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Standard Guide to Site Characterization for Engineering Design and Construction Purposes[1]

This standard is issued under the fixed designation D 420; 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

Investigation and identification of subsurface materials involves both simple and complex techniques that may be accomplished by many different procedures and may be variously interpreted. These studies are frequently site specific and are influenced by geological and geographical settings, by the purpose of the investigation, by design requirements for the project proposed, and by the background, training, and experience of the investigator. This guide has been extensively rewritten and enlarged since the version approved in 1987. Material has been added for clarification and for expansion of concepts. Many new ASTM standards are referenced and a bibliography of non-ASTM references is appended.

This document is a guide to the selection of the various ASTM standards that are available for the investigation of soil, rock, and ground water for projects that involve surface or subsurface construction, or both. It is intended to improve consistency of practice and to encourage rational planning of a site characterization program. Since the subsurface conditions at a particular site are usually the result of a combination of natural, geologic, topographic, and climatic factors, and of historical modifications both natural and manmade, an adequate and internally consistent exploration program will allow evaluation of the results of these influences.

1. Scope

1.1 This guide refers to ASTM methods by which soil, rock, and ground water conditions may be determined. The objective of the investigation should be to identify and locate, both horizontally and vertically, significant soil and rock types and ground water conditions present within a given site area and to establish the characteristics of the subsurface materials by sampling or in situ testing, or both.

1.2 Laboratory testing of soil, rock, and ground water samples is specified by other ASTM standards not listed herein. Subsurface exploration for environmental purposes will be the subject of a separate ASTM document.

1.3 Prior to commencement of any intrusive exploration the site should be checked for underground utilities. Should evidence of potentially hazardous or otherwise contaminated materials or conditions be encountered in the course of the investigation, work should be interrupted until the circumstances have been evaluated and revised instructions issued before resumption.

1.4 The values stated in (SI) inch-pound units are to be regarded as the standard.

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.*

1.6 *This guide 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*

[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.

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health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 119 Terminology Relating to Dimension Stone
C 294 Descriptive Nomenclature for Constituents of Natural Mineral Aggregates
C 851 Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
D 75 Practice for Sampling Aggregates
D 653 Terminology Relating to Soil, Rock, and Contained Fluids
D 1194 Test Method for Bearing Capacity of Soil for Static Load and Spread Footings
D 1195 Test Method for Repetitive Static Plate Load Tests of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements
D 1196 Test Method for Nonrepetitive Static Plate Load Tests of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements
D 1452 Practice for Soil Investigation and Sampling by Auger Borings
D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils
D 1587 Practice for Thin-Walled Tube Sampling of Soils
D 2113 Practice for Rock Core Drilling, and Sampling of Rock for Site Investigation
D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)
D 2573 Test Method for Field Vane Shear Test in Cohesive Soil
D 2607 Classification of Peats, Mosses, Humus, and Related Products
D 3017 Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
D 3213 Practices for Handling, Storing, and Preparing Soft Undisturbed Marine Soil
D 3282 Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
D 3385 Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometers
D 3404 Guide to Measuring Matric Potential in the Vadose Zone Using Tensiometers
D 3441 Test Method for Deep, Quasi-Static, Cone and Friction-Cone Penetration Tests of Soil
D 3550 Practice for Ring-lined Barrel Sampling of Soils
D 3584 Practice for Indexing Papers and Reports on Soil and Rock for Engineering Purposes
D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)
D 4220 Practices for Preserving and Transporting Soil Samples
D 4394 Test Method for Determining the In Situ Modulus of Deformation of Rock Mass Using the Rigid Plate Loading Method
D 4395 Test Method for Determining the In Situ Modulus of Deformation of Rock Mass Using the Flexible Plate Loading Method
D 4403 Practice for Extensometers Used in Rock
D 4428 Test Methods for Crosshole Seismic Testing
D 4429 Test Method for CBR (California Bearing Ratio) of Soils in Place
D 4452 Methods for X-Ray Radiography of Soil Samples
D 4506 Test Method for Determining the In Situ Modulus of Deformation of Rock Mass Using a Radial Jacking Test
D 4544 Practice for Estimating Peat Deposit Thickness
D 4553 Test Method for Determining the In Situ Creep Characteristics of Rock
D 4554 Test Method for In Situ Determination of Direct Shear Strength of Rock Discontinuities
D 4555 Test Method for Determining Deformability and Strength of Weak Rock by an In Situ Uniaxial Compressive Test
D 4622 Test Method for Rock Mass Monitoring Using Inclinometers
D 4623 Test Method for Determination of In Situ Stress in Rock Mass by Overcoring Method—USBM Borehole Deformation Gage
D 4630 Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test
D 4631 Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using the Pressure Pulse Technique
D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems
D 4645 Test Method for Determination of the In Situ Stress in Rock Using the Hydraulic Fracturing Method
D 4700 Guide for Soil Sampling from the Vadose Zone
D 4719 Test Method for Pressuremeter Testing in Soils
D 4729 Test Method for In Situ Stress and Modulus of Deformation Using the Flatjack Method
D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)
D 4879 Guide for Geotechnical Mapping of Large Underground Openings in Rock
D 4971 Test Method for Determining the In Situ Modulus of Deformation of Rock Using the Diametrically Loaded 76-mm (3-in.) Borehole Jack
D 5079 Practices for Preserving and Transporting Rock Core Samples
D 5088 Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites
D 5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers

[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.

D 5093 Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring
D 5126 Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone
D 5195 Test Method for Density of Soil and Rock In-Place at Depths Below the Surface by Nuclear Methods
E 177 Practice for the Use of the Terms Precision and Bias in ASTM Test Methods
E 380 Practice for the Use of the International System of Units (SI) (the Modernized Metric System)
G 51 Test Method for pH of Soil for Use in Corrosion Testing
G 57 Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method

3. Significance and Use

3.1 An adequate soil, rock, and ground water investigation will provide pertinent information for decision making on one or more of the following subjects:

3.1.1 Optimum location of the structure, both vertically and horizontally, within the area of the proposed construction.

3.1.2 Location and preliminary evaluation of suitable borrow and other local sources of construction aggregates.

3.1.3 Need for special excavating and dewatering techniques with the corresponding need for information, even if only approximate, on the distribution of soil water content or pore pressure, or both, and on the piezometric heads and apparent permeability (hydraulic conductivity) of the various subsurface strata.

3.1.4 Investigation of slope stability in natural slopes, cuts, and embankments.

3.1.5 Conceptual selection of embankment types and hydraulic barrier requirements.

3.1.6 Conceptual selection of alternate foundation types and elevations of the corresponding suitable bearing strata.

3.1.7 Development of additional detailed subsurface investigations for specific structures or facilities.

3.2 The investigation may require the collection of sufficiently large soil and rock samples of such quality as to allow adequate testing to determine the soil or rock classification or mineralogic type, or both, and the engineering properties pertinent to the proposed design.

3.3 This guide is not meant to be an inflexible description of investigation requirements; methods defined by other ASTM standards or non-ASTM techniques may be appropriate in some circumstances. The intent is to provide a checklist to assist in the design of an exploration/investigation plan.

4. Reconnaissance of Project Area

4.1 Available technical data from the literature or from personal communication should be reviewed before any field program is started. These include, but are not limited to, topographic maps, aerial photography, satellite imagery, geologic maps, statewide or county soil surveys and mineral resource surveys, and engineering soil maps covering the proposed project area. Reports of subsurface investigations of nearby or adjacent projects should be studied.

NOTE 1—While certain of the older maps and reports may be obsolete and of limited value in the light of current knowledge, a comparison of the old with the new will often reveal valuable information.

4.1.1 The United States Geological Survey and the geological surveys of the various states are the principal sources of geologic maps and reports on mineral resources and ground water.

4.1.2 United States Department of Agriculture Soil Conservation Service soil surveys, where available and of recent date, should enable the investigator to estimate the range in soil profile characteristics to depths of 5 or 6 ft (1.5 or 2 m) for each soil mapped.

NOTE 2—Each soil type has a distinctive soil profile due to age, parent material, relief, climatic condition, and biological activity. Consideration of these factors can assist in identifying the various soil types, each requiring special engineering considerations and treatment. Similar engineering soil properties are often found where similar soil profiles characteristics exist. Changes in soil properties in adjacent areas often indicate changes in parent material or relief.

4.2 In areas where descriptive data are limited by insufficient geologic or soil maps, the soil and rock in open cuts in the vicinity of the proposed project should be studied and various soil and rock profiles noted. Field notes of such studies should include data outlined in 10.6.

4.3 Where a preliminary map covering the area of the project is desired, it can be prepared on maps compiled from aerial photography that show the ground conditions. The distribution of the predominant soil and rock deposits likely to be encountered during the investigation may be shown using data obtained from geologic maps, landform analysis and limited ground reconnaissance. Experienced photo-interpreters can deduce much subsurface data from a study of black and white, color, and infrared photographs because similar soil or rock conditions, or both, usually have similar patterns of appearance in regions of similar climate or vegetation.

NOTE 3—This preliminary map may be expanded into a detailed engineering map by locating all test holes, pits, and sampling stations and by revising boundaries as determined from the detailed subsurface survey.

4.4 In areas where documentary information is insufficient, some knowledge of subsurface conditions may be obtained from land owners, local well drillers, and representatives of the local construction industry.

5. Exploration Plan

5.1 Available project design and performance requirements must be reviewed prior to final development of the exploration plan. Preliminary exploration should be planned to indicate the areas of conditions needing further investigation. A complete soil, rock, and ground water investigation should encompass the following activities:

5.1.1 Review of available information, both regional and local, on the geologic history, rock, soil, and ground water conditions occurring at the proposed location and in the immediate vicinity of the site.

5.1.2 Interpretation of aerial photography and other remote sensing data.

5.1.3 Field reconnaissance for identification of surficial geologic conditions, mapping of stratigraphic exposures and outcrops, and examination of the performance of existing structures.

5.1.4 On site investigation of the surface and subsurface materials by geophysical surveys, borings, or test pits.

5.1.5 Recovery of representative disturbed samples for laboratory classification tests of soil, rock, and local construction material. These should be supplemented by undisturbed specimens suitable for the determination of those engineering properties pertinent to the investigation.

5.1.6 Identification of the position of the ground water table, or water tables, if there is perched ground water, or of the piezometric surfaces if there is artesian ground water. The variability of these positions in both short and long time frames should be considered. Color mottling of the soil strata may be indicative of long-term seasonal high ground water positions.

5.1.7 Identification and assessment of the location of suitable foundation material, either bedrock or satisfactory load-bearing soils.

5.1.8 Field identification of soil sediments, and rock, with particular reference to type and degree of decomposition (for example, saprolite, karst, decomposing or slaking shales), the depths of their occurrence and the types and locations of their structural discontinuities.

5.1.9 Evaluation of the performance of existing installations, relative to their structure foundation material and environment in the immediate vicinity of the proposed site.

6. Equipment and Procedures for Use in Exploration

6.1 *Pertinent ASTM Standards*—Practices D 1452, D 2113, D 4544, D 5088, D 5092; Method D 1586; and Test Methods D 4622, D 4633, D 4750.

6.2 The type of equipment required for a subsurface investigation depends upon various factors, including the type of subsurface material, depth of exploration, the nature of the terrain, and the intended use of the data.

6.2.1 *Hand Augers, Hole Diggers, Shovels, and Push Tube Samplers* are suitable for exploration of surficial soils to depths of 3 to 15 ft (1 to 5 m).

6.2.2 *Earth Excavation Equipment*, such as backhoes, draglines, and drilled pier augers (screw or bucket) can allow in situ examination of soil deposits and sampling of materials containing very large particles. The investigator should be aware of the possiblity of permanent disturbance of potential bearing strata by unbalanced pore pressure in test excavations.

6.2.3 Soil and rock boring and drilling machines and proofing devices may be used to depths of 200 to 300 ft in soil and to a much greater depth in rock.

6.2.4 Well drilling equipment may be suitable for deep geologic exploration. Normally samples are in the form of sand-sized cuttings captured from the return flow, but coring devices are available.

7. Geophysical Exploration

7.1 *Pertinent ASTM Standards*—Test Methods D 4428 and Method G 57.

7.2 Remote sensing techniques may assist in mapping the geological formations and for evaluating variations in soil and rock properties. Satellite and aircraft spectral mapping tools, such as LANDSAT, may be used to find and map the areal extent of subsurface materials and geologic structure. Interpretation of aircraft photographs and satellite imagery can locate and identify significant geologic features that may be indicative of faults and fractures. Some ground control is generally required to verify information derived from remote sensing data.

7.3 Geophysical survey methods may be used to supplement borehole and outcrop data and to interpolate between holes. Seismic, ground penetrating radar, and electrical resistivity methods can be particularly valuable when distinct differences in the properties of contiguous subsurface materials are indicated.

7.4 Shallow seismic refraction/reflection and ground penetrating radar techniques can be used to map soil horizons and depth profiles, water tables, and depth to bedrock in many situations, but depth penetration and resolution vary with local conditions. Electromagnetic induction, electrical resistivity, and induced polarization (or complex resistivity) techniques may be used to map variations in water content, clay horizons, stratification, and depth to aquifer/bedrock. Other geophysical techniques such as gravity, magnetic, and shallow ground temperature methods may be useful under certain specific conditions. Deep seismic and electrical methods are routinely used for mapping stratigraphy and structure of rock in conjunction with logs. Crosshole shear wave velocity measurements can provide soil and rock parameters for dynamic analyses.

7.4.1 The seismic refraction method may be especially useful in determining depth to, or rippability of, rock in locations where successively denser strata are encountered.

7.4.2 The seismic reflection method may be useful in delineating geological units at depths below 10 ft (3 m). It is not constrained by layers of low seismic velocity and is especially useful in areas of rapid stratigraphic change.

7.4.3 The electrical resistivity method, Method G 57, may be similarly useful in determining depth to rock and anomalies in the stratigraphic profile, in evaluating stratified formations where a denser stratum overlies a less dense stratum, and in location of prospective sand-gravel or other sources of borrow material. Resistivity parameters also are required for the design of grounding systems and cathodic protection for buried structures.

7.4.4 The ground penetrating radar method may be useful in defining soil and rock layers and manmade structures in the depth range of 1 to 30 ft (⅓ to 10 m).

NOTE 4—Surface geophysical investigations can be a useful guide in determining boring or test hole locations. If at all possible, the interpretation of geophysical studies should be verified by borings or test excavations.

8. Sampling

8.1 *Pertinent ASTM Standards*—Practices D 75, D 1452, D 1587, D 2113, D 3213, D 3550, D 4220, D 5079; Test Method D 1586; Methods D 4452; and Guide D 4700.

8.2 Obtain samples that adequately represent each subsurface material that is significant to the project design and construction. The size and type of sample required is dependent upon the tests to be performed, the relative amount of coarse particles present, and the limitations of the test equipment to be used.

NOTE 5—The size of disturbed or bulk samples for routine tests may vary at the discretion of the geotechnical investigator, but the following quantities are suggested as suitable for most materials: (*a*) Visual classification—50 to 500 g (2 oz to 1 lb); (*b*) Soil constants and particle size analysis of non-gravelly soil—500 g to 2.5 kg (1 to 5 lb); (*c*) Soil compaction tests and sieve analysis of gravelly soils—20 to 40 kg (40 to 80 lb); (*d*) Aggregate manufacture or aggregate properties tests—50 to 200 kg (100 to 400 lb).

8.3 Accurately identify each sample with the boring, test hole, or testpit number and depth below reference ground surface from which it was taken. Place a waterproof identification tag inside the container, securely close the container, protect it to withstand rough handling, and mark it with proper identification on the outside. Keep samples for natural water content determination in sealed containers to prevent moisture loss. When drying of samples may affect classification or engineering properties test results, protect them to minimize moisture loss. Practices D 4220 and D 5079 address the transportation of samples from field to laboratory. Most of the titles of the referenced standards are self-explanatory, but some need elaboration for the benefit of the users of this guide.

8.3.1 Practice D 75 describes the sampling of coarse and fine aggregates for the preliminary investigation of a potential source of supply.

8.3.2 Practice D 1452 describes the use of augers in soil investigations and sampling where disturbed soil samples can be used. Depths of auger investigations are limited by ground water conditions, soil characteristics, and equipment used.

8.3.3 Test Method D 1586 describes a procedure to obtain representative soil samples for identification and classification laboratory tests.

8.3.4 Practice D 1587 describes a procedure to recover relatively undisturbed soil samples suitable for laboratory testing.

8.3.5 Practice D 2113 describes a procedure to recover intact samples of rock and certain soils too hard to sample by Test Method D 1586 or Practice D 1587.

8.3.6 Practice D 3550 describes a procedure for the recovery of moderately disturbed, representative samples of soil for classification testing and, in some cases, shear or consolidation testing.

9. Classification of Earth Materials

9.1 *Pertinent ASTM Standards*—Terminology C 119; Descriptive Nomenclature C 294; Classifications D 2487, D 2607, D 3282; Practices D 2488, D 4083.

9.2 Additional description of samples of soil and rock may be added after submission to the laboratory for identification and classification tests in accordance with one or more ASTM laboratory standards or other applicable references, or both. Section 10.6.3 discusses the use, for identification and for classification purposes, of some of the standards listed in 9.1.

10. Determination of Subsurface Conditions

10.1 Subsurface conditions are positively defined only at the individual test pit, hole, boring, or open cut examined. Conditions between observation points may be significantly different from those encountered in the exploration. A stratigraphic profile can be developed by detailed investigations only where determinations of a continuous relationship of the depths and locations of various types of soil and rock can be inferred. This phase of the investigation may be implemented by plotting logs of soil and rock exposures in walls of excavations or cut areas and by plotting logs of the test borings. Then one may interpolate between, and extrapolate a reasonable distance beyond, these logs. The spacing of these investigations should depend on the geologic complexity of the project area and on the importance of soil and rock continuity to the project design. Exploration should be deep enough to identify all strata that might be significantly affected by the proposed use of the site and to develop the engineering data required to allow analysis of the items listed in Section 4 for each project.

NOTE 6—Plans for a program of intrusive subsurface investigation should consider possible requirements for permits for installation and proper closure of bore holes and wells at the completion of the investigation.

10.2 The depth of exploratory borings or test pits for roadbeds, airport paving, or vehicle parking areas should be to at least 5 ft (1.5 m) below the proposed subgrade elevation. Special circumstances may increase this depth. Borings for structures, excavations, or embankments should extend below the level of significant stress or ground water influence from the proposed load as determined by subsurface stress analysis.

10.3 When project construction or performance of the facility may be affected by either previous water-bearing materials or impervious materials that can block internal drainage, borings should extend sufficiently to determine those engineering and hydrogeologic properties that are relevant to the project design.

10.4 In all borrow areas the borings or test pits should be sufficient in number and depth to outline the required quantities of material meeting the specified quality requirements.

10.5 Where frost penetration or seasonal desiccation may be significant in the behavior of soil and rock, borings should extend well below the depth from finished grade of the anticipated active zone.

10.6 Exploration records shall be kept in a systematic manner for each project. Such records shall include:

10.6.1 Description of each site or area investigated. Each test hole, boring, test pit, or geophysical test site shall be clearly located (horizontally and vertically) with reference to some established coordinate system, datum, or permanent monument.

10.6.2 Logs of each test hole, boring, test pit, or cut surface exposure shall show clearly the field description and location of each material and any water encountered, either by symbol or word description. Reference to a Munsell color chart designation is a substantial aid to an accurate description of soil and rock materials.

NOTE 7—Color photographs of rock cores, soil samples, and exposed strata may be of considerable value. Each photograph should include an identifying number or symbol, a date, and reference scale.

10.6.3 Identification of all soils based on Classification D 2487, Practice D 2488, Classification D 2607, or Practice D 4083. Identification of rock materials based on Terminology C 119, Descriptive Nomenclature C 294, or Practice C 851. Classification of soil and rock is discussed in Section 9.

10.6.4 Location and description of seepage and water-bearing zones and records of piezometric elevations found in each hole, boring, piezometer, or test pit.

10.6.5 The results and precise locations of in situ test results such as the penetration resistance or vane shear discussed in 8.3, plate load tests, or other in situ test-engineering properties of soils or rock.

10.6.6 Percentage of core recovery and rock quality designation in core drilling as outlined in 8.3.5.

10.6.7 Graphical presentation of field and laboratory and its interpretation facilitates comprehensive understanding subsurface conditions.

11. In Situ Testing

11.1 *Pertinent ASTM Standards*—Test Methods D 1194, D 1195, D 1196, D 1586, D 2573, D 3017, D 3441, D 3885, D 4394, D 4395, D 4429, D 4506, D 4553, D 4554, D 4555, D 4623, D 4630, D 4631, D 4645, D 4719, D 4729, D 4971, D 5093, D 5195, G 51; Guides D 3404, D 5126; and Practice D 4403.

11.2 In situ testing is useful for: (*a*) measurement of soil parameters in their undisturbed condition with all of the restraining or loading effects, or both, of the surrounding soil or rock mass active, and (*b*) for rapid or closely spaced measurements, or both, of earth properties without the necessity of sampling. Most of the titles of the various referenced standards are self-explanatory, but some need elaboration for the users of this guide.

11.2.1 Test Method D 1586 describes a penetration test that has been correlated by many authors with various strength properties of soils.

11.2.2 Test Method D 2573 describes a procedure to measure the in situ unit shear resistance of cohesive soils by rotation of a four-bladed vane in a horizontal plane.

11.2.3 Test Method D 3441 describes the determination of the end bearing and side friction components of the resistance to penetration of a conical penetrometer into a soil mass.

11.2.4 Practice D 4403 describes the application of various types of extensometers used in the field of rock mechanics.

11.2.5 Test Method D 4429 describes the field determination of the California Bearing Ratio for soil surfaces in situ to be used in the design of pavement systems.

11.2.6 Test Method D 4719 describes an in situ stress-strain test performed on the walls of a bore hole in soil.

NOTE 8—Other standards for in situ test procedures and automated data collection are being prepared by ASTM Committee D-18 for publication at a later date.

12. Interpretation of Results

12.1 Interpret the results of an investigation in terms of actual findings and make every effort to collect and include all field and laboratory data from previous investigations in the same area. Extrapolation of data into local areas not surveyed and tested should be made only for conceptual studies. Such extrapolation can be done only where geologically uniform stratigraphic and structural relationships are known to exist on the basis of other data. Cross sections may be developed as part of the site characterization if required to demonstrate the site conditions.

12.1.1 Cross sections included with the presentation of basic data from the investigation should be limited to the ground surface profile and the factual subsurface data obtained at specific exploration locations. Stratigraphic units between the locations of intrusive explorations should only be indicated if supported by continuous geophysical profiles.

12.1.2 Cross sections showing interpretations of stratigraphic units and other conditions between intrusive explorations but without support of continuous geophysical profiles should be presented in an interpretative report appendix or in a separate interpretative report. The interpretive cross sections must be accompanied by notes describing anomalies or otherwise significant variations in the site conditions that should be anticipated for the intended design or construction activities.

NOTE 9—Additional exploration should be considered if there is not sufficient knowledge to develop interpretative cross sections, with realistic descriptions of anticipated variations in subsurface conditions, to meet project requirements.

12.2 Subject to the restrictions imposed by state licensing law, recommendations for design parameters can be made only by professional engineers and geologists specializing in the field of geotechnical engineering and familiar with purpose, conditions, and requirements of the study. Soil mechanics, rock mechanics, and geomorphological concepts must be combined with a knowledge of geotechnical engineering or hydrogeology to make a complete application of the soil, rock, and ground water investigation. Complete design recommendations may require a more detailed study than that discussed in this guide.

12.3 Delineate subsurface profiles only from actual geophysical, test-hole, test-pit, or cut-surface data. Interpolation between locations should be made on the basis of available geologic knowledge of the area and should be clearly identified. The use of geophysical techniques as discussed in 7.2 is a valuable aid in such interpolation. Geophysical survey data should be identified separately from sample data or in situ test data.

13. Report

13.1 *Pertinent ASTM Standards*—Terminology D 653; Practices D 3584, E 177, E 380; and Guide D 4879.

13.2 The report of a subsurface investigation shall include:

13.2.1 The location of the area investigated in terms pertinent to the project. This may include sketch maps or aerial photos on which the test pits, bore holes, and sample areas are located, as well as geomorphological data relevant to the determination of the various soil and rock types. Such data includes elevation contours, streambeds, sink holes, cliffs, and the like. Where feasible, include in the report a geologic map or an agronomic soils map, or both, of the area investigated.

13.2.2 A description of the investigation procedures, including all borings and testhole logs, graphic presentation of all compaction, consolidation, or load test data tabulation of all laboratory test results, and graphical interpretations of geophysical measurements.

13.2.3 A summary of the findings obtained under Sections 4, 10, and 12, using subhead titles for the respective sections and appropriate recommendations and disclaimers for the use of the report.

14. Precision and Bias

14.1 This guide provides qualitative data only; therefore, a precision and bias statement is not applicable.

15. Keywords

15.1 explorations; feasibility studies; field investigations; foundation investigations; geological investigations; geophysical investigation; ground water; hydrologic investigations; maps; preliminary investigations; reconnaissance surveys; sampling; site investigations (see Practice D 3584); soil surveys; subsurface investigations

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