Soils: Texture and Water Retention Properties

Know Your Soils!!

Description

Soils are one of our most important natural resources. An individual soil is a natural body that occurs on the land surface, occupies space, and is characterized by horizons or layers and has the ability to support rooted plants in a natural environment.
Soils are made partly from weathered rock and partly from organic materials. Soils differ in their color, texture, capacity to retain water, and ability to support the growth of many kinds of plants
Soils also are important for the beauty their many colors add to our landscapes. Most of us overlook this natural beauty because we see it every day. Often these colors blend with vegetation, sky, water, etc.
Soils are crucial to life on Earth. Soils will continue to supply us with nearly all of our food (except for what can be harvested from the oceans).
Soil units, particles, properties, characteristics, materials, and behavior are the most important natural consideration when we want to build on earth. Any human structure placed on the surface of the earth needs to account for specific soil properties tied to the soil on which it is developed.
Today we are going to study 2 very important soil properties and characteristics and show how they are important when considering construction materials and decisions about how to build structures on the earth surface

Objectives

Students will be able to:

- Name the various materials that comprise soil, including weathered rock and other organic matter;
- Understand and identify the various components of the Soil textural Triangle and their usefulness in soil science.
- Learn techniques in determining the textural class of a soil by direct and indirect methods.
- Perform experiments to demonstrate soil water retention properties.
- Identify the usefulness of soil properties in construction and other human activities

North Dakota State Standards

9-10.1.1	Explain how models can be used to illustrate scientific principles
9-10.2.1	Explain how scientific investigations can result in new ideas
9-10.2.6	Design and conduct a guided investigation
9-10.2.7	Maintain clear and accurate records of scientific investigations
9-10.2.8	Analyze data found in tables, charts, and graphs to formulate conclusions
9-10.6.3	Explain how emerging technologies may impact society and the environment
11-12.1.2	Identify structure, organization, and dynamics of components within a system
11-12.8.1	Identify the criteria that scientific explanations must meet to be considered valid

Schedule

09:00-09:30	General Organization and Cultural Connection
09:30-10:00	PowerPoint Presentation
10:00-10:30	Activity 1
10:30-11:15	Activity 2
11:15-12:00	Activity 3
12:00-12:45	Lunch
12:45-01:45	Activity 4
01:45-02:30	Activity 5
02:30-02:50	Activity 6
02:50-03:00	Wrap-up activity and Reflection questions

Cultural Connection:

Terminology to Note:

The soil
A soil
Soils
Porosity
Permeability
Soil texture
Textural class
Sand
Silt
Clay
Soil water
Pedologists
Edaphologists
Soil scientists
Soil classification
Soil survey (web soil survey)
Soil Orders
Biotic and abiotic soil factors
CLORPT
Secondary fuels:

Activity 1: Investigating Local Soils Using Web Soil Survey (WSS)

Introduction:

The United States Department of Agriculture (USDA) through it Soil Survey agency, recently classified and identified all soils in the USA! It is currently possible for you to find out detailed information on any soils of interest to you such as soils on which your home is built.

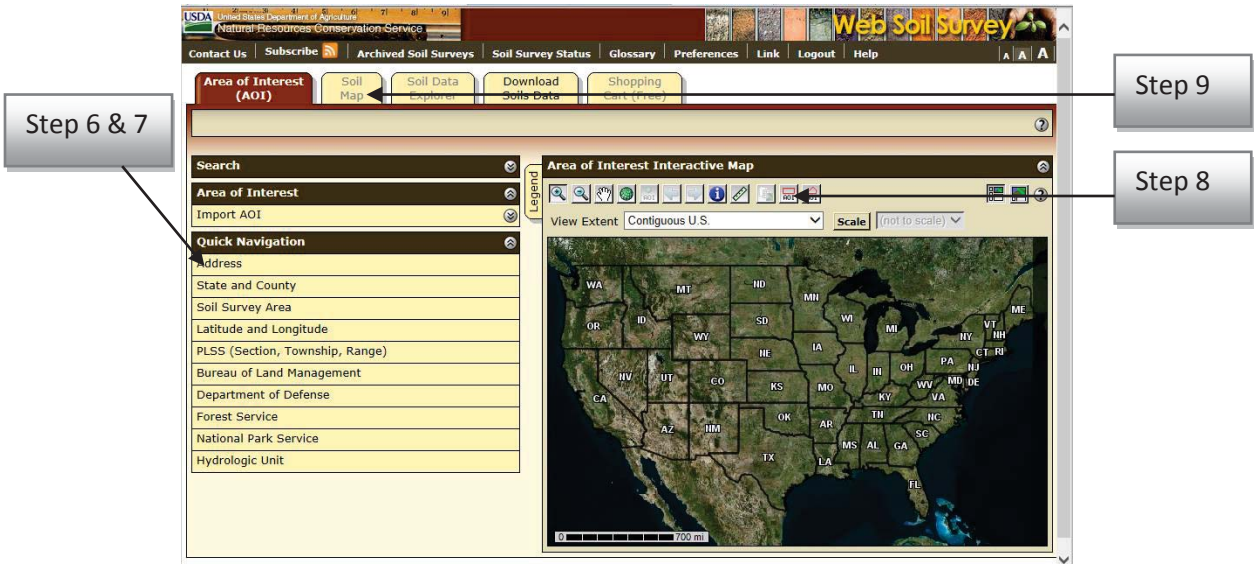
No two soils are the same and this activity will essentially demonstrate this fact. The USDA has provides the data it has collected about soils for free to the public on its web soil survey website. Today we are going to identify and characterize the soils on which your homes are built using this very important service.

Materials:

Computer
Internet connection
Your home address

Procedure:

1. Log on to a computer and start a web browser.
2. Go to the following website: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
3. Click on the icon "START WSS" to launch the application
4. Explore the tools and various taskbars provided by this online application
5. The next step is to identify an Area Of Interest or AOI unit.



6. On the Quick Navigation Menu, click on ADDRESS. A drop down box opens.
7. Type in your address and click on the view button. The map zooms in to your address location.
8. On the map's toolbar, select the AOI icon with the red rectangle to create a zone of interest in the map.
9. Select the Soil Map menu to see the soil information data for your selected area.
10. Click on each map unit name to find out a classification and soil characteristic for that unit.
11. Click on the Soil Data Explorer menu to find out more information about the soils on your property.

Question
What is the name of the soil type on which your house is built?

Activity 2: Investigating Local Soils

Introduction:
A soil is made up of rock material that has been broken down over time into tiny grains by wind and rain. Soil also contains a variety of materials including minerals, and decayed plant and animal material.

Materials: (Each student)
3 One-quart plastic bags
Soil samples
Paper plates
Magnifying glass
Strainer
Pan
Paper
Pencils
Shovels or a tool to dig and scoop soil material

Procedure:

1. Use 15 minutes to go out into the yard around campus, find a hill and identify 3 location: at the top, middle and bottom of the hill; pick a spot in each location to collect a soil sample. Find samples of soil from different areas so a wider range of soil types can be examined.
2. Fill a one-quart plastic bag about 2/3 full of soil from each of these locations.
3. Once you return to your work stations, you will investigate and observe your samples.

4. Pour one of your samples onto paper plate and look carefully at all of the materials in the soil.
5. While observing your soil sample, answer the following questions.

Questions

1. What is the color of the soil? (Dark brown, light brown, reddish-brown, etc.)

2. How does it feel? (Gritty, sandy, smooth, etc.)

3. What kinds of things can be seen in the sample? (Leaves, small twigs, rocks, etc.)

4. What is the texture of the soil? Is it soft, or does the sample have hard clumps in it?

5. How do you think the soil may have formed?

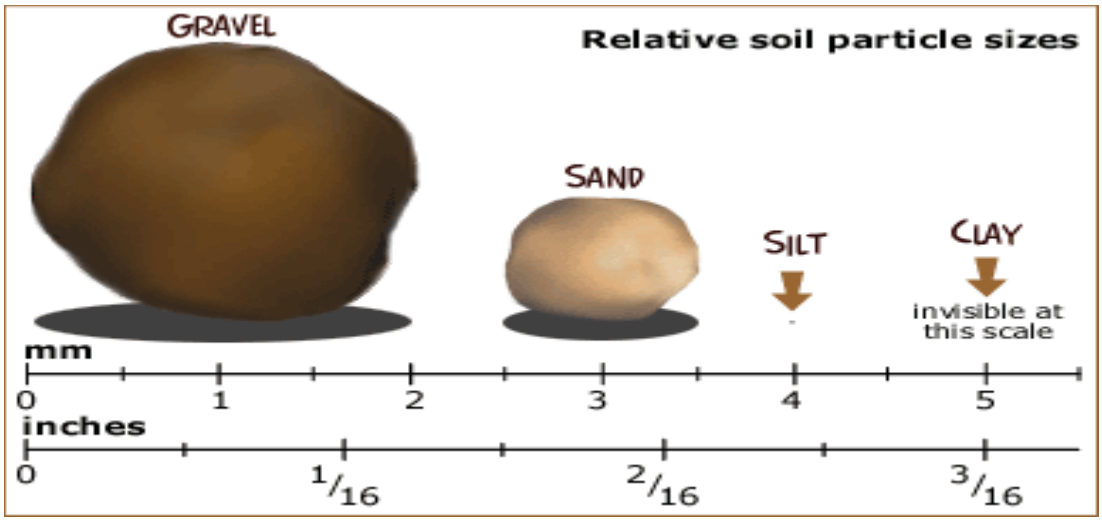
6. Which kind of soil do you think would be best for plant growth? Which kind will be ideal a building material?

Soil Texture

Soil texture is important for determining suitability for various uses of the soil. Texture is considered a basic property of soil because it doesn't change, giving it consistency for comparison. Most soils have a combination of soil particles sizes. Three soil separates are sand, silt, and clay.

- Sand has a gritty feel, can be seen with the naked eye, and leaves no residue on your hand when hand sampling.
- Silt has a powdery smooth feel, flour-like texture when dry and a creamy slick, slippery feel texture when wet. Silt doesn't have a sticky or plastic feel. You can see silt with a hand lens or microscope. When hand sampling, silt will coat your hand, but can be brushed off.

- Clay feels hard when dry and has a sticky, plastic feel when wet. Clay particles can only be seen with an electron microscope. It will stick to your fingers after hand sampling.



Activity 3: Soil Texture Mathematics

Introduction

In this activity we demonstrate the basic mathematics involved in determining a soil textural class. As mentioned earlier, soils are made up of 3 main particle sizes which combine to form the soil textural classes. These are:

- CLAY
- SILT
- SAND

These particle sizes typically combine to form 100% of the soil in varying ratios depending on the soil type and the location from which you collected your sample.

Example: a soil could be 5% Clay, 45% Silt, and 50% Sand for a total of 100%!!!

Materials: (Each student)

Soil Textural Triangle Sheet

Procedure

We apply the basic mathematics involved in determining a soil textural class. We are going to use percentage calculations to identify the textural class of our hypothetical soils!

Remember, all soils have 3 main particle sizes! Clay, silt, and sand! Usually, you only need 2 numbers to determine the textural class of any soil. Hence a third number may not be necessary because this number is usually easy to figure out!!!!

Table 2: Fill in the right textural class for each soil based on the textural class triangle and the percentages listed below

SOIL #	CLAY	SILT	SAND	Textural Class
1	8%	49%	43%	
2	25%	10%	65%	
3	23%	55%	22%	
4	20%	20%	60%	
5	25%	30%	45%	
6	15%	50%	35%	
7	5%	70%	25%	
8	40%	45%	15%	
9	1%	2%	97%	
10	35%	40%	25%	
11	20%	70%	10%	
12	10%	45%	45%	

Questions

1. How many textural classes are represented in your table?

2. Which textural class is the most common class in your table? How many soils fall in this class?

3. Which textural class is the least common class in your table?

Activity 4: Soil Texture Analysis by Suspension Method

1. Use a wide-mouth, quart-size jar with a lid.

2. Fill the jar half full of soil.

3. Wet the soil to a mud consistency and tap the jar to settle the soil.

4. Mark the level of soil on the jar with a marking pen or whiteout.

5. If you have some Calgon put a teaspoon full in the jar.

6. Add water to the top of the jar and shake the soil water mix till the soil is all mixed up in the water.

7. Put the jar on a table and let the soil settle out for 40 seconds, mark the level of soil on the jar. This is sand portion in the soil.

8. Wait 6 hours and mark the level of the soil in the jar. The difference between the bottom mark, which is the sand, and the second mark up is the silt portion of the soil. The total sand plus silt is the distance from the bottom of the jar to the second mark.

9. Calculate the percent sand, silt, and clay by measuring the depth of the soil. Measure in inches: the distance from the bottom to the first mark for the sand fraction; the distance from the first mark up to the second mark for the silt fraction; and the distance from the bottom to the third mark for the sand plus silt plus clay fraction. If you have the time to do this, let the jar sit for several days before you measure it for a more accurate calculation. Also, the sand , silt, and clay is a volume percentage. The soil triangle and table below is by weight. You can convert from percent volume to percent weight by multiplying the percentage of sand by 1.19, the percentage of silt by 0.87 and the percentage of clay by 0.94. These numbers are the weight ratios of bulk density compared to average bulk density of the material.

10. The percent sand is the depth of the sand divided by the depth of the total soil.

11. The percent silt is the depth of the silt divided by the depth of the total soil.

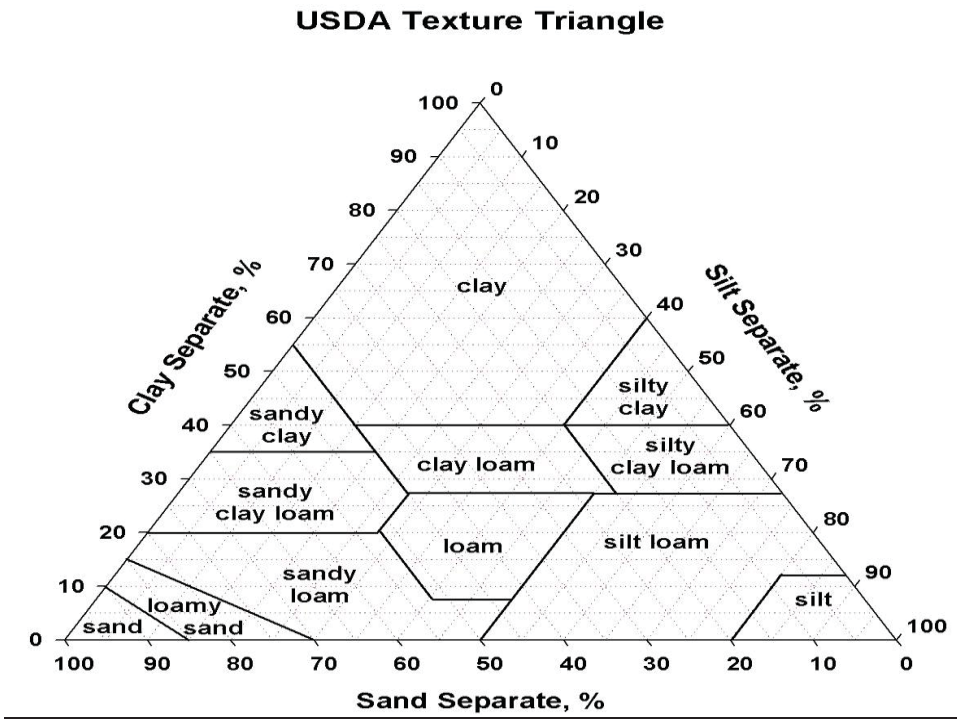
12. The percent clay is 100 minus the percent sand plus silt.

13. To determine the soil texture knowing percent sand silt and clay, a simple method to estimate the percent sand silt and clay in a soil and determine its texture is by using the table below:

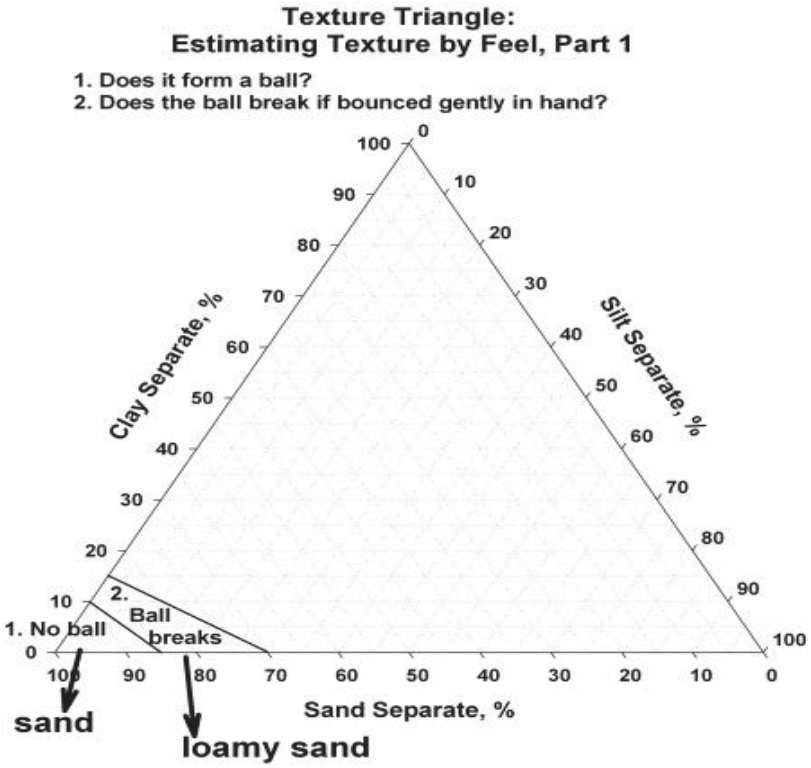
oil classification	Clay Soil	Loam Soil	Sandy Soil
percent clay	40-100%	7-27%	1-10%
percent silt	0-40%	28-50%	1-15%
percent sand	0-45%	23-52%	85-100%

Activity 5: Estimating Soil Texture by Feel Method

A more precise determination of soil texture and percent sand silt and clay uses the soil triangle. When estimating soil texture using the feel method, there are essentially four steps to approximate the USDA Soil Textural Triangle. The USDA Texture Triangle has 12 texture categories, or classes, as can be seen in the diagram below:



Step 1.
Take a handful of soil. If the soil is dry, moisten it just enough to determine if it will form a ball when squeezed in the palm of the hand. If the moist soil will not form a ball, it is a sand.



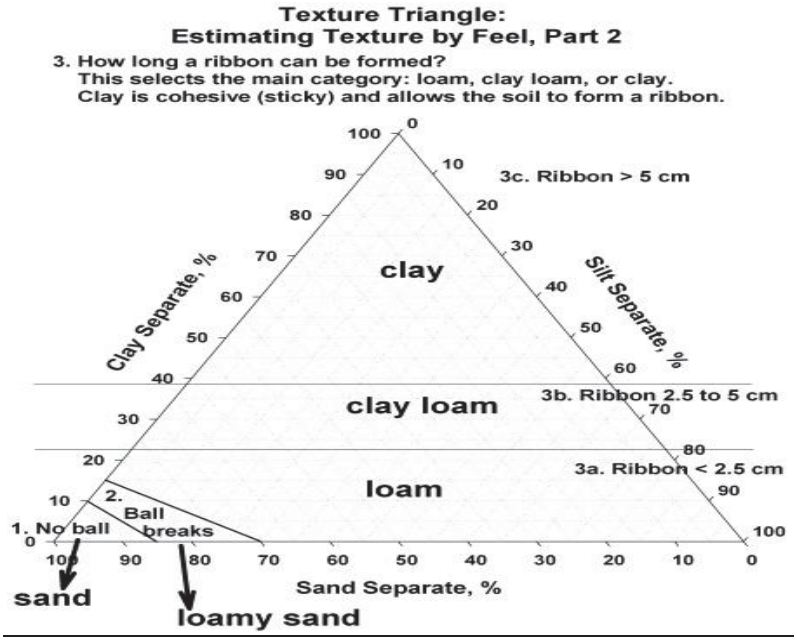
Step 2.
Bounce the ball. If the moist soil remains in a ball when the hand is opened, bounce the ball in the hand. If the ball breaks when it hits the hand, it is a loamy sand. Notice, these textures occupy only the bottom, left corner of the triangle. If the ball does not break, move on to Step 3.

Step 3.
Determine if the moist soil will form a ribbon when extruded between the thumb and forefinger (or how long a 1/8" or 3 mm diameter ribbon will form when rolled on a flat table). The principle behind forming ribbons is related to the cohesion that exists among clay particles. Clays are sticky when moist, and so the ribbon length is proportional to the clay content.

Caution: When starting with dry clays, make sure to allow time for the clays to become moist, and make sure "gritty" particles are not aggregates.

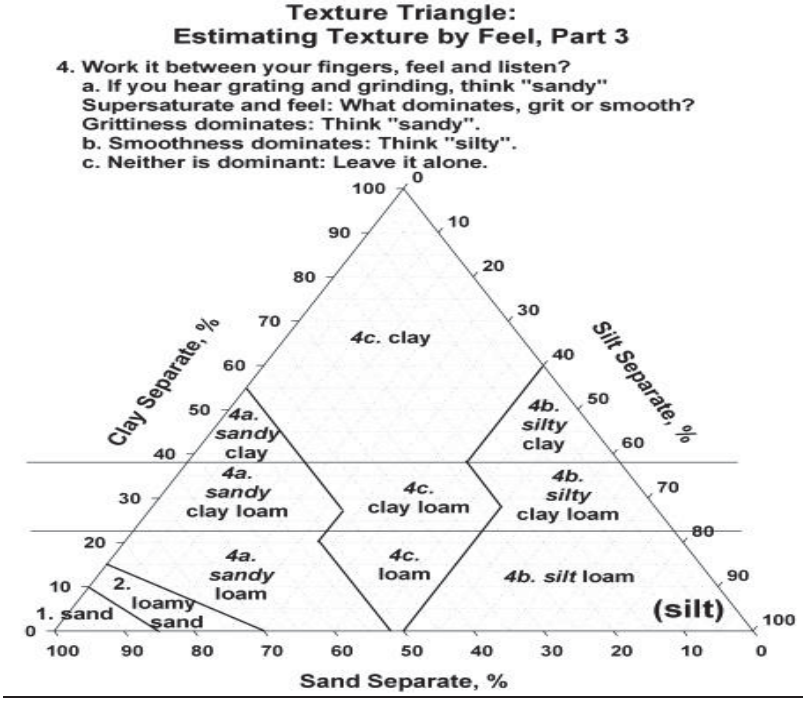
3a. If the ribbon length is less than 2.5 cm, the general category is loam.
3b. If the ribbon length is between 2.5 cm and 5 cm, the general category is clay loam.
3c. If the ribbon length is greater than 5 cm, the general category is clay.

After determining the general category by clay content, move to Step 4.



Step 4.

Are modifiers (sandy, silt, or silty) necessary? Feel and listen as the sample is worked in the hand. If grittiness dominates, then the modifier, "sandy" will be added to the general category determined in Step 3, e.g., sandy loam, sandy clay loam, or sandy clay. If grittiness does not dominate, but smoothness does, then a form of silt will be added, e.g., silt loam, silty clay loam, or silty clay. Silt is not sticky, but is smooth like flour, foundation make-up, or talcum powder.



The 3 P's: Soil Porosity, Permeability and Particle Size

The ability of water to go through a soil is influenced by the soil's porosity, permeability and dominant particle size. Porosity refers to the amount of air space between soil particles. Permeability refers to the ability of water to move through soil. Particle Size refers to how large a grain of soil is; it is also known as TEXTURAL CLASSES!

The implications for the 3 P's are use especially when we look at the soils ability to sustain human activity, natural processes, and ecosystem functions. Agriculture, road construction, building a house, a stock dam or reservoir, installing a land fill, building a septic system, and even sporting arenas, have very detailed requirements for how water needs to interact with the soil!

Activity 6: Soil and Water Retention

Soil water Retention Demonstration (To be done by students in groups)

In this activity we demonstrate water holding capacity of soils and talk about factors that influence water retention in soils. The following experiment/demonstration will show the water retention capacity for different soil types.
We are going to compare and demonstrate three different samples of soil.

Sample 1: A sample of very sandy soil, (by a river's flood plain)
Sample 2: A sample of fertile soil, (from a farm)
Sample 3: A sample of hard, clay-like soil (sticky gumbo till soil)

We will put one of the samples in a strainer and hold it over a pan. Pour water over the soil sample to see how well it absorbs the water.

Questions

1. What happens to water when it is poured on sample 1? How will this affect a plant that tries to grow in this soil?

2. What happens to water when it is poured on sample 2? How will this affect a plant that tries to grow in this soil?

3. What happens to water when it is poured on sample 3? How will this affect a plant that tries to grow in this soil?

4. How important is soil for holding the water that plants need for growth?

Permeability Experiment

Now we are going to measure water permeability of your respective soil samples. Different soils have different permeability capacities. Some soils drain water faster than others. This activity will measure the time it takes for each of your soils to effectively drain water through the soil into a cup.

Materials:
- clear plastic soda bottle with the bottom cut open
- Your respective soil sample collected outside (from above)
- Two clear plastic cups
- Food color dyed water (blue, red or green works well)
- Knife or cutting material to remove the bottom of the pop bottle
- Cotton balls and plastic scoops/spoons
- Timer

Set Up:
1. Cut open and remove the bottom portion of your soda bottle. Invert the bottle with the cut bottom upward so that it resembles a funnel.
2. Place a cotton ball at the lower end of the bottle or its mouth.
3. Using the scoop, fill with about 4 scoops of soil sample.
4. Fill the first cup with enough fresh colored water to completely saturate the soil sample.
5. Place the second cup under the inverted bottle and fill bottle with colored water. Do this only once. If you try to fill the bottle again after the soil and cotton ball is saturated, the cotton ball and sample will fall out.
6. The water will take some time to filter through each sample.
7. Record your time and observations

Questions

1. How long does it take the water to start trickling into the clear plastic cup below?

2. Did you recover all the water which was filled in cup 1 in cup 2? Why?

3. Which of the soils samples in the demonstration above (samples 1, 2, and 3) is most closely related to your soil based on the ease with which water passes through the soil?

Wrap Up Activity: Soil Properties of Importance in Human Activities

The textural and water retentive abilities of soils have huge engineering and agricultural implications that determine how successful man's activities are on the surface of the earth.

Based on our understanding of the soil properties and characteristics of soils we have studied, rate how important each of the soil components listed are for each of man activity. Place a check mark in a box for each component that will affect an activity.

Human Activity	Sand	Silt	Clay	Porosity	Permeability	Water retention
Road Construction						
Stock dam construction						
House construction						
Golf course construction						
Powwow Grounds construction						
Rodeo grounds construction						
Paddy rice field						
Wetland habitat						
Vegetable Garden						
MSW and Landfill site						