

SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE TITLE: WATER POLLUTION (Outline & Lab Manual)

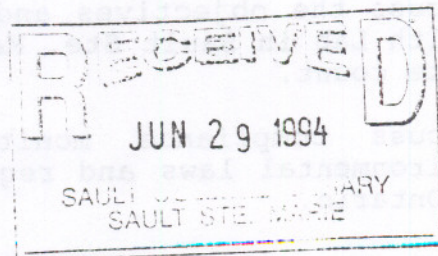
CODE NO.: BIO 129-4 SEMESTER: II, V

PROGRAM: WATER RESOURCES/ENVIRONMENTAL ENGINEERING/  
PULP & PAPER TECHNOLOGY

AUTHOR: V. WALKER

DATE: DECEMBER 1993 PREVIOUS OUTLINE DATED: JANUARY 1993

APPROVED: DEAN DATE



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III. TOPICS TO BE COVERED:

WEEK		
1,2	UNIT 1	INTRODUCTION <ul style="list-style-type: none"> <li>- what is pollution?</li> <li>- complexity of pollution</li> <li>- the ecosystem concept</li> <li>- biomonitoring</li> <li>- (Video: Great Lakes Troubled Waters)</li> </ul>
2,3,4	UNIT 2	FRESHWATER SYSTEMS <ul style="list-style-type: none"> <li>- general characteristics</li> <li>- the lotic environment</li> <li>- the lentic environment</li> <li>- stability of ecosystems</li> <li>- seasonal production cycles</li> </ul>
3	LAB 1	WINTER LAKE STUDY
4		TERM TEST #1
5,6	UNIT 3	TYPES AND SOURCES OF POLLUTION <ul style="list-style-type: none"> <li>- Water pollution categories:               <ul style="list-style-type: none"> <li>- disease causing agents</li> <li>- inorganic chemicals and minerals</li> <li>- plant nutrients (nitrogen, phosphorus cycles)</li> <li>- sediments</li> <li>- heat</li> <li>- radioactive substances</li> <li>- oxygen demanding wastes</li> <li>- synthetic organic chemicals</li> </ul> </li> <li>- Areas of concern in the Great Lakes Basin</li> <li>- Major sources of water pollution</li> <li>- (Video: Early Warning)</li> <li>- (Speaker: R.A.P. Representative)</li> </ul>
7,8,9	UNIT 4	TOXICOLOGY <ul style="list-style-type: none"> <li>- types of toxic pollutants</li> <li>- toxicity</li> <li>- acute toxicity determination</li> <li>- factors affecting toxicity</li> <li>- toxic substances and health effects in Wildlife</li> <li>- human health</li> </ul>
		TERM TEST #2

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IV. EVALUATION METHODS:

Oral Presentation:	10 marks	85% and over	- A+
Lab Reports and Participation:	30 marks,	76%	- A
Term Tests (3):	60 marks	68%	- B
		60%	- C
	<u>100</u> marks	Under 60%	- R

Students with a final grade of less than 60% will receive an "R" grade. All labs must be submitted for a passing grade.

ATTENDANCE:

Lab attendance is **compulsory**. Students missing labs without documented reason run the risk of repeating the course.

V. REQUIRED STUDENT RESOURCES:

TEXTBOOK:

1. Water Pollution Outline and Lab Manual (Campus Bookstore)
2. Colborn, Theodora E. et al 1990. Great Lakes, Great Legacy? The Conservation Foundation and the Institute for Research on Public Policy, Washington and Ottawa, 301 p.
3. Environment Canada, Department of Fisheries and Oceans and Health and Welfare Canada, 1991. Toxic Chemicals in the Great Lakes and Associated Effects - Synopsis. Government of Canada, Ottawa, 51 p.

OPTIONAL PURCHASES:

Mason, C.F., 1981. Biology of Freshwater Pollution. Longman Group Ltd., New York.

Vallentyne, J.R. 1974. The Algae Bowl. Lakes and Man. Canada Dept. of the Environment, Fish and Marine Service, Mosc. Spec. Pub. No. 22:186 pp.

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VI. ADDITIONAL RESOURCE MATERIAL - 2

Delwiche, C.C. 1981. Denitrification, Nitrification and Atmospheric Nitrous Oxide. Wiley, New York

Edmondson, W. T. (1969). Eutrophication in North America. In - Eutrophication - Causes, Consequences, Correctives. pp. 124-49. National Academy of Sciences, Washington.

Environment Canada 1986. From Cradle to Grave. A Management Approach to Chemicals. Ministry of Supply & Services Ottawa. TD 196.C45T38 1986

Environmental Protection Agency. 198\_. Water Quality Criteria. E.P.A. R3-73-033. Washington, D.C.

\*Environmental Studies Board. 1983. Committee on Atmospheric Transport and Chemical Transformation in Acid Precipitation. Acid Deposition: Atmospheric Processes in Eastern North America. National Academy Press, Washington, D.C.

Evans, M. S. (ed). 1988. Toxic Contaminants and Ecosystem Health: A Great Lakes Focus. John Wiley and Sons, N.Y. TD180.A38V.21

Heeman, A.M., Robert Haveman and Allen Kneese. 1984. The Economics of Environmental Policy. R.E. Krieger Publishing Co., Inc., Florida

\*Goldman, Charles R. and A. J. Horne. 1983. Limnology. McGraw-Hill, Toronto.

\*Gordon, Malcolm S. 1982. Animal Physiology: Principles and Adaptations (4th edition). MacMillan Publishing Co., Inc. New York.

Gore, James A. 1985. The Restoration of Rivers and Streams: Theories and Experience. Butterworth Publishing Co., Boston

Hammer, Mark J., 1986. Water and Wastewater Technology. John Wiley and Son Inc., New York.

Heath, Alan G. 1987. Water Pollution and Fish Physiology. CRC Press Inc., Boca Raton, Florida. SH174.H43 1987

\*Hoar, W. S. 1983. General and Comparative Physiology (3rd Edition). Prentice-Hall, Inc., New Jersey.

Hoar, W. S., and D.J. Randall, (eds.). 1979. Fish Physiology. Vol.7: Locomotion Academic Press, Inc., London.

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ADDITIONAL RESOURCE MATERIAL - 4

Minns, Charles Kenneth 1986. Project Quinte: point-source phosphorus control and ecosystem response in the Bay of Quinte, Lake Ontario. Cdn. Special Publicaition of Fisheries and Aquatic Sciences. Dept. of Fisheries & Oceans, Ottawa TD227.06 P73

Misener, A. D. and G. Daniel (eds.) 1982. Decisions for the Great Lakes. Great Lakes Tomorrow, Hiram, Ohio.

Morgan, James and Werner Stum. 1981. Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibrium in Natural Waters. Wiley, New York

Murty, A.S. 1986. Toxicity of Pesticides to Fish. CRC Press. Bocaaraton, FLA.

\*National Research Council of Canada. 1985. TFM and Bayer 73: Lampricides in the Equatic Environment. Pub. No. NRCC 22488, Ottawa.

Owen, O.S. 1985. Natural Resources Conservation - An Ecological Approach. MacMillan, New York

olmer, C. Mervin. 1980. Algae and Water Pollution. Castle House Publications, Ltd., England.

Pavoni, J.L., 1977. Handbook of Water Quality Management Planning. Van Nostrand Reinhold Co., Litton Educaitional Publishing Inc., New York.

Pickering, A.D. 1981. Stress and Fish. Academic Press, San Diego, California. QL639.1 S74 1981

Rand, Gary M and Sam, R. 1985. Fundaments of Aquatic Toxicology; Methods and Applications. Hemisphere Publications, Washington.

\*Reid, George K. 1961. Ecology of Inland Waters and Estuaries. Van Nostrand Reinhold Co., Toronto.

\*Ruttner, F. 1963. Fundamentals of Limnology. University of Toronto Press, Toronto.

Salle, A.J., 1967, Fundamental Principles of Bacteriology. 6th edition, McGraw-Hill Book Co., Toronto.

Schmidtke, N. W. 1986. Toxic Contamination in Large Lakes. World Conference on Large Lakes. Lewis Publishers QH545.W3 W67 1986

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LAB SCHEDULE\*

- |           |   |
|-----------|---|
| 1. Lab 1. | Temperature and Oxygen Consumption in Aquatic Organisms |
| 2. Lab 2. | Winter Lake Study                                       |
| 3. Lab 3. | Bioassay  |
| 4. Lab 4. | Standard Bacterial Plate Count/Bacterial Staining       |

\*Subject to change

PRESENTATION TOPICS

Students are required to deliver an oral presentation of approximately 20 minutes during a predetermined time slot. Presentations will include visual aids as well as oral material delivered by each student. Term Test #3 will include information from students' presentations. The following topics are available for presentation:

NOTE: RELATE YOUR TOPIC TO WATER POLLUTION.

1. Mercury
2. Polychlorinated biphenyls (PCB's)
3. Oil
4. Insecticides (DDT, Dieldrin, Toxaphene, Lindane)
5. Absorbable Organic Halogen (AOX)
6. Waste heat, (thermal pollution)
7. Nuclear pollution (radioactive waste)
8. Dioxin (2,3,7,8-TCDD), Furan (2, 3, 7, 8 - TCDF)
9. Herbicides (2,4D; Glyphosphate; Hexazinone)
10. Detergents
11. Acid rain

REPORT WRITING

All lab reports should include the following components:

1. Title Page with appropriate information.
2. Purpose/Objective - a brief statement outlining the intent of the exercise. Objectives may be itemized, i.e.,
  - a) to determine LC<sub>50</sub> for zinc using rainbow trout
  - b) to investigate the relationship between water temperature, pH, alkalinity and the toxicity of zinc to rainbow trout
3. Method/Procedure - a brief outline of how the exercise was conducted. In many instances "Refer to manual" will suffice.
4. Results - a presentation of results, and only results, in an organized format, i.e., TABLE FORMAT. There should be no sentences, no paragraphs--table and figures (graphs) only. Be sure all table and figures are entitled and numbered and include proper units.

Table 1 - Physical Characteristics of the Great Lakes

Lake	Area (km <sup>2</sup> )	Area of Drainage Basin (km <sup>2</sup> )	Average Depth (m)	Volume (ckm)	Retention time (yr)
Superior	82,100	127,700	147	12,100	191
Michigan	57,800	118,000	85	4,920	99
Huron	59,600	134,000	59	3,540	22
Erie	25,700	78,000	19	484	2.6
Ontario	18,960	64,030	86	1,640	6

5. Calculations - one example of each different calculation used in presenting the results should appear in this section. Subsequent work using the same calculations should appear in the Appendix. Hence, with the exception of one example calculation, all calculations used to generate data in tables must be shown in the Appendix.

9. Appendix

- present calculations for all values appearing in tables.

10. References Cited

- presented on a separate page at end of report,
- all citations in text of report must be listed alphabetically in this section and conversely all references listed in this section must be cited in the text of the report.

i.e.:

- 1) For paper presented in a journal:

Mason, C. F. and R. J. Bryant. 1974. The structure and diversity of the animal communities in a broad land reed-swamp, J. Zool., 172, 289-309.

issue no. page reference

- 2) For book references:

Hynes, H. B. N., 1970. The Ecology of Running Waters, Liverpool University Press, Liverpool.

- 3) For paper/chapter presented in publication:

Chapman, D.W. 1978. Production fish populations. In Ecology of Freshwater Fish Production (S. D. Gerking, ed.). Blackwell. Oxford.

See previous list of references for other examples.

MAJOR DO'S AND DON'TS

1. Don't use first person in report text, i.e., I, we, our.
2. Do refer to tables and figures by number. Be sure all tables and figures in Results are numbered and entitled.
3. Use correct citation of references.
4. Do not use quotes.
5. Scientific names of species need only appear once in text of report. They are placed in brackets and underlined after the common name of the species appears for the first time.



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ACRONYMS

- ADI Acceptable Daily Intake: The dose that is anticipated to be without risk to humans when taken daily. It is not assumed that this dose guarantees absolute safety. The determination of the ADI is often based on the application of laboratory animal toxicity data concerning chronic (long-term) doses to the environmental doses to which humans are exposed.
- AOC(s) Areas of Concern: Geographic locations recognized by the International Joint Commission where water, sediment or fish quality are degraded, and the objectives of the Great Lakes Water Quality Agreement of local environmental standards are not being achieved.
- BaP Benzo-a-pyrene
- BAT Best Available Technology/Treatment
- BATEA Best Available Technology/Treatment Economically Achievable
- bCF Bioconcentration Factor; the ratio of the concentration of a particular substance in an organism to concentration in water.
- BCT Best Conventional Technology/Treatment
- BEJ Best Engineering Judgement
- BHC Benzene Hexachloride or Hexachlorocyclohexane. There are three isomers; alpha, beta, and gamma. Gamma-BHC is the insecticide lindane.
- BOD Biochemical Oxygen Demand: The amount of dissolved oxygen consumed during the decomposition of organic nutrients in water during a controlled period and temperature.
- BMP Best Management Practices
- BPAC Binational Public Advisory Committee
- BPJ Best Professional Judgement
- BPT Best Practical Treatment

<u>COURSE NAME</u>	<u>COURSE NUMBER</u>
<u>EC-50</u>	Effective concentration of a substance producing a defined response in 50% of a test population. The higher the EC-50, the less effective the substance is because it requires more material to elicit the desired response.
<u>EMS</u>	Enforcement Management System
<u>EP</u>	Extraction Procedure
<u>EP/OR</u>	Environmental Protection, Ontario Region, Environment Canada
<u>EPA</u>	United States Environmental Protection Agency
<u>FDA</u>	Food and Drug Administration
<u>GLISP</u>	Great Lakes International Surveillance Plan. It provides monitoring and surveillance guidance to U.S. and Canadian agencies responsible for implementing the provisions of the GLWQA that include general surveillance and research needs as well as monitoring for results of remedial actions.
<u>GLWQA</u>	Great Lakes Water Quality Agreement
<u>HCB</u>	Hexachlorobenzene
<u>HCBD</u>	Hexachlorobutadiene
<u>HCE</u>	Hexachloroethane
<u>HWC</u>	Health and Welfare Canada
<u>IJC</u>	International Joint Commission: A binational organization established in 1909 by the Boundary Waters Treaty. Through the IJC, Canada and the United States cooperatively resolve problems along their common border, including water and air pollution, lake levels, power generation and other issues of mutual concern.
<u>IPP</u>	Industrial Pretreatment Program

<u>COURSE NAME</u>	<u>COURSE NUMBER</u>
<u>OCS</u>	Octachlorostyrene
<u>OMNR</u>	Ontario Ministry of Natural Resources
<u>OMOE</u>	Ontario Ministry of the Environment/Environment Ontario
<u>PAH</u>	Polynuclear Aromatic Hydrocarbons, also known as Polycyclic Aromatic Hydrocarbons or Polyaromatic Hydrocarbons. Aromatic Hydrocarbons composed of at least 2 fused benzene rings, many of which are potential or suspected carcinogens.
<u>PBB</u>	Polybromated biphenyl; used primarily as a fire retardant.
<u>PCB</u>	Polychlorinated biphenyls; a class of persistent organic chemicals with a potential to bioaccumulate and suspected carcinogens; a family of chemically inert compounds, having the properties of low flammability and volatility and high electric insulation quality. Past applications include use as hydraulic fluids, heat exchange and dielectric fluids; plasticizers for plastics.
<u>PEAS</u>	Pollution Emergency Alert System
<u>pH</u>	The negative power to the base 10 of the hydrogen ion concentration. A measure of acidity or alkalinity of water on a scale from 0 to 14; 7 is neutral; low numbers indicate acidic conditions, high numbers, alkaline.
<u>PL</u>	Public Law
<u>POTW</u>	Publicly Owned Treatment Works
<u>PTS</u>	Persistent Toxic Substance: Any toxic substance with a half-life in water of greater than eight weeks.
<u>PWQO</u>	Provincial Water Quality Objectives
<u>QCB</u>	Pentachlorobenzene
<u>RAP</u>	Remedial Action Plan
<u>RCRA</u>	Resource Conservation and Recovery Act

COURSE NAME

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**TERMINOLOGY**

<u>ABSORPTION</u>	Penetration of one substance into the body of another.
<u>ACCLIMATION</u>	Physiological and behavioural adjustments of an organism in response to a change in environment. See also Adaptation.
<u>ACCIMATIZATION</u>	Acclimation of a particular species over several generation in response to marked environmental changes.
<u>ACCUMULATION</u>	Storage and concentration of a chemical in tissue to an amount higher than intake of the chemical. May also apply to the storage and concentration of a chemical in aquatic sediments to levels above those that are present in the water column.
<u>ACUTE</u>	Involving a stimulus severe enough to rapidly induce a response; in bioassay tests, a response observed within 96 hours is typically considered an acute one.
<u>UTE TOXICITY</u>	Mortality that is produced within a short period of time, usually 24 to 96 hours.
<u>ADAPTATION</u>	Change in the structure forms or habits of an organism to better fit changed or existing environmental conditions. See also Acclimation.
<u>ADSORPTION</u>	The taking up of one substance at the surface of another.
<u>AEROBIC</u>	The condition associated with the presence of free oxygen in the environment.
<u>ALGA(E)</u>	Simple one celled or many celled micro-organisms, usually free floating, capable of carrying on photosynthesis in aquatic ecosystems.
<u>ALGICIDE</u>	A specific chemical highly toxic to algae. Algicides are often applied to water to control nuisance algal blooms.
<u>ALKALINITY</u>	A measurement of acid neutralization or buffering capability of a solution (See pH).
<u>AMBIENT</u>	Pertaining to the existing/surrounding environment and its components.

<u>COURSE NAME</u>	<u>COURSE NUMBER</u>
<u>BIOASSAY</u>	A determination of the concentration or dose of a given material necessary to affect a test organism under stated conditions.
<u>BIOCONCENTRATION</u>	The ability of an organism to concentrate substances within its body at concentrations greater than in its surrounding environment or food.
<u>BIOCONCENTRATION FACTOR</u>	The <u>ratio</u> of the measured residue within an organism compared to the residue of the substance in the ambient air, water or soil environment of the organism.
<u>BIOLOGICAL MAGNIFICATION</u>	The concentration of a chemical up the food chain.
<u>BIOMASS</u>	Total dry weight of all organisms in a given area or volume.
<u>BIOMONITORING</u>	The use of organisms to test the toxic effects of substances in effluent discharges as well as the chronic toxicity of low level pollutants in the ambient aquatic environment.
<u>BIOLOGICAL DIVERSITY</u>	Species of all the plants and animals occurring within a certain area or region.
<u>CARCINOGEN</u>	Cancer causing chemicals or substances.
<u>CHIRONOMID</u>	Any of a family of midges that lack piercing mouth parts.
<u>CHRONIC</u>	Involving a stimulus that lingers or continues for a long period of time, often one/tenth of the life span or more.
<u>CHRONIC TOXICITY</u>	Toxicity marked by a long duration, that produces an adverse effect on organisms. The end result of chronic toxicity can be death although the usual effects are sublethal; e.g. inhibits reproduction or growth. These effects are reflected by changes in the productivity and population structure of the community. See also Acute Toxicity.
<u>COMMUNITY</u>	Group of populations of plants and animals in a given place; ecological unit used in a broad sense to include groups of various sizes and degrees of integration.

<u>COURSE NAME</u>	<u>COURSE NUMBER</u>
<u>DENSITY</u>	Number of individuals in relation to the space.
<u>DETRITUS</u>	A product of disintegration, defecation, destruction, or wearing away.
<u>DIATOM</u>	Any of a class of minute planktonic unicellular or colonial algae with silicified skeletons.
<u>DIOXIN</u>	A group of approximately 75 chemicals of the chlorinated dibenzodioxin family, including 2, 3, 7, 8 - tetrachlorodibenzo-para-dioxin (2, 3, 7, 8 - TCDD) which is generally considered the most toxic form.
<u>DISSOLVED OXYGEN</u>	The amount of oxygen dissolved in water.
<u>DRAINAGE BASIN</u>	A waterway and the land area drained by it.
<u>DREDGE SPOILS</u>	The material removed from the river, lake, or harbor bottom during dredging operations.
<u>DREDGING GUIDELINES</u>	Procedural directions designed to minimize the adverse effects of shoreline and underwater excavation with primary emphasis on the concentrations of toxic materials within the dredge spoils.
<u>ECOSYSTEM</u>	The interacting complex of living organisms and their non-living environment; the biotic community and its abiotic environment.
<u>EFFLUENT</u>	Contaminated waters discharged from facilities to either wastewater sewers or to surface waters.
<u>ENVIRONMENT</u>	All the biotic and abiotic factors that actually affect an individual organism at any point in its life cycle.
<u>EPHEMERAL</u>	A plant that grows, flowers, and dies in a few days.
<u>EPHEMERA</u>	Invertebrates (mayflies) that live as adults only a very short time.
<u>EPILIMNION</u>	The warm, upper layer of water in a lake that occurs during summer stratification.

<u>COURSE NAME</u>	<u>COURSE NUMBER</u>
<u>GROUNDWATER</u>	Water entrained and flowing below the surface which may supply water to wells and springs.
<u>GUIDELINES</u>	Any suggestion or rule that guides or directs; i.e. suggested criteria for programs or effluent limitations.
<u>HALF-LIFE</u>	The period of time in which a substance loses half of its active characteristics (used specifically in radiological work); the amount of time required for the concentration of a pollutant to decrease to half of the original value through natural decay or decomposition.
<u>HAZARDOUS SUBSTANCES</u>	Chemicals considered to be a threat to man in the environment, including substances which (individually) or in combination with other substances) can cause death, disease (including cancer), behavioural abnormalities, genetic mutations, physiological malfunctions or physical deformities.
<u>HYDROLOGIC CYCLE</u>	The natural cycle of water on earth, including precipitation as rain and snow, runoff from land, storage in groundwaters, lakes, streams, and oceans, and evaporation and transpiration (from plants) into the atmosphere to complete the cycle.
<u>HYPOLIMNION</u>	The cold, dense, lower layer of water in a lake that occurs during summer stratification.
<u>ICHTHYOLOGY</u>	A branch of zoology that deals with fishes.
<u>INCIPIENT LC<sub>50</sub></u>	The level of the toxicant which is lethal for 50% of individuals exposed for periods sufficiently long that acute lethal action has ceased. Synonymous with lethal threshold concentration.
<u>INCIPIENT LETHAL LEVEL</u>	That concentration of a contaminant beyond which an organism could no longer survive for an indefinite period of time.
<u>INSECTICIDE</u>	Substances or a mixture of substances intended to prevent, destroy or repel insects.
<u>LACUSTRINE</u>	Formed in, or growing in lakes.

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NONPOINT SOURCE

Source of pollution in which pollutants are discharged over a widespread area or from a number of small inputs rather than from distinct, identifiable sources.

NUTRIENT

A chemical that is an essential raw material for the growth and development of organisms.

ORGANOCHLORINE

Chlorinated hydrocarbon pesticides.

PATHOGEN

A disease causing agent such as bacteria, viruses, and parasites.

PERIPHYTON

Organisms that live attached to underwater surfaces.

PERSISTENT TOXIC SUBSTANCES

Any toxic substance with a half-life in water and greater than eight weeks.

PESTICIDE

Any substance used to kill plants, insects, algae, fungi or other organisms; includes herbicides, insecticides, algicides, fungicides.

PHENOLICS

Any of a number of compounds with the basic structure of phenol but with substitutions made onto this structure. Phenolics are produced during the coking of coal, the distillation of wood, the operation of gas works and oil refineries, from human and animal wastes, and the microbiological decomposition of organic matter.

PHOTOSYNTHESIS

A process occurring in the cells of green plants and some micro-organisms in which solar energy is transformed into stored chemical energy.

PHYTOPHAGOUS

Feeding on plants.

PHYTOPLANKTON

Minute, microscopic aquatic vegetative life; plant portion of the plankton; the plant community in marine and freshwater situations which floats free in the water and contains many species of algae and diatoms.

POINT SOURCE

A source of pollution that is distinct and identifiable, such as an outfall pipe from an industrial plant.



<u>COURSE NAME</u>	<u>COURSE NUMBER</u>
<u>SELENIUM</u>	A nonmetallic element that chemically resembles sulfur and is obtained chiefly as a by-product in copper refining, and occurs in allotropic forms of which a gray stable form varies in electrical conductivity with the intensity of its illumination and is used in electronic devices.
<u>SESSILE</u>	An animal that is attached to an object or is fixed in place (e.g. barnacles).
<u>SIGMOID CURVE</u>	S-shaped curve (e.g. the logistic curve)
<u>SLUDGE</u>	The solids removed from waste treatment facilities.
<u>SOLUBILITY</u>	Capability of being dissolved.
<u>STABILITY</u>	Absence of fluctuations in population; ability to withstand perturbations without large changes in composition.
<u>STRATIFICATION</u>	(or layering) The tendency in deep lakes for distinct layers of water to form as a result of vertical change in temperature and therefore, in the density of water.
<u>SUBACUTE</u>	Involving a stimulus below the level that causes death.
<u>SUBCHRONIC</u>	Effects from short-term multiple dosage or exposure; usually means exposure for less than three months.
<u>SUB-LETHAL</u>	Involving a stimulus below the level that causes death.
<u>SUSPENDED SEDIMENTS</u>	Particulate matter suspended in water.
<u>SYNERGISM</u>	The joint action of two or more substances is greater than the sum of the action of each of the individual substances. The improvement in performance is achieved because two agents are working together. See also Antagonism.

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TROPHIC STATUS

A measure of the biological productivity in a body of water. Aquatic ecosystems are characterized as oligotrophic (low productivity), mesotrophic (medium productivity) or eutrophic (high productivity).

TUBIFICID

Of aquatic oligochaete or sludge worms which is tolerant to organically enriched waters.

TURBIDITY

Deficient in clarity of water.

WATER QUALITY OBJECTIVES

Under the Great Lakes Water Quality Agreement, goals set by the Governments of the United States Agreement, goals set by the Governments of the United States and Canada for protection of the uses of the Great Lakes.

WATER QUALITY STANDARD

A criterion or objective for a specific water use standard that is incorporated into enforceable regulations.

WIND SET-UP

A local rise in water levels caused by winds pushing water to one side of a lake. (See Seiche)

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COMMONLY USED TERMINOLOGY

Measurements & Units

mg/l	= milligram per litre	= part per million (ppm)
ug/l	= microgram per litre	= part per billion (ppb)
ng/l	= nanogram per litre	= part per trillion (ppt)
pg/l	= picograms per litre	= part per quadrillion (ppq)
mg/kg	= milligram per kilogram	= part per million (ppm)
ug/kg	= microgram per kilogram	= part per billion (ppb)
ng/kg	= nanogram per kilogram	= part per trillion (ppt)
L/d	= litre per day	
m <sup>3</sup> /d	= cubic metres per day	
kg/ann (kg/yr)	= kilograms per year	
t/ann (kg/yr)	= tonnes per year	
uS/cm	= microsiemens per centimetre (conductivity)	
mgd	= millions of gallons per day	
cfs	= cubic feet per second	