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HYDROLOGIC RECONNAISSANCE OF THE NORTH FORK KUSKOKWIM RIVER BASIN. ALASKA 1983-1984

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HYDROLOGIC RECONNAISSANCE OF THE NORTH FORK KUSKOKWIM RIVER BASIN, ALASKA, 1983-84

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PROJECT DESCRIPTION

Alaska DGGS personnel reconnoitered the North Fork Kuskokwim River basin in central Alaska in June 1983 and April 1984 to collect hydrologic data to describe the flow characteristics and quality of the surface water in the basin under both summer (high-flow) and winter (low-flow) conditions.

The 320-mi-long North Fork of the Kuskokwim River drains 5,130 mi^2 of interior Alaska. The river drops 1,900 ft from its headwaters in the Kuskokwim Mountains to its confluence with the South Fork for an average slope of 0.0011 ft/ft or 6 ft/mi. Spruce-hardwood forest covers most of the basin, with alpine tundra at the higher elevations. Dense spruce forest with occasional stands of willow and alder line the banks of the North Fork. Poorly drained soils with a peaty surface layer over a shallow permafrost table predominate within the basin (Selkregg, 1976).

The North Fork Kuskokwim River basin straddles parts of the Kuskokwim Mountains, Tanana-Kuskokwim Lowlands and Central Alaska Range as described by Wahrhaftig (1965). The western part of the central Alaska Range drains to the North Fork via the East Fork Kuskokwim River and several swift, braided glacial streams. Lowland areas of schist, quartzite, metavolcanics, chert, limestone and shale that range in age from Precambrian to Cretaceous protrude through Quaternary outwash fans (Reed and Nelson, 1980; Patton and others, 1980; Bundtzen and Gilbert, 1983). The basin contains extensive areas of inactive sand dunes (Selkregg, 1976).

The North Fork Kuskokwim River basin lies within the continental climatic zone of Alaska, characterised by cold winters and hot summers. The weather station at Lake Minchumina (just outside the basin) records a mean summer temperature of 42" to 68°F, mean winter temperature of -14" to 18°F, and extremes of -62°F and 89°F over a 24-year

period (Selkregg, 1976). Regional variations should be expected with the basin.

DGGS personnel floated the North Fork Kuskokwim River from the Fish Creek confluence (river mi 209) to its mouth in June 1983 and obtained discharge, water-quality and stream-channel measurements at 14 sites. A helicopter was used to visit 4 additional sites upstream from the Fish Creek confluence. In April 1984 all of the sites were revisited by helicopter.

Information in this report can be used to assess runoff and baseflow conditions of the river system and to estimate the year-round regimen of this interior Alaska river basin.

EXPLANATION OF GRAPHICS

Figure 1 is an index of U.S. Geological Survey (USGS) 1:250,000- and 1:63,360-scale topographic maps of the North Fork Kuskokwim River basin.

Figure 2 shows the generalized physiography of the basin superimposed over a diagrammatic representation of the riverine system.

Figure 3 is a profile of the North Fork Kuskokwim River and selected tributaries compiled from USGS 1:63,360-scale topographic maps. Comparative gradients along river segments and the position of tributaries and data-collection sites are shown.

Figure 4 contains a channel cross section of each data-collection site. Cross sections were developed from survey measurements taken during the June 1983 reconnaissance. Bankfull channel stage was determined from the flood-plain surface and the lower limits of permanent vegetation (Childers and Kernodle, 1983); maximum-evident-flood (MEF) stage was extrapolated from high-water marks found on the riverbanks.

Table 1 is a summary of the bed-material size, channel geometry, and discharge

measurements taken during the two reconnaissance trips and the calculated unit runoff based on these measurements. Unit runoff, obtained by dividing stream discharge by drainage area, can be used to compare seasonal water yields in a basin or subbasin (Childers and Kernodle, 1983).

Table 2 contains calculations based on the observed data. From the channel cross-sections, the approximate discharge for bankfull and MEF conditions are calculated with the simplified slope-area method (Riggs, 1979). The bankfull discharge indicates the maximum amount of flow that may be expected without flooding, and the MEF discharge indicates the maximum instantaneous peak discharge at the site in recent years (Childers and Kernodle, 1983). Drainage-basin characteristics are used to calculate predicted 2-yr and 50-yr floods using Lamke's (1979) method. (A 2-yr flood has a 50 percent chance of being exceeded in a particular year, whereas a 50-yr flood has a 2 percent chance of being exceeded; these values are based on multiple regression analysis of streamflow records and, like the bankfull and MEF discharges, should be considered rough estimates only.) The Froude number is a mathematical relationship between mean velocity, mean depth, and the gravitational constant: and is used to compare states of flow at the sites. In a rectangular channel, flow is tranquil if the Froude number is less than 1.0 and is rapid if greater than 1.0 (Dalrymple and Benson, 1968). Observed summer stage was used as a basis in calculating discharge using the simplified slope-area method and may be compared to the actual discharge values in Table 1. Discrepancies between calculated and measured discharge values can be attributed to several factors including possible backwater conditions at tributaries and confluences, nonideal channel reach, and other site-specific conditions.

Table 3 is a summary of water-quality data gathered at all sites during the 1983 and 1984 reconnaissance trips.

Table 4 is a summary of notes taken by DGGS personnel during the June 1983 reconnaissance trip, containing general observations of conditions encountered on the North Fork Kuskokwim River.

ACKNOWLEDGEMENTS

The authors thank R.A. Clay (formerly of DGGS) and K. Swanson (former DGGS student intern) for their assistance in gathering data for this report, and T.K. Bundtzen (DGGS) for his thoughtful review.

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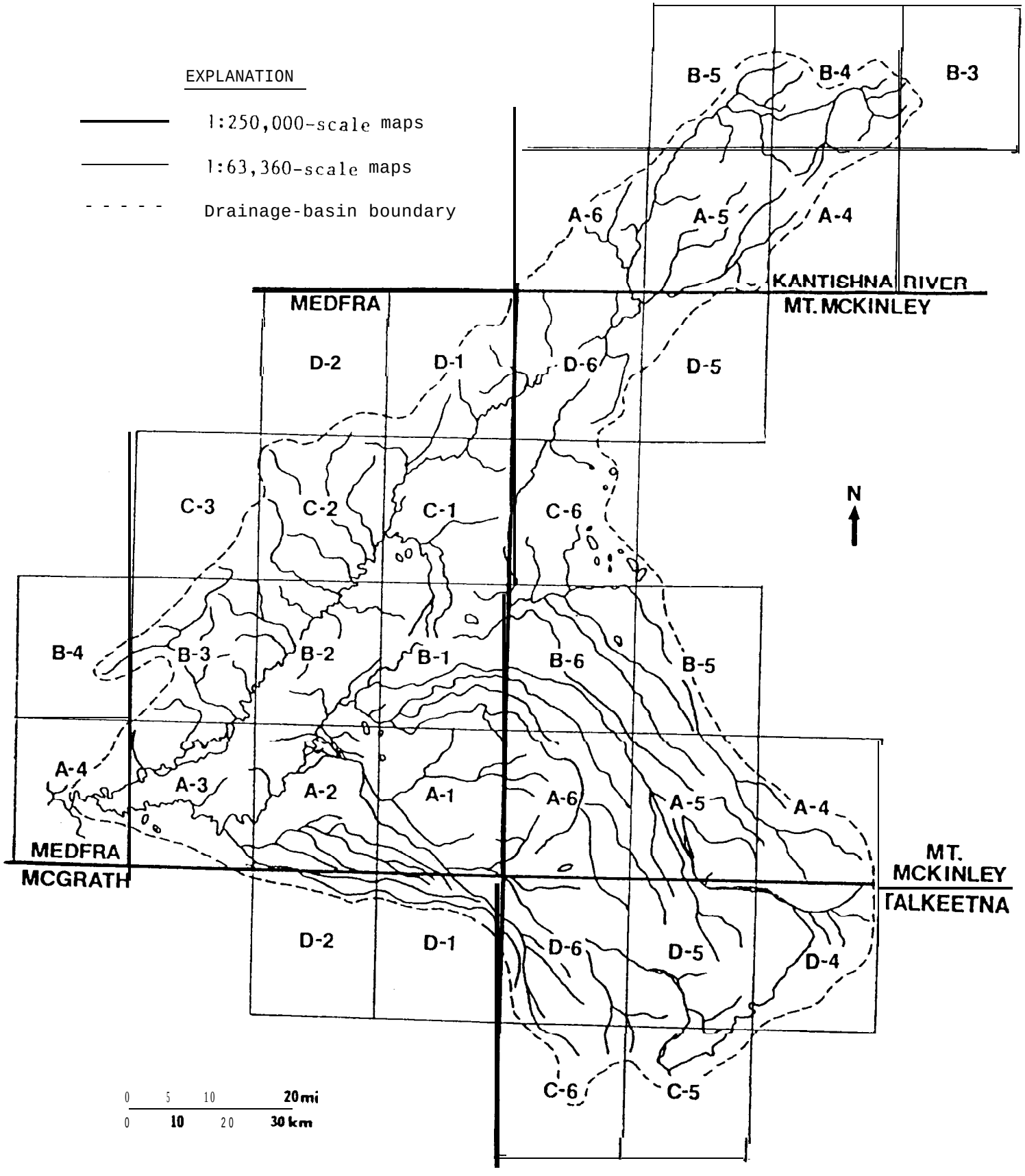

Figure 1. Index of U.S. Geological Survey topographic maps by quadrangle for the North Fork Kuskokwim River basin, Alaska.

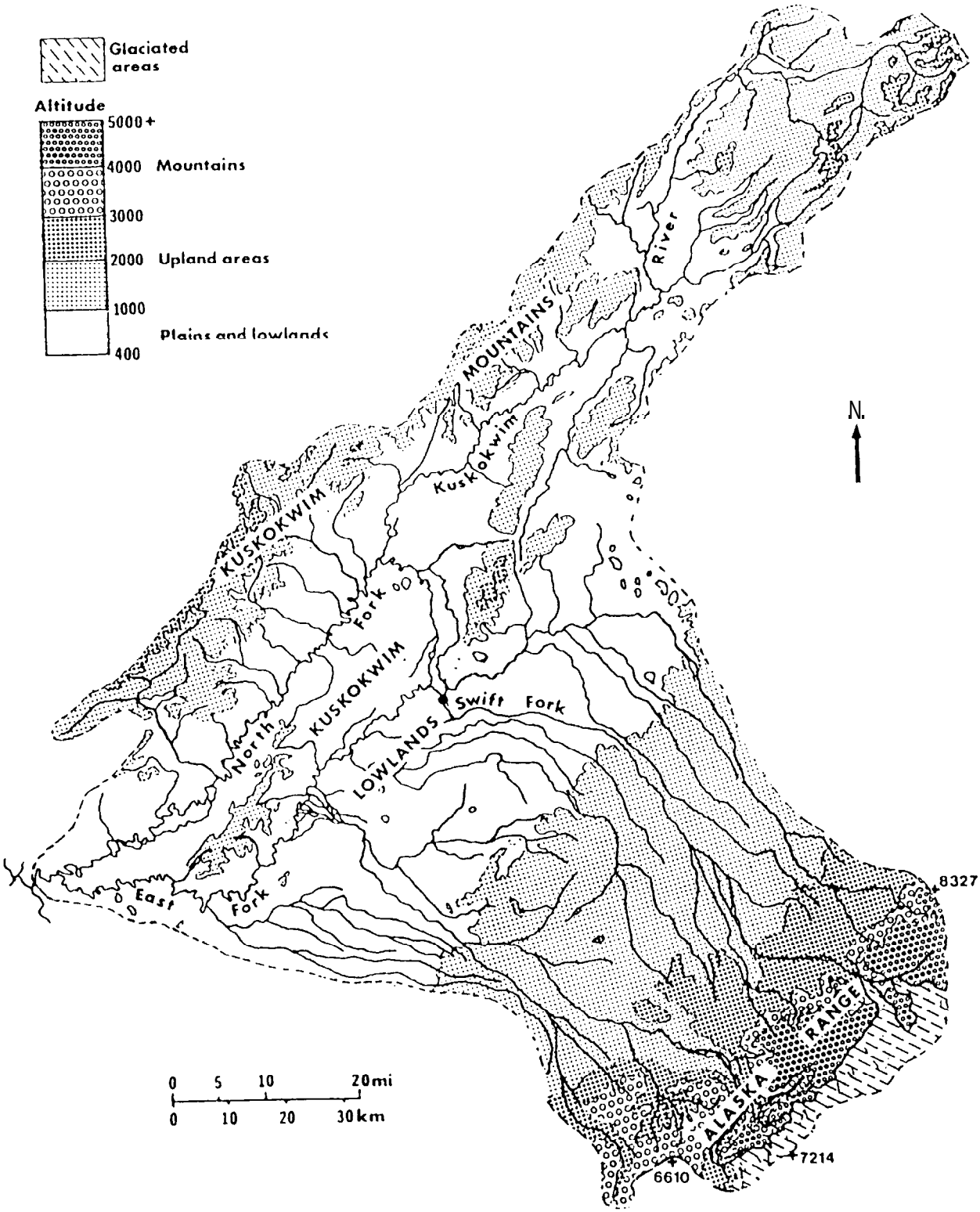

Figure 2. Generalized physiography, North Fork Kuskokwim River basin, Alaska.

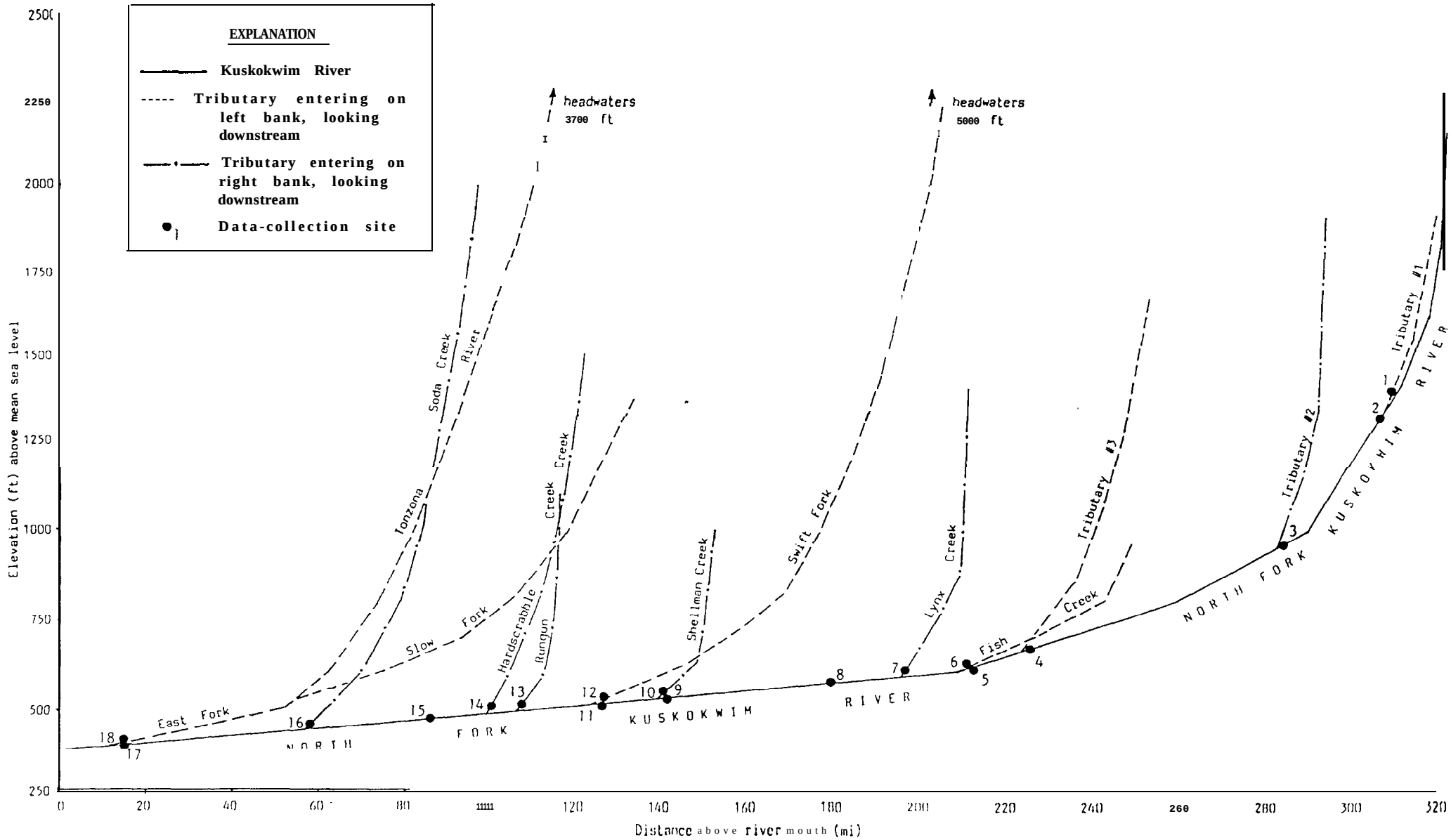

Figure . Profile of North Fork Kuskokwim River and selected tributaries, Alaska.

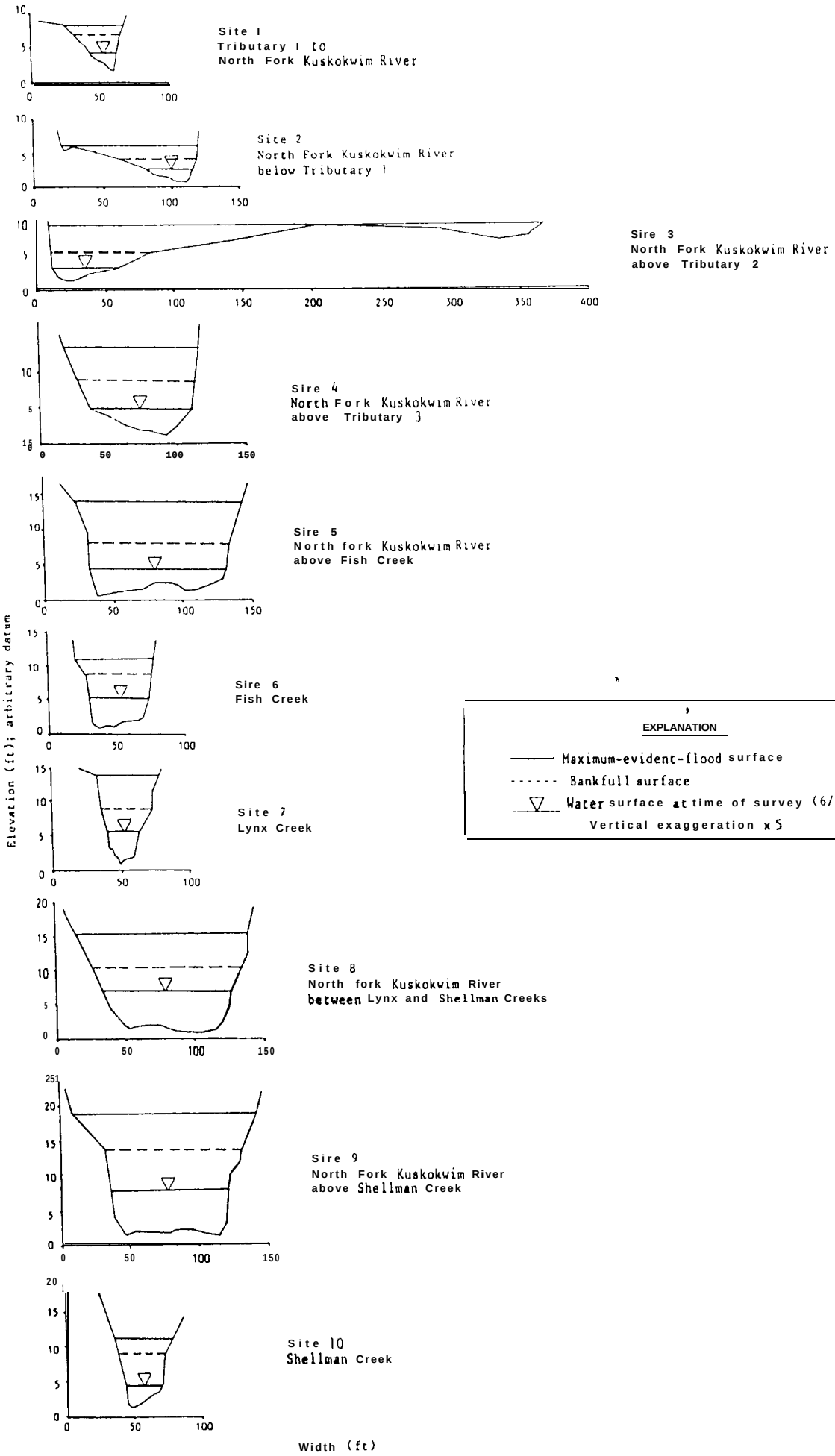

Figure 4. Channel cross-sections, North Fork Kuskokwim River basin, Alaska, June 1983

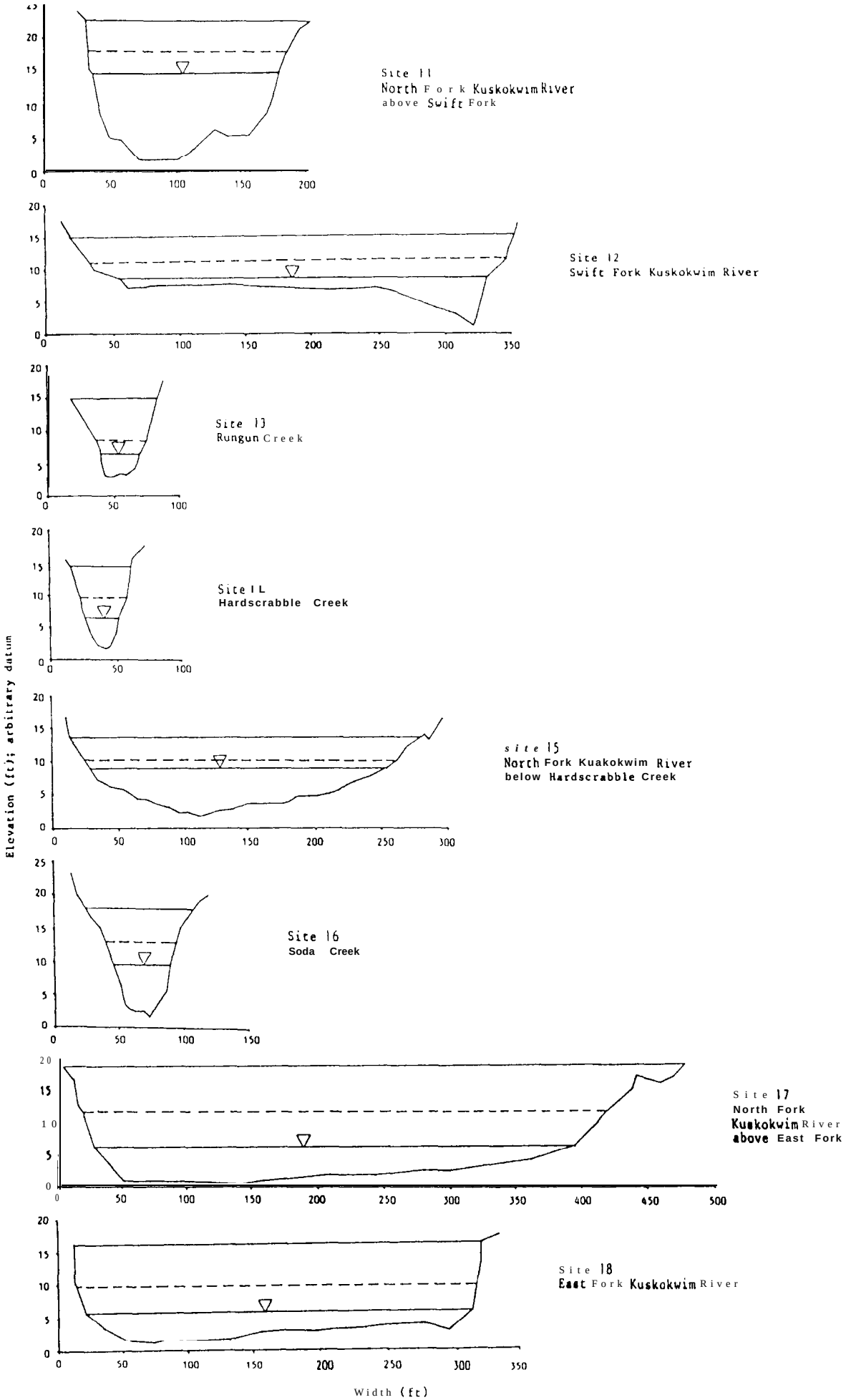

Figure 4. Channel cross-sections, North Fork Kuskokwim River basin, Alaska, June 1983. (cont'd)

Table 1. Summary of observed discharge and cross-sectional data, North Fork Kuskokwim River basin, Alaska 1983-W.

Data collection site	Bed material	Slope (ft/ft)	Cross-sectional area-ft²		Water-surface width (ft)		Mean depth (ft)		Maximum depth (ft)		Mean velocity (fps)		Maximum velocity (fps)		Discharge (cfs)		Unit runoff (cfs/mi²)	
			winter[a]	summer	winter	summer	winter	summer	winter	summer	winter	summer	winter	summer	winter	summer	winter	summer
1. Trib. 1 to N. Fork Kuskoknim River	gravel, cobbles	0.00180	0	25	0	23	0	1.1	0	2.5	0	0.9	0	1.5	0	28	0	0.58
2. N. Fork below tributary 1	gravel, cobbles	0.00102	1	33	7	33	0.2	0.9	0.2	1.9	0.0	1.2	1.5	2.2	1	52	0.01	0.48
3. N. Fork above tributary 2	sand, gravel	0.00096	21	50	27	48	0.0	1.0	1.1	1.9	0.2	1.5	0.4	2.4	6	94	0.03	0.50
4. N. Fork above tributary 3	silt, sand	0.00050	62	179	42	76	1.4	2.2	2.7	3.7	0.4	1.0	0.7	1.9	30	243	0.06	0.49
5. N. Fork above Fish Creek	silt, sand	0.00023	144	245	65	90	1.7	2.5	2.8	4.0	0.2	1.1	0.5	1.8	37	318	0.06	0.44
6. Fish Creek	sand, gravel	0.00027	75	133	36	44	2.0	2.6	2.8	4.0	0.3	1.1	0.5	1.9	28	162	0.14	0.82
7. Lynx Creek	silt	0.00003	21	82	27	24	0.0	3.2	1.7	4.9	0.02	0.04	0.1	0.1	1	5	0.02	0.09
e. N. Fork between Lynx & Shellman	silt	0.00006	185	415	a5	90	2.1	4.2	4.2	5.6	0.2	1.0	0.5	1.9	49	536	0.05	0.50
9. N. Fork above Shellman Creek	clay, silt	0.00008	232	462	79	84	2.0	s.2	4.0	6.6	0.3	1.3	0.6	2.0	69	671	0.07	0.60
10. Shellmdn Creek	silt	0.00073	17	50	24	28	0.7	1.7	2.1	3.2	0.3	0.3	0.8	0.5	8	19	0.18	0.37
11. N. Fork above Swift Fork Kuskoknim	silt, sand	0.00002	1,370	1,400	133	144	9.2	9.2	14.4	13.2	0.1	0.3	0.1	0.6	111	534	0.10	0.43
12. Swift Fork Kuskoknim	sand	0.00045	493	547	237	287	2.0	1.9	3.8	7.9	1.2	1.5	1.9	3.3	661	1,100	0.56	0.86
13. Rungun Creek	silt	0.00001	[b]	78		32		2.5		3.3		0.05		0.1		5		0.14
14. Hardscrabble Creek	clay	0.00007	19	93	21	30	0.0	2.3	2.2	4.5	0.4	0.3	0.7	0.6	11	32	0.20	0.52
15. N. Fork below Hardscrabble Cr.	clay, silt, sand, gravel	0.00015	655	305	235	226	2.6	4.5	5.5	7.6	1.0	1.6	1.9	2.4	819	1,870	0.31	0.66
16. Soda Creek	silt	0.00003	96	232	53	44	1.9	5.0	4.2	0.0	0.1	0.4	0.1	0.9	7	135	0.06	1.03
17. N. Fork above East Fork Kuskokwim	sand	0.00012	792	1,330	382	353	1.9	3.7	3.5	5.5	0.9	1.8	1.5	2.7	817	2,740	0.27	0.82
18. E. Fork Kuskoknim	sand	0.00019	349	807	220	290	1.6	2.7	3.8	4.3	1.0	1.7	2.2	2.8	536	1,670	0.33	0.94

[a] 'Winter' refers to reconnaissance of April 1984; 'summer' to June 1983
[b] No winter measurements made.

Table 2. Summary of calculated discharge and cross-sectional data, North Fork Kuskokwim River basin, Alaska, 1983-84.

Data collection site	Calculated bankfull characteristics: Cross-sectional area (ft^2)	Water-surface width (ft)	Mean depth (ft)	Maximum depth (ft)	Mean velocity (fs)	Discharge (cfs)	Calculated MEF characteristics: Cross-sectional area (ft^2)	Discharge (cfs)	Unit runoff (cfs/mi)	Drainage basin characteristics: Area (mi^2)	Mean annual precipitation (in.)	Mean minimum temperature, June (°F)	% of basin forested	% of basin under lakes	Predicted flood Q_2 (cfs) 2-year flood	Q_{50} 50-year flood	Froude number (June 1983 flow)	Calculated slope-area discharge at observed June 1983 stage (cfs)
1. Trib. 1 to N. fork Kuskokwim River	95	35	2.7	5.5	2.9	274	135	437	9.10	48	13	-12	9	0	386	1,390	0.15	46
2. N. Fork below tributary 1	105	50	2.1	3.0	2.4	253	270	889	5.23	108	13	-12	7	0	a43	2,770	0.22	54
3. N. Fork above tributary 2	190	78	2.4	4.0	2.3	544	565	2,320	12.27	159	13	-12	9	1	1,220	3,660	0.27	92
4. N. fork above tributary 3	375	87	4.3	9.5	2.3	1,100	680	2,430	4.84	501	13	-12	21	1	2,703	7,120	0.12	411
5. N. fort above Fish Creek	615	102	6.0	7.5	2.3	1,420	1,230	3,570	4.96	720	13	-12	26	2	3,410	a.530	0.12	417
6. Fish Creek	488	62	7.a	a.5	2.3	1,120	665	1,690	a.55	198	13	-12	95	3	805	2.350	0.12	199
7. Lynx Creek	205	37	5.5	8.0	0.6	117	395	280	5.19	54	15	-12	a1	1	310	1,090	0.004	35
a. N. Fork between Lynx & Shellman	800	105	7.6	a.5	1.3	1,040	1,400	2,200	2.05	1,080	15	-12	48	2	5,060	12,000	0.09	435
9. N. Fork above Shellman Creek	970	99	9.5	12.0	1.6	1,560	1,520	2,830	2.51	1,130	15	-12	49	3	4,990	11,800	0.10	582
10. Shellman Creek	190	36	5.3	a.0	2.7	504	250	726	14.24	51	15	-12	92	1	289	971	0.04	a5
11. N. Fork above Swift Fork Kuskokwim	1,670	153	12.2	16.0	0.9	1,760	2,470	2,480	2.01	1.230	15	-12	52	3	5,380	11,900	0.02	1,200
12. Swift Fork Kuskokwim	1,163	315	3.6	7.5	3.8	4,410	2,190	10,300	8.10	1,280	15	-12	76	7	4,630	10,100	0.19	1,630
13. Rungun Creek	165	41	4.0	6.5	0.3	46	415	158	4.39	36	15	-12	94	0	237	a39	0.01	17
14. Hardscrabble Creek	140	33	4.2	6.5	0.8	111	335	355	5.52	61	15	-12	77	0	400	1,320	0.03	64
15. N. Fork below Hardscrabble Cr.	1,250	238	5.3	6.5	2.4	2,980	2,120	5,030	2.13	2,830	15	-12	67	5	10,500	20.700	0.11	2,170
16. Soda Creek	375	54	6.9	11.5	0.7	262	710	612	4.67	131	15	-12	88	a	529	1,630	0.03	138
17. N. Fork above East Fork Kuskokwim	2,850	400	7.1	11.0	2.a	8,000	5,690	20,100	6.03	3,340	17	-12	71	5	13,300	27,200	0.17	2.920
18. E. Fork Kuskokwim	1,900	300	6.3	5.5	3.1	5,800	3,650	13,900	7.17	1,790	17	-12	a7	3	7.760	17,200	0.18	1.870

Table 3. field water quality at data-collectionsites, North fork Kuskokwim River basin, Alaska, 1983-84.

Data collection site	Water temperature (°C) winter[a]	summer	Specific conductance (umhos/cm @ 25°C) winter	summer	Dissolved oxygen (mg/l) winter	summer	pH winter	summer
1. Tributary 1 to North Fork Kuskokwim River	[b]	5.3		45		-		6.6
2. North Fork below tributary 1	0.0	5.7	2&8	54	4.2	-	6.1	6.6
3. North Fork above tributary 2	2.9	6.6	66	51	a.3	-	6.1	6.2
4. North Fork abcve tributary 3	0.0	9.1	91	53	6.0	-	6.1	6.3
5. North Fork abcve Fish Creek	-0.1	8.4	94	66	0.0	-	6.0	6.4
6. fish Creek	-0.2	9.1	196	42	7.2	-	6.2	6.4
7. Lynx Creek	0.1	6.5	145	80,	0.2	-	6.0	6.7
6. North Fork between Lynx and Shellman Creeks	-0.2	9.9	lhl	70	0.2	-	5.6	6.4
9. North Fork abcve Shellman Creek	-0.1	10.6	167	71	0.5	-	6.7	6.5
10. Shellman Creek	-0.2	7.4	435	217	11.0	-	7.0	7.5
11. North Fork abcve Swift Fork Kuskokwim River	-0.2	11.6	193	70	0.1	-	6.1	6.4
12. Swift Fork Kuskokwim River	-0.2	15.2	269	246	6.0	-	7.2	1.5
13. Rungun Creek		10.5		227		-		7.0
14. Hardscrabble Creek	-0.2	9.2	436	407	10.6	-	7.0	7.6
15. North fork below Hardscrabble Creek	-0.2	16.0	261	199	5.6	-	6.6	7.2
16. Soda Creek	0.0	11.1	437	345	3.0	-	6.9	6.1
17. horth fork abcve East fork Kuskokwim River	-0.2	15.4	332	239	6.0	-	6.0	7.3
16. East Fcri Kuskokwim River	-0.2	15.3	311	271	6.3	-	6.6	7.5

[a] 'Winter' refers to reconnaissance of April 1984; 'summer' to June 1983.
[b] No measurements made.

Table 4. *River* **log notes,** *North* **Fork Kuskokwim River, Alaska, June 1983.**

River, reach and location	Weather	Description
North Fork Kuskokwim River between Fish Creek and Lynx Creek (mi 208-195)	50°F, partly cloudy, trace of rain	Meandering reach, width of active channel c.150 ft and depth 3-5 ft. Predominantly undercut silt banks with some sloping areas and frequent slumping. Bed is mostly silt with occasional gravel and cobbles. No channel bars. Crass on sloping banks.
North Fork Kuskokwim River between Lynx Creek and Shcllman Creek (mi 195-138)	60°F, clear	Meandering reach, width of active channel c. 150 ft and depth 3-6 ft. Silt banks, undercut and raw at outer bends with massive slump blocks. Bed is predominantly silt. Point bars, covered with dead willow and alder from beaver activity and larger dead *trees* from bank sloughing. Occasional short riffles and old sloughs. Breakup flood evidence (ice scars on banks and/or trees). Willow on upper banks, grass on lower banks.
North Fork Kuskokwim River between Shellman Creek and Swift Fork (mi 138-122)	65°F, clear	Meandering reach, width of active channel c. I75 ft and depth 5-9 CL. Silt banks, undercut at outer bends, sloping c.30° otherwise. Bed is fine silt and sand. Point bars, some with grass, and abundant beaver cuttings. Many dead trees at channel bends. Pools to 13 ft deep. Gradient decreases above Swift Fork. Breakup flood evidence (cabins at Swift Fork confluence reported by occupants to be flooded occasionally with 1-2 ft of water). Grass, willow and alder on banks; tower 2 ft raw.
North Fork Kuskokwim River between Swift Fork and Hardscrabble Creek (mi 122-99)	65°F clear	Meandering reach, width of active channel c.300 ft and depth 5-10 ft. Sandy banks with raw, slumping outer bends. Outer banks slope c.45°, inner c.40°; some 20-30 ft high. Bed is predominantly sand. Point bars vith some willow. Numerous snags on outer bends, some mid-channel; many beaver cuttings. Brown stain to water. Gradient increases below Swift Fork. Breakup flood evidence. Some grass on banks; mostly bare.
North Fork Kuskokwin River near Soda Creek (mi 50-30)	65°F, clear	Meandering reach, width of active channel c.200 ft and depth 5-13 ft (one of two active channels which diverge for 12-15 mi below Soda Creek). Banks sand and *gravel,* predominantly raw and sloping. Banks generally IO-15 ft high; 75 ft near mi 88. Bed is sand and gravel. Occasional bare channel bars, numerous snags, less beaver ev idcncc. Brown stain to water, moderate turbidity, some sand-sized sediment movement. Breakup flood evidence. Some willow on banks.
North Fork Kuskokwim River above East Fork confluence (mi 20-7)	55°F, overcast, occasional rain	Meandering reach, width of active channel c.300 ft and depth 8-15 ft. Sandy banks with raw outer bends, predominantly sloping. Sandy bed with some *small gravel.* Bare channel bars *at* straight reaches ; point bars with willow and some alder. *Occas* iona 1 snags, sweepers and beaver cuttings along banks. Pools to 21 ft deep. Some willow on inside bends.