National Exams May 2014

04-Env-B4: Site Assessment and Remediation
3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. Answer:

   a) THREE (3) of the FIVE (5) questions in Section A

   b) TWO (2) of the THREE (3) questions in Section B.

   Only the first <u>three</u> and the first <u>two</u> questions in each section will be marked as they appear in the answer booklet.

4. Each question is of equal value at 20 marks.

5. Questions require calculation and/or answer in essay format. Clarity and organization of the answer are important.

Section A: **Three** out of the **Five** Questions

A-1)   A strip mall exists in a residential area. One of the mall units is occupied by a dry cleaning outlet, that uses perchloroethylene (PCE) to clean the clothes brought in by customers. The soil type under the paved parking lot is sandy loam. Outline and discuss the steps you will follow in completing a site assessment as the owners are trying to obtain an insurance policy to cover potential environmental issues. The community is on municipal water, drawn from local groundwater sources.

A-2)   You are the environmental coordinator for a multi-national firm that produces fasteners (nails and screws) at a variety of locations. The fasteners are made of various metal alloys, with lubricates being an important component of the fastener production process. Due to consolidation of some of the production, one of the plants will be closed. Comment and discuss the type of samples you might take during a Phase II sampling program, including locations where you might take samples from. Also comment and discuss how these samples are to be collected, where they are to be stored and how they are shipped to the analytical lab for analysis.

A-3)   Railway shipment of crude oil is growing in popularity due to the increased need of energy. A typical tanker car holds 10,000 L of crude oil. Describe what happens to the oil if there is a derailment. No explosion occurs, but the tanker is punctured, allowing the oil to drains in 3 h. The soil, silty loam, has a water content of 15% (wt), porosity of 0.51 and a bulk density of 1375 kg/m^3. The top of the unconfined aquifer is 2.0 m below soil surface. There is a house 500 m away from the spill site, with the house having a septic tank and a private well into the confined aquifer 30 m below grade.

A-4)   Upon arrival on site described in A-3 as the first responder for environmental issues, you realize that there is natural wetland 2 km south of the site. The ground surface and water table are sloped toward the wetland. Describe your first response decisions from an environmental perspective. That is, what kind of remedial steps do you take to minimize the spread of the oil and initiate clean-up of the site.

A-5)   Comment on the need of a Record of Site Condition for a Brownfield location. The site previously housed a refrigerator manufacturer. One proposal is for the redevelopment of the location to 30% parkland, 40% high density housing and 30% low density housing. Also comment on the steps the municipality can take to ensure that redevelopment of the Brownfield takes place.

Section B: **Two** out of the **Three** Questions

B-1)   A subsurface investigation has shown that the groundwater has become contaminated with PCE. Describe how a reactive barrier can be used to treat this contamination. Use a sketch in your answer.

Calculate the total amount of F_e^0 needed in metric tons to degrade the PCE plume with a reactive barrier. The initial concentration of PCE is 95 mg/L, with the target concentration of the treated groundwater at 5 µg/L. Assume that the cross-section of plume is 80 m^2, with a groundwater velocity of 0.12 m/d. The aquifer porosity is 0.35 and the specific surface area of the granular iron is 1.0 m^2/g.

Given:

i.   surface area normalized rate constant k_{sa} for PCE = 2.1 x 10^{-3} L($m^2 \cdot h$)
ii. degradation of PCE at 10°C is 35% of k_{sa}
iii. use a safety factor of 3

B-2)   Phase II testing has shown that the groundwater surrounding an underground storage tank has a benzene concentration of 700 µg/L. The soil consists of sandy loam with a bulk density of 1450 kg/m^3, a porosity value of 0.42 and a f_{oc} = 1.5 %. How much benzene has sorbed to the silty loam soil? If K_{oc} is 85 mL/g, and the groundwater velocity (v) is 0.00002 km/h, how long before the benzene plume front travels 2 km? Comment on the reasonableness of this time. How does this travel time impact remediation efforts?

B-3)   A tanker carrying pure m-xylene (C_8H_{10}) was involved in an accident, and the contents spilled on the roadway. In total, 5,000 L were spilled in a layer 2.5 mm thick. Estimate the time it takes for the m-xylene to volatilize into the air. Assume a wind speed of 3 m/s 8 m above the ground. The density of m-xylene is 0.867 g/mL. Assume standard temperature of 25°C and pressure of 1 atm, with m-xylene having a partial pressure of 0.0109 atm. Use an air-phase mass transfer coefficient of 1500 cm/h. What is the impact of the wind speed on the volatilization rate?