

AGRY 560 EXAM, October 4, 2006
(100 points, 10 pages total)

- (8) 1. Listed below in the left column are 6 methods that are used to measure some aspect of soil structure. In the right column are listed the actual information which we would like to know about the soil. For each item in the right column, choose the one best method from the choices on the left (a-f).

Methods

- a. dry crushing between 2 plates
- b. dry sieving
- c. wet sieving
- d. air-to-water permeability ratio
- e. raindrop tower
- f. pore size distribution

Desired Information

- ___ Relative stability of different soils under long-term wastewater disposal fields
- ___ Stability of aggregates to breakdown by water erosion
- ___ Aggregate size distribution for seedbed preparation
- ___ Volume of pores of suitable size for root growth

- (6) 2. Various types of penetrometers and other devices are used to obtain quick estimates of soil strength for different purposes. Listed below in the left column are instruments that can be used. In the right column is listed the type of process for which an index is desired. For each item in the right column, choose the one best instrument from the choices on the left (a-d).

Instruments

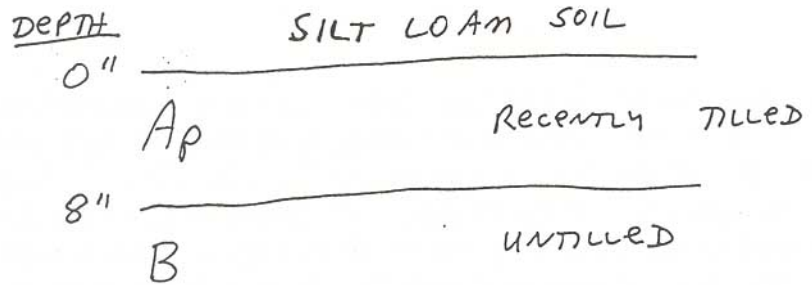
- a. modulus of rupture
- b. cone penetrometer
- c. Proctor penetrometer
- d. shear vane

Index desired

- ___ Soil bearing capacity
- ___ Shearing failure of soil by tillage implements
- ___ Ability of roots to grow through soil

- (5) 3. What is a semi-variogram and how is it constructed? Describe in general terms (not equations) how the values are calculated and plotted, and what the overall objective is when doing this type of calculation.

(8) 4.



You are studying the effects of different tillage tools (plow, chisel, rototiller, etc.) on the bulk density and water flow characteristics of a silt loam soil. For the Ap horizon, you want to know how loose the soil is immediately after the tillage is performed. For the B horizon, you want to know the density of the untilled soil, including some idea of macropore volume, since you are interested in how rapidly water can move through the soil. You have 3 standard bulk density methods to choose from: 1) intact cores, 2) excavation, 3) clod.

a) Choose the one best method of measurement for the Ap horizon, given the information above. Justify why you chose that method (i.e. convince me that this method is the best, for what you want to know.)

b) Choose the one best method of measurement for the upper B horizon, given the information above. (This might be the same method or a different method than for the Ap horizon). Justify why you chose that method.

- (8) 5. a) Sketch a graph (label the axes) of soil bulk density vs. gravimetric water content, after compaction in a Proctor Test apparatus. What is the purpose of the Proctor Test, and what does the curve you drew illustrate?
- b) Now assume that the curve you already drew represents the curve from a sandy clay loam soil with 3% organic matter. Draw another curve on the graph you've already drawn, showing a sandy clay loam soil with 1% organic matter. (Be sure to label the curves.) Explain the differences between the curves and why they exist.

- (4) 6. In each of the following pairs of soils, indicate which one would have the greatest volumetric heat capacity, and which would have the greatest thermal conductivity. (It is possible that the same soil could have both the highest heat capacity and the highest thermal conductivity.)

		heat capacity <u>(a or b?)</u>	thermal conductivity <u>(a or b?)</u>
a) dry soil at BD=1.3 g/cm ³	b) wet soil at BD = 1.3 g/cm ³	_____	_____
a) compact soil at saturation	b) loose soil at saturation	_____	_____

(6) 7. For each of the following surface soil treatments listed below, 1) state whether the average soil temperature in the top 5 cm will probably increase or decrease, compared with a bare, flat, smooth soil surface, and 2) briefly explain the reasons for the increase or decrease. (Assume it is in the spring of the year, when the soil is starting to warm up.)

a) straw mulch added to the surface

b) clear plastic

(4) 8. When we perform particle size (texture) analysis, why must we remove organic matter and carbonates, and disperse clays?

(3) 9. In expressing the results of wet sieving analysis for water-stable aggregates, results are sometimes expressed as a “geometric mean diameter” (GMD) rather than the more typical “mean weight diameter (MWD). Why?

(4) 10. Describe two ways in which earthworms improve soil properties.

- (8) 11. How many cm of water are stored in the top 60 cm of this soil profile? We measured gravimetric water content (θ_g) and bulk density (BD) as follows: **SHOW ALL WORK AND UNITS!**

(Other information you may or may not need:

particle density = 2.65 g/cm^3
density of water = 1.0 g/cm^3)

<u>Depth (cm)</u>	<u>$\theta_g(\text{g/g})$</u>	<u>$\text{BD}(\text{g/cm}^3)$</u>
0-10	0.17	1.22
10-25	0.22	1.34
25-60	0.28	1.42

- (8) 12. Given the following data from the clod bulk density procedure, calculate the soil bulk density. **SHOW ALL WORK AND UNITS!**

Moist soil clod	= 275 g
Moist soil clod + saran	= 285 g
Saran density	= 1.3 g/cm ³
Bucket + water	= 400 g
Bucket + water + suspended clod	= 550 g
Water density	= 1 g/cm ³
Oven dry soil + saran	= 240 g

(10) 13. Excellent quality melons are produced in southwestern Indiana along the Wabash River near Vincennes. The main production areas are in the sandy and sandy loam soils formed in wind-blown deposits near the river. These soils are also susceptible to drought stress, and so irrigation is a necessity for melon production.

a) Using information contained on the xerox sheet from the Knox County Soil Survey, estimate the available water (in inches) stored in the rooting zone of the soil profile at the beginning of the growing season. Calculate using the high end of the estimated available water for each horizon.

Soil type: Bloomfield loamy fine sand (B1B)

Rootzone depth: 0-36 inches

b) If the typical melon crop requires 30 inches of water total to yield well in the Vincennes climate, how much rainfall must be received during the growing season, for the crop to not suffer from water stress?

c) Because of the high value of the crop and the probability of drought stress occurring, the producer installed a pumping well for irrigation. If the farm has 5 acres of melons, and they want to be prepared to apply 3 inches per week of irrigation, then how many gallons of irrigation water are required each week?

1 gallon = 0.1337 ft³

1 Acre = 43,560 ft²

1 foot = 12 inches

(18) 14. You have been asked to talk to a group of scientists about soil structure and tilth. These scientists include a mix of chemists, physicists and biologists who have no experience with soils or agriculture (other than their own gardens!). Prepare a written summary that could accompany your lecture to this group (3 pages maximum, i.e. back of this sheet and front and back of attached sheet of paper). Your written discussion should include at least some attention to all of the following 5 main questions:

- 1) What is soil structure?
- 2) Why is good soil structure important? What are some of the characteristics of a "healthy soil"?
- 3) How are aggregates created? destroyed?
- 4) Compare soil tilth and organic matter content from the following systems, and explain why those differences occur:
 - a) uncultivated (virgin) soil vs. cultivated soils
 - b) row crops vs. crop rotations that include some hay crops (alfalfa, clovers, grasses, or other perennials) or "meadow" or pasture
- 5) If you wanted to improve soil structure rapidly on a field in Indiana that was compacted and that had a low organic matter content, what are some of the things you would recommend, and why?

Question 14 continued.