



Standard Practice for Use of Color in the Visual Examination and Forensic Comparison of Soil Samples¹

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1. Scope

1.1 This practice covers visual color determination of soil/geologic material within the context of a forensic examination and is intended for use by laboratory personnel.

1.1.1 This practice recommends use of soil color for: the initial screening of soil samples in forensic casework, prioritization of known soil exemplars for detailed analysis, and includes a test method for color determination in the Munsell color system and comparison among samples.

1.2 *Units*—Units in the Munsell color system are used throughout this document.

1.3 This practice is intended for use by competent forensic science practitioners with the requisite formal education, discipline-specific training (see Practice E2917), and demonstrated proficiency to perform forensic casework.

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

- D1535 Practice for Specifying Color by the Munsell System
- E620 Practice for Reporting Opinions of Scientific or Technical Experts
- E1492 Practice for Receiving, Documenting, Storing, and

- Retrieving Evidence in a Forensic Science Laboratory
- E2917 Practice for Forensic Science Practitioner Training, Continuing Education, and Professional Development Programs
- E3272 Guide for Collection of Soils and Other Geological Evidence for Criminal Forensic Applications

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)³

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.

3.1.1.2 *Discussion*—This use of the term aggregate is distinct from this term's use in construction as the sand or crushed rock mixed with cement to form mortar, grout, or concrete.

3.1.2 *color contrast*, *n*—the degree of visual difference that is evident between one soil color compared with another in close proximity.

(adapted from Ref (2))

3.1.2.1 *Discussion*—Within this practice, color contrast refers to color difference between evidentiary soil samples.

3.1.3 *color contrast classes*, *n*—degree of color distinction (*color contrast*) between colors within a soil are categorized as *faint*, *distinct* and *prominent*.

(2)

3.1.3.1 *Discussion*—Within this practice, these contrast classes are used to describe the degree of color distinction between two evidentiary soil samples, whereas the United States Department of Agriculture – National Resource Conservation Service – National Cooperative Soil Survey (NCSS) uses these contrast classes to describe color distinction within soil horizons. *Faint* color contrast is evident only on close examination. *Distinct* color contrast is readily seen but contrasts only moderately with the color to which it is compared.

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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.

³ The boldface numbers in parentheses refer to the list of references at the end of this standard.

Prominent indicates colors which contrast strongly with the color to which it is compared; prominent colors are commonly the most obvious color feature of the section described. The NCSS thresholds between faint and distinct color contrast (2) are adapted as exclusion criteria in forensic comparisons of soil (see 6.6).

3.1.4 *known soil sample, n*—known soil samples are intentionally collected, typically from crime scene or alternate locations, for comparison to a *questioned soil sample*.

3.1.4.1 *Discussion*—Soils are heterogeneous mixtures of organic matter and minerals that vary vertically with depth and horizontally across the landscape. Typically, a greater number of known soil samples are needed than manufactured materials to represent the range of variation (see Guide E3272). Reference sample and control sample are synonyms or sub-types of known soil samples (3, 4).

3.1.5 *matrix color, n*—dominant or background color component of a soil sample, soil aggregate, ped, clod, or horizon. (adapted from Ref (5), see Fig. 1)

3.1.6 *metamerism, n*—when colors are perceived to be matching despite having different spectral profiles.

3.1.6.1 *Discussion*—These spectral differences often become apparent under different illumination conditions.

3.1.7 *mottles, mottling, n* (*mottled, adj.*) or *non-matrix color, n*—segregations within the soil matrix with different color or shades of color interspersed with the dominant (*matrix*) color (see Fig. 1).

3.1.7.1 *Discussion*—The NCSS reserves the term *mottles* for color variations that cannot be associated with compositional properties of the soil, whereas color variations attributable to compositional variations are designated with distinct terms (redoximorphic features, concentrations, ped coatings,

etc; Ref (5). However, in a forensic examination mottling is often used to describe any *color contrast* within a soil aggregate, regardless of its origin.

3.1.8 *Munsell color code, n*—Munsell color is recorded as alpha-numeric *Hue Value/Chroma*, H V/C (for example, 7.5YR 5/4 or 5R 6/4); neutral colors, lacking a hue tone, (chroma = 0) are designated with a “hue” of N and omit chroma or list it as zero (N 3/ or N 3/0).

3.1.9 *Munsell color system, n*—an ordered system to quantify and describe color based on the three qualities or attributes: *hue* (H), *value* (V), and *chroma* (C) (see Practice D1535 and Fig. 2).

3.1.9.1 *chroma (C), n*—the saturation or brilliance of a color, from 0 (no color) to ~8 (for vividly colored soils) or higher (for non-soil materials) in the *Munsell color system*.

(adapted from Ref (5))

3.1.9.2 *hue (H), n*—hue is that attribute of a color in the Munsell color system by which we distinguish red from green, blue from yellow, etc.

3.1.9.3 *Discussion*—The *Munsell color system* has principal hues of red (R), yellow (Y), green (G), blue (B), and purple (P), placed at equal intervals around a neutral point. Between the principal hues are five intermediate hues: yellow-red (YR), green-yellow (GY), blue-green (BG), purple-blue (PB) and red-purple (RP) (see Fig. 2). Munsell hue is designated with an alpha-numeric code (for example, 7.5YR).

(adapted from Ref (5))

3.1.9.4 *value (V), n*—the lightness of a color, from 0 (pure black) to 10 (pure white) in the *Munsell color system*.

(adapted from Ref (5))



NOTE 1—Photo is courtesy of USDA Natural Resources Conservation Service.
FIG. 1 Example Orange-Brown Soil Matrix Interspersed With Grey Mottles

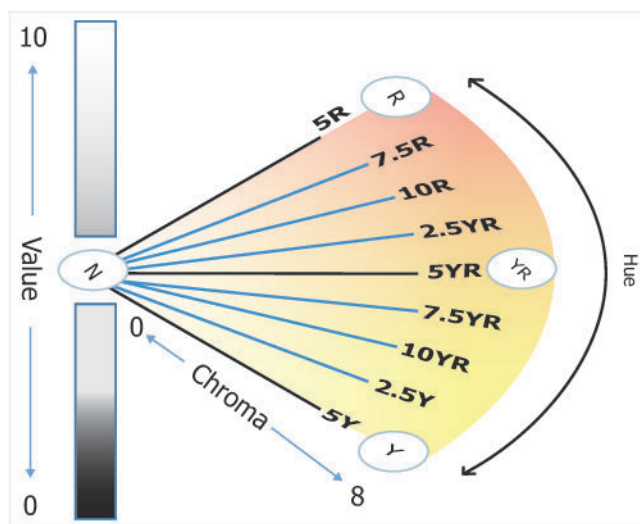


FIG. 2 Schematic Representation of the Munsell Soil Dimensions in the Hue Ranges Common in Soils

3.1.10 *questioned soil sample, n*—soil evidence of unknown origin, or *questioned soil sample*, typically consists of: debris adhering to an evidentiary object or exhibit (for example, tire, wheel well, garment, shoe, digging tool); exogenous 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 within a body (for example, nasal, stomach, or lung contents).

4. Significance and Use

4.1 Color is an easily observable characteristic of soils and is integral to the taxonomic classifications of soils (6-8); factors including parent material, hydrology, vegetation, and extent of soil weathering, can affect soil color, making color a valuable diagnostic tool for forensic examination purposes.

4.2 Soil color is sufficiently variable among soils to be used for differentiation of many soils in forensic examinations (9, 10) (see Section 6 for the test method for color determination and comparison criteria) as determined by visual characterization in the Munsell color system.

4.3 Instrumental techniques are suitable for color determination of soil evidence but are not covered within this practice.

4.4 Color determinations of soil samples are also used within soil provenance assessments to provide investigative leads or aid in searches. Interpretation of soil color for soil provenance is case-specific and beyond the scope of this practice, but the methods of color determination (6.5.1 to 6.5.2) and documentation (6.7) described here should be applied to soil color within soil provenance cases.

5. Procedure

5.1 *Preliminary Visual Examination*—Conduct a visual assessment of questioned soil samples for aggregates of varying color and texture.

5.1.1 Segregate and analyze soil aggregates of different colors, particle sizes, or morphologies separately for color determination and other subsequent analytical methods (4, 11, 12).

NOTE 1—Aggregates with distinctly different colors can indicate the presence of more than one soil source within the sample or mottling of the source material.

5.1.2 If segregation of the visually distinct soils is not possible, then the varied colors should be determined within the intact soil aggregates.

5.2 *Color Determination*—Soil colors are determined using a soil color chart as described in the test method, Section 6.

5.3 *Comparison of Soils Based on Color*—When forensic examinations of soil are conducted to determine if two or more soil samples could be derived from the same source, or alternatively exhibit exclusionary differences (6.6.2.4), compare the determined colors using the procedures and criteria in sections 6.5.3 and 6.6.2 within the included test method.

NOTE 2—When numerous known soil exemplars are collected, a visual color assessment can be used to quickly omit those known soil exemplars that differ most from the questioned soil evidence from more detailed examination. The omitted samples do not require full color documentation.

5.4 *Comparisons of Soil Color to Reference Data (Optional)*—Soil color determined in the context of a forensic examination may be compared to published reports of soil color, typically within soil surveys (13-15). Reference data may be used to describe the prevalence or rarity of a soil color within an area of interest or to aid as an investigative lead to define more likely source locations for a questioned soil.

6. Test Method — Soil Color Determination and Interpretation

6.1 Scope:

6.1.1 This test method covers color determination of evidentiary soils in a laboratory setting by visual comparison of soil samples to pigmented chips in a Munsell Soil Color Chart (16).

6.1.1.1 Munsell colors are quantitative, but discrete, when determined with a Munsell Soil Color Chart.

6.1.2 The test method provides criteria for soil color comparisons within a soil examination scheme (see 17).