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DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

RECONNAISSANCE OF SURFACE-WATER RESOURCES IN THE KOBUK RIVER BASIN, ALASKA, 1979-80

By Joseph M. Childers and Donald R. Kernodle

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JAMES G. WATT, Secretary

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Dallas Peck, Director

For additional information write to:

U.S. Geological Survey
Water Resources Division
1515 East 13th Avenue
Anchorage, Alaska 99501

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CONVERSION TABLE

Multiply	By	To obtain
inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
mile per hour (mi/h)	1.609	kilometer per hour (km/h)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [(ft^3/s)/mi^2]	0.0109	cubic meter per second per square kilometer [(m^3/s)/km^2]
degree Fahrenheit (°F)	(°F-32)0.555	degree Celsius (°C)
micromho per centimeter at 25°C (µmho/cm)	1	microsiemen per centimeter at 25°C (µS/cm)

Other abbreviations in this report are:

µg/L, micrograms per liter
mg/L, milligrams per liter

Note: The National Geodetic Vertical Datum of 1929 (NGVD of 1929) is a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

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ABSTRACT

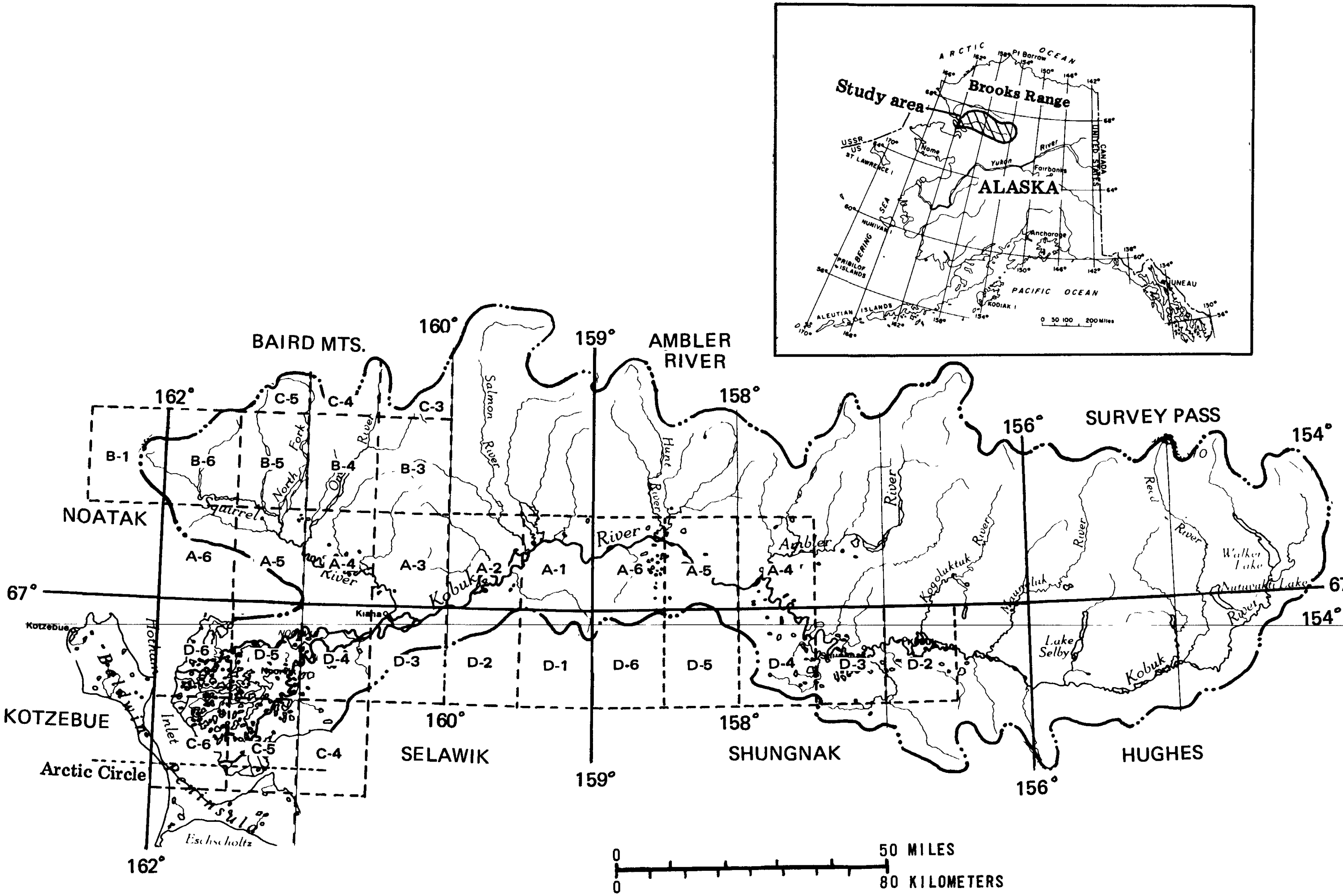
Surface-water data were collected at selected sites in the Kobuk River basin in northwest Alaska in August 1979 and April 1980. In August 1979, frequent heavy rains caused abnormally high flows in the basin; unit runoff values, computed from discharge measurements at 25 sites, ranged from 0.08 to 12.2 cubic feet per second per square mile. Mean unit runoff for August computed from 13 years of record at a streamgaging station on the Kobuk River ranged from 1 to 3 cubic feet per second per square mile. Unit runoff computed from discharge measurements made at eight sites in April 1980 ranged from 0 to 0.30 cubic feet per second per square mile. These values are in reasonable agreement with those derived from the record at the gaging station.

High-water marks of maximum evident floods and evidence of ice-affected flooding were found at near bankfull stages at 17 sites on the Kobuk River and its tributaries. Computed unit runoff for the maximum evident floods generally decreases with increasing drainage area. Unit runoff ranges from about 50 to 75 cubic feet per second per square mile for drainage areas less than 1,000 square miles to less than 25 cubic feet per second per square mile for larger areas.

Field determinations were made of water temperature, pH, alkalinity, dissolved-oxygen concentration, and specific conductance, and discharge was measured at about 40 stream sites and one spring. Water samples for laboratory analysis of dissolved inorganic constituents and biological samples were collected in August 1979. Water-quality data indicate that the surface waters would be acceptable for most uses; they are a calcium bicarbonate type having dissolved-solids concentrations generally between about 50 and 140 milligrams per liter. The pristine nature of the waters is also indicated by the overall diversity and composition of its benthic invertebrate community. A more highly mineralized (about 550 milligrams per liter dissolved solids) sodium bicarbonate water flows from Reed River Hot Spring.

INTRODUCTION

The Kobuk River basin in northwest Alaska has been virtually undisturbed by man's activities. Parts of the basin are included in either the Kobuk Valley National Park or the Gates of the Arctic National Park and Preserve. The upper reach of the Kobuk River (above Selby River) was added to the National Wild and Scenic Rivers System under provisions of the Alaska National Interest Land Conservation Act (ANILCA) of 1980. The Salmon River, a large tributary of the Kobuk, was also designated a Wild and Scenic River, and the Squirrel River, a smaller tributary, is now being studied by the National Park System for possible inclusion in the system.



EXPLANATION

——— 1:250,000 scale quadrangle map (map name in capital letters)

– – – – 1:63,360 scale quadrangle map

Figure 1.--Index of U.S. Geological Survey topographic maps by quadrangle for the Kobuk River basin, Alaska.

This report contains data on physiographic and climatic characteristics of the Kobuk River basin, as well as stream channel hydraulic properties, seasonal quantity and quality of surface waters, floods, channel erosion, and benthic invertebrates. The data show the magnitude and ranges of stream discharge, width, depth, and velocity of flow that can be expected in late winter and summer periods, and indicate flood and erosion hazards in the basin. The water-quality and benthic-invertebrate data could be used to evaluate the suitability of the water for proposed uses and as a base from which to measure future changes in water quality. Data needs for management of the water resources of the Kobuk basin are discussed in the final section of the report.

Hydrologic reconnaissance surveys were made in the Kobuk River basin in August 1979 (late summer in northern Alaska) by boat and helicopter and in March and April 1980 (late winter) by snowmobile. Personnel from Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, assisted the authors in the data collection.

This report is a product of a U.S. Geological Survey program, under way since the early 1970's, to study environmental conditions in selected frontier areas of Alaska where development has begun or is planned. This program has been conducted primarily in the Arctic region (north of the Yukon River) and along existing or proposed transportation corridors. Numerous reports have been published, including results of a study of surface-water resources of the Noatak River basin (Childers and Kernodle, 1981).

SETTING AND CLIMATE

The Kobuk River basin has an area of 11,980 mi^2 (Selkregg, 1976). It lies south of the western part of the Brooks Range and just north of the Arctic Circle (fig. 1). The basin contains five villages along the Kobuk River (Kobuk, Shungnak, Ambler, Kiana, and Noorvik) (fig. 2). Bornite, a mining camp, is on Ruby Creek, a tributary to the Shungnak River which is a major tributary of the Kobuk River. Abandoned mining camps and settlements are scattered throughout the Kobuk basin. A few people live in isolated cabins, most of which are along streams. Temporary camps are seasonally occupied for fishing and mining. Transportation in the basin is by boat in the summer, snowmobile in the winter, and aircraft year round. Unpaved roads connect Kobuk village with nearby mines and winter trails are used for access between Kotzebue and inland villages.

The Kobuk River originates in the Central and Eastern Brooks Range (fig. 2). It then flows westward for more than 300 mi through the Kobuk-Selawik Lowland (Wahrhaftig, 1965) to its delta on Hotham Inlet (locally called Kobuk Lake). Most of the drainage is from the Baird and Schwatka Mountains, which are extensions of the Brooks Range to the north. The river passes through two canyons, Upper and Lower Kobuk Canyons.

The slope of the Kobuk River (fig. 3) is about 0.4 ft/mi between Kobuk village and its mouth at Hotham Inlet. In the approximately 110 mi from the rapids at the outlet of Walker Lake to Kobuk village, the elevation difference is about 500 ft and the slope is about 4.5 ft/mi. The tributaries have much steeper slopes. Figure 3 may be used to estimate distance along the river between indicated points, as well as slope and range in elevation of the particular reach.

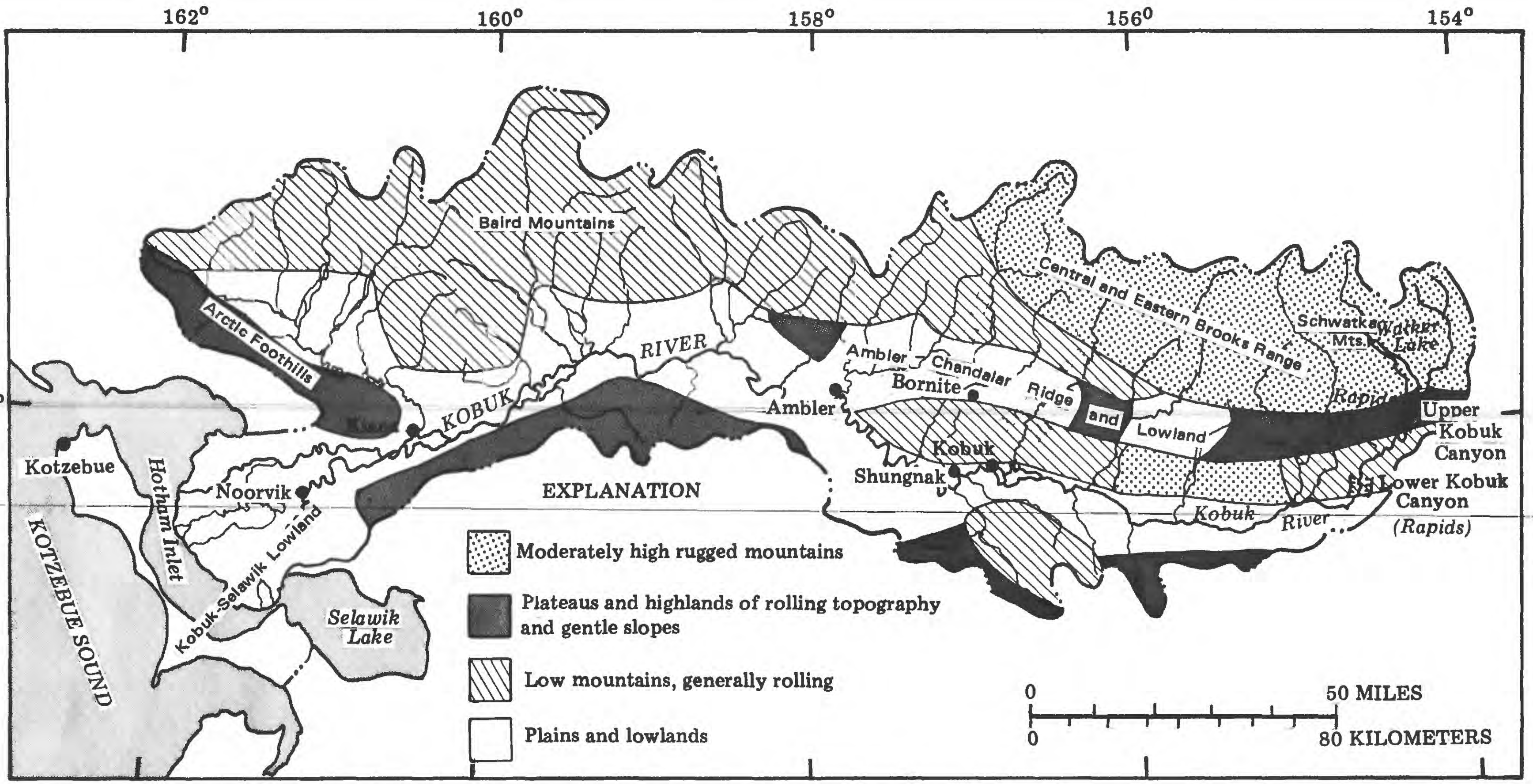


Figure 2.--Physiography of Kobuk River basin, Alaska (modified from Wahrhaftig, 1965).

Long, severe winters dominate the Kobuk River basin climate. Summers are often wet, and rainfall generally increases as summer progresses. Fog, rain, snow, and whiteout conditions are common. Daylight is continuous from May to August, but in December darkness prevails except for 6 to 7 hours of twilight each day. Weather records for Kobuk indicate that winter temperatures range from -24° to 1°F, and summer temperatures range from 42° to 69°F. Precipitation averages 20 in. annually, which includes 56 in. of snow. In this part of Alaska, winds average 10 to 15 knots the year-round (Selkregg, 1976, p. 16).

SEASONAL VARIATIONS IN HYDROLOGY

The Arctic climate strongly affects hydrologic conditions in the Kobuk River basin. Streams begin to freeze in October, and streamflow decreases through the winter to reach its annual low-flow period in March and April. The ice cover on most streams breaks up in May, and peak flows from snow-melt runoff occur in May and June. High-altitude streams freeze earlier and break up later. Summer rainstorms are common and can cause high stream discharge and flooding. Permafrost is discontinuous, but restricts infiltration where it is present.

Late Summer Conditions

Late summer weather in the Kobuk River basin varies from clear and warm to cloudy, rainy, and cold. If summer is mostly clear and warm with little or no rainfall, stream discharges are relatively low, exposed gravel bars are common, and flow is confined to the gravel-armored streambeds. If summer is mostly rainy, stream levels are high and the water may be quite turbid due to bank erosion.

Stream discharge measurements were made at 26 sites during the period August 11-29, 1979 (fig. 4 and table 1). Frequent, heavy rains occurred during the middle and latter part of August. Thus streamflow was probably higher than normal; measured discharge increased from 1,090 ft^3/s above Walker Lake outlet (site 1) to 50,800 ft^3/s below Jade Creek (site 26). Flow at Kobuk River below Onion Portage and at Squirrel River and its tributaries was too great to measure using the equipment available.

Unit runoff, a value obtained by dividing stream discharge by drainage area, can be used to compare seasonal water yields in a basin or yields from different parts of a basin. Unit runoff in August 1979 increased from between 3.3 and 4.5 $(ft^3/s)/mi^2$ in the upper Kobuk River (sites 1, 4, 8, and 10) to 7.6 $(ft^3/s)/mi^2$ below Jade Creek (site 26) in the middle reach of the river. Rainfall during the time between measurements most likely accounts for this increase. However, even the lower values are probably higher than normal for August, based on records from the long-term streamgaging station, Kobuk River at Ambler (site 24, fig. 4).

Unit runoff for the Kobuk River tributaries ranged from 0.1 $(ft^3/s)/mi^2$ at the outlet of Kollioksak Lake (site 14) to 12.2 $(ft^3/s)/mi^2$ at Akillik River (site 27). Most major tributaries draining the Baird and Schwatka Mountains from the north had significantly higher unit runoff than tributaries draining the lower relief areas from the south. The discharge measurement of one of these southern tributaries, the Pah River (site 11), indicated that unit runoff was 0.5 $(ft^3/s)/mi^2$.

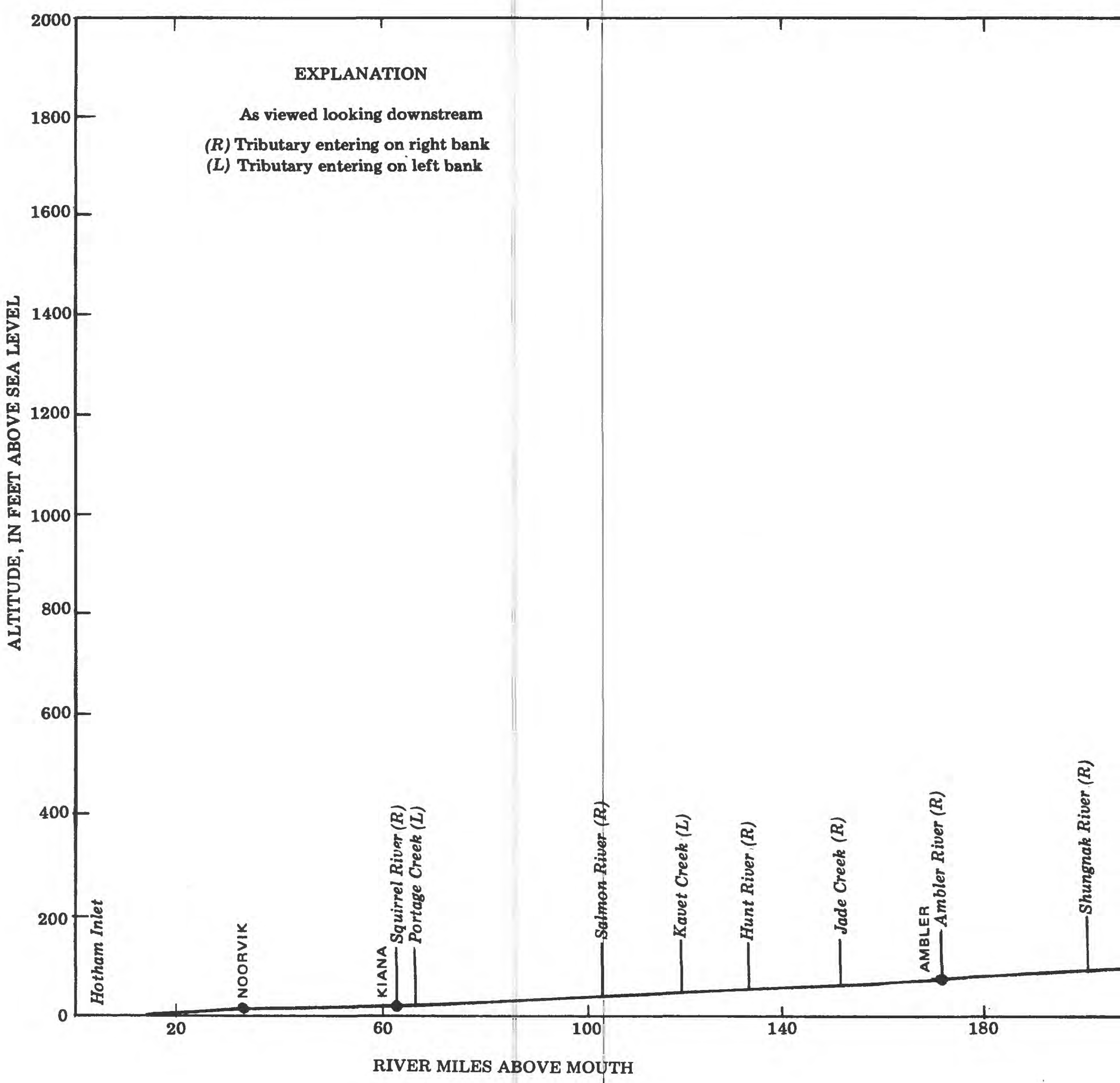
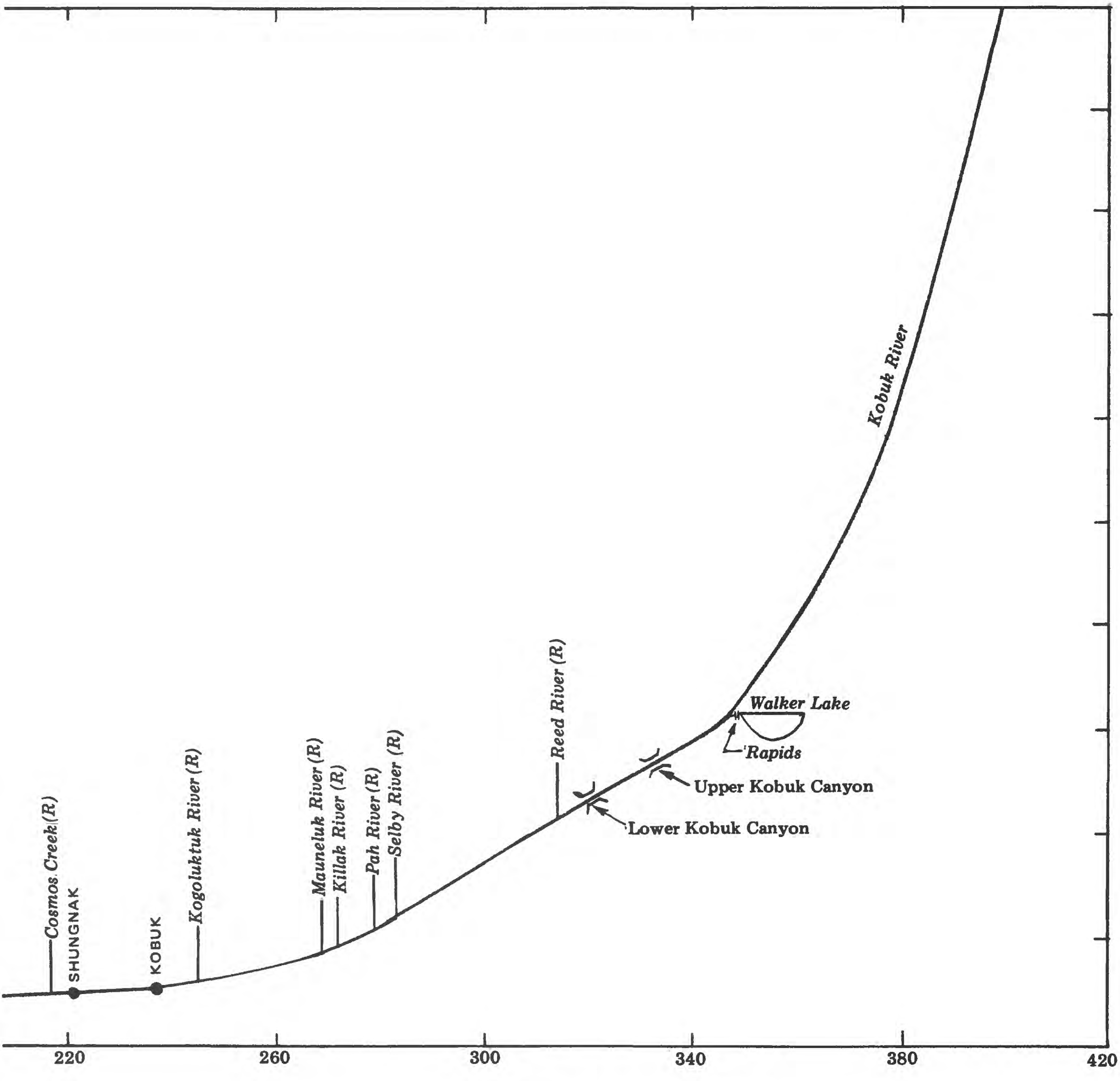


Figure 3.--Profile of Kobuk River and position of tributary junctions.



Cosmos Creek (R)
SHUNGNAK
KOBUK
Kogoluktuk River (R)
Maunelu River (R)
Killak River (R)
Pah River (R)
Selby River (R)
Reed River (R)
Lower Kobuk Canyon
Upper Kobuk Canyon
Walker Lake
Rapids
Kobuk River
220
260
300
340
380
420
RIVER MILES ABOVE MOUTH

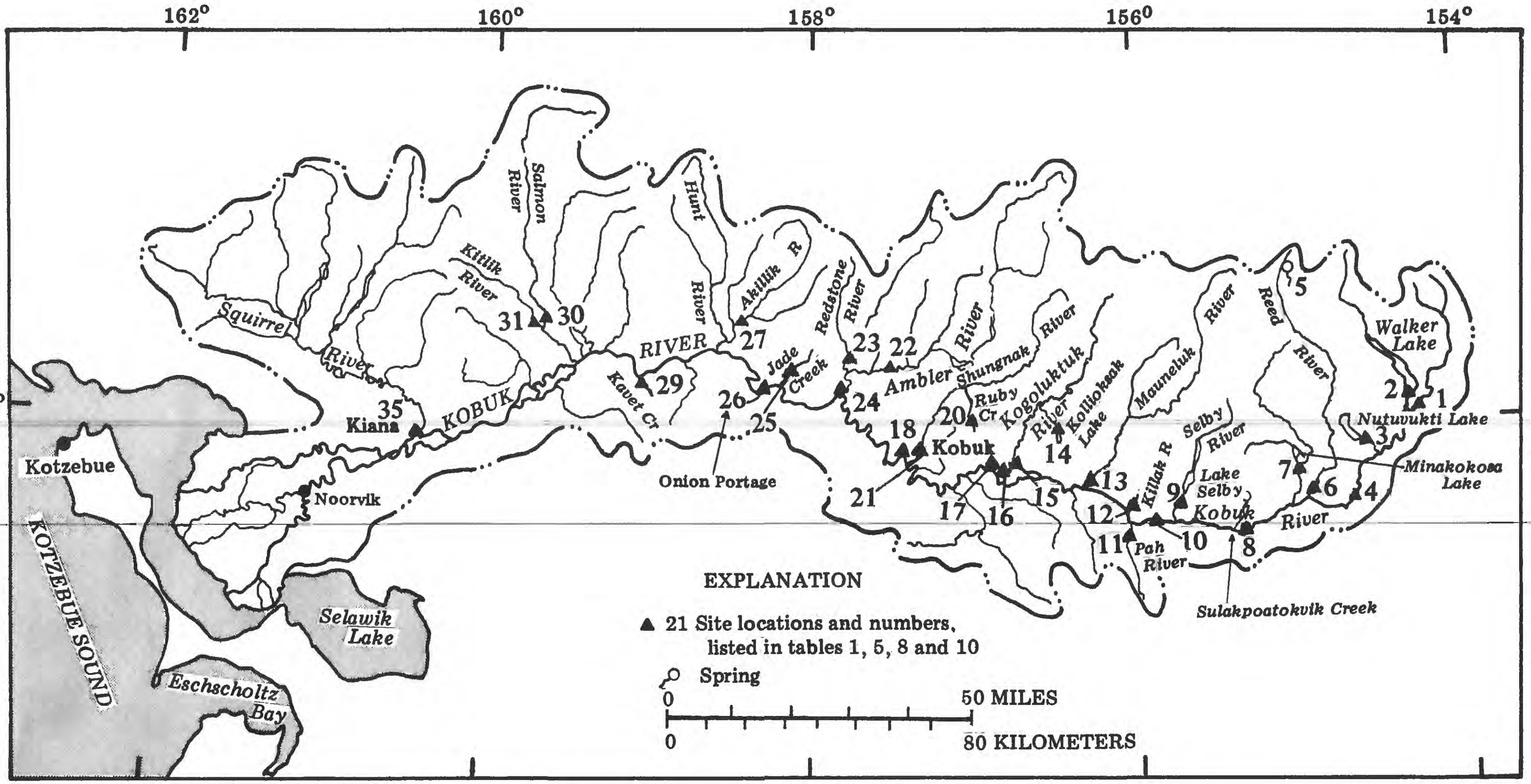


Figure 4.--Site locations, surveys of August 1979, Kobuk River basin.

Table 1. -- Stream site descriptions, surveys of August 1979 in Kobuk River basin
[See figure 4 for site locations]

Site no.	Stream site (lat, long)	Kobuk River mile	Drainage area (mi²)	Date measured (day)	Discharge (ft³/s)	Unit runoff [(ft³/s)/mi²]	Width (ft)	Mean depth (ft)	Maximum depth (ft)	Mean velocity (ft/s)	Maximum surface velocity (ft/s)	Bed material (table 2)
1	Kobuk River above Walker Lake outlet (67°01'37", 154°20'36").	349	285	11	1,090	3.82	217	1.5	2.7	3.4	4.7	Cobbles, gravel.
2	Walker Lake outlet (67°03'29", 154°18'49").	--	178	11	1,160	6.52	195	2.1	4.4	2.8	3.5	Boulders, gravel, sand.
3	Nutuvukti Lake outlet (66°57'19", 154°35'50").	--	29	14	47	1.62	30	2.1	2.8	.75	1.1	Gravel, sand.
4	Kobuk River above Lower Kobuk Canyon (66°50'06", 154°39'00").	323	714	13	2,380	3.33	347	3.2	5.0	2.1	2.6	Cobbles, gravel, sand.
5	Reed River Hot Spring near Kobuk (67°15'50", 155°02'39").	--	--	15	0.3	--	1.3	0.2	0.3	1.0	1.9	Rock.
6	Reed River near mouth (66°49'25", 154°57'31").	--	364	15	1,640	4.51	268	2.4	3.5	2.5	3.2	Gravel, sand.
7	Minakokosa Lake outlet (66°54'23", 155°00'44").	--	33	14	88	2.70	78	2.8	3.4	0.4	.55	Silt, sand.
8	Kobuk River above Sulak-poatokvik Creek (66°46'36", 155°10'18").	302	1,560	16	6,930	4.45	432	4.0	5.5	4.0	5.2	Cobble, gravel.
9	Lake Selby outlet (66°51'04", 155°41'04").	--	113	16	332	2.94	260	1.7	2.7	.75	.94	Boulder, cobbles, gravel.
10	Kobuk River below Selby River (66°46'18", 155°50'00").	282	2,000	17	7,240	3.62	398	4.5	7.0	4.0	6.0	Cobbles, gravel.
11	Pah River near mouth (66°44'30", 156°03'48").	--	956	17	458	.48	195	2.3	3.3	1.0	1.5	Do.
12	Killak River near mouth (66°48'54", 156°05'00").	--	42	18	92	2.19	27	1.2	2.5	2.9	3.6	Do.
13	Mauneluk River near mouth (66°52'40", 156°16'45").	--	573	18	2,980	5.20	281	2.7	4.5 est.	3.9	4.5 est.	Boulder, cobble, gravel.
14	Kollioksak Lake outlet (66°59'43", 156°26'31").	--	6	18	.5 est.	.08	14	3.5	--	.01 est.	--	Soft silt.
15	Kogoluktuk River near mouth (66°56'42", 156°45'06").	--	626	19	2,540	4.06	284	2.3	3.5 est.	4.0	4.5 est.	Boulder, cobble.
16	Kobuk River above Kobuk (66°54'12", 156°53'06").	237	4,170	24	21,900	5.25	627	9.6	12.5	3.7	4.8	Cobble, gravel.
20	Ruby Creek at Bornite (67°04'36", 156°56'12").	--	13	21	80	6.15	26	.9	1.0	3.5	4.3	Do.
21	Shungnak River near mouth near Shungnak (66°56'47", 157°19'03").	--	213	23	1,520	7.14	175	2.4	4.0 est.	3.6	4.3	Boulder, cobble.
22	Ambler River above Redstone River (67°09'18", 157°32'23").	--	716	19	5,030	7.03	319	3.5	6.0	4.5	5.0 est.	Gravel, cobble.
23	Redstone River near Ambler (67°12'01", 157°36'05").	--	211	22	1,100	5.21	102	3.1	4.5 est.	3.5	4.0 est.	Gravel.
25	Jade Creek near Ambler (67°10'49", 158°07'47").	--	57	22	150	2.63	48	.95	1.5	3.2	3.5	Boulder, cobble.
26	Kobuk River below Jade Creek (67°06'35", 158°14'51").	153	6,724	28	50,800	7.56	1,530	9.5	14.5	3.5	5.0	Not observed.
27	Akillik River above Hunt River near Ambler (67°14'22", 158°28'05").	--	303	22	3,700 est.	12.2	150	6.7	10.0 est.	3.7	5.0 est.	Gravel.
29	Kavet Creek at mouth near Kiana (67°07'24", 159°01'30").	--	25	29	55	2.20	42	1.4	1.8	1.0	1.2	Sand.
30	Salmon River above Kitlik River near Kiana (67°15'12", 159°38'58").	--	515	23	4,400	8.54	390	2.3	5.0 est.	4.8	6.0 est.	Boulder, cobble, gravel.
31	Kitlik River near Kiana (67°14'30", 159°40'06").	--	98	23	851	8.68	84	2.7	5.3	3.8	5.0	Cobble.

Values of the hydraulic properties measured during August 1979 are listed in table 1. Cross sections at survey sites on the Kobuk River are shown in figure 5. The survey sites were selected to measure the variation in hydrologic and hydraulic properties along the river in reaches that had (1) uniform cross-sectional shape; (2) minimum channel bend; and (3) well-defined high-water marks to indicate the maximum evident flood. (See section on Floods and Erosion.) Elevations of the maximum evident flood surface, the bankfull channel surface, and the water surface at the time of the survey are shown on the cross sections. In August 1979 the channel of the Kobuk River from above Walker Lake outlet (site 1) to Okok Point at the head of the Kobuk River delta was fairly uniform in cross-sectional shape; that is, it was not an alternating pool-and-riffle sequence.

Stream width on the Kobuk River increased in a downstream direction from about 200 ft at Walker Lake outlet to 1,500 ft near the mouth. Maximum depths increased from 3 ft to 15 ft in the same reach. Maximum surface velocity ranged from about 3 ft/s to 6 ft/s. From Walker Lake outlet to Kobuk village the river is generally a tranquil stream and has good recreational boating conditions. The only navigation hazards were rapids at Walker Lake outlet (figs. 6 and 7) and in Lower Kobuk Canyon (figs. 8 and 9). A portage trail is on the left bank (as viewed downstream) at Walker Lake outlet rapids, but no trail exists in the Lower Kobuk Canyon. Downstream from Kobuk village, the river is wide, deep, and smooth flowing. Most reaches of the channel have gravel, cobble, or boulder bottoms (table 2), and the water is usually clear.

Table 2. -- Scale of streambed material particle sizes

Class	Millimeters	Inches
Boulders	>256	>10
Cobbles	256-64	10-2.5
Gravel	64-2	2.5-0.078
Sand	2-0.062	0.078-0.0024

Late Winter Conditions

During the March and April 1980 survey, nine stream sites were visited. The sites are listed in downstream order in table 3, and their locations are shown in figure 10. In March, snow and ice in the Kobuk River basin supported snow vehicles and airplanes equipped with skis. Such travel was unsafe after April 1 because snowmelt caused by afternoon sunshine infiltrated and weakened the snowpack and seeped as overflow onto ice. This unexpected change thwarted the survey party's efforts to make late winter low-flow measurements in some parts of the central and eastern Kobuk basin. However, the weather change presented an opportunity to observe changes that can occur in ice and snow conditions at the beginning of "spring breakup."

Because of the snow-melt contributions to streamflow, discharges measured in April at the Kogoluktuk River near Kobuk (site 15) and at the Kobuk River above Kobuk (site 16) may not reflect minimum winter discharges. The minimum discharges probably occurred in late March. Overflow on the Shungnak River near Shungnak (site 21) prevented the survey party from measuring discharge (fig. 11). The discharge of Canyon Creek near Kiana (site 33) was measured in an open lead (fig. 12). Downstream from the lead the creek overflowed onto a large icing (fig. 13).

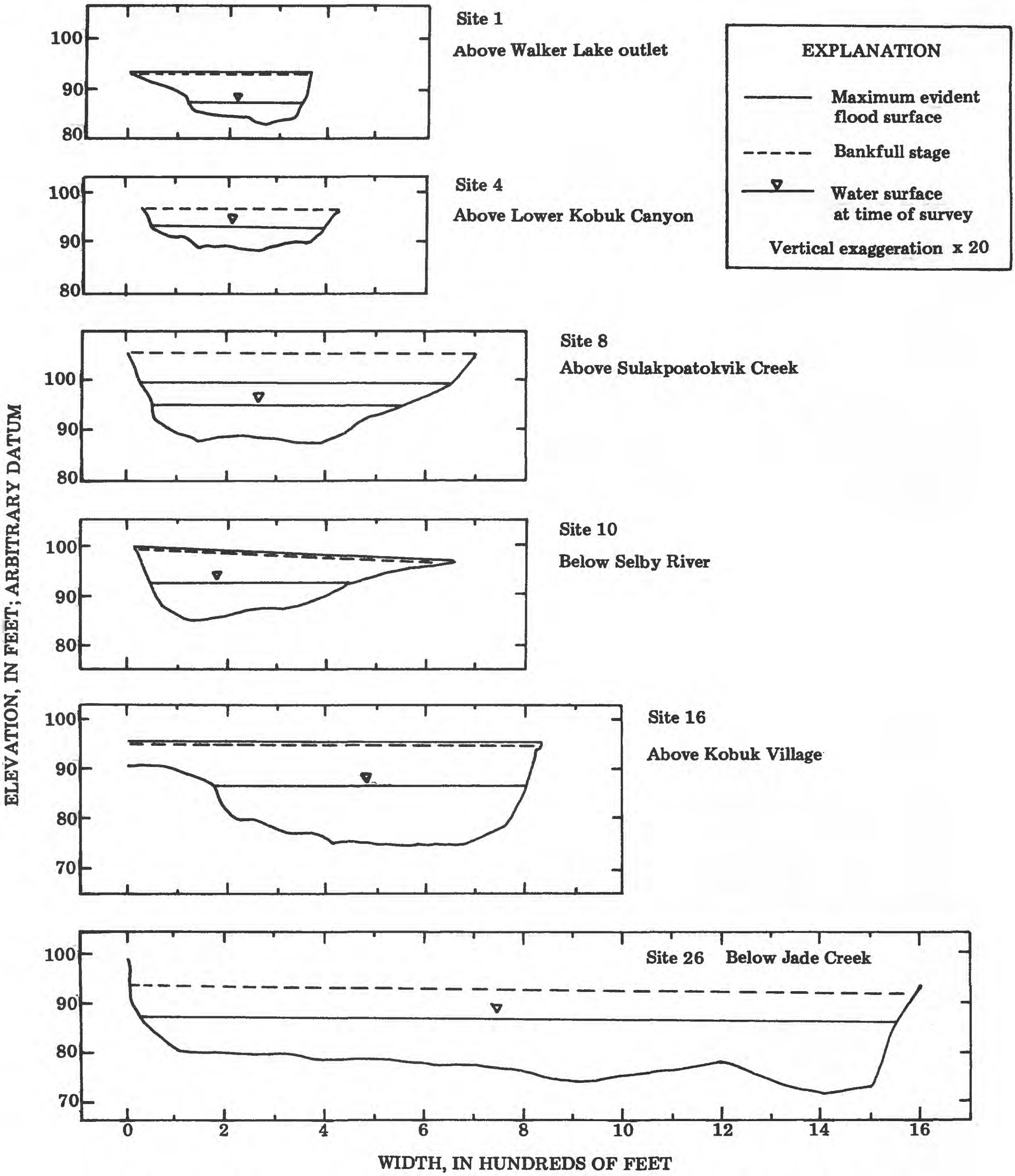


Figure 5.--Kobuk River cross sections as viewed looking downstream, August 1979. (Information about sites is given in tables 1 and 5.)

Figure 6.--Aerial photograph of Walker Lake outlet, June 1, 1979. Stream about 50 feet wide at rapids in lower center of photograph. See figure 7 for close-up of rapids.

Figure 7.--Walker Lake outlet, August 11, 1979; view downstream from left bank.

Figure 8.--Aerial photograph of Lower Kobuk Canyon rapids, June 1, 1979. Stream width about 300 feet in area of rapids, lower right-hand portion of photograph.

Figure 9.--Close-up aerial photograph of Lower Kobuk Canyon rapids, August 14, 1979.

Table 3. -- Discharge measurements during March and April 1980 in Kobuk River basin
[See figure 10 for site locations]

Site no.	Stream site (lat, long)	Drainage area (mi^2)	Date measured	Discharge (ft^3/s)	Unit runoff [(ft^3/s)/mi^2]	Width (ft)	Mean depth (ft)	Maximum depth (ft)	Mean velocity (ft/s)	Remarks
15	Kogoluktuk River near mouth (66°56'42", 156°45'06").	626	4/2	63.0	0.10	110	1.5	2.9	0.41	2.4-ft ice cover.
16	Kobuk River above Kobuk (66°54'12", 156°53'06").	4,170	4/2	1,240	.30	350	4.7	7.8	.72	2.5-ft ice cover.
19	Cosmos Creek near Shungnak (66°54'06", 157°11'00").	38.9	3/31	No flow	0	24	--	--	--	4.0-ft ice cover.
21	Shungnak River near mouth near Shungnak (66°56'47", 157°19'03").	213	3/31	----No measurement----		100	--	--	--	Overflow, unsafe to measure.
28	Hunt River near Ambler (67°11'54", 158°32'42").	646	3/28	164	.25	190	5.6	11.3	.13	4.0-ft ice cover.
32	Portage Creek near Kiana (66°53'30", 160°18'15").	18.4	3/24	0.5	.03	10	.3	--	.15 est.	3.0-ft snow, 0.1 ft ice cover.
33	Canyon Creek near Kiana (67°05'09", 160°17'36").	10.3	3/23	1.76	.17	13	.3	.4	.5	Measured in open lead.
34	Squirrel River near Kiana (67°02'00", 160°24'00").	1,609	3/24	26	.02	220	10.3	17.0	.01	3.0-ft ice cover.
36	Kobuk River at Okok Point near Kiana (66°56'04", 160"30'12").	11,054	4/5	1,860	.17	1,350	7.3	12.9	.18	2.8-ft ice cover.

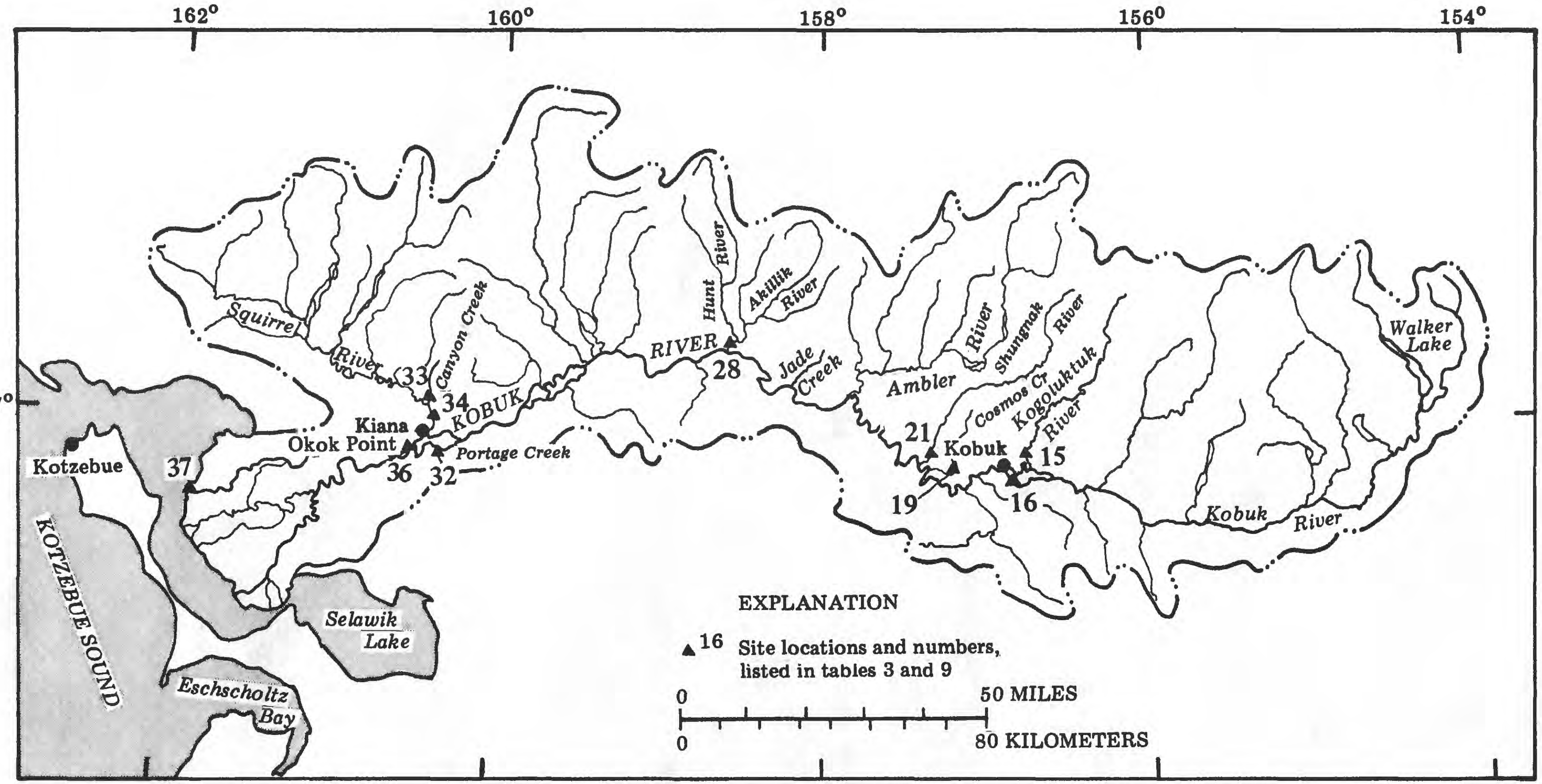


Figure 10.--Site locations, surveys of March and April 1980, Kobuk River basin.

Figure 11.--Overflow ice on Shungnak River near Shungnak, April 4, 1980.

Figure 12.--Canyon Creek near Kiana at survey site, March 23, 1980.

Figure 13.--Icing on Canyon Creek near Kiana, March 23, 1980.

Even though streamflow was affected by snowmelt, the late winter data indicate some areal variability of low flow in the Kobuk basin; values approaching no flow may be expected from some tributaries. For example, the measured discharge at Squirrel River near Kiana (site 34) was 26 ft^3/s, which indicates a unit runoff of only 0.02 $(ft^3/s)/mi^2$, and there was no apparent flow on Cosmos Creek (site 19) under 6 ft of ice.

STREAMGAGING RECORDS

The Geological Survey operated a streamgaging station on the Kobuk River at Ambler from 1965 to 1978. Mean monthly discharge and monthly mean discharges that were exceeded in 75, 50, and 25 percent of the months during the 13-year period are shown in table 4.

Streamflow varies greatly from one season to another. For example, the median discharge (50 percent probability) for June is nearly 27 times the median discharge for March. The ratio of 25 to 75 percent discharge, Q_{25}/Q_{75}, can be used to show the variability of flow within a given period or season. The ratio of 1.3 for April indicates much less variability than does the ratio of 2.5 for June. The maximum daily mean discharge at Ambler in the 13-year period of record was 95,000 ft^3/s, on May 29, 1971. The minimum daily mean discharge, 700 ft^3/s, occurred April 1-15, 1975.

Table 4. – Flow characteristics of Kobuk River at Ambler. Drainage area, 6,570 mi²; period of record, 13 years (1965-78). Discharge values (Q) in cubic feet per second.

Month	Mean monthly discharge	Monthly mean discharges exceeded the given percents of time: 75 percent	50 percent	25 percent	$\frac{Q_{25}}{Q_{75}}$
October	8,585	5,203	6,910	11,830	2.3
November	3,245	2,204	3,560	3,983	1.8
December	1,904	1,399	2,000	2,394	1.7
January	1,448	1,016	1,513	1,720	1.7
February	1,237	950	1,152	1,418	1.5
March	1,111	925	1,000	1,300	1.4
April	1,155	976	1,160	1,304	1.3
May	15,030	10,080	15,140	19,070	1.9
June	30,900	18,260	26,640	45,370	2.5
July	14,390	8,199	13,850	18,640	2.3
August	15,320	9,127	11,280	20,700	2.8
September	13,590	8,670	11,950	16,150	1.9

Unit runoff values calculated from median monthly mean discharges at the gaging station provide a base for estimating the probability level of the miscellaneous measurements. Computed low-flow unit runoff (March) for the station is 0.15 $(ft^3/s)/mi^2$. Late summer unit runoff (August and September) is about 1.7 $(ft^3/s)/mi^2$. The maximum recorded unit runoff, based on recorded maximum daily discharge, is about 15 $(ft^3/s)/mi^2$.

The gaging station at Ambler was discontinued in 1978. Another station, Kobuk River near Kiana, was established in 1976; the drainage area for this station is much larger than that of the Ambler station (9,520 vs. 6,570 mi²).

FLOODS AND EROSION

Flood hazards along a stream valley can be evaluated by studying evidence left by past floods. If large floods have occurred in the recent past (within the last 50 year), traces of these floods can usually be recognized from accumulations of debris, washlines on steep banks, and channels swept clear of vegetation. If one assumes that future flood conditions will be similar to those in the past, potential hazards can be estimated by interpreting this evidence. The highest floodmarks at a site are indications of "maximum evident floods," or MEF, at that site. The areal extent of inundation can be determined by mapping marks by the MEF. Profiles of the water surface at flood stage can be determined by surveying MEF marks.

If the channel position and configuration have remained stable since the MEF occurred, hydraulic properties of the channel can be measured and used to compute discharge of the flood (Riggs, 1976). Computed MEF discharge is an estimate of the maximum instantaneous peak discharge that has occurred in the channel in the recent past.

Surveys were made to measure channel geometry and, where possible, to compute MEF discharge at six sites along the Kobuk River and on 15 tributaries (fig. 4 and table 5). Some of the sites had evidence of ice-affected floods (table 5). If the floodmarks were adequate to define the water-surface profile, MEF discharge was computed even though unknown ice conditions may have caused significant backwater at the site during the flood. If significant backwater were present, computed MEF discharge would be higher than the true discharge.

Along the Kobuk River, computed MEF discharge ranged from 22,600 ft^3/s above Walker Lake outlet to 71,700 ft^3/s at Kobuk. MEF unit runoff calculated from those discharges ranged from 79.3 $(ft^3/s)/mi^2$ above Walker Lake outlet (site 1) to 15.7 $(ft^3/s)/mi^2$ below Selby River (site 10). At all survey sites along Kobuk River and its tributaries, MEF unit runoff was less than 100 $(ft^3/s)/mi^2$; for drainage areas larger than 1,000 mi^2 it was less than 25 $(ft^3/s)/mi^2$. No MEF discharge was computed for the gaging station at Ambler. However, the maximum daily mean discharge recorded at the site, 95,000 ft^3/s, yields a unit runoff of 14.5 $(ft^3/s)/mi^2$.

Channel hydraulic geometry and computed discharge at bankfull stage are indicated in table 5. At most survey sites one or more unvegetated channels were bounded by grassy or brush-covered sloping banks and overbank areas covered with trees, brush, or tundra. Spruce and poplar trees and willow shrubs were common on the flood plain along the Kobuk River and its tributaries. Bankfull elevations were determined by observing the flood-plain surface (Leopold and Skibitzke, 1967) and the edge of mature flood-plain forest or vegetation (Sigafoos, 1964). Bankfull surface elevations ranged from about 5 ft to more than 10 ft higher than the water surface at the time of the surveys along the Kobuk River (fig. 5) and most of its tributaries. At the sites on lake outlets, bankfull elevations ranged from less than 1 ft to a little over 2 ft higher than the water surface. At most sites the stage of the MEF was approximately the same as bankfull stage; therefore bankfull stage appears to be a usable parameter for assessing flood hazards in the Kobuk River basin.

Lamke (1979) found that three conditions or characteristics of a drainage basin -- drainage area, percent of area covered by forests, and percent of area covered by lakes and ponds -- have a significant effect on the flood characteristics of Alaskan streams. Values of those drainage basin characteristics applicable to the survey sites in the Kobuk River basin are shown in table 5. Discharges for the 2-year flood (Q_2) and the 50-year flood (Q_{50}) were computed for the flood survey sites from these drainage basin characteristics, using multiple regression equations developed by Lamke (table 5). A Q_2 flood discharge has a 50 percent change of being exceeded in a particular year; a Q_{50} flood discharge has a 2 percent chance of being exceeded. The Q_2 and Q_{50} flood estimates, as well as the MEF discussed above, are subject to substantial errors.

Vegetation generally protects soils from erosion. However, many bare, high banks in the Kobuk River valley are composed of silty sands that are easily eroded during brief periods of high water. Melting of exposed permafrost can also cause erosion. When the soil-ice mass thaws, it is weakened and easily eroded by flowing water, or it may slump, sometimes as large chunks. During the August 1979 survey, the Kobuk River channel appeared to be stable at the surveyed sites and throughout most of its length. However, slumping banks and exposed ice masses were observed near Shungnak (fig. 14).

Table 5. -- Bankfull channel, maximum evident flood, basin, and flood characteristics at flood survey sites in the Kobuk River basin, 1979

Site no.	Stream site (lat, long)	Streambed material	Water surface slope (ft/ft)	Bankfull channel: Width (ft)	Bankfull channel: Mean depth (ft)	Bankfull channel: Max. depth (ft)	Bankfull channel: Discharge, computed (ft³/s)	Maximum evident flood: Width (ft)	Maximum evident flood: Discharge, computed (ft³/s)	Maximum evident flood: Unit runoff [(ft³/s)/mi²]	Basin characteristics*: Drainage area (mi²)	Basin characteristics*: Forests area (percent)	Basin characteristics*: Lakes and ponds area (percent)	Flood characteristics (ft³/s): Q_2 (2-yr flood)	Flood characteristics (ft³/s): Q_{50} (50-yr flood)
1	Kobuk River above Walker Lake outlet (67°01'37", 154°20'36").	Cobble, gravel.	0.0024	367	6.6	10.3	22,600	367	a 22,600	79.3	285	43.2	0	3,820	12,000
2	Walker Lake outlet (67°03'29", 154°18'49").	Boulders, gravel, sand.	.001B	207	4.1	6.6	5,000	207	5,000	28.1	178	23.9	8.7	1,750	5,740
3	Nutuvukti Lake outlet (66°57'19", 154°35'50").	Gravel, sand.	.00016	32	2.4	3.2	70	b	--	--	29	59.3	22.2	240	983
4	Kobuk River above Lower Kobuk Canyon (66°50'06", 154°39'00").	Cobble, gravel, sand.	.0096	391	5.9	8.2	15,000	391	a --	--	714	47.0	4.2	6,530	18,000
6	Reed River near mouth (66°49'25", 154°57'31").	Gravel, sand.	.00067	300	6.1	8.0	9,500	300	a 9,500	26.1	364	34.5	1.2	4,280	13,000
8	Kobuk River above Sulakpoatokvik Creek (66°46'36", 155°10'18").	Cobble, gravel.	.00074	700	13.3	18.1	86,900	624	a 36,600	23.5	1,560	49.2	3.3	14,000	34,700
9	Lake Selby outlet (66°51'04", 155°41'04").	Boulder, cobble, gravel.	.00030	290	2.5	3.7	2,000	290	2,000	17.7	113	37.0	11.1	1,030	3,580
10	Kobuk River below Selby River (66°46'18", 155°50'00").	Cobble, gravel.	.00047	659	7.5	14.0	31,300	659	31,300	15.7	2,000	54.1	3.4	18,700	41,600
11	Pah River near mouth (66°44'30", 156°03'48").	do.	.00023	296	7.8	11.2	8,500	296	8,500	8.9	956	71.4	10.1	7,010	18,400
13	Mauneluk River near mouth (66°52'40", 156°16'45").	Boulder, cobble, gravel.	.00098	493	8.6	13.2	34,400	493	34,400	60.0	573	26.2	0	7,870	22,700
15	Kogoluktuk River near mouth (66°56'42", 156°45'06").	Boulder, cobble.	.00192	354	8.7	11.1	29,000	354	a 35,000	55.9	626	35.1	2.6	6,450	18,100
16	Kobuk River above Kobuk (66°54'12", 156°53'06").	Cobble, gravel.	.00021	833	14.5	20.6	71,700	833	a 71,700	17.2	4,170	50.2	4.7	33,000	72,200
20	Ruby Creek at Bornite (67°04'36", 156°56'12").	do.	.0054	53	2.7	4.1	690	53	690	53.1	13	69.2	0	200	935
21	Shungnak River near mouth near Shungnak (66°56'47", 157°19'03").	Boulder, cobble.	.00261	213	5.6	8.0	8,900	213	8,900	41.8	213	31.4	0	3,050	9,960
22	Ambler River above Redstone River (67°09'18", 157°32'23").	Cobble, gravel.	.00126	435	8.2	12.4	30,000	435	30,000	41.9	716	39.9	.6	8,360	23,300
23	Redstone River near Ambler (67°12'01", 157°36'05").	Gravel.	.00069	145	5.6	7.8	3,300	145	a 3,300	15.6	211	22.2	3.7	2,370	7,670
25	Jade Creek near Ambler (67°10'49", 158°07'47").	Boulder, cobble.	.0082	60	3.2	4.1	1,100	b	--	--	57	38.1	0	866	3,350
26	Kobuk River below Jade Creek (67°06'35", 158°14'51").	Not observed.	.00006	1,585	14.2	19.7	88,000	--	a --	--	6,724	44.0	4.7	52,600	108,000
27	Akillik River above Hunt River near Ambler (67°14'22", 158°28'05").	Gravel.	.000415	377	7.2	15.3	10,200	377	12,600	41.6	303	28.4	1.4	3,640	11,300
30	Salmon River above Kitlik River near Kiana (67°15'12", 159°38'58").	Boulder, cobble, gravel.	.00196	650	3.7	8.1	20,900	530	19,900	38.6	515	36.0	.7	6,170	17,900
31	Kitlik River near Kiana (67°14'30", 159°40'06").	Cobble.	.00153	245	2.2	7.9	2,600	245	2,600	26.5	98	53.9	0	1,370	4,920

* Mean annual precipitation for all sites was 20 inches, and mean minimum January temperature was -16°F.
a Ice flood evidence.
b No flood evidence.

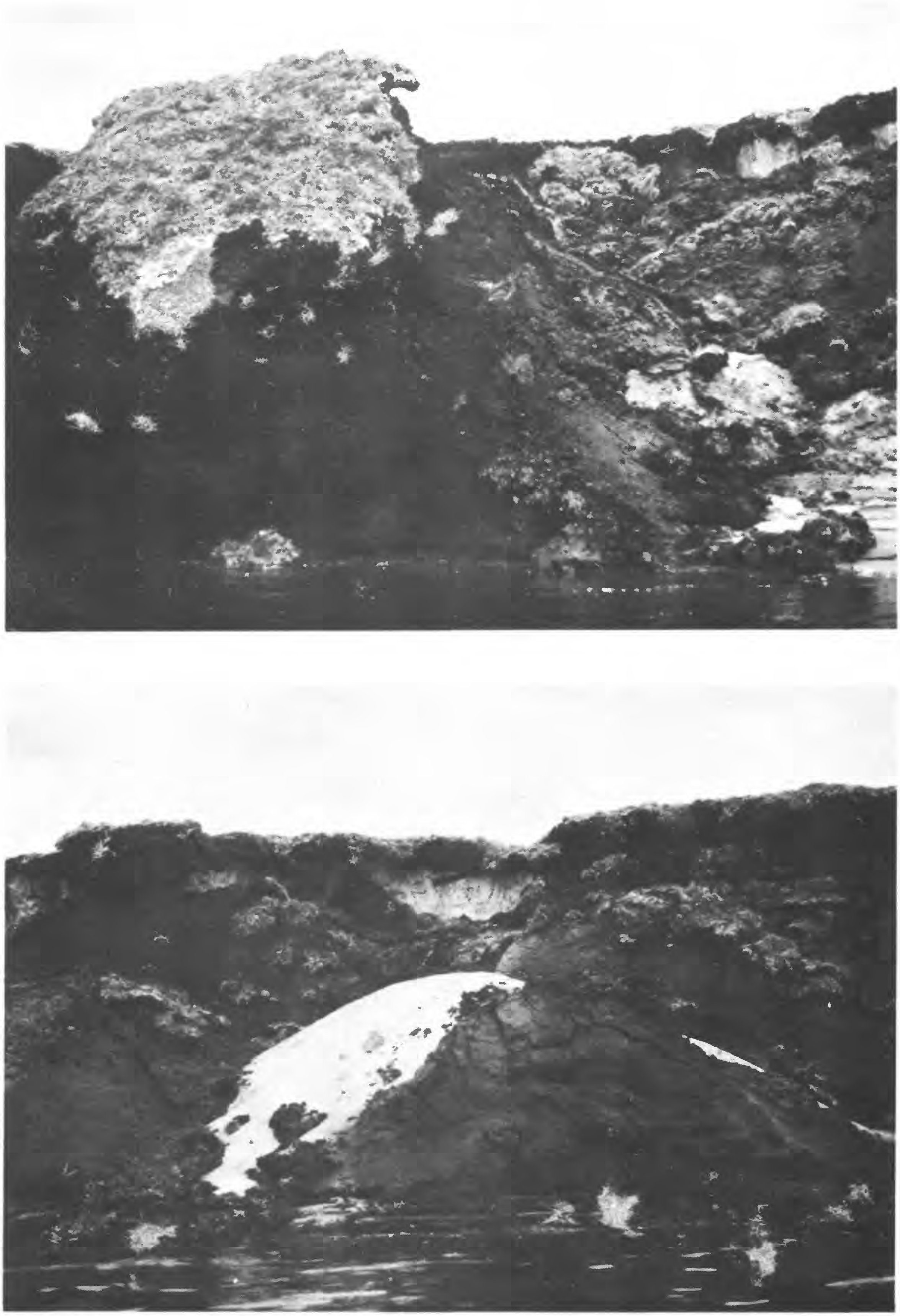


Figure 14.--Bank erosion and ice in bank along Kobuk River near Shungnak, August 26, 1979. Banks shown are about 15 feet high.

 (page 23 follows)

WATER QUALITY

Several readily measured properties -- specific conductance, dissolved oxygen concentration, temperature, alkalinity, and pH -- indicate the general suitability of water for various uses. Field determinations of these properties of the surface waters of the Kobuk River basin were made during both reconnaissance trips in this study. Samples were collected for laboratory analysis during the August trip. Specific conductance, or the ability of water to conduct electrical current, is an indicator of the dissolved mineral concentration. The pH of water is defined as the logarithm of the reciprocal of the concentration of free hydrogen ions and is thus an indicator of the acidity or basicity of the water. The pH affects aquatic organisms because it regulates the solubility and toxicity of many constituents in water. Water temperature and dissolved oxygen content are also vitally important in determining suitability of an aquatic habitat for fish, benthic invertebrates, and other organisms.

Prior to this study, water-quality data were collected on the Kobuk River at the village of Shungnak, and at the gaging stations at Ambler and near Kiana. Data from the Ambler and Kiana sites are shown in tables 6 and 7.

Late Summer Samples

Water samples were collected at 30 sites in the Kobuk River basin during August 1979 (fig. 4): 10 sites on the Kobuk River, 14 sites on tributary streams, 5 near lake outlets, and 1 at a thermal spring. Laboratory analyses for major inorganic ions were made of samples from four of the sites on the Kobuk River and from nine other sites in the basin (table 8); the analyses show that surface waters in the Kobuk River basin are predominantly calcium bicarbonate type.

August water temperatures in the Kobuk River ranged from 8.5°C at Ambler to 14.0°C above Lower Kobuk Canyon. Temperatures in tributaries ranged from 6.5°C at Jade Creek to 13.5°C at Pah River. Stream sites near lake outlets had the warmest water; these temperatures ranged from 13.5°C at Kollioksak Lake to 17.5°C at Nutuvukti Lake. Water temperature at Reed River Hot Spring was 47.5°C.

Dissolved oxygen (DO) concentrations were measured at 18 sites at and downstream from the mouth of the Killak River. Concentrations on the Kobuk River ranged from 10.8 mg/L at two sites to 11.6 mg/L. Concentrations of DO in tributaries ranged from 11.3 mg/L in Kavet Creek to 13.5 mg/L in the Killak River. A comparatively low 7.5 mg/L DO was measured at the outlet of Kollioksak Lake.

The pH of the Kobuk River ranged from 7.3 above Sulakpoatokvik Creek and both above and below Kobuk village to 7.9 above Lower Kobuk Canyon. The pH of the tributaries ranged from 6.5 in the Killak and Kitlik Rivers to 7.9 in the Ambler River. Lake outlet water had pH values similar to that of the tributaries.

The alkalinity of water in the Kobuk River ranged from 53 mg/L as $CaCO_3$ above Sulakpoatokvik Creek to 97 mg/L as $CaCO_3$ at the village of Kiana. Concentrations in tributaries ranged from 14 mg/L in the Kitlik River near Kiana to 117 mg/L in Kavet Creek. Lake-outlet water had concentrations mostly near 24 mg/L, but alkalinity at Walker Lake outlet was 60 mg/L. Water at Reed River Hot Spring had an alkalinity of 313 mg/L.

Table 6. -- Selected water-quality data from Kobuk River at Ambler
[Values are in milligrams per liter, except as indicated; data from U. S. Geological Survey (1968-73; 1976)]

Month	Day	Year	Discharge (ft³/s)	Specific conductance (µmho/cm at 25°C)	Water temperature (°C)	pH	Color (platinum-cobalt units)	Dissolved oxygen	Dissolved solids, sum of constituents	Silica, dissolved	Hardness, total as $CaCO_3$	Calcium, dissolved	Magnesium, dissolved	Sodium, dissolved	Potassium, dissolved	Alkalinity as $CaCO_3$	Sulfate, dissolved	Chloride, dissolved	Fluoride, dissolved	Nitrate plus nitrite, dissolved as N	Iron, dissolved (µg/L)
September	25	1967	9,060	135	--	7.7	10	--	--	4.0	68	22	3.3	0.8	0.3	62	6.0	0.7	0.0	1.1	26
June	4	1968	59,200	59	2	6.7	75	--	32	1.4	28	9	1.3	.3	.2	28	0	.4	.1	.5	--
August	19	1968	7,640	155	13	7.9	--	--	88	3.1	81	26	4.0	.7	.3	72	9.8	.7	.1	.3	--
March	9	1969	555	203	0.0	8.4	0	--	118	6.2	105	33	5.3	1.5	1.2	100	10	.0	.1	.5	--
May	31	1969	5,890	114	10	7.6	20	--	65	3.2	57	18	2.8	.8	.7	52	7.6	.7	.0	.2	--
September	25	1969	5,050	171	1	8.2	25	--	93	3.6	83	25	5.0	1.0	.8	75	12	.0	.0	.6	--
March	9	1970	1,010	200	.0	7.5	10	--	115	6.6	98	31	5.1	2.1	.9	83	17	.4	.2	1.3	80
March	9	1970	1,010	212	.0	7.7	5	--	122	5.6	104	34	5.9	2.1	1.3	100	11	.7	.2	1.5	30
June	8	1970	12,300	110	--	7.9	20	--	62	3.3	54	18	2.4	.6	.5	47	8.4	.1	.1	.5	70
July	11	1970	6,510	158	12	7.9	5	--	89	3.0	80	25	4.0	.8	.5	70	12	.4	.2	.7	50
August	16	1970	9,900	146	15	7.7	10	--	81	2.2	73	24	3.0	1.0	.6	62	12	.0	.2	.8	20
September	23	1970	7,010	159	.0	7.8	10	--	86	3.3	80	25	4.1	1.0	.5	67	11	.8	.1	.2	--
March	21	1971	920	198	.0	7.6	5	--	114	5.9	103	33	5.2	1.5	.5	91	12	.0	.1	.2	70
March	26	1972	933	201	.0	7.6	5	--	116	6.8	103	32	5.3	1.6	.6	95	11	.0	.1	.1	--
June	5	1975	37,400	108	6.5	7.8	20	--	55	1.1	52	17	2.3	.5	.4	48	3.6	.8	.1	.12*	140

*NO_2 + NO_3 as N Total

Table 7.-- Selected water-quality data from Kobuk River near Kiana
[Values are in milligrams per liter, except as indicated; data from U. S. Geological Survey (1977-80)]

Month	Day	Year	Discharge (ft^3/s)	Specific conductance (µmho/cm at 25°C)	Water temperature (°C)	pH	Color (platinum-cobalt units)	Dissolved oxygen	Dissolved solids, sum of constituents	Silica, dissolved	Hardness, total as $CaCO_3$	Calcium, dissolved	Magnesium, dissolved	Sodium, dissolved	Potassium, dissolved	Alkalinity as $CaCO_3$	Sulfate, dissolved	Chloride, dissolved	Fluoride, dissolved	Nitrate plus nitrite, dissolved as N	Iron, dissolved (µg/L)
April	19	1976	1,010	175	0.0	7.1	--	--	120	5.5	110	34	6.3	2.5	2.2	96	11.0	1.0	0.1	0.30	--
September	1	1976	8,910	173	14	7.1	--	--	93	2.5	87	28	4.2	1.0	.6	74	11	.6	.1	.12	110
November	19	1977	5,220	140	.0	6.7	--	--	94	4.1	92	29	4.7	1.1	.6	67	13	.8	.1	.52	450
March	9	1977	1,950	205	.0	6.6	--	--	110	5.4	100	33	5.4	1.4	.6	82	13	1.3	.1	.17	--
April	29	1977	1,800	195	.0	6.7	--	--	112	5.7	110	33	5.5	1.3	.6	90	11	.7	.1	.34	--
June	30	1977	17,500	140	16	7.5	--	--	67	2.5	65	21	3.1	.7	.5	57	4.4	.3	.0	.12	110
August	25	1977	12,100	145	15	7.0	--	--	91	2.3	80	25	4.3	.8	.5	67	15	2.9	.1	.09	--
September	23	1977	22,000	140	3	6.8	--	--	82	3.4	72	23	3.6	.8	.4	54	18	.3	.1	.88	80
February	2	1978	1,900	190	.0	6.8	--	--	118	5.5	98	31	5.0	.9	.5	100	13	1.1	.1	.27	60
April	21	1978	1,620	205	.0	7.0	--	--	107	5.7	100	32	5.4	.8	.5	88	9.4	.6	.1	.28	30
June	10	1978	34,200	95	10	7.8	--	11.6	83	2.2	51	16	2.6	.6	.3	45	7.7	.5	.0	.15	70
July	25	1978	28,100	148	15.5	--	--	9.8	87	2.8	81	26	3.9	.9	.5	--	15	.4	.1	.12	--
August	25	1978	15,400	155	12	--	--	10.6	85	3.2	79	25	4.0	1.0	.5	--	12	.7	.1	.10	50
September	21	1978	18,600	160	4.5	7.4	--	9.0	90	3.1	74	23	4.1	.9	.3	66	18	.7	.1	.14	--
December	7	1978	4,140	177	.0	7.2	--	8.7	106	5.3	96	30	5.0	2.0	1.3	79	13	1.6	.0	.27	100
April	18	1979	1,870	200	.0	--	--	6.8	110	5.3	100	32	5.2	.9	.3	--	15	1.0	.1	.29	60
April	19	1979	--	--	--	7.3	--	--	--	--	--	--	--	--	--	95	--	--	--	--	--
June	1	1979	58,600	85	8.5	6.2	--	11.6	45	2.3	41	13	2.1	.8	.2	30	7.9	.4	.1	.16	160
July	31	1979	21,500	135	15	7.8	--	10.2	78	3.0	69	22	3.5	.7	.5	57	13	.4	.1	.13	--
August	21	1979	52,800	123	11	7.2	--	10.4	77	2.7	64	20	3.5	.7	.2	52	18	.6	.1	.10	--
September	18	1979	--	169	1.5	7.1	--	13.8	103	3.5	79	25	4.1	1.1	.4	67	27	.1	.1	.15	160

Table 8. -- Water quality and related parameters from selected sites in Kobuk River Basin, August 1979
Dissolved constituents were analyzed from samples filtered through a 0.45-micron membrane filter.

Parameters and constituents	Site number	1	2	3	4	5	6
	Site name	Kobuk R. ab Walker Lk outlet	Walker Lk outlet	Nutuvukti Lk outlet	Kobuk R. ab Lower Kobuk Canyon	Reed R. Hot Spring nr Kobuk	Reed. R. nr mouth
	Day	11	11	14	13	15	15
	Time	17:30	07:30	14:10	09:20	15:25	09:45
Discharge (ft^3/s)*		1,090	1,160	47	2,380	0.3	1,640
Specific conductance (µmho/cm at 25°C)		175	130	65	160	750	110
Water temperature (°C)		10.5	14.5	17.5	14	47.5	9.5
pH		7.7	7.9	6.8	7.9	6.9	7.2
Color (platinum-cobalt units)		0	0	15	0	0	0
Turbidity (nephelometric turbidity units)		0.25	0.15	0.35	0.35	0.70	0.30
Dissolved oxygen (mg/L)		--	--	--	--	--	--
Dissolved solids, residue at 180°C (mg/L)**		--	70	--	82	498	55
Dissolved solids, calculated sum (mg/L)		--	82	--	89	543	61
Silica, dissolved (mg/L)		--	2	--	2.1	85	2.7
Hardness (mg/L as $CaCO_3$)		--	68	--	77	64	50
Calcium, dissolved (mg/L)		--	23	--	26	24	17
Magnesium, dissolved (mg/L)		--	2.5	--	2.9	1	1.9
Sodium, dissolved (mg/L)		--	0.6	--	0.7	160	0.9
Potassium, dissolved (mg/L)		--	1.1	--	0.9	12	0.7
Alkalinity (mg/L as $CaCO_3$)		79	60	31	68	313	39
Sulfate, dissolved (mg/L)		--	11	--	14	53	13
Chloride, dissolved (mg/L)		--	0.2	--	0.3	12	0.1
Fluoride, dissolved (mg/L)		--	0.1	--	0.1	8.2	0.2
Nitrate plus nitrite, dissolved (mg/L as N)		--	1.2	--	0.22	0.17	0.31
Phosphorus, dissolved (mg/L as P)		--	0.00	--	0.00	0.00	0.00
Iron, dissolved (µg/L)		--	10	--	80	30	50
Manganese, dissolved (µg/L)		--	1	--	6	70	6

*e = estimated
**Dissolved residue is calculated from the sum of following constituents: Ca, Mg, Na, K, alkalinity, Cl, SO_4 and SiO_2

7	8	9	10	11	12	13	14	15
Minakokosa Lk outlet	Kobuk R. ab Sulakpoatokvik Creek	Lake Selby outlet	Kobuk R. bl Selby R.	Pah R. nr mouth	Killak R. nr mouth	Mauneluk R. nr mouth	Kollioksak Lk outlet	Kogoluktuk R. nr mouth
14	16	16	17	17	18	18	18	19
15:30	09:25	15:00	10:20	14:05	14:25	11:00	16:20	11:35
88	6,930	332	7,240	458	92	2,980	0.5 e	2,540
70	135	85	135	80	55	155	45	180
16	10.5	17	13	13.5	7.5	9	13.5	9
7.7	7.3	7.5	7.5	7.1	6.5	7.4	6.2	7.3
0	0	10	0	60	45	25	60	25
0.35	0.45	0.30	0.30	0.85	0.50	0.65	2	0.85
--	--	--	--	--	13.5	--	7.5	11.8
--	--	--	--	51	--	--	--	104
--	--	--	--	51	--	--	--	103
--	--	--	--	6.1	--	--	--	2.9
--	--	--	--	39	--	--	--	89
--	--	--	--	11	--	--	--	29
--	--	--	--	2.9	--	--	--	4
--	--	--	--	2.1	--	--	--	0.9
--	--	--	--	0.2	--	--	--	1
24	53	23	54	35	22	56	24	64
--	--	--	--	6.4	--	--	--	26
--	--	--	--	0.5	--	--	--	0.3
--	--	--	--	0.1	--	--	--	0.1
--	--	--	--	0.02	--	--	--	0.13
--	--	--	--	0.02	--	--	--	0.00
--	--	--	--	650	--	--	--	90
--	--	--	--	20	--	--	--	10

Table 8. -- Water quality and related parameters from selected sites in Kobuk River Basin, August 1979 -- continued

Parameters and constituents	Site number	16	17	18	20	21	22
	Site name	Kobuk R. ab Kobuk	Kobuk R. bl Kobuk	Kobuk R. bl Shungnak	Ruby C at Bornite	Shungnak R. nr mouth nr Shungnak	Ambler R. ab Redstone R.
	Day	24	25	25	21	23	19
	Time	15:45	10:50	13:25	18:25	16:10	16:09
Discharge (ft^3/s)*		21,900	--	--	80	1,520	5,030
Specific conductance (µmho/cm at 25°C)		165	170	150	235	127	170
Water temperature (°C)		12	11.5	12	6.5	11	10
pH		7.3	7.3	7.5	7.5	7.6	7.9
Color (platinum-cobalt units)		30	20	25	20	20	25
Turbidity (nephelometric turbidity units)		0.20	--	0.20	0.20	0.40	0.40
Dissolved oxygen (mg/L)		11	10.8	10.8	11.6	12.9	11.4
Dissolved solids, residue at 180°C (mg/L)**		95	--	--	130	--	--
Dissolved solids, calculated sum (mg/L)		95	--	--	129	--	--
Silica, dissolved (mg/L)		3.4	--	--	3	--	--
Hardness (mg/L as $CaCO_3$)		83	--	--	120	--	--
Calcium, dissolved (mg/L)		27	--	--	37	--	--
Magnesium, dissolved (mg/L)		3.7	--	--	6.2	--	--
Sodium, dissolved (mg/L)		0.8	--	--	0.5	--	--
Potassium, dissolved (mg/L)		0.7	--	--	0.0	--	--
Alkalinity (mg/L as $CaCO_3$)		59	63	56	103	51	71
Sulfate, dissolved (mg/L)		23	--	--	17	--	--
Chloride, dissolved (mg/L)		0.2	--	--	0.4	--	--
Fluoride, dissolved (mg/L)		0.1	--	--	0.1	--	--
Nitrate plus nitrite, dissolved (mg/L as N)		0.13	--	--	0.07	--	--
Phosphorus, dissolved (mg/L as P)		0.01	--	--	0.00	--	--
Iron, dissolved (µg/L)		100	--	--	40	--	--
Manganese, dissolved (µg/L)		9	--	--	7	--	--

*e = estimated
**Dissolved residue is calculated from the sum of following constituents: Ca, Mg, Na, K, alkalinity, Cl, SO_4, and SiO_2

23	24	25	26	27	29	30	31	35
Redstone R. nr Ambler	Kobuk R. at Ambler	Jade C. nr Ambler	Kobuk R. bl Jade C.	Akillik R. ab Hunt R. nr Ambler	Kavet C. at mouth nr Kiana	Salmon R. ab Kitlik R. nr Kiana	Kitlik R. nr Kiana	Kobuk R. at Kiana
22	27	22	28	22	29	23	23	30
13:45	13:58	12:24	10:23	10:19	11:49	10:23	12:59	14:44
1,100	--	150	50,800	3,700 e	55	4,400	851	--
100	150	62	145	95	220	185	55	230
8	8.5	6.5	9	7	8	7.5	7.5	9
7	7.5	6.8	7.7	6.9	7.8	7.5	6.5	7.5
60	30	20	40	20	50	15	5	40
0.50	2	0.40	0.70	0.80	3.5	0.60	0.15	0.30
12.1	11.3	12.2	11.6	11.8	11.3	11.8	11.6	11.1
--	--	--	86	--	128	136	29	130
--	--	--	97	--	132	138	33	129
--	--	--	2.5	--	6.4	2.7	2.6	2.2
--	--	--	91	--	120	110	24	120
--	--	--	29	--	40	33	7.4	35
--	--	--	4.5	--	4.8	7.6	1.4	7.9
--	--	--	0.5	--	1.6	0.7	0.5	0.6
--	--	--	0.3	--	0.3	0.1	0.0	0.1
43	75	31	73	47	117	67	14	97
--	--	--	15	--	4.5	51	11	23
--	--	--	0.3	--	0.5	0.3	0.1	0.6
--	--	--	0.1	--	0.1	0.1	0.1	0.1
--	--	--	0.12	--	0.56	0.52	0.05	0.09
--	--	--	0.01	--	0.02	0.00	0.00	0.00
--	--	--	100	--	1,800	20	50	130
--	--	--	7	--	50	20	8	8

Specific conductance of water in the Kobuk River ranged from 135 µmho/cm above Sulakpoatokvik Creek and below Selby River to 230 µmho/cm at Kiana. Values for tributaries ranged from 55 µmho/cm in the Kitlik River to 235 µmho/cm in Ruby Creek. Lake-outlet water had specific conductance values ranging from 45 µmho/cm at Kollioksak Lake to 130 µmho/cm at Walker Lake. Reed River Hot Spring had a specific conductance of 750 µmho/cm.

The flow of Reed River Hot Spring issued from two main openings when the spring was visited on August 15. A discharge of 0.30 ft^3/s was measured at the orifice having the greater flow; no measurements were made at the other orifice. Field water-quality measurements were made and a sample was collected for laboratory analysis. The concentration of lead in a sample from the spring was estimated by a semi-quantitative method to be about 1,000 µg/L; due to method accuracy, another analysis would be required to verify that value.

The relatively high temperature (47.5°C on August 15) of the water at Reed River Hot Spring is apparently conducive to the abundant growth of algae and aquatic plants on the spring-bottom surfaces. Nearby terrestrial plant growth is also luxuriant for this Arctic region -- large areas of ferns and several stands of cottonwood trees are present. The bottoms and adjacent shore areas of pools and channels downstream from the spring outlet are encrusted by chalky white mineral deposits.

Late Winter Samples

In March and April 1980, field water-quality parameters were measured and samples collected at three sites on the Kobuk River and at five tributary sites. Results of the field determination and laboratory analyses of the samples are listed in table 9. Overflow and hazardous ice conditions prevented sampling or discharge measurements in the Shungnak River (site 21); and at Cosmos Creek (site 19) no flow could be detected under approximately 6 ft of ice. Streams in the upper part of the basin, particularly above Kobuk village, could not be sampled because of the onset of "breakup".

Water temperatures were near 0°C. At that temperature, the solubility of oxygen in water (at normal atmopsheric pressure of 760 mm Hg) is about 14 mg/L. A DO concentration of 14 mg/L was measured only in the Kogoluktuk River; DO values measured at four other sites ranged from about 8 to 9 mg/L. At these four sites the source of streamflow is probably ground water derived from tundra or the boggy areas that dominate the valley bottoms. The decomposition of inorganic matter in such areas tends to utilize DO and reduce the concentration in water. The DO concentrations measured in winter 1980 were higher than the recommended minimum concentration of 5 mg/L for sustaining fish life (National Academy of Sciences, 1972).

Field determinations of alkalinity, specific conductance, and pH were also made during the winter reconnaissance trip. Alkalinity as $CaCO_3$ ranged from 38 mg/L in Hunt River near Ambler to 167 mg/L in Squirrel River near Kiana. Specific conductance ranged from 110 µmho/cm in Hunt River to 330 µmho/cm in Squirrel River. Values of pH in the tributaries ranged from 6.7 to 7.6, and was 6.6 in water at the Kobuk River sites.

Table 9. -- Water quality and related parameters from sites in Kobuk River basin, March and April 1980

Site number	15	16	28	32	33	34	36	37
Site name	Kogoluktuk R. nr mouth	Kobuk R. ab Kobuk	Hunt R. nr Ambler	Portage C. nr Kiana	Canyon C. nr Kiana	Squirrel R. nr Kiana	Kobuk R. at Okok Pt. nr Kiana	Kobuk R. at mouth (Riley Channel)
Month/Day	4/2	4/2	3/28	3/25	3/23	3/24	4/5	4/6
Time	13:27	15:25	14:18	09:06	15:20	12:51	14:17	10:00
Discharge (ft^3/s)	63	1,240	164	0.5 est.	1.76	26	1,860	--
Specific conductance (µmho/cm at 25°C)	260	170	110	215	220	330	170	270
Water temperature (°C)	0.5	0.0	0.0	0.0	0.5	0.5	0.0	0.5
pH	7.1	6.6	6.7	--	7.6	7	6.6	--
Dissolved oxygen (mg/L)	14	8.9	9.1	--	--	8.5	7.9	--
Alkalinity (mg/L as $CaCO_3$)	95	70	38	--	--	167	96	--

AQUATIC INVERTEBRATES

The presence or absence of aquatic organisms in a given reach of a stream is influenced by water temperature, pH, DO concentration, type of substrate, and stream velocity. Long-term water-quality conditions have an important bearing on aquatic invertebrates in a stream. These organisms, when considered in the context of groups rather than as individual species, can often be used as an indicator of stream conditions over periods of time much longer than the sampling visits (Hynes, 1970; Hart and Fuller, 1974; Whitton, 1975).

The sampling areas chosen were in most instances the same sites where other information was collected during the trip. Sampling procedure involved placing the dip net on the streambed, then disturbing bottom material upstream from the net to dislodge organisms. These organisms were subsequently carried into the dip net by streamflow. Samples were collected in small riffles, straight reaches, areas having submerged brush and roots, side pools, and at undercut banks. These conditions are typical of those found along this river.

Dip net samples were collected during August from 25 sites (table 10; fig. 4): 5 sites on the Kobuk River, 14 sites on tributaries of the Kobuk, 5 sites near lake outlets, and 1 site at a thermal spring, Reed River Hot Spring. The average number of taxa (insect groups) at each site was 15; the range was 11 to 21. Large percentages of Cladocera (water fleas) were present in several samples collected near lake outlets. For example, at the Lake Selby site about 8,600 invertebrates, nearly 80 percent of them Cladocera, were collected. At Minakokosa Lake outlet 54 percent of the invertebrates were Cladocera and in the Pah River near its mouth, more than half were Cladocera. The Pah river at this site is a typical slow-flowing, Arctic lowland, brown-water stream. Leeches, which are common in lakes and slow-moving water, were also present at this site. In Reed River Hot Spring, in pools and slower flowing sections originating from this spring, and in Reed River itself, Gastropods (snails) were more common than at other sites and were the dominant organisms. In the immediate area of the main orifice at Reed River Hot Spring only Gastropods were observed; however, in the cooler water downstream, Chironomid (midges) and Trichopteran (caddis flies) larvae were present.

Ephemeroptera (mayflies) and Plecoptera (stone flies) are generally associated with natural, undisturbed environments that are biologically healthy. These orders were found at all sites sampled except Reed River Hot Spring. The Diptera family Chironomidae, a major fish-food organism common in Alaskan streams, was well-

Table 10. -- Aquatic organisms collected by dip net at sites within the Kobuk River basin, August 1979 (Results shown as percentages of total number of organisms collected per sample.)

Phylum	Class	Order	Family	Common name	Kobuk R. ab Walker Lake outlet	Walker Lake outlet	Nutuvukti Lake outlet	Kobuk R. ab Lower Kobuk Canyon	Reed R. Hot Spring nr Kobuk	Reed R. nr Kobuk mouth	Minakokosa Lake outlet	Kobuk R. ab Sulakpoatokvik C.	Lake Selby outlet	Kobuk R. bl Selby R.	Pah R. nr mouth	Killak R. nr mouth	Mauneluk R. nr mouth	Kollioksak Lake outlet	Kogoluktuk R. nr mouth	Kobuk R. ab Kobuk	Ruby C. at Bornite	Shungnak R. nr mouth nr Shungnak	Ambler R. ab Redstone R.	Jade C. nr Ambler	Akillik R. ab Hunt R. nr Ambler	Kavet C. at mouth nr Kiana	Salmon R. ab Kitlik R. nr Kiana	Kitlik R. nr Kiana	Redstone R. nr Ambler
				Site number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	20	21	22	23	25	27	29	30	31
				Day	11	11	14	13	15	15	14	16	16	17	17	18	18	18	19	24	21	23	19	22	22	22	29	23	22
Arthropoda	Insecta	Diptera	Chironomidae	Midges	24	20	5	30	26	23	4	61	7	46	13	75	31	50	45	55	24	35	36	38	55	47	54	10	22
			Certopogonidae	Biting midges	6	--	P	P	1	P	1	P	--	P	P	1	P	1	2	--	1	--	--	10	1	P	--	1	4
			Emphididae	Dance flies	--	--	--	--	P	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	P	--	--
			Ephydridae	Shore flies	--	--	--	--	--	--	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			Psychodidae	Moth flies	1	--	--	P	3	--	--	--	--	--	--	1	--	--	1	--	1	1	P	7	P	--	2	--	1
			Simuliidae	Blackflies	1	P	P	P	--	3	--	2	--	4	P	2	5	--	2	P	1	14	--	5	P	P	1	3	24
			Tabanidae	Horseflies	--	--	--	--	--	--	--	--	--	--	P	--	--	--	--	--	P	--	--	--	P	--	--	--	--
			Tipulidae	Crane flies	3	3	P	P	--	1	P	1	P	2	P	1	2	1	1	--	P	P	2	2	1	3	1	2	1
		Ephemeroptera		Mayflies	11	1	6	4	--	7	--	6	P	11	P	4	10	--	3	5	14	5	1	2	15	24	4	49	20
		Plecoptera		Stone flies	31	--	--	4	--	3	--	9	--	10	--	5	25	--	9	--	34	3	1	8	13	4	P	8	8
		Trichoptera		Caddis flies	3	5	2	2	P	1	P	6	P	5	2	2	2	9	--	1	P	12	3	13	1	1	12	P	8
		Coleoptera	Dytiscidae	Diving beetles	P	--	P	--	P	P	P	P	P	P	P	--	--	--	--	--	--	--	--	--	--	1	P	--	--
			Haliplidae	Water beetles	--	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			Psephenidae	Riffle beetles	--	--	--	--	--	--	--	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Hemiptera	Corixidae	Water boatmen	--	--	3	--	--	--	2	P	P	1	--	--	--	7	--	1	--	--	--	--	P	--	--	--	--
			Hebridae	Velvet water bugs	--	--	--	--	--	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			Mesoveliidae	Water treaders	--	--	P	--	P	2	P	--	P	--	P	--	--	1	--	--	--	--	--	--	--	--	--	--	--
		Collembola		Springtails	--	--	--	P	P	--	--	P	P	P	--	1	P	--	--	1	P	1	--	P	P	--	P	--	P
		Odonata		Dragonflies	--	--	--	--	--	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Crustacea	Amphipoda	Gammaridae	Side swimmers	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Cladocera		Water fleas	--	11	2	10	10	--	55	--	79	P	54	P	P	14	1	6	3	2	1	1	--	1	--	--	--
		Eucopepoda		--	P	11	4	5	1	2	18	1	1	1	1	2	1	11	3	8	2	4	1	P	--	2	4	1	--
		Podocopa		Seed shrimp	P	15	59	5	24	1	14	1	3	1	7	3	P	1	--	4	4	6	3	2	2	--	13	--	2
		Pelecypoda		Clams	--	2	8	--	3	--	2	--	--	--	P	--	--	1	--	P	--	--	--	--	--	--	--	--	--
	Arachnoidea	Acarina		Water mites	18	2	1	12	1	15	1	9	P	15	3	3	20	1	30	12	15	10	51	11	6	17	7	5	7
Annelida	Oligochaeta			Aquatic earthworms	P	1	--	1	--	1	1	1	P	2	3	1	--	1	--	2	1	P	P	P	5	--	--	--	--
	Hirudinea	Rhynchobdellida	Glossiphoniidae	Leeches	--	--	--	--	--	--	P	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--	--	--
			Pisciolidae	Leeches	--	--	--	--	--	--	P	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	P	--	--
Nematoda				Roundworms	1	P	--	6	P	P	P	P	P	1	P	--	1	--	2	3	--	P	--	--	P	--	P	P	--
Mollusca	Gastropoda			Snails	P	29	10	20	30	41	2	1	10	1	12	--	P	2	--	P	--	8	P	--	--	--	P	--	--
Tardigrada				Water bears	--	P	--	--	--	--	P	--	--	--	3	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Chordata	Osteichthyes	Pisces	Cottidae	Sculpins	P	--	--	--	--	--	--	--	--	P	P	--	1	--	--	P	P	P	--	--	P	1	--	P	1
Number of taxa per sample					16	14	16	16	16	15	18	16	17	19	21	14	15	14	11	16	16	16	12	14	16	12	16	11	12
Number of organisms collected per sample					554	1,738	1,287	577	1,311	511	2,808	486	8,632	719	5,469	369	424	183	179	239	997	442	375	232	1,202	267	542	616	274

P - Present but less than 1 percent

represented at all sites and in most places was the most abundant taxon. The presence of immature stages of stone flies and mayflies and the overall diverse composition of benthic organisms suggest that the surface waters in the Kobuk River basin have not been appreciably altered from their natural state and are generally of excellent quality.

DATA AND INFORMATION NEEDS FOR FUTURE PLANNING

Future development in the Kobuk River basin will require planning for water supplies, flood control, and related water-based activities. The types of development proposed or envisioned will govern the type of hydrologic information required to do such planning. Early identification of priorities for water information will allow data collection programs to be tailored to those needs.

Estimates of streamflow characteristics may be required at any site on any stream, but the means of meeting those needs depend on the nature of the project. For large water-development projects such as hydroelectric generation, flood control, or water storage, long-term streamgaging records are desirable. Definition of instream flow requirements for protection or enhancement of aquatic life also should be based on streamgaging records. The accuracy of estimates of streamflow characteristics at any site depends primarily on the length of gaging station record. For example, statistical analysis of Alaska streamgaging records indicates that the standard error of estimate of mean monthly discharge is 12 percent for 10-year records and 6 percent for 25-year records. Prediction accuracy, which is based on these statistics, is a factor in major project planning.

For other types of projects, less precise records may suffice. Streamflow characteristics for ungaged sites may be estimated from streamgaging records of adequate length at nearby, hydrologically similar sites. The selection of a representative gaging station for comparison requires consideration of pertinent factors such as topography, precipitation, geology, and basin size. Again, the accuracy of the estimate for the ungaged site will depend on the length of record at the gaged site and the similarity of the two drainage basins.

Streamflow characteristics useful in many planning applications could be determined by establishing gaging stations at several of the survey sites described in this report. A station on the Kobuk River above Walker Lake outlet or on Reed River near its mouth would represent flow conditions on streams that drain high, rugged mountains but are not affected by lake storage. A station at Walker Lake outlet would provide a record reflecting effects of lake storage. Data from a station on the Pah River would represent a stream draining plains and lowlands.

The gaging station on the Kobuk River near Kiana, established in 1976, is a NASQAN (National Stream-Quality Accounting Network) station that provides records of streamflow discharge and water quality representing a summation from all the Kobuk basin except the Kobuk delta. The Ambler and Squirrel Rivers are both principal streams, tributary to the Kobuk, and streamgaging stations would be required on each to specifically define their flow characteristics.

Knowledge of the flood characteristics of a stream is essential to land-use planning for flood plains. The 1979 survey showed that the water-surface elevations of the MEF were at or above bankfull levels at almost all survey sites in the Kobuk River basin. Although the frequency of the MEF is unknown, it is reasonable to consider the MEF as a flood that will probably be exceeded during the next 25 to 50 years. However, until sufficiently long flood-discharge records are available in the Kobuk basin, more reliable estimates of flood magnitude and frequency cannot be made.

SUMMARY

The Kobuk River basin reconnaissance surveys of 1979 and 1980 were made under unusual weather conditions. The summer survey data were collected during a period of high flows in much of the central and western parts of the basin; the winter survey was not completed as planned because unseasonably warm weather prevented access to much of the basin. Additional surveys could improve understanding of normal streamflow conditions, but this reconnaissance study provided the following significant findings:

- In late winter, runoff of about 0.1 to 0.2 $(ft^3/s)/mi^2$ is probably available from most of the basin, but values approaching no flow may be expected in some smaller tributary basins.
- In late summer 1979, runoff ranged from about 3 $(ft^3/s)/mi^2$ in the upper Kobuk River and tributaries to about 8 $(ft^3/s)/mi^2$ below Jade Creek in the middle reach of the river.
- Maximum evident flood discharge along the Kobuk River ranges from 22,600 ft^3/s [79.3 $(ft^3/s)/mi^2$] above Walker Lake outlet to 71,700 ft^3/s [17.2 $(ft^3/s)/mi^2$] at Kobuk. The MEF was near bankfull stage at most sites.
- Both chemical analyses and the invertebrate communities present in the streams indicate the surface water is generally of excellent quality.

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