3395

TOXIC WATER POLLUTION IN CANADA: REGULATORY PRINCIPLES FOR REDUCTION AND ELIMINATION

A Paper Prepared for the

Canadian Institute of Resources Law
Faculty of Law
University of Calgary

by

Paul Muldoon

with the assistance of
Marcia Valiante

on behalf of the

Canadian Environmental Law Research Foundation
Toronto, Ontario

September, 1987

Table of Contents

> For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death.... They have entered and lodged in the bodies of fish, birds, reptiles, and domestic and wild animals so universally that scientists...find it almost impossible to locate subjects free from contamination.

Rachel Carson, Silent Spring, (1962), p. 24

INTRODUCTION

For every person in North America, approximately one ton of chemicals is generated by industry every year. This figure represents the explosion in both the number and volume of chemicals produced since the so-called "chemical revolution" began with World War II. Various indices of chemical production demonstrate the impact of this revolution on our lives - production of synthetic fibres have increased 60 fold; synthetic organic chemicals have increased 10 fold with the use of mercury in the manufacturing of chlorine having an increase of some 40 times. The growth rate, if anything, seems to be accelerating in recent years. [1]

Estimates suggest there are well over 70,000 chemicals in commercial use in the North America. By the time those chemicals are combined, the number of chemical species is probably over

200,000. Some 1,500 to 2,000 new chemicals are introduced into the world market each year. In Canada, about 250 manufacturers produce over two-thirds of the total used in Canada. The other one-third is imported by some 10,000 importers into Canada. [2]

Many of these chemicals, although no one is quite sure of the number, are toxic in nature and a considerable number of these find their way into the environment, and quite often, into the rivers, lakes, and groundwater supplies. A recent study by Toronto's Board of Health, for example, found that 83 chemicals were found in that city's drinking water - including 30 chemicals which are potential human carcinogens. Toronto's water contains ~~with~~ the highest levels of trihalomethanes, created when raw water containing organic chemicals is chlorinated, of any municipality in Ontario.[3]

Another report found that significant concentrations of residues of an insecticide called aldicarb were found in the ground and tap waters in Prince Edward Island. Similar problems are also present in the Prairies. The Regina sand aquifier is thought to contain trace amounts of numerous heavy metals and PCBs.[4]

While problems associated with toxic contamination may have been suspected for some time, improved analytical capability has allowed the identification of complex organic chemicals at trace levels which before had not been detected at all.

One of the key distinguishing features between conventional pollutants and many toxic chemicals is their "persistence" - their ability to remain chemically stable in the environment for a long period of time. Some of these chemicals, like PCBs and dioxins, also tend to accumulate in the fatty tissues of organisms at each stage of the food chain. In some instances, as accumulation occurs through the food chain, concentrations become magnified. Hence, fish may have concentrations of a toxic substance hundreds times greater than the concentration of that substance in their water habitat.

It is only in recent years that the long-term health effects produced by persistent chemicals and their impacts on the aquatic environment have begun to be documented. Currently, intensive research is now verifying the range of impacts of toxic chemicals - including carcinogenic and mutagenic effects, various behaviour abnormalities to humans and a source of tumors, deformities, reproductive definiencies in fish and other aquatic organisms, and deformities in fish, together other with detrimental environmental effects. However, the extent of the risk posed by chemicals is not yet known. A study a National Academy of Sciences committee found that there was no data available on 70% of the more than 60,000 chemicals in commercial use in North America and almost no information on human exposure to these chemicals.[5]

For more than decade, both federal and provincial governments in Canada, like their counterpart agencies in the

United States, have been attempting to come to grips with the problem, with something less than satisfactory results.

The Great Lakes basin, for instance, has been a focal point for toxic water pollution research for almost two decades. Despite a fairly intense bi-national control effort, the levels of many toxic substances within the basin have only marginally declined; some have actually continued to rise again after a slight downward trend.

From the Great Lakes experience with this problem, as well as other experiences throughout Canada, it is apparent that toxic water pollution challenges many fundamental scientific, institutional, and regulatory assumptions inherent in traditional pollution control strategies.

From a scientific perspective, for instance, scientists have had to respond to the need for information about the effects from low level exposure to chemicals and the pathways and fates of chemicals in the environment. Until the 1980s, testing of chemicals was limited to studying the short-term impacts, with relatively high or concentrated doses, of a single chemical at a time. Emphasis has now shifted toward studying a multitude of chemicals over the long-term at very low concentrations. Testing remains focused on human health effects with very little study centered on environmental risks.

From an institutional perspective, there are numerous barriers to meeting the toxic water pollution challenge. For instance, the mobility of toxic substances once in the environment has led to the realization that governments cannot work in isolation; intergovernmental cooperation and coordination is imperative for any effective control strategy. Hence, various new institutional arrangements must be forged to meet this challenge.

Perhaps the greatest challenge is to the present regulatory framework. Existing regulatory approaches are framed in terms of "control" of direct discharges of wastes to water based upon the concentration of pollutants in a water body. The ineffectiveness of these approaches calls for preventive regimes directed toward the reduction of total loadings of pollutants from both direct and indirect discharges in all media.

It is the purpose of this paper to review in detail the challenges posed by toxic pollution on Canadian water quality law and suggest principles for regulatory reform to overcome these challenges. For the most part, the focus of the paper will be on Canadian federal legislation and Ontario law (with passing reference to other provinces.)

The paper's scope is limited in three ways. First, the focus of the paper is on "persistent toxic substances." While the regulatory assumptions and measures discussed may be applicable to other pollutants, certainly they are most compelling for this particular category of contaminants.

Second, in reviewing the adequacy of existing regulatory frameworks, and suggesting principles for reform, a certain degree of generality is needed. The thesis of the paper calls for a rethinking of some of the most fundamental assumptions underlying the current regimes of environmental law and policy. Discussion, therefore, is focused more upon a conceptual, than an operational, level.

Third, not all legal components of the toxics issue can be comprehensively discussed. For instance, no attempt will be made to review enforcement and compliance practices of existing laws, liability and compensation rules and schemes for injuries arising from toxic chemicals; or other avenues for redress in statutory or common law.

The thesis of the paper can be summarized as follows:
(a) persistent toxic substances are of a nature and character different than conventional pollutants. These differences ought to be reflected in the regulatory goals, assumptions and implementation strategies;
(b) the differences with conventional pollutants supports the long-term regulatory goal of the virtual elimination of the inputs of persistent toxic substances into the nation's waters, and other parts of the environment; and
(c) the current array of regulatory controls should be supplemented by controls under the following headings:

* controls directed toward the absolute reduction of the persistent toxic chemicals entering the

environment;

* controls which address the inter-media transfers of toxic pollutants; and
* controls which promote interjurisdictional cooperation stemming from the potential of toxic pollutants to cross political borders.

Implementation of these controls would constitute a toxic pollution reduction and eventual elimination strategy. The constitutent elements of such a strategy are based on the concepts of a cross-media perspective, source reduction, load reductions, non-point source controls, and ecosystemic orientation.

Before these principles are discussed in detail, Chapter 1 reviews the sources, pathways, fates, and effects of toxic water pollution. Chapter 2 provides a brief outline of the current regulatory approach for the control of toxic water pollution in Canada and puts in context the regulatory principles for a toxic substances reduction and elimination strategy. The remaining chapters then more particularly explore the nature of each principle and application of that principle to Canadian law.

Finally, throughout the paper, the Great Lakes basin will often be used as a reference point for discussion. The Great Lakes are a good model to study for a number of reasons, including the sensitivity of the Great Lakes to toxic pollution; the history and on-going emphasis by the basin jurisdictions to deal with toxic pollution, and the large amount of scientific research focused upon the Great Lakes. Further, in light of shared responsibility among so many governments, it is fair to state that the basin provides a micrososm of a larger national picture.

CHAPTER 1 - The Problem of Toxic Water Pollution

Introduction

The purpose of this chapter is to identify those characteristics of toxic substances of most concern which distinguish such substances from the more conventional kinds of pollutants for the purpose of regulation. The sources, pathways, and fates of toxic substances are briefly discussed and an outline of the potential human and ecological effects of such substances is provided. As a result of this discussion, the general class of persistent toxic substances is singled as justifying special regulatory treatment.

1.1 The Nature of Toxics Contaminants

The best known toxic substances include PCBs (polychlorinated biphenyls); PAHs (polycyclic aromatic hydrocarbons); PCDDs (dioxins); benzene; and various heavy metals (such as lead, cadmium, zinc, arsenic, nickel, selenium and mercury). Although there is no single universially accepted definition of what is a toxic chemical, especially for regulatory purposes, there are general parameters [1] which may be used to set these substances apart from the more conventional kinds of pollutants, such as nutrients (like phosphorus), suspended solids, and ammonia.

Generally, toxicity is understood as the capacity of a substance to cause temporary or permanent adverse effects in living organisms or their offspring, such as behavioural abnormalties, cancer, genetic mutation, physiological or reproductive malfunctions.

Acute toxic effects are the most obvious. These are effects that appear soon after a single or short-term exposure to a substance. Existing environmental standards usually reflect a good understanding of levels where immediate effects occur. However, it is now known that there are subtler effects due to longer exposure to lower levels than those that cause acute effects. Some of these effects are "latent," that is, they appear many years after exposure has occurred.

Knowing the potential effects of a substance is only part of the story. The risk of experiencing that effect is related not only to the nature of a substance, but also to its dose, and to length of exposure, since any substance in a large enough dose can result in toxic effects.

Toxicology, historically, has focused on experiments that determine the acute effects of chemicals. Tests are conducted on animals, such as rats or fish, at increasingly concentrated dose until a "threshold" level is found - the level of observable effects - and then until a lethal dose is reached. These tests are usually conducted over a relatively short period of time. The results of these tests are then extrapolated to humans, on the basis of certain assumptions and "safety" factors, in order to set environmental standards.

An indication of the risk of genetic mutation and possibly cancer is derived from tests on microorganisms including the "Ames" test. This approach raises a number of uncertainties, including the validity of extrapolating from animals to humans. Because most exposure to chemicals in the environment is at relatively low levels over long periods of time, there is also uncertainty about the validity of extrapolating from these tests to set standards to protect against chronic exposure.

It is the chronic effects of toxics which account for their insiduous nature - namely, that it may be years after their introduction into the environment that their real effects become demonstrable. By then, it may be too late to prevent real harm.

A further complication is that for some substances there may be no threshold, that is, any amount of a substance has the potential to trigger genetic mutation. These are known as "genotoxic" substances.

Hence, it is clear that the risks from exposure to toxic substances have to be viewed from the perspective of quantity of the dose and the length of exposures as well as the nature of the substances. From a control point of view, chronic effects from exposure to toxic pollution pose a real problem for understanding how much is too much, that is, what are "acceptable" concentrations in the environment that will not produce such effects and therefore what rate of release will keep concentrations under that level. The scientific uncertainty surrounding most chemicals and their interactions in the environment makes this task inherently complex and "fraught with opportunity for misinterpretation."[2]

* persistence

Some toxic substances are "persistent," in that they do not degrade or break-down quickly, into less toxic substances through physical, chemical or metabolic processes. Many persistent toxic substances are elements, which means that they cannot be broken down any further. Others are composed of complex, stable organic compounds which normally do not breakdown by photochemical, chemical, or microbial action.

The fact that some chemicals are persistent means that they accumulate in the environment so that even if they are emitted in less than toxic amounts, they can build-up to toxic amounts. These amounts may be tied up in sediments and not biologically available at all times. This makes measurement of build-up impossible. However, microbial action or physical disturbance can release these substances.

Persistence raises a serious challenge to the governing control philosophy which assumes that effects relate to the level released. When a toxic substance is also persistent, it must be assumed that any release to the environment, even if widely dispersed, adds to the existing environmental store of that substance. By focusing only on the rate of discharge over a short time, regulation fails to take account of total exposure.

* bioaccumulation and biomagnification

In addition to persistence, many toxics are also lipophilic, which means that they tend to concentrate in the fatty tissue of organisms. As smaller organism are consumed by larger organisms, the concentration of toxic substances increases at each trophic level. As ultimate consumers, humans can acquire relatively high body burdens of persistent contaminants, such as PCBs, DDT, dioxins, and furans, as a number of studies of populations bordering the Great Lakes have demonstrated. [3]

In fish, the concentration of toxic contaminants can be several orders of magnitude greater than the water concentration of the same toxic substances. For example, PCB levels in fish have been found to be as much as one million times greater than the level in the water.[4]

Thus, biomagnification has definite implications for setting regulatory levels. Moreover, it should be noted that some toxics do not accumulate to cause serious harm.

The characteristics of some toxic substances to be persistent and to biomagnify distinguish such substances from other types of polltuants to warrant special concern and special regulatory treatment. If the underlying goal of our existing regulatory approach is to protect health and the environment, then a special regulatory approach for persistent toxics is necessary in order to be able to achieve that goal.

1.2 Sources of Toxic Pollution

The sources and pathways of persistent toxics into the environment are many and diverse. Table I presents a sampling of what sources contribute particular contaminants to the environment. Non-point sources contribute as much or more than point source pollutants. Nevertheless, point sources still must be considered a major contributor to toxic chemicals to the environment.

The major sources of toxic water pollution include:

* industrial processing

Perhaps the best known sources of toxic contaminants are industrial processes. Metal processing (such as steelmaking, nickel and copper refining), petroleum refining and the related petrochemical and the plastics industries and the pulp and paper industry are perhaps the most significant stationary contributors in Canada, located in Ontario, Quebec, British Columbia, and Alberta. Toxic substances associated with these source include volatile organic compounds (VOCs), industrial solvents, and metals (such as arsenic, zinc, copper, and mercury).

* municipal and storm sewer discharges

SOURCE CATEGORY VS. CHEMICAL CONTAMINANT

CHEMICAL CONTAMINANT

SOURCE	PAH	PCB	PCDD/F	DDT	TOXAPHENE	MIREX	DIELDRIN	HCB	LEAD	MERCURY	SOLVENTS	PHTHAL.
INDUSTRIAL EMISSIONS	X	X				X		X	X	X	X	X•
MSW INCINERATORS	X•	X	X•					X	X•	X•		?
HAZARDOUS WASTE INCINERATORS	X	?	X					X	X	X		
MUNICIPAL SEWAGE TREATMENT	X	X						X			X•	X
LANDFILLS		X						X			X	X
SURFACE IMPOUNDMENTS		X?						X			X•	X
PESTICIDE SPRAYING			X?	X	X	?		?		X?	X	
HOSPITAL INCINERATORS	X	X?	X•						X	X		
MOBILE SOURCES	X•								X		X•	
EVAPORATIVE EMISSIONS											X•	
MISC. INDUSTRIAL EMISSIONS	X•	?	X			X		X	X•	X•	X•	X•

X — SOURCE YIELDS SUCH CHEMICAL EMISSIONS
• -- MAJOR SOURCE OF CHEMICAL
? -- ADDITIONAL INFORMATION IS NEEDED OR SOME QUESTION ABOUT THE NATURE OF EMISSIONS

TABLE I

The direct discharge of pollutants into sewer systems is a major source since most sewage treatment plants are not capable of treating toxic wastes. These wastes then end up either in the effluent from the plant which eventually flows into river and lake systems or in the sludge which is then spread on agricultural land or incinerated. In Ontario, this problem has been identified for PCBs and heavy metals, among other pollutants.[5]

In addition, in many urban areas, sanitary sewer overflows are connected to storm sewers. During storms and snowmelt, toxics from sanitary sewer overflow and from ordinary urban storm sewers discharge directly into nearby lakes and rivers.

* atmospheric desposition

From both mobile (automobiles, trucks, trains) and stationary (commercial, institutional, residential) sources, the combustion of gasoline and other fossil fuels are important contributors of toxic substances to the environment. Mobile sources are a significant source for lead and various volatile organics such as benzene. Stationary sources introduce metals such as cadmium, arsenic, selenium, chromium, and mercury, and organics (such as PAHs), into the environment, mainly through air emissions. The burning of coal, for instance, not only contributes the well-known acid-causing emissions, such as sulphur dioxide, but also particulate on which is concentrated toxic substances either found in the fuel or created during combustion. Gases and very find particulate are not usually removed with traditional pollution control equipment for fossil fuels, such as precipitators. Once in the air these substances may travel long distances, but are eventually deposited to soil, vegetation, or water.

Since the early 1980s, toxic air pollution has been demonstrated to be one of the major sources of toxic inputs in the Great Lakes. Up to 80% of PCBs deposited annually in Lake Superior, for instance, is thought to be attributable to atmospheric desposition.[6]

* agricultural and urban run-off

Agricultural and urban runoff are major sources of toxic water pollution. Run-off emanates from such activities as pesticides and sludge disposal. Sludge disposal is of a major concern. Sludge, which is a by-product of sewage treatment systems, is typically spread over land as a fertilizer, with the remainder incinerated if the concentration of toxic substances exceeds a guidelines. Because many sewage treatment plants cannot treat toxic substances, the sludge is often highly concentrated with heavy metals and organics such as dioxins, and chlorobenzenes. When sludge is spread on agricultural land, these substances may leach into the soil and either affect water quality or vegetation. If the sludge is incinerated, these substances may be released into the air.

Estimates of the magnitude of this source are demonstrated by a study examining the annual loadings into the Great Lakes from urban run-off. Combined loadings of zinc, lead, copper, nickel and chromium was about 420 tons, 0.077 ton for PCBs, and 8 tonnes for cobalt, mercury, arsenic, selenium, and cadmium.[7]

* reactivation from sediments

Sediments are a sink for toxic contaminants. Many pollutants tend to settle out of water because they exist as particles, or adsorb readily onto particulate.

Toxics in sediments can be easily reactivated (that is, re-introduced into the water) by upsetting the bottom of lakes. This can be done through natural processes such as the scavanging of fish on the lake bottom and when storms upset the sediments. Operations such as dredging also contribute to the reactivation of toxics into the water. One of the larges sources of PCBs in Lake Michigan is said to be in-place pollutants in Waukegan Harbour.[8]

* waste disposal

Toxics enter the environment through a number of pathways pertaining to waste disposal. Municipal solid waste incineration is a source of furans, dioxins, lead, mercury, nickel, chromium and cadmium, among others. While little information is known, a growing amount of evidence suggests that some persistent toxic substances volatilize from waste storage facilities, settling ponds, waste lagoons, and the like, into the atmosphere by the formation of gases during chemical or biological degradation.

Leachate containing toxic substances forms when wastes are buried in sanitary landfills and hazardous waste dumps and contributes to ground and surface water pollution. For example, it is estimated that 50% of all toxics present in the Niagara River is due to leachate from landfills sites along the waterway.[8]

* groundwater contamination

Shallow waste-disposal sites (like landfills, lagoons, and dumpsites), deep well disposal of liquid wastes and (migration of persistent compounds in pesticides) have been documented as potential sources of contamination to groundwater. Once in the groundwater, these contaminants can be transported to surface waters.

Groundwater contamination is also of particular concern since over 30% of the Canadian population (and in some provinces, like Prince Edward Island, 100%) is dependent on groundwater as its source of drinking water. Because 80% of these groundwater supplies are from shallow sand and gravel aquifers, they are especially suspectible to toxic pollution since they lack the natural protection afforded them by overlying silts or claybeds. For example, aquifers in the lower Fraser Valley of B.C. are tapped by some 4,000 operating wells and are threatened by contamination by nitrates and pesticides from agricultural run-off by leachate from landfills. Such problems can be found throughout Canada, and in particular, in the Prairies provinces, Ontario and P.E.I.. The aquifer supplying water to Regina, for instance, has been threatened by heavy metal sludges from local industry.[10]

At the present time, it is difficult to give a complete picture of the extent of the toxic water pollution problem in Canada, in part because of the absence of a comprehensive data base, and in part, because the nature, basis and extent of the problem differs from region to region.

What is clear from this discussion is that toxic substances cycle through the environment. For example, even if a substance starts out as an air pollutant, it is deposited at some point downwind either directly to water or to the land (either soil or vegetation) from where, because of erosion or leaching, it may end up in water. Some substances, such as mercury and PCBs, can also volatize from water surfaces back into the air.

Pollution controls that limit the output of a substance in effluent but then require incineration concentrate the substance in sludge or ash may in the end only change the point of entry of the substance into the environment, not the total loading. For regulation of persistent substances, all pathways into the environment have to be understood and controlled in order to prevent long-term damage.

1.3 Effects of Toxic Pollution

A complete understanding of the impact of toxic chemicals on human health and the environment is a long way down the road. However, known impacts range from cancer, genetic mutation, reproductive and behavioural abnormalities and learning disabilities to physical irritation or other temporary illnesses.[11] Further research is required to have a complete understanding of the multiple exposure routes toxic chemicals have to humans. The more common pathways are through the drinking water, water contact through washing, swimming and other recreational uses, inhalation, and consumption of food (such as fish or crops grown in soils containing toxic chemicals).

Figure I presents a simplified version of various pathways and exposure routes toxic substances may have to humans.

In Toronto's drinking water, for instance, over 50 chemicals, almost half of which were inorganic, were consistently found to exist in test samples. There still remains considerable debate on the potential health effects of drinking the water, owing to a lack of comprehensive epidemiological studies on the matter.[12]

Other exposure routes are less obvious. For instance, studies in the late 1970s demonstrated that Ontario women had the highest PCB content in their breast milk. The implications of this are unknown at this time.As one study concluded, "[C]onsidering the latency period of cancers to appear (20 to 30 years), high exposures of infants to contaminants may result in significant future health effects."[13]

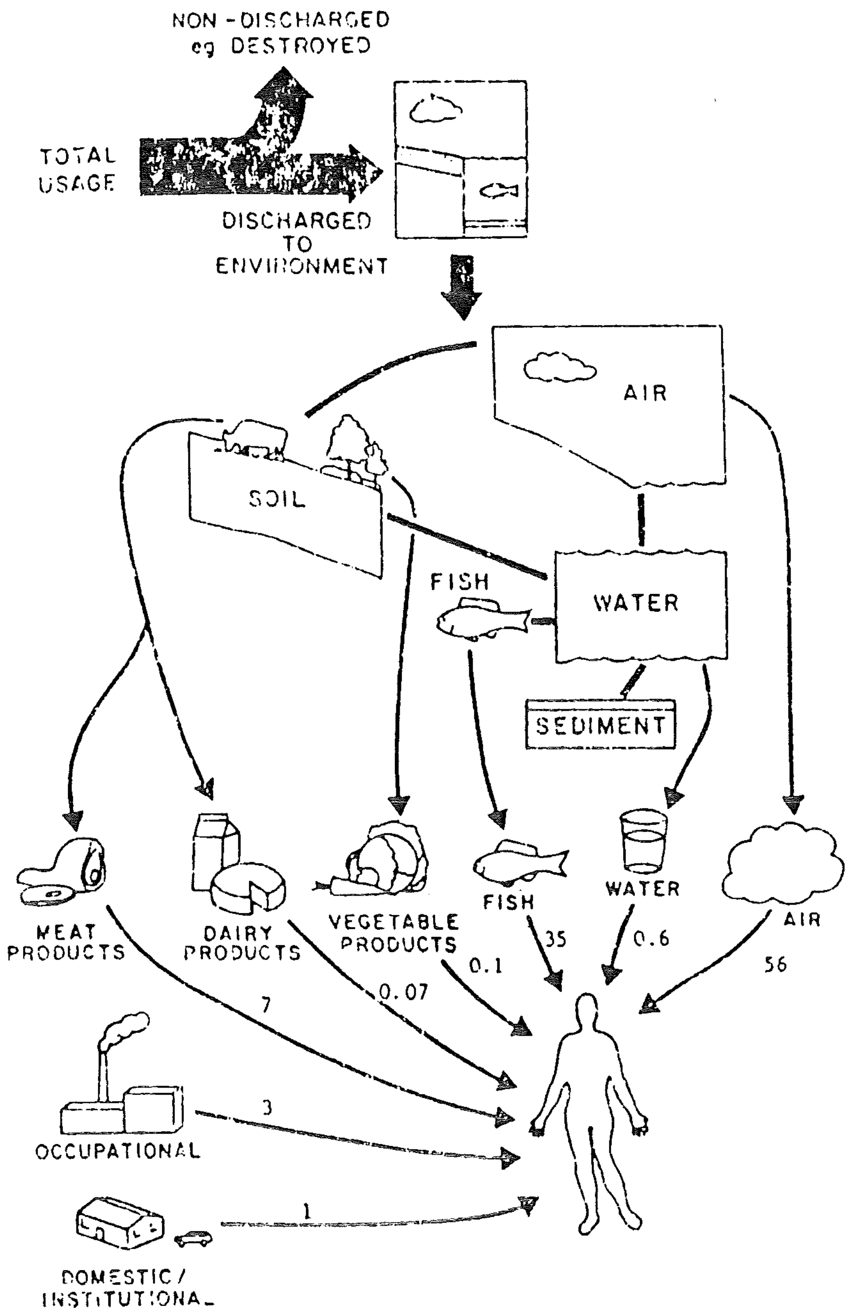
NON - DISCHARGED
eg DESTROYED
TOTAL
USAGE
DISCHARGED
TO
ENVIRONMENT
AIR
SOIL
FISH
WATER
SEDIMENT
MEAT
PRODUCTS
DAIRY
PRODUCTS
VEGETABLE
PRODUCTS
FISH
WATER
AIR
7
0.07
0.1
35
0.6
56
OCCUPATIONAL
3
1
DOMESTIC /
INSTITUTIONAL

FIGURE I

Such evidence left one report to conclude that "[T]he adipose tissue of all Canadians has become a rich repository for fat-soluble environmental contaminants, including large number of pesticides, flame retardants and industrial transformer fluids, all of which integrate into the body's metabolism."[14]

The environmental impacts of toxic chemicals are becoming better documented, and thus far, have been associated with physical deformities, reproductive failures, tumors, and other physiological effects in birds, fish, and other biota.[15] In the Great Lakes, for instance, abnormalities and reproductive problems of herring gull eggs provided early warning signals of the extent of toxic contamination owing to the sensitivities of the gull eggs to toxic effects. More recently, many types of fish species are thought to be "sentinel" organisms to toxic effects. Various studies have been underway attempting to document the kinds, origins and conditions of tumors which have been identifed in a variety of fish species in the Great Lakes.[16] In one instance, a test conducted by a New York State agency found one fish with a PCB level five times over the recommended limit for human consumption with high levels of dioxins and furans in its flesh and eggs.[17]

1.4 Summary and Conclusions

From the information science is continually revealing, it is apparent that toxic water pollution holds significant human and environmental health implications. However, there is a critical lack of information. What is apparent is that the very nature of the problem, the serious potential effects, the minute concentrations that can have adverse effects, the long latency periods, and the widespread sources, makes them much more insidious than conventional pollutants.

It is these particular characteristics of toxic chemicals, when applied to persistent substances, which create an acute regulatory challenge.

CHAPTER 2 - Toxic Water Pollution as a Regulatory Challenge

Introduction

The last chapter provided an overview of the nature, sources, and effects of toxic water pollution. From that chapter, it is apparent that toxic chemical pollution is unlike contamination from conventional pollutants, which in turn, provides the basis for a toxic water pollution strategy.

This chapter further develops this theme by reviewing the adequacy of the existing regulatory response to the toxic water pollution problem. The first section of this chapter will briefly describe the current regulatory response to toxic water pollution by the federal and Ontario governments. The second section argues that, in light of the nature, sources, and characteristics of toxic substances, current regulatory framework is inadequate to meet the challenges of toxic water pollution. Elements that ought to be included in a toxic regulatory strategy are then proposed. Each principle proposed for reform subsequently forms the basis of a separate chapter.

2.1 Overview of Current Regulatory Framework

CHAPTER 2

Two of the striking features of toxic water law in Canada is the absence of any coherent or consistent national policy and the piecemeal approach which governs its regulation.

In part, these features are attributable to the overlapping jurisdiction over water quality resulting from the division of powers under the Canadian Constitution. Federal environmental jurisdiction is derived primarily from its powers to legislate in the areas of interprovincial trade and commerce, navigation and shipping, sea coast and inland fisheries, the criminal law (including the protection of public health), and the general power to make laws for the peace order and good government of Canada.[1]

Provincial jurisdiction is derived from authority to legislate in regard to property and civil rights; local works and undertakings; and all matters of a merely local or private nature. Provinces are also given ownership to lands and other natural resources including water within their boundaries.[2] Further, they have sole jurisdiction over municipal governments.

The federal government recent introduction of the _Canadian Environmental Protection Act_ attempts to provide a national toxic substances policy, although, as noted later, falls considerably short of that goal.

Owing to the constitutional division of legislative powers concerning the environment, there is some doubt the extent to which the Canadian federal government could legislate toxic substance control measures. Traditionally, issues pertaining to the manufacture, use, transportation, imports and exports of toxic chemicals have been accepted being under federal legislative authority while waste disposal has been regarded as primarily a matter under provincial jurisdiction.[3]

Traditionally, federal jurisdiction has been limited to a residual role in the regulation of contaminants with the provinces taking the lead role in the regulation of chemicals, other than in areas of clear federal jurisdiction, such as fisheries protection, interprovincial transportation and trade. This view, however, has been considered narrow interpretation of federal authority by commentators seeking a stronger, more coherent approach to the control of toxic substances in Canada. One argument for national source reduction policy is based upon the federal authority to make laws "peace, order and good government" of Canada.[4] The Clean Air Act standards for lead pollution were upheld under this head of power.[5] Owing to the mobility of toxics to transverse political boundaries, their diverse sources and the serious of the problem, a national toxic chemical control strategy could be considered as falling within the "national dimensions" test.[6]

2.1.1 Federal Legislation Governing Toxic Pollution

Federal water quality law is found in the Fisheries Act[7], and the Canada Water Act[8], even though the latter does not deal with toxics explicitly, but holds the potential to a create a water quality management area in which toxics could be controlled. The Environmental Contaminants Act[9] is perhaps the federal government's primary toxic control mechanism. This statute seeks to regulate certain toxic chemicals, irrespective of what component of the environment may be affected.

As it will argued below, the control of toxic water pollution can be effected if both air and land based sources are taken into account.[10] Hence, it is necessary to have a cursory understanding of other pertinant legislation like the Clean Air Act,[11] the Motor Vehicle Safety Act[12] and the Pest Control Products Act.[13]

* Fisheries Act

The Fisheries Act remains Canada's primary mechanism for the control of water quality. The purpose of the Act is to protect fish and fish habitat; it is not a health or broad environmental protection statute.

Its chief mode of control is a prohibition the discharge of any "deleterious substance" into water frequented by fish, and then prescribing, by regulation, specified levels or amounts of certain contaminants to be put into the water.[14] Since the early 1970s, Liquid Effluent Regulations have been developed for various industrial sectors, including: pulp and paper, mercury from chlor-alkali plants, petroleum refining, meat and poultry products, potato processing, metal mining, and metal finishing.[15] Toxic substances have not been specified in the regulations under the Fisheries Act, except for some heavy metal, phenols, ammonia-nitrogen, and mercury.[16]

The Act also has provisions that allows the Minister of the Environment to require any plans for new operations. The Minister may then require modification if there is a possibility that the operation may lead to a violation of the general prohibition.

The prohibition section of the Act, discussed above, is administered by the Department of the Environment, while the rest of the Act is administered by the Department of Fisheries and Oceans. While a federal statute, some provinces, like Ontario, are delegated the authority to enforce the statute, although such authority is not exercised frequently.

* Canada Water Act

The Canada Water Act does not control any toxic substances at the present time. However, the Act is worthy of mention since the federal government, upon the fulfillment of certain conditions, waters of a "significant national interest" a water quality management area.[17] Once so designated, extensive powers are bestowed to maintain the water quality of that area. To date, no region has been designed as a water quality management are by the federal government.

Part III of the Act provides for the making of regulation to control nutrients and phosphorous in cleaning agents.[18]

* <u>Environmental Contaminants Act</u>

The <u>Environmental Contaminants Act</u> is jointly administered by the Departments of the Environment and National Health and Welfare. Under the Act, there are certain notification requirements for chemicals imported or manufactured in Canada for the first time. Further, the Ministers may require information on chemicals if they have reason to believe that a substance may constitute a danger to human health or the environment. Once the information is submitted, the Cabinet must be "satisfied" that the substance will constitute a "significant danger" to human health or the environment before a substance can be added to the schedule.[20] Once on the schedule, restrictions can be placed on the manufacture or use of the substance, or emissions limits imposed.

Under the Act, since the notification requirements are only triggered after the chemicals are already manufactured or imported; there is no systematic procedure to screen chemicals for toxic effects before they are introduced. Moreover, Act is meant to be a residual statute and only used where it is not possible to regulate under a more appropriate statute. Finally, the onerous nature of some requirements to have chemicals placed on the schedule accounts for the limited number of chemicals which have been regulated under the Act since its inception in 1975. These chemicals include PCBs, mirex, polybrominated bipehnyls (PBBs), polychlorinated terphenyls (PCT), and chlorofluorocarbons (CFC). [21]

* Other Legislation Pertaining to Toxics Control

The <u>Clean Air Act</u>, which is administered by Environment Canada, is the federal government's main air quality control law. It establishes various kinds of regulatory controls.[22] National Ambient Air Quality Objectives set non-binding goals for ambient air on a national basis with the intention that all provinces will adopt the goals.[23] Ambient objectives have been set for sulphur dioxide, carbon monoxide, nitrogen dioxide, and suspended particulate.[24]

National emission guidelines,[25] which are also unenforceable, are intended to encourage uniform standards across the country through their adoption by the provinces. Emission guidelines have been set for the cement industry, metallurgical coke manufacturing, the asphalt paving industry, arctic mining, packaged incinerators, wood pulping industry and thermal power generation.[26] The Clean Air Act also authorizes National Emission Standards[27] where, which are enforceable, where necessary to prevent a significant danger human health or a violation of an international air quality agreement. To date, only four such standards have been set: emissions of lead from secondary lead smelters, mercury from chlor-alkali plants, asbestos from mining and milling, and vinyl chloride from vinyl chloride manufacturing.[28]

The Motor Vehicle Safety Act, under the jurisdiction of the Ministry of Transportation, has been to make regulations to control nitrogen oxides, carbon monoxide, HC and particulate emissions to prevent health effects from motor vehicles. The Canada Shipping Act also has air pollution regulations applicable to all vessels within Canadian jurisdiction.

The Pest Control Products Act, administered by Agriculture Canada, governs the registration and labelling of all pesticides that may be used in Canada. In order for a pesticide to be registered, it must satisfy three criteria: safety, merit and value. From a toxic control perspective, the two main mechanisms under the Act are the power to accept or refuse an application for registration and the power to stipulate what should appear on the level.

In addition to these statutes, there is a host of other federal laws which pertain, in one context or another, to the regulation of toxic contamination, such as the Atomic Energy

Control Act[29] and the Hazardous Products Act.[30]

Finally, mention should also be made of the proposed Canadian Environmental Protection Act[31] given first reading in Parliament on June 26, 1987. In summary fashion, the Act aims has two basic goals: to amalgamate existing federal environmental law in one umbrella statute. Statutes incorporated into the proposed law include: the Clean Air Act, the Canada Water Act, the Ocean Dumping Control Act,[32] the Environmental Contaminants Act, and the Department of Environment Act[33]. Second, the proposed law is intended to enact a package of reforms to the existing Environmental Contaminants Act. The precise nature of the reforms, together with other features of the Act are discussed throughout the paper.

2.2.3 Ontario Legislation Governing Toxics

The primary water protection statute in Ontario is the Ontario Water Resources Act.[34] Its companion statute, the Environmental Protection Act,[35] regulates all other media. While neither statutes specifically deals with toxics, the Ontario Ministry of the Environment recently introduced a new toxic control strategy, the Minicipal-Industry Strategy for Abatement (MISA).[36] The Pesticides Act[37] implements the federal Pest Control Products Act.

* Ontario Water Resoures Act

The Ontario Water Resources Act (OWRA), administered by the Ministry of the Environment, sets out a general prohibition against pollution and then creates an exemption for sewage and water treatment works if those facilities have been granted a certificate of approval. It also requires an approval for new dischargers or ones significantly altered;[38] it is not an offence to operate without an approval.

Neither the OWRA nor its regulations prescribe effluent limitations. Instead, "water quality objectives" have been set which are used in prescribing the terms of the approval on a case-by-case basis.[39] These water quality objectives are to ensure that the surface waters of the province are of a quality which is satisfactory to aquatic life and recreation.

In addition to water quality objectives, there are also groundwater and drinking water quality objectives. For groundwater, the approach is regulation of waste discharges on a case-by-case basis. The drinking water objectives cover 42 chemicals out of some 800 known to exist in the Great Lakes alone.[40]

* Environmental Protection Act

The Ontario Environmental Protection Act (EPA) makes it an offence to discharge any contaminant into the environment that may be harmful to the environment or human health and comfort.[41] While regulations are in place for air contaminants,[42] it may be recalled there are no specific legally defined limits that automatically defines an offence for impairment of water quality.

The Ministry of the Environment is given fairly extensive powers under the Act, including the powers to accept program approvals (a polluter's plan for abatement),[43] control orders[44] and stop orders.[45] The Ministry has recently, issued regulations for sulphur dioxide emissions for INCO from its smelter in Sudbury and similiar for emissions from fossil fuel power plants from Ontario Hydro.[46]

The EPA also requires a Certificate of Approval for the release of any substance into the natural environment, except water.[47] Further waste management is regulated by EPA; any operator a waste disposal site or waste management system must receive ministry approval.[48] Often these approvals set out allowable levels of leachate parameters at the property line or adjoining water courses. An ambitious masterplan for waste management, "Blueprint for Waste Management" was issued in June, 1983, although no legislation has followed it.

Finally, the EPA contains a "spills" provisions to deal with the some 1000 spills each year in the province. The provisions provide a clean-up regime and makes the owner of the vehicle absolutely liable.[49]

* Minicipal-Industry Strategy for Abatement

In June of 1986, the Ontario Ministry of the Environment introduced a new non-regulatory initiative for the the control of toxic water pollution, the Minicipal-Industry Strategy for Abatement (MISA). The MISA's goal is to control toxic contaminants in municipal and industrial discharges into waterways by creating a comprehensive data base on contaminant discharges across Ontario; increasing the emphasis on control technology, and in particular, the best available technology; strengthening and expanding existing water quality impact approach; and strengthening enforcement mechanisms.

* Sewer Use By-Laws

The OWRA, and other laws, only govern discharges into the province's waterways. Discharges of toxic substances into sewers is the responsiblity of the owner of the sewer system - the municipality. For the most part, municipalities regulate discharges through the use of sewer use bylaws. It is probably fair to state that there are as many different by-laws in Ontario as there are municipalities. Generally, however, many follow a model sewer use by-law.[50] This by-law essentially prescribes qualitative limits on the kinds of discharges permitted into the sewers. The most obvious problem with the approach is that of enforcement - not only is it difficult to monitor each discharge and trace where the discharge originated, but often the discharges are mix of a wide range of chemicals.

* Other Laws Pertaining to Toxic Substances Control

Like at the federal level, a variety of other statutes are directly or indirectly pertain toxic substances control. The Pest Control Safety Act, for instance, implements the federal Pest Products Control Act. Under the Act, a system of permits and licences is established, together with a regulatory framework governing the use, transportation, storage and record keeping of the substances. Only substances registered at the federal level can be sold and used in Ontario. The Act includes a series of six schedules which classify the substances according to a descending order of toxicity and level of expertise required for use.

2.2 Principles for Regulatory Reform

As noted earlier, the impetus for a regulatory strategy to deal with toxic water pollution is the recognition of the insiduous characteristics of persistent toxic chemicals. Its basis, however, is the inadequacy of the current regulatory framework to respond to the particular exigencies of toxic water pollution. As this section points out, and further developed later, current regulatory assumptions are challenged, and indeed, decimated, by the toxic water pollution.

While the nature of these regulatory challenges, and the suggested reforms, are outlined below, it is imperative to review the regulatory goals of the strategy.

2.2.1 The Goal of Virtual Elimination

Certainly the basic goal of environmental law in general is the protection of human and environmental health. When most of the environmental laws in Canada were enacted throughout the 1960s and 1970s, however, they were designed to address most of the conventional pollutants, such suspended solids and biological oxygen demanding (BOD) substances. A regulatory assumption in the formulation of these laws was that over time, these pollutants would degrade, transform, or leave the system quickly enough to retain the biological integrity of the waterways. The regulatory goal was simply one of identifying human health tolerance limits or the carrying capacity of the waterways and find the appropriate discharge standard to fit those tolerance or capacity levels. In short, the goals of environmental regulation were, and for the most part, remain, to find "safe" levels of pollutant discharges.

Persistent toxics challenge these very regulatory assumptions. Their accumulations in the environment, their long residency times, their low concentration thresholds for biological effects (if they exist at all), their mobility, and the lead time between the introduction of the substances into the environment and the manifestation of effects strongly suggest that these pollutants are simply incongruent finding a "safe" level of discharge. Instead, the regulatory goal for persistent toxics is best articulated as the virtual elimination of discharges of toxic substances into the environment.

At present, while there is some question whether there is nation-wide regulatory goal pertaining to persistent toxic substances. It may be fair to state that, if not formally accepted, there is considerable support for the goal of virtual elimination at both the federal and provincial levels.

In 1978, Canada and the United States concluded the Great Lakes Water Quality Agreement (GLWQA).[51] While this Agreement had a number of innovations, one of the most important was the articulation of its purpose, which is, inter alia, "...the discharge of any or all persistent toxic substances be virtually eliminated..."[52] and that the "... philosophy adopted for control of inputs of persistent toxic substances shall be zero discharge."[53]

The goal in the GLWQA is mirrored in the U.S. Clean Water Act [54] which has, as its goal, "zero discharge" of certain pollutants.[55] Unfortunately, there is no direct parallel in Canadian federal legislation. The recently introduced Bill C-74, the Canadian Environmental Protection Act, in its preamble, reiterates the need to meet international obligations, which would include those obligations which emanate from such agreements as the GLWQA.

Most provinces are still in the process of developing toxic control strategies and formulating appropriate goals. In Ontario's most recent policy statement, the 1986 Municipal-Industrial Strategy Abatement (MISA), its stated "ultimate" goal "...is the virtual elimination of toxic contaminants in municipal and industrial discharges into waterways."[56] Similarly, this goal is reflected in Principle IV of the Great Lakes Toxic Substances Control Agreement, an accord which the province of Ontario adopted in principle in 1986.[57]

Even though there is some support for the goal of virtual elimination, its scope and operationalization have received little attention. Virtual elimination is not a "ban" on the release of all toxic substances into the environment; instead, it envisages a regulatory process that seeks to gradually reduce absolute loadings of all persistent toxic chemicals until the point where there will be "virtually" no discharges.

The overall implication of a virtual elimination goal is that what needs to be developed is not a toxic substances "control" strategy, but a toxic "reduction" and "elimination" strategy. In the end, the adequacy of any strategy must be adjudged to the extent that this goal will be fulfilled. The pertinant question is whether the present regulatory framework is oriented to the achievement of the goal.

2.2.2 Strategies for Implementation

From a regulatory, a toxics substances reduction and elimination strategy can be said to have three functional goals. First, it seeks to ensure that the regulatory net is broad enough to capture those persistent toxic substances posing threats to human or ecological health. Second, among other factors, it must result in an overall reduction of loadings of those chemicals into the environment (in anticipation of the long-term goal of virtual elimination). Finally, provisions have to be in place to cope with those chemicals already in the environment and still posing an environmental or health concern.

The achievement of these functional goals may be possible through adjustments and "tightening" of the present regulatory controls both at the federal and provincial levels. The kinds of reforms anticipated under this approach may include:

* identifying those priority pollutants which have yet to regulated and expediate the process to have them covered under present controls;

* improve and strengthen existing standards for those chemicals presently regulated;

* enhance current regulatory enforcement and compliance mechanisms to ensure that the existing framework is working at its optimum; and

* through the use of direct environmental regulations [such as the Fisheries Act] and indirect means [such as a system of incentives through the tax system], and mandating more advanced technological controls.

While the recognition and implementation of these "adjustments" may be a positive step to toxic substances control, the goal of virtual elimination may not be realized simply because the basic assumptions and control measures within the current regulatory framework were never designed to achieve this goal.

Hence, while adjustments to the present framework provide a positive, interim step, other provisions may be necessary to supplement, rather supplant, current environmental laws. Such controls work toward the virtual elimination goal while recognizing and addressing the particular control problems of persistent toxics.

The three primary control issues and pertinant regulatory principles may be summarized as follows:

A. The Cross-Media Approach: Current water pollution controls, with some exceptions, attempts to regulate water quality without recognizing the movement of pollutants through each media of the water, air and land, which in turn, limits the effectiveness of environmental protection efforts;

B. The Source Reduction Approach: For the most part, existing laws focus on determining what kind of controls at the end of the pipe ought to be in place to regulate the flow of pollutants rather than attempting to reduce the overall production of the chemical waste products at the source. This goal can be achieved, foremost, by establishing source reduction laws that seek to regulate those industrial process which produce toxic substances as waste products. Other regulatory mechanisms include the use of standards which mandate "absolute" reductions in the amounts or loadings of pollutants entering the system and non-point source control programs which are absent in many regulatory programs in place today.

C. An Ecosystem Approach: Most regulations fail to recognize the contribution of pollutants from outside of their jurisdiction and the impact of their polluting sources on other jurisdictions.

2.4 Summary and Conclusions

The current regulatory framework was neither intended nor designed to deal with many of the unique challenges posed by toxic water pollution. It is only reasonable that, as more is understood about pollutants and their interactions with the environment, the regulatory framework is appropriately reformed to reflect the current understanding of such relationships. The principles suggested in this chapter, which will be explored in the remainder of the paper, form a brief sketch of the nature and content of some of those reforms.

regulations must be flexible to allow for improvement its stated intention of integrating federal environmental law. Apart from technical, yet important, revisions to the Environmental Contaminants Act under Part I of the CEPA, the proposed law simply gathers existing legislative provisions together in a single Act: Part III is essentially what is now Part III of the Canada Water Act; and Part V incorporating what is now international air pollution provisions in section 19.1 et seq. of the Clean Air Act. CEPA also includes the Ocean Dumping Control Act.

Further, the consolidation was not complete. Some of the important statutes excluded include: the Fisheries Act, the Atomic Energy Control Act, the Pest Control Products Act, food and drug legislation, Hazardous Products Act, among others that are relevant to toxics control.

* Ontario

Provincial toxics management follows a similar pattern to the federal government in that they are characterized by a sectoral and fragmented approach.

In Ontario, for example, water discharges are governed by the Ontario Water Resources Act (OWRA), air emissions by Part II of the Environmental Protection Act (EPA) and Regulations 296 and 308, with land based activities governed by Part V of the EPA and Regulation 309, and the Pesticides Act, among other related statutes.

In the setting of standards and in the granting of permits, neither the OWRA nor EPA requires that the cross-media impacts of chemicals be taken into consideration. Indeed, according to Ministry of the Environment (MOE) officials, its Water Resources Branch would rarely be informed of air permit applications reviewed by the Air Resources Branch. Any degree of cooperation or coordination at this point is undertaken, if ever, on a strictly ad hoc basis.[30]

One of few exceptions to this is found under the new initiatives to limit acid gas emissions to reduce impacts on water quality.[31] A major disappointment is the failure of the Ministry to coordinate their initiatives for reform of Ontario water regulations, MISA, air regulations, and waste management regulations in a way that would develop a more integrated toxics management strategy. Under MISA, "Ontario's water quality management program will be brought more in line with similar Ministry programs for controlling toxic emissions to air and toxic waste disposal to land...," in practice there has not been a formal or informal process to integrate air emission or waste disposal impacts into water quality standards.[32] At present, the only initiative is to slightly strengthen air and disposal regulation.

Water pollution control in Ontario is complicated by the large role played by the municipalities in regulating discharges to sewers.

The municipal sector in Ontario consists of some 400 sewage treatment plants (more than half operated by the MOE) and treats waste water from approximately 11,000 industries. According to a 1986 report, there is just as much toxic pollution flowing into the province's waterways from Ontario's sewage treatment plants (STPs) as there is directly from industries.[33] While there are 300 direct industrial dischargers with provincial certificates, there are at least 11,000 industries discharging their waste directly into municipal sewer systems.[34] for the most part unenforced

These discharges are regulated under municipal sewer-use by-laws which specify an allowable concentration for many toxic substances (primarily metals) but also allow industries to exceed these concentrations through negotiated agreements and payment of a fee. These by-laws are based on a model by-law drafted by the province, the federal government and municipal engineers, so that there is some degree of consistency between municipalities. However, the model by-law does not address cross-media problems (such as the volatilization of toxic substances from STPs) and enforcement is extremely inconsistent among the municipalities.

Hence, the only toxic controls for the 11,000 industries discharging into the sewer sewer system is municipal sewer-use by-laws, which are at best only suited to dealing conventional pollutants.

The situation is not corrected under MISA. While effluents coming out of STPs will be regulatied under MISA, the control of toxic substances going into the sewage treatment plant will be left to the municipalities.

3.4 Summary and Recommendations

It is apparent that, like in many instances in the U.S., the Canadian environment suffer because are sectoral in nature. Further, there are relatively few indications that a cross-media approach is either recognized or accepted as a priority for reform.

It is, therefore, recommended that:

(a) both the federal and Ontario regulators commit in policy to a cross-media approach to environmental management;

(b) the pertinant laws are reviewed to note where there is an absence of a cross media perspective and attempts made to better coordinate and cooperate to bring that perspective down to an operational level;

(c) and that, until comprehensive reform is forthcoming, interim initiatives be considered such water standards which take into account the inputs from air and land based sources and an integrated permitting systems which licence the total environmental exposure from the facility rather than simply a discharge into a single media.

CHAPTER 4 - From Waste Management to Source Reduction

Introduction

For persistent toxic substances, the goal of virtual elimination can not be achieved by simply strengthening existing environmental protection standards. This is because focusing solely on the concentration of a substance in effluents and emissions does not necessarily cut down on the total amount of the substance produced by a polluting facility which enters the environment.

Rather than an approach which reacts to a waste problem by collecting chemical by-products at the "end of the pipe", an approach is needed which works forward preventing creation of such chemical wastes and by-products in the first place.

Many U.S. jurisdictions have committed to the source reduction approach through policy enactments, research and demonstration projects, and various legislative initiatives. In Canada, however, there is little sign of acceptance of the approach; the "end of the pipe" regulation is still very much in vogue.

This chapter will first explore how the regulatory approach tends to take a "waste management" perspective then examine the source reduction concept as a preventive regime, and finally, examine source reduction in the context of Canadian law and policy.

4.1 The Problem of the Waste Management Perspective

Current pollution controls in Canada and the United States almost invariably have an "end of the pipe" focus. Their orientation is to ensure that waste streams entering the environment are environmentally acceptable. For the most part, this task has been achieved by adding pollution abatement equipment to the end of the process to keep "unacceptable" levels of pollutants out of the effluent. In short, existing pollution controls do just that - they attempt to control and manage pollution, not necessarily eliminate it.

This "end of the pipe" focus leads to the following consequences: first, it may not reduce the overall environmental risks posed by a process but instead, may serve only to transfer pollutants from one medium to another.

For example, pollution abatement equipment is now commonly used in both Canada and the United States. Such technologies on combustion processes, such as scrubbers and sophisticated particulate collection equipment such as baghouses, leave behind a sludge residue or fly ash. Both contain high concentrations of toxic chemicals and require disposal. For some major industrial waste landfills, these residue compounds account for almost one-quarter of their waste receipts. For a petroleum refinery, for example, over one-half of its wastes emanate from its pollution control equipment.[1] In essence, the risk is simply transferred. The residue must either be buried or burned and both options may well lead, inadvertently or not, (such as when pollutants volatilize back into the air during storage or leachate escapes from the landfill where the sludge was buried) to the introduction of the prohibited chemical into the environment. This problem is further complicated because jurisdictions are increasingly banning toxic waste from landfill disposal or incineration. This creates even more critical dilemma of what to do with the wastes accumulating as chemicals continue to be produced.

PCBs illustrate the problem. Although never manufactured in Canada, the Environmental Contaminants Act essentially banned their manufacture and most uses, yet failed to address an appropriate mechanism for their disposal. From 1982 to 1986, Ontario allowed only storage of PCB wastes as an acceptable "fate." [2] As more and more PCBs were taken out of use, the stored wastes increased in volume, increasing that chance that these wastes would find their way into the environment.[3]

An analogous situation is with the Ocean Dumping Control Act which regulates disposal of wastes in the ocean. As controls on ocean dumping become more restrictive, pressure is place upon industrial waste disposal facilities on land.[4]

Second, end of the pipe controls may contribute to the toxic waste problem. For instance, when effluent concentrations are restricted, additional raw materials and energy must be used, which in turn generate waste by-products, to meet the standards set for the particular industrial sector.[5]

Finally, traditional approaches also fail to take into account that allowable discharges of persistent toxic substances may nevertheless cause significant long-term harm. Persistence means that chemicals discharged into the environment, even in the smallest of quantities, will build-up. Perhaps one of the best known examples is the mercury pollution in the Wabigoon-English River system. In the early 1960s, a pulp and paper company in Northern Ontario built a chlor-alkali plant, which used a mercury cell process to produce chlorine which, in turn, was used to bleach the paper.[6]

It has been estimated that some 10 tonnes of mercury were discharged into the river system by 1970, with incremental discharges continuing until 1975 when the mercury cell process was replaced.[7] Most of that settled out of the water into the sediments. Despite stringent controls after 1972, significant amounts of mercury are still being released from the sediment back into the water, varying with changes on factors such as temperature and microbial activity.

As a result, native communities within the Wabigoon-English river system remain at risk from mercury contamination due to accumulation in the food chain to magnification in fish.

The inability to dispose of toxic chemicals, and their bioaccumulative nature, suggests that the safest course in dealing with these chemicals is simply not to introduce them into the environment in the first place. The philosophy of trying to prevent the discharge of pollutant before they are released is contrary to the current philosophy which focuses on controlling the effects of pollution once discharged. One of the most important preventive strategies from a regulatory point of view is "source reduction."

4.2 The Source Reduction Response

The notion of trying to prevent the creation of pollution is not new. "Anticipate and prevent" strategies have been advocated by such bodies as the O.E.C.D.[8] and recommended in various international reports, such the Brundtland Report (the World Commission on Environment and Development)[9] and the report from the World Industry Conference on Environmental Management (WICEM).[10]

Yet, despite broad acceptance of the principle, there has been little agreement on how to operationalize it in order to make it a viable and feasible alternative. Indeed, the U.S. Office of Technology Assessment concluded in its in-depth 1986 report on the subject that the "major obstacles to increased waste reduction are institutional and behavioural rather than technical."[11]

However, the tide may be changing. In recent years, intensive research throughout the world has been conducted on perhaps the most important component of a preventive environmental strategy - source reduction. While terms like low waste technology, closed loop recycling or waste reuse methodologies were at one time unheard of, it is apparent that, in light of burgeoning interest from governments, industry and the public, the topic will become an integral aspect in the forthcoming generation of environmental law and policy.

* Implementation of the Source Reduction Concept

Source reduction is an expansive term. It includes "low waste," "non-waste" or "clean" technology designed to (1) yield the optimal efficiency of an industrial process; (2) minimize the creation of pollution at its source; and (3) reduce or eliminate waste generation at the source.

While "source reduction" includes the reduction, recovery, recycling, and reuse of wastes (the "4 Rs"), it goes further concerning itself with waste prevention as well as waste minimization.[12] Source reduction requires an assessment of an entire industrial process to find ways of reducing the amount of hazardous by-products rather than accepting such substances as the inevitable consequence of the activity. This source reduction techniques include process and product substitution.

Source reduction is justified on a number of grounds:

a. it makes good environmental sense to find processes and products that do not add persistent toxic substances to the environment;

b. it also makes good economic sense since to use raw materials more efficiently to reduce long-term waste mangement costs and to curtail regulatory and enforcement costs;[13]

c. it also helps alleviate the hazardous waste disposal problem in the future. As more is know about toxics, it is likely that environmental controls will become stricter; the tougher the standards, and with the trend to banning the landfilling of hazardous waste, the more difficult it will become to discharge to the environment.[14]

The notion of reducing pollution at its source is not new, especially in Europe.[15] In the U.S., Environmental Protection Agency was established in 1970, the concept appeared in its official documents.[16] Yet, it is generally agreed that the U.S. is considerably behind most countries, like France, Germany, Denmark, Norway, the Netherlands and Austria, in their commitment to implementing source reduction through the promotion of low waste and "clean" technologies.[17]

While the roots of source reduction thinking have existed in the U.S. for some time, it has not yet been seriously pursued as a strategy.[18] Financial support continues to be minimal. According to one report, over 99 percent of federal and state environmental spending is devoted to controlling pollution once generated; less than one percent is concerned with reducing the amount of pollutants generated.[19]

For the most part, U.S. law focuses on "managing" pollutants once produced rather than on programs to reduce or prevent them at source. Where such programs are in place, the focus is on the narrower goal of waste reduction as opposed to source reduction. Demonstrating of this approach are the 1984 amendments to the U.S. Resource Conservation and Recovery Act (RCRA).[20] The dual aspects of both preventing (waste 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.

Despite this "policy" recognition of source reduction, the legislation is limited in the extent to which it implements their policy. For example, RCRA's regulations mandate that companies either treat their waste onsite or ship their waste to be treated offside prior to 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 are subject to biennial reporting requirements.[21]

This limited legislative commitment is exacerbated by a limited agency commitment. As one report noted, "[L]ittle money has been requested for implementation of waste minimization through FY 1987, and waste minimization is a minor feature of long range plans."[22]

Most U.S. states have, like the federal government, endorsed source reduction in principle and not in practice. On average, only one percent of environmental budgets are spent on waste reduction. Of the programs that do exist, they tend to be non-regulatory in nature by centering on information dissemination to industry and the offering of research grants. They also remain more oriented toward waste management rather than waste reduction; and, with the exception of North Carolina, all concentrate their effort on RCRA regulated wastes exclusively, as opposed to a multimedia focus.[23]

The New York Department of Environmental Conservation has recently announced that it will begin to significantly emphasize the source reduction approach commencing with a new policy, which will be developed and implemented by mid-1988.[24] At present, in addition to RCRA requirements, New York state has instituted an Environmental Regulatory Fee System and a State Superfund Fee Program. These program tax generators based on the amounts of hazardous waste 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.

Apart from New York's initiatives, at least a dozen states are contemplating following California's Proposition 65. The proposition, which won approval in November of 1986, prohibits the discharge of any chemical known to cause cancer or birth defects anywhere they could enter domestic drinking water supplies. The U.S. Public Health Service lists 180 such chemicals, 60 of which are in common use.[25] Already, at least 10 states have waste reduction programs in place and have established a central coordinating office responsible for promoting waste reduction and for implementating their waste reduction plans.[26]

While governments have been dilitory in their response to source reduction, industry has forged ahead to capture the economic benefits of source reduction.[27] The 3M Corporation, for example, with its 3P program (Pollution Prevention Pays), has saved some $350 million since the program commenced in 1975. In addition, the Corporation boasts that it has prevented over 104,000 tons of pollutants entering the air; 13,000 tons from entering the water and 280,000 tons of sludge and solid waste from being buried.[28]

Results like these have recently sparked a number of reports which examine the theory and practice of source reduction in the United States.[29] Essentially, the reports conclude that the primary elements of a source reduction strategy must be:

* an office to encourage source reduction within the jurisdiction;
* economic incentives for further research, technical research and information and technology transfer;
* legislation that provides a multi-media focus and other adjustments that would promote source reduction.[30]

4.2 Source Reduction Under Canadian Law

The source reduction concept has often surfaced in studies at the federal and provincial levels in Canada. However, it is found to a much lesser extent in policies in most provincies and in particular, Alberta, Manitoba, Ontario, and Quebec. Despite the recognition of the concept, few provinces, if any, have implemented a comprehensive legislative program or even made it a program priority for its operationalization.[31]

* Federal

The need for a preventive approach has been reiterated throughout the years in federal government studies. As early as 1972, a governmental task force concluded that "... the existing legislation reflects a single concern, for example the deposit of wastes in water or the discharge of contaminants to the air. It is reactive rather than preventive and essentially ad hoc in its approach."[32]

More recently, the Royal Commission on the Economic Union and Development Prospects for Canada (the Macdonald Commission), in its 1985 report, advocated the "... greater use of a preventive approach to environmental decision-making, an approach that reflects and reinforces the growth in public support for policies that contribute to regeneration of ecological systems."[33]

It has been reported that approximately 63 million tons of waste are generated each year in the Canadian industrial sector alone, 3.5 million tons of which are of a hazardous nature.[34]

Despite these vast quantities, there is neither an explicit national policy nor legislative provisions promoting source reduction, despite the fact that the federal government has declared that waste reduction and recovery should be an integral component of hazardous waste management in Canada. [35]

Instead, the federal government has chosen a number of non-regulatory options directed, for the most part, to providing incentives for industry to develop new technologies.[36] Most notably, the D-RECT (Development and Demonstration of Resource and Energy Conservation) program, by contributing up to 50% of project costs, acts as an incentive for industry to encourage the development of energy conservation and source reduction technologies.

It also sponsors initiatives such as the Canadian Waste Materials Exchange, a program intended to bring together owners and buyers of wastes. Not only have the results of this program been very modest, but clearly the program is directed to find ways to deal with wastes already created than avoiding new wastes.

The latest federal initiative, the Canadian Environmental Protection Act, neither mentions, nor seeks to implement, source reduction. Critics of the proposed law suggest that it takes a 1970s to environmental protection by attempting to manage waste, and not reduce it.[37]

* Ontario

In one form or another, Ontario policy has alluded to source reduction policy. In 1983, for example, the Ministry of the Environment released "Blueprint for Waste Management in Ontario." The Blueprint recognizes the worthy goals of the "4Rs" but does not go beyond then to source reduction. Similarly, when the province created the Ontario Waste Management Corporation in 1981, one of the Corporation's mandates was to promote the reduction, reuse, and recovery of waste.[38] Most recently, in the province's Throne Speech on April 28, 1987, a commitment was made to introduce a new comprehensive waste management funding program that will stimulate efforts by Ontario industries to develop effective means of reducing, recycling, reusing, and recovering waste products.[39]

Despite such policy pronouncements, in practice, a commitment to source reduction is not apparent. At present, there are no legislative provisions concerning source reduction per se. Even in Ontario's new MISA program, which aims at reducing the absolute quantities of toxic chemicals from entering the province's water ways, hardly even mentions source reduction. Indeed, Ontario, like most other provinces, have assumed that market forces, and in particular, increasing waste disposal costs, will naturally push industry toward other options, including source reduction.

While a number of industries have already turned to source reduction,[40] many agree that strong economic and legislative intervention is required to spark industry into the source reduction arena.[41]

At present, the office delegated the responsibility for source reduction is the waste reduction section of the Ministry of the Environment.

4.3 Summary and Recommendations

Source reduction is an essential component of a toxic substances reduction/elimination strategy. While the concept is become increasingly recognized and implemented abroad, Canadian legislatures have yet to eagerly follow suit. Instead, the existing emphasis on attempting to find ways and means of dealing with wastes once created seems well entrenched.

To overcome this dilemma, it is recommended that:

(a) both federal and provincial governments proclaim an explicit source reduction policy; and as elements of that policy, include,

(b) financial incentives and disincentives which will act catalysts to industry to develop source reduction measures;

(c) the enactment of legislative schemes to promote source reduction measures, such as pretreatment standards; land burial restrictions; statutorily mandated reduction and recycling measures; technology-forcing provisions that require new facilities to install clean technology; other provisions that ensure that existing industry are using the most current measures to reduce, reuse, and recycle their wastes; and

(d) greater emphasis on information gathering and exchange pertaining to on waste streams, waste technology and source reduction generally.

CHAPTER 5 - From Concentrations to Load Reductions

Introduction

Cross-media regulation requires an examination of 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, the next question is how to reduce that overall input of persistent toxic chemicals. Source reduction strategies are important pillar of this approach. However, while virtual elimination of all persistent toxic substances remains the ultimate goal, it is necessary to find ways to reduce total loadings until that goal can be achieved.

Contrary to the needs of a toxic reduction and elimination strategy, most environmental protection standards share the same weakness - they do not consider total loadings of a substance to the environment or ways of gradually reducing overalls loading of pollutants into the environment. Because of the persistent nature of some toxics, it is necessary to reorient these "relative" environmental quality standards to "absolute" environmental quality standards.

While quantity based standards are not new, a resurgence of their use has occurred in a number of areas, most notably in various Great Lakes jurisdictions.

Both the federal and provincial governments have recognized the merit of absolute pollution standards, although neither has integrated them into the mainstream of their environmental laws.

5.1 Relative Pollution Standards

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."[1] While virtual elimination of the discharge of persistent toxics remains the primary regulatory goal, a more pragmatic view suggests that the long-term goal can not foresake the need for short and mid-term strategies to deal with those substances or sources where source reduction is not yet possible. The goal of such strategies ought to be the achievement of a gradual, yet absolute reduction in loadings of persistent toxics into the environment.

Unfortunately, the present regulatory processes in North America are not oriented toward the achievement of this goal.

Historically, environmental laws in both Canada and the United States employed "ambient" or water quality based standards. These standards typically define a "designated use" for a stream or lake and pollutant "criteria" which specify the maximum concentration of pollutants which can exist in the water without impairing the designated use. For example, a designated use as a "warm water fishery" may limit the concentration of a chemical to a maximum of 5.0 micrograms per litre. This is known as an "ambient" standard. Polluters, therefore, have to ensure that their discharges will not cause the concentration of pollutants to exceed the ambient levels.

Ambient standards have been criticized on a number of grounds.[2] For instance, it is always a problem to determine precisely how much a given industry can discharge without violating a particular ambient level. When there are several industries discharging to the same water and the ambient limits are exceeded, it may be impossible to determine which of several upstream dischargers was culpable.

Further, ambient standards neither purport to nor, in fact, result in an absolute limit on discharges to the receiving waters. They may even encourage further discharges since industries have typically been allowed to pollute "up to" the level prescribed by the designated use. For the most part, the actual volume of chemicals entering the system may depend on a variety of factors totally removed from the protection of the waterways - the volume of the waters, the flow rate of the waters; the concentrations of dischargers; the type and dispersion characteristics of pollutants; the accuracy of the monitoring and modelling devices, among many others. For air emissions, the techniques to get within regulatory levels are well documented.

Another problem is that ambient standards were originally designed to control "conventional pollutants" - those which degrade and disperse relatively rapidly. Thus there is an assumption that water bodies can tolerate a certain amount of contamination over a given amount of time. Ambient standards, therefore, are simply a statement about the perceived assimilative capacity of the water for that chemical. For many persistent toxics, however, there is no real or practical assimilative capacity level owing to their persistent and bioaccumulative nature.

Perceived weaknesses in ambient standards under the U.S. Clean Water Act precipitated fairly drastic reform of the Act in 1972. Under those reforms, the regulatory emphasis was placed upon direct "end of the pipe" controls on the discharge itself based upon the best available technology (BAT). 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.[3]

Technology-based standards are an improvement to the ambient regime. They have, however, a number of weaknesses relevant to the control of persistent toxic substances. Most importantly, setting the particular standards for industrial sectors, the existing pollution control technology and cost of achieving effluent reductions, among factors taken into account.[4] This makes the technological feasibility of reducing the discharge the limiting factor in setting the standards, not the direct environmental effects and necessary responses. Because it is often the case that the technology needed to abate an existing source to sufficiently protect the environment is not economically available, BAT standards are supplemented by the ambient water quality based standards.

However, like ambient standards, technology-based standards may not an overall reduction in the loading of pollutants into the environment. The standards do not take into account greater production levels, more industries, outdated technologies, all of which are factors that may contribute to increasing loadings in a particular river at the same time that the regulations are complied with.

While both technological and ambient water quality standards are important and necessary in any toxic control strategy, there is a need for a supplemental mechanism to ensure the total reduction of persistent chemicals entering the environment.

5.2 Quantity Based Standards as a Response

"Relative" standards, in effect, mean that the basis of the standard is relative to something - the use of water for a certain purpose; the technological feasiblity of a control, risk of causing cancers in humans, among many others. "Absolute" standards, on the other hand, are set so as to achieve total or "absolute" reductions in loadings of pollutants into the environment. These are called quantity based standards. In effect, they are standards which specify the total quantities or loadings of pollutants to be allowed over time.

There have been a number of instances where quantity-based standards have been used, in many cases successfully. Many of the seminal attempts and, indeed, current attempts at quantity-based standards have been in the Great Lakes basin.[5]

In the early 1970s, for instance, scientists found that high phosphate levels discharged into the lake system led to a proportionate increase in algae productivity and various secondary consequences. The impacts included deoxygenation and the loss of certain species. This process, known as eutrophication or "premature aging," reached a near crisis stage in the lower lakes.

Through the auspices of the International Joint Commission, governments agreed that programs to reduce inputs of phosphorus and other nutrients should be undertaken, should be based on confirmed target loads, allocated among jurisdictions, and should be completed by May, 1980. The 1983 Phosphorus Load Reduction Supplement confirmed the original target loads for all lakes but Lake Ontario.[6]

The phosphorus example is of interest because the load reduction concept was applied with respect to conventional pollutants. Two more recent examples may be cited with respect to toxic chemical pollution.

In July of 1986, the states of Illinois, Indiana, Michigan, Wisconsin and Region V of the U.S. Environmental Protection Agency (EPA) concluded perhaps the most ambitious initiative to date, the Lake Michigan Toxic Pollutant Control/Reduction Strategy.[7] The purpose of the strategy is to address the problem of toxic pollution in Lake Michigan by reducing the loading rates into the Lakes. The goal is to be accomplished by identifying sources of toxins, quantifying toxic inputs to the lake, and then systematically reducing those inputs. Initially, the participants will focus on 11 toxic pollutants of concern.[8] After extensive monitoring and modelling exercises, they intend to calculate a "mass balance" for those pollutants, to the extent possible based upon available data. (The mass balance concept is dealt with in Chapter 6 of this paper).

More recently, 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 in February of 1987.[9] The major components of the Agreement are the establishment of a coordinating committee, an extensive monitoring program, and most important, a reduction by 50 percent of loading of certain persistent toxic chemicals into the river.

While both the Lake Michigan and Niagara River Agreements share the load reduction concept, they differ somewhat in their approach.

With load reduction, a number of important issues arise: on what basis should the load reduction targets be set and how should they be achieved? What formula should be used to allocate among water users (whether by industry or jurisdictions) the total quantities to be reduced?

In terms of the appropriate load reduction target, the Niagara Accord sets an arbitrary 50% reduction in loadings - a target which has no relationship to the target that may in fact be needed to rehabilitate the river. Even with a 50% reduction, it is estimated that as much as 4.5 tonnes of chemicals could flow into the river every day.[10] Under the Lake Michigan Agreement, load reduction have to be sufficient to ensure compliance with the water quality standards established under the U.S. Clean Water Act.[11] What is interesting is that neither accord has as its ultimate goal the "virtual elimination" of discharges of toxic substances, despite this being the goal of the Great Lakes Water Quality Agreement.

Rather than arbitrarily setting load reduction targets, it would seem reasonable that load reductions targets be based upon criteria designed to protect local waterways and ecosystems.[12] 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. Environmental Protection has attempted to, in part, address the issue under their "Toxics

Control Strategy."[13] Under the Strategy, a national policy is to be developed for the formulation of permit limitations based on the toxicity of the effluent discharge as a whole.[14] Under this approach, toxicity limits are developed for the whole effluent using a variety of biological testing techniques (as opposed to solely using a chemical specific approach). This approach is now under review in some parts of Canada.[15]

At least initially, both the Niagara and Michigan agreements rely on existing laws and processes to achieve the necessary reductions. This is viewed by many as inadequate on that grounds that existing environments standards are not sufficient stringent to attain present regulatory objectives, much less stringent 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 NPDES (National Pollution Discharge Elimination System) permit. The Niagara River agreement provides for a 50% reduction shared equally between Canada and the U.S.. However, because something like 80% of chemicals entering the river are discharged from the American side, U.S. polluters will be able to pollute approximately four times as much as their Canadian counterparts.

It is quite clear from these few attempts that the load reduction concept has a number of implementation problems; however, it is aimed in the right direction - toward the gradual overall reduction of discharges of toxic chemicals into the waters of the North America.

5.3 The Load Reduction Concept Under Canadian Law

* Federal Law

Certainly, the federal government has recognized the load reduction concept, as least to the extent of its participation in the phorphorus reduction programs and the Niagara River Agreement.

Within the context of domestic legislation, however, there is little evidence of suport for the concept. Even in the 1970s, many recognized that relative standards at the federal level were not solving the problems they were set up to solve. For example, with respect to national emission standards for secondary lead smelters under the Clean Air Act, 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 semlter 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.[16]

These standards are similar to all those found in federal regulations and guidelines. There are no absolute standards under federal law.

* Ontario Law

The province of Ontario, like other provinces, has traditoinally used quality based standards. Recently, however, Ontario has begun using some quantity based standards.

Under its MISA program, its new strategy to deal with toxics, Ontario intends to develop effluent standards based upon the best available technology most economically achievable (BAT) for the major categories of industries. If the BAT 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 BAT, MISA is expected to achieve its ultimate goal, the overall reduction of toxic substances entering the environment.

Whether or not the BAT standards will lead to an overall reduction of toxic chemicals in the environment is the subject of some debate. First, arriving at the definition of BAT has not been an easy task in the U.S., where it has been used as part of water regulation since 1977. In fact, this problem has continually delayed the implementation of such water regulations.

Second, the proposed Ontario standards assume that by making them more stringent over time, there will be an overall reduction of discharges. Such assumptions not only fail to relate the standards to the actual water quality implications of discharges, but fail to take into account new industrial inputs. Finally, there is little incentive under the program to develop new, more advanced, and efficient technology. Without these "technology forcing" measures the BAT standards may remain fairly stagnant.

Another load reduction program with more promise is Ontario's Countdown Acid Rain Program.[17] Under this program, industries emitting acid-causing emissions are required to meet load reduction targets according to a preset timetable. Further, Ontario Hydro is required to meet 50% load reductions by the early 1990s for sulphur dioxide emissions.[18]

5.4 Summary and Recommendations

Quantity based standards are not radical. They are specifically designed to address urgent problems that may have severe environmental implication. Certainly all of the existing standards should not be completely removed. Instead, quantity based standards are designed to supplement, not supplant traditional controls. They are a check to ensure that the overall new inputs of toxics. These programs must be considered a priority.

6.2 Responses to Non-Point Source Toxic Water Pollution

It is beyond the scope of the present study to examine in detail specific responses to the problem of non-point source of toxic water pollution. The responses are as diversified as the the sources themselves. Instead, what is discussed are a few key elements which may be included in an toxic substances reduction and elimination strategy which respond, in a preliminary fashion, to the control problems mentioned above. These elements include: a mass balance approach; non-point source abatement programs; and remediation programs.

* A Mass Balance Approach

Before the goal of reducing total loadings of persistent toxics can be attained, it is necessary to understand all inputs (both point and non-point source) of pollutants into the system. That is the essence of the mass balance approach.

Under a mass balance approach, 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 which have not been identified and quantified, or the quantities in or out are not accurate. In either case, environmental monitoring programs are in needed of further development or refinement.

Once a mass balance has been done for pollutants of concern, the long-term effects on water quality of the waterbodies under study can be simulated by mathematical modelling. From that process, it may be possible to estimate if, and when, water protection will be exceeded; in such an event, efforts can be directed to reducing the sources most amenable to control and remediation.

In the U.S., and in particular, the Great Lakes basin, the mass balance approach has gradually gained acceptance as a vital research, and indeed, regulatory tool. For instance, the Superfund Amendments and Reauthorization Act of 1986[7] calls for various in-depth study on the mass balance approach to assess, *inter alia*, its value in determining the accurcy of information on toxic chemical releases and the effectiveness of toxic chemicals regulations; and its implications as part of a national annual quantity toxic chemical release program.[8]

In its five year strategy for the Great Lakes National Program Office (1986-1990), the U.S. EPA has committed itself to the further use, development, and refinement of the mass balance approach.[9] One of the most serious attempts to the employ the approach, supported by the National Program Office is in Green Bay, Wisconsin. In Green Bay, one of the most heavily polluted areas in the basin, a modeling framework is being developed and tested to provide greater understanding of the soruces, transport, and fate of toxic substances and to ultimately guide and support regulatory activity.[10]

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 a mass balance could possibly be complete sometime in the early 1990s.[11] Depending on the findings of the mass balance analysis, further, and more stringent, loading restrictions may be imposed.

Owing to 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 data base is the lack of comprehensive, coordinated monitoring and biomonitoring networks for sources and receptors.

* Non-Point Source Reduction Programs

Owing to the diversity and complexity of non-point sources, the control programs that are developed and maintained in any one jurisdiction are usually dependent upon local concerns and priorities. Few jurisdictions in North America, however, have an and comprehensive non-point source control programs.

Within the Great Lakes basin, some jurisdictions have made the development of such programs a policy priority with an research agenda and workplan set in place.[12] Other interjurisdictional coordination, and as such, appear to be fragmented, duplicated, and, as a result, possibly ineffectual.

In regard to toxic water pollution in the Great Lakes basin, the International Joint Commission has identified the dilemma and posed the problem this way:

> 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]

Jurisdictional diversity also brings to light other regulatory problems. One recent study identified the disparity and inconsistency of environmental standards, and methodologies employed for establishing those standards. In the eight U.S. states and two provinces within the basin, the standards for four toxic chemicals were compared. The study found significant variances in water quality standards for those chemicals and the procedures employed to arrive at those standards.[2]

Inconsistent standards means industries in jurisdctions with the less stringent standards are in a position to pollute more of the shared water body. The stronger the standard, the more difficult it is for industry to meet it since a significant pollution quantities may be originating from those states with weak standards.

In sum, 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 chemicals, limiting the effectiveness of individual action and necessitating coordinated action by all jurisdictions. This is the basis of the ecosystem approach.

7.2 The Ecosystem Response

The term "ecosystem" was first used in 1935 to refer to plant communities and their environments which together formed an integrated ecological system.[3] The term has subsequently been applied to refer to many types of systems enclosed by boundaries, such as watersheds, city limits, or the biosphere. It has been adopted and applied by a number of international bodies, including the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Man and the Biosphere Programme, instituted to further the approach.

The ecosystem approach is thought to be characterized by three primary features. First, the ecosystem approach focuses on a geographical area with ecological boundaries, as opposed to a particular jurisdiction with political borders, as a management unit. Ecosystem thinking as a planning tool is in part derived from the regional planning and river basin management concepts developed in the U.S. in the 1920s.[4] They suggest that all actions taken within an ecologically defined territory will have to take into account the effects upon the ecological unit as a whole - simply because that action will affect all the interests within the basin. Decision-makers within the region, therefore, must expand their policy horizons beyond the edge of their political jurisdictions to the ecological limits of the watershed.

Second, an ecosystem approach also takes a comprehensive approach in the sense that encompasses the entire system, physical, chemical and biological, and includes the land, air and water. From a regulatory point of view, an ecosystem approach inherently encompasses a cross-media perspective in that it recognizes the interconnectedness of all components of the environment and their interactions.[5]

Third, the approach is multidisciplinary in nature as it recognizes the interactions between the ecological, social, economic, and political systems within the region. Economic development patterns, consumer trends, and 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."[6] It mandates a strong emphasis on interjurisdictional coordination, common goal formulation, mechanisms for appropriate allocation and use of resources, and cooperative planning.

In terms of a comprehensive toxic substances reduction/ elimination strategy, the ecosystem concept fits in extremely well.

7.3 Ecosystemic Perspective Under Canadian Law

At an international level, both the Canadian federal and provincial governments have recognized the merits of an ecosystem approach, and in particular, with respect to the Great Lakes basin. In 1978, Canada and the United States concluded the Great Lakes Water Quality Agreement. This Agreement specifically recognizes, and adopts the ecosystem approach as it declares that its purpose is "to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem."[7]

In accordance with this mandate, it 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.

The Agreement also recognizes airborne and land-based pollution and the need for intergovernmental cooperation and coordination.

Since the conclusion of the 1978 Agreement, other bilateral arrangements have also embraced the ecosystem concept. In 1985, all basin states and provinces, including the provinces of Ontario and Quebec signed the Great Lakes Charter, a statement of principles to deal with the issues of interbasin water transfers and consumptive uses. The Charter specifically recognizes the Great Lakes as an ecosystem and that it should be treated "as a single hydrologic system."[8] It further establishes a framework for cooperative planning and management among the member jurisdictions.

More recently, in May of 1986, a parallel accord was concluded entitled the Great Lakes Toxic Substances Control Agreement. Principle II of the Agreement, commit the signatories "to managing the Great Lakes as an integrated ecosystem, recognizing that the water resources of the Basin transcend political boundaries." In furthering the approach, the accord pledges to control point source and non-point sources and then provides fairly elaborate provisions to implement the agreement including the development of coordinated permitting systems, cooperative waste management strategies, joint monitoring and surveillance activities, information exchanges, among others.

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." [9] However, a document responding to public comments on MISA, the Ministry of the Environment admitted that MISA does not contain a specific transboundary component.[10]

In Ontario, the ecosystem approach has also been sought to be implemented at a local level. As it may be recalled, throughout the Great Lakes, the International Joint Commission has identified areas of concern, for which remedial action plans (RAP) are being developed. Owing to the varied agency responsibilities, some of the RAPs, like the one pertaining to the Toronto harbour, have attempted to take an ecosystem approach, although it is still too early to evaluate its success.

7.4 Summary and Recommendations

The ecosystemic approach has gained considerable acceptance in Canada. The furtherance of the approach is crucial in the development of any pollution control strategy, and especially, toxic substances reduction and elimination strategy.

It is therefore recommended that:

(a) governments in Canada attempt to further the ecosystem concept in their environmental laws and environmental management strategies;

(b) further research is undertaken to better understand the scientific, planning, management, and legal aspects of the approach in order that it may be implemented more coherently.

CHAPTER 8 - Summary and Recommendations

Persistent toxic water pollution poses a significant threat to Canada's long-term environmental and human health. Present regulatory controls, however, are not designed to deal with the particular characteristics of persistent toxic chemicals, and as such, may be inadequate to arrest the challenge.

This paper proposed certain principles which ought to guide regulators, environmental managers, and others dealing with reform of environmental law and policy. The underlying objective behind these principles is the virtual elimination of persistent toxic discharges into the environment. To realize this goal, the principles proposed include the adoption of a cross-media approach, a source reduction strategy (which also includes a revamping of standards oriented to load reductions and the control of non-point sources), and recognition of an ecosystemic perspective.

For convenience, the specific recommendations concerning these principles discussed throughout the paper are reiterated below.

A CROSS-MEDIA PERSPECTIVE

It is recommended that:

(a) both the federal and Ontario regulators commit in policy to a cross-media approach to environmental management;

(b) the pertinant laws are reviewed to note where there is an absence of a cross-media perspective and attempts made to better coordinate and cooperate to bring that perspective down to an operational level;

(c) and that, until comprehensive reform is forthcoming, interim initiatives be considered such water standards which take into account the inputs from air and land based sources and an integrated permitting systems which licence the toal environmental exposure from the facility rather than simply a discharge into a single media.

SOURCE REDUCTION

It is recommended that:

(a) both federal and provincial governments proclaim an explicit source reduction policy; and as elements of that policy, include,

(b) financial incentives and disincentives which will act catalysts to industry to develop source reduction measures;

(c) the enactment of legislative schemes to promote source reduction measures, such as pretreatment standards; land burial restrictions; statutorily mandated reduction and recycling measures; technology-forcing provisions that require new facilities to install clean technology; other provisions that ensure that existing industry are using the most current measures to reduce, reuse, and recycle their wastes; and

(d) greater emphasis on information gathering and exchange pertaining to waste streams, waste technology and source reduction generally.

LOAD REDUCTIONS

It is recommended that:

(a) both federal and provincial government consider quantity-based standards for persistent toxic substances, and the development of appropriate implementation programs, to supplement the current array of standards;

(b) the load reduction targets be commensurate with reductions needed to protect waterways and local ecosystems from irreparable toxic contamination; and

(c) efforts be made to better monitor the impact of reduction targets with the corresponding impact on the environment.

NON-POINT SOURCE CONTROL

It is recommended that:

(a) both federal and provincial governments further efforts to establish non-point source control programs; and, in particular,

(b) explore the usefulness and feasibility of employing mass balance, at least in areas amenable to the approach;

(c) institute programs directed to both controlling present non-point sources and remediating past problems;

(d) further study the kinds of non-point source control programs in other jurisdictions which are of merit; and

(e) provide monies and resources to execute these programs.

AN ECOSYSTEM PERSPECTIVE

It is therefore recommended that:

(a) governments in Canada attempt to further the ecosystem concept in their environmental laws and environmental management strategies;

(b) further research is undertaken to better understand the scientific, planning, management, and legal aspects of the approach in order that it may be implemented more coherently.

While perhaps not always apparent, the implementation of the principles may not require a radical restructuring of existing environmental laws as much as a clearer articulation of goals and a refocusing of the existing approach. Moreover, many of the principles are not necessarily all that new. In fact, some of the principles are being employed in various jurisdictions throughout North America, often where traditional controls have found to be ineffectual to cope with the problem of toxic water pollution.

NOTES - INTRODUCTION

1. Ross H. Hall and Donald A. Chant, Ecotoxicity: Responsibilities and Opportunities (Ottawa: Canadian Environmental Advisory Council, Report No. 8, 1979), at 3.

2. Ibid.; D. Mackay, "A Critique of Aspects of the Proposed Environmental Protection Act" in Canadian Environmental Advisory Council, Review of the Proposed Environmental Protection Act (Ottawa: March, 1987), Annex 3, at 70.

3. K. Davies and J. Campbell, Toronto's Drinking Water: A Chemical Assessment (City of Toronto, Department of Public Health, April, 1984); also see: K. Davies, "Great Lakes Drinking Water: Risky Refreshment" (1986) 13 Alternatives 33-35.

4. Toby Vigod, "Federal and Provincial Water Law and Policy" in How to Fight for What's Left of the Environment (Toronto: Canadian Environmental Law Association, 1985), H-2 to H-3.

5. Conservation Foundation, State of the Environment (Washington, D.C., 1984), at 65.

NOTES - CHAPTER 2 - Toxic Water Pollution as a Regulatory Challenge

1. Section 91 of the Constitution Act, 1867.

2. Section 92 of the Constitution Act, 1867.

3. J.F. Castrilli, Hazardous Waste Management in Canada: The Legal and Regulatory Response (Toronto: Canadian Environmental Law Research Foundation, 1982), at 87.

4. Section 91 of the Constitution Act, 1867.

5. CITE TO BE PROVIDED

6. Castrilli, supra, note 3, at 88. For cases interpreting the proper test for the POGG power, see: Attorney-General of Ontario v. Canada Temperance Federation [1946] A.C. 193; Labatt Breweries of Canada Limited v. The Attorney General of Canada et al., (1980), 1 S.C.R. 914; Re Canada Metal Company Limited and Her Majesty the Queen et al. (1983), 12 C.E.L.R. 1, at 4 (1983), 19 Man. R.(2d) 268 (Q.B.).

7. Fisheries Act, R.S.C. 1970, c. F-14, as amended.

8. Canada Water Act, R.S.C. 1970 (1st Supp.), c. 5.

9. Environmental Contaminants Act,S.C. 1974-75, c. 72.

10. Other statutes than those that discussed that pertain to water quality include: the Territorial Lands Act, R.S.C. 1970, c. T-6; Northern Inlands Waters Act, R.S.C.1970 (1st Supp.), c. 28; Ocean Dumping Control Act, S.C. 1974-75-76, c. 55; Canada Shipping Act, R.S.C. 1970, c. S-9; the Arctic Waters Pollution Prevention Act, R.S.C. 1970 (1st Supp.), c. 2 and the Transportation of Dangerous Goods Act, S.C. 1980, c. 36.

11. Clean Air Act, S.C. 1970-71-71, c. 47, as amended.

12. Motor Vehicle Safety Act, R.S.C. 1970 (1st Supp.), c. 26.

13. Pest Control Products Act, R.S.C. 1970, c. P-10.

14. Fisheries Act, supra, s. 33

15. Chlor-Alkali Mercury Liquid Effluent Regulations, C.R.C., c. 811; Metal Mining Liquid Effluent Regulations, C.R.C., c. 819; Petroleum Refinery Liquid Effluent Regulations, C.R.C., c. 828; Potato Processing Plant Liquid Effluent Regulations, C.R.C., c. 829; Pulp and Paper Effluent Regulations, C.R.C., c. 830.

16. In five of these regulations (pulp and paper, meat and poultry products, potatoe processing, petroleum refinery and metal mining industry sector), acute toxicity testing requirements are also required which in terms on based upon

various LC50s and various bioassay procedures.

17. Canada Water Act, supra, ss. 4, 5, and 11.

18. See: Phosphorus Concentration Control Regulations, C.R.C., c. 393

19. Environmental Contanimants Act, supra, s. 4(6).

20. Ibid., s. 7

21. Chlorobiphenyl Regulations No. 1, C.R.C. c. 564; Chlorofluorocarbons Regulations, SOR/80-254; Mirex Regulations, SOR/78-891; Polybrominated Biphenyles Regulations SOR/79-351; Polybrominated Terphenyls Regulations SOR/79-369.

22. Apart from the three discussed below, the Clean Air Act also authorizes specific emission standards directed toward all works and undertakings under federal jurisdiction and pursuant to a federal -provincial agreement under ss. 19 and 20 of the Act.

23. Clean Air Act, supra, s. 4.

24. Ambient Air Quality Objectives, C.R.C. c. 403; Ambient Air Quality Objectives, No. 2, C.R.C. c. 404; Ambient Air Quality Objectives, No. 3, SOR/78-74.

25. Clean Air Act, supra, s. 8.

26. Cement Industry Emission Gudelines, Canada Gazette (Part I), Oct. 12, 1974; Asphalt Paving Industry Emission Guidelines, Canada Gazette (Part I), April 5, 1975; Metallurgical Coke Industries Emission Guidelines, Canada Gazette (Part I) May 26, 1976; Arctic Mining Industries Emission Guidelines, Canada Gazette (Part I), July 17, 1976; Packaged Incinerators Emission Guidelines, Canada Gazette, (Part I), Nov. 25, 1978; Wood Pulp and Paper Industries Emission Guidelines for New Stationary Sources, Canada Gazette (Part I), September 22, 1979; Thermal Powere Generation Emissions - National Guidelines for New Statonary Sources, Canada Gazette (Part I), April 25, 1981.

27. Clean Air Act, supra, s. 7.

28. Asbestos Mining and Milling National Emissions Standards Regulations, C.R.C. c. 405; Chlor-Alkali Mercury National Emission Standards Regulations, C.R.C. c. 406; Secondary Lead Smelter National Emission Standards Regulations, C.R.C. c. 412; Vinyl Chloride National Emission Standards Regulations, SOR 79/299.

29. R.S.C. 1979, c. A-19.

30. R.S.C. 1970, c. H-3.

31. "Canadian Environmental Protection Act" Bill C-74, First reading, -June 26, 1987, 2nd Session, 33rd Parliament.

32. CITE TO BE PROVIDED

33. CITE TO BE PROVIDED

34. R.S.O. 1980, c. 361.

35. R.S.O. 1980, c. 141, as amended.

36. Ministry of the Environment, <u>Municipal-Industrial Strategy for Abatement (MISA)</u>, June, 1986 [hereinafter cited as MISA].

37. CITE TO BE PROVIDED

38. <u>Ontario Water Resources Act</u>, supra, ss. 23-24.

39. Ministry of the Environment, <u>Water Management - Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment</u>, November, 1978, revised May, 1984.

40. Ministry of the Environment, <u>Ontario Drinking Water Objectives</u>, 1984.

41. <u>Environmental Protection Act</u>, supra, s. 5.

42. Air Quality Regulations, R.R.O. 1980, Reg. 308

43. <u>Environmental Protection Act</u>, supra, ss. 9/10

44. Ibid., s. 7.

45. Ibid., s. 6.

46. CITE TO BE PROVIDED

47. <u>Environmental Protection Act</u>, supra, s. 8. Air emission limits are set through two regulations. One regulation sets desired ambient air concentrations for some 100 contaminants at the "point of infringement." Hence, regulatory levels are set not by the concentration at the point of emission but at the point of imprimgement, (that is, the point where a given pollutant comes into contact with human, vegetation or property). Any emission of a contaminant at a point of infringement that exceeds the standards which are prescribed in the regulations are prohibited. Air Quality Regulations, R.R.O. 1980, Reg. 308

48. <u>Environmental Protection Act</u>, Part V.

49. Ibid., Part IX.

50. CITE TO BE PROVIDED

51. <u>Great Lakes Water Quality Agreement of 1978</u>, 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.

52. Ibid., art II

53. Ibid., Annex 12, s. 2(a)(ii).

54. 33. U.S.C. ss. 1251-1376 (1982)

55. 33 U.S.C. s. 1251(a) (1982)

56. MISA, supra, note 36, at 7.

57. Great lakes Toxic Substances Control Agreement, signed at Mackinac Island, Michigan, May 26, 1986.

NOTES - CHAPTER 3 - From a Sectoral to a Cross-Media Perspective

1. Conservation Foundation, Controlling Cross-Media Pollutants (Washington, D.C., 1984), at 5.

2. Discussion with Roger Kanerva, Illinois Environmental Protection Agency, Janurary 16, 1987.

3. The results of these studies are summarized in: Conservation Foundation, "Examples of Cross-Media Pollution Problems and Control Approaches in North America" A paper prepared for the Environment Directorate, Organisation for Economic Cooperation and Development, 1986, at 14-18.

4. Trichlorethylene is not a persistent compound per se. Because it can degrade quickly, with a half life ranging from a few hours to a few weeks. Even though it is not persistent, its continual release inot hte environment assures there will always be some quantity of the substance present. The substance can easily corss different media before it degrades. Ibid., at 15.

5. Ibid., at 15-16.

6. Ibid., at 16.

7. Clean Water Act, 33 U.S.C. s. 1251 et seq. (1982, Supp. II 1984).

8. Resource Conservation and Recovery Act, 42 U.S.C. s. 6901 et seq. (1982, Supp. I 1983).

9. Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. s. 9601 et seq. (1982, Supp.I 1983).

10. Congress of the United States, Office of Technology Assessment, Serious Reduction of Hazardous Waste (Washington, D.C.: September, 1986), at 20.

11. See: "Economics and the Environment: Not Conflict but Symbiosis" Probe Post, October, 1984, at 20-21.

12. The U.S. EPA has done a number studies pertaining to the cross media approach, for instance, see: M.A. Gruber, Office of Policy Analysis, Integrated Environmental Management Division, "The Industry Approach to Integrated Environmental Management: Rationale, Objectives, and Methods" (Washington, D.C.: U.S. Environmental Protection Agency).

13. The Washington, D.C. based Conservation Foundation has undertaken a number of studies with respect to the cross-media approach, including: supra, note 1; Barry G. Babe, Fragmentation and Integration in State Environmental Management (Washington,

NOTES - CHAPTER 4 - From Waste Management to Source Reduction

1. Congress of the United States, Office of Technology Assessment, Serious Reduction of Hazardous Waste (Washington, D.C.: September, 1986), at 29.

2. Ontario Reg. 11/82.

3. CITE TO BE PROVIDED

4. J.F. Castrilli, "Hazardous waste Mangement in Canada: The Legal and Regulatory Response" (Toronto: Canadian Environmental Law Research Foundation, 1982), at 43.

5. V. Adamson, Breaking the Barriers: A Study of Legislative and Economic Barriers to Industrial Waste Reduction and Recycling (Toronto: Canadian Environmental Law Research Foundation and Pollution Probe Foundation, 1984), at 8.

6. Conservation Foundation, "Examples of Cross-Media Pollution Problems and Control Approaches in North America" A paper prepared for the Environment Directorate, Organisation for Economic Cooperation and Development, 1986, at 18-21.

7. Ibid., at 20

8. See: "Economics and the Environment: Not Conflict but Symbiosis" October, 1984,Probe Post 20, at 21.

9. World Commission on Environment and Development, Our Common Future (New York: Oxford University Press, 1987), at 310 -312.

10. World Industry Conference on Environmental Management (WICEM) Outcome and Reactions (United Nations Environmental Programme, 1984).

11. Office of Technology Assessment, supra, note 1, at 55.

12. For varying definitions, see: Office of Technology Assessment, supra, note 1, at 16; Adamson, supra, note 5 at 10; Environmental Defense Fund, Approaches to Source Reduction - Practical Guidance from Existing Policies and Programs (Washington, D.C., 1986), at 8-9.

13. Office of Technology Assessment, supra, note 1, at 8; Adamson, supra, note 5, at 8.

14. It is clear that there is a growing trend toward environmental controls in this regard, especially with respect to landfilling; see: K.Oldenburg and J. Hirschhorn, "Waste Reduction: A New Strategy to Avoid Pollution" Environment, March, 1987, at 17; Robert Lindsey, "Many States Move to Curb Disposal of Chemicals" The New York Times, December 21, 1986.

15. See generally in this regard: Glenn Munroe, "Where is Industrial Waste Reduction Taking Us?" Probe Post, Summer, 1986, at 14-18.

16. Oldenburg and Hirschhorn, supra, note 14, at 19; Office of Technology Assessment, supra, note 1, at 26.

17. Office of Technology Assessment, supra, note 1, at 31.

18. Ibid., at 26.

19. Ibid., at 8.

20. As amended by Hazardous and Solid Waste Amendments of 1984, 42 U.S.C. ss. 6901 et seq..

21. See: Resource Conservation and Recovery Act, 42 U.S.C. s. 6922(b) and 50 Federal Register 28702, 15 July, 1985.

22. Oldenburg and Hirschhorn, supra, note 14, at 18.

23. Ibid., at 41.

24. New York State Department of Environmental Conservation, "Summary Draft - New York State Department of Environmental Conservation Great Lakes Agenda Issues and Recommendations" April, 1987.

25. Lindsay, supra, note 14.

26. Office of Technology Assessment, supra, note 1, at 50.

27. See generally: M. Campbell and W. Glenn, Profit from Pollution Prevention: A Guide to Industrial Waste Reduction and Recycling (Toronto: Pollution Probe Foundation, 1982)

28. 3M, Pollution Prevention Pays, Status Report, March, 1987, at 1.

29. For eg., Environmental Defense Fund, supra, note 12; and Office of Technology Assessment, supra, note 1.

30. Environmental Defense Fund, supra, note 12,at 7; and Office of Technology Assessment, supra, note 1, at 58-59;

31. Castrilli, supra, note 4, at 66; Adamson, supra, note 5, at 13.

32. Government of Canada, Task Force Report on Environmental Contaminants Legislation (Cross-Mission)(Ottawa: September, 1972), at 5-6.

33. Royal Commission on the Economic Union and Development Prospects for Canada, (Ottawa: Supply and Services, 1985), Vol. II, at 526 -528.

34. Adamson, supra, note 5, at 3.

35. Castrilli, supra, note 4, at 26.

36. For example, other programs include: the IRAP (Industrial Research Assistance Program); and the IRDP (Industrial and Regional Development Program). For further details, see: Castrilli, supra, note 4 at 26-27;

37. Canadian Environmental Advisory Council, Review of the Proposed Environmental Protection Act (March 1987), at 86. Energy Probe article.

38. CITE TO BE PROVIDED.

39. Province of Ontario, Speech from the Throne, Address of the Honourable Lincoln Alexander, Lieutenant Governor of the Province of Ontario on the opeining of the Third Session of the 33rd Parliament of the Province of Ontario, April, 28, 1987, at 25.

40. For a discussion of examples, see: Adamson, supra, note 5, at 2 and 42.

41. Castrilli, supra, note 4, at 66-67.

NOTES - CHAPTER 5 - From Concentrations to Load Reductions

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

2. In the U.S., see: J.M. Gaba, "Regulation of Toxic Pollutatns Under the Clean Water Act: NPDES Toxics Control Strategies (1984/85), 50 Journal of Air Law and Commerce 761, at 768-69; B.W. Wyche, "The Regulation of Toxic Pollutants Under the Clean Water Act: EPA's Ten Year Rulemaking Nears Completion" (19??), 15 Natural Resources Lawyer 511, at 512-13.

3. Wyche, ibid., at 513.

4. Gaba, supra, note 2, at 768.

5. National Research Council of the United States and the Royal Society of Canada, The Great Lakes Water Quality Agreement - An Evolving Instrument for Ecosystem Management (Washington, D.C.: National Academy Press, 1985), at 74. [hereinafter cited as NRC/RSC Report]

6. 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 Provinces of the Great Lakes Basin (Ottawa, Washington, 1986), at 35.

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

8. The pollutants of concern include: PCB's, dieldrin, hexachlorobenzene, 2,3,7,8-TCDD, Chlordane, toxaphene, heptachlor/heptachlor epoxide, DDT/TDE, Hexachlorocyclohexane, PCDF's, PAH's, ibid., Table 1.

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

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

11. 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, "Water-Quality Standards, Maximum Loads, and the Clean Water Act: The Need for Judicial Enforcement" (1983) 34 Hastings Law Journal 1245.

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

13. 49 Fed. Reg. 38,000 (1984). See: Gaba, supra, note 2, at 763-764.

14. 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.

15. C. Blaise, N. Bermingham, and R. Van Collie, "The Integrated Ecotoxicological Approach to Assessment of Ecotoxicity" (1985), 10 Water Quality Bulletin 3.

16. D. Estrin and J. Swaigen, Environment on Trial (Toronto: Canadian Environmental Law Research Foundation, 1978), at 92-93.

17. CITE TO BE PROVIDED

18. TO BE PROVIDED

U.S. EPA.
Green Bay Mass Balance
Work Plan, Draft, Sept. 30/86