SEDIMENT DISCHARGE DATA FOR SELECTED SITES IN THE SUSITNA RIVER BASIN, ALASKA, OCTOBER 1982 TO FEBRUARY 1984

U.S. GEOLOGICAL SURVEY
OPEN-FILE REPORT 85-157
Prepared in cooperation with the
ALASKA POWER AUTHORITY

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SEDIMENT DISCHARGE DATA FOR SELECTED SITES IN THE SUSITNA RIVER BASIN, ALASKA, OCTOBER 1982 TO FEBRUARY 1984

by James M. Knott and Stephen W. Lipscomb

OPEN-FILE REPORT 85-157

Prepared in cooperation with the

ALASKA POWER AUTHORITY

Anchorage, Alaska

1985

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

Dallas Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
Water Resources Division
4230 University Drive, Suite 201
Anchorage, Alaska 99508-4664

Copies of this report can be purchased from:

Open-File Service Section
Western Distribution Branch
Box 24425, Federal Center
Denver, Colorado 80225
Telephone: (303) 234-5888

CONTENTS

	Page
Introduction	1
Description of area	1
Climate	1
Data collection and analysis	2
Sediment discharge	3
Sediment transport	3
Suspended-sediment concentration and discharge	3
Relation between suspended-sediment discharge and water discharge	4
Bedload discharge and hydraulic characteristics	5
Relation between bedload discharge and water discharge	6
Bed-material data	7
Estimated sediment yield	8
References	9

ILLUSTRATIONS

	Page
Figure 1. Map showing location, major streams, and U.S. Geological Survey streamgaging and sediment-sampling stations in the Susitna River basin	vii
2-5. Graphs showing sediment-transport curves of suspended silt-clay and sand discharge for:	
2. Susitna River near Talkeetna	10
3. Chulitna River below canyon near Talkeetna	11
4. Talkeetna River near Talkeetna	12
5. Susitna River at Sunshine	13
6. Graph showing suspended silt-clay and sand discharge versus water discharge for Susitna River below Chulitna River near Talkeetna	14
7-10. Graphs showing relation between total suspended-sediment discharge and water discharge for:	
7. Susitna River near Talkeetna and at Gold Creek	15
8. Chulitna River below canyon near Talkeetna	16
9. Talkeetna River near Talkeetna	17
10. Susitna River at Sunshine	18
11. Graph showing total suspended-sediment discharge versus water discharge for Susitna River below Chulitna River near Talkeetna	19
12-16. Graphs showing cross sections and distribution of bedload discharge:	
12. Susitna River near Talkeetna:	
a. May 19, 1983	20
b. June 8, 1983	21
c. August 11, 1983	22
d. October 6, 1983	23

ILLUSTRATIONS--Continued

Page

13. Chulitna River below canyon near Talkeetna:
    a. May 19, 1983 24
    b. June 9, 1983 25
    c. August 9, 1983 26
    d. October 5, 1983 27
14. Susitna River below Chulitna River near Talkeetna:
    a. May 20, 1983 28
    b. July 19, 1983 29
    c. August 30, 1983 30
    d. October 5, 1983 31
15. Talkeetna River near Talkeetna:
    a. May 23, 1983 32
    b. June 9, 1983 33
    c. August 11, 1983 34
    d. October 7, 1983 35
16. Susitna River at Sunshine:
    a. May 18, 1983 36
    b. June 8, 1983 37
    c. August 9, 1983 38
    d. October 4, 1983 39

17-20. Graphs showing bedload-transport curves of sand and gravel for:
17. Susitna River near Talkeetna 40
18. Chulitna River below canyon near Talkeetna 41
19. Talkeetna River near Talkeetna 42
20. Susitna River at Sunshine 43
21. Graph showing bedload discharge of sand and gravel versus water discharge for Susitna River below Chulitna River near Talkeetna 44

22-25. Graphs showing relation between bedload discharge and water discharge for:
22. Susitna River near Talkeetna 45
23. Chulitna River below canyon near Talkeetna 46
24. Talkeetna River near Talkeetna 47
25. Susitna River at Sunshine 48
26. Graph showing bedload discharge versus water discharge for Susitna River below Chulitna River near Talkeetna 49

27-32. Graphs showing particle-size distribution and median diameter (D_{50}) of bedload for:
27. Susitna River near Talkeetna 50
28. Chulitna River below canyon near Talkeetna 51
29. Susitna River (right channel) below Chulitna River near Talkeetna 52
30. Susitna River (left channel) below Chulitna River near Talkeetna 53
31. Talkeetna River near Talkeetna 54
32. Susitna River at Sunshine 55

TABLES

		Page
Table 1.	Suspended-sediment data for selected stations in the Susitna River basin, October 1982 to October 1983	56
2.	Hydraulic and bedload data for selected stations in the Susitna River basin, October 1982 to February 1984	59
3.	Bed-material data for selected stations in the Susitna River basin, May to October 1983	63
4.	Water discharge and estimated sediment yields at selected stations in the Susitna River basin, October 1982 to September 1983	67

CONVERSION TABLE

Multiply	by	to obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
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)
ton, short	0.9072	megagram (Mg)
ton per day (ton/d)	0.9072	megagram per day (Mg/d)
degree Fahrenheit (°F)	°C=5/9 (°F-32)	degree Celsius (°C)

Milligram per liter (mg/L) is a standard reporting unit for which no inch-pound equivalent is used.

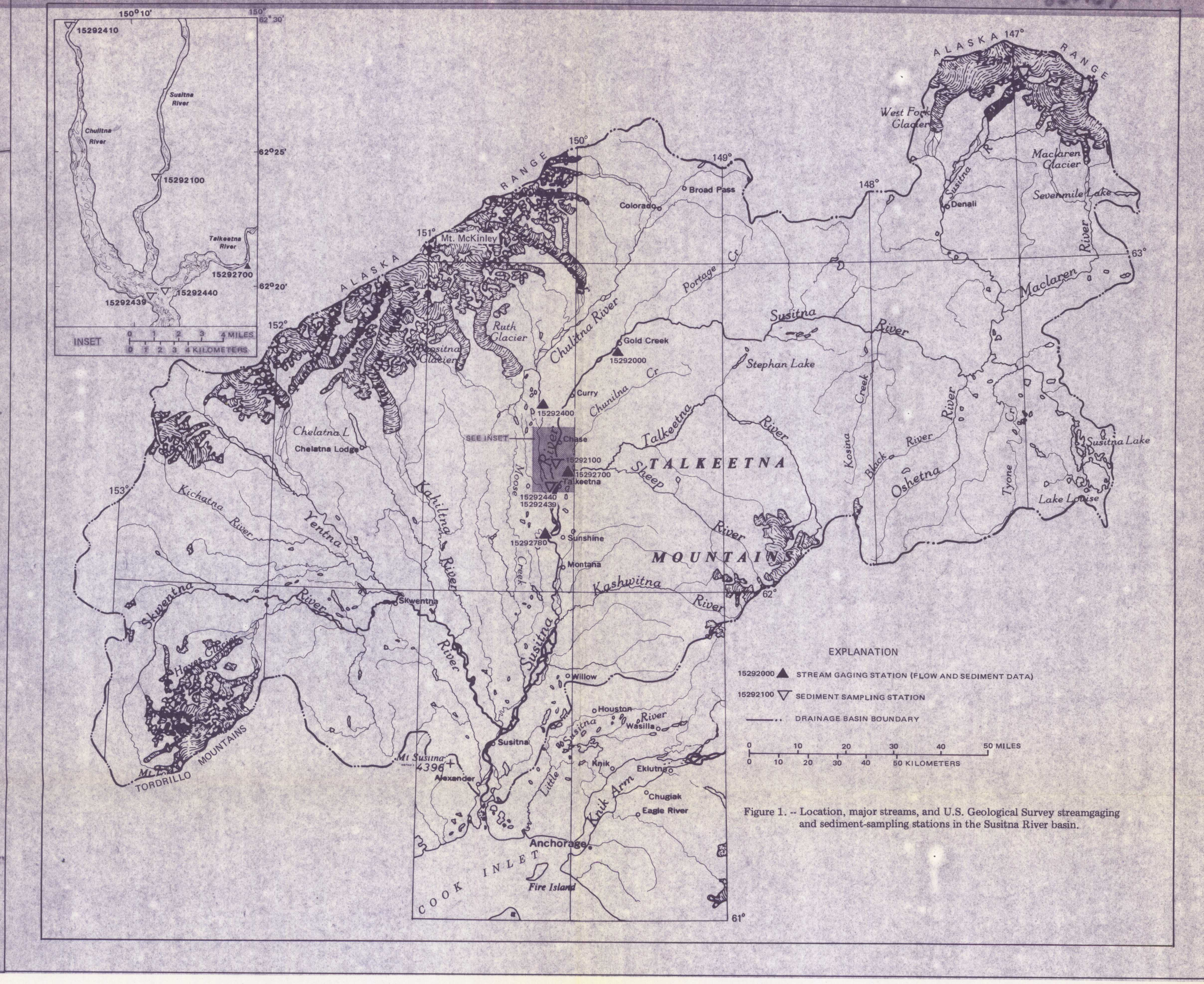

Figure 1. -- Location, major streams, and U.S. Geological Survey streamgaging and sediment-sampling stations in the Susitna River basin.

SEDIMENT DISCHARGE DATA FOR SELECTED SITES IN THE SUSITNA RIVER BASIN ALASKA, OCTOBER 1982 TO FEBRUARY 1984

By James M. Knott and Stephen W. Lipscomb

INTRODUCTION

The Susitna River is one of the major rivers in Alaska, ranking fifth in drainage area. The upper reaches of the river are being considered as potential sites for several dams and reservoirs that would be part of a large power-generation system in southcentral Alaska.

This report presents a summary of sediment and hydraulic data collected at six sites in the Susitna River basin in the area between the proposed damsites and Sunshine (fig. 1). The data were collected during the period October 1982 to February 1984 as part of a cooperative program between the Alaska Power Authority and the U.S. Geological Survey. Similar data for the 1981-82 water years are summarized in a previous report by Knott and Lipscomb (1983).

DESCRIPTION OF AREA

The Susitna River basin (fig. 1) lies on the southern flank of the Alaska Range in southcentral Alaska. The basin, which has a drainage area of about 19,400 mi², is a contrast of steep rugged mountains towering above wide valley lowlands. Altitudes range from 20,320 ft at Mt. McKinley to sea level where the Susitna River empties into Cook Inlet.

Tributaries to the Susitna River are commonly referred to as glacial or nonglacial streams. The nonglacial streams are noted for their clarity, even during intense summer rainstorms. Glacial streams are turbid throughout most of the open-water season (May through September). The Susitna River and its larger tributaries are all affected to some degree by glacial runoff.

CLIMATE

The climate of the Susitna River basin is divided into two broad categories according to maps prepared by Searby (1968). The higher altitude parts of the basin are included in the Continental Zone, where diurnal and annual temperature variations are great. Mean annual temperature ranges from 15 to 25° F (Hartman and Johnson, 1978). The lowlands lie in the Transition Zone where temperatures are less variable than in the Continental Zone. Mean annual temperatures generally range from 25 to 35° F.

Mean annual precipitation of the basin ranges from less than 20 in. near the mouth of the Susitna River to more than 80 in. at higher altitudes (National Weather Service, 1972). Climatological records for the Talkeetna weather station are probably representative of lowland areas. A summary of climatological data for this station (Selkregg, 1974) indicates that mean daily temperatures range from 38 to 62° F in summer, and from -9 to 18° F in winter; extremes range from -44 to 85° F. Annual precipitation averages 28 in., about 60 percent of which is rainfall.

DATA COLLECTION AND ANALYSIS

Beginning in 1981, systematic measurements of sediment discharge and hydraulic properties have been made to define the amount and distribution of sediment transported by the Susitna River and its major tributaries between Gold Creek and Sunshine (fig. 1). In 1981, data were collected at four sites in July, August, and September. Two of the sites were on the Susitna River, one at Gold Creek and the other at the Parks Highway crossing at Sunshine. The remaining two sites were located on major tributaries to the Susitna River, one each on the Chulitna and Talkeetna Rivers.

During 1982 the data-collection program was revised to obtain weekly samples during the open-water season (May to September). A new sampling site was established on the Susitna River, upstream of the Chulitna River confluence (Susitna River near Talkeetna). The stream-gaging station and the former program of monthly suspended-sediment sampling were continued at Gold Creek. A sixth site (Susitna River below Chulitna River near Talkeetna) was established during 1983 (fig. 1). At each site data collection included:

1) Suspended sediment samples
2) Bedload samples
3) Bed material samples
4) Water-discharge measurements
5) Measurements of channel geometry

Selected samples of suspended sediment, bedload, and bed material were analyzed for particle-size distribution. Streamflow characteristics were defined from data available for existing stream-gaging stations. At sampling sites that did not coincide with stream-gaging stations, sufficient discharge measurements were obtained to develop stage-discharge relations. All measurements were made from a boat; either a cableway or sextant was used to determine stationing along the measuring section.

Suspended-sediment samples were collected using a standard depth-integrating P-61 sampler (Guy and Norman, 1970). Two samples were obtained at each of five selected verticals in the stream cross section (at centroids of flow) and analyzed to determine average values of suspended-sediment concentration and the particle-size distribution of sediment in the water-sediment mixture. Both samples were generally composited to obtain one analysis. A few samples were analyzed for individual verticals. Samples of suspended sediment include those particles (usually finer than 2.0 mm) transported in the stream between the water surface and a point about 0.5 ft above the streambed.

Sediment transported within 0.3 ft of the streambed was sampled using a bedload sampler (Helley and Smith, 1971) designed for collecting coarse material (0.062-

76.2 mm). Sampling time, number of sampling points, stream width and depth, and weight of dry sediment were recorded as a basis for calculating bedload discharge. Trap efficiency of the sampler was assumed to be 1.0. Characteristics of the Helley-Smith sampler and procedures for its use have not yet been fully evaluated. In the interim, the Geological Survey follows a provisional method of obtaining samples at about 20 equally spaced verticals (U.S. Geological Survey, written comm., 1979) based largely on field tests by Emmett (1980).

A few bed-material samples were obtained at each site using a 6-inch diameter pipe dredge. At some sites, deep water and a swift current, armoring, and the presence of coarse particles on the streambed made sampling difficult. Although indicative of the sizes of particles present in the streambed (less than 128 mm), bed-material data presented in this report may not be representative of actual particle-size distributions. Samples were also obtained at the surface of bar and island areas at the site "Susitna River below Chulitna River near Talkeetna". These samples, obtained above the water surface, are representative of actual particle-size distributions.

Measurements of depth and width at sampling sections were usually made during bedload measurements. Depths were measured by sounding with the Helley-Smith sampler at 16 to 25 verticals in the cross section. Stream width was determined from station markings on cableways or from sextant readings. Average velocity was determined by dividing the rated discharge of the stream by the cross-sectional area.

SEDIMENT DISCHARGE

Sediment Transport

Sediment is transported in suspension, by rolling and bouncing along the streambed or as a combination of both. Suspended sediment, as the name implies, consists of particles which are transported in a stream while being held in suspension by the turbulent components of the flowing water. Coarse sediment that is transported on or near the streambed constitutes the bedload. Clay and silt particles usually are moved in suspension and gravel particles move on or near the streambed. Sand particles may be transported either as suspended load, as bedload, or both.

Suspended-Sediment Concentration and Discharge

Suspended-sediment sampling for this study was initiated during the 1981 water year; data for the period October 1982 to October 1983 are listed in table 1. Suspended-sediment concentrations for the winter periods of 1982 and 1983 (October to April) when the rivers are lowest were typically less than 10 mg/L and were similar to those for earlier years (1980-81). During 1983, spring breakup occurred at all sampling sites in early May. Suspended-sediment concentrations through late May ranged from 90 mg/L for the Talkeetna River (station No. 15292700) to 622 mg/L for the Susitna River at Sunshine (station No. 15292780). The amount of sand-size material (0.062-2.0 mm) was large relative to the finer silt-clay fraction (0.062 mm) suggesting that sediment was supplied primarily from the erosion of stream channels by snowmelt.

Suspended-sediment concentrations at individual sampling sites are most variable during the summer (June to August). The larger concentrations typically occur during periods of storm runoff.

The Susitna River near Talkeetna (station No. 15292100) and the Talkeetna River are moderately affected by glacial runoff; glaciers cover 5 and 7 percent of their respective drainage areas. Sampled concentrations at these sites ranged from about 100 to 1,000 mg/L, and averaged about 500 mg/L during June to August 1983. Suspended-sediment discharge of the Susitna River averaged 38,000 ton/d or about three times that of the Talkeetna River.

The drainage area of the Chulitna River above the sampling site (2,580 mi^2) is about 40 percent as large as the drainage area of the Susitna River near Talkeetna. Twenty-seven percent of the Chulitna River drainage area is covered by glaciers. Summer concentrations of suspended sediment in the Chulitna River are typically more than twice as high as those for either the Susitna or Talkeetna Rivers near Talkeetna.

Suspended-sediment data obtained at the sampling site designated Susitna River below Chulitna River near Talkeetna (station Nos. 15292439 and 15292440 for the right and left channels, respectively) are representative of the combined discharge of the Susitna River near Talkeetna and Chulitna River below canyon near Talkeetna (station No. 15292410). The site, about 1 mi below the confluence of the Chulitna and Susitna Rivers, includes two major channels separated by a stable, vegetated island, and several minor channels. At this site, the right channel (viewed looking downstream) of the Susitna River carries the entire flow of the Chulitna River, along with smaller but varying amounts of "crossover" flow from the Susitna's left channel. Suspended-sediment concentration and discharge for the right channel were typically several times higher than that of the left channel in the period June through August 1983.

Suspended-sediment concentrations for the Susitna River at Sunshine ranged from 381 to 2,840 mg/L from June through August 1983. Suspended sediment concentrations at this site represent the result of the mixing of the Chulitna, Susitna, and Talkeetna Rivers. Suspended-sediment discharge for the Susitna River at Sunshine agrees closely with the sum of sediment discharges for the Chulitna, Susitna, and Talkeetna Rivers.

Suspended-sediment concentrations and discharge usually decline during September and October as cooler weather reduces the melting rate of the glaciers. In 1983, no major storms occurred during this period and sampled concentrations of the sites at Susitna and Talkeetna Rivers near Talkeetna were less than 50 mg/L. Concentrations for the Chulitna River declined substantially below summer values but remained greater than 200 mg/L by early October.

Relation Between Suspended-Sediment Discharge and Water Discharge

A common method for analyzing sediment-transport characteristics at a site is to construct a graph of sediment discharge versus water discharge. This relation is generally illustrated by a plot on logarithmic paper and is referred to as a sediment-transport curve. Data for 1982 and 1983 were used to develop transport curves for the silt-clay and sand fractions of suspended sediment for the Susitna, Chulitna, and Talkeetna Rivers (figs. 2-6). Coefficients of determination (r^2) were computed from a least-squares fit of log-transformed values to provide a measure of the variance of sediment discharge to water discharge. The transport curves for suspended sediment should be considered representative only for the period of open water (May to September). Particle-size data collected in winter periods (October to April) are too few to construct similar curves.

The transport curves of silt-clay material for all sampling sites showed a similar trend; that is, silt-clay discharge increased at roughly the same exponential rate relative to increases in water discharge. Exponents of water discharge, Q, in the relations (figs. 2-6) ranged from 2.92 to 3.08; r^2 ranged from 0.68 to 0.94.

Transport curves for suspended sand indicate a larger variation in exponents than those for silt-clay material. Exponents of water discharge range from 2.13 for the Susitna River at Sunshine to 3.22 for the Susitna River near Talkeetna; r^2 values range from 0.74 to 0.89.

The small number of data points obtained at the sampling site Susitna River below Chulitna River near Talkeetna during 1983 are considered insufficient to develop transport curves for estimating monthly or annual sediment yield. The proximity of the data points to established curves for Susitna River at Sunshine (fig. 5), however, suggests that transport relations at the sites are comparable.

Transport curves of total suspended-sediment discharge for winter periods (October to April) were prepared from recent historical data (figs. 7-11). Pre-1975 data were generally excluded from the analyses because of apparent differences in transport relations for several years following the extremely wet year of 1971. Transport curves of total suspended-sediment discharge for summer periods (May to September) were developed by combining curves for sand and silt-clay.

Bedload Discharge and Hydraulic Characteristics

The bedload and hydraulic data for the sampling sites "near Talkeetna" and the Susitna River at Sunshine are summarized in table 2. Bedload data are expressed both as transport rate in tons per day, and in terms of their particle size distribution in percent finer than the indicated sieve size.

Winter samples (through ice cover) of bedload were collected twice at all sites -- once during March 1983 and again during February 1984. Bedload discharges computed from samples collected during February and March probably indicate near-minimum rates of transport because these are the months of minimum streamflow. Bedload discharges of the Chulitna, Susitna, and Talkeetna Rivers near Talkeetna were extremely low, ranging from zero to about 2 ton/d. During February 1984, bedload discharge of the Susitna River increased to 52 ton/d at the site "below Chulitna River near Talkeetna" and to more than 200 ton/d at Sunshine. Bedload at all sites was predominantly sand during the winter, but significant amounts of gravel were detected at sampling sites on the Chulitna River and the Susitna River at Sunshine.

During the 1983 open-water period, bedload discharge of the Susitna River near Talkeetna ranged from 27 to 854 ton/d (table 2). During this same period, water discharge ranged from 10,700 to 39,100 ft³/s. The transported material generally consisted of large amounts of sand (80-99 percent) and minor amounts of gravel (1-20 percent). The percentage of gravel (2.0-64.0 mm) in transport increased dramatically (to 79 percent) during the high flow measurement of June 1, 1983. A similar occurrence of a high proportion of gravel during major storms was observed in June 1982 (Knott and Lipscomb, 1983).

Bedload discharge of the Chulitna River below the canyon ranged from 3,360 to 11,800 ton/d as water discharge ranged from 9,170 to 47,800 ft³/s. The particle-size distribution of bedload on the Chulitna River tended toward a higher percentage of sand than gravel; sand commonly constituted 50 to 60 percent of the bedload. The percentage of gravel increased during high flows, as it did for the Susitna River.

During the open-water period, bedload discharge of the Talkeetna River near Talkeetna ranged from 29 to 1,700 ton/d for flows ranging from 2,280 to 13,600 ft³/s. The particle sizes of bedload at this site were typically from 70 to 100 percent sand. The percentage of gravel exceeded that of sand only during the high flow of June 3, 1983.

Bedload discharge of the Susitna River at Sunshine ranged from 1,320 to 9,380 ton/d at flows ranging from 25,200 to 115,000 ft³/s. Sand and gravel fractions varied with season and water discharge. During May and June the bedload mixture was about 40 percent sand and 60 percent gravel Later in the summer, the percentage of sand was generally greater than gravel, except during periods of high flow. The bedload was predominantly sand during winter measurements.

Channel cross sections for selected sites, with a corresponding plot of bedload discharge at individual sampling points, are shown on figures 12-16. In most cases maximum bedload movement occurs in the zone between the thalweg (maximum channel depth) and the mid-channel. Maximum stream velocities also occurred in this zone.

The volume of bedload material at individual sampling points was visually estimated and converted to equivalent weight during sampling. Individual samples were composited for sieve analyses. The estimated weights were used, together with the actual weight of the composited sample, to give an estimate of bedload for each sampling point. This method gives a qualitative approximation for the lateral distribution of bedload movement.

Relation Between Bedload Discharge and Water Discharge

A relation between bedload discharge and water discharge can be defined using similar methods as for suspended sediment. Log-transformed data and a least-squares analysis were used to obtain a best-fit line through the plotted points. Transport curves and corresponding equations describing the relations are shown in figures 17-26.

The line of best fit, computed by the least-squares method, provides a reasonable relation between bedload and water discharge for the Susitna River near Talkeetna (fig. 17). The data points are reasonably distributed about the line, suggesting that increases in water discharge result in corresponding increases in sand and gravel discharge. Data for the other monitoring sites show considerably more scatter, indicating that bedload discharge is influenced by factors other than water discharge. The other factors may include glacial processes, availability of coarse material, and complex transport of sand as suspended load or bedload.

During periods when glacial or storm processes were dominant, the slope of the bedload to water discharge relation appeared similar to that for suspended-sand discharge. Transport curves developed from graphical comparisons between bedload and suspended-sand discharge were used when coefficients of determination (r^2) for regression equations were unusually low (0.50 or less).

Cumulative curves of particle-size distribution (figs. 27-32) are useful for classifying sediment mixtures. The median diameter (D_{50}) determined from these curves provides a single reference size for bedload or bed material. Histograms showing the percentage of individual groups of particle sizes are useful to indicate the abundance or deficiency of those sizes in the total mixture.

The particle-size distribution of bedload is similar for all sampling sites. During low flows the bedload is composed almost entirely of fine to medium sand (0.25 - 0.50 mm). As the flow increases the percentage of fine to medium sand remains large, but the total bedload is augmented by increasing amounts of medium to coarse gravel (8.0 - 32.0 mm). The Susitna River near Talkeetna transports small amounts of gravel only at the higher flows whereas the Susitna River at Sunshine and the Chulitna River transport gravel at all ranges of flow.

The sampling site on the Susitna River below the Chulitna River consists of two major channels. Sediment-transport characteristics of the right channel are similar to those for the Chulitna River, whereas characteristics of the left channel reflect those of the Susitna River above the confluence.

A noticeable characteristic of bedload particle-size distributions at all sampling sites is the general deficiency of material in the coarse sand to fine gravel sizes range (1.0 - 4.0 mm). Deficiency of these particles results in a bi-modal bedload size distribution. Pettijohn (1947, p. 41-45) notes that such a general deficiency in intermediate grain sizes (2.0 - 8.0 mm) has been reported by many authors.

Pettijohn suggests that particles in the intermediate size range are mechanically unstable and thus subject to rapid disintegration by abrasion. Other explanations suggest that bi-modal distributions are due to the dual nature of fluvial sediment transport (sediment transport as suspended load and as bedload).

BED-MATERIAL DATA

Bed-material samples that would be representative of the sediment present in submerged parts of the channels were extremely difficult to obtain because the rivers were too deep and swift for direct access to streambeds. Samples considered representative of particles finer than 128 mm were obtained at Chulitna River below canyon near Talkeetna, Susitna River below Chulitna River near Talkeetna, and at most sampling points at Susitna River at Sunshine. A few representative samples were obtained at the Talkeetna River and Susitna River near Talkeetna sites. Most samples obtained at the latter sites consisted of a few coarse particles. Bed-material data for 1983 are listed in table 3.

ESTIMATED SEDIMENT YIELD

The sediment yield from a drainage basin is commonly expressed in terms of weight (short or metric tons) or volume (acre-feet or cubic meters). Sediment yields may be estimated by different methods, depending on the amount and type of available data. If daily records of streamflow are available, but sediment discharge has been measured only infrequently, the method most commonly used requires defining a relation between instantaneous sediment discharge and water discharge and applying this relation to daily values of water discharge. This method was used initially to estimate sediment yield for this study.

At some sites, however, a single sediment-transport curve could not be applied for the open-water period because of seasonal changes in the amount and particle-size distribution of sediment for given water discharges. At the "Chulitna River below canyon" site, the scatter of bedload-discharge data was such that even the definition of a bedload-water discharge relation is subject to individual interpretation. Thus, several alternative methods were selected to estimate sediment yield for the 1983 water year.

Suspended-sediment yield was estimated using the Colby-shift control method (Colby, 1956). According to Colby, part of the scatter of sediment data in sediment transport relations is due to random or very short-term fluctuations in concentration, particularly the concentration of the coarse sediments. Part of the scatter may be due to an actual change that may persist for days, weeks, or seasons. It is assumed that most of the observed scatter is due to seasonal changes and complex mixing of sediment produced from glacial melt and storm runoff, and Colby's method would result in more accurate estimates.

Colby suggests that if a change in the relation between water and sediment discharge persists for several days or more, the transport curve should be shifted to pass through or near each individual measurement. The method is subjective because judgment is used to decide whether the measurement is representative of an actual change or of a random fluctuation. An important advantage in using this method is that the accuracy of fit of the transport curve is of small importance.

Bedload yield also was estimated using the Colby shift-control method. At sites for which the scatter in bedload-discharge data was extreme, the initial transport curve was constructed based on transport curves of suspended sand. Sediment-transport curves were constructed for silt-clay, sand, and gravel components for both suspended sediment and bedload discharge measurements.

Estimated sediment yields for the 1983 water year are given in table 4. Total sediment yields (sum of bedload and suspended sediment yield) for the sites near Talkeetna ranged from 1.2 million tons for the Talkeetna River to 9.4 million tons for the Chulitna River. The Susitna River near Talkeetna, which has a drainage area larger than the Chulitna and Talkeetna Rivers combined, transported only 3.5 million tons. Total sediment transported past the three sites "near Talkeetna" (14.1 million tons) agrees closely with that estimated for the Susitna River at Sunshine (14.3 million tons). Bedload estimates, however, indicate that the amount of coarse sand and gravel transported past the Sunshine site was only about 60 percent of the amount transported past the upper sites.

REFERENCES

Colby, B. R., 1956, Relationship of sediment discharge to streamflow: U.S. Geological Survey open file report, 170 p.

Emmett, W. W., 1980, A field calibration of the sediment-trapping characteristics of the Helley-Smith bedload sampler: U.S. Geological Survey Professional Paper 1139, 44 p.

Guy, H. P., and Norman, V. W., 1970, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water Resources Investigations Book 3, Chapter C2, 59 p.

Hartman, C. W. and Johnson, P. R., 1978, Environmental atlas of Alaska (2nd ed.): University of Alaska, Institute of Water Resources, 95 p.

Helley, E.J., and Smith, Winchell, 1971, Development and calibration of a pressure-difference bedload sampler: U.S. Geological Survey open file report, 18 p.

Knott, J. M., and Lipscomb, S. W., 1983, Sediment discharge data for selected sites in the Susitna River basin, Alaska, 1981-82: U.S. Geological Survey Open-File Report 83-870, 45 p.

National Weather Service, 1972, Mean annual precipitation--inches: National Weather Service [Alaska], map.

Pettijohn, F.J., 1949, Sedimentary rocks: New York, Harper and Brothers Publishers, 526 p.

Searby, H. W., 1968, Climates of the States -- Alaska: Environmental Data Service ESSA, Climatology of the United States, No. 60-49.

Selkregg, L. L., editor, 1974, Alaska regional profiles -- southcentral region: University of Alaska, Arctic Environmental Information and Data Center, 255 p.

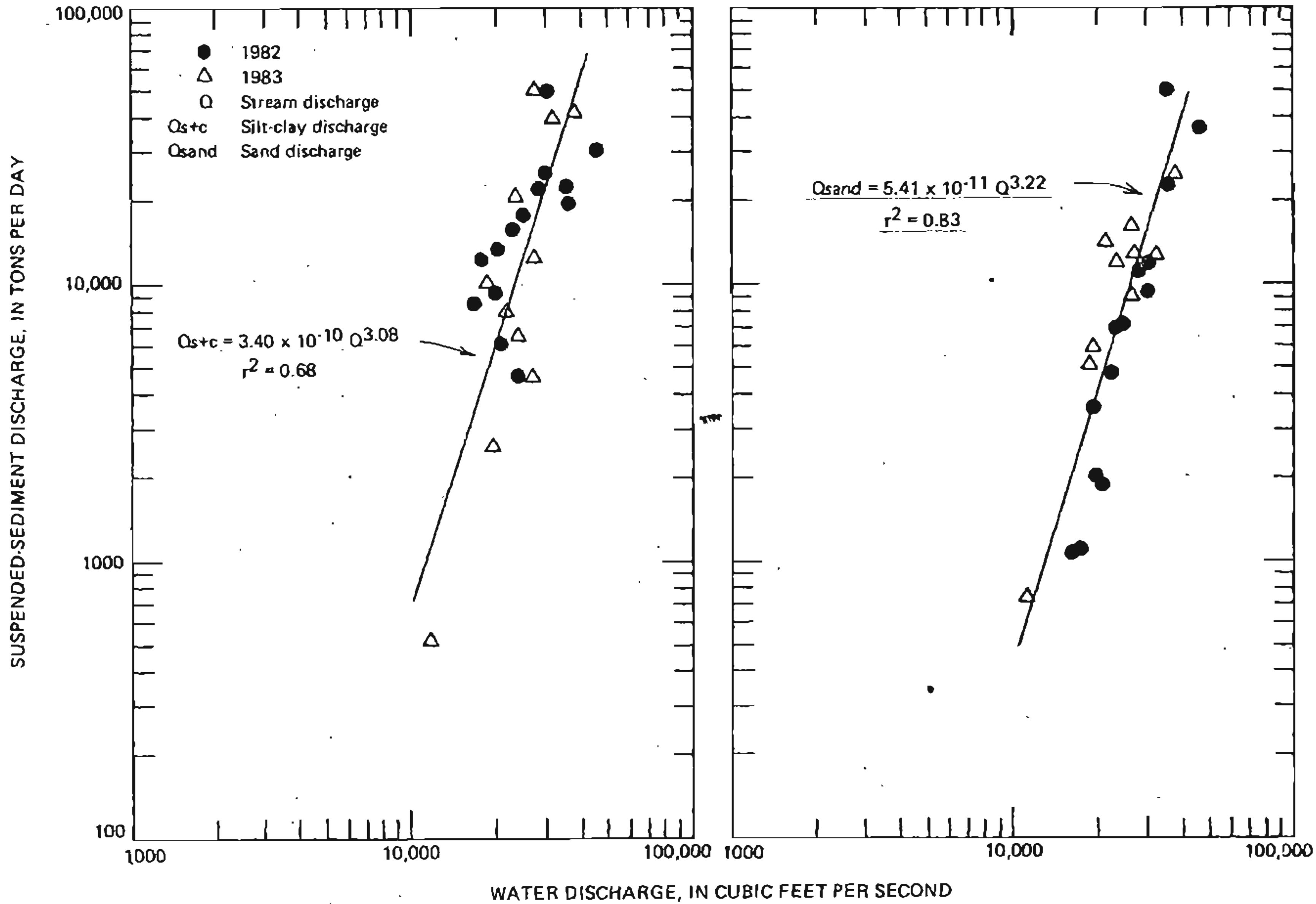

Figure 2.–Sediment-transport curves of suspended silt-clay and sand discharge for Susitna River near Talkeetna, May to September, 1982 and 1983.

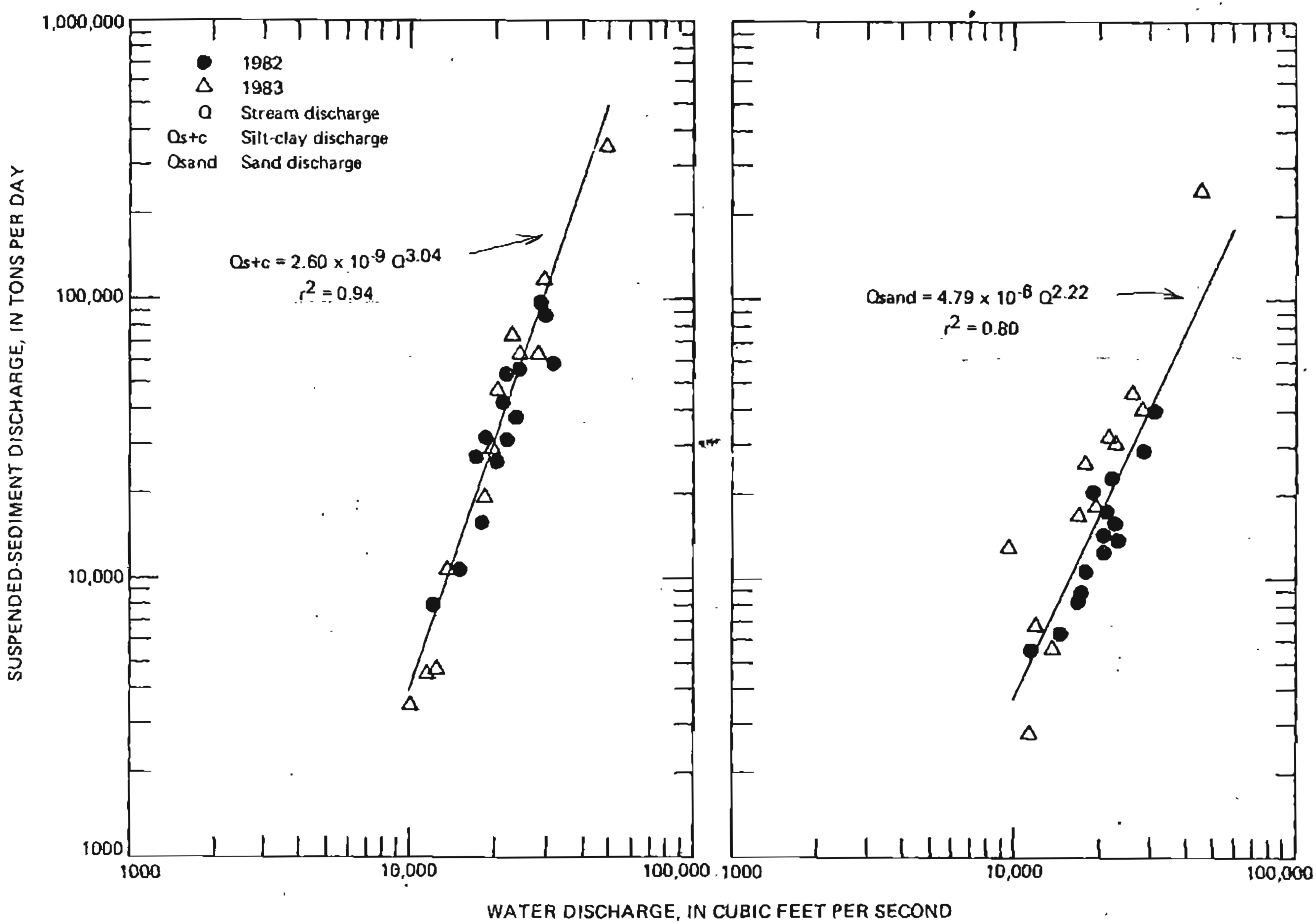

Figure 3.--Sediment-transport curves of suspended silt-clay and sand discharge for Chulitna River below canyon near Talkeetna, May to September, 1982 and 1983.

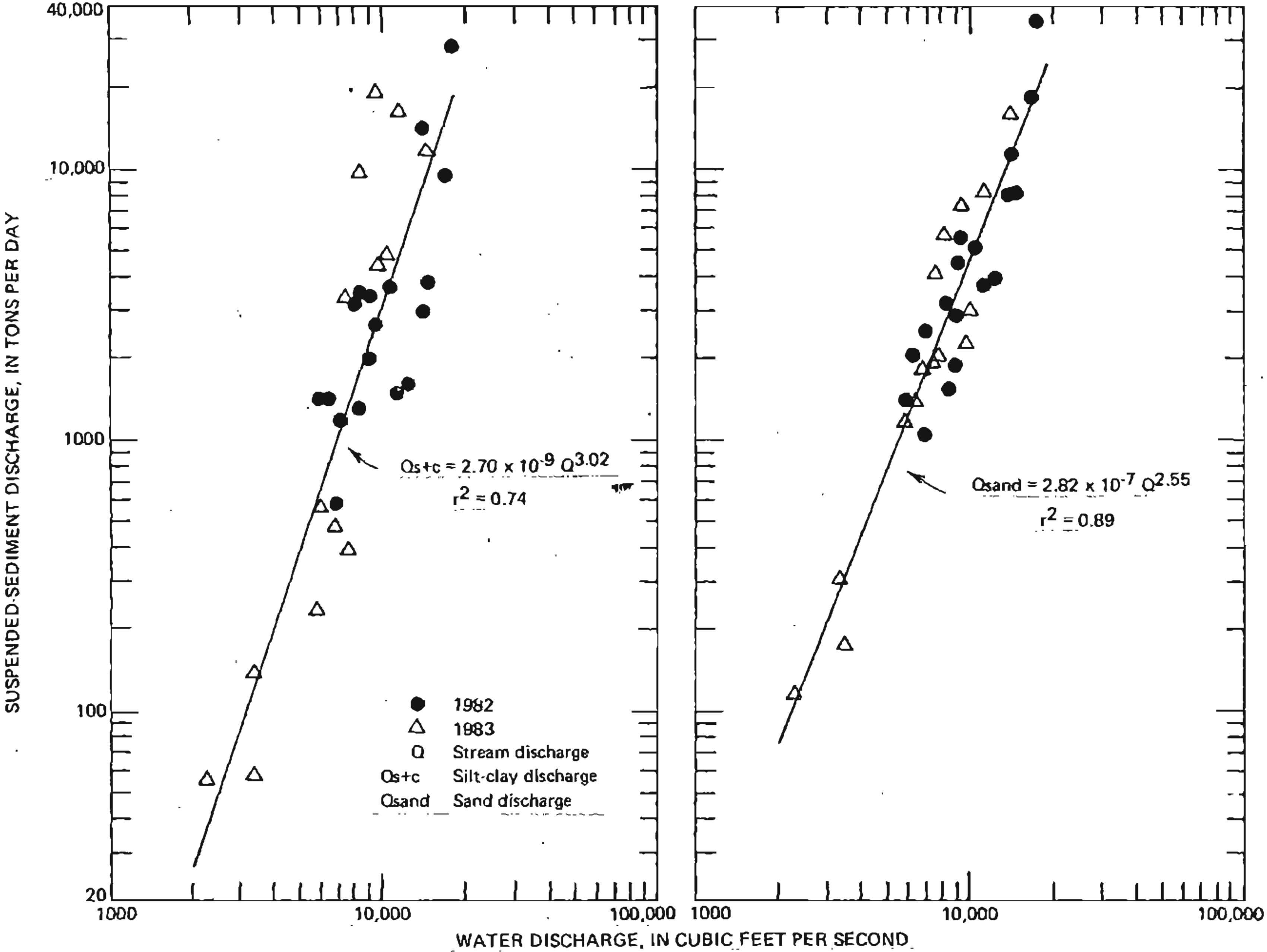

Figure 4.--Sediment-transport curves of suspended silt-clay and sand discharge for Talkeetna River near Talkeetna, May to September, 1982 and 1983.

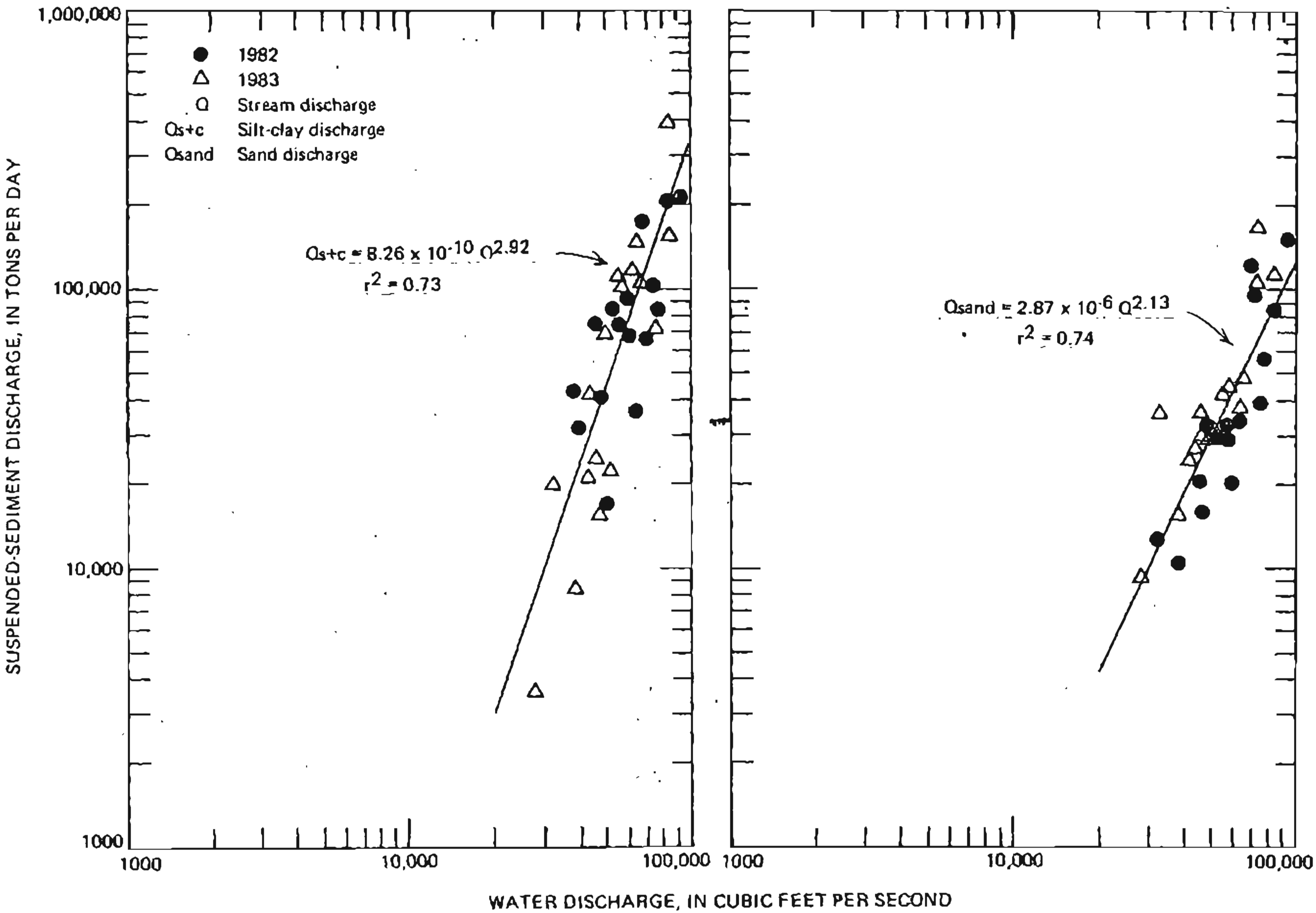

Figure 5.--Sediment-transport curves of suspended silt-clay and sand discharge for Susitna River at Sunshine, May to September, 1982 and 1983.

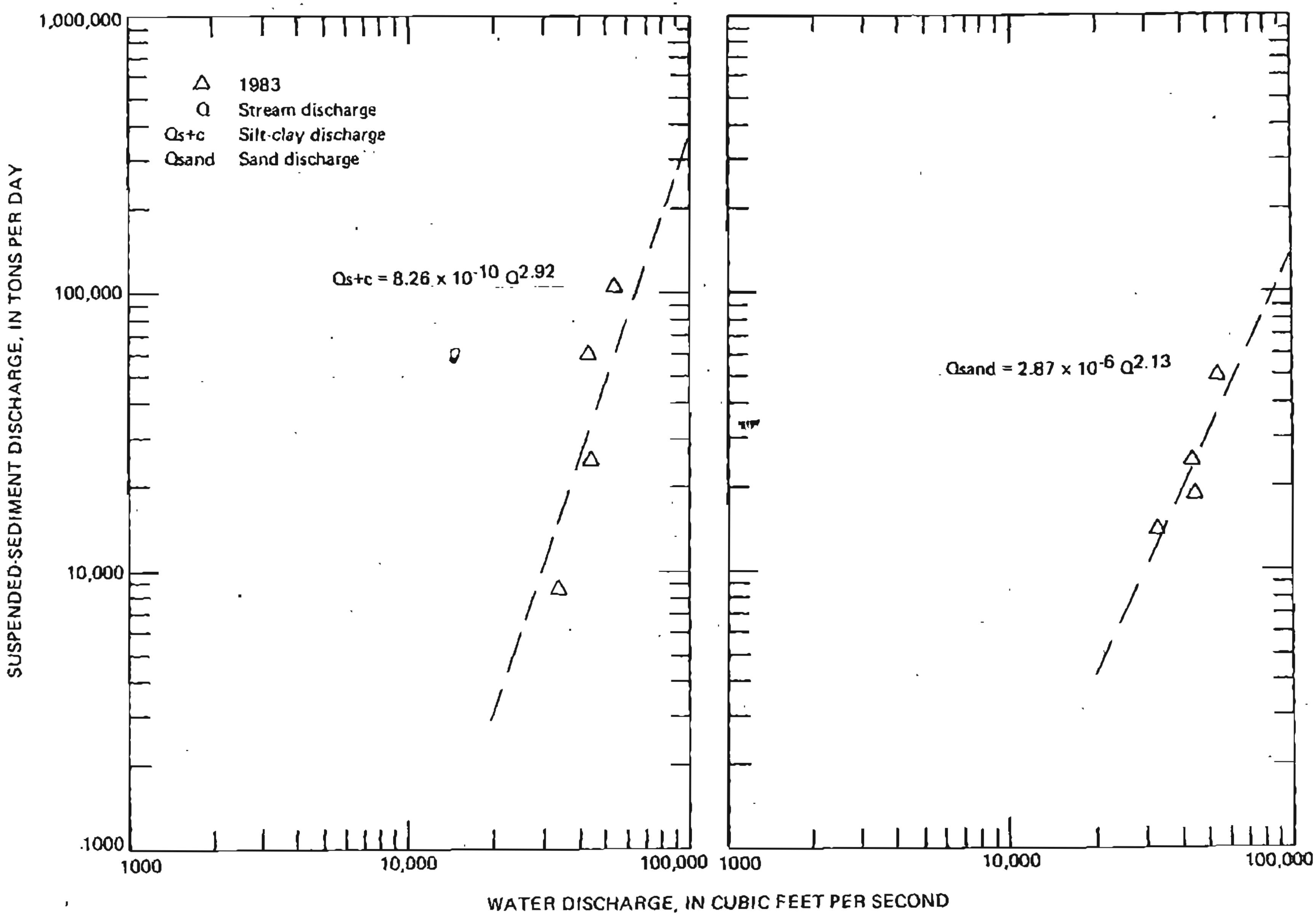

Figure 6.--Suspended silt-clay and sand discharge versus water discharge for Susitna River below Chulitna River near Talkeetna (sum of right and left channels), May to September 1983. Dashed lines correspond to transport curves established for Susitna River at Sunshine, May to September, 1982 and 1983.

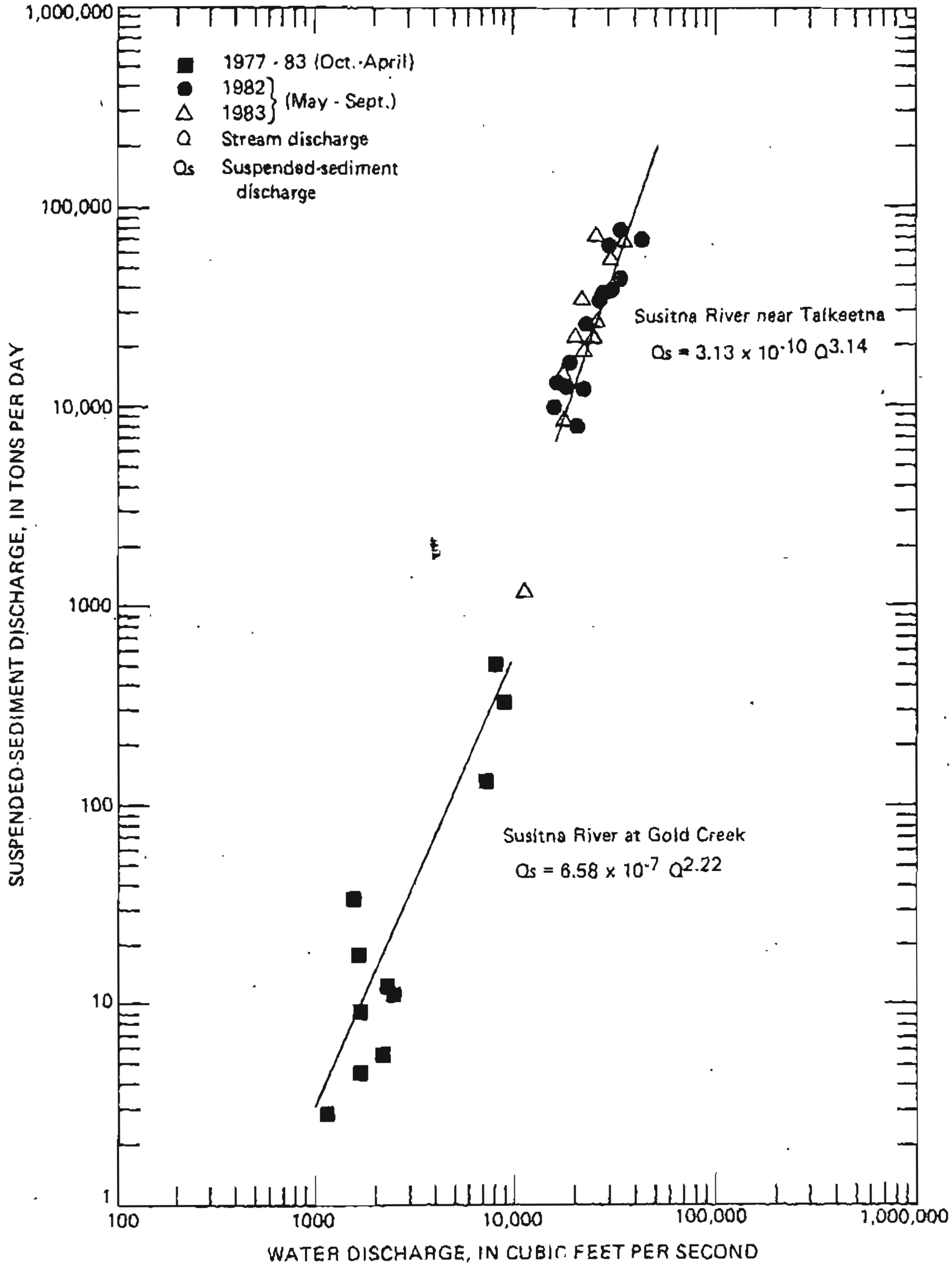

Figure 7.--Relation between suspended-sediment discharge and water discharge for Susitna River near Talkeetna (May to September, 1982 and 1983) and Susitna River at Gold Creek (October to April, 1977 through 1983).

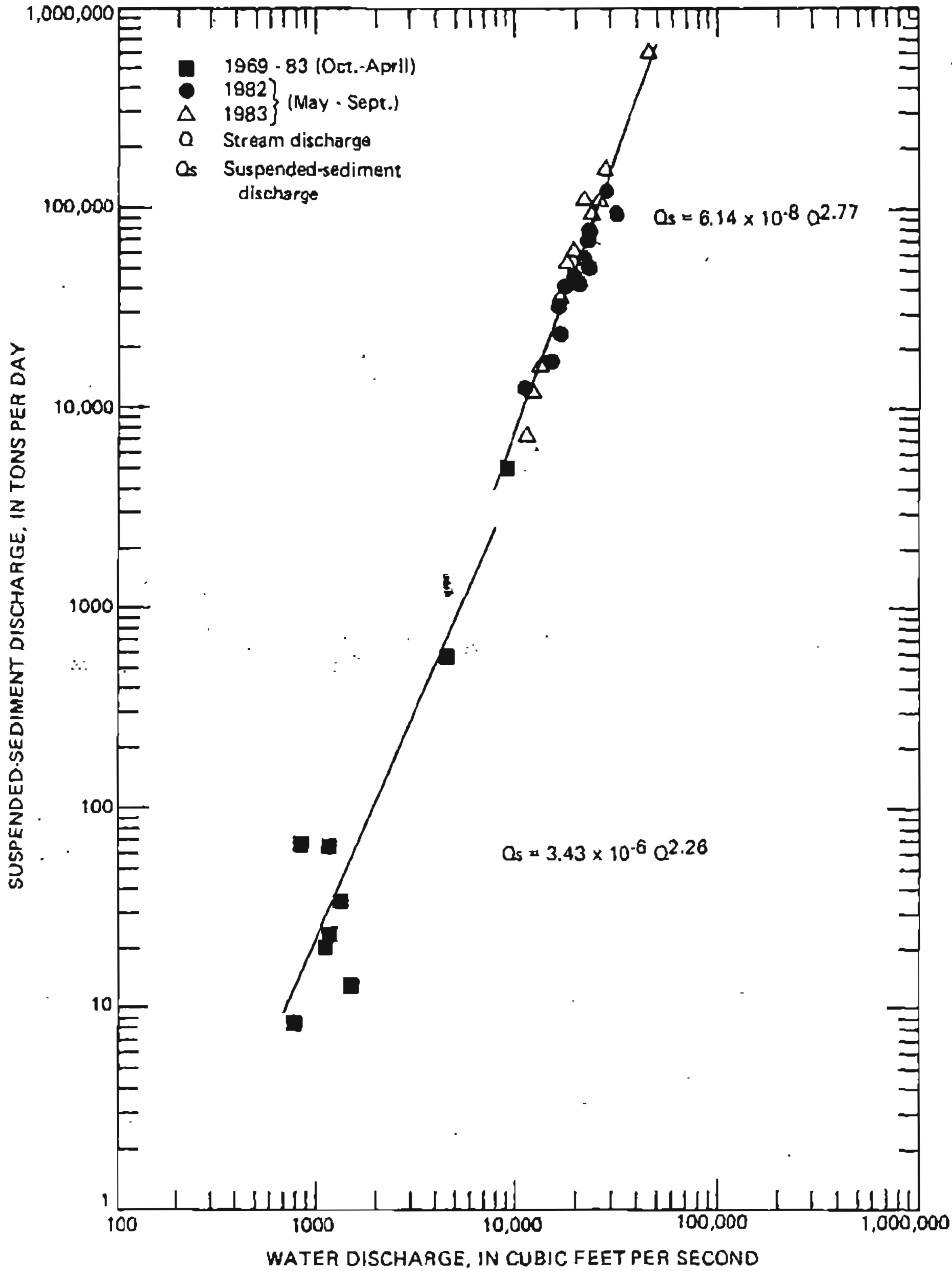

Figure 8.--Relation between suspended-sediment discharge and water discharge for Chulitna River below canyon near Talkeetna, May to September, 1982 and 1983 and October to April, 1969 through 1983.

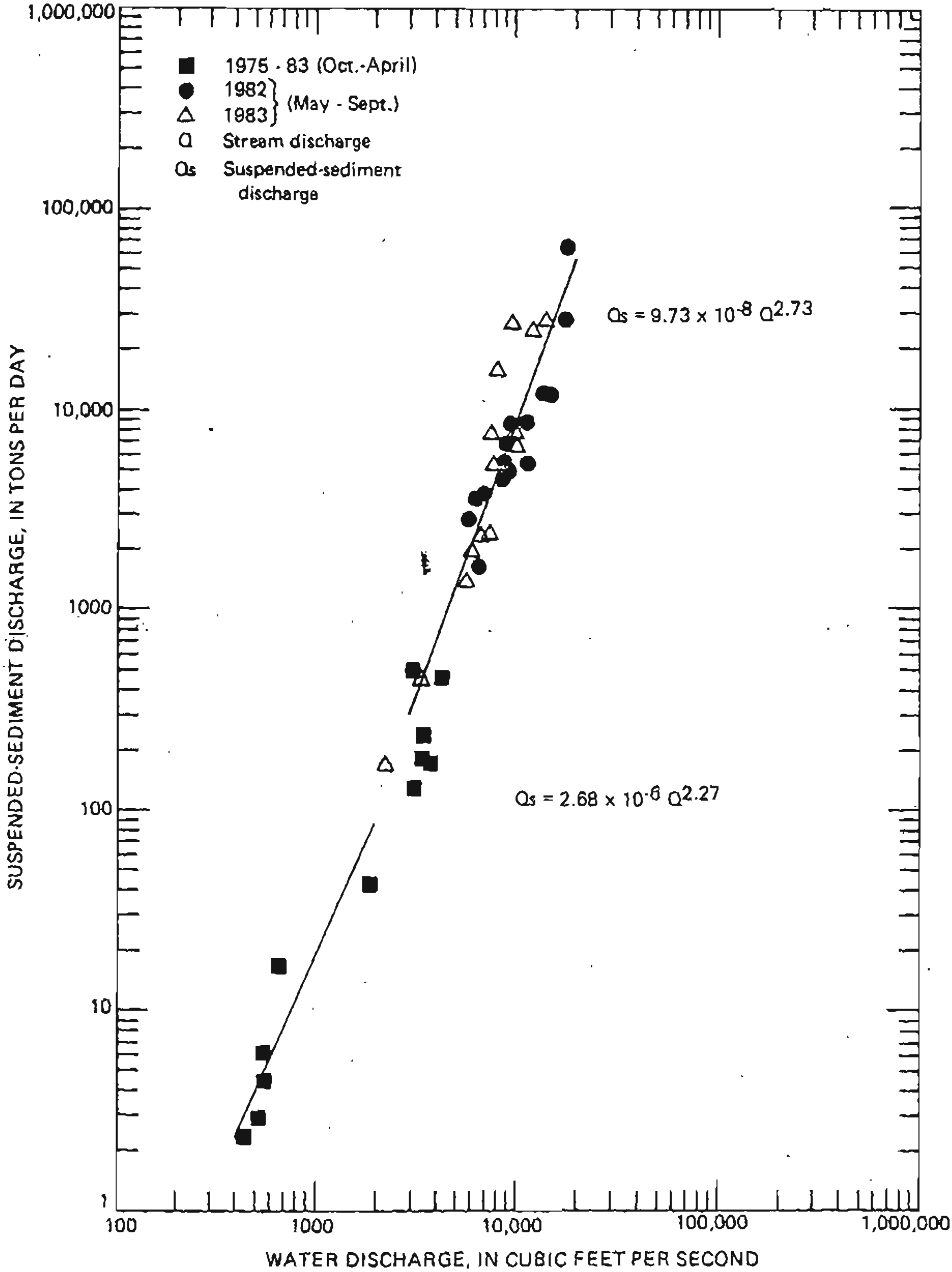

Figure 9.–Relation between suspended-sediment discharge and water discharge for Talkeetna River near Talkeetna, May to September, 1982 and 1983 and October to April, 1975 through 1983.

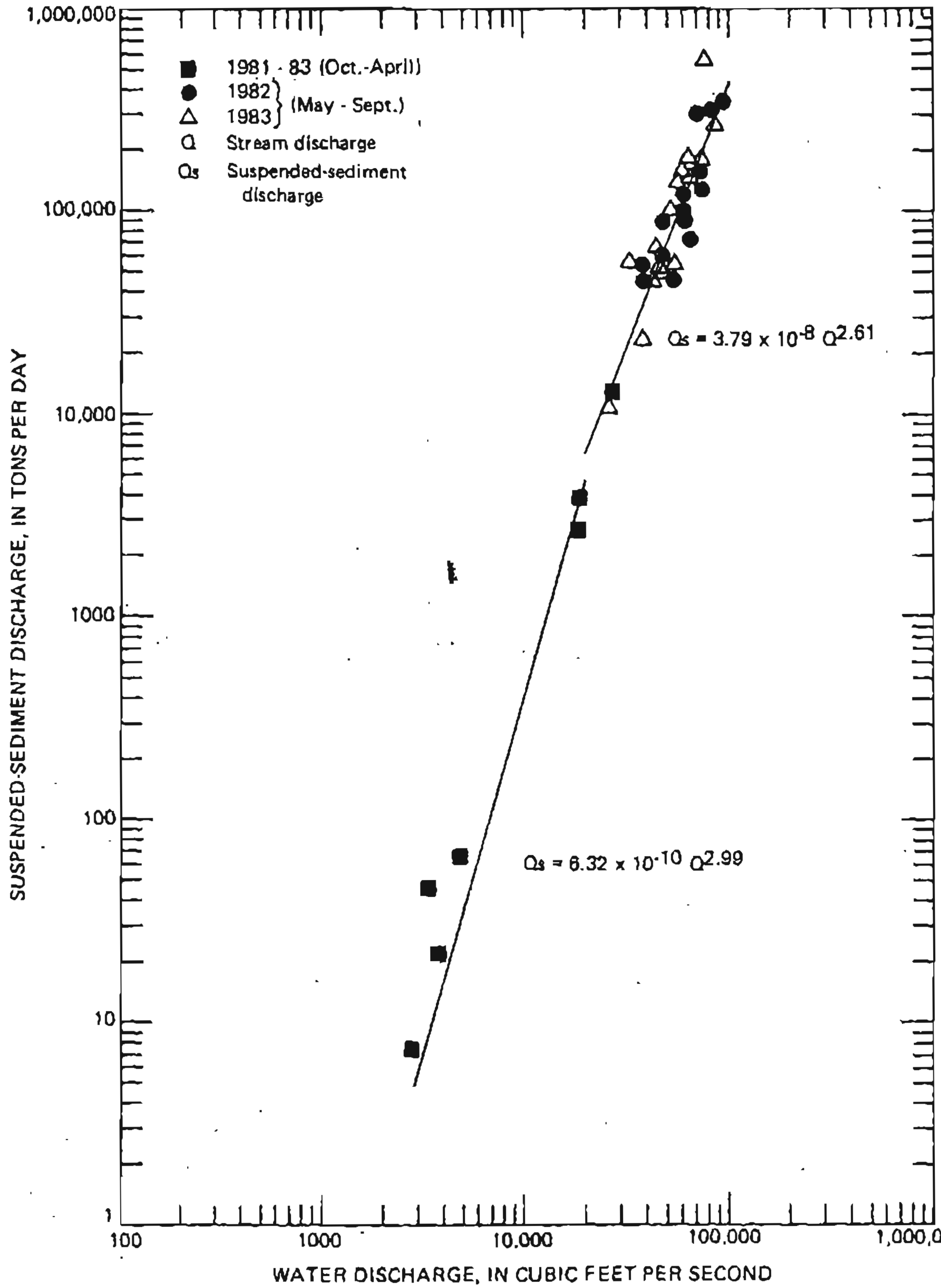

Figure 10.--Relation between suspended-sediment discharge and water discharge for Susitna River at Sunshine, May to September, 1982 and 1983 and October to April, 1981 through 1983.

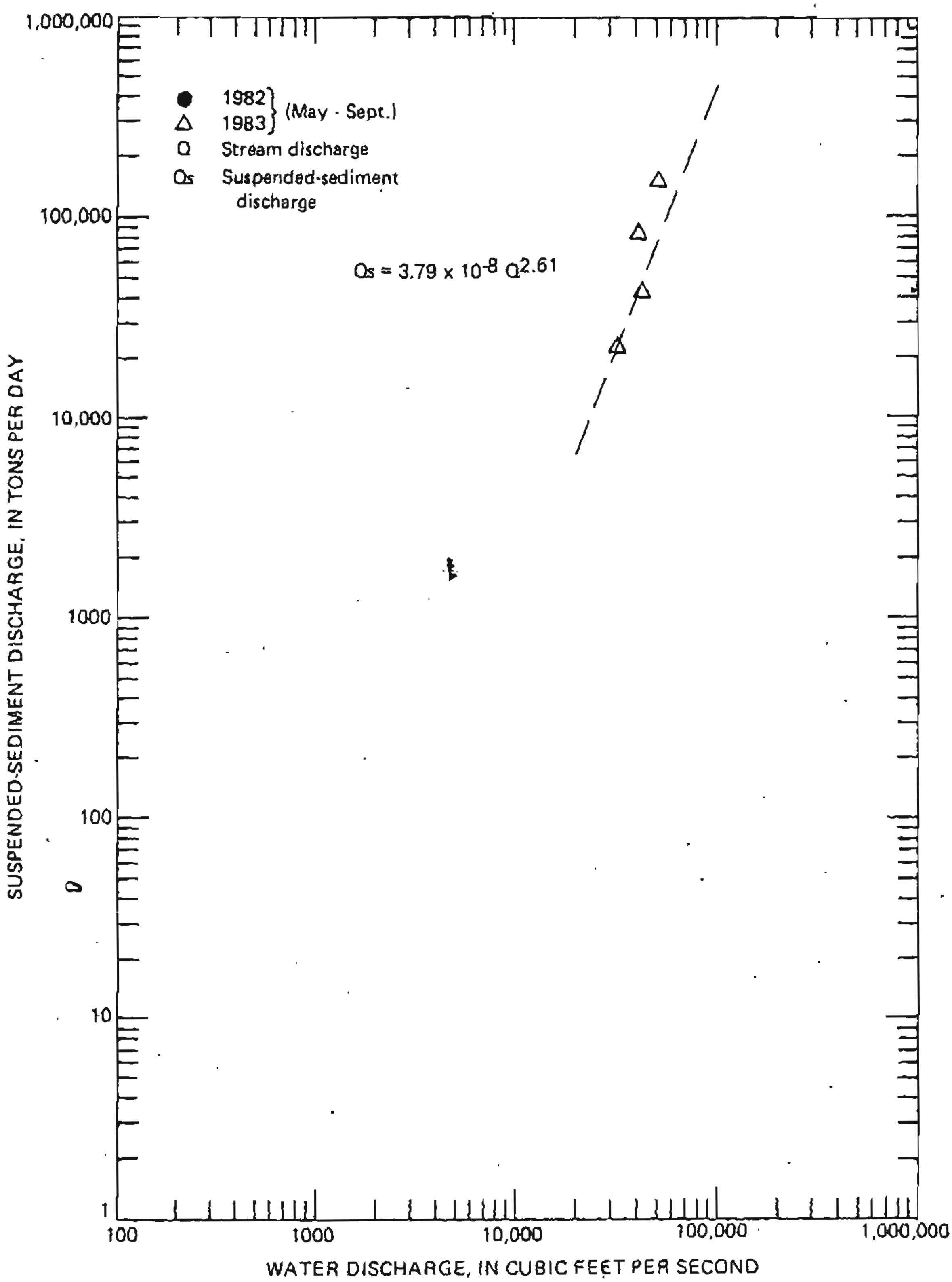

Figure 11.–Suspended-sediment discharge versus water discharge for Susitna River below Chulitna River near Talkeetna (sum of right and left channels), May to September 1983. Dashed line corresponds to transport curve established for Susitna River at Sunshine, May to September, 1983.

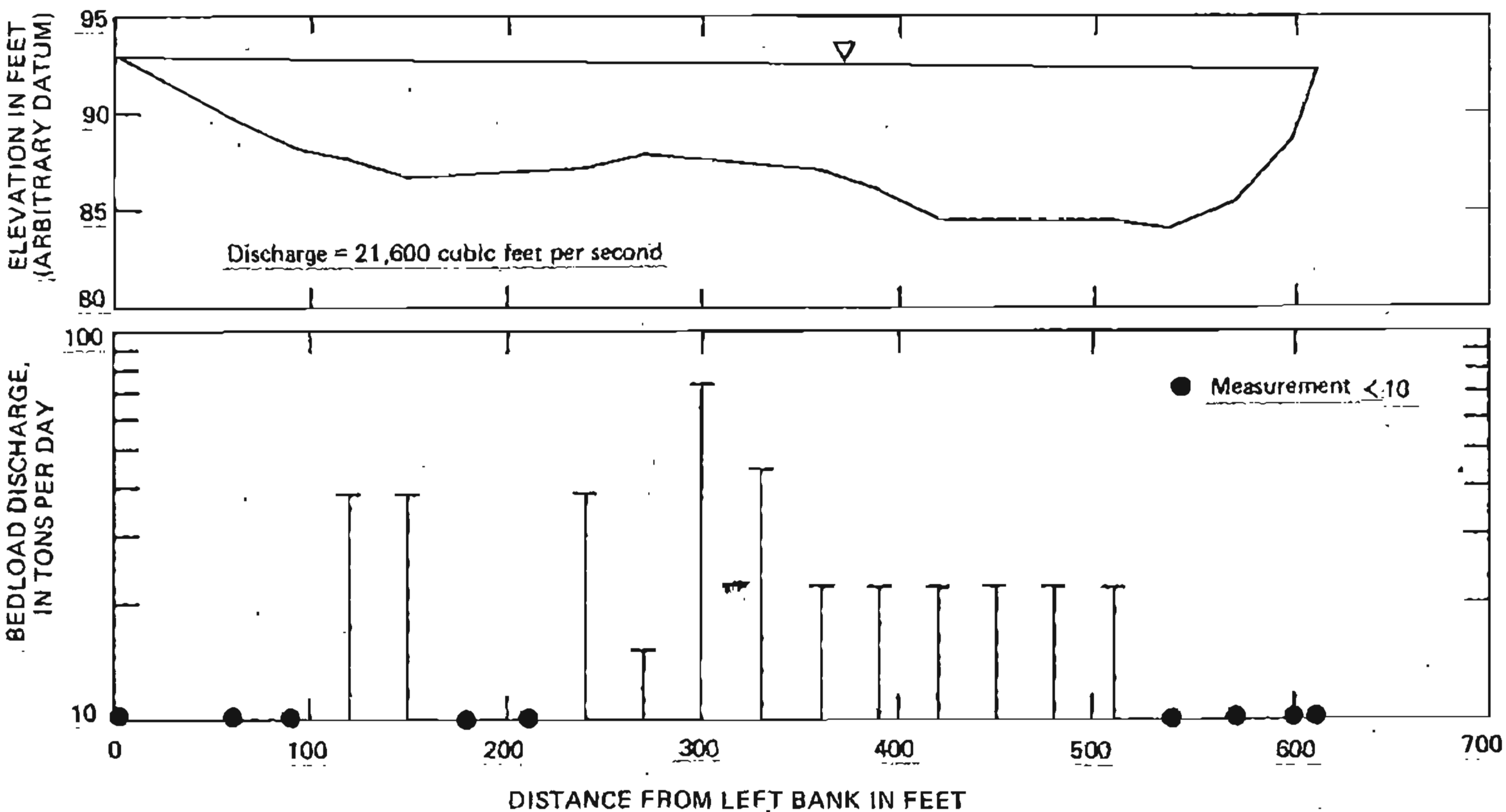

Figure 12a.--Cross section and distribution of bedload discharge, Susitna River near Talkeetna, May 19, 1983.

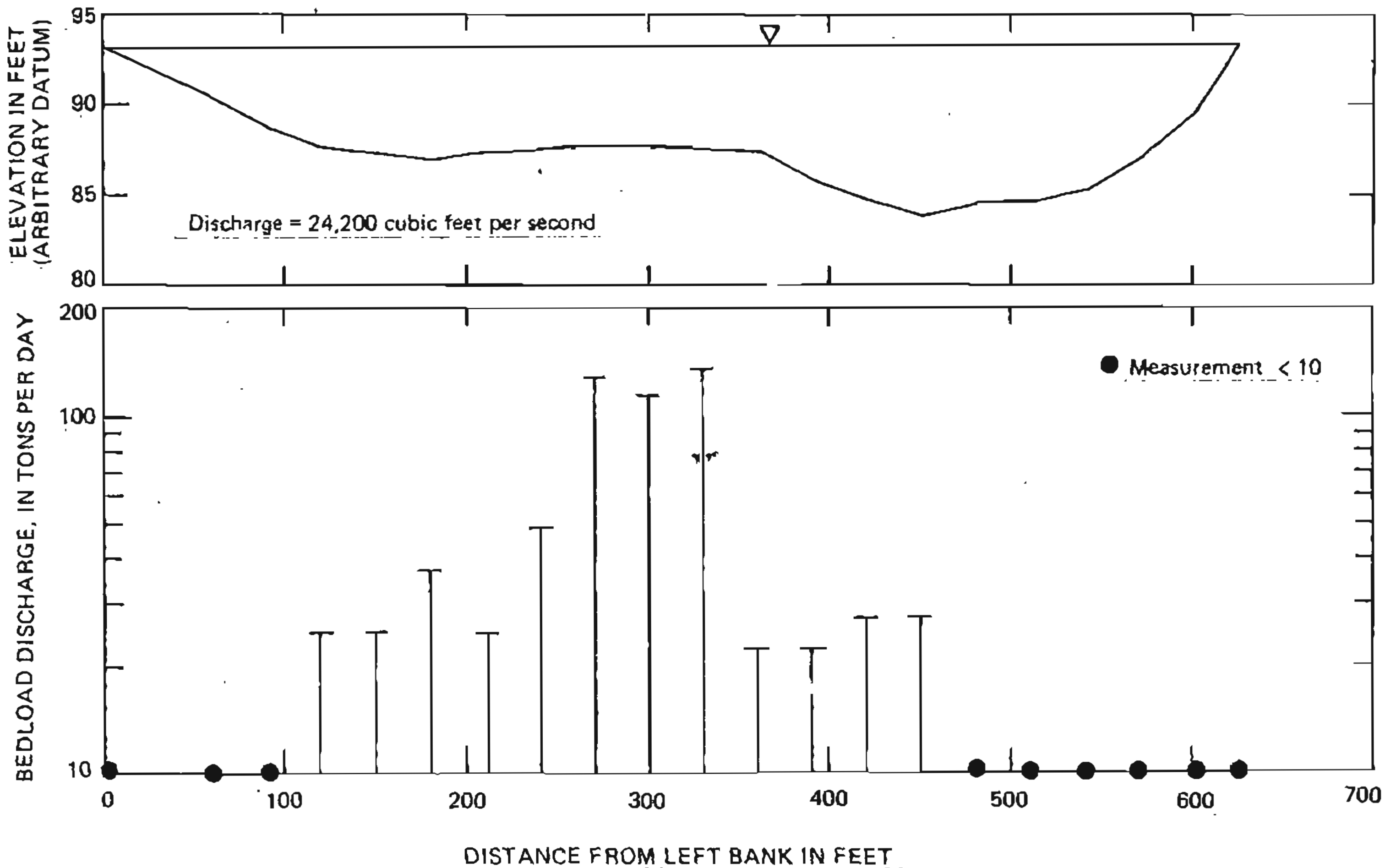

Figure 12b.--Cross section and distribution of bedload discharge, Susitna River near Talkeetna, June 8, 1983.

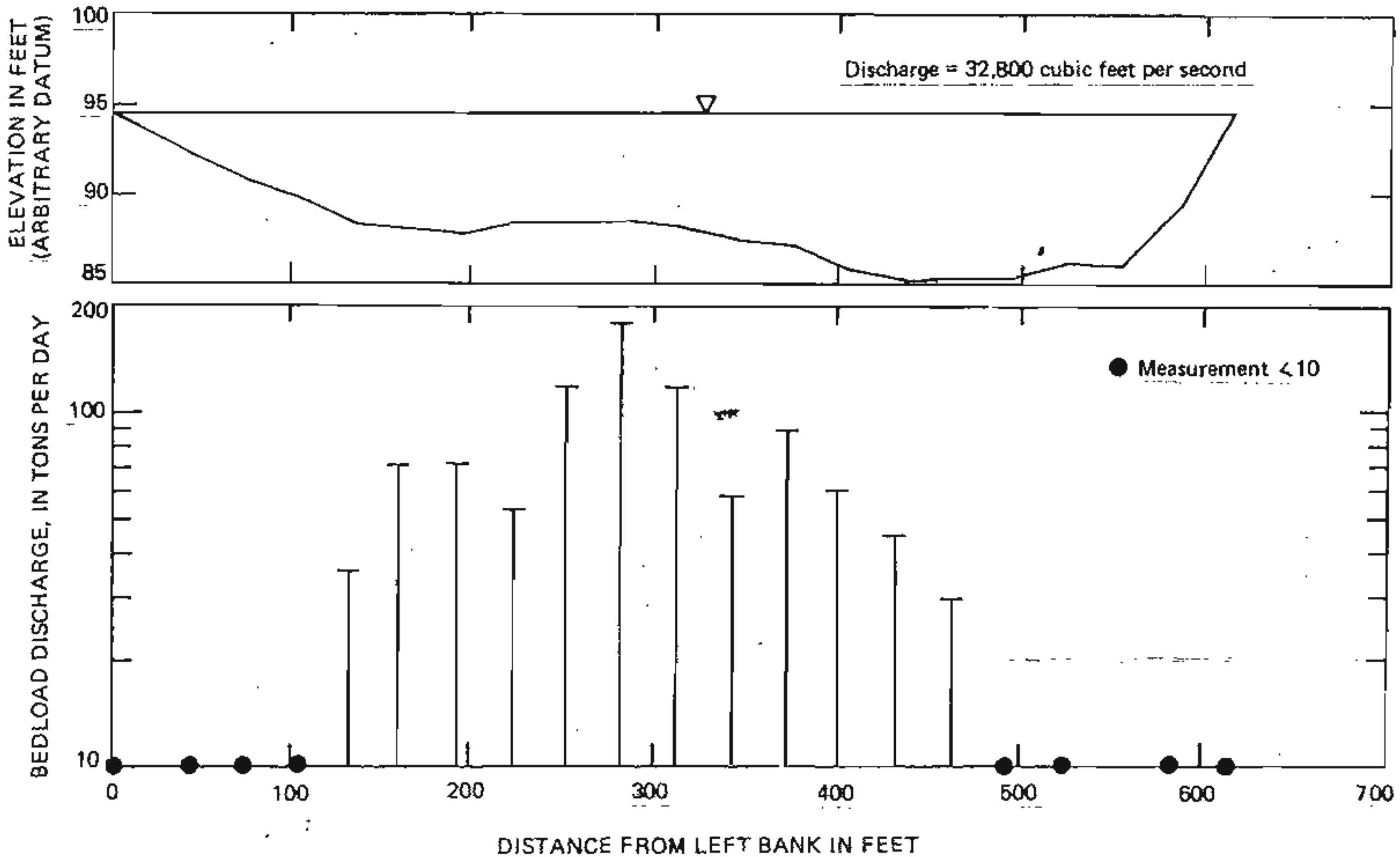

Figure 12c.--Cross section and distribution of bedload discharge, Susitna River near Talkeetna, August 11, 1983.

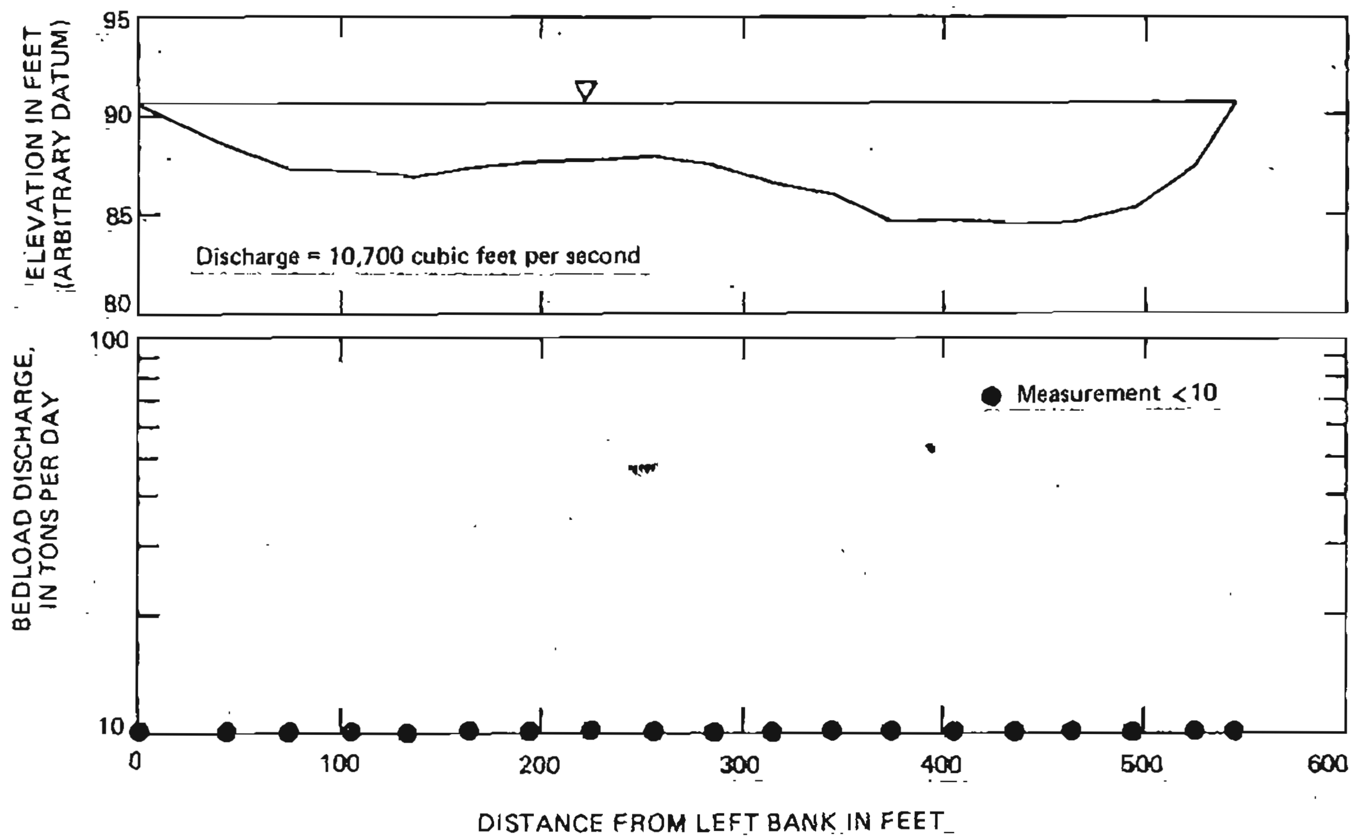

Figure 12d.--Cross section and distribution of bedload dischrage, Susitna River near Talkeetna, October 6, 1983.

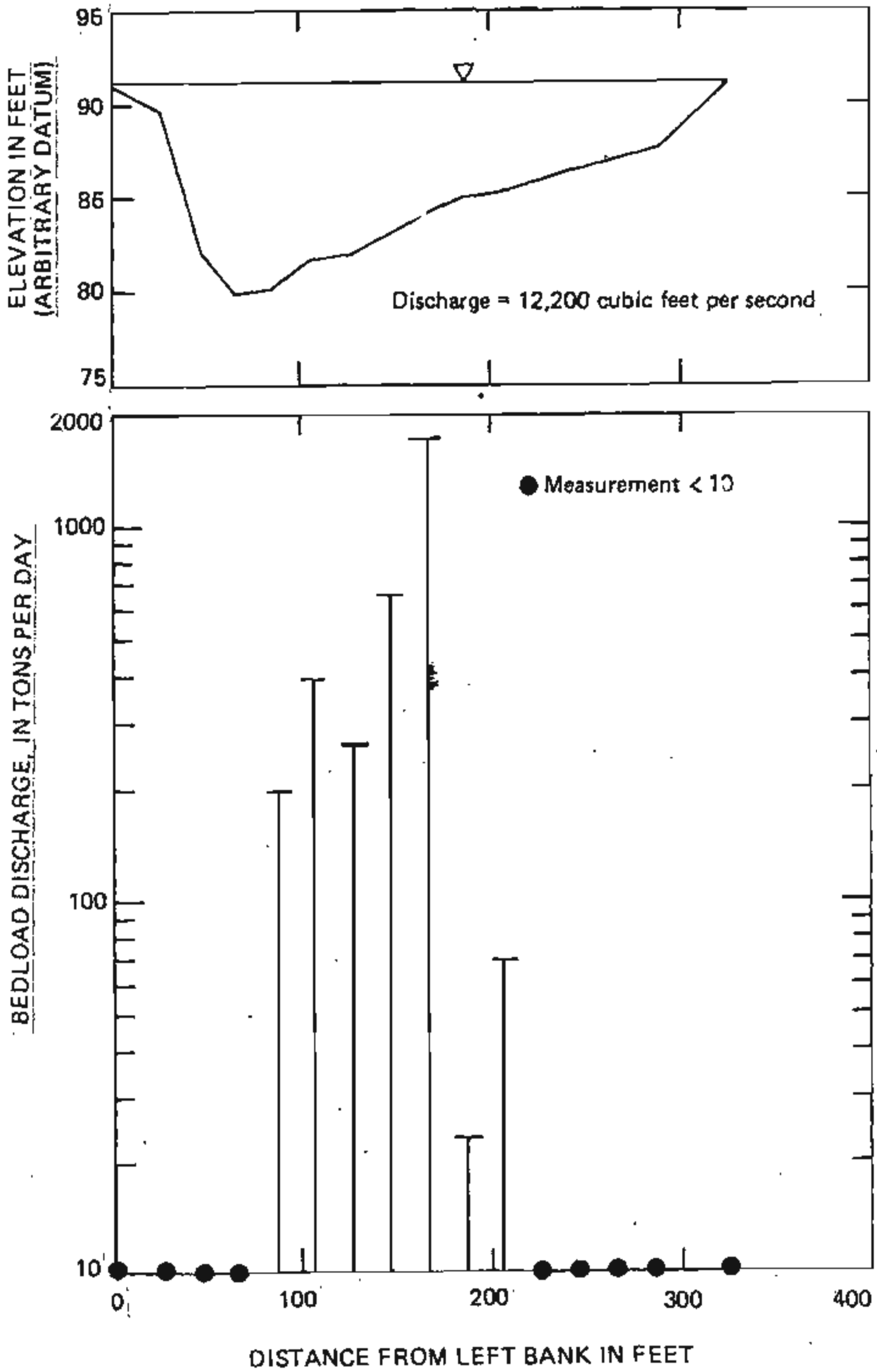

Figure 13a.--Cross section and distribution of bedload discharge, Chulitna River below canyon near Talkeetna, May 19, 1983.

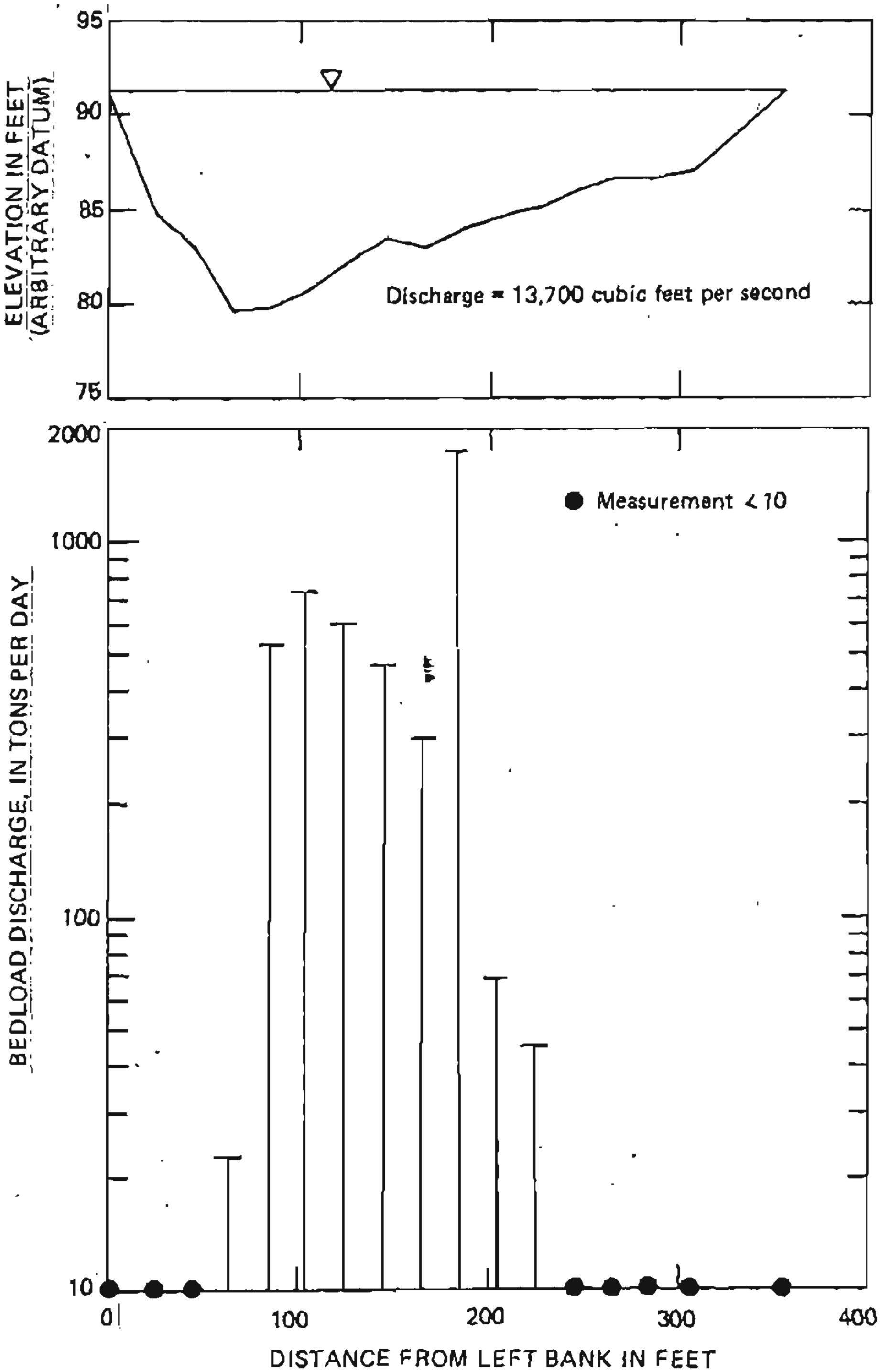

Figure 13b.--Cross section and distribution of bedload discharge, Chulitna River below canyon near Talkeetna, June 9, 1983.

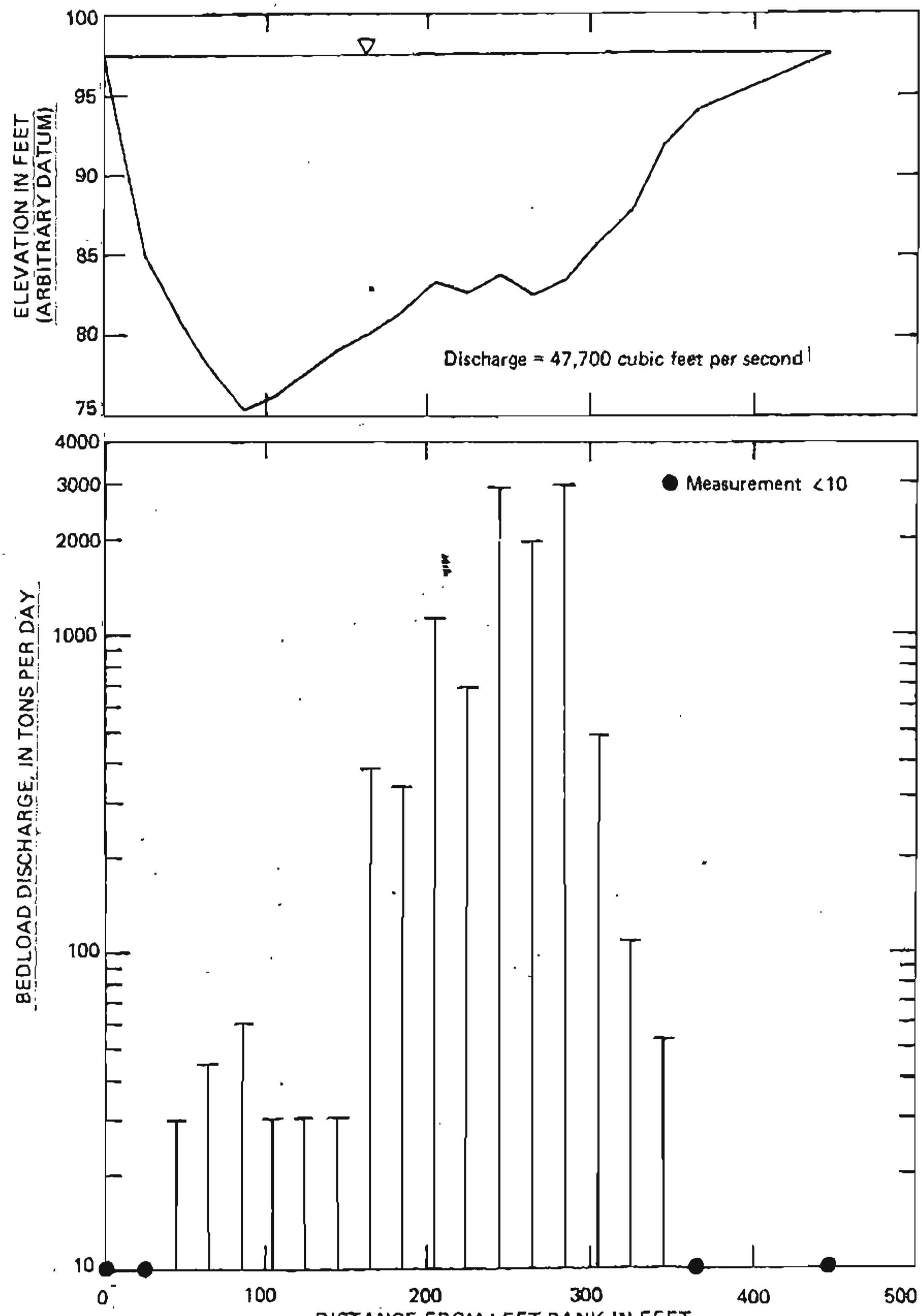

Figure 13c.–Cross section and distribution of bedload discharge, Chulitna River below canyon near Talkeetna, August 9, 1983.

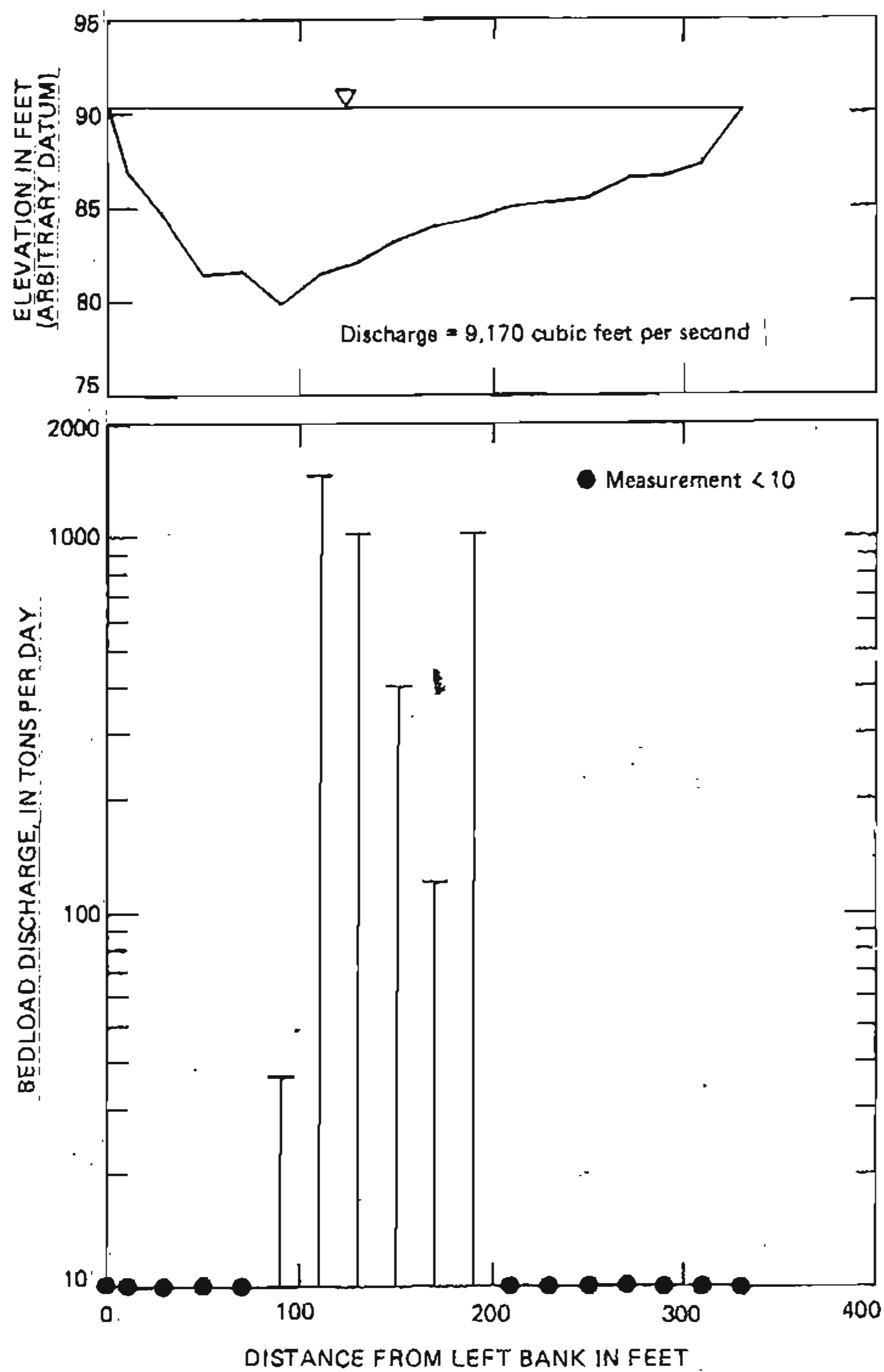

Figure 13d.--Cross section and distribution of bedload discharge, Chulitna River below canyon near Talkeetna, October 5, 1983.

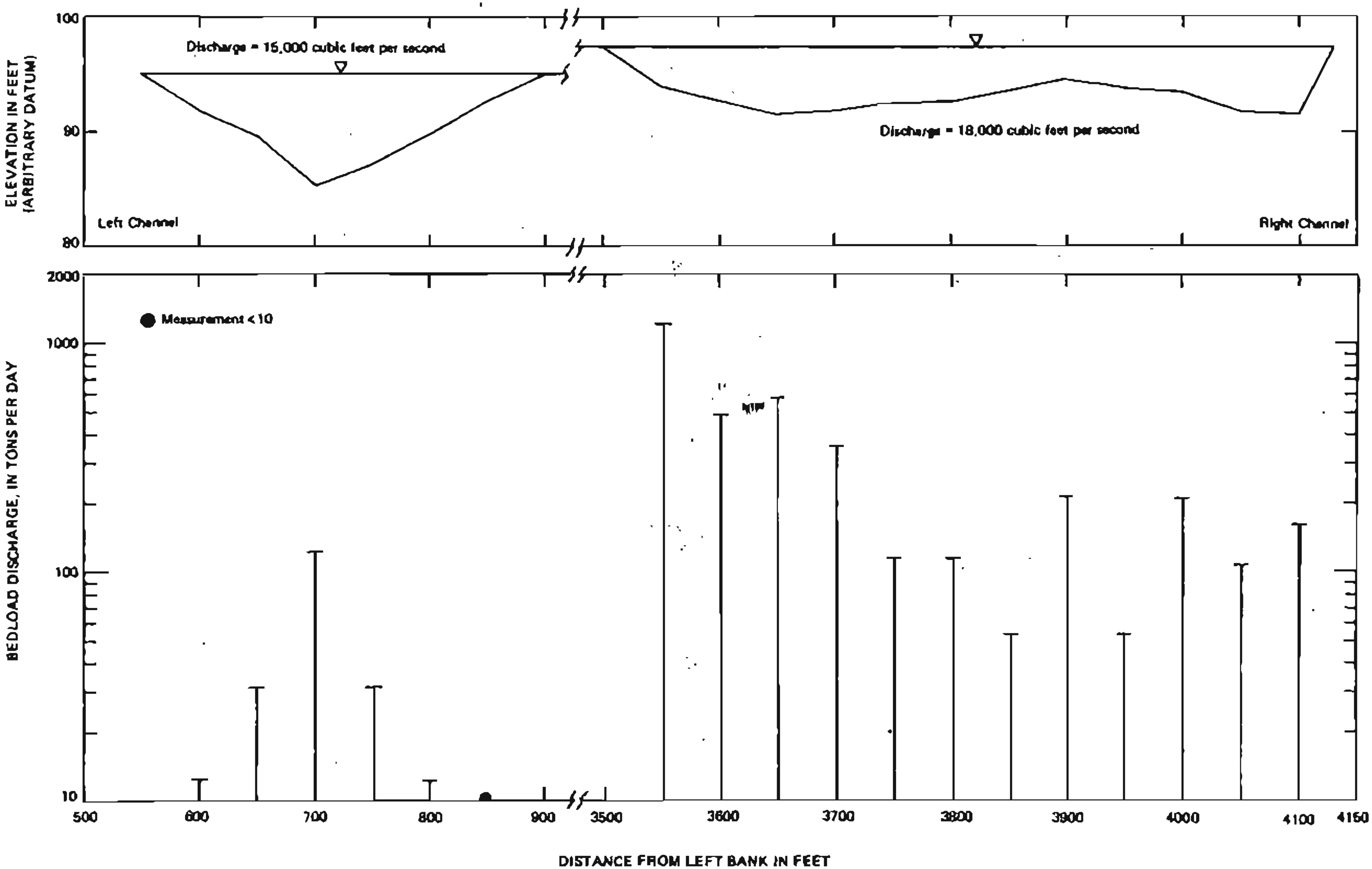

Figure 14a.--Cross section and distribution of bedload discharge, Susitna River below Chulitna River near Talkeetna, May 20, 1983.

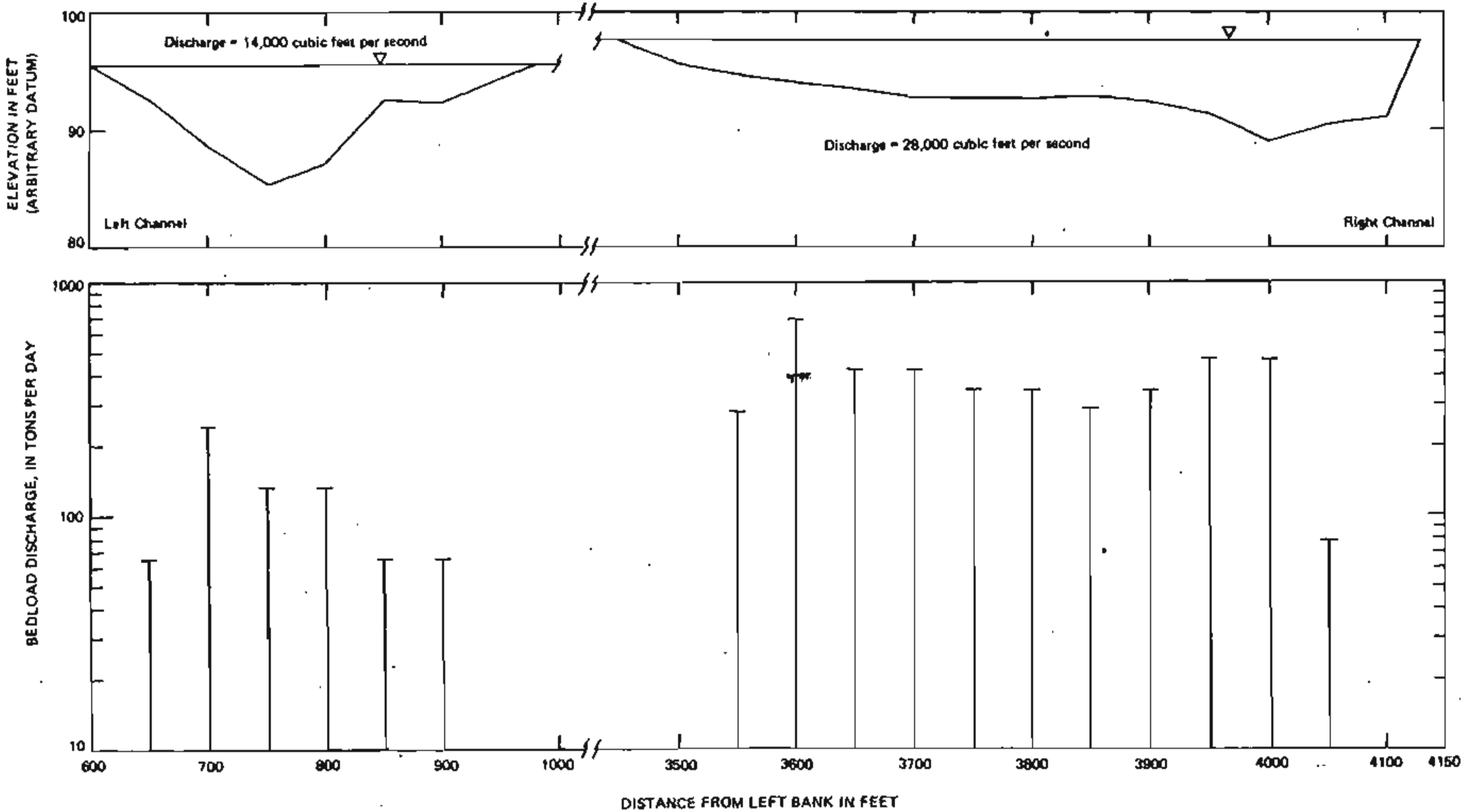

Figure 14b.--Cross section and distribution of bedload discharge, Susitna River below Chulitna River near Talkeetna, July 19, 1983.

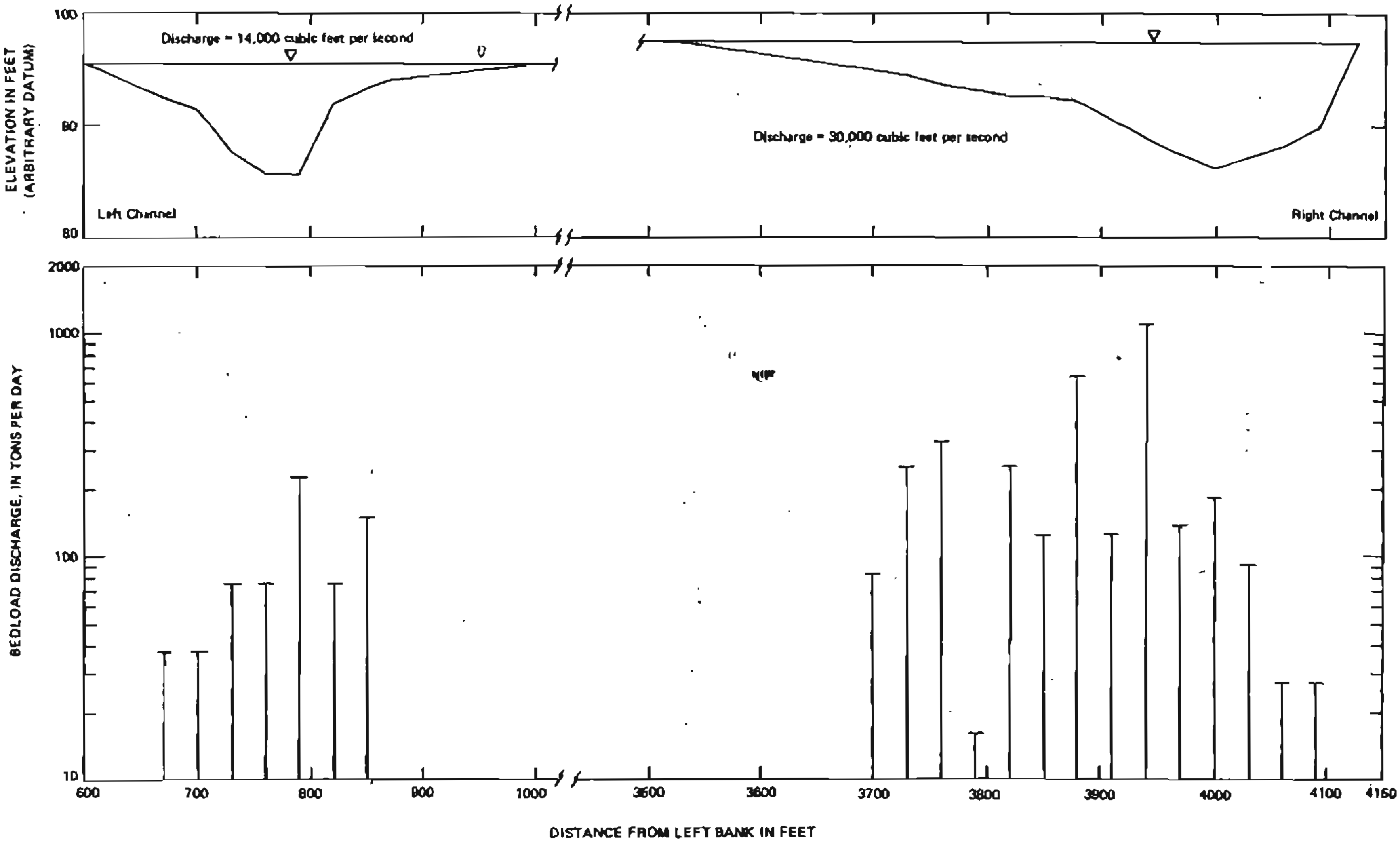

Figure 14c.--Cross section and distribution of bedload discharge, Susitna River below Chulitna River near Talkeetna, August 30, 1983.

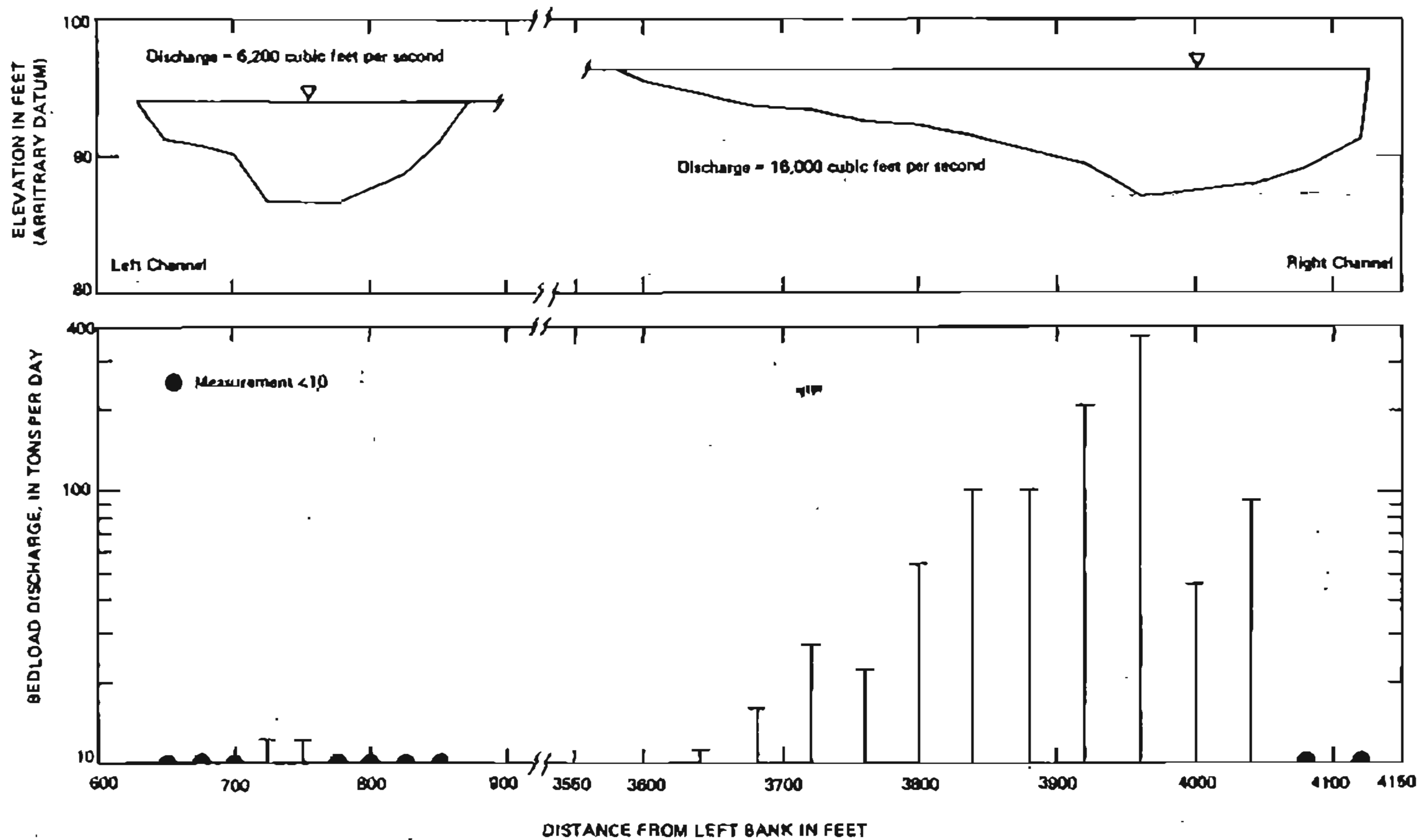

Figure 14d.–Cross section and distribution of bedload discharge, Susitna River below Chulitna River near Talkeetna, October 5, 1983.

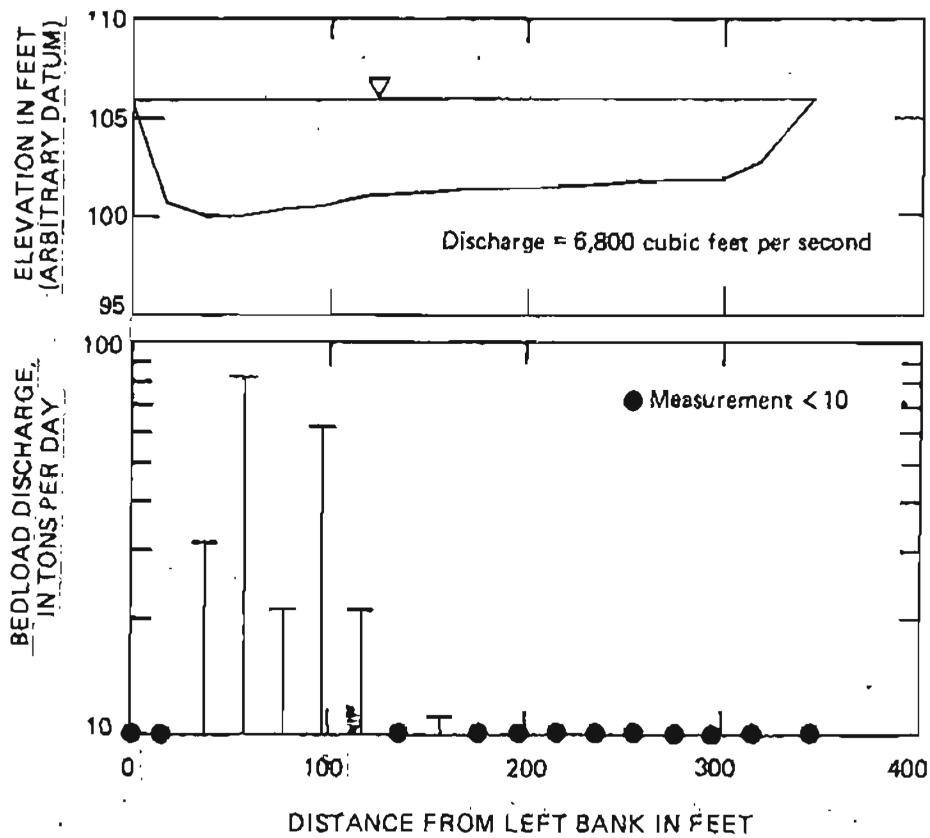

Figure 15a.–Cross section and distribution of bedload discharge, Talkeetna River near Talkeetna, May 23, 1983.

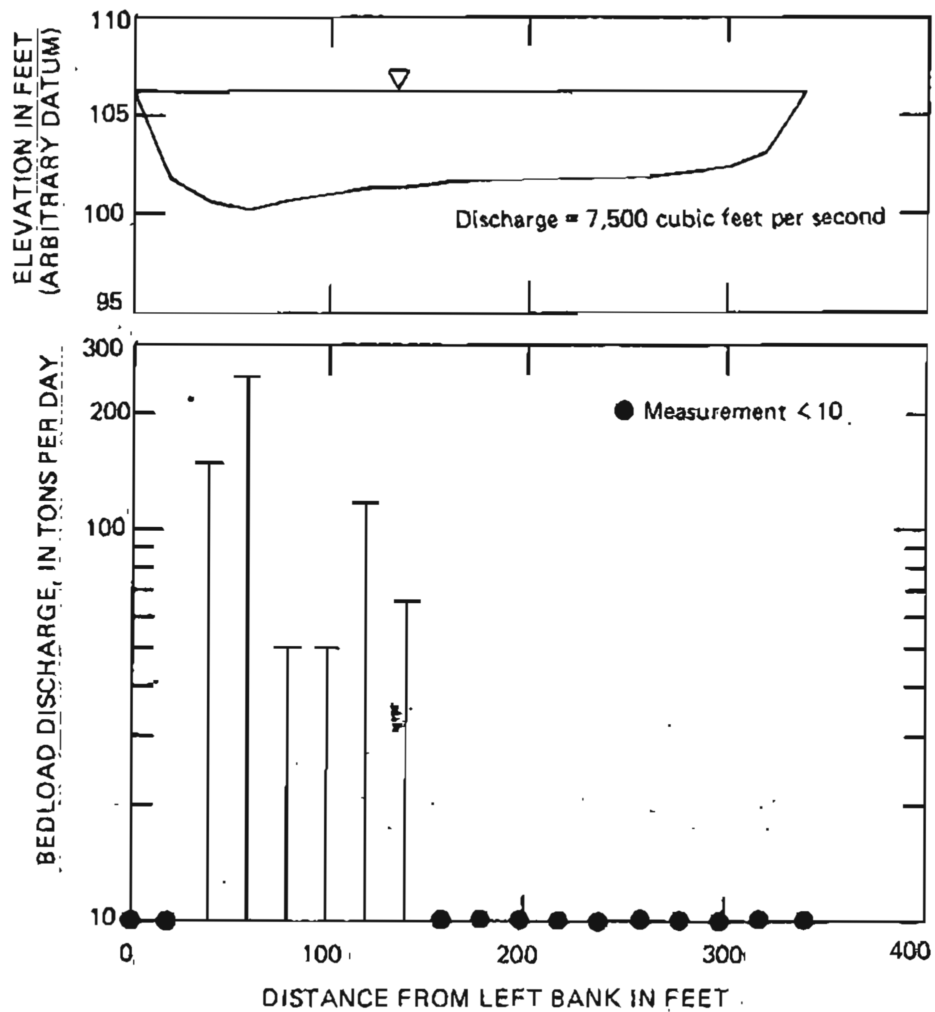

Figure 15b.--Cross section and distribution of bedload discharge, Talkeetna River near Talkeetna, June 9, 1983.

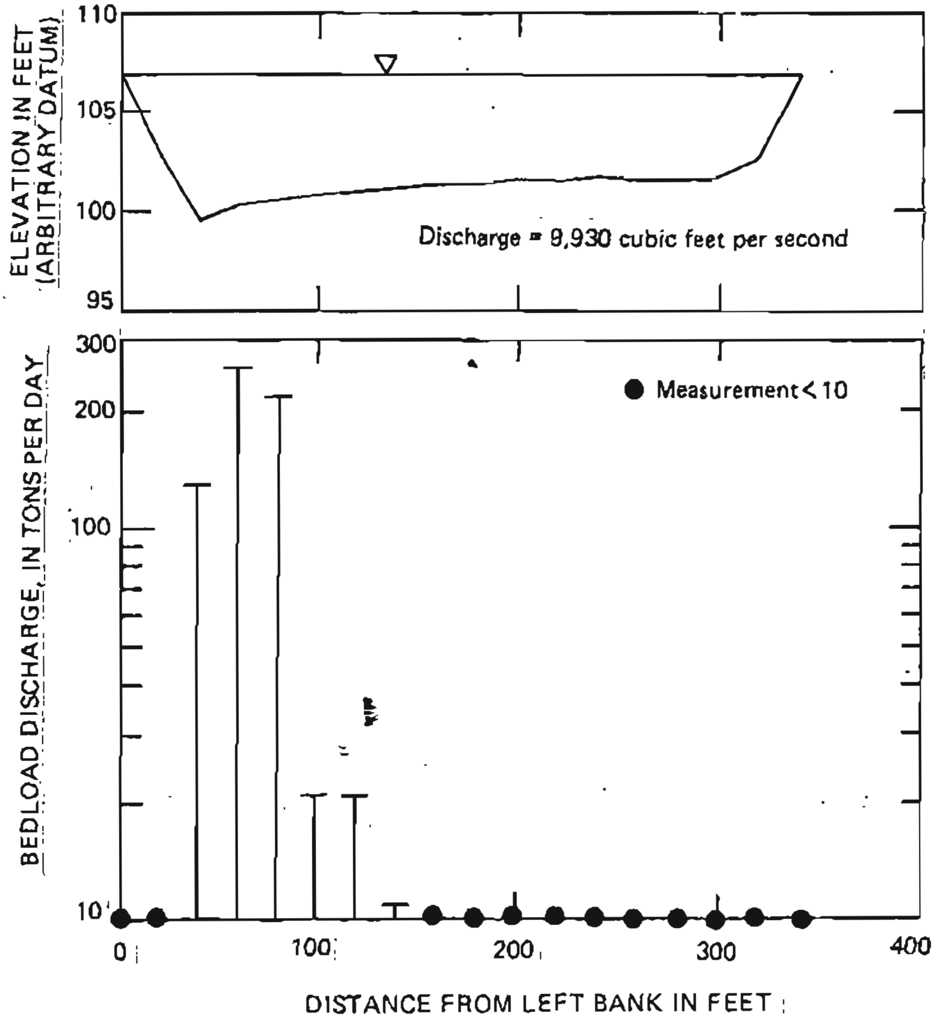

Figure 15c.–Cross section and distribution of bedload discharge, Talkeetna River near Talkeetna, August 11, 1983.

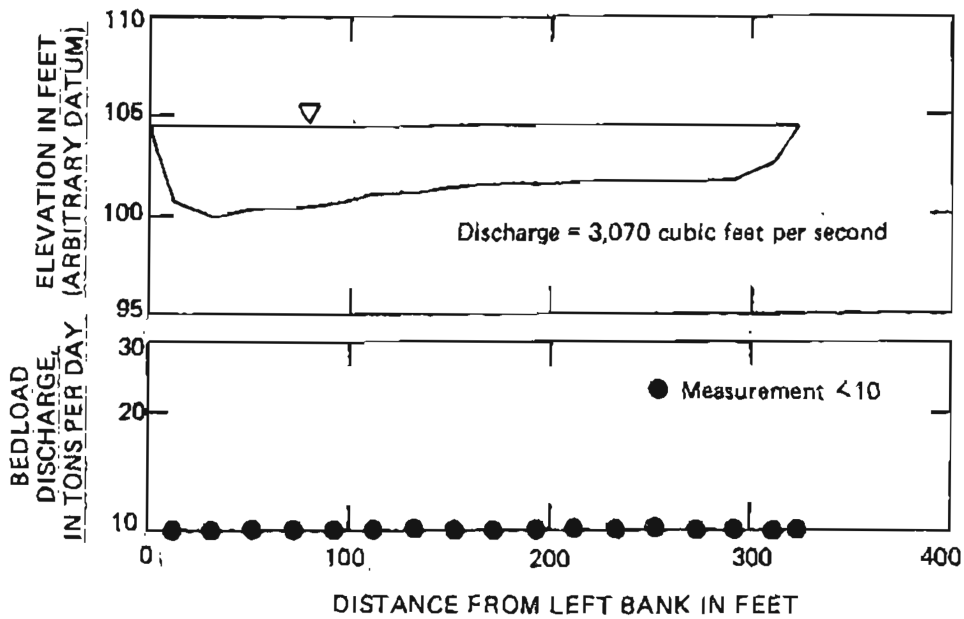

Figure 15d.--Cross section and distribution of bedload discharge, Talkeetna River near Talkeetna, October 7, 1983.

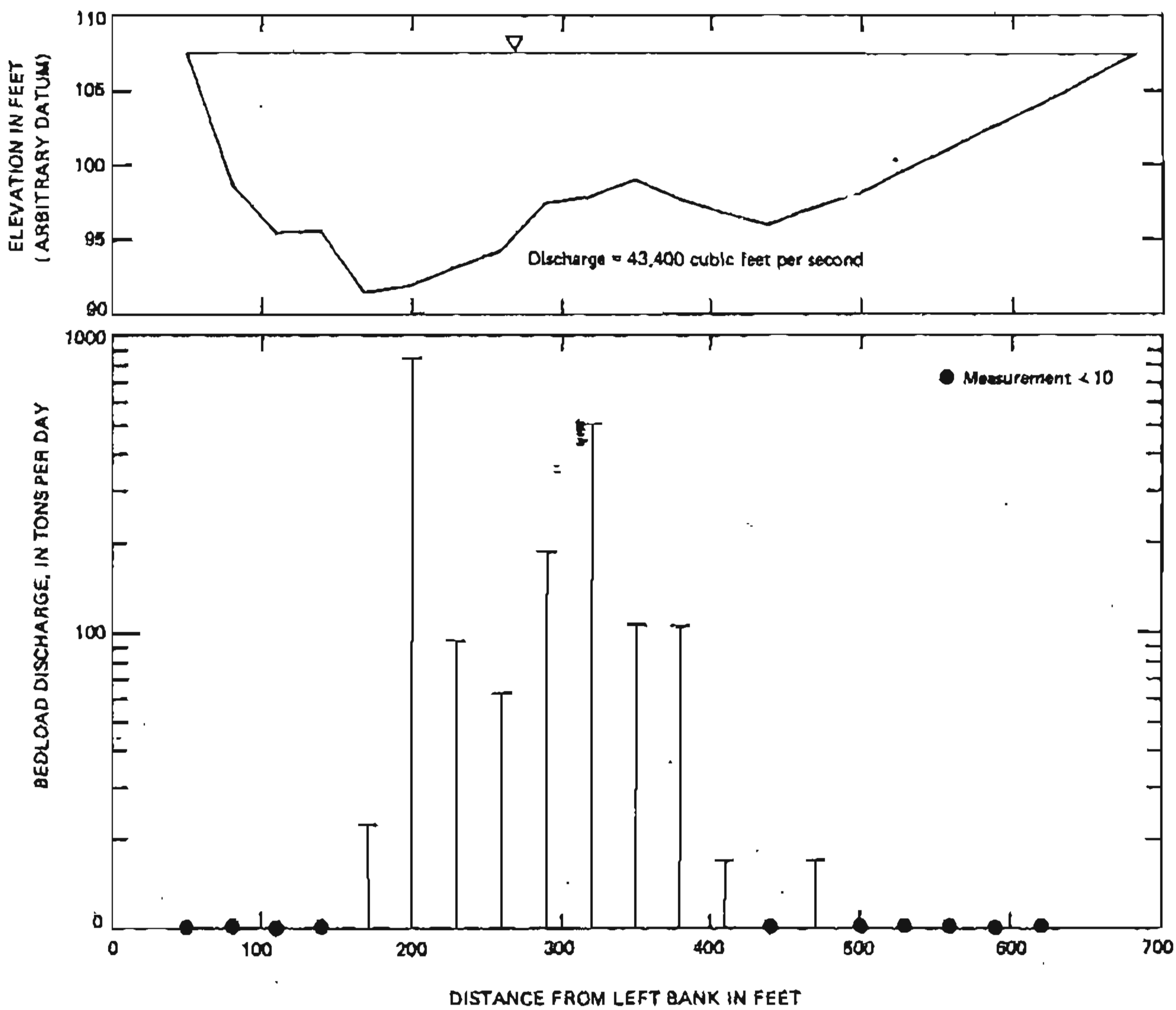

Figure 16a.–Cross section and distribution of bedload discharge, Susitna River at Sunshine, May 18, 1983.

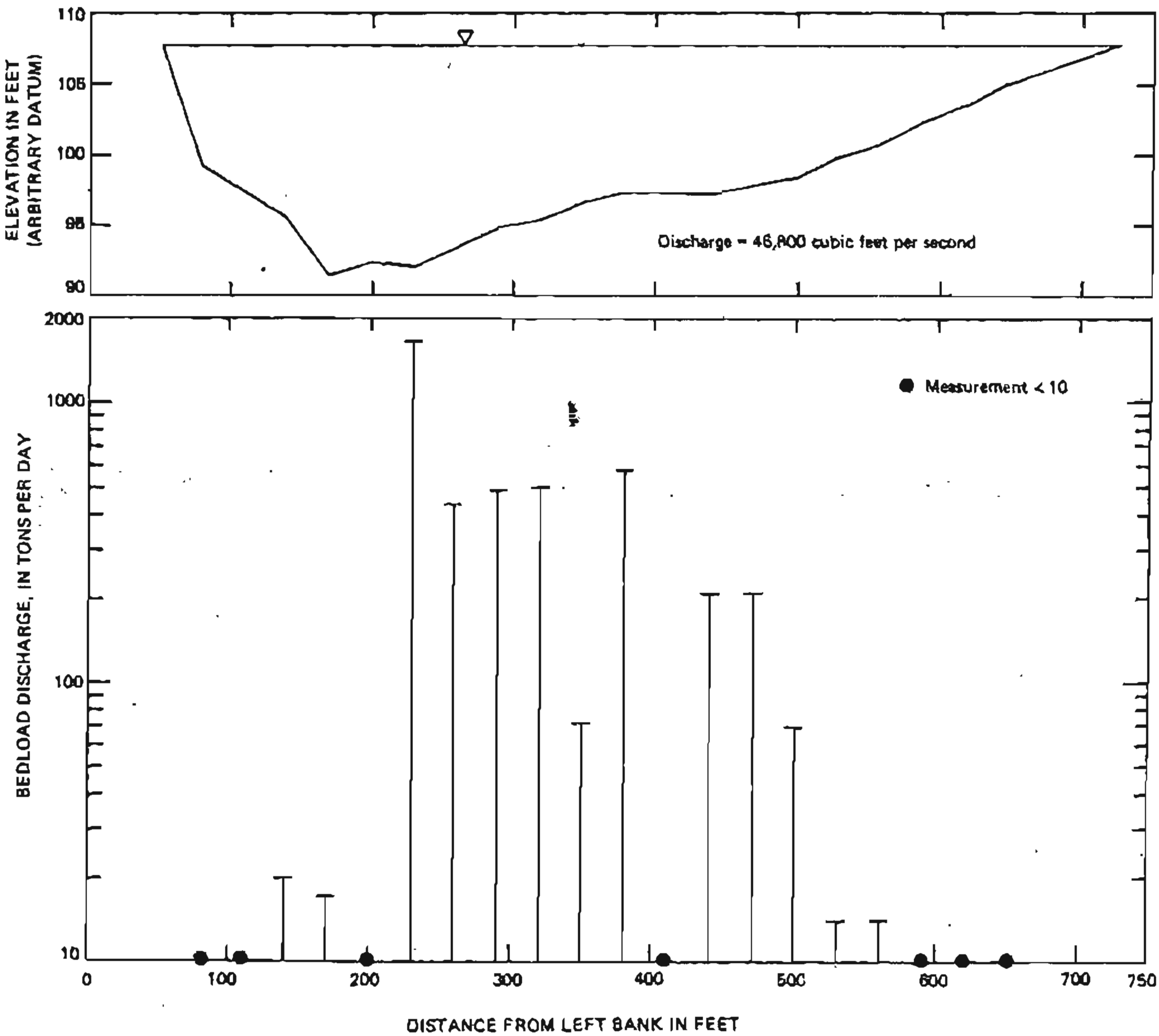

Figure 16b.–Cross section and distribution of bedload discharge, Susitna River at Sunshine, June 8, 1983.

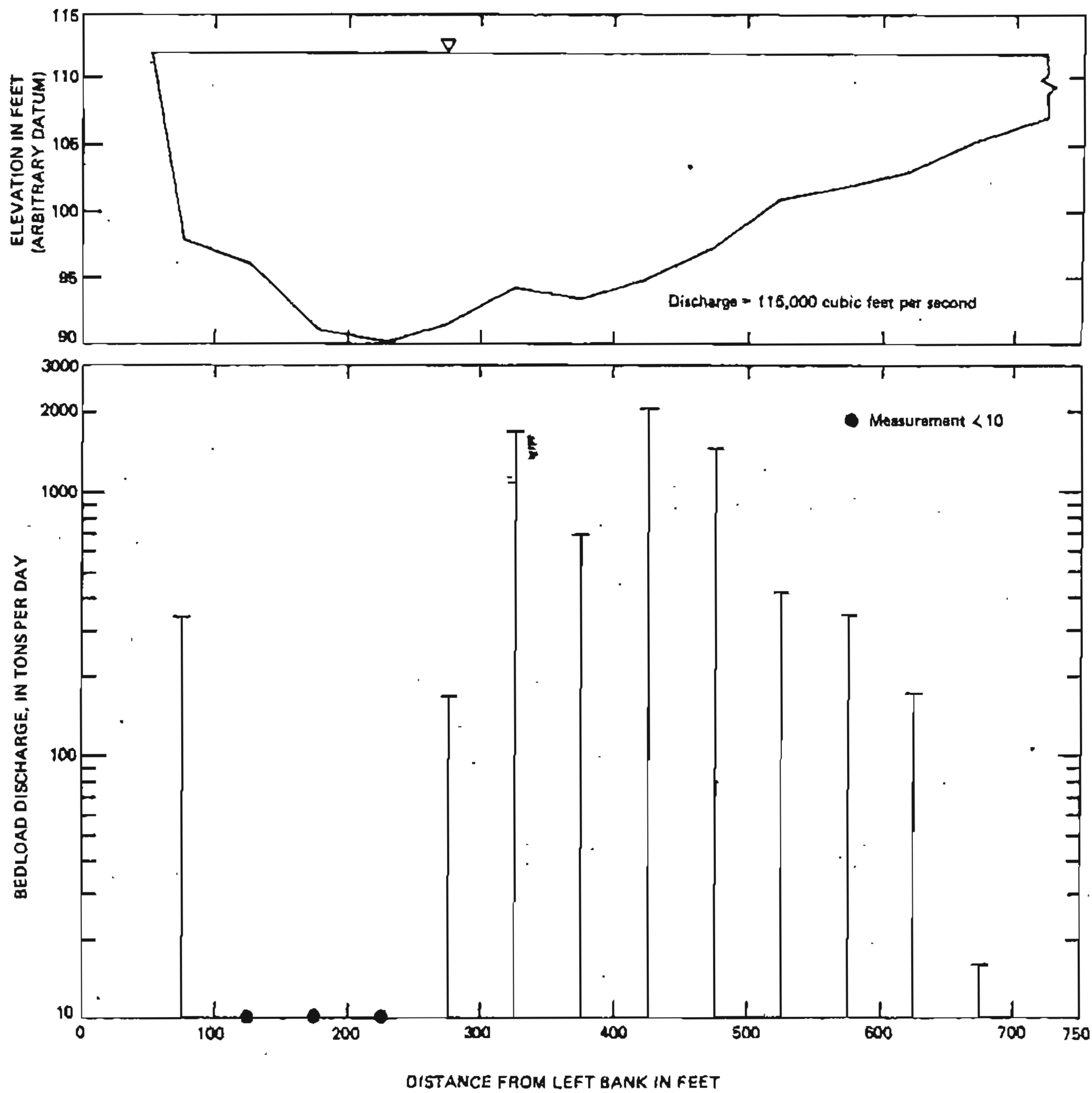

Figure 16c.--Cross section and distribution of bedload discharge, Susitna River at Sunshine, August 9, 1983.

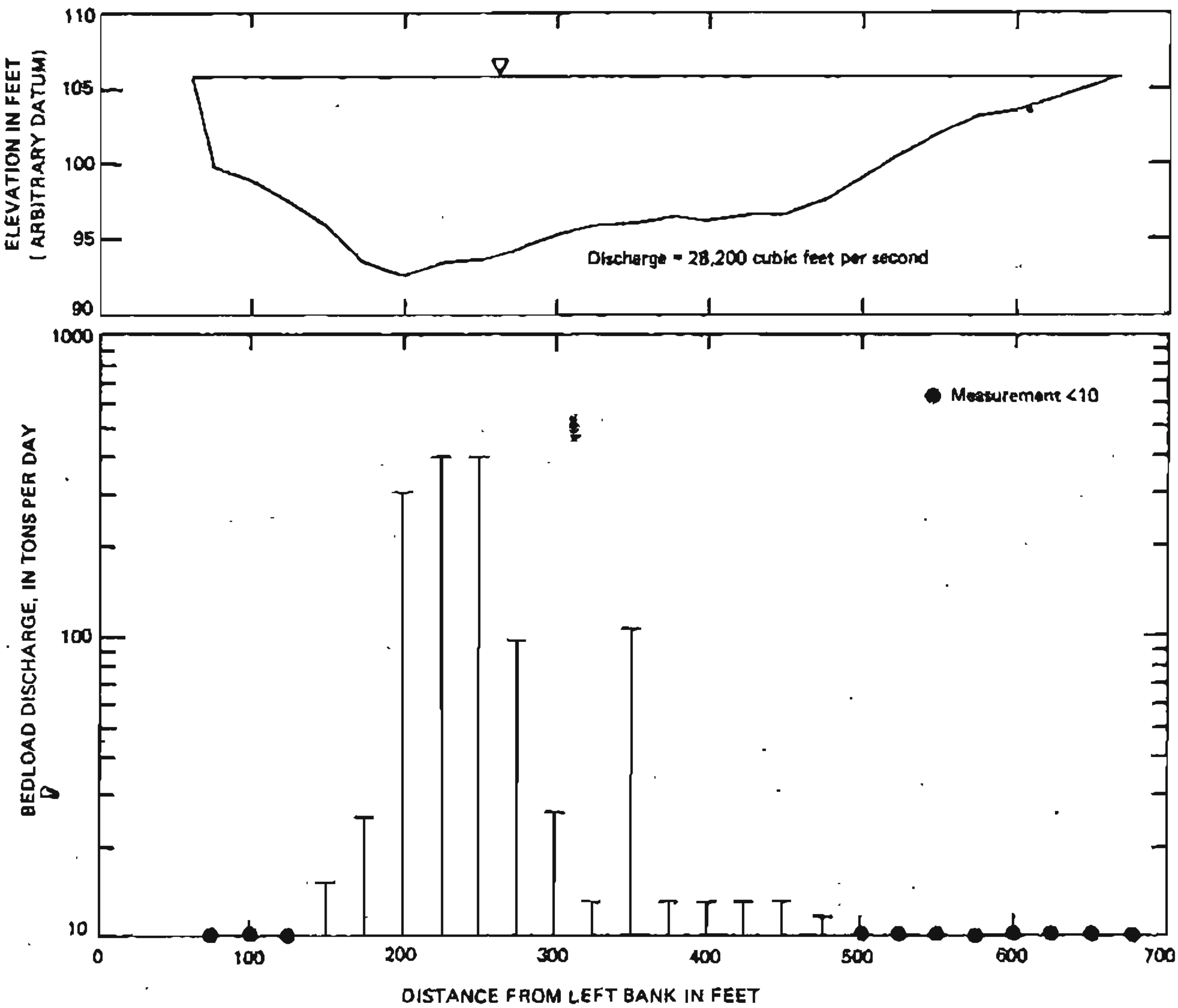

Figure 16d.--Cross section and distribution of bedload discharge, Susitna River at Sunshine, October 4, 1983.

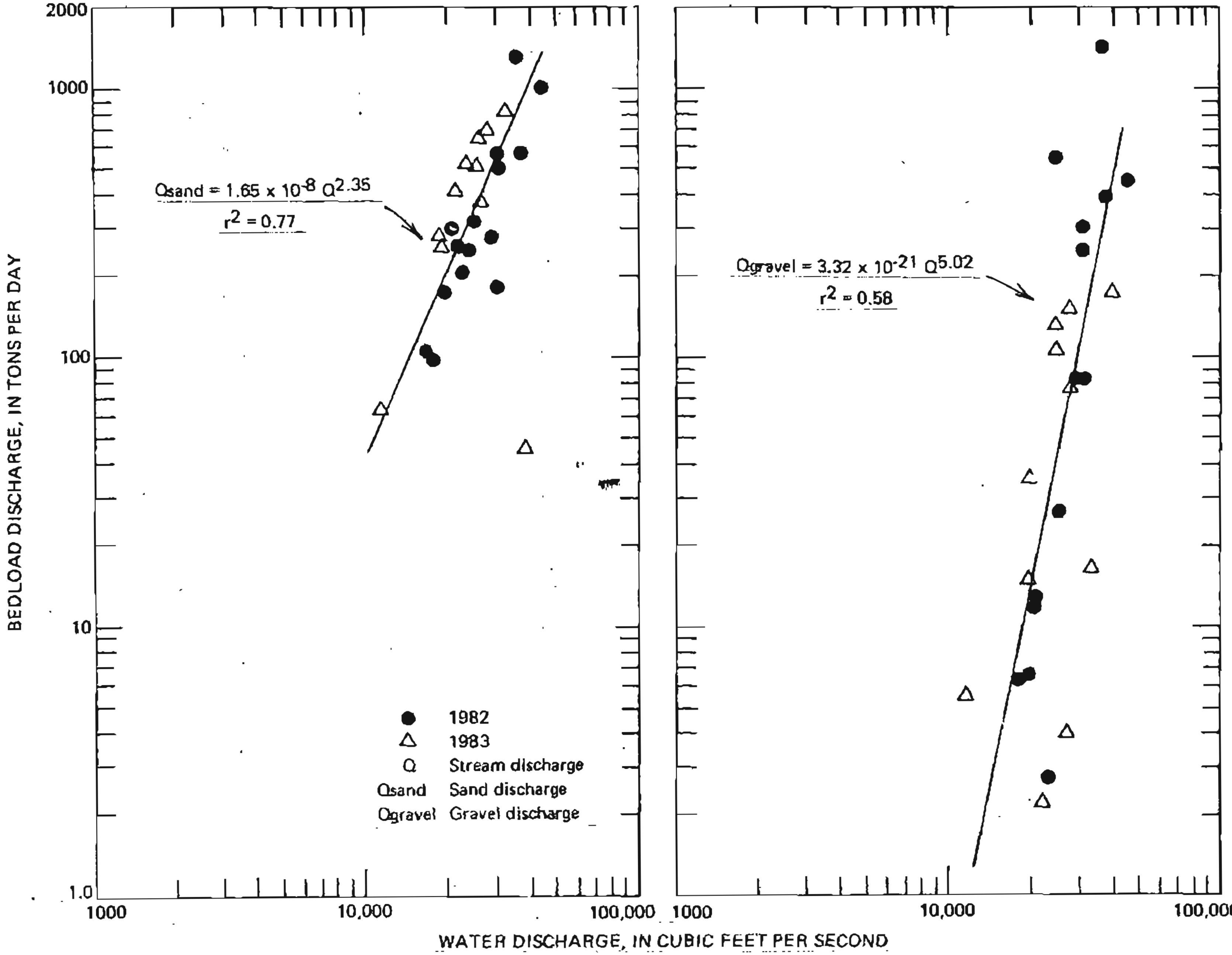

Figure 17.--Bedload-transport curves of sand and gravel for Susitna River near Talkeetna, May to September, 1982 and 1983.

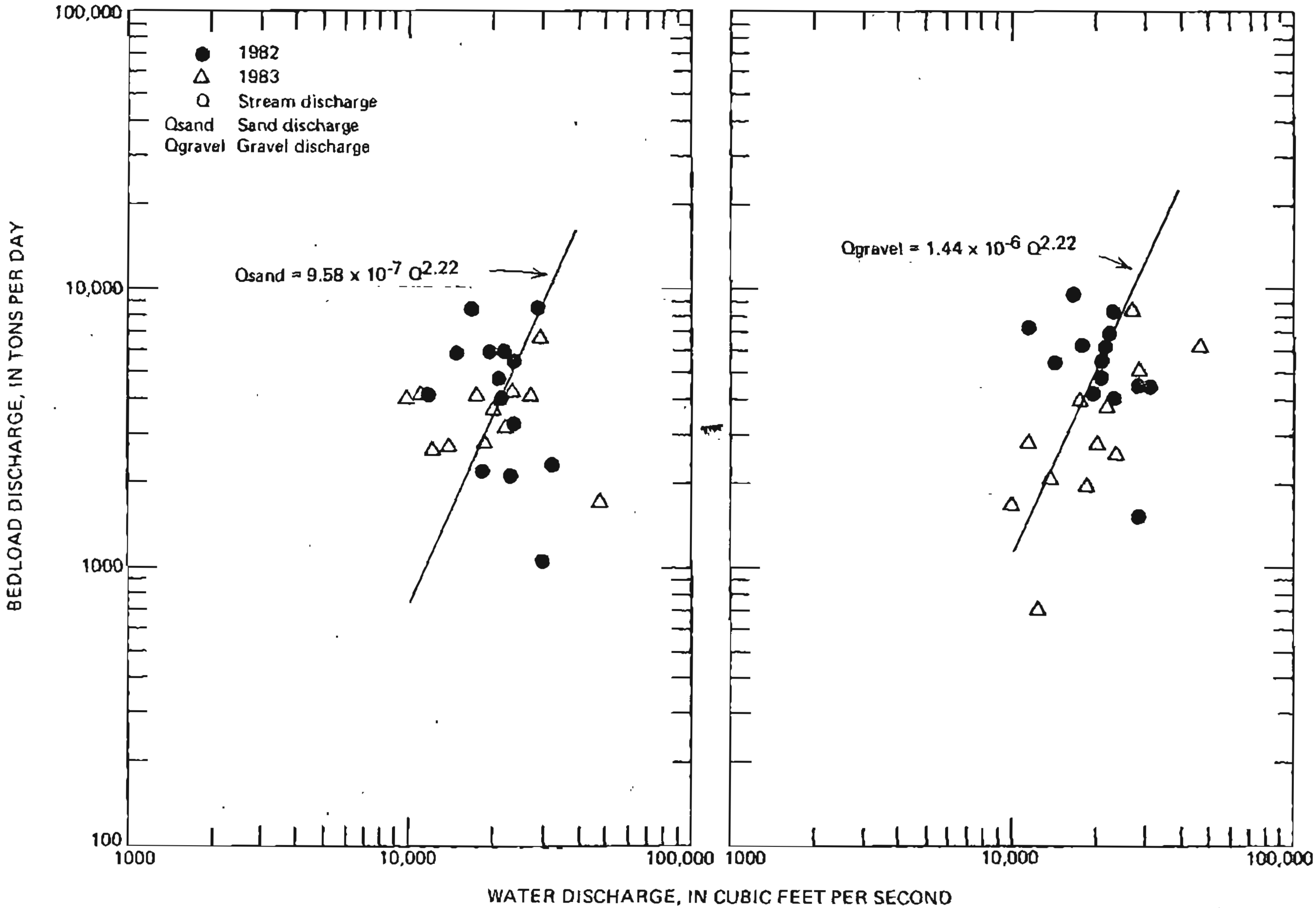

Figure 18.--Bedload-transport curves of sand and gravel for Chulitna River below canyon near Talkeetna, May to September, 1982 and 1983. Transport curves are based on assumed bedload/suspended sand relations. Equations obtained from least-squares analysis were not used (r^2 less than 0.20).

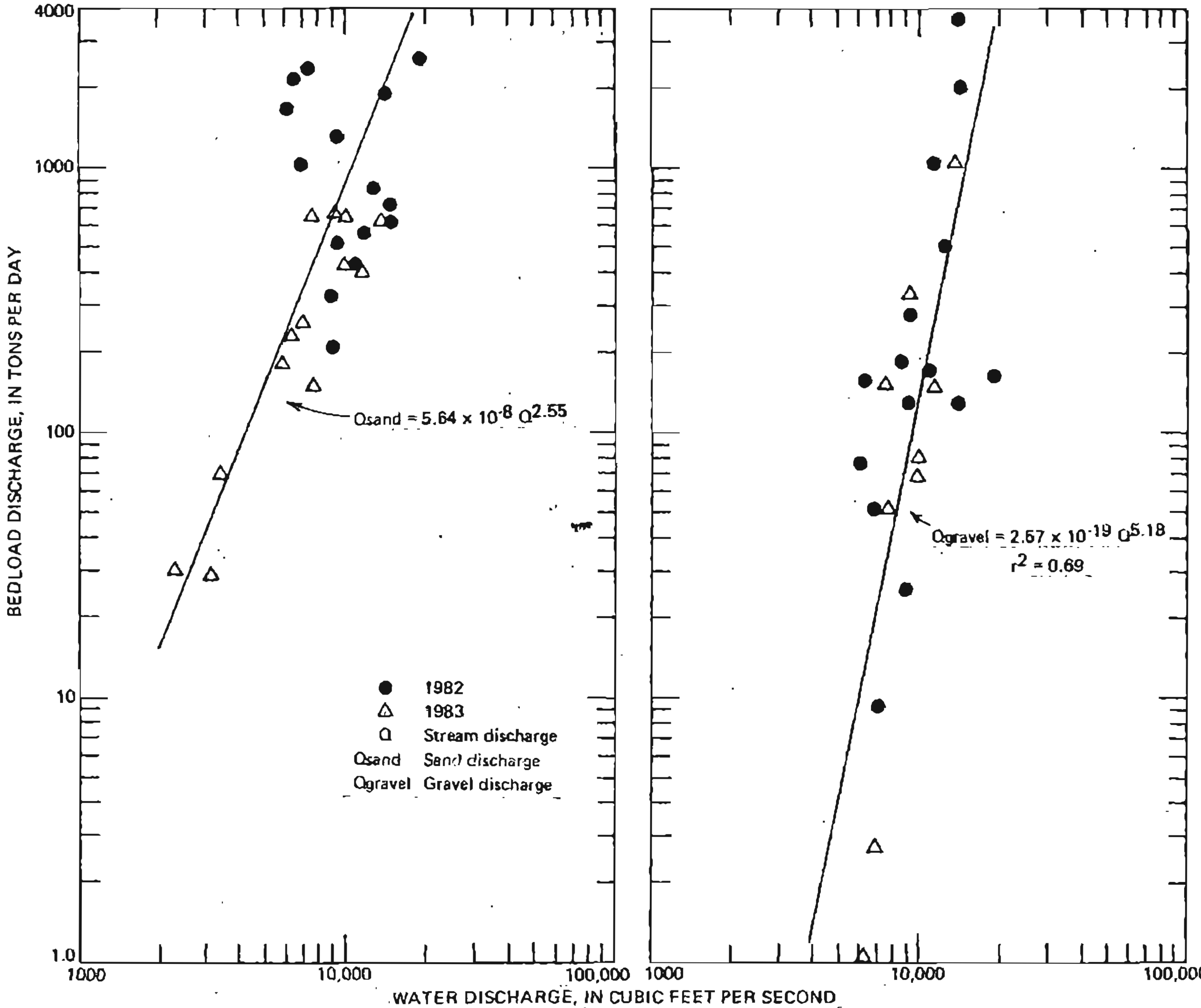

Figure 19.--Bedload-transport curves of sand and gravel for Talkeetna River near Talkeetna, May to September, 1982 and 1983. Transport curve of bedload sand based on assumed bedload/suspended sand relation. Equation obtained from least-squares analysis was not used ($r^2 = 0.46$).

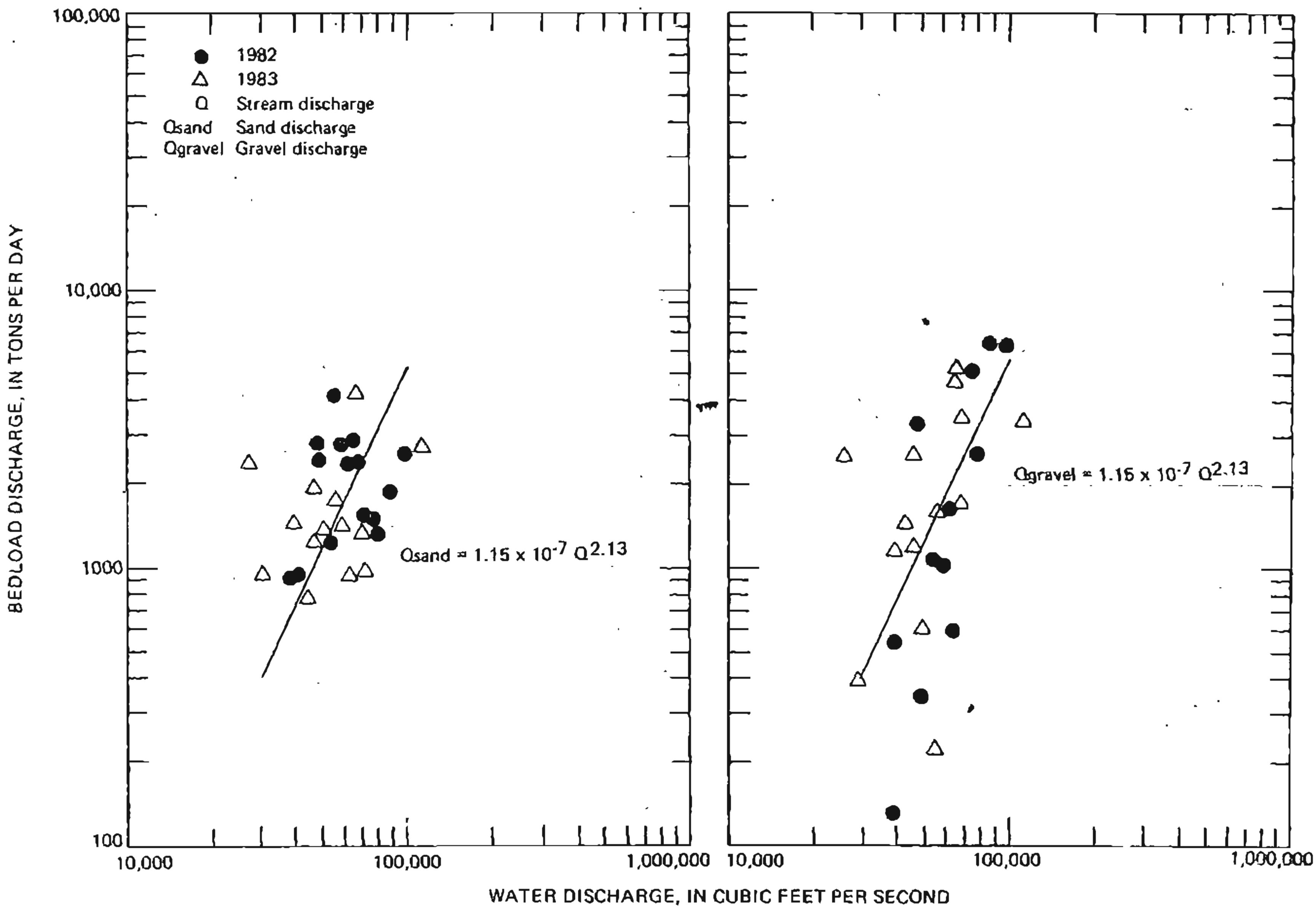

Figure 20.–Bedload-transport curves of sand and gravel for Susitna River at Sunshine, May to September, 1982 and 1983. Transport curves are based on assumed bedload/suspended sand relations. Equations obtained from least-squares analysis were not used (r^2 less than 0.27).

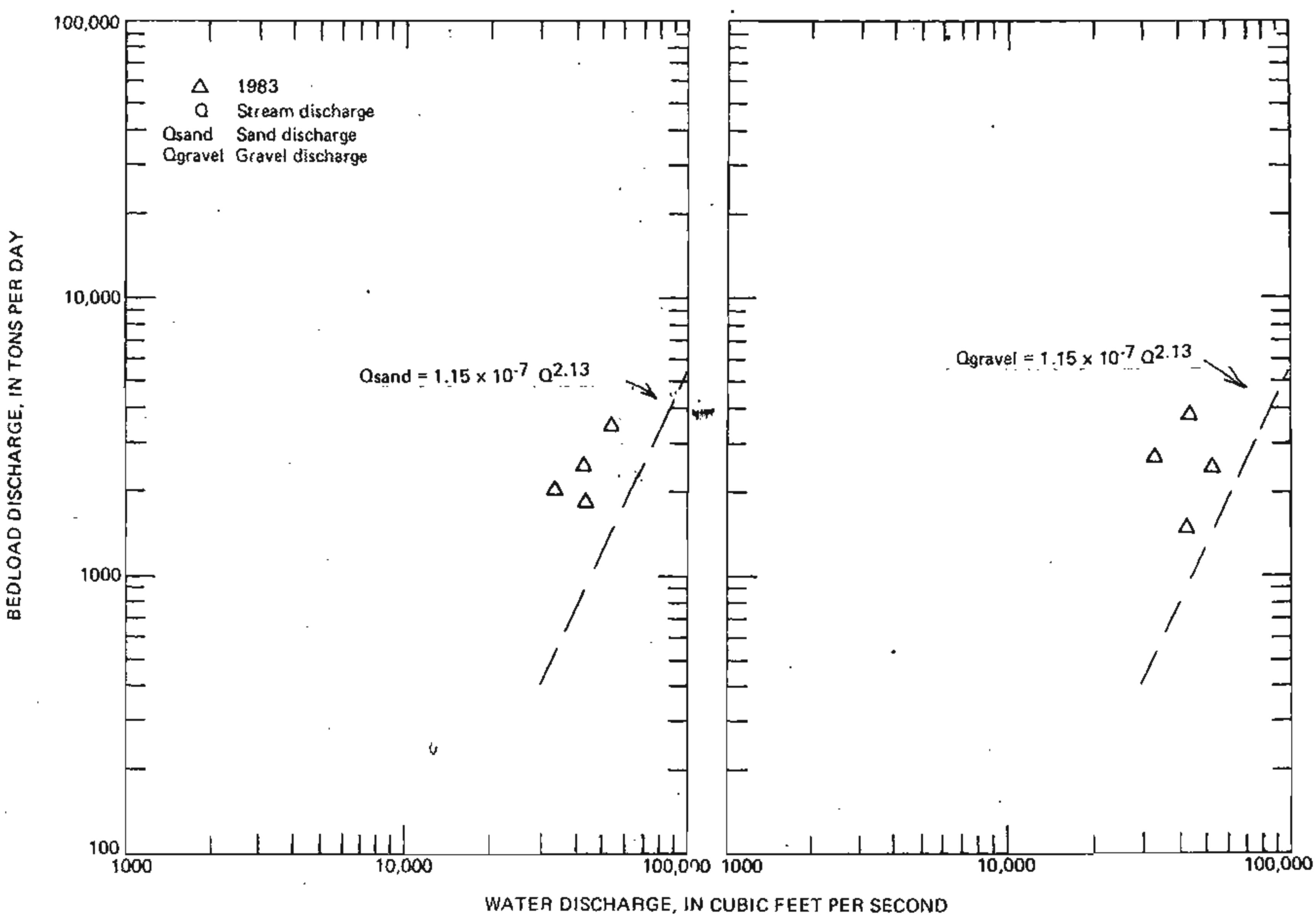

Figure 21.--Bedload discharge of sand and gravel versus water discharge for Susitna River below Chulitna River near Talkeetna (sum of right and left channels), May to September 1983. Dashed lines correspond to transport curves established for Susitna River at Sunshine, May to September, 1982 and 1983.

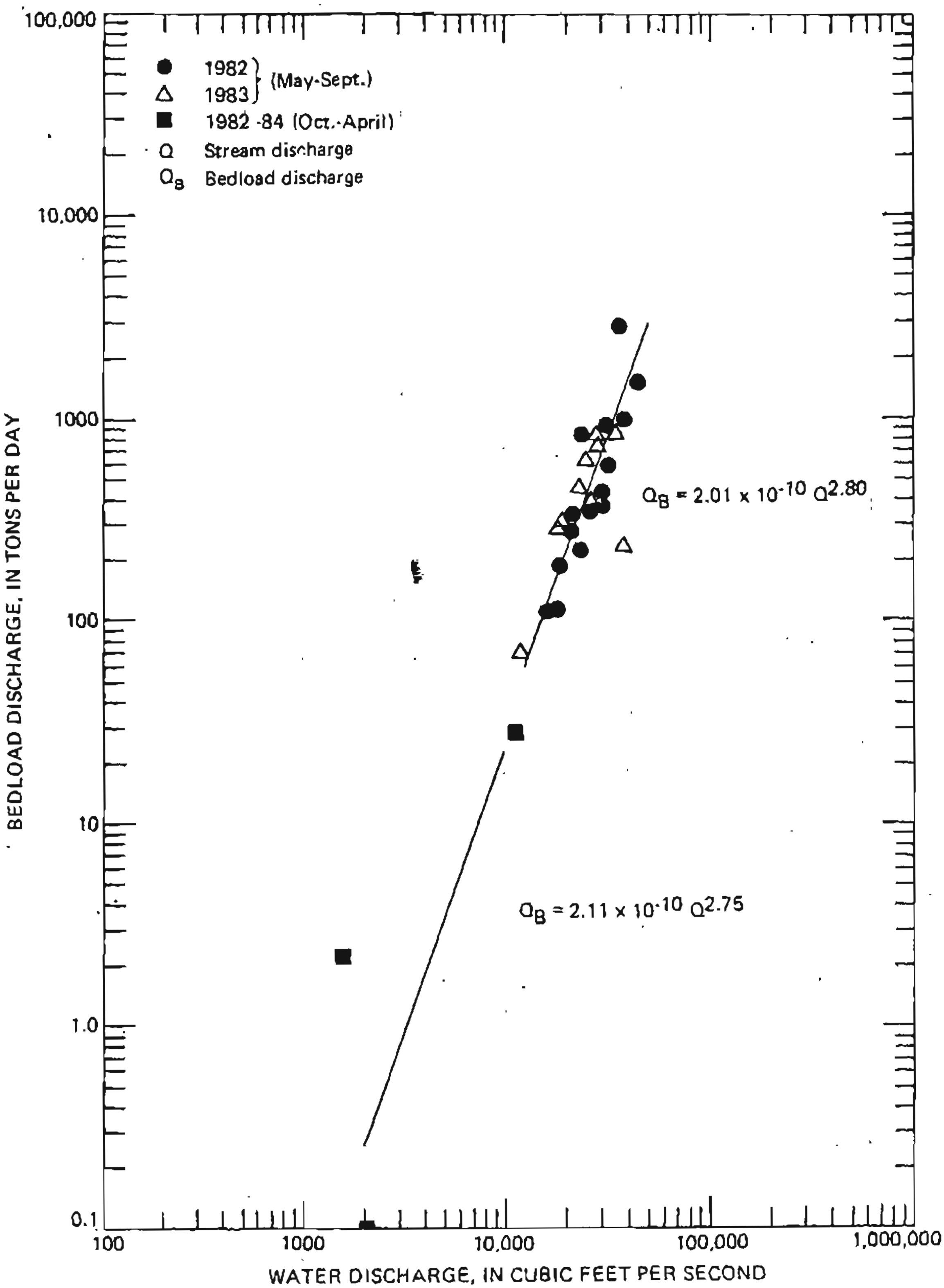

Figure 22.–Relation between bedload discharge and water discharge for Susitna River near Talkeetna, May to September, 1982 and 1983 and October to April, 1982 through 1984.

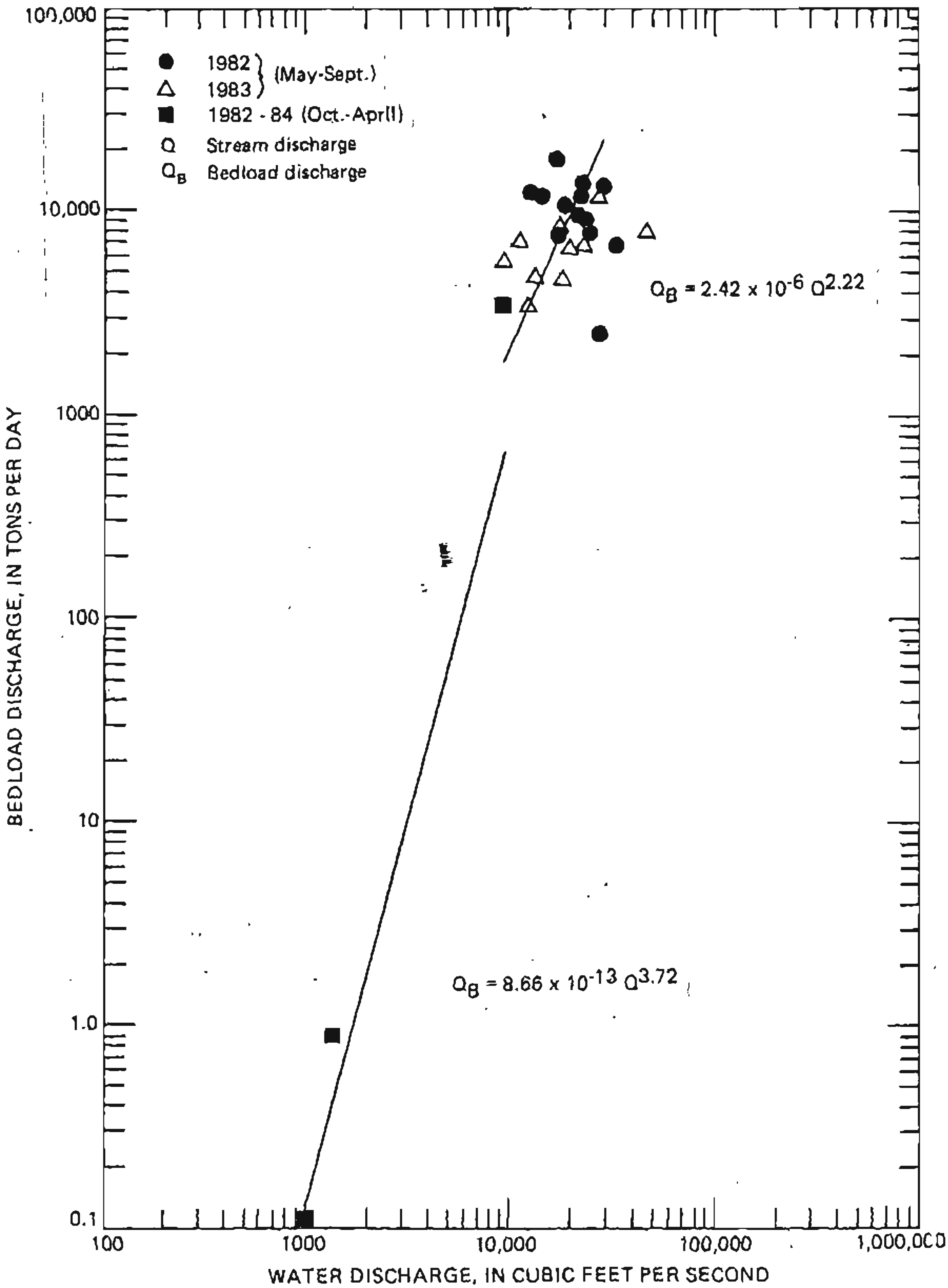

Figure 23.--Relation between bedload discharge and water discharge for Chulitna River below canyon near Talkeetna, May to September, 1982 and 1983 and October to April, 1982 through 1984.

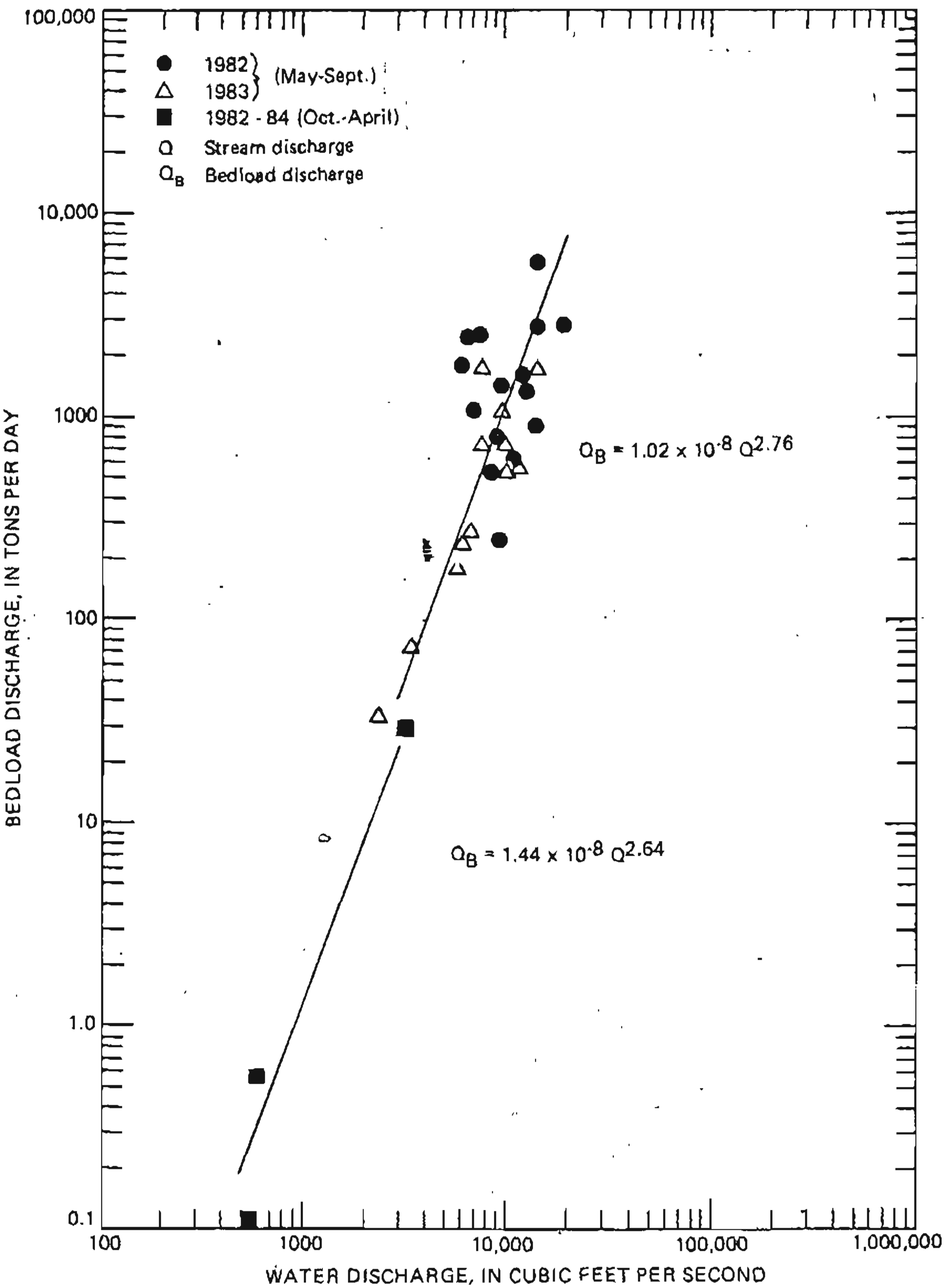

Figure 24.–Relation between bedload discharge and water discharge for Talkeetna River near Talkeetna, May to September, 1982 and 1983 and October to April, 1982 through 1984.

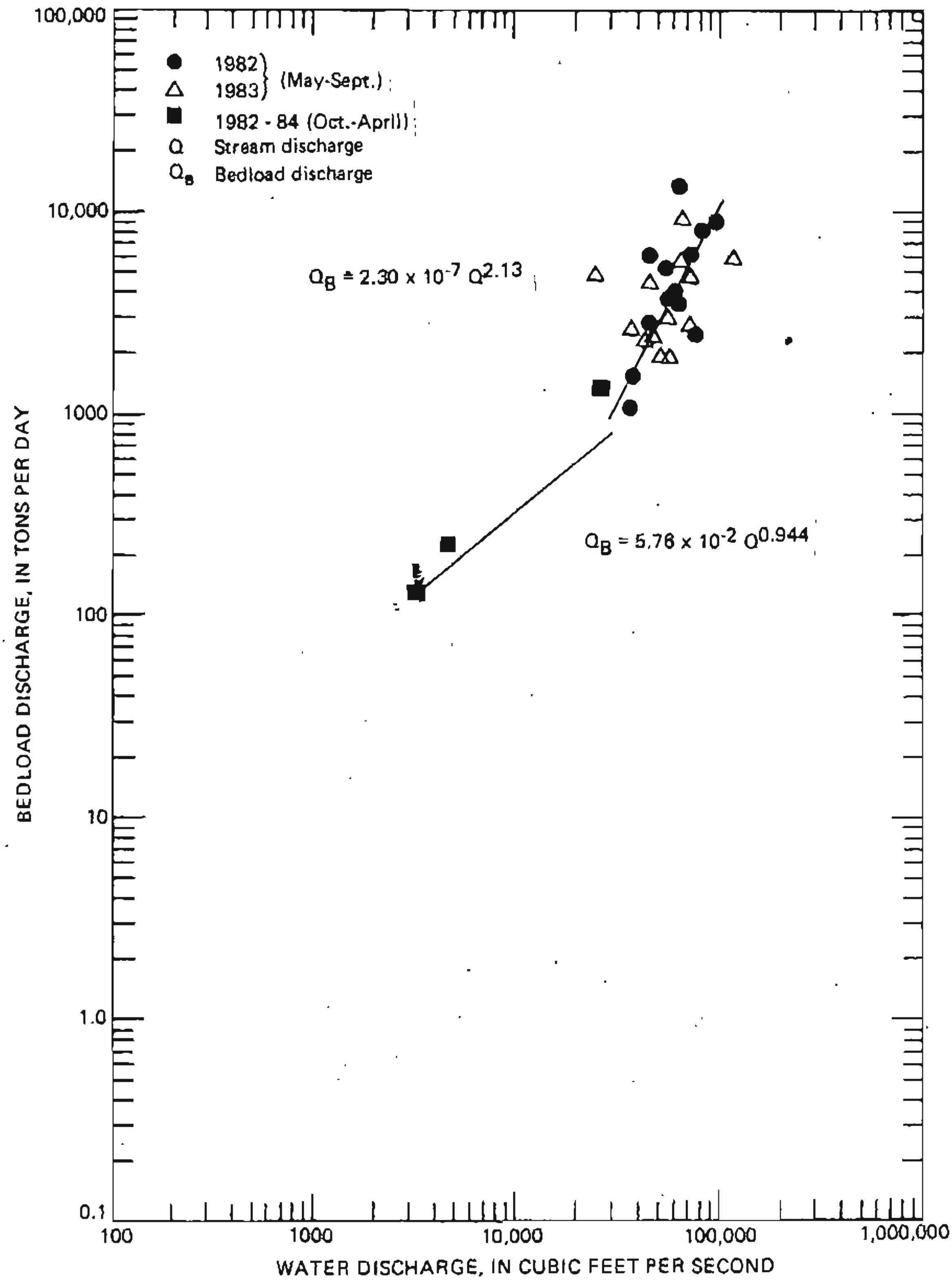

Figure 25.–Relation between bedload discharge and water discharge for Susitna River at Sunshine, May to September, 1982 and 1983 and October to April, 1982 through 1984.

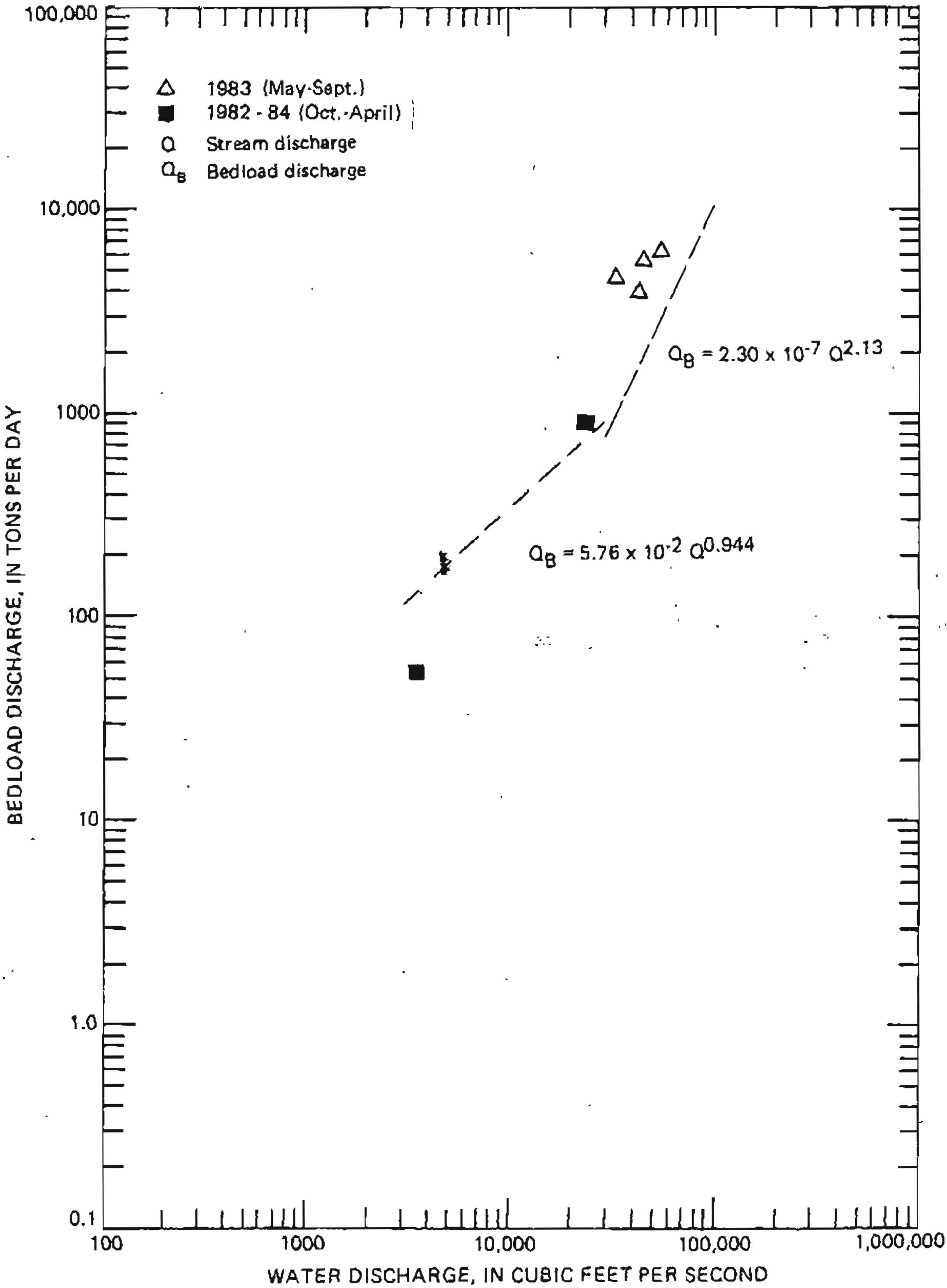

Figure 26.--Bedload discharge versus water discharge for Susitna River below Chulitna River near Talkeetna (sum of right and left channels), May to September, 1983 and October to April, 1982 through 1984. Dashed lines correspond to transport curves established for Susitna River at Sunshine, May to September, 1982 and 1983 and October to April, 1982 through 1984.

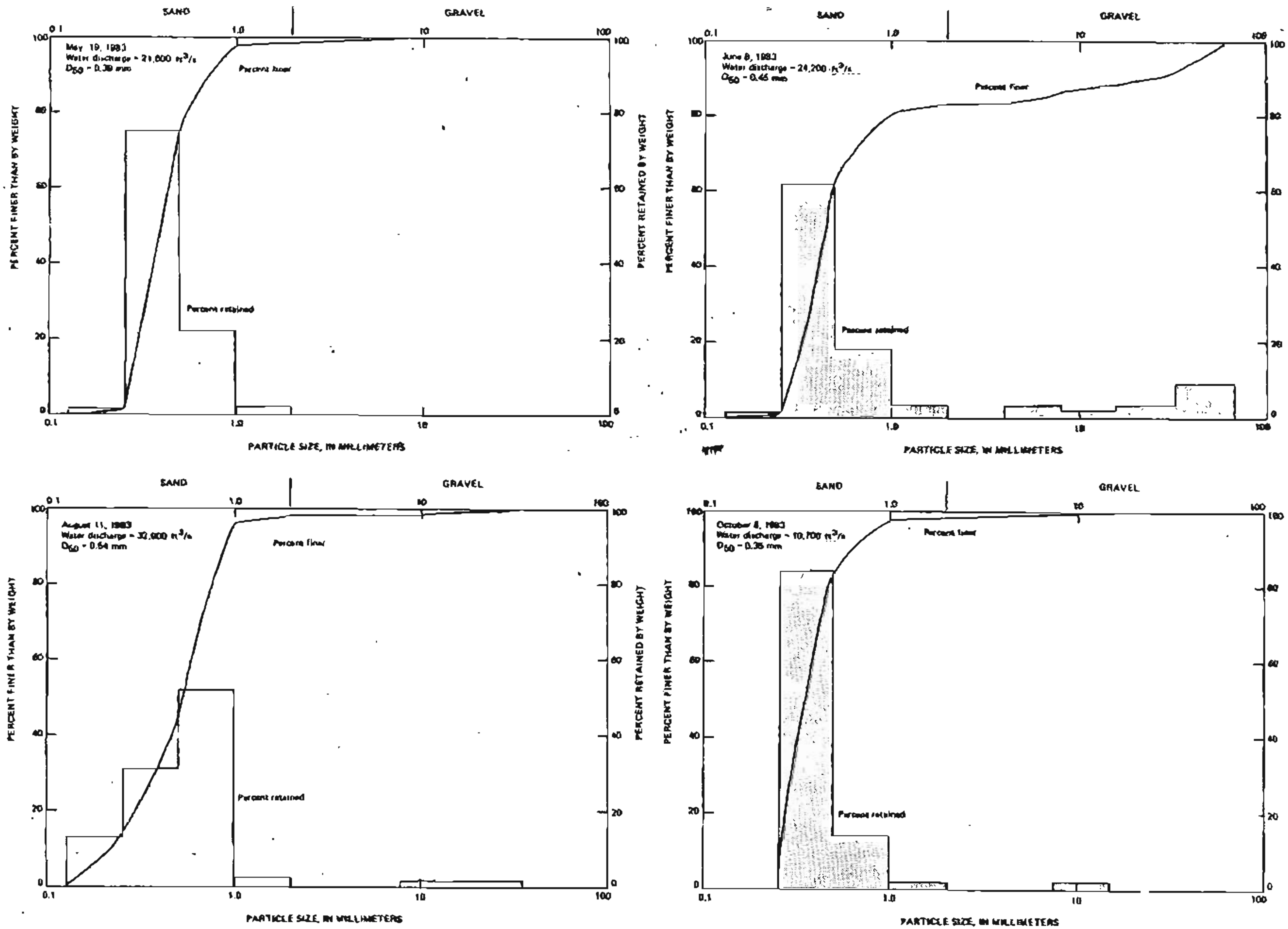

Figure 27.--Particle-size distribution and median diameter (D_{50}) of bedload, Susitna River near Talkeetna.

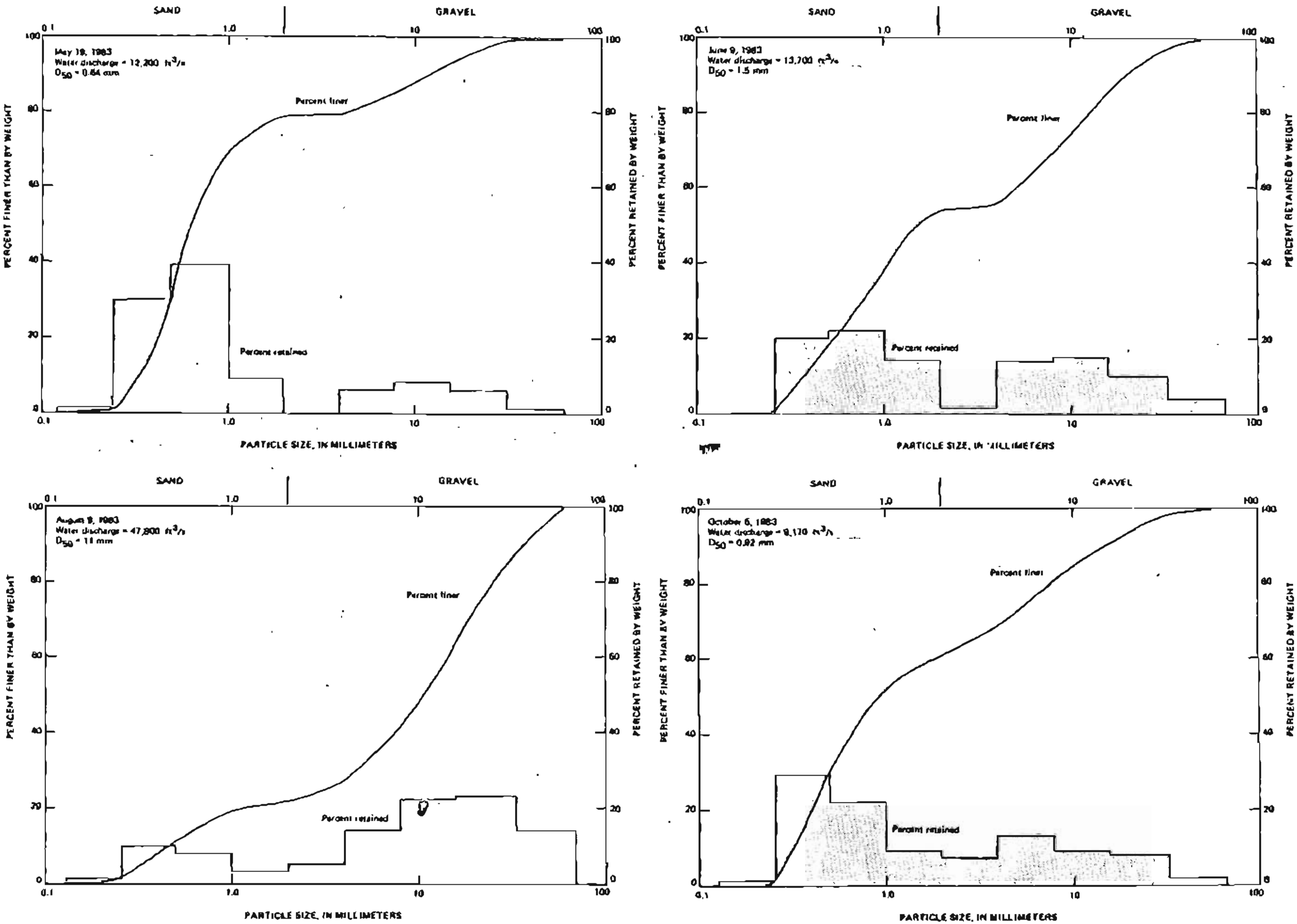

Figure 28.--Particle-size distribution and median diameter (D_{50}) of bedload, Chulitna River below canyon near Talkeetna.

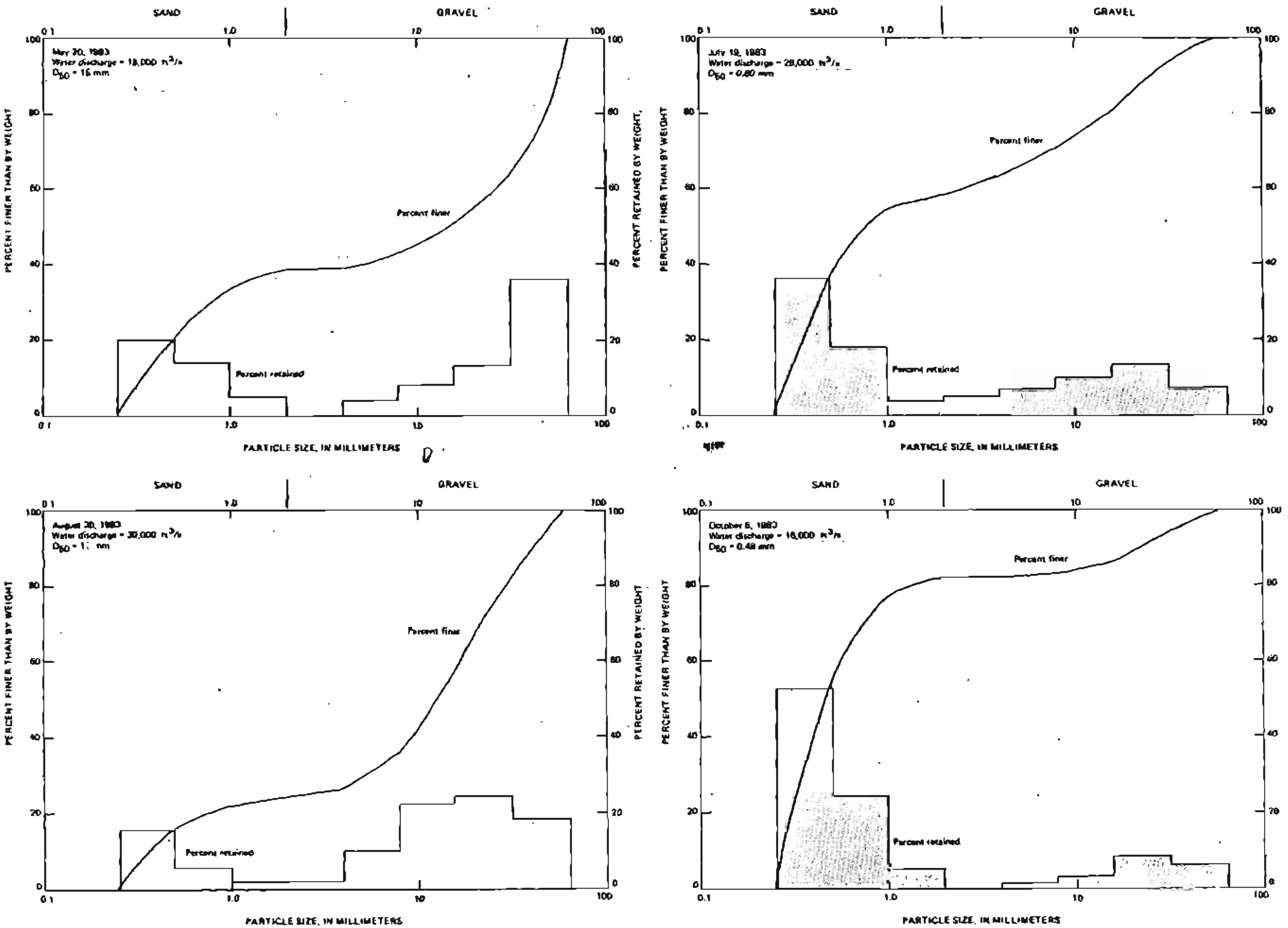

Figure 29.--Particle-size distribution and median diameter (D_{50}) of bedload, Susitna River (right channel) below Chulitna River near Talkeetna.

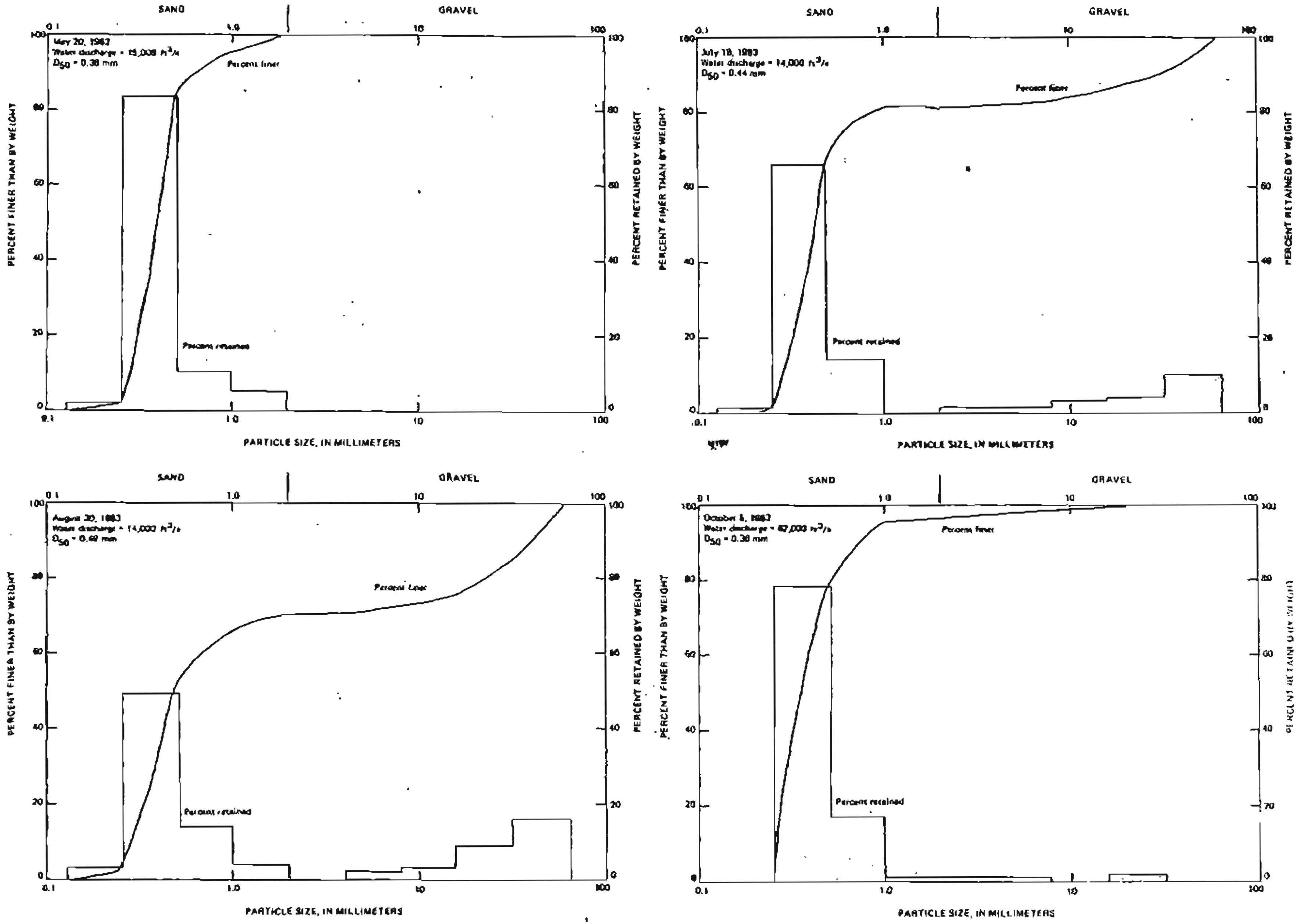

Figure 30.–Particle-size distribution and median diameter (D_{50}) of bedload, Susitna River (left channel) below Chulitna River near Talkeetna.

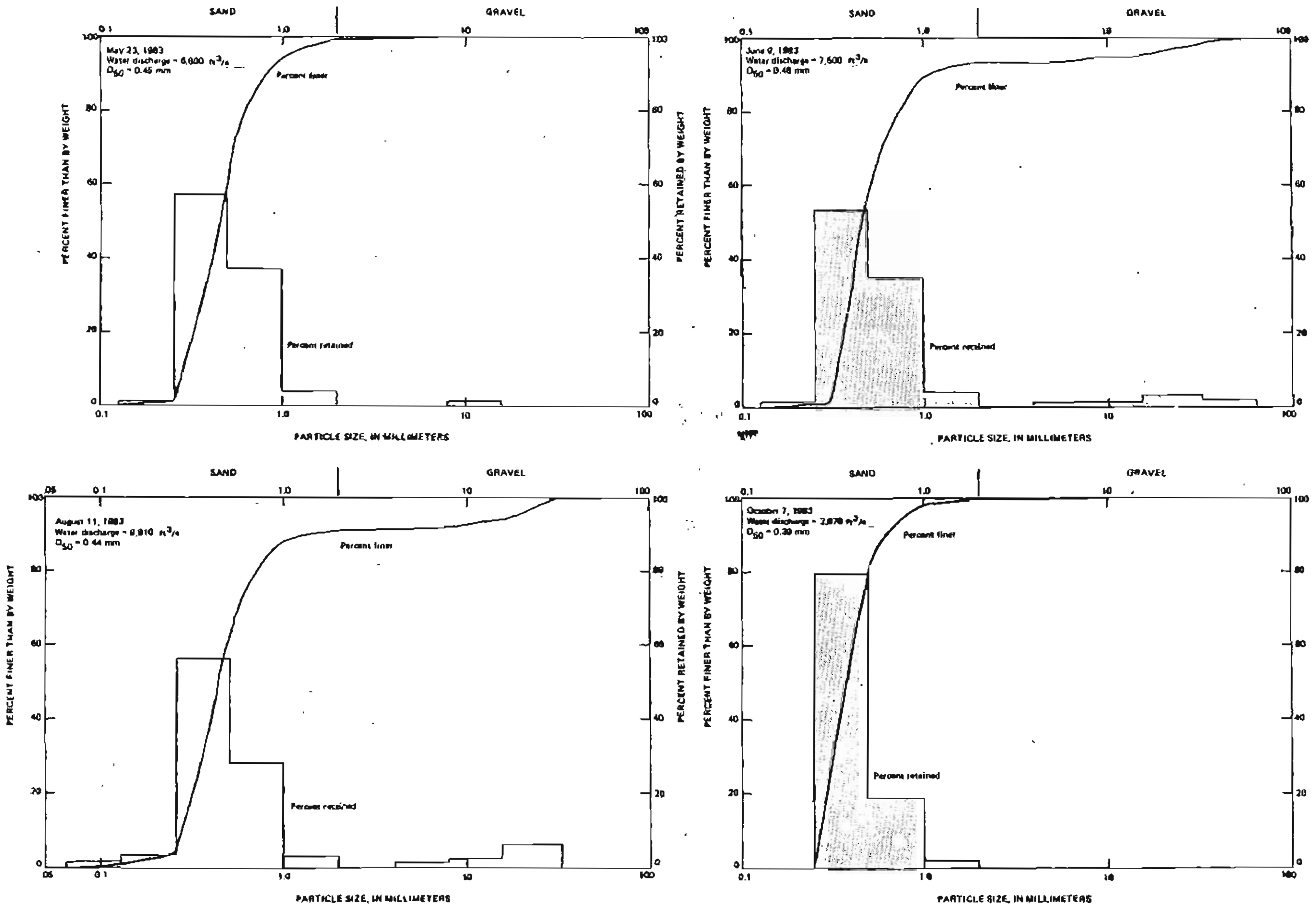

Figure 31.--Particle-size distribution and median diameter (D_{50}) of bedload, Talkeetna River near Talkeetna.

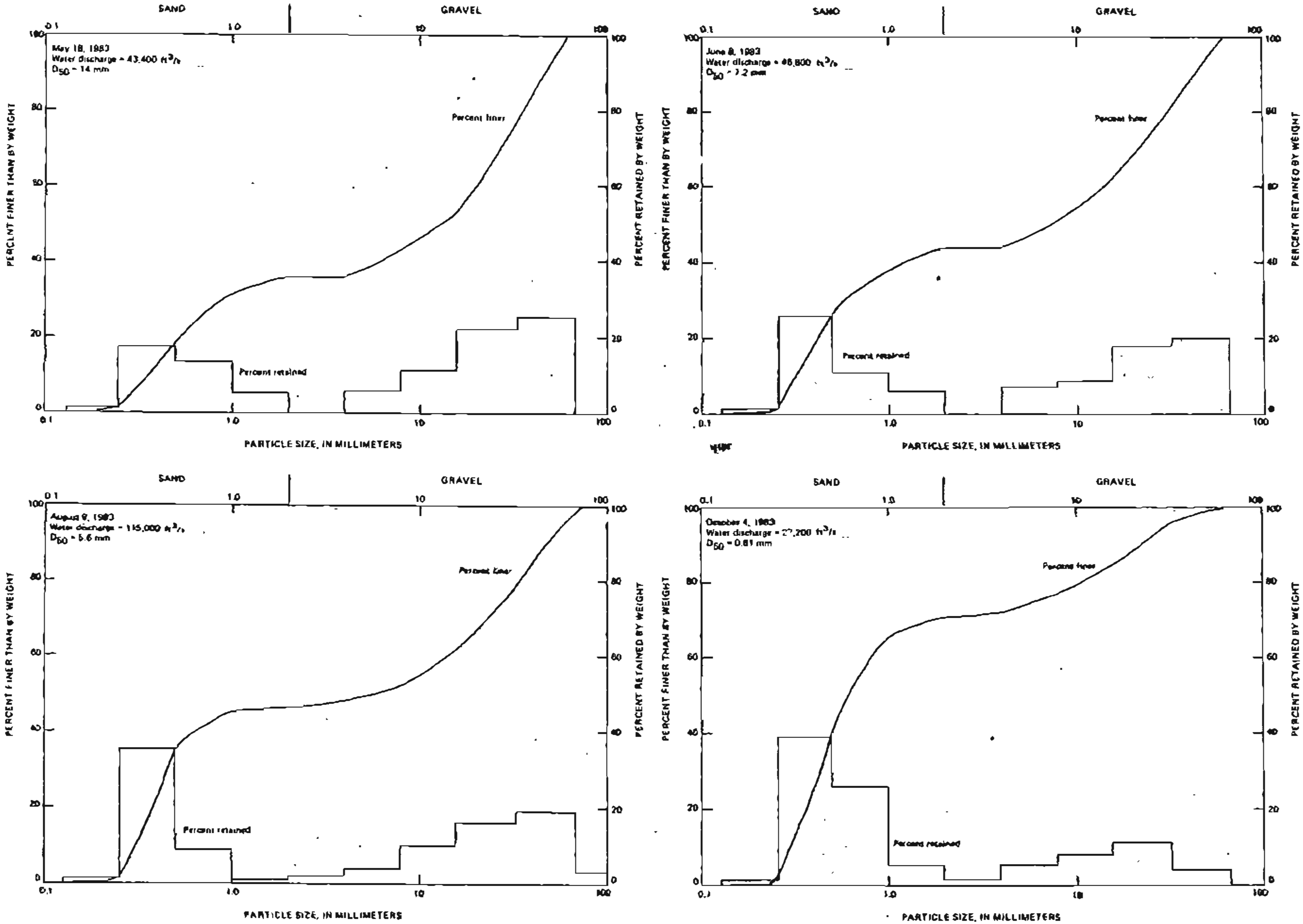

Figure 32.--Particle-size distribution and median diameter (D_{50}) of bedload, Susitna River at Sunshine.

Table 1. – Suspended-sediment data for selected stations in the Susitna River basin, October 1982 to October 1983

Station name and number	Date of collection	Discharge (ft^3/s)	Water temperature (°C)	Sediment concentration (mg/L)	Sediment discharge (ton/d)	Suspended sediment, Percent finer than size indicated, in millimeters										
						0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000
Susitna River at Gold Creek (15292000)	1983															
	Mar. 18	1,670	0.0	4	18	--	--	--	--	--	--	--	--	--	--	--
	May 19	20,000	4.0	456	24,600	--	--	--	--	--	37	--	--	--	--	--
	June 28	27,000	12.0	747	54,500	--	--	--	--	--	63	--	--	--	--	--
	July 28	18,200	14.0	399a	19,600	--	--	--	--	--	66	--	--	--	--	--
	Aug. 25	27,700	8.0	494	36,900	--	--	--	--	--	40	--	--	--	--	--
Susitna River near Talkeetna (15292100)	1983															
	May 19	21,600	4.5	386	22,500	9	11	--	18	--	36	52	76	97	100	--
	May 25	19,300	6.5	164	8,550	--	--	--	--	--	31	40	57	76	99	100
	June 1	38,000	9.0	663	68,000	9	13	16	28	44	63	72	91	100	--	--
	June 8	24,200	10.5	287	18,800	--	--	--	--	--	35	46	76	98	100	--
	June 23	27,700	14.0	346	25,900	14	21	--	35	--	49	57	74	89	98	100
	July 7	27,400	--	958	70,900	--	--	--	--	--	73	--	--	--	--	--
	July 21	18,900	13.0	297	15,200	--	--	--	--	--	66	73	84	99	100	--
	Aug. 2	23,800	14.0	521	33,500	28	33	36	46	55	64	73	89	100	--	--
	Aug. 11	32,600	11.0	603	53,100	23	26	33	46	58	76	88	98	100	--	--
	Aug. 31	26,800	9.0	297	21,500	--	--	--	--	--	22	36	71	99	100	--
	Sept. 14	11,300	6.0	41	1,250	--	--	--	--	--	41	52	73	100	--	--
	Oct. 6	10,600	.5	23	658	--	--	--	--	--	32	36	53	98	100	--

Table 1. -- Continued

Station name and number	Date of collection	Discharge (ft³/s)	Water tem-pera-ture (°C)	Sediment concen-tration (mg/L)	Sediment discharge (ton/d)	Suspended sediment, percent finer than size indicated, in millimeters: 0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000
Chulitna River near Talkeetna (15292400)	1983															
	Jan. 20	1,400	--	9	34	--	--	--	--	--	--	--	--	--	--	--
	Mar. 17	1,060	--	7	20	--	--	--	--	--	--	--	--	--	--	--
Chulitna River below canyon near Talkeetna (15292410)	1983															
	May 19	12,300	5.5	347	11,500	11	18	--	28	--	42	51	67	97	98	99
	May 25	11,600	--	235	7,360	25	33	--	50	--	63	70	86	100	--	--
	May 31	18,500	7.0	1,080	53,900	17	19	27	35	44	53	66	84	99	100	--
	June 2	17,600	7.5	773	36,700	22	31	37	43	50	54	61	75	100	--	--
	June 9	13,700	6.5	443	16,400	29	40	44	55	61	66	70	79	100	--	--
	June 22	23,500	10.0	1,500	95,200	33	34	44	54	62	67	77	87	97	99	100
	July 6	29,300	16.5	2,040	161,000	31	33	34	35	36	75	82	91	100	--	--
	July 20	20,000	6.0	1,240	67,000	--	--	--	--	--	73	--	--	--	--	--
	Aug. 2	22,400	6.5	1,770	107,000	23	32	42	51	61	70	79	92	100	--	--
	Aug. 9	47,500	6.0	4,690	601,000	19	25	28	38	50	60	73	87	97	100	--
	Aug. 31	27,000	6.5	1,500	109,000	20	29	34	43	51	58	69	87	99	100	--
	Sept. 13	9,850	5.5	614	16,300	9	11	13	18	21	22	24	30	50	100	--
	Oct. 5	9,170	1.5	200	4,950	18	21	--	30	--	39	48	67	99	100	--
Susitna River (right channel) below Chulitna River near Talkeetna (15292439)	1983															
	May 20	18,000a	7.0	253	12,300	10	16	--	25	--	41	50	73	98	100	--
	June 24	29,000a	10.5	1,600	125,000	24	35	43	54	62	68	76	88	97	99	100
	July 19	28,000a	8.5	855	64,600	28	35	47	56	66	73	78	87	100	--	--
	Aug. 30	30,000a	8.5	428	34,700	21	26	31	44	58	66	75	89	100	--	--
	Oct. 5	16,000a	1.5	166	7,170	--	--	--	--	--	30	37	50	98	100	--
Susitna River (left channel) below Chulitna River near Talkeetna (15292440)	1983															
	May 20	15,000a	7.0	254	10,300	--	--	--	--	--	38	55	76	98	100	--
	June 24	25,000a	14.0	424	28,600	20	28	39	48	55	62	70	88	100	--	--
	July 19	14,000a	12.5	526	19,900	20	25	29	38	52	62	72	88	100	--	--
	Aug. 30	14,000a	10.0	240	9,070	--	--	--	--	--	23	33	90	99	100	--
	Oct. 5	6,200a	1.5	44	737	--	--	--	--	--	24	34	75	100	--	--

Table 1. – Continued

Station name and number	Date of collection	Discharge (ft³/s)	Water tem-pera-ture (°C)	Sediment concen-tration (mg/L)	Sediment discharge (ton/d)	Suspended sediment: Percent finer than size indicated, in millimeters										
						0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000
Talkeetna River near Talkeetna (15292700)	1982															
	Oct. 14	3,450	1.0	25	233	--	--	--	--	--	25	38	66	96	100	--
	1983															
	Mar. 18	555	.0	3	4.5	--	--	--	--	--	--	--	--	--	--	--
	May 23	6,720	6.5	126	2,290	--	--	--	--	--	21	36	63	100	--	--
	May 26	5,790	5.5	90	1,410	--	--	--	--	--	17	28	49	100	--	--
	June 3	14,400	5.5	724	28,100	9	11	13	19	30	42	59	84	100	--	--
	June 9	7,500	8.0	114	2,310	--	--	--	--	--	17	27	56	100	--	--
	June 22	10,000	11.0	287	7,750	23	28	--	41	--	61	71	85	99	100	--
	June 23	10,100	10.5	249	6,790	--	--	--	--	--	61	71	81	100	--	--
	July 8	11,400	9.0	806	24,800	--	--	--	--	--	67	--	--	--	--	--
	July 18	7,460	10.0	372	7,490	--	--	--	--	--	45	54	64	99	100	--
	July 29	7,960	11.5	738	15,900	--	--	--	--	--	63	--	--	--	--	--
	Aug. 3	9,420	10.5	1,060	27,000	16	20	22	31	39	73	81	92	100	--	--
	Aug. 11	9,860	10.0	253	6,740	--	--	--	--	--	66	88	100	--	--	--
	Sept. 1	6,050	7.0	120	1,960	--	--	--	--	--	29	41	74	99	100	--
	Sept. 12	3,380	8.0	49	447	--	--	--	--	--	31	50	83	100	--	--
	Sept. 27	2,280	.5	28	172	--	--	--	--	--	32	64	96	100	--	--
	Oct. 4	4,250	1.5	41	470	--	--	--	--	--	17	--	--	--	--	--
Susitna River at Sunshine (15292780)	1982															
	Oct. 13	19,400	0.5	50	2,620	--	--	--	--	--	36	44	69	100	--	--
	1983															
	Jan. 20	4,720	.0	5	64	--	--	--	--	--	--	--	--	--	--	--
	Mar. 17	3,320	.0	5	45	--	--	--	--	--	--	--	--	--	--	--
	May 12	33,100	4.0	622	55,600	--	--	--	--	--	36	--	--	--	--	--
	May 18	43,400	5.5	396	46,400	13	16	--	26	--	47	56	72	85	97	100
	May 24	39,200	6.5	225	23,800	--	--	--	--	--	35	43	65	98	99	100
	June 1	75,300	7.5	871	177,000	10	12	17	24	34	41	57	83	98	100	--
	June 8	47,000	11.0	431	54,700	--	--	--	--	--	46	--	--	--	--	--
	June 23	67,900	14.0	850	156,000	25	33	43	52	61	69	78	89	100	--	--
	June 24	67,100	11.5	942	171,000	--	--	--	--	--	73	--	--	--	--	--
	July 5	66,800	14.0	1,060	191,000	--	--	--	--	--	80	--	--	--	--	--
	July 19	50,800	10.0	753	103,000	--	--	--	--	--	71	--	--	--	--	--
	July 27	44,400	12.5	570	68,300	--	--	--	--	--	62	--	--	--	--	--
	Aug. 1	59,200	13.0	950	152,000	20	29	41	49	59	70	79	90	100	--	--
	Aug. 3	57,500	10.5	1,030	160,000	22	31	42	54	66	73	80	91	100	--	--
	Aug. 8	76,100	10.0	2,840	584,000	13	22	23	35	51	71	85	95	99	100	--
	Aug. 11	87,200	9.0	1,160	273,000	--	--	--	--	--	59	--	--	--	--	--
	Aug. 24	54,800	9.5	381	56,400	--	--	--	--	--	43	--	--	--	--	--
	Aug. 29	47,700	8.5	401	51,600	--	--	--	--	--	31	41	65	99	100	--
	Sept. 12	25,200	7.5	167	11,400	20	27	--	34	--	41	47	66	100	--	--
	Oct. 4	28,000	2.0	171	12,900	12	15	--	19	--	29	37	68	99	100	--

a Estimated

Table 2. -- Hydraulic and bedload data for selected stations in the Susitna River basin, March 1983 to February 1984

Station name and number	Date of collection	Water discharge (ft3/s)	Average depth (ft)	Width (ft)	Average velocity (ft/s)	Water surface slope (ft/ft)	Bedload discharge (ton/d)	Particle-size distribution of bed sediment: Percentage, by weight, finer than size (mm) indicated: 0.062	0.125	0.25	0.5	1.0	2.0	4.0	8.0	16.0	32.0	64.0	76.0
	1983																		
Susitna	Mar. 25	1,600	--	--	--	--	2.1	--	0	3	75	100	--	--	--	--	--	--	--
River near	May 19	21,600	5.8	617	6.0	.0013	430	--	0	1	76	98	100	--	--	--	--	--	--
Talkeetna	May 25	19,300	5.5	601	5.8	.0012	298	--	0	1	64	87	88	89	89	90	92	100	--
(15292100)	June 1	39,100	7.4	662	8.0	.0016	225	--	0	1	19	21	21	21	23	27	29	100	--
	June 8	24,200	5.8	624	6.7	.0013	632	--	0	1	62	80	83	83	86	88	91	100	--
	June 23	27,000	6.0	615	7.3	.0014	840	--	0	1	60	80	82	82	83	85	86	100	--
	July 7	27,400	6.5	601	7.0	.0015	776	--	0	1	65	87	90	91	92	94	95	100	--
	July 21	19,200	5.2	598	6.2	.0013	302	--	0	1	87	94	95	95	95	96	100	--	--
	Aug. 2	24,000	5.9	600	6.8	.0014	668	--	0	1	63	78	80	81	83	85	89	100	--
	Aug. 11	32,900	6.2	611	8.7	.0015	854	--	0	13	44	96	98	98	98	99	100	--	--
	Aug. 31	26,800	6.4	636	6.6	.0014	399	--	0	1	80	98	99	99	100	--	--	--	--
	Sept. 14	11,300	4.0	565	5.0	.0014	70	--	--	0	76	88	92	93	93	93	100	--	--
	Oct. 6	10,700	3.9	545	5.0	.0014	27	--	--	0	84	98	99	99	99	100	--	--	--
	1984																		
	Feb. 17	2,000	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
	1983																		
Chulitna	Mar. 24	1,000	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
River near	May 19	12,200	6.3	323	6.0	.00068	3,360	--	0	1	31	70	79	79	85	93	99	100	--
Talkeetna	May 25	11,400	6.7	335	5.1	.00068	7,050	--	--	0	12	40	60	64	78	90	99	100	--
(15292410)	May 31	18,500	7.7	353	6.8	.0010	4,740	--	0	2	18	38	59	60	71	82	92	100	--
	June 2	17,800	8.0	339	6.6	.0012	8,240	--	0	1	20	39	51	52	66	76	87	100	--
	June 9	13,700	6.6	353	5.9	.0010	4,810	--	--	0	20	42	56	57	71	86	96	100	--
	June 22	23,500	9.0	370	7.1	.0015	6,840	--	0	1	29	50	63	64	70	78	90	100	--
	July 6	29,000	10.1	388	7.4	.0015	11,800	--	0	1	21	45	57	58	67	76	88	100	--
	July 20	20,000	8.6	356	6.5	.0010	6,500	--	0	1	25	51	58	61	70	79	93	100	--
	Aug. 2	22,200	8.2	370	7.3	.0013	6,980	--	0	1	21	42	46	47	53	65	80	97	--
	Aug. 9	47,800	11.9	445	9.0	.0026	7,980	--	0	1	11	19	22	27	41	63	86	100	--
	Aug. 31	27,200	9.1	386	7.7	.0012	11,600	--	0	1	19	30	36	41	54	69	84	98	--
	Sept. 13	9,850	6.0	332	4.9	.00064	5,780	--	--	0	31	50	71	77	87	94	100	--	--
	Oct. 5	9,170	5.8	330	4.8	.00044	3,380	--	0	1	30	52	61	68	81	90	98	100	--
	1984																		
	Feb. 29	1,420	--	--	--	--	.88	0	1	2	49	73	79	79	84	100	--	--	--

Table 2. – Continued

Station name and number	Date of collection	Water discharge (ft³/s)	Average depth (ft)	Width (ft)	Average velocity (ft/s)	Water surface slope (ft/ft)	Bedload discharge (ton/d)	Particle-size distribution of bed sediment: Percentage, by weight, finer than size (mm) indicated 0.062	0.125	0.25	0.5	1.0	2.0	4.0	8.0	16.0	32.0	64.0	76.0
Susitna	1983																		
River	Mar. 23	1,000a	--	--	--	--	0.56b	--	--	0	90	100	--	--	--	--	--	--	--
(right	May 20	18,000a	3.0	1,080	5.5	--	4,310	--	--	0	20	34	39	39	43	51	64	100	--
channel)	June 24	29,000a	4.2	1,110	6.8	--	2,560	--	0	1	28	45	53	54	60	69	79	100	--
below	July 19	28,000a	4.5	862	7.2	--	3,300	--	--	0	36	54	58	63	70	80	93	100	--
Chulitna	Aug. 30	30,000a	4.4	817	8.4	--	4,750	--	--	0	16	22	24	26	36	58	82	100	--
River near	Oct. 5	16,000a	4.4	714	5.1	--	818	--	--	0	53	77	82	82	83	86	94	100	--
Talkeetna	1984																		
(15292439)	Feb. 16	1,400a	--	--	--	--	52	--	--	0	50	99	100	--	--	--	--	--	--
Susitna	1983																		
River (left	Mar. 23	1,600a	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--
channel)	May 20	15,000a	4.0	550	6.9	--	350	--	0	2	85	95	100	--	--	--	--	--	--
below	June 24	25,000a	5.0	774	6.5	--	3,720	--	0	2	43	60	62	63	67	73	84	100	--
Chulitna	July 19	14,000a	3.7	605	6.2	--	660	--	0	1	67	81	81	62	83	86	90	100	--
River	Aug. 30	14,000a	3.3	618	6.9	--	968	--	0	3	52	66	70	70	72	75	84	100	--
near	Oct. 5	6,200a	3.3	454	4.1	--	69	--	--	0	78	95	96	97	98	98	100	--	--
Talkeetna	1984																		
(15292440)	Feb. 16	2,000a	--	--	--	--	0	--	--	--	--	--	--	--	--	--	--	--	--

Table 2. – Continued

Station name and number	Date of collection	Water discharge (ft^3/s)	Average depth (ft)	Width (ft)	Average velocity (ft/s)	Water surface slope (ft/ft)	Bedload discharge (ton/d)	Particle-size distribution of bed sediment: Percentage, by weight, finer than size (mm) indicated: 0.062	0.125	0.25	0.5	1.0	2.0	4.0	8.0	16.0	32.0	64.0	76.0
Talkeetna	1983																		
River near	Mar. 30	550	--	--	--	--	0.06	--	--	0	60	100	--	--	--	--	--	--	--
Talkeetna	May 23	6,780	4.5	343	4.4	--	273	--	0	1	58	95	99	99	99	100	--	--	--
(15292700)	May 26	5,790	4.2	335	4.1	--	188	--	0	1	69	97	100	--	--	--	--	--	--
	June 3	13,600	6.3	348	6.2	--	1,700	--	0	1	20	34	38	38	46	64	90	100	--
	June 9	7,500	4.4	340	5.0	--	736	--	0	1	54	89	93	93	94	95	98	100	--
	June 22	9,880	4.6	335	6.4	--	534	--	0	1	39	78	85	85	87	90	99	100	--
	July 8	11,400	5.4	345	6.1	--	574	--	0	2	41	71	74	75	76	78	87	100	--
	July 18	7,500	4.4	338	5.0	--	1,700	--	0	1	50	89	91	91	91	92	93	100	--
	Aug. 3	9,160	4.7	340	5.7	--	1,040	--	0	1	28	62	68	70	75	82	93	100	--
	Aug. 11	9,910	5.3	341	5.5	--	752	--	1	4	60	88	91	91	92	94	100	--	--
	Sept. 1	6,070	3.9	334	4.7	--	240	--	0	1	65	96	100	--	--	--	--	--	--
	Sept. 12	3,380	2.8	323	3.7	--	73	--	--	0	63	98	100	--	--	--	--	--	--
	Sept. 27	2,280	2.4	320	3.0	--	32	--	--	0	50	91	98	99	99	100	--	--	--
	Oct. 7	3,070	3.0	323	3.2	--	29	--	--	0	79	98	100	--	--	--	--	--	--
	1984																		
	Feb. 28	590	--	--	--	--	.56	0	1	3	48	97	100	--	--	--	--	--	--

Table 2. – Continued

Station name and number	Date of collection	Water discharge (ft³/s)	Average depth (ft)	Width (ft)	Average velocity (ft/s)	Water surface slope (ft/ft)	Bedload discharge (ton/d)	Particle-size distribution of bed sediment: Percentage, by weight, finer than size (mm) indicated											
								0.062	0.125	0.25	0.5	1.0	2.0	4.0	8.0	16.0	32.0	64.0	76.0
Susitna	1983																		
River at	Mar. 23	3,200	--	--	--	--	126	--	0	1	47	93	95	95	97	100	--	--	--
Sunshine	May 18	43,400	9.3	635	7.3	--	2,190	--	0	1	18	31	36	36	42	53	75	100	--
(15292780)	May 24	39,200	9.1	645	6.7	.0023	2,580	--	0	1	33	54	57	57	60	68	83	98	100
	June 1	75,000	10.6	952	7.4	.0023	4,680	--	0	1	19	26	28	29	34	49	75	96	100
	June 8	46,800	9.4	672	7.4	.0019	4,440	--	0	1	27	38	44	44	51	62	80	100	--
	June 23	68,400	10.2	902	7.4	.0021	9,380	--	0	1	27	39	45	46	56	75	93	100	--
	July 5	66,400	10.5	903	7.0	.0020	5,610	--	0	9	14	17	17	27	53	68	89	100	--
	July 19	50,800	10.0	675	7.5	.0020	1,960	--	0	1	46	66	70	73	77	85	96	100	--
	Aug. 1	59,400	9.3	901	7.1	.0018	2,900	--	0	2	31	44	48	52	60	72	89	100	--
	Aug. 3	57,500	9.1	901	7.0	--	1,940	--	0	1	67	86	89	92	95	98	100	--	--
	Aug. 8	73,900	10.4	955	7.4	.0021	2,600	--	0	2	26	34	37	42	50	59	82	100	--
	Aug. 9	115,000	13.4	958	9.0	.0023	5,920	--	0	1	36	45	46	48	52	62	78	97	100
	Aug. 29	47,700	9.9	670	7.2	.0018	2,400	--	0	1	37	48	52	56	64	73	89	96	100
	Sept. 12	25,200	7.4	595	5.7	.0012	4,870	--	--	0	31	44	49	52	63	78	93	100	--
	Oct. 4	26,200	7.9	610	5.9	.0014	1,320	--	0	1	40	66	71	72	77	85	96	100	--
	1984																		
	Feb. 23	4,630	--	--	--	--	216	--	0	1	30	58	61	64	69	77	93	100	--

a Estimated

b Minimum value, total cross section not sampled.

Table 3.-- Bed-material data for selected stations in the Susitna River basin
May to October 1983

(Sampling point stationing from left bank)

Station name and number	Date of collection	Sampling point	Bed material: Percent finer than size indicated, in millimeters 0.062	0.125	0.25	0.50	1.0	2.0	4.0	8.0	16.0	32.0	64.0	128.0
Susitna River near Talkeetna (15292100)	May 16	110a	--	--	--	--	--	--	--	--	--	--	--	--
		140b	--	--	--	--	--	--	--	--	--	0	14	100
		170c	--	--	--	--	--	--	--	0	1	26	100	--
		230c	--	--	--	--	--	0	1	2	11	22	100	--
		260a	--	--	--	--	--	--	--	--	--	--	--	--
		290c	--	--	--	--	0	1	1	2	5	24	83	100
		320c	--	--	--	0	1	1	1	3	10	39	100	--
		350c	--	--	--	--	--	--	--	0	1	8	19	100
		380c	--	--	--	--	--	--	--	--	0	36	100	--
		410c	--	--	--	--	--	--	--	0	1	2	100	--
		440b	--	--	--	--	--	--	--	--	--	--	0	100
		470c	--	--	--	--	--	--	--	--	0	12	67	100
		500c	--	--	--	--	--	--	--	--	--	0	28	100
		530b	--	--	--	--	--	--	--	--	--	0	31	100
		560a	--	--	--	--	--	--	--	--	--	--	--	--
	Sept. 14	115a	--	--	--	--	--	--	--	--	--	--	--	--
		155b	--	--	--	--	--	--	--	--	--	0	14	100
		195b	--	--	--	--	--	--	--	--	--	0	30	100
		235b	--	--	--	--	--	--	--	--	--	0	16	100
		275b	--	--	--	--	--	--	--	--	--	1	6	100
		315b	--	--	--	--	--	--	--	--	0	1	5	100
		355b	--	--	--	--	--	--	--	--	--	--	0	100
		395b	--	--	--	--	--	--	--	--	--	0	17	100
		435b	--	--	--	--	--	--	--	--	--	0	6	100
		475b	--	--	--	--	--	--	--	--	--	0	32	100
		515a	--	--	--	--	--	--	--	--	--	--	--	--

See footnotes at end of table

Table 3.--Continued

(Sampling point stationing from left bank)

Station name and number	Date of collection	Sampling point	Bed material											
			Percent finer than size indicated, in millimeters											
			0.062	0.125	0.25	0.50	1.0	2.0	4.0	8.0	16.0	32.0	64.0	128.0
Chulitna River below canyon near Talkeetna (15292410)	May 19	70c	--	--	--	--	--	--	--	--	0	11	100	--
		110c	--	--	0	2	4	42	51	74	90	100	--	--
		150c	--	--	0	16	60	70	70	75	83	90	90	100
		190c	--	--	0	19	59	65	66	68	72	78	78	100
		230c	--	--	0	1	1	15	31	70	87	89	100	--
	Sept. 13	50a	--	--	--	--	--	--	--	--	--	--	--	--
		90c	--	--	--	0	1	11	27	51	76	97	100	--
		130c	--	0	1	61	90	92	92	93	95	98	100	--
		170c	--	--	0	22	36	47	47	55	70	89	100	--
		210c	--	--	0	23	23	36	42	53	72	93	100	--
		250c	--	--	--	0	1	3	3	4	9	43	100	--
		290a	--	--	--	--	--	--	--	--	--	--	--	--
Susitna River (right channel) below Chulitna River near Talkeetna (15292439)	May 19	2920cd	--	--	--	--	--	--	0	1	4	13	50	100
		2960cd	--	0	3	35	72	76	76	79	84	90	100	--
		3570cd	--	0	1	16	45	59	60	68	78	99	100	--
		3620cd	--	--	0	1	4	7	8	16	38	88	100	--
		3670cd	--	--	0	1	1	2	2	3	13	49	100	--
		3720cd	--	--	0	1	3	4	5	9	23	64	100	--
		3770cd	--	--	0	1	2	4	4	8	20	57	100	--
		3820cd	--	--	--	0	1	1	2	5	11	44	100	--
		3870cd	--	--	--	0	1	2	2	2	4	7	53	100
		4000cd	--	--	--	0	1	1	1	2	3	9	39	100
	Oct. 7	3830cd	--	--	--	--	--	--	--	0	1	22	100	--
		3980cd	--	--	0	2	8	10	10	11	12	12	12	100
		4060cd	--	--	0	7	39	50	53	57	68	80	83	100

See footnotes at end of table

Table 3.--Continued

(Sampling point stationing from left bank)

Station name and number	Date of collection	Sampling point	Bed material: Percent finer than size indicated, in millimeters											
			0.062	0.125	0.25	0.50	1.0	2.0	4.0	8.0	16.0	32.0	64.0	128.0
Susitna River (left channel) below Chulitna River near Talkeetna (15292440)	May 17	1100ce	1	1	3	6	11	16	16	21	29	41	67	100
		1300ce	2	4	7	9	11	15	16	24	37	59	84	100
		1500ce	2	4	22	92	100	--	--	--	--	--	--	--
		1700ce	1	2	4	7	10	15	15	22	35	51	100	--
		1900ce	1	2	3	12	20	26	27	35	48	73	85	100
		2100ce	13	30	94	100	--	--	--	--	--	--	--	--
		2160ce	11	29	94	99	100	--	--	--	--	--	--	--
		2370ce	21	39	71	88	89	89	89	89	91	94	100	--
		2500ce	0	2	4	5	9	15	16	26	41	65	100	--
		2700ce	0	1	3	9	13	16	16	20	26	42	67	100
		2880ce	7	14	28	45	48	51	51	56	62	76	100	--
	May 18	100c	--	--	--	--	--	--	--	--	0	5	26	100
		225c	--	--	--	--	--	--	--	0	1	10	23	100
		700c	--	--	0	2	3	4	5	10	20	39	100	--
		750c	--	--	--	--	--	--	0	1	4	14	77	100
		800c	--	--	0	1	7	10	11	13	18	35	55	100
		850c	--	--	0	1	2	3	3	7	20	53	100	--
		900c	--	--	--	--	0	1	1	2	11	42	100	--
		950c	--	--	--	--	--	--	--	0	3	10	43	100
		1000c	--	--	--	--	--	--	0	1	2	14	50	100
	Oct. 7	670c	--	--	--	--	--	--	--	--	0	5	49	100
		750c	--	--	--	--	--	--	--	--	0	7	26	100
		820c	--	--	--	--	--	--	--	--	0	5	59	100

See footnotes at end of table

Table 3.--Continued

(Sampling point stationing from left bank)

Station name and number	Date of collection	Sampling point	Bed material: Percent finer than size indicated, in millimeters 0.062	0.125	0.25	0.50	1.0	2.0	4.0	8.0	16.0	32.0	64.0	128.0
Talkeetna River near Talkeetna (15292700)	May 18	60b	--	--	--	--	--	--	--	--	--	--	--	100
		90c	--	0	1	30	58	58	58	59	59	59	100	--
		120c	--	--	--	0	1	2	2	3	6	23	34	100
		150c	--	--	--	0	3	6	6	9	15	49	100	--
		180c	--	--	--	0	1	2	2	3	10	50	100	--
		210c	--	--	--	--	--	--	--	0	1	14	100	--
		240c	--	--	--	--	--	--	--	--	--	0	18	100
		270c	--	--	--	--	--	--	--	0	1	5	75	100
		300b	--	--	--	--	--	--	--	--	--	0	8	100
		330c	--	--	--	--	--	--	--	--	0	4	65	100
	Sept. 13	60a	--	--	--	--	--	--	--	--	--	--	--	--
		100c	--	--	0	37	47	48	48	48	49	49	49	100
		140c	--	--	0	1	4	5	5	5	5	11	67	100
		180c	--	--	--	--	--	--	--	0	3	31	100	--
		220c	--	--	--	--	--	--	--	--	0	4	17	100
		260c	--	--	--	--	--	--	--	--	0	2	19	100
Susitna River at Sunshine (15292780)	May 18	150a	--	--	--	--	--	--	--	--	--	--	--	--
		200c	--	--	0	3	6	14	15	30	51	81	100	--
		300c	--	--	--	1	1	2	2	5	13	43	100	--
		400c	--	--	--	--	1	2	2	4	9	20	84	100
		500c	--	--	--	1	1	1	1	3	9	43	78	100
		600c	--	--	--	--	--	--	--	--	--	1	11	100
	Oct. 4	100a	--	--	--	--	--	--	--	--	--	--	--	--
		150a	--	--	--	--	--	--	--	--	--	--	--	--
		200c	--	--	0	9	20	23	24	32	45	57	100	--
		250c	--	--	0	2	6	9	14	31	61	84	100	--
		300c	--	--	--	0	1	1	2	6	14	28	41	100
		350c	--	--	--	--	0	1	1	1	5	18	100	--
		400c	--	--	--	--	--	--	--	--	0	5	28	100
		450a	--	--	--	--	--	--	--	--	--	--	--	--
		500a	--	--	--	--	--	--	--	--	--	--	--	--
		550b	--	--	--	--	--	--	--	--	--	0	100	--

a Streambed too coarse for obtaining samples
b Few particles obtained, non-representative sample
c Representative sample obtained for particles finer than 128 mm
d Stationing from left bank of Susitna River, left channel (15292440)
e Samples obtained from island and bar areas

Table 4. – Water discharge and estimated sediment yields at selected stations in the Susitna River basin, October 1982 to September 1983

Station name and number	Drainage area (mi^2)	Period	Water discharge (acre-ft)	Suspended sediment (tons) Silt-clay	Suspended sediment (tons) Sand	Suspended sediment (tons) Total	Bedload (tons) Sand	Bedload (tons) Gravel	Bedload (tons) Total	Total sediment (tons)
Susitna River near Talkeetna (15292100)	6,320	October	450,000a	--	--	9,300	360	28	388	9,690
		November	160,000a	--	--	780	16.	.8	17	797
		December	150,000a	--	--	720	14	.7	15	735
		January	150,000a	--	--	740	15	.8	16	756
		February	140,000a	--	--	620	12	.6	13	633
		March	110,000a	--	--	340	5.6	.3	5.9	346
		April	120,000a	--	--	500	9.7	.5	10	510
		May	1,000,000a	140,000	210,000	350,000	7,300	1,100	8,400	358,000
		June	1,600,000a	480,000	440,000	920,000	20,000	7,200	27,200	947,000
		July	1,400,000a	750,000	330,000	1,080,000	14,000	1,600	15,600	1,100,000
		August	1,600,000a	570,000	410,000	980,000	16,000	930	16,900	997,000
		September	850,000a	35,000	86,000	121,000	3,400	400	3,800	125,000
		October to April	1,280,000a	--	--	13,000	432	32	465	13,500
		May to September	6,450,000a	1,970,000	1,480,000	3,450,000	60,700	11,200	71,900	3,520,000
		Total	7,730,000a	--	--	3,460,000	61,100	11,300	72,400	3,530,000
Chulitna River below canyon near Talkeetna (15292410)	2,580a	October	338,100	--	--	37,000	2,500	1,900	4,400	41,400
		November	149,600	--	--	5,100	80	47	127	5,230
		December	114,000	--	--	2,600	26	14	40	2,640
		January	96,700	--	--	1,900	17	9.0	26	1,930
		February	57,500	--	--	630	2.8	1.3	4.1	634
		March	64,600	--	--	720	3.2	1.5	4.7	725
		April	74,300	--	--	1,100	8.6	4.4	13	1,110
		May	546,100	120,000	130,000	250,000	55,000	32,000	87,000	337,000
		June	1,124,000	1,100,000	560,000	1,660,000	110,000	80,000	190,000	1,850,000
		July	1,372,000	2,000,000	760,000	2,760,000	130,000	100,000	230,000	2,990,000
		August	1,364,000	1,800,000	1,400,000	3,200,000	95,000	84,000	179,000	3,380,000
		September	652,500	240,000	390,000	630,000	88,000	60,000	148,000	778,000
		October to April	894,800	--	--	49,100	2,640	1,980	4,610	53,700
		May to September	5,059,000	5,260,000	3,240,000	8,500,000	478,000	356,000	834,000	9,330,000
		Total	5,953,000	--	--	8,550,000	481,000	358,000	839,000	9,390,000

a Estimated

Table 4. – Continued

Station name and number	Drainage area (mi²)	Period	Water discharge (acre-ft)	Suspended sediment (tons) Silt-clay	Suspended sediment (tons) Sand	Suspended sediment (tons) Total	Bedload (tons) Sand	Bedload (tons) Gravel	Bedload (tons) Total	Total sediment (tons)
Talkeetna River near Talkeetna (15292700)	2,006	October	206,100	--	--	10,000	1,200	150	1,350	11,400
		November	73,980	--	--	850	63	2.8	66	916
		December	66,550	--	--	630	45	1.5	47	677
		January	51,410	--	--	380	25	.7	26	406
		February	32,210	--	--	140	7.6	.2	7.8	148
		March	34,770	--	--	150	8.3	.2	8.5	158
		April	39,790	--	--	230	15	.4	15	245
		May	279,800	13,000	33,000	46,000	4,200	430	4,630	50,600
		June	536,300	110,000	110,000	220,000	15,000	4,100	19,100	239,000
		July	535,100	260,000	170,000	430,000	19,000	5,000	24,000	454,000
		August	541,300	240,000	110,000	350,000	20,000	6,300	26,300	376,000
		September	234,700	7,800	16,000	23,800	3,600	120	3,720	27,500
		October to April	504,800	--	--	12,400	1,360	156	1,520	13,900
		May to September	2,127,000	631,000	439,000	1,070,000	61,800	15,900	77,700	1,150,000
		Total	2,632,000	--	--	1,080,000	63,200	16,100	79,300	1,160,000
Susitna River at Sunshine (15292780)	11,100	October	994,900	--	--	110,000	12,000	4,800	16,800	127,000
		November	374,900	--	--	4,500	5,400	1,200	6,600	11,100
		December	345,100	--	--	3,200	5,100	1,000	6,100	9,300
		January	320,700	--	--	2,700	4,800	950	5,750	8,450
		February	259,000	--	--	1,700	3,900	730	4,630	6,330
		March	214,000	--	--	780	3,400	540	3,940	4,720
		April	249,700	--	--	1,700	3,800	700	4,500	6,200
		May	1,930,000	370,000	560,000	930,000	23,000	23,000	46,000	976,000
		June	3,457,000	2,100,000	1,300,000	3,400,000	74,000	110,000	184,000	3,580,000
		July	3,405,000	2,900,000	1,000,000	3,900,000	37,000	64,000	101,000	4,000,000
		August	3,725,000	2,700,000	2,000,000	4,700,000	44,000	38,000	82,000	4,780,000
		September	1,786,000	280,000	410,000	690,000	73,000	55,000	128,000	818,000
		October to April	2,758,000	--	--	125,000	38,400	9,920	48,300	173,000
		May to September	14,300,000	8,350,000	5,270,000	13,600,000	251,000	290,000	541,000	14,100,000
		Total	17,060,000	--	--	13,700,000	289,000	300,000	589,000	14,300,000

a Estimated