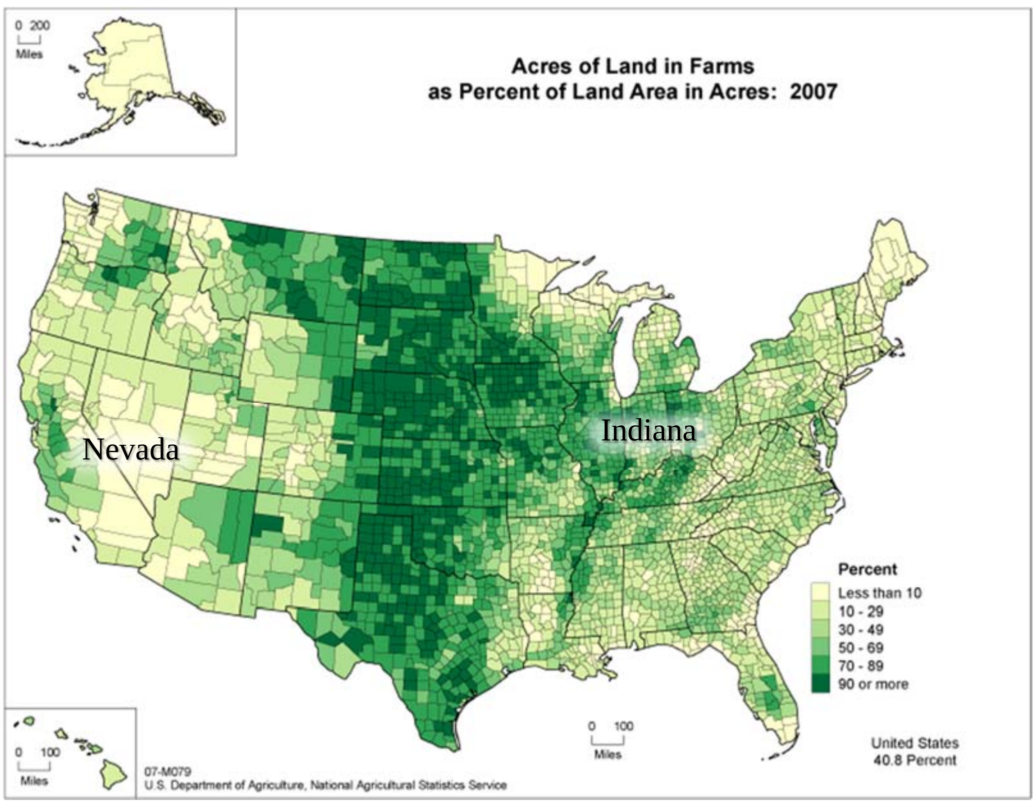
Lab 8 Student Answer Sheet
Soils

NAME (please print clearly) ______________________________

<u>Objective</u>: Use soil characteristics to determine soil engineering properties.
For this lab, we use the scientific method to determine which of the three soil samples would be best for planting a vegetable garden. We will learn how to make *observations* and *measurements*. Each of these soil samples were taken from O, A and B horizons.

<u>Background</u>:
Soils are diverse. Depending on how the soil was formed (parent material, age, climate, slope/topography, and biologic processes), the soil will have different properties. Humans take advantage of these properties by using different soils for different purposes. Take a look at the map below:



Have you ever wondered why farming is so concentrated in the Midwestern states? Why do you think we don't have farms in Southern Nevada? (Answer below.)

Hypothesis:

Soil scientists use something called "Soil Taxonomy" to define different soil types based on how the soils form and their subsequent characteristics. These are organized similarly to how living things are organized into kingdom, phylum, class … etc. The largest classification for soils are Orders. There are 12 Soil Orders. For this lab, you will attempt to characterize your soil based on Order and then relate the characteristics of that order to the engineering properties and soil uses.

To formulate your hypothesis, start by making some *observations* and answering these questions:

Your instructor will have three soil samples. Using a sharpie or pen, divide the plate into three sections, labeled A, B, and C. Place a small scoop of each soil sample on your plate in the correct section. Make some observations and discuss with your group. Which soil (A, B, or C) will be the best for planting a vegetable garden? Just look at the soils, with your group, and make a *tentative hypothesis*.

The table on the following page describes different soil orders, and the figure your instructor provides shows pictures of those soil orders. Make a hypothesis about which soil sample belongs to which soil order. (Note: no two samples belong to the same order.)

Soil A:

Soil B:

Soil C:

Order	General Properties
Entisol	May not have distinct horizons. But usually have an O-Horizon visible at the top; and A-horizon, which can vary from dark (brown to black) due to the accumulation of humus (decaying plant material) and Al and Fe oxides to light (e.g., white, yellow, orange, and pink); many are recently deposited unconsolidated sediments like sands and gravel (parent material); often young soils (age); many are found on steep slopes but can also be found along shorelines and sand dunes (topography); can form in all climates (climate); usually covered with grasses, some trees, mostly monocots, e.g., palms, grass-trees, and bamboo (vegetation); all soils that cannot be characterized into the other soil orders are classified as Entisols. These soils must be heavily amended for non-native agricultural use.
Alfisols	Distinct soil horizons, including a deep B-horizon (columnar); O and A-horizons are often depleted (have low concentrations) of calcium carbonate, but rich in aluminum and iron-bearing clay minerals, giving them a dark gray brown to dark brown color; well-weathered from varying parent materials (parent material); can be young or old depending on parent material (age); usually found in basins or flat lands that may flood (topography); form in wet, humid seasonal climates (climate); usually covered with a deciduous forest with some evergreen and grass (vegetation). These soils are ideal for row-crop farming as they are high in mineral nutrient content.
Ultisols	Distinct soil horizons, upper horizons clays have accumulated iron-oxides giving soils a strong yellow to reddish color and have high amounts of humus, soils are extensively leached; many are well weathered from varying silicate-rich parent materials (parent material); usually very old soils (age); usually found in basins or flat areas that may flood (topography); form in wet, humid climates (climate); usually covered by forests (vegetation). These soils are highly acidic and low in mineral nutrients (Ca, Mg, and K) which makes them poor soils for agricultural use.

Other Soil Facts

- Small sediments sizes like silt and clay allow soils to hold on to nutrients like nitrogen (N) and phosphorus (P). Both N and P are necessary nutrients for plant growth. Soils high in clay can be very nutrient rich soils. Silt and clay rich soils developed on floodplains and/or glacial deposits are called “fertile soils” because they are rich in plant nutrients.
- Larger sediments like sand and gravel allow soils to drain water, allowing soils to move from saturated to unsaturated conditions. These also prevent soils from becoming compressed or compacted which can reduce soil porosity and permeability.

Now that you have an idea about which soil orders your samples belong to, which soil do you think would be the best for growing a vegetable garden? Why? Does this agree with your original hypothesis (on page 2)?

Experiment:

Color: The first measurement we will make is to look at the Munsell colors of our samples. Start by just looking at the soils and making a general observation about the colors of each. Are they the same? Different? How would you describe the color? Then use the Munsell Soil Color Book to give an actual measurement of the soils color. Compare your results to the Soil Taxonomy table on page 3. How do the colors relate to the soil orders?

Sample	Observed Color	Measured Color*	Soil Taxonomy
A			
B			
C			

* Record the color code (example: 2.5YR 7/3) and name (example: light reddish brown)

What are the differences in color between the three samples? What accounts for these differences?

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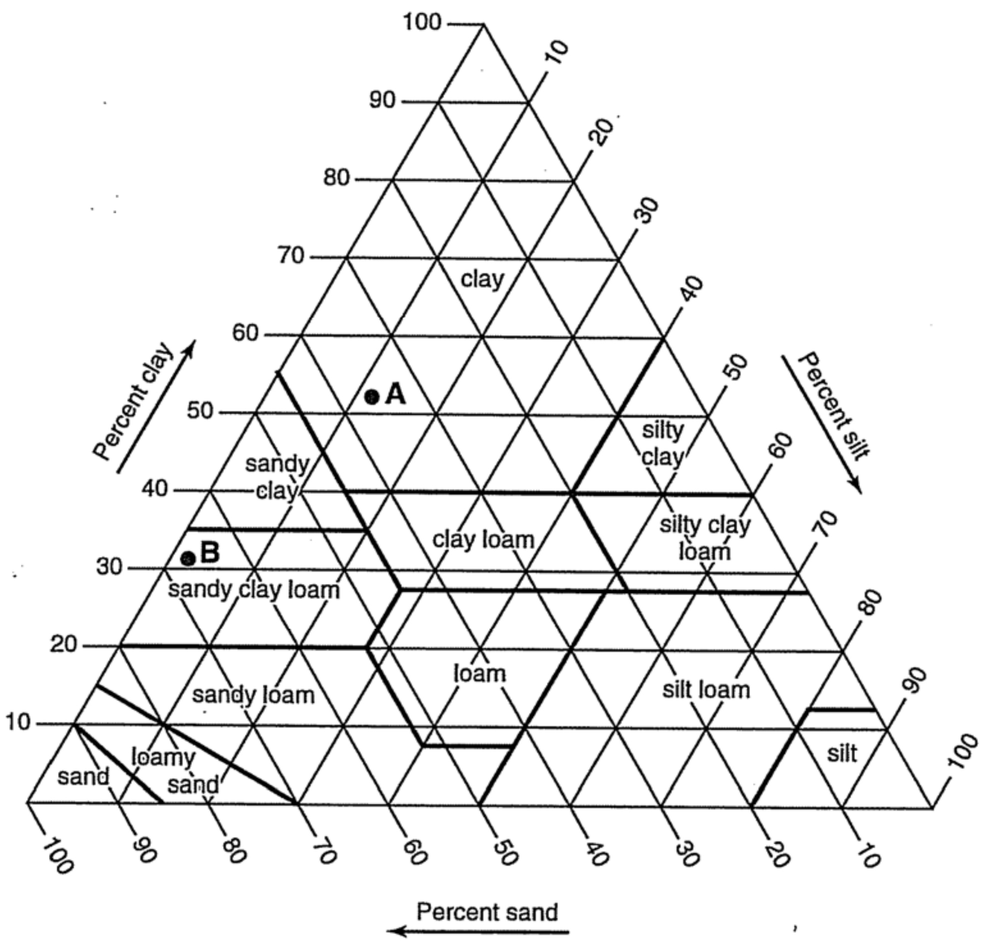
Texture (Practice): The second thing we will do is to look at the soil texture composition**.** Let's practice using a soil texture triangle to name soil types based on the sand, silt, and clay composition**.**

1) Use the Soil Texture Triangle (at the bottom of this page) to name the following by its correct texture class.
   a) 17% sand, 28% silt, 55% clay: ______________________________
   b) 31% sand, 55% silt, 14% clay: ______________________________

2) Determine the percentage of each particle size for examples A and B plotted on the soil texture triangle.

   a) A:__________ % sand, __________ % silt, __________ % clay.
   b) B:__________ % sand, __________ % silt, __________ % clay.



Now, take your sample out and spread it onto a plate. Make a general observation about the sediment sizes of your samples. Consult Figure 1 and Table 1 from your manual.

Using Table 3 from your lab manual, how would you characterize your soil? Is it gritty or smooth or something in between?

Soil Sample A ____

Soil Sample B ____

Soil Sample C ____

We will now attempt to ***measure*** the texture. Your instructor will assign you **one** of the three soil samples to measure.
Materials: Two sieves (1-2mm and 0.063mm), clear cups, soil sample, scale, white sample cups, mortar & pestle

I. Get three small, white sample cups. Label them the following: "Gravel (>2.0 mm)," "Silt and Clay
(<0.063 mm)," and "Sand (0.063 – 2.0 mm)."
II. Using the balance, weigh each cup. Record the weights in the table on the following page.
III. Put one of the wide-mouth clear cups on the balance, then add at least 50 grams of your soil sample to the cup. (It does not have to be exactly 50 grams.)
IV. Pour all of your sample into the mortar. Using the pestle, crush the sediment until there are no clumps. Remove any larger rocks and put them in the "Gravel (>2.0 mm)" cup.
V. Sieve your sample to separate the particle sizes.
VI. Start with the 1 - 2 mm sieve: Put the sieve over the wide - mouth clear cup. Pour all of your sample through the 1 - 2 mm sieve. Gently tap the sieve against your hand to move the sediments through.(Do not use your fingers in the sieve as oil and moisture on your hands can cause the particles to clump.) Collect what is left in your sieve and put it in the cup labeled, "Gravel (> 2 mm)." These are gravel particles and humus (or plant material).
VII. Pour the contents that passed through the sieve and into the wide-mouth clear cup back into your mortar. Wipe out the wide - mouth clear cup with a paper towel to remove any extra debris.
VIII. Next use the 63 micron sieve. This is delicate, so please be careful! Be patient. You may find that very little actually passes through the sieve. Collect what passes through the sieve into the wide - mouth clear cup and pour the fine sediments into the sample cup labeled "Silt and Clay (< 0.063 mm).
IX. Pour what is left in the 63 micron sieve into a cup labeled "Sand (0.063 mm to 2 mm)."

viii. Using the balance, weigh the mass of each fraction, then calculate the percentages. Fill out the table below. (You will only be able to separate the sand particles from the silt and clay because the clay particles are very small, only a few microns, 0.002 mm or smaller, in diameter.)
ix. Collect the data for the other soils from your classmates. Fill out the tables below.
x. Your instructor may have prepared settling columns for you to see the distribution of the sediment sizes for each sample. Can you guess which is which?

Gravel -

Sample	Mass of Gravel & Humus + Cup (g)	Mass of Cup (g)	Mass of Gravel & Humus (g)
A			
B			
C			

Sand -

Sample	Mass of Sand + Cup (g)	Mass of Cup (g)	Mass of Sand (g)
A			
B			
C			

Silt and Clay -

Sample	Mass of Silt and Clay + Cup (g)	Mass of Cup (g)	Mass of Silt and Clay (g)
A			
B			
C			

* Subtract the mass of the sample cup to calculate the mass of the sediment fraction.

Percentages -

Sample	Total Mass* (g)	% Gravel**	% Sand**	% Silt and Clay**
A				
B				
C				

* Total mass is calculated by adding the mass of each size fraction.
** To calculate percentage, take the mass of each size fraction, divide by the total mass, then multiply by 100.

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Using both your observations and measurements, how would you characterize the soil textures of each sample? Use the descriptors in Table 3.

Soil Sample A ____

Soil Sample B ____

Soil Sample C ____

<u>Results and Interpretations</u>: Based on what you know about the role of different sized sediments in soil function, which soil do you think would be the best to grow a vegetable garden? Why?

Structure: Because we didn't dig the holes ourselves, we will have to *observe* and *measure* the structure of these sediments based on pictures.

1) Use the provided figure of soil orders, and attempt to identify the soil horizons in each profile.

(If time and weather permits, your instructor may take you outside to dig a hole to observe the soil horizons of the soils here on campus.)

Entisol: ____

Alfisol: ____

Ultisol: ____

Using your observations, match the soil order to the soil sample based on soil structure:

Soil Sample A ____

Soil Sample B ____

Soil Sample C ____

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Results and Interpretations: Based on the structure and the descriptions of how the soils formed, which soil would have taken the longest to create? Which one would have been created here in Indiana?

Porosity (Hydraulic Conductivity): We will make some *observations* and *measurements* about how quickly water moves through our soils. This is important for determining if our soils would be good for our vegetable garden because we want our plants to have water. A soil that is too tightly packed with clays will result in water sitting on the surface and not being absorbed into the soil layers where our plant's roots can take up the water. Soil that has too much sand will drain too quickly, not allowing our plants to absorb the water. We want a soil that is "just right."

Look at Table 4 of your lab manual. Based on the textures you *observed* in the previous section on Texture, what can you deduce about how quickly water will move through your different soils?

Soil Sample A ____

Soil Sample B ____

Soil Sample C ____

You will now test your deductions. Follow this method to prepare the porosity experiment.

i. A soil sample will be provided to your group.
ii. Pour the soil sample into the graduated cylinder up to the 5 mL line.
iii. Use a ruler to measure the height of the soil column. Measure from the bottom of the soil column, not the table. Record this height in the column below.
iv. Fill the beaker with at least 4 mL of water. You will use a timer to time how quickly water moves from the top of your soil column to the bottom of the graduated cylinder.
v. Once you pour the water, start the timer. Once the water reaches the bottom of the graduated cylinder, stop the timer. Record the time in the table for your sample.
vi. Collect the data for the other soil samples from your classmates. Fill out the rest of the table.

Sample	Height of soil column (cm)	Time for water to reach the bottom (s)	Hydraulic conductivity (cm/second)
A			
B			
C			

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Results and Interpretations: Plants do best when soils work to both saturate plant roots and allow water to drain through. Soils that remain saturated for too long will drown the plants, but soils that drain too quickly will not allow the plants to take-up the water. Based on your observations and measurements, which soil would be the best for growing a vegetable garden? Why?

Summary and Conclusion: Based on what you learned about your soils, do you accept or reject your original hypothesis? (Circle one.)

ACCEPT REJECT

Which soil would you think would be the best for you to grow your vegetable garden? Explain.

Reflection and Learning: The definition of *Sustainability* is that we use resources in a way that conserves them for future generations. The three assumptions are: (1) Resources are finite or nonrenewable. They cannot be recreated within a human lifetime. (2) Resources are being used faster than they can be replenished. (3) And that resources we use today will be needed by future generations.

When you look around the outskirts of Indianapolis, you often see signs that say “Prime farmland for sale. Zoned industrial.” This means that the land use will likely change from a farm to an industrialized area. Given what you learned about how special soils are that can be used to grow food (and reviewing the map), do you think it is a good idea for Hoosiers to continue to convert farmland into industrial, urban, or suburban areas? Apply the concept of sustainability in your answer.

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Cleaning up:

- Clean out your sample cups and return them to the stacks at the front of the class.
- Wash out your graduated cylinder. Pour the muddy contents into the “waste” cups located next to the sink. Do not pour the soil down the drain!
- Wipe out – do not wash – your mortar and pestle.

References for this lab:

Jenny, H. 1941. Factors of soil formation. McGraw-Hill, New York, NY.

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McSweeney, Kevin. “Soil Morphology, Classification, and Mapping: Soil Orders.” *University of Wisconsin-Madison, Department of Soil Science*. September 8, 1999. Web. July 18, 2013. <http://www.soils.wisc.edu/courses/SS325/soilorders.htm>.

NRCS. “Soil Classification.” *United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS): Technical References*. January 2013. Web. July 18, 2013. < http://www.cals.uidaho.edu/soilorders/index.htm>.

USDA. “2007 Census Ag Atlas Maps – Farms.” United States Department of Agriculture (USDA), Censuse of Agriculture. April 24, 2012. Web. July 18, 2013. http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Ag_Atlas_Maps/Farms/Land_in_Farms_and_Land_Use/07-M079.php.