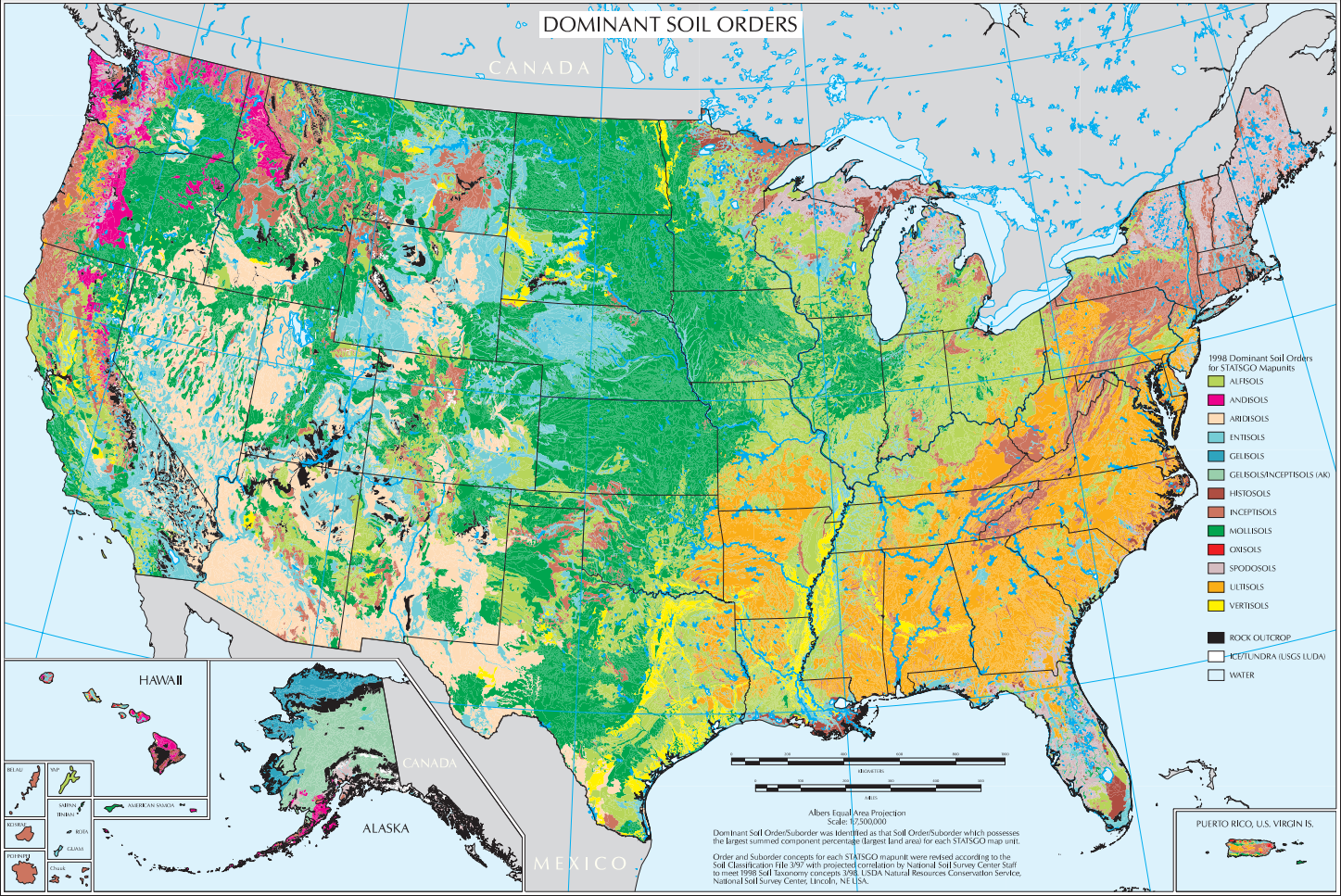
**2021 Virtual National Soil Judging Contest**



**Figure 1. Dominant soil orders of the United States of America.**

[**https://nationalsoiljudgingcontest2021.weebly.com/**](https://nationalsoiljudgingcontest2021.weebly.com/)

**April 5-16, 2021**

**PREFACE**

This handbook provides information about the 2021 National Soil Judging Contest. Much of the material comes from Regional handbooks. Other references used to develop this handbook include: Chapter 3 of the *Soil Survey Manual* (Soil Survey Division Staff, 2017), *Field Book for Describing and Sampling Soils,* version 3.0(Schoeneberger et al., 2012), *Soil Taxonomy* (Soil Survey Staff, 1999), *Keys to Soil Taxonomy* 12th Edition (Soil Survey Staff, 2014), and *National Soil Survey Handbook* (Soil Survey Staff, 1996).

We would like to welcome the teams to the virtual contest and hope that this contest will provide an educational and enjoyable experience. Many thanks to those who helped with preparations and funding for this event. We are grateful to sponsors, volunteers, coaches, and students who make this event possible.

**2021 Virtual National Soil Judging Contest Committee**

Christopher A. Baxter

Professor, Soil and Crop Science and Reclamation, Environment and Conservation (REC)

Nutrient Management Specialist, UW-Extension

University of Wisconsin-Platteville

E: [baxterch@uwplatt.edu](mailto:baxterch@uwplatt.edu)

John M. Galbraith

Associate Professor of Pedology

Virginia Tech

E: [john.galbraith@vt.edu](mailto:john.galbraith@vt.edu)

John Lawley

Research Associate

NAPT Sample Logistics Director

Utah State University

E: [john.lawley@usu.edu](mailto:john.lawley@usu.edu)

Kristopher Osterloh,

Assistant Professor of Pedology

Department of Agronomy, Horticulture, and Plant Science

South Dakota State University

E: [Kristopher.Osterloch@sdstate.edu](mailto:Kristopher.Osterloch@sdstate.edu)

Bryant C. Scharenbroch

Associate Professor of Pedology

College of Natural Resources

University of Wisconsin-Stevens Point

E: [bryant.scharenbroch@uwsp.edu](mailto:bryant.scharenbroch@uwsp.edu)

**TABLE OF CONTENTS**

|  |  |
| --- | --- |
| **Topic** | **Page** |
| Introduction | 5 |
| Role of the coach | 5 |
| Contest overview | 6 |
| Contest scoring | 8 |
| Component 1: Pedon description, classification, and interpretation | 12 |
| 1. Soil morphology | 12 |
| 1. Horizonation | 13 |
| 1. Boundary | 14 |
| 1. Texture | 15 |
| 1. Color | 15 |
| 1. Structure | 16 |
| 1. Consistence | 18 |
| 1. Soil features | 19 |
| 1. Soil profile characteristics | 21 |
| 1. Root-limiting layers | 21 |
| 1. Hydraulic conductivity | 21 |
| 1. Loading rate | 22 |
| 1. Effective soil depth | 24 |
| 1. Water retention difference | 25 |
| 1. Soil wetness class | 26 |
| 1. Site characteristics | 26 |
| 1. Parent material | 27 |
| 1. Slope profile | 28 |
| 1. Surface runoff | 29 |
| 1. Erosion potential | 30 |
| 1. Soil classification | 31 |
| 1. Epipedon | 31 |
| 1. Subsurface horizons or features | 31 |
| 1. Order | 31 |
| 1. Suborder | 31 |
| 1. Great Group | 31 |
| 1. Interpretations | 31 |
| 1. Houses with basements | 32 |
| 1. Septic tank absorption fields | 32 |
| 1. Local roads and streets | 32 |
| 1. Corn | 33 |
| 1. Hopyards | 33 |
| 1. Created wetlands | 33 |
| Component 2: Soil hand-texturing | 34 |
| Component 3: Identification of soil features | 35 |
| References | 36 |
| Appendix | 37 |

**INTRODUCTION**

A soil judging contest provides opportunities for students to study soils through direct experience in the field. Students learn to describe soil properties, identify different kinds of soils and associated landscape features, and interpret soil information for agriculture and other land uses. These skills are developed by studying a variety of soils formed from a wide range of parent materials and vegetation in different topographic settings. Students gain an appreciation for soil as a natural resource by learning about soils and their formation. We all depend on soil for growing plants, crops, and range for livestock; building materials; replenishing water supplies; and waste disposal. If we do not care for our soils, loss of productivity and environmental degradation will follow. By understanding more about soils and their management through activities like the soil contest, we stand a better chance of conserving soil and other natural resources for future generations.

Students participate in regional and national contests held annually in different states. These contests are an enjoyable and valuable learning experience, giving students an opportunity to obtain a first-hand view of soils and land use outside their home areas. As an activity within the American Society of Agronomy and the Soil Science Society of America, the United States is divided into seven regions and students from over 40 universities are involved with soil contests. Long-term sponsorship and cooperation come from the Students of Agronomy, Soils, and Environmental Sciences (SASES), the American Society of Agronomy (ASA), the Crop Science Society of America (CSSA), the Soil Science Society of America (SSSA) and the United States Department of Agriculture Natural Resource Conservation Service (USDA-NRCS).

The 2021 National Soil Judging Competition will be a virtual event and significant modifications have been made to the format of the contest while still preserving its intent.

**ROLE OF THE COACH**

The National Soil Judging Contest is a co-curricular educational event that is organized under the auspices of the American Society of Agronomy (ASA), Crop Science Society of America (CSSA), and Soil Science Society of America (SSSA). Team participation in the event requires an instructor (coach) to prepare students in the fundamentals of soil morphological description, taxonomic classification, and application of the information for land use interpretations before travelling to the host region. A particularly valuable aspect of the event is the chance to learn from a coach about soils and landscapes. It is expected therefore, that an instructor (coach) work with the students throughout the duration of the event to teach students about the geology, soil morphology, taxonomy, and interpretations. Furthermore, the instructor (coach) is needed for administration of the practice and competition aspects of the contest. The instructors (coaches) of each team form the committee that determines the rules and sets future hosts of the contest.

The coach for this contest will ensure all rules are followed which includes facilitation of all testing for the individual and group competitions of their students.

**CONTEST OVERVIEW**

The contest will consist of three components: 1) pedon description, classification, and interpretation, 2) soil hand texturing, and 3) identification of soil features.

**Component 1: Pedon description, classification, and interpretation**

Students will describe, classify, and interpret soil pedons. Soil pedon information will be compiled from disclosed or undisclosed locations throughout the USA. Coaches and other participants are encouraged to submit pedons to be included in the contest. Each pedon will include a narrative (with location, landform, and background information), an image of the landform and/or landscape, a diagram of the hillslope position, a high-quality image of the soil profile, and a partially filled in contest site card (see example in the appendix). Pedons will be selected by the contest committee to be reserved for the competition and the remaining pedons will be used for practice. Students will fill in the missing content for the pedons on the soil contest site card following the rules described in this handbook. Coaches will administer the practice and competition for the soil pedon component of the contest. This portion of the contest is open book, but limited to these resources: Keys to Soil Taxonomy, Illustrated Guide to Soil Taxonomy, Field Book for Describing and Sampling and Soils, Soil Survey Manual, the Contest Handbook, and a calculator. Student scores will be sent to the contest committee by the indicated due date.

**Component 2: Hand texturing of soil samples**

Students will determine the texture class, and also estimate sand, silt, and clay contents on soil samples. The soil samples are from disclosed or undisclosed locations throughout the USA. The samples have been sieved and dried. The amounts of sand, silt, and clay have been identified on each sample using the pipette and/or hydrometer methods. Each participating coach will receive a set of texture samples, but will not be informed of the measured values until after the competition. The samples will include practice sample and competition samples. The coach will administer the practice and competition for the hand texturing component. The texture triangle is the only allowable resource for this portion of the contest. Student scores will be sent to the contest committee by the indicated due date.

**Component 3: Identification of soil features**

Students will identify soil features and landforms from high quality pictures. Any soil features or landforms listed in the Soil Taxonomy, Keys to Soil Taxonomy, Illustrated Guide to Soil Taxonomy, Field Book for Describing and Sampling Soils may be included in the contest. Participating coaches and others are encouraged to send high quality images of soil features to the contest committee to be included in the content. The compiled images will be from disclosed or undisclosed locations throughout the USA. A portion of the images will be reserved for the competition and the remaining will be available for practice. The coach will administer the practice and competition for the soil feature identification component. Each participating coach will receive instructions for administration of the feature identification competition. This portion of the contest is closed book. Student scores will be sent to the contest committee by the indicated due date.

**Component Weighting for the Contest**

Scores from each of the three components will be compiled and then weighted (Table 1).

**Table 1. Components and weights.**

|  |  |
| --- | --- |
| **Component** | **Weight (%)** |
| Pedon description, classification, and interpretation | 60 |
| Soil hand texturing | 20 |
| Identification of soil features | 20 |

**Practice**

The Soil Judging Contest is an educational event and the practice is necessary for student learning. Coaches should work with students to practice on the three components of the contest. Practice materials for the contest will be provided to coaches or made available to coaches via the contest website.

**Individual Competition**

Students must work alone for all the individual competition aspects of the contest. Coaches will be responsible for ensuring the students work alone during these individual aspects of the contest. Any contestant found in violation of these rules will be disqualified from the contest. Up to 8 individuals are eligible for individual awards from a university. Prior to the contest, coaches will notify the host who is on their A team (scores count towards team) and who is on their B team (scores do not count towards team score). Students not on the A or B teams are welcome to also participate, but will not be eligible for individual awards.

**Group Competition**

All students from a university may participate in the group contest. A university may have as many students as they want participate in the group competition.

**Team Competition (Overall)**

The official team from a university will consist of four undergraduate students and the group. The four students for the overall team scores will be identified prior to the competition. Any number of students including those not on the official team can participate in the group portion of the contest.

**Eligibility and Qualification for the National Collegiate Soils Contest**

The 2021 National Soil Judging Contest is open to all universities and students. No restrictions on eligibility and qualification exist for this Virtual contest. Graduate students are eligible to compete in the contest. Graduate students will not compete against undergraduate students for individual awards and they can not participate on group judging with undergraduate students.

**Awards**

Recognition be given to the top 5 overall individuals, the top 3 universities in the group contest, and the top 3 overall teams. Recognition will also be given to top students, groups, and teams participating in virtual only (components 1 and 3). Plaques, trophies, etc. may be provided, depending on available funding.

**CONTEST SCORING**

**Individual Competition**

**Component 1: Pedon description, classification, and interpretation**

Each contestant will complete three pedons on the scorecards. Each contestant will have 60 minutes per site and 3 hours total for the three scorecards. The total points from the three scorecards will be summed and a percentage will be computed based on the maximum possible points available for this component (Table 2).

**Table 2. Example of weighted score for individual for component 1.**

|  |  |  |
| --- | --- | --- |
| **Pedon** | **Points awarded** | **Total points** |
| 1 | 195 | 285 |
| 2 | 275 | 320 |
| 3 | 330 | 345 |
| Total | 800 | 950 |
| Percent for component 1 | | 800 / 950 = 0.842 |
| Weighted score for component 1 | | 0.842 \* 60 = 50.52 |

**Tie Breaker Rules**

In case of a tie, the total points for the pedon 1 be used as a tiebreaker. The individual with the higher total points will win. If a tie still exists, the second pedon will be compared, followed by the third if necessary.

**Component 2: Soil hand texturing**

Contestants will submit estimates of soil texture and percentages of sand, silt, and clay for five soil texture samples using the standard scorecard. Each contestant will have 10 minutes per sample and 50 minutes total to complete the soil hand texturing. For each sample, contestants will receive 10 points for the identification of the correct soil texture class. Students will receive 5 points for each percentage of sand, silt, and clay that is within 5% of the correct value. Partial credit of 3 points will be awarded for percentages that within 6 to 8% of the correct percentage of the sand, silt, and clay. The total points from the texture samples summed and a percentage will be computed based on the maximum possible points available for this component (Table 3).

**Table 3. Example of weighted score for individual for component 2.**

|  |  |  |
| --- | --- | --- |
| **Sample** | **Points awarded** | **Total points** |
| 1 | 15 | 25 |
| 2 | 10 | 25 |
| 3 | 18 | 25 |
| 4 | 21 | 25 |
| 5 | 25 | 25 |
| Total | 89 | 125 |
| Percent for component 2 | | 89 / 125 = 0.712 |
| Weighted score for component 2 | | 0.712 \* 20 = 14.24 |

**Tie Breaker Rules**

In case of a tie, the percent clay content of the first soil texture sample will be used. The individual with the clay content closest to the actual value will win. If a tie still exists, the clay content of the second sample will be compared, followed by the third, fourth, fifth, and sixth if necessary.

**Component 3: Identification of soil features**

All contestants will submit answers on the identification of soil features. This exam will be a multiple choice exam and each contestant will receive a percentage for this component based on the number of features properly identified. Questions might also include interpretations of these soil features. Points will be assigned for each question (Table 4).

**Table 4. Example of weighted score for individual for component 3.**

|  |  |  |
| --- | --- | --- |
| **Feature** | **Points awarded** | **Total points** |
| All | 75 | 100 |
| Percent for component 3 | | 75 / 100 = 0.750 |
| Weighted score for component 3 | | 0.750 \* 20 = 15.00 |

**Tie Breaker Rules**

In case of a tie, the answer for the first question will be used. The individual with the correct response will win. If a tie still exists, the second question will be compared, followed by the third, fourth, etc. until a winner is selected.

The total points for each contestant will be summed from the three weighted components. A maximum score of 100 points can be achieved by any contestant (Table 5).

**Table 5. Example of weighted score for individual for components 1, 2, and 3.**

|  |  |
| --- | --- |
| **Component** | **Weighted score** |
| 1 | 50.52 |
| 2 | 14.24 |
| 3 | 15.00 |
| Total for Individual 1 | 79.76 |

**Group Competition**

The contest will also include a group competition in which all students may work together to complete the three components. The group competition will include two pedons, three texture samples, and a separate feature identification exam. Each group will have 30 minutes per site and 1 hour total complete the two scorecards. Each group will have 10 minutes per sample and 30 minutes total to complete the soil hand texturing. The scoring for the group competition for these components will follow the same rubrics as shown in the Individual Competition (Table 6).

**Table 6. Example of weighted score for group for components 1, 2, and 3.**

|  |  |
| --- | --- |
| **Component** | **Points** |
| 1 | 55.63 |
| 2 | 18.12 |
| 3 | 16.33 |
| Total for Group | 90.08 |

**Team Competition**

The official team from a university will consist of four undergraduate students and the group. The four students for the overall team scores will be identified prior to the competition. Any number of students including those not on the official team can participate in the group portion of the contest. The overall team score will be the sum of the four individual total scores achieved, plus the group competition score. A maximum score of 500 points can be achieved in the overall competition (Table 7).

**Table 7. Example of score for team.**

|  |  |
| --- | --- |
| **Team** | **Points** |
| Individual 1 | 79.76 |
| Individual 2 | 85.66 |
| Individual 3 | 55.21 |
| Individual 4 | 94.33 |
| Group | 90.08 |
| Total for Team | 405.04 |

**Tie Breaker Rules**

In case of a tie, the percent clay content of the first soil texture sample will be used. The mean clay content will be calculated from the estimates provided by all members of a given team. The team with the mean estimate closest to the actual value will win. For example, a tie breaker with the actual clay content of tie breaker horizon = 33% (Table 8).

**Table 8. Example of tie breaker rules.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Team #5** | **Clay (%)** | **Team #7** | **Clay (%)** |
| Individual 1 | 38 | Individual 1 | 33 |
| Individual 2 | 34 | Individual 2 | 29 |
| Individual 3 | 30 | Individual 3 | 22 |
| Individual 4 | 39 | Individual 4 | 30 |
| Mean | 35 | Mean | 29 |
| Difference | 2 | Difference | 4 |

TEAM #5 wins!. If a tie still exists, the clay content of the second sample will be compared, followed by the third, fourth, fifth, and sixth if necessary. The actual clay content of the first soil sample will be compared to that estimated by each individual or group if tied. If a tie still exists, the clay content of the clay content of the second sample will be compared, followed by the third, fourth, fifth, and sixth if necessary.

**Grading**

Component 1 materials will be double-graded with a three-team rotation. Coaches will be instructed on how this grading will be occur. Component 2 and 3 materials will be graded by the Contest Committee.

**COMPONENT 1: PEDON DESCRIPTION, CLASSIFICATION, AND INTERPRETATION**

The scorecard consists of five parts: 1) Soil Morphology; 2) Soil Profile Characteristics; 3) Site Characteristics; 4) Soil Classification; and 5) Site Interpretations. Numbers in parentheses after each item in a section indicate the points scored for one correct judgment. All boxes on the scorecard will be scored as noted in the scorecard. If no entry is needed, then the contestant should enter a dash (---). A list of acceptable abbreviations can be found in this handbook. Students must use these abbreviations. Illegible entries or any abbreviations other than those listed in this handbook will be marked wrong. If a pedon has more than one parent material or diagnostic subsurface horizon, five points will be awarded for each correct answer. In these sections of the scorecard, negative credit (minus 5 points for each extra answer, with a minimum score of zero for any section) will be used to reduce guessing. More than one entry in other items of the scorecard will be considered incorrect and will result in no credit for that item.

Students will be provided with partially filled in scorecards and need to complete the remaining portions of the scorecards with the provided information. Information that is provided on the scorecard is identified as **GIVEN** in the sections below. Students will need to fill in all other information not given.

1. **SOIL MORPHOLOGY**

For entering answers in the morphology section of the scorecard, the provided standard abbreviations (see Abbreviations page) may be used or the word(s) may be written out. Abbreviations or words that are ambiguous or may be interpreted as an incorrect answer will not receive credit. The Munsell color notation (e.g., 10YR 4/2) should be used and not the color names. The *Field Book for Describing and Sampling Soils (version 3.0, 2012)*, Chapter 3 of the *Soil Survey Manual* (1993) entitled, “Examination and Description of Soils”, and Chapter 18 of *Keys to Soil Taxonomy* 12th Edition (2012) entitled “Designations for Horizons and Layers” should be used as a guide for horizon symbols and descriptions.

**Horizonation**

Students will designate horizons. The number of horizons to be described will be provided. Capital letters are used to designate master horizons (or in some cases, transition horizons; Table 9). Lower case letters are used as suffixes to indicate specific characteristics of the master horizon and layers. Arabic numerals are used both as suffixes to indicate vertical subdivisions within a horizon or layer and as prefixes to indicate lithological discontinuities. Prime symbols following master horizons are used to indicate repeating layers separated by a different horizon and carets are used before the master horizon to indicate human transported materials. Although Histosols will not be included in this contest, organic soil materials and organic horizons may exist. Organic horizons will be distinguished by the organic carbon and rubber fiber content. Structure and consistence will not be listed for organic horizons if they are present.

**Table 9. Accepted horizon designators for scorecard Section A and their descriptions.**

|  |  |
| --- | --- |
| **Horizon Designation** | **Description** |
| Prefix | Lithological discontinuities will be shown by the appropriate Arabic numeral(s) or Caret (^) symbol (included in Master Horizon box). If no discontinuities exist in the profile, enter a dash. A dash or blank will receive credit where there is no prefix on the master horizon and should be used in lieu of the Arabic number one, which will receive no credit. |
| Master | The appropriate master horizon (O, A, E, B, C, and R), as well as any transitional horizons (e.g., EB) or horizons having dual properties of two master horizons (e.g., B/E, B and E) should be entered as needed.  Primes ( ′ ) are added after the master horizon on the lower of two horizons having identical master and subordinate distinction designations, but which are separated by a different kind of horizon (e.g. B′ t is correct, Bt′ is not).  Carets ( ^ ) are added before the master horizon to indicate human transported materials (HTM). Carets should be added to all horizons that have been human transported. |
| Subordinate Distinction  (Subscript) | Enter the appropriate lower case letter or letters, according to the definitions given in Chapter 18 of *Keys to Soil Taxonomy* (2014). If used in combination, the subscripts must be written in the correct sequence in order to receive full credit. If a subordinate distinction (subscript) is not applicable, enter a dash in the box. |
| Number | Arabic numerals are used as suffixes to indicate vertical subdivisions within a horizon or layer. Sequential subhorizons having the same master horizon and subordinate distinction designations should be numbered to indicate the vertical sequence. Where no suffixes are required, a dash should be entered on the scorecard. Note that the numbering of vertical subdivisions within a horizon is not interrupted at a lithological discontinuity if the same master horizon and subordinate distinction is used in both materials (e.g., Bt1-Bt2-2Bt3-2Bt4). |

**Boundary**

**Depth of Lower Boundary – GIVEN**

Boundary depths will be given. The depth (cm) from the mineral soil surface to the middle of the lower boundary of each horizon will be listed. If the total soil profile depth corresponds to the lower boundary of the last horizon, the horizon boundary depth is noted. Otherwise, a dash or the total soil profile depth with a + sign (e.g., 100+) will be entered on the scorecard. Boundary measurements are made at the center of the boundary separating the two horizons, particularly when the boundary distinctness is not abrupt. If a lithic or paralithic contact occurs at or above the specific observation depth, the contact should be marked as a subsurface feature in Part D of the scorecard and should be considered in evaluating the hydraulic conductivity, effective rooting depth, and water retention. Otherwise, the lowest horizon should be mentally extended to a depth of up to 200 cm for all relevant evaluations. When a lithic or paralithic contact occurs within the specified observation depth, the contact should be considered as one of the requested horizons, and the appropriate horizon nomenclature should be applied (e.g., Cr or R). However, morphological features of Cr or R layers need not be provided in Part A of the scorecard. If the contestant gives morphological information for a designated Cr or R layer, the information will be ignored and will not count against the contestant’s score. If contestants are unsure if a layer is a Cr, they are encouraged to complete the morphological information for that layer. Lab data (% organic carbon, % base saturation) will not be provided for Cr or R layers, but will instead be dashed on the pit card.

**Distinctness of Boundary – GIVEN**

Boundary distinctness will be given. The distinctness of boundaries separating various soil horizons must be described if they fall within the designated profile depth indicated by the official judges for each site. Categories of distinctness of soil boundaries are shown in Table 3. Very abrupt boundaries will be considered abrupt for the purposes of the contest. No boundary distinctness designator should be given for the last horizon, unless a lithic or paralithic contact exists at the lower boundary. A dash is acceptable for distinctness of the last horizon to be described when a lithic or paralithic contact is not present.

**Table 10. Soil horizon boundary distinctness categories.**

|  |  |  |
| --- | --- | --- |
| **Category** | **Symbol** | **Boundary Distinctness** |
| Abrupt | A | < 2 cm |
| Clear | C | 2 to < 5 cm |
| Gradual | G | 5 to < 15 cm |
| Diffuse | D | ≥ 15 cm |

**Texture**

**Sand, Silt, and Coarse Fragments – GIVEN**

Estimates for percent sand, silt, and coarse fragments will be given.

**Percent Clay**

Students will need to determine and record the clay percentage.

**Coarse Fragment Modifier**

Students will record the appropriate coarse fragment modifier if needed. Modifications of texture classes are required whenever coarse fragments > 2 mm occupy more than 15% of the soil volume. Adjectives are used based on the size of the coarse fragments according to table below. For a mixture of sizes (e.g. both gravels and stones present), the largest size class is generally named. A smaller size class is named only if its quantity (%) exceeds 2 times the quantity (%) of a larger size class. The total rock fragment volume is used (i.e. sum of all the separate size classes) to determine which modifier goes with the fragment term (e.g. none, very, or extremely). See table 11 below for modifiers and their associated percentages. For example, a horizon with 30% gravel and 14% stones (44% total fragments) would be named very gravelly (VGR), but only 20% gravel and 14% stones (34% total fragments) would be named stony (ST).

**Table 11. Coarse fragment modifier size and shape requirements and symbols.**

|  |  |  |
| --- | --- | --- |
| **Size (diameter or longest dimension)** | **Adjective** | **Symbol** |
| Spherical or equiaxial | | |
| 0.2 to 7.5 cm | Gravelly | GR |
| 7.6 to 25.0 cm | Cobbly | CB |
| 25.1 to 60 cm | Stony | ST |
| >60 cm | Bouldery | BD |
| Flat | | |
| 0.2 to 15 cm | Channery | CH |
| 15.1 to 38.0 cm | Flaggy | FL |
| 38.1 to 60 cm | Stony | ST |
| >60 cm | Bouldery | BD |

**Table 12. Rock fragment modifiers by percent rock fragment (> 2mm) present by volume.**

|  |  |
| --- | --- |
| **Percent rock (by volume)** | **Rock fragment modifier** |
| < 15 % | No special term used with the soil textural class. Enter a dash or leave blank. |
| 15 to 34 % | Use size adjective “gravelly, cobbly, stony, bouldery, channery, or flaggy” |
| 35 to 59 % | Use “very (V) + gravelly, cobbly, stony, bouldery, channery, or flaggy” |
| 60 to 90 % | Use “extremely (X) + gravelly, cobbly, stony, bouldery, channery, or flaggy” |

**T**e**xture Class**

Students will determine the soil texture class. Texture classes are those defined in the *Soil Survey Manual* (1993). Any deviation from the standard nomenclature will be considered incorrect (e.g., silty loam). Sandy loam, loamy sand, and sand should be further specified if the soil is dominated by a particular sand size other than medium sand (see list under Abbreviations). Very coarse sand should be included with coarse sand for this contest.

**Color – GIVEN**

Munsell soil color will be given. Munsell soil color is the the moist soil matrix color for each horizon described. Color is designated by hue, value, and chroma. More than one color may be listed for a horizon. Color is described for each horizon by selecting soil material to represent that horizon. The color of the surface horizon is determined on a moist, rubbed (mixed) sample. For lower horizons (in some soils this will also include the lower portion of the epipedon), selected peds are collected from near the central part of the horizon and broken to expose the matrix. If peds are dry, they should be moistened before the matrix color is determined. Moist color is that color when there is no further change in soil color when additional water is added. For Bt horizons with continuous clay films, care is taken to ensure that the color of a ped interior rather than a clay film is described for the matrix color. The dry color may be provided if it may affect the classification of a horizon. For the purposes of this contest, horizons meeting the minimum percent organic carbon criteria for mollic epipedons will be assumed to also meet the minimum dry color values required for mollic epipedons.

**Structure**

Soil structure will be given. Soil structure refers to the aggregation of primary soil particles into secondary compound groups or clusters of particles. These units are separated by natural planes, zones, or surfaces of weakness. Dominant type (formerly called shape) and grade of structure for each horizon are described. If the horizon lacks definite structural arrangements or if there is no observable aggregation, “0 (structureless)” is recorded in the grade column and either “MA (massive)” or “SGR (single grain)” (whichever is appropriate) is recorded in the type column. If various types of structure exist within the horizon, the type and grade of structure that is most common. Compound structure (e.g., prismatic parting to angular or subangular blocky structure) is common in the horizons of many soils. In this case, structure having the stronger grade should is described. If the structures are of equal grade, the structure type with the largest peds is described. The term "blocky" always requires a modifier, either angular or subangular blocky.

**Grade – GIVEN**

The grade of structure is the distinctness of the aggregates and their durability (Table 13). Expression of structure grade is often moisture dependent and so may change with drying of the soil.

**Table 13. Soil structure grades, symbols, and descriptions.**

|  |  |  |
| --- | --- | --- |
| **Grade** | **Symbol** | **Description** |
| Structureless | 0 | That condition in which there is no observable aggregation or no definite, orderly arrangement of natural lines of weakness. |
| Weak | 1 | Soil breaks into a very few poorly formed, indistinct peds, most of which are destroyed in the process of removal. Type of structure is barely observable in place. Clay coatings, if present, are thin and ped interiors look nearly identical to outer surfaces. |
| Moderate | 2 | Soil contains well-formed, distinct peds in the disturbed soil when removed by hand. They are moderately durable with little unaggregated material. The type of structure observed in the pit face may be indistinct. |
| Strong | 3 | Durable peds are very evident in undisturbed soil of the pit face with very little or no unaggregated material when peds are removed from the soil. The peds adhere weakly to one another, are rigid upon displacement, and become separated when the soil is disturbed. |

**Type – GIVEN**

Types of soil structure are described below (Table 14) and on page 2-53 in *Field Book for Describing and Sampling Soils, version 3.0, 2012*.

**Table 14. Soil structure types, symbols, and descriptions.**

|  |  |  |
| --- | --- | --- |
| **Type** | **Symbol** | **Description** |
| Granular | GR | Spheroids or polyhedrons bounded by curved planes or very irregular surfaces, which have slight or no accommodation to the faces of surrounding peds. For the purposes of this contest crumb structure is included with granular structure. |
| Subangular Blocky | SBK | Polyhedron-like structural units that are approximately the same size in all dimensions. Peds have mixed rounded and flattened faces with many rounded vertices. These structural units are casts of the molds formed by the faces of the surrounding peds. |
| Angular Blocky | ABK | Similar to subangular blocky but block-like units have flattened faces and many sharply angular vertices. |
| Platy | PL | Plate-like with the horizontal dimensions significantly greater than the vertical dimension. Plates are approximately parallel to the soil surface. This does not apply to weathered rock structure. |
| Wedge | WEG | Elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides. Wedges are not limited to vertic materials. |
| Prismatic | PR | Prism-like with the two horizontal dimensions considerably less than the vertical. Vertical faces are well defined and arranged around a vertical line with angular vertices. The structural units have angular tops. |
| Columnar | COL | Same as prismatic but with rounded tops or caps. |
| Massive | MA | No structure is apparent and the material is coherent. The individual units that break out of a profile have no natural planes of weakness. |
| Single-grained | SGR | No structure is apparent. Soil fragments and single mineral grains do not cohere (e.g., loose sand). In some cases where weak cohesive/adhesive forces with water exist, some seemingly cohesive units can be removed. However, under very slight force, they fall apart into individual particles. |
| Rock structure | RS | Having retained the character of the parent material; most (>50%) of the rock structure must be retained. |

**Consistence**

**Moist strength - GIVEN**

Moist strength is given. Soil consistence refers to the resistance of the soil to deformation or rupture at a specified moisture level and is a measure of internal soil strength. Consistence is largely a function of soil moisture, texture, structure, organic matter content, and type of clay, as well as adsorbed cations. As field moisture will affect consistence, contestants should use their personal judgment to correct for either wet or dry conditions on the day of the contest. These corrections also will be made by the official judges. Consistence is the rupture resistance of moist soil (midway between air-dry and field-capacity) for a ped or soil fragment from each horizon as outlined in the *Field Book for Sampling and Describing Soils, 2012* and Table 8.

**Table 15. Moist rupture resistance classes, symbols, and descriptions.**

|  |  |  |
| --- | --- | --- |
| **Class** | **Symbol** | **Description** |
| Loose | L | Soil is non-coherent (e.g., loose sand). |
| Very Friable | VFR | Soil crushes very easily under very slight force (gentle pressure) between thumb and finger but is coherent when pressed. |
| Friable | FR | Soil crushes easily under slight force (gentle to moderate pressure) between thumb and forefinger and is coherent when pressed. |
| Firm | FI | Soil crushes under moderate force (moderate pressure) between thumb and forefinger, but resistance to crushing is distinctly noticeable. |
| Very Firm | VFI | Soil crushes or breaks only when strong force is applied between thumb and all fingers on one hand. |
| Extremely Firm | EF | Soil cannot be crushed or broken by strong force between thumb and all fingers but can be by applying moderate force between hands. |
| Slightly Rigid | SR | Soil cannot be crushed by applying moderate force between hands but can be by standing (entire body weight on one foot) on the structural unit. |
| Rigid | R | Soil cannot be crushed by standing on it with one body weight but can be if moderately hit with hammer. |
| Very Rigid | VR | Soil requires heavy, strong blow(s) with hammer to crush. |

**Soil Features**

**Redoximorphic Features – GIVEN**

Redoximorphic (redox, RMF) features are given. Redox features are caused by the reduction and oxidation of iron and manganese associated with soil wetness/dryness and NOT rock color. Characteristic color patterns are created by these processes. Redox features are colors in soils resulting from the concentration (gain) or depletion (loss) of pigment when compared to the soil matrix color. Reduced iron (Fe2+) and manganese (Mn2+) ions may be removed from a soil if vertical or lateral fluxes of water occur. Wherever iron and manganese is oxidized and precipitated, they form either soft masses or hard concretions and nodules. Redox features are used for identifying aquic conditions and determining soil wetness class. For this contest, only the presence or absence of redoximorphic features (Y or N [will also allow a dash or blank]) in terms of redox concentrations and redox depletions will be given. Movement of iron and manganese as a result of redox processes in a soil may result in redoximorphic features that are defined as follows:

1. Redox concentrations – These are zones of apparent pedogenic accumulation of Fe-Mn oxides, and include: nodules and concretions (firm, irregular shaped bodies with diffuse to sharp boundaries; masses (soft bodies of variable shapes in the soil matrix; zones of high chroma color (“red” for Fe and “black” for Mn); and pore linings (zones of accumulation along pores). Dominant processes involved are chemical dissolution and precipitation; oxidation and reduction; and physical and/or biological removal, transport, and accrual. Yes (Y) indicates that RMF concentrations are present. No (N, blank, or -) indicates RMF concentrations are not present.
2. Redox depletions – These are zones of low chroma (2 or less) and normally high value (4 or more) where either Fe-Mn oxides alone or Fe-Mn oxides and clays have been removed by eluviation. Yes (Y) indicates that RMF depletions are present. No (N, blank, or -) indicates RMF depletions are not present.

For the purposes of the contest, only depletions of chroma 2 or less and value of 4 or more will be described and used in identifying depth to seasonal high water table and “Aqu-” suborders. Horizons with a depleted matrix (meeting these color requirements) due to wetness (i.e. Bg horizons) should also be marked as having depletions present. Low chroma (≤ 2) in the soil may be due to drainage, parent material, or other features. However, parent material variations and other such features should not be considered in evaluating soil wetness or soil drainage characteristics. Colors associated with the following features will not be considered as redox features: carbonates, concretions, nodules, krotovinas, rock colors, roots, or mechanical mixtures of horizons such as B horizon materials in an Ap horizon. Redox features can be retained as relic features in soils (now called “mottles”) from prior soil moisture regimes. A soil must have current hydrologic conditions (e.g., water table, landscape position, etc.) needed for redox features to be marked with a “Y” in this contest. If no redox features are present, enter an “N” or dash. Specific definitions may be found in *Soil Taxonomy* (1999) in the “Aquic Conditions” section of “Other Diagnostic Soil Characteristics.”

**Effervescence – GIVEN**

Effervescence is given. Effervescence is the the gaseous response (seen as bubbles) of HCl applied to soil, which is used to test for the presence of carbonates. Effervescence is tested and described according to the *Field Book for Sampling and Describing Soils, 2012.* 1N HCl is added to a small sample of each horizon and the resulting reaction recorded (Table 16). Only the soil matrix should be tested and visible carbonate masses should be avoided (visible carbonate masses are denoted separately by using the subscript “k” on the horizon).

**Table 16. Effervescence classes, abbreviations, and criteria.**

|  |  |  |
| --- | --- | --- |
| **Effervescence Class** | **Abbreviation** | **Criteria** |
| Noneffervescent | NE | No bubbles form. |
| Very Slightly Effervescent | VS | Few bubbles form. |
| Slightly Effervescent | SL | Numerous bubbles form. |
| Strongly Effervescent | ST | Bubbles form a low foam. |
| Violently Effervescent | VE | Bubbles rapidly form a thick foam. |

1. **SOIL PROFILE CHARACTERISTICS**

**Hydraulic Conductivity**

In this contest, the vertical, saturated hydraulic conductivity of the surface horizon (Hydraulic Conductivity/ Surface Horizon) and the most limiting horizon (Hydraulic Conductivity/Limiting Layer) within the depth specified to be described by the official judges will be estimated. "Limiting layer" refers to the horizon or layer with the slowest hydraulic conductivity. Not all root-limiting layers act the same with respect to hydraulic conductivity. If a lithic, manufactured layer, or paralithic contact occurs at or above the specified observation depth and redox depletions are present in the overlying horizon, the hydraulic conductivity for the limiting layer is low. Also, the hydraulic conductivity for the limiting layer is low if a fragipan, densic materials or cemented horizons that are continuous (90% or more lateral continuity) occur at or above the specified observation depth. In some soils, the surface horizon is the limiting horizon with respect to saturated hydraulic conductivity. In this case, the surface hydraulic conductivity would be reported in two places on the scorecard. For a discussion of factors affecting hydraulic conductivity, refer to the *Soil Survey Manual* (1993). The hydraulic conductivity classes, flow estimates, and descriptions of included soil textural classes and profile features for each hydraulic conductivity class used in this contest are found in Table 17.

**Table 17. Hydraulic conductivity classes, flow rates and descriptions.**

|  |  |  |
| --- | --- | --- |
| **Class** | **Hydraulic Conductivity** | **Description** |
| High | >10 μm/s | Textures of coarse sand, sand, fine sand, very fine sand, loamy coarse sand, loamy sand, loamy fine sand, loamy very fine sand, and coarse sandy loam; *or* horizons containing large quantities of rock fragments and insufficient fines to fill many voids between the fragments are also in this class; *or* organic horizons |
| Moderate | 0.1 to 10 μm/s | Includes those materials excluded from “High” and “Low” classes. |
| Low | < 0.1 μm/s | Includes: 1) Textures of clay, silty clay, and sandy clay that have moderate or weak structure, or are massive, 2) Silty clay loams and clay loams that have weak structure or are massive, 3) Cemented horizons and contacts with cemented horizons (B…m) with 90% or more lateral continuity, 4) Cr, R or M layers where the horizon directly above contains >2% redoximorphic depletions or a depleted matrix due to saturation and reduction (value ≥4 with chroma ≤2); and 5) fragipan, densic materials, and permafrost. |

**Loading Rate**

Many rural homes use septic system and loading rate defines the rate wastewater enters the soil. The differences in wastewater loading rates are related to soil hydraulic conductivity and pore sizes and pore size distribution. Individual states and some counties have developed loading rate tables based on soil morphologic features. In this contest we will use the criteria in Table 18 which is a simplified version of the Illinois and Wisconsin state codes. To simplify things and save time we will not evaluate every horizon in this contest. We will only evaluate the loading rate for the material at 75 cm (including a Cr or R, if present, at 75 cm.) If the lower boundary of a horizon falls exactly on 75 cm, use that horizon. To use the loading rate table first identify the row with texture and then identify the column using structure and consistence. To receive full credit for loading rate, contestants must indicate the correct loading rate, and the appropriate row/column reference from the table. For example, for a sandy loam formed in till and having moderate, subangular blocky structure and friable consistence, a contestant would receive full credit if they indicated a loading rate of 0.84gpd/ft2 and Ref. D4.

**Table 18. Loading rate.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Onsite Wastewater Loading Rates at 75 cm (gal/day/ft2)** | | | | | | | | | |
| Structure shape  | | SGR  PL  RS\* | GR, SBK, ABK, WEG, PR | | | | MA  (Massive) | | |
| Structure grade  | | any | Weak  (Grade 1) | | Moderate or Strong  (Grade 2 or 3) | | None (Grade = 0) | | |
| Moist consistence  | | any | L  VFR  FR | FI  VFI  EFI | VFR  FR | FI  VFI  EFI | VFR | FR | FI  VFI  EFI |
| Row  Reference  | Column  Reference  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Texture  | NR = *not recommended or not applicable* | | | | | | | |
| A | Organic materials  Densic materials  Fragipan  Cr horizon  R horizon  Continuous cemented horizons (B…m)  Permafrost  > 35% RFʈ |
| B | S  COS  VCOS  LCOS  LS | 1 | 1 | NR | NR | NR | 1 | NR | NR |
| C | FS  LFS  COSL | 0.84 | 0.91 | NR | NR | NR | 0.91 | 0.84 | NR |
| D | SL  FSL | 0.75 | 0.75 | NR | 0.84 | NR | 0.84 | 0.75 | 0.69 |
| E | L  SIL  VFSL  SCL  SI  VFS  LVFS | 0.62 | 0.69 | 0.62 | 0.75 | 0.52 | 0.62 | 0.52 | 0.45 |
| F | SICL ( 35% clay)  CL ( 35% clay) | 0.52 | 0.52 | 0.45 | 0.62 | 0.52 | 0.52 | 0.45 | 0.27 |
| G | SICL (> 35% clay)  CL (> 35% clay) | NR | NR | 0.4 | 0.45 | 0.4 | NR | 0.2 | NR |
| H | SC, SIC, C | NR | NR | NR | NR | 0.2 | NR | NR | NR |

**\***Rock structure **ʈ**Rock fragments

**Effective Soil Depth**

The depth of soil to a root-limiting layer, or effective soil depth, is the depth of soil that can be easily penetrated by plant roots. Soil materials must be loose enough so that roots do not experience severe physical resistance and yet fine enough to hold and transmit moisture. Horizons that provide physical impediments to rooting limit the effective depth of the soil. For this contest, the following are considered root-limiting layers: densic materials, a duripan; a fragipan; petrocalcic, petrogypsic, and placic horizons; continuous ortstein (i.e., 90 percent or more cemented and has lateral continuity); and lithic, paralithic, and petroferric contacts. The depth to a root-limiting layer is measured from the soil surface. The presence or absence of roots may be helpful in determining the effective soil depth, but should not be used as the sole indicator. In many cases, the plants growing at the site may be shallow rooted or, conversely, a few roots may penetrate into or through the restrictive layer, particularly along fractures or planes of weakness, but any roots should be >10cm apart for the layer to be considered restrictive. A soil is considered very deep if no root-limiting layers appear in the upper 150 cm (Table 19). If the profile is not visible to a depth of 150 cm, or if you are requested to describe a soil only to a shallower depth, then you may assume that the conditions present in the last horizon described extend to 150 cm (unless a lithic or paralithic contact occurs at the observation depth).

**Table 19. Soil depth classifications based upon depth to root**-**limiting feature.**

|  |  |
| --- | --- |
| **Depth Class** | **Depth to Root-limiting Feature** |
| Very shallow | <25 cm |
| Shallow | 25 to 49 cm |
| Moderately deep | 50 to 99 cm |
| Deep | 100 to 149 cm |
| Very Deep | ≥150 cm |

**Water Retention Difference**

Water retention difference refers to the soil water held between -33 kPa (field capacity) and -1500 kPa (permanent wilting point), which approximates the range of available water for plants. This depends on the effective depth of rooting, the texture of the fine earth fraction (< 2 mm) (Table 19), and the content of rock fragments in the soil. The amount of available water stored in the soil is calculated for the top 150 cm of soil or to a root-limiting layer, whichever is shallower. Total available water holding capacity is calculated by summing the amount of water held in each horizon (or portion of a horizon if it extends below 150 cm). If the depth designated for describing soil morphology is less than 150 cm, contestants should assume that the water retention properties of the last horizon extend to 150 cm or to the top of a root-limiting layer, if either feature is observed at a depth shallower than 150 cm. Root-limiting layers and all horizons below should be excluded when calculating the available water holding capacity. For natric horizons and fragipans, and all horizons below the natric horizons and fragipans, the available water content is reduced by 50%. Rock fragments are assumed to hold no water that is available for plant use. If a soil contains rock fragments, the volume occupied by the rock fragments must be estimated and the available water holding capacity corrected accordingly. For example, if a silt loam A horizon is 25 cm thick and contains coarse fragments occupying 10% of this volume, the available water holding capacity of that horizon would be 4.5 cm of water rather than 5.0 cm (25 cm \* 0.20 cm water/cm soil \* 90% fine fraction = 4.5 cm).

**Table 20. Soil texture and water retention difference values.**

|  |  |
| --- | --- |
| **Texture class** | **Water retention (cm water / cm soil)** |
| All sands and loamy coarse sand | 0.05 |
| Loamy sand, loamy fine sand, loamy very fine sand, and coarse sandy loam | 0.10 |
| Sandy loam, fine sandy loam, sandy clay loam, sandy clay, silty clay, and clay | 0.15 |
| Very fine sandy loam, loam, silt loam, silt, silty clay loam, clay loam, and organic soil materials | 0.20 |

Once the water retention difference is calculated for the appropriate soil profile depth, the water retention class can be determined using Table 21. An example water retention difference calculation and classification for a theoretical soil profile can be found in Tables 22 and 23.

**Table 21. Water retention difference class based upon amount of plant available water to 150 cm.**

|  |  |
| --- | --- |
| **Water Retention Class** | **Plant available water (cm water / 150 cm soil)** |
| Very low | <7.5 cm |
| Low | 7.5 to <15.0 cm |
| Moderate | 15 to <22.5 cm |
| High | ≥22.5 cm |

**Table 22. Theoretical profile for calculating water retention difference.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Horizon** | **Depth (cm)** | **Texture class** | **Rock fragment (%)** |
| A | 20 | SL | 5 |
| Bt1 | 60 | CL | 10 |
| Bt2 | 80 | L | 10 |
| 2C | 150 | S | 50 |

**Table 23. Sample of calculation of water retention difference for a theoretical profile.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Horizon** | **Thickness (cm)** | **Water Retention** | **RF ʈ Correction** | **cm of water** |
| A | 20 | 0.15 | 0.95 | 2.9 |
| Bt1, Bt2 | 60 | 0.20 | 0.90 | 10.8 |
| 2C | 70 | 0.05 | 0.50 | 1.8 |
| Total | | | | 15.5 |

**ʈ** Rock fragments

**Soil Wetness Class**

The soil wetness class will be determined by the depth to seasonal high water table as defined in the *Soil Survey Manual* (1993) (Table 24). Soil wetness is a reflection of the rate at which water is removed from the soil by both runoff and percolation. Position, slope, infiltration rate, surface runoff, hydraulic conductivity (permeability), and redoximorphic features are significant factors influencing the soil wetness class. The depth to chroma ≤ 2 and value ≥ 4 redox features due to wetness (depletions or reduced matrix) will be used as a criterion to determine the depth of the wetness class for this contest.

**Table 24. Soil wetness classes based upon depth to pertinent wetness features.**

|  |  |
| --- | --- |
| **Class** | **Depth to wetness features from soil surface (cm)** |
| 1 | >150 |
| 2 | 100 to 150 |
| 3 | 50 to 99 |
| 4 | 25 to 49 |
| 5 | <25 |

1. **SITE CHARACTERISTICS**

**Landform – GIVEN**

Landform will be given. A landform is a physical, recognizable form or feature of the Earth’s surface that usually has a characteristic shape and is produced by natural causes. Parent materials are often associated with particular landforms. Only one landform should be identified at each site.

**Parent Material - GIVEN**

Parent materials will be given. Parent material refers to the material in which soils form. Parent materials include bedrock, various kinds of sediments, and "pre-weathered" materials. Soils may be developed in more than one parent material, and this should be indicated on the scorecard. For this contest, a parent material should be ≥30 cm thick if it is on the surface or ≥10 cm thick if at least 30 cm below the soil surface to be indicated on the scorecard. A different parent material should only be indicated for the bottom horizon if at least 10cm of material is located above the depth to be described.

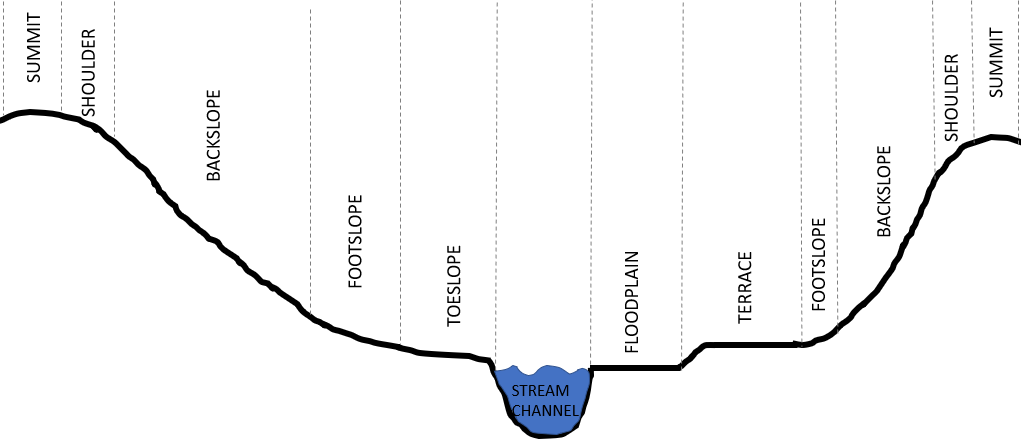
**Slope – GIVEN**

Slope will be given. Slope refers to the inclination of the ground surface and has length, shape, and gradient. Gradient is usually expressed in percent slope and is the difference in elevation, in length units, for each one hundred units of horizontal distance. Slope are measured by an Abney level or by a clinometer. Slope classes are based on the gradient.

**Slope Profile**

Hillslope position represents the two-dimensional geomorphic segment of the topography on which the soil is located (Table 25). These slope components have characteristic geometries and greatly influence soils through differences in slope stability, water movement, and other slope processes. Not all profile elements may be present on a given hillslope. The landscape unit considered when evaluating hillslope profile position should be relatively large and include the soil pit and/or the area between the slope stakes. Minor topographic irregularities are not considered for this contest. Illustrations of simple hillslope profile components can be found in Figure 2.

**Figure 2. Hillslope profile components of a typical landscape.**



**Table 25. Hillslope profile positions and descriptions.**

|  |  |
| --- | --- |
| **Hillslope Position** | **Description** |
| Summit | Highest level of an upland landform with a relatively gentle, planar slope, typically less than 2%. The summit is often the most stable part of a landscape. Not every hillslope has a summit, as some hillslopes have shoulders at the crest of the hill. |
| Shoulder | Rounded (convex-up) hillslope component below the summit. The shoulder is the transitional zone from the summit to the backslope and is erosional in origin. |
| Backslope | Steepest slope position that forms the principal segment of many hillslopes. The backslope is commonly linear along the slope, is located between the shoulder and the footslope positions, and is influenced by a mix of erosional and depositional processes. |
| Footslope | Slope position at the base of a hillslope that is generally formed by deposition of sediments originating on the slopes above. The footslope should be concave and located at the base of gentle to steep slopes. |
| Toeslope | Lowest landform component that extends away from the base of the hillslope. Toeslopes typically have a slope <2%. |
| None (gradient <2%) | This designation should only be used when the slope at the site is < 2%, and the site is not in a well-defined example of one of the slope positions given above (e.g., within a terrace or floodplain of large extent). |

**Surface Runoff**

Surface runoff refers to the relative rate at which water is removed by overland flow. Soil characteristics, management practices, climatic factors (e.g., rainfall intensity), vegetative cover, and topography determine the rate and amount of runoff. In this contest, six runoff classes as described in the *Soil Survey Manual* (1993) will be used (Tables 26 and 27). Contestants should consider vegetative cover quantity and quality to determine the runoff class. Where good vegetative cover (bare soil generally not visible below cover) OR an O horizon is present, contestants should mark the next slower surface runoff class (up to very low). Contestants should mark Ponded for sites in a depression with no surface runoff. Brief descriptions of the six runoff classes used in this contest can be found in Table 28.

**Table 26. Surface runoff classes in relation to slope and surface hydraulic conductivity.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Slope** | **Limiting hydraulic conductivity within 50 cm of soil surface** | | |
| **High** | **Moderate** | **Low** |
| Depression | Ponded | Ponded | Ponded |
| 0-<2% slope | Very slow | Slow | Slow |
| ≥2-6% slope | Slow | Slow | Medium |
| ≥6-12% slope | Medium | Medium | Rapid |
| ≥12-20% slope | Rapid | Rapid | Very Rapid |
| ≥20% slope | Rapid | Very Rapid | Very Rapid |

**Table 27. Surface runoff classes and descriptions.**

|  |  |
| --- | --- |
| **Runoff Class** | **Description** |
| Ponded | Added water flows away very slowly and free water lies on the soil surface for very long periods. Most of the water enters and passes through the soil or evaporates. |
| Very Slow | Added water flows away so slowly that free water lies on the surface for long periods. Much of the water enters and passes through the soil or evaporates. Fairly open and porous soils in which the water enters immediately are also considered to have very low runoff. Soils with very low runoff are commonly nearly level to gently sloping depending on the surface hydraulic conductivity. |
| Slow | Added water flows away so slowly that free water covers the soil for brief, periods or a large part enters the soil in the case of sandy or porous soils. Soils with low runoff can be found in nearly level to strongly sloping depending on the surface hydraulic conductivity (See Table 19). There is usually little or no erosion problem. |
| Medium | Added water flows away at such a rate that moderate amounts enter the soil and free water lies on the surface for a very brief period. These soils are usually gently sloping or moderately sloping, but can be found in all slope classes depending on the surface hydraulic conductivity. |
| Rapid | A large portion of added water moves rapidly over the surface with only a small part entering the soil. These soils may be on gently sloping to steep slopes depending on the surface hydraulic conductivity. |
| Very Rapid | A small part of the added water enters the soil and surface water runs off as fast as it is added. These soils are on moderately sloping to steep slopes depending on the surface hydraulic conductivity. |

**Soil Erosion Potential**

Soil erosion potential refers to the likelihood of soil erosion by water. The potential for future erosion losses is influenced mainly by the texture of the surface soil and the amount of surface runoff at a site. Soil erosion potential is estimated using Table 28. Very fine, fine, and coarse sand-modified textural classes are included with their medium sand equivalent classes.

**Table 28. Soil erosion potential classes in relation to surface runoff and surface horizon texture.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Surface Runoff** | **Surface Horizon Texture** | | | |
| **S, LS, Organic** | **SCL, SC** | **SL, CL, C, SIC** | **L, SI, SIL, SICL** |
| Ponded | Very Low | Very Low | Very Low | Very Low |
| Very slow | Very Low | Very Low | Low | Medium |
| Slow | Very Low | Low | Medium | Medium |
| Medium | Very Low | Low | Medium | High |
| Rapid | Low | Medium | High | Very High |
| Very Rapid | Medium | High | Very High | Very High |

1. **SOIL CLASSIFICATION**

This section includes identification of the soil taxonomic class. The reference used in this section are the *Keys to Soil Taxonomy,* 12th Edition (Soil Survey Staff, 2014) and, or the *Illustrated Guide to Soil Taxonomy*, Version 2.0(Soil Survey Staff, 2015). Students may use either or both of these reference materials to classify the soil. Contest pedons will be selected to ensure the same classification is attained using both of these reference materials.

**Epipedon**

Identify and list the epipedon from choices shown in Appendix 2. For example: Ochric.

**Subsurface Horizon and/or Diagnostic Features**

Identify and list all subsurface diagnostic horizons and/or features from those listed in Appendix 2. For example: Albic and Argillic.

**Order**

Identify and list the soil Order. Pay special attention to the check depth for suspected Ultisols and Mollisols. For example: Alfisol.

**Suborder**

Identify and list the soil Suborder. For example: Udalf.

**Great Group**

Identify and list the soil Great Group. For example: Hapludalf.

1. **SITE INTERPRETATIONS**

This section illustrates applications of soil information to land use. For this contest, there will be six interpretations determined for each soil described: 1) dwellings with basements, 2) septic tank absorption fields, 3) the local roads and streets, 4) corn, 5) hopyards, and 6) created wetlands. The interpretations involve the determination of the degree of limitation within each soil for a specific use. The most restrictive property determines the limitation rating. In cases where the depth to be described does not extend to the required interpretive depth in the table (e.g., 150 cm for some criteria), contestants should assume that the lowest horizon in the pit extends to the depth of interest (unless a lithic or paralithic contact occurs at the observation depth). Use the following tables to determine the degree of limitation and limiting reason number for each interpretation. The first most-limiting reason listed in the table should be marked on the scorecard. For slight limitations, the Reason is dashed or left blank.

**Table 29. Dwellings with Basements. Adapted from NSSH Table 620-3.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Factors Affecting Use** | **Degree of Limitation** | | |
| **Slight** | **Moderate** | **Severe** |
| 1. Flooding or ponding frequency | None |  | Rare to Frequent |
| 2. Potential shrink-swell (continuous thickness of C, SIC, or SC with very high plasticity or slickensides) starting in the upper 100 cm | <8 cm | 8-16 cm | >16 cm |
| 3. Depth to seasonally high water table (cm) | >200 | 100 - 200 | <100 |
| 4. Depth to root-limiting layer other than hard rock (R) (cm) | >200 | 50 - 200 | <50 |
| 5. Depth to hard rock (R) (cm) | > 200 |  | <200 |
| 6. Slope (%) | <6 | 6 - 20 | >20 |

**Table 30. Septic Tank Absorption Fields. Adapted from NSSH Table 620-17.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Factors Affecting Use** | **Degree of Limitation** | | |
| **Slight** | **Moderate** | **Severe** |
| 1. Flooding or ponding frequency | None |  | Rare to Frequent |
| 2. Loading rate (gal/ft2/day) | 0.6 – 0.8 | 0.2 – 0.59,  0.81– 1.0 | NR loading rate |
| 3. Depth to seasonally high water table (cm) | >150 | 100 - 150 | <100 |
| 4. Occurrence COS, S, FS, VFS, LCOS, LS, LFS, LVFS textures | > 100 | < 50 | 50 - 100 |
| 5. Depth to root-limiting layer (cm) | >150 | 100 - 150 | <100 |
| 6. Slope (%) | <6 | 6 - 20 | >20 |

**Table 31. Local Roads & Streets. Adapted from NSSH Table 620-17.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Factors Affecting Use** | **Degree of Limitation** | | |
| **Slight** | **Moderate** | **Severe** |
| 1. Flooding or ponding frequency | None | Not a choice | Rare to Frequent |
| 2. Potential shrink-swell (continuous thickness of C, SIC, or SC with very high plasticity or slickensides) starting in the upper 100 cm | <8 cm | 8-16 cm | >16 cm |
| 3. Depth to seasonally high water table (cm) | >50 | 50 - 25 | <25 |
| 4. Potential Frost Action (upper 50 cm and only applicable for mesic and cooler STR) | S, LS, SL | all others | SI, SIL, SICL |
| 5. Depth to bedrock or other continuous cemented layer (cm) | >150 | 100 - 150 | <100 |
| 6. Slope (pct) | <6 | 6 - 15 | >15 |

**Table 32. Corn.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Factors Affecting Use** | **Degree of Limitation** | | |
| **Slight** | **Moderate** | **Severe** |
| 1. Extreme cold; short growing season (soil temp.regime) | All others | Frigid | Cryic or gelic |
| 2. Flooding or ponding frequency | Protected  or None | Rare | Common  to Frequent |
| 3. COS, S, FS, VFS, LCOS, LS, LFS, LVFS surface texture thickness (cm) | <50 | 50 - 100 | >100 |
| 4. Depth to seasonally high water table (cm) | >50 | 25 - 50 | <25 |
| 5. Water retention difference (class) | Moderate, High | Low | Very Low |
| 6. Depth to root-limiting layer (cm) | > 50 | 25 - 50 | <25 |
| 7. Slope (%) | <6 | 6 - 10 | >10 |

**Table 33. Hopyards. Assume they are on drip irrigation.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Factors Affecting Use** | **Degree of Limitation** | | |
| **Slight** | **Moderate** | **Severe** |
| 1. Extreme cold; long growing season (soil temp.regime) | All others | Thermic, Hyper- thermic, or Cryic | Gelic |
| 2. Flooding or ponding frequency | Protected  or None |  | Rare to Frequent |
| 3. COS, S, FS, VFS, LCOS, LS, LFS, LVFS surface texture thickness (cm) | <25 | Not a choice | >25 |
| 4. Depth to seasonally high water table (cm) | >50 | 25 - 50 | <25 |
| 5. Water retention difference (class) | Very Low to Moderate | High | Not a choice |
| 6. Depth to root-limiting layer (cm) | >150 | 100 - 150 | <100 |
| 7. Slope (%) | <2 | 2 - 4 | >4 |

**Table 34. Created wetlands.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Factors Affecting Use** | **Degree of Limitation** | | |
| **Slight** | **Moderate** | **Severe** |
| 1. Occurrence of COS, S, FS, VFS, LCOS, LS, LFS, or LVFS textures at the indicated depth (cm) | >75 | Not a choice | <75 |
| 2. Current depth to seasonally high water table (cm) | <50 | Not a choice | >50 |
| 3. Organic carbon in current surface layer horizon (%) | >1.5 | 1.0 – 1.5 | <1.0 |
| 4. Current depth to R or Cr (cm) | >100 | Not a choice | <100 |
| 5. Curent slope (%) | <0.5 | 0.5 – 1.5 | >1.5 |

**COMPONENT 2: SOIL HAND TEXTURING**

Students will determine the texture class, and also estimate sand, silt, and clay contents on soil samples. Students may use a water bottle, soil knife, and the texture triangle during this portion of the contest.

**Individual contest**

Each contestant will have 10 minutes per sample and 50 minutes total to complete the soil hand texturing for five samples.

**Group contest**

Each group will have 10 minutes per sample and 30 minutes total to complete the soil hand texturing for three soil samples.

**Scoring**

For each sample, contestants will receive 10 points for the identification of the correct soil texture class. Students will receive 5 points for the sand modifier (if necessary), and 5 points for each percentage of sand, silt, and clay that is within 5% of the correct value. Partial credit of 3 points will be awarded for percentages that are within 6 to 8% of the correct percentage of the sand, silt, and clay. The total points from the texture samples summed and a percentage will be computed based on the maximum possible points available for this component. Each contestant or team will record their answers on the soil texture samples. The coach will submit all answers for each student to a google document for grading. A worksheet is provided for coaches to collect individual and group responses on the hand-texturing component (Table 35).

**Table 35. Sample hand-texturing data recording sheet.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample Number** | **Texture class** | **Sand modifier** | **Sand (%)** | **Silt (%)** | **Clay (%)** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**COMPONENT 3: IDENTIFICATION OF SOIL FEATURES**

Students will identify soil features and landforms from high quality pictures. This exam will be multiple choice. Questions might also include interpretations of these soil features. This portion of the contest is closed book. Any soil features or landforms listed in the *Field Book for Describing and Sampling Soils* may be included in the contest. The coach will administer the soil feature identification component contests. All contestants will submit answers on the identification of soil features.

**Individual contest**

Each contestant will have two minutes per sample and 40 minutes total to complete the feature identification for 20 samples.

**Group contest**

Each group will have two minutes per sample and 40 minutes total to complete the feature identification for 20 samples.

**Scoring**

Points will be assigned for each question. Each contestant and/or group will receive a percentage for this component based on the number of features properly identified. The coach will submit all answers for each student to a google document for grading.

**Table 36. Identification of soil features data recording sheet.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Question** | **Response** | **Question** | **Response** |
| **1** |  | **11** |  |
| **2** |  | **12** |  |
| **3** |  | **13** |  |
| **4** |  | **14** |  |
| **5** |  | **15** |  |
| **6** |  | **16** |  |
| **7** |  | **17** |  |
| **8** |  | **18** |  |
| **9** |  | **19** |  |
| **10** |  | **20** |  |

**REFERENCES**

Schoenberger, P.J., Wysocki, D.A., Benham, E.C., and Broderson, W.D. (editors), 2012. Field Book for Describing and Sampling Soils, Version 3.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

Soil Survey Staff-NRCS. 1996. National Soil Survey Handbook (title 430-VI). US Government Printing Office, Washington, DC 20402.

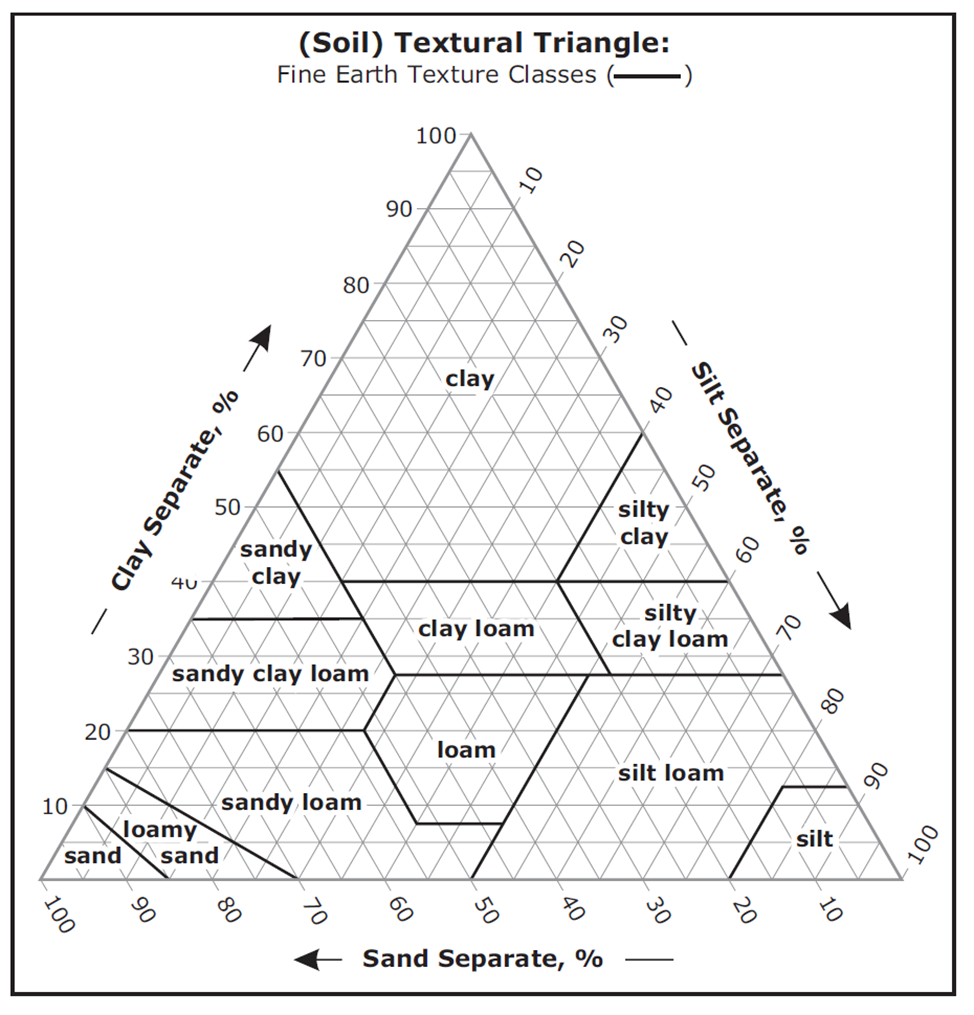
Soil Survey Staff-NRCS. 1999. Soil Taxonomy, 2nd edition. USDA Agricultural Handbook 436. Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

Soil Survey Staff -USDA-NRCS. 2014. Keys to Soil Taxonomy, 12th Edition. US Government Printing Office, Washington, DC 20402.

USDA-Soil Survey Division Staff. 1993. Soil Survey Manual. USDA Agricultural Handbook 18. Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

**APPENDIX 1**

Soil Texture Triangle



**APPENDIX 2**

**Possible Choices for Epipedon and Diagnostic Subsurface Horizon/Features. For specific definitions refer to Keys to Soil Taxonomy (12th Ed.) or The Illustrated Guide to Soil Taxonomy (Ver. 2.0)**

**Epipedon**

Anthropic—A thick horizon that formed in human-altered or human transported material

Folistic—A thick organic horizon not associated with saturation

Histic—A thick organic horizon associated with saturation

Melanic—A thick, dark-colored, humus-rich horizon in which organic carbon is associated with poorly

crystalline, short-range-order minerals or aluminumhumus complexes

Mollic—A thick, dark-colored, humus-rich horizon with high base status

Ochric—A more or less minimally developed surface horizon, typically thin or light colored, that does

not meet the criteria for any other epipedon

Plaggen—A thick, dark-colored, humus-rich horizon from long-term manuring

Umbric—A thick, dark-colored, humus-rich horizon with low base status

**Subsurface Horizon or Feature**

Abrupt Textural Change—A considerable increase in clay content over a short vertical distance

Albic Horizon—Light-colored, leached subsoil horizon

Andic Soil Properties—Unique soil properties associated with materials that are rich in volcanic glass or poorly crystalline minerals

Anhydritic Horizon—Horizon with an accumulation of anhydrite

Anhydrous Conditions—Very cold and very dry soil conditions

Aquic Conditions—Saturation in the soil to the extent that it results in the depletion of oxygen

Argillic Horizon—Subsoil horizon with an illuvial accumulation of clay

Calcic Horizon—Subsoil horizon with an illuvial accumulation of calcium carbonate (CaCO3)

Cambic Horizon—Subsoil horizon with minimal development

Cryoturbation—Intense frost churning

Densic Materials—Root-restrictive, noncemented, dense, compact material

Duripan—Subsoil layer that is cemented by silica

Fragipan—A root-restrictive subsoil layer that is firm and brittle, but not cemented

Free carbonates—soil carbonates that effervesce when treated with cold, dilute HCl.

Gelic Materials—Soil materials (mineral or organic) above permafrost with frost churning

Glacic Layer—Layer of ice in the soil

Glossic Horizon—A degrading argillic, kandic, or natric horizon with loss of clay and/or iron oxide

Gypsic Horizon—Surface or subsoil horizon with an accumulation of gypsum

Identifiable Secondary Carbonates—Visible calcium carbonate (CaCO3) that has been precipitated in the soil

Interfingering of Albic Materials—Narrow penetrations of light-colored, leached material into a subsoil horizon

Kandic Horizon—Subsoil horizon with a low nutrient-holding capacity and significantly more clay than the overlying surface layer

Lamellae—Two or more thin layers with accumulation of illuvial clay

Lithic Contact—Contact between unconsolidated soil material and the underlying root-restrictive hard bedrock

Natric Horizon—Subsoil horizon with an illuvial accumulation of clay and high levels of sodium

Ortstein— Root-restrictive subsoil horizon that is cemented by iron and organic matter >25 mm thick

Oxic Horizon—Subsoil horizon that is extremely weathered and has a very low nutrient-holding capacity

Paralithic Contact—Contact between unconsolidated soil material and the underlying root-restrictive soft bedrock

Permafrost—Frozen layer within the soil

Petrocalcic Horizon—Root-restrictive subsoil horizon that is cemented by calcium carbonate (CaCO3)

Petroferric Contact—Boundary between unconsolidated soil and a layer cemented with iron

Petrogypsic Horizon—Root-restrictive subsoil horizon that is cemented by gypsum

Placic Horizon—Root-restrictive subsoil horizon that is cemented by iron and organic matter

Plinthite—Subsoil feature consisting of a firm iron-oxide-rich mass that irreversibly hardens after exposure to repeated wet-dry cycles

Salic Horizon—Saline horizon with an accumulation of salts

Slickensides—Subsoil feature consisting of polished and grooved surfaces caused by shrinking and swelling

Sombric Horizon—Subsoil horizon with an illuvial accumulation of humus

Spodic Horizon—Subsoil horizon with an illuvial accumulation of organic matter in complex with aluminum and also commonly iron

Sulfidic Materials—Soil materials containing acid-producing, oxidizable sulfur compounds

Sulfuric Horizon—Subsoil horizon that has become highly acid due to oxidation of sulfide minerals

**APPENDIX 3. RULES AND TIPS FOR COACHES TO ADMINISTER CONTEST**

**To do before contest**

* Submit names for all students to the TEAMS excel (Students tab) by 04/09/21.
* Identify the 4 students to compete on A team and 4 students on the B team. Other students can still compete, but will not be eligible for individual awards.
* Practice with your teams.

**Tips for conducting the contest**

* Contest dates are April 5-16, 2021. You are free to hold your contest however you wish, but you must adhere to the rules stated in the Handbook, which is are summarized here. Note: this is only a summary, all official rules are listed in the handbook.
* Component 1 – Pedons
  + Provide hard copies or electronic pedon description forms for each student or group for each pedon.
  + Have the students fill in the pedon description form, ensure that they include their name.
  + Individuals will complete 3 pedons and have 60 minutes per pedon.
  + Groups will complete 2 pedons and have 30 minutes per pedon.
  + Allowed resources:
    - Keys to Soil Taxonomy, Illustrated Guide to Soil Taxonomy, Field Book for Describing and Sampling and Soils, Soil Survey Manual, Contest Handbook, and a calculator
  + Create a pdf of each pedon, Name the pdf file with the student, school, and pedon number (e.g., HansJenny\_UC\_Pedon01).
  + Share the pedons of your A, B, and group with your Pedon Grading Group; if you have more students you will need to grade those pedons yourself.
  + Double grade all pedons using the Keys provided by the Contest Committee.
  + Submit double-graded pedons to the Contest Committee.
* Component 2 – Texture
  + Individuals will complete 5 texture samples and have 10 minutes per sample.
  + Groups will complete 3 texture samples and have 10 minutes per sample.
  + Allowed resources:
    - Soil texture triangle
  + Students can report their answers directly on the google form.
  + Alternatively, you can have students report answers on an answer sheet and you can submit the answers on their behalf.
* Component 3 – Identification
  + Individuals will complete 20 identification questions and have 2 minutes per question.
  + Groups will complete 20 identification questions and have 2 minutes per question.
  + Allowed resources:
    - None, closed book
  + Students can report their answers directly on the google form.
  + Alternatively, you can have students report answers on an answer sheet and you can submit the answers on their behalf.