FLORIDA DEPARTMENT OF HEALTH
BASIC SOILS TRAINING PROGRAM MANUAL
MAY 2015

Forward:
The majority of this material has been produced by Joseph N. Schuster, Soil Scientist, in consultation with soil scientists from the USDA Natural Resources Conservation Service, Florida Soil Survey Staff, and soil scientists from state and private organizations, as well as Department of Health staff. Additionally, the Florida Association of Environmental Soil Scientists has allowed use of a great deal of material on hydric soils from the *Hydric Soils of Florida Handbook*, *Fourth Edition*. The document is provided by the Florida Department of Health. The purpose of this manual is to supplement a standardized soils training program for personnel involved in the permitting of Onsite Sewage Treatment and Disposal Systems. This manual should be used in conjunction with soil survey information.

SOIL DEFINED

DEFINITION of soil. SOIL is the collection of dynamic natural bodies, at or near the earth's surface, made up of earthy materials and supports or is capable of supporting plant growth. For the purpose of soil survey investigations, the soil is usually described to a depth of 80 inches, or to hard bedrock, whichever comes first. --Derived from Soil Taxonomy.

The methods described in this manual are used to predict the properties of the soil as it is defined above. These methods may not support the definition or concepts of soil used by other disciplines.

Most persons think of soil as being a substance. In our definition, soil is part of the planet, just as a mountain or lake is part of the planet. We cannot hold a mountain in the palm of our hands nor can we hold the soil in our hands. We must examine the soil outdoors, where it has formed. We can however, remove a sample from the soil and take it to a laboratory to analyze.

Exclusions To The Definition

We can further clarify our concept of soil by discussing the nature of things that are both included and excluded from the definition.

For example, the material that we purchase in plastic bags called “potting soil” is excluded from the definition. Although it can support plants and is made up of earthy materials, it is not a part of the earth's surface.

The sediment at the bottom of a lake or the ocean is excluded from the definition. This is geologic material from which a soil might later form if the sea level drops sufficiently.

Excavated fill material is excluded from the definition. It can be the material that once was part of a soil, but after excavation it is no longer part of the earth’s surface. Per USDA NRCS guidelines, if the fill material can support plant growth after it is placed, it becomes a new layer of a soil.

Essential Elements In The Definition

Soil Material. Soil material is the substance from which soil is made. The components of soil material are discussed in the next chapter of this manual.

Landforms. Soils are on LANDFORMS, or segments of natural landscapes such as dune swales, hill slopes, river terraces, cypress domes, or coastal plain flats.

Soil Genesis. Soils FORM or develop over time from geologic and biological material that is called PARENT MATERIAL. Some types of parent material are ocean deposits, rock that has been weathered in place, windblown sands or silts, minerals carried by a river and deposited on a floodplain, and decayed plant materials. Many soils form in materials derived from several kinds of parent materials such as ocean deposits and decayed plant materials. The natural processes that change parent material into soil material are collectively referred to as SOIL GENESIS. Some of the processes of soil genesis include biochemical alteration of substances, accumulation of humus and other materials on the soil surface and the movement of substances and particles through a soil by percolating rainwater.

Soil Morphology. The characteristics of a soil that form and can be observed are referred to as the MORPHOLOGY of the soil. When a person conducts an onsite investigation of a soil, he or she is looking for morphological features that will help predict certain physical and chemical properties of a soil. For example, the color pattern of a soil is a morphological feature that can help one predict the depth to the seasonal high water table (even if the observation is made during the dry season).

Soil Horizons. The primary morphological unit in a soil is called a HORIZON. A soil horizon is a layer that is nearly parallel to the soil surface. Some soil horizons are easy to distinguish from another horizon that lies above or below because there is a distinct boundary between the two layers. Other horizons change so gradually with depth that it is difficult to determine their boundaries.

COMPONENTS OF SOIL

There are four basic components of soil. These are minerals, organic matter, water, and gases.

Soil Minerals: Particle Size

Mineral Type vs. Size. Mineral material is the most abundant component of most soils. Two important ways to classify minerals are by the SIZE of the mineral particle and by the TYPE of the mineral particle. The most common type of mineral in Florida soils is quartz. For the purpose of making most Onsite Sewage Treatment and Disposal System (OSTDS) land use decisions, particle SIZE is the mineral classification scheme that is most important to consider.

Three Mineral Sizes. The three basic sizes of soil mineral particles are **SAND** size, **SILT** size, and **CLAY** size. Each basic particle size has distinguishing properties that can be observed even when the individual particles cannot be seen.

Sand. Soil minerals are essentially weathered rock. The forces of nature, over time, have split and crushed rocks until they have become the size of a SAND grain. SAND is the largest soil particle. Sand ranges in size from 0.05 millimeters to 2.0 millimeters in diameter. Individual sand particles can be seen by the naked eye. Sand feels gritty when rubbed, and barely holds together when moist. Water moves through sand rapidly to very rapidly. Sand is nearly inert (it has very low chemical activity). It supplies few or no nutrients to plants.

Sand Size Subdivisions. The sand particle can be subdivided into more detailed classes. These are very coarse sand, coarse sand, medium sand, fine sand, and very fine sand. Very coarse sand particles are about the size of a lower case alphabetic character produced by a standard typewriter. Medium sand particles are about the size of a sugar grain. Fine sand particles are about the size of pin point or the diameter of a strand of hair. Individual particles of very fine sand are difficult to see without the aid of a magnifying glass.
Fine sand and Medium sand (medium sand is referred to simply as "sand") are the most common of the sand sizes that are found in Florida soils. Coarser sands are not common in Florida soils but are sometimes found on banks of swift flowing rivers and on beaches.

Silt. The SILT sized particle is intermediate in diameter between sand and clay. If you were able to smash a sand grain with a hammer until it became powdery, you would have created silt particles. The diameter of an individual silt particle is 0.002 to 0.05 millimeters. Individual particles of silt are difficult to see without magnification. When moist, silt feels smooth and silky. It holds together well when molded, but cannot be formed into a RIBBON. (A ribbon is a thin, flat, elongated form that can be molded from materials containing clay).

Silt is somewhat chemically active. In Florida, soils dominated by silt are not common. They are primarily found on the floodplains of large rivers, in some tidal marshes, and in broad areas of the southernmost part of the Florida Peninsula.

Clay. The smallest soil mineral particle is the CLAY sized particle. Individual particles of clay have diameters that are smaller than 0.002 millimeters. Individual particles of clay are so small that they can only be viewed using powerful microscopes.
Clay is chemically active, and may provide a large amount of nutrients to plants. Water moves slowly through materials dominated by clay particles. Clay is easily molded into shapes, or into a long ribbon that will hold together without easily breaking. It may be sticky when moist.
It is rare to find soil materials that are pure silt or pure clay (nearly pure sand is common). Most soil materials are a mixture of the three particle sizes. For example, a soil layer might contain material that is 75 percent sand, 10 percent silt, and 15 percent clay. We refer to this mixture of particle sizes as SOIL TEXTURE.

PARTICLE SIZE CLASSIFICATION FOR SOIL MINERALS		
Size (diameter)	**Class**	**Identification**
<0.002 mm	**clay**	**need powerful microscope to see**
0.002 mm to 0.05mm	**silt**	**regular microscope needed**
0.05 to 2.0 mm	**sand**	**visible to naked eye**

Figure 1.

Soil Minerals: Texture

Field vs. Laboratory Determination. Soil texture can be accurately determined in the laboratory using various measuring techniques or soil texture can be estimated in the field by rubbing a **MOIST** sample between the fingers. It is generally impractical, time consuming, and costly to send permit site samples to the laboratory; however with practice, the field estimate can be quite accurate, and acceptable for the planning of onsite sewage treatment and disposal systems.

Texture and Soil Properties. Because each different size of mineral particle has unique properties, soil material that is a mixture of sand, silt, and clay will have properties that are influenced by each of the different particle sizes. For example, soil material that is 40 percent sand, 40 percent silt, and 20 percent clay will have some grittiness, like sand; some stickiness, like clay, and be able to hold a substantial amount of water, like silt.

The Textural Triangle. In order to simplify the description of particle size mixtures, a system was developed called the USDA SOIL TEXTURAL CLASSIFICATION. In this scheme, twelve classes of soil texture are depicted on a 3-axis graph called the USDA SOIL TEXTURAL TRIANGLE.

USDA Textural Classes. A LOAM is a mixed textural class that has properties nearly equally derived from each of the three particle sizes. Loam is somewhat gritty, a bit sticky, yet also smooth when rubbed. It contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. Note that the Loam class is located at the lower center of the textural triangle.
Other textural classes are positioned to the left, right, or above the loam class on the textural triangle. Classes to the left of loam contain a higher percentage of sand particles; classes to the right contain a higher percentage of silt particles and classes above contain a higher percentage of clay particles.
For soil materials that are dominantly sand, dominantly silt, or dominantly clay, there are soil textural classes by the same name of the dominant particle: the SAND class, the SILT class, and the CLAY class. The SAND textural class contains *mostly* sand particles, but may contain some silt particles and clay particles. Similarly, the SILT textural class, contains *mostly* silt particles, and the CLAY textural class contains *mostly* clay particles.
Other soil textural classes include SILT LOAM, CLAY LOAM, and SANDY LOAM; LOAMY SAND, SANDY CLAY, and SILTY CLAY; SANDY CLAY LOAM and SILTY CLAY LOAM.

Common Soil Textures in Florida. The most common soil textures in Florida are fine sand, sand, loamy fine sand, loamy sand, fine sandy loam, sandy loam, sandy clay loam, and sandy clay. On occasion, the textures clay, clay loam, and loam are encountered. In most parts of the state, it is extremely rare to find soil materials with textures silt loam, silty clay loam, silty clay, and silt. Note that the most commonly occurring textures in Florida are those depicted on the lower left corner of the USDA TEXTURAL TRIANGLE.

Textural Class Names Modified by Sand Sizes. Only the textural classes sand, loamy sand, and sandy loam are modified by the sand size subdivisions. Examples of the modified classes are fine sand, loamy very fine sand, loamy coarse sand, and very fine sandy loam. Detailed written descriptions of these and the other textural classes are found in the section on USDA Soil Textural Classification System in Chapter 64E-6.

Broad Textural Categories. Three broad categories are sometimes used when referring to the dominant texture of a soil. These are not true categories of the USDA SOIL TEXTURAL CLASSIFICATION SYSTEM, but rather unofficial groups often used in conversation by soil scientists. SANDY soils have textures that are primarily sand (including the subdivisions of fine sand, etc.). SAND is the dominant constituent. For example, all sands (coarse, medium, fine and very fine) and all types of loamy sands, ***EXCEPT FOR LOAMY VERY FINE SAND, WHICH IS CONSIDERED A LOAMY SOIL***. LOAMY soils are those having a texture of one of the classes with loam or loamy in the class name where loam is the dominant constituent. For example sandy loam, fine sandy loam, clay loam or sandy clay loam. CLAYEY soils have textures in the classes of sandy clay, silty clay, or clay.

NOTICE THAT THE DOMINANT PARTICLE SIZE IS NAMED LAST IN ALL INSTANCES, EXCEPT AS NOTED.

Touch Texturing. When estimating the soil textural class by the field method called TOUCH TEXTURING. The sample must have enough water in it so that the finer textured soil aggregates (silt and clay particles) have been completely broken down and it is like moist putty in your hand. Do not use soil that is too wet or too dry. Sandy soil textures will not feel like moist putty. Use the textural flow chart guide provided in this manual until you have it committed to memory. Proficiency in touch texturing is possible only with experience and practice. The flow chart should be used to determine textural groups in conjunction with the textural triangle. Soil samples with known laboratory determined particle size distribution can be valuable learning tools for reference.

Coarse Fragments. Mineral particles that have a diameter greater than 2.0 millimeters are called COARSE FRAGMENTS. Coarse fragments include gravels, boulders, and stones. While coarse fragments are not counted towards the percentage of soil mineral particles in the textural classification, they can be used as a modifier. For example, a sample of soil having a texture of sandy loam and containing an additional 15 percent of gravels (***by volume, not weight***), is called a GRAVELLY sandy loam. If the sample contains a minimum of 35 percent gravels, the modified textural classification would be VERY GRAVELLY sandy loam.

Continuous bedrock that lies below a soil layer is not considered to be part of the soil, nor is it considered to be a coarse fragment. Soil scientists classify it by type of rock, (usually limestone in Florida) and by its degree of hardness (*hard* versus *soft*). Soft bedrock can be excavated by light power equipment and hard bedrock cannot be excavated by light power equipment.

Organic Matter

ORGANIC MATTER is the second solid component of soils. Organic matter consists primarily of pieces and parts of plants that are in various states of decay. Organic matter is also sometimes called humus. Generally, less decayed materials lie on the soil surface, especially where there is a thick canopy of trees.

Effects of Organic Matter on Mineral Soils. The soil layer often called topsoil, is a mineral layer that is dark colored because it contains a small amount of well decayed organic matter, generally less than 2 percent. Organic matter is normally black or brownish colored and so it imparts a black or brownish color to the soil. *Organic matter also increases the water holding capacity of the soil*. Usually, a small amount of organic matter adds tilth, or loosens the soil, making it less compacted (dense). Compare that to the scenario where a soil material contains a substantial amount of organic matter, any weight placed on the soil can increase the compaction. Both can be compacted, but the higher the organic matter content, the more it can compact.

Organic Matter in Dry vs. Wet Soils. In very dry to dry sandy soils, very little organic matter accumulates and there may be none to very little black or brownish coloration to the topsoil. In contrast, wet soils usually have dark colored layers containing large amounts of organic matter. Some wet soils, especially those in swamps and marshes, have thick layers consisting of all or nearly all organic matter with little or no mineral soil material. This is called ORGANIC SOIL MATERIAL.

Kinds of Organic Soil Material. MUCK and PEAT are terms used to describe organic soil materials comprised of about 20 to 30 percent (or more) organic matter. Muck is used to describe a greater state of decay than peat. Most organic soil materials in Florida are classified as muck. Remember that texture refers to mineral soil materials only, but if the soil material is muck, it is used *in place of* texture. If a soil material contains about 10 to 20 percent organic matter, the terms MUCKY or PEATY are used as textural modifiers. For example, a mineral soil material with the texture fine sand, and containing about 15 percent organic matter would be called MUCKY FINE SAND. In general, if the muck or peat layers in a soil are greater than 16 inches thick, the soil is called an ORGANIC SOIL.

Water: The Mobile Soil Component

All soils contain spaces between individual particles and between soil aggregates (clumps of particles). Most soils contain about 50 percent pore space and these pores are filled with either air or water. Air and water are the last two non-living components of soil. It is the *movement* of water through the soil that is extremely important for OSTDS design.

Permeability. Water moves through the soil at variable rates depending on the physical properties of the soil. Many different terms are used to describe water movement through soils, each having a slightly different definition. For our purposes the rate or speed at which water moves through a soil, a soil horizon, or through material used for fill, will be referred to as PERMEABILITY.

In general, sandy soils have the highest permeability rates and clayey soils have the lowest permeability rates. There are some exceptions to this generality. For example, a common sandy soil found in Florida has a layer below the surface that has a slower permeability than might be expected for a sandy layer. This layer is called a SPODIC horizon, or stained layer. The significance of the spodic horizon will be discussed at a later point.

USDA Permeability Classes. Classes for the standard USDA soil permeability rates are given in the following table. These classes define estimated values. They are obtained by considering laboratory measured rates of saturated soil samples along with such factors as volume of coarse fragments, degree of soil compaction, and soil texture.

The USDA permeability classes are used to describe either the rate of water movement through a specified horizon (horizon or layer permeability), through soil material or geologic material, or the rate of water movement through the entire soil (soil permeability). If applied to the entire soil, the permeability used is that of the most restrictive (slowest) permeability of any horizon in that soil. Note that the permeability rates are for undisturbed native soils. Also, permeability rates are for the movement of water through the soil, not effluent from a septic tank.

Permeability vs. Water Tables. Although permeability has a profound effect on the kind of water table and the depth to the water table, permeability and wet season water table should never be confused. Do not assume for example, that because a sandy soil has a rapid permeability, that it must be a well-drained soil. If the water has no outlet, then the soil pores will remain saturated with water, and despite rapid permeability, the soil will be poorly drained.

Permeability vs. Loading Rates. Do not confuse the permeability rates given here with the loading rates given in Chapter 64E-6, Florida Administrative Code. Although the terms are similar, the units of measurement are different, as are the boundaries of the classes that describe loading rates.

Altered Soil Permeability. The discussion has focused thus far on the correlation between soil texture and permeability. This relationship is strong. However it should be emphasized that other factors affect permeability and should be considered when estimating the permeability rate. Compaction of the soil by vehicle traffic (especially construction traffic) can significantly reduce permeability. The aggregation of loamy or clayey soils into SOIL STRUCTURES, called *peds*, can greatly increase permeability in loamy and clayey soils. Medium size and large size roots of shrubs and trees can be conduits for water and thus increase permeability tremendously. There are many other factors affecting permeability that are beyond the scope of this manual. Any good estimate of a permeability rate should consider obvious site factors and data presented in the published or web soil survey. ***Note that any weight placed on the soil can increase the compaction and hence decrease permeability***.

USDA Permeability Classes

Permeability Class	Rate (inches per hour)
very extremely slow	**0.0 to 0.01**
extremely slow	**0.01 to 0.06**
very slow	**< 0.06**
slow	**0.06 to 0.2**
moderately slow	**0.2 to 0.6**
moderate	**0.6 to 2.0**
moderately rapid	**2.0 to 6.0**
rapid	**6.0 to 20.0**
very rapid	**> 20**

Gases.

The fourth component is gas. The pores in the soil that are not filled with liquid will have some type of gas in them.

DESCRIBING SOILS

USDA notation and terminology for describing soils is the most widely used methodology today and thus should always be used to attain the maximum transfer of technology. ***Regarding the OSTDS program, the use of USDA techniques, notation and terminology are required. No other methodology can be accepted.***

Munsell Color Notation

Hue, Value, and Chroma. Munsell color notation is used to describe soils so that there is accurate communication about soil color. The Munsell color system utilizes three descriptive elements called HUE, VALUE, and CHROMA. In the reddish Munsell color '10R 4/6', 10R is the hue, 4 is the value, and 6 is the chroma. The descriptive elements of this system are organized into a book of colors (Munsell Color Book) much like a paint store uses color strips. The Munsell Color Book must have all of the current hue cards in order to be used (and be clean and have all chips).

Hue. Hue identifies the basis spectral color or wavelength (the relationship to the colors Red, Yellow, Green, Blue and Purple). In soils, these are the hues Red, designated by a capital R and Yellow, designated by a capital Y. Halfway between the Hue R and the Hue Y, is the hue YR, which represents yellow-red. *Each hue consists of a different page in the Munsell color book.* All of the colors on a single page have the same hue, except for the gley charts. In Florida, the basic hues are supplemented by several intermediate hues. The hues in progression from red to yellow are 5R, 7.5R, 10R, 2.5YR, 5YR, 7.5YR, 10YR, 2.5Y and 5Y.

The Gley Charts. There are two supplemental charts called the GLEY charts. These group many of the grayish, bluish, and greenish colors often found in very wet mineral soils. The gley chart contains several hues on one page, and they contain more yellow than the other non-gley charts. Chart One has the hues N (these hues have value, but no chroma designation), 10Y (yellow), 5GY (green-yellow), 10GY and 5G (green). Chart Two has 10G, 5BG (blue-green), 10BG, 5B (blue), 10B and 5PB (purple-blue). In older versions of the Munsell Color Book, colors with chroma of 0 appear on some of the single hue pages. Soils with colors on the gley charts are very wet. *Munsell books that do not have a complete, clean set of gley charts must be updated.*

Value. Value indicates the degree of lightness or darkness. Note on the first column of any page (any hue) that value increases from black at the bottom of the page, through the grays, to nearly white at the top of the page. Pure white would have a value of 10 in the Munsell scale and pure black would have a value of 0.

Chroma. Chroma is the relative strength or purity of the color. As chroma increases, the color becomes more intense. The scales of chroma extend from 0, which indicates no strength, or the lack of spectral color, to 20 which has the greatest amount of spectral color (for soil color, chroma ranges from 0 to 8). When chroma equals 0, the HUE is classified as neutral and therefore specified as "N" in the notation. That means for example that the color 2.5YR 3/0 is exactly the same color as 7.5YR 3/0. When chroma equals 0, the notation used is N chroma/value, as in the expression N 3/0. The expression may also be simplified to N3. These colors have no hue and no chroma, but range in value from black (N2.5) to white (N8). An example of a notation for a neutral (achromatic) color is N5 (gray). A column of color chips with neutral hue and no chroma is located on chart one for gley colors.

Field Measurement of Soil Color. When measuring soil color the sun should be behind you. The evaluator should not be wearing sunglasses or any type of tinted lenses. Very early morning or late afternoon measurements are not accurate. The sample should be moist. A moist sample will not get any darker when water is added to the sample, and it will not glisten. A sample that is too wet will glisten in the sunlight, or the water puddles on the sample. The sample should be placed behind the holes on the unaltered color chart so that the sun shines on the chip and soil sample (no shadows) and compared to the color chip that is most like the color of the soil sample. It is understood that an exact match is not likely, but that the closest color match will be used. In Florida, it is usually best to start on the 10YR page and make page turns to the left if the hue is not red enough, or make page turns to the right if the hue is not yellow enough. When the closest match is found, write the color notation using the hue (page) first, followed by value (left column), then write a slash, followed by the chroma (look to the bottom of the page); for example, "10YR 4/4". Care must be exercised to keep the color chips clean. ***These pages MUST be used in an unaltered form, meaning that they cannot be copied, laminated, etc.***

USDA Horizon Designations

Soil Profiles. The best way to study a soil is to dig a fresh pit in the ground and examine the wall or face of the pit. The face of the pit shows a sequence of horizons called the SOIL PROFILE. We describe each horizon in the profile by first designating a symbol, for the type of layer, followed by the depth in inches where the horizon begins and ends (for example, 0 to 9 inches), followed by the Munsell name of the color, the Munsell notation in parentheses, and the soil texture. For example, consider the following description:

USDA NOTATION
A1--0 to 9 inches; (10YR 2/1) fine sand;
Bt1--9 to 15 inches; (10YR 5/6) and (7.5YR 5/4) SCL

If there are mottles (be they redoximorphic features or not), they are described next by color and abundance. Mottles are described in quantity, contrast and color. ***Redoximorphic Features are mottles that indicate seasonal high water table elevations***. Quantity is indicated by three percentage classes of the observed surface. These are:

Few (<2%)
Common (2 to 20%) Abbreviation is CMN.
Many (>20%). No abbreviation. Write out.

Size refers to the dimensions as seen on the plane surface. If the length of the mottle is not more than two or three times the width, the dimension recorded is the greater of the two.
If the mottle is long and narrow, as a band of color at the periphery of a ped, the dimension recorded is the smaller of the two and the shape and location are also described. Three classes are used.

Fine: <5mm
Medium: 5 to 15mm
Coarse: >15mm

Contrast refers to the degree of visual distinction that is evident between associated colors. ***The color contrast (faint, distinct, prominent) is determined by use of Soil Survey Technical Note Number 2, Soil Color Contrast,*** found later in this manual. For example, the soil color contrast between a 10YR 5/4 and 10YR 5/8 is no change in hue or value, but a change of four units of chroma, which would be a prominent color contrast. ***DO NOT COUNT CHIPS (OR PAGES FOR HUES) TO DETERMINE COLOR CONTRAST, COUNT THE UNITS OF DIFFERENCE BETWEEN HUES, VALUES AND CHROMAS, RESPECTIVELY***.

Faint mottles are only evident upon close examination. They commonly have the same hue as the color to which they are compared and differ by no more than 1 unit of chroma or 2 units of value.

Distinct mottles are those that are readily seen but contrast only moderately with the color to which they are compared. They commonly have the same hue as the color to which they are compared to but differ by up to 3 units of chroma and up to 3 units of value. Distinct is abbreviated as DST.

Prominent mottles contrast strongly with the color to which they are compared. Prominent mottles are commonly the most obvious color feature of the section described. Prominent mottles that have medium chroma and value commonly differ from the color to which they are compared by at least 5 units (two pages) of hue if chroma and value are the same; or by at least 4 units of value or chroma if the hue is the same. Prominent is abbreviated as PRM.

It can also be stated that bright mottles are those that appear to moderately or substantially contrast with the matrix, or the dominant color of the layer. These could be referred to as **distinct** or **prominent** mottles, respectively. These are the minimum parameters needed to sufficiently describe a soil for OSTDS interpretations.

For DOH OSTDS site evaluations, the minimum standard is the correct Munsell notation, followed by the soil texture, then the depth in inches where the horizon begins and ends. For example:

7.5YR 4/2 FS 0-6"

The redoximorphic features (abbreviated as RF) must be identified in the soil profile on a separate line, or in the remarks section. For example:
The following matrix soil color and textures are in a horizon at a depth of 15-28”:
10YR 6/4 FS 15-28”, which would be followed by the redoximorphic features that exist within that horizon. For example:
10YR 6/6 CMN/DST RF FS 17-20"
The reason the soil color contrast is distinct is because there is no change in hue or value, but two units of change in chroma. Review of the soil color contrast memo shows this to be a DISTINCT contrast.
It is allowable to identify the actual percentage of redoximorphic features, such as:
10YR 6/6 5% DST RF FS 17-20"

Additionally, any restrictive layers must be properly identified, for example a spodic horizon (a Bh horizon) could be noted as:
5YR 3/2 FS spodic 20-30"

Auger Investigation. Since it is typically impractical to dig a fresh pit for every onsite investigation, the soil is usually examined using a bucket auger. Each sample brought to the surface in the auger must be carefully examined to determine if there is a sufficient difference in texture and/or color to designate a new horizon.

Texture and color pattern are the parameters used most to distinguish one horizon from another. Note that the use of a bucket auger less than 2¾ inches provides a comparatively small sample. Consequently, soil indicators could be less abundant and more difficult to identify. The use of a larger bucket will increase the amount of surface area where soil indicators would be present. The best place to observe soil conditions is in the center of the bucket auger sample. Remove the sample from the bucket, keeping it intact and then separate it into two halves on the long axis. This provides a natural, relatively undisturbed sample for color identification and soil texturing. Soil coloring should be done prior to soil texturing. Accurate profile descriptions require many hours of study and good observational skills.

Horizon Designation Symbols. The horizon designation symbol is related to the color, texture and other characteristics of the layer with respect to how the layer formed. The symbol usually consists of a capital letter and a lower case subscript, if applicable.

O Horizon. A layer of organic matter <u>on the surface</u> of a mineral soil is called the O horizon. This soil layer consists of decaying plant residues. In an extremely wet soil it is comprised of peat (partially decomposed, where individual pieces of plants are identifiable), or muck (where all plant material is totally decomposed). This layer has the master horizon designation of a capital **O** (for **<u>O</u>rganic**).

L Horizon. Limnic (means fresh water) Includes both organic and mineral limnic materials that were either (1) deposited in water by precipitation or the action of aquatic organisms such as algae or diatoms, or (2) derived from underwater and floating plants and subsequently modified by aquatic animals. These layers include coprogenous earth (sedimentary peat), diatomaceous earth, and marl. They occur only in Histosols (organic soils). They have the following subordinate distinctions (suffixes) of **co** (coprogenous), **di** (diatomaceous), **ma** (marl). They do not have the subordinate distinctions of other master horizons.

A Horizon. The topsoil layer, colored dark by organic matter, is always designated with a capital letter **A**. The surface layer is almost always an A horizon. The subscript '**p**' indicates that the surface has been plowed (Ap). On disturbed sites, the **A** horizon may be missing due to erosion or removal (e.g. grading).

The Classic Soil Profile. A classic soil profile would have a subsurface layer next, followed by subsoil layer, and a parent material layer. However, layers are sometimes missing from the sequence. For example, there is not always a subsoil layer or the parent material layer may be too deep in the profile to describe.

E Horizon. The typical subsurface layer is a "LEACHED" zone from which downward moving rainwater has translocated either clay particles and/or iron and other substances. This zone is designated by a capital **E**. An E horizon is *always* followed by a subsoil layer.

B Horizon. The typical subsoil layer underlies the subsurface layer. In Florida, the typical subsoil contains an accumulation of clay particles or aluminum complexed with organic acids. Most of the substances accumulated in the subsoil were leached from the overlying A horizon and/or the E horizon. The subsoil is designated the **B** horizon.

C and R Horizons. The material below the B horizon, generally lacks evidence of soil development and is usually considered to be relatively unaltered parent material. It designated the **C** horizon. Hard bedrock is designated the **R** horizon. The R horizon can also be considered parent material if it is thought that the soil formed in place from the weathering bedrock.

M Horizon. Root-limiting subsoil layers consisting of nearly continuous, horizontally oriented, human-manufactured materials. Examples are geotextile liners, asphalt, concrete, rubber and plastic.

W Horizon. Water. <u>This symbol indicates water layers within or beneath the soil.</u> The water layer is designated as *Wf* if it is permanently frozen and *W* if it is not permanently frozen. The *W (or Wf)* is not used for shallow water, ice or snow above the soil surface.

Transitional Horizons. Sometimes if a layer looks and feels similar to both the layer above and the layer below, a transitional layer is designated by the conjugation of two master horizon symbols. For example, a layer that was intermediate in color between an overlying A horizon and underlying E horizon, may be designated as the AE horizon.

Horizon Subscripts. Numerous subscripts can be attached to the master horizons designated by the capital letters. A '**g**' indicates that the horizon is predominantly a "gley" color or gray color which is normally chroma 2 or less, and includes the colors on the gley charts, with the exceptions noted earlier. The low chroma can be the color of reduced iron or the color of uncoated sand and silt particles from which iron has been removed. These areas may include redox concentrations. A '**t**' may be used with a B horizon to indicate a subsoil accumulation of clay or an '**h**' indicates an accumulation of organic acids. The Bh horizon is the spodic horizon referred to earlier. Other subscripts used in Florida soils include '**w**' and '**v**' for subsoils. A '**v**' indicates the accumulation of soft iron nodules (plinthite) and a '**w**' indicates development of a subsoil layer without the accumulation of substances found in Bt and Bh horizons. A '**b**' is used to indicate quickly buried soil layers. The layers have usually been buried within the past several hundred years and are recognizable as soil layers as opposed to sedimentary materials.

Classification of the Soils.

This section in the soil survey manual deals with soil series and their morphology, or their structure and form. Here you will find <u>detailed</u> descriptions of each soil horizon for each soil series that is recognized in the soil survey area. Additional information that you will find here is the type of topography the soil is normally located on and the soil drainage classification. You will note that there is a listing of <u>geographically associated</u> soils. The listing of the associated soils will normally indicate some of the differences among the soils. <u>It is important to note that after the detailed descriptions there is information on variations on thickness, textures and colors of the soil horizons. This information is extremely important in determining soil classifications.</u> When performing a soil profile, it is understood that an exact match is not likely, but that the closest match will be used. You could also encounter variations in a soil profile. Use of the information regarding the variations allowed in describing the soil color will assist in identifying the soil series. Accurate classification of soils require many hours of practice and good observational skills.

Soil Taxonomy: How Soils Are Classified

Soil Taxonomy is the USDA classification system used by soil scientists to group like soils and give them names. The system is a complex one that is well beyond the scope of the current discussion. For making most OSTDS decisions, it is only necessary to be familiar with the concept of soil classification. Therefore, only a brief overview will be featured here. Soil Taxonomy is a hierarchical system that has several levels of classification, just as the biological classification system that is used to classify plants and animals. Consider for example that humans are first distinguished as animals (vs. plants) then they are in the kingdom of animalia, phylum chordata, class mammalia, order primata, family homidae, genus homo, species sapiens. In a similar way, a soil is first classified as mineral or organic, then into a soil order, a suborder within the order, a great group within the suborder, a sub group within the great group, and a family within the great group. A name is then conjugated from the formative components of the order through the family. For example, the soil series Myakka is a mineral soil classified as a Sandy, siliceous, hyperthermic Aeric Alaquod. Sandy siliceous hyperthermic is the family indicating quartz sand composition in a warm climate; Aeric is the greatgroup indicating a relative thin surface due to slightly more aeration; **Al** is the subgroup formative element indicating an aluminous subsoil complexed with organic acids; **Aqu** is the suborder formative element indicating wetness and **Od** is the soil order formative element for the order of Spodosols.

Soil Orders In Florida

Soil orders commonly found in Florida are discussed briefly below.

Histisols. These are the organic soils (they are almost always very wet soils). The formative suffix for this order is **ist**, as in the suborder Saprist.

Entisols. These are weakly developed soils or ones that are sandy throughout (excluding spodosols). The formative suffix for this order is **ent**, as in the suborder Aquent.

Spodosols. These are sandy soils with a subsoil accumulation of organic acids called a spodic horizon. The spodic horizon is sometimes called an organic hardpan, but this term should be used carefully because not all spodic horizons are hard and dense. Myakka fine sand, the state soil of Florida, is a spodosol. The formative suffix for this order is **od**, as in the suborder Aquod.

Mollisols. These are alkaline or non-acid soils with thick black surfaces. In Florida, they are usually wet

soils. The formative suffix for this order is **oll**, as in the suborder Aquoll.
Inceptisols. In Florida, these are essentially soils that do not fit well into the other soil orders. It includes soils similar to Mollisols that are acid instead of alkaline and some floodplain soils. The formative suffix for this order is **ept**, as in the suborder Aquept.
Alfisols and Ultisols. These are soils with loamy or clayey subsoils that underlie horizons with less clay. Alfisols have alkaline subsoils and Ultisols have acid subsoils (more or less). The formative suffixes are **alf** and **ult**, as in the suborders Aqualfs and Aquults.

Typical Horizon Sequences

Each of the Florida soil orders has a typical sequence of horizons. It must be stressed however that numerous variations of the basic sequence are possible. For the sequences given below, those horizon designations (or parts of the designation) delineated in **bold**, are most diagnostic for the specified soil order.

Histosols **O**a, **O**e, C1, C2.
Entisols A, **C**1, **C**2, **C**3.
Spodosols A, E, **Bh**1, **Bh**2, BC, C.
Mollisols **A**p, **A1**, **A**2, AC, C.
Inceptisols Ap, E, **Bw**, BC, C.
Alfisols and Ultisols Ap, E1, E2, **Bt**1, **Bt**2, BC.

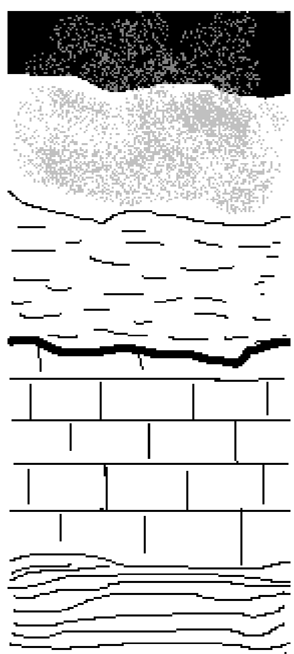
Representative Profile Schematic of the Classic Soil Profile

A-Topsoil. Mineral horizon colored dark by organic matter.
AE-Transitional horizon has characteristics similar to both the A & E horizons

E – Horizon of maximum leaching, or loss of substances such as clay particles

Bt or **Bh** – Horizon of maximum soil development, usually the accumulation of organic acids or of clay particles.

C-Horizon of geologic material that is relatively unaltered by soil forming processes.



Surface layer

Subsurface layer.

Subsurface layer.

Subsoil layer.

Substratum or underlying layer

Figure W

SOIL WATER TABLES

In Florida, the soil water table is the soil property most often considered for planning a variety of land uses. For urban land uses, the problem is likely to be "too much water" rather than "not enough water."

Where to Start Measurements
All indicators are measured from the natural soil surface, which includes all horizons that were made by the soil forming process. The natural soil surface is measured from mineral, muck or mucky mineral soil. Do not measure from peat or mucky peat surface unless using Hydric Soil Indicators A1, A2 or A3 *(note for A3: this one would be an unusual case and probably would never meet the color requirement)*.
Where the natural soil surface has been altered by the action of man via soil addition or removal, the indicators must be judged using natural soil surface criteria, accounting for what was added or removed. As a notation, remember that redox features may form in fill material and extra care must be taken during their evaluation.
Water Table Fluctuations. The soil water table is the depth to saturated soil material. The depth to the water table can be measured at any time, but a single measurement is not useful for making land use interpretations. A group of water table measurements, taken weekly over a period of many years, will show how the water table fluctuates up and down in a soil. Unfortunately, this method is not practical for most land uses. Using soil morphology however, it is possible to predict the depth to the SEASONAL HIGH WATER TABLE (SHWT), also sometimes called the wet season water table.

SHWT Definition. The SHWT is the highest average depth to a zone of saturation. The SHWT normally persists at its depth for several weeks or more, and normally occurs during the time of the year when the most rain falls. Informationally, the USDA NRCS uses a 30 day criteria to judge SHWT for the ranges presented in their soil surveys. In addition, because some years are drier than others, and some years are wetter, the SHWT may not be reached in some years while it may be exceeded in other years. Many different factors affect the seasonal high water table including climatic variation, relative landscape position, landscape development, vegetation, and soil texture. Although it is soil morphology that is the basis for SHWT estimation, other factors should always be considered.

Matrix and Mottle Color as SHWT Indicators

Soil Color is the dominant morphological feature used to predict the SHWT. Soil color determination and terminology is obtained from the Munsell soil color charts. When describing the color of a soil horizon, there are two components to be considered. Recall that the dominant color of the layer is called the matrix color and splotches of color are called mottles (where indicative of the seasonal high water table, they are termed ***Redoximorphic features or RF***). Often, mottles are not present in a soil horizon, but when they are present, both the color of the matrix and the color(s), amount and contrast of the mottles must be described. The color contrast (faint, distinct, prominent) is determined by use of *Soil Survey Technical Note Number 2, Soil Color Contrast,* found later in this manual.

DOH and Hydric Soils/Redoximorphic features from Natural Soil Surface to 12 Inches and use of Hydric Soil Indicators (HSI).
DOH does not define the term "hydric soil" nor exert regulatory control because the soil may be hydric. In the broadest sense a hydric soil equates to a SHWT within 6" of the soil surface if a sandy soil, or within 12" if non-sandy. Hydric soils have specific indicators that are used to identify them, collectively called Hydric Soil Indicators (HSI). The HSI used in Florida and their descriptions can be found later in this manual. Note that HSI must be used to determine the SHWT in all soils from surface down to 12". Additionally, HSI can also be used as SHWT indicators at depths greater than 12", just make sure you follow the specific criteria for the indicators, except for them having to be within 6" or 12" of the surface.

Redoximorphic Features in Loamy and Clayey Soils. In loamy or clayey soil horizons, ***INCLUDING THE TEXTURE LOAMY VERY FINE SAND,*** the best indicator of the depth to the seasonal high water table below a depth of 12" (30 cm) from the natural soil surface is the depth to grayish low chroma soil colors, either as the matrix or have common appearance as "mottles" (iron depletions). These low chroma colors have a value of ≥5 (note the higher values) with a chroma of ≤2 down to a depth of one meter (39.37 inches). Below one meter, the depth to saturation is the depth to common to many distinct or prominent redox

depletions or a matrix color with value ≥5 and chroma ≤3. There is an important exception to use of this color pattern as an indicator. If low chroma colors directly underlie a dark topsoil layer, the SHWT is at, near, or above the soil surface. **Additionally, Hydric Soil Indicators can be used to determine the SHWT at any depth in the profile.** Note that the Gley Chart colors having a value ≥4 are also indicators.
Note: *For depths of one meter or less, depletions of chroma 2 or less is required and for depths of more than one meter, depletion of chroma 3 or less is required. The difference is that this phenomenon is reported from thousands of field sites, and by remembering that the requirements for reduction (microbial activity, saturated soil, lack of oxygen and organic matter) become less and this might lead to less dissolution of iron even when the soils are just as wet and just as reduced.*

Redoximorphic Features in Sandy Soils. In sandy soils or soil horizons, the best SHWT indicators below a depth of 12” from the natural soil surface are the depth to bright colored redox features (concentrations) and/or a gley color matrix. ***THIS IS FOR THE TEXTURE LOAMY FINE SAND AND COARSER.*** Recall that gley colors are low chroma colors, including types of greenish, grayish, and bluish low chroma colors found on special charts in the Munsell Color Book called the gley charts and values ≥4 are considered redoximorphic features. Bright mottles are those that appear in *substantial contrast* to the matrix. These are more accurately described as **distinct or prominent** mottles, which were discussed in a prior section. See USDA NRCS Technical Note 2, Soil Color Contrast later in this manual for color contrast identification procedures. The matrix has a chroma of ≥3 and/or high value and the mottles are mid value (≥5) and high chroma (≥6). Sometimes the appearance of bright mottles will coincide with an abrupt matrix color change. A likely change is from a brighter matrix color above to a lighter (often white) matrix color below.

In sandy soils with a chroma ≥3 and below a depth of 12” from the natural soil surface, the depth to saturation is the depth to common to many distinct or prominent redox concentrations having a hue between 2.5YR and 10YR, value ≥5, and chroma ≥6. Between the soil surface and 12”, the Hydric Soil Indicators must be used. This is due to the amount of biological activity as well as the high organic matter content in Florida soils.

Any contemporary redoximorphic concentration cannot have a hue that is 10R or more red, as this indicates a relict feature. This applies to hydric and non-hydric soils. Redox concentrations having a hue of 10R or redder would indicate relict wetness. So, to summarize for contemporary redox concentrations:

1.) The hues that can be used for non-hydric redoximorphic concentrations range from 2.5YR to 10YR to indicate concurrent wetness.

2.) The hues that can be used for hydric soil redoximorphic concentrations range from 2.5YR to 5Y, as long as the concentration meets the criteria of value and chroma for the element type being considered. For example, if the concentration were iron (Fe), the value and chroma would have to be ≥4. See hydric soil indicators for more information.

Please note that gley colors are depletions not concentrations, so the gley charts would not be used to identify redoximorphic concentrations.

Stripped Matrix. Another indicator used in sandy soils is the presence of low chroma colors where no matrix color appears to be dominant. *This pattern appears as a splotchy, faintly contrasting arrangement of 2 or more colors of which at least one is low chroma and the others are relatively dull.* In Munsell notation, these "dull" colors are defined as having a value of ≥5 and a chroma of 3 or 4. *The boundaries between the colors are diffuse, which means that the color grades over ≥2mm.* A clear boundary has a color grade over <2mm. A sharp boundary has a color grade that is not visible to the naked eye. This color pattern is called the stripped matrix. The stripped (lighter colored) areas must be at least 10% of the volume of the sample. The depth to the stripped matrix is used as the SHWT indicator more often in wet soils but can be applied even in better drained soils. In most areas of Florida, the stripped matrix may be difficult to identify because of its characteristic subtle color patterns. ***PLEASE SEE THE SECTION ON HYDRIC SOIL INDICATORS FOR MORE INFORMATION.***

Problems Identifying SHWT Indicators

Stray Mottles and Microenvironments. The distribution and amount of mottles in a soil is extremely important for determining the depth to the seasonal high water table. **Make sure the mottles are actually Redoximorphic Features.** In many soils, the mottled zone begins gradually, and often a few stray mottles occur above a zone of substantial mottling. A stray mottle should not be used to estimate the SHWT (must be at least 2%). In addition to stray mottles, there are sometimes micro-environments that contain gray matrix colors or features that appear to be mottles. These micro-environments may be golf ball size to basketball sized but the actual size is nearly impossible to determine from a bucket auger sample. A soil micro-environment may have formed as a result of a number of different factors, including soil disturbances by plants (e.g., decayed roots) or animals (e.g. burrows). This is only one of many reasons why a proper site evaluation requires more than one auger hole.

Misidentification of Mottles. There is another important point to consider when using mottling as a SHWT indicator: **MAKE SURE THAT YOUR MOTTLE IS A REDOXIMORPHIC FEATURE**. In some sandy soils, layers of contrasting texture often have highly contrasting colors. The abrupt contact of a light colored, upper sandy horizon that tongues into a bright colored loamy or sandy layer below may be confused with mottling when observed in an auger sample. *When a mottle is encountered that is the same color as the subsoil below, the suspected mottle should be examined carefully to see if it contains an increase in clay percentage as compared to the matrix. Some sandy soils contain a subsoil accumulation of clay that is distributed in fine lateral bands called **LAMELLAE**. Lamellae usually appear in contrasting colors, and are not normally indicative of wetness.* And finally, in some cases, splotches of brown and red in a loamy or clayey soil might actually be called mottles *but they are not drainage mottles and they are not indicators of the SHWT.*
Another possible problem is oxidized rhizospheres (root channels or roots). Even in well drained soils with no actual SHWT indicators, roots from plants will sometimes cause "mottles" to form around the roots. These are not indicative of the SHWT. *However, in a **HYDRIC SOIL**, oxidized rhizospheres are indicative of the SHWT.* We will discuss this later in greater detail.

Estimating Drainage Classes in Spodosols

Soils Without SHWT Indicators. Some sandy soils lack the obvious SHWT indicators such as high chroma or gley redoximorphic features. Most often, this deficiency is observed in spodosols. A spodosol has a horizon sequence consisting of a topsoil layer (an 'A' horizon), normally underlain by a lighter layer (an 'E' horizon), underlain by a slightly hardened, darkly colored layer (a 'Bh' horizon) called a SPODIC horizon. **As a general rule, the spodic layer has a value ≤4 and a chroma ≤3. This must occur below the 'A' horizon.** The spodic horizon formed as rainwater washed tea-colored humic acids from decaying plants and down through the porous sandy soil. Here the "tea" sloshed up and down with the fluctuating water table for many hundreds of years, coating the sand grains to form the spodic horizon. In Florida, while the spodic horizon also contains a substantial amount of aluminum, iron is usually deficient and therefore iron oxide mottling is absent. A stripped matrix might be present, but recall that this indicator is often difficult to identify. Where high chroma mottles are present within the actual spodic layer, they are not a reliable seasonal high water table indicator. Normally, the seasonal high water table is above these mottles.

The Depth to Spodic Fallacy. In the past, some persons estimated the SHWT in spodosols to be the depth where the spodic horizon begins. While it is generally true (but not always) that the SHWT is somewhere above the spodic horizon, an exact correlation usually cannot be made with the depth to the top of the spodic horizon.

Conceptual Drainage Models. When the SHWT indicators are not obvious, or are difficult to interpret, a good way to find support for an uncertain estimate is to organize spodosol data from the soil survey in a conceptual model for landscape position and drainage. By studying and learning the morphological differences between spodosols of differing landscape positions, a drainage sequence can be constructed and used to estimate general SHWT classes. The most commonly occurring spodosol drainage sequence in Florida, from wettest to driest is given in the following table. The wettest spodosol of the sequence is '**a.**' and the driest is '**d**'**.** Note in this sequence that as the soil gets better drained, the subsurface layer becomes lighter and the subsoil layer changes in color from black or brownish to reddish and finally yellowish. This is a broad, generalized model only and there are many variations and substitutions possible.

Conceptual Drainage Sequence for Spodosols in Florida

a.1. Thick, very dark colored surface, grayish or no apparent subsurface, black or dark colored spodic horizon. SHWT at about 0 to 6 inches below soil surface.

a.2. Thick, very dark colored surface, grayish subsurface, sometimes stripped with a deep, black or dark colored spodic horizon often beginning below 50 inches. SHWT at about 0 to 6 inches.

b. Grayish or salt and pepper surface, light gray subsurface, reddish brown or dark brown spodic horizon. SHWT at about 6 to 18 inches.

c.1. Light gray or light salt and pepper surface, white subsurface, reddish brown gradually changing to yellowish brown spodic horizon. SHWT at about 18 to 42 inches.

c.2. Light gray or light salt and pepper surface, white or light yellowish subsurface grading to white or light gray, brown spodic horizon below 50 inches. SHWT at about 18 to 42 inches.

d. Thin, very light gray or light salt and pepper surface (that is sometimes not discernible from the subsurface), white subsurface tonguing abruptly into a brownish yellow subsoil with a thin spodic layer at contact of the white subsurface and brownish yellow subsoil. Underlying layer gradually lightens to white and may have bright mottles. SHWT at about 40 inches or greater.

Vegetation and SHWT

Vegetation is a natural indicator that can help provide confidence in a SHWT estimate, but should be used carefully because there are so many "exceptions to the rule" and because vegetation is so easily and quickly changed by natural and human forces. A section on vegetative indicators will be featured later in this manual.

Organic Matter Content and SHWT

The presence of organic matter in a soil may also be helpful in estimating the SHWT of a soil. Organic matter, which darkens the mineral soil, does not fully decompose in wet soils. If a soil has a dark colored surface composed of fully decayed plant material, called MUCK, the SHWT is at or above the soil surface. Muck imparts a slightly sticky, often greasy feel to the soil material (it is often confused with clay or silt). It is usually black or dark brownish colored. If the texture is not muck, but there is enough muck in the surface to modify the textural class (i.e., mucky sand), then the seasonal high water table can be predicted to be at or slightly above the soil surface. To determine the amount of organic material in these types of soils one must use the “Near-saturated Soil Rub Test” which **IS NOT** the same as texturing mineral soil. In this test, the material is wet enough to squeeze water out of the sample. If, after two light quick rubs between your thumb and forefinger, the soil feels gritty (meaning dominated by sand particles), the soil is neither muck or mucky mineral, it is mineral. If, after three MORE light quick rubs, the soil feels either gritty or plastic, the soil is not muck, it is mucky mineral. Only after not feeling grit or plastic after at least 6 rubs (preferably 10) should the soil be considered to be a muck.

Lesser amounts of organic matter, which may be easier to see than to feel, can be used to predict seasonal high water table depth. A black surface for example, usually has a SHWT within 12 inches. A very dark gray surface usually has a SHWT at about 12 (9-15) inches. Dark gray is usually >15 inches.

USDA Drainage Classes

Soils with similar SHWT's are often grouped into broad categories called DRAINAGE CLASSES. It must be emphasized that correlation of these classes to SHWT ranges is generalized and drainage class should never be given when depth to the SHWT is requested. There are six classes commonly used in Florida. VERY POORLY DRAINED soils generally have SHWT's at 0 to 24 inches above the surface. POORLY DRAINED SOILS generally have SHWT's at about 0 to 18 inches below the surface. SOMEWHAT POORLY DRAINED soils generally have SHWT's at 12 to 30 inches below the surface. MODERATELY WELL DRAINED soils generally have SHWT's at 24 to 48 inches below the soil surface. WELL DRAINED soils generally have SHWT's at 60 inches or more. The well drained class is rarely applied to soils that are sandy throughout. EXCESSIVELY DRAINED soils are always sandy throughout and have a SHWT greater than 72 inches below the surface.

USING THE SOIL SURVEY

Nearly every county in the state of Florida has a published soil survey. The soil survey is an extremely valuable reference and every environmental health specialist must have his or her own copy. There are three basic parts to the soil survey. They are the soil maps, the interpretive and data tables, and the informative text. A brief primer called "How To Use This Soil Survey" is located on the inside cover of each modern soil survey publication. There is now a Web soil survey that supersedes any legacy documents (printed copies of soil surveys). The best way to get to the web soil survey is to go to a search engine and look up "web soil survey" and find the one from the USDA NRCS.. The current web address is http://websoilsurvey.nrcs.usda.gov/app/.

Detailed Soil Maps

Maps, Symbols, and Legends. The detailed soil survey maps are located in the back of the published soil survey. The map "base" is an aerial photograph. Lines have been placed on the photograph that DELINEATE or encircle a type of soil that differs from the type of soil on the outside of the delineation. Inside each delineation there will be a numerical symbol (sometimes an alpha character group in older soil surveys) that identifies the soil type. To find out the name of the soil represented by the numerical symbol, turn to the page at the beginning of the set of soil maps and refer to the SOIL LEGEND. Note that to the right of the soil legend, on the same fold-out page, there is a CONVENTIONAL AND SPECIAL SYMBOLS LEGEND. All of the other symbols that might be drawn on the detailed maps are defined in this legend. For example, a narrow perennial stream (one that flows almost all of the time) is denoted by a dash-dot-dash-dot pattern that traces the stream's course.
The detailed soil survey sheets are called ATLAS SHEETS or MAP SHEETS. The atlas sheet is usually identified by a page number in the upper left hand or upper right hand corner, directly over an arrow that points north. The atlas sheet number is encircled by a bold line.

Map Scale. On the bottom or side of the atlas sheet, there is a ruler-like SCALE that graphically depicts the length of a mile and a kilometer on the detailed map. Note that below the ruler scale, a written scale appears. For example, the line might say SCALE 1:24,000 (one to twenty-four thousand). This means that one inch on the map equals 24,000 inches on the ground. This can be converted mathematically to one mile equals 2.64 map inches OR one map inch equals 0.3787 miles equals 2000 feet. Most Florida soil surveys will have scales of 1:24,000 or 1:20,000. Some older surveys may have somewhat different scales. Mostly the scales range generally from 1:15,000 to 1:24,000.

Finding A Location On Soil Survey Maps

Perhaps the most difficult part about using the soil survey is locating a point on the detailed map. There is absolutely no substitute for experience, and experience can only be gained by practice in locating points.
Getting Started: Index to Map Sheets. Directions to a field site may consist of a set of written instructions, or perhaps a crudely drawn map. It is usually best to then locate the general area of the site on a county map that you are comfortable using. Next, turn to the INDEX TO MAP SHEETS located in the soil survey on a fold out page just before the set of detailed maps. Note that a county map has been blocked out into forty or more rectangles. Each rectangle represents the area mapped on a detailed atlas sheet, and the number in the left hand corner of the rectangle is the atlas sheet number. Use this index to locate the general area of your site. Then turn to the correct atlas sheet.

Aerial Photos and the Changing Landscape.
Because so many areas in Florida are rapidly developing, landscapes photographed from the air can change dramatically in a short period of time. This is why it is important to be familiar with the date of the aerial photograph. The date of the photo is located on the atlas sheet, often on the inside margin. Most soil survey photography will be at least 5 to 10 years old. If an area has developed intensely, finding a point will not be easy for an inexperienced soil survey user.

Geographic Reference Points. The first step is to find a familiar starting point on the atlas sheet. The best reference point is often the intersection of two numbered roads. Small named lakes and ponds, other named features, and land boundaries make good reference points. Using a favorite county map, look for familiar shapes and patterns (i.e., the shape of a parking lot or pattern of roads in a development).

Measuring Distances on the map. In many instances, it will be necessary to use a ruler or scale to measure the distance to a turn from the last known point. For example, a written instruction might say to" turn south from the intersection of two roads, go 0.3 miles and turn left, then go 0.4 miles to the lot on the right". If the atlas sheet scale is 1:24,000, then it is known that one mile equals 2.64 inches. Divide 2.64 by ten to get the distance for one tenth of a mile. This equals 0.264 inches. Then, to get the 0.3 mile distance given in the directions, multiply 0.264 by 3 to get the result that three tenths of a mile equals 0.792 inches, or about 0.8 inches. Complete the conversion in a similar manner for the other distance. The map directions now read "turn south from the intersection of the two roads and go 0.8 inches, then go about 1 inch east to the lot on the right. Locate the point and identify the soil.

Land Survey Systems

Locations or parcels of land are often referenced using a **land survey system**. Two types of land survey systems are commonly used to describe land ownership. They are the **metes and bounds system** and the **U.S. Public Land Survey (PLS).**

Metes and Bounds. The metes and bounds system describes the boundaries of a parcel of land referenced by compass settings or geographic features such as shorelines and named roads. This system is generally not useful for locating specific points. Here is an example of an older metes and bounds parcel description: *"Begin at the confluence of Red Creek and the South River and proceed along the shoreline of Red Creek to the point where it intersects with Oldtown Road, following Oldtown Road to the intersection with South River, then along the shoreline of South River to the starting point."*

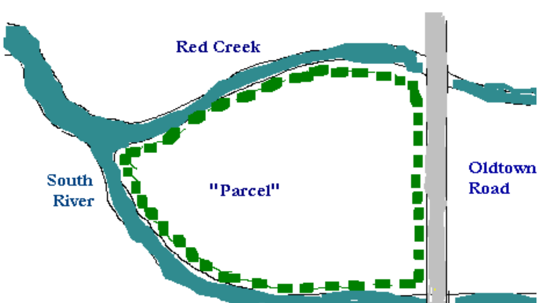


Fig. Parcel described in metes & bounds

U.S. Public Land Survey. The U.S. Public Land Survey is a system that uses a grid originating at the intersection of a north-south line and an east west line, analogous to lines of longitude and latitude. The north-south lines are called **meridians**, or **range lines**. The east-west lines are called **parallels**, or **township lines**. The origin of the grid is formed by the intersection of a **principal meridian** with the intersection of a **principal parallel**, or **base line**. The principal meridian used in Florida is drawn through Tallahassee and is called the **Tallahassee Meridian**. The principal parallel used in Florida is called the **Tallahassee Base Line**. It runs approximately from Jacksonville to Pensacola. Additional parallels and meridians are added to form the grid. These additional lines are about 6 miles apart. They enclose a 36 square mile area called a **sectionalized township**. Each sectionalized township is further divided into 36 individual 1 square mile areas called **sections**.

All of the land area in a strip bounded by a meridian to the west and a meridian to the east, lies within the same numbered range. The ranges that lie west of the principal meridian are numbered in succession as follows Range 1 West (abbreviated R.1W), R.2W, and so forth. The ranges that lie east of the principal meridian are numbered similarly: R.1E, R.2E, R.3E. Townships identify strips of land that extend from east to west, bounded by parallels, and they are numbered in the same method used for ranges: T.1N, T.2N, T.3N, and T.1S, T.2S, etc. The intersection of all the land that lies within an individual range and an individual township is the 36 square mile area called the sectionalized township. Each sectionalized township is identified as in the example: R.1E T.3S.

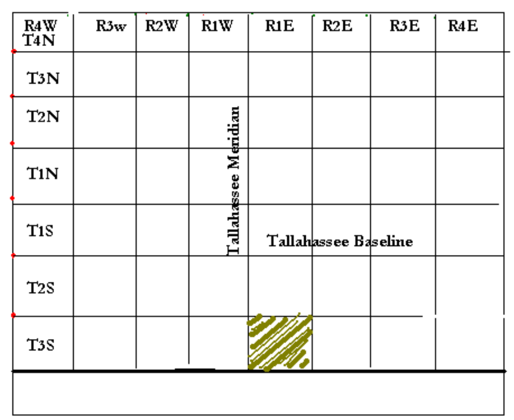
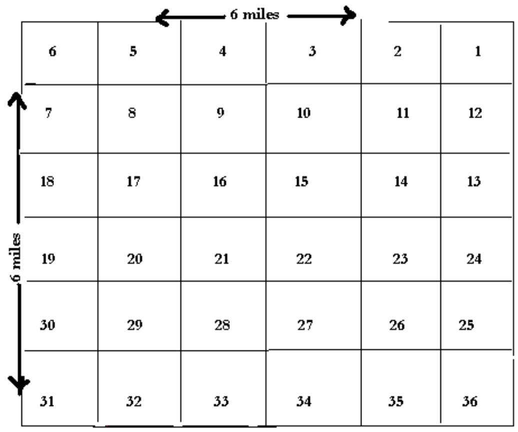


Figure Townships and Ranges

Each of the 36 individual 1 square mile parcels in the sectionalized townships, called sections, is identified by a number. The numbering of the sections begins with 1 in the northeastern most section in the sectionalized township and ends with 36 in the southeastern most section in the sectionalized township.



Sectionalized Township

Each section can be further subdivided, most commonly in increments of quarters. Each quarter of a section, can also be subdivided by quarters, as can each successive subdivision. The following designation of a parcel of land is read: SW1/4, NE1/4, NW1/4, Sec. 35, R.2E. T.3N. as "*the southwest one quarter of the northeast one quarter of the northwest one quarter of section 35, range 2 east, township 3 north.*"

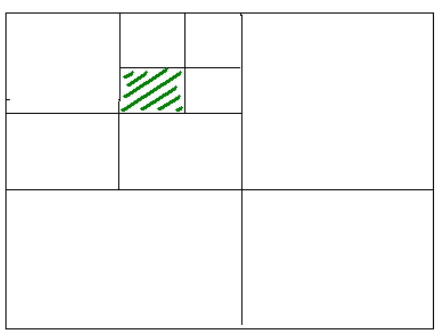


Figure: SW 1/4, NE 1/4, NW 1/4

Using the PLS with maps. A clear plastic grid guide is useful for determining the PLS location of a parcel. The guides contain printed lines that divide the section into quarters, divide each quarter again, and divide each quarter one more time. It is extremely important that the scale of the guide corresponds exactly with the scale of the reference map. Some guides contain a grid for only one scale, while others contain a guide for several scales. The guides often list the acreage of a cell for each subdivision. A perfect section is equal to 1 square mile which is equal to 640 acres. A quarter section will therefore be equal to 160 acres, and this parcel quartered will yield 4 parcels, each containing 40 acres.

When locating specific points on a map (as opposed to parcels of land), it is often best to specify the point by the distance in 2 cardinal directions from the closest corner of the section in which the point lies. For example, a point might be referenced: 625 feet south and 1220 feet east of the NW corner of section 3, R.4E. T.7S.

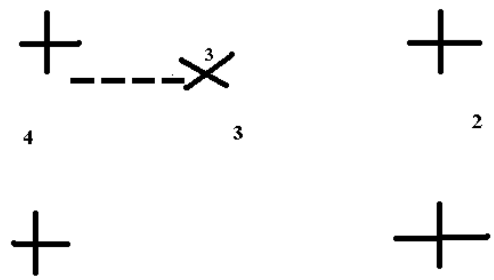


Figure: 625 ft. S. and 1220 ftE, NW corner of section 3

Using the PLS with the soil survey. All of the photography that appears on a single soil survey atlas sheet is bordered by a solid line called a match line. One township or range is divided from the adjacent township or range by a single dash that is oriented perpendicular to the match line and the township or range is identified as in the example: R.21E.|R.22E. . The corners of each section are marked by a large plus sign (+). A bold section number is placed as near to the center of the section as is practical. Although section corners are placed on the soil survey atlas sheet as accurately as possible (usually within 100 feet), their use in the document is intended to be for reference only. **Land Grants.** Because the U.S. Public Land Survey was authorized by the Land Ordinance of 1785, earlier land survey systems had already been in place. In Florida, British and Spanish Land Grants had established land boundaries that had been in place for over a century in some cases. These land grant boundaries are still in existence today, and supersede the section boundaries of the PLS . For a parcel of land surveyed by a land grant, the section number is replaced by the land grant number, as in the example: *Land Grant 66, R.2E. T.3N.* **It is generally not appropriate to describe quarters of the land grant because few of the land grants are square. Land Grant numbers are always greater than 36 so that they are not mistaken for PLS section numbers. Land grant boundaries are often delineated by a dashed line separated by two dots (---- ▪▪ ----), while only corner points delineate a PLS section.**

The Soil Survey Text

Map Units. The numeric or alphabetic symbol that identifies the type of soil on the atlas sheet actually identifies an entity called the MAP UNIT. The map unit may include 2 or 3 soil types, only one soil type, or possibly a land type that does not include any soil type. "Urban land" for example is a map unit that includes mostly parking lots and city buildings.

Map Unit Descriptions (MUD's). Refer to the "Detailed soil map units" section of the text (see the CONTENTS section in the beginning of the publication). The written descriptions of the map units are arranged in numerical order. Turn to the description for map unit number of interest. The order of the data presented in the map unit description will be the same for every map unit in the county. Most often, the map unit name is the conjugation of a soil series, soil texture, and slope class. The texture in the map unit name identifies the most common surface texture for the map unit in the survey area.

The opening paragraph identifies the slope class, the drainage class, the landscape position that the soil is on, and the general shape and range in size of the delineations.

The second paragraph gives a non-technical description of the soil profile.

Inclusions. The third paragraph talks about INCLUSIONS. All map units contain inclusions. An inclusion is a kind of soil that differs from the one named in the map unit title. Sometimes there are soil inclusions in a map unit delineation because an area of the different kind of soil is too small to encircle with a pencil line. Note that to be delineated on a soils map, a particular soil type must be at least 6mm square (1/16 sq. inch). Maps with smaller scales usually have delineations commonly 1.5-2 times the size of the minimum area that can be shown. For example, on a 1:20,000 scale, the minimum size delineated is 4 acres, while on a 1:24,000 scale, it is 5.7 acres. Other times it is a transition soil found near the edge of the delineation. For the map scale 1:24,000, the printed line used to encircle the delineation of soil is 50 feet wide in real life! Be sure to note in this paragraph that the types of inclusions are identified by name so that they will be easier to identify if encountered in the field. ***INCLUSIONS ARE THE PRIMARY REASON WHY ON SITE SOIL INVESTIGATIONS ARE REQUIRED TO SUPPLEMENT SOIL SURVEY DATA.***

Physical Data in the MUD. Next find a paragraph that gives physical data for the soil. Available water capacity, permeability, and water table data are generally given. If data is grouped by a class, the class data range will be identified in the glossary. For example, if the permeability is given as moderate, turn to the glossary and look up "permeability". The glossary entry will provide a table showing that moderate permeability equals 0.6 to 2.0 inches per hour.

Vegetation in the MUD. Another paragraph describes the natural vegetation that grows most often in areas of the specified map unit. The last several paragraphs discuss limitations and potentials for specified land uses including major crops grown on the soil and urban land uses.

Technical Soil Descriptions. To read a technical description of the soil series components of map units in the county, turn to the section entitled "Classification of the Soils". Preceding an alphabetically arranged set of soil series descriptions, note the short introduction to the soil classification system used by the USDA Natural Resources Conservation Service.

Like the map unit description, the technical description uses a standard format for each soil series described. The technical description is also called the taxonomic unit description or the series description.

The last sentence of the introductory paragraph always gives the taxonomic classification for the soil. The third paragraph begins the actual soil profile description, written in technical terminology.

Following the description, the range of characteristics describes the allowable variation in horizon thicknesses, colors, textures and other parameters for the soil series.

Use and Management of the soils. The types of information presented in the interpretive data tables are discussed in a text section entitled USE AND MANAGEMENT OF THE SOILS. Information such as county land use data, soil map units used for certain land uses, and practices used to overcome soil limitations are given in this section. Subsections are usually written for cropland, rangeland, woodland management, windbreaks, recreation, wildlife habitat, building site development, sanitary facilities, construction materials, and water management. The individual subsections also discuss the interpretive table ratings for the specified land use.

Soil Properties Section. The types of information presented in the data tables are discussed in a text section entitled SOIL PROPERTIES. Engineering index properties, physical and chemical properties, soil and water features; physical, chemical and mineralogical analyses of selected soils, and engineering index test data are some of the titles of subsections that discuss everything from laboratory methods, local data, and other classification systems. This brief portion of the soil survey text is intended primarily for the advanced professional user.

Soil Survey Tables

The TABLES section of the soil survey is located between the detailed soil maps and the text. There are two basic types of tables. They are DATA TABLES and INTERPRETIVE TABLES.

Generally, the first data table is "Temperature and Precipitation". Use this table to learn how rainfall is distributed throughout the year and when the highest water tables might be expected in years with normal rainfall patterns.

Note carefully the data table entitled "acreage and proportionate extent of the soils". Use this table to find out which soils are most extensive in the county. Read the map unit descriptions for these soils carefully.

Many of the interpretive tables that follow are agricultural. They give yield data and limitations for the specified use.

The urban land use tables give a rating of slight, moderate or severe for the components of each map unit and also give a reason for moderate and severe ratings. In the "sanitary facility" table, septic tank absorption field ratings will often seem more restrictive than might be expected under Florida law. The last table appearing in this section is the engineering and other laboratory data. Be sure to consult the Soil Properties section of the text. The table "Soil and Water Features" will probably be most useful. This table contains data on flooding potential and water tables. Water table data here is often more generalized than given in the map unit description. If there is a difference between tabular data ranges, and map unit data ranges, use the data range given in the map unit description.

The General Soils Map

Find the color fold-out county map preceding the detailed soil maps. This is the General Soils Map. Delineations on the general soils map show broad areas of the same GROUP of soils. The general soils map unit is named after the two or three most extensive soils in the unit. An example is the *Candler-Tavares-Apopka association*. The general soils map unit description also identifies other minor soils commonly found in the general soil map unit area. Often, the general soils map unit lines correspond to lines on geomorphic or physiography maps.

Several general soils map units might be grouped into even a broader category. For example, the Candler-Tavares-Apopka association and Zolfo-Tavares association could be in the broad legend category *Soils of the Uplands*. When conducting a soil investigation in a general soils map unit called Zolfo-Tavares association, note that there is a description of the geologic landform where the soils are found. The Zolfo-Tavares association is on *uplands at a lower elevation than the main ridges of the county.*

Landscape positions are also given for the individual soil components of the general soils map unit. Using this information, it is possible to construct a landscape model that can be drawn on paper and used for reference. In the Zolfo-Tavares association, Tavares is the on the highest landscape position along with the minor soil Millhopper. Zolfo soils are on the next lowest landscape position along with Adamsville and Sparr soils. Myakka soils are on the lowest landscape positions. The landscape model can be used in the field to predict inclusions to the mapped soil especially when there is a noticeable landform change.

In conclusion, each environmental health specialist should have a personal copy of the soil survey. Sites should be marked, and there should be notes in the margin. A successful site investigator often uses the soil survey for reference.

Web Soil Survey

The current official soil survey for the nation is the Web Soil Survey, which was created by the USDA NRCS. The following address will take you to the current site.

http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

This site will let you find current properties with much more current photography. There are different ways with which to navigate the system. Please go to the site and start using it. Should you have questions please contact a co-worker or your departmental program consultant.

Soil Series Name Search

This site will allow the user to type in a name of a soil and retrieve the classification information on the soil. It is highly useful to all as it is the more updated resource than some of the older soil surveys. The following address will take you to the site.

https://soilseries.sc.egov.usda.gov/osdnamequery.asp

This site is particularly useful if a county health department receives a soil profile with a series name that is unfamiliar to them. All that needs to be done is to type the soil name into the blank, hit “process” and then “view description” to obtain the technical soil description. If you have questions regarding this, please contact your departmental program consultant.

Older Soil Surveys

The soil survey program began in the United States in the 1890's. Some Florida soil surveys were published in the first decade of the 1900's and, unfortunately, some still have not been replaced by a modern soil survey publication. The good news is that only a small number of counties in Florida lack a modern publication.

Older soil surveys are not obsolete. Modern soil surveys are better because of the technological advancements in the second half of the 20th century that have increased our knowledge base and given us better tools to work with. Currently, the Web Soil Survey is the official soil survey for the entire nation.

In general older soil surveys are less useful because: 1. they don't include as much data (for example they may lack soil characterization data); 2. the methodologies of soil survey have changed (for example, the soil classification system has changed);

Changes in methodologies may be so drastic that data compared between an older and modern soil survey appear to be in contradiction. One such apparent contradiction is the difference in SHWT ranges. The difference exists because in general many more soil series are recognized now and the older soil series simply encompassed a wider range of characteristics. For example, currently the Lakeland series has a SHWT that is greater than 80 inches and it has a texture throughout of sand or fine sand only. At one time the Lakeland series had a texture range of loamy fine sand to coarse sand with or without finer textured subsoils that began at various depths as shallow as 30 inches. A water table could be perched above the subsoil at any depth. Now there are over 20 soil series that cover this same range of characteristics.

If a modern soil survey or interim report does not yet exist, the best way to accommodate the older soil survey is by obtaining supplemental data and/or special training from the Natural Resources Conservation Service. In many areas, supplemental data correlates new information with the soil series and map units of older surveys. Ask the local NRCS office if this information is in a format for distribution. In some cases, a special workshop may be requested to discuss the data in the older publication.

Conversion of Old Horizon Designations

Before about 1981, soils surveys and other documents contained profile descriptions that used a slightly different group of horizon designations. A list of some old designations and their equivalent designations in the new system is shown.

Old	New
O1	Oi or Oe
O2	Oa or Oe
A1	A
A2	E
A3	AB or EB
AC	AC
B1	AB or BA
B2	B or Bw
B3	BC or CB

Horizon numbering in the old system is the same as in the new system, however the inclusion of numbers in old master horizon designation makes interpretation somewhat confusing. Consider the following example:

Old	New
A11	A1
A12	A2
A21	E1
A22	E2
B21t	Bt1
B22t	Bt2

VEGETATION AND SOILS

There is an intimate relationship between soil type and vegetation type. Plants have varying nutrient and water requirements, just as different soils have varying nutrient and water contents. Therefore, recognizing certain vegetative clues can help us predict certain soil characteristics. The cypress tree, for example, almost always grows in soils that have a seasonal high water table at or above the surface.

Ecological Plant Communities. There are few specific soil-vegetation relationships that are as easy to recognize and use as the cypress example given. Some relationships change in different areas of the state. A good general way of using the soil-vegetation relationship is by grouping plants in communities. There are many plant community classification schemes, but the one that will be considered here was developed by the Natural Resources Conservation Service in Florida. This soil based system organizes vegetation into ECOLOGICAL PLANT COMMUNITIES. This is a generalized classification scheme and does not seek to provide detailed classes for the entire range of variation possible in Florida plant communities.

Some of the more rare plant communities will not be considered in the following discussion. In addition, some communities have been grouped together for the purpose of this manual.

Be reminded that recognition of plant communities can assist in the decision making process but there is still no substitute for a soil investigation.

Coastal Strand. These communities of north and south Florida are adjacent to the gulf and ocean. They consist primarily of dunes, swales and beaches. Soils are generally sandy throughout with droughty soils on dune ridges and wet soils in the lowest swales. These soils generally lack much profile development. There are few good specific vegetative indicators. Look for plants like *Spartina patens* (saltmeadow cordgrass), black needlerush, and *Spartina alterniflora* (smooth cordgrass or saltmarsh cordgrass**)** in the wet areas. If protected from salt spray, some wet swales may contain Swamp or Pond vegetation.

Sand Pine Scrub. This community is recognized for its even-aged stands of sand pine or thick scrubby oak growth. This community is found throughout the state, from the coast to inland sites. Generally, soils are somewhat poorly drained to excessively drained. Commonly, the excessively and well drained soils have weakly developed spodic characteristics including a yellowish subsoil beneath a white, leached subsurface. Drier sites have a sparse understory, and wetter sites have a thicker understory. There are few areas in this community that have wet soils. Rosemary is a plant more associated with the driest sites in this community. Some areas of this community are locally called the "sandhills".

Longleaf Pine-Turkey Oak Hills. This community is also found in areas called the sandhills. Landscapes are generally rolling lands with level to strong slopes. Vegetation is dominantly longleaf pine, turkey oaks, with a sparse understory of wiregrass. The soils are generally sandy throughout, and well drained to excessively drained. Some soils have a loamy subsoil below a thick sandy surface. Wetter soil inclusions are often easy to identify because they are on an obviously lower landscape position.

Mixed Hardwood and Pine. This community grows almost exclusively in the upper Florida Panhandle. It is much like the typical hardwood forest that northern tourists don't expect to find in Florida. The landscapes are nearly level to sloping, and the soils have shallow, loamy to clayey subsoils. The soils are generally moderately well drained to well drained. Older communities often have a relatively open understory. Dominant trees are beech, maple, oaks, magnolia, hickories and holly.

Flatwoods. These plant communities are broad flat lands supporting mostly saw palmettos and pine trees. In the south Florida condition, they are much like a savannah with only scattered pine trees and extremely thick palmetto growth in their natural state. In north Florida, there is likely to be a thicker stand of pine trees and the understory is usually mixed with other shrubs like wax myrtle and gallberry (North Florida Flatwoods). Other variations of this plant community include areas where south Florida slash pine dominates the sparse overstory, where cabbage palms replace slash pine (Cabbage Palm Flatwoods) or where tropical vegetation is included and soils are underlain by limestone at shallow depths (Everglades Flatwoods). Except in the Everglades Flatwoods, soils are poorly to somewhat poorly drained. The classic soil is a spodosol such as the Myakka series in south Florida and the Leon series in north Florida. Some soils have a loamy subsoil, but rarely is there a shallow clayey subsoil.

Upland Hardwood Hammocks. This community is mostly in central and northern peninsular Florida. It is usually on rolling terrain with nearly level to strong slopes. It is similar in many respects to the mixed hardwood pine community, but it generally lacks pine trees, or contains very few. The understory is commonly sparse and open. Common trees are beech, magnolia, live oak, laurel oak, holly, black cherry and dogwood. Soils are generally somewhat poorly drained to well drained with sandy surfaces and loamy to clayey subsoils.

Wetland Hardwood Hammock. This community grows predominantly just inland, but generally parallel to the Big Bend coast from Wakulla county to Pasco county. The landscape is nearly level and the soils are poorly to somewhat poorly drained, with sandy surfaces and loamy to clayey subsoils. The soils are often alkaline, and shallow limestone is found in many areas. The vegetation is luxurious with thick canopies of evergreen and semi-evergreen deciduous trees. The trees include live oak, laurel oak, red bay, sweetgum, and magnolia. In some areas, red cedar is the dominant tree.

Swamps. The ecological communities that grow in swamps will not be described in detail here. These include Scrub Cypress, Cypress Swamps, Mangrove Swamps, Swamp Hardwoods, and Shrub Bog-Bay Swamps. They are on nearly level landscapes with a variety of very poorly drained soils and sometimes a few poorly drained soils. Remember that if there are cypress trees, the site is likely to have soils with seasonal high water tables at or near the surface. A plant identification handbook should be used to identify and learn about other plants that are indicators of very poorly drained soil conditions.

Bottomland Hardwoods. This community is on the floodplains of the large north Florida rivers. The landscape is nearly level along the river courses and often ends abruptly at higher, non-flooded landscapes. Soils are generally somewhat poorly drained to very poorly drained with flooding that occurs mostly in the winter and spring. In many areas, the vegetation looks like that in other hardwood communities, so it is probably best to learn to recognize this landscape.

Pitcher Plant Bogs. This community is on flat landscapes that resemble a savannah. There are scattered pines, bay trees, and shrubs with thick grass and sedge growth containing numerous patches of pitcher plants. Pitcher plants are a good wet soil indicator. The soils in this community are usually very poorly drained, but can also be poorly drained. They are usually sandy but may have a loamy subsoil.

Sawgrass marsh. This community is the wet, nearly level grassland of the Everglades. Sawgrass is a good wet soil indicator. Trees are rare, and in fact the community is often a monotype of sawgrass. The soils are very poorly drained, and they are often Histosols.

Freshwater marsh. This community is usually easy to recognize because it is essentially a shallow pond landscape. The landscape is covered with water most of the time and the vegetation generally does not include trees or shrubs. Look for maidencaine, reeds, and rushes. The soils are very poorly drained and are often Histosols.

Salt Marsh. This community occurs along the Gulf and Atlantic coasts adjacent to rivers and bays. In estuaries, it often transitions gradually to freshwater marshes. The landscape is flat and usually flooded daily by tides. Vegetation consists primarily of grasses, sedges and rushes. The soils are very poorly drained and are often Histosols. They often contain high contents of sulfur and emit a characteristic rotten egg odor.

Sloughs. This community is often difficult to recognize. Part of the problem is that the word slough has so many different connotations to different people. For our purposes, the slough is a long, relatively narrow or strand-like, open expanse of grasses, sedges, and rushes. It often contains scattered trees and shrubs. It is nearly level, and the soils have a water table at or near the surface during the rainy season. Water on the surface of this landform often flows slowly towards an outlet. Representative soils in the slough community have sandy surfaces or are sandy throughout and often have a weakly developed spodic-like subsoil that varies in color from yellowish to brownish. The slough is primarily a south central and southern Florida community.

Cutthroat Seeps. This community is on nearly level to gently sloping landscapes, mostly in Polk and Highlands counties. The vegetation is savannah-like with a dominance of cutthroat grass and other grasses and scattered shrubs, slash pine, saw palmetto and wax myrtle. The soils are usually poorly drained spodosols.

Occurrence and Density of Vegetative Indicators. There are many good individual plant indicators for a variety of soil conditions. Many of these indicators are more useful in some parts of the state than others. It is not only the *occurrence* of an individual plant but also the *density* of the occurrence that can be important. For example, one turkey oak on a site might just indicate an exception to the rule but a small community of turkey oaks growing in an area thought to be poorly drained is likely to indicate a slightly drier site. Please go to the following link for a listing of plants from the USDA NRCS. http://plants.usda.gov/

Non-Water Table Factors. Changes in vegetation can provide other clues about soil conditions in addition to the SHWT. In some areas of Florida, an abundance of eastern red cedar and cabbage palms is a clue that the underlying limestone is at a shallower depth. The occurrence of salt tolerant plants such as black needle rush might indicate that the site is occasionally inundated by the tides or subject to salt spray.

Non-Soil Factors. It is important to remember however that factors other than soil conditions affect the occurrence and density of certain plants. Management by humans, natural succession, lightning caused fires, animal populations, insect pests and many other factors can influence the vegetative characteristics of a site or area. Experience in an area is by far the best help for effective use of plant indicators. Learn how to identify plants through the experience of others, attending formal training sessions and by obtaining a guide book for plants in Florida. Vegetative characteristics alone should be used only in rare instances to predict SHWT's. Remember, exceptions to the rule can be very common in some areas of the state.

METHODS OF SOIL INVESTIGATION

The following methods and procedures can only be used successfully if the information presented previously in the Florida Soils Manual is fully understood. Consult the manual and the published soil survey (if one is available) frequently. Discuss observations made during your site investigation with co-workers or supervisors. Request assistance from a soil scientist when unusual soil conditions are encountered. There is no substitute for practice and experience.

Obtaining Soil Survey Data

The official soil survey for the nation is the Web Soil Survey. It should be used in place of the printed (legacy) copies. These legacy documents are still good sources of information and can be taken into the field to help identify the soils that actually exist on site, which often are inclusions of different soil series. They also are an excellent source of older aerial photography.

When using the legacy documents, the following methodology should be used.

1. Find and record the soil survey data that will be used for all site investigations. This step needs to be taken only once and the information obtained should be committed to memory and/or recorded in a convenient location in your copy of the soil survey (such as on the inside cover). The ***date*** that the aerial photography was taken for the atlas sheets is usually located on the inside margin of each atlas sheet page. The ***atlas sheet scale*** is often both depicted graphically, in a ruler-like plot, and given as a ratio.

The ruler can be traced and copied for use in measuring distances on the atlas sheet or the ratio can be mathematically converted to a more usable ratio such as map inches per ground feet. Consider the following conversion for the scale 1:24,000 (pronounced "one to twenty-four thousand"):
a. to obtain map inches: ground feet, divide 24,000 by 12 (12 inches per foot). This results in the new ratio "one inch on the map equals two thousand feet."
b. divide 2000 by 5280 (5280 feet per mile) to get "one map inch equals 0.3787 ground miles."
c. divide 5280 by 2000 to get "one ground mile equals 2.64 map inches." Divide by 10 to get the very usable ratio "0.264 map inches equals one tenth of a mile on the ground." Since most directions are given by tenths of miles and car odometers report mileage in tenths, this may be the easiest ratio conversion to use.

2. Locate the site on an auxiliary map(s) of your choice. This could be a county road map, a USGS topographical map, a plat directory map, a map from the tax assessor’s office, or any other type of map. In general, the best auxiliary maps to use are those that depict and name the most geographic details. Note the scale of your auxiliary map and date of publication and last update.

3. Using the Index to Map Sheets in the published soil survey, identify the atlas sheet for the site location.

4. Reference the General Soils Map for the location and read about the general soils map unit in the section that normally resides near the beginning of the soil survey publication. The most important information here is the landscape for the unit (example: soils of the sand ridges; . . .uplands. It consists of nearly level to gently sloping soils on broad ridges and sloping soils on hillsides, around sinkholes and in drainageways) and the group of associated soils normally included in this general soils map unit. The soil or soils in the name of the general soils map unit are the dominant soils; minor soils are usually listed towards the end of the general soils map unit description. Continued referencing of the general soils map will allow you to make better estimates about the nature of the soils and their associated landscape patterns. In addition, any information that you obtain before augering a hole will help make you more aware of what morphological features to be looking for in the profile.

5. Because of rapid growth and land use changes in Florida, maps seem to become obsolete soon after they are published. This can make site location in older soil surveys difficult at times. If the site has been located on an auxiliary map, note the map scale and compare it to the scale of the soil survey. On the auxiliary map locate some geographic reference points such as lakes, roads that have been in place for a long time, etc... Take careful note of the shapes of these features and try to find those same shapes and features on the soil survey atlas sheet. Using a combination of this method along with measured distances, site location should be easier.

6. After locating the site on the soil survey atlas sheet, find the numeric or alphabetic symbol that identifies the map unit for the delineation. Also make note of adjacent delineation symbols and any special symbols. Turn to the ***soil legend*** to find the name of the map unit identified by the symbol. Adjacent to the soil legend, find the ***conventional and special symbols legend*** to determine the meaning of any other nearby symbols. The section called ***detailed soil map units*** contains the non-technical descriptions of the map unit. Take special note of the depth to the ***seasonal high water table***, the ***textures*** of the soil layers and the depths where the layers begin and end, typical ***vegetation*** for the map unit, and the names of the ***included soils***. To find a technical description of the soil series component(s) in the map unit, turn to the section called ***classification of the soils***. At the end of the description look for the ***typical pedon***, or typical profile for the soil series, and note the ***range of characteristics*** for the soil series. Make note of the information and use it to make you aware of what morphological features to be looking for when you conduct the on-site investigation.

Evaluation of Surroundings

1. As you near the site, take note of the surroundings. While it is the soil morphology that allows us to predict seasonal high water tables, any clues that can be obtained can be used to provide confidence in that estimate. Remember that *<u>native vegetation</u>* can be among the best supporting evidence for the seasonal high water table estimate. Observe nearby land uses and determine if they are consistent with a particular SHWT range. (For example, a series of nearby drainage ditches might indicate that the area is wet.) Also, do not necessarily disregard the information given by an area resident, if any information is offered.
2. Observe the landscape. Is it flat or sloping? How much relief is there between a nearby swamp or marsh and the site, or between the site and any other landscape feature? If the landscape is sloping, is the OSTDS planned for an upslope or downslope location? Look around and pay attention. This step is much more important than you might suspect. Do not overlook any landscape information that might be important for safe function of an OSTDS. For example, if the site requires a mound, be sure that the mound will not block natural drainage. Intermittent streams or landforms that convey stormwater should never be blocked. Not only might the blockage cause undesirable impoundment of water, it might cause failure of the system. In addition, during an intense storm event, stormwater might erode all or part of the mound and saturate the system. Remember that development in other nearby areas can drastically affect the amount and direction of stormwater flow. Be especially aware of the condition where the site is downslope from a paved surface such as a road or parking lot.
3. Take notice of any other clues. What might a nearby irrigation system mean? Does the road abruptly swerve and why? Are there swales along the road? Are there chunks of limestone lying around nearby lots? Gather all available information that might help give confidence in your judgment of the predicted soil properties.

The Onsite Soil Investigation

1. Before digging, anticipate the sequence of soil horizons that you might expect based on the soil survey data, surrounding vegetation, and any other clues. Select a place to auger that is within the area planned for the drainfield, but appears to be the least disturbed and furthest from large trees that might have roots which could interfere with augering. In addition, pay

attention to any flags, metal boxes, or other indicators of buried utilities.

2. As you auger, examine the soil material before the bucket is emptied, paying special attention to a change in color or texture. Record the depths where sufficient morphology changes necessitate the designation of a new horizon and the depth at which the seasonal high water table indicators are encountered, with specific information to validate the SHWT. Samples of each horizon should be laid out or arranged in the order in which they were augered and examined more closely after the profile has been augered to the required depth. This examination must include determination of Munsell color and soil texture for each soil horizon.

3. A minimum of two profiles must be performed, but it is always best to dig as many as necessary to properly evaluate the site. In many cases, additional profile examinations increase the precision of the seasonal high water table estimation. In other instances, additional examinations uncover morphological evidence that was overlooked or weakly expressed during the previous examination.

Soil Color Determination – A reminder

When measuring soil color the sun should be behind you. Very early morning or late afternoon measurements are not always accurate. The sample should be moist. A moist sample will not get any darker when water is added to the sample, and it will not glisten. A sample that is too wet will glisten in the sunlight, or the water puddles on the sample. The sample should be placed behind the holes on the unaltered color chart so that the sun shines on the chip and soil sample (no shadows on the sample) and compared to the color chip that is most like the color of the soil sample. It is understood that an exact match is not likely, but that the closest color match will be used. In Florida, it is usually best to start on the 10YR page and make page turns to the left if the hue is not red enough, or make page turns to the right if the hue is not yellow enough. When the closest match is found, write the color notation using the hue first, followed by value (look to left of page), then write a slash, followed by the chroma (look to the bottom of the page); for example, "10YR 4/4".

It is not as important to record the Munsell soil name (example: dark yellowish brown), as it is to record the Munsell notation for the color (10YR 4/4). Also, remember to give the color of the soil matrix, or dominant color, and any other color splotches or streaks. Consider the example: "10YR 8/2 with 10YR 4/4 and 10YR 6/6 mottles." Soil color information must be gathered from an undisturbed sample first, before being textured. Use the middle of the soil sample from the auger (break open lengthwise) to get color and texture samples.

The Touch Texture Method

The process of squeezing and molding a moist soil sample between the thumb and forefinger, called touch texturing, is used routinely by persons who classify soils and is considered sufficiently accurate for almost all uses when conducted by experienced persons.

Recall that there are three basic sizes for mineral soil particles, each of which have their own tactile signatures. Sand is gritty. When moist, clay is plastic and often sticky. When moist, silt is smooth, floury, and malleable. The USDA textural class loam should therefore exhibit nearly equal expression of the properties of each particle size. In fact, when moist, loam feels somewhat gritty like sand; slightly sticky like clay and somewhat smooth and floury like silt. Each of the other USDA textural classes has distinguishing tactile characteristics dominated by the properties of one or two of the mineral particle sizes. Descriptions for the most common texture classes in Florida appear in Chapter 64E-6, Florida Administrative Code.

To perform touch texturing obtain a teaspoon size sample (or more) of moist soil material. Moisten with water if it is too dry. The sample should not be so wet that water puddles in your hand but it should be moist enough that it can be manipulated by your thumb and forefinger. Note the amount of grittiness or stickiness in the sample. If the sample has any malleable properties, try to form a "ribbon". A ribbon is a thin elongated form of uniform thickness (2mm) that can be molded from materials containing clay. Soil materials containing the most clay will form the longest ribbon.

Based on the observed tactile properties of the sample, use the flow chart found on the Texture By Feel Analysis section later in this manual to determine the USDA textural class as depicted on the USDA textural triangle shown in this manual. Note that textural classes modified by the sand subdivisions are not found on the flow chart. The differentiating characteristics between the modified classes are difficult to describe.

Remember that the coarse sand is the largest sand size and will therefore be the grittiest. Grittiness decreases as the sand size becomes smaller. Very fine sand feels almost like silt. How can the sample be classified if it contains substantial amounts of differing sand fractions? At this point, tactile examination is supplemented by visual recognition. If the sample contains silt and clay, add water to the sample cupped in your hand. Carefully rub the sample with your forefinger and decant the water with the suspended clay and silt. Repeat if necessary until only the sand fraction remains in your hand. Then, visually estimate the percentage of each of the sand fractions. For reference, very coarse sand is about the size of a standard typewriter character; medium sand is about the size of a sugar grain and fine sand has approximately the diameter of a strand of human hair. A set of sieve separated sand fractions can be used for comparison of the various sand fractions. The most common soil textures in Florida are sands, fine sands, loamy sands, loamy fine sands, sandy loams, sandy clay loams, and sandy clays. Silty textural classes are rare in most parts of the state. They are found in some areas such as the floodplains of rivers and in some tidal marshes. **Be aware of typical particle size distributions for the soils in your county based on the lab data tables and estimated properties in the published soil survey.**

Organic matter can easily affect the tactile characteristics of a soil sample but its presence is easy to detect. Recall that organic matter imparts a dark brownish or blackish color to mineral soil material. Muck is the form of organic matter that affects texture most in Florida. Muck is found only in very wet soils. Muck imparts tactile characteristics similar to those imparted by silt. Some describe muck as feeling "greasy". If a sample is taken from a wet soil and/or is dark brownish or blackish in color and/or feels smooth and greasy, the sample is likely to contain an appreciable amount of organic matter.

MUCK and PEAT are terms used to describe organic soil materials comprised of about 20 to 30 percent organic matter or more. Muck is used to describe a greater state of decay than peat. Most organic soil materials in Florida are classified as muck. Remember that texture refers to mineral soil materials only, but if the soil material is muck, it is used *in place of* texture. If a soil material contains about 5 to 20 percent organic matter, the terms MUCKY or PEATY are used as textural modifiers. For example, a mineral soil material with the texture fine sand, and containing about 8 percent organic matter would be called MUCKY FINE SAND.

Mineral particles that have a diameter greater than 2.0 millimeters, are called COARSE FRAGMENTS. Coarse fragments include gravels, boulders, stones, and nearly any other kind of loose rock. While coarse fragments are not counted towards the percentage of soil mineral particles in the textural classification, they can be used as a modifier. For example, a sample of soil having a texture of sandy loam and containing an additional 15 percent of gravels **(by volume, not weight)**, is called a GRAVELLY sandy loam. If the sample contains greater than 35 percent gravels, the modified textural classification would be VERY GRAVELLY sandy loam.

Continuous bedrock that lies below a soil layer is not considered to be part of the soil, nor is it considered to be a coarse fragment. Soil scientists classify it by type of rock, (usually limestone in Florida) and by its degree of hardness (*hard* versus *soft*). Soft bedrock can be excavated by light power equipment and hard bedrock cannot be excavated by light power equipment.

The Soil Description

When recording the soil profile information for the site investigation, your soil description must include the Munsell color notation, the soil texture and the beginning and ending depths of the horizon. Consider the following description:

10YR 2/1	FS	0-9 in.
10YR 5/6 and 7.5YR 5/4	SCL	9-15 in.

If the horizon contains mottles, the color of the mottles must also be described. Soil colors are recorded in order of most to least color present in the sample. Since the space for soil profile information is limited on the site evaluation form, mottles or other features indicative of the SHWT can be recorded in the soil profile section or the remarks section.

Use of horizon designation symbols can be helpful, but is not necessary. Refer back to pages 8 for definitions of the horizon designation symbols.

There are several options available for identifying the USDA soil series on the application form. If the site has been located in a published soil survey, the series can be identified as in the following example: mapped Apopka sand. If you feel that you recognize the sequence and occurrence of horizons, the series can be identified as in the following example: similar to Rutlege mucky fine sand. Ideally, both types of information would be recorded for each soil profile. If the information is not available, the term unknown can be recorded.

Sieve Analysis

Laboratory methods used to measure particle size and soil texture are generally impractical for use by the county health departments. For many uses, including OSTDS design, the benefits of laboratory measured soil texture rarely justify the cost of precision equipment and laboratory infrastructure.

The use of sieves to determine particle size and estimate USDA soil textural classes has been a topic of discussion for many years in Florida's County Health Department offices. Sieves are relatively inexpensive and easily produce what may appear to be acceptable data. They can be helpful and educational when properly used, but their uninformed use can provide unreliable or erroneous results. The most practical use of sieves will be to collect reference samples of each of the sand subclasses.

The following method can be used only if the texture of the sample material is coarser than loamy coarse sand (coarse sand, sand, fine sand, very fine sand, or one of these classes containing gravels).

The type of sieves used for particle size separation can be stacked or nested on top of each other. The number of sieves and their sizes are often referred to as the stack. The stack used for particle size separation must have sieves openings that correspond to the boundaries of USDA particle size classes. That stack has the following sequence of sieves: (U.S. standard sieve sizes) 10 (2.00 mm), 18 (1.00 mm), 35 (0.50), 60 (0.25 mm), 140 (0.10 mm), and 270 (0.05mm), and has a solid bottomed pan to collect material passing through the 270 sieve.

In addition to the sieve stack, an accurate scale will be needed to weigh the samples.

1. Determine the texture of the sample by the touch texture method. If the texture is estimated to be sand or one of the sand subclasses, proceed with this method.
2. If the material is from a spodic horizon or contains spodic material, this analysis cannot be performed. Also, this analysis should not be used for A horizon material (topsoils) or any material that contains enough organic matter to give the sample a dark brownish or blackish color.
3. Dry the sample well, and break up any clods. A 200 degree oven can be used to dry the sample, or it can be air dried. The prepared sample should be loose and single grained like dry beach sand.
4. Depending on the height and diameter of the sieves being used, obtain a sample that is no larger than will fill an individual sieve about half way. Weigh the sample carefully and record the weight.
5. Place the sample in the uppermost sieve in the nest. Secure the lid, and begin shaking in a motion that is both circular and vertical. This should be continued for several minutes or more. Remove each sieve, one at a time, and shake over a clean sheet of paper. Any sample material that passes through the sieve should be brushed off of the paper into the next smallest sieve in the nest. Weigh the material retained in each sieve and the pan.
6. Divide the weight of material recorded for each sieve by the total sample weight to obtain the percentage of each particle size in the sample. The material in the pan below the number 270 sieve, is silt and clay. Silt cannot be separated from clay using sieves. If any material is too large to pass the number 10 sieve, the weight of this material must be subtracted from the total sample weight. The new adjusted sample weight should be used in particle size calculations because the material on the number 10 sieve is larger than 2.0 mm and is not considered when determining soil texture. However, remember that if the weight of material on the number 10 sieve is greater than 10 percent, the texture is modified as in the example gravelly fine sand.
7. Compare the percentages retained in each sieve to the textural class descriptions to determine the USDA soil textural class.

Interpretation of Commercial Lab Data

The USDA system for classifying particle sizes and textures is only one of many different classification systems. Other systems include the Unified system (designed for general construction purposes), AASHTO (American Association of State Highway and Transportation Officials, (for highway and airfield construction), and FAA. Each system has different particle size boundaries and uses different methods for classifying soil and fill material textures. Because of these differences, laboratories who measure particle size distribution often report the data in a format that differs from the data format needed to classify a sample to the USDA textural classification system.

Commercial labs often report particle size data as cumulative percent passing, or percent finer. This data format must be converted to percent retained in each sieve so that the sample can be classified to the USDA system. Percent retained for a particular sieve size is calculated by subtracting the cumulative percent passing from the cumulative percent passing value for the next largest sieve. Consider the following example:

Sample Laboratory Data Conversion

Sieve size	Cumulative Percent Passing	Calculation	Percent Retained	USDA Particle Size
10 2.00mm	100.0	100-100	0	coarse fragments
18 1.00mm	96.0	100-96	4	very coarse sand VCOS
35 0.5mm 500µm	94.0	96-94	2	coarse sand COS
60 0.25mm 250µm	42.0	94-42	52	Sand S
140 0.106mm 106µm	14.0	42-14	28	fine sand FS
270 0.053mm 53µm	6.0	14-6	8	very fine sand VFS
>270 <53µm (PAN)	0	6-0	6	silt plus clay

Commercial laboratory data for particle size analysis must satisfy certain conditions to be acceptable for classifying a soil or fill sample in the USDA system. Those conditions are:

1. If the percentage of silt plus clay is greater than about 10 percent, then sieve analysis alone is not acceptable. A method such as hydrometer or pipette, which separates clay from silt, must also be used.
2. The following sieve stack must be used for analysis: (standard U.S. sieve size numbers) 10, 18, 35, 60, 140, and 270. Data from sieve stacks that do not match USDA particle size boundaries cannot be accepted.

NOTE: HYDROMETER/PIPETTE METHODS BY THEMSELVES ARE NOT ADEQUATE TO DETERMINE SAND TEXTURES! MUST USE WITH SAND SIZE INFORMATION.

Particle Size Data For Sand Liners

Part II of Chapter 64E-6 requires that sand liners for OSTDS in the Florida Keys use construction material "of such size whereby at least 90 percent of the particles pass a U.S. Standard number 18 sieve and less than 10 percent pass the number 60 sieve". This more or less corresponds to the USDA textures of coarse sand and medium sand.

Alternatively, suitable sand filter material is also described as having an effective grain size (D_{10}) of 0.25 to 1.00 mm and a uniformity coefficient (Cu) of less than 3.5. This is more or less equivalent to the expression given above. Definition of Uniformity Coefficient: the ratio of the grain size that is 60% finer by weight to the grain size that is 10% finer by weight on the grain size distribution curve. It is a measure of how well or poorly sorted the sediment is. However, to obtain D_{10} and Cu, cumulative percent passing or percent finer must be plotted against grain size. A gradation curve is then drawn to connect the points on the graph.

D_{10} is defined as the particle size for which 10 percent of the soil is finer than that size particle. Similarly D_{60} is defined as the particle size for which 60 percent of the soil is finer than that size particle. These D values are obtained by reading the point on the gradation curve for 60 percent and 10 percent finer, and then drawing straight lines downward to determine the grain size. The Cu is calculated by dividing D_{60} by D_{10}.

Evaluating Fill Material

Fill is any soil material used in the construction of an OSTDS. This includes any soil materials that have previously been placed on a building site. Dredged spoil material that has been in place for a number of years is still fill material because it was not created by any soil forming processes. Note that the loading rates for fill material can be different than those for undisturbed native soil. Provided that fill materials have the requisite textures, they would be suitable for OSTDS usage.

1. Acceptable Soil Texture--Materials that are acceptable for use in the construction of filled or mounded drainfields are defined by Chapter 64E-6. The current acceptable textures for fill material includes sand, coarse sand, loamy coarse sand, fine sand, sandy loam, coarse sandy loam, loamy sand, fine sandy loam; very fine sand, loamy very fine sand and loamy very fine sand. Loading rates given are in gallons per square foot per day. Recall that these textures are suitable only if the corresponding loading rates specified by Chapter 64E-6 are utilized. Coarse sand has a restriction based on the depth of bottom of drainfield to the seasonal high water table. Moderately or slightly limited soils may be used for mound slopes only.

2. While all fill material should be evaluated with care, it becomes more difficult with the material possibly being highly variable from the provider. While one load may be a sand texture, another load could be coarse fragments and coarse sand, or finer textured soils with too much clay or silt particles. During transportation of fill there can be settling of finer textured material from more coarse particles which can lead to a non-homogenous situation. Depending on how the contractor places the fill, it could result in a "layering" effect where the layer may not meet standards, possibly placing much or all of the system in violation. The unacceptable fill material may be located only in specific areas of the system (not necessarily a layer). Any sampling should account for the worst case scenario and not be a composite sample. All fill material needs to comply with department regulations. When checking for coarse fragments remember this is still performed by volume of the layer. This should be done by taking the layer of soil (fill material) containing the coarse fragments and using direct observation to measure the volume of these fragments. Since this is a volumetric approach it may be best to spread your sample in an area that allows the observation of the majority of the soil. For example, as opposed to having a clod of soil in your hands with some observable gravel-sized particles on the outside, press the clod into a layer in an appropriate container, thus exposing all fragments for observation, some of which may not have been seen if the clod was not broken up. Once coarse fragment volume reaches 15 percent, the mineral texture will be modified with the appropriate adjective, usually gravelly, as in "gravelly sand" and is unsuitable for use for the construction of any onsite sewage treatment and disposal system.

3. Included materials--Contamination of suitable fill material with unacceptable materials is considered unacceptable when there is more than about 2 percent contamination. Unacceptable materials include pieces of spodic material, trash, organic debris, organic matter, and chunks of material with a texture other than permitted by the code. Use the Charts for Estimating Proportions of Mottles and Coarse Fragments found in the Munsell book to determine the amount of unacceptable materials. These charts can also be found at the back of this manual.

PROBLEM SOILS

SOIL GENESIS is the study of how soils form. By studying how soils form, predictions can be made about how a soil might develop after it has been disturbed by humans or a natural catastrophic event. The basic principles of soil genesis also allow evaluation of soil properties that seem to have formed in contradiction of accepted theory. In other words, soils that are the "exception to the rules" present the greatest challenge to persons conducting on site soil investigations.

Large areas of land in Florida have undergone filling, generally because of either wetness or shallow limestone. The pre-existing morphological properties of the fill are not indicative of soil properties at the fill site. For example, fill material excavated from a wet area may have gray mottles, but if the fill is placed on a new site, those gray mottles in the fill have absolutely nothing to do with the SHWT at the fill site. In addition, diagnostic soil properties such as mottles can take hundreds of years to form. If however, the surface of the undisturbed native soil can be located below the fill, the seasonal high water table of the old soil can be estimated, and a correction factor based on the thickness of the fill can be used to estimate the seasonal high water table at the site. Consider the example of a very poorly drained soil has been filled. Records indicate that the site has been filled. A hole is augered and 20 inches of clean yellow sand is encountered before a black fine sand surface is encountered. The augering continues, and it is estimated that the old buried soil had a seasonal high water table at 6 inches below its surface. With 20 inches of fill, the depth to the seasonal high water table from the existing surface can be estimated at 26 inches below the existing surface. On certain landscapes, this correction scenario for adjusting SHWT depths may not be correct. For example, this method may not work when closed depressions are partly filled because there is no outlet from which water can drain.

What happens if the original surface of a soil has been removed before filling? Now the situation becomes more complicated. If some other diagnostic feature, such as a loamy subsoil can be located, it might be possible to project its depth from the original surface. Local knowledge of area soils combined with the use of other data including a published soil survey may provide enough clues to make a reliable estimate. Also, use of old aerial photographs might show the original patterns of landscape and vegetation before the site was altered. This is the kind of situation where it would probably best to contact a professional soil classifier for assistance.

Consider a situation where a seemingly undisturbed soil has a water table that is much higher than the depth predicted using the soil survey? First, consult the soil survey. Look for clues that might help predict a disturbance. Perhaps the site was once used as a bus parking lot and the soil became so compacted that its permeability rate was slowed. Perhaps nearby construction has resulted in more local runoff or diverted natural water flow. Also, be aware of recent rainfall amounts, intensities, and local distribution. Remember that summer thunderstorms in Florida can be intense, quick, and not affect other areas. Short duration water tables can rise above the seasonal high water table depth especially after either a short duration, high intensity rainfall event or perhaps after a prolonged period of higher than average rainfall.

In some instances, it might be difficult to believe that a water table can rise as high as might be predicted by diagnostic features in the soil. There are rare instances when soil color is not indicative of soil wetness. This is an extremely difficult call. If this occurs, contact your program mediator from the State Health Office for guidance.

There are numerous other instances when soil decisions are not easily made. Often the most efficient action will be to contact a professional soil classifier. Always be sure to consult the Web soil survey. In many instances, especially in urban areas, the nature and degree of mass soil disturbances are described.

Here is a website for Florida Aerial Photography. This has many old aerial photographs you can use to help you determine the old landscape when the soil surveys were originally performed.
http://ufdc.ufl.edu/aerials/

Here is another website for aerial photography from Florida Department of Transportation (FDOT). You may want to open a free account.
https://fdotewp1.dot.state.fl.us/AerialPhotoLookUpSystem/

Appendix X
SOIL HORIZON DESIGNATIONS

Master Horizons

O--Muck or peat (organic) layer in very wet soils; has been used in the past to describe the leaf, twig, etc.

L—Limnic formed under fresh water. Includes coprogenous, diatomaceous and marl types of soil.

A--Mineral surface layer colored dark by a small amount of organic matter. Sometimes called topsoil.

E--Subsurface layer from which downward percolating rainwater has "leached" or removed smaller particles or substances. Can only be used if a deeper layer in the profile is designated a B horizon.

B--Subsoil layer where substances or particles, leached down from above, have accumulated. Also used to indicate a layer that is more intensely developed than the others (i.e., has more intense coloration).

C--Underlying layer, often called parent material. This layer is relatively unaltered by soil forming processes. Does not include hard bedrock.

R- Hard bedrock. Can be the parent material. In Florida, the R layers are usually limestone.

M- Root-limiting subsoil layers consisting of nearly continuous, horizontally oriented, human-manufactured materials. Examples are geotextile liners, asphalt, concrete, rubber and plastic

W- Water. <u>This symbol indicates water layers within or beneath the soil.</u>

Transitional Horizons

AE, EA, AB, BA, AC, BC, CB--These are all transitional master horizons. For example, the AE horizon has some characteristic(s) that is/are similar to characteristics of both the A and E horizons. The AE is more like the A horizon, and the EA horizon is more like the E horizon. The AE horizon lies between the A horizon above and the E horizon below. A transitional horizon is usually similar to the master horizons in color and/or texture.

Subhorizon Suffixes

a-muck (highly decomposed organic materials). O only. (Oa)
b-buried layer. (Ab), not used in O horizons.
c-concretions or nodules, significant and cementation required
e-mucky peat. (intermediate decomposed organic materials) O only. (Oe)
g--gley color from wetness (lack of oxygen), reduction of iron (Cg)
h-subsoil accumulation of organic acids (spodic). B only. (Bh)
i-peat. O only (least decomposed organic materials) (Oi)
k-accumulation of carbonates, usually $CaCO_3$
m-cementation or induration, >90%
n-accumulation of sodium
p- This symbol is used to indicate a disturbance of the surface layer by mechanical means, pasturing, or similar uses. A disturbed organic horizon is designated Op. A disturbed mineral horizon is designated Ap even though clearly once an E, B, or C horizon. A or O only. (Ap)
q-accumulation of silica
r-soft or weathered bedrock. C only. (Cr)
t-subsoil accumulation of clay particles. B only. (Bt)
v-plinthite (soft iron nodules) accumulation. (Btv)
w-subsoil that is more intensely developed than others in color or structure, without clay accumulation or spodic development. B only. (Bw)

Numbering Horizons

Arabic numerals are used to designate subdivisions of the master horizon or subhorizon. Examples: **A1, A2; Bt1, Bt2, Bt3; AE1, AE2.**

Typical Horizon Sequences

Histosols **O**a, **O**e, C1, C2.

Entisols A, **C**1, **C**2, **C**3.

Spodosols A, E, **Bh**1, **Bh**2, BC, C.

Mollisols **A**p, **A1**, **A**2, AC, C.

Inceptisols Ap, E, **Bw**, BC, C.

Alfisols and Ultisols Ap, E1, E2, **Bt**1, **Bt**2, BC.

Conversion of Old Horizon Designations

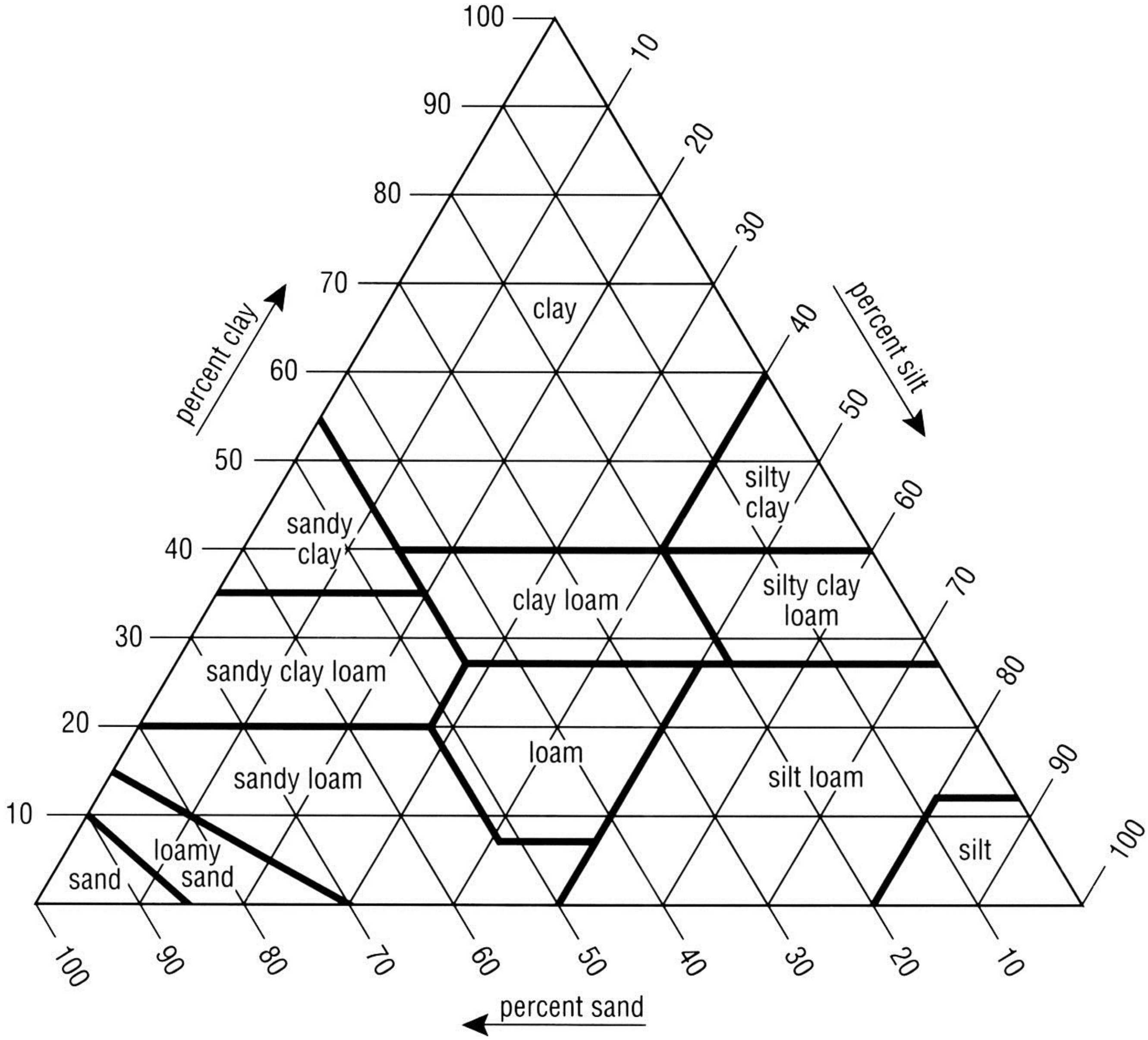
Before about 1981, soil surveys and other documents contained profile descriptions that used a slightly different group of horizon designations. Below is a list of some old designations and their equivalent designations in the new system.

Old	New
O1	Oi or Oe
O2	Oa or Oe
A1	A
A2	E
A3	AB or EB
AC	AC
B1	AB or BA
B2	B or Bw
B3	BC or CB

Horizon numbering in the old system is the same as in the new system, however the inclusion of numbers in old master horizon designation makes interpretation somewhat confusing. Consider the following example:

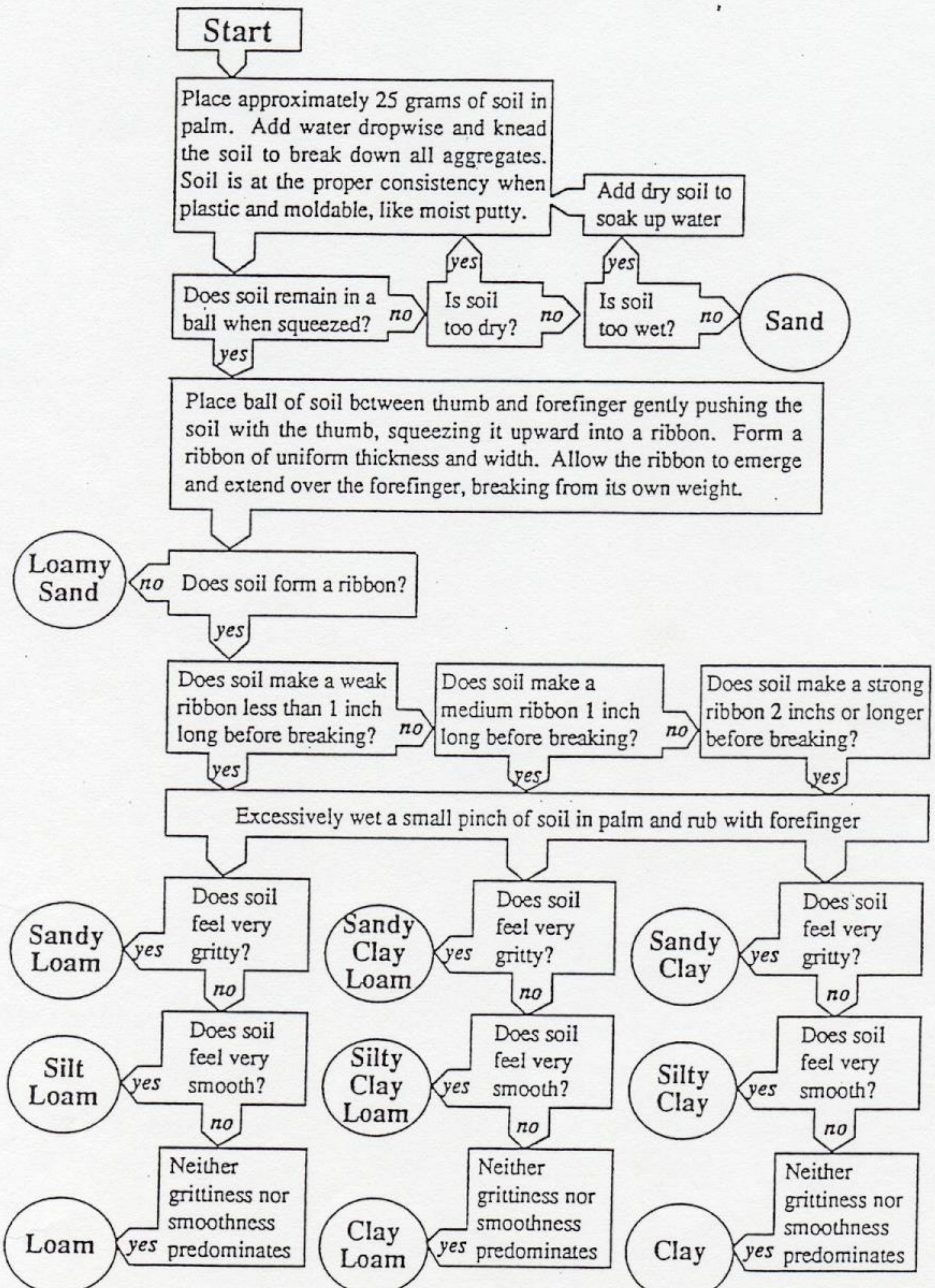
Old	New
A11	A1
A12	A2
A21	E1
A22	E2
B21t	Bt1
B22t	Bt2

Appendix Y



SOIL TEXTURAL TRIANGLE

Texture-By-Feel Analysis



SUMMARY OF SEASONAL HIGH WATER TABLE INDICATORS (REDOXIMORPHIC FEATURES)

FEBRUARY 2012

All indicators area measured from the natural soil surface, which includes all horizons that were made by the soil forming process. The natural soil surface is measured from either mineral, muck or mucky mineral soil. The soil surface is the very top of the material upon which standing when applying Hydric Soil Indicators A1, A2 and A3, including mucky peat or peat *(note for A3: This would be an unusual case and probably would never meet the color requirement)*. Where the natural soil surface has been altered by the action of man by soil addition or removal, the indicators must be judged using natural soil surface criteria accounting for what was added or removed. Simple soil addition over natural soil is easier to recognize than soil removal, or fill material over soil where removal has occurred. When contemplating proper use of redoximorphic features, careful observations must be made and reasonable scientific judgment used when considering all factors. Redox features may form in fill material and extra care must be taken during their evaluation.

For all soil textures: From natural soil surface down to 12 inches (30 cm) use Hydric Soil Indicators (HSI). Special note: HSI can be used at any depth to determine the SHWT. The following oxidized forms of Iron [Fe] and Manganese [Mn] (redox concentrations) are to be used when employing HSI. Refer to HSI in soil manual for complete descriptions.

Mineral Type:	**Value/Chroma**		**Hue**
Mn:	**≤2**	**≤2**	**2.5YR to 5Y**
Fe/Mn masses:	**3**	**3**	**2.5YR to 5Y**
Fe:	**≥4**	**≥4**	**2.5YR to 5Y**

(Hue 10R or more red indicates relict features)

Note for Mn: except on flood plains of the Florida Panhandle, redoximorphic Mn is relatively unimportant.

All redoximorphic features must be distinct or prominent and have diffuse boundaries (except where a specific indicator dictates otherwise) **Note regarding nodules and concretions: Nodules are cemented or hardened plinthite while concretions are similar except for the presence of visible, concentric layers around a point or line. Both have sharp boundaries and except as noted specifically in the HSI, are not redoximorphic features.**

DEPTHS >12" (30 CM.) FROM NATURAL SOIL SURFACE:

Loamy or Clayey Soils, including the soil texture LVFS and finer:

1. The SHWT is indicated by the depth to specific low chroma colors.
In non-hydric soils below 12" (30 cm) down to 39.37" (one meter) from the natural soil surface, the depth to saturation is the depth to common to many distinct or prominent redox depletions with value ≥5 and chroma ≤2. The entire matrix may be depleted. At depths >1 meter (>39.37") from the soil surface, the depth to saturation is the depth to common to many distinct or prominent redox depletions (including the matrix) with value ≥5 and chroma ≤3.
NOTE: If low chroma immediately underlies a dark colored mineral surface, the SHWT is at or near the surface.
NOTE: The SHWT is indicated by the depth to gley colors of value ≥4. See Hydric Soil Indicators for proper use of gley indicators.
2. Depth to a Hydric Soil Indicator (meeting all criteria except depth from surface)

Sandy Soils, including textures of LFS and coarser:
****Note: Redox concentrations having a hue of 10R or redder would indicate relict wetness. This applies to both hydric and non-hydric soils.**

1. In non-hydric sandy soils with a matrix of chroma 3 or more, the depth to saturation is the depth to common to many distinct or prominent contemporary redox concentrations with the hues ranging from 2.5YR to 10YR, value ≥5, and chroma ≥6.

2. Hues that are to be used for hydric soil redoximorphic concentrations range from 2.5YR to 5Y, as long as the concentrations meet the criteria of value and chroma for the mineral type being considered. For example, if the concentration was iron (Fe), the value and chroma would have to be ≥4. Please note that gley colors are depletions not concentrations. The gley charts would not be used to identify redoximorphic concentrations.

3. The SHWT is indicated by the depth to gley colors of value ≥4. See Hydric Soil Indicators for proper use of gley indicators.

4. Depth to a Hydric Soil Indicator (meeting all criteria except depth from surface; for example stripped matrix at 7").

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Natural Resources Conservation Service

NATIONAL SOIL SURVEY CENTER
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Soil Survey Technical Note No. 2

Soil Color Contrast

Purpose

This technical note provides uniform definitions for color contrast terms among the *Soil Survey Manual* (Soil Survey Staff, 1993), the *Field Book for Describing and Sampling Soils* (Schoeneberger et al., 1998), and the *Field Indicators of Hydric Soils in the United States* (U.S. Department of Agriculture, 1998). It also describes a new procedure to determine the difference in hue between colors.

Background

In an effort to synchronize the definition among the *Soil Survey Manual*, the *Field Book for Describing and Sampling Soils*, and the *Field Indicators of Hydric Soils in the United States*, a provisional definition for color contrasts was field tested nationally in 1998. After the testing period, a call for final comments was requested regarding final adoption of the provisional definition. The definition and other items contained in this technical note are the result of these collaborations and deliberations.

Introduction

Color contrast is the degree of visual distinction that is evident between one soil color compared with another in close proximity. In this application it is a visual impression of the prominence between a minor color component (mottle or concentration) and an associated major color component (matrix). The *Soil Survey Manual* provides three categories of soil color contrast:

1) *faint* for contrasts that are evident only on close examination,
2) *distinct* for contrasts that are readily seen but are only moderately expressed, and
3) *prominent* for contrasts that are strongly expressed.

This technical note provides guidelines to help the soil scientist assign contrast terms consistently. Determining soil color contrast is not always simple. Prominent mottles are likely the first thing one notices when observing a freshly broken piece of soil fabric. However, if a fabric has several shades and less contrast, it takes time and concentration to fully record colors and color patterns. The contrast between two colors decreases with decreasing value and/or chroma, and it becomes faint if value is 3 or less and chroma is 2 or less, regardless of differences in hue. Furthermore, there can be a considerable amount of error in distinguishing and contrasting the colors of two features, depending on the water state; the quality of light; the time of day; roughness of the soil surface; the quantity, size, and shape attributes of the two features; and boundary distinctions. Error can be exacerbated when the two features are among an intricate pattern of other soil colors. Care in the identification of soil colors in the field thus continues to be of primary importance in minimizing errors.

Definitions of soil color contrast terms

Note: If the mottle and matrix both have **values** of ≤ 3 and **chromas** of ≤ 2, the color contrast is ***Faint***, **regardless of the difference in hue**.

Faint - Evident only on close examination. The contrast is faint if the:

1) difference in hue = 0, difference in value is ≤2, and difference in chroma is ≤1, or
2) difference in hue = 1, difference in value is ≤1, and difference in chroma is ≤1, or
3) difference in hue = 2, difference in value = 0, and difference in chroma = 0, or
4) difference in hue is ≥ 3 and both colors have values of ≤3 and chromas of ≤2.

Distinct - Readily seen but contrast only moderately with the color to which compared. The contrast is distinct if the:

1) difference in hue = 0, and
   a. difference in value is ≤2 and difference in chroma is >1 to <4, or
   b. difference in value is >2 to <4 and difference in chroma is <4.
2) difference in hue = 1, and
   a. difference in value is ≤1 and difference in chroma is >1 to <3, or
   b. difference in value is >1 to <3, and difference in chroma is <3.
3) difference in hue = 2, and
   a. difference in value = 0 and difference in chroma is >0 to <2, or
   b. difference in value is >0 to <2 and difference in chroma is <2.

Prominent - Contrasts strongly with the color to which compared. Color contrasts that are not faint or distinct are prominent.

Table 1 - Tabular key for contrast determination using Munsell® notation

Note: If both colors have values of ≤ 3 and chromas of ≤ 2, the color contrast is *Faint* (regardless of the difference in hue).					
Hues are the same (Δ h = 0)			***Hues differ by 2 (Δ h = 2)***		
Δ Value	**Δ Chroma**	**Contrast**	**Δ Value**	**Δ Chroma**	**Contrast**
0	≤1	Faint	0	0	Faint
0	2	Distinct	0	1	Distinct
0	3	Distinct	0	≥2	Prominent
0	≥4	Prominent	1	≤1	Distinct
1	≤1	Faint	1	≥2	Prominent
1	2	Distinct	≥2	---	Prominent
1	3	Distinct			
1	≥4	Prominent			
≤2	≤1	Faint			
≤2	2	Distinct			
≤2	3	Distinct			
≤2	≥4	Prominent			
3	≤1	Distinct			
3	2	Distinct			
3	3	Distinct			
3	≥4	Prominent			
≥4	---	Prominent			
Hues differ by 1 (Δ h = 1)			***Hues differ by 3 or more (Δ h ≥ 3)***		
Δ Value	**Δ Chroma**	**Contrast**	**Δ Value**	**Δ Chroma**	**Contrast**
0	≤1	Faint	Color contrast is prominent, except for low chroma and value.		Prominent
0	2	Distinct			
0	≥3	Prominent			
1	≤1	Faint			
1	2	Distinct			
1	≥3	Prominent			
2	≤1	Distinct			
2	2	Distinct			
2	≥3	Prominent			
≥3	---	Prominent			

Procedure for determining the difference between hues

The spokes of the Munsell® hue circle in figure 1 represent hues spaced at intervals of 2.5. Spokes colored red (or in **bold** if in black and white) are those hues that are approved by the National Cooperative Soil Survey (NCSS) for soil color determinations.[1] In a clockwise direction in figure 1, the NCSS-approved hues of 5R through 5Y are spaced at intervals of 2.5. From 5Y through 5PB, the hue spacing changes to 5-unit intervals.

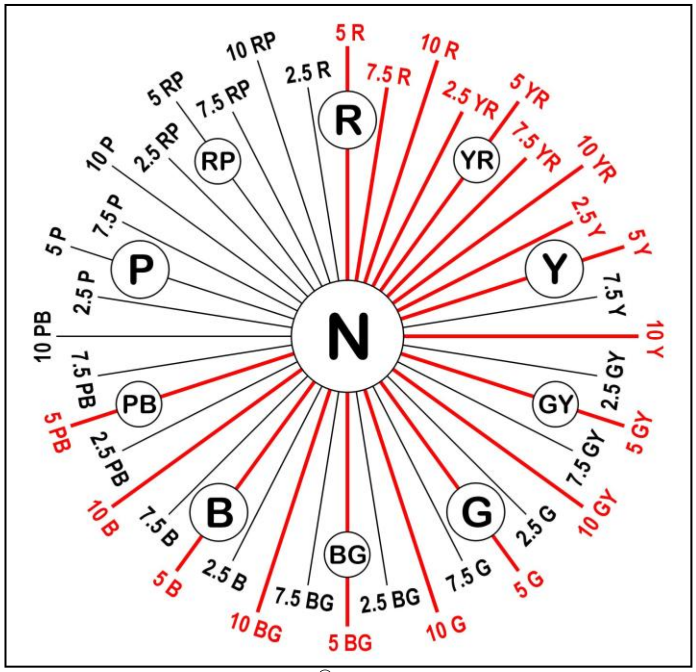

Figure 1.—Munsell® hue circle (modified from Munsell Book of Color, 1976).

To determine the "difference in hue" between colors, count the number of 2.5-unit intervals. For example, hues of 2.5Y and 7.5YR differ by two 2.5-unit intervals, and so their difference in hue is counted as "2." Hues of 5Y and 5GY differ by four 2.5-unit intervals, and so their difference in hue is counted as "4."

The suggested procedure is to write down the colors as observed, then to determine the difference between hues, rather than count pages. The old technique of counting the number of page separations to record the difference in hue is not recommended for the following reasons:

1) It is difficult to know the interval spacing where hues may occur on the same page, such as on the Munsell® color gley charts and on the recently approved 10Y-5GY color chart from MUNSELL® Soil Color Charts, by GretagMacbeth.
2) Hue pages might be missing, or they might be disorganized relative to the ordered progression of the Munsell® hue circle (figure 1).
3) Although separate hues may occur on adjacent pages, their hue spacing may be either 1 or 2, depending on whether the hues are at 2.5- or 5-unit intervals (figure 1).
4) The same hue can occur on adjacent pages, such as in the EarthColors™ soil color book, from Color Communications, Inc.

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ABBREVIATIONS FOR SOIL TEXTURES

Gravelly or gravels-------------------- GR

Mucky ---------------------------------- MK

Peaty ------------------------------------ PT

Very Coarse Sand --------------------- VCOS

Coarse Sand ---------------------------- COS

Sand -------------------------------------- S

Fine Sand-------------------------------- FS

Very Fine Sand------------------------- VFS

Loamy Coarse Sand------------------- LCOS

Loamy Sand ---------------------------- LS

Loamy Fine Sand ---------------------- LFS

Loamy Very Fine Sand --------------- LVFS

Gravelly Sandy Loam----------------- GSL

Sandy Loam ---------------------------- SL

Fine Sandy Loam ---------------------- FSL

Very Fine Sandy Loam --------------- VFSL

Loam ------------------------------------ L

Gravelly Loam ------------------------- GL

Stony Loam ----------------------------- STL

Silt -- SI

Silt Loam -------------------------------- SIL

Clay Loam ------------------------------ CL

Silty Clay Loam------------------------ SICL

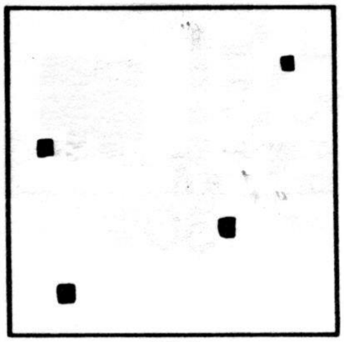
Sandy Clay Loam---------------------- SCL

Stony Clay Loam ---------------------- STCL

Silty Clay -------------------------------- SIC

Clay C

CHARTS FOR ESTIMATING PROPORTIONS OF MOTTLES AND COARSE FRAGMENTS



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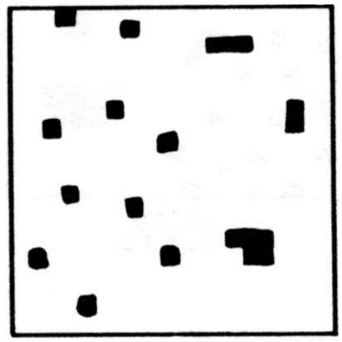

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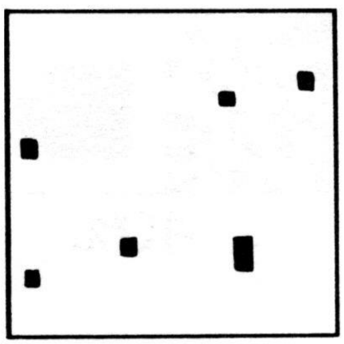

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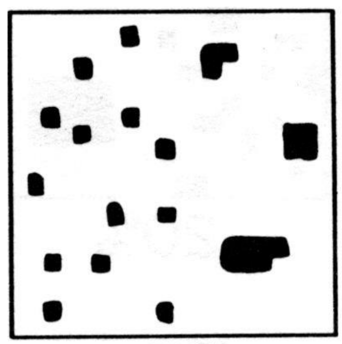

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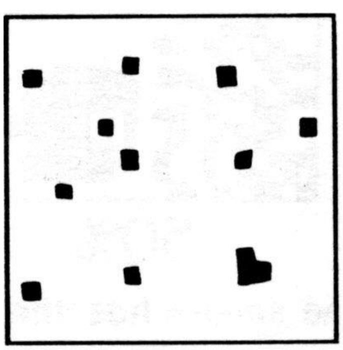

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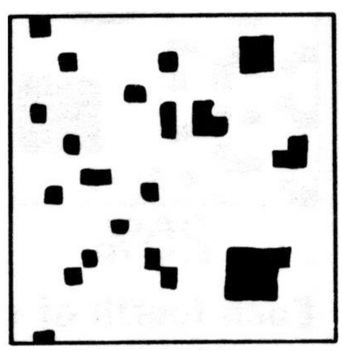

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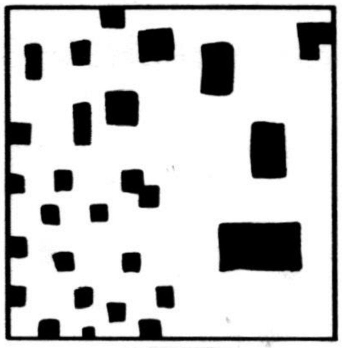

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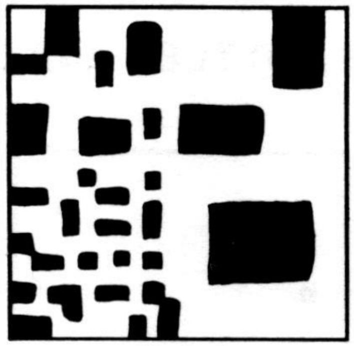

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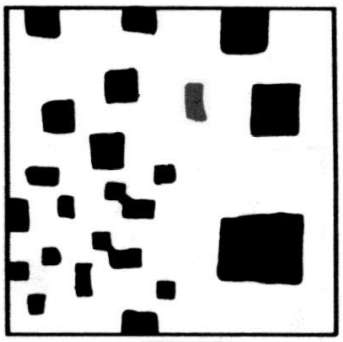

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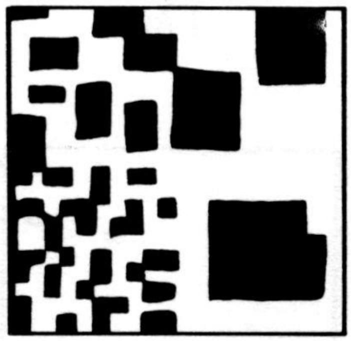

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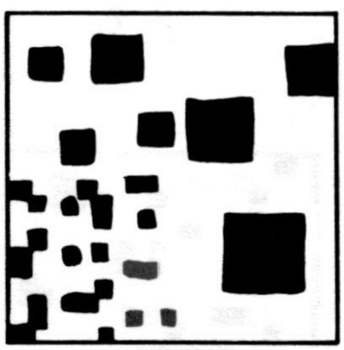

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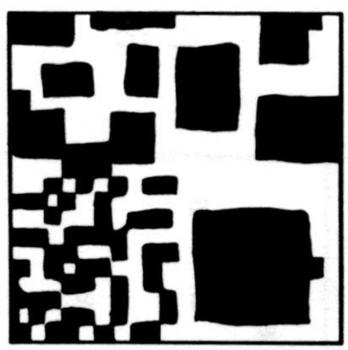

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Each fourth of any one square has the same amount of black

Hydric Soils Indicators

Hydric soil indicators are divided into two groups. The first group has those indicators normally used to delineate hydric soils. These normally occur at the hydric soil boundary. The second group are often used to identify hydric soils but, because they are maximum expressions of anaerobiosis (life without oxygen), they are rarely used for delineation purposes.

THE FOLLOWING OXIDIZED FORMS (REDOXIMORPHIC FEATURES) OF IRON (Fe), and MANGANESE (Mn) ARE TO BE USED WHEN USING THE HYDRIC SOIL INDICATORS.

Mineral Type:	**Value/Chroma**		**Hue**
Mn:	**≤2**	**≤2**	**2.5YR to 5Y**
Fe/Mn masses	**3**	**3**	**2.5YR to 5Y**
Fe:	**≥4**	**≥4**	**2.5YR to 5Y**

(Hue 10R or more red indicates relict features)

NOTE FOR Mn: except on flood plains of the Florida Panhandle, redoximorphic Mn is relatively unimportant.

REDOXIMORPHIC FEATURES MUST BE DISTINCT OR PROMINENT AND HAVE DIFFUSE BOUNDARIES (EXCEPT WHERE A SPECIFIC INDICATOR DICTATES OTHERWISE). ***REDOX CONCENTRATIONS MAY HAVE SHARP BOUNDARIES WHERE THE MATRIX HAS VALUE ≤3 AND CHROMA ≤1.***

Hydric Soil Delineation Indicators for All Soils

These indicators area to be used for all soils regardless of texture. All mineral layers above any of the "A" indicators have a dominant chroma of 2 or less or the layer(s) with the dominant chroma of more than 2 is less than 6" thick. Also, nodules and concretions are not redox concentrations.

A1. Histosol (*For use in all LRRs*) or Histel (*For use in LRRs with permafrost).* Classifies as a Histosol (except Folist) or as a Histel (except Folistel).
Histosol User Notes: A Histosol has 40 cm (16 inches) or more of the upper 80 cm (32 inches) as organic soil material. Organic soil material has an organic carbon content (by weight) of 12 to 18 percent, or more, depending on the clay content of the soil. These materials include muck (sapric soil material), mucky peat (hemic soil material), or peat (fibric soil material).

A2. Histic Epipedon. *For use in all LRRs.* A histic epipedon underlain by mineral soil material with chroma 2 or less.
Histic Epipedon User Notes: Most histic epipedons are surface horizons 20 cm (8 inches) or more thick of organic soil material. Aquic conditions or artificial drainage are required.

A3. Black Histic. *For use in all LRRs.* A layer of peat, mucky peat, or muck 20 cm (8 inches) or more thick starting within the upper 15 cm (6 inches) of the soil surface having hue 10YR or yellower, value 3 or less, and chroma 1 or less underlain by mineral soil material with chroma 2 or less.
Black Histic User Notes: Unlike indicator A2 this indicator does not require proof of aquic conditions or artificial drainage.

A4. Hydrogen Sulfide. *For use in all LRRs.* A hydrogen sulfide odor within 30 cm (12 inches) of the soil surface.
Hydrogen Sulfide User Notes: This "rotten egg smell" indicates that sulfate-sulfur has been reduced and therefore the soil is anaerobic. In most hydric soils, the sulfidic odor is only present when the soil is saturated and anaerobic.

A5. Stratified Layers. *For use in all LRRs.* Several stratified layers starting within the upper 15 cm (6 inches) of the soil surface. One or more of the layers has value 3 or less with chroma 1 or less and/or it is muck, mucky peat, peat, or mucky modified mineral texture. The remaining layers have chroma 2 or less. Any sandy material that constitutes the value 3 or less and chroma 1 or less layer using a 10X or 15X hand lens, must have at least 70% of the visible soil particles masked with organic material. Observation without a hand lens appears to be close to 100% masked (<2% unmasked).
Stratified Layers User Notes: Use of this indicator may require assistance from a trained soil scientist with local experience. The minimum organic carbon content of at least one layer of this indicator is slightly less than required for indicator A7 (Mucky Modified Mineral Texture. ***An undisturbed sample must be observed.*** Individual strata are dominantly less than 2.5 cm (1 inch) thick. A hand lens is an excellent tool to aid in the identification of this indicator. Many alluvial soils have stratified layers at greater depths; these are not hydric soils. Many alluvial soils have stratified layers at the required depths but lack chroma 2 or less; these do not fit this indicator. Stratified Layers occur in any type soil material.

A6. Organic Bodies. ***For use in all LRRs.*** **Presence of 2% or more organic bodies of muck or a mucky modified mineral texture, approximately 1 to 3 cm (0.5 to 1 inches) in diameter, starting within 15 cm (6 inches) of the soil surface. In some soils the organic bodies are smaller than 1 cm.**
Organic Bodies User Notes: The percent organic carbon in organic bodies is the same as in the Muck or Mucky Texture Indicators. This indicator includes the indicator previously named "accretions" (Florida Soil Survey Staff, 1992). Many organic bodies lack the required amount of organic carbon and are not indicative of hydric soils. The content of organic carbon should be known before this indicator is used. Organic bodies of hemic (mucky peat) and/or fibric (peat) soil materials do not qualify as this indicator. Material consisting of partially decomposed root tissue does not qualify as the indicator.

A7. 5 cm Mucky Mineral. ***For use in all LRRs.*** **A layer of mucky modified mineral soil material 5 cm (2 inches) or more thick starting within 15 cm (6 inches) of the soil surface.**
5 cm Mucky Mineral User Notes: "Mucky" is a USDA texture modifier for mineral soils. The organic carbon content is at least 5 and ranges to as high as 18 percent. The percentage requirement is dependent upon the clay content of the soil; the higher the clay content, the higher the organic carbon requirement. An example is mucky fine sand, which has at least 5 percent organic carbon but not more than about 12 percent organic carbon. Another example is mucky sandy loam, which has at least 7 percent organic carbon but not more than about 14 percent organic carbon.

A8. Muck Presence. ***For use in LRR U.*** **A layer of muck with value 3 or less and chroma 1 or less within 15 cm (6 inches) of the soil surface.**
Muck Presence User Notes: The presence of muck of any thickness within 15 cm (6 inches) is the only requirement. Normally this expression of anaerobiosis is at the soil surface; however, it may occur at any depth within 15 cm (6 inches). Muck is sapric soil material with at least 12 to 18 percent organic carbon. Organic soil material is called muck (sapric soil material) if virtually all of the material has undergone sufficient decomposition such that plant parts cannot be identified. Hemic (mucky peat) and fibric (peat) soil materials do not qualify. Generally muck is black and has a "greasy" feel; sand grains should not be evident.

A9. 1 cm Muck. ***For use in LRRs P, and T.*** **A layer of muck 1 cm (0.5 inches) or more thick with value 3 or less and chroma 1 or less starting within 15 cm (6 inches) of the soil surface.**
1 cm Muck User Notes: Unlike Indicator A8 (Muck Presence) there is a minimum thickness requirement of 1 cm. Normally this expression of anaerobiosis is at the soil surface; however, it may occur at any depth within 15 cm (6 inches). Muck is sapric soil material with at least 12 to 18 percent organic carbon. Organic soil material is called muck (sapric soil material) if virtually all of the material has undergone sufficient decomposition to limit recognition of the plant parts. Hemic (mucky peat) and fibric (peat) soil materials do not qualify. Generally muck is black and has a "greasy" feel; sand grains should not be evident.

A11. Depleted Below Dark Surface. ***For use in all LRRs.*** **A layer with a depleted or gleyed matrix that has 60% or more chroma 2 or less starting within 30 cm (12 inches) of the soil surface that has a minimum thickness of either:**

a. 15 cm (6 inches), or

b. 5 cm (2 inches) if the 5 cm (2 inches) consists of fragmental soil material.

Loamy/clayey layer(s) above the depleted or gleyed matrix must have value 3 or less and chroma 2 or less. Any sandy material above the depleted or gleyed matrix must have value 3 or less, chroma 1 or less and using a 10X or 15X hand lens, at least 70% of the visible soil particles must be masked with organic material. Observation without a hand lens appears to be close to 100% masked (<2% unmasked).

Depleted Below Dark Surface User Notes: This indicator often occurs in Mollisols but also applies to soils with umbric epipedons and dark colored ochric epipedons. For soils with dark colored epipedons greater than 30 cm (12 inches) thick, use Indicator A12. Redox concentrations including iron/manganese soft masses and/or pore linings are required in soils with matrix colors of 4/1, 4/2, and 5/2. A, E and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present.

A12. Thick Dark Surface. *For use in all LRRs.* **A layer at least 15cm (6 inches) thick with a depleted or gleyed matrix that has 60% or more chroma 2 or less starting below 30cm (12 inches) of the surface. The layer (s) above the depleted or gleyed matrix must have value 2.5 or less and chroma 1 or less to a depth of at least 30cm (12 inches) and value 3 or less and chroma 1 or less in any remaining layers above the depleted or gleyed matrix. Any sandy material above the depleted or gleyed matrix using a 10X or 15X hand lens must have at least 70% of the visible soil particles masked with organic material. Observation without a hand lens appears to be close to 100% masked (<2% unmasked).**
Thick Dark Surface User Notes: This indicator has a black layer 30 cm (12 inches) or more thick and has value 3 or less, chroma 1 or less in any remaining layers immediately above a depleted matrix or gleyed matrix. This indicator is most often associated with overthickened soils in concave landscape positions. A depleted matrix requires a value of 4 or more and chroma 2 or less. Redox concentrations including iron/manganese soft masses and/or pore linings are required in soils with matrix colors of 4/1, 4/2, and 5/2. A, E and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present.

<u>Hydric Soil Delineation Indicators for Sandy ("S") Soils</u>
These indicators are to be used for soil materials with a USDA texture of loamy fine sand and coarser. All mineral layers above any of the "S" indicators except for indicator S6 have dominant chroma of 2 or less, or the layer(s) with dominant chroma more than 2 is less than 6" thick. Also, nodules and concretions are not redox concentrations.

S4. Sandy Gleyed Matrix. ***For use in all LRRs.*** **A gleyed matrix which occupies 60% or more of a layer starting within 15 cm (6 inches) of the soil surface.**
Sandy Gleyed Matrix User Notes: Gley colors are not synonymous with gray colors. Gley colors are those colors that are found on the gley page (Gretag/Macbeth, 2000). They have hue N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value 4 or more. The gleyed matrix only has to be present within 15 cm (6 inches) of the surface. Soils with gleyed matrices are saturated for a significant duration; this is why no thickness of the layer is required.

S5. Sandy Redox. ***For use in all LRRs.*** **A layer starting within 15 cm (6 inches) of the soil surface that is at least 10 cm (4 inches) thick, and has a matrix with 60% or more chroma 2 or less with 2% or more distinct or prominent redox concentrations as soft masses and/or pore linings.**
Sandy Redox User Notes: Distinct and prominent are defined in the Glossary. Redox concentrations include iron and manganese masses (reddish mottles) and pore linings. Included within this concept of redox concentrations are iron/manganese bodies as soft masses with diffuse boundaries. The iron/manganese masses are 2 to 5 mm in size and have value 3 or less and chroma 3 or less; most commonly they are black. Iron/manganese masses should not be confused with concretions and nodules associated with plinthitic or relict concretions. Common to many redox concentrations are required. <u>***Redox concentrations may have sharp boundaries where the matrix has value ≤3 and chroma ≤1***</u>.

S6. Stripped Matrix. ***For use in all LRRs.*** **A layer starting within 15 cm (6 inches) of the soil surface in which iron-manganese oxides and/or organic matter have been stripped from the matrix exposing the primary base color of soil materials. The stripped areas and translocated oxides and/or organic matter form a faintly contrasting pattern of two or more colors with diffuse boundaries. The stripped zones are 10% or more of the volume and are rounded.**
Stripped Matrix User Notes: This indicator includes the indicator previously named "polychromatic matrix" as well as the term "streaking." Common or many areas of stripped (uncoated) soil materials are required. The stripped areas are typically 1 to 3 cm (0.5 to 1 inch) in size but may be larger or smaller. Commonly, the stripped areas have value of 5 or more and have chroma of 1 and/or 2 and unstripped areas have chroma of 3 and/or 4. The matrix (predominant color) may not have the material with 3 and/or 4 chroma. The mobilization and translocation of oxides and/or organic matter is the important process and should result in splotchy coated and uncoated soil areas. This may be a difficult pattern to recognize and is more evident when observing a horizontal slice.

S7. Dark Surface. ***For use in all LRRs.*** **A layer 10 cm (4 inches) thick starting within the upper 15 cm (6 inches) of the soil surface with a matrix value 3 or less and chroma 1 or less. Using a 10X or 15X hand lens, at least 70% of the visible soil particles must be masked with organic material. Observation without a hand lens appears to be close to 100 percent masked (<2% unmasked). The matrix color of the layer immediately below the dark layer must have the same colors as those described above or any color that has chroma 2 or less.**
Dark Surface User Notes: The organic carbon content of this indicator is slightly less than required for "mucky." <u>***An undisturbed sample must be observed.***</u> Many wet soils have a ratio of about 50 percent soil particles that are covered or coated with organic matter and about 50 percent uncoated or uncovered soil particles, giving the soil a salt and pepper appearance. Where the percent of coverage is less than 70 percent, a Dark Surface indicator is not present.

S8. Polyvalue Below Surface. ***For use in LRRs T and U.*** **A layer with value 3 or less and chroma 1 or less starting within 15 cm (6 inches) of the soil surface. Using a 10X or 15X hand lens, at least 70% of the visible soil particles in this layer must be masked with organic material. Observation without a hand lens appears to be close to 100% masked (<2% unmasked). [Editor's note: This layer is underlain by a layer(s) where translocated organic matter unevenly covers the soil material forming a diffuse splotchy pattern.] Immediately below this layer, the organic coating occupies 5% or more of the soil volume and has value 3 or less and chroma 1 or less. The remainder of the soil volume has value 4 or more and chroma 1 or less to a depth of 12 inches (30 cm) or to the spodic horizon, whichever is less.**
Polyvalue Below Surface User Notes: This indicator describes soils with a very dark gray or black surface or near surface layer less than 10 cm (4 inches) thick underlain by a layer where organic matter has been differentially distributed within the soil by water movement. The mobilization and translocation of organic matter results in splotchy coated and uncoated soil areas as described in the Sandy Redox and Stripped Matrix Indicators except that for S8 the whole soil is in shades of black and gray. The chroma 1 or less is critical because it limits application of this indicator to only those soils which are depleted of iron. This indicator includes the indicator previously termed "streaking."

S9. Thin Dark Surface. ***For use in LRRs T and U.*** **A layer 5 cm (2 inches) or more thick within the upper 15 cm (6 inches) of the soil surface, with value 3 or less and chroma 1 or less. Using a 10X or 15X hand lens, at least 70% of the visible soil particles in this layer must be masked with organic material. Observation without a hand lens appears to be close to 100% masked (<2% unmasked). This layer is underlain by a layer(s) with value 4 or less and chroma 1 or less to a depth of 30 cm (12 inches) or to the spodic horizon, whichever is less.**
Thin Dark Surface User Notes: ***An undisturbed sample must be observed.*** This indicator describes soils with a very dark gray or black near-surface layer at least 5 cm (2 inches) thick underlain by a layer where organic matter has been carried downward by flowing water. The mobilization and translocation of organic matter results in an even distribution of organic matter in the eluvial (E) horizon. The chroma 1 or less is critical because it limits application of this indicator to only those soils which are depleted of iron. This indicator commonly occurs in hydric Spodosols; however, a spodic horizon is not required.

Hydric Soil Delineation Indicators for Loamy and Clayey Soils
These indicators are to be used for soil materials with a USDA texture of loamy very fine sand and finer (loamy and clayey soils). All mineral layers above any of the "F" indicators except for indicators F8 and F12 have dominant chroma 2 or less, or the layer(s) with dominant chroma of more than 2 is less than 6 inches thick. Also, nodules and concretions are not redox concentrations.

F2. Loamy Gleyed Matrix. ***For use in all LRRs.*** **A gleyed matrix that occupies 60% or more of a layer starting within 30 cm (12 inches) of the soil surface.**
Loamy Gleyed Matrix User Notes: Gley colors are not synonymous with gray colors. Gley colors are those colors that are found on the gley pages (Gretag/Macbeth. 2000). They have hue N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, or 5PB, with value 4 or more. The gleyed matrix only has to be present within 30 cm (12 inches) of the surface. Soils with gleyed matrices are saturated for a significant duration; this is why no thickness of the layer is required.

F3. Depleted Matrix. ***For use in all LRRs.*** **A layer with a depleted matrix that has 60% or more chroma 2 or less and that has a minimum thickness of either:**

a. 5 cm (2 inches) if the 5 cm is entirely within the upper 15 cm (6 inches) of the soil, or

b. 15 cm (6 inches); starting within 25 cm (10 inches) of the soil surface.

Depleted Matrix User Notes: Redox concentrations including iron/manganese soft masses and/or pore linings are required in soils with matrix colors of 4/1, 4/2, and 5/2. A, E and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present. The low chroma matrix must be due to wetness and not a relict or parent material feature.

F6. Redox Dark Surface. ***For use in all LRRs.*** **A layer at least 10 cm (4 inches) thick entirely within the upper 30 cm (12 inches) of the mineral soil that has:**

a. matrix value 3 or less and chroma 1 or less and 2% or more distinct or prominent redox concentrations as soft masses or pore linings, or

b. matrix value 3 or less and chroma 2 or less and 5% or more distinct or prominent redox concentrations as soft masses or pore linings.

Redox Dark Surface User Notes: Redox concentrations in high organic matter mineral soils with dark surfaces are often difficult to see. The organic matter "masks" some or all of the concentrations that may be present. ***Redox concentrations may have sharp boundaries where the matrix has value ≤3 and chroma ≤1***. Careful examination is required in order to see what are often brownish "mottles" in the darkened materials. In some instances, drying of the samples makes the concentrations (if present) easier to see. Dried colors, if used, need to have matrix chromas of 1 or 2 and the redox concentrations need to be distinct or prominent. In soils which are wet due to subsurface saturation, the layer immediately below the dark epipedon should have a depleted or gleyed matrix. Soils which are wet due to ponding or shallow perched layer of saturation may not always have a depleted/gleyed matrix below the dark surface. It is recommended that delineators evaluate the hydrologic source and examine and describe the layer below the dark colored epipedon when applying this indicator. Redox concentrations including iron/manganese soft masses and/or pore linings are required in soils with matrix colors of 4/1, 4/2, and 5/2. A, E and calcic horizons may have low chromas and high values and may therefore be mistaken for a depleted matrix; however, they are excluded from the concept of depleted matrix unless common or many, distinct or prominent redox concentrations as soft masses or pore linings are present.

F8. Redox Depressions. ***For use in all LRRs.*** **In closed depressions subject to ponding, 5% or more distinct or prominent redox concentrations occurring as soft masses or pore linings in a layer 5 cm (2 inches) or more thick entirely within the upper 15 cm (6 inches) of the soil.**
Redox Depressions User Notes: This indicator occurs on depressional landforms such as: vernal pools, playa lakes, rainwater basins, “Grady” ponds, and potholes: not micro-depressions (≤ 1meter) on convex or plane landscapes.

F10. Marl. ***For use in LRR U.*** **A layer of marl with a value ≥5 and chroma <2 starting within 10 cm (4 inches) of the soil surface.**
Marl User Notes: Marl is a limnic material deposited in water by precipitation of $CaCO_3$ by algae as defined in *Soil Taxonomy* (USDA NRCS, 1999). It has a Munsell value 5 or more and reacts with dilute HCl to evolve CO_2. Marl is not the carbonatic substrate material associated with limestone bedrock. Some soils have materials with all the properties of marl except they lack the required Munsell value. These soils are hydric if the required value is present within 10 cm (4 in) of the soil surface. Normally this indicator occurs at the soil surface.

F12. Iron/Manganese Masses. ***For use in LRRs P, and T.*** **On flood plains, a layer 10 cm (4 inches) or more thick with 40% or more chroma 2 or less, and 2 percent or more distinct or prominent redox concentrations as soft iron/manganese masses with diffuse boundaries. The layer occurs entirely within 30 cm (12 inches) of the soil surface. Iron/manganese masses have value 3 or less and chroma 3 or less; most commonly they are black. The thickness requirement is waived if the layer is the mineral surface layer.**
Iron/Manganese Masses User Notes: These iron/manganese masses are usually small (2 to 5 mm in size) and have a value and chroma 3 or less. They can be dominated by manganese and therefore have a color approaching black. The low matrix chroma must be due to wetness and not be a relict or parent material feature. Iron/manganese masses should not be confused with the larger and redder iron nodules associated with plinthite or with concretions that have sharp boundaries. This indicator occurs on flood plains of rivers such as the Apalachicola, Congaree, Mobile, Savannah, and Tennessee Rivers.

F13. Umbric Surface. ***For use in all LRRs.*** **In depressions and other concave landforms, a layer 25 cm (10 inches) or more thick starting within 15 cm (6 inches) of the soil surface in which the upper 15 cm (6 inches) must have value 3 or less and chroma 1 or less, and the lower 10 cm (4 inches) of the layer must have the same colors as above or any other color that has a chroma 2 or less.**
Umbric Surface User Notes: Thickness requirements maybe slightly less than those required for an umbric epipedon. Microlows are not considered to be concave landforms. Umbric surfaces on higher landscape positions, such as side slopes dominated by Humic Dystrudepts, are excluded.

F7. Depleted Dark Surface. ***For use in all LRRs.*** **Redox depletions, with value 5 or more and chroma 2 or less, in a layer at least 10 cm (4 inches) thick entirely within the upper 30 cm (12 inches) of the mineral soil that has:**
a. matrix value 3 or less and chroma 1 or less and 10% or more redox depletions, or
b. matrix value 3 or less and chroma 2 or less and 20% or more redox depletions.
Depleted Dark Surface User Notes: Care should be taken not to mistake mixing of an E or calcic horizon into the surface layer as depletions. The "pieces" of E and calcic horizons are not redox depletions. Knowledge of local conditions is required in areas where E and/or calcic horizons may be present. In soils which are wet due to subsurface saturation, the layer immediately below the dark surface should have a depleted or gleyed matrix. Redox depletions should have associated microsites redox concentrations that occur as Fe pore linings or masses within the depletion(s) or surrounding the depletion(s).

F22. Very Shallow Dark Surface. ***For use in MLRA 138 of LRR P, MLRA 154 of LRR U, and Florida portion of MLRA 152A in LRR T.*** **In depressions and flood plains subject to frequent ponding and/or flooding, one of the following:**

a) if bedrock occurs between 15 cm (6 inches) and 25 cm (10 inches), a layer at least 15 cm (6 inches) thick starting with in 10 cm (4 inches) of the soil surface with value 2.5 or less and chroma 1 or less, and the remaining soil to bedrock must have the same colors as above or any other color that has a chroma 2 or less, or

b) if bedrock occurs within 15 cm (6 inches), more than half of the soil thickness must value 2.5 or less and chroma 1 or less, and the remaining soil to bedrock must have the same colors as above or any other color that has a chroma 2 or less.

INDICATORS USED FOR WETTEST AREAS (INTERIOR WET AREAS)

A1, A2, A3, A4, A11, A12, S4, F2, F7

INDICATORS USED FOR BORDERS OF WET AREAS

A5, A6, A7, A8, A9, S5, S6, S7, S8, S9, F3, F6, F8, F10, F12, F13, F22

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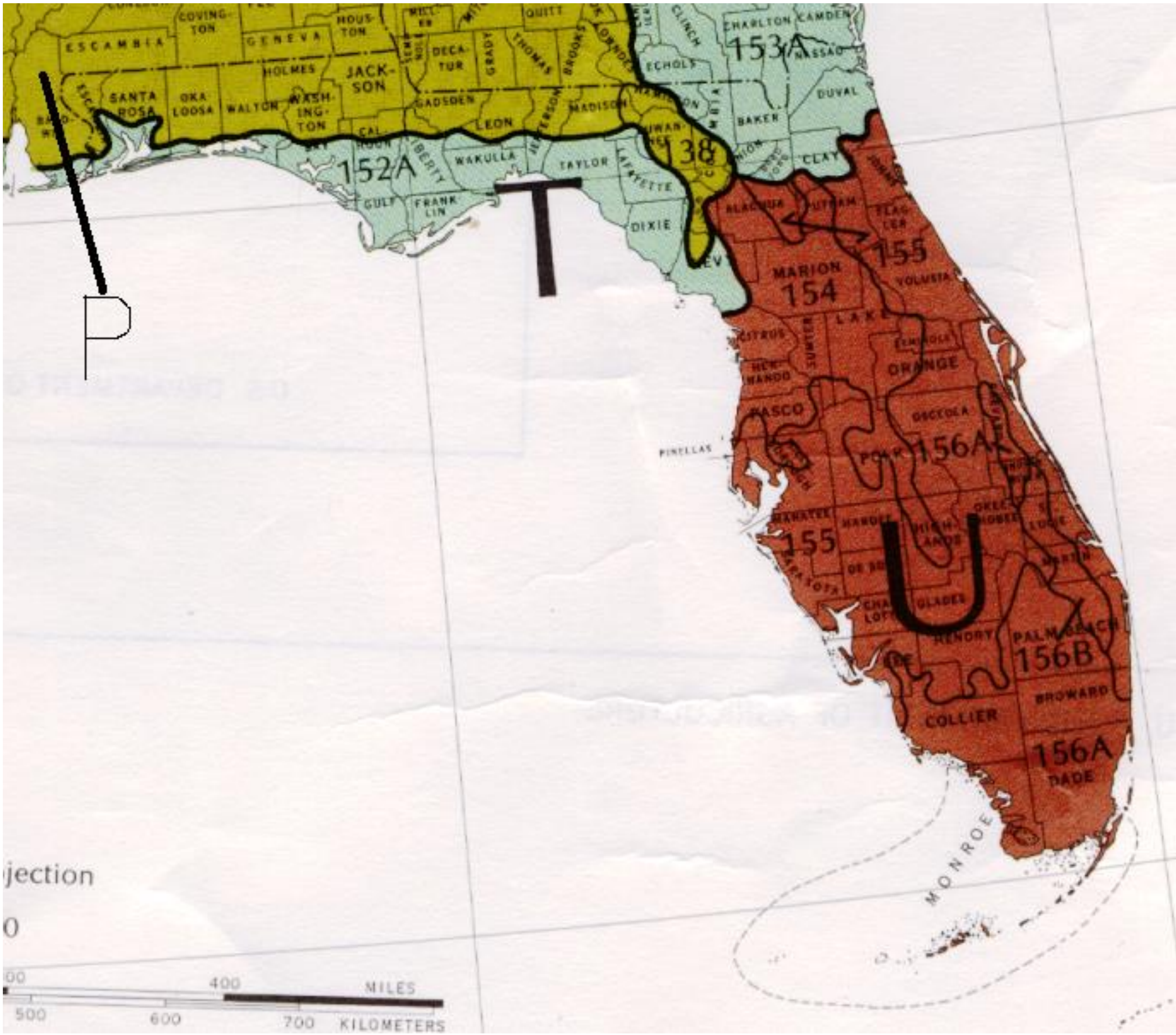
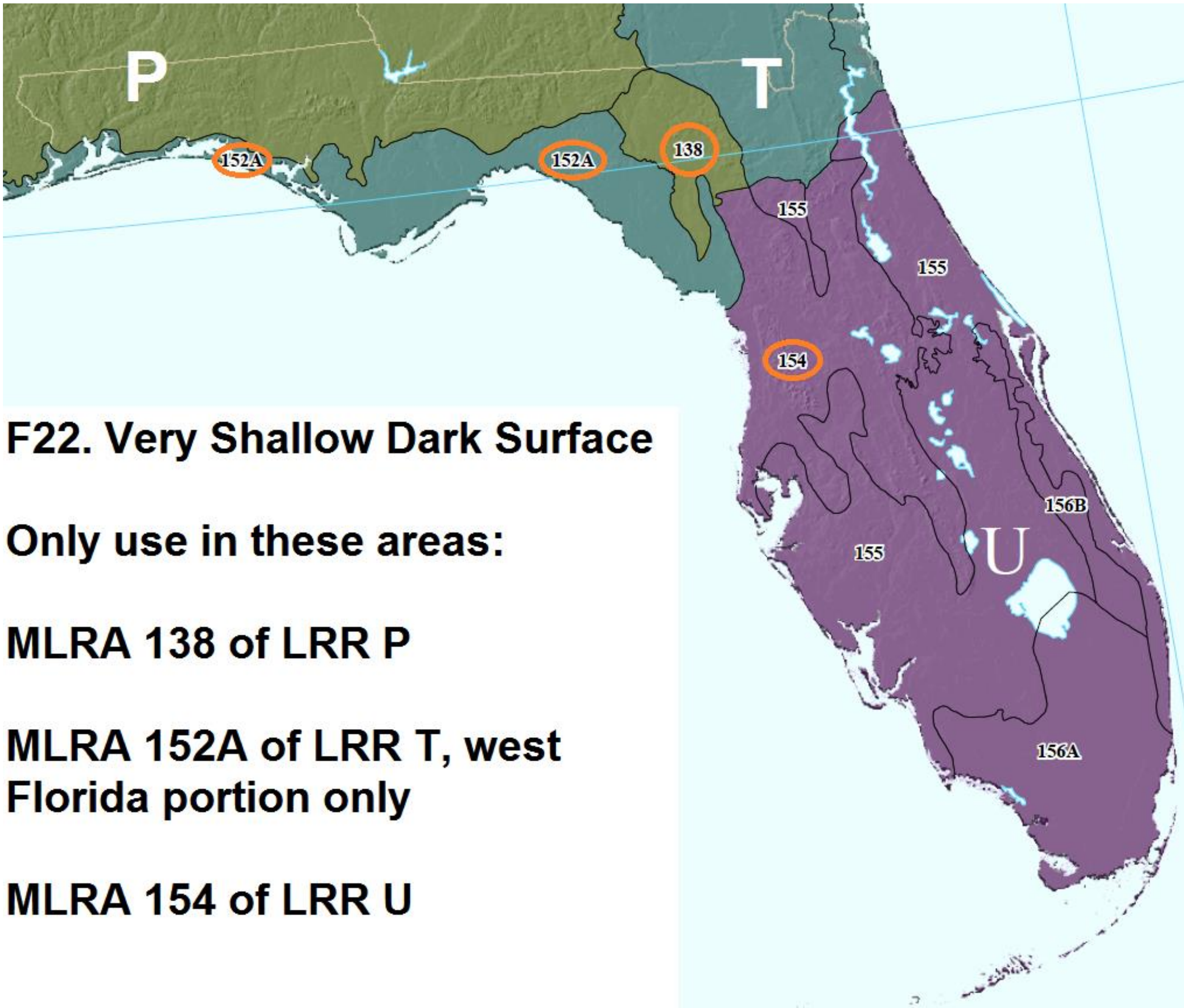


LAND RESOURCE REGIONS (LRR'S) IN FLORIDA



F22. Very Shallow Dark Surface

Only use in these areas:

MLRA 138 of LRR P

MLRA 152A of LRR T, west Florida portion only

MLRA 154 of LRR U

APPENDIX S

SOIL TEXTURES – WHAT THEY FEEL LIKE AND DEFINITIONS

Soil texture is a term commonly used to designate the proportionate distribution of different sized mineral particles in a soil material. The three basic sizes of soil mineral particles are the sand size, the silt size and the clay size. The sand size class is subdivided further into the subclasses of very coarse sand, coarse sand, medium sand, fine sand, and very fine sand. Individual particles, based on their size, are grouped into separates. These soil separates are classified by size into the groupings shown below:

Separate	Diameter Limit In Millimeters
Very coarse sand	2.00-1.00
Coarse sand	1.00-.50
Medium sand	.50 -.25
Fine sand	.25-.10
Very fine sand	.10-.05
Silt	.05-.002
Clay	less than .002

Florida's major soil texture classifications and some of the characteristics which can be utilized in the field for identification of these soil texture groups is accomplished primarily by rubbing moist samples of soil material between the fingers and observing how the material feels.

(a) Sand – Sand feels extremely gritty and does not form a ribbon or ball when wet or moist. A sand is loose and single grained. The individual grains can readily be seen or felt.

(b) Loamy sand – Loamy sand feels extremely gritty and forms a weak ball that cannot be handled without breaking.

(c) Sandy loam – A sandy loam feels extremely gritty and slightly sticky. When moist, it forms a cast that will bear careful handling without breaking.

(d) Loam – A loam feels somewhat gritty, yet fairly smooth and slightly plastic. When moist, it forms a cast that may be handled quite freely without breaking. Loam forms only short ribbons about 0.25 inch to 0.50 inches in length. This soil texture is not common in Florida soils.

(e) Silt loam – Silt loam lacks grittiness and feels extremely floury when moist or dry. When dry it may appear cloddy but the lumps can be readily broken. When moist it will form casts that can be freely handled without breaking. It will not form a ribbon but will give a broken appearance. This soil texture is not common in Florida soils.

(f) Silt – Silt lacks grittiness and feels extremely floury when moist or dry. It will not ribbon and forms a weak ball that will tolerate careful handling without breaking. This soil texture is extremely rare in Florida soils.

(g) Sandy clay loam – Sandy clay loam feels very gritty and sticky. When moist it forms a firm ball and may form a ribbon of one to two inches before it breaks.

(h) Clay loam – A clay loam feels very sticky with little or no grittiness. When moist it will form a ribbon that is about one to two inches long. The moist soil is plastic and will form a cast or ball that will bear much handling. When kneaded in the hand it does not crumble readily but tends to work into a heavy compact mass.

(i) Sandy clay – Sandy clay feels extremely sticky and very gritty. When moist and forms a firm ball and produces a ribbon that is over two inches in length before breaking.

(j) Silty clay – Silty clay feels both plastic and extremely sticky when moist and lacks any gritty feeling. It forms a firm ball and readily ribbons to over two inches in length before it breaks. This soil texture is not common in Florida soils.

(k) Clay – A clay feels extremely sticky and is neither gritty nor floury. When moist it forms a ribbon over two inches in length before breaking. It will form a hard ball or cast which will not break when handled.

(l) Organic soils – Muck, peat, and mucky peat are used in place of textural class names in organic soils. Muck is well decomposed organic soil material; peat consists of raw undecomposed organic soil material; and mucky peat designates materials intermediate in decomposition between muck and peat.

Definitions of the soil texture classes according to distribution of size classes of mineral particles less than 2 millimeters in diameter are as follows:

(a) Sands – 85 percent or more sand and the percentage of silt plus 1 1/2 times the percentage of clay is 15 or less.

1. Coarse sand – 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.

2. Sand – 25 percent or more very coarse, coarse and medium sand, but less than 25 percent very coarse and coarse sand, and less than 50 percent either fine sand or very fine sand.

3. Fine sand – 50 percent or more fine sand; or less than 25 percent very coarse, coarse, and medium sand and less than 50 percent very fine sand.

4. Very fine sand – 50 percent or more very fine sand.

APPENDIX S

(b) Loamy sands – At the upper limit 85 to 90 percent sand and the percentage of silt plus 1 1/2 times the percentage of clay is 15 or more; at the lower limit 70 to 85 percent sand and the percentage of silt plus twice the percentage of clay is 30 or less.

1. Loamy coarse sand – 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.

2. Loamy sand – 25 percent or more very coarse, coarse, and medium sand and less than 50 percent either fine sand or very fine sand.

3. Loamy fine sand – 50 percent or more fine sand; or less than 50 percent very fine sand and less than 25 percent very coarse, coarse, and medium sand.

4. Loamy very fine sand – 50 percent or more very fine sand.

(c) Sandy loams – 20 percent or less clay and 52 percent or more sand and the percentage of silt plus twice the percentage of clay exceeds 30; or less than 7 percent clay, less than 50 percent silt, and between 43 and 52 percent sand.

1. Coarse sandy loam – 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.

2. Sandy loam – 30 percent or more very coarse, coarse, and medium sand, but less than 25 percent very coarse and coarse sand, and less than 30 percent either fine sand or very fine sand.

3. Fine sandy loam – 30 percent or more fine sand and less than 30 percent very fine sand; or between 15 and 30 percent very coarse, coarse, and medium sand; or more than 40 percent fine and very fine sand, at least half of which is fine sand, and less than 15 percent very coarse, coarse, and medium sand.

4. Very fine sandy loam – 30 percent or more very fine sand; or more than 40 percent fine and very fine sand, at least half of which is very fine sand, and less than 15 percent very coarse, coarse, and medium sand.

(d) Loam – 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.

(e) Silt loam – 50 percent or more silt and 12 to 27 percent clay; or 50 to 80 percent silt and less than 12 percent clay.

(f) Silt – 80 percent or more silt and less than 12 percent clay.

(g) Sandy clay loam – 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand.

(h) Clay loam – 27 to 40 percent clay and 20 to 45 percent sand.

(i) Silty clay loam – 27 to 40 percent clay and less than 20 percent sand.

(j) Sandy clay – 35 percent or more clay and 45 percent or more sand.

(k) Silty clay – 40 percent or more clay and 40 percent or more silt.

(l) Clay – 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.