Soil Bulk Density

Field and Lab Guide

Task

To obtain three bulk density measurements for a given soil horizon in a soil profile

What You Need

- ❑ Balance
- ❑ Sampling cans or other containers or pipes (enough for three per horizon plus a few extra, in case some of the cans bend)
- ❑ Permanent marker
- ❑ Wood block
- ❑ Hammer
- ❑ Nail
- ❑ Pencil or pen
- ❑ Sealable plastic bags, jars, or other containers to store samples and extra soil
- ❑ Drying oven
- ❑ Graduated cylinder
- ❑ Water (or possibly alcohol if soil samples contain twigs)
- ❑ #10 Sieve (2 mm mesh openings)
- ❑ Latex gloves
- ❑ Paper to catch sieved soil
- ❑ Rolling pin, hammer, or other utensil for crushing peds and separating particles
- ❑ Trowel, shovel, or other digging device
- ❑ One copy of the *Bulk Density Data Sheet* per horizon
- ❑ paper or cloth wipe towel

In the Classroom Before Sampling

1. Collect required equipment. You will need 3 cans or pipes for each horizon that you identified at your *Soil Characterization Site*. If you think that the cans may bend as they are hammered into the soil at your site, you should prepare extra cans to bring to the field.

2. Punch a small hole into the bottom of each can using the nail and hammer. (**Note:** this is not necessary if using a pipe with two open ends).

In the Field

1. Go to your *Soil Characterization Study Site*. For each horizon in your soil profile, push a can or pipe into the side of the horizon (images 1a and 1b). If necessary, wet the soil first in order to ease the can into the soil. Stop when soil pokes through the small hole in the bottom of the can (or has reached the edge of the pipe, so that the pipe is full of soil). If it is difficult to push the can into the soil, place a piece of wood over the can and hit the wood with a hammer (image 2). This spreads the force of the hammer blow to all edges of the can at once and minimizes bending the can sides. If the sides of the can become bent, this will change the volume of the can and may compact the soil sample, affecting the measurement results. If the sides of a can bend beyond perpendicular, discard that can and use another.

   Note: If you do not have a pit or other exposed soil profile you can measure the bulk density of the soil surface as follows:

   a. Choose three locations close to the site where you performed the *Soil Characterization Protocol*. Remove vegetation and other material from the soil surface.
   b. At each of the three locations, push a can or pipe into the surface of the soil. If necessary, wet the soil first in order to ease the can into the soil. Stop when soil pokes through the small hole in the bottom of the can (or has reached the edge of the pipe, so that the pipe is full of soil).

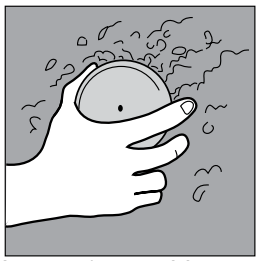


Image 1a, pushing sample can into soil

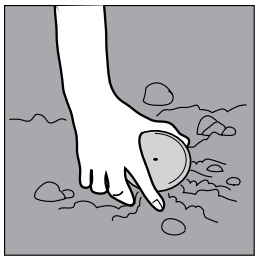


Image 1b, pushing sample can into soil

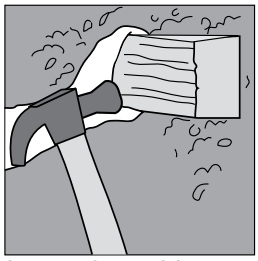


Image 2, pushing sample can into soil

2. Using a trowel or shovel, dig around the can or pipe to remove it and the surrounding soil. Trim the soil from the top of the can (and bottom for a pipe) and around the edges of the can so that the volume of the soil is the same as the volume of the can or pipe.

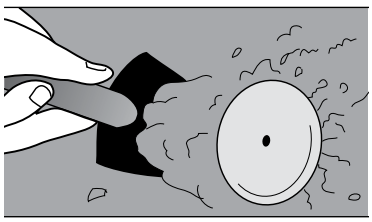


Image 3, use trowel to dig up sample can

3. Cover the can with its lid or other cover. Label the can with a container number (image 4) and record this number on your *Data Sheet*. If using a pipe, label it with a container number, record this number on your *Data Sheet*, and place the pipe in a plastic bag.

Image 4, label the sample cans

4. Repeat this procedure so that you have three bulk density samples for each horizon in your profile (image 5).

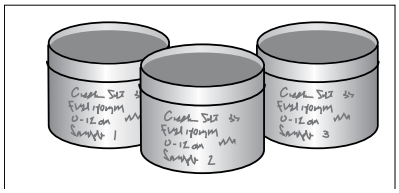


Image 5, repeat procedures for three samples per horizon

In the Classroom After Sampling

1. Calibrate the balance to 0.1 g.

2. Remove the lid off the sample can. Measure the mass of each sample in its can (image 6), and record this as the wet mass on the *Bulk Density Data Sheet*. If you used a pipe instead of a can, remove the pipe filled with soil from the plastic bag and weigh it to determine the wet mass, which should then be recorded on the *Bulk Density Data Sheet*.

Image 6, weigh wet mass sample and can

3. Dry the samples in a soil-drying oven (image 7). See the *Gravimetric and Volumetric Soil Moisture Protocol* for instructions on drying soils.

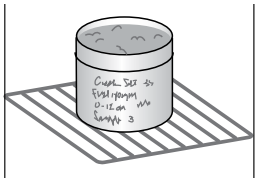


Image 7, dry sample without lid in oven

4. After the soils have dried, determine the mass of each sample and its container (image 8) and record this as the dry mass on the *Bulk Density Data Sheet*.

Image 8, weigh dry mass sample and can

5. Place a sieve (#10, 2 mm mesh) on a paper plate or large piece of paper (such as newspaper) and pour one sample onto the sieve (image 9).

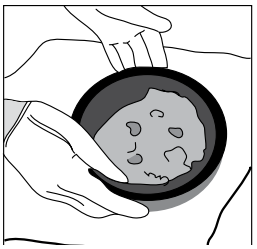


Image 9, pour sample through sieve

6. Wipe the inside of the can or pipe with a wipe towel (image 10). Measure the mass of the can or pipe without the lid on and record this mass on the *Data Sheet*.


Image 10, wipe inside of sample can

7. To measure the volume of the clean, dry container, fill the 500 mL graduated cylinder with water. Record the initial volume (Vi) of water in milliliters. Pour water from the cylinder into the container filling it to the brim (Image 11). Record the volume of water remaining in the graduated cylinder (Vf). To obtain the volume of the container, subtract the remaining volume of the water in the graduated cylinder (Vf) from the initial volume (Vi) of water. This calculation, (Vi) - (Vf), will provide you with the volume of the container.

   For pipes, measure the mass and calculate the volume using the following equation:

   $$\text{Volume pipe} = Pi \times r^2 \times h \times 1\ mL/1\ cm^3$$

   where Pi is the mathematical constant approximately equal to 3.141592654

   r is the radius of the base of the pipe (cm)

   h is the height of the pipe (cm)


Image 11, measure volume of sample can

8. Put on latex gloves to avoid contaminating your sample with acids from your skin, and pick up the sieve full of soil.

9. Carefully push the dried soil material through the mesh onto the paper plate. Be careful not to bend the wire mesh by forcing the soil through. Rocks will stay on top of the sieve. If no sieve is available, carefully remove the rocks by hand. Save the sieved soil from each sample for other lab analyses.

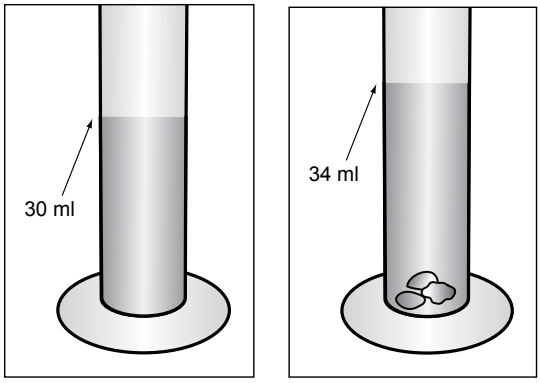
Image 12, Push dry soil through sieve

10. If rocks are present, use the following procedure to determine the mass and volume of the rocks.
    a. Measure the mass of these rocks (image 13) and record on the *Bulk Density Data Sheet*.
    b. Place 30 mL of water in a 100 mL graduated cylinder. Record this volume of water on the *Bulk Density Data Sheet*. Gently place the rocks in the water. Read the level of the water after all the rocks have been added. Record this volume of water on the *Bulk Density Data Sheet*.

Image 13, determine mass of rocks

Note: As you add the rocks, if the volume of water and rocks in the cylinder comes close to 100 mL, record the increase in volume, empty the cylinder and repeat the procedure for the remaining rocks. In this case, you must record the sum of the water volumes with the rocks and the sum of the water volumes without the rocks.

If you have sticks or other organic debris, substitute alcohol for water, and follow the same procedure.



Images 14a and 14b, measure volume of rocks by water displacement

11. Transfer the rock-free dry soil from the paper under the sieve to clean dry plastic bags or containers (image 15). Seal the containers, and label them with horizon number, top and bottom depth, date, site name, and site location. This soil can now be used for other lab analyses. Store these samples in a safe, dry place until they are used.

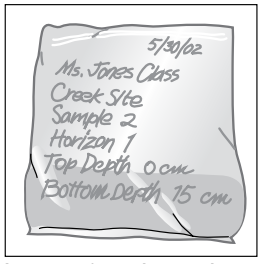


Image 15, place sieved soil in labeled bags