ENVS 3333 GROUNDWATER CONTAMINATION
(3 credits) 3 hours lecture, 3 hours lab)

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Calendar Description:

This course will provide a basic understanding in applied hydrogeology with emphasis being on the fate and behaviour of industrial chemicals in the groundwater, the impact of industrial activities on groundwater quality, control, monitoring and remediation of contaminated groundwater systems.

Course Rationale:

Groundwater which is ubiquitous in the crust of the earth, represents a very important natural resources that needs to be protected from contamination. Chemicals from landfills, industrial lagoons, agricultural fields, septic fields, accidental spills may migrate into the groundwater. The potential for contaminants to leach into the groundwater, to persist or to be attenuated is very complex and must be evaluated and understood for minimizing health, environmental risks and formulate cost-effective corrective actions.

Prerequisites:

Successful completion of semesters 1 and 2 of the Bachelor of Applied Science-Environmental Science Program or equivalents or Department approval

University Wide Outcomes:

This course fulfills the following aspects of the university wide outcomes:

1) Thinking Skills

- Design appropriate sampling and sampling programs to obtain quality and defensible data
- Evaluate data in light of the hydrogeological and chemical nature of the contaminated system
- Evaluate the potential risks posed by the data to various receptors
- Follow critically appropriate guidelines

2) Group Effectiveness

- Work in a team in carrying out lab exercises
- Work in a team in planning field data collection, scheduling analytes parametization and maintaining appropriate quality assurance/control for class project

3) Communication Skills

- Write lab reports using appropriate technical terms and lab report format as outlined in the lab manual
- Write the class project in a consulting format
- Communicate progress report to instructor in an oral format on the class project results
- Formulate a formal written project of their project according to government guidelines following a consulting report format

4) Information Retrieval

- Retrieve information to facilitate data interpretation
- Research information for analyte parametization
- Reference the sources of information in lab and project reports
- Evaluate the validity of the information

5) Computer Literacy

- Use the computer to access pertinent information related to the course such as provincial and federal guidelines and regulations
- Use the computer for preparing lab and project reports

6) Ethical Reasoning

- Understand the importance of confidentiality vis-à-vis the client
- Understand the right-to-know of the public
- Recognize the potential for conflict of interest

Course Outcomes:

This course is designed to be an introduction to contaminant hydrogeology and is designed to provide a balance between theory, regulation and field experience to students and environmental practitioners. Upon completion of the course, the successful student will have:

- An understanding of the principles and concepts governing groundwater contamination
- An understanding of the sampling and monitoring methods
- An understanding of groundwater flow
- An understanding of transport processes, theory and equations
- An appreciation of potential sources for groundwater contamination
- An appreciation of the legal measures

Course Objectives:

Environmental awareness and governmental regulations are placing increased pressure on industry and other sectors in society. The primary objective of this course is to provide a working knowledge to the students of methods and principles used to address processes of both groundwater flow and issues relating to contaminant investigation and fate in the saturated zone.

Course Organization:

Below is a list of topics and description covered by the course:

Topic 1)

Groundwater hydrogeology: This section begins with an introduction to the vadose zone which generally lies above the water table. It is devoted to the properties of the saturated zone including the definition of saturated zone systems and the parameters that can be used to characterize them. Porosity, hydraulic conductivity, hydraulic gradient are all important in determining the rate and direction of groundwater flow. Equipotential lines and flow nets representations in two dimensions are used to provide a graphical picture of ground water heads and gradients flow. A physical model is used to facilitate the conceptualization of ground water system by the students.

Topic 2)

Sources of groundwater contamination: This section provides a historical account of most common sources of ground water contamination. In particular, underground storage tanks, septic tanks, landfills, agricultural activities, oilfield activities. It also covers conceptual models for what happens to a typical LNAPL, DNAPL and a dissolved plume.

Topic 3)

Materials Balance: This section covers two fundamental aspects of elementary physic laws: the law of conservation of mass and the law of conservation of

energy. These laws tell us that within any environmental system we should be able to account for the flow of energy and materials into, and out of, that system. When coupled with other thermodynamic principles, these laws are useful in a number of applications, including the study of global climate change, thermal pollution, and the dispersion of pollutants.

Topic 4)

Groundwater flow assessment: This section covers the methods that have been used to predict rates of flow and direction in saturated systems. Various equations are used and solved.

Topic 5)

Subsurface investigation for contamination: This section addresses the methods used to characterize soil and ground water contamination problems in sufficient details to facilitate the design of a cost-effective corrective action program. For this purpose, geologic, hydrologic, and chemical data collection aspects and interpretation are covered in a systematic manner. Case studies are used to facilitate the lecture.

Topic 6)

Contaminants transport mechanisms: This sections explores transport concepts relating to the migration and fate of contaminants. The concepts presented serve as a synthesis of existing theory highlighted by examples for understanding and predicting migration and transport of solutes in the saturated zone. The main transport processes of concern are advection, diffusion, dispersion, sorption, biodegradation and chemical reaction.

Topic 7)

Groundwater sampling/monitoring: This section covers field methods for acquisition of soil and ground water quality data commonly used in contaminated site investigation. It covers installation of ground water monitoring wells, aquifer permeability testing, proper handling of soil and ground water samples for contaminant analysis. Emphasis is on the more conventional and commonly used techniques.

Topic 8)

Groundwater remediation: Various methods of containment, hydraulic control, pump and treat, bioremediation, soil vapor extraction and NAPL control are presented in detail.

Student Evaluation:

Students enrolled in this course will be evaluated as follows:

Mid-term	30%
Assignments	15%
Labs	10%
Project	10%
Final	35%

Percentage Grades

Percentage Grade (%)	Letter Grade	
95-100	A+	Excellent
85-94	A	Excellent
80-84	A-	Excellent
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77-79	B+	Good
73-76	B	Good
70-72	B-	Good
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67-69	C+	Satisfactory
63-66	C	Satisfactory
60-62	C-	Satisfactory
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55-59	D+	Poor
50-54	D	Poor
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0-49	F	Fail

Resource Materials:

The following resource materials will be used for this course:

The lecture notes are available on the course blackboard site.
Guidelines considered in the course:
CCME
Alberta Tier 1: Soil and Groundwater Remediation Guidelines
Alberta Tier 2: Soil and Groundwater Remediation Guidelines