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SEDIMENT TRANSPORT IN THE TANANA RIVER IN THE VICINITY OF FAIRBANKS, ALASKA, 1977

Prepared by the United States
Department of the Interior
Geological Survey
in cooperation with
U.S.Army Corps of Engineers
Alaska District

OPEN FILE REPORT 78-290

ERRATA * * * ERRATA * * * ERRATA

The following are corrections for the report "Sediment Transport in the Tanana River in the vicinity of Fairbanks, Alaska, 1977", by William W. Emmett, Robert L. Burrows, and Bruce Parks.

Pages 5 and 6:	The illustration on page 6 goes with the caption on page 5; the illustration on page 5 goes with the caption on page 6.
Page 11:	Units for unit bedload transport should read (lb/s)/ft, not lbs/ft.
Page 14:	abscissa should read sieve size, not sieve site.
Page 18:	Paragraph 2, line 10: The first two words should read medium sand, not median sand.
Page 19:	The caption for figure 6 should read "Particle-size distribution of suspended sediment, Tanana River at Fairbanks, Alaska."

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SEDIMENT TRANSPORT IN THE TANANA RIVER IN THE VICINITY OF FAIRBANKS, ALASKA, 1977

By

William W. Emmett, Robert L. Burrows, and Bruce Parks

in cooperation
with U.S. Army Corps of Engineers
Alaska District

OPEN-FILE REPORT 78-290
(Basic data)

Anchorage, Alaska
1978

UNITED STATES DEPARTMENT OF THE INTERIOR

Cecil D. Andrus, Secretary

GEOLOGICAL SURVEY

V.E. McKelvey, Director

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U.S. Geological Survey
Water Resources Division
218 E Street, Skyline Building
Anchorage, Alaska 99501

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FACTORS FOR CONVERTING ENGLISH UNITS

The following factors may be used to convert the English units published herein to the International System of Units.

Multiply English units	by	to obtain SI units
inches (in)	25.4	millimeters (mm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
pounds (lb)	0.4536	kilograms (kg)
ton, short (t)	0.9072	tonne (t)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)
pounds per foot (lb/ft)	1.488	kilograms per meter (kg/m)

Suspended-sediment concentrations are given only in milligrams per liter (mg/L) because these values are (within the range of values presented) numerically equal to equivalent values expressed in parts per million.

LIST OF SYMBOLS

Symbol

- A - Cross-sectional area of flow (ft^2)
- C - Mean depth of flow (ft)
- Q - Discharge of flow rate (ft^3/s)
- V - Mean velocity of flow (ft/s)
- W - Surface width of flow (ft)
- D_{50} - Median particle size (mm)
- G_B - Bedload-transport rate (tons/day)
- G_s - Suspended-load transport rate (tons/day)
- r - Correlation coefficient

SEDIMENT TRANSPORT IN THE TANANA RIVER IN THE VICINITY OF FAIRBANKS, ALASKA, 1977

By William W. Emmett, Robert L. Burrows, and Bruce Parks

ABSTRACT

Measurements of suspended- and bedload-sediment transport for the Tanana River in the vicinity of Fairbanks, Alaska, show that suspended-sediment load, G_s in tons per day, relates to water discharge, Q, in cubic feet per second, as:

$$G_s = 1.66 \times 10^{-8} Q^{2.83}$$

The bedload transport rate is approximately one percent of the suspended-sediment transport rate.

The median particle size of suspended sediment is generally silt (<0.062 mm), but at some low-water discharges, the median particle size is very fine sand. The median particle size of bedload is generally gravel (>2.0 mm, and often in the range of 10 to 20 mm), but at some low transport rates, the median particle size is medium sand. At all water discharges and sediment-transport rates, the particles constituting the suspended load are significantly smaller than the particles constituting the bedload.

INTRODUCTION

To facilitate the design and operation of engineering structures on the Tanana River and the quarrying of gravel from the river in the vicinity of Fairbanks, the U.S. Army Corps of Engineers, Alaska District, requested that the U.S. Geological Survey collect and evaluate sediment-transport and river hydraulic data during the period of principal runoff in 1977. This report presents tables of selected data and computations. Most of these tables are followed by graphical presentation of the data. The majority of the text is devoted to explanation of the tables and graphs. The primary purpose of this report is to provide the Corps of Engineers, at the earliest possible time, information that is pertinent to their design computations.

The study program is funded by the Corps of Engineers through a cooperative agreement with the U.S. Geological Survey. All field work and the compilation of data were conducted by personnel of the U.S. Geological Survey. Most laboratory analyses of particle-size determinations and suspended-sediment concentrations were conducted by personnel of the Corps of Engineers. Laboratory analyses for the April and October data were carried out by personnel of the Geological Survey.

STUDY OBJECTIVES

The primary objectives of the study are to define for two stations near Fairbanks the suspended- and bedload-sediment transport rates as functions of stream discharge, and the size distributions of suspended and bedload sediment. These objectives were agreed upon by the U.S. Geological Survey and the Corps of Engineers. Data collection sites were established at the U.S. Geological Survey gaging station, Tanana River at Fairbanks, Alaska (station no. 15485500) and at a newly established water-data station, Tanana River near North Pole, Alaska (unnumbered miscellaneous site). The station near North Pole is approximately 15 river miles upstream of the Fairbanks station. Existing streamflow data for the Fairbanks station may be found in the annual publications of the U.S. Geological Survey entitled "Water Resources Data for Alaska". New data for both stations will be published in future issues of the same series.

The primary objectives of the study are to define for these two stations, with emphasis given to the Fairbanks station, the suspended- and bedload-sediment transport rates as functions of stream discharge, and the size distributions of suspended and bedload sediment.

INSTRUMENTATION AND DATA COLLECTION

Streamflow gage heights during the open water season at the Fairbanks station were documented by a continuous trace on a Stevens A-35 recorder. The continuous trace was analyzed to determine daily mean gage heights and corresponding daily mean discharges. During the winter flow period, October through April, values of daily mean discharge were estimated utilizing periodic discharge measurements, climatological data, and correlation with data available from the gaging station, Tanana River at Nenana, Alaska. At the North Pole station, only the water-surface elevations at the times of discharge measurements were recorded. All measurements were made from a boat. The boat was positioned using sextant readings on a base line for cross channel stationing and visual reference to the cross-section end markers for on-station locationing. Water-discharge measurements were made each time sediment data were collected, and these instantaneous values of discharge were used in evaluating the sediment-transport data.

A P-61 suspended-sediment sampler (Guy and Norman, 1970) was used to collect depth-integrated water samples for analysis of concentration and particle-size distribution of the suspended sediment. A Helley-Smith type bedload sampler (Helley and Smith, 1971) was used to collect bedload samples that enabled determination of bedload-transport rate and particle-size distribution of the bedload sediment. The Helley-Smith bedload sampler has not been adopted by the U.S. Geological Survey as standard equipment; therefore, the results obtained through its use cannot be certified for accuracy. However, a field determination of the sediment-trapping characteristics of the Helley-Smith bedload sampler

(Emmett, W.W., unpub. data) indicates that no correction factor need be applied to the bedload data as collected. Additionally, the sampler has been used with apparent success in other rivers (Emmett, 1976) that have bedload transport rates and bedload particle size characteristics similar to those of the Tanana River.

For most of the bedload-data collection, samples were obtained at 50-foot increments across the part of stream width active in the bedload-transport process. Generally this resulted in the collection of 18 to 20 samples across the stream width. Sampling duration was 30 seconds at each location. For most traverses of the stream, each individual bedload sample was given equal consideration in the determination of the average stream-wide transport rate. In the few instances where duplicate samples were obtained at a given location, these samples were averaged and the average value used in the same manner as individual values. Samples collected at each end of the traverses were given the same consideration as other individual samples regardless of the incremental width of channel associated with the end samples.

Streamflow Data and Channel Geometry

Table 1 presents a summary of discharge measurements made during the period of sediment sampling at the Tanana River at Fairbanks. Cross-section data for several of the discharge measurements included in table 1 are plotted in figure 1 and illustrate several characteristics of the river. The cross section is non-uniform in shape, with the deepest water near the left bank. At river stages less than about 27 feet, all of the flow is confined to the deeper portion of the channel; above a stage of about 27 feet, the sand and gravel bar area becomes submerged, and the surface width of the stream more than doubles. This is apparent from table 1 by comparing the measurement for October 3 with any of the other measurements. As river stage changes, there is considerable shifting of bed material from the sand and gravel bar area to the thalweg and vice-versa.

Excluding the October 3 measurement in table 1, the remaining measurements were analyzed to provide relations of hydraulic and channel parameters to values of streamflow. Using log-transformed least-squares techniques, the relations for width, depth, flow area, and velocity, respectively, are:

$$W = 5.91\ Q^{0.49}$$

$$D = 0.18\ Q^{0.35}$$

$$A = 1.06\ Q^{0.84}$$

$$V = 1.07\ Q^{0.15}$$

These relations are plotted as at-a-station curves of hydraulic geometry (Leopold and Maddock, 1953) in figure 2. Water-surface slopes were obtained as part of a special study in 1973 by the U.S. Geological

Table 1.--Summary of discharge measurements made during period of sediment samplings, Tanana River at Fairbanks, Alaska

Date (1977)	Gage Height (ft)	Discharge (ft^3/s)	Flow Area (ft^2)	Surface Width (ft)	Mean Velocity (ft/s)	Mean Depth (ft)
June 7	28.09	26,500	5,140	865	5.16	5.94
June 16	29.28	40,100	8,420	1,060	4.76	7.94
June 29	30.10	46,700	10,900	1,180	4.28	9.24
July 6	28.82	41,200	7,620	1,073	5.41	7.10
July 12	28.93	38,100	7,020	1,060	5.43	6.62
July 20	29.56	44,800	8,800	1,175	5.09	7.49
July 26	29.60	50,200	9,090	1,275	5.52	7.13
Aug. 3	30.56	59,300	10,000	1,300	5.93	7.69
Aug. 11	30.42	51,500	9,350	1,220	5.51	7.66
Aug. 18	30.16	51,100	9,070	1,240	5.63	7.31
Aug. 31	28.95	49,800	8,310	1,000	5.99	8.31
Oct. 3	26.92	20,900	4,090	440	5.11	9.30

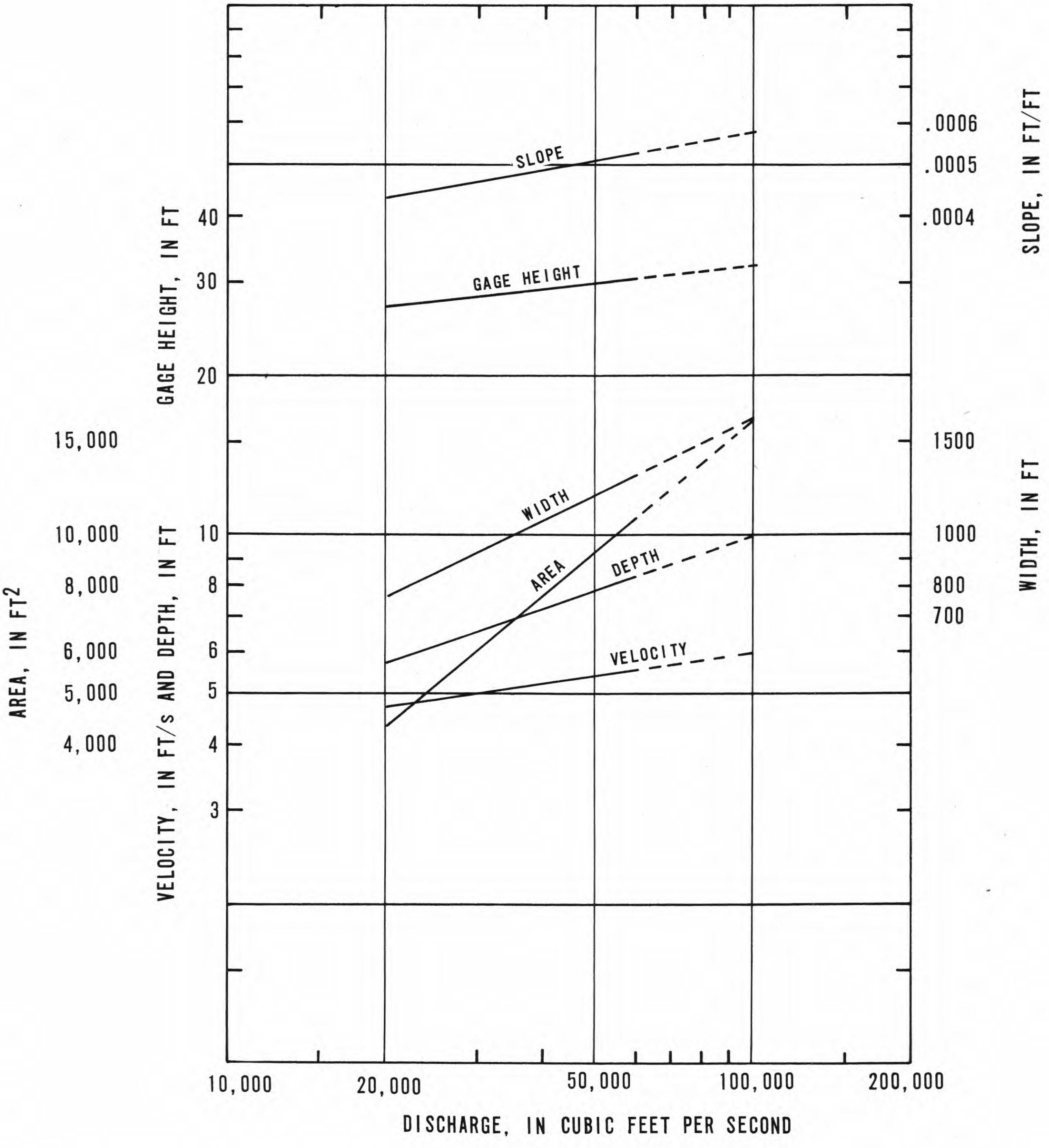

Figure 1.--Cross section of the Tanana River at Fairbanks, Alaska, as measured several times during the sediment transport study.

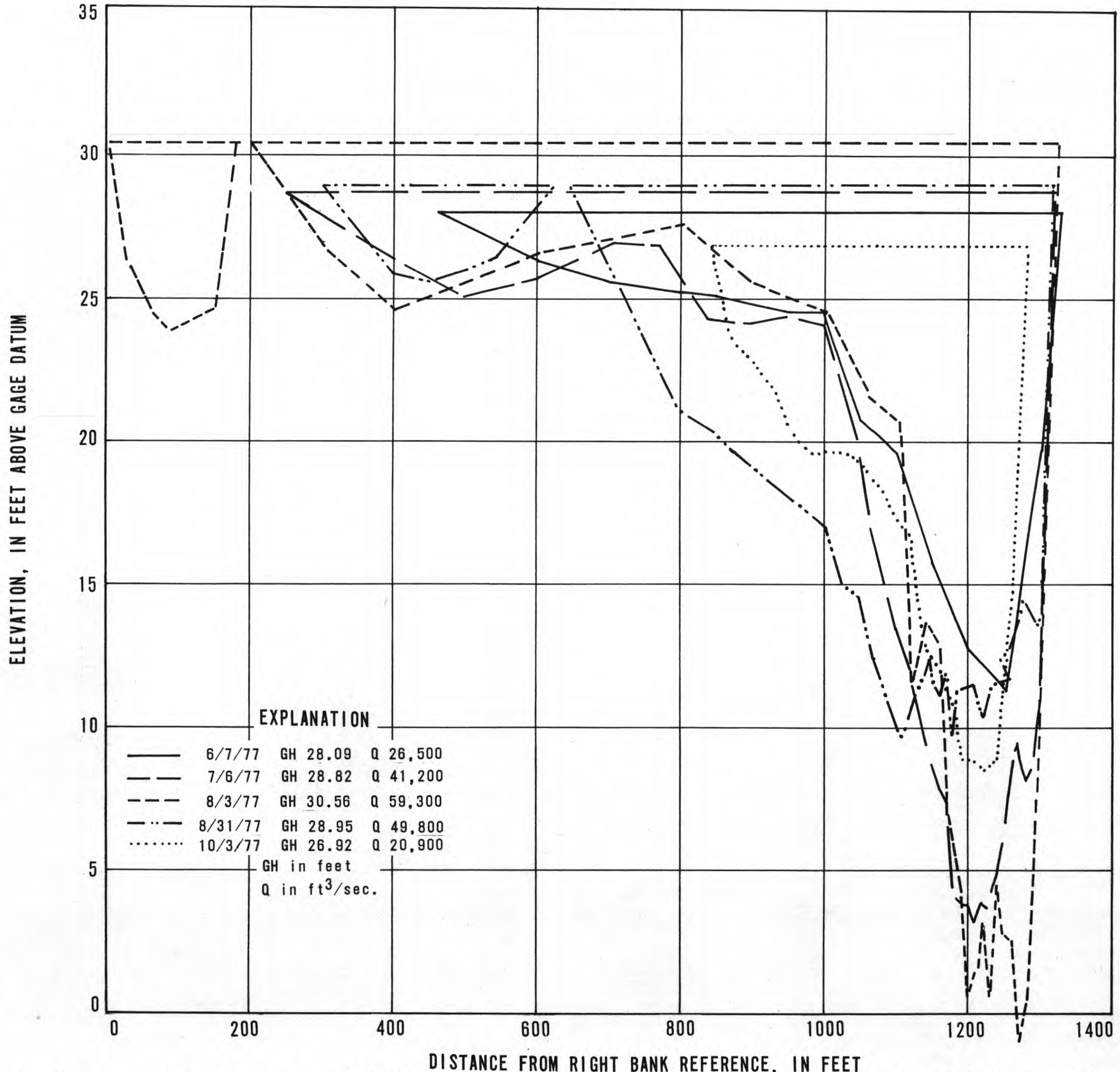

Figure 2.--At-a-station relations of hydraulic and channel geometry, Tanana River at Fairbanks, Alaska.

Survey in cooperation with the U.S. Army Corps of Engineers. The relation for water-surface slope shows increasing values of slope with increasing discharge. The relation of gage height to discharge shown is the current rating curve.

Values of daily mean discharge, 1977 water year, for the Tanana River at Fairbanks, are presented in table 2. Daily mean discharge is not available for the station near North Pole; the only streamflow data available for this station are those collected at times of sediment measurements, and these data are presented in this report.

Sediment Transport Data

Table 3 lists values of instantaneous discharge, suspended-sediment concentration, suspended-sediment load, and median particle size. The suspended-sediment load in tons per day is computed as:

$$\text{Load} = 0.0027 \times \text{concentration (mg/L)} \times \text{discharge (ft}^3\text{/s)}$$

Table 4 lists values of instantaneous discharge and bedload-transport rate. The total bedload transport, in tons per day, was computed by applying the unit transport rate over the full width of the channel.

The relations of suspended- and bedload-sediment transport as a function of discharge are illustrated in figure 3. The data are from tables 3 and 4. Using a log-transformed least-squares technique, the correlation coefficient for the log-transformed data, $r = .995$, indicates a high degree of correlation. The equation describing the suspended-sediment relation is:

$$G_s \text{ (tons/day)} = 1.66 \times 10^{-8}\ Q \text{ (ft}^3\text{/s)}^{2.83}\ .$$

The paucity of bedload data restricts the application of least-squares techniques; the dashed-line relation for bedload data as shown in figure 3 suggests that bedload is on the order of one percent of suspended load. That is,

$$G_B \text{ (tons/day)} \simeq 0.01\ G_s \text{ (tons/day)}.$$

Particle Sizes of Suspended and Bedload Sediment

Table 5 and figures 4 (a-c) and 5 present the size-distribution data for suspended sediment. Size determination was made by sieve analysis for particles larger than silt (>0.062 mm) and pipet analyses for particles of silt size and smaller. In all instances, data are expressed in percentage, by weight, finer than indicated particle size.

Table 2.--Values of daily mean discharge[1/] (ft³/sec)
1977 Water Year
Tanana River at Fairbanks, Alaska (15485500)

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	13,000	6,000	4,500	4,500	5,200	6,200
2	12,600	6,000	4,500	4,500	5,200	6,200
3	12,200	6,000	4,500	4,500	5,200	6,200
4	12,000	5,000	4,500	4,500	5,400	6,000
5	12,000	5,000	4,500	4,500	5,400	6,000
6	11,800	5,000	4,500	4,500	5,600	6,000
7	11,800	5,000	4,500	4,500	5,800	5,800
8	11,700	5,000	4,500	4,500	5,800	5,800
9	11,000	5,000	4,500	4,500	5,800	5,800
10	11,000	5,000	4,500	4,500	5,800	5,800
11	10,500	5,000	4,500	4,500	5,800	5,800
12	10,000	5,000	4,500	4,500	6,000	5,800
13	10,000	5,000	4,500	4,500	6,000	5,800
14	10,000	5,000	4,500	4,500	6,000	5,600
15	9,000	5,000	4,500	4,500	6,000	5,600
16	9,000	5,000	4,500	4,500	6,000	5,600
17	9,000	5,000	4,500	4,500	6,000	5,600
18	9,000	5,000	4,500	4,500	6,000	5,600
19	8,000	5,000	4,500	4,500	6,200	5,400
20	8,000	5,000	4,500	4,500	6,200	5,400
21	8,000	5,000	4,500	4,500	6,200	5,400
22	8,000	5,000	4,500	4,500	6,200	5,400
23	8,000	4,500	4,500	4,500	6,200	5,400
24	7,000	4,500	4,500	4,500	6,200	5,400
25	7,000	4,500	4,500	4,500	6,200	5,400
26	7,000	4,500	4,500	4,500	6,200	5,400
27	7,000	4,500	4,500	4,500	6,200	5,400
28	7,000	4,500	4,500	4,500	6,200	5,400
29	6,000	4,500	4,500	4,800		5,400
30	6,000	4,500	4,500	4,800		5,400
31	6,000		4,500	5,000		5,400

[1/] Winter flow period, October through April, estimated based on periodic discharge measurements, climatological records, and correlation with data obtained for Tanana River at Nenana, Alaska.

Table 2.--Values of daily mean discharge[1/] (ft³/sec)
1977 Water Year
Tanana River at Fairbanks, Alaska--Continued

Day	Apr.	May	June	July	Aug.	Sept.
1	5,400	14,000	30,600	51,400	40,900	48,100
2	5,400	15,000	30,600	48,000	38,800	44,600
3	5,600	16,000	29,000	48,100	35,300	39,700
4	5,600	19,000	27,300	47,800	33,100	36,400
5	5,600	23,600	27,000	42,600	31,000	33,200
6	5,800	26,000	28,000	39,000	62,100	30,900
7	6,000	28,000	27,300	37,300	60,300	28,700
8	6,200	29,000	24,800	36,400	56,200	28,600
9	6,400	29,000	23,800	36,400	52,600	27,600
10	6,400	28,300	23,300	38,900	52,500	25,400
11	6,600	24,300	24,000	40,600	53,400	23,800
12	6,800	16,900	25,500	40,600	52,000	25,000
13	7,000	16,600	31,100	43,200	52,000	26,900
14	7,000	16,800	38,700	45,100	52,000	27,000
15	7,000	16,700	38,800	46,800	54,000	26,200
16	7,000	17,300	39,800	48,400	52,000	26,000
17	8,000	17,100	41,000	48,400	52,000	25,600
18	8,000	16,800	41,700	48,000	51,600	25,200
19	8,000	18,400	43,400	47,500	53,000	24,400
20	8,000	24,500	43,600	56,000	54,000	24,000
21	9,000	24,800	40,600	57,000	56,000	25,000
22	9,000	19,600	41,400	54,000	60,000	25,000
23	9,000	17,300	46,400	55,000	62,400	25,000
24	10,000	16,500	49,000	56,000	60,000	24,000
25	10,000	15,700	50,000	54,000	58,000	23,000
26	10,000	15,600	50,000	52,000	56,000	23,200
27	10,000	16,600	50,800	49,000	54,000	23,300
28	11,000	18,800	50,600	46,000	52,000	23,500
29	12,000	20,200	49,900	44,000	48,000	23,600
30	13,000	23,000	54,100	40,700	46,600	24,800
31		26,000		40,600	47,700	

[1/] Winter flow period, October through April, estimated based on periodic discharge measurements, climatological records, and correlation with data obtained for Tanana River at Nenana, Alaska.

Table 3.--Summary of suspended-sediment data, Tanana River, Alaska, 1977

Date	Discharge (ft^3/sec)	Suspended sediment conc. (mg/L)	Suspended sediment load (tons/day)	Median particle size (mm)
Apr. 13	6,950	58	1,088	—
Apr. 26	10,200	146	4,021	.19
June 7	26,500	952	68,120	.077
June 16	40,100	1,642	177,800	.033
June 29	46,700	1,865	235,200	.062
July 6	41,200	1,512	168,200	.077
July 12	38,100	1,487	153,000	.053
July 20	44,800	2,205	266,700	.064
July 26	50,200	1,818	246,400	.033
Aug. 3	59,300	4,340	694,900	.023
Aug. 4*	59,000	3,100	493,800	.023
Aug. 11	51,500	3,269	454,600	.040
Aug. 18	51,100	2,625	362,200	.029
Aug. 19*	59,000	1,729	487,600	.045
Aug. 31	49,800	2,017	271,200	.092
Oct. 3	20,900	563	31,770	.16

*Tanana River near North Pole, Alaska; all other data from Tanana River at Fairbanks, Alaska.

Table 4.--Summary of river hydraulics and bedload data, Tanana River, Alaska, 1977

Date	Discharge (ft^3/s)	Surface Width (ft)	Mean Depth (ft)	Mean Velocity (ft/s)	Flow Area (ft^2)	Slope (ft/ft)	Bedload Transport Unit (lbs/ft)	Bedload Transport Total (tons/d)	Median Particle Size (mm)
Fairbanks Station									
June 7	26,500	869	6.23	4.90	5,415	0.00045	0.0260	975	9.0
June 29	46,700	1,147	7.59	5.33	8,706	.00050	.1668	8,264	10
July 6	41,200	1,078	7.27	5.23	7,838	.00049	.0441	2,052	20
July 12	38,100	1,038	7.07	5.17	7,341	.00048	.0627	2,813	1.8
July 20	44,800	1,123	7.48	5.30	8,408	.00050	.0304	1,473	16
Aug. 3	59,300	1,289	8.25	5.52	10,635	.00052	.1072	5,969	15
Aug. 11	51,500	1,203	7.85	5.41	9,450	.00051	.0834	4,333	20
Aug. 18	51,100	1,198	7.83	5.40	9,389	.00051	.0466	2,413	.44
Aug. 31	49,800	1,183	7.76	5.38	9,188	.00051	.0424	2,169	.30
Oct. 3	20,900	400	9.30	5.01	4,090	.00043	.0455	787	.30
North Pole Station									
Aug. 4	27,700*	800	6.9	5.7	4,900	.00112	.0944	3,262	12
	19,000**	615	4.7	6.5	2,900	.00112	.0359	954	15
	59,000***	--	--	--	--	--	--	4,216	13
Aug. 19	25,900*	715	5.8	6.3	4,140	.00112	.0741	2,287	11
	22,100**	655	5.2	6.5	3,430	.00112	.0309	873	5.4
	59,100***	--	--	--	--	--	--	3,160	9.6

*North Channel
**South Channel
***Total

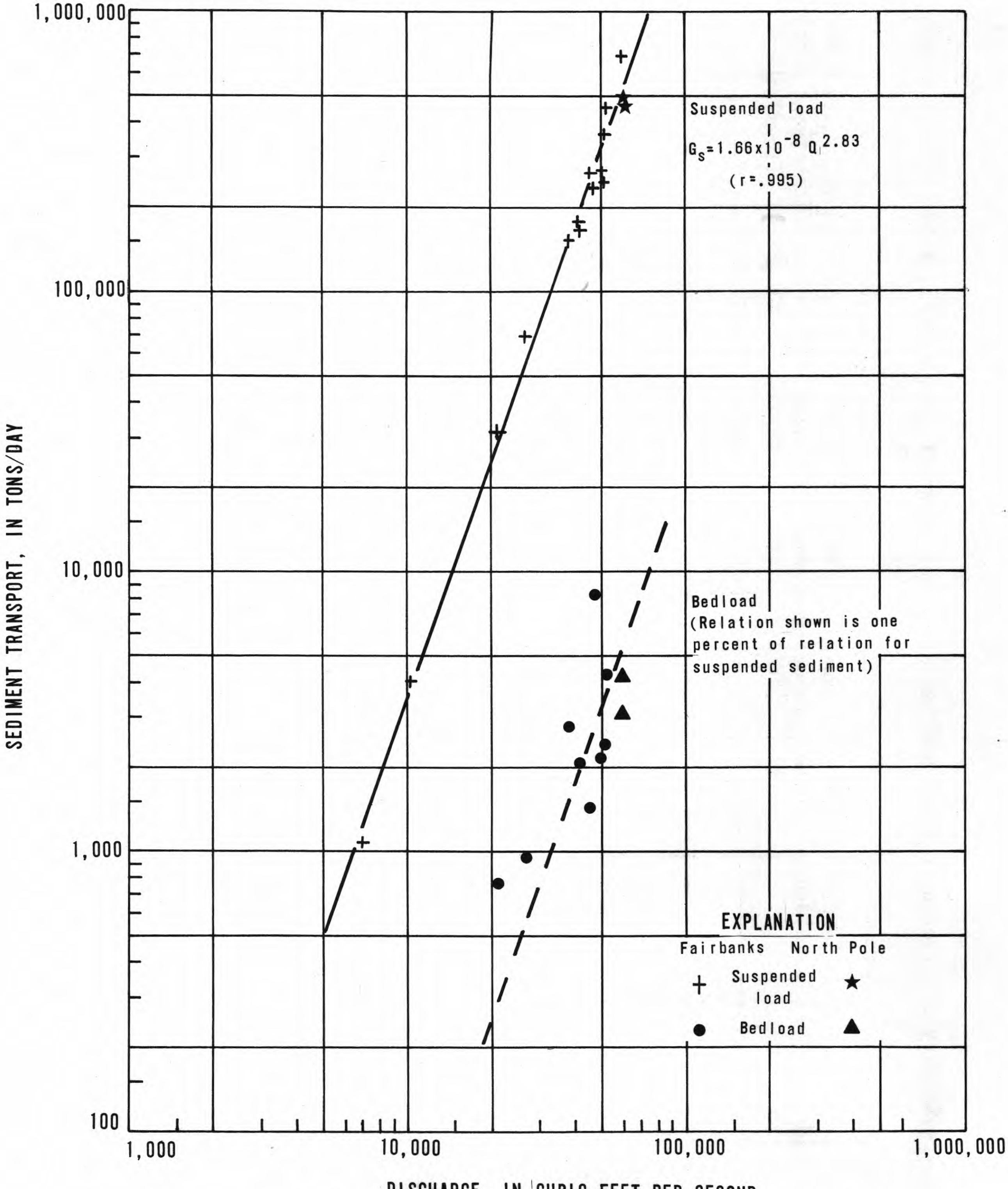

Figure 3.--Suspended- and bedload-sediment transport as functions of stream discharge, Tanana River in the vicinity of Fairbanks, Alaska.

Table 5.--Particle-size distribution of suspended sediment, Tanana River, Alaska, 1977 [Percentage, by weight, finer than particle size indicated].

Particle size (mm)	June 7	June 16	June 29	July 6	July 12	July 20	July 26
1.0				100			
0.50	100	100	100	99	100	100	100
0.25	95	99	96	94	97	97	97
0.125	68	89	74	71	77	75	85
0.062	45	69	51	43	52	52	63
0.031	37	49	35	29	44	36	49
0.016	29	38	30	20	33	31	34
0.008	22	24	16	16	23	23	31
0.004	16	15	9	14	15	14	18
0.002	10	11	6	8	6	5	14

	Aug. 3	Aug. 4*	Aug. 11	Aug. 18	Aug. 19*	Aug. 31	Oct. 3
1.0							
0.50	100	100	100	100	100	100	100
0.25	98	99	98	97	99	95	88
0.125	88	90	81	83	89	61	32
0.062	71	70	61	62	72	41	20
0.031	56	56	45	51	39	31	14
0.016	43	43	36	39	36	25	10
0.008	27	29	26	27	32	18	6
0.004	21	23	19	20	18	12	4
0.002	12	11	8	11	12	5	2

*Tanana River near North Pole; all other data, Tanana River at Fairbanks, Alaska.

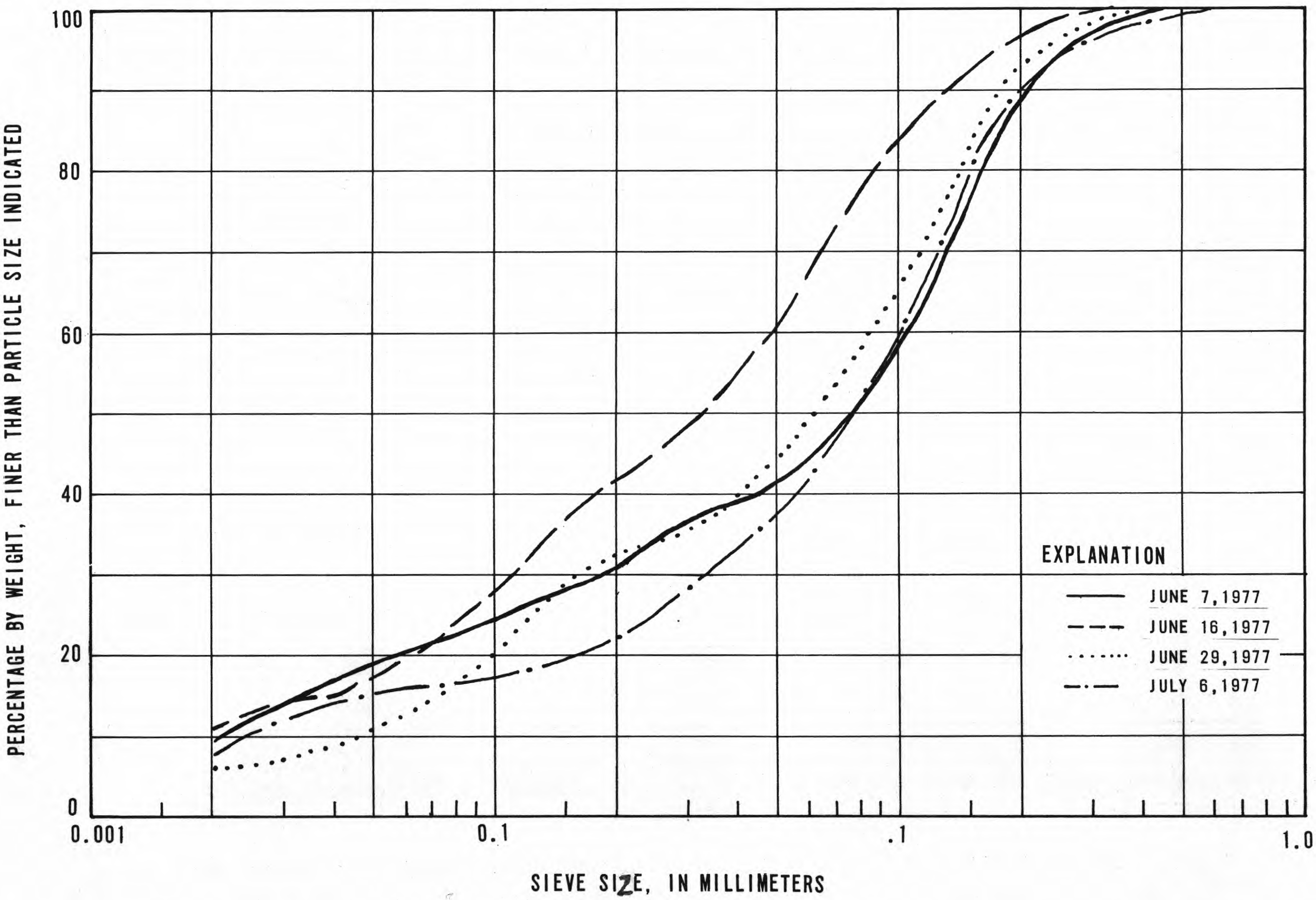

Figure 4a.--Particle-size distribution of suspended sediment for Tanana River at Fairbanks, Alaska.

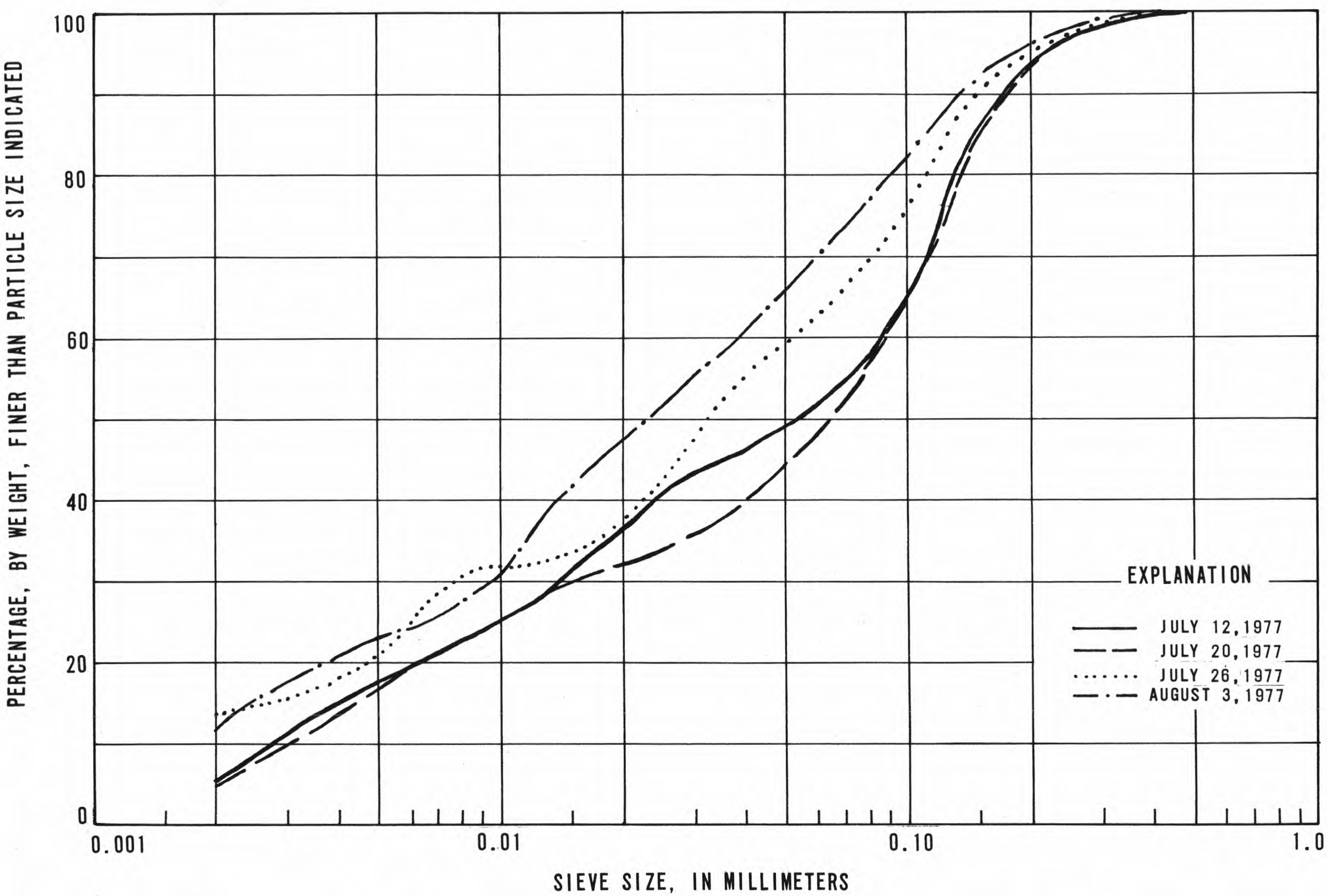

Figure 4b.--Particle-size distribution of suspended sediment for Tanana River at Fairbanks, Alaska.

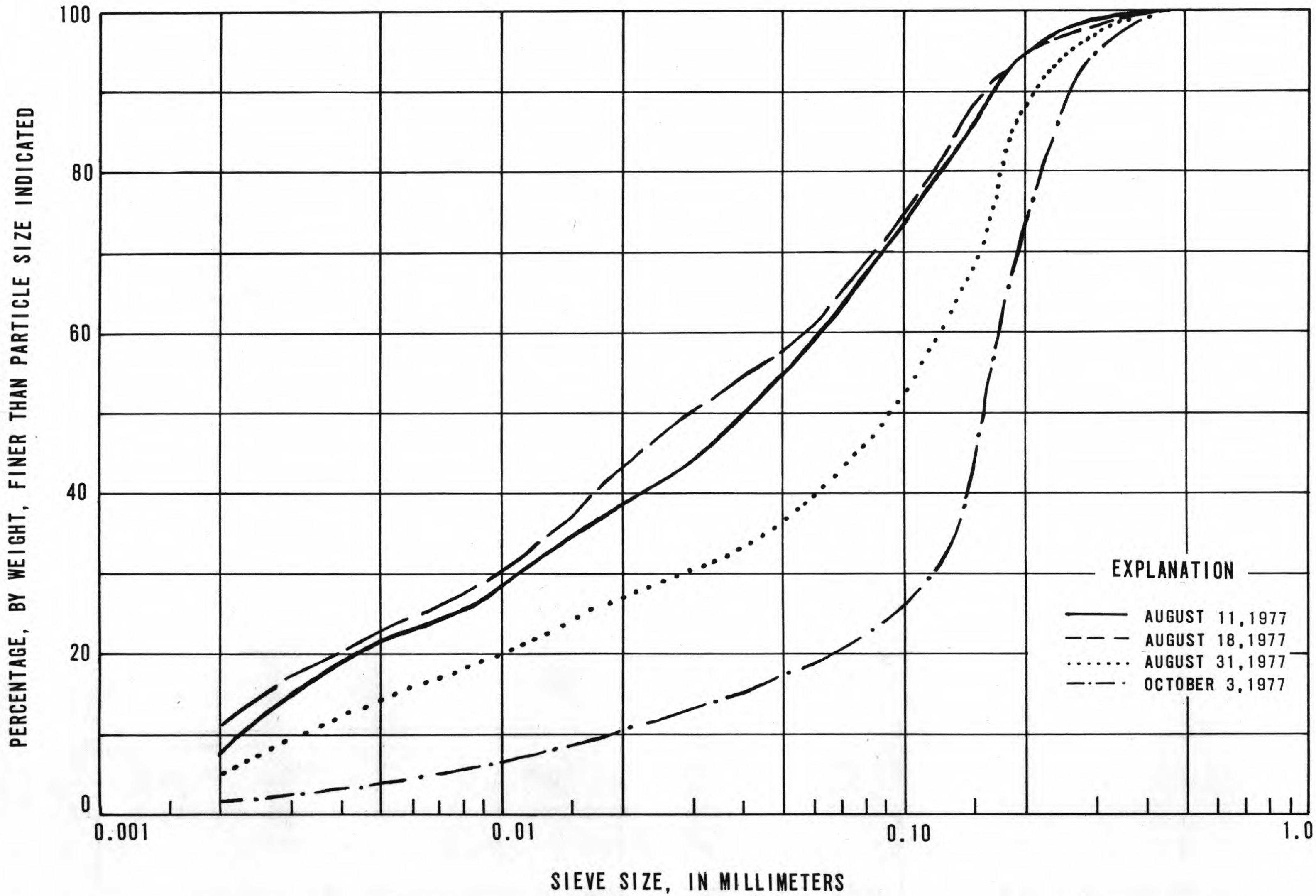

Figure 4c.--Particle-size distribution of suspended sediment for Tanana River at Fairbanks, Alaska.

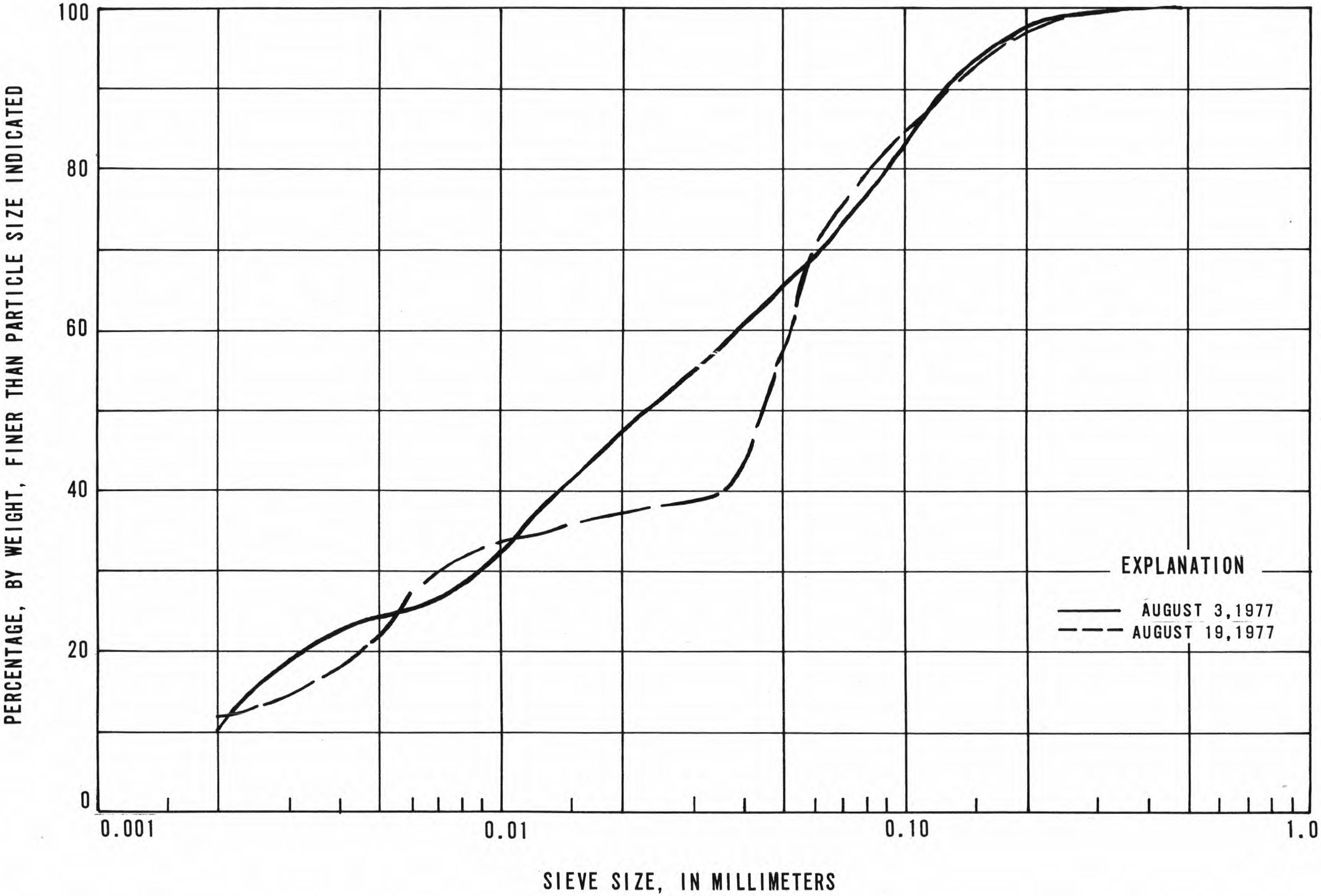

Figure 5.--Particle-size distribution of suspended sediment for Tanana River near North Pole, Alaska.

Values of median particle size were read from the graphs of figure 6 and included as part of the suspended-sediment data presented in table 3. Although it is not a well-defined relation, median particle size of suspended sediment decreases as water discharge increases. This suggests a watershed source of sediment during snowmelt runoff and a within-channel source of sediment during lower runoff periods.

Table 6 presents the size-distribution data for bedload sediment as determined by dry sieve analysis. Data are expressed in percentage by weight, finer than sieve size indicated. Statistics of the particle-size determinations are presented in table 7; this compilation of data is especially useful in the visualization of bedload-particle sizes as functions of discharge or transport rate. The median particle size, D_{50}, from this compilation is included in table 4 as part of the bedload transport data. The median particle size of bedload is generally gravel, but at several low bedload-transport rates, the median particle size is median sand. This abrupt change in median particle size has been observed previously (Emmett, 1976) and is related to the availability and mobility of particle sizes composing the bed material.

Tables 8 and 9 show the transport-weighted, composite size distribution of bedload for the Fairbanks station and North Pole station, respectively. Figure 6 is a graph of these data and clearly shows that the particle sizes of bedload transported past the two stations are of the same sizes, an expected observation for two locations only 15 river miles apart. The graphs of figure 6 allow presentation of particle-size data referenced to standard sieve sizes and these data are included in tables 8 and 9. Statistics of the particle-size data are shown at the bottom of tables 8 and 9 and indicate a bimodal distribution of particle sizes. On the average, bedload composition is about one-third medium sand, and about one-half to two-thirds gravel that is coarser than 10 millimeters. Intermediate sizes of material, coarse sand and fine gravel, are present in much smaller quantities.

The bimodal size distribution of bedload suggests a bimodal size distribution of bed material. A single representative sample of bed material was not obtained for size analysis; however, size data are available for scattered bed-material samples representative of either sandy or gravelly portions of the bed. A composite of these samples, with consideration given to the percentage of bed area assigned each sample and to the size distribution of measured bedload, provides an estimated size distribution of bed material. This estimated particle-size distribution of bed material is shown in figure 7. For comparison, an average curve for bedload particle-size distribution has been taken from figure 6 and included in figure 7. The two particle-size curves in figure 7 are similar, with the bedload curve showing a greater percentage of sand than the bed-material curve. This reflects bed material as the source of bedload, but the river has the capability to transport the sand fraction over a greater range in flow than the gravel fraction.

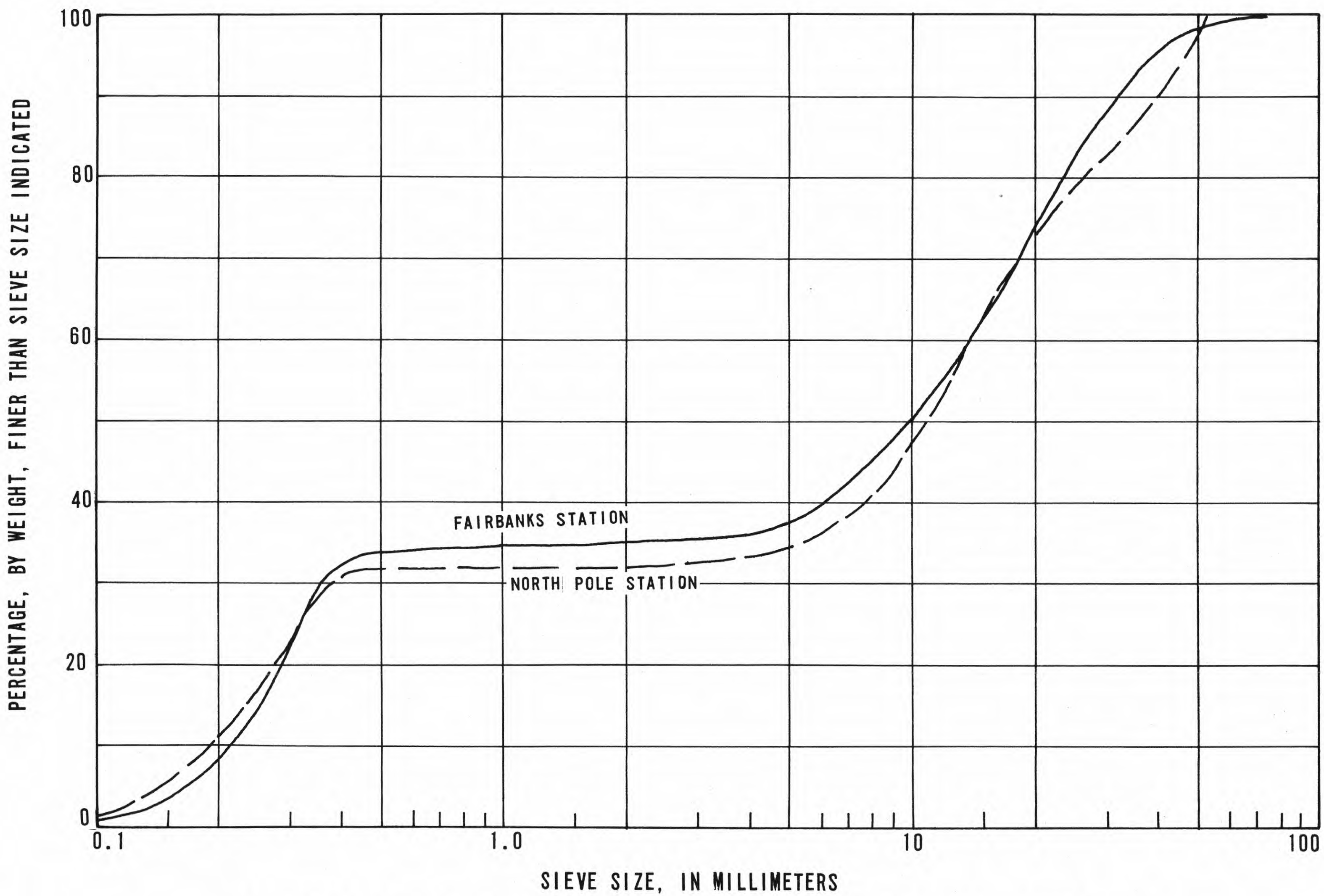

Figure 6.--Particle-size distribution of suspended sediment, Tanana River , Alaska.

Table 6.--Particle-size distribution of bedload sediment, Tanana River, Alaska, 1977 [Percentage, by weight, finer than sieve size indicated].

	FAIRBANKS STATION				
Sieve size* (mm)	June 7	June 29	July 6	July 12	July 20
76.2			100.0		100.0
50.8		100.0	93.6	100.0	91.8
38.1	100.0	96.8	92.0	95.6	71.1
25.4	96.2	91.8	57.9	91.1	67.2
19.1	83.3	81.9	48.7	77.8	57.3
12.7	67.1	62.3	40.0	68.9	43.9
9.52	53.3	47.1	36.4	62.2	37.2
4.76	36.6	27.5	31.4	53.0	29.5
2.00	35.4	25.6	30.0	50.3	27.7
.84	35.1	25.1	29.3	48.6	27.2
.42	34.6	24.8	27.8	46.9	23.6
.297	22.0	16.9	8.3	30.1	12.8
.149	3.2	2.5	.5	3.9	2.2
.074	.6	.9	.2	.7	.7

*Metric equivalent of English unit sieves used by the Corps of Engineers lab.

Table 6.--Particle-size distribution of bedload sediment, Tanana River, Alaska, 1977 [Percentage, by weight, finer than sieve size indicated]--Continued

	FAIRBANKS STATION--Continued				
Sieve size* (mm)	Aug. 3	Aug. 11	Aug. 18	Aug. 31	Oct. 3
76.2		100.0			
50.8	100.0	92.3			
38.1	89.1	87.8	100.0	100.0	
25.4	72.6	70.2	96.2	94.7	
19.1	63.6	49.9	92.7	86.5	
12.7	42.7	47.6	81.1	78.0	
9.52	35.1	43.8	73.7	72.6	100.0
4.76	27.0	36.0	63.9	68.0	99.8
2.00	25.3	34.5	61.4	67.2	99.6
.84	25.2	33.8	60.3	66.8	99.4
.42	24.6	32.8	49.3	65.9	95.0
.297	10.7	19.6	39.8	44.5	50.0
.149	2.1	4.3	5.7	4.5	16.0
.074	.6	1.5	1.2	.9	.5

*Metric equivalent of English unit sieves used by the Corps of Engineers lab.

Table 6.--Particle-size distribution of bedload sediment, Tanana River, Alaska, 1977 [Percentage, by weight, finer than sieve size indicated].--Continued

	NORTH POLE STATION					
Sieve size* (mm)	August 4			August 19		
	North Channel	South Channel	Total	North Channel	South Channel	Total
76.2						
50.8	100.0	100.0	100.0		100.0	100.0
38.1	85.5	83.8	85.1	100.0	85.3	95.9
25.4	73.1	66.6	71.7	90.7	76.4	86.8
19.1	64.9	59.9	63.7	84.5	72.1	81.1
12.7	51.4	44.6	49.9	61.4	65.9	62.6
9.52	43.1	38.5	42.1	45.3	61.8	49.9
4.76	34.6	30.4	33.6	29.7	48.6	34.9
2.00	33.0	29.5	32.2	29.0	45.7	33.6
.84	32.1	28.8	31.3	28.8	44.7	33.2
.42	32.0	27.7	31.0	28.5	43.3	32.6
.297	21.9	17.1	20.8	17.9	26.7	20.3
.149	7.3	2.3	6.1	2.8	5.4	3.5
.074	1.8	.7	1.5	.8	1.6	1.0

*Metric equivalent of English unit sieves used by the Corps of Engineers lab.

Table 7.--Statistical data, particle-size distribution of bedload sediment, Tanana River, Alaska, 1977 [Particle diameter (mm) at given percent-finer parameter]

	FAIRBANKS STATION				
Percent-finer parameter	June 7	June 19	July 6	July 12	July 20
D_5	0.17	0.19	0.25	0.16	0.18
D_{16}	.26	.29	.32	.23	.33
D_{35}	.80	7.0	8.0	.32	8.0
D_{50}	9.0	10	20	1.8	16
D_{65}	12	13	28	11	24
D_{84}	20	20	32	22	45
D_{90}	22	24	36	58	48
D_{95}	24	31	58	37	56
Largest*	38	51	76	51	76

	Aug. 3	Aug. 11	Aug. 18	Aug. 31	Oct. 3
D_5	0.21	0.16	0.14	0.15	0.14
D_{16}	.31	.27	.19	.21	.20
D_{35}	9.4	2.5	.27	.27	.26
D_{50}	15	20	.44	.30	.30
D_{65}	20	24	.58	.40	.32
D_{84}	34	33	14	17	.37
D_{90}	39	44	17	22	.40
D_{95}	45	59	23	27	.43
Largest*	51	76	38	38	8.0

*Smallest sieve size that largest particle passed.

Table 7.--Statistical data, particle-size distribution of bedload sediment, Tanana River, Alaska, 1977 [Particle diameter (mm) at given percent-finer parameter]--Continued

	NORTH POLE STATION					
Percent — finer parameter	August 4			August 19		
	North Channel	South Channel	Total	North Channel	South Channel	Total
D_5	0.12	0.18	0.14	0.17	0.14	0.16
D_{16}	.23	.28	.25	.28	.23	.25
D_{35}	4.8	7.5	6.0	6.5	.34	4.8
D_{50}	12	15	13	11	5.4	9.6
D_{65}	19	23	21	13	12	13
D_{84}	36	38	37	19	35	21
D_{90}	42	45	43	24	42	28
D_{95}	47	48	47	29	47	36
Largest*	51	51	51	38	51	51

*Smallest sieve size that largest particle passed.

Table 8.--Composite size distribution (transport weighted) of bedload sediment, Fairbanks Station, Tanana River, Alaska, June 7-Aug. 31, 1977 [Data expressed in percentage by weight].

Sieve size (mm)	Percent retained	Percent finer	Standard sieve size* (mm)	Percent retained	Percent finer
76.2		100.0	128		100.0
50.8	1.9	98.1	64	0.5	99.5
38.1	5.2	92.9	32	10.5	89.0
25.4	10.9	82.0	16	24.5	64.5
19.1	11.0	71.0	8	20.0	44.5
12.7	13.9	57.1	4	8.0	36.5
9.52	8.8	48.3	2.0	1.2	35.3
4.76	11.2	37.1	1.0	.3	35.0
2.00	1.8	35.3	.5	1.0	34.0
.84	.6	34.7	.25	20.0	14.0
.42	1.6	33.1	.125	12.5	1.5
.297	12.8	20.3	.062	1.0	.5
.149	17.2	3.1			
.074	2.2	.9	Pan	.5	0
Pan	.9	.0			

Particle-size Statistics

Parameter	Size (mm)
D_5	0.175
D_{16}	.265
D_{25}	.325
D_{35}	1.00
D_{50}	10.0
D_{65}	16.5
D_{75}	21.0
D_{84}	27.5
D_{90}	34.0
D_{95}	41.5

*Standard sieve size distribution is interpolated from distribution curves determined from the Corps of Engineers sieves.

Table 9.--Composite size distribution (transport weighted) of bedload sediment, North Pole Station, Tanana River, Alaska, Aug. 4-19, 1977 [Data expressed in percentage by weight].

Sieve size (mm)	Percent retained	Percent finer	Standard sieve size* (mm)	Percent retained	Percent finer
76.2			128		
50.8		100.0	64		100.0
38.1	10.3	89.7	32	16.0	84.0
25.4	11.6	78.1	16	20.0	64.0
19.1	7.0	71.1	8	24.0	40.0
12.7	15.8	55.3	4	6.5	33.5
9.52	9.9	45.4	2.0	1.0	32.5
4.76	11.3	34.1	1.0	.2	32.3
2.00	1.4	32.7	.5	.3	32.0
.84	.7	32.0	.25	16.0	16.0
.42	.5	31.5	.125	13.0	3.0
.297	10.9	20.6	.062	2.0	1.0
.149	15.6	5.0			
.074	3.7	1.3	Pan	1.0	.0
Pan	1.3	.0			

Particle-size Statistics

Parameter	Size (mm)
D_5	.15
D_{16}	.25
D_{25}	.33
D_{35}	5.6
D_{50}	11.0
D_{65}	16.5
D_{75}	22.5
D_{84}	32.0
D_{90}	40.0
D_{95}	46.0

*Standard sieve size distribution is interpolated from distribution curves determined from the Corps of Engineers sieves.

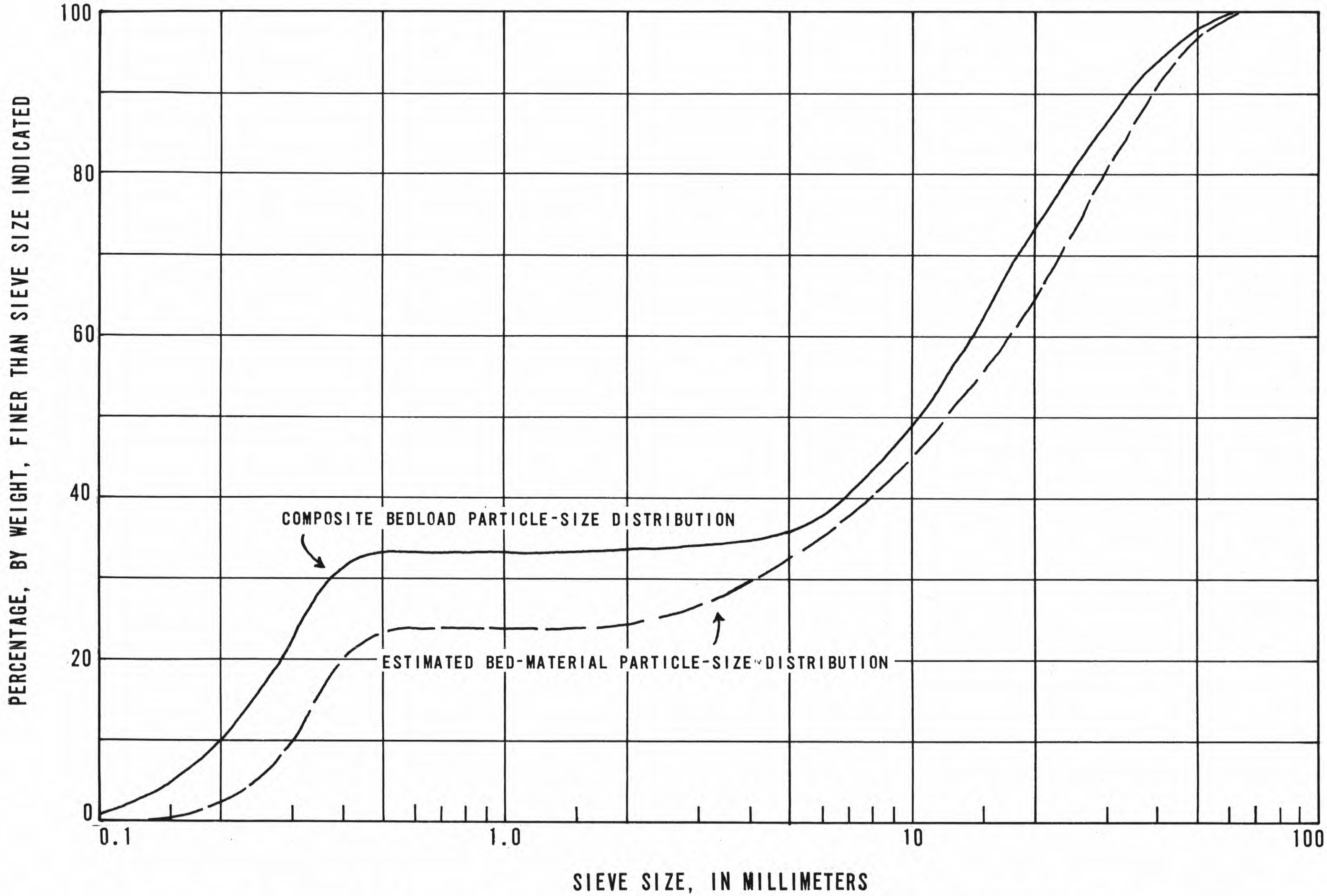

Figure 7.--Comparison of particle-size distributions of composite bedload and estimated bed material, Tanana River in the vicinity of Fairbanks, Alaska.

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