Study Guide for Soil Classifiers Certification Examination

The examination is designed to assess the applicant soil classifier's knowledge of soil science and the use of soils for on-site wastewater disposal, along with related topics. In order to be eligible to be certified in the State of Georgia, applicants must pass the exam with a score of 70% or better. The examination will consist of largely objective (multiple choice/matching/fill in) questions. The examination will also include a few short answer questions and questions related to interpretations of pedon descriptions and landscapes. The exam should take about 2 hours to complete. No reference material or other resources will be used by the applicant during the exam.

The focus of the examination will be in the following areas:

1. Basic pedology/soil morphology	30%
2. Soil taxonomy/classification	10%
3. Soil mapping/landscapes	20%
4. Basic hydology/water quality	20%
5. Soil interpretations for onsite systems	20%

The following materials are included to indicate the scope of materials covered within the above categories, and to give example topics and questions similar to those that might be included on the examination.

1. Pedology/morphology

Textural classes: be able to identify textural classes given % sand, silt and clay of soil sample.

Soil color: define hue, value, and chroma in the Munsell system, and give critical values of these variables in soil classification and soil drainage classes. What gives soils color?

Redoximorphic features: Why is soil morphology used to estimate seasonal water table height instead of direct measurement? Define/describe the three types of redoximorphic features; describe conditions necessary for formation of redoximorphic features; be able to interpret the significance of redoximorphic features in terms of seasonal saturation. Describe soil and landscape features that can be used to differentiate contemporaneous and relict redoximorphic features. Describe conditions under which a soil horizon may be saturated but no redoximorphic features form.

Soil sturcture: define/identify grade and shape of soil structural (granular, platy, blocky, single grain, massive) and understand where they typically occur in soil profiles.

Consistence: define moist consistence terms

Other horizon features and properties: be able to give general definitions for other features commonly found in Georgia soils, i.e. plinthite, ironstone, slickensides, clay films, etc., and other general soil properties, i.e. CEC, pH, base saturation, bulk density, etc. Have a general concept of formation/interpretations of these features and properties.

Horizon boundary: define thickness ranges for classes of horizon boundary (abrupt, clear, etc.)

Horizon designations: give definitions and criteria for master horizons (O,A,E,B,C,R) and the common subordinate designations commonly used in Georgia soils (a,i,e,p,b,t,h,w,g,v,x,c);given a soil profile description, be able to assign complete horizon designations. Pedons included on the exam will be only those found in Georgia.

Soil formation: describe, in general term, processes and changes in profile properties that occur during soil formation. Describe the five factors of soil formation.

2. Soil taxonomy/classification

Diagnostic horizons and orders: define and be able to identify on a pedon description diagnostic horizons and soil orders commonly found in Georgia (umbric, ochric, histic, cambic, kandic, argillic, spodic, fragipan; Entisols, Inceptisols, Alfisols, Ultisols, Histosols, Spolosols).

Structure of soil taxonomy: the six categorical levels of Soil Taxonomy; the soil properties most commonly included in the soil family; family particle-size classes.

Nomenclature: given a soil taxon, give general interpretations of soil properties.

3. Soil mapping/Landscapes

Map scales and topography: be able to compute ground distances give a map scale and map dimensions; be able to compute slope gradients from on topographic maps.

Landscape positions: name and be able to identify landscape positions on a typical hillslope; describe how soil features (solum depth, drainage class) are likely to change on a typical hillslope extending from a hill crest to a stream bottom. Describe hydrologic implications of concave and convex slope positions. Differentiate between properties of soils found on floodplains and stream terraces.

Soil mapping unit designations: define consociation, association, complex, variant, taxadjunct, phase, and similar terms related to map units. If a variant or taxadjunct is used on an on-site soil survey, what additional information is required.

Mapping intensity and purity: define level 2 and 3 mapping intensity; give number of borings at each level and the number required for individual lot assessment; define approximate mapping unit purity required in level 2 an d3 surveys. Which level is required for approval of a subdivision?

Map requirements: Give the minimum scale for a level 3 soil survey. What are the requirements for the base map for the level 3 survey?

Map interpretation: given a topo map, identify landscape positions and features, and be able to predict how soil series and/or properties might change within the landscape.

Georgia landscapes: be able to identify major land resource areas on a map of Georgia, describe common parent materials, general topographic characteristics, and general soil properties in each MLRA.

Location: Give location accuracy criteria required for a level 3 soil survey and describe methods that can be used to accurately locate your position on the landscape and on an associated map.

Mapping: Given a set of pedon descriptions, the location of each pedon on a map, and topographic information for the site; interpret each description for the soil's suitability for a conventional on-site system or alternate system, group soils that interpret similarly, and place lines that separate similarly interpreting soils on a site map.

4. Basic hydology/Water quality

Hydrologic cycle: define major processes within the hydrologic cycle; write the basic water balance equation and define terms; describe the normal seasonal variation in precipitation, evapotranspiration, stream flow, and soil profile moisture content for Georgia.

Water flow in soils: write Darcy's law and define and explain terms in the equation; describe how to measure variables in Darcy's law in the laboratory; describe how water flows through soils with slowly permeable layers on sloping landscapes; define the term recharge area, and what types of soils and geology are associated with aquifer recharge; define perched and free (also known as apparent or surface) water tables, and describe where they are likely to be found in the landscape over different seasons of the year.

Permeability and percolation: describe how to correctly perform a borehole test (perc test) using the modified Taft method; explain the relationship between K_{sat} and permeability measured using the borehole method; describe how permeability measurements can be used in site assessment for septic suitability; list major soil properties affecting permeability for intact and disturbed soil (fill), and explain their role in water flow. What factors contribute to the decline in wastewater infiltration rate (movement of wastewater from the absorption trench into the soil) over time.

Water quality: list the major water pollutants that are associated with failure of on-site septic systems; identify pathways by which these pollutants may contaminate ground-and surface water; explain soil and microbial processes involved in attenuation of each of these pollutants in a functioning septic system; list and explain soil properties important in attenuation processes listed above.

5. Soil interpretations for onsite systems

On-site systems: describe the purpose and function of the septic tank and soil absorption field in an on-site system.

Siting systems: for conventional installations, compute approximate drainfield sizes given relevant soils and housing specifications; describe how to determine the appropriate depth of trench installation; list specified setbacks from wells, groundwater tables (perched and free) and surface waters, and how specific soil/site conditions may modify these established setbacks.

Alternative systems: describe the layout and operation of alternative systems such as drip with aerobic pretreatment and full (Wisconsin) mound systems; specify soil and/or site conditions which may indicate the suitability of these systems; describe conditions under which modified mound systems may be used on marginal sites.

Specifications for soils reporting: list and describe all elements which must be included in the final delivered site report, including map specifications, written/tabular soils information, and interpretations. Who can make a soil survey of a subdivision for on-site systems? Individual lot?

Soil characteristics: give minimum separations between base of sewage absorption trench and a seasonal high water table, impervious horizon, bedrock for untreated and aerobically treated effluent. Describe other soil characteristics (estimated perc rate, slope, bedrock depth, etc.) that can limit use of a site for an on-site system. Describe how the following soil properties affect soil suitability and placement for on-site wastewater systems: soil texture, saturated hydraulic conductivity, depth of seasonal water tables, soil structure. Why is a seasonal water table considered to be limiting for installation of an on-site wastewater system?

A Brief Outline of Soil Color and Redoximorphic Features

Soil Color
Obvious property of soils. Common descriptor – “black soils”, “red soils”, “brown soils”, etc.
Soil Coloring Agents:

Uncoated mineral grains: Usually gray to white (color of quartz) but may be most any color depending on minerals present.

Coatings:

Organic matter: Black or brown

Iron and Manganese Oxides and Hydroxides as coatings on grains:

Red (hermatitie), yellowish-brown (geothite), orange (lepidocrocite), black (Mn oxides, yellow (jarosite); overall effect of mixture may be “brownish”

Redoximo rphic Features

Redoximorphic features (mottles and other features) – soil morphological characteristics that results from the reduction and oxidation of Fe and Mn compounds

Types:

Redox concentrations – zones of accumulation of Fe-Mn oxides

Nodules or concretions, masses (red mottles), pore linings

Redox depletions – zones of low chroma (2 or less) where Fe-Mn oxides with or without clay have been depleted, i.e. coatings of Fe and Mn oxides have been removed and color is that of uncoated grains

Reduced matrix – matrix color has low chroma in situ, but changes hue or chroma after exposure to air; occurs because reduced Fe and/or Mn is present in the soil material, i.e. color changes because reduced Fe (low chroma) becomes oxidized on exposure to air

The formation of redox concentrations and depletions are due to the movement of Fe and Mn from depletions (loss of Fe) to concentrations (addition of Fe). The movement of Fe and Mn in soils is related to redox processes caused by saturation with water. Oxidized Fe and Mn (Fe^{3+} and Mn^{4+}) are essentially insoluble in water and immobile in soils. Reduced Fee and Mn (Fe^{2+} and Mn^{2+}) are soluble in water and can move from one part of a horizon to another or can move greater distances.

Because the diffusion rate of oxygen into water is extremely slow, microbial activity can deplete the oxygen dissolved in water in a saturated horizon. As long as O2 is present, it is used as the electron acceptor for respiration. After dissolved oxygen has been depleted, faculative anaerobic bacteria use other ions as electron acceptors for respiration (addition of electrons = reduction).

Order in which different ions are used depends energy of the reactions, i.e. oxygen is most energetically favorable.

Order of reduction in soils

$O^2 \rightarrow O^{-2}$

$NO_3^{-1} \rightarrow N^2$ or N^2 (denitrification)

$Mn^{+4} \rightarrow Mn^{+2}$ (at very low pH, Mn is more easily reduced than nitrate)

$Fe^{+3} \rightarrow Fe^{+2}$

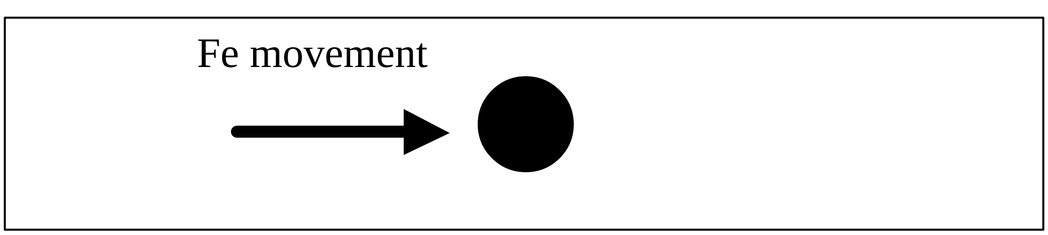
$SO_4^{-2} \rightarrow S^{-2}$ (H_2S)

HCO_3^{-1}, $CO_2 \rightarrow CH_4$

Because reduction is microbially driven, three conditions must be present in the soil for reduction to occur and for redox features to form: 1) saturation with water, 2) presence of anaerobic bacteria (almost always true), and 3) organic matter available as a food source for the bacteria. A fourth condition must also be present which is the presence of Fe in the horizon (almost always true except for a few very sandy horizons).

Because organic matter is needed for microbial activity, redox feature formation is usually slower in subsoil horizons than in surface horizons. Also, redox depletions in subsurface horizons often occur around dead plant roots and other sources of organic matter as food for microbes.

Redox concentrations and depletions are formed by movement of Fe within a horizon, between horizons within a pedon, or across the landscape. Soil horizons may have reduced micro-sites and oxidized microsites at the same time. Oxidized microsites serve as a sink for reduced Fe, i.e. because site is oxidized, a diffusion gradient exists between reduced areas and oxidized areas. There is a concentration of Fe^{2+} in reduced zones while the concentration in oxidized zones is 0. which establishes the diffusion gradient. This gradient causes Fe to move from reduced microsites (redox depletion to oxidized microsites (redox concentrations).



If redox features form in a saturated horizon and conditions change so that the horizon is no longer saturated, the redox features are not destroyed (oxidized Fe and Mn are immobile). Thus, redox features formed under periodic saturation at some time during the history of a soil's development, will remain even if the soil is currently well drained. There are mophological clues that can be used to separate relict from contemporary redox features (primarily boundaries of the redox features; sharp boundaries are commonly interpreted as relict and diffuse boundaries interpreted as contemporaneous). Even though relict redox features occur, the vast majority reflect current hydrologic conditions.

Importance of redox features:

Seasonal water table must be at least 24 inches below base of absorption field.

Many studies from various parts of the country and world have established that redox depletions with chroma of 2 or less is positive evidence of a seasonal water table. Duration of saturation varies.

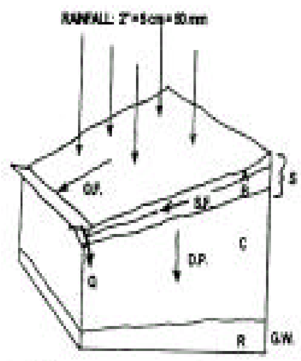
Though any area within a horizon with lower chroma than the matrix is considered to be a depletion, most interpretations of seasonal water tables use depletions or the matrix color with chroma of 2 or less. A few studies in the southeast have suggested that a chroma of 3 is diagnostic of seasonal saturation. Also, a study in southwest Georgia found that horizons with redox concentrations without 2 chroma depletions were saturated 20% of the year. In this study, 2 chroma depletions were always present a few inches below the concentrations and these horizons were saturated for about 40% of the monitoring period.

Annual Budget for Georgia

		mm/y	
Input (rainfall)		1250	
Outputs:			
Evapo-transpiration	850	(68%)	
Runoff (discharge to streams)		400	(32%)
Deep percolation to GW		---	(?)

ET is determined by:		Max ET when:
Plant canopy cover (leaf area)		(Full canopy)
Temperature	(Hot)	
Solar radiation input		(Sunny)
Relative humidity		(Low humidity)
Wind speed		(Windy)

Weekly budget for a watershed of 1 ha (hectare, =10,000 m2)



Input: 2" = 5 cm =
$0.05 \text{ m} \times 10{,}000 \text{ m}^2 = 500 \text{ m}^3$

Outputs:
Q= stream discharge
Note Q= Overland Flow + Subsurface Flow

Measure: 100 m^3 (stream gage)
$100 \text{ m}^3/10{,}000 \text{ m}^2 = 0.01 \text{ m} = 1 \text{ cm}$
(that's 1/5=20% of rain....)

ET = evapotranspiration from plants
(estimated from climatic data)
= 1 cm

Deep Percolation = 0 (impermeable layers limit deep movement.....?...)

Basic Water Balance Equation: $P = Q + ET + \Delta S$
$5 = 1 + 1 + \Delta S$; $\Delta S = 3$ cm
3 cm more water held in soil at end of week . . .

> if soil is initially *dry* (high ET in summer), water is rapidly soaked up, held in soil (increases ΔS temporarily, reduces Q)
> if soil is already wet (low ET in winter), water may either--
— run off surface to nearest stream
— percolate downward within profile (lateral or deep flow...)
mostly becomes Q . . .

Useful References

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Field Book for Describing and Sampling Soils – http://www.statlab.iastate.edu/soils/nssc/field_gd/field_gd.htm

Official series descriptions – http://www.statlab.iastate.edu/soils/nsdaf/

USDA-NRCS Soils Data Access Facility – http://www.statlab.iastate.edu/soils/nsdaf/

Order photos and maps – http://www.statlab.iastate.edu/soils/photogal/orders/soiord.htm

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