Physical **H**ydrology for **E**cosystems

BEE 3710

Final Exam (Take-Home):

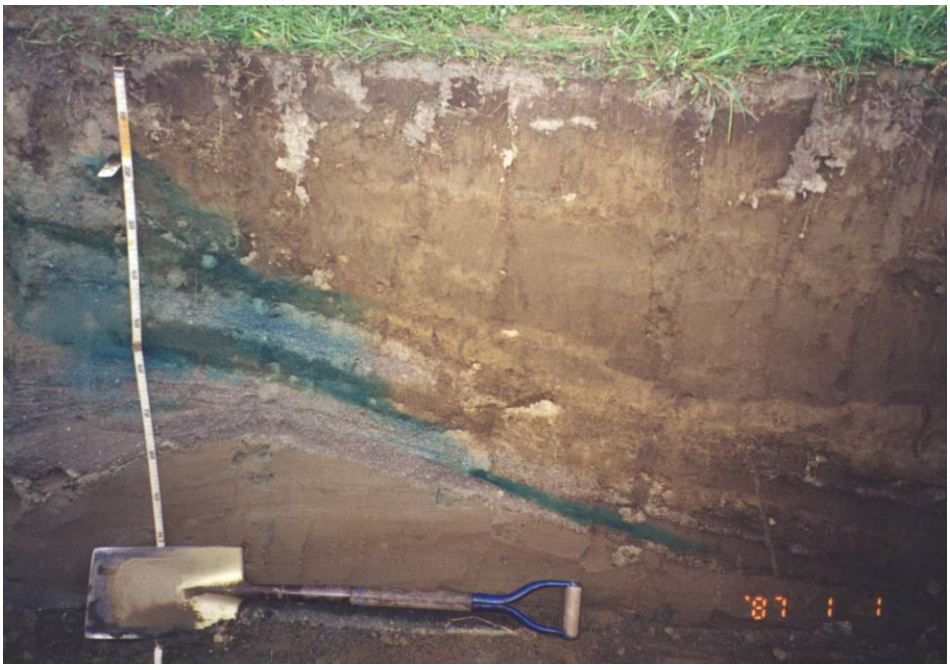
- This is an open book/note, test!
- Put your name on all pages turned in to me; do not cram answers onto the test. (1 pt)
- Show your work (NEATLY)
- If you use any data from the text or other sources, cite the source(s) and page(s).
- You may wish to use a computer for some problems, please attach, well-labeled graphs and tables if you do so.
- Please work independently.
- Turn in this exam with your answers.
- DUE at day and time of our scheduled final
- Each numbered question worth 9 pts

1) Is it even possible to have evaporation if the relative humidity is 100%, i.e., the air is at its saturation point with respect to water vapor? Give an example that backs up your answer.

2) How did Becky Marjerison distinguish flash floods from “river” floods?

3) During the first half of 2012 in Ithaca the air temperature was on average 20% higher per month than normal and received less than 70% of the normal precipitation than as normal. Would you expect that the evaporation was, lower, or the same as normal, especially in May and June? Explain.

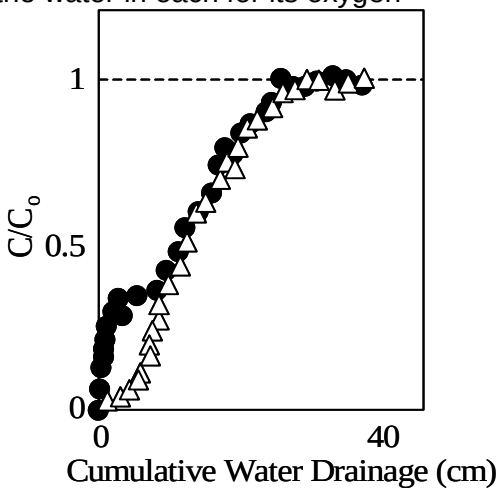
4) I put a dye on the surface of the soil and several months later I came back and dug a hole to see where the dye went. To my surprise it had moved laterally OVER a relatively coarse (sandy-gravely) layer (see picture below). Explain why?



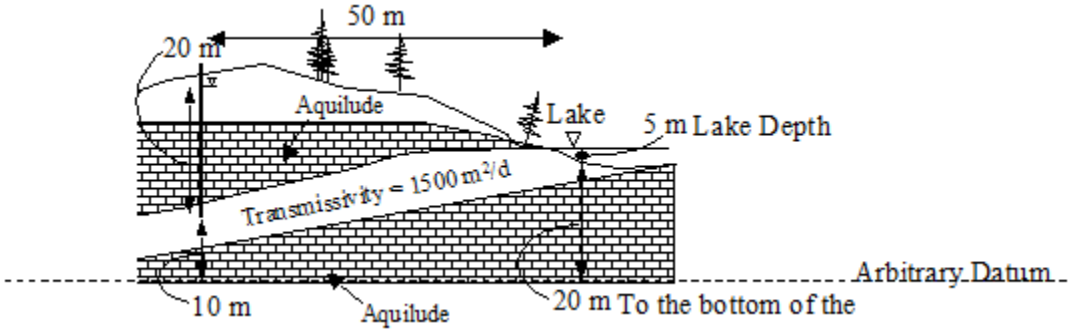
5) Why are cloudy nights often warmer than clear nights; draw a picture showing the major energy fluxes at night in Ithaca.

6) Two water samples taken in Texas, A and B, got mixed up in my lab. One was collected from tap water and the other from rainfall. We analyzed the water in each for its oxygen isotope signature and found that A was more enriched with ^{18}O than B. Which sample was probably from tap water, and how do you know?

7) The graph to the right summarizes the results of an experiment in which chloride enriched rainwater (concentration = C_o) infiltrated through two different soil profiles and the drainage was collected from below the profile. One soil was a deeply plowed (mixed) agricultural soil and the other was a soil in the Cornell arboretum (undisturbed for a long time). Which symbol (circles or triangles) correspond to arboretum experiment and which to the plowed-field experiment. Explain.



8) Consider the diagram of a confined aquifer connected to a lake with a peizometer located 50 m from the lake. What is the flow per unit width in the aquifer and is the aquifer draining or feeding the lake? Note: Transmissivity is the product of saturated hydraulic conductivity and aquifer thickness.



9) Consider a local field (groundwater recharge ~40 cm/yr). DDT was banned in 1980. Assuming DDT's soil partition coefficient (a.k.a. adsorption coefficient) (k) is 10000 cm^3/g and the soil bulk density (ρ_b) is 1.5 g/cm^3, how deeply has it moved into the vadose zone by now (i.e., in ~30 years)?

10) A 50 cm^3 core sample of moist soil weighed 68 g. After drying at 105^{o}C for 24-h it weighed 60 g. What is the volumetric water content?

11) The topographic index can be calculated for any point in the landscape with the following equation:

$$\lambda = \ln\left(\frac{a}{DKs}\right)$$

where a is the upland watershed above the point in the landscape, D is the depth of soil below the point in the landscape or the deepest the height of the groundwater can be before

the soil is saturated, K is the saturated hydraulic conductivity, and s is the slope of the land at the point in the landscape.

(a) If λ is large, does it indicate a high or low probability that the position in the landscape will be saturated? Explain.

(b) Also, list two additional environmental parameters that aren't included in the topographic index that may affect soil moisture patterns and explain why.

Extra Credit (3 pts each)

1) Based on our in-class experiment, would you expect a glacier resting in salt water or fresh water to melt fastest? Explain.

2) At steady state, a fine grained soil can theoretically have a capillary fringe that reaches 10 m above the water table. Explain why the water near the top of this capillary fringe region is unlikely to contribute substantial water to evaporation and transpiration processes (assume the moisture content is still well above the wilting point). Hint: consider how and why hydraulic conductivity is related to moisture content.