University of Idaho Extension

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Soil and the Environment

A Land and Homesite Evaluation Handbook and Training Guide

Contents

Program Background

The Idaho State Land and Soil Evaluation Program is a cooperative effort among many individuals and organizations. It involves youths from both FFA and 4-H. The program was initiated at Burley in 1971 when Soil Conservation Service Soil Scientist Glen Logan worked with a group of Future Farmers of America (now known as FFA) at a state event. He also went with them to Oklahoma City and participated in the national event. Since that time the program has grown to include several thousand FFA and 4-H youths participating in regional events throughout Idaho and the state event at Burley, Idaho. Four or five regional land and soil judging field days and the state event are held during the months of September and October each year.

In 1985, the Maynard Fosberg Land Judging Endowment was established to help support the program financially. Partial support for the Land and Soil Evaluation Events comes from the endowment interest. Individuals and organizations make donations to the endowment.

Cooperators

The following agencies and organizations are involved in the Idaho State Land and Soil Evaluation Program. In addition, Idaho agricultural science and technology instructors, the State FFA, and district FFA organizations support the program.

- **U. S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS)**—Soil scientists and soil conservationists work to organize, provide technical support, and assist in conducting the regional and state events.
- **Idaho Division of Professional-Technical Education**—The State FFA as housed at the Idaho Division of Professional-Technical Education provides office and technical support associated with the state event. The Division of Professional-Technical Education also hosts an annual steering committee meeting and oversees scheduling of the state and regional events.
- **University of Idaho College of Agricultural and Life Sciences**—Extension soil specialists and soil scientists in the Department of Plant, Soil and Entomological Sciences provide technical support and assist with the overall state program, including scheduling, organizing, and conducting the regional and state events. They maintain the official handbook, *Soil and the Environment: A Land and Homesite Evaluation Handbook and Training Guide* (Bulletin 795). Faculty in the Department of Agricultural Education and 4-H Youth Development assist in the development and coordination of regional and state events.
- **University of Idaho Extension**—Extension educators in county offices of University of Idaho Extension work with 4-H leaders and FFA advisors as well as their members. They assist in preparing and participating in the regional and state events.
- **Idaho Association of Soil Conservation Districts**—IASCD Auxiliary and individual soil conservation districts support the program through planning, conducting events, and contributing funding. The East and West Cassia soil conservation districts have for years been major sponsors of the state event in Burley.

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Soil and the Environment

A Land and Homesite Evaluation Handbook and Training Guide

Edited by: **P. A. McDaniel, A. L. Falen, and M. A. Fosberg**

Idaho has approximately 53 million acres of land area. Only about 10 percent of the entire area is suitable for crop production. All soil and land, including that suitable for cultivation, is subject to one or more natural limitations such as adverse soil texture or permeability, erosion hazard, wetness, restricted rooting depth, and climate. Climatic factors are important in Idaho because some areas lack sufficient natural precipitation (mostly southern Idaho) and some areas, because of elevation and latitude (eastern Idaho and portions of northern Idaho), lack sufficient heat unit input for good crop production.

Soil may be defined as a natural body developed from a mixture of broken and weathered mineral material (rocks) and decaying organic material (remains of living organisms). Soil covers the earth in a relatively thin layer. It supplies air, water, and nutrients for plant growth. Soil also provides mechanical support for plants, buildings, and other types of construction.

Plants and animals derive support and nutrients directly or indirectly from the soil. As plants and animals live and die, their waste products and remains are returned to the earth to form the organic fraction of the soil. Development of 1 inch of "soil" may require many hundreds of years under natural conditions.

Soils differ in their potential to produce food and fiber and in their usefulness for construction sites and other nonagricultural uses. These differences are contained in the soil profile with specific characteristics indicated in each soil horizon. The best use and management of any given plot of land is based upon characteristics of the soil comprising that plot of land. Knowledge of soil characteristics is necessary to determine potential land value, select adapted crops, recommend proper management, and determine necessary conservation measures to ensure proper land use.

Based on soil characteristics and potential management problems, soils are grouped into eight land capability classes. These classes are used by many agricultural workers and others to plan and practice wise use of the land.

Soil engineering properties and interpretations may also be determined using the soil characteristics and potential problems as a basis. These properties and interpretations may be used for selecting suitable sites for building houses and septic tank drainage systems, locating roads and streets, planning parks and playground areas, and many other construction uses of soil.

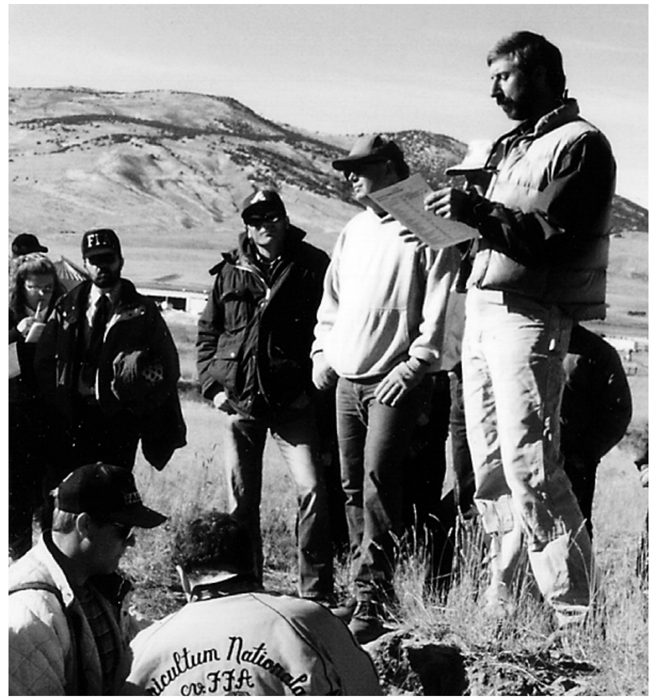

Fig. 1. Former UI soils specialist Terry Tindall, right, gives instructions to students in a soils event.

What Is Land and Homesite Evaluation?

Land and homesite evaluation is an event designed to "evaluate" a soil or set of soils. The purpose of land and homesite evaluation is to teach an individual to recognize soil factors and to evaluate soil characteristics. This will allow the individual to make wise decisions in managing and in using the soil or the land. Wise decisions in land use will help conserve Idaho's most valuable natural resource—our soils. Land evaluation can help individuals understand:

1. Basic soil differences.
2. How physical and chemical soil properties affect crop growth.
3. Why various soils respond differently to management practices.
4. The influence of land topographic features on production, land protection, geology, and native vegetation.
5. Soil and water conservation practices.
6. Proper land use and treatment.
7. How soil properties may be used as a basis for making a better selection of homesites.

Organization

The Idaho Land and Soil Evaluation Program includes regional field days and a state event. The state event is restricted to FFA and 4-H members who have competed and qualified at regional field days.

State Event

The state event is held in October each year. The site and date of the event are determined by the State Land and Soil Evaluation Committee.

The two top teams from each FFA district and the top two 4-H teams at the Regional Field Days qualify for the state event. Additionally, the highest-placing chapter or 4-H club at each regional event (that did not qualify as one of the top two teams in their respective district) will be invited to attend. The teams in the state event, both FFA and 4-H, have three to five members, with no alternates.

State Land and Soil Evaluation Committee

The State Land and Soil Evaluation Committee includes a University of Idaho Extension soil specialist or soil scientist, a Natural Resources Conservation Service (NRCS) soil scientist from the state office, NRCS area soil scientists, the Idaho Division of Professional-Technical Education program manager, a representative of the University of Idaho Department of Agricultural Education and 4-H Youth Development, a representative of the Idaho Association of Soil Conservation Districts (IASCD), the state 4-H director, and others appointed by the chair. Members of the state committee work closely with individuals at University of Idaho Extension county offices and individuals at NRCS, SCD, and FFA responsible for conducting the regional field days and the state event.

State Event Rules

1. Clip boards are allowed (recommend clear boards).
2. No calculators, no cell phones, or personal water bottles.
3. Evaluation cards will be handed out after the practice site has been completed.
4. No talking within the field description site.
5. The area between the flagging in the soil pits should not be disturbed by participants.
6. A white nail will mark the top of the soil profile in the flagged area. Other white nails may be used in the flagged area for topsoil present or the depth of the soil.
7. If site information is reviewed, it will be done at the end of the state event, not at the end of each site.
8. The three-person team will check the official placings at each site before the contest begins. Any errors on the official scorecards will be corrected only after consultation with the state coordinator. However, the slope, texture, soil depth, and topsoil depth determinations made by contest officials are final.

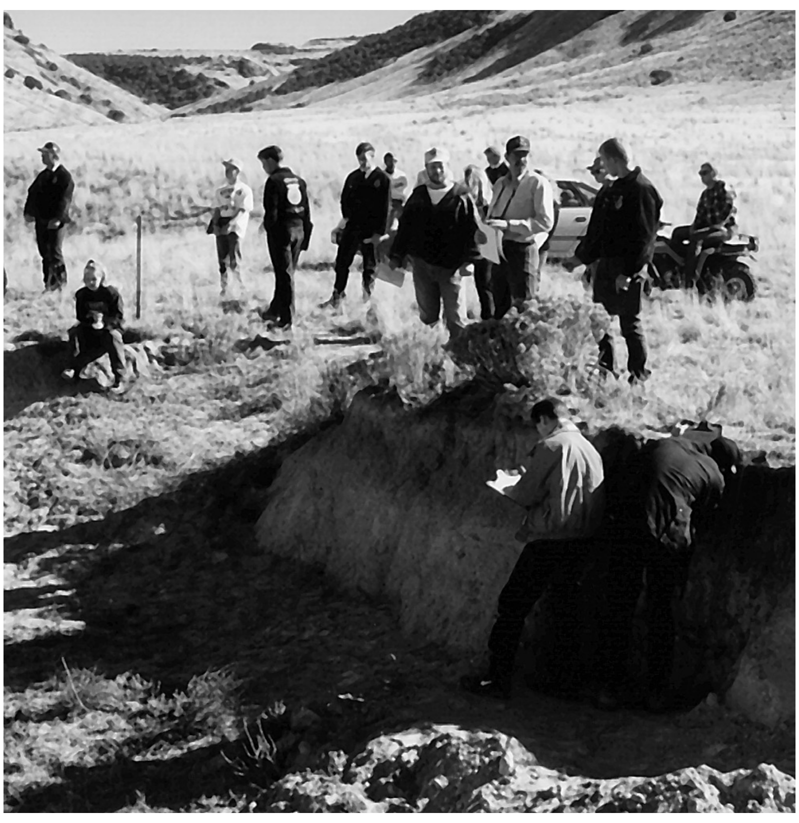

Fig. 2. FFA and 4-H participants evaluate a soil profile in an exposed cut below at left, and review soil characteristics in an urban setting below at right.

Regional Field Days

The regional field days are held in the fall before the state event. Regional field days are held in northern Idaho, southwestern Idaho, southcentral Idaho, and once or twice in eastern Idaho. Efforts are made to ensure that locations of the area field days are rotated within the region to take advantage of assistance from local representatives of NRCS, SCD, University of Idaho Extension, FFA, and other organizations.

The number of participants making up a team at regional field days will be a minimum of three with a maximum of five. Winning teams are determined by totaling the scores of the three highest individuals for each team. The number of alternates (nonteam members) who may participate in the regional field days is not limited. Official scorers may grade the scorecards of alternates or may leave the grading to advisors and 4-H leaders.

Local or Practice Events

Local events may be held for practice. These can be arranged by the team advisor or coach if they feel there is a need. Help in conducting such events for training team advisors or participants can be obtained from NRCS, SCD, UI, or other soil scientists.

Local advisors should attempt to involve local organizations such as a Chamber of Commerce, Soil Conservation Districts, Irrigation Districts, or individuals representing agribusiness. They should be involved in obtaining and presenting awards, supporting banquets, etc.

Setting Up an Event

1. The event date should be set at the annual steering committee meeting (usually held in February).
2. Estimate the expected participation, if possible.
3. Locate a farm or adjacent farms that have different soil and landscape conditions that can provide a variety of sites for evaluation.
4. Secure permission from the owner(s) to use the selected site(s).
5. Several days before the event, select sites and prepare pits or other soil profile exposures. Road cuts, stream banks, and other such soil profile exposures can be used. Make official scorings and evaluations of each site. Prepare extra copies of the official scorecards for use by scorers and others to explain the scoring to participants after the contest.
6. Obtain scorecards and prepare packets consisting of a practice card, three land evaluation cards, and one homesite card (two homesite cards at the state event) for each participant. A tabulation card to serve as a registration card should be prepared for each team.
7. Prepare extra packets for alternates at the regional field days who wish to participate.
8. Arrange for transportation of participants to the fields and between sites as necessary. (During the event allow 20 minutes at each event site.)
9. When possible, break participants into groups so that no two members of the same team are in the same group. Prohibit talking between participants. Assigned group leaders will supervise each group and lead participants to the sites.
10. Where possible, provide an individual at each site (pit monitor) to answer questions, collect scorecards, keep water bottles filled, and monitor participants. At the regional field days and the state event the official scoring for each site will not be given by the pit monitor at the end of the timed period for evaluating the site. Advisors and/or coaches or soil scientists can enhance the educational experience at the regional field days and state event by going over the official placing of each site at their discretion.
11. If it has not been done beforehand, select leaders and tabulators (graders) the morning of the event.
12. Arrange for a place to conduct the grading and designate someone to collect the scorecards as participants finish the different fields to speed the grading process as much as possible.

National Event Eligibility

State and national soils events are restricted to individuals and teams that have previously qualified by winning regional field days and state events. Students who have previously participated in a national soils event are not eligible to participate in state soils events in subsequent years. Regional field day coordinators could allow participants in previous national soil events to participate at the regional field days if adequate helpers are available to grade their cards. It is very important for individuals to continue their education in soils.

The top five FFA and 4-H teams are eligible to participate in the National Land and Range Judging Contest held in the spring in Oklahoma City, Oklahoma. Support monies are provided by Idaho local sponsors and by the Maynard Fosberg Endowment for the first- and second-place teams recognized at the state event. If they choose not to participate, support monies would go to a lower-standing team (third-, then fourth-, then fifth-place teams). Eligible teams are informed of the details of the support at the state event.

How Land Evaluation Works

Land and homesite evaluation is a training method similar to livestock evaluation, using classes of "fields" instead of classes of animals. "Fields" are evaluated according to established criteria for their suitability and limitations for various uses. The term "field" refers to a plot of land 100 feet square selected from a uniform portion of a farm or other area (Fig. 3). Land and homesite evaluation consists of four "fields." Participants evaluate "fields" using the criteria in this handbook and by recording their evaluations and interpretations on the scorecards.

Only those features within the boundaries of the "fields" will be considered in evaluating each field. **Surface runoff**, **flooding hazard**, and **wetness hazard** may require consideration beyond the field boundaries to properly evaluate the homesite field and this information will be provided on the site placard.

The soil profile is exposed to allow participants to examine soil depth, topsoil depth, and soil structure. Fig. 4 shows samples of the topsoil and subsoil placed in containers for determination of textures and permeability. Official scoring of the fields is by a qualified evaluator(s).

Qualified evaluators may include one or more soil scientists, extension educators, agricultural science and technology instructors, soil conservationists, or any other individuals who understand the criteria in the handbook.

The evaluators set climatic conditions, soil test information, and other factors that are not obvious. The conditions are given on a placard located at each site (Fig. 5).

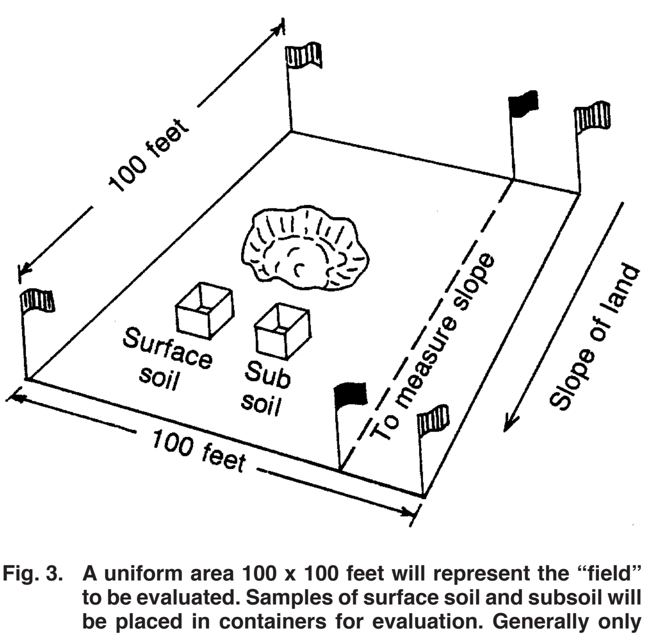

Fig. 3. A uniform area 100 x 100 feet will represent the "field" to be evaluated. Samples of surface soil and subsoil will be placed in containers for evaluation. Generally only features occurring within the boundaries of the field will be considered in evaluating the site.

A sample placard may look like this:

Field number **1**.
Original depth of **A horizon 22** inches[1]
Present depth of **A horizon 10** inches[2]
Climate
Annual precipitation **8** inches
Frost-free days **125**
Soil analysis
pH **7.5**
Nitrogen (NO_3N) .... **30** ppm
Phosphorus (P_2O_5) .... **9** ppm
Potassium (K_2O) .... **300** ppm
Zinc (Zn) .... **1.5** ppm
Other factors[3]

[1]Since variation will occur from area to area and with evaluator's interpretation, the original depth given here should be specified as "...depth of **topsoil 22** inches," "... depth of **A horizon 22** inches," or other designation to prevent confusion for the participant.

[2]If not obvious to the participant, the present depth of the designated portion of the profile zone can also be given and thus only a simple calculation is necessary to determine erosion losses.

[3]Factors given to the participant where information is not obvious. Examples are irrigation water availability, flooding frequency, water table depth, and manure availability.

Fig. 4. Some type of container, such as a plastic pan, will be used at each site to hold samples of surface soil and subsoil material. This ensures that all participants will be considering the same horizon of the exposed soil profile.

Scoring the Event

The graders will determine the official scores for each entry on the scorecard. The following is an example of how a field could be scored.

PART I
Soil and Land Characteristics

Factors	Points
A. Surface texture	4
B. Subsoil texture	4
C. Subsoil permeability	4
D. Depth of soil	3
E. Slope	3
F. Erosion loss	3
G. Surface runoff	3
H. Drainage	3
I. Climate	3
J. Major factors	10[1]
Total points, Part I	40

PART II
Land Capability Class and Recommended Land Treatments

Treatments	Points
K. Land capability class	5
L. Vegetative	13[1]
M. Mechanical	9[1]
N. Fertilizer/soil amendment	8[1]
Total points, Part II	35
Total points, both parts	75

[1]One point given for each item (correctly marked or not marked).

Definition of a Team

Three to five participants comprise a team in the **regional field days,** and additional participants are encouraged to take part as alternates. At the state event, three to five members are allowed for any participating chapter or club with no alternates. The scores of the high three members comprise the team score.

In Case of Ties

In the case of a tie between individuals, the individual having the highest total score in Field 1 would be declared the winner. If the total score at Field 1 is the same for each individual, the evaluation will continue with Field 2 and so on through Field 3 and Field 4 until the tie is broken. Using Part I and Part II scores from Field 1 to break the ties is not feasible because only total scores are recorded and the original cards are often unavailable.

In case of a tie in a team score (using the top three scores), the score of the fourth individual will be used as the tiebreaker. If a team having only three members is tied with a team of four members, a composite score from the top three team members will be used in a manner similar to that used to break a tie for individuals.

Learning More About Soils

The primary purpose of a soil and land evaluation event is to provide an educational experience in the area of soil science. Advisors and/or coaches can enhance the educational experience by going over the official placing of each site. Soil and land evaluation educational guides are available online from previous regional and state events (http://www.uidaho.edu/cals/pses/research-and-extension/pedology-laboratory/land-and-soil-evaluation-program). Allowing participants to practice filling out cards, trading cards, and grading cards also helps them learn.

Fig. 5. A land and homesite evaluation set-up looks much like the one below, with some type of container, such as a plastic pan, used to hold a sample of surface soil or subsoil material, a placard on which is written site conditions, and an exposed soil profile.

Study of Soils

Since many agricultural science and technology teachers use this handbook as a student text for teaching soils, this section has been added. This information can be used to enhance the understanding of basic soils and the Idaho Land and Soil Evaluation Event.

The study of soils is complex. One of the better definitions of "soil" indicates some of the important aspects of this valuable resource.

> **SOIL**: A **living**, **dynamic system** at the **interface** between air and rock. Soil forms in response to forces of **climate and organisms** that act on **parent material** in a specific **landscape** over a long period of **time**.

This definition is especially good because each key word says something important about the soil. Why **living**? Because the soil is full of living organisms: roots large and small, animals and insects, millions of microscopic fungi and bacteria, etc.

Equally important are the decaying remains of dead plants and animals. They form soil organic matter, or humus, which is vitally important for good soil tilth and productivity.

Dynamic says that the soil is constantly changing. Idaho soils change from very wet and cold in the winter to very dry and hot in the summer. Even under irrigation, the amount of water in the soil and soil temperature can vary widely.

Soil organic matter and nutrients increase when crop residues are worked into the soil, and decrease as fresh plant materials decay. Soil nutrients increase as soil minerals break down and decrease as water moving through the soil carries certain nutrients away. Even soil acidity or alkalinity (soil pH) changes seasonally.

The word **system** says that all parts of the soil work together to make up the dynamic whole. A change in one part may cause changes in many other parts.

Suppose, for example, we add water until the soil is very wet. That reduces the amount of air available to plant roots. It makes the soil colder, and the activity of roots and soil microbes (very small plants and animals) slows down. The wet soil is sticky and cannot bear as much weight as when it is dry.

When the excess water is removed by drainage, the whole system changes to a warmer and drier soil. This is better for plant growth, and the soil is easier for farmers to till and plant.

The word **interface** stresses the idea that soil is indeed a very thin "skin" at the earth's surface. When air meets rock, especially if the air is warm and the rock is moist, the rock begins to change. Some changes are **physical**. Physical changes are obvious when rocks are broken down into smaller pieces. Other changes are **chemical**. Chemical changes can destroy some of the original minerals and create new ones.

These physical and chemical changes are called **weathering**. Weathering occurs only in the first few feet of the earth's surface. Examples of strongly weathered soils can be found in the Idaho Soils Atlas.[1] Soil 26 is a remnant of a highly weathered soil that has been nearly lost by erosion. Soil 51 is also a highly weathered soil that has developed in volcanic ash material.

Now consider the size of the earth. The distance from the surface to the center of the earth is about 4,000 miles. Thus, 10 feet of weathered rock out of 4,000 miles is something less than 0.00005 percent. Soil does occur at the point of contact between earth and atmosphere!

Factors of Soil Formation

The rest of the key words in this definition of soil tell something about how soil forms. There are five **soil-formation factors**. Two factors—climate and organisms—are called **active**. They provide the forces that cause soil to form. The other three—parent material, topography, and time—are called **passive** factors. They respond to the forces exerted by climate and organisms.

Together, the interactions between the forces (active factors) and the responses (passive factors) result in a new product, a unique natural resource, called soil.

Climate

Climate affects soil most directly through temperature and precipitation. In warm, moist climates, rocks and minerals weather very quickly. The soil that forms often has a reddish color. This reddish color is due to the form that iron takes in the weathering process.

High precipitation or irrigation also causes **leaching**—the removal of soil materials (including chemicals and nutrients) by water flowing through the soil. Free lime is completely leached from most northern Idaho soils. These soils are acid (pH less than 7.0). Free lime is still present in most southern Idaho soils because precipitation is needed to move this relatively insoluble material out of the soil. Leaching also moves NO_3-N out of the soil system and may contribute to degradation of groundwater quality.

Warm, moist climates encourage lush plant growth, which means large amounts of soil organic matter. The opposite is true in hot, dry climates. Soils in northern Idaho are generally dark-colored because they have a high content of organic matter. Soils in southern Idaho are generally light-colored because they have little organic matter.

Organisms

Organisms come in several different forms and types:

[1]Barker, R. J., R. E. McDole, and G. Logan, Univ. of Idaho, Moscow, ID, 1983.

large plants, large animals, and tiny plants and animals (microorganisms). Roots of large plants help break apart rocks and mix soil materials. Root channels provide pathways for water and air movement through the soil. When plants die, the above-ground plant parts decay, thereby building up the organic matter in the soil.

Microscopic organisms, or **microorganisms**, are an extremely important part of the soil. They are the primary decomposers of organic material added to the soil. They change raw plant material into a complex, black substance called "humus." At the same time they release nitrogen from proteins in the organic material. Nitrogen is an essential nutrient that plants need in large quantities. Thus, rich, fertile topsoils are rich and fertile because they are well supplied with humus. Some soils are composed almost entirely of organic material. Even the earthy smell of moist, rich topsoil is caused by a microorganism.

Microorganisms and the humus they produce also act as a kind of glue to hold soil particles together in clumps or "aggregates." Well-aggregated soil is ideal for providing the right combination of air and water to plant roots.

Without microorganisms, therefore, soil would be a virtually inert (lifeless) body. With microbes, soil is truly a living, dynamic system.

Animals, including large burrowing animals, small earthworms, and insects, are important because they help mix the soil. Undoubtedly man is the most important human animal influencing soil development in areas where he tills and manages the soil. Mixing by animals carries raw plant debris from the soil surface down into the topsoil. Only then can the microorganisms do their job of changing plant material to humus.

Parent Material

Parent material is the original geologic material that has been changed into the existing soil. Parent material is passive because it simply responds to the changes brought about by weathering and biological activity.

Parent materials can be a bedrock (residuum) like sandstone, basalt, or granite. Other parent materials are transported deposits of sediments carried by water, wind, or ice. Volcanic ash, lake-laid silts, stream deposits, loessal silts, dune sand, glacial till, and glacial gravels are all examples of transported parent materials.

Time

Time from the standpoint of soil formation may be measured in centuries rather than years. The years of man's lifetime are rather brief when compared to the age of soil. Many soils are thousands and even tens of thousands of years old. Time is the great equalizer. Young soils inherit the properties of their parent materials. They tend to have the same color, texture, and chemical composition as their parent materials. The older the soil the less impact parent material has on soil characteristics.

As soils age, many original minerals are destroyed. Many new ones are formed. Soils become more leached, more acid, and more clayey with advancing age. In short, the soil becomes more strongly developed with the passage of time.

Topography

Topography, or landscape position, causes localized changes in such factors as parent material, moisture, and temperature. When rain falls on a hillslope, for example, water runs away from the top of the hill. Excess water collects at the bottom of the hill. The drier soils at the top are quite different from the wetter soils at the bottom, even though both soils formed under the same overall conditions of climate, organisms, parent material, and time.

Another effect of topography is affected by the direction that a slope faces. Soils on north-facing slopes, for example, tend to be cooler and wetter than soils on south-facing slopes. The drier and warmer south-facing slopes usually produce less vegetation and thus have lower organic matter content and are more subject to erosion.

Soil Profile

A soil has unique and distinctive layers called soil horizons. The various horizons or sequence of horizons make up a soil profile. The soil profile developed is the result of the interaction of the five soil-forming factors. The soil profile is usually not over 5 feet thick as this is usually as deep as weathering processes go. Further discussion on horizons follows in a later section.

Processes of Soil Formation

The definition of soil has identified five **factors** of soil formation. We can also think in terms of four major **processes** that change parent material into life-sustaining soil. They are **additions**, **losses**, **translocations**, and **transformations**.

Additions

The most obvious addition of materials to the soil is the addition of organic matter. As soon as plant life begins to grow in fresh parent material, organic matter begins to accumulate. Organic matter gives a black or dark brown color to surface soils. Therefore, even very young soils often have a dark-colored surface layer.

Other additions come with precipitation. On the average, precipitation adds about 5 pounds of nitrogen each year to every acre of soil. Precipitation can also be acid, as it dissolves various natural or man-made chemicals. Precipitation, by causing soils to erode and rivers to flood, is responsible for the addition of new sediments to the soil at the bottoms of slopes and on stream floodplains.

Losses

Most losses occur by leaching. Water moving through the soil dissolves certain minerals and carries them out of the soil profile. Some minerals or salts are readily soluble and are completely removed from the profile even in areas of relatively low precipitation. Other minerals, such as lime, are only slightly soluble, so moderate to high amounts of precipitation are necessary to remove them completely from the profile. Man's influence can be a big factor as his use of irrigation can change a sparsely vegetated and low-producing desert (with 8 to 10 inches of annual precipitation) to a lush-growing, highly productive cropland when 24 to 36 inches of irrigation water are applied each summer.

Many fertilizers, especially nitrogen and sulfur fertilizers, are highly soluble in water. They, too, are readily lost by leaching, either by natural rainfall or from irrigation water. These materials can also drastically alter chemical properties of soils by altering soil pH (increasing acidity).

Other minerals, such as iron and aluminum oxides and silica grains, dissolve very slowly. These minerals remain in very old and highly weathered soils.

Losses also occur as gases or solids. Oxygen and water vapor are lost from soil as fresh organic matter decays. When soils are very wet, nitrogen can be changed to a gas and lost to the atmosphere. Solids are lost by erosion that removes mineral soil particles and organic materials as well as dissolved and undissolved salts. Such losses are very serious, for the soil lost by erosion is usually the most productive part of the soil profile. Erosion losses also reduce the thickness or depth of the profile.

Translocations

Translocation means movement from one place to another. Usually we think of movement out of a horizon near the soil surface and into another horizon that is deeper in the soil.

In low rainfall areas, leaching often is incomplete. Water starts moving down through the soil profile, dissolving soluble minerals (salts) as it goes. But there isn't enough water to move the minerals all the way through the soil profile. When the water stops moving, due to surface evaporation losses or plant use, salts are left behind. That is how subsoil accumulations of free lime are formed. These layers are often referred to as caliche layer in southern Idaho. When these layers become cemented with lime and/or silica, they are hardpans or duripans. Hardpans are often similar to concrete, limiting the useful depth of the soil.

Upward translocation is also possible. Even in the dry areas of southern Idaho, some soils have high water tables. This means that plant roots are adversely affected by the water in the profile, and only certain plants will grow. In some cases the water may be at the surface for extended periods of time, creating a "marsh" or "swamp." Evaporation at the surface causes water to move upward continually. Salts are dissolved on the way up through the profile and are left behind as the water evaporates. Salty soils are difficult to manage and are usually not productive.

Another kind of translocation involves extremely fine sized (less than 0.002 mm) clay particles. Water moving through the soil can physically carry these particles from one horizon to another, or from place to place within a horizon. When the water stops moving, the clay particles are deposited on the surface of soil aggregates. These coatings of clay particles are called **clay skins**. Clay skins have a dark, waxy appearance.

Transformations

Transformations are changes that take place in the soil. Microorganisms that live in the soil feed on fresh organic matter and change it into humus. Chemical weathering changes the original minerals of the parent materials. Some minerals may be destroyed completely while others are changed into new minerals. Many of the clay particles in soils are actually new minerals that form during soil development.

Still other transformations change the form of certain elements. Highly oxidized forms of iron (iron oxides) usually give soils a yellowish-brown or reddish- brown color. In water-logged soils, however, iron oxides become **reduced**. The reduced forms of iron give soils bluish, greenish, or grayish colors. Reduced forms of iron are quite easily lost from the soil through leaching.

Repeated cycles of wetting and drying create a multicolored soil material or "mottling." Part of the soil is grayish because of the loss of iron, and part where the iron oxides are not reduced remains yellow-brown. Mottling is an important clue when identifying soils on associated riparian zones, which occur along streams, ponds, or other areas of free or unbound water.

Rock to Soil

How do all these processes work together to form soil? Let's start with a fresh parent material. Climate starts acting on it immediately. Weathering begins to change minerals. Leaching removes the more soluble salts, then the less soluble free lime. As soon as plants begin growing in the soil, they add organic matter and organic acids. Biological activity increases, and humus forms. After several years a dark-colored surface horizon is present.

Weathering and leaching continue to change soil minerals and remove soluble components. More horizons develop beneath the surface. The soil becomes more acid. Clay minerals begin to form. Clay is translocated and clay skins become evident.

As the amount of clay in subsoil horizons increases, the rate of water movement through the soil decreases.

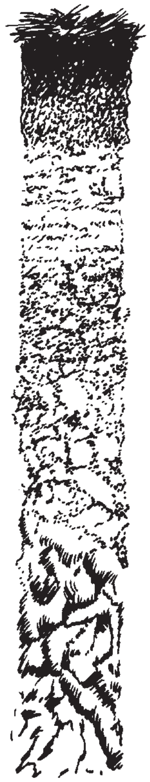

Fig. 6. Schematic of theoretical soil profile showing the six master horizons. Rarely do national soils contain all six of these master horizons.

Weathering continues but leaching is not as rapid. As time progresses, further change is very slow, and the soil-plant-landscape system is in a relatively stable condition.

Kinds of Soil Horizons

A soil horizon is a layer of soil usually lying parallel to the surface. It has a unique set of physical, chemical, and biological properties. The properties of soil horizons are the results of soil forming processes. These properties distinguish each horizon from adjacent horizons.

Soil horizons are named using combinations of letters and numbers. Six general kinds of horizons may occur in soil profiles (Fig. 6). These general kinds of horizons, called master horizons, are named with capital letters: O, A, E, B, C, and R.

Gradual changes from one master horizon to another give rise to transition horizons. These are named with two letters (for example, AB, BA, BC). Special kinds of master horizons are named by adding lower-case letters (for example, Ap, Bt, Cr). Thick horizons may be subdivided using Arabic numbers, as in A1, A2, or Bwl, Bw2, Bw3.

A single soil profile probably never has all the master horizons. Most Idaho soils have A, B, C, and one or two transition horizons. Other Idaho soils may have an A horizon resting directly on a C horizon, or an A-E-B-C horizon sequence or even an O-E-B-C sequence.

Because all six master horizons occur somewhere in Idaho, students need to recognize each horizon and understand how it differs from the others.

Master Horizons

Each master horizon has a distinct set of properties. These properties are summarized in the following section.

O Horizon

An O horizon is composed of organic material. It does not have to be 100 percent organic material, but most are nearly so. Forest soils usually have thin organic horizons at the surface. They consist of leaves, twigs, and other plant materials in various stages of decay. Wet soils in bogs or drained swamps often have only O horizons.

A Horizon

The A horizon is the surface horizon of a mineral soil. The unique characteristic of an A horizon is the dark color which is due to the humus content. Granular structure (small rounded aggregates) and ease of crushing are also typical.

The thickness of A horizons ranges from a few inches in low precipitation (desert) rangeland soils to 20 inches or more in the Palouse area of northern Idaho. Steeper slopes have less of an A horizon than lower areas or areas of accumulations.

The A horizons are extremely important in maintaining soil fertility and providing a favorable environment for root growth. They should be protected from damage by erosion or compaction. The A horizons are usually the horizons referred to as "topsoil." Topsoil is a less definitive term. It is usually the surface 6 to 12 inches of the profile and may actually include no A horizon, as in the case of severely eroded or scraped areas.

E Horizon

This horizon has a light gray or whitish color. It is present only in areas of relatively high precipitation. It usually occurs immediately beneath an O or an A horizon or immediately above a very slowly permeable horizon.

E horizons are light-colored because nearly all the iron and organic matter has been removed. Remember the E as meaning exit or leaching.

B Horizon

The B horizon is the subsoil layer that changes the most because of the soil-forming processes. Several kinds of changes are possible.

In some soils, the B horizon has the brightest yellowish-brown or reddish-brown color. In others, it has the most evident blocky or prismatic structure. Many B horizons have more clay than any other horizons in the profile and show evidence of clay skins. Each of these major kinds of B horizons is discussed more fully in the next section, "Special Kinds of A, B, and C Horizons."

The B horizons are part of the subsoil. In cases where the A horizons have been completely lost by erosion or other man-caused reason, the B horizon may be at the surface and thus constitutes the "topsoil."

C Horizon

The C horizon is weathered geologic or parent material below the A or B horizon. Any material that can be dug with a shovel but which has not been changed appreciably by soil forming processes is considered C horizon. The C horizon is also considered part of the subsoil.

R Horizon

The R horizon designation is used for bedrock. Bedrock is relatively unweathered rock material. Depending on the depth to bedrock, the R horizon may occur directly beneath any of the other master horizons.

Special Kinds of A, B, and C Horizons

Many horizons are the result of unique processes that leave a distinct mark on the horizon. These horizons are identified with a lower-case letter immediately following the master horizon symbol. More than 25 letters and combinations of letters are possible. This discussion will only cover the nine most commonly used symbols in Idaho.

Ap Horizon

The surface horizon of any soil that has been plowed or cultivated is called the plow layer. This is designated with the small letter p. Cultivation thoroughly mixes the upper 8 to 12 inches of the soil and destroys any natural horizons that may have been present.

If the original A horizon was very thick (more than 8 to 12 inches), plowing converts the upper part of the horizon into an Ap horizon, and the lower part remains an A horizon. If the original A horizon was very thin, the Ap could rest on a B, C, or transition horizon. In areas where the A horizon was less than plow depth, the term "topsoil" will be synonymous with Ap horizon.

Even when a soil has been so severely eroded that all the original A is gone, plowing an exposed B or C horizon would automatically make the surface horizon an Ap.

Bt Horizon

The t designation indicates that the B horizon has been enriched with clay and is a "textural" B horizon. Textural B horizons have distinctly more clay than the horizons above or below. The "feel" method of texture determination should show this difference.

Some of the clay comes from the horizons above the Bt horizon. Water moving down through the soil carries with it some very fine clay particles. When the downward movement stops, the clays are deposited, building up the waxy coatings of clay skins. Some of the clay may also come from the weathering of original minerals in the Bt. The Bt horizons are quite common in soils of high precipitation. They usually have well developed blocky or prismatic structure.

Bg Horizon

The g designation indicates that a horizon is strongly **gleyed**. Gleying occurs when iron in the soil is chemically reduced, and much of it has been leached out of the soil. As a result, gleyed horizons are usually dark gray, bluish, or greenish in color. They may also be mottled.

Gleyed horizons indicate that the soil is poorly or very poorly drained for long periods of time each year. Gleying is not restricted to the Bg; other gleyed horizons include Ag, BAg, BCg, and Cg. These horizons are associated with wetlands and may be restricted from being drained.

Bs Horizon

The s designation indicates a distinctive, bright yellowish-brown or reddish-brown color that fades with depth. The Bs horizon forms when iron, aluminum, and organic matter all are leached out of surface horizons, carried downward, and deposited in the subsoil.

Bw Horizon

The w reflects a weathered horizon. The Bw horizons have been changed by weathering, but not enough to form a Bt, Bg, or Bs. The Bw horizon differs from the C horizons by having weak or moderate blocky structure. The Bw may also have a brighter color and be more leached than the C horizon. The Bw horizons are common in soils of moderate precipitation or in young soils in high precipitation areas.

Bx Horizon

This designation reflects a special feature called a **fragipan**. A fragipan is a massive, dense soil horizon that is not sufficiently cemented to be called a hardpan. The fragipan is often mottled and has streaks of gray silt scattered throughout. It is often overlain by an E horizon. The fragipan is so dense that neither plant roots nor water can penetrate, except in cracks or root channels. Soils with these horizons occur primarily in high precipitation areas under timber.

Bk Horizon

This horizon has an accumulation of calcium or other carbonates, or free lime. Carbonates leached from upper horizons have been redeposited in the Bk horizon. White streaks, seams, or nodules of lime should be evident. These will bubble violently when a drop of hydrochloric acid (HCl) is placed on them.

Some soil parent materials originally contained free lime and would react to the acid. The k is used only to indicate a horizon enriched in carbonates by translocation. A Bk horizon may have an ordinary C horizon beneath that contains only its original amount of lime.

Bkqm Horizon

This horizon is called a hardpan or, in more scientific language, a duripan. It is enriched with calcium carbonate (k) and silica (q) and is strongly cemented (m).

Duripans are common in many soils in southern Idaho. Limited rainfall leaches lime and silica from the upper 10 to 15 inches of the soil profile and redeposits it in the Bkqm horizon. Thin, pinkish coatings may be present on the upper surfaces of duripan fragments. The duripan can be as thin as 1/8 inch but is usually 6 to 10 inches thick. It is so cemented that plant roots cannot penetrate.

A dense mat of roots, spreading horizontally, is a good indicator of a duripan. Sometimes, however, there are fractures in the duripan that will allow some plant roots to find a way down into and through the horizon. If the pan is shallow enough it can be broken by ripping, but this requires heavy equipment.

Cr Horizon

Weathered bedrock, or rock that is soft enough to slice with a knife or a shovel, is designated as a Cr horizon. It is rock material, with evidence of the original rock structure, but it is not hard enough to be designated R.

Transition Horizons

Master horizons rarely change abruptly from one to another. Instead, the changes occur gradually throughout a zone that may be 5 or 10 inches thick. These zones are called transition horizons. Three transition horizons are commonly seen.

AB Horizon

This transition horizon occurs between the A and B horizons. It is dominated by properties of the A horizon, but some of the properties of the B horizon are evident. Dark colors associated with organic matter are fading because organic matter is decreasing. The structure often changes from granular to subangular blocky.

BA Horizon

This horizon also occurs between the A and B horizons, but it has more of the characteristics of the B horizon. Generally, the structure will be the same type as the B horizon, but less strongly expressed. The color may be a little darker than the B horizon, or the clay content may be less than the maximum in the B horizon.

BC Horizon

This is a transition from the B horizon to the C horizon. Properties of the B horizon are dominant, but some influence of the C horizon is evident. Often the clay content will be less than the maximum in the B horizon but more than in the C horizon, or the color will be fading. If the C horizon is massive (no evidence of structure) and the BC horizon has definite evidence of structure, the transitional BC horizon should have larger units and be more weakly expressed than in the B horizon.

Subdivisions of Thick Horizons

Sometimes one or two of the horizons in a soil are so thick that they need to be subdivided. Small changes in texture, color, or structure are commonly used to make the subdivision.

Subdivisions, or vertical sequences within any single kind of horizon, are always indicated by a number immediately following the letter symbol(s). Here are a few examples of how some thick soil horizons can be subdivided:

Thick A horizon—A1, A2
Thick Bg horizon—Bg1, Bg2
Thick Bt horizon—Bt1, Bt2
Thick Bw horizon—Bw1, Bw2
Thick C horizon—C1, C2

More Than One Kind of Parent Material

Parent material is the geologic materials from which soils form. It may be a river deposit, volcanic ash, clays weathered from rock in place, or one of many other kinds of materials. When all the horizons of a soil have formed in a single kind of parent material, the master horizon designations are simply A, B, C, and R.

Some soils, however, have formed in more than one kind of parent material with one overlying the other. As examples, wind-deposited silts (loess) can be laid down over bedrock; fine alluvium (water-deposited material) over coarse alluvium or over bedrock, and volcanic ash may be deposited on top of glacial deposits.

If soil horizons are developed in more than one parent material, the number 2 is placed in front of the master horizon designation of the second parent material. The geologic material at the surface is always assumed to be the first one, and the number 1 is never used.

A third parent material is designated 3, and so on. Thus, a soil developed in silt loam over gravel could have the following set of horizons: A-AB-B-2BC-2C.

Definitions of Terms and Criteria for Land Evaluation

The following is an interpretation of the terms and criteria used on the land evaluation scorecard.

Part I. Soil and Land Characteristics

Soil Texture (Surface Soil and Subsoil)

Texture is the proportion of sand-, silt-, and clay-sized soil particles (Fig. 7) making up the soil minerals. (In events, a sample of soil material taken from the profile will be placed in a container at the event site to be used for estimating textures as in Fig. 5.)

Definition of Terms Used

Depending on how much sand, silt, and clay are present, we give the texture a name like sandy loam, clay loam, or silty clay loam (Fig. 7).

Texture is an important soil property because it is closely related to many aspects of soil behavior. The ease of tilling the soil and the ease of plant root development within the soil are both influenced by soil texture. Texture affects the amounts of air and water a soil will hold and the rate of water movement into and through the soil.

Plant nutrient supplies are also related to soil texture. Tiny silt and clay particles provide more mineral nutrients to plants than large sand grains. Sandy soils can be managed to improve their productivity, but they require more fertilizer and more frequent irrigation than soils with higher amounts of silts and clays.

Sand, silt, and clay are the three size classes of soil particles. *Gravel or coarse fragments greater than 2 mm, however, are not included in texture*. Sand particles range in size from 0.05 to 2 mm. They are large enough to see each grain with the naked eye, and they feel gritty.

Silt particles cannot be seen without a hand lens or

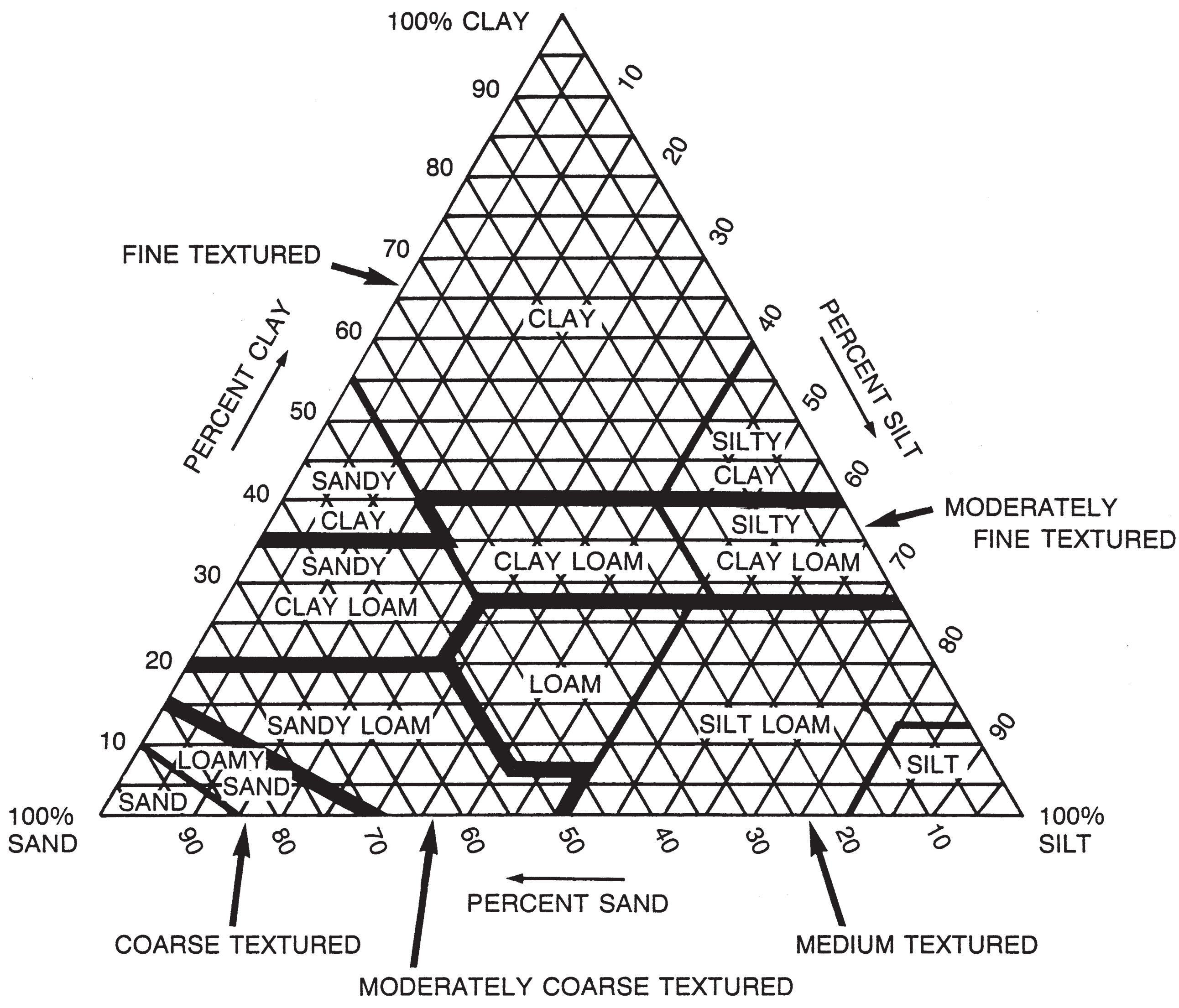

Fig. 7. Soil texture triangle with 12 textural classes. For land evaluation purposes, the 12 textural classes are grouped into five categories—coarse, moderately coarse, medium, moderately fine, and fine.

microscope. Silt has a smooth feeling, like flour or corn starch. It is not sticky.

Clay particles are less than 0.002 mm in size. They can be seen only with extremely high-powered microscopes. When wet, clay feels sticky and can be molded into "ribbons" or "wires" or other forms much like modeling clay used in grade school.

Every soil contains a mixture of various amounts of sand, silt, and clay. Since there are three size classes of particles, a three-sided **textural triangle** is used to show all the possible combinations (Fig. 7). We also use the triangle to form groups, or classes of soil texture, which are identified with a textural class name.

A soil that is primarily sand-sized particles would lie very close to the sand corner of the triangle. Its textural class name would simply be **sand**.

Similarly, a soil dominated by clay would lie near the clay corner of the triangle and is called **clay**.

Now consider a **mixture** of sand, silt, and clay. All three separates are present, though not in exactly equal proportions. (Actually, it takes less clay to balance the mixture than either sand or silt.) These soils lie in the lower center portion of the triangle and are called **loams**.

Now suppose we were to alter a mixture of sand, silt, and clay by adding more sand (Fig. 8). As sand begins to dominate, the texture class moves away from the center of the triangle toward the sand corner. The texture would change from loam to sandy loam and ultimately to a sand.

If we were to add clay to a loam, the textural class will move first to a clay loam, then a clay. If we were to add both silt and clay to a loam, the textural class moves away from the center toward something intermediate between silt and clay. The textural class becomes a silty clay loam.

Precise boundaries between textural classes are shown in Fig. 7. Each side of the triangle is a base line, or zero point, for the particle size in the opposite corner. If we know how much sand, silt, and clay a soil contains, we can easily plot its location on the triangle and determine the textural class.

Here's a simple example. Suppose we have a soil that contains 40 percent sand, 45 percent silt, and 15 percent clay. Start with the clay content. Go to the midpoint of the baseline running from sand to silt. Then go vertically up to the third horizontal line. Every soil along this horizontal line contains 15 percent clay.

Next, along with the baseline between silt and sand, locate the 40 percent sand line, which runs diagonally up and to the left. Follow this line up until it intersects the 15 percent clay line. Mark that point.

If you wish, you can find the 45 percent silt line (along the baseline between silt and clay) and follow it diagonally down and to the left to the same point. Note, however, that it only takes **two** points to determine the texture. This sample is a loam.

Field Determination of Texture

Determine soil texture in the field by wetting a tablespoon size portion of soil with water and working the soil between thumb and fingers. The "feel" of the different sized soil particles, excluding gravel, is used in estimating the amounts of sand, silt, and clay. Estimate sand by the gritty feeling. Estimate clay by the length of the ribbon formed (see Figs. 9, 10, and 11). The procedure for doing this is highlighted on page 16 in the next section, "Texture by Feel."

Four key points on the textural triangle provide guidelines to classify textures. These include: 27 percent clay, 40 percent clay, 20 percent sand, and 50 percent sand. These points don't exactly match the textural class boundaries on Fig. 7, but they're close enough to make good estimates.

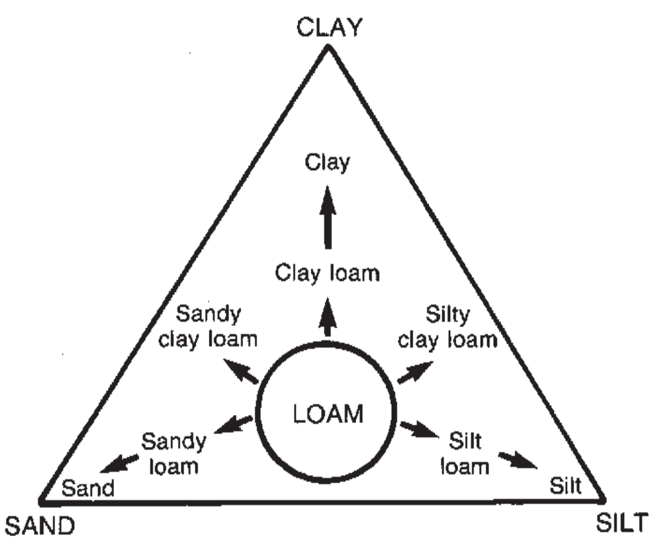

Fig. 8. Generalized texture triangle showing how theoretical additions of sand, clay, and silt move textural classes away from the centrally located loam textural class.

Fig. 9. A sandy loam textured soil, with 73 percent sand, 23 percent silt, and 4 percent clay, forms only a short, easily broken ribbon when squeezed between the thumb and fingers.

Fig. 10. A silty clay loam textured soil, with 3 percent sand, 68 percent silt, and 29 percent clay, forms a smooth ribbon about an inch in length before it breaks off.

Fig. 11. A silty clay textured soil, with 2 percent sand, 54 percent silt, and 44 percent clay, can be squeezed up and between thumb and fingers to form a ribbon 2 to 3 inches long before it breaks.

Study the locations of these key values carefully. Note that none of the texture names below 27 percent clay contains the word **clay**. Texture names between 27 and 40 percent clay contain both the words **clay** and **loam**. Textural class names above 40 percent clay contain the word **clay**, but not the word **loam**.

Similarly, soils having more than 50 percent sand all have names that include the words **sand** or **sandy**. If there is less than 20 percent sand, **silt** or **silty** is usually part of the name. If soil contains between 20 and 50 percent sand, neither silt nor sand is part of the name.

Other clues to the way each kind of soil texture feels are highlighted in the following section and in Table 1.

Texture by Feel

1. Fill the palm of your hand with dry soil.
2. Moisten the soil enough so that it sticks together and can be worked with the fingers. ***Don't saturate it to runny mud.*** If the soil sticks to your fingers, it's too wet to feel texture. Add more dry soil.
3. Knead the soil between your thumb and fingers. Take out the pebbles and crush all the soil aggregates. You may need to add a little more water.
4. Continue working the soil until you crush all the aggregates.
5. Estimate the sand content by the amount of textural grittiness you feel. *(Continued on page 19.)*

Table 1. Structural and textural characteristics commonly associated with each of the classes of permeability.

Permeability class	Soil characteristics	Type of structure	Texture class
1. Rapid over 6.0 inches/hr	Many large pores, no hardpan, low percentage of silt, very small amount of "sticky" clays	Subangular blocky, single grain	Loamy sand, sand
2. Moderate 0.2 to 6.0 inches/hr	High percentage of silt, weakly cemented hardpan, moderate amount of "sticky" clays	Prismatic, platy, angular and subangular blocky, granular	Silt, silt loam, loam, sandy clay loam, sandy loam
3. Slow 0.06 to 0.2 inch/hr	High bulk density, few pores, high amount of "sticky" clays	Prismatic, platy, angular blocky	Silty clay loam, clay loam, sandy clay
4. Very slow less than 0.06 inch/hr	Cemented hardpan, high bulk density, few pores, very high amount of "sticky" clay	Massive, columnar angular blocky	Clay, silty clay

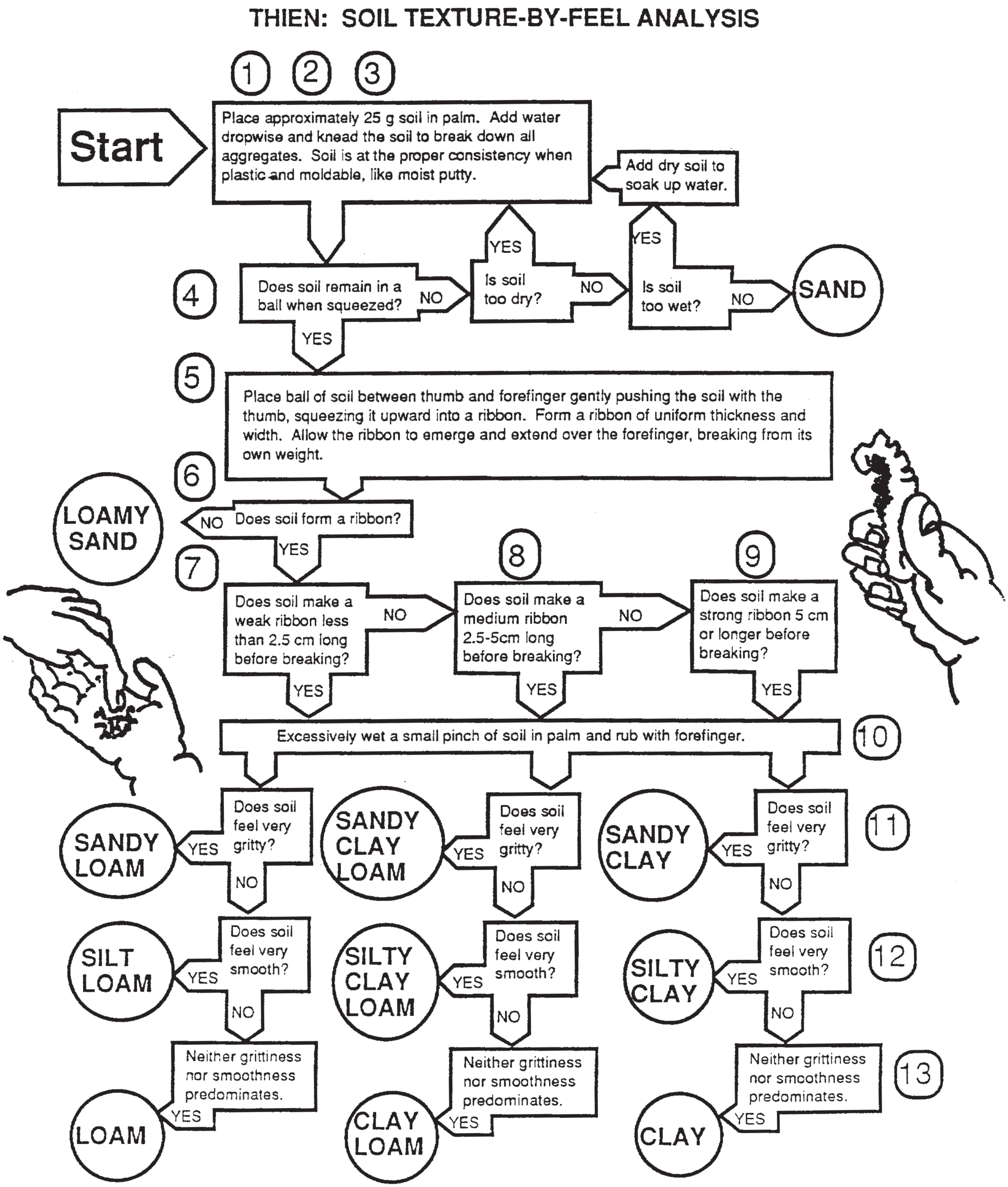

Fig. 12. Flow chart for determining soil texture by feel. Adapted from Thien, S. J., 1979, "A Flow Diagram for Teaching Texture-by-Feel Analysis," Journal of Agronomic Education, Vol. 8:54-55 by permission of the American Society of Agronomy.

Clues to the Feel of Textural Classes

Sand

— Moist sample collapses after squeezing.

— Your hands don't get dry working the sample.

Loamy Sand

— Sample has very little body.

— Moist soil barely stays together after squeezing.

— Just enough silt and clay to dirty your hands.

Sandy Loam

— Sand dominates noticeably.

— Enough silt and clay to give the sample body.

— Moist soil stays together after squeezing.

— Hardly forms any ribbon at all.

Sandy Clay Loam

— Feels gritty *and* sticky.

— Forms ribbon 1 to 2 inches (2.5 to 5 cm) long.

Sandy Clay

— Feels definitely sandy.

— Forms ribbon 2 to 3 inches (5 to 7.5 cm) long.

Loam

— Sand noticeably present, but does not dominate.

— Sample works easily between thumb and fingers.

— Contains enough silt and clay to give sample good body.

— Sample only forms short, broken ribbons.

Silt Loam

— Feels smooth, like flour or corn starch.

— Tends to be nonsticky.

— Only forms short, broken ribbons.

Clay Loam

— Noticeably gritty, but sand doesn't dominate.

— Noticeably sticky.

— Noticeably hard to work between thumb and fingers.

— Forms ribbons 1 to 2.5 inches (2.5 to 6 cm) long.

Silty Clay Loam

— Feels smooth and sticky.

— Contains very little sand.

— Forms ribbons 1 to 2.5 inches (2.5 to 6 cm) long.

Clay and Silty Clay

— Dry sample absorbs a lot of water before it is moist enough to work.

— Sample very hard to work between thumb and finger.

— Forms ribbon 2.5 to 4 inches (6 to 10 cm) long.

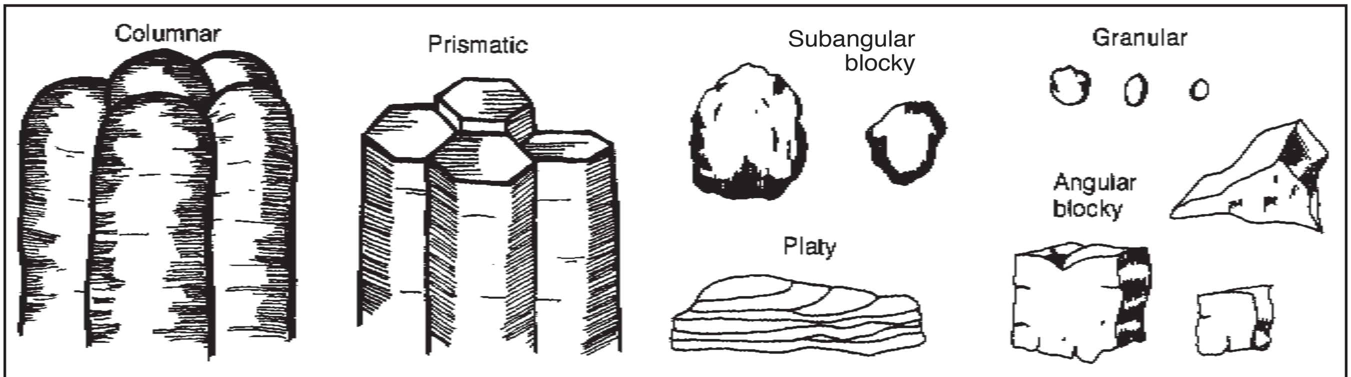

Fig. 13. Diagrammatic representations of various soil structure types.

a. More than 50 percent—Sand dominates. The textural name contains the word **sandy**.
b. 20 to 50 percent—Sand is noticeably present but not dominant. The texture is most likely **loam** or **clay loam**, though **silt loam** or **clay** are possible.
c. Less than 20 percent—Silt and clay dominate. The textural name is **silt loam**, **silty clay loam**, or **clay**.

6. Estimate the clay content by pushing the sample up between your thumb and index finger to form a ribbon.
   a. Less than 27 percent (Fig. 9)—The ribbon is less than 1 inch (2.5 cm) long. Textural names contain the word **loam** but not the word **clay**.
   b. 27 to 40 percent (Fig. 10)—The ribbon is 1 to 2 or 2.5 inches (2.5 to 5 or 6 cm) long. Textural names contain both the words **clay** and **loam**.
   c. More than 40 percent (Fig. 11)—Clay dominates. The ribbon is more than 2.5 inches (6 cm) long. The textural name contains the word **clay** but not the word **loam**.
7. Combine your estimates of sand and clay. Fig. 12 shows the Thien texture-by-feel soil analysis method.

		Sand (%)	
Clay (%)	**>50%**	**20 to 50%**	**<20%**
>40	Sandy clay	Clay	Clay Silty clay
27 to 40	Sandy clay loam	Clay loam	Silty clay loam
<27	Sandy loam Loamy sand Sand	Loam	Silt loam

Soil scientists recognize 12 soil textural classes (Fig. 7). For the purpose of Land Evaluation Events, soils are grouped into five broad textural categories. As you will see later, only three categories are used in the homesite evaluation. The moderately coarse, medium, and moderately fine soils are combined into the loamy textured category.

1. Coarse-textured soils	Sands Loamy sands
2. Moderately coarse-textured soils	Sandy loam Fine sandy loam Very fine sandy loam
3. Medium-textured soils	Loam Silt loam Silt
4. Moderately fine-textured soils	Clay loam Sandy clay loam Silty clay loam
5. Fine-textured soils	Sandy clay Silty clay Clay

Permeability

Soil permeability is the ability of the soil to transmit water or air. *The soil permeability is based on the most limiting horizon, that is, the topsoil or the subsoil.* Soils are placed into relative permeability classes based on soil texture and degree of cementation found in the topsoil or subsoil horizons and based on the most limiting of these properties. Soil structure (Fig. 13), bulk density (relationship between air and mineral volume), organic matter content, and other characteristics relating to pore space are also considered to a lesser extent. As the soil compaction increases, bulk density increases. Water infiltration, a term used to express the rate of water movement into a soil's surface, is related to soil permeability. Low infiltration rate of a soil, accompanied by slow permeability subsoil horizon(s), may result in water runoff, erosion, and limited root development.

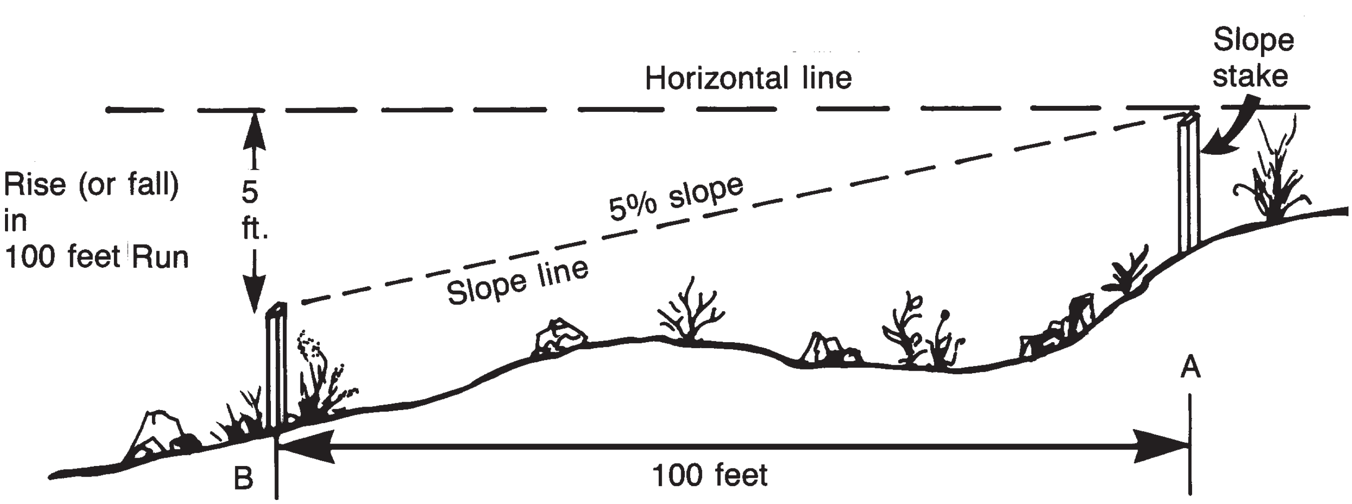

Fig. 14. Using the tops of the two slope stakes and ignoring the irregularities of the ground surface between the stakes, the fall from the top of stake A to the top of stake B is 5 feet. This translates into a 5 percent slope.

Soil Structure

Soil structure forms when individual grains of sand, silt, and clay are bound together in larger units called **peds** or **aggregates**. Plant roots, soil organic matter, and clay particles all provide physical and chemical binding agents. The shape of the peds formed determines the type of structure. The extent of ped formation and how distinctly the peds can be recognized together determine the **grade** of the structure.

Soil structure is important because it modifies some of the undesirable effects of texture on soil behavior. Strong granular structure creates relatively large pores that favor water entry into the soil and water movement within the soil. Even clayey soils, which tend to have very small pores, can have good rates of water movement if they have strong granular structure.

Good granular soil structure also means good aeration and a favorable balance between pores that contain air and pores that store water for plant use. Soils with good structure are easy to work and provide ideal environments for plant root growth. In short, good structure means good tilth.

Organic matter is vital to the formation and maintenance of good soil structure. The horizon of northern Idaho soils are naturally high in organic matter. Soil structure in these horizons tends to be well-developed, and peds resist breakdown from tillage and raindrop impact.

The horizons of southern Idaho soils are naturally low in organic matter. Soil structure tends to be weakly formed and unstable. These soils have slower entry of water (infiltration) and have a higher erosion hazard.

Keeping up the organic matter level is essential if you want to maintain good soil structure. Incorporation of animal wastes and crop residues into the soil is an excellent way to increase soil tilth. One of the real benefits of conservation tillage programs is that crop residues are used to form stable soil structure. You can determine both the type and the grade of soil structure by carefully observing the soil and by gently breaking it apart. The first step is to examine the subsoil sample in the container to see if structural peds are evident. If you can detect the shapes of individual peds, then the grade is probably strong.

The next step is to fill your hand with a large chunk of soil. Observe how easily the soil breaks and falls apart. The easier it breaks, the stronger the structure. Observe also the shapes of the peds that lie in your hand.

Then hold a large piece of the soil in both hands and gently apply pressure to break the soil apart. If the soil breaks easily along a natural plane of weakness, you've separated it into distinct peds. If the soil fractures randomly leaving an irregular, dull surface, you've simply forced a break through a ped.

The ease with which the soil mass breaks into peds and the amount of unaggregated soil that remains in your hand together indicate the structural grade. The shapes of the peds you broke out of the soil indicate the structural type.

Common types (or shapes) of soil structure include **granular**, **platy**, **blocky**, and **prismatic** (Fig. 13). Soils lacking peds are said to be either **massive** or **single** grain and represent the lack of structure.

Soil Depth

The depth of the soil includes the total thickness of the soil horizons readily penetrated by plant roots, water, and air. A restrictive layer may be dense clay (if it restricts roots), hardpan, or bedrock. Water, however, is not a restrictive layer. A white nail may be used in the flagged area to mark the depth of the soil. Information concerning the total depth may also be placed on the placard.

1. **Very Shallow**—Soils less than 10 inches deep.
2. **Shallow**—Soils 10 to 20 inches deep.
3. **Moderately Deep**—Soils 20 to 40 inches deep.
4. **Deep**—Soils 40 to 60 inches deep.
5. **Very Deep**—Soils over 60 inches deep.

Slope

Slope, given in percent, is the number of feet of rise (or fall) in 100 feet of horizontal distance (**run**). This is one of the most important factors to be considered in good land management. Runoff increases with slope, which contributes to an increase in the erosion hazard for most uses of the land.

Slope can be measured by several methods. A transit or other surveying instrument gives the most precise measurement. Hand-held devices such as a clinometer or an Abney level are faster and usually precise enough for most purposes. Participants and advisors should practice with a clinometer before the event.

Slope-measuring devices of any kind are not permitted in an event. The slope must be estimated by visual observation. This may be difficult, especially in areas of rolling topography. Looking up a slope or down a slope can sometimes create an illusion of excess steepness or lack of steepness.

To estimate a slope (Fig. 14), stand at one end of the slope line (Point A) and project a horizontal line to the other end of the slope line (Point B). The theoretical horizontal line can be determined with the aid of the horizon or by selecting a distant point on the horizon that appears to be at an equal elevation. Estimate the distance from the top of stake B to the point on the theoretical horizontal line immediately above stake B. This is the feet of fall, and since the two slope stakes are 100 feet apart, the feet of rise (or fall) is the same as percent slope.

Move to point B, look back at point A, and use the same method to estimate the distance from the top of stake A to the theoretical horizontal line. If the estimated slopes obtained from point A and point B are the same, this is probably a good estimate of the slope. If they are not the same, take the average of the two values.

If the two slope stakes are not 100 feet apart, this formula is used to calculate the percent slope:

$$\frac{\text{Rise (or fall) in feet}}{\text{Run in feet}} \times 100 = \%\ \text{slope}$$

Note: When the horizontal run is 100 feet, the two 100s cancel so that the feet or rise (or fall) is the same as percent slope.

A further check of the estimated slope can be obtained by standing to the side of the slope line (perpendicular) and trying to establish a theoretical horizontal line from the top of one of the two slope stakes. Again the distance from the theoretical horizontal line to the top of the other stake will give the feet of rise (or fall) from the top of one stake to the other. Establishing the theoretical horizontal line can be aided by the earth's horizon that can be observed behind the two stakes. Averaging the three estimates may give the closest approximation of the actual slope. If a big discrepancy exists, rechecking one or more of the estimates may be warranted.

There are two possible slope groupings: (1) grouping for nonirrigated cropland, rangeland, and woodland, and (2) grouping for irrigated cropland. *All irrigated cropland is considered to be surface-irrigated*. Irrigated cropland is much more likely to have erosion problems so the permitted slopes are necessarily much more gentle.

	Nonirrigated cropland, range, and woodland	**Irrigated cropland**
1. Nearly level	0 to 3%	0 to 1%
2. Gently sloping	3 to 8%	1 to 3%
3. Moderately sloping	8 to 12%	3 to 5%
4. Strongly sloping	12 to 20%	5 to 8%
5. Steep	20 to 45%	8 to 12%
6. Very steep	more than 45%	more than 12%

Erosion—Wind and Water

Erosion is the loss of soil by wind and water. Loss of soil can be highly detrimental to crop production. The surface soil, which is usually the soil material lost, is the most productive portion of the soil. It is a fact that less productive soils are usually more erosive, thus the more a soil is eroded the more susceptible it becomes to erosion.

Soils in the land evaluation event will be evaluated on erosion that has occurred in the past. Determining the amount of erosion will be a simple calculation based on original depth of soil material and the depth of soil material existing at present. The original depth of soil material will be given on the placard. When the existing topsoil depth is difficult to determine, evaluators may mark the present depth of the topsoil with a white nail in the flagged area. Information concerning the present topsoil depth may also be placed on the placard.

Note: Since soil horizons will vary from area to area and the official evaluators may interpret the depths of soil material differently, the information given on the placard may vary from event to event.

As an example, the original depth of topsoil given on the placard may be given as ". . .depth of topsoil 22 inches," which represents the soil layers readily penetrated by plant roots, water, and air. This is the most productive portion of the soil profile. This information will help the participant decide what part of the existing profile needs to be measured (estimated) to calculate the soil loss. When determining the existing depth of the topsoil, use a sharp object outside the flagged area to feel and/or see the first change in soil texture, soil structure, or soil color.

If for an example the remaining depth is 10 inches and the original depth given on the placard is 22 inches, then the formula for calculations is 12/22 x 100 = 55 percent soil loss from erosion. The following categories will be used in evaluating:

1. **None to Slight**—Less than 25 percent of the soil has been removed.
2. **Moderate**—25 to 75 percent of the soil removed.
3. **Severe**—More than 75 percent of the soil removed.
4. **Very Severe**—More than 75 percent of the soil removed with frequent uncrossable gullies or severe accumulation by wind.

Surface Runoff or Surface Drainage

Surface runoff results from a combination of natural factors including land slope and water infiltration rate of the soils. Surface runoff refers to the relative rate at which water is removed by flow over the surface of the soil when no vegetation is present on the soil.

1. **Rapid**—Surface water flows rapidly. A considerable amount of precipitation is lost from the surface, which increases the hazard of erosion and reduces available water for plants. This may be critical under nonirrigated cropland. Fields with slopes of 3 percent and above (except for coarse-textured and moderately coarse-textured surface soils) would be placed in this category.
2. **Moderate**—This is considered as "normal" runoff from soils with slopes of 1 to 3 percent (except for coarse-textured and moderately coarse-textured surface soils).
3. **Slow**—Surface water flows away slowly and surplus water may be a problem. This category includes nearly level areas (less than 1 percent slope) with medium- and moderately fine-textured surface soils. Included in this category are all soils with coarse-textured or moderately coarse-textured surfaces with all slopes.
4. **Very Slow**—Surface water flows away very slowly. Includes soils on nearly level slopes (less than 1 percent) with fine-textured surface soil.

Subsoil or Internal Drainage

Subsoil drainage is that quality of a soil that permits the downward flow of excess water through the profile. Free water (a water table) is sometimes present in a soil profile. Where not obvious, the depth of the water table will be given on the placard. The definitions below consider both movement of water through the soil profile and the presence of a water table:

1. **Excessively**—Rarely saturated with water and excess amounts drain away quickly, causing droughty conditions. Includes only rapidly permeable soils.
2. **Well**—Saturation with water is limited to only a few days, and plant roots are not injured.
3. **Somewhat Poorly**—Saturation with water (water table) in root zone (upper 4 feet of profile) is limited to 1 or 2 weeks each year during the growing season. This will injure plant roots.
4. **Poorly**—Saturation with water (water table) in root zone (upper 4 feet of profile) for 2 to 12 weeks each year during the growing season. This severely injures plant roots so that crop yield is appreciably reduced or the crop is destroyed. Few visible mottles.
5. **Very Poorly**—Saturation with water (water table) in root zone during most of growing season (more than 12 weeks). Suitable only for grazing and hay production. These soils have many visible mottles.

Climate

Climatic limitations affect crop production and thus are considered in land capability classification. A short growing season and low natural precipitation where irrigation water is unavailable are limitations in many parts of Idaho. Availability of irrigation water will be given on the placard.

1. **Good**—More than 140 frost-free days along with 14 or more inches of average annual precipitation. If less than 14 inches of average annual precipitation occurs, irrigation water must be available.
2. **Fair**—100 to 140 frost-free days and/or 10 to 13 inches of average annual precipitation. If less than 10 inches of average annual precipitation occurs, irrigation water must be available.
3. **Poor**—Less than 100 frost-free days and/or less than 10 inches of average annual precipitation with irrigation water not available.

Major Factors

The following major factors are considered in selecting the land capability class. Any one or more factors that would keep the area out of Class I land will be checked.

1. **Surface Texture**—Surface soil texture is a major factor for coarse-textured, moderately coarse-textured, and fine-textured soils. Coarse-textured soils can be no better than Class III because of wind erosion hazard.
2. **Subsoil Texture**—Subsoil texture is a major factor for coarse-textured and fine-textured soils only.
3. **Permeability**—Only rapid and very slow permeabilities will be major factors.
4. **Depth**—Only moderately deep, shallow, and very shallow soils will be major factors.
5. **Slope**—Any slopes more than nearly level will be major factors.
6. **Erosion**—All conditions except none to slight will be major factors.
7. **Surface Runoff**—Only rapid or very slow will be major factors.
8. **Subsoil or Internal Drainage**—Excessive, somewhat poor, poor, and very poor drainage conditions will all be major factors.
9. **Climate**—Fair and poor climates are major factors.
10. **None**—Class I land, with no major factors.

Land Capability Classes

The following are broad definitions. See "General Guide for Selecting Land Capability Classes" (page 23).

Land suited for cultivation and other uses such as grassland, forestry, wildlife, and recreation.

Class I—These soils have few limitations that restrict their use.

Class II—These soils have some limitations that reduce the choice of plants, or require special conservation practices, or both.

Class III—These soils have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Class IV—These soils have very severe limitations that restrict the choice of plants, or require careful management, or both.

Land suited for grassland, forestry, wildlife, and recreation. Not suited for cultivation.

Class V—These soils have little or no erosion hazards (nearly level slopes) but they have very poor drainage, which limits their use largely to grassland, hayland, wildlife habitat, or wetlands area.

Class VI—These soils have severe limitations that make them generally unsuited for cultivation and limit their use largely to grassland, woodland, or wildlife habitat. They may be cultivated sufficiently to establish permanent cover.

Class VII—These soils have very severe limitations that restrict their use mostly to grassland, woodland, or wildlife habitat. Use is restricted to pasture grasses, wildlife, recreation, woodland watershed, and aesthetics.

Class VIII—These soils and land forms have limitations that preclude their use for commercial plant production and restrict their use to wildlife, recreation, water supply, or aesthetic purposes.

General Guide for Selecting Land Capability Classes

Soil factor	Best land class possible
A. Surface Texture	
Coarse-textured	III
Moderately coarse-textured	II
Medium-textured	I
Moderately fine-textured	I
Fine-textured	II
B. Subsoil Texture	
Coarse-textured	II
Moderately coarse-textured	I
Medium-textured	I
Moderately fine-textured	I
Fine-textured	II
C. Permeability	
Rapid	III
Moderate	I
Slow	I
Very slow	III
D. Depth—Surface and Subsoil	
Very shallow	VII
Shallow	IV
Moderately deep	III
Deep	I
Very deep	I
E. Slope	
Nearly level	I
Gently sloping	II
Moderately sloping	III
Strongly sloping	IV
Steep	VI
Very steep	VII
F. Erosion Loss	
None to slight	I
Moderate	II
Severe	VI
Very severe	VIII
G. Surface Runoff	
Rapid	III
Moderate	I
Slow	I
Very slow	II
H. Drainage	
Excessively	III
Well	I
Somewhat poorly	II
Poorly	IV
Very poorly	V
I. Climate	
Good	I
Fair	II
Poor	III

Part II. Recommended Land Treatments

Recommendations for land treatments are ***based on the highest and best potential use of the land.*** Regardless of the present use of the "field," recommended land treatments should be ***based on the land capability class***. The following are land treatment considerations to be applied in the management of different land capability classes:

Vegetative

1 through 4. **Conservation Cropping Systems**—These practices apply to the use of rotations that contain grasses and legumes (soil conserving and/or improving crops) as well as sequences in which the desired benefits are achieved without use of such crops. Soil-conserving crops are close-seeded crops that tend to prevent or retard erosion and maintain organic matter. Soil-improving crops are grasses and legumes that improve soil structure and tilth, organic matter levels, and water infiltration. Use soil conserving and/or improving crops as follows:

a. Not necessary—applicable to Class I.

b. Every fourth or fifth year—applicable to Class II.

c. Every third or fourth year—applicable to Class III.

d. Every second or third year—applicable to Class IV.

5. **Crops Residue Use**—Use plant residues in cultivated fields to prevent erosion and improve the soil. *Do not burn residues*. Applies only to potential cultivated soils (classes I, II, III, or IV). Even if the "field" is not presently used for cultivated crops, but the soil has the potential for cultivated crops, this category should be marked.
6. **Weed Control**—Could apply to all land classes. In general, five or more weed plants or any noxious weed within the boundary of the field being evaluated would be considered a weed problem. However, because there could be different interpretations of what determines a weed (alive or dead, native or not part of the current crop) in a given area or land evaluation site the weed control box will always be marked for all land classes. No information will be given on the placard concerning noxious weed problems or other weeds.
7. **Strip Cropping**—Using alternate strips of land for various crops or fallow conditions to control water and wind erosion. Would apply to land classes III and IV (nonirrigated).
8. **Brush and Tree Control**—This implies the use of chemical sprays and/or specialized machinery. The purpose is to improve the desirable vegetative cover by removing or killing undesirable brush, trees, or timber so that the land can be farmed as is

the case for land classes I to IV. This practice should not be used when brush material can be controlled by normal farm plowing—Sagebrush, rabbitbrush, and similar plants can usually be removed with normal land preparation, so their removal would not be considered to be brush control. For pasture, range, wildlife, or woodland (classes V and VI) normal land preparation will remove undesirable brush, trees, or timber that may inhibit improved grass production, so their removal would not be considered to be brush control. In wetland or riparian areas the planting of brush and trees is encouraged especially in land classes VII and VIII and should not be removed.

9. **Grasses and Legumes**—This practice is to be used on lands not producing suitable permanent vegetation or on idle or cultivated lands not suitable for cultivated crops. Because of differences in interpretation as to what is considered suitable and practical, this practice will be used for all land classes V, VI, and VII except where tree plantings are made.
10. **Pasture, Range, Hay Management**—Use proper treatments of grasses and legumes to maintain optimum vegetative production. Only apply this practice on Land Classes V and VI, where reseeding is planned. If reseeding is planned, that information will be given on the site placard.
11. **Tree Planting**—Planting tree seedlings or cuttings to establish a stand of forest trees. *Not suitable for Class V lands.*
12. **Woodland Harvest Cutting**—Removing marketable trees from woodland.
13. **Wildlife, Recreation, and Watershed**—Retaining, establishing, or managing wildlife habitats and watersheds and installing needed structures or revegetation for recreation, wetland, and riparian management lands (includes Class V through VIII).

Mechanical—Irrigated/Dryland Only

For Classes I, II, III, and IV, Irrigated Land Only

14. **Sprinkler Irrigation (for slopes >3 percent)**—On slopes >3 percent, a sprinkler system is recommended to reduce potential surface erosion. If this occurs, mark this category.
15. **Irrigation Water Management**—Use and management of irrigation water so that the quantity of water used for each irrigation is determined by the moisture-holding capacity of the soil and the need of the crop (evapotranspiration). This means applying the water at such a rate and in such a manner that the crops can use it efficiently, and significant erosion and leaching does not occur.
16. **Water Control Structures (for slopes <3 percent)**—For water management in a surface irrigation system, structures are needed to convey water. They may include diversions, canals, ditches to control direction or rate of flow, maintain a desired water surface elevation, and remove excess tail-water and sediments at the end of the field. If all of these are not included in the field, mark this category.

For Classes I, II, III, and IV, Dryland Only

17. **Diversion or Terrace**—A channel with a supporting ridge on the lower side constructed across the slope, or an earth embankment or ridge and channel constructed across the slope at a suitable spacing and grade. Used on moderately sloping land.
18. **Grass Waterway**—A natural waterway or outlet shaped or graded with suitable vegetation as needed for the safe disposal of runoff. Used on moderately sloping lands.
19. **Contour Farming**—Conducting farming operations on sloping land in such a way that plowing, land preparation, planting, and cultivation are done on the contour. Used on moderately or strongly sloping land ranging from 8 to 20 percent.
20. **Plow Uphill**—Severe tillage erosion occurs on moderately and strongly sloping land (8 to 20 percent slopes) when the plow furrow-slice is continually thrown downhill. On these lands all moldboard plowing should be limited and done only by throwing the furrow slice uphill. In addition to preventing tillage erosion, this also tends to leave more surface residue and a rougher surface, which reduces runoff on moderately and strongly sloping land.

Mechanical—Irrigated and Dryland

For Classes I, II, III, and IV,
Both Irrigated and Dryland

21. **Subsurface Drainage System**—A graded ditch or buried tile of a designated size for collecting subsurface water within a field or area. *Used on somewhat poorly and poorly drained areas and only where these systems have been used historically.* Installation of a drainage system is no longer allowed because of federal wetland regulations. Very poorly drained areas should be restored to their original conditions.
22. **Minimum Tillage**—Limiting the number of cultural operations to those that are properly timed and essential to produce a crop and prevent soil erosion, compaction, and structural changes. Minimum tillage is also essential to decreasing soil erosion by increasing the amount of crop residue left on the soil surface.

Fertilizers and Soil Amendments

Use fertilizer materials and soil amendments as determined by soil tests to achieve economical responses, optimum production, and improve the soil.

Soil test information for the "field" pertaining to need for lime or gypsum and to correct deficiencies of nitrogen (N), phosphorus (P), potassium (K), and zinc (Zn) will appear on the placard. Information given will include soil pH and concentrations (ppm) of N, P, K, and Zn. Also, the availability of organic materials, such as manure, which can be applied to the "field," will be given on the placard.

No set limits on lime, gypsum, or fertility requirements will fit all areas and all crops. Each has its own levels. This is to acquaint the participants with present day terminology and provide some practical knowledge about soil amendment and soil fertility needs for Idaho crops and soils.

Levels of nutrients needed in soils (indexes) to produce crops depend on extraction methodology and have to be correlated to field response in research trials.

23. **Nitrogen**—Low levels of N in Idaho soils are less than 20 ppm NO_3-N in the plant root zone. However, soils up to 40 ppm of NO_3-N do require additional N as commercial fertilizers for most crops (other than legumes). When values of less than 40 ppm are shown on the placard, check No. 23 on the scorecard. Excessive N fertilizer should be avoided to decrease the NO_3-N leaching potential.
24. **Phosphorus**—Low levels of P in Idaho vary with the soil characteristics and the crop being grown. In general, apply P fertilizer when a soil test in the sample taken to the 12-inch soil depth is below 6 ppm on acid soils (pH less than 7.0) and 15 ppm on alkaline soils (pH greater than 7.0). A pH of 7.0 will not be used in the contests. When P fertilizer is needed, check No. 24 on the scorecard.
25. **Potassium**—Low levels of K in Idaho also vary with the soil characteristics and the crop being grown. In general, apply K fertilizer when the soil test in the sample taken to the 12-inch soil depth is below 80 ppm on acid soils (pH less than 7.0) and below 150 ppm on alkaline soils (pH greater than 7.0). A pH of 7.0 will not be used in the contests. Check No. 25 on the scorecard when K is needed.
26. **Micronutrients**—Zinc is the most common micronutrient for which deficiencies have been observed in Idaho soils. When zinc levels are shown below 0.6 ppm in the soil sample taken from the 0- to 12-inch soil depth, check No. 26 on the scorecard.
27. **Lime**—Soils with pH values of 4 to 5 usually require lime for maximum crop production. When field pH values are less than 5.7, check No. 27 on the scorecard.
28. **Gypsum**—Soils having pH values above 8.5 are called alkali (sodic or sodium-affected) soils and may require a source of calcium to replace the sodium to allow correction of the problem. Gypsum is a good source of calcium. If the soil pH is greater than 8.5, check No. 28 on the scorecard.
29. **Organic Matter**—Livestock manures, composts, or other organic materials are valuable in increasing soil organic matter. When any organic material is shown on the placard as being available for use, check No. 29 on the scorecard.
30. **Fertilizer or Amendments Not Needed**—When all nutrients are high in the soil, no organic material is available and pH values are between 5.7 and 8.5, check No. 30 on the scorecard.

Example—Information on the placard shows:

Soil pH	7.5	ppm
Nitrogen (NO_3N)	20	ppm
Phosphorus (P_2O_5)	8	ppm
Potassium (K_2O)	300	ppm
Zinc	2	ppm

No statement that manure or compost is available. On the scorecard, check No.'s 23 (nitrogen) and 24 (phosphorus).

Homesite Evaluation

This part of the event is designed to emphasize the importance of soils and their limitations for non-agricultural purposes. Many of the soil and land characteristics used in evaluating soils for agricultural use will also be used in evaluating an area for a homesite. The event is based on use of the site for a single family dwelling without a basement, and related uses.

While this event/activity is limited to homesites, the importance of a soil's suitability for parks and playgrounds, roads streets, and other nonagricultural uses could also be stressed.

Limitations for Nonagricultural Use

The discussion of individual soil characteristics to be considered are related to limitations for a specific use. The limitations are defined as follows:

Slight—Those soils or locations that have properties favorable for the planned use with little or no problems.

Moderate—Those soils or locations that have properties only moderately favorable for the planned use. Limitations can be overcome or modified with special planning, design, or maintenance. Special treatment of the site for the desired use may be necessary.

Severe—Those soils or locations that have one or more properties unfavorable for the planned use. Limitations are difficult and costly to modify or overcome for the use desired.

Very Severe—Those soils or locations that have one or more features so unfavorable for a particular use that overcoming the limitation is very difficult and expensive. For the most part, these kinds of soils should not be used for the purpose for which they are being rated.

Factors Affecting Suitability

Texture

This refers to the texture of the surface soil. (See Land Evaluation section on pages 14-19 for help in determining soil texture.) Surface texture is not a factor for sewage lagoons because lagoons are dug below the surface, and most of the surface soil is used to make the banks around the lagoon. You will notice that the textural groupings for homesite evaluation are different from those used in land evaluation. In homesite evaluation, only three soil textural groupings are used (Fig. 15) instead of the five soil textural groupings used in land evaluation.

1. Sandy soils (coarse-textured soils)	Sands Loamy sands
2. Loamy soils (moderately coarse-, medium-, and moderately fine-textured soils)	Sandy loam Loam Silt loam Clay loam Sandy clay loam Silty clay loam
3. Clayey soils (fine-textured soils)	Sandy clay Silty clay Clay

Sandy Soils—Moderate limitations for all uses. May require stabilization with organic material and/or loamy topsoil to improve capability of the soil to hold and supply moisture and nutrients for desired plant growth. Water and wind erosion may be a problem during construction. Shrink-swell potential is very low.

Loamy Soils—None to slight limitations for all uses. Exercise care during construction to be sure the surface soil is not covered by less desirable subsoil material.

Clayey Soils—Severe limitations for uses other than sewage lagoons. Soil is sticky when wet, hard when dry, and difficult to work when used for lawns, flower beds, shrubs, and gardens. The soils crack when dry and swell when wet. Clayey soils have a high shrink-swell potential. Special planning and design are required for foundations. May be droughty and need frequent additions of low rates of water for establishing and maintaining vegetative growth.

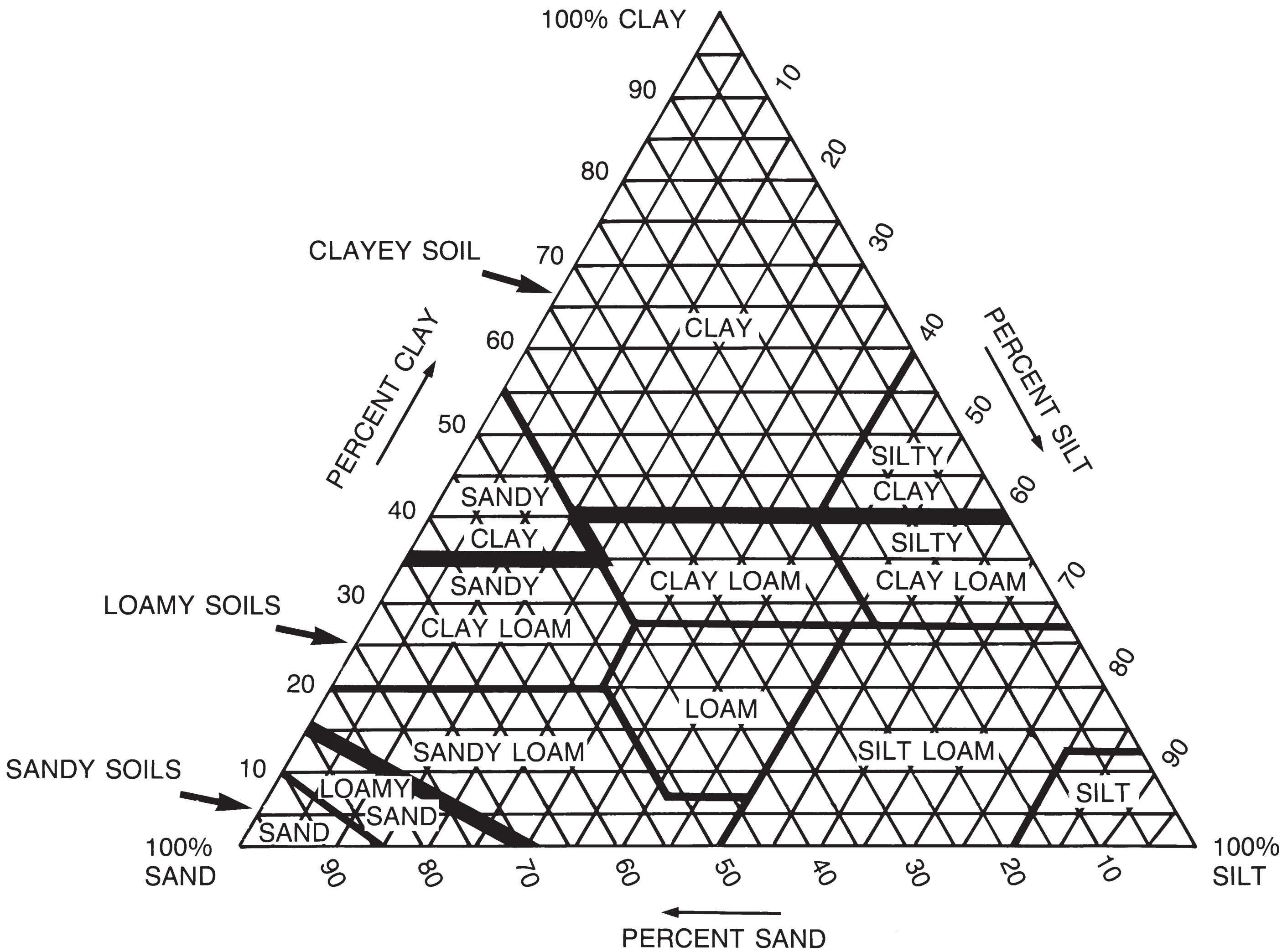

Fig. 15. Soil texture triangle for homesite evaluation with the three textural groupings—sandy, loamy, and clayey.

Permeability

This refers to the rate of movement of water or air through the subsoil. This is considered internal drainage and is based on soil texture and soil structure. (For help in determining soil permeability, refer to Land Evaluation section on pages 16 and 19.)

Laterals for septic systems may be located below the subsoil in some soils. For that reason, this should serve as a warning, and final design should be based on a detailed on-site evaluation to determine suitability where soils are slowly permeable. It is an important factor in deciding between a septic tank system or a sewage lagoon. Soil percolation tests would be required before making further plans.

Rapid Permeability—Soils generally are sandy loam or sandy textured throughout. Permeability is greater than 6.0 inches per hour. *Moderate limitations* exist in use for septic tank system disposal field due to the fact that sewage water may be percolated away too rapidly. (1) *Slight limitations* also exist for foundations; (2) *moderate limitations* for lawns, shrubs, and gardens; and (3) *very severe limitations* for sewage lagoons. Seepage from lagoons would make it difficult to maintain adequate depth of water and could contribute to pollution of groundwater.

Moderate Permeability—*Slight to moderate limitations*. Soils are generally medium textured, but also includes silty clay loam or clay loam with strong structure or compacted sandy loam. (1) *None to slight* limitations for septic tank systems, lawns, shrubs, and gardens. Permeability ranges (0.2 to 6.0 inches per hour) would indicate a need for a percolation test if thought to be on the low side of the range. (2) *Moderate limitations* for sewage lagoon as leakage may occur. *None to slight* limitations for foundations.

Slow Permeability—*Severe limitations for septic tank systems*. Soils generally would include moderately fine-textured soils with weak to moderate structure and fine-textured soils with strong structure. Water movement is 0.06 to 0.2 inch per hour. Percolation tests would be required for design of septic tank disposal field. Limitations would be (1) *none to slight* for sewage lagoons, (2) *moderate* for foundations and lawns, shrubs, and gardens.

Very Slow Permeability—*Very severe limitations for septic tank systems*. Soils are fine-textured (silty clay, sandy clay, and clay). Soil structure is usually not well developed with tendency toward massive (without structure). Water movement is less than 0.06 inch per hour. Percolation tests would be required for design of septic tank disposal field. Limitations would be (1) *none to slight* for sewage lagoon, (2) *moderate* for foundations, and (3) *severe* for lawns, shrubs, and gardens.

Soil Depth

The depth of the soil includes the total thickness of soil layers readily excavated for construction purposes. These are also the soil layers that are readily penetrated by plant roots, water, and air. A restrictive layer is clay, hardpan, or bedrock. The degree of limitation due to restricted soil depth will vary greatly for different uses. Use Table 2 as a guide for evaluation of soil depth for desired uses.

Slope

Slope of the land, given in percent, is the number of feet of rise (or fall) in 100 feet of horizontal distance (run). For further explanation and guides to estimating slope, see discussion of slope under the Land Evaluation section (pages 19 and 20). Broader and different slope groupings are used for homesite consideration than normally apply to agricultural uses of the land. Table 3 will aid in the interpretation of limitations based on the slope of the site.

Table 2. Effect of soil depth on limitations for a homesite.

Site characteristic	Depth in inches	Foundations w/o basement	Lawn, shrubs, and gardens	Septic system	Sewage lagoon
V. shallow	less than 10	Severe	V. severe	V. severe	V. severe
Shallow	10 to 20	Moderate	Severe	V. severe	V. severe
Moderately deep	20 to 40	None to slight	None to slight	Severe	Severe
Deep	40 to 60	None to slight	None to slight	Moderate	Moderate
Very deep	over 60	None to slight	None to slight	None to slight	None to slight

Table 3. Effect of slope on limitations for a homesite.

Site characteristic	Slope (%)	Foundations w/o basement	Lawn, shrubs, and gardens	Septic system	Sewage lagoon
Near level	0 to 3	None to slight	Moderate	None to slight	None to slight
Gently sloping	3 to 5	None to slight	None to slight	None to slight	None to slight
Moderately sloping	5 to 8	Moderate	Moderate	None to slight	Moderate
Strongly sloping	8 to 15	Severe	Severe	Moderate	Severe
V. strongly sloping	over 15	V. severe	V. severe	Severe	V. severe

Erosion

Erosion is the loss of soil material due to the action of wind and water. Loss of soil can be highly detrimental to homesite and other uses of the land. The surface soil, which is usually the soil material lost, is the most productive portion of the soil. The loss of topsoil or surface soil is not as critical for homesite uses as it is for agricultural uses. This is true because the small area involved in a homesite allows developers to haul in topsoil to replace the loss.

Soils in the event will be evaluated on erosion that has occurred in the past. The determination of the amount of erosion will be a simple calculation based on original depth of soil material (given on the placard) and the amount of soil lost to reach the presently existing depth. For further information on calculating losses, see discussion of erosion under Land Evaluation section (page 21).

None, Slight, and Moderate (less than 75 percent of soil lost)—None to slight limitations for all uses.

Severe (75 to 100 percent of soil lost)—Slight limitations for foundations, severe limitations for lagoons, and moderate limitations for other uses. May require leveling, modification of surface, or bringing in topsoil for lawns, gardens, septic systems, etc.

Very Severe (75 to 100 percent soil lost with uncrossable gullies)—Very severe limitations to all uses.

Surface Runoff

This is generally an important factor in connection with drainage, permeability, and erosion. Special attention needs to be given to surrounding areas including features outside the site or "field" being evaluated. Runoff from adjacent areas onto contemplated building site and the possibility of ponding and water accumulations on the homesite need consideration. Surface runoff is not a factor for sewage lagoons because they will be protected from outside water.

Rapid—Occurs on slopes greater than 3 percent but does not include sandy-textured surface soils. Severe limitations require care to maintain and prevent erosion on lawns. None to slight limitations for foundations or septic system.

Moderate—None to slight limitations for all uses. Occurs on slopes of 1 to 3 percent, but does not include sandy surface textures.

Slow—Occurs on sandy-textured surface soils on all slopes. None to slight limitations for all uses.

Very Slow—Occurs on slopes (<1 percent), but does not include sandy-textured surface soils. Severe limitations may require costly modification for foundations and special design of septic tank disposal fields. Moderate limitations for lawns, shrubs, and gardens.

Shrink-Swell

Shrink-swell is the property of soil to swell when it is wetted and to shrink when it dries. The tendency to shrink and swell is related to the amount and type of clay present. Because it is important in foundation design, this factor should have special consideration. The most clayey layer in the profile is generally considered in relation to shrink-swell. In the event, consider the shrink-swell of the heaviest (most clayey) of the surface soil or subsoil. Shrink-swell is not generally a factor for lawns, shrubs, and gardens.

Low—Soil texture classes included in this category are sands, loamy sands, and all sandy loams. There are none to slight limitations for all uses.

Moderate—Soil texture classes included in this category are silt, silt loam, loam, clay loam, silty clay loam, and sandy clay loam. There are none to slight limitations for sewage lagoons and moderate limitations for other uses.

High—Sandy clay, silty clay, and clay texture classes fall into this category. These have severe limitations for foundations, septic systems, and other uses except none to slight limitations for sewage lagoons.

Water Table

The internal wetness of an area is influenced by most of the factors previously discussed. Generally, internal drainage is a reflection of permeability and topographic position. For example, a very slowly permeable soil exhibits poor to very poor internal drainage. The presence and depth of a water table is not necessarily a reflection of soil permeability. It must be evaluated on the basis of depth and permanency, frequently requiring study during different seasons of the year. Attention should be given to features outside the "field" being evaluated with special attention to topographic position, stream channels, and evidence of a water table. Unless obvious, water table depth or seasonal fluctuations will be given on the placard. Use Table 4 as a guide for water table depth.

Deep—None to slight limitations for all uses. No evidence of water table above 72 inches.

Table 4. Depth to water table.

Degree of limitations	Foundations for buildings	Lawns and landscaping	Septic systems absorption fields	Sewage lagoons
	(inches)	(inches)	(inches)	(inches)
Slight	more than 36	more than 24	more than 72	more than 60
Moderate	24 to 36	12 to 24	48 to 72	36 to 60
Severe	less than 24	less than 12	less than 48	less than 36

Moderately Deep—Temporary or permanent water table present at depth of 48 to 72 inches.

Shallow—Temporary or permanent water table at depths less than 48 inches.

Flooding

The occurrence of floods is a factor frequently overlooked. Flooding may not occur on an area for many years; then a serious flood may occur. Urban development on a small stream watershed can increase runoff up to 75 percent, thus greatly increasing flooding hazard. Soils can give an indication, but records must be studied to determine the true condition. Position on the landscape and proximity to nearby streams are good indicators of frequency of flooding. Attention should be given to features outside the "field" being evaluated. Frequency of flooding will be given on the placard at the site.

None—No flooding. Limitations none to slight for all uses.

Occasional—Flooding occurs infrequently under usual weather conditions. For a period of record, flooding occurs 50% or less of the time. Moderate limitations exist for foundations, lawns, shrubs, and gardens; severe limitations exist for septic tank drain fields and sewage lagoons.

Frequent—Flooding occurs infrequently under usual weather conditions. For a period of record, flooding occurs more than 50% of the time. Very severe limitations exist for development, i.e., for foundations, lawns, shrubs, gardens, septic systems (septic tank drain fields), and sewage lagoons.

For example, if flooding occurs at a site in 5 (or fewer) years out of 10, mark "occasional" on the scorecard. If flooding occurs at a site 6 or more years out of 10, mark "frequent" on the scorecard.

How To Use the Scorecards

Land Evaluation Scorecard—Part I

1. Part I (left side) of the scorecard deals with characteristics of the soil and land that the participant must determine about the field.
2. Place an "X" in the appropriate box or boxes to mark your answers.

Land Evaluation Scorecard—Part II

1. Part II (right side) of the scorecard deals with selecting the land capability class and picking appropriate recommended land treatments or conservation practices that you decide are necessary based on characteristics found in Part I.
2. Using the information from major factors, select the Land Capability Class by placing an "X" in the appropriate box.
3. In the Vegetative, Mechanical, and Fertilizer/Soil Amendment sections, place an "X" in the box preceding the treatment that should be used. (Note: For scoring, any incorrectly marked or incorrectly not-marked item will be counted wrong.)

Homesite Evaluation Scorecard

1. Part I of the scorecard deals with soil and land characteristics that the participant must determine about the field. Place an "X" in the appropriate box to indicate site characteristics. With the exception of shrink-swell, water table, and flooding, the factors are similar to those for land evaluation. Do not make a straight checkoff from the land evaluation to homesite scorecard, however. While the factors are the same, different separations are made.
2. After selecting the site characteristic in Part I, determine the severity of limitations that the characteristic imposes on the planned uses listed in Part II of the scorecard and mark the appropriate box with an "X."
3. Summarize the limitations for each of the four uses by selecting the worst degree of limitation for a use and carrying it down to the bottom of the column and marking the appropriate box with an "X."
4. The "final evaluation" of the site, in the lower left box, is a summary of the limitations of the four uses.

University of Idaho Extension

Field No.______________________

Contestant No. ________________

Name ________________________

Idaho Land Evaluation Scorecard

(Indicate answer by placing an X in the appropriate box.)

PART I—Soil and Land Characteristics

A. SURFACE TEXTURE
- ☐ 1. Coarse
- ☐ 2. Moderately coarse
- ☐ 3. Medium
- ☐ 4. Moderately fine
- ☐ 5. Fine

B. SUBSOIL TEXTURE
- ☐ 1. Coarse
- ☐ 2. Moderately coarse
- ☐ 3. Medium
- ☐ 4. Moderately fine
- ☐ 5. Fine

C. PERMEABILITY (heaviest layer)
- ☐ 1. Rapid
- ☐ 2. Moderate
- ☐ 3. Slow
- ☐ 4. Very slow

D. DEPTH OF SOIL
- ☐ 1. Very shallow (less than 10")
- ☐ 2. Shallow (10" to 20")
- ☐ 3. Moderately deep (20" to 40")
- ☐ 4. Deep (40" to 60")
- ☐ 5. Very deep (over 60")

E. SLOPE

	Dry	Irrigated
☐ 1. Nearly level	0 to 3%	0 to 1%
☐ 2. Gently sloping	3 to 8%	1 to 3%
☐ 3. Moderately sloping	8 to 12%	3 to 5%
☐ 4. Strongly sloping	12 to 20%	5 to 8%
☐ 5. Steep	20 to 45%	8 to 12%
☐ 6. Very steep	over 45%	over 12%

F. EROSION LOSS
- ☐ 1. None to slight (less than 25% lost)
- ☐ 2. Moderate (25 to 75% lost)
- ☐ 3. Severe (over 75% lost)
- ☐ 4. Very severe (uncrossable gullies, accumulation by wind)

G. SURFACE RUNOFF
- ☐ 1. Rapid
- ☐ 2. Moderate
- ☐ 3. Slow
- ☐ 4. Very slow

H. DRAINAGE
- ☐ 1. Excessively
- ☐ 2. Well
- ☐ 3. Somewhat poorly
- ☐ 4. Poorly
- ☐ 5. Very poorly

I. CLIMATE
- ☐ 1. Good
- ☐ 2. Fair
- ☐ 3. Poor

J. MAJOR FACTORS
Any kind of area out of Class I
- ☐ 1. Surface texture
- ☐ 2. Subsoil texture
- ☐ 3. Permeability
- ☐ 4. Depth
- ☐ 5. Slope
- ☐ 6. Erosion
- ☐ 7. Surface runoff
- ☐ 8. Drainage
- ☐ 9. Climate
- ☐ 10. None

PART II—Land Capability Class and Recommended Land Treatments

K. LAND CAPABILITY CLASS
- ☐ 1. Class I
- ☐ 2. Class II
- ☐ 3. Class III
- ☐ 4. Class IV
- ☐ 5. Class V
- ☐ 6. Class VI
- ☐ 7. Class VII
- ☐ 8. Class VIII

L. VEGETATIVE
Use soil conserving and/or improving crops:
- ☐ 1. Not necessary (Class I)
- ☐ 2. Every 4-5th year (Class II)
- ☐ 3. Every 3-4th year (Class III)
- ☐ 4. Every 2-3rd year (Class IV)
- ☐ 5. Crop residue use
- ☐ 6. Weed control
- ☐ 7. Strip cropping
- ☐ 8. Brush and tree control
- ☐ 9. Grasses and legumes
- ☐ 10. Pasture, range, hay management
- ☐ 11. Tree planting
- ☐ 12. Woodland harvest cutting
- ☐ 13. Wildlife, recreation, and watershed

M. MECHANICAL

Irrigated Only
- ☐ 14. Sprinkler irrigation
- ☐ 15. Irrigation water management
- ☐ 16. Water control structures

Dryland Only
- ☐ 17. Diversion or terrace
- ☐ 18. Grass waterway
- ☐ 19. Contour farming
- ☐ 20. Plow uphill

Both Dryland and Irrigated
- ☐ 21. Subsurface drainage system
- ☐ 22. Minimum tillage

N. FERTILIZERS AND SOIL AMENDMENTS
- ☐ 23. Nitrogen (N)
- ☐ 24. Phosphorus (P)
- ☐ 25. Potassium (K)
- ☐ 26. Micronutrients
- ☐ 27. Lime
- ☐ 28. Gypsum
- ☐ 29. Organic matter
- ☐ 30. Fertilizer or amendments not needed

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______________________ SCORE PART I (Possible 40)

______________________ SCORE PART II (Possible 35)

______________________ SCORE (TOTAL) (Possible 75)

The land evaluation scorecard is used to record your judgment. Be sure to mark your record carefully.

University *of* Idaho
Extension

Field No.______________________

Contestant No. _________________

Name ________________________

Homesite Evaluation Scorecard

(Indicate answer by placing an X in the appropriate box.)

PART I—Soil and Land Characteristics	**PART II—Limitation for various uses of site for a single family dwelling without a basement.**				
Features of the Site Being Considered	**Degree of limitation**	**Foundation without basement**	**Lawns, shrubs, and gardens**	**Septic system**	**Sewage lagoon**
A. SURFACE TEXTURE ☐ Sandy ☐ Loamy ☐ Clayey	Slight Moderate Severe	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	
B. SUBSOIL PERMEABILITY ☐ Rapid (over 6" per hour) ☐ Moderate (0.2" to 6.0" per hour) ☐ Slow (0.06" to 0.2" per hour) ☐ Very slow (less than 0.06" per hour)	Slight Moderate Severe Very severe	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
C. SOIL DEPTH ☐ Very shallow (less than 10") ☐ Shallow (10" to 20") ☐ Moderately deep (20" to 40") ☐ Deep (40" to 60") ☐ Very deep (over 60")	Slight Moderate Severe Very severe	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
D. SLOPE ☐ Nearly level (0 to 3%) ☐ Gently sloping (3 to 5%) ☐ Moderately sloping (5 to 8%) ☐ Strongly sloping (8 to 15%) ☐ Steep (over 15%)	Slight Moderate Severe Very severe	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
E. EROSION ☐ None to slight (less than 25% lost) ☐ Moderate (25 to 75% lost) ☐ Severe (over 75% lost) ☐ Very severe (uncrossable gullies)	Slight Moderate Severe Very severe	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
F. SURFACE RUNOFF ☐ Rapid (slopes over 3%) ☐ Moderate (slopes 1 to 3%) ☐ Slow (sandy surface texture) ☐ Very slow (less than 1%)	Slight Moderate Severe	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	
G. SHRINK-SWELL (heaviest layer) ☐ Low ☐ Moderate ☐ High	Slight Moderate Severe	☐ ☐ ☐		☐ ☐ ☐	☐ ☐ ☐
H. WATER TABLE (permanent or temporary) ☐ Deep (none evident above 72") ☐ Moderately deep (48" to 72") ☐ Shallow (less than 48")	Slight Moderate Severe	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
I. FLOODING ☐ None ☐ Occasional (floods 50% of the time or less) ☐ Frequent (floods more than 50% of the time)	Slight Moderate Severe Very Severe	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
FINAL EVALUATION ☐ All factors none to slight ☐ 1 or more factors moderate; none severe ☐ 1 or more factors severe; none very severe ☐ 1 or more factors very severe	Slight Moderate Severe Very severe	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐

This scorecard is used to record your decisions. Be sure to mark your record carefully.

Revised 7/12

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