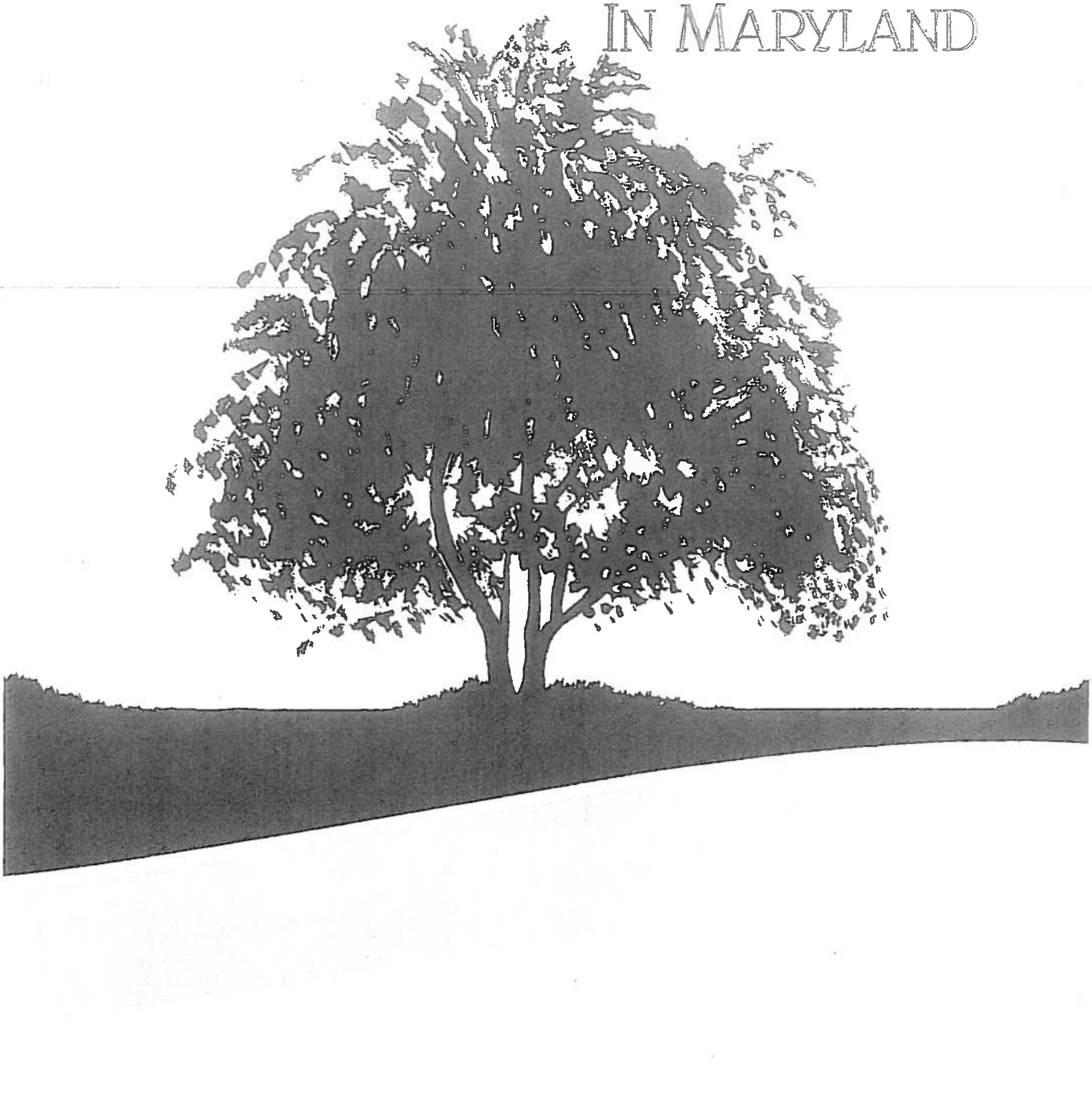
A Guide To Land Judging In Maryland



The University of Maryland
Cooperative Extension Service
College Park • Eastern Shore
Bulletin 232

Preface

This bulletin is a soil judging guide for high school students in Maryland. In 1973, the bulletin was revised to include the uniform scorecard, which currently is used. In 1979, a second revision was made to alter the scorecard slightly to accommodate certain soil conditions that have been encountered during field testing. In 1985, a third revision incorporated changes to keep the manuscript and scorecard more in line with the new Soil Survey Manual. Use this bulletin in conjunction with Extension Bulletin 212 *Maryland Soils*, which provides a more detailed account of Maryland soils and their properties. Other references are the soil survey reports, which are available for all Maryland counties. These reports contain detailed descriptions of the soils in the area and provide information on their use and management. Students in Delaware and New Jersey should consult with their university Extension service or Soil Conservation Service, U.S. Department of Agriculture (USDA), for further information regarding soils in their locality.

Detailed information about Maryland soils and agriculture also is available through fact sheets and bulletins from the Cooperative Extension Service or through the College of Agriculture at The University of Maryland.

The description and measurement of soil properties follow the criteria of the Soil Survey Manual, USDA.

Acknowledgments

The author is indebted to the following Soil Conservation Service personnel for their contributions to and review of this manuscript: David L. Yost, state soil scientist, Maryland; Richard L. Hall, state soil scientist, Delaware, Carl E. Robinette, area soil scientist, Maryland; and Edgar A. White, area soil scientist, Maryland. Appreciation also is extended to Dr. Martin C. Rabenhorst and Dr. Delvin S. Fanning for their review of the manuscript. The author also wishes to acknowledge all the former contributors to prior versions of this publication, particularly Dr. Fred P. Miller and Dr. John E. Foss.

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Revised 1985-86

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914 in cooperation with the U.S. Department of Agriculture, The University of Maryland and local governments. Craig S. Oliver, Director of Cooperative Extension Service, The University of Maryland.

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INTRODUCTION

Land Is a Limited Natural Resource

Only about one-quarter of the earth's surface is land. Vast areas of this 25 percent of the earth's surface virtually are uninhabitable because of extreme temperatures, topography or moisture conditions. Cultivated soils, accounting for only 10 percent of the earth's land area, average less than 1 acre per person.

Approximately 70 percent of the people in the United States live on about 2 percent of the land. In Maryland, there are more than 700 soil types in less than 10,000 square miles. Less than 3 percent of the state's land is class I land (in other words, those soils suitable for both agricultural and urban uses with few or no limitations). The competition among Maryland's nearly 4 million people for these high-quality soils continues to increase.

Land is a natural resource as are water and mineral deposits. It is essentially fixed; more land cannot be made—except what little might be reclaimed from the sea or filled into water bodies. Much land and its associated soil resources have been misused—many acres to the point where reclamation is nearly impossible or impractical. As our population increases and the pressure for land intensifies, it is important that the wisest use be made of this resource. We can no longer afford to mismanage land and soil.

Why Land Judging?

Farmers must know soil conditions and proper management practices to produce 150- to 200-bushel-per-acre corn crops. Some soils are not capable of such production, and it is a waste of time and money to use these soils in this manner. Knowledge of the properties of soils enables farmers to most effectively use their soils. This same reasoning is applied when soils are to be used to support a housing development. Therefore, everyone needs basic knowledge of soils and landscapes before growing vegetables, establishing a lawn or selecting a site for a house. The most accurate and sound decision can be rendered only when all facts and properties are known.

Soil judging is learning to evaluate a soil for its best use through an examination of its properties. Although many sophisticated techniques and instruments are used to determine and measure soil properties, several important soil characteristics can be readily determined by laypeople. A brief introduction to soil science equips you to make several basic evaluations of a soil and limited predictions concerning its behavior under various types of management and use

Implications of Soil Variation

Farmers know that soils vary greatly, even over short distances. Vegetable growers and truck farmers prefer well-drained, coarse-textured soils (sand and loamy sand), which warm up quickly in the spring and are workable shortly after a rain. For the extensively grown agronomic crops, farmers prefer deep, well-drained, medium-textured soils (loam and silt loam). These provide moisture to crops without irrigation. Farmers raising cranberries want acid soils that have water tables near the surface.

Soils differ and their capability depends not only on the soil itself but also on how it is used. A soil may have the potential to produce 150 to 200 bushels of corn year after year, but this same soil may also be well suited for a home site. Other soils may be unsuitable as a foundation or may be slowly permeable at a depth that would prohibit the proper functioning of a septic system. However, these same soils may be capable of producing 150 to 200 bushels of corn under proper management. The need for trained people to identify and interpret soils is increasingly important.

The soil survey program in Maryland recognizes over 700 different soil types, and each has been placed in eight major capability classes depending on the hazards for agricultural use. This classification is further refined by considering the types of hazards and management requirements. Similar systems are used to classify soils for nonagricultural uses.

In judging soils, first determine the various soil properties and then assess the soil's potential for a particular use.

The Soil Profile

Factors of Soil Formation

Soils are natural expressions of the environment in which they were formed. They are derived from an infinite variety of materials that have been subjected to a wide spectrum of climatic conditions. Soil development is influenced by the topography on which soils occur, the plant and animal life which they support and the amount of time which they have been exposed to these conditions.

Soil scientists recognize five major factors that influence soil formation: 1) parent material, 2) climate, 3) living organisms (especially native vegetation), 4) topography and 5) time. The combined influence of these soil-forming factors determines the properties of a soil and their degree of expression. These factors modify each other to the point where it is impossible to determine where one begins and the other ends.

Soil Horizons

Soils are composed of a series of one or more layers. These layers, labeled horizons, usually run parallel to the soil's surface. A soil profile is a vertical section of the soil that exposes these horizons. Each horizon is unique with respect to one or more soil properties—such as thickness, color, texture, structure, pH and density—and differs from adjacent horizons. Horizons originate from the weathering processes acting on the parent material. Organic matter and the modifying effects of topography and time also influence horizon development.

A simple analogy of this process is illustrated by combining equal portions of sand and sugar in a container. This mixture represents the soil's parent materials. If water is sprinkled periodically on this mixture, the sugar will dissolve and move to the lower part of the container. This process reflects the climate's influence on soil formation. After the mixture is dry, the upper horizon is composed of sand since the sugar has 'leached out'. The lower horizon contains sand and sugar but more sugar than sand since the dissolved sugar recrystallized during drying. The composition of both horizons now differs from the original mixture. If plants could grow in this mixture, organic matter would be incorporated in the surface layer and still another horizon would be formed.

Of course the real situation is much more complex, but the same principles apply. Physical, chemical and biological weathering processes have been at work for a long time in most soils.

To describe, study and classify soils, symbols are used to designate the horizons. The letters O, A, E, B, C and R are used to label the major or master horizons from the surface downward. Numbers and lowercase letters are added when more detailed descriptions are necessary.

See Figure 1 for an illustration of the relationship of the various horizons to the soil profile.

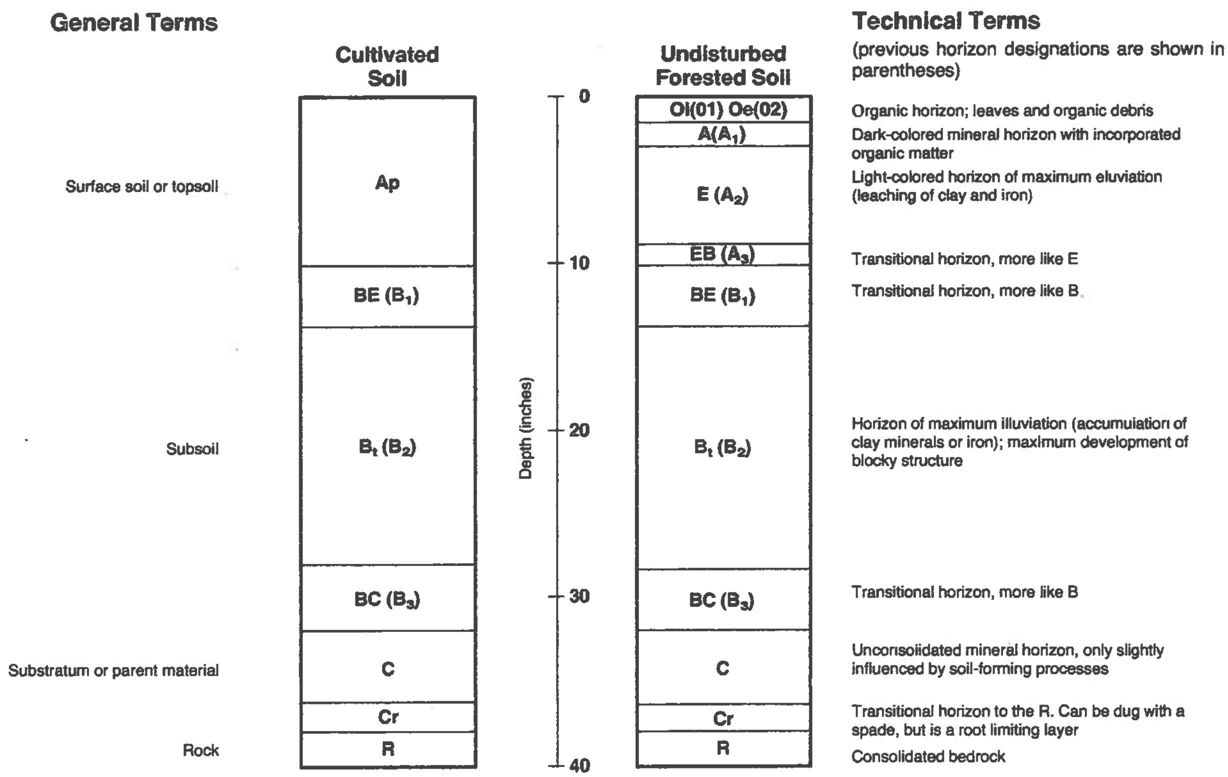


Figure 1.

Hypothetical soil profile showing major horizons of cultivated and undisturbed forested sites and a general and technical descriptive terminology.

O Horizon. This horizon is formed from accumulations of organic litter from plants and animals. The upper portion (Oi) consists of fresh and partially decayed vegetative matter such as freshly fallen leaves and older leaves that still are recognizable. The lower portion of this horizon, the humus, (Oe) is composed of decayed residues of plants and animals. This horizon is present in forested areas or where soils have not been disturbed. When disturbed by clearing, fire, erosion, pasturing and cultivation, this horizon is destroyed or incorporated within the plow layer. The Oi and Oe horizons will not be present in cultivated fields.

A Horizon. The A horizon is the uppermost layer of the mineral soil profile and commonly is referred to as topsoil or surface soil. Enough organic matter commonly is incorporated into this horizon to give it a dark color. In cultivated fields, the plow layer often can be distinguished by its darker appearance when contrasted with lower horizons. In cases of severe erosion, the A horizon may be lost and the plow layer may include portions of lower horizons. Most Maryland soils possessed A horizons that were 10 to 15 inches thick before cultivation. Through successive years of cultivation and the applications of lime and fertilizers, the A horizon has become more fertile than the lower horizons.

E Horizon. The E horizon often is lighter in color than both the overlying A horizon and the underlying B horizon. This light color results from weathering that removes all but the more resistant minerals such as quartz. Also, the E horizon generally has measurably less organic matter than the A horizon. This horizon, or a portion of this horizon, may be incorporated into the plow layer in cultivated soils.

B Horizon. Although the boundaries between horizons are not always easy to recognize, the B horizon, in many well-drained soils, commonly is characterized by a higher clay content, brighter colors and a stronger structure than the overlying A or E horizon. The most obvious property of most well-drained B horizons is the characteristic reddish-brown, yellowish-brown or brown color and coatings of fine clay on the structural (ped) faces. The B horizon commonly is referred to as the subsoil. The B horizon is important to crop production because of its nutrient and water holding capacity.

C Horizon. This horizon consists of unconsolidated mineral material that has been only slightly influenced by soil-forming processes. If this material is the same as that from which the overlying soils have formed, it is called the parent material. A Cr horizon indicates layers of soft or highly fractured bedrock or saprolite that roots cannot enter except along fracture planes. This material can be dug with a spade, but usually is considered to be a root limiting layer.

R Horizon. This horizon is the upper limit of consolidated bedrock, such as granite, sandstone, limestone or shale.

Most soils in Maryland have been influenced by soil-forming processes to depths ranging from 3 to 5 feet. Of course, there are shallower soils on steep slopes and certain types of resistant bedrock. Likewise, there are some soils with profiles deeper than 5 feet. Most soils, however, can be judged for agricultural purposes from pits or cuts that are at least 3 feet deep. Usually, the upper 3 to 4 feet of soil influence plant growth. Thus, this is where the major interest of agricultural soil scientists is concentrated. Observations below this depth, however, commonly are made for nonagricultural interpretations.

CATEGORIES ON THE SCORECARD

I. Landscape Features

Soils are considered as landscapes in addition to individual profiles. Many land-use decisions are based heavily on landscape characteristics, as well as the specific profile features. For example, two soils with similar profiles but with contrasting slopes could result in one being suitable for intertilled crops and the other for permanent pasture. Landscapes affect the potential erosion, runoff, flooding, slippage, drainage, moisture relations and other properties. Thus, the agricultural and nonagricultural use of the soil resource can be influenced greatly by landscape features.

The soil landscape can be described in a variety of ways, but the usual descriptive forms used in land judging include position, percent slope, parent material and stoniness. Soil interpretations for cropping systems and erosion control practices also require evaluation of the complexity, length, shape and aspect (orientation, for example, a north facing slope) of slopes.

A. Position

Position generally refers to the point on the landscape where the soil is located. Most soil series have a rather limited range of position and land form. In Figure 2, the landscape is divided into (1) upland, (2) upland depression, (3) terrace and (4) floodplain. Most soils can be classified into one of these landscape positions by observing the general surroundings in respect to streams or natural drainage systems.

The floodplains refer to areas near streams that flood periodically. These soils may be quite productive, but they have a flooding hazard that seriously limits their use for urban development or agriculture. Terrace refers to soils developed in older alluvial materials above the zone of current flooding. Upland depressions or waterways refer to soils developed on concave land forms or at the

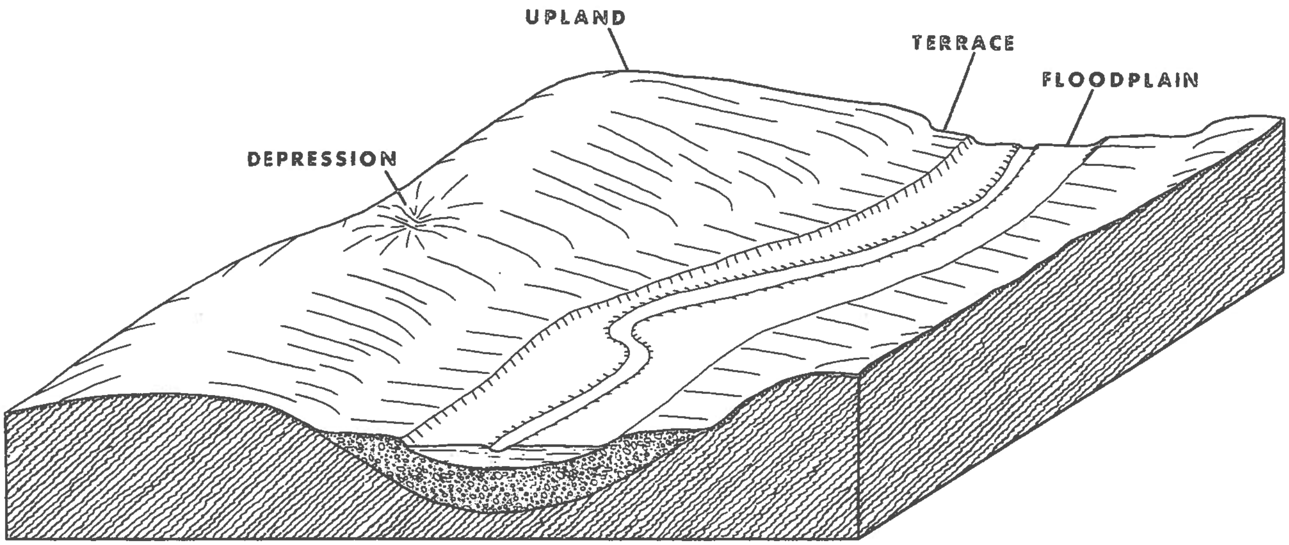


Figure 2.
Block diagram illustrating position of floodplain, high terrace, and upland on the landscape.

heads of drainage ways and along waterways where surface drainage is retarded. Water tends to pond in these depressions, and the soils commonly have a darker and thicker surface horizon because of organic matter accumulations. Areas unaffected by stream activity in recent geologic time, and ordinarily lying at higher elevations (than alluvial plains) on rolling and convex positions, are designated upland.

B. Slope Characteristics

In evaluating slope as a factor in land use, terms such as gradient (steepness), length, shape, aspect and complexity are used. Only the gradient is recorded on the scorecard. The gradient generally is expressed as a percentage that is calculated by dividing the difference in elevation between two points by the horizontal distance and multiplying by 100. For example, a 10 percent slope would have a 10-foot drop per 100 horizontal feet. The percent slope can be estimated visually, but the Abney level, or a similar type of instrument, is used for more precise measurements.

Slope classes are used for interpretive purposes. The classes listed on the scorecard are: nearly level, gently sloping, strongly sloping, moderately steep, steep and very steep. The range in percentages for these classes will vary depending on the topography of the area. Because of constrasting landscapes, two divisions are used in establishing limits for the slope classes in Maryland: (1) the Coastal Plain and (2) a combination formed by the Appalachian and Piedmont provinces (Figure 3). The slope classes and appropriate ranges of percent for the two divisions are:

Slope Class	Coastal Plain	Piedmont-Appalachian	Soil Survey
	Percentage	Percentage	Letter Designation
Nearly level	0–2	0–3	A
Gently sloping	2–5	3–8	B
Strongly sloping	5–10	8–15	C
Moderately steep	10–15	15–25	D
Steep	15–25	25–50	E
Very steep	25+	50+	F

Slope characteristics other than gradient also are important factors in the selection and layout of water conservation and cropping systems. For example, in areas where slopes are very complex, contour stripcropping is not practical, but field stripcropping can be used. The length of slope is an important consideration in determining whether diversion terraces are necessary to supplement contour stripcropping on long slopes. Direction of slope, or aspect, will affect the microclimate, and this point is especially important in considering the location of frost-sensitive crops.

C. Parent Material

The parent material refers to the type of material from which the soil formed. Soils are formed from a variety of materials including rock formations, glacial deposits, recently deposited alluvium along rivers and streams, and older deposits of water-borne unconsolidated sediments.

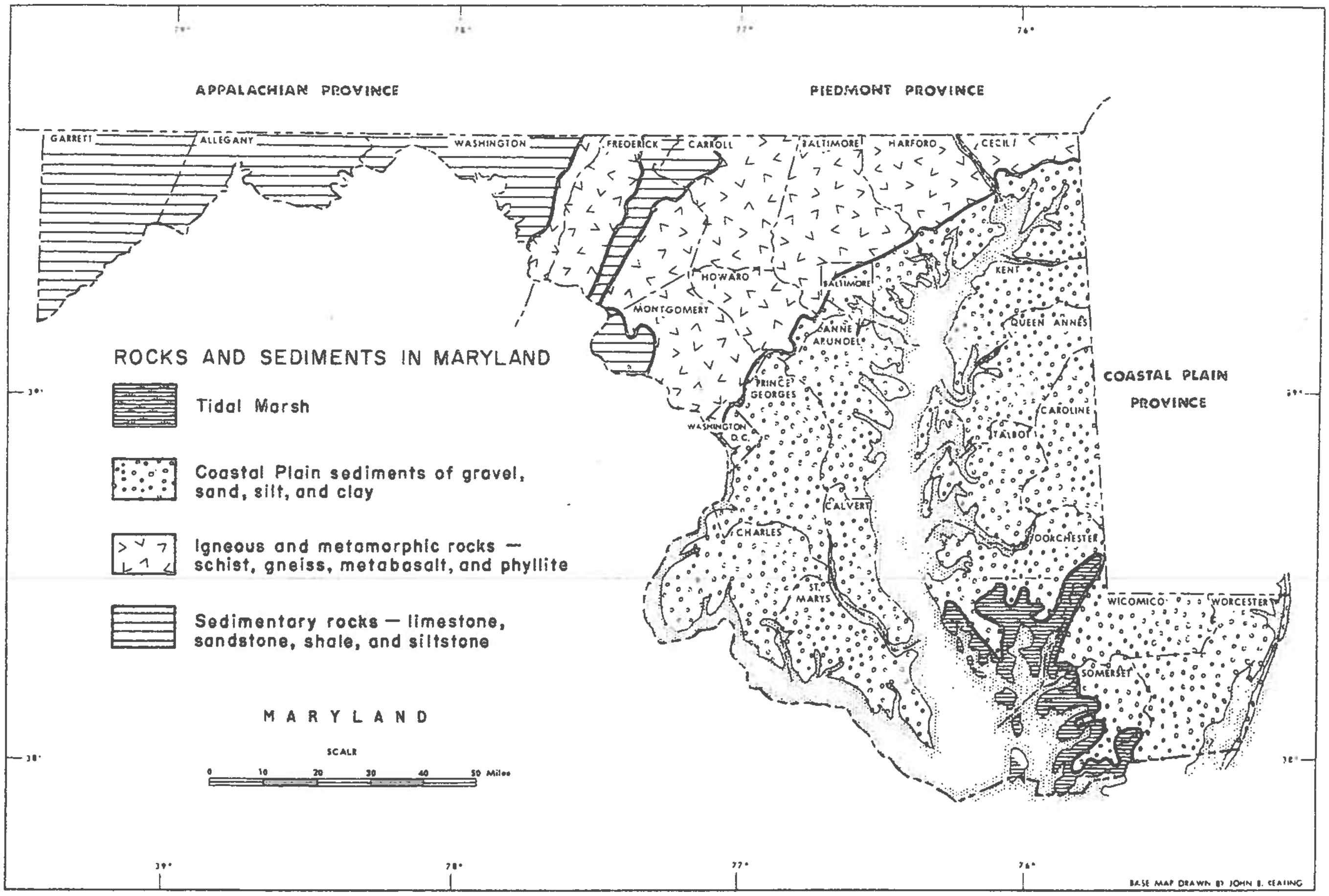


Figure 3.

Provincial map of Maryland showing the distribution of several types of rocks and sediments.

Soils inherit some of their properties or characteristics from the parent material. For example, a house built on a soil over granite may be much more stable than a house built on soil formed from deep deposits of recent alluvium.

Bedrock such as limestone, sandstone, shale, granite, gneiss and schist, slate, marble and many others break down into residuum (residue) through the weathering process. It is this residuum that becomes the parent material of soil and imparts some of the parent characteristics into the resulting soil profile. On the scorecard, those soils formed in place from bedrock residuum are considered to have **residual** parent material.

Soil material and rock fragments may fall, roll or slide downslope under the influence of gravity and water. This incoherent mass of material that generally accumulates on the lower portion of slopes and in depressions is called **colluvium**. Rock fragments in colluvium generally are angular in contrast to the rounded waterworn cobbles and stones found in alluvium and glacial outwash.

Streams and rivers commonly overflow their banks and deposit fresh materials on the floodplains. These fresh or recent deposits, commonly topsoil, comprise the parent materials for the soils developed on these floodplains. Since there is new material added almost annually, the soils never have time to form well-developed horizons. Therefore, these young soils have poorly developed profiles, and most of their character is inherited from the parent material. This type of parent material exceeds 20 inches in depth, and it is referred to on the scorecard as **recent alluvium**.

Soils located on stream terrace positions that contain waterworn coarse fragments have parent materials referred to as **old alluvium**. These soils were originally deposited by water and commonly have had time to form well-developed horizons. They never or rarely flood, and thus are not influenced by deposition of fresh materials.

In the Mid-Atlantic region, large areas are underlain by the complex series of water-deposited sediments left by previous geologic events. These older sediments comprise the Coastal Plain (Figure 3) along the Atlantic seaboard. In Maryland, these materials occupy half of the land area, and they comprise nearly all the parent material for Delaware soils and large segments of New Jersey. These Coastal Plain sediments, although much older than the recent alluvium along streams, have not been cemented and consolidated into bedrock—thus, the name unconsolidated sediments. Often these sediments have been capped or coated with a thin (several inches to several feet) veneer or sheet of material consisting mainly of silt (loess). The wind may have carried this material from the glacial outwash areas before the rise in sea level that formed the Chesapeake Bay. The Coastal Plain soils are formed in these sediments and silt-cap parent materials. Therefore, soils occurring on the upland portions of the Coastal Plain are considered to have Coastal Plain sediments as their parent materials on the scorecard. Recent alluvium can and does occur on the Coastal Plain in the same landscape positions (along streams and rivers) as in other sections of the state (Figure 2).

D. Stoniness

Stones larger than 10 inches in diameter and rock outcrops can influence greatly the use of soil. These criteria are more important factors in land use in certain parts of Maryland and the Mid-Atlantic region.

Stoniness refers to the relative proportion of stones over 10 inches in diameter in or on the soil surface horizon. There are six classes of stoniness recognized by soil scientists, but the scorecard only recognizes one class. For land judging purposes, the 'very stony' category will be checked only when the amount of stones present makes tillage of intertilled crops impracticable. However, the soil can be worked for hay crops or improved pasture if other soil characteristics are favorable. Soils that qualify as 'very stony' on the scorecard can be no better than class V lands since tillage is impractical. Occasional stones or gravelly surface soils would not qualify as very stony on the scorecard. As a guide, consider stones 10 inches in diameter and 30 feet apart to 5 feet apart as covering from 0.1 to 3 percent of the surface, respectively. This condition would prohibit cultivation and should be considered the minimum standard for the 'very stony' category on the scorecard.

Rockiness refers to the relative proportion of bedrock exposures. Rockiness differs from stoniness in that the former is characterized by fixed rock (bedrock) exposures whereas stoniness refers more to soils having detached fragments of rock. Like stoniness, there are six classes of rockiness, but for scoring purposes only 'rock outcrop' is considered. Check this category only when sufficient bedrock exposures make tillage of intertilled crops impracticable. However, the soil can be worked for hay crops or improved pasture if other soil characteristics are favorable. Again, the soil landscape can be no better than class V land since tillage is impractical. The minimum condition for 'rock outcrop' should be bedrock exposures that are no more than 100 feet apart and cover at least 2 percent of the surface. The condition is especially common in the limestone valleys of Maryland.

II. Soil Features

There are many properties or features that describe and characterize soils. Some of these features (such as color, texture and depth) are relatively easy to record while others require very sophisticated equipment and highly technical procedures (such as chemical data and mineralogical analysis). On the card, judge only the more observable properties.

A. Color

To the casual observer, color is the most noticeable soil property. Maryland soils vary in color from red, yellow and brown to gray in the subsoil (B horizon) and from black to very light gray in the topsoil (A horizon). Color is a significant indicator of several soil properties, including the organic matter content and drainage condition.

Black or very dark colors in the A horizon suggest relatively high organic matter contents. Most cultivated Maryland soils have organic matter in their plow layer ranging between 1 and 4 percent by weight. In some poorly drained soils, the organic matter content will reach 10 percent and higher. Generally, the darker the A horizon, the higher its organic matter content. In Maryland, this generalization can be taken a step further; a deep, dark colored A horizon indicates the soil was formed under very poorly drained conditions. Organic matter enhances soil tilth (physical condition) or structure and is a natural nitrogen supplier under favorable conditions. As the organic matter content decreases, the color is determined more by the mineral components of the horizon. Pale colors indicate that the horizon has a relatively low organic matter content.

Subsoil colors are not greatly influenced by organic matter. Usually, the iron compounds coating the mineral particles are largely responsible for the color of this horizon.

Soils formed under well-drained conditions, where oxygen is readily available, have subsoils with bright colors, usually brown, red or yellow. Some grayish tones may occur in these soils, but they are associated with the weathering of rocks and not drainage. Brown, red or yellow colors can be interpreted as indicating good natural drainage making artificial drainage unnecessary. Septic systems should work in these soils unless they contain too much clay. Also, these soils should provide good dry locations for houses with basements.

When these bright colors are mixed with spots and areas of gray, the soil developed under conditions of imperfect drainage. The mixed pattern, called **mottling**, indicates that the soil is saturated with water for significant periods during the year. Artificial drainage usually is necessary for good crop production, and septic systems are subject to periodic failure when installed in these soils.

When gray predominates with only streaks and spots of brighter colors, the soil was formed under poorly drained conditions. This situation indicates that the water table is at or near the surface for long periods during the year. Artificial drainage is necessary for crop production, and these soils are poor building sites, especially where septic systems are needed.

When determining soil colors, make sure that the soil is moist. Moistened soil better illustrates color variations, making it easier to distinguish one horizon from another. Soil scientists use standard color (Munsell) charts to determine color; this permits uniformity and eliminates some of the human variable. According to the chart, a soil horizon described as yellowish-brown in Maryland has exactly the same color as a yellowish-brown horizon in California.

B. Texture

The composition of most soils actually is a three-phase system—solid, liquid and gas (Figure 7). The mineral grains and organic matter are the solids, and the pores between the solids contain the liquids and gases. These liquids and gases constantly are changing proportions as they are influenced by the weather.

The mineral grains vary in size from coarse gravel and sand to fine silt and clay. The size of individual mineral grains and their relative proportion in the soil mass are referred to as soil **texture**. In determining the texture of soils, only material less than 2 millimeters (about ⅛ of an inch) is considered (in other words, only the sand, silt and clay). Particles larger than 2 millimeters, such as gravel, stones and coarse fragments, are considered as modifiers of soil texture, but are not included in the textural classes indicated on the scorecard. Coarse-textured (light) soils are composed predominantly of sand particles. Fine-textured (heavy) soils are dominated by clay particles. Medium-textured soils, such as loams, are characterized by having sand, silt and clay in such proportions as to exert nearly equal influence on the character of the soil.

Soil texture is very important; it influences a soil's available water capacity; tilth; ease of tillage; resistance or susceptibility to erosion; drainage and permeability; and capacity to absorb and release nutrients. Therefore, texture exerts a profound influence on soil productivity and management requirements.

Some soils are so coarse (sands and gravels) that they have little or no value for agriculture, unless irrigated. However, generally they have good stability for supporting roads and buildings.

Well-drained, coarse- and moderately coarse-textured soils warm earlier in spring as compared to the finer textured or poorly drained soils. Farmers, therefore, prefer these soils for early market truck crops. Of course, these soils must be irrigated, and they require carefully managed amounts of fertilizer. These soils can be worked following rains sooner than other soils.

The medium-textured soils, such as loams and silt loams, are preferred for agronomic crops since they have higher available water capacities and larger nutrient reserves than the coarser soils. However, these medium-textured soils require adequate applications of lime and fertilizer to maintain a proper fertility level.

Fine-textured soils, such as clays and sandy clays, are very difficult to manage. They tend to be cloddy and usually impede water and air movement. Generally, they are poor for roads and buildings because they lack stability and become plastic when moist, and sticky when wet.

Texture can be determined in the laboratory by a particle size analysis, where the sand, silt and clay fractions are separated and weighed, and the weight-percentage is calculated. Since many sizes of particles are found in soils, arbitrary limits must be imposed so that the terms sand, silt and clay have definite meaning. The U.S. Department of Agriculture particle size scale (Figure 4a) and texture triangle (Figure 4b) are used by soil scientists to determine texture. Sands range in size from 2 millimeters (very coarse) to 0.05 millimeter (very fine); silts range from 0.05 to 0.002 millimeter and clays are less than 0.002 millimeter.

Sand particles can be distinguished by the naked eye. The coarse silt fraction can be seen under a low-power magnifying glass, but individual clay particles are so fine that only electron microscopes can reveal them. See Figure 5 for the particle size composition of several textural classes.

Soils are composed of many particle sizes, and since time and equipment are not always available, soil scientists need a quick method for determining soil texture in the field. Moistening the soil and rubbing it between the thumb and forefinger permit a close textural class estimate. By employing this method, even the beginning student can acquire the skill of determining several textural classes. (Remember to use only less than the 2-millimeter material.) See Figure 6 for an illustration of several textural classes being rubbed out between the fingers. In Table 1, USDA textural classes (for example, sandy loam and clay loam) are correlated with the textural classes used on the scorecard. Usually, the subsoil in most Maryland soils will contain more clay than the surface soil. Thus, the surface or A horizon may be classed as 'coarse' or 'medium' while the subsoil might be classed as 'medium', 'moderately fine' or 'fine'. Many moderately fine- or fine-textured soils do not allow water to percolate

USDA Particle Size Scale

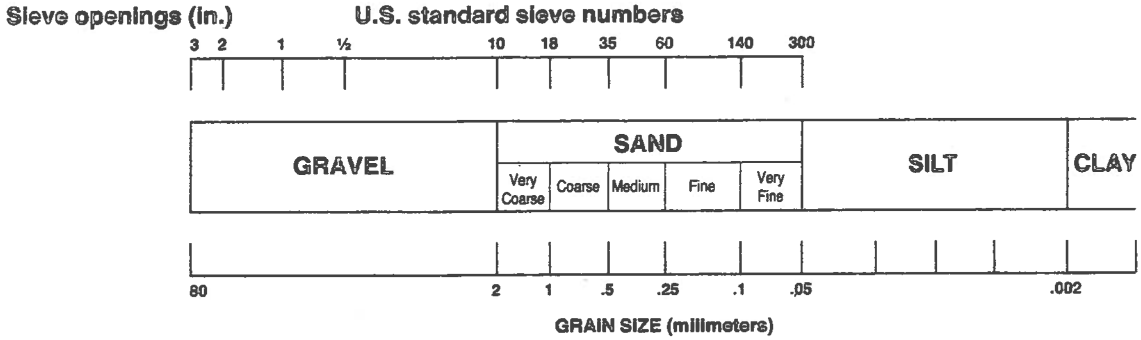


Figure 4a.
USDA particle size scale

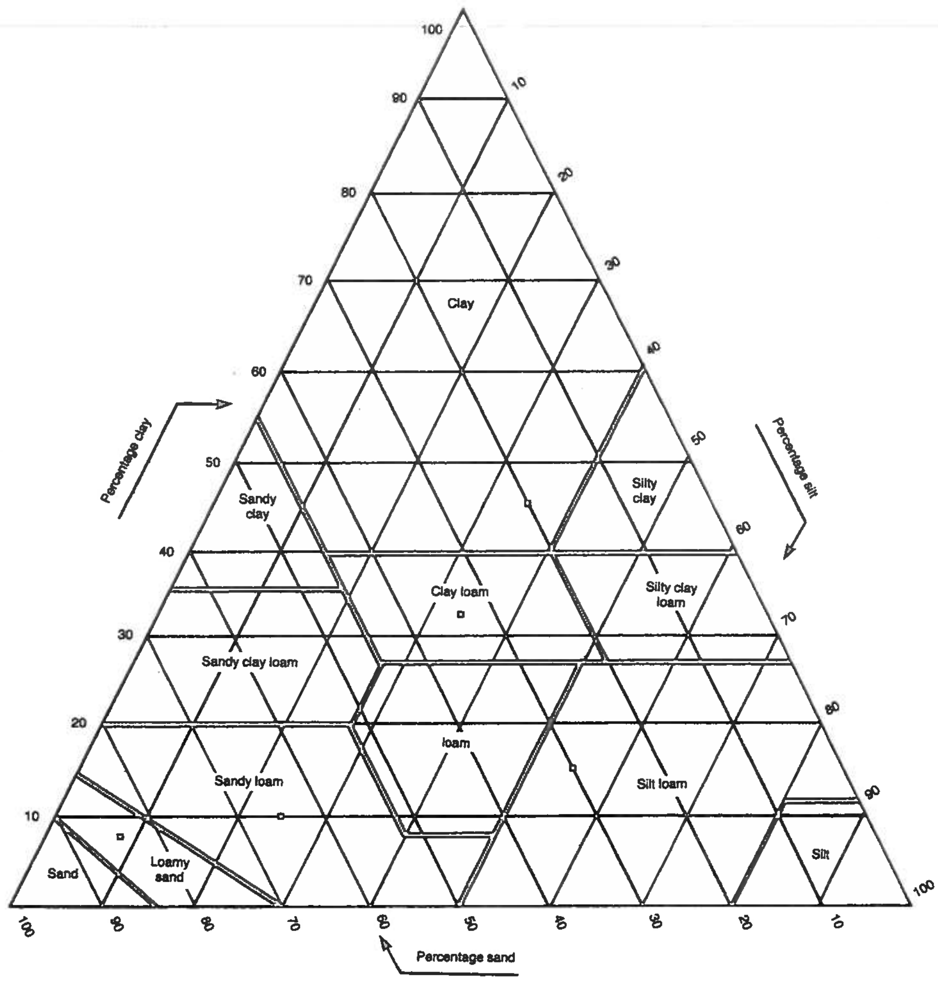


Figure 4b.
USDA textural triangle and textural classifications
(* indicates location of textures shown in Figure 5.)

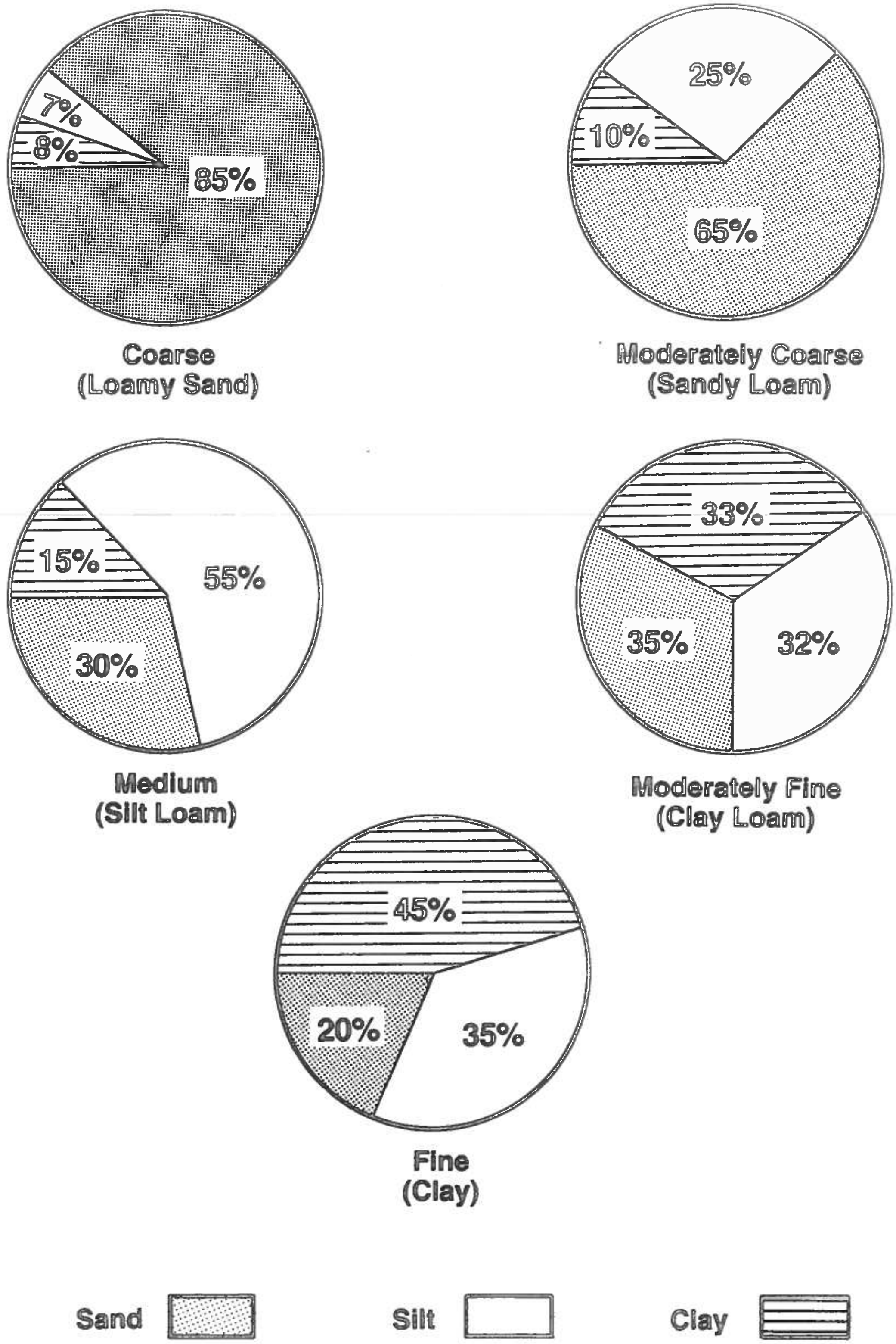
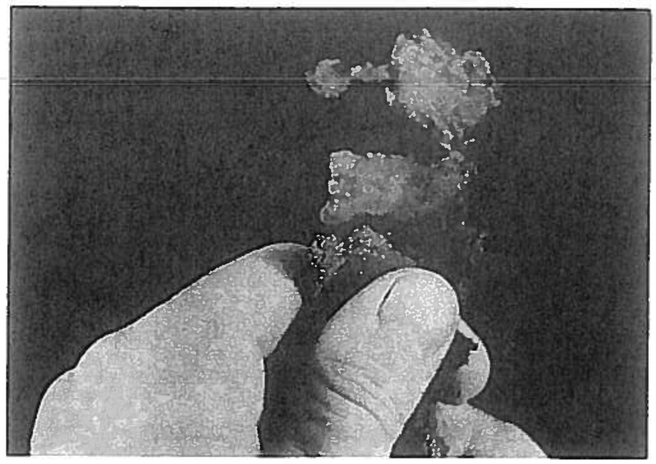


Figure 5.
Percentage of sand, silt and clay in various textural classes.

Loamy sand

Silt loam



Clay

Figure 6.
Photographs illustrating the formation of a ribbon with increasing clay content in moist soils.

very rapidly, making them poorly suited for septic systems.

Coarse. Coarse-textured soils feel gritty and do not hold together when moist. The sand and loamy sand soils belong in this group. They tend to be droughty and very permeable. However, these soils may contain enough silt and clay to provide some available water and nutrient holding capacity. Thus, under ideal rainfall or irrigation, these soils commonly are used for agriculture. They are preferred for early spring truck crops because they drain quickly (where water tables are not high) and warm rapidly. Irrigation commonly is practiced to ensure timely watering. Where drainage is good, these soils provide adequate sites for septic systems although renovation of the wastewater and ground water contamination may be a problem.

Moderately Coarse. Moderately coarse-textured soils feel gritty but they hold together in a ball or when rolled out under gentle pressure. The sandy loam soils fall into this textural category. These soils hold more water than the coarse-textured soils, but they also are commonly irrigated since they do not have the available water capacity of the medium-textured soils. Moderately coarse-textured soils are highly desirable for crop production, and they also make excellent building sites when well drained.

Medium. Medium-textured soils, such as loams, silt loams and sandy clay loams contain significant proportions of sand, silt and clay. When rubbed between the fingers, medium-textured soils feel smooth but not sticky. A ribbon tends to form when a moistened sample is rubbed out, but this ribbon breaks apart because of insufficient quantities of clay. These textures provide good water and nutrient supplying capacities, and they are usually the most productive agricultural soils. Septic systems usually are long lived if these soils are well drained.

Moderately Fine. Moderately fine-textured soils such as silty clay loams and clay loams, contain between 27 to 40 percent clay. When moist, these soils feel slightly sticky and are slightly plastic. When a sample is rubbed between the thumb and forefinger, a ribbon can be formed. The more clay that is present, the stickier the sample and the longer and more flexible the ribbons.

Fine. Fine-textured soils are those containing greater than 40 percent clay. When moist samples are rubbed between the forefinger and thumb, a ribbon can be formed. This ribbon will feel stiff and usually has a very shiny appearance. These soils feel sticky or very sticky, and are plastic or very plastic when moist. Fine-textured soils harden and form clods when dry and are puddled easily if worked when wet. For this reason, they are very difficult to manage and are not the best agricultural soils or best soils for building sites that require septic systems.

C. Depth

The depth of a soil is considerably important both for agricultural and nonagricultural uses. A shallow-rooted crop may produce equally well on either a deep or shallow soil. However, deeply rooted plants such as trees or alfalfa require deep soils for best growth. During droughty periods, crops on shallow soils usually are the first to show damage because of the lack of moisture. This results from a soil volume that cannot hold adequate water.

Houses with basements or septic systems should be built on deep, well-drained soils. The lack of deep soil may necessitate a house with a slab or shallow foundation, and a septic system may not be functional or permitted on such soils.

Shallow soils restrict plant growth by impeding root growth and provide only limited water and nutrient reserves. The processes of soil formation may have been such that only a thin veneer of soil has formed over a very hard or resistant parent material. Erosion may have reduced the thickness of a once-deep soil. Coarse gravel and sand layers also can impede root penetration as can sustained high water tables. In addition, root-restricting horizons or pans may have been formed during soil formation.

Most of the better agricultural soils in Maryland have a thickness of at least 40 inches. These soils are considered deep for agricultural and judging purposes. Any soil possessing a root-restricting horizon at a depth of less than 20 inches is considered shallow. Moderately deep soils are those between these two extremes.

In summary, the categories of soil depth are:

Very deep	greater than 60 inches
Deep	40 to 60 inches
Moderately deep . . .	20 to 40 inches
Shallow	10 to 20 inches
Very shallow	less than 10 inches

D. Drainage

Some soils can be worked soon after heavy rains while others may remain saturated or ponded for long periods. Coarse-textured soils such as sands allow water to drain through the soil very rapidly if outlets are available. Moderately coarse-, medium-, moderately fine- and fine-textured soils on similar landscape positions usually require correspondingly longer periods before they can be worked. Soils on extensive level areas or those in depressions commonly are poorly drained, and water tables may be at or near the surface for a long time.

Plants require good aeration as well as moisture for optimum growth. Soils that are excessively drained (such as sand) are well aerated but dry out quickly thus restricting crop production. Poorly drained soils, unless artificially drained, retard crop production because long periods of water saturation starve roots of required oxy-

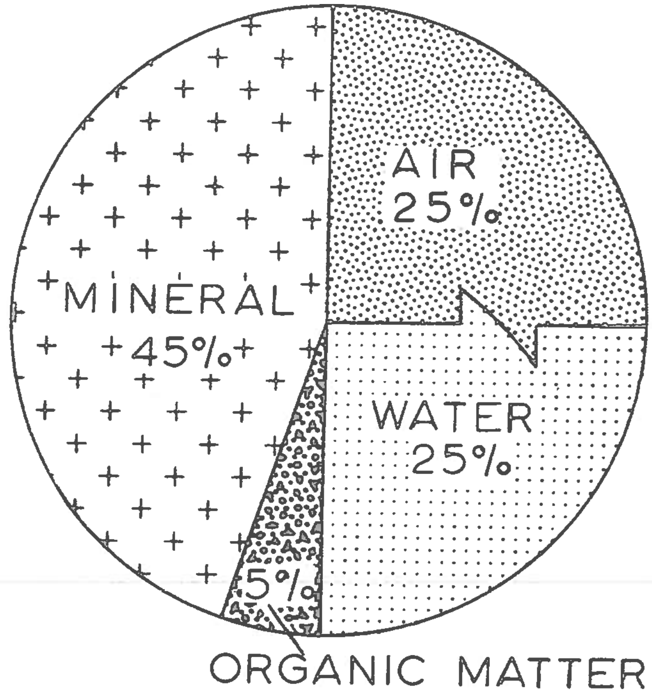


Figure 7.
Schematic representation of solid, liquid and gaseous composition of a soil.

gen. Also, these soils do not warm readily in the spring. Thus, the best agricultural soils are those that are deep and allow excess water to readily pass through the profile while retaining enough water to supply crops until the next rain.

Soils that are deep, well drained, moderately coarse and medium textured are preferred for agricultural production because they have a very desirable air-water relationship for many crops. These soils are about half mineral and organic material and half pore space (Figure 7). Ideal conditions exist when approximately half of this pore space is filled with water and half with air. Of course, these proportions fluctuate with the rainfall pattern. Coarse-textured soils (such as sand) contain a much greater proportion of air than water in this pore space, and they must be irrigated for good crop production. On the other hand, fine-textured soils (such as clay) possess a higher proportion of water than air in the pore space.

Well-drained soils also are preferred for many nonagricultural uses. Home sites and housing developments should be located in well-drained soils, especially if basements are to remain dry and septic systems are to function efficiently.

In judging a soil's drainage condition, one of the best indicators is soil color. The more mottling and gray in the subsoil, the poorer the soil drainage. The longer and higher the water tables stand in a soil profile, the more intense is the mottling and the higher it occurs within the profile. Soil scientists recognize six drainage classes in the field.

Excessively drained. Water is removed from the soil very rapidly because of either coarse textures (such as sand and loamy sand) or shallow, porous profiles on steep slopes. Excessively drained soils are suited poorly to agriculture unless irrigation is practiced. No drainage mottles occur in these soils.

Well drained. Good aeration occurs. Subsoil colors are bright and the profile lacks mottling above 40 inches. Brown, yellowish brown and reddish brown colors are common.

Moderately well drained. In these soils, mottling is present above 40 inches indicating that saturated conditions or water tables occur above this depth at various times during the year. Mottles are restricted to the 20- to 40-inch zone for classification in this category. These soils may retard crop growth in wet years, but crops may do very well during drought periods. Artificial drainage may be beneficial during wet periods. Septic systems may experience periodic failure during saturated conditions.

Somewhat poorly drained. Mottling occurs within the 10- to 20-inch zone, indicating prolonged periods of saturation or high water tables. Serious crop injury or failure may result during wet years. Unless artificial drainage is provided, crop production is restricted and septic systems commonly fail.

Poorly drained. These soils have dark surface horizons and gray subsoils with mottling occurring above 10 inches. They have high water tables or are ponded for long periods or both. These soils usually occupy level areas or footslope positions and are productive only if they are artificially drained. Development of these soils for home sites should be avoided.

Very poorly drained. Water is removed so slowly that the water table remains at or on the surface much of the year. These soils usually occupy low-lying and concave or depressed positions on the landscape. They normally have very dark or black, thick surface horizons with relatively high organic matter contents. The subsoils usually are gray. These soils can be used for agriculture, but only if intensive drainage is practiced.

In summary, see Figure 8 for the relationship between topography or position on the landscape and the resulting soil drainage. The water table, as indicated on the figure, is shown as it might appear during wet seasons.

E. Permeability

The movement of water and air through the soil is termed permeability, and it is measured by noting the rate of water movement through the soil in inches per hour. Factors that influence permeability include soil structure, texture, porosity, cracking and substratum characteristics.

The movement of water through a clayey soil usually is slower than movement through a medium-textured or sandy soil. However, fine-textured soils with good structure can have moderate permeability. In some soils, the upper horizons of a soil may allow water to pass readily through them. A compact or cemented horizon beneath will reduce the rate of water movement and determine the permeability for the entire soil profile.

Soils of rapid permeability are not necessarily well drained. Sandy soils may lack a slowly permeable horizon, but because of high water tables the soil is considered poorly drained. Well-drained soils may be classed as having moderate permeability, but slowly permeable soils usually have a drainage problem.

Farmers who must design drainage systems for their poorly drained fields are interested in permeability. Sandy soil that is poorly drained and has rapid permeability will respond to tile drains placed at varying depths and spacings. But a poorly drained soil with slow permeability caused by a tight pan has a limited depth at which the

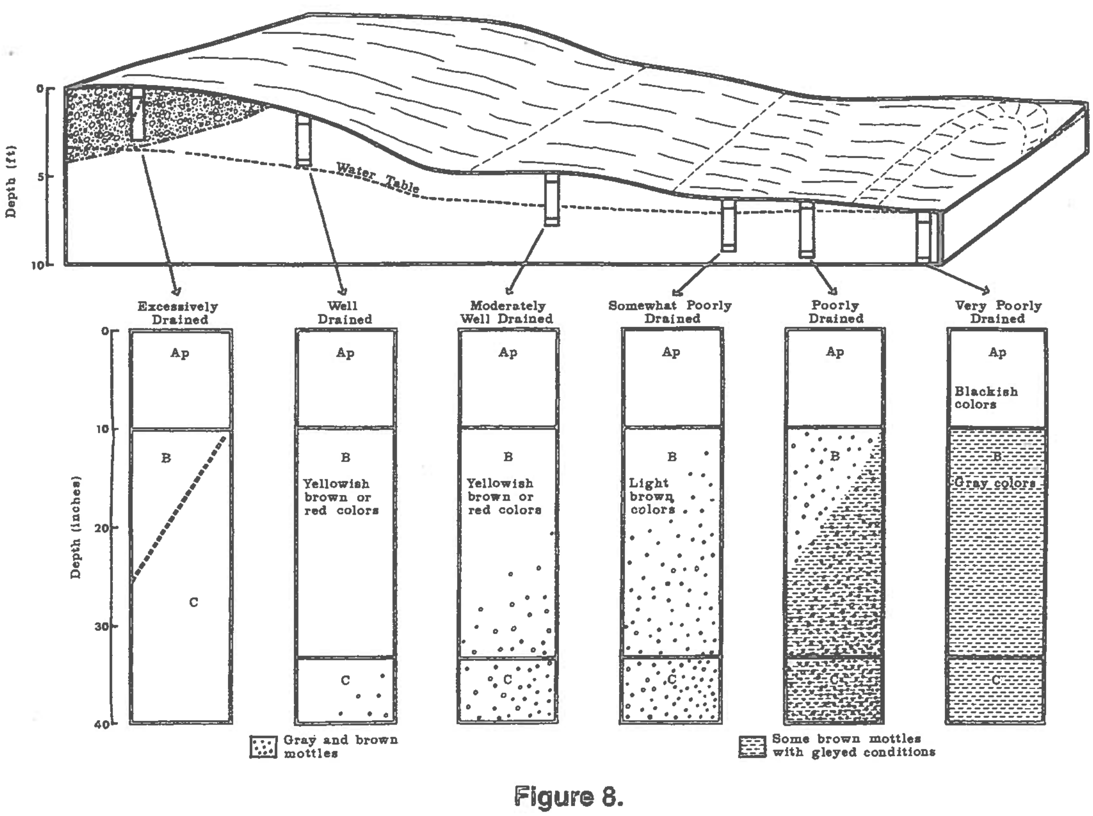


Figure 8.

Diagram illustrating soil drainage classes showing position on landscapes, depth to mottling, and color of B horizons. Rooting depth is approximately equal to depth of mottling. The dashed line on the excessively drained profile indicates the variability in thickness (or absence) of the B horizon. The shaded portion of the landscape in which the excessively drained profile occurs represents sand or gravel deposits overlying finer textured materials.

tile can be laid and spaced. Permeability will affect irrigation frequency and rate of application.

Installing a septic system in a slowly permeable soil can present difficulties. This is the reason most counties and health departments require a percolation test before the installation of a septic system. This test is designed to determine whether the permeability of the soil is such that it can absorb the effluent from the septic system.

On the scorecard, three categories of permeability are considered.

Rapid. Water moves through the soil at a rate of at least 2.0 inches per hour. Coarse-textured soils such as loamy sand, sand and gravel usually are found in this category. These soils tend to be droughty.

Moderate. Water moves through the soil at rates ranging between 0.6 to 2.0 inches per hour. Most of the medium-textured soils fall into this class provided pans or impervious layers do not influence water movement within the profile.

Slow. Water moves through the soil at a rate of less than 0.6 inch per hour. Fine-textured soils or those with impervious pans or cemented layers are placed in this category. These soils are poorly drained, and the mottling and gray colors indicate that there is either a high water table or slowly permeable horizon or both.

F. Available Water Capacity

The available water capacity of a soil is closely related to texture. As mentioned previously, air and water occupy the pore space between the particles comprising the soil skeleton. The bigger the soil particles (such as sand or gravel), the larger the pores between them. Thus, water drains first and rapidly from these larger pores. This results in droughty soils because the plants are supplied only from the small amount of remaining moisture. Irrigation is necessary on these soils even in humid climates.

As the particles become smaller, the pores between the grains also are reduced in size. This results in the retention of more water for plant use. Therefore, medium-textured and moderately fine-textured soils, such as loam, silt loam and clay loam have much higher available water capacities than coarse-textured soils. The moderately coarse-textured soils (such as sandy loam) are intermediate in those categories. Fine-textured soils (such as clay) have such small pores that plant roots are unable to obtain much more water from these fine soils than is available from medium-textured soils. Moderately coarse-, medium- and moderately fine-textured soils are, therefore, preferred for agricultural use because they provide good, available water capacity and aeration while being easily worked.

To calculate the water available within the soil profile, consider only the first 40 inches or to a root limiting layer if it occurs above 40 inches. The available water capacity of each horizon down to 40 inches, when added together, will give the total available water for the profile. A deep silt loam will hold more water than a soil with 10 inches of silt loam surface soil and the remainder sand. Therefore, both the surface and subsoil must be considered in computing the available water.

See Table 1 for a general guide when calculating the amount of available water in a 40-inch profile. The range and average water availability are presented in inches of available water per inch of soil depth.

For example, if a soil consists of 20 inches of silt loam over loamy sand, the available water capacity would be affected by both textural classes. In determining the water in the 20 inches of silt loam or medium-textured material, simply multiply the depth (20 inches) by the amount of available water held by the silt loam textural class (0.23 inch of water per inch of soil). This calculation gives 4.6 inches of available water in the 20-inch zone. Now the remaining 20 inches (to complete the 40-inch profile) is loamy sand or coarse-textured material which holds only 0.05 inch of water per inch of soil. Multiplying 20 inches of loamy sand times 0.05 yields a total of 1.0 inch of available water. Therefore, the 40-inch soil profile has an available water capacity of 4.6 inches (silt loam) plus 1.0 inch (loamy sand) or 5.6 inches of available water.

G. Erosion

Soils under their natural vegetative cover attain equilibrium with their environment. When this vegetative cover is removed and the soils are cultivated, this equilibrium

Table 1. Amount of available water by textural classes.

	Available water: inches H_2O/inch soil	
Textural Class	**Range**	**Average**
Coarse (sand, loamy sand)*	.02-.09	0.05
Moderately coarse (sandy loam, fine sandy loam)	.09-.19	0.14
Medium (loam, sandy clay loam, silt loam)	.19-.27	0.23
Moderately fine (clay loam, silty clay loam)	.10-.19	0.15
Fine (silty clay, sandy clay, clay)	.07-.19	0.13

*Soil layers dominated (greater than 35 percent by volume) by gravel or fragments of rock also should be rated as coarse.

The four available water capacity categories on the scorecard have the following limits:

Available water capacity	Range: Inches H_2O in 40 inches of soil
Very low	less than 2.5 inches
Low	2.6 to 4.5 inches
Medium	4.6 to 7.0 inches
High	greater than 7.0 inches

is changed. At certain times of the year, the soils are exposed to heavy rains with little or no vegetative cover to break the impact of the rain drops. As a result, soil particles are dislodged and runoff waters carry these particles downslope and deposit them on other parts of the landscape or carry them into streams. Wind also is an effective carrier of particles on sandy soils. Regardless of the process, the removal of soil is called erosion.

Some soils in Maryland have been cultivated for hundreds of years, and many of these soils are severely eroded. Often, the entire original surface horizon has been removed, leaving the subsoil exposed. In some parts of the Piedmont, it is estimated that from 24 to 36 inches of the soil have been lost. The degree or severity of erosion is an important soil property.

The degree of past erosion can be determined by comparing the original soil depth, observed in virgin forests, with the present soil depth. The less surface soil, or the closer the subsoil is to the surface, the more severe the erosion problem.

The amount of past erosion often is misinterpreted when based on the depth of existing plow layer or topsoil. As erosion progresses, the subsoil is mixed with topsoil by moldboard plowing or chisel plowing, but the depth of the plow layer remains at about 8 inches. After prolonged use of no-till practices, often a very dark layer 2 to 4 inches thick develops. For these reasons, an estimate of past erosion is based on a comparison between the original thickness of the soil and the present thickness of both A and B horizons. The original thickness of the soil often is difficult to assess and will be given to the student at the judging site. The amount of past erosion is estimated as a measure of the soil that remains in relation to the given original thickness. The following categories are used to define the severity or degree of erosion in Maryland.

None to slight. Less than 3 inches of the original soil have been lost. No mixing of the subsoil into the plow layer is evident.

Moderate. Between 3 and 8 inches of the original soil have been removed. Subsoil material may be mixed with the plow layer, but the plow layer remains darker than the subsoil.

Severe. More than 8 inches of the original soil have been lost. Commonly, subsoil material is mixed with the plow layer, and the plow layer color closely resembles the subsoil color. Where the subsoil is exposed or gullies occur, the soil is severely eroded. Severe erosion automatically lowers the land capability class one class from that dictated by slope. For example, gently sloping, moderately eroded equals IIe; gently sloping, severely eroded equals IIIe.

H. Erosion Potential

Erosion potential is determined by the steepness of the slope, length of slope, the nature of the soil (soil texture, infiltration rate and tilth) and the type of vegetative cover. A soil's susceptibility to erosion will influence greatly how the soil is used. Relative ratings for potential cropland erosion for various soil and landscape conditions are listed in Table 2. These ratings provide guidance as to which conservation practices are needed to keep soil losses within tolerable limits.

Erosion potential can be determined primarily by evaluating factors such as slope gradient, slope length and soil texture. These factors for cropland are represented in Table 2.

III. Land Capability Classification

The variation in soils over the landscape forms a continuous spectrum. A single field or farm easily may contain several different soil types. These soils vary in their potential for production as well as other uses. With as many as 700 different soil types in Maryland, it is very cumbersome, if not impossible, to assign each soil a specific capability potential. In light of this, the Soil Conservation Service has developed a system of grouping soils for agricultural uses based on similar hazards or limitations. This system, the land capability classification, divides all soil types into eight capability classes. The risks of soil damage or limitations in use become progressively greater from class I to class VIII.

Several subdivisions are used to define this system for more meaningful interpretation. The broadest category, the capability class is based on the degree of limitation and is designated by the Roman numerals I to VIII. The next subdivision is the subclass, based on the kinds of limitations, which include 1) erosion hazard, 2) wetness, 3) rooting-zone limitations (low available water, sandiness, stoniness, shallow depth) and 4) climate. These are designated by the letters "e", "w", "s" and "c", respectively. The final subdivision is the capability unit that groups all soils having similar responses to systems of management of common cultivated crops and pasture plants. Thus, Maryland's approximately 700 different soil types can be placed into eight capability classes, which can then be subdivided in accordance with the subclass and unit criteria. Land judging is concerned only with the first two categories—the capability class and subclass.

Of the eight capability classes, only the first four are considered usable for cropland. Class I land has little or no hazard for crop production and is the best agricultural land. Classes II, III and IV need progressively more care and protection when cultivated crops are grown. Soils in classes V, VI and VII are suited for adapted native plants (such as forests), although some soils in classes V and VI are capable of producing specialized crops such

Table 2. Erosion potential for cropland.*

Surface texture	Slope gradient	Slope length	Erosion potential rating
	Soil Factors		
Coarse and moderately coarse	Nearly level	All	Slight
	Gently sloping	<300 ft >300 ft	Slight Moderate
	Strongly sloping	<300 ft >300 ft	Moderate Severe
Medium	Nearly level	< 150 ft >150 ft	Slight Moderate
	Gently sloping	<150 ft >150 ft	Moderate Severe
	Strongly sloping	All	Severe
Moderately fine	Nearly level	<150 ft >150 ft	Slight Moderate
	Gently sloping	<150 ft 150-300 ft >300 ft	Slight Moderate Severe
	Strongly sloping	All	Severe
Fine	Nearly level	<300 ft >300 ft	Slight Moderate
	Gently sloping	<150 ft 150-300 ft >300 ft	Slight Moderate Severe
	Strongly sloping	All	Severe
All textures	Moderately steep or greater	All	Severe

*Erosion potential for hay land, pasture or woodland can be considered *slight*.

as fruit trees and ornamentals. Soils in class VIII do not respond to management without major reclamation since they include the very steep and rocky areas of the mountain regions and the very wet tidal marshes in Maryland.

A. Major Limiting Factors

When assigning a soil to a capability class and subclass, several limiting factors including flooding, stoniness, depth, permeability, available water capacity, drainage, slope and erosion must be considered. If any one or combination of these factors is limiting to crop growth, the capability classification will be determined by the most limiting factor. While texture is an important soil property that often is a limiting factor in land use, it is not listed separately because it is related to several other limiting factors such as permeability, available water capacity and drainage. Where drainage is excessive, the 'permeability' and 'available water' factors should be checked.

When determining the land capability classification, for example, a soil may be deep, well drained and have a medium texture with good available water capacity and permeability. But if the soil occurs on a 4-percent slope, it is subject to erosion and must be placed in the second capability class (II) instead of the first (I). This soil would be placed in the IIe subclass. Likewise, a similar soil on level topography, but with mottling within 10 to 20 inches of the surface, must be placed in a capability class of at least III because this soil is wet or has a high water table for long periods. This soil does not have an erosion problem but does have a drainage problem. Thus, the subclass would be indicated with the letter "w" and the soil would be placed in IIIw.

These two examples show that although soils can possess many desirable properties from the standpoint of crop production, one adverse condition or a combination of adverse properties can render some degree of hazard in using the soil. Management practices such as contour tillage, stripcropping, terracing and drainage, often can overcome some soil problems and reduce the severity of others. However, the capability class and subclass reflect the degree and type of hazard and are directly related to the management that must be used to correct or minimize the hazard.

In the following paragraphs, the eight capability classes are defined and the limiting soil properties are indicated to help determine the appropriate class and subclass on the scorecard. The most intensive use always is assumed. It will also be helpful to review the placement of the various soil mapping units in the capability classes in the soil survey report of your county.

B. Capability Classes Suitable for Cultivation of Row Crops

Class I

Soils in this class have few limitations that restrict their use.

These soils are the best in nearly all respects for both agricultural production and nonagricultural uses. They are deep (40 inches or more), well drained and medium textured with medium to high available water capacities, moderate permeability and none to moderate erosion. These soils are easily worked and are among the most productive in the state. Slopes should not exceed 2 percent in the Coastal Plain or 3 percent in the Piedmont and Appalachian provinces. Management should include maintenance of proper plant nutrient balance and tilth.

Class II

Soils in this class have some limitations that reduce the choice of plants or require moderate conservation practices.

Although these soils are rated good and usually are productive, some physical conditions render them less desirable than class I land. Likewise, the drainage class, soil depth, permeability or available water capacity may be less desirable than class I soils. In general, slopes ranging between 2 and 5 percent in the Coastal Plain, and 3 and 8 percent in the remainder of the state would place this soil in class II. Drainage may be the limiting factor with mottling within the 20- to 40-inch zone of the profile. A slow or rapid permeability, low available water capacity or moderate soil depth (20 to 40 inches) also could eliminate this soil from class I. Although several limitations may exist, only one is necessary to place this soil in class II.

Management practices, in addition to those for class I, should include moderate erosion control (including rotations with sod or cover crops), contour farming, moisture retention methods or drainage depending on the type of limitation.

Class III

Soils in this class have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Limitations similar to class II soils may be present in these soils, but these limitations are more severe, restricting the use of these soils. Large acreages of class III land are strongly sloping and subject to moderate to severe erosion. Slope limits for this class range between 5 and 10 percent for the Coastal Plain and 8 and 15 percent for the remainder of the state. If drainage is the limiting factor, mottling should occur within the 20-inch zone, indicating that saturated conditions or high water tables are present at some time during the year. Shallow soils (less than 20 inches), coarse-textured surface layers, fine-textured subsoils with slow permeability or very low available water capacity also can limit the use of soils to the extent that they are placed in this class. The very coarse soils with very low available water capacities also fit into this class and require irrigation to realize production.

The soils in this class require more intense management than the previous classes. Management practices should include intensive erosion control measures such as terracing and stripcropping. Where excessive water is limiting, drainage practices are necessary to make these soils productive.

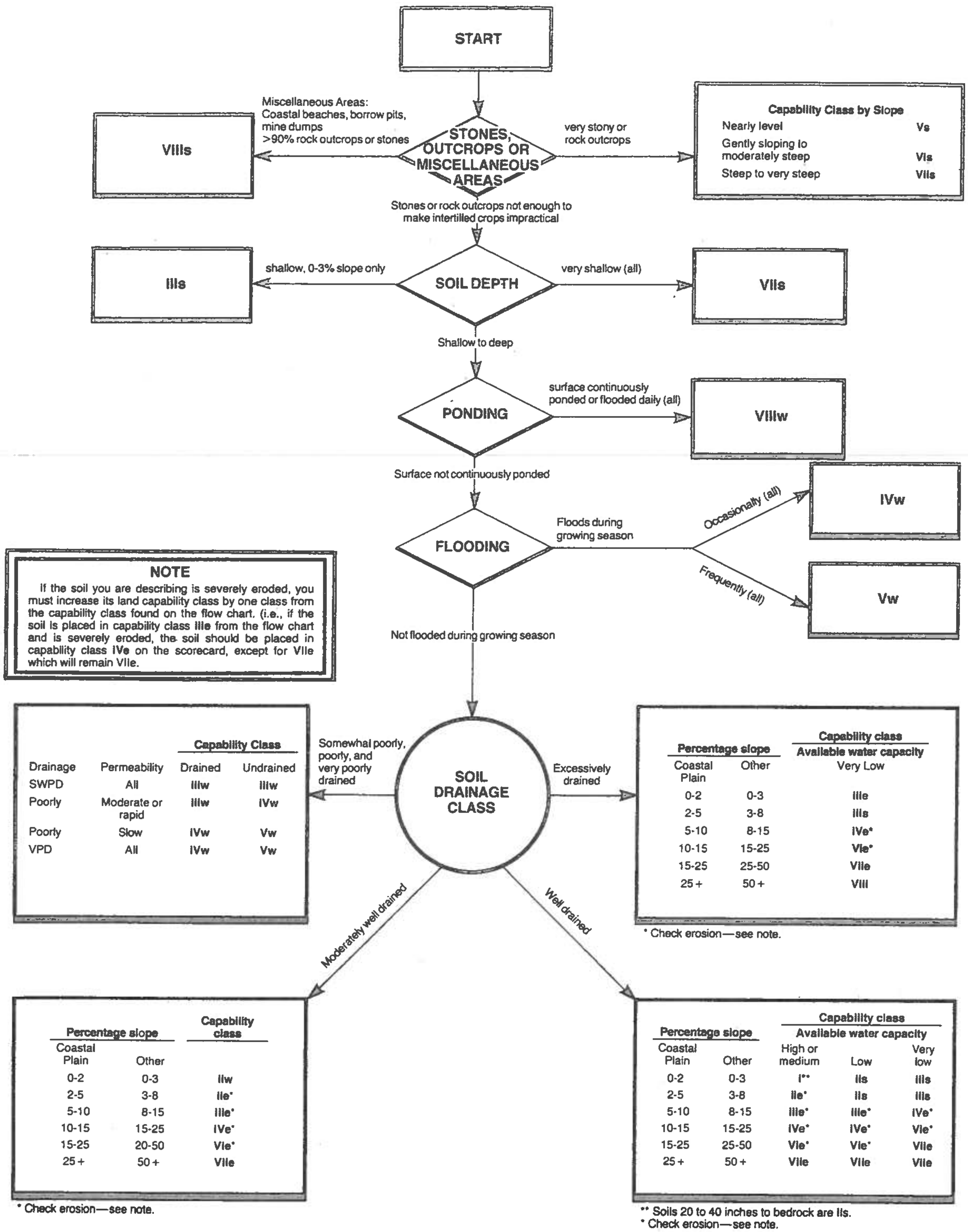
Class IV

Soils in this class have very severe limitations that restrict the choice of plants or require very careful management, or both.

Where erosion is limiting, this land is good for only occasional cultivation under careful management. Sod crops should occupy a large portion of the rotation because of the severe erosion hazard. Slope limits for this class range between 10 and 15 percent in the Coastal Plain, and 15 and 25 percent in the Piedmont and Appalachian sections of the state. Very poorly drained soils in depressions have such high water tables, or are saturated for such long periods, that only very intensive drainage management can make these soils productive.

Soils that are severely eroded or gullied with little or no surface soil must be placed in this capability class, even though these soils may occur on slopes similar to those required for class III soils (see note on Figure 9).

Very intensive management practices are required for production on these soils. Where erosion is the hazard,



NOTE

If the soil you are describing is severely eroded, you must increase its land capability class by one class from the capability class found on the flow chart. (i.e., if the soil is placed in capability class IIIe from the flow chart and is severely eroded, the soil should be placed in capability class IVe on the scorecard, except for VIIe which will remain VIIe.

Somewhat poorly, poorly, and very poorly drained:

Drainage	Permeability	Capability Class: Drained	Undrained
SWPD	All	IIIw	IIIw
Poorly	Moderate or rapid	IIIw	IVw
Poorly	Slow	IVw	Vw
VPD	All	IVw	Vw

Excessively drained:

Percentage slope: Coastal Plain	Other	Capability class, Available water capacity: Very Low
0-2	0-3	IIIe
2-5	3-8	IIIs
5-10	8-15	IVe*
10-15	15-25	VIe*
15-25	25-50	VIIe
25 +	50 +	VIII

* Check erosion—see note.

Moderately well drained:

Percentage slope: Coastal Plain	Other	Capability class
0-2	0-3	IIw
2-5	3-8	IIe*
5-10	8-15	IIIe*
10-15	15-25	IVe*
15-25	20-50	VIe*
25 +	50 +	VIIe

* Check erosion—see note.

Well drained:

Percentage slope: Coastal Plain	Other	Capability class, Available water capacity: High or medium	Low	Very low
0-2	0-3	I**	IIs	IIIs
2-5	3-8	IIe*	IIs	IIIs
5-10	8-15	IIIe*	IIIe*	IVe*
10-15	15-25	IVe*	IVe*	VIe*
15-25	25-50	VIe*	VIe*	VIIe
25 +	50 +	VIIe	VIIe	VIIe

** Soils 20 to 40 inches to bedrock are IIs.
* Check erosion—see note.

Figure 9.
Guide for selecting land capability classes and subclasses

cultivated crops may be grown only once in several seasons. Sod crops such as hay, pasture or cover crops are necessary to minimize the erosion loss. Even under excellent management, crop failures or severe yield reductions can be expected occasionally.

C. Capability Classes Unsuited for Cultivation

Class V

Soils in this class are nearly level and not subject to erosion, but because of excessive wetness resulting from frequent flooding or some permanent obstruction like rock outcrops, they are not suited for cultivation.

Streams that overflow frequently, excessive seepage, very stony soils or numerous outcroppings of bedrock make these soils unsuited for cultivation. Many of these soils are deep, however, and they have few limitations for pasture or forestry.

These soils respond to good management, which is necessary for satisfactory production.

Class VI

Soils in this class have severe limitations that make them generally unsuited for cultivation, and that limit their use largely to pasture, woodland, or wildlife food and cover.

These soils have continuing limitations that cannot be corrected economically such as steep slopes (15 to 25 percent in the Coastal Plain and 25 to 50 percent in the Piedmont and Appalachian provinces), a severe erosion hazard, effects of past erosion, or stoniness. These factors produce some limitation for pasture and forestry. It should be pointed out that even for most of these uses, the better classes are preferred for maximum protection.

Class VII

Soils in this class have very severe limitations that make them unsuited for cultivation and that restrict their use largely to grazing, woodland or wildlife.

Although not suited for cultivation, intensive management can make productive pasture and woodland possible. Even in rough, timbered areas, special care is required to prevent excessive erosion. Soils on very steep slopes, very shallow soils and very stony soils that occur on slopes greater than 25 percent in the Coastal Plain and greater than 50 percent in the Piedmont are the most common members of this class. This class includes the least capable soils with regard to pasture and woodland.

Class VIII

Soils and landforms in this class have limitations that preclude their use for commercial production of plants and restrict their use to recreation, water supply, wildlife or esthetic purposes.

Tidal marshes that are flooded daily, continuously ponded areas (areas containing water for more than 6 months of a year), and areas with greater than 90 percent rock outcrop, stones or boulders are included in this class as well as borrow pits, barren mine dumps and sandy beaches. These land areas have few or none of the physical soil features (found in class I soils) necessary to support any type of agriculture.

Guide for Selecting Capability Classes I Through VIII

Figure 9 is a guide for placing soils in the appropriate capability subclass according to their physical features. A soil placed in classes other than class I commonly has more than one undesirable feature. It will be helpful to examine the capability classification of various soil series in local soil survey reports.

To use the flow chart, enter at **start** and proceed to the first soil characteristic polygon. Exit that polygon along the most appropriate pathway for the soil you are describing. If you reach a land capability class, terminate your search, check erosion and record the appropriate land capability class and subclass on your scorecard. You will always terminate your search at the first land capability class you encounter. If you do not reach a land capability class continue to the next soil characteristic polygon and exit along the most appropriate pathway. Continue through the flow chart in the manner described until you reach a land capability class. Be sure to read the **note** in the double lined box pertaining to **severely eroded soils**.

This flow chart can be used during the contest.

IV. Land Management and Interpretations

The difficult task of establishing an overall priority for soil use has not been accomplished, although certain local governments have developed plans for using this natural resource. Because land is an irreplaceable resource, it is increasingly valuable. Planning its ultimate use, therefore, should be one of the major goals in resource development.

In spite of the lack of an overall plan, certain procedures can be initiated in current conservation or wise use of soils. One of the first steps is to recognize the capabilities and limitations of soils. Analyzing the landscape and profile characteristics mentioned previously will go far in this direction. Knowledge of the capabilities of soils can aid in the development of sound plans for urban expansion. For example, in urban centers, some areas are not suited for high density development (floodplains or extremely rocky areas); thus, these areas can be designated for recreational areas. Knowledge of soils is used in agriculture to provide suitable management to obtain the highest economic return from production while controlling erosion. Fortunately, many of the practices used for continued high production also are useful in erosion control. Thus, a thorough knowledge of the capabilities and limitations of soils can benefit potential users of the land.

In planning the ultimate use of the land resources, certain lands should be earmarked for parks, recreational areas, wildlife sanctuaries, hunting grounds and wilderness areas. The value of these areas for leisure time use will increase tremendously in the years ahead. Evaluation of the landscape and soil features will aid in selecting appropriate areas for preservation and determine the hazards and suitability of other areas for specific uses.

Agricultural Management

A. Drainage

Drainage problems in Maryland are associated with low-lying areas, depressions, areas subject to flooding by streams or tidal activity, and certain soils having slowly permeable horizons that restrict downward movement of water. Drainage systems are designed to remove excess surface water or lower the water table. The feasibility and type of drainage system is based on the presence of a suitable outlet, permeability of each soil horizon, topography, land capability and the drainage requirements of the crops to be grown.

The outlet should be one of the first considerations when selecting a drainage system, for without an adequate outlet to remove excess water, drainage obviously is not possible. The choice of tile drainage or open ditch methods, in addition to the economics involved, is based on the permeability of soils and landscape characteristics. Tile drainage is primarily for subsurface drainage. However, this system is unsatisfactory for fine-textured, slowly permeable soils. Open ditching can be used to remove surface water, as well as lower the water tables. The 'shallow ditch' drainage treatment on the scorecard should be used for those soils with slow permeability. Land forming frequently is used with ditching to improve surface drainage. In many instances, a combination of tile and open ditching methods is used to remove excess surface and subsurface water.

B. Erosion Control Practices

The basic cause of water erosion on cultivated land is the impact of the raindrop on the bare soil surface. This erosive force is responsible for detaching soil particles and the gradual downslope movement. Some of the finer sediment is carried farther by surface runoff and stream activity. Erosion can be reduced drastically on sloping land by having a vegetative cover or mulch on the soil to absorb the energy of the falling raindrops. This, of course, is not possible if agriculture is to feed over 220 million people in the United States and help feed millions in food-deficient countries. Therefore, rotations are established to provide soil-conserving crops at certain intervals between row crops. This type of rotation, plus practices such as conservation tillage, contour stripcropping, terracing, grassed waterways and diversions, permits intensive agriculture while minimizing soil loss through erosion.

The selection and layout of appropriate practices on a given soil is quite technical. The Soil Conservation Service of USDA, working through the Maryland Soil Conservation Districts, has the prime responsibility for this job. For the purpose of land judging, however, some general recommendations can be made based on the factors listed on the scorecard. Place special emphasis on the capability class and slope characteristics.

None, other than cover crops, is used on capability classes I, IIw, IIs, IIIs and IVs where slopes are nearly level, wind erosion is not a factor, and intertilled crops may be grown continuously. Erosion potential for cropland is *slight*.

Contour farming refers to cultivation on the contour or at right angles to the direction of the slope. This practice is used primarily on capability class IIe soils or soils that are gently sloping and have a *moderate* potential erosion hazard for cropland.

Contour stripcropping refers to the growing of alternate strips of row crops (corn or soybeans in wide rows) with close grown crops such as small grain or forages in conjunction with contour farming. This practice is used primarily on capability class IIIe soils or soils that are strongly sloping and on soils that have a *severe* potential erosion hazard for cropland and slope lengths less than 300 feet. (For purposes of land judging, only the contour stripcropping practice should be checked since contour farming is inferred.)

Diversions are grassed channels, referred to in some areas as diversion terraces, that cut across the slope more or less on the contour. They are used to shorten slope lengths and thus reduce erosion by diverting water to channels designed to handle excess runoff, in many cases to grassed waterways. Diversion terraces help protect gullied areas and contour strips from erosion and protect soils lower on the landscape from overland flow. They are used on capability class IIIe and IVe soils where the potential erosion hazard is severe and slope lengths exceed 300 feet. (For purposes of land judging, slope length *will be given* on the information sheet at each soil pit.) Commonly, diversions are used in conjunction with contour stripcropping.

Grassed waterways are natural or constructed drainage ways which allow excess surface water to flow safely from sloping lands. Properly constructed and maintained, they provide an excellent means of surface water removal. They are used frequently with diversions and in conjunction with both contour farming and contour stripcropping on capability class IIe, IIIe and IVe land.

Terraces are broad, cropped ridges designed to intercept water moving down the slope. The water is then removed from the field at reduced velocities through an outlet. Terraces prevent water from attaining erosive velocities on long slopes. These structures generally are recommended on long slopes with gradients of less than 8 percent and on soils with deep fertile subsoils that are medium to moderately coarse textured throughout. They are not used extensively in Maryland.

Gully control should be checked on the scorecard when gullies exceeding about a foot in depth are found in the judging area. In places where gullies coincide with natural drainage ways, they should be checked on the scorecard along with grassed waterways.

Wind erosion control is necessary primarily on coarse-, moderately coarse-, and medium-textured surface soils in fields or large open areas where prevailing winds (mostly northwest to southeast) are *uninterrupted* by permanent vegetation. Permanent vegetation is interpreted to be shrubs or trees that are at least 15 feet tall and occur at spacings of no more than 1,000 feet apart. Wind erosion usually is a factor on slopes that are nearly level or gently sloping. The key to wind erosion control is to provide a vegetative cover or mulch to reduce wind velocity at the soil surface. This is important especially in the spring when wind velocities are high and soil surfaces dry out rapidly. Windbreaks can be constructed perpendicular to prevailing winds at appropriate intervals particularly in sandy areas to help control wind erosion.

No-till farming refers to tillage and planting operations where at least 30 percent of the soil surface is covered by crop residues. Generally, soil disturbance is minimal and most crop residues are left on the surface. Weed control is accomplished primarily with herbicides. If no-till equipment is available, use of the practice in conjunction with other erosion control practices results in excellent erosion control on cropland. However, this practice alone usually will keep erosion within tolerable limits on soils with slopes up to 10 percent and slope lengths of less than 300 feet. Where slopes exceed 10 percent or are longer than 300 feet, no-till farming practices should be used in conjunction with contour stripcropping, or contour stripcropping with diversions. (For purposes of land judging, the availability of no-tillage equipment will be documented on the information sheet.)

Permanent vegetation refers to the establishment and maintenance of permanent vegetative cover consisting of grasses, legumes or timber on soils with a very high erosion potential or soils with other limitations such as wetness, flooding, stoniness or very shallow rooting depths that severely limit their use for cropland. Generally, this practice is used on lands that are in capability class V and higher. In addition, for land judging it should be checked when the soil pit actually is located within the bounds of a grassed waterway on capability classes II through IV. In such a case, this practice might be checked in conjunction with grassed waterways and any other practices dictated by the landscape conditions in the judging area.

C. Most Intensive Land Use

Effective crop and soil management should provide for good soil tilth; erosion control; elimination of weeds, insects, and diseases; adequate supplies of nutrients and water; and sustained high yields at a reasonable profit. As noted from these requirements, it is extremely difficult to work out sound management practices for the great number and variety of soils in Maryland. Adding to the difficulty are the many cropping systems and types of farming operations around the state, such as dairying in the Piedmont; tobacco production in southern Maryland; and truck farming, cash grains and the broiler industry on the Eastern Shore. On the scorecard, evaluate the management practices for the most intensive agricultural use for the particular soil. The most intensive use is continuous intertilled crops; permanent vegetation is considered the least intensive. Erosion control measures, fertilizer application, rotations and drainage should be adjusted accordingly.

The basis for selection of the most intensive use and subsequent practices is the capability classification (see section III). These classes are based, of course, on the landscape and soil features. The various land uses, examples of rotations and the respective capability classes are presented in Table 3.

For many years, rotations of varying length were thought to be necessary for all types of land management. Presently, a continuous intertilled cropping system is profitable where several types of crops are necessary for the farming enterprise. In this case, each crop may be grown on the most suitable soil, such as corn on the level land and forages on the steeper land. However, continuous intertilled cropping is recommended only for soils without an erosion hazard or in class IIw, IIs and IIIs

Table 3. Examples of rotations and capability classes for four land use conditions.

Land	Examples of Rotations[a]	Capability Class
Continuous intertilled crops	CCCC; CSCS	I, IIw, IIIw[b], IIs and IIIs[c]
Intertilled crops not continuously but one-half or more of the time	CCOH; CCOc	IIe, IIIe, IIIw
Intertilled crops less than one-half of the time	COHHH	IV
Permanent vegetation	Pasture, Forest	V, VI, VII, VIII

[a]Symbols used include: C = corn; S = soybeans; O = oats; Oc = oats with legume; H = hay

[b]Soil in the IIw subclass are not subject to erosion, but they may have impeded drainage or a flooding hazard.

[c]IIs, IIIs soils must be nearly level and must be irrigated if other factors permit cultivation.

soils where irrigation is possible and other factors permit cultivation. Also, the management of a continuous intertilled cropping system is much more exacting. Weed, insect and disease problems, and deterioration of soil structure are common.

For most of the soils in Maryland, rotations definitely are recommended. Rotations provide many favorable features in satisfying the requirements for effective cropping systems and soil management practices previously mentioned. The specific rotation, however, must be adapted after careful analysis of the soil-landscape features and the type of farming enterprise.

D. Supplemental Nutrients and Amendments

The success of a soil management program depends on the nutrient supply available to the plants. A soil test is one basis for evaluating the nutrient status of a given soil. In actual practice, samples taken by farmers or homeowners are sent to the Soil Testing Laboratory in the Agronomy Department at The University of Maryland, where fertilizer recommendations are made by the county Extension agent.

For the purpose of land judging, however, a soil test and the crop to be grown will be posted at each site. After careful examination of the test results, the 'judger' is asked to check the appropriate nutrients or amendments needed for the crop to be grown. If legumes are the crop to be grown, nitrogen should not be checked. The actual amounts of fertilizer or lime to apply are not included on the scorecard because this would involve many management factors such as the availability of farm manures. Details on the nutrient requirements of various crops can be obtained from Extension fact sheets and agronomy mimeos and standard textbooks relating to crop and soil science.

Figure 10 provides an example of the information that will be provided at each soil pit. This sheet will provide information concerning the crops to be grown, soil test results, field size, slope length, flooding frequency, availability of no-till equipment, original soil thickness, supplemental nutrient data, and other data needed to properly complete the land judging scorecard.

Nonagricultural Management

Usually, the best agricultural soils also are the most sought after soils for nonagricultural uses including residential home sites, developments, shopping centers, roads, industrial locations, parks and playgrounds. In areas of rapid urbanization, the best agricultural soils commonly are the first to undergo development. However, since land near urban centers is so valuable, development eventually takes place regardless of the soil type. As a result, many soils are put to uses for which they are not suited.

Problems that arise from using soils beyond their capabilities are many and varied. Homes built on poorly drained soils commonly have wet basements, and wet periods may render septic systems completely useless. Roads and small buildings constructed on unstable clayey soils may be subject to failure because of expansion and contraction of the clays, or earth slides on unstable slopes. Floodplains are attractive places on which to build because they are level and easy to develop. But elaborate measures must be taken to keep flood waters out of these areas. Building in areas of shallow soils with underlying hard bedrock is an expensive and frustrating experience. Likewise, laying pipelines or locating residential streets in these areas is expensive. This expense often is unnecessary if care is taken to locate more suitable soils nearby.

FIELD

Soil Test Results | **Special Test**

Field No.	Soil Texture*	pH	Magnesium Mg	Phosphate P_2O_5	Potash K_2O	Special Test
						Size of field: 10 acres Slope length: 250 ft
Site #1		5.9	L	M	H	Flood frequency: None
						No-tillage equipment: Available
						Original soil thickness: 38 inches

* F = Fine; S = Sand or Sandy; L = Loam or Loamy; Si = Silt or Silty; Cl = Clay

VL . . . . . . Very Low
L . . . . Low
M . . . . Medium
H . . . . High
VH . . . . . . Very High

Recommendations

Field No.	Crop to be grown	Lime requirement		Plant food recommended				How to apply	Special notes	Remarks
		Total oxides (CaO + MgO) lb/acre	Minimum MgO lb/acre	N lb/acre	P_2O_5 lb/acre	K_2O lb/acre	Mg lb/acre			
	Corn									

* For interpretation purposes, (if no gray mottles are observable in the soil profile, it is assumed that none exist above 72 inches.)

Figure 10.
Land judging—sample information sheet.

Extremely acid and corrosive conditions are prevalent in certain subsoils and substrata. Locating pipelines or planting trees and shrubs in this material is not advised.

All these examples of improper land use could have been predicted and ultimately avoided or corrected had someone taken the time to investigate the soils *before* construction. Of course, civil engineers and others would never allow construction of large buildings or highways without onsite investigations of the soil and substrata to determine if they will support these projects. However, for much of our nonagricultural land use, no effort is made to obtain adequate information about soil conditions to correct potential hazards *before* they develop into major problems.

By knowing a soil's texture, depth, drainage characteristics, permeability, available water capacity, the degree of slope and erosion, and susceptibility to flooding, a general prediction can be made on how well this particular soil is suited to a given use.

Poorly drained soils are not suited for septic tanks or homes with basements, but these soils may be used for homes without basements where public sewers are available. Soils in floodplains have certain characteristics that identify them as being developed from materials deposited from periodic inundation by flood waters. Permanent structures should not be built on these soils, but they may be well suited to parks and playgrounds where periodic flooding will not cause serious damage.

People trained in soil science are being sought by developers, real estate agencies, planning commissions, health departments and various government agencies to give advice on soil suitability for various uses. These people and agencies are responsible for many land use decisions and they want to make sure that the soils in an area are suitable, or the problems associated with these soils can be corrected. Many examples could be cited of soils being used beyond their capabilities with no investigation preceding their development. Farmers have known for a long time that it is a waste of time and money to attempt to produce 150 bushels per acre of corn on unsuitable soils. It also is being realized that using soils unsuited for specific nonagricultural purposes invites trouble.

To provide the student with a practical exercise in soil judging, the last section of the scorecard deals with rating the soil for three nonagricultural uses: 1) limitations for residential homes with basements, 2) limitations for septic systems and 3) suitability for lawns and shrubs.

E. Suitability for Homesites

In rating the soil for homesites with basements, consider depth to water table, soil depth to bedrock, slope and flooding. The limitations in rating soils for their suitability for homesites is as follows.

None to slight. Soils with no gray mottles or bedrock above a depth of 72 inches and with slopes less than 8 percent are considered suitable for homesites.

Moderate. Limitations such as short periods of high water table or saturated conditions (soils with no gray mottles above 40 inches), bedrock between 40 to 72 inches and slopes of 8 to 15 percent, would place these soils in the moderate class.

Severe. Where soils possess serious hazards or where excessive construction costs would result, the site is rated as severe. The hazards would include soils with gray mottles above 40 inches, bedrock at a depth of less than 40 inches and slopes greater than 15 percent.

F. Suitability for Septic Systems

In rating soil suitability for septic systems, consider depth to water table, permeability, depth to bedrock, flooding and slope. The limitations in rating soils for their suitability for septic systems are as follows.

None to slight. Soils with no gray mottles or bedrock above a depth of 72 inches, moderate permeability and slopes of less than 8 percent are preferred for septic systems. The soil is rated on its ability to absorb and renovate effluent. Soils with rapid permeability (such as sand and gravelly sand) are rated as having severe limitations because they may present a potential contamination hazard to the ground water.

Moderate. Soils with no gray mottles above 40 inches and bedrock between 40 to 72 inches will accommodate a septic system most of the year. Short periods of a high water table may render the system useless or reduce its efficiency during this time, but the system usually functions normally most of the year. Soils with slopes ranging between 8 and 15 percent may be considered as having moderate limitations for septic systems.

Severe. Soils with high water tables (gray mottles present above 40 inches) for long periods are unsuited to septic systems. Shallow soils (bedrock above 40 inches) or slow permeability may render the soil useless for this type of sewage disposal. Slopes greater than 15 percent would not be well suited for septic systems because of the potential hazard of the effluent seeping out at the surface downslope. Systems installed on floodplains are a potential source of contamination during flooding. Soils with rapid permeability (such as sand and gravelly sand) are rated as having severe limitations, because they may present a potential contamination hazard to the ground water.

Other factors may necessitate placing the soil in one of the classes. Use common sense when determining whether the soil is fit for either of these uses.

G. Suitability for Lawns and Shrubs

Millions of dollars are spent annually on turf and ornamental establishment and maintenance by homeowners. Much of this money is spent because plant growth is attempted under unsuitable conditions. Many factors are important to the establishment and upkeep of lawn and ornamental plants. Turf production in wet and clayey or sandy and sloping soils often will fail. In attempting to evaluate a homesite for lawns and shrubs, the scorecard lists four soil properties important to the success of lawns and ornamental shrubs. The final site evaluation is determined by the most limiting factor. For example, if a site has only slight limitations for every soil property except texture, the final site evaluation would be marked moderate or severe if the textural limitation was moderate or severe, respectively.

Land Judging Scorecard
Maryland–New Jersey–Delaware

Name ______________________________

School ______________________________

State ______________ Site No. ______________

Score

Part I ______________

Part II ______________

Part III ______________

Part IV ______________

TOTAL ______________

Part I: Landscape Features

A. Position
- ☐ Upland
- ☐ Upland depression
- ☐ Terrace
- ☐ Floodplain

B. Slope Characteristics
- ☐ Nearly level
- ☐ Gently sloping
- ☐ Strongly sloping
- ☐ Moderately steep
- ☐ Steep
- ☐ Very steep

C. Parent Material
- ☐ Residual
- ☐ Glacial
- ☐ Recent alluvium
- ☐ Old alluvium
- ☐ Coastal plain sediments
- ☐ Colluvium

D. Stoniness
- ☐ None
- ☐ Very stony
- ☐ Rock outcrop

Part II: Soil Features

A. Color

(1) Surface soil
- ☐ Brown or dark brown
- ☐ Reddish brown
- ☐ Gray or grayish brown
- ☐ Black

(2) Subsoil
- ☐ Yellowish brown or red, no gray mottling
- ☐ Yellowish brown or red, some gray mottling
- ☐ Light brown with gray mottling
- ☐ Gray, some brown mottling

B. Texture

(1) Surface soil
- ☐ Coarse
- ☐ Moderately coarse
- ☐ Medium
- ☐ Moderately fine
- ☐ Fine

(2) Subsoil
- ☐ Coarse
- ☐ Moderately coarse
- ☐ Medium
- ☐ Moderately fine
- ☐ Fine

C. Depth
- ☐ Very deep
- ☐ Deep
- ☐ Moderately deep
- ☐ Shallow
- ☐ Very shallow

D. Drainage
- ☐ Excessively drained
- ☐ Well drained
- ☐ Moderately well drained
- ☐ Somewhat poorly drained
- ☐ Poorly drained
- ☐ Very poorly drained

E. Permeability
- ☐ Rapid
- ☐ Moderate
- ☐ Slow

F. Available Water Capacity
- ☐ High
- ☐ Medium
- ☐ Low
- ☐ Very low

G. Erosion
- ☐ None to slight
- ☐ Moderate
- ☐ Severe

H. Erosion Potential
- ☐ Slight
- ☐ Moderate
- ☐ Severe

Part III: Land Capability

A. Major Limiting Factors
- ☐ None
- ☐ Flooding or ponding
- ☐ Slope
- ☐ Erosion
- ☐ Depth
- ☐ Drainage
- ☐ Permeability
- ☐ Available water capacity
- ☐ Stoniness or rock outcrop

B. Land Capability Class and Subclass (Circle the class and subclass)

I	IIe	IIIe	IVe	—	VIe	VIIe	—
—	IIw	IIIw	IVw	Vw	—	—	VIIIw
—	IIs	IIIs	—	Vs	VIs	VIIs	VIIIs

Part IV: Land Management and Interpretations

Agricultural Management

A. Drainage
- ☐ None
- ☐ Deep ditch or tile or both
- ☐ Shallow ditch

B. Erosion Control
- ☐ None, other than cover crops
- ☐ Contour farming
- ☐ Contour stripcropping
- ☐ Diversions
- ☐ Grassed waterways
- ☐ Terrace
- ☐ Gully control
- ☐ Wind erosion control
- ☐ No-till farming
- ☐ Permanent vegetation

C. Most Intensive Land Use
- ☐ Intertilled crops continuous
- ☐ Intertilled crops continuous with irrigation
- ☐ Intertilled crops one-half or more of the time
- ☐ Intertilled crops less than one-half of the time
- ☐ Permanent vegetation

D. Supplemental Nutrients and Amendments
- ☐ Lime
- ☐ Nitrogen
- ☐ Phosphorus
- ☐ Potassium
- ☐ Magnesium

Nonagricultural Management

E. Limitations for Residential Homes With Basements

Limitations
- ☐ None to slight
- ☐ Moderate
- ☐ Severe

Major limiting factors
- ☐ High water table
- ☐ Depth of bedrock
- ☐ Flooding or ponding
- ☐ Slope

F. Limitations for Disposal of Sewage Effluent From Septic Tanks

Limitations
- ☐ None to slight
- ☐ Moderate
- ☐ Severe

Major limiting factors
- ☐ Depth of soil to bedrock
- ☐ Flooding or ponding
- ☐ High water table
- ☐ Slope
- ☐ Permeability

G. Site Evaluation for Lawns and Shrubs

Soil Property	Limiting Factors	Degree of Limitation: Slight	Moderate	Severe
1. Surface soil texture	Moderately coarse–medium	☐		
	Moderately fine, coarse or gravelly		☐	
	Fine, stony or rock outcrops			☐
2. Slope–erosion	Level to gently sloping	☐		
	Strongly sloping		☐	
	Moderately steep to very steep or severe erosion			☐
3. Available water capacity	High, medium	☐		
	Low		☐	
	Very low			☐
4. Drainage	Well, moderately well	☐		
	Somewhat poor, excessive		☐	
	Poor, very poor			☐
5. Final site evaluation		☐	☐	☐

THE UNIVERSITY OF MARYLAND
Cooperative Extension Service
College Park - Eastern Shore