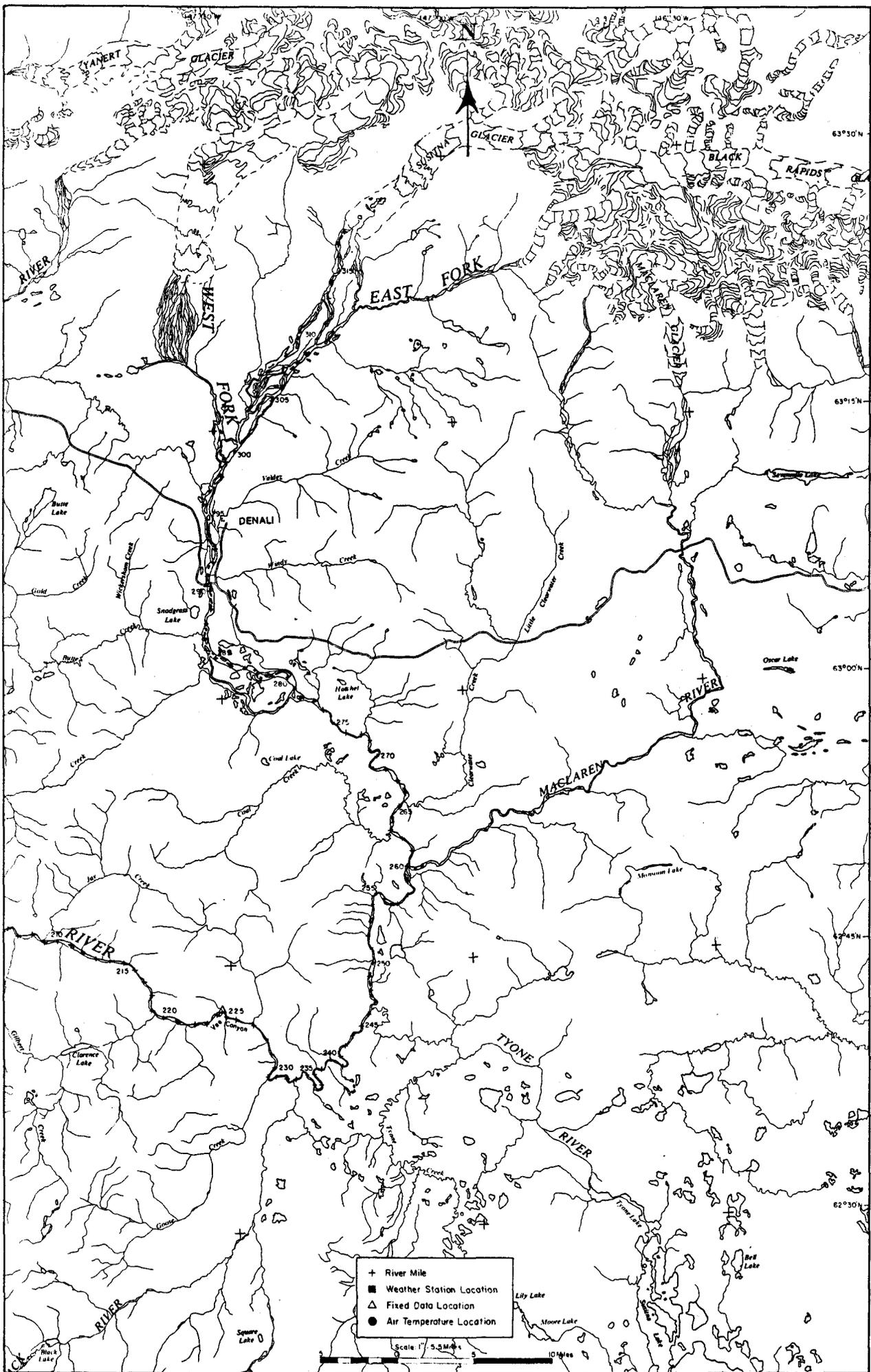
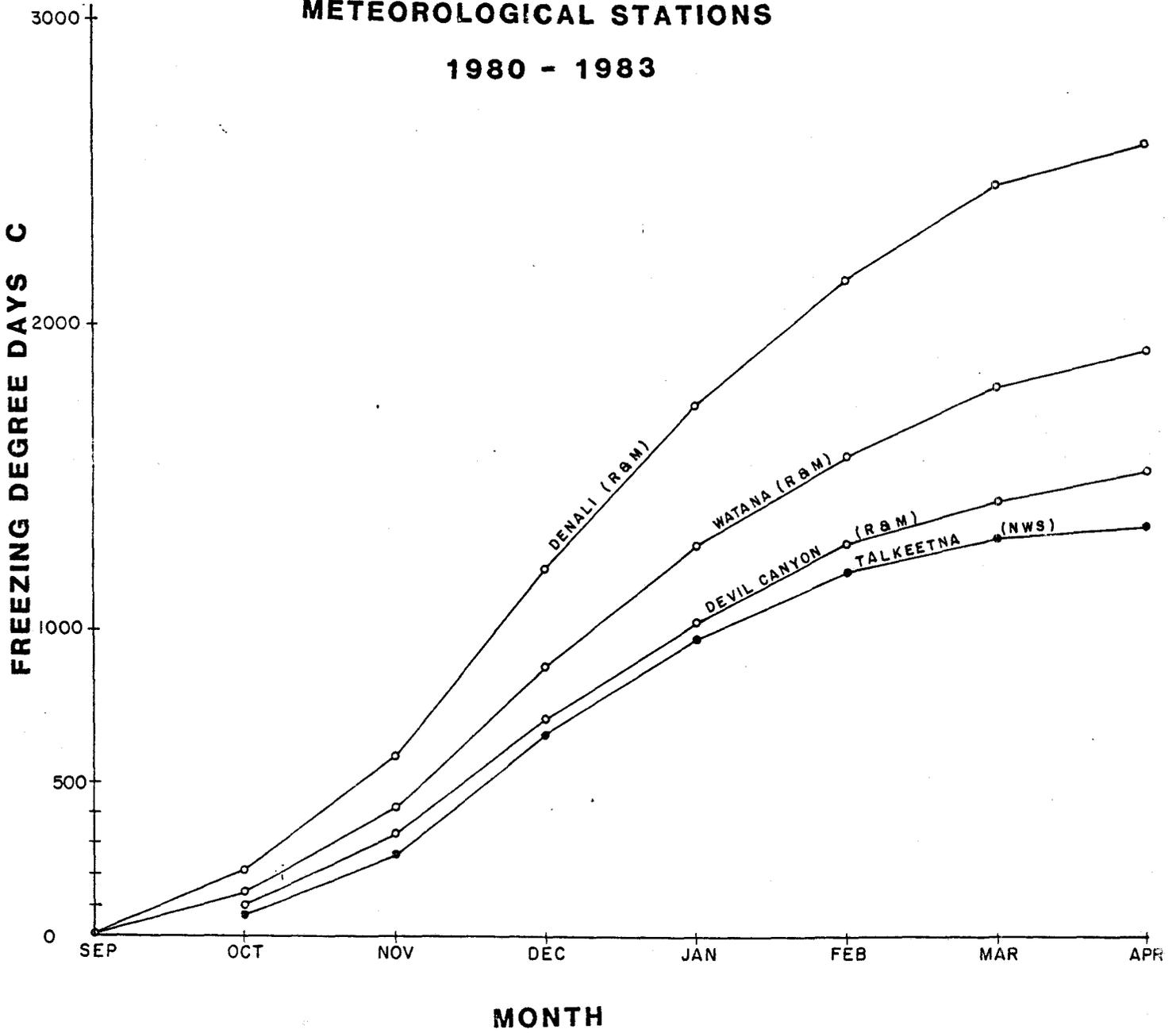


Figure 4. Upper River

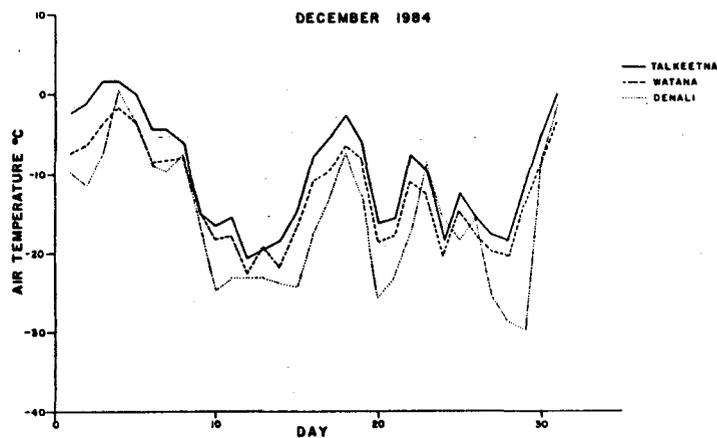
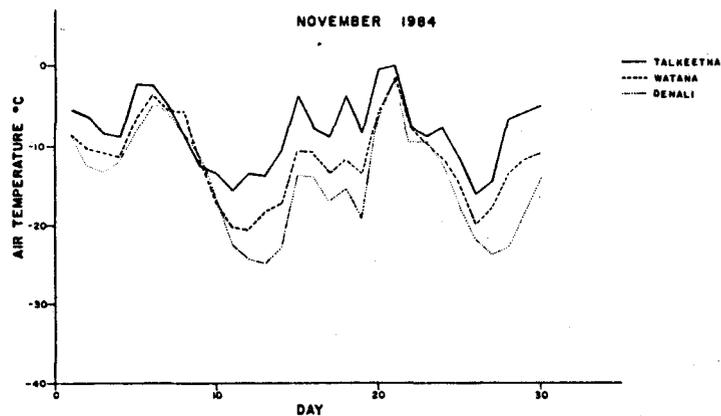
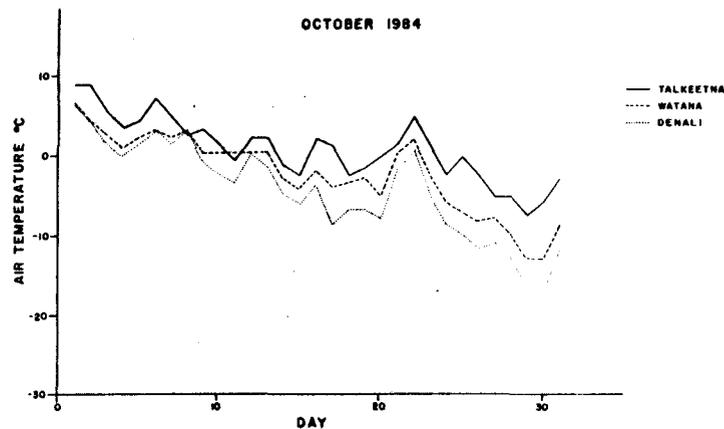
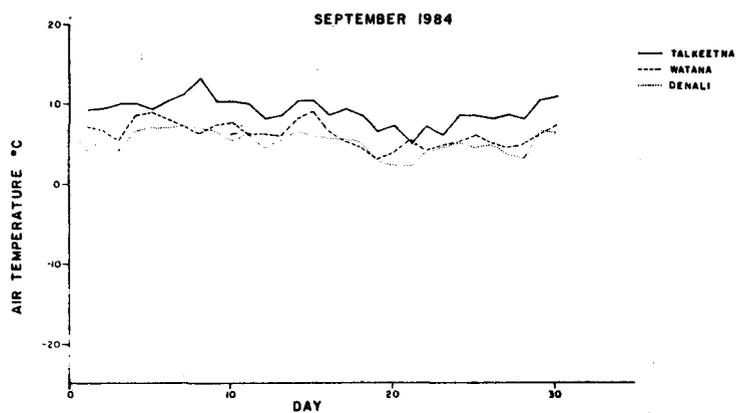
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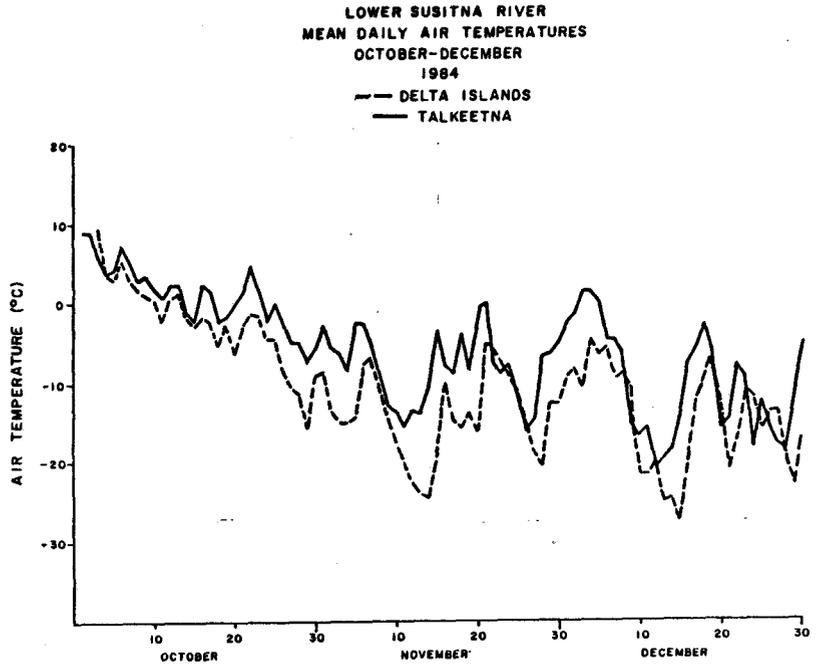
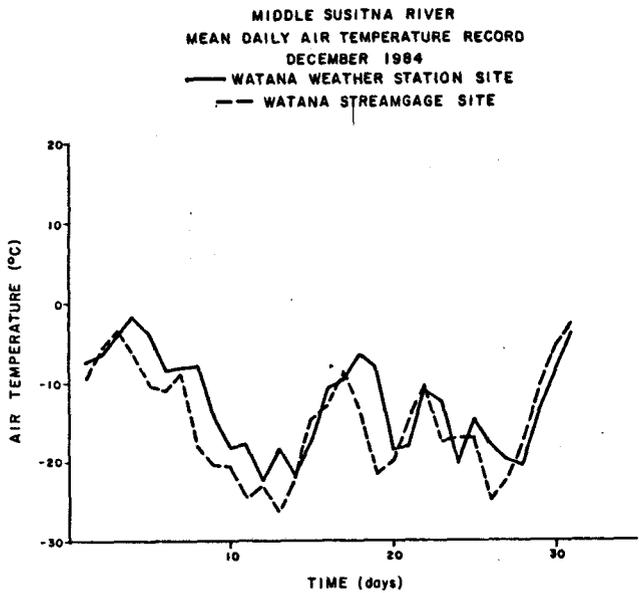
**AVERAGE HISTORICAL
ACCUMULATED FREEZING DEGREE DAYS
FOR SUSITNA RIVER BASIN
METEOROLOGICAL STATIONS
1980 - 1983**



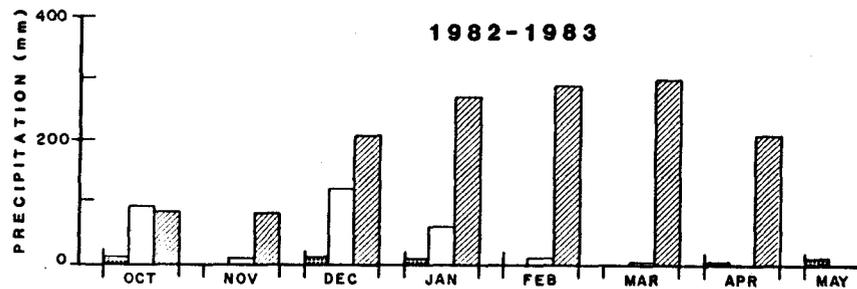
FIGURE

UPPER SUSITNA RIVER BASIN AIR TEMPERATURE VARIATION

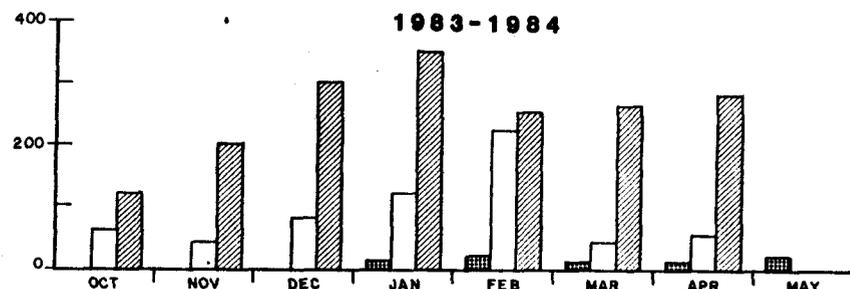




MONTHLY PRECIPITATION DATA

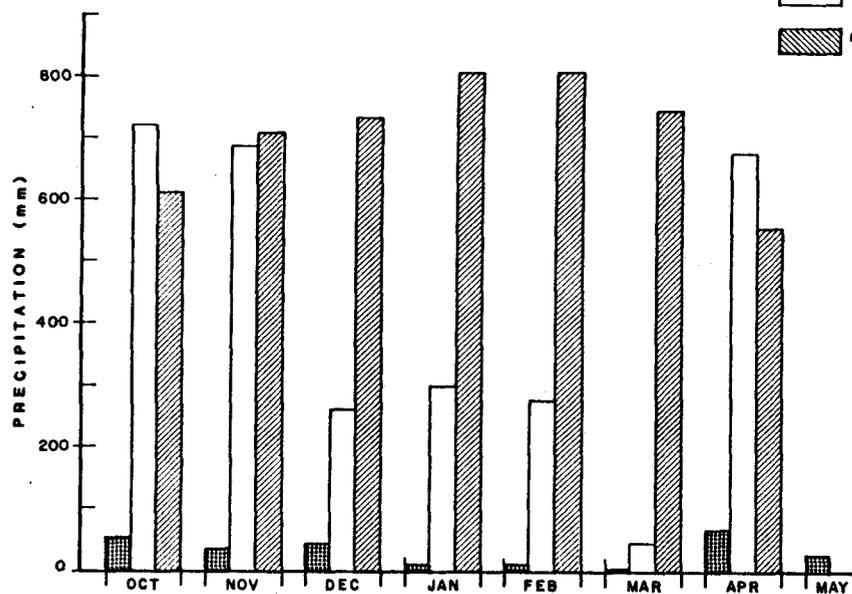


Location: WATANA

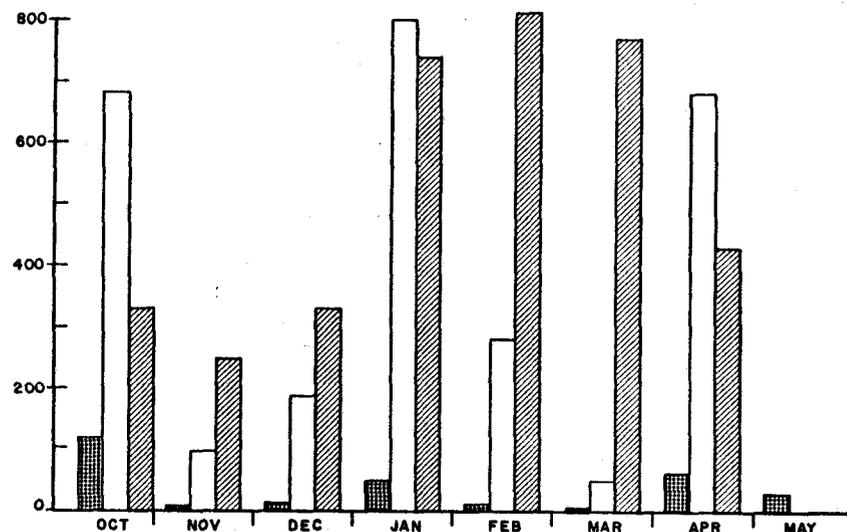


Location: WATANA

 precipitation water equivalent
 precipitation snowfall
 maximum snow depth on ground

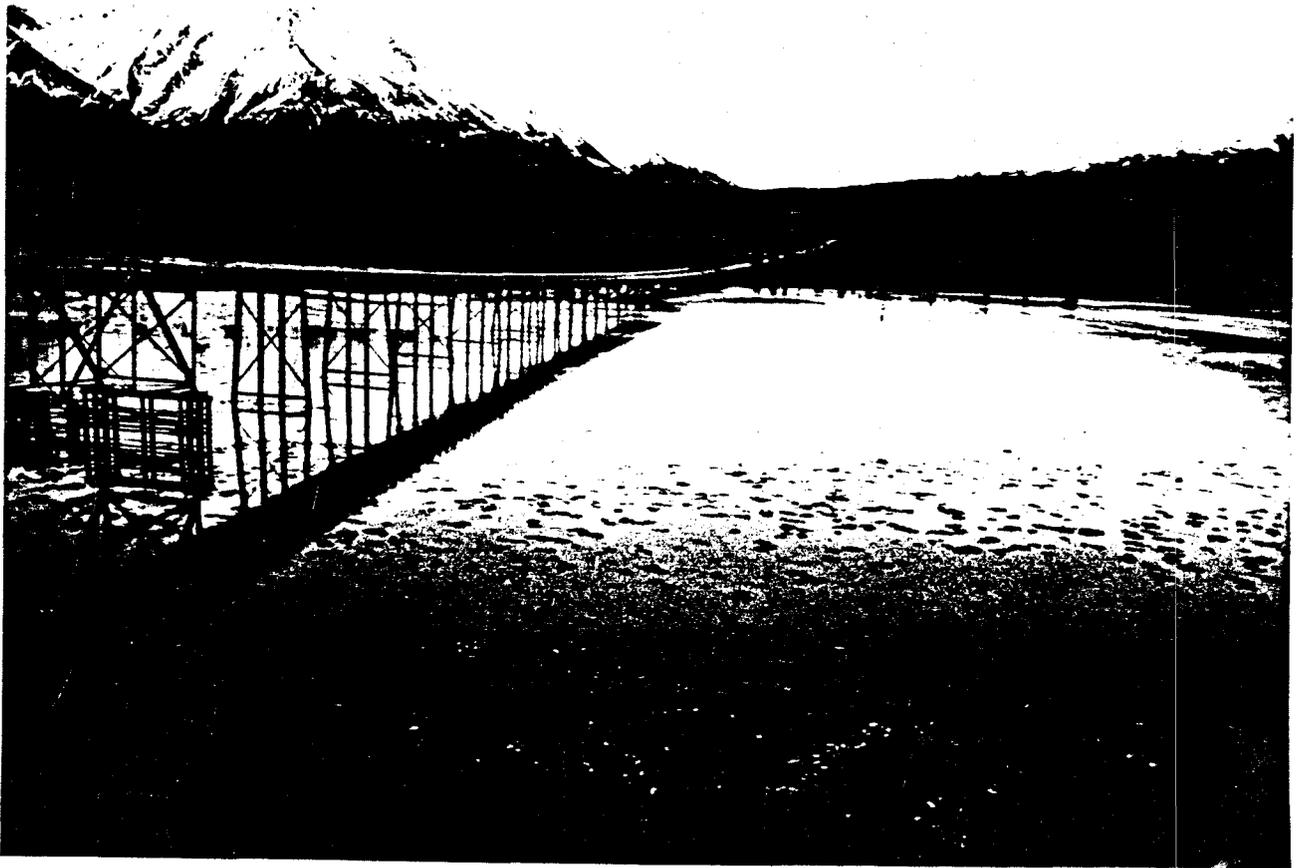


Location: TALKEETNA



Location: TALKEETNA

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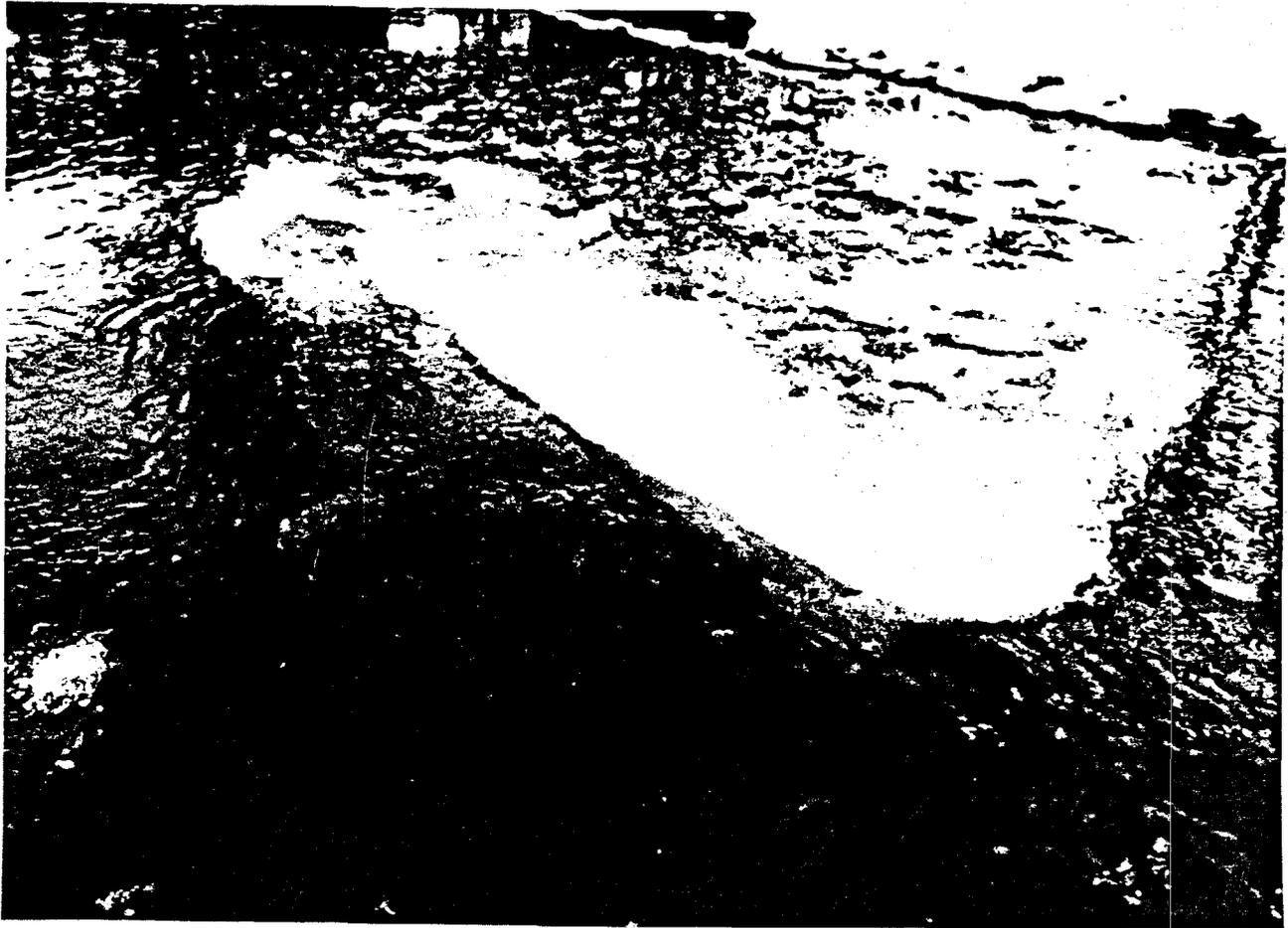
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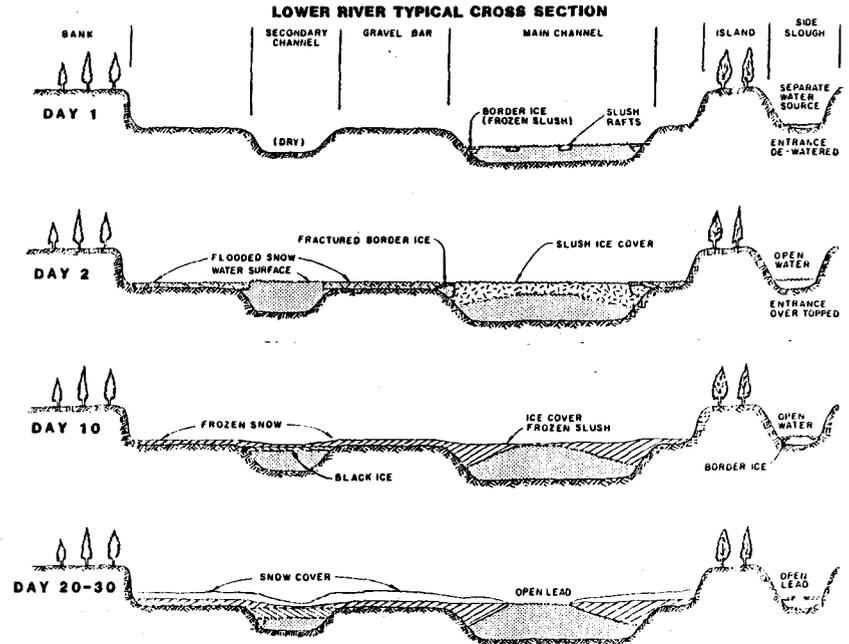
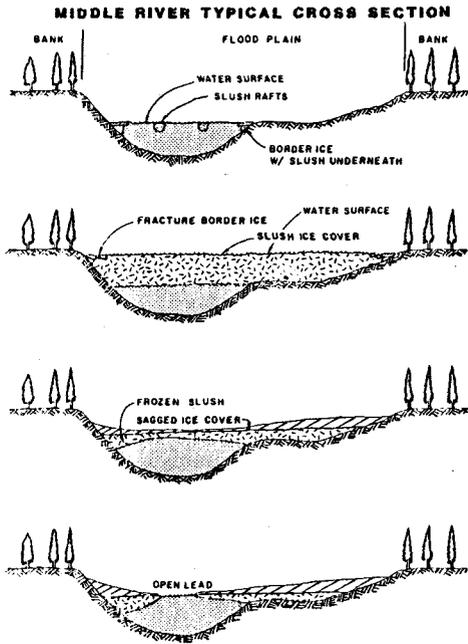
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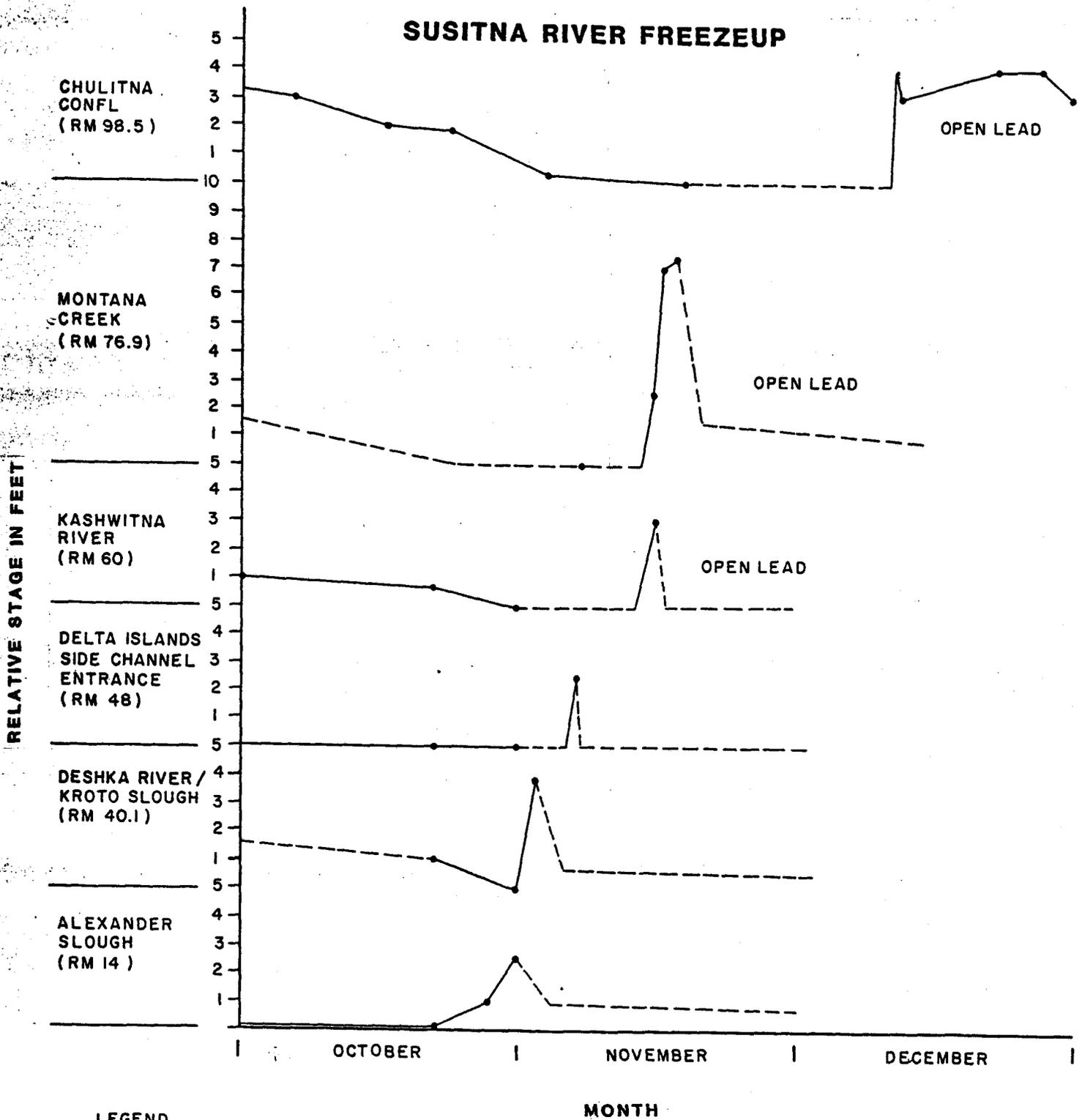




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RELATIVE STAGE LEVELS AT SELECTED SITES DURING 1983

SUSITNA RIVER FREEZEUP

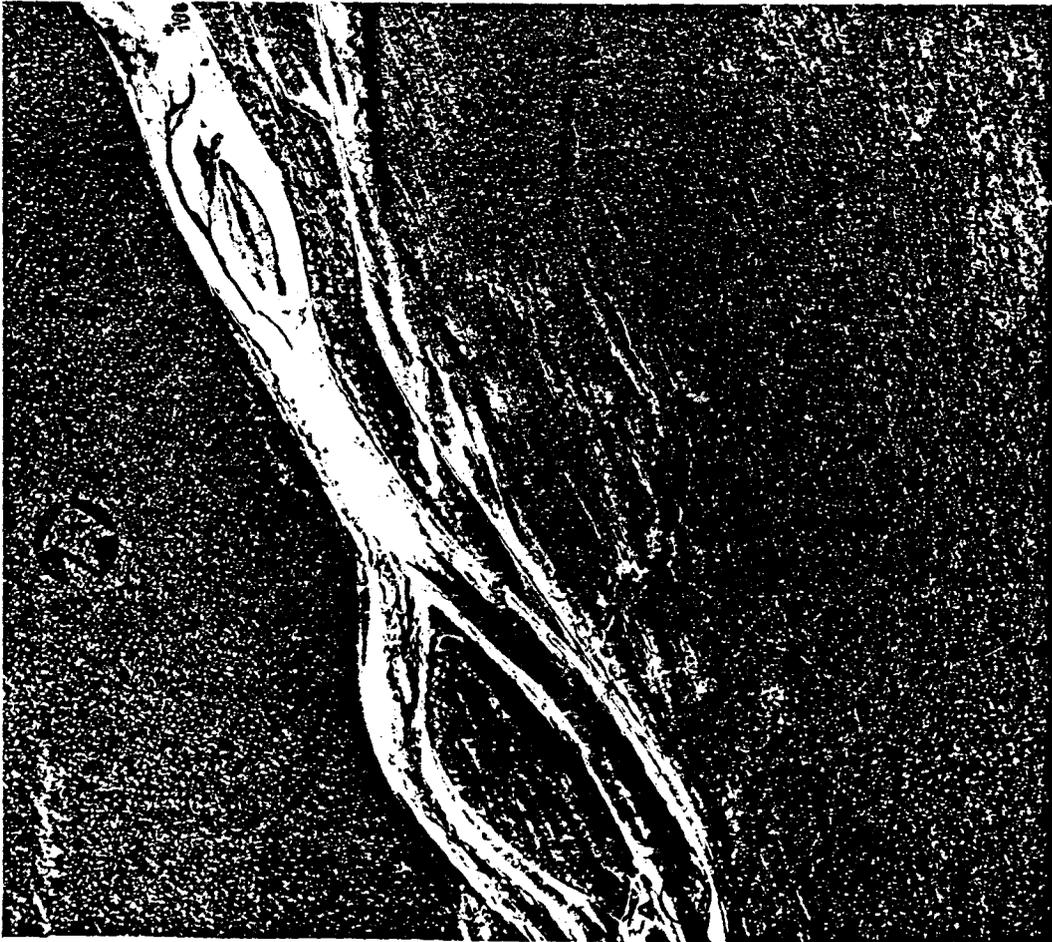
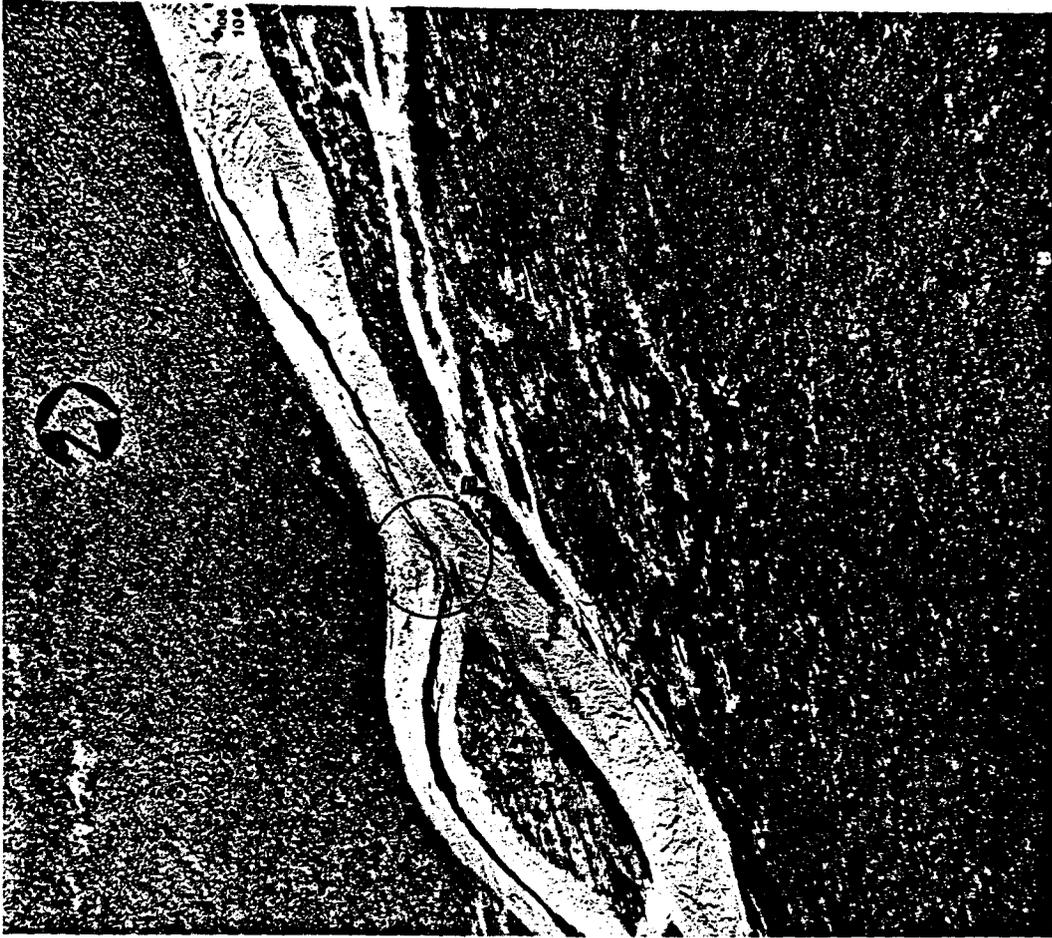


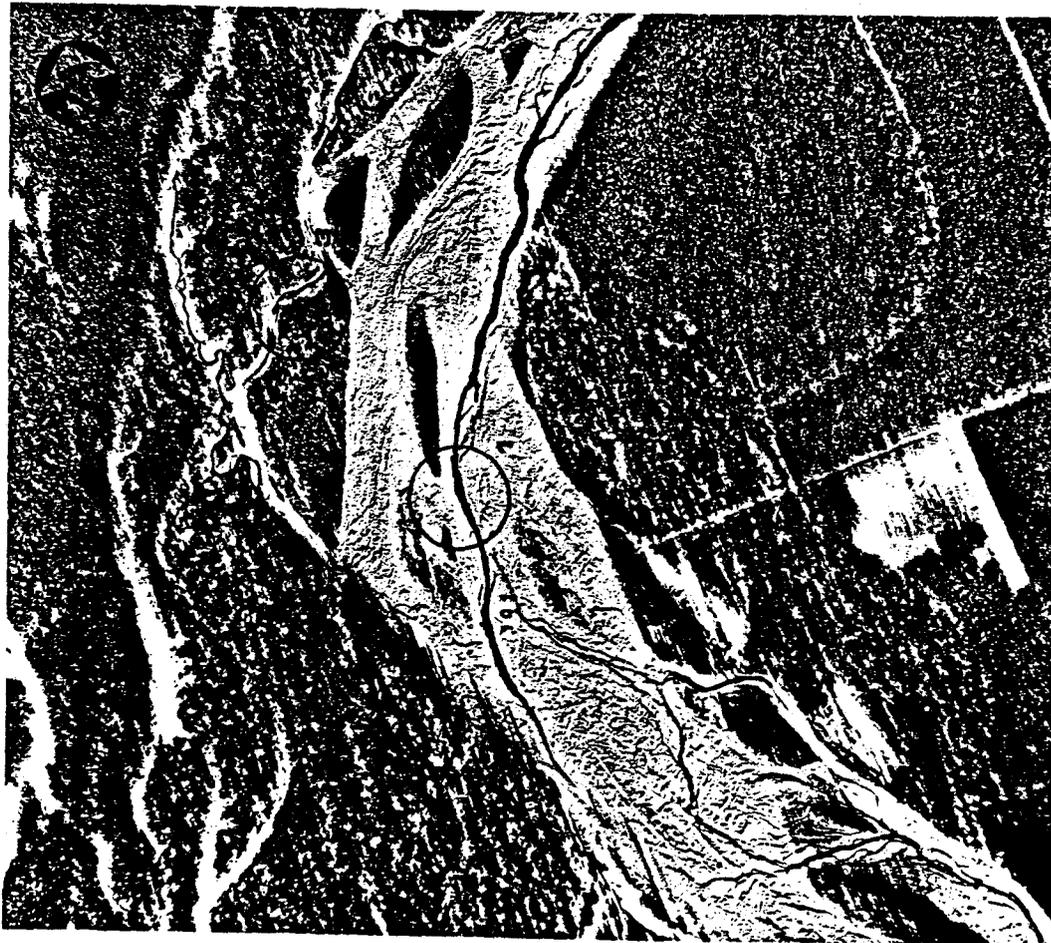
LEGEND

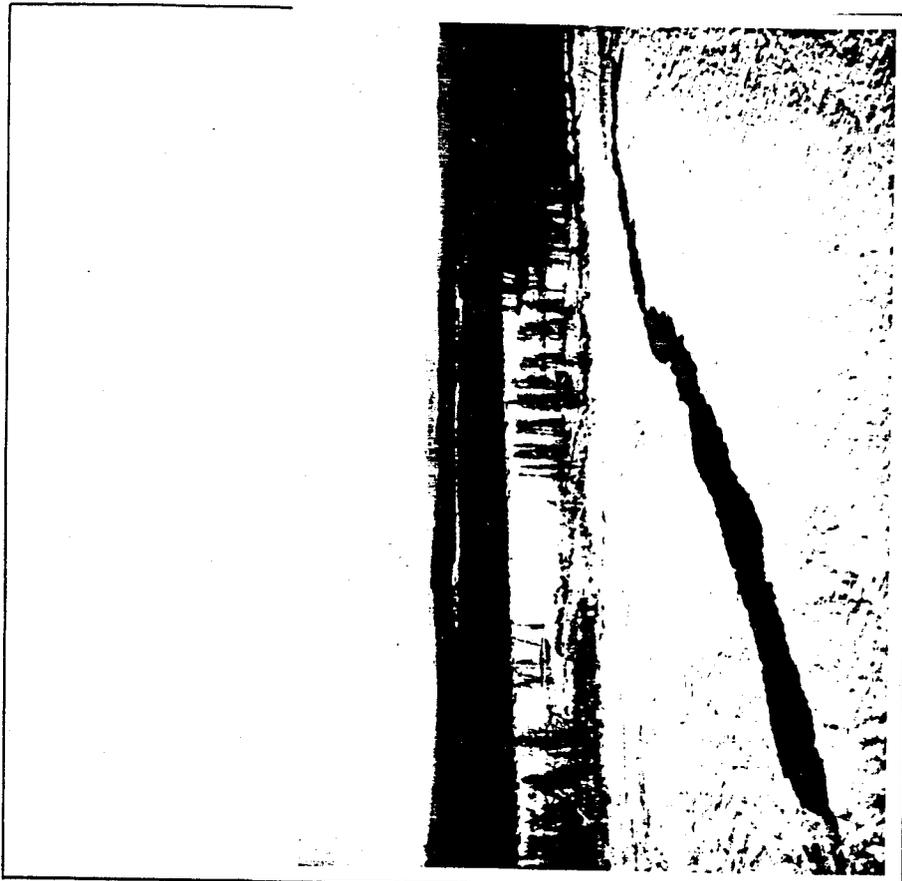
- INTERPRETATION BASED ON OBSERVATION
- INTERPRETED STAGE BETWEEN DATA POINTS
- SURVEYED DATA POINTS





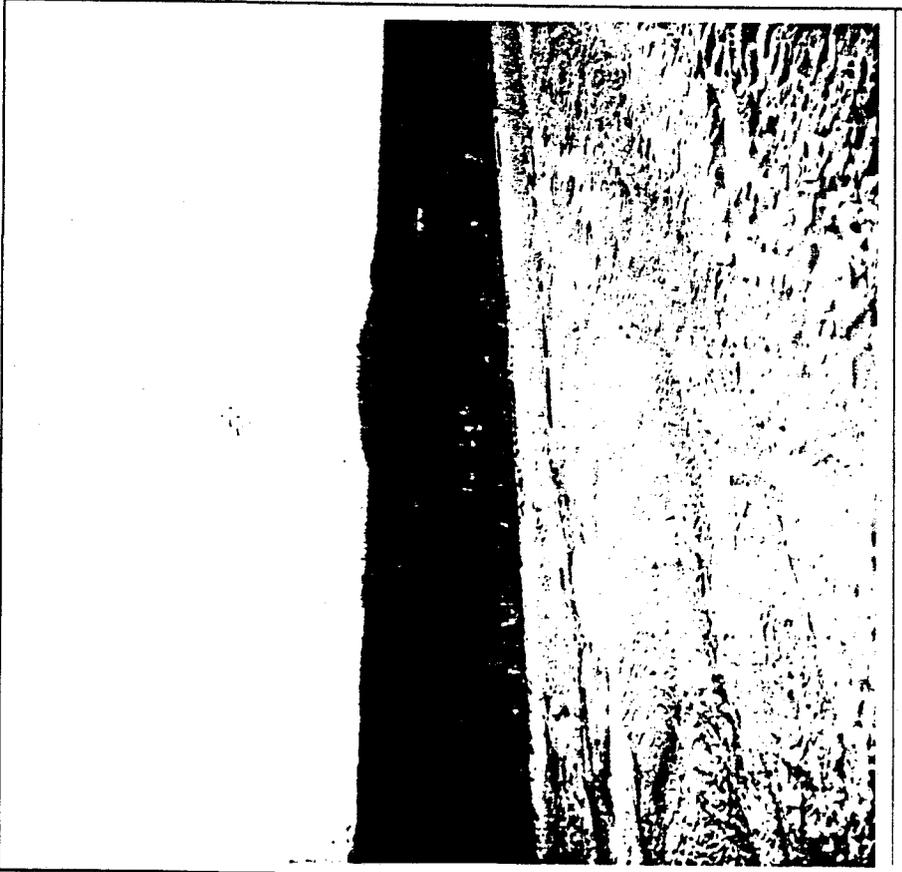






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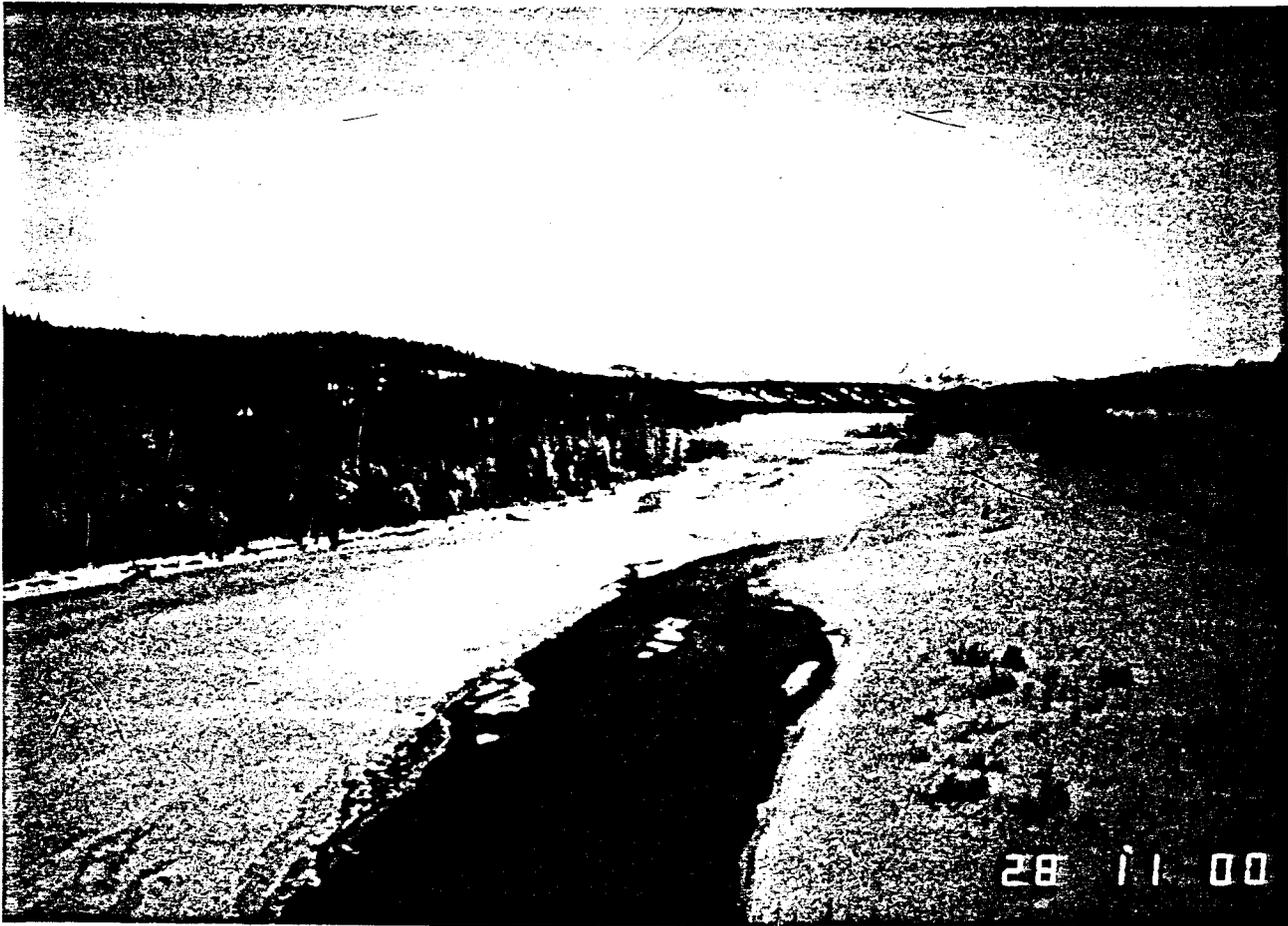


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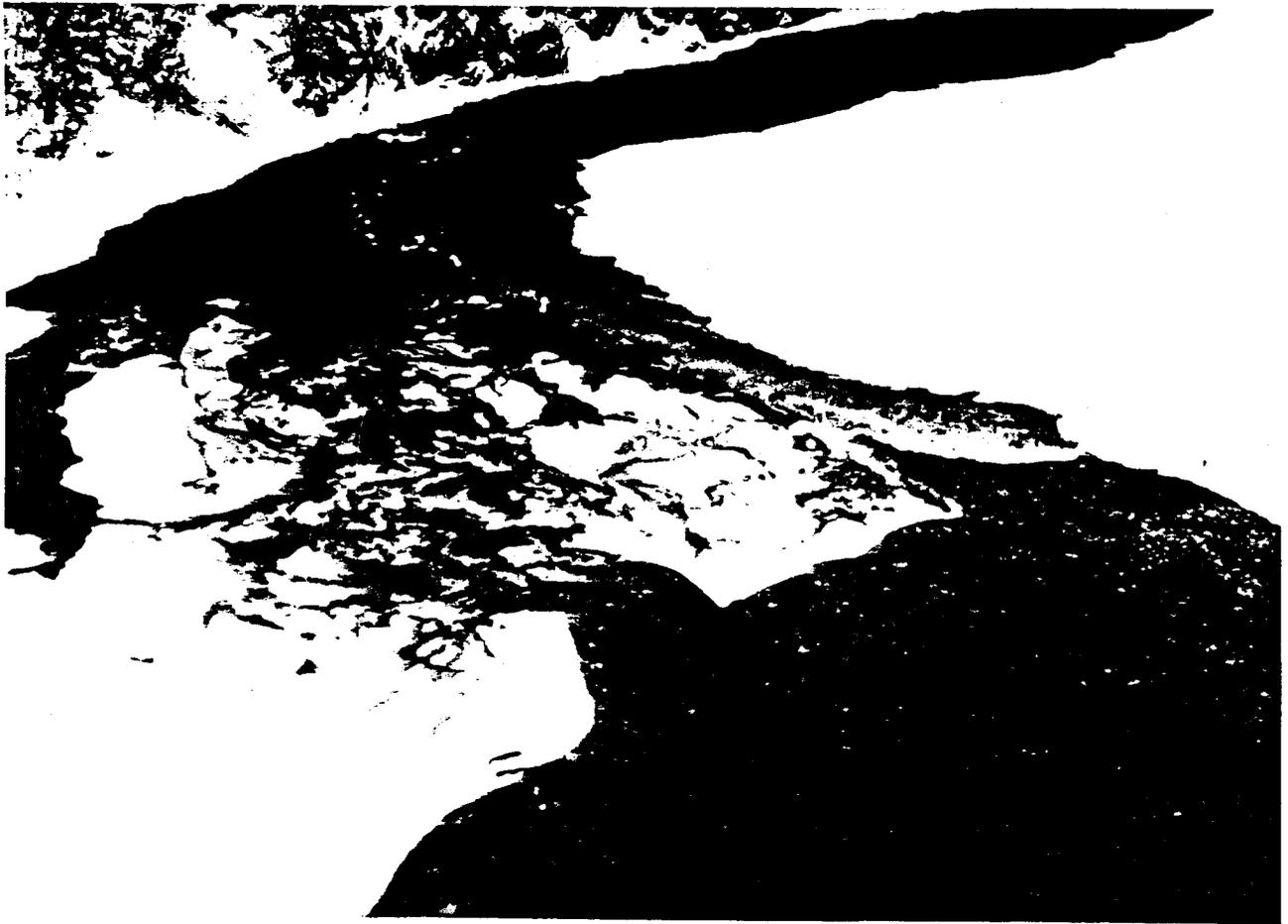
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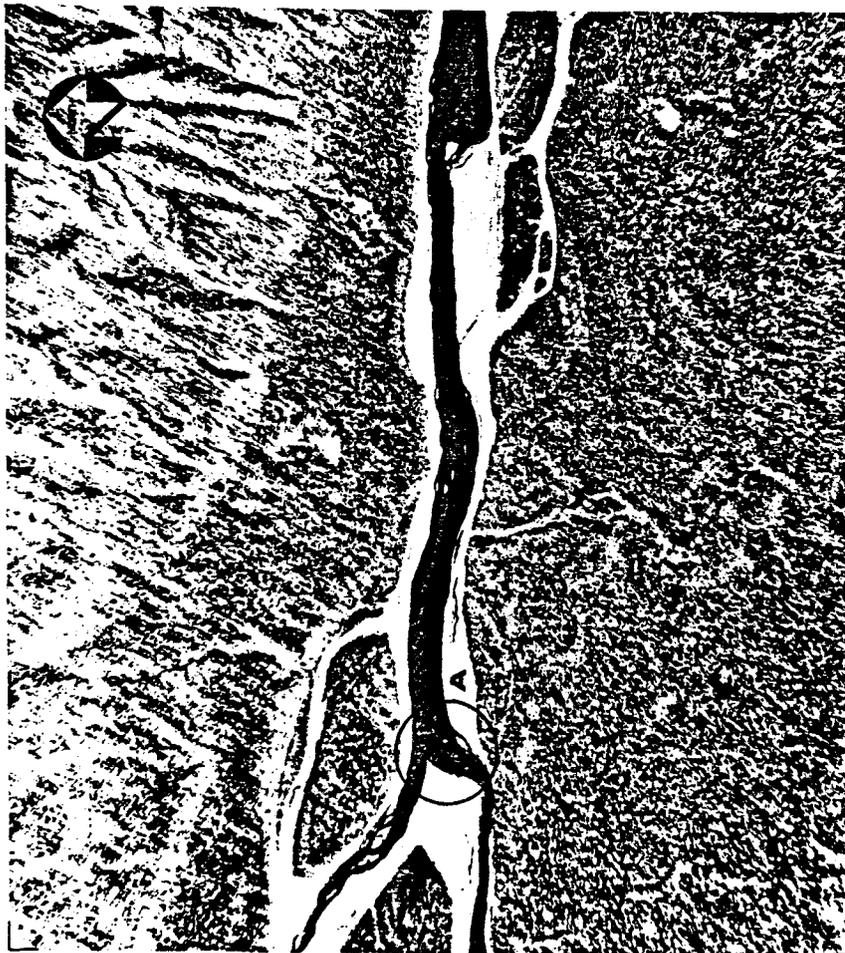
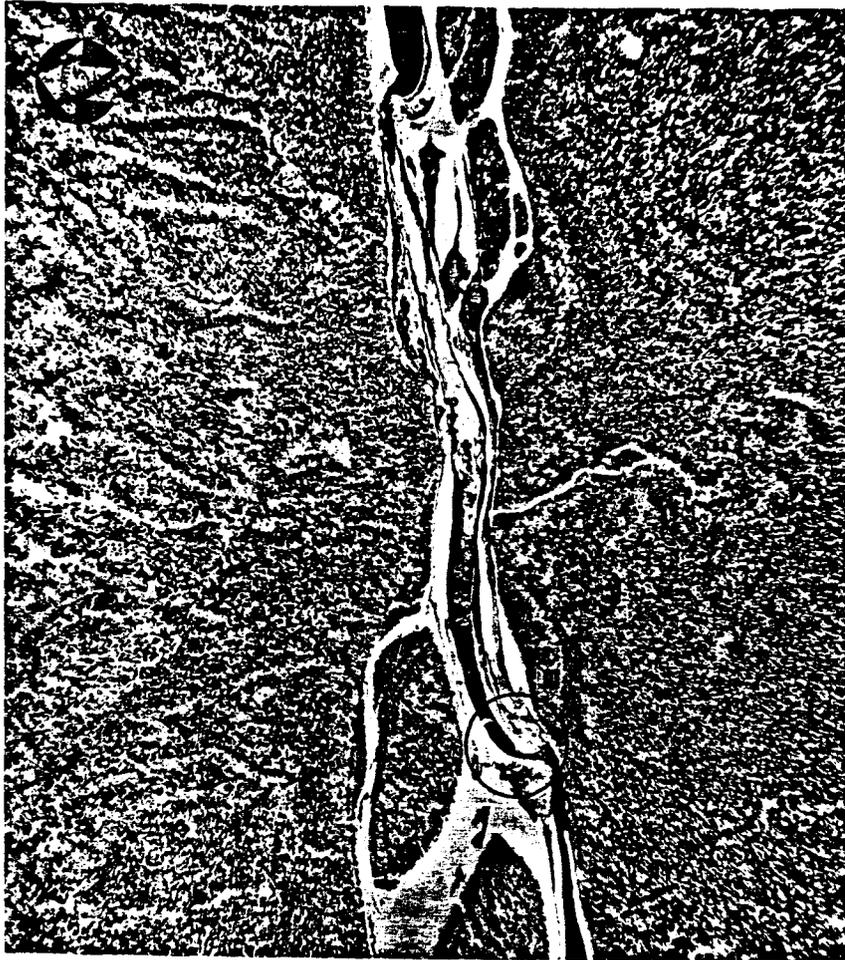
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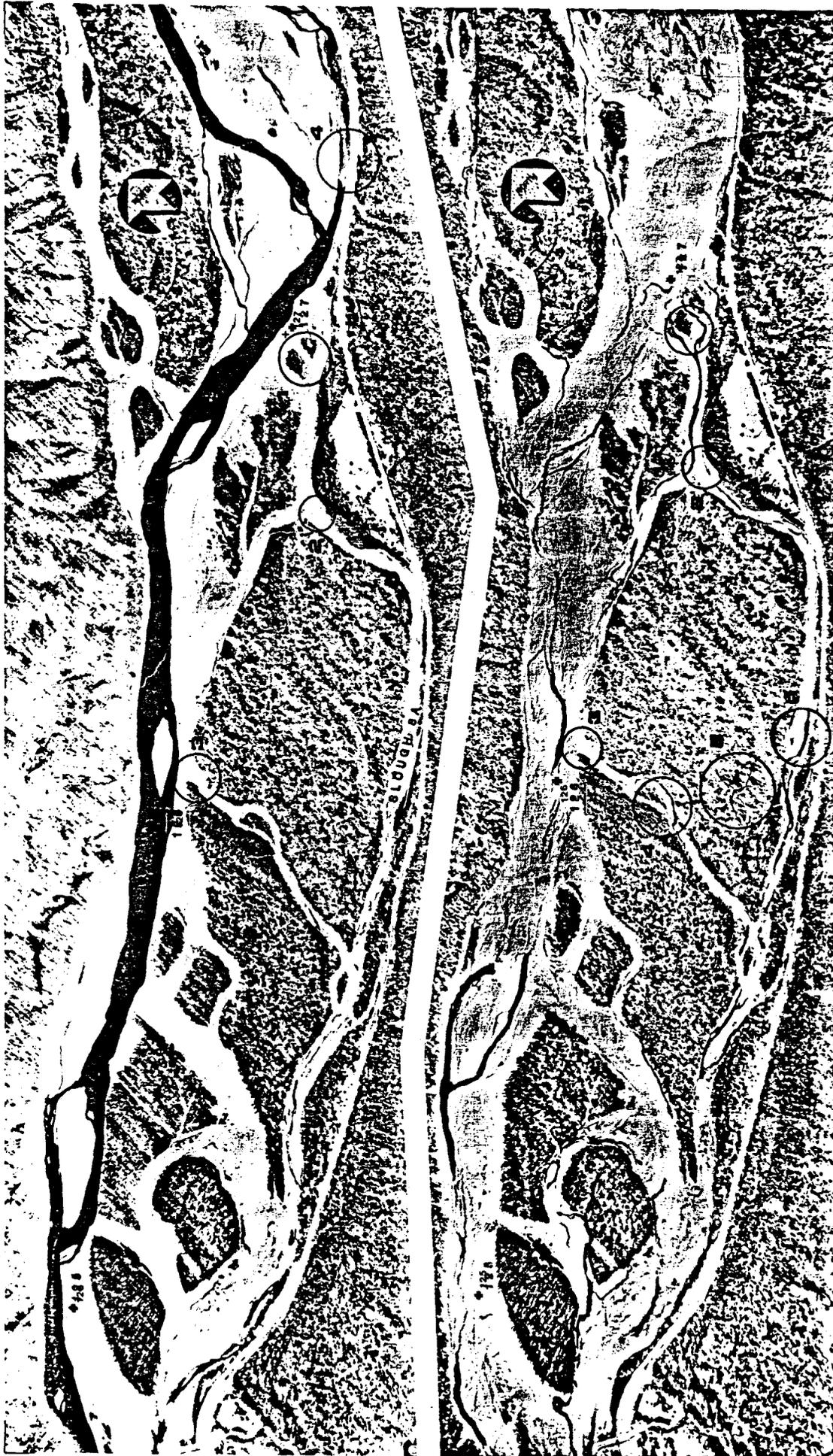
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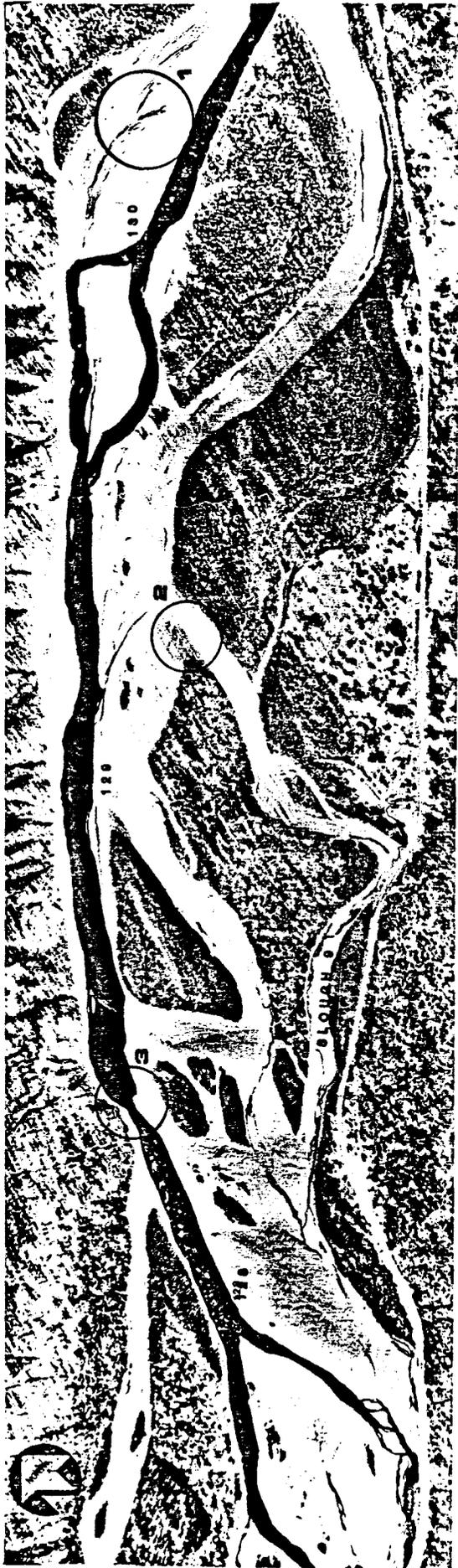
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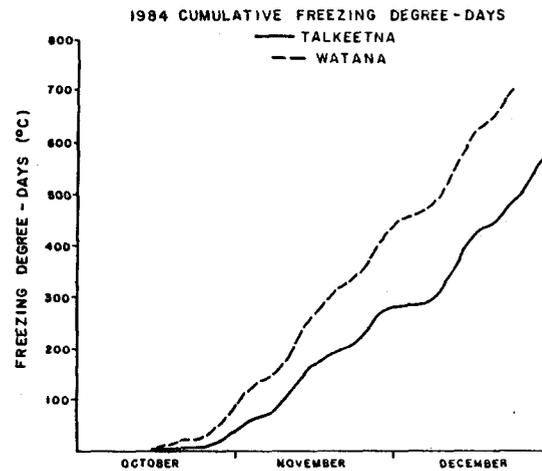
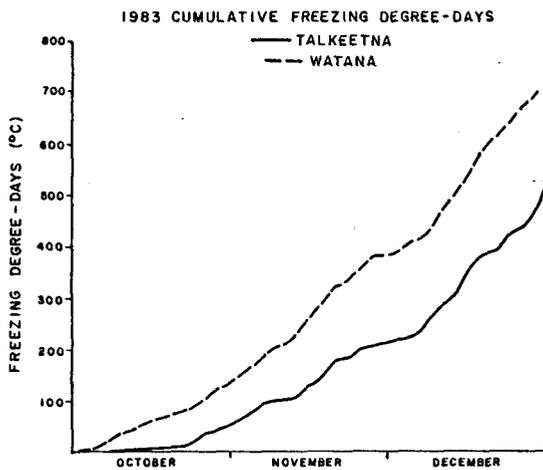
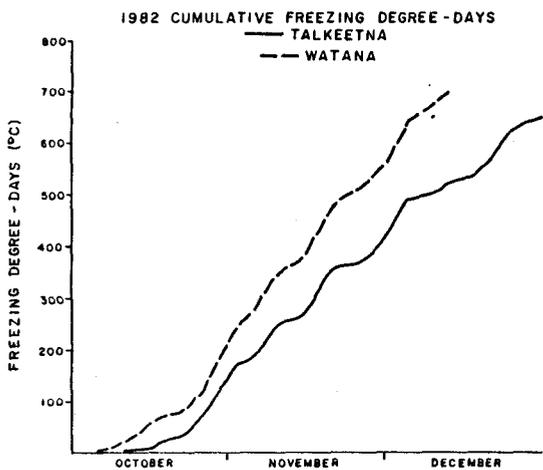
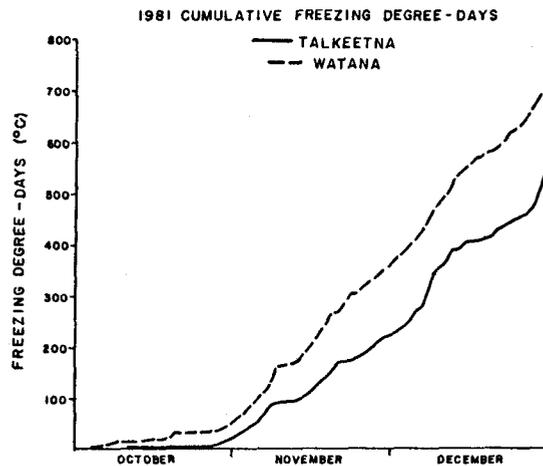
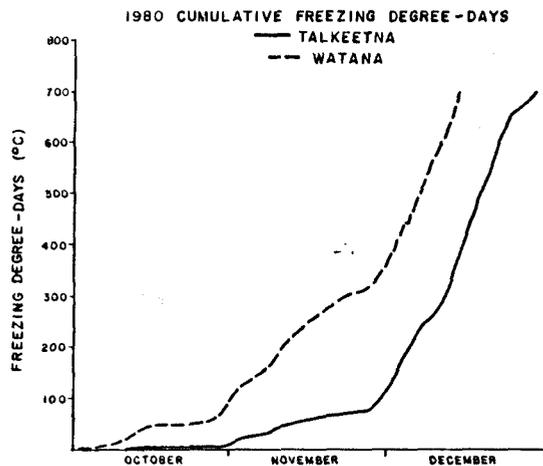




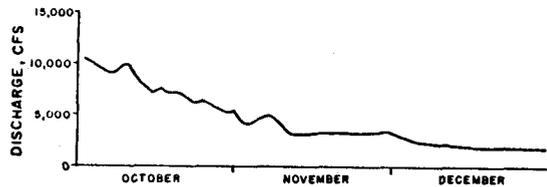




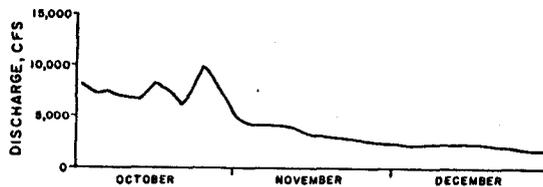
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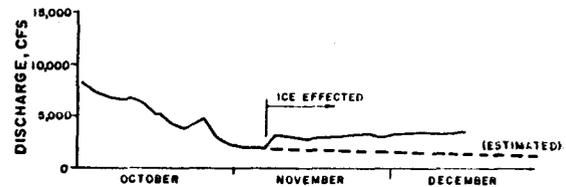
1980 USGS STREAMFLOW RECORD
GOLD CREEK



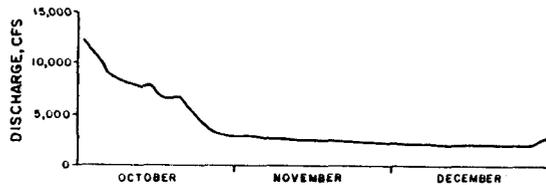
1981 USGS STREAMFLOW RECORD
GOLD CREEK



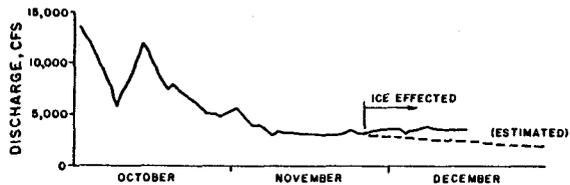
1984 R&M CONSULTANTS STREAMFLOW RECORD
GOLD CREEK
(BASED ON WIRE WEIGHT READINGS)



1982 USGS STREAMFLOW RECORD
GOLD CREEK

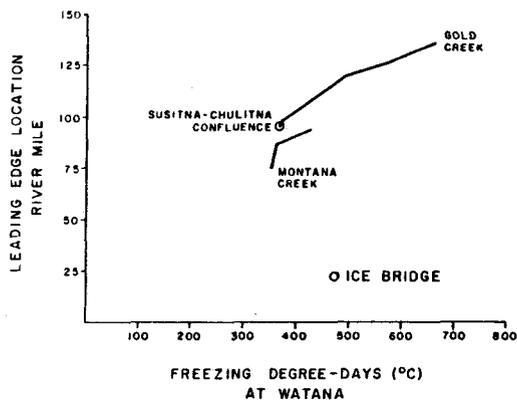


1983 R&M CONSULTANTS STREAMFLOW RECORD
GOLD CREEK
(BASED ON WIRE WEIGHT READINGS)

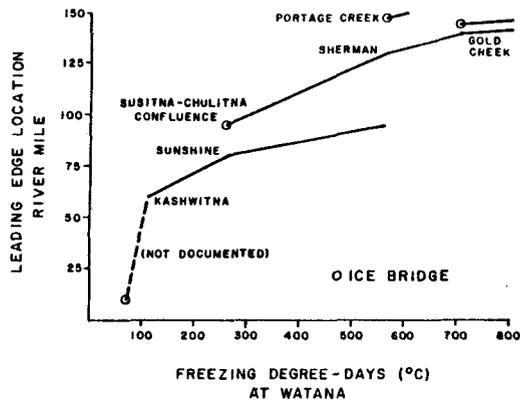


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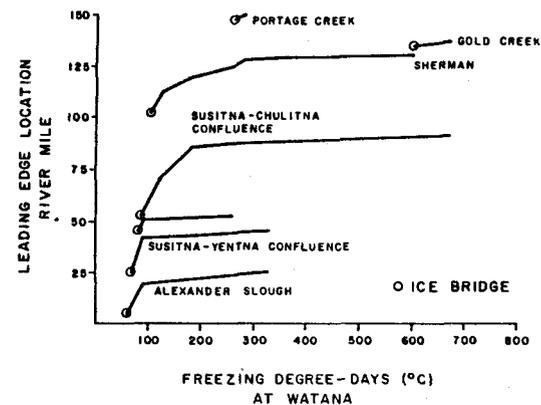
1980 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



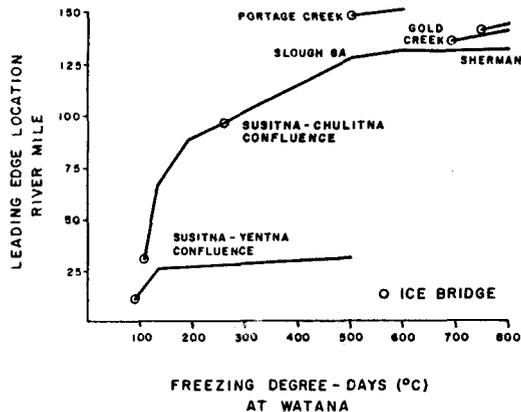
1981 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



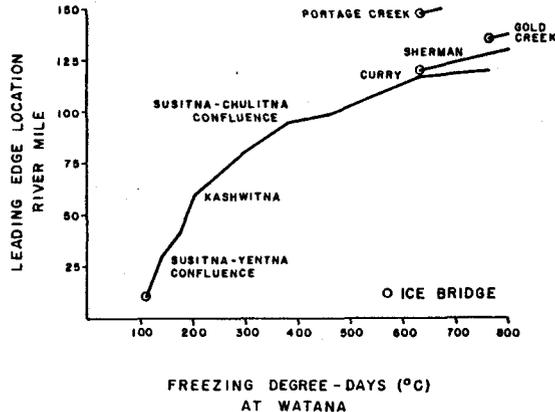
1984 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



1982 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



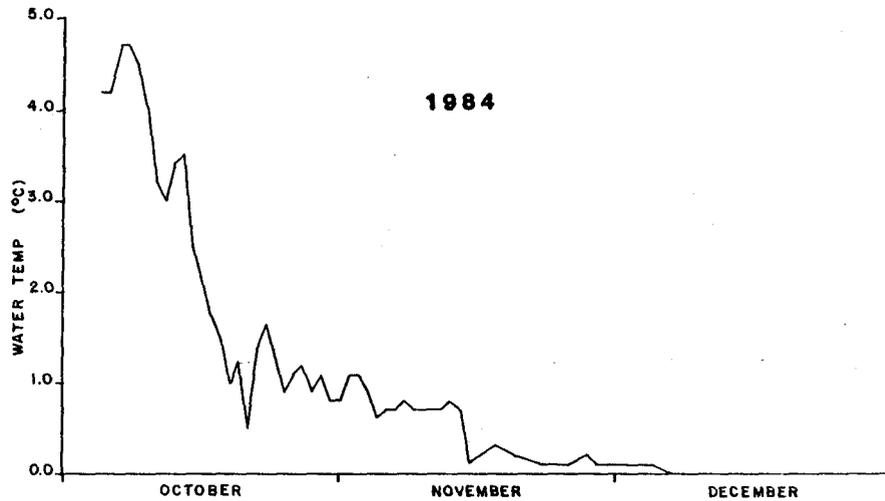
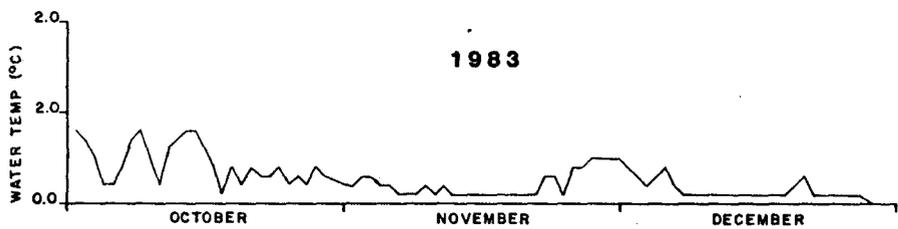
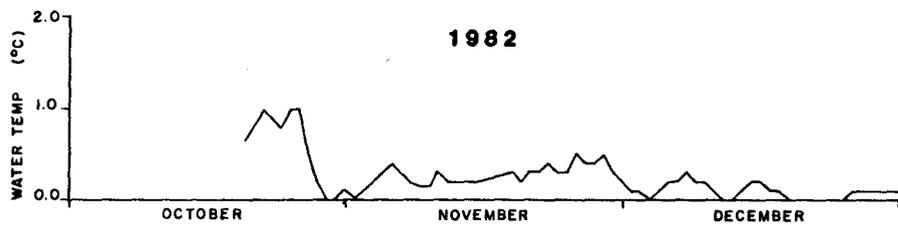
1983 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



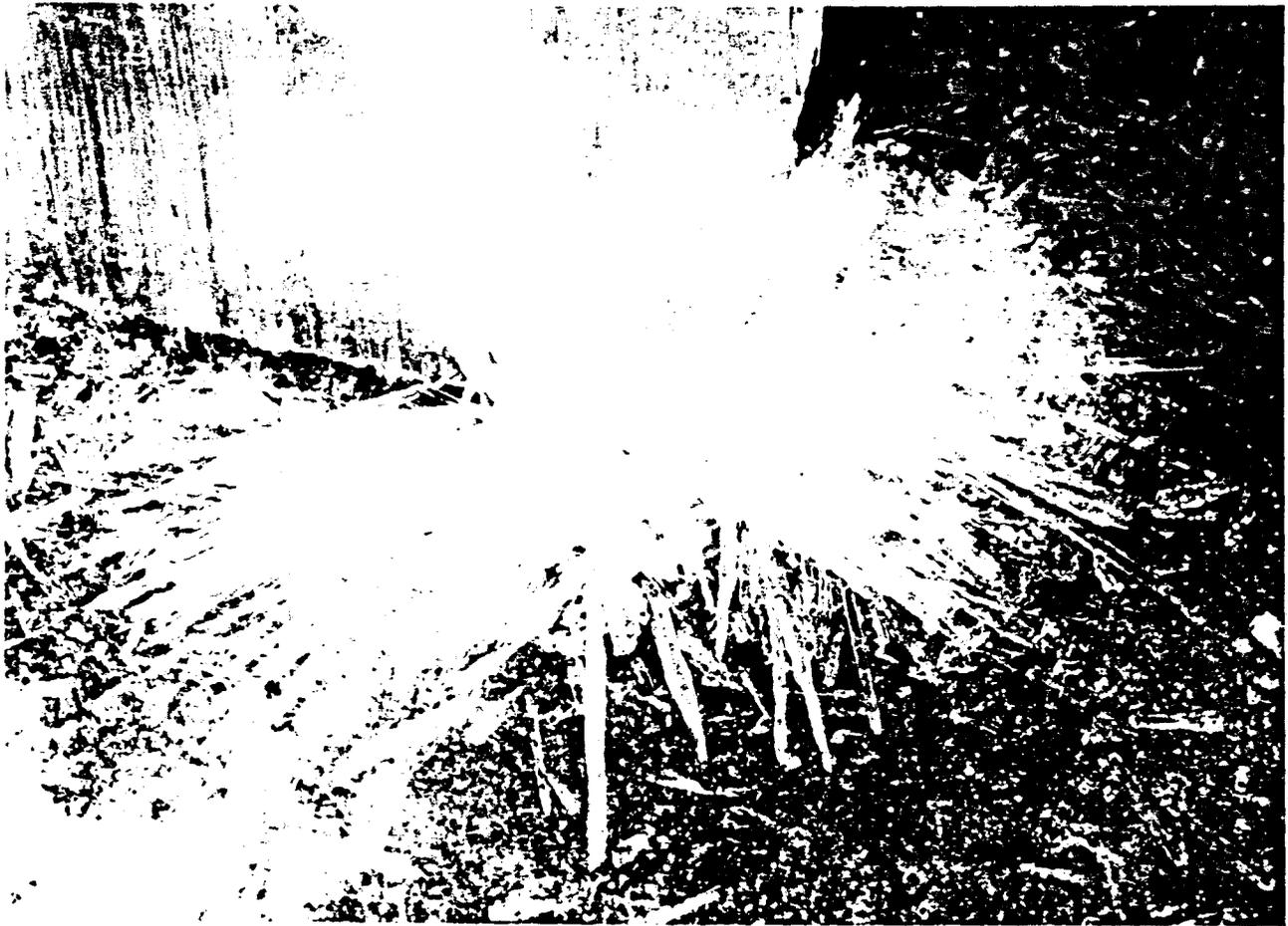
LOCATION	RIVER MILE
ALEXANDER SLOUGH	RM 19
YENTNA RIVER CONFLUENCE	RM 26
KASHWITNA RIVER	RM 60
MONTANA CREEK	RM 78
SUNSHINE	RM 84
CHULITNA RIVER CONFLUENCE	RM 98.5
SLOUGH 8A	RM 126
SHERMAN	RM 130
GOLD CREEK	RM 136.6
PORTAGE CREEK	RM 149

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WATER TEMPERATURES AT GOLD CREEK



72



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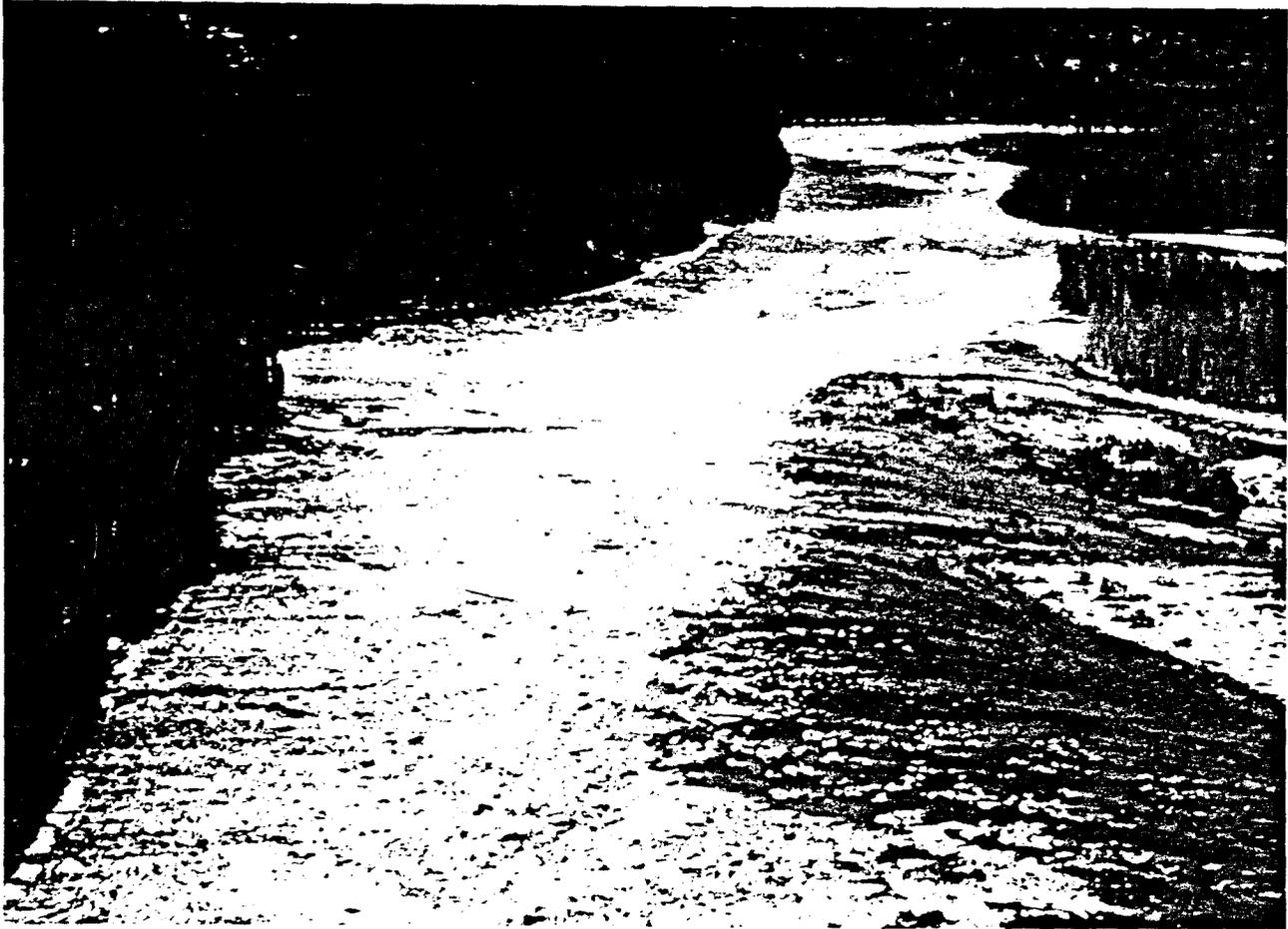
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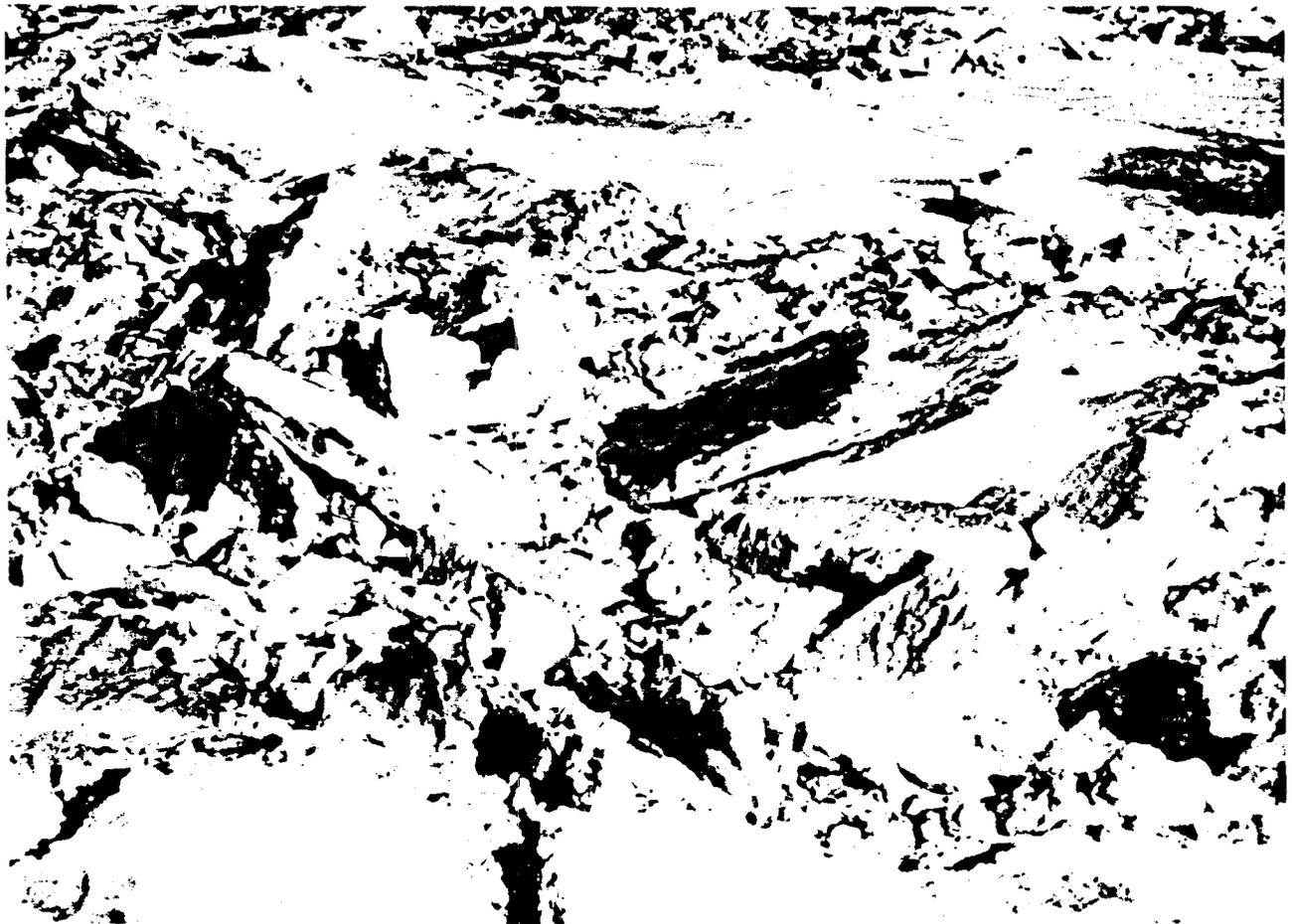
R&M CONSULTANTS, INC.

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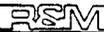
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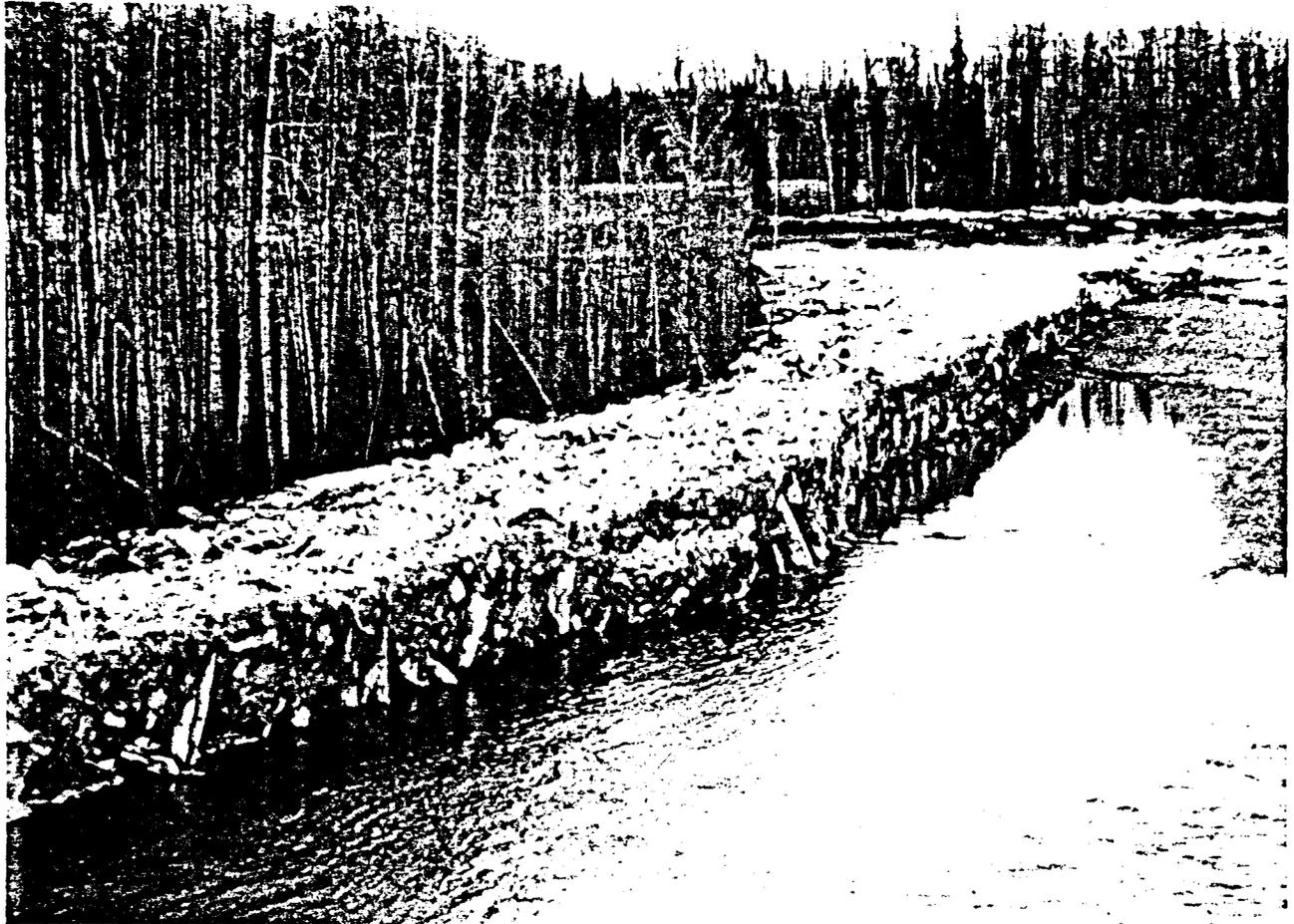
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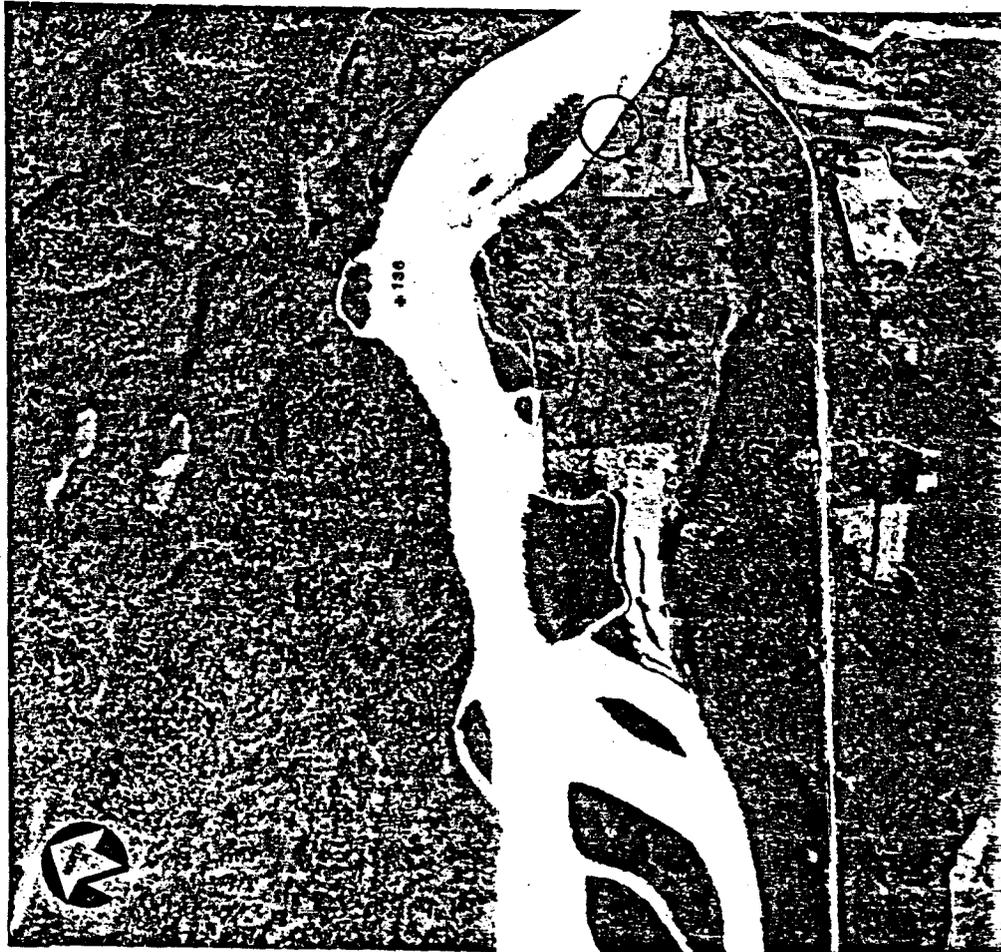
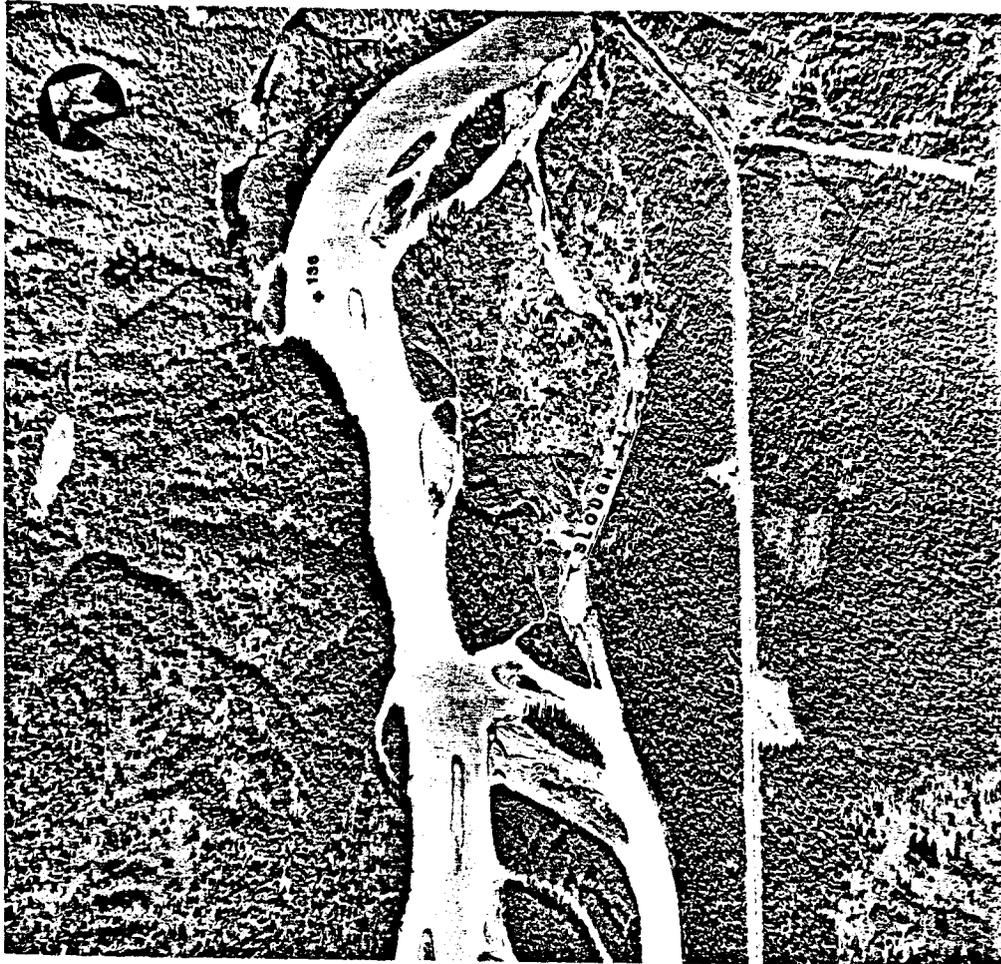
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SUSITNA JOINT VENTURE



SUSITNA PROJECT
TALKEETNA AIR TEMPERATURES
NOVEMBER - MARCH
1944 - 1983

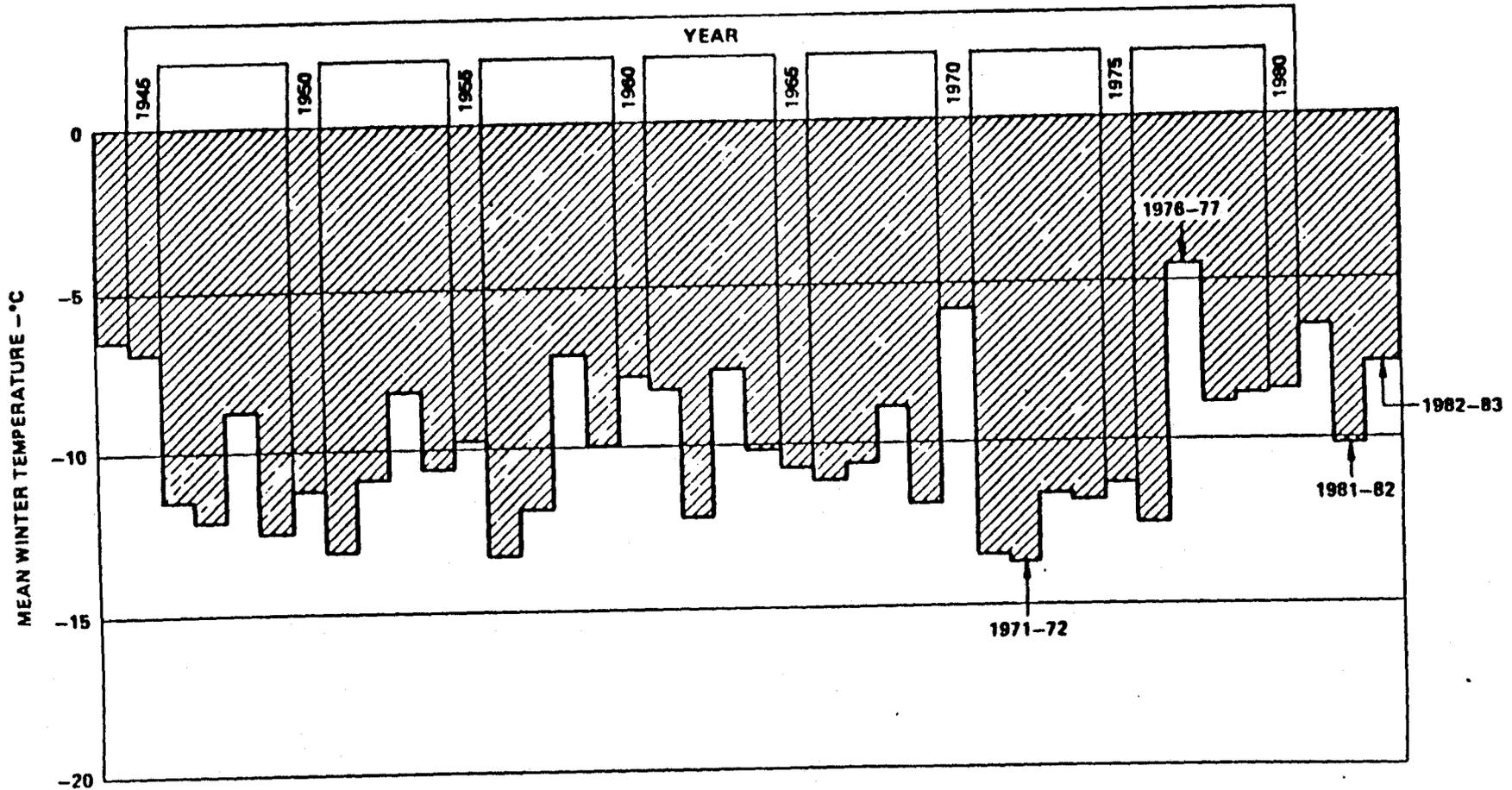


FIGURE 5

1001

102

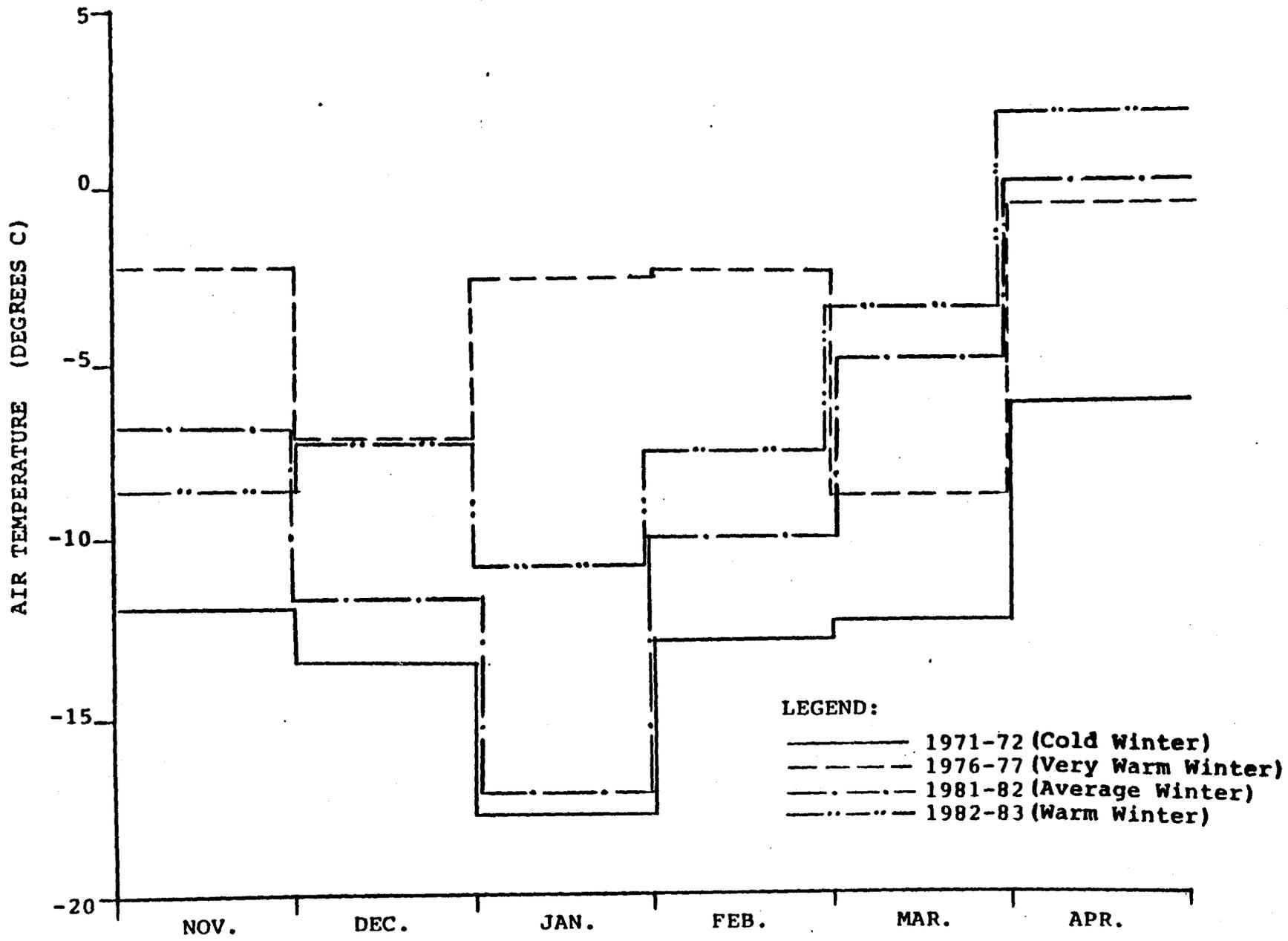
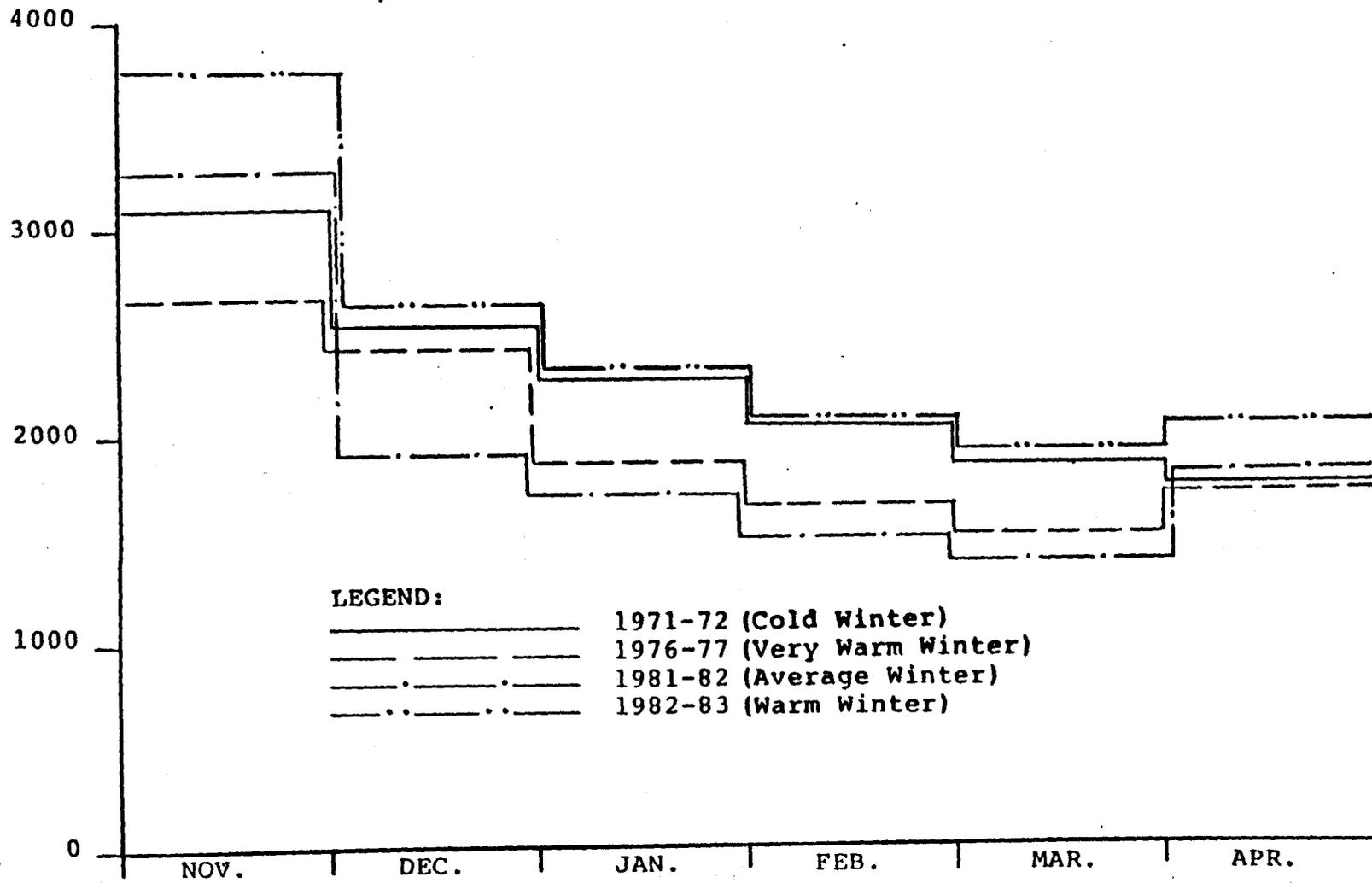


FIGURE 3 - AVERAGE MONTHLY AIR TEMPERATURES AT TALKEETNA

MARZA-EBASCO

EXHIBIT 2
5.54

SI KEARLE DON (103)



LEGEND:

- 1971-72 (Cold Winter)
- - - - - 1976-77 (Very Warm Winter)
- . - . - 1981-82 (Average Winter)
- 1982-83 (Warm Winter)

Harza - SUSITNA RIVER NATURAL STREAMFLOWS AT GOLD CREEK - AVERAGE MONTHLY VALUES

EXHIBIT 3.
A19.55

601

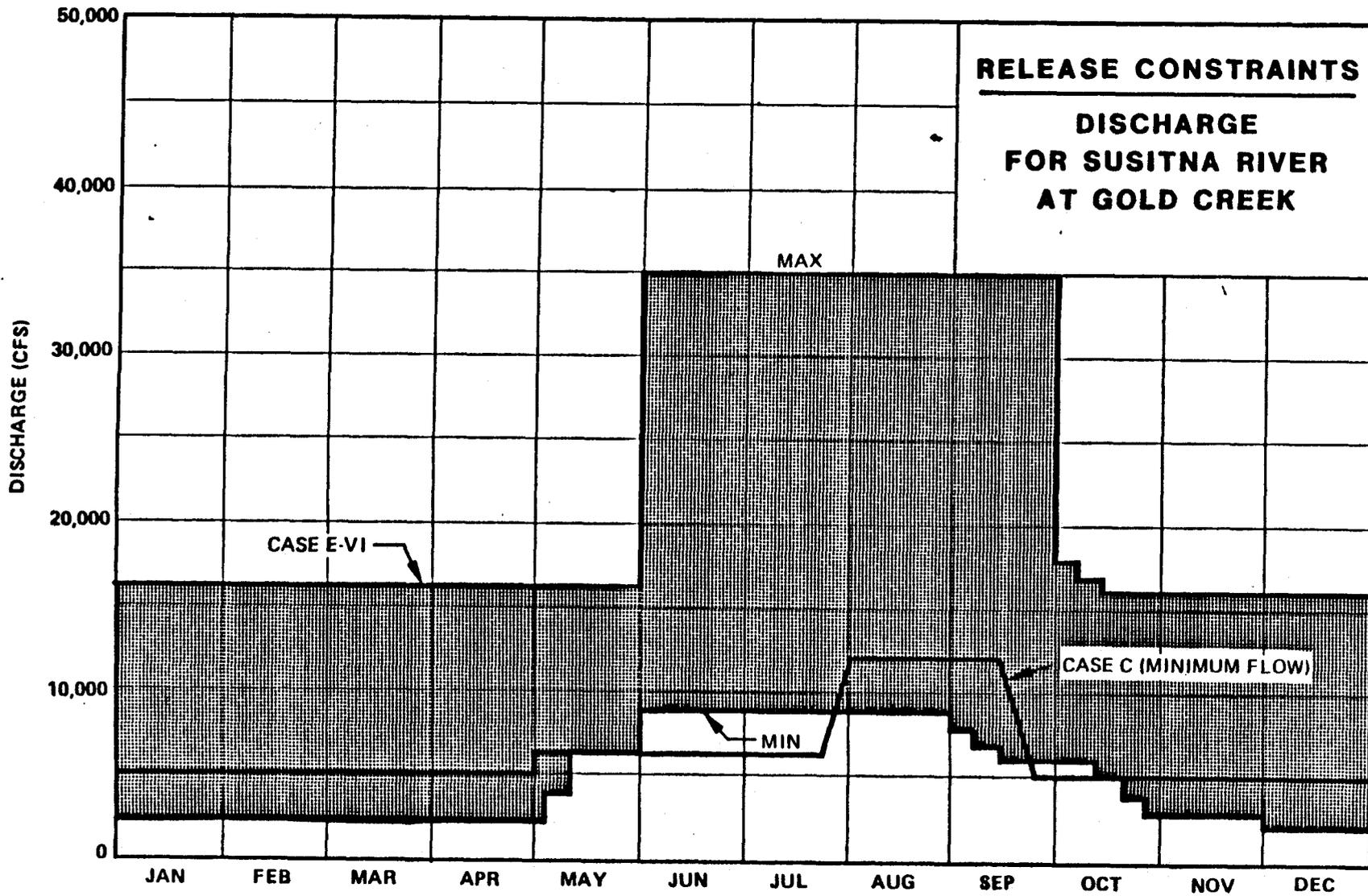
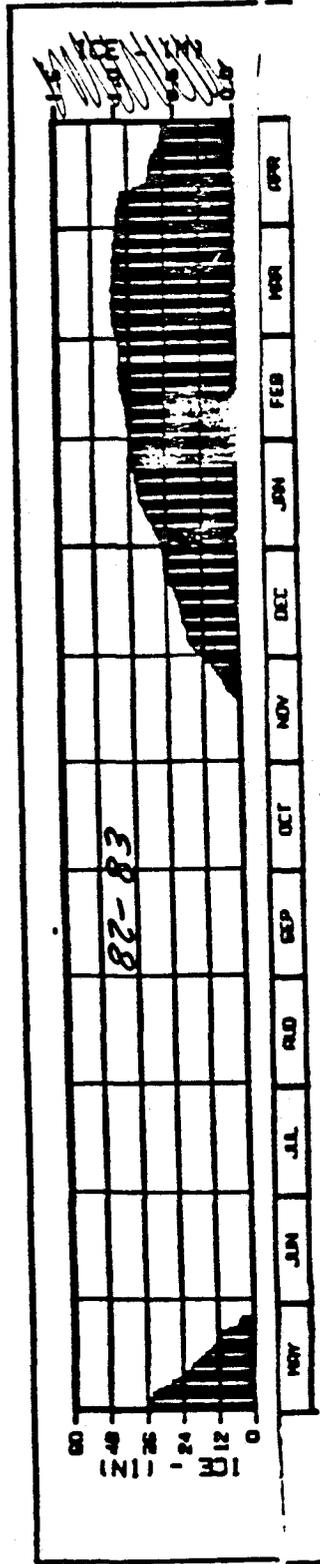
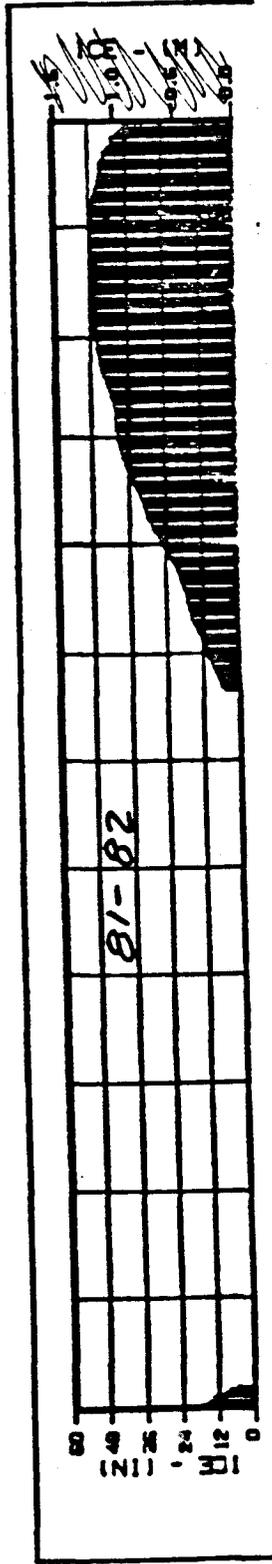
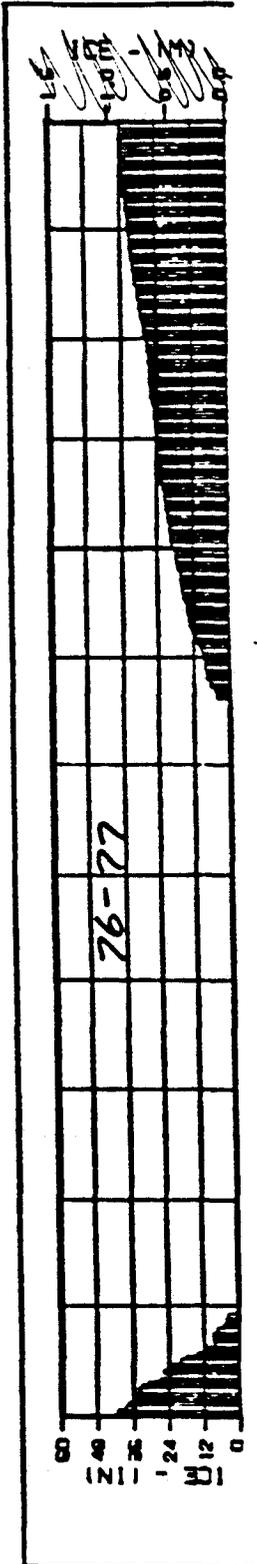
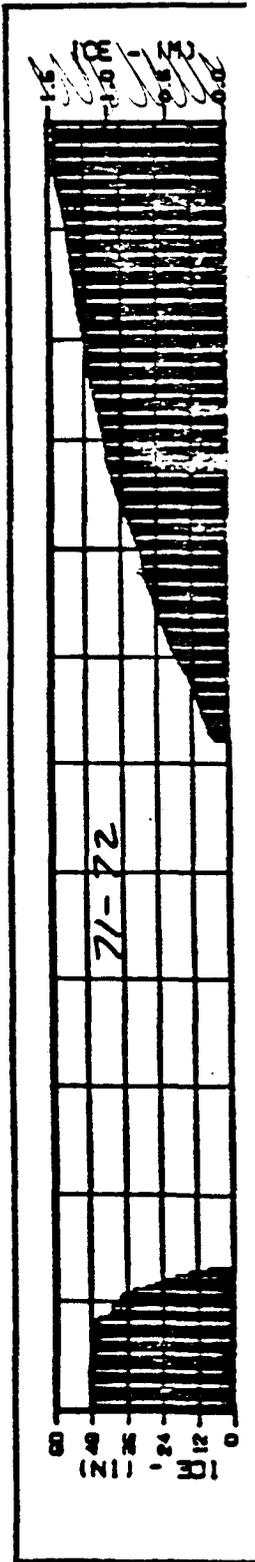


EXHIBIT - 4
Fig. 56

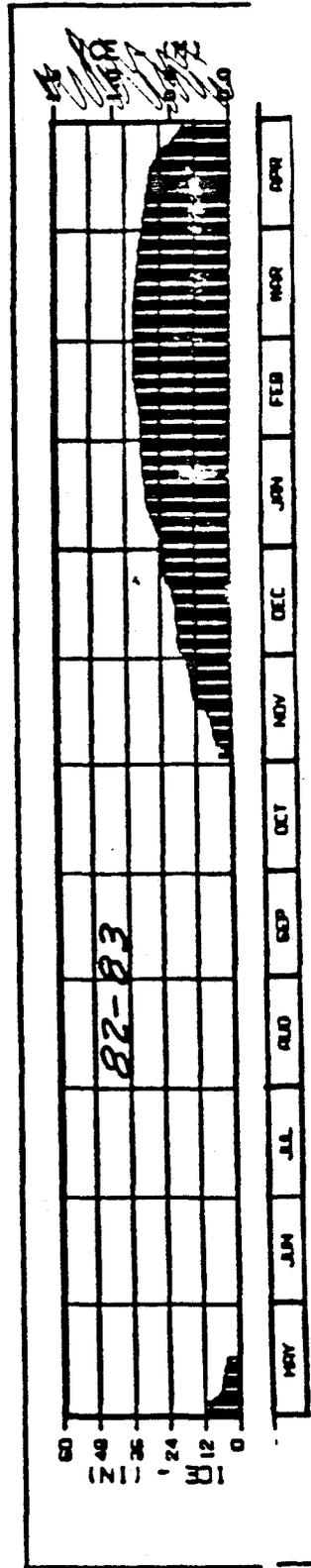
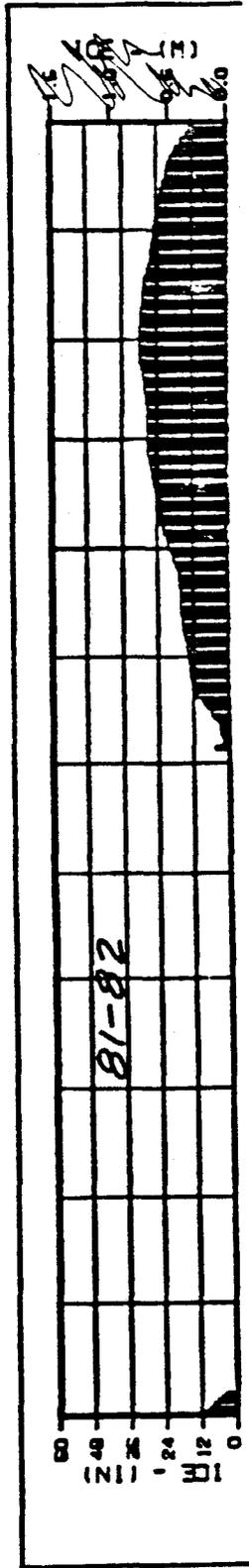
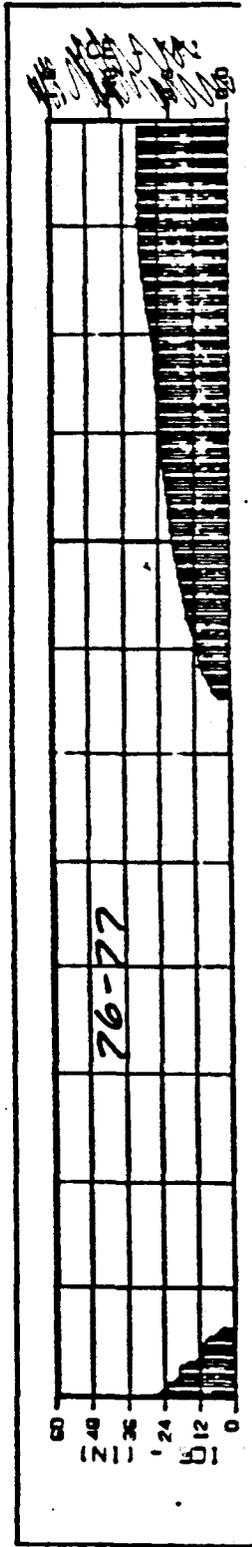
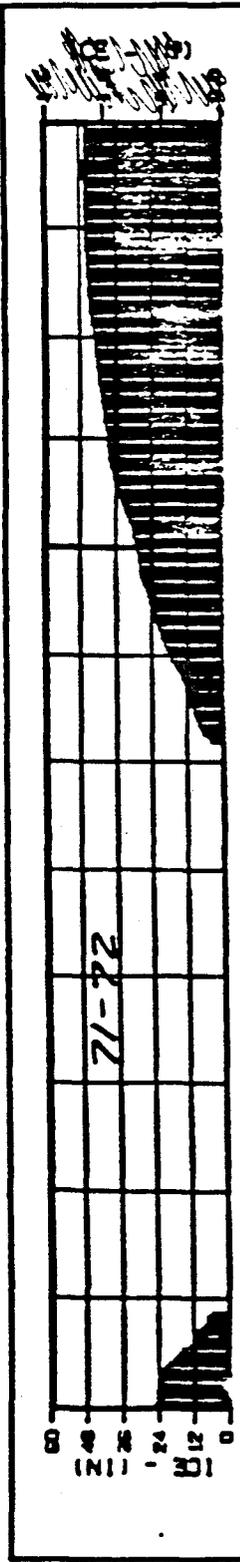


HARZA-ENERGO JOINT VENTURE
 PROJECT: NA 000000 0 JAN 80 01-0000-00

NATANA RESERVOIR
 ICE GROWTH

1996-CASE C

ALASKA POWER AUTHORITY
 QUALITY PROJECT GREEN PAPER



ALASKA POWER AUTHORITY
SUSTAIN PROJECT DIVISION MODEL

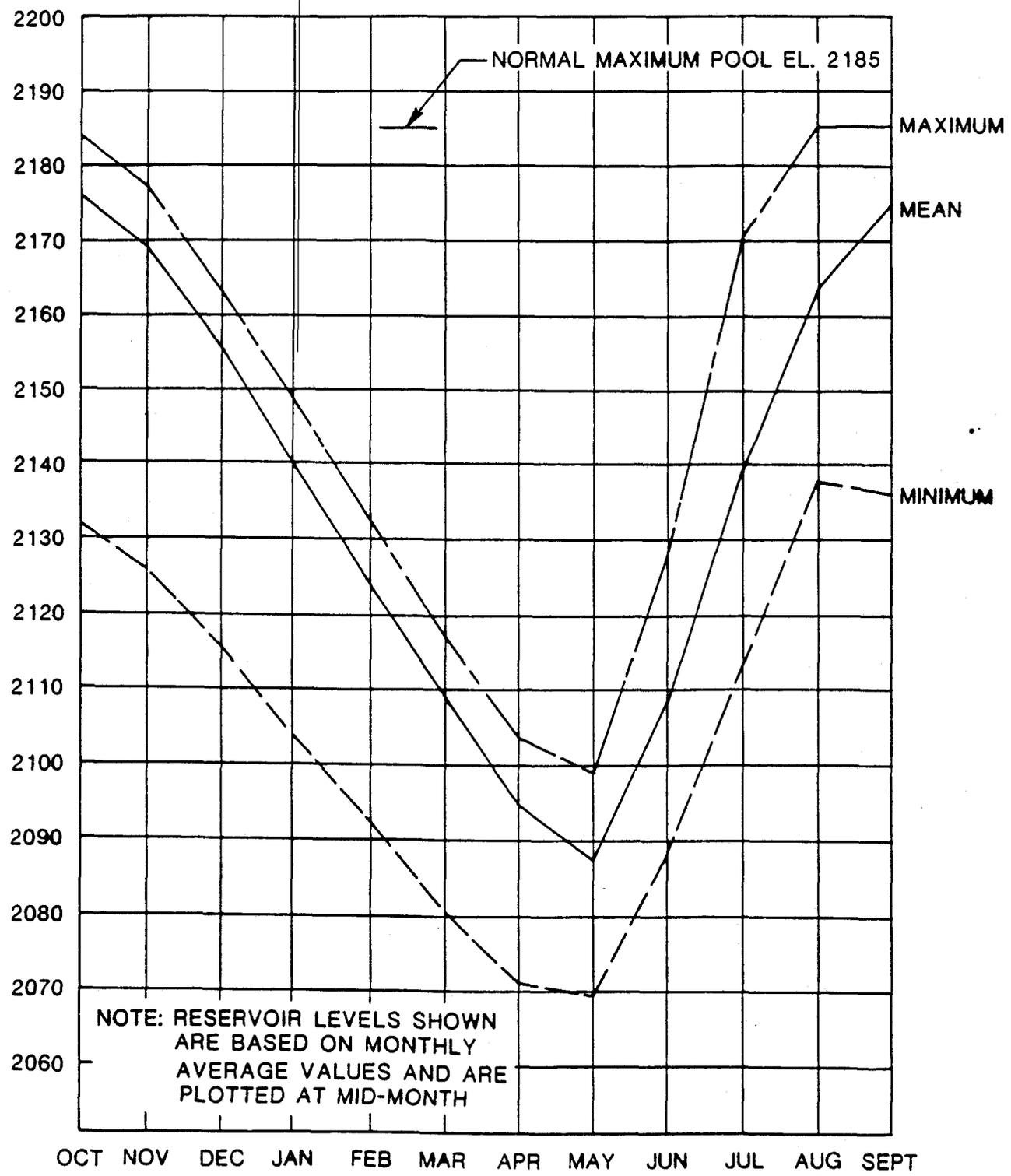
DEVIL CANYON RESERVOIR
ICE GROWTH

2002-CASE C

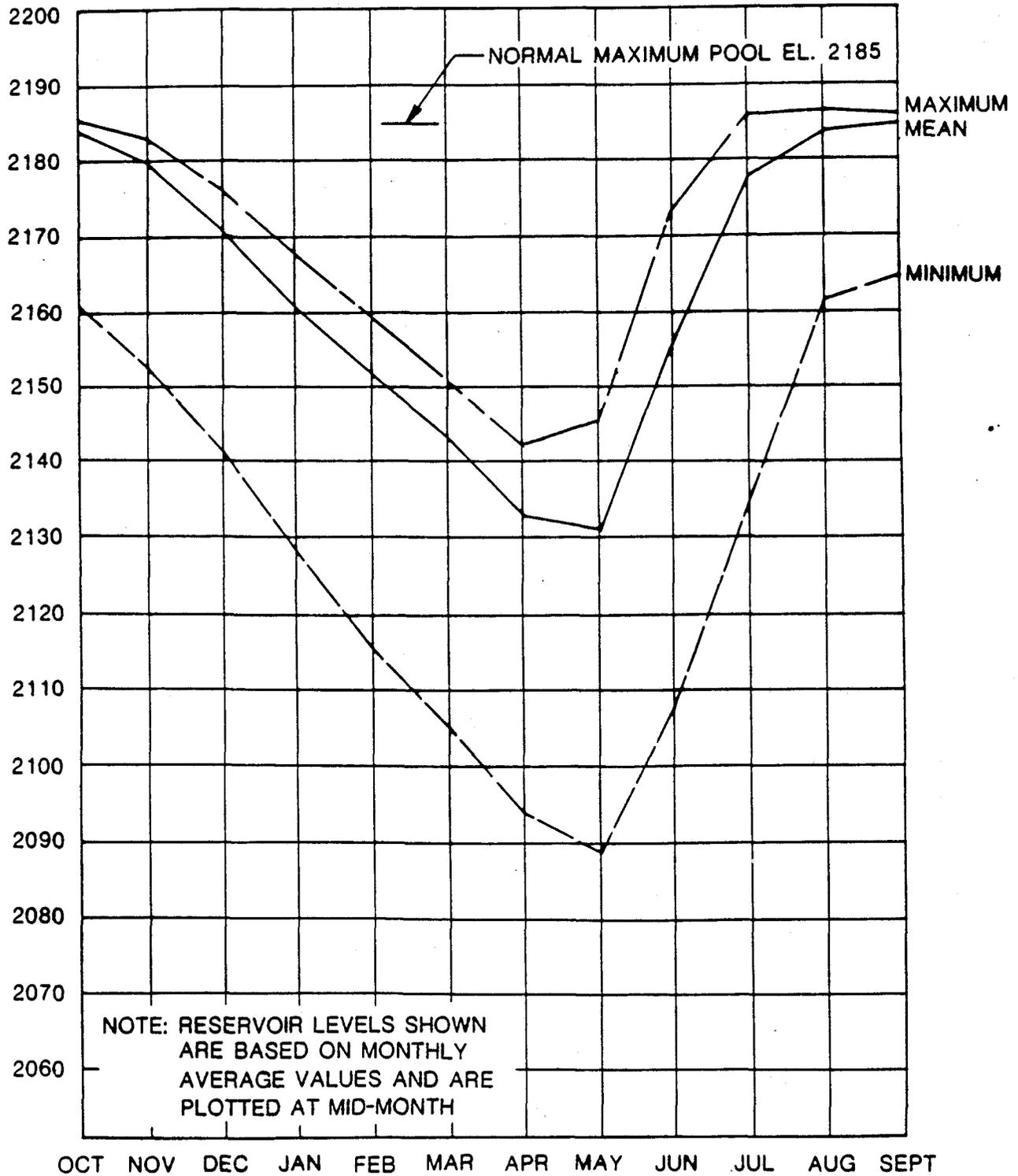
HARZA-EBECO JOINT VENTURE
SUSTAIN PROJECT DIVISION MODEL

59

WATANA RESERVOIR WATER LEVELS WATANA ONLY OPERATING 2001 SIMULATION CASE E-VI

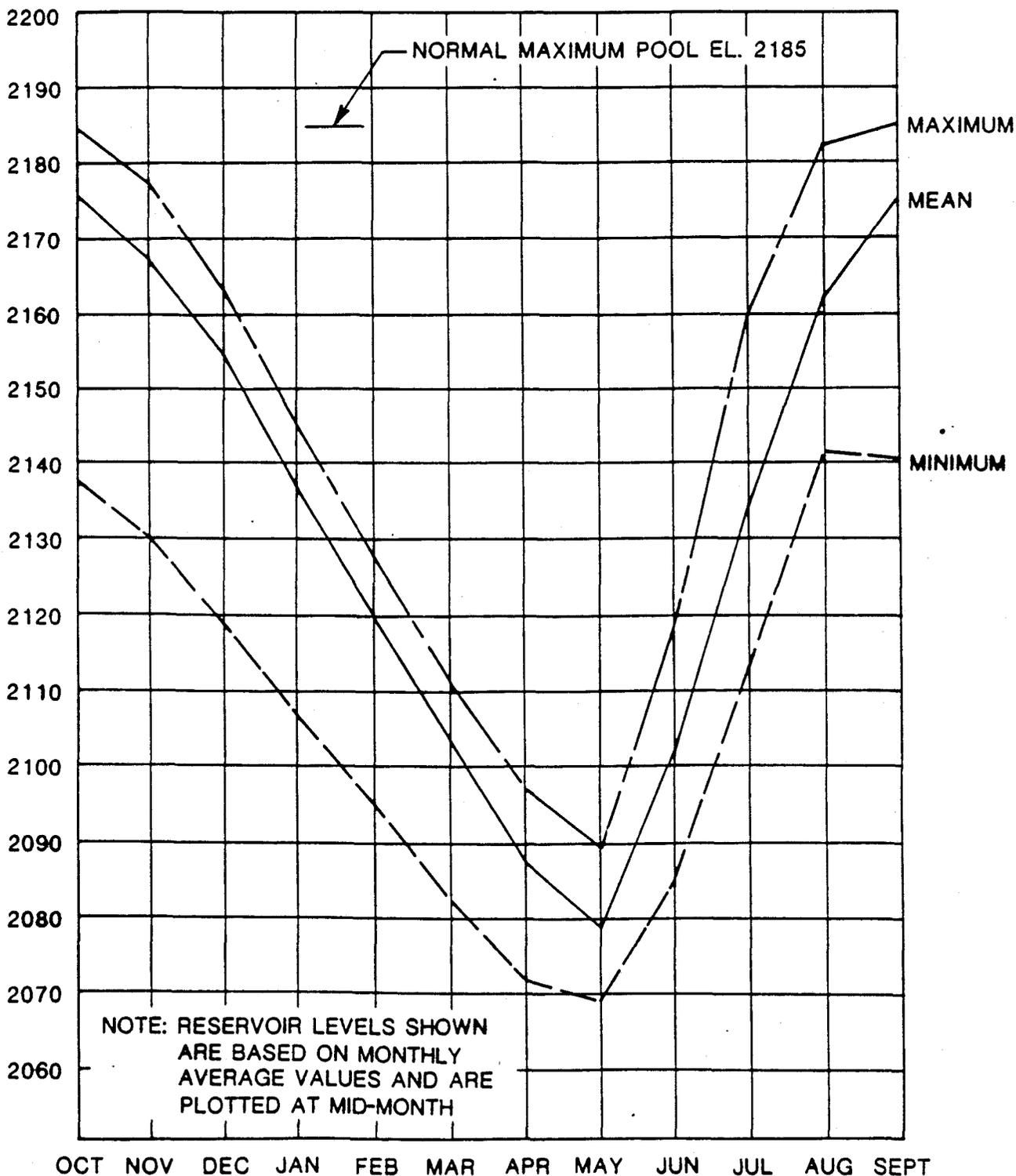


WATANA RESERVOIR WATER LEVELS WATANA AND DEVIL CANYON OPERATING 2002 SIMULATION CASE E-VI

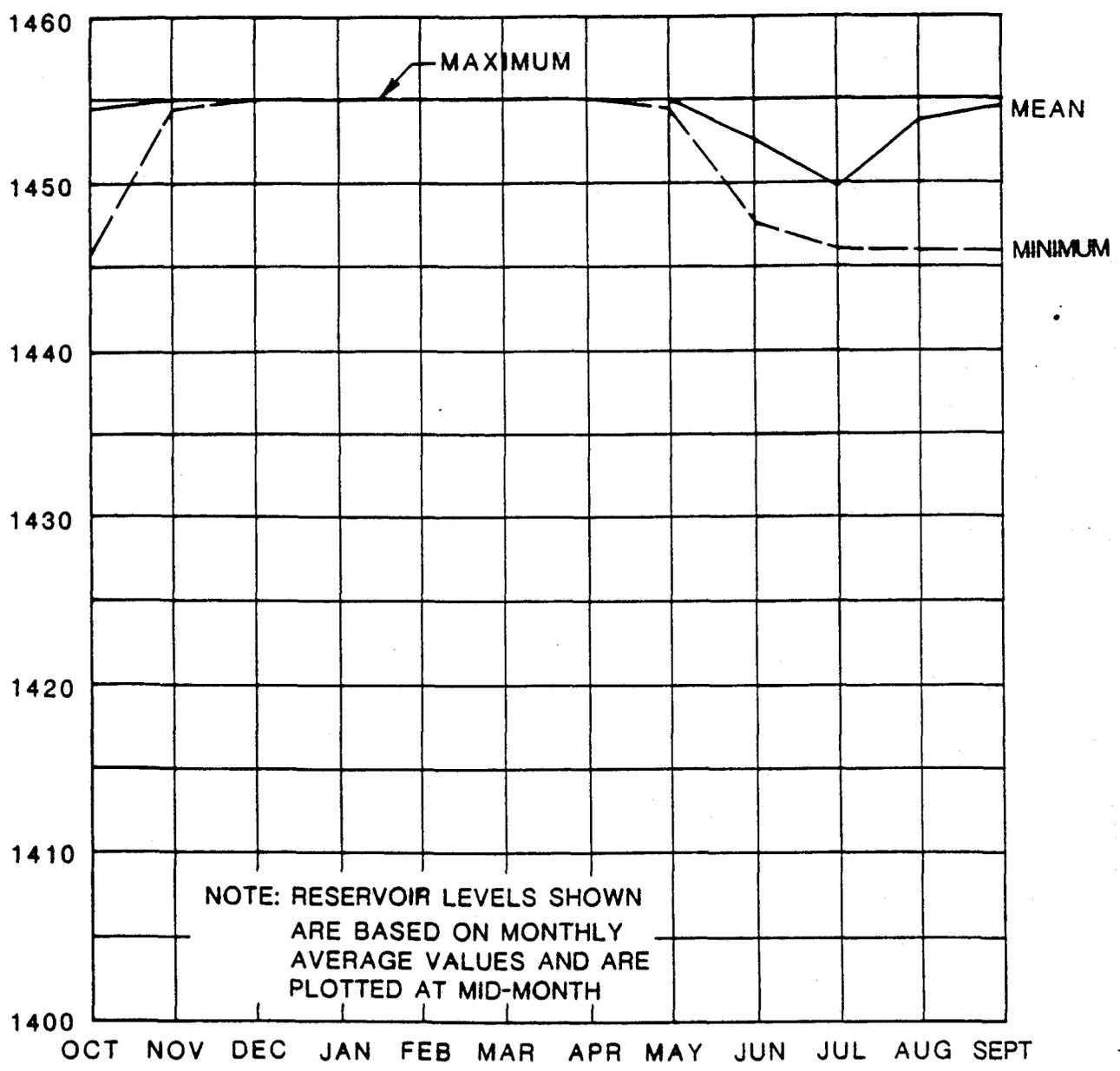


66

WATANA RESERVOIR WATER LEVELS WATANA AND DEVIL CANYON OPERATING 2020 SIMULATION CASE E-VI



DEVIL CANYON WATER LEVELS 2002 SIMULATION CASE E-VI



DEVIL CANYON WATER LEVELS 2020 SIMULATION CASE E-VI

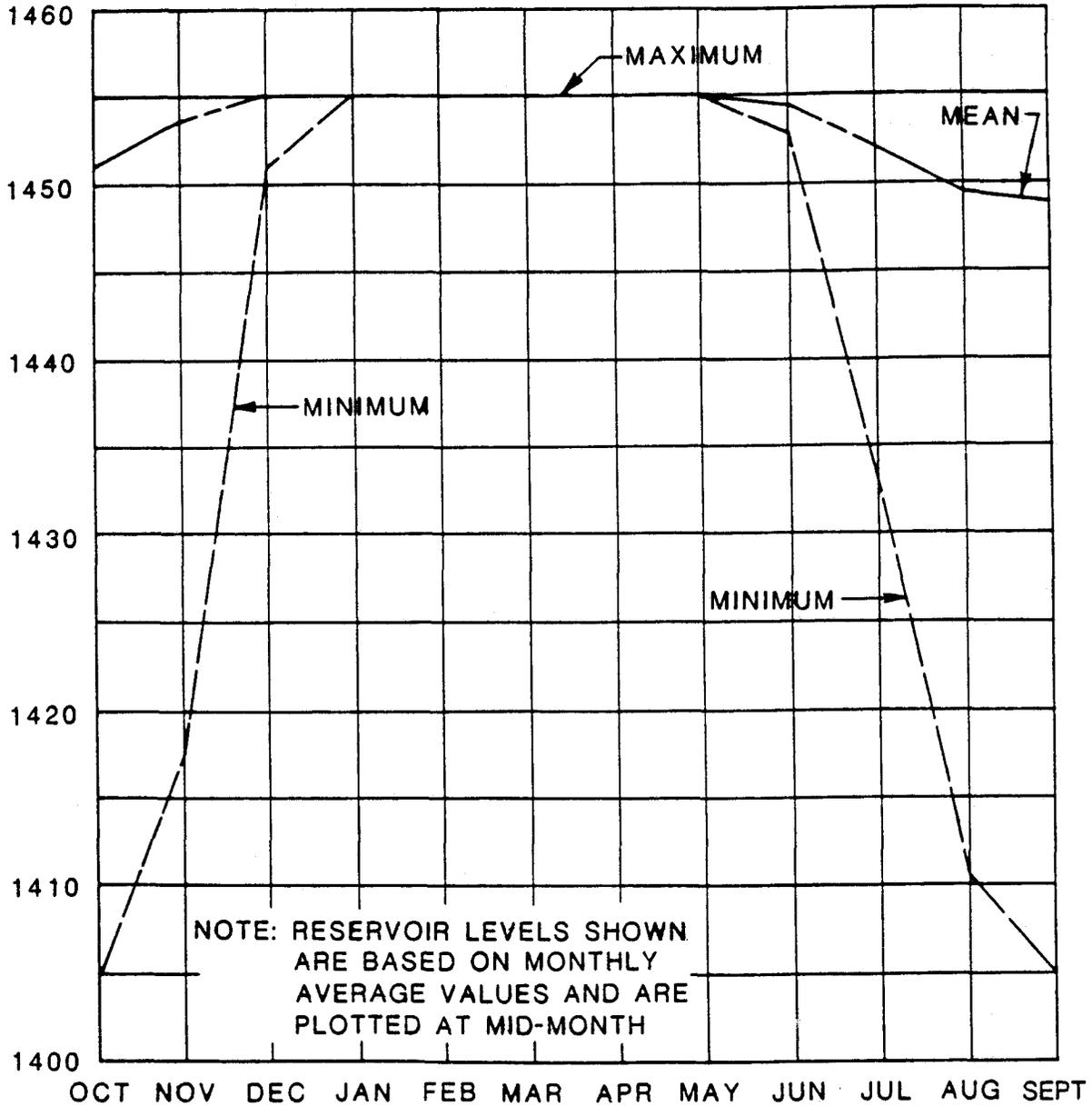


Photo 1.

5/19/84



Figure 6. Reservoir ice cover (A) laid down onto the exposed reservoir bottom below the banks (B).

CYW

Special Report 82-31

December 1982

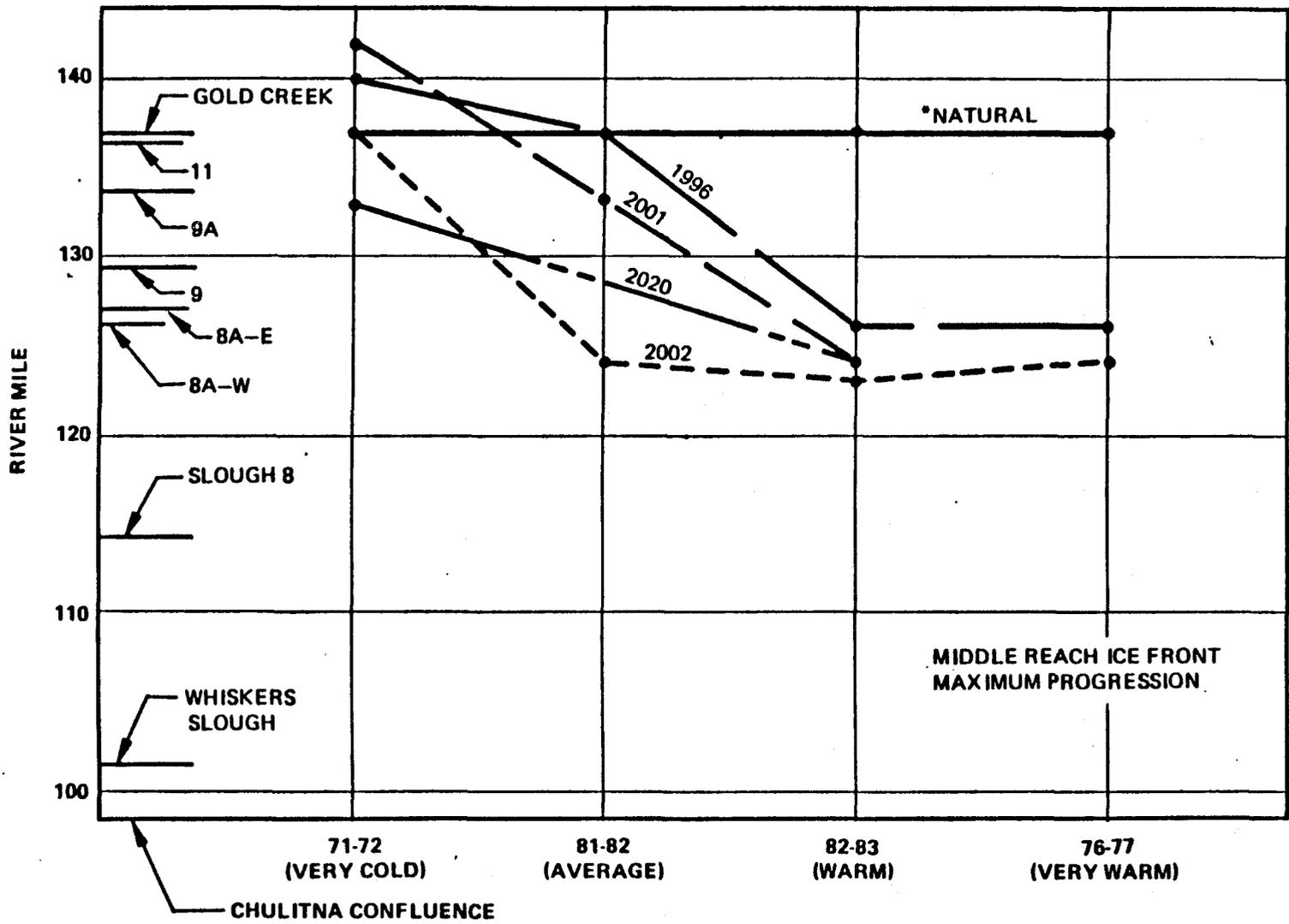


**US Army Corps
of Engineers**

Cold Regions Research &
Engineering Laboratory

Reservoir bank erosion caused and influenced by ice cover

Lawrence W. Gatto



*Natural front progression has been observed to stop at Gold Creek. Ice cover upstream forms by closure from lateral ice.

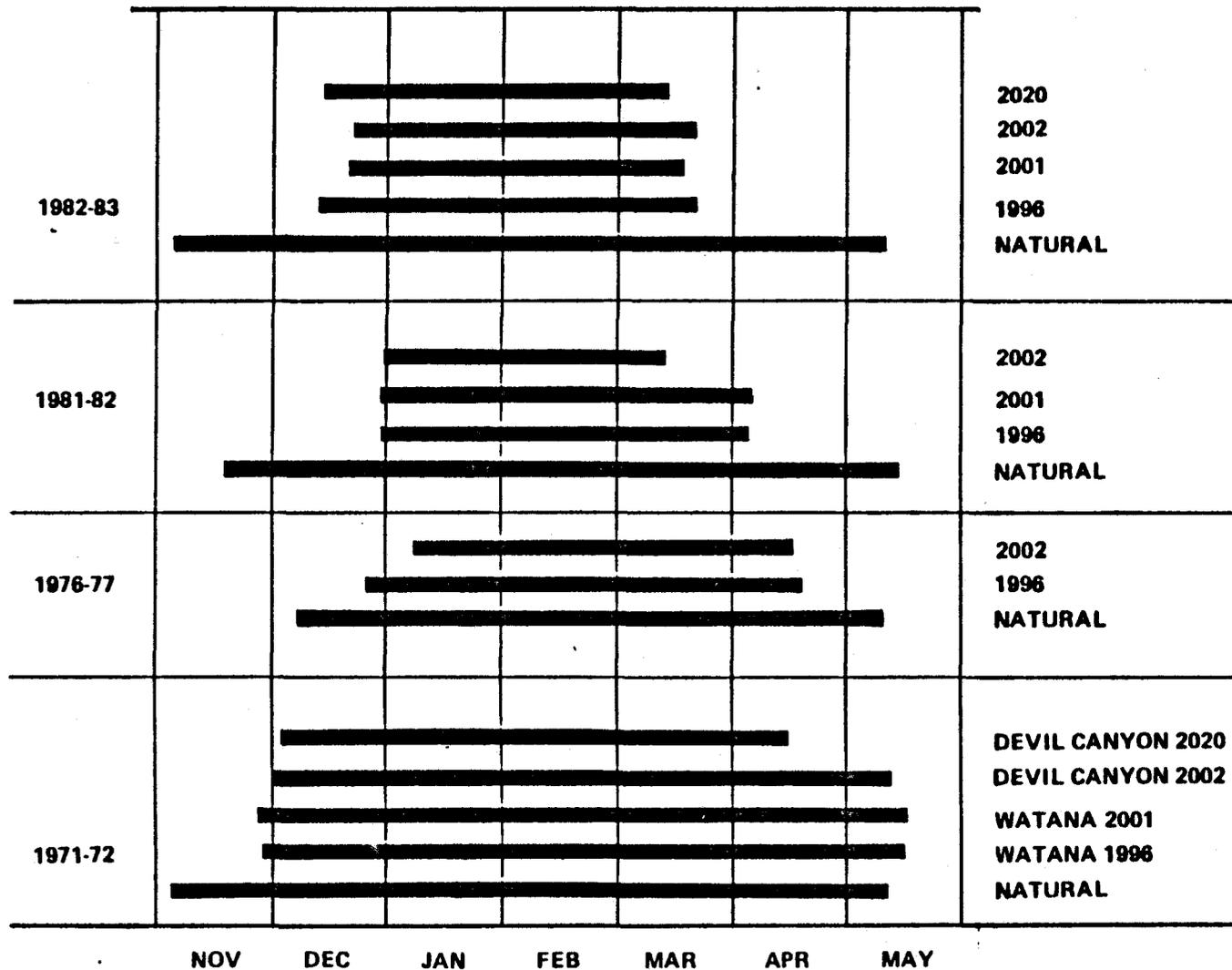
EXHIBIT 7.1

12

113

1

711



**MIDDLE REACH
ICE COVER DURATION**

EXHIBIT 8
13

**SUSITNA HYDROELECTRIC PROJECT
MAXIMUM SIMULATED WINTER RIVER STAGES**

TABLE IV

Slough or Side Channel River Mile Threshold Elevation

Whiskers 101.5 367 ✓

Gash Creek 112.0 Unknown

6A 112.3 (Upland)

8 114.1 476 ✓

MS II 115.5 482

MS II 115.9 487

Curry 120.0 Unknown

Moose 123.5 Unknown

8A West 126.1 573 ✓

8A East 127.1 582 ✓

9 129.3 604 ✓

9 u/s 130.6 Unknown

4th July 131.8 Unknown

9A 133.7 651 ✓

10 u/s 134.3 657

11 d/s 135.3 Unknown

11 136.5 687 ✓

17 139.3 Unknown

20 140.5 730

21 (A6) 141.8 747

21 142.2 755

22 144.8 788

Slough or Side Channel	River Mile	Threshold Elevation	NATURAL CONDITIONS					WATANA ONLY					WATANA AND DEVIL CANYON					WATANA FILLING			
			1971-72	1976-77	1981-82	1982-83	1971-72	1976-77	1981-82	1982-83	1971-72 ^W	1971-72	1982-83	1971-72	1976-77	1981-82	1982-83	1971-72	1982-83	YR. 1	YR. 2
			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Whiskers	101.5	367 ✓	369	366	369	367	372	370	371	370	371	372	370	371	368	369	369	372	370	367	367
Gash Creek	112.0	Unknown	456	455	455	456	459	457	460	459	460	459	461	458	456	456	457	459	457	455	455
6A	112.3	(Upland)	459	457	457	459	462	460	462	462	463	461	463	480	459	458	480	461	459	457	457
8	114.1	476 ✓	474	472	472	474	478	475	477	476	477	476	478	475	474	475	475	476	475	473	473
MS II	115.5	482	484	480	484	484	490	486	488	488	488	489	489	487	486	485	487	490	488	481	483
MS II	115.9	487	485	482	486	486	492	489	491	491	490	491	492	489	489	488	490	492	490	485	486
Curry	120.0	Unknown	522	520	523	520	526	525	527	525	523	525	521	522	520	520	520	525	523	520	521
Moose	123.5	Unknown	552	546	549	548	556	552	555	550	552	555	550	553	547	548	545	555	550	546	548
8A West	126.1	573 ✓	572	569	571	570	576	574	574	572	572	575	568	574	568	568	568	575	572	568	570
8A East	127.1	582 ✓	584	581	583	582	587	583	585	582	582	586	581	584	581	580	581	585	582	580	582
9	129.3	604 ✓	605	603	606	605	609	603	607	603	603	610	603	606	601	601	602	608	603	602	603
9 u/s	130.6	Unknown	622	616	620	621	624	617	620	617	617	625	617	620	616	616	616	621	617	616	618
4th July	131.8	Unknown	632	626	629	630	635	628	631	628	628	636	628	633	627	627	627	631	628	625	628
9A	133.7	651 ✓	655	649	651	651	657	650	653	650	650	659	650	652	650	650	650	651	650	650	650
10 u/s	134.3	657	662	654	657	658	663	656	659	656	656	665	656	659	655	655	655	657	656	658	655
11 d/s	135.3	Unknown	673	667	670	672	675	667	670	668	668	676	668	670	667	667	667	668	668	670	668
11	136.5	687 ✓	684	681	683	684	688	684	687	683	683	690	683	685	682	682	682	684	684	682	682
17	139.3	Unknown	-	-	-	-	717	716	715	715	715	727	715	714	714	714	714	715	715	712	713
20	140.5	730	-	-	-	-	732	729	729	729	729	741	729	728	728	728	728	729	729	727	729
21 (A6)	141.8	747	-	-	-	-	746	746	746	746	745	751	746	746	746	746	746	747	747	745	745
21	142.2	755	-	-	-	-	753	753	753	753	753	755	753	752	752	752	752	753	754	751	750
22	144.8	788	-	-	-	-	787	787	787	786	787	787	786	785	785	785	785	787	787	782	782

NOTES:

1. Indicates locations where maximum river stage equals or exceeds a known slough threshold elevation. See Exhibits A-T for duration of overtoppings.
2. "Case C" operating guide is assumed for with-project simulations.
3. 1971-72^W simulation assumes warm, 4° C reservoir releases. All other with-project simulations assume an "inflow-matching" temperature policy.
4. Upstream extent of simulated ice cover progression for Watana filling occurs upstream of River Mile 144.8.

Upstream Boundary of Natural Simulations

Upstream Extent of Ice Cover Progression

5. All river stages in feet.
6. Winter air temperatures:
1971-72 cold
1976-77 very warm
1981-82 average
1982-83 warm

EXHIBIT 4
14

**SUSITNA HYDROELECTRIC PROJECT
TOTAL ICE THICKNESS
MAXIMUM SIMULATED VALUES**

TABLE VIII

Slough or Side Channel	River Mile	NATURAL CONDITIONS				WATANA ONLY					WATANA AND DEVIL CANYON				WATANA FILLING									
		✓ 1971-72	1976-77	1981-82	1982-83	✓ 1971-72	1976-77	1981-82	1982-83	1971-72 ^w	1971-72	1982-83	2002 DEMAND	2020 DEMAND	1971-72	1982-83	YR. 1	YR. 2						
Whiskers	101.5	5	2	4	3	5	1	3	2	3	5	2	5	1	2	2	4	1	2	3				
Gash Creek	112.0	5	4	4	4	5	3	5	5	6	5	7	5	2	2	3	4	1	3	4				
6A	112.3	6	5	4	5	5	3	5	4	6	5	7	5	3	3	4	4	1	5	5				
8	114.1	5	2	4	4	5	3	4	3	4	5	5	4	2	3	3	4	1	3	3				
MSII	115.5	5	2	5	5	6	2	5	5	4	5	6	4	4	3	4	4	2	3	5				
MSII	115.9	5	3	7	6	7	4	7	6	6	5	8	4	6	4	6	5	3	5	8				
Curry	120.0	6	5	7	4	7	5	8	5	3	5	1	4	1	1	1	4	2	4	6				
Moose	123.5	10	4	7	5	9	5	8	2	4	6	2	7	1	1		7	2	5	6				
8A West	126.1	5	2	3	3	5	2	3	1	1	5		3				3	1	1	2				
8A East	127.1	5	2	3	3	4		2			4		3				3		1	2				
9	129.3	6	4	7	6	5		3			6		3				3		2	4				
9 u/s	130.6	8	3	6	7	5		2			6		3				2		3	6				
4th July	131.8	7	1	3	5	5		2			7		3				2		1	3				
9A	133.7	7	1	3	3	6		2			6		3						3	2				
10 u/s	134.3	11	1	3	4	7		2			9		4						6	2				
11 d/s	135.3	6	1	3	5	6		2			6		3						3	3				
11	136.5	5	1	3	4	3		2			5		1						3	4				
17	139.3	Upstream Boundary of Natural Simulations				2						13								1	4			
20	140.5					2									12							1	4	
21 (A6)	141.8					Upstream Extent of Ice Cover Progression										3							1	2
21	142.2																		1					
22	144.8																		1	1				

NOTES:

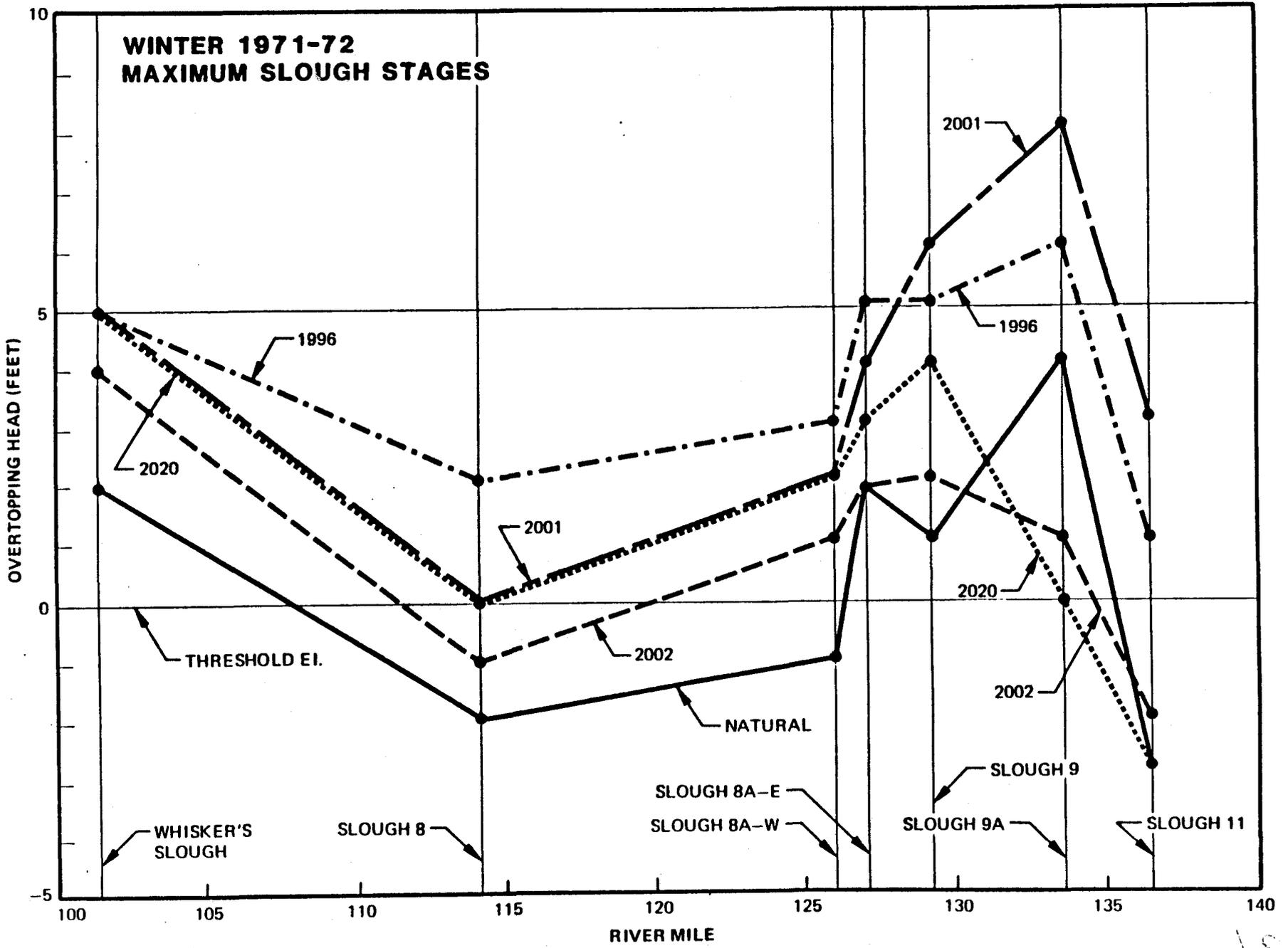
1. "Case C" operating guide is assumed for with-project simulations.
2. 1971-72^w simulation assumes warm, 4°C reservoir releases. All other with-project simulations assume an "inflow-matching" temperature policy.
3. Upstream extent of simulated ice cover progression for Watana filling occurs upstream of River Mile 144.8.

4. All ice thickness in feet.
5. Winter air temperatures:
1971-72 cold
1976-77 very warm
1981-82 average
1982-83 warm

116

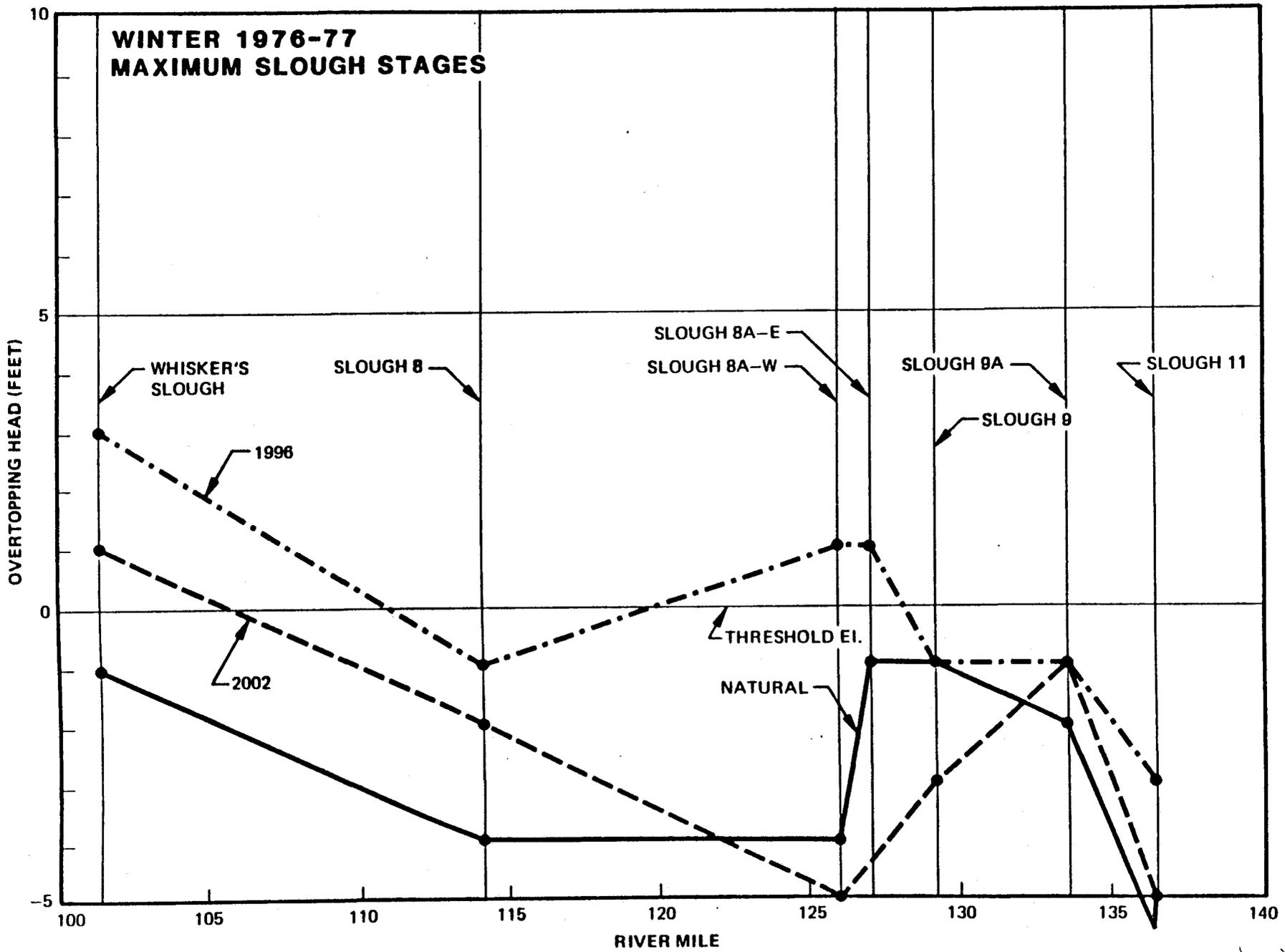
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118



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EXHIBIT 17E

111

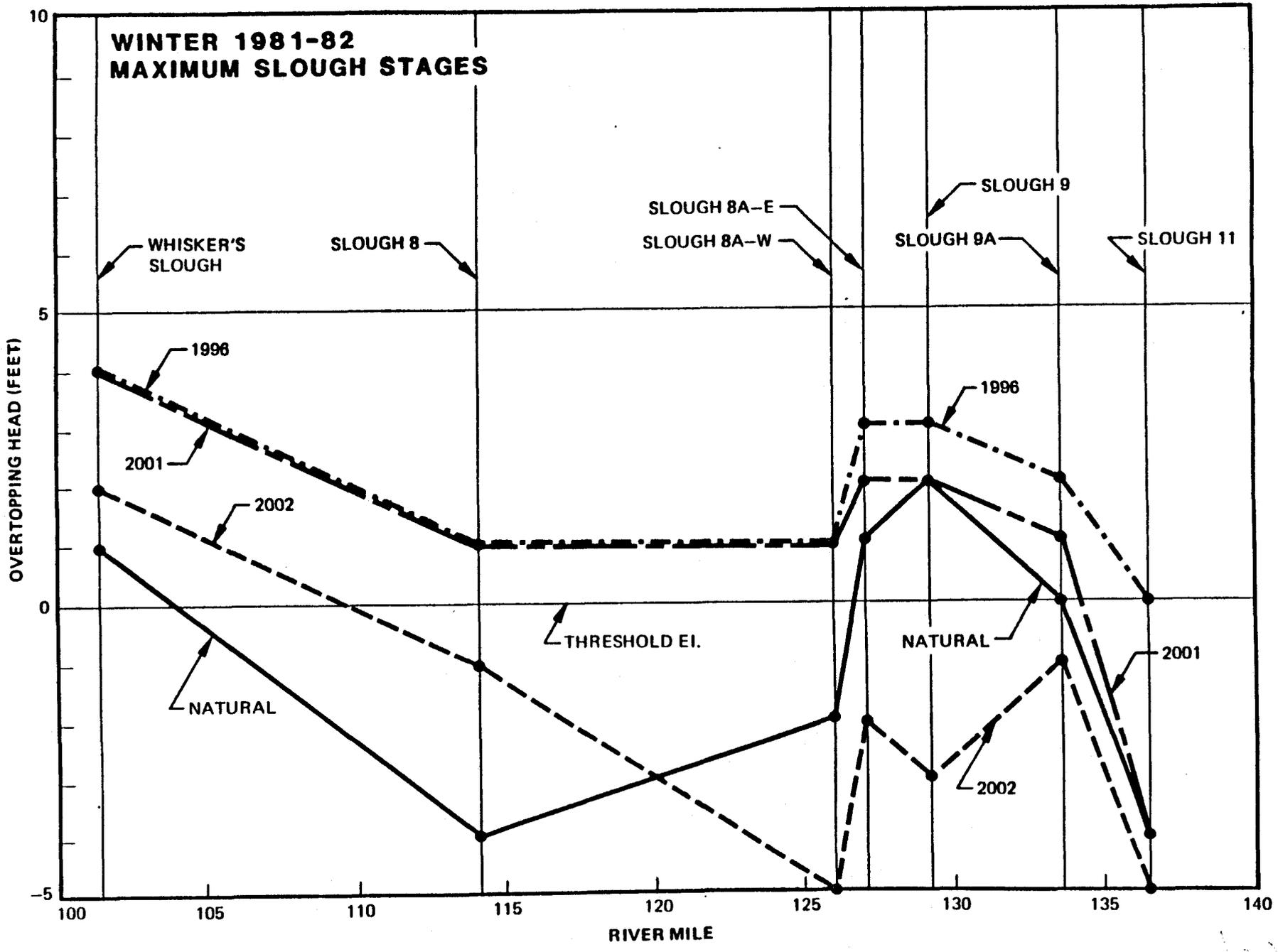
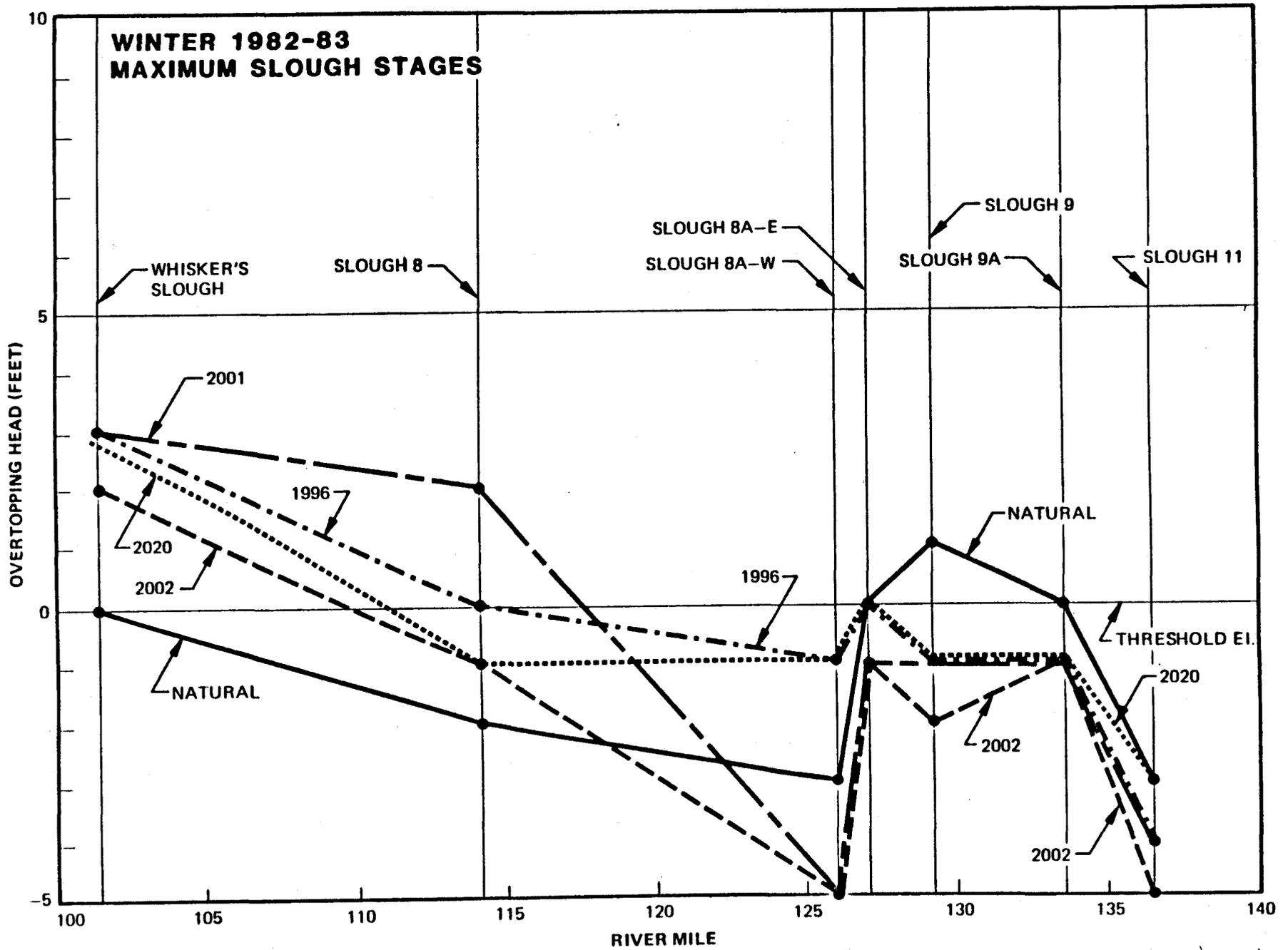


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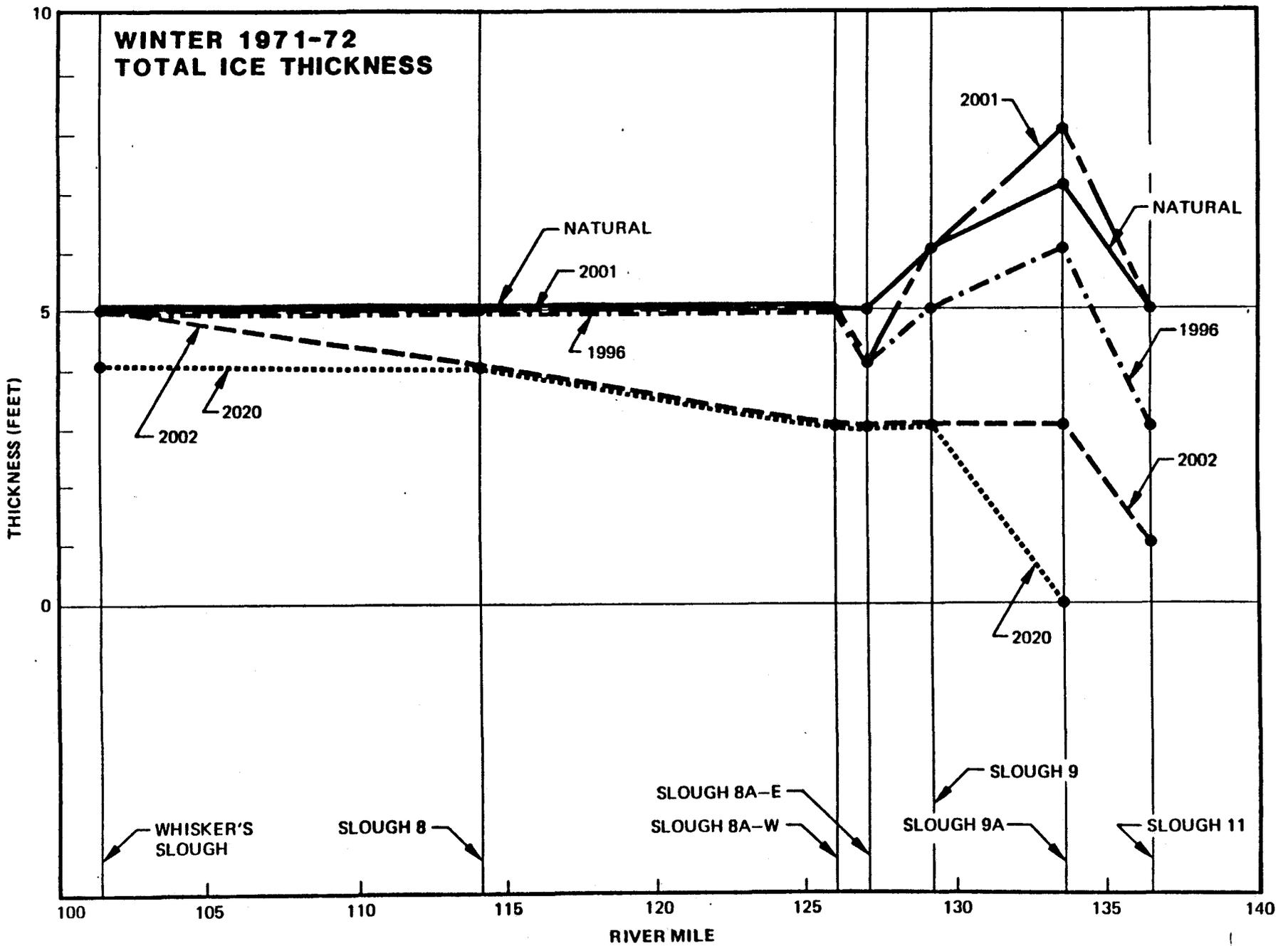
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62

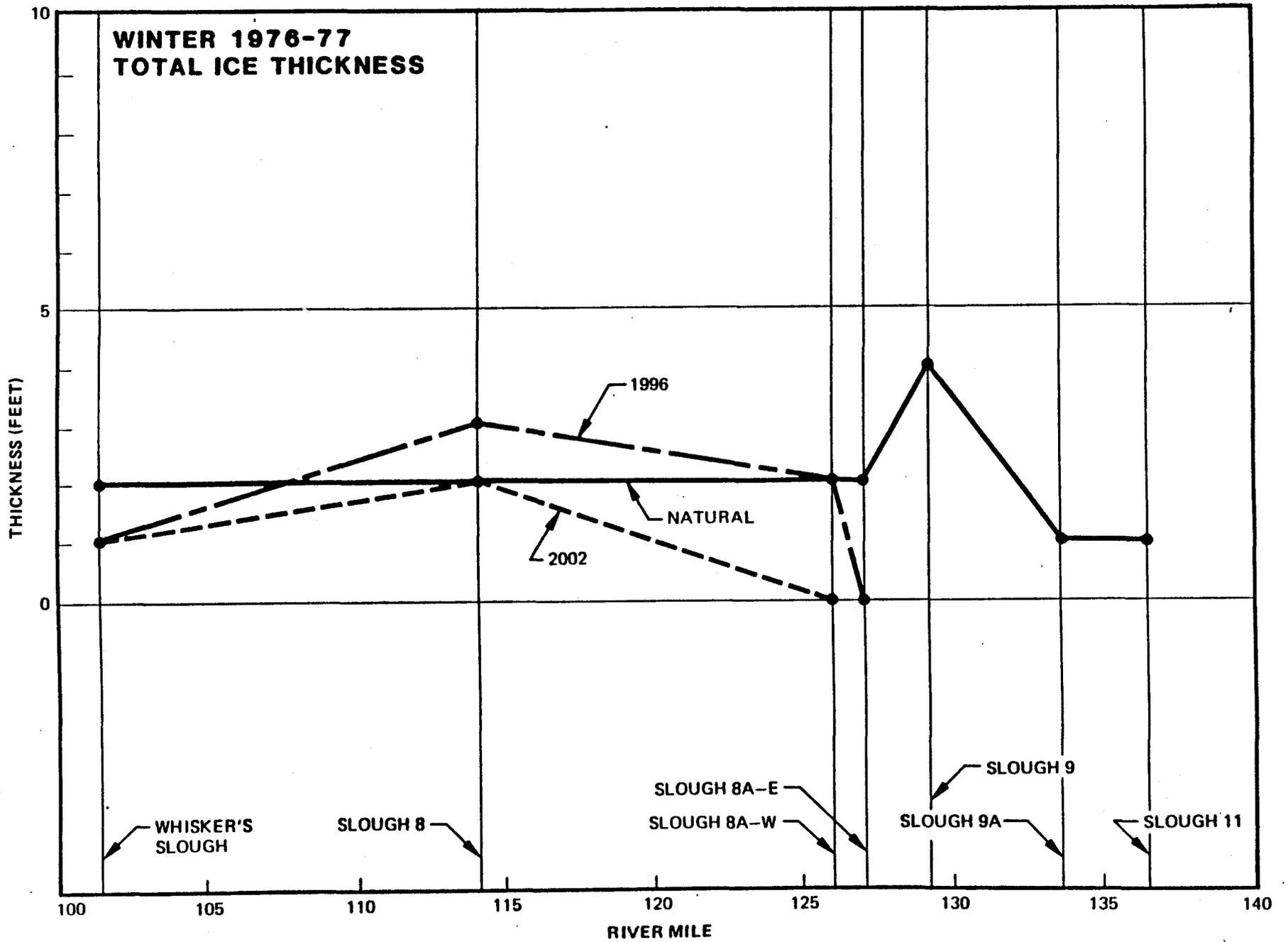
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19

121



CAN/D 11 20
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122



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123

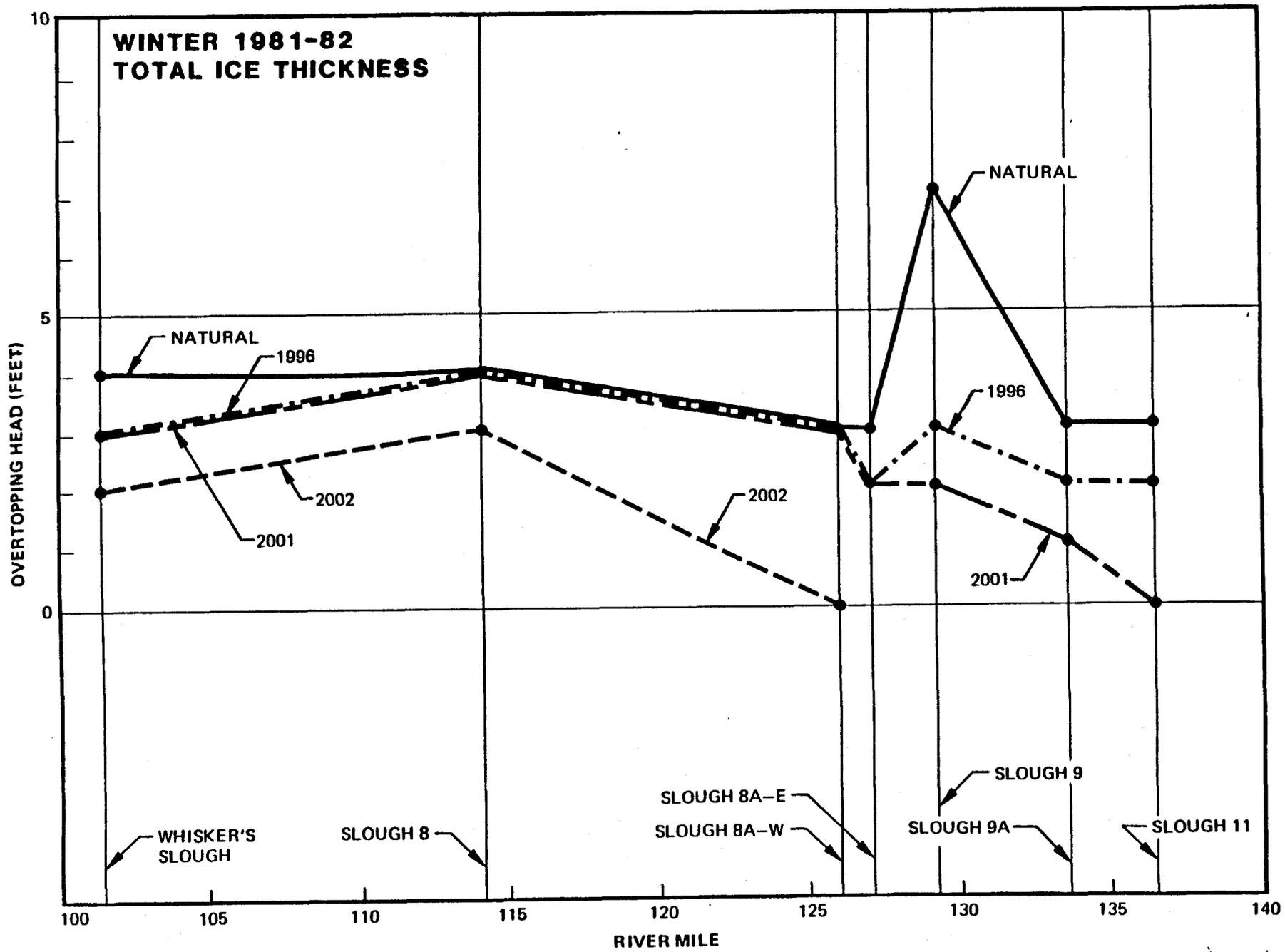


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124

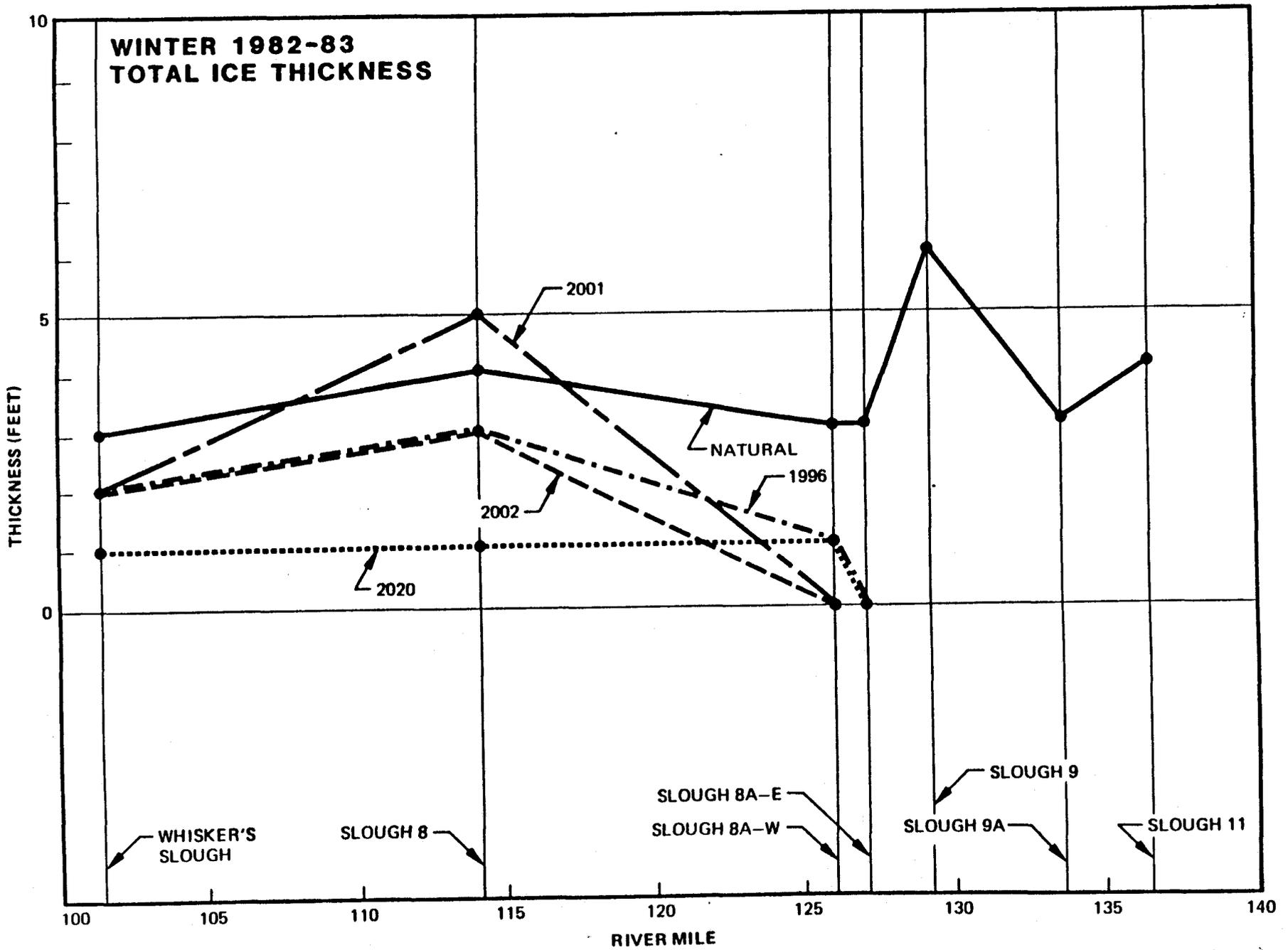


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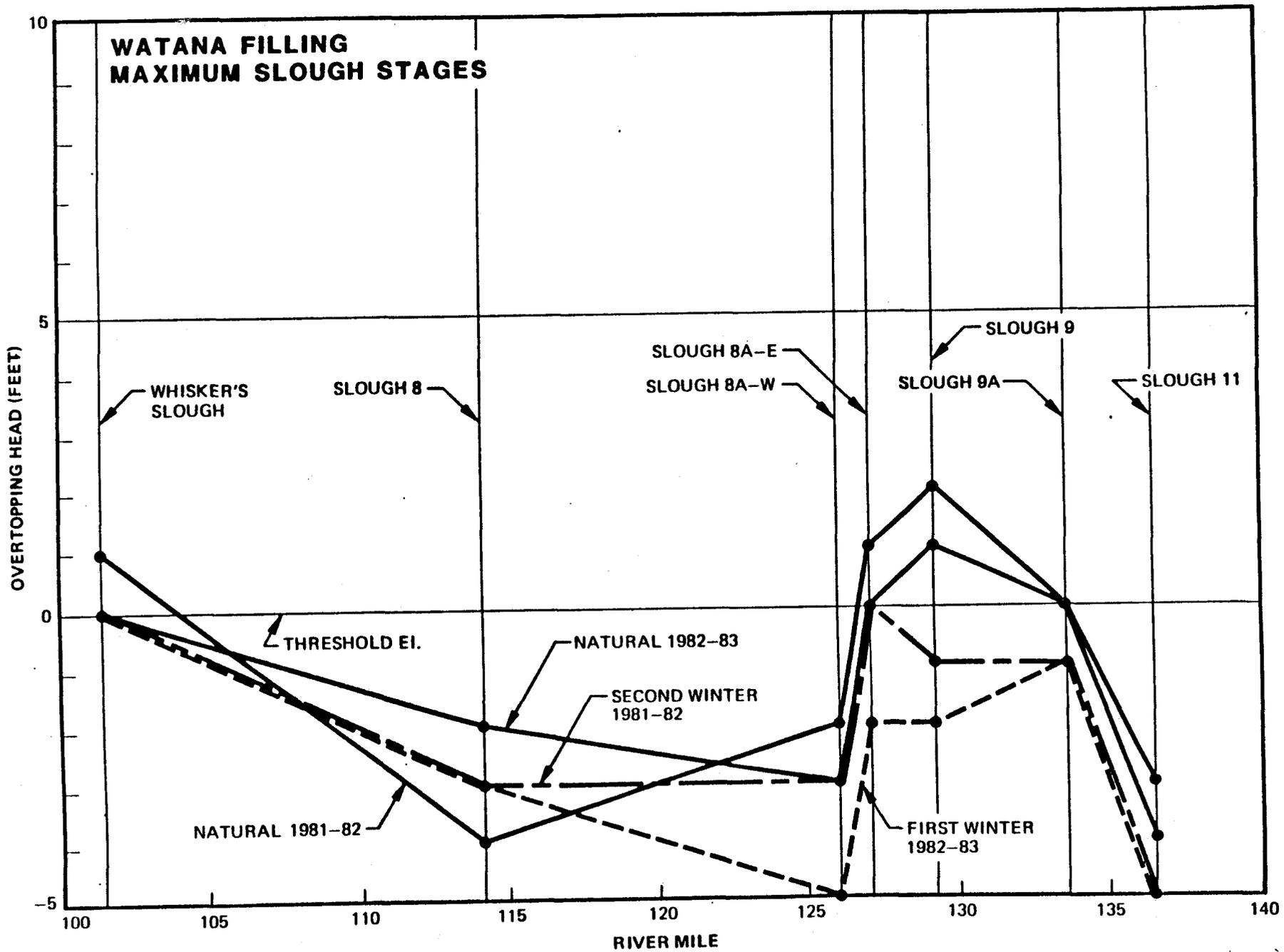
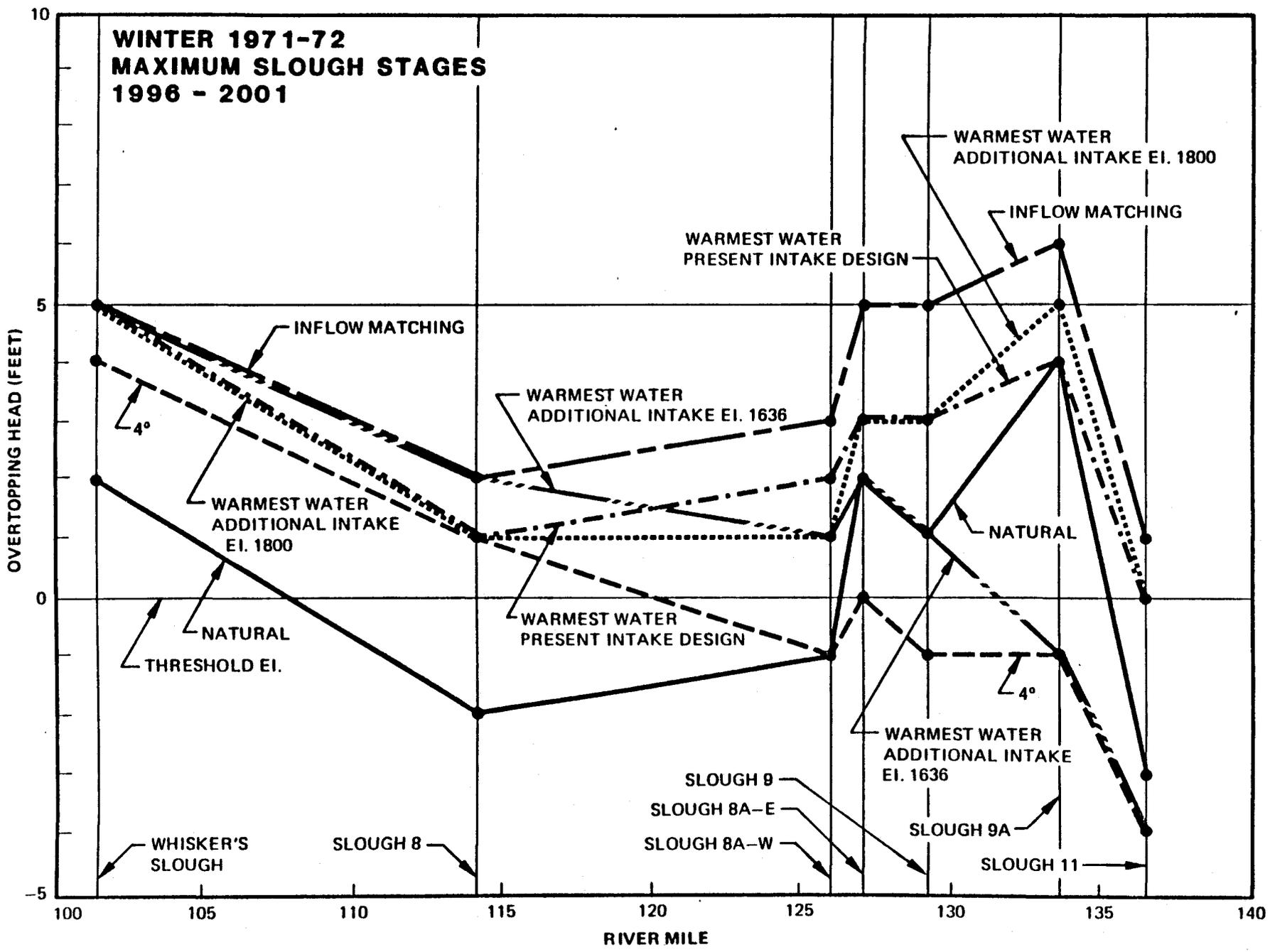


EXHIBIT 1
42
44

126



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25
78

127

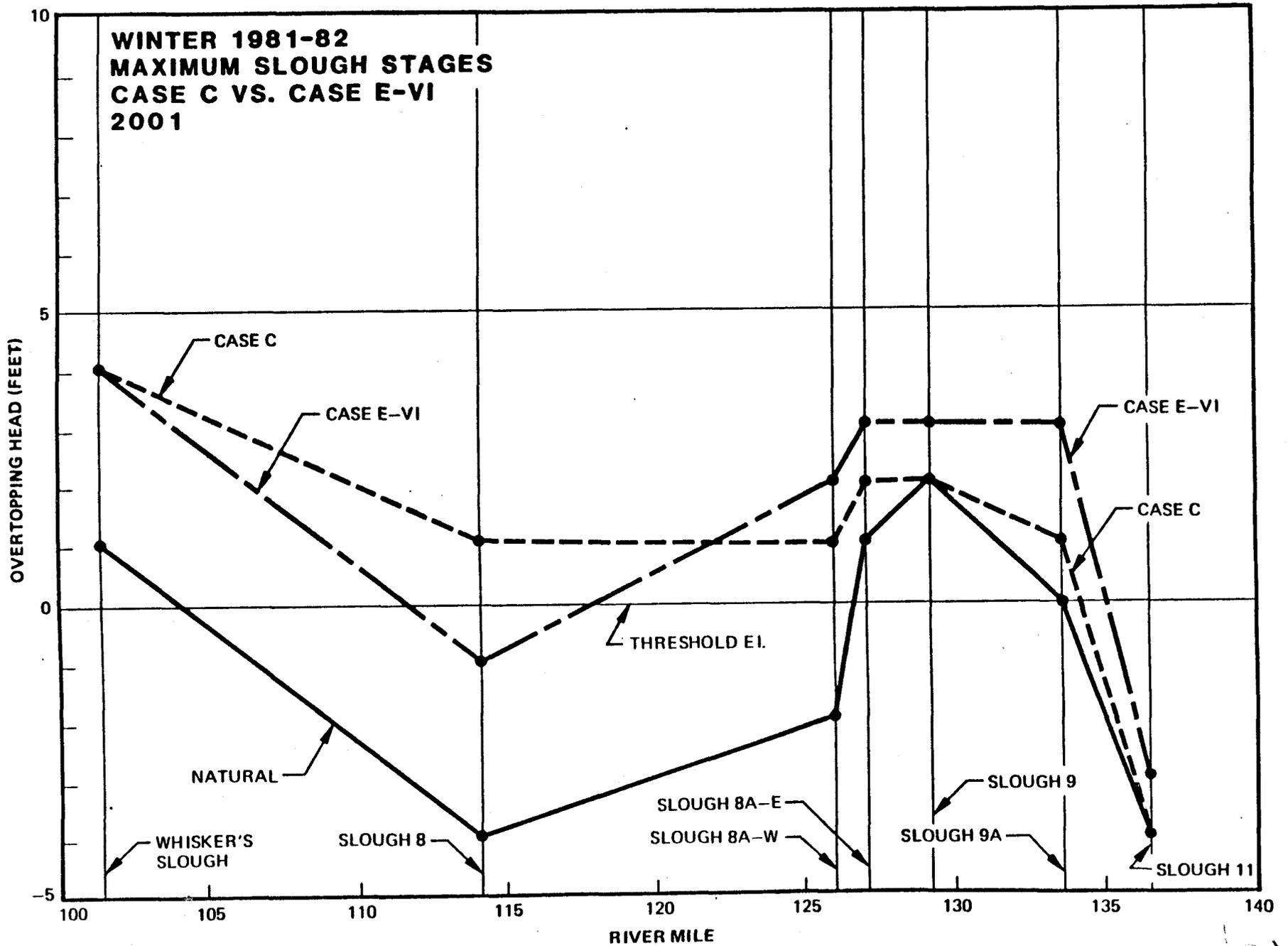
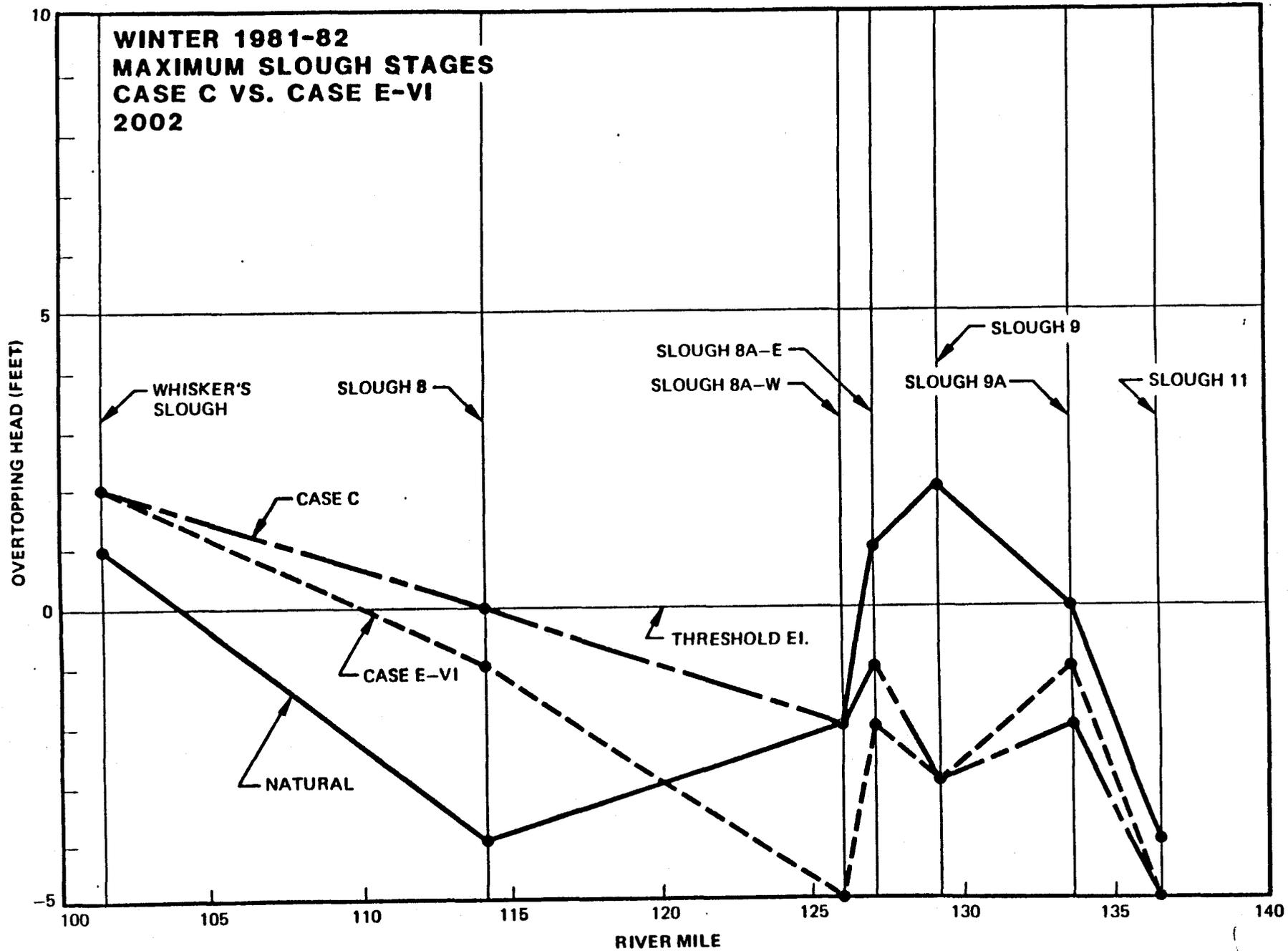


EXHIBIT 26

79

128



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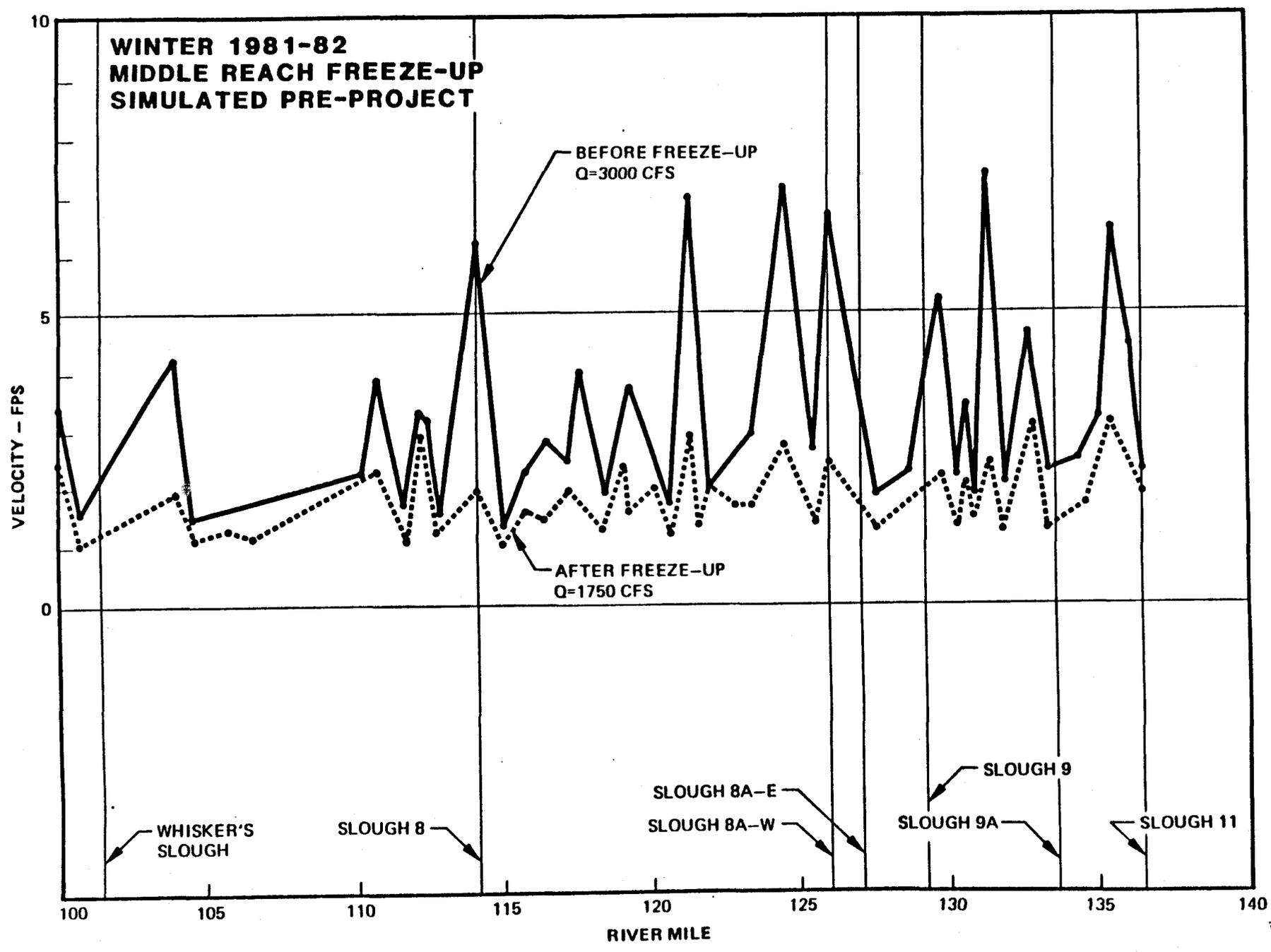
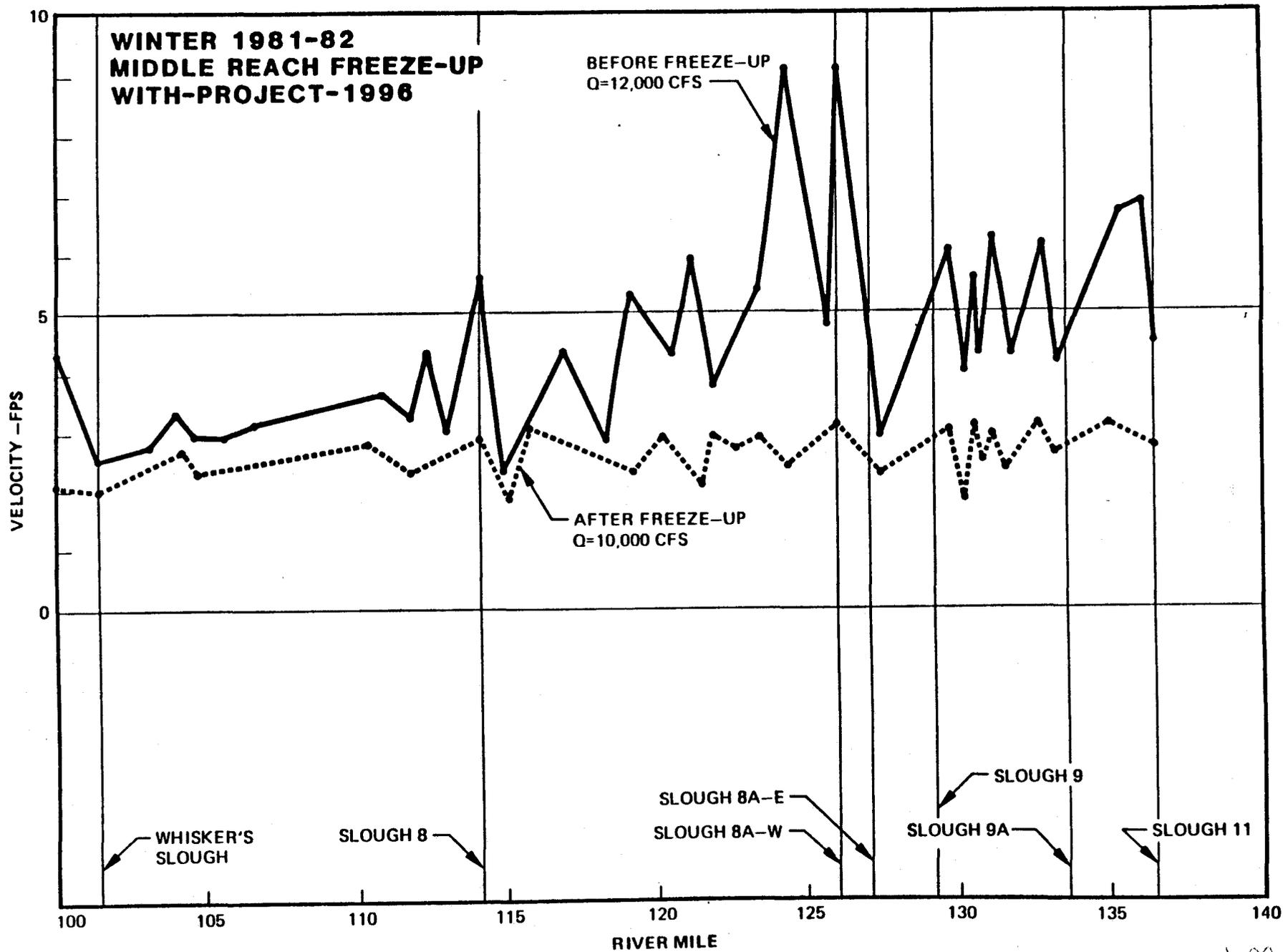


EXHIBIT 11
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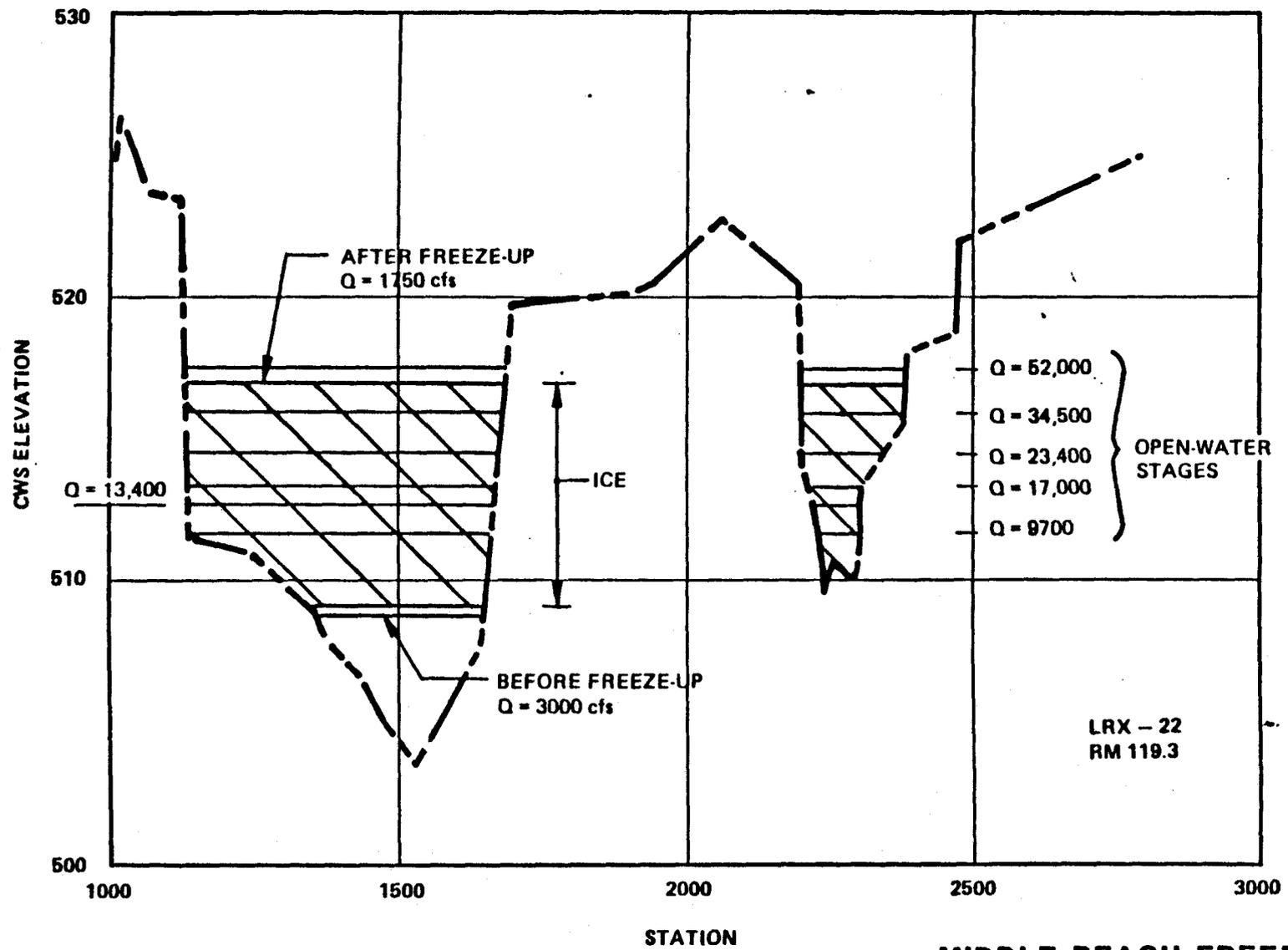
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182

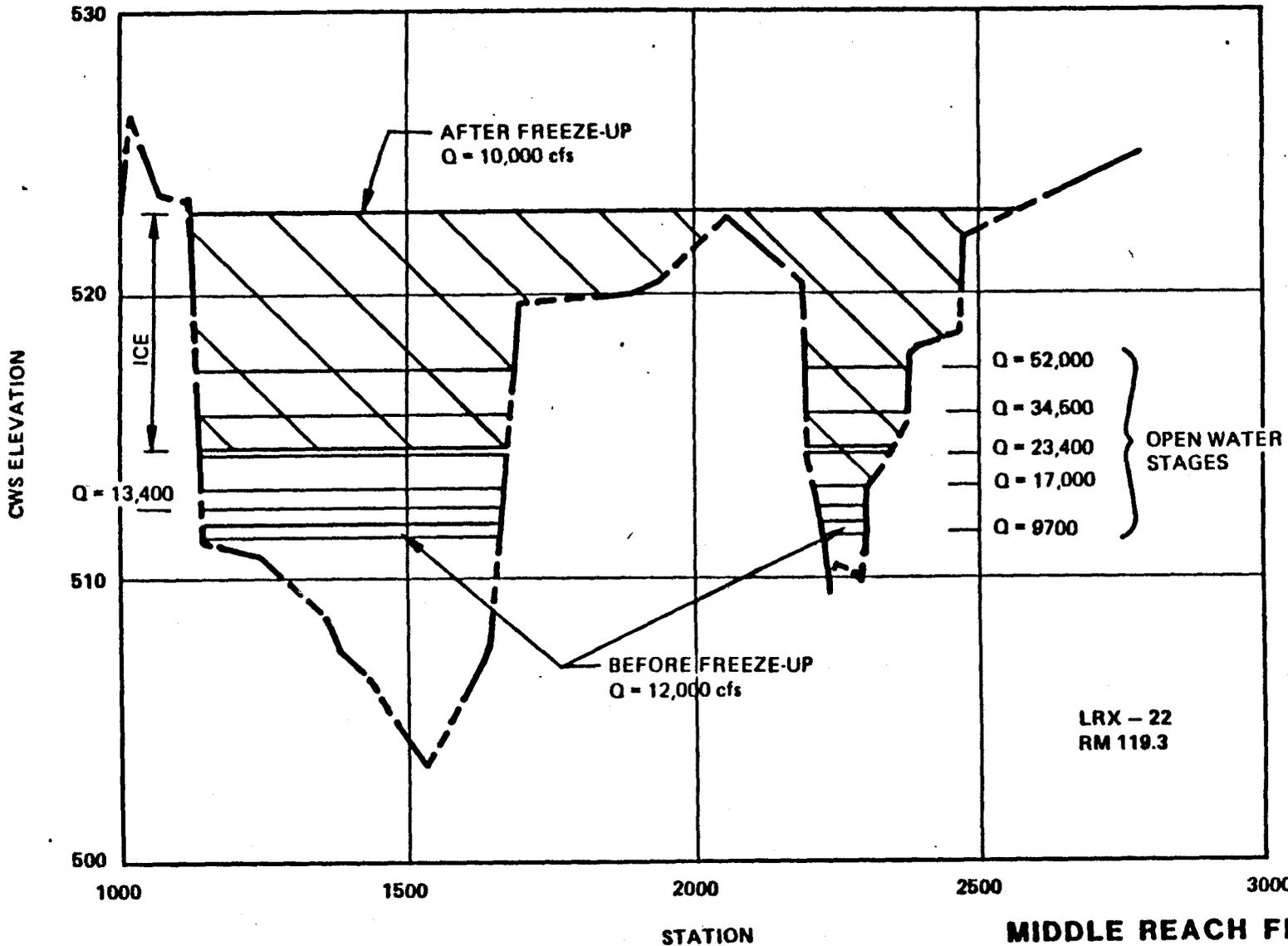
EXHIBIT
24.
29

131



**MIDDLE REACH FREEZE-UP
SIMULATED PRE-PROJECT
WINTER 1981-82**

EXHIBIT 25
20

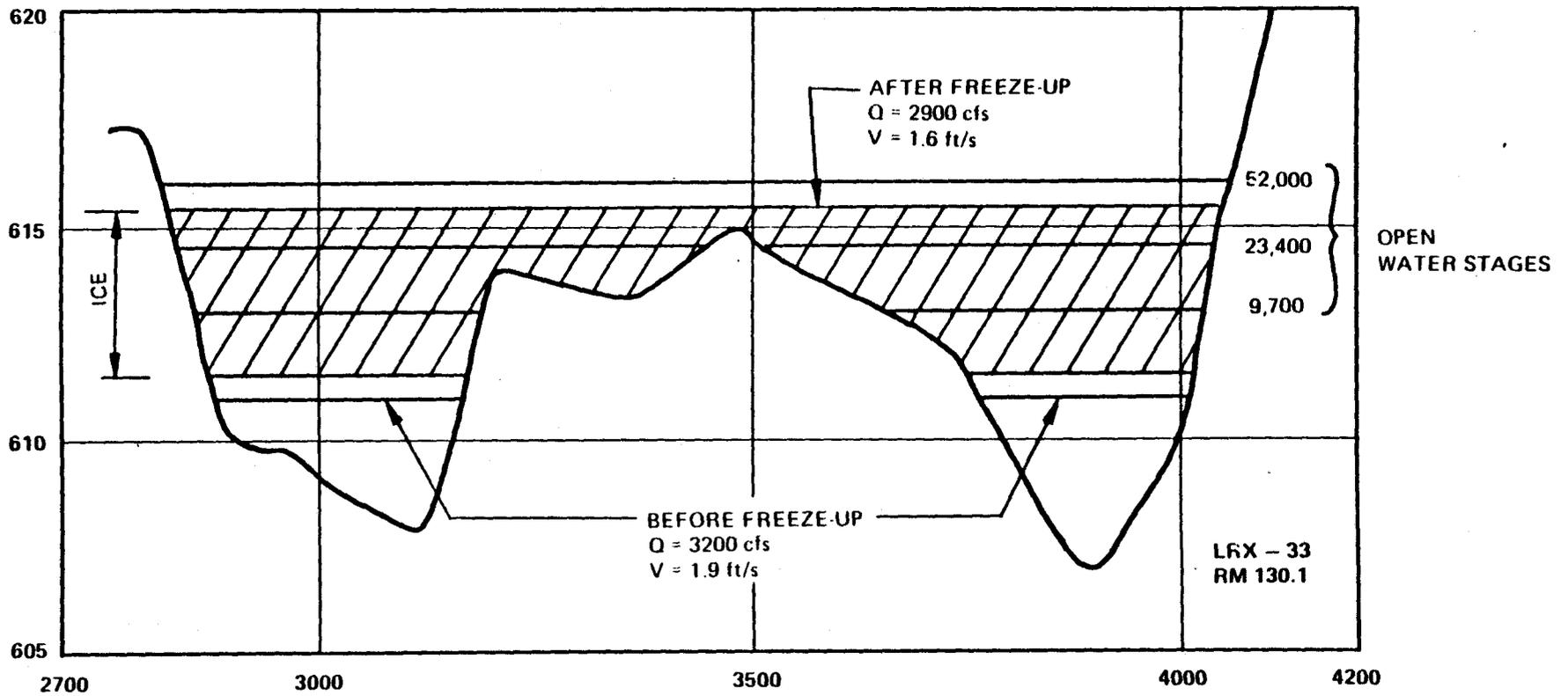


**MIDDLE REACH FREEZE-UP
WITH PROJECT - 1996
WINTER 1981-82**

EXHIBIT 17

26.
31

132

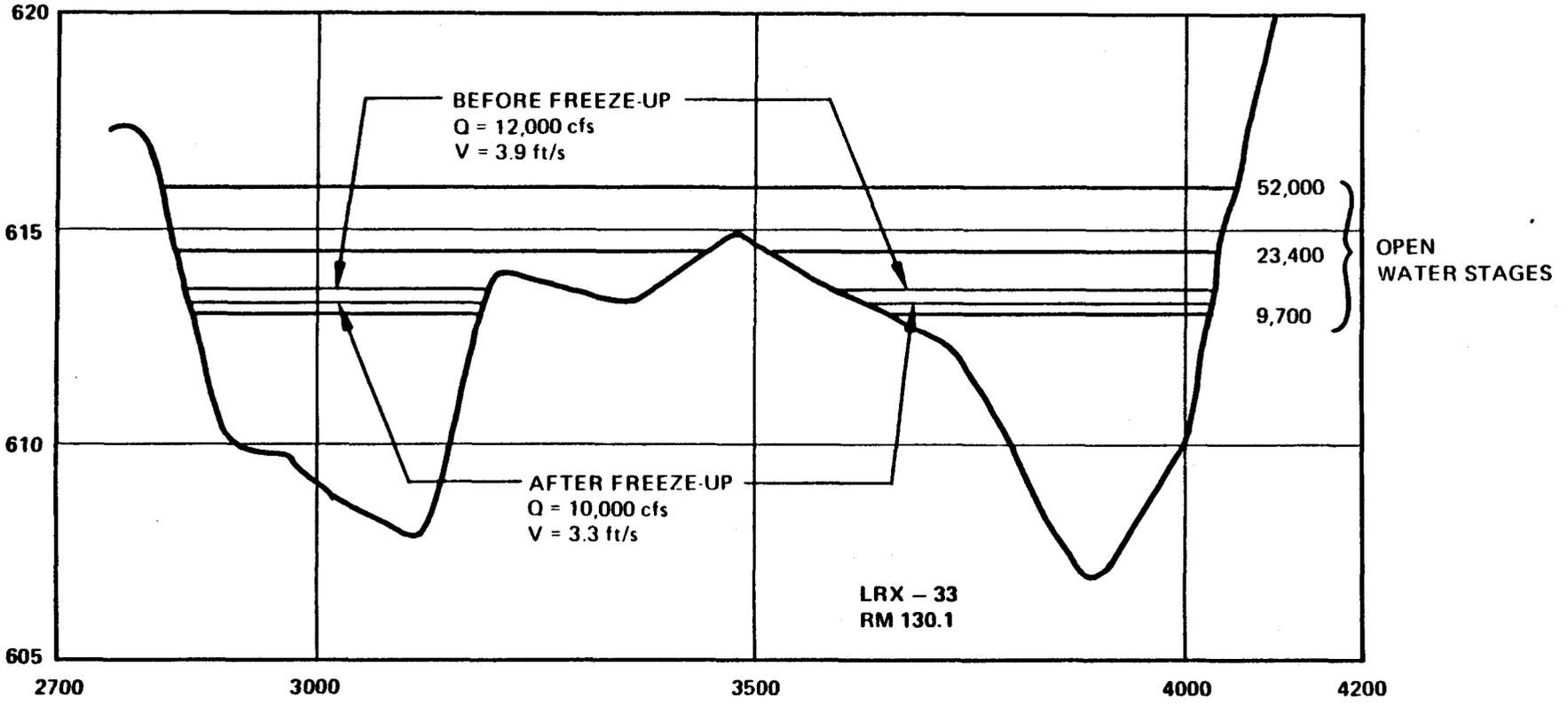


133

**MIDDLE REACH FREEZE-UP
 SIMULATED PRE-PROJECT
 WINTER 1982-83**

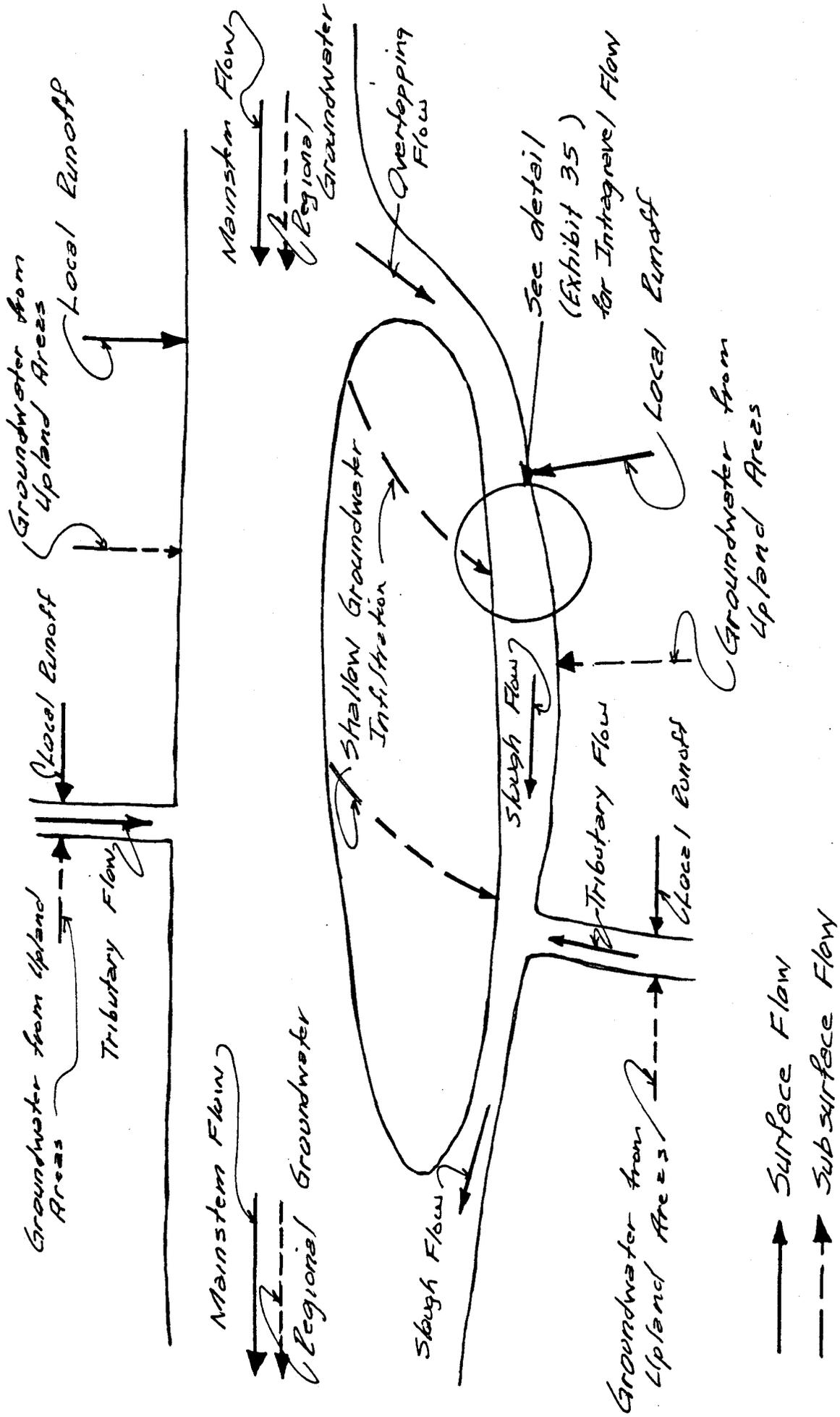
EXHIBIT 32

85

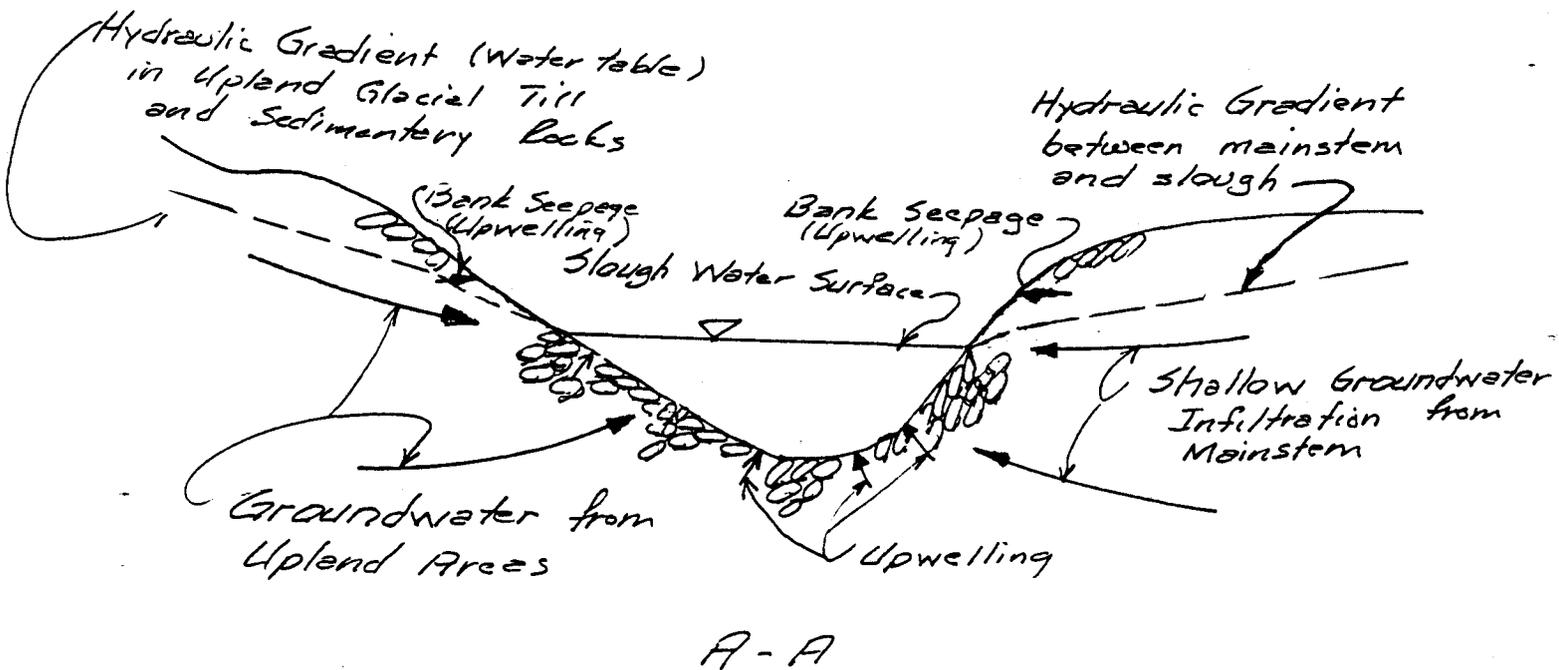
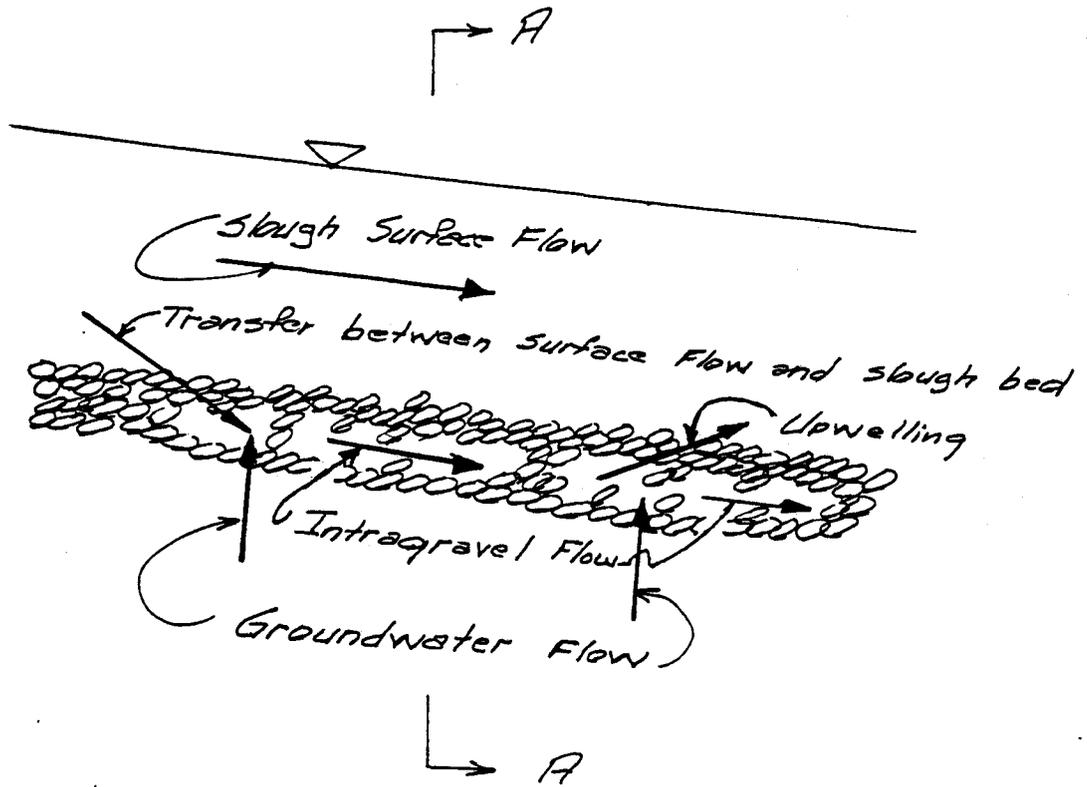


**MIDDLE REACH FREEZE-UP
 WITH-PROJECT 1996
 WINTER 1982-83**

86
 EXHIBIT 3



PLAN VIEW SHOWING FLOW COMPONENTS
TYPICAL SLOUGH



Detail Of Intra-gravel Flow
From Exhibit 34

89
 Figure 9 Susitna River drainage Basin fish
 Species by study zone

FIGURE:

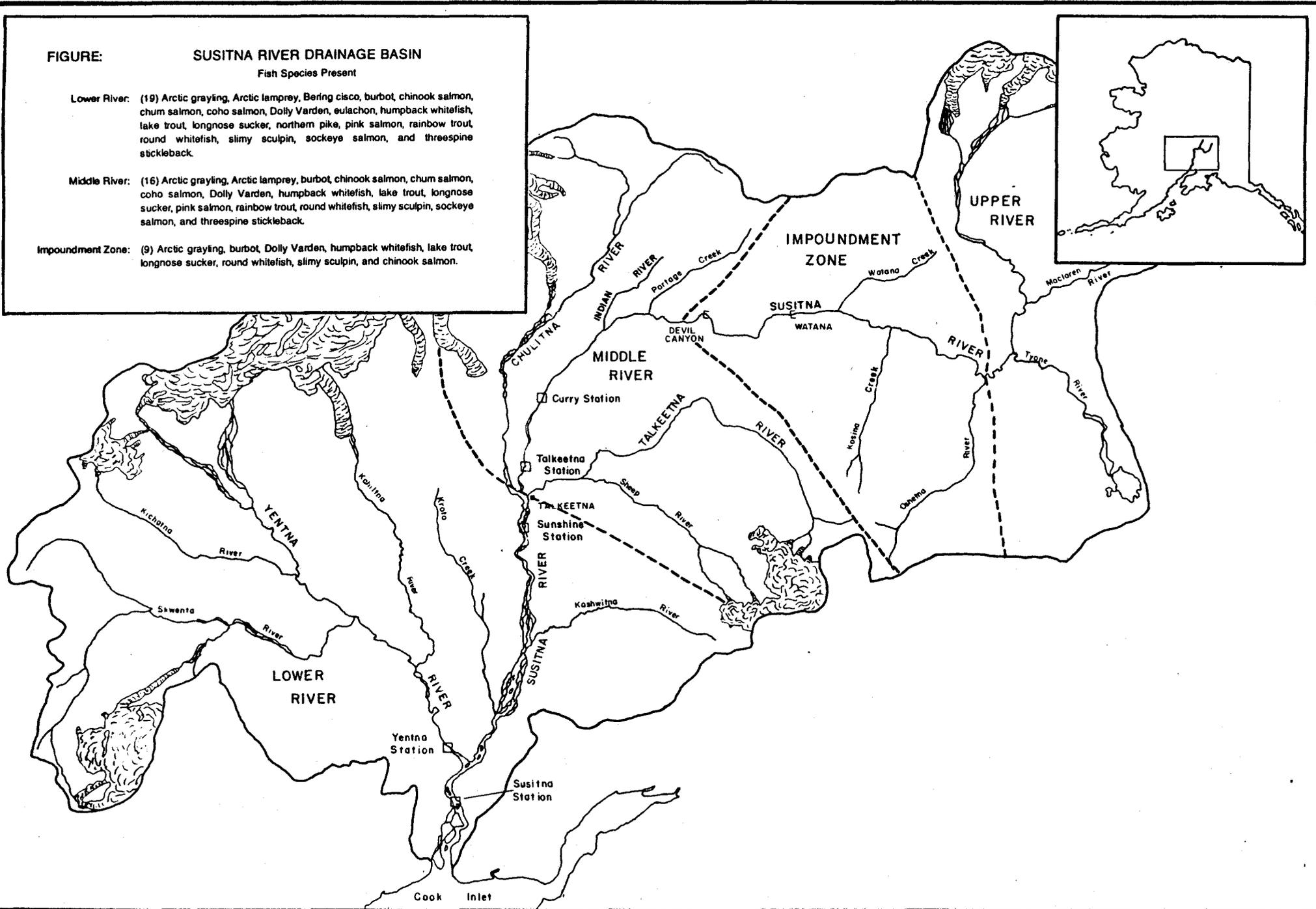
SUSITNA RIVER DRAINAGE BASIN

Fish Species Present

Lower River: (19) Arctic grayling, Arctic lamprey, Bering cisco, burbot, chinook salmon, chum salmon, coho salmon, Dolly Varden, eulachon, humpback whitefish, lake trout, longnose sucker, northern pike, pink salmon, rainbow trout, round whitefish, slimy sculpin, sockeye salmon, and threespine stickleback.

Middle River: (16) Arctic grayling, Arctic lamprey, burbot, chinook salmon, chum salmon, coho salmon, Dolly Varden, humpback whitefish, lake trout, longnose sucker, pink salmon, rainbow trout, round whitefish, slimy sculpin, sockeye salmon, and threespine stickleback.

Impoundment Zone: (9) Arctic grayling, burbot, Dolly Varden, humpback whitefish, lake trout, longnose sucker, round whitefish, slimy sculpin, and chinook salmon.



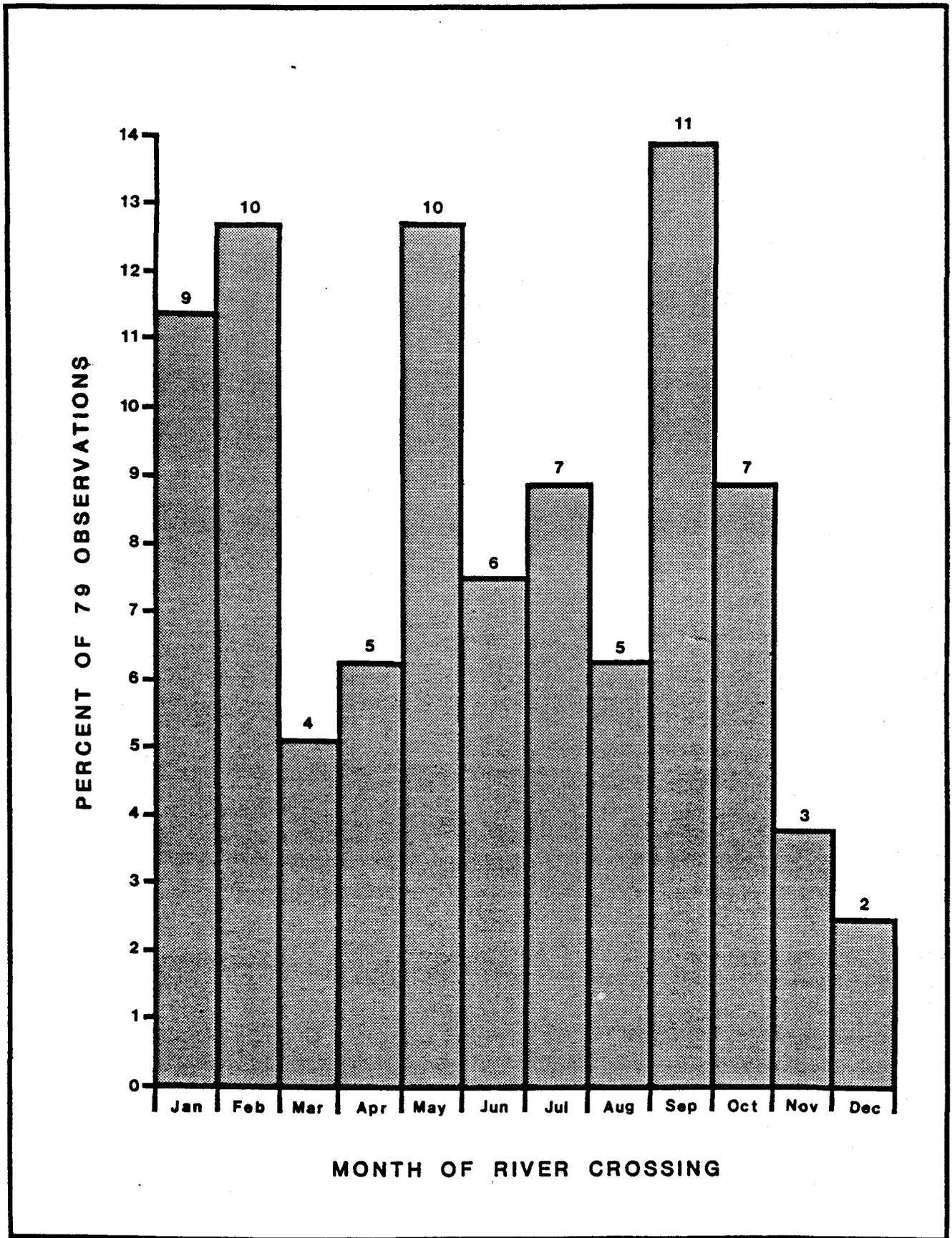


Figure 90. Timing of 79 crossings by moose of the middle Susitna River above Devil Canyon from April 1980 through December 1982 (Source: modified from data in Ballard et al. 1983a).

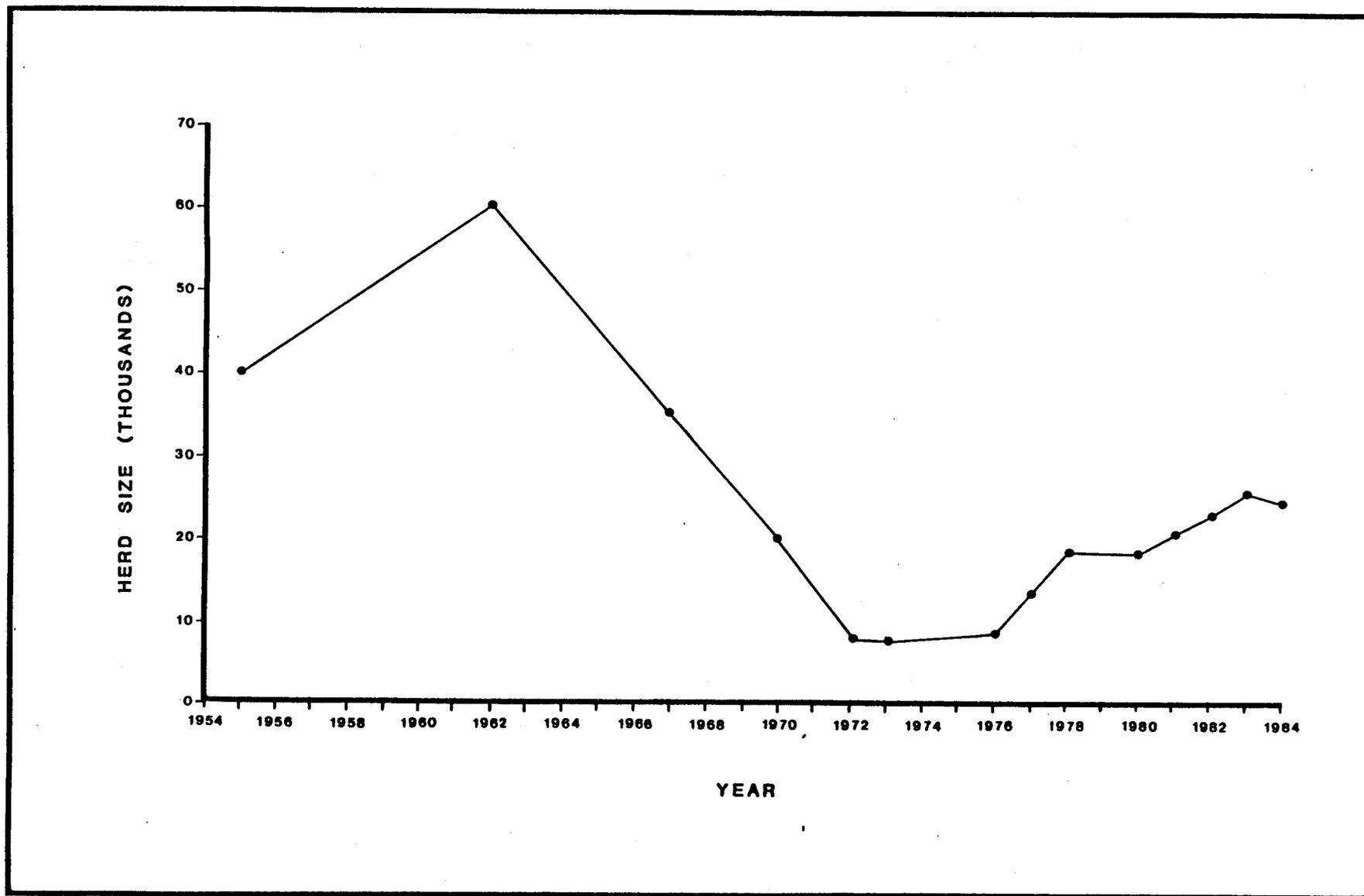


Figure 91. Population estimates for main Nelchina caribou herd (Sources: Pitcher 1984, 1985; Lieb et al. 1985).

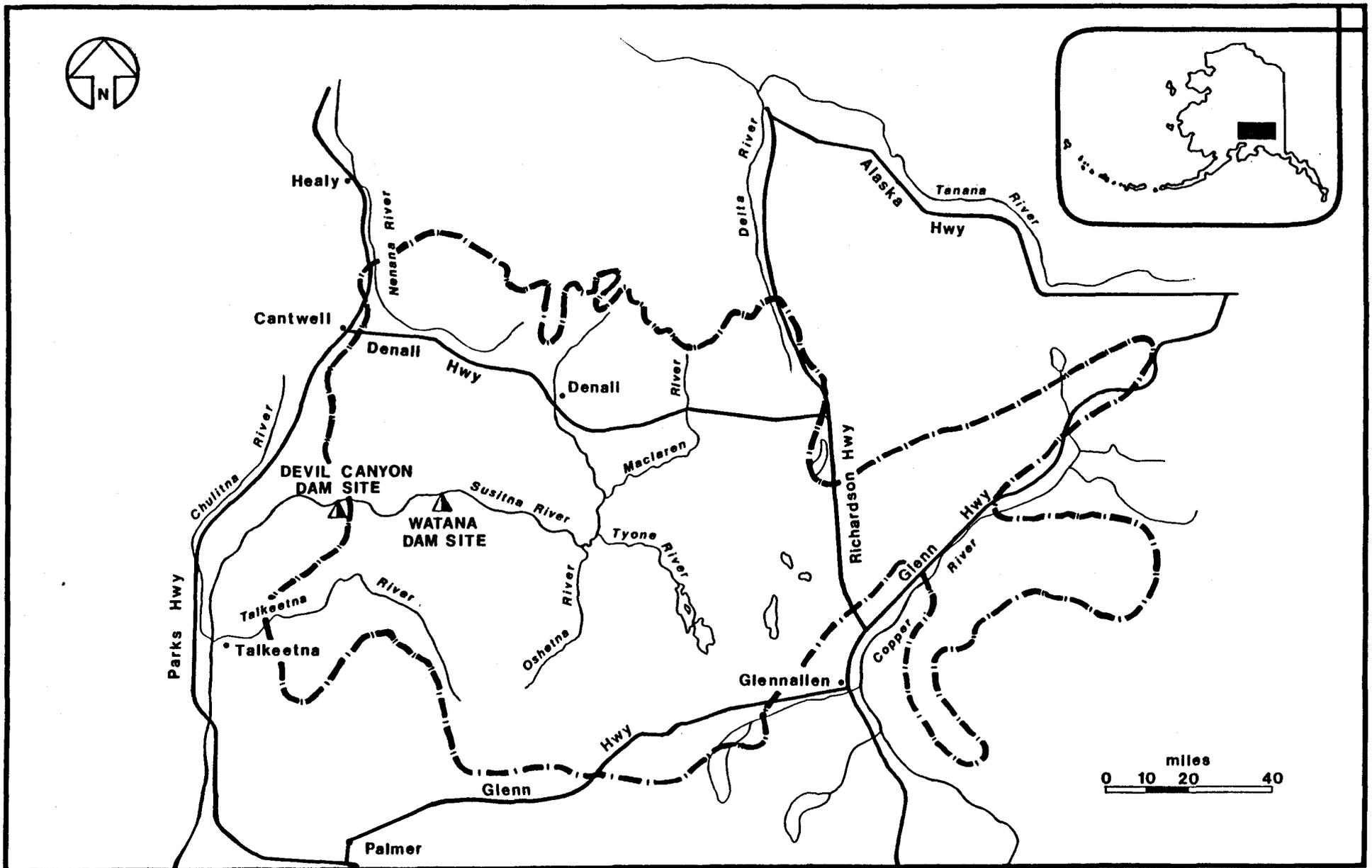


Figure 92. Historical range of the Nelchina caribou herd (Source: Hemming 1971).

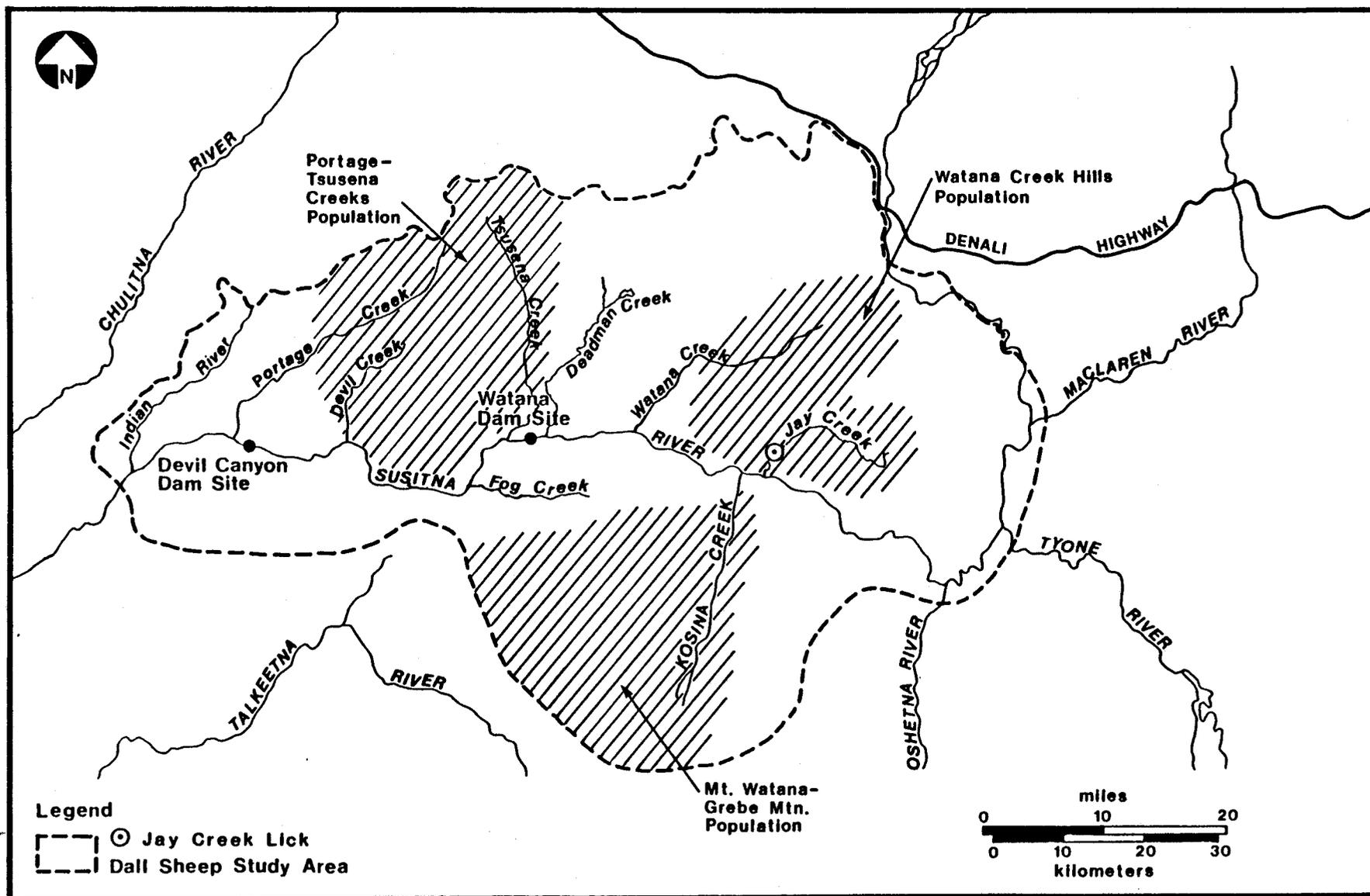


Figure 93. Dall sheep study area and local populations (Source: Tankersley 1984).

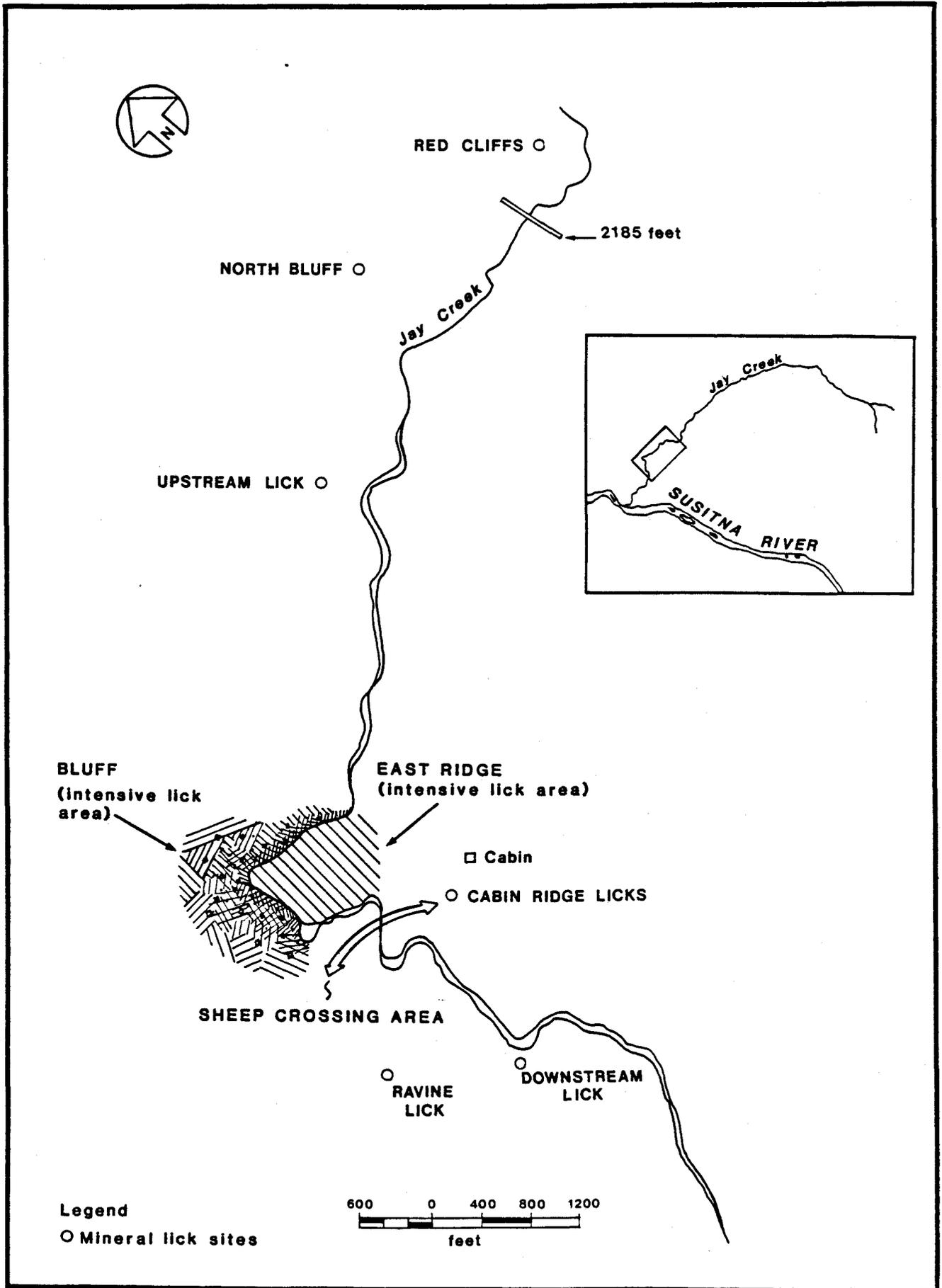
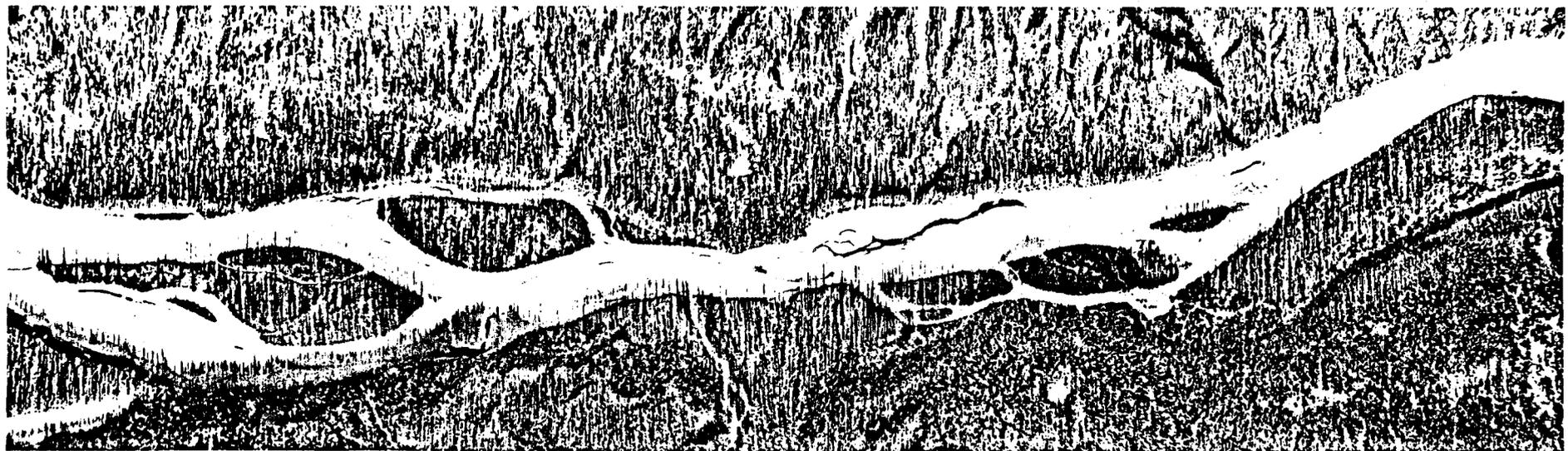


Figure 94. The Jay Creek mineral lick complex (Source: Tankersley 1984).

APPENDIX A
LOWER SUSITNA RIVER

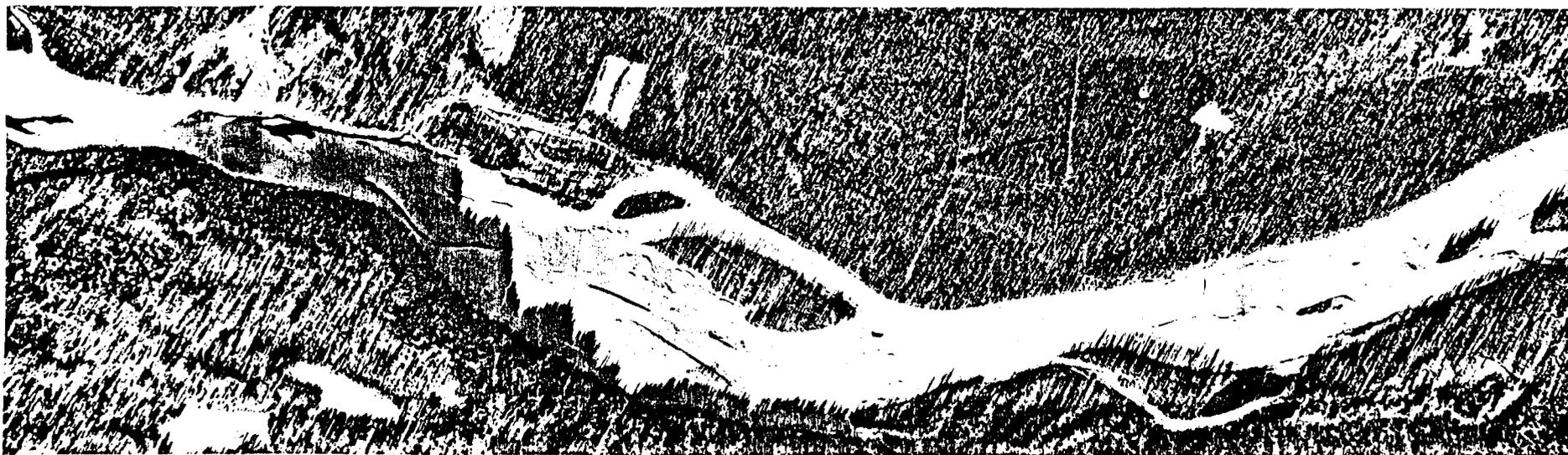
PHOTOGRAPHY NOT AVAILABLE FOR DRAFT REPORT -
WILL BE IN FINAL DRAFT

APPENDIX B
MIDDLE SUSITNA RIVER

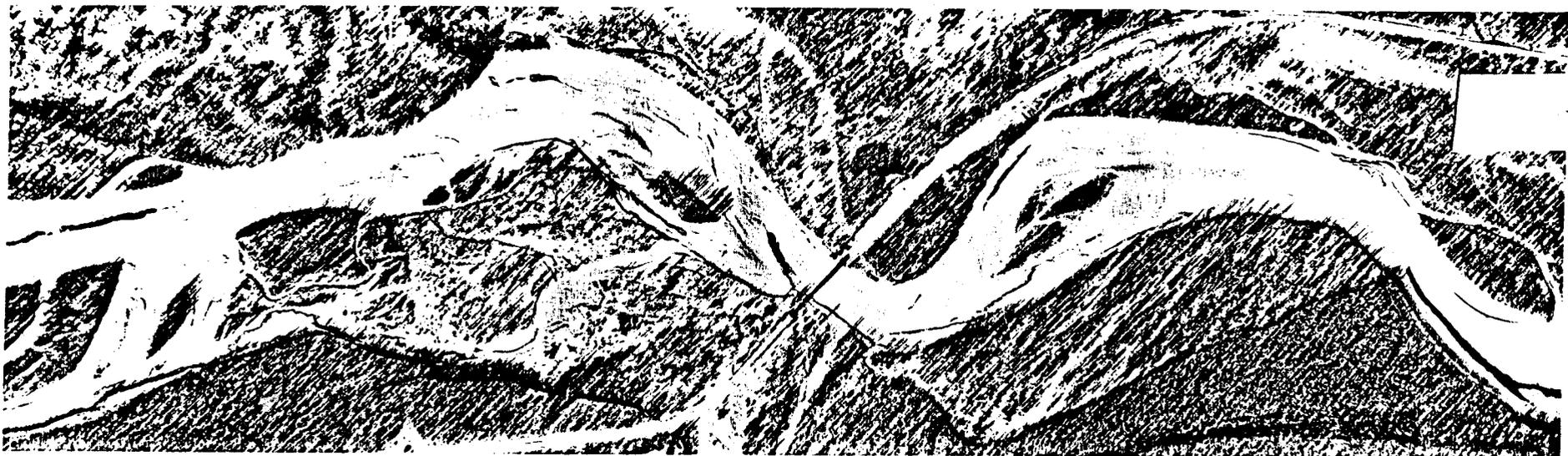


MIDDLE SUSITNA RIVER

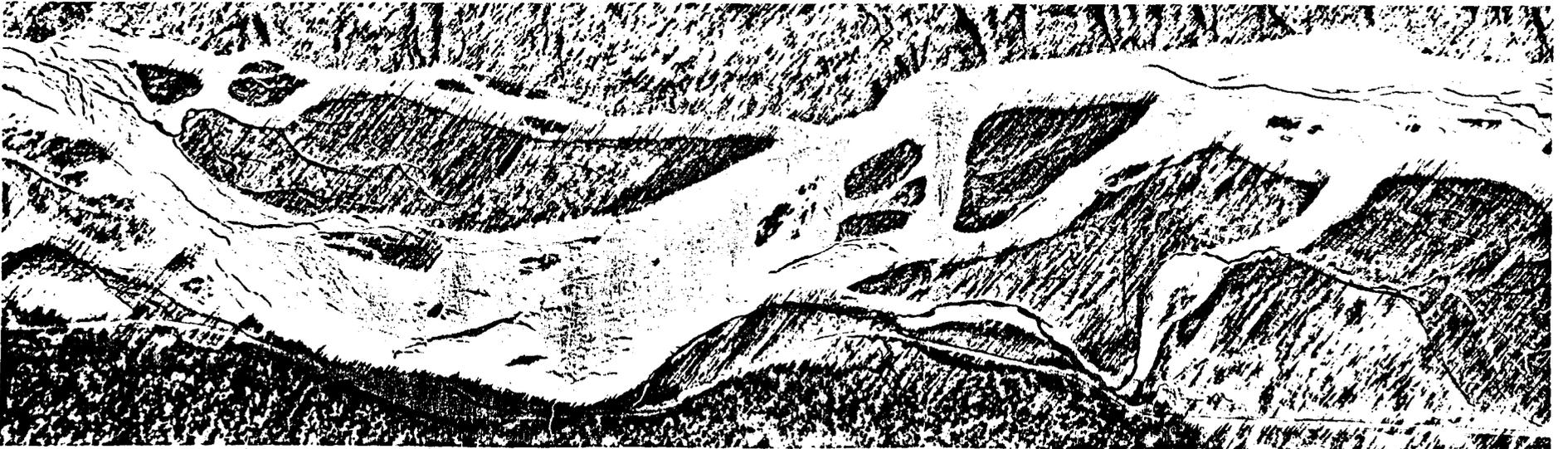
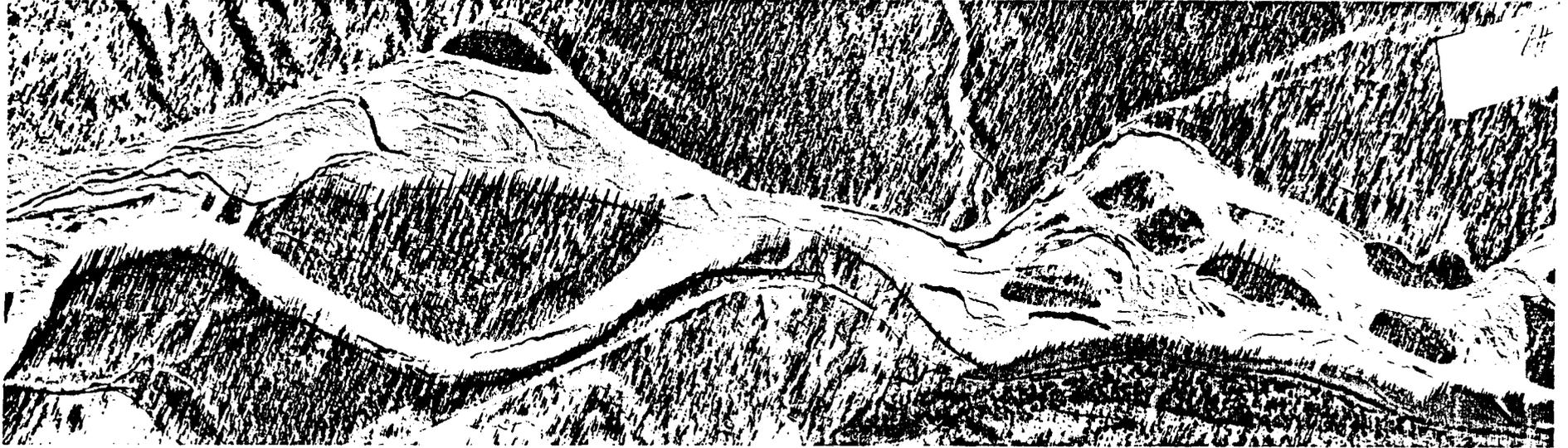
Top: River Mile 147 to 149
Bottom: River Mile 144 to 146
March 2, 1983 Scale: 1"=1000'



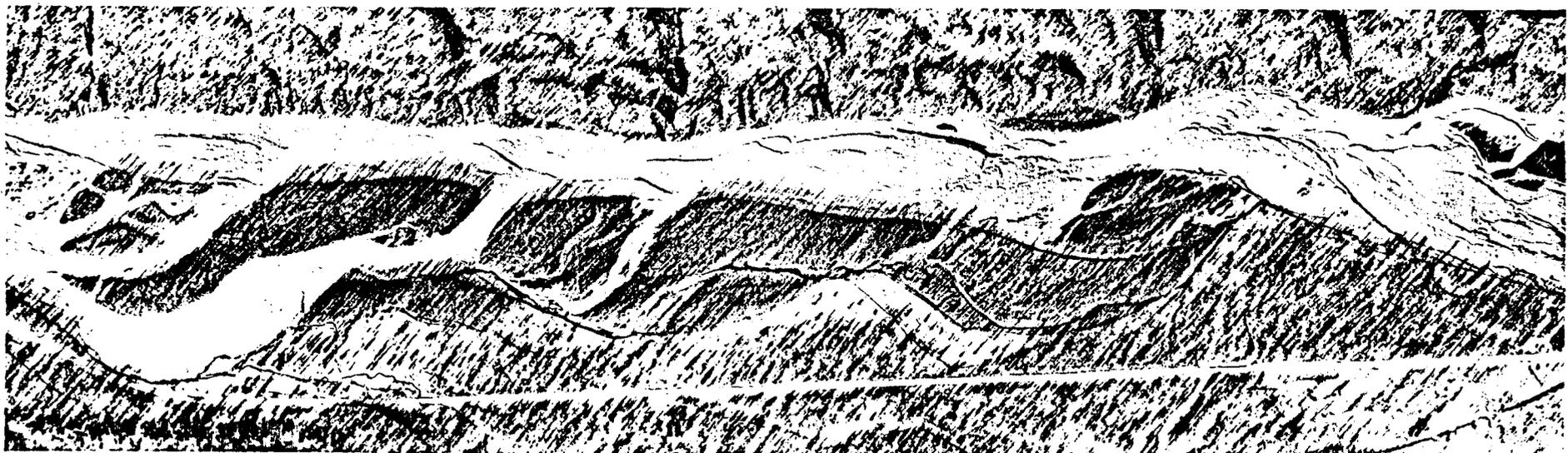
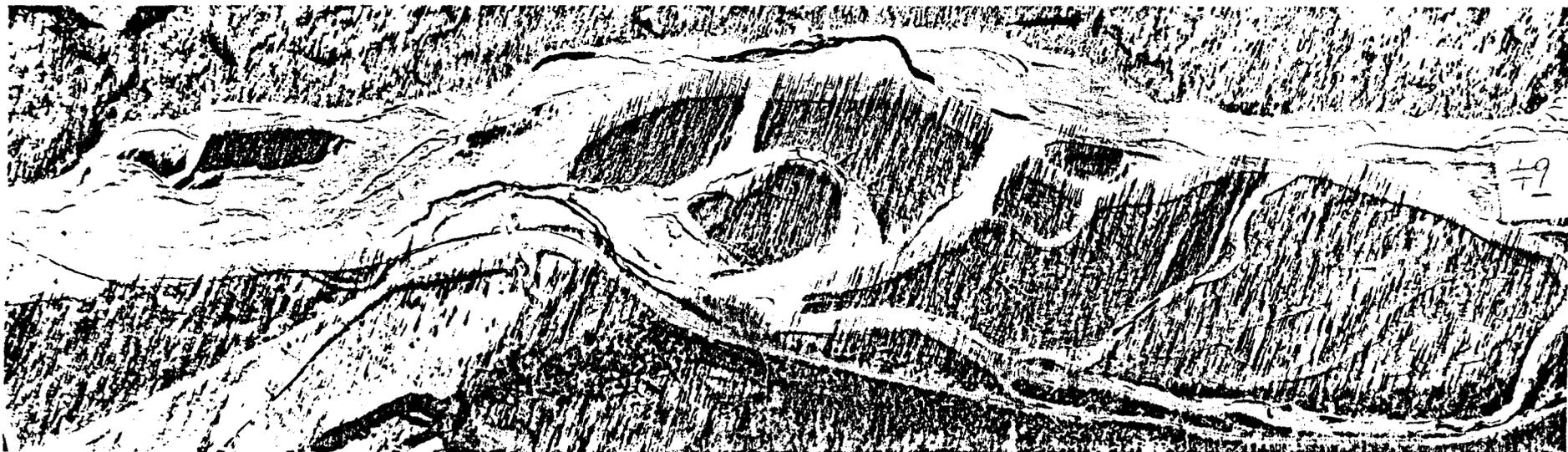
MIDDLE SUSITNA RIVER
Top: River Mile 142 to 144
Bottom: River Mile 139 to 141
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 136 to 138
Bottom: River Mile 133 to 136
March 2, 1983 Scale; 1"=1000'



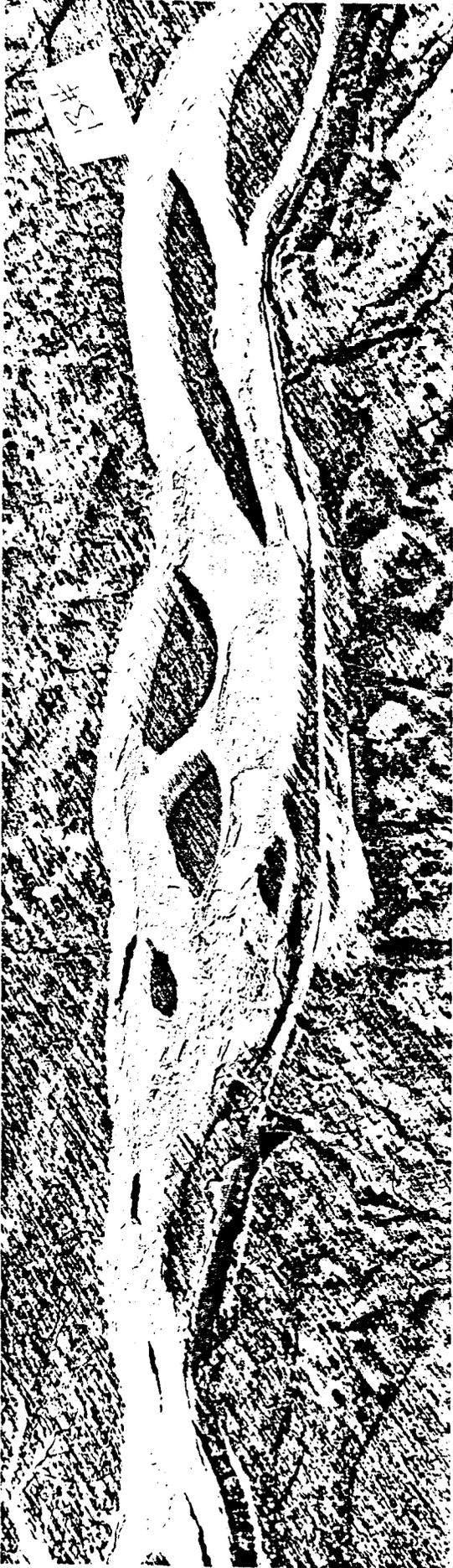
M MIDDLE SUSITNA RIVER
Top: River Mile 130 to 132
Bottom: River Mile 127 to 129
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 124 to 126
Bottom: River Mile 122 to 124
March 2, 1983 Scale: 1"=1000'



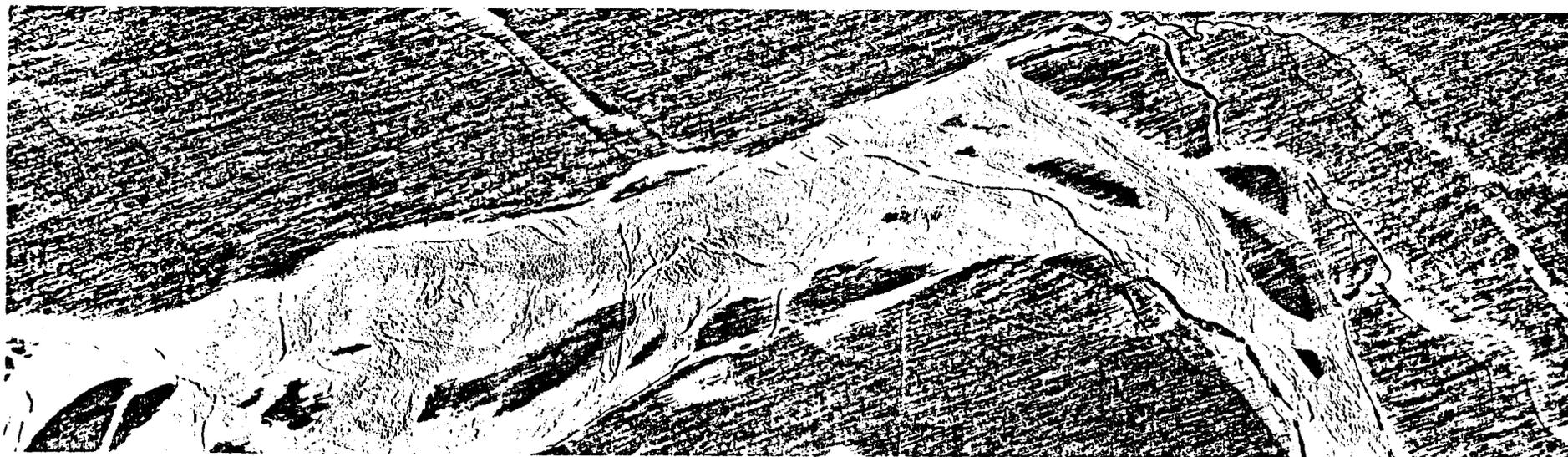
MIDDLE SUSITNA RIVER
Top: River Mile 119 to 121
Bottom: River Mile 116 to 118
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 113 to 115
Bottom: River Mile 110 to 112
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 108 to 110
Bottom: River Mile 105 to 107
March 2, 1983 Scale; 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 102 to 104
Bottom: River Mile 101 to 102
March 2, 1983 Scale: 1"=1000'