UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

PROGRESS REPORT

INVESTIGATIONS OF FLUVIAL SEDIMENTS

MIDDLE LOUP RIVER NEAR DUNNING AND MILBURN, NEBRASKA

By

R. B. Vice and E. F. Serr III

Compiled as part of program of
Interior Department for development of
Missouri River basin

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INTRODUCTION

This progress report covers determinations of sediment and water discharges made from August 17 to September 14, 1949, on the Middle Loup River at Dunning and near Milburn, Nebr., and on the Dismal River at Dunning. The determinations were made to provide general information on bed-load movement and to furnish an approximate basis for estimating total sediment load to be expected at the site of a proposed diversion dam near Milburn. The proposed dam and related structures are part of the program of the Bureau of Reclamation in the Loup River basin. Bed-load movement at the dam site near Milburn might be computed by comparison with data obtained at a turbulence flume about 18 miles upstream on the Middle Loup River at Dunning. This turbulence flume was completed in May 1949 and is 1,150 feet below the bridge where daily samples of suspended sediment were collected from April 10, 1946, to March 21, 1950.

Th problem of computing total sediment load at the site of the proposed diversion dam near Milburn was discussed at a meeting in Lincoln, Nebr., on August 10, 1949. In attendance were W. M. Borland, J. L. Honnold, J. F. Mayne, and Ivan Bauer of the Bureau of Reclamation, and P. C. Benedict and R. B. Vice of the Geological Survey. Time limitations of the Bureau of Reclamation required that collection of field data be completed by September 15. Data were needed by the Bureau of Reclamation for use in connection with the preliminary design of structures and equipment for the

Milburn diversion works, the construction and operation costs of which were estimated at several million dollars.

In this report, the total sediment load is divided into two parts, suspended sediment and bed load. Suspended sediment is the sediment whose concentration can be sampled with a suspended sediment sampler. The remaining part of the total sediment load is called bed load.

It was generally believed that the relationship between the suspended load and bed load would vary in a given reach for different shapes of channel cross section and that this relationship would be the same for similar channel cross sections near Milburn and near Dunning. A program was designed to determine the suspended load at two sections near Milburn and, on the basis of similar sections at Dunning, the probable relationship between the suspended load and bed load at the two sections near Milburn. Observations at the entrance section of the turbulence flume were included as a part of the current research program respecting bed load. Measurements of the Dismal River were required to evaluate the water and sediment contribution of this major tributary between Dunning and Milburn. Usually each sediment discharge measurement included a water discharge measurement to determine the quantity and distribution of flow.

The study was organized to include determinations at eight different times of each of the following:

1. The suspended sediment discharge for a wide section near Dunning, and for a similar section near Milburn.

2. The suspended sediment discharge for a typical section near Dunning, and for a similar section near Milburn.

3. The suspended sediment discharge at the daily sampling section at Dunning where a continuous suspended-load record is available from April 10,

1946, to March 21, 1950.

4. The suspended sediment discharge at the entrance to the turbulence flume, and at the artificial section on the downstream side of the flume.

5. The suspended sediment discharge of the Dismal River at Dunning.

6. The slope of the water surface at the sections under items 1 and 2.

The collection of each complete set of data required a minimum of 2 days. The field work was carried on by the personnel of the Geological Survey, Lincoln, Nebr., and of the district office of the Bureau of Reclamation, Grand Island, Nebr. The laboratory and office work was done in the Lincoln office of the Geological Survey. The Bureau of Reclamation detailed one engineer to Lincoln to assist in the preparation of the data.

SEDIMENT SAMPLING SECTIONS

A map of the Middle Loup River from Dunning to Milburn, Nebr., is shown in figure 1. The seven sections at which observations were made on the Middle Loup River have been designated as sections A to G, in downstream order. The section on the Dismal River at Dunning was designated section H. Maps of the Dunning and Milburn areas (figs. 2 and 3) show the locations of these sections. Photographs of all sampling sections are shown in figures 4 to 12.

The general characteristics and varying condition of the stream sections are illustrated in plates 1 to 16 in the appendix. These illustrations present in graphical form the following four characteristics for each of the eight observations at each section: (1) distribution of water discharge across the section, (2) depth of water across the section, (3) velocity distribution across the section, and (4) distribution of suspended sediment across the section.

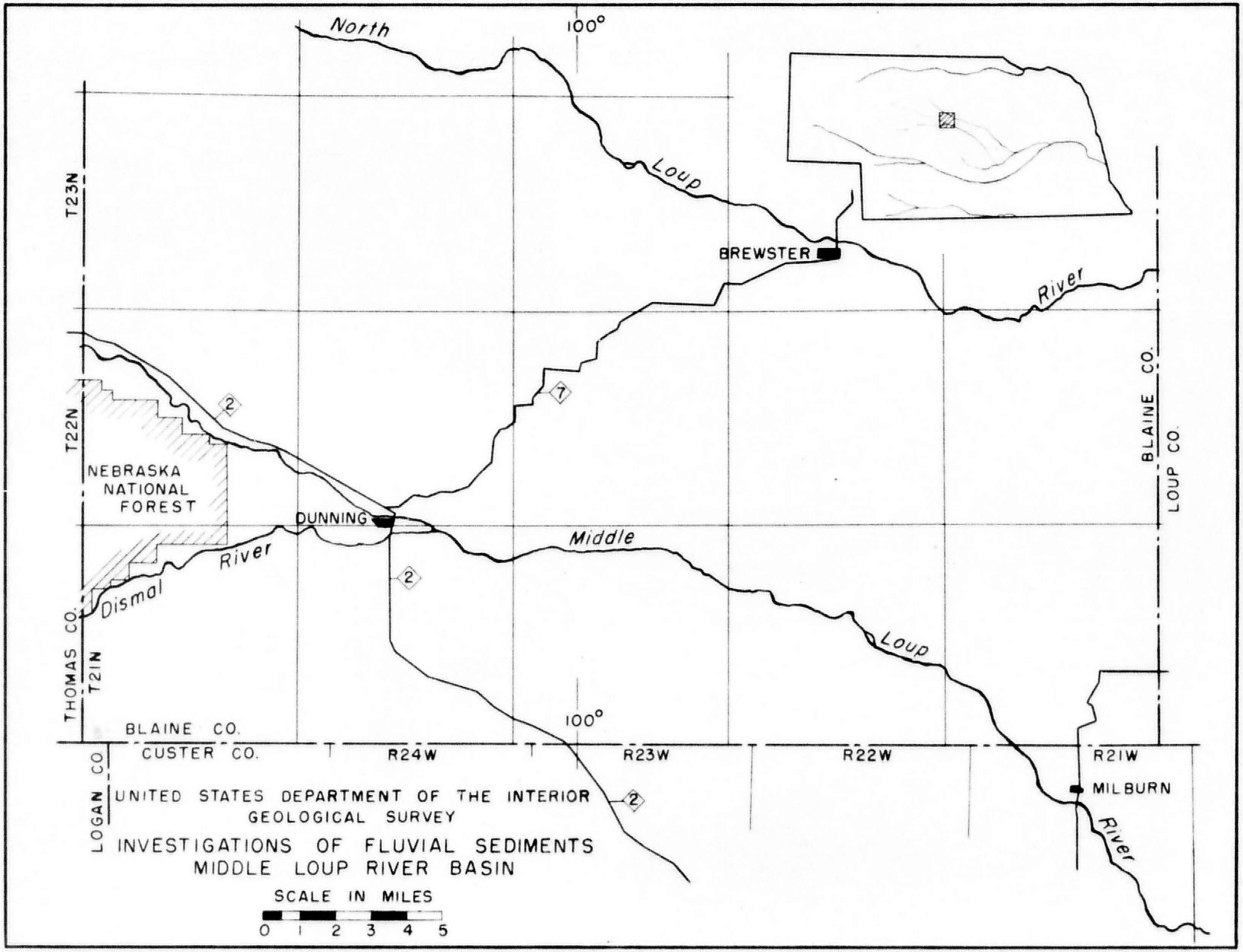


Figure 1.--Map of the Middle Loup River from Dunning to Milburn, Nebraska.

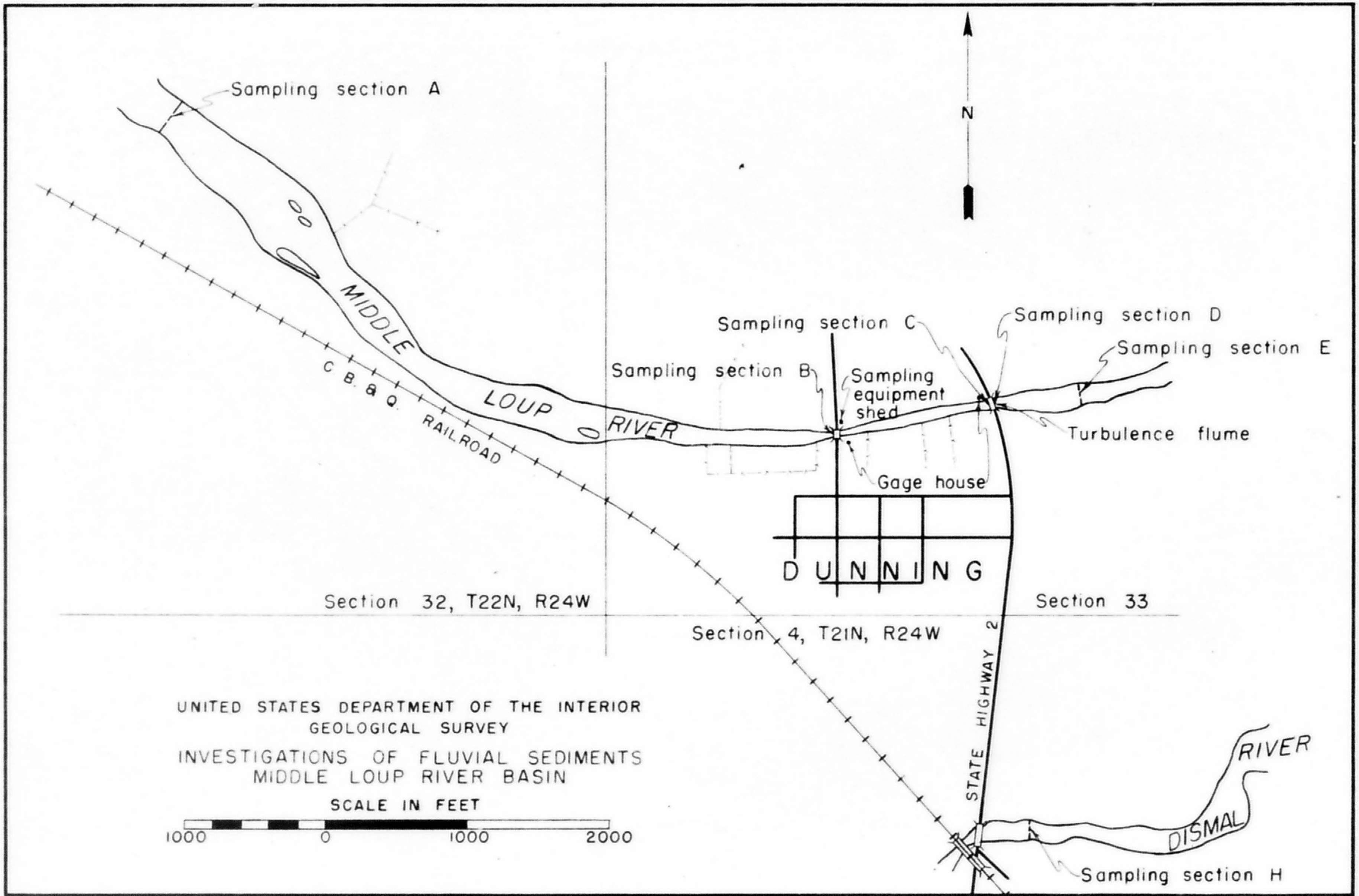


Figure 2.--Sediment sampling sections on the Middle Loup and Dismal Rivers near Dunning, Nebr.

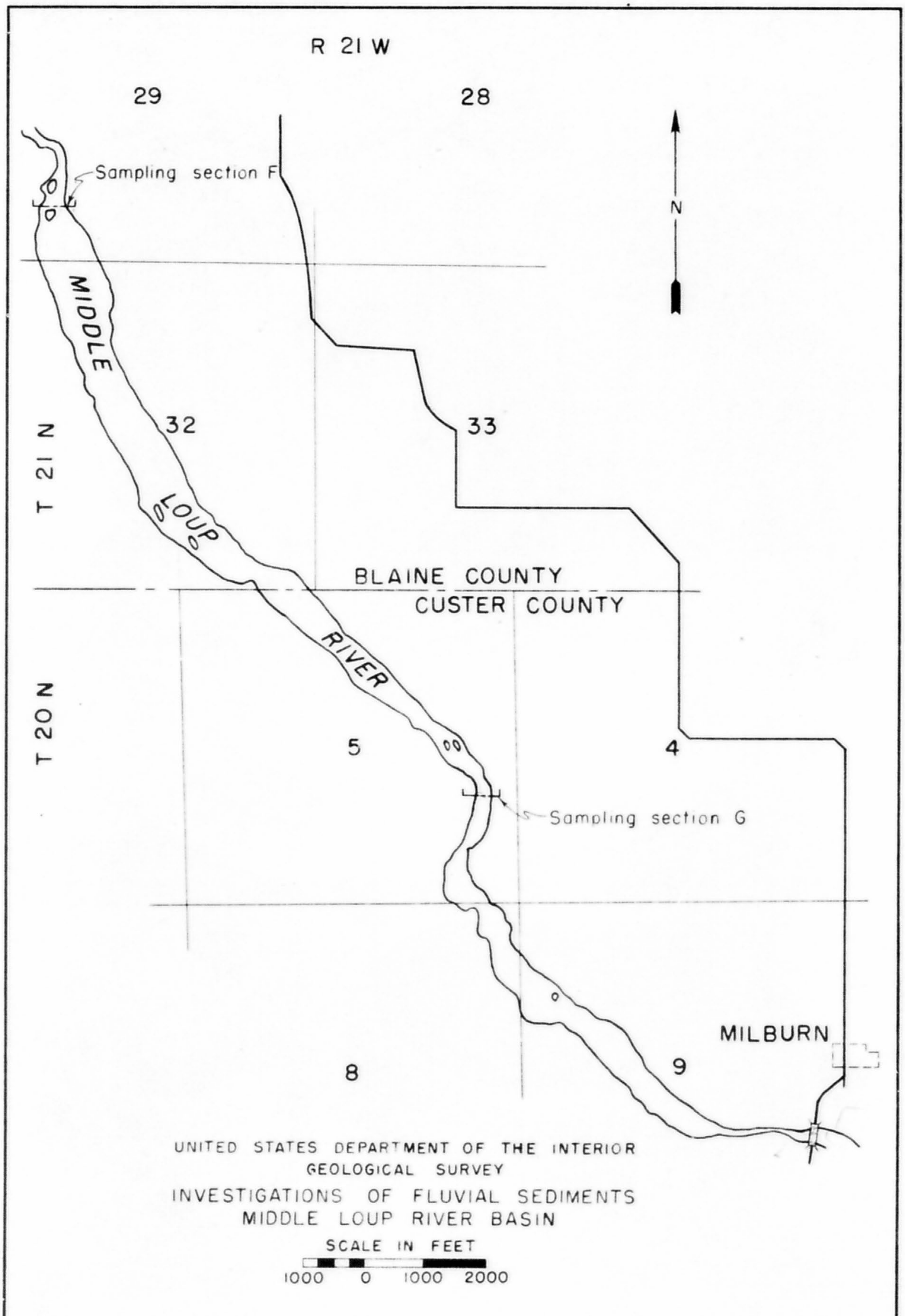


Figure 3.--Sediment sampling sections on the Middle Loup River near Milburn, Nebr.

A. View of section A looking downstream. Vehicle parked at right edge of section.

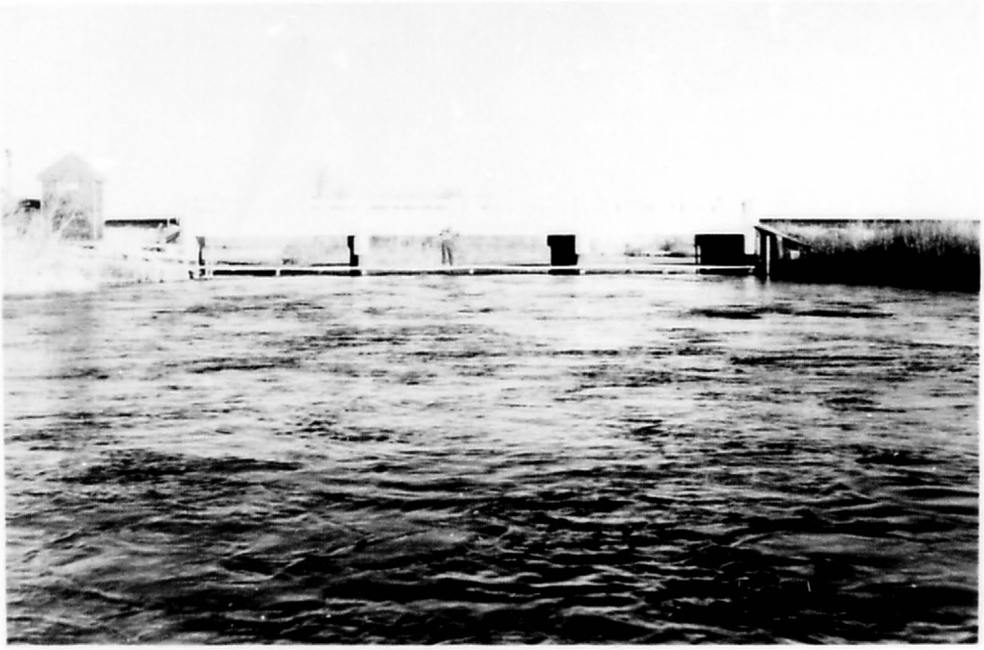
B. View upstream from section A. Post marks right edge of section.

Figure 4--Section A on the Middle Loup River near Dunning, Nebr.

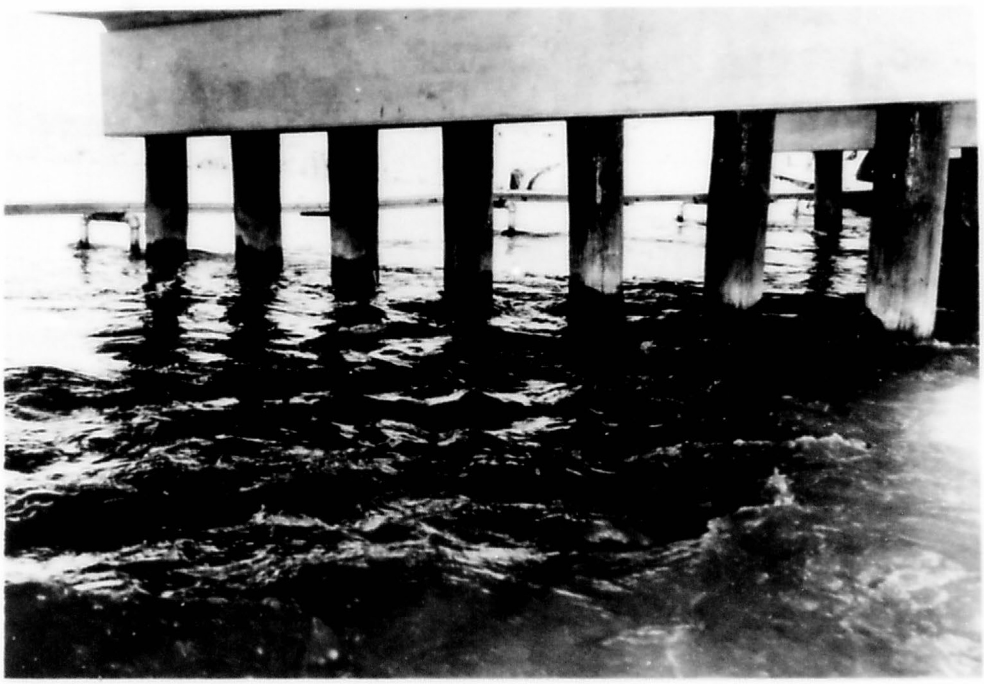
A. View of section B looking downstream. Measurements taken from upstream side bridge.

B. View of section B looking downstream from left bank. Gage well 30 feet downstream from bridge.

Figure 5--Section B on the Middle Loup River at Dunning, Nebr.

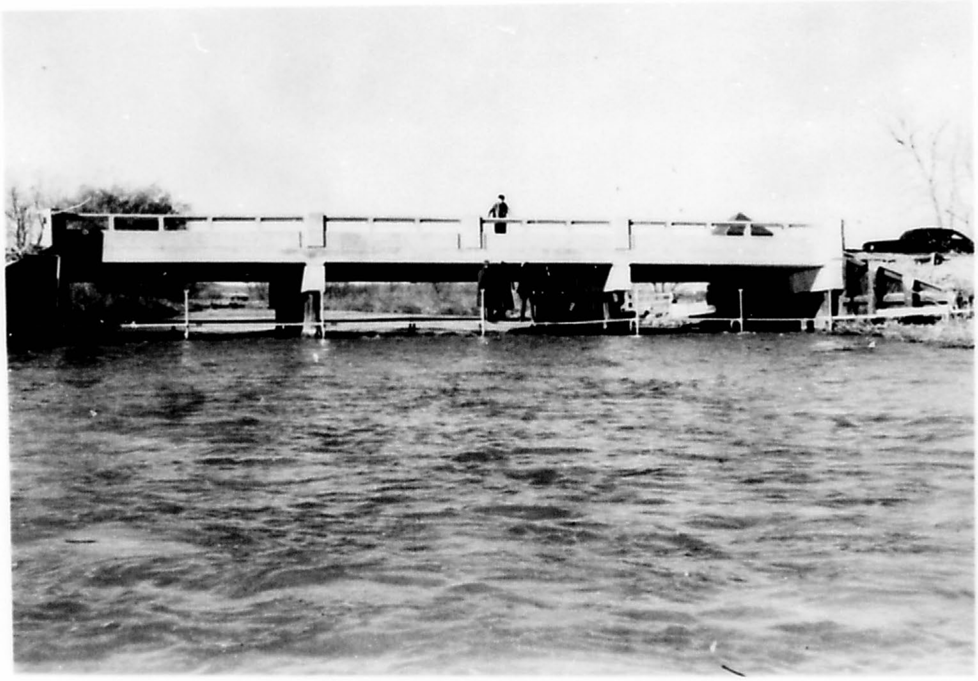


A. View of section C looking downstream. Measurements taken from walkway.



B. View of section C looking upstream from right abutment at section D. Baffles of turbulence-inducing structure causing riffles in foreground.

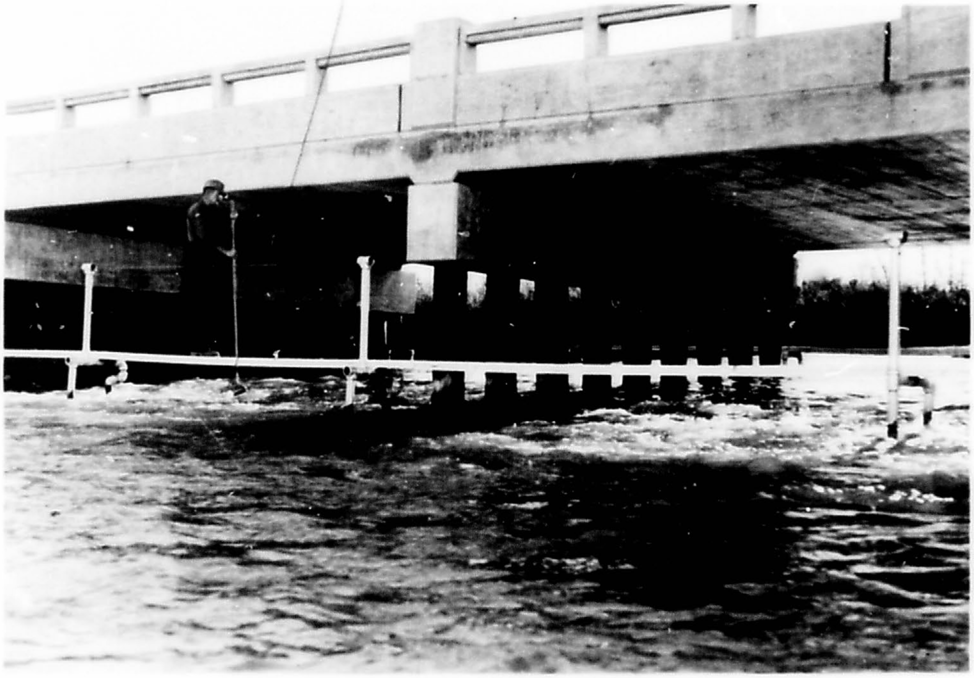
Figure 6--Section C on the Middle Loup River at Dunning, Nebr.



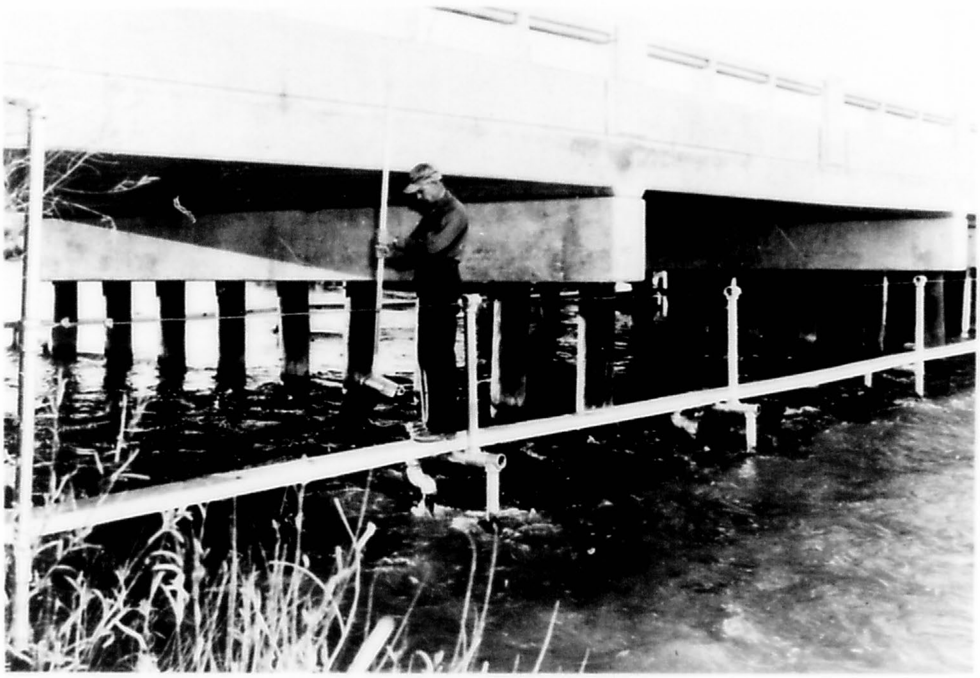
A. View of section D looking upstream.

B. Center reach of section D looking upstream. Hand sampler (US DH-48) in use.

Figure 7--Section D on the Middle Loup River at Dunning, Nebr.

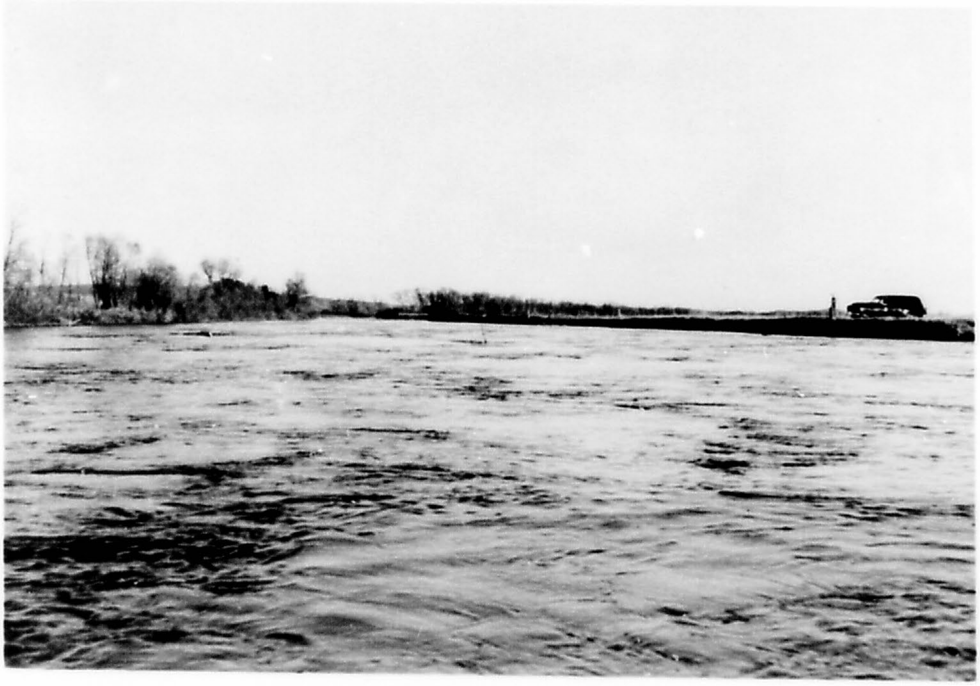


A. View of section D from left bank. Loss of head through structure about 0.35 foot.



B. View of section D from right bank.

Figure 8--Section D on the Middle Loup River at Dunning, Nebr.

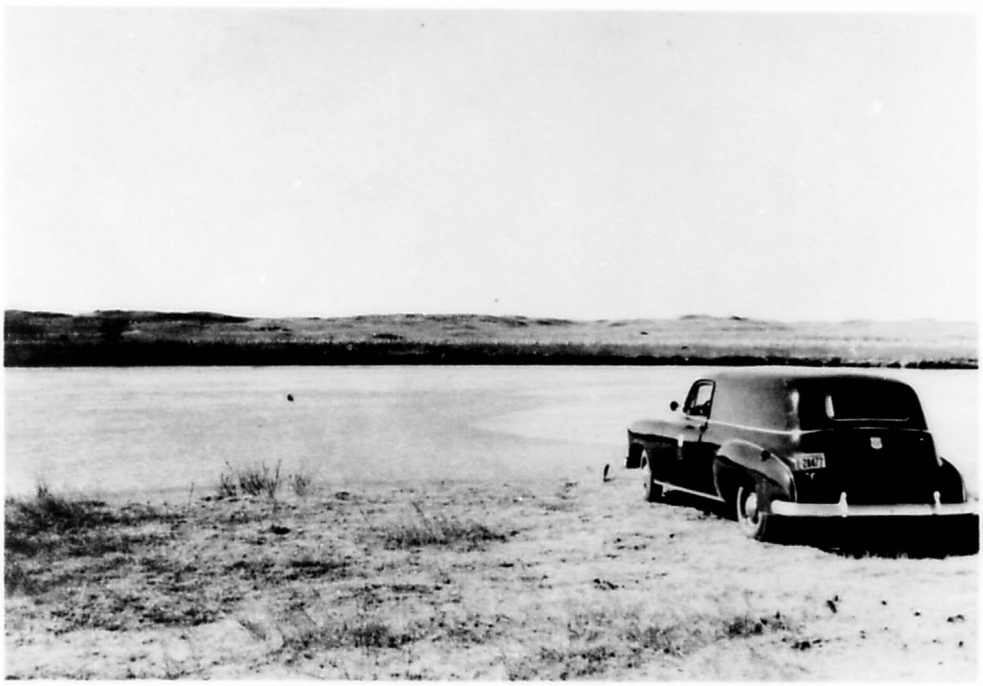


A. View of section E looking downstream. Man standing at right edge of section.

B. View across river at section E.

Figure 9--Section E on the Middle Loup River at Dunning, Nebr.

A. View of section F looking upstream. Vehicle at right parked at left edge of section.



B. View across river at section F.

Figure 10--Section F on the Middle Loup River near Milburn, Nebr.

A. View of section G looking upstream. Portion of bank in view at left is right edge of section..

B. View across river at section G Post marks left edge of section.

Figure 11--Section G on the Middle Loup River near Milburn, Nebr.

A. View across river at section H. Post directly opposite marks left edge of section.

B. View of section H looking downstream from highway bridge.

Figure 12--Section H on the Dismal River at Dunning, Nebr.

At all sections, except section D, the contour of the stream bed was changing constantly and was irregular owing to the characteristic sand dune movement of the material in the bed. This irregular bed resulted in unfavorable conditions for the accurate determination of water discharge and suspended sediment concentration. The typical steep front of the sand dunes made additional care in sampling necessary to avoid lowering the intake nozzle of the sampler into the sand. A description of each section follows:

Section A.--The section was selected as similar in hydraulic characteristics to section F at Milburn and is in a wide reach of the river 6,600 feet upstream from the turbulence flume. It is typical of wide reaches of the channel in that a large part of the discharge occurs in less than 50 percent of the channel width. During the period of this study a wide sand bar near the north bank was barely submerged. A large part of the flow crossed the section at an angle varying as much as 20 degrees from normal. Each determination of suspended sediment concentration was based on four samples at each of 14 verticals. The unfavorable conditions indicate that water discharge measurements may be as much as 10 percent in error.

Section B.--The section is at the upstream side of the county highway bridge, 1,150 feet upstream from the turbulence flume. Daily samples of suspended sediment were collected at this section prior to March 21, 1950. It is the most contracted of all sections and has no sand bars or shallow flow at any point. However, the distribution of flow in the section varied continually with time. Each determination of suspended sediment concentration was based on four samples at each of five verticals. Conditions for measurement of both water discharge and sediment concentration were favorable.

Section C.--The section is at the upstream edge of the turbulence flume, and 6 feet upstream from the first row of baffles. A walkway with supports set in the concrete floor of the flume facilitates gaging and sampling at this section. Generally, the normal sandbed of the river extended to the first row of baffles and covered the paved surface of the flume under the walkway by variable amounts. From time to time a narrow strip of the paved surface was exposed but seldom exceeded 5 feet in a total width of 80 feet. The mean suspended sediment concentration was determined from four samples at each of 15 verticals. Occasional samples with extremely high concentrations were disregarded in computing the mean concentration. The distribution of flow in the section varied through only a small range, and conditions for measuring water discharge and suspended sediment concentration were considered to be good.

Section D.--Concentrations determined at this section were very important, and a great amount of care was used in all observations. The section is at the downstream edge of the 6- by 16-inch measuring sill and 6 feet upstream from the downstream edge of the turbulence flume. A walkway, similar to that at section C, facilitates gaging and sampling. The total sediment load was assumed to be in suspension at this section. The US DH-48 hand sampler was operated so that the intake nozzle touched the top of the measuring sill. The distribution of flow in the section varied only a small amount with time and in all instances increased slowly from the north to the south side of the flume. The slower velocities on the north side resulted in the formation of a narrow sand deposit extending along the flume, parallel with the flow lines, and intersecting the measuring sill at about station 72. On August 25, 30, and 31 this deposit was negligible, and the measuring sill was clean and exposed for its entire width. On

August 17 and 23 and September 7 and 13 the deposit was of sufficient depth to cover the sill 1 to 2 inches deep over a width of 2 to 4 feet. On September 9 the deposit covered the sill to a maximum depth of 6 inches for a width of 6 feet. Prior to the collection of samples, the top and sides of the sill were cleaned with a shovel. This procedure insured that only material actually in transport would be obtained in the sample.

A study of all collected samples indicated that the concentration at any point in this section was subject to wide variations. Even with the care exercised here, a few samples were excessively high in concentration and were considered erroneous because of improper sampling technique. The mean concentration for September 7 and 9 was determined from one sample at each of 80 verticals. The mean concentration for other observations was determined from four samples at each of 15 to 17 verticals. Because the vertical velocity distribution at this section is not normal, the water discharge measurements were considered only fair. The water discharge was not measured on August 17 and 23.

<u>Section E</u>.--The section is about 500 feet downstream from section D. It is considered typical for this reach of the river and has hydraulic characteristics similar to section G near Milburn. The distribution of flow across the section was fairly uniform and varied less with time than at the other natural river sections. The mean concentration was determined from four samples at each of 10 verticals. The accuracy of water discharge measurements was considered to be good.

<u>Section F</u>.--The section is about 11,200 feet upstream from the bridge at Milburn, at a wide section of the river, and has hydraulic characteristics similar to section A. It has wide shifting sand bars, which cause angular and variable flow. One or more comparatively narrow channels,

which constantly shift their location, carry a large percentage of the total flow. The mean suspended concentration was determined from four samples at each of 14 verticals. The accuracy of the water discharge measurements was considered to be fair.

Section G.--The section is about 6,400 feet downstream from section F and about 4,800 feet upstream from the highway bridge at Milburn. It is considered to be a typical section for this reach of the river and is similar to section E. No sand bars were exposed, and channel shifting was much less than at section F. The mean concentration was determined from four samples at each of 10 verticals. The accuracy of water discharge measurements was considered to be good.

Section H, Dismal River at Dunning.--The section is 300 feet downstream from the state highway bridge and is typical for this reach of the river. The distribution of flow in the section was fairly uniform, and the shifting of the channel was less than average for other sections. The mean suspended concentration was determined from four samples at each of seven verticals. Conditions for measurement of water discharge were comparatively good.

SUMMARY OF DATA

Sediment Discharge Measurements

The principal data obtained in the eight sets of observations at each section are compiled in tables 1 to 8. Except as otherwise noted, the sediment discharges shown in these tables were computed from the mean sediment concentrations and water discharges as measured. No attempt was made to adjust the water discharge for changes which may have occurred during the time interval between gaging and sampling or for inaccuracy owing to poor measuring conditions.

Table 1.--Sediment discharge measurements of the Middle Loup River near Dunning, Nebr., section A.

Date	Aug. 17	Aug. 23	Aug. 25	Aug. 30	Aug. 31	Sept. 7	Sept. 9	Sept. 13
Mean time of water discharge measurement	11:20 a.m.	9:05 a.m.	9:25 a.m.	9:05 a.m.	8:25 a.m.	9:00 a.m.	8:50 a.m.	8:50 a.m.
Mean time of sampling	2:00 p.m.	10:00 a.m.	11:00 a.m.	10:00 a.m.	9:15 a.m.	10:00 a.m.	10:00 a.m.	10:00 a.m.
Mean sediment concentration (p.p.m.)	273	250	209	298	314	370	408	508
Water discharge (sec.-ft.)	382	314	312	374	424	379	399	419
Rate of sediment discharge (tons per day)	282	212	176	301	359	379	440	575
Mean velocity (ft. per sec.)	1.54	1.50	1.37	1.78	1.63	1.65	1.63	2.12
Area (sq. ft.)	247	208	227	210	259	230	245	198
Width (ft.)	335	343	337	293	301	297	298	278
Slope of water surface (ft. per mile)	7.1	7.8	7.8	6.8	6.7	6.6	6.9	7.7
Elevation of water surface 200 feet upstream (m.s.l.)	2,619.12	2,619.08	2,619.08	2,619.04	2,619.04	2,619.00	2,618.98	2,619.04
Elevation of water surface 200 feet downstream (m.s.l.)	2,618.58	2,618.49	2,618.49	2,618.52	2,618.53	2,618.50	2,618.46	2,618.46

Table 2.--Sediment discharge measurements of the Middle Loup River at Dunning, Nebr., section B.

Date	Aug. 17	Aug. 23	Aug. 25	Aug. 30	Aug. 31	Sept. 7	Sept. 9	Sept. 13
Mean time of water discharge measurement	12:15 p.m.	9:40 a.m.	9:05 a.m.	9:15 a.m.	8:45 a.m.	9:00 a.m.	9:00 a.m.	10:40 a.m.
Mean time of sampling	1:25 p.m.	11:25 a.m.	10:15 a.m.	11:20 a.m.	10:00 a.m.	9:50 a.m.	10:15 a.m.	12:05 p.m.
Mean sediment concentration (p.p.m.)	373	456	496	408	475	463	522	598
Water discharge (sec.-ft.)	369	339	345	394	390	404	386	425
Rate of sediment discharge (tons per day)	372	417	462	434	500	505	544	686
Mean velocity (ft. per sec.)	2.70	2.28	2.58	2.80	2.76	2.66	2.96	2.99
Area (sq. ft.)	137	149	134	141	141	152	130	142
Width (ft.)	64	65	64	65	63	64	64	64

Table 3.--Sediment discharge measurements of the Middle Loup River at Dunning, Nebr., section C.

Date	Aug. 17	Aug. 23	Aug. 25	Aug. 30	Aug. 31	Sept. 7	Sept. 9	Sept. 13
Mean time of water discharge measurement	3:45 p.m.	1:25 p.m.	1:35 p.m.	1:20 p.m.	10:45 a.m.	11:40 a.m.	11:10 a.m.	2:45 p.m.
Mean time of sampling	5:30 p.m.	2:50 p.m.	2:35 p.m.	3:50 p.m.	12:35 p.m.	1:45 p.m.	1:10 p.m.	4:45 p.m.
Mean sediment concentration (p.p.m.)	a/ 470	b/ 334	341	366	c/ 453	383	530	461
Water discharge (sec.-ft.)	387	339	330	354	373	403	399	366
Rate of sediment discharge (tons per day)	491	306	304	350	456	417	571	455
Mean velocity (ft. per sec.)	2.68	2.33	2.42	2.40	2.61	2.92	2.81	2.63
Area (sq. ft.)	144	146	136	147	143	138	142	139
Width (ft.)	80	80	80	80	80	80	80	80

a/ Concentration (4,730) for 1 of 15 verticals was estimated to be 600 in computing mean concentration.

b/ Concentrations (14,300; 11,100; 6,250) for 3 of 15 verticals were each estimated to be 400 in computing mean concentration.

c/ Concentrations (7,650; 22,900; 4,780) for 3 of 60 samples were not considered in computing mean concentration.

Table 4.--Sediment discharge measurements of the Middle Loup River at Dunning, Nebr., section D.

Date	Aug. 17	Aug. 23	Aug. 25	Aug. 30	Aug. 31	Sept. 7	Sept. 9	Sept. 13
Mean time of water discharge measurement	-	-	1:25 p.m.	1:35 p.m.	10:35 a.m.	11:35 a.m.	11:05 a.m.	2:05 p.m.
Mean time of sampling	5:45 p.m.	2:50 p.m.	2:45 p.m.	3:50 p.m.	1:15 p.m.	1:45 p.m.	1:30 p.m.	4:55 p.m.
Mean sediment concentration (p.p.m.)	a/1,090	595	750	737	b/1,060	885	891	843
Water discharge (sec.-ft.)	-	-	351	339	370	378	398	390
Rate of sediment discharge (tons per day)	c/1,140	c/545	711	674	1,060	903	957	888
Mean velocity (ft. per sec.)	-	-	2.82	2.71	2.94	2.83	3.21	3.16
Area (sq. ft.)	-	-	125	125	126	133	124	123
Width (ft.)	-	-	80	80	80	80	80	80

a/ Concentration (3,020) for 1 of 18 verticals estimated to be 400 p.p.m. in computing mean concentration.

b/ Concentrations (6,300; 7,250; 5,050) for 3 of 72 samples not considered in computing mean concentrations.

c/ Water discharge measured at section C used in computation.

Table 5.--Sediment discharge measurements of the Middle Loup River at Dunning, Nebr., section E.

Date	Aug. 17	Aug. 23	Aug. 25	Aug. 30	Aug. 31	Sept. 7	Sept. 9	Sept. 13
Mean time of water discharge measurement	6:10 p.m.	1:30 p.m.	2:45 p.m.	2:50 p.m.	12:40 p.m.	12:55 p.m.	12:50 p.m.	3:10 p.m.
Mean time of sampling	7:15 p.m.	2:30 p.m.	3:45 p.m.	3:45 p.m.	1:15 p.m.	1:45 p.m.	1:30 p.m.	4:00 p.m.
Mean sediment concentration (p.p.m.)	370	298	271	359	329	369	307	339
Water discharge (sec.-ft.)	388	331	331	348	386	369	377	361
Rate of sediment discharge (tons per day)	388	266	242	337	343	368	312	330
Mean velocity (ft. per sec.)	2.12	2.09	2.09	2.19	2.18	2.19	2.13	2.17
Area (sq. ft.)	183	159	159	160	177	169	177	166
Width (ft.)	154	152	153	152	152	152	154	152
Slope of water surface (ft. per mile)	6.3	6.4	6.6	7.4	7.6	7.8	6.9	7.9
Elevation of water surface 200 feet upstream (m.s.l.)	2,608.86	2,608.695	2,608.68	2,608.74	2,608.73	2,608.72	2,608.67	2,608.68
Elevation of water surface 200 feet downstream (m.s.l.)	2,608.38	2,608.21	2,608.18	2,608.18	2,608.15	2,608.13	2,608.15	2,608.08

Table 6.--Sediment discharge measurements of the Middle Loup River near Milburn, Nebr., section F.

Date	Aug. 18	Aug. 22	Aug. 24	Aug. 29	Sept. 1	Sept. 6	Sept. 8	Sept. 12
Mean time of water discharge measurement	12:40 p.m.	3:30 p.m.	10:20 a.m.	2:55 p.m.	9:35 a.m.	3:30 p.m.	9:55 a.m.	4:00 p.m.
Mean time of sampling	2:20 p.m.	5:00 p.m.	11:30 a.m.	4:30 p.m.	11:00 a.m.	4:20 p.m.	10:50 a.m.	5:00 p.m.
Mean sediment concentration (p.p.m.)	407	283	460	428	444	405	563	606
Water discharge (sec.-ft.)	906	653	661	750	708	729	768	764
Rate of sediment discharge (tons per day)	a/923	499	821	867	849	797	1,170	a/1,410
Mean velocity (ft. per sec.)	2.13	1.85	1.91	2.01	1.61	2.18	2.10	2.03
Area (sq. ft.)	425	353	346	374	440	335	364	376
Width (ft.)	444	344	349	374	391	384	379	394
Slope of water surface (ft. per mile)	7.1	6.5	6.4	3.2	-	4.0	4.4	6.9
Elevation of water surface 200 feet upstream (m.s.l.)	2,480.12	2,480.05	2,480.015	2,479.92	-	b/2,479.90	b/2,479.90	b/2,479.98
Elevation of water surface 200 feet downstream (m.s.l.)	2,479.58	2,479.56	2,479.53	2,479.68	-	2,479.66	2,479.64	2,479.57

a/ Water discharge measured at section G used in computation. Measuring conditions at G considered more favorable.
b/ Original reference stake destroyed by stream erosion Aug. 31. New reference stake set 115 ft. downstream from section.

Table 7.--Sediment discharge measurements of the Middle Loup River near Milburn, Nebr. section G.

Date	Aug. 18	Aug. 22	Aug. 24	Aug. 29	Sept. 1	Sept. 6	Sept. 8	Sept. 12
Mean time of water discharge measurement	12:55 p.m.	6:30 p.m.	1:50 p.m.	5:30 p.m.	3:00 p.m.	5:55 p.m.	1:05 p.m.	2:30 p.m.
Mean time of sampling	2:40 p.m.	7:15 p.m.	3:00 p.m.	7:00 p.m.	4:00 p.m.	6:20 p.m.	2:00 p.m.	2:30 p.m.
Mean sediment concentration (p.p.m.)	569	405	451	517	392	a/369	408	781
Water discharge (sec.-ft.)	840	626	671	730	715	764	760	863
Rate of sediment discharge (tons per day)	1,290	684	817	1,020	757	761	837	1,820
Mean velocity (ft. per sec.)	2.45	2.12	2.25	2.24	2.53	2.42	2.24	2.69
Area (sq. ft.)	343	295	299	326	282	316	338	321
Width (ft.)	246	247	245	250	247	243	248	248
Slope of water surface (ft. per mile)	5.9	6.6	6.4	5.3	6.5	5.9	5.9	5.6
Elevation of water surface 200 feet upstream (m.s.l.)	2,463.90	2,463.71	2,463.69	2,463.65	2,463.70	2,463.77	2,463.75	2,463.77
Elevation of water surface 200 feet downstream (m.s.l.)	2,463.45	2,463.21	2,463.205	2,463.25	2,463.21	2,463.32	2,463.30	2,463.35

a/ Three concentrations (8,680; 7,910; 8,200) from a total of 40 samples were not included in computing mean concentration. Uncorrected mean concentration was 962.

Table 8.--Sediment discharge measurements of the Dismal River at Dunning, Nebr., section H.

Date	Aug. 19	Aug. 23	Aug. 25	Aug. 30	Aug. 31	Sept. 7	Sept. 13
Mean time of water discharge measurement	9:55 a.m.	4:25 p.m.	4:45 p.m.	11:15 a.m.	2:45 p.m.	2:55 p.m.	11:45 a.m.
Mean time of sampling	10:40 a.m.	4:35 p.m.	5:15 p.m.	12:00 m.	3:30 p.m.	3:45 p.m.	12:30 p.m.
Mean sediment concentration (p.p.m.)	704	416	402	454	376	713	850
Water discharge (sec.-ft.)	315	a/298	278	316	300	300	314
Rate of sediment discharge (tons per day)	599	335	302	387	305	578	721
Mean velocity (ft. per sec.)	2.51	2.33	2.26	2.37	2.33	2.29	2.29
Area (sq. ft.)	126	128	123	133	129	131	137
Width (ft.)	82	92	83	83	82.5	82	81
Slope of water surface (ft. per mile)	5.7	-	5.9	6.7	5.9	5.6	6.1
Elevation of water surface 300 feet upstream (m.s.l.)	2,608.54	-	2,608.51	2,608.58	2,608.53	2,608.49	2,608.48
Elevation of water surface 300 feet downstream (m.s.l.)	2,608.11	-	2,608.06	2,608.07	2,608.08	2,608.07	2,608.02

a/ Discharge measurement not made at regular section.

In general the water discharges, the slopes of the water surface, and the width and average depth of the cross sections were relatively constant from August 17 to September 13. Changes in the mean sediment concentrations and in the measured rates of sediment discharge also were not large. Table 9 is a listing of mean suspended sediment concentrations by sections for each set of observations. Table 10 contains the discharges of suspended sediment as computed for each sediment discharge measurement. The sediment discharges are shown in figure 13 by bar graphs.

Percentages of total sediment discharge in suspension at sections A, B, C, and E were computed and are shown in table 11 and in figure 14. The measured sediment discharges at section D were assumed to be the total sediment discharge. (See p. 18.) No adjustments were applied for possible aggradation or degradation between any of the sections and section D or for changes in sediment discharge at section D during any one set of observations.

On September 13, a study was made of the variations of suspended sediment concentration with time at four selected verticals in section D. Fourteen consecutive samples were collected at approximately 1-minute intervals at each of the four verticals, but the samples at the different verticals were not collected concurrently. Although the data (fig. 15) represent only the concentration pattern for one short interval of time, they are a guide to the range of variation that can be expected. They seem to indicate that a high concentration sometimes occurs for a short time. Thus at points of section D, discharge of sediment may take place in occasional spurts that greatly exceed the normal rate of sediment discharge.

Table 9.--Summary of mean suspended sediment concentrations in parts per million, Middle Loup River near Dunning and Milburn, Nebr.

Date	Section A	Section B	Section C	Section D	Section E	Section F	Section G	Section H
1949								
Aug. 17	273	373	470	1,090	370			
Aug. 18						407	569	
Aug. 19								704
Aug. 22						283	405	
Aug. 23	250	456	334	595	298			416
Aug. 24						460	451	
Aug. 25	209	496	341	750	271			402
Aug. 29						428	517	
Aug. 30	298	408	366	737	359			454
Aug. 31	314	475	453	1,062	329			376
Sept. 1						444	392	
Sept. 6						405	369	
Sept. 7	370	463	383	885	369			713
Sept. 8						563	408	
Sept. 9	408	522	530	891	307			-
Sept. 12						606	781	
Sept. 13	508	598	461	843	339			850

Table 10.--Summary of suspended sediment discharges in tons per day, Middle Loup River near Dunning and Milburn, Nebr.

Date	Section A	Section B	Section C	Section D	Section E	Section F	Section G	Section H
<u>1949</u>								
Aug. 17	282	372	491	1,140	388			
Aug. 18						923	1,290	
Aug. 19								599
Aug. 22						499	684	
Aug. 23	212	417	306	545	266			335
Aug. 24						821	817	
Aug. 25	176	462	304	711	242			302
Aug. 29						867	1,020	
Aug. 30	301	434	350	674	337			387
Aug. 31	359	500	456	1,060	343			305
Sept. 1						849	757	
Sept. 6						797	761	
Sept. 7	379	505	417	902	368			578
Sept. 8						1,170	837	
Sept. 9	440	544	571	957	312			-
Sept. 12						1,410	1,820	
Sept. 13	575	686	455	888	330			721
Average	340	490	419	860	323	917	998	461

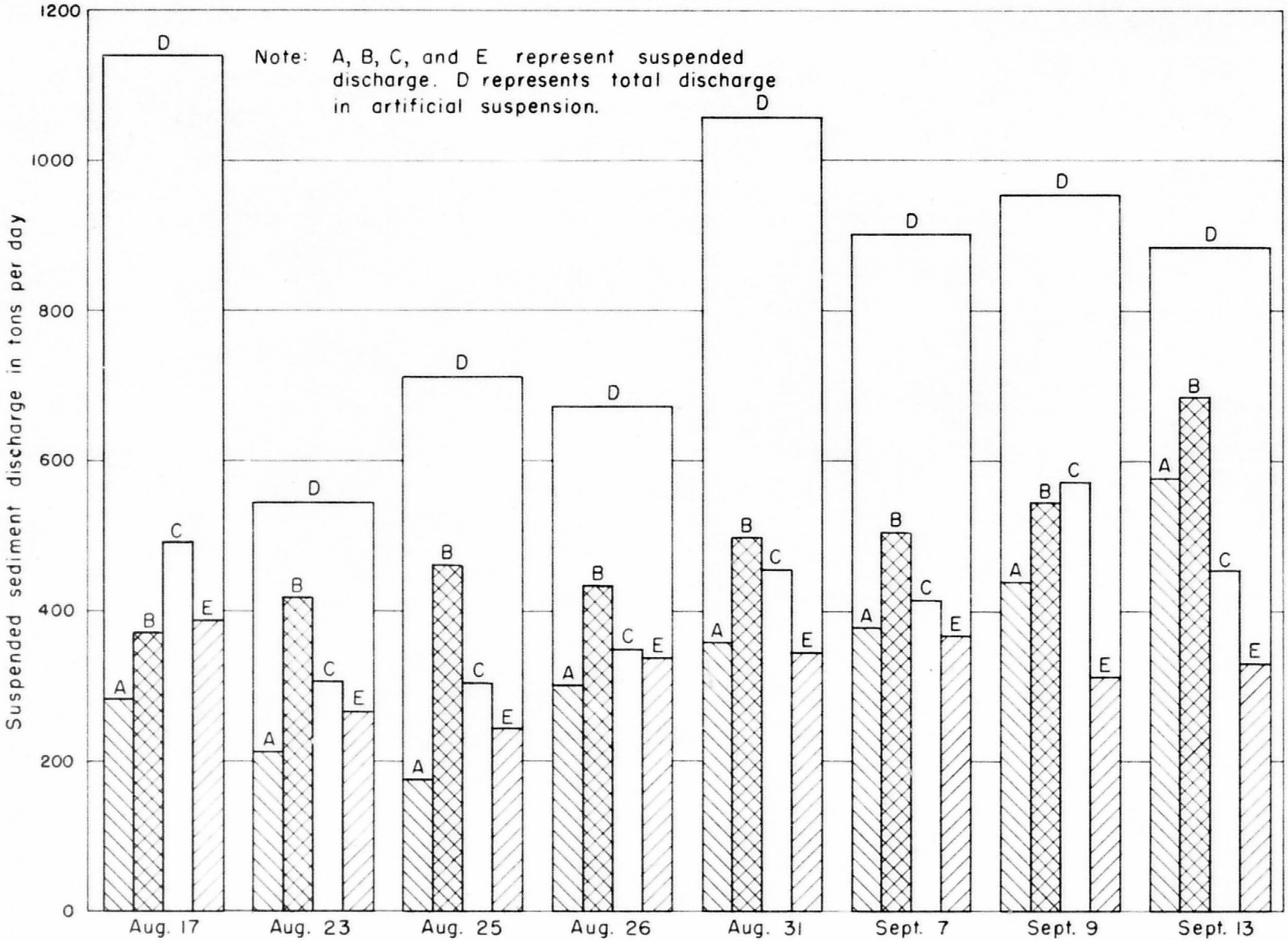


Figure 13.--Suspended sediment discharge measured at sections A to E on the Middle Loup River near Dunning, Nebr.

Table 11.--Percentage of total sediment discharge in suspension at sections A, B, C, and E.

Date	Section A	Section B	Section C	Section E
1949				
Aug. 17	25	34	43	34
Aug. 23	42	77	56	50
Aug. 25	28	66	45	36
Aug. 30	40	55	50	49
Aug. 31	30	45	43	31
Sept. 7	41	52	43	41
Sept. 9	46	59	60	34
Sept. 13	60	71	55	40
Average	39	57	49	39

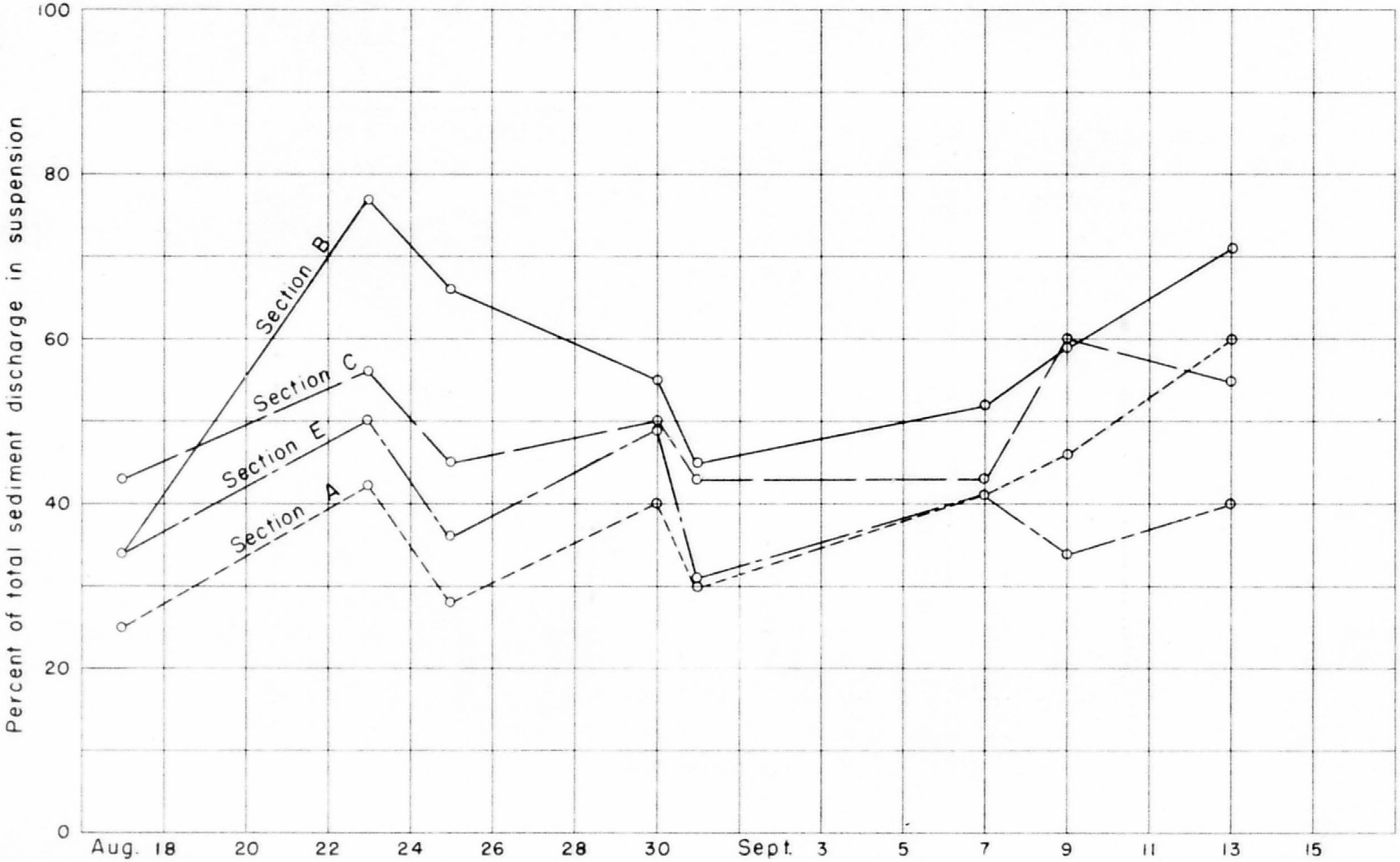


Figure 14.– Suspended sediment discharges at sections A to E in percentage of total discharge measured at section D.

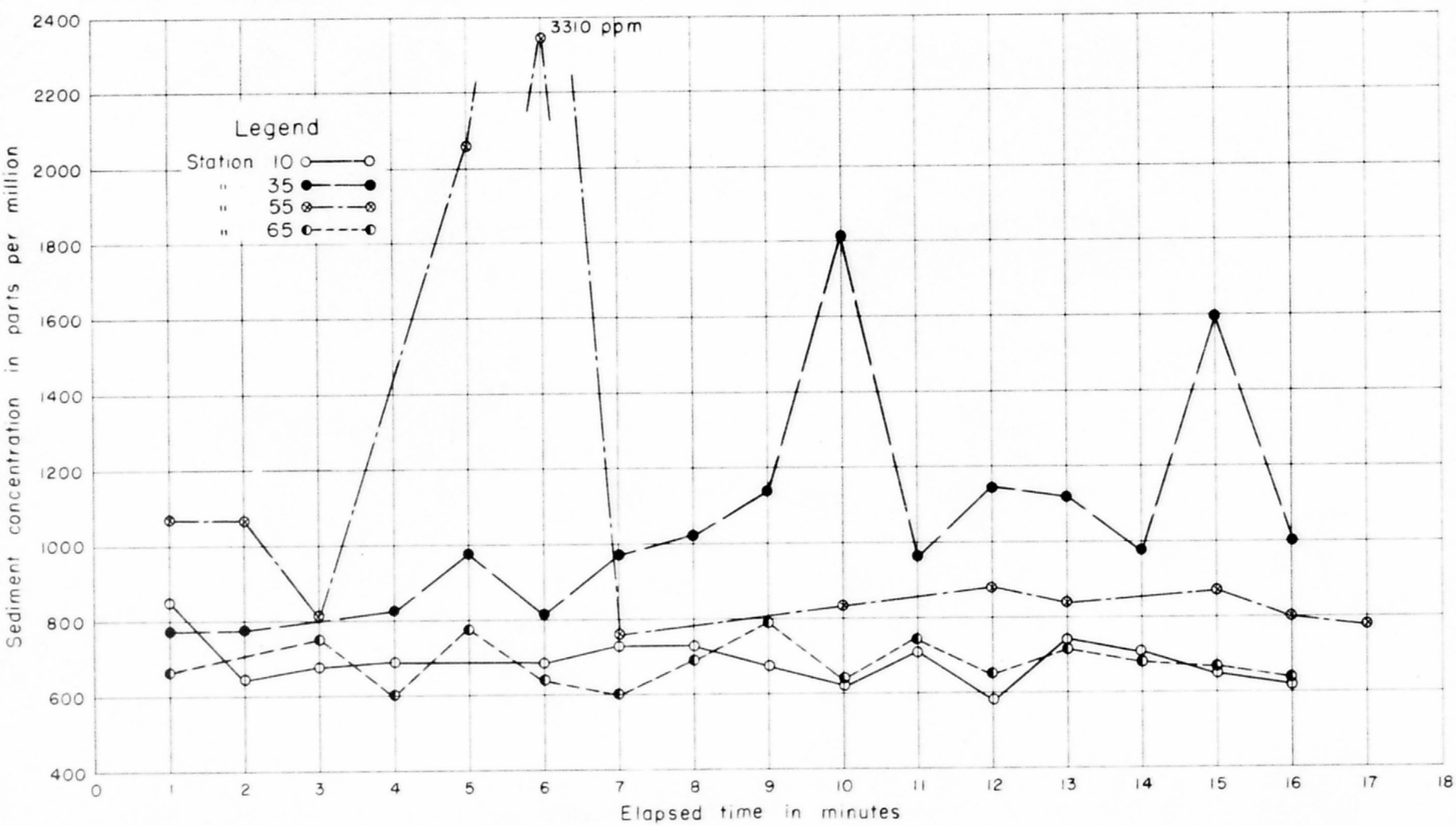


Figure 15.--Variation of suspended sediment concentration with time at section D.

Particle-Size Analyses

Two analyses of the particle size of suspended sediments for each section were made by the bottom-withdrawal tube method. The results of these analyses are shown in figures 16 to 23. Samples of bed material were collected at three points in each section (except section D) and were analyzed by the dry-sieve method. The results of these analyses are shown in figures 24 to 30. A composite size-distribution curve for the three bed material samples at each section is shown in each of figures 16 to 23 with the size-distribution curves for suspended sediment.

The relation between sedimentation diameters and sieve diameters was studied. Three comparisons were made and are included in the above illustrations. Duplicate analyses of the bed material from sections F and G were made with the bottom-withdrawal tube and the dry-sieve methods (figs. 21 and 22). Duplicate analyses of suspended material at section D were made with the bottom-withdrawal tube and wet-sieve methods (fig. 19). The comparisons indicate good agreement for sedimentation and mechanical diameters. The high degree of rounding, or sphericity, of the particles, clearly evident from visual observation, supports the agreement between the two types of analyses.

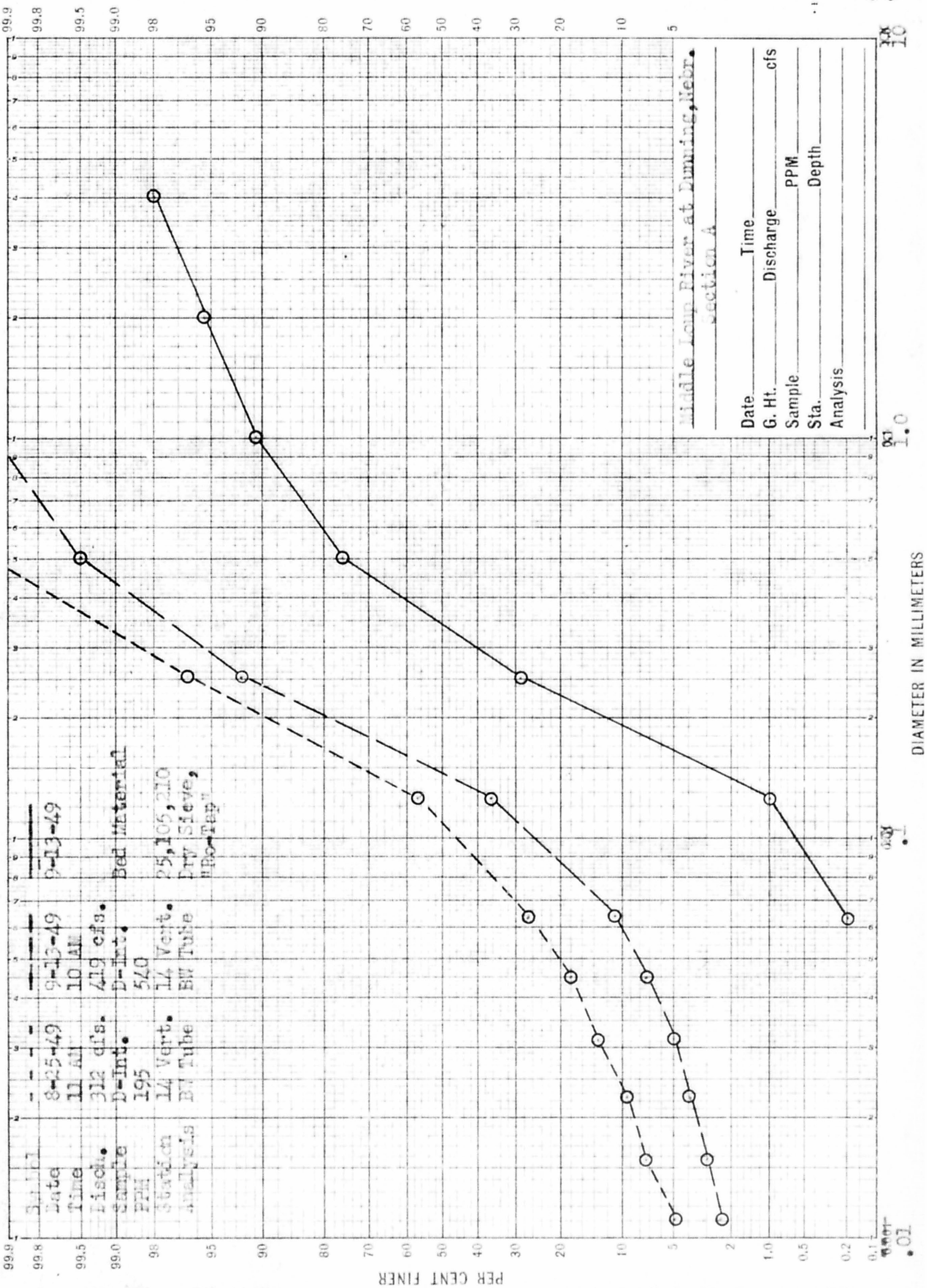


Figure 16.--Particle size analyses of suspended and bed material from section A.

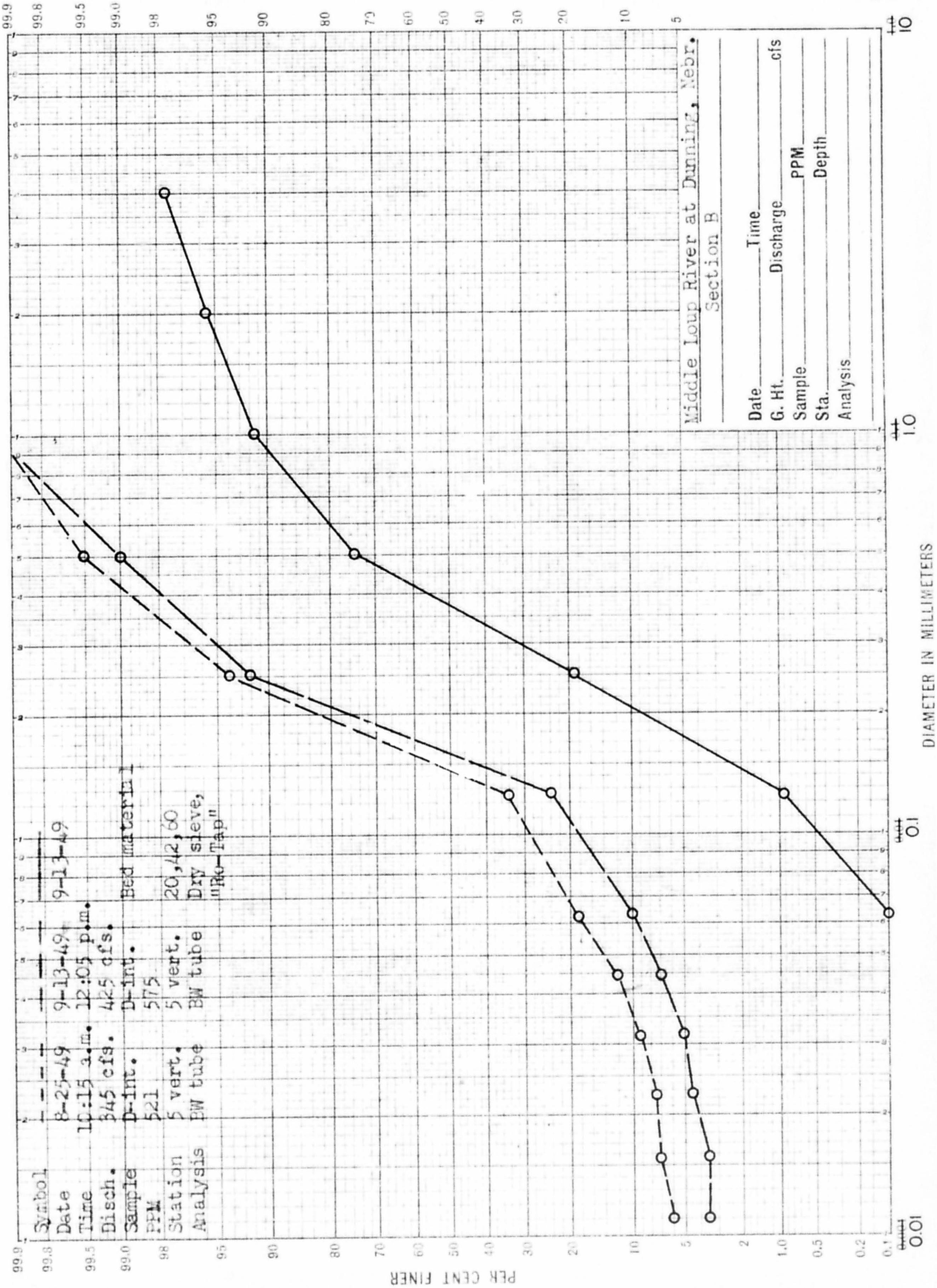


Figure 17-- Particle size analyses of suspended and bed material from section B

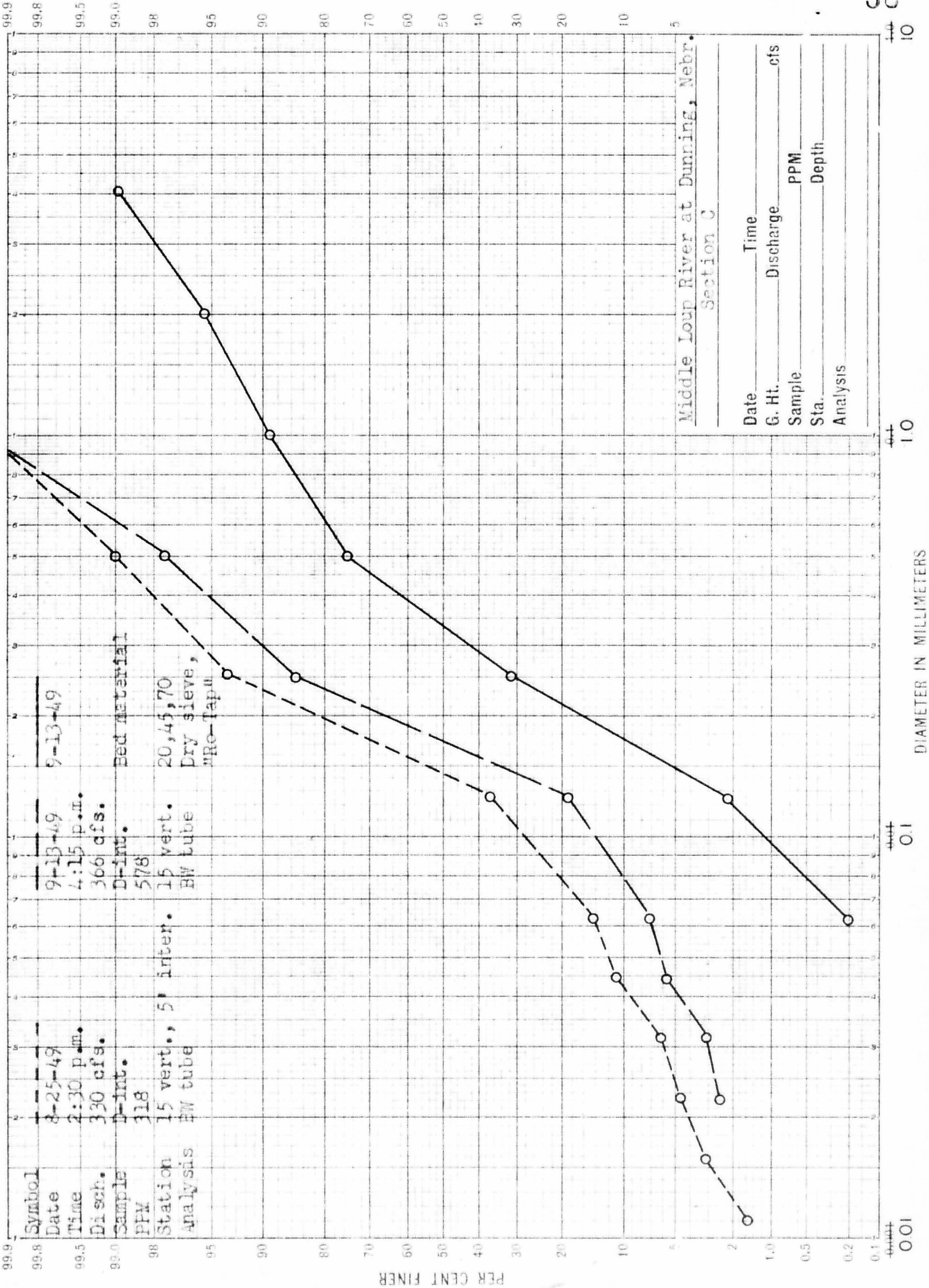


Figure 18.--Particle size analyses of suspended and bed material from section C

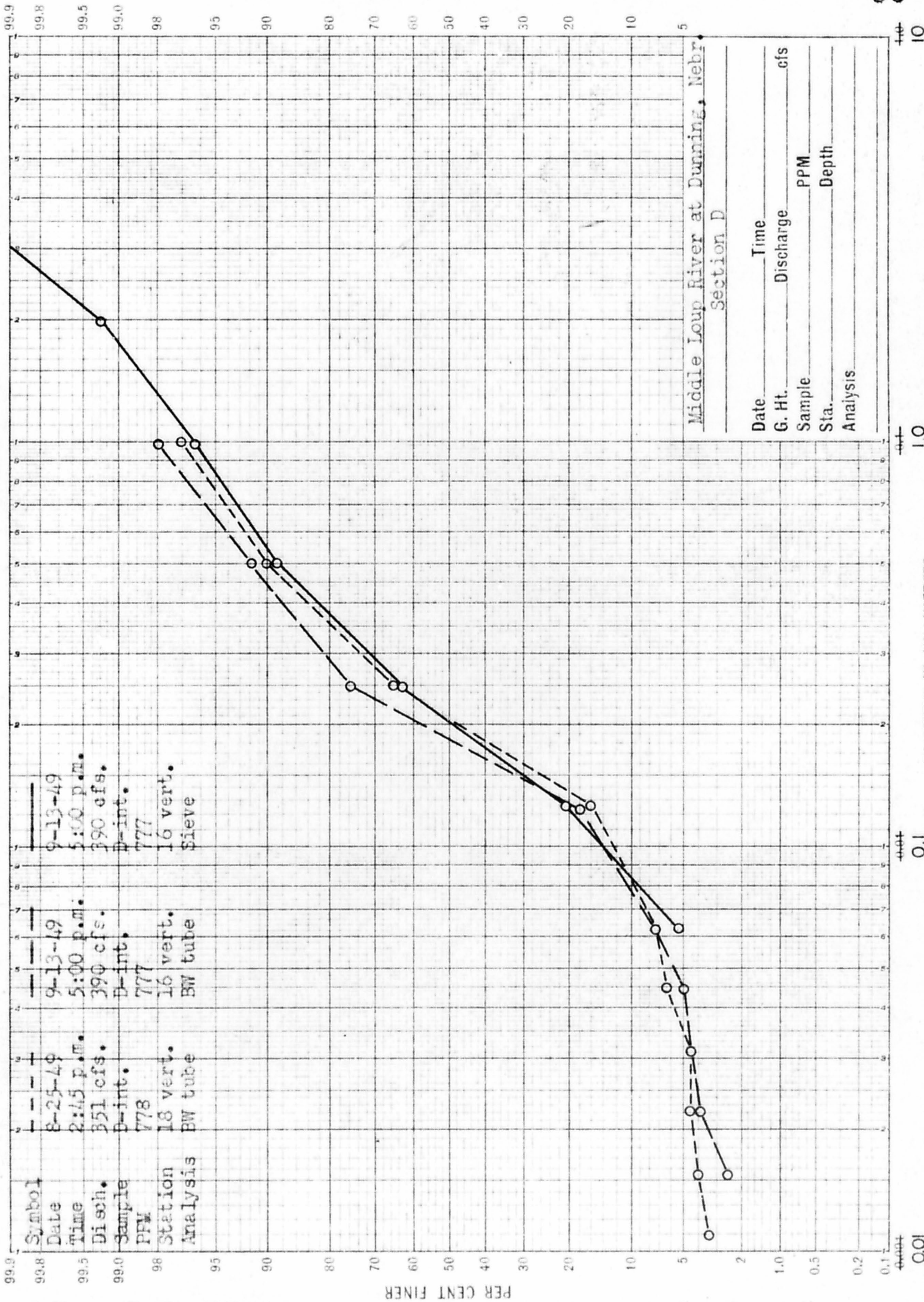


Figure 19.--Particle size analyses of suspended and bed material from section D

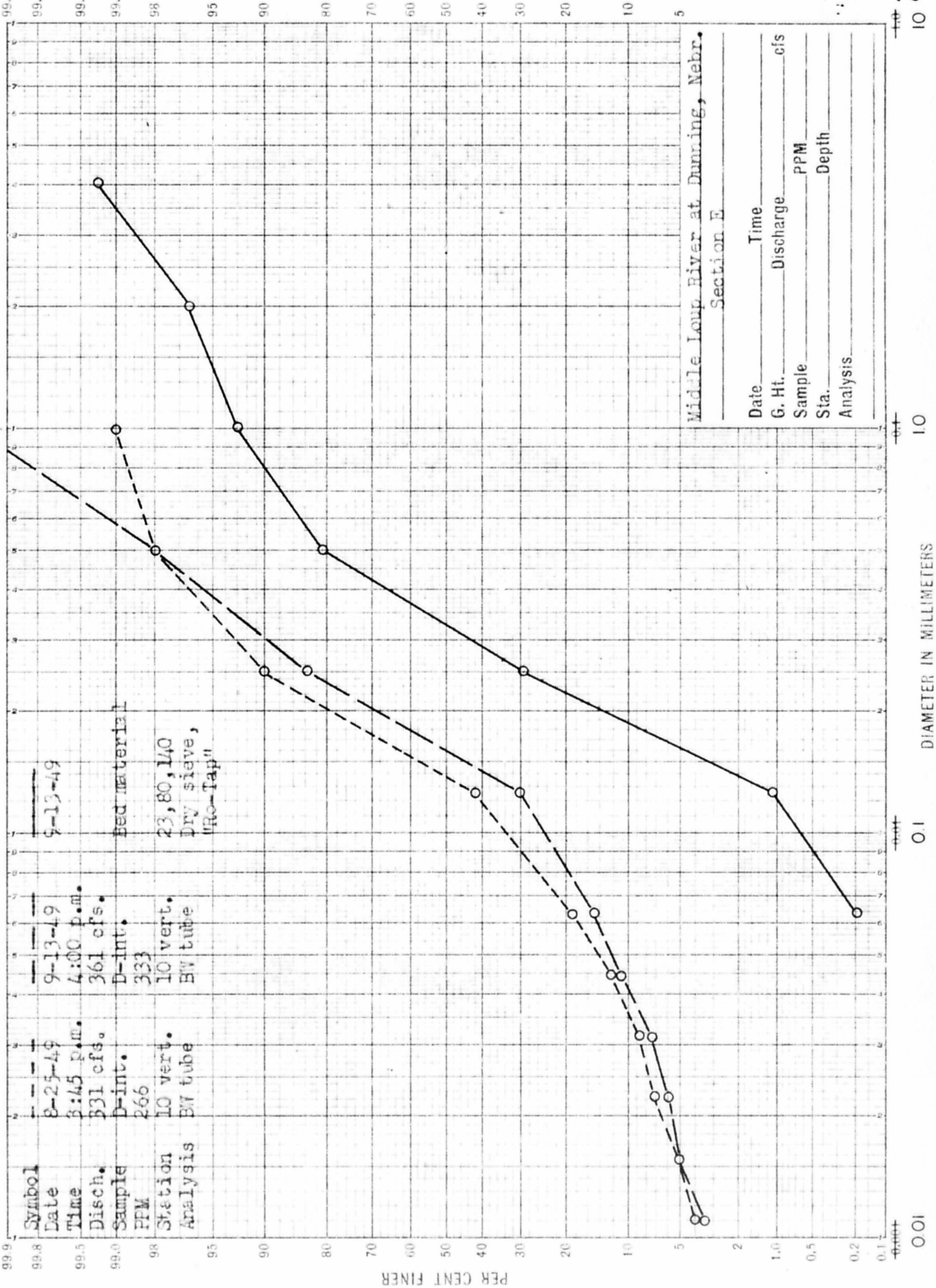


Figure 20.--Particle size analyses of suspend and bed material from section E

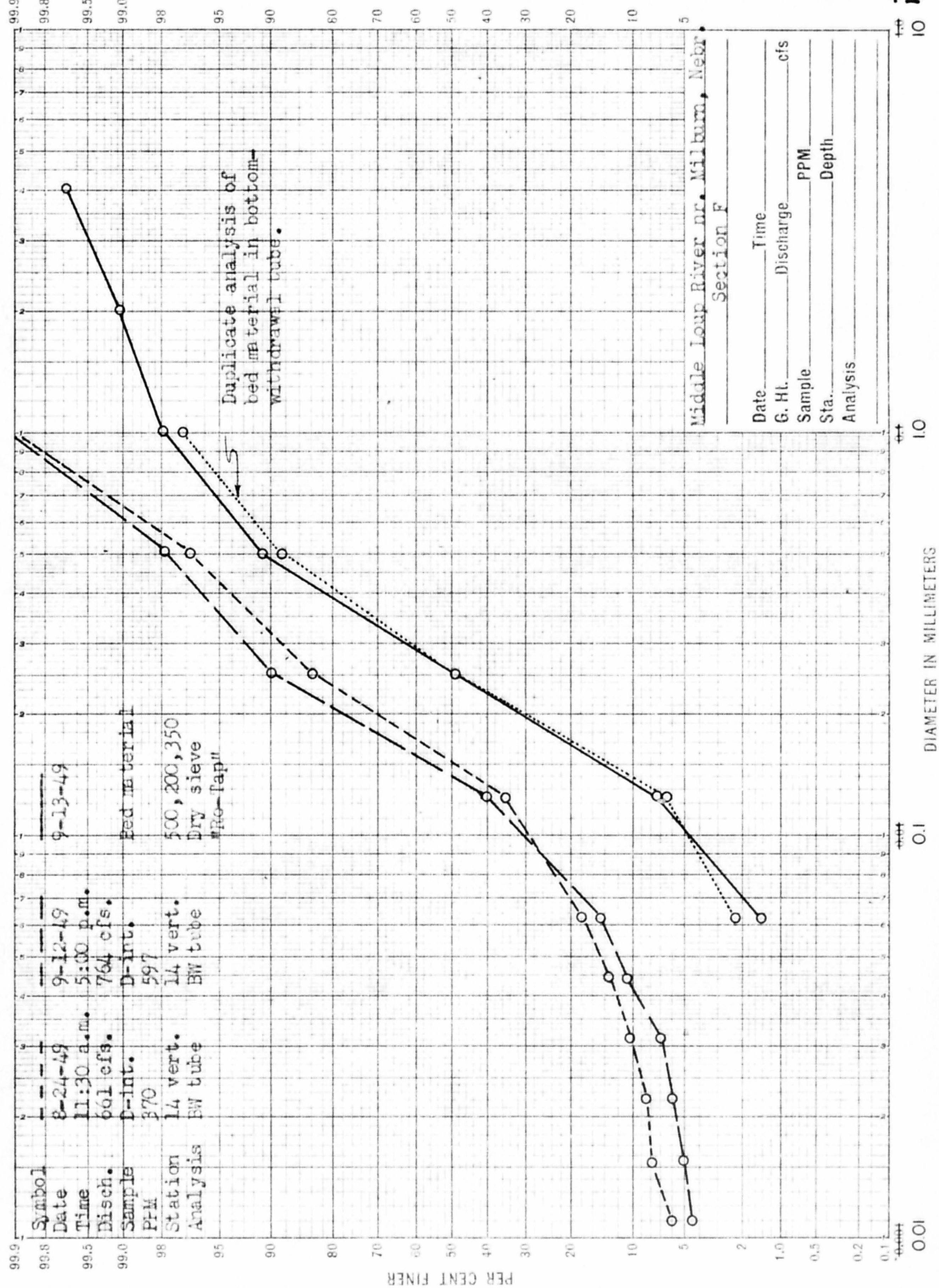


Figure 21.--Particle size analyses of suspended and bed material from section F

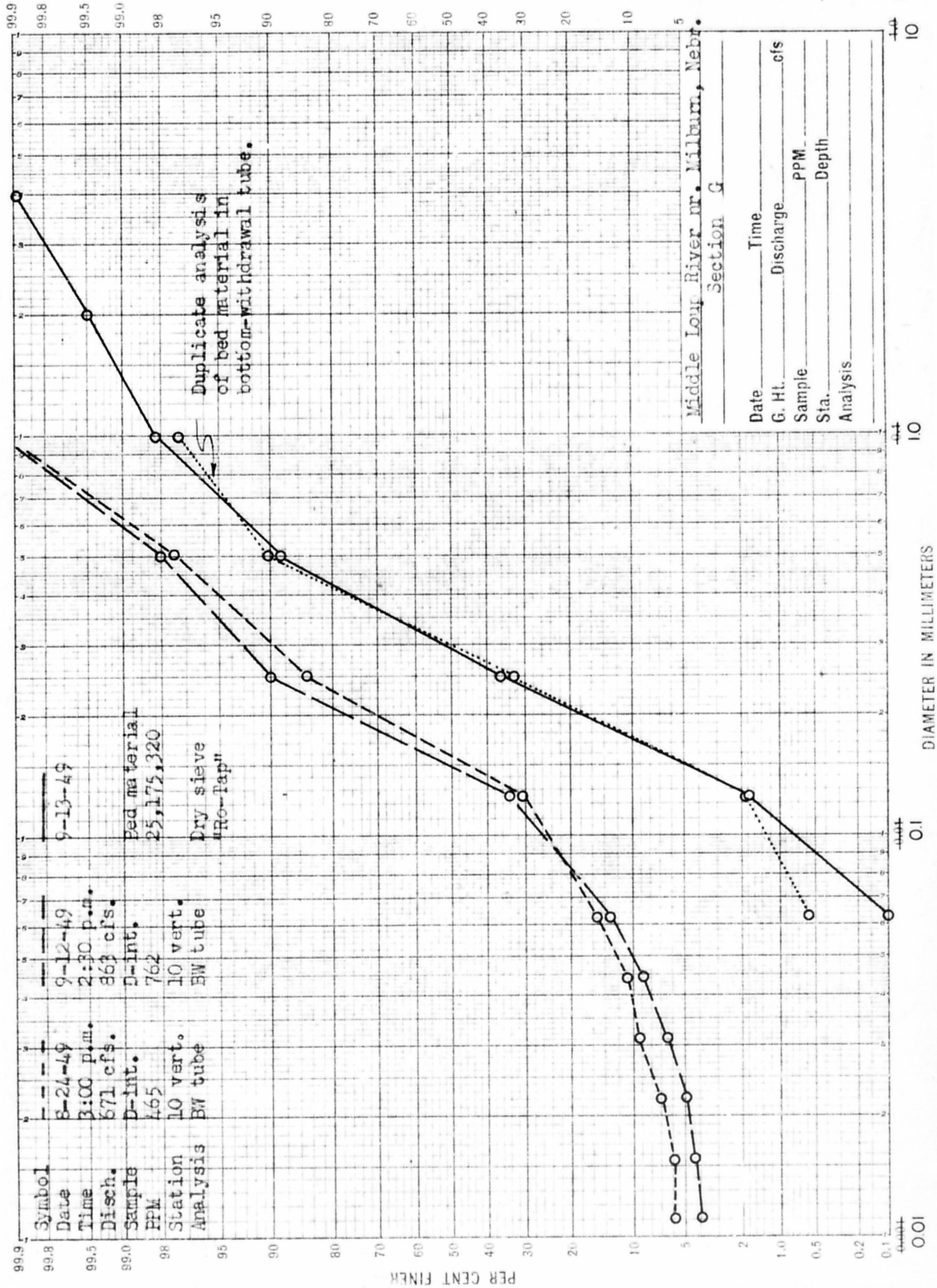


Figure 22.--Particle size analyses of suspended and bed material from section G

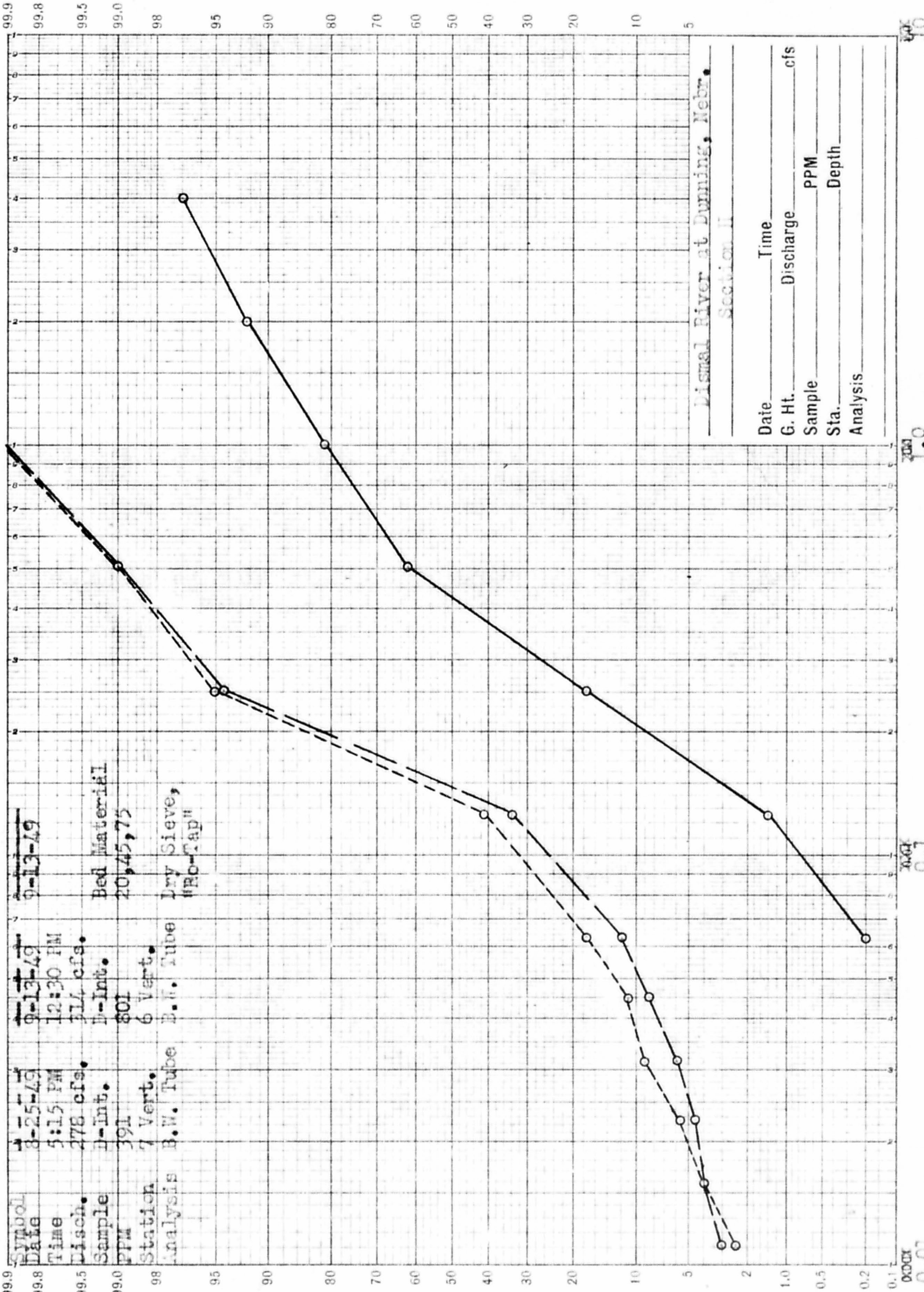


Figure 23.--Particle size analyses of suspended and bed material from section H.

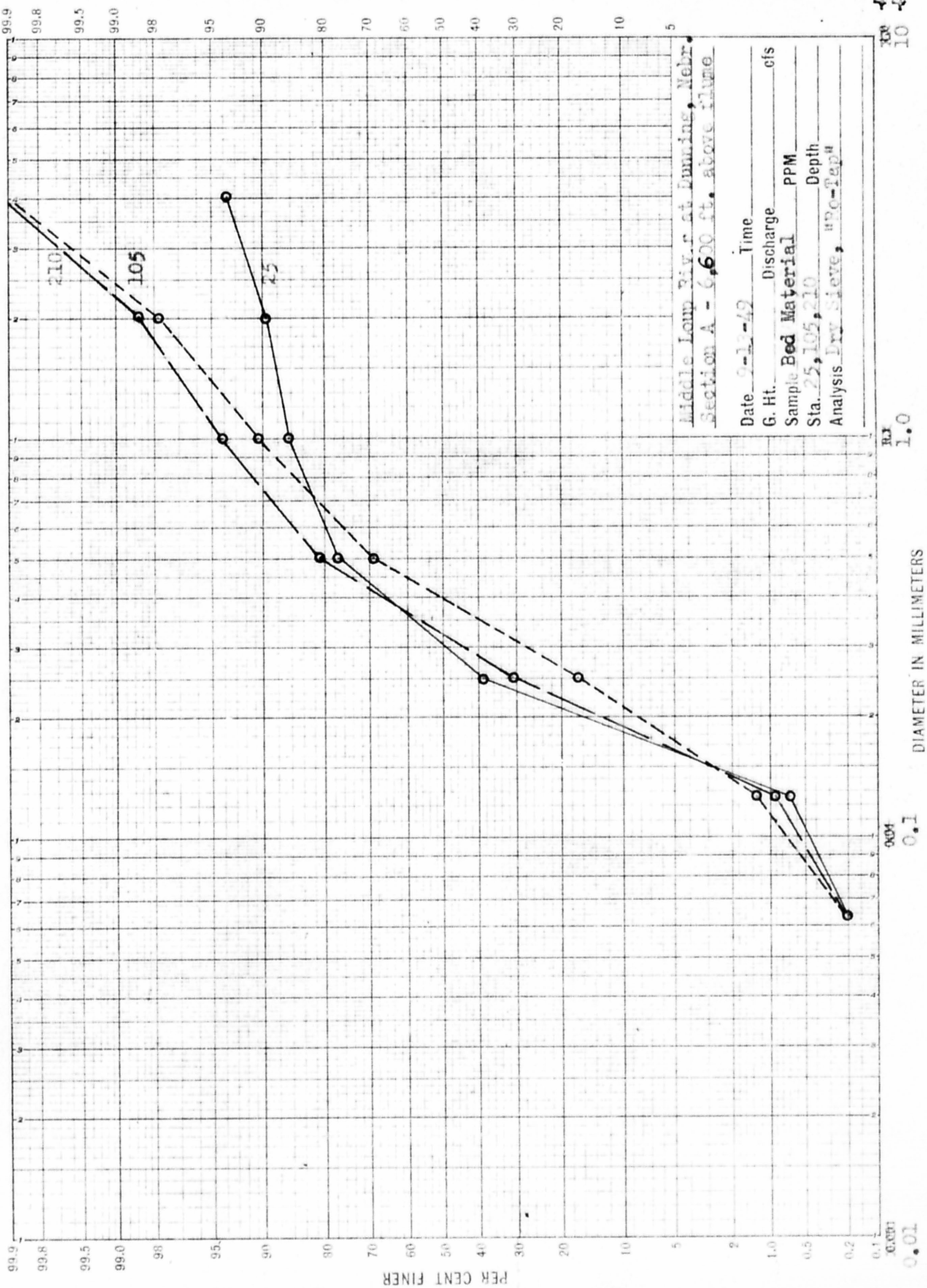


Figure 24.--Particle size analyses of bed material from section A.

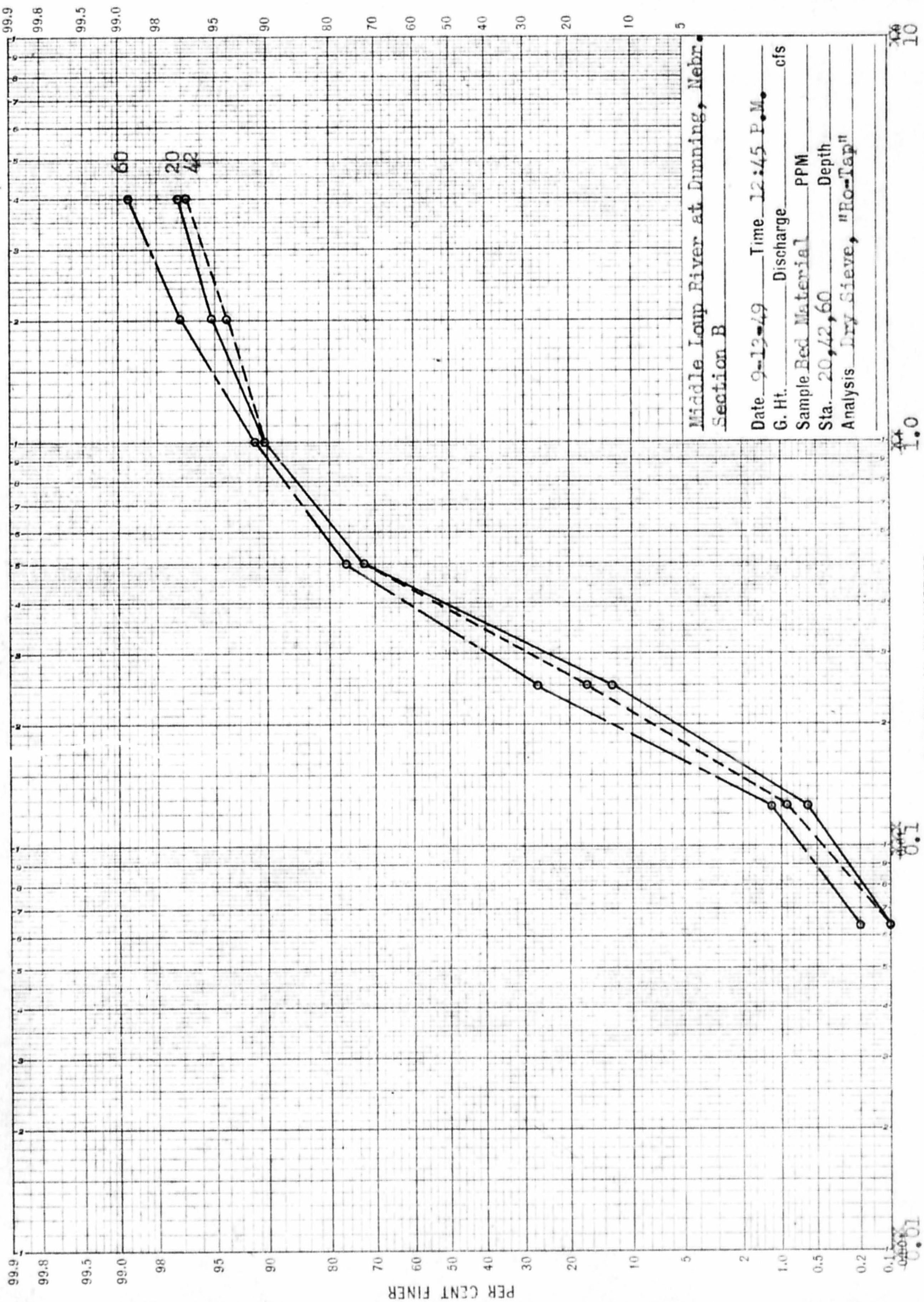


Figure 25.--Particle size analyses of bed material from section B.

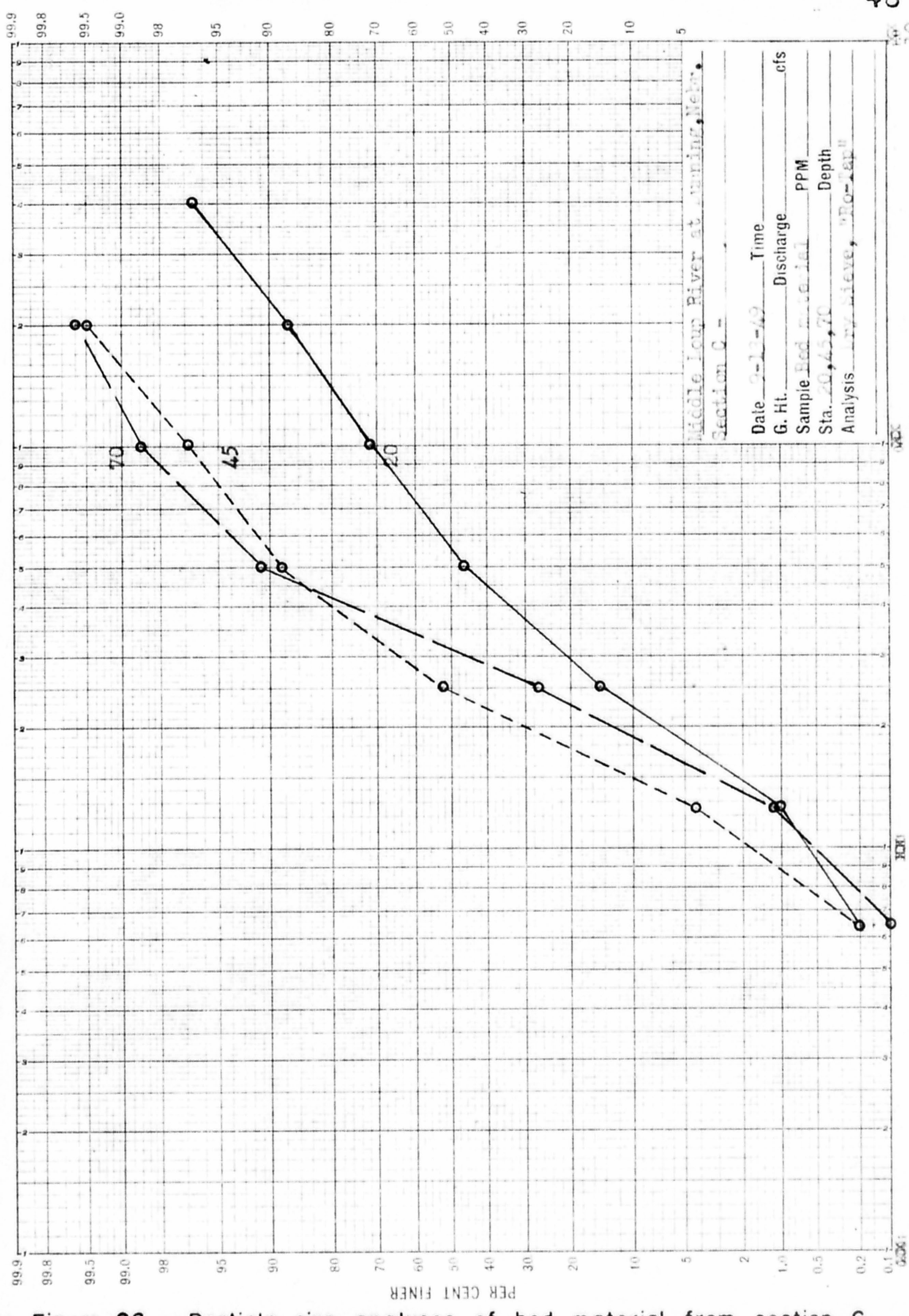


Figure 26.--Particle size analyses of bed material from section C.

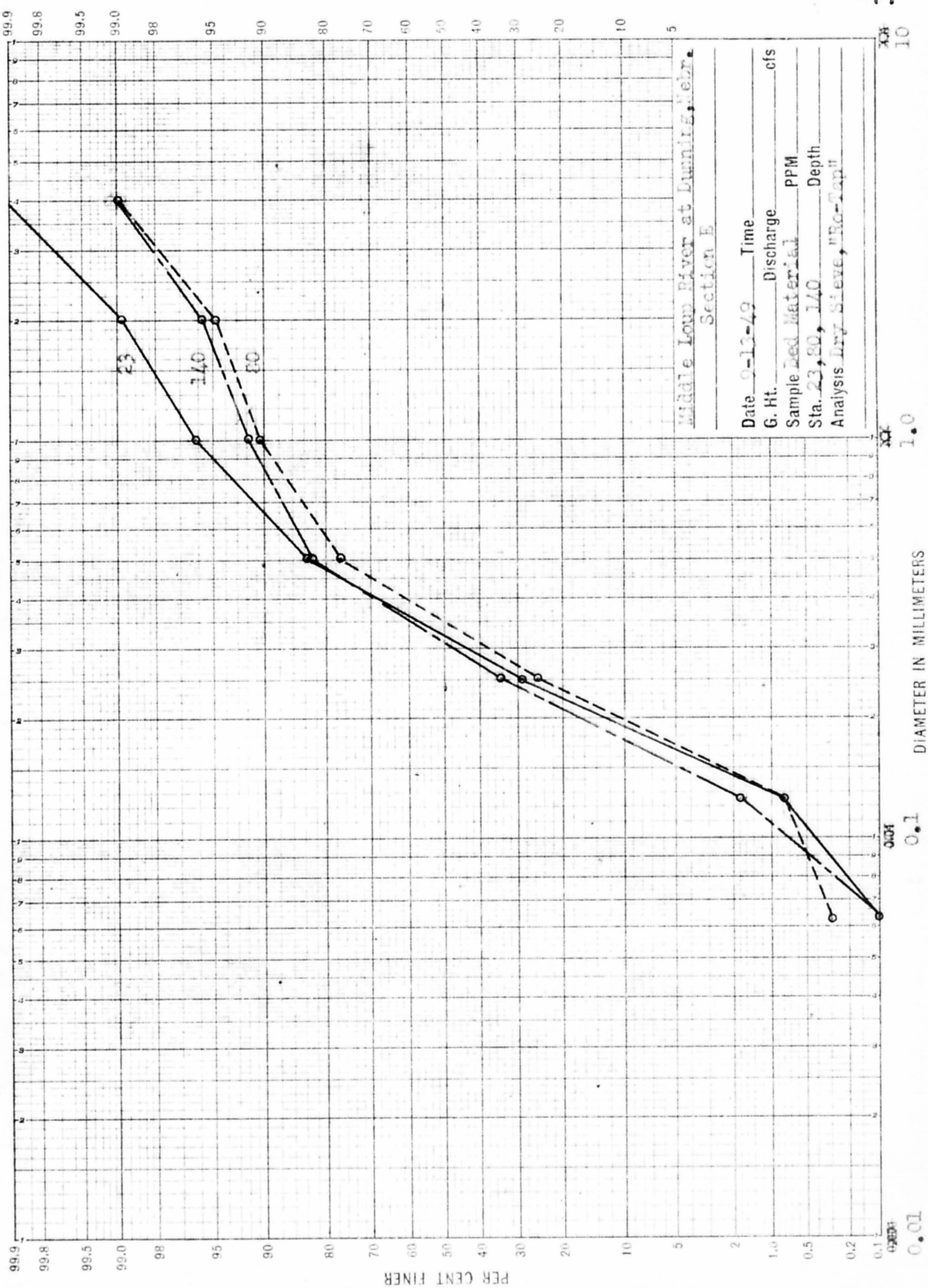


Figure 27--Particle size analyses of bed material from section E.

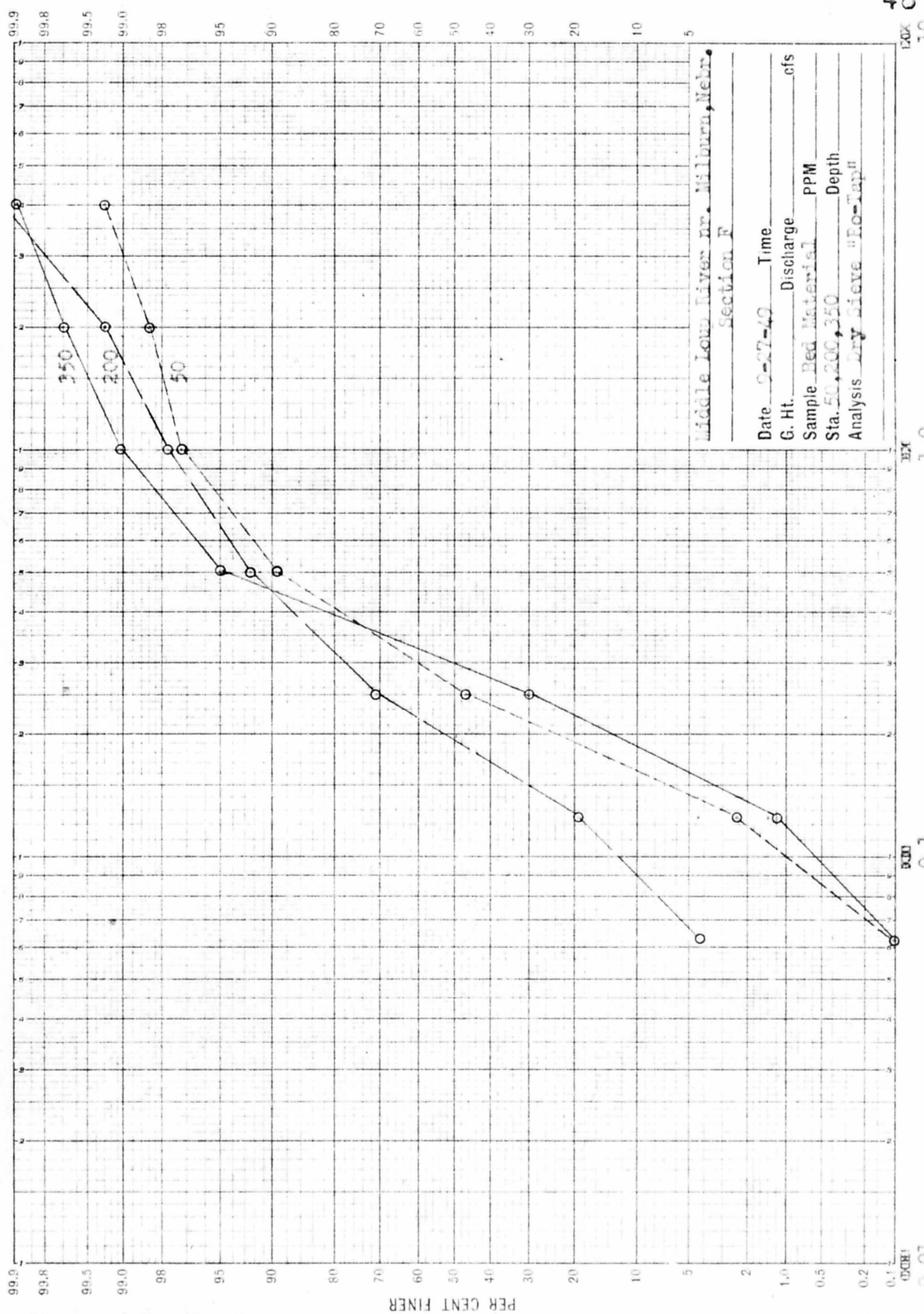


Figure 28.--Particle size analyses of bed material from section F.

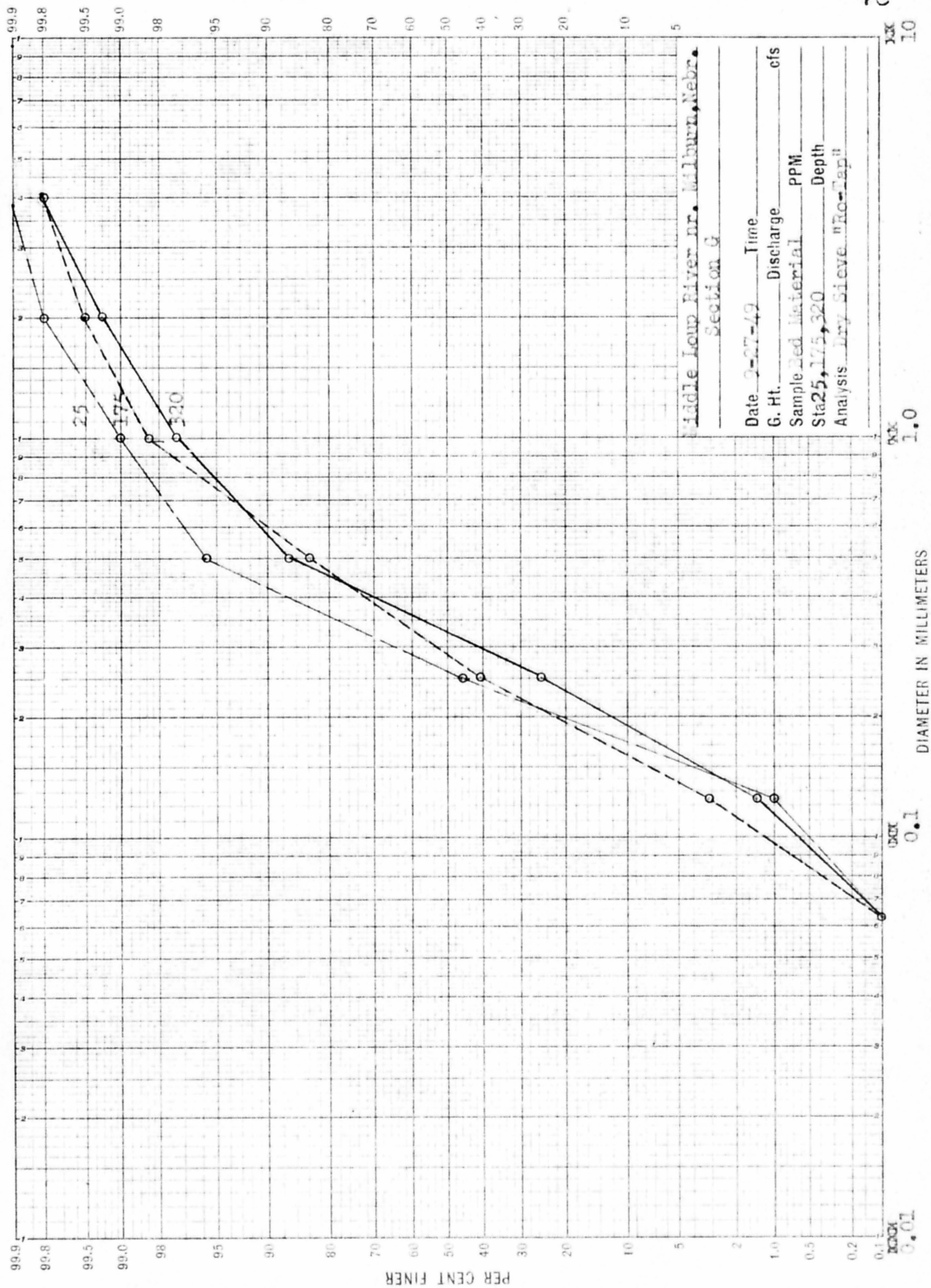


Figure 29.--Particle size analyses of bed material from section G.

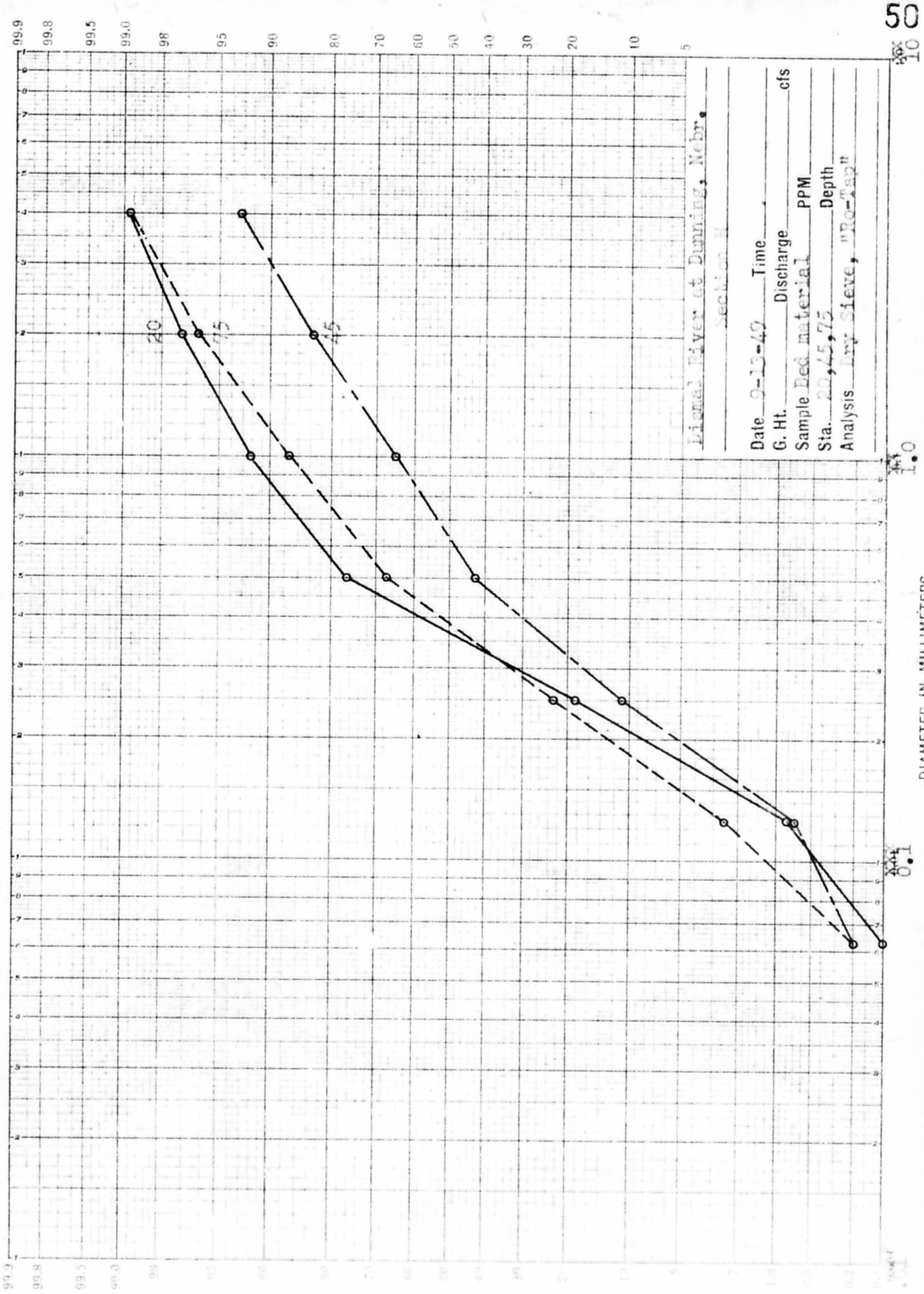


Figure 30.-- Particle size analyses of bed material from section H.

TENTATIVE CONCLUSIONS

This progress report covers results from less than a month of field work at the turbulence flume on the Middle Loup River near Dunning and at associated cross sections. Obviously only tentative conclusions can be drawn from the data obtained in so short a time; these conclusions must be confirmed or revised on the basis of additional information.

At least most of the time, the sediment discharge measured at section D represented the total discharge of suspended sediment and bed load that was moving down the stream.

The narrow range of sediment concentrations and of water discharges probably will seriously limit the use of data from the turbulence flume in checking equations that have been proposed for computing bed load.

Percentages of sediment discharge in suspension at sections A, B, C, and E varied considerably from time to time, but the average percentage was highest at section B; second highest at section C; and lowest at sections A and E, for which the average at each was 39 percent. The average widths and velocities for the eight determinations were 64 feet and 2.72 feet per second for section B, 80 feet and 2.60 feet per second for section C, 153 feet and 2.14 feet per second for section E, and 310 feet and 1.65 feet per second for section A. Thus the percentage of sediment in suspension increased with velocity (or decreased with width). However, this relationship fails when only sections A and E, which are laterally unconfined sections of an alluvial stream, are compared.

The average of eight determinations of suspended sediment discharge was 917 tons per day for section F and 998 tons per day for section G. The average width and velocity were 247 feet and 2.37 feet per second for section G and 382 feet and 1.98 feet per second for section F. Thus these two sections near Milburn also show little relationship between width or average velocity and percentage of sediment in suspension.

Comparisons of sections A with E and sections F with G indicate that the average velocity and the total width of a cross section probably are poor measures of percentage of sediment in suspension for unconfined sections of a shallow alluvial stream. Presumably the sediment discharge occurs principally through the deeper and faster parts of these irregular sections, and the shallower and slower parts of the sections are relatively ineffective in sediment transportation.

At least for some points in section D, the sediment concentrations occasionally exceed the normal concentrations by large and erratic amounts for short periods. Therefore many samples are required to determine a reasonably accurate average concentration at any one vertical or for the whole cross section.

The particle-size analyses determined with the bottom-withdrawal tube showed satisfactory agreement with the few duplicate analyses that were made by wet-sieve and dry-sieve methods. In general the mechanical analyses of the bed material were much the same at all sections.

A P P E N D I X