Course Title: Remediation of Contaminated Land
Department: Soil Science
Credit Hours: 3
Course Number: SOIL 4500
Academic Session: Winter 2017

Prerequisite: SOIL 3600 or instructor’s permission

Classroom Location: 245 Ellis Bldg
Meeting Days and Class Hours: Tuesday 6:00 pm – 9:00 pm

Department Office location: 362 Ellis Bldg
Phone Number: (204) 474-8153

Instructor Information
Name: Francis Zvomuya
Email: francis.zvomuya@umanitoba.ca
Office Location: 315 Ellis Bldg
Office Phone No: (204) 474-9932
Office Hours: Check with instructor

Course Philosophy

Students’ Learning Responsibilities
It is critical that you maintain a high attendance record in order to maximize your benefits from this course. Similarly, it is important to keep up with assigned readings and participate in class discussions. The final grade will be based on class participation, individual performance and group work; it is your responsibility to ensure that you optimize all three.

Why is this course useful?
The course will increase the student’s awareness of the factors controlling contaminant transport and fate in the subsurface, and how these affect the choice of remedial strategies for contaminated sites. Students will gain an understanding of the basis and mechanics of various established, emerging and innovative remediation technologies.

Who should take this course?
The course is designed for students who envisage a career in the environmental sector, particularly the sub-sector involved in environmental site assessments and site remediation.

Course Objectives
In general, students should understand the significance of site and contaminant characteristics in the assessment and remediation of a contaminated site.

In particular, students should be able to:
1. Understand the important acts and regulations governing identification and cleanup of contaminated sites;
2. Identify the major steps in the site assessment of a contaminated site;
3. Know the major classes of contaminants and their attributes;
4. Understand the properties of a site which influence the potential impact of contamination;
5. Understand the risk of contaminants to impacting human and environmental health;
6. Describe representative physical, chemical and biological approaches to remediation of contaminated land; and
7. Understand the derivation of assessment and remediation endpoints and the regulatory framework within which land remediation must operate in Canada.

**Course Evaluation**

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<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Class participation</td>
<td>5%</td>
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<tr>
<td>Midterm</td>
<td>25%</td>
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<tr>
<td>Site Assessment</td>
<td>25%</td>
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<td>Final Exam</td>
<td>45%</td>
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**Schedule for Term Examinations:**

- Midterm: February 28
- Final Exam: TBA

**Description of Assignments**

Students will be required to read assigned material ahead of class and submit a summary of the readings at the start of each class. Students will also conduct a Phase I Environmental Site Assessment group project during the term and prepare a report for submission at the end of the term. A short quiz may be given at any time in class, and may not be made up if missed.

*Due date for ESA report: April 18*

**Description of Examinations**

One midterm (1 hour) and one final exam (2 hours) will be given. Both exams will include a short answer section and a long answer section. Students are expected to apply the concepts covered in class as well as understand the legislation governing contaminated site remediation.

**Assignment Due Dates**

Assignment due dates will be announced at the time the homework is handed out. **The group project is due the last day of class (April 18).**

**Texts, Readings, Materials**

**Textbooks**

There are no required texts for the course. However, the following are good references:

**Supplementary Reading**

**Course Policies**

**Late Assignments**
A 10% penalty will be assessed on the grade for each day after the assignment is due. No points (0%) will be awarded for submissions received after the homework is returned to the rest of the class.

**Missed Assignments**
If you miss a class and an assignment is given or due, it is still your responsibility to submit the assignment on time. A penalty will be assessed on late homeworks as indicated above unless a full explanation is submitted ahead of the due date explaining exactly why you will not be able to submit the assignment on the due date.

**Missed Exams**
Make-up exams will not be granted except in the case of a documented emergency.

**Academic Integrity**
Plagiarism or any other form of cheating in examinations, term tests or academic work is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). Cheating in examinations or tests may take the form of copying from another
student or bringing unauthorized materials into the exam room (e.g., crib notes, pagers or cell phones). Exam cheating can also include exam personation. (Please see Exam Personation, found in the Examination Regulations section of the General Academic Regulations). A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty. Students should acquaint themselves with the University’s policy on plagiarism, cheating, exam impersonation and duplicate submission (see Section 8, p. 29 in the University of Manitoba Undergraduate Calendar 16/17).
Course Outline

Module 1 - Introduction

Introduction

- Terminology and definitions
- What does the remediation worker need to know?

Regulatory Framework

- The context of public and environmental safety: The Love Canal Jolt
- Canadian Council of the Ministers of the Environment (CCME)
- Contaminated Sites Remediation Act
- Dangerous Goods Transportation Act
- Other sorts of liability

Quantifying Contamination Risk

- Defining contamination
- The source-pathway-receptor pollutant linkage concept
- Establishing assessment criteria and remediation end-points
- Risk assessment and risk-based end-points
- Site specific risk assessment (risk based corrective action)
- Environmental Impact Assessment (EIA)
- Environmental Site Assessments (Phase I/II ESA)

Module 2 – Contaminant Characteristics and Partitioning

Understanding contaminant dynamics in the environment key to remediation efforts

Fate and Transport of Contaminants

- Classification of contaminants
- Examples of contaminated lands in Manitoba and Canada
- Interaction with water
- Interaction with the gas phase
- Interaction with the solid phase
- Equations of transfer
- Contaminant degradation
- Inorganic contaminants
- Mechanisms of contaminant injury to humans and the environment

Module 3 – Site Characterization

Characterizing the environment, level of contamination and impact on health

- Site Description
- Sampling methodologies
  - defining Data Quality Objectives (DQO)
  - importance of QA/QC
  - soil sampling methods
  - geostatistical sampling
Module 4 - Remediation Approaches

Choosing the right remediation and reclamation approach

- Remedial Standards - Tier 1, II, III CCME
- Biological approaches to remediation (Bioremediation)
  - Intrinsic remediation (natural attenuation)
  - Bioenhancement
  - Bioventing
  - Bioslurping
  - Biosparging
  - Bioslurry systems (Bioreactors)
  - Biopiles
  - Landfarming
  - Phytoremediation
- Physical & chemical approaches
  - Soil washing
  - Encapsulation
  - Soil vapor extraction (SVE)
  - In situ air sparging
  - Dual phase extraction
  - Surfactant and solvent flushing
  - LNAPL/DNAPL
  - Low temperature thermal desorption
  - Incineration
  - Vitrification
  - Solidification/stabilization
  - Nanoremediation

Site Assessment Projects

Each group will choose an actual site in Manitoba that is suspected to be contaminated. A site within Winnipeg will make site visits easier. The group will be asked to provide a report including:

i) A discussion of the regulatory framework and site assessment process as they would pertain to the site,

ii) a description of the site,

iii) a description of the contaminant,

iv) a proposal for a site assessment,

v) an assessment of the potential fate of the contaminant,

vi) an assessment of the potential impact of the contaminant, and

vii) a discussion of remediation approaches, where applicable.

Each group will present a summary of their report to the class on the last day of class.