Soil Science
Professional Practice Exam

Performance Objectives

Soil Science Society of America's

Council of Soil Science Examiners

Effective December 2007

CSSE PROFESSIONAL PRACTICE PERFORMANCE OBJECTIVES

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FOREWARD

This booklet represents the Performance Objectives (POs) for the Soil Science Professional Practice Examination. The POs presented are the minimal professional competencies needed by the professional soil scientists. These competencies are given as a list of POs.

The development of the POs began in 1994 when the Soil Science Society of America (SSSA) asked the practicing soil consultants, state licensing boards, government officials and academicians to collectively develop a nationally applicable set of standards fundamental to the rigorous solution of environmental and agronomic problems. Subsequently, this group evolved into the Council of Soil Science Examiners (CSSE) which refined that original list of standards and continues to refine the list on a systematic basis leading to the most recent 2008 edition. The POs have been developed to assist the student in studying for the Professional Practice Exam. The CSSE is also charged with the development of the examinations required for certification and licensure. The examinations are the product of the balanced application of the POs and can best be studied for by developing a technical understanding of each PO.

The goal of the POs, the examinations and the CSSE is to protect the health and welfare of the public by insuring only competent soil scientists are certified and /or licensed. In doing so, the CSSE repeatedly scrutinized the POs to insure we are testing the most pertinent soils knowledge. In this right, a subcommittee of the CSSE is formed along with an end user group to review and revise the POs on a routine basis culminating in this document.

Soil Science is a dynamic field where new discoveries and approaches continue to occur at a rapid pace. The CSSE encourages comments and suggestions concerning possible modifications to the 2008 edition of the POs. Comments should be sent to: SSSA CSSE, 677 South Segoe Road, Madison, WI 53711.

The SSSA and CSSE would like to thank the many volunteers who contributed to the continuing refinement of this document. It would not be possible without their dedication to the profession of soil science.

I. SOIL CHEMISTRY AND MINERALOGY

COMPETENCY AREA 1. ADVANCED SOIL CHEMISTRY CONCEPTS

1. Explain the use of clay minerals to form organo-clay complexes
    a. from soil solution for removing organic constituents
    b. to reduce transport of organic constituents within soil profiles
    c. for remediation of polluted soil or water

COMPETENCY AREA 2. SOLID PHASE

2. Differentiate surface charge characteristics for phyllosilicate and hydrous metal oxides
    a. classify clay minerals by group according to isomorphic substitution
    b. location of charge within the crystal lattice
    c. relationship to shrink-swell properties
    d. suitability for in design of physical structures

COMPETENCY AREA 3. MINERAL WEATHERING

3. Know weathering rates of primary minerals

4. Explain climate affects on the progression of weathering in a soil profile relative to
    a. soil pH
    b. organic matter
    c. profile depth
    d. salt accumulation
    e. carbonate accumulation
    f. leaching of anions and cations

5. Explain weathering impacts on clay content, distribution, and mineralogy in a soil profile

COMPETENCY AREA 4. SOLID/SOLUTION EQUILIBRIA

6. Identify the dominant mineral phase when given a stability diagram and soil chemical parameters

7. Explain the mechanism for reducing lead, cadmium, copper, nickel and zinc solubility through *in situ* treatment with phosphate

COMPETENCY AREA 5. SORPTION AND PRECIPITATION REACTIONS

8. Relate electronegativity to binding strength between ions in solution with colloid surfaces

9. Recognize differences in sorption strengths of Lead, Cadmium, Chromium, Arsenic, and Selenium

10. Describe how differences in sorption strengths of compounds affect their movement through soils

11. Explain how the following impact inorganic and organic compounds in soils
    a. K_{OC}
    b. half life
    c. solubility
    d. vapor pressure
    e. ionic form
    f. K_d

12. List soil factors that influence the corrosion of concrete and iron containing materials placed in soils

13. Recognize the difference between specific (inner sphere) and non-specific (outer sphere) adsorption

COMPETENCY AREA 6. ACIDITY

14. Know the effect of soil pH on speciation of
    a. Aluminum
    b. Iron
    c. Chromium
    d. Copper
    e. Zinc
    f. Lead
    g. Phosphorus
    h. Carbonate
    i. Arsenic

15. Explain the relationship between $SO_{2(g)}$, $CO_{2(g)}$, and $NO_{2(g)}$ and soil acidity

COMPETENCY AREA 7. OXIDATION AND REDUCTION

16. Explain the effect of oxidation-reduction reactions on solubility of
    a. iron
    b. manganese
    c. arsenic
    d. lead

17. Describe the relationship between pe and Eh

18. Describe the relationship between pH and Eh

19. Explain the relationship between microbial activity and Eh

II. SOIL FERTILITY

COMPETENCY AREA 1. ROLES OF NUTRIENTS IN PLANTS AND THEIR AVAILABILITY IN SOILS

20. Explain how chelates (organometallic complexes) are used to increase bioavailability of plant nutrients

21. Identify the relative mobility of nutrients in the soil

COMPETENCY AREA 2. pH

22. Explain effect on soil pH upon drainage of an acid sulfate soils

23. Describe the relationship between plant root growth, soil pH and aluminum solubility

COMPETENCY AREA 3. ACIDIFYING AND LIMING OF SOIL

24. Explain the effect of adding pyrite containing material on soil pH

25. Explain the effects of gypsum and soil organic matter on soil
    a. pH
    b. aluminum bioavailability

COMPETENCY AREA 4. SALT AFFECTED SOILS

26. Calculate the leaching requirement to ameliorate salt affected soils when provided with water quality and soil salinity data

27. Describe management strategies to mitigate salt accumulation in rooting zones

28. Describe the effects of gypsum, sulfur and sulfuric acid on chemical and physical properties when remediating saline-sodic or sodic soils

COMPETENCY AREA 5. NUTRIENT SOURCES

29. Calculate the quantity of bioavailable nutrients when provided the with nutrient concentration of organic and inorganic nutrient sources

30. Identify appropriate physiological and environmental timing for application of nutrient sources

COMPETENCY AREA 6. NUTRIENT MANAGEMENT

31. Describe impact of tillage practices, crop species selection, and cropping sequence on nutrient cycling

32. Explain how soil disturbances affect nutrient cycling

33. Explain how plant removal affects nutrient cycling

III. SOIL PHYSICS

COMPETENCY AREA 1. PHYSICAL PROPERTIES

34. Explain how to mitigate physical limitations of sodic, saline, and saline-sodic soils

35. Analyze how the following parameters affect soil physical properties both individually or in groups:
    a. particle size distribution
    b. specific surface
    c. soil structure and aggregation with characteristics of:
        i. crusting
        ii. aggregate characteristics (size, distribution, stability)
        iii. use of soil conditioners
    d. hydrophobicity
    e. bulk density
    f. porosity
    g. mass wetness
    h. volume wetness

36. Explain the effect of compaction on a forest soil

COMPETENCY AREA 2. SOIL-WATER RELATIONSHIPS

37. Calculate a soil water balance

38. Analyze a soil moisture characteristic curve for use in evaluating a soil for various uses

39. Explain how hysteresis and tortuosity affect soil water content and potential

40. Describe how water input affects water table geometry

41. Analyze soil water potentials
    a. total soil-water potential
    b. gravitational potential
    c. pressure potential
    d. matric potential
    e. osmotic potential

42. Propose field techniques to measure soil water potentials

43. Diagram the water balance of a root zone

44. Differentiate levels of evapotranspiration under varying types of
    a. soil moisture regimes
    b. ground cover
    c. vegetative characteristics
    d. climates/microclimates

COMPETENCY AREA 3. WATER MOVEMENT AND TRANSPORT PROCESSES

45. Compare and contrast the rate and pattern of water flow in saturated and unsaturated soils

46. Discriminate between the following types of flow:
    a. homogeneous
    b. inhomogeneous
    c. isotropic
    d. anisotropic

47. Analyze flow using Darcy's Law

48. Evaluate the limitations of Darcy's Law

49. Propose field and lab methods to measure saturated hydraulic conductivity

50. Compare and contrast field and lab methods to measure saturated hydraulic conductivity

51. Assess hydraulic conductivity with respect to texture and suction

52. Describe how structure and texture affect water movement, retention and plant available water holding capacity

53. Describe how preferential flow affects groundwater quality

54. Explain how land use affects water movement, retention and availability

55. Distinguish between infiltration and hydraulic conductivity

56. Assess surface characteristics and their effect on infiltration rate

57. Explain how the following affect infiltration rate:
    a. time from the beginning of rain or irrigation
    b. hydraulic conductivity
    c. antecedent soil moisture
    d. depth of soil profile
    e. layered profiled
    f. crusted soils
    g. instability of wetting fronts
    h. preferential flow

COMPETENCY AREA 4. SOIL TEMPERATURE

58. Prepare and analyze an energy balance for a given soil

59. Differentiate modes of energy transfer in soil systems:
    a. Radiation
    b. Convection
    c. Conduction

60. Analyze and be able to modify a soil's thermal regime for use in management decisions

61. Compare and contrast volumetric heat capacity and thermal conductivity

62. Describe how thermal properties of soil are affected by
    a. water content
    b. organic matter
    c. air filled porosity
    d. soil texture
    e. surface residue
    f. albedo

63. Understand the soil thermal regime and its relationship to soil system as a whole

64. Describe manipulation of the soil thermal regime to manage temperature

COMPETENCY AREA 5. SOIL GASES

65. Appraise the composition of soil air under different circumstances:
    a. oxygen
    b. carbon dioxide
    c. methane
    d. hydrogen sulfide
    e. relative humidity

66. Differentiate and explain why soil respiration differs
    a. in vegetated versus fallow areas
    b. during different seasons of the year
    c. throughout different times of the day
    d. with varying degrees of microbial activity
    e. with varying degrees of soil wetness

67. Compare and contrast movement of gases under the following terms:
    a. convective
    b. diffusion
    c. emission of greenhouse gases

COMPETENCY AREA 6. ENGINEERING PROPERTIES

68. Compare and contrast the following particle size classification systems:
    a. United States Department of Agriculture (USDA)
    b. American Society for Testing Materials (Unified Soil Classification System)
    c. United States Geological Survey (USGS) (modified Wentworth scale)

69. Define soil strength and shear stress

70. Provide BMPs for soil compaction

71. Describe the ways in which soil can fail

72. Evaluate factors affecting slope stability and soil mass movement hazards

73. Assess soil compaction under different conditions of soil texture, wetness, land use

IV. SOIL GENESIS, MORPHOLOGY, AND CLASSIFICATION

COMPETENCY AREA 1. SOIL FORMING FACTORS

74. Evaluate the five soil forming factors influence on soil properties

75. Relate soil properties to the following parent materials:
    a. alluvium
    b. colluvium
    c. till
    d. eolian sand
    e. loess
    f. marine sediments
    g. residuum
    h. glacial outwash
    i. coastal sediments
    j. lacustrine sediments

COMPETENCY AREA 2. HORIZON FORMING PROCESSES

76. Describe important soil forming processes given morphologic, hydrologic, and landscape information

77. Explain the dominant pedogenic processes for a given soil profile description

78. Identify major soil forming processes leading to development of diagnostic horizons

COMPETENCY AREA 3. SOIL PROFILE DESCRIPTIONS

79. Evaluate soil morphologic properties in land use decisions

80. Interpret soil genetic processes utilizing morphologic information

81. Evaluate the seasonally high water table location using soil morphology.

COMPETENCY AREA 4. SOIL INTERPRETATIONS AND LAND USE MANAGEMENT

82. Utilize soil profile descriptions to evaluate and make land use decisions

COMPETENCY AREA 5. SOIL CLASSIFICATION CONCEPTS

83. Distinguish between endosaturation and episaturation

84. Integrate soil taxonomic information with soil morphology, genesis, landscapes, and land use decision making

COMPETENCY AREA 6. SOIL MAPPING AND GEOSPATIAL INFORMATION

85. Utilize information found in a modern National Cooperative Soil Survey Report to evaluate a site

86. Identify scale limitations of Soil Surveys

87. Describe how to acquire, manipulate, interpret and present the following:
    a. soil maps
    b. topographic maps
    c. wetlands inventory maps
    d. aerial imagery,
    e. remote sensing & satellite data
    f. bedrock and surficial geology maps
    g. watershed maps
    h. land cover inventories
    i. hydrology maps
    j. hydrogeology maps
    k. cultural resources

88. Utilize geospatial information to develop best management practices (BMP's) for:
    a. soil testing
    b. nutrient recommendations
    c. erosion control practices
    d. cropping practices

COMPETENCY AREA 7. GEOMORPHOLOGY

89. Use landscape position and geologic information to predict soil properties

90. Describe dominant pedologic and hydrologic properties of the following hillslope positions:
    a. summit
    b. shoulder
    c. backslope
    d. footslope
    e. toeslope

91. Differentiate convex, concave, and linear landscape segments and describe their impact on soil and hydrologic properties and land use

92. Distinguish convergent and divergent flow

93. Utilize topographic information in order to evaluate how a landscape partitions water

94. Define and delineate a watershed

COMPETENCY AREA 8. SOILS IN ECOSYSTEMS

95. Describe and interpret important soil properties of soils associated with:
    a. Forests
    b. Deserts
    c. Prairies
    d. Tundra
    e. Wetlands

COMPETENCY AREA 9. SOIL VARIABILITY

96. Differentiate between natural variability and anthropogenic variability

97. Define pedo-transfer functions and utilize them in characterizing soil variability

98. Evaluate and design sampling schemes in order to capture variability across scales

V. SOIL BIOLOGY AND BIOCHEMISTRY

COMPETENCY AREA 1. SOIL ECOLOGY

99. Given appropriate data, discuss how soil moisture, texture, aeration, pH and nutrient levels will impact populations and activities of key groups of organisms in soil
    a. aerobic
    b. heterotrophic bacteria and fungi
    c. autotrophic bacteria involved in the nitrogen and sulfur cycles
    d. earthworms

100. Discuss how the following conditions affect competition for nutrients in soil by microorganisms
    a. soil texture
    b. organic matter content
    c. presence or absence of plant roots

101. Discuss the impact of soil fungi on the formation of stable aggregates in soil.

102. Discuss the dynamic nature of the rhizosphere with reference to:
    a. microbial populations
    b. nutrient transformation
    c. phytoremediation
    d. aggregate development and stability

103. Discuss the impacts of soil disturbance on soil microbial populations and activities:
    a. intensive tillage
    b. flooding
    c. compaction

104. Discuss the conditions under which one should consider the use of inoculants for leguminous crops.

105. Discuss how mycorrhizal and rhizobial symbioses are affected by soil:
    a. moisture
    b. aeration
    c. fertilizer additions
    d. pH

COMPETENCY AREA 2. BIOLOGICAL AND BIOCHEMICAL ACTIVITIES

106. Discuss the conditions under which microbial activities can affect the oxidation and reduction of the following elements.
    a. Arsenic
    b. Iron
    c. Manganese
    d. Mercury
    e. Nitrogen
    f. Selenium
    g. Sulfur

107. Given appropriate data, evaluate how the following soil factors will impact the decomposition of organic materials in soil:
    a. pH
    b. moisture
    c. temperature
    d. aeration
    e. oxidation-reduction potential
    f. inorganic nutrients
    g. clay type and amount

108. Given appropriate data on organic material composition and efficiency of microbial decomposition, calculate the following:
    a. quantity of stable humus produced
    b. nitrogen mineralization or immobilization
    c. phosphorus mineralization or immobilization

109. Discuss how the nitrification process is affected by soil:
    a. pH
    b. moisture
    c. temperature
    d. aeration

110. Discuss how the denitrification process is affected by soil:
    a. moisture
    b. temperature
    c. aeration
    d. available carbon

111. Discuss the conditions under which inorganic nitrogen can be lost from the soil nitrogen cycle.

112. Design a phytoremediation plan based on concentrations and species of contaminants and site conditions

COMPETENCY AREA 3. SOIL ORGANIC MATTER

113. Discuss how the exchange capacity of stable soil organic matter is affected by soil acidity

114. Discuss how retention of nutrients, organic pollutants or inorganic pollutants are affected by exchange capacity and changes in soil pH

115. Discuss the importance of the following to the function and stability of soil organic matter:
    a. fulvic acids
    b. humic acids
    c. organo-clay complexes
    d. microbial biomass

116. Discuss the mechanisms by which soil organic matter interacts with the following:
    a. acidity (H^+ or H_3O^+)
    b. aluminum
    c. cations (e.g., Ca^{2+}, Cd^{2+}, Na^+, Pb^{2+}, etc…)
    d. polar and non-polar pesticides
    e. organic xenobiotics

117. Describe how plant materials of differing age and chemical composition influence the rate of organic matter formation.

COMPETENCY AREA 4. ENVIRONMENTAL AND AGRICULTURAL APPLICATIONS

118. Design a bioremediation plan based on concentrations and species of contaminants and site conditions

VI. LAND USE MANAGEMENT

COMPETENCY AREA 1. EROSION AND SEDIMENT CONTROL

119. For a given site recommend best management practices (BMP's) for erosion & sediment control

120. Evaluate a site to select appropriate values to use in the USLE

121. Assess site vulnerability to wind and/or water erosion

122. Rank erosivity characteristics of soil and rainfall that contribute to:
    a. sheet erosion
    b. rill erosion
    c. gully erosion

123. Define highly erodible land (HEL)

124. Explain limitations of HEL

125. Evaluate and provide appropriate BMPs for soil properties that contribute to:
    a. Creep
    b. Saltation
    c. suspension

126. Identify co-contaminants associated with suspended particulates in the air

127. Develop a conservation land use plan

128. Evaluate the effectiveness of management practices in controlling water and wind erosion

129. Describe how grazing management affects the hydrologic cycle and soil erosion

COMPETENCY AREA 2. WETLANDS AND HYDRIC SOILS

130. List criteria used to delineate a jurisdictional wetland

131. Describe characteristics of the following wetland environments:
    a. prairie potholes
    b. coastal marshes
    c. peatlands
    d. bottomland hardwoods
    e. mangrove swamps
    f. tidal marshes
    g. riparian zones
    h. wet meadows
    i. seeps

132. Describe how to identify hydric soils

133. Given morphologic information, distinguish hydric soils from non hydric soils

134. List the major hydric soil indicators

135. Calculate hydrologic recharge rates

136. Formulate methods to measure recharge, discharge and saturation in wetlands

137. Evaluate differences in water movement in peat versus mineral substrate wetlands

138. Describe methods used to avoid, minimize, or mitigate adverse effects to wetlands

139. Define constructed versus restored wetlands for wetland mitigation

COMPETENCY AREA 3. SOIL QUALITY AND MANAGEMENT

140. Calculate the amount of carbon sequestered in soil given land management practices and the amount of carbon in the material

141. Use bulk density, organic carbon concentration, and soil thickness to calculate amount of organic carbon in a soil

142. Calculate the amount of organic matter in the soil given the appropriate data

143. Given C:N:P:S ratio, determine amount of P,N,S sequestered per ton of carbon

COMPETENCY AREA 4. WASTE MANAGEMENT

144. Describe methods and management for the beneficial use of biosolids, animal wastes, and effluents

145. Describe the advantages and disadvantages of land application of biosolids, animal wastes, and effluents

146. List the dominant contaminants in municipal biosolids and industrial wastes

147. Calculate application rates of nutrient containing amendments based on soil test recommendations, crop requirements and/or crop removal

148. Use $CaCO_3$ equivalent to adjust lime application rate to meet biosolid application recommendations

149. Calculate application rates of biosolids, effluents, and industrial wastes based on yearly and cumulative identified loading rates

150. Given data for loading rate and soil properties, determine suitability and size of an on-site waste disposal system that accounts for spatial variability and multiple sites

151. Identify best management practices (BMP's) for managing soils contaminated with:
    a. Cadmium
    b. Chromium
    c. Lead
    d. Zinc
    e. Nickel
    f. Arsenic
    g. Selenium
    h. Mercury

152. Describe the fate of human and animal pathogens and waste products introduced into the soil environment from application of manures or biosolids

153. Evaluate capacity of a constructed wetlands for to mitigate outflow contaminants

COMPETENCY AREA 5. CROPLAND, RANGELAND AND FIELD MANAGEMENT

154. Describe how tillage and residue management affects:
    a. soil structure
    b. water infiltration
    c. aggregate stability
    d. bulk density
    e. organic matter content
    f. soil temperature
    g. soil water content
    h. penetration resistance
    i. soil erosivity
    j. heat capacity

155. Describe effects of grazing and overgrazing on rangeland soils

156. Given appropriate information and data, design a nutrient management plan for a farm of CAFO

157. Describe impact of a prescribed grazing program on nutrient cycling and soil physical properties

COMPETENCY AREA 6. WATER QUALITY AND MANAGEMENT

158. Calculate nutrient loading rates given concentrations and flow rates

159. Describe how soils can be used to treat contaminated waters:
    a. land application of effluent
    b. pump and land apply

160. Distinguish between point and non-point sources of pollution

161. Describe how suspended soil particulates in air or water:
    a. are transported
    b. affect human health
    c. affect water quality

162. Determine the suitability of sites for use in:
    a. agricultural production – crops, animal agriculture feedlot, range
    b. construction
    c. waste disposal and remediation
    d. forestry
    e. natural habitats
    f. mine reclamation

COMPETENCY AREA 7. REGULATORY AND RESOURCE AGENCIES

163. Know aspects related to soil science or materials impacted by soils in Federal Programs pertaining to:
    a. National Pollution Discharge Elimination Systems (NPDES)
    b. Confined Animal Feeding Operations/Animal Feeding Operations (CAFOs/AFOs)
    c. Total Maximum Daily Loads (TMDLs)
    d. Coastal Zone Act
    e. Clean Water Act
    f. National Environmental Policy Act (NEPA)
    g. Superfund Amendments and Reauthorization Act (SARA)
    h. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
    i. Resource Conservation and Recovery Act (RCRA)

164. Compare and contrast the responsibilities of federal agencies with respect to the programs:
    a. National Pollution Discharge Elimination Systems (NPDES)
    b. Confined Animal Feeding Operations/Animal Feeding Operations (CAFOs/AFOs)
    c. Total Maximum Daily Loads (TMDLs)
    d. Coastal Zone Act
    e. Clean Water Act
    f. National Environmental Policy Act (NEPA)
    g. Superfund Amendments and Reauthorization Act (SARA)
    h. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
    i. Resource Conservation and Recovery Act (RCRA)

COMPETENCY AREA 8. SURFACE MINE AND MINE SPOIL RECLAMATION

165. Define the following surface mine and mine spoil reclamation terms:
    a. acid/base accounting
    b. top soil substitute
    c. acid forming materials
    d. toxic forming materials
    e. acid mine drainage

166. Calculate the lime requirement based upon the acid/base account

167. List criteria for selecting top soil substitute material instead of native soil

168. Describe methods of surface mine reclamation

169. Describe methods of surface mine reclamation and revegetation

170. List sources of acid in acid mine drainage

COMPETENCY AREA 9. URBAN AND DISTURBED SOILS

171. Identify common physical and chemical properties and concerns of the following fill materials:
    a. fly ash
    b. railroad ties
    c. concrete
    d. asphalt
    e. construction debris
    f. biosolids
    g. demolition debris

172. Identify chemical concerns associated with the following items from industrial storage areas:
    a. transformers
    b. Naturally Occurring Radioactive Materials (NORM)
    c. tires
    d. industrial waste drums
    e. batteries

173. Compare and contrast characteristics and properties of the following:
    a. native soils
    b. urban soils
    c. disturbed soils

174. Identify common physical properties and chemical concerns of the following:
    a. construction debris
    b. heavy metals
    c. petroleum waste products
    d. household waste

175. Define brownfields and construct a plan to assess soils on a brownfield site

176. Describe procedures to ameliorate site compaction

177. Distinguish cut and fill and compacted site materials from native soils

178. Formulate a reclamation plan for soils associated with pipeline construction

179. Evaluate substrate materials for suitability as a topsoil substitute

COMPETENCY AREA 10. FOREST SOILS

180. Explain how erosion and infiltration differ for the following forest areas:
    a. logging roads
    b. landings
    c. skid trails
    d. harvested area
    e. undisturbed forest

181. Describe nutrient cycling and losses in the following forest scenarios:
    a. clear cut harvesting
    b. prescribed burn
    c. wildfire
    d. plantation forestry
    e. undisturbed forest

182. Explain the effect of forest fires on the following soil factors
    a. hydrophobicity
    b. nutrient transformations
    c. organic horizons
    d. soil surface
    e. nitrogen losses
    f. carbon losses

VII. FIELD AND LABORATORY TECHNIQUES

183. Propose field measurement techniques to measure soil physical properties

184. Propose lab measurement techniques to measure soil physical properties

185. Compare and contrast field versus lab measurements of soil physical properties

186. Describe how to collect a representative sample of the following:
    a. soil
    b. soil vapor
    c. soil water

187. Explain the use of a penetrometer in field testing compaction

188. Explain limitations for using platinum electrodes to measure soil Eh

189. Explain use and limitation of electromagnetic soil conductivity to measure soil salinity

190. Describe the soil sampling strategy as affected:
    a. tillage system
    b. nutrient application method

191. Evaluate sampling schemes based on available equipment and properties to be sampled

192. List equipment used to collect and measure gases and liquids in soil

193. Describe factors to consider when collecting and measuring field samples with the following:
    a. tensiometer
    b. constant head permeameter
    c. piezometer
    d. lysimeter
    e. infiltrometer
    f. penetrometer
    g. capacitance probe
    h. ground penetrating radar
    i. TDR
    j. neutron probe
    k. wells

194. Interpret laboratory measurements for field decisions for the following parameters:
    a. pH
    b. particle size using USDA & ASTM standards
    c. bulk density
    d. volumetric and gravimetric water content
    e. organic carbon and organic matter
    f. universal soil extractions for bioavailable nutrients (e.g. Mehlich III)
    g. cation exchange capacity
    h. heavy metals
    i. semi-volatile organic carbon
    j. species dissolved in solution
    k. microbial biomass

VIII. ETHICS

195. Describe obligations a professional soil scientist has to a client and the interests of the client

196. Describe a professional soil scientist obligation to protect the confidence of a client

197. Describe a professional soil scientist responsibility for protection of a clients information