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Standard Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations[1]

This standard is issued under the fixed designation D6169/D6169M; 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 guidance for the selection of soil and rock sampling devices used with drill rigs for the purpose of characterizing in situ physical and hydraulic properties, chemical characteristics, subsurface lithology, stratigraphy and structure, and hydrogeologic units in environmental investigations.

1.2 This guide does not specifically address selection of soil sampling devices for use with direct-push sampling systems, but the information in this guide on thick-wall and thin-wall samplers is generally applicable to direct-push soil sampling.

1.3 This guide should be used in conjunction with referenced ASTM guides, practices, and methods on drilling techniques for geoenvironmental investigations and use of sampling devices referenced in 2.1, and with Guide D5730.

1.4 This guide does not address selection of sampling devices for hand-held soil sampling equipment, and soil sample collection with solid-stem augering devices, or collection of grab samples or hand-carved block samples from accessible excavations. Refer to Appendix X1.2 for guidance on these topics. This guide should be used in conjunction with Guide D4700 when thin-walled, split barrel, ring-lined barrel and piston samplers with solid- and hollow-stem augers are used in the unsaturated zone.

1.5 This guide does not address devices for collecting cores from submerged sediments or sampling devices for solid wastes. Refer to Guide D4823 for guidance on these topics.

1.6 The values stated in either SI units or inch-pound units 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.

1.7 *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.*

1.8 *This guide offers an organized collection of information or series of options and does not recommend a specific course of action. This document cannot replace education and experience and should be used in conjunction with professional judgment. The word "Standard" in the title of this document means that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D1452 Practice for Soil Exploration and Sampling by Auger Borings

D1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils

D1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes

D2113 Practice for Rock Core Drilling and Sampling of Rock for Site Exploration

D3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils

D3694 Practices for Preparation of Sample Containers and for Preservation of Organic Constituents

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4220 Practices for Preserving and Transporting Soil Samples

D4452 Practice for X-Ray Radiography of Soil Samples

D4700 Guide for Soil Sampling from the Vadose Zone

D4823 Guide for Core Sampling Submerged, Unconsolidated Sediments

[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**

D5079 Practices for Preserving and Transporting Rock Core Samples
D5084 Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
D5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock
D5730 Guide for Site Characterization for Environmental Purposes With Emphasis on Soil, Rock, the Vadose Zone and Groundwater (Withdrawn 2013)[3]
D5781 Guide for Use of Dual-Wall Reverse-Circulation Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5782 Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5784 Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
D5872 Guide for Use of Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
D5875 Guide for Use of Cable-Tool Drilling and Sampling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
D5876 Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and Installation of Subsurface Water-Quality Monitoring Devices
D5911 Practice for Minimum Set of Data Elements to Identify a Soil Sampling Site
D6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

3. Terminology

3.1 *Definitions*—For definitions of general technical terms used within this guide, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *borehole grab sampler*—a sampling device with a cutting head that advances by rotation and collects a sample by scraping side or bottom rather than coring. (See Section 8.1.)

3.2.2 *chemically intact core sample*—a soil or rock core sample in which the sampling device, collection and handling procedures result in preservation of the chemical properties to a degree that satisfies the purpose for which the sample was taken.

3.2.2.1 *Discussion*—For nonsensitive chemical constituents, representative samples will generally provide chemically intact samples. Nonrepresentative samples may also be chemically intact, but are generally not suitable for analysis because of their uncertain integrity, location or origin. For sensitive chemical constituents, special sample collection and handling procedures are generally required to obtain chemically intact samples as discussed in 6.4 and 6.10. Physically intact samples will generally provide chemically intact samples provided that sampling technique, and materials for sampling devices and containers are selected to avoid chemical alteration.

3.2.3 *clearance ratio (inside)*—the difference between inside diameter of the sampling tube and inside diameter of cutting edge or shoe divided by the inside diameter of the cutting shoe or edge.

3.2.3.1 *Discussion*—Refer to Hvorslev (**1**)[4] and Paikowsky et al. (**2**) for appropriate formulas for calculating wall area ratio.

3.2.4 *core—for the purposes of this guide*, a cylindrical sample of soil or rock obtained by means of a thick-wall, thin-wall, or rotating core sampler.

3.2.5 *direct push sampling system—for the purposes of this guide*, a subsurface sampling system using samplers generally 50 mm [2 in.] in diameter or less that use hand-held percussion driving devices, or mobile hydraulic, vibratory or percussion drive systems that are mounted to a small truck, van, all-terrain vehicle (ATV), trailer, skid, or drill rig.

3.2.6 *drill rig—for the purposes of this guide*, a land-based wheeled, ATV, or skid-mounted assembly or offshore or barge mounted assembly capable of drilling boreholes and collecting soil or rock samples with a diameter generally greater than 50 mm [2 in.] using rotary, drive, push, or vibratory advancement methods.

3.2.7 *drill-rod core sampling*—a sampling process in which a fixed drill rod assembly advances a thick-wall or thin-wall sampler or a rotating drill rod assembly advances a rotating core samplers.

3.2.8 *group A*—samples for which only general visual identification is necessary (see Practices D4220).

3.2.9 *group B*—samples for which only water content and classification tests, optimum dry density or relative density, or profile logging is required and bulk samples that will be remolded or compacted into specimens for swell pressure, percent swell, consolidation, permeability, shear testing, CBR, stabilimeter, etc. (see Practices D4220).

3.2.9.1 *Discussion*—Group B samples are disturbed, remolded samples used primarily for engineering properties tests.

3.2.10 *group C*—intact, natural formed or field fabricated, samples for density determination; or for swell pressure, percent swell, consolidation, permeability testing and shear testing with or without stress-strain and volume change measurements, to include dynamic and cyclic testing (see Practices D4220).

3.2.10.1 *Discussion*—Group C samples are intact samples used primarily for engineering properties tests. Some of these

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

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

tests, such as bulk density and permeability are useful for environmental investigations. Additional physical and hydrologic properties that require Group C type samples are identified in Table 1.

3.2.11 *group D*—samples that are fragile or highly sensitive for which tests in Group C are required (see Practices D4220).

3.2.12 *intact sample*—a soil sample that has been obtained by methods in which every precaution has been taken to minimize disturbance to the sample (see Terminology D653). (See also definitions for *chemically intact sample* and *physically intact sample*.)

3.2.13 *liner*—cylindrical tubes or rings made of metal or plastic placed inside a core sampling device to facilitate sample retrieval and handling.

3.2.14 *nonrepresentative sample*—a soil sample that consists of drill cuttings of uncertain integrity, location or origin, or other incomplete or contaminated portions of subsurface materials; generally not suitable for testing or analysis (**3**).

3.2.15 *physically intact core sample*—a soil or rock core sample in which the sampling device, collection and handling procedures result in preservation of the in situ physical and hydraulic properties (such as, structure, density, and moisture content) to a degree that satisfies the purpose for which the sample was taken.

3.2.15.1 *Discussion*—Group C and D core samples are physically intact. Generally collection of intact samples require use of thin-wall or double-tube rotating core sampling devices, but as discussed in 6.2, thick-wall samplers may be satisfactory for some objectives.

3.2.16 *piston core sampler*—a thin-wall or, less commonly, thick-wall sampling device in which the inner piston is held in a fixed position and the cutting head and outer barrel is advanced mechanically or hydraulically into the soil. (See 7.5.)

3.2.17 *representative soil sample*—a soil sample from a known subsurface interval in which some structural features do not survive but other properties, such as moisture content, grain size and gradation and chemical characteristics of the sample interval are preserved; suitable for mechanical and chemical analysis for nonsensitive chemical constituents, and lithologic logging. (See discussion in 6.3.) **Adapted from U.S. Geological Survey, 1980**

3.2.17.1 *Discussion*—This definition follows general usage in the geologic profession, and differs from the definition of representative sample in the statistical sense. The sample is only representative of the subsurface material encountered by the sampler and is not necessarily representative of the formation being sampled. Sample representativeness in the latter sense needs to be addressed in the sample design that defines the specific location of sampling.

3.2.18 *rotating core sampler*—a rotating cylindrical sampler with a coring bit that cuts away soil or rock material from around the core. (See 7.6.)

3.2.19 *sensitive chemical constituents*—chemical species or compounds for which the composition or concentration in soil may change rapidly in soil in response to disturbance, or interaction with sample container materials, due to processes such as volatilization, degassing, microbial action or abiotic oxidation-reduction reactions.

3.2.20 *thick-wall sampler*—a core sampler that does not satisfy the requirements for collection of intact Group C and D samples.

3.2.20.1 *Discussion*—Generally, samplers with a wall area ratio greater than 15 % (see Table 2 for additional specifications). Typical thick wall samplers are found in Test Method D1586 and Practice D3550. (See 7.3.)

3.2.21 *thin-wall sampler*—a sampler that meets the specifications in Practice D1587. (See 7.4.)

3.2.22 *vibratory core sampling*—a sample process in which a thick-wall or thin-wall sampler is advanced using high frequency vibrations rather than hydraulic or percussion forces.

3.2.23 *wall area ratio*—the ratio of gross wall area due to thickness divided by the inside opening of the sampler.

3.2.23.1 *Discussion*—Refer to Hvorslev (**1**) and Paikowsky et al. (**2**) for appropriate formulas for calculating wall area ratio.

TABLE 1 General Sample-Type Requirements for Measurement of Physical and Chemical Properties

Tests to be Performed	Physically Intact	Chemically Intact	Representative
Physical/Hydrologic Properties			
Hydraulic Conductivity	X	. . .	. . .
Specific Yield	X	. . .	. . .
Pressure Head (Matric Potential)	X	. . .	. . .
Moisture Characteristic Functions[A]	X	. . .	X
Water Content	. . .	. . .	X
Particle Size Distribution	. . .	. . .	X
Bulk Density/Porosity	X	. . .	. . .
Strength Properties	X	. . .	. . .
Compressibility	X	. . .	. . .
Mineralogy			
Gross Mineralogy	. . .	. . .	X
Soil Thin Section Micromorphology	X	. . .	. . .
Surface Properties			
Ion Exchange Capacity	. . .	X	. . .
Sorption (Batch Tests)	. . .	X	. . .
Sorption (Flow-Through Tests)	X	. . .	. . .
Sorption Site Density	. . .	X	. . .
Surface Area	. . .	. . .	X
Nonsensitive Chemical Constituents[B]			
Most Total Elemental Concentrations	. . .	. . .	X
Carbonate	. . .	. . .	X
Soil Organic Carbon	. . .	. . .	X
Sensitive Chemical Constituents[C]			
Microbiology	. . .	X	. . .
Volatile and Semivolatile Organics	. . .	X	. . .
Nitrogen- and Sulfur-Containing Species	. . .	X	. . .
Redox-Sensitive Species (As, Cr, Fe, Mn, Se)	. . .	X	. . .
Other Sensitive Inorganics (Hg, cyanides)	. . .	X	. . .

[A] Physically intact sample preferred, but repacked representative sample may be adequate.
[B] Chemical constituents that are sufficiently stable that no special attention need to be given to sample device/container compatibility, or sample handling, transport, and storage if analyzed within a few months.
[C] Special consideration of sample device/container compabitility, sample collection, handling and transport required to obtain chemically intact samples.