



ENGG*4240 Site Remediation

Fall 2019

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 1.00 - September 04, 2019

1 Course Details

1.1 Calendar Description

Remediation of contaminated sites is done to mitigate impacts to the environment and public health. The course will: review the applicable legislation; identify the important soil, water, air and chemical interactions; review the steps of an environmental risk assessment so that contaminated sites can be identified and evaluated to see if remediation is required; and evaluate and appraise various remediation technologies to complete the soil and groundwater remediation.

Co-Requisites: ENGG*3590, ENGG*3670

1.2 Course Description

Completion of this course will provide students with: (i) an understanding on what classifies a site as being contaminated and the governing legislation; (ii) an appreciation of cross-media issues for a contaminant in the groundwater, non-aqueous phase liquids, soil, and soil-air matrices; (iii) an appreciation of human health and ecological risk assessment in context of a contaminated site; (iv) insight on how to select and apply appropriate soil and groundwater remediation technologies; and (v) insight on how to design a remediation action plan. Students will also become familiar with the technical literature dealing with contaminated sites, and with select analytical and computational modeling methods used to characterize contaminated sites. The following specific activities will be required:

- i. **Submit a Literature Review:** Students will complete a comprehensive literature that will identify and evaluate the resources available to them, and will critique a site remediation theme.
- ii. **Submit Phase I and Phase II ESA Projects:** Students will complete a Phase I and a Phase II Environmental Site Assessment (ESA) of a specific property, and justify the need for site remediation.

- iii. **Submit a Phase III Remediation Project:** Based on a specific site, students will design a remediation plan to address the contamination present.

1.3 Timetable

Lectures: Tues, Thur 10:00AM - 11:20AM in MCKN, Room 238

Tutorials/Labs:

section 1: LAB Wed 08:30AM - 09:20AM in CRSC, Room 101 OR LAB Wed 08:30AM - 09:20AM in THRN, Room 1116 AND SEM Mon 04:30PM - 05:20PM MCKN, Room 233

section 2: LAB Wed 10:30AM - 11:20AM in MCKN, Room 059 OR LAB Wed 10:30AM - 11:20AM in THRN, Room 1116 AND SEM Mon 04:30PM - 05:20PM MCKN, Room 233

1.4 Final Exam

No final is scheduled for this course.

2 Instructional Support

2.1 Instructional Support Team

Instructor:	Erica Pensini
Email:	epensini@uoguelph.ca
Telephone:	+1-519-824-4120 x56746
Office:	THRN 2525

2.2 Teaching Assistants

Teaching Assistant:	Michelle Leahey
Email:	mleahey@uoguelph.ca
Office Hours:	Has no scheduled office hours. Regular contact time is in tutorials.

3 Learning Resources

3.1 Required Resources

Course Website (Website)

<https://www.courselink.uoguelph.ca>

Course materials, news, announcements, and grades will be regularly posted to the ENGG*4240 Courselink site. You are responsible for checking the site regularly. **As per University regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly;** e-mail is the official route of communication between the University and students.

Practical Design Calculations for Groundwater and Soil Remediation (Textbook)

<https://subzero.lib.uoguelph.ca/login?url=https://www.taylorfrancis.com/books/9781466585249>

Kuo, J. (2014), CRC Press, Second Edition, ISBN 9781466585249.

eBook is available for download through the University of Guelph Library: search for book on Primo, and follow link to "Online resources".

3.2 Additional Resources

Lecture (Notes)

Lecture notes will be posted on Courselink prior to the respective lectures. Some supporting information will also be occasionally posted on the Courselink site.

Projects (Other)

Project assignments will be posted on Courselink at an appropriate time according to the due date schedule given in this handout.

In Situ Remediation of Chlorinated Solvent Plumes (Textbook)

<https://link-springer-com.subzero.lib.uoguelph.ca/book/10.1007%2F978-1-4419-1401-9>

Stroo, H.F., Ward, C.H. (2010), Springer Science+Business Media, ISBN 978-1-4419-1400-2.

eBook is available for download through the University of Guelph Library: search for book on Primo, and follow link to "Online resources".

Remediation Engineering: Design Concepts (Textbook)

<https://www.crcpress.com/Remediation-Engineering-Design-Concepts-Second-Edition/Suthersan-Horst-Schnobrich-Welty-McDonough/p/book/9781498773270>

Suthersan, S.S., Horst, J., Schnobrich, M., Welty, N. (2016), CRC Press, Second Edition, ISBN 9781498773270.

3.3 Announcements

Information related to ENGG*4240 will be posted on Courselink. In addition, per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly. This e-mail is the official route of communication between the University and students.

4 Learning Outcomes

The goal is to prepare students to deal with open-ended site remediation problems that

consist of contaminated groundwater and soil, similar to situations that they will encounter as working professionals. Students will learn and experience how to:

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Selectively search and critically review scientific literature on a site remediation topic of their choice;
2. Collect and analyze relevant information for a target site to complete Phase I and II Environmental Site Assessments;
3. Complete a risk assessment on the target site to evaluate whether site remediation is needed; and
4. Knowledgeably select an appropriate remediation technology, and design an effective, feasible and safe remediation plan for the target site.

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 2, 3, 4
1.1	Recall, describe and apply fundamental mathematical principles and concepts	2, 3, 4
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1, 2, 3, 4
1.3	Recall, describe and apply fundamental engineering principles and concepts	1, 2, 3, 4
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2, 3, 4
2	Problem Analysis	2, 3, 4
2.1	Formulate a problem statement in engineering and non-engineering terminology	2, 3, 4
2.2	Identify, organize and justify appropriate information, including assumptions	2, 3, 4
2.3	Construct a conceptual framework and select an appropriate solution approach	4
3	Investigation	2, 3, 4
3.1	Propose a working hypothesis	3, 4

#	Outcome	Learning Outcome
3.3	Analyze and interpret experimental data	2, 3, 4
3.4	Assess validity of conclusions within limitations of data and methodologies	2, 3, 4
4	Design	4
4.1	Describe design process used to develop design solution	4
4.2	Construct design-specific problem statements including the definition of criteria and constraints	4
4.3	Create a variety of engineering design solutions	4
4.4	Evaluate alternative design solutions based on problem definition	4
5	Use of Engineering Tools	4
5.1	Select appropriate engineering tools from various alternatives	4
5.3	Recognize limitations of selected engineering tools	4
6	Individual & Teamwork	2, 3, 4
6.1	Describe principles of team dynamics and leadership	2, 3, 4
6.2	Understand all members' roles and responsibilities within a team	2, 3, 4
6.3	Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude	2, 3, 4
6.4	Apply strategies to mitigate and/or resolve conflicts	2, 3, 4
6.5	Demonstrate leadership through, for example, influencing team vision and process, promoting a positive team culture, and inspiring team members to excel	2, 3, 4
7	Communication Skills	1, 2, 3, 4
7.1	Identify key message(s) and intended audience in verbal or written communication as both sender and receiver	1, 2, 3, 4
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	2, 3, 4
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and audience	1, 2, 3, 4

#	Outcome	Learning Outcome
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	1, 2, 3, 4
7.5	Demonstrate ability to process oral and written communication by following instructions, actively listening, incorporating feedback, and formulating meaningful questions	1, 2, 3, 4
8	Professionalism	2, 3, 4
8.1	Demonstrate an understanding of what it means to be a professional engineer and distinguish between legislated and non-legislated professions	2, 3, 4
8.3	Demonstrate professional behaviour	2, 3, 4
9	Impact of Engineering on Society and the Environment	2, 3, 4
9.1	Analyze the safety, social, environmental, and legal aspects of engineering activity	2, 3, 4
9.2	Evaluate the uncertainties and risks associated with engineering activities	2, 3, 4
9.3	Anticipate the positive and negative impacts of introducing innovative technologies to solve engineering problems	3, 4
10	Ethics & Equity	3, 4
10.3	Demonstrate values consistent with good ethical practice, including equity, diversity, and inclusivity	3, 4
11	Economics and Project Management	4
11.3	Estimate economic impact and feasibility of an engineering project or design using techniques such as cost benefit analysis over the life of the project or design	4
12	Life Long Learning	1, 2, 3, 4
12.1	Identify personal career goals and opportunities for professional development	2, 3, 4
12.2	Self-assess skills relative to career goals and SOE defined learning outcomes	2, 3, 4
12.3	Demonstrate capability for continuous knowledge and skill development in a changing world	1, 4

4.3 Relationships with other Courses & Labs

ENGG*4240 is a senior Environmental Engineering elective. As such, students are required to build on the knowledge gained in all the preceding courses, applying engineering analysis and design principles to the design problem at hand.

Subject areas discussed and applied in this course predominantly include: transport phenomena (fluid mechanics, mass transfer); physical, inorganic and organic chemistry; soil mechanics; groundwater hydrology; environmental sciences; regulatory law; economics; sociology; health and safety. Proficiency in some of these subjects, and familiarity with most, is expected.

5 Teaching and Learning Activities

5.1 Lecture

Lecture Notes 1

Topics: Regulations and Brownfields Overview - definitions, remediation issues, brownfields

Lecture Notes 2

Topics: Environmental Site Assessment Phase I

Lecture Notes 3

Topics: Contaminant Chemistry - inorganic, organic, chemical partitioning

Lecture Notes 4

Topics: Contaminant Interactions with Soil Components - soil composition, physical chemistry of soil contaminants, geochemistry

Lecture Notes 5

Topics: Contaminant Transport Mechanisms and Principles

Lecture Notes 6

Topics:	Remediation Technologies Overview - ex-situ, in-situ, green processes
Lecture Notes 7	
Topics:	Nanoremediation
Lecture Notes 8	
Topics:	Pump and treat and surfactant flushing
Lecture Notes 9	
Topics:	Electrokinetic remediation
Lecture Notes 10	
Topics:	Smoldering and other new remediation approaches
Lecture Notes 11	
Topics:	Phase II Environmental Site Assessment - regulations and guidelines
Lecture Notes 11	
Topics:	Risk Assessment Toxicology - exposure pathways and models, ecological risk, human health risk
Lecture Notes 12	
Topics:	Health and Safety Issues at Contaminated Sites - personnel, training, personal protective equipment, site controls
Lecture Notes 13	
Topics:	Bioremediation
Lecture Notes 14	
Topics:	Permeable Reactive Barriers (PBR)

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Topics: Air sparging and soil vapor extraction

Lecture Notes 16

Topics: Phase III Remediation - Remedial Action Plan, remediation guidelines, site closure

Lecture Notes 17

Topics: Brownfields Redevelopment - environmental site registry, social, economic and environmental benefits, funding

5.2 Other Important Dates

- i) Classes begin: Thursday 6th Sept. 2019
- ii) Thanksgiving holiday: Monday 14th Oct. 2019
- iii) Fall Study Break Day: Tuesday 15th Oct. 2019

6 Assessments**6.1 Marking Schemes & Distributions**

Additional assignments will be given throughout the term but they will not be graded. Consider them as formative.

Name	Scheme A (%)
Individual Literature Review	10
Phase I ESA Report	15
Term Test 1	15
Phase II ESA Report	20
Term Test 2	15
Phase III Remediation Project (Part 1) Presentation	10
Phase III Remediation Project (Part 2) Report	15
Total	100

6.2 Assessment Details

Individual Literature Review (10%)

Due: Thu, Sep 26, 11:59 PM, CourseLink Dropbox

Learning Outcome: 1, 1

Phase I ESA Report (10%)

Due: Thu, Oct 10, 11:59 PM, CourseLink Dropbox

Learning Outcome: 2

Term Test 1 (20%)

Date: Tue, Oct 23, 10:00 AM - 11:20 AM, MCKN 238

Learning Outcome: 1, 2

Phase II ESA Report (15%)

Due: Thu, Nov 7, 11:59 PM, CourseLink Dropbox

Learning Outcome: 2

Term Test 2 (20%)

Date: Thu, Nov 21, 10:00 AM - 11:20 AM, MCKN 238

Learning Outcome: 1, 3, 4

Phase III Remediation Project (Part 1) Presentation (10%)

Date: Week 12, Tutorial and/or Lecture classroom, as scheduled for each group

Learning Outcome: 1, 3

Presentations will be scheduled in the Tutorial and/or Lecture sessions between Monday Nov 25th and Thursday Nov 28.

Phase III Remediation Project (Part 2) Report (15%)

Due: Fri, Nov 29, 11:59 PM, CourseLink Dropbox

Learning Outcome: 4

6.3 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: <http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor at the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations: <http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

Passing grade: In order to pass the course, students must obtain an overall grade of 50% or higher on the aggregate of all the course work outlined in Section 6.1.

Late Reports: There will be no extension of the deadlines for submissions, except for serious

health or compassionate reasons, with the appropriate documentation. Late projects will be assigned lower marks (15% penalty for each late day).

6.4 Course Format

Classes are scheduled twice a week on Tuesdays and Thursdays. There is also a tutorial on Mondays and labs/tutorials on Wednesdays. The format of the course is problem-based learning, where students will learn by doing. It is expected that each student will spend an average of 10 to 12 h per week on the course. The active learning component will require group discussions and presentations on material related to the lecture material.

Phase I, II and III projects are done in teams of two. All other assessments are individual.

7 School of Engineering Statements

7.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

7.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

7.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

8 University Statements

8.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly:

e-mail is the official route of communication between the University and its students.

8.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

8.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

8.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student

Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

8.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

8.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

8.8 Resources

The Academic Calendars are the source of information about the University of Guelph's

procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>
