Florida Department of Transportation – Aviation Office
Airport Stormwater Management

Test

Name: ____

Email address: ____________________________________

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Signature: ____

Session 1 – Introduction (included with Session 2)	
Session 2 – Florida Airports and Stormwater Management	(14 points)
Session 3 – Hydrology	(10 points)
Session 4 – Overland Flow and Infiltration	(10 points)
Session 5 – Lunch (not recorded)	
Section 6 – Chemistry and Load	(10 points)
Section 7 – Airport General Permit, Best Management Practices Manual and BMPs	(10 points)
Session 8 – Permitting (no test questions included)	
Section 9 – Working Example	(6 points)

Test Grade _____________ %

- Clearly circle the correct letter of the answer for each question **and** clearly and legibly mark this answer in the left margin next to the chosen answer.
- A grade of 70% is required to pass this test.
- Your work must be your own. By submitting the test, you affirm that it is the independent work of the signee.
- There is no time limit for the test.
- By placing my name on this test, I agree not to discuss the test with anyone in the class who has not taken this test; or if taking a re-scheduled test I have not discussed any aspect of this test with anyone who has taken the test or has information of a substantive nature regarding this test
- Scan and return entire test as a clear and legible pdf to Dr. Abdul Hatim at Abdul.Hatim@dot.state.fl.us, or mail your completed test to:

  Dr. Abdul Hatim
  FDOT – Aviation Office, MS 46
  605 Suwannee Street
  Tallahassee, FL 32399-0450

SESSION 2 – Florida Airports and Stormwater Management

1. The Florida Statewide Airport Stormwater Study:
   a. was done to evaluate water intrusion and lightning damage to runway and taxiway circuits
   b. established the quality characteristics of airside pavement runoff
   c. evaluated selected airport and water management compatible best management practices
   d. both b. and c.

2. Direct and indirect economic impacts of airports in Florida are about:
   a. $18 million annually
   b. $1.8 billion annually
   c. $114 billion annually
   d. $75 million annually

3. 3. The airport airside includes:
   a. Runways, taxiways and aprons
   b. Areas serving passengers, flight crews, air cargo and surface transportation
   c. Safety and Object Free Areas
   d. Both a. and c.

4. AvGas contains ____ grams per gallon lead and accounts for less than ______ of the total fuel used for transportation each year
   a. 0.001 and .5%
   b. 2.0 and 0.5%
   c. 0.2 and 0.5%
   d. 2.0 and 5%

5. Large aircraft routinely dump fuel because:
   a. Aircraft landing weights are less than aircraft takeoff weights
   b. Excess fuel on landing is a fire hazard
   c. They do not routinely dump fuel
   d. Both a. and b.

6. In an emergency, such as engine failure due to bird strike on takeoff, a large aircraft may need to dump fuel because:
   a. The allowable landing weight is less than the maximum takeoff weight
   b. The engine thrust is unbalanced
   c. The aircraft will float better with less fuel
   d. Engine shutdown is accelerated as the tanks empty

7. The FAA Advisory Circulars are:
   a. Federal law that must be followed by all airports
   b. Documents that must be followed as an FAA Grant Condition
   c. Federal rules that must be followed by all airports
   d. Suggestions for airports that are voluntary in all cases

8. Over ____ of the reported bird strikes happen within ______ feet of the ground:
   a. 25% and 1,000 feet
   b. 40% and 300 feet
   c. 40% and 1,000 feet
   d. 60% and 300 feet

9. Federal Grant Terms and Conditions:
   a. Require compliance with the Clean Water Act (33USC1368)
   b. Require complying with the Advisory Circulars
   c. Both a. and b.
   d. None of the above

10. Unmanaged stormwater:
    a. Results in adverse changes in water quality
    b. Is encouraged to restore natural systems
    c. Is beneficial to watershed and stream hydrology
    d. Both b. and c.

11. Recreational fishing and boating contribute an estimated ______ dollars annually to the Florida economy
    a. $114 million
    b. $18 million
    c. $11.4 million
    d. $18 billion

12. Nitrogen
    a. Is a primary greenhouse gas
    b. As NH_3 is highly toxic to aquatic life and corrosive to metals
    c. As NOx has been found to prevent methemoglobinemia
    d. Has no adverse effect on surface water quality and hence is unregulated on any level

13. The primary contaminant in airport airside runoff is:
    a. Fuel
    b. Nitrogen
    c. Phosphorus
    d. Copper and other metals

14. The best estimates of airport airside runoff abstractions after overland flow are made using:
    a. The Green-Ampt equation
    b. The NRCS/SCS Curve Number (CN)
    c. The Rational Method Coefficient (C)
    d. The Hantush Equation with Dupuit Assumption

SESSION 3 – Hydrology

1. The classical Green-Ampt model of infiltration abstractions accounts for the following two primary physical mechanistic phenomena in soils:
   a. Evaporation and Capillary Suction
   b. Lateral Drainage and Surface Tension
   c. Gravitational Drainage and Capillary Suction
   d. Evaporation and Gravitational Drainage
   e. Answer b. and c.

2. With respect to a clayey soil that might be typical of areas of North Central Florida and the Panhandle, the classical Green-Ampt model of infiltration abstractions is dominated by:
   a. Evaporation as compared to Capillary Suction
   b. Lateral Drainage as compared to Surface Tension
   c. Gravitational Drainage as Compared to Capillary Suction
   d. Capillary Suction as compared to Gravitational Drainage
   e. None of the above

3. With respect to a clean sandy soil that might be typical of areas of South and Coastal Florida, the classical Green-Ampt model of infiltration abstractions is dominated by:
   a. Evaporation as compared to Capillary Suction
   b. Lateral Drainage as compared to Surface Tension
   c. Gravitational Drainage as Compared to Capillary Suction
   d. Capillary Suction as compared to Gravitational Drainage
   e. None of the above

4. Increasing surface imperviousness for watershed soils results primarily in the following phenomena:
   a. Increased evaporation and higher gravitational drainage
   b. Increased lateral drainage and decreased evaporation
   c. Increased runoff and increased gravitational drainage
   d. Deteriorating water chemistry and increased capillary suction
   e. Deteriorating water chemistry and increased runoff
   f. All of the above

5. Increasing surface imperviousness primary through asphalt pavement alters the following attributes of the hydrologic cycle:
   a. Evaporation increases, Infiltration decreases, Runoff volume increases, Peak flow increases
   b. Evaporation increases, Infiltration increases, Runoff volume increases, Peak flow increases
   c. Evaporation decreases, Infiltration increases, Runoff volume increases, Peak flow increases
   d. Evaporation decreases, Infiltration decreases, Runoff volume increases, Peak flow increases
   e. None of the above

6. Qp = CIA:
    a. Is an empirical equation that is dimensionally correct
    b. Can be used to develop the shape of a design hydrograph
    c. Is only applicable for design hydrographs of small paved urban watersheds of small slope
    d. Is only applicable for large, steeply-sloped sandy soil watersheds
    e. Is only applicable for peak flow from small, steep and impervious watersheds
    f. Is used to design the retention volume for a 25-year, 24-hour return storm

7. SWMM represents:
    a. The Storm Water Management Model
    b. A non-proprietary open-source model
    c. A model that can be downloaded at http://www.epa.gov/nrmrl/wswrd/wq/models/swmm/
    d. One of a suite of watershed, water quality and hydrodynamic models that can be downloaded with documentation at http://www.epa.gov/athens/wwqtsc/html/swmm.html
    e. A model of hydrologic components and hydraulics for urban networks and watersheds
    f. Model of event-based, frequency-based and continuous simulations of hydrology and hydraulics
    g. The most widely utilized and comprehensive urban hydrology modeling system on earth
    h. All of the above

8. In SWMM, a "node" represents:
    a. Conduit, pipe, weir, pump
    b. Junction, storage unit, outfall
    c. None of the above
    d. All of the above

9. In SWMM, a "link" represents:
    a. Conduit, pipe, weir, pump
    b. Junction, storage unit, outfall
    c. None of the above
    d. All of the above

10. Pollutant load transport:
    a. Can be developed using build-up and wash-off functions in SWMM for conservative pollutants
    b. Is strongly correlated to hydrology
    c. Is more rigorously developed outside of SWMM with hydrologic and hydraulic SWMM results
    d. All of the above

SESSION 4 – Overland Flow and Infiltration

1. Three common physically-based mechanistic infiltration models are:
    a. Green-Ampt, Phillips and CN
    b. Green-Ampt, Horton and CN
    c. Green-Ampt, Phillips and Horton
    d. All of the above
    e. No of the above

2. Three common loss (abstraction) indices that are not mechanistic are:
    a. Green-Ampt, Phillips and CN
    b. Volumetric C, Phi-index, CN
    c. Volumetric, C, Phillips and Horton
    d. All of the above
    e. No of the above

3. Loss (abstraction) indices differ from physically-based mechanistic infiltration models:
    a. Because they are not mechanistically-based
    b. Because such indices lump multiple phenomena when translating rainfall to runoff
    c. Because they are constant during a storm event
    d. Answer a and b
    e. Answer a, b and c

4. Horton's model of infiltration:
    a. Can be derived from Richard's equation for constant hydraulic conductivity, K and diffusivity, D
    b. Assumes K and D are independent of moisture content
    c. Assumes a first order rate constant with time
    d. Assume initial and final infiltration approximate role of soil suction and gravity, respectively
    e. Answers a, b and d
    f. Answers a, b, c and d

5. Phillips's model of infiltration:
    a. Can be derived from Richard's equation for variable hydraulic conductivity, K and diffusivity, D
    b. Assumes K and D are dependent on moisture content
    c. Assumes a Boltzmann transform to convert Richard's equation to an ordinary differential eq.
    d. Assumes saturated conditions
    e. Approximates the role of soil suction and gravity in the model
    f. Answers a, b and d
    g. Answers a, b, c and e

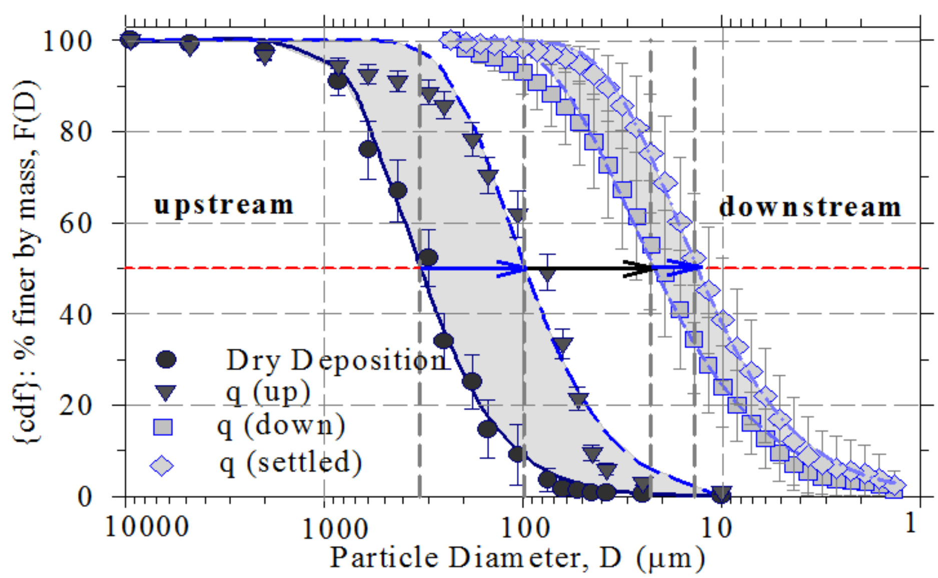
6. Green-Ampt model of infiltration:
    a. As with Horton and Phillips Green-Ampt is physically-based
    b. Parameters are related to soil properties of hydraulic conductivity, capillary suction, porosity
    c. Governing equation is a representation of reality but utilizes an exact solution to the equation
    d. Non-linear result as a function of time but can be solved in spreadsheet like Horton and Phillips
    e. Physically-intuitive model since model directly accounts for soil properties
    f. Requires an iterative approach to a solution for infiltration rate but is not a black-box like the CN
    g. All of the above

7. The Penman-Monteith equation:
    a. Is an evaporation model
    b. Is a potential evaporation model
    c. Accounts for the two primary driving phenomena of energy and aerodynamics
    d. Accounts and weights the two primary driving phenomena of energy and aerodynamics
    e. Energy is determined through net radiation and aerodynamics from wind speed
    f. The vapor pressure gradient and psychometric constant are combined in creating the weighting factors that must sum to 1.0
    g. Is a evapotranspiration model
    h. Answers a, c, d, e, f and g
    i. Answers b, c, d, e and f

8. Hydrologic delivery of mass and concentration; the so-called "first-flush":
    a. Is currently enshrined in the concept of a "water quality volume"
    b. Is never known a-priori
    c. Provides the same transport profile of mass and concentration
    d. Is set by regulatory bodies a-priori based on rain depth without knowledge of mass delivery
    e. Is set by regulatory bodies a-priori based on runoff depth without knowledge of mass delivery
    f. If known a-priori, can be used to establish a treatment capture volume
    g. Classically, is represented mathematically as only a first-order exponential transport of mass
    h. Is represented mathematically as a first-order exponential transport or linear transport of mass
    i. All of the above

9. Sampling of rainfall-runoff (stormwater) phenomena:
   a. Is most commonly conducted by automated samplers developed for primary WWTP effluent with solids (particulate matter, PM) that are small, low density flocs transported at steady flow
   b. Is rarely conducted with representative manual sampling and checked with a mass balance
   c. Is time dependent (6 to 12 hrs) for PM flocculation and chemical partitioning even when chilled
   d. In particular, auto samplers mis-represents the PM phase and to a lesser degree dissolved phase
   e. Can misrepresents concentrations, loads and BMP maintenance using automated samplers
   f. Is difficult to carry out through representative manual sampling without good graduate students
   g. All of the above

10. Refer to the following figure which illustrates typical particle size distributions (PSDs) curves from 17 storm event-based PSDs from a small paved urban watershed that drains by a 25 m long storm sewer through a sedimentation basin. The coarsest PSD is dry deposition on the pavement, q(up) is the PSD at the edge of the pavement at the entry to the storm sewer, q(down) is the outfall end of the storm sewer to the basin and q(settled) is basin effluent. These results indicate that:
    a. Transport across the pavement provides a greater reduction in PSD than the basin
    b. Transport through the storm sewer provides a greater reduction in PSD than the basin
    c. While the scale factor (for example d_{50}) changes at each location the shape factor (uniformity) change is not so dramatic.
    d. The gamma distribution curves shown well-represent the measured PSD data
    e. This storm sewer is not self-cleaning and PM is deposited in the 25 m length
    f. All of the above
    g. Answer b, c, d and e
    h. Answer a, c, and d



SESSION 6 – Chemistry and Load

1. Concentrations of TN, TP, Total Copper, and PM are:
   a. All higher on an airside of an airport compared to urban or highway land use
   b. Are all significantly lower on the airside of an airport compared to urban or highway land use
   c. Only higher on the airside for TN
   d. Only higher on the airside for Total Copper

2. Analysis of unit operations (aka BMPs) for removal of loads of TN, TP, Copper and PM:
   a. Is very difficult since these systems are black-boxes and are difficult to understand
   b. Can be analyzed with methods that range from basic engineering mechanics and monitoring applied in a spreadsheet format, or with more complex computational fluid dynamics (CFD)
   c. Are beyond the scope of conventional engineering practice
   d. All of the above
   e. None of the above

3. While neither Scott Brady in the 1970s (Georgia) or Barre de Saint-Venant in the 1870s (France), 100 years earlier, did not derive the "Saint-Venant" equations in one hour they both agree that:
   a. These equations are very difficult since they are Greek and difficult to comprehend in English or French
   b. Require a combination of the Continuity Equation and Darcy's Law for a Control Volume
   c. Require a combination of Continuity and the Momentum Equation for a Control Volume and form the basis for CFD
   d. Are beyond the scope of conventional engineering practice
   e. None of the above

4. The Saint-Venant equations whether applied in SWMM or in CFD:
   a. In the full dynamic wave form, accounts for acceleration, pressure, gravity and friction terms
   b. Can be simplified to the diffusion wave form when acceleration terms are negligible
   c. Can be further simplified to the kinematic wave when diffusion and acceleration are negligible
   d. Can account for backwater effects and incorporated into distributed routing methods
   e. All of the above
   f. Answers a and d

5. Newton's Law for particle settling in a basin or pond:
   a. Is applicable to all particle sizes and settling regimes
   b. Is the Law from which Stokesian settling is derived yet is only applicable for PM < than 100 μm.
   c. Assumes discrete particle settling (no interaction between PM)
   d. In not represented by measured data across the entire size gradation
   e. All of the above
   f. Answers a, b and c

6. Whether a PSD is utilized in a spreadsheet, SWMM (earlier versions) or CFD to model BMPs:
   a. The PSD d_{50} can fully represent BMP treatment or maintenance requirements with low error
   b. A PSD must be discretized into 8 to 16 particle sizes to reduce model or simulation error
   c. When represented by indices such as TSS the model error can exceed 50%
   d. The PSD can be determined by laser diffraction, electrical sensing, sieves and hydrometer
   e. All of the above
   f. Answers a, b and d

7. PSDs are important because:
   a. PM itself, in particular the suspended fraction, can result in lethality to aquatic species
   b. PM serves as the primary substrate from and to which chemicals adsorb and desorb
   c. PM is a primary maintenance concern in drainage conveyance systems and BMPs
   d. PM loads removed by source control do not become a pollutant source in runoff
   e. Quantifying PM loads recovered during maintenance practices can results in TP and TN credits in a BMAP process in Florida
   f. All of the above

8. Results of TP distribution on PM:
   a. Indicates that as particle size decreases, TP concentration [mg/kg] increases
   b. Indicates that the greatest TP mass (load) is associated with the coarser PM of the PSD
   c. All of the above
   d. None of the above
   e. Answer b only

9. Compared to a linear basin with a trapezoidal x-section, a baffled basin:
   a. Can double the treatment efficiency for the same surface area and volume
   b. Can reduce the basin area by approximately half and provide the same treatment efficiency
   c. Can be modeled in CFD for unsteady historical storms or design storms
   d. All of the above
   e. None of the above
   f. Answer b only

10. Combining CFD with airport basin redesign/optimization/monitoring:
    a. Allows design and basin parameters to be implemented across Florida
    b. Can provide improved treatment efficiency and reduced basin area requirements
    c. Brings a tool that we use to design jet engines, pumps and reactors to airport water management even under unsteady conditions
    d. Has the potential to be coupled with SWMM for continuous simulation of treatment
    e. All of the above
    f. None of the above

SESSION 7 – Airport General Permit, Best Management Practices Manual and BMPs

1. What are the primary criteria that must be met to use the proposed general permit?
   a. Nutrient loading post development must not exceed nutrient loading from a natural vegetative community
   b. No adverse off-site flooding or flooding of non-airport owned properties
   c. No violation of FAA Program Guidance Letters
   d. Both a. and b.
   e. Both a. and c.

2. Structural Best Management Practices used for airport airside include:
   a. Aquifer Storage and Recovery
   b. Overland Flow
   c. Class III Reinforced Concrete Pipe
   d. Heavy Duty Grate Inlets within the Safety Area
   e. Both c. and d.

3. Turf Management and System Maintenance are examples of:
   a. Structural Best Management Practices
   b. Required Part 139 Airport Certification
   c. Procedural Best Management Practices
   d. Wildlife Attractants outlined in AC 150/5200-33
   e. All of the above

4. A natural vegetative community has defined Event Mean Concentrations of ______ for Nitrogen and _____ for Phosphorus.
   a. 1.0mg/l for TN and 0.10 mg/l for TP
   b. 0.125 mg/l for TN and 0.10 mg/l for TP
   c. 1.0mg/l for TN and 1.0 mg/l for TP
   d. 1.125 mg/l for TN and 0.10 mg/l for TP
   e. None of the above

5. An air carrier runway has Event Mean Concentrations of ____ for Nitrogen and ______ for Phosphorus.
   a. 1.125 mg/l for TN and 0.10 mg/L for TP
   b. 0.365 mg/l for TN and 0.081 mg/L for TP
   c. 0.401 mg/l for TN and 0.049 mg/L for TP
   d. 0.398 mg/l for TN and 0.057 mg/L for TP
   e. Both b. and c.

6. All of the following geotechnical information is needed or desirable for designing airside storm water management systems using overland flow except:
   a. Saturated, undrained triaxial shear
   b. Soil borings and or test pits
   c. Laboratory permeability
   d. Field permeability
   e. Groundwater elevation

7. In continuous simulation models, decreasing the time step in the analysis:
    a. Increases the calculated runoff rate
    b. Does not effect the runoff rate
    c. Decreases the calculated runoff rate
    d. Was not evaluated in the studies and no conclusion can be drawn
    e. Should be avoided since rainfall for loads in continuous simulation is average annual

8. The airside conveyance system should normally be designed for:
    a. the 5-year rainfall event
    b. the 10-year rainfall event
    c. the 25-year rainfall event
    d. the 50-year rainfall event
    e. the 100-year rainfall event

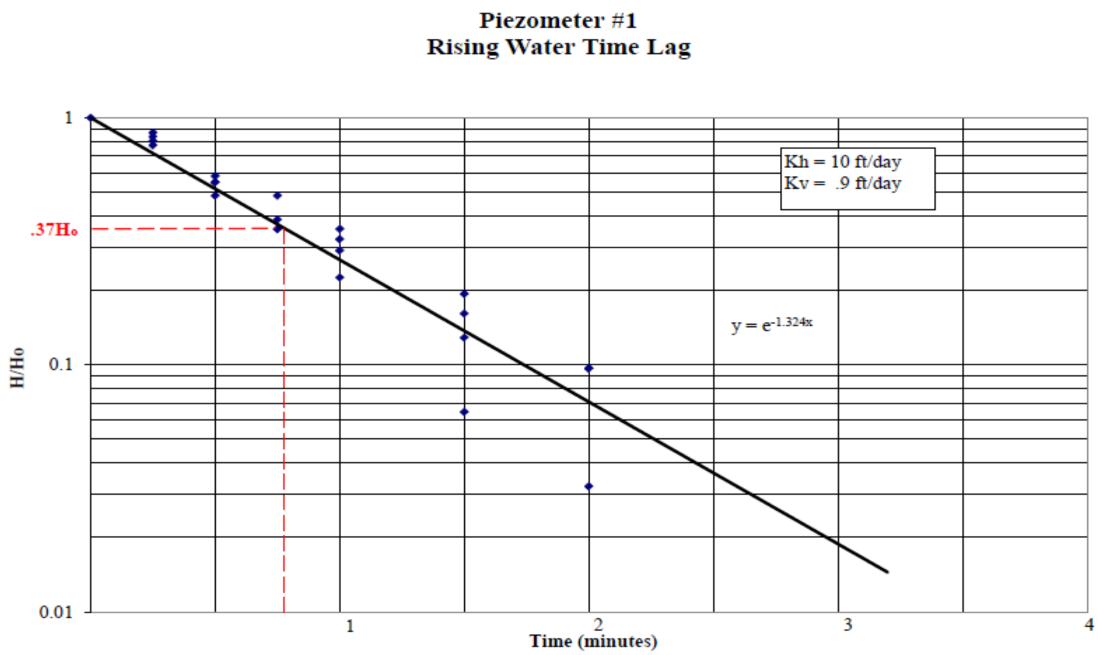
9. The Hantush Equation can be used:
    a. To estimate the probability of a birdstrike at a given location and time
    b. To estimate the infiltration rate of compacted soil
    c. To estimate ground water mounding
    d. To estimate the runoff potential of a site
    e. Both b. and d.

10. Landside projects:
    a. Will be addressed in FAC 62-341.449 when it is adopted as rule
    b. Are not covered by draft rule FAC 62-341.449
    c. May be able to use the same analytic methods for load calculation as airside
    d. Must use event based design exclusively for water management
    e. Both b. and c.

SESSION 9 – Working Example

1. The example project demonstrates that sites with high groundwater and deep muck soils:
   a. Cannot use the procedures for load matching proposed for airport airside projects
   b. Can be modified to use overland flow for airside water management
   c. Cannot be considered for airport construction due to the environmental issues
   d. May require chemical stabilization for structural support, but need no modification to use overland flow for airport water management
   e. Both b. and d.

2. The following figure illustrates results of a field test used to estimate:
   a. The lag time for HEC-1 watershed hydrology
   b. The lag time for groundwater mounding
   c. In-situ field permeability
   d. Field hydraulic conductivity
   e. Either c. or d.



3. Laboratory permeability tests on compacted soil samples are needed to:
   a. Estimate the permeability of soil after construction is complete
   b. Estimate the “best” volumetric moisture content for compaction
   c. Estimate the “best” moisture content by weight for compaction
   d. Both b. and c.
   e. None of the above

4. The porosity of the example soils ranged from ____ to _____ in soil compacted to 90% of ASTM D1557 and from ___ to ____ in soils compacted to 95% of ASTM D1557.
    a. 26 to 38%   and 30-41%
    b. 30-41% and 26-38%
    c. 37-466 lbs and 5.4-69 lbs
    d. 8-12% and 8-12%
    e. 5-19% and 16-20%

5. Special Permit Conditions may include:
    a. Unlimited, unannounced and unescorted access to airside areas
    b. Payment of special processing fees
    c. Periodic tests for grain size and specific gravity of soils used in construction
    d. Periodic tests for saturated, undrained triaxial shear
    e. Either c. or d.

6. All of the following are potential pitfalls in the design and permitting of the water management system, EXCEPT:
    a. Designing to tolerances that are not practicable to construct
    b. Failing to recognize that soil conditions may change from those used in design
    c. Collecting insufficient geotechnical data
    d. Testing during construction to confirm properties used in design
    e. Failing to recognize the limits to model results