National Exams December 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.

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) A foreclosed abandoned plating factory exists on the perimeter of a residential area. This factory was involved with chrome, zinc and silver plating and had an onsite wastewater treatment facility that included 4 concrete tanks, with the sludge deposited in an onsite lagoon. The soil type for the entire property was sandy loam, with a creek flowing along the entire west side of the property. The wastewater treatment plant was located 50 m east of the property line where the creek was located, with the lagoon immediately north of the wastewater treatment plant. Treated water was recycled onsite, while the sludge was placed in the lagoon. Residential areas are located to the north and east of the property approximately 1 km from the wastewater treatment plant. An arterial road exists to the south, about 200 m from the wastewater plant. The plating facility is about 200 m east of the wastewater treatment plant. Outline and discuss the steps you will follow in completing a site assessment as the bank is determining if they can sell the property for residential development. The community is on municipal water, drawn from local groundwater sources.

A-2) You work for the operator of a closed hazardous waste landfill. Concerns have been raised by the municipality that the leachate liner has failed, releasing leachate into the subsurface. The first step in addressing the issue is confirming the quality of the leachate generated, so a sampling program is being developed for the leachate. Where would you collect samples from and how frequent? Comment and discuss the parameters that will be analyzed for. 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 hazardous chemicals continues as it is cheaper and faster than truck transport. However, accidents happen. A typical tanker car holds 10,000 L of chemical. Describe what happens to the contents of the tank if there is a derailment. Contents are perchloroethylene (PCE). No explosion occurs, but the tank is punctured, allowing the PCE to drain in 3.5 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. The groundwater flow direction is towards the house.

A-4) You work for a remediation company. Your firm receives an urgent call from the municipal landfill that liquid mercury was spilled on the soil cover adjacent to the tipping face. Apparently, someone placed a container with approximately 10 L of mercury in the household waste, and during compaction in the truck, the container was punctured. As the garbage load was getting readied for unloading, the container fell out and released the mercury onto the soil. Visual reports suggest that the majority of mercury was pooled on the soil surface. Describe your first response decisions from an environmental perspective. That is, what kind of remedial steps should you take to minimize the spread of the mercury, initiate clean-up of the site and protect the workers.

A-5) Comment on the environmental impact of hydraulic fracturing (fracking) if it was allowed to proceed for natural gas extraction in the rural areas 20 km north of Chatham, Ontario (south western Ontario).

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

B-1) Soil surrounding a leaking underground storage tank was sampled and tested in the laboratory for total petroleum hydrocarbons (TPHC) as diesel. The resulting TPHC concentration was 800 mg/kg on a dry weight basis. A bench scale test using a completely mixed slurry-phase reactor was conducted, giving a first-order half life of 18 d. Based on the positive lab results, it was decided to build a reactor in the field. The amount of contaminated soil is approximately 500 m^3. Determine the following:

i) hydraulic residence time to reduce the soil concentration to 100 mg/kg
ii) volume of the field scale reactor if the slurry flow rate is 5 m^3/d
iii) If the dilution ratio of soil to slurry is 1:3, how long will it take to clean the soil?
iv) comment on any scale-up issues.

B-2) Contaminated soil was sampled for toluene, with the concentration being 30 g/kg on a wet basis. The dry bulk density of the soil was 1950 kg/m^3, with a porosity of 0.35. The volumetric water content was 0.20 %, with an organic carbon content fraction of 0.03. The properties of toluene are as follows:

Chemical formula: C_7H_8 MWT: 92.15
Solubility at 20°C = 515 mg/L Dimensionless Henry's Law Coefficient = 0.235
K_{ow} = 537

Estimate the distribution in grams for the toluene in the various phases: water, air and on soil. Assume no pure toluene exists in the soil.

B-3) Two ponds are hydraulically connected as shown by the figure. A tanker spills trichloroethane (1,1,1-TCA) into the top pond. Assuming that:

$$v_{contaminant} = \frac{v_{pore}}{R}$$

where: $v_{contaminant}$ = contaminant velocity, m/d
v_{pore} = average pore velocity, m/d
R = retardation factor

estimate the travel time of TCA (K_{ow} of 317) from Pond 1 to Pond 2. The sand lens has a dry bulk density of 2,000 kg/m^3 and a f_{OC} of 0.005. Sand porosity is 0.32, with hydraulic conductivity of 4 x 10^{-5} m/s.