Designation: D 5730 – 02

Standard Guide for Site Characterization for Environmental Purposes With Emphasis on Soil, Rock, the Vadose Zone and Ground Water[1]

This standard is issued under the fixed designation D 5730; 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.

INTRODUCTION

This guide covers the selection of the various ASTM Standards that are available for the investigation of soil, rock, the vadose zone, ground water, and other media where the investigations have an environmental purpose.[2] It is intended to improve consistency of practice and to encourage rational planning of a site characterization program by providing a checklist to assist in the design of an environmental reconnaissance/investigation plan. The subsurface conditions at a particular site are usually the result of a combination of natural geologic, topographic, hydrologic, and climatic factors, and of historical modifications both natural and manmade. An adequate and internally consistent site characterization program will allow evaluation of the results of these influences. Site characterization for engineering, design, and construction purposes are addressed in a separate guide, Guide D 420.

The understanding of environmental processes occurring in soil and rock systems depends on adequate characterization of physical, chemical, and biological properties of soil and rock. Processes of interest may include, but are not limited to, surface and subsurface hydrology, contaminant mobilization, distribution, fate and transport; chemical and biological degradation of wastes; and geomorphological/ecological processes. Although this guide focusses primarily on characterization of soil and rock, it is understood that climatic and biotic factors may also be important in understanding environmental processes in soil and rock systems.

1. Scope

1.1 This guide covers a general approach to planning field investigations that is useful for any type of environmental investigation with a primary focus on the subsurface and major factors affecting the surface and subsurface environment. Generally, such investigations should identify and locate, both horizontally and vertically, significant soil and rock masses and ground water conditions present within a given site area and establish the characteristics of the subsurface materials by sampling or in situ testing, or both. The extent of characterization and specific methods used will be determined by the environmental objectives and data quality requirements of the investigation. This guide focuses on field methods for determining site characteristics and collection of samples for further physical and chemical characterization. This guide does not address special considerations required for characterization of karst and fractured rock terrane. In such hydrogeologic settings refer to Quinlan and Guide D 5717, **(1)**.

1.2 This guide refers to ASTM standard methods by which soil, rock, vadose zone, and ground water conditions may be determined. Laboratory testing of soil, rock, and ground-water samples is specified by other ASTM standards which are not specifically discussed in this guide. Laboratory methods for measurement of physical properties relevant to environmental investigations are included in Appendix X1.

1.3 The values stated in SI units are to be regarded as the standard.

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.01 on Surface and Subsurface Characterization.

Current edition approved July 10, 2002. Published October 2002. Originally published as D 5730 – 95. Last previous edition D 5730 – 98.

[2] This guide is under the jurisdiction of Subcommittee D18.01 (Surface and Subsurface Characterization) of the Committee on Soil and Rock, and as such has a primary focus on subsurface characterization, including soil, rock, and fluids contained therein (including liquid and gaseous components), and subsurface biota. Surface hydrology, meteorology, air quality, geomorphic processes, biota, and waste materials (when present at a site) are to a greater or lesser extent linked to environmental processes in soil and rock systems. Consequently other ASTM methods of particular relevance to environmental site investigations are identified in this guide, but are addressed in less detail.

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.*

1.5 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document 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 ASTM standard 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 document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 The pertinent ASTM guides for selection of field investigation methods are listed at appropriate points in the sections that follow, and a comprehensive list of guides, standards, methods, practices, and terminology is contained in Appendix X1. Table X1.1 and Table X1.2 provide an index of field and laboratory standards listed in Appendix X1.

2.2 *ASTM Standards:*

C 998 Practice for Sampling Surface Soil for Radionuclides[3]

D 420 Guide to Site Characterization for Engineering, Design, and Construction Purposes[4]

D 422 Test Method for Particle-Size Analysis of Soils[4]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[4]

D 1140 Test Method for Amount of Material in Soils Finer than the No. 200 (75-µm) Sieve[4]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[4]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[4]

D 1587 Practice for Thin-Walled Tube Geotechnical Sampling of Soils[4]

D 2113 Practice for Diamond Core Drilling for Site Investigation[4]

D 2434 Test Method for Permeability of Granular Soils (Constant Head)[4]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[4]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[4]

D 2922 Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)[4]

D 3404 Guide for Measuring Matric Potential in the Vadose Zone Using Tensiometers[4]

D 3441 Test Method for Deep, Quasi-Static, Cone and Friction-Cone Penetration Tests of Soil[4]

D 3550 Practice for Ring-Lined Barrel Sampling of Soils[4]

D 3584 Practice for Indexing Papers and Reports on Soil and Rock for Engineering Purposes[4]

D 4043 Guide for Selection of Aquifer-Test Method in Determining of Hydraulic Properties by Well Techniques[4]

D 4044 Test Method (Field Procedure) for Instantaneous Change in Head (Slug Tests) for Determining Hydraulic Properties of Aquifers[4]

D 4050 Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems[4]

D 4104 Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Test)[4]

D 4105 Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Modified Theis Nonequilibrium Method[4]

D 4106 Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Theis Nonequilibrium Method[4]

D 4127 Terminology Used with Ion-Selective Electrodes[5]

D 4210 Practice for Interlaboratory Quality Control Procedures and a Discussion on Reporting Low Level Data[5]

D 4220 Practice for Preserving and Transporting Soil Samples[4]

D 4448 Guide for Sampling Groundwater Monitoring Wells[6]

D 4547 Practice for Sampling Waste and Soils for Volatile Organics[6]

D 4630 Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test[4]

D 4631 Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using the Pressure Pulse Technique[4]

D 4687 Guide for General Planning of Waste Sampling[6]

D 4696 Guide for Pore-Liquid Sampling from the Vadose Zone[4]

D 4700 Guide for Soil Sampling from the Vadose Zone[4]

D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[4]

D 5079 Practices for Preserving and Transporting Rock Core Samples[7]

D 5084 Test Method of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter[7]

D 5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers[7]

D 5093 Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer With a Sealed-Inner Ring[7]

[3] *Annual Book of ASTM Standards*, Vol 12.01.
[4] *Annual Book of ASTM Standards*, Vol 04.08.
[5] *Annual Book of ASTM Standards*, Vol 11.01.
[6] *Annual Book of ASTM Standards*, Vol 11.04.
[7] *Annual Book of ASTM Standards*, Vol 04.09.

D 5195 Test Method for Density of Soil and Rock In-Place at Depths Below the Surface by Nuclear Methods[7]

D 5254 Practice for Minimum Set of Data Elements to Identify a Ground-Water Site[7]

D 5269 Test Method for Determining Transmissivity of Nonleaky Confined Aquifers by the Theis Recovery Method[7]

D 5270 Test Method for Determining Transmissivity and Storage Coefficient of Bounded, Nonleaky, Confined Aquifers[7]

D 5314 Guide for Soil Gas Monitoring in the Vadose Zone[7]

D 5408 Guide for Set of Data Elements to Describe a Ground-Water Site; Part 1—Additional Identification Descriptors[7]

D 5409 Guide for Set of Data Elements to Describe a Ground-Water Site; Part 2—Physical Descriptors[7]

D 5410 Guide for Set of Data Elements to Describe a Ground-Water Site; Part 3—Usage Descriptors[7]

D 5447 Guide for Application of a Ground-Water Flow Model to a Site-Specific Problem[7]

D 5451 Practice for Sampling Using a Trier Sampler[6]

D 5717 Guide for the Design of Ground-Water Monitoring Systems In Karst and Fractured-Rock Aquifers[4]

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[8]

E 380 Practice for Use of the International System of Units (SI) (The Modernized Metric System)[8]

E 1527 Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process[6]

G 57 Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method[9]

NOTE 1—*Non-ASTM References*:Appendix X2 identifies major non-ASTM references that focus on field methods for environmental site characterization. Other guidance documents covering procedures for environmental investigations with specific objectives or in particular geographic settings may be available from federal, state, and other agencies or organizations. The appropriate agency or organization should be contacted to determine the availability and most current edition of such documents.

3. Terminology

3.1 *Definitions:* [10]

3.1.1 *site*, *n*—a place or location designated for a specific use, function, or study.

3.1.2 *site*, *v*—to determine a place or location for a specific use, function, or study.

3.1.3 *characterization*, *n*—the delineation or representation of the essential features or qualities existing at a site.

3.1.4 *characterize*, *v*—the process of delineation or representation of the essential features or qualities existing at a site.

3.1.5 *conceptual site model*, *n*—for the purposes of this guide, a testable interpretation or working description of the relevant physical, chemical, and biological characteristics of a site.[11]

3.1.6 *environment*, *n*—the aggregate of conditions, influences, and circumstances that affect the existence or development of properties intrinsic to a site.

3.1.7 *environmental*, *adj*—having to do with the environment.

3.1.8 *environmental site characterization*, *n*—the delineation or representation of the essential features or qualities, including the conditions, influences, and circumstances, existing at a place or location designated for a specific use, function, or study.[12]

3.1.9 *environmental audit*, *n*—the investigation process to determine if the operations of an existing facility are in compliance with applicable environmental laws and regulations.

3.1.10 *environmental site assessment (ESA)*, *n*—the process by which a person or entity seeks to determine if a particular parcel of real property (including improvements) is subject to recognized environmental conditions.[13]

3.2 In addition to Terminology D 653, Appendix X3 identifies major references from a range of disciplines that can be used as sources for definitions of terms that are related to environmental site characterization.

4. Significance and Use

4.1 This guide provides a general approach to environmental site characterization. Environmental site characterization provides information for a wide variety of uses including:

4.1.1 Determination of ambient background or baseline conditions, including, but not limited to, geochemistry, hydrogeology, microbiology, mineralogy, and water quality.

4.1.2 Assessment of site suitability for a future use or a use which may be compromised by site characteristics, such as flooding, seismic activity, and landslides (mass wasting).

4.1.3 Protection of site quality from the detrimental effects of human activities and natural processes, or minimization of

[8] *Annual Book of ASTM Standards*, Vol 14.02.

[9] *Annual Book of ASTM Standards*, Vol 03.02.

[10] The first seven definitions are ordered logically to illustrate construction of the definition for *environmental site characterization* rather than in alphabetical order.

[11] The meaning of conceptual site model may have more restricted or specific meanings depending on the objective or use of the model. For example, ground water flow modeling focuses on the physical characteristics as they relate to subsurface flow (see Guide D 5447), and a conceptual site model for the purpose of risk assessment will focus on contaminant sources, pathways, and receptors to exposure.

[12] Environmental audits and environmental site assessments as defined below are examples of environmental site characterization with specific objectives.

[13] This definition is taken from Practice E 1527. Other definitions of environmental site assessment may apply in other contexts. For example, EPA's Site Assessment Branch, Hazardous Site Evaluation Division in the Office of Emergency and Remedial Response defines site assessment as the decision process for identifying the most seriously contaminated uncontrolled hazardous waste sites that will receive funding for long-term remediation. Practice E 1527 defines *recognized environmental conditions* as "the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, ground water, or surface water of the property." In other environmental site investigations, nonhazardous substances (because of their physical condition, smell, or other aesthetic properties) or substances that have hazardous characteristics but do not meet a regulatory definition of hazardous may be the focus of concern.

adverse environmental impacts. Specific examples of uses of environmental site characterization for these purposes include: (*1*) delineation of ground-water or wellhead protection areas, (*2*) assessing the suitability of sites for disposal of industrial and residential liquid and solid wastes, (*3*) assessing soil suitability for land treatment of wastes, and (*4*) evaluating soil suitability for agricultural practices in order to minimize soil erosion and contamination from agricultural chemicals.

4.1.4 Assessment of the type, distribution, and extent of surface and subsurface contamination to determine compliance; risk to human health and the environment; and responsibility for remediation. Such assessments include: (*1*) sites involved in real estate transactions, (*2*) controlled and uncontrolled hazardous waste sites, (*3*) controlled and uncontrolled municipal solid waste, wastewater, and other nonhazardous waste disposal sites.

4.1.5 Assessment of surface and subsurface environmental processes that affect the fate, mobilization, and rate of transport of natural and anthropogenic chemicals in the subsurface.

4.1.6 Assessment of the type, distribution, and extent of natural and anthropogenic radioactive elements in the subsurface.

4.1.7 Assessment of the degree of risk that adverse subsurface site conditions not related to 4.1.4 and 4.1.5 pose to human health and safety or the natural ecosystem.

4.1.8 Selection and design of remediation systems for cleanup of subsurface contamination and of other reclamation or rehabilitation practices on disturbed land.

4.2 This guide is meant to be a flexible description of investigation requirements; methods defined by other ASTM Standards (Appendix X1) or non-ASTM techniques (Appendix X2) may be appropriate in some circumstances. The methods and amount of effort required for environmental site characterization will vary with site conditions and objectives of the investigation. This standard does not set mandatory guidelines and does not constitute a list of necessary steps or procedures for all investigations. In karst and fractured rock hydrogeologic settings, this guide should be used in conjunction with Guide D 5717.

5. Steps in Planning and Conducting Environmental Site Characterization

5.1 The following minimum elements, not necessarily in sequential order, are required for most environmental site investigations to determine project and site strategy:

5.1.1 Definition of objectives, site boundaries,[14] and other information necessary for efficient project planning.[15]

5.1.2 Collection of available existing data and information about the site, pertinent to the objectives of the investigation.[16]

5.1.3 Development of one or more conceptual site models of the site from existing information. The objectives of the investigation will affect the type and complexity of site conceptualization.

5.1.4 Performance of a reconnaissance site investigation, that may include nondestructive geophysical methods, and relatively simple field sampling and characterization methods,[17] to refine the conceptual model of the site.

5.1.5 Development of a detailed site investigation and sampling plan, that identifies methods to be used to collect and analyze required additional data, protocols for sampling and field measurements, and procedures to ensure quality assurance and quality control of site characterization data. Criteria

[14] The boundaries of a site are defined using one or more of the following considerations: (*1*) land ownership, (*2*) current and past land use, (*3*) natural site characteristics (topography, soils, geology, hydrology, biota). Where site boundaries are initially defined by ownership, natural site characteristics should be evaluated to determine whether the scope of at least parts of the investigation should include areas that are offsite. For example, investigations of ground water contamination should include identification of any potential sources of contamination that are upgradient from a site.

[15] This should include, but not necessarily be limited to: (*1*) definition of the technical and scientific approach to be used, (*2*) organization of a data management system, including both paper and electronic records, (*3*) identification of types of personnel and technical expertise, appropriate ASTM and other methods and field equipment required to meet the defined objective, (*4*) defining how spatial data will be recorded (see Section 7.1.3), (*5*) identification of applicable primary and secondary regulatory programs, and any required coordination with government agencies and other organizations, (*6*) development of health and safety plans, where appropriate, (*7*) identification of scheduling and budgetary constraints, (*8*) definition of data quality requirements for each stage of the investigation, (*9*) identification of deliverables at intermediate stages of the investigation and upon completion, (*10*) selection of performance measures to determine whether the objective has been achieved, and (*11*) definition of project decision statements.

[16] A site visit prior to extensive collection of existing data should be made unless the limited scope of a project does not allow multiple visits. The advantage of such a visit is that it may prevent preconceived ideas derived from inaccurate existing information from influencing initial conceptual site model development.

[17] When contaminated sites are being investigated, field chemical analytical methods can be valuable for identifying areas where more detailed investigations may be required, and for designing cost-effective detailed sampling and monitoring plans. Surface geophysical methods may be especially valuable for guiding placement of exploratory drillholes and placement of vadose zone and ground water monitoring installations. Any such field methods should be documented for quality assurance and quality control.