Lesson C1–2

Understanding Soil Texture and Structure

Unit C. Basic Principles of Agricultural/Horticultural Science

Problem Area 1. Using Basic Soil Science Principles

Lesson 2. Understanding Soil Texture and Structure

New Mexico Content Standard:

Pathway Strand: Natural Resources and Environmental Systems

Standard: **VII:** Apply scientific principles to environmental services.

Benchmark: **VII-B:** Describe soil compositions and properties to demonstrate knowledge of soil science.

Performance Standard: **1.** Describe soil geology. **2.** Describe composition of soil. **3.** Describe the biological properties of soil. **4.** Identify the physical properties of soil. **5.** Describe the chemical properties of soil. **6.** Test soil samples to determine characteristics. **7.** Explain classification of soil water. **8.** Explain the relationship between soil classifications and land use.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Describe the concept of soil texture and its importance.
2. Determine the texture of a soil sample.
3. Describe soil structure, its formation, and importance.
4. Identify various soil structures.

List of Resources. The following resources may be useful in teaching this lesson:

Biondo, Ronald J. and Jasper S. Lee. *Introduction to Plant and Soil Science and Technology*, Second Edition. Danville, Illinois: Interstate Publishers, Inc., 2003. (Textbook and Activity Manual, Chapter 7)

Plaster, Edward J. *Soil Science & Management*. Albany, New York: Delmar Publishers, 1997. (Textbook and Lab Manual, Chapter 3)

Other Resources. The following resources will be useful to students and teachers:

Illinois Master Gardener. University of Illinois at Urbana-Champaign, Cooperative Extension Service.

Porter, Lynn, et al. *Environmental Science and Technology,* Second Edition. Danville, Illinois: Interstate Publishers, Inc., 2003. (Textbook and Activity Manual, Chapter 13)

Sager, Robert J., et al. *Modern Earth Science.* Austin, Texas: Holt, Rinehart, and Winston, Inc., 1998. (Textbook, Chapter 12 & 14)

VAS U4052a, *Understanding Soils.* Urbana, Illinois: Vocational Agriculture Service.

VAS U4030, *Soil Texture.* Urbana, Illinois: Vocational Agriculture Service.

VAS U4028, *Soil Structure.* Urbana, Illinois: Vocational Agriculture Service.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Sample of soil
Copies of Student Lab Sheets
Transparencies from attached masters
Soil pit

Terms. The following terms are presented in this lesson (shown in bold italics):

Clods
Loam
Peds
Permeability
Soil structure
Soil texture
Soil workability
Textural triangle
Water-holding capacity

Interest Approach. Provide students with various samples of soil. One sample should be nearly all sand, one nearly all clay, and one nearly all silt. Ask students to determine how the samples differ. Would each sample be equally productive? Indicate that the samples vary according to the size of soil particles. Ask students how particle size might affect various soil properties. Allow comments to lead to a discussion of soil texture.

Summary of Content and Teaching Strategies

Objective 1: Describe the concept of soil texture and its importance.

Anticipated Problem: What is soil texture and why is it important?

I. A. ***Soil texture*** is the fineness or coarseness of a soil. It describes the proportion of three sizes of soil particles. These are:

1. Sand—large particle
2. Silt—medium sized particle
3. Clay—small particle

B. Texture is important because it affects:

1. ***Water-holding capacity***—the ability of a soil to retain water for use by plants
2. ***Permeability***—the ease with which air and water may pass through the soil
3. ***Soil workability***—the ease with which soil may be tilled and the timing of working the soil after a rain
4. Ability of plants to grow—some root crops like carrots and onions will have difficulty growing in a fine-textured soil

Use TM: C1–2A to show students the relative size of soil particles. It would be helpful to display samples of the various textural classes in order to understand relative sizes of soil particles. Use TM: C1–2B to discuss the importance of texture as it relates to other factors. The appropriate sections of the text materials will also be helpful for students to understand the related concepts.

Objective 2: Determine the texture of a sample of soil.

Anticipated Problem: How is the texture of soil determined?

II. A. Soil texture may be determined in one of two ways:

1. The percentages of sand, silt, and clay may be tested in the lab. Once tested, you may determine the textural class of the soil by referring to the ***textural triangle***. There are 12 basic textural classes:
   a. Silt
   b. Silt loam
   c. Silty clay loam

d. ***Loam***—contains some of all 3 soil particle sizes
e. Sandy clay loam
f. Loamy sand
g. Sand
h. Sandy loam
i. Sandy clay
j. Clay loam
k. Silty clay
l. Clay

1. The relative amounts of sand, silt, and clay may also be determined in the field using the ribbon method. Five textural classes may be determined using the ribbon method:
   a. Fine-textured—a ribbon forms easily and remains long and flexible.
   b. Moderately fine-textured—a ribbon forms but breaks into pieces ¾ to 1 inch long.
   c. Medium-textured—no ribbon forms. The sample breaks into pieces less than ¾ inch long. The soil feels smooth and talc-like.
   d. Moderately coarse-textured—no ribbon forms. The sample feels gritty and lacks smoothness.
   e. Coarse-textured—no ribbon forms. The sample is composed almost entirely of gritty material and leaves little or no stain.

Use TM: C1–2C to explain the textural triangle. Give students various percentages of sand, silt, and clay (making sure percentages add up to 100), and ask them to determine the soil texture using the textural triangle. When students have mastered this, divide them into groups and have them complete LS: C1–2A, Sedimentation Test of Soil Texture. Finally, discuss the various textural classes listed above for the ribbon method. Give each student several different samples to determine soil texture using the ribbon method as instructed on LS: C1–2B.

Objective 3: Describe soil structure, its formation, and importance.

Anticipated Problem: What is soil structure, how does it form, and why is it important?

III. A. ***Soil structure*** is the arrangement of the soil particles into clusters or aggregates of various sizes and shapes. Aggregates that occur naturally in the soil are referred to as ***peds***, while clumps of soil caused by tillage are called ***clods***.

B. Structure is formed in two steps.
   1. A clump of soil particles sticks loosely together. These are created through:
      a. Plant roots surrounding the soil and separating clumps
      b. Freezing and thawing of soil
      c. Soil becomes wet and then dries

d. The soil is tilled
e. Fungal activity

2. Weak aggregates are cemented to make them distinct and strong. Clay, iron oxides, and organic matter may act as cements. When soil microorganisms break down plant residues, they produce gums that also glue peds together.

C. Soil structure is important for several reasons:
1. It improves soil tilth.
2. It improves permeability.
3. It resists the beating action of raindrops, minimizing the formation of crusts that reduce crop stands.

Have students read the appropriate section in text material on soil structure. Take a sample of soil with good structure and place it on a tabletop or desktop. Students should be able to see that the soil does not all fall apart. These naturally occurring clusters demonstrate soil structure. Using the notes above, discuss how soil structure is formed and why it is important for good plant growth.

Objective 4: Identify various soil structures.

Anticipated Problem: What are the various soil structures and what do they look like?

IV. There are eight primary types of structure. They are:

A. Granular—aggregates are small, non-porous, and strongly held together.
B. Crumb—aggregates are small, porous, and weakly held together.
C. Platy—aggregates are flat or plate-like. Plates overlap, usually causing slow permeability.
D. Prismatic or Columnar—aggregates are prism-like with the vertical axis greater than the horizontal. Prismatic has flat caps while columnar has rounded caps.
E. Blocky—aggregates are block-like, with six or more sides. All three dimensions are about the same.
F. Structureless—there is no apparent structure. It may be found in one of two forms:
1. Single grain—soil particles exist as individuals and do not form aggregates.
2. Massive—soil particles cling together in large uniform masses.

Use TM: C1–2D to demonstrate the various types of soil structure. If possible, dig a soil pit to show students the different types of soil structure and where they can be found. Remind students that granular, crumb, and platy are usually found in the top soil or A horizon; prismatic, columnar, and blocky are usually found in the subsoil or B horizon; and that structureless is usually found in the substratum or C horizon.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at end of chapters in the textbook may also be used in the review/summary.

Application. Application can involve one or more of the following student activities using attached lab sheets:

Sedimentation Test of Soil Texture—LS: C1–2A

Determining Soil Texture Using the Ribbon Method—LS: C1–2B

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1=e, 2=d, 3=a, 4=b, 5=f, 6=c

Part Two: Completion

1. soil workability
2. loam
3. fine-textured
4. clods
5. massive and single grain

Part Three: Short Answer

1. a. large
   b. small
   c. medium
2. Plants which have large structures that grow underground have difficulty growing in fine-textured soils.
3. Students can list any two of the following: improves soil tilth, improves permeability, and reduces formation of crusts which reduces crop stand.

Test

Lesson C1–2: Understanding Soil Texture and Structure

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. water-holding capacity	c. peds	e. soil texture
b. soil structure	d. permeability	f. textural triangle

_____ 1. The fineness or coarseness of soil particles.

_____ 2. The ease with which air and water may pass through the soil.

_____ 3. The ability of soil to retain moisture for plants.

_____ 4. The arrangement of soil particles into clusters or aggregates.

_____ 5. A chart used to classify soil according to its coarseness or fineness.

_____ 6. Aggregates that occur naturally in the soil.

Part Two: Completion

Instructions. Complete the following statements.

1. The ease with which soil may be tilled is referred to as _____.
2. A sample that contains some of each of the sizes of soil particles is referred to as a _____.
3. When conducting the ribbon method for determining texture, the soil forms a long, pliable ribbon. This soil's texture could be classified as _____.
4. Clumps of soil that are caused by tillage are referred to as _____.
5. A soil that has no structure may appear in one of two forms. They are _____ and _____.

Part Three: Short Answer

Instructions. Use the space provided to answer the following questions.

1. Classify the following soil particles as small, medium, or large in comparison to each other:
   a. sand—

   b. clay—

   c. silt—

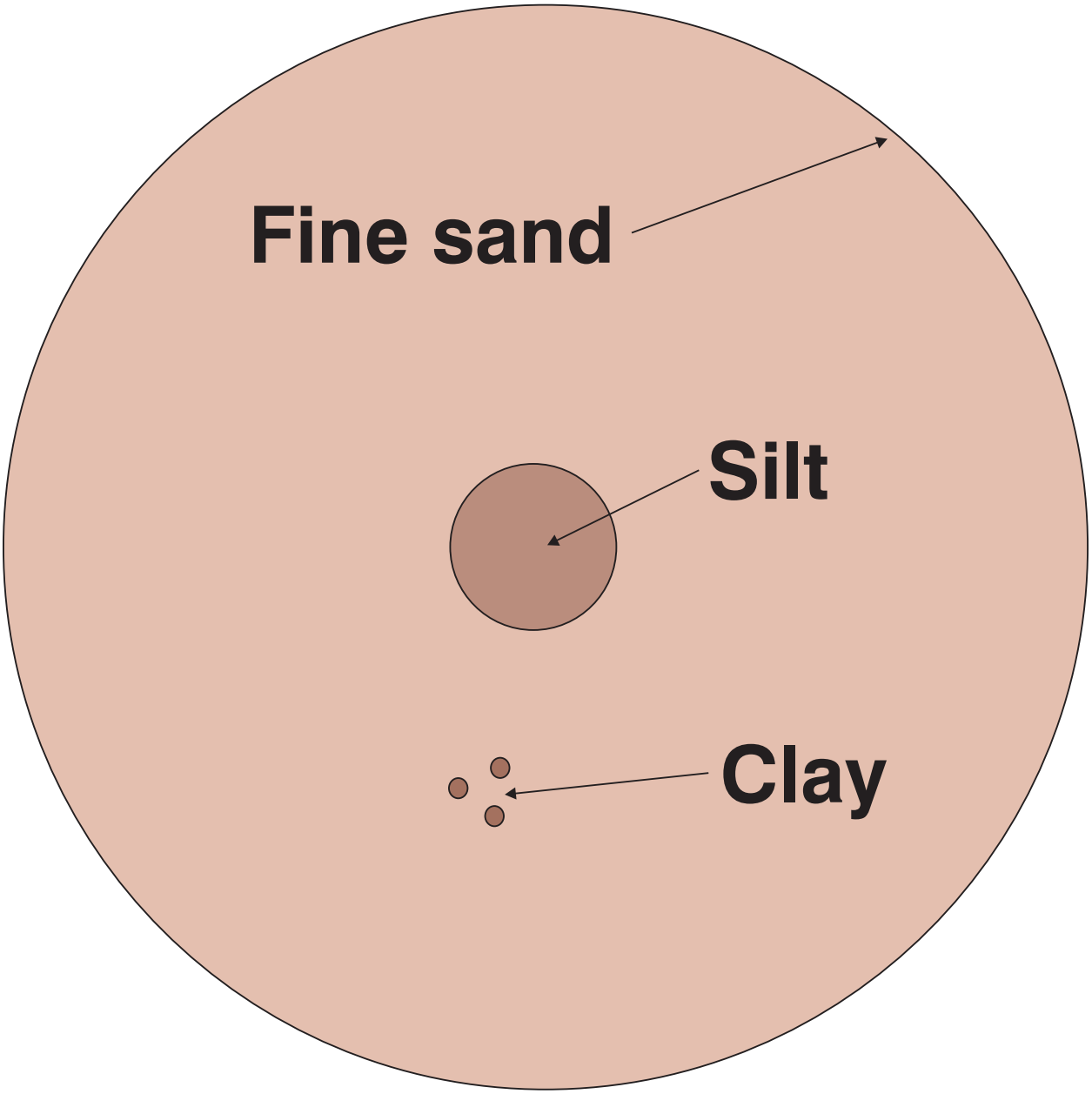
2. How does texture affect the ability of plants like carrots and onions to grow?

3. Briefly explain two of the three ways that soil structure is beneficial to plant growth.
   a.

   b.

TM: C1–2A

The Relative Sizes of Sand, Silt, and Clay Particles



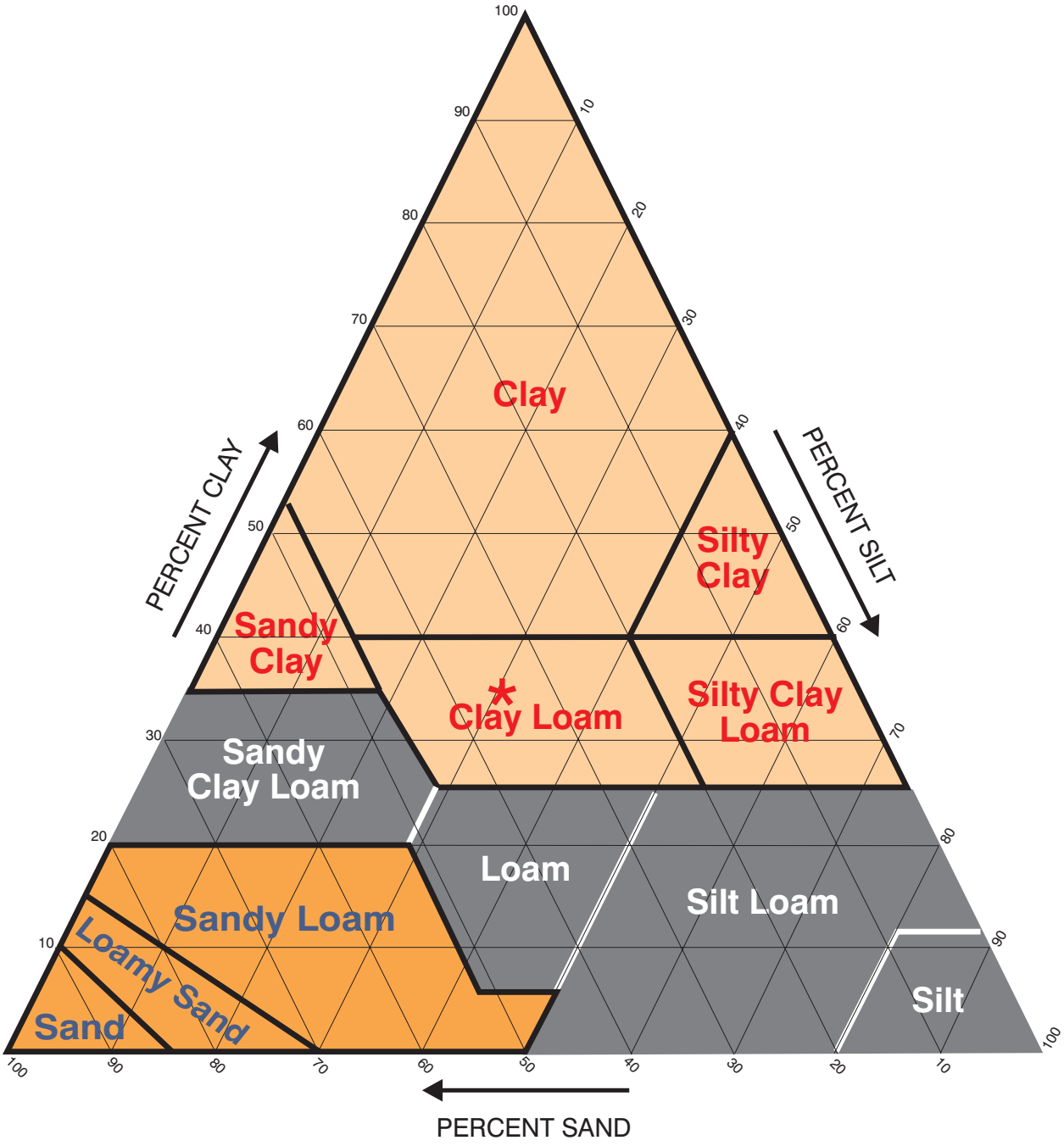
TM: C1–2B

Factors Affected by Texture

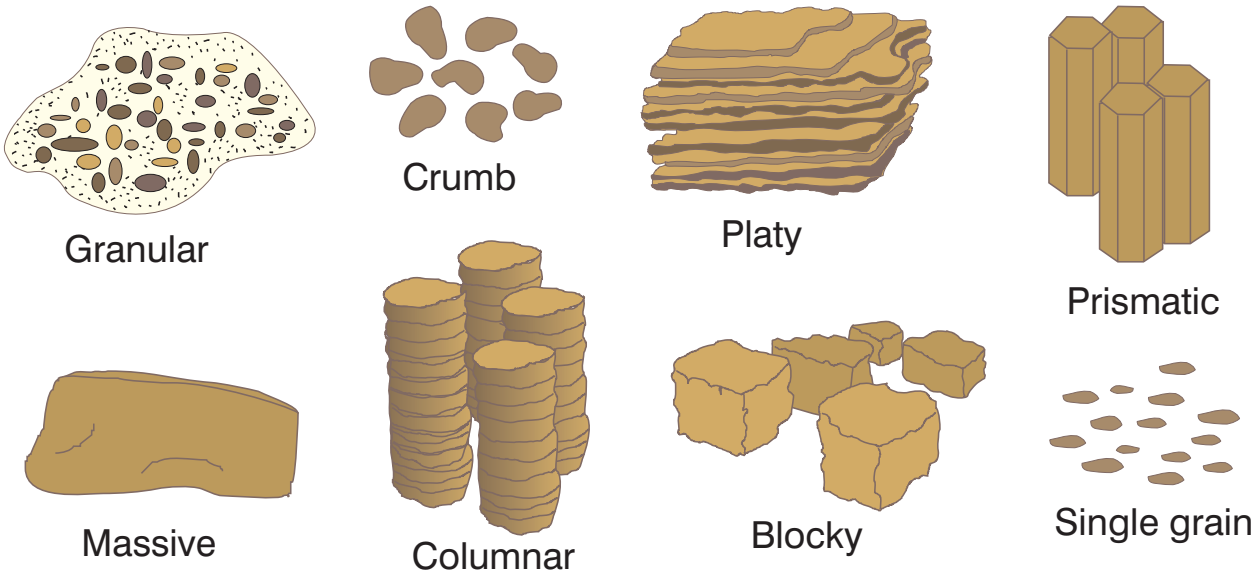
1. Water-holding capacity
2. Permeability
3. Soil workability
4. Ability of plants to grow

TM: C1–2C

Soil Triangle



Common Types of Soil Structure



 Name_____

Lab Sheet

Sedimentation Test of Soil Texture

Purpose:

Measure relative amounts of sand, silt, and clay in a sample of soil. This activity is based on the fact that large, heavy particles will settle most rapidly in water, while, small, light particles will settle most slowly. The Calgon laundry powder is used to "dissolve" the soil aggregates and keep the individual particles separated.

Objectives:

1. Determine the amount of sand, silt, and clay in a given sample of soil.
2. Determine the textural class by using a textural triangle.
3. Recognize differences in soil textures.

Materials:

Soil sample
One 1-quart fruit jar with lid
Eight percent Calgon solution—mix 6 tablespoons of Calgon (a laundry powder available in stores) per 1 quart of water
Metric ruler
Measuring cup
Tablespoon

Procedure:

1. Place about ½ cup of soil in the jar. Add 3½ cups of water and 5 tablespoons of the Calgon solution.
2. Cap the jar and shake for 5 minutes. Leave the jar on the desk. Allow it to settle for 24 hours.
3. After 24 hours, measure the depth of the settled soil. All soil particles have settled. This is known as the TOTAL DEPTH. Record and label it.
4. Shake the jar for another 5 minutes. Allow it to stand 40 seconds. This enables the sand to settle. Measure the depth of the settled soil and record as SAND DEPTH.
5. Do not shake the jar again. Let it stand for another 30 minutes. Measure the depth. Then subtract the sand depth to determine the SILT DEPTH.
6. The remaining unsettled particles are clay. Calculate the CLAY DEPTH by subtracting the silt and sand depth from total depth.

7. Now calculate the percentage of each soil separate using these formulas:

$$\% \text{ sand} = \frac{\text{Sand depth}}{\text{Total depth}} \times 100$$

$$\% \text{ silt} = \frac{\text{Silt depth}}{\text{Total depth}} \times 100$$

$$\% \text{ clay} = \frac{\text{Clay depth}}{\text{Total depth}} \times 100$$

8. Determine the textural class of the soil sample using the textural triangle.

 Name_____

Lab Sheet

Determining Soil Texture Using the Ribbon Method

Purpose:

Determine the relative textural classes in the field using the ribbon method. This method is only useful for estimating soil texture.

Objectives:

1. Determine textural class using the ribbon method.
2. Recognize differences in soil according to their texture.

Materials:

Soil sample
Water bottle

Procedure:

1. Moisten a sample of soil to the consistency of a firm workable putty.
2. Make a ball about ½ inch in diameter.
3. Hold the soil ball between your thumb and forefinger. Gradually press your thumb forward, forming the soil into a ribbon.
   A. If a ribbon forms easily and remains long and flexible, the sample is classified as fine-textured.
   B. If a ribbon forms but breaks easily, the soil is classified as moderately fine-textured.
   C. If no ribbon is formed, but the soil feels smooth and talc-like with no grittiness, the soil is classified as medium-textured.
   D. If no ribbon is formed and the sample feels gritty and lacks smoothness, the soil is classified as moderately coarse-textured.
   E. If no ribbon is formed and the sample is composed almost entirely of gritty material and leaves no stain on your hand, the soil is classified as coarse-textured.
4. Classify the sample of soil provided.