

# ENVIRONMENTAL APPLIED SCIENCE AND MANAGEMENT

## CURRICULUM

revisions pending

### Master of Applied Science

<b>DEGREE REQUIREMENTS</b>		<b>Credits</b>
ES8901*	Chem and Biological Pathways	1
ES8930	Seminar: Env App Sci and Mgmt	1
AND one of the following two courses:		
ES8920	Environmental Policy and Mgmt	1
ES8921	Environmental Law	1
AND one of the following Options:		
<b>PROFESSIONAL PROJECT Option</b>		
	Master's Project	(Milestone)
	Seven Elective credits, with a minimum of two from Group A and two from Group B	7
<b>THESIS Option</b>		
	Master's Thesis	(Milestone)
	Four Elective credits, with a minimum of one from Group A and one from Group B	4

### Doctor of Philosophy

<b>DEGREE REQUIREMENTS</b>		<b>Credits</b>
	Doctoral Research Symposium	(Milestone)
	Candidacy Examination	(Milestone)
	Dissertation	(Milestone)
ES9001	Adv Studies in Env Policy Mgmt	1
ES9002	Research Methods: Env App Sc and Mgt	1
AND One Course from each of Group A and Group B		2

### ELECTIVES

<b>Group A: Environmental Applied Science</b>		<b>Credits</b>
ES8901*	Chem and Biological Pathways	1
ES8902*	Wtr Pollution Control Process	1
ES8903*	Pollution Prevention	1
ES8904*	Waste Management	1
ES8906	Surface Water Pollution Analysis	1
ES8907	Wastewater Engineering	1
ES8908	Soil Remediation	1
ES8909	Environmental Biotechnology	1
ES8910*	Energy and the Environment	1
ES8911	Ecotoxicology	1
ES8912	Applied Ecology	1
ES8913	Special Topics: Env App Science	1
MS8117	Molecular Ecology	1
<b>Group B: Environmental Management</b>		<b>Credits</b>
ES8801	FacI Siting and Env Risk Asses	1
ES8920	Environmental Policy and Mgt	1
ES8921	Environmental Law	1
ES8922	GIS for Environmental Mgmt	1
ES8923	Environmental Assessment	1

ES8924	Environmental Mgmt Systems	1
ES8925	Dec Making and Strat Plan Mgmt	1
ES8926	Environmental Economics	1
ES8927	Risk Assessment in Envi Mgmt	1
ES8928	Special Topics: Env Management	1
ES8929	Responding to Climate Change	1
ES8931	Bus. Fundamen. for Envir. Professionals	1
SA8921	Spatial Analysis of Land Resources	1
SA8922	Remote Sensing and Spatial Analysis	1
SA8923	Land/Geographic Information Systems	1

**Group C: Environmental Applied Science and Management** **Credits**

ES8950	Indepdt Study Env Sci Mgmt, Masters	1
ES8951	Interntl Env Field Research	1
ES9950	Independent Study Enviro Sci Mgmt, PhD	1
SS8000	Stat. Analysis in Social Sci. Research	1
SS8001	Adv. Qualitative Methods	1

**\*Platform Courses:** The program offers a set of five platform courses in environmental applied science. They are structured to provide both foundational knowledge and advanced study at the graduate level. These courses enable students from a wide range of academic backgrounds (including Geography, Public Health, Urban and Regional Planning, and Environmental Studies) to take engineering and applied science subjects. Students who successfully complete a Platform Course will have the option of enrolling in advanced applied environmental science courses in subsequent semesters.

**COURSE LISTING**

**Master's Project**

The research project option is intended for students following a professional career path in environmental applied science and management, and is typically conducted in an applied setting. In the project, students propose and carry out advanced work in an industry or a public sector organization under the direction of a faculty supervisor and a project supervisory committee. The research project is submitted in a written report to the faculty supervisor and is evaluated by a project examining committee. This is a "Milestone". Pass/Fail

**Master's Thesis**

In the thesis option, students conduct an advanced examination of a topic in the environmental applied science and management areas. Students propose and carry out the research under the direction of a faculty supervisor and a thesis supervisory committee. On completion, the research is submitted in a thesis format, to the supervisor and defended by the student before a thesis examining committee. This is a "Milestone". Pass/Fail

**Doctoral Research Symposium**

This is a mandatory requirement for all PhD students. The milestone consists of the organization, by the cohort of PhD students, of a one-day symposium normally held in the Winter semester. The symposium will focus on a current interest in the areas of environmental applied science, policy and management. This is a "Milestone." Pass/Fail.

**Candidacy Examination**

This is a "Milestone". Pass/Fail

**Dissertation**

The student is required to conduct advanced research on a topic related to one (or more) of the following specialty areas: environmental applied science, policy and management. The topic is chosen in consultation with the student's supervisor, the student presents the research plan in writing, and the research is carried out under the direction of the supervisor and monitored by a supervisory committee. The student must submit the completed research in dissertation format to Program and School of Graduate Studies examination committees and make oral presentations to these committees, which will make an assessment. Through the dissertation, the student is expected to furnish evidence of competence in research and a sound understanding of the chosen specialty area(s). The research must lead to an original contribution of knowledge in the specialty area(s).

Pre-requisite: successful completion of the candidacy examination. This is a "Milestone." Pass/Fail

**ES8801 Facility Siting & Env. Risk Assessment**

This course explores the theory and practice of public facility siting and the role that risk analysis and risk assessment play in the siting process. The course will examine the nature of facility siting conflicts, the effects of objective and perceived risks, the methods used in risk analysis and assessment, and the means presently employed in environmental management practice to analyze and manage risks that are the unavoidable consequences of many large-scale public undertakings. Antirequisite: PLE815. 1 Credit

**ES8901 Chem and Biological Pathways**

This course is devoted to the examination of fundamental and applied aspects in chemical and bio-geochemical processes in the environment. It will primarily deal with the mechanisms which affect the dispersion of naturally occurring and xenobiotic compounds in soils and water. The use of such information and its incorporation into environmental models will be covered. The effect of environmental impacts on chemical and biological processes will be emphasized. The course will include a combination of lectures, student-led seminars and case studies, and a computer-modeling workshop/laboratory. (Platform Course) 1 Credit

**ES8902 Water Pollution Control Processes**

This course will examine the sources of water pollution including wastewater, non-point source pollutants and storm water run off. The analytical characterization of contaminants will be covered for the major sources and control processes will be reviewed with a focus on wastewater processes. This will be followed by a review of the most relevant technologies used to treat industrial and municipal effluents. (Platform Course) Antirequisite: CV8200. 1 Credit

**ES8903 Pollution Prevention**

The course examines a number of industry-environment interactions. It discusses pollution prevention and industrial ecology, and it presents a survey of environmental concerns including material and energy budgets, life-cycle assessment, and industrial process wastes and their minimization. Design for environmental quality is discussed including energy use and design for energy efficiency. The course explores the future of industrial activity with regard to the environment and it reviews studies in selected industrial applications. (Platform Course) Antirequisite: ME8149. 1 Credit

**ES8904 Waste Management**

This course describes the development of solid waste management in response to legislative requirements for waste transport and disposal. To know when solid waste is a resource or a disposal problem requires its analysis and classification. Processing and handling of solid waste demands the proper application of available technology and basic engineering principles. These will be explained and followed by more advanced principles related to separation (including recycling), processing, and transformation of solid waste. Hazardous waste and hazardous materials, as well as federal and provincial regulatory processes governing hazardous wastes, will also be examined. Waste stabilization and solidification, land disposal of waste, environmental site and subsurface characterization will be discussed. Physical conversion of waste including incineration technologies, chemical and biological conversion technologies as well as successful combinations of the three will be described. The course will conclude with a brief review of the main issues in integrated solid waste management. (Platform Course) Antirequisite: CV8207. 1 Credit

**ES8906 Surface Water Pollution Analysis**

A quantitative analysis of surface and subsurface water pollution pathways is crucial to the development of water pollution prevention and control plans. This course discusses the point and non-point pollution sources in urbanized areas with emphasis on modeling approaches and analysis techniques. It examines the surface pollution processes. Topics include: surface hydrology, municipal water use cycle, urban drainage systems, point and non-point pollution sources and pollution control and treatment strategies for sanitary, storm, combined sewer systems. Antirequisite: CV8202 1 Credit

**ES8907 Wastewater Engineering**

The course is an advanced description of the unit operations in wastewater engineering. It includes physical, chemical and biological processes. In the first case, filtration, sedimentation and clarification of solids will be discussed. Liquid-liquid and gas-liquid separations will follow. Chemical operations will include neutralization, precipitation, chemical redox and ion exchange. The last part of the course will cover fixed and suspended growth biological processes. 1 Credit

**ES8908 Soil Remediation**

This course overviews the design and operation of processes for soil remediation. Contaminants of interest include halogenated and non-halogenated volatiles, halogenated and non-halogenated semi-volatiles, fuel hydrocarbons, pesticides and inorganics. Seven groups of technologies will be examined: (1) excavation and off-site disposal, (2) soil venting, (3) bioremediation, (4) thermal technologies, (5) chemical technologies, (6) mechanical flushing and washing, and (7) natural attenuation. Antirequisite CV8204. 1 Credit

**ES8909 Environmental Biotechnology**

This course, as a series of lectures and student-led discussions, covers the application of biologically-based technologies in bioenergy and bio-remediation. Areas of application covered include biologically-based remediation of air, soil, solid waste, wastewater, bio-energy, and biofuels. The relevant technologies are discussed along with the potential positive and negative impacts which may be associated with the use of biotechnologies in the environment. 1 Credit

**ES8910 Energy and the Environment**

A review of thermodynamic fundamentals is provided including combustion, electricity generation, co-generation, heating, cooling and incineration. Energy utilizing technologies in the residential, commercial, institutional, industrial and transportation sectors and their impacts on the environment are examined. Methods and technologies for controlling and reducing the environmental impacts of energy technologies are discussed. The course covers the design of energy technologies for environmental management. (Platform Course) 1 Credit

**ES8911 Ecotoxicology**

The course examines the fate and transport of the major inorganic and organic contaminants in the biosphere. Their properties, release, environmental destiny, and impact on ecological systems will be studied. Included will be the molecular basis of pollutant toxicity, progressing to consequent effects at higher levels of organization including cellular, whole organism, population, community, and ecosystem. From lower levels of ecological structure to global effects, including geopolitical ramifications, it provides perspectives on this multidisciplinary science. 1 Credit

**ES8912 Applied Ecology**

This course will address fundamental principles and approaches in ecology and illustrate how they are applied to current environmental problems. We will cover topics such as application of regression analysis in natural resource management; landscape ecology and global change; fisheries management; multivariate descriptive techniques (ordination); and ecological processes structuring biological communities in space and time. Emphasis will be placed on application of ecological theory in practice, and on addressing current natural resource management concerns. 1 Credit

**ES8913 Special Topics: Env Applied Science**

This course provides the opportunity for the program occasionally to offer a course in response to special non-recurring circumstances. The content will relate to specific topical areas related to environmental applied science that are not covered by existing courses. The particular timing, theme, and structure of the course will vary. 1 Credit

**ES8920 Environmental Policy and Mgmt**

This course focuses on existing notions of policy formation by drawing on a range of policy theories and environmental policy case studies. It examines the relationship between public policymaking and environmental issues, and reviews major themes such as risk, complexity, evidence, expertise, technology, and institutions. This course is interdisciplinary in nature and examines a range of environmental policy studies that help to explain how environmental awareness and scientific evidence affect the policy process. 1 Credit [restricted to Masters level students]

**ES8921 Environmental Law**

The field of environmental law in Canada continues to have a dramatic evolution. This course covers major topics of environmental law, including constitutional division of powers, relevance of administrative law, endurance of common law and importance of civil litigation, as well as the role of science in standard setting for regulatory law. Course materials emphasize the substantial contrasts between: common law, criminal law and regulatory law approaches to environmental issues, covering many significant Canadian cases. 1 Credit

**ES8922 GIS for Environmental Mgmt**

Geographic Information Systems (GIS) are used to examine the spatial dimensions of environmental data and provide capabilities for data analysis in managing environmental problems. GIS systems are being increasingly recognized for their environmental modeling capabilities. This course indicates the uses of GIS in support of site evaluations, effects monitoring, policy development and decision making. Environmental management research opportunities are explored through lectures, case studies, seminars and hands-on activities using major GIS software packages. 1 Credit

**ES8923 Environmental Assessment**

This course provides an integrated, interdisciplinary approach to the application and evaluation of current biophysical, social and economic impact assessment. It examines environmental assessment as an environmental decision making instrument in provincial, federal and international contexts and it reviews methods to predict, evaluate and mitigate impacts in both human and natural environments. The course reviews the technical and scientific concepts that must be addressed in a comprehensive assessment of project impacts on complex, interacting physical and human systems. This is complemented by a critical appraisal of institutional structure and decision making in environmental management. Evaluation methods and practical applications are emphasized. 1 Credit

**ES8924 Environmental Management Systems**

This course examines the legal, economic and ethical reasons for the development, implementation and monitoring of a comprehensive, location-specific Environmental Management System (EMS). An EMS enables an organization to systematically identify environmental concerns and address them. The elements of a generic EMS are explored: planning and risk assessment phases; establishment of a policy; the outline of organization arrangements; design of the array of programs that address specific sets of environmental concerns such as production methods, energy use and waste disposal; and the development of a program of periodic environmental audits. The requirements of ISO 14000 are explored. Issues relating to the integration of EMS with quality management systems and occupational health and safety systems are discussed. Antirequisite: ME8148. 1 Credit

**ES8925 Decision Making/Strategic Plan. in Mgt.**

This course presents methods in tackling decision making problems and strategic planning issues in engineering and management. Topics in quantitative decision theory such as influence diagrams, decision trees, subjective probability assessment, and the role of information in decision making including Bayesian analysis are discussed. Multi-criteria decision making techniques such as multi-attribute utility theory and Analytic Hierarchy Process are covered. Key steps and end results of the strategic planning process are analysed. Formulating planning assumptions, analysing opportunities, setting objectives, developing strategies and implementing strategic plans are discussed. Case studies are an integral part of the course. 1 Credit

**ES8926 Environmental Economics**

Environmental economics considers economic tools and analyses and their application in understanding environmental issues. Key economic concepts such as opportunity cost, marginal benefits and costs, and consumer and producer surplus are applied in examining the relationship between economic activities and the environment. The equimarginal principle, the Coase theorem, and the central concepts in cost-effectiveness and cost-benefit analyses are discussed. Case studies are used to illustrate the role of economics in evaluating environmental policies and regulations. The course also examines how business managers are meeting the environmental challenge. The question of how environmental problems and policies affect different groups within society is a central focus of the course. 1 Credit

**ES8927 Risk Assessment in Environmental Mgmt**

This course examines the application of risk analysis and assessment in environmental management. It reviews the methods of estimating probabilities and consequences of risks in the environment including new technologies, chemicals, biological agents and

risk generating facilities. Risk analysis includes risk identification, risk pathways, exposure models and dose-response relationships. The course also sets out the principles of risk management and the process by which risks are perceived and communicated in making environmental decisions. A critical evaluation of risk assessment in environmental decision making is supported by a review of selected cases. 1 Credit

**ES8928 Special Topics: Environmental Management**

This course provides the opportunity for the program occasionally to offer a course in response to special non-recurring circumstances. The content will relate to specific topical areas related to environmental management that are not covered by existing courses. The particular timing, theme, and structure of the course will vary. 1 Credit

**ES8929 Responding to Climate Change**

This course provides an examination of the complex nature and underpinnings of the international discussion on anthropogenic climate change. The course reviews the technical and social concepts that must be addressed in a comprehensive understanding of the evolving response to the changing climate system, particularly within the context of the United Nations Framework Convention for Climate Change. 1 Credit

**ES8930 Seminar: Env Appl Sci and Mgt**

The seminar course introduces students to a range of environmental problems and the ways scientific analysis and management concepts, drawn from environmental science and management, can be applied. Seminars will include academic and professional experts who will present research and case reviews in environmental practice. Students will make a presentation on their research in progress for discussion with faculty and students. It is expected that students will have submitted their research proposals prior to enrolling. 1 Credit

**ES8931 Business Fundamentals for Environmental Professionals**

This course is an introduction to the principles of management and their application to business in the context of environmental management. The course focuses on providing students with a general knowledge of how a business works by exposing them to the various functional areas of an organization and the strategic process. Topics include the current types & environment of businesses, leadership and organization, accounting and finance, marketing, operations, strategy and responsible business. 1 Credit

**ES8950 Indepdt Study Env Sci Mgmt, Masters**

Individual directed study of subject areas in environmental applied science and management not addressed in the current curriculum will be carried out under the supervision of a faculty member. A program of supervised, advanced study related to the student's area of concentration will be negotiated on an individual basis with the supervising faculty member. The independent study course is normally intended for students in the final semesters of study. Antirequisite: ES8951. 1 Credit

**ES8951 International Environmental Field Research**

Emphasis in this course is on the broadening of a student's perspectives by incorporating field experience in an international setting. The course provides an opportunity to undertake an individual (or group) research project under the direct supervision of a faculty member in the field. A program of supervised research will be developed collaboratively. Antirequisite: ES8950. 1 Credit

**ES9001 Adv Studies in Env Policy Mgmt**

This course provides an advanced and critical analysis of the relationship between public policymaking and environmental issues. Drawing from a range of theories and case studies, students will develop the skills to evaluate and understand how challenging and controversial themes in environmental science such as risk, complexity, evidence, expertise, technology, and institutions, shape and are shaped by the policymaking process. It is an interdisciplinary course that will require students to engage in critical discussion of a range of literature that has direct bearing on explaining how environmental issues, scientific evidence, and the policy process converge. 1 Credit.

**ES9002 Research Methods: Env App Sc and Mgt**

This seminar course involves study and application of methods appropriate to research in the environmental sciences and environmental management studies. It focuses on the challenges of engaging in research in a multi-disciplinary environment where students examine the conventions of research in their study areas. The purpose is to enable students to identify valid questions open to research and to introduce the methods needed to answer the question in ways that are unambiguous and supportable. 1 Credit

**ES9950 Independent Study Envir Sci and Mgmt, PhD**

Individual directed study of subject areas in environmental applied science and management not addressed in the current curriculum will be carried out under the supervision of the doctoral student's principal faculty supervisor. A program of supervised advanced study will be negotiated on an individual basis with the faculty supervisor. A proposal will require the approval of both the faculty supervisor and program director before enrollment. 1 Credit

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