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Standard Guide for Sampling Wastewater With Automatic Samplers[1]

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1. Scope

1.1 This guide covers the selection and use of automatic wastewater samplers including procedures for their use in obtaining representative samples. Automatic wastewater samplers are intended for the unattended collection of samples that are representative of the parameters of interest in the wastewater body. While this guide primarily addresses the sampling of wastewater, the same automatic samplers may be used to sample process streams and natural water bodies.

1.2 The guide does not address general guidelines for planning waste sampling activities (see Guide D 4687), development of data quality objectives (see Practice D 5792), the design of monitoring systems and determination of the number of samples to collect (see Practice D 6311), operational details of any specific type of sampler, in-situ measurement of parameters of interest, data assessment and statistical interpretation of resultant data (see Guide D 6233), or sampling and field quality assurance (see Guide D 5612). It also does not address sampling groundwater.

1.3 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1129 Terminology Relating to Water[2]

D 3694 Practices for Preparation of Sample Containers and for Preservation of Organic Constituents[3]

D 3856 Guide for Good Laboratory Practices in Laboratories Engaged in Sampling and Analysis of Water[2]

D 4687 Guide for General Planning of Waste Sampling[4]

D 4840 Guide for Sampling Chain-of-Custody Procedures[2]

D 5088 Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites[5]

D 5283 Practice for Generation of Environmental Data Related to Waste Management Activities Quality Assurance and Quality Control Planning and Implementation[4]

D 5612 Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program[2]

D 5792 Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives[4]

D 5851 Guide for Planning and Implementing a Water Monitoring Program[3]

D 5956 Guide for Sampling Strategies for Heterogeneous Wastes[4]

D 6233 Guide for Data Assessment for Environmental Waste Management Activities[4]

D 6311 Practice for Generation of Environmental Data Related to Waste Management Activities: Optimizing Sampling Design[4]

E 856 Definitions of Terms and Abbreviateions Relating to Physical and Chemical Characteristics of Refuse Derived Fuel[4]

3. Terminology

3.1 *composite sample*, *n*—a combination of two or more samples. **(D 1129)**

3.2 *representative sample*, *n*—a sample collected such that it reflects one or more characteristics of interest (as defined by the project objectives) of a population from which it was collected. **(D 5956)**

3.3 *sample*, *n*—a portion of material taken from a larger quantity for the purpose of estimating properties or composition of the larger quantity. **(E 856)**

4. Significance and Use

4.1 This guide provides persons responsible for designing and implementing wastewater sampling programs with a summary of the types of automatic wastewater samplers, discusses the advantages and disadvantages of the different types of samplers and addresses recommended procedures for their use.

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[1] This guide is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.01 on Planning for Sampling.

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 11.02.

[4] *Annual Book of ASTM Standards*, Vol 11.04.

[5] *Annual Book of ASTM Standards*, Vol 04.09.

TABLE 1 Advantages and Disadvantages of Manual versus Automatic Sampling of Wastewater (3)

Type	Advantages	Disadvantages
Manual	Low capital cost	Increased variability due to sample handling
	Personnel can compensate for various situations	Inconsistency in collection
	Personnel can document unusual conditions	High cost of labor assuming composite or multiple grab samples are collected
	No maintenance	Repetitious and monotonous task for personnel
	Extra samples can be collected in a short time if necessary	
Automatic	Consistent samples	Considerable maintenance for batteries and cleaning; susceptible to plugging by solids
	Decreased variability caused by sample handling	Restricted in size to the general specifications
	Minimal labor requirement for sampling	Greater potential for sample contamination
	Capable of collecting multiple grab and multiple aliquot composite samples	May be subject to damage by vandals
		High capital cost

5. Automatic Versus Manual Sampling (1, 2)[6]

5.1 The advantages and disadvantages of manual and automatic sampling are summarized in Table 1. The decision as to whether to use manual or automatic sampling involves many considerations in addition to equipment costs. In general, manual sampling is indicated when infrequent samples are required from a site, when biological or sediment samples, or both, are also required, when investigating special incidents, where sites will not allow the use of automatic devices, for most bacteriological sampling, where concentrations remain relatively constant, etc. The use of automatic samplers is indicated where frequent sampling is required at a given site, where long-term compositing is desired, where simultaneous sampling at many sites is necessary, etc. Automatic sampling is often the method of choice for storm-generated discharge studies, for longer outfall monitoring, for treatment plant efficiency studies, where 24-h composite samples are required, etc. The user should review 7.1.22 before selecting manual or automatic sampling.

6. Types of Samples Collected by Automatic Samplers

6.1 *Grab Samples*—As defined under the U.S. Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination Program, grab samples are individual samples collected over a period of time not exceeding 15 min and are representative of conditions at the time of sampling **(4)**. Grab samples are sometimes also called individual or discrete samples **(5)**. Sequential grab samples are a series of grab samples collected at constant increments of either time or flow and provide a history of variation. Grab samples are appropriate when samples are needed to:

6.1.1 Characterize an effluent that is not continuous,

6.1.2 Provide information about instantaneous concentrations of pollutants,

6.1.3 Allow collection of samples of varied volume,

6.1.4 Corroborate composite samples,

6.1.5 Monitor parameters not amenable to compositing (for example, pH, temperature, dissolved oxygen, chlorine, purgeable organics (unless a specialized sampler is used), oil and grease and others specified by a permit which may include phenols, sulfites and hexavalent chromium).

6.1.6 Characterize a waste stream in detail where rapid fluctuations of parameters occur (sequential grabs).

6.2 *Composite Samples*—Composite samples are collected over time, either by continuous sampling or by mixing discrete samples, and represent the average characteristics of the waste stream during the compositing period. Composite samples are collected when stipulated in a permit, when average pollutant concentration during the compositing period is to be determined, and when wastewater characteristics are highly variable. There are four types of composite samples.

6.2.1 *Time Composite Samples*—This method requires discrete sample aliquots be collected in one container at constant time intervals. The method is appropriate when the flow of the stream is constant (flow rate does not vary more than ±10 % of the average flow rate **(4)**) or when flow monitoring equipment is not available. The EPA allows time-proportional sampling and requires samples be collected every 15-min, on average, over a 24-h period.

6.2.2 *Flow-Proportional Composite Samples*—There are two methods used for this type of sample **(4)**. The most commonly used method with automatic samplers collects a constant sample volume at varying time intervals proportional to stream flow based on input from a flow monitor (for example, a 200-mL aliquot is collected for every 5000 L of flow). In the other flow-proportional compositing method, the sample is collected by varying the volume of each aliquot as the flow varies, while maintaining a constant time interval between the aliquots.

6.2.3 *Sequential Composite Samples*—A sequential composite sample is composed of a series of short-period composites, each of which is held in an individual container, for example, four sample aliquots are composited (one every 15 min) to form hourly composites **(4)**. The 24-h sequential composite is then manually made by compositing the individual 1-h composite sample.

6.2.4 *Continuous Composite Samples*—This method requires that the sample be collected continuously at a constant rate or proportional to flow **(4)**. This method is seldom used with automatic samplers.

7. Attributes of Automatic Samplers

7.1 The EPA **(6)** developed a list of attributes of the ideal automatic sampler for their use and EPA Region 4 **(7)** and others **(3)** have noted other important attributes. These attributes and requirements may be specific to EPA's use and were primarily directed at suction lift type automatic samplers. Not all these sampler characteristics will be important to all users but their consideration may guide persons selecting automatic samplers. The desirable features of automatic samplers listed below have been summarized and combined from

[6] The boldface numbers given in parentheses refer to a list of references at the end of the standard.

the referenced documents.

7.1.1 Capable of AC/DC operation with adequate dry battery energy storage for 120-h operation at 1-h sampling intervals.

7.1.2 Suitable for suspension in a standard manhole yet still accessible for inspection and sample removal. A secure harness or mounting device if the sampler is placed in a sewer.

7.1.3 Total weight, including batteries, less than 18 kg. Compact and portable enough for one-person installation.

7.1.4 Sample collection interval adjustable from 10 min to 4 h.

7.1.5 Capable of collecting a single 9.5-L (2.5-gal) sample and/or collecting 500-mL (0.13-gal) discrete samples in a minimum of 24 containers. The individual sample aliquot must be at least 100 mL.

7.1.6 Capable of multiplexing repeated aliquots into discrete bottles.

7.1.7 One intake hose with a minimum inner diameter of 0.64 cm (0.25 in) and a weighted, streamlined intake screen which will prevent accumulation of solids.

7.1.8 Intake hose liquid velocity adjustable from 0.6 to 3 m/s (2.0 to 10 ft/s) with dial setting.

7.1.9 Minimum lift capacity of 6.1 m (20 ft).

7.1.10 Explosion proof construction.

7.1.11 Watertight exterior case to protect components in the event of rain or submersion.

7.1.12 Exterior case capable of being locked, including lugs for attaching steel cable to prevent tampering and to provide security.

7.1.13 An integral sample container compartment capable of maintaining samples at 4 to 6°C for a period of 24 h at ambient temperatures up to 38°C.

7.1.14 Capable of operating in a temperature range from–10 to 40°C with the exception of the intake hose.

7.1.15 A purge cycle to flush the sample intake tubing before and after each collection interval, and a mechanism to sense and clear a plugged sample line and then collect the complete sample.

7.1.16 Capable of collecting flow-proportional and time-composite samples.

7.1.17 Materials of construction that contact the sample must not compromise the integrity of the sample for the intended use.

NOTE 1—Some references prohibited sample contact with metal **(6)** and contact with plastic or metal parts when parameters to be analyzed could be impacted by these materials **(7)**.

7.1.18 Water velocity in intake hose (greater than 0.6 m/s [2.0 ft/s]) and aliquot volume are independent of lift heights experienced during the sampling event.

7.1.19 Overall construction, including casing, of materials resistant to corrosion (plastics, fiberglass, stainless steel).

7.1.20 Exterior surface a light color to reflect sunlight.

7.1.21 Low cost, availability of spare parts, warranty, ease of maintenance, reliability and ruggedness of construction, and capable of being repaired in the field.

7.1.22 *Other Factors*—Other factors **(3)** that should be considered in selecting an automatic sampler are the:

7.1.22.1 Expected variation in water or wastewater composition with time,

7.1.22.2 Variation of flow rate with time,

7.1.22.3 Specific gravity of the liquid

7.1.22.4 Concentration and density of suspended solids of interest,

7.1.22.5 Presence of floating materials,

7.1.22.6 Characteristics of the site where the sampler will be placed,

7.1.22.7 Range of intended use (a permanent site or traveling sampler),

7.1.22.8 Skill level required for installation and operation of the sampler, and

7.1.22.9 The level of accuracy desired.

8. Types of Automatic Samplers (1,2,3)

8.1 There are three main types of automatic samplers, suction lift, pressure or forced flow, and mechanical. Each has its advantages and limitations and all types are available in models designed to preserve samples via cooling (iced or refrigerated). While all automatic samplers can collect samples through time, some samplers are designed to be triggered by inputs from online devices measuring flow, pH, temperature, conductance, etc., and collect samples under specific conditions (for example, pH >9.0).

8.2 *Suction Lift*—Suction lift devices can be further subdivided into peristaltic and vacuum type samplers. Peristaltic pump devices are the most commonly used type in the United States and use a rotating head to pinch a flexible hose creating a vacuum to transport the sample to the container. Vacuum devices **(8)** are more popular in Europe and use a vacuum pump to transport the sample to the sample container. Suction lift samplers are portable, versatile due to their light weight and can purge the transport line between samples. Their main limitation is that their lift capacity which is claimed to range up to 9 m but may be significantly less. Also, since suction lift devices use a vacuum to transport samples, they cause some degassing of the sample and are generally unsuitable for sampling dissolved gases and volatile organic compounds (VOC). Peristaltic pump samplers can be used to collect pressurized line samples if the pressure is less than 100 kPa (15 psi). Vacuum systems must use a flow-through cell which adds cost to the system.

8.3 *Pressure or Forced Flow*—With pressure or forced flow systems, a submersible pump or pneumatic pressure is used to force the sample from the source to the collection container. Because the sample is under positive pressure during collection, gases and VOC are less likely to be lost than in suction lift systems. Pressure systems can be used to lift samples considerable heights.

8.4 *Mechanical*—Mechanical systems use scoops, or cups on a chain or paddle wheel to remove a sample from the source and transfer it to the collection container. Some mechanical systems use a plunger to trap a small volume sample and transfer it to the collection container. This latter type is particularly suited for sampling pressurized pipes. Mechanical systems are prone to fouling. The scoop and cup mechanical types are often large, and unable to be moved but can lift samples to great heights and can collect samples integrated across the entire flow path.

8.5 *Samplers for Volatile Organic Compounds*—Most of the previously mentioned automatic samplers are not designed to retain VOC in the collection container, even if they are not volatilized during sample collection. Automatic samplers specifically designed for the collection of VOCs are now commercially available from several sources **(2)**. One system uses a bladder pump to collect up to 24 discrete 40-mL vial samples with zero headspace over a 24-h period. Another device collects a 100-mL composite sample using a motor driven syringe pump. The syringe is then transported to the analytical laboratory for sample analysis. A third device used a hydropneumatic sample system to collect a composite sample which is then transferred to volatile organic analysis vials for shipment to the analytical laboratory.

9. Using Automatic Samplers

9.1 *General*—Sampling is conducted to achieve specific objectives that must be well defined at the outset. Those objectives may be to demonstrate or determine compliance with regulations, check on industrial processes, check on the performance of industrial or waste processes, or acquire specific data needed to achieve certain data quality objectives. The design of a liquid waste monitoring program is beyond the scope of this standard, but in general, there should be a written sampling plan or procedures defining:

9.1.1 Overall and sampling objectives,

9.1.2 A monitoring system design (sampling location, types of samples, frequency of sampling, parameters of interest) (see Practice D 6311),

9.1.3 Detailed sampling procedures (sampling equipment and cleaning procedures, exact sampling location, sample containers and volumes required, sample preservation and shipping procedures, documentation requirements including chain-of-custody procedures if needed, etc.) or references to them (see Guide D 4687),

9.1.4 Analytical procedures,

9.1.5 Field and laboratory quality assurance procedures (see Guide D 5612),

9.1.6 Plans for data assessment and interpretation (see Practice D 5792 and Guide D 6233), and

9.1.7 Safety procedures.

9.2 *Selection of Sampling Locations*—In many cases, sampling locations may be specified in a permit but samples should be collected from representative sites. "Representative point" is defined **(3)** as a location in surface or ground waters at which specific conditions or parameters may be measured in such a manner as to characterize or approximate the quality or condition of the water body; or a location in process waters or wastewaters where specific conditions or parameters are measured that adequately reflect the actual conditions of those waters or wastewaters. Some general criteria that can aid in selecting the best specific sampling sites include:

9.2.1 *Accessability, Convenience and Practicality*—These factors are important but they must be secondary to the representativeness of sampling. Manholes on busy streets should be avoided if possible. Sites with a history of surcharging or submergence by surface water, or both, should also be avoided if possible. Sites with AC power may be preferred, especially if the samples require preservation by cooling to 4°C. Sites where the automatic sampler can be protected from vandalism are preferred.

9.2.2 *Safety*—Hazardous sampling locations should be avoided if at all possible, especially those requiring explosion proof samplers, respiratory protection or confined space entry.

9.2.3 *Flow Characteristics*—The homogeneity or heterogeneity of the water or wastewater is vitally important. Turbulence and good mixing resulting from a hydraulic jump, enhance the homogeneity or uniform distribution of the constituents in the body of water and samples should be collected in such areas. Influent wastewater to sewage treatment plants is preferably sampled at highly turbulent flow locations but in many instances the most preferable location is not accessible. Preferable influent locations include: the upflow siphon following a comminutor (in the absence of a grit chamber); the upflow distribution box following pumping from the main plant wet well; aerated grit chamber; flume throat; pump wet well when the pump is operating; or downstream of the preliminary screening **(1)**. An exception to this guidance is that when sampling for volatile organic compounds, a site with low turbulence should be selected to reduce the amount of entrapped air in the sample **(5)**. The sampling site should be far enough downstream of tributary inflow to ensure mixing of the tributary with the main stream. Sampling sites should be in a straight section of channel, at least 20 channel widths below bends if heavier suspended, floating solids or particles with a specific gravity much less than 1 are of interest **(1)**. A dye such as Rhodamine WT can be used as an aid in determining the most representative sampling location.

9.3 *Sample Intake Design and Placement*—The appropriate location of the sampler intake depends on the characteristics of the body of water or wastewater being sampled and the parameters of interest. Particles that rapidly sink or float are difficult to sample representatively and if such particles are of interest more detailed guidance should be sought **(1)**. Sample intake velocity should be at least equivalent to the flowrate of the wastewater being sampled but not less than 0.6 m/s (2 ft/s). The following recommendations on sample inlet placement are based on an assumed need to representatively sample particulate material with a hydraulic size (hydraulic size is based on particle settling velocity) no greater than fine sand. When particulate matter is not of concern, or the particles of interest have a small hydraulic size (silt, clay, neutrally buoyant particles, etc), the inlet placement recommendations below are much less important.

9.3.1 In general, samples should be collected where the sample stream is well mixed, but not at the point of maximum turbulence. Samples should be collected at a point midway between the point of maximum turbulence and the edge, at ⅔ to ¾ **(1)** the depth of the liquid **(5)**.

9.3.2 Under circumstances where low flows need to be sampled in an intermittent stream such as a surface runoff channel, the intake should be mounted horizontally and at a right angle to the flow, in the middle of the stream and with its lowest surface about 5 cm (2 in.) above the bottom **(1)**.

9.3.3 For continuously flowing, small natural streams, such as might be encountered in an urban runoff study, the intake should be mounted near the low flow mid-depth, in a vertical position with the intake opening facing up.

9.3.4 In man-made channels and conduits, there is no concern for bottom scour and the intake screen can be allowed to rest on the bottom unless significant bedload depths are anticipated. Trailing the intake downstream by the intake tubing is a common practice but this is not recommended because the depth of sampling is never known. An alternate approach is to fix the sample intake tubing in the stream and let a short section of tubing trail downstream. This allows the intake depth to fluctuate over a limited range and accommodate changes in flow velocity. Initial studies also objected to trailing the intake downstream because it was thought not to gather representative solids due to momentum effects **(1)**. However, subsequent study has shown that pointing the nozzle directly downstream appears to have a higher particulate sampling efficiency than when the nozzle is oriented at a right angle to the flow **(9)**.

9.3.5 Where flow is continuous but variable, the intake should be firmly mounted near the low flow mid-depth point. As opposed to natural streams, in many man-made conduits it will be more convenient to dangle the weighted intake from above with the suction tube pointing down. Although the vertical orientation is preferable (intake facing up), the dangling approach is acceptable **(1)**.

9.3.6 For the rare case where relatively steady flow is anticipated in either natural or man-made conduits, the intake should be mounted at about ⅔ **(5)** to ¾depth unless site specific information indicates otherwise **(1)**.

9.3.7 Due to the nature of most wastewater flows, a fine mesh screen over the intake to prevent blockage and exclude debris is not desirable. A screen made up of a number of rather large holes, about 0.3 to 0.6 cm (⅛ to ¼ in.) in diameter is preferred **(1)**.

9.3.8 The sample intake hose should be as short as possible, sample lift should be minimized, there should be no bends or kinks in the inlet hose and the hose should be as vertical as possible or at least on a constant slope to aid in drainage **(1)**.

9.4 *Sampling Procedures*:

9.4.1 All equipment should be properly maintained, and materials contacting samples should be thoroughly cleaned and chemically compatible with the parameters to be measured. Sample collection containers are usually glass or chemically resistant plastic (polyethylene or polypropylene). For most analytes, either type of container is acceptable but glass is specified for samples being collected for determination of: oil and grease, and organic priority pollutants including phenols, pesticides, and polychlorinated biphenyls. Depending on the analytes of interest sample tubing should be poly vinyl chloride or TFE-fluorocarbon (for priority pollutant organics) and on peristaltic pumps, pump head tubing should be silicone or specialized flexible tubing that is chemically resistant and minimally leachable (for priority pollutant organics). All tubing should be new and precleaned using procedures appropriate for the analytes of interest. For more information on tubing selection, see Selection of Equipment for Water Sampling **(10)** and for EPA procedures on cleaning automatic wastewater samplers and tubing (see Appendix C of Ref **(7)**) (also see Practice D 5088).

9.4.2 The automatic sampler should be installed as close to the sampling point as practical to minimize sample lift while avoiding submergence. The equipment should be firmly secured at the sampling site to help prevent vandalism.

9.4.3 When collecting samples or installing sampling equipment, personnel should always wear a new pair of appropriate protective gloves (for example, disposable latex gloves, rubber gloves, etc.) to prevent contamination of the sample and reduce exposure to hazardous substances.

9.4.4 The automatic sampler should be programmed according to the manufacturers instructions and consistent with the permit or sampling plan. The automatic sampler should initially be operated manually to ensure correct operation and that sample volumes are correct. It may also be necessary to collect a rinsate sample prior to formal sampling. The sample line should be flushed prior to and immediately after a sample aliquot has been collected and the sample flow rate in tubing should be a minimum of 0.61 m/s (2 ft/s).

9.4.5 As appropriate, samples should be preserved by chilling during sampling, preserved after sampling and during containerization and sample splitting, and sent to the analytical laboratory as soon as possible to minimize sample holding times.

9.4.6 Standard documentation should be recorded in field logbooks on sample labels, chain-of-custody logs, etc. (see Guide D 4687).

10. Keywords

10.1 automatic sampler; composite; sample; wastewater; water sampling

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