A STUDY OF METHODS USED IN

MEASUREMENT AND ANALYSIS OF SEDIMENT
LOADS IN STREAMS

REPORT Y

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A BAG-TYPE SUSPENDED-SEDIMENT SAMPLER

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Forest Service ** Bureau of Reclamation

Federal Highway Administration ** Office of Surface Mining

REPORT Y

DEVELOPMENT OF A BAG-TYPE SUSPENDED-SEDIMENT SAMPLER

By

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ABSTRACT

Standard U.S. series suspended-sediment samplers have a limited depth range determined by the size of the container, the nozzle diameter, and the stream velocity. To circumvent this limitation, a collapsible-bag sampler was developed. A U.S. D-77 sampler, which has a 3-liter capacity, was adapted for use with a thin plastic food-storage bag. A solenoid-actuated valve was developed to provide point-integration capability as well as the ability to depth-integrate deep rivers segmentally.

The system was tested in a laboratory flume, measuring sample volumes collected during various sampling periods, and at various flow rates. The average nozzle intake velocity was calculated and divided by the measured stream velocity where the sample had been collected. This ratio, the relative sampling rate, was in the desired range of 1.00 ± 0.15 for stream velocities from 0.47 m/s to 2 m/s, which is the maximum stream velocity attainable in the flume.

INTRODUCTION

Suspended-sediment samplers which utilize a collapsible bag have been investigated as an improvement over the U.S. series of suspended-sediment samplers, which use rigid plastic or glass bottles as collection containers. Air must be evacuated from the bottles while samples are collected. This removal of air must be accomplished in such a manner that the fluid-sediment mixture that enters the nozzle experiences little acceleration, so as to minimize sampling errors. Controlling this acceleration imposes a limit on the vertical transit rate and on the depth for sample collection due to the compressibility of the air within the bottle. This problem is eliminated when using the collapsible-bag sampler.

This report describes the development of a collapsible bag-type sampler that has the following features: (a) it is designed around the existing U.S. D-77 sampler, shown in figure 1. This sampler is equipped with a 3-liter bottle, nozzle cap and nozzle, (b) it collects samples in an inexpensive, commercially-available food-storage bag, and (c) it is equipped with a solenoid-actuated valve which allows for the collection of point-integrated samples at any depth, as well as for the collection of depth-integrated samples in deep streams (by sampling incrementally). An additional advantage of the valve is that it is easily replaceable in the field. Valves used in other point-integrating samplers are much less accessible.

Testing was accomplished through the collection of samples in a laboratory flume. Sample volumes were measured, then average nozzle intake velocities were calculated for comparison with the measured stream velocities.

Two variations of the basic design provided satisfactory results for stream velocities in the range of 0.5 to 2.0 meters per second (m/s). The 2.0-m/s limit was imposed by limitations of the test flume.

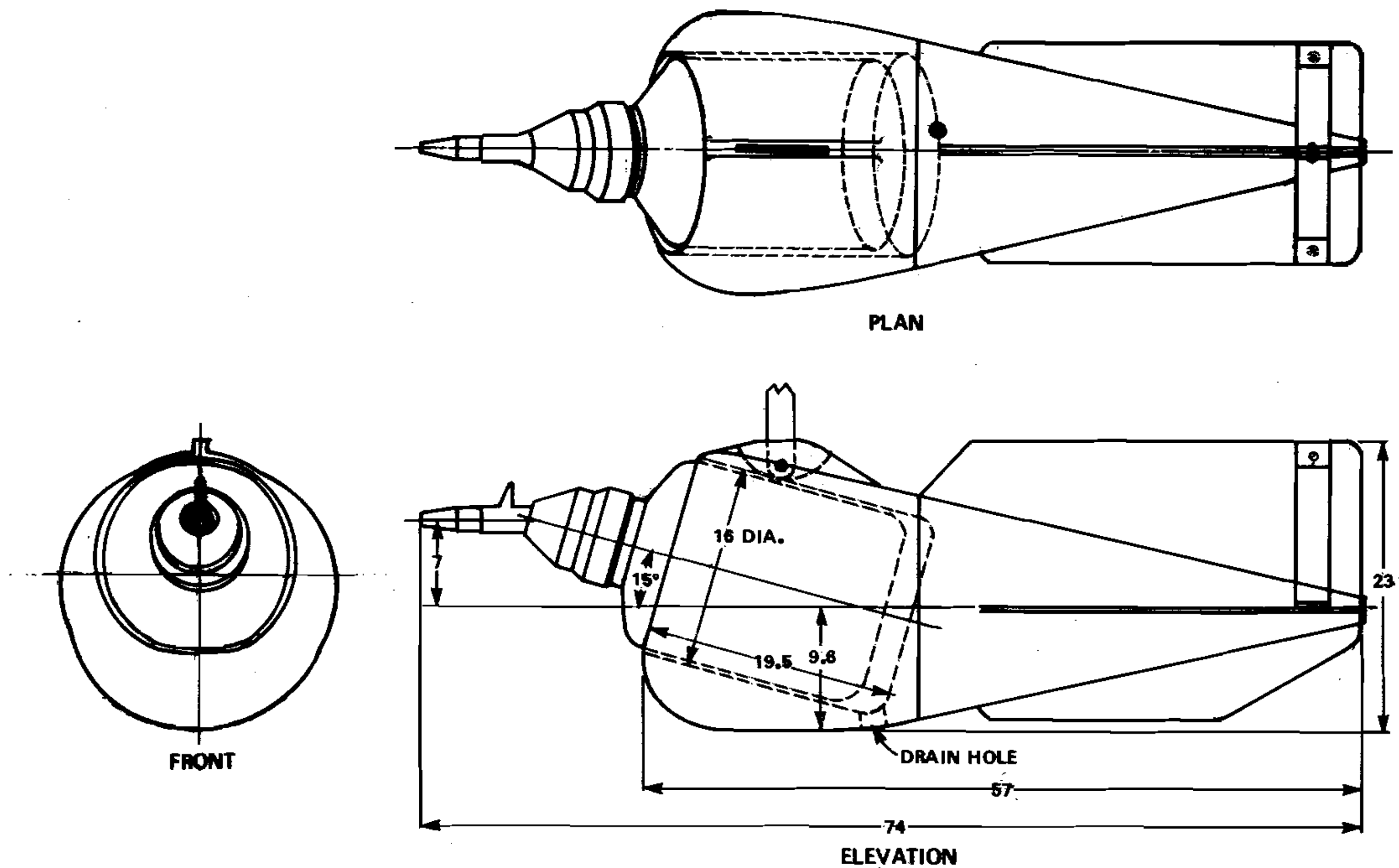


Figure 1.--Depth-integrating suspended-sediment sampler, U.S. D-77. All linear dimensions are given in centimeters.

PREVIOUS INVESTIGATIONS

Several investigators have researched collapsible-bag samplers. Two early models were developed by Gluschkoff and by the Rhine Works Authority (Rept. No. 1, ICWR, 1940). The Gluschkoff sampler, developed in Russia, consists of several balloon-shaped rubber bags, each fitted with a nozzle. The nozzles are mounted on a vertical staff and are all oriented horizontally in the same direction. When sampling, the staff is inserted into the stream with the nozzles facing downstream and with the bags devoid of air. The staff is then twisted so that the nozzles face upstream. The bags simultaneously collect point-integrated samples at various depths. The staff is again twisted so that the nozzles face downstream, pinching off any further inflow. The staff is carefully lifted out of the water and samples removed. The major problem with this arrangement is that bags are unprotected and must be handled very carefully.

The Rhine Works Authority sampler consists of a latex balloon, a nozzle, and a metal frame with a tail fin. When sampling, a pinch clamp located at the neck of the balloon is operated by an auxiliary line to allow flow into the balloon. The sampler is not streamlined, and combined with the necessity for the auxiliary line, limits the use of this sampler to waterways with low velocities.

More recently, Stevens and others (1980, p. 611-616) and Nordin (written communication, 1981) constructed bag samplers fashioned from steel bands welded together to make a frame.

Nordin used the D-77 nozzle and nozzle cap, and sometimes used the same bottle and bag described in this report. The other researchers had a cover hinged to the sampler frame which closed over the mouth of the bottle. A nozzle extended through the cover and slightly into the bottle. Their plastic bag was relatively thick, as described later in this report. Both designs were inexpensive and simple to construct, but neither was streamlined, and therefore had high drag. When either sampler was used in swift flows a streamlined sounding weight was attached above or below the sampler. This created additional problems in that the unsampled zone increased when the weight was suspended below the sampler. With the sounding weight above the sampler, there is a tendency to force the nozzle of the sampler into the streambed when sampling to the bottom.

BAG SAMPLER COMPONENTS

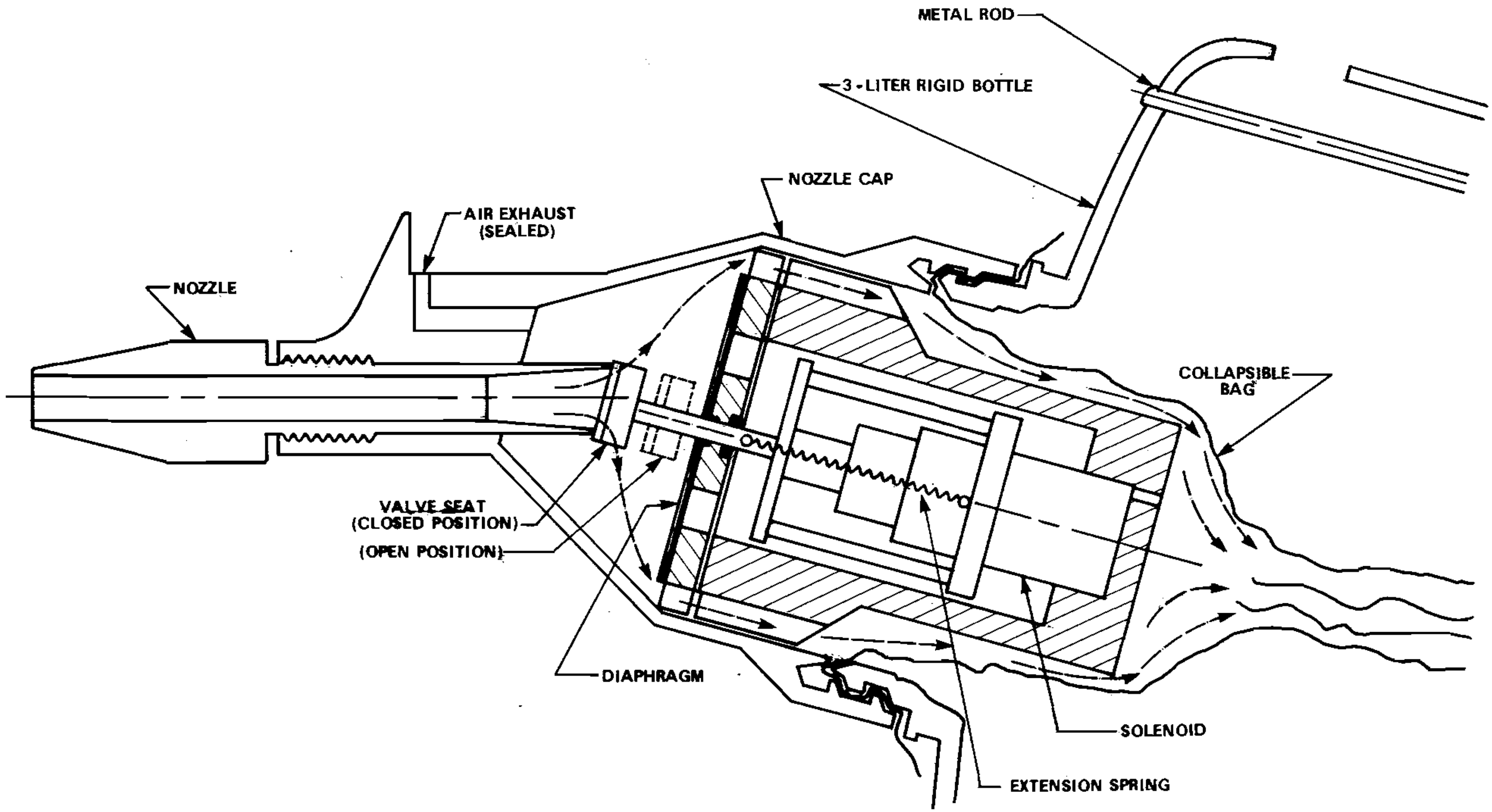
A bag sampling device was conceived that would have a streamlined body and be equipped with a field-replaceable valve to allow for point integration and for depth integration at depths greater than 5.5 meters (m).

The U.S. D-77 depth-integrating suspended-sediment sampler (fig. 1) was selected for modification to a bag sampler for several reasons. The streamlined sampler body is cast from bronze and has an attached welded stainless-steel tailcone assembly. The sampler is moderate in weight (30 kilograms). The rigid plastic sample bottle that fits into it has a large capacity (3 liters) and can be equipped with a special nozzle and nozzle cap.

As originally designed, the D-77 collects samples in the rigid 3-liter container, which contains air prior to sampling. The air is then exhausted through a vent in the nozzle cap during sampling. The sampler was modified by inserting a flexible bag inside the rigid container and by installing an electrically operated valve inside the cap, as shown in figure 2. The downstream end of the nozzle was cut at an angle to form a seal with the valve seat. The air exhaust was sealed. Figure 3a shows the sampling device.

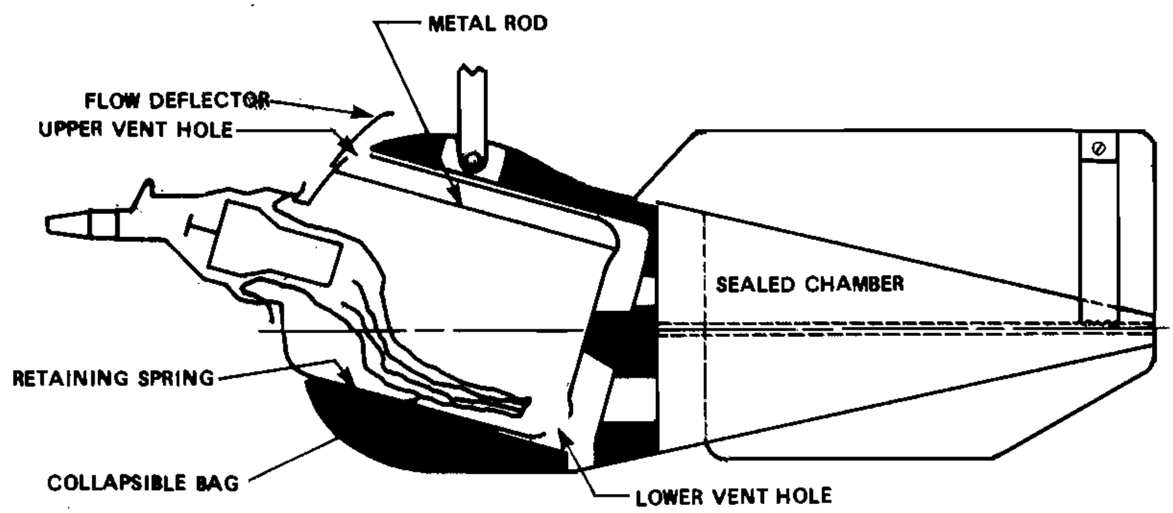
Immediately prior to sampling, the space inside the rigid container must be flooded (fig. 3b). During sampling this water must be exhausted to permit the bag to expand (fig. 3c). One vent hole was placed at the lower corner of the rigid bottle and one at the top to allow for flooding and exhausting. A metal rod was inserted near the upper hole to prevent the bag from floating upward and plugging the opening.

The bag is a commercially available food-storage bag, 28 cm wide, 33 cm long, and about 0.02 mm thick. It has a maximum volume of about 2.9 liters.

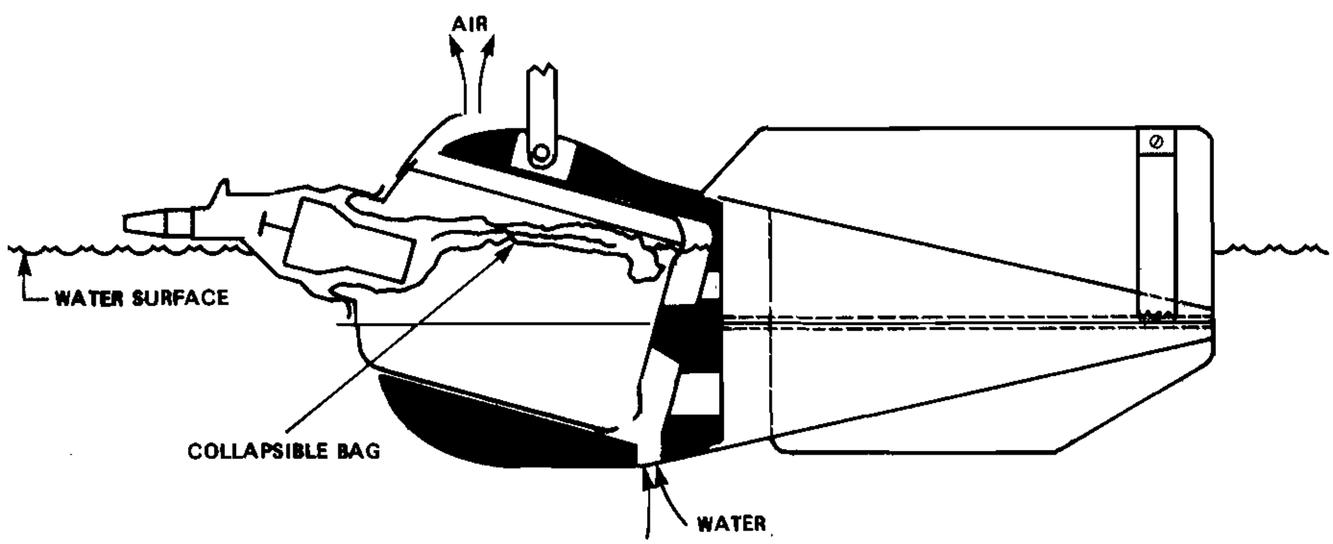


- -➤ Sample flow path

Figure 2.--Illustration of solenoid valve mounted in sampler (simplified). Not to scale.

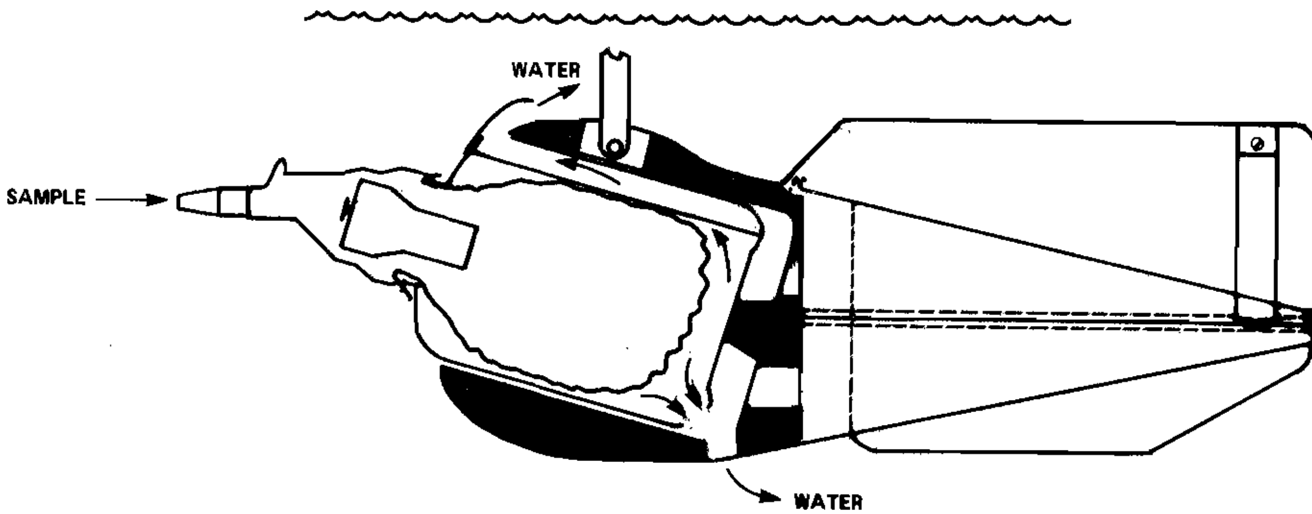


A. BAG AND VALVE INSTALLED.

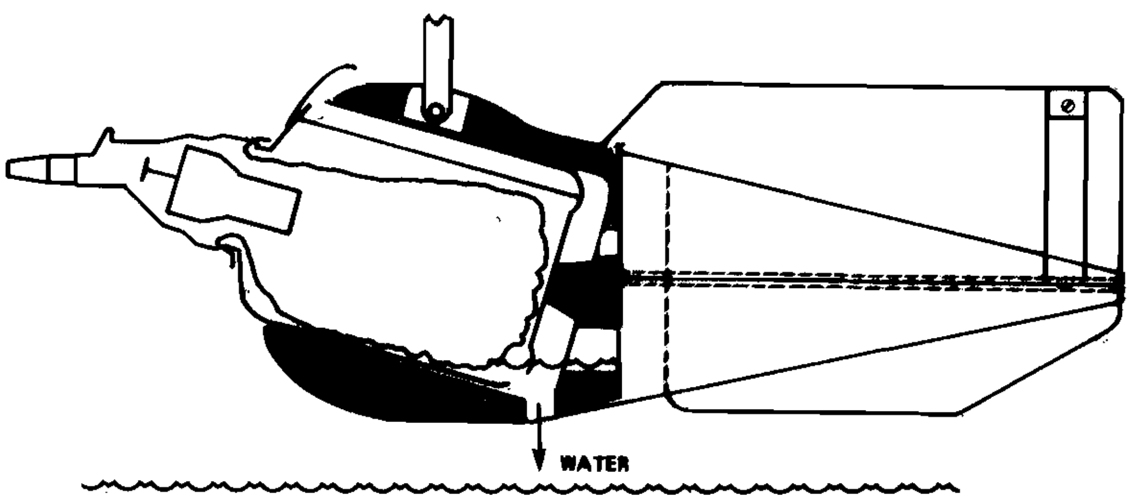


B. FLOODING

Figure 3.--Bag sampler before, during, and after sample collection.



C. SAMPLING



D. RETRIEVAL

Figure 3.--Continued.

The valve contained a linear-travel solenoid which, when energized, pulled the plunger, shaft and valve seat away from the exit end of the nozzle. When the solenoid was de-energized, extension springs returned the valve to the closed position. The inner cavity of the valve was filled with methanol to inhibit freezing and corrosion. Methanol was also advantageous because it is less viscous than water, and it allowed the plunger to move within the solenoid cylinder more readily. A latex diaphragm was used to compensate for volumetric changes within the valve when it was cycled. Valve housings were machined from aluminum, Teflon, or polyvinylchloride (PVC). The PVC versions were used for the majority of tests. The BP-76 battery-pack power supply, designed for use with the P-61 and P-63 point-integrating samplers, was used to activate the valve. Other components, such as masks and a retainer plate, were developed as needed. They will be described later in the text.

TEST FACILITY

The St. Anthony Falls Hydraulic Laboratory free-water surface flume was used for the tests. Water is obtained from the Mississippi River above the dam at St. Anthony Falls. Flume flow is controlled with two 50-cm hydraulic gate valves, located at the bottom of a drop shaft which is about 3-m downstream from the test station. The flume at the test station is 0.9-m wide and 2-m deep. The channel is constricted approximately 3-m upstream of the test station. Flume flow can be varied from zero to approximately 2 m/s. Once set, flow velocity could be maintained at a steady value. An overhead hydraulic hoist was used to lower and raise the sampler.

TEST PROCEDURE, RESULTS AND DISCUSSION

General

Sampling was initially conducted without the solenoid valve. A stopper was inserted into the nozzle, then the sampler was lowered into the water to flood the sampler cavity. The sampler was then further lowered to the sampling depth, where the stopper was removed by pulling on an attached string. A stopwatch was used to measure sampling time. Sampling was terminated by hoisting the sampler out of the flow. Sample volume was measured by pouring the collected water into a graduated cylinder. Stream velocity was then measured at the sampling depth with a Price current meter. Water temperature was measured with a mercury thermometer. The above procedure was also followed when sampling with the valve installed. The stopper was eliminated, and sampling started and stopped by energizing and de-energizing the valve.

An average nozzle intake velocity was calculated from the following equation:

$$Q = \frac{\pi D^2}{4} \nu_i t$$

where Q = sample volume

D = internal nozzle diameter at the entrance

ν_i = average nozzle intake velocity

t = sampling time

Solving for ν_i and simplifying, where Q is in liters, $D = 7.94$ mm, ν_i is in meters per second, and t is in seconds:

$$\nu_i = \frac{4 Q}{\pi D^2 t} = \frac{20.20 Q}{t}$$

Although the nozzle length and exit diameter were changed slightly during the tests, D was never changed, so the above equation was valid throughout testing.

At every instant in time the intake velocity should be equal to the stream velocity (ν_s). This ideal condition would insure the collection of water-sediment mixtures with no error in concentration.

The calculated value for ν_i and the corresponding relative sampling rate (ν_i/ν_s) are average values for the period of sampling. Test results indicated that the relative sampling rate was greater than unity for small sample volumes, near unity for 1 to 2 liter volumes, and less than unity for volumes greater than 2 liters. (See figs. 4 and 5). Since ν_s was steady during any measurement, the variation in ν_i/ν_s occurred because the instantaneous intake velocity changed as the bag filled. Samples that were collected with an average nozzle intake velocity equal to the stream velocity were not truly collected in an ideal manner. This is because the actual instantaneous intake velocities at the beginning of sampling, which were high, were off-set by lower instantaneous intake velocities during the remainder of sampling. Errors in concentration for particle sizes will be partially compensated, with smallest error for finest particle sizes (Stevens and others, 1980, p. 611-616). The relative sampling rate could range between 0.85 and 1.15 without causing significant concentration errors.

Bottle/casting gap

The D-77 sampler has a cavity, formed during casting, which holds the 3-liter bottle. The clearance between the bottle and the casting is 1 to 2 mm, which is great enough to allow water to flow through the gap during sampling. This water interfered with flow from the vents while the bag was filling (fig. 3c). The interference caused a reduction in the relative sampling rates.

Machining the casting and adding a sleeve to eliminate the gap was impractical. It was believed that an O-ring or foam-rubber ring at the entrance to the cavity would not survive rugged use. In an effort to seal the gap at the lower vent, the bottle-retaining spring located in the lower part of the sampler cavity and along the bottle was removed, then elastic material was placed in the upper portion of the cavity between

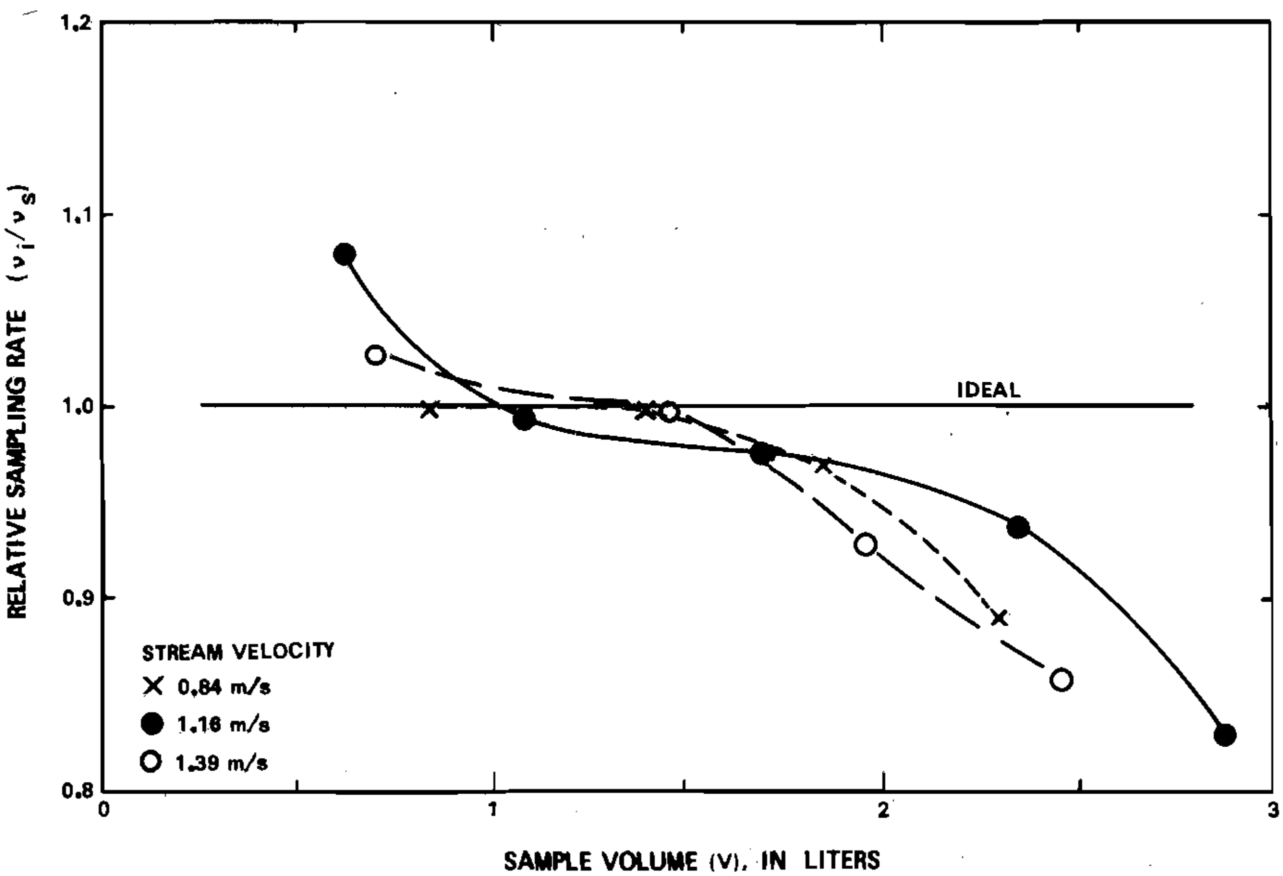


Figure 4.--Effect of collected sample volume on relative sampling rate for various stream velocities. Sampling was conducted without the solenoid valve or deflector. The plastic-bag mask was used. Water temperature was 21.5°C.

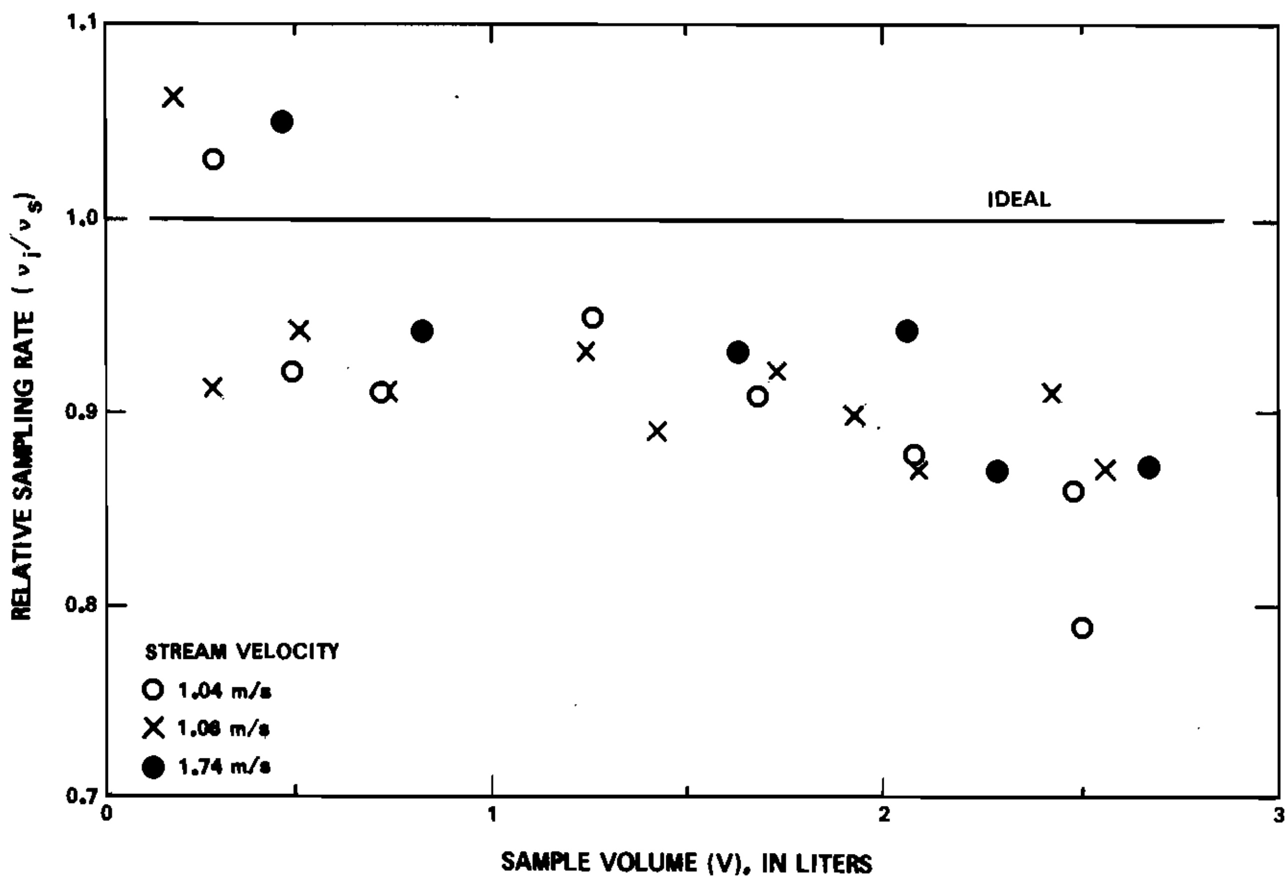


Figure 5.--Effect of collected sample volume on relative sampling rate for several stream velocities. Testing was conducted with the valve and deflector installed and no mask. Aft venting was through the bottom of the bottle. Water temperature was 13°C.

the cavity wall and the bottle. This attempt failed to increase the relative sampling rate, so changes in venting were investigated. To measure the effectiveness of the upper vent, the lower vent was closed. With only the upper vent open, the relative sampling rate increased to approximately 1.0, but flooding time increased from less than 1/2 minute to approximately 2 1/2 minutes.

The tape was removed from the lower vent and most of the upper vent was sealed; allowing a small opening to permit flooding. Flooding time was about 50 seconds, but the relative sampling rate was only about 0.50. The test indicated that flow through the lower vent was inadequate to produce an acceptable sampling rate.

Relative sampling rate did improve when the upper vent hole was enlarged to a diameter of 30 mm. This rate decreased during autumn when water temperatures were cooler, but addition of a deflector (fig. 3a) immediately upstream of the upper vent returned sampling rates to acceptable levels (fig. 6).

Four 12.7-mm diameter holes were drilled through the casting a few centimeters downstream from the maximum girth of the D-77 body, then matching holes were cut in the rigid 3-liter bottle. Relative sampling rate did not improve noticeably when sampling was conducted with this configuration.

Another scheme for venting was investigated. The vent hole in the lower corner of the 3-liter bottle was sealed and a new hole was cut in the center of the flat base. A ring of foam rubber was fastened to the base of the cavity to seal the new vent from the gap. A new venting path was completed by drilling holes either in the casting or in the tailcone section upstream from its sealed chamber. Relative sampling rate increased but was still too low at low stream velocities. (See fig. 7). Figure 8 shows the results for this configuration with the addition of a latex band tied across the front of the sampler. The elastic band was used to force the bottle tightly against the foam-rubber seal.

The configuration which provided the relative sampling rates closest to ideal over the widest range in stream velocities (fig. 9) consisted of

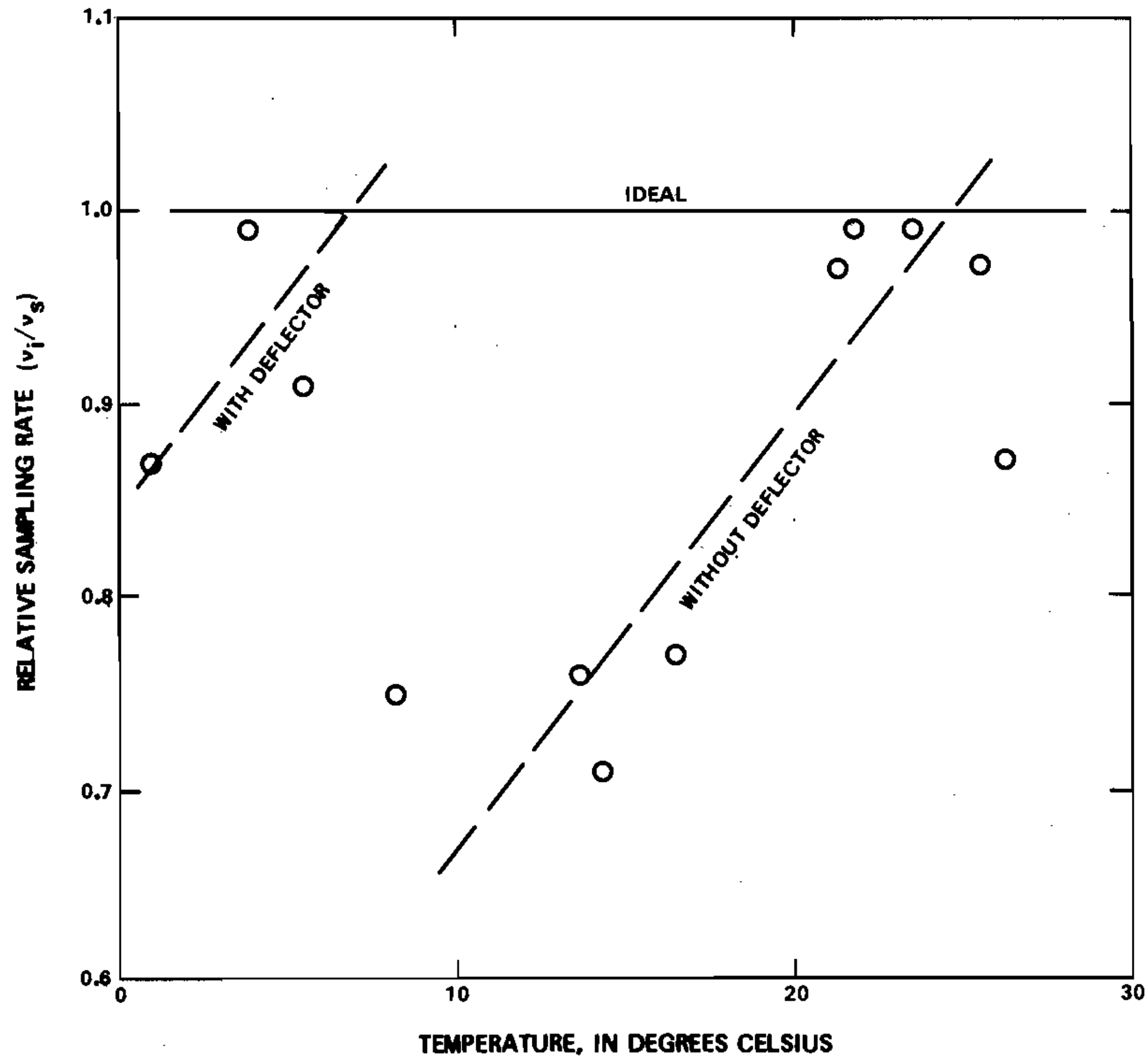


Figure 6.--Graph indicating improvement in relative sampling rate with use of the deflector. Data collected with a 0.91-m/s stream velocity and a sample volume of 2.0 liters.

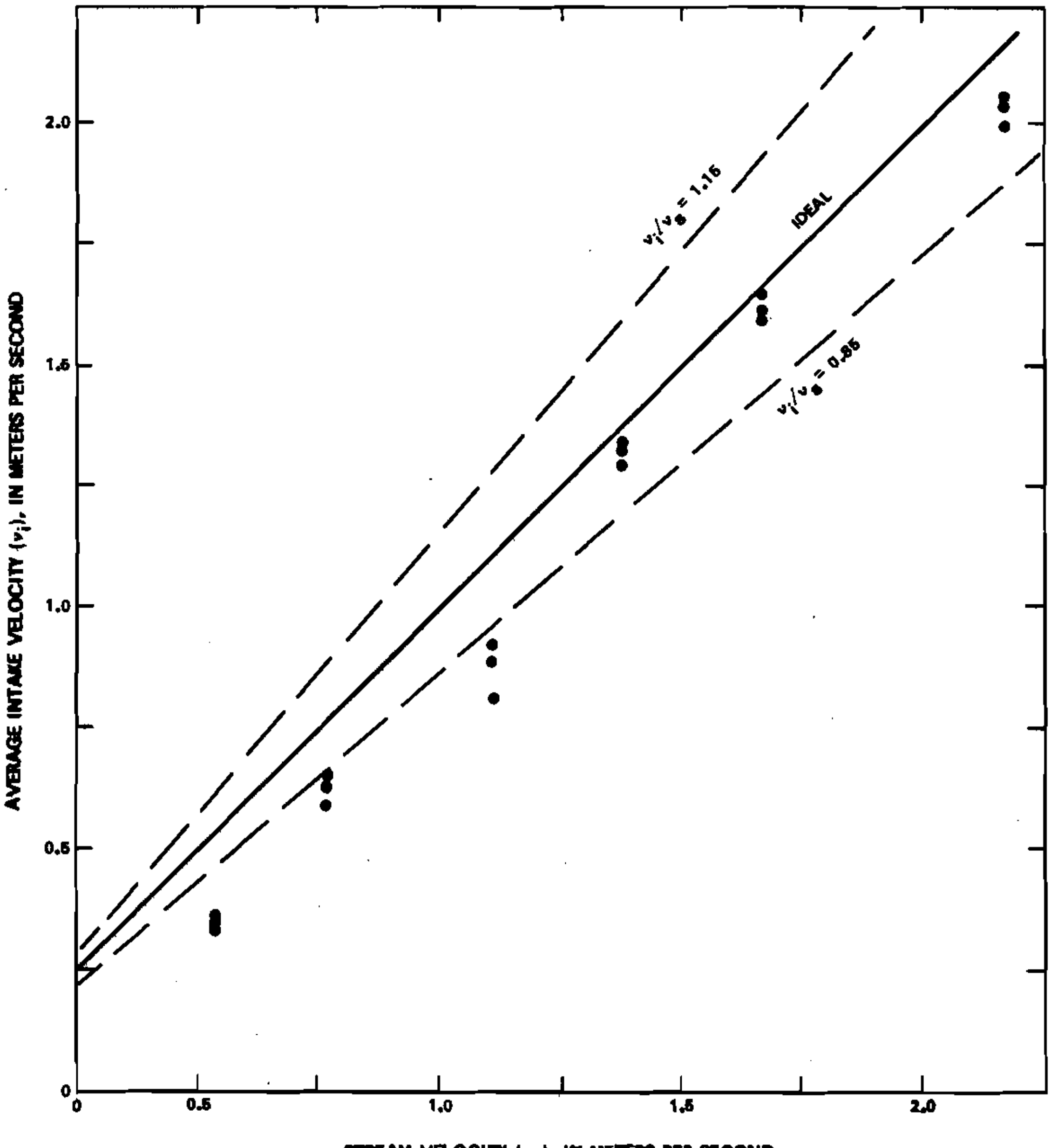


Figure 7.--Graph showing average nozzle intake velocities for several stream velocities. All sample volumes were in the 2.0-2.5 liter range. Sampling was conducted with the valve and deflector. Aft venting was through the bottom of the bottle; the mask was not used. Water temperature was 5°C.

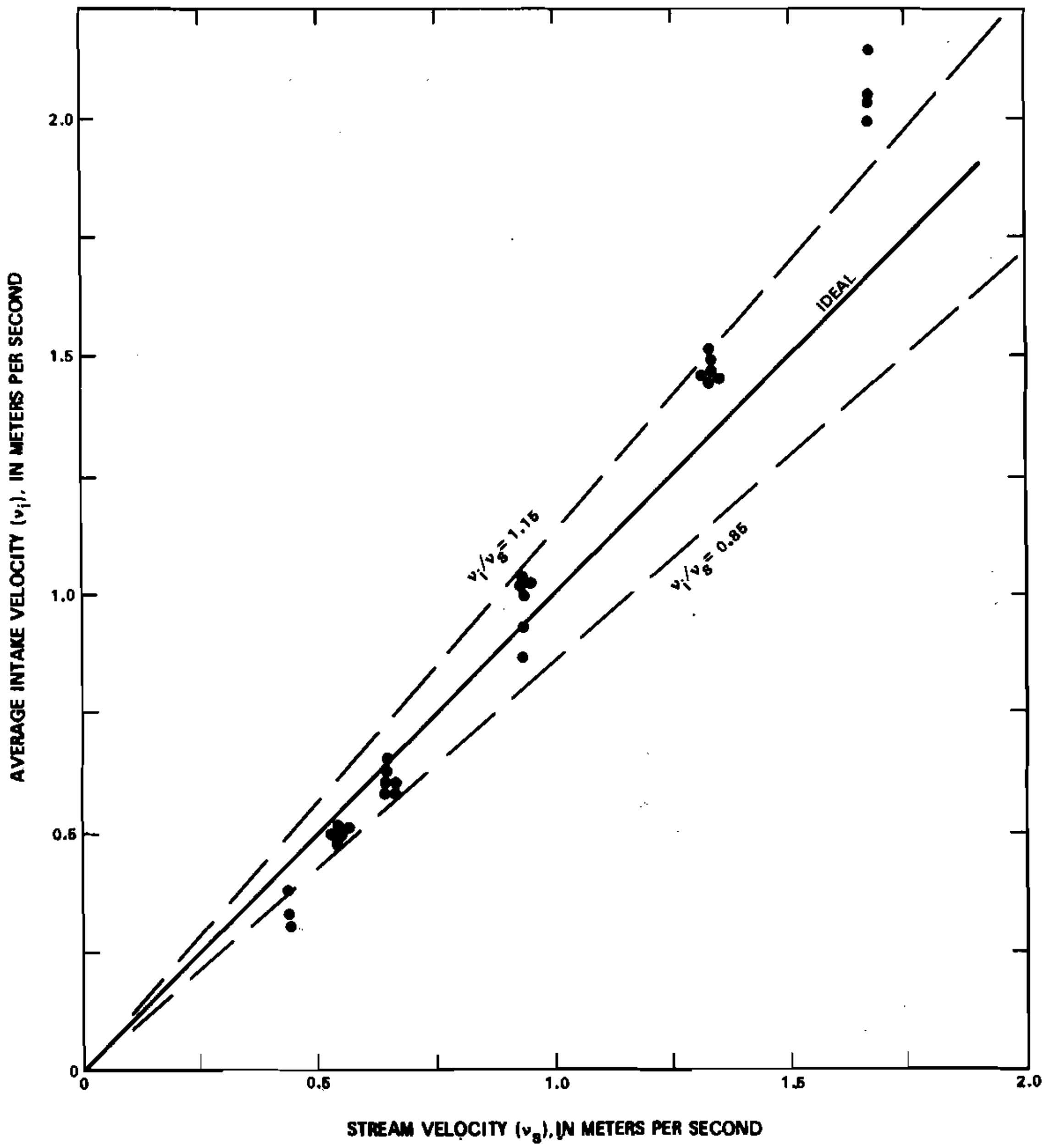


Figure 8.--Average nozzle intake velocities for various stream velocities. Sample volumes were approximately 2.0 liters. Sampling was conducted while using the latex band, valve, and deflector. Aft venting was through the bottom of the bottle. Water temperature was 9.5°C.

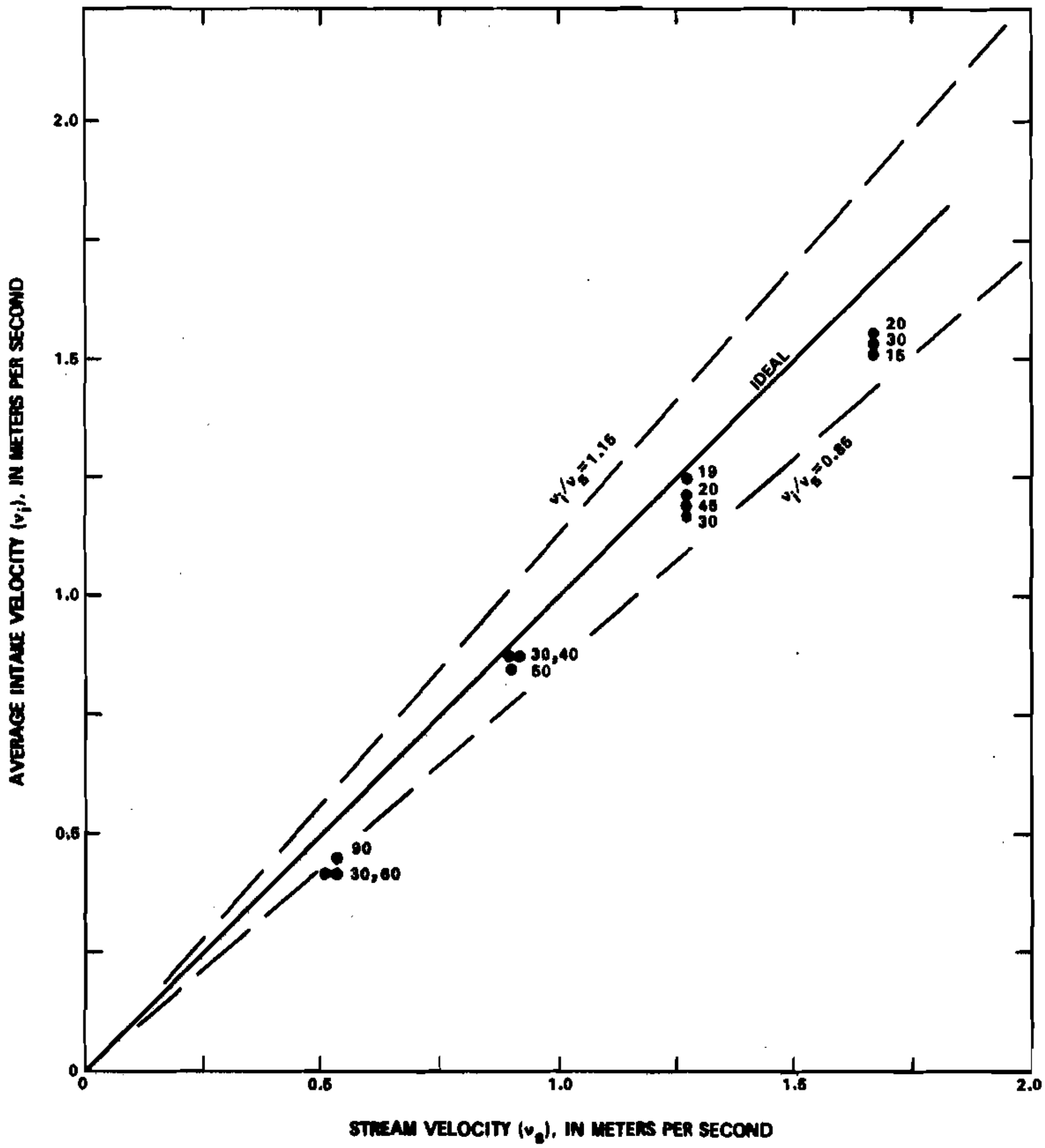


Figure 9.--Data showing average nozzle intake velocities for various stream velocities. Intake velocities are closest to ideal in the mid range of stream velocities. Sampling was conducted with the solenoid valve and plastic bag mask. Water temperature was 22°C. Numbers by data points indicate sampling duration in seconds.

the original lower vent, the enlarged upper vent hole with the deflector, and a thin mask that covered the upstream section of the bottle and casting. The original mask was cut from a sampling bag. A hole was cut in the bag to fit around the nozzle cap. The remainder of the material was trimmed to extend 3 to 5 cm beyond the bottle/casting gap. When wet, the plastic sheet adhered to the sampler, and was forced against the sampler by stream current when submersed. A mask more suitable for field conditions was made from a piece of rubber inner tube. The cupped-shape of the tube conformed well with the surface contour of the bottle and casting. One 6-mm hole was punched in each side of the upper portion of the mask and was stretched over lugs installed on the casting. (See fig. 10).

Bags

The thin (0.02 mm) food-storage bag was compared with the 0.11 mm thick plastic bag used by Stevens and others (1980, p. 611-616). At a stream velocity of 0.72 m/s, the thicker bag would not expand. When the velocity was increased to 1.3 m/s, the relative sampling rate was 0.57 with the thicker bag and 0.80 with the thinner bag. The water temperature was 9°C. The data were adjusted for 2-liter sample volumes.

It was thought that the used, pre-soaked, food-storage bags were more supple than either dry or unused ones and would therefore expand more readily during sampling. On several occasions bags that were new and dry were compared with bags used a few times or many (20-30) times. Some of the used bags were dry and some had been wet for at least the previous 24 hours. Comparisons revealed no systematic difference in relative sampling rate. New bags are therefore considered to be adequate for use without any treatment.

Tests were conducted to investigate leakage into a collapsed bag. The sampler was submerged for a measured amount of time without actuating the valve. The sampler was then retrieved and the volume of water that leaked into the bag was measured. Leakage rate was approximately 60-mL per minute (stream velocity at 0.9 m/s). Repeated tests with the addition

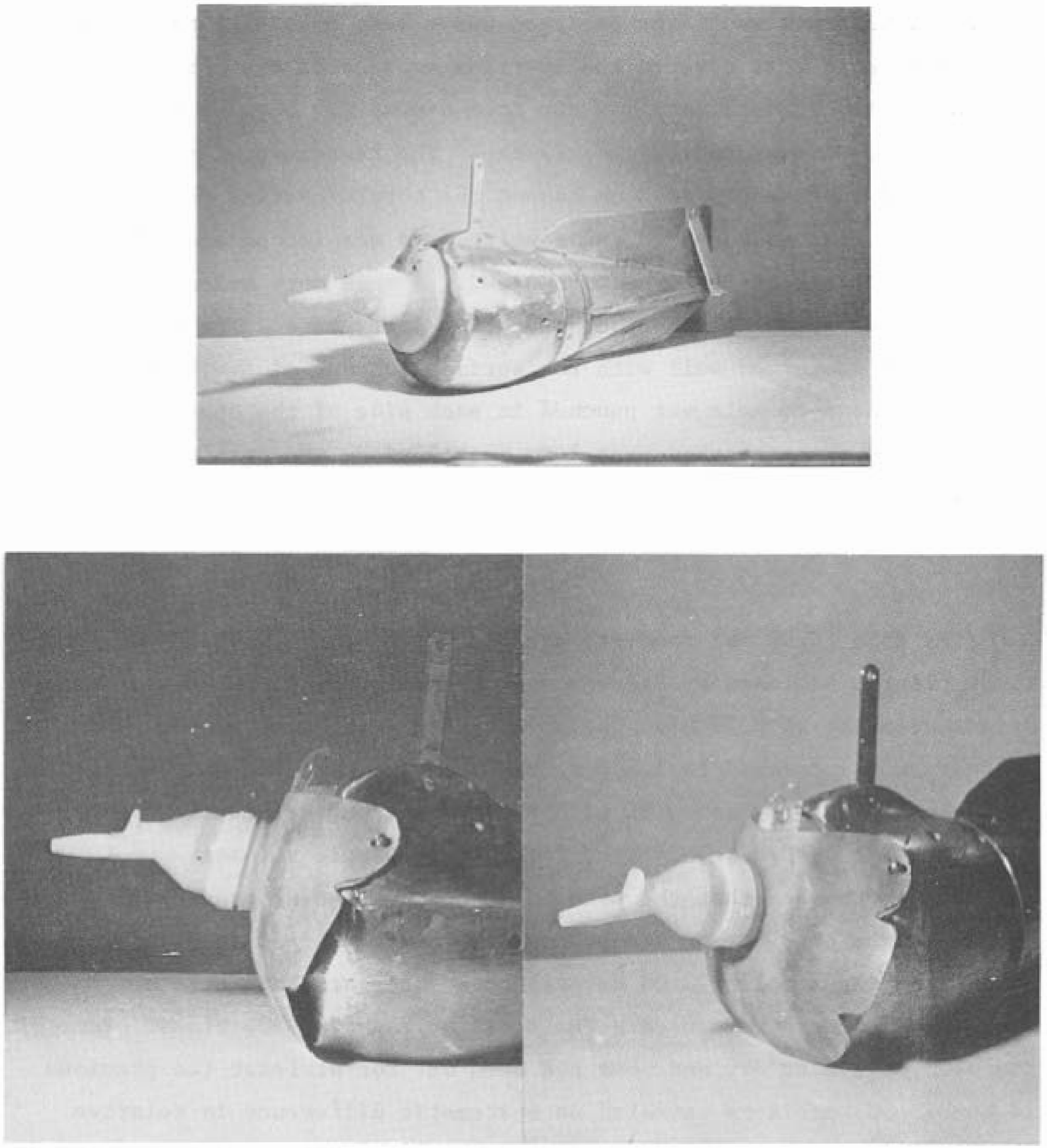


Figure 10.--Upper photograph shows the sampler prior to attachment of the mask. Lower photographs show the sampler with the mask in place. The 12.7-mm holes in the sampler casting are not part of the final configuration.

of a stopper inserted in the nozzle entrance demonstrated that leakage was not through the nozzle. Tightening the nozzle cap reduced leakage past the bottle threads to 10-15 mL per minute. At this rate the quantity of leakage is negligible compared to the total volume of sample collected.

Stream velocity limits

Relative sampling rates are low at the lowest stream velocities because the forces that inflate the bag are approximately equal to or less than the forces that resist inflation. Inflation forces are caused by the negative pressures which develop at the vents and by the positive pressure at the nozzle. Relative sampling rate reached the acceptable minimum level of 0.85 (as previously discussed) at a stream velocity of 0.47 m/s. This level was attained while using the mask. When using the alternate configuration with the hole in the bottom of the bottle and the foam rubber ring, stream velocities were between 0.5 to 0.9 m/s when the 0.85 value was reached.

Relative sampling rates were generally acceptable at the highest stream velocities attained in the test flume, therefore no maximum stream velocity was established. Figure 8 shows a relative sampling rate of about 1.25 for the highest stream velocity attained during that test (1.64 m/s). The rate could be reduced by sampling without the latex band (or deflector).

Flooding time

The time required to flood the sampler cavity prior to sampling was reduced from 27 seconds to about 5 seconds by increasing the size of the upper vent hole and by cutting a slot in the upper portion of the bottle. This slot was aligned with the hanger-bar slot in the casting. The slot in the bottle did not affect the relative sampling rate.

Sampling time and temperature effects

Figure 11 shows the time required for collecting 2-liter and 2.5-liter samples for various stream velocities. Data were collected when the water temperature was 9.5°C. Collection time was greater when sampling at lower temperatures and decreased at higher stream temperatures. The temperature effect was caused by changes in water viscosity and in bag stiffness.

Maximum sample volume

A maximum sample volume had to be established to prevent overfilling the bag, which would result in loss of sample through the nozzle after the sampler is retrieved from the water (when not using the solenoid valve). As the bag approaches fullness, the relative sampling rate will diminish and will result in a misrepresentative sample. Tests were conducted without the valve. Samples were collected until the bag was full, then the excess water was allowed to drain through the nozzle. The volume of the water remaining in the bag was then measured. The test was repeated several times and the water remaining in the bag was found to vary from 2.6 to 2.7 liters. A volume of 2.5 liters is suggested for a maximum sample volume. This maximum limit will reduce the possibility of losing part of the sample during retrieval when sampling without the valve. Also, figure 4 shows that if sample volumes are less than 2.5-L, the relative sampling rates will be acceptable.

Trapped air

Excess air within the sampling bag is undesirable because it may interfere with venting, will decrease the maximum sample volume, and will adversely affect the relative sampling rate. Tests were conducted to determine the amount of trapped air. Samples were collected while following established procedures. The rigid 3-liter bottle was then withdrawn from the sampler. The bottle was placed nozzle side down in a tank of water. Air within the bag was isolated near one of the holes in

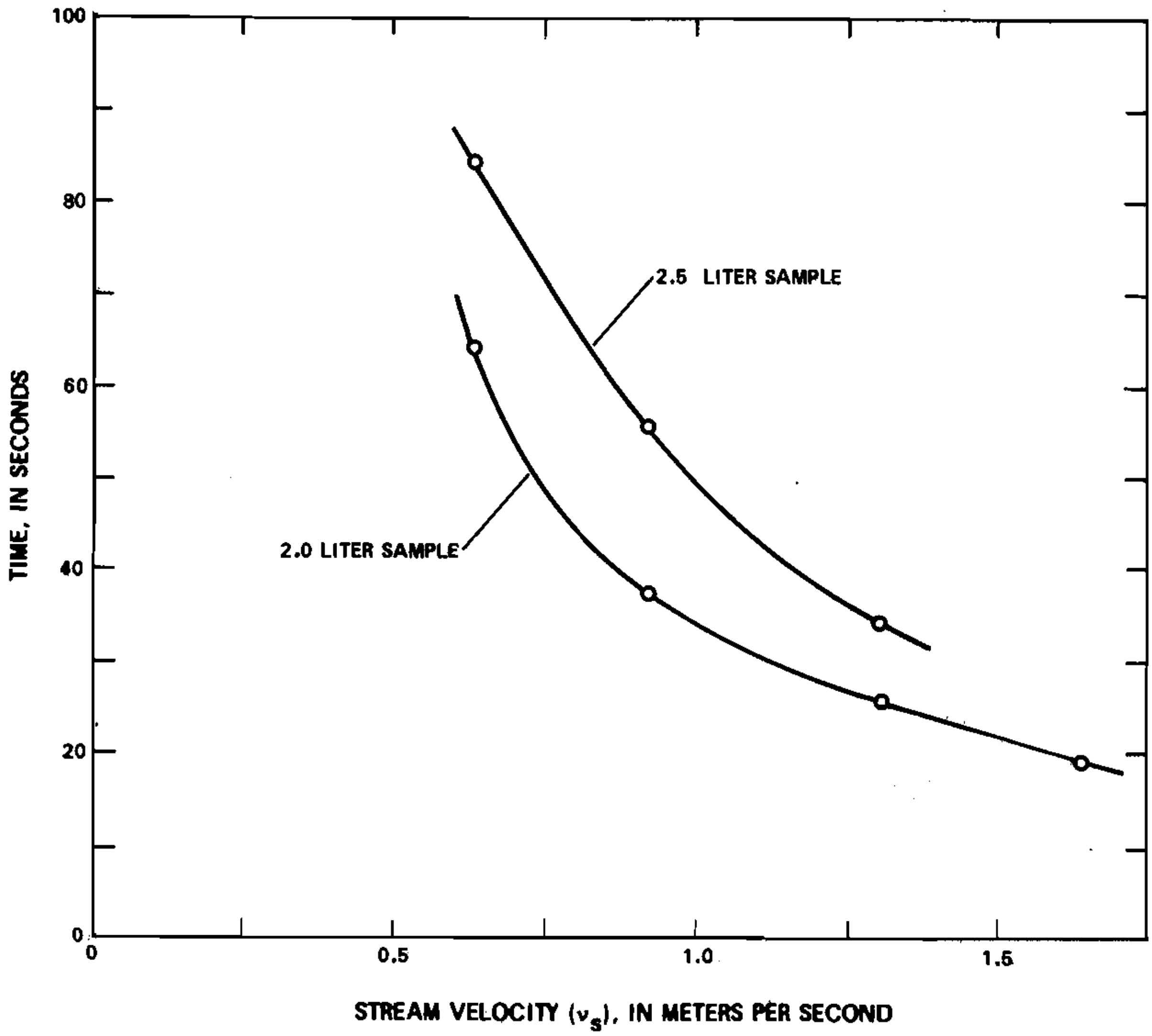


Figure 11.--Graph showing sampling time required to collect 2.0 and 2.5-liter samples for various stream velocities. Data points shown were extrapolated and interpolated from data collected when the water temperature was 9.5°C. Sampling was conducted while using the valve, mask, and deflector.

the bottle. The bag was punctured and the escaping air was collected in a submersed, inverted, water-filled, graduated cylinder. The test was repeated several times. Collected air volumes ranged from 50 to 150 mL, which is a tolerable level. Trapped air can be kept at a minimum by following proper pre-sampling procedures (see Appendix A).

Retainer plate

Two complaints from the field concerning loss of bottles due to weakening of the D-77 sampler retainer spring prompted a review of the design. A flat plate, about 3.5-cm wide and the length of the cavity in the D-77 sampler, was attached to the upper port-side wall. This provided a snug fit with the bottle installed. Wear on the plastic bottle was negligible.

Sampling without the valve

The relative sampling rate was determined for sampling with the valve removed. This arrangement provided less resistance to sample inflow and increased the relative sampling rate. Results indicated that it may be preferable to use the bag sampler with the valve removed for depth integration from the surface when low velocity flow and cooler water temperatures prevail.

Solenoid valve

The solenoid-actuated valve performed satisfactorily, though internal misalignment occurred on several occasions. Misalignment was caused by machining errors and was easily corrected. The original design was modified to reduce headloss by reducing the cross-sectional area of the valve body. Material was also removed from the forward edge of the valve body to streamline the flow in this constricted area.

The base for the pad at the nozzle exit was redesigned to flex a few degrees to improve sealing while closed.

The latex diaphragm was found to be incompatible with methanol, so Teflon [1/] sheet and silicone-rubber cloth were substituted, each of which performed satisfactorily.

Adhesion of sediment to bag

Several bags of sediment-water mixture were allowed to stand for a few days. The mixtures were then poured out and the bags examined. Clays did not appear to adhere to the plastic, but bags that had contained silt and fine-sand sizes retained some of these particles within residual beads of water. Two procedures for recovering these particles are outlined within Appendix C.

FINDINGS

The bag sampler system can sample with relative sampling rates in the 0.85 to 1.15 range when stream velocities are greater than 0.47 m/s. Tests were not conducted above 2 m/s, so no upper limit is established.

The relative sampling rate is dependent on the sample size. It is high for the early part of collection, steady in the 1 to 2-liter range, and decreases as the bag approaches fullness.

Flow through the gap between the 3-L bottle and the inner walls of the D-77 body must be prevented. Such flow interferes with proper venting and reduces the relative sampling rate.

A deflector placed upstream of the upper vent increases the relative sampling rate.

The sample intake rate through the nozzle is temperature dependent, increasing with an increase in temperature and decreasing with a decrease in temperature.

1/ Trade names are included for information of the reader and do not constitute endorsement by the United States Government.

The modified D-77 sampler used for these laboratory tests did not show any adverse handling characteristics.

The solenoid valve developed during these tests performed satisfactorily.

The sample collection bags can be used without any pre-treatment.

Small amounts of sediment are retained by the bags, but are recoverable.

A maximum sample volume of 2.5-L has been established.

The sampler cavity can be flooded in 5 seconds.

A retainer plate was developed to replace the bottle-retainer spring in the D-77.

CONCLUSIONS

The bag sampler system, which consists of the D-77 sampler, 3-liter bottle, nozzle, and nozzle cap, along with the commercially-available plastic food-storage bag and the newly-developed solenoid valve, has potential for field use.

Two variations of the basic design evolved from these tests. The configuration that uses the mask provides relative sampling rates closest to ideal over the widest range of stream velocities. The configuration with the foam-rubber ring and vent hole through the bottom of the bottle shows less reliable performance at low stream velocities, but it also eliminates the need for the mask.

NEED FOR ADDITIONAL TESTING

Laboratory development and testing should continue in order to eliminate need for the mask.

Relative sampling rates at low stream velocities and low temperatures should be improved. Suggested approaches are to increase the waterway area around the valve and to find a more supple bag.

Nozzles having smaller internal diameters should be tested.

Field-tests should be conducted to test the bag sampler and P-61 sampler side-by-side. Tests should be at stream velocities and depths greater than those attainable in the laboratory. Samples should be collected and analyzed for sediment concentration and particle size.

Tests should be conducted to authenticate or improve procedures mentioned in this report.

Reliability and salt-water damage to the solenoid valve should be investigated, as well as the retention of sediment within the nozzle cap-valve assembly.

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APPENDIX A

Set-up and sampling procedures

To deplete air from the bag, grasp an upper corner and the lower corner on one side of the bag, using thumb and fingers of each hand. Pleat the bag while holding ends taut. Insert the closed end into the bottle. Flair the top of the bag over the mouth of the bottle, then distribute the material evenly around the bottle threads. Gently screw on the nozzle cap while holding the outer bag material against the neck of the bottle. Check for leakage between the nozzle and valve seat as described in Instructions for use of the solenoid valve, (Appendix B). Connect the BP-76 battery pack to the valve assembly and test the unit as directed by the Instructions for battery pack BP-76 (Skinner, J. V., 1976).

Insert the bottle into the D-77 sampler cavity. The bottle should be firmly seated against the foam seal when using this configuration. If the mask configuration is used, install the mask by stretching the upper left and right holes over the lugs on the D-77 body.

Lower the sampler into the water until the top is several centimeters below the surface. The 3-liter bottle is flooded when bubbling ceases. Sample collection may now proceed. Use techniques similar to those used for the P-61 and P-63 suspended-sediment samplers.

Post-sampling procedures are explained under Sample extraction, (Appendix C).

APPENDIX B

Instructions for use of the solenoid valve

1. Remove the valve assembly from the nozzle cap by removing the retainer screw located on the side of the cap. Slide the valve out of the nozzle cap. Be careful not to damage the two wires that connect the valve to the cap.

2. Remove either of the screws on the side of the valve. These screws have rubber O-ring seals under the head. With the valve plunger down fill the valve with methanol, then replace the screw. WARNING: Do not remove the screw(s) at the aft end of the assembly. Expect some leakage around the shaft. If methanol contamination of the sample is unacceptable, use distilled water instead.

3. Manually actuate the solenoid plunger by depressing the valve seat with your thumb. Repeat several times to verify the plunger moves smoothly.

4. Reinstall the valve in the nozzle cap; be careful not to pinch the wires. Pull any slack wire back to the end of the valve and tape to the aft portion of the assembly (optional). Do not install the retainer screw.

5. Check for tightness of seal between the valve seat and the nozzle by blowing gently into the nozzle. If leakage is present withdraw the valve from contact with the nozzle and turn the nozzle slightly in either direction. Reinsert the valve and repeat procedure as necessary. WARNING: Do not turn the nozzle while the valve is closed. This may damage the valve seat pad and the extension springs within the unit.

6. Connect the BP-76 battery pack to the valve. Switch the battery pack to the "CHARGE" position. Wait at least 60 seconds, then switch to the "SAMPLE" position (hold the switch, do not release). The valve should function with an audible "CLICK." Blow into the nozzle to

confirm that the valve is in the open position. The valve should close when the switch is released. Install the retainer screw.

7. The valve is now ready for sampling. Repeat switching sequence as mentioned above during actual sampling.

8. Drain the fluid from the valve at the end of each work day. Refill with fresh fluid and test the valve at the start of the next work day.

APPENDIX C

Sample extraction

The handling of unconfined filled sample bags is unadvisable due to the likelihood of rupture and leakage. A bag filled with sample cannot be conveniently removed from the rigid bottle. Shipping in the modified bottle is not advisable because the collapsible bag could be punctured through the vent holes and because this would be an inefficient use of the specialized container. The suggested procedure for handling of the sample is to remove the nozzle cap with one hand while holding the loose plastic bag material against the neck of the bottle with the thumb and forefinger of the other hand. This will help prevent tearing of the bag. Maintain the grasp on the bottle neck and pour the sample into a standard D-77 3-liter plastic bottle. This will allow excess water and sediment from outside of the collapsible bag to drain from the bag without contaminating the sample. Remove the bag and rinse off any sediment adhering to the exterior.

Now, either (1) rinse the inside of the bag with a known (recorded) amount of sediment-free water and add it to the sample; or (2) insert the bag into the bottle containing the sample. Screw on the cap. The sample is now ready for labeling, transporting, and storage. If the bag was included with the sample, laboratory personnel should remove the sediment from the bag prior to analysis of the sample.

An investigation of sediment adhesion to the plastic bag was conducted. Clay did not appear to present a problem, but beads of water remaining with the bag entrapped silt and fine sand sizes. Retention of the bag with the sample may be preferable for this reason.