This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

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Standard Guide for Field Filtration of Groundwater Samples[1]

This standard is issued under the fixed designation D6564/D6564M; 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.

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 to 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 *Units*—The values stated in either SI Units or inch-pound units given in brackets are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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

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—in groundwater sampling*, to pass a fluid containing particles through a filter medium whereby particles are separated from the fluid.

3.2.2 *filter, n—in groundwater sampling*, 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.

3.2.3 *filter medium, n—in groundwater sampling*, the permeable material used for a filter that separates particles from a fluid passing through it.

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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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.

***A Summary of Changes section appears at the end of this standard**

3.2.4 *filter system, n—in groundwater sampling*, the combination of one or more filter with all the associated process hardware required for filtration.

3.2.5 *filtration, v—in groundwater sampling*, the process by which particles are separated from a fluid by passing the fluid through a permeable material.

3.2.6 *filtered sample, n—in groundwater sampling*, a groundwater sample which has passed through a filter medium.

3.2.6.1 *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.

4. Significance and Use

4.1 A correctly 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. Filtration should be completed in as short a time as practicable 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 **(1)**[3].

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 and the like); 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

[3] 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 needed for filtration, time needed 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 (**1**);

7.1.3.2 Potential for positive bias due to desorption or leaching of constituents into the sample (**2-5**);

7.1.3.3 Reduction of the effective filter pore size caused by clogging when filtering water containing suspended particles; (**5**) and

7.1.3.4 Aeration of the sample leading to precipitation of some constituents (for example, ferric hydroxide) (**2**).

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 is to be selected after considering filter pore size, and materials of construction. Groundwater samples requiring field filtration are to 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 (**6**). 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 "pre-rinsed" on filter packaging and provide directions if additional field preconditioning is needed prior to filter use.

NOTE 5—Some filters require preconditioning procedures that can only be done in the laboratory (for example, GF/F filters are to 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 the filter preconditioning protocols in the field to make sure 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.