

# Environmental and Water Resource Engineering (EWRS)

*Graduate Programs for Civil and Environmental Engineering*

## Environmental and Water Resources Systems

The Environmental and Water Resources Systems (EWRS) Engineering area represents one of the major divisions within the School of Civil and Environmental Engineering. Research activities in this area address the development and application of quantitative systems methods for the analysis, evaluation, planning, and operation of water resource and environmental systems.

Courses and research consider the integration and analysis of systems engineering and of economic-policy issues posed by the need to manage water, land, air and human resources, as well as environmental remediation efforts. Such analyses are based upon an understanding of hydrology, hydraulics, environmental sciences, biology and environmental engineering. For this reason, individuals in our area frequently interact with the other environmentally-orientated groups within our School, as well as with other departments in the College of Agriculture and Life Sciences.

The analytical methods employed to address environmental issues fall within the realm of systems sciences, which include operations research, computer science, statistics, risk analysis, economics and engineering management. By examining engineering, socio-economics, ecology, and public policy issues using analytic model-oriented frameworks, EWRS projects strive to develop and communicate estimates of the impact and risks of alternative decisions to the many stakeholders associated with environmental management issues. Most members of the EWRS faculty are also members of the CEE Schools' Engineering Systems and Management (ESM) mission area. EWRS students often take courses offered by that group in Engineering Management. The Applied Systems Engineering

Program within the Engineering College provides additional opportunities.

Student projects in the EWRS area have addressed regional water resources management issues in California, New York, New Jersey, Mexico, North Africa, Europe and parts of Asia. Members of the program have developed specialized software packages for water resources system simulation, support of negotiations, stochastic stream flow generation, and flood frequency analysis that have been used around the world.

The beginning of the 21st century is a time of quantum leaps in computing technology. At the same time, local and national governments face tight budgets. As a whole, society has a desire for economic efficiency and sustainability, an interest in the intelligent use of environmental resources, and a concern for risks to human health. This is the challenge and the opportunity for environmental systems engineering and is why this is an important and promising area for study and research.

With these goals in mind, the EWRS program seeks to advance the quality and capability of analytical methodologies for environmental management and to facilitate the application of such techniques to the solution of real problems. In collaboration with faculty from a number of fields across the Cornell campus, research and course offerings represent one of the strongest environmental systems programs in the country.

Cornell University offers three degree programs in EWRS: Master of Engineering (Civil), Master of Science, and Doctor of Philosophy.

The ME(C) is a compact and intense program that students usually complete in one year. They can go on to a PhD program here or elsewhere. The orientation is often toward engineering practice, and an engineering project is a part of the program.

# Environmental and Water Resource Engineering (EWRS)

## *Graduate Programs for Civil and Environmental Engineering*

The MS program is orientated toward research and is generally a two-year program. The PhD program has a strong research emphasis. Most students in the MS and PhD programs currently receive financial support in the form of a fellowship, research assistant or teaching assistant and are either in the MS/PhD program or the PhD program. Two-year MS programs have more time than the ME(C) professionally-orientated degree, which allows for a wider range of courses and the experience of a research-orientated thesis.

Additional information can be found at:

[http://  
ceeserver.cee.cornell.edu/mw24/enveng/](http://ceeserver.cee.cornell.edu/mw24/enveng/)  
[http://  
www.cee.cornell.edu](http://www.cee.cornell.edu)

## Faculty

The EWRS faculty is committed to providing the highest quality graduate education and to preparing engineers and scholars who will educate the students of the future, placing them on the cutting edge of developments in their fields. Faculty associated with the EWRS program include:

### **Oliver Gao**

- Transportation, air quality and energy systems and their interactions
- Transportation/environment planning and clean transportation-energy alternatives

- Emissions and health impacts of alternative transportation-fuel technologies
- Large, spatially-indexed transportation and air quality databases
- Mathematical models and statistical data analysis

### **Douglas Haith**

- Environmental Systems Analysis
- Land Disposal of Wastes
- Nonpoint Source Water Pollution
- Solid Waste Management

### **Peter Loucks**

- Water Resource and Environmental Management Systems
- Interactive Simulation Modeling
- Decision Support Systems
- Sustainability and Water Resource Management

### **Christine Shoemaker**

- Water Resource and Water Quality Modeling
- Modeling Groundwater Contamination and Remediation
- Pesticide Source Reduction
- Optimization Algorithms and Supercomputing

### **Jery Stedinger**

- Water Resource Systems Operations and Planning
- Risk Analysis
- Stochastic Hydrology
- Environmental Statistics
- Flood Risk Management

# Environmental and Water Resource Engineering (EWRS)

## *Graduate Programs for Civil and Environmental Engineering*

### Master of Engineering ME(C) Degree Program

The ME(C) degree program in Environmental Systems Engineering is a professionally-oriented graduate program preparing students for careers in an environmental engineering firm or in government service. It may also be used as an entry program before a subsequent research degree, such as the PhD.

Candidates without a Civil or Environmental Engineering bachelor's degree may need to include courses that provide needed background. This is a way for individuals without an accredited engineering Bachelor of Science degree to earn a Master of Engineering degree.

ME(C) degree requirements consist of 30 semester hours of graduate-level courses beyond the equivalent of the typical undergraduate civil engineering curriculum.

ME(C) students can take one three-hour project course, or a six-hour, two-course engineering design project sequence. In the design project, students work on a realistic engineering systems problem, often in cooperation with a consulting firm or government agency. In total, students must take a minimum of 30 semester hours of technical course work, generally 5000, 6000 and 7000-level courses.

A strength of our ME(C) program is its roots in all of our environmental engineering programs, coupled with support from the engineering management program in the School of Civil and Environmental Engineering.

### Major Courses of Study for the Master of Engineering ME(C) Degree Program

Master of Engineering students majoring in Environmental Systems Engineering should take five courses in their major area, generally including CEE 5930 and at least two others from the following list:

**CEE 5930** (Fall)

Engineering Management Methods:  
Data, Information, and Modeling

**CEE 5970** (Spring)

Risk Analysis and Management

**CEE 6200** (Spring)

Water-Resources Systems Engineering

**CEE 6210** (Spring, when offered)

Stochastic Hydrology

**CEE 6230** (Fall, when offered)

Environmental Quality Systems Engineering

**CEE 6550** (Fall)

Transport, Mixing, & Transformation in  
the Environment

**CEE 6650** (Spring)

Transportation, Energy and  
the Environment

Students and their advisors should decide upon additional courses. Suitable courses include those listed above or the following:

# Environmental and Water Resource Engineering (EWRS)

## *Graduate Programs for Civil and Environmental Engineering*

**OR&IE 3300** (Fall)  
Operations Research I: Optimization I

**OR&IE 3310** (Spring)  
Optimization II

**OR&IE 5550** (Fall)  
Applied Time-Series Analysis

### Sample of ME(C) Degree Program for Students Majoring in EWRS

#### Fall Semester

**CEE 5010** (3 Credits)  
Design Project

**CEE 5930** (3 Credits)  
Engineering Management Methods:  
Data, Information, and Modeling

**CEE 4540** (3 Credits)  
Sustainable Small-Scale  
Water Supplies

**CEE 6010** (1 Credit)  
Water Resources and  
Environmental Engineering Seminar

**CEE 6550** (3 Credits)  
Transport, Mixing, and Transformation  
in the Environment

**CEE 4310** (3 Credits)  
Introduction to Groundwater Hydrology

#### Spring Semester

**CEE 5020** (3 Credits)  
Design Project II

**CEE 5970** (3 Credits)  
Risk Analysis and Management

**CEE 6200** (3 Credits)  
Water-Resources Systems Engineering

**CEE 6280** (1 Credit)  
Environmental and Water Resources  
Systems Analysis Seminar

**CEE 6310** (3 Credits)  
Computational Simulation of Flow and  
Transport in the Environment

**AEM 6510** (4 Credits)  
Environmental and Resource Economics

## ME(C) Versus MS

The ME program differs from the more traditional Master of Science (MS) program in orientation and curriculum requirements. Major curriculum differences include a required course in professional practice and a one or two-course sequence in the design aspects of environmental systems engineering (which replaces the MS thesis requirement). The ME does not require a research thesis, which is required for the MS.

The ME degree program has an emphasis on professional practice (with its requirement of a design project); the emphasis of the MS program is on an intensive, independent research study which provides a more intensive exposure to research problems in environmental or water resource systems engineering than the ME program.

The MS degree is recommended for students contemplating eventual completion of a PhD but is also available as a rigorous program of graduate study for individuals who may not pursue a career in teaching or research. A thesis presenting results of an independent study is required for a MS.

Another major difference between the two programs is the time required to complete the programs. The ME program can usually be completed

# Environmental and Water Resource Engineering (EWRS)

## *Graduate Programs for Civil and Environmental Engineering*

in two semesters (nine months) by a student with a Civil Engineering undergraduate degree. The MS program typically requires 24 months (including research work in the summer).

It is possible for students who complete an ME to later enter a PhD program. However, most students who plan on PhD research do an MS/PhD program, which implies that they write an MS thesis in the early stage of their graduate study for a PhD. Since the MS and PhD research topics are usually closely connected, writing an MS first does not typically add much to the time required to complete a PhD.

Students who do not plan to obtain a PhD are more likely to obtain financial aid for the ME program than for the MS program.

### MS Program

At Cornell, MS programs are administered by the Graduate School, which is subdivided into over 90 fields or subject areas. The Graduate School sets no course, credit-hour or grade requirements. It leaves such responsibilities to each student's Special Committee. Thus, the MS and PhD programs are very flexible and can be tailored to each student's background and objectives.

Candidates for the MS degree choose two (or more) faculty members to serve as their Special Committee. The Special Committee approves the student's course program, oversees the thesis work, and administers the final examination for the Master's Degree. One Committee member serves as Chairman.

The Special Committee provides considerable guidance to graduate students. It is highly desirable that students work with faculty whose interests coincide with their own. Students are free to change their Committee members when and as appropriate. General guidelines are:

- (1) Fifteen semester hours of core course material and supporting areas to satisfy the major requirement of Environmental Systems Engineering or Water Resource Systems Engineering;
- (2) Other electives to bring the program total to approximately 24 semester hours or more (see end of this document for possible electives); and
- (3) A research thesis, an intensive report or an independent study that is normally a research project. The topic of the thesis should be of mutual interest to both the student and the Special Committee. Information on faculty research interests is available at [www.cee.cornell.edu](http://www.cee.cornell.edu).

Preliminary planning for the thesis should begin early in the Master's degree program. More extensive development should occur during the second semester. Data acquisition and analysis ordinarily is completed during the summer and fall semester following the academic year of course work. Most MS students with assistantships spend 24 months in the program.

Students interested in pursuing the MS degree in EWRS must apply to the Graduate School for admission to the field of Civil and Environmental Engineering. They should indicate a desire to major in the Environmental or Water Resource Systems Engineering (concentration). Applications and other general graduate information may be obtained from the Graduate School website: [www.gradschool.cornell.edu](http://www.gradschool.cornell.edu).

A baccalaureate degree in engineering is not required for admission to the MS program. Admission of students with strong backgrounds in the physical, chemical, social or biological sciences is considered on an individual basis. Applicants

# Environmental and Water Resource Engineering (EWRS)

## *Graduate Programs for Civil and Environmental Engineering*

with deficient backgrounds in mathematics, chemistry, physics, statistics or fluid mechanics may be required to make up deficiencies in a lengthened program. Interested students who think they might have such deficiencies should contact members of the EWRS faculty.

### Sample First Year MS Degree Program in EWRS

#### Fall Semester

**CEE 5090** (3 Credits)  
Heuristic Methods for Optimization

**CEE 5930** (3 Credits)  
Engineering Management Methods:  
Data, Information, and Modeling

**CEE 6010** (1 Credit)  
Water Resources and  
Environmental Engineering Seminar

**CEE 6550** (3 Credits)  
Transport, Mixing, and Transformation  
In the Environment

**OR&IE 3300** (3 Credits)  
Operations Research I: Optimization I

#### Spring Semester

**CEE 5970** (3 Credits)  
Risk Analysis and Management

**CEE 6200** (3 Credits)  
Water-Resources Systems Engineering

**CEE 6280** (1 Credit)  
Environmental and Water Resources  
Systems Analysis Seminar

**CEE 6320** (3 Credits)  
Hydrology

#### **CEE 6650** (Spring)

Transportation, Energy and the Environment

### Doctor of Philosophy (PhD)

The PhD program in EWRS prepares students for research careers in universities or in government agencies and consulting firms. It is a demanding program that ultimately assures a mastery of the major subject area. Candidates must exhibit the ability to grasp theoretical concepts, to apply such concepts in the management of the environment, and to undertake independent research of high caliber.

The PhD program, like the MS program, is administered by the Graduate School and the student's Special Committee. There are no absolute course or grade requirements, because the program is individualized. Students choose at least three faculty to serve as the Special Committee. The Committee Chairman must be chosen from the EWRS faculty.

The Committee administers three required examinations: (1) the Qualifying Exam, (2) the Examination for Admission to PhD candidacy, and (3) the Final Examination for PhD candidates. They also approve course work in support of the major areas, examine the student's qualifications, oversee the dissertation, and recommend that the degree be awarded when earned. Most students do an MS before the PhD. An example of the first year of course work for an MS is given above. The typical time for a student with an assistantship to do an MS, followed by a PhD, is about five years, although some students have been able to complete the program more quickly.

Course work, which may be required, depends on a student's background, as well as the particular research project selected. Doctoral students are expected to demonstrate the ability to pursue the PhD program during the Qualifying Exam, sometime at the end of the first year of study, and to

# Environmental and Water Resource Engineering (EWRS)

## *Graduate Programs for Civil and Environmental Engineering*

demonstrate knowledge of the major subject material during a comprehensive written and oral Admission-to-Candidacy exam at the end of the formal course work.

### Graduate Elective Courses in EWRS

One of the strengths of Cornell's graduate program in EWRS engineering is the abundance of supporting courses offered by other units within the University, as well as by CEE's faculty. A course catalog is available upon registration or on-line at [www.cornell.edu/academics/courses.cfm](http://www.cornell.edu/academics/courses.cfm). Students should review this catalog to identify elective courses of possible interest. Courses taken by graduate students in EWRS include:

#### **Applied Systems Engineering**

- SYSEN 5100 ... Applied Systems Engineering (F)
- SYSEN 5200 ... Systems Architecture, Behavior, and Optimization (S)
- SYSEN 5300 ... Systems Engineering for Design of Reliable Systems (F)

#### **Biological and Environmental Engineering**

- BEE 4730 ..... Watershed Engineering (F)
- BEE 4760 ..... Solid Waste Engineering (S)
- BEE 4800 ..... Intro Atmospheric Chemistry (F)
- BEE 4870 ..... Sustainable Energy Systems (F)
- BEE 4900 ..... Biofuels: Economic & Envir. Interactions (S)
- BEE 6510 ..... Bioremediation: Engineering Organisms to Clean Up the Environment (S)
- BEE 6710 ..... Analysis of the Flow of Water and Chemicals in Soils (F)
- BEE 6720 ..... Drainage (S)
- BEE 6740 ..... Ecohydrology (S)
- BEE 7540 ..... Water & Culture in the Mediterranean (S)

#### **Applied Economics and Management**

- AEM 4510 ..... Environmental Economics (S)
- AEM 6510 ..... Environmental and Resource Economics (S)
- AEM 6600 ..... Agroecosystems, Economic Development, and Environment (S)
- AEM 7010 ..... Econometrics I (S)
- AEM 7020 ..... Environmental Economics (S)

#### **City and Regional Planning**

- CRP 3800..... Environmental Politics (S)
- CRP 4530..... Environmental Aspects of International Planning (F)
- CRP 5190..... Urban Theory and Spatial Development (S)
- CRP 5440..... Resource Management and Environmental Law (S)
- CRP 5510..... Environmental Law (F)
- CRP 6270..... Regional Economic Impact Analysis (F)

#### **Environmental Engineering**

- CEE 4510..... Microbiology for Environmental Engineering (F)
- CEE 4540..... Sustainable Small Scale Water Supply (F)
- CEE 4550..... Aguaclara: Sustainable Water Supply Project (F)
- CEE 6530..... Water Chemistry for Environmental Engineering (F)
- CEE 6540..... Aquatic Chemistry (S)
- CEE 6550..... Transport, Mixing, and Transformation in the Environment (F)

#### **Computer Science**

- CEE 5290..... Heuristic Methods for Optimization (S) [also COM S 572]
- CEE 6290..... Numerical Methods for Engineers (F)
- CS 4210 ..... Numerical Analysis (F)
- CS 6210 ..... Matrix Computations (F)

# Environmental and Water Resource Engineering (EWRS)

## Graduate Programs for Civil and Environmental Engineering

- CS 6220..... Sparse Matrix Computations (F)  
CS 6240..... Numerical Solution of Differential  
Equations (S)  
CS 6766..... Reasoning about Uncertainty (F)

### **Economics**

- ECON 3130 ..... Intermediate Microeconomic  
Theory (F, S)  
ECON 3140 ..... Intermediate Macroeconomic  
Theory (F, S)  
ECON 6090 ..... Microeconomic Theory I (F)  
ECON 6190 ..... Econometrics I (F)  
ECON 6200 ..... Econometrics II (S)

### **Engineering Management**

- CEE 4630 ..... Transportation and Information  
Technology (F)  
CEE 5090 ..... Heuristic Methods for Optimiza (F)  
CEE 5900 ..... Project Management (F, S)  
CEE 5930 ..... Engineering Management  
Methods: Data, Information, and  
Modeling (F)  
CEE 5940 ..... Economic Methods for Engineer-  
ing and Management (S)  
CEE 5970 ..... Risk Analysis & Management (S)  
CEE 6900 ..... Creativity, Innovation and  
Leadership (S)

### **Hydraulics and Hydrology**

- EAS 4710 ..... Intro Groundwater Hydrology (S)  
CEE 6310 ..... Flow and Containment Transport  
Modeling in Groundwater (S)  
CEE 6320 ..... Hydrology (S)  
CEE 6330 ..... Flow in Porous Media and  
Groundwater (F)  
CEE 6360 ..... Env. Fluid Mechanics (S)

### **Natural Resources**

- NTRES 4220 ..... Wetland Ecology & Manage-  
ment (F)  
NTRES 4560 ..... Stream Ecology (S)

### **Operations Research & Information Engineering**

- OR&IE 5300 ..... Operations Research 1:  
Optimization I (F)  
OR&IE 5310 ..... Optimization II (S)  
OR&IE 5550 ..... Applied Time-Series Analysis (F)  
OR&IE 5580 ..... Simulation Modeling & Analysis (F)  
OR&IE 6300 ..... Mathematical Programming I (F)  
OR&IE 6310 ..... Mathematical Programming II (S)  
OR&IE 6510 ..... Probability (S)  
OR&IE 6700 ..... Statistical Principles (F)  
OR&IE 6780 ..... Bayesian Statistics & Data  
Analysis (S)

### **Remote Sensing and Spatial Modeling**

- CEE 6100 ..... Remote Sensing Fundamentals (F)  
CEE 6150 ..... Digital Image Processing (S)  
CSS 6200 ..... Spatial Modeling and Analysis (S)

## Application Forms and Information

Applications are available at the Graduate School's website: [www.gradschool.cornell.edu](http://www.gradschool.cornell.edu). Two forms are available—one to apply interactively (\$70 application fee) and one to download, print out, fill out, and return by regular mail (\$80 application fee). Additional information about the graduate programs in Civil & Environmental Engineering can be obtained from our web site ([www.cee.cornell.edu](http://www.cee.cornell.edu)) or by contacting our Graduate Program Coordinator at:

*School of Civil and Environmental Engineering  
Cornell University  
219 Hollister Hall  
Ithaca, NY 14853-3501  
Telephone: 607-255-3760  
Email: [cee\\_grad@cornell.edu](mailto:cee_grad@cornell.edu)*