National Exams May 2012

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 three and the first two 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) You are employed by a consulting firm specializing in sub-surface investigations. Your firm receives a panic phone call from an independent gas bar and convenience store operator. Basically the inventory records do not match and approximately 7000 L of gasoline are missing. Theft has been ruled out, plus a heavy gasoline smell is noticed in the drop tube boxes (places where underground storage tanks are filled). Indentify the steps that you will take to confirm the presence of leaking underground tank system. Indentify any safety measures that you might implement. Assume that the soil is sandy loam with the water table 4 m below grade. Community is on municipal water.

A-2) Phase II investigations are an important component of Brownfield site investigation and remediation. Identify the different type of samples that can be collected (solid, liquid and vapour if appropriate) during a Phase II investigation. Comment on how these samples are to be collected and stored for submission to the analytical lab.

A-3) A new industrial facility located on former agriculture land uses the chemical perchloroethylene (PCE) during the manufacturing process as a degreaser. PCE has a density of 1600 kg/m^3. One of the underground storage tanks leaks and releases 5000 L of PCE into the subsurface. 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 3 m below the tank. Describe what happens to the leaking PCE and identify a remediation plan that you would implement to restore the site to background levels. The site is connected to all municipal services, with the exception of drinking water, which is provided by a private well.

A-4) Bioremediation is an important tool in remediating contaminated sites in-situ. Comment on the contaminant families that bioremediation is well suited for and the optimum conditions under which remediation works.

A-5) Outline and discuss the steps to be followed in completing a Phase II assessment of a Brownfield site that previously housed a tire manufacturing facility. The Brownfield site, approximately 6 ha in size, is located in a mid-size Ontario community and is entirely surrounded by residential housing, both high and low density. A fence has been erected around the Brownfield site and the community relies on municipally supplied drinking water.

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

B-1) Soil samples were taken from property contaminated with PAHs. Concentrations reveal the contamination averages out to 3000 mg/kg. Laboratory tests show that bioremediation works well when sufficient nutrients are provided. Based on the following test data, how long will it take to reduce the soil contamination to 300 mg/kg. Assume that optimum degradation conditions exist in both the lab and in-situ, where degradation follows first-order rate kinetics.

Time (d)	C (ug/g)
0	400
2	350
5	275
7	250
10	198
12	150
15	115

B-2) Contaminant X is found in the subsurface of a former industrial complex. Following the Phase II investigation, it was decided that a permeable reactive barrier (PRB) would be installed to treat contaminant X. Describe how a PRB works, using figures as appropriate. Outline the chemical family that contaminant X belongs to.

B-3) A tanker truck carrying perchloroethylene (PCE) is involved in an accident and some PCE is released. The volume spilled is 9,000L. The soil where the spill happens is of low permeability, however it is within the capture zone of an unconfined aquifer. The water table is 6 m below grade. The surface area of the spill is 30 m^2. Assume that the residual saturation of the PCE in soil is 40 L/m^3, with a density of 1600 kg/m^3.

1. How much PCE will be retained by the soil?
2. How much PCE will reach the groundwater? What happens when it does? Why?
3. If the maximum concentration level (MCL) for PCE is 5 µg/L, with a solubility of 160 mg/L, how much groundwater is contaminated by PCE?