# FINAL REPORT

## A Sustainability Module for a new Maymester course entitled "Geo-Environmental Methods for Site Characterization"

Molly M. Gribb, Associate Professor
Department of Civil and Environmental Engineering
University of South Carolina
300 Main Street, Columbia, SC 29208
Phone: 777-6166; Fax: 777-0670; e-mail: gribb@sc.edu

**Introduction**.

With support from the Sustainable Universities Initiative, I created a sustainability module for a new Maymester course that I intended to teach this May. However, a number of factors have made offering this course impossible this year. I hope to teach this course during the regular semester, perhaps at the 500-level. This report describes Maymester course syllabus and activities, as well as the module developed to expose graduate students in Civil and Environmental Engineering, as well as students from related disciplines (Geology, Geography, Masters of Earth Resource Management students) to the topic of sustainability and how it relates to civil engineering practice. While it was not possible to schedule this class for May, I was able to use parts of the module I created on sustainability in my University 101 for Engineers last semester, and plan to add more sustainability content to the course next fall.

**The Maymester Course.**

This course entitled, "Geo-Environmental Methods for Site Characterization," was designed to be taught with assistance from other faculty in the department. Guest lectures from experts from USC and Savannah River Site are included in the syllabus to provide a unique learning experience for students. In the first part of the course, students study different techniques for site characterization, see demonstrations of various investigative methods, and gain experience collecting environmental data in the field. The field work and demonstrations are to be performed primarily at the MWD area at the Savannah River Site (SRS). This uncontaminated area has been the subject of numerous characterization efforts and as such, is an ideal location for this component of the course. Students then analyze the data they obtain from the demonstrations and field activities to characterize the study site. This part of the course is be followed by a module on sustainability that will include selected readings, lectures by guest speakers, field trips and student discussion sessions. Restoration projects at SRS and a constructed wetlands area near Aiken are used as vehicles for discussion of the applicability of sustainability to civil engineering practice.

**Course Description.**

**Maymester Course – Methods for Geo-environmental Site Characterization (3 cr).**

**Bulletin Description:**

ECIV 790: Methods for geo-environmental site characterization. Students will learn the principles of site characterization through demonstrations of important field test methods such as cone penetration testing, soil and groundwater sampling, and well testing. Students will participate in well testing and other sampling activities. Students will analyze field data obtained during demonstrations of the various methods and will prepare oral presentations and written reports on their findings. Students will be introduced to the principles of sustainability and explore the relationships between sustainability and geo-environmental engineering.

**Course Outline:**

1. Course Overview

    - Introduction, definitions, principles of sustainability
    - Relationship between sustainability and engineering practice

2. Introduction to Site Characterization

    - Review of historical data, maps, etc. – guest lectures by practicing engineers, hydrogeologists: Conrad Lawrence, PG, John Lessley, PE, S&ME.
    - Developing a sampling plan, selecting methods, locations, and frequencies
    - Regulatory issues

3. Data Collection Methods: Field Experiences at the MWD area, SRS

    - Slug testing in existing wells at MWD area– student participation
    - Soil sampling – demonstration by Gregg Drilling and Testing, Inc.
    - Cone penetration testing – demonstration by Gregg Drilling and Testing, Inc.

4. Demonstrations of Other Sampling and Characterization Methods

    - Groundwater sampling – demonstration and landfill field trip, Lorris Environmental, Inc.
    - Ground penetrating radar – demonstration by vendor, lecture by Dr. Gassman (at USC)

- Time domain reflectrometry – lecture and demonstration, Dr. Pierce (at USC)

4. Geo-Environmental Data Analysis

- Interpretation of cone penetration and drilling logs, slug test data
- Organization and integration of new data with existing site data
- Construction of stratigraphic and potentiometric maps
- Pulling it all together: Use of site data for design of a waste disposal facility at the MWD area

5. Sustainability and Geo-Environmental Engineering

- SRS restoration projects as case studies (e.g., restoration of thermally impacted streams, Carolina Bay restoration project). Field trips to these areas. Sampling of invertebrates as indicators of ecosystem health. Guest lectures on plants and animals in Carolina Bay communities by Dr. Barbara Taylor and others.
- Guest lectures by Dr. Gene Eidson and field trip to constructed wetlands.

**Principal texts/journals/other required materials:**

1. Hawken, P., 1993. The Ecology of Commerce – A Declaration of Sustainability, Harper Business, New York. ISBN: 0-88730-655-1. Chapters 2, 3, 5, 9, 12.

2. Custom text composed of:

- Sara, M. N., 1994. Standard Handbook for Solid and Hazardous Waste Facility Assessments, Lewis Publishers, Boca Raton, FL (selected chapters).
- Benson, R. C., 1993. “Geophysical techniques for subsurface site characterization,” In: Geotechnical Practice for Waste Disposal, D. E. Daniel, ed., Chapman and Hall, London.
- Rosenberg, A. A., 1993. “Achieving sustainable use of renewable resources,” Science, 262, 828-829.
- Arrow et al., 1995. “Economic growth, carrying capacity and the environment,” Science, 268, 520-521.
- Ehrlich, P. and E. O. Wilson, 1991. “Biodiversity studies: Science and policy,” Science, 253, 758-761.
- Rawat, A. 1996. “Technological change and environmental management in industry,” International Journal of Environment and Pollution, 6:(2-3) 172-184.

- Fiorino, D. J., 1996. “Toward a new system of environmental regulation: The case for an industry sector approach,” Environmental Law, 26, 457-488.

3. Web sites with supporting information:

- The Sustainable Universities Initiative web page, c/o USC School of the Environment: http://www.sc.edu/sustainableu/
- Reference material about SRS, the restoration projects on site, etc.

  http://www.srs.gov/general/srenviro/erd/gen/map98.pdf
  Roles of historical photography in waste site characterization, closure, and remediation (http://www.srs.gov/general/sci-tech/fulltext/ms9800096/ms9800096.html)
- http://www.sc.edu/sustainableu/ecofootintro.htm (calculating one’s ecological footprint)
- DOE’s web page for sustainability: http://www.sustainable.doe.gov/
- EPA’s sustainable industry web page: http://www.epa.gov/sustainableindustry/
- http://www.uga.edu/~srel/Fact%20Sheets/restoration_streams.htm – (discusses restoration of thermally impacted streams at SRS)

**The Sustainability Module.**

**Session 1**.

The topic of sustainability is introduced to students first by a presentation of common definitions of sustainability by the World Commission on Environment and Development and P. Hawken in his book, The Ecology of Commerce. Principles of sustainability developed by the Manitoba Round Table and benchmarks for sustainable industrial development espoused by the EPA are then presented. Students break into small groups to compare and contrast the various views on sustainability and begin to consider the links to engineering practice. Students groups present their ideas to the entire class. Session 1 teaching materials are as follows:

**What is sustainability?**

What is sustainability?

There are over 100 definitions of sustainability and sustainable development, but the best known is the World Commission on Environment and Development’s. This suggests that development is sustainable where it “meets the needs of the

present without compromising the ability of future generations to meet their own needs" (World Business Council for Sustainable Development web page).

This definition and others related to sustainability are available on the World Business Council for Sustainable Development. Download this list for future reference: http://www.wbcsd.ch/aboutdfn.htm.

From Hawken (p. 139):
"The word "sustainability" can be defined in terms of carrying capacity of the ecosystem, and described with input-output models of energy and resource consumption. Sustainability is an economic state where the demands placed upon the environment by people and commerce can be met without reducing the capacity of the environment to provide for future generations. It can also be expressed in the simple terms of an economic golden rule for the restorative economy: Leave the world better than you found it, take no more than you need, try not to harm life or the environment, make amends if you do. Sustainability means that your business must deliver clothing, objects, food, or services to the customer in a way the reduces consumption, energy use, distribution costs, economic concentration, soil erosion, atmospheric pollution, and other forms of environmental damage."

On the principles of sustainability from the Manitoba Round Table:
(source: http://www.susdev.gov.mb.ca/wildlife/main/principles.html)

**Integration of Environmental and Economic Decisions**
Economic decisions should adequately reflect environmental, human health and social effects. Environmental and health initiatives should adequately take into account economic, human health and social consequences.

**Stewardship**
The economy, the environment, human health and social well-being should be managed for the equal benefit of present and future generations. Manitobans are caretakers of the economy, the environment, human health and social well-being for the benefit of present and future generations. Today's decisions are to be balanced with tomorrow's effects.

**Shared Responsibility and Understanding**
Manitobans should acknowledge responsibility for sustaining the economy, the environment, human health and social well-being, with each being accountable for decisions and actions in a spirit of partnership and open cooperation. Manitobans share a common economic, physical and social environment. Manitobans should understand and respect differing economic and social views, values, traditions and aspirations. Manitobans should consider the aspirations, needs and views of the people of the various geographical regions and ethnic groups in Manitoba, including aboriginal peoples, to facilitate equitable management of Manitoba's common resources.

**Prevention**
Manitobans should anticipate, and prevent or mitigate, significant adverse economic, environmental, human health and social effects of decisions and actions, having particular careful regard to decisions whose impacts are not entirely certain but which, on reasonable and well informed grounds, appear to pose serious threats to the economy, the environment, human health and social well-being.

**Conservation and Enhancement**
Manitobans should (a) maintain the ecological processes, biological diversity and life-support systems of the environment; (b) harvest renewable resources on a sustainable yield basis; (c) make wise and efficient use of renewable and non-renewable resources; and (d) enhance the long-term productive capability, quality and capacity of natural ecosystems.

**Rehabilitation and Reclamation**
Manitobans should (a) endeavour to repair damage to or degradation of the environment; and (b) consider the need for rehabilitation and reclamation in future decisions and actions.

**Global Responsibility**
Manitobans should think globally when acting locally, recognizing that there is economic, ecological and social interdependence among provinces and nations, and working cooperatively, within Canada and internationally, to integrate economic, environmental, human health and social factors in decision-making while developing comprehensive and equitable solutions to problems

EPA benchmark indicators for sustainable industrial development:
(source: http://www.epa.gov/opesdweb/criteria.html)

**Environmentally Sound Products, Processes, and Services**

- Accept responsibility for environmental effects throughout all phases of a product's life.
- Practice materials and resource conservation throughout the organization.
- Establish company sustainable development goals and measure progress towards those goals on a periodic basis.
- Implement supplier programs designed to reduce environmental impacts or add environmental value to the design or redesign of products and services provided to the company.

**Integration of Sustainable Development Into Business Strategies**

- Pursue investment strategies that support communities, promote equity and/or enrich jobs, while reducing risks to human health and harm to the environment.
- Seek technological innovations that achieve superior environmental protection at lower unit costs for the firm and the economy.
- Introduce policies and commitments to adopt home country standards, or equivalent or not less stringent standards of operation, abroad, where existing environmental management systems are weak or ineffective.
- Demonstrate progress towards sustainable production and consumption.

**Reducing Risks and Hazards to Human Health and to the Ecosystem**

- Voluntarily provide environmental information, in excess of governmental regulations, to help the public assess potential risks to environmental and human health, including that of workers.
- Phase out processes and chemicals that pose the greatest environmental risk, disposing of any such processes and chemicals in an environmentally sound manner.
- Modify procedures, including among affiliates and suppliers, in order to reflect the heightened risks of special populations and sensitive ecological areas.
- Commit at the highest level to ecosystem management that incorporates an appraisal of the inter-relationship between human and natural systems.

**Community/Stakeholder Participation in Sustainable Development**

- Involve workers and non-industrial stakeholders in the firm's sustainable development decision-making.
- Explain how any beyond compliance recommendations or voluntary standards develop by other organizations (EPA, PCSD, ICC, CMA, etc.), have changed the operations of the business.
- Collaborate on research and development of environmentally sound technologies and programs with non-industrial stakeholders such as academics, community groups, minorities, indigenous people, local authorities, Federal Government and/or international organizations.
- Periodically report verified global environmental, health and safety performance information to the public, providing details for smaller geographic regions.

**Establishing the Basis for Sustainable Development for Future Generations**

- Develop proactive sustainable development responses to current human and/or ecological threats that may be the result of the firm's, or its sector's, past and/or present practices.

- Acknowledge the need for and participate in moving toward a greater reliance on pricing systems that internalize environmental costs.
- Participate in industry-wide efforts to recast products and processes for sustainable production and consumption patterns for future generations.
- Reconsider business strategy in light of the carrying capacity of human and natural systems, and the challenge of resource productivity.

**Session 2.**

During this computer session, students calculated their ecological footprints (via the link on the SUI web page) and write an essay in which they reflect on the results of their analysis. Students search the web for additional resources for increasing their understanding of sustainability and how it relates to environmental work they see themselves doing in the future. Students create electronic bibliographies and document them. Various readings from The Ecology of Commerce, Science, and other sources (provided to students as a custom textbook) are assigned for the next session. Discussion questions are assigned for session 3.

**Session 3.**

In this session, small groups discuss the assigned readings and review their notes from Session 1. Guest lecturers to help lead the discussion for this session.

**Session 4.**

Ecological restoration projects that have been undertaken at the Savannah River Site are discussed in this session. Plans are to include Carolina Bay remediation project and restoration of thermally impacted streams as case studies for students to study and evaluate. In addition, Dr. Gene Eidson agreed to lecture on constructed wetlands project he is involved in. Field trip and sampling exercises for the students in the remediated Carolina Bay area, or streams at SRS, or at the constructed wetland site will be included. This field trip would involve aquatic sampling and discussing the ecology of the systems, activities that engineering and geology students rarely (if ever) perform. These activities will increase students' awareness of the effects of engineering projects on aquatic ecosystems and how to quantify these effects. Dr. Barbara Taylor of the Savannah River Ecology Laboratory agreed to assist in leading a field trip and sampling exercises in a Carolina Bay at SRS.

**Summary of SUI grant activities:**

A sustainability module for inclusion in a new Maymester course was created. In developing this module, I completed a literature review and compiled a bibliography of relevant materials. I composed a course outline and reading list, including four sessions on sustainability, and submitted the syllabus for this course to the Starfish web site. I arranged for the guest speakers, field trips and

aquatic sampling exercises, and submitted the course for departmental and university approval. My proposal met with approval at the department level, but was tabled by the graduate council pending further information. At the same time that the request for additional information was made, it became obvious that resources at the department and college level to pay for a van and provide for other needed materials were insufficient to allow successful implementation of this course. However, I was able to incorporate Session 2 of the sustainability module in my 101E course in Fall 1999, with very positive reaction from the students. I believe it gave them a much better feel for how many resources they are consuming, even while living in a relatively small dorm room. My plans for teaching 101E again in the fall include incorporation of the entire module as described above.