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BIO 129-4
COURSE NUMBER

Water Pollution
COURSE NAME

SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

WATER POLLUTION (Outline & Lab Manual)

COURSE TITLE:

CODE NO.: BIO 129-4

II, V

SEMESTER:

PROGRAM:

WATER RESOURCES/ENVIRONMENTAL ENGINEERING/
PULP & PAPER TECHNOLOGY

AUTHOR:

V. WALKER

DATE:

JANUARY 1993

PREVIOUS OUTLINE DATED:

JANUARY 1992

APPROVED:

DEAN

DATE

Jan 15/93

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PREREQUISITE: AQUATIC BIOLOGY 125-3

I. PHILOSOPHY/GOALS:

This is a course designed to provide an introduction to the biological effects of water pollution and to ways of detecting, describing and quantifying these effects in the field and the laboratory. Types and sources of pollution, sampling strategies and legislation governing water quality will be discussed.

II. STUDENT PERFORMANCE OBJECTIVES:

Upon successful completion of this course the student will be able to:

1. Define pollution and discuss its complexity in aquatic ecosystems.
2. Discuss the physical, biological and ecological relationships in lentic versus lotic environments.
3. List and discuss the water pollution categories and their impact on aquatic systems.
4. List and discuss the major sources of water pollution.
5. Outline the procedure for setting up a bioassay and discuss the determination of LC50's, ET50's and toxicity curves.
6. Discuss generally toxic substances and health effects in wildlife in the Great Lakes basin.
7. Describe the transition in macroinvertebrates, bacteria, algae and fish with increasing eutrophy.
8. Demonstrate the use of various biotic and diversity indices to assess water quality.
9. Discuss the objectives and testing procedure of the Public Health Lab in Sault Ste. Marie.
10. Discuss compliance monitoring and enforcement of environmental laws and regulations to protect water quality in Ontario.

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III. TOPICS TO BE COVERED:

WEEK

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

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WEEK

10	LAB 2	BIOASSAY
10,11	UNIT 5	BIOLOGICAL ASPECTS OF WATER POLLUTION <ul style="list-style-type: none"> - eutrophication - macroinvertebrates - bacteria - algae - fish - (Speaker: MOE)
12	LAB 3	STANDARD BACTERIAL PLATE COUNT AND BACTERIAL STAINING
12, 13	UNIT 6	STUDENT PRESENTATIONS
14	UNIT 7	SAMPLING FOR WATER QUALITY <ul style="list-style-type: none"> - (Speaker: St. Mary's Paper representative) - apparatus - sampling sites - sampling strategy - (Speaker: APHU) - index species (SCI, biotic, diversity, indices)
15	UNIT 8	LEGAL ASPECTS OF WATER POLLUTION <ul style="list-style-type: none"> - acts and legislation governing water quality - MOE speaker - (Video: Speaking Out - The Politics of Garbage) - (Video: Strike Force)
15	TERM TEST #3	

NOTE: Schedule subject to change

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IV. EVALUATION METHODS:

Oral Presentation:	10 marks	90% and over	- A+
Lab Reports:	40 marks,	80	- A
Term Tests (3):	50 marks	70	- B
		60	- C
	<u>100 marks</u>	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

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 AVAILABLE IN THE COLLEGE LIBRARY:

Adams, S. Marshall (ed.) 1990. Biological Indicators of Stress in Fish. American Fisheries Society Symposium 8. AFS. Bethesda, Maryland QL 639.1B55 1990

Alabaster, J.S. and R. Lloyd. 1982 Water Criteria for Freshwater Fish (2nd Edition). Butterworth's Inc., Yarmouth MA.

*American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1975, Standard Methods for the Examination of Water and Wastewater. 14th ed. Am. Publ. Health Assoc., Washington, D.C.

*American Society for Testing and Materials. 1977. Bacterial Indicators - Health Hazards Associated with Water. ASTM, Phil.

*American Society for Testing and Material. 1977. Aquatic Toxicology and Hazard Evaluation. ASTM, Philadelphia.

*Andrews, W. A. 1972. A Guide to the Study of Environmental Pollution. Prentice-Hall, Inc. Scarborough, Ontario.

Ashworth, W. 1989. The Late, Great Lakes: An Environmental History. Collins Publ., Stockton, California. QH 545.A1 A57 1989

Black, John A. 1977. Water Pollution Technology. Reston Publishing Company, Inc. Virginia.

Brewer, Richard. 1979. Principles of Ecology. Saunders, Philadelphia

Brown, Lester Russell. 1988. State of the World: A Worldwatch Institution Report on Progress Toward a Sustainable Society. W. W. Norton, New York

Burns, Noel M. 1985. Erie: The Lake that Survived. Rowman & Allanheld Pub., Totowa, N.J.

*Cairns, John Jr. 1982. Biological Monitoring in Water Pollution. Pergamon.

Cairns, V.W., Hodson, Peter V. and Nriagu, J.O. 1984. Contaminant Effects on Fisheries. John Wiley & Sons, New York.

Chant, D. A. 1970. Pollution Probe. New Press, Toronto.

Colborn, Theodora E. 1990. Great Lakes, Great Legacy? Conservation Foundation and Institute for Research on Public Policy in Canada. Halifax, N.S. TD 181.G73 G73 1990

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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

Freeman, 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 - 3

*Hoar, W.S., D.J. Randall and J.R. Brett (eds). 1979. Fish Physiology. Vol.8: Bioenergetics and Growth. Academic Press, Inc., London.

Hocutt, Charles H. and Jay R. Stauffer Jr. (eds). 1980. Biological Monitoring of Fish. Lexington Books, Lexington, Mass.

Huntley, R.V. and R.Z. Rivers (eds). 1986. Proceedings of the Acid Rain Evaluation Seminar. Dept. of Fisheries and Oceans, Ottawa.

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

_____. 1974. The Biology of Polluted Waters. University Toronto Press, Toronto.

Isom, Billy G., S.D. Dennis, J.M. Bates. 1986. Impact of Acid Rain and Deposition on Aquatic Biological System. ASTM, Philadelphia.

Johnson, Raymond E. 1982. Acid Rain/Fisheries: Proceedings of an International Symposium on Acidic Precipitation and Fishery Impacts in Northeastern North America, Cornell University, Ithaca, New York, August 2-5, 1981. American Fisheries Assoc., Bethesda, Md.

Kimball, John W. 1978. Biology. 4th Ed. Addison-Wesley, Don Mills, Toronto.

*Krenkel, P.A. and Parker, F.L. 1973. Nation Symposium on Thermal Pollution Proceedings: Biological Aspects of Thermal Pollution.

*Larkin, P.A. 1974. Freshwater Pollution Canadian Style. McGill-Queen's University Press, Montreal.

*Laws, Edward A. 1981. Aquatic Pollution - An Introductory Text. John Wiley and Sons, Toronto.

Mason, C. F. 1981. Biology of Freshwater Pollution. Longman.

McKane, L. and Kandel J., 1985. Micro-Biology Essentials and Applications. McGraw-Hill Book Co., Toronto.

*McNeely, R. N., V. P. Neimanis and L. Dwyer. 1979. Water Quality Sourcebook Guide to Water Quality Parameters. Environment Canada, Inland Waters Directorate, Water Quality Branch, Ottawa.

McPhee, John 1989. The Control of Nature. Strauss, Farrar and Giroux, N.Y.

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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 Publicaiton 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

Palmer, 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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ADDITIONAL RESOURCE MATERIAL - 5

Shubert, Elliot L. 1984. Algae as Ecological Indicators. Academic Press, San Diego, California. QK 565.A46 1984

*Smith, R. L. 1974. Ecology and Field Biology. Harper and Row Publishers, New York.

*Sprague, J. B. 1973. The ABC's of pollution bioassay using fish. Biological Methods for the Assessment of Water Quality, ASTM STP 528, American Society for Testing and Materials, 1973, pp. 6-30. (Reprint available)

Suffet, Irwin H. 1977. Fate of Pollutants in the Air and Water Environments. Wiley, New York.

Tinsley, Ian J. 1979. Chemical Concepts in Pollution Behaviour. Wiley Interscience, New York.

Tourbier, J. and R. W. Pierson, Jr. (eds.). 1976. Biological Control of Water Pollution. University of Pennsylvania Press, Inc., PA.

Tu, Anthony T. (ed). 1982. Survey of Contemporary Toxicology, Vol. 2. Wiley, New York.

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

Viessman, W.Jr. and M.J. Hammer. 1985 Water Supply and Pollution Control. Harper and Row, Publishers, New York.

Wagner R. H., 1971. Environment and Man. Norton, New York.

Warren, C. E. 1971. Biology and Water Pollution Control. Saunders, Philadelphia.

Wetzel, Robert G. 1983. Limnology (2nd Edition). Saunders. College Publishing, Toronto.

Wetzel, R. G., and G. E. Likens, 1979. Limnological Analyses. Saunders, Philadelphia.

*Wilber, Charles G. 1969. The Biological Aspects of Water Pollution. Charles C. Thomas. Illinois.

*Worf, D. L. 1980. Biological Monitoring for Environmental Effects. Lexington Books, San Diego, CA

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LAB SCHEDULE

- 1. Lab 1. Winter Lake Study
- 2. Lab 2. Bioassay
- 3. Lab 3. Standard Bacterial Plate Count/Bacterial Staining

*Subject to change

PRESENTATION TOPICS

Students are required to deliver a 20-minute oral presentation 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; Glyphosate; Hexazinone)
- 10. Detergents
- 11. Acid rain

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- 12. Mirex
- 13. Water-borne pathogens
- 14. Food Processing Wastes
- 15. Alkylated lead
- 16. Acid mine drainage
- 17. Hexachlorobenzene (HCB)
- 18. Zebra mussels
- 19. Polyanuclear aromatic hydrocarbons (PAHs)

NOTE: INCLUDE IN EACH PRESENTATION:

- 1. Description of the pollutant.
- 2. Sources of the pollutant (natural, man-caused).
- 3. The effect of the pollutant on the aquatic environment.
- 4. The water quality guidelines (standards) for the pollutant.
- 5. Any pertinent incidents* involving the pollutant.
- 6. Clean up/Controls (if applicable).

*Canadian incidents if possible

Each student is responsible for producing a typed abstract (summary) of information presented as well as a list of references used.

Copies of each presentation summary and reference list will be produced (by instructor) for all students, prior to each presentation.

REPORT WRITING

All lab reports should include the following components:

1. Purpose/Objective - a brief statement outlining the intent of the exercise. Objectives may be itemized, i.e.,
 - a) to determine LC_{50} for zinc using rainbow trout
 - b) to investigate the relationship between water temperature, pH, alkalinity and the toxicity of zinc to rainbow trout
2. Method/Procedure - a brief outline of how the exercise was conducted. In many instances "Refer to manual" will suffice.
3. 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.

Table 1 - Physical Characteristics of the Great Lakes

Lake	Area (km ²)	Area of Drainage Basin (km ²)	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

4. 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 use to generate data in tables must be shown in the Appendix.

5. Discussion of Results and Conclusions - results are interpreted and discussed. Carefully observe data to determine trends and relationships among all parameters measured.

Are apparent relationships consistent with established relationships present in literature? In this section, you are responsible for conducting a literature search to compare your findings with that of established authors.

Be sure to refer to your data using table and figure numbers - e.g., a direct linear relationship between white sucker weight and fork length is apparent in Figure 2. This relationship agrees well with that established for white sucker by J. A. Smith (1982), W. T. Jones (1974) and B. R. Brown (1971).

If your findings are not consistent with other studies or theories, offer some explanation for the deviation.

e.g., According to Saunders (1972), the principle component of lake trout stomach samples (n=785) in Round Lake prior to 1965 was lake herring (Coregonus artedii) at 72% by volume. Data from this study, however, indicates rainbow smelt (Osmerus mordax) as the dominant food item in 525 lake trout sampled, averaging 97% of stomach contents by volume (Figures 1 and 2). This change in forage species preference is attributed to the introduction of rainbow smelt in 1969 (Wilson, 1971).

All questions posed at the end of a lab exercise should be answered in this section.

N.B. There are several acceptable methods of citing references and referring to your data within the text of your report. Footnotes are not acceptable. Quotes are not acceptable.

N.B. Scientific names of species should appear in brackets only once after the first time the common name appears in the text.

In addition to interpreting and discussing, conclusions should be clearly stated, often itemized, at the end of this section.

6. Sources of Error - itemize all conceivable sources of error.

7. Appendix

- present calculations for all values appearing in tables.

8. Reference 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.

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.

REPORT MARKING - ONE REPORT SUBMITTED PER STUDENT

SECTION	MARK	MARKING BASED ON
1. Purpose	1	Conciseness; completeness
2. Method	1 (if applicable)	Conciseness; completeness
3. Results	2	Organization; labels, numbers on tables, figures; neatness; correctness
4. Calculations	1	Correctness, completeness
5. Discussion	4 or 5 if method not applicable	Conciseness; organiz- ation; reference material used and cited; complete- ness
6. Errors	1	Completeness
TOTAL		10
7. Appendix	minus 1 mark if absent or incorrect	
8. Reference	minus 1 mark if absent or incorrect	

N.B. Ten percent (10%) deducted per day for late reports.

GLASSWARE PREPARATION

For accuracy, glassware must be properly cleaned of all impurities prior to conducting lab exercises.

1. Wash all glassware needed in warm soapy water. Use brushes if necessary.
2. Rinse glassware 3 times under tap water.
3. Rinse glassware well with distilled water 3 times.
4. Place glassware upside down on paper towel to drain.

N.B. Ten percent (10%) deducted per day for late reports.

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 ³ /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		

Acronyms

- AOC Area of Concern: An area recognized by the International Joint Commission where water uses are impaired or where objectives of the Great Lakes Water Quality Agreement or local environmental standards are not being achieved.
- BOD Biochemical Oxygen Demand: The amount of dissolved oxygen required for the bacterial decomposition of organic waste in water.
- COA Canada-Ontario Agreement
- COD Chemical Oxygen Demand: The amount of oxygen required to oxidize completely by chemical reagents the oxidizable compounds present.
- CSO Combined Sewer Overflow
- DDT Dichlorodiphenyltrichloroethane: A widely used, very persistent pesticide (now banned from production and use in many countries) in the chlorinated hydrocarbon group.

- GLISP Great Lakes International Surveillance Plan
- IJC 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.
- LC₅₀ That concentration of a toxicant or effluent which is lethal to 50% of the test organism over a specified time period.
- LD₅₀ That dose which is lethal to 50% of the test organism over a specified time period.
- MDNR Michigan Department of Natural Resources
- MISA Municipal-Industrial Strategy for Abatement: The principal goal of this program is to clean up Ontario's waterways. It represents a new approach to controlling point source water pollution. MISA will control and reduce the amount of toxic contaminants in all industrial and municipal effluents discharged into Ontario's surface waters. The ultimate goal of MISA is the virtual elimination of toxic contaminants from all municipal and industrial discharges into the province's waterways.
- NOAA National Oceanic and Atmospheric Administration
- OMNR Ontario Ministry of Natural Resources
- OMOE Ontario Ministry of the Environment
- PAH Polynuclear aromatic hydrocarbons
- PTS Persistent Toxic Substance: Any toxic substance with a half-life in water of greater than eight weeks.
- RAP Remedial Action Plan: This is a plan to be developed with citizen involvement to restore and protect water quality of the Great Lakes. There are 42 Areas of Concern in the Great Lakes Basin which will develop a RAP.

UGLCCS Upper Great Lakes Connecting Channels Study
U.S. EPA United States Environmental Protection Agency
STP/WPCP Sewage Treatment Plant/Water Pollution Control Plant.
WWTP Waste Water Treatment Plan

OTHER TERMINOLOGY

ALGA (ALGAE) - Simple one-celled or many-celled micro-organisms capable of carrying on photosynthesis in aquatic ecosystems.

ANOXIA The absence of oxygen necessary for sustaining most life. In aquatic ecosystems this refers to the absence of dissolved oxygen in water.

AMBIENT WATER The water column or surface water as opposed to groundwaters or sediments.

BENTHIC/BENTHOS Bugs which live in and on the bottom of the river.

BIOMASS Total dry weight of all living organisms in a given area.

BIOMONITORING The use of organisms to test the acute toxicity of substances in effluent discharges as well as the chronic toxicity of low-level pollutants in the ambient aquatic environment.

CARCINOGEN Cancer-causing chemicals, substances or radiation.

DISSOLVED OXYGEN The amount of oxygen dissolved in water. See BIOCHEMICAL OXYGEN DEMAND.

DRAINAGE BASIN A waterway and the land area drained by it.

ECOSYSTEM The interacting complex of living organisms and their non-living environment.

EFFLUENT Wastewaters discharged from industrial or municipal sewage treatment plants.

EPILIMNION The warm, upper layer of water in a lake that occurs with summer stratification.

EROSION The wearing away and transportation of soils, rocks and dissolved minerals from the land surface or along shorelines by rainfall, running water, or wave and current action.

EUTROPHICATION The process of fertilization that causes high productivity and biomass in an aquatic ecosystem. Eutrophication can be a natural process or it can be a cultural process accelerated by an increase of nutrient loading to a lake by human activity.

EXOTIC SPECIES Species that are not native to the Great Lakes and have been intentionally introduced or have inadvertently infiltrated the system.

FOODCHAIN The process by which organisms in higher trophic levels gain energy by consuming organisms at lower trophic levels.

GREAT LAKES WATER QUALITY AGREEMENT A joint agreement between Canada and the United States which commits the two countries to develop and implement and plan to restore and maintain the many desirable uses of the waters in the Great Lakes Basin.

GROUNDWATER Water entrained and flowing below the surface which is the supply of water to wells and springs.

HALF-LIFE The amount of time required for the concentration of a pollutant to decrease to half of the original value.

HYDROLOGIC CYCLE The natural cycle of water on earth, including precipitation as rain and snow, runoff from land, storage in lakes, streams, and oceans, and evaporation and transpiration (from plants) into the atmosphere.

HYPOLIMNION The cold, dense, lower layer of water in a lake that occurs with summer stratification.

LEACHATE Materials suspended or dissolved in water and other liquids usually from waste sites that percolate through soils and rock layers.

MASS BALANCE An approach to evaluating the sources, transport and fate of contaminants entering a water system as well as their effects on water quality. In a mass balance budget, the amounts of a contaminant entering the system less the quantity stored, transformed or degraded must equal the amount leaving the system. If inputs exceed outputs, pollutants are accumulating and contaminant levels are rising. Once a mass balance budget has been established for a pollutant of concern, the long-term effects on water quality can be simulated by mathematical modelling and priorities can be set for research and remedial action.

NON-POINT 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.

PCBs Polychlorinated biphenyls - A class of persistent organic chemicals that bioaccumulate.

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

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

PHYTOPLANKTON Minute, microscopic aquatic vegetative life.

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

PUBLIC Any person, group, or organization.

RESUSPENSION (Of sediment) The remixing of sediment particles and pollutants back into the water by storms, currents, organisms and human activities such as dredging.

SEDIMENT The fines or soils on the bottom of the river.

SEICHE An oscillation in water level from one end of a lake to another due to rapid changes in winds and atmospheric pressure. Most dramatic after an intense but local weather disturbance passes over one end of a large lake.

STRATIFICATION (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.

THERMOCLINE A layer of water in deep lakes separating cool hypolimnion (lower layer) from the warm epilimnion (surface layer).

TOXIC SUBSTANCE As defined in the Great Lakes Agreement, any substance that adversely affects the health or well being of any living organism.

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).

WIND SET-UP A local rise in water levels caused by winds pushing water to one side of a lake.

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JUL 18 1983
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ppm? ppb? ppt?

What's That In English?

"Parts per million", "parts per billion", and even "parts per trillion" have gradually worked their way into commonly accepted usage as expressions of air and water pollutant measurements. But who, other than the experts, really knows what these terms mean? What are the terms of reference? How small is small?

Research chemists recently undertook the challenge of delineating some readily understandable terms of reference. The assignment clearly sparked the group's collective imagination, as the list of comparisons they produced shows.

One part per million:

- = one inch in 16 miles;
- = one minute in two years;
- = one ounce in 31 tons of potato chips;
- = one bad apple in 2,000 barrels.

One part per billion:

- = one inch in 16,000 miles;
- = one second in 32 years;
- = a pinch of salt in 10 tons of potato chips;
- = one bad apple in 2 million barrels.

One part per trillion:

- = one hairsbreadth (blond specified) in a trip around the world;
- = one second in 320 centuries;
- = a pinch of salt in 10,000 tons of potato chips;
- = a drop of vermouth in 250,000 hogsheads of gin; or, getting even more specific;
- = one flea in 360 million elephants.

At what point are chemicals perceived? Table salt in water becomes somewhat unpalatable at one part per thousand; swimmers can detect chlorine in a pool at one part per million; and sensitive noses can detect the odour of fuel oil at one part per billion. One part per trillion of anything is not detectable without the use of advanced and costly analytical equipment.

