ENV-470 6/97

HYDROGEOLOGY

A. ENV 470 - Hydrogeology

B. Offered by: the Department of Environmental Science and Geography

C. Prepared by: Dr. Richard R. Pardi, Ph.D. (Geochemist)

Other Qualified Instructor: Dr. Karen Swanson, Ph.D. (Geochemist)

D. Credit Hours: 3 credits - 2 x 75 min. = 150 min.

E. Intended Audience: Environmental Science Majors

F. Prerequisites: General Geology, General Chemistry and Calculus

G. Course Description:

Hydrogeology encompasses the interrelationships of geologic materials and processes with water. It addresses the occurrence, distribution, movement, and chemistry of all waters of the Earth. Topics studied include the hydrologic cycle, drainage, floods and engineering controls, water pollution, and water supply.

H. Course Objectives:

To enable the student to interpret and analyze problems and plans for water development as a renewable natural resource within the context of our present and future social needs.

To develop the background of knowledge and principles which will be applicable to the solution of hydrologic problems associated with environmental modification.

I. Course Content: (Major categories represent one or two lectures each)

1) Water
   a) Water
   b) Hydrology and hydrogeology
   c) The hydrologic cycle
   d) Energy transformations
   e) The hydrologic equation
   f) Hydrogeologists
   g) Applied hydrogeology
   h) Sources of information

2) Evaporation and Precipitation
   a) Evaporation
   b) Transpiration

c) Evapotransportation
d) Condensation
e) Formation of precipitation
f) Measurement of precipitation
g) Snow measurements
h) Effective depth of precipitation

3) Runoff and Streamflow
a) Events during precipitation
b) Hydrography separation
c) Rational equation
d) Duration curves
e) Determining groundwater recharge from baseflow
f) Measurement of streamflow
g) Manning equation

4) Soil Moisture and Ground Water
a) Porosity of Earth materials
b) Specific yield
c) Hydraulic conductivity of Earth materials
d) Effective porosity
e) Forces acting on groundwater
f) Water table
g) Infiltration
h) Soil moisture
i) Theory of unsaturated flow
j) Water-table recharge
k) Aquifers
l) Aquifer characteristics
m) Homogeneity and isotropy

5) Principles of Ground Water Flow
a) Introduction
b) Mechanical energy
c) Hydraulic head
d) Force potential and hydraulic head
e) Darcy's Law
f) Permeameters
g) Equations of ground-water flow
h) Solution of flow equations
i) Gradient of hydraulic head
j) Flow nets
k) Refraction of streamlines
l) Steady flow in a confined aquifer
m) Steady flow in an unconfined aquifer
n) Fresh-water saline-water relationships

6) Ground-water Flow to Wells
   a) Introduction
   b) Unsteady radial flow
   c) Well hydraulics - confined aquifers
   d) Well hydraulics - semiconfined aquifers
   e) Partial penetration of wells
   f) Water-table aquifers
   g) Use of piezometers
   h) Steady-state radial flow - Theim equations
   i) Well interference
   j) Effect on hydrogeologic boundaries
   k) Pumping-test design

7) Regional Ground-Water Flow
   a) Introduction
   b) Steady regional ground-water flow in unconfined aquifers
   c) Confined aquifers
   d) Transient flow in regional ground-water systems
   e) Noncyclical ground water
   f) Springs
   g) Geology of regional flow systems
   h) Ground-water-lake interactions

8) Geology of Ground-Water Occurrence
   a) Introduction
   b) Unconsolidated aquifers
   c) Lithified sedimentary rocks
   d) Igneous and metamorphic rocks
   e) Ground water in permafrost regions
   f) Coastal Plain Aquifers
   g) Ground water in desert areas
   h) Ground water regions of the United States

9) Water Chemistry
   a) Introduction
   b) Types of chemical reactions in water
   c) Common ion effect
   d) Chemical activities
   e) Carbonate equilibrium
   f) Oxidation potential
   g) Surface phenomenon
   h) Isotope hydrology
   i) Presentation of results of chemical analyses

10) Water Quality and Ground-Water Contamination

a) Introduction
b) Water-quality standards
c) Collection of water samples
d) Ground water monitoring
e) Vadose-zone monitoring
f) Mass transport of solutes
g) Ground-water contamination
h) Ground-water restoration

11) Ground Water development and Management
a) Introduction
b) Dynamic equilibrium in natural aquifers
c) Ground-water budgets
d) Management potential of aquifers
e) Paradox of safe yield
f) Water Law
g) Artificial recharge
h) Protection of water quality of aquifers
i) Ground-water mining and cyclic storage
j) Conjunctive use of ground-water and surface water
k) Trends in water resources management

12) Field Methods
a) Introduction
b) Fracture-trace analysis
c) Surficial methods of geophysical investigations
d) Geophysical well logging
e) Hydrogeologic site evaluations
f) Project reports

13) Ground-Water Models
a) Introduction
b) Applications of ground-water models
c) Data requirements for models
d) Finite-difference methods
e) Finite-element models
f) Method of characteristics
g) Use of published models

J. Teaching Methods:

a) Lecture and demonstration sessions
b) Problem solution and discussion
c) Supervised laboratory and/or field work assignments
d) Presentation of materials through use of audio-visual media or computer simulations when applicable

K. Evaluation of Students:

a) Class recitation
b) Problem/field assignment submissions
c) Periodic quizzes and examinations

L. Assessment of Student Learning Outcomes & Objectives:

a) Students should understand the basic principles that define the unit hydrograph for a stream.
b.) Demonstrate an understanding of the derivation and use of basic groundwater flow equations.
c.) Demonstrate an understanding of the basic principles of groundwater chemistry.
d.) Demonstrate familiarity with classical remediation techniques as illustrated in case studies.

M. Textbook:

Applied Hydrogeology 3rd ed., C. W. Fetter, Merrill Publishing Co., Columbus, Ohio, 592 pp.

N. References:

Handbook of Applied Hydrology, Chow, Ven T., McGraw-Hill Book Co., NY, 1964

Water in Environmental Planning, Dunne, T., and Leopold, L.B., W.H. Freeman and Company, Sand Francisco, 818 pp., 1978

Design with Nature, McHarg, I.L., The Natural History Press, Garden City, NY, pp. 197, 1969

Ground Water Hydrology, Todd, D.K., John Wiley and Sons, NY 1959

O. Cost Analysis: (24 students) (values in parenthesis indicate items on hand)

1. Permanent Equipment and Software:

a)	Field Equipment	($4,000.00) +	$2,000.00
b)	Software	($300.00) +	$ 400.00
		Sub Total	$6,700.00

2. Supplies (expendable):

a)	Chemicals	NONE
b)	Live material	NONE
c)	Preserved species	NONE

d) Media NONE
e) Other NONE

3. Audio-Visual Materials:
   a) Film rental & purchase NONE
   b) Tapes & Audio-cassettes (300.00)
   c) Slides (400.00)
   d) Filmstrips NONE

Sub Total $ 700.00

4. Library books & journals $ 500.00

Sub Total $ 500.00

5. Computation of cost for course/24 per section:

Grand Total $ 9,900.00

Available Material $ 6,000.00

Actual Cost $ 3,900.00