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SAMPLING EQUIPMENT

A Handline Suspended-Sediment Sampler

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Many streams having shifting beds may be waded for most or all of their width at any given section. Occasionally, however, relatively narrow segments of the channel are too deep to be waded. A crane and US D-43 sampler must be used to sample such a channel segment. The assembling and dismantling of the crane, reel, and sampler are nearly as time consuming as the securing of samples from the stream segment that can be waded. To obviate the use of a crane and US D-43 sampler on many occasions, a relatively lightweight handline sampler has been fabricated for the purpose of sampling relatively deep, narrow segments of a stream or deep low-velocity streams. The sampler has been tested in verticals having velocity-depth products up to 27, but criteria for the limits of usage have not been determined. In this report, the sampling characteristics of the handline sampler are compared with those of standard samplers, and results of several field tests are presented.

The handline sampler is a US DH-48 sampler that has certain modifications. (See fig. 1.) A tail fin was welded in a shallow groove that extends along the top of the skirt section from about 1 inch behind the wading-rod recess to the rear of the skirt section. The bottom of the vertical fin is approximately level with the lowest point of the sample bottle in the sampling position. Thus the sampler is oriented with the flow before the nozzle enters the water. A narrow horizontal tail vane was added to the vertical fin to give greater stability to the sampler.

The wading-rod recess was slotted to fit a standard weight hanger. A hole was drilled and threaded to secure the lower end of the hanger. A stop was placed at the front of the hanger slot so that the hanger cannot tilt forward past the vertical. The hanger stop keeps the sampler suspended horizontally even though the weight is not divided equally by the hanger pivot point. The hanger stop may be eliminated by placing the hanger further back on the sampler.

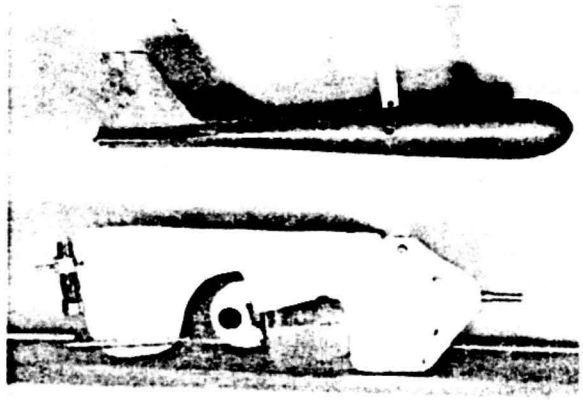

Figure 1.—Side view of a handline suspended-sediment sampler.

A rough lead casting was attached to the lower front section of the US DH-48 sampler and was secured to the sampler body by a single bolt. The lead casting was then smoothed and streamlined with plastic auto lead. The lead weight serves as added weight for stability and prevents the sampler from tilting forward when the sampler touches the streambed. T' design allows sampling within about 0.3 foot of the str mbed.

For ease and convenience during sampling at night, a small detachable, waterproof flashlight may be mounted on the rear of the vertical fin. The light illuminates the horizontal tail surface and serves both to locate the sampler while it is being lowered and raised and to determine the instant at which the sampler becomes submerged.

A 15-pound brass sounding weight may be attached to the hanger 0.5 or 0.6 foot above the sampler. The sampler may be used without the brass weight in low-velocity streams. The sampler with the 15-pound brass weight would be used for most nonwadeable stream segments if the mean velocity in the sampling vertical is greater than 1.0 foot per second. The weight of the sampler is approximately 9 pounds. The total weight of the sampler, brass sounding weight, and handline is approximately 25 pounds.

An adjustable, spring-loaded base plate having an attached pulley or reel is planned for ease and uniformity in lowering and raising the handline sampler. The pulley device would be adjustable to various widths of bridge rails. The weight and design of the device would permit it to be carried, placed on the bridge rail, and removed from the rail with one hand.

The handline sampler has been tested in various Nebraska streams since April 1954 and has been checked against sampling by the US D-49, US D-43, and US DH-48 samplers. The depth and velocity of the water, the amount of downstream drift, the magnitude of drag, and the concentration, type, and vertical distribution of suspended sediment are factors to be considered in the use of the handline sampler.

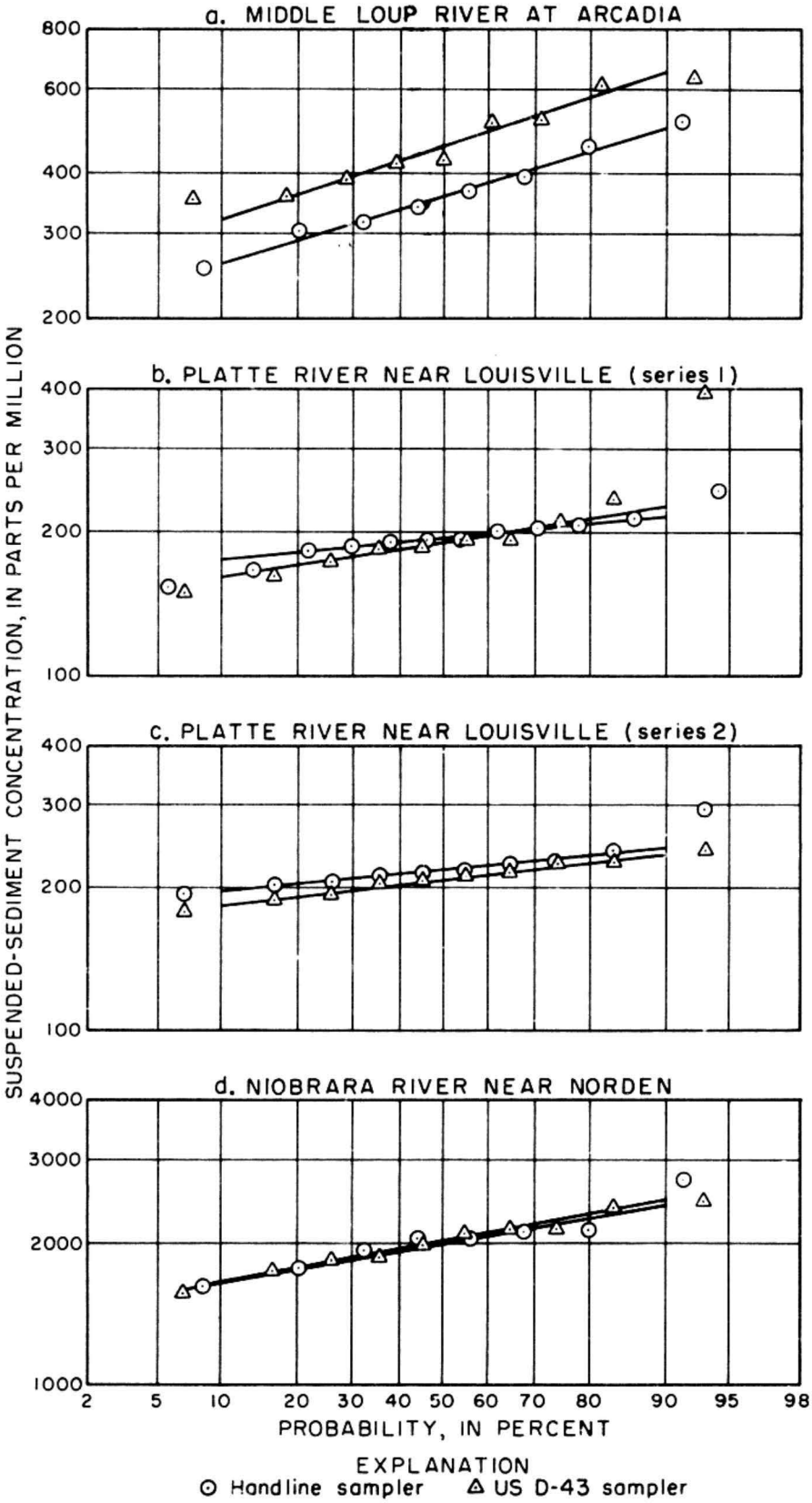

Figure 2—Suspended-sediment concentrations with handline and US D-43 samplers.

No laboratory tests have been made to determine the effect of sampler shape on nozzle characteristics. At the present time the field worker, using his own discretion and judgment, determines if flow conditions permit the use of the handline sampler.

In some tests, samples were obtained by using alternately a handline sampler and a US D-43 sampler at a single vertical. Tests were made in the Middle Loup River at Arcadia, Platte River near Louisville, and Niobrara River near Norden, all in Nebraska. At each site, the suspended sediment is predominantly in the sand-size range. Also, the concentrations of sediment fluctuate greatly in the short periods required for consecutive sampling.

At Arcadia, the suspended-sediment samples contained approximately 80 percent sand and 20 percent silt and clay. The streambed was mostly medium and fine sand. The channel was relatively shallow and wide and had an irregular bed of sand waves and bars. The sampling vertical was in a main current where the mean velocity was about 3 feet per second and the depth varied from 3.0 to 3.2 feet during the sampling period. The results of the sampling comparison at this station differ from those at the other sites; the concentrations from the handline sampler averaged 22 percent lower than the concentrations from the US D-43 sampler. (See fig. 2a.) However, the average concentration of 3 samples collected with a standard US DH-48 sampler was 35 percent lower than the average concentration of 10 samples collected with a US D-43 sampler during the same sampling period. It is believed that the two samplers do not differ greatly in sampling characteristics and that sampling techniques or flow or load characteristics would not account for the observed differences. However, streambed characteristics may cause some of the observed differences. The Loup River streambed is rather irregular and has migrating sand waves and dunes. The sand bed is generally firm but at times may become soft and semifluid in small areas. If the 50-pound US D-43 sampler is lowered to the bed when a soft area is under the sampling vertical, it may sink into the bed. Thus part of the sample is collected considerably less than 0.4 foot from the bed surface. The lighter weight handline sampler would be much less affected by a soft bed. Another possible explanation for some of the observed differences in concentration is that, because of differences in shape and design between the US D-43 and the handline sampler, the US D-43 may sample considerably closer to the bed on the downstream side of migrating dunes.

Two series of tests were run on the Platte River near Louisville. The stream normally has a higher water discharge, finer bed material, and a gentler slope than the Middle Loup River at Arcadia. The depth of water at the sampling vertical remained at 3.0 feet during the sampling period, and the estimated mean velocity was 2.5 feet per second. The particle-size distribution of suspended sediment was approximately 70 percent sand and 30 percent silt and clay. The concentrations and the variability of samples were lower than those at Arcadia. (See fig. 3b and c.) For these tests, the concentrations of the handline samples were about 5 percent greater than those of the US D-43 samples. The agreement in these tests is so good that one sampler apparently has the same sampling characteristics as the other. Part of the observed differences in concentration may reflect the greater depth to which the handline sampler was lowered; the handline nozzle is lowered to about 0.3 foot from the bed, whereas the US D-43 nozzle descends to about 0.4 foot from the bed.

The mean velocities, the concentrations of suspended sediment, and the mean particle sizes of suspended sediment and bed material at the Niobrara River near Norden are higher than those at the Arcadia and Louisville stations. The streambed is irregular and is scoured in consolidated rock; sand deposits are present in the minor bedrock irregularities. The depth of water at the sampling vertical was 4.1 feet, and the mean velocity was 6.5 feet per second. The bridge deck is 17 feet above the water surface. Both the handline and US D-43 samplers drifted downstream and oscillated laterally. Downstream drift averaged slightly more for the handline sampler. Lateral movement was approximately the same for the two samplers. Two samples collected with the handline sampler were disregarded because of excessively high concentration, which may indicate that the sampler nozzle collected material from a sand deposit in the irregular bed. The average concentration at the vertical was about 2,000 ppm, and the two sets of samples agree very closely. (See fig. 2d.)

The data for the three streams are presented in tables 1, 2, and 3. The results seem to be affected neither by time trends nor by cyclic variations of concentration during periods of measurement. The concentrations of 13 samples taken consecutively with the handline sampler in the Platte River near Louisville were 211, 277, 205, 214, 204, 212, 226, 203, 217, 248, 226, 210, 234, 204, 169, and 202 ppm.

Another type of test was made at Salt Creek at Lincoln, Nebr., to compare a handline sampler with a US D-49 sampler (table 4). Pairs of samples were obtained for various concentrations throughout the summer of 1954. Most of the measured suspended-sediment discharge at the station consists of silt and clay.

In conclusion, the handline sampler has sampling characteristics similar to those of US D-43 and US D-49 samplers. The handline sampler may be used in place of the crane-operated US D-43 or US D-49 samplers when conditions for its use are more suitable than for the larger samplers. The handline sampler may sample concentrations somewhat higher or lower than a US D-43 sampler if streambed characteristics are such that the US D-43 sampler nozzle is closer to or further from the streambed than the handline sampler nozzle at the identical vertical. The handline sampler used at present is not claimed to be a finished product but may be worthy of further testing and refinements in design.

Table 1. —Suspended-sediment concentrations, in parts per million, obtained by US D-43, US DH-48, and handline samplers

Middle Loup River at Arcadia, Nebr.			Platte River near Louisville, Nebr.				
Sampling period: 40 minutes			Sampling period: 60 minutes			Sampling period: 30 minutes	
US D-43	US DH-48	Handline sampler	US D-43	US DH-48	Handline sampler	US D-43	Handline sampler
354				136			214
		341			184	193	
521			193				228
636				182		211	
		394		188			206
515			390			178	
		515			167		195
	427		150			204	
391					205		240
	179			173		226	
421				157			226
359					191	207	
	289				189		203
		369		152		227	
		456			154		292
		305	212			240	
429					192		218
		318	188			215	
		254			213		218
613			187			189	
					209		
			163				
					203		
			239				
					247		
			177				
			194				
					192		

Table 2. --Summary of statistics for comparing the handline sampler and the US D-43 sampler

Number of observations		Mean concentration		Standard error of mean		Fiducial limits of mean (90-percent level)	
Handline sampler	US D-43	Handline sampler	US D-43	Handline sampler	US D-43	Handline sampler	US D-43
Middle Loup River at Arcadia, Nebr.							
8	9	369	471	35	30	312-426	406-536
Platte River near Louisville, Nebr.							
12	9	195	189	6.8	8.7	183-207	173-205
10	10	224	209	8.6	6.0	208-240	198-220

Table 3. —Suspended-sediment concentrations by sampling alternately with the US D-43 sampler and handline sampler, Niobrara River near Norden, Nebr.

Time (a.m.)	Concentration (ppm)	
	US D-43	Handline sampler
10:20	2,090	
10:21		2,610
10:22	2,130	
10:23		Bed material
10:24	2,120	
10:25		2,130
10:26	1,830	
10:27		1,770
10:28	2,430	
10:29		2,040
10:30	1,750	
10:31		1,630
10:32	1,990	
10:33		1,920
10:34	1,870	
10:35		2,130
10:36	2,390	
10:37		2,030
10:38	1,570	
10:39		Bed material
Average	2,020	2,030

Table 4. —Results of comparative tests of the US D-49 sampler and the handline sampler, Salt Creek at Lincoln, Nebr.

Depth of water (feet)	Suspended-sediment concentration (ppm)	
	Handline sampler	US D-49
3.0	380	393
2.5	297	318
4.8	5,580	5,620
4.8	5,580	5,460
7.0	9,040	9,060
3.0	491	474
4.0	3,680	3,620
10.0	19,200	18,800

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