HYDROLOGIC DATA FOR THE LOWER COPPER RIVER, ALASKA MAY TO SEPTEMBER 1992

By Timothy P. Brabets

U.S. GEOLOGICAL SURVEY

Open-File Report 93-162

Prepared in cooperation with the
ALASKA DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

Anchorage, Alaska
1993

U.S. DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
acre-foot (acre-ft)	1,233	cubic meter
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
ton per day (ton/d)	0.9072	megagram per day

Abbreviations used in this report:

mg/L, milligram per liter
mm, millimeter

National Geodetic Vertical Datum of 1929 (NGVD of 1929):

A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

A geomorphology study of the lower Copper River was begun in April 1991. As part of this study, discharge, suspended sediment, and bedload data were collected at sites along the Copper River Highway. In addition, monuments were established using Global Positioning System techniques and 10 cross sections of the Copper River were surveyed between the Million Dollar Bridge and Flag Point. This report presents data collected from May to September 1992.

INTRODUCTION

The lower Copper River (fig. 1), including the Copper River Delta, is a highly complex and dynamic system. Near its mouth, the river drains an area approximately 24,000 mi^2 in size and has an average discharge of about 67,000 ft^3/s, the third largest discharge in the State of Alaska. Large quantities of suspended sediment from glaciers in the basin and also from erodible banks are transported. Channels in the approximately 300-square-mile delta constantly scour and fill, shifting the flow from one channel to another. In addition, the lower Copper River floods approximately every 5 years because of the outburst of glacier-dammed Van Cleve Lake.

The Copper River Highway begins at Cordova and crosses 11 bridges as it traverses the Copper River Delta to the east (fig. 2). The road presently ends after 48 mi at the Million Dollar Bridge. Several bridges on the delta have been damaged by excessive scour around their piers, and one, Bridge 342, has undergone major reconstruction to repair damage caused by lateral migration of the channel.

In April 1991, under a cooperative water resources agreement with the State of Alaska Department of Transportation and Public Facilities, the U.S. Geological Survey (USGS) began a study of the geomorphology of the lower Copper River. The objectives of this study are: (1) to document the lateral migration and vertical scour of channels in the lower Copper River, (2) to determine the ongoing processes causing the lateral migration and vertical scour of these channels, and (3) to predict areas within the lower Copper River that will be subject to future erosion or deposition. This report summarizes data collected from May to September 1992 between the Million Dollar Bridge and Flag Point (fig. 1). A previous report (Brabets, 1992) summarized data collected from May to September 1991.

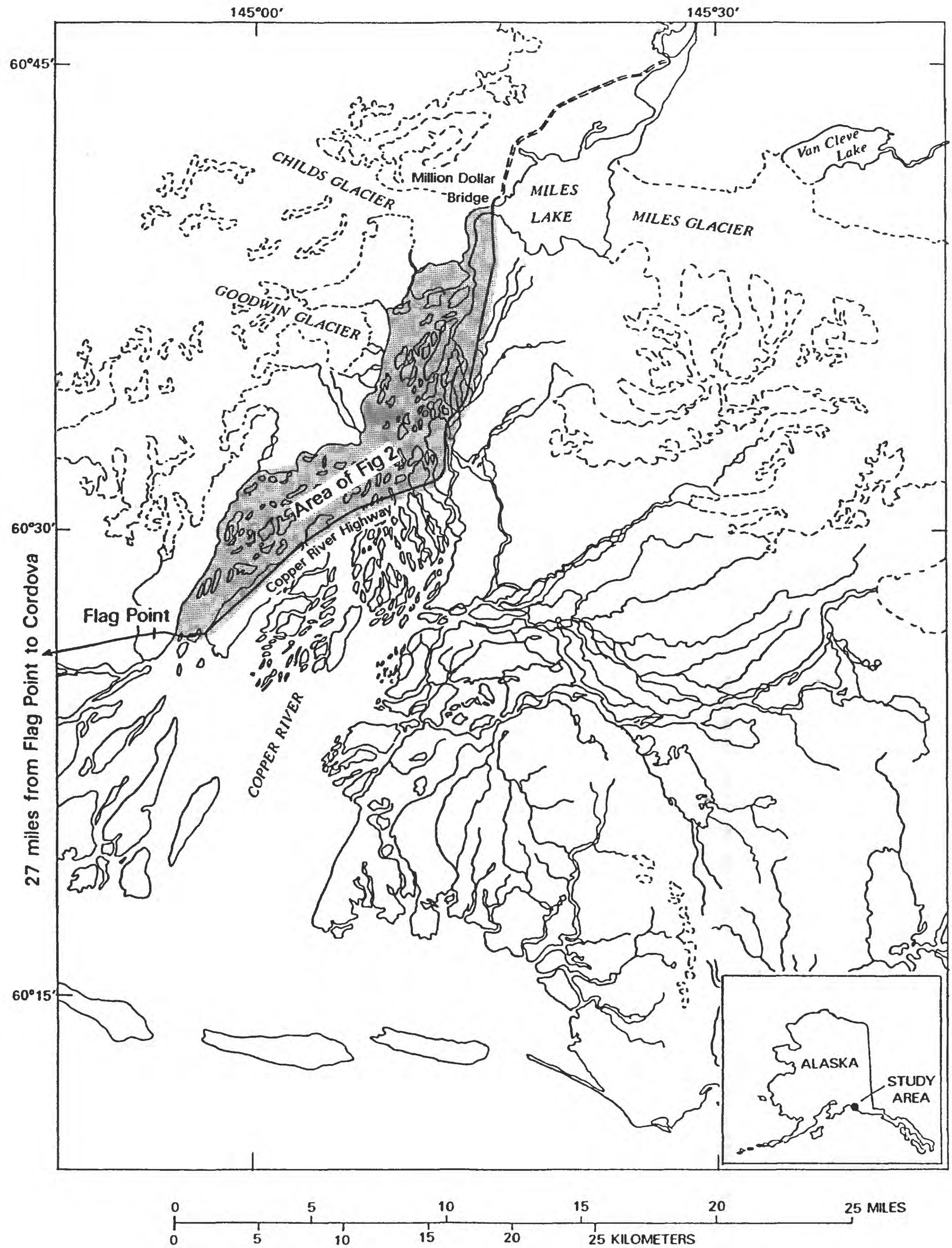

Figure 1. The lower Copper River Delta.

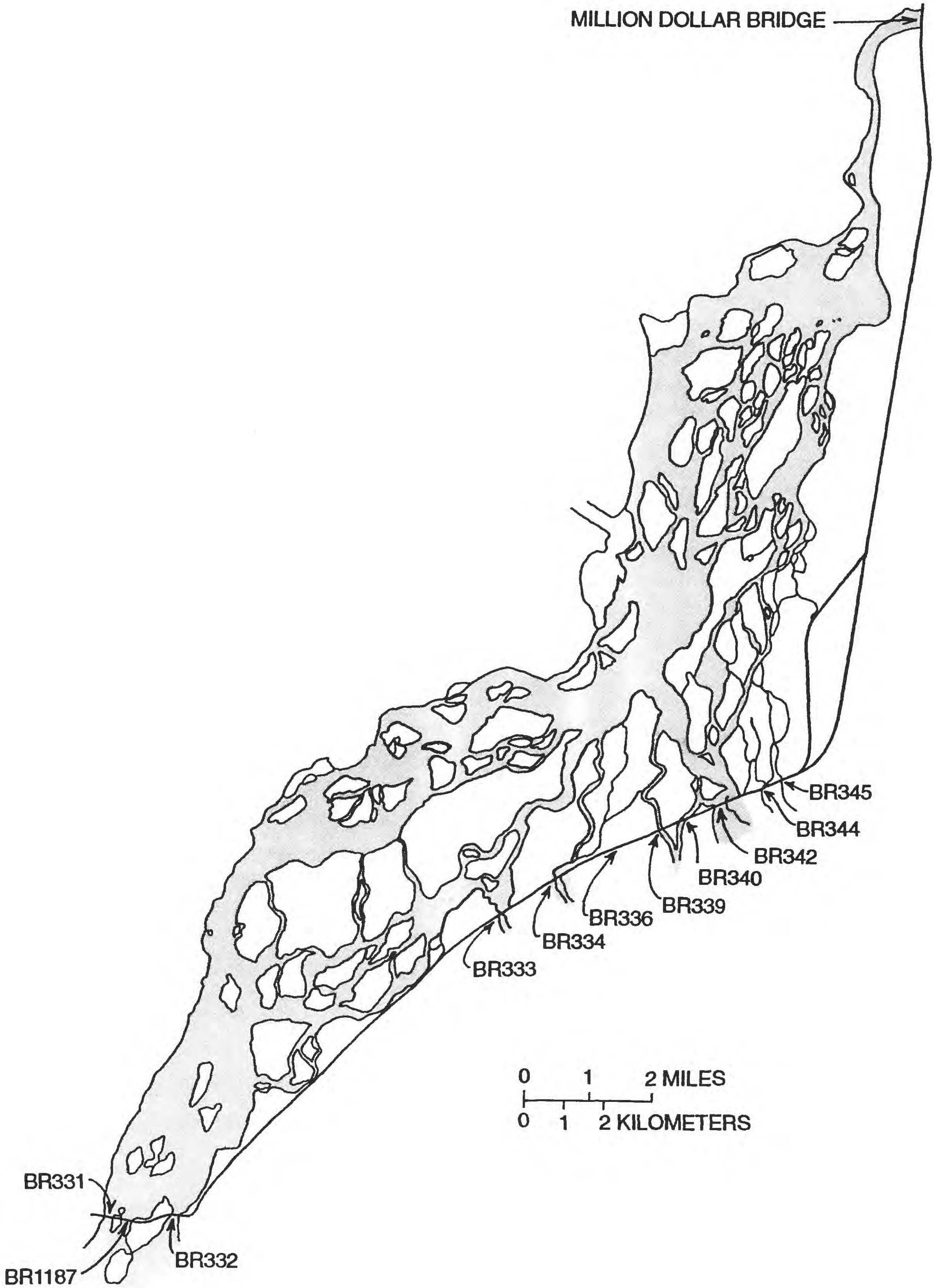

Figure 2. Locations of bridges along the Copper River Highway.

DISCHARGE

The USGS has operated a daily streamflow station on the Copper River at the Million Dollar Bridge since 1988. In water year 1992, continuous streamflow data were collected from May 21 (shortly after breakup) through freezeup in October. During this period, mean daily discharge ranged from 26,600 to 299,000 ft^3/s (fig. 3). Three distinct high-flow periods occurred: the first, on about July 5, resulted from snowmelt runoff in the basin; the second, on about August 9, was caused by the breakout of Van Cleve Lake; and the third, on about August 26, resulted from rainfall runoff. During the breakout of Van Cleve Lake, an estimated 1.14 million acre-ft of water was released from the lake.

Discharge measurements were made at the 11 bridges (fig. 2) along the Copper River Highway at approximately 2-week intervals from late May through September (table 1). The measurements determined flow distribution of the Copper River as it passed under the highway. The highest discharges were measured at Bridge 342; they were between 34 and 72 percent of the concurrent flow at the Million Dollar Bridge. At Bridge 331, measured flows were between 30 and 54 percent of the flow at the Million Dollar Bridge. No flow occurred at Bridges 336 and 344.

SUSPENDED SEDIMENT

Suspended-sediment samples were collected concurrently with the discharge measurements. Samples at the Million Dollar Bridge and at Bridges 331, 1187, 332, and 342 were collected using a P-63 point sampler or a D-74 depth integrating sampler. The samples were obtained by the equal-discharge increment (EDI) method as described by Guy and Norman (1970). Suspended-sediment samples at the remaining bridges were collected by dip sampling or by use of the P-63 or D-74 samplers.

Concentrations of suspended sediment were primarily flow dependent (tables 2 and 3). The lowest concentrations were found in samples collected in September, a low-flow period. Highest concentrations of suspended sediment were found in July or August during high-flow periods. It is during these high-flow periods that the majority of the sediment is transported past the bridge sites. Most of the suspended sediment is composed of silt and clay material.

BEDLOAD

Bedload samples were collected from the beginning of June through the end of August at Bridges 331, 1187, 332, and 342. Three bedload samples were collected at the Million Dollar Bridge. Bedload samples were collected using a Helley-Smith bedload sampler (Helley and Smith, 1971) which is designed to sample fine-to-coarse material (0.062-76.2 mm) within 0.3 ft of the streambed. The sampler was held on the bed for 30-second intervals at 15 to 20 equally spaced points across the channel. Duplicate samples were collected intermittently. The particle-size distributions for all samples are shown in figures 4-7. Values of median diameter (d_{50}) and bedload discharge (table 4) were calculated using the averages of the samples collected.

Some general observations can be made concerning the limited amount of bedload data collected (table 4, figs. 4-7). No bedload was found in the three samples from the Million Dollar Bridge. Also, a distinct difference is apparent in the size of the bedload transported past Bridge 342 and the size of bedload transported past Bridges 331, 1187, and 332. On June 23, and 24, 1992, for example, median diameter (d_{50}) was 16.0 mm at Bridge 342 and 3.0 1.0, and 0.8 mm, respectively at Bridges 331, 1187, and 332.

SURVEY AND CROSS-SECTIONAL DATA

Because part of this study will probably involve flow and (or) sediment modeling, a common datum was established for the entire study area. Monuments were placed at all bridges, and in 1991, control was established using the Global Positioning System (GPS) (Brabets, 1992). Additional monuments were established in 1992 throughout the study area (table 5, fig. 8) using GPS techniques. Surveyed cross sections of the Copper River (fig. 9) could then be referenced to the same datum. The cross sections were surveyed using a fathometer attached to a boat. The sites of the cross sections contained most of flow of the Copper River.

Severe erosion problems have occurred at Bridge 342. During the winter of 1990-91, spur dikes were constructed at this bridge to protect the structure from further erosion. In May 1991, a bathymetric survey was done by boat in the vicinity of the dikes and the bridge to document conditions before the runoff season began. Another bathymetric survey was done in June 1992. In September 1992, the ground features of the area were surveyed.

The most noted feature from the June 1992 bathymetric survey was a 65-foot scour hole located about 100 ft off the tip of the upstream left spur dike (fig. 10). The ground survey in September indicated that about 400 ft of the upstream gravel bar had eroded since June 3 (fig. 11). Cross sections of the channel at Bridge 342 obtained from discharge measurements made during 1992, indicate that the right part of the channel has scoured (fig. 12).

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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.

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.

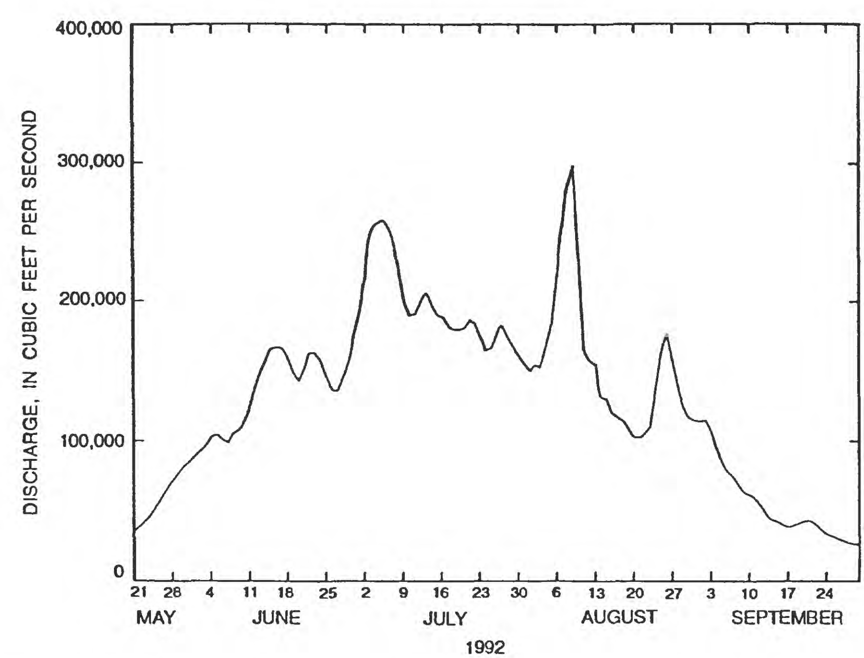

Figure 3. Mean daily discharge of the Copper River at Million Dollar Bridge, May 21 to September 30, 1992.

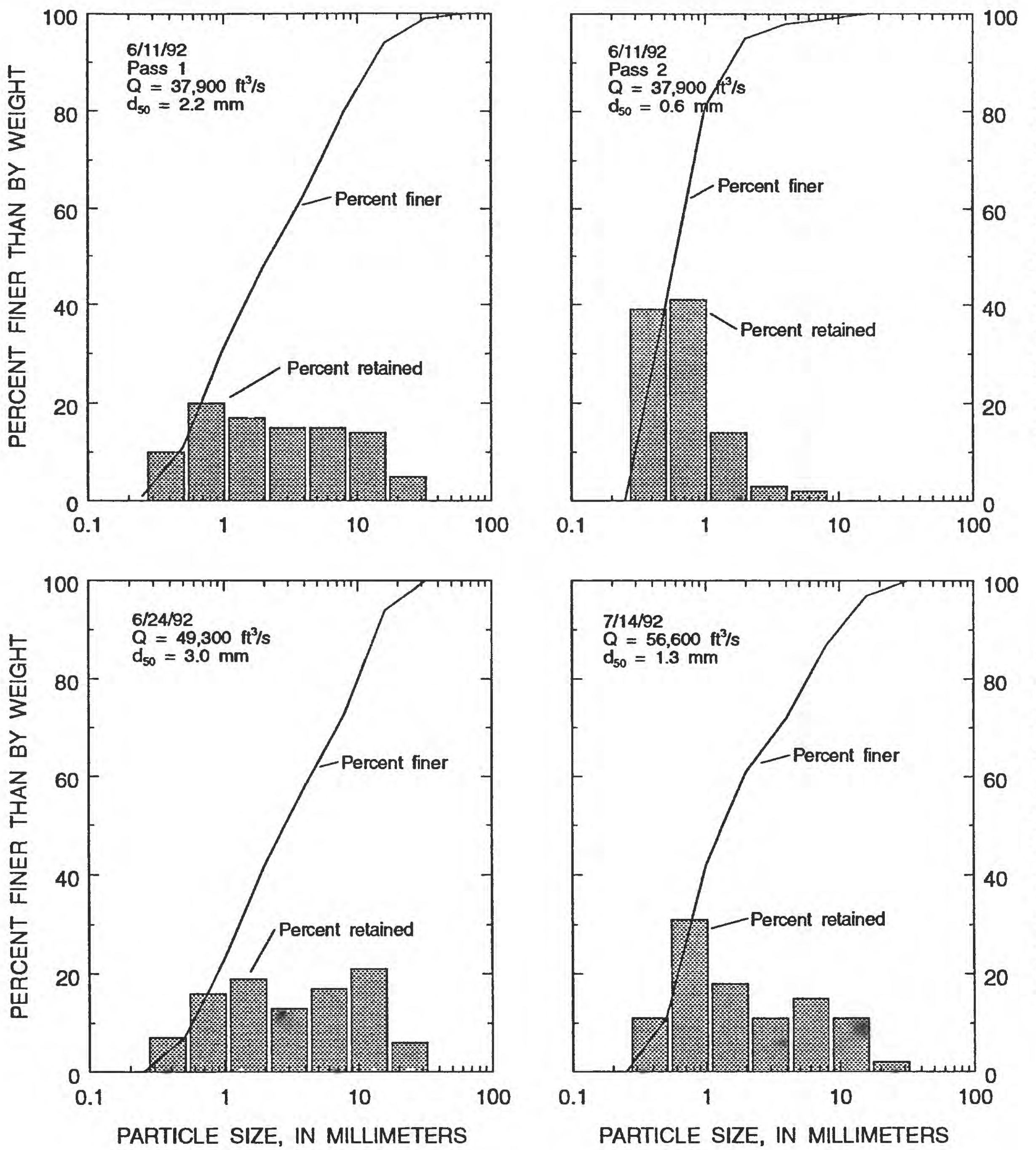

Figure 4. Particle-size distribution and median diameter (d_{50}) of bedload, Copper River at Bridge 331.

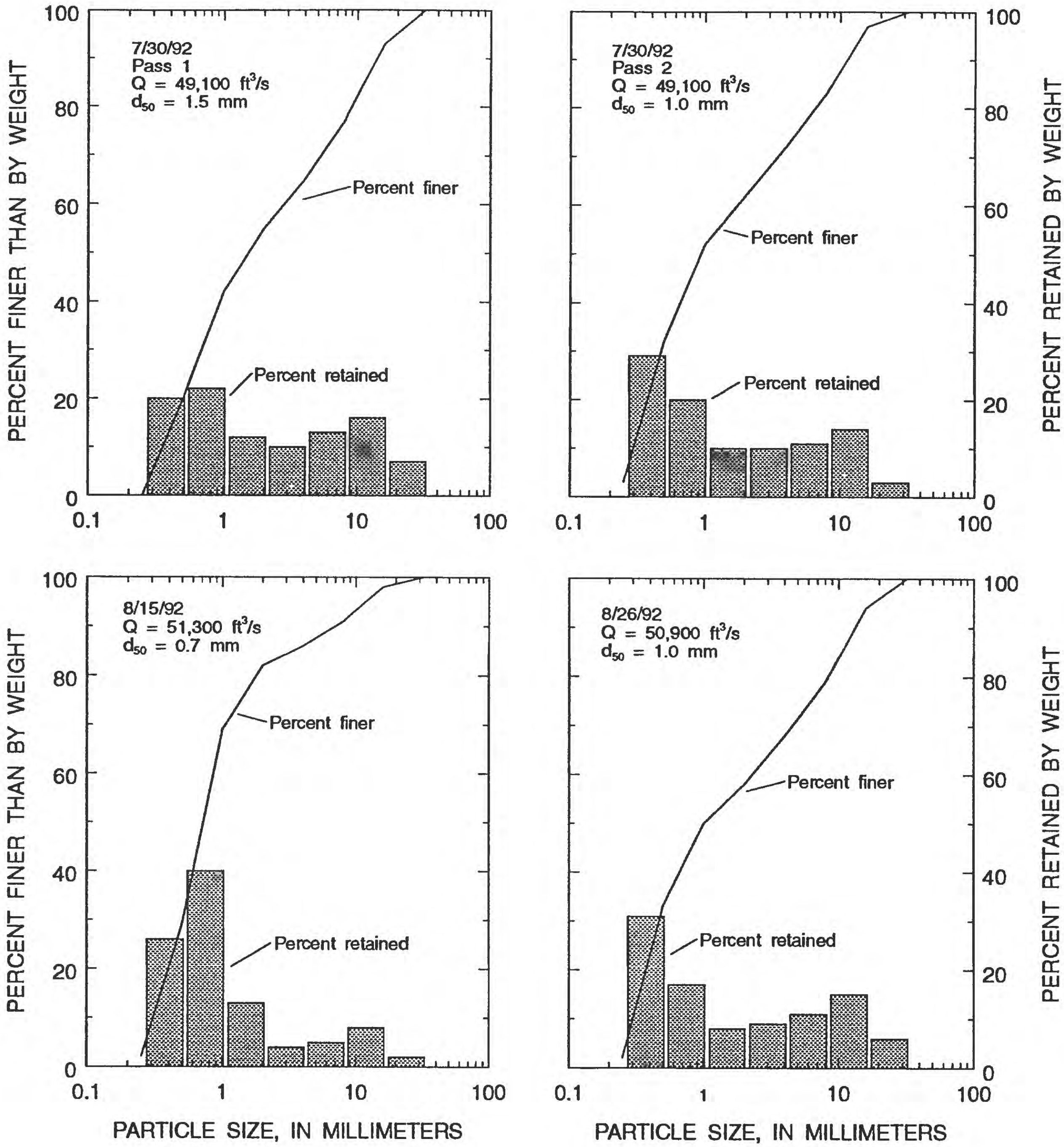

Figure 4. Continued

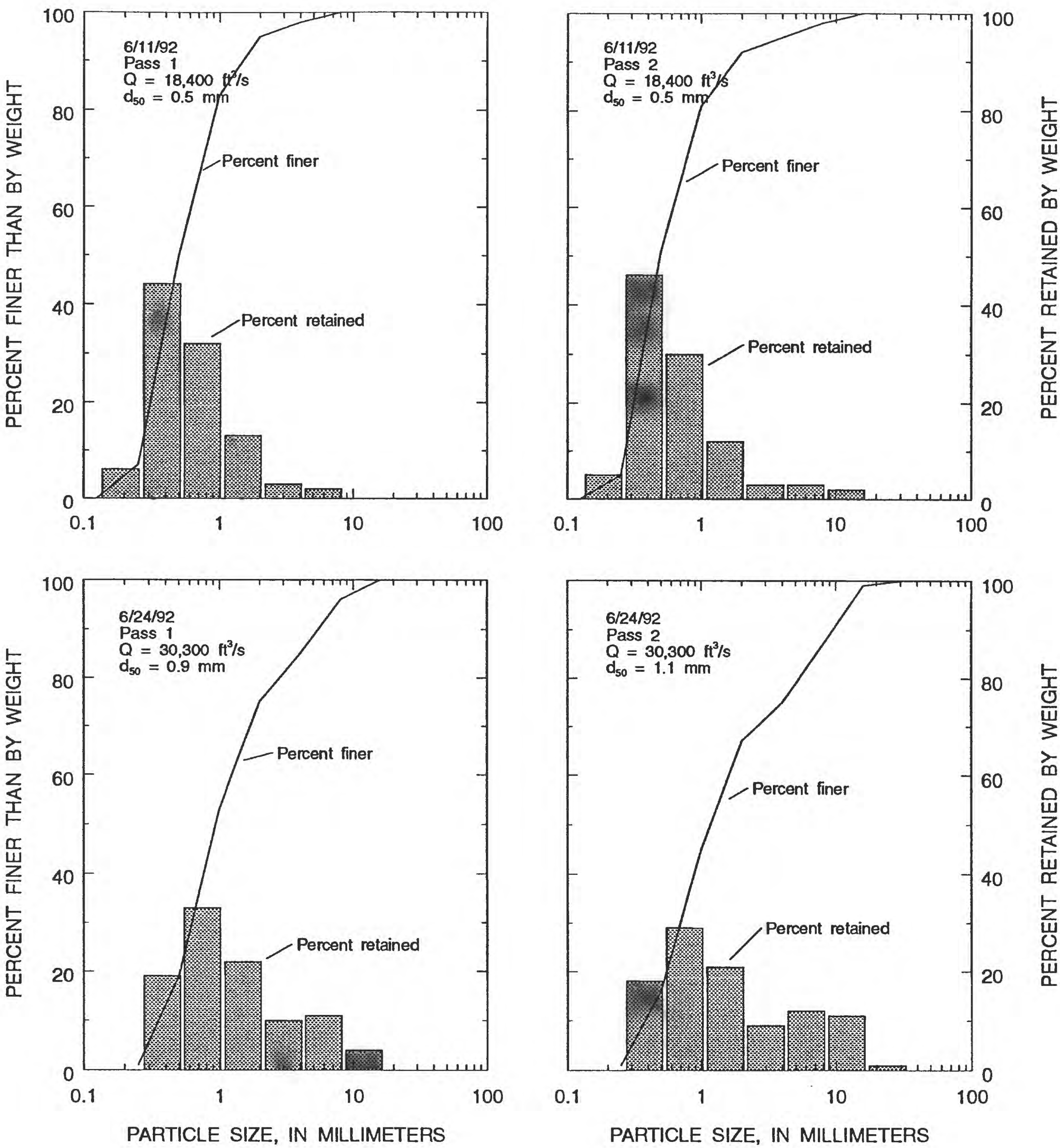

Figure 5. Particle-size distribution and median diameter (d_{50}) of bedload, Copper River at Bridge 1187.

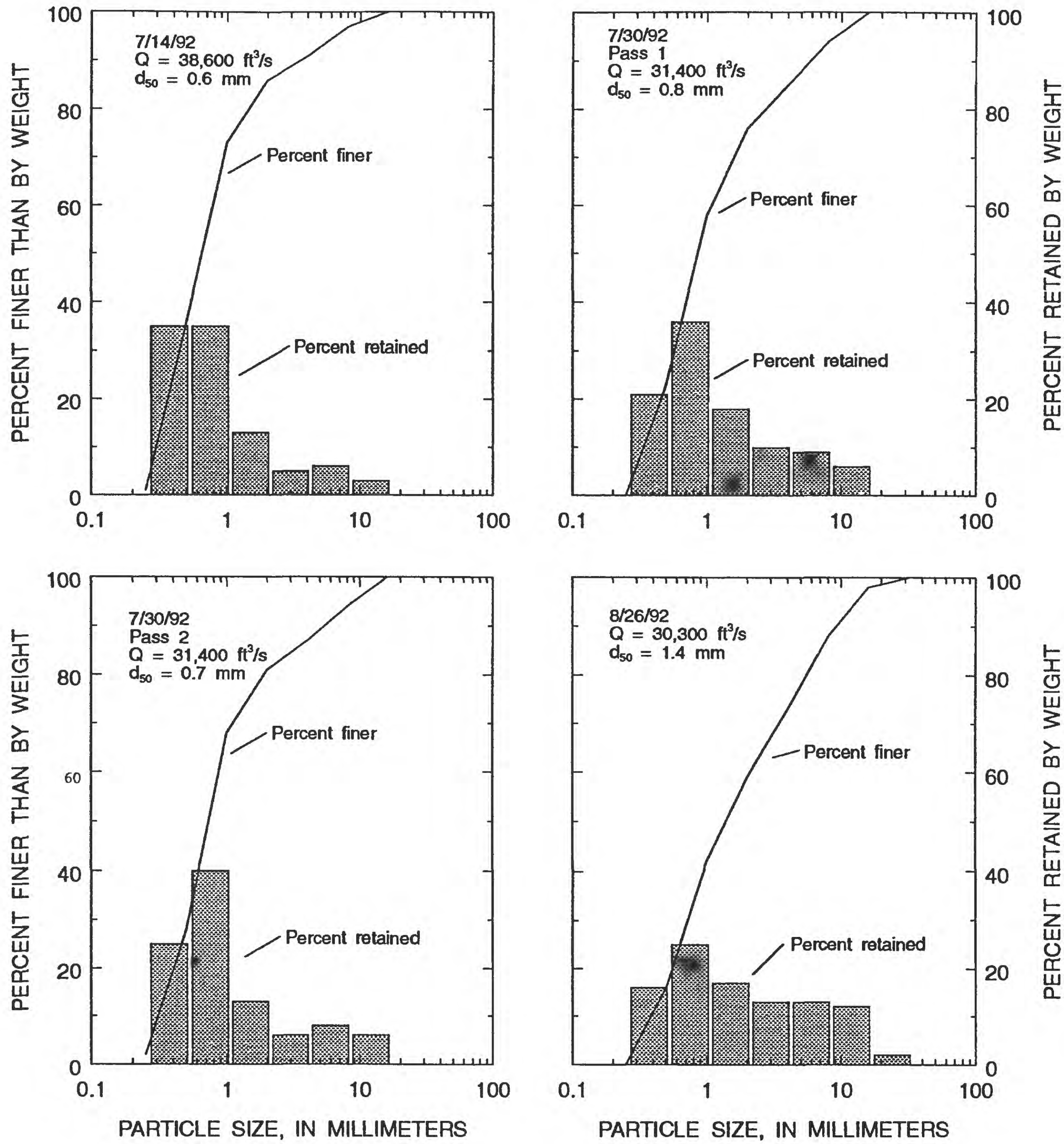

Figure 5. Continued.

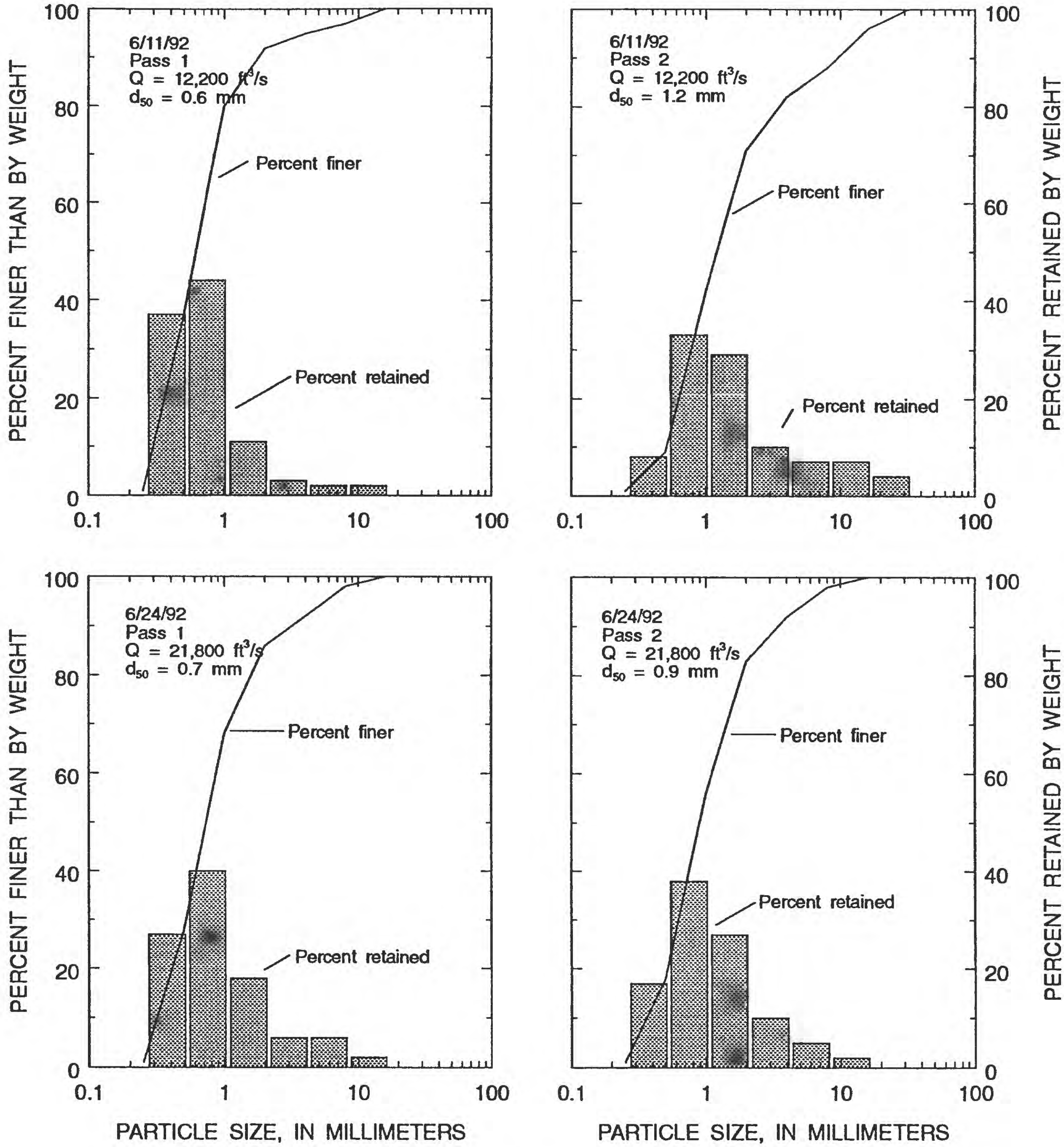

Figure 6. Particle-size distribution and median diameter (d_{50}) of bedload, Copper River at Bridge 332.

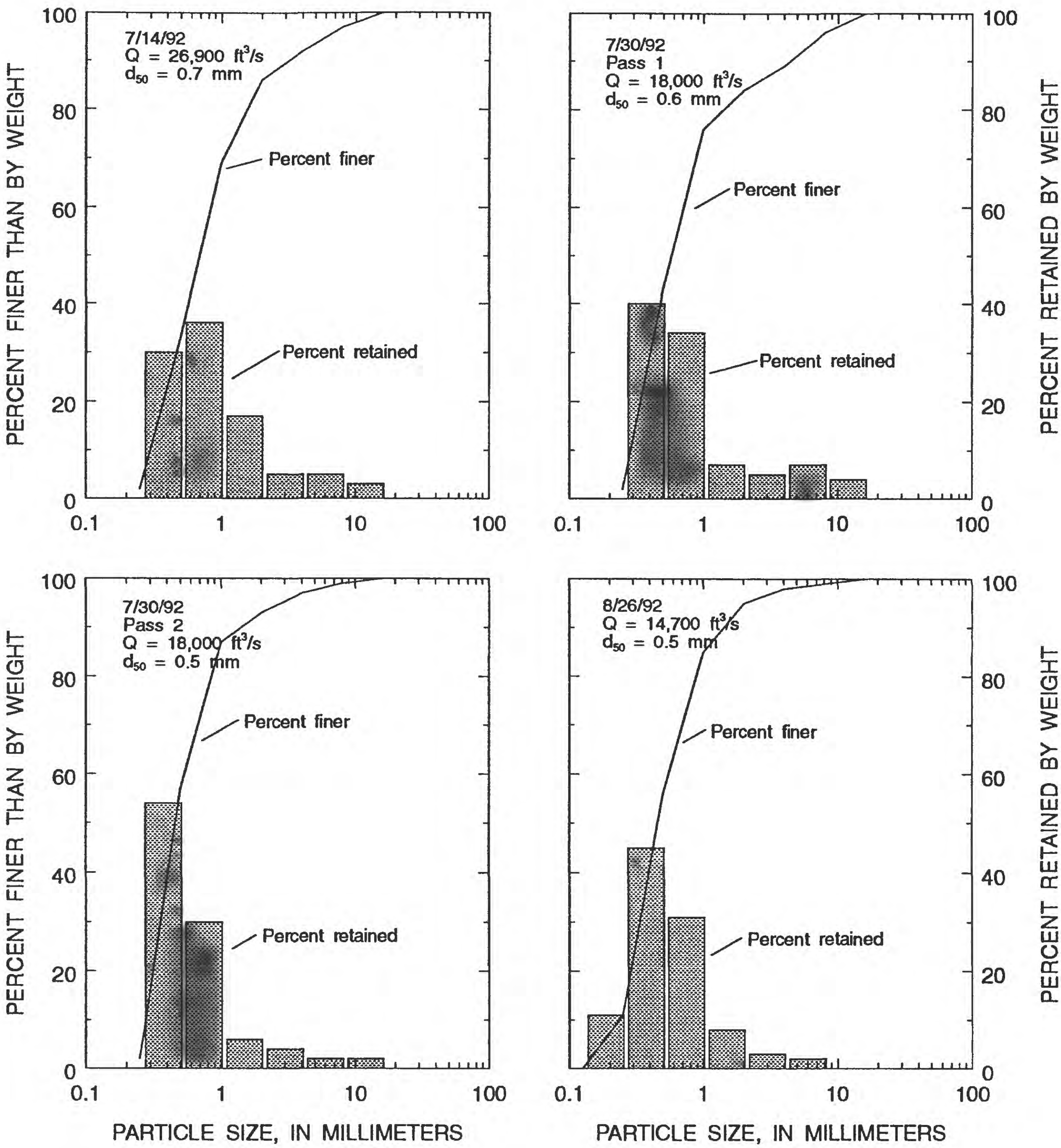

Figure 6. Continued

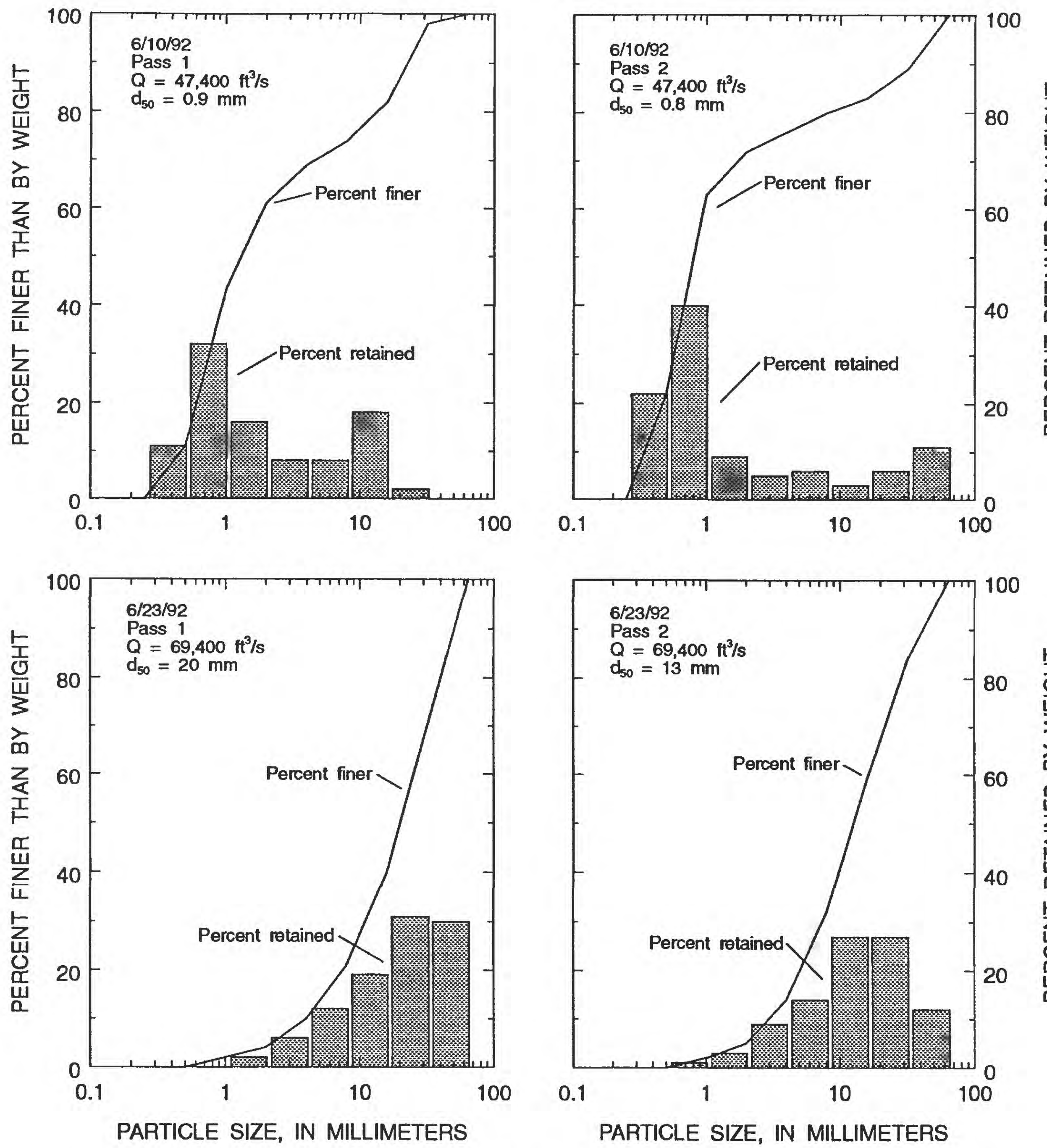

Figure 7. Particle-size distribution and median diameter (d_{50}) of bedload, Copper River at Bridge 342.

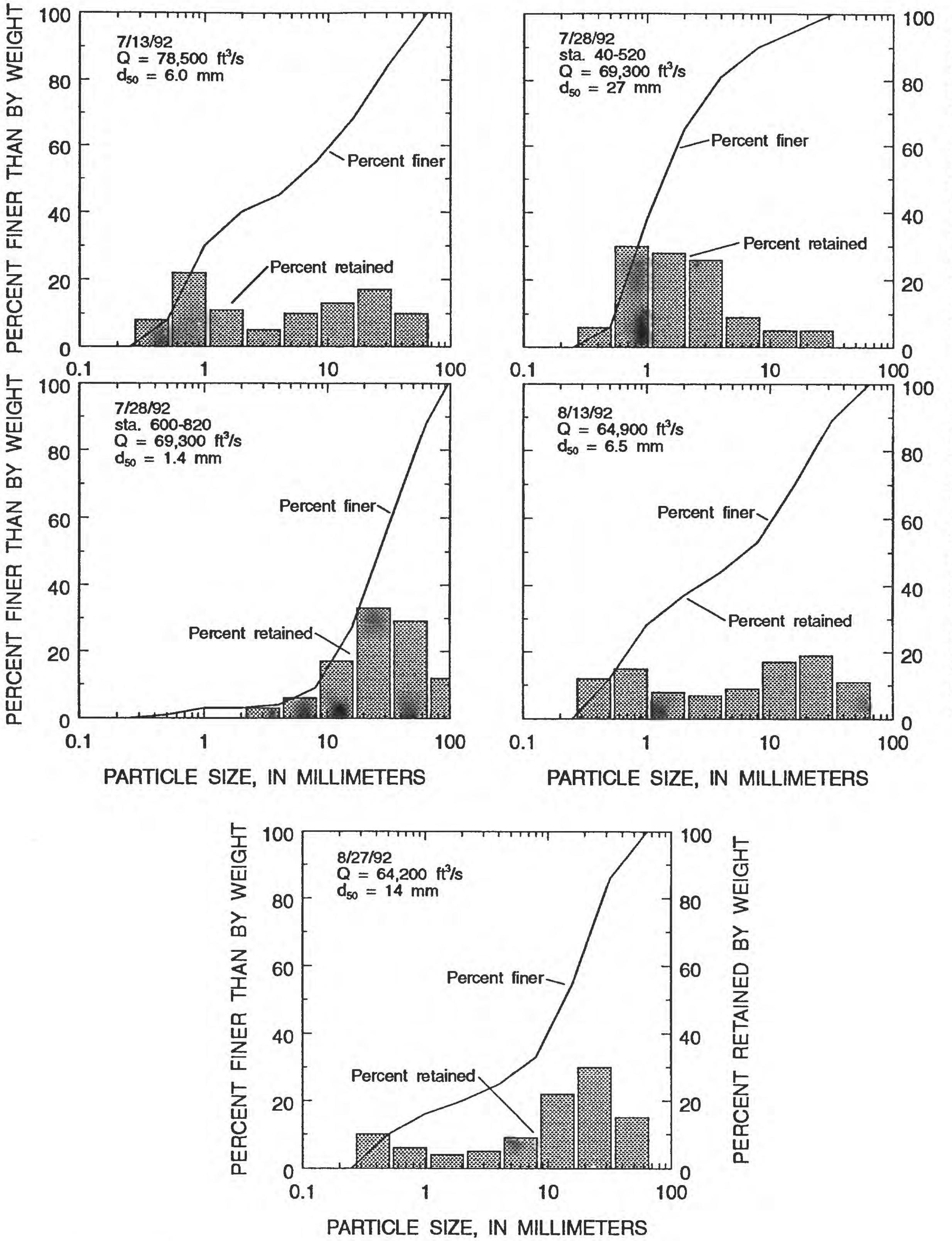

Figure 7. Continued.

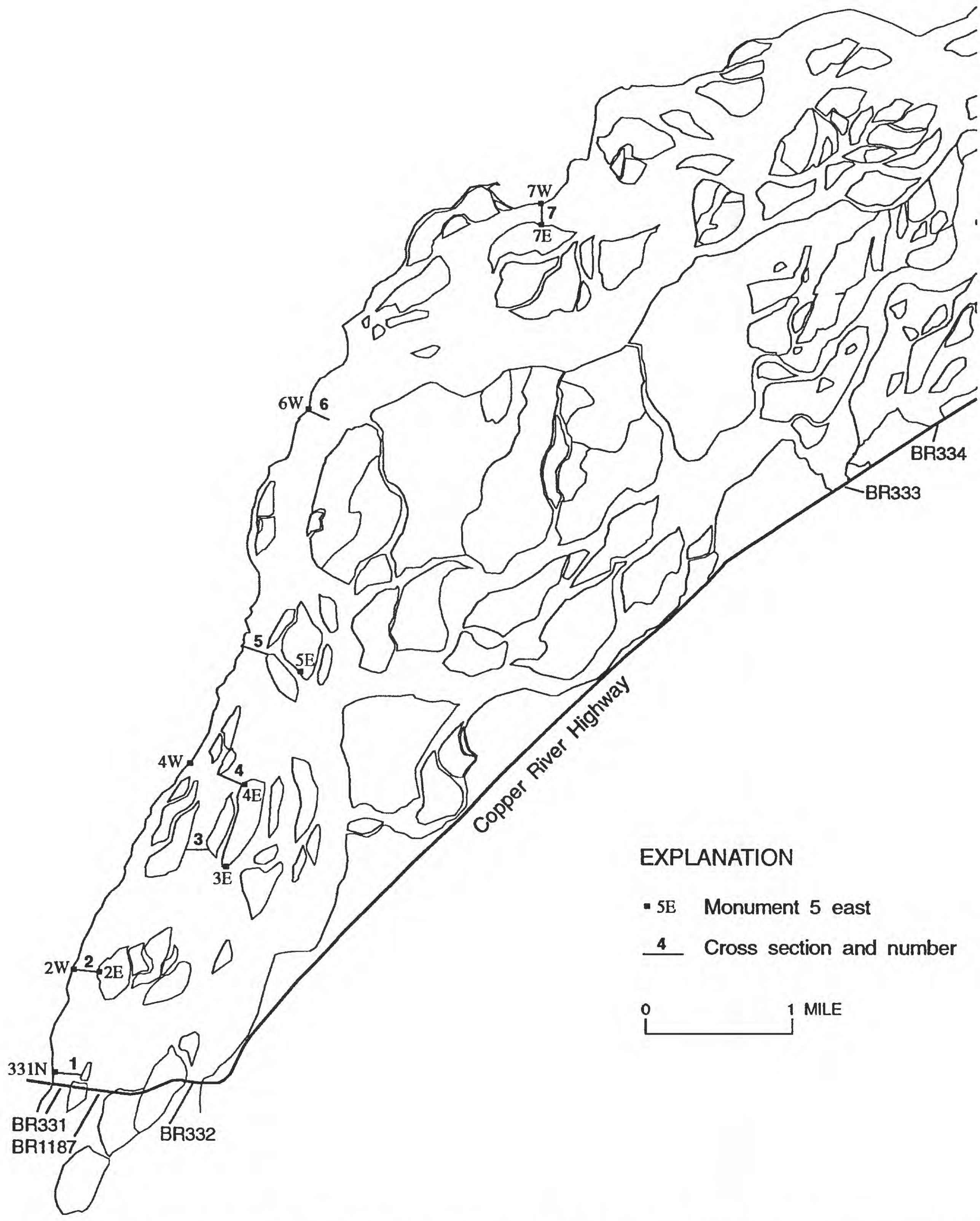

Figure 8. Location of cross sections, monuments, and bridges (see table 5 for description of monument positions).

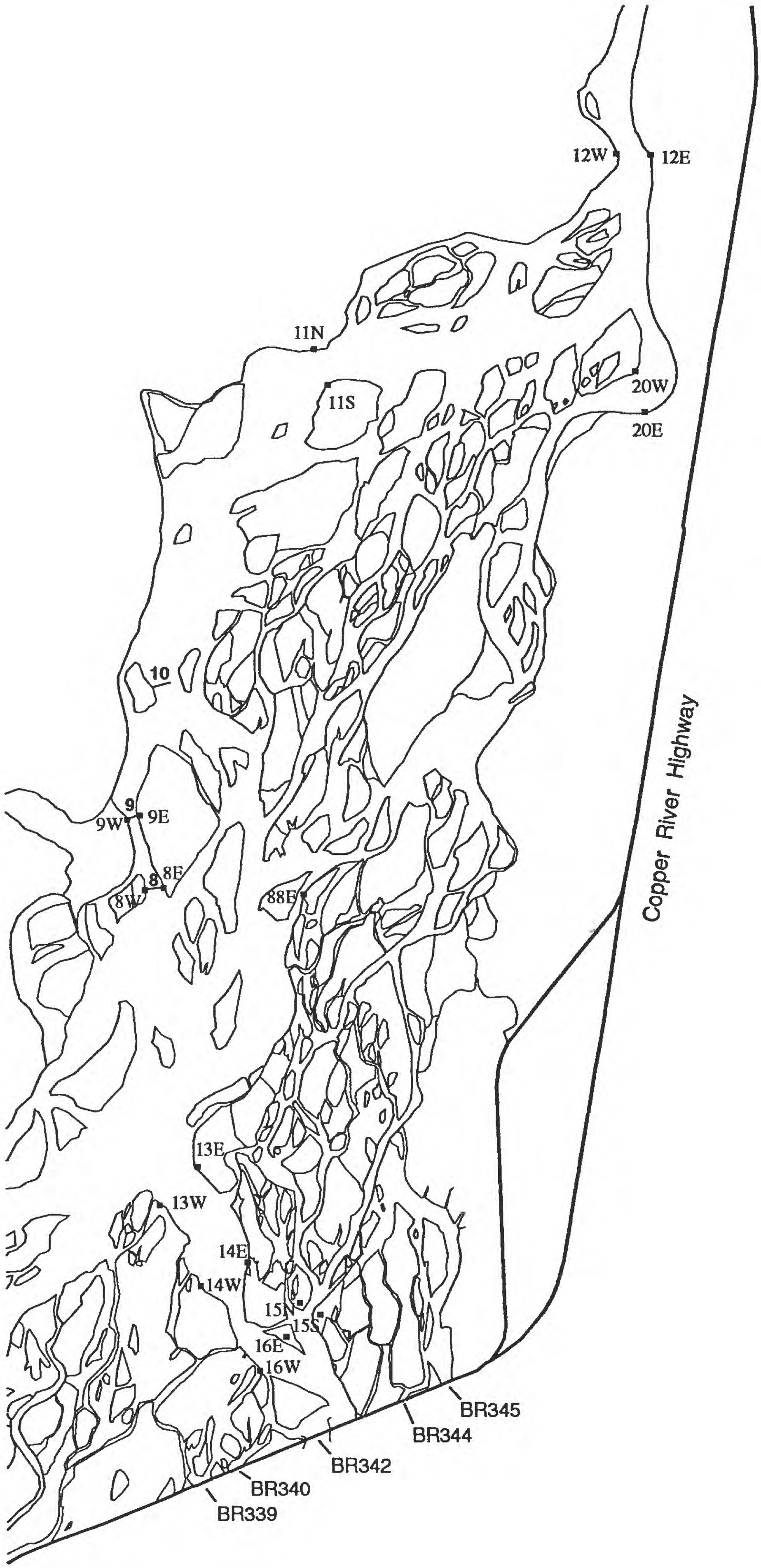

Figure 8. Continued.

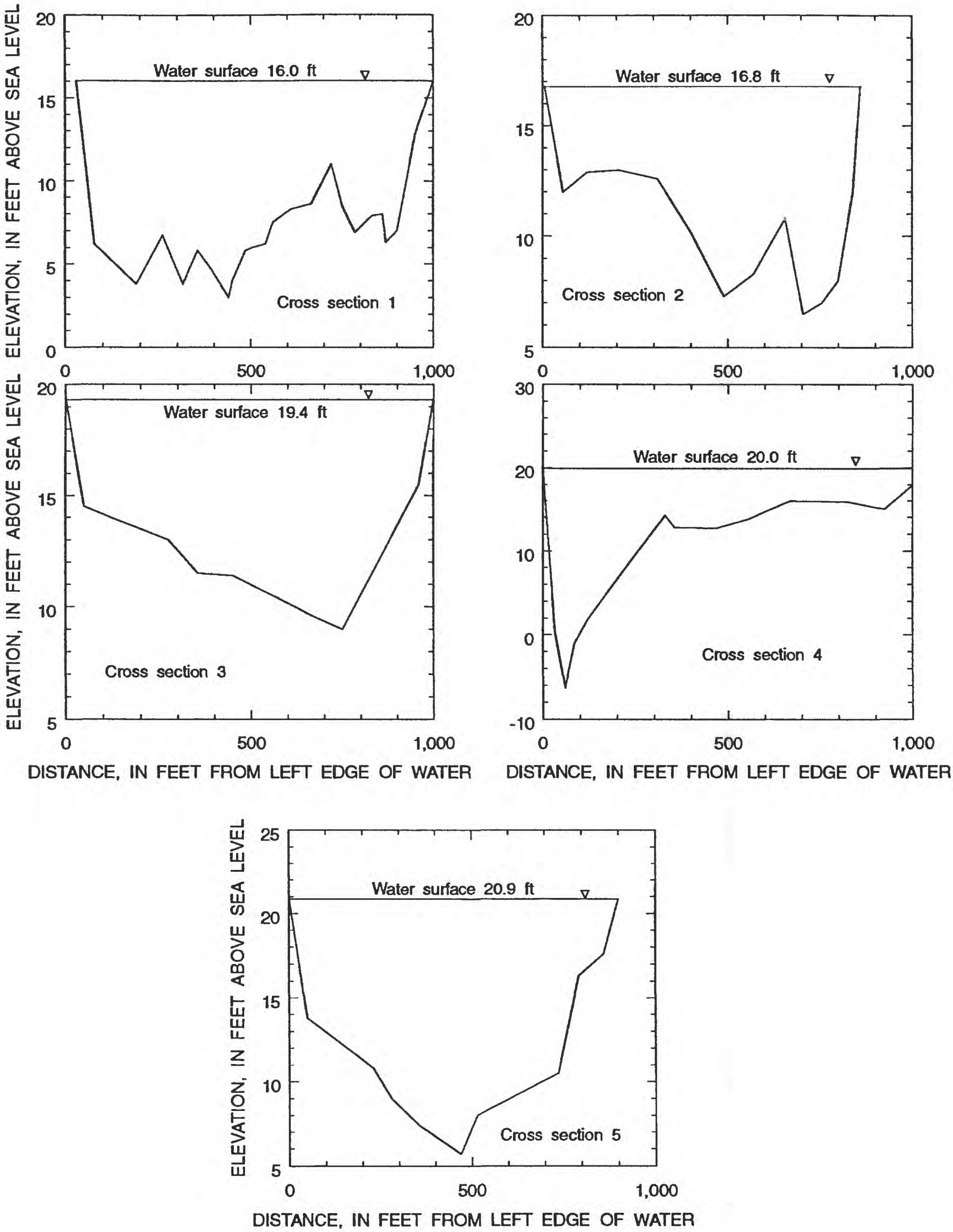

Figure 9. Cross sections of the Copper River (see figure 8 for cross-section locations).

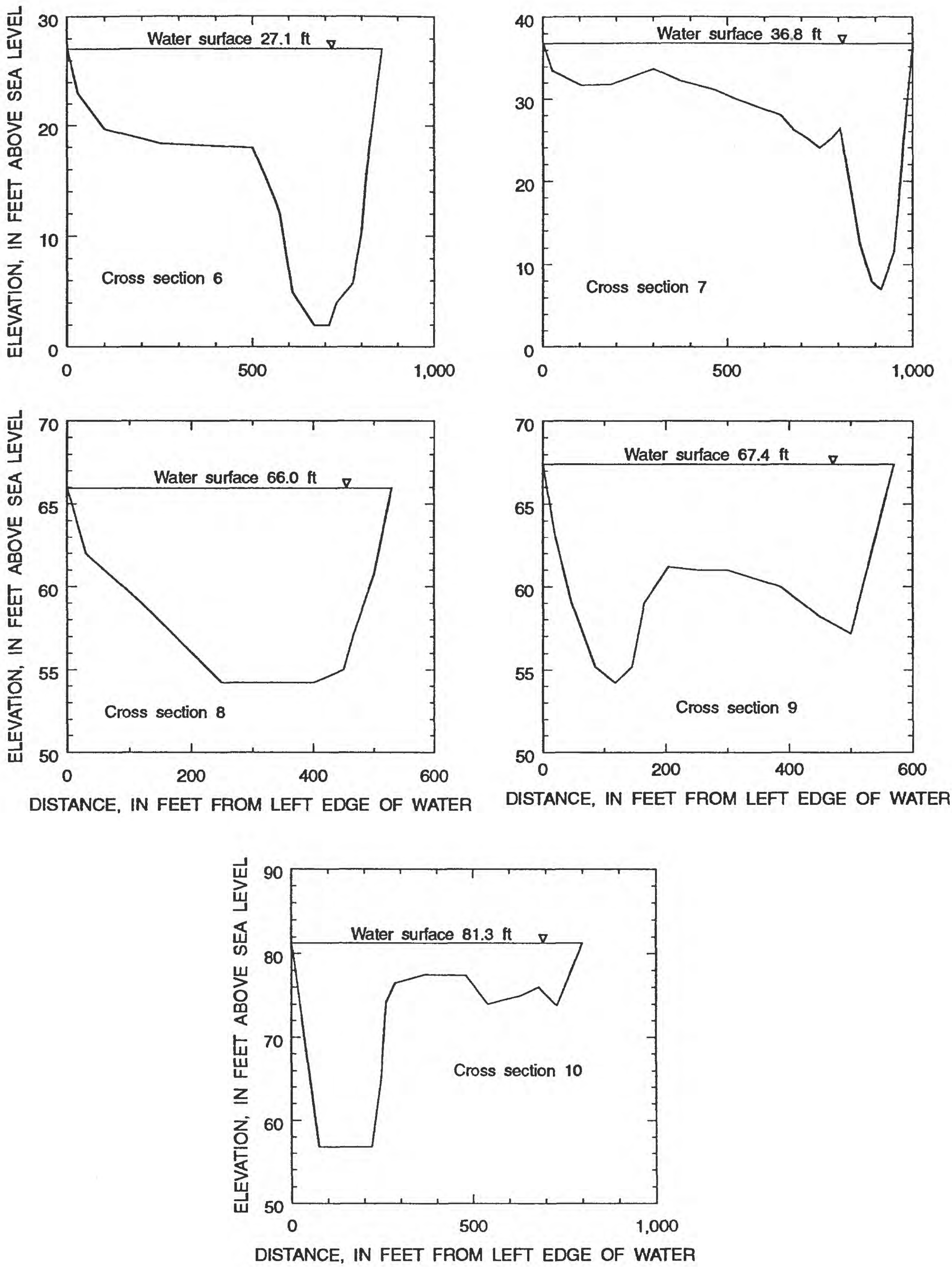

Figure 9. Continued.

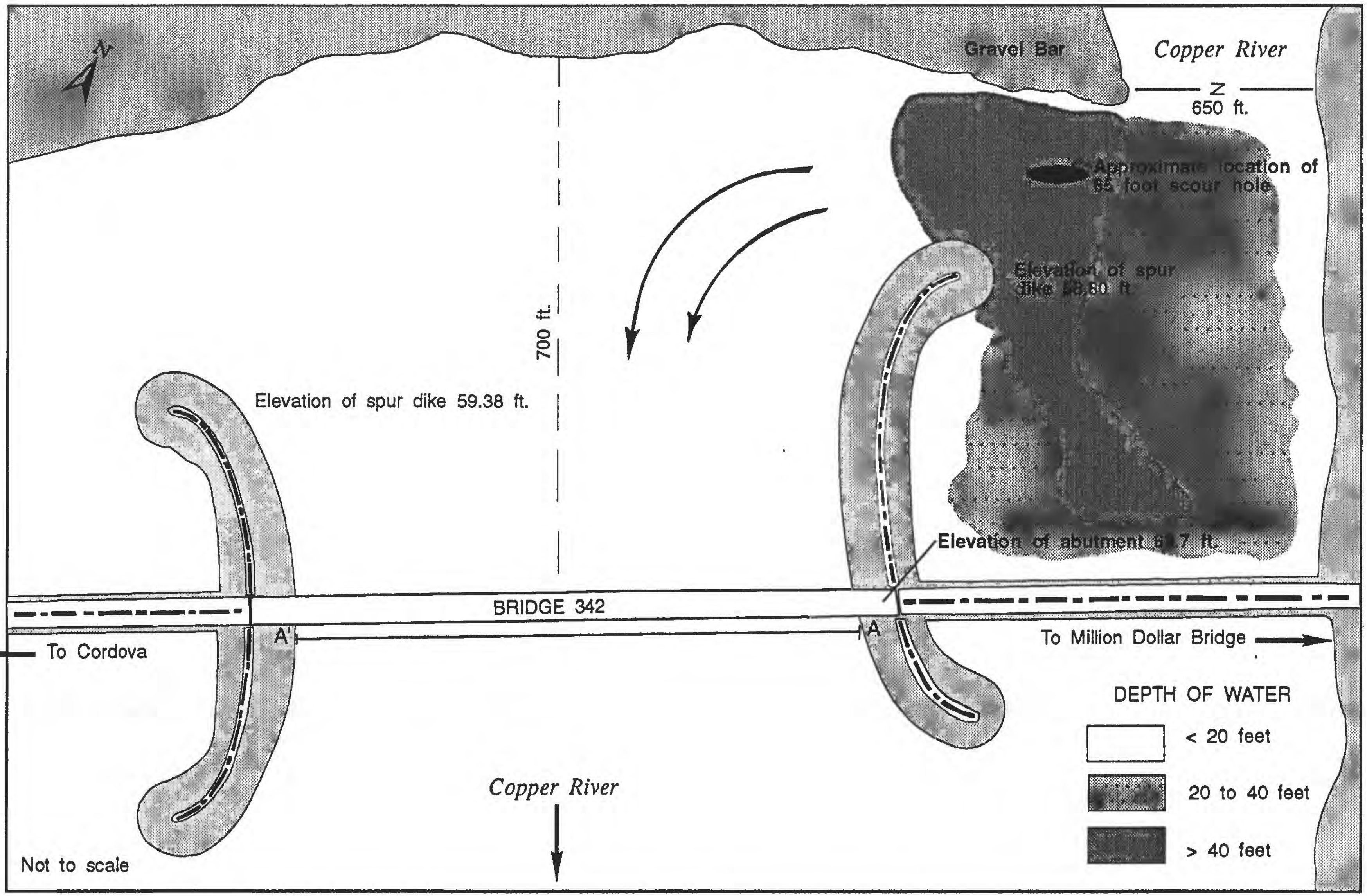

Figure 10. Bridge 342 area, June 3, 1992, showing elevation of spur dikes, water depths, and location of cross-section A-A'.

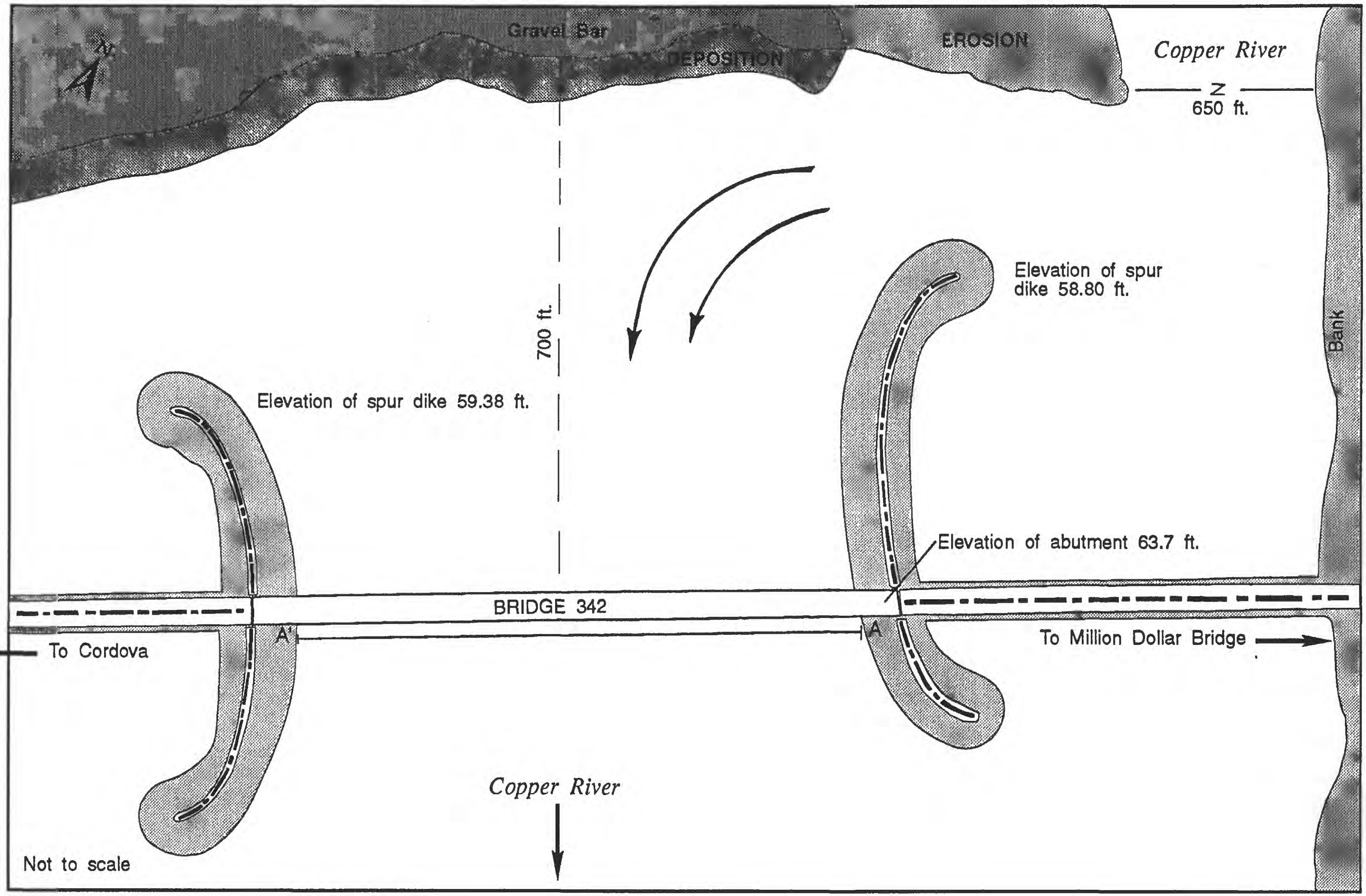

Figure 11. Bridge 342 area, showing erosion and deposition of gravel bar upstream from bridge between June 3 and September 16, 1992.

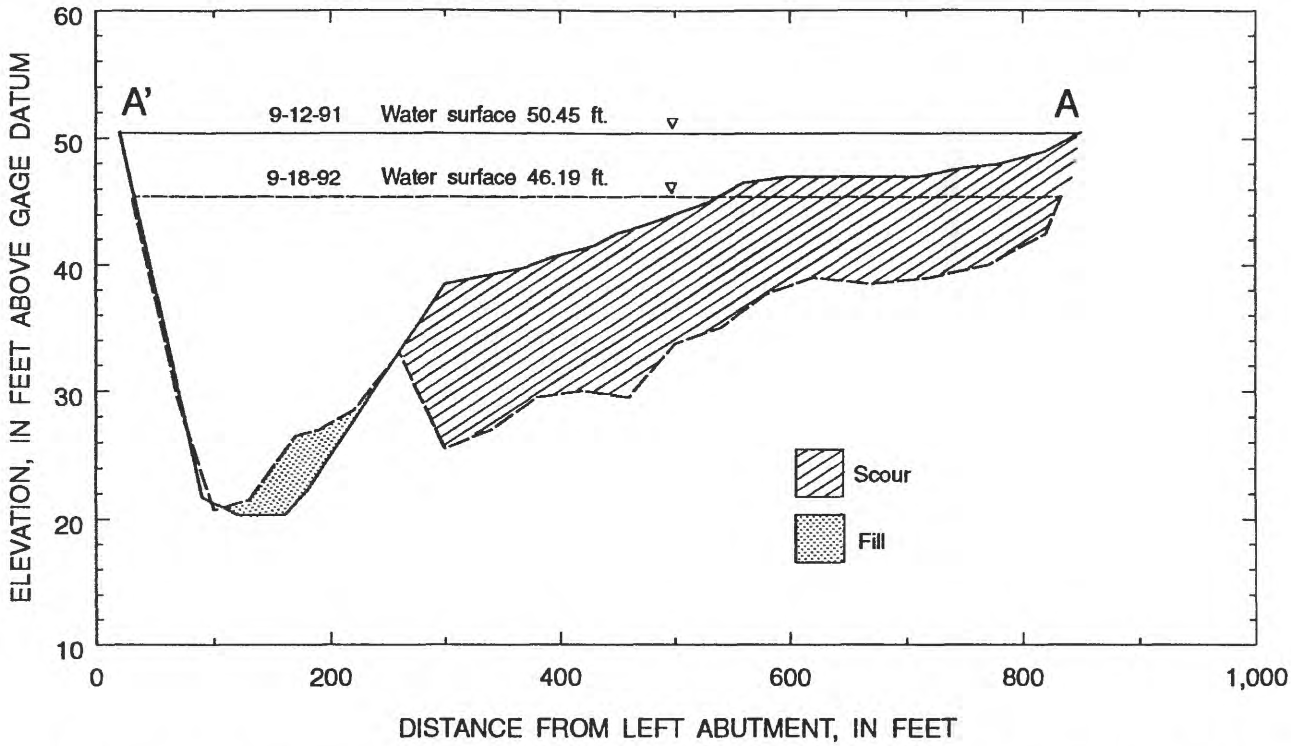

Figure 12. Cross-section profile, downstream side of Bridge 342, showing scour and fill characteristics (see figure 10 for location of A-A').

Table 1.--Discharge of the Copper River at bridges along the Copper River Highway

[Data values in cubic feet per second]

Date 1992	Bridge name										
	331	1187	332	333	334	336	339	340	342	344	345	Million Dollar
5/21-5/22	16,600	0	0	0	0	0	0	0	26,800	0	0	[a]36,000
6/8-6/9	37,900	18,400	12,200	2,160	620	0	368	1,140	47,400	0	0	[a]106,000
6/22	49,300	30,300	21,800	5,070	5,560	0	2,240	6,270	69,400	0	0	162,000
7/13-7/14	56,600	38,600	26,900	8,710	13,100	0	3,700	7,150	78,500	0	318	[a]203,000
7/27-7/31	49,100	31,400	18,000	4,860	5,540	0	3,200	5,770	69,300	0	0	[b]169,000
8/11-8/12	51,300	30,300	15,000	5,240	8,470	0	3,800	5,860	64,900	0	0	[a]162,000
8/24-8/25	50,900	30,300	14,700	2,510	3,860	0	2,160	3,470	64,200	0	0	[a]146,000
9/8-9/9	29,400	11,500	2,280	710	246	0	425	235	30,200	0	0	[a]67,000
9/18	21,600	6,950	367	<100	0	0	<10	0	13,400	0	0	39,500

[a]Average for 2-day period.
[b]Average for 5-day period.

Table 2.--Suspended-sediment data for the Copper River at bridges along the Copper River Highway

[ft³/s, cubic foot per second; mg/L, milligram per liter; ton/d, ton per day]

Bridge name	Date	Time	Water discharge (ft^3/s)	Suspended sediment		
				Concen-tration (mg/L)	Discharge (ton/d)	Percent finer than 0.062 mm
331	6-11-92	1630	37,900	783	81,100	80
	6-23-92	1730	49,300	891	118,600	77
	8-12-92	1510	51,300	2,298	318,300	91
	9-9-92	1415	29,400	748	59,400	82
	9-22-92	1300	21,600	1,220	71,200	90
1187	6-11-92	1600	18,400	843	41,900	78
	6-23-92	1700	30,300	788	64,500	82
	8-12-92	1430	30,300	2,156	176,400	94
	9-9-92	1345	11,500	592	18,400	90
	9-22-92	1310	6,950	309	5,800	94
332	6-11-92	1530	12,200	852	28,100	74
	6-23-92	1515	21,800	798	47,000	83
	8-12-92	1330	15,000	2,095	84,800	96
	9-9-92	1245	2,280	560	3,450	89
333	6-10-92	1445	2,160	532	3,100	90
	6-23-92	1515	5,070	583	7,980	98
	7-13-92	1730	8,710	1,220	28,700	96
	7-31-92	1430	4,860	781	10,200	95
	8-13-92	1325	5,240	1,780	25,200	97
	8-27-92	1530	2,510	1,080	7,320	95
	9 -9-92	1505	710	485	930	99
334	6-10-92	1430	620	299	500	100
	6-23-92	1500	5,560	640	9,610	95
	7-13-92	1550	13,100	1,180	41,700	97
	7-31-92	1330	5,540	706	10,600	98
	8-13-92	1315	8,470	1,990	45,500	97
	8-27-92	1500	3,860	1,120	11,700	96
	9-9-92	1515	246	252	167	100

Table 2.--Suspended-sediment data for the Copper River at bridges along the Copper River Highway--Continued

Bridge name	Date	Time	Water discharge (ft^3/s)	Suspended sediment: Concentration (mg/L)	Suspended sediment: Discharge (ton/d)	Suspended sediment: Percent finer than 0.062 mm
339	6-10-92	1415	368	439	436	98
	6-23-92	1430	2,240	654	3,960	94
	7-13--92	1510	3,700	1,150	11,500	98
	7-28-92	1200	3,200	878	7,580	90
	8-13-92	1300	3,800	2,170	22,300	96
	8-27-92	1430	2,160	1,260	7,350	89
	9-9-92	1525	425	412	473	100
340	6-10-92	1400	1,140	425	1,310	96
	6-23-92	1400	6,270	676	11,400	91
	7-13-92	1430	7,150	1,160	22,400	97
	7-28-92	1130	5,770	1,030	16,000	93
	8-13-92	1240	5,860	2,170	34,300	96
	8-27-92	1415	3,470	1,220	11,400	93
	9-9-92	1530	235	351	222	100
342	6-10-92	1200	47,400	513	65,600	88
	6-23-92	1100	69,400	739	138,500	87
	8-13-92	1100	64,900	2,316	405,800	95
	9-9-92	1545	30,200	651	53,100	90
	9-22-92	1010	13,400	262	9,480	99
345	7-13-92	1245	318	991	850	99
Million Dollar	6-29-92	1231	151,000	722	294,400	90
	7-10-92	1821	190,000	2,210	1,134,000	98
	8-13-92	0930	156,000	2,210	930,900	98
	9-4-92	1200	91,800	1,520	376,700	98
	9-22-92	0930	39,900	1,620	174,500	92

Table 3.--Suspended-sediment data and particle-size analyses for the Copper River at bridges along the Copper River Highway

[ft^3/s, cubic foot per second; mg/L, milligram per liter; ton/d, ton per day]

Bridge	Date	Time	Water discharge (ft^3/s)	Suspended sediment		Suspended sediment, percent finer than size indicated, in millimeters								
				Concentration (mg/L)	Discharge (ton/d)	0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500
331	7-14-92	1720	56,600	1,130	172,700	36.2	44.1	52.5	66.9	82.4	91	96	99	100
	7-30-92	1556	49,100	951	126,100	30.0	35.7	41.8	58.9	72.3	84	91	97	99
	8-26-92	1445	50,900	2,050	281,700	20.3	22.6	29.1	41.6	57.9	74	90	96	99
1187	7-14-92	1645	38,600	1,170	121,900	28.3	42.0	58.0	71.4	83.8	90	95	98	99
	7-30-92	1520	31,400	884	74,900	30.3	37.6	45.6	60.1	74.5	88	93	96	99
	8-26-92	1400	30,300	2,000	163,600	19.5	22.4	29.4	42.3	63.1	78	90	97	99
332	7-14-92	1610	26,900	1,110	80,600	33.8	45.8	55.7	71.3	83.3	91	95	98	100
	7-30-92	1455	18,000	871	42,300	31.2	43.0	50.7	64.6	81.3	88	93	97	99
	8-26-92	1315	14,700	1,810	71,800	19.5	20.8	28.7	43.7	64.7	81	91	98	100
342	7-13-92	1315	78,500	1,160	245,900	40.7	49.8	57.5	72.4	85.7	94	97	99	100
	7-28-92	1003	69,300	984	184,100	33.4	45.7	62.2	75.9	86.9	94	97	98	100
	8-27-92	1345	64,200	1,200	208,000	23.3	38.0	54.1	67.1	80.9	93	97	98	100
Million Dollar	7-29-92	1350	169,000	947	432,100	33.1	38.0	48.9	65.0	79.0	93	99	100	
	8-27-92	1030	160,000	1,020	440,600	20.0	20.7	27.3	39.7	58.4	93	98	99	100

Table 4.--Bedload data for the Copper River at bridges along the Copper River Highway

[ft^3/s, cubic foot per second; mm, millimeter; ton/d, ton per day; --, no data]

Bridge name	Date	Time	Water discharge (ft^3/s)	Bedload	
				Median diameter (d_{50})(mm)	Discharge (ton/d)
331	6-11-92	1500	37,900	1.4	2,600
	6-24-92	1000	49,300	3.0	3,450
	7-14-92	1300	56,600	1.3	3,300
	7-30-92	1240	49,100	1.2	1,750
	8-13-92	1600	51,300	0.7	730
	8-26-92	1600	50,900	1.0	2,170
1187	6-11-92	1400	18,400	0.5	1,540
	6-24-92	1100	30,300	1.0	1,450
	7-14-92	1400	38,600	0.6	4,010
	7-30-92	1030	31,400	0.8	3,880
	8-26-92	1430	30,300	1.4	4,690
332	6-11-92	1100	12,200	0.9	3,800
	6-23-92	0900	21,800	0.8	2,350
	7-14-92	1200	26,900	0.7	3,340
	7-30-92	0840	18,000	0.5	1,380
	8-26-92	1300	14,700	0.5	1,280
342	6-10-92	1100	47,400	0.8	1,000
	6-23-92	1000	69,400	16.0	8,540
	7-13-92	1400	78,500	6.0	12,800
	7-28-92	1003	69,300	14.0	7,140
	8-13-92	1300	64,900	6.0	3,510
	8-26-92	1300	64,200	14.0	2,770
Million Dollar	6-24-92	0900	151,000	--	0
	7-12-92	0930	190,000	--	0
	7-29-92	1000	169,000	--	0

Table 5.--Monuments established in the study area by Global Positioning System techniques

(N, North; S, South; E, East; W, West)

Monument (fig. 8)	Latitude	Longitude	Elevation (feet) (NGVD of 1929)
331N	60° 26' 50.65"	145° 05' 03.30"	45.79
2E	60° 27' 25.21"	145° 04' 19.79"	24.81
2W	60° 27' 29.49"	145° 04' 39.15"	23.07
3E	60° 28' 03.57"	145° 02' 49.45"	26.19
4E	60° 28' 28.58"	145° 02' 30.57"	27.96
4W	60° 28' 34.82"	145° 02' 47.40"	22.96
5E	60° 29' 13.92"	145° 02' 10.79"	29.02
6W	60° 30' 36.32"	145° 01' 45.50"	31.09
7E	60° 31' 41.86"	144° 58' 43.58"	39.20
7W	60° 31' 51.51"	144° 58' 39.22"	39.91
8E	60° 33' 56.32"	144° 51' 22.72"	69.82
8W	60° 33' 54.36"	144° 51' 44.24"	68.71
88E	60° 34' 04.02"	144° 50' 03.70"	71.02
9E	60° 34' 44.83"	144° 51' 47.34"	75.83
9W	60° 34' 42.37"	144° 51' 57.62"	74.04
11S	60° 37' 00.66"	144° 49' 49.42"	95.53
11N	60° 37' 12.27"	144° 49' 45.34"	97.92
12E	60° 38' 15.16"	144° 45' 50.54"	123.04
12W	60° 38' 15.00"	144° 46' 11.60"	143.30
13E	60° 32' 55.69"	144° 51' 11.40"	62.81
13W	60° 32' 40.72"	144° 51' 49.85"	61.43
14E	60° 32' 09.12"	144° 50' 32.22"	59.84
14W	60° 32' 00.18"	144° 50' 59.76"	57.76
15N	60° 32' 04.58"	144° 50' 01.83"	59.78
15S	60° 32' 02.19"	144° 49' 49.74"	57.92
16E	60° 31' 46.43"	144° 49' 48.21"	55.70
16W	60° 31' 39.68"	144° 50' 39.93"	57.49
20E	60° 36' 47.73"	144° 45' 54.69"	110.46
20W	60° 37' 01.09"	144° 46' 09.52"	109.13