



Standard Guide for Collection of Soils and Other Geological Evidence for Criminal Forensic Applications¹

This standard is issued under the fixed designation E3272; 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 standard provides guidance to instruct crime scene professionals in good practices for the documentation, collection, and preservation of soil and other geological evidence for use in criminal investigations. Sampling for environmental geology is outside of its scope. It is designed as a resource for professionals whose job responsibilities include the collection and preservation of soil evidence and for forensic scientists to enable them to advise crime scene investigators.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.3 This standard cannot replace knowledge, skills, or abilities acquired through education, training, and experience (Practice E2917), and is to be used in conjunction with professional judgment by individuals with such discipline-specific knowledge, skills, and abilities.

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

1.5 *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

D6966 Practice for Collection of Settled Dust Samples

¹ This guide is under the jurisdiction of ASTM Committee E30 on Forensic Sciences and is the direct responsibility of Subcommittee E30.11 on Interdisciplinary Forensic Science Standards.

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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.

Using Wipe Sampling Methods for Subsequent Determination of Metals

D7296 Practice for Collection of Settled Dust Samples Using Dry Wipe Sampling Methods for Subsequent Determination of Beryllium and Compounds

D7144 Practice for Collection of Surface Dust by Microvacuum Sampling for Subsequent Determination of Metals and Metalloids

D5755 Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Structure Number Surface Loading

D5756 Test Method for Microvacuum Sampling and Indirect Analysis of Dust by Transmission Electron Microscopy for Asbestos Mass Surface Loading (Withdrawn 2017)³

E1188 Practice for Collection and Preservation of Information and Physical Items by a Technical Investigator

E1459 Guide for Physical Evidence Labeling and Related Documentation

E1732 Terminology Relating to Forensic Science

E2917 Practice for Forensic Science Practitioner Training, Continuing Education, and Professional Development Programs

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *aggregate(s) [clump(s)]*, *n*—a group of soil particles that cohere to each other more strongly than to other surrounding particles.

(1)⁴

3.1.1.1 *Discussion*—Soil aggregates can be natural (a *ped*) or formed by human activities (a *clod*). Often the genesis of evidentiary soil aggregates is unknown, so aggregate is often a preferred term in descriptions of soil evidence.

3.1.2 *alibi location(s)*, *n*—a known location suggested or linked to a subject (for example, a subject's home) that is distinct from the crime scene.

3.1.2.1 *Discussion*—The term alibi or alibi location can be perceived negatively, but comparisons of geological materials

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

⁴ The boldface numbers in parentheses refer to a list of references at the end of this standard.

from alibi locations can be exonerating. Alibi location is used in this document to be succinct, however use of this term in documentation of evidence, evidence examination reports, or courtroom testimony is discouraged.

3.1.3 *known*, *adj*—of established origin associated with the matter under investigation. **E1732**

3.1.3.1 *Discussion—Known soil samples* are intentionally collected, typically from crime scene or alibi locations, for comparison to a questioned soil sample. Soils are heterogeneous mixtures of organic matter and minerals that vary with depth and across the landscape. Typically, more known samples are needed to represent the range of variation in soils than are required for manufactured materials. “Reference sample” is used synonymously in Ref (2).

3.1.4 *provenance*, *n*—a place or origin; specifically, the area from which the constituent materials of a sedimentary rock or facies are derived, also, the rocks of which this area is composed.

adapted from Ref (3)

3.1.4.1 *Discussion—*In the context of forensic provenance examination, geological material is analyzed and interpreted to estimate or limit the geographic or environmental conditions of the source of this material to provide an investigative lead. For example, soil on a shovel can be examined to aid in the search for a clandestine grave, typically by comparison of observations to reference data. “Geographic attribution” is an alternative term for provenance.

3.1.5 *questioned sample*, *n*—material collected as or from items of evidence which have a known location but an unknown originating source. **(4)**

3.1.5.1 *Discussion—*Soil evidence of unknown origin, or questioned soil sample, typically consists of: debris adhering to an evidentiary object or exhibit (3) (for example, tire, wheel well, garment, shoe, digging tool); foreign soil left at a crime scene (for example, transferred from a shoe/tire, or adhering to a re-buried body/object); or debris recovered from on or within a body (for example, nasal, stomach, or lung contents).

3.1.6 *soil*, *n*—sediments or other unconsolidated accumulations of solid particles (for example, minerals and organic matter) that are produced by the physical, chemical, and biological disintegration of parent material, or which has the ability to support rooted plants in a natural environment, or both; and which can include manufactured materials.

adapted from Ref (1)

3.1.6.1 *Discussion—*Within this document, “soil” includes native soil, as well as unconsolidated material emplaced by human activities.

3.1.7 *soil horizon*, *n*—a layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistency, kinds and numbers of organisms present, degree of acidity or alkalinity, etc. **(1)**

3.1.8 *soil core sampler [soil corer; soil probe]*, *n*—a device used to collect virtually undisturbed sub-surface soil samples for documenting a soil profile.

3.1.9 *soil profile*, *n*—a vertical section of soil exposed from the ground surface to a depth of interest. A soil profile can be observed in a freshly dug pit, along a road bank, or in many other places.

adapted from Ref (1)

4. Significance and Use

4.1 This guide describes good practices for the collection (5), packaging, and preservation (8.3) of soils in criminal forensic investigations. Some of the information in this guide is demonstrated in its companion video, which is available on-line and is intended as a complementary resource to this guide (6).

4.2 Individual agencies can use this guide to develop agency-specific procedures regarding the collection of soils for forensic applications.

5. Collection Tools

5.1 Collection Tool Materials:

5.1.1 Tools for forensic soil collection should either be new, disposable items (for example, plastic spoons, swabs, wipes, filters) or non-porous tools, cleaned prior to each use (see 5.2) to prevent contamination from either the tool itself or a previously collected sample.

5.1.2 Tools for collection of softer materials (for example, unconsolidated sand) can be made of plastic, but for collection of harder materials, tools made of steel are recommended.

5.1.3 Examples of some non-disposable tools are shown in Fig. 1 (see 8.3 for soil evidence packaging materials and recommendations).

5.2 Cleaning Tools:

5.2.1 In most circumstances, non-disposable tools can be cleaned by rinsing with clean water (deionized or distilled are recommended) or with a pre-moistened wipe and dried (preferably with a lint free material). Pre-moistened wipes are convenient for cleaning tools during field collections.

5.2.2 Alcohol, bleach, or other suitable disinfectant solutions can be used to help with the decontamination of tools used to collect samples with biological components.

5.2.3 Do not re-use tools that cannot be cleaned.

5.2.4 An item is considered sufficiently clean when no particles are seen on a clean cloth used to wipe the tool.

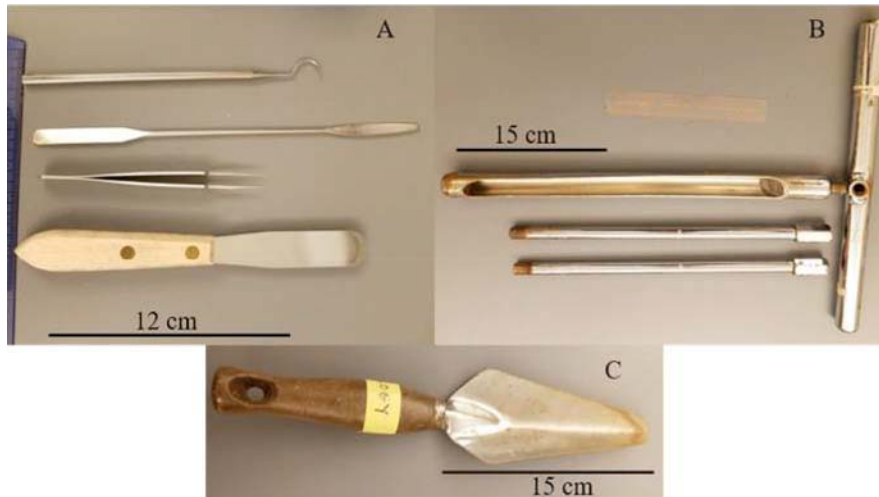
NOTE 1—More rigorous tool cleaning methods are required to achieve DNA-free tools.

5.3 Tools for Collection of Questioned Soils:

5.3.1 For Small Quantities of Questioned Soils (Fig. 1A):

NOTE 2—These tools can also be used to collect a non-native soil aggregate from a crime scene.

- 5.3.1.1 Tweezers,
- 5.3.1.2 Forceps,
- 5.3.1.3 Dental picks,
- 5.3.1.4 Spoons,
- 5.3.1.5 Spatulas, and
- 5.3.1.6 Palette knives.



NOTE 1—(A, top to bottom) dental pick, micro-spatula, forceps, and spatula; (B) soil corer (with T-handle and two extension rods); (C) trowel. (Photographs courtesy of Dr. Libby Stern.)

FIG. 1 Some Common Tools Used to Collect Soil Evidence

5.3.2 For Collection of Thin Deposits of Questioned Soil:

- 5.3.2.1 Spatulas;
- 5.3.2.2 Ice scrapers;
- 5.3.2.3 Clean/new razor blades;

5.3.2.4 Other flat tools suitable for prying or scraping the soil deposit loose; and

5.3.2.5 Trays, dust pan, cardboard, or paper plates to recover dislodged soil.

5.4 Tools for Collection of Known Soils:

NOTE 3—In most cases, known soils are collected to represent the range of soil properties present at a location. As a result, known soil samples tend to be larger than questioned soil samples, requiring larger tools. A soil corer can be used to collect a surface to near-surface soil profile. Smaller tools, such as pallet knives or tweezers, should be used to collect soils from within impressions. A spade or pickaxe are recommended to access soils from sub-surface, but smaller, like 5.4.1 – 5.4.4 tools are typically used for collection of known soil specimens.

- 5.4.1 Garden trowels (Fig. 1C);
- 5.4.2 Soil corers (Fig. 1B);
- 5.4.3 Pointed (archaeologist’s/masonry) trowels;
- 5.4.4 Spoons;
- 5.4.5 Spades;
- 5.4.6 Mining picks (maddocks, pickaxes, hoepicks); and
- 5.4.7 Trays, dustpan, cardboard or paper plates to collect recovered soil, particularly for subsurface soil collections.

5.5 Tools for Collection of Dust:

5.5.1 Particulate filtration cassettes similar to those described in Test Methods D5755 and D5756 and Practice D7144;

NOTE 4—Do not use “evidence vacuum filters” because the convoluted filter material prevents recovery of dust and geological materials.

5.5.2 Low-tack tapes (similar to 3M Post-it⁵ notes);

NOTE 5—Do not use high tack tapes or those used to lift fingerprints

because their strong adhesives prevent soil recovery and analysis (5).

- 5.5.3 Wipes (Practices D6966, D7296); and
- 5.5.4 Swabs (polyurethane is preferable).

6. Collection of Questioned Soils

6.1 Thoroughly document all questioned soil samples prior to collection. This includes any depositional (structure or layer) characteristics (7, 8).

6.2 Refer to 8.3 for methods of packaging and preserving soil evidence.

6.3 Collection of Questioned Soil on Object of Interest:

6.3.1 Objects that have soil evidence adhering to them (for example, shoes, tires, garments) should be documented and then collected intact and submitted to the forensic laboratory whenever possible. (See 8.3.4 for packaging of soil adhering to objects.)

6.3.2 If the object cannot be submitted to the forensic laboratory, then careful documentation of the soil on the object should be done prior to the soil removal.

6.4 Removal of Questioned Soil from Non-Porous Objects When Object Cannot be Submitted Intact:

NOTE 6—Evidentiary soil can occur on the surfaces and in crevices of objects that cannot be delivered to the laboratory.

6.4.1 Soil dried on a large hard surface, such as a vehicle, should be documented in place and then pried or scraped off with a flat tool (5.3.2) onto a clean piece of paper, or onto a clean collection pan, while trying to preserve intact aggregates which can have layering (7, 8).

6.5 Removal of Questioned Soil from Porous Objects When Object Cannot be Submitted Intact:

6.5.1 Remove soil from porous surfaces, such as upholstery, by gentle scraping with a spatula or similar tool, taking care to preserve intact soil aggregates.

6.5.2 Alternatively, low tack adhesive materials can be used to collect debris loosely attached to the substrate.

⁵ A trademark of 3M Company in St. Paul, MN.

6.6 Foreign Soil Transferred to a Crime Scene:

NOTE 7—Foreign soil, or soils derived from another location, can be left at a crime scene inadvertently when the soil material, usually as dried aggregates, falls off items such as shoes, tires, or vehicles. Foreign soils can confirm the location history of a person or vehicle. Evidence collection teams should seek foreign soil aggregates from locations in or near tire tracks and shoe prints.

6.6.1 Collection of foreign soil aggregates found within a shoe or tire impression should be done after documentation of the impressions by casting, photography or both.

6.6.1.1 If the foreign soil aggregate adheres to the casting material, carefully package the cast and note that this aggregate should be recovered in the laboratory.

6.6.1.2 After documentation of the impression evidence, this questioned soil should be collected along with known soils adjacent to and from within the impression as elimination samples (7.5.3.1).

6.6.1.3 Collect these foreign soil aggregates using a small tools, such as spoons, pallet knives, or tweezers.

6.7 Questioned Soil On or Within Bodies:

NOTE 8—Soil on or within a body (for example, under fingernails, on skin, or within body cavities), or on its clothing, could be probative as an indicator of the prior locations of a victim either pre- or post-mortem. Questioned soil samples associated with a corpse, in particular those soils recovered from within a body, are often recovered by a medical examiner or coroner.

6.7.1 Crime scene professionals should coordinate collections of soil evidence associated with a corpse with the medical examiner or coroner.

6.7.2 Evidence collection professionals should seek and document foreign soils that are associated with a body and, if permitted, collect these soil samples prior to removal of the body from the recovery location.

6.7.3 If soil evidence cannot be collected from a body prior to its removal from the scene, then any visible soil evidence should be documented photographically, and appropriate personnel (for example, medical examiners) should be contacted about the need to collect and preserve the soil evidence.

6.7.4 Collect additional known soils from the body recovery location as elimination samples (7.5.3.1).

6.8 Questioned Soil from Living Persons:

6.8.1 A living person (victim or suspect) can have soils on or within them (for example, under fingernails, on skin, or within body cavities). These soils might be collected by a medical professional so evidence collection personnel should communicate the need for soil evidence collection to the medical team and provide guidance on appropriate documentation and packaging.

6.8.2 The tools used to collect soils from living persons are likely to be those in a medical facility such as swabs, wipes, tweezers, or tongue depressors; medical specimen cups are useful for soil evidence containment.

7. Collection of Known Soils

7.1 Known soil samples are purposefully collected to represent the range of soil characteristics at a crime scene or alibi location to enable a forensic soil examiner to compare a

questioned soil to the known soils and conclude if it is possible that the questioned soil could have originated from the same source as the known soil(s). Known soils can also be collected as reference materials in a soil provenance investigation, however, the collection strategies described here are primarily aimed at collection for soil comparisons.

7.2 Surface Versus Sub-Surface Origin Of Questioned Soils:

7.2.1 Try to determine if the questioned soil is derived from a surface or sub-surface soil source (for example, soil on a shovel could have originated from soil from beneath the surface, whereas soil on a shoe or garment is likely to be derived from soil at the ground surface).

7.2.2 Prior knowledge of the nature of the questioned soil evidence and the crime scene will affect the types of known soil samples collected.

7.2.3 Unless there is prior knowledge that the source of a questioned soil could be from an area such as burial sites, holes, river banks, cut banks, or deep tracks or ruts, collection of known surface, rather than sub-surface, soils is recommended. (See 7.6 for surface soil collection and 7.7 for sub-surface soil collections.)

7.3 Background Information:

7.3.1 To aid in selection of appropriate known soil samples, acquire domain relevant background information prior to the collection of known soil samples to aid in the selection of appropriate known soils samples (for example, is it known where the suspect/vehicle had been walking/driving?; has preliminary examination of soil evidence been conducted in the case to guide known soil sample collection?)

7.3.2 Other types of background information that might be useful in guiding collection of known soils include: soil survey information; geological survey information; appropriate maps (including geo-political, topographical, road, vegetation, land cover, geological, and soil survey maps); and the exact location where the questioned sample was collected, including geographic (GPS) coordinates or equivalent, such as that obtained with a total-station or orthogonal drone imagery.

7.4 Minimizing Environmental Alteration:

7.4.1 Collect and preserve soil samples as early as possible in the investigation to limit environmental alteration or degradation over time (5).

7.4.2 Collection of additional soil samples might be necessary at a later date, but these samples might not represent the materials that were present at the time of the crime.

7.5 Known Soil Sample Volume:

7.5.1 When possible, collect approximately 30 mL (2 to 3 Tbsp) per sample.

7.5.2 Coarse-grained or lower density materials, or both, such as gravel, pebbles, or soils with high botanical content might require a significantly larger sample volume/size; if objects or features larger than approximately 2 mm (or about 1/8 in.) are present, attempt to collect a volume of soil that is at least ten times larger in its linear dimensions than the largest grain or feature (for example, if soil has 4 mm diameter grains, collect a sample volume greater than ~40 mm × 40 mm × 40 mm, or 64 mL, or about one-quarter cup).

7.5.3 Number of Known Soil Samples to Collect:

7.5.3.1 The number of known soils samples to collect is case- and scene-dependent.

NOTE 9—While there is no specific minimum number of samples that must be collected, some authors have made recommendations regarding appropriate sample numbers (9, 10). In general, it is recommended to collect a greater number of samples rather than fewer, with typically 3 to 20 known soil samples collected depending on the site details. Fewer soil samples are needed if: the crime scene/alibi area is small, there is minimal variation in topography or vegetation, there are no visual differences in the soils present, and there is only a single path of ingress and egress. As the complexity of the scene increases, a greater number of known samples should be collected to capture the potential variations.

7.5.3.2 Collection of Elimination Soils—When collecting questioned soil evidence, it is important to collect known soils from the same location to eliminate that site as a possible source of the soil evidence.

Examples:

(1) When a crime victim has soil on their trousers, collect an elimination soil sample from the victim recovery location for comparison to the soiled trousers to allow for the possible elimination of the recovery site as a source of the questioned soil.

(2) When a digging tool is recovered from a suspect’s home for comparison to a distant burial site, soils from the suspect’s yard should be collected as elimination samples, because if these samples are similar to the soil on the digging tool, the yard must be included as a possible soil source.

7.6 Collection of Known Surface Soil Samples:

7.6.1 Strategies for Collection of Known Surface Soils:

7.6.1.1 When collecting known soils from a location, there are several different strategies which can be employed and are selected based upon case circumstances. The strategies in 7.6.1.2 – 7.6.1.4 describe where to collect surface soils from an area of interest (crime scene or alibi location) to represent the soil variability. (See 7.7 for details about sampling sub-surface soils.)

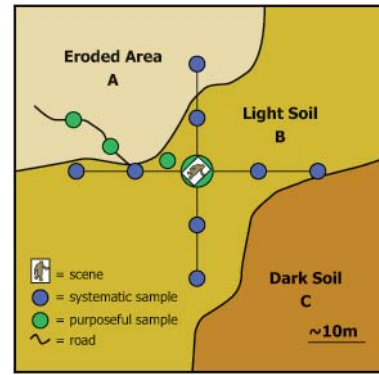
7.6.1.2 Purposeful—Collection of known surface soils from identified areas of interest such as: areas of entry, areas of egress, burial sites, areas of soil disturbance, footwear or tire impressions, areas with visual (texture or color) similarities to questioned samples, or areas with anomalous appearances relative to the surrounding materials.

NOTE 10—If background information (7.3) indicates soil variation within the area of interest, intentional collection of soils representing each soil type is recommended (Fig. 2). For additional examples of this type of collection, see (7, 9, 11, 12).

7.6.1.3 Systematic—Pattern-based technique for the collection of samples. A variety of patterns can be used, including grids, circular patterns, compass points, etc. (11, 13, 14).

NOTE 11—This technique is useful when there are no obvious features from which to sample (for example, looking for a burial site or buried object) or for sampling around a single object of interest (such as a body) when no other features (such as shoeprints or tire impressions) are present. Example: If a suspect claims the soil on their shoes came from somewhere in their backyard, and the yard is featureless, a systematic sampling approach can be used to gather representative soils from the yard (Fig. 2).

7.6.1.4 Combination—Many cases benefit from a combined approach including both purposeful and systematic sampling



NOTE 1—Image courtesy of OSAC Geological Materials Subcommittee.

FIG. 2 Example of a Combination of Purposeful Sampling (Green Circles) Along a Road and Other Areas of Interest Combined with Systematic Sampling (Blue Circles) Around a Crime Scene

techniques (Fig. 2). A systematic approach to sampling ensures that soils will be collected from a wide range of locations at the scene, while purposeful sampling ensures that soil sample from important features not included in the systematic approach (such as likely paths of entry and egress, or notably distinct soils) are also collected (11).

7.6.2 Site- or Case-Specific Consideration for Known Surface Soil Sampling:

7.6.2.1 Sampling Known Surface Soils Within Low Variability Sites—In locations with no or low visually apparent soil variability (for example, color, grain size, land use, vegetation), samples should be collected in order to encompass potential variations within the soil at the site.

NOTE 12—Changes in vegetation or topography (slope position) often are associated with changes in soil characteristics, so these features can be used to guide the collection locations.

7.6.2.2 Sampling Known Surface Soils Within High Variability Sites—High levels of visual variability in a location can require the collection of a larger number of samples to capture the full range of variability present at the site. This soil spatial variability could arise from natural variations or from land use and landscaping.

7.6.2.3 Sampling Known Surface Soils at Sites with Spatial Complexity—A crime scene can have complexity arising from multiple people or vehicles leaving impressions in the soil, multiple potential paths of egress, or from other case information indicating a large number of points of interest. Once an impression has been documented/photographed/cast, collect soil samples from within the area of the impression (sidewalls and floor) as well as adjacent areas close to the impression to avoid any residual casting material (11).

7.6.3 Depth of Collection of Known Surface Soils—Collect from the soil surface to approximately 1 to 2 cm (½ to ¾ in.) deep or to the depth of any existing impressions (for example, tire tracks or shoe prints) or other features of interest (12).

7.7 Collection of Known Sub-Surface Soils—Soil variation with depth is significant and can be visual/morphologic (color, structure, and texture) or compositional (chemical, mineralogical, physical, biological, etc.). Therefore, in locations where soil has been removed from below the surface,