University of Manitoba

Faculty of Agricultural and Food Sciences

Course Title: Remediation of Contaminated Land
Department: Soil Science
Course Number: SOIL 4500
Credit Hours: 3
Academic Session: Winter 2021

Prerequisite: SOIL 3600 or instructor's permission

Classroom Location: Online via Zoom
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: Theresa Adesanya
Email: adesanyt@myumanitoba.ca
Office Location: 327 Ellis Bldg
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

Class participation	5%
Midterm	25%
Site Assessment	25%
Final Exam	45%

Schedule for Term Examinations:
Midterm: February 23
Final Exam: TBA

Description of Assignments
Students will be required to read assigned material ahead of class. A short quiz may be given at any time in class and may not be made up if missed.
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.
***Due date for ESA report**: April 13

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 13).**

Texts, Readings, Materials

Textbooks

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

Barnhisel, R.I., R. D. Darmody, and W.L. Daniels (Eds.). 2000. Reclamation of Drastically Disturbed Lands. Agronomy No. 41. ASA-CSSA-SSSA, Madison, WI.
Suthersan, S.S. 2017. Remediation Engineering: Design Concepts. CRC-Lewis Publishers, Boca Raton, FL.
Swartjes, F. A. (Ed.) 2011. Dealing with contaminated sites: From Theory Towards Practical Application. Springer, Dordrecht, The Netherlands.

Supplementary Reading

CCME. 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. 215 pp. CCME Publication No. PN1332. Available online: www.ccme.ca.
CCME 1997. Guidance Document on the Management of Contaminated Sites in Canada 58 pp. CCME Publication Number PN1279. Available online: www.ccme.ca.
CCME 1996. Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada. 45 pp. CCME Publication Number PN1197. Available online: www.ccme.ca.
CCME 1996. A Framework for Ecological Risk Assessment: General Guidance. 50 pp. CCME Publication Number PN1195. Available online: www.ccme.ca.
Manitoba Conservation. 1997. Guideline for the Designation of Contaminated Sites in Manitoba. Guideline 97-01E, Revised January 2004. Available online: http://www.gov.mb.ca/conservation/envprograms/contams/standards/index.html.
Manitoba Conservation. 1998. Environmental Site Investigations in Manitoba. Guideline 98-01, June 1998, Revised May 2002. Available online: http://www.gov.mb.ca/conservation/envprograms/contams/standards/index.html.

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 homework 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
    - water sampling methods

    - air sampling methods
- Analysis

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 prepare a site assessment of your case study as if you were a consultant hired to do so. 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.