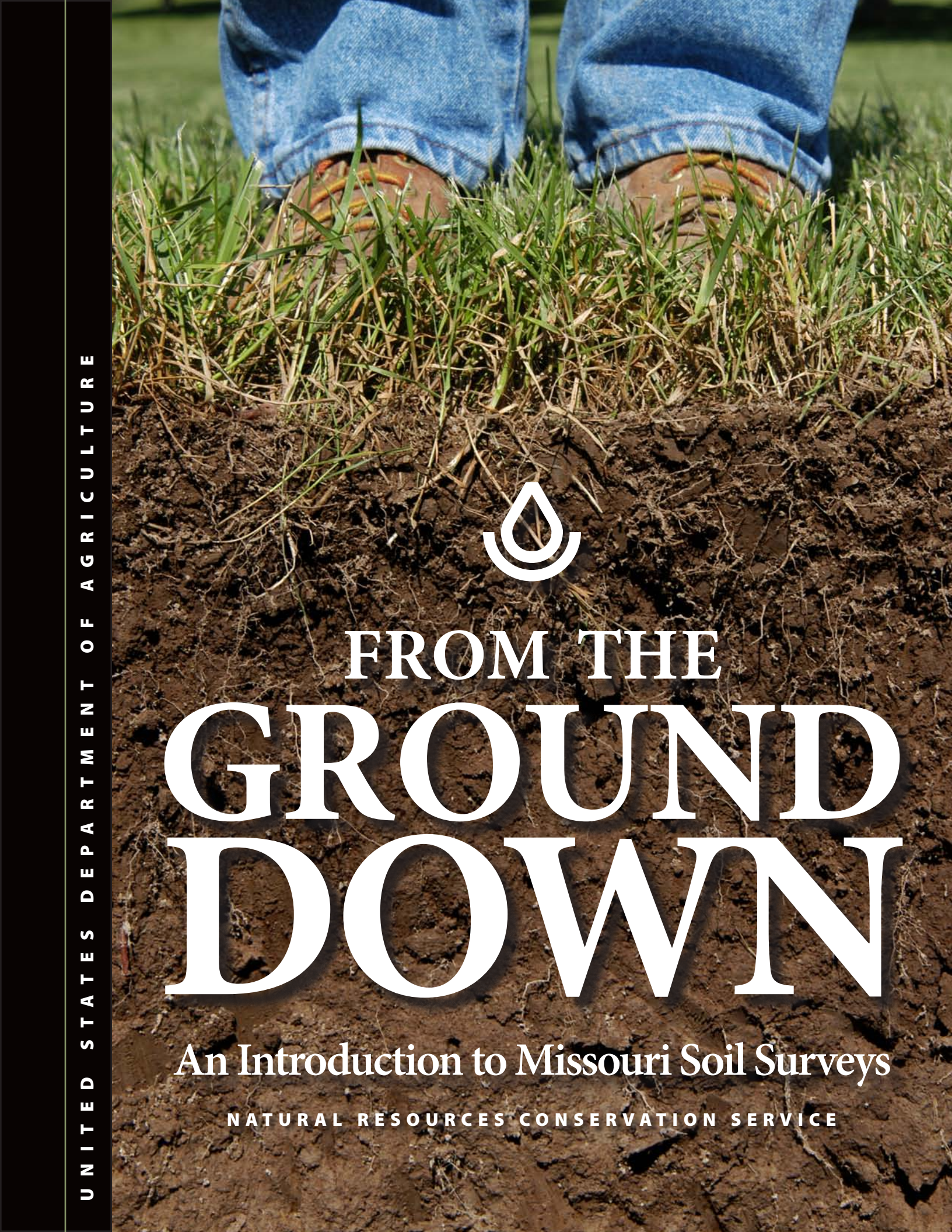


UNITED STATES DEPARTMENT OF AGRICULTURE

FROM THE GROUND DOWN

An Introduction to Missouri Soil Surveys

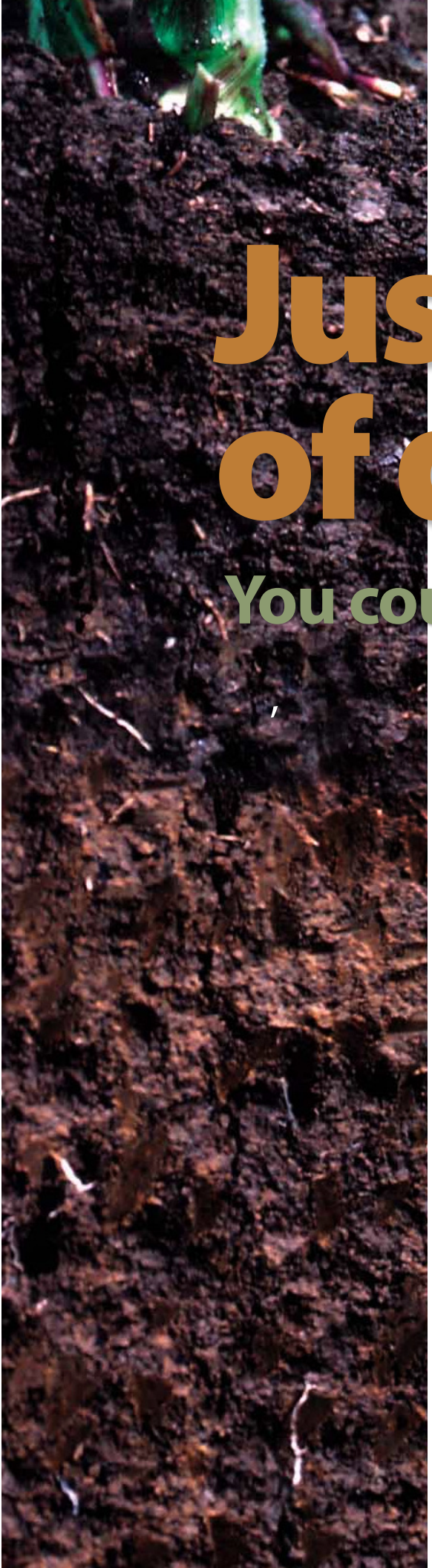
NATURAL RESOURCES CONSERVATION SERVICE

An Introduction to Missouri Soil Surveys

FROM THE GROUND DOWN

NRCS
Natural Resources Conservation Service

Helping People Help the Land in Missouri



Just a bunch of dirt?

You couldn't be more wrong.

Like snowflakes, no two soils are exactly the same. Each different kind of soil is called a series. These soil series are named for towns or local landmarks. For example, Menfro soils are named for the town of the same name located in east-central Missouri. More than 10,000 soil series have been named and described in the United States, and more are being defined each year. There are about 488 soil series in Missouri.

Much of our life's activities and pursuits are influenced by the soil beneath our houses, roads, sewage systems, airports, parks, recreational sites, farms, forests, schools and shopping centers. What is put on the land should be guided by the soil that is beneath it. A soil's behavior, once known, is true for that type of soil no matter where the soil is. Different soils, with great differences in properties, can occur within relatively short distances, even within the same subdivision or field.

The mission of the Missouri Cooperative Soil Survey is to continue developing science-based soil system information, customized to meet users' needs for natural resources management.

A soil survey is text and soil maps that help land users identify the potentials and limitations of soils. Soil surveys are prepared

by soil scientists, who recognize and record the properties of the soil and predict soil behavior for a host of uses. These predictions, called soil interpretations, are developed to help users of soils manage the resource. Soil surveys of each county are available in three formats: as publications; on CDs; and online.

The publications represent a snapshot in time. They contain information that was current at the time of printing. But the text, tables and soil maps may have been updated since publication. Information about the soil survey program in Missouri is available at **http://soils.missouri.edu**. The Natural Resources Conservation Service (NRCS) also has several web sites devoted to the soil survey program on a national basis. The primary one is **http://websoilsurvey.nrcs.usda.gov/app/**.

To gather information for a soil survey, soil scientists walk over landscapes, dig holes with soil augers shovels and probes, and examine cross-sections of soil profiles. They observe soil textures (the ratio of sand, silt and clay) soil color, structure and thickness of the different soil horizons. These and many other soil properties are studied in the field, while others are determined through laboratory tests.

The intent of this publication is to acquaint users and potential users of soil survey reports with the content of those reports, and to help them extract useful soils data. To be proficient in using soil survey data, it is imperative that users have a basic understanding of the concepts of soil development and of soil-landscape relationships. These topics are covered briefly in the next two sections of this guide.

Photo: NRCS soil scientists (from left) Melvin Simmons, Caryl Radatz and Bill Pauls, examine a soil core in a Missouri field.

Soil Horizons

Soils develop into layers. These layers, called horizons, can be seen where roads have been cut through hills and other areas where the soil is exposed. The presence and thickness of each horizon varies with location. Under disturbed conditions, such as intensive agriculture, building sites, or where there is severe erosion, some horizons may not be present. The photos on page 6 are profiles of Missouri soils with visible horizons labeled.

O Horizon

The uppermost soil layer is called the organic layer, or O Horizon. It consists of leaf litter and other organic material on the surface. This layer has a dark color. It is present in undisturbed woodlands.

A Horizon

Below the O Horizon is the A Horizon, or topsoil. It may be referred to as the surface layer in a soil survey report. Usually topsoil is darker than soil in lower horizons. Topsoil is loose and crumbly with varying amounts of organic matter. Topsoil is the most productive layer of soil.

E Horizon

Below the A Horizon is the E Horizon, or subsurface layer soil. The soil in the E Horizon is generally bleached. As water moves through this horizon, soluble minerals and nutrients dissolve, and some of the dissolved materials are leached out. The main feature of this horizon is the loss of clay, iron, aluminum and humus, resulting in a concentration of sand and silt particles.

B Horizon

Below the E Horizon is the B Horizon, or subsoil. Subsoil is lighter colored than soil in the A Horizon. It is often more dense and lower in organic matter than the soils in the horizons above it. The subsoil is a zone of accumulation; most of the materials leached from the A and E horizons accumulate in the B Horizon.

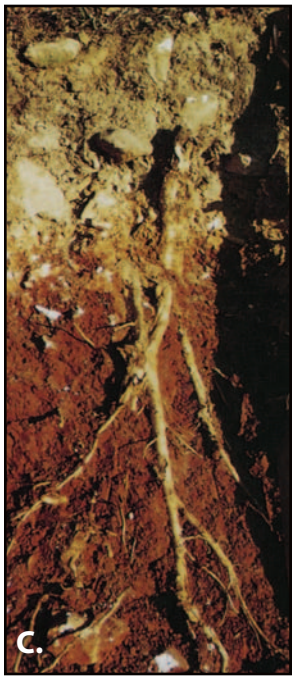
C Horizon

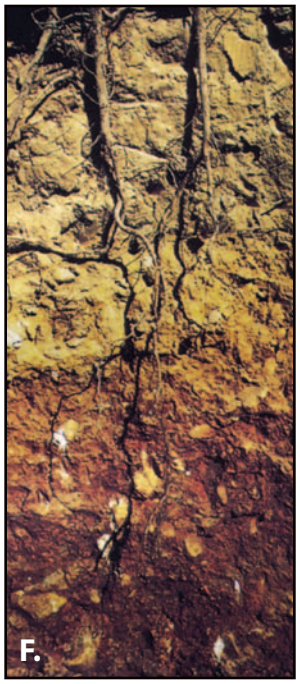
Still deeper is the C Horizon, comprised primarily of mineral particles and, sometimes, partially weathered bedrock. It is between the B Horizon and bedrock.

R Horizon

The lowest horizon, the R Horizon, is bedrock. Bedrock can be within a few inches of the surface or many feet below the surface.

Missouri Soil Horizons





A. Well-drained soil with a thin A Horizon over a B Horizon

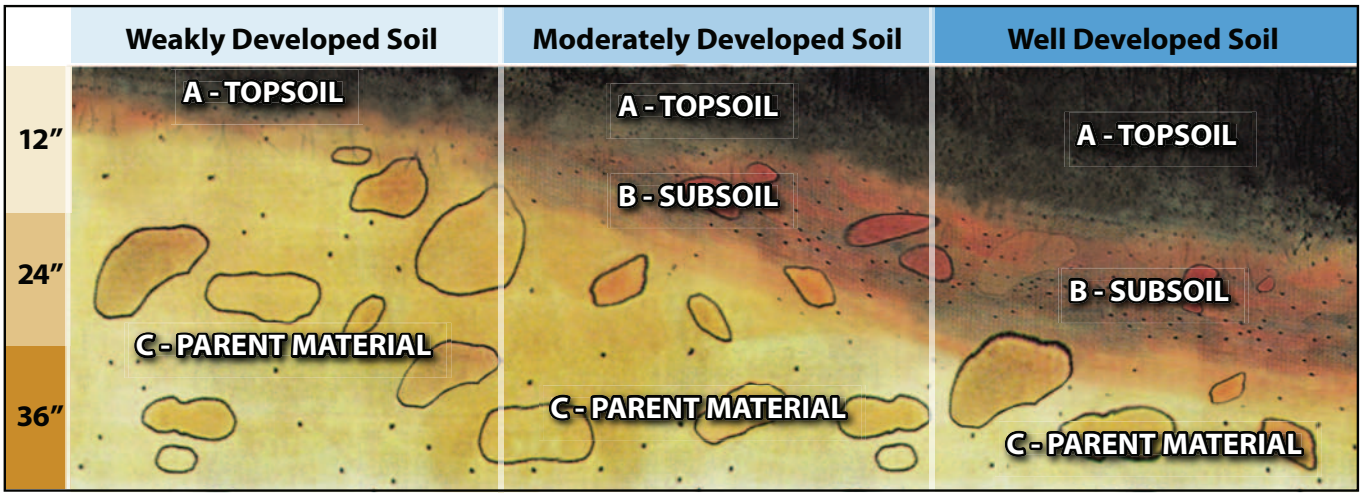
B. Extremely cobbly fragipan layer at 24" - 36"

C. Well-drained soil formed in colluviam and the the underlying residum

D. The B Horizon in the profile shows well-developed prismatic structure.

E. Thick, black A Horizon, highly organic, with a poorly drained gray B Horizon

F. Brown A Horizon, light brown B Horizon with a dense layer at about 15 inches preventing root penetration



How Soil Develops

The three boxes in the diagram, represent a soil in the same spot at different times in history. During that time, climate, living organisms and topography changed the soil. Notice in this example how the parent material is broken down, and the soil's structure changes from weakly developed to well-developed. Not all soils undergo this exact type of change, and the time for change differs with location. These differences occur because the climate differs from one location to another, as do the number and types of living organisms living in the soil.

Parent Material

Parent material (C Horizon) consists of the loosely arranged mineral and organic matter from which soils are developed. Parent material can be ash from volcanoes, sediments moved and deposited by wind and water, or sand and rock deposited by glaciers. Broken down bedrock is another example of parent material.

Climate

Climate helps change parent material into subsoil, subsurface soil and topsoil. Freezing, thawing, wetting and drying breaks parent material apart. Rain dissolves some minerals and transports them deeper into the soil.

Living Organisms

Plants and animals change the weathered parent material into subsoil and topsoil. Leaves, twigs, stems, and bark from plants fall onto the soil, and are broken down by fungi, bacteria, insects and other animals that live in the soil. Insects and earthworms burrowing through the soil eat and break down organic matter and minerals into simpler compounds. Plants and animals help make the soil rich in nutrients as they die and decay.

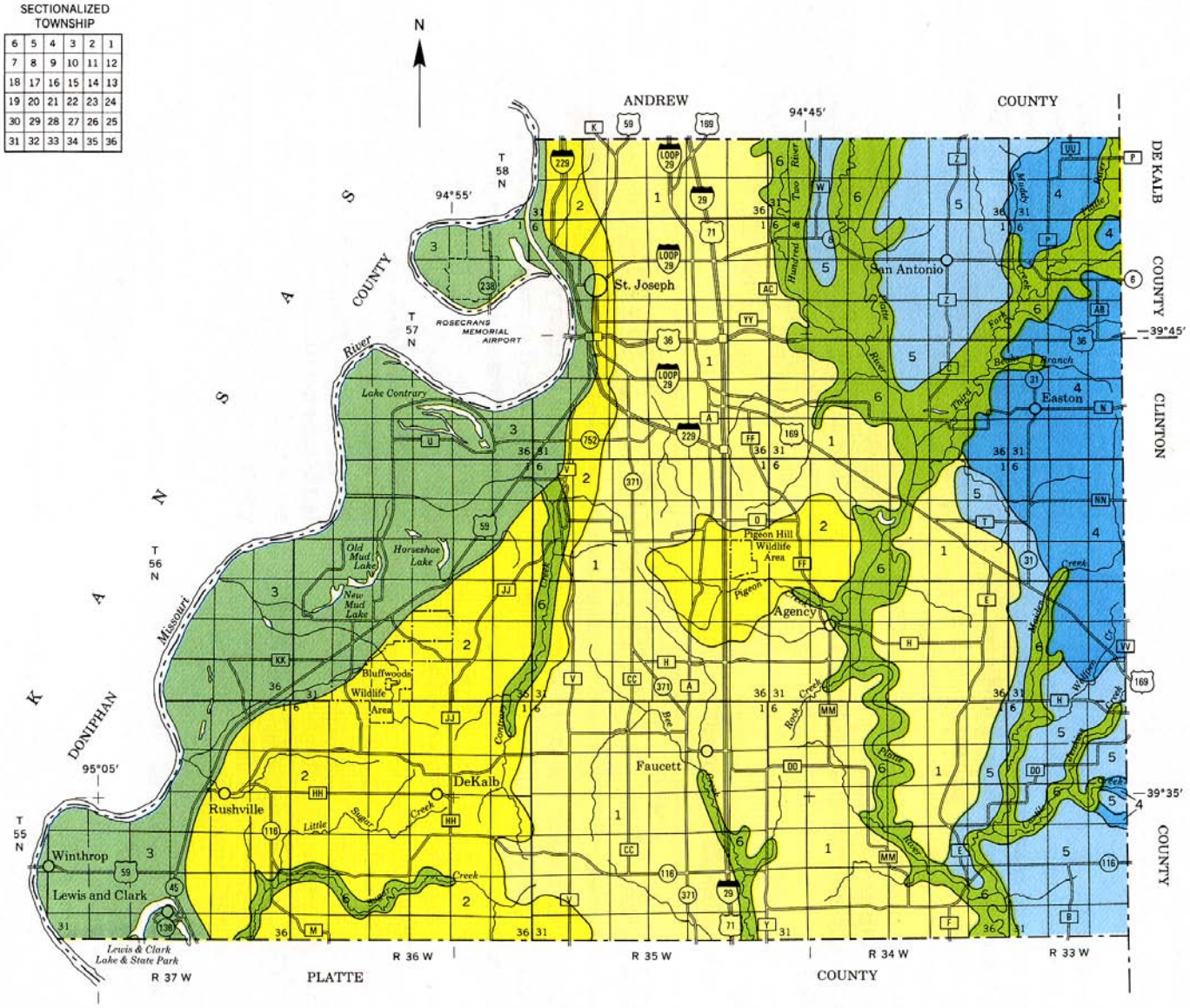
Topography

Topography refers to the lay of the land. Steeper slopes may have eroded topsoil, exposing subsoil or parent material. This makes the soil look like the weakly developed soil in the diagram (above).

Soils in low areas and depressions tend to be moist and poorly drained. In contrast, soils in more sloping areas tend to be drier and well drained. Soils in these areas will look more like the moderately developed and well-developed soils in the diagram.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



LEGEND

1	MARSHALL-CONTRARY association: Gently sloping to strongly sloping, well drained soils formed in loess on uplands
2	KNOX association: Moderately sloping to very steep, well drained soils formed in a thick layer of loess on uplands
3	HAYNIE-ONAWA-WALDRON association: Nearly level, moderately well drained and somewhat poorly drained soils formed in calcareous alluvium on flood plains
4	LAMONI-SHARPSBURG-HIGGINSVILLE association: Gently sloping to strongly sloping, moderately well drained and somewhat poorly drained soils formed in loess or glacial till on uplands
5	MARSHALL-LAMONI-HIGGINSVILLE association: Gently sloping to strongly sloping, well drained and somewhat poorly drained soils formed in loess or glacial till on uplands
6	COLO-NODAWAY-ZOOK association: Nearly level, poorly drained and moderately well drained soils formed in alluvium on flood plains

COMPILED 1986

U.S. DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

BUCHANAN COUNTY, MISSOURI

1 0 1 2 3 Mi
1 0 3 6 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

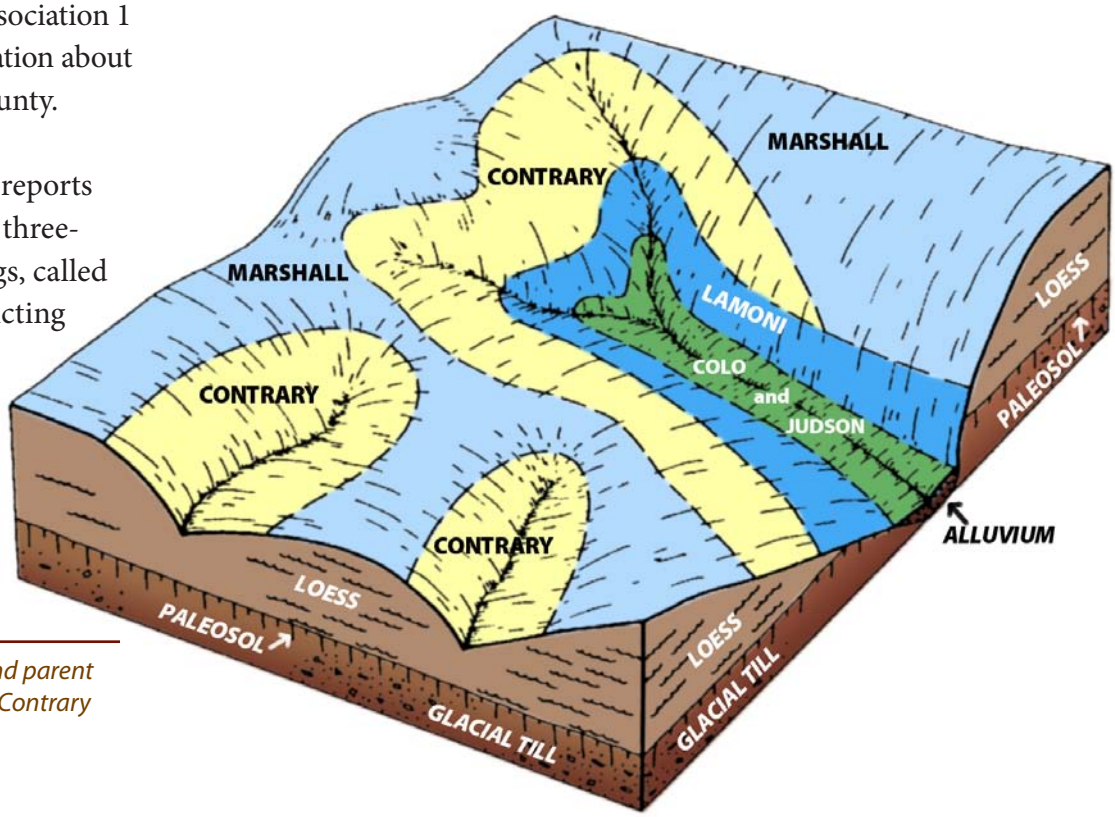
General Soil Maps

A General Soil Map is a small-scale map of the survey area. It is color coded to show major soil associations. Descriptions of each of the soil associations are near the front of the soil survey report, immediately following the short introductions to cultural and natural features of the area. This section of the report is labeled ***General Soil Map Units*** in the Table of Contents of a Soil Survey. A poster of the General Soil Map of Missouri is also available upon request from the NRCS State Office in Columbia.

Each color-coded area on the General Soil Map has a corresponding description. In the example General Soil Map of Buchanan County (page 8) the area coded 1 and shaded light yellow designates the Marshall-Contrary soil association. As the name of the map implies, Marshall and Contrary are the major soils that occupy the landscapes of this section of Buchanan County. Likewise, the description of soil association 1 gives general information about this section of the county.

Missouri soil survey reports contain a number of three-dimensional drawings, called block diagrams, depicting the relationships of soils, parent material and topography for the major soil associations. The illustration below shows the Marshall-Contrary soil association as it occurs in Buchanan County. Note the relationship of parent material (loess, glacial till and alluvium) and the topography to the different soils. Please refer to the ***How Soil Develops*** (page 7) section of this guide for additional insights on these relationships.

The General Soil Map can be used to compare the suitability of large areas for general land uses. Because of the small scale, it is not intended to be used to make management decisions on specific sites. Soils within a soil association may vary greatly in slope, depth, drainage and other characteristics that affect management.



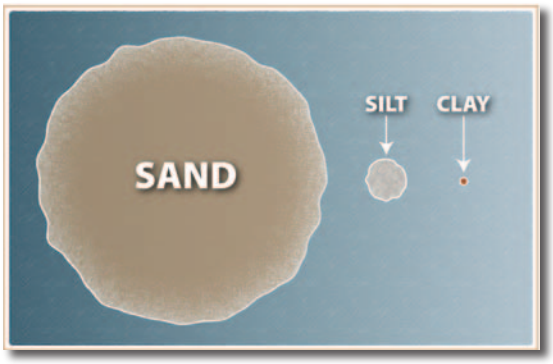
Typical pattern of soils and parent material in the Marshall-Contrary soil association.

Soil Properties

All soils contain properties that impact their suitability for specific uses. Although some properties such as slope may be altered to some extent to make a site more suitable, it is usually impractical to modify these properties extensively. Following is a list of major soil properties that affect the suitability of soils for a number of specific uses. The table on Page 13 provides examples of various land uses that are affected by specific soil properties.

Texture

Soil particles vary in size. From coarsest to finest, they are sand, silt or clay. The percentage of each in any given soil determines its texture.



Relative sizes of sand, silt and clay

Texture is an important soil property because it is closely related to many aspects of soil behavior. It influences ease of tillage and root development. It also affects the availability of nutrients in the soil, the amount of water that a soil will hold and how water moves through the soil. Sand causes little restriction of air, water and root movement through the soil, whereas clay often reduces movement.

Structure

Two soils with the same texture may have distinctly different physical properties because of the arrangement of soil particles. This arrangement is called soil structure. Soil structure forms when individual grains of sand, silt and clay are bound together physically or chemically. Plant roots, organic matter and clay particles all provide physical and chemical binding agents. These bound particles form larger units called peds. A ped is a single unit of soil structure. The shapes of peds, which range in size, determine the structure type (granular, platy, blocky or prismatic).

Soil structure is constantly changing. Although the process is too slow for you to notice, a soil's structure becomes stronger and more distinct over time.

Color

Color is one of the most noticeable properties of the soil. Color is affected by organic-matter content, climate, soil drainage and minerals in the soils. Most soil minerals are naturally white or light gray. However, humus and iron compounds change the outer color of the soil particles much like a coat of paint.

Soil color gives clues about the nature of the root zone, which is the normal depth that roots penetrate into the soil. Dark colors reflect favorable amounts of humus. Gray colors suggest wetness. Brown and red colors indicate favorable air-water relations.

Depth to Bedrock

Bedrock is the solid rock under the soil and parent material. Sometimes it is exposed at the surface. The depth from the soil surface to bedrock influences the soil's potential and limitations.

Depth Classes

Very Shallow:
less than 10 inches to bedrock

Shallow:
10 to 20 inches to bedrock

Moderately Deep:
20 to 40 inches to bedrock

Deep:
40 to 60 inches to bedrock

Very Deep:
More than 60 inches to bedrock

Depth to High Water Table

The groundwater level, or water table, may be high year round or just during periods of heavy rains. How high the water table rises, and how long it stays at that level, will affect the use of the soil.

Permeability and Saturated Hydraulic Conductivity

Permeability and Saturated Hydraulic Conductivity both refer to how easily water moves through soil. Water movement is influenced by texture, structure, compaction and the presence or absence of cementing agents.

Permeability is measured as the inches per hour that water

Soil Scientist David Skaer gets a close look at a soil sample.

moves downward through saturated soil. (see the illustration at the bottom of this page).

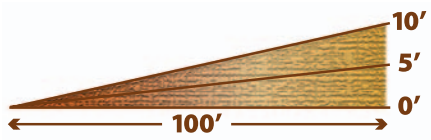
Saturated hydraulic conductivity is the currently used measurement of this downward movement of water through the soil. It is measured in micrometers per second. It is represented by the symbol "Ksat."

Available Water Capacity

Available Water Capacity is a measure of how much water a soil can store for use by plants. The Available Water Capacity is influenced by soil texture, organic matter content and compaction. It is measured in inches of water per inch of soil.

Slope

Perfectly level land has a slope of 0 percent. All other land rises or falls to some degree. Slope is an important factor and impacts soil erosion and surface drainage.



Slope - 0′ is level ground

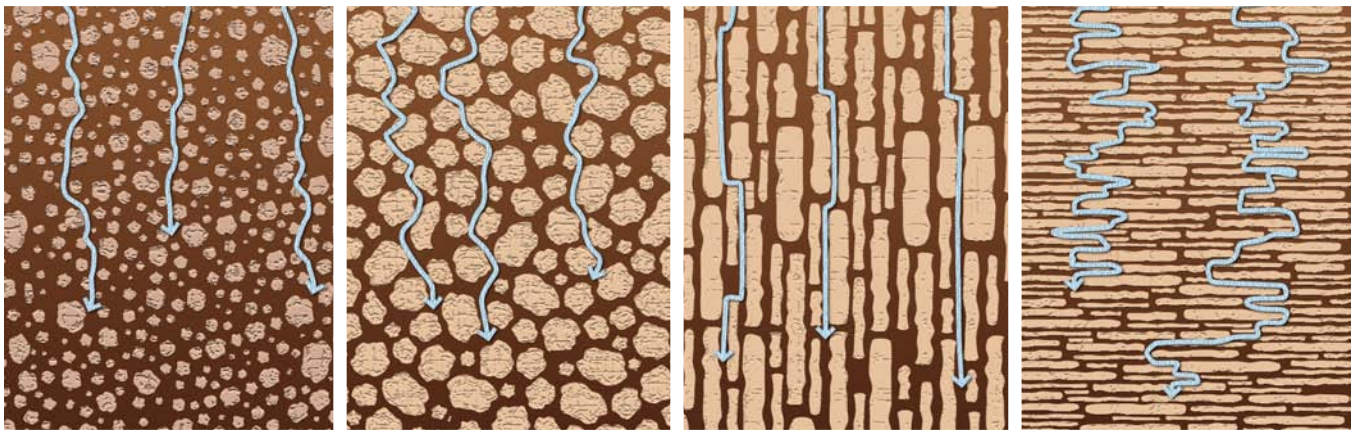
Rock Fragments

The number of rock fragments on the surface and the percentage of fragments in the soil profile are important to land-use planning. Excessive rock fragments reduce the available water capacity of the soil.

Flooding and Ponding

Periodic floodwater from overflowing streams or runoff from nearby slopes makes sites risky for some uses. If floodwaters persist, they may delay planting and harvesting.

Permeability and Saturated Hydraulic Conductivity-
How Water Moves Through Soil

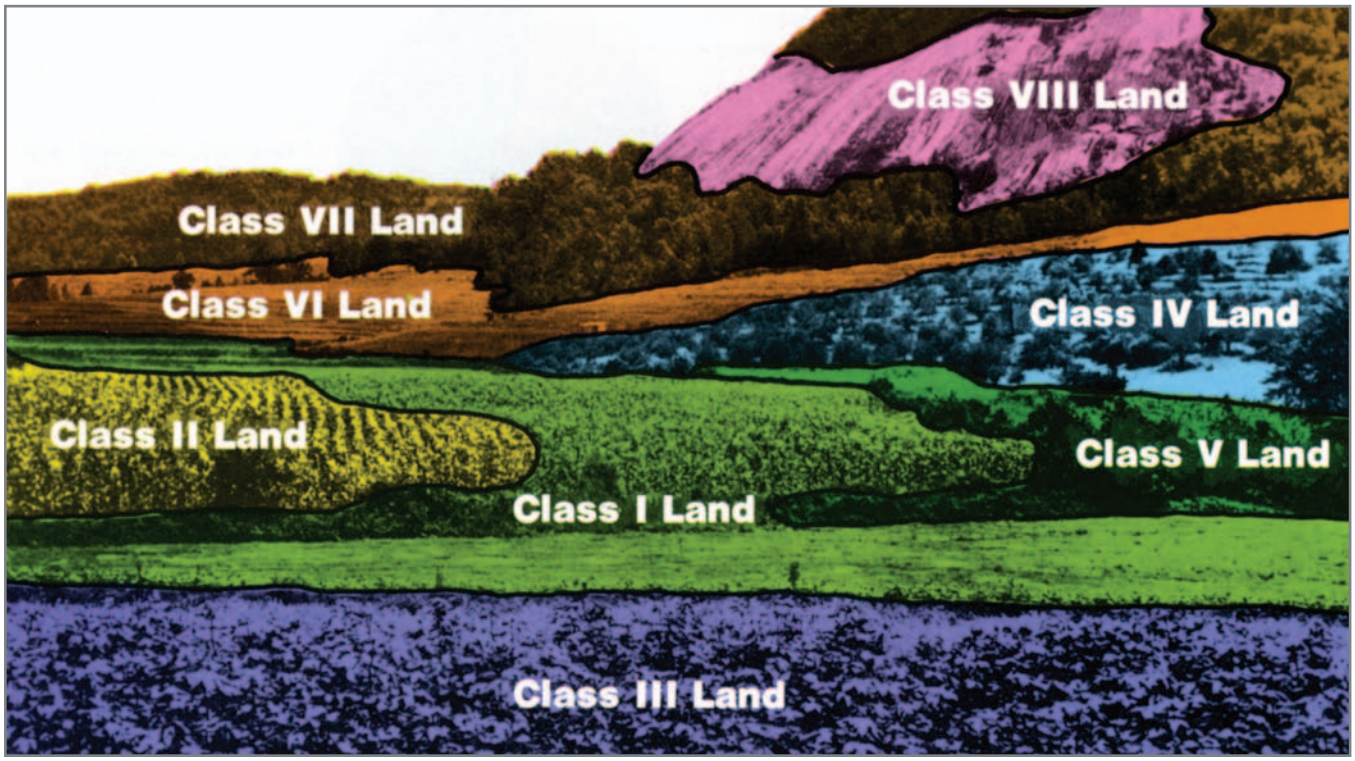


Granular | *Subangular Blocky* | *Columnar or Prizmatic* | ***Platy*** *(closely resembles clay and compacted soils)*

Soil Property – Land Use Table

X Indicates a particular land use that could be affected by a specific soil property.

SELECTED LAND USE	SOIL PROPERTY								
	Wetness	Perme-ability	Depth to Rock	Slope	Surface Texture	Sub-surface Texture	Small Stones	Large Stones	Flooding
Tank Absorption Fields	X	X	X	X				X	X
Sanitary Landfill (Trench)	X	X	X	X		X		X	X
Sanitary Landfill (Area)	X	X		X					X
Dwellings Without Basements	X		X	X		X		X	X
Dwellings With Basements	X		X	X		X		X	X
Small Commercial Buildings	X		X	X		X		X	X
Local Roads and Streets	X		X	X		X		X	X
Lawns and Landscaping	X		X	X	X		X	X	X
Camp Areas	X	X		X	X		X	X	X
Picnic Areas	X			X	X		X	X	X
Playgrounds	X	X	X	X	X		X	X	X
Paths and Trails	X			X	X		X	X	X
Golf Fairways	X		X	X	X		X	X	X



Natural Resources Conservation Service photo illustration

Soil Capability Classes

Each soil is grouped by capability class, and in most cases by subclass. These groupings reveal the suitability of soils for field crops and pasture, and indicate associated risks and responses to conservation treatment and management.

There are eight capability classes, which represent progressively greater limitations and narrower choices for practical land use. These classes are designated by Roman numerals I through VIII.

Classes:

I - have few limitations that restrict their use. Class I has no subclasses because these soils have few limitations.

II - have moderate limitations that restrict the choice of plants or that require moderate conservation practices.

III - have severe limitations that reduce the choices of plants or that require special conservation practices, or both.

IV - have very severe limitations that reduce the choice of plants or that require very careful management, or both.

V - are not likely to erode but have other limitations, impractical to remove, that limit their use.

VI - have severe limitations that make them generally unsuitable for cultivation.

VII - have very severe limitations that make them unsuitable for cultivation.

VIII - soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are noted with an "e," "w" or "s" following the capability class numbers. For example, in 2e, the "e" indicates the soil is erosive. A "w" would signify a wetness limitation. An "s" would denote a shallow, droughty or stony soil.

How To Use Soil Capability Classes

On the whole, farmers are making rational use of their farmland. Almost all of the United States' land in Capability Class I – with soils that are level, deep, well-drained and easy to work – is being used to grow crops. The more extensive capability classes of II and III supply the majority of cultivated cropland, although that land generally requires conservation measures.

In Missouri, there are also about 653,000 acres of cultivated cropland on land in Capability Class IV. Soil conservation on that land is often expensive and difficult to apply and maintain. But, as one Missouri farmer said, "Sure, I'm cropping Class IV land, but it's all I've got."

Of Missouri's 10.3 million acres of cultivated cropland, 92.1 percent is in capability classes I – III; 6.4 percent is in Class IV; and only 1.5 percent is in classes V – VIII.

Woodland Suitability

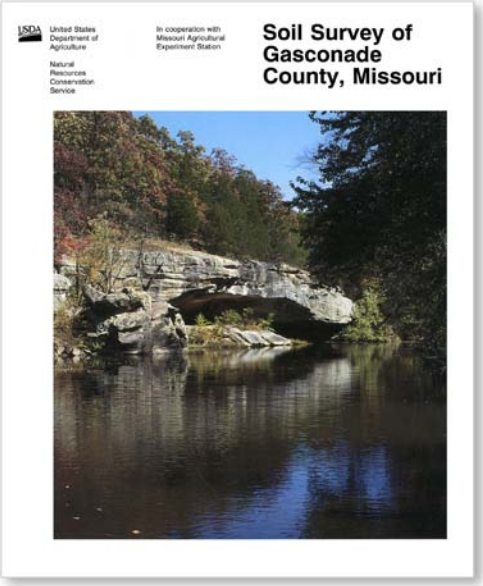
Woodland suitability groups indicate the relative potential productivity of soils to grow selected species of trees. For example, a rating of 1 is the least productive. The letters that appear after the numbers indicate the following:

R - relief of slope
X - stony or rocky on the surface
W - wetness
D - restricted rooting depth
C - clay in the upper part of the soil
S - sandy texture
F - rock fragments in the soil
A - no limiting factors

Locating Information

Specific soil properties or interpretations are easy to locate within a soil survey report by using the Table of Contents or Summary of Tables in the front of a published soil survey. The following list is a reference for commonly sought after items.

The first sections in the list below can be found in the Table of Contents, the italicized sections are tables that can be found in the Summary of Tables.



acreage extent – Acreage and Proportionate Extent of the Soils, *Capability Classes and Subclasses*

available water capacity – Soil Descriptions, *Physical and Chemical Properties of the Soils*

building sites – Soil Associations, Soil Descriptions, Woodland Management and Productivity, *Building Site Development*

capability class – Soil Descriptions, *Capability Classes and Subclasses*

color – Soil Associations, Soil Descriptions, Crops and Pasture, *Acreage and Proportionate Extent of the Soils, Engineering Index Properties*

flooding – Soil Descriptions, Soil and Water Features, *Soil and Water Features*

high water table – Soil Descriptions, Soil and Water Features, *Soil and Water Features*

landscape position – Soil Associations, Soil Descriptions, Soil Series and their Morphology

natural fertility – Soil Descriptions, Crops and Pasture

non-tech description – Soil Associations, Soil Descriptions,

parent material – Soil Series and their Morphology, Formation of the Soils

permeability – Soil Descriptions, Soil Series and their Morphology, *Physical and Chemical Properties of the Soils*

predicted yields – *Yields of Crops and Pasture*

prime farmland – Prime Farmland

septic systems – Soil Associations, Soil Descriptions, Engineering, *Sanitary Facilities*

slope of unit – Soil Descriptions, Soil Series and their Morphology, Formation of the Soils

soil classification – *Classification of the Soils*

soil depth – Soil Descriptions, Soil and Water Features, Soil Series and their Morphology, *Engineering Index Properties, Soil and Water Features*

soil drainage – Soil Associations, Soil Descriptions, Crops and Pasture, Soil Series and their Morphology, *Water Management*

soil reaction – Soil Descriptions, *Physical and Chemical Properties of the Soils*

structure – Soil Associations, Soil Descriptions, Crops and Pasture, *Acreage and Proportionate Extent of the Soils, Engineering Index Properties*

T&K values – *Physical and Chemical Properties of the Soils*

technical description – Soil Series and their Morphology

temperature/precipitation – Temperature and Precipitation, *Freeze Dates in Spring and Fall, Growing Season*

texture – Soil Associations, Soil Descriptions, Crops and Pasture, *Acreage and Proportionate Extent of the Soils, Engineering Index Properties*

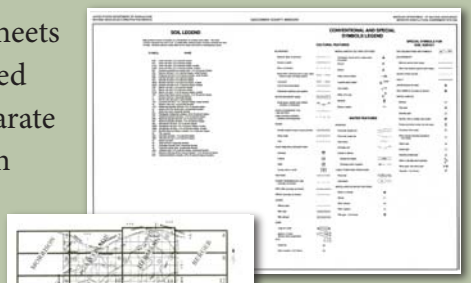
trees to plant – Woodland Management and Productivity

tree productivity – Woodland Management and Productivity, *Woodland Management and Productivity*

woodland suitability – Soil Descriptions, Woodland Management and Productivity, *Woodland Management and Productivity*

Using Soil Maps

The General Soil Map, Index to Map Sheets and Detailed Soil Map Sheets are located at the back of the soil survey, or as separate maps in a folder. To obtain information about a particular plot of land, locate the area on the Index to Map Sheets, select the appropriate map sheet number, and locate the map sheet. Map sheets are in numerical order in the soil survey. Then locate a specific parcel of land on the map sheet by noting imagery or section numbers, roads, streams and towns.



Soil and Symbols Legend (above) can be found on the back of the Index to Map Sheets.

Index to Map Sheets (left).

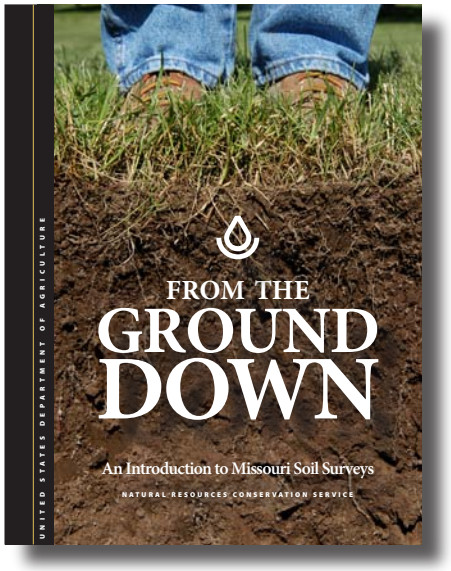
The symbols on the map sheets are listed on the back of the Index to Map Sheets with the names of each soil that they represent. You can obtain detailed information about each soil area of interest by referring to the map unit description located in the text or interpretive tables located in the back of the soil survey publication. The map unit description or tables can be located easily by using the Index to Map Units or Summary of Tables in the front of the publication.

Areas identified on the soil maps may contain more than one soil. They generally include areas of similar soils, and possibly small areas of contrasting soils. The composition of soils is explained in each map unit description. The soil maps provide sufficient information for developing resource plans, but onsite investigation is needed to plan intensive uses in small areas.

Other Information

The soil survey includes a table that lists total acreages, total land area and water areas.

For each map unit, there are tables that list soil-use limitations or hazards. Alternatives to help overcome limitations or hazards are given in the "Use and Management of the Soils" section. There is also a section with tables that gives detailed climate information.



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For questions about information contained in this publication or in specific soil surveys, contact the Resource Inventory and Assessment Staff at the above address, or call (573) 876-0907.
For information about NRCS and its programs in Missouri, visit us online at **www.mo.nrcs.usda.gov**

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