ZERO DISCHARGE

A Strategy for the Regulation of Toxic Substances in the Great Lakes Ecosystem

Canadian Environmental Law Association

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ABBREVIATIONS

ADI	-	acceptable daily intake
BACT	-	best available control technology
BATEA	-	best available control technology economically achievable
CELRF	-	Canadian Environmental Law Research Foundation
EDF	-	Environmental Defense Fund
EPA	-	U.S. Environmental Protection Agency
GLWQA	-	Great Lakes Water Quality Agreement of 1978
IJC	-	International Joint Commission
MISA	-	Municipal-Industrial Strategy for Abatement (Ontario)
NPDES	-	National Pollution Discharge Elimination System
OECD	-	Organisation for Economic Cooperation and Development
PPT	-	parts per trillion
RAP	-	Remedial Action Plan
GLTSCA	-	Great Lakes Toxic Substances Control Agreement
UG/1	-	micrograms per litre
WQS	-	Water Quality Standards under the U.S. Clean Water Act

Chapter 1 - Introduction

1.1 Toxic Contamination and the Great Lakes Basin

The Great Lakes basin is one of the most important natural resources in North America. Some 35 million people live within the Great Lakes basin, representing over one-quarter of the Canadian population and one-tenth of the United States population. The basin accounts for some 7 percent of U.S. agricultural production and nearly 25 percent of Canadian agricultural production. In addition, the waters of the basin serve a variety of competing uses, ranging from industrial processing to shipping, recreational and commercial fishing, to drinking water.[1]

While the lakes have been a major source of prosperity for the region, these competing uses have also created a history of environmental challenges. At the turn of the century, there was a threat from the transmission of cholera and other water-borne diseases as a result of poor sanitation. By the 1950s, there was a serious decline in commercial fishing because of decimation of valuable species and changing populations of species from over-exploitation, increasing exotic species like the lamprey, degradation of spawning habitat, and pollution from municipal, industrial, and shipping discharges.[2]

By the 1960s, eutrophication resulting from phosphates in detergents and human wastes entering the lakes, loss of wetlands, various problems arising from shoreline developments, dredging for navigation, and fluctuating water levels alerted authorities to the fragile nature of the Great Lakes and prompted international responses. A reference to the International Joint Commission in 1964 led eventually to the conclusion of the 1972 Great Lakes Water Quality Agreement between Canada and the United States[3] that, among other things, called for the cooperative development of programs to control nutrient inputs to the lakes.

While problems with conventional pollutants remain, the last decade has witnessed the rise of another stress that has proved difficult to understand, complex to research, and complicated to control - that of toxic contamination.

Since the so-called chemical revolution beginning with World War II, there has been an explosion in the number and volume of chemicals produced. Estimates suggest there are well over 60,000 chemicals in commercial use in North America. By the time those chemicals are combined, the number of chemical species is probably over 200,000. Some 1500 to 2000 new chemicals are introduced into the world market each year. Of these, an estimated 500-1000 are toxic.[4]

Toxic chemicals have been regulated for more than 15 years in both Canada and the United States. During that time, many serious hazards have been addressed and risks reduced. However, there are now signs that suggest that toxic contaminants continue to threaten the well-being of the basin and its inhabitants. They are much more difficult to control than was thought. Because of a critical lack of data, it is impossible to point to trends in the inputs of more than a handful of the chemicals of concern in the basin. It seems clear, however, that toxic contamination in the basin is not improving overall: there are more and more chemicals being produced about which there is little or no substantial information. There are serious impacts (such as fish tumours), being documented in the basin and there remain 42 "areas of concern" throughout the basin (see Figure 1.3).[5]

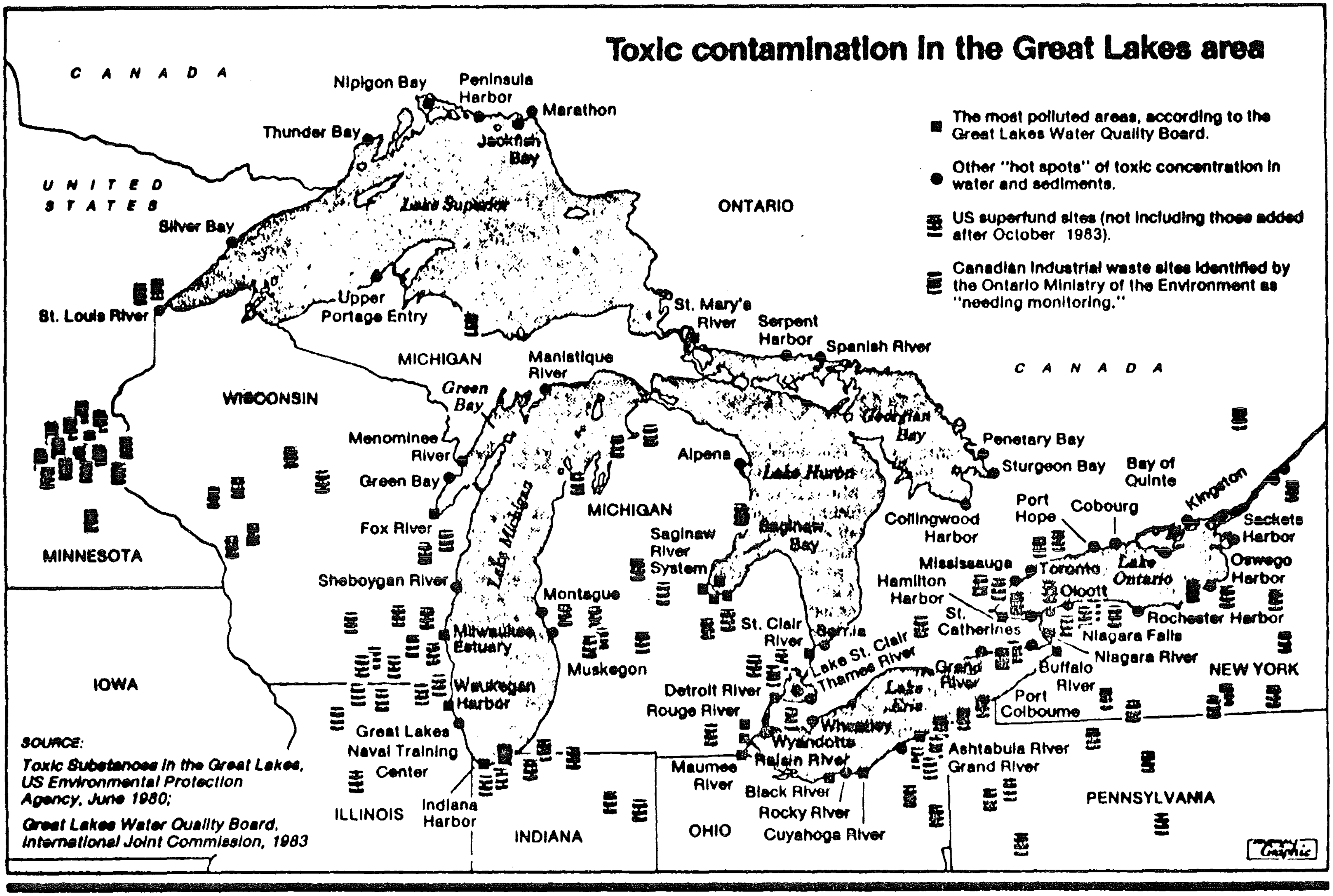
The long-term solution to the problem has been agreed upon by all basin governments in international accords and supported by groups and individuals within the basin. The agreed solution is to treat the basin as an ecosystem, to work cooperatively to preserve the health of the entire ecosystem, and to take a preventive approach to the toxic chemical problem. This holistic preventive approach is best expressed in the goal of "virtual elimination" of inputs of persistent toxic substances into the basin. Such a solution, which found early expression in the 1978 Great Lakes Water Quality Agreement, is reaffirmed in the 1987 amendments to that agreement.[6]

Despite the expenditure of considerable effort and resources, the goal has not been attained. It has not and will not be attained easily because the regulatory frameworks at the international, national, and state/provincial levels are not designed to make it possible. Rather, these frameworks are largely reactive, uncoordinated, limited in scope, and have not been modified so as to achieve the goals of the 1978 Great Lakes Water Quality Agreement. Thus, despite agreement on objectives, no basin-wide regulatory strategy to deal with the problems of toxic contamination has been developed or implemented.

1.2 Purpose of the Report

The purpose of this report is to explore the principles and elements of a preventive and comprehensive regulatory strategy that would ensure real improvements in the health of the Great Lakes ecosystem. More specifically, this regulatory strategy seeks to realize the basin-wide goal of virtual elimination of persistent toxic substances. The report examines whether existing regulation can be used to attain the goal of virtual elimination and if not, how to improve the existing system in order to do so. It then recommends a number of principles that form the framework of a regulatory strategy to implement the objectives of the Great Lakes Water Quality Agreement.

FIGURE 1.3



Credit: Toxic Substances in the Great Lakes, US Environmental Protection Agency, 1980.

The development of this regulatory strategy is intended to give regulators, environmental managers, and other professionals in the field - in both the U.S. and Canada - some guidance for reform. Many of the details of reform are of necessity left to each jurisdiction to develop, in keeping with its own regulatory framework. The strategy may also be of assistance to others who want to use these principles as primary criteria for assessing law-reform initiatives.

1.3 Scope

Although the study attempts to take a broad look at regulation, the study of all the laws of 12 Great Lakes jurisdictions makes that an enormous task. Hence, the focus of the study has been narrowed in a number of ways. First, the study is limited to the "approvals process," which is defined in this report as the processes involved in the formulation of environmental protection standards [the standard-setting process] and the issuance of permits for the discharge of pollutants into the basin [the permit-issuing process]. It was felt that because the approvals process is the step in regulation at which broad policy goals (e.g., protection of health) are translated into everyday practice, it was the stage where reform could make the most difference.

Second, in examining the approvals processes, this study examined regulatory approaches, assumptions, and frameworks. It does not purport to provide a detailed analysis of the particular administrative practices implementing the approvals processes in each jurisdiction - or compliance rates or trends of those processes.

Although the focus of the study is on the approvals process, other regulatory processes were reviewed and discussed where particularly relevant, such as non-point source-control programs, and remediation, rehabilitation, and liability programs. Further, even though the report examines the Great Lakes situation in regard to persistent toxic substances, the principles proposed in the report have broader application for other jurisdictions and, in varying degrees, for all toxic substances.

1.4 Methodology

This study began in 1986 and is composed of three distinct, yet interrelated, components:

a. The Research Component

This study is part of a long-term program of the Canadian Environmental Law Research Foundation (CELRF) that looks at the problems associated with toxic substances in the environment through an integrated, ecosystem perspective. One of the first major results of this program was a book entitled The Regulation of Toxic and Oxidant Air Pollution in North America[7], which addresses the transboundary and cross-media movements of toxic air pollution in the Great Lakes, among other issues. Its conclusions include the need to address air-pollution regulation in the cross-media, ecosystem perspective of the 1978 Great Lakes Water Quality Agreement.

Subsequently, CELRF published another book that examined the extent to which governments, groups, and individuals of one Great Lakes basin jurisdiction could participate in the courts and environmental decision-making processes (such as assessments, permit-issuing, or standard-setting) of other basin jurisdictions to prevent or control further pollution. This publication, Cross-Border Litigation: Environmental Rights in the Great Lakes Ecosystem[8], put forth the view that, because the activities in one jurisdiction affect the health and environment in other jurisdictions, existing barriers to cross-border litigation ought to be removed. One way to achieve this goal would be through the adoption of a model law in each basin jurisdiction - the "Ecosystem Rights Act."

The present study builds upon these initiatives through an examination of the environmental regulatory frameworks within the Great Lakes basin. The next CELRF study proposes to explore more specifically how to implement and translate into practice the recommendations of this report.

In addition to the case study and consultation components described below, basic research for the study was developed through literature reviews, interviews, and correspondence with literally dozens of scientists, academics, lawyers, environmental groups, industrialists, environmental administrators, and regulators throughout the basin area.

b. The Case Study Component

One of the primary research tools employed in the development of the recommendations in the report is the case study[9]. The case study examines the regulatory regimes of each basin jurisdiction for four toxic chemicals in order to understand the similarities, disparities, and inconsistencies of regulatory approaches to the control of these chemicals within the basin. The four chemicals used in the case study - dieldrin, hexachlorobenzene, hexavalent chromium, and lead - have been known and troublesome-to-control pollutants throughout the basin for a considerable time.

The approach used in the case study was to explore and compare the standard-setting processes in each basin jurisdiction for each chemical for all media: air, water, and land. Once this analysis was completed, the standards of each basin jurisdiction were compared with one another for each medium. The specific results of the case study are discussed throughout this report.

c. The Consultation Component

With the general research component under way, a discussion paper entitled Ecosystem Regulation and the Approvals Process: Implementing an Ecosystem Approach in the Great Lakes Basin[10] was drafted. This document, which contained preliminary analysis of the case study, was then used as the basis for discussion at a series of workshops that were convened in each of the jurisdictions within the basin. Participants in each workshop included representatives of the host environmental agency, local environmental groups, and often other researchers with an interest in the field.

The 12 workshops served to provide feedback on the recommendations proposed, to identify barriers to their implementation, and to relate experiences with their regulatory strategies concerning the control of toxic chemicals. An itinerary of the locations and dates for the meetings is provided in appendix A.

1.5 Summary of Findings and Recommendations

The recommendations contained in the report are directed to both the policy and, to the extent possible, the operational levels. The general thrust of these findings and recommendations may be summarized as follows:

a. Toxic chemical pollution continues to pose a serious threat to the Great Lakes basin ecosystem.

b. Despite sharing the common goal of virtual elimination, the current array of environmental protection laws within the basin fail to bring about this goal because these laws are not designed to bring about an absolute reduction of persistent toxic chemicals entering the environment.

c. In order to achieve accepted basin goals, regulatory frameworks must be reformed:

i. to be more comprehensive by better addressing and taking into account the inter-media transfers of toxic pollutants;

ii. to reduce the use and discharge of these pollutants at their source;

iii. to move away from concentration-based standards toward standards with targets for reducing the total amounts of pollutants entering the system; and

iv. to promote inter-jurisdictional cooperation and coordination of efforts.

The next chapter reviews in more detail the problem of toxic contamination in the Great Lakes basin. Chapter 3 then outlines the regulatory challenges and recommended responses to those problems. These responses are in the nature of a set of regulatory principles to guide regulators, environmental managers, and the legal community in their efforts to implement the objectives of the Great Lakes Water Quality Agreement. The four primary principles pertaining to the approvals process - which are cross-media, source reduction, load reduction, and ecosystem approach - are addressed in the next four chapters (4-7). Finally, chapter 8 summarizes the recommendations.

Chapter 2 - Persistent Toxic Substances in the Great Lakes Basin

2.1 Introduction

Although the thrust of this report addresses how regulatory strategies can best control risks from toxic substances, it also is useful to consider the nature of these substances. An understanding of their nature and the extent of the problem in the basin is essential to allow a meaningful assessment of the strategies to be made and appropriate reforms to be suggested.

This chapter examines the nature and the salient characteristics of toxic chemicals of concern in the Great Lakes basin, their sources and pathways, and an overview of the current understanding about the environmental and human-health impacts of toxic chemicals in the basin.

2.2 The Nature of Toxic Substances

An understanding of the problem of toxic substances begins with an understanding of the concept of "toxicity," followed by a discussion of the most pertinent characteristics of these chemicals: their cycling through the environment, their persistence, and their bio-accumulative nature.

2.2.1 The meaning of "toxicity"

There is no single definition of toxicity that is accepted in all disciplines. Toxicity can be defined as the ability of a chemical substance to cause an adverse effect in a living organism. This definition includes the range of effects from short-term, reversible irritation to irreversible, debilitating conditions, such as cancer and death. Obviously, chemicals that are likely to be present at levels known to cause or contribute to irreversible effects are of most concern. Yet, because an understanding of the mechanisms of toxicity is far from complete, all toxic chemicals deserve attention and study.

The toxic effect likely to occur on exposure is related to the inherent toxicity of the chemical, how the chemical works on the exposed organism, the dose to which the organism is exposed, and the organism's sensitivity to the toxic effect. For people, exposure to toxic chemicals can be through the ambient environment, by inhalation or skin exposure outdoors or indoors at work or home, or by ingestion of food, water, or drugs containing contaminants. Even though many chemicals can produce toxic effects at relatively high doses, environmental exposure is generally associated with very low doses. Some chemicals are toxic at these very low levels while others can build up in the environment to toxic levels. In addition, the effect of long-term exposure to low levels of substances known to have acute effects is simply unknown.

2.2.2 Cycling

Different forms of matter and energy move through different components of the environment; this is known as "cycling." Pollutants also cycle through the environment. Pollutants emitted into the air may be deposited on land or in waters; substances on land or in soil can leach out or be released by erosion and end up in water or they can evaporate into the air, while many substances in water can evaporate into the air as well. This activity occurs because the components of the physical environment - air, water and land - are interdependent and because the nature of the particular substances allows them to be mobile. The narrow view of "air pollution" and "water pollution," therefore, is meaningless in many situations because the overall environmental risks of pollutants must be considered.

The cycling of toxic chemicals is evident in the Great Lakes basin. Although the lower lakes of Michigan, Erie, and Ontario are usually considered more polluted than the upper lakes, because of cycling and non-point source contributions, all the lakes are affected by toxic contaminants. For example, it has been estimated that 87 percent of the lead, 68 percent of the chromium, and 80 percent of the PCBs entering Lake Superior every year are deposited from the air.[1] Erosion and run-off contribute a significant amount of pesticides and heavy metals to the lakes. Perhaps, though, the best-known example of Great Lakes cycling is the contamination of the Niagara River through the leaching of dioxins and other toxic substances from waste-disposal sites into groundwater and eventually into the river.

2.2.3 Persistence

The ability of some substances to build up to toxic levels relates to their "persistence," their resistance to breakdown by physical, chemical, or metabolic processes. Persistent substances include elements (substances that cannot be broken down any further by environmental processes) and complex, stable organic compounds, such as PCBs. Other examples of persistent toxic substances are listed in table 2.1. Once discharged into the environment, persistent toxic substances can accumulate for a relatively long period of time. If discharged into water, for example, they can build up in sediments, where they remain until disturbed by bottom-feeding organisms or by dredging activities.

Persistence may also refer to immobility of a chemical in one part of the environment, such as lead in sediments. A substance that is resistant to breakdown in

TABLE 2.1.1

CHEMICALS FOUND IN THE GREAT LAKES WITH KNOWN EFFECTS IN MAMMALS THAT ARE CURRENTLY SUBJECTED TO REGULATORY MONITORING*

CHEMICAL NAME	CAS NO.	MONITORING PROGRAM**			
PESTICIDES					
Aldrin	309-00-2	DW	F	WQO	
Chlordane (total isomers)	57-74-9	DW	F	WQO	
2,4-Dichlorophenoxyacetic acid(2,4-D)	94-75-7	DW			
DDT (DDE, 72-55-9 and DDD, 75-54-8)	50-29-3	DW	F	WQO	
Diazinon	333-41-5	DW			
Dieldrin	60-57-1	DW	F	WQO	
Endrin	72-20-8	DW	F	WQO	
Heptachlor	76-44-8	DW		WQO	
Heptachlor epoxide	1024-57-3	DW		WQO	
Lindane (γ-hexachlorocyclohexane)	58-89-9	DW		WQO	
Methoxychlor	72-43-5	DW		WQO	
Mirex (and photomirex, 39801-14-4)	2385-85-5		F	WQO	
Silvex	93-72-1	DW			
Toxaphene	8001-35-2	DW	F	WQO	
HALOGENATED HYDROCARBONS					
Polychlorinated biphenyls	1336-36-3		F	WQO	
Trihalomethane (chloroform)	67-66-03	DW			
(bromoform)	75-25-2				
(bromodichloromethane)	75-27-4				
(chlorodibromomethane)	124-48-1				
(iododichloromethane)	594-04-7				
ELEMENTS					
Arsenic	7440-38-2	DW	F	WQO	
Cadium	7440-43-9	DW		WQO	
Chromium	7440-47-3	DW		WQO	
Lead	7439-92-1	DW		WQO	
Mercury (methyl)	115-09-3	DW	F	WQO	
Selenium	7782-49-2			WQO	WQO-P
Silver	7440-22-4	DW			WQO-P
ETHERS					
2,3,7,8-Tetrachlorodibenzodioxin	1746-01-6		F		

* Monitoring based on concern for human health.

** DW - United States or Canadian drinking water guideline or standard
F - Guideline for acceptable levels in fish (health protection)
WQO - Water Quality Objective in Annex 1 of the 1978 Great Lakes Water Quality Agreement
WQO-P - Water Quality Objective proposed by the Aquatic Ecosystems Objectives Committee, IJC Science Advisory Board

Source: Committee on the Assessment of Human Health Effects of Great Lakes Water Quality 1982 Annual Report to Great Lakes Water Quality Board/Great Lakes Science Advisory Board (Windsor, 1982), at p. 36.

CHEMICALS FOUND IN THE GREAT LAKES WITH THE POTENTIAL TO IMPACT ON HEALTH THAT ARE NOT CURRENTLY SUBJECT TO REGULATORY MONITORING BUT FOR WHICH SURVEILLANCE SHOULD BE CONSIDERED* -1982

TABLE 2.1.2

CHEMICAL NAME	CAS NO.	SURVEILLANCE RECOMMENDED** WATER	FISH	AIR
PESTICIDES				
Endosulfan (thiosulfan)	115-29-7	NS	WL	
Hexachlorobenzene	118-74-1		WL	
Oxychlordane+	26880-48-8	NS	WL	
Pentachlorophenol	87-86-5	NS	WL;NS	
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	93-76-5	NS	WL	
HALOGENATED HYDROCARBONS				
Carbon tetrachloride	56-23-5	ID;NS	WL	
1,2-Dichloroethane	107-06-2	ID;NS	WL	A
1,2-Dibromoethane	106-93-4		WL	A
Hexachloroethane	67-72-1	NS	WL	
1,2-Dichloroethylene	540-59-0	ID;NS		
Trichloroethylene	79-01-6	NS	WL	
Tetrachloroethylene	127-18-4	ID	WL	
Vinyl chloride	75-01-4	ID	WL	A
Vinyl bromide	593-60-2	ID	WL	A
3-Chloro-1-propene	107-05-1	ID		
2,3-Dichlorobutadiene	1653-19-6	ID;NS	WL	
Hexachlorobutadiene	87-68-3	NS	WL	
Dichlorobenzene (1,2-)	95-50-1	NS	WL	
(1,3-)	541-73-1			
(1,4-)	106-46-1			
a-Hexachlorocyclohexane	319-84-6		WL	
Chlorinated naphthalenes		NS	WL	
Brominated biphenyls		NS	WL	
Chlorinated terphenyls		NS	WL	
AROMATIC HYDROCARBONS				
Ethylbenzene	100-41-4	NS		
Styrene	100-42-5	NS	WL	
Benzo(a)pyrene	50-32-8	NS	WL	A
Chrysene	218-01-9	NS	WL	A
Dibenz(a,h)anthracene	53-70-3	NS	WL	A
Benzo(b)fluoranthene	205-99-2	NS	WL	A
Benzo(j)fluoranthene	205-82-3	NS	WL	A
PHENOLS				
Cresol+ (o,m,p)	1319-77-3	ID,NS		
Trichlorophenol+ (2,4,5-)	95-95-4	NS	WL	
(2,4,6-)	88-06-2			
ETHERS				
Dioxane	123-91-1	ID;NS	WL;NS	
ACIDS AND ESTERS				
Phthalic acid, diisobutyl ester	84-69-5		WL	
Phthalic acid, di(2-ethylhexyl) ester	117-81-7		WL	
MISCELLANEOUS				
Aniline	62-53-3	ID		
Azobenzene	103-33-3	ID		
3,3'-Dichlorobenzidine	91-94-1	ID		
ELEMENTS				
Nickel	7440-02-0	ID		A,ID

* 'Potential to impact on health' based on all available data on toxicity, use and environmental levels.

** ID - industrial discharges
WL - whole lake
NS - Near shore
A - Ambient

+ covered under parent compound in some jurisdictional guidelines.

Source: Committee on the Assessment of Human Health Effects of Great Lakes Water Quality 1982 Annual Report to Great Lakes Water Quality Board/Great Lakes Science Advisory Board (Windsor, 1982), at p. 39.

one component of the environment but not in another, where it would readily be decomposed, must still be considered persistent. Relative persistence is measured by comparing the "half-lives" of substances in the environment. The longer it takes for a substance to be removed from the environment through chemical reactions or metabolic actions, the more persistent it is.

The Great Lakes are particularly susceptible to the presence of persistent toxic substances because of physical factors such as the long time it takes for waters to be "flushed" through the system. The long retention times result because the outflows from the Great Lakes are small (less than 1 percent per year) relative to the total volume of water. Lake Superior, for instance, has a retention time of some 200 years. Thus, pollutants that enter the lakes are retained in the system and become more concentrated with time. In addition, the low sediment load in most of the lakes means that these accumulating contaminants remain in the water or unburied at the bottom, increasing the opportunity for exposure by fish and other organisms.[2]

2.2.4 Bio-accumulation

Toxic substances can also build up in the biological component of the environment through a mechanism known as bio-accumulation. For substances that are more readily soluble in fat than in water, ingestion can result in the substance accumulating in an exposed organism's fatty tissues. When this organism is then consumed by a predator, which also consumes other such organisms, the concentration is magnified, so that at the top of the food chain, concentrations in tissues can be several orders of magnitude greater than the concentration in water. Bio-accumulation is known to occur for many complex organic compounds including DDT, PCBs, dioxins, and methylated mercury, among others.

2.3 Sources and Pathways of Toxic Substances

Entry into the environment of toxic substances can be from an identified "point" source or from a large number of small dispersed sources. The major source types have been summarized as follows:

a. Industrial processing: This large category includes manufacturing, metal refining, processing and plating, petroleum refining, the related petrochemical and plastics industries, and pulp-and-paper production. Toxic substances associated with these sources include volatile organic compounds, solvents, and metals. They can be intentionally discharged to the environment in effluent or stack emissions, or unintentionally released as "fugitive" emissions through process leaks, storage, or spills of chemicals. Effluents can be discharged to a water body directly or through a sewer system and sewage treatment plants. The latter contribute a large share of toxic pollution to surface waters because sewage treatment is not generally effective in removing toxic substances.

The Great Lakes basin contains about 50 percent of Canadian and 20 percent of American industrial activities.[3] Industrial discharges have been identified as sources of toxic contaminants and conventional pollutants in 30 of the 42 "areas of concern" identified by the International Joint Commission.[4]

b. Fuel combustion: Fossil fuel combustion by stationary power generation plants and by transportation is a significant source of toxic substances in the atmosphere that eventually are deposited into water and land.[5] These power plants and transportation sources contribute both the well-known acid-gas emissions plus trace concentrations of metals and organic chemicals that are constituents of the fuel or are created during combustion.

c. Waste disposal: Waste-disposal practices for municipal solid waste and industrial waste can contribute toxic substances to the environment in a number of ways. When wastes are landfilled, leachate containing toxic substances forms from infiltrating water and can end up in ground and/or surface water. Landfills are also a source of atmospheric emissions. Deep-well disposal of liquid wastes may not be ecologically secure, allowing toxic substances to migrate into groundwater formations and thence into surface waters.[6] Incineration of wastes can release toxic metals into the air and, if combustion is inefficient, can lead to the formation of toxic compounds from the chemical constituents in the waste.[7] Finally, volatile organic chemicals and other substances can evaporate from settling ponds and waste storage and handling facilities. Once in the air, these pollutants can then be deposited into surface waters and on to land.

Municipal treatment plants in the basin have been found to be major sources of PCBs, trihalomethanes (resulting from chlorination), and metals. One study of Great Lakes basin water showed that chlorinated water was 2-10 times more mutagenic than raw lake water because of the formation of trihalomethanes during chlorination.[8]

In addition, combined sewer overflows contribute toxic chemicals from urban run-off. In the basin, these are a significant source of pollution in 19 of the 42 areas of concern. Most industrial and municipal treatment of waste-waters results in sludge that is ultimately disposed of on land or incinerated. If disposed of on land, the leachate from the sludge can contaminate both surface waters and groundwater in the area. Inefficient incineration contributes to toxic air pollution.

d. Non-point agricultural and urban sources: The use of pesticides can contribute toxic substances to a broader area of the environment than was intended. Aerial spraying practices result in the dispersion of pesticides through the atmosphere, while run-off, erosion, and leaching cause the residue to enter both the air and water.[9] Run-off and erosion of heavily fertilized lands are also major contributors of nutrients to surface waters. The spreading of sewage sludge containing contaminants on agricultural lands similarly introduces these contaminants to the broader environment.

Urban non-point sources include run-off from streets on which chemicals have been deposited or spilled, such as lead deposits from automobile emissions, and overflows from combined sewer systems.

Land-use activities within the basin contribute large amounts of toxic chemicals to the Great Lakes. The Pollution from the Land Use Activities Reference Group (PLUARG) has estimated that 11 million tons of sediment from land reaches the lakes each year, carrying phosphorus, metals, and other pollutants. [10] Table 2.2 presents another estimate of total annual loadings from run-off.

e. In-place pollutants: Because toxic substances accumulate in sediments and the future disturbance of these sediments can release contaminants into the water column, these pollutants can be a significant source of contamination in some areas. In fact, "sediments in 38 of the 42 areas of concern ... are moderately to heavily contaminated, mainly with toxic substances."[11] The best-known example of in-place pollutants is the PCB-laden sediments in Waukegan Harbor that are thought to be the biggest source of PCBs in Lake Michigan.[12]

Sediments contaminated with toxic chemicals can easily be reactivated, that is reintroduced into the water column, by upsetting the bottom of the lake through natural processes or through such activities as dredging. Bottom-dwelling organisms can be affected directly and can accumulate the contaminants in their tissue, contributing to bio-accumulation.

f. Atmospheric deposition: This is widely thought to be one of the major sources of toxic chemicals in the Great Lakes, and it is also one of the least-regulated sources.[13]

Studies have shown over 80 percent of PCB loadings to Lake Superior result from atmospheric deposition.[14] Of the total PCB loadings, two-thirds is made up of vapour and particulate deposition, while one-third is rain or snow.[15] Predictions for thermodynamic data indicate that the atmosphere and sediments of the lakes act as sinks for toxic elements in the water column.[16] These findings show toxic chemicals can cycle between the water, the atmosphere, and the land for long periods.

2.4 Effects of Toxic Chemicals

Most information on toxic effects of chemicals comes from laboratory experiments with animals and plants and from studies of people who have been exposed to contaminants through their work or accidental exposure. Tests in which an animal is exposed to controlled and increasingly higher doses of a substance are done to determine lethal doses and the dose level at which observable effects occur (the "threshold" level). Because many of these tests are conducted over a short period of time and with relatively large doses, they produce evidence of "acute" effects. Other studies try to determine carcinogenesis, a "chronic" effect. To use these results for regulatory purposes, results are extrapolated to humans and a safety factor built in to account for the fact that environmental exposure to a toxic substance is usually to low levels over long periods of time. Other information on toxicity comes from tests on bacteria and other micro-organisms that are conducted as a way of determining the risk of genetic mutation and possibly cancer from exposure to a substance. Again, these results must be extrapolated to humans.

Table 2.2

Annual Lakes Pollutant Loadings From Run-Off*

Pollutants	Tons
Zinc, lead, copper, nickel and chromium	420.00
Cobalt, mercury, arsenic, selenium, and cadium	8.00
PCBs	0.077
Chlorinated benzenes	0.069
Organochlorine pesticides	0.034

Source: Canadian Great Lakes Toxic Chemicals Committee, Toxic Chemicals, Issues and Priorities 1985-1986 (Toronto, 1984), as reported in National Research Council and Royal Society of Canada, The Great Lakes Water Quality Agreement: An Evolving Instrument for Ecosystem Management (Washington: National Academy Press, 1985), at pp. 49-50.

This kind of toxicological data, to date, has been the best information available, but its use raises a number of uncertainties. Extrapolating from animals to humans assumes similar metabolic processes that may not be justified as a general rule. Extrapolating from acute to chronic exposure may not be justified because effects from chronic exposure are often different in kind from acute effects and usually may appear only many years after first exposure. In addition, it is now thought by many scientists that some substances initiate or promote cancer through genetic mutation and for these there may be no threshold level; that is, genetic mutation could occur upon exposure to any concentration. These are known as "genotoxic" substances.

Dealing with toxic chemicals is difficult because they act and interact in complex ways that are not well documented. There is a critical absence of data on the mechanisms by which toxic chemicals cause or contribute to different effects, particularly at low doses.

The lack of information means that there are simply not enough data available to make an assessment of hazard for more than a handful of chemicals. It has been estimated that of the approximately 60,000 chemicals in use in North America, less than 2 percent have sufficient data available about them to make a complete hazard assessment.[17] According to Dr. Ross Hume Hall, "in the U.S. the number of chemicals in industrial use today for which there is a complete spectrum of toxic effects is zero. Of the 60,000 industrial chemicals, 50,000 have never been tested for any toxicological effects whatsoever. For the other 10,000 chemicals, information is scanty."[18]

For the Great Lakes ecosystem, the situation is the same. There is very little known about the 500 chemicals of concern identified by the Great Lakes Water Quality Board in 1983 in the basin.[19]

Another area in which data are lacking concerns the toxicity of chemicals in combination with other chemicals. It is common for effluents or emissions from a plant to contain mixtures of chemicals; in any event, mixtures are present in the environment. As Professor C.D. Metcalfe recently noted, "very little is known about the combined effects ("synergistic effects") of the cocktail of chemicals present in Great Lakes water."[20] Similarly, data on additive and antagonistic effects is also lacking. Human exposure to environmental contaminants is by nature exposure to low doses of a large number of chemicals in concentrations and in combinations that vary over time. Information about the direct effects of single chemicals may have little relevance to the reality of exposure situations in the basin.

Also, there is no generally accepted method of judging the health of the ecosystem. The usual approach is to gather information about the ambient concentrations of particular chemicals in the lakes or about concentrations in the effluents of individual plants and then to compare these concentrations against objectives in regulations that have been set at levels designed to protect human or environmental health.

Unfortunately, this approach can only give a partial view of the "state of the Lakes." The chemicals that are monitored on a regular basis are usually those that are already regulated, which is only a fraction of the potentially toxic chemicals estimated to be present in the lakes. Because of the gaps in understanding the effects of chronic exposure, ambient or effluent concentrations and regulatory objectives tell us little about the long-term risks to the health of the ecosystem from exposure to these concentrations. The relationship between effluent concentrations and the ultimate manifestation of effects is not clear because of the residual environmental concentrations and the multiple-exposure pathways of many substances. Thus, looking at single-medium regulatory objectives may underestimate the risks associated with a particular concentration of a particular chemical.

Other monitoring programs, such as the Canadian Wildlife Service's Herring Gull egg program, that focus on organisms in the environment provide a more complete picture of ecosystem health[21], but at present they are few in number and very limited in scope. Despite these uncertainties and gaps in knowledge, there are indications that serious local and basin-wide impacts are being identified and being linked to exposure to toxic substances.

In 1985, a Science Advisory Board Task Force reviewed studies of the effects of specific persistent toxic substances on Great Lakes biota. They found that few chemicals and few species had been studied, but concluded that "It is reasonable to assume that concentrations of persistent toxic chemicals have had significant effects on the health of Great Lakes aquatic populations. This is particularly valid for localized areas near sources of pollutant inputs such as the 39 'Areas of Concern' identified by the IJC(1981). Furthermore, it is possible, though not well documented, that lake-wide effects have occurred because of high ambient concentrations of toxic chemicals."[22]

2.4.1 Impacts on fish

Studies of the effects of exposure to toxic substances on Great Lakes fish identify a range of effects, including:

- mortality of Lake Trout fry
- lower survival of Lake Trout eggs
- disease frequency
- reproductive failure
- increased rate of hyperplasia

One of the most disturbing trends observed is the increased incidence of fish tumours. Figures such as 30 percent of brown bullhead in the Black River of Ohio having liver cancer and 25 percent with skin cancer are echoed throughout the basin, primarily in areas of concern, including Hamilton Harbour, Saginaw Bay, Welland, and the Buffalo River. Well-known examples include thyroid hyperplasia in Great Lakes coho salmon; gonadal tumors in fish found at the mouth of the Rouge River at Detroit with a tumour rate of 100 percent in older male carp; and lip papillomas in 40 percent of the white suckers in southern Lake Huron.[23] Tumours appear most often in bottom-feeding fish from areas within the basin with heavily contaminated sediments. One study found fish from the polluted Fox River near Green Bay had a significantly higher frequency of tumours than the same species in a non-polluted control lake (5.18 v. 1.01 percent).[24] "These findings suggest that, as toxic chemical pollution increases, there is a corresponding rise in tumours in fishes."[25] However, there is as yet no "direct proof of a causal role for toxic contaminants" in the development of tumours and there is a great deal of uncertainty about which chemicals are responsible and what levels of exposure are of concern.

The increased incidence of fish tumours, cancers, and reproductive problems is significant. As one scientist noted, fish are "sentinels sending out a warning about the presence of dangerous chemicals in the environment."[26]

2.4.2 Impacts on wildlife and birds

Organisms other than fish have also been found to be affected by toxic-chemical exposure. Ranch mink, once plentiful in and around Lake Ontario, have been found to have severe reproductive problems, probably owing to their diet of polluted lake trout.

A similar story can be told of beluga whales, found along the St. Lawrence River downstream from Quebec City. As they die off in increasing numbers, the "level of PCBs alone in the milk of these mammals is up 800 times greater than the amount considered safe for humans."[27]

Impacts on birds alerted the world in the 1960s to the cumulative impacts of the use of DDT and other organochlorine pesticides. Although DDT has long been banned, birds are still susceptible to toxic contamination. Impacts that have been recorded include reproductive failure, abnormal nesting behaviour, and congenital anomalies.

A variety of bird species have been found to be the most contaminated in the world; they include eagles, falcons, herring gulls, double-crested cormorants, and the common tern from the lower lakes. Not only have their populations periodically collapsed but "in some cases birds were not able to lay eggs, in others the nestlings were deformed." [28]

2.4.3 Human impacts

Human exposure to contaminants in the basin occurs through ingestion of drinking water and food, inhalation, and skin exposure. It has been estimated that total exposure to all toxic chemicals is approximately 85 percent from food, 11 percent from drinking water, and 4 percent from inhalation.[29] (These figures vary, of course, depending on the nature of the substance and its sources.)

Some 20 million people depend on the Great Lakes for drinking water. Since the early 1970s, minute quantities of toxic chemicals have been found in all drinking water. Indeed, according to a study of Toronto drinking water by Dr. Katherine Davies, a total of 83 chemicals have been identified since 1971, including 28 inorganic and 55 organic chemicals, 7 known carcinogens and 23 suspected.[30]

Another report noted that the U.S. population generally now carries several dozen man-made chemicals, many of them carcinogenic, in its body fat. This appears to be true for the population of the Great Lakes.[31] According to a report by the Royal Society of Canada and the U.S. National Research Council, "humans living in the Great Lakes Basin are exposed to and accumulate greater amounts of toxic chemicals than humans in other similarly large regions of North America."[32] Researchers have found 23 parts per billion of PCBs in mother's milk.[33]

An important food source containing toxic substances in the basin is fish. A number of studies have related maternal consumption of fish contaminated with PCBs and other chemicals to several health and behavioural indicators in newborn babies, including lower birth weights, premature birth, and certain other behavioural defects.[34] Consumption advisories urge pregnant and nursing mothers, women of child-bearing age, and children to avoid eating Great Lakes fish altogether.

The relationship between increasing numbers of fish tumours in the basin and the threat of increased human cancers has not been studied and thus it is premature to draw conclusions. However, it has been noted that "The increased incidence of tumours in fish strongly suggests the presence of either carcinogens or promoters of carcinogenesis in the waters inhabited by these organisms"[35]. Because of the potential for bio-accumulation, the presence of these substances in water and fish in the basin is a matter of significant concern for human health, as many areas of the basin already have higher-than-average levels of cancer mortality for both Canada and the United States.

In 1985, the Science Advisory Board's Human Health Effects Committee (HHEC) reviewed the concentrations of 36 toxic chemicals found in Great Lakes fish or water. They found exposure "levels of concern" for human health for 7 of these chemicals in fish and 12 in water (4 in both). Where data were available, concentrations were not at levels of concern for 2 chemicals in fish and 10 in water, but there were insufficient monitoring data for 27 chemicals found in fish and 14 in water to determine an exposure level of concern.[36]

What these disparate pieces of information add up to is not clear. It is clear, however, that the presence of toxic contamination in the Great Lakes basin is having an effect on the health and functioning of the ecosystem in a number of locations. This information signals what may be the state of the lakes in the future if action is not taken.

2.5 Trends of Toxic Inputs in the Great Lakes Basin

Because ecosystem health is so difficult to measure, one way of looking at the seriousness of the existing situation is to look at the trends in inputs of toxic substances to the basin and the measures of these substances in sediments and biota over time. Generally speaking, these data are much more complete and go back much further than most other environmental measures.

For North America as a whole, there is evidence that a number of serious toxic pollution problems have greatly improved since the 1960s, when production and use of toxic substances were largely uncontrolled.

According to one report, despite some gains like the reduction of 68 percent in lead air emissions and 19 percent in sulphur dioxide emissions since 1975 in the U.S., the more general picture actually demonstrates that annual total air emissions have either remained constant or increased. Earlier decreases in air particulates, nitrogen oxides, and carbon monoxide established prior to 1982 rose as much as 4 percent between 1982 and 1985.[37] Similarly, any modest gains to reduce discharges into U.S. waterways have been more than offset by continued overall water-quality deterioration and "little or no over-all improvement" in the levels of the most obvious pollutants.[38] The situation is the same for most toxic chemicals; "The occurrence of three serious pollutants - nitrate, arsenic, and cadmium - has increased considerably."[39]

The U.S. Conservation Foundation's State of the Environment: A View Toward the Nineties echos many of above noted findings. For example, while dramatically lower lead levels were found in air and water, the "environmental levels of other toxic metals ... show no strong trends."[40]

The situation within the Great Lakes reflects the general pattern in North America. There have been some significant accomplishments in improving the quality of the Great Lakes basin in terms of inputs of conventional pollutants. The once "dying" Lake Erie witnessed a reincarnation through an over 30 percent decrease of phosphates entering the lake between 1972 and 1982; $10 billion was spent to reduce phosphorous inputs to the lakes to achieve these improvements.[41] However, eutrophication is still an important issue in the Great Lakes.

Even for toxic chemicals, there have been some dramatic achievements. Certainly, there have been significant reductions of DDT, mirex, mercury, and PCB inputs to the basin and to levels in fish and other wildlife since the early 1970s. However, DDT residues are still found in the tissues of organisms years after use was banned, and the International Joint Commission (IJC) has found that these decreasing trends have stabilized and may be reversing.[42] In addition, these chemicals represent only a handful of the over 500 chemicals of concern now found in the Great Lakes.

A complete inventory and historical analysis of annual loading trends for the Great Lakes is not available. Because only known and regulated toxins are routinely monitored, most of the available information cannot be used to describe trends for other contaminants. To the extent that sources of a number of common pollutants have been controlled, decreases in contaminants have occurred. For example, particulate reductions will result in decreases of emissions of contaminants adsorbed onto the particulate. However, because of cycling, total loadings may be significantly unaffected. Nevertheless, it is suspected that for the majority of the chemicals no major downward shift has occurred since the increases of inputs commencing in the 1950 to 1960 period.[43]

For the most toxic form of dioxin, 2,3,7,8 TCDD, a recent report by the U.S. Environmental Protection Agency (EPA) shows that levels in sediments at the mouth of the Niagara River have increased from 1 part per trillion (ppt) in 1983 to 499 ppt in 1986.[44] At the same time, levels in fish have remained constant, but are expected to increase in proportion to the increase in sediments.[45] On top of direct discharges, significant amounts of leachate are still entering the river from some of the 215 landfills adjacent to the river.

For hexachlorobenzene (HCB), there are some conflicting data, varying by location. Thus, while there has been a significant decline in HCB levels in herring gull eggs from Lakes Michigan, Erie, and Ontario, levels in sediments from the mouth of the Niagara River have remained constant since 1970 and have increased dramatically since 1979 in fish from the St. Clair River.[46]

Even for the most stringently controlled chemicals, the earlier good news of decreasing levels turns sour. According to the IJC in its third biennial report, released in March 1987:

> While residual quantities of some of the older toxic substances that were regulated in the 1960s and 1970s [such as DDT and PCBs] have declined in most areas, this trend may now have stabilized or even reversed. Other substances have not decreased significantly in the Great Lakes ecosystem, one example being dieldrin ... More importantly, many other persistent organic chemicals are now being identified in the ecosystem.[47]

Hence, while the concentrations of chemicals such as DDT and PCBs have declined dramatically since their use was banned in the basin, they have not been eliminated from the water or biota of the basin. The levels of other chemicals that have been monitored for many years have not declined, while new chemicals of concern emerge every year.

2.6 Findings

a. There has yet to be developed a coherent, in-depth, and comprehensive data base for most toxic chemicals.

b. Toxicological research is limited in regard to its applicability for understanding or predicting the effects resulting from long-term low-level exposure to toxic chemicals.

c. Routine monitoring of sources and emissions is uncoordinated between jurisdictions (therefore few or no comparisons are presently available) and limited to a very few individual chemicals. To date, there are only a few programs in the basin monitoring effects on the ecosystem, e.g., wildlife monitoring programs.

d. Present evidence indicates that levels of some toxic chemicals have gone down, but that levels of others in water, fish, and sediments have not gone down despite stringent controls. New chemicals are being introduced to the ecosystem continually.

e. The presence of toxic substances is contributing to significant impacts throughout the Great Lakes ecosystem, with most severe manifestations in the 42 Areas of Concern.

Recommendations dealing with needed research are outlined in Chapter 8.

Chapter 3 - Toward a Strategy for Zero Discharge

3.1 Introduction

In the previous chapter, the nature, sources, pathways, and impacts of persistent toxic chemicals were reviewed. The toxic chemical problem in the Great Lakes basin is continuing and seems to be getting worse in the face of more than 15 years of environmental regulation by basin jurisdictions. This chapter examines two fundamental questions: first, can the existing regulatory framework solve the toxic-pollution problem and second, if not, what reforms are needed to existing approaches to accomplish real and lasting solutions?

In exploring the adequacy of the current regulatory framework, it is necessary to inquire into the appropriate regulatory goals to protect human and ecological health. Once the goals have been defined, the next issue is to consider whether those goals are capable of being met under existing law.

This chapter states the argument that the nature and impacts of toxic chemicals dictate that the only legitimate, long-term regulatory goal for these chemicals is the goal already agreed to by all basin jurisdictions - the virtual elimination of inputs of persistent toxic chemicals in the basin. It argues that this goal can be furthered by better application and implementation of existing laws. However, to fully realize the virtual elimination goal, a number of reforms to existing regulatory frameworks is necessary.

Finally, the chapter recommends that regulators buttress existing regulatory frameworks and supplement them on the basis of certain principles designed to achieve the goal of zero discharge. The principles introduced in this chapter form an outline for a regulatory strategy for zero discharge and are then discussed in detail throughout the remainder of the report.

3.2 What Are the Appropriate Regulatory Goals?

3.2.1 Zero discharge and the ecosystem approach

The general policy objective of all environmental regulation is the protection of environmental and human health and welfare, although individual statutes and programs specify this objective in different ways. For example, some statutes protect against imminent danger to human health, others protect water quality or wildlife. It is to fulfill this policy objective that standards are set and permits are issued. It is this objective, therefore, that must serve as the measure of success for a regulatory program.

How is this policy objective articulated with respect to persistent toxic chemicals within the basin? While the debate may linger, a decade ago, the national governments of Canada and the United States, states and provinces, and environmental groups agreed that the only long-term, sustainable solution to the problem of persistent toxic pollution is to stop putting into the system those substances that the system could not handle - the concept known as zero discharge. It is the goal of zero discharge, then, that must serve as a benchmark for the success of regulatory programs within the basin.

3.2.2 The Great Lakes Water Quality Agreement

In the Great Lakes basin, the policy goals respecting toxic substances were established by Canada and the United States in 1978 and subsequently affirmed by all the states and provinces and the public in the basin. The national governments have reaffirmed these goals in 1987. These goals are set out in the Great Lakes Water Quality Agreement (GLWQA) of 1978.[1] This agreement built on an earlier agreement in 1972 [2] by addressing an issue of growing concern - pollution of the basin by toxic substances. The agreement's purpose is stated to be "to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem."[3]

To achieve this purpose, the parties agreed to develop programs to better understand the ecosystem and to "eliminate or reduce to the maximum extent practicable the discharge of pollutants into the Great Lakes System" and agreed that their policy would be that "the discharge of toxic substances in toxic amounts be prohibited and the discharge of any or all persistent toxic substances be virtually eliminated."[4]

The agreement sets forth qualitative and quantitative objectives that are expected to fulfil these goals. Toxic substances are divided into two categories: (a) "hazardous polluting substances" for which the parties are to develop and implement programs and measures to minimize or eliminate the risk of release [5] and (b) "persistent toxic substances" for which programs are to act to "virtually eliminate the input" of such substances. In regard to the latter category of substances, the agreement states that "[ii] The philosophy adopted for control of inputs of persistent toxic substances shall be zero discharge."[6]

The 1987 Protocol amending the 1978 GLWQA strengthens the focus on zero discharge as the ultimate goal for persistent toxic substances. These amendments eliminated any conflict between zero discharge on the one hand and the allowance of limited use zones and specific objectives on the other by asserting for the first time that specific objectives and other regulatory tools are "interim", "steps toward virtual elimination" or efforts to be taken "pending virtual elimintation."[7]

Two implications flow from these policies. First, the basin is to be treated as a single ecosystem, and, second, a preventive approach that involves real reductions in inputs is the way to restore and maintain the integrity of the ecosystem.

3.2.3 Other support for the virtual-elimination goal

These goals are reflected in the 1986 Great Lakes Toxic Substances Control Agreement adopted by the Great Lakes governors and premiers.[8] This agreement flows out of the earlier Great Lakes Charter in which the governors and premiers committed themselves to the "joint pursuit of unified and cooperative principles, policies and programs mutually agreed upon as the most effective means of protecting, conserving and managing" the basin.[9]

The Toxic Substances Control Agreement contains two noteworthy principles. Principle II commits the governors to "managing the Great Lakes as an integrated ecosystem." Principle IV commits the signatories to "reducing toxics in the Great Lakes Basin" consistent with the "virtual elimination" goal in the Great Lakes Water Quality Agreement.

These principles and the extent of their implementation have been reviewed in reports by the Royal Society of Canada and the U.S. National Academy of Sciences,[10] by the binational environmental coalition of some 200 groups, Great Lakes United,[11] and by the International Joint Commission in its review of the 1978 agreement.[12] Each of these reviews has urged the respective governments to reaffirm the legitimacy of the goals and recommended continued support of them.

However, these reviews also confirm the information presented in chapter 2 pertaining to levels of toxic contamination in the basin: that is, that despite some local improvements and limited successes, the basin-wide goals of zero discharge and virtual elimination are not being met. In fact, little real progress has been made in their implementation. They call for development of a regulatory strategy to implement the goals of the agreement.

The failure to make any headway on these basin-wide goals raises a number of questions. Most pertinent is the question of whether the current regulatory frameworks are working toward their fulfilment? To put the issue bluntly, all other factors being equal, are the existing regulatory frameworks within the basin capable of achieving the goals of zero discharge and virtual elimination? More and more regulators, researchers, administrators, and academics are giving a negative response.

3.3 Nature of the Existing Regulatory Approaches: Can They Achieve Zero Discharge?

While the 1978 Great Lakes Water Quality Agreement established a number of goals and objectives, little guidance was given concerning how to implement them. Implementation of the agreement was left to the individual jurisdictions. None of the jurisdictions responded to this mandate by restructuring its regulatory system. It appears that all assumed that zero discharge could be achieved within present regulatory frameworks. Yet, when the nature of these approaches is reviewed in relation to both the nature of toxic substances and the goals and objectives of the Great Lakes Water Quality Agreement, it is fair to conclude that limitations inherent in the present approaches make change essential, if there is to be any hope of achieving zero discharge and, thereby, restoring the integrity of the ecosystem.

Most environmental regulations within the 12 jurisdictions of the Great Lakes basin evolved at roughly the same time and reflected understanding of the problems that were known at the time. This understanding related primarily to conventional pollutants affecting first surface waters, and subsequently, air quality. While lead and mercury were toxic pollutants of concern from the beginning of environmental regulation in North America, very little was then known about the nature and implications of toxic contamination (outlined in chapter 2). It is, therefore, not surprising such legislative enactments are simply inadequate to cope with many of the features of persistent toxic chemicals. Four of the limitations of the existing regulatory frameworks are discussed below.

3.3.1 Existing laws are reactive

Most environmental protection laws, with a few important exceptions, allow the free discharge of a chemical to the environment until harm can be proved, at which time a standard will be set and control actions taken. The difficulty and expense of developing sufficient data to formulate standards in anticipation of crises means that many potentially hazardous substances remain uncontrolled or inadequately controlled. For bio-accumulative substances, regulation many come too late to protect the ecosystem for years. For example, the impacts of the use of DDT were not known until the 1960s and regulation in the form of a complete ban on its use came in 1972. The legacy of years of uncontrolled use are still present in the environment.

3.3.2 Existing laws regulate air, water, land separately

An important characteristic of the existing regulatory approaches within the basin is that they are "medium specific" - that is, each component of the environment (air, water, and land) is regulated separately. "Air" pollution, "water" pollution, and "land based" pollution are treated as if, for example, air or land-based pollution has no impact on water quality or that land-based pollution would have no impact on air quality, and so on. This contradicts the fact that pollutants cycle through the environment and means that risks may be underestimated and result in the transfer of pollutants from a highly controlled medium to a less controlled one with little reduction in total loadings to the environment as a whole.

In most Great Lakes jurisdictions, the regulatory and administrative structures governing one medium are isolated from those governing another, and there is little communication between those responsible for each. The result is that, for toxic substances in particular, the environmental risks from a polluting source or a pollutant may not be reduced, despite significant expenditures on pollution-control equipment and enforcement. For instance, a pollutant may be stringently regulated in terms of its discharges to the receiving waters, but may be totally ignored as an air pollutant. Through air deposition, then, the waters being protected may still suffer adversely from the toxic contamination and if the wastes that are not released to water are landfilled, there is potential for the contaminants to leach into the groundwater. Thus, the medium-specific approach is both ineffective and inefficient in protecting the environment at a reasonable cost.

3.3.3 Existing laws do not take into account the build-up of toxic substances

From the first enactments, the basic goal of environmental policy and law has been the protection of human and environmental health. Because most of the first environmental laws in Canada and the United States were designed to address "conventional" pollutants, these regulations were based on the assumption that, over time, these pollutants would degrade, transform, or leave the system quickly enough to retain the biological integrity of the waterways. It was also assumed for the purpose of regulation that individual chemicals did not interact. The regulatory method was to first identify human-health tolerance limits or carrying capacity of the waterways for each type of pollutant and then to find the appropriate discharge concentrations from individual plants that would allow those tolerance or capacity levels to be achieved. In short, the approach of environmental regulation was, and for the most part remains, to find "safe" levels of pollutant discharges.

Persistent toxic substances challenge these very regulatory assumptions. Their accumulation in the environment, their long residency times, their low concentration thresholds for biological effects (if such thresholds exist at all), their mobility, and the lead time between the introduction of the substances into the environment and manifestation of effects strongly suggest that these pollutants are simply incongruent with finding a "safe" level of discharge. With bio-accumulative, persistent toxic substances, any new inputs add to the existing environmental burden and it is this total burden that has to be considered when evaluating risks of exposure. Even if a substance is banned tomorrow, the residual concentrations will remain in the environment as a potential risk possibly for years to come.

3.3.4 Existing laws do not take into account the inter-jurisdictional movement of pollutants

Most environmental laws are intended to protect the ecology and public health of the jurisdiction that adopts them. They are based in part on the assumption that pollution is a local problem having only local consequences and in part on the constitutional limits on extra-territorial application of law. Hence, all too often, regulators and environmental administrators fail to take into account whether their decisions on standards or pollution permits will sufficiently protect the interests of neighbouring jurisdictions. When one jurisdiction, for example, has very stringent standards, and an adjacent, upstream jurisdiction has weak standards, the ability of the downstream jurisdiction to meet its own regulatory limits and protect its own interests will be limited. Even though some of the most heavily polluted parts of the basin are the localized "areas of concern," the basin as a whole is affected because of the mobility of substances through the environment.

There is also very little consultation or cooperation between basin jurisdictions on regulatory decisions. While efforts are being made in the Great Lakes basin to share information on permits, a comparison of environmental standards for some of the most persistent toxic pollutants still reveals a marked disparity on the basis, the formulation, and numerical calculation of these standards.

These circumstances make the control of pollution in the basin as an ecosystem (as required in the 1978 Agreement) difficult if not impossible. They result in overlaps, gaps, and conflicting actions. This means costs will be incurred with little corresponding benefit. This is ineffective and an inefficient process.

3.4 Attaining the Goal of Virtual Elimination: Principles for Persistent Toxic Regulation

The goal of virtual elimination envisages the development of regulatory controls that reduce absolute loadings of persistent toxic chemicals to the point where there will be "virtually" no inputs to the basin. This implies that all basin jurisdictions must act, that such actions must be coordinated, that all persistent, bio-accumulative toxic substances must be addressed, and that inputs from all sources - run-off and sediments, as well as direct discharges - must be gradually reduced and, eventually, stopped. This requires rehabilitative as well as preventive actions.

The development of this toxic-reduction strategy should be guided by three fundamental principles that address the nature of the problems posed by persistent toxic substances and thus allow the achievement of the "virtual elimination" goal. These three principles are:

3.4.1 Comprehensiveness: total environmental exposure to chemicals or polluting sources must be addressed

Environmental laws, and in particular, the procedural mechanisms implementing those laws, can only address all pollutants of concern and all sources if they take into account total environmental exposure to a chemical or a polluting source. An integrated, "cross-media" approach allows this to be done.[13]

The need for a cross-media approach, which has been explored in depth by such groups as the Organization for Economic Cooperation and Development (OECD)[14] and the Conservation Foundation,[15] has become more recognized in recent years. A cross-media approach can be considered an integral aspect of the ecosystem concept found in the Great Lakes Water Quality Agreement.

3.4.2 Prevention: total loadings to the basin must be reduced

For persistent toxic substances, the goal of virtual elimination can only be achieved by taking a preventive approach. This necessitates the establishment of stringent, yet workable, "source-reduction" strategies that seek gradually to eliminate industrial processes using toxic substances or producing toxic substances as products, by-products, and wastes. Other regulatory mechanisms include the use of standards that mandate "absolute" reductions in the amounts or loadings of pollutants entering the system.[16]

Such an approach falls directly in line with the "anticipate and prevent" strategies advocated by such bodies as the World Commission on Environment and Development[17] and the Great Lakes Science Advisory Board.[18]

3.4.3 Cooperation: a basin-wide approach to mutual problems must be taken

Like no other problem facing the Great Lakes basin, the problem of toxic contamination has brought to light the need for inter-jurisdictional cooperation and coordination in development and implementation of strategies to deal with the problem.

Implementation of an ecosystem approach requires the cooperative development of joint or parallel regulation, consultation, and coordination of efforts so that extra-jurisdictional impacts that affect the basin as a whole are taken into account. Implementation ought to be undertaken at every level of endeavour, including policy, legislation, research, and monitoring.[19]

3.5 Implementing Basin-Wide Goals

The Great Lakes Water Quality Agreement gives little guidance about how the virtual-elimination goal is to be achieved. Even though the two national governments agreed to implement programs to achieve it, the goal's scope and operationalization have received little attention since 1978.

How can the barriers be overcome and the goal implemented in accordance with the three principles? There are two ways to go about it: to work within the existing frameworks or to change them.

3.5.1 The "adjustment" or "tinkering" view

Many argue that the virtual-elimination goal may be possible through adjustments and "tightening" of the present regulatory controls, at both the federal and provincial/state levels. The kinds of reforms anticipated under this approach would include:

a. identifying those priority pollutants that have yet to be regulated and set standards for those pollutants;

b. reviewing and strengthening existing standards for those chemicals presently regulated either by decreasing allowable emissions or by changing the basis of the standard (e.g., changing from a weekly average to a 24-hour average for air standards); and

c. increasing the resources necessary to attain higher compliance levels with existing laws and employing a variety of methods to attain those levels, including financial incentives and disincentives.

While the recognition and implementation of these "adjustments" would be a positive step to toxic substances control, the goal of virtual elimination may not be realized simply because the same basic assumptions and fundamental weaknesses of the approach, as discussed above, remain.

3.5.2 The "reorientation" approach

Regulators within the Great Lakes basin have, in the past, not sought to "adjust" existing regulations when they were faced with serious pollution problems such as those posed by PCBs, DDT, or even phosphorus. Instead, they sought to reorient their approach. And, for the most part, they were successful in doing so. Indeed, the success stories have a common thread running through them: efforts resulted in a drastic and absolute reduction in amount of the offending pollutant entering the environment through joint action by all jurisdictions. The mercury contamination problem in eastern Lake Erie and the phosphorus control program in the late 1960s and 1970s, together with efforts to control PCBs and DDT, are prime examples. Some of the efforts banned these chemicals altogether, while others gradually reduced basin loadings from all sources. If a substance, such as dieldrin, is controlled in one medium rather than banned, the declines are much less dramatic and may be ineffective in the long term. Regardless of the approach, the intent was to reduce drastically or stop the amount of pollutants entering the environment. Thus, it would be fair to say that, when significant problems had to be addressed in the past, the "orientation" view has been favoured over the "adjustment" view.

Those who advocate the "adjustment" view often underestimate the resources necessary to make a regulatory framework achieve goals that that framework was simply not designed to attain. In the long run, it may be more cost-effective and efficient to establish a framework that is specially engineered and suited to achieve the predetermined objectives.

Hence, while adjustments to the present framework would provide positive improvements, more innovative actions that seek to reduce the absolute quantities of persistent toxic substances from entering the environment are also necessary - an approach that seeks to supplement, rather than supplant, current environmental laws.

The overall implication of a virtual elimination goal is that a preventive strategy is not a "control" strategy, but a toxic "reduction" and "elimination" strategy.

3.6 Findings and Recommendations

3.6.1 Findings

a. The goal of virtually eliminating the discharge of persistent toxic substances into the Great Lakes basin is one that has been affirmed by basin governments and supported by environmental organizations, industry, and the public.

b. Despite this consensus, there is still no coordinated and integrated regulatory strategy for toxic substances for the basin as a whole or within basin jurisdictions.

c. The more stringent application and enforcement of existing regulations will assist in addressing the problem of persistent toxic contamination.

d. However, existing laws are not designed to achieve the basin-wide goal of virtual-elimination because, for the most part, they do not reduce the absolute quantities of persistent toxic substances entering the ecosystem.

3.6.2 Recommendations and Action Steps

a. A basin-wide regulatory strategy should be developed to implement the objectives of the Great Lakes Water Quality Agreement.

b. All basin jurisdictions should work together to develop the strategy and to agree on targets and schedules for implementation.

c. Such a strategy should have as its ultimate objective the virtual elimination of persistent toxic substances and should encompass the three principles of comprehensiveness, prevention, and cooperation.

d. Each basin jurisdiction should ensure the implementation of the strategy in its regulatory processes.

e. Existing regulatory processes should be strengthened to provide the most complete coverage and best enforcement possible.

f. In addition, four concepts should be integrated into the regulatory processes of each jurisdiction. These concepts include: (1) a cross-media approach; (2) source reduction; (3) load reductions; and an (4) ecosystem approach.

Chapter 4 - From a Sectoral to a Cross-Media Perspective

> Toxic chemicals always seem to find their way to the place of least regulation and not necessarily the place where it is the most environmentally acceptable.
>
> *A participant at the Illinois Workshop (January 1987)*

4.1 Introduction

Most environmental laws in North America regulate air, water, and land use separately. An industrial plant, then, can have different parts of its process regulated under different laws and even by different agencies. Because pollutants released into one medium can "cycle" through other environmental media, control that focuses only on the initial pathway into the environment is not necessarily control that will result in environmental or health protection. To overcome this problem, a "cross-media" approach to pollution control is needed.

A cross-media approach is a preliminary principle in any regulatory strategy. It provides a regulatory focus for the strategy because it demands a response to a number of basic questions. What is the most effective means of controlling the environmental risks from a given pollutant? What is the most effective means with respect to a polluting source? How can a particular receptor best be protected? The response to these questions forms the substance of a regulatory strategy. While some basin jurisdictions have recognized the need to take a cross-media approach, others have yet to pursue this principle in any meaningful way.

This chapter explores the regulatory problems associated with "sectoral" laws, explores the "cross-media" response to the problems, and then concludes with recommendations for reform.

4.2 The Problem of a Medium-Specific Approach

Environmental laws in basin jurisdictions, as in all of North America, evolved in a piecemeal, fragmented fashion. Separate legislative initiatives were established to protect air resources,[1] water resources,[2] and even land-based activities.[3] This approach worked well in addressing specific, obvious, but serious pollution problems such as fish kills from pulp-and-paper effluent or respiratory problems resulting from local air pollution.[4] Gradually, as research better revealed how pollutants interacted with the environment, new statutes attempting to control the effects of the production or uses of specific chemicals were passed. However, even though these statutes were chemical specific, they "did not bridge this fundamental gap between air and water pollution management. On the contrary, the emergence of legislation that was not exclusively addressed toward a single medium served in some respects to further fragment the system."[5] There was no legislative attempt to coordinate or integrate the differing approaches to environmental regulation.

The reason for the fragmented approach of contemporary environmental legislation is, in part, historical. In both Canada and the Unites States, water pollution reached the political, and eventually the legislative, agenda several years before air pollution.[6] Land-based regulations, such as waste-disposal laws, emerged a considerable time after both air-and water-pollution regulations had been in place.

As time progressed, the formulation of programs, procedures, and laws for each medium continued to evolve incrementally and independently of each other. As a result, their interrelationship is often unclear. For example, many environmental laws have differing policy objectives; some seek to protect human health or welfare;[7] others pertain to the protection of certain resources;[8] many have differing levels for proof of differing levels of harm. Different factors, such as risk-benefit analysis under The Toxic Substances Control Act, the Best Available Control Technology (BACT) under the Clean Water Act, or the adequate margin of safety for hypersensitive people under the U.S. Clean Air Act, are taken into account when setting standards under each act.[9]

In addition to differing legislative and policy approaches, incrementalism has also brought on institutional complexity and regulatory confusion. According to one report, at the U.S. federal level, 25 separate laws are designed to address some aspect of toxic substances to control toxic and hazardous waste. Moreover, these legislative programs are administered by no less than 10 federal agencies or other independent commissions, including the Environmental Protection Agency, the Food and Drug Administration, the U.S. Department of Transportation, and the Consumer Products Safety Commission. Within the main-line environmental agencies, there are separate branches or offices for air, water, waste, toxic substances, and pesticides.[10]

The situation is the same in Canada. Under some 30 federal statutes, 24 departments have responsibility over different aspects of toxic and hazardous substance control.[11] The situation, of course, is further exacerbated when the myriad of state/provincial laws are added. In the United States, there are separate and federally delegated state programs and, as pointed out by Ritts and Dower, a complex system of federal entitlements on which state and local agencies rely for resources and technical guidance to address hazardous substances.[12]

What is the result of medium-specific policies for the approvals process?[13]

Because environmental standards are too often developed, formulated, implemented, and enforced with little or no regard to the relationship among various media or to the environment as a whole, and because permits are also uncoordinated, the policy objectives of protecting human and environmental health are not being achieved. There are at least four reasons for this failure.

a. **Medium-specific standards result in the transfer of pollutants from one medium to another rather than the elimination of the pollutants.** Single-medium standards specify the amount of a particular pollutant that can be discharged into either air, water, or land. Any amount produced by an industry or other source above the controlled amount then becomes "waste" that must then be "managed." Common methods of waste management, including incineration, land disposal, use of settling ponds or storage, can release the controlled contaminants into the air, ground, or water, defeating the purpose of the original control. Thus, rather than limiting the amount of those pollutants in the environment, the single-medium control may only effect a change in their place or rate of entry into the environment.

A number of examples illustrate the point. More stringent air-pollution standards for toxic particulates may require the use of electrostatic precipitators or baghouses that capture fly ash. This ash will be heavily concentrated with toxic substances and must then be disposed of. If it is landfilled, there is the potential for the contaminants to leach out and contaminate the soil and groundwater, eventually reaching surface waters.

Sewage treatment plants produce a sludge that, as recent reports have documented, can be heavily contaminated with toxic substances. If the sludge is spread on farm land, there exists the potential for the pollutants to be taken up by the crops, released into the air or water through wind and erosion or into the ground through leaching. If the sludge is incinerated, the toxic contaminants may be released into the atmosphere. In essence, what happens is that in an effort to control pollutants in one medium without considering the waste-management question, the environment as a whole is forgotten and the perceived level of protection is misleading.

b. **Single-medium standards do not take into account the cycling of pollutants through the environment.** When deciding what is an "acceptable" concentration of a toxic substance that can be released into the environment, it is often assumed that the chemicals will remain in the same medium. In fact, chemicals once released into the environment can undergo physical, chemical, or biological changes and migrate through the environment, increasing the possible routes of exposure.

Sulphur dioxide, for example, a so-called "conventional" pollutant, has been regulated as an air pollutant (because of its local effects on human respiratory function) for more than 15 years in both the United States and Canada. It is now known to contribute directly to vegetation and soil damage and water pollution, even hundreds miles away from its source. The solution chosen to improve local air quality was the use of tall stacks to increase dispersion. The result was acid rain.

c. **Medium-specific standards ignore multiple exposure routes on a particular receptor.** Another problem with medium-specific standards is that they can drastically overestimate the permitted exposure to humans or the environment. This overestimation results because, when ambient standards are developed so as to protect a particular receptor, it is assumed that the receptor will only be exposed to the chemical through that single medium. Many air-quality standards, for example, are developed on the basis of the effects from inhalation of that pollutant without assuming that the average person will be exposed to the same pollutant when eating contaminated fish or when drinking water.

The problem is similar for drinking-water standards. A comparison of the drinking-water standards in Ontario and Ohio illustrates the problem.[14] Ontario's criterion for dieldrin in drinking water limits the concentration to 0.7 ug/l (micrograms per litre). Ohio's standard, in contrast, is 0.000071 ug/l, a difference of 10,000 times.

This enormous difference exists because Ontario did not take a cross-media approach in setting its standard. Ontario's criterion of 0.7 ug/1 was calculated on the basis of the health effects on the average person who drinks 2 litres of water per day and assumed that the person would receive 20 percent of the acceptable daily intake (ADI) of dieldrin from drinking water. Ohio's standard, on the other hand, is derived by taking into account the assumption that a person would be exposed to the chemical through drinking 2 litres of water, but also from eating 6.5 grams of fish per day.

Another problem of failing to take account of cross-media movement is that when effluent or emission standards are set so as to allow attainment of the ambient standards, inputs to the water, for example, from non-point sources, are not factored in. Deposition from the atmosphere and urban and agricultural run-off are significant sources of water pollution for many chemicals in the basin. To focus only on direct discharges to the water of the basin underestimates the total risk. Many chemicals change, as they cycle through the environment, through physical, chemical, or biological processes into substances with sometimes greater toxicity than the chemicals initially emitted. Failure to consider the by-products of discharges in setting standards further underestimates total risk.

d. **Permit-issuance under the medium-specific approach is done separately without consultation.** Medium-specific legislation usually requires separate permits for discharges of contaminants to each part of the environment, even for a single plant. As Ritts and Dower summarize the problem: "With few exceptions, present statutory schemes for granting permits are implemented under separate laws and rarely at the same time so that the impact of releases into the environment are rarely evaluated simultaneously."[15] For example, for a primary metal processor, one permit would be needed to release contaminants into the air during smelting, another to discharge the process water, and yet another to bury the residues in a landfill. Each permit would be processed independently by different branches of one agency or perhaps even by different departments, usually without notification to branches responsible for other media.

Throughout the Great Lakes basin, this lack of consultation and coordination is the norm. The result is that industries may be paying more than necessary to control their emissions and manage their wastes and the resulting environmental protection may be less than appears.

4.3 Cross-Media Approach as a Response to Medium-Specific Law

Because the failure to account for the movement of chemicals through different compartments of the environment may transfer risks within the ecosystem and underestimate actual exposure to toxic substances, an approach that does account for such movement is a necessary component of a comprehensive risk-reduction strategy for persistent toxic substances. A "cross-media" approach is not a new concept, having been studied by such agencies as the Organisation for Economic Cooperation and Development (OECD), the U.S. Environmental Protection Agency, and various non-governmental organizations.[16]

The conceptual basis for a cross-media approach is summarized in a statement from a publication by the Conservation Foundation, a U.S. organization that has led the way in studying this approach:

> An alternate approach [to the medium specific approach] bases control decisions on an understanding of the way pollutants travel through the environment and how they ultimately have an impact on people and other living things. In a cross-media approach to pollution control, managers and regulators ask, "What is the optimum form of control to reduce risk from a pollutant in the environment as a whole?"[17]

The concept requires consideration of total environmental exposure and risk and of ways of reducing that risk in an efficient and effective manner. Thus, once the expected total environmental exposure of a polluting source is known, a mix of controls to reduce the risks associated with that exposure must be sought.

For persistent toxic substances, where the goal is virtual elimination of inputs to the Great Lakes basin, it is necessary to review the entire manufacturing or industrial process in order to determine whether - through source-reduction techniques such as raw-material substitution and process reformulation, or through waste-reduction techniques such as recycling and re-use - the overall amount of toxic outputs or the toxicity of those outputs can be reduced or even eliminated. Pollution "control" for persistent toxic substances also has to recognize the exposure associated with residual concentrations building up in the environment, which, to reduce risk, requires reductions in total loadings. Ideally, non-point sources should be treated in a similar manner.

4.4 Cross-Media Approach in the Great Lakes Basin

It may well be argued that a cross-media approach has already been accepted in principle within the basin. Certainly the Great Lakes Water Quality Agreement of 1978 recognizes the need for an ecosystem approach, the impact of land-based pollution and air deposition on water quality, and the goal of virtual elimination of inputs of persistent toxic substances.[18] In themselves these elements alone indicate the need for a comprehensive approach. The 1987 amendments go further, prescribing action on pollution from contaminated sediments, groundwater, land-use activities including urban and rural drainage, and atmospheric deposition.[19] More particularly, the 1986 Great Lakes Toxic Substances Control Agreement (GLTSCA) notes in Implementation Principle 1(c): "Full control of toxic discharges requires that the permitting of toxic substances released to surface water, groundwater and air be better integrated."[20] In the Toxic Substances Control Agreement Permitting Workplan, it is noted that "A model program will be developed by September, 1988 to assist states in evaluating their programs and insure that the cumulative impacts on Great Lakes water quality from all sources are integrated into the permit issuance process."[21]

However, even if the cross-media concept has been accepted in principle, there has been little official effort put into development of a regulatory strategy that implements the concept. There have been many attempts to coordinate environmental management at an administrative level, but almost none for the substantive integration necessary for a comprehensive approach. To date, the United States has made some attempt to implement such an approach through comprehensive environmental-assessment proceedings or consolidated permitting procedures.[22]

a. **Comprehensive environmental assessment:** In New York, under the state equivalent of the National Environmental Policy Act (NEPA), the State Environmental Quality Review Act (SEQRA) reviews the overall environmental impact of a proposed source and the impacts that source may have on each medium.[23] For example, for a coal-fired power generation station, the contribution to acid rain and the environmental impacts of the disposal of sludge collected from the scrubbers designed to reduce acid-gas emissions must be assessed.

b. **Coordinated permitting:** In the late 1970s, the U.S. Environmental Protection Agency (EPA) established a Permits Consolidation Task Force with the "ultimate" environmental goal of regulating pollutants of concern through all phases of air, water, and solid waste cycles and the goal of making it possible to issue a single environmental permit for all new and existing sources. While federal regulations issued in 1979 were designed to implement these goals, they never got off the ground, in part because of the change in national administration in 1980.[24]

Following passage of the Toxic Substances Control Act in 1976, U.S. EPA looked into different ways to integrate the agency's approach to toxic substances. These efforts culminated in the Integrated Environmental Management Division of the Office of Policy, Planning, and Evaluation, which analyses cost-effective ways of reducing risk in all media. Two approaches are used: one that looks at total risk from a particular type of industry, and another that looks at risks in a region heavily concentrated with population, industry, and waste facilities. The division addresses data needs and makes control recommendations but is not given authority to regulate directly.[25]

A number of states have also consolidated their permitting processes so that an applicant can have the total environmental impact of a project reviewed and approved in a single proceeding. Initiatives in still other states include the simple requirement of circulating each environmental permit application for review and requiring it be checked off by each department responsible for a particular medium.[26] An example of such a program in the Great Lakes basin is Illinois' Coordinated Review of Permits. Where more than one permit is required in Illinois, the applicant is subject to the Coordinated Review of Permits (CROPA). Under this program, meetings are regularly held among the agency's permit managers to insure consistency among permits prepared by different divisions.[27]

The limitation of this approach is that the effort needed to manage a coordinated permit-issuing process or a comprehensive assessment process is often underestimated and can raise criticisms of delay, complexity, and added costs for the applicant. Further, the technologies required to reduce the environmental risks may be unavailable or economically prohibitive.

4.5 Implementing a Cross-Media Approach

The elements to be considered in the design of a regulatory strategy that implements a cross-media approach include:

i Science: Does the existing approach to data-gathering and research give an agency the information it needs to implement a cross-media approach?

ii Institutional: Is there cooperation and coordination of agency functions in standard setting and permit-issuing?

iii Standards: Do the ambient standards reflect total exposure? Do effluent standards take into account effects on other media? Do permits for a plant focus on all emissions from the plant into the environment as a whole?

4.5.1 Data and research: the need for mass-balance

Before the goal of achieving virtual elimination of inputs of persistent toxic pollutants can be attained, it is necessary to know the amounts of inputs (both point and non-point source) of pollutants into the system, the amounts that accumulate in the system, and the amounts that leave the system. The present approach to research and monitoring in the basin does not address these three information needs. They are, however, addressed in a "mass-balance approach," which is used in some places in the basin.

Under a mass balance approach,[28] the quantity of contaminants entering the system - less the quantities stored, transformed, or degraded within the system - must be equal to the quantity leaving the system. If the quantities do not balance, either there are sources that have not been identified and quantified, or the quantities in or out are not accurate.

Once mass-balances have been done for pollutants of concern, the long-term effects on water quality can be simulated by mathematical modelling. From that process, it may be possible to estimate if, and when, water- and health-protection standards will be exceeded. With this information, efforts can be directed to reducing inputs from the sources most amenable to control and remediation.

In the Great Lakes basin, the mass-balance approach has gradually gained acceptance as a vital research and regulatory tool. In the United States, the Superfund Amendments and Reauthorization Act of 1986 calls for various in-depth study on the mass-balance approach to assess, inter alia, its value in determining the accuracy of information on toxic-chemical releases and the effectiveness of toxic-chemical regulations, as well as its implications as part of a national annual quantity toxic-chemical release program.[29]

In its five-year strategy for the Great Lakes National Program Office (1986-90), the U.S. EPA has committed itself to the further use, development, and refinement of the mass-balance approach.[30] One of the most serious attempts to employ the approach was supported by the National Program Office in Green Bay, Wisconsin. In Green Bay, one of the most heavily polluted areas in the basin, a modelling framework is being developed and tested to provide greater understanding of the sources, transport, and fate of toxic substances, and ultimately to guide and support regulatory activity.[31]

In the Lake Michigan Toxic Pollutant Control/Reduction Strategy, one of the most important bases for further control initiatives is the use of mass-balance. According to the strategy's workplan, it is estimated that mass-balances could possibly be completed sometime in the 1990s. Depending on the findings of the mass-balance analysis, further, and more stringent, loading restrictions may be imposed.[32]

The need for research on mass-balance and action levels based on multi-media exposure is recognized in Annex 17 of the 1987 Amendments to the Great Lakes Water Quality Agreement.[33]

Because of the complexities of the approach, however, its success will depend on development of a comprehensive data base about the interactions of toxic chemicals in the environment. One of the most serious limitations on developing that base is the lack of comprehensive, coordinated monitoring and bio-monitoring networks for sources and receptors.

4.5.2 Institutional changes

For institutions, measures to coordinate permit-issuing and standard-setting and, in some cases, to consolidate environmental agencies should be considered.[34] At minimum, a cross-media focus would require the governmental department responsible for air quality to cooperate, and perhaps even to integrate its duties, with those responsible for water resources and land-use activities, such as waste management.

4.5.3 Approvals process

From a regulatory point of view, a cross-media approach would shift emphasis from medium-specific laws toward an integrated framework that looks at total environmental exposure and seeks to minimize risks by (a) controlling all toxic emissions from a source, (b) controlling every discharge of a particular pollutant, and (c) controlling all toxic substances affecting a particular receptor. Each approach has its limitation.[35]

a. **Regulating sources** [multi-media permits]: A cross-media perspective could also focus on reducing all risks from a polluting source such as an industrial facility. For point-source discharges, this perspective would attempt to account for total environmental emissions. This effort would allow for more integrated (and therefore a more efficient mix of) controls on point sources, but would ignore all non-point source emissions. Treating each non-point source type as a point source is possible, but limited by a lack of data and of control options.

b. **Controlling all releases of particular pollutants** [multi-media standards]: One option for cross-media regulation is to focus on the control of specific pollutants with the goal of reducing their overall environmental and human-health risks. For most persistent toxic chemicals, this would require measures to reduce total loadings into the environment and to remediate existing problems. This approach would be comprehensive in the sense of taking account of non-point as well as point sources, but there are limits to its use. While multi-media movements of individual chemicals can be traced, focusing on the nature of individual chemicals overlooks the fact that chemicals are seldom discharged in isolation and are often combined with other chemicals in the environment.

c. **Controlling of all toxic substances affecting a particular receptor:** Focusing on a geographic region or a particular receptor is the most comprehensive of these approaches. It allows total exposure - all chemicals from all sources - to be taken into account when developing standards and permits. However, even more than with the other approaches, limited available data about emissions, behaviour in the environment, and effects, limit the usefulness of this approach in practice.

In summary, a cross-media approach in its broadest sense provides a new focus to pollution control, requiring new research and analytical methods, the creation of new or restructured institutions, and reformed legislation. In a more narrow sense, however, a cross-media approach suggests at least that, within existing institutional frameworks, there must be a greater understanding of the sources and fates of toxic pollutants, greater coordination between governmental departments sharing responsibility, and legislation that contains integrative aspects that recognize the inter-media transfer of pollutants.

4.6 Findings and Recommendations

4.6.1 Findings

a. Virtual elimination requires a comprehensive approach. Environmental legislation within the basin tends to be fragmented, attempting to regulate the air, water, and land as separate media. Such a medium-specific, sectoral approach, creates situations in which

- toxic pollutants are transferred to another part of the environment and not destroyed;
- non-point sources are ignored for regulatory purposes;
- long-range transport and transformations of pollutants are not taken into account in standard-setting;
- total exposure to toxic substances is not taken into account in setting standards; and
- legislative requirements, standards and permits are not coordinated resulting in overlapping, contradictory, or absent regulation.

b. The lack of a cross-media perspective has frustrated attempts to deal comprehensively with many toxic chemical pollution problems. Where attempts have been made, they have been treated merely as add-ons to the conventional system. The current approach has resulted in an inefficient, costly, and ineffectual system.

4.6.2 Recommendations and Action Steps

a. All regulatory processes should incorporate a cross-media approach, that is, standard-setting and permitting processes ought to recognize the total exposure to toxic substances (including all sources and all pathways of exposure).

b. Each jurisdiction should review its air, water, and waste management standards and its standard-setting and permitting processes to judge their potential for integration of cross-media concerns. Inter-agency consultation and coordination of efforts in standard-setting and permitting review should be instituted immediately.

c. The goal of the standard-setting process should be to control the total environmental exposure to persistent toxic substances. Multi-media standards should be developed by each jurisdiction and in coordination with all other basin jurisdictions.

d. As part of the development of such standards, all basin jurisdictions should cooperate in the development of a comprehensive data base to allow mass-balances to be done.

e. Permitting processes should take into account all toxic emissions and wastes (including fugitive emissions) from a source.

f. The granting of permit applications should be based upon criteria that require the best mix of controls to minimize total risk from a source. This requires coordination of applications or single applications for each source.

g. Mechanisms for extending permitting to non-point sources should be explored.

In addition to these recommendations, other related recommendations dealing with needed research and institutional reform are outlined in chapter 8.

Chapter 5 - From Waste Management to Source Reduction

> There will come a time when we will just have to stop putting these [kinds of] chemicals into the environment.
>
> *A participant at the Ontario Workshop (March 1987)*

5.1 Introduction

The long-term risks posed by the build-up of persistent toxic chemicals in the environment are unknown but potentially very serious. Existing approaches to controlling the release of these substances into the environment have failed to eliminate associated risks to human and environmental health. Once a comprehensive focus is taken through adoption of a cross-media approach, however, programs to achieve real reductions in risk can be developed.

One program with the potential to lead to eventual elimination of persistent toxic substances from the environment is source reduction. This chapter explores the nature of the problems associated with the existing regulatory approaches, the elements of source reduction as a method for remedying those problems, and the ways this approach can be implemented in the Great Lakes basin.

5.2 The Problem: Existing Regulations of Persistent Toxic Substances

Persistent toxic substances are those that are resistant to physical, chemical, or biological modification or breakdown into less toxic substances. When persistent substances are released into the environment, they can build up in sediments, in soil, or in biota, where over time the concentrations can reach levels at which toxic effects can occur. Concentrations of some persistent chemicals are also magnified in the food chain so that predatory species can receive toxic concentrations from consumption of exposed organisms at the same time that levels in the ambient environment are considered non-toxic.

Using the existing data base, it is very difficult to know what levels can be released into the environment without creating undue risk. Indeed, the U.S. EPA has noted that "the sources and role of toxic contaminants are not understood well enough to determine whether current laws and environmental programs will be adequate for clean-up."[1] This statement describes the consequences of the existing controls in Canada as well as in the United States because similar approaches are followed in both countries.

Existing controls on the release of toxic substances are based on a combined "pollution control" and "waste management" approach. Both approaches are reactive, in the sense that action is not initiated against the release of a particular chemical into the environment until there is proof that the concentration of the chemical poses a risk to human or environmental health.

Once a hazard is proved, the pollution control approach has meant the setting of a standard at a level that will protect against observable effects. All discharges must meet this standard, which usually relates to only one component of the environment. The accepted method for meeting this limit is through end-of-the-pipe controls and, in fact, U.S. water-quality legislation requires the use of best-available control technology. End-of-the-pipe controls take an industrial process and its potential for generating contaminants as givens and apply equipment or chemicals to trap the contaminants (usually the excess above the standard) before the waste stream is released into the environment. This residue is then classified as "waste" that must be "managed." The most common waste-management techniques have been disposal in landfill for contaminants not released to the air; in settling ponds for waste-water; and by land disposal or incineration of the sludge.

Toxic substances are not destroyed by most pollution-control and waste-management techniques. Instead, these techniques

> ...only alter the problem, shifting it from one form to another, contrary to this immutable law of nature: the form of matter may change but matter does not disappear...[2]

These techniques also shift the problem from one component of the environment to another, but do not thereby reduce ultimate environmental exposure. For example, a strict limit on direct discharge of a contaminant into a water course could result in its concentration in sludge, which is then either disposed of on land or incinerated. In either case, the contaminant can still enter the water environment - from land by leaching or erosion and from air by deposition. If the incinerator also has controls for that contaminant, the contaminant would be concentrated in the fly ash or bottom ash, which are usually landfilled and thus subject to leaching.

Some waste-management techniques destroy toxic substances. For example, incineration of chlorinated organic compounds such as PCBs can result in their breakdown into non-toxic compounds. Efficient combustion can have a greater than 99 percent destruction efficiency. However, with inefficient combustion that occurs in most existing incinerators, highly toxic organic compounds such as dioxins can be formed. Heavy metals are not destroyed during combustion.

Several other aspects of these approaches reveal that risks of exposure are not being controlled comprehensively. First, because of the high degree of certainty demanded of toxicity information before a standard can be set, many potentially toxic substances are uncontrolled or are controlled when released to only one medium. A good example concerns U.S. emission standards for hazardous air pollutants (NESHAPS). Even though EPA has had a list of 37 hazardous substances in need of control for 10 years, it has only promulgated standards for 7 substances.[3] Many of these unregulated substances have water standards that are to some degree negated by the lack of air standards.

Second, a pollution control approach focused on point sources tolerates the manufacture of products that either are "toxic in use" or create disposal problems. Examples of hazardous products that contribute to environmental exposure include pesticides, paints, oils, and solvents. Controlling the use and disposal of such products is often very difficult.

Third, most pollution control standards are based on effects associated with short-term exposure through one exposure pathway, not with accumulative exposure over time from all possible routes. For persistent toxic substances, allowable exposure time could be greatly overstated as a result.

In addition to environmental considerations, there are serious economic and administrative consequences resulting from the traditional approaches. Increasingly stringent and complex government regulation is expensive for both industry in complying and government in developing standards, evaluating permit applications, and enforcing compliance. In the United States, it has been estimated that spending by industry and government has totalled $10 million for every page of federal environmental statutes and regulations.[4] It is also increasingly recognized that pollution is a sign of wasteful inefficiency in industrial processes because it requires substantial investment in control equipment, which uses substantial amounts of energy and other resources to operate and creates residues that are costly to treat or dispose of.

For the jurisdictions in the Great Lakes basin, the above summary comments apply. In Ontario for example, there are air standards, water-quality objectives, waste-management regulations, soil guidelines, and sludge spreading guidelines. These all establish contaminant limits; permits are issued only to those applying industries that can demonstrate their processes can meet the relevant limits. However, persistence of toxic substances is not always taken into account when standards are set, and total exposure is not considered in standard-setting. For example, air standards relate to the effects of exposure to a contaminant in ambient air only, and pollutants are transferred to other media through waste-management practices.

Thus, the pollution control and waste-management approaches to the control of environmental inputs of toxic substances are reactive, inefficient, costly, and unable to achieve their main purpose of protecting human and environmental health.

5.3 The Proposed Solution: Source Reduction

5.3.1 Introduction

The failings of the existing system point to the need for a preventive approach to pollution control. Because reacting to pollutants after they are created is both ineffective and inefficient, the concept of eliminating or reducing the generation of pollutants appeals to industry, governments, and the public as being less expensive, easier to monitor and enforce, and less risky. This concept of "anticipate and prevent" has been widely accepted at the international level by, for example, the Organization for Economic Cooperation and Development, the World Commission on Environment and Development (Brundtland Commission), and the World Industry Conference on Environmental Management (WICEM); at the national level in both Canada and the United States; and by industries.[5] Despite this widespread acceptance, most expenditures and research efforts continue to be devoted to pollution control and waste-management. While reduction of pollution "is at the top of everyone's hierarchy as a theoretical goal ... practical consideration and implementation are postponed to a vague future."[6]

There are many examples of companies initiating pollution-prevention efforts but a number of barriers remain.[7] The preventive solution, referred to in this report as "source reduction," is discussed generally, but the focus of recommendations is the role of Great Lakes basin governments in implementing this reduction through their standard-setting and permit-issuing processes.

5.3.2 What is source reduction?

The term "source reduction" as representative of a preventive approach to pollution control is not a term of art. Some organizations use the term "waste reduction" to mean what this report means by source reduction, but that term is confusing because it has in most practical applications meant techniques of waste management (such as recycling) that reduce the volume of waste after it is generated.[8] In this report, source reduction refers to techniques used within a plant that avoid or reduce the generation of hazardous substances; it is contrasted with pollution control and waste-management techniques.

It is important, however, to understand that source reduction cannot completely replace pollution control and waste-management. Because there will be wastes that cannot be eliminated, source reduction should be seen as a major component of a comprehensive risk-reduction strategy. However, with only 0.1 percent of environmental spending in the United States now devoted to source reduction, there is a long way to go before source reduction can play a major role in environmental protection.[9]

The motivation for exploring ways to implement source reduction is the need to reduce exposure to persistent toxic substances in the Great Lakes basin. In North American practice, use of source reduction to date has been motivated by economics and by the need to conserve non-renewable resources. Source reduction has been initiated voluntarily largely by industry because increasingly stringent regulations have made pollution control and waste management increasingly expensive. The motivation for source reduction has come more recently from regulatory changes that restrict the landfilling of hazardous wastes, particularly in the United States with the 1984 amendments to the Resource Conservation and Recovery Act (RCRA) and a number of state initiatives.[10] In Europe and Japan, source reduction has been used as a tool to improve industrial efficiency, economic growth, and international competitiveness, and not solely for environmental protection.[11]

In Europe, source reduction is implemented through regulation in France, the Netherlands, and West Germany. Although these programs are very different, they share three common characteristics:

i. Source-reduction requirements are not separate but are made part of existing regulatory programs such as the authorization of new plants or the issuance of permits to discharge pollutants.

ii. Regulations do not generally set specific standards for the types or amounts of hazardous wastes that must be avoided or reduced.

iii. Enforcement depends on a high degree of technical knowledge about industrial processes and alternative technologies.[12]

West Germany is the most advanced in the use of source and waste reduction. Its primary statute requires facilities emitting contaminants to be operated in such a way as to avoid or recycle their wastes to the extent that it is technically and economically feasible to do so. Before a licence to emit can be granted, an applicant must demonstrate that it has examined all possibilities to avoid, reduce, and recycle its wastes. To make source reduction more feasible, West Germany has developed a comprehensive catalogue of environmentally preferred alternative technologies and is working to develop uniform technical standards for different industry types.[13]

The oft-cited experience of 3M illustrates the various benefits of source reduction. In 1975, 3M launched its 3P -Pollution Prevention Pays - program. The company was responding to regulations requiring it to install and operate expensive pollution control equipment and to pay for treatment or disposal of residues. The 3P program was intended to minimize the amount of pollution generated "at the source so that treatment at the end of the manufacturing process is not necessary. And after the product leaves the factory, there are no major problems in use or in final disposal."[14]

Since 1975, the 3P program has included 2126 projects world-wide, with annual results in the United States of the following pollution prevented: 104,079 tons of air pollutants, 13,000 tons of water pollutants, 1 billion gallons of waste-water and 280,000 tons of sludge and solid waste. There have also been substantial energy savings and annual cost savings of $390 million for control equipment that did not have to be purchased, reduced operating costs, and retained sales of products that would have been found to be environmentally unacceptable.[15] 3M has also "reaped an incredible amount of good publicity as a result of their efforts."[16] Hundreds of other companies, including other multinational corporations such as Union Carbide, Dow, and Monsanto, have instituted projects that prevent the generation of pollutants.[17]

What kinds of techniques will prevent or reduce the generation of toxic substances? The particular techniques are as varied as the thousands of industrial processes in use, but the general categories of source-reduction techniques include the following:

i Product reformulation or substitution, to reduce hazardous by-products or to reduce toxicity of the product itself.

ii Raw-material substitution, to reduce toxic inputs or hazardous by-products.

iii Process modification (for example, from batch to continuous operations, or use of closed-loop processes, to improve efficiency and reduce hazardous outputs).

iv Equipment modification (for example, from one- to two-stage combustion, to reduce hazardous outputs).[18]

Techniques that reduce either the volume of waste (such as recycling, re-use or recovery of materials, incineration or de-watering) or the toxicity of waste (such as physical/chemical treatment) after the waste is created are waste-reduction techniques and thus not included here. Techniques that eliminate toxicity from wastes have the same result as source reduction techniques and it is not intended to downplay their importance. They do, however, produce risks of exposure during production, storage, and transportation that are greater than if no toxic wastes were generated in the first place.

5.3.3 Source reduction in the Great Lakes basin

The voluntary character of source reduction applies in the Great Lakes Basin jurisdictions as in other jurisdictions in North America. Government initiatives are almost entirely directed at waste reduction, although there is growing recognition of the importance of source reduction as a means to achieve the goal of eliminating inputs of persistent toxic substances to the basin.

The types of initiatives found in basin jurisdictions are discussed below in general terms. The details of the policies and programs are set out in table 5.1.

The 1978 Great Lakes Water Quality Agreement establishes the goal of virtual elimination of persistent toxic substances from the ecosystem but fails to address the methods that should be followed in working out this goal. Some subsequent work of the International Joint Commission and its boards has shown a recognition of the need for "anticipate and prevent" strategies, but no real effort has been directed toward establishing source reduction as a preferred approach for achieving the goal of virtual elimination.[19] In the 1987 amendments to GLWQA there is a passing recognition of the importance of source reduction when the parties agreed to encourage, wherever possible

> "...reduction in the generation of contaminants, particularly persistent toxic substances, either through the reduction of the total volume or quantity of waste or through the reduction of the toxicity of waste, or both..."

TABLE 5.1 SOURCE REDUCTION IN THE GREAT LAKES BASIN ECOSYSTEM

JURISDICTION	POLICY	PROGRAM	LEGISLATION	INSTITUTION	TARGET
1. INTERNATIONAL					
a. Canada-U.S.	virtual elimination of persistent toxic substances		Great Lakes Water Quality Agreement	Parties	No
b. Great Lakes States and Provinces	source reduction is preferred waste reduction where source reduction is not feasible		Toxic Substances Control Agreement	States Provinces	No
2. UNITED STATES FEDERAL	waste minimization; no landfill of hazardous waste without pretreatment	reporting requirements; certification of waste minimization programs research	Resource Conservation Recovery Act Amendments	EPA	No
3. ILLINOIS	waste reduction no land disposal of hazardous waste	Research fund Free technical assistance, development of database, dissemination of information Matching funds Governors Award	No	Hazardous Waste Research and Information Centre	No
4. MICHIGAN	Resource conservation source separation and waste reduction	Hazardous waste Strategy, financial incentives, tax breaks technical assistance	Hazardous Waste Management Act	Dept. of Natural Resources	No

Source: APPENDIX B

TABLE 5.1 (Cont)

JURISDICTION	POLICY	PROGRAM	LEGISLATION	INSTITUTION	TARGET
5. Minnesota	source reduction/ waste reduction as preferred approach	MnTAP - Hazardous Waste Reduction Program: evaluation of all feasible alternatives to landfill technical assistance information provided development of database list of consultants, research grants intern program to conduct waste audits conferences, workshops Governors' Award financial assistance, tax breaks	Waste Management Act	University of Minnesota; Waste Management Board	31% reduction by 2000; interim targets
6. OHIO	Waste profile review policy	review of alternative technologies technical assistance reporting requirements Governor's Award	No		No
7. WISCONSIN	Waste reduction encouraged	no formal program technical assistance grants for waste reduction Governor's Awards	No		No
8. PENNSYLVANIA	No formal policy	no formal program technical assistance for waste reduction	No		No

and the development of "alternative products" to reduce the effects of airborne toxic substances.[20]

In the United States, the federal government introduced a policy of "waste minimization" with the 1984 amendments to the RCRA, the act that deals with management of specific hazardous wastes. The dual purposes of both preventing (reduction) and controlling (managing) wastes are revealed in the act's preamble, which states:

> The Congress hereby declares it to be the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment.[21]

Despite this seeming recognition of source reduction as national policy, the implementing regulations make it clear that the policy is in fact one of waste reduction.[22] The regulations impose a series of landfill "bans," which only amount to a statutory presumption against the landfilling of hazardous wastes. There are small-quantity exemptions for wastes containing specific contaminants (ignoring the persistence of some) and the requirement that companies either treat their waste on-site or ship their waste to be treated off-site prior to land disposal. If shipped, the waste generator must certify on the shipping manifest that a waste-minimization program is in place. In addition, any company generating hazardous waste is subject to biennial reporting requirements. Although "waste minimization" is not expressly defined, recycling or re-use of materials after wastes are generated are considered acceptable waste-minimization techniques, and "industry has tended to respond to the waste-minimization regulations by looking for ways to treat wastes after they are generated. Government (both state and federal) has also put most of its resources into treatment alternatives."[23]

Institutional commitment to source reduction is also lacking. In its 1986 Report to Congress: Minimization of Hazardous Waste, U.S. EPA proposed that the agency not decide on whether regulations should be adopted until 1990 and that it spend the time until then conducting studies and gathering data. The agency also proposed to delay its funding request for development of a technical information program until 1988.[24]

a. U.S. state initiatives

Most U.S. states have, like the federal government, endorsed source reduction in principle but not in practice. On average, less than 1 percent of environmental budgets are spent on waste reduction.

In the Great Lakes basin, the principle of source reduction for hazardous wastes is recognized by the states and provinces in the Great Lakes Toxic Substances Control Agreement whereby they agree "that the most economical and effective way

TABLE 5.1 (Cont)

JURISDICTION	POLICY	PROGRAM	LEGISLATION	INSTITUTION	TARGET
9. NEW YORK	Waste hierarchy - waste reduction given priority [developing source reduction policy]	Industrial Materials Recycling Program technical assistance data base development surveys of management techniques (potential for reduction) dissemination of information financial assistance; tax breaks; penalties for land disposal waste exchange cooperative ventures	Industrial Materials Re-Cycling Act	DEC	No
10. INDIANA	no formal policy	office to provide technical assistance to small businesses and municipalities to foster compliance with environmental laws and legislation workshops	No	Dept. of Environmental Management (Office of Technical Assistance)	
11. CANADA FEDERAL	no formal policy	no formal program financial assistance for technology development waste exchange	No		No
12. ONTARIO	Blueprint for Waste Management waste hierarchy preference to reduction	technical assistance dissemination of information financial assistance	No	MOE	No

to reduce the adverse effects of toxic chemicals is to eliminate their entrance into the environment at the point that they are produced or used."

They go on to require the consideration of developing incentives for new manufacturing processes and assisting businesses in the development of alternative technologies and the pursuit of waste reduction "in situations where source reduction may not be feasible."[25]

In practice, basin states have not yet implemented these principles. The state programs that exist in Illinois, Ohio, Michigan, Wisconsin, Indiana, and Pennsylvania are non-regulatory in nature. They concentrate on the dissemination of information and technical assistance to industry and the offering of limited financial incentives or research grants. They are also oriented toward waste management rather than source reduction and concentrate their efforts exclusively on RCRA-regulated wastes, without taking a multi-media focus.

In New York, there is an existing program giving priority to waste reduction. In addition, the Department of Environmental Conservation has recently announced that it will begin to emphasize the source-reduction approach as part of its Great Lakes Agenda, commencing with a new policy, expected to be developed and implemented by mid-1988.[26] At present, in addition to RCRA requirements, New York state has an Environmental Regulatory Fee System and a State Superfund Fee Program. These programs tax waste generators based on the amounts of hazardous wastes generated and on how the wastes are managed, with the highest fees levied for wastes destined for landfills. These fee programs are intended to induce source-reduction measures and to shift industry to clean and low waste technologies. Further, the state has severely restricted the landfilling of many types of wastes, and instituted a number of programs directed to encouraging industry to take source-reduction initiatives.

Minnesota has an extensive hazardous waste-reduction program that is largely non-regulatory but that also includes a statutory target of 31 percent reduction in hazardous waste generated by the year 2000, as well as interim targets. The program gives preference to reduction and emphasizes in-plant source reduction through "such techniques as using products which are non-hazardous, changing operating procedures, and using different process equipment" as the best way of "staying ahead of the hazardous waste problem."[27] This source reduction focus is limited to waste management and does not extend to the control of air and water pollution.

b. Canadian initiatives

In Canada, neither source reduction nor waste reduction command much regulatory attention. At the federal level, the need for an "anticipate and prevent" approach to pollution has long been recognized. Recently, the Report of the National Task Force on Environment and Economy, the submission of Environment Canada to the World Commission of Environment and Development and the <u>Report of the Royal Commission on the Economic Union and Development Prospects for Canada</u> emphasized the importance of the preventive approach to both the ecology and economy of Canada.[28] However, despite calls for increased use of a preventive approach to environmental decision making and for waste reduction and recovery to be an integral component of hazardous waste management, there is no national policy to that effect.

The federal government's recent statutory initiative, the Canadian Environmental Protection Act, was claimed by the minister to take a preventive approach but it neither mentions nor contains any provisions to implement source reduction or even waste reduction.[29] Critics of the bill suggest that it takes a 1970's approach to environmental protection by attempting to manage waste, and not reduce it.

Instead of statutory requirements, the federal government uses a number of non-regulatory programs directed, for the most part, at providing industry with financial incentives to develop new technologies, including source-reduction technologies. The Development and Demonstration of Resource and Energy Conservation (D-RECT) program, contributes up to 50 percent of project costs, encouraging the development of energy conservation and source-reduction technologies. Other financial-incentive programs include the Industrial Research Assistance Program and the Industrial Regional and Development Programs. The federal government also sponsors the Canadian Waste Materials Exchange, a waste-management program that seeks to find uses for wastes already generated.

Ontario has a more comprehensive approach to waste reduction that could include source reduction but is not limited to it. Ontario's policy toward waste reduction is found in the 1983 "Blueprint for Waste Management in Ontario," which adopts a waste-management hierarchy preferring the "4 Rs" - first reduce, then recover, re-use, and recycle - over on-site treatment and off-site treatment or disposal. Until 1986, little action was taken in Ontario to promote the 4 Rs. Recently, however, a special office was created in the Waste Management Branch with a mandate to promote waste reduction and an $8.5 million program providing grants for waste reduction and recycling projects was established; $1 million was targeted for projects dealing with hazardous industrial wastes, but no reduction targets were set. The grants will go to pay up to 50 percent of capital and start-up costs and up to 100 percent of costs of pilot-scale projects. The office also provides technical-information assistance to small firms.

Beyond its waste-management programs, Ontario has no policy or program for encouraging source reduction as part of its pollution control regulations.

5.4 Implementing Source Reduction in the Great Lakes Basin

Of all the basin jurisdictions, only New York and Minnesota refer at all in their policies to "source reduction," but no jurisdiction has adopted source reduction as its preferred approach to controlling environmental contamination. There is a preference in all cases for non-regulatory programs, leaving industry to make the leap if the information and financial help from government are sufficient to overcome the inertia to change. All jurisdictions are also relying on the gradually increasing cost of land disposal, the need for pre-treatment of wastes, and the increasing liability for the effects of poor waste-management practices to eventually push industries toward waste reduction, which may or may not include source reduction.

Given the present serious nature of the toxic substance problem in the Great Lakes basin and the confusion toward true source reduction caused by the narrow waste-reduction focus of all the jurisdictions, a strong impetus for change is needed. Source reduction as a major component of environmental protection regulation can only develop out of the present pollution-control and waste-management culture with strong support from governments. This support requires each jurisdiction to develop a source-reduction strategy and to implement that strategy through legislation. In Europe, countries such as West Germany and the Netherlands have recognized that higher waste management costs are not enough to cause the adoption of source reduction. Instead, the strategy of regulations, incentives, and technical assistance is used.[30]

There are many possible components to an effective source-reduction strategy and many of the basin programs for waste reduction could be expanded to include source reduction. Any strategy needs to start with a strong policy commitment to source reduction by each basin jurisdiction.

Once a policy of source reduction is in place, steps can be taken to implement it. The Environmental Defense Fund's report, Approaches to Source Reduction, sets out steps toward implementation.[31] These include the development of a comprehensive information base as a prerequisite to an "action plan," in which decisions about which sources to target for reduction and about realistic source-reduction targets can be made. Once an action plan is in place, the specific programs, including financial ones and institutional changes required for implementation, can be undertaken. Institutional requirements could be met by attempts to integrate existing agency mandates and to change existing program foci away from strict pollution control or waste management to source reduction, or a new agency may be appropriate in some jurisdictions.

Integration of source reduction into the existing regulatory framework is necessary if targets are to be reached within a reasonable period of time and to ensure the continuing role of pollution control where needed. For standard-setting, a number of changes could be made to include prohibitions on all inputs to the environment of persistent toxic substances coupled with a schedule of targets for reduction at source, relying on particular source reduction technologies. As information is gathered about technical changes or product substitutions applicable to particular industries, these could be built into the standards with which plants within those industries must comply.

To receive a permit to operate, a plant could be required to meet the applicable source reduction standards. A permit application should require an assessment of alternative technologies available to allow the target to be met. To ensure progress toward virtual elimination, a plant that could not meet the standards through existing technology should be required to demonstrate the reasons, to develop a schedule for when it could reasonably be expected to reach the targets, and to report on its progress.

An effective source reduction strategy depends on continual technical development and thus on the ready exchange of technical and financial assistance between governments and industry and among industries. Although cooperative action is essential to success, mandatory targets will ensure the timely implementation of source reduction strategies and thus the virtual elimination of persistent toxic substances from the Great Lakes basin.

5.5 Findings and Recommendations

5.5.1 Findings

a. Governments within the basin rely on a pollution control and waste-management approach to environmental protection that controls contaminants "at the end of the pipe" through application of control technology.

b. The existing waste-management approach produces residual toxic wastes that must then be treated or disposed of, often at great expense. This approach tends to be reactive and ineffectual in protecting the environment, and is usually economically inefficient as well.

c. Most basin governments agree that the generation of toxic products and wastes ought to be minimized; however, little effort is made to implement this goal. Efforts to date have been predominantly ones of "waste reduction" (recycling, recovery, and re-use programs) that reduce the volume or toxicity of wastes after they are generated and do not necessarily eliminate the input of toxic substances to the environment.

d. Source reduction, as an explicit policy and priority, has yet to evolve in the basin. Basin jurisdictions have neither devoted the necessary resources to this program nor set source reduction targets. The limited initiatives to minimize or reduce wastes are through voluntary, non-regulatory programs.

5.5.2 Recommendations and Action Steps

a. Basin governments should adopt source reduction as the preferred objective for pollution control and waste management regulation. Waste reduction as a secondary objective should also be adopted.

b. This objective should be legislated by each jurisdiction and should be supported by financial and technical programs and assistance.

c. Support should be given to assist in encouraging the development of technology for substitute products, low and non-waste processes, and alternative raw materials.

d. Standards should be developed to specify materials, products, processes, and process technology that will minimize the potential risk of exposure to toxic substances. Standards should be industry-specific and allow for a range of alternative technologies.

e. Standards should address both existing and new facilities and include specific reduction targets.

f. Permit applications should be reviewed on the basis of a "source reduction assessment" of a proposed facility which would canvass alternatives available and consider material, product, process, and technology choices in terms of the minimum potential risk of exposure and cost effectiveness.

g. Existing facilities should be required to conduct a review of their processes and their ability to achieve the source reduction standards. Schedules for implementation of the standards should be required. Financial support should be considered, if necessary, to meet the schedule.

h. All facilities should be required to report their source reduction efforts to the governing agency in order to maintain an information bank which can be shared by others within the same industry and by other industrial sectors.

i. Source reduction techniques should also be developed for non-point sources to minimize the potential for exposure to toxic substances.

Other recommendations related to needed research and institutional reform flowing from these recommendations are enunciated in chapter 8.

Chapter 6 - From Allowable Concentrations to Absolute Load Reductions

Load allocations are nothing new.

A participant at the Wisconsin Workshop (January 1987)

6.1 Introduction

There are a number of steps required in a comprehensive approach to achieving virtual elimination of persistent toxic substances from the Great Lakes basin. Cross-media regulation is necessary to controlling total exposure and focuses on the total input of chemicals to the environment, irrespective of whether the substances are first released into the air, water, or land. Having this information and focus, the next step toward virtual elimination is to take steps to reduce the risks of those inputs of persistent toxic chemicals.

Source reduction strategies have been suggested as essential to reducing risks from exposure to such chemicals. However, source reduction does not provide a complete answer. There is still need for an improved approach to the control of pollution that cannot be, or has yet to be, eliminated. Such an approach should focus on reducing, in absolute terms, the inputs of persistent toxic substances to the environment.

Contrary to the needs of a toxic reduction and elimination strategy, existing environmental protection standards do not limit the total quantities of a substance entering the environment or impose gradual reductions in loadings to the environment. Rather, they most often set a rate of input - per unit of production, for example - that is expected to achieve an acceptable concentration in the environment. Some standards refer to the technology available to control emissions of contaminants and do not refer to environmental impact at all. Because of the persistent and bio-accumulative nature of some toxic substances, it is necessary to reorient these "relative" standards to an "absolute load-reduction" approach. While absolute load reduction is not a new concept, a resurgence of its use has occurred in a number of areas, most notably in various Great Lakes jurisdictions. Indeed, many Great Lakes jurisdictions have recognized the merit of absolute pollution limits, even though none has integrated them into the mainstream of its environmental laws.

6.2 The Problem of Relative Pollution-Control Standards

Virtual elimination of the discharge of persistent toxic chemicals cannot be achieved through source reduction alone. Practically speaking, there will always be a need for "control" and "management" strategies because even source reduction techniques do not eliminate all residues and because in the short term, some industries will have difficulties identifying and implementing source reduction techniques. The importance of source reduction as the preferred strategy to risk reduction was discussed in chapter 5. There, the characteristics of persistence, bio-accumulation, and low-level toxicity were seen to require a preventive strategy that results in absolute reductions in inputs to the environment as a whole. The prevailing pollution control and waste-management approaches were seen to be reactive, inefficient, costly, and unable to achieve their main purpose of protecting human and environmental health.[1] It is still necessary to discuss an appropriate strategy for controls where source reduction is not or cannot be used. In that sense, source reduction and controls are complementary strategies and should be viewed as two parts of a comprehensive approach to risk reduction. According to a recent U.S. report, "no matter how strongly waste reduction is advocated, pollution control regulations will always be needed for wastes that cannot be or have not yet been reduced."[2]

There are now a number of different approaches used to control inputs of toxic substances to the environment. All require the setting of generally applicable standards that can then be applied to individual industries through a permit-issuing process. The most common approaches involve the setting of ambient and emission standards and technology-based standards.

Historically, environmental laws in both Canada and the United States employed "ambient" standards for both air and water. For water, use of these standards begins by defining a "designated use" for a stream or lake, and pollutant "criteria" specifying the maximum concentration of pollutants that can exist in the water without impairing the designated use. For example, a designated use such as a "warm-water fishery" may mean this use can be maintained if the concentration of a chemical does not exceed 5.0 micrograms per litre. This is known as an "ambient" standard. Polluters are then permitted to discharge pollutants in doses that result in environmental concentrations within the ambient standard. Sometimes the effluent or emission standard is not directly related to the ambient limit and allows merely a concentration per unit volume. For example, air standards set by the Canadian federal government are a concentration per unit of raw material put into the process. With respect to the secondary lead-smelter standards, it has been noted that they only created an illusion of controlling emissions without really doing so. This is because the standard "does not set any upper limit on the total amount of lead a smelter may emit, but only the amount the smelter may emit in each cubic metre of air. By increasing production and pushing more cubic metres of air out of the stack, the smelter may vastly increase the amount of lead it emits."[3]

There are a number of inherent limitations associated with ambient standards that impair their usefulness in achieving long-term risk reduction.[4] First, ambient standards are attempts to find a concentration at which no adverse effects will be felt. For example, in Ontario, the ambient air-quality criteria are the levels where no effects will be felt if the receptor is exposed to that concentration for a given period of time. As mentioned in chapter 2, there is a controversy about whether there are thresholds for some carcinogens, and there is very little present understanding of the environmental or health risks associated with long-term, low-level exposure. Thus, the certainty about effects implied by the ambient numbers chosen is misleading. In addition, ambient standards were originally designed for "conventional pollutants" - those that degrade relatively rapidly. Thus, the standards reflect an assumption about the assimilative capacity of the environment for each chemical. For many persistent toxic substances, however, there can be no real or practical assimilative capacity level because of their persistent and bio-accumulative nature.

There are also limitations in the way ambient standards are used in practice. In using them as the basis for setting effluent or emission standards for different industries, it is difficult to determine precisely how much a given industry can discharge without violating a particular ambient level. When there are several industries discharging into the same water course and the ambient limits are exceeded, it may be impossible to determine which of several upstream dischargers caused the excess.

Further, ambient and effluent standards neither purport to nor, in fact, result in an absolute limit on discharges into the environment. They may even encourage further discharges since many industries have been allowed to pollute "up to" the level prescribed for the designated use and, as has been discussed in chapters 4 and 5, controls on pollutants entering one medium may only result in a transfer of the substances to another medium and not in a reduction of total loadings.

With a few exceptions, the ambient standard continues to be the primary approach to both air and water pollution control in Canada. However, standards differ in the United States. Perceived weaknesses in ambient standards under the U.S. Clean Water Act[5] precipitated sweeping reform of the act in 1972. Under those reforms, the regulatory emphasis was placed on the technology to control the discharge itself, in this case the best-available control technology (BACT). These technology-based effluent controls specify the quality of waste-water that can be discharged from a particular point source and are typically expressed in terms of concentration per unit of production as opposed to concentration in the receiving water.[6]

Technology-based standards are an improvement over the ambient regime because they ensure control of pollutants even when there is insufficient data available to be able to establish ambient standards. They have, however, a number of weaknesses relevant to the control of risk from persistent toxic substances. Most important, the standards are a compromise of economic practicality and environmental protection; that is, in setting the particular standards for industrial sectors, existing pollution control technology and the ability of a particular industry to pay to achieve effluent reductions are the factors taken into account.[7] This makes the technical and economic feasibility of reducing the discharge the limiting factor in setting the standards, rather than the level of risk posed by the discharge. When the technology needed to abate an existing source for purposes of sufficiently protecting the environment is not economically available, as is often the case, BACT standards are supplemented with ambient air or water-quality standards.

Like ambient standards, technology-based standards may not bring about a reduction in the total loading of pollutants into the environment. Even if complied with, these standards allow pollutant loadings to increase as production increases or as the number of polluting industries expands. For some pollutants, the available technology may be such that there is more control than is necessary to minimize the risk. For persistent toxic substances, however, technology-based standards that do not reduce absolute loadings below the level at which they leave the system cannot lead to virtual elimination.

Finally, all relative standards assume that the environment can absorb the allowable concentration forever. While environmental and technical standards are reviewed and updated as new information and studies become available, they usually become more stringent but do not set targets that move toward virtual elimination by gradual reduction of total allowable loadings. This approach has resulted in a situation where only a crisis will prompt the banning of a chemical, and where the residue problem haunts the environment for years.

While the traditional "relative" standards are necessary in any toxic-control strategy, a supplemental strategy using a different approach is necessary for the virtual elimination of risk from persistent toxic substances. This approach requires an absolute reduction, over time, in quantities of persistent toxic chemicals entering the environment.

6.3 The Proposed Solution: Absolute Load Reductions

6.3.1 What Are Absolute Load Reductions?

In this study, "relative" standards are those where the basis of the standard is relative to something - the use of water for a certain purpose, the technological practicality of control, an acceptable risk of human cancers. "Absolute load reduction," in contrast, requires controls that achieve real reductions in quantities of pollutants entering the environment as a whole over given time periods. This concept requires an understanding of all sources and fates of particular pollutants, the quantities entering the basin, and the quantities degrading or leaving the basin. Such information is used to calculate a "mass balance" (described in chapter 4), and to set the reduction targets.

6.3.2 Absolute Load Reductions in the Great Lakes Basin

There have been a number of instances where the absolute load reduction approach has been used, in many cases successfully. Many such attempts have been employed in the Great Lakes basin.

The best-known example is the "war" on phosphorus in the basin. In the early 1970s, scientists found that high phosphate levels entering the basin caused eutrophication to such an extent in the lower lakes that they were said to be dying. Under the auspices of the International Joint Commission, Canadian and American governments agreed that programs to reduce total inputs of phosphorus and other nutrients should be undertaken. These programs were based on gradually decreasing target loadings that were allocated between jurisdictions, and were to be achieved by May 1980. The 1983 Phosphorus Load Reduction Supplement reconfirmed the allocation of the original target loads for all lakes except Lake Ontario.[8] Although the phosphorus programs related to controlling direct discharge to the lakes from industries and sewage treatment plants, steps were also taken to study ways of reducing non-point-source inputs including run-off from agricultural lands and atmospheric deposition. This comprehensive approach is an essential element of an absolute reduction strategy.

The phosphorus example is of interest because the load-reduction concept was applied to conventional pollutants. Two more recent examples have focused on toxic chemical pollution. In July 1986, the states of Illinois, Indiana, Michigan, Wisconsin, and Region V of the U.S. EPA concluded the Lake Michigan Toxic Pollutant Control/Reduction Strategy.[9] The purpose of the strategy is to address the problem of toxic pollution in Lake Michigan by reducing total loadings into the lake. The goal is to be accomplished first, by identifying all sources of toxins; second, by quantifying toxic inputs to the lake; and third, by systematically reducing those inputs. Initially, the parties will focus on 11 toxic pollutants of concern.[10] After extensive monitoring and modelling exercises, which will identify and quantify sources, pathways, and fates of the pollutants, the parties intend to calculate a "mass balance" for each pollutant.

More recently (February 1987), after years of negotiation, the governments of Canada and the United States, the province of Ontario and New York State signed the Niagara River Four-Party Agreement.[11] The major components of the agreement are the establishment of a coordinating committee, an extensive monitoring program, and most important for this study, a loading reduction of 50 percent for certain persistent toxic chemicals in the river by 1994.

While both the Lake Michigan and Niagara River agreements share the absolute load reduction concept, they differ somewhat in approach. In terms of the load reduction target, the Niagara accord sets an arbitrary 50 percent reduction in loadings by 1994 - a target that has no relationship to the target that may in fact be needed to rehabilitate the river. Even with a 50 percent reduction, it is estimated that as much as 4.5 tonnes of chemicals could enter the river every day.[12] In the Lake Michigan agreement, the load reduction target is not quantified but will have to be sufficient to ensure compliance with the ambient water-quality standards established under the U.S. Clean Water Act.[13] Neither accord has as its ultimate goal the "virtual elimination" of inputs of toxic substances - the goal of the Great Lakes Water Quality Agreement.

At least initially, both the Niagara and Michigan agreements rely on existing laws and processes to achieve the necessary reductions. This circumstance is viewed by many as inadequate on the grounds that existing environmental standards are not sufficiently stringent to attain present regulatory objectives, much less more onerous load reduction targets. The Lake Michigan strategy, unlike the Niagara accord, contains a mechanism for overcoming this inadequacy. If after a predetermined time the targets have not been met, new controls, to be established at a later date, are contemplated.

The issue of how to distribute the load allocations is somewhat complex in the Lake Michigan agreement because the new limits are to be incorporated into each National Pollution Discharge Elimination System (NPDES) permit. The Niagara River agreement provides for a 50 percent reduction shared equally between Canada and the United States.

Load reductions are also called for in the 1987 amendments to the GLWQA. The Parties agreed to develop and implement "Lakewide Management Plans" for each lake that are designed to reduce loading to the lakes of bioaccumulative pollutants whose presence impairs uses of the ecosystem. These plans are interim measures to be taken pending the achievement of virtual elimination. The Lake Ontario Toxics Management Plan is the first of these to be completed.[14]

a. U.S. "Maximum-Loads" Concept

It is important to differentiate the absolute load reduction concept from other concepts such as the "maximum-loads" concept found in the U.S. Clean Water Act and implemented through state law.

Under the Clean Water Act, there are two methods of pollution control: the first requires all point sources to use the best-available control technology (BACT) and the second requires the setting of water-quality standards (WQS) for designated waters. When the WQS are violated, even when there is compliance with BACT requirements, the act requires "maximum loads" to be set by state agencies, and approved by U.S. EPA.[15]

Maximum load requirements can be satisfied by devising a plan for ensuring WQS compliance. Although certainly the most common plan is to reduce waste-water discharges, other plans are also possible, such as diverting wastes to another water segment or increasing river-flow.

There are a number of methodologies used to reduce waste-water discharges, but they all follow the same basic formula. In Wisconsin and New York, for instance, a total maximum load is the maximum quantity of a pollutant that can be discharged into a water segment over a specified period of time to maintain the applicable ambient standards.[16] The maximum load is arrived at by determining the assimilative capacity for a particular water segment and the amount each polluter currently discharges into that segment (the "baseline load"). The next step is to take the difference between the assimilative capacity and the total upstream baseline effluent load, the "total allowable amount," which is then divided among the dischargers.

Because many states have been reluctant to set maximum loads, their effectiveness as a regulatory tool is still unknown. In fact, it was the reluctance of state governments to set these loads that led to the Scott v. Hammond [17] decision, which provided the impetus to the 1986 Lake Michigan Toxic Pollutant Control/Reduction/Elimination Strategy.

Where maximum loads have been set, other problems have arisen.[18] First, the determination of maximum loads is based on the concept of assimilative capacity of the particular water segment. As has been noted, that concept is inappropriate for the control of persistent toxic substances.[19] Second, the allocated waste load, in some states, is transferrable or reallocable to other polluters. In some instances, there is no consideration given to the effects of reallocation upon toxic discharges. For example, often the rules do not account for the fact that a non-toxic discharging company could reallocate its waste-load allocation to a toxic-substance-discharging company.[20] Finally, maximum loads may prevent the direct discharge to water of particular substances, but because there is no comprehensive or multi-media approach taken, the result may be the transfer of the wastes to another environmental compartment and eventually even into the water body that is to be protected.

b. Ontario Initiatives

The province of Ontario, like other provinces, has traditionally used ambient quality-based objectives and standards. Recently, however, Ontario had begun moving toward including a version of the concept of load reduction in its environmental control strategy for direct discharges into water. However, there is no plan to set absolute load reduction targets. The only such initiative is the Countdown Acid Rain program.

Under its new strategy to deal with toxic chemicals, the Municipal Industrial Strategy for Abatement (MISA)[21] in Ontario is developing effluent standards based on the "best available technology most economically achievable" (BATEA) for the major types of polluting industries. If the BATEA standards are found to be insufficient to protect water quality at a particular site, more stringent water-quality-based effluent limits for that plant will be identified through water-quality impact assessments. By reviewing and updating the regulatory definition of BATEA, MISA is expected to achieve its ultimate goal - the overall reduction of toxic substances entering the environment.

Whether or not the BATEA standards will lead to an overall reduction of toxic chemicals in the environment is the subject of some debate. First, BATEA alone is unlikely to result in absolute load reductions, as was described earlier. It is only the combination of BATEA and the site-specific quality assessment that could provide any absolute reduction. Because the strategy does not address the concept of absolute reduction targets for persistent toxic substances, it is not expected that they will spontaneously result. Second, the proposed Ontario standards assume that by making standards more stringent over time, there will be an overall reduction in discharges. Such assumptions not only fail to relate the standards to the actual ongoing water-quality implications of discharges, but also fail to take into account new industrial inputs that increase total loading. Finally, there is little incentive under the program to develop new, more advanced, and more efficient technology. Without these "technology-forcing" measures, the BATEA standards may remain fairly stagnant.

c. Acid Rain Controls

Throughout the basin, there has been a tendency to take an absolute load reduction approach with the acid rain problem. A maximum deposition rate for sulphur dioxide was established which represents the assimilative capacity of the environment, or the threshold level at which no adverse effects on fish or vegetation are manifested. Legislation in Wisconsin adopts a goal of greater than pH 4.7 for precipitation; to accomplish this goal, the state has set a ceiling on total emissions of sulphur dioxide from all major sources of 325,000 tonnes per year beginning in 1993. Until 1993, and for small sources, the statute provides for a maximum average emission rate for private and public emitters. A similar program is established for nitrogen oxides emissions.[22]

In Ontario, the Countdown Acid Rain Program requires major industries emitting acid-causing emissions to meet load reduction targets according to a timetable. This requirement affects Inco, Falconbridge, and Algoma Steel, the major private sources, and Ontario Hydro (the province's power utility), which are required to meet 50 percent load reductions for sulphur dioxide emissions by 1994.[23]

It is quite clear from these few attempts that the load reduction concept has not been put to widespread use in the basin or elsewhere. This may be because there are a number of implementation problems. However, the value of the concept has been recognized as a viable way to achieve a gradual overall reduction of discharges of toxic chemicals into the environment of North America.

6.4 Implementing Absolute Load Reduction

The experience with absolute load reduction in the basin points to the difficult implementation issues that must be addressed in developing a comprehensive risk-reduction strategy for persistent toxic substances. The issues that must be addressed in an absolute load-reduction approach include:

i. What is the ultimate target? In the Great Lakes basin, the target for persistent toxic substances is virtual elimination of inputs, in essence no inputs from any source.

ii. What are the interim targets? This issue addresses the appropriate timing for reaching the ultimate target and the basis for setting the target, e.g., should it be arbitrarily set or based on environmental criteria? The answer will involve striking a balance between the polluters' abilities to adapt their processes and the seriousness of the environmental risks. For persistent toxic substances, it seems appropriate to require quick action on the road to virtual elimination. Rather than arbitrarily setting load reduction targets, it seems reasonable that such targets should be based on criteria designed to protect the health of the ecosystem.[24] In light of the uncertain long-term effects of many toxic chemicals, the setting of load reduction targets in this way may be a difficult task.

The U.S. EPA attempted to address the issue, in part, under its Toxics Control Strategy.[25] Under the strategy, a national policy is being developed for the formulation of permit limitations based on the toxicity of the effluent discharge as a whole.[26] Under this approach, toxicity limits are developed for the whole effluent using a variety of biological testing techniques (as opposed solely to using a chemical-specific approach). This approach is now under review in some parts of Canada.[27] As it is further developed, widespread use of load reductions will become more feasible.

iii. How should the reductions be allocated? In the Great Lakes basin, there must be allocation among jurisdictions, as well as among polluters in each jurisdiction. Allocation between jurisdictions can only be done through consultation. The equal division between Canada and the U.S. used in the Niagara River accord may have been the only possible compromise at the time, but it bears no relation to existing contributions and thus no relation to the extent of risk reduction necessary to achieve the goal of zero discharge. A more equitable allocation schedule is more consistent with the principles of load reduction, though obviously more difficult to agree on.

It must be remembered that load reduction is only one part of a comprehensive strategy to reduce exposure to persistent toxic substances. It is intimately connected with the multi-media concept and requires the use of mass-balance to be effective. It is also supplemental to a source reduction strategy, on the one hand serving as an incentive to turn to source reduction, and on the other hand, filling the gaps that source reduction does not fill. However, even a strategy of absolute load reductions alone will go a long way toward achieving the goal of virtual elimination.

6.5 Findings and Recommendations

6.5.1 Findings

a. The source reduction concept will only be fully implemented over the long term; even when fully implemented, there still may be residual pollutants.

b. Relative standards were designed and developed to respond to pollution problems different from those posed by toxic pollution. They are neither designed nor intended to bring about an overall reduction in quantity of pollutants entering the basin.

c. There have been only a limited number of initiatives within the basin that have involved standards designed specifically to reduce the absolute quantities of pollutants entering the water body.

6.5.2 Recommendations and Action Steps

a. All basin governments should jointly set load reduction targets for chemicals of concern entering the ecosystem.

b. Load reduction targets should be based upon ecotoxicological data and indicators of ecosystem health (including early response indicators) and annual targets should be set at levels that gradually reduce the absolute quantities entering the ecosystem.

c. Basin jurisdictions should allocate load reductions among them on an equitable basis.

d. Within each jurisdiction, the basin-wide targets should be integrated with existing standards and reductions should be allocated among the sources in that jurisdiction. A formula for equitable allocation of the reductions between different industries/source types and between existing and new sources should be developed by each jurisdiction according to its own priorities.

e. Financial and technical assistance should be given to assist achievement of the targets. Preference for assistance should be given to source reduction techniques.

f. Periodic monitoring and annual reporting of progress toward the targets should be done by all jurisdictions.

g. Until load reduction targets can be set, standards should be reviewed and made more stringent for persistent toxic substances and the basis for standards, e.g. weekly v. daily exposure levels, should be reviewed and revised. Permits should require biological tests of whole effluent as the basis for prohibiting toxic inputs.

Further recommendations pertaining to the further research needs and institutional reforms are enunciated in chapter 8.

Chapter 7 - From Jurisdictional Diversity to an Ecosystem Perspective

> The ecosystem approach does have the advantage that industry cannot just cross a political border to avoid more stringent environmental protection standards.
>
> *A participant at the Michigan Workshop (January 1987)*

7.1 Introduction

In chapter 3, the need for cross-media regulation was demonstrated by the fact that toxic substances travel between and through different media. Toxic chemicals are also mobile in other ways: they traverse the political borders within a river basin or shared water body. The successful implementation of comprehensive toxic-substances control and abatement strategies is, therefore, impeded when the responsibility over the water or river body is shared by more than one government or by different levels of government that do not act in concert. The diversity of jurisdictions can produce a fragmented approach, and in some cases, overlapping or duplicated efforts as each government attempts to deal with a problem in an isolated way.

The need to treat the Great Lakes basin as a single integrated system was recognized in the 1978 Great Lakes Water Quality Agreement, which adopted the ecosystem approach as the preferred one to Great Lakes management. The ecosystem approach responds to both cross-media and jurisdictional diversity problems by taking a unified, holistic approach to solving basin problems. Although it is fair to say that the concept of ecosystem-wide management is becoming more accepted, there is still a considerable way to go before it is firmly entrenched in the regulatory schemas of the jurisdictions within the basin. The use of an ecosystem approach was mandated in the agreement, but no guidance was given concerning how to implement it within the basin. To overcome jurisdictional diversity, such an approach demands, at a minimum, a great degree of intergovernmental coordination and cooperation on many fronts. (Overcoming cross-media problems was discussed in chapter 4). This chapter explores some ways of using an ecosystem approach in a regulatory strategy intended to achieve virtual elimination of inputs of persistent toxic substances to the environment.

7.2 The Problem of Jurisdictional Diversity

The adage that "pollution does not respect political boundaries" is appropriate for toxic chemical pollution. Long-range transport of toxic air pollutants (described in chapter 2) is one illustration of this phenomenon. Also, in a single ecosystem that is shared by a number of jurisdictions, chemicals moving into and through the system are by definition transboundary pollutants. This is the situation in the Great Lakes basin, which is governed by 12 major jurisdictions - 2 national governments, 2 Canadian provinces, and 8 U.S. states - in addition to a large number of county, municipal, and local subdivisions within each larger jurisdiction.

Because of the shared management responsibilities among all these jurisdictions and a lack of inter-agency and inter-jurisdictional coordination, environmental protection strategies are fragmented and duplicated and, as a result, inefficient and possibly ineffective.

The International Joint Commission (IJC) has long recognized the problem and described it as follows:

> The underlying problem ... is the absence of an overall Great Lakes Ecosystem strategy for toxic substances control activities that are being carried out under the various pieces of legislation among the jurisdictions. Programs have been compartmentalized under each legislative mandate, and the resources have been allocated accordingly... This fragmentation has resulted in duplicated activities in some cases, incomplete program coverage in others, and a limited management capacity to effectively address emerging complex problems.[1]

For the approvals process, jurisdictional diversity raises a number of questions:

- What is the geographic scope of regulation by each jurisdiction?
- Does it allow consideration of impacts in other jurisdictions?
- Is there consistency in the approaches taken by the jurisdictions?
- Are data-gathering and regulatory efforts coordinated among different jurisdictions?

7.2.1 Scope of regulation (extra-jurisdictional considerations)

When establishing environmental protection standards or issuing pollution discharge permits, the environmental board or agency in each jurisdiction takes into account a variety of factors that is usually specified in legislation. Unfortunately, few agencies and boards within the Great Lakes basin take into account the impacts of their standards or permits on neighbouring jurisdictions or on the basin as a whole.

One of the reasons why jurisdictions seldom take extra-jurisdictional considerations into account is that enabling statutes often impose "territorial limitations."[2] Many statutes direct boards, tribunals, or administrative agencies to protect "waters of the state," "the natural resources of the state," "natural environment of the province," or use similar language.[3] Concern has been expressed that this narrow statutory authority limits the extent to which these boards, tribunals, or administrative agencies can issue permits or set standards that will protect the environment of neighbouring states and provinces of the basin as a whole.

However, in practice, a territorial limitation is not always strictly adhered to. For example, some states explicitly recognize, to varying degrees, certain extra-territorial obligations. Minnesota's "other uses" concept[5] requires that jurisdictions sharing water resources of the state be considered in determining the designated uses of the waters of the state.[4] New York's regulations recognize obligations under international agreements.[5]

7.2.2 Extra-territorial impacts

Territorial limitations can also be interpreted to include consideration of extra-jurisdictional effects. For instance, while most agencies are mandated to protect only the waters of the jurisdiction, the purpose of such language is not to exclude information being presented on extra-jurisdictional effects. Such information is taken into account, at least where there are also effects within the jurisdiction.

Moreover, a term like "waters of the state" is often expanded by definition, especially with regard to the Great Lakes. Thus, for example, "waters of the state" may be defined to include those bodies of water that "flow through" or "border upon" the jurisdiction or even "the Great Lakes and its connecting waterways."[6] Such definitions allow some consideration of discharges to that body of water flowing out of the jurisdiction.

From a strict legal point of view, authority probably exists for basin governments to include the interests of the basin as a whole in their approvals process. Unfortunately, the perception persists that such authority is not present and is therefore in need of clarification. For example, clarification could be made in a similar manner to Ontario's attempt to deal with the issue. Provincial policy states: "In addition, Ontario borders on inter-provincial and international waters, and the implication of the Province's activities must be considered in that context."[7]

Alternatively, a legislated definition of "environment" that does not refer to political jurisdictions would accomplish the same purpose.

7.2.3 Consistency of approach

The case study undertaken by CELRF [8] (described in chapter 1) identified significant disparities and inconsistencies of standards for four toxic chemicals, and the methodologies employed for establishing those standards among the states and provinces within the basin. These findings are found in table 7.1 and are summarized below.

All basin jurisdictions have ambient water-quality criteria for lead and hexavalent chromium (although the Indiana, Ohio and Ontario standards apply to total chromium). All jurisdictions, except Indiana, Michigan, and Minnesota have criteria for dieldrin. However, only New York, Ontario, Pennsylvania, Quebec, and Wisconsin have ambient standards for hexachlorobenzene (HCB). The lack of ambient water-quality criteria for a contaminant does not necessarily indicate that a jurisdiction does not consider the contaminant a concern.

Most jurisdictions have procedures whereby criteria can be set on an ad hoc basis or borrowed from another authoritative source, usually the U.S. EPA. This is particularly the case for those states that rely on narrative standards and therefore have limited numerical water-quality standards.[9] However, lack of a standard does demonstrate the extent to which the jurisdiction has closely reviewed the impact of that contaminant in relation to the ecosystem.

Perhaps more significant than the fact that certain jurisdictions have not promulgated water-quality standards for dieldrin and HCB is the extent of divergence evident in those water-quality standards. The greatest variance is found in the ambient criteria for dieldrin. Illinois has promulgated a standard of 1.0 ug/l for drinking water compared to the human health standard of 0.000076 ug/l in Wisconsin or 0.000071 ug/l in Ohio. A similar divergence in standards for HCB can be found by comparing New York's guidance value for human-health standard of 0.02 ug/l to Wisconsin's similar purpose standard of 0.000074 ug/l. In the case of lead and hexavalent chromium, there is a great deal more uniformity but Michigan's and New York's standards for chromium VI of 6 and 11 ug/l, respectively, are substantially lower than the 50 ug/ l of the other jurisdictions. Similarly, Ohio's standard for lead is just less than half the allowable concentration of 50 ug/l in most other jurisdictions.

There is also variation in the basis on which these standards are set, primarily between a traditional "threshold" approach, where a level of no observable effect is found, and a risk-assessment approach, where no threshold is assumed and the objective of setting standards is to protect against an "acceptable" level of risk, e.g., one cancer in a million. The risk-assessment approach highlights many of the limitations of the traditional process of establishing water-quality standards. The overriding limitation is that both the traditional and risk-assessment approaches assume, either implicitly or explicitly, that zero discharge of toxics will not or cannot be achieved. The toxicity tests applied to generate the data base used in this process are largely based on tests on limited aquatic species with a single concentration of a contaminant. Such an approach does not address the nature of ecotoxicology, which concerns the collective results of all types of toxic stresses acting on the environment.[10]

Water-quality standards may be perceived as objectively determined concentration levels based on proved scientific methodology. Thus, they provide a certain degree of confidence with regard to the attainment of a healthy ecosystem

TABLE 7.1 CELRF CASE STUDY COMPARISON HUMAN HEALTH AND DRINKING WATER CRITERIA IN THE GREAT LAKES BASIN

GENERAL USE AND AQUATIC HEALTH CRITERIA (ug/l)

Jurisdiction	Dieldrin	HCB	Chromium VI	Lead
CANADA	0.004	0.0065	20 to protect fish 2 to protect other life	1 to 7
ONTARIO	0.001	0.0065	100	5 to 25
QUEBEC	0.25 (A) 0.00019 (C)	--	40 (TCr)	5 to 30
U.S. EPA	2.5 (A) 0.0019 (C)	250 (A) 50 (C)	16 (1hr ave) 11 (4day ave)	34 to 200 (Max) 1.3 to 7.7 (4day ave)
OHIO	0.005	Formula	10 (30 day ave) 50 (L. Erie)	30 (L. Erie)
MICHIGAN	Formula	0.0019	6	$exp^{[1.53(\ln H)-5.92]}$
PENN.	2.5 (A) 0.0019 (C)	250 (Max)	16 (Max) 11 (1day ave)	50
NEW YORK	0.001	0.02	16 (Max) 11 (1day ave)	$exp^{[1.266(\ln H)-4.661}$
ILLINOIS	Formula	Formula	50	100
MINNESOTA	2.5 (A) 0.0019 (C)	250 (A) 50 (C)	20 (TCr)	34 to 200 (A) 1.3 to 7.7 ((
WISCONSIN	2.5 (A) 0.22 (C)	Modified EPA	$2.315(H)^{.7129}$ (A) $0.968(H)^{.7129}$ (C)	$8.4(H)^{1.0519}$ (A) $0.0014(H)^{2.3493}$ (C
INDIANA	Formula	Formula	50 (TCr)	50

HUMAN HEALTH AND DRINKING WATER CRITERIA (ug/l)

Jurisdiction	Dieldrin	HCB	Chromium VI	Lead
CANADA	0.7	--	50 (TCr)	50
ONTARIO	0.7	--	50 (TCr)	50
QUEBEC	0.000071	0.0072	50 (TCr)	50
U.S. EPA	0.00071	0.0072	50	50
OHIO	0.000071	Formula	10 to 19	50
MICHIGAN	Formula	Formula	Formula	$exp^{[1.53(\ln H)-5.92]}$
PENN.	0.001 (Lake Erie)	0.0072	50	50
NEW YORK	0.0009	0.02	50 (TCr)	50
ILLINOIS	1	--	50 (TCr)	50
MINNESOTA	0.00071	0.0072	50	50
WISCONSIN	0.000071	0.000072	50	50
INDIANA	--	--	50 (TCr)	50

when they are achieved. The limited nature of the data base, especially for toxic chemicals, and the need to apply safety factors and to extrapolate data for application to human health objectives belies this perception. The risk-assessment approach, which requires a judgment about what constitutes an acceptable level of risk, further demonstrates the subjective nature of water-quality standards. Value judgements, such as the determination of an acceptable level of risk, are usually resolved according to the competing interests within the promulgating jurisdiction. The effects of these decisions are, however, manifested throughout the ecosystem.

Inconsistent standards mean industries in jurisdictions with less-stringent standards are in a position to pollute more of the shared water body. In jurisdictions with stricter standards, it is more difficult for industry to meet the standards because significant pollution quantities may be originating from states with weaker standards.

7.2.4 Coordination of research and regulation

Within the basin, there are few coordinated efforts at research and monitoring or at regulation (standard setting and permit-issuing). Routine monitoring of the air and waters of the basin are not coordinated between the different jurisdictions, although there is some sharing of findings through the IJC's boards. Because the monitoring programs are uncoordinated, the protocols may be different, so that data cannot be compared and different jurisdictions monitor for different contaminants. Monitoring data primarily relate to single-medium concentrations of individual chemicals; there is no monitoring of effects on the ecosystem. The mechanism used for gathering and evaluation of monitoring data in the basin is the Great Lakes International Surveillance Plan (GLISP).[11]

In 1984, the Council of Great Lakes Research Managers was established to provide advice on research needs to the IJC and to coordinate research efforts in the basin.[12] The council reviewed the effectiveness of Great Lakes research programs and recently reported that research should be directed more fully toward developing data about total exposure, diffuse sources, ecosystem health parameters, effects on biota of mixtures of contaminants, and other such programs. These recommendations are reflected in the requirements for research in the 1987 amendments to the GLWQA.[13]

Coordination of regulation between jurisdictions occurs even less often than coordination within jurisdictions (discussed in chapter 4). Standards are set and permits are issued with little input from other jurisdictions, even when effects are transboundary.

Finally, an in-depth study has already been undertaken indicating that there are a number of important barriers preventing residents of one jurisdiction from participating in the environmental decision-making processes of another.[14] Hence, in some instances, residents may be unable to put forth their views when standards are being set or permits issued in neighbouring jurisdictions.

Thus, a diversity of jurisdictions within an ecosystem can impede the goal of integrated environmental and natural resource management. The curative actions of one jurisdiction can be mitigated by the inaction or counteraction of another jurisdiction. All jurisdictions within a shared basin, lake, or other water body contribute to the overall burden of toxic chemical input limiting the effectiveness of individual action and necessitating coordinated action by all jurisdictions. This is the basis of the ecosystem approach.

7.3 The Ecosystem Response

The term "ecosystem" was first used in 1935 to refer to plant communities and their physical and chemical environments, which together formed an integrated ecological system. The term has subsequently been applied to refer to many types of interacting systems enclosed by boundaries, such as watersheds, city limits, or the biosphere.[15] The concept has been adopted and applied by a number of international bodies such as the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Man and the Biosphere Programme.

An ecosystem approach to environmental planning and management is said to be characterized by three primary features. First, an ecosystem approach focuses on a geographical area with ecological boundaries (as opposed to a particular political jurisdiction) as the management unit. Ecosystem thinking as a planning tool is in part derived from the regional planning and river-basin management concepts developed in the United States in the 1920s.[16] These concepts suggest that because actions taken within an ecologically defined territory will affect all components of the system, the effects upon the ecological unit as a whole must be taken into account before allowing actions to be pursued. Further, decision makers within an ecological region that crosses political boundaries must expand their policy horizons beyond the edge of their political jurisdictions to the ecological limits of the watershed or other ecosystem.

Second, an ecosystem approach is comprehensive, in the sense that it encompasses an entire system - physically, chemically, and biologically - and includes the land, air, and water, as well as all human interactions. Because of this, an ecosystem approach inherently encompasses a cross-media perspective in that it recognizes the interconnectedness of all components of the environment.[17]

Third, the approach is transdisciplinary in nature because it recognizes the interactions between the ecological, social, economic, and political systems within the region. Economic development patterns, resource policy, consumer trends, and public attitudes must be considered in the overall context of the approach because of their actual or potential impacts on the integrity of the system.

The ecosystem approach, as one report notes, "is a departure from an earlier focus on localized pollution, management of separate components of the ecosystem in isolation, and planning that neglects the profound influences of land uses on water quality."[18] It mandates a strong emphasis on inter-jurisdictional coordination, common goal formulation, coordinated mechanisms for allocation and use of resources, and cooperative planning.

These features of an ecosystem approach make it a necessary component of a comprehensive and preventive approach to the virtual elimination of persistent toxic substances.

At an international level, both the Canadian federal and provincial governments first recognized the merits of an ecosystem approach within the Great Lakes basin in the 1978 Great Lakes Water Quality Agreement. This agreement specifically recognizes and adopts the ecosystem approach, declaring that its purpose is "to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem" and defines the ecosystem as "the interacting components of air, land, water and living organisms, including man, within the drainage basin of the St. Lawrence River."[19]

In accordance with this mandate, the agreement sets as its goals the development of surveillance and monitoring programs, the setting of general and specific water-quality goals and standards, including the goal of virtual elimination of persistent toxics.[20] The agreement also recognizes airborne and land-based pollution, and the need for intergovernmental cooperation and coordination.[21]

Since the conclusion of the 1978 agreement and the 1987 amendments to that agreement that reaffirm the ecosystem approach, other bilateral arrangements have also embraced the ecosystem concept. In 1985, all basin states and the provinces of Ontario and Quebec signed the Great Lakes Charter, a statement of principles to deal with the issues of inter-basin water transfers and consumptive uses. The charter specifically recognizes the Great Lakes as an ecosystem that should be treated "as a single hydrologic system."[22] It further establishes a framework for cooperative planning and management among the member jurisdictions.

More recently (May of 1986), a parallel accord was concluded, entitled the Great Lakes Toxic Substances Control Agreement (GLTSCA).[23] Principle II of the agreement, commits the signatories "to managing the Great Lakes as an integrated ecosystem, recognizing that the water resources of the basin transcend political boundaries." In furthering this approach, the accord pledges to control point source and non-point sources and then provides fairly elaborate provisions for implementing the agreement, including the development of coordinated permit-issuing systems, cooperative waste-management strategies, joint monitoring and surveillance activities, and information exchanges.

U.S. EPA's Five Year Strategy for the Great Lakes National Program Office also adopts as its goal "to apply an ecosystem approach to management by considering effects of use of the Lakes on the health of biota and on human health."[24] Ontario's MISA program contains a commitment to an "integrated ecosystem approach" to ensure that "all the air, water and land regulatory components will be made compatible and complementary."[25] However, in a document responding to public comments on MISA, the Ministry of the Environment admitted that MISA does not contain a specific transboundary component.

Efforts have been made to implement the ecosystem approach at a local level. Throughout the Great Lakes, the IJC has identified areas of concern for which remedial action plans (RAP) are being developed. Because of varied agency responsibilities, some RAPs have attempted to take an ecosystem approach, although it is still too early to evaluate their success.

7.4 Implementing the Ecosystem Approach in the Great Lakes Basin

Because no guidance was given in the 1978 or subsequent agreements on how to implement an ecosystem approach, little progress has been made toward its implementation. This was the conclusion of the reviews done of the 1978 agreement. Full implementation of the approach requires education, economic planning, and value change, as well as regulatory action. Public support for implementation is crucial to its accomplishment.

One of the most difficult management and regulatory problems associated with the concept of an ecosystem approach is how to address the inter-ecosystem questions, particularly when a political jurisdiction may be part of several ecosystems. The 1987 amendment to the GLWQA require the notification of the non-Basin jurisdiction responsible for atmosphere emissions that contribute to Great Lakes pollution and the seeking of a "suitable response."[26] Obviously, coordination according to similar principles would be required.

For the approvals process, the following issues must be considered in designing a strategy for implementation.

i. Scope of regulation: all the jurisdictions must be able to consider the interests of the basin as a whole.

ii. Consistency of approach: all the jurisdictions should set standards and issue permits on the same basis, i.e., using the same or similar criteria, a common data base, and consistent techniques. One option is to have a single basin-wide standard as a term of reference for all jurisdictions.

iii. Coordination: steps must be taken to reduce overlap and duplication of research, monitoring, and regulatory effort and to close regulatory gaps both within and between jurisdictions.

iv. Fairness: steps should be taken to ensure non-discriminatory access to basin courts and tribunals for environmental decision-making.

The coordination issue is of particular importance. Each jurisdiction must make a functional assessment of its agencies and communicate that information to other jurisdictions as a first step. Only then can coordination between jurisdictions be undertaken. Cooperative efforts, such as monitoring or data collection and dissemination, should be considered a priority. This issue was addressed by the 1985 IJC's Water Quality Board report, which recommended that the Great Lakes International Surveillance Program (GLISP) should be updated and refocused toward ecosystem concerns.[27] The kind of monitoring information required relates to ecosystem health indicators, such as effects on biota and food-web dynamics, to effects from mixtures of chemicals, and to comprehensive tracking of sources and pathways of toxic substances entering the basin. There is also a need to standardize techniques used and to cooperate in managing monitoring programs. These recommendations and others have been adopted in the 1987 amendments to the GLWQA.[28]

Research needs have been addressed recently by the Council of Great Lakes Environmental Research Managers.[29] They reviewed research needs and concluded that more socio-economic research was necessary, that management goals should be established to make scientific research more coordinated and collaborative, and that scientific research should focus on more integrated issues such as effects of mixtures of chemicals, effects on the health of the ecosystem, inputs from diffuse sources, and relative contributions from different routes of human exposure. At a minimum permit-issuing on an ecosystem basis requires consultation between jurisdictions. The efforts of the states under the Permitting Agreement of the GLTSCA to gradually move toward more cooperative permitting should be continued. The need for foresight makes the issue of institutional mechanisms inevitable. Most coordination can be achieved through joint consultation and regular meetings of affected agencies.

7.5 Findings and Recommendations

7.5.1 Findings

a. Pollution entering the Great Lakes basin is pollution that can affect 12 political jurisdictions. Each of the 12 federal, state, provincial, as well as various municipal governments, have regulatory programs that attempt to control the inputs of toxic chemicals to the basin. These programs are divided between numerous agencies, even within each jurisdiction, and contain differing goals, and rely on differing grounds for control.

b. This diversity of political jurisdictions and programs has led to fragmented, duplicative, and inefficient approaches to toxic pollution.

c. Different priorities in regulation between jurisdictions can mean the inaction of one government in the face of positive action by other governments. The effect can be to negate or blunt positive action to the detriment of the basin as a whole.

d. The Great Lakes Water Quality Agreement of 1978 and the Great Lakes Charter adopt the ecosystem approach as the basis for management of the Great Lakes. An ecosystem approach requires that actions be coordinated between the jurisdictions of the basin and that cooperative efforts be taken where possible.

5.4.2 Recommendations and Action Steps

a. The ecosystem concept should be integrated into the laws, regulations, programs, and institutions of each basin jurisdiction.

b. Basin-wide standards for persistent toxic substances should be developed. This can be done either by joint agreement on the goal or basis for the standards with development of the particular standards left to each jurisdiction, or, by the joint development of uniform standards for the basin as a whole which are enforced by each jurisdiction.

c. In the absence of uniform standards, the standard-setting process in each jurisdiction should be modified to include the following principles:

(i) consideration of extra-territorial impacts;
(ii) consultation with other basin governments, including notification of proposed standards and opportunity to comment; and
(iii) access to the process (right to notice, comment, intervention) by all citizens of the basin on an equal basis.

d. Each jurisdiction should continue to issue permits for sources within its territory but the process should be modified to include the following principles:

(i) consideration of extra-territorial impacts;
(ii) consultation with other basin governments; and
(iii) non-discriminatory citizen access.

e. All jurisdictions should work together to develop coordinated non-point source control programs with the aim of addressing the same source types in similar ways.

f. Monitoring programs should be coordinated. All jurisdictions should agree on the minimum list of chemicals to be monitored in the basin and all basin jurisdictions should use compatible sampling, testing, and reporting methods.

Further recommendations pertaining to research needs and institutional reforms are enunciated in chapter 8.

Chapter 8 - Conclusions and Recommendations

8.1 Introduction

Toxic chemical pollution continues to pose a significant human-health and environmental risk in the Great Lakes basin. After a decade and a half of regulation of toxic chemical pollution, there have been some successes in reducing the risks in specific areas within the basin and from specific chemicals. Despite successes, however, toxic chemical pollution remains the most significant threat to the health of the ecosystem.

The toxic dilemma facing the Great Lakes basin cannot be fully resolved under the current regulatory framework. The existing framework was designed in an earlier era, when the primary concern was over conventional pollutants and was based on what is now seen to be an incomplete understanding of the ecological effects and interactions of many pollutants.

To reverse the continuing trend of toxic degradation and to reduce the risks to long-term human and environmental health from exposure to toxic substances, a regulatory strategy is needed. Such a strategy must be grounded in principles of comprehensiveness, prevention, and cooperation that flow from a recognition of the behaviour of toxic substances in the environment and a recognition of the agency and jurisdictional divisions within the Great Lakes basin. Implementing this strategy requires both a need to fortify existing efforts and a need to adopt new concepts particularly for persistent toxic substances.

This report has attempted to capture the current thinking from literature reviews, interviews, and workshops held in all corners of the basin - about the weaknesses and strengths of the existing regulatory regimes that attempt to control toxic chemicals. The fundamental thrust of the report is that the only viable long-term solution to the problem is an anticipatory, preventive approach. In terms of regulatory policy, this approach is best summed up in the goal of virtual elimination of inputs of persistent toxic substances as implemented through the cross-media, source reduction, load reduction, and ecosystem concepts.

Below is a compilation of the recommendations contained in this report that, in effect, form a regulatory strategy for the reduction and elimination of toxic substances in the Great Lakes basin. This regulatory strategy, while introducing new concepts, assumes not only the viability of current regimes, but also the need for greater resources at the local, state/provincial, federal, and international levels to monitor, enforce, and fully implement existing environmental protection laws. No detailed analysis is given on to how to blend current and newer concepts and legislation so as to achieve integration. This blending requires a complete review of the laws and institutions in each jurisdiction. Rather, the focus is on the principles and elements of a strategy that can fulfill the goal of virtual elimination.

Although a coherent regulatory strategy will assist and, indeed, is a vital component of a strategy to reduce risks from toxic substances, it is just one of many components. Other imperative components include increased funding and coordination of scientific research; mobilizing of political will; changes in local and inter-jurisdictional institutions, social attitudes, resource use, industrial products, and consumer purchasing patterns; and improved environmental education. Significant changes to the structure of resource policy and use is also needed. Priority must be given to better understanding of resource-conservation pricing and how to bring environmental concerns into the mainstream of Great Lakes economic decision-making.

These concepts and proposals are, of course, only one step on the road to a virtual elimination strategy. Much more work is required, within and among the 12 basin jurisdictions, to develop the detailed mechanisms for change. This is a formidable challenge that requires imagination, courage, and commitment, but the benefits are clear and worth the effort.

8.2 A Regulatory Strategy for Achieving Zero Discharge in the Great Lakes Basin

The following eight recommendations represent a strategy, or perhaps a blueprint for regulatory reform to be considered by all governments of the Great Lakes basin. The recommendations are followed by suggestions or "action steps" for implementation.

Recommendation 1.0 Regulatory Policy Goals

1.1 A basin-wide regulatory strategy should be developed to implement the objectives of the Great Lakes Water Quality Agreement.

1.2 All basin jurisdictions should work together to develop the strategy and to agree on targets and schedules for implementation.

1.3 Such a strategy should have as its ultimate objective the virtual elimination of persistent toxic substances and should encompass the three principles of comprehensiveness, prevention, and cooperation.

1.4 Each basin jurisdiction should ensure the implementation of the strategy in its regulatory processes.

1.5 Existing regulatory processes should be strengthened to provide the most complete coverage and best enforcement possible.

1.6 In addition, four concepts should be integrated into the regulatory processes of each jurisdiction. These concepts include: (1) a cross-media approach; (2) source reduction; (3) load reductions; and an (4) ecosystem approach.

1.7 Priority for research and regulation should be given to persistent, bioaccumulative toxic substances.

Recommendation 2.0 Cross-media Approach

2.1 All regulatory processes should incorporate a cross-media approach, that is, standard-setting and permitting processes ought to recognize total exposure to toxic substances (including all sources and all pathways of exposure).

2.2 Each jurisdiction should review its air, water, and waste management standards and its standard-setting and permitting processes to judge their potential for integration of cross-media concerns. Inter-agency consultation and coordination of efforts in standard-setting and permitting review should be instituted immediately.

2.3 The goal of the standard-setting process should be to control the total environmental exposure to persistent toxic substances. Multi-media standards should be developed by each jurisdiction and in coordination with all other basin jurisdictions.

2.4 As part of the development of such standards, all basin jurisdictions should cooperate in the development of a comprehensive data base to allow mass balances to be done.

2.5 Permitting processes should take into account all toxic emissions and wastes (including fugitive emissions) from a source.

2.6 The granting of permit applications should be based upon criteria that include the best mix of controls to minimize total risk from a source. This requires coordination of applications or single applications for each source.

2.7 Mechanisms for extending permitting to non-point sources should be explored.

Recommendation 3.0 Source Reduction

3.1 Basin governments should adopt source reduction as the preferred objective for pollution control and waste management regulation. Waste reduction as a secondary objective should also be adopted.

3.2 This objective should be legislated by each jurisdiction and should be supported by financial and technical programs and assistance.

3.3 Support should be given to assist in encouraging the development of technology for substitute products, low and non-waste processes, and alternative raw materials.

3.4 Standards should be developed to specify materials, products, processes, and process technology that will minimize the potential risk of exposure to toxic substances. Standards should be industry-specific and allow for a range of alternative technologies.

3.5 Standards should address both existing and new facilities and include specific reduction targets.

3.6 Permit applications should be reviewed on the basis of a "source reduction assessment" of a proposed facility which would canvass alternatives available and consider material, product, process, and technology choices in terms of the minimum potential risk of exposure and cost effectiveness.

3.7 Existing facilities should be required to conduct a review of their processes and their ability to achieve the source reduction standards. Schedules for implementation of the standards should be required. Financial support should be considered, if necessary, to meet the schedule.

3.8 All facilities should be required to report their source reduction efforts to the governing agency in order to maintain an information bank which can be shared by others within the same industry and by other industrial sectors.

3.9 Source reduction techniques should also be developed for non-point sources to minimize the potential for exposure to toxic substances.

Recommendation 4.0 Load Reductions

4.1 All basin governments should jointly set load reduction targets for chemicals of concern entering the ecosystem.

4.2 Load reduction targets should be based upon ecotoxicological data and indicators of ecosystem health (including early response indicators) and annual targets should be set at levels that gradually reduce the absolute quantities entering the ecosystem.

4.3 Basin jurisdictions should allocate load reductions among them on an equitable basis.

4.4 Within each jurisdiction, the basin-wide targets should be integrated with existing standards and reductions should be allocated among the sources in that jurisdiction. A formula for equitable allocation of the reductions between different industries/source types and between existing and new sources should be developed by each jurisdiction according to its own priorities.

4.5 Financial and technical assistance should be given to assist achievement of the targets. Preference for assistance should be given to source reduction techniques.

4.6 Periodic monitoring and annual reporting of progress toward the targets should be done by all jurisdictions.

4.7 Until load reduction targets can be set, permits should require biological tests of whole effluent.

Recommendation 5.0 Ecosystem Approach

5.1 The ecosystem concept should be integrated into the laws, regulations, programs, and institutions of each basin jurisdiction.

5.2 Basin-wide standards for persistent toxic substances should be developed. This can be done either by joint agreement on the goal or basis for the standards with development of the particular standards left to each jurisdiction, or, by the joint development of uniform standards for the basin as a whole which are enforced by each jurisdiction.

5.3 In the absence of uniform standards, the standard-setting process in each jurisdiction should be modified to include the following principles:

(a) consideration of extra-territorial impacts;
(b) consultation with other basin governments, including notification of proposed standards and opportunity to comment; and
(c) access to the process (right to notice, comment, intervention) by all citizens of the basin on an equal basis.

5.4 Each jurisdiction should continue to issue permits for sources within its territory but the process should be modified to include the following principles:

(a) consideration of extra-territorial impacts;
(b) consultation with other basin governments; and
(c) non-discriminatory citizen access.

5.5 All jurisdictions should work together to develop coordinated non-point source control programs with the aim of addressing the same source types in similar ways.

5.6 Monitoring programs should be coordinated. All jurisdictions should agree on the minimum list of chemicals to be monitored in the basin and all basin jurisdictions should use compatible sampling, testing, and reporting methods.

Recommendation 6.0 Developing the Data Base

6.1 All basin jurisdictions should support the development of a comprehensive data base that will allow the timely implementation of the objectives of the Great Lakes Water Quality Agreement.

6.2 Basin governments should develop transdisciplinary research programs that address the sources, pathways, fates and effects of toxic substances in the basin.

6.3 More specifically, areas in need of further research include:

- inventory of toxic substances of concern;
- effects of toxic substances in combination, together with synergistic, antagonistic, and additive effects;
- effects on different trophic levels;
- the use of "bioindicators" and early response system in the ecosystem;
- relationship between laboratory and field studies;
- all loadings from all sources into the basin including atmospheric and groundwater inputs to the Lakes;
- accidental releases of toxic substances;
- exchange between air, water, sediments, land and biota;
- socio-economic impacts of toxic substances; and
- trends of loadings of persistent toxic substances.

6.4 Basin agreements should devote more effort to developing the data base for mass balance analyses. This requires:

(a) inventory of sources (point and non-point within and beyond the ecosystem) and inputs from each source; and
(b) models of transport, transformation and degradation within the system.

6.5 Basin governments should support the development of products and processes that minimize the creation of toxic substances.

Recommendation 7.0 Institutions

7.1 Each basin jurisdiction should review the mandate and activities of its agencies and ensure,

(a) coordination between medium-specific agencies in standard-setting and permit review; and
(b) cooperation and consultation with agencies in other jurisdictions.

7.2 All jurisdictions should work together, and with the International Joint Commission, to develop:

(a) a mechanism for joint action concerning the development of load reduction targets, Basin wide goals/standards, non-point source programs, research and monitoring programs;

(b) a mechanism for information sharing (laws, permits, standards, process);

(c) a mechanism for consultation (such as contact persons to notify each permit application and proposed standard); and

(d) a data bank, together with appropriate mechanisms to maintain the bank for such information as research on chemicals, sources, pathways, fates, effects in basin AND results of monitoring programs, compliance programs and RAP implementation.

Recommendation 8 Research for Ecosystem Law

8.1 There is a need to expand research on regulatory mechanisms for zero discharge and methodologies for its full implementation.

8.2 More specifically, further research is needed in the following areas:

- mechanisms for coordination of changes in each jurisdiction;
- mechanisms for reaching joint decisions, together with the role of the IJC and its agencies;
- ensuring accountability for decisions affecting the ecosystem;
- developing dispute resolution mechanisms;
- bettering financial and program reporting requirements;
- developing equitable allocation of load reduction targets;
- promoting inter-ecosystem relations; and
- ensuring public participation.

8.3 Making Zero Discharge Work

The principles outlined here are just that, principles, that still must be implemented through the specific actions of a great many people. The concepts of ecosystem, cross-media and "anticipate and prevent" may be understood and accepted at a certain level but their implementation requires fundamental change in this society's assumptions and values. Many beliefs (for example, in the endless bounty of nature and in perpetual economic growth) are being re-thought as global economic and ecological interdependence are increasingly demonstrated. Fundamental changes are difficult to accomplish, even when there is agreement on the principles, as there is in the Great Lakes basin. To bring about fundamental change cooperatively, incrementally and peacefully requires time, but more importantly, it requires imagination, commitment and political will.

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6. K.U. Oldenburg and J.S. Hirschhorn, "Waste Reduction: A New Strategy to Avoid Pollution," (1987) 29:2 Environment 16-45, at p. 19.

7. The major barriers to widespread use of preventive approaches are lack of financial incentives, current waste disposal pricing, non-compliance with existing pollution control standards, lack of legislation and simply lack of information. See, generally, V.F. Adamson, Breaking the Barriers: A Study of Legislative and Economic Barriers to Industrial Waste Reduction and Recycling, prepared for Environment Canada (Toronto: Canadian Environmental Law Research Foundation and Pollution Probe Foundation, 1984); and Resource Integration Systems Ltd., Barriers to Reduction, Recycling, Exchange and Recovery of Special Waste in Ontario, prepared for the Ontario Waste Management Corporation (Toronto: OWMC, 1984); and Oldenburg and Hirschhorn, supra, note 6.

8. See, for example, Office of Technology Assessment, supra, note 2, which defines waste reduction as: "In- plant practices that reduce, avoid, or eliminate the generation of hazardous waste so as to reduce risks to health and environment," at p. 16.

9. Office of Technology Assessment, supra, note 2, at p. 27.

10. See: Oldenburg and Hirschhorn, supra note 6. In practice, acceptable measures under the RCRA Amendments are in fact waste, not source reduction. This is discussed further in the next section.

11. Office of Technology Assessment, supra note 2, at p. 31; M.G. Royston, "Making Pollution Prevention Pay" in Huisingh and Bailey, supra note 5, pp. 1-16, at p. 15; and G. Munroe, "Where is Industrial Waste Reduction Taking Us?" (1986), 9:2 Probe Post 14-18, at pp. 16-17.

12. A.C. Williams, "A Study of Waste Minimization in Europe: Public and Private Strategies to Reduce Production of Hazardous Waste," (1987), 14 Boston College Environmental Affairs Law Review 165-225, at p. 187.

13. Ibid., at p. 192.

14. R.H. Susag, "Pollution Prevention Pays: The 3M Corporate Experience," in Huisingh and Bailey, supra note 5, 17-22, at p. 19.

15. 3M, Pollution Prevention Pays: Status Report (March 1987); and Susag, supra note 14, at p. 20.

16. Munroe, supra note 11, at p. 15.

17. See, generally, Huisingh and Bailey, supra note 5; Oldenburg and Hirschhorn, supra note 6.

18. See: Environmental Defense Fund, Approaches to Source Reduction: Practical Guidance from Existing Policies and Programs (Berkeley: 1986), p. 9 and Figure 1.

19. See: for example, Great Lakes Science Advisory Board, 1987 Report to the International Joint Commission (Windsor: IJC, 1987), pp. 29-35. The 1987 Amendments to the Great Lakes Water Quality Agreement refer to the need to develop "alternative products to reduce the effects of airborne chemicals" on the ecosystem, in addition to pollution control efforts. Annex 16, s. 4(b).

20. Protocol, Articles XVI, XIX.

21. Resource Conservation and Recovery Act, 42 U.S.C.A. s. 6901, as amended the Hazardous and Solid Waste Amendments of 1984, s. 6902 (b).

22. EPA Reg. on Land Disposal Restrictions, 40 CFR 268, May 28, 1986; amended by 51 F.R. 40636, Nov. 7, 1986; amended and corrected by 52 FR 21014, June 4, 1987; amended by 52 FR 25787, July 8, 1987.

23. Oldenburger and Hirschhorn, supra, note 6, at p. 18.

24. U.S. EPA, Report to Congress: Minimization of Hazardous Waste, Executive Summary (Washington, D.C.: October 1986)

25. Great Lakes Toxic Substances Control Agreement, Implementation Principles - Hazardous Waste.

26. New York State Department of Environmental Conservation, Great Lakes Management Agenda; Issues and Staff Recommendations, Summary Draft (Albany: April 1987), at p. 1.

27. Minnesota Technical Assistance Program, MnTAP Annual Report 1986.

28. Environment Canada, Survival in a Threatened World, Submission by the People of Canada to the World Commission on Environment and Development, Ottawa, May, 1986; Royal Commission on the Economic Union and Development Prospects for Canada, Report (Ottawa: Supply and Services, 1985). Canada, National Task Force on Environment and Economy, Report to the Canadian Council of Resource and Environment Ministers, September 1987.

29. "Canadian Environmental Protection Act" Bill C-74, First reading, - June 26, 1987, 2nd Session, 33rd Parliament, Second Reading, October 16, 1987.

30. Williams, supra, note 12, at p. 241.

31. Environmental Defense Fund, supra, note 23.

NOTES - Chapter 6 - From Concentrations to Load Reductions

1. See Chapter 5.

2. Congress of the United States, Office of Technology Assessment, Serious Reduction of Hazardous Waste (Washington, D.C.: September, 1986), at p. 14.

3. M.A. Calswell and J. Swaigen, (eds.), Environment on Trial (Toronto: Canadian Environmental Law Research Foundation, 1978), at pp. 92-93.

4. Many have been critical of ambient standards, for example, in the U.S., see: J.M. Gaba, "Regulation of Toxic Pollutants Under the Clean Water Act: NPDES Toxics Control Strategies (1984/85), 50 Journal of Air Law and Commerce 761, at pp. 768-69; B.W. Wyche, "The Regulation of Toxic Pollutants Under the Clean Water Act: EPA's Ten Year Rulemaking Nears Completion," 15 Natural Resources Lawyer 511, at pp. 512-13.

5. Clean Air Act, 42 U.S.C. ss. 7401, et seq..

6. Wyche, supra, note 4, at p. 13.

7. Gaba, supra, note 4, at p 768.

8. See: International Joint Commission, Third Biennial Report Under the Great Lakes Water Quality Agreement of 1978 to the Governments of the United States and Canada and the States and Province of the Great Lakes Basin (Ottawa, Washington, 1986), at 35-36.

9. Lake Michigan Toxic Pollutant Control/Reduction Strategy, FINAL, July, 1986.

10. The pollutants of concern include: PCBs, dieldrin, hexachlorobenzene, 2,3,7,8-TCDD, Chlordane, toxaphene, heptachlor/heptachlor epoxide, DDT/DDE, Hexachlorocyclohexane, PCDFs, PAHs, ibid., Table 1.

11. Niagara River Four-Party Agreement, February, 1987.

12. Pam Millar, "Niagara River Accord Signed" The Great Lakes United, vol. II, no. 1, Spring, 1987, p. 3.

13. Under the Clean Water Act, if the water quality standards are not being met, "daily maximum loads" are mandated to be set. See: 33 U.S.C. 1311(b) 1313(d) and Comment [Basel], "Water-Quality Standards, Maximum Loads, and the Clean Water Act: The Need for Judicial Enforcement" (1983), 34 Hastings Law Journal 1245.

14. Protocol, Article VIII.

15. Ibid.

16. New York State Department of Environmental Conservation, Waste Assimilative Capacity Analysis and Allocation for Setting Water Quality Based Effluent, April 1, 1986.

17. Scott v. City of Hammond, 741 F.2d 992 (7th Cir. 1984).

18. Basel, supra, note 13, at p. 1254.

19. For example, see: Susan Mudd, "Wisconsin's 'Dirty Water Rules' - A Long Step Backward" CBE Environmental Review (Winter, 1986), at pp. 8-10.

20. Ibid.

21. Ministry of the Environment, Municipal-Industrial Strategy for Abatement (MISA), June, 1986 [hereinafter cited as MISA].

22. Legislation in Wisconsin adopts a goal of greater than pH 4.7 for precipitation and to accomplish this goal sets a ceiling on total emissions of sulphur dioxide from all major sources of 325,000 tonnes per year beginning in 1993. Until 1993 and for small sources, the statute provides for a maximum average emission rate for private and public emitters. A similar program is established for nitrogen oxides emissions. (W.S.A. title 15, c. 144, sections 144.385-144.389).

23. O. Regs. 660/85; 661/85; 662/85; 663/85, December 12, 1985. Ontario Hydro is limited in its emission of sulphur dioxide and nitrogen oxides in an aggregate amount from all of its fossil fuel generating stations. For each major source an annual ceiling is set that gradually reduce loadings over a number of years.

24. See: M. Gilbertson, "Need for Development of Epidemiology for Chemically Induced Diseases in Fish in Canada" (1984), 41 Can. J. Aquat. Sci. 1534.

25. 49 Fed. Reg. 38,000 (1984). See: Gaba, supra, note 4, at 763-764.

26. See: 49 Fed. Reg. 9016 (1984); and EPA 440/4-85-032. Also see: J.D. Giattina and L. Anderson-Carnahan, "Presentation on U.S. EPA Region V Approach for the Control of Wastewater Toxics Using the NPDES Permit System" November 26, 1986.

27. C. Blaise, N. Bermingham, and R. Van Collie, "The Integrated Ecotoxicological Approach to Assessment of Ecotoxicity" (1985), Water Quality Bulletin 3.

NOTES - Chapter 7 - From a Parochial to an Ecosystemic Perspective

1. International Joint Commission, First Biennial Report Under the Great Lakes Water Quality Agreement (Ottawa/Washington: June, 1982), at p. 5-6

2. Paul Muldoon, with David Scriven and James Olson, Cross-Border Litigation: Environmental Rights in the Great Lakes Ecosystem (Toronto: Carswell, 1986).

3. For example, see: Water Pollution Control Law, Ohio Rev. Code Ann. s.6111.03(A); Environmental Protection Act, R.S.O. 1980, c. 141, as amended, s. 2.

4. See: Appendix C

5. Ibid.

6. Ibid.

7. Ibid.

8. Canadian Environmental Law Research Foundation, "Water Quality Regulation in the Great Lakes Ecosystem - A Case Study" (1987).

9. See: Appendix C.

10. See generally: R.H. Hall and D.A. Chant, Ecotoxicity: Responsibilities and Opportunities (Ottawa: Canadian Environmental Advisory Council, Report No. 8, August 1979).

11. See: Great Lakes Water Quality Board Report to the International Joint Commission, 1985 Report on Great Lakes Water Quality (Kingston: June, 1985), at pp. 65-109; Great Lakes Water Quality Board Report to the International Joint Commission, 1983 Report on Great Lakes Water Quality (Windsor, November 1983), at pp. 85-6.

12. Great Lakes Science Advisory Board, Report to the International Joint Commission, 1987 Report, Presented November, 1987 at Toledo, Ohio, at pp. 63-69.

13. Protocol, Article XXI.

14. Supra, note 1.

15. Great Lakes Science Advisory Board, The Ecosystem Approach: Scope and Implications of an Ecosystem Approach to Transboundary Problems in the Great Lakes Basin (Windsor: Special Report to the International Joint Commission, 1978).

16. C. Deknatel, "Regionalism and Environment: The Search for Planning Strategy and Organization in the Great Plains" (1986), 10 Environmental Review 107, at 108-109.

17. Environment Canada, et al., The Great Lakes: An Environmental Atlas and Resource Book (1987), at 40.

18. Ibid.

19. Great Lakes Water Quality Agreement of 1978, Agreement, with annexes, and terms of reference between the United States of America and Canada, signed at Ottawa, November 22, 1978, 30 U.T.S. 1383, T.I.A.S. No. 9257, Article II.

20. Ibid., Article I (g).

21. See Chapter 2.

22. For example, supra, note 18, at arts. VI 1(l); VI 1(e).

23. Great Lakes Governors Task Force on Water Diversion and Great Lakes Institutions, Final Report and Recommendations - A Report to the Governors and Premiers of the Great Lakes States and Provinces, prepared at the request of the Council of Great Lakes Governors, January, 1985.

24. Great Lakes Toxic Substances Control Agreement, signed May 21, 1987, at Mackinac Island, Michigan.

25. U.S. EPA, Great Lakes National Program Office, Five Year Program Strategy for Great Lakes National Program Office: 1986-1990 (Chicago: U.S. EPA, 1985), at p. 1.

26. Protocol, Article XIX.

27. Ontario Ministry of the Environment, Municipal-Industrial Strategy for Abatement (MISA), June, 1986, at 53.

28. Protocol, Articles XV through XXI.

29. Great Lakes Water Quality Board Report to the International Joint Commission, 1985 Report on Great Lakes Water Quality, supra, note 11, at pp. 65-109;

30. Great Lakes Water Quality Board Report to the International Joint Commission, 1983 Report on Great Lakes Water Quality, supra, note 11, at pp. 85-6.

GLOSSARY

acute effects: The adverse effects that occur or develop rapidly after a single exposure to a toxic substance.

ambient standards: The concentration of a toxic substance in the ambient air or water that, based on available data, will not result in significant risks of adverse effects to a large human population.

approvals process: Those processes involved in the formulation of environmental protection standards [the standard-setting process] and the issuance of permits for the discharge of pollutants in the basin [the permit-issuing process].

assimilative approach: The process whereby it is assumed that a body of water has the ability to receive pollutants without adverse effects to aquatic life or humans who consume the water.

bio-accumulation: The process of accumulating toxic chemicals through the food chain. The concentration of a toxic chemical is sequentially increased as it moves up from one trophic level to the next.

bio-assay: Tests used to evaluate the relative potency of a chemical by comparing its effect on living organisms with the effect on a contron, without the test chemical, which is run under identical conditions.

bio-concentration: The process of accumulating toxic chemicals directly from the water because more toxic chemicals are absorbed than excreted.

bio-concentration factor: A unitless value describing the degree to which a chemical can be concentrated in the tissues of an organism in the aquatic environment. It is the concentration of a chemical in the tissues divided by the average concentration the tissue was exposed to.

bio-indicators: The use of living organisms to monitor the quantity of toxic chemicals in the environment.

bio-magnification: A cumulative increase in the concentration of a persistent toxic in successively higher trophic levels of the food chain. It is the total result of bio-concentrations and bio-magnification.

bio-monitoring: 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 aquatic environment.

chronic effects: Adverse effects that manifest themselves after the lapse of some time. They can be caused by repeated exposures to low doses of toxic chemicals or by one large dose.

cumulative effects: Effects produced by a simultaneous dose of two or more toxic chemicals. The final effects can take on three forms: (1) additive effects, where the total effect is simply the sum of the individual effects; (2) antagonistic effects, where the effect of one toxic chemical is reduced by the presence of another; (3) synergistic effects, where the presence of one or more toxic chemicals produces effects greater than the sum of individual effects.

EC50: The concentration of a toxic chemical that will cause adverse effects to 50 percent of living organisms exposed to it over a specific period of time.

ecosystem: A community of living organisms, together with their habitat, and including the interactions among these components. It is described by specifying the non-living and living things (including humans) in it, and interactions between them.

ecotoxicology: The collective result of all types of toxic stresses acting on the environment. Living organisms are essential tools for assessing environmental quality because they are exposed to the combined effects of toxic chemicals.

epidemiology: The scientific study of the distribution of diseases and human-health risks.

LC50: The concentration of a toxic chemical that is lethal to 50 percent of living organisms exposed to it over a given period of time (usually 96 hours).

leachate: Materials suspended or dissolved in water and other liquids, usually from waste dump sites, that percolate through soil and rock layers.

lipophilic: Having an affinity for fats and oils.

load reduction: The process of decreasing the absolute amount or quantities of pollutants entering the environment from point and non-point sources.

mass-balance approach: 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 toxic chemicals 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.

mixing zone: The zone extending from a discharge point assumed to be required to dilute the toxic chemical to a concentration equal to that in the water body. Toxic levels in the mixing zone can be significantly higher than water-quality standards for the body of water.

modeling: Mathematical simulation of actual conditions that is used to predict the fate of toxic chemicals in the ecosystem.

NOAEL: The concentration of toxics where no observable adverse effects occur.

non-point source: A discharge into a receiving medium that takes place over an extended area and for which no point source can be readily identified. An example is the movement of agricultural pesticides into groundwater and surface water.

objectives: These denote maximum water quality or maximum contaminant concentration to be achieved. They can be expressed as both numerical and narrative statements.

permitting process: The process that determines the extent to which pollutants may lawfully be discharged into the environment.

persistent toxic substances: A toxic substance that tends to exist in the environment for prolonged periods of time. They are usually defined as having a half-life of more than eight weeks.

point source: A discharge made into a receiving medium via a fairly well-defined discharge point such as a sewer outlet.

primary waste treatment: The first stage in waste treatment where substantially all floating or settling solids are removed by floatation or sedimentation.

quality-based standards: A standard that is set based on the characteristics of the receiving medium and related to the attainment or maintenance of quality standards. The ability of the receiving medium to assimilate the total pollutant load is a key aspect in determining a quality-based standard.

risk assessment: A process for estimating the likelihood that a toxic response could take place if people or animals were exposed to certain concentrations of toxic chemical over a given period of time.

secondary waste treatment: The biochemical treatment of waste-water using bacteria to consume organic matter. Disinfection with chlorine is the final stage of secondary treatment.

source reduction: Techniques used within a plant to avoid or reduce the generation of hazardous substances; it is contrasted with pollution-control and waste-management techniques.

synergistic effects: Effects produced by a simultaneous dose of two or more toxins. The final effect may be greater than, equal to, or less than the sum of effects caused by individual toxic chemicals.

technology-based standards: A standard based on the technology that can be used to reduce the discharge of a pollutant. A technology-based standard can either specify a process or processes to be used or can specify a numerical standard that has been calculated based on specific processes. This standard does not depend on the dispersion ability of the receiving medium.

total loads: The amount of toxic chemicals, in absolute terms, entering the ecosystem via point and non-point sources.

toxic substance: A substance that can cause death, disease, behaviourial abnormalities, cancer, genetic mutations, physiological or reproductive malfunctions, or physical deformities in any organism or its off-spring or that can become poisonous after concentrations in the food chain or in combinations with other substances.

trophic levels: The individual stages in the food chain, beginning with micro-organisms and ending with humans.

use-quality standard: A standard set for a specific use of a water body. The most common use categories are drinking water, recreation, and fish propagation.

APPENDIX A

Itinerary of Consultation Meetings

Environment Canada,
Ottawa, Ontario,
March 20, 1987

Illinois Environmental Protection Agency,
Springfield, Illinois,
January 16, 1987

Indiana Department of Environmental Management,
Indianapolis, Indiana,
January 29, 1987

Michigan Department of Natural Resources,
Lansing, Michigan,
January 30, 1987

Minnesota Pollution Control Agency,
St. Paul, Minnesota,
January 12, 1987

New York Department of Environmental Conservation,
Albany, New York,
January 26, 1987

Ohio Environmental Protection Agency,
Columbus, Ohio,
January 28, 1987

Ontario Ministry of the Environment,
Toronto, Ontario,
March 19, 1987

Pennsylvania Department of Environmental Resources,
Harrisburg, Pennsylvania,
January 27, 1987

Quebec Ministre de L'Environnement,
[Telephone Meeting]
March, 1987

U.S. Environmental Protection Agency,
Region V,
Chicago, Illinois,
January 13, 1987

Wisconsin Department of Natural Resources,
Madison, Wisconsin,
January 14, 1987

APPENDIX B

Source Documents for Table 5.1

1. International

Great Lakes Water Quality Agreement Between Canada and the United States of America, November 22, 1978, 30 U.S.T.S. Art. II, Annex 12.

Council of Great Lakes Governors, Great Lakes Toxics Substances Control Agreement, May 1986.

2. U.S. Federal

Resource Conservation and Recovery Act, 42 U.S.C. s.6901, et seq. as amended by the Hazardous and Solid Waste Amendments of 1984, 42 U.S.C. s.8002 et seq.

Discussion with E. Eby, U.S. Environmental Protection Agency, July, 1987.

3. Illinois

D.L. Thomas, D.D. Kraybill and G.D. Miller, A Waste Reduction Program and Assessment of Current Status for Illinois (n.d.).

Illinois Hazardous Waste Research and Information Center, Information Brochure.

Discussion with D. Thomas, Hazardous Waste Research and Information Center, July, 1987.

4. Michigan

Discussion with M. Fisher, Department of Natural Resources, July 24, 1987.

5. Minnesota

Minnesota Waste Management Board, Fact Sheets.

Minnesota Technical Assistance Program, Annual Reports for 1985, 1986.

Discussion with N. Miller, Waste Management Board, July, 1987.

6. Ohio

Discussion with K. Kanudtsen, Ohio Environmental Protection Agency, July, 1987.

7. Wisconsin

Discussion with M. Hamel, Wisconsin Department of Natural Resources, July 24, 1984.

8. Pennsylvania

Discussion with L. Tritt, Department of Environmental Resources, July, 1987.

9. New York

New York State Environmental Facilities Corporation, Industrial Materials Recycling Program, Fifth Annual Report (Albany: Summer, 1987)

New York State Environmental Facilities Corporation, Status Report (Albany: Summer 1987)

Discussion with P. Simpson, Environmental Facilities Corporation, July 1987.

10. Indiana

Department of Environmental Management, Office of Technical Assistance, Technical Bulletin (Indianapolis: January, April, June, August, 1987).

Indiana State Board of Health, A Guide to Recycling the Source Separation Way (Indianapolis: 1979, revised 1981).

11. Canada - Federal

Discussion with R. Booth, Environment Canada, July, 24.

12. Ontario

Ministry of the Environment, Blueprint for Waste Management in Ontario (Toronto: June, 1983).

Ministry of the Environment, The Comprehensive Funding Program for Waste Management: Facts for Municipalities (Toronto: July 3, 1987).

Discussion with B. Killackey, Ministry of the Environment, July, 1987.

APPENDIX C

Source Documents For Tables 7.1 and 7.2

1. Wisconsin

Wisconsin Department of Natural Resources, Water Quality Standards for Wisconsin Surface Waters, Chapter NR 102 (1979, as revised).

Wisconsin Department of Natural Resources, Waste Load Allocate Water Quality Related Effluent Limitations, Chapter NR 212 (1986).

2. Ohio

Ohio Environmental Protection Agency, State of Ohio Water Quality Standards (Ch. 3745-1 of the Adminstrative Code) (Columbus, 1985).

Ohio Environmental Protection Agency, Water Quality Criteria Development Guidelines for Toxic Chemicals:

Part I - Protection of Human Health, prepared by P. Shulec;
Part II - Proteciton of surface water Aesthetic Quality, prepared by P. Shulec;
Part III - Protection of Aquatic Life, prepared by H. Heitzman (Columbus: Draft, April, 1986).

Ohio Environmental Protection Agency, Policy for Small Discharger Final Effluent Limitations (Columbus, August, 1986).

3. New York

New York State Department of Environmental Conservation, BRJ Methodologies (Albany: April 1985).

New York State Department of Environmental Conservation, SPDES Permit Drafting Strategy (Albany: May, 1985).

New York State Department of Environmental Conservation, Bureau of Technical Services and Research, Analytical Detectability Guidelines for Selected Environmental Parameters (Albany: July 1985).

New York State Department of Environmental Conservation, Ambient Water Quality Standards and Guidance Values (Albany: July 1985).

New York State Department of Environmental Conservation, Surface Water and Groundwater Classification and Standards, New York Codes, Rules and Regulations, Title 6, Chapter X, Parts 700 -705.

4. Indiana

Indiana Stream Pollution Control Board, Water Quality Standards Applicable to All State Waters, 330 IAC 1-1, effective August 16, 1985.

Indiana Stream Pollution Control Board, Grand Calumet River and Indiana Harbor Ship Canal, 330 IAC 2-2, effective October 16, 1985.

Indiana Stream Pollution Control Board, Lake Michigan and Contiguous Harbor Areas, 330 IAC 2-i.

5. Michigan

Michigan Water Resources Commission Act, Act 245 of 1929, as amended.

Department of Natural Resources, Water Resources Commission, General Rules:
Part 4 - Water Quality Standards (January 1985)
Part 21 - Wastewater Discharge Permits (April 1985).

Department of Natural Resources, Natural Resources Commission, Guidelines for Rule 57(2); Levels; and Allowable Levels (Lansing: January, 1985).

6. Pennsylvania

Department of Environmental Resources, Water Quality Standards, 25 PaS, c. 93.

Department of Environmental Resources, Toxics Strategy, Appendix C: Water Quality Criteria and Threshold Levels for the Priority Pollutants and Other Toxics (Harrisburg: Draft, October 1985).

7. Minnesota

Minnesota Pollution Control Agency, Classification and Standards for Waters of the State: Standards for the Protection of the Quality and Purity of the Waters of the State, c. 7050.

Minnesota Pollution Control Agency, Procedures on Setting Water Quality Based Effluent Limitations for Discharges of Toxic Substances (April, 1984).

8. Illinois

Illinois, Rules and Regulations, Title 35, Environmental Protection, Subtitle C: Water Pollution, Chapter 1: Pollution Control Board (March 1985).

9. U.S. Federal

U.S. EPA, Region V, Presentation on U.S EPA Region V Approach for the Control of Wastewater Toxics Using the NPDES Permit System (Nov. 26, 1986).

U.S. EPA, Office of Water Regulations and Standards, Ambient Water Quality Criteria for
Chromium - 1984 (Washington, D.C. -January 1985)
Lead -1984 (Washington, D.C. -Janurary 1985)
Chlorinated Benzenes (Washington, D.C. - October 1980)
Aldrin/Dieldrin (Washington, D.C.: October 1980)

10. Canada

Department of National Health and Welfare, Guidelines for Canadian Drinking Water Quality, 1978 (Ottawa: Ministry of Supply and Services, 1979).

Pest Control Products Regulations, C.R.C. c. 1243.

11. Ontario

Ministry of the Environment, Rationale for the Establishment of Ontario's Provincial Water Quality Objectives (Toronto: 1979).

Ministry of the Environment, Water Management: Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment (Toronto: November, 1978, revised May 1984).

Ministry of the Environment, Ontario Drinking Water Objectives (Toronto: 1983).

L. McCarty, M. Lupp and M. Shea, Scientific Criteria Document for Standard Development No. 3-84: Chlorinated Benzenes in the Aquatic Environment, prepared for Water Resources Branch, Ontario Ministry of the Environment (Toronto: 1984).

12. Quebec

Ministere de l'environnement du Quebec, Direction generale de l'assainissement des eaux, Programme d'assainissement des eaux uses, Plan D'Equipement: 1985-1988 (Quebec: 1985).

Ministere de l'environnement du Quebec, La Rationalization des Objectifs de Traitement: Le Cas des Toxiques.

D. Govin, Direction des Etudes du milieu aquatique, Ministere de L'environnement, "La Determination des Objectifs de Traitement dans un Project d'Assinissement" (1984), 17:4 Sciences et Techniques de l'eau 383-388.

*"THE PHILOSOPHY ADOPTED FOR CONTROL OF INPUTS OF PERSISTENT TOXIC SUBSTANCES SHALL BE ZERO DISCHARGE."**

In 1978 Canada and the United States signed the Great Lakes Water Quality Agreement, thus committing themselves to restoration and maintenance of the integrity of the Great Lakes ecosystem. The Agreement set forth the objective of virtual elimination of persistent toxic substances entering the ecosystem – the philosophy of "zero discharge".

The Agreement was thoroughly reviewed by members of the public, industry, environmental organizations, municipal, state, provincial and federal governments in 1987. Both countries have now renewed their commitment to the goal of virtual elimination of persistent toxic substances from the ecosystem.

It is a sad fact, however, that while levels of some persistent toxic substances are decreasing, for others they are increasing. The threat to fish, wildlife and human health throughout the basin continues to grow.

Regulatory actions taken in Canada and the U.S. since 1978 have failed to achieve the objectives of the Agreement. Without substantial changes in our approach to the regulation of toxic substances in air, land and water, these objectives will remain unfulfilled.

The problem *can* be solved, however. The goal of virtual elimination is attainable. This report sets forth recommendations for a number of specific and positive steps which can be taken to implement the philosophy of zero discharge in the Great Lakes ecosystem.

* Great Lakes Water Quality Agreement of 1978, renewed by Canada and the United States, 1987.

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