Operator's Manual for the US DH-81 Depth-Integrating Suspended-Sediment Sampler

Characteristics

Description: The US DH-81 is not a specific sampler in the sense of other Federal Interagency Sedimentation Project (FISP) depth-integrating suspended-sediment samplers. The US DH-81A is a plastic adapter with a threaded insert, which accepts a 1/2-inch (in) wading rod and is used with a variety of caps, nozzles, and containers to assemble a hand-held sediment sampler designated as the US DH-81. The US DH-81A will accept a plastic or perfluroalkozy (PFA) US D-77 cap or a US D-95™ Cap which is made of tetrafluoroethylene (TFE). The US D-77 cap is threaded to accept any container with Mason jar threads. The US D-95™ Cap is threaded to accept a 1-liter (L) fluorinated ethylene propylene (FEP) bottle. US D-77 plastic and TFE nozzles with internal diameters of 3/16, 1/4, and 5/16 in can be used with the US D-77 and US D-95™ Caps. The stainless steel wading rod used with the US DH-81A is available with or without a covering of plastic heat-shrink tubing to help prevent contamination of samples for trace metal analysis in water-quality sampling. An assembled US DH-81 sampler is shown in figure 1.

Container: US D-77 caps are threaded to accept any container with Mason jar threads, including containers with volume capacities up to several liters and containers made of glass. However, FISP only recommends the use of plastic or FEP 1-L bottles in the US DH-81 sampler. The sampler is difficult to use with large volume containers such as a 3-L bottle. The difficulty is in trying to submerge such a large volume of air by hand. Doing so is analogous to pushing a soccer ball underwater by hand. Maintaining a correct transit rate with the large volume container is difficult due to the compression rate of the large air volume. Use of a large volume container with the US DH-81 sampler results in a large unsampled zone compared with the 1-L bottle, which is especially important in shallow wadable streams. FISP recommends that glass containers not be used with the US DH-81 sampler. The container is completely unprotected in a US DH-81 and glass containers break easily when accidentally mishandled in streams with rocks and cobbles. If a glass container must be used, extreme caution should be exercised when touching the stream bottom during a transit.

Several cap/bottle combinations can be used to configure a US DH-81 sampler (figure 2). The 1-L plastic bottle has Mason jar threads and may be used with either the plastic or PFA US D-77 cap. Normally a plastic bottle would not be used with a PFA cap. However, in the event that a user had a PFA cap in hand and needed to take samples that did not require the use of the more expensive FEP bottle, a plastic bottle could be used. Use of a 1-L FEP bottle with a PFA US D-77 cap requires a 1-L bottle adapter (figure 3) because the FEP bottle does not have Mason jar threads. However, the US D-95™ Cap is designed to accept the 1-L FEP bottle directly. If use of a US DH-81 sampler is required for a sampling program, the user may contact FISP to determine the appropriate combination, especially if some of the parts are already in-hand. Table 1 presents cap/bottle combinations. Table 2 gives FISP part numbers for US DH-81 sampler equipment parts.

Sampler function: When the sampler is submerged with the nozzle pointing into the flow, the water-sediment mixture flows through the nozzle into the bottle, forcing air to exhaust through the air vent hole in the cap. A continuous stream filament is discharged into the sample container during the entire time of submergence.

Limitations

Velocity limitations: The US DH-81 sampler will collect flow-weighted samples at acceptable inflow efficiency in stream velocities from 2.0 to 6.2 feet per second (ft/sec) with a 3/16-in nozzle, 1.5 to 7.6 ft/sec with a 1/4-in nozzle, and 2.0 to 7.0 ft/sec with a 5/16-in nozzle. Inflow efficiency is defined as the ratio of the water-sediment velocity entering the nozzle to the ambient stream velocity. An inflow efficiency of 1.0 is referred to as isokinetic. An acceptable inflow efficiency has been determined to be 0.9 to 1.1.

Volume limitation: Although the US DH-81 sampler uses a 1-L bottle, it is recommended that the sample volume collected not exceed approximately 800 milliliters (mL). The nozzle is horizontal when the sampler is in the stream collecting a sample. If the sampler is filled to approximately 1-L, the level of the sample in the container is near the bottom of the nozzle. If the rear of the nozzle becomes submerged by the water in the sample container, the inflow velocity will be reduced and the sediment concentration may no longer reflect the ambient suspended-sediment concentration.

Depth limitation: Based on the recommended maximum volume of 800 mL, the US DH-81 sampler will collect flow-weighted samples to a maximum recommended depth of 12 feet (ft) at sea level. The sampler can be used to a depth of 15 ft at sea level by collecting up to 1-L of sample. To sample to depths greater than can be waded, wading rod extensions in 1- and 3-ft lengths can be added to the sampler. With the extensions, the sampler can be deployed from a low bridge or boat.

A maximum safe wading depth depends on the size of the user, the stream velocity, and the streambed material. Each user should know and strictly adhere to his/her personal wading limitation. A wading factor can be determined by multiplying the depth (ft) of the stream by the stream velocity (ft/sec). As a general guide, a stream condition that produces a factor of 10 or greater should not be waded. Caution should always be used when wading streams deeper than 3 ft. Additional caution should be used when the streambed is composed of loose or slippery material. Algae-coated cobbles can be as slippery and as dangerous as ice. A personal flotation device should always be worn when wading (USGS WRD Memo 99.32). Additional safety information on wading is available in S.R. Abt, et. al., Human Stability in a High Flood Hazard Zone, American Water Resources Association, Water Resources Bulletin, V.25, no. 4, 1989, pp. 881-889.

Unsampled zone: The unsampled zone is the distance between the nozzle and the streambed at the lowest point to which the sampler is lowered. If the sampler is allowed to touch the streambed, the unsampled zone is the distance between the nozzle and the bottom of the sampler,

which in the case of the US DH-81 sampler is the bottom of the container. The unsampled zone for the US DH-81 sampler with a 1-L bottle is approximately 4 in. The unsampled zone for other containers must be determined by the user.

Transit rate limitation: The transit rate (R_t) is the speed of lowering and raising the sampler in the stream vertical. Transit rate diagrams for various combinations of the US DH-81 sampler are presented in figures 4-12. The dark blue shaded area shows the transit rate for the recommended volume of 800 mL, and the light blue shaded area shows the transit rate for the maximum acceptable volume of 1000 mL. Table 3 gives the filling time to collect 800 mL of sample at various velocities using the three available nozzle intake diameters. The following factors should be considered when selecting a transit rate:

1. R_t must be fast enough so the bottle is not overfilled.
2. R_t must be slow enough to obtain a sample of sufficient volume for analysis.
3. R_t must not exceed the approach angle limit (0.4 times the mean stream velocity).
4. R_t must be slow enough to not exceed the compression rate limit.

Instruction for use of the US DH-81 sampler

Cap modification: US D-77 plastic and PFA caps are molded with four locking "lugs" on the outside of the rear of the cap (figure 13). The lugs are located at the 12:00, 3:00, 6:00, and 9:00 o'clock positions. The top lug (12:00 o'clock position) must be removed before the cap will fit into the US DH-81A. FISP removes the lug prior to shipment to a user. However, some caps that have the top lug may be still in the field. If so, it must be removed prior to use in the US DH-81A. It can be removed easily with a utility knife.

In 1994, the US D-77 cap mold was modified so that four longitudinal "ribs" are molded on the angled face of the cap and are located at the 12:00, 3:00, 6:00, and 9:00 o'clock positions (figure 13). All four ribs on the angled face of the plastic cap must be removed prior to use in the US DH-81A. The ribs should not be removed from the PFA cap prior to use in the US DH-81A. These modifications are required because of the difference in shrinkage between plastic and PFA in the molding process. PFA shrinks more than plastic, so the ribs are needed to ensure that the PFA cap is tightly secured in the US DH-81A. The plastic cap does not need the ribs to be secured properly. FISP removes the ribs on plastic caps before shipment to a user. However, if the user has a plastic cap that has the ribs, they must be removed prior to use in the US DH-81A. The ribs can be removed with a utility knife. PFA caps molded prior to 1994 that do not have the ribs on the angled face require other modifications prior to use in the US DH-81A. FISP should be contacted for proper modification instructions for these early production caps.

The US D-95™ Cap requires no modification prior to use in the US DH-81A.

Inspection: The cap should be inspected for proper lug and rib configuration. The vent hole (figure 13) should be clear and unobstructed. The user should never make modifications to the vent hole. The threads in the nozzle hole should be checked for stripping and obstructions. The

threads can be chased with a 9/16-18 NF threading tap. The cap should be checked for cracks. A cracked cap should be discarded.

The US DH-81A should be checked for cracks. A damaged part should be discarded. The threaded aluminum insert that accepts the wading rod should be inspected. Damaged threads can be chased with a 3/8-20 NS threading tap. The US DH-81A should never be acid rinsed. Doing so will lead to corrosion of the metal insert.

Nozzles should be inspected for any visible damage. Nozzles with any deformation around the intake should be discarded. The nozzle bore should be checked for any burrs or roughness. Nozzles with bore damage should be discarded. The threads on the nozzle should be checked for damage. Damaged threads can be chased with a 9/16-18 NF threading die. Plastic nozzles should not be used when an acid rinse is required in the sampling protocol. Use only TFE nozzles when an acid rinse is required. All plastic US D-77 nozzles produced after May 2000 have a red identification ring.

The wading rod and any wading rod extensions should be checked for damage to the screw threads. If damaged, the threads can be chased with a 3/8-20 NS threading die. The female threads of wading rod extensions can be chased with a 3/8-20 NS threading tap. Attempting to mate a wading rod with damaged threads to a US DH-81A can damage the threads in the aluminum insert in the US DH-81A (figure 14). Plastic coated wading rods and extensions should be checked for damage to the plastic coating. Damaged coverings should be replaced with high quality 1/2-in diameter clear heat shrink tubing.

Sampler assembly: The selected cap should be inserted into the US DH-81A. The US DH-81A is designed with three semi-circular slots (figure 14) in the rear that accepts the three locking lugs on the cap. The cap will fit into the US DH-81A only one way. Once inserted, the cap should be rotated clockwise (viewed from the rear) until it is firmly seated. When correctly assembled, the vent hole in the cap should be in line with the wading rod receptacle. The nozzle can now be threaded into the cap. It should be hand-tightened only. Pliers or wrenches should not be used, as they may damage the nozzle. The wading rod and any extensions are subsequently attached. Lastly, the appropriate bottle is threaded into the cap.

Sampling: Detailed instructions for suspended-sediment sampling are contained in Edwards and Glysson's Field Methods for Measurement of Fluvial Sediment, Techniques of Water-Resources Investigations of the US Geological Survey, Book 3 Applications of Hydraulics Chapter C2, 1999, pages 35-70. Detailed instructions for water-quality sampling are contained in the National Field Manual for the Collection of Water-Quality Data, Techniques of Water-Resources Investigations of the U.S. Geological Survey, Book 9, Chapter A4, Collection of Water Samples, 1999, pages 25-48. Prior to collecting a sample, measure or estimate the mean velocity at each stream vertical. When using the equal-discharge-increment (EDI) technique, an approximately equal volume of sample should be collected at each stream vertical if the samples are composited prior to analysis. A transit rate can be determined from the information presented in table 3. First, locate the velocity in the first column of the table; then find the corresponding time to collect 800 mL of sample for the nozzle size being used. To determine the transit rate, multiply

the stream depth at the sampling vertical by 2 and divide by the sampling time. The result is the transit rate in ft/sec.

Example:

Mean velocity in the sampling vertical = 4.0 ft/sec
Sampling time for 3/16-in nozzle = 37 (sec Table 3)
Depth at sampling vertical = 3.0 ft
Transit rate = 2 x (3 ft) ÷ (37 sec) = 0.16 ft/sec

With the EDI method, the transit rate at each vertical will be dependent upon the depth and mean velocity at that vertical. To determine a transit rate for a volume less than 800 mL, divide 800 by the desired volume, then multiply the transit rate as determined for 800 mL. For the above example, the transit rate to collect 400 mL would be 800 ÷ 400 x 0.16 or 0.32 ft/sec.

Sampling using the Equal-Width-Increment (EWI) method requires the user to maintain a consistent transit rate in every vertical in the stream cross-section. The user should determine the mean stream velocity and the deepest sampling depth in the cross-section. Find the transit rate diagram for the container and nozzle being used. Apply the velocity and depth information to determine a proper transit rate.

Example:

Mean stream velocity = 3 ft/sec
Maximum depth in sampling vertical = 2.5 ft
Container: 1-liter plastic
Nozzle: 3/16 in diameter plastic
Use transit rate diagram in figure 5
Find 2.5 ft depth on Y-axis, move horizontally to middle of "Recommended" zone
Move vertically to intersect the X-axis and read the "Transit Rate Divided by Mean Velocity", 0.1 for this example
Multiply 0.1 times the mean velocity, 0.1 x 3 ft/sec = 0.3 ft/sec
The transit rate is 0.3 ft/sec and should be maintained at every vertical

When wading a stream to collect a sample, the user should minimize flow resistance and maximize stability. By turning sideways, the force of the water against the body that would push the user downstream can be minimized. Slightly bending the upstream knee and leaning into the flow will increase stability. The sampler should be held away from the body and as far upstream as possible. The wading rod should be held vertically with the sampler nozzle horizontal and pointing upstream. Figure 15 shows a proper position for sampling. Begin the transit with the sampler above the surface of the stream using the predetermined transit rate. Maintain the transit rate until the sampler container touches bottom, then immediately reverse the direction of the transit and maintain the transit rate until the sampler clears the surface. Care should be taken when touching the stream bottom so as not to disturb loose sediment and bias the sample. Once the sampler clears the surface, the user should be careful not to tilt the sampler forward so that the nozzle tilts down. If the container is nearly full, water could run out of the container back through the nozzle and bias the sample.

Upon completion of sampling with a particular container, remove it by firmly holding the cap with one hand and removing the container with the other hand. The wading rod may be secured under the user's arm, or rested on the user's shoulder during the operation. When collecting water-quality samples, the 2-person, clean-hands/dirty hands sampling technique should be used as described in the National Field Manual for Collection of Water-Quality Data, Chapter A4, pages 17-18. Cap and label the container. Each sample container label should contain adequate information. For sediment sampling, the following information should be considered:

- Name of stream
- Location of cross-section
- Location of vertical
- Stream depth covered by sample
- Stage of stream
- Date
- Time
- Identification of personnel
- Sampling time
- Water temperature
- Coordination with sample groups
- Serial number of sample

Appropriate documentation should be made for water-quality samples.

Questions and comments regarding sampler operation should be addressed to:

FEDERAL INTERAGENCY SEDIMENTATION PROJECT
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
(601) 634-2721
woneal@usgs.gov

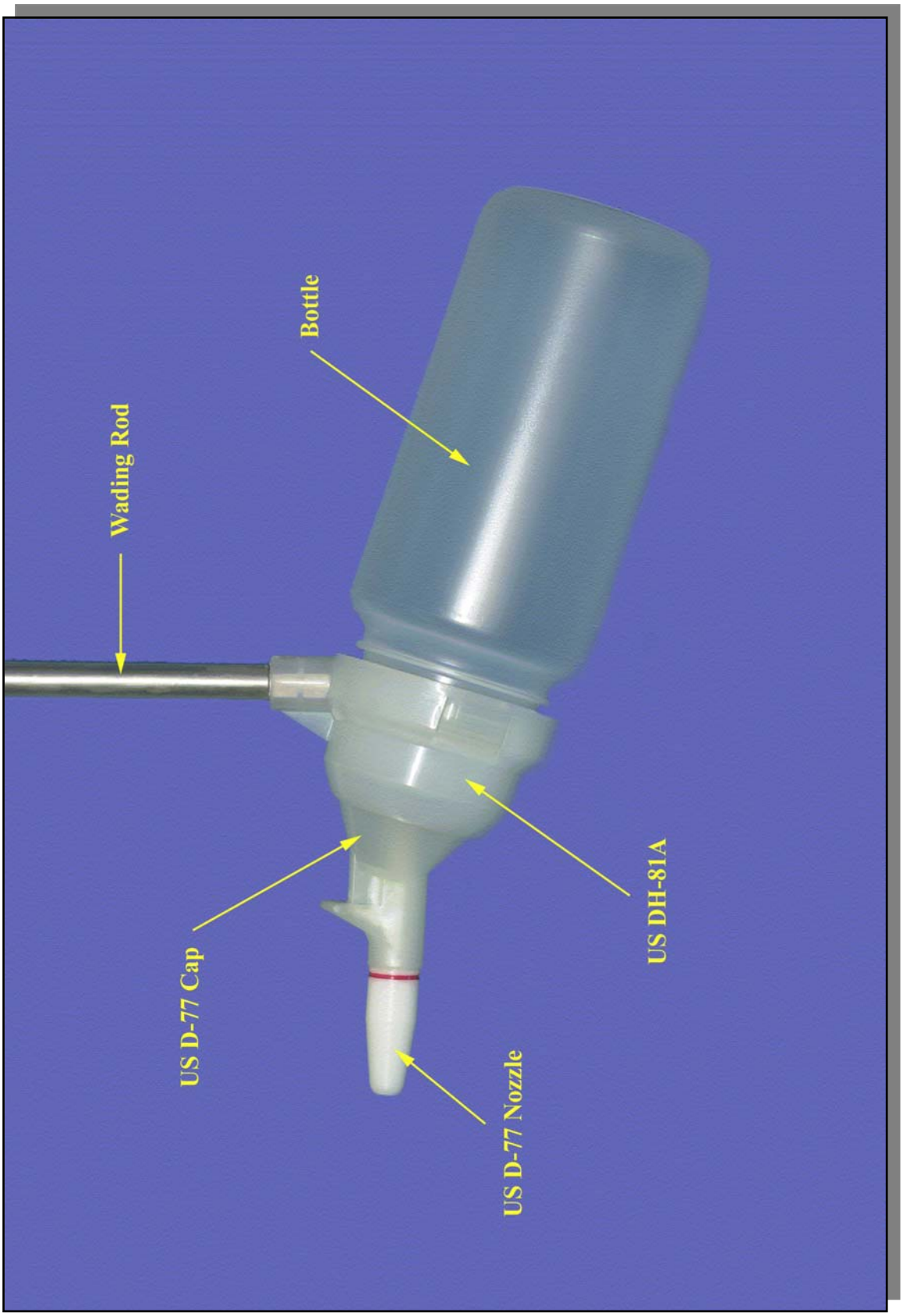


Figure 1. US DH-81 sampler

Figure 2. US DH-81 sampler cap/bottle combinations

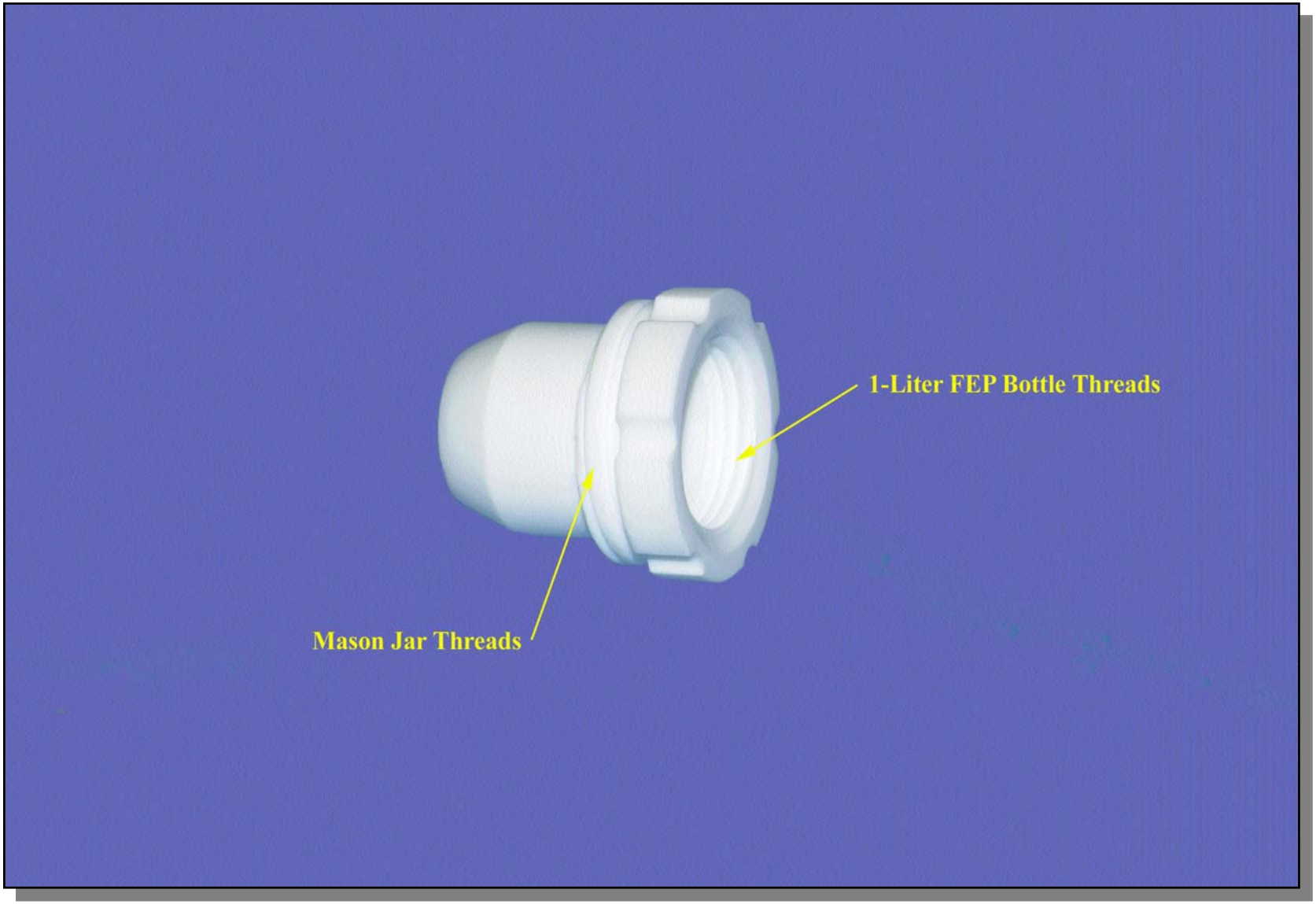
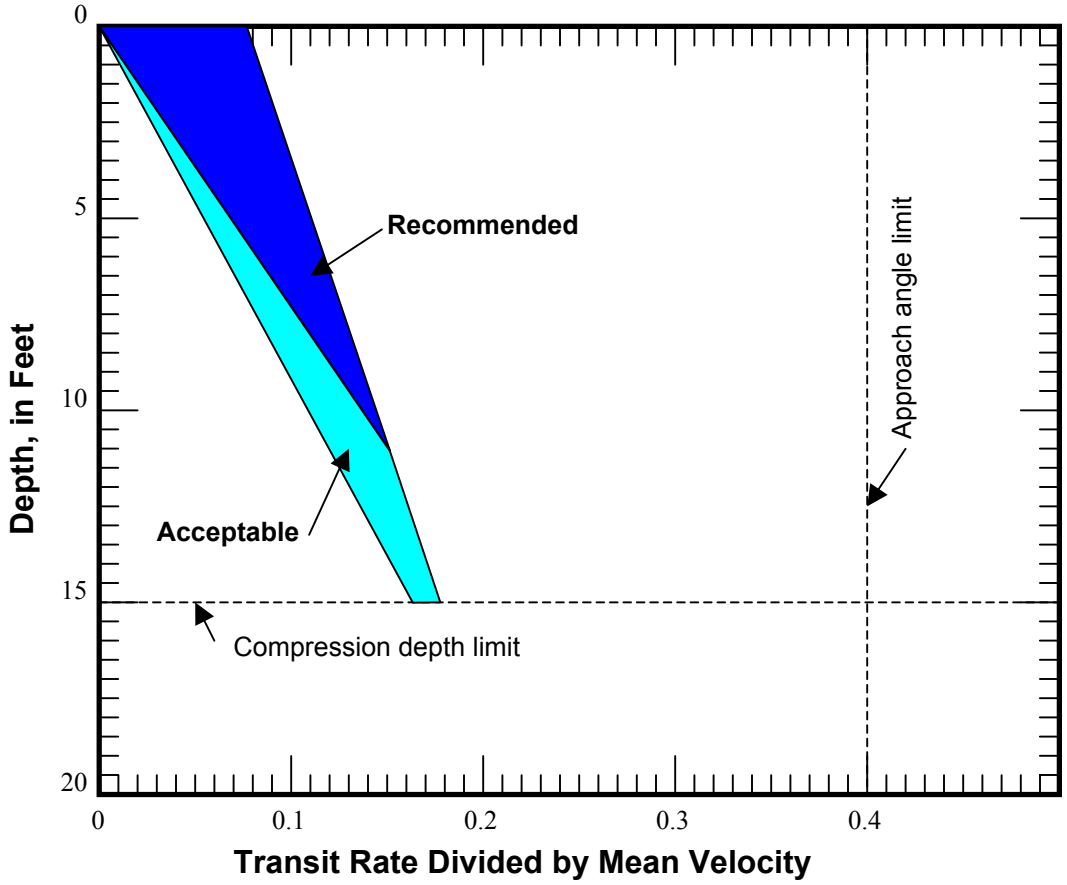
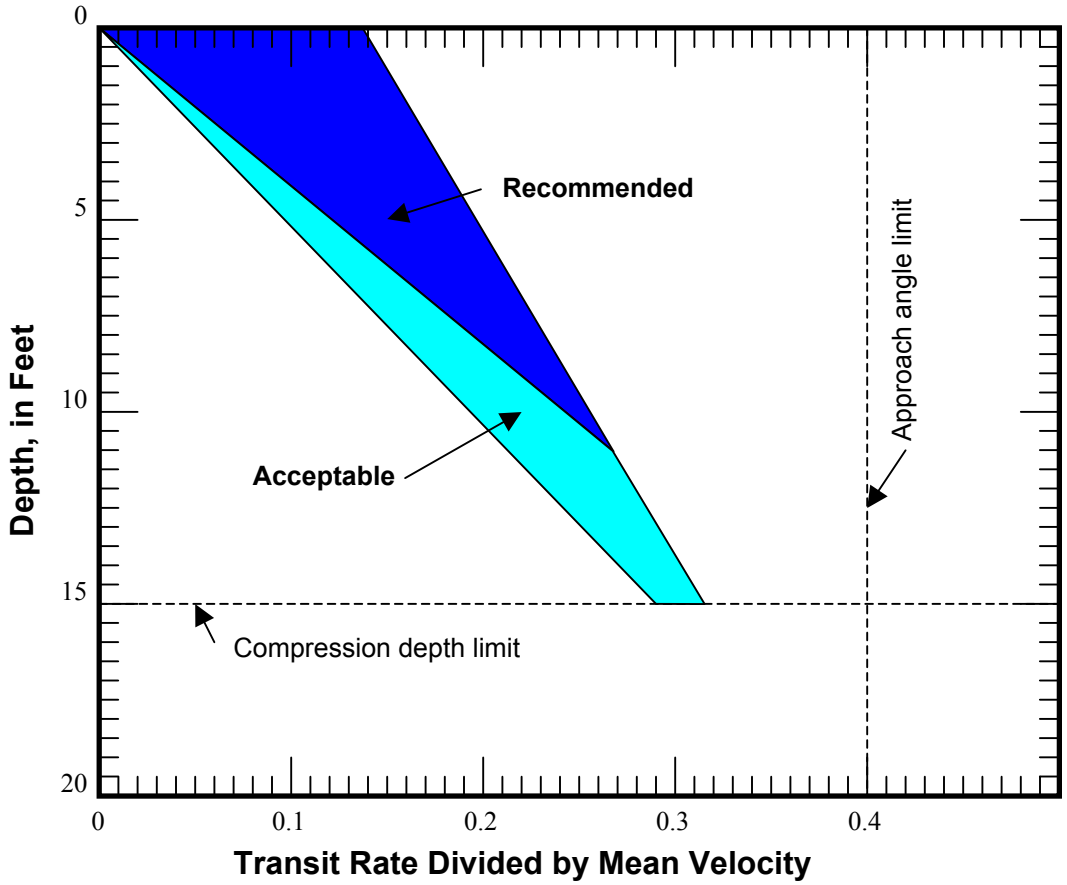


Figure 3. One liter TFE bottle adapter



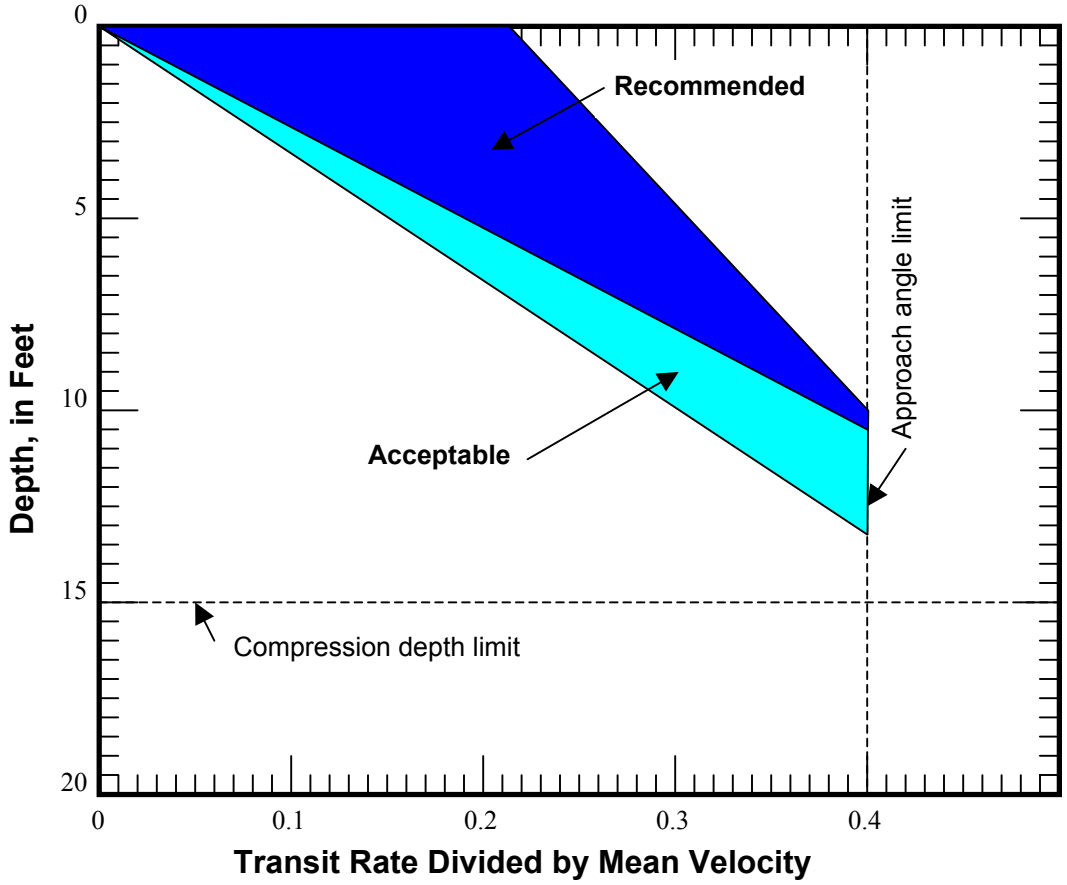
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1215 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

Figure 4. Transit rate diagram for the US DH-81 sampler with a US D-77 plastic cap, 1-L plastic bottle and a 3/16-in plastic nozzle



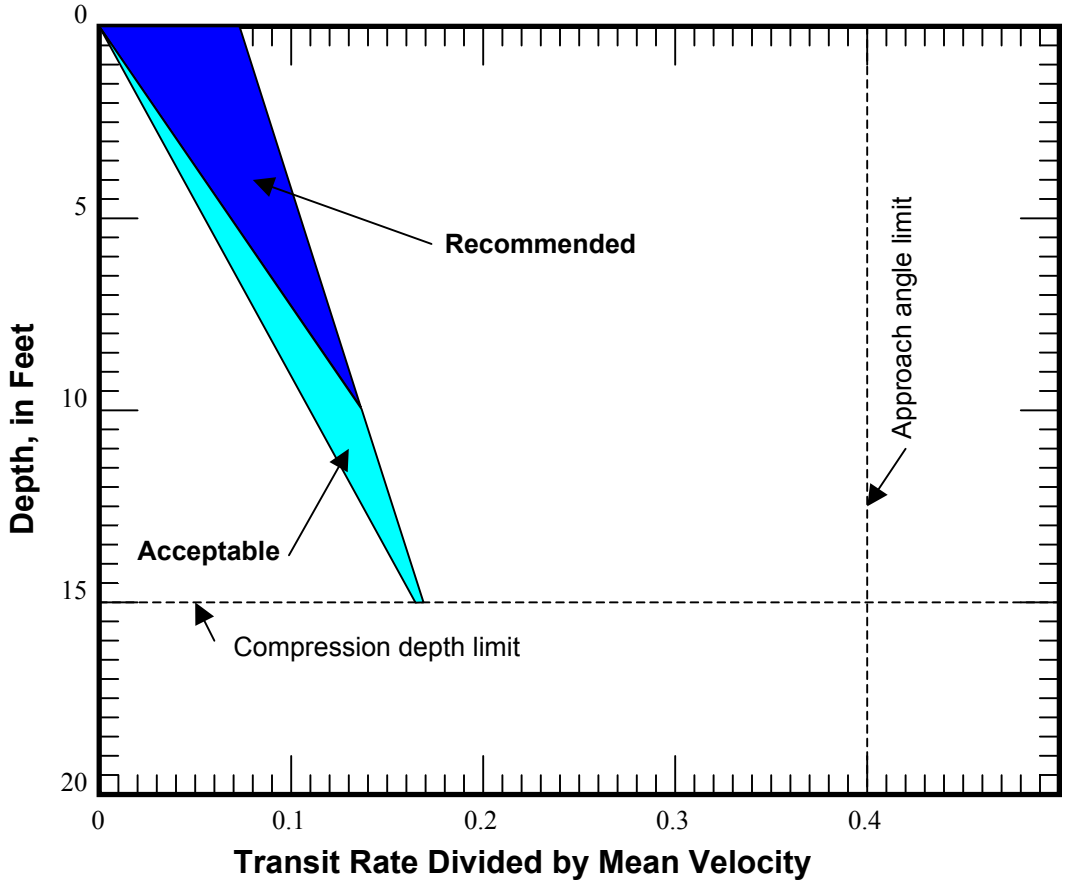
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1215 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

Figure 5. Transit rate diagram for the US DH-81 sampler with a US D-77 plastic cap, 1-L plastic bottle and a 1/4-in plastic nozzle



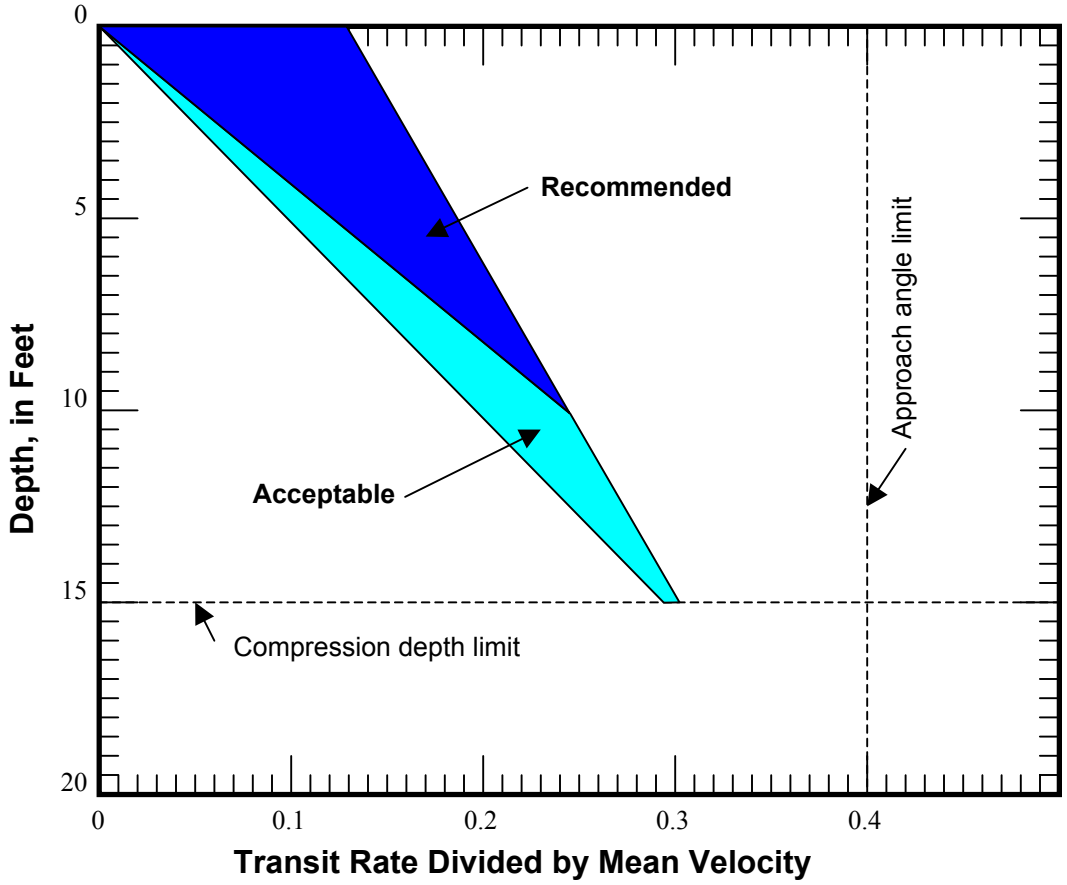
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1215 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

Figure 6. Transit rate diagram for the US DH-81 sampler with a US D-77 plastic cap, 1-L plastic bottle and a 5/16-in plastic nozzle



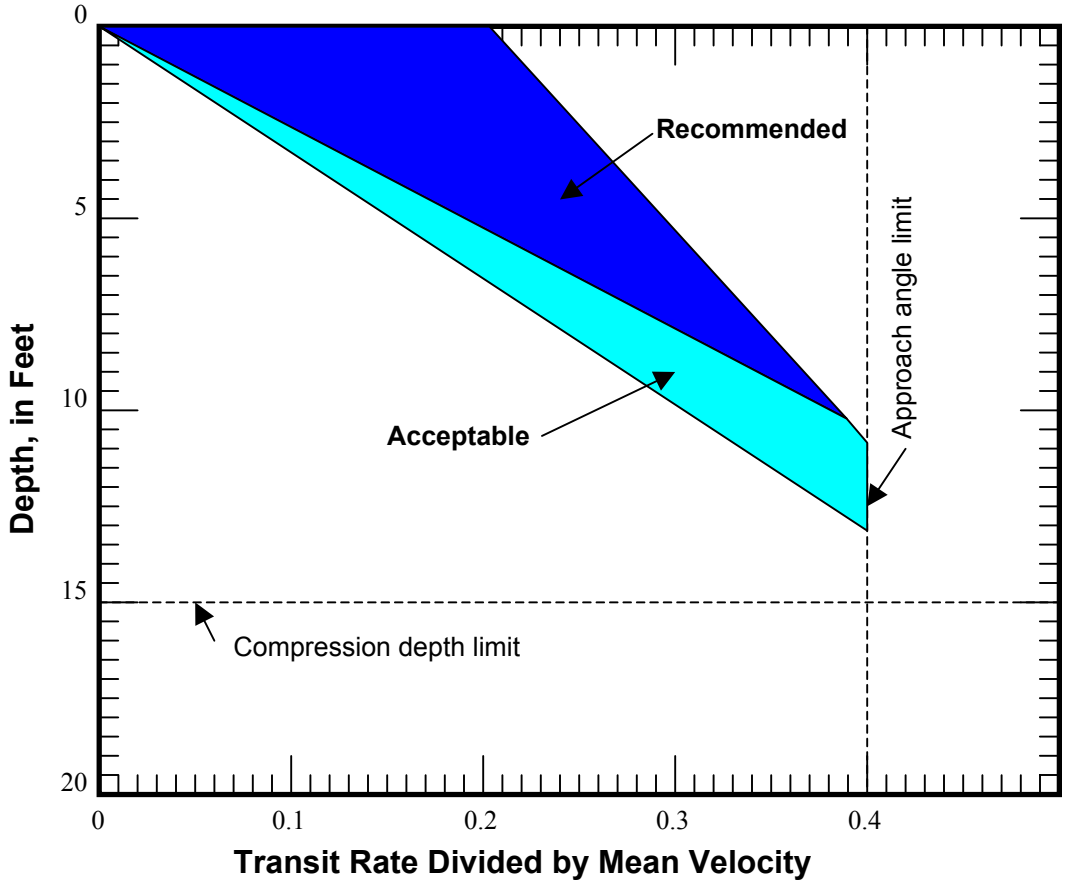
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1265 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

Figure 7. Transit rate diagram for the US DH-81 sampler with a US D-77 PFA cap, TFE bottle adapter, 1-L FEP bottle and a 3/16-in TFE nozzle



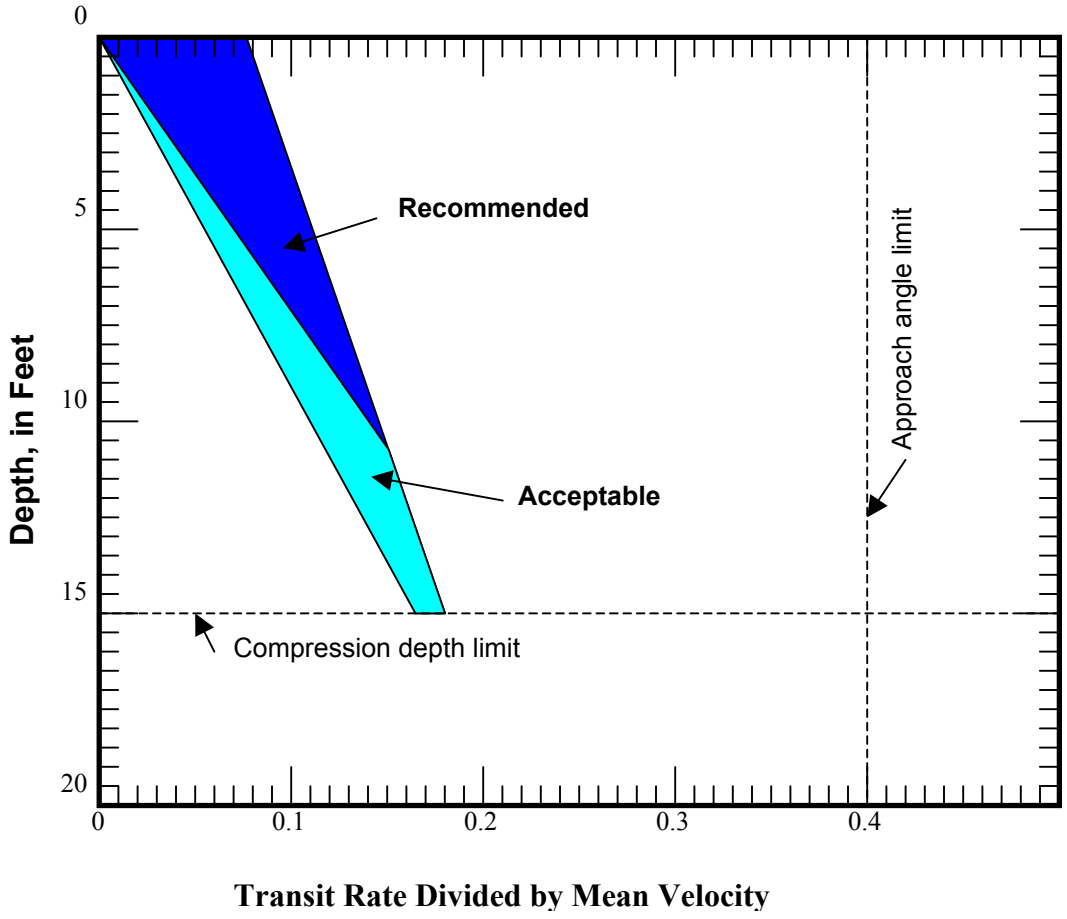
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1265 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

Figure 8. Transit rate diagram for the US DH-81 sampler with a US D-77 PFA cap, TFE bottle adapter, 1-L FEP bottle and a 1/4-in TFE nozzle



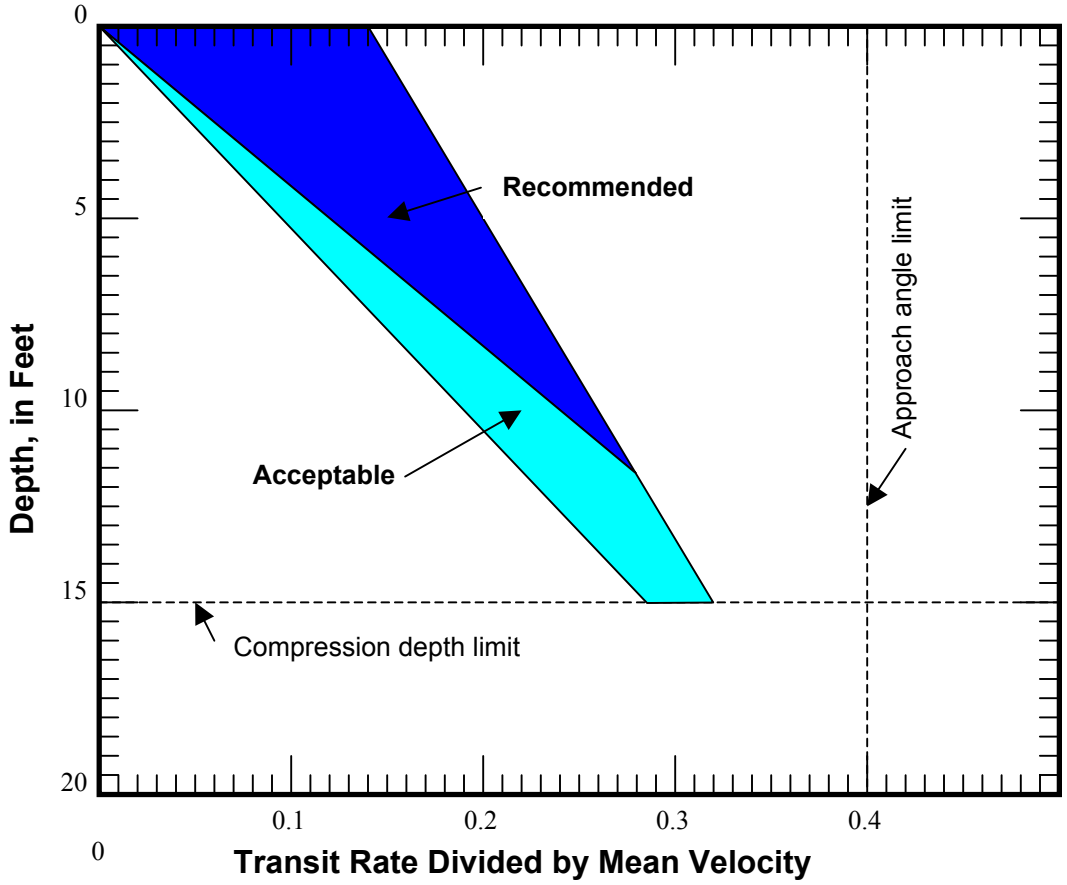
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1265 mL. The maximum recommended volume is 800 mL. The maximum acceptable volume is 1000 mL.

Figure 9. Transit rate diagram for the US DH-81 sampler with a US D-77 PFA cap, TFE bottle adapter, 1-L FEP bottle and a 5/16-in TFE nozzle



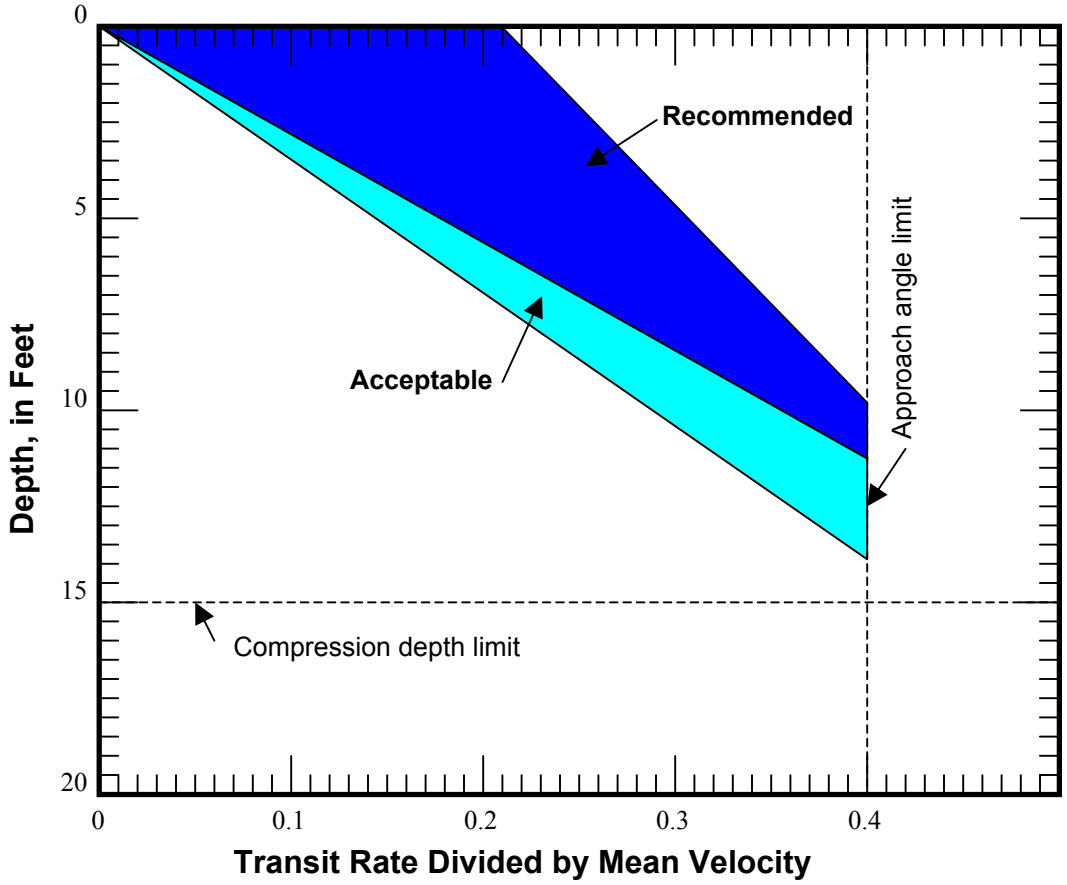
Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1195 mL. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1000 mL.

Figure 10. Transit Rate Diagram for US DH-81 sampler with a US D-95™ Cap, 1-L FEP bottle, and 3/16-in TFE Nozzle



Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1195 mL. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1000 mL.

Figure 11. Tansit Rate Diagram for the US DH-81 sampler with a US D-95™ cap, 1-L FEP bottle, and 1/4-in TFE nozzle



Note: The following volumes were used to produce this diagram. The total volume of the sampler container is 1195 mL. The maximum recommended sample volume is 800 mL. The maximum acceptable sample volume is 1000 mL.

Figure 12. Transit Rate Diagram for US DH-81 sampler with a US D-95™ Cap, 1-L FEP bottle, and a US D-77 5/16-in TFE nozzle

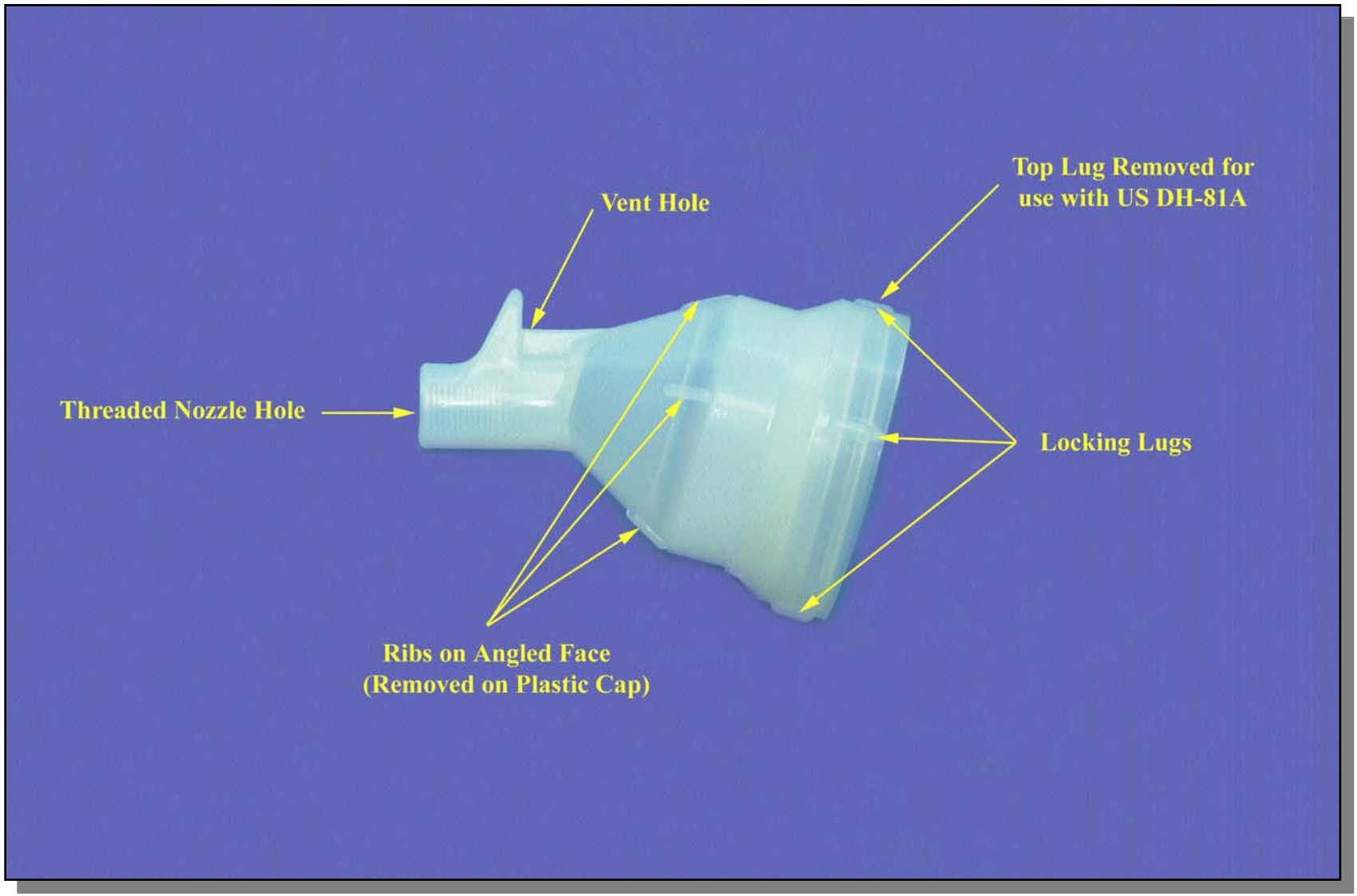


Figure 13. US D-77 cap

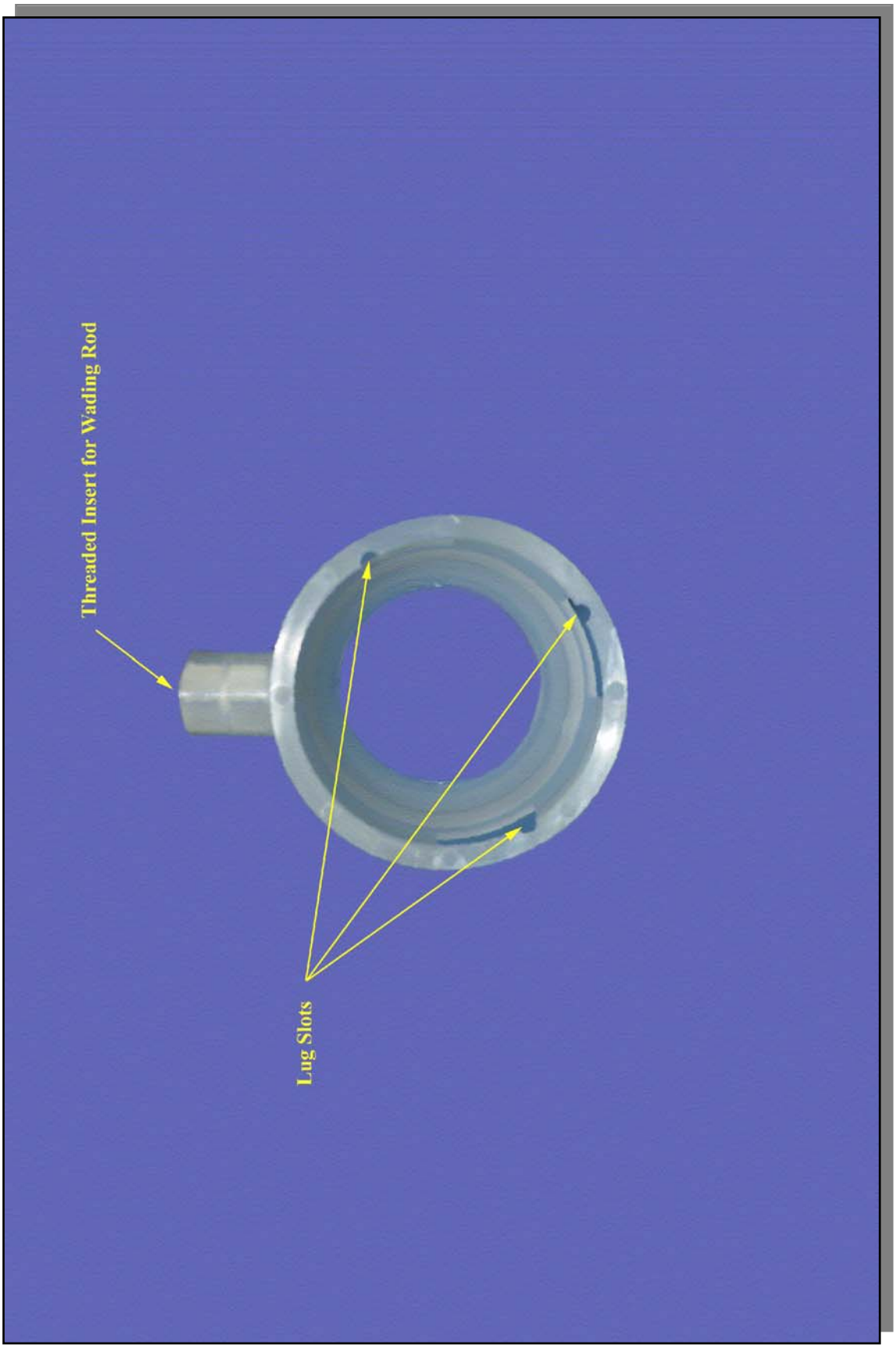


Figure 14. Rear view of US DH- 81A

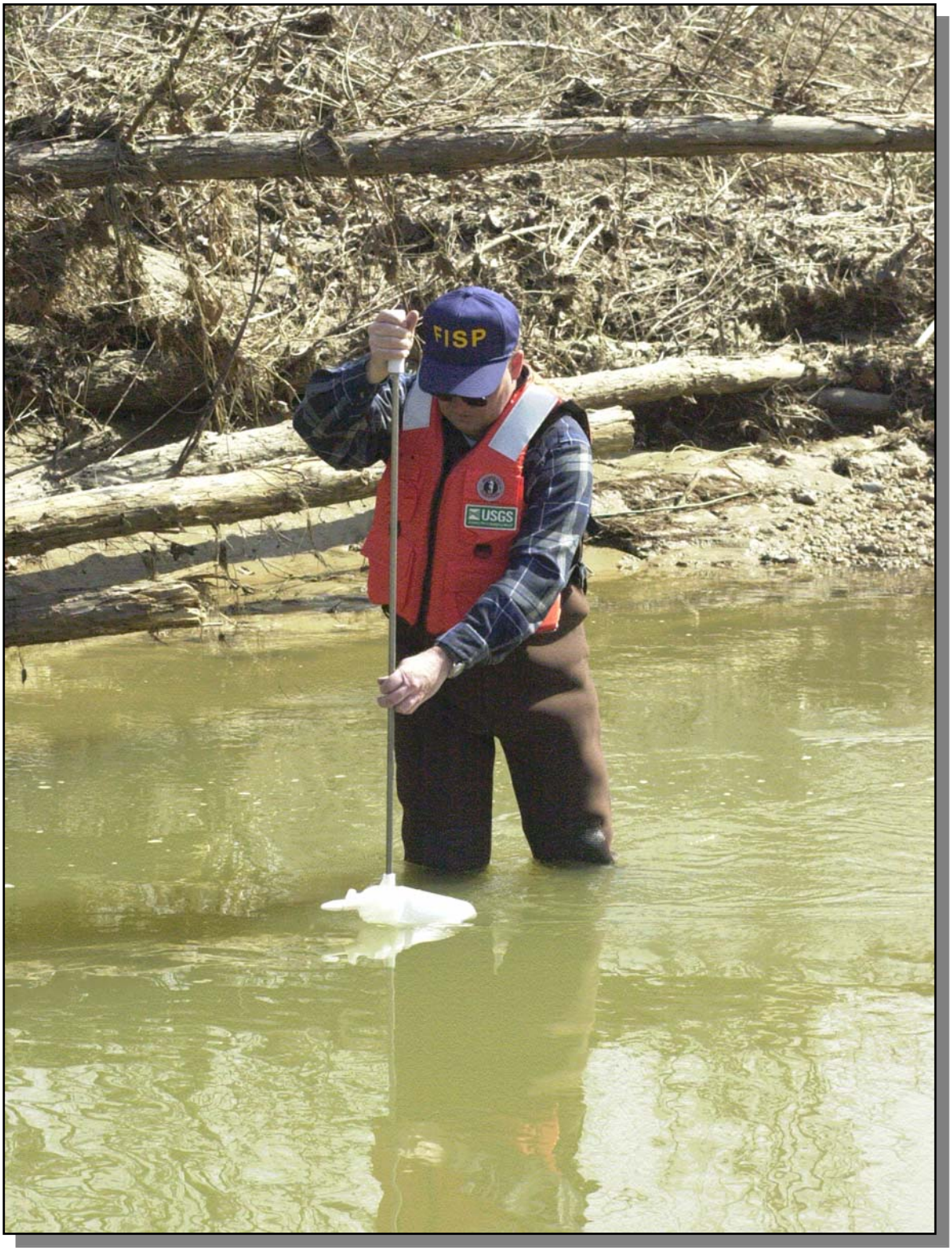


Figure 15. Example of proper position for sampling

Table 1. US DH-81 sampler cap/bottle combinations

Cap	Bottle	Bottle adapter required
US D-77 Plastic	Plastic/MJT[1]	No
US D-77 PFA[2]	Plastic/MJT[2]	No
US D-77 PFA	FEP	Yes
US D-95™ (TFE)	FEP	No

[1]MJT: Mason Jar Threads
[2]See page 1, Container section for explanation of PFA/plastic combination

Table 2. US DH-81 sampler parts and part numbers

Part	Part number
US DH-81A	002010
US D-77 plastic cap	002390
US D-77 PFA cap	002430
1-L bottle adapter	002250
US D-95™ Cap (TFE)	001365
1-L plastic bottle	002040
1-L FEP bottle	002050
3/16 in plastic US D-77 nozzle	002270
3/16 in TFE US D-77 nozzle	002310
1/4 in plastic US D-77 nozzle	002280
1/4 in TFE US D-77 nozzle	002320
5/16 in plastic US D-77 nozzle	002290
5/16 in TFE US D-77 nozzle	002330
1 ft wading rod	002020
3 ft wading rod	002070
3 ft plastic covered wading rod	002071
1 ft wading rod extension	002030
1 ft plastic covered wading rod extension	002031
3 ft wading rod extension	002080
3 ft plastic covered wading rod extension	002081

***Table 3 -- Filling time for the US DH-81 sampler using a 1-L bottle*, seconds**

Velocity, ft/sec	Volume, mL	3/16-in nozzle	1/4-in nozzle	5/16-in nozzle
1.4	800		59	
1.6	800		52	
1.8	800		46	
2.0	800	74	41	27
2.2	800	67	38	24
2.4	800	61	35	22
2.6	800	57	32	20
2.8	800	53	30	19
3.0	800	49	28	18
3.2	800	46	26	17
3.4	800	43	24	16
3.6	800	41	23	15
3.8	800	39	22	14
4.0	800	37	21	13
4.2	800	35	20	13
4.4	800	33	19	12
4.6	800	32	18	12
4.8	800	31	17	11
5.0	800	29	17	11
5.2	800	28	16	10
5.4	800	27	15	10
5.6	800	26	15	9
5.8	800	25	14	9
6.0	800	25	14	9
6.2	800	24	13	9
6.4	800		13	8
6.6	800		13	8
6.8	800		12	8
7.0	800		12	8
7.2	800		12	
7.4	800		11	
7.6	800		11	