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Standard Guide for Field Filtration of Groundwater Samples[1]

This standard is issued under the fixed designation D6564; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Editorial changes were made throughout in May 2012.

1. Scope

1.1 This guide covers methods for field filtration of groundwater samples collected from groundwater monitoring wells, excluding samples that contain non-aqueous phase liquids (either Dense Non-Aqueous Phase Liquids (DNAPLs) or Light Non-Aqueous Phase Liquids (LNAPLs)). Methods of field filtration described herein could also be applied to samples collected from wells used for other purposes. Laboratory filtration methods are not described in this guide.

1.2 This guide provides procedures available for field filtration of groundwater samples. The need for sample filtration for specific analytes should be defined prior to the sampling event and documented in the site-specific sampling and analysis plan in accordance with Guide D5903. The decision should be made on a parameter-specific basis with consideration of the data quality objectives of the sampling program, any applicable regulatory agency guidelines, and analytical method requirements.

1.3 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This guide cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This guide is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this guide be applied without consideration of the many unique aspects of a project. The word "Standard" in the title of this guide means only that the guide has been approved through the ASTM consensus process.

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:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D5088 Practice for Decontamination of Field Equipment Used at Waste Sites

D5092 Practice for Design and Installation of Groundwater Monitoring Wells

D5903 Guide for Planning and Preparing for a Groundwater Sampling Event

D6089 Guide for Documenting a Groundwater Sampling Event

F740 Definitions of Terms Relating to Filtration (Withdrawn 2002)[3]

3. Terminology

3.1 *Definitions:* For definitions of common technical terms in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *filter, v*—to pass a fluid containing particles through a filter medium whereby particles are separated from the fluid. **F740**

3.2.2 *filter, n*—a device for carrying out filtration which consists of the combination of the filter medium and suitable hardware for constraining and supporting it in the path of the fluid. **F740**

3.2.3 *filter medium*—the permeable material used for a filter that separates particles from a fluid passing through it. **F740**

3.2.4 *filter preconditioning*—the process of preparing a filter medium for filtration

3.2.5 *filter system*—the combination of one or more filter with all the associated process hardware required for filtration. **F740**

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

3.2.6 *filtrate*—the fluid that has passed through the filter. **F740**

3.2.7 *filtration*—the process by which particles are separated from a fluid by passing the fluid through a permeable material. **F740**

3.2.8 *filtered sample*—a groundwater sample which has passed through a filter medium.

3.2.8.1 *Discussion*—This type of sample may also be referred to as a "dissolved" sample. An unfiltered sample containing dissolved, sorbed, coprecipitated and all suspended particles may be referred to as a "total" sample.

3.2.9 *particle*—a small discrete mass of solid or liquid matter. **F740**

4. Significance and Use

4.1 A properly designed, installed and developed groundwater monitoring well, constructed in accordance with Practice D5092, should facilitate collection of samples of groundwater that can be analyzed to determine both the physical and chemical properties of that sample. Samples collected from these wells that require analysis for dissolved constituents should be filtered in the field prior to chemical preservation and shipment to the laboratory for analysis.

5. Purpose of Groundwater Sample Filtration

5.1 Groundwater samples may be filtered to separate a defined fraction of the sample for analysis.

6. Timing of Groundwater Sample Filtration

6.1 Groundwater samples should be filtered immediately upon collection and prior to chemical preservation of the sample. (**1**)[4] Filtration should be completed in as short a time as possible while minimizing sample aeration, agitation, pressure changes, temperature changes and prolonged contact with ambient air.

NOTE 1—The pressure change that occurs when the sample is brought to the surface may cause changes in sample chemistry which include losses of dissolved gases and precipitation of dissolved constituents such as metals. When handling samples during filtration operations, additional turbulence and mixing of the sample with air can cause aeration and oxidation of dissolved ferrous to ferric iron. Ferric iron rapidly precipitates as amorphous iron hydroxide and can absorb other dissolved trace metals (**2**).

7. Groundwater Sample Filtration Procedures

7.1 *Preparation for Groundwater Sample Filtration*—The groundwater sample filtration process consists of three phases: selection of filtration method; selection and pretreatment of filter media; and groundwater sample filtration prior to transfer into the sample container.

7.1.1 *Filtration Method Selection Criteria*—A wide variety of methods are available for field filtration of groundwater samples. In general, filtration equipment can be divided into positive pressure filtration and vacuum (negative pressure) filtration methods, each with several different filtration medium configurations. Groundwater samples undergo pressure changes as they are brought from the saturated zone (where groundwater is under pressure greater than atmospheric) to the surface (where it is under atmospheric pressure), resulting in changes in sample chemistry. Vacuum filtration methods further exacerbate pressure changes. For this reason, positive pressure filtration methods are preferred. Table 1 presents equipment options available for positive pressure and vacuum filtration of groundwater samples. Fig. 1 presents examples of common filter characteristics and applications.

7.1.2 When selecting a filtration method, the following criteria should be evaluated on a site-by-site basis:

7.1.2.1 Effect on sample integrity considering the potential for the following to occur:

7.1.2.2 Sample aeration (Note 2),

7.1.2.3 Sample agitation (Note 2),

NOTE 2—Sample aeration and increased agitation may result in sample chemical alteration.

7.1.2.4 Change in partial pressure of sample constituents resulting from application of negative pressure to the sample during filtration,

7.1.2.5 Sorptive losses of components from the sample onto the filter medium or components of the filtration equipment (for example, flasks, filter holders etc.); and

7.1.2.6 Leaching of components from the filter medium or components of the filtration equipment into the sample.

7.1.2.7 Volume of sample to be filtered;

7.1.2.8 Chemical compatibility of filter medium with groundwater sample chemistry;

7.1.2.9 Anticipated amount of suspended solids and the attendant effects of particulate loading (reduction in effective filter pore size);

7.1.2.10 Time required to filter samples (Note 3);

NOTE 3—Short filtration times are recommended to minimize the time available for chemical changes to occur in the sample.

7.1.2.11 Ease of use;

7.1.2.12 Availability of an appropriate medium in the desired filter pore size

7.1.2.13 Filter surface area;

7.1.2.14 Use of disposable versus non-disposable equipment;

7.1.2.15 Ease of cleaning equipment if not disposable;

7.1.2.16 Potential for sample bias associated with ambient air contact during sample filtration; and

7.1.2.17 Cost, evaluating the costs associated with: equipment purchase price, expendable supplies and their disposal,

TABLE 1 Examples of Equipment Options for Positive and Negative Pressure Filtration of Groundwater Samples

Positive Pressure Filtration Equipment:
• In-line capsules
attached directly to a pumping device discharge hose
attached to a pressurized transfer vessel
attached to a pressurized bailer
• Free-standing disk filter holders
• Syringe filters
• Zero headspace extraction vessels
Negative Pressure Filtration Equipment:
• Glass funnel support assembly

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

Media[1]	Analytes						Filter EFA[2] *(Diameter in mm)*								Pore Size (µm)					Filter Type					
	Major Ions	Minor Ions	Trace Metals	Nutrients	Organic Compounds	Dissolved/Suspended Organic Carbon	17 cm^2 (47 mm)	20 cm^2 (50 mm)	64 cm^2 (90 mm)	158 cm^2 (142 mm)	250 cm^2	600 cm^2	700 cm^2	770 cm^2	0.1	0.2	0.45	1.0	5.0	Flat Disc	Capsule	Syringe Filter	Funnel	Zero Headspace Extractor (ZHE)	Pressure Device
Acrylic Copolymer	X		X	X			X	X		X			X				X	X	X	X	X	X	X		
Glass Fiber					X		X	X	X	X								X		X		X		X	X
Mixed Cellulose Esters				X			X	X		X					X	X	X	X	X	X			X		
Nylon			X				X	X				X		X			X	X	X	X	X	X	X		
Polycarbonate	X	X	X	X			X	X							X	X	X			X	X		X		
Polyethersulfone	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		
Polypropylene	X	X	X	X										X				X	X		X				
Silver						X	X										X			X					

[1] Other media maybe appropriate for specific analytes of interest
[2] EFA - Effective Filtration Area

FIG. 1 Examples of Common Filter Characteristics and Applications

time required for filtration, time required for decontamination of non-disposable equipment and quality control measures.

7.1.2.18 The filtration method used for any given sampling program should be documented in the site-specific sampling and analysis plan and should be consistent throughout the life of the sampling program to permit comparison of data generated. If an improved method of filtration is determined to be appropriate for a sampling program, the sampling and analysis plan should be revised and implemented in lieu of continuation of the existing filtration method. In this event, the effect on comparability of data needs to be examined and quantified to allow proper data analysis and interpretation (Note 4).

NOTE 4—Statistical methods may need to be implemented to determine the significance of any changes in data resulting from a change in filtration method.

7.1.3 *Filtration Equipment Materials of Construction*—Filtration equipment and filtration media are available in a wide variety of materials of construction. Materials of construction should be evaluated (for example, by contacting manufacturers, conducting leach tests or collecting equipment blanks) to minimize sample bias:

7.1.3.1 Potential for negative bias due to adsorption of constituents from the sample (**2**);

7.1.3.2 Potential for positive bias due to desorption or leaching of constituents into the sample (**3-6**);

7.1.3.3 Reduction of the effective filter pore size caused by clogging when filtering water containing suspended particles; (**6**) and

7.1.3.4 Aeration of the sample leading to precipitation of some constituents (for example, ferric hydroxide) (**3**).

7.1.4 *Selection and Pretreatment of Filter Media*—Filtration media are manufactured with specific pore size diameters designed to permit particles of a selected size to be retained by the filter medium. Filtration media must be selected after considering filter pore size, and materials of construction. Groundwater samples requiring field filtration must be filtered using a medium with a pore size that meets the requirements of the approved sampling and analysis plan.

7.1.5 *Preconditioning of the Filtration Medium:*

7.1.5.1 Filter media require preconditioning prior to sample filtration (**7**). Purposes of filter preconditioning include: to minimize positive sample bias associated with residues that may exist on the filter surface or constituents that may leach from the filter; and to create a uniform wetting front across the entire surface of the filter to prevent channel flow through the filter and increase the efficiency of the filter surface area. Preconditioning the filter medium may not completely prevent sorptive losses from the sample as it passes through the filter medium.

7.1.5.2 In most cases, filter preconditioning should be done at the wellhead (Note 5) immediately prior to use. Some manufacturers prerinse filters prior to sale. These filters are typically marked "prerinsed" on filter packaging and provide directions for any additional field preconditioning required prior to filter use.

NOTE 5—Some filters require preconditioning procedures that can only be done in the laboratory (for example, GF/F filters must be baked prior to use).

7.1.5.3 The procedure used to precondition the filter medium is determined by the following: the design of the filter (that is, filter capsules, or disks), the material of construction of the filter medium, the configuration of the filtration equipment, and the parameters of concern for sample analysis. Filtration medium manufacturers' instructions should be followed prior to implementing any filter preconditioning protocols in the field to ensure that proper methods are employed and to minimize potential bias of samples being filtered.

7.1.5.4 The volume of water used in filter preconditioning is dependent upon the surface area of the filter and the medium's ability to absorb liquid. Many filter media become fragile when saturated and are highly subject to damage during handling.

Therefore, saturated filter media should be handled carefully and are best preconditioned immediately prior to use.

7.1.6 *Preconditioning of Disk Filters*—Disk filters (also known as plate filters) should be preconditioned as follows:

7.1.6.1 Hold the edge of the filter with filter forceps constructed of materials that are appropriate for the analytes of interest (Note 6) ;

NOTE 6—Manufacturers often use colored parchment paper disks (for example, yellow or blue) to separate filter disks and these should not be confused with the filtration medium.

7.1.6.2 Saturate the entire filter disk with water (Note 7) (while holding the filter over a containment vessel (not the sample bottle or filter holder) to catch all run-off, then;

NOTE 7—Filter manufacturers should be consulted to determine filter-specific volumes of water or medium-specific aqueous solution to be used for optimum filter preconditioning.

7.1.6.3 Place the saturated filter on the appropriate filter stand or holder in preparation for sample filtration;

7.1.6.4 Complete assembly of the filtration apparatus;

7.1.6.5 Pass recommended volume of water through the filter to complete preconditioning;

7.1.6.6 Discard preconditioning water;

7.1.6.7 Begin sample filtration using a clean filtration containment vessel or flask.

7.1.6.8 When preconditioning disk filters, care should be taken not to perforate the filter. The filter medium should not be handled with anything other than filter forceps. Otherwise, there may be a reduction in the porosity and permeability of the filter medium as defined in Terminology F740. In addition, care should be taken to avoid exposure of the filter medium to airborne particulates to minimize introduction of contaminants onto the filter surface.

7.1.7 *Preconditioning of Capsule Filters*—Preconditioning of capsule filters requires that liquid be passed through the filter prior to sample filtration. A volume of water (see Note 7) should be passed through the filter while holding the capsule upright, prior to sample collection.

7.2 *Groundwater Sample Filtration Methods:*

7.2.1 *Positive Pressure Filtration Methods*—Positive pressure filtration methods are preferred for groundwater sample filtration (**2**) . There are two general categories of positive pressure filtration equipment: in-line filtration equipment used with pumping devices, and remote pressurized filtration equipment that is not in-line with a pumping device.

7.2.2 *In-Line Filtration Systems Using Pumping Devices*—Groundwater samples using in-line filtration systems should be filtered according to the following sequence:

7.2.2.1 If using disk filters, assemble the disk filter holder and filtration equipment so it is leak tight and the filter (handled with forceps) is centered on the holding device. Connect the filtration equipment to the discharge hose of the pumping device;

7.2.2.2 If using capsule filters, attach the filter directly to the discharge hose of the pumping device;

7.2.2.3 Precondition the filter as described in 7.1.5.2 of this guide;

7.2.2.4 Initiate and gradually increase the flow of water through the filter to reach the appropriate rate and pressure, not to exceed the maximum recommended by the filtration equipment manufacturer (for example, 450 kPa (< 65 psi)) pressure for many capsule filters);

7.2.2.5 Collect the filtered groundwater sample directly into a prepared sample bottle;

7.2.2.6 Preserve the filtered groundwater sample as required on a parameter-specific basis;

7.2.2.7 Release the pressure from the filtration equipment and disconnect it from the sampling device discharge hose;

7.2.2.8 Discard any disposable materials (for example, filter media) in accordance with the site-specific waste management provisions of the sampling and analysis plan;

7.2.2.9 Decontaminate any equipment used for filtration of the next sample following procedures described in Practice D5088.

7.2.3 *Independent Pressure Filtration Method*—Groundwater samples can also be filtered using positive pressure equipment that is not operated in-line with a pumping device. To operate this equipment, the following procedures should be implemented:

7.2.3.1 Assemble the filtration holder and support equipment checking to make sure the system is leak tight;

7.2.3.2 Precondition the filter medium as described in 7.1.5.2 of this guide;

7.2.3.3 Remove a sample of groundwater from the monitoring well;

7.2.3.4 Carefully decant the sample into the filtration vessel (if not using the sampling device itself as the vessel) to minimize aeration, agitation, or sample turbulence and prevent introduction of airborne contaminants into the sample during transfer;

7.2.3.5 Pressurize the filtration vessel using oil-free, inert gas (for example, nitrogen) or some type of oil-free air pump (for example, hand pressure pump). Pressure should not exceed manufacturer's guidelines for the equipment in use;

7.2.3.6 Collect the sample directly into a prepared sample container;

7.2.3.7 Preserve the filtered groundwater sample as required on a parameter-specific basis;

7.2.3.8 Once the sample container is filled and preserved, release the pressure from the filtration equipment and disconnect it from the sampling device discharge hose;

7.2.3.9 Discard any disposable materials (for example, filter media) in accordance with the site-specific waste management provisions of the sampling and analysis plan; and

7.2.3.10 Decontaminate any common equipment used for filtration of the next sample following procedures described in Practice D5088.

7.2.4 *Negative Pressure Filtration Methods*—Negative pressure filtration systems that require applying a vacuum or suction to draw samples through a filter medium are available for groundwater samples. To filter groundwater samples with this equipment, these procedures should be followed:

7.2.4.1 Assemble the filter holder and support equipment making sure it is leak tight;

7.2.4.2 Precondition the filter medium using the methods described in 7.1.5.1 of this guide;

7.2.4.3 Remove a sample of groundwater from the monitoring well;

7.2.4.4 Decant the sample into the filtration vessel taking care not to agitate the sample, increase turbulence or introduce airborne contaminants into the sample during transfer;

7.2.4.5 Apply a negative pressure to the vessel using a vacuum pump. The vacuum (negative pressure) created should not exceed manufacturers guidelines for the equipment in use;

7.2.4.6 Collect the filtrate into a flask or other vessel;

7.2.4.7 Release the negative pressure at the vacuum pump connected to the filtration equipment and transfer the filtrate into a prepared sample container taking care not to agitate the sample, increase turbulence or introduce airborne contaminants into the sample;

7.2.4.8 Preserve the filtered groundwater sample as required on a parameter-specific basis;

7.2.4.9 Discard any disposable materials in accordance with the site-specific waste management provisions of the sampling and analysis plan; and

7.2.4.10 Decontaminate any common equipment used for filtration of the next sample following procedures described in Practice D5088.

8. Decontamination of Filtration Equipment

8.1 Any sample-contacting element in the filtration equipment configuration that is not designed to be disposed between individual samples must be cleaned to prevent cross contamination of samples. All equipment should be thoroughly cleaned in accordance with Practice D5088. Cleaning should take place prior to use of any equipment at any groundwater monitoring well and between uses in either the same well (if two or more discrete samples are to be collected) or in another well. To verify the effectiveness of cleaning, equipment blanks should be collected as recommended in Practice D5088. To avoid the potential for cross contamination of samples that may occur when common filtration equipment is used, disposable filtration equipment may be used. Disposable equipment should not be reused.

9. Reporting

9.1 Records should be kept of the various operations associated with field filtration of groundwater samples. The following items should be recorded as described in Guide D6089:

9.1.1 Filtration method used (positive or negative pressure),
9.1.2 Filter medium used,
9.1.2.1 Filter design (disk, capsule),
9.1.2.2 Material of construction,
9.1.2.3 Filter surface area, and
9.1.2.4 Pore size,
9.1.3 Filter preconditioning procedures followed,
9.1.4 Volume of sample filtered per filter,
9.1.5 Total volume of samples filtered,
9.1.6 Number of filters used per sample,
9.1.7 Time elapsed between sample collection and filtration,
9.1.8 Time required to filter each sample,
9.1.9 Disposable equipment used,
9.1.10 Description of appearance of unfiltered and filtered samples, and the residue retained by the filter;
9.1.11 Common equipment used,
9.1.12 Decontamination procedures followed,
9.1.13 Description of quality control samples collected,
9.1.13.1 How collected,
9.1.13.2 When collected, and
9.1.13.3 How many collected,
9.1.13.4 Parameters to be analyzed on control sample,
9.1.14 Who collected the sample, and
9.1.15 Who filtered the sample.

10. Keywords

10.1 capsule filters; disk filters; dissolved constituents; filter pore size; groundwater samples; negative pressure filtration; positive pressure filtration; pressure filtration; preconditioning filters; sample filtration

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