COLUMBIA UNIVERSITY
School of Professional Studies

Master of Science in Sustainability Science (SUSC)
Environmental Investigation and Remediation (PS5330)   **September 2023**

Once per week
3 credits

Instructor:	Edward Garvey, e.garvey@columbia.edu, 862-226-1268
Classroom:	To be determined
Office Hours:	Wednesdays before class, 3:00 to 4:00 PM. Room to be determined. Second hour to be determined. Also, by appointment
Response Policy:	I am available for discussions before class, after class or on e-mail. Longer meetings should be scheduled by appointment. I generally respond within 24 hours during the work week.

Course Overview

This course covers the major steps in the investigation, assessment, and remediation of contaminated sites. The course will introduce the student to the multidisciplinary aspects of environmental remediation, an important background for any environmental career, such as an environmental consultant, a corporate remediation manager or a government regulator. Management and remediation of contaminated sites is an important consideration in sustainable regional development, since failure to control contamination usually yields an ever-increasing area of impact, with greater environmental and societal costs. Using US EPA Superfund guidance as a framework, the course will explore the major steps in identifying a site, establishing the degree of contamination, identifying the likely ecological and human receptors, and selecting and implementing a remedial action. The Superfund process has been extensively developed through more than 30 years of legislature and agency guidance, and now provides a robust approach for pollution assessment and remediation. Contaminated sites typically involve a broad spectrum of contaminants across at least two media, including soils, sediments, groundwater, surface water, and air. In this course we will examine the main steps involved in environmental investigation and remediation primarily from a technical perspective, although legal aspects will be incorporated at the major decision points in the process. In particular, the course will focus on the main environmental sampling and analytical techniques needed to conduct a remedial investigation, and cover some of the main remedial engineering considerations for the successful selection and implementation of a remedy. Students will be assigned one of several completed Superfund sites to track the application of the Superfund process to a real-world example as the class proceeds, providing a regular link between theory and application.

Main Topics

1. An outline of the Superfund process, briefly touching on the various Superfund laws: CERCLA, SARA and RCRA
2. Preliminary Assessment/Site Investigation (Site Assessment)
3. Remedial investigation considerations, including sampling design, selection of contaminants, and sampling techniques
4. Contaminant geochemistry (fate and transport processes)
5. Overview of the ecological and human health risk assessment process, including data needs and identification of contaminants of concern.
6. Remedial technology alternatives, development of possible remedial actions and evaluation of their effectiveness (feasibility study)
7. Selection of a site remedy (record of decision)
8. The remedial design process

9. Remedy implementation.
10. Sustainable ("Green") remedial considerations
11. Remedy monitoring and assessment of remedy success
12. Community impacts and incorporation of public input

Learning Objectives

By the end of this course, students will be able to:

L1: Recognize many of the likely problems and technical challenges associated with a contaminated site.
L2. Identify the technical resources required to conduct a site investigation and remediation.
L3: Design a framework to conduct an environmental investigation and remediation for a contaminated site.
L4: Design an initial sampling program to investigate site contamination.
L5: Outline likely routes of human and ecological exposure, depending on site layout and contaminants.
L6: Identify sustainable options for consideration in a remedial design.
L7: Identify the on-line technical resources available for support.

Readings
Required Text

Alter, B. 2019. *Environmental Consulting Fundamentals: Investigation, Remediation, and Brownfields Redevelopment.* 2nd Edition. CRC Press Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-

Required Readings

US EPA Superfund documents and guidance. https://www.epa.gov/superfund/superfund-cleanup-process (pages to be assigned).

U.S. Environmental Protection Agency (2008). *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, April 2008, 56 pages. EPA 542-R-08-002

Additional Readings (chapters to be assigned)

Chunlong, Z. (2013) *Incorporation of green remediation into soil and groundwater cleanups.* International Journal of Sustainable Human Development, 1(3), 128-137.

U.S. Environmental Protection Agency (1988). Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, 186 pages. OSWER Directive 9355.3-01

U.S. Environmental Protection Agency (1989). Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (Part A), 291 pages, 12/1989., EPA/540/1-89/002

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Resources

U.S. Environmental Protection Agency Web Sites
EPA websites will provide the majority of the material for the real-world examples to be tracked by the students. These are listed in the weekly assignments. Remedial design information can be found here: https://clu-in.org. Additional websites for other remedial sites can be found at www.epa.gov/superfund.

Columbia University Library
Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online: http://library.columbia.edu/.

SPS Academic Resources
The Office of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: http://sps.columbia.edu/student-life-and-alumni-relations/academic-resources.

Programming
Students should be familiar with standard office software to support their completion of course assignments.

Course Requirements (Learning Objectives)

Real-World Example (20%) (L1, L2, L3, L4, L5, L6)

Students will be required to work in groups of two to examine and report on a real-world example of a site investigation and remediation throughout the semester. Students will be directed to select among several site categories (such as soil contamination, groundwater contamination, sediment contamination, etc.) so that the class is exposed to a range of remedial settings through the presentation process. The goal of this assignment to emphasize the multidisciplinary approach that is needed to fully characterize a site, and design and implement a remediation. At various points in the schedule, students will make a 5 to10 minute report on their site, summarizing how the current topic applied to their site and identifying important aspects of the application. A total of 5 to 6 presentations will be made by each team. Students in a team should alternate giving presentations, but both members of a pair are expected to be familiar with the pertinent aspects of the site for the topic of the week.

Midterm Paper (35%) (L1, L2, L3, L4)

Students will prepare a short midterm "paper" analyzing a fictitious site whose features will be provided as part of the exam. The paper will cover the initial steps of a remedial investigation, incorporating a discussion of the site history, the nature and extent of contamination, sampling program design, analytical results interpretation, contaminant fate and transport considerations and an identification of likely exposed populations (approximately 8 pages plus references and multiple figures). The goal of this assignment is to have the students implement the various steps learned from the real-world examples on a fictitious unknown site, improving their grasp of the investigative process.

Final Paper (40%) (L1, L2, L3, L4, L5, L6)

Students will prepare a final "paper," continuing their analysis of the fictitious site. The paper will cover aspects of a feasibility study report, incorporating the results of the midterm paper. The final paper will include calculation of potential remedial goals, the development of several remedial options comprised of various engineering technologies, an evaluation of the likely success these options, the estimation of the approximate costs, and lastly, a recommendation for the remedy selection, with supporting

arguments for the selection. Sustainable technologies must be considered in the possible remedies. Students will prepare both a written description of the project results (approximately 15 pages) plus maps and diagrams describing the basis for the selection and how it might be implemented). The goal of this assignment is again to have the students implement the various steps learned from the real-world examples on a fictitious unknown site, only this time improving their grasp of the remedial design and implementation process.

Class Participation (5%) (L1, L2, L3, L4, L5, L6)

Class participation, including oral and written communication, exercises important job skills. Weekly readings must be completed before class and will help contextualize class discussions. We will assign weekly readings and we will start each class collecting questions from the students to get us started. Please come to class having read the material, having written down one or more questions, and ready to participate in classroom discussions. General classroom participation makes up 5% of your final grade. Additional class participation credit is given as part of the real-world example requirement.

Evaluation/Grading

Participation (5%)

Participation will be graded on a scale of 0-100. Participation includes class attendance and active discussions in class. The students are expected to show critical thinking, respectful interactions with classmates and a positive attitude towards learning and freely discussing the topics each week.

Real World Example (20%)

Each presentation will be graded on a scale of 0-100. Each student will receive a grade for each presentation, the full grade when they are the presenter and half the grade when they are the assistant. Students will be graded for the depth of their analyses as they identify how each step in the environmental investigation and remediation process was conducted at their site.

Midterm Paper (35%)

The midterm paper will be judged on a scale of 0-100. The four sections of the paper should clearly address the data available, and as appropriate, identify the main outcome of each analysis. The paper should make extensive use of graphics to describe site conditions and the likely underlying causes of contamination. Approximately one-quarter of the evaluation will be based on the clarity of the written work. Instructor comments will be returned with the graded work and should be considered in the final project paper.

Final Project Paper (40%)

The written final project report will be graded on a scale of 0-100. The written report will be graded based on completeness (i.e., including the evaluation of engineering alternatives, and the selection of a proposed solution, conclusions, and references) and correct interpretation of the results. The paper should make extensive use of graphics to describe the alternatives and their physical layout on the site.

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The final grade will be calculated as described below:

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

ASSIGNMENT	% Weight
Real world example presentations	20
Midterm paper	35
Final paper	40
Participation	5

Course Policies

Participation and Attendance
Students are expected to come to class prepared to discuss their assigned contaminated site in the context of the topic for that week. For example, students should be able to discuss the main aspects of their site's ecological risk assessment for the risk assessment topic. Students are expected to complete all assigned readings and, attend all class sessions, thereby providing their classmates information on the application of the general topics discussed in class to their real world example. If you need to miss a class for any reason, please discuss the absence with me in advance. If you miss an experience in class, you miss an important learning moment and the class misses your contribution. More than one absence will affect your grade.

Late work
Work that is not submitted on the due date noted in the course syllabus <u>without advance notice and permission from the instructor</u> will be graded down 1/3 of a grade for every day it is late (*e.g.,* from a B+ to a B).

Citation & Submission
All written assignments must use [citation format], cite sources, and be submitted to the course website (not via email).

School Policies [Include all school/university policies as written below.]

Copyright Policy
Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a

photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity
Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at http://sps.columbia.edu/student-life-and-alumni-relations/academic-integrity-and-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility
Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: http://health.columbia.edu/services/ods/support.