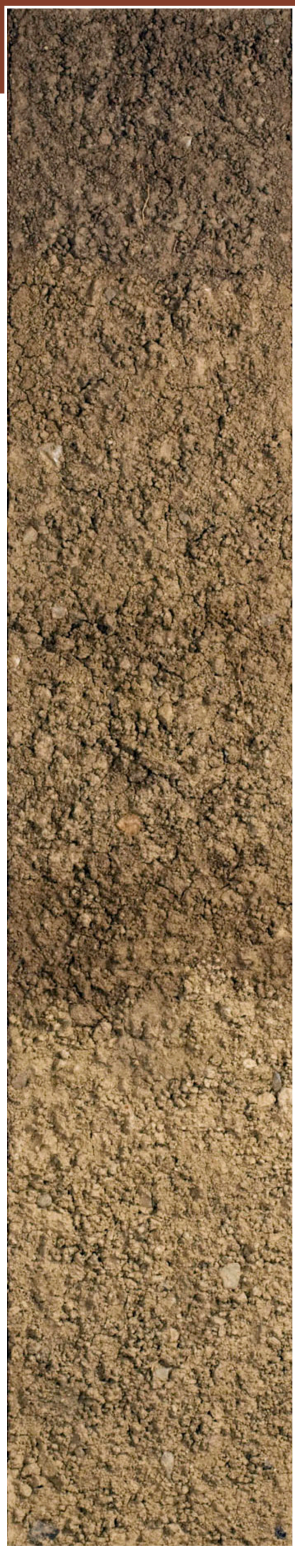
LESTER

Minnesota State Soil

Soil Science Society of America



Introduction

Many states have designated an official state bird, flower, fish, tree, rock, or natural resource. Similarly, each state has a state soil. A state soil is a soil that has significance or is very important to the state. Lester is the state soil of Minnesota. How important is the Lester soil to Minnesota?

History

The Lester soil was first proposed in 1939, in McLeod County–near Lester Prairie, Minnesota, and established as an official soil series in 1945, in Dakota County, Minnesota. In 1985, the Minnesota Association of Professional Soil Scientists (MAPSS) formed a committee to designate a state soil. The members voted to designate Lester as their state soil in 1987. In 2012, a significant legislative effort was undertaken to establish Lester as the "Official Minnesota State Soil." The culmination of this effort was the signing of the legislation establishing Lester as the "Official Minnesota State Soil" by Minnesota Governor Mark Dayton on April 28, 2012.

What is Lester Soil?

Lester soil is a deep, well-drained soil developed from sediments that were deposited by glaciers. Every soil can be separated into three different size fractions called *sand*, *silt*, and *clay*, which makes up the *soil texture*. They are present in all soils in different proportions and say a lot about the character of the soil. The surface texture of the Lester soil is a loam (mixture of *sand, silt* and *clay*), while the subsoil contains more clay and would be classified as loam or clay loam. Figure 1 shows a Lester soil profile as it would look if you dig a hole to a depth of 78 inches. You can see definite changes as you go down. Soil scientists describe the layers as "*horizons*" using the scientific notation on the right side of the soil photo.

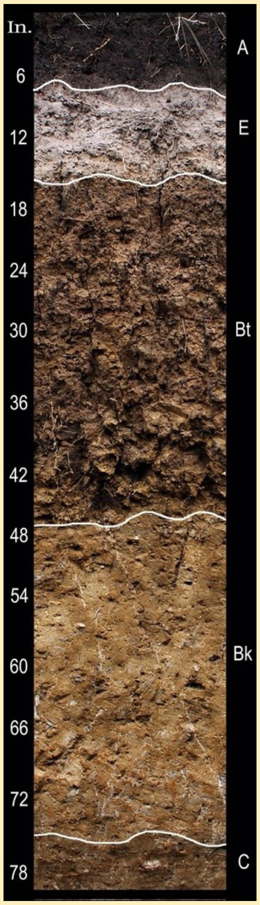
Where to dig a Lester

Yes, you can dig a soil. It is called a soil pit and it shows you the *soil profile* **(Fig. 1)**. Lester soil is currently mapped in 17 Minnesota counties, mostly in central and south-central Minnesota **(Fig. 2)**. They are of moderate extent and are mapped on approximately 400,000 acres. Lester is one of over 1,000 different soil series recognized in Minnesota.

Importance

Agriculture is extremely important in Minnesota and Lester soil is considered prime farmland due to the ease of cultivation and high natural fertility. Lester soil is therefore very productive and of significant importance to the economy of Minnesota. The principal crops are corn and soybeans.

Photo: Chip Clark/Smithsonian Institution



A Horizon

This is the surface *horizon*. It is darker than other horizons as it contains the most *organic matter*. Organic matter coats and stains the soil particles. The organic matter comes from annual accumulation of plant material that decomposes in the soil each year.

E Horizon

This horizon is grayer than the other layers because *clay* and organic matter have been moved downward by water. Soils that have trees growing on them usually have E horizons. Soils that have grasses growing on them usually lack E horizons.**(see note below)*

Bt Horizon

This horizon has clay accumulation that leached from the horizons above. This layer has the most clay in the Lester profile, which has a large effect on water movement, compaction, and workability.

Bk Horizon

Calcium carbonate (lime) accumulates in this horizon as a result of being leached from the surface when the soil was first forming about 12,000 years before present. It often has a higher pH than other horizons.

C Horizon

This is the unaltered *parent material* (the material from which the soil formed) that was produced by glaciers grinding up rocks and stones as they moved through Minnesota. The C horizon has little or no soil development and looks much like it did when first deposited.

Note: *This image shows the Lester series in an undisturbed state with an E horizon. Because the E horizon rarely extends below tillage depth, Lester soils under agricultural land use no longer have an E as it has been mixed with the A horizon. The profile on page 1 is likely from a cultivated field.*

Fig. 1. Soil profile of a Lester soil formed in glacial till. (credit: Minnesota Association of Professional Soil Scientists)

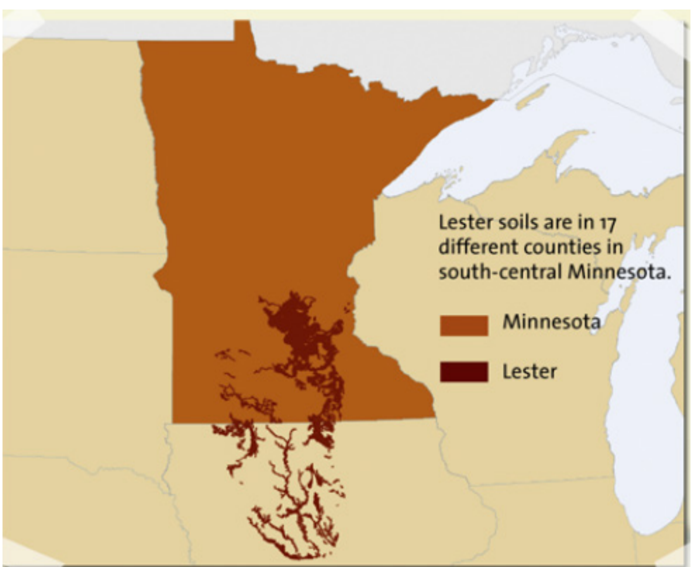


Fig. 2. Lester soil is distributed in central and south-central Minnesota and northern Iowa (credit: http://forces.si.edu/soils/interactive/statesoils/index.html).

Uses

Soils can be used for many purposes, including agriculture (growing food, raising animals, stables); engineering (roads, buildings, tunnels); ecology (wildlife habitat, wetlands), recreation (ball fields, playground, camp areas), and water filtration and purification.

The Lester soil is well suited for growing annual crops, forages, and forest production. Most areas of Lester soils are in cropland, but some areas are grazed by livestock or used as forestlands **(Fig. 3)**.

Limitations

When a soil cannot be used for one or more of the described functions, it is referred to as a limitation. Soil experts, called *Soil Scientists*, studied Lester soil and identified very few limitations to any of the possible uses described above. The only exception for the Lester soil is some areas of steeper slopes, which combined with the moderate permeability of the clay-rich subsoil, can restrict its use for water filtration and purification.

Management

Lester soils typically have good amounts of organic matter and relatively high natural fertility. This native fertility can be further enhanced through the careful application of organic or inorganic fertilizers. Controlling erosion on the Lester soil is the main management concern. Using minimum tillage, incorporating plant residues, terracing, or farming on the contour increase water infiltration and reduce runoff and erosion.

Fig. 3. Lester soil is often used for agriculture in Minnesota. This is a typical landscape where Lester soil occurs. (credit: Minnesota Association of Professional Soil Scientists)

Lester Soil Formation

Before there was soil there were rocks and in between, ClORPT. Without ClORPT, there would be no soil. So, what is ClORPT? They are five major factors that are responsible for forming a soil like the Lester series. These are **cl**imate, **o**rganisms, **r**elief, **p**arent material and **t**ime. ClORPT is responsible for the development of soil profiles and the chemical properties that differentiate soils. So, the characteristics of Lester soil (and all other soils) are determined by the influence of ClORPT. Weathering takes place when environmental processes such as rainfall, freezing and thawing act on rocks causing them to dissolve or fracture and break into pieces. In the case of the Lester soil, most of the soil particles were broken apart from rocks in a different place, then transported by glaciers as they advanced across Minnesota during the last Ice Age. After the ice melted, the Lester soil started to form in the sediments that were left behind.

Climate–Temperature and precipitation influence the rate at which parent materials weather and dead plants and animals decompose. They affect the chemical, physical, and biological relationships in the soil. Lester soil developed under the influence of a mid-latitude, humid, continental climate, marked by warm summers and severe winters, with no pronounced dry season. The influence of this climate resulted in the *leaching* of *soluble bases* (calcium and other elements) *and clay illuviation* (the downward movement of small, clay-sized particles with water).

Organisms–This refers to plants and animal life. Plants roots spread through soil, animals burrow in it, and bacteria make a living by eating (and decomposing) plant and animal tissue. Animals breakdown complex compounds into small ones and in so doing add organic matter to soil. Plants determine the kinds and amounts of organic matter that are added to a soil under normal conditions. Lester soil formed at the boundary of two important biomes (large areas of similar vegetation), the grasslands (or prairies) of the Great Plains and the broadleaf forests of the Eastern U.S. As the boundary between those biomes has shifted back and forth, the Lester soil formed under alternating prairie and forest vegetation. Therefore, Lester soil has some characteristics of forest soils (such as an E horizon) and some characteristics of prairie soils (such as a thicker A horizon). Today, much of the natural vegetation has been removed in most areas for agricultural production, but the effects of that vegetation have left a lasting impact on the soil.

Relief–Relief describes the shape of the land (hills and valleys), and the direction it faces. This makes a difference in how much sunlight the soil gets and how much water it can store. The position of a soil on a hillslope also has a large effect on how easily water moving through the soil can drain. Soils on higher portions of hillslopes are usually well drained, while soils at the bottom of slopes are poorly drained. Lester soils are well drained because they are formed on upper hillslope positions **(Fig. 4)**.

Parent material (C horizon)–Just like people inherit characteristics from their parents, every soil inherited some traits from the material from which it forms. Some parent materials are transported and deposited by glaciers, wind, water, or gravity. Most of the state of Minnesota was covered in glacial ice during the last Ice Age. Lester soil developed in unsorted materials containing sand, silt, clay, and gravel that were deposited from glacial ice. This unsorted material is known as glacial till, and is composed of rocks and minerals that are similar to the rocks that the glacier moved over and ground up as it advanced. The glaciers that deposited the parent material for the Lester soil moved over rocks that were high in pH (calcareous) and rich in nutrients such as calcium, so the Lester soil has a high level of native fertility.

Time–All the factors act together over a very long time to produce soils. The length of time that soil material has been exposed to the soil-forming processes makes older soils different from younger soils. Generally, older soils have better defined *horizons* than younger soils. Lester soil has been forming since the end of the last Ice Age, about 12,000 years. This might sound like a long time, but it is still relatively young as far as soils go – some soils are over 1 million years old! Even though it is young, the Lester soil has relatively well defined horizons due to significant amounts of rainfall, leaching, and organic matter accumulation.

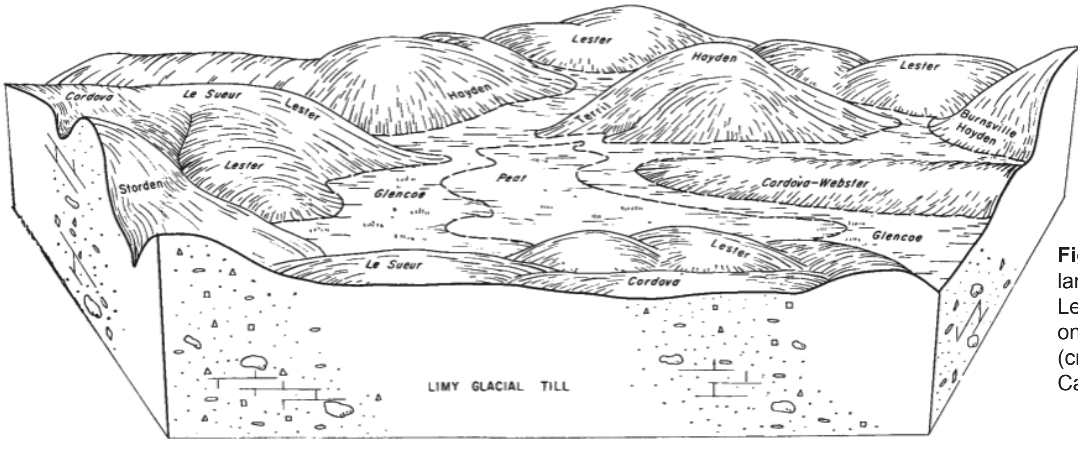
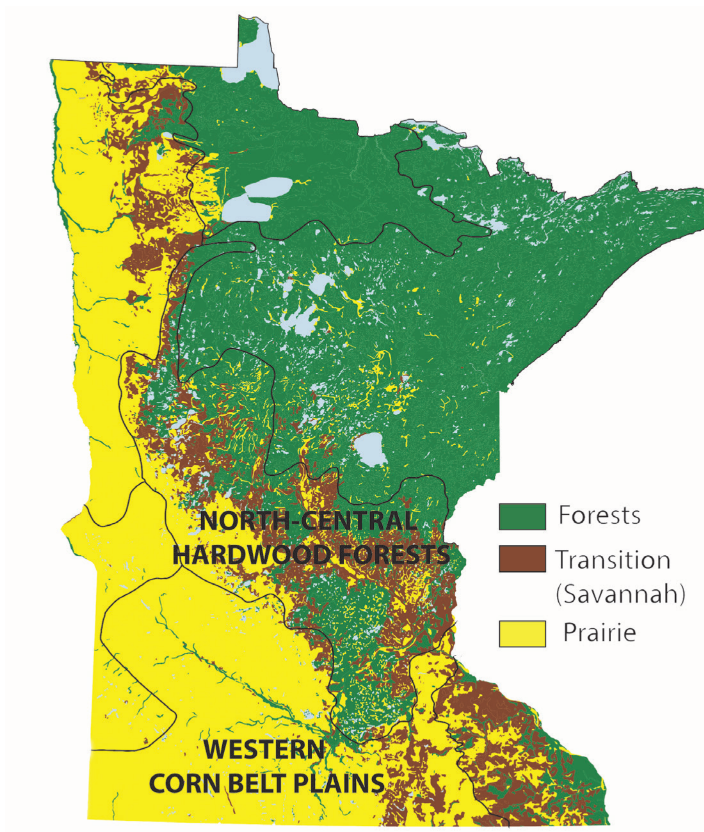


Fig. 4. Relationship of Lester soil to landform position and parent material. Lester soil is well drained and located on gently rolling convex upper slopes (credit: USDA-NRCS. Soil Survey of Carver County, MN).



The North-Central Hardwoods ecoregion is transitional between the predominantly forested Northern Lakes and Forests to the north and the agricultural ecoregions to the south. The ecoregion is characterized by a high density of streams, wetlands, and lakes on gently rolling plains. Land-use is a mosaic of forest land, cropland agriculture, pasture, and dairy operations, with some areas of urban, suburban, and rural residential land.

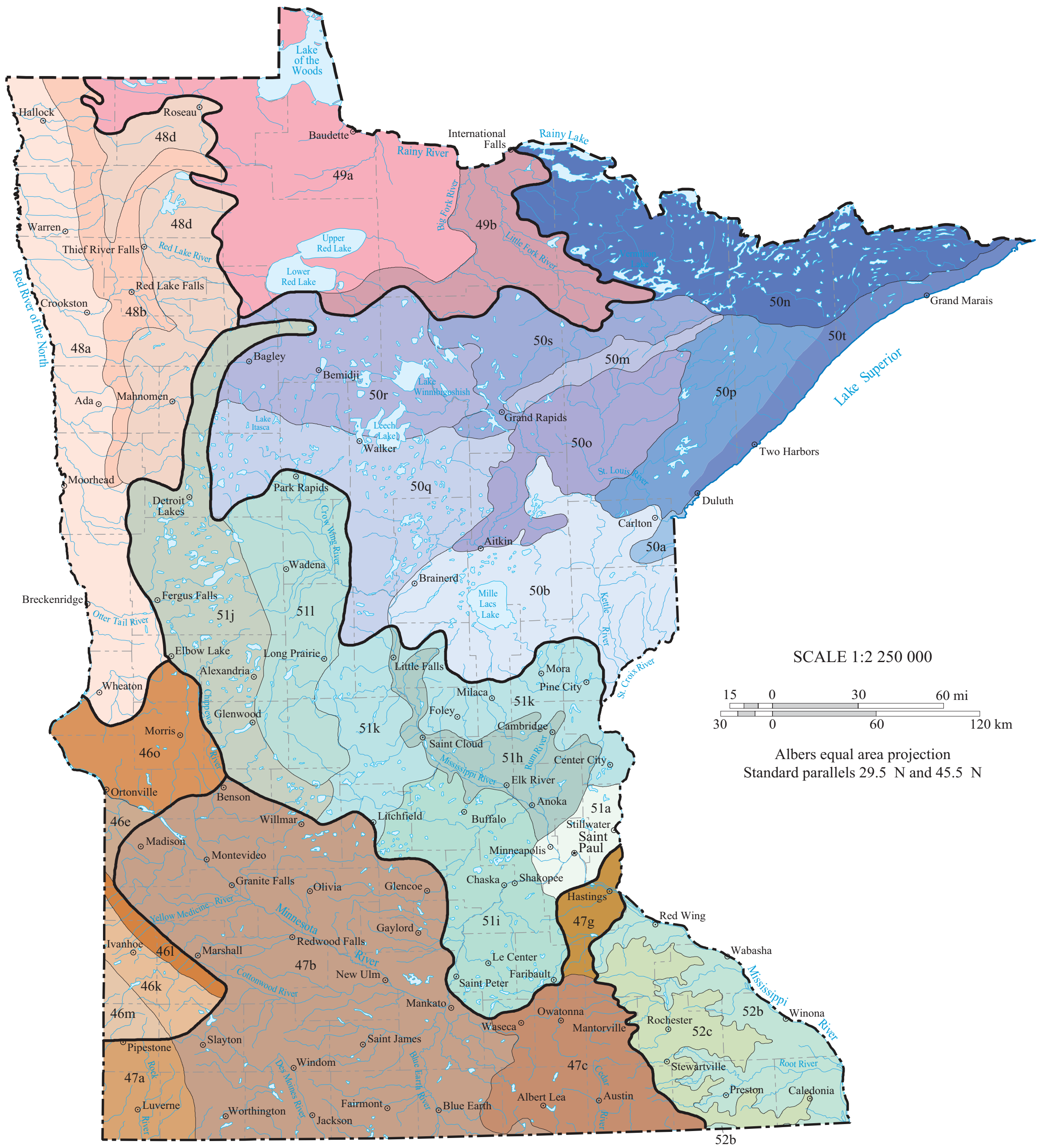
The Western Corn Belt Plains ecoregion is predominantly used for cropland agriculture (> 75%) and much of the remainder is in forage for livestock. It is one of the most productive areas of corn and soybeans in the world. The ecoregion is characterized by streams, many of which have been ditched or channelized, on a landscape of rolling glaciated till plains.

Fig. 5. Lester soil formed in the transition (tension zone) between forest and prairie vegetation (credit: Data from Minnesota Department of Natural Resources).

Ecoregions, Soils and Land Use in Minnesota

The state of Minnesota lies at the intersection of two important North American biomes: the prairies of the Great Plains, and the Eastern forests. This intersection, which runs roughly diagonally from the northwest to southeast corners of the state, is locally known as the "tension zone" and marks an important boundary that has a large impact on vegetation and soil development. The Lester soil formed predominantly in the tension zone between prairie and forest vegetation (sometimes called "savannah") in the North-Central Hardwoods and Western Corn Belt Plains ecoregions. This gives the Lester soil distinct properties of both prairie soils (Mollisols) and forest soils (Alfisols) **(Fig. 5)**. An expanded view of the Minnesota ecoregions can be seen in **(Fig. 6)**.

MINNESOTA LEVEL III AND IV ECOREGIONS



46 Northern Glaciated Plains
- 46e Tewaukon/Big Stone Stagnation Moraine
- 46k Prairie Coteau
- 46l Prairie Coteau Escarpment
- 46m Big Sioux Basin
- 46o Minnesota River Prairie

47 Western Corn Belt Plains
- 47a Loess Prairies
- 47b Des Moines Lobe
- 47c Eastern Iowa and Minnesota Drift Plains
- 47g Lower St. Croix and Vermillion Valleys

48 Lake Agassiz Plain
- 48a Glacial Lake Agassiz Basin
- 48b Beach Ridges and Sand Deltas
- 48d Lake Agassiz Plains

49 Northern Minnesota Wetlands
- 49a Peatlands
- 49b Forested Lake Plains

50 Northern Lakes and Forests
- 50a Lake Superior Lacustrine Clay Plain
- 50b Minnesota/Wisconsin Upland Till Plain
- 50m Mesabi Range
- 50n Boundary Lakes and Hills
- 50o Glacial Lakes Upham and Aitken
- 50p Toimi Drumlins
- 50q Itasca and St. Louis Moraines
- 50r Chippewa Plains
- 50s Nashwauk/Marcell Moraines and Uplands
- 50t North Shore Highlands

51 North Central Hardwoods
- 51a St. Croix Outwash Plain and Stagnation Plains
- 51h Anoka Sand Plain and Mississippi Valley Outwash
- 51i Big Woods
- 51j Alexandria Moraines and Detroit Lakes Outwash Plain
- 51k McGrath Till Plain and Drumlins
- 51l Wadena/Todd Drumlins and Osakis Till Plain

52 Driftless Area
- 52b Blufflands and Coulees
- 52c Rochester/Paleozoic Plateau Upland

Provisional, 11 May 2007

Source: EPA

Glossary

Clay: A soil particle that is less than 0.002 mm in diameter. Clay particles are so fine they have more surface area for reaction. They hold a lot of nutrients and water in the soil. A clay soil is a soil that has more than 40% clay, less than 45% sand and more than 60% silt.

Ecoregion: Represents areas with similar biotic and abiotic characteristics which determine the resource potential and likely responses to natural and man-made disturbances. Characteristics such as, climate, topography, geology, soils and natural vegetation define an ecoregion. They determine the type of land cover that can exist and influence the range of land use practices that are possible.

Geology: The study of the physical earth, its composition (materials), history and processes (physical and chemical) that act on it.

Geologic formation: Is a body of rock of considerable extent with distinctive characteristics that allow geologists to map, describe, and name it.

Geomorphology: A branch of geology and geography that studies the development of landforms.

Horizon: see Soil horizons

Leaching: The removal of soluble material from soil or other material by percolating water.

Organic matter: Material derived from the decay of plants and animals. Always contains compounds of carbon and hydrogen.

Parent material: The materials that a soil formed from.

Physiographic province: Are broad-scale subdivisions based on terrain texture, rock type, and geologic structure and history.

Sand: A soil particle between 0.05 and 2.0 mm in diameter. Sand is also used to describe soil texture according to the soil textural triangle, for example, loamy sand.

Sandy Loam: Soil material that contains between 43-85% sand, 0-50% silt and 0-50% clay. It has less sand than loamy sand.

Silt: A soil particle between 0.002 and 0.05 mm diameter. It is also used to describe a soil textural class.

Soil Horizon: A layer of soil with properties that differ from the layers above or below it.

Soil Management: The sum total of how we prepare and nurture soil, select type of crops that suitable for a type of soil, tend the crop and the soil together, type of fertilizer and other materials added to soil so as to maintain productive and preserve soil.

Soil Profile: The sequence of natural layers, or horizons, in a soil. It extends from the surface downward to unconsolidated material. Most soils have three major horizons, called the surface horizon, the subsoil, and the substratum.

Soil Scientist: A soil scientist studies the upper few meters of the Earth's crust in terms of its physical and chemical properties; distribution, genesis and morphology; and biological components. A soil scientist needs a strong background in the physical and biological sciences and mathematics.

Soil Texture: The relative proportion of sand, slit, and clay particles that make up a soil. Sand particles are the largest and clay particles the smallest. Learn more about soil texture at www.soils4teachers.org/physical-properties

Soluble bases: Elements (calcium, magnesium, sodium and potassium) that are present in soil as ions and form what is called Cation Exchange Capacity. The amount in the soil can be reduced through leaching.

Subsoil: (B horizon) The soil horizon rich in minerals that eluviated, or leached down, from the horizons above it. Not present in all soils.

Topography: The shape of the land surface. (Relief: refers to differences in elevation of different points in a region.)

Topsoil: (A horizon)–The horizon that formed at the land surface. Mostly weathered minerals from parent material with a little organic matter added.

Water table: The top layer of ground water where the soil is filled with standing water.

Additional Resources

Lindbo, D. et al. 2008. *Soil! Get the Inside Scoop*. Soil Science Society of America, Madison, WI.

Lindbo, D. L., D. A. Kozlowski, and C. Robinson (ed.) 2012. *Know Soil, Know Life*. Soil Science Society of America, Madison, WI.

Web Resources

SOIL SCIENCE LINKS:

Soil Science Society of America—http://www.soils.org/

Soils4Teachers—http://www.soils4teachers.org/

Soils4Kids—http://www.soils4kids.org/

Smithsonian Soils Exhibit—http://forces.si.edu/soils/

MINNESOTA LINKS:

Minnesota Association of Professional Soil Scientists: http://www.mnsoilscientist.org/minnesota-state-soil

Natural Resources Conservation Service, Minnesota Homepage– http://www.nrcs.usda.gov/wps/portal/nrcs/site/mn/home/

Natural Resources Conservation Service– http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/

Natural Resources Conservation Service, Educational Resources– http://soils.usda.gov/education/resources/k_6/

Minnesota Agricultural Experiment Station, Saint Paul, MN, University of Minnesota–https://www.maes.umn.edu

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United States Department of Agriculture, Soil Conservation Service; Minnesota Agricultural Experiment Station, St. Paul, MN, University of Minnesota. 1983. Soil Survey of Dakota County, Minnesota.

United States Environmental Protection Agency. 2013. Level III Ecoregions of the Conterminous United States. U.S. EPA Office of Research and Development (ORD) - National Health and Environmental Effects Research Laboratory (NHEERL).
ftp://ftp.epa.gov/wed/ecoregions/us/us_eco_l3.zip, http://edg.epa.gov

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