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October 28, 1998

OFFICE OF WATER QUALITY TECHNICAL MEMORANDUM 99.02
OFFICE OF SURFACE WATER TECHNICAL MEMORANDUM 99.01

Subject: Guidance for Collecting Discharge-Weighted Samples in
Surface Water Using an Isokinetic Sampler

PURPOSE AND SCOPE

The purpose of this memorandum is to provide guidance for collecting discharge-weighted, depth-integrated samples in surface water using isokinetic samplers. Tables 4-15 and 17-24 in Appendix 4 quantify acceptable ranges of reeling and transit rates for rigid-bottle and bag isokinetic samplers when used with standard reels. This memorandum also reviews common terminology to provide a better understanding of surface-water sampling procedures.

This memorandum does not provide guidance on other sampling techniques such as point sampling, area-weighted sampling, or non-isokinetic sampling. The techniques may be useful and/or desirable depending on the sampling design and objectives of a project.

BACKGROUND

Under most field conditions, isokinetic, depth-integrated sampling techniques must be used to collect discharge-weighted samples. Constituent concentrations determined from discharge-weighted samples are used to compute the discharge of any constituent. The discharge of any constituent is the product of the stream discharge and the discharge-weighted concentration of the constituent.

The Office of Surface Water and the Office of Water Quality recognize that the uses and limitations of depth-integrating samplers are not well documented. Consequently, samples that must be collected using discharge-weighted, depth-integrated, isokinetic sampling techniques are sometimes being collected under depth and velocity conditions that are outside the range where isokinetic samples are obtainable with available samplers. The following information is presented to better define and document the operational ranges of the most commonly used depth-integrating samplers used by the U.S. Geological Survey. Similar information is presented in Chapters A2, A4, and A6 of Techniques of Water-Resources Investigations book 9, "National Field Manual for the Collection of Water-Quality Data," by Wilde and others, eds., in press.

GUIDANCE FOR COLLECTING DISCHARGE-WEIGHTED SAMPLES IN SURFACE WATER USING AN ISOKINETIC SAMPLER

Many factors can affect whether the concentration of a constituent (property) in a discharge-weighted sample adequately represents the discharge-weighted concentration of that constituent in the stream at the time of sampling. This memo primarily discusses the inherent physical limitations of commonly used depth-integrating samplers. These samplers collect isokinetic samples under a relatively narrow set of conditions that need to be understood by those collecting the sample. The operational ranges of commonly used samplers are presented in tables 4 through 15 and 17 through 24 in Appendix 4. If water samples are obtained within these operational ranges, the sample can be reasonably assumed to be representative of the stream at the time of sampling.

Equal-Discharge-Increment and Equal-Width-Increment Sampling Methods: Uses and Limitations

Isokinetic sampling is necessary to discharge-weight (velocity-weight) samples and to accurately collect the sand fraction of suspended sediment. Equal-discharge-increment (EDI) and equal-width-increment (EWI) sample-collection methods are specifically designed to result in the collection of discharge-weighted, depth-integrated, isokinetic samples (Appendixes 2 and 3). If used correctly, and samples are taken within the limitations of the sampler used, both methods result in samples that have the same concentration of constituents.

EDI is the most universally applicable discharge-weighted sampling method. This method can be used to collect a single composite sample or a series of samples representing each increment of discharge. The basic assumption that must be made for the EDI method to be properly used is that the concentration of any constituent collected at the centroid of the equal increment of discharge represents the mean concentration in that entire increment of discharge. When using the EDI method and compositing the sample, the total composite sample volume can be estimated on-site before sampling begins because an approximately equal volume (at least the minimum volume shown for the deepest vertical) of water is collected at each increment of discharge. The total composite volume can be estimated by multiplying the volume collected at the deepest vertical by the number of increments of equal discharge sampled.

When using the EDI method and not compositing, the samples at each vertical are analyzed separately. The volume collected at each vertical can be any volume from within the isokinetic range of the sampler for that vertical. The total constituent discharge is the sum of the products at the individual increment stream discharge and the constituent concentration from that increment.

The EDI method can be used to collect discharge-weighted samples at water velocities less than about 1.5 feet per second in nonstratified streams. Although the samplers do not collect true isokinetic samples at flows less than about 1.5 feet per second, a lack of suspended sand makes it unnecessary to collect fully isokinetic samples under these conditions (Office of Water Quality Technical Memorandum 76.17, "Water Quality--Sampling Mixtures of Water and Suspended Sediment in Streams," May 12, 1976, states that a velocity of 2 feet per second is required to transport sand). The EDI method cannot be used under these low velocity conditions since this method assumes isokinetic sampling in each vertical, which is not possible at velocities less than about 1.5 feet per second.

The EDI method is broadly applicable to streams in which the cross section has a relatively uniform depth and water velocity. EDI is more limited in application than is the EDI method, primarily because of the requirement to use only one transit rate and because of sampler limitations. All EDI samples must be collected within the isokinetic range of the sampler because EDI samples are by definition discharge-weighted samples and the isokinetic collection ability of the sampler is used to discharge weight the sample. All EDI water-quality samples must be composited.

The EWI method cannot be used if a significant number of verticals in the cross section require transit rates slower than the transit rate used at the deepest, fastest vertical because of the one-transit-rate requirement. Tables 7, 11, 15, 20, and 24 in Appendix 4 provide transit rates for a range of stream depths and velocities for several bottle and nozzle combinations. To determine if the slower velocity verticals can be sampled at the same transit rate as the faster velocity verticals, compare the slowest transit rate that will fill the bottle at the deepest (highest velocity) vertical with the maximum rate allowable at the slowest vertical. When using a bottle sampler, the full reeling or transit rate at the deepest, fastest vertical will usually exceed the fastest allowed rate at one or two verticals near the streambank. The difference in constituent concentration in a composite sample caused by this error may be insignificant because (a) the cumulative discharge associated with slow and shallow sections is usually negligible with respect to the total discharge, and (b) the sample volume collected isokinetically from these sections is negligible with respect to the total sample volume. Also, there may be compensating errors of excessive transit rates and oversampling in slow water velocities.

Currently available bottle samplers generally are not designed to collect samples isokinetically at water velocities of less than about 1.5 feet per second. Currently available bag samplers generally do not collect samples isokinetically at water velocities of less than about 3 feet per second. Thus, the EWI method cannot be used at cross sections at which all, or large parts, of the sampling cross section have velocities of less than about 1.5 feet per second when using a bottle sampler, or less than 3 feet per second when using a bag sampler.

Usable Range of Bottle Samplers

Generally, bottle samplers (see Appendix 1, "Definitions") can collect isokinetic samples in streams up to 15 feet deep, at water velocities greater than about 1.5 feet per second, as long as the sampler does not fill above the outlet of the nozzle, or the transit rate does not exceed 0.4 times the mean stream velocity at the sampling vertical (see Appendix 3).

Common errors observed in the use of a 3-liter bottle sampler include excessively fast transit rates and its use in streams that are too shallow. A clear indication that the transit rate is too fast is the absence of bubbles from the exhaust port when the sampler is lowered, or an insufficient volume of water in the sampler after a round-trip transit has been completed (see Appendix 4, tables 4 through 24).

Usable Range of Bag Samplers

Currently available bag samplers may collect samples isokinetically to any depth that the bag capacity is not exceeded by the minimum round-trip sample volume (Appendix 4, table 16) if (1) the temperature is greater than about 8 degrees Celsius, (2) the mean velocity at verticals is more than about 3 feet per second, and (3) the transit rate is less than 0.4 times the mean stream velocity at the sampling vertical (see Appendix 4, tables 17-24). Because several factors can affect the sampling efficiency of bag samplers, it is recommended that a field calibration of the bag samplers hydraulic efficiency be done on-site before each set of samples is collected.

Sampling Streams Less Than 15 Feet Deep

Container selection

There is no substantial difference in the range of depths and velocities that can be sampled with different 1- and 3-liter sample bottle and nozzle combinations. However, transit rates can differ substantially for different 1- and 3-liter bottle and nozzle combinations. The 1-liter bottle sampler is the best choice for isokinetic sampling for water chemistry in streams less than 15 feet deep. The 1-liter sampler has a smaller unsampled zone and requires much smaller minimum volumes for each vertical than the 3-liter bottle sampler.

The 3-liter bottle sampler has an unsampled zone of at least 7 inches and should not be used in streams less than about 2 to 3 feet deep when (1) the EWI method is being used or (2) sand is to be analyzed as part of the sample and the stream velocity is sufficient to transport sand. The 3-liter bottle sampler requires very slow transit rates in slow to moderate stream velocities.

Currently available bag samplers can be used for depth-integrated, isokinetic water-quality sampling of streams less than 15 feet deep and provide a much wider isokinetic range in depth and velocity than do bottle samplers. Bag samplers require water temperatures above about 8 degrees Celsius, velocities greater than 3 feet per second, strict attention to transferring all the sand out of the bag, and clean sampling techniques when appropriate. The D-77 bag sampler can be used in streams as shallow as 2 to 3 feet deep. Frame-type bag and bottle samplers require deeper streams in order to minimize the effect of the unsampled zone. For deep, swift streams (greater than about 7 feet per second) a heavily weighted frame-type bag or bottle sampler would be a reasonable choice for water-quality sampling.

Sampling Streams More Than 15 Feet Deep

Point samplers, as described in Edwards and Glysson (1998), are the preferred samplers to collect isokinetic, depth-integrated samples in streams deeper than about 15 feet. Point samplers are known to contaminate trace-element samples and cannot be easily sterilized so that if samples are to be analyzed for trace elements or bacteria, bag samplers must be used.

Nozzle selection

For 1-liter bottles, the 5/16-inch nozzle for shallow depths and the 1/4-inch nozzle for greater depths provide adequate ranges in transit and reeling rates. For 3-liter bottles, even the 5/16-inch nozzle requires excessively slow transit rates at shallow depths. For a bottle sampler, larger nozzles provide greater range between the slowest and fastest isokinetic transit rates (in feet per second). Smaller nozzles provide a larger difference between the slowest and fastest, total round-trip transit time. These statements may seem counter intuitive but examination of the tables for bottle transit rates and reeling rates will clarify the statement. Smaller nozzles require slower transit rates. Nozzle size has little effect on minimum sample volumes. For a pint bottle, the 3/16-inch nozzle increases the isokinetic depth capabilities from 9 feet for the 1/4-inch nozzle to 15 feet for the 3/16-inch nozzle. No substantial increases in depth capabilities are provided by reducing the nozzle size for any other bottle.

Nozzles 3/16 inch and larger are recommended for sampling suspended sediment.

For bag samplers, smaller nozzles may be preferred because they provide isokinetic sampling in greater depth and velocity ranges and smaller minimum volumes than do larger nozzles. Smaller nozzles also provide a greater range between the slowest and fastest, total round-trip transit time. And, as opposed to bottle samplers, smaller nozzles also provide greater range between the slowest and fastest isokinetic transit rates.

LOCATION AND DESCRIPTION OF OTHER INFORMATION

In the public ftp depot on `srv3rvares.er.usgs.gov`, the directory `</var/ftp/pub/wwebb/smplr.dat>` contains Excel workbook files that include tables 3 through 24 of Appendix 4 and additional workbook files for different bottle, bag, and nozzle sizes. The workbooks can be printed as is or can be modified to meet user needs.

SELECTED REFERENCES

Edwards, T.K., and Glysson, G.D., 1998, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C2, 80 p.

Federal Interagency Sedimentation Project, 1952, The design of improved types of suspended-sediment samplers--Interagency Report 6: Minneapolis, Minnesota, St. Anthony Falls Hydraulic Laboratory, 103 p.

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Wilde, F.D., and Radtke, D.B., eds., in press, Field Measurements, *chapter A6 of National Field Manual for the Collection of Water-Quality Data: U.S. Geological Survey Techniques of Water-Resources Investigations*, book 9, chap. A6.

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4 attachments

Keywords: Isokinetic, EDI, EWI, sampler, depth-integrated sample, discharge-weighted sample, area-weighted sample, surface-water quality, transit rate, reeling rate, suspended sediment.

Distribution: A, B, DC, S, FO, PO
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Appendix 1.

DEFINITIONS

Isokinetic sampling: "To sample in such a way that the water-sediment mixture moves with no change in velocity as it leaves the ambient flow and enters the sampler intake." (ASTM)

Discharge-weighted sample: A sample that contains an equal volume from each unit of discharge sampled.

Depth-integrated sample: A sample that is collected so that each vertical portion of the stream depth is represented in the sample in proportion to the desired sampling scheme.

Depth integration (for a discharge-weighted sample as defined by ASTM): "A method of sampling at every point throughout a given depth (the sampled depth) whereby the water-sediment mixture is collected isokinetically so that the contribution from each point is proportional to the stream velocity at the point. This process yields a sample with properties that are discharge weighted over the sampled depth." (ASTM)

Depth integration to collect a discharge-weighted sample: "Depth-integrated sample--a discharge-weighted (velocity-weighted) sample of water-sediment mixture collected at one or more verticals in accordance with the technique of depth integration; the discharge of any property of the sample expressible as a concentration can be obtained as the product of the concentration and the water discharge represented by the sample." (ASTM)

Equal-width-increment (EWI) and equal-discharge-increment (EDI) sample-collection methods: Sampling methods that are specifically designed to result in the collection of discharge-weighted, depth-integrated, isokinetic samples. The procedures for collecting EWI and EDI samples are described in Edwards and Glysson (1998). When either method is used properly, the resulting samples contain the same property concentrations.

Bottle samplers: Samplers that have rigid sample containers. Because these bottles are rigid, they do not instantly transmit the ambient pressure to the interior of the sample container and

have neither pressure compensation nor opening and closing valves. Point samplers described in Edwards and Glysson (1998) use rigid bottles but have pressure compensation and opening and closing valves and are not considered bottle samplers for the purposes of this document. The tables in Appendix 4 were not designed for use with point samplers. Point samplers should perform as bottle samplers if held open from before the sampler enters the water to until the sampler leaves the water.

Bag samplers: Samplers that have sample containers (bags) that instantly transmit the ambient pressure to the interior of the sample container and do not have opening or closing valves.

Transit rate: The rate at which the sampler is passed through the water from the stream surface to the streambed or from the streambed to the surface.

Unsampled zone: The part of the sampling vertical, usually assumed to be the zone from the streambed to the sampler intake. Sampler intakes are generally 4 to 7 inches above the streambed, depending on the type of sampler used.

Increment: Refers to the subdivisions of the stream cross section made based on equal widths (using EWI) or equal discharge (EDI).

Vertical: Refers to that location within the increment at which the sampler is lowered and raised through the water column.

Centroid: The vertical within the increment at which discharge is equal on both sides.

Appendix 2. Some uses and advantages of the equal-width-increment (EWI) and equal-discharge-increment (EDI) sampling methods

EWI method	Advantages of the EWI method
<p>USE EWI WHEN:</p> <ul style="list-style-type: none"> • Information required to determine locations of sampling verticals for the EDI method is not available. <p>OR</p> <ul style="list-style-type: none"> • The stream cross section has relatively uniform depth and velocity. <p>AND ESPECIALLY WHEN:</p> <ul style="list-style-type: none"> • The location of EDI sampling verticals changes significantly at the same discharge from one sampling time to another. This situation occurs frequently in sand bed streams. 	<ul style="list-style-type: none"> • The EWI method is easily learned and used for small streams. • Generally, less time is required on site if the EWI method can be used and information required to determine locations of sampling verticals for the EDI method is not available.
EDI method	Advantages of the EDI method
<p>USE EDI WHEN:</p> <ul style="list-style-type: none"> • Information required to determine locations of sampling verticals for the EDI method is available. <p>AND ESPECIALLY WHEN:</p> <ul style="list-style-type: none"> • Small, non-homogeneous increments need to be sampled separately from the rest of the cross section. The samples from those verticals can be analyzed separately or appropriately composited with the rest of the cross-sectional sample. (Have your sampling scheme approved.) <p>OR</p> <ul style="list-style-type: none"> • Flow velocities are less than the isokinetic transit-rate range requirement. A discharge-weighted sample can be obtained, but the sample will not be isokinetic. <p>OR</p> <ul style="list-style-type: none"> • The EWI sampling method cannot be used. For example, isokinetic samples cannot be collected because stream velocities and depths vary so much that the isokinetic requirements of the sampler are not met at several sampling verticals. <p>OR</p> <ul style="list-style-type: none"> • Stage is changing rapidly. (EDI requires less sampling time than EWI, provided the locations of sampling verticals can be determined quickly.) 	<ul style="list-style-type: none"> • Fewer increments are necessary, resulting in a shortened collection time (provided the locations of sampling verticals can be determined quickly and constituents are adequately mixed in the increment). • Sampling during rapidly changing stages is facilitated by the shorter sampling time. • Subsamples making up a sample set may be analyzed separately or may be appropriately composited with the rest of the cross-sectional sample. • The cross-sectional variation in constituent discharge can be determined if sample bottles are analyzed individually. • A greater range in velocity and depth can be sampled isokinetically at a cross section. • The total composite volume of the sample is known and can be adjusted before sampling begins.

Appendix 3. Isokinetic, depth-integrating water-quality samplers and sampler characteristics

[R_t , transit rate in feet per second (ft/s); V_m , mean stream velocity in the vertical being sampled, in ft/s; DH, depth integrating hand-held sampler; PN, polypropylene cap and nylon nozzle; PFA, fluorocarbon polymer; C&N, cap and nozzle; PC, plastic coated; PT, polypropylene or fluorocarbon polymer bottle; PDC, plastic dip coated; ND, to be determined; D, depth integrating sampler; AL, aluminum; PTB, polypropylene bottle with plastic bag (Reynolds™ oven bag only type tested) or fluorocarbon polymer bag; FB, D-77 cap and nozzle with frame and bag; L, liter; DFS, dependent on frame size]

Sampler designation	Sampler construction material	Sampler dimensions			Distance of nozzle from bottom, in inches	Suspension method	Maximum calibrated velocity, in feet per second	Maximum depth, in feet	Sample container size, in liters ^a	Nozzle intake size, ^b in inches	Maximum transit rate ratio, ^c R_t/V_m
		Length (inch)	Width (inch)	Weight (pound)							
US DH-81	plastic PN or PFA C&N	6.5 ^d	3.2	0.5 ^d	4 ^e	hand-held (PC)	8.9	15	1 (PT)	3/16	0.2
								14		1/4	0.3
										5/16 ^b	0.4
US DH-95	bronze (PDC) with PN or PFA C&N	23	6.0	35	4.5	hand line	ND	15	1 (PT)	3/16	0.2
								15		1/4	0.3
								14		5/16 ^b	0.4
US D-95	bronze (PDC) with PN or PFA C&N	28.5	6.0	64	4.5	cable & reel	7.5	15	1 (PT)	3/16	0.2
								15		1/4	0.3
								14		5/16 ^b	0.4
US D-77	bronze (PDC) with PN or PFA C&N	29	9.0	75	7	cable & reel	7.2	15	3 (PT)	1/4	0.1
										5/16 ^b	0.2
US D-77AL	Aluminum (PDC) with PN or PFA C&N	29	9.0	42	7	cable & reel	3.3	15	3 (PT)	1/4	0.1
										5/16 ^b	0.2
D-77 BAG ^f	bronze (PDC) with PN or PFA C&N	29	9.0	75	7	cable & reel	7.2	95	3 (PTB)	3/16	0.4
								56		1/4	0.4
								36		5/16	0.4
FB ^{f,g} (3 L)	steel (PDC) with PN or PFA C&N	DFS			DFS	cable & reel	ND	95	3	3/16	0.4
								56		1/4	0.4
								36		(PTB)	5/16
FB ^{f,g} (8 L)	steel (PDC) with PN or PFA C&N	DFS			DFS	cable & reel	ND	>200	8 (PTB)	3/16	0.4
								160		1/4	0.4
								100		5/16	0.4

^aBottle with standard mason jar threads.

^bNozzle sizes are those recommended for the application shown.

^cRefer to NFM 4, Appendix A, for maximum transit-rate ranges, and to Office of Surface Water Technical Memorandum 94.05, Maximum Sampling Depths and Transit Rates for Suspended Sediment and Water-Quality Samplers, dated January 31, 1994.

^dLength, width, and weight will depend on specific bottle dimensions. Weight indicated is for cap and nozzle only. Handle is plastic coated with clear heat-shrinking tubing.

^eDistance of nozzle from the bottom will depend on specific bottle dimensions.

^fDo not use D-77 bag sampler if water temperature is less than 8°C.

^gHydraulic efficiency of bag samplers has not been verified.

Appendix 4.**TABLES**

Tables 3 through 24 provide guidelines for using bag and bottle samplers to collect discharge-weighted, depth-integrated, isokinetic samples. Tables of reeling rates and transit rates (tables 4-15 and 17-24) list the theoretically defined minimum and maximum reeling rates (in seconds per turn) and transit rates (in feet per second) for various stream depths and velocities for commonly used nozzles and bottle or bag combinations when using an A, B, or E reel. In the tables, the minimum values are defined as "full" to indicate that when using a listed rate, the bottle will be full after one round-trip transit; the maximum values are defined as "fastest" to indicate the fastest reeling rate or transit rate that can be used for the isokinetic range of the sampler. The tables also list the volumes that should be in the samplers after one complete round-trip transit. The sample volumes, reeling rates, and transit rates assume one complete round-trip vertical transit of a sampler that, starting empty, goes from the stream surface to the streambed and returns to the surface at a sampling vertical of specified depth and mean velocity for a given bottle and nozzle combination. All depths shown in tables 3 through 24 are water depth minus the unsampled zone. A key assumption used here and in previously published work is that the velocity distribution at each vertical is that described in Edwards and Glysson (1998) in which the water velocity at the deepest point in the transit is 0.5 of the mean stream velocity in the vertical.

The information provided in the tables is not new, but rather is a tabular representation of the information presented in the following references: Edwards and Glysson, 1998; Federal Interagency Sedimentation Project (FISP), 1952; and a written communication (distributed with each US D-77 sampler) from Hydrologist-in-Charge, Federal Inter-Agency Sedimentation Project, 2/21/79, Operating Instructions D-77 Suspended Sediment Sampler or similar identically computed information for newer samplers. The values in these tables were computed at each depth and velocity from the minimum and maximum transit rate ratios shown in figures similar to 39, 40, and 41 of Edwards and Glysson (1998) for the applicable nozzle and bag or bottle combination.

The utility of the tables of reeling and transit rates may be enhanced if used with a vertical transit pacer VTP 74 (available from FISP).

The mean velocity and depth of a sampling vertical must be known to use the tables and assure that 1- and 3-liter bottle samplers are used within their isokinetic range. The mean velocity of a vertical can be estimated adequately for sampling purposes by dividing 10 by the seconds required for a floating object to travel 11.6 feet at the sampling vertical. (Timing a peanut passing an 11.6-foot length of flagging trailing from a suspension cable works quite well.)

Tables For Bottle Samplers

Tables 3 through 15 in Appendix 4 apply to specific bottle, cap, and nozzle combinations and apply to samplers when that bottle, cap, and nozzle combination is used with the sampler. For example, the table for a 1-liter bottle and 5/16-inch nozzle applies to any of the approved samplers (such as US DH-81, US DH-95, US D-95) when that bottle, cap, and nozzle are used in the sampler. The range of velocities on the tables may exceed the velocity of a stream in which some samplers are stable. (An aluminum D-77 sampler is unstable in stream velocities greater than 3.5 feet per second, but the 3-liter table shows reeling and/or transit rates for 9 feet per second.)

Table 3 lists the minimum volume that must be in the sample bottle after the first transit of the sampler from the stream surface to the streambed and return to the surface, at a sampling vertical of specified depth for a given bottle and nozzle combination. If the volume of sample in the bottle is less than that listed in table 3, the sample was not collected isokinetically. A volume equal to or greater than that listed and less than the maximum volume indicates, but does not guarantee, that the sample was collected isokinetically. Further indication that a sample was collected isokinetically is obtained by comparing the volume in the sampler with the volume computed from the product of nozzle area, mean stream velocity, and total transit time at the vertical.

The volumes in table 3 were calculated for each size sample bottle using the minimum allowable transit rate for that bottle, nozzle, and depth combination. The minimum required volume depends only on the stream depth, bottle size, and atmospheric pressure and is independent of stream velocity and transit rate. The volumes listed in table 3 are for sea level and should be increased by about 4 percent for each 1,000 feet of elevation.

When a sampler filled to the maximum (full) volume is tipped down from the horizontal, water will spill out of the nozzle; this spillage might increase the concentration of sand in the sample. When using the EWI method, sample spillage would result in underrepresentation of that vertical in the composited sample. In some conditions the maximum depth of sampling should be limited because the "full" volume of the sampler needs to be limited to a volume such that water will not be spilled when the sampler is used. For bottle samplers, the tables provide reeling and transit rates designated as "-10 tip." When these or faster rates are used, the sampler will not spill if tipped 10 degrees down from horizontal. A 10-degree-down tip reduces the operational depth of 1- and 3-liter bottle samplers about 3 feet because of the reduced maximum sample volume.

When a sampler is filled to a volume exceeding the -10 tip volume, watch carefully to assure that the sampler has not overflowed. When a sampler is filled to the maximum (full) volume it is difficult to determine that it has not overflowed and spilled back to the maximum (full) volume.

Tables 4, 5, and 6 list the minimum (full), -10 tip, and maximum (fastest) reeling rates (in seconds per turn) for various depths and velocities for a 1-liter bottle, cap, and 1/4-inch nozzle combination when using an A, B, or E reel.

Table 7 lists the full, -10 tip, and fastest transit rates (in feet per second) for various depths and velocities for a 1-liter bottle, cap, and 1/4-inch nozzle combination.

Tables 8, 9, and 10 list the full, -10 tip, and fastest reeling rates (in seconds per turn) for various depths and velocities for a 1-liter bottle, cap, and 5/16-inch nozzle combination when using an A, B, or E reel.

Table 11 lists the full, -10 tip, and fastest transit rates (in feet per second) for various depths and velocities for a 1-liter bottle, cap, and 5/16-inch nozzle combination.

Tables 12, 13, and 14 list the full, -10 tip, and fastest reeling rates (in seconds per turn) for various depths and velocities for a 3-liter bottle, cap, and 5/16-inch nozzle combination when using an A, B, or E reel.

Table 15 lists the full, -10 tip, and fastest transit rates (in feet per second) for various depths and velocities for a 3-liter bottle, cap, and 5/16-inch nozzle combination.

Appendix 4.--Table 1. List of tables for bottle samplers

Table	Type	Bottle	Nozzle	Reel	Units
4	Reeling	1 L	1/4	A	seconds/turn
5	Reeling	1 L	1/4	B	seconds/turn
6	Reeling	1 L	1/4	E	seconds/turn
7	Transit	1 L	1/4	any	feet/second
8	Reeling	1 L	5/16	A	seconds/turn
9	Reeling	1 L	5/16	B	seconds/turn
10	Reeling	1 L	5/16	E	seconds/turn
11	Transit	1 L	5/16	any	feet/second
12	Reeling	3 L	5/16	A	seconds/turn
13	Reeling	3 L	5/16	B	seconds/turn
14	Reeling	3 L	5/16	E	seconds/turn
15	Transit	3 L	5/16	any	feet/second

Tables for Bag Samplers

Table 16 lists the minimum (full) volume that must be in a bag sampler after the first complete transit from the surface of the stream to the streambed and return to the surface, at any sampling vertical of specified depth for the specified nozzle. If there is less sample in the sampler than listed in table 16, the sample was not collected isokinetically, possibly because the transit rate exceeded four-tenths the mean stream velocity at that vertical. (Four tenths the mean stream velocity at a vertical is the maximum (fastest) transit rate allowed for isokinetic sampling.)

The depths and velocities in the tables are arbitrary but focus on typical conditions that may frequently be encountered. There are many configurations for bag samplers and only the field personnel will know the stable range of their bag-sampler configuration.

There is no single, exact volume for a bag sampler because each bag installation results in a slightly different volume. The full volumes used to develop tables for bag samplers assume the sampler is not allowed to spill and the nozzle is not tipped below horizontal. The maximum usable volume of a 3-liter bag sampler is estimated to be 2.6 liters based on USGS field experience.

Tables 17, 18, and 19 list the minimum (full) and maximum (fastest) reeling rates (in seconds per turn) for various depths and velocities for a 3-liter bag, cap, and 1/4-inch nozzle combination when using an A, B, or E reel.

Table 20 lists the minimum and maximum transit rates (in feet per second) for various depths and velocities for a 3-liter bag, cap, and 1/4-inch nozzle combination.

Tables 21, 22, and 23 list the minimum and maximum reeling rates (in seconds per turn) for various depths and velocities for a 3-liter bag, cap, and 5/16-inch nozzle combination when using an A, B, or E reel.

Table 24 lists the minimum and maximum transit rates (in feet per second) for various depths and velocities for a 3-liter bag, cap, and 5/16-inch nozzle combination.

Appendix 4.--Table 2. List of tables for bag samplers

Table	Type	Bag	Nozzle	Reel	Units
17	Reeling	3 L	1/4	A	seconds/turn
18	Reeling	3 L	1/4	B	seconds/turn
19	Reeling	3 L	1/4	E	seconds/turn
20	Transit	3 L	1/4	any	feet/second
21	Reeling	3 L	5/16	A	seconds/turn
22	Reeling	3 L	5/16	B	seconds/turn
23	Reeling	3 L	5/16	E	seconds/turn
24	Transit	3 L	5/16	any	feet/second

Appendix 4.--Table 3. Minimum volumes for bottle samplers

MINIMUM VOLUMES FOR ISOKINETIC SAMPLING, in mL						
Conditions:						
1. Transit rate up = transit rate down 2. For bottle samplers 3. One complete transit starting empty 4. Sampler spills at -10 degree tilt below double line						
Bottle	Pint		Quart	1 Ltr + cap		3 Ltr + cap
Nozzle	3/16	1/4	3/16 or 1/4	1/4	5/16	1/4 or 5/16
Depth, in feet						
1	51	51	106	132		
2	95	97	197	243		712
3	133	145	275	340		993
4	166	193	343	423		1237
5	194	241	402	497		1451
6	220	290	455	562		1641
7	242	338	502	620		1890
8	263	386	544	672		1960
9	281	435	558	719		2096
10	297		617	761		2220
11	312		649	800	830	2332
12	326		677	836	906	2435
13	353		704	868	981	2529
14	381		728	898		2615
15	408			926		2695
Max. volume	475	475	735	1050	1050	2830

Table 4. A reel ISOKINETIC REELING RATES, 1 LITER BOTTLE, 1/4 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol.	volume- min. vol. mL
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	-10 vol. min vol.	
1	full	36	27	22	18	16	14	12	11	9.1	7.8	6.8	6.0	1050	918
1	-10 tip	28	21	17	14	12	10	9.2	8.3	6.9	5.9	5.2	4.6	798	667
1	fastest	4.5	3.4	2.7	2.3	1.9	1.7	1.5	1.4	1.1	1.0	0.9	0.8	132	
2	full	18.1	13.6	10.9	9.1	7.8	6.8	6.0	5.4	4.5	3.9	3.4	3.0	1050	806
2	-10 tip	13.8	10.3	8.3	6.9	5.9	5.2	4.6	4.1	3.4	3.0	2.6	2.3	798	555
2	fastest	4.2	3.1	2.5	2.1	1.8	1.6	1.4	1.3	1.0	0.9	0.8	0.7	243	
3	full	12.1	9.1	7.2	6.0	5.2	4.5	4.0	3.6	3.0	2.6	2.3	2.0	1050	710
3	-10 tip	9.2	6.9	5.5	4.6	3.9	3.4	3.1	2.8	2.3	2.0	1.7	1.5	798	458
3	fastest	3.9	2.9	2.3	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.7	340	
4	full	9.1	6.8	5.4	4.5	3.9	3.4	3.0	2.7	2.3	1.9	1.7	1.5	1050	626
4	-10 tip	6.9	5.2	4.1	3.4	3.0	2.6	2.3	2.1	1.7	1.5	1.3	1.1	798	375
4	fastest	3.7	2.7	2.2	1.8	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6	423	
5	full	7.2	5.4	4.3	3.6	3.1	2.7	2.4	2.2	1.8	1.6	1.4	1.2	1050	553
5	-10 tip	5.5	4.1	3.3	2.8	2.4	2.1	1.8	1.7	1.4	1.2	1.0	0.9	798	301
5	fastest	3.4	2.6	2.1	1.7	1.5	1.3	1.1	1.0	0.9	0.7	0.6	0.6	497	
6	full	6.0	4.5	3.6	3.0	2.6	2.3	2.0	1.8	1.5	1.3	1.1	1.0	1050	488
6	-10 tip	4.6	3.4	2.8	2.3	2.0	1.7	1.5	1.4	1.1	1.0	0.9	0.8	798	236
6	fastest	3.2	2.4	1.9	1.6	1.4	1.2	1.1	1.0	0.8	0.7	0.6	0.5	562	
7	full	5.2	3.9	3.1	2.6	2.2	1.9	1.7	1.6	1.3	1.1	1.0	0.9	1050	430
7	-10 tip	3.9	3.0	2.4	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.7	798	178
7	fastest	3.1	2.3	1.8	1.5	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.5	620	
8	full	4.5	3.4	2.7	2.3	1.9	1.7	1.5	1.4	1.1	1.0	0.8	0.8	1050	378
8	-10 tip	3.4	2.6	2.1	1.7	1.5	1.3	1.1	1.0	0.9	0.7	0.6	0.6	798	126
8	fastest	2.9	2.2	1.7	1.4	1.2	1.1	1.0	0.9	0.7	0.6	0.5	0.5	672	
10	full	3.6	2.7	2.2	1.8	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6	1050	288
10	-10 tip	2.8	2.1	1.7	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.5	798	37
10	fastest	2.6	2.0	1.6	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	761	
12	full	3.0	2.3	1.8	1.5	1.3	1.1	1.0	0.9	0.8	0.6	0.6	0.5	1050	214
12	-10 tip														
12	fastest	2.4	1.8	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4	836	
14	full	2.6	1.9	1.6	1.3	1.1	1.0	0.9	0.8	0.6	0.6	0.5	0.4	1050	152
14	-10 tip														
14	fastest	2.2	1.7	1.3	1.1	0.9	0.8	0.7	0.7	0.6	0.5	0.4	0.4	898	
15	full	2.4	1.8	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4	1050	124
15	-10 tip														
15	fastest	2.1	1.6	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4	926	

Table 5. B reel ISOKINETIC REELING RATES, 1 LITER BOTTLE, 1/4 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol.	volume-
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	-10 vol.	min. vol.
1	full	54.3	40.8	32.6	27.2	23.3	20.4	18.1	16.3	13.6	11.6	10.2	9.1	1050	918
1	-10 tip	41.3	31.0	24.8	20.7	17.7	15.5	13.8	12.4	10.3	8.9	7.7	6.9	798	667
1	fastest	6.8	5.1	4.1	3.4	2.9	2.6	2.3	2.0	1.7	1.5	1.3	1.1	132	
2	full	27.2	20.4	16.3	13.6	11.6	10.2	9.1	8.2	6.8	5.8	5.1	4.5	1050	806
2	-10 tip	20.7	15.5	12.4	10.3	8.9	7.7	6.9	6.2	5.2	4.4	3.9	3.4	798	555
2	fastest	6.3	4.7	3.8	3.1	2.7	2.4	2.1	1.9	1.6	1.3	1.2	1.0	243	
3	full	18.1	13.6	10.9	9.1	7.8	6.8	6.0	5.4	4.5	3.9	3.4	3.0	1050	710
3	-10 tip	13.8	10.3	8.3	6.9	5.9	5.2	4.6	4.1	3.4	3.0	2.6	2.3	798	458
3	fastest	5.9	4.4	3.5	2.9	2.5	2.2	2.0	1.8	1.5	1.3	1.1	1.0	340	
4	full	13.6	10.2	8.2	6.8	5.8	5.1	4.5	4.1	3.4	2.9	2.5	2.3	1050	626
4	-10 tip	10.3	7.7	6.2	5.2	4.4	3.9	3.4	3.1	2.6	2.2	1.9	1.7	798	375
4	fastest	5.5	4.1	3.3	2.7	2.3	2.1	1.8	1.6	1.4	1.2	1.0	0.9	423	
5	full	10.9	8.2	6.5	5.4	4.7	4.1	3.6	3.3	2.7	2.3	2.0	1.8	1050	553
5	-10 tip	8.3	6.2	5.0	4.1	3.5	3.1	2.8	2.5	2.1	1.8	1.5	1.4	798	301
5	fastest	5.1	3.9	3.1	2.6	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.9	497	
6	full	9.1	6.8	5.4	4.5	3.9	3.4	3.0	2.7	2.3	1.9	1.7	1.5	1050	488
6	-10 tip	6.9	5.2	4.1	3.4	3.0	2.6	2.3	2.1	1.7	1.5	1.3	1.1	798	236
6	fastest	4.8	3.6	2.9	2.4	2.1	1.8	1.6	1.5	1.2	1.0	0.9	0.8	562	
7	full	7.8	5.8	4.7	3.9	3.3	2.9	2.6	2.3	1.9	1.7	1.5	1.3	1050	430
7	-10 tip	5.9	4.4	3.5	3.0	2.5	2.2	2.0	1.8	1.5	1.3	1.1	1.0	798	178
7	fastest	4.6	3.4	2.8	2.3	2.0	1.7	1.5	1.4	1.1	1.0	0.9	0.8	620	
8	full	6.8	5.1	4.1	3.4	2.9	2.5	2.3	2.0	1.7	1.5	1.3	1.1	1050	378
8	-10 tip	5.2	3.9	3.1	2.6	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.9	798	126
8	fastest	4.3	3.3	2.6	2.2	1.9	1.6	1.4	1.3	1.1	0.9	0.8	0.7	672	
10	full	5.4	4.1	3.3	2.7	2.3	2.0	1.8	1.6	1.4	1.2	1.0	0.9	1050	288
10	-10 tip	4.1	3.1	2.5	2.1	1.8	1.5	1.4	1.2	1.0	0.9	0.8	0.7	798	37
10	fastest	3.9	3.0	2.4	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.7	761	
12	full	4.5	3.4	2.7	2.3	1.9	1.7	1.5	1.4	1.1	1.0	0.8	0.8	1050	214
12	-10 tip														
12	fastest	3.6	2.7	2.2	1.8	1.5	1.4	1.2	1.1	0.9	0.8	0.7	0.6	836	
14	full	3.9	2.9	2.3	1.9	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.6	1050	152
14	-10 tip														
14	fastest	3.3	2.5	2.0	1.7	1.4	1.2	1.1	1.0	0.8	0.7	0.6	0.6	898	
15	full	3.6	2.7	2.2	1.8	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6	1050	124
15	-10 tip														
15	fastest	3.2	2.4	1.9	1.6	1.4	1.2	1.1	1.0	0.8	0.7	0.6	0.5	926	

Table 6. E reel ISOKINETIC REELING RATES, 1 LITER BOTTLE, 1/4 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second											max vol.	volume- min. vol. mL	
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00		-10 vol. min vol.
1	full	72.5	54.3	43.5	36.2	31.1	27.2	24.2	21.7	18.1	15.5	13.6	12.1	1050	918
1	-10 tip	55.1	41.3	33.1	27.5	23.6	20.7	18.4	16.5	13.8	11.8	10.3	9.2	798	667
1	fastest	9.1	6.8	5.4	4.5	3.9	3.4	3.0	2.7	2.3	1.9	1.7	1.5	132	
2	full	36.2	27.2	21.7	18.1	15.5	13.6	12.1	10.9	9.1	7.8	6.8	6.0	1050	806
2	-10 tip	27.5	20.7	16.5	13.8	11.8	10.3	9.2	8.3	6.9	5.9	5.2	4.6	798	555
2	fastest	8.4	6.3	5.0	4.2	3.6	3.1	2.8	2.5	2.1	1.8	1.6	1.4	243	
3	full	24.2	18.1	14.5	12.1	10.4	9.1	8.1	7.2	6.0	5.2	4.5	4.0	1050	710
3	-10 tip	18.4	13.8	11.0	9.2	7.9	6.9	6.1	5.5	4.6	3.9	3.4	3.1	798	458
3	fastest	7.8	5.9	4.7	3.9	3.3	2.9	2.6	2.3	2.0	1.7	1.5	1.3	340	
4	full	18.1	13.6	10.9	9.1	7.8	6.8	6.0	5.4	4.5	3.9	3.4	3.0	1050	626
4	-10 tip	13.8	10.3	8.3	6.9	5.9	5.2	4.6	4.1	3.4	3.0	2.6	2.3	798	375
4	fastest	7.3	5.5	4.4	3.7	3.1	2.7	2.4	2.2	1.8	1.6	1.4	1.2	423	
5	full	14.5	10.9	8.7	7.2	6.2	5.4	4.8	4.3	3.6	3.1	2.7	2.4	1050	553
5	-10 tip	11.0	8.3	6.6	5.5	4.7	4.1	3.7	3.3	2.8	2.4	2.1	1.8	798	301
5	fastest	6.9	5.1	4.1	3.4	2.9	2.6	2.3	2.1	1.7	1.5	1.3	1.1	497	
6	full	12.1	9.1	7.2	6.0	5.2	4.5	4.0	3.6	3.0	2.6	2.3	2.0	1050	488
6	-10 tip	9.2	6.9	5.5	4.6	3.9	3.4	3.1	2.8	2.3	2.0	1.7	1.5	798	236
6	fastest	6.5	4.8	3.9	3.2	2.8	2.4	2.2	1.9	1.6	1.4	1.2	1.1	562	
7	full	10.4	7.8	6.2	5.2	4.4	3.9	3.5	3.1	2.6	2.2	1.9	1.7	1050	430
7	-10 tip	7.9	5.9	4.7	3.9	3.4	3.0	2.6	2.4	2.0	1.7	1.5	1.3	798	178
7	fastest	6.1	4.6	3.7	3.1	2.6	2.3	2.0	1.8	1.5	1.3	1.1	1.0	620	
8	full	9.1	6.8	5.4	4.5	3.9	3.4	3.0	2.7	2.3	1.9	1.7	1.5	1050	378
8	-10 tip	6.9	5.2	4.1	3.4	3.0	2.6	2.3	2.1	1.7	1.5	1.3	1.1	798	126
8	fastest	5.8	4.3	3.5	2.9	2.5	2.2	1.9	1.7	1.4	1.2	1.1	1.0	672	
10	full	7.2	5.4	4.3	3.6	3.1	2.7	2.4	2.2	1.8	1.6	1.4	1.2	1050	288
10	-10 tip	5.5	4.1	3.3	2.8	2.4	2.1	1.8	1.7	1.4	1.2	1.0	0.9	798	37
10	fastest	5.3	3.9	3.2	2.6	2.3	2.0	1.8	1.6	1.3	1.1	1.0	0.9	761	
12	full	6.0	4.5	3.6	3.0	2.6	2.3	2.0	1.8	1.5	1.3	1.1	1.0	1050	214
12	-10 tip														
12	fastest	4.8	3.6	2.9	2.4	2.1	1.8	1.6	1.4	1.2	1.0	0.9	0.8	836	
14	full	5.2	3.9	3.1	2.6	2.2	1.9	1.7	1.6	1.3	1.1	1.0	0.9	1050	152
14	-10 tip														
14	fastest	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3	1.1	0.9	0.8	0.7	898	
15	full	4.8	3.6	2.9	2.4	2.1	1.8	1.6	1.4	1.2	1.0	0.9	0.8	1050	124
15	-10 tip														
15	fastest	4.3	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	0.9	0.8	0.7	926	

Table 7. ISOKINETIC TRANSIT RATES, 1 LITER BOTTLE, 1/4 inch nozzle

(transit rates in feet per second; Depth is water depth - unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol. -10 vol. min vol.	volume- min. vol. mL
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00		
1	full	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.11	0.13	0.15	0.17	1050	918
1	-10 tip	0.04	0.05	0.06	0.07	0.08	0.10	0.11	0.12	0.15	0.17	0.19	0.22	798	667
1	fastest	0.22	0.29	0.37	0.44	0.51	0.59	0.66	0.73	0.88	1.03	1.17	1.32	132	
2	full	0.06	0.07	0.09	0.11	0.13	0.15	0.17	0.18	0.22	0.26	0.29	0.33	1050	806
2	-10 tip	0.07	0.10	0.12	0.15	0.17	0.19	0.22	0.24	0.29	0.34	0.39	0.44	798	555
2	fastest	0.24	0.32	0.40	0.48	0.56	0.63	0.71	0.79	0.95	1.11	1.27	1.43	243	
3	full	0.08	0.11	0.14	0.17	0.19	0.22	0.25	0.28	0.33	0.39	0.44	0.50	1050	710
3	-10 tip	0.11	0.15	0.18	0.22	0.25	0.29	0.33	0.36	0.44	0.51	0.58	0.65	798	458
3	fastest	0.26	0.34	0.43	0.51	0.60	0.68	0.77	0.85	1.02	1.19	1.36	1.54	340	
4	full	0.11	0.15	0.18	0.22	0.26	0.29	0.33	0.37	0.44	0.52	0.59	0.66	1050	626
4	-10 tip	0.15	0.19	0.24	0.29	0.34	0.39	0.44	0.48	0.58	0.68	0.77	0.87	798	375
4	fastest	0.27	0.36	0.46	0.55	0.64	0.73	0.82	0.91	1.09	1.28	1.46	1.64	423	
5	full	0.14	0.18	0.23	0.28	0.32	0.37	0.41	0.46	0.55	0.64	0.74	0.83	1050	553
5	-10 tip	0.18	0.24	0.30	0.36	0.42	0.48	0.54	0.61	0.73	0.85	0.97	1.09	798	301
5	fastest	0.29	0.39	0.49	0.58	0.68	0.78	0.87	0.97	1.17	1.36	1.55	1.75	497	
6	full	0.17	0.22	0.28	0.33	0.39	0.44	0.50	0.55	0.66	0.77	0.88	0.99	1050	488
6	-10 tip	0.22	0.29	0.36	0.44	0.51	0.58	0.65	0.73	0.87	1.02	1.16	1.31	798	236
6	fastest	0.31	0.41	0.52	0.62	0.72	0.82	0.93	1.03	1.24	1.44	1.65	1.86	562	
7	full	0.19	0.26	0.32	0.39	0.45	0.52	0.58	0.64	0.77	0.90	1.03	1.16	1050	430
7	-10 tip	0.25	0.34	0.42	0.51	0.59	0.68	0.76	0.85	1.02	1.19	1.36	1.52	798	178
7	fastest	0.33	0.44	0.55	0.65	0.76	0.87	0.98	1.09	1.31	1.53	1.74	1.96	620	
8	full	0.22	0.29	0.37	0.44	0.52	0.59	0.66	0.74	0.88	1.03	1.18	1.32	1050	378
8	-10 tip	0.29	0.39	0.48	0.58	0.68	0.77	0.87	0.97	1.16	1.36	1.55	1.74	798	126
8	fastest	0.34	0.46	0.57	0.69	0.80	0.92	1.03	1.15	1.38	1.61	1.84	2.07	672	
10	full	0.28	0.37	0.46	0.55	0.64	0.74	0.83	0.92	1.10	1.29	1.47	1.66	1050	288
10	-10 tip	0.36	0.48	0.61	0.73	0.85	0.97	1.09	1.21	1.45	1.69	1.94	2.18	798	37
10	fastest	0.38	0.51	0.63	0.76	0.89	1.01	1.14	1.27	1.52	1.78	2.03	2.28	761	
12	full	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10	1.32	1.55	1.77	1.99	1050	214
12	-10 tip														
12	fastest	0.42	0.55	0.69	0.83	0.97	1.11	1.25	1.39	1.66	1.94	2.22	2.50	836	
14	full	0.39	0.52	0.64	0.77	0.90	1.03	1.16	1.29	1.55	1.80	2.06	2.32	1050	152
14	-10 tip														
14	fastest	0.45	0.60	0.75	0.90	1.05	1.20	1.36	1.51	1.81	2.11	2.41	2.71	898	
15	full	0.41	0.55	0.69	0.83	0.97	1.10	1.24	1.38	1.66	1.93	2.21	2.48	1050	124
15	-10 tip														
15	fastest	0.47	0.63	0.78	0.94	1.10	1.25	1.41	1.57	1.88	2.19	2.50	2.82	926	

Table 8. A reel ISOKINETIC REELING RATES, 1 LITER BOTTLE, 5/16 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second											max vol. -10 vol. min vol.	volume -min. vol. mL	
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00			9.00
1	full	23	17	14	12	10	9	8	7	5.8	5.0	4.3	3.9	1049	918
1	-10 tip	18	13	11	9	8	7	5.9	5.3	4.4	3.8	3.3	2.9	800	668
1	fastest	2.9	2.2	1.7	1.5	1.2	1.1	1.0	0.9	0.7	0.6	0.5	0.5	132	
2	full	11.6	8.7	7.0	5.8	5.0	4.3	3.9	3.5	2.9	2.5	2.2	1.9	1049	806
2	-10 tip	8.8	6.6	5.3	4.4	3.8	3.3	2.9	2.7	2.2	1.9	1.7	1.5	800	557
2	fastest	2.7	2.0	1.6	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.4	243	
3	full	7.7	5.8	4.6	3.9	3.3	2.9	2.6	2.3	1.9	1.7	1.4	1.3	1049	709
3	-10 tip	5.9	4.4	3.5	2.9	2.5	2.2	2.0	1.8	1.5	1.3	1.1	1.0	800	460
3	fastest	2.5	1.9	1.5	1.3	1.1	0.9	0.8	0.8	0.6	0.5	0.5	0.4	340	
4	full	5.8	4.3	3.5	2.9	2.5	2.2	1.9	1.7	1.4	1.2	1.1	1.0	1049	626
4	-10 tip	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3	1.1	0.9	0.8	0.7	800	376
4	fastest	2.3	1.8	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4	424	
5	full	4.6	3.5	2.8	2.3	2.0	1.7	1.5	1.4	1.2	1.0	0.9	0.8	1049	552
5	-10 tip	3.5	2.7	2.1	1.8	1.5	1.3	1.2	1.1	0.9	0.8	0.7	0.6	800	303
5	fastest	2.2	1.6	1.3	1.1	0.9	0.8	0.7	0.7	0.5	0.5	0.4	0.4	497	
6	full	3.9	2.9	2.3	1.9	1.7	1.4	1.3	1.2	1.0	0.8	0.7	0.6	1049	487
6	-10 tip	2.9	2.2	1.8	1.5	1.3	1.1	1.0	0.9	0.7	0.6	0.6	0.5	800	238
6	fastest	2.1	1.6	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.3	562	
7	full	3.3	2.5	2.0	1.7	1.4	1.2	1.1	1.0	0.8	0.7	0.6	0.6	1049	429
7	-10 tip	2.5	1.9	1.5	1.3	1.1	0.9	0.8	0.8	0.6	0.5	0.5	0.4	800	180
7	fastest	2.0	1.5	1.2	1.0	0.8	0.7	0.7	0.6	0.5	0.4	0.4	0.3	620	
8	full	2.9	2.2	1.7	1.4	1.2	1.1	1.0	0.9	0.7	0.6	0.5	0.5	1049	377
8	-10 tip	2.2	1.7	1.3	1.1	0.9	0.8	0.7	0.7	0.6	0.5	0.4	0.4	800	128
8	fastest	1.9	1.4	1.1	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.3	0.3	672	
10	full	2.3	1.7	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4	1049	287
10	-10 tip	1.8	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	800	38
10	fastest	1.7	1.3	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	762	
11	full	2.1	1.6	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.4	1049	219
11	-10 tip														
11	fastest	1.7	1.3	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	830	
12	full	1.9	1.4	1.2	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	1049	143
12	-10 tip														
12	fastest	1.7	1.3	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	906	
13	full	1.8	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.3	1049	68
13	-10 tip														
13	fastest	1.7	1.3	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	981	

Table 9. B reel ISOKINETIC REELING RATES, 1 LITER BOTTLE, 5/16 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol. -10 vol. min vol.	volume -min. vol. mL
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00		
1	full	34.8	26.1	20.9	17.4	14.9	13.0	11.6	10.4	8.7	7.4	6.5	5.8	1049	918
1	-10 tip	26.5	19.9	15.9	13.3	11.4	9.9	8.8	8.0	6.6	5.7	5.0	4.4	800	668
1	fastest	4.4	3.3	2.6	2.2	1.9	1.6	1.5	1.3	1.1	0.9	0.8	0.7	132	
2	full	17.4	13.0	10.4	8.7	7.4	6.5	5.8	5.2	4.3	3.7	3.3	2.9	1049	806
2	-10 tip	13.3	9.9	8.0	6.6	5.7	5.0	4.4	4.0	3.3	2.8	2.5	2.2	800	557
2	fastest	4.0	3.0	2.4	2.0	1.7	1.5	1.3	1.2	1.0	0.9	0.8	0.7	243	
3	full	11.6	8.7	7.0	5.8	5.0	4.3	3.9	3.5	2.9	2.5	2.2	1.9	1049	709
3	-10 tip	8.8	6.6	5.3	4.4	3.8	3.3	2.9	2.7	2.2	1.9	1.7	1.5	800	460
3	fastest	3.8	2.8	2.3	1.9	1.6	1.4	1.3	1.1	0.9	0.8	0.7	0.6	340	
4	full	8.7	6.5	5.2	4.3	3.7	3.3	2.9	2.6	2.2	1.9	1.6	1.4	1049	626
4	-10 tip	6.6	5.0	4.0	3.3	2.8	2.5	2.2	2.0	1.7	1.4	1.2	1.1	800	376
4	fastest	3.5	2.6	2.1	1.8	1.5	1.3	1.2	1.1	0.9	0.8	0.7	0.6	424	
5	full	7.0	5.2	4.2	3.5	3.0	2.6	2.3	2.1	1.7	1.5	1.3	1.2	1049	552
5	-10 tip	5.3	4.0	3.2	2.7	2.3	2.0	1.8	1.6	1.3	1.1	1.0	0.9	800	303
5	fastest	3.3	2.5	2.0	1.6	1.4	1.2	1.1	1.0	0.8	0.7	0.6	0.5	497	
6	full	5.8	4.3	3.5	2.9	2.5	2.2	1.9	1.7	1.4	1.2	1.1	1.0	1049	487
6	-10 tip	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3	1.1	0.9	0.8	0.7	800	238
6	fastest	3.1	2.3	1.9	1.6	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.5	562	
7	full	5.0	3.7	3.0	2.5	2.1	1.9	1.7	1.5	1.2	1.1	0.9	0.8	1049	429
7	-10 tip	3.8	2.8	2.3	1.9	1.6	1.4	1.3	1.1	0.9	0.8	0.7	0.6	800	180
7	fastest	2.9	2.2	1.8	1.5	1.3	1.1	1.0	0.9	0.7	0.6	0.6	0.5	620	
8	full	4.3	3.3	2.6	2.2	1.9	1.6	1.4	1.3	1.1	0.9	0.8	0.7	1049	377
8	-10 tip	3.3	2.5	2.0	1.7	1.4	1.2	1.1	1.0	0.8	0.7	0.6	0.6	800	128
8	fastest	2.8	2.1	1.7	1.4	1.2	1.0	0.9	0.8	0.7	0.6	0.5	0.5	672	
10	full	3.5	2.6	2.1	1.7	1.5	1.3	1.2	1.0	0.9	0.7	0.7	0.6	1049	287
10	-10 tip	2.7	2.0	1.6	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	800	38
10	fastest	2.5	1.9	1.5	1.3	1.1	0.9	0.8	0.8	0.6	0.5	0.5	0.4	762	
11	full	3.2	2.4	1.9	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6	0.5	1049	219
11	-10 tip														
11	fastest	2.5	1.9	1.5	1.3	1.1	0.9	0.8	0.8	0.6	0.5	0.5	0.4	830	
12	full	2.9	2.2	1.7	1.4	1.2	1.1	1.0	0.9	0.7	0.6	0.5	0.5	1049	143
12	-10 tip														
12	fastest	2.5	1.9	1.5	1.3	1.1	0.9	0.8	0.8	0.6	0.5	0.5	0.4	906	
13	full	2.7	2.0	1.6	1.3	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	1049	68
13	-10 tip														
13	fastest	2.5	1.9	1.5	1.3	1.1	0.9	0.8	0.8	0.6	0.5	0.5	0.4	981	

Table 10. E reel ISOKINETIC REELING RATES, 1 LITER BOTTLE, 5/16 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second											max vol. -10 vol. min vol.	volume -min. vol. mL	
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00			9.00
1	full	46.3	34.8	27.8	23.2	19.9	17.4	15.4	13.9	11.6	9.9	8.7	7.7	1049	918
1	-10 tip	35.3	26.5	21.2	17.7	15.1	13.3	11.8	10.6	8.8	7.6	6.6	5.9	800	668
1	fastest	5.8	4.4	3.5	2.9	2.5	2.2	1.9	1.7	1.5	1.2	1.1	1.0	132	
2	full	23.2	17.4	13.9	11.6	9.9	8.7	7.7	7.0	5.8	5.0	4.3	3.9	1049	806
2	-10 tip	17.7	13.3	10.6	8.8	7.6	6.6	5.9	5.3	4.4	3.8	3.3	2.9	800	557
2	fastest	5.4	4.0	3.2	2.7	2.3	2.0	1.8	1.6	1.3	1.2	1.0	0.9	243	
3	full	15.4	11.6	9.3	7.7	6.6	5.8	5.1	4.6	3.9	3.3	2.9	2.6	1049	709
3	-10 tip	11.8	8.8	7.1	5.9	5.0	4.4	3.9	3.5	2.9	2.5	2.2	2.0	800	460
3	fastest	5.0	3.8	3.0	2.5	2.1	1.9	1.7	1.5	1.3	1.1	0.9	0.8	340	
4	full	11.6	8.7	7.0	5.8	5.0	4.3	3.9	3.5	2.9	2.5	2.2	1.9	1049	626
4	-10 tip	8.8	6.6	5.3	4.4	3.8	3.3	2.9	2.7	2.2	1.9	1.7	1.5	800	376
4	fastest	4.7	3.5	2.8	2.3	2.0	1.8	1.6	1.4	1.2	1.0	0.9	0.8	424	
5	full	9.3	7.0	5.6	4.6	4.0	3.5	3.1	2.8	2.3	2.0	1.7	1.5	1049	552
5	-10 tip	7.1	5.3	4.2	3.5	3.0	2.7	2.4	2.1	1.8	1.5	1.3	1.2	800	303
5	fastest	4.4	3.3	2.6	2.2	1.9	1.6	1.5	1.3	1.1	0.9	0.8	0.7	497	
6	full	7.7	5.8	4.6	3.9	3.3	2.9	2.6	2.3	1.9	1.7	1.4	1.3	1049	487
6	-10 tip	5.9	4.4	3.5	2.9	2.5	2.2	2.0	1.8	1.5	1.3	1.1	1.0	800	238
6	fastest	4.1	3.1	2.5	2.1	1.8	1.6	1.4	1.2	1.0	0.9	0.8	0.7	562	
7	full	6.6	5.0	4.0	3.3	2.8	2.5	2.2	2.0	1.7	1.4	1.2	1.1	1049	429
7	-10 tip	5.0	3.8	3.0	2.5	2.2	1.9	1.7	1.5	1.3	1.1	0.9	0.8	800	180
7	fastest	3.9	2.9	2.3	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.7	620	
8	full	5.8	4.3	3.5	2.9	2.5	2.2	1.9	1.7	1.4	1.2	1.1	1.0	1049	377
8	-10 tip	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3	1.1	0.9	0.8	0.7	800	128
8	fastest	3.7	2.8	2.2	1.9	1.6	1.4	1.2	1.1	0.9	0.8	0.7	0.6	672	
10	full	4.6	3.5	2.8	2.3	2.0	1.7	1.5	1.4	1.2	1.0	0.9	0.8	1049	287
10	-10 tip	3.5	2.7	2.1	1.8	1.5	1.3	1.2	1.1	0.9	0.8	0.7	0.6	800	38
10	fastest	3.4	2.5	2.0	1.7	1.4	1.3	1.1	1.0	0.8	0.7	0.6	0.6	762	
11	full	4.2	3.2	2.5	2.1	1.8	1.6	1.4	1.3	1.1	0.9	0.8	0.7	1049	219
11	-10 tip														
11	fastest	3.3	2.5	2.0	1.7	1.4	1.3	1.1	1.0	0.8	0.7	0.6	0.6	830	
12	full	3.9	2.9	2.3	1.9	1.7	1.4	1.3	1.2	1.0	0.8	0.7	0.6	1049	143
12	-10 tip														
12	fastest	3.3	2.5	2.0	1.7	1.4	1.3	1.1	1.0	0.8	0.7	0.6	0.6	906	
13	full	3.6	2.7	2.1	1.8	1.5	1.3	1.2	1.1	0.9	0.8	0.7	0.6	1049	68
13	-10 tip														
13	fastest	3.3	2.5	2.0	1.7	1.4	1.3	1.1	1.0	0.8	0.7	0.6	0.6	981	

Table 11. ISOKINETIC TRANSIT RATES, 1 LITER BOTTLE, 5/16 inch nozzle

(transit rates in feet per second; Depth is water depth - unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol.	volume- min. vol. mL
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	-10 vol. min vol.	
1	full	0.04	0.06	0.07	0.09	0.10	0.12	0.13	0.14	0.17	0.20	0.23	0.26	1049	918
1	-10 tip	0.06	0.08	0.09	0.11	0.13	0.15	0.17	0.19	0.23	0.26	0.30	0.34	800	668
1	fastest	0.34	0.46	0.57	0.69	0.80	0.92	1.03	1.15	1.38	1.61	1.84	2.07	132	
2	full	0.09	0.12	0.14	0.17	0.20	0.23	0.26	0.29	0.35	0.40	0.46	0.52	1049	806
2	-10 tip	0.11	0.15	0.19	0.23	0.26	0.30	0.34	0.38	0.45	0.53	0.60	0.68	800	557
2	fastest	0.37	0.50	0.62	0.74	0.87	0.99	1.12	1.24	1.49	1.74	1.98	2.23	243	
3	full	0.13	0.17	0.22	0.26	0.30	0.35	0.39	0.43	0.52	0.60	0.69	0.78	1049	709
3	-10 tip	0.17	0.23	0.28	0.34	0.40	0.45	0.51	0.57	0.68	0.79	0.91	1.02	800	460
3	fastest	0.40	0.53	0.67	0.80	0.93	1.07	1.20	1.33	1.60	1.87	2.13	2.40	340	
4	full	0.17	0.23	0.29	0.35	0.40	0.46	0.52	0.58	0.69	0.81	0.92	1.04	1049	626
4	-10 tip	0.23	0.30	0.38	0.45	0.53	0.60	0.68	0.75	0.91	1.06	1.21	1.36	800	376
4	fastest	0.43	0.57	0.71	0.86	1.00	1.14	1.28	1.43	1.71	2.00	2.28	2.57	424	
5	full	0.22	0.29	0.36	0.43	0.50	0.58	0.65	0.72	0.86	1.01	1.15	1.29	1049	552
5	-10 tip	0.28	0.38	0.47	0.57	0.66	0.75	0.85	0.94	1.13	1.32	1.51	1.70	800	303
5	fastest	0.46	0.61	0.76	0.91	1.06	1.21	1.37	1.52	1.82	2.13	2.43	2.73	497	
6	full	0.26	0.35	0.43	0.52	0.60	0.69	0.78	0.86	1.04	1.21	1.38	1.55	1049	487
6	-10 tip	0.34	0.45	0.57	0.68	0.79	0.91	1.02	1.13	1.36	1.58	1.81	2.04	800	238
6	fastest	0.48	0.64	0.81	0.97	1.13	1.29	1.45	1.61	1.93	2.26	2.58	2.90	562	
7	full	0.30	0.40	0.50	0.60	0.71	0.81	0.91	1.01	1.21	1.41	1.61	1.81	1049	429
7	-10 tip	0.40	0.53	0.66	0.79	0.92	1.06	1.19	1.32	1.58	1.85	2.11	2.38	800	180
7	fastest	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	2.04	2.38	2.73	3.07	620	
8	full	0.35	0.46	0.58	0.69	0.81	0.92	1.04	1.15	1.38	1.61	1.84	2.07	1049	377
8	-10 tip	0.45	0.60	0.75	0.91	1.06	1.21	1.36	1.51	1.81	2.11	2.42	2.72	800	128
8	fastest	0.54	0.72	0.90	1.08	1.26	1.44	1.62	1.80	2.16	2.51	2.87	3.23	672	
10	full	0.43	0.58	0.72	0.86	1.01	1.15	1.29	1.44	1.73	2.01	2.30	2.59	1049	287
10	-10 tip	0.57	0.75	0.94	1.13	1.32	1.51	1.70	1.89	2.26	2.64	3.02	3.40	800	38
10	fastest	0.59	0.79	0.99	1.19	1.39	1.59	1.78	1.98	2.38	2.77	3.17	3.57	762	
11	full	0.47	0.63	0.79	0.95	1.11	1.27	1.42	1.58	1.90	2.22	2.53	2.85	1049	219
11	-10 tip														
11	fastest	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	830	
12	full	0.52	0.69	0.86	1.04	1.21	1.38	1.55	1.73	2.07	2.42	2.76	3.11	1049	143
12	-10 tip														
12	fastest	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	906	
13	full	0.56	0.75	0.94	1.12	1.31	1.50	1.68	1.87	2.24	2.62	2.99	3.37	1049	68
13	-10 tip														
13	fastest	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	981	

Table 12. A reel ISOKINETIC REELING RATES, 3 LITER BOTTLE, 5/16 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second											max vol. -10 vol. min vol.	volume -min. vol. mL	
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00			9.00
2	full	31	23	19	16	13	12	10	9	7.8	6.7	5.9	5.2	2830	2118
2	-10 tip	27	20	16	14	12	10	9.1	8.2	6.8	5.8	5.1	4.5	2461	1749
2	fastest	7.9	5.9	4.7	3.9	3.4	2.9	2.6	2.4	2.0	1.7	1.5	1.3	712	
3	full	20.8	15.6	12.5	10.4	8.9	7.8	6.9	6.3	5.2	4.5	3.9	3.5	2830	1837
3	-10 tip	18.1	13.6	10.9	9.1	7.8	6.8	6.0	5.4	4.5	3.9	3.4	3.0	2461	1468
3	fastest	7.3	5.5	4.4	3.7	3.1	2.7	2.4	2.2	1.8	1.6	1.4	1.2	993	
4	full	15.6	11.7	9.4	7.8	6.7	5.9	5.2	4.7	3.9	3.3	2.9	2.6	2830	1593
4	-10 tip	13.6	10.2	8.2	6.8	5.8	5.1	4.5	4.1	3.4	2.9	2.5	2.3	2461	1224
4	fastest	6.8	5.1	4.1	3.4	2.9	2.6	2.3	2.0	1.7	1.5	1.3	1.1	1237	
5	full	12.5	9.4	7.5	6.3	5.4	4.7	4.2	3.8	3.1	2.7	2.3	2.1	2830	1379
5	-10 tip	10.9	8.2	6.5	5.4	4.7	4.1	3.6	3.3	2.7	2.3	2.0	1.8	2461	1010
5	fastest	6.4	4.8	3.8	3.2	2.7	2.4	2.1	1.9	1.6	1.4	1.2	1.1	1451	
6	full	10.4	7.8	6.3	5.2	4.5	3.9	3.5	3.1	2.6	2.2	2.0	1.7	2830	1190
6	-10 tip	9.1	6.8	5.4	4.5	3.9	3.4	3.0	2.7	2.3	1.9	1.7	1.5	2461	820
6	fastest	6.0	4.5	3.6	3.0	2.6	2.3	2.0	1.8	1.5	1.3	1.1	1.0	1641	
7	full	8.9	6.7	5.4	4.5	3.8	3.3	3.0	2.7	2.2	1.9	1.7	1.5	2830	1021
7	-10 tip	7.8	5.8	4.7	3.9	3.3	2.9	2.6	2.3	1.9	1.7	1.5	1.3	2461	652
7	fastest	5.7	4.3	3.4	2.9	2.4	2.1	1.9	1.7	1.4	1.2	1.1	1.0	1809	
8	full	7.8	5.9	4.7	3.9	3.3	2.9	2.6	2.3	2.0	1.7	1.5	1.3	2830	870
8	-10 tip	6.8	5.1	4.1	3.4	2.9	2.5	2.3	2.0	1.7	1.5	1.3	1.1	2461	501
8	fastest	5.4	4.1	3.2	2.7	2.3	2.0	1.8	1.6	1.4	1.2	1.0	0.9	1960	
9	full	6.9	5.2	4.2	3.5	3.0	2.6	2.3	2.1	1.7	1.5	1.3	1.2	2830	734
9	-10 tip	6.0	4.5	3.6	3.0	2.6	2.3	2.0	1.8	1.5	1.3	1.1	1.0	2461	365
9	fastest	5.1	3.9	3.1	2.6	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.9	2096	
10	full	6.3	4.7	3.8	3.1	2.7	2.3	2.1	1.9	1.6	1.3	1.2	1.0	2830	610
10	-10 tip	5.4	4.1	3.3	2.7	2.3	2.0	1.8	1.6	1.4	1.2	1.0	0.9	2461	241
10	fastest	4.9	3.7	2.9	2.5	2.1	1.8	1.6	1.5	1.2	1.1	0.9	0.8	2220	
12	full	5.2	3.9	3.1	2.6	2.2	2.0	1.7	1.6	1.3	1.1	1.0	0.9	2830	396
12	-10 tip	4.5	3.4	2.7	2.3	1.9	1.7	1.5	1.4	1.1	1.0	0.8	0.8	2461	26
12	fastest	4.5	3.4	2.7	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.8	0.7	2435	
14	full	4.5	3.3	2.7	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.8	0.7	2830	215
14	-10 tip														
14	fastest	4.1	3.1	2.5	2.1	1.8	1.5	1.4	1.2	1.0	0.9	0.8	0.7	2615	
15	full	4.2	3.1	2.5	2.1	1.8	1.6	1.4	1.3	1.0	0.9	0.8	0.7	2830	135
15	-10 tip														
15	fastest	4.0	3.0	2.4	2.0	1.7	1.5	1.3	1.2	1.0	0.9	0.7	0.7	2695	

Table 13. B reel ISOKINETIC REELING RATES, 3 LITER BOTTLE, 5/16 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second											max vol. -10 vol. min vol.	volume -min. vol. mL	
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00			9.00
2	full	46.9	35.2	28.1	23.4	20.1	17.6	15.6	14.1	11.7	10.0	8.8	7.8	2830	2118
2	-10 tip	40.8	30.6	24.5	20.4	17.5	15.3	13.6	12.2	10.2	8.7	7.6	6.8	2461	1749
2	fastest	11.8	8.8	7.1	5.9	5.1	4.4	3.9	3.5	2.9	2.5	2.2	2.0	712	
3	full	31.3	23.4	18.8	15.6	13.4	11.7	10.4	9.4	7.8	6.7	5.9	5.2	2830	1837
3	-10 tip	27.2	20.4	16.3	13.6	11.6	10.2	9.1	8.2	6.8	5.8	5.1	4.5	2461	1468
3	fastest	11.0	8.2	6.6	5.5	4.7	4.1	3.7	3.3	2.7	2.3	2.1	1.8	993	
4	full	23.4	17.6	14.1	11.7	10.0	8.8	7.8	7.0	5.9	5.0	4.4	3.9	2830	1593
4	-10 tip	20.4	15.3	12.2	10.2	8.7	7.6	6.8	6.1	5.1	4.4	3.8	3.4	2461	1224
4	fastest	10.2	7.7	6.1	5.1	4.4	3.8	3.4	3.1	2.6	2.2	1.9	1.7	1237	
5	full	18.8	14.1	11.3	9.4	8.0	7.0	6.3	5.6	4.7	4.0	3.5	3.1	2830	1379
5	-10 tip	16.3	12.2	9.8	8.2	7.0	6.1	5.4	4.9	4.1	3.5	3.1	2.7	2461	1010
5	fastest	9.6	7.2	5.8	4.8	4.1	3.6	3.2	2.9	2.4	2.1	1.8	1.6	1451	
6	full	15.6	11.7	9.4	7.8	6.7	5.9	5.2	4.7	3.9	3.3	2.9	2.6	2830	1190
6	-10 tip	13.6	10.2	8.2	6.8	5.8	5.1	4.5	4.1	3.4	2.9	2.5	2.3	2461	820
6	fastest	9.1	6.8	5.4	4.5	3.9	3.4	3.0	2.7	2.3	1.9	1.7	1.5	1641	
7	full	13.4	10.0	8.0	6.7	5.7	5.0	4.5	4.0	3.3	2.9	2.5	2.2	2830	1021
7	-10 tip	11.6	8.7	7.0	5.8	5.0	4.4	3.9	3.5	2.9	2.5	2.2	1.9	2461	652
7	fastest	8.6	6.4	5.1	4.3	3.7	3.2	2.9	2.6	2.1	1.8	1.6	1.4	1809	
8	full	11.7	8.8	7.0	5.9	5.0	4.4	3.9	3.5	2.9	2.5	2.2	2.0	2830	870
8	-10 tip	10.2	7.6	6.1	5.1	4.4	3.8	3.4	3.1	2.5	2.2	1.9	1.7	2461	501
8	fastest	8.1	6.1	4.9	4.1	3.5	3.0	2.7	2.4	2.0	1.7	1.5	1.4	1960	
9	full	10.4	7.8	6.3	5.2	4.5	3.9	3.5	3.1	2.6	2.2	2.0	1.7	2830	734
9	-10 tip	9.1	6.8	5.4	4.5	3.9	3.4	3.0	2.7	2.3	1.9	1.7	1.5	2461	365
9	fastest	7.7	5.8	4.6	3.9	3.3	2.9	2.6	2.3	1.9	1.7	1.4	1.3	2096	
10	full	9.4	7.0	5.6	4.7	4.0	3.5	3.1	2.8	2.3	2.0	1.8	1.6	2830	610
10	-10 tip	8.2	6.1	4.9	4.1	3.5	3.1	2.7	2.4	2.0	1.7	1.5	1.4	2461	241
10	fastest	7.4	5.5	4.4	3.7	3.2	2.8	2.5	2.2	1.8	1.6	1.4	1.2	2220	
12	full	7.8	5.9	4.7	3.9	3.3	2.9	2.6	2.3	2.0	1.7	1.5	1.3	2830	396
12	-10 tip	6.8	5.1	4.1	3.4	2.9	2.5	2.3	2.0	1.7	1.5	1.3	1.1	2461	26
12	fastest	6.7	5.0	4.0	3.4	2.9	2.5	2.2	2.0	1.7	1.4	1.3	1.1	2435	
14	full	6.7	5.0	4.0	3.3	2.9	2.5	2.2	2.0	1.7	1.4	1.3	1.1	2830	215
14	-10 tip														
14	fastest	6.2	4.6	3.7	3.1	2.7	2.3	2.1	1.9	1.5	1.3	1.2	1.0	2615	
15	full	6.3	4.7	3.8	3.1	2.7	2.3	2.1	1.9	1.6	1.3	1.2	1.0	2830	135
15	-10 tip														
15	fastest	6.0	4.5	3.6	3.0	2.6	2.2	2.0	1.8	1.5	1.3	1.1	1.0	2695	

Table 14. E reel ISOKINETIC REELING RATES, 3 LITER BOTTLE, 5/16 inch nozzle

(Reeling rates in SECONDS PER TURN; Depth is water depth-unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol. -10 vol. min vol.	volume -min. vol. mL
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00		
2	full	62.5	46.9	37.5	31.3	26.8	23.4	20.8	18.8	15.6	13.4	11.7	10.4	2830	2118
2	-10 tip	54.3	40.8	32.6	27.2	23.3	20.4	18.1	16.3	13.6	11.6	10.2	9.1	2461	1749
2	fastest	15.7	11.8	9.4	7.9	6.7	5.9	5.2	4.7	3.9	3.4	2.9	2.6	712	
3	full	41.7	31.3	25.0	20.8	17.9	15.6	13.9	12.5	10.4	8.9	7.8	6.9	2830	1837
3	-10 tip	36.2	27.2	21.7	18.1	15.5	13.6	12.1	10.9	9.1	7.8	6.8	6.0	2461	1468
3	fastest	14.6	11.0	8.8	7.3	6.3	5.5	4.9	4.4	3.7	3.1	2.7	2.4	993	
4	full	31.3	23.4	18.8	15.6	13.4	11.7	10.4	9.4	7.8	6.7	5.9	5.2	2830	1593
4	-10 tip	27.2	20.4	16.3	13.6	11.6	10.2	9.1	8.2	6.8	5.8	5.1	4.5	2461	1224
4	fastest	13.7	10.2	8.2	6.8	5.9	5.1	4.6	4.1	3.4	2.9	2.6	2.3	1237	
5	full	25.0	18.8	15.0	12.5	10.7	9.4	8.3	7.5	6.3	5.4	4.7	4.2	2830	1379
5	-10 tip	21.7	16.3	13.0	10.9	9.3	8.2	7.2	6.5	5.4	4.7	4.1	3.6	2461	1010
5	fastest	12.8	9.6	7.7	6.4	5.5	4.8	4.3	3.8	3.2	2.7	2.4	2.1	1451	
6	full	20.8	15.6	12.5	10.4	8.9	7.8	6.9	6.3	5.2	4.5	3.9	3.5	2830	1190
6	-10 tip	18.1	13.6	10.9	9.1	7.8	6.8	6.0	5.4	4.5	3.9	3.4	3.0	2461	820
6	fastest	12.1	9.1	7.2	6.0	5.2	4.5	4.0	3.6	3.0	2.6	2.3	2.0	1641	
7	full	17.9	13.4	10.7	8.9	7.7	6.7	6.0	5.4	4.5	3.8	3.3	3.0	2830	1021
7	-10 tip	15.5	11.6	9.3	7.8	6.7	5.8	5.2	4.7	3.9	3.3	2.9	2.6	2461	652
7	fastest	11.4	8.6	6.8	5.7	4.9	4.3	3.8	3.4	2.9	2.4	2.1	1.9	1809	
8	full	15.6	11.7	9.4	7.8	6.7	5.9	5.2	4.7	3.9	3.3	2.9	2.6	2830	870
8	-10 tip	13.6	10.2	8.2	6.8	5.8	5.1	4.5	4.1	3.4	2.9	2.5	2.3	2461	501
8	fastest	10.8	8.1	6.5	5.4	4.6	4.1	3.6	3.2	2.7	2.3	2.0	1.8	1960	
9	full	13.9	10.4	8.3	6.9	6.0	5.2	4.6	4.2	3.5	3.0	2.6	2.3	2830	734
9	-10 tip	12.1	9.1	7.2	6.0	5.2	4.5	4.0	3.6	3.0	2.6	2.3	2.0	2461	365
9	fastest	10.3	7.7	6.2	5.1	4.4	3.9	3.4	3.1	2.6	2.2	1.9	1.7	2096	
10	full	12.5	9.4	7.5	6.3	5.4	4.7	4.2	3.8	3.1	2.7	2.3	2.1	2830	610
10	-10 tip	10.9	8.2	6.5	5.4	4.7	4.1	3.6	3.3	2.7	2.3	2.0	1.8	2461	241
10	fastest	9.8	7.4	5.9	4.9	4.2	3.7	3.3	2.9	2.5	2.1	1.8	1.6	2220	
12	full	10.4	7.8	6.3	5.2	4.5	3.9	3.5	3.1	2.6	2.2	2.0	1.7	2830	396
12	-10 tip	9.1	6.8	5.4	4.5	3.9	3.4	3.0	2.7	2.3	1.9	1.7	1.5	2461	26
12	fastest	9.0	6.7	5.4	4.5	3.8	3.4	3.0	2.7	2.2	1.9	1.7	1.5	2435	
14	full	8.9	6.7	5.4	4.5	3.8	3.3	3.0	2.7	2.2	1.9	1.7	1.5	2830	215
14	-10 tip														
14	fastest	8.3	6.2	5.0	4.1	3.5	3.1	2.8	2.5	2.1	1.8	1.5	1.4	2615	
15	full	8.3	6.3	5.0	4.2	3.6	3.1	2.8	2.5	2.1	1.8	1.6	1.4	2830	135
15	-10 tip														
15	fastest	7.9	6.0	4.8	4.0	3.4	3.0	2.6	2.4	2.0	1.7	1.5	1.3	2695	

Table 15. ISOKINETIC TRANSIT RATES, 3 LITER BOTTLE, 5/16 inch nozzle

(transit rates in feet per second; Depth is water depth - unsampled zone;

RATE, Full, fills bottle, -10tip fills bottle with no spillage up to a 10 degree down tip of the nozzle from horizontal; fastest is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol.	volume- min. vol. mL
		1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	-10 vol. min vol.	
2	full	0.03	0.04	0.05	0.06	0.07	0.09	0.10	0.11	0.13	0.15	0.17	0.19	2830	2118
2	-10 tip	0.04	0.05	0.06	0.07	0.09	0.10	0.11	0.12	0.15	0.17	0.20	0.22	2461	1749
2	fastest	0.13	0.17	0.21	0.25	0.30	0.34	0.38	0.42	0.51	0.59	0.68	0.76	712	
3	full	0.05	0.06	0.08	0.10	0.11	0.13	0.14	0.16	0.19	0.22	0.26	0.29	2830	1837
3	-10 tip	0.06	0.07	0.09	0.11	0.13	0.15	0.17	0.18	0.22	0.26	0.29	0.33	2461	1468
3	fastest	0.14	0.18	0.23	0.27	0.32	0.36	0.41	0.46	0.55	0.64	0.73	0.82	993	
4	full	0.06	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.26	0.30	0.34	0.38	2830	1593
4	-10 tip	0.07	0.10	0.12	0.15	0.17	0.20	0.22	0.25	0.29	0.34	0.39	0.44	2461	1224
4	fastest	0.15	0.20	0.24	0.29	0.34	0.39	0.44	0.49	0.59	0.68	0.78	0.88	1237	
5	full	0.08	0.11	0.13	0.16	0.19	0.21	0.24	0.27	0.32	0.37	0.43	0.48	2830	1379
5	-10 tip	0.09	0.12	0.15	0.18	0.21	0.25	0.28	0.31	0.37	0.43	0.49	0.55	2461	1010
5	fastest	0.16	0.21	0.26	0.31	0.36	0.42	0.47	0.52	0.62	0.73	0.83	0.94	1451	
6	full	0.10	0.13	0.16	0.19	0.22	0.26	0.29	0.32	0.38	0.45	0.51	0.58	2830	1190
6	-10 tip	0.11	0.15	0.18	0.22	0.26	0.29	0.33	0.37	0.44	0.52	0.59	0.66	2461	820
6	fastest	0.17	0.22	0.28	0.33	0.39	0.44	0.50	0.55	0.66	0.77	0.88	0.99	1641	
7	full	0.11	0.15	0.19	0.22	0.26	0.30	0.34	0.37	0.45	0.52	0.60	0.67	2830	1021
7	-10 tip	0.13	0.17	0.21	0.26	0.30	0.34	0.39	0.43	0.52	0.60	0.69	0.77	2461	652
7	fastest	0.18	0.23	0.29	0.35	0.41	0.47	0.53	0.58	0.70	0.82	0.93	1.05	1809	
8	full	0.13	0.17	0.21	0.26	0.30	0.34	0.38	0.43	0.51	0.60	0.68	0.77	2830	870
8	-10 tip	0.15	0.20	0.25	0.29	0.34	0.39	0.44	0.49	0.59	0.69	0.79	0.88	2461	501
8	fastest	0.18	0.25	0.31	0.37	0.43	0.49	0.55	0.62	0.74	0.86	0.99	1.11	1960	
9	full	0.14	0.19	0.24	0.29	0.34	0.38	0.43	0.48	0.58	0.67	0.77	0.86	2830	734
9	-10 tip	0.17	0.22	0.28	0.33	0.39	0.44	0.50	0.55	0.66	0.77	0.88	0.99	2461	365
9	fastest	0.19	0.26	0.32	0.39	0.45	0.52	0.58	0.65	0.78	0.91	1.04	1.17	2096	
10	full	0.16	0.21	0.27	0.32	0.37	0.43	0.48	0.53	0.64	0.75	0.85	0.96	2830	610
10	-10 tip	0.18	0.25	0.31	0.37	0.43	0.49	0.55	0.61	0.74	0.86	0.98	1.10	2461	241
10	fastest	0.20	0.27	0.34	0.41	0.48	0.54	0.61	0.68	0.82	0.95	1.09	1.22	2220	
12	full	0.19	0.26	0.32	0.38	0.45	0.51	0.58	0.64	0.77	0.90	1.02	1.15	2830	396
12	-10 tip	0.22	0.29	0.37	0.44	0.52	0.59	0.66	0.74	0.88	1.03	1.18	1.32	2461	26
12	fastest	0.22	0.30	0.37	0.45	0.52	0.60	0.67	0.74	0.89	1.04	1.19	1.34	2435	
14	full	0.22	0.30	0.37	0.45	0.52	0.60	0.67	0.75	0.90	1.05	1.19	1.34	2830	215
14	-10 tip														
14	fastest	0.24	0.32	0.40	0.48	0.57	0.65	0.73	0.81	0.97	1.13	1.29	1.45	2615	
15	full	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80	0.96	1.12	1.28	1.44	2830	135
15	-10 tip														
15	fastest	0.25	0.34	0.42	0.50	0.59	0.67	0.76	0.84	1.01	1.18	1.34	1.51	2695	

Table 16. Minimum volumes for bag samplers

The volumes listed below are the minimum volumes in milliliters that must be in a bag sampler to have not exceeded 0.4 times the mean stream velocity.

Generally bag samplers must be operated in water warmer than about 8 degrees Celsius and where the velocity is greater than 3 feet per second.

WATER DEPTH MINUS UNSAMPLED ZONE IN FEET	NOZZLE DIAMETER IN INCHES			WATER DEPTH MINUS UNSAMPLED ZONE IN FEET
	3/16	1/4	5/16	
1	27	48	75	1
2	54	96	151	2
3	81	145	226	3
4	109	193	301	4
5	136	241	377	5
6	163	289	452	6
7	190	338	528	7
8	217	386	603	8
9	244	434	678	9
10	271	482	754	10
11	298	531	829	11
12	326	579	904	12
13	353	627	980	13
14	380	675	1055	14
15	407	724	1131	15
20	543	965	1507	20
25	678	1206	1884	25
30	814	1447	2261	30
35	950	1688	2638	35
40	1085	1930	3015	40
45	1221	2171	3392	45
50	1357	2412	3769	50
55	1492	2653	4146	55
60	1628	2894	4522	60
65	1764	3136	4899	65
70	1899	3377	5276	70
75	2035	3618	5653	75
80	2171	3859	6030	80
85	2306	4100	6407	85
90	2442	4342	6784	90
95	2578	4583	7161	95
100	2713	4824	7537	100
120	3256	5789	9045	120
140	3799	6754	10552	140
160	4342	7718	12060	160
180	4884	8683	13567	180
200	5427	9648	15075	200

minimum volume = area of nozzle x time in water x mean stream velocity in vertical @a transit rate = 0.4 x mean stream velocity

minimum volume in ml = 15 x 3.14 x 2.54 cubed x nozzle dia in inches squared x depth in feet

Table 17. A reel ISOKINETIC REELING RATES, 3 LITER BAG, 1/4 inch nozzle
 (REELING RATE, in SECONDS PER TURN; DEPTH, is water depth-unsampled zone;
 RATE; full, fills bottle, fastest, is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol.	max. vol
		2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	12.00	min vol.	-min. vol ml
6	full	9.00	7.50	6.43	5.63	5.00	4.50	3.75	3.21	2.81	2.50	2.25	1.88	2607	2318
6	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	290	
8	full	6.75	5.63	4.82	4.22	3.75	3.38	2.81	2.41	2.11	1.88	1.69	1.41	2607	2221
8	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	386	
10	full	5.40	4.50	3.86	3.38	3.00	2.70	2.25	1.93	1.69	1.50	1.35	1.13	2607	2125
10	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	483	
12	full	4.50	3.75	3.21	2.81	2.50	2.25	1.88	1.61	1.41	1.25	1.13	0.94	2607	2028
12	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	579	
14	full	3.86	3.21	2.76	2.41	2.14	1.93	1.61	1.38	1.21	1.07	0.96	0.80	2607	1931
14	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	676	
16	full	3.38	2.81	2.41	2.11	1.88	1.69	1.41	1.21	1.05	0.94	0.84	0.70	2607	1835
16	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	773	
18	full	3.00	2.50	2.14	1.88	1.67	1.50	1.25	1.07	0.94	0.83	0.75	0.63	2607	1738
18	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	869	
20	full	2.70	2.25	1.93	1.69	1.50	1.35	1.13	0.96	0.84	0.75	0.68	0.56	2607	1642
20	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	966	
22	full	2.45	2.05	1.75	1.53	1.36	1.23	1.02	0.88	0.77	0.68	0.61	0.51	2607	1545
22	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1062	
24	full	2.25	1.88	1.61	1.41	1.25	1.13	0.94	0.80	0.70	0.63	0.56	0.47	2607	1449
24	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1159	
26	full	2.08	1.73	1.48	1.30	1.15	1.04	0.87	0.74	0.65	0.58	0.52	0.43	2607	1352
26	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1255	
28	full	1.93	1.61	1.38	1.21	1.07	0.96	0.80	0.69	0.60	0.54	0.48	0.40	2607	1255
28	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1352	
30	full	1.80	1.50	1.29	1.13	1.00	0.90	0.75	0.64	0.56	0.50	0.45	0.38	2607	1159
30	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1449	
35	full	1.54	1.29	1.10	0.96	0.86	0.77	0.64	0.55	0.48	0.43	0.39	0.32	2607	917
35	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1690	
40	full	1.35	1.13	0.96	0.84	0.75	0.68	0.56	0.48	0.42	0.38	0.34	0.28	2607	676
40	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1931	
45	full	1.20	1.00	0.86	0.75	0.67	0.60	0.50	0.43	0.38	0.33	0.30	0.25	2607	435
45	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	2173	
50	full	1.08	0.90	0.77	0.68	0.60	0.54	0.45	0.39	0.34	0.30	0.27	0.23	2607	193
50	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	2414	
53	full	1.02	0.85	0.73	0.64	0.57	0.51	0.42	0.36	0.32	0.28	0.25	0.21	2607	48
53	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	2559	

Table 18. B reel ISOKINETIC REELING RATES, 3 LITER BAG, 1/4 inch nozzle
 (REELING RATE, in SECONDS PER TURN; DEPTH, is water depth-unsampled zone;
 RATE; full, fills bottle, fastest, is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol.	max. vol
		2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	12.00	min vol.	-min. vol ml
6	full	13.5	11.3	9.64	8.44	7.50	6.75	5.63	4.82	4.22	3.75	3.38	2.81	2607	2318
6	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	290	
8	full	10.1	8.44	7.23	6.33	5.63	5.06	4.22	3.62	3.16	2.81	2.53	2.11	2607	2221
8	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	386	
10	full	8.10	6.75	5.79	5.06	4.50	4.05	3.38	2.89	2.53	2.25	2.03	1.69	2607	2125
10	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	483	
12	full	6.75	5.63	4.82	4.22	3.75	3.38	2.81	2.41	2.11	1.88	1.69	1.41	2607	2028
12	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	579	
14	full	5.79	4.82	4.13	3.62	3.21	2.89	2.41	2.07	1.81	1.61	1.45	1.21	2607	1931
14	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	676	
16	full	5.06	4.22	3.62	3.16	2.81	2.53	2.11	1.81	1.58	1.41	1.27	1.05	2607	1835
16	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	773	
18	full	4.50	3.75	3.21	2.81	2.50	2.25	1.88	1.61	1.41	1.25	1.13	0.94	2607	1738
18	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	869	
20	full	4.05	3.38	2.89	2.53	2.25	2.03	1.69	1.45	1.27	1.13	1.01	0.84	2607	1642
20	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	966	
22	full	3.68	3.07	2.63	2.30	2.05	1.84	1.53	1.31	1.15	1.02	0.92	0.77	2607	1545
22	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1062	
24	full	3.38	2.81	2.41	2.11	1.88	1.69	1.41	1.21	1.05	0.94	0.84	0.70	2607	1449
24	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1159	
26	full	3.12	2.60	2.23	1.95	1.73	1.56	1.30	1.11	0.97	0.87	0.78	0.65	2607	1352
26	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1255	
28	full	2.89	2.41	2.07	1.81	1.61	1.45	1.21	1.03	0.90	0.80	0.72	0.60	2607	1255
28	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1352	
30	full	2.70	2.25	1.93	1.69	1.50	1.35	1.13	0.96	0.84	0.75	0.68	0.56	2607	1159
30	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1449	
35	full	2.31	1.93	1.65	1.45	1.29	1.16	0.96	0.83	0.72	0.64	0.58	0.48	2607	917
35	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1690	
40	full	2.03	1.69	1.45	1.27	1.13	1.01	0.84	0.72	0.63	0.56	0.51	0.42	2607	676
40	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1931	
45	full	1.80	1.50	1.29	1.13	1.00	0.90	0.75	0.64	0.56	0.50	0.45	0.38	2607	435
45	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	2173	
50	full	1.62	1.35	1.16	1.01	0.90	0.81	0.68	0.58	0.51	0.45	0.41	0.34	2607	193
50	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	2414	
53	full	1.53	1.27	1.09	0.96	0.85	0.76	0.64	0.55	0.48	0.42	0.38	0.32	2607	48
53	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	2559	

Table 19. E reel ISOKINETIC REELING RATES, 3 LITER BAG, 1/4 inch nozzle
 (REELING RATE, in SECONDS PER TURN; DEPTH, is water depth-unsampled zone;
 RATE; full, fills bottle, fastest, is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol.	max. vol
		2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	12.00	min vol.	-min. vol ml
6	full	18.0	15.0	12.9	11.3	10.0	9.0	7.5	6.4	5.6	5.0	4.5	3.8	2607	2318
6	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	290	
8	full	13.5	11.3	9.64	8.44	7.50	6.75	5.63	4.82	4.22	3.75	3.38	2.81	2607	2221
8	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	386	
10	full	10.8	9.00	7.71	6.75	6.00	5.40	4.50	3.86	3.38	3.00	2.70	2.25	2607	2125
10	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	483	
12	full	9.00	7.50	6.43	5.63	5.00	4.50	3.75	3.21	2.81	2.50	2.25	1.88	2607	2028
12	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	579	
14	full	7.71	6.43	5.51	4.82	4.29	3.86	3.21	2.76	2.41	2.14	1.93	1.61	2607	1931
14	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	676	
16	full	6.75	5.63	4.82	4.22	3.75	3.38	2.81	2.41	2.11	1.88	1.69	1.41	2607	1835
16	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	773	
18	full	6.00	5.00	4.29	3.75	3.33	3.00	2.50	2.14	1.88	1.67	1.50	1.25	2607	1738
18	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	869	
20	full	5.40	4.50	3.86	3.38	3.00	2.70	2.25	1.93	1.69	1.50	1.35	1.13	2607	1642
20	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	966	
22	full	4.91	4.09	3.51	3.07	2.73	2.45	2.05	1.75	1.53	1.36	1.23	1.02	2607	1545
22	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1062	
24	full	4.50	3.75	3.21	2.81	2.50	2.25	1.88	1.61	1.41	1.25	1.13	0.94	2607	1449
24	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1159	
26	full	4.15	3.46	2.97	2.60	2.31	2.08	1.73	1.48	1.30	1.15	1.04	0.87	2607	1352
26	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1255	
28	full	3.86	3.21	2.76	2.41	2.14	1.93	1.61	1.38	1.21	1.07	0.96	0.80	2607	1255
28	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1352	
30	full	3.60	3.00	2.57	2.25	2.00	1.80	1.50	1.29	1.13	1.00	0.90	0.75	2607	1159
30	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1449	
35	full	3.09	2.57	2.20	1.93	1.71	1.54	1.29	1.10	0.96	0.86	0.77	0.64	2607	917
35	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1690	
40	full	2.70	2.25	1.93	1.69	1.50	1.35	1.13	0.96	0.84	0.75	0.68	0.56	2607	676
40	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1931	
45	full	2.40	2.00	1.71	1.50	1.33	1.20	1.00	0.86	0.75	0.67	0.60	0.50	2607	435
45	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	2173	
50	full	2.16	1.80	1.54	1.35	1.20	1.08	0.90	0.77	0.68	0.60	0.54	0.45	2607	193
50	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	2414	
53	full	2.04	1.70	1.46	1.27	1.13	1.02	0.85	0.73	0.64	0.57	0.51	0.42	2607	48
53	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	2559	

Table 20. ISOKINETIC TRANSIT RATES, 3 LITER BAG, 1/4 inch nozzle

(Transit rate, in feet per second; Depth, is water depth - unsampled zone;

RATE: full; fills bottle; fastest, is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol. -10 vol. min vol.	volume- min. vol. mL
		2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	12.00		
6	full	0.11	0.13	0.16	0.18	0.20	0.22	0.27	0.31	0.36	0.40	0.44	0.53	2607	2318
6	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	290	
8	full	0.15	0.18	0.21	0.24	0.27	0.30	0.36	0.41	0.47	0.53	0.59	0.71	2607	2221
8	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	386	
10	full	0.19	0.22	0.26	0.30	0.33	0.37	0.44	0.52	0.59	0.67	0.74	0.89	2607	2125
10	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	483	
12	full	0.22	0.27	0.31	0.36	0.40	0.44	0.53	0.62	0.71	0.80	0.89	1.07	2607	2028
12	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	579	
14	full	0.26	0.31	0.36	0.41	0.47	0.52	0.62	0.73	0.83	0.93	1.04	1.24	2607	1931
14	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	676	
16	full	0.30	0.36	0.41	0.47	0.53	0.59	0.71	0.83	0.95	1.07	1.19	1.42	2607	1835
16	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	773	
18	full	0.33	0.40	0.47	0.53	0.60	0.67	0.80	0.93	1.07	1.20	1.33	1.60	2607	1738
18	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	869	
20	full	0.37	0.44	0.52	0.59	0.67	0.74	0.89	1.04	1.19	1.33	1.48	1.78	2607	1642
20	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	966	
22	full	0.41	0.49	0.57	0.65	0.73	0.81	0.98	1.14	1.30	1.47	1.63	1.96	2607	1545
22	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1062	
24	full	0.44	0.53	0.62	0.71	0.80	0.89	1.07	1.24	1.42	1.60	1.78	2.13	2607	1449
24	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1159	
26	full	0.48	0.58	0.67	0.77	0.87	0.96	1.16	1.35	1.54	1.73	1.93	2.31	2607	1352
26	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1255	
28	full	0.52	0.62	0.73	0.83	0.93	1.04	1.24	1.45	1.66	1.87	2.07	2.49	2607	1255
28	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1352	
30	full	0.56	0.67	0.78	0.89	1.00	1.11	1.33	1.56	1.78	2.00	2.22	2.67	2607	1159
30	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1449	
35	full	0.65	0.78	0.91	1.04	1.17	1.30	1.56	1.81	2.07	2.33	2.59	3.11	2607	917
35	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1690	
40	full	0.74	0.89	1.04	1.19	1.33	1.48	1.78	2.07	2.37	2.67	2.96	3.56	2607	676
40	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1931	
45	full	0.83	1.00	1.17	1.33	1.50	1.67	2.00	2.33	2.67	3.00	3.33	4.00	2607	435
45	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	2173	
50	full	0.93	1.11	1.30	1.48	1.67	1.85	2.22	2.59	2.96	3.33	3.70	4.44	2607	193
50	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	2414	
53	full	0.98	1.18	1.37	1.57	1.77	1.96	2.36	2.75	3.14	3.53	3.93	4.71	2607	48
53	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	2559	

Table 21. A reel ISOKINETIC REELING RATES, 3 LITER BAG, 5/16 inch nozzle
 (REELING RATE, in SECONDS PER TURN; DEPTH, is water depth-unsampled zone;
 RATE; full, fills bottle, fastest, is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max. vol.	min. vol.
		2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	12.00	min vol.	ml
2	full	17.3	14.4	12.3	10.8	9.6	8.6	7.2	6.2	5.4	4.8	4.3	3.6	2604	2453
2	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	151	
4	full	8.63	7.19	6.16	5.39	4.79	4.31	3.59	3.08	2.70	2.40	2.16	1.80	2604	2302
4	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	302	
6	full	5.75	4.79	4.11	3.59	3.19	2.88	2.40	2.05	1.80	1.60	1.44	1.20	2604	2151
6	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	453	
8	full	4.31	3.59	3.08	2.70	2.40	2.16	1.80	1.54	1.35	1.20	1.08	0.90	2604	2000
8	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	604	
10	full	3.45	2.88	2.46	2.16	1.92	1.73	1.44	1.23	1.08	0.96	0.86	0.72	2604	1849
10	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	755	
12	full	2.88	2.40	2.05	1.80	1.60	1.44	1.20	1.03	0.90	0.80	0.72	0.60	2604	1698
12	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	906	
14	full	2.46	2.05	1.76	1.54	1.37	1.23	1.03	0.88	0.77	0.68	0.62	0.51	2604	1547
14	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1057	
16	full	2.16	1.80	1.54	1.35	1.20	1.08	0.90	0.77	0.67	0.60	0.54	0.45	2604	1396
16	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1208	
18	full	1.92	1.60	1.37	1.20	1.06	0.96	0.80	0.68	0.60	0.53	0.48	0.40	2604	1245
18	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1359	
20	full	1.73	1.44	1.23	1.08	0.96	0.86	0.72	0.62	0.54	0.48	0.43	0.36	2604	1094
20	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1509	
22	full	1.57	1.31	1.12	0.98	0.87	0.78	0.65	0.56	0.49	0.44	0.39	0.33	2604	943
22	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1660	
24	full	1.44	1.20	1.03	0.90	0.80	0.72	0.60	0.51	0.45	0.40	0.36	0.30	2604	792
24	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1811	
26	full	1.33	1.11	0.95	0.83	0.74	0.66	0.55	0.47	0.41	0.37	0.33	0.28	2604	642
26	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	1962	
28	full	1.23	1.03	0.88	0.77	0.68	0.62	0.51	0.44	0.39	0.34	0.31	0.26	2604	491
28	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	2113	
30	full	1.15	0.96	0.82	0.72	0.64	0.58	0.48	0.41	0.36	0.32	0.29	0.24	2604	340
30	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	2264	
32	full	1.08	0.90	0.77	0.67	0.60	0.54	0.45	0.39	0.34	0.30	0.27	0.22	2604	189
32	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	2415	
34	full	1.01	0.85	0.72	0.63	0.56	0.51	0.42	0.36	0.32	0.28	0.25	0.21	2604	38
34	fastest	1.00	0.83	0.71	0.63	0.56	0.50	0.42	0.36	0.31	0.28	0.25	0.21	2566	

Table 22. B reel ISOKINETIC REELING RATES, 3 LITER BAG, 5/16 inch nozzle
 (REELING RATE, in SECONDS PER TURN; DEPTH, is water depth-unsampled zone;
 RATE; full, fills bottle, fastest, is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max. vol.	min. vol.
		2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	12.00	min vol.	ml
2	full	25.9	21.6	18.5	16.2	14.4	12.9	10.8	9.2	8.1	7.2	6.5	5.4	2604	2453
2	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	151	
4	full	12.9	10.8	9.24	8.09	7.19	6.47	5.39	4.62	4.04	3.59	3.23	2.70	2604	2302
4	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	302	
6	full	8.63	7.19	6.16	5.39	4.79	4.31	3.59	3.08	2.70	2.40	2.16	1.80	2604	2151
6	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	453	
8	full	6.47	5.39	4.62	4.04	3.59	3.23	2.70	2.31	2.02	1.80	1.62	1.35	2604	2000
8	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	604	
10	full	5.18	4.31	3.70	3.23	2.88	2.59	2.16	1.85	1.62	1.44	1.29	1.08	2604	1849
10	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	755	
12	full	4.31	3.59	3.08	2.70	2.40	2.16	1.80	1.54	1.35	1.20	1.08	0.90	2604	1698
12	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	906	
14	full	3.70	3.08	2.64	2.31	2.05	1.85	1.54	1.32	1.16	1.03	0.92	0.77	2604	1547
14	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1057	
16	full	3.23	2.70	2.31	2.02	1.80	1.62	1.35	1.16	1.01	0.90	0.81	0.67	2604	1396
16	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1208	
18	full	2.88	2.40	2.05	1.80	1.60	1.44	1.20	1.03	0.90	0.80	0.72	0.60	2604	1245
18	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1359	
20	full	2.59	2.16	1.85	1.62	1.44	1.29	1.08	0.92	0.81	0.72	0.65	0.54	2604	1094
20	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1509	
22	full	2.35	1.96	1.68	1.47	1.31	1.18	0.98	0.84	0.74	0.65	0.59	0.49	2604	943
22	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1660	
24	full	2.16	1.80	1.54	1.35	1.20	1.08	0.90	0.77	0.67	0.60	0.54	0.45	2604	792
24	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1811	
26	full	1.99	1.66	1.42	1.24	1.11	1.00	0.83	0.71	0.62	0.55	0.50	0.41	2604	642
26	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	1962	
28	full	1.85	1.54	1.32	1.16	1.03	0.92	0.77	0.66	0.58	0.51	0.46	0.39	2604	491
28	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	2113	
30	full	1.73	1.44	1.23	1.08	0.96	0.86	0.72	0.62	0.54	0.48	0.43	0.36	2604	340
30	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	2264	
32	full	1.62	1.35	1.16	1.01	0.90	0.81	0.67	0.58	0.51	0.45	0.40	0.34	2604	189
32	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	2415	
34	full	1.52	1.27	1.09	0.95	0.85	0.76	0.63	0.54	0.48	0.42	0.38	0.32	2604	38
34	fastest	1.50	1.25	1.07	0.94	0.83	0.75	0.63	0.54	0.47	0.42	0.38	0.31	2566	

Table 23. E reel ISOKINETIC REELING RATES, 3 LITER BAG, 5/16 inch nozzle
 (REELING RATE, in SECONDS PER TURN; DEPTH, is water depth-unsampled zone;
 RATE; full, fills bottle, fastest, is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max. vol.	min. vol.
		2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	12.00	min vol.	ml
2	full	34.5	28.8	24.6	21.6	19.2	17.3	14.4	12.3	10.8	9.6	8.6	7.2	2604	2453
2	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	151	
4	full	17.3	14.4	12.3	10.8	9.58	8.63	7.19	6.16	5.39	4.79	4.31	3.59	2604	2302
4	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	302	
6	full	11.5	9.58	8.21	7.19	6.39	5.75	4.79	4.11	3.59	3.19	2.88	2.40	2604	2151
6	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	453	
8	full	8.63	7.19	6.16	5.39	4.79	4.31	3.59	3.08	2.70	2.40	2.16	1.80	2604	2000
8	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	604	
10	full	6.90	5.75	4.93	4.31	3.83	3.45	2.88	2.46	2.16	1.92	1.73	1.44	2604	1849
10	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	755	
12	full	5.75	4.79	4.11	3.59	3.19	2.88	2.40	2.05	1.80	1.60	1.44	1.20	2604	1698
12	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	906	
14	full	4.93	4.11	3.52	3.08	2.74	2.46	2.05	1.76	1.54	1.37	1.23	1.03	2604	1547
14	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1057	
16	full	4.31	3.59	3.08	2.70	2.40	2.16	1.80	1.54	1.35	1.20	1.08	0.90	2604	1396
16	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1208	
18	full	3.83	3.19	2.74	2.40	2.13	1.92	1.60	1.37	1.20	1.06	0.96	0.80	2604	1245
18	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1359	
20	full	3.45	2.88	2.46	2.16	1.92	1.73	1.44	1.23	1.08	0.96	0.86	0.72	2604	1094
20	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1509	
22	full	3.14	2.61	2.24	1.96	1.74	1.57	1.31	1.12	0.98	0.87	0.78	0.65	2604	943
22	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1660	
24	full	2.88	2.40	2.05	1.80	1.60	1.44	1.20	1.03	0.90	0.80	0.72	0.60	2604	792
24	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1811	
26	full	2.65	2.21	1.90	1.66	1.47	1.33	1.11	0.95	0.83	0.74	0.66	0.55	2604	642
26	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	1962	
28	full	2.46	2.05	1.76	1.54	1.37	1.23	1.03	0.88	0.77	0.68	0.62	0.51	2604	491
28	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	2113	
30	full	2.30	1.92	1.64	1.44	1.28	1.15	0.96	0.82	0.72	0.64	0.58	0.48	2604	340
30	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	2264	
32	full	2.16	1.80	1.54	1.35	1.20	1.08	0.90	0.77	0.67	0.60	0.54	0.45	2604	189
32	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	2415	
34	full	2.03	1.69	1.45	1.27	1.13	1.01	0.85	0.72	0.63	0.56	0.51	0.42	2604	38
34	fastest	2.00	1.67	1.43	1.25	1.11	1.00	0.83	0.71	0.63	0.56	0.50	0.42	2566	

Table 24. ISOKINETIC TRANSIT RATES, 3 LITER BAG, 5/16 inch nozzle

(Transit rate, in feet per second; Depth, is water depth - unsampled zone;

RATE: full; fills bottle; fastest, is the fastest allowable rate for isokinetic sampling)

DEPTH in feet	RATE	MEAN STREAM VELOCITY IN VERTICAL feet per second												max vol.	volume- min. vol. mL
		2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	12.00	-10 vol. min vol.	
2	full	0.06	0.07	0.08	0.09	0.10	0.12	0.14	0.16	0.19	0.21	0.23	0.28	2604	2453
2	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	151	
4	full	0.12	0.14	0.16	0.19	0.21	0.23	0.28	0.32	0.37	0.42	0.46	0.56	2604	2302
4	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	302	
6	full	0.17	0.21	0.24	0.28	0.31	0.35	0.42	0.49	0.56	0.63	0.70	0.83	2604	2151
6	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	453	
8	full	0.23	0.28	0.32	0.37	0.42	0.46	0.56	0.65	0.74	0.83	0.93	1.11	2604	2000
8	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	604	
10	full	0.29	0.35	0.41	0.46	0.52	0.58	0.70	0.81	0.93	1.04	1.16	1.39	2604	1849
10	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	755	
12	full	0.35	0.42	0.49	0.56	0.63	0.70	0.83	0.97	1.11	1.25	1.39	1.67	2604	1698
12	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	906	
14	full	0.41	0.49	0.57	0.65	0.73	0.81	0.97	1.14	1.30	1.46	1.62	1.95	2604	1547
14	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1057	
16	full	0.46	0.56	0.65	0.74	0.83	0.93	1.11	1.30	1.48	1.67	1.86	2.23	2604	1396
16	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1208	
18	full	0.52	0.63	0.73	0.83	0.94	1.04	1.25	1.46	1.67	1.88	2.09	2.50	2604	1245
18	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1359	
20	full	0.58	0.70	0.81	0.93	1.04	1.16	1.39	1.62	1.86	2.09	2.32	2.78	2604	1094
20	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1509	
22	full	0.64	0.77	0.89	1.02	1.15	1.28	1.53	1.79	2.04	2.30	2.55	3.06	2604	943
22	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1660	
24	full	0.70	0.83	0.97	1.11	1.25	1.39	1.67	1.95	2.23	2.50	2.78	3.34	2604	792
24	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1811	
26	full	0.75	0.90	1.06	1.21	1.36	1.51	1.81	2.11	2.41	2.71	3.01	3.62	2604	642
26	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	1962	
28	full	0.81	0.97	1.14	1.30	1.46	1.62	1.95	2.27	2.60	2.92	3.25	3.90	2604	491
28	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	2113	
30	full	0.87	1.04	1.22	1.39	1.57	1.74	2.09	2.43	2.78	3.13	3.48	4.17	2604	340
30	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	2264	
32	full	0.93	1.11	1.30	1.48	1.67	1.86	2.23	2.60	2.97	3.34	3.71	4.45	2604	189
32	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	2415	
34	full	0.99	1.18	1.38	1.58	1.77	1.97	2.37	2.76	3.15	3.55	3.94	4.73	2604	38
34	fastest	1.00	1.20	1.40	1.60	1.80	2.00	2.40	2.80	3.20	3.60	4.00	4.80	2566	