SOIL PROBE EVALUATION

5

OBJECTIVES

The purpose of this chapter is to:

- **Understand the basic principles of soil formation.**
- **Identify the individual horizons in a soil profile.**
- **Describe soil profile characteristics:**
  - ✓ **Color**
  - ✓ **Mottling (redoximorphic features)**
  - ✓ **Texture**
  - ✓ **Structure**
  - ✓ **Consistence**
  - ✓ **Rock fragments**
- **Describe and identify different limiting zones.**
- **Write a soil profile description.**

The Limiting Zone

Section 71.1

(i) A seasonal high water table, whether perched or regional, determined by direct observation of the water table or indicated by soil mottling (redoximorphic features).

(ii) A rock with open joints, fracture or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments.

(iii) A rock formation, other stratum or soil condition which is so slowly permeable that it effectively limits downward passage of effluent.

As an SEO, you will describe the characteristics in the soil profile, to establish and support the following:

1) the depth of suitable soil,

2) the limiting zone type, and

3) the characteristics of the soil horizons.

Your description is in effect painting a picture of the soil profile.

For effective sewage renovation, good drainage and suffient soil depth are required. Suitable soil must be present to renovate the effluent. Rocks with open joints will not adequately renovate effluent.

Without being renovated, the effluent could pass from the absorption area directly into a water source for human consumption. If the effluent does not properly drain through the soil, it could contaminate the surface of the soil as well.

NOTES

Soil Formation

FACTORS OF SOIL FORMATION

1) _____

2) _____

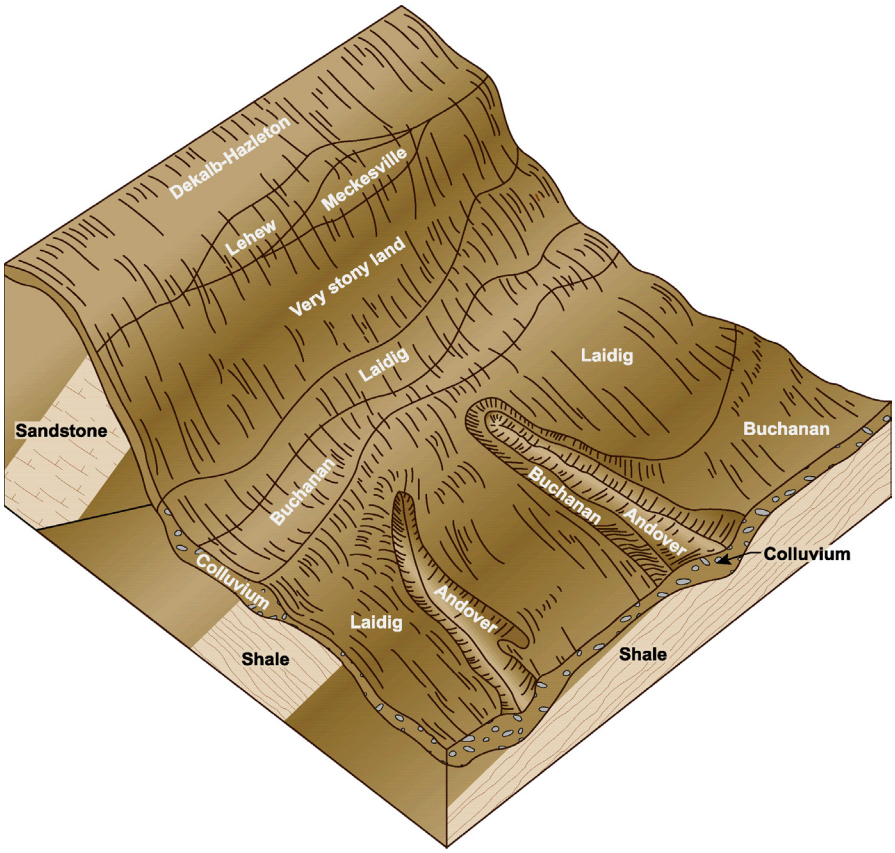
3) _____

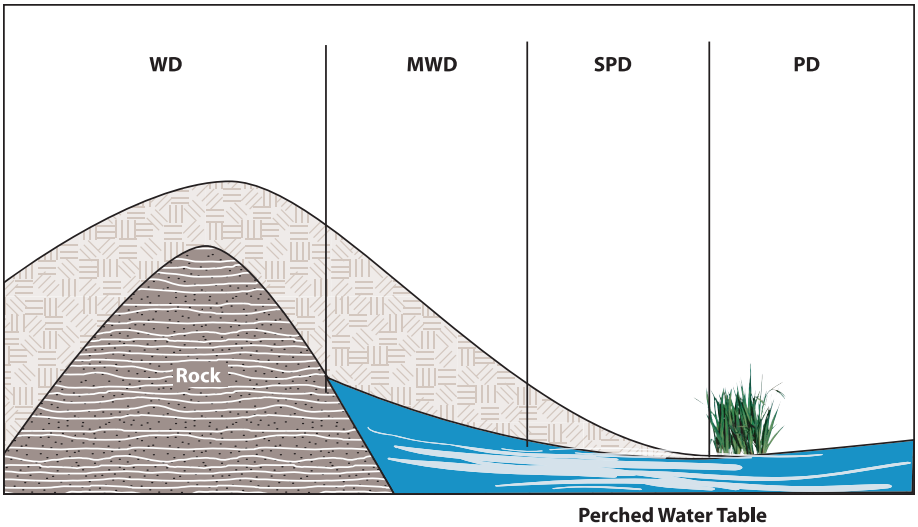
4) _____

5) _____

NOTES

RELIEF AND CATENA DIAGRAM





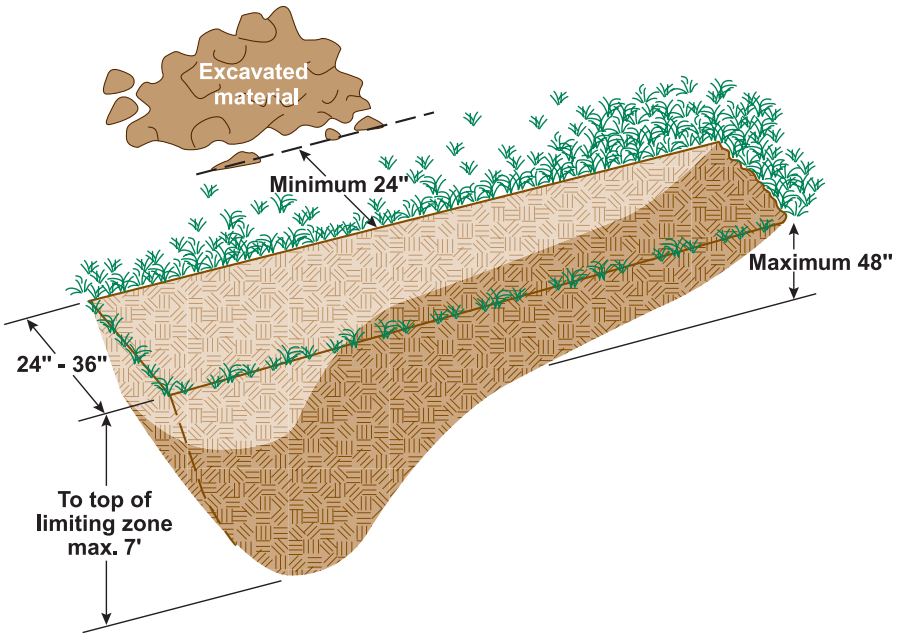
NOTES

What is a Soil Probe, and Where is it Dug?

NOTES

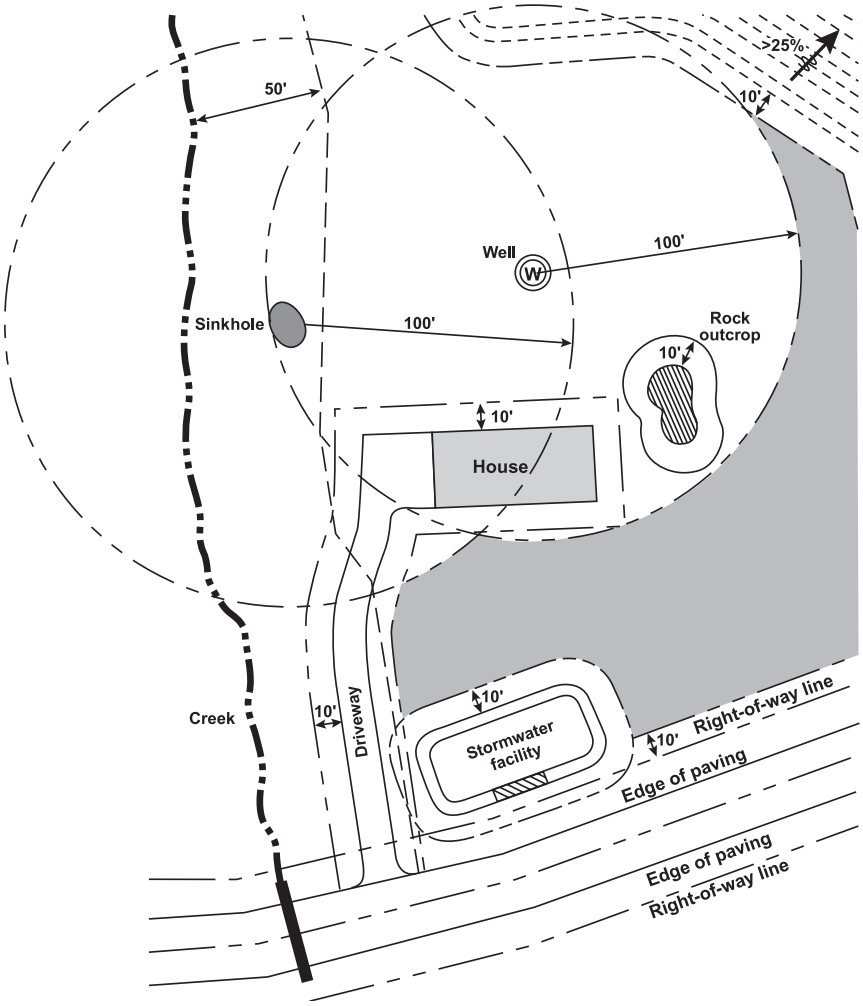
What is a soil probe?

Soil Probe for an SEO Soil Evaluation



Where is a soil probe dug?

NOTES



Note: Multiple probes may be required to establish site suitability for a potential absorption area.

How should the soil probe be dug?

NOTES

The probe should be excavated in an area where isolation distances can be maintained. In addition, the slope must be less than or equal to 25 percent.

Dig probes until either a suitable site is found or all possible sites have been exhausted. When some of the soil probes are determined to be unsuitable, sufficient testing must be conducted to ensure suitable soil depths throughout an absorption area. If too few or no suitable soil probes are found, then the lot is considered to be unsuitable for a conventional onlot sewage disposal system.

Once a suitable site is found, confirm the isolation distances and make sure slope is not a problem. The absorption area must be placed within 10 feet of the probe, or probes. The regulations state that a minimum of one probe is required. However, more than one probe may be needed to help determine site suitability.

Soil Profile Description

NOTES

Note: As an SEO, you may be writing the soil description or you may be reviewing the description. Either way, you need to be familiar with the terminology and contents of a complete description.

A soil profile has recognizable features that are used to describe the soil characteristics. To describe a soil profile, certain characteristics must be identified in each horizon. A standard terminology is used to describe the soil conditions and boundaries.

WHAT TO INCLUDE IN A SOIL PROFILE DESCRIPTION

Sample Soil Profile Description

0-5 in.	Dark brown (10YR 3/3) (color) loam (texture), granular (structure), friable (consistence)
5-36 in.	Yellowish red (7.5YR 5/6) clay loam, subangular blocky structure, friable, 10% rock fragments
36-53 in.	Yellowish red (5YR 4/6) clay loam, subangular blocky structure, friable, 10% rock fragments
53-84 in.	Red (2.5YR 4/6) gravelly sandy clay loam, subangular blocky structure, friable, 15% rock fragments
	No observable limiting zone to 84 inches.

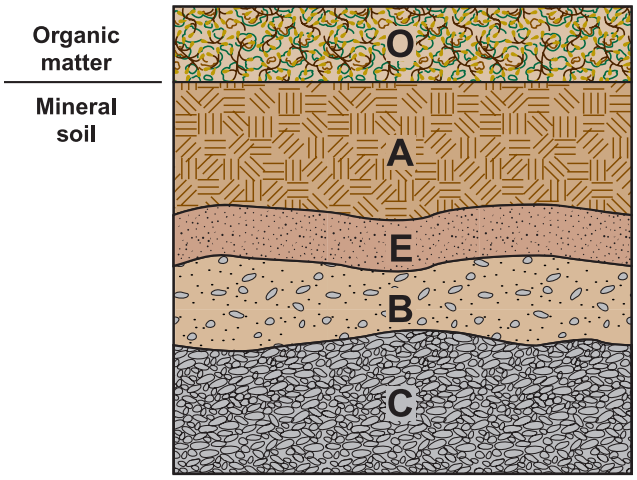
When these characteristics are identified, you can interpret soil features, estimate its permeability, and evaluate the corresponding suitability for onlot sewage disposal.

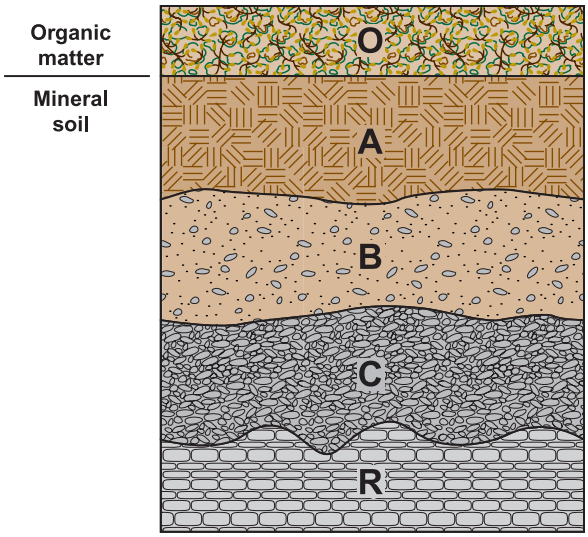
MASTER HORIZONS

NOTES

Master horizons are labeled in capital letters O, A, E, B, C, and R. These horizons represent different layers of the soil, which have characteristics that are often associated with the soil formation process.

A change in a soil horizon occurs when differences in soil characteristics, such as color, texture, or structure, are identified.





Characteristics of the Master Soil Horizons

NOTES

MASTER HORIZON	CHARACTERISTICS
Organic Horizons	
O	Horizon or layer dominated by fresh and/or decomposed organic material.
Mineral Horizons	
A	Mineral horizon formed at the surface or below an "O" horizon. "A" horizons exhibit one or both of the following: 1) An accumulation of humified organic matter mixed with the mineral fraction, not dominated by properties of the "E" and "B" horizons (described below). 2) Properties resulting from cultivation, pasturing, or other disturbances.
E	Mineral horizon in which the dominant feature is the eluvial loss of clay, iron, aluminum, organic matter, or a combination. These losses result in a concentration of sand and silt particles and lighter colors. All or much of the original parent material structure is obliterated.
B	Mineral horizons in which all or much of the parent material structure is obliterated. "B" horizons exhibit one or more of the following properties: 1) Illuvial concentrations of clay, iron, aluminum, organic matter, or a combination of them. 2) A redder and often darker soil. 3) Color change (lower value, higher chroma, or redder hue) in relation to overlying and underlying horizons. 4) Alteration of original material to form clay and/or release oxides and form granular, blocky, or prismatic structure.
C	Mineral horizons or layers, excluding "R" horizons, that are relatively unaffected by soil-forming processes. Properties are dominated by the parent material. Unconsolidated with low to moderate excavation difficulty, this horizon is still considered soil.
R	Hard bedrock that is difficult to excavate. Cracks, if present, are too few or too small to allow root penetration.

SUBORDINATE DESIGNATIONS

NOTES

There may also be differences among soil features noted within a master horizon. These subtle changes are described by subordinate designations within the master horizon. A lowercase letter is used to represent these designations. A few subordinate designations may be important when evaluating a profile description for suitability for an onlot sewage disposal system.

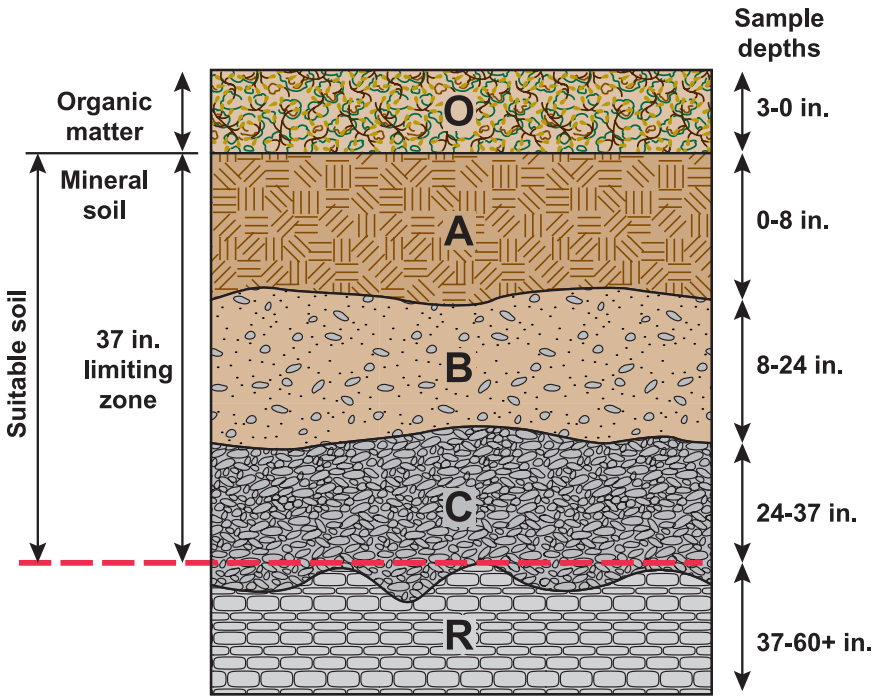
Subordinate Horizon Designations Common to PA

SUBORDINATE DESIGNATION	CHARACTERISTICS
Mineral Horizons	
b	Buried genetic horizon (A, E, or B); features formed before burial.
c	Concentrations or nodules of iron, manganese, or aluminum in significant accumulation (O, A, E, B, or C).
d	Dense, root-restricting layer (B or C; not with fragipan).
g	Strong gleying; matrix chromas generally $\leq$2, resulting from saturation and reduction (A, E, B, or C).
h	Illuvial accumulation of organic matter (B only).
p	Plowing or other disturbance (O or A only).
r	Weathered or soft bedrock; root-restricting layer that can be excavated with a shovel (C only).
s	Illuvial accumulation of sesquioxides (oxides and hydroxides of iron and aluminum) and organic matter (B only).
t	Accumulation of clay by illuviation or concentration (usually B; may be used in C or R).
w	Development of color and structure with little or no illuvial accumulation (B only).
x	Fragipan character as indicated by genetically developed firmness, brittleness, and high bulk density that restricts root penetration (B or C).

DEPTH OF HORIZON

The depth of each horizon is part of the soil description and should be measured and recorded. A change in any characteristics such as color, structure, or texture will indicate a new horizon.

Note: The O horizon is measured but not included in the depth to a limiting zone. For an onlot sewage disposal system, the suitable soil begins at the top of the A horizon and continues to the upper limit of the limiting zone. Example: the O horizon is written as 3-0 inches and the A horizon as 0-8 inches.



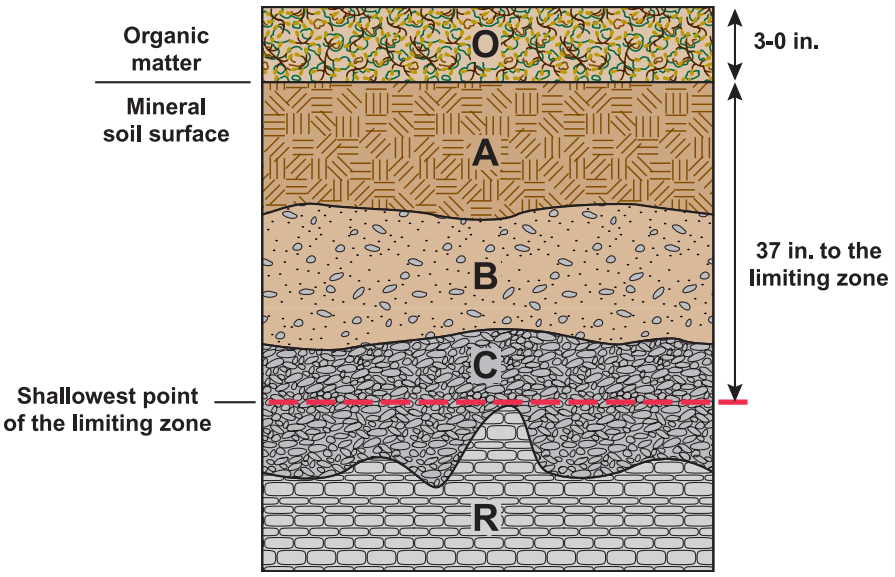
NOTES

NOTES

DEPTH TO A LIMITING ZONE

The limiting zone is a horizon in the soil that may prevent effluent from being properly renovated. Once a limiting zone is identified, you measure from the shallowest point at which that soil horizon occurs from the mineral soil surface.

Look around the entire probe to find the shallowest depth in the profile, not just on one side.



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What is the depth of the first horizon in the soil description for soil probe GG?

Soil Characteristics

NOTES

COLOR

The Munsell color system characterizes three elements of color: hue, value, and chroma. These three components make up a color notation.

HUE, VALUE, AND CHROMA

Hue, value, and chroma are used to describe the color of the soil. When determining the color of a soil, it must be moist.

Hue is the color—red, yellowish red, and yellow.

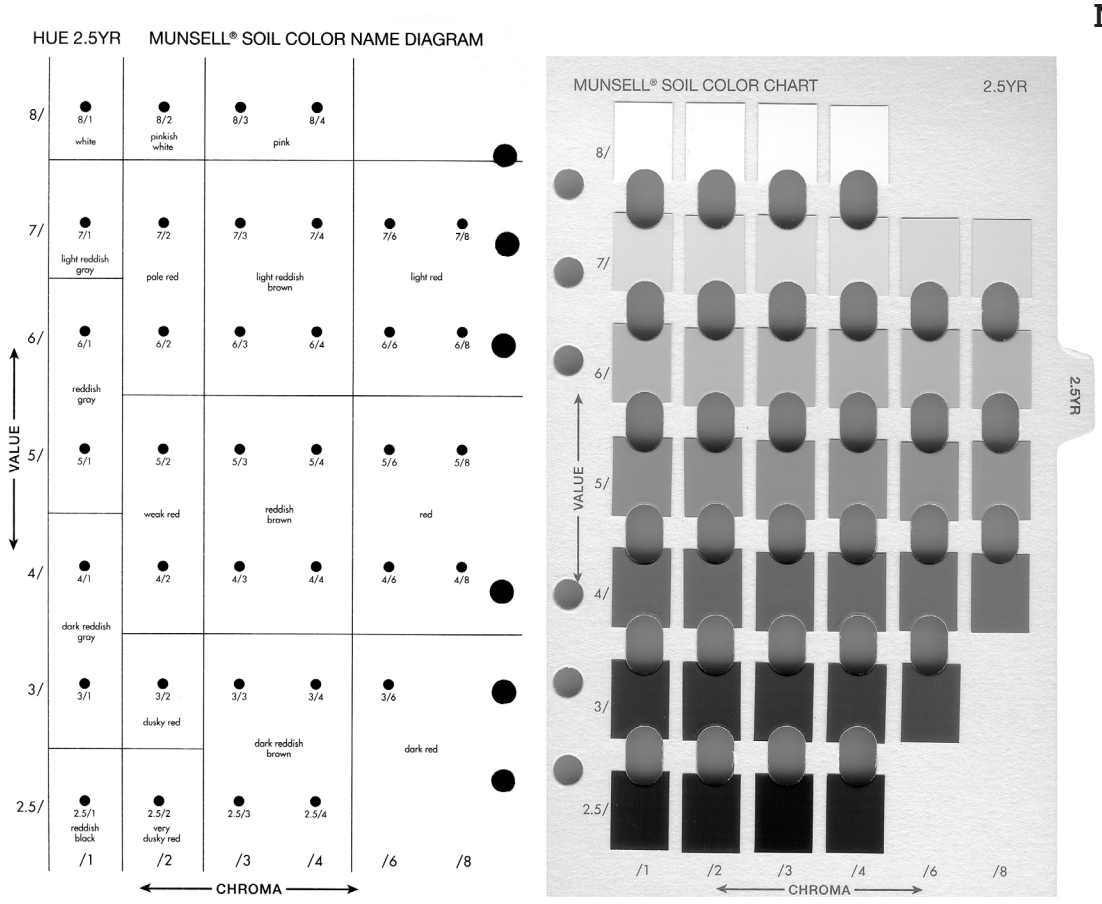
Value is the degree of lightness or darkness of the color.

Chroma describes the strength of the color.

These three components describe the color of a soil. For each horizon, a color should be identified and recorded. The Munsell color book is the standard that you would use in the field to determine the color of the soil.

Appendix 5–A has information on ordering the Munsell color book.

NOTES



The soil section of the field manual has more information on hue, value, and chroma.

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What is the color of the first horizon in the soil description for soil probe GG?

MOTTLES (REDOXIMORPHIC FEATURES)

NOTES

Mottling, which is a type of redoximorphic feature, is a soil characteristic associated with wetness. It results from the reduction and oxidation of iron in the soil.

Iron often gives soil its color. During a saturated period, the iron goes into a solution and is redeposited in concentrations, which may appear as red spots. Because the iron has left the soil, the resulting mottled soil is depleted and often grey in color.

Mottles are indicators that saturation occurs during certain times of the year when water is present in soil pores. This seasonal saturation is commonly referred to as a seasonal high water table. A seasonal high water table is a limiting zone.

- Redoximorphic features – Soil properties associated with wetness that result from the reduction and oxidation of iron and manganese compounds in the soil after successive periods of saturation and desaturation.

- Mottles are indicators that _____ occurs during certain times of the year when water is present in soil pores.

- Mottling is an _____ of a seasonal high water table.

- A seasonal high water table is a _____ _____.

ABUNDANCE AND CONTRAST

NOTES

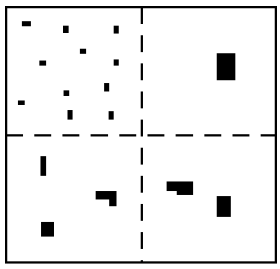
Abundance and contrast are two of the characteristics used to describe mottles.

Abundance – How many mottles?

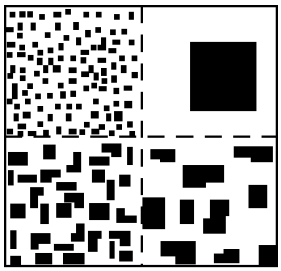
Few:	<2% surface area
Common:	2 to 20% surface area
Many:	>20% surface area

Contrast – How easy is it to see the mottles?

Faint:	Evident only on close examination.
Distinct:	Readily seen but contrast only moderately with the color to which they are compared.
Prominent:	Contrast strongly with the color to which they are compared. Prominent mottles are commonly the most obvious color feature of the section described.



2%



20%

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Is there any soil mottling noted in the soil profile description for soil probe GG?

TEXTURE

NOTES

Soil texture refers to the weight proportion of the separates for particles less than 2 mm. There are three components to soil texture:

1)

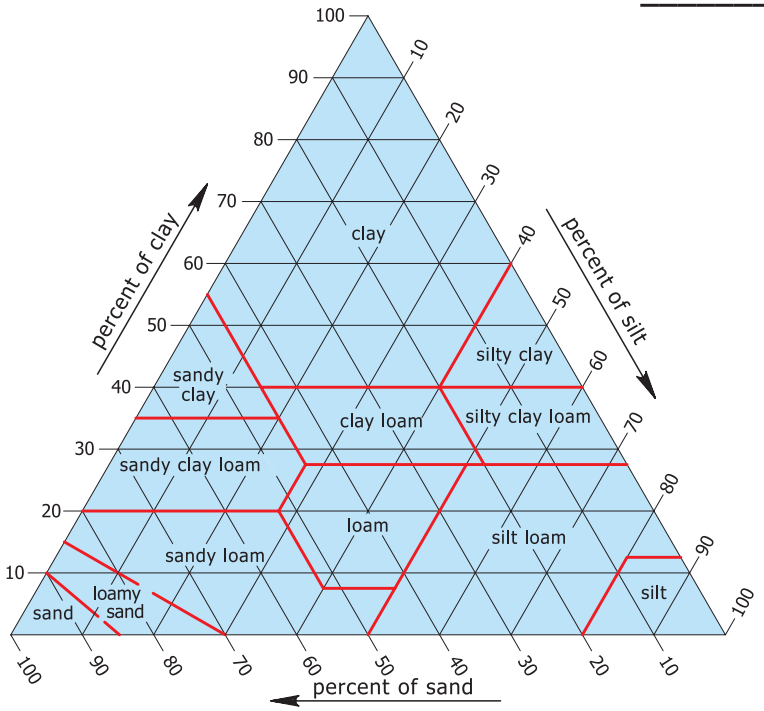
2)

3)

The relative percentage of these components determines the texture of the soil.

The soil textural triangle displays percentages of sand, silt, and clay and presents the 12 textural classes.

Example: 40% sand
40% silt
20% clay
Soil texture: _____



EXERCISE 5-1

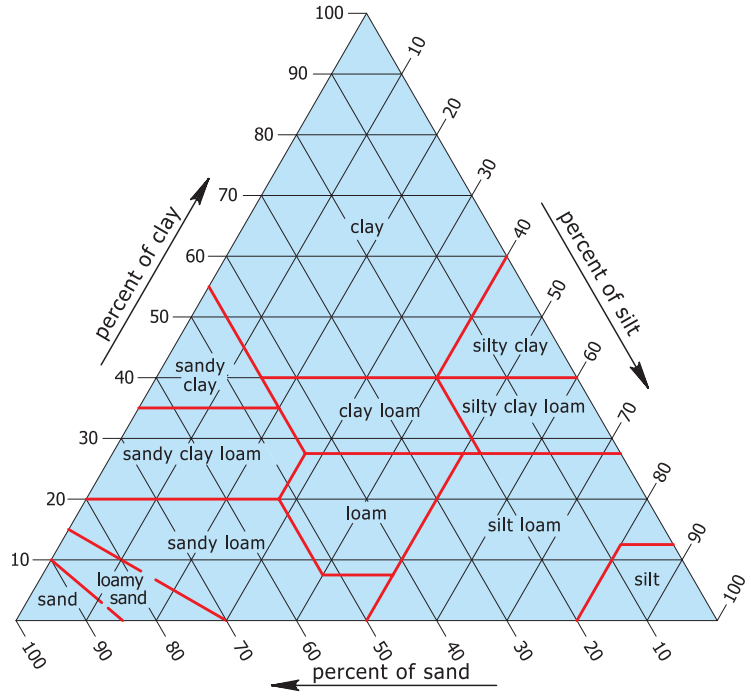
Use the soil triangle to determine what textural class the samples below are.

NOTES

Sample #1: 20% sand
60% silt
20% clay
=_____

Sample #2: 50% sand
30% silt
20% clay
=_____

Sample #3: 60% sand
30% silt
10% clay
=_____



The soil section in the field manual has additional detailed instructions on the method used to determine soil texture.

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What texture is identified in the surface horizon of the soil description for soil probe GG?

NOTES

STRUCTURE

NOTES

The structure of the soil represents the shape of a soil unit that is bound together. The structural units are like pieces of a puzzle that fit together within the soil mass. These structural units are called peds.

STRUCTURELESS

Structureless soils have no noticeable peds. Examples follow:

1) Massive – large, solid mass of material that is bound together with no indivdual units apparent

2) Single grain – single grains of sand

Water Flow – A massive structure will often restrict the flow of water, and single grains will typically percolate too fast for proper renovation.

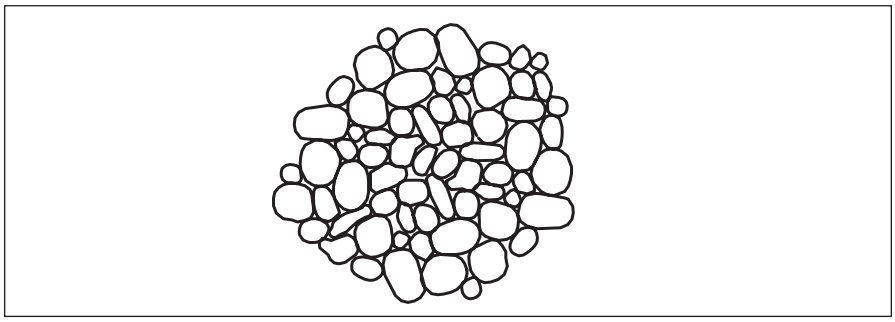
STRUCTURE – SHAPE

NOTES

The following terms describe the basic shapes and related arrangements of individual structural units:

A) Granular: The units are approximately spherical and are bounded by curved or very irregular faces.

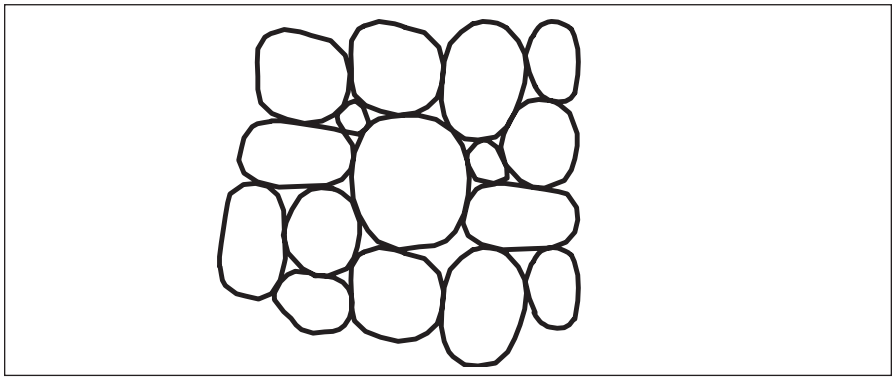
Water flow – Water moves through this structure easily.



B) Blocky: The units are blocklike. The structure is described as angular blocky if the faces intersect at very sharp angles and as subangular blocky if the faces are a mixture of rounded plane faces with mostly rounded corners.

NOTES

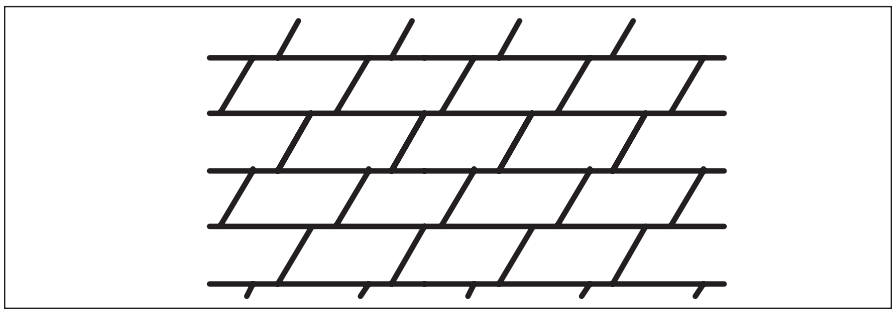
Water flow – Typically, liquid moves through both angular and subangular blocky structures easily.



C) Platy: The units are flat and platelike. They are generally oriented horizontally.

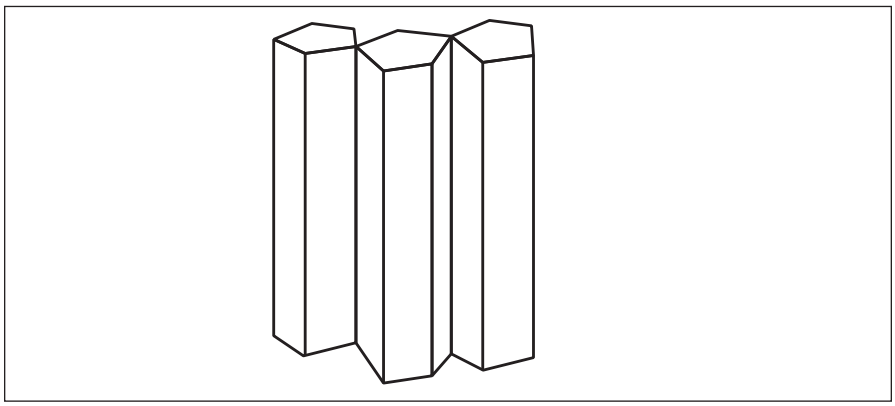
NOTES

Water flow - A platy structure most often restricts the flow of water. The water must move horizontally.



D) Prismatic: The units are distinctly longer vertically. The tops of the prisms are somewhat indistinct and normally flat.

Water flow – A prismatic structure causes water to flow through channels around the prismatic structure. The water usually flows in the root channels or along the ped surfaces, and often ponds above this restrictive structural unit.



What are the different types of soil structural shapes?

NOTES

What are the two types of structures that can be identified as structureless?

Which structures restrict the flow of water?

Which structures have a potential to drain well?

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What type of structure is in the surface horizon in the soil description for soil probe GG?

NOTES

MOIST CONSISTENCE

NOTES

Soil consistence is the resistance of a soil structural unit to deformation under pressure at various moisture contents.

- Moist consistence may be a good indicator of permeability.
- Resistance of soil material to rupture is described by how friable or firm the soil is. It represents how the soil material behaves when held between your fingers with force being applied.
- Consistence is highly dependent on soil moisture content, which is reflected in the use of the appropriate terminology.
- Several moisture levels may be used to describe consistence. In this course we will focus on moist consistence. Wet and dry terminology will not be addressed.

Consistence _____

MOIST SOIL CONDITION:	SPECIMEN BREAKS APART WITH:
Loose	Intact specimen not obtainable
Very friable	Very slight force between fingers
Friable	Slight force between fingers
Firm	Moderate force between fingers
Very firm	Strong force between fingers
Extremely firm	Moderate force between hands

For more information on consistence, refer to the soil section of the field manual.

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What is the moist consistence of the surface horizon in the soil description for soil probe GG?

NOTES

ROCK FRAGMENTS

NOTES

Rock fragments are unattached pieces of rock, 2 mm in diameter or larger, that are strongly cemented or are more resistant to rupture.

Rock fragments are described as follows:

Size – diameter of rock fragment

Shape – spherical, cubelike, or equiaxial

Percent of rock fragments – the percentage of the solid matter within the horizon that is rock

EXCESSIVE ROCK FRAGMENT CONTENT

If the rock fragments are excessive, look closely to see if there are sufficient fines between the rocks to renovate the effluent. Excessive rock fragments are a limiting zone if voids exist between the fragments.

ROCK FRAGMENT MODIFIERS

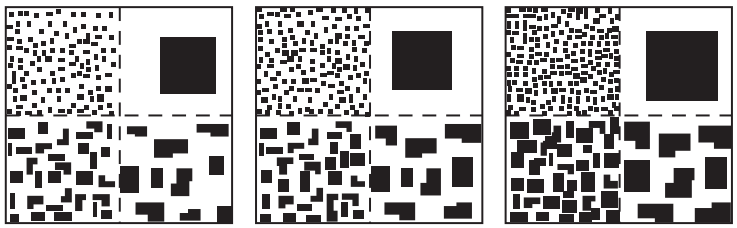
NOTES

Rock fragment modifiers are used to describe the percentage of rock fragments in the horizon. These modifiers are presented in association with soil textural class names.

Fragment Content (% by volume)	Rock Fragment Modifier Usage
<15	No texture adjective is used; e.g., loam.
15 to <35	Use adjectives for appropriate size; e.g., gravelly loam.
35 to <60	Use "very" with the appropriate size adjective; e.g., very gravelly loam.
60 to <90	Use "extremely" with the appropriate size adjective; e.g., extremely gravelly loam.
≥90	No adjective or modifier is used. If ≤10 percent fine earth, use the appropriate noun for the dominant size class; e.g., gravel.

ROCK FRAGMENT MODIFIER		
Gravelly - GR	Very gravelly - VGR	Extremely gravelly - EGR
Cobbly - CB	Very cobbly - VCB	Extremely cobbly - ECB
Channery - CH	Very channery - VCH	Extremely channery - ECH
Flaggy - FL	Very flaggy - VFL	Extremely flaggy - EFL
Stony - ST	Very stony - VST	Extremely stony - EST
Bouldery - BD	Very bouldery - VBD	Extremely bouldery - EBD

Pages 9 and 10 of the Munsell book have pictures showing the percentage of rock fragments to use as a guide, similiar to the example shown



20% 25% 35%

Size Classes

ROUNDED, SPHERICAL, OR CUBELIKE

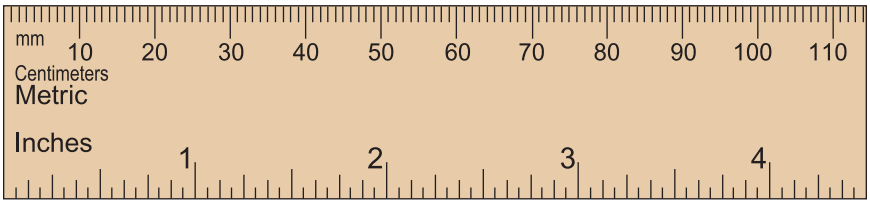
(The measurement represents the diameter of the rock.)

Size	Noun	Adjective
>2-75 mm/0-3 in.	gravel	gravelly
>75-250 mm/3-10 in.	cobbles	cobbly
>250-600 mm/10-24 in.	stones	stony
>600 mm/>24 in.	boulders	bouldery

FLAT

(The measurement represents the longest axis of the rock.)

Size	Noun	Adjective
>2-150 mm/0-6 in.	channers	channery
>150-380 mm/6-15 in.	flagstones	flaggy
>380-600 mm/15-24 in.	stones	stony
>600 mm/>24 in.	boulders	bouldery



PADEP 1/02 SITE TESTING/SOIL I-C-20

NOTES

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What is the percentage of rock fragments in the surface horizon in the soil description for soil probe GG?

IDENTIFICATION OF LIMITING ZONES

Section 71.1

NOTES

The limiting zone is the primary factor that helps to determine:

1) Site suitability for onlot sewage disposal.

2) The type of system that may be used on the site.

In determining onlot sewage suitability, the limiting zone is often the most important feature in a soil profile.

The limiting zone is the level at which effluent passing through the soil may not be renovated properly.

The following is DEP's definition of a limiting zone.

A limiting zone is a soil horizon or condition in the soil profile or underlying strata which includes one of the following:

1) A seasonal high water table, whether perched or regional, determined by direct observation of the water table or indicated by soil _____ (redoximorphic features).

2) Rock with open _____, fracture or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments.

3) A rock formation, other stratum or soil conditions which is so slowly _____ that it effectively limits downward passage of effluent.

SAMPLE PROBLEM

NOTES

0 to 10 inches
Dark brown (10YR 4/3) silt loam; weak, fine granular structure; friable; abrupt, smooth boundary.

10 to 18 inches
Yellowish brown (10YR 5/4) silt loam; weak, medium platy structure that breaks to moderate, fine subangular blocky; friable; clear, wavy boundary.

18 to 26 inches
Strong brown (7.5YR 5/6) silt loam; moderate, fine and medium subangular blocky structure; friable; gradual, wavy boundary.

26 to 38 inches
Yellowish brown (10YR 5/6) silt loam; moderate, medium subangular blocky structure; friable; gradual, wavy boundary.

38 to 56 inches
Yellowish brown (10YR 5/4) silt loam; weak, thick, platy structure; friable to firm; gradual, wavy boundary.

56 to 72 inches+
Yellowish brown (10YR 5/4) silt loam; massive; firm; light brownish gray (10YR 5/2) mottles.

What is the depth to the limiting zone in the soil description above? Why?

Limiting zone at _____ .

EXERCISE 5-2

Find the depth to a limiting zone in the two soil descriptions below.

NOTES

Description #1

0 to 14 inches
Dark brown silt loam; weak, fine granular structure; friable; 5% rock fragments.

14 to 30 inches
Strong brown silty clay loam; moderate, medium subangular blocky structure; friable; 10% rock fragments.

30 to 51 inches
Yellowish red gravelly silty clay; moderate, medium subangular blocky structure; friable; 15% rock fragments.

51 to 64 inches
Strong brown gravelly clay loam; weak, coarse subangular structure; friable; 20% rock fragments.

64 to 86 inches
Yellowish red extremely gravelly clay loam; moderate, coarse subangular blocky structure; friable; 70% rock fragments with open joints and solution channels.

Limiting zone at _____ due to _____

_____.

Description #2

NOTES

0 to 7 inches
Dark brown (10YR 4/3) silt loam; weak, medium subangular blocky structure; friable; many roots; 5% sandstone, siltstone, and shale fragments; abrupt, smooth boundary.

7 to 10 inches
Dark yellowish brown (10YR 4/4) silty clay loam; moderate, medium subangular blocky structure; friable; common roots; 5% randomly oriented sandstone, siltstone, and shale fragments; clear, wavy boundary.

10 to 18 inches
Brown (10YR 4/3) silty clay loam; moderate, medium subangular blocky structure; friable; common roots; thin continuous brown (7.5YR 4/4) clay films on faces of peds; 5% sandstone, siltstone, and shale fragments; gradual, wavy boundary.

18 to 26 inches
Yellowish brown (10YR 5/4) silty clay loam; moderate, medium angular blocky structure; firm; few roots; thin continuous dark yellowish brown (10YR 4/4) clay films; 5% randomly oriented sandstone, siltstone, and shale fragments; clear, smooth boundary.

26 to 40 inches
Yellowish brown (10YR 5/4) silty clay loam; few, medium, faint, strong brown (7.5YR 5/6) and common, medium, distinct, grayish brown (10YR 5/2) mottles; moderate, medium angular blocky structure; firm; few roots; thin continuous light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/4) clay films on faces of peds; 5% randomly oriented sandstone, siltstone, and shale fragments; few concentrations (iron and manganese oxides); gradual, wavy boundary.

40 to 55 inches
Yellowish brown (10YR 5/4) silty clay loam; common, fine, distinct, olive brown (2.5Y 5/6) and grayish brown (10YR 5/2) mottles; weak, medium, and coarse subangular blocky structure; firm; thin patchy grayish brown (2.5Y 5/2) and dark grayish brown (2.5Y 4/2) clay films on faces of peds; 10% randomly oriented sandstone fragments; few concentrations (iron and manganese oxides); gradual, wavy boundary.

55 to 70 inches
Yellowish brown (10YR 5/4) silty clay; many, medium, faint, olive brown (2.5Y 5/6) and few, fine, distinct, light brownish gray (2.5Y 6/2) mottles; massive; firm; 10% randomly oriented siltstone fragments, few concentrations (iron and manganese oxides); gradual, wavy boundary.

70 to 80 inches
Yellowish brown (10YR 5/6) channery clay loam; many medium, distinct, grayish brown (2.5Y 5/2) mottles; massive; firm; 20% randomly oriented sandstone, siltstone, and shale fragments.

Limiting zone at _____ due to _____

_____.

NOTES

JONES PERMIT

JONES

NOTES

What are the limiting zone depths for the Jones's soil probes?

Below _____ in. for GG

Below _____ in. for HH

SYSTEMS

NOTES

Often, the limiting zone depth determines the type of system. Two types of systems are covered in this academy. Each system has a different minimum suitable soil depth requirement.

1) In-ground – minimum of _____ inches of suitable soil (The system installation cannot violate the 48-inch separation between the bottom of the system aggregate to the top of the limiting zone.)

2) Elevated – minimum of _____ inches of suitable soil

What type of system would work with:

Description 1 –

Description 2 –

JONES

What type of system would work with:

Jones probe GG –

LAB

There are three lab stations. You will have approximately 10 to 12 minutes to complete the tasks at each station. A signal will be given to rotate to the next station. You may work as a group or individually. This lab provides an opportunity for you to practice identifying and describing individual soil characteristics prior to the field exercise tomorrow.

You will not need your workbook for the lab. This is not a test but an opportunity for you to practice and gain experience in the soil information discussed today. There will be an instructor at each station to help, to give demonstrations, and to reveal the correct answers before each group rotates to the next station.

Station 1 – Color

Station 2 – Texture

Station 3 – Structure, consistence, and mottling

NOTES

KEY POINTS

- Make sure your soil profile description is complete.
- The depth to the limiting zone will partially determine if a permit may be issued.
- A complete soil profile description will support the limiting zone interpretation.
- There must be a minimum of _____ inches of suitable soil to consider a site for a conventional onlot sewage disposal system installation, excluding IRSIS.
- The limiting zone depth may determine the type of system.
- There must be at least _____ inches of suitable soil to a limiting zone in order to install an inground system on the site.
- There must be at least _____ inches of suitable soil to a limiting zone in order to install an elevated system on the site.

NOTES

SOIL LAB

NOTES

STATION 1 – Color

SAMPLE A _____

SAMPLE B _____

STATION 2 – Texture

SAMPLE A _____

SAMPLE B _____

STATION 3 – Structure Consistence Mottling

SAMPLE A _____

SAMPLE B _____

SAMPLE C _____

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Soil Field Sheet

Name_____ **SEO#**_____ **Date**_____ **Site**_____

No. of horizons_____ **Profile depth**_____ **Slope**_____

Limiting zone depth_____ **Limiting zone type**_____

Soil Morphology

Boundary		**Color**			**Texture**		**Structure**	**Consistence**	**Mottling (Redox. Features)**	
Depth Top		Hue	Value	Chroma	Rock Fragment Modifier	Class	Type	Moist	Abundance	Contrast