HYDROLOGIC AND SEDIMENTOLOGIC DATA COLLECTED DURING THREE CRUISES AT LOW WATER ON THE MISSISSIPPI RIVER AND SOME OF ITS TRIBUTARIES, JULY 1987- JUNE 1988

by John A. Moody and Robert H. Meade

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TABLES

CONVERSION FACTORS

Multiply	*By*	*To obtain*
	Length	
micrometer (μm)	0.00003937	inch
millimeter (mm)	0.03937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
	Area	
square meter (m^2)	10.76	square foot
square kilometer (km^2)	0.3861	square mile
	Volume	
milliliter (mL)	0.03382	ounces, fluid
liter (L)	0.2642	gallon
cubic meter (m^3)	35.31	cubic foot
	Flow	
centimeter per second (cm/s)	0.03281	foot per second
meter per second (m/s)	3.281	foot per second
cubic meter per second (m^3/s)	35.31	cubic foot per second
cubic meter per year (m^3/y)	35.31	cubic foot per year
kilometer per hour (km/h)	0.6214	mile per hour
liter per minute (L/min)	0.2642	gallon per minute
	Mass	
milligram (mg)	0.00003527	ounce, avoirdupois
gram (g)	0.002205	pound, avoirdupois
metric ton	2,205	pound, avoirdupois
	Temperature	
degree Celsius (°C)	F=1.8×°C+32	degree Fahrenheit

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ABSTRACT

Water, suspended-sediment, and bed-sediment samples were collected for physical (particle size and mineralogy) and chemical analysis (radioactive elements, trace metals, nutrients, petrochemical hydrocarbons, organic volatiles, pesticides, detergents, organic carbon, and humic substances) from 21 sites on the Mississippi River and its main tributaries. Three cruises were made at low water during a 1-year period from July 18, 1987, to June 7, 1988. The maximum measured discharge was about 10,400 cubic meters per second on December 15, 1987, at Vicksburg, Mississippi, and the maximum measured suspended-sediment discharge was 354,000 metric tons per day in the Missouri River at Hermann, Missouri, on July 20, 1987. The equal-width-increment (equal-transit-rate), depth-integration method was used at 10-40 verticals across the river to collect between 70 and 137 liters of river water with an isokinetic sampler (made of Teflon to prevent chemical contamination).

This report contains the following hydrologic data associated with the suspended-sediment samples: cross-sectional area of the river; mean depth; mean velocity; water discharge; particle sizes; concentrations of the suspended sand, silt, and colloid fractions; and surface temperature and conductivity at 10-40 locations across the river. These data provide the framework for subsequent interpretive chemical analyses of the samples collected during the three cruises.

INTRODUCTION

The Mississippi River drains about 40 percent of the conterminous United States. At Vicksburg, Mississippi, it has a mean annual water discharge of about 500×10^9 m^3/y and a sediment load of about 200×10^6 metric tons/y. At 120 river miles below Vicksburg, approximately 25 percent of the water discharge and sediment discharge is diverted from the Mississippi River into the Atchafalaya River by the Old River Control Structures. The remaining water (375×10^9 m^3/y) and sediment (150×10^6 metric tons/y) are discharged by the Mississippi River directly into the Gulf of Mexico.

On the basis of distinctive differences in water chemistries, the Mississippi River basin has been divided into eight subbasins shown in figure 1 and listed in table 1 with their corresponding drainage areas, and the mean annual discharges of water and sediment.

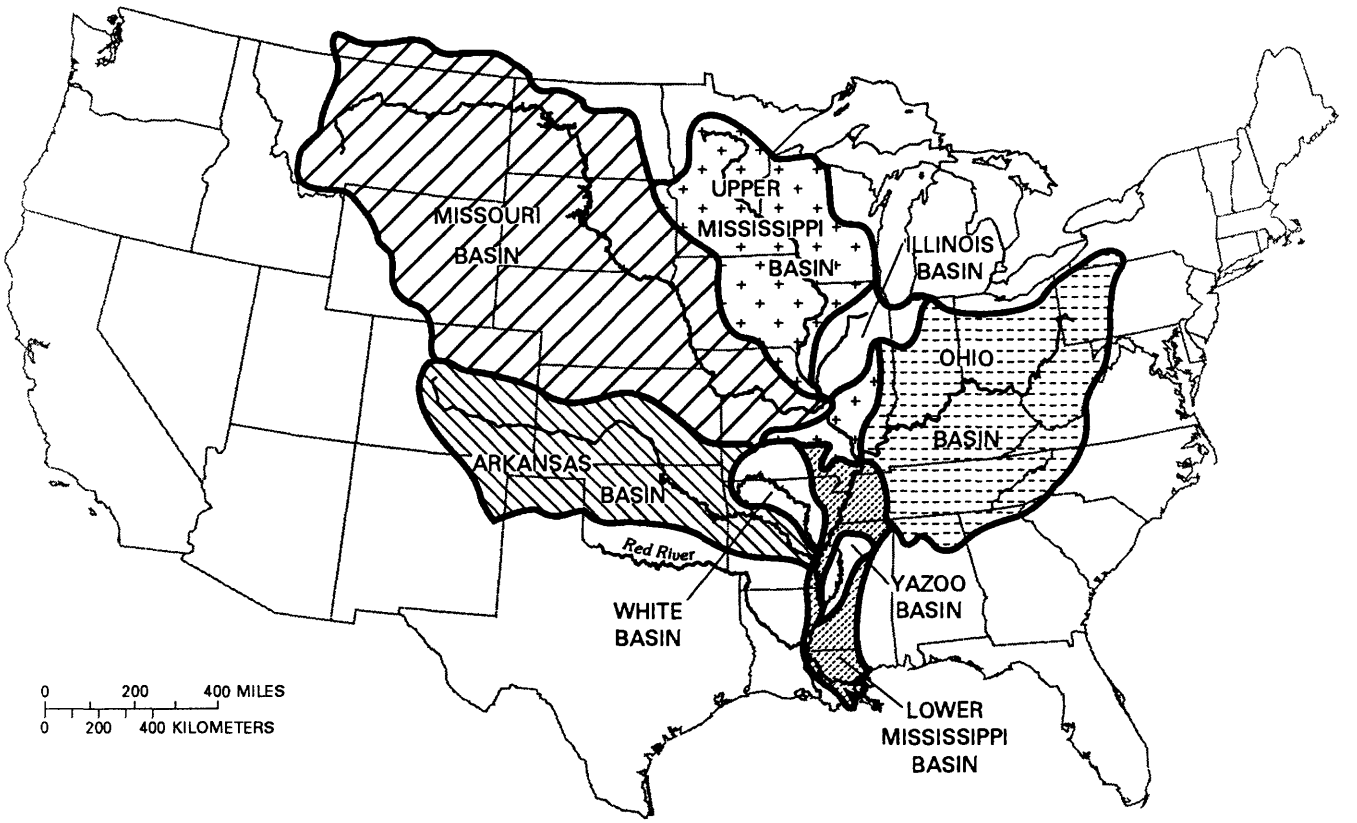


Figure 1.--Mississippi River drainage basin, which comprises eight subbasins. The Red River basin was not included because it is no longer a tributary to the Mississippi River. Adapted from Bragg (1977).

Acknowledgments

The U.S. Army Corps of Engineers representatives from the following districts provided extremely helpful and friendly assistance during and after the cruises: Samuel Lehr and Dorothy Wilson, Memphis District; Billy Garrett and John Miller, New Orleans District; Claude Strauser, Robert Barkau, and Shirley Bledsoe, St. Louis District; Henry Noble, Thomas Runnels and Wesley Bird, Vicksburg District; and James Farrel with the Lower Mississippi Valley Division.

Table 1.--*Drainage-basin areas and mean annual discharges of water and sediment for each basin*

[The basin areas and sediment discharges are taken from Keown and others (1981) except where noted. Values of the water discharges were taken from the U.S. Geological Survey water-resources data reports for the appropriate States, except where noted]

Basin	Length of record (years)	Drainage basin area (km^2)	(percent)	Mean Annual Discharge: Water (10^9 m^3/year)	(percent)	Sediment (10^6 metric tons/year)	(percent)
Upper Mississippi River less the Illinois River	58	407,660	14	[1]73	15	16.0	8
Illinois River	48	80,810	3	[2]20	4	6.7	3
Missouri River	88	[3]1,357,670	45	72	15	78.5	40
Ohio River	58	528,310	18	243	50	[4]72.6	37
White River	2	[5]66,190	2	19	4	3.4	2
Arkansas River	60	416,600	14	37	8	10.3	5
Lower Mississippi River less the Yazoo River[6]	17-50	80,530	3	11	2	6.7	3
Yazoo River	20	35,840	1	[7]12	2	3.8	2
TOTAL		2,973,610		487		198.0	

[1]Discharge for Mississippi River at Alton, Illinois minus discharge for the Illinois River.
[2]Discharge for the Illinois River below Meredosia, Illinois.
[3]Drainage area taken from the Missouri Water Resources Data for water years 1985-86.
[4]Sediment discharge was estimated by Keown and others (1981) by differences.
[5]Drainage area is for the gaging station at Clarendon, Arkansas. Discharge was supplied by the U.S. Army Corps of Engineers, Memphis, Tennessee.
[6]Seven tributaries: St. Francis, Obion, Hatchie, Wolf, Big Black, Homochitto, and Buffalo Rivers.
[7]Combined discharges (1967-87?) for the Yazoo River at Greenwood, Mississippi, and the Big Sunflower River at Sunflower, Mississippi (Henry Noble, U.S. Army Corps of Engineers, oral commun., 1988).

Many people along the river provided permission for docking, loading, and repairing the ship and equipment, and they often went out of their way to be helpful: Renee Ory and people at Ory Brothers Marine Service of America in Hartford, Illinois; Rusty Sutton in Grafton, Illinois; Pablo Lara, Ron Brant, and people at the Central Illinois Power Company in Meredosia, Illinois; Daniel Gipe and people at Hermann Sand and Gravel Company in Hermann, Missouri; Captain William Carroll and the people at Gateway River Cruises in St. Louis, Missouri; Kent Hoffmeister and the workers at Missouri Dry Dock and Repair Company in Cape Girardeau, Missouri; the crew at Lock and Dam 53 near Olmsted, Illinois; the U.S. Coast Guard Station in Hickman, Kentucky; John Janoush and the people at Janoush Marine, Inc., in Rosedale, Mississippi; the crew at Norrell Lock #1 near Arkansas Post, Arkansas; Mary Hosemann and the people working on the Spirit of Vicksburg in Vicksburg, Mississippi; and the people running the New Roads Ferry at St. Francisville, Louisiana, and the Belle Chasse Ferry at Belle Chasse, Louisiana.

Paul Hayes helped us on the Illinois River; Leon Reed and Larry Lumpkin helped us on the Missouri River at Hermann; Dale Hatten, George Gray, Leonard Huber, and Roger Nygaard have gone out of their way repeatedly to cooperate with us in making simultaneous measurements of the Mississippi River at St. Louis; Jack Doyle was helpful with measurements of the Ohio River; Harry Doyle made an extra effort to see that some specialized equipment was delivered to the ship in Memphis, Tennessee; Terry Lamb provided special and practical information on the Arkansas River; Harold Bishop, Fred Morris, Paul Grantham and Destry Phillips have altered their schedules to assist on sampling the sluggish but chemically interesting Yazoo River and the wide and deep Mississippi River at Vicksburg, Mississippi; and Charles Demas and Nolan Couvillion have been valuable sources of practical and technical assistance in sampling and measuring the Mississippi River at St. Francisville and Belle Chasse, Louisiana. Bill Matthes, Carol Anderson, and Mike Werito completed all the particle-size analyses. C. Clare Cranston constructed and installed some of the sampling equipment and taught us how to use it.

The crew of the R/V ACADIANA--Lee Black, Wayne Simoneaux, Chuck Guidry, Steve Rabalais, Ken Olivier, and Wilton Delaune--have been especially accommodating and have shown an unusual interest and concern in maintaining proper scientific operations.

Measuring river discharge or collecting suspended-sediment samples from large rivers is not a two-man operation and the following people's collaboration was necessary to get the job done: Terry Brinton, Pat Brown, John Garbarino, Tom Leiker, Jerry Leenheer, Brent McKee, Ted Noyes, Wilfred Pereira, Jim Ranville, Terry Rees, Colleen Rostad, Bob Stallard, Herb Stevens, Howard Taylor, and Tim Willoughby.

Objectives of Project

The broad objectives of this multidisciplinary project are to investigate the movement, mixing, and storage processes of sediment-associated pollutants in the Mississippi River system. Some specific objectives are to:

1. Understand the compartmentalization of synthetic organic agrochemicals between the water, sediment, and biotic phases.
2. Investigate the processes of mixing, partitioning, and redistribution of the various pollutants below major river confluences.
3. Understand the movement, storage, and remobilization of suspended sediment and associated pollutants at seasonal or longer time scales.
4. Predict the location and travel time of water masses and the associated sediment and pollutants.
5. Examine the geochemistry of the colloidal and dissolved phases of river water.

Purpose and Scope

The purpose of this report is to provide a description of the sampling sites on the Mississippi River and its principal tributaries and a description of the sampling procedures used to collect water and suspended-sediment samples for physical and chemical analysis. The basic hydrologic data associated with these samples are the water depth, river discharge, surface temperature and conductivity, concentration of suspended sand (>63 μm), silt/clay and colloidal material (<63 μm) in suspension, and the size distribution of the suspended and bed sediments. Chemical data are published elsewhere. The hydrologic data that are published in this report provide some of the necessary framework for interpreting the chemical data.

The 17-m research vessel ACADIANA, owned and operated by the Louisiana Universities' Marine Consortium, was used for collecting the samples because it has a shallow draft (about 1.2 m), permitting samples to be collected close to the river banks. Each cruise started upriver from St. Louis, Missouri, and samples were collected in a Lagrangian scheme that tried to follow the same water mass downriver. This sampling scheme was limited by the logistical constraints of using a single ship to sample the tributaries and the mainstem Mississippi River, and by the time available to process samples. This report includes data from three cruises; the first cruise was from July 18 to August 9, 1987; the second cruise was from November 29 to December 20, 1987; and the third cruise was from May 16 to June 7, 1988. Seventeen sites or sections (see table 2 and fig. 2) were sampled during the first cruise, and sixteen sections during the second and third cruises.

The cruises were planned to collect samples at different stages of the annual flow hydrograph; but, because of drought conditions during spring 1988 (when normal high stages occur), all three cruises occurred during low discharge (see figs. 3, 4, 5, and 6).

Table 2.--*Cross-section sampling locations during cruises of July-August 1987, November-December 1987, and May-June 1988*

[The X designates that the cross section was sampled]

Section name	River mile[1]	Cruise		
		July-August 1987	November-December 1987	May-June 1988
Mississippi River near Winfield, Mo.	UM 239.2	X	X	X
Illinois River below Meredosia, Ill.	IL 67.2	X	X	X
Mississippi River at Hartford, Ill.	UM 197.7	X		
Missouri River at Hermann, Mo.	MO 97.9	X		X
Missouri River at St. Charles, Mo.	MO 28.1		X	
Mississippi River at St. Louis, Mo.	UM 179.3	X	X	X
Mississippi River at Chester, Ill.	UM 108.9	X		
Mississippi River at Thebes, Ill.	UM 43.9		X	X
Ohio River below Smithland Locks and Dam, Ill.-Ky.	OH 919.2	X		
Ohio River at Olmsted, Ill.	OH 965.0	X	X	X
Mississippi River below Hickman, Ky.	LM 916.8	X	X	X
Mississippi River at Fulton, Tenn.	LM 777.3		X	X
Mississippi River at Helena, Ark.	LM 663.9	X	X	X
White River at Mile 11.5, Ark.	WH 11.5	X	X	X
Arkansas River at Mile 55.9, Ark.	AR 55.9	X		
Mississippi River above Arkansas City, Ark.	LM 566.0	X	X	X
Yazoo River at Mile 10, Miss.	YZ 10.0		X	X
Mississippi River below Vicksburg, Miss.	LM 433.4	X	X	X
Old River Outflow Channel near Knox Landing, La.	--	X	X	X
Mississippi River near St. Francisville, La.	LM 266.4	X	X	X
Mississippi River below Belle Chasse, La.	LM 73.1	X	X	X

[1]UM, Upper Mississippi River miles measured upriver of confluence with Ohio River.
IL, Illinois River miles measured upriver of confluence with Mississippi River (UM 218.0).
MO, Missouri River miles measured upriver of confluence with Mississippi River (UM 195.3).
OH, Ohio River miles measured downriver of Pittsburgh, Pa. Ohio-Mississippi River confluence is at Ohio River Mile 981.5 and Lower Mississippi River Mile 953.8.
LM, Lower Mississippi River miles measured upriver of Head of Passes, La.
WH, White River miles measured upriver of confluence with Mississippi River (LM 598.8).
AR, Arkansas River miles measured upriver of confluence with Mississippi River (LM 581.5).
YZ, Yazoo River miles measured upriver of confluence with Mississippi River (LM 437.2).

Figure 2.--Mississippi River and some tributaries. Sampling cross sections are shown as dots. See table 2 for more detailed information on location.

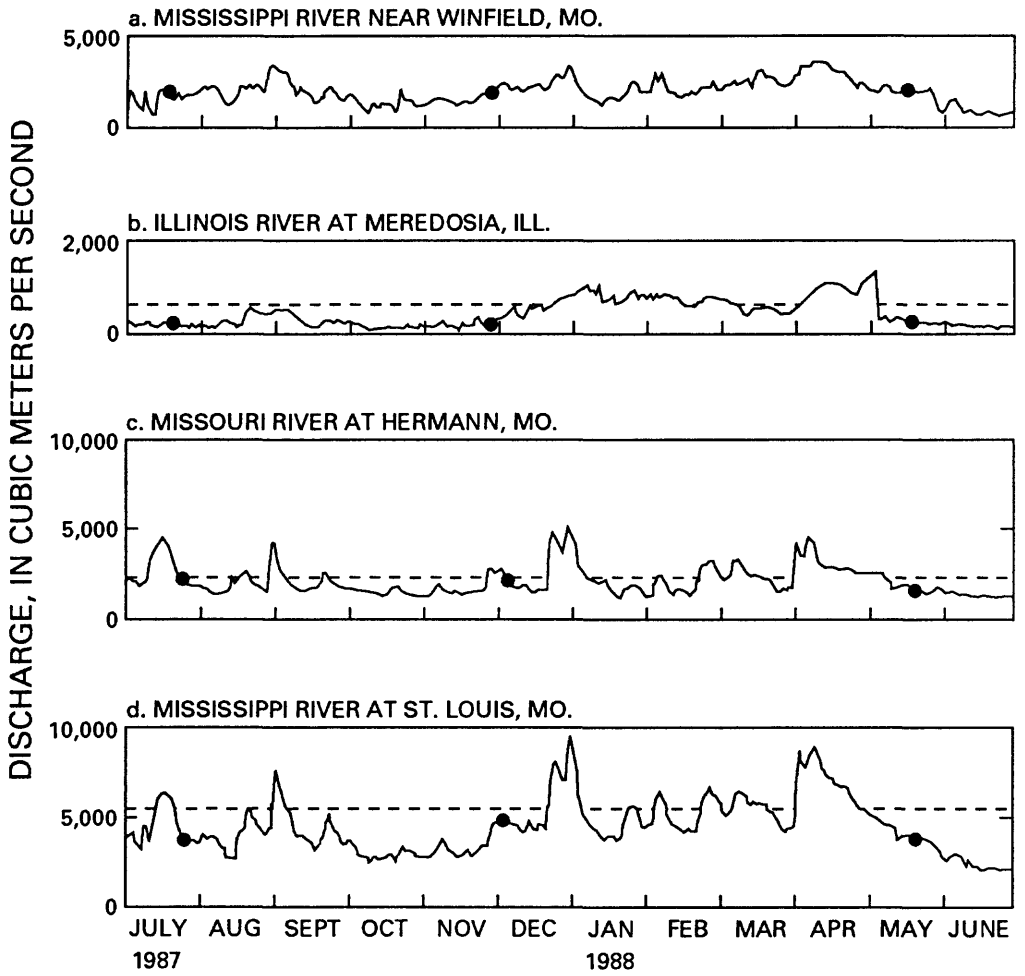


Figure 3.--Value of daily water discharges at selected sampling sections from July 1, 1987, to June 31, 1988. The day each section was measured (see tables 9, 10, and 11 for measured discharges) is shown as a solid dot. Dashed line is the mean discharge based on at least 49 years of record. Based on discharge data of the U.S. Geological Survey, except for the Mississippi River at Dam 22 (U.S. Army Corps of Engineers, Rock Island District).

a. Mississippi River near Winfield, Mo., is shown as the total of the Mississippi River at Dam 22 plus the Salt River at New London, Mo.
b. Illinois River at Meredosia, Ill.
c. Missouri River at Hermann, Mo.
d. Mississippi River at St. Louis, Mo.

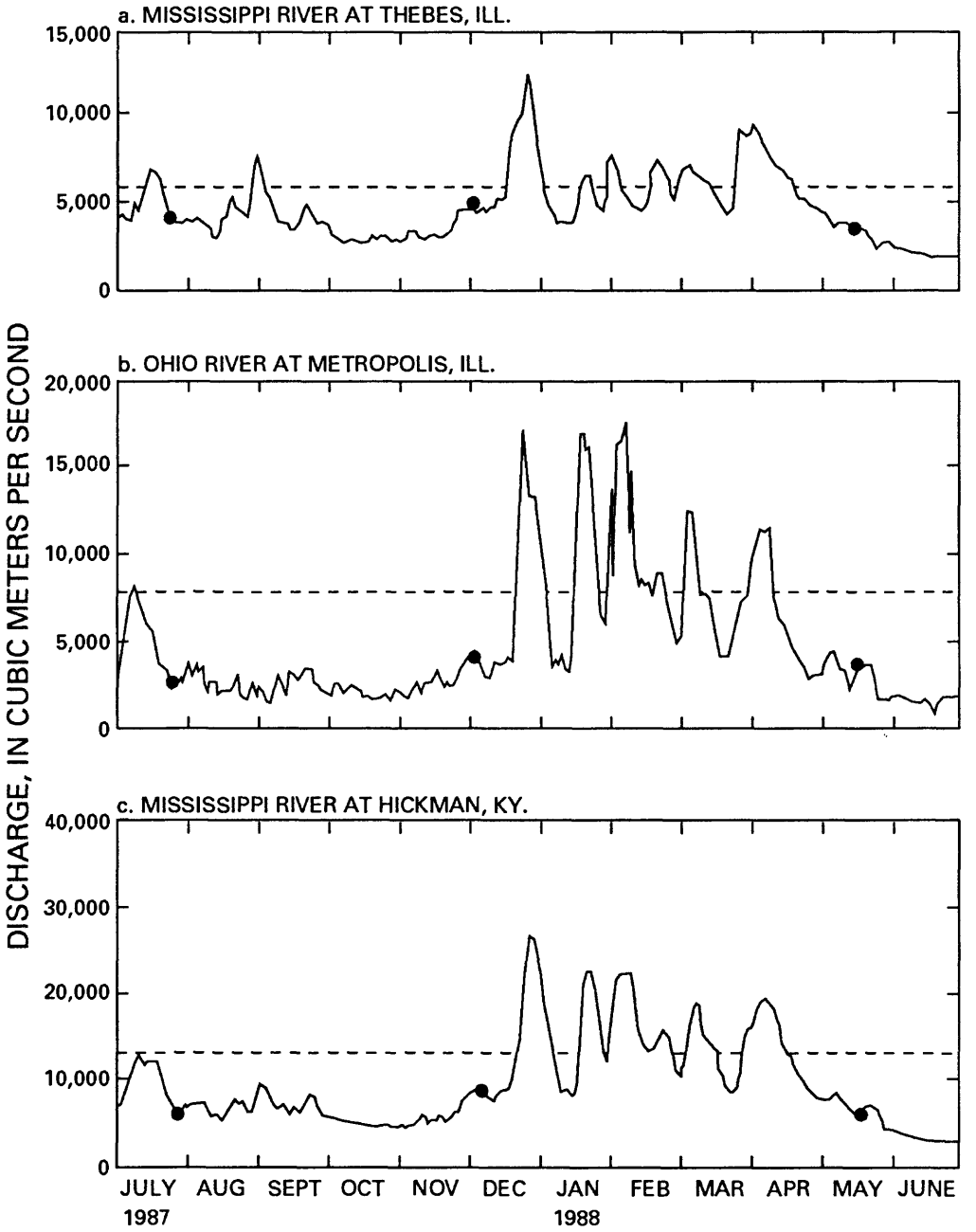


Figure 4.--Value of daily water discharges at selected sampling sections from July 1, 1987, to June 31, 1988. The day each section was measured (see tables 9, 10, and 11 for measured discharges) is shown as a solid dot. Dashed line is the mean discharge based on at least 49 years of record. Based on discharge data of the U.S. Geological Survey, except for the Mississippi River at Hickman (U.S. Army Corps of Engineers, Memphis District).

a. Mississippi River at Thebes, Ill.
b. Ohio River at Metropolis, Ill.
c. Mississippi River at Hickman, Ky.

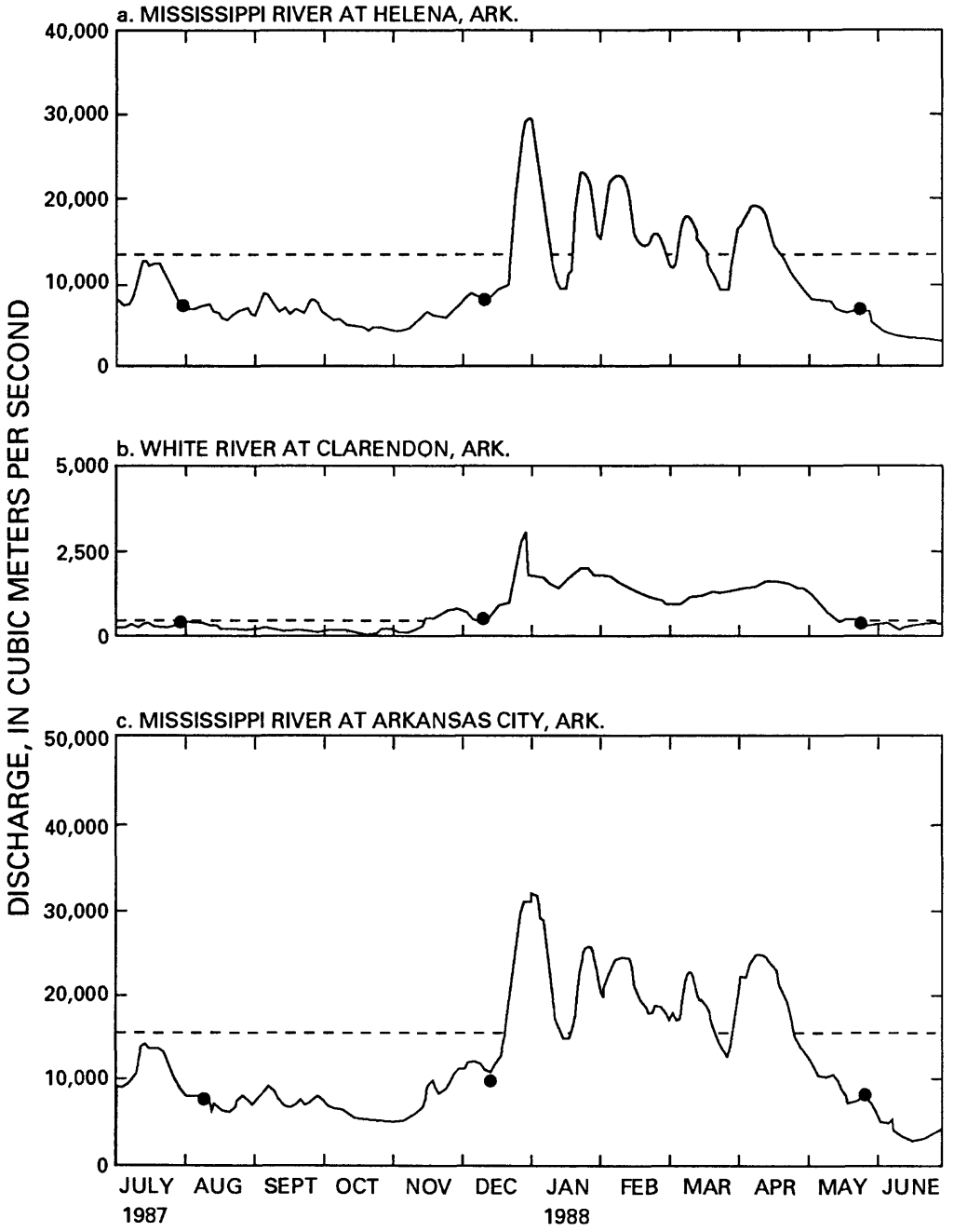


Figure 5.--Value of daily water discharges at selected sampling sections from July 1, 1987, to June 31, 1988. The day each section was measured (see tables 9, 10, and 11 for measured discharges) is shown as a solid dot. Dashed line is the mean discharge based on at least 49 years of record. Based on discharge data of the U.S. Army Corps of Engineers, Memphis and Vicksburg Districts.

a. Mississippi River at Helena, Ark.
b. White River at Clarendon, Ark., about 80 miles upriver of sampling section
c. Mississippi River at Arkansas City, Ark.

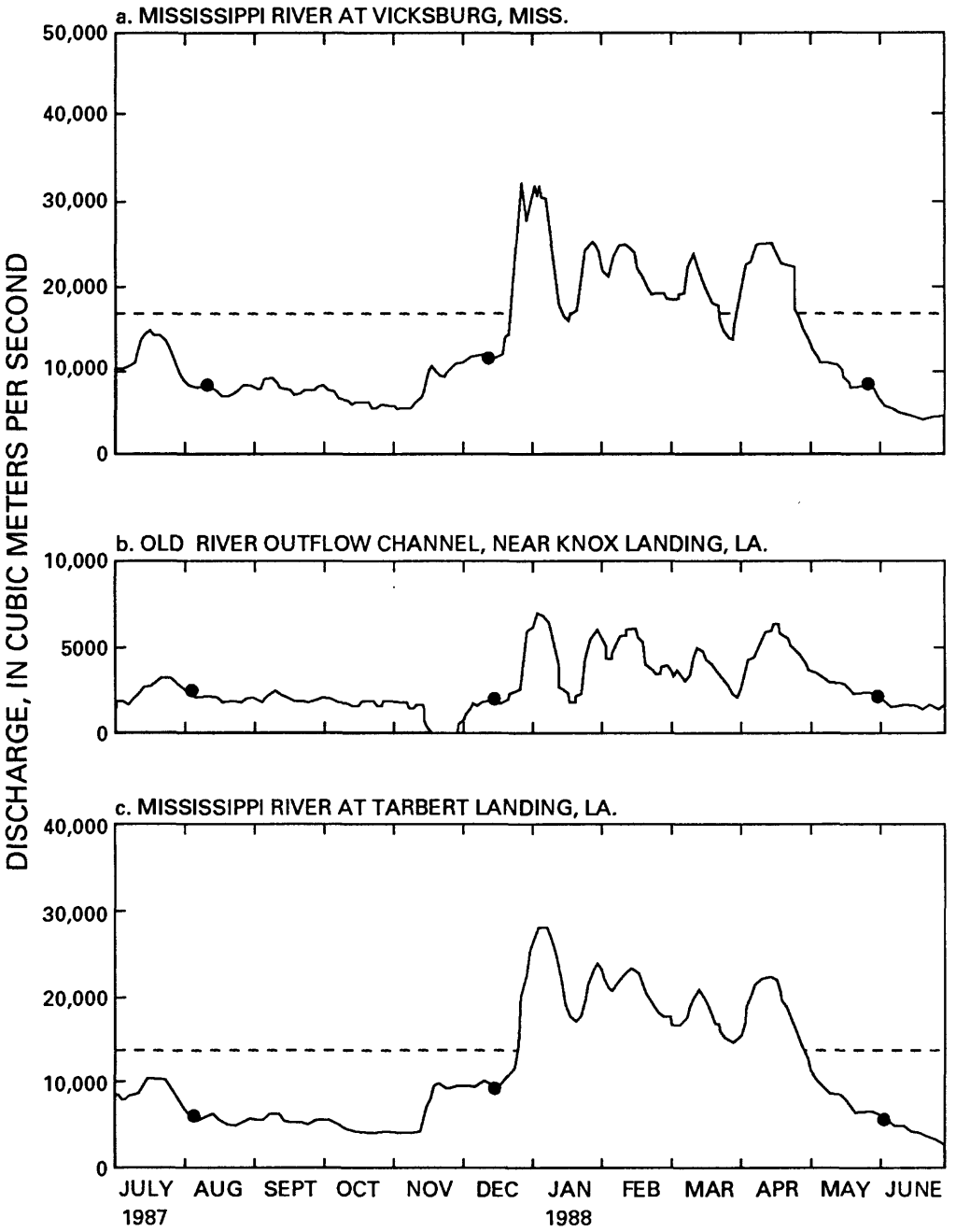


Figure 6.--Value of daily water discharges at selected sampling sections from July 1, 1987, to June 31, 1988. The day each section was measured (see tables 9, 10, and 11 for measured discharges) is shown as a solid dot. Dashed line is the mean discharge based on at least 49 years of record. Based on discharge data of the U.S. Army Corps of Engineers, Vicksburg and New Orleans Districts.

a. Mississippi River at Vicksburg, Miss.
b. Old River Outflow Channel, near Knox Landing, La.
c. Mississippi River at Tarbert Landing, La., 40 miles upriver from St. Francisville, La.

BED SEDIMENTS

A BM-54 sampler (Guy and Norman, 1970, p. 15) was used to collect bed-sediment samples for physical and chemical analyses. At the beginning of the measurement of each section, while equipment was being set up for the water-discharge measurement and suspended-sediment sampling, the ship drifted downstream; when it crossed the line of section, a bed-sediment sample was taken for physical analysis and as soon as possible a second sample was taken for chemical analysis. A fathometer (Lowrance, Model X16)[1] was used to obtain a continuous record of depth; at the time each bed sample was taken, a mark was made on this continuous trace of the river bottom. Samples were collected at approximately 0.25, 0.50, and 0.75 of the distance between left and right banks during the first and second cruises (tables 3 and 4). During the third cruise bed samples were collected at approximately 0.1, 0.3, 0.5, 0.7, and 0.9 of the distance between the left and right banks (table 5).

[1]The use of brand, trade, or firm names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Table 3.--*Particle size, determined by sieving, of sediment collected from the beds of the Mississippi River and its principal tributaries, July 20 to August 9, 1987*

[Analyses by M.J. Werito and J.A. Moody]

Date	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size in millimeters (mm)								Median diameter[2] (mm)
			0.063	0.125	0.250	0.500	1.00	2.00	4.00	8.00	16.00	
1987						Missouri River at Hermann, Mo.						
7-20	0.25	6.7	0.1	1.1	50.5	99.3	99.9	100.0				0.25
	0.50	6.7	0.0	0.4	21.7	60.4	88.5	94.2	96.5	98.0	99.3	0.43
	0.75	5.5	0.0	0.2	9.8	36.7	81.4	94.4	98.9	99.8	100.0	0.65
						Mississippi River at St. Louis, Mo.						
7-22	0.25	9.4	0.1	1.2	79.4	99.7	99.9	100.0				0.20
	0.50	7.6	0.1	0.8	16.0	63.3	84.2	91.9	96.5	99.5	100.0	0.43
	0.75	5.8	0.1	0.4	9.3	59.5	91.5	96.6	98.0	98.6	100.0	0.45
						Mississippi River at Chester, Ill.						
7-23	0.25	6.4	0.1	0.3	29.0	95.6	99.6	99.7	99.8	100.0		0.33
	0.50	7.9	0.1	0.7	32.3	78.2	92.8	95.4	96.3	97.0	100.0	0.35
	0.75	6.1	0.2	0.7	22.5	51.3	76.9	92.0	98.0	100.0		0.49
						Ohio River below Smithland Locks and Dam, Ill.-Ky.						
7-26	0.00	0.0	1.1	10.4	79.3	99.6	99.8	99.9	100.0			0.20
						Ohio River at Olmsted, Ill.						
7-27	0.25	3.7	0.5	2.5	13.4	68.8	81.8	84.6	88.8	[1]96.0	100.0	0.42
	0.50	6.1	0.4	1.8	4.7	27.8	65.2	85.4	94.3	[1]98.1	100.0	0.80
	0.75	7.9	0.2	1.2	2.5	37.5	73.3	80.6	85.5	[1]91.8	100.0	0.67
						Mississippi River below Hickman, Ky.						
7-28	0.25	5.8	0.1	0.5	4.8	7.8	35.9	53.9	64.6	73.7	100.0	1.78
	0.50	6.4	0.0	0.4	14.3	53.3	96.5	99.8	100.0			0.48
	0.75	6.4	0.2	0.9	51.7	94.6	98.8	99.5	99.8	100.0		0.25
						Mississippi River at Helena, Ark.						
7-30	0.25	8.8	0.0	0.0	2.9	71.8	99.4	100.0				0.42
	0.50	6.1	0.1	0.2	2.8	88.0	99.7	99.8	100.0			0.39
	0.75	8.2	0.0	0.1	19.2	96.9	99.8	99.9	100.0			0.35
						White River at Mile 11.5, Ark.						
7-31	0.25	2.7	0.4	0.9	1.8	63.0	97.0	98.8	99.4	100.0		0.45
	0.50	3.0	0.2	1.0	17.1	91.5	99.4	99.8	99.9	100.0		0.36
	0.75	2.7	0.0	0.1	8.2	90.9	99.5	99.8	100.0			0.38
						Arkansas River at Mile 55.9, Ark.						
8-01	0.25	3.7	0.1	0.8	61.9	99.8	99.8	99.9	99.9	100.0		0.23
	0.50	4.9	0.1	1.1	62.4	98.8	98.9	98.9	99.0	99.0	100.0	0.22
	0.75	4.9	0.0	0.3	18.7	97.5	99.7	99.9	100.0			0.35
1987						Mississippi River above Arkansas City, Ark.						
8-02	0.25	11.3	0.2	2.7	74.1	99.8	99.9	100.0				0.21
	0.50	14.3	0.1	1.4	28.4	97.4	99.8	99.8	99.9	100.0		0.33
	0.75	10.4	0.1	0.3	0.8	91.9	99.0	99.0	100.0			0.39
						Mississippi River below Vicksburg, Miss.						
8-04	0.25	11.6	0.1	0.4	7.4	30.2	67.1	83.6	91.2	98.4	100.0	0.77
	0.50	9.1	0.0	0.2	9.1	96.6	99.9	100.0				0.37
	0.75	4.0	0.1	0.9	26.4	99.7	99.8	100.0				0.33
						Old River Outflow Channel near Knox Landing, La.						
8-06	0.25	5.5	0.0	0.4	13.5	91.1	99.0	99.4	99.6	99.7	100.0	0.37
	0.50	4.3	0.0	0.2	8.9	88.4	99.1	99.7	99.9	100.0		0.38
	0.75	3.0	0.1	0.5	11.6	89.9	97.8	98.7	99.2	99.8	100.0	0.37
						Mississippi River near St. Francisville, La.						
8-07	0.25	7.0	0.2	1.9	92.4	99.9	100.0					0.19
	0.50	7.0	0.1	0.3	15.0	98.4	99.9	99.9	100.0			0.35
	0.75	11.0	0.1	0.2	16.3	97.7	100.0					0.35
						Mississippi River below Belle Chasse, La.						
8-09	0.25	23.0	0.2	2.2	42.2	95.7	99.2	99.4	99.5	99.6	100.0	0.29
	0.50	23.0	2.3	7.3	61.8	96.7	99.7	99.9	100.0			0.22

[1]Clamshell fragments were larger than 16 mm.
[2]Median diameter determined by straight-line interpolation.

Table 4.--*Particle size, determined by sieving, of sediment collected from the beds of the Mississippi River and its principal tributaries, November 30 to December 20, 1987*

[Analyses by M.J. Werito]

Date	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size in millimeters (mm)								Median diameter[2] (mm)
			0.063	0.125	0.250	0.500	1.00	2.00	4.00	8.00	16.00	
1987				Mississippi River near Winfield, Mo.								
11-30	0.25	8.2	<0.1	0.2	4.1	38.5	78.1	93.6	99.1	99.8	100.0	0.69
	0.50	7.0	<0.1	0.1	3.3	56.6	96.0	99.9	100.0			0.47
	0.75	4.5	1.0	1.4	4.8	35.3	71.2	86.5	95.4	99.6	100.0	0.70
				Missouri River at St. Charles, Mo.								
12-02	0.25	6.0	0.1	0.6	9.3	40.5	90.9	99.6	100.0			0.59
	0.50	5.3	0.1	0.4	18.5	75.5	94.7	96.1	96.8	98.1	100.0	0.39
	0.75	5.6	<0.1	0.1	0.1	25.9	78.9	94.7	97.3	98.3	100.0	0.73
				Mississippi River at St. Louis, Mo.								
12-03	0.25	9.5	0.1	1.1	76.7	94.3	97.7	99.1	100.0			0.21
	0.50	8.9	0.1	1.2	69.9	87.5	94.9	97.1	98.4	100.0		0.21
	0.75	7.5	<0.1	1.0	40.9	86.5	98.0	99.0	99.7	100.0		0.30
				Mississippi River at Thebes, Ill.								
12-05	0.25	8.0	<0.1	0.1	0.8	22.5	79.1	94.3	98.6	100.0		0.74
	0.50	6.8	0.7	2.1	4.3	87.9	99.6	100.0				0.39
	0.75	6.5	0.1	0.5	10.9	88.5	99.6	100.0				0.38
				Ohio River at Olmsted, Ill.								
12-06	0.25	5.7	1.8	3.1	9.1	78.8	96.0	97.6	99.1	[1]99.7	100.0	0.40
	0.50	10.1	1.0	12.9	22.2	62.2	78.3	82.6	89.5	[1]97.8	100.0	0.42
	0.75	9.4	5.7	8.7	28.5	61.9	76.7	86.4	94.4	100.0		0.41
				Mississippi River below Hickman, Ky.								
12-07	0.25	8.0	0.0	0.2	10.5	25.5	46.8	77.1	95.0	99.9	100.0	1.11
	0.50	8.5	<0.1	0.8	26.3	55.2	93.4	99.6	100.0			0.46
	0.75	9.3	0.0	0.2	8.4	86.2	99.1	99.7	99.8	100.0		0.38
				Mississippi River at Fulton, Tenn.								
12-08	0.25	11.2	0.0	<0.1	1.2	11.7	64.8	92.0	96.4	98.2	100.0	0.86
	0.50	15.0	0.0	0.4	22.5	94.6	99.9	100.0				0.35
	0.75	12.2	0.1	0.8	31.5	96.2	99.9	100.0				0.32
				Mississippi River at Helena, Ark.								
12-11	0.25	9.8	0.0	<0.1	1.1	52.9	99.1	99.9	99.9	100.0		0.49
	0.50	7.5	0.0	0.3	14.0	91.5	99.8	99.9	100.0			0.37
	0.75	8.0	0.1	0.4	22.3	85.7	98.7	99.6	99.8	100.0		0.36
1987				White River at Mile 11.5, Ark.								
12-12	0.25	4.5	0.4	1.0	25.3	94.5	99.5	99.8	99.8	100.0		0.34
	0.50	3.9	0.4	1.4	30.4	97.2	99.6	99.7	99.8	100.0		0.32
	0.75	4.0	0.4	0.8	0.8	86.8	95.6	96.4	97.3	98.9	100.0	0.39
				Mississippi River above Arkansas City, Ark.								
12-13	0.25	13.0	0.4	4.3	77.7	99.4	100.0					0.20
	0.50	15.5	0.2	2.5	51.8	99.6	100.0					0.25
	0.75	12.0	0.1	0.3	1.1	86.4	99.1	99.5	99.6	100.0		0.39
				Mississippi River below Vicksburg, Miss.								
12-15	0.25	12.0	0.1	1.5	35.2	68.1	99.4	99.7	99.9	100.0		0.36
	0.50	10.4	0.6	3.2	21.3	98.3	100.0					0.34
	0.75	5.0	0.1	0.5	17.6	99.7	99.7	99.8	100.0			0.35
				Old River Outflow Channel near Knox Landing, Ark.								
12-17	0.25	6.0	0.3	0.8	6.7	89.3	98.6	99.1	99.7	100.0		0.38
	0.50	6.1	0.4	1.0	7.4	91.3	99.5	99.8	100.0			0.38
	0.75	4.3	2.9	7.8	21.7	99.0	100.0					0.34
				Mississippi River near St. Francisville, La.								
12-18	0.25	8.0	0.8	2.2	99.3	100.0						0.19
	0.50	9.5	0.2	2.0	50.5	99.6	99.8	99.9	100.0			0.25
	0.75	12.0	0.0	0.3	8.7	96.8	99.9	100.0				0.37
				Mississippi River below Belle Chasse, La.								
12-20	0.25	23.5	0.8	9.3	86.9	99.2	99.6	99.7	99.9	100.0		0.19
	0.50	24.0	0.7	7.0	78.4	99.3	99.9	100.0				0.20

[1]Clamshell fragments were larger than 16 mm.
[2]Median diameter determined by straight-line interpolation.

Table 5.--*Particle size, determined by sieving, of sediment collected from the beds of the Mississippi River and its principal tributaries, May 16 to June 7, 1988*

[Analyses by M.J. Werito]

Date	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size in millimeters (mm)													Median diameter[2] (mm)
			0.063	0.090	0.125	0.180	0.250	0.355	0.50	0.71	1.00	1.41	2.00	4.00	8.00	16.00	
1988						Mississippi River near Winfield, Mo.											
5-17	0.1	8.0	0.0	0.1	0.2	0.6	1.6	10.5	40.8	72.2	89.4	94.3	99.2	100.0			0.56
	0.3	7.5	0.0	0.0	0.1	1.3	10.5	50.2	88.5	98.2	99.4	99.6	99.6	99.7	100.0		0.36
	0.5	6.4	0.0	<0.1	0.2	1.7	6.2	21.9	48.5	71.7	86.2	90.4	96.1	98.8	100.0		0.51
	0.7	4.9	0.2	0.4	1.1	2.9	8.8	34.2	69.2	84.5	89.4	91.8	93.2	95.6	97.1	100.0	0.43
	0.9	4.0	0.1	0.3	0.4	0.6	2.2	14.7	43.2	68.6	85.2	90.9	98.7	100.0			0.56
						Illinois River below Meredosia, Ill.											
5-16	0.1	2.0	17.0	18.4	35.1	44.2	68.2	89.1	95.7	97.8	98.7	99.1	99.3	99.5	100.0		0.20
	0.3	3.0	7.1	9.1	16.5	23.7	47.6	75.9	86.0	86.6	89.0	89.3	89.7	90.5	91.7	95.0	0.26
	0.5	5.5	3.3	4.0	8.3	19.0	37.3	63.3	89.8	97.9	99.3	99.6	99.8	99.8	100.0		0.30
	0.6	6.0	49.1	54.8	60.3	67.8	82.2	96.5	99.6	99.8	99.8	99.8	100.0				0.07
	0.9	2.0	42.4	50.1	63.2	67.7	75.7	86.7	93.7	95.3	95.5	95.9	96.1	97.0	100.0		0.09
						Missouri River at Hermann, Mo.											
5-19	0.2	5.8	0.0	<0.1	0.2	1.0	6.4	19.1	30.6	42.5	58.7	74.7	85.5	96.8	99.5	100.0	0.84
	0.3	5.3	0.0	0.0	0.1	4.3	20.6	39.3	73.0	84.2	90.5	92.5	95.8	97.8	98.9	100.0	0.40
	0.5	4.3	0.0	<0.1	0.3	4.4	28.7	61.0	94.5	99.2	99.7	99.8	99.9	99.9	100.0		0.35
	0.7	3.5	0.0	0.0	0.1	2.2	9.5	20.4	69.8	93.3	98.2	98.8	99.2	99.2	100.0		0.44
	0.9	2.6	<0.1	0.2	1.6	8.8	26.2	46.4	85.2	96.2	98.9	99.5	99.7	100.0			0.27
						Mississippi River at St. Louis, Mo.											
5-20	0.2	10.0	0.0	0.0	<0.1	0.9	6.7	35.1	97.4	99.1	99.6	99.7	99.9	100.0			0.39
	0.3	7.8	0.0	0.0	0.2	3.4	20.1	58.9	91.3	95.4	97.3	98.3	98.8	99.3	99.6	100.0	0.33
	0.5	6.2	0.0	0.0	0.2	3.8	18.5	42.2	67.6	79.6	86.7	88.9	93.2	96.5	98.7	100.0	0.40
	0.7	5.3	0.0	<0.1	0.3	3.6	23.6	60.7	82.1	95.7	99.0	99.5	99.7	99.8	100.0		0.32
	0.9	5.5	0.0	0.0	0.1	0.7	1.9	6.8	31.6	79.8	95.4	97.8	99.5	99.8	100.0		0.58
						Mississippi River at Thebes, Ill.											
5-22	0.1	6.5	0.0	0.1	1.8	13.5	56.6	68.7	70.0	70.6	71.4	72.9	75.3	82.7	91.7	100.0	0.24
	0.4	7.0	0.0	0.0	0.1	2.4	19.2	74.5	93.8	96.9	97.9	98.1	98.5	98.9	99.4	100.0	0.31
	0.6	7.8	0.0	0.0	0.6	7.3	42.1	83.7	95.4	97.9	98.8	99.1	99.2	99.4	99.6	100.0	0.27
	0.8	6.7	0.0	0.0	0.1	1.6	6.8	19.4	41.0	71.6	91.0	94.8	98.6	99.5	100.0		0.56
						Ohio River at Olmsted, Ill.											
5-23	0.1	2.3	2.9	3.2	4.0	5.7	14.0	53.8	95.6	99.0	99.4	99.6	99.8	100.0			0.34
	0.3	5.0	0.2	0.5	0.7	1.5	4.7	22.6	76.2	93.3	97.2	98.2	99.7	100.0			0.43
	0.5	7.5	0.1	0.3	0.8	1.0	1.2	3.6	26.4	70.6	87.5	94.0	96.7	99.4	99.9	100.0	0.61
	0.7	7.8	0.1	0.6	1.5	3.1	5.5	13.3	42.0	68.8	82.2	86.3	93.1	96.7	99.8	100.0	0.56
	0.8	8.4	2.0	3.8	7.8	11.3	17.4	37.1	53.0	60.0	63.5	66.4	69.6	81.9	94.0	100.0	0.47
						Mississippi River below Hickman, Ky.											
5-24	0.1	6.6	0.0	0.1	0.4	1.5	1.9	2.2	2.8	5.0	13.4	19.7	39.9	57.3	67.5	77.1	3.16
	0.3	5.7	0.0	<0.1	0.5	3.2	11.5	16.3	18.9	21.9	30.3	44.9	58.9	83.8	95.3	97.9	1.63
	0.5	6.0	0.0	<0.1	0.4	5.4	25.0	58.3	68.1	74.7	81.8	84.2	88.2	90.7	92.8	97.6	0.33
	0.7	7.9	0.0	<0.1	0.5	4.4	67.1	90.4	96.9	99.0	99.5	99.6	99.7	99.8	100.0		0.23
	0.9	5.3	37.8	45.1	54.4	71.2	86.6	94.8	98.0	98.6	98.8	99.1	99.7	100.0			0.11
						Mississippi River at Fulton, Tenn.											
5-26	0.1	4.3	<0.1	0.1	0.4	2.4	18.5	60.3	94.4	99.7	99.9	100.0					0.33
	0.3	9.0	0.0	0.0	0.1	0.9	2.3	4.1	9.8	19.5	38.4	51.2	83.1	95.2	98.0	100.0	1.37
	0.5	13.0	0.0	0.0	0.1	0.9	4.9	20.5	61.8	96.8	99.9	100.0					0.46
	0.7	10.5	0.0	0.0	0.6	7.0	33.8	79.2	99.0	100.0							0.29
	0.9	6.0	0.2	0.3	0.7	6.6	42.8	72.8	88.5	96.7	98.9	99.5	99.9	100.0			0.28
						Mississippi River st Helena, Ark.											
5-28	0.1	10.3	0.0	0.0	<0.1	0.1	0.7	4.1	15.5	43.6	77.4	90.3	92.9	94.3	95.8	100.0	0.77
	0.4	9.4	0.0	0.0	0.1	0.4	5.1	21.2	51.2	88.1	97.6	99.0	99.3	99.6	100.0		0.49
	0.6	7.5	0.0	0.0	0.1	1.6	15.8	49.8	94.3	99.7	100.0						0.36
	0.7	6.9	0.0	0.0	0.3	6.4	36.5	81.2	99.1	99.8	99.8	99.8	99.9	99.9	100.0		0.29
	0.9	4.7	0.5	0.7	1.5	4.4	18.7	57.5	92.1	98.5	99.4	99.6	99.8	100.0			0.33

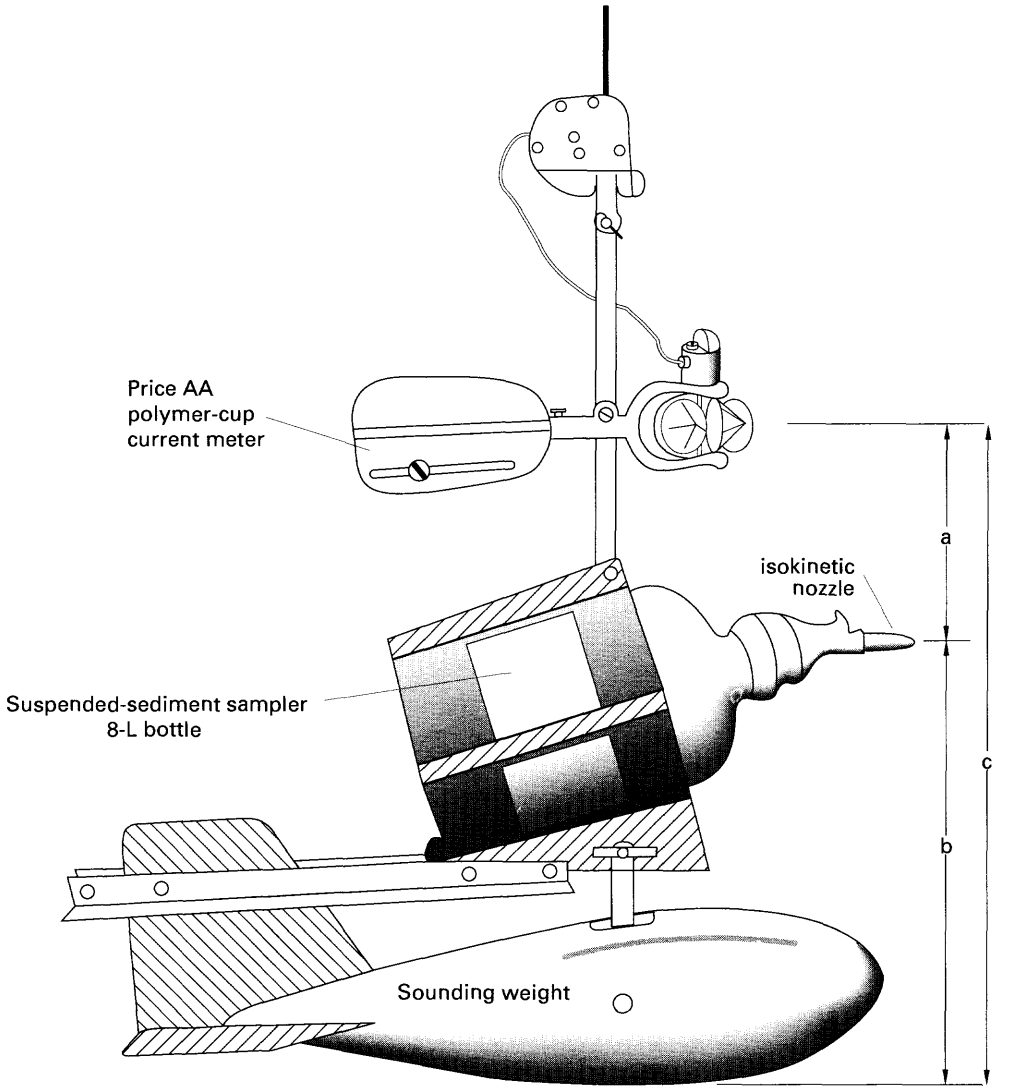
Table 5.--*Particle size, determined by sieving, of sediment collected from the beds of the Mississippi River and its principal tributaries, May 16 to June 7, 1988*--Continued

Date	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size in millimeters (mm)													Median diameter[2] (mm)
			0.063	0.090	0.125	0.180	0.250	0.355	0.50	0.71	1.00	1.41	2.00	4.00	8.00	16.00	
1988						White River at Mile 11.5, Ark.											
5-29	0.1	4.5	3.4	4.8	6.5	11.3	19.9	45.5	85.5	92.4	92.9	93.5	95.1	98.4	100.0		0.37
	0.3	3.8	0.2	0.2	0.5	2.8	24.2	72.9	95.0	98.8	99.4	99.6	99.8	99.9	100.0		0.31
	0.5	3.3	0.1	0.1	0.2	1.8	16.6	66.6	97.5	99.7	99.9	100.0					0.32
	0.7	3.2	<0.1	0.1	0.9	1.5	12.6	56.7	93.5	99.0	99.6	99.8	99.8	99.9	100.0		0.34
	0.9	3.5	0.2	0.3	0.6	2.3	7.5	32.0	85.8	97.6	99.2	99.6	99.8	100.0			0.40
						Mississippi River above Arkansas City, Ark.											
5-30	0.1	4.0	0.5	1.1	10.3	57.1	98.6	99.7	100.0								0.17
	0.3	15.1	0.0	0.2	2.0	11.6	44.2	86.9	98.4	99.8	100.0						0.26
	0.5	14.0	0.0	<0.1	0.6	2.5	19.4	58.8	91.7	98.5	99.2	99.2	99.3	99.5	99.7	100.0	0.33
	0.7	11.0	0.1	0.3	1.0	2.2	3.4	11.3	49.0	74.5	82.0	83.7	84.7	86.6	90.2	100.0	0.51
	0.9	10.1	2.0	4.1	15.6	29.1	37.1	46.1	80.3	97.9	99.5	99.6	99.7	99.8	100.0		0.37
						Mississippi River below Vicksburg, Miss.											
6-02	0.1	12.0	0.0	0.1	0.3	1.8	3.4	10.8	55.4	88.8	95.3	96.5	97.1	97.7	99.3	100.0	0.48
	0.3	10.3	0.0	<0.1	0.2	0.7	1.9	8.0	36.0	67.9	84.3	90.5	93.0	96.4	99.0	100.0	0.59
	0.5	7.0	0.0	<0.1	0.2	1.5	10.8	36.2	96.9	99.7	99.8	100.0					0.39
	0.7	4.0	0.2	0.4	0.9	2.0	19.0	95.2	99.8	99.9	99.9	100.0					0.29
	0.9	2.1	0.3	0.8	1.9	10.2	33.0	56.7	99.0	99.9	99.9	100.0					0.33
						Old River Outflow Channel near Knox Landing, La.											
6-04	0.1	5.9	0.0	<0.1	0.1	0.7	3.8	18.2	77.7	96.2	98.8	99.3	99.6	99.7	100.0		0.43
	0.3	5.3	0.0	0.0	<0.1	1.6	22.1	60.8	98.1	99.8	99.9	99.9	99.9	99.9	100.0		0.33
	0.5	4.1	0.0	<0.1	0.5	5.7	57.3	77.9	96.1	99.6	99.8	99.9	99.9	99.9	100.0		0.24
	0.7	2.9	0.1	0.2	1.0	7.2	50.4	70.5	92.2	99.2	99.9	100.0					0.25
	0.9	3.6	0.8	1.1	1.7	7.4	37.6	76.7	94.0	97.6	99.1	99.6	99.9	100.0			0.28
						Mississippi River near St. Francisville, La.											
6-05	0.1	2.9	1.2	2.4	15.5	75.9	99.8	100.0									0.16
	0.3	6.8	0.1	0.7	5.3	37.7	97.5	99.6	99.9	100.0							0.19
	0.5	8.6	0.1	0.2	0.8	2.9	25.7	78.8	98.0	99.9	100.0						0.30
	0.7	10.1	0.2	0.7	2.3	5.3	13.0	61.5	98.6	99.8	99.9	99.9	99.9	99.9	100.0		0.33
	0.9	11.0	0.1	0.1	0.4	0.6	1.3	6.5	49.2	88.1	93.9	95.4	96.3	97.8	99.7	100.0	0.50
						Mississippi River below Belle Chasse, La.											
6-07	0.1	18.7	17.9	26.8	39.2	71.5	86.6	93.8	97.4	99.0	99.8	100.0					0.14
	0.3	22.0	0.4	0.6	5.1	29.6	73.8	94.3	99.4	99.8	99.9	99.9	99.9	99.9	99.9	100.0	0.21
	0.5	23.0	0.4	0.9	3.5	21.2	60.1	83.2	98.5	99.9	100.0						0.23
	0.7	21.1	1.6	1.9	5.2	18.9	61.6	90.9	99.5	100.0							0.23
	0.9	19.0	69.8	79.9	85.7	90.9	95.5	99.5	99.7	99.8	99.8	99.8	100.0				<0.06

[1]Gravel sizes contained mostly gastropod and bivalve shell fragments.
[2]Median diameter determined by straight-line interpolation.

WATER-DISCHARGE MEASUREMENT

The mean velocity at each vertical was measured by depth integration as the suspended-sediment sampler and current meter (fig. 7) were lowered from the surface to the bottom at a constant transit rate and then immediately upon



DISTANCE, IN CENTIMETERS

WEIGHT, IN POUNDS	a	b	c
150	22	42	64
200	22	45 (42)	67
300	22 (27)	48	70 (75)

Figure 7.--Suspended-sediment sampler with current meter. Value in parenthesis for b and c, opposite 200 lbs. is for the July-August 1987 cruise. Value in parenthesis for a and c, opposite 300 lbs. is for the Mississippi River at Hickman, Fulton, and Helena during the November-December 1987 cruise.

touching the bottom, the sampler and current meter were raised at the same constant transit rate to the surface. Ideally, for discharge measurements, the transit rate should be as slow as possible so that the integration time is as long as possible. However, at very slow transit rates, the suspended-sediment sampler would overfill. The transit rate was therefore determined by the requirements for collecting 90 to 100 L of water and suspended sediment (see Nordin and others, 1983) and for keeping the transit rate less than 20 percent of the mean flow in order to obtain a reliable mean velocity and hence discharge measurement (see tables 6, 7, and 8 for a listing of transit rates used at each section).

Since the ship usually was not anchored during the vertical sampling procedure, the measured velocities were corrected for ship drift (Nordin and others, 1983; Moody and Troutman, in press) by using two microwave transmitter/receiver stations on shore and a master station (Del Norte Technology Trisponder system) aboard the ship to measure the change in upriver-downriver position and cross-river position. The mean depth was obtained from the fathometer which produced a continuous strip-chart record of depth during the down- and upcast. In the Mississippi River, 30 to 40 equally spaced vertical locations typically were occupied to collect suspended-sediment samples and to measure water discharge. At some sections (especially those with asymmetrical cross sections) additional verticals were occupied (tables 6, 7, and 8) in order to obtain additional velocity measurements in areas where the discharge per unit width was large. Even though no suspended-sediment sample was collected at these extra verticals, a sample bottle was put in the holder so that the current-meter calibration was not altered. For the July-August 1987, and for part of the November-December 1987 cruises, the mean velocity was computed as the average of the down- and upcasts (referred to as $Q_{initial}$). We eventually realized that the current meter was in the turbulent shadow of the relatively large sampling bottle on

Table 6.--*Statistics of the vertical depth-integration method which was used to collect suspended sediment, July 18 to August 9, 1987*

[V_c is the total volume collected by depth integration; V_d is the total volume dewatered = total volume collected minus the aliquots taken by each research project]

Date	River and section	Number of verticals	Length of section (hr)	Time per vertical (min)	Average transit rate (cm/s)	Mean water velocity (cm/s)	Nozzle diameter (inch)	Volume V_c (L)	Volume V_d (L)
1987									
7-19	Mississippi R. near Winfield, Mo.	1	No	depth-integrated			sample	92.0	[1]92.0
7-18	Illinois R. below Meredosia, Ill.	1	No	depth-integrated			sample	92.0	[1]92.0
7-21	Mississippi R. at Hartford, Ill.	35	3.27	5.6	12	54	5/16	98.8	93.2
7-20	Missouri R. at Hermann, Mo.	28	3.90	8.3	13	123	1/4	64.1	58.4
7-22	Mississippi R. at St. Louis, Mo.	30	3.10	6.2	12	110	1/4	91.1	85.4
7-23	Mississippi R. at Chester, Ill.	30	2.85	5.7	14	112	1/4	71.0	65.3
7-26	Ohio R. below Smithland Locks and Dam, Ill.-Ky.	18	No	depth-integrated		sample	5/16	[2]90.9	86.1
7-27	Ohio R. at Olmsted, Ill.	28	6.78	14.5	5	42	5/16	88.4	82.0
7-28	Mississippi R. below Hickman, Ky.	30	3.57	7.1	10	102	1/4	87.0	81.4
7-30	Mississippi R. at Helena, Ark.	30	3.60	7.2	12	144	1/4	112.1	104.5
7-31	White R. at Mile 11.5, Ark.	20	2.85	8.6	6	67	5/16	102.7	96.7
8-1	Arkansas R. at Mile 55.9, Ark.	40	4.43	6.6	9	65	5/16	93.5	87.4
8-2	Mississippi R. above Arkansas City, Ark.	30	4.77	9.5	9	78	3/16	89.6	84.0
8-4	Mississippi R. below Vicksburg, Miss.	36	4.70	7.8	7	95	3/16	83.6	77.8
8-6	Old R. Outflow Channel near Knox Landing, La.	26	3.90	9.0	11	95	5/16	90.7	85.4
8-7	Mississippi R. near St. Francisville, La.	32	3.02	5.7	9	No	1/4	84.0	78.4
8-9	Mississippi R. below Belle Chasse, La.	2	0.13	3.9	10	data	1/4	4.3	none
		18	3.87	12.9	10	for	5/16	56.5	none
		5	0.67	8.0	20	velocity	none	30.1	86.3

[1]Sample was collected by pumping from a small boat at anchor.
[2]Sample was collected by lowering the sampler into the water and steaming forward to create flow.

Table 7.--*Statistics of the vertical depth-integration method which was used to collect suspended sediment, November 29 to December 20, 1987*

[V_c is the total volume collected by depth integration; V_d is the total volume dewatered = total volume collected minus the aliquots taken by each research project]

Date	River and section	Number of verticals	Length of section (hr)	Time per vertical (min)	Average transit rate (cm/s)	Mean water velocity (cm/s)	Nozzle diameter (inch)	Volume	
								V_c (L)	V_d (L)
1987									
11-30	Mississippi R. near Winfield, Mo.	29	4.76	9.8	6	64	1/4	92.1	85.8
11-29	Illinois R. below Meredosia, Ill.	7	0.76	6.5	4	36	5/16	22.1	[1]22.1
		14	2.54	10.9	6	37	none	66.8	[1]66.8
12-02	Missouri R. at St. Charles, Mo.	28	4.55	9.8	10	121	1/4	96.1	90.7
12-03	Mississippi R. at St. Louis, Mo.	30	5.38	10.8	16	129	1/4	112.1	98.5
12-05	Mississippi R. at Thebes, Ill.	30	4.63	9.3	17	131	1/4	83.0	78.3
12-06	Ohio R. at Olmsted, Ill.	30	4.92	9.8	7	55	5/16	115.7	109.5
12-07	Mississippi R. below Hickman, Ky.	30	4.04	8.1	14	111	1/4	94.4	87.6
12-08	Mississippi R. at Fulton, Tenn.	30	4.68	9.4	12	116	3/16	95.1	89.3
12-11	Mississippi R. at Helena, Ark.	30	3.63	7.3	21	147	1/4	89.5	83.6
12-12	White R. at Mile 11.5, Ark.	20	6.28	18.8	10	73	5/16	110.5	105.6
12-13	Mississippi R. above Arkansas, City, Ark.	30	5.98	12.0	13	100	3/16	85.0	79.0
12-14	Yazoo R. at Mile 10, Miss.	20	4.32	13.0	6	33	none	87.1	75.8
12-15	Mississippi R. below Vicksburg, Miss.	36	5.89	9.8	12	109	3/16	82.2	76.0
12-17	Old R. Outflow Channel near Knox Landing, La.	32	4.05	7.6	9	63	5/16	99.1	93.1
12-18	Mississippi R. near St. Francisville, La.	32	3.55	6.7	13	93	1/4	107.9	101.9
12-20	Mississippi R. below Belle Chasse, La.	20	4.86	14.6	10	61	1/4	98.9	92.9

[1]Aliquots taken from separate individual depth-integrated samples collected after the 22.15-L and 66.81-L samples were collected.

Table 8.--*Statistics of the vertical depth-integration method which was used to collect suspended sediment, May 14 to June 7, 1988*

[V_c is the total volume collected by depth integration; V_d is the total volume dewatered = total volume collected minus the aliquots taken by each research project; and V_p is the total volume collected by pumping at mid-depth or at 5 meters depth (whichever was smaller) directly into the centrifuge. A second value in this column is the portion of the pumped volume that was collected from the outlet of the centrifuge and processed through the ultrafilter]

Date	River and section	Number of verticals	Average transit rate (cm/s)	Mean water velocity (cm/s)	Nozzle diameter (inch)	Sample Volumes		
						V_c (L)	V_d (L)	V_p (L)
1988								
5-17	Mississippi R. near Winfield, Mo.	30	4	55	1/4	93.6	86.1	501
5-16	Illinois R. below Meredosia, Ill.	20	7	40	none	136.6	118.1	462
5-19	Missouri R. at Hermann, Mo.	30	12	98	5/16	94.9	78.2	503
5-20	Mississippi R. at St. Louis, Mo.	29	10	102	1/4	106.8	82.8	335
								326
5-22	Mississippi R. at Thebes, Ill.	30	10	113	1/4	112.2	92.7	403
5-23	Ohio R. at Olmsted, Ill.	30	6	58	5/16	127.3	91.3	352
								352
5-24	Mississippi R. below Hickman, Ky.	30	11	105	1/4	97.7	80.2	500
5-26	Mississippi R. at Fulton, Tenn.	30	7	107	3/16	126.8	103.3	503
								339
5-28	Mississippi R. at Helena, Ark.	30	14	127	1/4	110.9	91.4	497
5-29	White R. at Mile 11.5, Ark.	10	5	84	5/16	86.0	70.5	506
5-30	Mississippi R. above Arkansas City, Ark.	30	8	89	3/16	107.8	88.3	510
6-01	Yazoo R. at Mile 10, Miss.	1	none	18	none	[1]70.1	54.9	600
6-02	Mississippi R. below Vicksburg, Miss.	40	8	103	3/16	109.7	85.7	505
								339
6-04	Old R. Outflow Channel near Knox Landing, La.	30	10	103	5/16	108.1	88.5	511
6-05	Mississippi R. near St. Francisville, La.	32	10	84	1/4	101.9	82.5	499
6-07	Mississippi R. below Belle Chasse, La.	30	10	37	5/16	139.2	66.3	916

[1]Surface dip sample collected from a small boat slowly moving upriver.

the downcast but not on the upcast, so that the upcast velocity, $\bar{U}_{up}$, was probably more accurate (Moody and Troutman, in press). The turbulent shadow has its greatest effect at faster transit rates, R_t, resulting in greater deviations of $Q_{initial}$ from the final discharge, Q_{final}, (based only on the upcast mean velocity). In figure 8, the ratio Tr, equal to $Q_{final}/Q_{initial}$, is plotted versus the discharge-weighted mean ratio of $R_t/\bar{U}_{up}$ for cross sections where both the downcast and upcast velocities were measured. The discharge-weighted mean ratio of $R_t/\bar{U}$ was then computed for the sections without upcast measurements during the July-August 1987 and November-December 1987 cruises. The corresponding value of Tr was then taken from the graph in figure 8, assuming that $R_t/\bar{U} = R_t/\bar{U}_{up}$. The final discharge equals the initial discharge times Tr. Values of Tr are listed in table 9 for the July-August 1987 cruise and in table 10 for the November-December 1987 cruise in addition to the mean velocity and the initial and final discharges. The summary of discharge measurements of the May-June 1988 cruise is in table 11. A more detailed discussion of the depth-integration method of measuring water discharge is given by Moody and Troutman (in press).

Seven discharge measurements made by the depth-integration method, during the November-December 1987 and May-June 1988 cruises, were compared with seven simultaneous discharge measurements made by personnel from the U.S. Geological Survey and the U.S. Army Corps of Engineers using the 0.2, 0.8, and 0.4 methods. The largest difference between these simultaneous measurements was 9 percent, the average difference was ±4 percent, and the standard error was 5 percent.

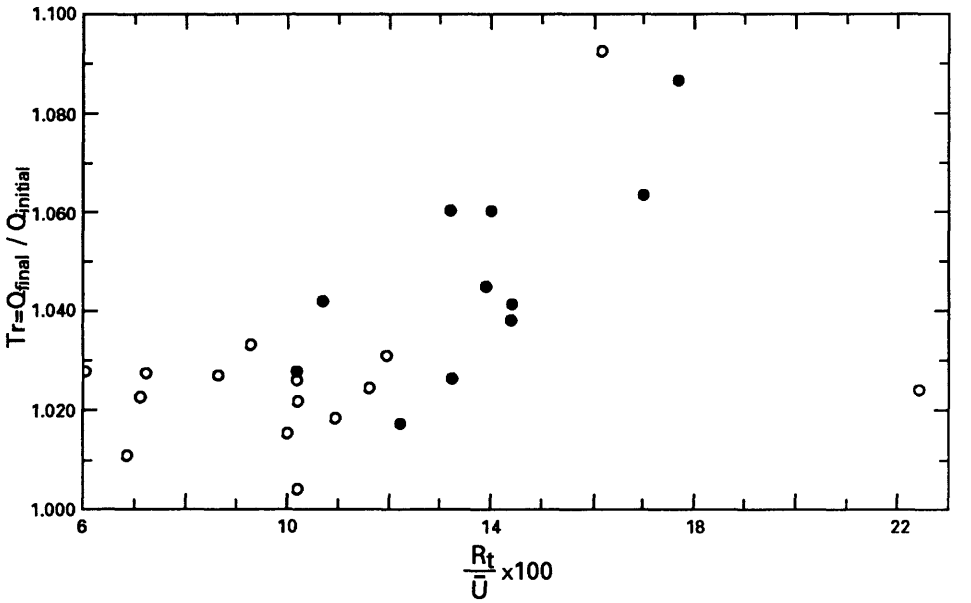


Figure 8.--Correlation between the vertical transit rate, R_t, expressed as a percent of measured mean velocity, $\bar{U}_{up}$, on the upcast and the ratio, Tr, of the final discharge to the average down- and upcast discharge. Solid circles are data from the November-December 1987 cruise and the open circles are data from the May-June 1988 cruise.

Table 9.--*Summary of discharge measurements made using the depth-integration method from the R/V ACADIANA between July 18 - August 9, 1987*

[All velocity measurements were made with a Price solid polymer bucket-wheel current meter (No. P8308282; calibration equation was velocity (in m/s) = 0.784*revolutions/sec + 0.028). The initial discharge listed below is the average of the downcast and upcast. Since the current meter is in the shadow of the sampling bottle on the downcast, the measurements were corrected to upcast velocity. The final discharge equals the initial discharge times Tr, the transit-rate correcting factor. See the text and figure 8 for explanation of Tr. Discharges and areas have been rounded to three significant figures]

Date	River and section	Mean depth[1] (m)	Width (m)	Area (m^2)	Mean velocity[2] (m/s)	Tr	Discharge Initial (m^3/s)	Discharge Final (m^3/s)
1987								
7-19	Mississippi R. near Winfield, Mo.	No	depth-integrated			measurement		[3]1,370
7-18	Illinois R. below Meredosia, Ill.	No	depth-integrated			measurement		[4]312
7-21	Mississippi R. at Hartford, Ill.	8.0	359	2,860	0.52	1.09	1,380	1,500
7-20	Missouri R. at Hermann, Mo.	5.6	377	2,130	1.24	1.03	2,560	2,640
7-22	Mississippi R. at St. Louis, Mo.	7.3	482	3,540	1.11	1.03	3,830	3,940
7-23	Mississippi R. at Chester, Ill.	6.5	591	3,820	1.11	1.04	4,090	4,250
7-26	Ohio R. below Smithland Locks and Dam, Ill.-Ky.	No	depth-integrated		measure-		[5]652	ment
7-27	Ohio R. at Olmsted, Ill.	5.4	930	4,980	0.42	1.05	1,970	2,070
7-28	Mississippi R. below Hickman, Ky.	6.1	995	6,080	1.03	1.03	6,090	6,270
7-30	Mississippi R. at Helena, Ark.	6.7	701	4,730	1.45	1.02	6,720	6,850
7-31	White R. at Mile 11.5, Ark.	2.9	168	490	0.68	1.03	322	332
8-01	Arkansas R. at Mile 55.9, Ark.	4.0	313	1,240	0.64	1.05	750	790
8-02	Mississippi R. above Arkansas City, Ark.	11.4	850	9,730	0.78	1.04	7,340	7,630
8-04	Mississippi R. below Vicksburg, Miss.	7.1	1,131	8,080	0.96	1.02	7,600	7,750
8-06	Old R. Outflow Channel near Knox Landing, La.	4.1	519	2,120	0.97	1.04	1,970	2,050
8-07	Mississippi R. near St. Francisville, La.	7.6	983	7,460	0.83	1.04	[6]5,950	6,190
8-09	Mississippi R. below Belle Chasse, La.	No	discharge		measurement		was	made

[1]Mean depth equals the area divided by the width.

[2]Mean velocity is equal to the final discharge divided by the area.

[3]Estimated discharge equals Mississippi River at Keokuk (875 m^3/s) plus Des Moines River at Keosauqua (495 m^3/s).

[4]Computed daily discharge from U.S. Geological Survey Illinois district data.

[5]Discharge was estimated by difference: Ohio River at Olmsted minus combined discharge (1,416 m^3/s) from the Kentucky Dam (Tennessee River) and the Barkley Dam (Cumberland River).

[6]An open-cup Price type AA current meter was used with a calibration equation: velocity (in m/s) = 0.694*revolutions/sec + 0.002. Mean velocities measured by this meter at five verticals in the Old River Outflow Channel near Knox Landing on August 6, 1987 (see table 9), were about 5% higher than the velocities measured by the Price solid polymer bucket wheel. The discharge was adjusted by multiplying the discharge, as calculated from the open-cup velocity measurements, by 0.95.

Table 10.--*Summary of discharge measurements made using the depth-integration method from the R/V ACADIANA between November 29 - December 20, 1987*

[The calibration equations were determined using a 150-pound sounding weight and were assumed to be the same for a 300-pound sounding weight. The initial discharge listed below is the average of the downcast and upcast. Since the current meter is in the shadow of the sampling bottle on the downcast, the downcast velocities were corrected to upcast velocities. The final discharge equals the initial discharge times Tr (the transit-rate correcting factor). See the text and figure 8 for explanation of Tr. Discharges and areas have been rounded to three significant figures]

Date	River and section	Mean depth[1] (m)	Width (m)	Area (m^2)	Mean velocity[2] (m/s)	Tr	Discharge Initial (m^3/s)	Discharge Final (m^3/s)
1987								
11-30	Mississippi R. near Winfield, Mo.	6.2	519	3,200	0.64	1.02	2,000	2,040
11-29	Illinois R. below Meredosia, Ill.	--	--	--	--	--	--	[3]262
12-02	Missouri R. at St. Charles, Mo.	5.3	428	2,270	1.24	1.02	2,750	2,810
12-03	Mississippi R. at St. Louis, Mo.	7.9	511	4,060	1.34	1.04	5,230	5,440
12-05	Mississippi R. at Thebes, Ill.	6.6	574	3,800	1.37	1.04	4,990	5,190
12-06	Ohio R. at Olmsted, Ill.	7.8	974	7,620	0.55	1.00	4,200	4,200
12-07	Mississippi R. below Hickman, Ky.	7.9	1,008	7,970	1.11	1.00	8,820	8,820
12-08	Mississippi R. at Fulton, Tenn.	9.7	844	8,160	1.16	1.00	9,470	9,470
12-11	Mississippi R. at Helena, Ark.	8.0	750	5,970	1.47	1.00	8,770	8,770
12-12	White R. at Mile 11.5, Ark.	4.0	177	711	0.73	1.00	519	519
12-13	Mississippi R. above Arkansas City, Ark.	11.0	904	9,950	1.00	1.00	9,920	9,920
12-14	Yazoo R. at Mile 10, Miss.	4.5	120	540	0.33	1.00	177	177
12-15	Mississippi R. below Vicksburg, Miss.	8.3	1,153	9,560	1.09	1.00	10,410	10,410
12-17	Old R. Outflow Channel near Knox Landing, La.	5.5	525	2,910	0.63	1.00	1,830	1,830
12-18	Mississippi R. near St. Francisville, La.	9.0	970	8,770	0.93	1.00	8,180	8,180
12-20	Mississippi R. below Belle Chasse, La.	20.3	776	15,740	0.61	1.00	9,560	[4]9,560

[1]Mean depth equals the area divided by the width.

[2]The mean velocity is equal to the final discharge divided by the area. Three different calibration equations were used to compute the mean vertical velocity at each vertical using a Price AA solid polymer bucket-wheel current meter (No. P8308282):

Sections	Calibration date	Equation
Hickman, Fulton, Helena	4-14-88	V(m/s) = 0.759*rev/s + 0.010
Arkansas City, Vicksburg	4-12-88	V(m/s) = 0.774*rev/s + 0.027
All other sections	4-07-88	V(m/s) = 0.780*rev/s + 0.005

[3]Computed daily discharge from the U.S. Geological Survey Illinois district data.

[4]Discharge may be affected by the tide because the river stage was very low.

Table 11.--*Summary of discharge measurements made using the depth-integration method from the R/V ACADIANA between May 16 - June 7, 1988*

[All velocity measurements were made with a Price solid polymer bucket-wheel current meter (No. P8308282, calibration equation was velocity (in m/s) = 0.774*revolutions/sec + 0.003). Discharges and areas have been rounded to 3 significant figures]

Date	River and section	Mean depth[1] (m)	Width (m)	Area (m^2)	Mean velocity[2] (m/s)	Discharge (m^3/s)
1988						
5-17	Mississippi R. near Winfield, Mo.	5.8	547	3,180	0.55	1,740
5-16	Illinois R. below Meredosia, Ill.	3.6	228	823	0.40	332
5-19	Missouri R. at Hermann, Mo.	4.3	350	1,510	0.98	1,480
5-20	Mississippi R. at St. Louis, Mo.	6.8	487	3,290	1.02	3,350
5-22	Mississippi R. at Thebes, Mo.	6.1	525	3,220	1.11	3,590
5-23	Ohio R. at Olmsted, Ill.	5.9	945	5,530	0.58	3,230
5-24	Mississippi R. below Hickman, Mo.	6.5	991	6,480	1.05	6,790
5-26	Mississippi R. at Fulton, Tenn.	8.4	805	6,730	1.07	7,170
5-28	Mississippi R. at Helena, Ark.	7.4	754	5,550	1.27	7,050
5-29	White R. at Mile 11.5, Ark.	3.2	164	520	0.84	438
5-30	Mississippi R. above Arkansas City, Ark.	11.0	838	9,180	0.89	8,160
6-01	Yazoo R. at Mile 10, Miss.	4.2	100	418	0.17	[3]73
6-02	Mississippi R. below Vicksburg, Miss.	6.8	1,129	7,690	1.03	7,950
6-04	Old R. Outflow Channel near Knox Landing, La.	4.1	515	2,090	1.03	2,150
6-05	Mississippi R. near St. Francisville, La.	7.6	900	6,830	0.83	5,700
6-07	Mississippi R. below Belle Chasse, La.	19.3	778	15,030	0.37	5,570

[1]Mean depth equals the area divided by the width.
[2]Mean velocity is equal to the discharge divided by the area.
[3]Measured by Bishop and Phillips (U.S. Geological Survey, Mississippi District) using a Price AA open metal cup meter #2808 from a small boat on a tagline.

SUSPENDED SEDIMENT

The equal-width-increment (equal-transit-rate), depth-integration method (Nordin and others, 1983; Richey and others, 1986; Meade and Stevens, 1990) was used to collect discharge-weighted suspended-sediment samples at 10-40 verticals per cross section (tables 6, 7, and 8). A collapsible-bag sampler (Stevens and others, 1980) fitted with an isokinetic nozzle (Guy and Norman, 1970, p. 8-10) collected suspended sediment in sand, silt, and clay sizes (see tables 6, 7, and 8 for nozzle diameters). The sampler was held in a frame so that the nozzle was horizontal (fig. 7) and about 45 cm above the bottom of a sounding weight. A Price AA current meter with a solid polymer cup was mounted 22 cm above the nozzle of the sampler. The current meter was used to determine the nozzle efficiency and to measure the mean velocity for computing water and sediment discharge. The vertical transit rate was controlled by a hydraulic winch, which was able to produce the same and constant rate for the downcast as well as for the upcast. The same transit rate was reproduced (to within 1 cm/s) for each vertical in the cross section by setting the transit rate with a hand-held tachometer at the beginning of the downcast and at the beginning of the upcast. The multiple gears on the hydraulic system allowed transit rates as slow as 4 cm/s and as fast as 21 cm/s (tables 6, 7, and 8).

Two 8-L plastic bottles with collapsible fluorinated-ethylene-propylene (FEP) Teflon bags and Teflon nozzles were used in the isokinetic sampler to collect separate composite samples identified as A and B. Bottle A was used to collect the odd-numbered verticals and bottle B the even-numbered verticals. The A and B samples were poured into separate glass, graduated cylinders through separate nickel-mesh 63-μm sieves to remove the sand. The water volume collected at each vertical was measured (see section "Tabulated Cruise Data") and then added to separate A and B Teflon-coated, stainless-steel, churn splitters. Leenheer and others (1989) describe the Teflon bags, nickel sieves, and churn splitters in more detail and discuss the evaluation of materials considered for the fabrication of each item so that they would meet the diverse requirements for trace-organic, trace-metal, and suspended-sediment analysis.

Aliquots were taken from the A and B composites for suspended-sediment concentration, trace-metal, trace-organic, mineral composition and nutrient analyses. Three aliquots (approximately 150-250 mL) were taken from each composite to measure the suspended-sediment concentration of material finer than 63 μm. Each of the six aliquots was filtered through paired, pre-weighed Millipore HA filters (0.45-μm pore size), dried at 110°C, and reweighed to give the silt and clay concentrations in tables 12, 13, and 14. The sand collected in the nickel sieves A and B was dried at 80°C and weighed to give the sand concentrations listed in tables 12, 13, and 14. The sand fraction contained some silt and clay material which was measured during the size analysis. This additional concentration of silt and clay material was added to the mean concentration of silt and clay obtained from the Millipore filter weights and is listed in tables 12, 13, and 14. The mean range in concentration (calculated from 2-4 filters) was 4 ± 3 percent of the mean concentration of silt and clay for July-August 1987 and 3 ± 2 percent for November-December 1987 and for May-June 1988. The higher percentage corresponded to the lowest concentrations. The average percent differences between the silt and clay concentrations of composite A and the concentrations of composite B were 2.7,

2.5, and 1.7 percent for the July-August 1987, November-December 1987, and the May-June 1988 cruises. The comparison of the concentrations in composites A and B is shown in figure 9a for silt and clay and in figure 9b for sand. The average percent differences between the sand concentrations of composites A and B were 6.4, 5.0, and 7.2 percent for the three cruises. The suspended-sediment concentrations were multiplied by the water discharges listed in

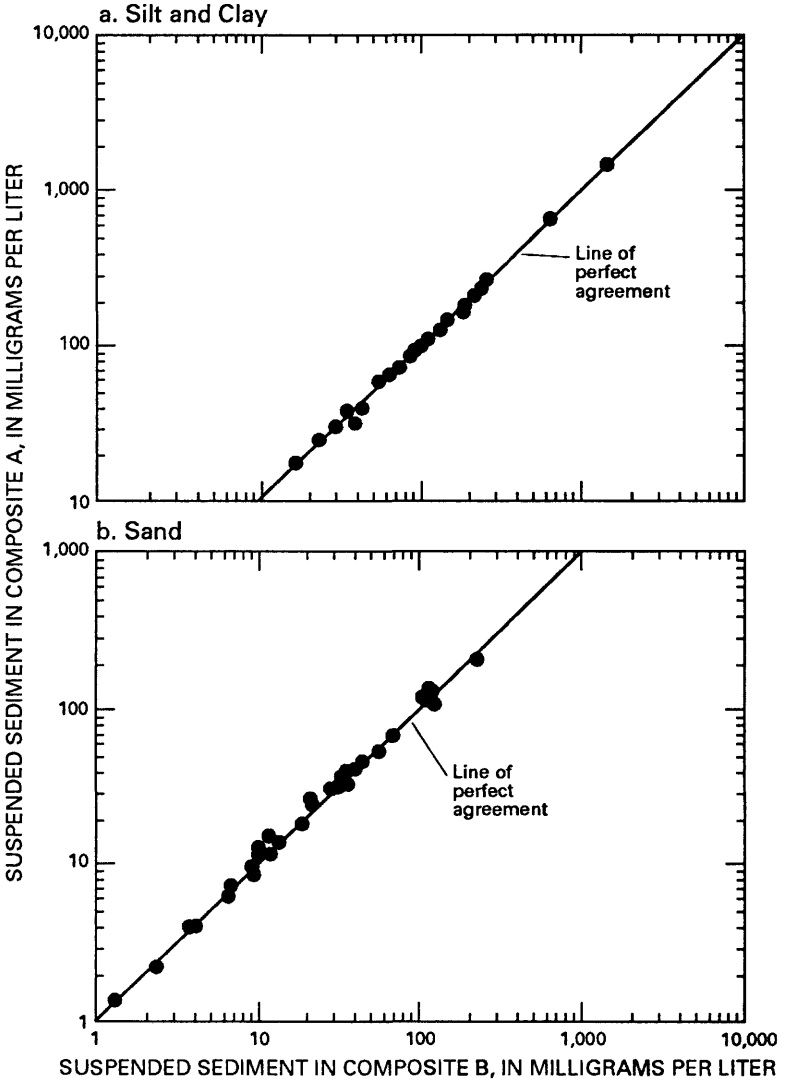


Figure 9.--Comparison of the concentration of the silt and clay fraction (a) and the sand fraction (b) in composite A and composite B for the July-August 1987, November-December 1987, and May-June 1988 cruises (from Meade and Stevens, 1990). The diagonal lines are not regression lines.

tables 9, 10, and 11, and by a constant (0.0864) to give the sediment discharges, in metric tons per day, listed in tables 12, 13, and 14. After all aliquots were taken, the A and B composites were combined into a single sample and run through the dewatering procedure described in section "Dewatering of Samples" (see tables, 6, 7, and 8 for a list of volumes collected and dewatered).

Table 12.--*Concentrations of suspended sediment in composite depth-integrated samples collected in the Mississippi River and principal tributaries and the corresponding sediment discharges, July 20 to August 9, 1987*

[Analyses by R.H. Meade. Water discharges measured by C.C. Cranston, J.A. Moody, and H.H. Stevens. mg/L, milligrams per liter; µm, micrometer; ND, no water discharge measurement]

Date	River and section	Composite	Number of verticals	Water discharge (m^3/s)	Sediment concentrations (mg/L)			Sediment discharge (metric tons/day)		
					Silt and clay <63 µm	Sand >63 µm	Total	Silt and clay <63 µm	Sand >63 µm	Total
1987										
7-21	Mississippi R. at Hartford, Ill.	A	17	1,500	41	<0.1	41	5,400	<10	5,400
		B	17		43	<0.1	43			
7-20	Missouri R. at Hermann, Mo.	A	14	2,600	1,466	108	1,574	329,000	25,000	354,000
		B	14		1,465	112	1,577			
7-22	Mississippi R. at St. Louis, Mo.	A	15	3,900	668	30	698	223,000	11,000	234,000
		B	14		654	34	688			
7-23	Mississippi R. at Chester, Ill.	A	15	4,300	651	23	674	243,000	8,200	251,000
		B	15		658	21	679			
7-26	Ohio R. below Smithland Locks and Dam, Ill.-Ky.		3	630	22	0	22	0	1,200	1,200
7-27	Ohio R. at Olmsted, Ill.	A	14	2,100	25	[1]0.3	25	4,400	<50	4,400
		B	14		24	[1]0.5	24			
7-28	Mississippi R. below Hickman, Ky.	A	15	6,300	177	3	180	96,000	1,400	97,000
		B	15		177	2	179			
7-30	Mississippi R. at Helena, Ark.	A	15	6,900	260	25	285	154,000	14,000	168,000
		B	15		257	22	279			
7-31	White R. at Mile 11.5, Ark.	A	10	330	123	4	127	3,500	110	3,600
		B	10		121	4	125			
8-01	Arkansas R. at Mile 55.9, Ark.	A	20	790	24	[1]0.3	24	1,600	10	1,600
		B	20		22	[1]0.3	22			
8-02	Mississippi R. above Arkansas City, Ark.	A	15	7,600	270	11	281	177,000	7,200	184,000
		B	15		263	11	274			
8-04	Mississippi R. below Vicksburg, Miss.	A	18	7,700	215	8	223	143,000	5,300	148,000
		B	18		216	8	224			
8-06	Old R. Outflow Channel near Knox Landing, La.	A	13	2,100	201	12	213	36,900	2,200	39,000
		B	13		206	12	218			
8-07	Mississippi R. near St. Francisville, La.	A	16	6,200	227	4	231	123,000	2,400	125,000
		B	16		233	5	238			
8-09	Mississippi R. below Belle Chasse, La.		15	ND	66	[1]0.05	66	ND	ND	ND

[1]Mostly organic.

Table 13.--*Concentrations of suspended sediment in composite depth-integrated samples collected in the Mississippi River and principal tributaries and the corresponding sediment discharges, November 29 to December 20, 1987*

[Analyses by R.H. Meade. Water discharges measured by J.A. Moody and H.H. Stevens. mg/L, milligrams per liter; µm, micrometer]

Date	River and section	Composite	Number of verticals	Water discharge (m^3/s)	Sediment concentrations (mg/L)			Sediment discharge (metric tons/day)		
					Silt and clay <63 µm	Sand >63 µm	Total	Silt and clay <63 µm	Sand >63 µm	Total
1987										
11-30	Mississippi R. near Winfield, Mo.	A	15	2,000	32	0	32	5,300	0	5,300
		B	14		29	0	29			
11-29	Illinois R. below Meredosia, Ill.		1	260	79	0	79	1,800	0	1,800
12-02	Missouri R. at St Charles, Mo.	A	14	2,800	264	211	475	65,000	54,000	119,000
		B	14		270	232	502			
12-03	Mississippi R. at St. Louis, Mo.	A	15	5,400	210	137	347	98,000	62,000	160,000
		B	15		210	129	339			
12-05	Mississippi R. at Thebes, Ill.	A	15	5,200	192	111	303	87,000	53,000	140,000
		B	15		196	126	322			
12-06	Ohio R. at Olmsted, Ill.	A	15	4,200	39	0.5	40	13,400	200	14,000
		B	15		35		36			
12-07	Mississippi R. below Hickman, Ky.	A	15	8,800	130	40	170	100,000	30,000	130,000
		B	15		132	38	170			
12-08	Mississippi R. at Fulton, Tenn.	A	15	9,500	99	35	134	81,000	28,000	109,000
		B	15		99	34	133			
12-11	Mississippi R. at Helena, Ark.	A	15	8,800	106	70	176	81,000	54,000	135,000
		B	15		108	71	179			
12-12	White R. at Mile 11.5, Ark.	A	10	520	95	7	102	4,300	300	4,600
		B	10		97	7	104			
12-13	Mississippi R. above Arkansas City, Ark.	A	15	9,900	106	44	150	92,000	36,000	128,000
		B	15		108	41	149			
12-14	Yazoo R. at Mile 10, Miss.	A	10	200	150	0	150	2,600	0	2,600
		B	10		146	0	146			
12-15	Mississippi R. below Vicksburg, Miss.	A	18	10,400	113	52	165	101,000	48,000	149,000
		B	18		111	55	166			
12-17	Old R. Outflow Channel near Knox Landing La.	A	16	1,800	111	4	115	17,000	600	18,000
		B	16		109	4	113			
12-18	Mississippi R. near St. Francisville, La.	A	16	8,200	117	36	153	84,000	26,000	110,000
		B	16		119	38	157			
12-20	Mississippi R. below Belle Chasse, La.	A	10	9,600	66	1.4	67	55,000	1,100	56,000
		B	10		66	1.3	67			

Table 14.--*Concentrations of suspended sediment in composite depth-integrated samples collected in the Mississippi River and principal tributaries and the corresponding sediment discharge, May 16 to June 7, 1988*

[Analyses by R.H. Meade. Water discharges measured by J.A. Moody and H.H. Stevens. mg/L, milligrams per liter; µm, micrometer]

Date	River and section	Composite	Number of verticals	Water discharge (m^3/s)	Sediment concentrations (mg/L)			Sediment discharge (metric tons/day)		
					Silt and clay <63 µm	Sand >63 µm	Total	Silt and clay <63 µm	Sand >63 µm	Total
1988										
5-17	Mississippi R. near Winfield, Mo.	A	15	1,700	34	0	34	5,000	0	5,000
		B	15		34	0	34			
5-16	Illinois, R. below Meredosia, Ill.	A	8	330	58	0	58	1,600	0	1,600
		B	9		57	0	57			
5-19	Missouri R. at Hermann, Mo.	A	15	1,500	79	46	125	10,200	5,900	16,000
		B	15		79	45	124			
5-20	Mississippi R. at St. Louis, Mo.	A	15	3,300	66	13	79	19,000	3,800	23,000
		B	14		65	14	79			
5-22	Mississippi R. at Thebes, Ill.	A	15	3,600	73	28	101	23,000	8,600	32,000
		B	15		75	27	102			
5-23	Ohio R. at Olmsted, Ill.	A	15	3,200	32	2	34	8,700	550	9,300
		B	15		31	2	33			
5-24	Mississippi R. below Hickman, Ky.	A	15	6,800	61	12	73	35,000	6,500	42,000
		B	15		58	10	68			
5-26	Mississippi R. at Fulton, Tenn.	A	15	7,200	68	13	81	42,000	7,800	50,000
		B	15		67	12	79			
5-28	Mississippi R. at Helena, Ark.	A	15	7,100	76	32	108	46,000	20,000	66,000
		B	15		75	32	107			
5-29	White R. at Mile 11.5, Ark.	A	10	440	95	5	100	3,600	170	3,800
		B	10		96	4	100			
5-30	Mississippi R. above Arkansas City, Ark.	A	15	8,200	87	9	96	61,600	6,700	68,000
		B	15		87	10	97			
6-01	Yazoo R. at Mile 10, Miss.	Surface dip sample		70	72	0	72	440	0	440
6-02	Mississippi R. below Vicksburg, Miss.	A	20	8,000	80	12	92	55,000	7,600	63,000
		B	20		79	10	89			
6-04	Old R. Outflow Channel near Knox Landing, La.	A	15	2,200	74	30	104	14,000	5,400	19,000
		B	15		73	27	100			
6-05	Mississippi R. near St. Francisville, La.	A	15	5,700	211	3	214	105,000	2,000	107,000
		B	15		216	5	221			
6-07	Mississippi R. below Belle Chasse, La.	A	20	5,600	18	0	18	8,500	0	8,500
		B	10		17	0	17			

During the third cruise (May 16 to June 7, 1988) a pumping method was developed for collecting large volumes of water and suspended sediment (300-900 L). A 12-mm-diameter, perfluorinated-alkoxy (PFA) Teflon tube inside a 12.7-mm-diameter, double-braided, stainless-steel housing was lowered below the surface at each vertical to a depth of 5 m or one-half the water depth (whichever was smaller) using a 200-pound sounding weight and a second hydraulic winch. Water was pumped up from the fixed depth by a compressed-air-driven double-diaphragm, all-PFA Teflon pump (Wilden MI/UP/TF/TF/TF). The volume of river water pumped (see table 8) into a calibrated funnel (45-L, upside-down carboy with no bottom) was proportional to the estimated fractional discharge at each vertical (Moody and Meade, unpub. data, 1992). The water was then processed through the centrifuge and ultrafilter stages described in the "Dewatering of Samples" section.

Suspended-Sediment Size Analysis

Particle-size distributions of the suspended sediment are listed in tables 15, 16, and 17. The particle-size distributions of the suspended sands (>63 μm) and the suspended silts and clays (<63 μm) were analyzed by two different techniques (visual-accumulation tube and Sedigraph), both of which are based on the settling properties of the particles. Both techniques involve preliminary chemical treatment that disaggregates the particles as they exist in the river. Therefore, the size analyses reported here are perhaps more representative of the assemblages of individual particles available to interact with the dissolved matter in the river, and perhaps less representative of the hydraulic properties of the grains as they are transported by the river. Stallard and Martin (1989) described markedly slower settling velocities of suspended sediments chemically dispersed for analysis, such as those reported here, than those allowed to settle immediately after sampling in native river water unaltered by added dispersing agents.

Size Analysis of Suspended Sands

Suspended sands were separated onsite by pouring the entire suspended-sediment sample, in increments as they were collected, through a 63-μm nickel-mesh sieve. The sands that were caught on the sieve were placed in glass jars and transported to the laboratory in Denver, Colorado, where they were dried at about 80°C and weighed. After they were weighed, the sand samples were washed into separate polypropylene bottles and taken to the USGS sediment laboratory in Iowa City, Iowa, for size analysis by the visual-accumulation-tube method (Guy, 1969).

A difficulty arose during the particle-size analysis of the sand samples when they were given the standard preparation treatment with hydrogen peroxide (Guy, 1969, p. 52) to remove organic matter. This treatment apparently disaggregates sand-size aggregates of silt particles. In most of the suspended-sand samples, the hydrogen peroxide treatment released silt grains from sand-size aggregates in quantities equivalent to concentrations of 1-4 mg/L. These quantities were subtracted from the sand concentrations and added to the concentration of the coarsest silt fraction (31 to 63 μm) in the data reported in tables 15, 16, and 17, as well as in tables 12, 13, and 14.

As an indicator of the reproducibility of the sampling and size-analysis procedures, table 18 shows comparisons of the size analyses of the sand fractions of the A and B composites of 12 suspended-sediment samples. When results were expressed as percentages of the sand fraction, differences between percents finer than certain sizes were as great as 7 percent. When results were expressed as percentages of the total sample, these differences were never more than 2 percent.

Size Analysis of Suspended Silt and Clay

Samples used in the particle-size analysis of suspended sediment finer than 63 μm were aliquots of the depth-integrated composite samples that were collected with the collapsible-bag sampler and passed through the 63-μm sieve. All analyses were made in the USGS sediment laboratory in Iowa City, Iowa, by the Sedigraph method as described by Lara and Matthes (1986).

The essential problem in preparing a suspended-sediment sample for particle-size analysis is one of dewatering--i.e., converting the dilute suspensions collected onsite into the concentrated suspensions required for Sedigraph analysis. This problem was solved in different ways for different samples, as indicated in the fourth column of tables 15, 16, and 17.

1. A few of the samples collected during the first cruise were filtered onto a sufficient number of membrane filters to provide enough material (about 600 mg) for analysis. Although the nominal pore size of the membrane filters was 0.45 μm, the thick cake that accumulated on the filters probably trapped even the finest sizes of particles. This material was redispersed from the membrane filters in an ultrasonic bath to prepare a suspension for Sedigraph analysis.

2. Most of the samples collected during the second cruise, and a few collected during the first cruise, were concentrated by overnight settling. On the day the river-water samples were collected, some 30-40 L of suspensions <63 μm were placed in 45-L carboys and allowed to settle overnight. Next morning, the supernatant water was decanted and the settled sediment was preserved in a glass jar to be transported to the USGS laboratory in Denver. In the laboratory, the settled material was dried, and splits of approximately 1 gram were taken by the cone-and-quarter method. The dried split was sent to the Iowa City laboratory where it was redispersed for Sedigraph analysis. Three samples from the first cruise were prepared by this method as well as by resuspension from filters; a comparison of the results listed in table 15 suggests that the overnight settling recovered slightly less of the finest size fractions than the filtering procedure. Judging from the quantities of material that were recovered by ultrafiltration of the decanted supernatant, the proportion of the sample that was not recovered for particle-size analysis by overnight settling averaged 27 (±12) percent of the total suspension <63 μm that was collected from the river. Because these proportions of unrecovered material were so large, the particle-size distributions (31 μm and finer) of samples designated "o.s." in the third column of table 16 should not be taken as accurate representations of the suspended sediment transported by the river. The

analyses of the settled silts are included here only as correlative data for the interpretation of the chemical analyses performed by other project members on splits of the same samples. The particle-size distributions of the sand fractions (63 μm and coarser) probably are accurate because they are based on separate analyses of the sand fractions.

3. One sample, collected from the Mississippi River below Belle Chasse on December 20, 1987 (table 16), was concentrated in the field by the continuous-flow centrifuge (see Leenheer and others, 1989). The drying and splitting procedures in the Denver laboratory were the same as those used on the samples concentrated by overnight settling. Like the samples that were settled overnight, this sample is likely not to have contained the finest 9 percent of the total suspension <63 μm that was collected from the river.

4. By the time of the third cruise, we had settled on the procedure that we have found to be most satisfactory for obtaining and concentrating suspensions of silt and clay for particle-size analysis. In this procedure, the sample remains wet from the time it is collected to the time it is analyzed. Aliquots of 10-20 L of the suspensions <63 μm are collected in the field in polyethylene carboys to which 10-15 mL of chloroform or formaldehyde is added to retard organic growth. The carboys are transported to the USGS laboratory in Denver where the suspended sediment is allowed to settle undisturbed for at least 15 days. At the maximum vertical settling distance of 36 cm in the carboys, this time is sufficient for all particles coarser than about 0.5 μm to settle out (assuming Stokesian settling). After 15 days or longer, the supernatant water is siphoned from the carboys, and the settled sediment is transferred to 1-L glass jars (maximum settling distance, 15 cm) where it is allowed to settle for another 10 days or more. The supernatant is siphoned once more, and the settled sediment is transferred to 250-mL polyethylene bottles. After its particle-size distribution has been determined by Sedigraph analysis, the sample is dried and weighed. The dry weight is compared with the weight of sediment that is predicted from the concentration of suspended sediment finer than 63 μm determined by the filtering-and-weighing procedure (silt and clay column in table 14) and the known volume of river water from which the analyzed sample was allowed to settle. The differences between the predicted weights and the measured dry weights in the samples analyzed from the third cruise were assumed to represent the quantities of material finer than 0.5 μm that remained in suspension and were siphoned from the carboys along with the supernatant water. These differences averaged 16 percent and have been added to the mass of material finer than 1 μm for purposes of calculating the percentages listed in table 17. That is, the percentages listed in table 17 have been corrected to adjust for the quantities of material lost by siphoning. No such corrections have been made in tables 15 and 16 to adjust for the quantities of material lost by decanting or centrifuging.

Table 15.--*Particle size, determined by Sedigraph and visual-accumulation (VA) tube, of composite suspended-sediment samples collected from the Mississippi River and its principal tributaries, July 20 to August 7, 1987. Particle sizes do NOT represent the suspended sediment transported by the river; they represent the particle size of the fraction that was chemically analyzed for trace contaminants. See text for explanation.*

[Sedigraph analyses by C.J. Anderson. VA analyses by W.J. Matthes and R.H. Meade. mg/L, milligrams per liter; μm, micrometers; o.s. is overnight settling; --, no size analysis of less than 63 μm]

Date	River and section	Total suspended concentration (mg/L)	Treatment of fraction finer than 63 μm	Percent finer than indicated size, in μm										Median diameter (μm)
				1	2	4	8	16	31	63	125	250	500	
1987														
7-20	Missouri River at Hermann, Mo.	1,576	Filter	44	54	63	72	82	91	93	95	99	100	2
			o.s.	41	51	57	70	83	91	93	95	99	100	2
7-22	Mississippi River at St. Louis, Mo.	693	Filter	45	56	66	75	86	93	95	97	100		1
			o.s.	47	55	64	73	84	93	95	97	100		1
7-23	Mississippi River at Chester, Ill.	676	Filter	52	60	68	76	86	94	97	98	100		1
			o.s.	50	59	67	75	87	95	97	98	100		1
7-28	Mississippi River below Hickman, Ky.	180	--	--	--	--	--	--	--	98	99	100		--
7-30	Mississippi River at Helena, Ark.	282	--	--	--	--	--	--	--	92	92	97	100	--
7-31	White River at Mile 11.5, Ark.	126	--	--	--	--	--	--	--	97	99	100		--
8-02	Mississippi River above Arkansas City, Ark.	278	--	--	--	--	--	--	--	96	100			--
8-04	Mississippi River below Vicksburg, Miss.	224	--	--	--	--	--	--	--	96	99	100		--
8-06	Old River Outflow Channel near Knox Landing, La.	216	--	--	--	--	--	--	--	94	96	99	100	--
8-07	Mississippi River near St. Francisville, La.	235	--	--	--	--	--	--	--	98	99	100		--

Table 16.--*Particle size, determined by Sedigraph and visual-accumulation (VA) tube, of composite suspended-sediment samples collected from the Mississippi River and its principal tributaries, November 29 to December 20, 1987. Particle sizes do NOT represent the suspended sediment transported by the river; they represent the particle size of the fraction that was chemically analyzed for trace contaminants. See text for explanation.*

[Sedigraph analyses by C.J. Anderson. VA analyses by W.J. Matthes and R.H. Meade. mg/L, milligrams per liter; μm, micrometers; o.s. is overnight settling]

Date	River and section	Total suspended concentration (mg/L)	Treatment of fraction finer than 63 μm	Percent finer than indicated size, in μm										Median diameter (μm)
				1	2	4	8	16	31	63	125	250	500	
1987														
11-30	Mississippi River near Winfield, Mo.		Insufficient material for analysis											
11-29	Illinois River below Meredosia, Ill.		Insufficient material for analysis											
12-02	Missouri River at St. Charles, Mo.	488	o.s.	25	29	35	42	49	53	55	60	93	100	18
12-03	Mississippi River at St. Louis, Mo.	343	No size analysis							61	66	98	100	
12-05	Mississippi River at Thebes, Ill.	313	o.s.	20	27	35	43	54	61	62	67	93	100	12
12-06	Ohio River at Olmsted, Ill.	38	o.s.	30	42	56	72	86	95	99	100			3
12-07	Mississippi River below Hickman, Ky.	170	o.s.	27	36	45	57	69	75	77	86	99	100	5
12-08	Mississippi River at Fulton, Tenn.	134	o.s.	25	31	39	49	61	70	75	81	98	100	8
12-11	Mississippi River at Helena, Ark.	178	o.s.	27	31	38	45	54	58	61	65	83	99	12
12-12	White River at Mile 11.5, Ark.	103	o.s.	39	45	53	62	76	86	93	96	100		3
12-13	Mississippi River above Arkansas City, Ark.	150	o.s.	29	34	42	50	61	68	72	90	100		8
12-14	Yazoo River at Mile 10, Miss.	148	o.s.	38	44	54	70	88	99	100				3
12-15	Mississippi River below Vicksburg, Miss.	166	o.s.	21	28	35	43	52	62	67	81	99	100	13
12-17	Old River Outflow Channel near Knox Landing, La.	114	o.s.	26	35	46	60	74	89	97	100			5
12-18	Mississippi River near St. Francisville, La.	155	o.s.	24	32	42	53	64	72	76	89	99	100	7
12-20	Mississippi River below Belle Chasse, La.	67	Centrifuge	45	57	69	77	86	95	98	99	100		1

Table 17.--*Particle size, determined by Sedigraph and visual-accumulation (VA) tube, of composite suspended-sediment samples collected from the Mississippi River and its principal tributaries, May 16 to June 7, 1988*

[Sedigraph analyses by C.J. Anderson; VA analyses by W.J. Matthes and R.H. Meade; mg/L, milligrams per liter; μm, micrometers; l.s. is long-term settling]

Date	River and section	Total suspended concentration (mg/L)	Treatment of fraction finer than 63 μm	Percent finer than indicated size, in μm										Median diameter (μm)
				1	2	4	8	16	31	63	125	250	500	
1988														
5-16	Illinois River below Meredosia, Ill.	58	l.s.	49	58	67	74	83	91	100				1
5-19	Missouri River at Hermann, Mo.	125	l.s.	31	37	43	47	53	62	64	67	97	100	12
5-20	Mississippi River at St. Louis, Mo.	79	l.s.	53	59	64	69	76	82	84	86	98	100	1
5-22	Mississippi River at Thebes, Ill.	102	l.s.	26	33	40	46	54	68	74	77	98	100	12
5-23	Ohio River at Olmsted, Ill.	34	l.s.	50	57	65	72	80	91	96	100			1
5-24	Mississippi River below Hickman, Ky.	70	l.s.	42	52	57	63	71	80	83	88	98	100	2
5-26	Mississippi River at Fulton, Tenn.	80	l.s.	43	49	54	60	68	79	83	87	98	100	2
5-28	Mississippi River at Helena, Ark.	108	l.s.	30	37	44	50	58	68	70	73	93	100	8
5-29	White River at Mile 11.5, Ark.	99	l.s.	50	56	62	71	82	92	96	98	100		1
5-30	Mississippi River above Arkansas City, Ark.	97	l.s.	41	47	53	61	71	84	91	98	100		3
6-01	Yazoo River at Mile 10, Miss.	72	l.s.	70	78	84	89	94	98	100				<1
6-02	Mississippi River below Vicksburg, Miss.	91	l.s.	47	53	59	66	75	84	88	96	100		2
6-04	Old River Outflow Channel near Knox Landing, La.	102	l.s.	38	43	48	53	60	68	73	79	97	100	6
6-05	Mississippi River near St. Francisville, La.	218	l.s.	33	39	46	56	74	93	98	100			5
6-07	Mississippi River below Belle Chasse, La.	18	l.s.	65	73	80	86	93	98	100				<1

Table 18.--*Comparisons of particle-size analyses of sand fractions (>63 μm) of composites A and B from selected samples*

[Visual-accumulation-tube analyses by W.J. Matthes and R.H. Meade]

River, station, and date	Composite	Percent of sand fraction finer than indicated size, in micrometers						Percent of total sample finer than indicated size, in micrometers			
		88	125	175	250	350	500	63	125	250	500
Mississippi River at Thebes, Ill.	A	3	14	53	82	95	100	63	68	93	100
December 5, 1987	B	2	13	53	83	96	99.5	61	66	93	100
Mississippi River below Hickman, Ky.	A	12	31	68	98	100		84	89	100	
May 24, 1988	B	13	34	68	99	100		86	91	100	
Mississippi River at Helena, Ark.	A	4	9	28	61	85	100	91	92	97	100
July 30, 1987	B	4	10	31	62	83	98	92	93	97	99.8
White River at Mile 11.5, Ark.	A	22	44	79	99.5	100		94	96	100	
December 12, 1987	B	20	45	78	99.5	100		93	96	100	
White River at Mile 11.5, Ark.	A	21	40	67	99	100		96	98	100	
May 29, 1988	B	20	36	61	99	100		96	98	100	
Mississippi River above Arkansas City, Ark.	A	13	62	88	99	100		71	89	100	
December 13, 1987	B	14	65	88	99	100		73	90	100	
Mississippi River above Arkansas City, Ark.	A	31	72	93	100			91	97	100	
May 30, 1988	B	28	65	86	99.5	100		89	96	100	
Mississippi River below Vicksburg, Miss.	A	32	62	88	98	100		96	99	100	
August 4, 1987	B	35	68	91	99	99.3	99.5	96	99	100	
Old River Outflow Channel near Knox Landing, La.	A	12	26	62	89	100		94	96	99	100
August 6, 1987	B	12	26	63	92	100		94	96	99	100
Old River Outflow Channel near Knox Landing, La.	A	82	100					97	100		
December 17,1987	B	82	98	100				97	100		
Mississippi River near St. Francisville, La.	A	41	65	90	100			98	99	100	
August 7, 1987	B	43	68	86	97	100		98	99	100	
Mississippi River near St. Francisville, La.	A	58	83	98	100			98	99	100	
June 5, 1988	B	50	80	98	100			98	99	100	

SURFACE-WATER PROPERTIES

At each vertical in the cross section (for the November-December 1987 and May-June 1988 cruises) a surface-water sample was collected with a bucket and the temperature, pH, and conductivity were measured (see "Tabulated Cruise Data" section). Temperatures and pH were measured with a Beckman pH meter (model ϕ12) and the conductivity was measured with an Amberscience conductivity meter (model 640). Both meters were calibrated with standards. During the May-June 1988 cruise, two 200-mL samples from each cross section were collected and the conductivity was measured with a salinometer (Guildine Autosal 8400). Thirty-four samples had an average difference of less than 1 microsiemen/cm and a range of difference from -21 to 15 microsiemens/cm.

DEWATERING OF SAMPLES

Settling, centrifugation, and ultrafiltration were used to remove the particles finer than 63 μm from the water samples. The combination of these methods that was used on each cruise is described below. A generalized flow diagram for the processing stages of dewatering the samples is shown in figure 10.

July-August 1987 Cruise

The combined A and B composites were allowed to settle in a glass carboy overnight on land to concentrate the silt and clay fraction (<63 μm). The vertical settling distance was approximately 40 to 50 cm, and, after settling, the water containing the colloid fraction (<3 μm) was siphoned from the glass carboy into a second carboy. The remaining silt/clay slurry was later centrifuged in a laboratory at 5,000 revolutions per minute (r.p.m.) for 30 minutes and then freeze dried. The mass of silt material recovered at each site for the first cruise is listed in table 19. The water containing the colloid fraction was pumped through a tangential-flow ultrafiltration unit (Dorr-Oliver, Series L) consisting of 15 flat plates supporting heat-sealed, regenerated, cellulose membranes with a pore size of about 0.005 μm [see Leenheer and others (1989) for specifications and testing of ultrafilter components]. The ultrafilter unit was disassembled and the colloid fraction was rubbed from the membranes, which were held in Teflon bags with a minimal volume of water that had not passed through the membrane. This concentrated colloid slurry was centrifuged at 8,000 r.p.m. for 30 minutes and then freeze dried. The mass of colloidal material recovered at each site for the first cruise is listed in table 19. Dissolved organics (Leenheer and others, 1989) were extracted from the ultrafilter permeate by adsorption chromatography on Amberlite XAD-8 resin, and about 20 L of the permeate was saved for radioactive chemical analysis.

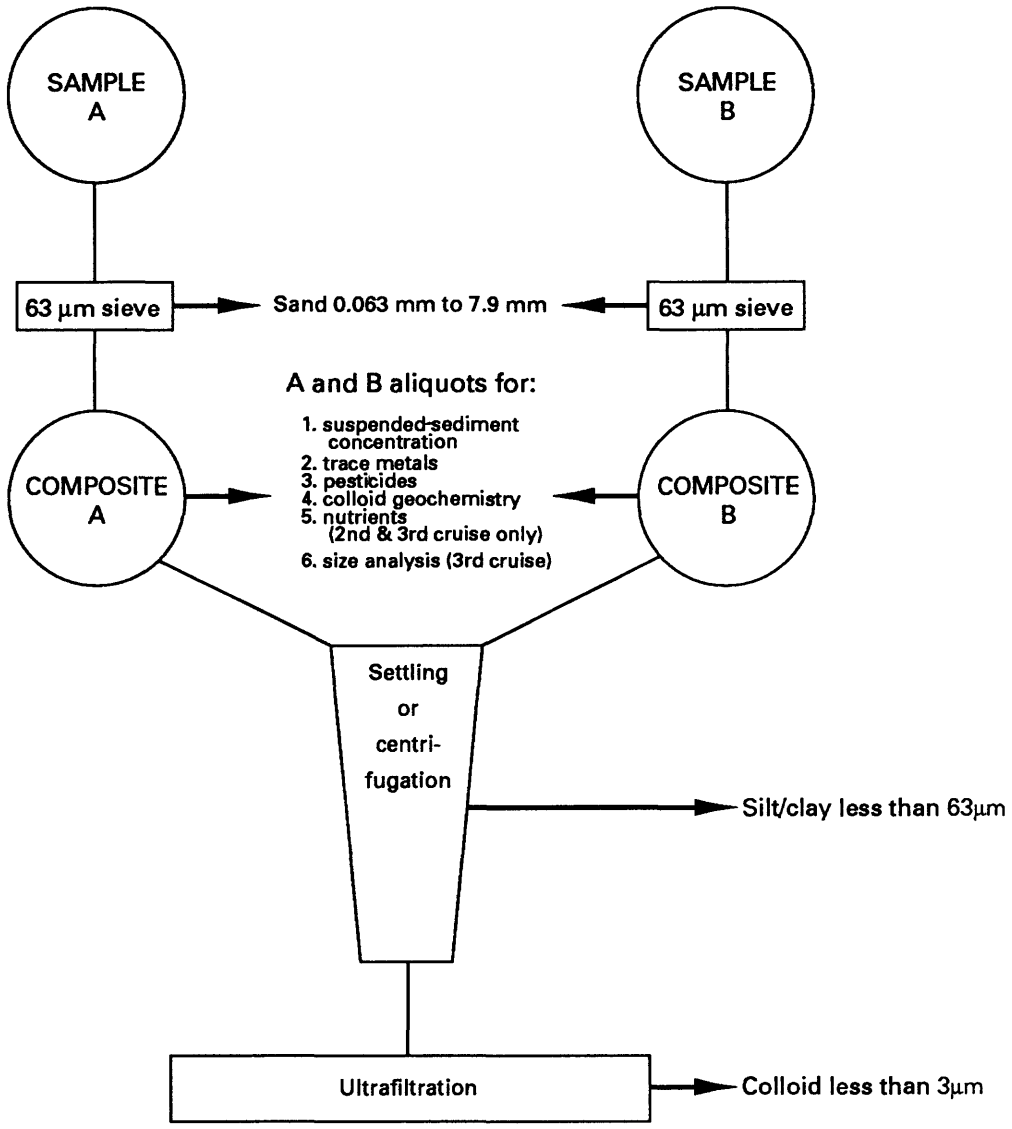


Figure 10.--Flow diagram for processing the suspended-sediment samples collected by depth integration.

Table 19.--*Water volume processed and mass of silt/clay and colloidal material recovered from samples of the Mississippi River and its principal tributaries between July 18 - August 9, 1987*

[Analyses by T.I. Brinton, P. Brown, T.I. Noyes, and R.H. Meade]

Date	River and section	Water volume processed (L)	Mass recovered			Total suspended sediment <63 μm[3] (g)	Percent recovery
			Silt/clay[1] (g)	Colloid[2] (g)	Silt/clay + colloid (g)		
1987							
7-19	Mississippi R. near Winfield, Mo.	92.0	0.92	3.45	4.37	--	--
7-18	Illinois R. at Naples, Ill.	92.0	3.46	3.83	7.29	--	--
7-21	Mississippi R. at Hartford, Ill.	93.2	1.75	1.57	3.32	3.91	85
7-20	Missouri R. at Hermann, Mo.	58.4	72.5	6.12	78.62	85.59	92
7-22	Mississippi R. at St. Louis, Mo.	85.4	46.5	6.43	52.93	56.44	94
7-23	Mississippi R. at Chester, Mo.	65.3	33.5	5.63	39.13	42.67	92
7-26	Ohio R. below Smithland Locks and Dam, Ill.-Ky.	86.0	0.80	0.63	1.43	1.89	76
7-27	Ohio R. at Olmsted, Ill.	82.0	0.95	0.48	1.43	2.01	71
7-28	Mississippi R. below Hickman, Ky.	81.4	10.39	2.07	12.46	14.40	87
7-30	Mississippi R. at Helena, Ark.	104.5	19.57	4.72	24.29	27.01	90
7-31	White R. at Mile 11.5, Ark.	96.7	8.53	1.10	9.63	11.80	82
8-01	Arkansas R. at Mile 55.9, Ark.	87.4	1.19	0.41	1.60	2.01	80
8-02	Mississippi R. above Arkansas City, Ark.	84.0	15.16	3.74	18.90	22.39	84
8-04	Mississippi R. below Vicksburg, Miss.	[4]77.8	10.14	[4]2.01	12.15	16.77	[4]72
8-06	Old R. Outflow Channel near Knox Landing, La.	85.4	11.04	3.99	15.03	17.38	86
8-07	Mississippi R. near St. Francisville, La.	78.4	13.45	2.92	16.37	18.03	91
8-09	Mississippi R. below Belle Chasse, La.	86.2	2.58	2.17	4.75	5.69	83

[1]Material which settled a vertical distance of approximately 40-50 cm overnight in a glass carboy.
[2]Material which was decanted from the settling carboy and collected on ultrafilter membranes (0.005-μm pore size).
[3]Suspended-sediment concentration (average of composite A and B in table 12 for <63-μm material) times water volume processed.
[4]Approximately 40 L was lost when a carboy broke.

November-December 1987 Cruise

Two dewatering methods were used to remove the silt and clay. A gimbal stand was constructed to hold the glass carboy and reduce the agitation from ship motion. One-half of the composite sample was settled overnight (settling distance 40-50 cm for 8-12 hours) aboard the research ship while it was moored to a dock, and the other one-half was centrifuged aboard the ship. The supernatant and centrifuge effluent were saved. The centrifuge [Sharples, Model AS-12; see Leenheer and others (1989) for more details] was operated at about 15,000 r.p.m. with a flow rate of about 2 L/min. The resulting settled and centrifuged silt slurries were later centrifuged in the laboratory ashore and freeze dried. The masses of settled and centrifuged silt recovered are listed in table 20. The supernatant from the settling process and the centrifuge effluent were separately pumped through the ultrafilter unit, which had only three regenerated, cellulose membranes. The colloid fraction removed from the membranes was centrifuged later at 5,000 r.p.m. for 20 minutes (except Yazoo River sample, which was centrifuged at 18,000 r.p.m. for 30 minutes) and freeze dried. The masses of settled and centrifuged colloids recovered are listed in table 20. Dissolved organics (Leenheer and others, 1989) were extracted from the ultrafilter permeate and about 20 L of the permeate was saved for radioactive chemical analysis (Mississippi River at St. Louis, below Hickman, below Vicksburg, and below Belle Chasse).

Table 20.--*Water volume processed and mass of silt/clay and colloidal material recovered from samples of the Mississippi River and its principal tributaries between November 29 - December 20, 1987*

[Analyses by T.I. Brinton, P. Brown, T.I. Noyes, and R.H. Meade]

Date	River and section	Collection method	Water volume processed (L)	Mass recovered			Total suspended sediment <63 μm[3] (g)	Percent recovery
				Silt/clay[1] (g)	Colloid[2] (g)	Silt/clay + colloid (g)		
1987								
11-30	Mississippi R. near Winfield, Mo.	settled	85.8	1.16	0.53	1.69	2.62	65
11-29	Illinois R. below Meredosia, Ill.	settled	89.0	2.66	1.05	3.71	7.03	53
12-02	Missouri R. at St. Charles, Mo.	settled	47.3	8.16	1.71	9.87	12.63	78
		centrifuged	43.4	6.61	0.33	6.94	11.61	60
12-03	Mississippi R. at St. Louis, Mo.	settled	44.8	15.47	2.15	17.62	20.60	86
		centrifuged	53.7	combined		with		settled
12-05	Mississippi R. at Thebes, Ill.	settled	38.5	5.11	1.25	6.36	7.47	85
		centrifuged	39.8	5.75	0.59	6.34	7.72	82
12-06	Ohio R. at Olmsted, Ill.	settled	50.4	0.98	0.54	1.52	1.86	82
		centrifuged	59.1	1.89	0.14	2.03	2.19	93
12-07	Mississippi R. below Hickman, Ky.	settled	43.5	3.35	1.12	4.47	5.70	78
		centrifuged	44.1	4.18	0.50	4.68	5.78	81
12-08	Mississippi R. at Fulton, Tenn.	settled	45.7	3.09	1.00	4.09	4.52	90
		centrifuged	43.6	3.00	0.35	3.35	4.32	78
12-11	Mississippi R. at Helena, Ark.	settled	42.6	2.86	1.06	3.92	4.56	86
		centrifuged	40.9	3.18	0.38	3.56	4.38	81
12-12	White R. at Mile 11.5, Ark.	settled	46.0	2.08	1.65	3.73	4.41	85
		centrifuged	59.6	3.20	1.03	4.23	5.72	74
12-13	Mississippi R. above Arkansas City, Ark.	settled	40.3	2.44	1.17	3.61	4.31	84
		centrifuged	38.7	2.47	0.35	2.82	4.14	68
12-14	Yazoo R. at Mile 10, Miss.	settled	42.1	2.34	2.98	5.32	6.23	85
		centrifuged	33.7	2.55	1.40	3.95	4.99	79
12-15	Mississippi R. below Vicksburg, Miss.	settled	35.7	2.09	0.97	3.06	4.00	77
		centrifuged	40.3	2.34	0.18	2.52	4.51	56
12-17	Old R. Outflow Channel near Knox Landing, La.	settled	44.0	2.94	1.23	4.17	4.84	86
		centrifuged	49.1	3.69	0.25	3.94	5.40	73
12-18	Mississippi R. near St. Francisville, La.	settled	46.0	3.07	1.15	4.22	5.42	78
		centrifuged	55.8	4.02	0.20	4.22	6.58	64
12-20	Mississippi R. below Belle Chasse, La.	centrifuged	92.9	4.41	0.56	4.97	6.13	81

[1]Material which was settled a vertical distance of approximately 40-50 cm for 8-12 hours in a glass carboy held in a gimballed stand onboard the ship moored to a dock, or material which was collected in a centrifuge bowl (approximate radius is 5.6 cm and length is 60 cm) operating at about 15,000 r.p.m. with a flow rate of about 2 L/min.

[2]Material which was collected on ultrafilter membranes (0.005-μm pore size) after settling or centrifugation.

[3]Suspended-sediment concentration (average of composite A and B in table 13 for <63 μm) times the water volume processed.

May-June 1988 Cruise

Only the centrifuge was used to remove the silt/clay fractions during this cruise. The centrifuge was operated between 15,000-16,000 r.p.m. with a flow rate of 2 L/min. The centrifuge effluent was pumped through the ultrafiltration unit; the collected retentate was centrifuged later at 12,000 r.p.m. for 30 minutes and then freeze dried. The masses of silt/clay and of the colloid fractions recovered are listed in table 21. Part of the ultrafilter permeate was saved for dissolved organic analysis (20 L) and radioactive chemical analysis (20 L from the same sections as the November-December 1987 cruise).

Table 21.--*Water volumes processed and mass of silt/clay, colloid, and ultraretentate recovered from samples of the Mississippi River and its principal tributaries between May 16 - June 7, 1988*

[Integ. or pump indicates that samples were collected by depth-integration or pumping method. Only the silt/clay mass was recovered from the samples collected by the pumping method. Analysis by T.I. Brinton, P. Brown, T.I. Noyes, and R.H. Meade]

Date	River and section	Collection method	Water volume processed (L)	Mass recovered			Total suspended sediment <63 μm[3] (g)	Percent recovery
				Silt/clay[1] (g)	Colloid[2] (g)	Silt/clay + colloid (g)		
1988								
5-17	Mississippi R. near Winfield, Mo.	integ.	86.2	1.06	0.10	1.16	2.93	40
		pump	501.	12.29				
5-16	Illinois R. below Meredosia, Ill.	integ.	118.1	6.88	0.18	7.06	6.79	104
		pump	462.	31.75				
5-19	Missouri R. at Hermann, Mo.	integ.	78.2	4.22	0.15	4.37	6.18	71
		pump	503.	38.96				
5-20	Mississippi R. at St. Louis, Mo.	integ.	82.8	4.22	0.22	4.44	5.42	82
		pump	335.	21.65				
		pump	326.		0.60			
5-22	Mississippi R. at Thebes, Ill.	integ.	92.7	4.95	0.28	5.23	6.86	76
		pump	403.	21.84				
5-23	Ohio R. at Olmsted, Ill.	integ.	91.3	1.82	0.14	1.96	2.88	68
		pump	352.	8.78	0.39			
5-24	Mississippi R. below Hickman, Ky.	integ.	80.2	3.67	0.14	3.81	4.77	80
		pump	500.	21.41				
5-26	Mississippi R. at Fulton, Tenn.	integ.	103.3	5.24	0.15	5.39	6.97	77
		pump	503.	29.00				
		pump	339.		0.71			
5-28	Mississippi R. at Helena, Ark.	integ.	91.4	4.26	0.21	4.47	6.90	65
		pump	497.	27.99				
5-29	White R. at Mile 11.5, Ark.	integ.	70.5	3.02	0.29	3.31	6.73	49
		pump	506.	35.22				
5-30	Mississippi R. above Arkansas City, Ark.	integ.	88.3	5.27	0.32	5.59	7.68	73
		pump	510.	27.08				
6-01	Yazoo R. at Mile 10, Miss.	dip	54.9	2.76	0.41	3.17	3.95	80
6-02	Mississippi R. below Vicksburg, Miss.	integ.	85.7	3.24	0.20	3.44	6.81	51
		pump	505.	26.39				
		pump	339.		0.91			
6-04	Old River Outflow channel near Knox Landing, La.	integ.	88.5	3.23	0.20	3.43	6.50	53
		pump	511.	23.54				
6-05	Mississippi R. near St. Francisville, La.	integ.	82.5	7.53	0.32	7.85	17.61	45
		pump	499.	78.81				
6-07	Mississippi R. below Belle Chasse, La.	integ.	66.3	0.52	0.12	0.64	1.16	55
		pump						

[1]Material recovered from a centrifuge bowl (approximate radius is 5.6 cm and length is 60 cm) operating at about 15,000 r.p.m. with a flow rate of about 2 L/min.

[2]Material recovered from ultrafilter membranes (0.005-μm pore size) after passing through the centrifuge.

[3]Suspended-sediment concentration (average of composite A and B in table 14 for <63-μm material) times the water volume processed.

NEAR BOTTOM CURRENT MEASUREMENTS

During the second cruise (November 29 to December 20, 1988), an oceanographic vector averaging current meter (EG&G, Model 610) and temperature/pressure recorder [Pacer (formerly Sea Data), Model TDR-2A] were deployed at seven river sites (table 22) for 4 to 16 hours. A tripod held the current meter 1.8 meters above the bottom and the temperature/pressure recorder 1.0 meter above the bottom. A data logger recorded an average measurement of current speed and water temperature every 28.125 seconds. The minimum and maximum current speed and temperature for the length of the record are listed in table 22. The mean current speed (table 22) was usually less than the mean current speed for the cross section (table 10) since the instruments were not deployed in the main river navigation channel.

Table 22.--*Deployment locations of a moored vector averaging current meter in seven rivers and statistics of current speed and temperature*

[The current meter was 1.8 meters above the bottom and the temperature sensor was about 1 meter above the bottom. A measurement of speed and direction was recorded after a 28.125-second averaging interval. Start and stop times are Greenwich mean time where yy = year, mm = month, dd = day, hh = hour, and mm = minutes]

Date	River and section	Time		Length of record (hours)	Water depth (meters)	Current speed			[1]Temperature	
		Start (yymmddhhmm)	Stop (yymmddhhmm)			min. (cm/s)	max. (cm/s)	mean (cm/s)	min. (°C)	max. (°C)
11-30	Mississippi R. near Winfield, Mo.	8711301602	8711302306	7.13	5.0	38.0	59.5	50.2	3.9	5.3
11-29	Illinois R. below Meredosia, Ill.	8711291641	8711292045	4.14	6.6	12.1	39.5	20.4	5.8	5.9
12-02	Missouri R. at St. Charles, Mo.	8712020024	8712021147	11.44	4.2	53.5	99.0	79.3	5.3	6.6
12-06	Ohio R. at Olmsted, Ill.	8712061440	8712062202	7.41	5.2	38.2	51.8	44.7	7.2	9.1
12-12	White R. at Mile 11.5, Ark.	8712121447	8712122315	8.51	3.6	57.2	92.9	79.6	8.4	10.3
12-14	Yazoo R. at Vicksburg Landing, Miss.	8712152335	8712161526	15.93	5.6	11.5	29.6	18.6	9.5	11.9
12-17	Old R. Outflow Channel near Knox Landing, La.	8712171353	8712172320	9.50	4.8	41.8	70.1	59.3	4.3	8.9

[1]The temperature values were averaged over eight intervals of 28.125 seconds to obtain the above 225-second average.

SURFACE-WATER TRAVEL-TIME MEASUREMENTS

During the third cruise (May 16 to June 7, 1988), 5,000 drift cards were released on the river surface to measure the surface-water travel time between sampling sites. The drift card consisted of a business reply postcard with a piece of fluorescent orange paper sealed inside a 12-cm by 20-cm clear plastic bag. The postcards were numbered sequentially from 1 to 5,000 and on one side there were blank spaces for the location and time of recovery to be recorded by the finder. Out of the 5,000 cards released, 41 were found floating and provided measurements of surface-water travel time, and 149 were recovered onshore. Minimum, maximum, and mean surface-water speeds are listed in table 23. The farthest distance traveled by a drift card was 311 km at a mean speed of 0.94 m/s. The travel times (see table 24) for river reaches between sampling cross sections have been computed using the limited data set in table 23.

Table 23.--*Statistics of drift cards released in the Mississippi River and its principal tributaries, May 15 to June 6, 1988*

[X=released from ship as it crossed the river from bank to bank. M=released from both sides of the ship in the navigation channel as the ship steamed upriver or downriver approximately. Numbers listed under USGS and Local are the cards found from the research ship ACADIANA during the cruise and those found by local residents. The -- indicates not enough data were available to calculate a value]

Release location	Release method	Date	Time CDT	Number of cards	Percent recovered	Recovered			Floating speed			Mean distance (km)	Recovered	Onshore distance		
						USGS	Local	Total	min. (km/hr)	max. (km/hr)	mean (km/hr)		Total	min. (km)	max. (km)	mean (km)
Mississippi R. at [1]Mile 239.2	X	5-17	1200	200	6	2	4	6	0.3	3.2	1.8	18	6	2	14	8
Illinois R. at Mile 34.0	M	5-15	0950	100	1	0	1	1	--	--	2.4	2	0	--	--	--
Illinois R. at Mile 67.2	M	5-15	1350	100	4	0	2	2	1.1	1.4	1.3	3	2	3	3	3
Illinois R. at Mile 67.2	X	5-16	1200	200	19	0	0	0	--	--	--	--	38	2	43	5
Missouri R. at Mile 50.0	M	5-18	1040	200	2	0	0	0	--	--	--	--	3	37	127	89
Missouri R. at Mile 97.8	X	5-19	0825	200	4	3	2	5	0.8	4.5	3.5	61	2	0	117	60
Mississippi R. at [1]Mile 179.2	X	5-20	0930	200	3	0	0	0	--	--	--	--	5	43	113	90
Mississippi R. at [1]Mile 110.0	M	5-21	0844	200	6	0	4	4	0.3	2.9	1.5	14	8	48	105	72
Mississippi R. at [1]Mile 44.3	X	5-22	1600	200	1	0	0	0	--	--	--	--	2	26	101	64
Ohio R. at Mile 965.0	X	5-23	0710	200	9	0	2	2	0.3	1.6	1.0	14	17	0	21	6
Mississippi R. at Mile 916.9	X	5-24	0920	200	2	0	0	0	--	--	--	--	3	8	27	21
Mississippi R. at Mile 849.0	M	5-25	1110	200	2	0	0	0	--	--	--	--	3	21	37	32
Mississippi R. at Mile 777.0	X	5-26	0550	300	3	0	5	5	1.1	1.1	1.1	85	4	13	68	48
Mississippi R. at Mile 730.0	[2]M	5-27	1700	200	0	0	0	0	--	--	--	--	0	--	--	--
Mississippi R. at Mile 664.0	X	5-28	0745	300	4	5	2	7	1.6	5.3	3.9	43	5	6	333	132
White R. at Mile 8.9	M	5-29	1450	200	2	1	2	3	0.5	3.5	2.4	56	0	--	--	--
Mississippi R. at Mile 566.0	X	5-30	1010	300	2	3	0	3	0.0	4.7	2.7	82	3	6	211	80
Mississippi R. at Mile 500.0	M	5-31	1500	200	1	1	0	1	--	--	3.4	311	1	--	--	438
Mississippi R. at Mile 433.0	X	6-02	0814	300	2	0	0	0	--	--	--	--	5	37	84	61
Mississippi R. at Mile 369.0	M	6-03	1425	200	1	1	0	1	--	--	4.2	8	1	--	--	93
Mississippi R. at Mile 342.0	M	6-03	1745	200	0	0	0	0	--	--	--	--	0	--	--	--
Mississippi R. at Mile 266.0	X	6-05	0905	300	14	0	1	1	--	--	0.5	92	40	0	61	14
Mississippi R. at Mile 167.0	M	6-06	1600	300	<1	0	0	0	--	--	--	--	1	--	--	2
Midriver release	M			2,100	1.4	3	9	12					19			
Crossriver release	X			2,900	>3.3	13	16	29					130			
TOTAL				5,000	>2.4	16	25	41					149			

[1]Upper Mississippi River miles measured upriver of confluence with Ohio River (see table 2).
[2]Cards were released in a sewage spill which occurred in Memphis at about 1400 hours on May 27, 1988.

Table 24.--*Surface-water travel time for river reaches between cross-section sampling sites on the Mississippi River and its principal tributaries, May 15 to June 6, 1988*

[NA indicates reach includes tributary and mainstem Mississippi so that a single discharge is not appropriate. The -- indicates no data]

River reach	Length (km)	Mean speed (m/s)	Travel time (days)	Water discharge (m^3/s)
Meredosia, Ill., to Mississippi-Illinois River confluence	108	0.45	2.8	330
Winfield, Mo., to St. Louis, Mo.	97	0.49	2.3	1,700
Meredosia, Ill., to St. Louis, Mo.	171	0.46	4.3	NA
Hermann, Mo., to St. Louis, Mo.	183	0.98	2.2	1,500
St. Louis, Mo., to Thebes, Ill.	217	0.49	5.1	3,300
Thebes, Ill., to Mississippi-Ohio River confluence	71	--	--	3,600
Olmsted, Ill., to Mississippi-Ohio River confluence	27	0.27	1.1	3,200
Thebes, Ill., to Hickman, Ky.	131	--	--	NA
Olmsted, Ill., to Hickman, Ky.	86	--	--	NA
Hickman, Ky., to Fulton, Tenn.	140	--	--	6,800
Fulton, Tenn., to Helena, Ark.	182	0.31	6.7	7,200
Helena, Ark., to Mississippi-White River confluence	105	1.07	1.1	7,100
White River at Mile 8.9 to Mississippi-White River confluence	14	0.67	0.2	440
Helena, Ark., to Arkansas City, Ark.	158	1.07	1.7	7,100
White River at Mile 8.9 to Arkansas City, Ark.	67	0.97	0.8	NA
Arkansas City, Ark., to Vicksburg, Miss.	214	0.80	3.1	8,200
Vicksburg, Miss., to St. Francisville, La.	269	0.65	4.8	8,000
St. Francisville, La., to Belle Chasse, La.	311	0.13	27.7	5,700

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TABULATED CRUISE DATA

The data in this section have been organized by cruises. In the listings of measurements made at each vertical the A and B after the vertical number indicates the composite, the X indicates an extra velocity measurement was made but no sample was collected, and an R indicates that the vertical was repeated because the velocity measurement was incorrect, the suspended-sediment collection bag leaked, or debris on the nozzle prevented the collection of a suitable sample. Verticals were usually occupied in numerical order. Exceptions due to weather conditions or towboat traffic have been noted under the REMARKS section of each cross-section listing. Inch-pound units appear in these listings as: (1) the designation of the nozzle used to sample suspended sediment, (2) gage heights which will serve as a reference for future cruises and can be more easily compared to existing gages in the field, (3) the name of a sampling weight, and (4) part of the name of a sampling cross section.

SOLID CUP refers to the standard Price AA current meter with solid-polymer bucket wheels, and OPEN CUP refers to the standard Price AA current meter with metal open cups. The SOLID CUP was used for the vertical integration measurements of discharge in this report because it does not respond to vertical velocities; later studies however, indicated that the SOLID CUP does not have a good cosine response to varying angles-of-attack and its use, by the USGS, has been discontinued.

Conductivity is reported in units of microsiemens per centimeter, which are equivalent to micromhos per centimeter. Conductivity has been temperature corrected to 25°C so that it is equivalent to specific conductance.

The following abbreviations are used in the tabulated cruise data and are listed below in the order that they appear in the listing.

SUSP. = suspension or sounding weight
DIST = distance
Vi = volume of river water collected by the depth-integration method
Vp = volume of river water collected by pumping
TEMP. = surface temperature of the river water
pH = surface pH of the river water
LEW = Left edge of water
REW = right edge of water
--- = no sample was collected or no measurement was made

DATA LISTINGS
FOR
JULY 18 - AUGUST 9, 1987
CRUISE

STATION: Mississippi River at Hartford, Ill. 07-21-87
PARTY: Black, Cranston, Stevens, and Moody METER: SOLID CUP
STARTING GAGE HEIGHT: 3.00 ft ENDING GAGE HEIGHT:
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 29.0°C
REMARKS: Transit rate was 13 cm/s and nozzle was 5/16 inch.
Total water discharge was 1380 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	
32B	44	9.0	0.36	78	2740
31A	48	9.4	0.39	42	2430
30B	67	8.5	0.33	39	2510
29A	76	8.7	0.45	45	2830
28B	90	9.8	0.38	30	2270
27A	92	9.8	0.44	39	2530
26B	108	9.6	0.44	49	1650
25A	115	9.8	0.52	28	3150
24B	119	9.4	0.47	37	3190
23A	132	9.3	0.51	50	2780
22B	140	9.4	0.47	44	3280
21A	152	9.1	0.52	48	3020
20B	160	9.4	0.52	22	3460
33A	161	9.1	0.53	22	2770
19A	169	9.6	0.51	61	2750
18B	186	9.6	0.51	47	3650
15A	188	9.0	0.60	30	3610
17A	197	9.8	0.50	54	3150
16B	210	8.8	0.55	91	3860
14B	235	8.5	0.54	79	3980
13A	244	8.7	0.58	28	3400
12B	246	8.5	0.52	22	3120
34B	254	8.5	0.50	26	3810
11A	258	8.2	0.52	30	3220
10B	268	8.2	0.53	48	3630
09A	280	8.2	0.53	41	2830
08B	287	8.1	0.54	44	2990
07A	300	7.9	0.49	48	2330
06B	312	7.8	0.43	39	3110
05A	323	7.6	0.50	42	2480
03A	334	6.6	0.42	17	2360
04B	335	7.2	0.43	8	2830
35A	339	4.9	0.81	38	2040
02B	354	4.0	0.41	16	1050
REW	359	0.0	0.00	0	

[1]The value of the discharge at each vertical should be multilpied by 1.09 to give the correct discharge. See text under Water-Discharge Measurement for explanation.

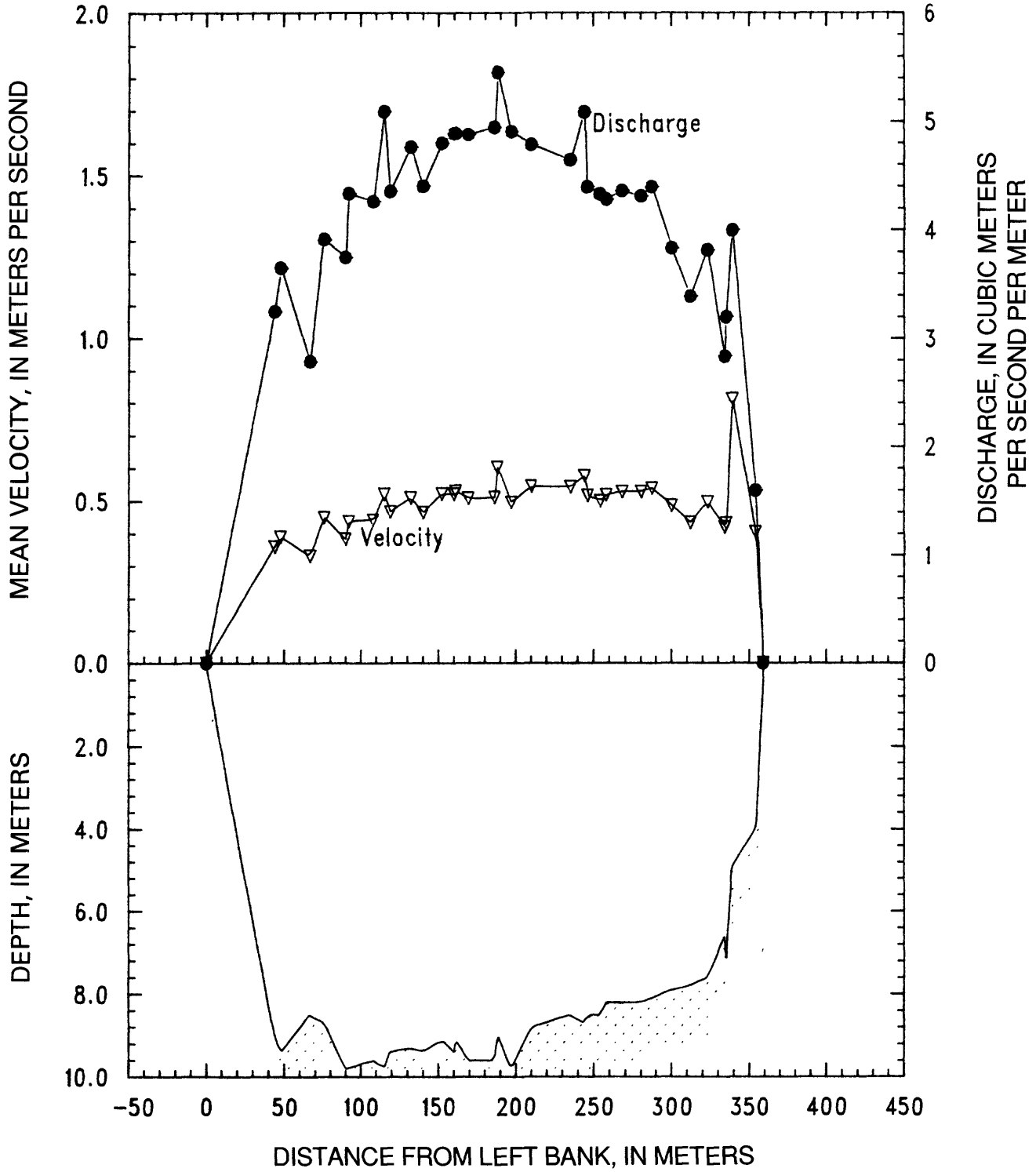

Figure 11. Mississippi River at Hartford, Ill. on July 21, 1987.

STATION: Missouri River at Hermann, Mo. 07-20-87
PARTY: Black, Cranston, Stevens, and Moody METER: SOLID CUP
STARTING GAGE HEIGHT: 13.78 ft ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 26.8°C
REMARKS: Transit rate was 13 cm/s and nozzle was 1/4 inch
Total water discharge was 2560 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
28A	18	7.0	0.49	60	1140
27B	35	7.4	1.20	142	3040
26A	50	6.9	1.24	107	3040
25B	60	7.0	1.27	107	2990
24A	74	6.8	1.38	122	3060
23B	86	6.9	1.56	112	3510
22A	95	6.2	1.44	117	1330
21B	112	6.2	1.54	138	3390
20A	124	6.4	1.50	120	2410
19B	137	6.6	1.52	111	3000
18A	146	6.4	1.37	114	3020
17B	163	6.2	1.53	129	3730
16A	173	6.6	1.54	113	2840
15B	185	6.4	1.55	108	3270
14A	195	6.6	1.40	93	3030
13B	205	6.2	1.56	131	2960
12A	222	5.9	1.44	115	3240
11B	232	5.6	1.27	75	2450
10A	243	5.1	1.36	97	2870
09B	260	5.0	1.25	87	1820
08A	271	4.4	1.17	72	1940
07B	288	4.5	0.96	76	1370
06A	306	5.3	0.87	63	1880
05B	315	5.0	0.69	44	1200
04A	331	4.7	0.69	47	620
03B	344	4.6	0.46	25	445
02A	355	4.7	0.37	20	275
01B	367	4.0	0.26	11	240
REW	377	0.0	0.00	0	

[1]The value of the discharge at each vertical should be multiplied by 1.03 to give the correct discharge. See text under Water-Discharge Measurement for explanation.

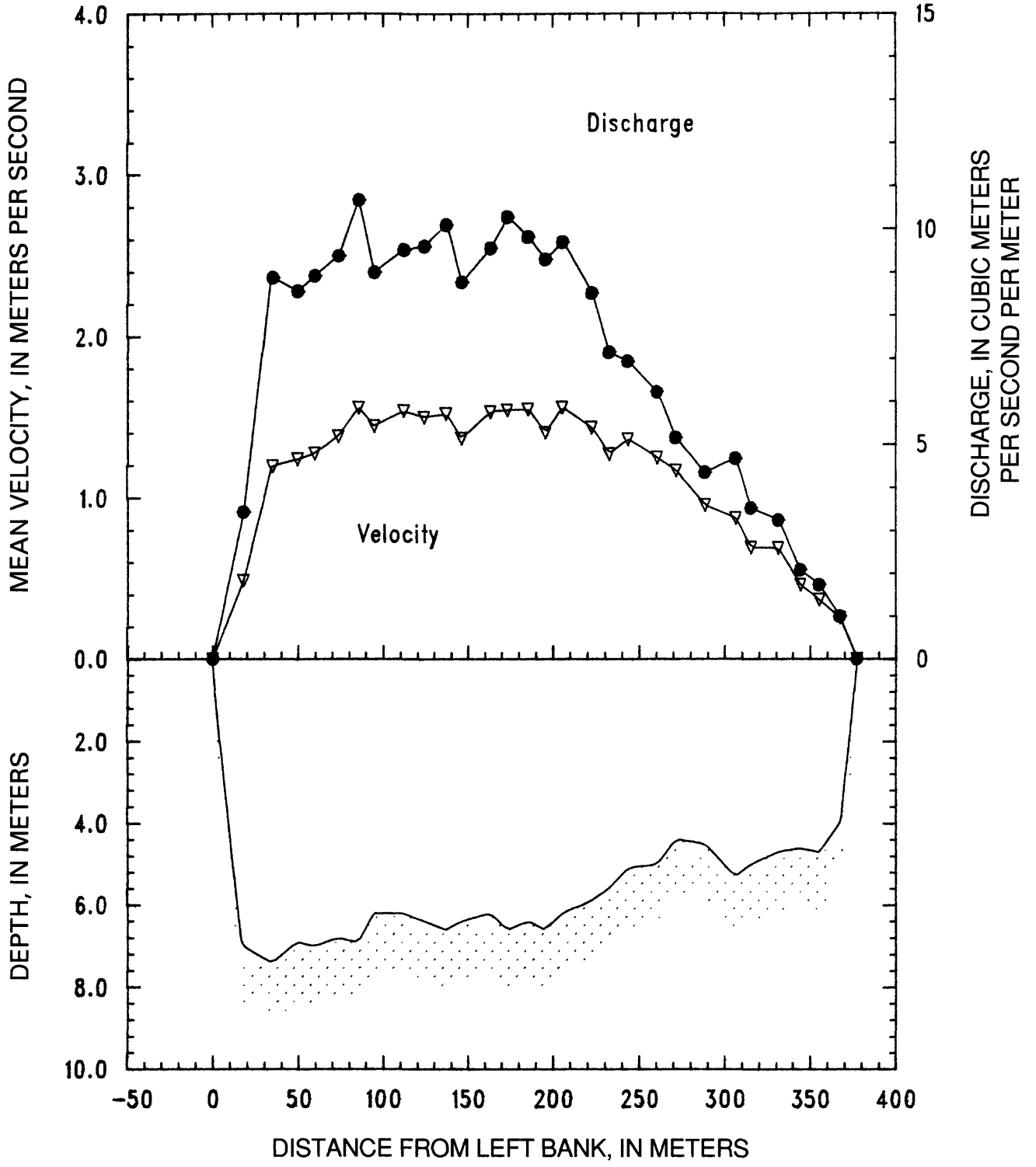

Figure 12. Missouri River at Hermann, Mo. on July 20, 1987

STATION: Mississippi River at St. Louis, Mo. 07-22-87
PARTY: Black, Cranston, Stevens, and Moody METER: SOLID CUP
STARTING GAGE HEIGHT: 3.25 FT ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 28.0°C
REMARKS: Transit rate was 14 cm/s and nozzle was 1/4 inch.
Total discharge was 3830 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
30B	31	9.4	1.14	177	--
29R	33	9.4	1.06	59	--
29A	43	9.6	1.25	108	4110
28B	51	9.8	1.19	145	4970
X02	68	9.5	1.21	132	--
27A	74	9.7	1.19	121	4250
26B	89	9.6	1.21	168	4980
25A	103	9.4	1.14	134	3280
24B	114	9.2	1.18	174	3700
23A	135	9.0	1.19	181	3330
22B	148	8.8	1.07	117	4040
21A	160	8.5	1.20	127	3460
20B	173	8.7	1.24	145	4160
19A	187	8.2	1.16	171	3290
18B	209	8.2	1.16	181	3910
17A	225	8.0	1.16	135	2710
16B	238	8.1	1.17	143	3520
15A	255	7.8	1.16	159	3210
14B	273	7.8	0.90	133	3440
13A	293	7.6	0.99	90	3490
12B	297	7.2	1.07	77	3350
11A	313	7.2	1.05	125	2470
10B	330	6.9	0.97	120	2180
09A	349	6.0	1.01	97	2460
08B	362	5.9	1.04	68	2590
07A	371	6.4	0.98	89	2220
06B	390	6.4	0.97	62	2440
X01	391	6.0	1.04	47	--
05A	405	5.9	0.99	87	2540
04B	421	5.9	0.97	85	2730
03A	435	5.8	0.84	76	1910
02B	452	5.9	0.70	54	1230
01A	461	5.3	0.53	42	1090
REW	482	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.03 to give the correct discharge. See text under Water Discharge Measurement for explanation.

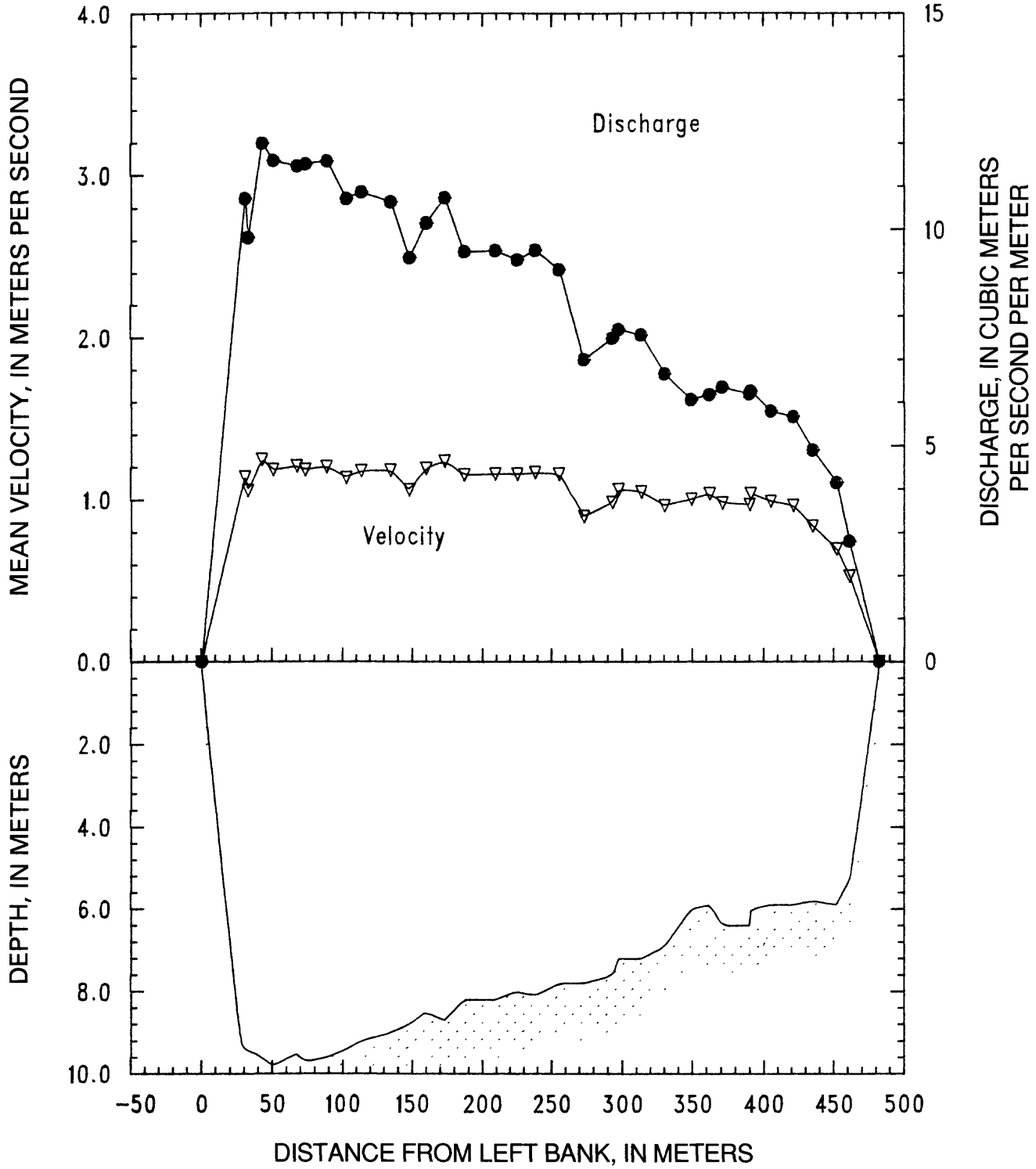

Figure 13. Mississippi River at St. Louis, Mo. on July 22, 1987.

STATION: Mississippi River at Chester, Ill. 07-23-87
PARTY: Black, Moody, Cranston, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 9.3 FT ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 28.5°C
REMARKS: Transit rate was 14_3cm/s and nozzle was 1/4 inch.
Total discharge was 4090 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
30B	20	4.9	0.51	48	880
29A	38	6.6	0.90	109	1860
28B	57	6.4	0.99	124	2320
27A	77	6.1	1.12	130	2680
26B	95	5.8	1.12	111	2390
25A	111	5.8	1.51	201	2580
24B	141	6.1	0.99	127	2960
23A	153	6.1	1.40	110	2390
22B	167	6.2	1.25	144	2390
21A	190	6.4	1.30	187	2610
20B	212	6.6	1.16	141	2830
19A	227	7.0	1.10	135	3070
18B	247	7.3	1.23	152	2590
17A	261	7.3	1.08	153	2690
16B	286	7.8	1.42	249	3440
15A	306	7.6	1.15	158	3140
14B	322	8.2	1.05	168	3100
13A	345	8.2	1.07	185	2660
12B	364	8.4	1.31	182	2970
11A	378	7.9	1.20	180	3270
10B	402	7.5	0.96	155	2690
09A	421	6.7	0.87	111	2170
08B	440	6.2	1.20	145	2150
07A	460	6.1	1.14	108	1570
06B	471	6.7	0.82	87	1820
05A	492	6.7	0.76	115	1610
04B	516	6.2	0.70	89	1670
03A	533	6.1	0.78	81	1650
02B	550	6.2	0.72	71	1670
01A	565	6.1	1.09	136	1210
REW	591	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.04 to give the correct discharge. See text under Water Discharge Measurement for explanation.

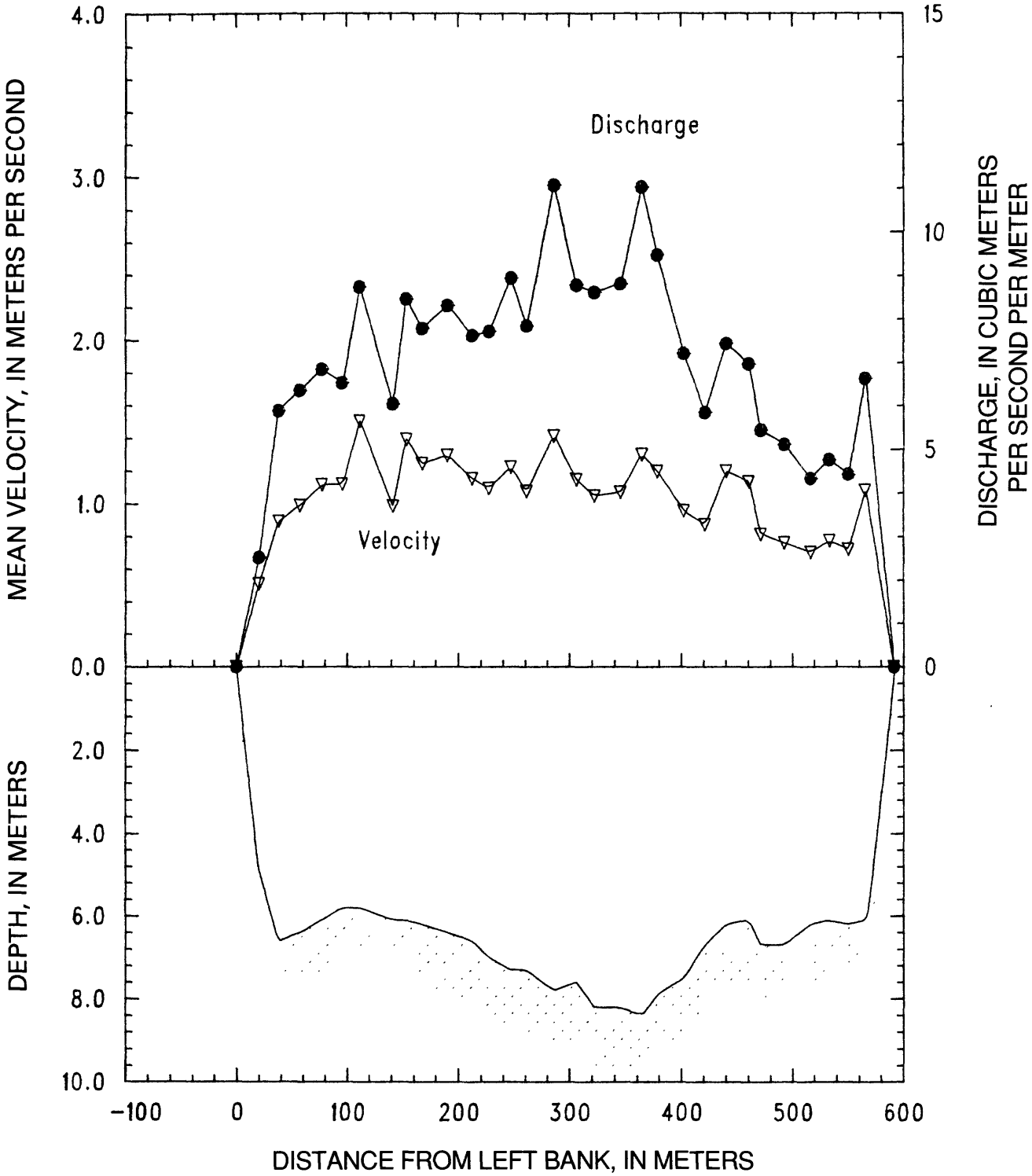

Figure 14. Mississippi River at Chester, Ill. on July 23, 1987.

STATION: Ohio River at Olmsted, Ill. 07-27-87
PARTY: Black, Cranston, Stevens, and Moody METER: SOLID CUP
STARTING GAGE HEIGHT: 14.9 ft at Lock & Dam 53 ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 30.5°C at vertical 19A and 29.7°C at vertical 7A
REMARKS: Transit rate was 3 cm/s for the downcast, 6-8 cm/s for the upcast, and the nozzle was 5/16 inch. The total discharge was 1970 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
28B	45	1.8	0.16	16	280
27A	115	1.9	0.22	19	530
26B	136	2.2	0.17	12	300
25A	181	3.0	0.21	27	720
24B	220	3.9	0.23	28	680
23A	244	3.7	0.26	21	1050
22B	265	3.4	0.31	29	1040
21A	299	3.8	0.32	46	1480
20B	339	5.0	0.31	48	2450
19A	360	5.7	0.33	34	3030
18B	375	6.0	0.31	63	2640
17A	427	6.6	0.36	80	3200
16B	443	6.7	0.37	65	2710
15A	479	6.7	0.38	86	4280
14B	510	7.2	0.39	81	4100
13A	537	6.7	0.47	88	4970
12B	566	6.7	0.57	134	3520
11A	607	7.2	0.51	115	4650
10B	629	7.2	0.47	85	3900
09A	657	7.2	0.51	123	4690
08B	696	7.2	0.50	114	5140
07A	720	7.2	0.48	119	5090
06B	764	7.3	0.47	101	5170
05A	779	7.2	0.46	80	6160
04B	812	7.5	0.49	106	4440
03A	837	7.9	0.40	99	4620
02B	874	8.0	0.35	89	4020
01A	901	7.6	0.29	61	3540
REW	930	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.05 to give the correct discharge. See text under Water Discharge Measurement for explanation.

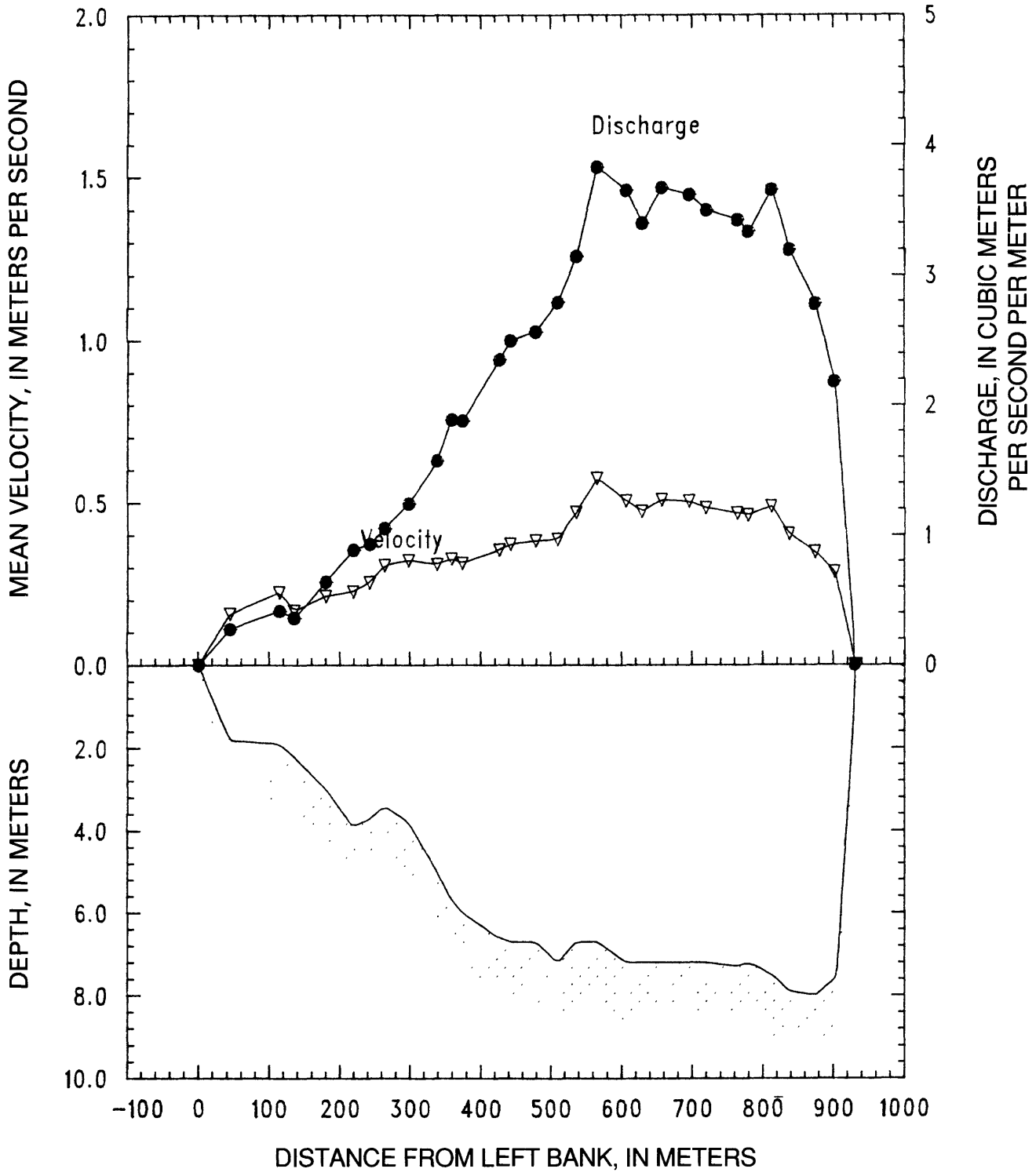

Figure 15. Ohio River at Olmsted, Ill. on July 27, 1987.

STATION: Mississippi River below Hickman, Ky. 07-28-87
PARTY: Black, Cranston, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 8.7 ft ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 29.5°C
REMARKS: Transit rate was 10 cm/s and the nozzle was 1/4 inch.
The total discharge was 6090 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
30B	28	5.6	0.74	148	[2]1920
31A	71	6.9	1.01	160	[2]4340
29A	74	6.7	1.06	139	2970
28B	110	6.9	1.08	253	3895
27A	142	6.6	1.22	218	3680
26B	164	6.6	1.11	212	3510
25A	200	6.7	1.20	281	2560
24B	234	6.0	1.28	299	2930
23A	278	5.9	1.13	203	2670
22B	295	5.7	1.09	140	3150
21A	323	4.9	1.06	200	3350
20B	372	5.4	1.14	244	2710
19A	402	5.5	1.05	189	2640
18B	437	5.9	0.99	194	2820
17A	468	5.5	1.12	200	2630
16B	502	5.6	1.01	164	2800
15A	526	5.4	1.08	160	2670
14B	557	5.9	1.04	175	2800
13A	583	5.9	1.04	151	2760
12B	606	6.4	0.94	175	3140
11A	641	7.7	1.01	238	3190
10B	667	7.0	1.05	210	3290
09A	698	7.5	0.92	213	3130
08B	729	7.0	0.99	237	3570
07A	766	7.2	0.90	269	2980
06B	812	6.9	0.88	233	3350
05B	843	6.4	0.86	160	3010
04B	870	7.4	0.82	176	2140
03A	901	7.5	0.82	118	[2]2910
32A	908	7.1	0.90	93	[2]3500
02B	930	7.5	0.78	161	2710
01A	963	3.9	0.62	79	1120
REW	995	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.03 to give the correct discharge. See text under Water Discharge Measurement for explanation.
[2]Separate samples--not part of either composite

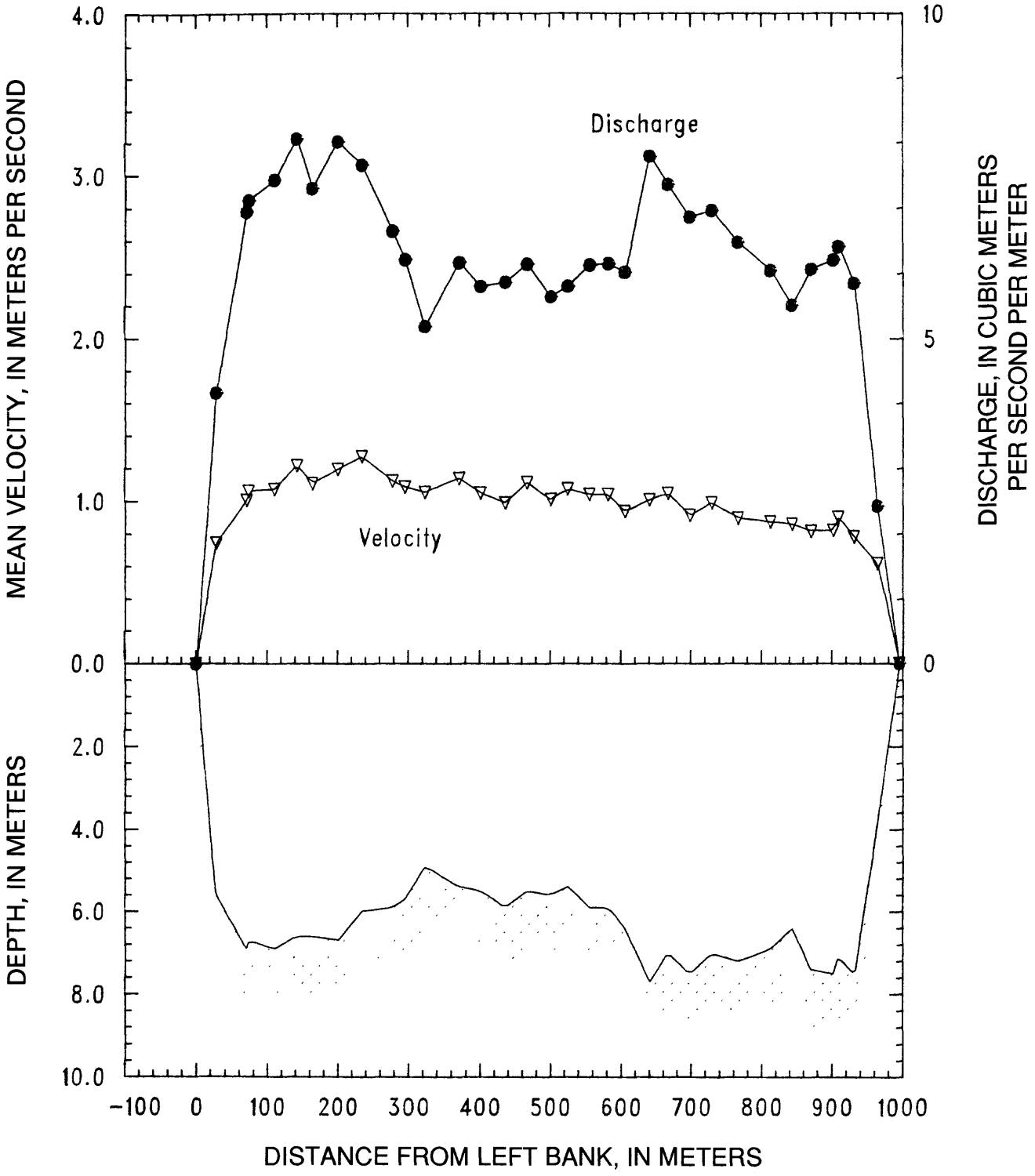

Figure 16. Mississippi River below Hickman, Ky. on July 28, 1987.

STATION: Mississippi River at Helena, Ark. 07-30-87
PARTY: Black, Moody, Cranston, Stevens and Noyes METER: SOLID CUP
STARTING GAGE HEIGHT: 6.52 ft ENDING GAGE HEIGHT: 6.38 ft
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 30.0°C
REMARKS: Transit rate was 13 cm/s and nozzle was 1/4 inch.
The total discharge was 6720 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
30B	24	6.5	1.58	196	3170
29A	38	8.5	1.75	409	4540
28B	79	9.2	1.62	410	4700
27A	93	9.3	1.74	308	4980
26B	117	9.3	1.74	316	5070
25A	132	9.3	1.61	277	3880
24B	154	9.3	1.60	364	5460
23A	181	9.1	1.57	314	5760
22B	198	9.0	1.51	259	4840
21A	219	8.8	1.50	284	5070
20B	241	8.6	1.49	290	4780
19A	264	8.3	1.41	269	4490
18B	287	8.3	1.42	241	4540
17A	305	8.6	1.33	246	4840
16B	330	8.4	1.32	260	4590
15A	352	8.2	1.35	233	4130
14B	372	8.0	1.35	228	3700
13A	394	8.0	1.25	205	4410
12B	413	7.3	1.28	196	3700
11A	436	7.3	1.38	226	4050
10B	458	8.0	1.19	172	3360
09A	472	7.4	1.23	214	4080
08B	505	6.2	1.28	209	3410
07A	525	5.8	1.22	124	2400
06B	540	5.5	1.10	146	2390
05A	573	4.3	1.09	122	1940
04B	592	3.2	1.03	53	1440
03A	605	2.5	0.87	38	840
02B	626	2.3	1.03	54	950
01A	650	1.8	0.94	63	600
REW	701	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.02 to give the correct discharge. See text under Water Discharge Measurement for explanation.

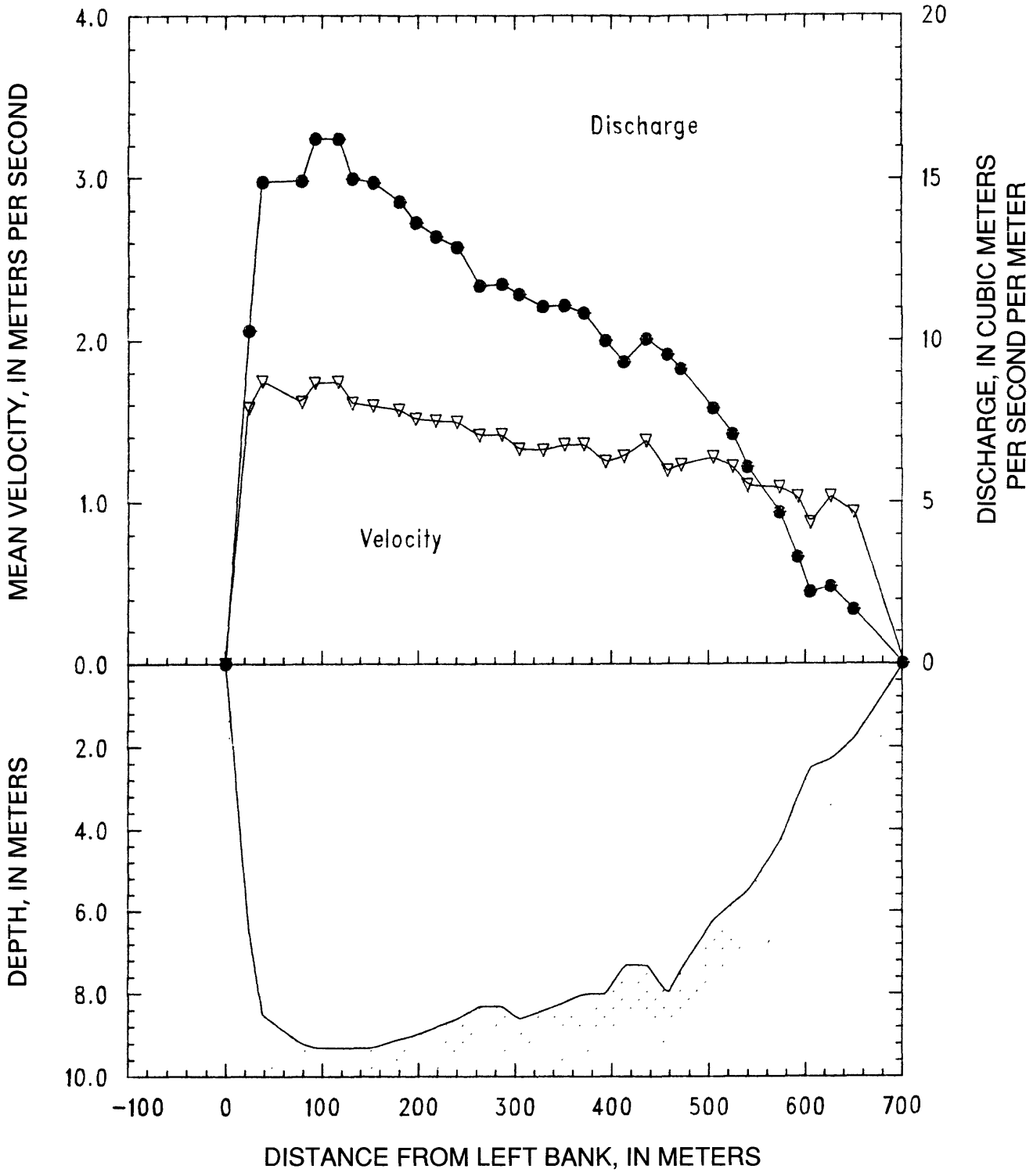

Figure 17. Mississippi River at Helena, Ark. on July 30, 1987.

STATION: White River at Mile 11.5, Ark. 07-31-87
PARTY: Black, Cranston, Stevens, and Moody METER: SOLID CUP
STARTING GAGE HEIGHT: 20.8 ft at tailwater gage on Norrell Lock
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 30.9°C
REMARKS: Transit rate was 4 cm/s for the downcast, 8 cm/s for the upcast, and the nozzle was 5/16. Total discharge was 322 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
10A	12	3.2	0.66	30	5230
10B	12	3.2	0.66	--	4790
09A	29	3.3	0.76	39	6610
09B	29	3.3	0.76	--	6310
08A	43	3.1	0.71	32	5710
08B	43	3.1	0.71	--	5970
07A	58	3.1	0.74	38	5650
07B	58	3.1	0.74	--	5560
06A	76	3.2	0.66	41	6080
06B	76	3.2	0.66	--	5390
05A	97	3.0	0.65	37	5120
05B	97	3.0	0.65	--	4840
04A	113	2.8	0.60	27	4330
04B	113	2.8	0.60	--	4740
03A	129	3.0	0.59	22	4520
03B	129	3.0	0.59	--	4030
02A	138	2.9	0.59	28	4070
02B	138	2.9	0.59	--	4510
01A	162	3.3	0.56	28	4500
01B	162	3.3	0.56	--	4740
REW	168	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.03 to give the correct discharge. See text under Water Discharge Measurement for explanation.

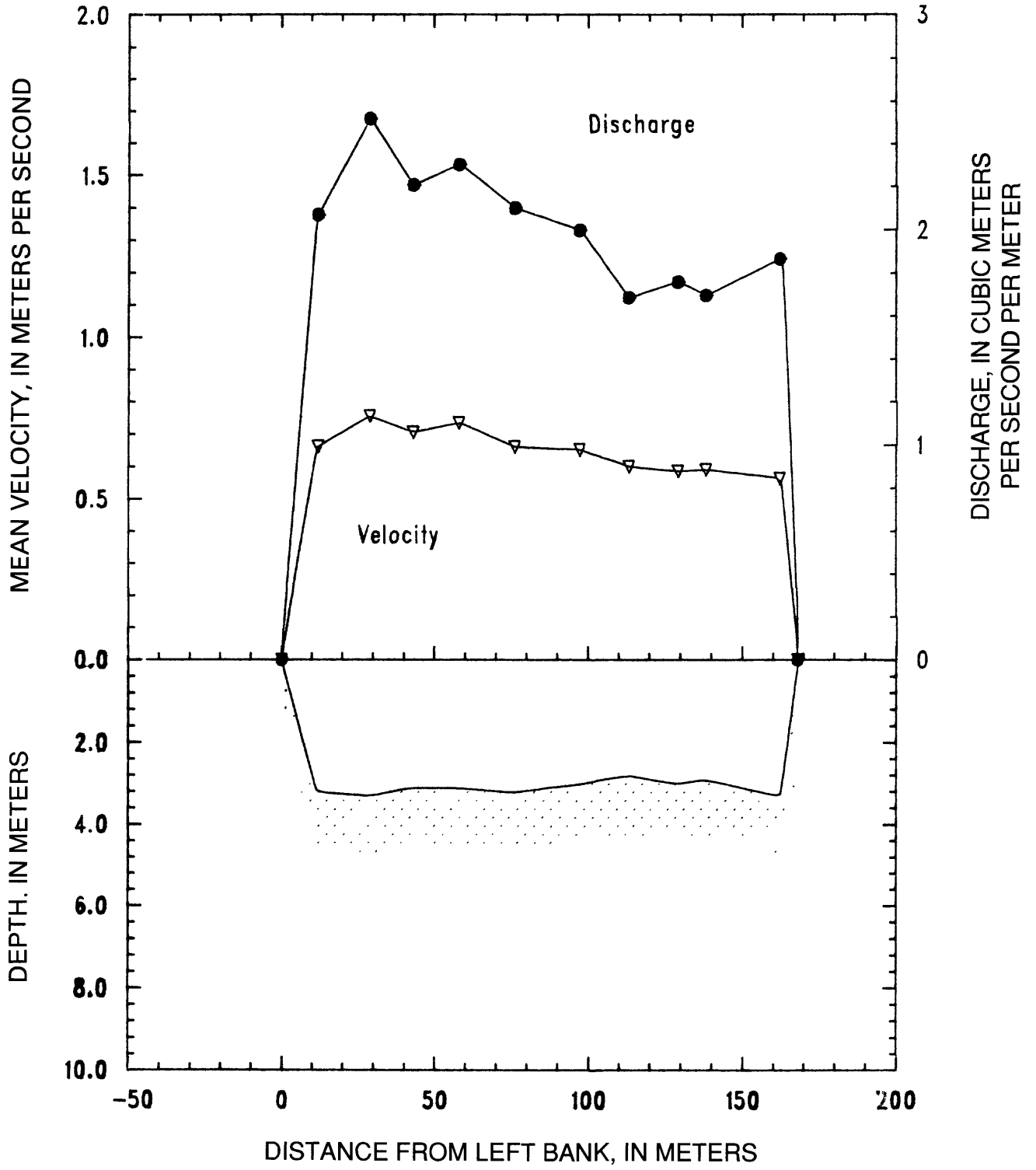

Figure 18. White River at Mile 11.5, Ark. on July 31, 1987.

STATION: Arkansas River at Mile 55.9, Ark. 08-01-87
PARTY: Black, Moody, Stevens, and Cranston METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 31.1--31.9°C
REMARKS: Transit rate was 9 3 cm/s, and the nozzle was 5/16 inch. The total discharge was 750 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
20A	36	3.2	0.36	26	810
20B	36	3.2	0.36	--	780
19A	45	3.1	0.34	18	900
19B	45	3.1	0.34	--	670
18A	70	3.1	0.36	19	780
18B	70	3.1	0.36	--	870
17A	79	3.1	0.42	12	1080
17B	79	3.1	0.42	--	1050
16A	88	2.9	0.42	18	880
16B	88	2.9	0.42	--	950
15A	108	3.4	0.45	22	1120
15B	108	3.4	0.45	--	1630
14A	117	3.2	0.46	20	1250
14B	117	3.2	0.46	--	1150
13A	135	3.5	0.52	23	1520
13B	135	3.5	0.52	--	1200
12A	142	4.0	0.57	29	1890
12B	142	4.0	0.57	--	2220
11A	160	4.5	0.56	40	1770
11B	160	4.5	0.56	--	2000
10A	174	4.4	0.63	41	2570
10B	174	4.4	0.63	--	2390
09A	190	4.5	0.69	49	2910
09B	190	4.5	0.69	--	3010
08A	205	4.6	0.70	47	2680
08B	205	4.6	0.70	--	3020
07A	219	4.9	0.72	51	3060
07B	219	4.9	0.72	--	3090
06A	234	5.1	0.76	46	3430
06B	234	5.1	0.76	--	3820
05A	243	5.0	0.72	43	3610
05B	243	5.0	0.72	--	4010
04A	258	5.6	0.72	55	3600
04B	258	5.6	0.72	--	3340

STATION: Arkansas River at Mile 55.9, Ark. 08-01-87
(continued)

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
03A	270	5.9	0.76	79	3720
03B	270	5.9	0.76	--	3890
02A	293	6.0	0.73	68	4130
02B	293	6.0	0.73	--	4490
01A	301	6.4	0.73	47	4420
01B	301	6.4	0.73	--	3760
REW	313	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.05 to give the correct discharge. See text under Water Discharge Measurement for explanation.

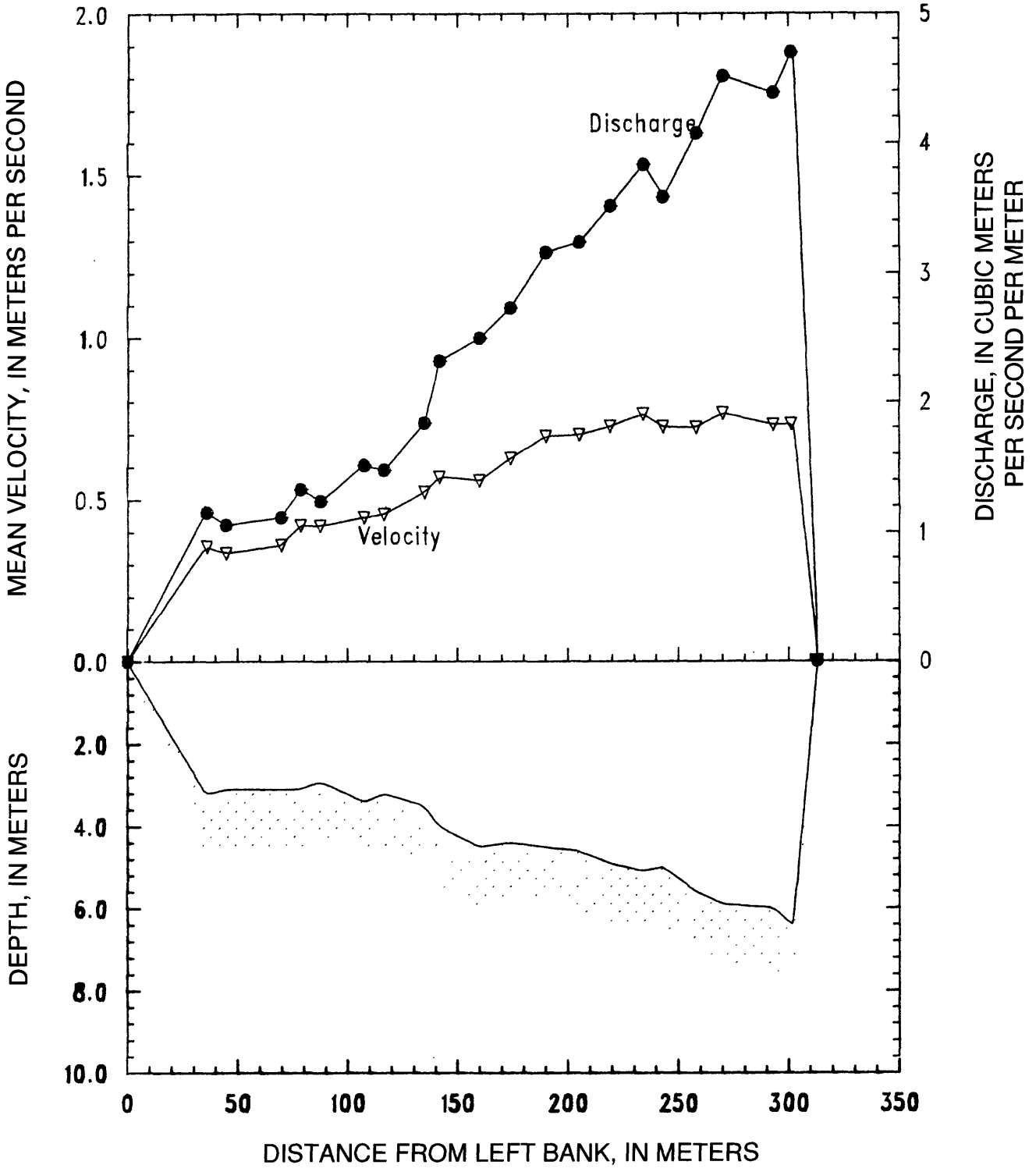

Figure 19. Arkansas River at Mile 55.9, Ark. on August 1, 1987.

STATION: Mississippi River above Arkansas City, Ark. 08-02-87
PARTY: Black, Moody, Cranston, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: 4.90 ft @ Ark. City
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 31.0°C at vertical 5A, and 30.9°C at vertical 17A.
REMARKS: Transit rate was 8 cm/s and nozzle was 3/16 inch.
The total discharge was 7340 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
30B	23	3.0	0.42	38	370
29A	60	6.2	0.46	78	830
28B	78	7.5	0.52	96	1210
27A	109	10.4	0.55	160	1540
26B	134	12.1	0.58	143	2280
25A	150	12.9	0.64	194	3080
24B	181	14.2	0.67	337	3340
23A	221	14.6	0.71	353	3480
22B	249	15.7	0.81	322	4910
21A	272	15.2	0.82	349	3210
20B	305	15.5	0.91	473	5630
19A	339	14.9	0.85	342	4530
18B	359	15.5	0.93	382	4820
17A	392	15.1	0.94	384	5260
16B	413	15.2	0.90	351	5260
15A	443	14.8	0.94	354	4900
14B	464	14.3	0.88	297	4040
13A	490	14.0	0.84	345	4130
12B	523	12.5	0.94	364	4560
11A	552	11.7	0.86	293	2980
10B	581	11.4	0.85	218	3760
09A	597	11.4	0.88	246	2880
08B	630	11.1	0.71	237	2240
07A	657	10.4	0.78	215	2830
06B	683	10.1	0.72	182	1800
05A	707	9.9	0.59	140	1500
04B	731	10.0	0.60	178	1980
03A	766	9.5	0.43	124	1040
02B	792	9.0	0.37	100	840
01A	826	5.0	0.33	48	390
REW	850	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.04 to give the correct discharge. See text under Water Discharge Measurement for explanation.

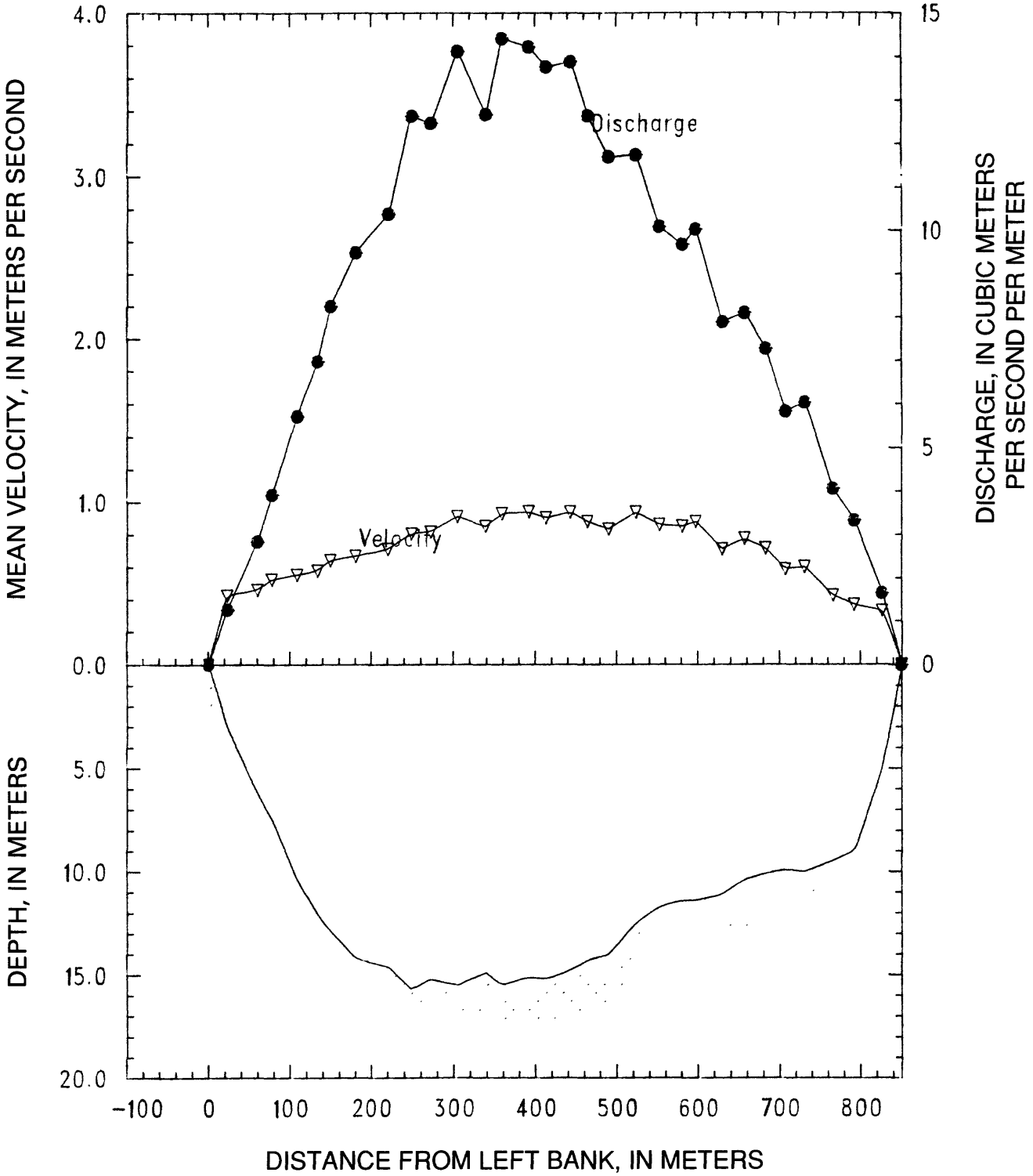

Figure 20. Mississippi River above Arkansas City, Ark. on August 2, 1987.

STATION: Mississippi River below Vicksburg, Miss. 08-04-87
PARTY: Black, Moody, Cranston, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 8.05 ft ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: no measurement
REMARKS: Transit rate was 8 cm/s and the nozzle was 3/16 inch.
The total discharge was 7600 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
36B	21	8.5	0.46	131	890
35A	67	13.6	1.05	641	3460
34B	111	13.1	1.15	564	4880
33A	142	12.3	1.17	346	3190
32B	159	11.7	1.15	316	3680
31A	189	11.4	1.19	419	4040
30B	221	10.8	1.10	382	4020
29A	253	10.5	1.07	327	3790
28B	279	9.5	1.15	321	3360
27A	312	9.7	1.09	296	3720
26B	335	9.0	1.13	310	2730
25A	373	8.7	1.14	337	3270
24B	403	8.7	0.91	202	3790
23A	424	8.8	1.00	273	3800
22B	465	8.7	0.93	263	4360
21A	489	8.8	1.17	292	2960
20B	522	8.1	1.02	289	3340
19A	559	8.0	0.91	232	2820
18B	586	8.1	0.88	215	3390
17A	619	7.2	0.86	183	2880
16B	645	7.7	0.80	164	2670
15A	672	6.9	0.84	166	2500
14B	702	6.7	0.87	199	2130
13A	740	5.9	0.70	131	900
12B	766	5.1	0.67	99	1230
11A	798	5.2	0.57	90	880
10B	827	4.0	0.67	82	950
09A	859	3.3	0.60	63	690
08B	891	3.1	0.55	53	510
07A	920	2.8	0.52	42	500
06B	949	2.8	0.48	39	600
05A	978	2.1	0.44	27	440
04B	1007	2.3	0.45	32	390
03A	1041	2.2	0.32	24	360
02B	1073	2.7	0.30	24	300
01A	1100	2.6	0.41	31	180
REW	1131	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.02 to give the correct discharge. See text under Water Discharge Measurement.

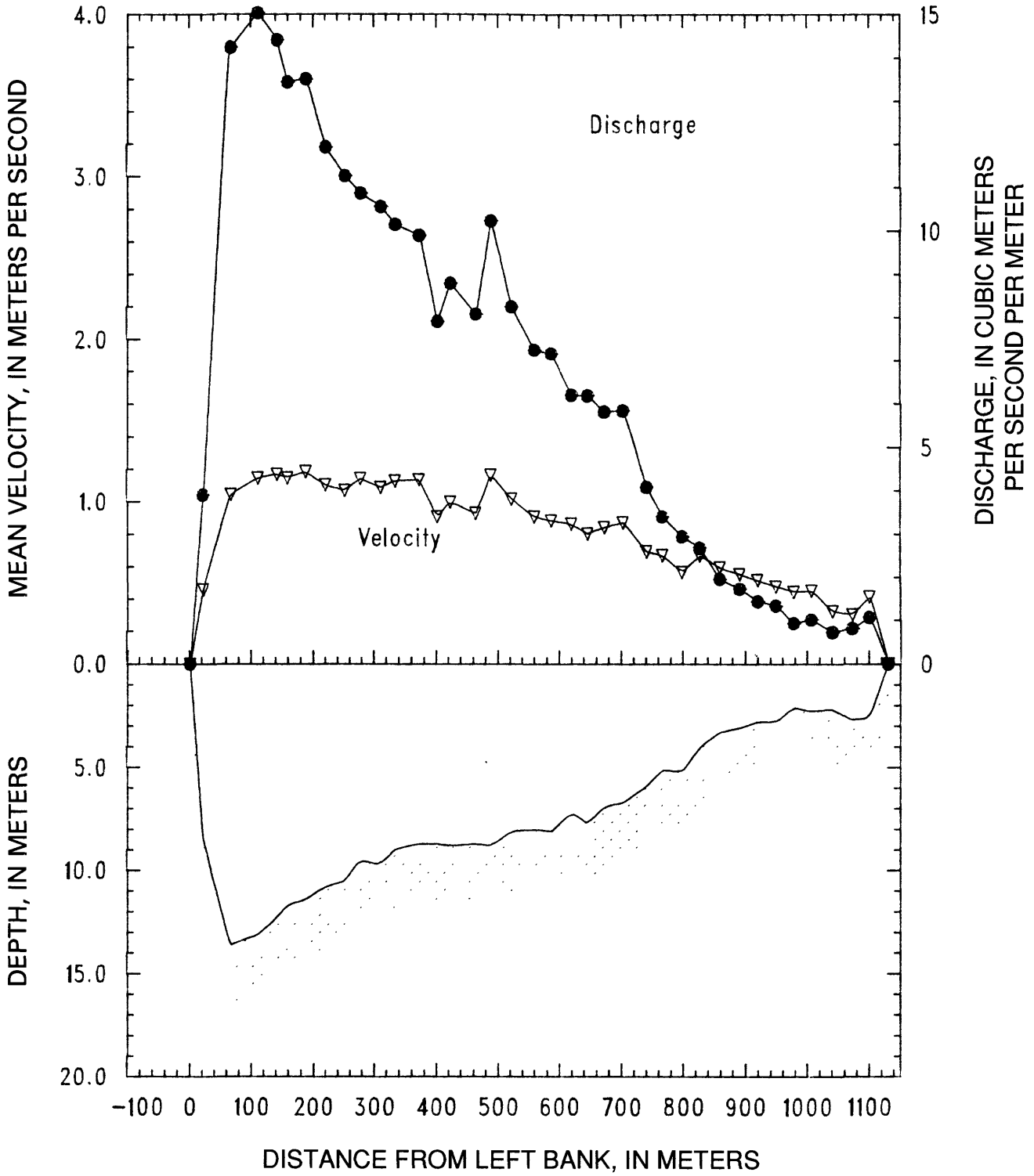

Figure 21. Mississippi River below Vicksburg, Miss. on August 4, 1987.

STATION: Old River Outflow Channel near Knox Landing, La. 08-06-87
PARTY: Black, Cranston, Stevens, and Moody METER: SOLID CUP
STARTING GAGE HEIGHT: 2.83 ft ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 11-04-87
WATER TEMP: 30.9°C
REMARKS: Transit rate was 10 cm/s and the nozzle was 5/16 inch. Anchored at verticals 3,5,7,9, and 11 where the open cup, Price AA current meter was compared with the solid cup Price AA current meter.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	--
X07	20	5.2	0.84	90	--
13A	41	5.5	1.14	142	5590
13B	41	5.5	1.14	--	4770
X06	65	5.0	1.10	97	--
12B	76	4.9	1.11	41	4520
12A	80	5.0	1.01	53	4720
X05	97	5.2	1.01	82	--
11B	111	5.3	--	--	4950
11A	111	5.3	1.06	99	4860
X04	132	5.2	1.12	113	--
10B	150	5.0	0.94	--	4280
10A	150	5.0	0.94	130	3940
09B	187	4.3	--	--	4100
09A	187	4.3	1.00	161	3800
08B	225	4.2	0.88	--	3600
08A	225	4.2	0.88	101	2830
X03	242	4.0	0.94	69	--
07B	262	3.6	--	--	3250
07A	262	3.6	0.94	97	2710
06B	299	3.8	0.80	--	2660
06A	299	3.8	0.80	108	2510
05B	333	4.0	--	--	2610
05A	333	4.0	0.68	83	2270
04R	360	3.4	0.78	38	--
04B	362	3.0	0.78	11	2730
04A	369	3.0	0.92	50	2270
03B	398	3.7	--	--	2530
03A	398	3.7	0.77	67	2400
X02	416	4.1	0.91	80	--
02B	441	4.1	0.81	45	3380
02A	443	4.3	0.90	74	3220
01R	479	4.1	0.94	71	--
X01	480	3.7	0.98	4	--
01B	481	4.1	0.95	2	3370
01A	481	4.0	0.86	65	2840
REW	519	0.0	0.00	0	--

[1]The value of the discharge at each vertical should be multiplied by 1.04 to give the correct discharge. See text under Water Discharge Measurement.

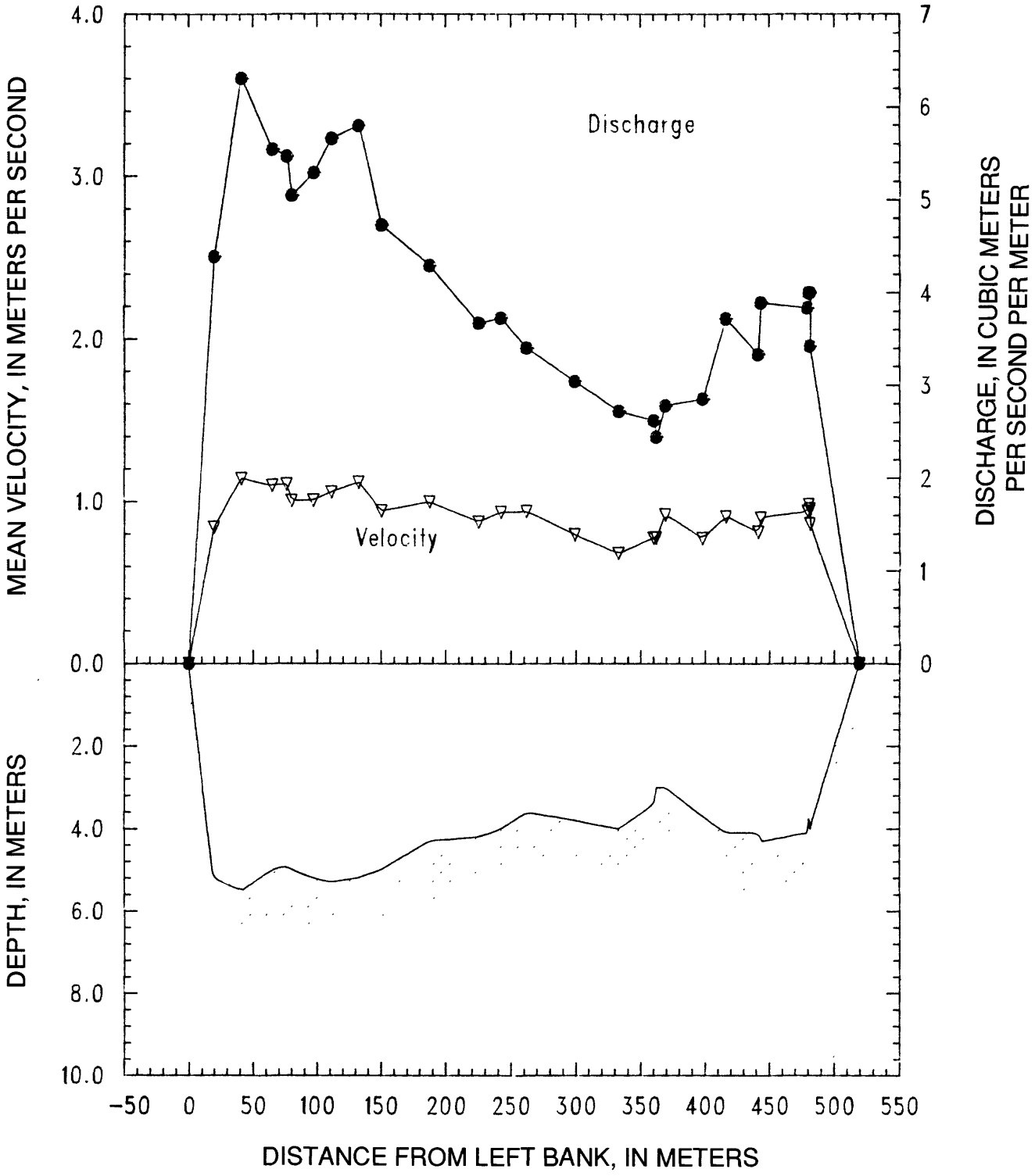

Figure 22. Old River Outflow Channel near Knox Landing, La. on August 6, 1987.

STATION: Mississippi River near St. Francisville, La. 08-07-87
PARTY: Black, Cranston, Stevens, Rees, and Noyes METER: OPEN CUP
STARTING GAGE HEIGHT: 2.65 ft ENDING GAGE HEIGHT --
SUSP. Bag sampler and 200-lb weight
METER No: W223906 DATE RATED: 11-06-87
WATER TEMP: no measurement
REMARKS: Transit rate was 12 cm/s and the nozzle was 1/4 inch.
The total discharge was 5950 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)
LEW	0	0.0	0.00	0	---
32B	16	4.0	0.35	32	580
31A	46	5.0	0.33	48	440
30B	74	4.9	0.42	65	520
29A	109	5.9	0.49	89	910
28B	135	5.9	0.69	120	1430
27A	168	5.9	0.72	121	1160
26B	192	6.4	0.69	97	1770
25A	212	6.2	0.70	156	1740
24B	264	6.9	0.78	220	1850
23A	294	7.3	1.03	210	2500
22B	320	7.3	0.92	208	2940
21A	356	7.3	0.91	212	2910
20B	384	7.3	0.93	170	2810
19A	406	7.2	1.00	217	2810
18B	444	7.3	0.88	215	2850
17A	473	7.3	1.01	250	2910
16B	512	7.0	0.99	204	2930
15A	532	7.5	1.02	241	2750
14B	575	8.8	0.84	225	3000
13A	593	8.4	0.95	204	3570
12B	626	8.8	0.84	219	3060
11A	652	10.1	0.93	292	3460
10B	688	9.6	0.94	287	3570
09A	716	9.4	0.93	258	3490
08B	747	11.6	0.65	248	3720
07A	782	9.9	0.99	279	5070
06B	804	11.9	0.84	300	4280
05A	842	10.1	1.00	358	3290
04B	875	9.1	0.97	233	3760
03A	895	10.2	0.87	244	3570
02B	930	7.8	0.72	149	2680
01A	948	5.8	0.64	98	1630
REW	983	0.0	0.00	0	--

[1]An open metal-cup Price AA current meter was used, at this section, which may measure 5% higher velocity than the solid polymer-cup Price AA current meter. The value of the discharge at each vertical should be multiplied by 0.95 to give the initial value in table 9 and then multiplied by 1.04 to correct for transit rate (see text under Water Discharge Measurement).

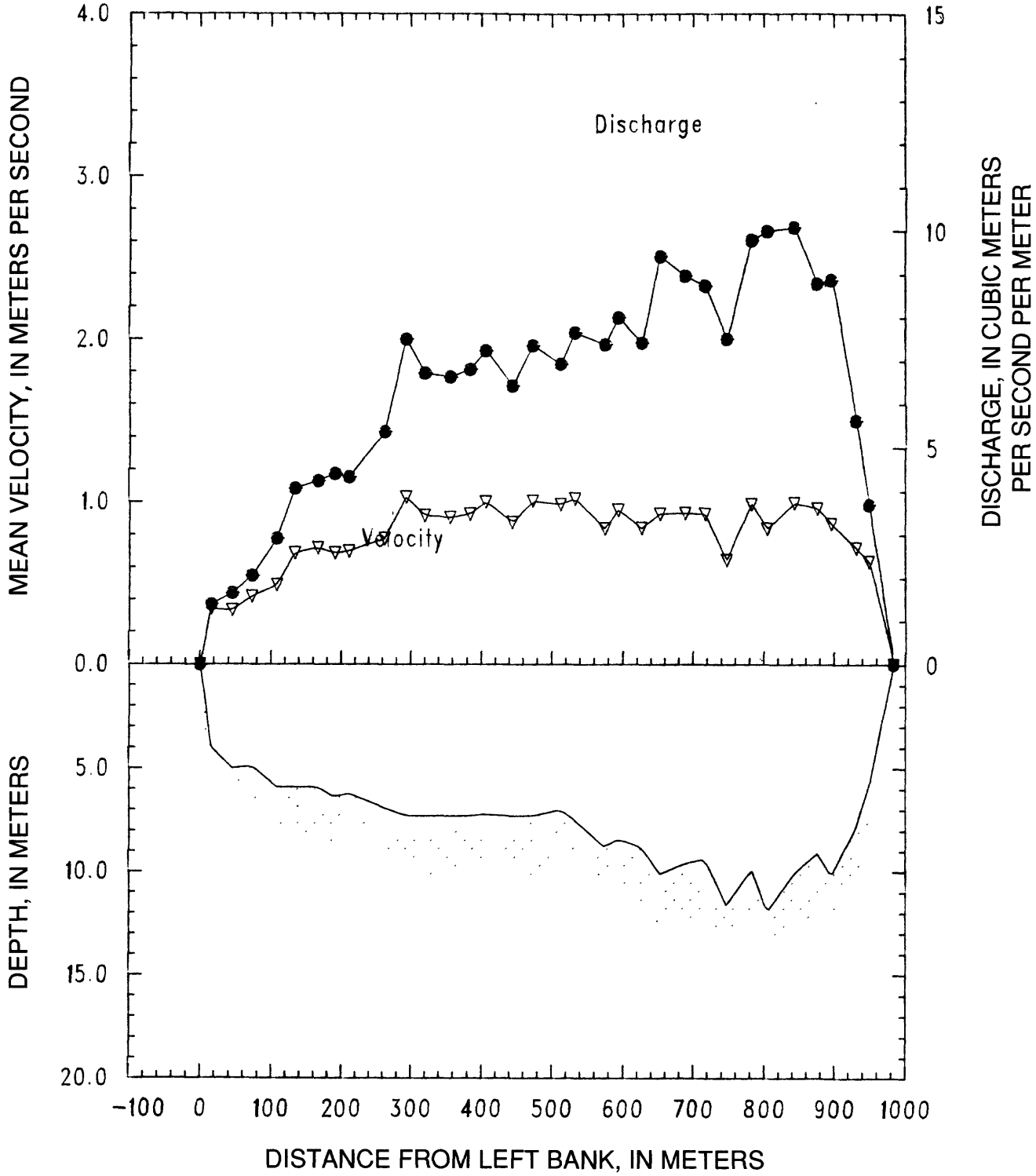

Figure 23. Mississippi R. near St. Francisville, La. on August 7, 1987.

DATA LISTINGS
FOR
NOVEMBER 29 - DECEMBER 20, 1987
CRUISE

STATION: Mississippi River near Winfield, Mo. 11-30-87
PARTY: Simoneaux, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: Tripod was deployed near the REW. Tailwater at Dam 25 was 423.02 ft. Transit rate was 6 cm/s and the nozzle was 1/4 inch. The total discharge was 2000 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
29A	30	8.0	0.48	97	2270	---	--	413
28B	51	9.0	0.78	133	5890	---	--	414
27A	68	8.8	0.79	125	5680	---	--	414
26B	87	9.0	0.82	144	5880	---	--	414
25A	107	8.7	0.81	133	5600	---	--	415
24B	125	8.5	0.79	91	4850	---	--	415
23A	134	8.4	0.75	79	5400	---	--	414
22B	150	8.3	0.76	105	5880	---	--	413
21A	167	8.4	0.73	113	5290	---	--	414
20B	187	8.2	0.73	110	4270	---	--	412
19A	204	8.1	0.72	64	5020	---	--	414
18B	209	7.9	0.69	76	4790	---	--	412
17A	232	7.5	0.59	80	3690	---	--	412
16B	245	7.4	0.60	76	3390	---	--	412
15R	266	7.0	0.56	65	--	---	--	---
14B	278	6.8	0.53	26	3140	---	--	412
15A	280	6.6	0.53	21	3120	---	--	413
14R	290	5.9	0.54	33	--	---	--	---
13A	301	5.8	0.45	23	2150	---	--	413
12B	308	5.7	0.50	43	1980	---	--	412
11A	331	5.6	0.47	39	1700	---	--	412
10B	338	5.4	0.46	50	2040	---	--	413
09A	371	4.5	0.48	47	2000	---	--	413
08B	382	4.3	0.45	39	1280	---	--	413
07A	411	4.1	0.43	29	1320	---	--	412
06B	415	4.0	0.45	26	1360	---	--	413
05A	440	3.5	0.41	26	850	---	--	413
04B	451	3.4	0.46	24	1040	---	--	411
03A	471	3.6	0.43	25	960	---	--	413
02B	483	4.3	0.43	20	720	---	--	418
01A	493	4.3	0.44	34	520	---	--	413
REW	519	0.0	0.00	0	--	---	--	---

[1]The value of the discharge at each vertical should be multiplied by 1.02 to give the correct discharge. See text under Water Discharge Measurement for explanation.

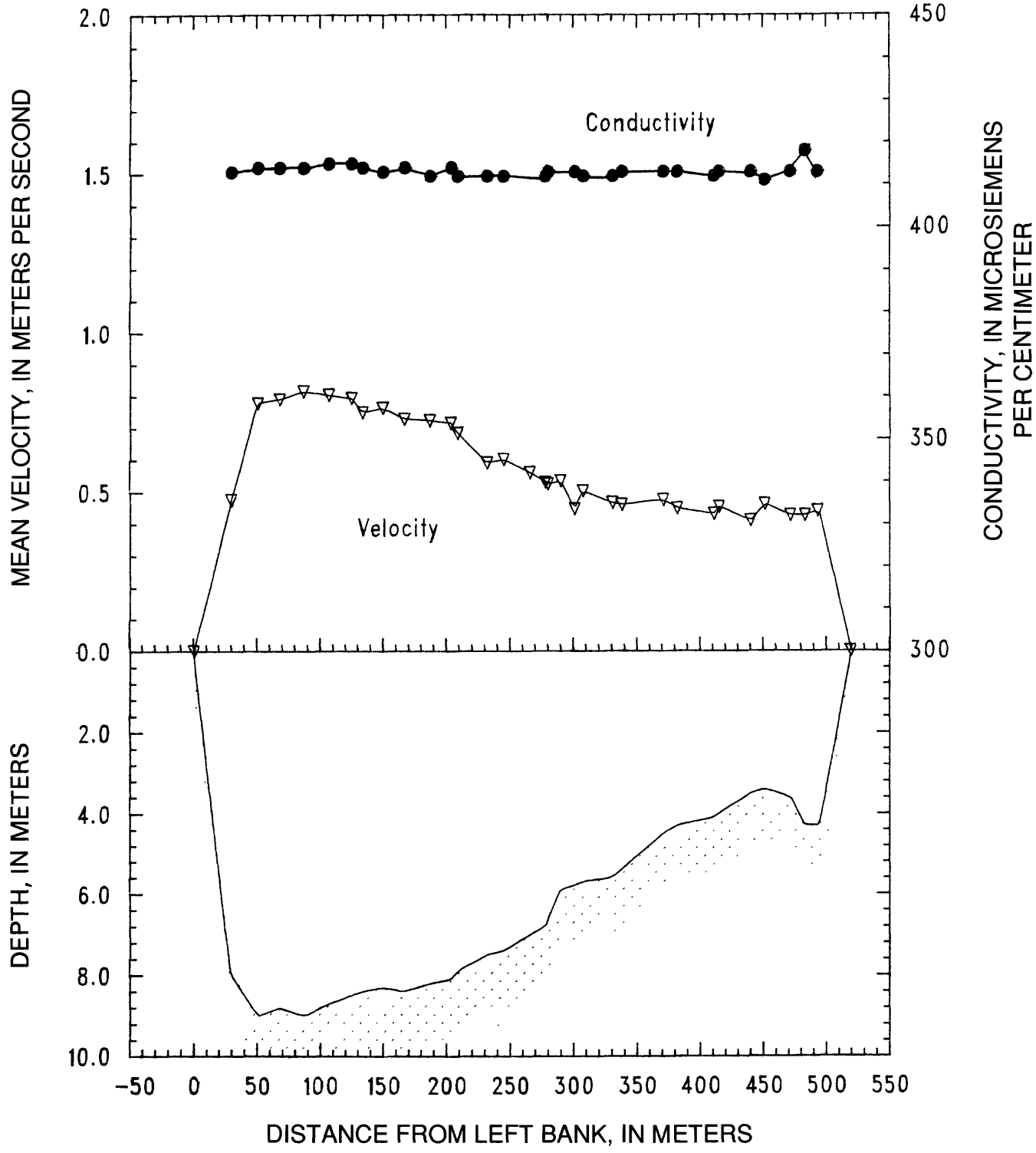

Figure 24. Mississippi River near Winfield, Mo. on November 30, 1987.

STATION: Missouri River at St. Charles, Mo. 12-02-87
PARTY: Simoneaux, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP. Bag sampler and 150-lb weight
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: Tripod with current meter was deployed during the night. A dredge was working upriver of the section. Transit rate was 12 cm/s and the nozzle was 1/4 inch. The total discharge was 2750 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
01A	13	5.0	0.93	84	2250	5.7	8.2	585
02B	36	6.7	1.33	133	3630	6.0	8.2	587
03A	43	6.7	1.21	85	3660	5.7	8.2	585
04B	57	6.6	1.31	117	4200	5.7	8.2	583
05A	70	6.5	1.38	121	3990	5.7	8.2	580
06B	84	6.5	1.51	142	4650	5.7	8.2	577
07A	99	5.9	1.56	130	4390	5.4	8.2	581
08B	112	5.5	1.61	116	4910	5.5	8.2	578
09A	125	5.6	1.66	126	3970	5.7	8.2	578
10B	139	5.2	1.69	159	5020	5.7	8.3	578
11A	161	5.4	1.68	118	4200	5.7	8.2	575
12B	165	5.5	1.52	109	4000	5.7	8.2	576
13A	187	5.0	1.44	105	4090	5.9	8.1	573
14B	194	5.7	1.69	86	4360	6.3	8.2	576
15A	205	5.4	1.53	132	3700	6.1	8.2	574
16B	226	4.7	1.30	95	3840	6.2	8.2	576
17A	236	4.8	1.45	101	4200	6.1	8.2	573
18B	255	5.3	1.30	104	3670	6.4	8.2	572
19A	266	5.8	1.35	95	3660	6.4	8.2	572
20R	274	5.9	1.36	37	--	---	--	---
20B	279	6.1	1.43	34	4610	6.3	8.2	575
21A	288	5.9	1.34	130	4090	6.4	8.2	573
22B	307	5.9	1.22	122	3830	6.4	8.2	574
23A	322	5.9	1.20	92	2450	6.3	8.2	573
24B	333	5.9	1.09	90	3080	6.4	8.2	574
25A	350	5.2	0.56	44	930	6.4	8.2	574
26B	363	3.3	0.02	1	230	6.4	8.2	575
28B	373	3.2	0.15	4	240	6.4	8.2	577
27A	381	4.8	0.08	6	210	6.2	8.2	575
X01	408	5.6	0.19	25	--	---	--	---
REW	428	0.0	0.00	0	--	---	--	---

[1]The value of the discharge at each vertical should be multiplied by 1.02 to give the correct discharge. See text under Water Discharge Measurement for explanation.

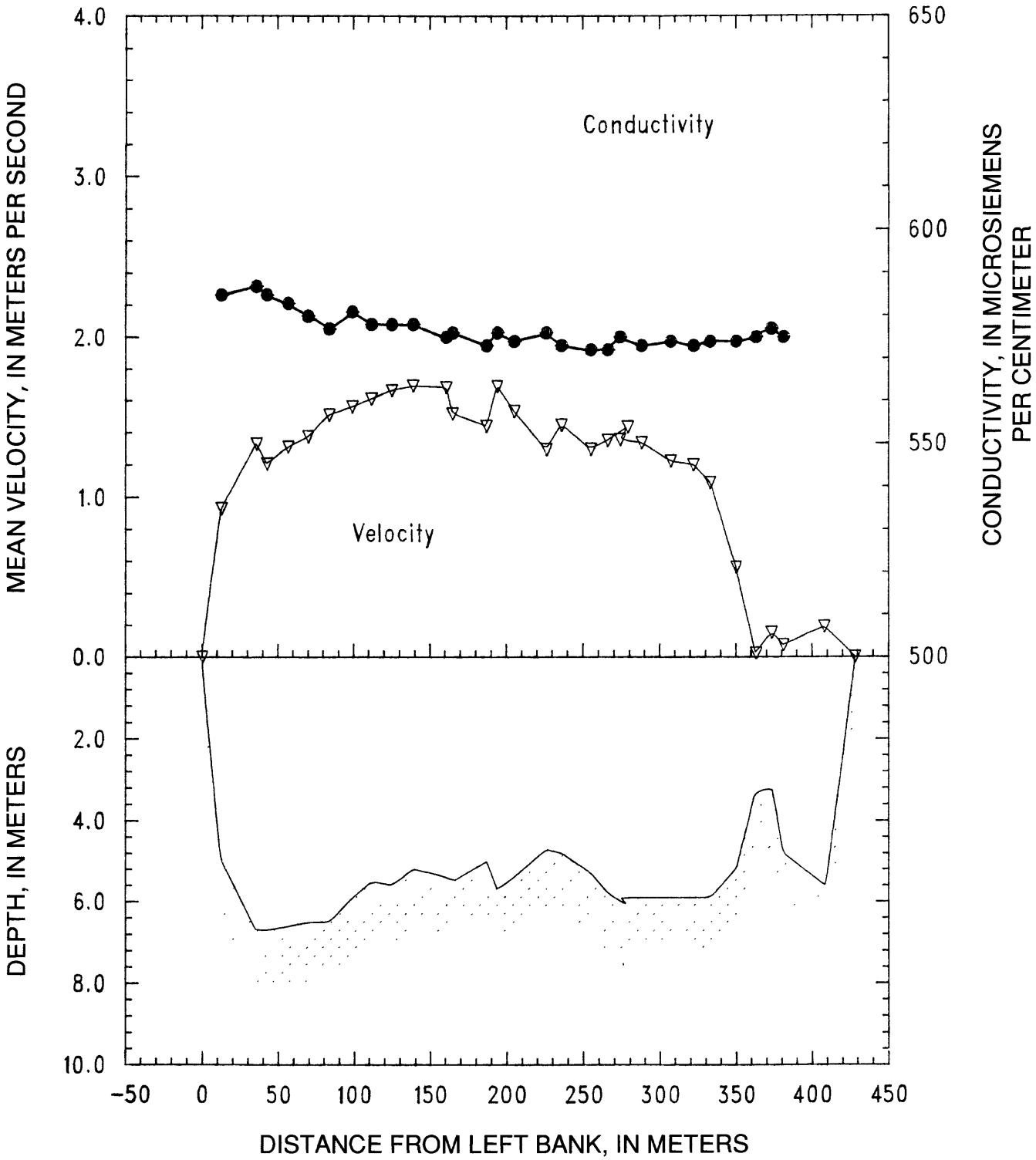

Figure 25. Missouri River at St. Charles, Mo. on December 2, 1987.

STATION: Mississippi River at St. Louis, Mo. 12-03-87
PARTY: Simoneaux, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 10.65 ft. ENDING GAGE HEIGHT: 10.60 ft.
SUSP: Bag sampler and 150-lb weight.
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: Very strong winds! Transit rate was 16 cm/s and the nozzle was 1/4 inch. The total discharge was 5230 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
01A	52	11.6	1.23	485	4850	5.5	8.6	473
02B	68	11.1	1.43	168	5180	5.4	8.6	471
03A	73	10.9	1.40	215	5240	5.5	8.6	473
04B	96	10.5	1.57	387	5940	5.4	8.6	472
05A	120	10.9	1.54	294	5600	5.5	8.6	473
06B	131	11.3	1.43	122	5080	5.5	8.6	472
07A	135	10.5	1.38	138	4600	5.5	8.5	477
08B	150	10.0	1.52	273	5680	5.7	8.5	481
09A	171	9.3	1.47	211	4680	5.7	8.5	488
10B	181	9.6	1.55	216	4680	5.6	8.5	489
11A	200	9.5	1.54	197	4520	5.8	8.5	496
12B	208	9.6	1.41	183	4450	5.8	8.4	494
13A	227	8.7	1.65	186	4770	6.2	8.4	501
14B	234	8.4	1.65	146	5120	6.5	8.4	512
15A	248	7.7	1.55	216	4250	7.1	8.3	521
16B	270	7.2	1.70	221	3890	6.8	8.4	514
17A	284	7.3	1.40	188	3080	6.8	8.3	513
18B	307	6.8	1.08	113	2600	6.7	8.3	527
19A	315	7.7	1.26	102	3080	6.7	8.3	528
20B	328	7.8	1.12	126	2970	6.9	8.0	529
21A	344	7.8	1.11	125	2680	7.4	8.3	527
22B	357	7.4	1.10	126	2330	---	--	---
23A	375	6.7	1.11	104	2580	7.4	8.0	538
24B	385	7.5	0.89	97	2110	7.2	8.1	540
25A	404	7.3	0.94	127	2290	7.2	8.1	538
26B	422	7.2	0.93	111	2520	7.7	8.1	543
27A	437	7.1	0.98	94	2220	7.1	8.1	540
28B	449	7.3	0.93	111	2380	7.7	8.1	540
29A	470	7.3	0.71	73	1670	---	--	---
30B	477	7.0	0.53	77	1060	---	--	---
REW	511	0.0	0.00	0	--	---	--	---

[1]The value of the discharge at each vertical should be multiplied by 1.04 to give the correct discharge. See text under Water Discharge Measurement for explanation.

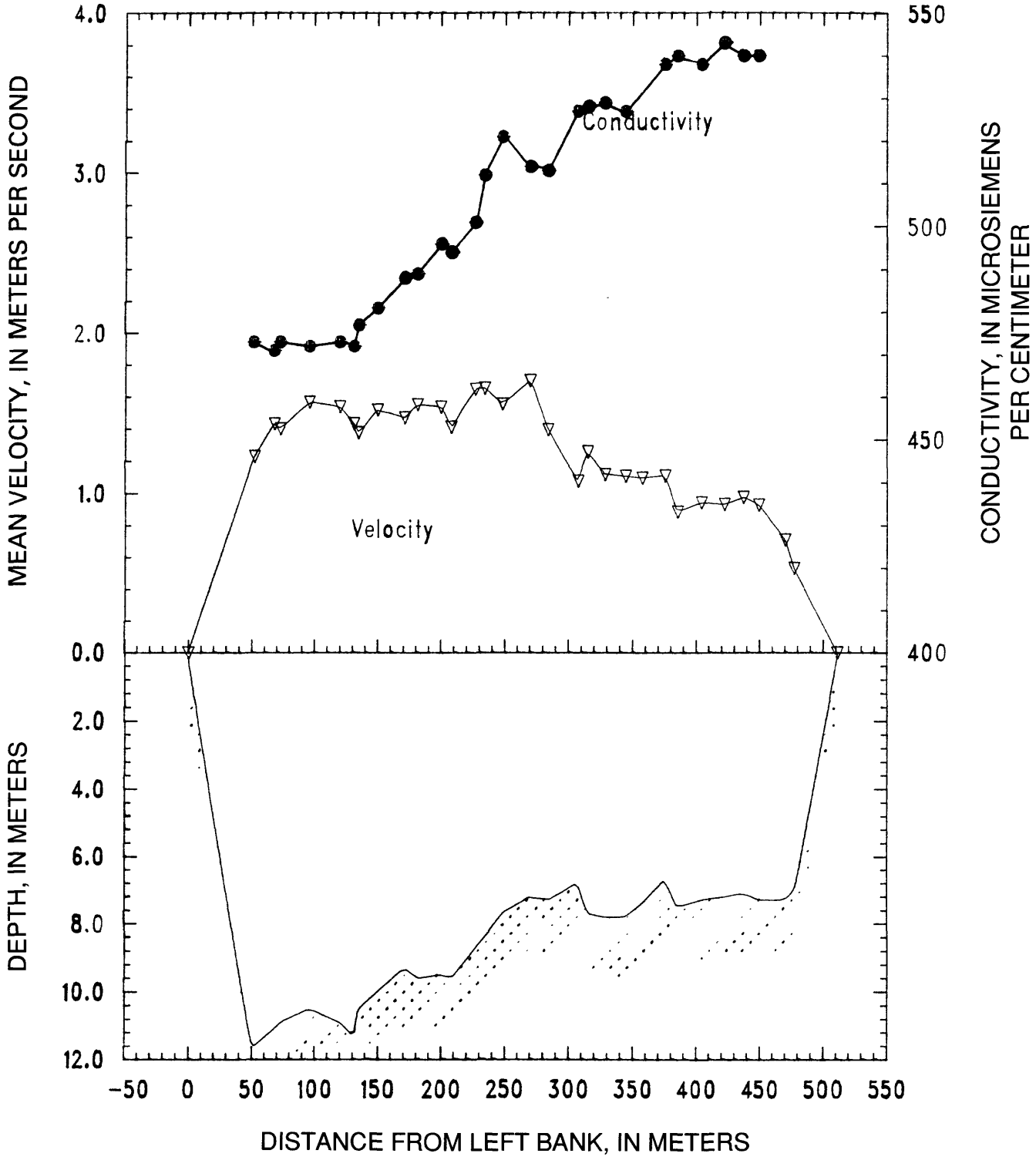

Figure 26. Mississippi River at St. Louis, Mo. on December 3, 1987.

STATION: Mississippi River at Thebes, Ill. 12-05-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 16.4 ft. ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight.
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: Transit rate was 18 cm/s and the nozzle was 1/4 inch.
The total discharge was 4990 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge[1] (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
01A	19	3.1	0.55	31	560	5.7	8.3	517
02B	37	5.0	0.71	64	1140	6.4	8.3	517
03A	55	8.1	0.82	119	1470	6.0	8.3	518
04B	73	7.8	1.10	115	2520	5.9	8.2	516
05A	82	7.7	1.20	167	2750	5.7	8.3	515
06B	109	8.6	1.23	243	3650	4.7	8.3	512
07A	128	8.5	1.59	216	3340	5.7	8.3	512
08B	141	8.4	1.38	237	3780	5.7	8.3	514
09A	169	8.6	1.46	213	4160	5.6	8.3	515
10B	175	8.4	1.41	172	3820	5.6	8.3	510
11A	198	8.4	1.50	221	3760	5.6	8.3	515
X17	210	8.6	1.55	93	--	---	--	---
12B	212	8.8	1.55	130	3710	5.5	8.3	509
X03	229	8.8	1.41	119	--	---	--	---
X16	231	8.8	1.49	105	--	---	--	---
13A	245	8.8	1.60	191	4150	5.5	8.3	510
14B	258	8.6	1.52	144	3700	5.5	8.3	510
15A	267	8.4	1.49	125	3730	5.7	8.4	514
X15	278	8.6	1.50	188	--	---	--	---
16B	296	8.7	1.24	163	3000	5.9	8.4	514
17A	308	8.1	1.36	121	3440	5.9	8.3	511
X12	318	8.1	1.50	133	--	---	--	---
18B	330	8.1	1.33	97	3580	5.8	8.3	515
X11	336	7.9	1.34	106	--	---	--	---
19A	350	7.8	1.37	112	3440	5.9	8.3	511
20B	357	8.4	1.39	99	3040	5.8	8.2	508
X09	367	7.6	1.38	116	--	---	--	---
21A	379	6.8	1.45	84	2980	5.8	8.2	507
X08	384	6.8	1.31	107	--	---	--	---
22B	403	6.8	1.26	150	2570	5.8	8.3	509
23A	419	6.1	1.23	127	2110	5.8	8.3	510
24B	437	6.1	1.32	104	1930	5.8	8.3	512
25A	445	6.4	1.27	130	2440	5.7	8.3	512
26B	469	5.4	1.26	133	2130	5.8	8.3	508
27A	484	5.0	1.27	74	2070	5.8	8.3	508
28B	492	4.9	1.20	61	1790	5.8	8.3	507
29A	505	4.9	1.29	117	1710	5.8	8.3	509
30B	529	2.0	0.86	59	550	5.4	8.3	511
REW	574	0.0	0.00	0	--	---	--	---

[1]The value of the discharge at each vertical should be multiplied by 1.04 to give the correct discharge. See text under Water Discharge Measurement for explanation.

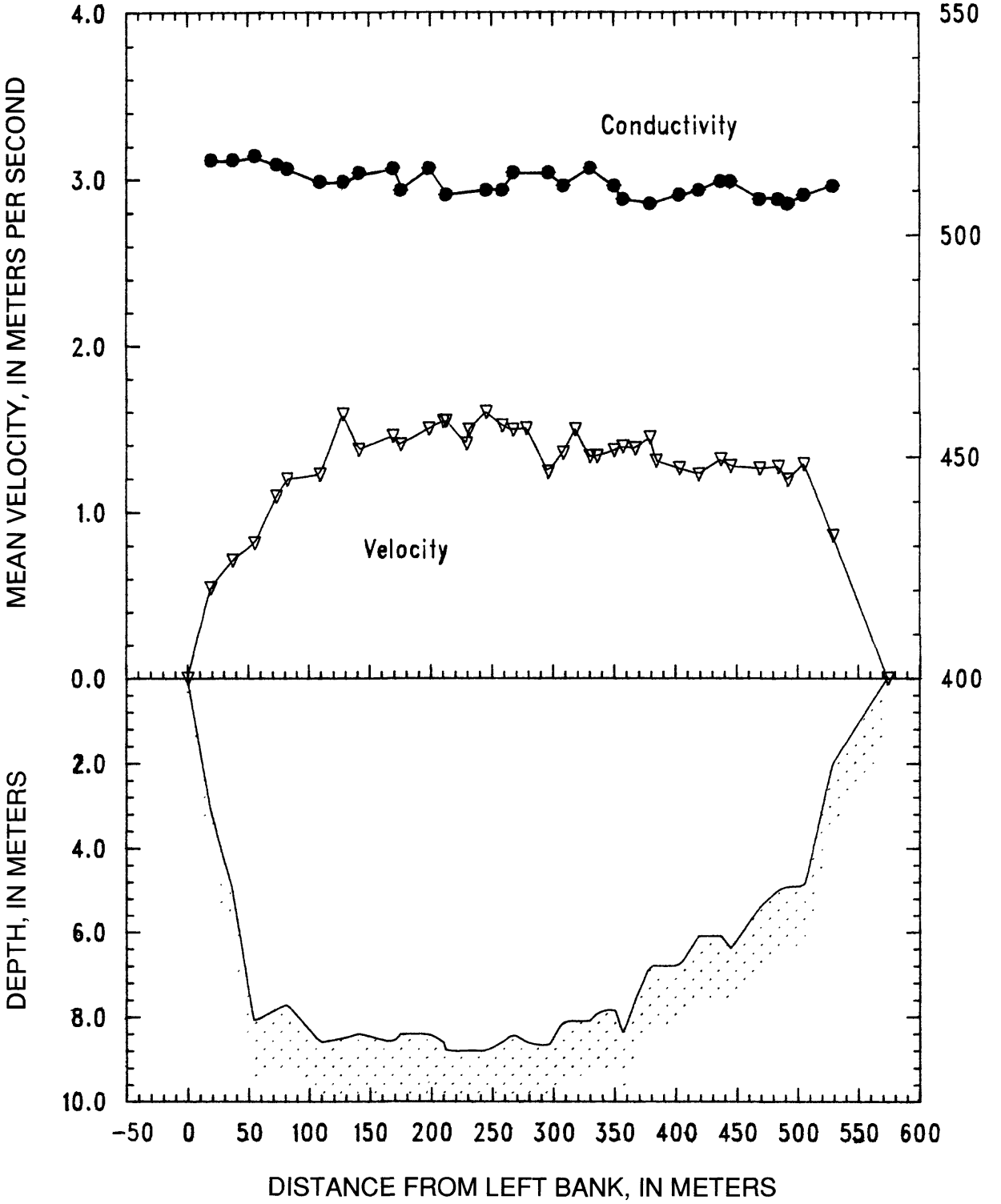

Figure 27. Mississippi River at Thebes, Ill. on December 5, 1987.

STATION: Ohio River at Olmsted, Ill. 12-06-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING ARBITRARY GAGE HEIGHT: 1.00 m ENDING GAGE HEIGHT: 0.95 m
SUSP: Bag sampler and 150-lb weight.
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: It rained off and on all day. Tripod was deployed near LEW in 6 m of water. Transit rate was 7 cm/s and the nozzle was 5/16 inch. Only upcast velocities are listed. The total discharge was 4200 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
30B	32	2.9	0.31	27	740	10.2	8.1	338
29A	61	3.2	0.21	22	610	10.4	8.1	341
28B	97	3.8	0.34	46	490	10.1	8.1	343
27A	133	4.8	0.27	36	810	9.4	8.0	345
26B	153	5.1	0.33	45	1080	10.1	8.1	346
25A	186	5.5	0.28	54	920	9.5	8.1	347
24B	224	6.4	0.40	81	1340	9.2	8.1	351
23A	249	7.1	0.43	86	1310	9.1	8.1	351
22B	280	7.4	0.40	109	3370	8.7	8.2	348
21A	323	8.3	0.44	139	2610	8.7	8.1	351
20B	357	8.8	0.48	122	3790	8.3	8.2	352
19A	381	9.0	0.49	105	2250	---	--	370
18B	405	9.4	0.47	134	5370	---	--	360
17A	442	9.9	0.54	181	4380	---	--	361
16B	473	10.2	0.51	151	4310	8.6	8.1	390
15A	500	9.9	0.60	176	3660	8.4	8.0	382
14B	532	9.9	0.56	187	6030	8.7	8.0	397
13A	565	9.8	0.61	201	3150	8.7	8.0	410
12B	599	9.2	0.68	201	6400	8.6	8.1	410
11A	629	8.1	0.84	208	6500	8.6	8.1	415
10B	660	8.8	0.76	216	6050	8.7	8.1	425
09A	693	9.2	0.68	176	6360	8.4	8.0	428
08B	716	9.5	0.92	253	6360	8.4	8.1	430
07A	751	10.0	0.71	243	6410	8.3	8.0	432
06B	784	9.6	0.65	222	6210	8.0	8.0	431
05A	822	9.7	0.66	200	6210	8.5	8.1	435
04B	846	9.9	0.59	166	6290	8.5	8.1	432
03A	879	10.0	0.53	176	5450	8.5	8.1	432
02B	912	10.3	0.50	154	5120	8.7	7.9	433
01A	939	7.7	0.34	81	2090	8.7	8.1	432
REW	974	0.0	0.00	0	--	---	--	---

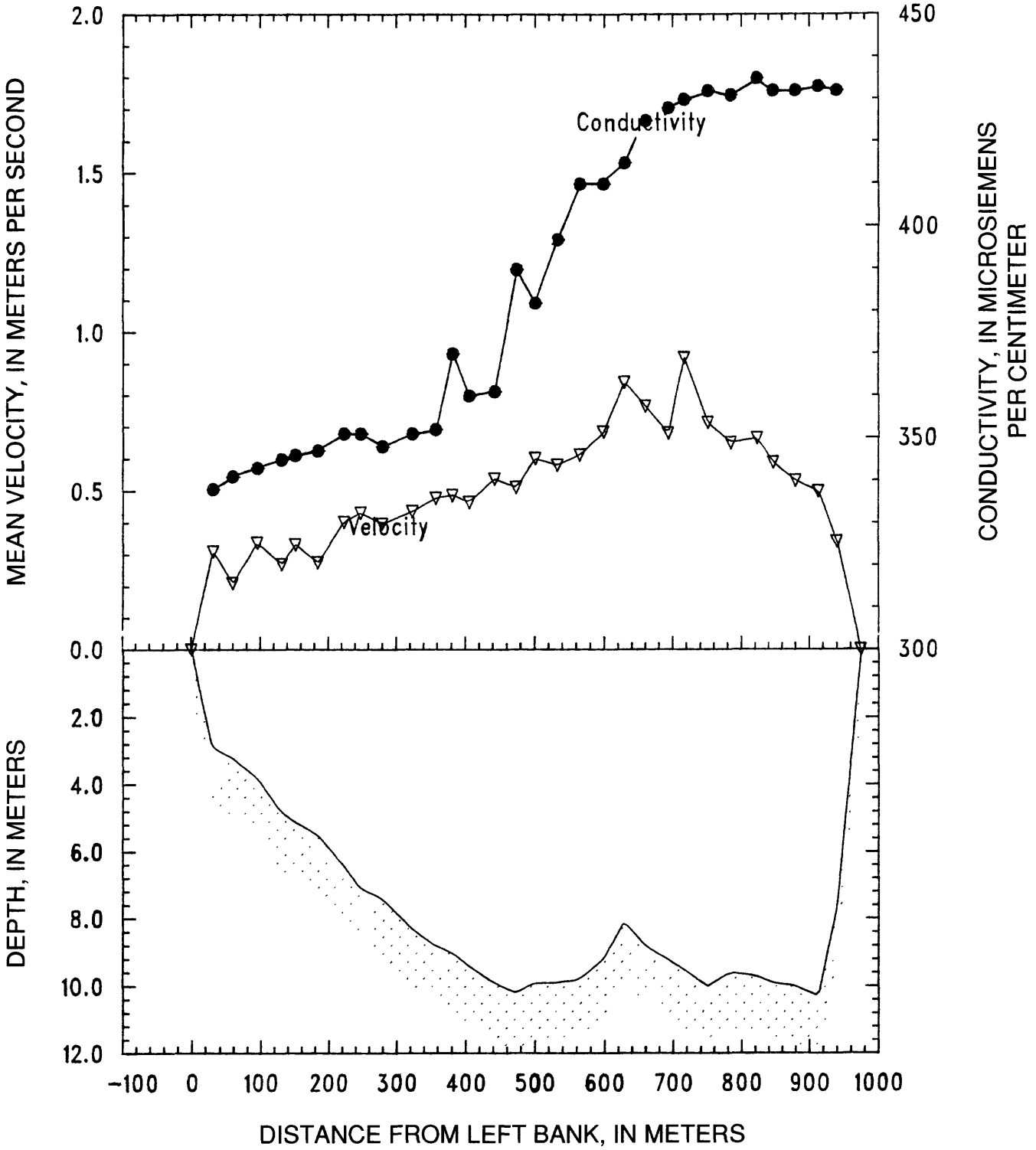

Figure 28. Ohio River at Olmsted, Ill. on December 6, 1987.

STATION: Mississippi River below Hickman, Ky. 12-07-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING PORTABLE GAGE HEIGHT: 0.20 m ENDING GAGE HEIGHT: 0.13 m
SUSP: Bag sampler and 300-lb weight
METER No: P8308282 DATE RATED: 4-14-88
REMARKS: Herb liked today because there was no rain. The transit rate was 14 cm/s and the nozzle was 1/4 inch. Only upcast velocities are listed. Total discharge was 8820 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
01A	36	7.3	0.82	197	1860	8.5	8.3	426
02B	66	7.4	0.92	220	2380	8.5	8.3	428
03A	101	8.7	1.29	370	4120	8.4	8.2	431
04B	132	8.7	1.26	351	4020	8.2	8.2	431
05A	165	8.2	1.41	411	4070	7.8	8.2	432
06B	203	7.8	1.28	234	4060	7.8	8.2	433
X01	212	7.8	1.30	152	--	---	--	---
07A	233	7.6	1.17	178	3140	7.8	8.2	435
X02	252	7.6	1.18	170	--	---	--	---
08B	271	7.7	1.25	197	3140	8.2	8.2	438
09A	293	7.6	1.19	231	3310	8.3	8.3	438
X03	322	7.8	1.20	182	--	---	--	---
10B	332	7.9	1.54	286	3680	8.6	8.3	442
11A	369	7.5	1.30	298	2770	8.1	8.3	445
12B	393	7.5	1.39	323	3290	7.6	8.3	441
13A	431	7.6	1.26	317	3710	7.8	8.3	450
X05	459	7.5	1.13	199	--	---	--	---
14B	478	8.5	1.15	187	3610	8.0	8.3	454
15A	497	8.7	1.29	269	3660	8.3	8.3	456
16B	526	8.6	1.07	337	3460	7.6	8.3	457
17A	570	8.4	1.02	262	3500	7.9	8.3	462
18B	587	8.9	1.07	228	3700	7.9	8.3	460
X06	618	9.2	1.10	218	--	---	--	---
19A	630	8.9	1.12	249	3760	7.0	8.4	468
20B	668	9.3	1.10	368	3560	7.2	8.2	471
21A	702	9.7	1.00	326	3530	7.1	8.1	478
22B	735	9.6	1.04	315	3460	7.6	8.4	485
23A	765	10.3	0.95	319	3270	7.2	8.4	482
24B	800	9.3	1.00	283	3480	6.8	8.4	474
25A	826	9.5	0.92	298	2440	6.8	8.4	479
26B	868	8.9	0.99	268	2930	6.9	8.4	480
27A	887	8.6	0.93	212	2950	6.9	8.5	481
28B	921	6.3	0.84	196	1660	6.8	8.4	481
29A	961	5.7	0.75	128	1390	7.2	8.3	482
30B	981	3.0	0.55	39	490	7.1	8.5	479
REW	1008	0.0	0.00	0	--	---	--	---

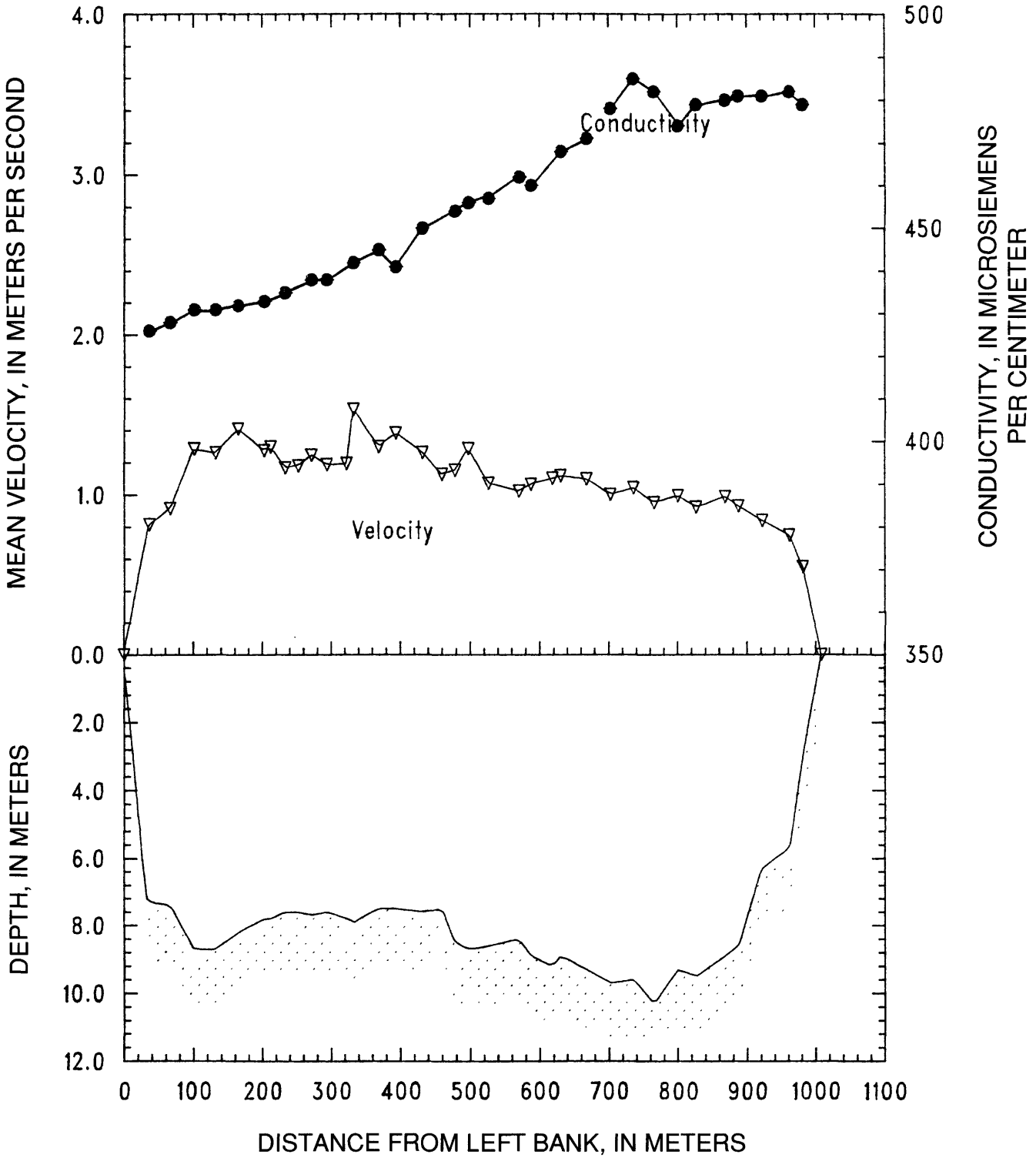

Figure 29. Mississippi River below Hickman, Ky. on December 7, 1987.

STATION: Mississippi River at Fulton, Tenn. 12-08-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
METER No: P8308282 DATE RATED: 4-14-88
REMARKS: Started at noon and finished in the dark on a very windy day. Transit rate was 10 cm/s and the nozzle was 3/16 inch. Only upcast velocities are listed. Total discharge was 9470 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (micro-siemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
30B	32	2.4	0.54	33	270	8.6	8.2	457
29A	51	3.2	0.62	46	360	8.0	8.2	459
28B	79	4.8	0.61	82	1040	8.2	8.0	460
X09	107	6.0	0.82	103	--	---	--	---
27A	121	4.8	0.82	49	1640	8.0	7.9	460
X08	132	6.2	0.89	111	--	---	--	---
25A	161	8.7	1.06	226	2660	8.7	8.2	460
24B	181	9.9	1.15	353	2820	8.2	8.2	461
23A	223	10.0	1.27	362	3800	9.6	8.2	460
22B	238	10.6	1.22	299	4100	8.2	8.1	460
21A	269	10.8	1.43	493	4000	8.9	8.2	461
20B	302	11.2	1.37	422	5070	9.0	8.1	464
19A	324	11.4	1.36	278	4610	9.4	8.2	461
X07	338	12.0	1.55	307	--	---	--	---
18B	357	13.4	1.29	243	5210	8.2	8.1	463
X06	366	14.8	1.29	315	4770	10.1	8.1	458
X05	390	14.9	1.33	375	--	---	--	---
16B	404	14.9	1.25	364	5400	8.6	8.2	459
15A	429	14.5	1.10	383	4600	8.6	8.1	462
X04	452	14.4	1.51	425	--	---	--	---
14B	468	14.5	1.16	285	5560	9.7	8.1	460
13A	486	14.4	1.27	465	5540	8.4	8.2	459
12B	519	13.8	1.32	447	4910	8.3	8.1	463
X03	535	12.0	1.34	257	--	---	--	---
11A	551	12.0	1.29	264	4270	9.9	8.2	465
10B	569	12.0	1.30	351	4500	8.2	8.1	460
X02	596	11.9	1.15	260	--	---	--	---
09A	607	11.5	1.14	150	3760	8.5	8.1	462
08B	619	11.2	1.10	233	2700	9.2	8.1	459
X01	645	11.2	1.22	301	--	---	--	---
07A	663	12.2	1.06	277	3460	8.9	8.1	465
06B	688	11.4	0.98	312	3070	9.2	8.0	462
05A	719	10.1	0.80	194	1860	8.2	8.0	460
04B	736	9.4	0.72	163	1570	8.4	8.0	463
03A	767	6.9	0.67	114	920	8.4	8.1	461
02B	786	4.5	0.64	71	680	8.8	8.1	458
01A	816	2.6	0.75	56	240	8.4	8.1	462
REW	844	0.0	0.00	0	--	---	--	---

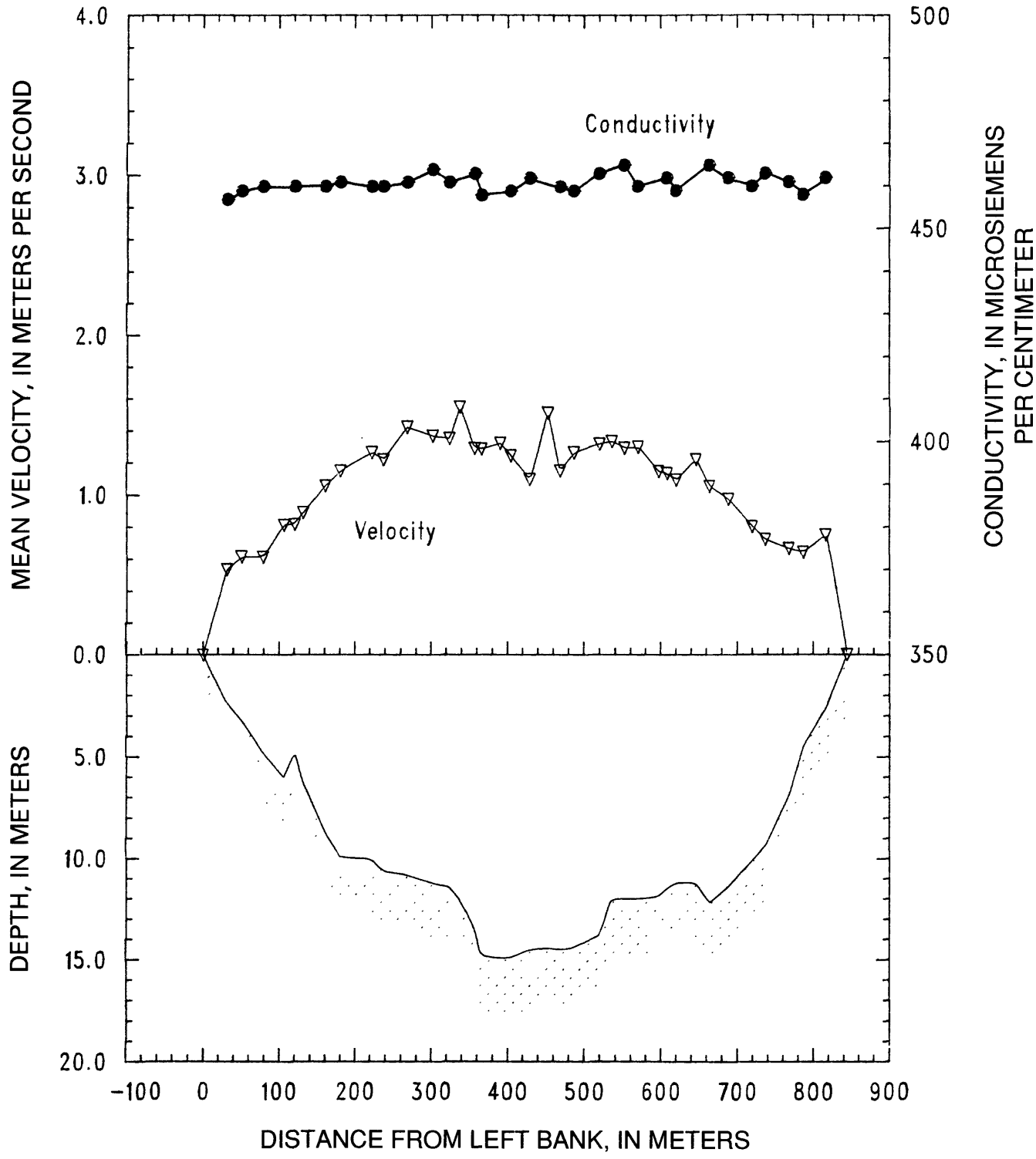

Figure 30. Mississippi River at Fulton, Tenn. on December 8, 1987.

STATION: Mississippi River at Helena, Ark. 12-11-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 9.70 ft. ENDING GAGE HEIGHT: 9.65 ft.
SUSP: Bag sampler and 300-lb weight
METER No: P8308282 DATE RATED: 4-14-88
REMARKS: Clear and sunny day. The transit rate was 22 cm/s and the nozzle was 1/4 inch. Only upcast velocities are listed. The total discharge was 8770 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
30B	20	7.2	1.47	196	2120	8.7	8.0	457
X12	37	10.6	1.67	247	--	---	--	---
29A	48	10.7	1.81	301	5000	8.9	8.1	458
X11	68	10.8	1.84	327	--	---	--	---
28B	81	10.9	1.93	200	5500	8.7	8.0	455
X10	87	11.2	1.70	190	--	---	--	---
27A	101	10.9	1.62	213	4480	8.7	8.0	453
X09	111	10.7	1.64	245	--	---	--	---
26B	129	10.7	1.54	189	4890	8.7	8.1	454
X08	134	10.7	1.65	132	--	---	--	---
25A	144	10.3	1.53	198	4260	8.6	8.0	454
X07	159	10.6	1.79	284	--	---	--	---
24B	174	10.5	1.64	180	4720	9.1	8.1	451
X06	180	10.8	1.70	192	--	---	--	---
23A	195	10.5	1.59	200	4780	8.8	8.0	453
X05	204	10.2	1.81	202	--	---	--	---
22B	217	10.2	1.64	209	4480	9.2	7.8	451
X04	229	10.2	1.64	184	--	---	--	---
21A	239	10.0	1.36	163	3760	8.7	7.9	451
X03	253	9.5	1.60	198	--	---	--	---
20B	265	9.5	1.70	226	4060	8.6	8.0	450
X02	281	9.0	1.48	181	--	---	--	---
19A	292	8.8	1.45	140	3600	8.5	7.9	449
X01	303	9.0	1.50	156	--	---	--	---
18A	315	8.7	1.58	200	3480	---	--	---
17A	332	8.2	1.64	329	3550	8.7	7.9	448
16B	364	7.6	1.11	223	2510	---	--	---
15A	385	7.4	1.55	269	2590	8.7	7.9	444
14B	411	7.3	1.29	218	2270	---	--	---
13A	431	7.5	1.28	250	2310	8.6	7.9	441
12B	463	8.5	1.35	310	2930	---	--	---
11A	485	8.7	1.41	240	2340	8.7	7.9	439
10B	502	8.4	1.38	203	2660	---	--	---
09A	520	8.2	1.05	202	1920	8.5	7.9	445
08B	549	8.0	1.29	320	2120	---	--	---
07A	582	7.4	1.12	185	2120	8.5	7.9	438
06B	594	7.6	1.12	191	1840	---	--	---

STATION: Mississippi River at Helena, Ark. 12-11-87
(continued)

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature ($^{\circ}C$)	pH	Conductivity (microsiemens/cm)
05A	627	6.4	1.43	280	1480	8.6	7.9	438
04B	655	6.2	1.20	167	1360	---	--	---
03A	672	4.8	1.08	114	1170	8.6	7.8	436
02B	699	3.3	1.27	106	660	---	--	---
01A	722	1.5	0.29	11	510	10.1	8.0	430
REW	750	0.0	0.00	0	--	---	--	---

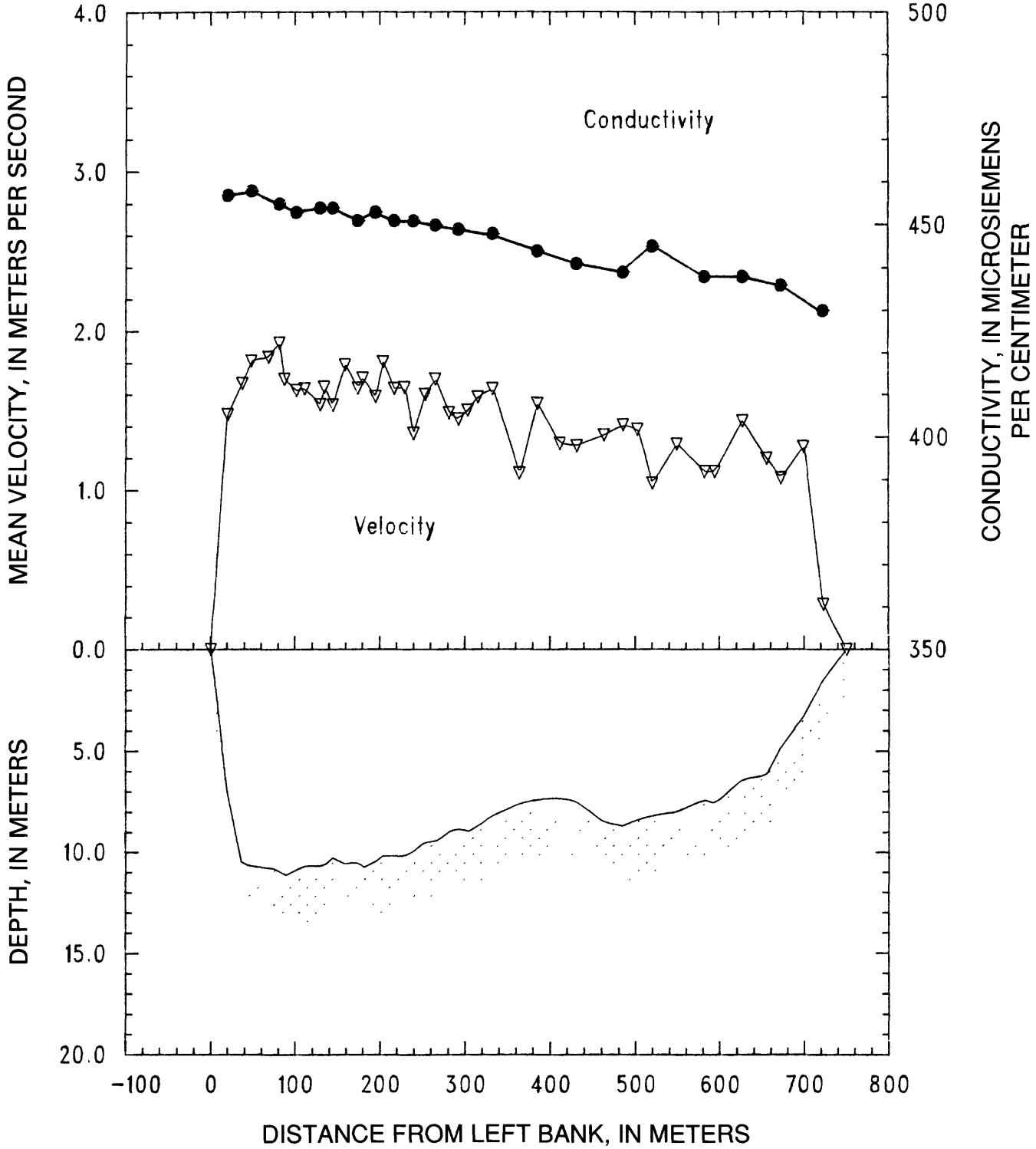

Figure 31. Mississippi River at Helena, Ark. on December 11, 1987.

STATION: White River at Mile 11.5, Ark. 12-12-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING ARBITRARY GAGE HEIGHT: 0.20 m ENDING GAGE HEIGHT: 0.15 m
SUSP: Bag sampler and 150-lb weight
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: Transit rate was 10 cm/s and the nozzle was 5/16 inch. Only upcast velocities are listed. The total discharge was 519 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature ($^{\circ}C$)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
10A	17	5.0	0.61	55	4960	11.9	7.7	239
10B	17	5.0	0.61	--	5440	---	--	---
09A	32	4.8	0.79	29	6010	11.4	7.8	230
09B	32	4.8	0.79	--	6600	---	--	---
X01	36	4.8	0.80	29	--	---	--	---
08A	51	4.6	0.84	58	6610	10.9	7.8	215
08B	51	4.6	0.84	--	6360	---	--	---
07A	62	4.6	0.81	50	6240	11.1	7.8	222
07B	62	4.6	0.81	--	6250	---	--	---
06A	78	4.5	0.81	65	5750	10.4	7.5	213
06B	78	4.5	0.81	--	6400	---	--	---
05A	98	4.2	0.76	49	5340	10.6	7.8	214
05B	98	4.2	0.76	--	5020	---	--	---
04A	109	4.2	0.74	45	5290	10.9	7.8	219
04B	109	4.2	0.74	--	5200	---	--	---
03A	127	4.3	0.68	57	4700	11.1	7.8	214
03B	127	4.3	0.68	--	4450	---	--	---
02A	148	4.1	0.69	47	4770	10.6	7.8	214
02B	148	4.1	0.69	--	4310	---	--	---
01A	160	4.1	0.60	35	5060	10.7	7.7	211
01B	160	4.1	0.60	--	5790	---	--	---
REW	177	0.0	0.00	0	--	---	--	---

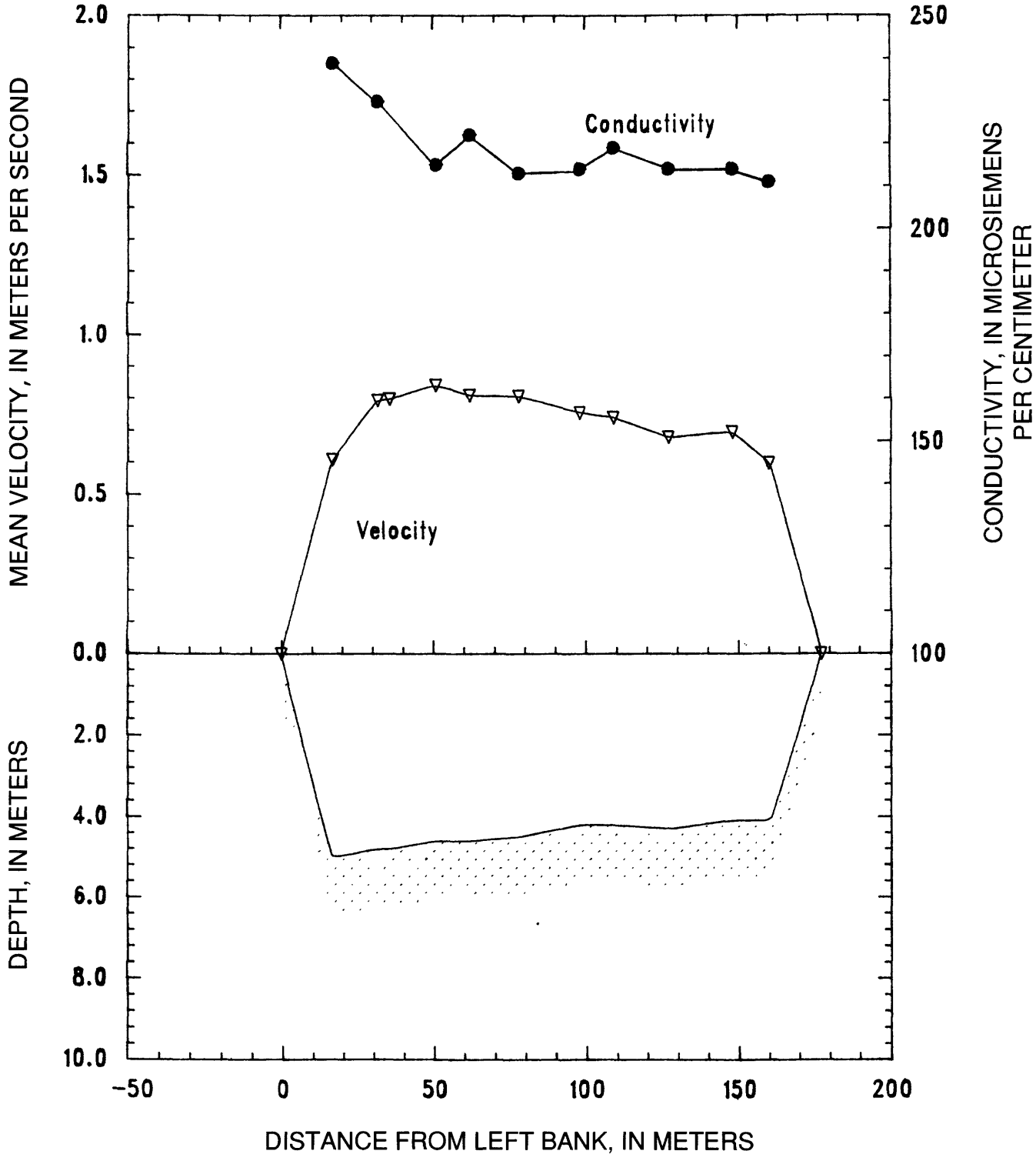

Figure 32. White River at Mile 11.5, Ark. on December 12, 1987.

STATION: Mississippi River above Arkansas City, Ark. 12-13-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
METER No: P8308282 DATE RATED: 4-12-88
REMARKS: It was very windy and raining. The transit rate was 12 cm/s and the nozzle was 3/16 inch. Only upcast velocities are listed. The total discharge was 9920 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
30B	32	3.4	0.26	26	370	8.2	8.0	455
29A	57	5.4	0.35	53	830	8.2	8.0	446
28B	88	8.5	0.66	169	1210	8.3	8.0	454
27A	117	9.8	0.78	226	1540	8.2	8.0	442
26B	147	12.1	0.87	256	2280	8.3	8.0	455
25A	166	11.5	0.87	131	3080	8.2	8.0	445
X15	173	11.5	1.04	137	--	---	--	---
X14	189	11.3	1.07	211	--	---	--	---
24B	208	11.7	1.23	280	3340	8.3	8.1	445
23A	228	10.4	1.35	315	3480	8.3	8.1	443
22B	253	10.8	1.29	445	4910	8.3	7.9	450
21A	292	11.2	1.23	304	3210	8.4	8.0	445
X13	297	11.8	1.11	170	--	---	--	---
20B	318	11.7	1.22	257	5630	8.3	7.9	448
X12	333	11.7	1.23	238	--	---	--	---
19A	351	11.6	1.45	294	4530	8.5	8.0	445
X11	368	12.2	1.32	257	--	---	--	---
18B	383	13.9	1.19	264	4820	8.5	8.0	448
X10	400	14.1	1.08	229	--	---	--	---
17A	413	14.9	1.03	246	5260	8.6	7.9	450
X09	432	15.6	1.16	299	--	---	--	---
16B	446	16.0	1.08	284	5260	8.7	8.0	455
X08	465	15.5	1.12	244	--	---	--	---
15A	474	15.3	1.09	226	4900	8.7	8.0	451
X07	492	15.0	1.10	248	--	---	--	---
14B	504	14.7	1.19	184	4040	8.7	8.0	454
X06	513	14.7	1.11	195	--	---	--	---
X05	528	14.5	1.18	231	--	---	--	---
X04	540	14.3	1.16	141	--	---	--	---
13A	545	14.5	1.08	110	4130	8.7	8.0	457
12B	554	14.1	1.17	222	4560	8.7	8.0	454
X03	572	13.3	1.04	207	--	---	--	---
11A	584	12.9	1.12	217	2980	8.8	8.0	454
X02	602	12.6	1.17	228	--	---	--	---
10B	615	12.6	1.00	221	3760	8.7	8.0	455
X01	637	12.5	1.06	252	--	---	--	---
09A	653	11.9	0.99	218	2880	8.8	8.0	454
08B	674	11.8	0.87	263	2240	8.8	8.0	457

STATION: Mississippi River above Arkansas City, Ark. 12-13-87
(continued)

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^{o}C)	pH	Conductivity (microsiemens/cm)
07A	704	11.7	0.86	236	2830	8.9	8.0	455
06B	721	11.5	0.93	298	1800	8.9	7.9	456
05A	760	11.0	0.69	246	1500	8.8	8.0	457
04B	786	11.1	0.78	263	1980	8.8	8.0	457
03A	821	10.6	0.60	208	1040	8.8	7.8	456
02B	851	8.9	0.48	127	840	8.8	8.0	456
01A	881	4.5	0.33	39	390	9.0	8.0	456
REW	904	0.0	0.00	0	--	---	--	---

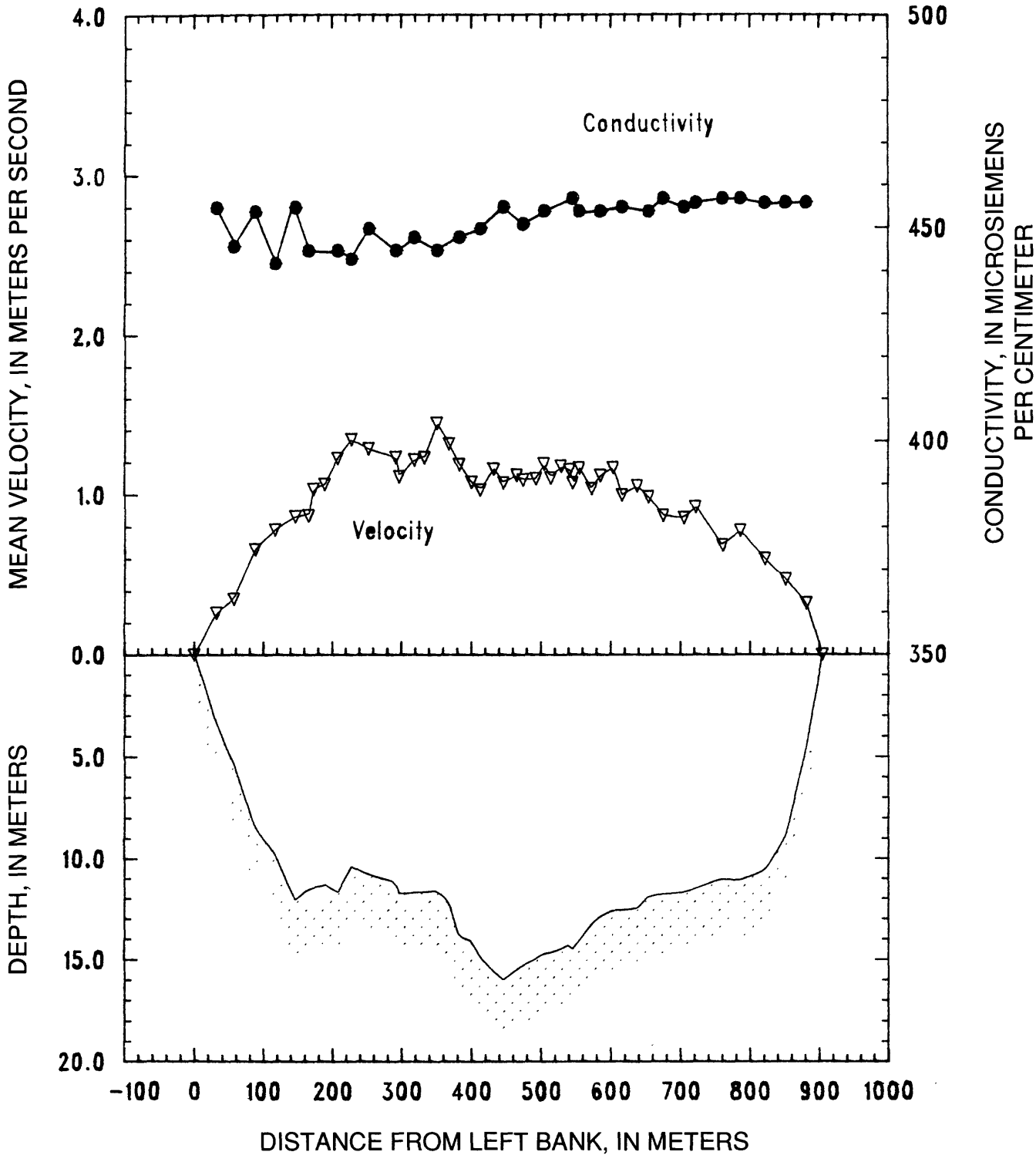

Figure 33. Mississippi River above Arkansas City, Ark. on December 13, 1987.

STATION: Yazoo River at Mile 10, Miss. 12-14-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING ARBITRARY GAGE HEIGHT: 0.20 m ENDING GAGE HEIGHT: 0.15 m
SUSP: Bag sampler and 150-lb weight
METER No: P8308282 DATE RATED: 14-7-88
REMARKS: Transit rate was 6 cm/s and there was no nozzle on the bag sampler. Only upcast velocities are listed. The total discharge was 177 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
01A	9	3.0	0.30	9	1050	12.3	6.8	83
01B	9	3.0	0.30	--	1860	--	--	--
02A	19	4.5	0.35	15	2240	12.3	6.8	85
02B	19	4.5	0.35	--	3950	--	--	--
03A	28	5.2	0.39	20	6150	12.3	6.8	88
03B	28	5.2	0.39	--	6160	--	--	--
04A	39	5.5	0.39	22	6350	12.7	6.8	86
04B	39	5.5	0.39	--	6480	--	--	--
05A	49	5.5	0.39	21	6390	12.5	6.9	83
05B	49	5.5	0.39	--	6070	--	--	--
06A	59	5.5	0.39	25	5480	12.4	6.9	81
06B	59	5.5	0.39	--	5900	--	--	--
07A	73	5.7	0.38	25	6230	12.4	6.7	86
07B	73	5.7	0.38	--	6280	--	--	--
08A	82	5.9	0.35	21	5250	12.5	6.9	82
08B	82	5.9	0.35	--	6180	--	--	--
09A	93	6.1	0.20	14	2230	12.3	6.9	83
09B	93	6.1	0.20	--	1530	--	--	--
10A	105	3.2	0.12	5	820	12.3	7.0	87
10B	105	3.2	0.12	--	510	--	--	--
REW	120	0.0	0.00	0	--	---	--	---

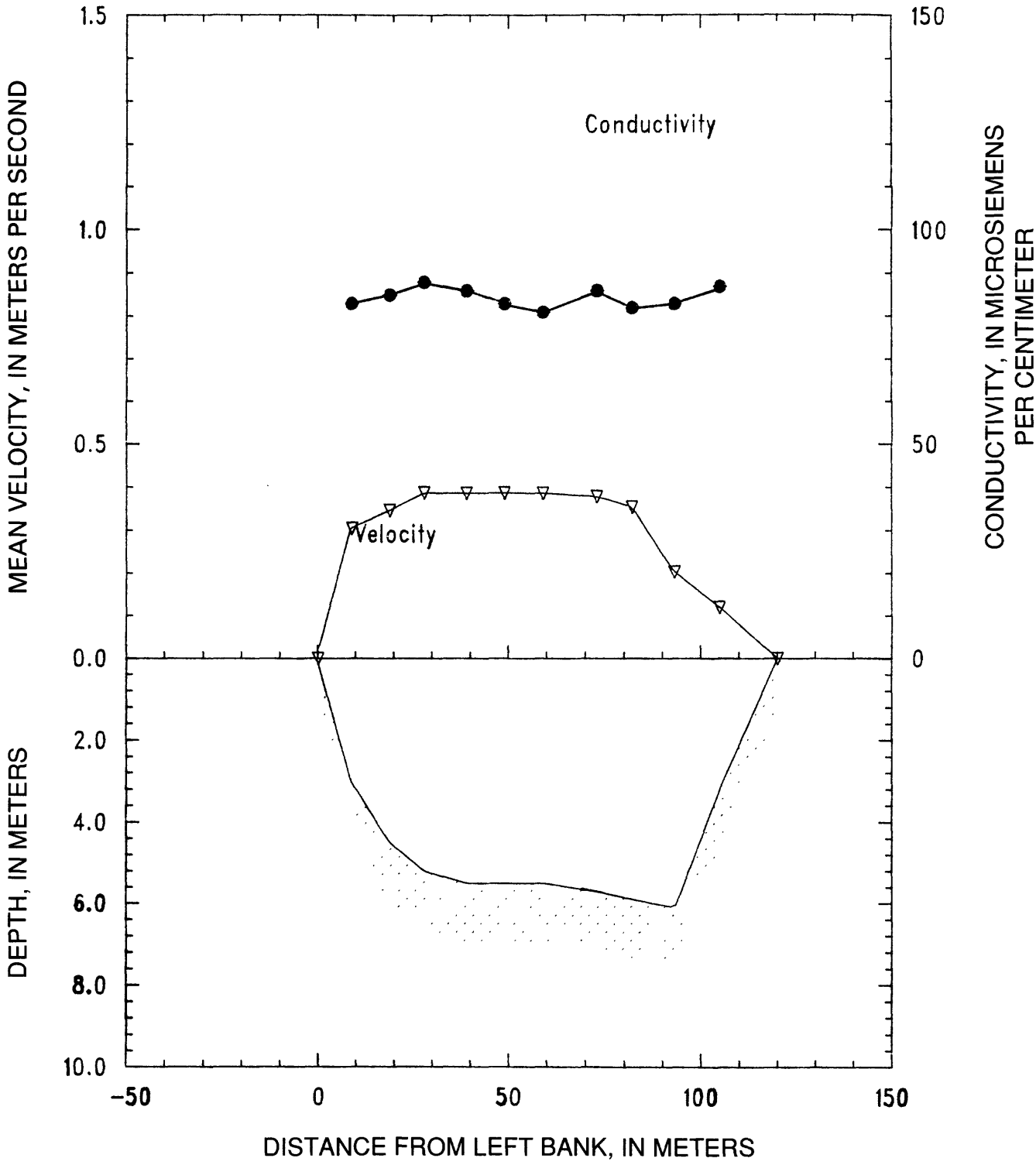

Figure 34. Yazoo River at Mile 10, Miss. on December 14, 1987.

STATION: Mississippi River below Vicksburg, Miss. 12-15-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 11.0 ft. ENDING GAGE HEIGHT:
SUSP: Bag sampler and 300-lb weight
METER No: P8308282 DATE RATED: 4-12-88
REMARKS: It was windy and cold. Transit rate was 12 cm/s and the nozzle was 3/16 inch. Only upcast velocities are listed. The total discharge was 10,410 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity[1] (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
01A	34	4.8	0.38	41	320	9.2	7.5	419
X01	45	6.6	0.47	42	--	---	--	---
02B	61	9.5	0.47	79	600	9.2	7.7	425
X02	80	12.3	0.80	207	--	---	--	---
03A	103	14.4	1.16	260	4980	8.9	7.6	419
X03	111	14.6	1.27	268	--	---	--	---
04B	132	14.3	1.28	365	4390	9.0	7.9	417
X04	151	13.7	1.32	208	--	---	--	---
05A	155	13.3	1.31	409	5020	9.1	7.8	433
X05	179	13.3	1.50	140	--	---	--	---
06B	198	13.6	1.35	221	4230	8.9	7.6	427
X06	212	13.6	1.47	449	--	---	--	---
07A	224	13.5	1.46	295	5340	9.1	7.5	431
X07	242	12.8	1.36	210	--	---	--	---
08B	248	13.1	1.50	344	4390	8.8	7.7	439
09A	277	13.2	1.47	659	4390	7.9	7.7	449
10B	316	12.5	1.36	552	4650	8.5	7.7	441
11A	342	11.7	1.37	464	3710	8.4	7.9	443
12B	374	10.6	1.34	406	3470	8.7	7.7	445
13A	399	10.9	1.23	423	3660	8.7	7.7	443
14B	437	10.4	1.16	432	3210	9.0	7.5	441
15A	471	10.2	1.36	404	3080	8.1	7.7	451
16B	495	10.2	1.04	302	2650	8.8	7.7	443
17A	528	10.1	1.03	321	2410	9.0	7.6	441
18B	557	10.0	1.07	326	2350	8.5	7.8	449
19A	589	9.3	1.03	318	2430	9.0	7.7	455
20B	623	8.9	1.11	320	2300	8.9	7.9	443
21A	654	8.8	1.13	283	2350	9.0	7.9	443
22B	680	8.8	0.95	267	2130	9.0	7.8	443
23A	718	8.0	0.98	275	1880	8.9	7.9	447
24B	750	7.6	0.79	160	1300	8.9	7.9	443
25A	771	6.6	0.85	162	1710	8.9	7.9	443
26B	808	5.7	0.76	141	1070	8.9	7.9	449
27A	836	5.5	0.75	132	710	9.0	7.9	449
28B	872	4.9	0.57	92	740	8.9	8.0	443
29A	902	4.3	0.55	70	480	9.0	7.9	447

STATION: Mississippi River below Vicksburg, Miss. 12-15-87
(continued)

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity[1] (microsiemens/cm)
30B	931	4.0	0.54	64	370	9.0	8.0	449
31A	961	3.3	0.58	63	350	8.9	7.9	447
32B	997	3.2	0.37	40	310	9.0	8.0	445
33A	1030	2.7	0.38	31	290	9.0	7.9	447
34B	1058	2.9	0.51	47	270	9.0	7.9	447
35A	1093	3.3	0.45	50	310	9.1	8.0	447
36B	1125	3.7	0.46	52	350	9.2	8.0	447
REW	1153	0.0	0.00	0	--	---	--	---

[1] It has been assumed that the conductivity measurements were made without the temperature compensation switch on. The original conductivity measurements made at the temperatures listed above have been corrected to 25^oC.

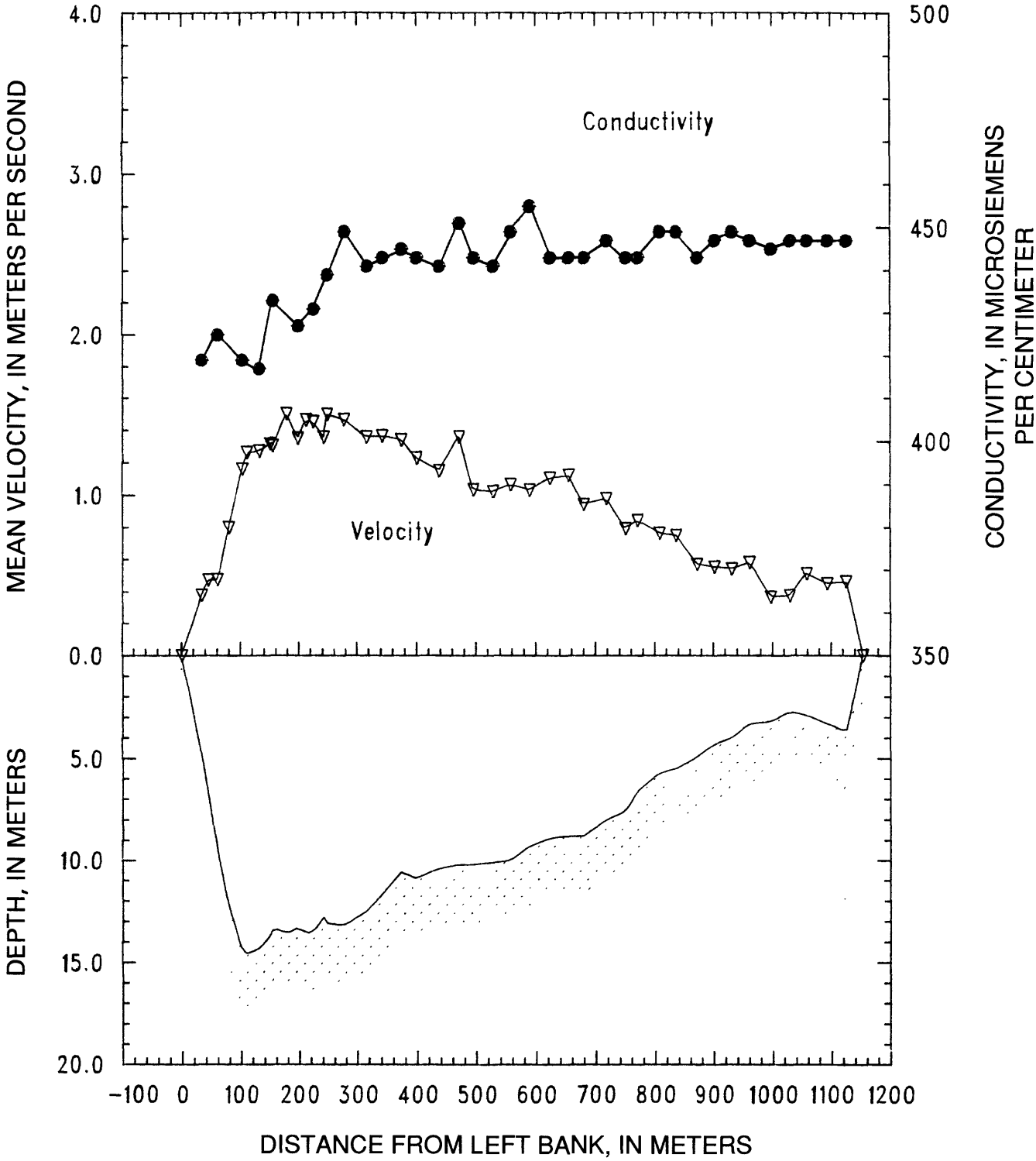

Figure 35. Mississippi River below Vicksburg, Miss. on December 15, 1987.

STATION: Old River Outflow Channel near Knox Landing, La. 12-17-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING ARBITRARY GAGE HEIGHT: 0.20 m ENDING GAGE HEIGHT: 0.13 m
SUSP: Bag sampler and 150-lb weight
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: Anchored at verticals 3,5 & 11 and the verticals were not occupied in numerical order. Transit rate was 9 cm/s and the nozzle was 5/16 inch. Only the upcast velocities are listed. The total discharge was 1830 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
X04	23	7.2	0.66	80	--	---	--	---
13B	34	7.1	0.65	55	4490	---	--	---
13A	47	7.3	0.70	75	4400	9.3	8.0	449
X03	63	7.4	0.69	61	--	---	--	---
12B	71	7.2	0.59	36	4530	---	--	---
12A	80	7.3	0.65	64	4440	9.1	8.0	455
X01	98	6.8	0.73	70	--	---	--	---
11B	108	6.9	0.66	--	7890			
11A	108	6.9	0.66	75	8190	9.1	8.1	455
X02	131	6.6	0.69	98	--	---	--	---
10B	151	6.4	0.71	--	3140	---	--	---
10A	151	6.4	0.71	134	3460	9.1	8.0	449
09B	190	6.5	0.65	--	3710	---	--	---
09A	190	6.5	0.65	132	3780	9.1	8.0	449
08A	213	6.2	0.63	70	3040	9.3	8.1	450
08B	226	6.3	0.60	74	3700	9.1	8.0	450
07B	252	5.9	0.61	58	5780	---	--	---
07A	258	6.0	0.54	68	5590	9.0	8.0	456
06A	294	5.3	0.67	74	2230	---	--	---
06B	300	5.1	0.60	52	2080	---	--	---
05B	328	4.7	0.55	--	2060	---	--	---
05A	328	4.7	0.55	92	1800	9.5	7.9	455
04B	371	4.9	0.58	--	2490	---	--	---
04A	371	4.9	0.58	118	2400	8.9	8.0	446
03B	410	5.2	0.57	--	4750	---	--	---
03A	410	5.2	0.57	106	4320	9.3	8.0	453
02A	442	5.3	0.63	66	2990	8.9	8.0	457
02B	450	5.1	0.60	65	2220	---	--	---
01B	485	5.0	0.57	--	3170	---	--	---
01A	485	5.0	0.57	107	2440	8.9	7.9	457
REW	525	0.0	0.00	0	--	---	--	---

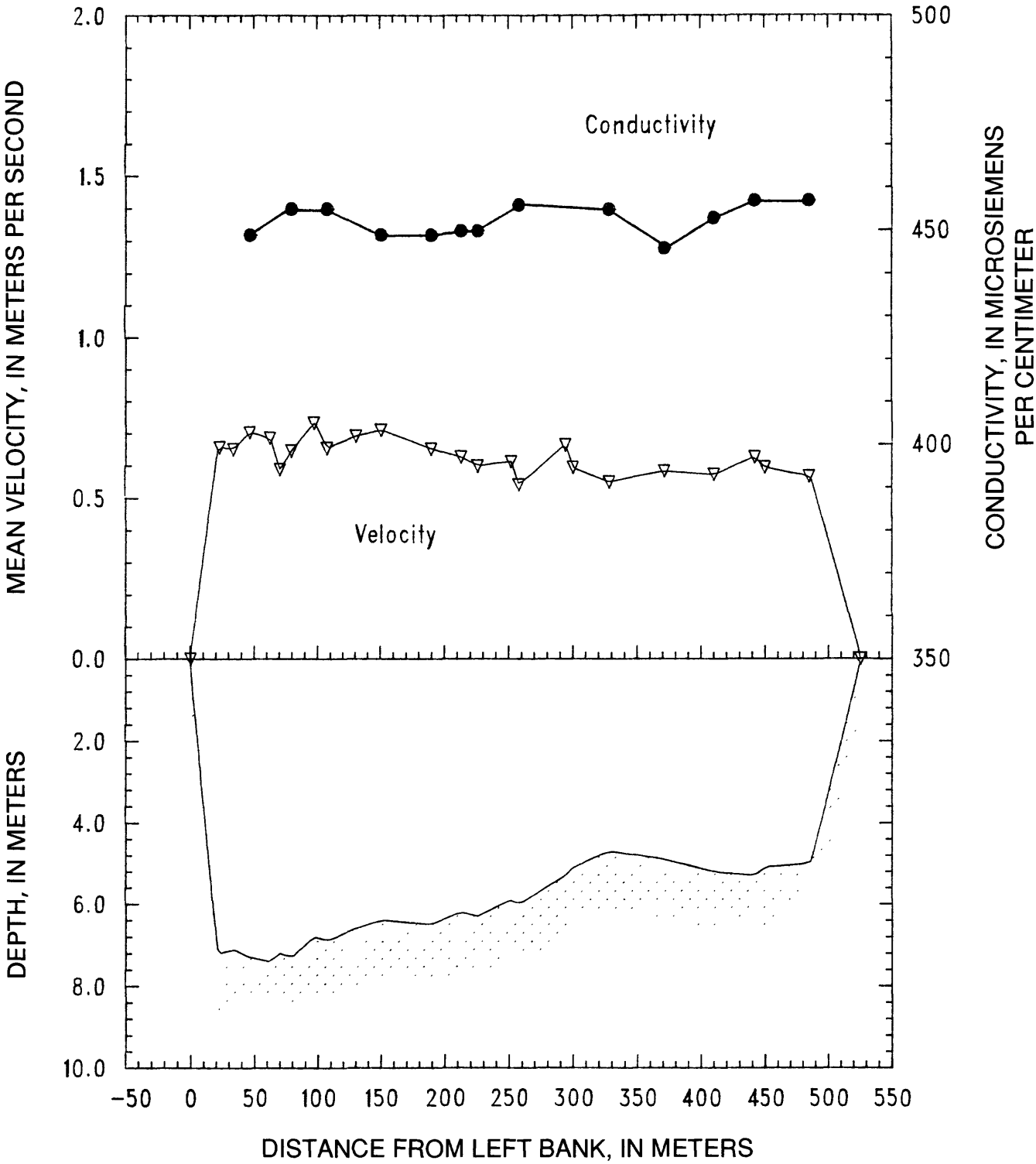

Figure 36. Old River Outflow Channel near Knox Landing, La. on December 17, 1987.

STATION: Mississippi River near St. Francisville, La. 12-18-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: Transit rate was 14 cm/s and the nozzle was 1/4 inch. Only the upcast velocities are listed. The total discharge was 8,180 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
32B	34	3.7	0.49	54	590	8.8	7.8	433
31A	60	4.3	0.63	74	830	8.8	7.8	435
30B	88	4.9	0.71	107	1270	8.8	7.8	433
29A	122	6.2	0.78	132	1580	8.8	7.8	434
28B	143	6.7	0.81	148	1800	8.8	7.8	435
27A	177	7.5	0.79	257	2060	8.8	7.8	444
26B	230	7.4	0.71	151	2390	8.7	8.0	445
25A	234	7.4	0.65	101	2190	8.8	7.8	435
24B	272	7.0	0.66	144	1920	8.7	8.1	447
23A	296	8.1	0.68	135	2090	8.7	8.1	435
22B	321	7.8	0.77	176	2200	8.7	7.9	435
21A	355	7.9	0.74	200	2410	8.7	7.9	439
20B	389	8.8	0.80	205	3200	8.7	7.9	436
19A	413	8.8	0.99	240	3010	8.7	7.9	437
18B	444	9.2	0.99	264	3500	---	--	---
17A	471	9.6	0.98	291	3400	8.7	7.9	435
16B	506	9.4	1.03	315	3930	8.6	7.9	437
15A	536	9.6	1.03	257	3570	8.6	7.9	443
14B	558	9.8	1.05	293	4180	8.6	7.9	434
13A	593	10.5	1.11	354	4910	8.6	7.9	431
12B	619	10.7	1.09	314	4520	8.6	7.9	436
11A	647	10.8	1.18	382	4830	8.6	7.8	445
10B	679	10.8	1.14	374	5120	8.7	7.7	441
09A	708	11.2	1.11	353	4870	8.7	7.7	445
08B	736	12.4	1.14	366	5190	8.7	7.7	435
07A	760	13.5	1.02	268	5080	8.7	7.7	435
X04	775	13.4	0.98	237	--	---	--	---
06B	796	13.7	0.99	190	5330	8.8	7.8	441
X03	803	14.0	0.98	199	--	---	--	---
05A	825	14.0	0.90	239	5670	8.8	7.8	445
X02	841	13.7	0.98	196	--	---	--	---
04B	854	13.3	0.96	153	4910	8.9	7.7	435
X01	865	13.2	0.91	161	--	---	--	---
03A	881	13.1	0.96	277	4430	8.9	7.7	435
02B	909	11.9	0.97	330	3990	8.9	7.7	445
01A	938	9.8	0.81	243	2940	---	--	---
REW	970	0.0	0.00	0	--	---	--	---

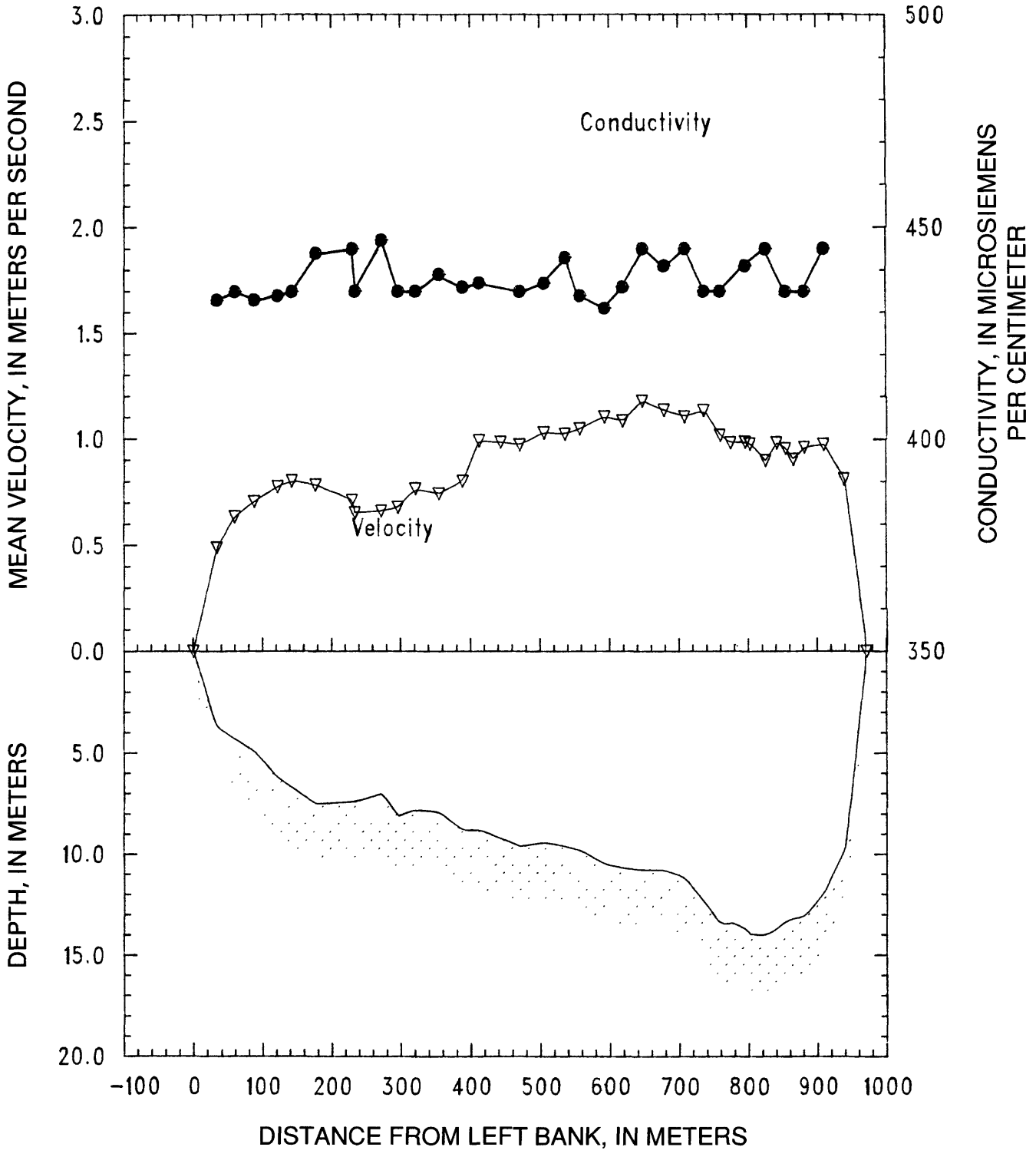

Figure 37. Mississippi River near St. Francisville, La. on December 18, 1987.

STATION: Mississippi River below Belle Chasse, La. 12-20-87
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: ENDING GAGE HEIGHT:
SUSP: Bag sampler and 150-lb weight
METER No: P8308282 DATE RATED: 4-7-88
REMARKS: Transit rate was 10 cm/s and the nozzle was 1/4 inch. Only the upcast velocities are listed. The total discharge was 9,560 m^3/s.

Vertical	Distance from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Sample volume (mL)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	---	--	---
20B	37	9.9	0.44	153	1330	12.3	7.9	497
19A	70	15.2	0.49	258	2660	12.3	7.9	495
18B	106	19.8	0.60	466	4620	11.4	7.9	495
17A	148	21.3	0.66	566	6000	11.9	7.8	497
16B	186	21.3	0.71	664	6620	17.0	7.9	495
15A	236	22.8	0.73	629	6820	17.0	7.9	492
14B	262	24.3	0.72	554	6790	16.6	7.9	491
13A	299	24.3	0.65	572	4430	16.6	7.9	487
12B	335	23.8	0.68	617	6370	16.6	7.9	489
11A	375	24.2	0.69	386	--	---	--	---
11A	381	23.9	0.68	219	5380	16.6	7.9	489
10B	402	23.6	0.66	496	6490	11.3	7.8	497
09A	445	24.0	0.65	652	5950	12.7	8.0	494
08B	485	23.6	0.62	569	5540	13.0	8.0	495
07A	523	23.0	0.57	446	5090	11.5	8.0	494
06B	553	22.8	0.57	430	4810	11.5	7.6	497
05A	589	23.2	0.52	475	4020	11.0	8.0	495
04B	631	23.1	0.50	482	4880	10.7	8.0	495
03A	672	21.2	0.50	374	3980	11.3	8.0	500
02B	702	21.4	0.50	305	4020	11.3	8.0	499
01A	729	15.6	0.42	245	3110	11.3	8.0	497
REW	776	0.0	0.00	0	--	---	--	---

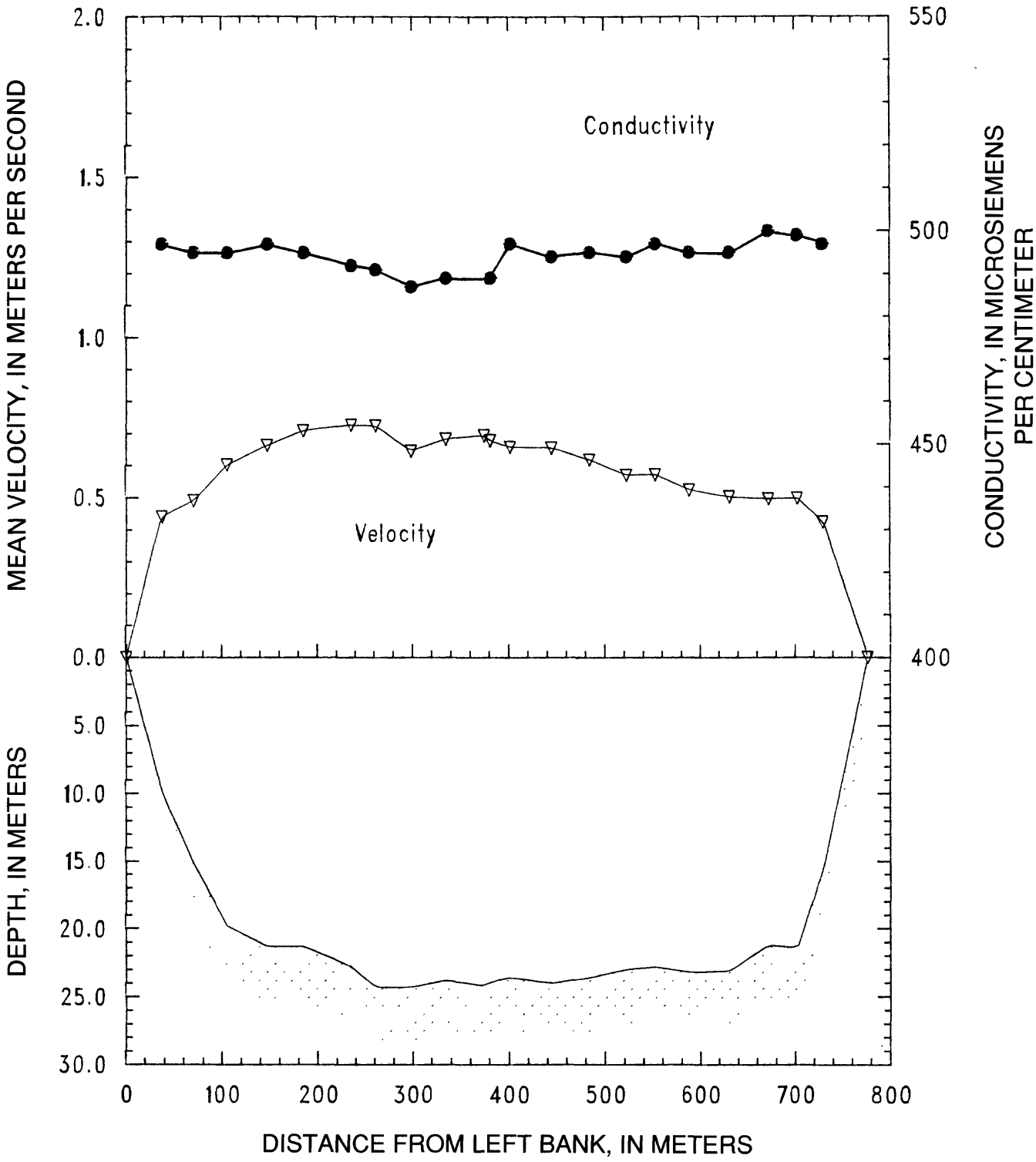

Figure 38. Mississippi River below Belle Chasse, La. on December 20, 1987.

DATA LISTINGS
FOR
MAY 16 - JUNE 7, 1988
CRUISE

STATION: Mississippi River near Winfield, Mo. 5-17-88
PARTY: Black, Moody, and Rees METER: SOLID CUP
STARTING GAGE HEIGHT: 422.33 ft ENDING GAGE HEIGHT: 422.33 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 4 cm/s and the nozzle was 1/4 inch. The total discharge was 1740 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH[1]	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	30	7.2	0.46	64	2060	11	20.6	8.5	422
02B	39	7.3	0.46	28	1880	21	20.2	8.3	419
03A	47	8.2	0.57	72	5090	26	20.2	8.5	420
04B	70	8.6	0.68	108	6410	27	20.4	8.6	417
05A	84	8.4	0.71	124	6290	28	20.6	8.6	417
06B	112	8.0	0.67	118	6120	27	20.2	8.6	415
07A	128	8.2	0.68	116	6280	27	20.8	8.5	416
08B	154	7.9	0.64	86	5060	27	20.7	8.5	414
09A	162	7.8	0.63	41	5740	25	19.8	8.1	413
10B	171	7.8	0.63	54	4400	24	21.2	7.5	415
10C	184	7.6	0.55	54	--	--	--	--	---
11A	197	7.4	0.57	72	4810	23	21.6	8.3	416
12B	218	7.0	0.60	83	4390	23	21.8	8.2	416
13A	236	6.8	0.57	60	4240	20	21.1	8.3	417
14B	249	6.5	0.59	59	3600	20	21.2	8.3	419
15A	267	6.5	0.55	68	3980	19	22.6	8.3	424
16B	287	6.1	0.50	46	--	--	--	--	---
16R	297	6.0	0.49	41	2850	17	22.3	8.2	425
17A	315	5.6	0.50	41	2350	15	21.4	8.2	428
18B	326	5.4	0.53	26	1960	13	21.4	8.2	421
19A	333	5.3	0.48	43	2500	13	22.3	8.3	429
20B	360	4.8	0.46	54	1650	11	21.2	8.4	424
21A	382	4.6	0.47	49	2040	11	23.0	8.4	424
22B	405	4.5	0.49	29	1220	10	22.6	8.4	418
23A	408	4.3	0.50	25	1940	9	22.4	8.4	427
24B	428	4.0	0.53	34	1180	8	22.6	8.4	423
25A	440	4.0	0.45	32	1410	8	21.5	8.3	425
26B	463	3.8	0.42	29	1120	9	21.2	8.3	418
27A	476	3.8	0.37	27	1170	8	22.0	8.3	425
28B	501	3.7	0.35	24	860	6	21.8	8.3	428
29A	514	4.0	0.28	17	340	8	22.6	8.3	433
30B	531	3.8	0.29	18	680	7	22.2	8.3	425
REW	547	0.0	0.00	0	--	--	--	--	---

[1]pH meter drifted so that the pH values have been corrected by linear interpolation between five readings in a standard pH 7 buffer solution.

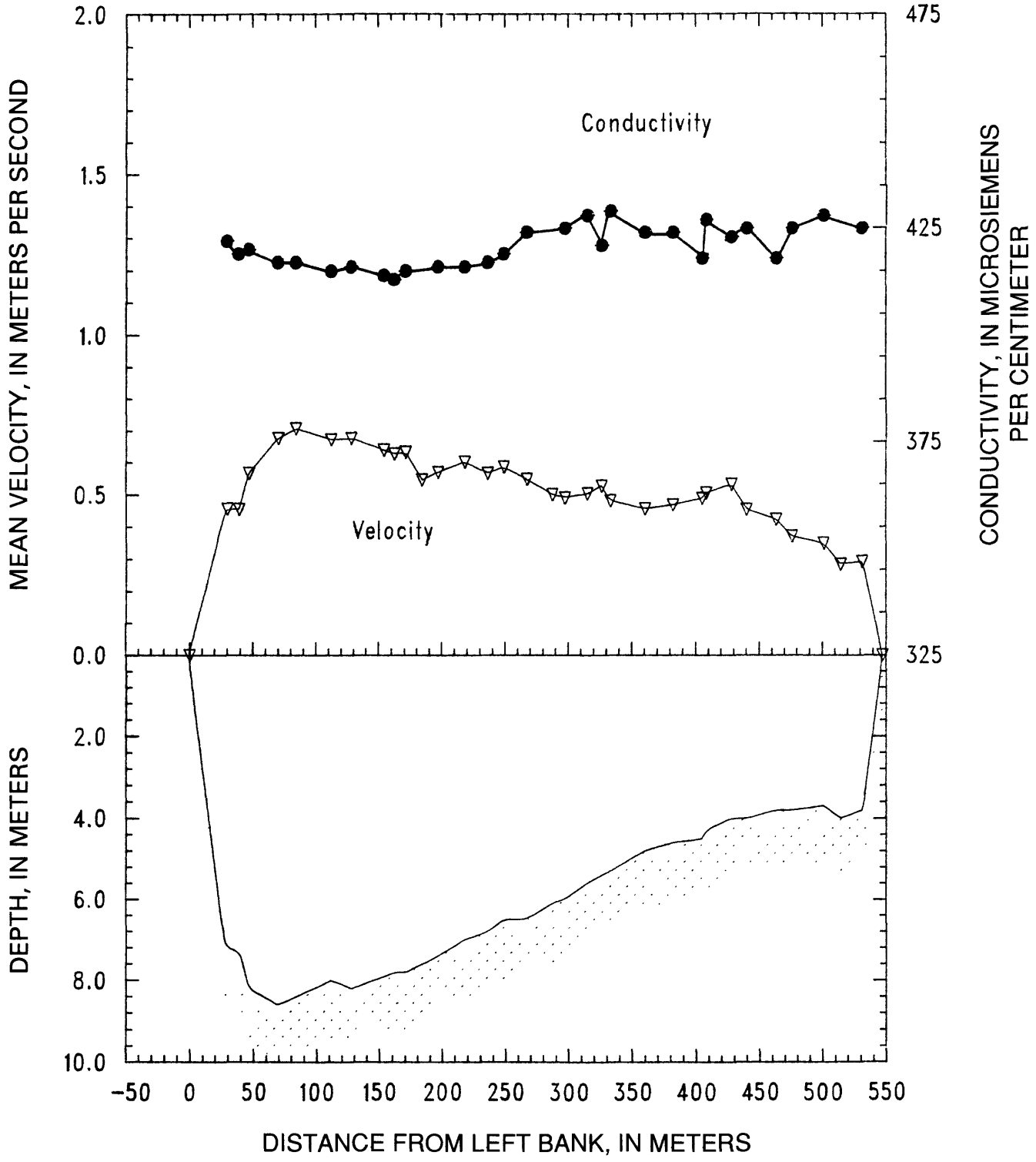

Figure 39. Mississippi River near Winfield, Mo. on May 17, 1988.

STATION: Illinois River below Meredosia, Ill. 5-16-88
PARTY: Black, Moody, and Rees METER: SOLID CUP
STARTING GAGE HEIGHT: 422.08 ft ENDING GAGE HEIGHT: 421.96 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 7 cm/s and no nozzle was used in the sampling bottle The vessel was anchored at each vertical in the following order: 14,13,12, 1+2+3, 11,10,9,4,16,15,17,18, 19+20, 5,6,7, and 8. The total discharge was 332 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH[1]	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
03B	30	2.2	0.22	10	2780	11	21.7	8.2	759
04A	44	1.9	0.37	8	3490	6	22.3	8.1	760
05B	52	2.0	0.29	7	3060	7	22.6	8.0	754
06A	68	2.8	0.35	12	5770	15	22.6	8.1	755
07B	76	3.2	0.41	9	6500	20	22.6	8.1	751
08A	82	3.3	0.40	13	7440	22	22.9	8.3	762
09B	96	5.0	0.49	31	8590	37	22.3	7.9	767
10A	107	5.4	0.43	29	12660	41	21.7	8.0	764
11B	121	5.7	0.47	31	11070	41	21.7	8.0	759
12A	130	5.6	0.43	28	13570	44	21.7	8.1	748
13B	144	6.0	0.44	33	10000	48	21.7	8.2	747
14A	155	6.1	0.41	30	12260	48	21.6	8.4	746
15B	168	5.8	0.46	22	11200	45	22.3	8.1	751
16A	172	5.7	0.39	21	11810	44	21.9	7.9	759
17B	187	4.9	0.39	23	6870	37	22.4	7.9	750
18A	196	3.7	0.33	10	5320	11	22.6	7.9	768
19B	204	2.5	0.38	15	4190	15	22.5	8.0	753
REW	228	0.0	0.00	0	--	--	--	--	---

[1]pH meter drifted so that the pH values have been corrected by linear interpolation between an initial and final calibration reading in a standard pH 7 buffer solution.

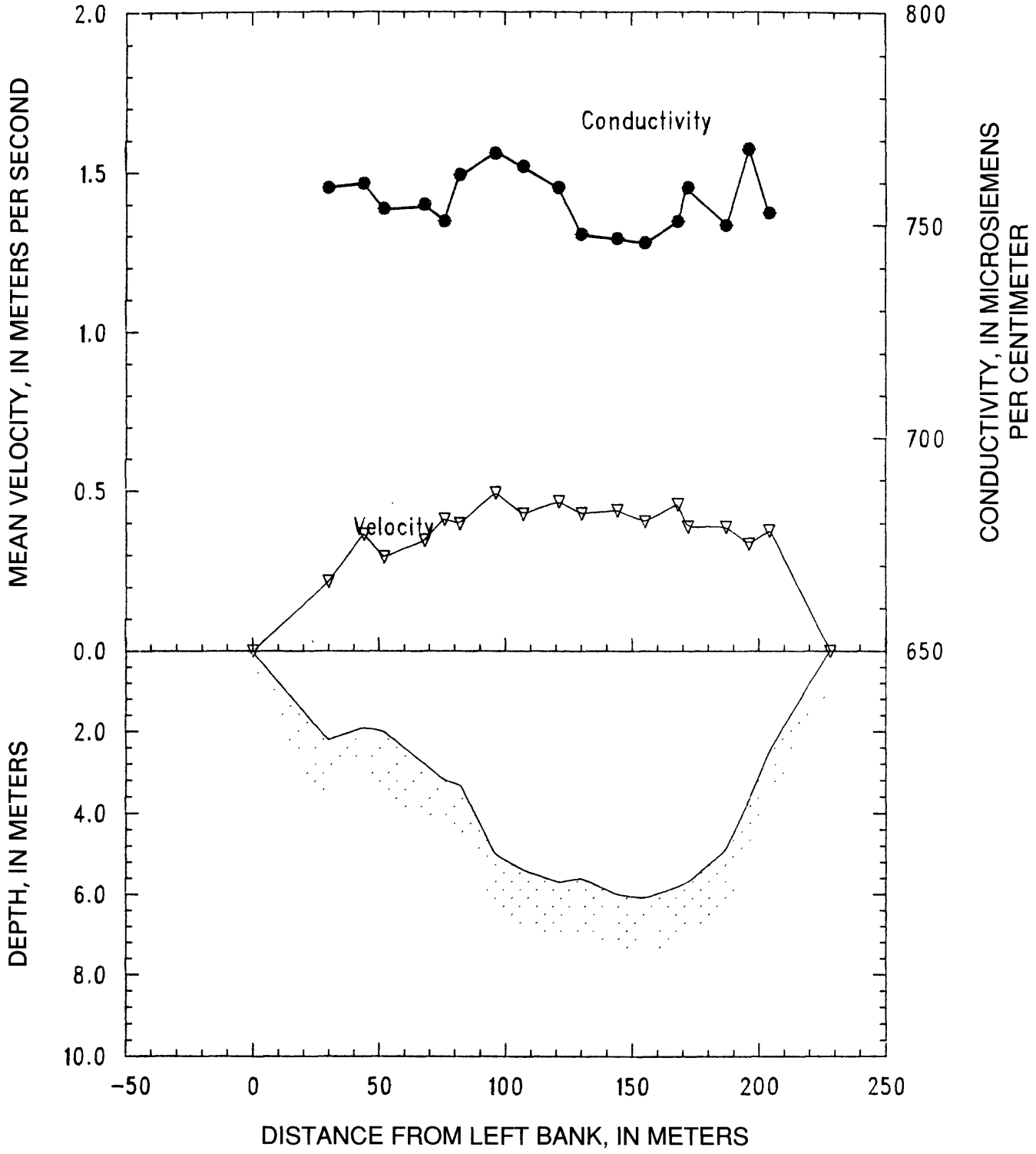

Figure 40. Illinois River below Meredosia, Ill. on May 16, 1988.

STATION: Missouri River at Hermann, Mo. 5-19-88
PARTY: Black, Moody, and Rees METER: SOLID CUP
STARTING GAGE HEIGHT: 8.5 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 12 cm/sec and the nozzle was 5/16 inch. Verticals were occupied in the following order: 1-12,15,13, 18,19,21-23,26,25,29,30,28, 27,24,14,16,17,20. The total discharge was 1480 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH[1]	Conductivity (micro-siemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	13	6.7	0.26	23	1640	34	20.7	8.3	700
02B	27	6.1	1.02	56	4460	21	21.0	8.3	725
02R	31	6.1	1.07	29	--	--	--	--	---
03A	36	5.8	1.11	39	4450	25	21.7	8.3	749
X01	43	5.7	1.18	37	--	--	--	--	---
04B	47	5.8	1.00	29	4980	24	21.6	8.3	744
X02	53	5.5	0.99	25	--	--	--	--	---
05A	56	5.3	0.95	30	3910	21	21.7	8.3	745
X03	65	5.3	1.16	43	--	--	--	--	---
06B	70	5.2	1.32	45	5020	22	21.7	8.2	741
X04	78	5.3	1.03	33	--	--	--	--	---
07A	82	5.4	0.87	30	3970	21	21.7	8.2	739
08B	91	5.1	1.09	41	4940	22	21.9	8.1	727
X06	97	4.9	1.29	37	--	--	--	--	---
09A	103	4.9	1.08	45	4460	19	21.7	8.2	729
X07	114	4.8	1.09	37	--	--	--	--	---
10B	117	4.9	0.90	15	4000	20	21.8	8.2	722
X08	121	4.9	1.11	25	--	--	--	--	---
11A	126	4.7	1.01	31	4060	20	21.8	8.1	707
X09	134	5.0	1.11	36	--	--	--	--	---
12B	139	4.8	1.07	44	4590	18	21.7	8.2	696
13A	151	5.1	1.02	49	4280	21	22.0	8.2	684
14B	158	5.3	1.16	52	4340	26	22.3	8.3	680
15A	168	5.3	1.04	72	3680	20	21.8	8.2	668
16B	184	5.3	1.06	85	4290	21	22.4	8.3	681
17A	198	4.9	1.12	98	3750	21	22.2	8.3	660
18B	220	4.5	1.05	100	4090	22	22.0	8.2	663
19A	220	4.5	1.05	--	2780	16	21.9	8.2	650
20B	240	3.7	1.14	74	3260	12	22.2	8.3	647
21A	240	3.7	1.14	--	2790	12	21.9	8.2	638
22B	255	3.2	1.09	35	2310	10	21.9	8.2	642

STATION: Missouri River at Hermann, Mo. 5-19-88
(continued)

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH[1]	Conductivity (microsiemens/cm)
23R	260	2.7	0.89	12	--	--	--	--	---
23A	265	2.7	0.93	19	1210	7	21.9	8.2	636
24B	275	2.4	0.63	20	1360	6	22.3	8.2	660
25A	291	2.5	0.73	29	1440	5	22.2	8.2	638
26B	291	2.5	0.73	--	1100	7	22.1	8.3	636
27A	307	2.8	0.83	34	1320	7	22.4	8.3	648
28B	320	2.7	0.66	21	620	7	22.2	8.3	640
29A	330	2.9	0.52	15	1020	7	22.1	8.2	636
30B	340	3.1	0.46	14	730	9	22.2	8.3	644
REW	350	0.0	0.00	0	--	--	--	--	---

[1]pH meter drifted so that the pH values have been corrected by linear interpolation between three readings in a standard pH 7 buffer solution.

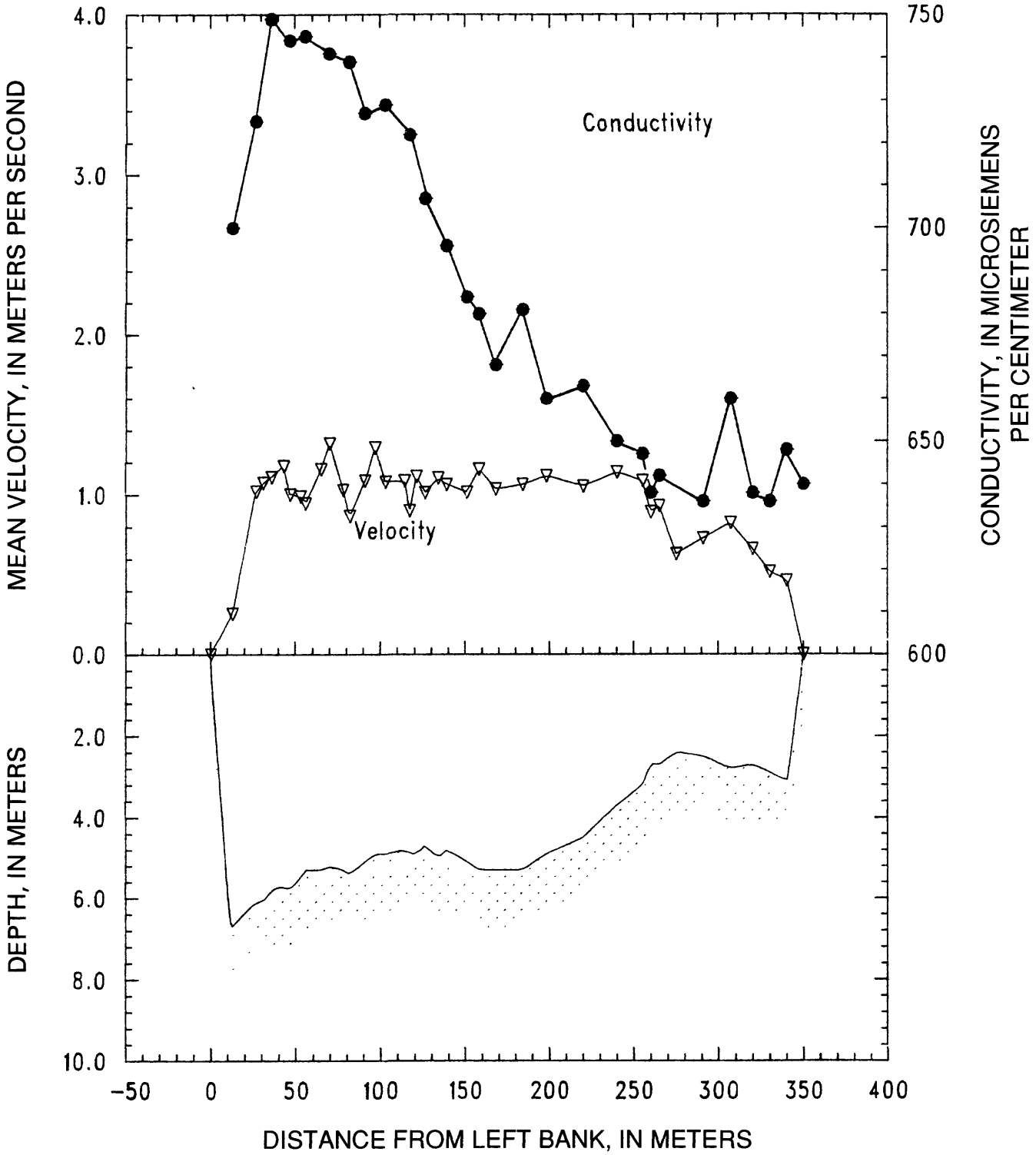

Figure 41. Missouri River at Hermann, Mo. on May 19, 1988.

STATION: Mississippi River at St. Louis, Mo. 5-20-88
PARTY: Black, Moody, and Rees METER: PLASTIC CUP
STARTING GAGE HEIGHT: 6.75 ft ENDING GAGE HEIGHT: 6.25 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 11 cm/sec and the nozzle was 1/4 inch. Total discharge was 3350 m^3/s. Verticals were occupied in the following order: 1-14,16,18-21,23-29,22,17,15 and 5.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	16	10.7	0.68	102	5030	20	22.1	8.6	513
X01	28	10.2	0.91	88	--	--	--	--	---
02B	35	10.1	1.10	83	5750	20	22.1	8.6	502
X02	43	10.1	1.18	95	--	--	--	--	---
03A	51	10.0	1.18	82	5670	20	22.2	8.5	499
X03	57	10.0	1.16	87	--	--	--	--	---
04B	66	10.0	1.24	75	6030	20	22.5	8.5	504
X04	69	10.0	1.16	46	--	--	--	--	---
05A	74	10.0	1.16	98	6090	20	23.2	8.3	524
X05	86	9.8	1.20	124	--	--	--	--	---
06B	95	9.7	1.19	87	5720	19	22.6	8.5	516
X06	101	9.5	1.13	70	--	--	--	--	---
07A	108	9.4	1.14	85	5340	17	22.6	8.5	519
X07	117	9.2	1.15	89	--	--	--	--	---
08B	125	9.5	1.12	58	5460	16	22.6	8.5	526
X08	128	8.7	1.11	82	--	--	--	--	---
09A	142	8.4	1.17	147	4470	15	22.9	8.4	522
10B	158	7.8	1.04	130	4460	14	22.9	8.4	533
11A	174	7.4	1.11	140	3840	12	22.7	8.4	544
12B	192	6.8	1.16	130	4110	11	23.0	8.3	567
13A	207	6.6	0.90	92	3100	10	22.8	8.4	579
14B	223	6.6	1.03	135	3490	10	23.2	8.2	585
15A	247	6.0	1.15	124	2980	9	23.7	8.1	580
16B	259	5.7	0.99	56	2720	9	22.8	8.3	584
17A	267	5.7	1.01	72	3080	9	23.1	8.2	602
18B	284	5.9	0.98	95	3250	8	23.1	8.3	619
19A	300	5.6	1.10	89	2700	8	23.1	8.1	622
20B	313	5.5	1.09	60	2570	9	22.8	8.1	612
21A	320	5.5	0.93	74	2490	7	22.8	8.2	607
22B	342	5.4	1.06	131	2710	8	23.3	8.1	631
23A	366	5.3	0.63	51	1830	7	23.1	8.1	643
24B	372	5.3	0.86	66	2310	7	23.0	8.1	641
25A	395	5.5	0.76	92	2440	7	23.2	8.0	646
26B	416	5.6	1.02	88	2290	7	23.3	8.0	651
27A	426	5.6	0.91	59	2310	7	23.2	8.0	662
28B	439	5.6	0.82	62	2260	8	23.2	7.9	671
29A	453	5.8	0.74	103	2320	8	23.3	7.9	669
REW	487	0.0	0.00	0	--	--	--	--	---

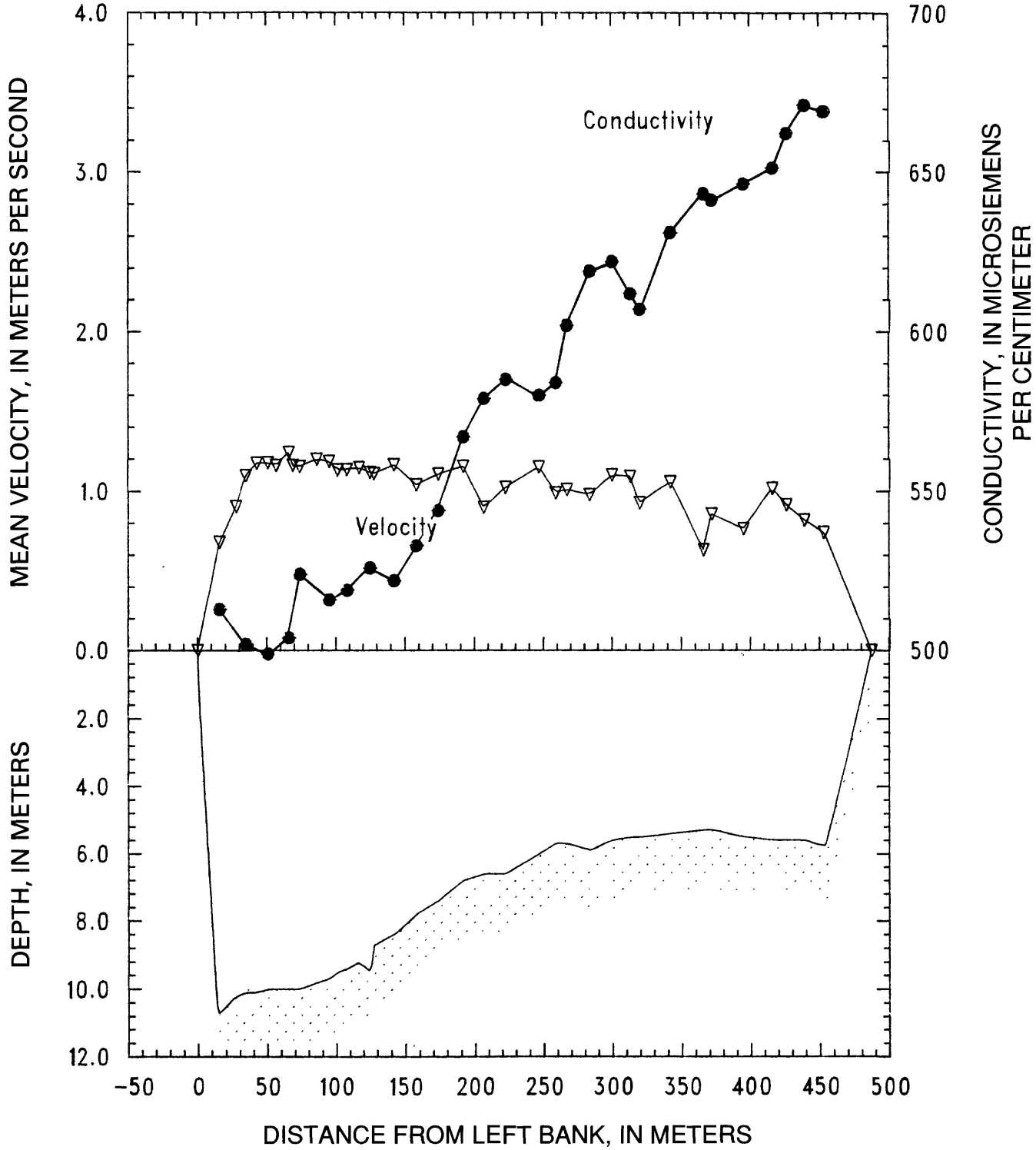

Figure 42. Mississippi River at St. Louis, Mo. on May 20, 1988.

STATION: Mississippi River at Thebes, Ill. 5-22-88
PARTY: Simoneaux, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 10 cm/sec and the nozzle was 1/4 inch. Total discharge was 3590 m^3/s. Verticals were occupied in the following order: 30-1. Cable broke between verticals 14A and 13B but nothing was lost!

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (micro-siemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01B	22	4.0	0.62	36	1400	4	22.8	8.2	575
02A	29	4.7	0.79	54	2010	12	22.9	8.2	578
03B	51	6.4	0.76	108	2360	14	23.0	8.3	578
04A	73	6.4	1.14	153	3330	13	23.0	8.3	586
05B	93	6.7	1.18	103	3580	12	23.1	8.2	582
06A	99	6.9	1.25	143	4230	15	23.1	8.2	581
07B	126	6.6	1.37	191	4350	15	23.0	8.2	577
08A	141	6.8	1.40	157	4900	14	23.1	8.2	593
09B	159	6.9	1.19	90	4530	15	23.2	8.2	587
10A	163	6.8	1.29	101	4040	15	23.2	8.2	588
11B	182	6.6	1.29	161	4840	15	23.1	8.2	580
12A	201	6.4	1.39	134	4170	14	23.1	8.2	594
13B	212	6.7	1.23	165	4150	15	22.7	8.2	584
14A	241	6.8	1.15	179	4260	14	22.8	8.2	580
15B	258	6.9	1.15	151	4360	17	22.7	8.3	577
16A	279	7.2	0.96	97	3830	15	22.7	8.3	580
17B	286	7.2	1.07	54	--	--	--	--	---
17B	293	7.4	1.20	75	3700	15	22.7	8.3	581
X10	303	7.4	1.28	71	--	--	--	--	---
18A	308	7.3	1.15	51	5020	15	22.8	8.3	582
X07	315	7.6	1.13	77	--	--	--	--	---
19B	326	7.8	1.12	92	4540	18	22.5	8.2	575
X06	336	7.7	1.17	76	--	--	--	--	---
20A	343	7.8	1.16	86	4720	18	22.8	8.3	586
X05	355	8.3	1.48	105	--	--	--	--	---
21B	360	8.1	1.16	57	5690	19	23.0	8.2	578
X04	367	8.4	1.12	66	--	--	--	--	---
22A	374	8.4	1.06	71	4870	21	23.0	8.2	577
X03	383	7.8	1.12	74	--	--	--	--	---
23B	391	7.5	1.18	53	4770	18	23.0	8.2	588
X02	395	7.1	1.10	51	--	--	--	--	---

STATION: Mississippi River at Thebes, Ill. 5-22-88
(continued)

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature ($^{\circ}C$)	pH	Conductivity (microsiemens/cm)
X01	404	6.5	1.16	72	--	--	--	--	---
24A	414	6.3	1.27	76	4000	15	22.9	8.2	583
25B	423	5.6	1.13	83	4530	12	22.9	8.2	592
26A	440	4.8	1.19	103	2780	8	22.7	8.2	587
27B	459	4.3	1.17	78	2780	7	22.8	8.3	591
28A	471	3.9	1.27	34	2100	7	22.9	8.3	584
29B	473	3.8	1.15	88	2120	6	23.0	8.3	582
30A	511	4.3	0.15	17	250	6	22.8	8.3	590
REW	525	0.0	0.00	0	--	--	--	--	---

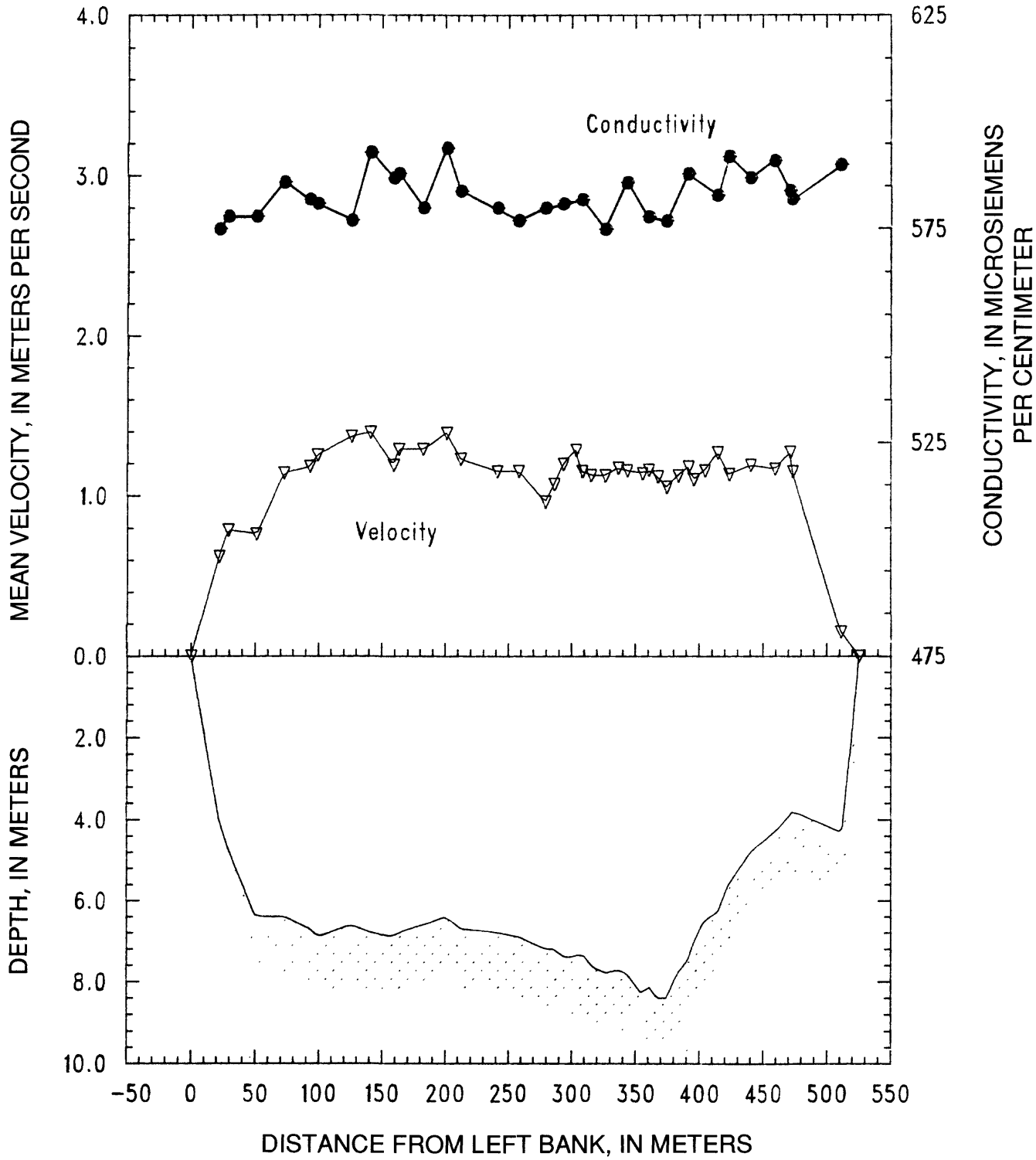

Figure 43. Mississippi River at Thebes, Ill. on May 22, 1988.

STATION: Ohio River at Olmsted, Ill. 5-23-88
PARTY: Simoneaux, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 16.3 ft ENDING GAGE HEIGHT: 16.0 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 6 cm/s and the nozzle was 5/16 inch. Anchored at each vertical in the following order: 1-30. The total discharge was 3230 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
30B	115	2.0	0.22	36	290	2	23.7	8.2	348
29A	160	2.8	0.23	23	410	3	23.2	8.3	347
28B	186	3.5	0.27	25	510	3	22.9	8.3	349
27A	212	3.9	0.40	42	1070	4	23.2	8.3	352
26B	240	4.5	0.45	52	1630	5	23.8	8.2	355
25A	263	4.8	0.42	50	1710	6	23.0	8.2	354
24B	289	5.1	0.44	64	2480	7	22.8	8.3	356
23A	320	5.4	0.49	68	2470	8	22.9	8.3	352
22B	340	5.3	0.53	70	2850	8	22.9	8.3	353
21A	370	5.7	0.59	109	3320	9	23.0	8.3	353
20B	405	5.3	0.55	85	4200	10	22.7	8.3	354
19A	428	6.7	0.59	97	4060	12	22.4	8.4	362
18B	454	7.1	0.68	126	5240	13	22.2	8.4	360
17A	480	7.7	0.62	137	5430	14	21.8	8.4	364
16B	511	7.7	0.63	119	5270	14	21.6	8.4	364
15A	529	8.0	0.61	141	5800	15	21.6	8.4	364
14B	569	7.8	0.72	151	6280	15	21.6	8.4	372
13A	583	8.3	0.67	118	6330	13	21.9	8.4	371
12B	612	7.2	0.68	138	5330	14	21.9	8.4	379
11A	639	7.5	0.71	158	5590	14	22.0	8.4	385
10B	671	8.0	0.71	167	6560	15	21.7	8.3	365
09A	698	8.3	0.65	141	5830	17	21.7	8.4	381
08B	723	8.7	0.69	164	6910	17	21.8	8.4	383
07A	753	8.3	0.67	142	6390	16	21.6	8.4	382
06B	774	8.3	0.64	107	5570	17	21.4	8.4	385
05A	793	8.5	0.68	177	6100	17	21.7	8.3	388
04B	835	8.3	0.73	188	6780	17	21.9	8.3	390
03A	855	8.4	0.65	120	6740	17	21.7	8.2	389
02R	879	8.7	0.50	105	--	--	--	--	---
02B	903	8.8	0.35	46	4300	18	21.7	8.2	389
01A	909	8.4	0.37	65	1820	12	22.2	8.2	389
REW	945	0.0	0.00	0	--	--	--	--	---

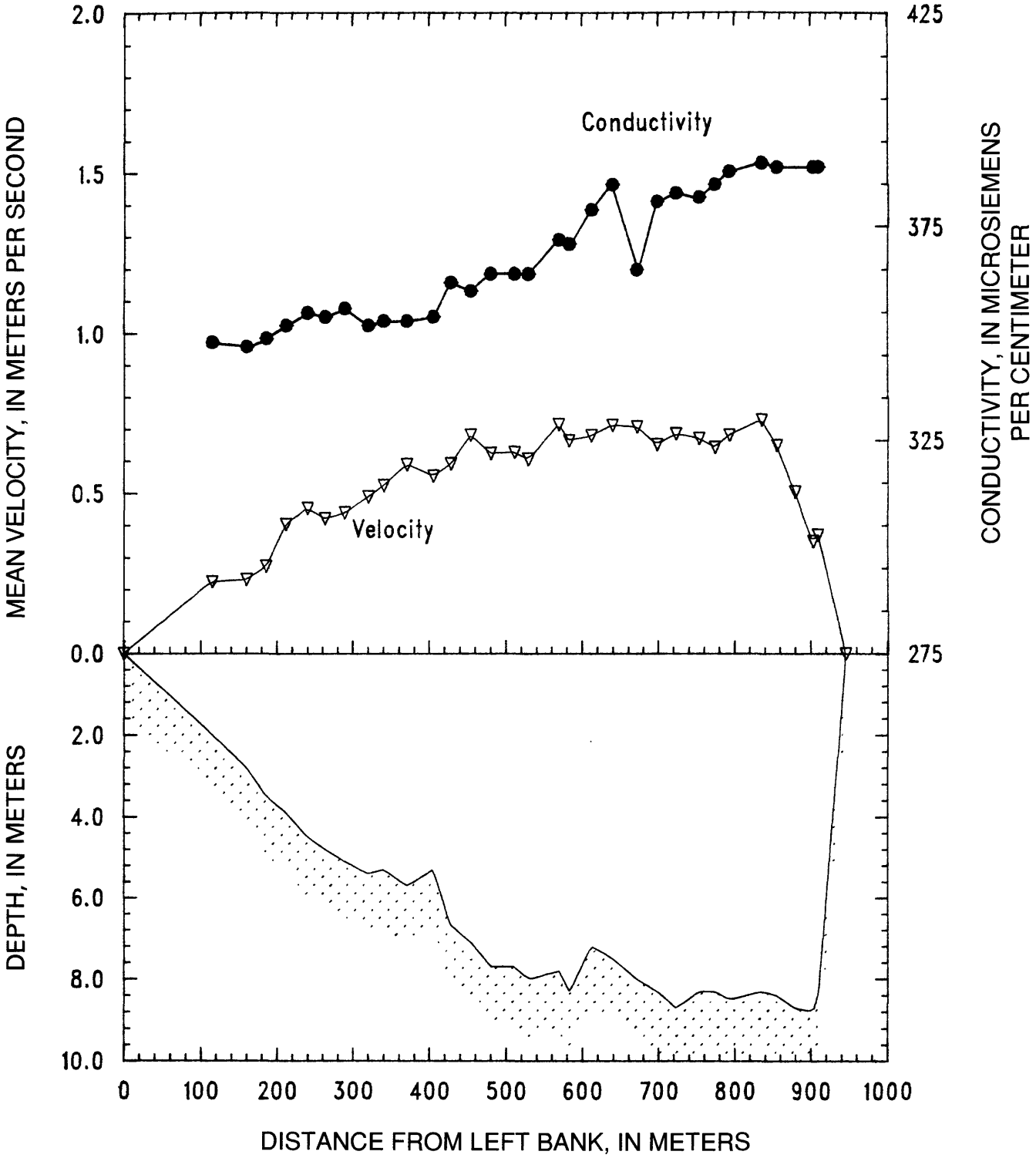

Figure 44. Ohio River at Olmsted, Ill. on May 23, 1988.

STATION: Mississippi River below Hickman, Ky. 5-24-88
PARTY: Simoneaux, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 10.17 ft ENDING GAGE HEIGHT: 10.5 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 11 cm/s and the nozzle was 1/4 inch. The total discharge was 6790 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01R	35	5.9	1.04	153	--	--	--	--	---
01A	50	6.4	0.94	138	2140	14	22.1	8.1	439
02B	81	7.2	1.21	239	3750	18	22.3	8.1	440
03A	105	7.2	1.24	218	3920	18	22.1	8.1	440
04B	130	6.8	1.19	206	4140	17	22.1	8.1	438
X02	156	6.5	1.36	159	--	--	--	--	---
05A	166	6.4	1.38	221	3780	15	21.9	8.1	439
06B	206	6.3	1.30	253	3750	15	22.0	8.1	440
07A	228	6.3	1.15	192	3710	14	21.9	8.1	440
08B	259	6.3	1.28	241	3660	14	22.0	8.1	451
09A	288	6.0	1.16	223	3360	14	22.1	8.1	448
10B	323	5.4	1.11	225	2870	14	22.2	8.1	460
11A	363	5.9	0.97	180	2720	14	22.0	8.1	452
12B	386	6.2	1.13	196	3360	13	21.9	8.1	455
13A	419	6.0	0.89	101	--	--	--	--	---
13R	424	6.0	1.02	104	2500	13	22.0	8.1	459
14B	453	6.0	1.10	194	2700	13	21.9	8.1	468
15A	483	6.1	1.08	207	2930	14	22.1	8.1	472
16B	516	6.5	1.03	211	2950	15	22.3	8.1	481
17A	546	6.9	0.96	216	3140	16	22.3	8.1	482
18B	581	7.6	1.03	264	3810	18	22.3	8.1	489
19A	613	7.7	0.97	217	3390	18	22.4	8.1	489
20B	639	7.9	0.98	252	3410	19	22.4	8.1	500
21A	678	8.1	0.97	260	3940	21	22.4	8.1	504
22B	705	8.3	0.92	219	3560	23	22.5	8.1	510
23A	735	8.3	1.17	300	3940	24	22.5	8.1	518
24B	767	8.4	1.00	282	3740	23	22.5	8.1	523
25A	802	8.4	0.97	266	3810	23	22.6	8.1	526
26B	832	7.8	0.98	182	3520	22	22.6	8.1	531
X01	850	8.0	0.92	137	--	--	--	--	---

STATION: Mississippi River below Hickman, Ky. 5-24-88
(continued)

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
27A	869	8.3	0.85	149	3550	24	22.7	8.1	535
28B	892	7.9	0.78	105	3140	22	22.7	8.1	535
28R	903	5.7	0.87	84	--	--	--	--	---
29A	926	5.5	0.83	146	2040	11	22.6	8.1	535
30B	967	2.4	0.61	47	500	2	22.5	8.2	527
REW	991	0.0	0.00	0	0	0	--	--	0

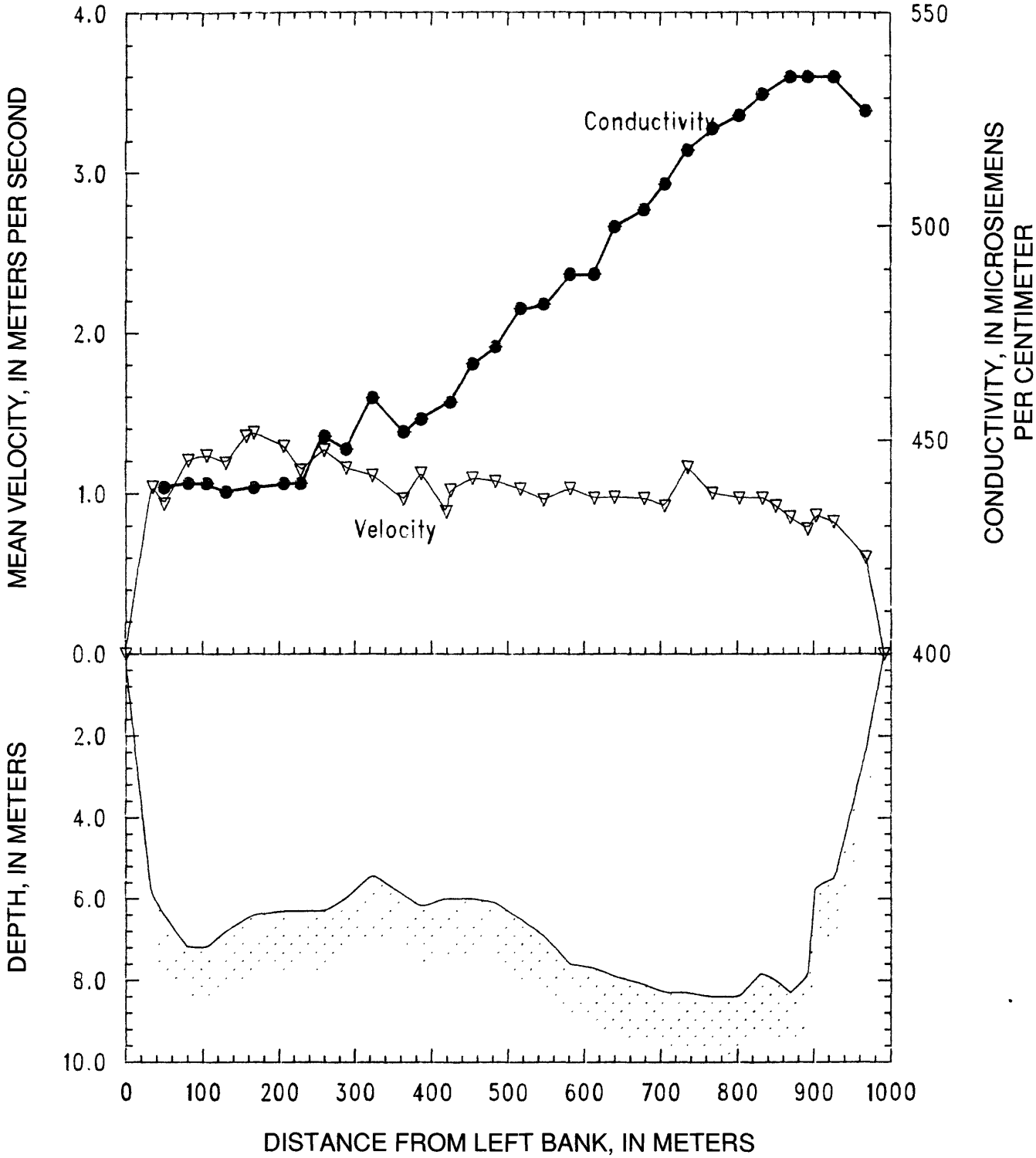

Figure 45. Mississippi River below Hickman, Ky. on May 24, 1988.

STATION: Mississippi River at Fulton, Tenn. 5-26-88
PARTY: Simoneaux, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: ENDING GAGE HEIGHT: -1.25 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate $_3$ was 7 cm/s and the nozzle was 3/16 inch. The total discharge was 7170 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (micro-siemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	64	3.6	0.73	106	770	2	21.2	8.1	477
02B	81	4.7	0.90	86	1490	3	21.1	8.1	473
03A	105	5.8	0.77	119	1970	4	20.9	8.1	478
04B	134	6.8	0.93	183	2530	6	20.6	8.1	482
05A	163	7.3	1.05	200	3490	8	20.8	8.1	480
06B	186	7.8	1.05	168	3470	14	20.8	8.1	480
07A	204	8.2	1.07	223	3960	17	20.9	8.1	480
08B	237	8.8	1.16	250	4970	19	21.5	8.0	465
09R	253	9.9	1.07	144	5580	20	21.5	8.0	465
09A	264	10.0	1.10	198	--	--	--	--	---
10B	289	10.5	1.28	302	5990	23	21.6	8.0	449
11A	309	10.4	1.29	248	6390	23	21.6	8.0	447
X01	326	10.8	1.25	175	--	--	--	--	---
12B	335	10.7	1.18	178	6090	23	21.6	8.0	478
13A	354	11.5	1.26	225	6020	26	21.7	8.1	460
X02	366	11.7	1.31	282	--	--	--	--	---
14B	391	11.8	1.10	304	5840	29	21.7	8.1	471
15A	413	12.6	1.13	242	6270	28	21.7	8.1	474
16R	425	12.3	1.12	124	5430	24	21.7	8.0	464
16B	431	12.7	1.12	200	--	--	--	--	---
17A	453	13.5	1.16	329	5520	25	21.7	8.1	477
18B	473	13.0	1.16	286	6460	27	21.7	8.1	478
19A	491	11.4	1.16	338	5120	27	21.8	8.1	473
20B	524	11.0	1.25	419	6020	23	21.8	8.1	463
21A	552	10.5	1.06	273	5290	23	22.0	8.1	469
22B	573	10.3	1.18	237	5000	20	22.2	8.1	452
23A	591	10.0	1.09	246	4730	18	22.4	8.1	467
24B	618	9.7	0.95	230	4180	19	22.0	8.1	476
25A	641	9.3	0.99	276	4570	16	22.1	8.1	475
26B	678	8.7	0.96	209	3560	12	22.2	8.1	477
27A	691	8.3	0.79	137	2730	10	22.1	8.1	484
28B	720	7.0	0.67	130	1930	7	22.2	8.1	480
29A	746	5.5	0.56	69	920	4	22.2	8.1	481
30B	765	2.8	0.45	37	510	3	22.2	8.1	480
REW	805	0.0	0.00	0	--	--	--	--	---

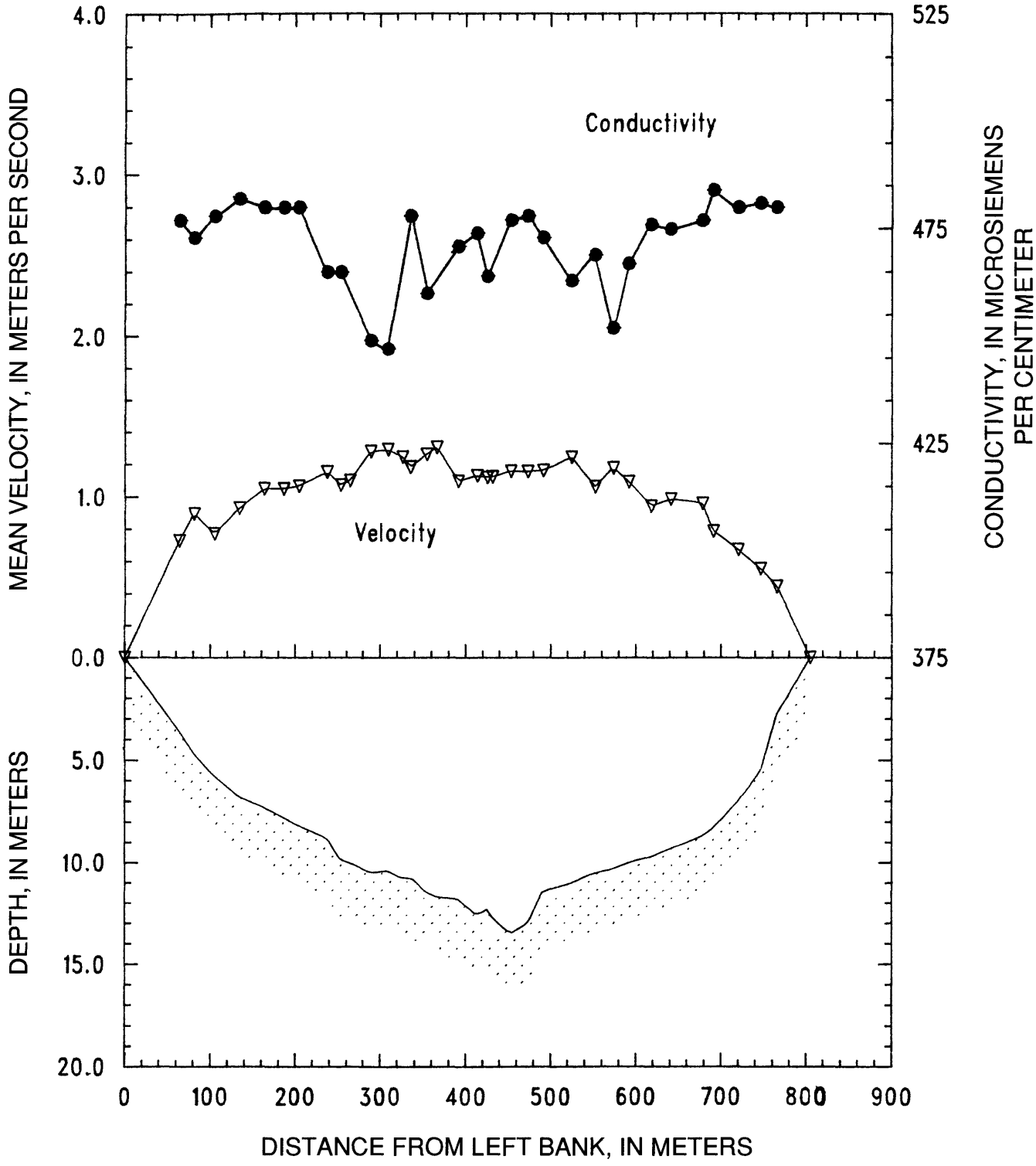

Figure 46. Mississippi River at Fulton, Tenn. on May 26, 1988.

STATION: Mississippi River at Helena, Ark. 5-28-88
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 7.05 ft ENDING GAGE HEIGHT: 7.20 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 4-22-88
REMARKS: Transit rate was 14 cm/sec and the nozzle was 1/4 inch. The total discharge was 7050 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	27	8.0	1.26	236	4150	17	22.2	8.1	476
X01	47	10.0	1.52	252	--	--	--	--	---
02B	60	9.8	1.23	150	5580	24	22.3	8.1	464
X02	72	10.1	1.60	153	--	--	--	--	---
03A	79	10.0	1.66	190	6570	26	22.3	8.1	477
X03	95	10.2	1.55	173	--	--	--	--	---
04B	101	10.0	1.62	194	6410	29	22.2	8.1	477
X04	119	10.3	1.63	234	--	--	--	--	---
05A	129	10.2	1.53	212	5860	27	22.3	8.1	479
X05	146	10.0	1.55	163	--	--	--	--	---
06R	150	10.1	1.69	111	5900	25	22.3	8.1	478
06B	159	10.0	1.72	180	--	--	--	--	---
X06	171	9.7	1.40	143	5390	24	22.4	8.1	479
07A	180	9.6	1.40	182	--	--	--	--	---
08B	198	9.5	1.46	257	5380	24	22.5	8.1	476
X07	217	9.4	1.58	216	--	--	--	--	---
09A	227	9.5	1.39	172	5440	22	22.4	8.1	478
X08	243	9.5	1.36	129	--	--	--	--	---
10B	247	9.4	1.47	166	5250	21	22.6	8.1	479
X09	267	9.3	1.33	155	--	--	--	--	---
11A	272	9.3	1.51	204	5020	19	22.4	8.1	479
12R	296	9.0	1.46	191	5470	20	22.6	8.1	477
12B	301	8.9	1.53	177	--	--	--	--	---
13A	322	8.5	1.35	247	4640	20	22.7	8.1	479
14B	344	8.5	1.21	262	3870	18	22.8	8.1	477
15A	373	8.1	1.31	265	4440	18	23.0	8.1	475
16B	394	7.7	1.17	203	3550	18	23.2	8.1	480
17A	418	7.3	1.10	168	3370	16	23.1	8.1	479
18R	436	7.3	1.23	157	3230	16	23.2	8.1	482
18B	453	7.1	1.10	101	--	--	--	--	---
19A	462	6.8	1.06	43	--	--	--	--	---
19R	465	6.8	1.20	110	3020	17	23.1	8.1	482
20B	489	6.8	0.96	157	2600	16	23.1	8.0	481

STATION: Mississippi River at Helena, Ark, 5-28-88
(continued)

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
21A	513	6.8	0.94	128	2220	15	23.1	8.1	483
22B	529	6.8	1.06	163	2240	13	23.1	8.1	480
23A	558	7.1	0.91	184	2170	12	23.2	8.1	480
24B	586	6.7	0.87	145	2170	11	23.3	8.0	481
25A	608	5.9	0.96	134	2210	8	23.3	8.1	482
26B	633	5.5	0.70	93	1330	6	23.1	8.1	481
27A	656	5.1	0.74	85	1350	6	23.2	8.1	481
28B	678	4.4	0.79	77	1090	4	23.3	8.1	478
29A	700	2.7	0.78	36	610	4	23.4	8.1	479
30B	712	2.4	0.84	55	380	3	23.8	8.1	481
REW	754	0.0	0.00	0	--	--	--	--	---

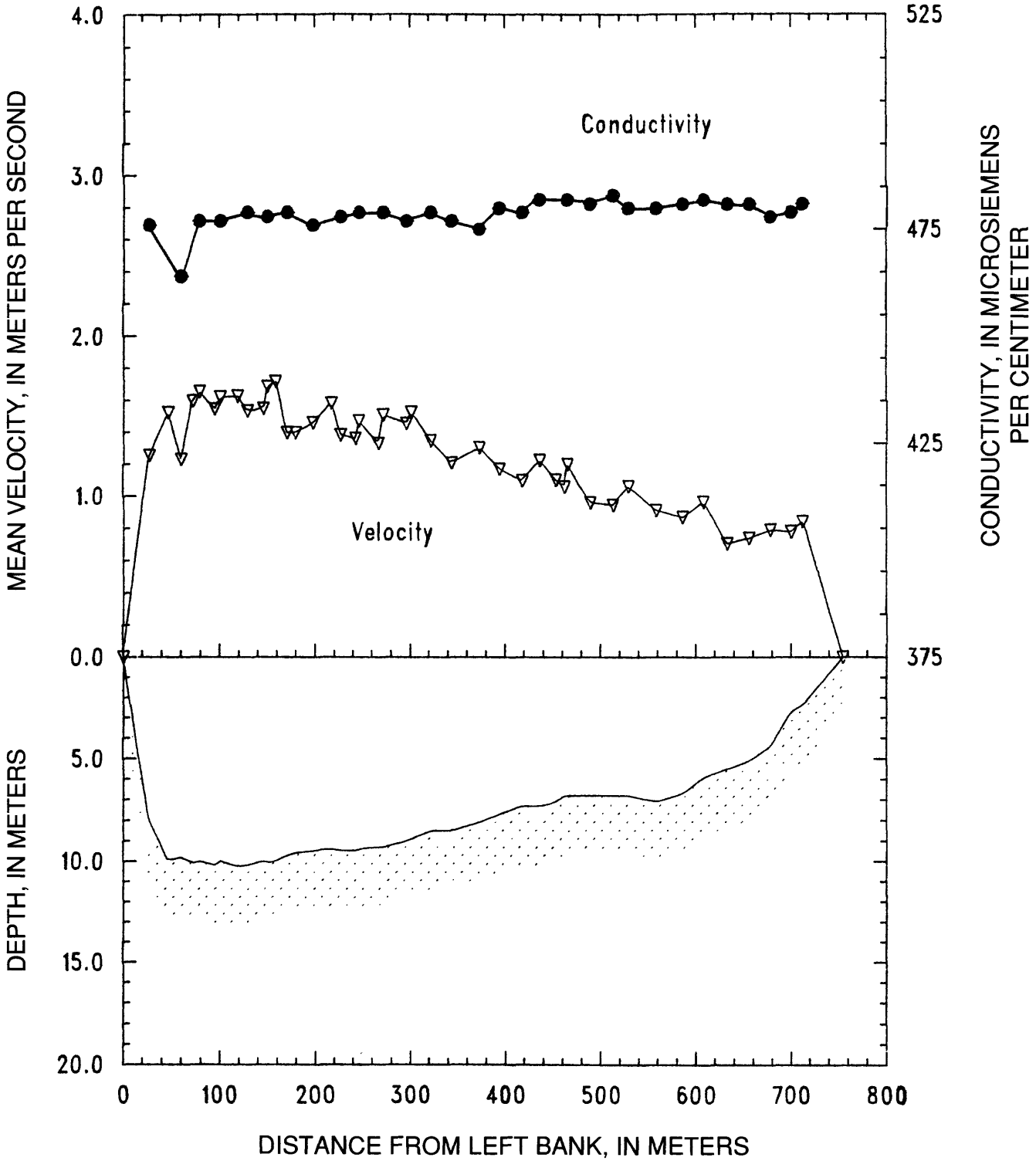

Figure 47. Mississippi River at Helena, Ark. on May 28, 1988.

STATION: White River at Mile 11.5, Ark. 5-29-88
PARTY: Black, Moody and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 21.9 ft, tailwater Norrell Lock ENDING: 21.9 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 5 cm/s and the nozzle was 5/16 inch. Anchored at all verticals which were occupied in the following order: 2,1, and 3-10. The total discharge was 438 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	17	4.3	0.85	40	6850	53	21.5	8.4	285
01B	17	4.3	0.85	--	6180	--	--	--	---
01R	22	4.3	0.95	35	--	--	--	--	---
02A	34	4.2	0.92	48	5200	62	23.2	8.4	286
02B	34	4.2	0.92	--	6180	--	--	--	---
03A	47	4.0	0.90	60	5160	55	22.2	8.4	287
03B	47	4.0	0.90	--	5680	--	--	--	---
04A	67	3.5	0.90	46	4240	57	21.8	8.3	283
04B	67	3.5	0.90	--	4300	--	--	--	---
05A	76	3.4	0.83	26	4200	56	21.9	8.3	291
05B	76	3.4	0.83	--	3790	--	--	--	---
06A	86	3.3	0.82	40	4530	47	22.2	8.3	287
06B	86	3.3	0.82	--	3090	--	--	--	---
07A	105	3.1	0.78	37	3450	42	22.3	8.2	284
07B	105	3.1	0.78	--	2820	--	--	--	---
08A	117	3.1	0.76	33	3620	45	22.5	8.3	291
08B	117	3.1	0.76	--	3700	--	--	--	---
09A	133	3.1	0.79	35	2670	42	22.6	8.3	292
09B	133	3.1	0.79	--	2930	--	--	--	---
10A	146	3.3	0.74	38	3760	47	22.2	8.3	292
10B	146	3.3	0.74	--	3660	--	--	--	---
REW	164	0.0	0.00	0	--	--	--	--	---

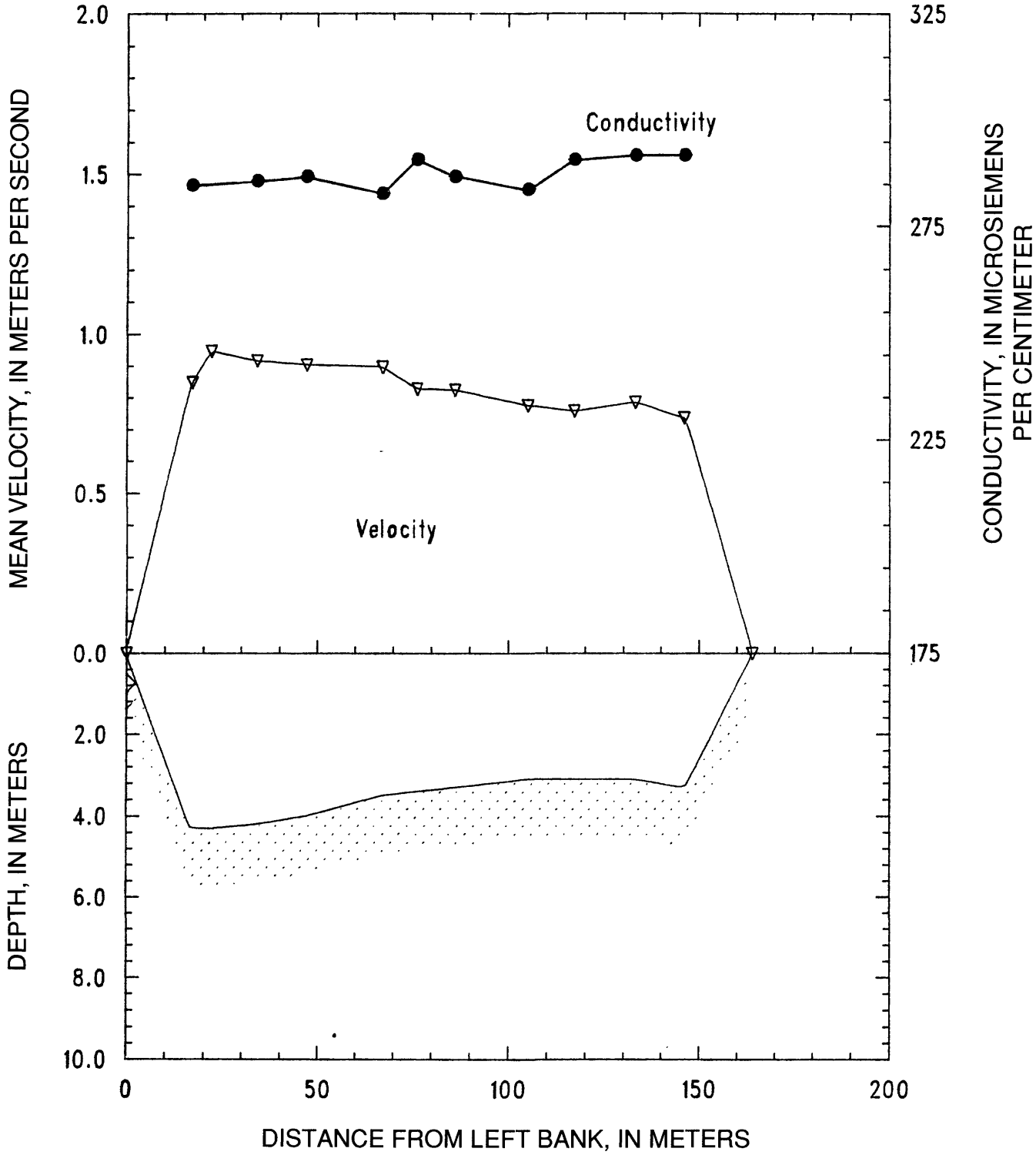

Figure 48. White River at Mile 11.5, Ark. on May 29, 1988.

STATION: Mississippi River above Arkansas City, Ark. 5-30-88
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 8.40 ft @ Chicot L. ENDING HEIGHT: 8.35 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 8 cm/sec and the nozzle was 3/16 inch. Verticals were occupied in the following order: 1-5,13,6,11,7-10,19,18,17,12,14-16,20-30. Verticals 1 & 2 are average of downcast and upcast. The total discharge was 8160 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (micro-siemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	30	2.5	0.16	14	420	3	23.3	8.0	473
02B	73	4.5	0.68	74	1650	5	23.7	8.0	471
03A	78	5.1	0.59	52	900	8	23.7	8.0	469
04B	107	7.9	0.67	146	2140	11	23.7	8.0	472
05A	133	9.4	0.56	142	1720	13	23.5	8.0	476
06R	161	11.0	0.78	164	3030	17	24.2	8.0	464
06R	171	12.7	0.74	165	--	--	--	--	---
07A	196	13.7	0.89	279	4330	18	24.6	8.0	475
08B	217	14.2	0.82	302	3960	20	24.2	8.0	476
09A	248	14.6	0.98	574	5140	24	24.7	8.0	478
10B	297	15.2	1.04	444	6150	26	25.1	7.9	467
11A	304	15.3	1.03	245	5690	28	24.2	8.0	463
12B	328	15.6	1.09	415	6730	24	24.7	8.0	474
13A	353	15.6	1.00	477	6180	27	23.8	8.0	474
14B	389	15.3	1.09	500	4820	27	23.7	8.1	466
15A	413	14.4	1.06	373	4780	26	23.6	8.0	472
16B	438	13.8	1.05	363	5950	26	23.5	8.0	471
17A	463	13.5	1.09	413	5660	24	24.7	8.0	471
18B	494	12.7	1.12	449	5840	22	24.7	8.0	475
19A	526	11.7	1.10	401	4910	22	24.5	8.0	471
20B	556	11.9	1.06	333	4880	19	23.7	8.0	470
21A	579	11.6	0.97	241	4030	18	23.6	8.0	473
22B	599	11.3	0.96	314	3970	19	23.7	8.0	473
23A	637	10.7	0.88	241	2930	15	23.5	8.0	474
24B	650	10.6	0.78	162	3230	15	23.6	8.0	473
25A	676	10.3	0.72	186	2370	14	23.5	8.0	474
26B	700	10.3	0.69	219	2200	12	23.5	8.0	473
27A	738	10.1	0.59	185	1690	11	23.6	8.0	473
28B	762	9.9	0.50	128	1550	8	23.6	8.0	472
29A	790	8.9	0.41	97	590	6	23.6	8.0	473
30B	815	6.3	0.38	58	370	3	23.7	8.0	472
REW	838	0.0	0.00	0	--	--	--	--	---

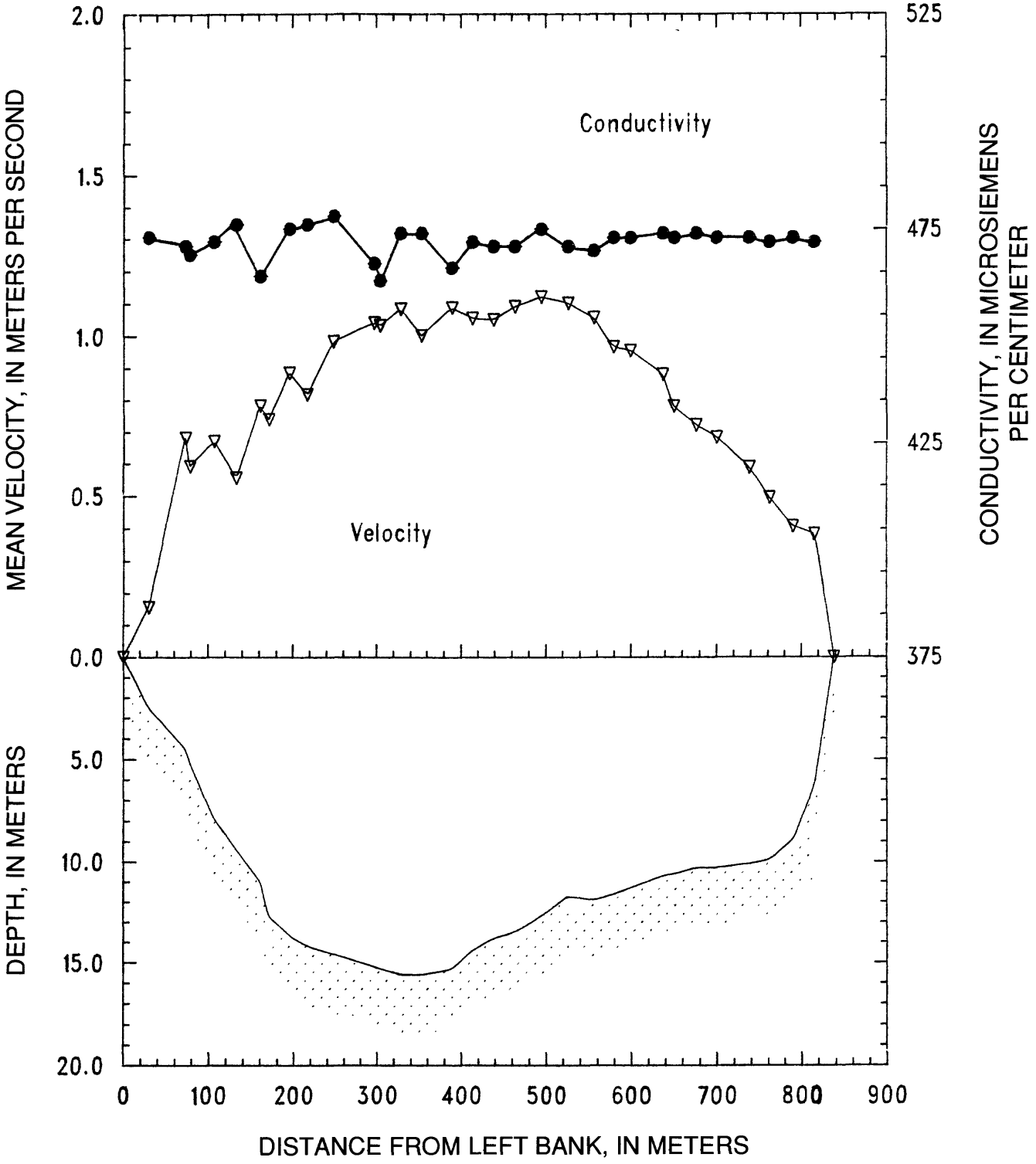

Figure 49. Mississippi River above Arkansas City, Ark. on May 30, 1988.

STATION: Yazoo River at Mile 10, Miss. 6-01-88
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 15.0 ft ENDING GAGE HEIGHT:
SUSP: Dip sample from bow of small boat
METER No: W297222 DATE RATED: 4-15-88
REMARKS: Anchored at one location and collected 600 L by pumping.
Mississippi District measured the discharge from a small boat and it was 80 m^3/s.
A dip sample was collected from the bow of the small boat to serve as the integrated sample.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	25	5.0	--	--	--	--	26.6	7.5	262
02B	50	6.5	--	--	--	--	27.0	7.6	262
REW	115	0.0	0.00	0	--	--	--	--	---

STATION: Mississippi River below Vicksburg, Miss. 6-02-88
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: 8.02 ft ENDING GAGE HEIGHT: 8.00 ft
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 8 cm/s and the nozzle was 3/16 inch. The total discharge was 7950 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	26	6.6	0.48	91	780	3	24.3	7.9	461
02B	57	11.2	0.98	314	4200	13	24.2	7.9	435
03A	83	12.8	1.17	413	6000	24	24.2	8.0	457
04B	112	12.8	1.25	473	6360	31	24.3	8.0	458
05A	142	12.4	1.24	409	6120	30	24.3	8.0	466
X01	165	12.3	1.21	222	--	--	--	--	---
06B	172	12.2	1.19	232	5860	29	24.4	8.0	467
07A	197	11.9	1.25	342	6220	28	24.3	7.9	465
X02	218	11.7	1.26	236	--	--	--	--	---
08B	229	11.6	1.28	260	5330	26	24.4	8.0	466
09A	253	11.3	1.24	301	5600	25	24.3	8.0	469
10B	272	10.9	1.18	181	4700	24	24.4	8.0	469
X03	281	10.8	1.23	226	--	--	--	--	---
11A	306	10.6	1.25	199	5150	23	24.4	8.0	469
X04	311	10.8	1.15	181	--	--	--	--	---
12B	335	9.8	1.12	274	5220	21	24.4	8.0	470
13A	361	9.4	1.17	302	4160	19	24.4	8.0	465
14B	390	9.7	1.11	301	4690	19	24.6	8.0	469
15A	417	9.6	0.98	245	4290	19	24.6	8.0	469
16B	442	9.2	1.05	260	3960	18	25.0	8.0	470
17A	471	8.8	1.23	303	3100	17	24.7	8.0	467
18B	498	8.4	1.16	239	4200	17	24.6	8.0	472
19A	520	8.5	0.99	218	3090	16	24.7	8.0	470
20B	550	7.0	1.03	165	2480	11	24.7	8.0	471
21A	566	6.5	1.00	190	2520	10	25.3	7.9	477
22B	608	6.0	1.09	251	2780	9	25.0	7.9	476
23A	643	5.7	0.99	150	1920	8	24.9	7.8	475
24B	661	5.4	0.86	111	1750	7	24.9	7.9	470
25A	691	5.1	0.83	133	1800	7	24.9	7.9	472
26B	724	4.6	0.78	99	1140	6	24.8	7.9	474
27A	746	4.4	0.74	84	670	5	24.9	7.9	475
28B	776	4.0	0.66	81	710	5	24.8	7.8	475
29A	807	3.3	0.63	56	850	4	24.9	7.8	475

STATION: Mississippi River below Vicksburg, Miss. 6-02-88
(continued)

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
30B	830	3.4	0.73	65	850	5	24.9	7.8	461
31A	860	3.0	0.52	41	460	3	25.1	7.8	468
32B	883	2.8	0.57	42	380	2	24.9	7.9	470
33A	913	2.6	0.52	38	320	3	25.1	7.9	451
34B	940	2.6	0.57	40	330	2	25.1	8.0	466
35A	968	2.3	0.59	38	350	2	25.1	7.9	470
36B	996	2.3	0.36	24	240	2	25.1	7.9	470
37A	1026	2.3	0.35	22	340	2	25.2	8.0	475
38B	1051	2.3	0.50	32	250	2	25.3	8.0	468
39A	1081	2.4	0.58	37	320	2	25.4	7.8	465
40B	1104	2.3	0.54	29	260	2	25.5	8.0	465
REW	1129	0.0	0.00	0	--	--	--	--	---

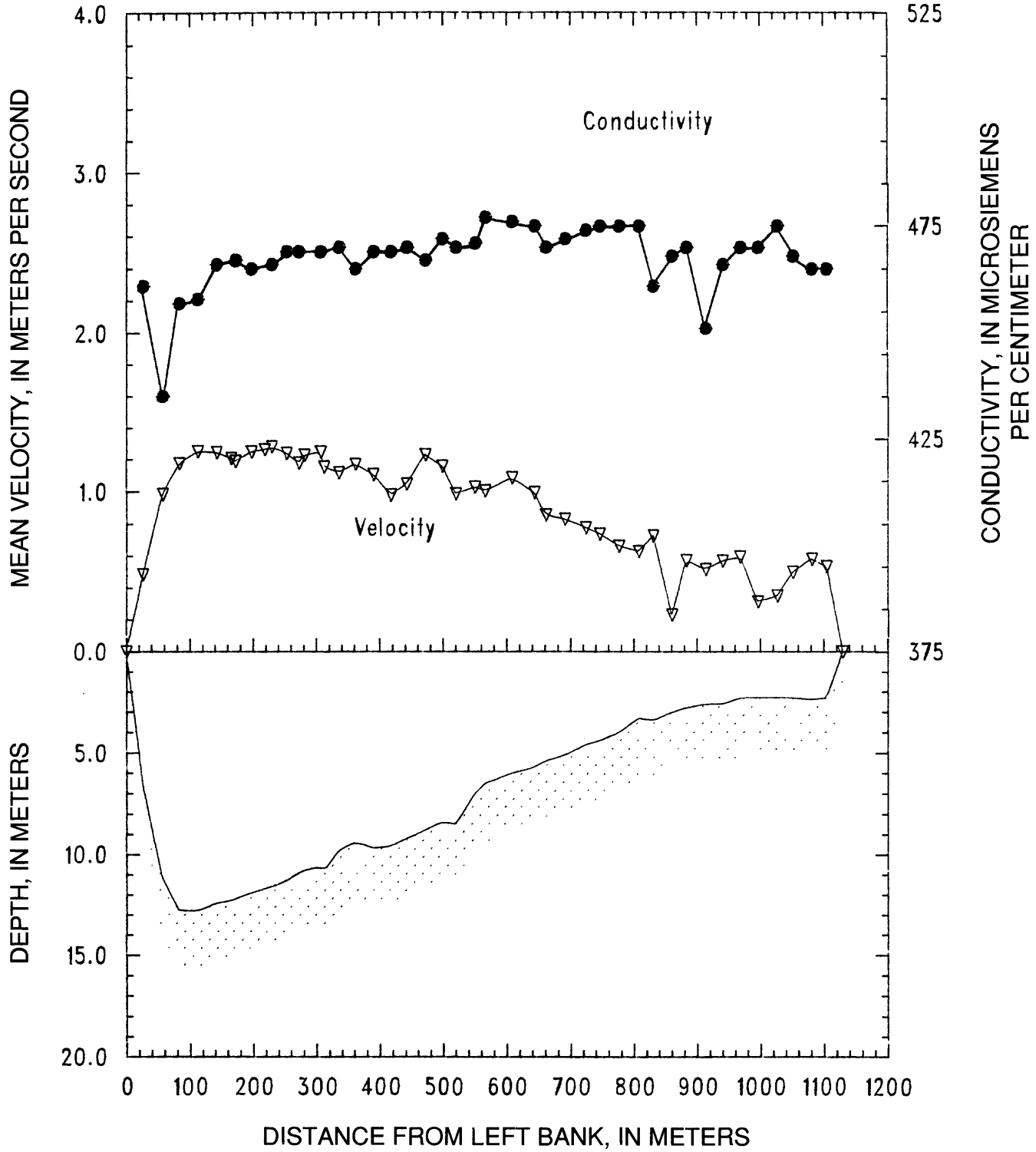

Figure 50. Mississippi River below Vicksburg, Miss. on June 2, 1988.

STATION: Old River Outflow Cannel near Knox Landing, La. 6-04-88
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 11 cm/sec and the nozzle was 5/16 inch. The total discharge was 2150 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	24	5.8	1.19	124	5660	15	24.5	7.9	465
02B	36	6.1	1.17	107	6090	23	24.3	8.0	470
03A	54	6.3	1.08	98	5760	33	24.5	8.0	475
04B	65	5.9	1.24	124	6270	29	--	--	---
05A	88	5.6	1.14	109	5500	28	--	--	---
06B	99	5.5	1.25	104	5680	29	--	8.0	472
07A	118	5.3	0.96	83	4880	25	--	--	---
08B	132	5.2	1.20	93	4570	23	24.6	8.0	476
09A	148	4.9	1.24	119	5040	22	24.6	8.0	476
10B	171	4.7	1.09	82	4550	21	24.5	8.0	476
11A	180	4.8	1.00	72	4370	20	24.6	8.0	477
12B	201	4.4	1.01	80	3720	19	24.5	8.0	515
13A	216	4.4	1.12	76	3890	18	24.6	8.0	470
14B	232	4.3	0.99	70	3530	17	24.4	8.0	514
15A	249	4.1	0.99	82	2910	17	24.3	8.0	467
16B	272	3.5	0.89	54	2770	13	24.2	8.0	467
17A	284	3.4	0.85	39	2430	12	24.6	8.0	515
18B	299	3.5	0.88	47	2430	12	24.3	8.0	471
19A	314	3.3	0.96	49	2360	11	24.6	8.0	471
20B	330	3.3	0.72	39	2050	11	24.6	8.0	468
21A	347	3.1	0.82	44	1960	10	24.6	8.0	464
22B	365	2.8	0.90	41	1650	9	24.5	8.0	471
23A	380	2.9	0.97	43	1860	9	--	--	---
24B	395	3.1	0.97	52	2200	12	24.7	8.0	477
25A	415	3.3	0.89	53	2660	12	24.6	8.0	475
26B	431	3.5	0.85	45	2590	13	24.6	8.0	475
27A	445	3.7	0.89	49	2710	13	24.7	8.0	474
28B	461	3.6	1.09	67	2820	13	24.7	8.0	476
29A	479	3.6	0.93	59	2950	10	24.8	8.0	475
30B	496	3.5	0.76	48	2190	12	24.7	8.0	475
REW	515	0.0	0.00	0	--	--	--	--	---

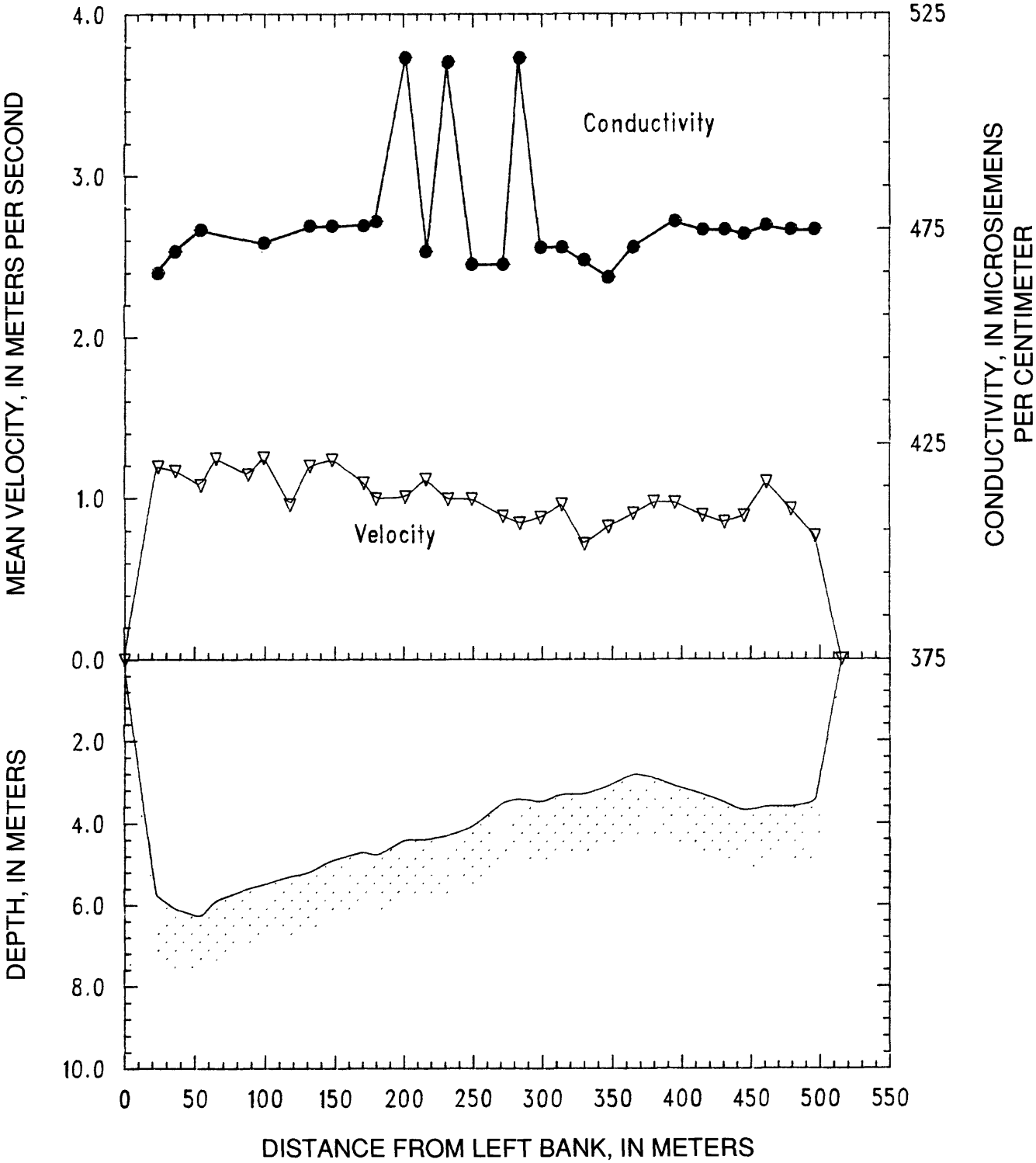

Figure 51. Old River Outflow Channel near Knox Landing on June 4, 1988.

STATION: Mississippi River near St. Francisville, LA 6-05-88
PARTY: Black, Stevens, and Rees METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: 11.45 ft at Bayou Sara
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: There was heavy rain lasting 1-2 hours before starting the section. Transit rate was 10 cm/sec and the nozzle was 1/4 inch. At verticals 29 and 30 the boat was anchored, the transit rate was 5 cm/sec, and the bottle was lowered twice. The total discharge was 5700 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
30B	90	2.3	0.24	26	420	9	25.2	8.0	513
29A	96	2.2	0.36	17	560	11	25.2	8.0	513
28B	133	4.9	0.45	70	670	10	24.8	8.0	513
27A	160	5.6	0.51	96	1170	10	24.6	8.0	509
26B	201	6.5	0.57	94	1660	11	24.6	8.0	514
25A	211	6.5	0.65	91	1640	10	24.9	8.0	512
24B	244	6.5	0.75	154	2150	13	24.8	8.0	514
23A	274	6.8	0.71	97	2490	18	25.2	8.0	517
22B	284	7.1	0.63	90	1300	16	24.6	8.1	476
21A	314	6.9	0.83	185	2670	16	24.6	8.0	518
20B	349	8.2	0.94	266	2750	17	25.1	8.1	479
19A	383	7.2	0.98	222	3200	17	25.3	8.0	467
18B	412	7.6	1.05	216	3620	16	24.9	8.1	469
17A	437	7.9	0.89	183	3640	18	24.5	8.0	470
16B	464	8.2	0.96	268	3810	16	24.8	8.0	470
15A	505	8.4	0.96	222	3960	19	24.6	8.0	462
14B	519	8.7	0.78	139	3480	17	24.4	8.1	475
13A	546	8.8	0.91	224	3860	19	24.3	8.0	460
12B	575	8.9	0.88	223	3690	18	24.2	8.1	467
11A	603	9.2	0.93	244	4250	22	24.8	8.1	471
10B	632	10.2	0.90	261	4320	21	24.6	8.1	467
09A	660	10.2	0.83	228	4860	21	24.5	8.1	463
08B	686	10.0	0.80	252	4860	18	24.8	8.1	467
07A	723	10.0	0.97	252	5110	23	24.6	8.1	468
06B	738	10.7	0.95	113	4860	24	24.6	8.1	464
X02	745	11.1	0.94	140	--	--	--	--	---
05A	765	11.4	0.91	207	5170	24	24.9	8.1	516
X01	785	11.6	0.91	144	--	--	--	--	---
04B	792	11.8	0.88	167	5660	21	24.6	8.1	461
03A	817	11.0	0.82	235	5930	21	24.7	8.1	474
02B	844	12.3	0.88	314	5620	14	24.4	8.1	466
01A	875	11.3	0.83	263	4540	9	24.2	8.0	516
REW	900	0.0	0.00	0	--	--	--	--	---

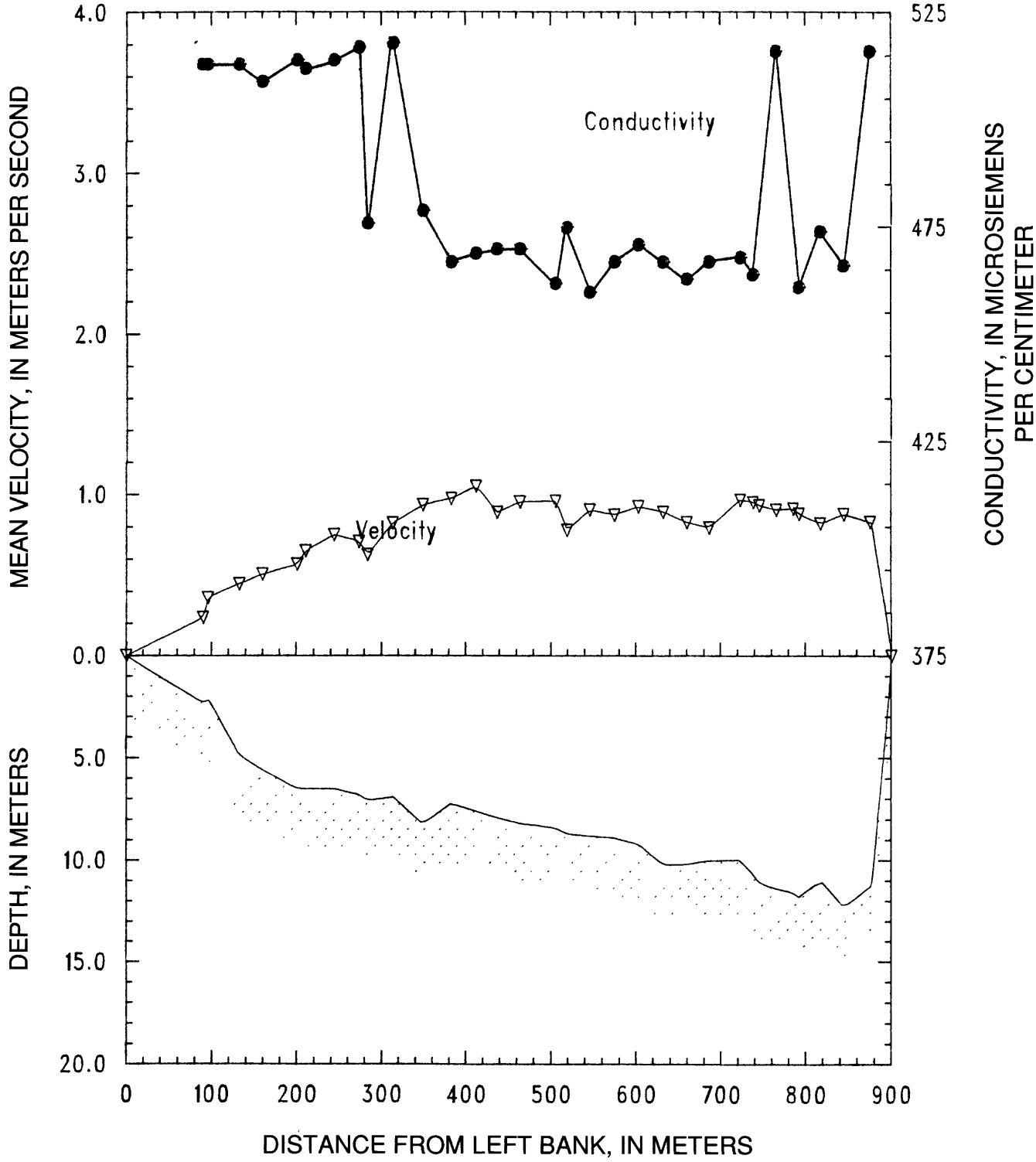

Figure 52. Mississippi River near St. Francisville, La. on June 5, 1988.

STATION: Mississippi River below Belle Chasse, La. 6-07-88
PARTY: Black, Moody, and Stevens METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT:
SUSP: Bag sampler and 200-lb weight
METER No: P8308282 DATE RATED: 6-28-88
REMARKS: Transit rate was 10 cm/s and the nozzle was 5/16 inch. Pumped continuously during the $_3$ station and collected a total of 916 L. The total discharge was 5570 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume Vi (mL)	Volume Vp (L)	Temperature (^oC)	pH	Conductivity (microsiemens/cm)
LEW	0	0.0	0.00	0	--	--	--	--	---
01A	29	8.0	0.22	49	1140	--	--	--	---
02B	57	13.2	0.33	107	2570	--	--	--	---
03A	78	15.4	0.32	110	2790	--	--	--	---
04B	101	19.0	0.41	213	5710	--	25.4	7.8	538
05A	132	19.8	0.37	189	4340	--	25.7	7.6	534
06B	153	20.3	0.42	229	5950	--	25.4	7.5	539
07A	186	20.9	0.46	257	6160	--	25.6	7.6	541
08B	207	21.8	0.44	228	6420	--	25.8	7.6	537
09A	233	22.4	0.48	200	6710	--	25.7	7.8	540
10B	244	22.7	0.44	242	6020	--	25.8	7.9	542
11A	281	23.2	0.40	284	6210	--	26.0	8.1	543
12B	305	23.4	0.42	272	5810	--	25.8	8.0	540
13A	337	23.3	0.42	255	7040	--	25.7	8.1	539
14B	357	23.4	0.40	245	6620	--	25.4	8.1	545
15A	390	22.4	0.41	244	6080	--	26.3	8.1	548
16B	410	22.7	0.35	199	4540	--	25.9	8.0	548
17A	440	23.3	0.38	306	6260	--	26.1	8.0	550
18B	480	22.9	0.36	282	4020	--	25.8	7.9	549
19A	509	22.6	0.34	117	5300	--	26.5	7.9	548
20B	510	22.5	0.46	149	5420	--	26.2	7.9	546
21A	538	22.2	0.42	273	5100	--	26.5	8.0	547
22B	568	21.8	0.38	204	4840	--	26.1	8.1	546
23A	587	20.8	0.22	109	3310	--	26.4	8.0	547
24B	615	21.0	0.29	173	3370	--	25.7	8.1	546
25A	644	20.6	0.30	158	3810	--	25.6	8.0	545
26B	666	20.3	0.31	110	3660	--	25.8	8.1	546
27A	679	21.0	0.26	127	3480	--	25.6	8.0	544
28B	713	20.0	0.28	126	3650	--	25.8	8.0	545
29A	724	14.8	0.29	80	2220	--	26.0	8.0	547
30B	751	5.2	0.23	32	660	--	26.3	8.0	537
REW	778	0.0	0.00	0	--	--	--	--	---

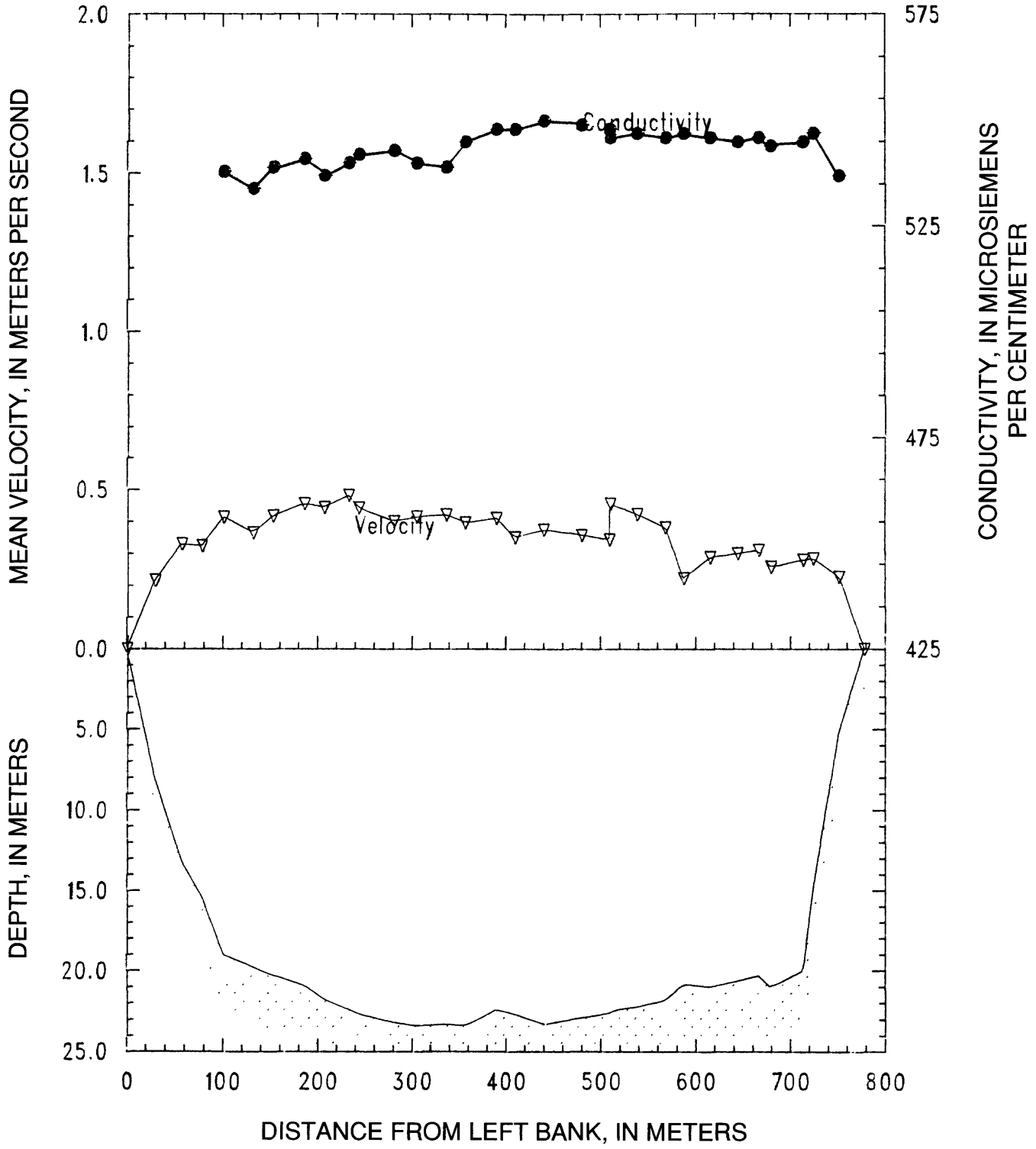

Figure 53. Mississippi River below Belle Chasse, La. on June 7, 1988.

*U.S. GOVERNMENT PRINTING OFFICE 1992-0-673-207/50028