National Exams May 2013

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.

Introduction to engineering, regulatory and management aspects of site assessments and restoration. Fundamentals and interactions between soils, groundwater, contaminants, and microorganisms. Site characterization and investigations. Monitoring and sampling strategies and techniques. Remedial action screening. Engineered solutions for site remediation including: physical, chemical, biological and in-situ and ex-situ techniques. Risk assessment. Brownfields. Computer modeling for assessment and remediation

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

A-1) An abandoned car rim stamping facility exists in a residential area. The soil type is clay. Explain and discuss the steps you will following in completing a site assessment as the new owners would like to place a condominium complex on the location. The community is on municipal water, drawn from local groundwater sources.

A-2) You are the project manager for the remediation of a closed heavy metal plating facility. Located on site are four concrete tanks, three of which contain liquid residue from the plating process, while the fourth holds a diluted solution of the degreasing agent PCE. Also on site is a sludge pit, containing the solids residue from the plating process. Comment and discuss where you might take samples from. Also comment and discuss how these samples are to be collected, where they are stored and how they are shipped to the analytical lab for analysis.

A-3) A 10 year old service station with gas bar has noticed some product loss. Records indicate a loss of approximately 6500 L. Your firm is called in to investigate. Describe what happens to the leaking gasoline as it leaves the underground storage tank. 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 bottom of the leaking tank is 2.5 m below grade, with the top of the unconfined aquifer 1.5 m below the tank. The site is connected to all municipal services.

A-4) A Phase II assessment was completed on the property in A-3. Contamination was found in both the soil and groundwater. Develop and discuss your ideal remediation solution.

A-5) Industrial properties continue to be abandoned as manufacturing firms close due to competitive reasons. Many of these properties are classified as Brownfields, making them ideal for redevelopment. Yet they sit abandoned. Comment and discuss as to why more Brownfields are not redeveloped.

Section B: Two out of the Three Questions

B-1) Approximately 30 L of TCE was spilled into an aquifer consisting of sandy loam soil. The porosity of the aquifer is 0.3, with average velocity of ground water (flux) at 0.03 m/d. If the solubility of TCE is 1100 mg/L and specific gravity at 1.47, how long will it take to clean up 1 m^3 of aquifer using pump and treat? Assume that 20 % of the spilled TCE is present in the unit m^3 of aquifer.

B-2) Ten tonnes of hydrocarbons were spilled on a site, which can be represented by hexane:

$C_6H_{14} + 9.5O_2 \rightarrow 6CO_2 + 7H_2O$

Soil conditions are sandy loam (Sand @ 62%; Clay @ 14%; OM @ 2.1 %, CEC @ 5.5 cmol/kg) with a density of 1410 kg/m^3, porosity of 0.35 and water content of 25% (wt).

If the spilled concentration is 2600 µg/g (dry basis), estimate the following:

i) Air flowrate need to promote bioventing where O_2 respiration is 10% of O_2/d

ii) If laboratory bioventing conditions determine that ln (k) = -3.688 d^{-1}, how long will remediation take in the field to attain a level of 200 ug/g under ideal conditions?

iii) Is you answer in (ii) realistic? Why?

B-3) Three rail tank cars derail, each holding 70,000 L of a dilute wastewater solution containing BTEX at 325 mg/L. The spilled solution flows onto the dry farm field adjacent to the rail track. Soil analysis shows that the soil is silt loam, with a bulk density of 1300 kg/m^3, porosity of 50 %, water content at 15 % and f_{oc} of 1.5 %. Lab analysis also determined that K_d is 1.8 L/kg.

i) Assuming that sorption kinetics governs, what volume of soil is contaminated?
ii) If the surface area in (i) is restricted to 40 m^2, how deep does the solution penetrate.
iii) What happens if the chemical has a higher affinity for sorption? Why?
iii) Discuss how this spill can be remediated?