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Backgrounder

Hazardous Waste Management in Canada

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HAZARDOUS WASTE MANAGEMENT IN CANADA

INTRODUCTION

Nobody seems to know for sure! This is a response which pervades the field of hazardous waste management, not only in Canada but throughout the world. The questions it may answer range from how much of a particular hazardous waste is generated each year and what is its long-term toxicological effect at sub-lethal concentrations, to how is a hazardous waste defined.

Fortunately, the importance of safe management of hazardous wastes has become widely recognized in the past few years. In Canada, a resurgence of public and government concern -- initiated by a dramatic but small-scale spillage of PCBs across northwestern Ontario and spurred by discovery of the "toxic blob" in the St. Clair River -- has focused attention on our own problem in this area.

The management of hazardous wastes is a relatively recent concern, resulting from the rapid generation of new chemical substances concurrent with industrial expansion since the 1940s. If the welfare of society depends on the constant expansion of production, then society will be forced to deal with the continued expansion of waste production, particularly hazardous waste production. Since large quantities and varieties of wastes are produced, their improper management has disastrous implications for the environment and human health.

This paper examines hazardous waste management, and in particular, hazardous waste management in Canada. The first section outlines the basic requirements for such management and some of the main problems encountered. The second section focuses on the generation, treatment and disposal of hazardous wastes in Canada, while the final section addresses legislation and the management process in this country. A province by province survey in the last two sections shows the spectrum of regional differences and provincial jurisdictions. The final, brief discussion section assesses the direction of hazardous waste management in Canada.

REQUIREMENTS FOR HAZARDOUS WASTE MANAGEMENT

A. Definitions and Classification

Generators and shippers of waste materials and owners of treatment and disposal facilities for wastes must increasingly decide whether a waste is considered "hazardous" and if so how it should be classified. With the recent emphasis on regulatory control, schemes for defining hazardous wastes and separating them from non-hazardous wastes have been evolving. Further demand for uniformity of classification has also arisen since transboundary shipment, both provincial (in Canada) and international, has become an important issue.(1,2)

What might appear to be a simple process at the outset (i.e. a definition and uniform classification scheme for hazardous wastes) has not yet been achieved in Canada, despite an indirect attempt by Canada's Transportation of Dangerous Goods Act (1980) (TDGA) and its Regulations (1985). Although most provinces are willing to use the TDGA classification system with their own provincial transport regulations and

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(1) M. Dowling, "Defining and Classifying Hazardous Wastes", Environment, Vol. 27, April 1985, p. 19.

(2) ECO/LOG, Hazardous Waste Management Handbook 1985, Corpus Information Services Ltd., Don Mills, Ontario, 1985, p. 125.

manifest systems, the lack of a uniform or national system is still cited as cause for delay in the implementing of hazardous waste management regulations in at least one province.(1)

Although definitions generally accompany specific pieces of legislation, as noted, there is not a single comprehensive definition of a hazardous waste which is universally acceptable for all circumstances. In Canada, the Federal Task Force on Hazardous Waste Definition agreed on the following general definitions:(2)

> Waste is any substance for which the owner/generator has no further use and which he discards.
>
> Hazardous wastes are those wastes which, due to their nature and quantity, are potentially hazardous to human health and/or the environment and which require special disposal techniques to eliminate or reduce the hazard.

Of more recent note is the definition of "Dangerous Goods" as defined in the TDGA:(3)

> any product, substance or organism included by its nature or by the regulations in any of the classes listed in the schedule.

For implementation, such formal definitions are not very useful and most countries have developed various types of hazardous waste lists and classification schemes. The most common approach is to include specific wastes identified as hazardous on an "inclusive list"; if a waste is on the list, it is automatically regulated. Another approach is the "exclusive list", a method formerly used in the United Kingdom. This conservative system describes wastes which are not hazardous; any compound which is not on the list is considered hazardous.(4)

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(1) Personal communication, Department of Environment, Saskatchewan, October 1986.

(2) ECO/LOG (1985), p. 127.

(3) Ibid.

(4) Dowling (1985), p. 36.

The TDGA uses an inclusive classification scheme which is in part based on that of the United Nations for hazardous materials. It contains a schedule that lists nine primary classes of dangerous goods as follows:(1)

> (1) Explosives, including explosives within the meaning of the Explosives Act,
> (2) Gases; compressed, deeply refrigerated, liquefied, or dissolved under pressure,
> (3) Flammable and combustible liquids,
> (4) Flammable solids; substances liable to spontaneous combustion; substances that on contact with water emit flammable gases,
> (5) Oxidizing substances; organic peroxides,
> (6) Poisonous (toxic) and infectious substances,
> (7) Radioactive materials and prescribed substances within the meaning of the Atomic Energy Control Act,
> (8) Corrosives, and
> (9) Miscellaneous products, substances and organisms considered by the Governor in Council to be dangerous to life, health, property or the environment when handled, offered for transport or transported, and prescribed to be included in this class.

Schedule II, Table II of this Act contains 1,915 separate listings of dangerous goods, providing a more precise basis for regulatory control.

B. Storage

Storage as discussed here refers to temporary containment of a hazardous waste for transport, or while awaiting treatment and/or disposal. Environmental and health hazards can arise during such storage, as has been amply demonstrated by the large number of reported spills and leakages of PCBs in recent years.

Detailed guidelines for the storage of hazardous wastes in Canada have been presented in federal and provincial codes or

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(1) ECO/LOG (1985), p. 128.

guidelines.(1,2) As well, guidelines for storage building designs and container designs for specific substances are outlined and include information regarding their proper handling. Recognition of the incompatibility of some wastes is important for proper storage as the mixing of certain wastes can result in violent, explosive reactions and/or toxic fumes. Various systems to assist in compatible storage have been set up, for example the "Hazardous Waste Compatibility Chart" of the U.S. Environmental Protection Agency or a similar system found in California.(3) These systems also require appropriate recognition and classification.

Monitoring at storage facilities should involve in-plant surveillance and inspection, together with thorough record keeping that can account for all qualities and quantities of wastes being stored. In the case of underground storage facilities and tanks, such as those frequently used for petroleum products, leak detectors or systems that can identify corrosion should be installed. The installation of leak detectors would have reduced the present problem in Prince Edward Island where there is groundwater contamination due to leaking underground storage tanks for petroleum. It appears that appropriate legislation is necessary to ensure that adequate storage guidelines are met(4) and in fact regulatory programs are being developed in some jurisdictions.(5,6)

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(1) Canada, Environment Canada, EPS, Code of Good Practice for Management of Hazardous and Toxic Wastes at Federal Establishments, Ottawa, January 1977.

(2) Ontario, Ministry of the Environment, Waste Management Branch, Guidelines for Environmental Protection Measures at Chemical Storage Facilities, Toronto, October 1978.

(3) ECO/LOG (1985), p. 191-1984.

(4) ECO/LOG (1984), p. 124-135.

(5) ECO/LOG (1985), p. 197-202.

(6) Environment Canada, Press Release, "McMillan Announces Joint PEI/Federal/Industry Project on Underground Storage Tanks", Ottawa, 19 June 1986, 2 p.

C. Treatment

Hazardous wastes may be treated to minimize their volume and make disposal easier, to render the waste less toxic or hazardous, or to enhance or facilitate the recovery and reuse of waste components of a solution.

Treatments can be classified as either physical, chemical, biological or thermal. Physical treatments are used to separate solids from liquids through the use of physical forces and mechanical devices. Chemical treatments are used to neutralize (e.g., by mixing acids and bases), precipitate, oxidize or reduce chemical components, or to cause a chemical alteration of a liquid phase to produce a solid, vapour or altered liquid phase. Biological treatments are used to biodegrade dilute organic wastes, while thermal treatments are used to cause the vaporization, oxidation or other destruction of liquid or solid phase components.

The following list shows the large number of specific unit treatment operations. A short description of each treatment can be found in:

ECO/LOG, Hazardous Waste Management Handbook 1985, Corpus Information Services Ltd., Don Mills, Ontario, 1984, p. 210-240.
(Library of Parliament, Br.V. *TD 811.5 H39 1985)

Physical:
- air stripping
- carbon adsorption
- centrifugation
- dialysis
- distillation
- evaporation
- pond filtration
- flocculation and precipitation
- flotation
- freeze crystallization
- high gradient magnetic separation
- liquid-liquid extraction
- resin adsorption
- reverse osmosis
- sedimentation
- steam distillation
- steam stripping
- ultrafiltration

Chemical:
- catalysis
- chemical dechlorination
- chlorinolysis
- dissolution
- electrolysis
- electrodialysis
- hydrolysis
- ion exchange
- microwave discharge
- neutralization
- oxidation
- ozonation
- photolysis
- reduction

Biological:
- activated sludge
- aerated lagoon
- anaerobic digestion
- enzyme treatment
- trickling filter
- waste stabilization

Thermal: calcination
incineration
molten salt
plasma destruction
pyrolysis
supercritical fluid oxidation
wet air oxidation

Generally, more than one process is used for waste treatment, as some physical/chemical process is often applied first to reduce the volume of dilute aqueous solutions. As well, no single process will be suitable for all categories of hazardous wastes and frequently several processes will be linked in a series or in a parallel configuration to form a waste-specific treatment. At present many of these treatments are well established in industrial operations, as on-site treatment or partial treatment in order to reduce bulk for transport is often desirable. Implementation of these treatments appears to be increasing, and, together with an increase in the application of the "four-R's" (reducing, recovering, reusing and recycling), there is a decrease in the quantities of high-Btu wastes, oily wastes, solvents and dilute watery wastes being received by waste disposal facilities, concurrent with an increase in more concentrated sludges and solids.

Considerable research is underway to develop new processes for the treatment of hazardous wastes and to refine existing ones. These include waste solidification studies in Alberta; ultraviolet treatment, reverse osmosis, ultrafiltration and plasma pyrolysis research in Ontario; and reverse osmosis, fluidized bed combustion, chemical oxidation and high-rate filtration and land farming. A great deal of this research is being conducted by the private sector through federal contracts.

1. Incineration

A common misconception is that incineration implies destruction. In fact it is only a method of reduction and conversion, with the resultant residues still requiring disposal. For example, even with an advanced rotary kiln incineration process which achieves a 99.98%

destruction efficiency, the incineration of 30,000 tonnes/yr, as proposed by the Ontario Waste Management (OWMC),(1) will still result in 6 tonnes/yr of residue requiring disposal.

Various compounds require varying temperatures and conditions for combustion. For example, the incineration of PCBs will be effected only at temperatures above 1100°C, with at least 3% excess oxygen and with a residence time of more than two seconds.(2) Since the products of incomplete combustion can be more toxic than the original compounds, it is essential that the appropriate system of incineration be used.

"Rotary kiln" and "multiple hearth" types of incinerators provide the highest degree of flexibility and adaptability and are able to exceed the required temperatures. A rotary kiln incinerator is basically a refractory-lined, rotating cylinder which is inclined 2-5° from the horizontal plane. The slow rotation and inclination result in a gradual progression of combustion products down the drum to the lower discharge end (Figure 1). A multiple hearth incinerator consists of a refractory-lined cylindrical shell in the vertical plane, equipped with several fixed hearths at different levels and a scraper to push the top-loaded waste from one hearth to the next until it emerges as ash on the bottom (Figure 2). On most incinerators, afterburners are necessary to effect complete combustion of the exhaust from the primary combustion chambers and some form of exhaust gas cleaning equipment is needed. More specifically, when halogenated or sulphurous wastes are incinerated, some form of wet scrubbing is required to reduce particulates and to absorb the acidic gases produced.(3)

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(1) Ontario Waste Management Corporation (OWMC), Facilities Development Process, Phase 3 Report, Toronto, Ontario, March 1984, p. 16-20.

(2) C.B. Cope et al., The Scientific Management of Hazardous Wastes, Cambridge University Press, Cambridge, United Kingdom, 1983, p. 403-426.

(3) Ibid., p. 457-461.

HIGH TEMPERATURE INCINERATORS SUITABLE FOR HAZARDOUS WASTES

FIGURE 1: ROTARY KILN INSTALLATION

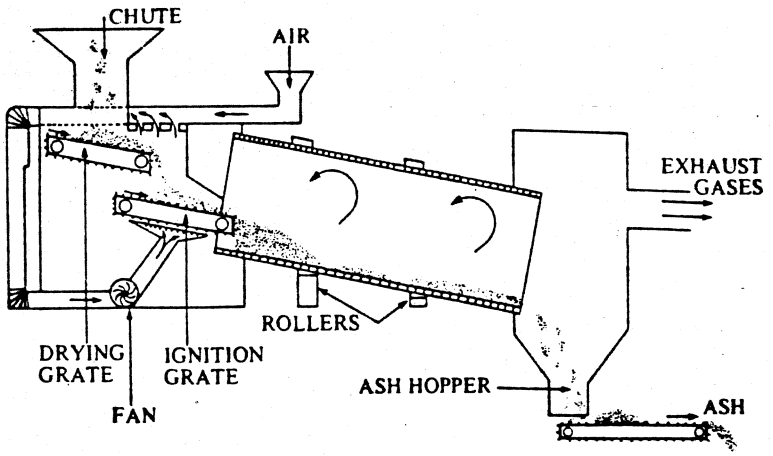
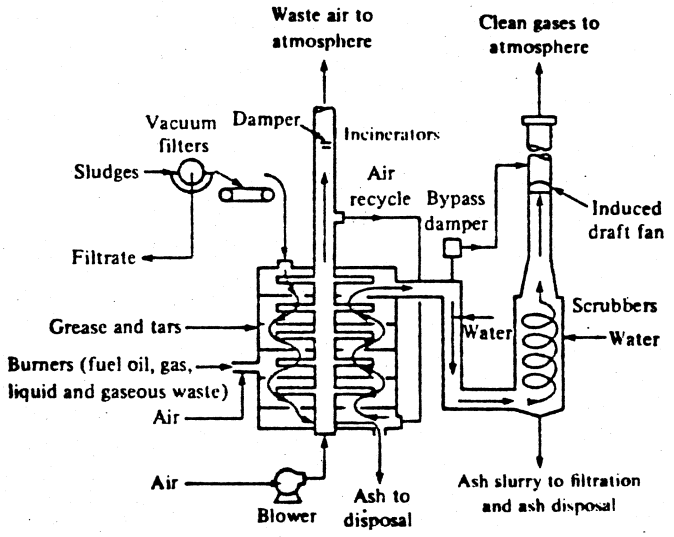


FIGURE 2: MULTIPLE HEARTH INCINERATOR (COURTESY NA CENTRE GSA)



Source of both figures: C.B. Cope et al., The Scientific Management of Hazardous Wastes, Cambridge University Press, United Kingdom, 1983, p. 449-450.

2. Solidification

Many of the treatments previously listed, including incineration, only serve to reduce the volume of a waste stream, while at the same time some increase the concentration of the contaminant and do little to ameliorate toxic dangers. Solidification is one of the more promising treatments for wastes that cannot undergo any further detoxification before final disposal.(1) At present, solidification seems most applicable to inorganic matter and is usually based on silicate-containing constituents (e.g. cement). Processes generally entail mixing the solidification constituents with waste "stock" to produce a slurry which sets as a solid material with properties that range from soil-like to rock-like. In addition to the chemical immobilization resulting from the solidification, there is usually a chemical fixation benefit.

Tests have shown dramatic reductions in leachate contamination from wastes after solidification (Tables 1 and 2) and indicate that solidification is a good treatment before further untreatable wastes are disposed of in "engineered landfills". At present there are two commercially available methods in Britain for solidification of inorganics, SEALOSAFE AND STABLEX (the latter method is also used in Quebec). Methods for solidification of organic wastes, however, are at present expensive and difficult due to the frequent presence of organic solvents in such wastes.

Considerable research continues on alternate solidification processes as well as on defining standardized methods of evaluating their effectiveness.(2) Although still experimental, one novel process called In-Situ Vitrification shows some promise. This involves the passage of a strong electrical current between two electrodes in contaminated soil; the process essentially melts contaminated soil and rock into an extremely hard glass-like substance, thus immobilizing any contaminants. This

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(1) Ibid., p. 403-426.

(2) "Waste Fixation Data Sought: Standard Testing Methods Needed", ECO/LOG WEEK, Vol. 14, No. 15, 18 April 1986, p. 1.

COMPARISON OF RAW WASTE AND LEACHATE OF WASTE AFTER SEALOSAFE TREATMENT

TABLE 1: RAW WASTES -- ANALYSIS OF INDUSTRIAL WASTES

	Electro-plating waste	Humus sludge	Paint sludge	Latex sludge	Acid tar
Total solid matter (%)	44.7	1.5	3.7	55.0	93.3
Ash on ignition (%)	46.5	0.3	2.4	0.1	1.3
pH	<1	6.1	9.0	8.1	<1
Cyanide (ppm)	0	0	0	0	0
Cadmium (ppm)	5	<1	1	<1	<1
Chromium (ppm)	120 000	3	1000	13	18
Copper (ppm)	11 600	25	20	40	146
Iron (ppm)	—	340	7200	24	600
Lead (ppm)	220	19	32	50	4080
Nickel (ppm)	2200	1	220	5	12
Zinc (ppm)	3200	300	2200	11	2400

TABLE 2: TREATED WASTES -- ANALYSIS OF LEACHATE (ppm)

	Electro-plating waste	Humus sludge	Paint sludge	Latex sludge	Acid tar
Cyanide	<0.007	—	—	—	<0.007
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.02
Chromium	<0.01	—	<0.01	<0.01	<0.01
Copper	<0.3	<0.3	<0.3	<0.3	<0.03
Lead	<0.3	<0.3	<0.3	<0.3	0.37
Nickel	<0.1	—	<0.1	<0.1	0.15
Mercury	—	<0.0005	<0.0005	<0.0005	—
Organic phosphorus	—	<0.02	—	—	—
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001

Source of both tables: C.B. Cope et al., The Scientific Management of Hazardous Wastes, Cambridge University Press, United Kingdom, 1983, p. 414-415.

particular solidification process may have more application as an alternative to excavation when dealing with hazardous wastes in landfills and with chemical spills in situ.

D. Hazardous Waste Exchange, Recycling and Reduction

Environment Canada policy has been that reuse and recycling should be encouraged as part of a comprehensive approach to the hazardous waste management problem. This general view is supported by international organizations including the International Joint Commission (IJC), the European Community, WHO, UNEP and NATO,(1) and the concept and practice of the "four-R's" are slowly being incorporated into hazardous waste management schemes by Canadian, British and European chemical industries.(2) In Canada, the largest active hazardous waste exchange program has been the Canadian Waste Materials Exchange (CWME) operating out of the Ontario Research Foundation. This is a useful first step, but it has been estimated that only 0.2% of the Liquid Industrial Waste (LIW) generated in Ontario was exchanged through the program in 1979-80.(3)

Although there are questions concerning the accuracy of such an estimate, as it is difficult to determine the actual quantity of LIW generated, the percentage exchanged is certainly low. In 1984, the Ontario Waste Exchange (OWE) was instituted as a joint project with the Ontario Waste Management Corporation (see p. 27) and the Ontario Research Foundation to increase the effectiveness of the CWME program. The OWE investigates when inquiries are made about specific wastes which have been listed in a bi-monthly Bulletin but, for some unknown reason have not been followed up. No data are available regarding the success of the OWE per se but some figures indicate the overall success of the program. From January 1978 until 1 September 1986 there were 18,350 inquiries concerning

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(1) J.F. Castrilli, Hazardous Waste Management in Canada: The Legal and Regulatory Response, Canadian Environmental Law Association, Toronto, Ontario, September 1982, p. 26.

(2) "The Four-R's, Communications are Key Elements of Waste Checklist", ECO/LOG WEEK, Vol. 13, No. 49, 13 December 1985.

(3) Castrilli (1982), p. 24.

exchange. It appears that once the process of exchange has been initiated most waste is exchanged continuously, at a rate of approximately 200,000 tonnes per year with an estimated value of $6 million per year.(1)

In 1985, Alberta also launched an active exchange program called the Alberta Waste Materials Exchange, modelled after that in Ontario. Manitoba has a passive waste exchange program in which it acts as a coordinator, but does not handle wastes directly.

Recycling of materials within an industry (e.g., using closed-loop systems for cyanide recovery in the electroplating industry and re-purifying solvents) can significantly reduce the quantities of hazardous waste generated. Additionally, process changes in industry can significantly reduce the amount of pollutants generated(2) and at the same time make considerable net savings. An example can be found at Bud Automotive, Kitchener, where installing a reverse osmosis system has allowed the reclaiming of industrial oil. Savings were also made as sewage charges, normally proportional to the waste loading a company exerts, were reduced. This company reclaimed its $100,000 expenditure on the reverse osmosis system in six months.(3)

The recent "Report to Congress on Minimization of Hazardous Waste" said:

> a survey of 22 industrial processes concluded that if existing techniques and new waste reduction technologies are fully used, hazardous wastes could be reduced by one-third or more".(4)

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(1) Personal communication, Ontario Research Foundation: OWE and CWME, 7 November, 1986.

(2) J. Jackson et al., Chemical Nightmare, Waterloo Public Interest Research Group, Between the Lines, 1982, p. 18.

(3) Robert Milko, Reverse Osmosis and its Application to Water Purification, Background Paper 146E, Research Branch, Library of Parliament, 9 April 1986, p. 12.

(4) "Report Urges Processing to Cut Toxic Wastes", The Citizen (Ottawa), 31 October 1986.

The report cites as examples a paper products plant which saved U.S. $1.8 million a year by recovering vaporized solvent, and a chemical facility which saved U.S. $72,000 by reprocessing its spent solvent.

In general, it appears that the greatest deterrent to such innovations has been the cheaper costs of landfills and the improper disposal methods which have been sanctioned until lately. These have made the prospect of recycling too expensive and troublesome.(1,2)

E. Common Disposal Methods

1. Landfill

Landfilling of hazardous wastes with domestic and municipal waste has been an accepted practice in Canada, mostly to the detriment of health and the environment. Although there is considerable movement to limit or refine this practice, landfills will continue to be used at least for "non-hazardous wastes". Hence an understanding of landfills and their by-product, leachates, is essential to understanding the problems of hazardous waste management.

Confusion exists about the term leachate, which can be defined as "the polluting liquor that is generated beneath a landfill as a result of degradation of refuse and the infiltration of water".(3) Leachate from landfills can affect groundwater, a growing problem that is not readily treated. Even if the leachate is isolated or trapped for sewage treatment, the incorporation of only 2% leachate (expressed as a percentage of the flow of domestic sewage) is sufficient to impair the performance of a conventional sewage treatment works. In reviewing leachate control, it can readily be concluded that "the only good landfill is a dry landfill", hence the need for an impermeable cover over the fill.(4) If and when a landfill is necessary it should be above-ground or properly engineered and constructed in a relatively impermeable subsurface (e.g., unfractured clay). Such a facility should contain

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(1) Ibid., p. 28.

(2) Cope et al. (1983), p. 25.

(3) Ibid., p. 221.

(4) Ibid.

a leachate collection system, an impervious leakage barrier (below and above) and monitoring wells. One "impermeable" layer often used is a clay called bentonite; however, concern has been expressed over bentonite's ionic exchange potential. It is therefore not recommended until further research on it and other impermeable layers (e.g., PVC) is completed.(1)

2. Co-disposal

Co-disposal is the procedure of mixing liquid and solid hazardous waste with conventional refuse in a sanitary landfill site. The main rationale for this method has been that chemical and physiochemical reactions are supposed to reduce the potential hazard of the deposited waste. For proper co-disposal, a knowledge of the ratio of liquid to solid, based on the bulk density of the refuse, is needed, as well as knowledge of the exact composition, size, age and chemical nature of the refuse. It should be obvious that these facts are almost impossible to ascertain. In fact, it has been meticulously detailed that the proper requirements for co-disposal and a sanitary landfill (used for co-disposal) are diametrically opposed, and that many of the published experimental data in this field are in doubt.(2)

3. Municipal Sewers

Municipal sewer systems are a recognized disposal route for a large but unknown quantity of hazardous wastes from industrial and individual homeowner sources. One unpublished federal report says that at least 75 Canadian factories are dumping cyanide into municipal sewers and 48% of these are failing to treat or monitor their cyanide discharges.(3) This study examined the metal surface-finishing industries, which have been repeatedly identified as the source of damage to sewer lines and sewage plants. Besides cyanide, high concentrations of acids and heavy

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(1) Organization for Economic Co-operation and Development (OECD), Hazardous Waste "Problem" Sites, Report of an Expert Seminar, Paris, 1983, p. 48.

(2) Cope et al. (1983), p. 226-262.

(3) The Citizen (Ottawa), 17 March 1986.

metals discharged in batches can hamper and at times destroy the biological activity required in the normal operations of a municipal waste treatment plant. A recently announced joint federal-provincial project plans to study the effectiveness of such plants in removing certain toxics under highly variable loads; their effectiveness under constant loadings is better understood at present.(1)

F. Problem Sites and Remedial Action

One of today's largest concerns in hazardous waste management in Canada and globally is how to deal with "problem" sites (e.g., inactive dumpsites that contain hazardous wastes). The OECD addressed the problem under three main headings:(2)

1) site identification and preliminary risk assessment
2) in-depth environmental and health impact assessment
3) remedial measures

Many difficulties are found in these three areas; some of them are outlined below, with OECD recommendations for overcoming them.

At the outset, identifying all problem sites has been difficult: some former waste-generating industries are now closed, there are few records, and some generators of waste are reluctant to cooperate because of fear of liability. Good industry-authority relations can help to reduce this last problem, although the integrity of authorities must be retained by avoiding relations that are "too good", as was the case in the St. Clair River toxic blob situation. In Canada, cooperation between industries and authorities has been improving to some degree.

Consistent site assessment on a national level, as attempted by the Environmental Protection Service (EPS) of Environment Canada,

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(1) Environment Canada, Joint News Release, Grants Provided to Study Removal of Toxic Contaminants by Sewage Treatment Plants, Ottawa, 15 September 1986, 1 p.

(2) OECD (1983), p. 1-62.

appears necessary to expedite remedial action at the more serious problem sites first. Following identification of these sites, their potential health effects should be scientifically evaluated. Such comprehensive evaluation is, however, difficult and time consuming, and should not delay remedial action at some problem sites.

In order to improve environmental and health impact assessment, more on-site analyses of leachates and further development of equipment appropriate to such analyses are needed. To assist in more exact analyses of leachate composition, the OECD has recommended that the anoxic condition of the leachate as collected be maintained for the analyses, that care to avoid cross-contamination of layers from sampling bore holes be exercised, and that inert sampling equipment be used to reduce adsorption/desorption effects. These precautions would assist in dealing with some of the problems in carrying out impact assessments of leachates.

Although good techniques exist for the control of many surface water contaminants, subsurface or groundwater remedial measures need a great deal of research. Specific technical areas requiring attention are:(1)

- leakage from surface sealings, migration of ions through cut-off walls and short-term resistance of construction materials used in encapsulation techniques;

- methods to increase impermeability of the soil strata surrounding hazardous wastes;

- on-site treatment through injection of chemicals to neutralize or immobilize hazardous materials in situ;

- treatment technologies and facilities (detoxification, destruction, neutralization, fixation) for handling excavated heterogeneous materials;

- preventing or minimizing contact between groundwaters and contaminants, including permanently depressing groundwater table without long-term pumping;

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(1) Ibid., p. 55.

- treatment of highly contaminated mixed waters such as those found in pits, ponds, lagoons, leachates and rain run-off; and

- subsurface treatment techniques for groundwaters including advanced chemical injection and microbiological degradation procedures.

Proper preventive management costs only a fraction of remedial actions. For example, in the United States, two-thirds of the U.S.$1.35 billion Superfund has been used in the past five years on only 30% of the 538 sites of the National Priorities List. While the U.S. EPA estimates 2,000 more sites will reach the list, the U.S. Office of Technology Assessment estimates 10,000 sites (or more) will require cleanup by Superfund.(1) The number of problem sites discovered in the U.S. and Canada continues to grow.

QUANTITIES OF HAZARDOUS WASTES IN CANADA

A. Hazardous Waste Inventories

A national inventory of hazardous and toxic wastes estimated that some 3,280,863 wet tonnes/year(2) are produced across Canada.(3) These estimates were generated by computing production factors for each of the manufacturing industry types of Canada (based on Standard Industrial Code identification numbers). Table 3 shows the quantities of hazardous wastes generated in each province for the three main industry groups, showing that nearly half of the total quantity generated in Canada is from Ontario and approximately 29% is from Quebec. Of the remaining 22%, 17%

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(1) United States, Office of Technology Assessment (OTA), Superfund Strategy, Washington, D.C., March 1985, p. 7.

(2) Note: Estimates of total U.S. wet and dry weights of hazardous wastes give a 2.5:1 wet to dry ratio, a ratio also used in Canada.

(3) Gorre and Storrie Ltd., Canadian National Inventory of Hazardous and Toxic Wastes, Vol. 3, prepared for the Environmental Protection Service (EPS), Environment Canada, Ottawa, January 1982, p. 8.

TABLE 3: HAZARDOUS WASTE QUANTITY SUMMARY
WET WEIGHT (TONNES PER YEAR)

PROVINCE	CHEMICALS	METALS	OTHER	TOTAL
Newfoundland	20,145	434	140	20,719
Nova Scotia	59,564	32,769	14,524	106,857
Prince Edward Island	308	96	2	406
New Brunswick	9,208	1,752	35,925	46,885
Quebec	575,460	237,949	138,508	951,917
Ontario	687,272	766,276	151,559	1,605,107
Manitoba	3,404	8,737	17,317	29,458
Saskatchewan	7,048	13,801	9,295	30,144
Alberta	127,985	47,330	40,629	215,944
British Columbia	45,403	147,956	80,066	273,425
Yukon Territory	1			1
Canada Total	**1,535,798**	**1,257,100**	**487,965**	**3,280,863**

Source: Gorre and Storrie Ltd., Canadian National Inventory of Hazardous and Toxic Wastes, Vol. 3, EPS, Environment Canada, Ottawa, January 1982, p. 8.

is from Western Canada, with British Columbia and Alberta as the main contributors, and 5% comes from the Maritimes.

As important as understanding where hazardous wastes are generated is knowing who the principal generators are. In Canada, the chemical industry is the largest of these, contributing 47% of the total, while the metal industries contribute approximately 38%. The remaining industries together contribute only 15%.

B. Hazardous Waste Disposal Sites

Given the large quantities of hazardous wastes generated, one cannot help wondering where they have been disposed of. According to the Economic Council of Canada, the lack of adequate treatment and disposal facilities in Canada has led to dubious and illegal dumping practices.(1) It is estimated that approximately 85% of the national total production of hazardous wastes is dealt with improperly,(2) and, more often than not, with costly and destructive repercussions. Lack of regulations or lack of their enforcement, rather than cost, has been the major reason for improper disposal. Proper disposal costs, however, would have been only a fraction of those of remedial actions required subsequent to improper disposal.(3)

In Canada, as in the rest of the world, landfilling has been the primary method of disposing of municipal, institutional, commercial, industrial and hazardous wastes.(4) To date there is no complete inventory of hazardous waste dumpsites in Canada and it may be that every municipal landfill has the potential to demonstrate some problems associated with improperly constructed hazardous waste disposal sites. In fact, as inventories of potential problem sites continue to be

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(1) Castrilli (1982), p. 3.

(2) Ibid.

(3) OECD (1983), p. 11.

(4) Environment Canada, Environmental Protection Service, Waste Management Branch, The Waste Disposal Sites Program: Phase I Overview, Ottawa, August 1984, p. 1.

conducted, the condition of most municipal sites is being investigated. Of course, some sites are already known to possess greater than average quantities of hazardous wastes or to be located in more environmentally sensitive areas.

In the past few years, inventories have been completed by most of the provinces and/or by the Waste Management Division of the Commercial Chemicals Branch, Environment Canada.(1) This EPS study, which began in 1981, was a joint federal-provincial project involving all the provinces except Quebec, Ontario and British Columbia.(2) Quebec has completed and published its own inventory, Ontario is still conducting one, and British Columbia has no plan to conduct such an inventory at this time. In these three provinces, only those sites located on federal Crown land were examined.

The project initially had three phases, but all jointly funded aspects of the project had to be discontinued, due to reduced financial resources as a result of the November 1984 Economic Statement. By that time, however, Phase I (initial cataloguing of abandoned sites) had been completed and in some locations Phase II and Phase III (preliminary on-site assessment and extensive testing, respectively) had also been completed or initiated. The cost of the project had been approximately $300,000/year since 1981.

In the study, all sites investigated were ranked as Priority 1, 2, or 3, according to their potential for adverse health and/or environmental impacts. This involved the scoring of sites against various criteria (e.g., type of waste, proximity to a water supply or groundwater, population, etc.). Priority 1 sites are those which could present a high-risk potential and which should be immediately assessed.

Omitting data for the three non-participating provinces, except for sites on federal Crown land, the study identified 5,364 active or inactive waste disposal sites across Canada. A breakdown of these sites

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(1) Formerly known as the Waste Management Branch in the Environment Protection Service (EPS). The study will be referred to as the EPS study.

(2) Ibid., p. 4.

by province or territory and by priority ranking is given in Table 4. A further breakdown of site descriptions is offered in the study's lengthy appendix or as computer-generated information available from the Waste Management Division. Since the study was terminated, no report on the major problem sites has been produced and any further work has been left in the hands of the provinces. Some of these problem sites are listed below:

New Brunswick
- Howes Lake
- French Village Road
- C.F.B. Gagetown (pesticides)

Nova Scotia
- Sydney [polynuclear aromatic hydrocarbons (PAH)]

British Columbia
- Fraser River Harbour Commission Landfill (toxic leachate)
- Premier St. Landfill, N. Vancouver (leachate)

Quebec
- Ville Mercier Lagoons (phenols, metals, organics)
- Ville La Salle (PAH, metals)

As previously illustrated, quantities and qualities of hazardous wastes vary depending on the province, the region and often the site-specific circumstances (e.g., leaking PCBs from the B.C. Hydro storage site at Mackenzie, B.C.).(1) A synopsis of each province's dumpsites follows.

Newfoundland: Little hazardous waste has been identified by the EPS study in this relatively industry-free province. Of the 236 sites identified, only one site was Priority 1, 95 sites were Priority 2, and 140 were Priority 3. But there are also about 15 PCB storage sites in the province and recent observations indicate PCB contamination in Cartwright(2) and Mellville in Labrador. A number of undiscovered sites may, of course, become known in circumstances which are at present unforeseen.

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(1) Globe and Mail (Toronto), 4 June 1985.

(2) The Evening Telegram (St. John's), 31 May 1985.

TABLE 4
WASTE DISPOSAL SITES IN CANADA IDENTIFIED BY THE PROVINCIAL/ FEDERAL EPS STUDY, 1984

Province/ Territory	Site Status	Priority 1	Priority 2	Priority 3	Not Rated	Total
Newfoundland*	Active		1	2		3
	Inactive		3	9		12
	Additional	1	91	129		221
	Total	**1**	**95**	**140**		**236**
Prince Edward	Active	7	87	150		244
Island	Inactive	4	44	169		217
	Total	**11**	**131**	**319**		**461**
New Brunswick	Active				245	245
	Inactive	9	46	136		191
	Total	**9**	**46**	**136**	**245**	**436**
Nova Scotia	Unknown	15	123	34	29	201
Quebec*	Active	6	13	0		19
	Inactive	5	19	2		26
	Unknown				3	3
	Total	**11**	**32**	**2**	**3**	**48**
Ontario*	Active					
	Inactive	6	14	105		125
	Total	**6**	**14**	**105**		**125**
Manitoba	Active	128	293	100	9	530
	Inactive	66	125	33	6	230
	Total	**194**	**418**	**133**	**15**	**760**
Saskatchewan	Active	78	603	188	89	958
	Inactive	19	109	83	155	366
	Total	**97**	**712**	**271**	**244**	**1,324**
Alberta	Active	77	161	467		705
	Inactive	88	133	226		447
	Unknown				38	38
	Total	**165**	**294**	**693**	**38**	**1,190**
British	Active	1	23	24	46	94
Columbia*	Inactive	6	15	12	10	43
	Unknown				4	4
	Total	**7**	**38**	**36**	**60**	**141**
Northwest	Active	15	42	50		107
Territories	Inactive	3	22	58		83
	Unknown	2	3	2	235	242
	Total	**20**	**67**	**110**	**235**	**432**
TOTAL CANADA		**546**	**1,970**	**1,979**	**869**	**5,364**

* Federal Lands only.
Unknown are those identified after completion of Phase I but not yet assessed.

Source: Environment Canada, Environmental Protection Service (EPS), The Waste Disposal Sites Program: Phase I Overview, Waste Management Branch, Ottawa, August 1984, p. 5.

New Brunswick: No priority ranking was made on the 245 active landfill sites but a ranking was completed for the 191 inactive sites. Phase II studies of six of the nine Priority 1 sites showed that leachate was being released to both ground and surface waters at five of them. In general, closed sites had few major problems since the wastes deposited were characteristically "mild" and good closing procedures had been used.

Prince Edward Island: Of the 471 sites surveyed, 21 were classified as Priority 1. It was noted that only three of 40 active dumpsites had been "approved" for use and that many sites contained agricultural chemical containers, animal carcasses and unauthorized sewage. The high population density of P.E.I. and its dependence on groundwater may soon present difficulties as herbicides, pesticides, nitrate and petroleum products are being found locally in groundwater. Although not listed (probably because of its location on private land) there is at least one PCB storage site on the island.(1)

Nova Scotia: The EPS study indicates 15 Priority 1, 123 Priority 2 and 34 Priority 3 sites, in addition to 29 unclassified sites which were not identified until after the study's completion. Of the Priority 1 sites, six are abandoned coal mines with problems of leachate from the tailings containing PAH and acid. One site is a lead/zinc mine and five are domestic dumpsites. One domestic dumpsite has been certified as containing 117 45-gallon drums which are leaking or have leaked PCBs, trichlorethylene and trichlorbenzenes. Two others are suspected of containing PCBs.

A federal-provincial agreement has recently been signed to clean up the Sydney Tar Ponds, a large chemical waste site containing an estimated 3,400 tonnes of polynuclear aromatic hydrocarbons (PAH). The clean-up is scheduled to take ten years at a cost of $34.3 million, split between the federal and provincial governments on a 73/30% basis.(2,3) The main generator of the waste, Sydney Steel Co. (SYSCO)

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(1) Globe and Mail (Toronto), 2 May 1985.

(2) Environment Canada, Joint News Release, "McMillan and Buchanan Agree to Tar Ponds Clean-Up", Ottawa, 30 June 1986, 2 p.

(3) Personal communication, Environment Canada, Atlantic Region, November 1986.

coke ovens will however, remain functioning until 1988. If they continue operating at the present 25% capacity they will continue loading 3.5 tonnes/year PAH into Muggah Creek.(1)

Quebec: The EPS study, restricted to federal land sites, shows that eight out of the 11 Priority 1 sites are in the Montreal and Quebec administrative regions. Phase II investigations indicated problems ranging from bacteriologically affected surface water to significant levels of phenols, arsenic and methane gas production. In addition to remedial action, further study is recommended at two sites.

Quebec's provincial inventory investigated 1,078 sites, rejected 761 as representing no risk, and classified 62 sites as Priority 1.(2) Of these 62 Priority 1 sites, 23 are deemed a direct health risk because of their proximity to either a private or domestic water source. In total, some 350 sites are the subject of an intensive five-year study and remedial program.

Outside Ontario, Quebec is the only province which at present has licensed hazardous waste treatment plants. There is a large Stablex fixation/solidification (inorganic) facility at Blaineville, which processes 60% of Quebec's liquid industrial wastes, and a Tricil liquid-organics incinerator in Ville Mercier. Additionally, plans exist for the construction of a large 50,000 tonnes/year high-temperature, rotary kiln incinerator for liquid, solid and semi-solid organic wastes.

Ontario: The province of Ontario is continuing to identify and classify active and inactive landfill sites. To date 1,339 active sites and 1,990 inactive sites have been listed, that is, their existence is known but the nature of the wastes they contain has not yet been investigated in all cases. It has been determined, however, that as of July 1986, 69

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(1) "Tar Pond Clean-Up Will Remove 3,400 Tonnes of PAH Over 7 Years", ECO/LOG WEEK, Vol. 14, No. 38, 26 September 1986, p. 2.

(2) Quebec, Ministry of the Environment, Groupe d'étude et de restauration des lieux d'élimination des déchets dangereux (GERLED), Document de synthèse, inventaire et caractérisation des lieux d'élimination des déchets dangereux, March 1985.

active sites and 88 inactive sites contain either liquid industrial wastes or hazardous wastes as defined by Regulation 309. The project is being actively pursued and an initial evaluation of all sites should be completed at the end of 1986. The purpose of the project is to ensure that all sites have a good data base to help to predict and prevent problems such as leachate migration or groundwater contamination, and to deal with existing problem sites. Another project, scheduled for completion in April 1987, is locating and evaluating abandoned coal gasification plant wastes such as were recently identified at the Lees Avenue Transit Station, Ottawa, and in Waterloo.(1)

The EPS study , examining only federal locations, identified six locations as Priority 1 sites:

Site	Synopsis
St. Régis Indian Reserve	garbage dump which is in close proximity to residential land and which reportedly received mercury contaminated dredge from the St. Lawrence River.
Serpent River Indian Reserve	demolished acid plant site, acidic soils contaminated with sulphur, pyrite and calcine wastes
CFB, Lowther	possible PCB contamination of well water
CFB, Kingston	laboratory wastes including incinerated carcasses of animals used in 1950s biological warfare tests, threat to aquifer and wells
Gloucester Township Landfill	banned pesticides and herbicide disposal, contaminated groundwater threatening wells
Point Pelée National Park	domestic, demolition and incinerator residue -- sensitive wetland/recreation area

Ontario does house two licensed waste treatment and incineration facilities: Tricil Limited's liquid injection incinerator (capacity of 160 million litres liquid waste/yr) near Sarnia and Syntath

(1) Personal communication, Waste Site Evaluation Unit, Ministry of Environment, Ontario, 30 October 1986.

Limited's small treatment centre and incinerator near St. Catharines. Although plans are to phase out the use of municipal landfills for the disposal of hazardous wastes, six landfills in Ontario are still licensed to accept liquid industrial wastes (LIW). These are located in Hamilton, Brantford, Guelph, Paris, Welland and Lambton.(1)

The Ontario Waste Management Corporation (OWMC) is a Crown agency established in 1981 to design, own and operate the province's waste management facilities. After a three and a half year detailed site selection process costing $10 million, in September 1985 a site for the facilities was selected in Lincoln Township in the Golden Horseshoe, the area which produces 70% of the province's hazardous wastes. Its initial capacity is expected to be 30,000 tonnes of organic wastes and 120,000 tonnes of inorganic wastes per year, with provision for a future doubling of this capacity. These amounts are only 15% of the inorganic and 7.5% of the organic waste production of Ontario, low amounts set to avoid having a facility with too large a capacity.(2)

Manitoba: Until recently, most disposal was by open dumping with only occasional compaction of the wastes and limited capping with cover material. Concern has arisen mainly due to the large number of sites close to many of the numerous water bodies in the province. Additionally, buildings constructed on old landfills may be subject to high (potentially explosive) concentrations of methane gas produced from the refuse. Phase II studies of 17 sites indicated that at five of them leaching into groundwater and/or gas production was an immediate problem. Preventive recommendations were made for the other sites as well. A hazardous waste Assessment Report that examines the quantities, qualities and disposal of waste material generated in the province has been produced. At present most hazardous wastes are stored and then shipped to Ontario.

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(1) ECO/LOG (1985), p. 783.

(2) Ontario Waste Management Corporation (OWMC), Facilities Development Process, Phase 3 Report, Toronto, Ontario, March 1984, p. 16-20.

Saskatchewan: A large number of sites have been ranked at the top two priority levels; however, little on-site investigation has taken place. The major problems encountered are pesticide contamination of surface water and, less frequently, groundwater contamination.

Alberta: Approximately 14% of the 1,152 sites investigated in Phase I of a large study were designated as Priority 1 sites. Of the known inactive sites, approximately one-third have been rehabilitated under a Heritage Trust Fund Program; however, some known industrial sites are still missing from the inventory. As the study progresses, detailed hydrogeological investigations at 17 of 18 suspect sites have been completed. Twelve of these appear to contribute minimally to groundwater contamination, two show water with contaminants above the 1978 Canadian Drinking Water upper acceptable limits and three have anomalous data.(1)

A Crown corporation, the Alberta Special Waste Management Corporation (1982) (ASWMC), is coordinating the construction of an integrated hazardous waste treatment plant by a subsidiary of Bow Valley Resources Services Ltd. (BVRS; Chem-Security). Situated near Swan Hills, 200 km northwest of Edmonton, the site will be in a good position to serve Edmonton's industry, which produces 68% of the province's hazardous wastes. The facility, whose final cost is estimated at $45 million, should be capable of treating and disposing of the 20,000 tonnes of hazardous wastes that are annually generated in the province and cannot be dealt with at the site of generation.

Unlike the situation in Ontario, where the OWMC is 100% Crown owned, the cost is split 60-40 between BVRS and the province. Under the Joint Venture Agreement, BVRS will be guaranteed a rate of return based on the original capital investment; the rate base will decline at 10% per year plus a formula-derived rate, based on the prime interest rate. Such an agreement was necessary to secure private sector involvement when the actual volumes and types of wastes BVRS will be handling are not yet known. The ASWMC and BVRS will have equal representation on a Board that

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(1) "Alberta Uncovers Some Problems in Phase III Landfill Studies", ECO/LOG WEEK, Vol. 14, No. 35, 5 September 1986.

will lay down policies and directions, audit financial returns and help set rates. BVRS's subsidiary, Chem-Security, will run day to day operations.(1,2)

Methods of deep well injection for waste disposal are unique to Alberta. In this case, hazardous industrial wastes are stored in rock strata at depths (between 300 and 2,000 metres) and in materials which it is hoped will protect groundwater supplies.

British Columbia: Excepting the EPS inventory of sites on Crown land, no inventory has been or is planned to be conducted in British Columbia, but the two sites mentioned on page 22 are of major concern. Initial research, involving a year and a half and $1.5 million, identified sites for a hazardous landfill in the Fraser Canyon, but no further action is planned. The original study, conducted by a private company, reported that such action was not economically feasible.

THE MANAGEMENT PROCESS IN CANADA: EXISTING AND POTENTIAL PROGRAMS AND LEGISLATION

The requirements for good management of hazardous wastes, some of which were outlined above, need some incentive for their development and application. Existing laws, policies and programs at all levels of government offer only a patchwork of approaches to the difficult issues presented.(3) The overall picture that emerges is one of a major national problem to which the regulatory and legal system is still evolving its response.(4,5)

Although the role of the federal government has been principally advisory, recent developments, such as adoption of the

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(1) "Future of Swan Hills Plant Assured", ECO/LOG WEEK, Vol. 14, No. 12, 28 March 1986, p. 1.

(2) Personal communication, ASWMC, 31 October 1986.

(3) Tom McMillan, Minister of Environment, Notes for an Address to the Fourth Environmental Government Affairs Seminar, Ottawa, 20 October 1986, p. 6.

(4) Ibid.

(5) Castrilli (1982), p. 13.

TDG Regulations, control aspects of and proposed amendments to the Environmental Contaminants Act, and plans to introduce an Environmental Protection Act,(1) indicate that the federal government does have a mandate to play a larger, legislative role.(2,3) Constitutionally, the two existing Acts can be said to be justified through the criminal law power and the general power of Parliament.

The main difficulty with legislation authorized solely pursuant to the criminal law power is that sanctions are limited to a prohibition-punishment, rather than a management, approach. However, the judiciary has held that the general power of Parliament is capable of supporting federal legislation where the subject matter has attained "national dimensions" or has become a matter of "national concern". According to the literature and recent developments (e.g., meetings of the Canadian Council of Resource and Environment Ministers (CCREM) in 1985 and 1986), the management of hazardous wastes has indeed become of grave national concern.

The possibility of "hazardous waste havens" in a province with less stringent standards, regulations or enforcement might best be avoided through national legislation for disposal standards, although such standards have previously been regarded as a provincial or local concern. It is difficult to expect the provinces to act adequately, given the scope of the problem nationally, so the proposed legislative intervention should not intrude upon provincial powers. One possibility is that the administration and implementation of national regulations could still be delegated to the provinces.(4) Implementing national standards might reassure the public and increase its willingness to accept disposal facilities. As well, recycling, reduction and exchange of wastes might become more

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(1) Environment Canada, Joint News Release, "Reports Lay Groundwork for Environmental Protection Legislation", 20 October 1986, 2 p.

(2) Castrilli (1982), p. 13.

(3) Griffiths Muecke Associates, A Strategy to Promote Hazardous Waste Management, prepared for Nova Scotia Department of the Environment, April 1985, p. 14.

(4) Castrilli (1982), p. 81-91.

attractive to industries, as costs for proper dumping and penalties for improper dumping increase.

The establishment of a trust fund for cleanup and victim compensation is most feasible under provincial authority for "property and civil rights within a province".(1) In Ontario, for example, a $10 million Environmental Security Fund has been set up to compensate victims and to deal quickly with spill cleanup costs. Although this system has been implemented so cleanups will not be delayed by the need to negotiate responsibility and funding, the present coal tar leakage at the Lees Avenue Transit Station in Ottawa still encountered problems concerning responsibility and costs. The Fund was not used in this situation, which, on its own, could have exhausted the resources. One suggestion is that a fund could be supported, like workmen's compensation, by special contributions from industries, or, like the U.S. Superfund, by a direct tax on industries.

The same legal analysis which supports the feasibility of a trust fund suggests it is possible that a mandatory recycling scheme could be imposed at a provincial level. It appears that such a system would be less likely to be upheld if based on the federal criminal law power. A system of mandatory recycling is now in effect in California(2) and there is mandatory membership by industries in a waste exchange program in Germany.(3)

Provincial governments have the strongest constitutional authority to deal with hazardous waste disposal and related matters, whereas the municipal authorities can address the problems from three traditional types of provincial enabling legislation. They can enact by-laws, protect health under local boards of health, and develop zoning by-laws. It appears that the evolution of local powers has not always resulted in actions compatible with provincial government initiatives and municipal attempts to restrict industrial burning could frustrate a national policy on the elimination of selected chemicals.(4)

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(1) Ibid., p. 91-92.

(2) ECO/LOG (1984).

(3) Castrilli (1982), p. 28.

(4) Ibid., p. 68-69.

Recent studies indicating that toxic compounds such as dioxins and furans are emitted from incinerators have lent credence to such concerns. In Canada this has led to the development of a National Incinerator Testing and Evaluation Program (NITEP).(1)

These questions of jurisdiction and the need for national standards are coming to the fore on most of the previously mentioned issues. In the recent 1986 CCREM meetings, agreement was reached on an action plan aimed at fostering uniform legislation, policies and programs for hazardous wastes. Being studied are the feasibility of a national contingency fund for cleanups of hazardous waste sites posing imminent danger to the environment or human health, and an action plan to implement life-cycle management for chemical products. The latter will include problems of incineration, landfilling and physio-chemical treatment. The respective roles and responsibilities of the various levels of government in these areas are now being addressed and will continue to be addressed in future discussions.

Public involvement has rapidly evolved in the decision-making process and in most provinces there is now provision for such involvement in both the drafting of policy and legislation.(2) In general, it appears that, at a provincial level, the more recently a province has ventured into the creation of a management plan, the stronger the public involvement. An increase in public involvement is also found at the federal level, where two related consultative programs have been quite successful. Two recent reports resulting from these consultations among government, industry and public interest groups will serve as

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(1) Environment Canada, The National Incinerator Testing and Evaluation Program: Two-Stage Combustion (PEI), Report EPS 3/UP/1, Ottawa, September 1985, 85 p.

(2) ECO/LOG (1985), p. 1-123.

ground-work for a new Environmental Protection Act.(1,2,3) In all public consultation, care must be taken to ensure the public is well informed, so as to avoid delays in the process and to ensure rational decisions.

A. Federal Legislation and Programs

In the past, due to perceived or actual constitutional constraints of the British North America Act (1867), the role of the Department of Environment in hazardous waste management, was principally advisory rather than regulatory.(4) Its mandate with respect to this subject has three major components:(5)

(1) the control of the international and interprovincial movement of hazardous wastes (under the legislative authority of the Transportation of Dangerous Goods Act);

(2) the management of hazardous wastes generated by federal facilities and the disposal of wastes on federal lands; and

(3) the control of dumping of materials into the ocean (under the legislative authority of the Ocean Dumping Control Act).

At present, there is no comprehensive federal legislation dealing with hazardous waste management although several legislative mechanisms are employed to limit and control the release of hazardous substances into the environment:(6,7)

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(1) "Reports Lay Groundwork for Environmental Protection Legislation", (1986).

(2) Environment Canada, Report of a task force representing industry, governments, labour, environmental groups and consumers, From Cradle to Grave: A Management Approach to Chemicals, Ottawa,September 1986, 56 p.

(3) Environment Canada and Health and Welfare Canada, Final Report of the Environmental Contaminants Act Amendments Consultative Committee, Ottawa, October 1986, 84 p.

(4) Castrilli (1982), p. 14.

(5) ECO/LOG (1985), p. 2.

(6) ECO/LOG (1984), p. 10-12.

(7) Castrilli (1982), p. 14.

Arctic Waters Pollution Prevention Act (1970)
Fisheries Act (1970)
Atomic Energy Control Act and Regulations (1978)
Canada Shipping Act, Oil Pollution Prevention Regulations (1978)
Ocean Dumping Control Act (1974)

Of most direct note in management is the Environmental Contaminants Act (1974-75), which will soon be amended following a recently completed study by a multi-partite Environmental Contaminants Act Amendments Consultative Committee. The Act deals mostly with the import, manufacture and use of toxic chemicals in industry, while the proposed amendments would create a notification scheme for new chemicals and give more powers to inspectors and to Ministers to pass regulations concerning the banning, use and release of such substances.(1,2) It is hoped thus to improve the compliance and enforcement provisions of the Act.

An integral component of a hazardous waste management program is controlling the transport of dangerous goods such as wastes. Since there is frequent transboundary movement of dangerous goods, the federal government has acknowledged that it has the jurisdiction to enact such legislation and on 1 November 1980 the Transportation of Dangerous Goods Act (TDGA) was proclaimed. The Act has a provision for federal-provincial agreements and for implementing and enforcing the law's provisions (Regulations) within a province. After 12 months of negotiating, if an agreement has not been reached the government may proclaim that the Act applies within a province. These Regulations, needed to meet the goal of the TDGA, struggled through drafting for five years and finally, on 1 July 1985, the bulk of them came into effect.

The Act also lists a Schedule of Hazardous Goods in an attempt to create a comprehensive classification system necessary for inter/intraprovincial and international transportation management. A

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(1) John Buccinni (EPS), "Environmental Contaminants Act Revision", Toxics and the Environment Conference, Ottawa, 12-13 June 1985.

(2) Final Report of the Environmental Contaminants Act Amendments Consultative Committee (1986), 84 p.

manifest system for tracking the substances in transport has also been drawn up and again it was hoped that the provinces would enact complementary legislation to create some degree of uniformity.(1,2) Although highly successful for interprovincial transport, similar manifest and tracking systems have not yet been implemented for transport within provincial boundaries in all the provinces.

Despite increased public and government attention on hazardous waste management, the federal Waste Management Branch was downgraded to a Division, lost half its person years and $1.2 million of its budget in the November 1984 Economic Statement. Although some functions were directed to other areas of the Department, overall there has been a reduction in effective strength to respond to increased demands for federal leadership and national uniformity.

One attempt to deal with this increased attention on hazardous wastes has been the development of a "Federal Environmental Protection Policy for the Eighties", in the form of a two-pronged approach:

1) cleanup
2) prevention

Cleanup may be the simpler of the two because of the difficulty of engaging people in prevention; seldom, however, is it the less expensive or less damaging. It is felt by taking a "life-cycle approach", whereby a chemical is followed from its production until its final state (destruction or market product), that a more comprehensive management, including more prevention, will be attained.(3) This "life-cycle approach" is also referred to as"cradle to grave" management. Embodying these principles and attempting to deal with priority issues have resulted in several federal programs and the contracting of much research, directly and indirectly, into dealing with hazardous wastes.

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(1) ECO/LOG (1985), p. 166-177.

(2) Castrilli (1982), p. 34-40.

(3) R. Slater (ADM of EPS), "Federal Perspectives on Issues in Chemical Management", Toxics and the Environment Conference, Ottawa, 12-13 June 1985.

Some federal programs of recent note are:

1) Guidelines for the Management of PCB Wastes

Recent reports of PCB spills resulted in public attention and consequent requests for assistance in establishing provincial regulatory licences and permits. Emphasis has therefore been on these guidelines, which deal with the handling, storage and disposal of PCBs as they are retired from service. The manual has been completed, was presented to CCREM and is expected to be released publicly in January 1987. The Environmental Contaminants Act prohibits the use of PCBs in new equipment or products.

2) Guidelines for the Secure Landfilling of Hazardous Wastes

Pre-empted by the PCB guidelines, this publication has been reduced in strength to a technical manual of practice. It is scheduled for completion in April 1987.

3) Federal-Provincial Waste Disposal Site Program

Initial results of the study have been listed above, (p. 21) but, as noted, the program has been restricted to federal lands because of a reduction in funds as a result of the November 1984 Economic Statement.

4) Institutional Waste Guidelines

Recently released, this technical manual provides management procedures and criteria for laboratory waste chemicals.

5) Canadian Waste Materials Exchange (CWME)

Initiated in 1978 and originally funded by the DOE, this program is managed through the Ontario Research Foundation. In the 1983-84 fiscal year, the CWME program facilitated the industrial exchange and hence recycling of over 210,000 tonnes of waste with a value of $6 million. At present, the CWME is jointly funded by the federal and provincial environment ministries and private industry (see p. 12).

B. Provincial Legislation and Programs

The provincial governments have substantial constitutional authority to deal with hazardous waste disposal and related matters. With few exceptions, however, provincial legislation, like federal law, has focused primarily on general air and water discharges. The recognized inadequacy of this approach has recently prompted some provincial initiatives which more directly address hazardous waste disposal.(1)

Newfoundland: The major piece of legislation, the Waste Material (Disposal) Act (1973), sets out provisions governing waste management systems and disposal sites and empowers the Lieutenant Governor to make regulations designating hazardous substances. To date this has not been done and no other direct hazardous waste legislation or program is in effect. Hazardous wastes have not been recognized as a serious problem because of their relatively small quantities.

After three years on the shelf, the province's Dangerous Goods Transportation Act was proclaimed in force on 20 December 1985 and its first regulations, which generally adopt the federal TDG Regulations were brought into effect. A more recent initiative has been the licensing of 12-15 interim storage sites for PCB wastes awaiting further disposal.

Other regulations and legislation bearing on hazardous waste management are:(2)

Environmental Assessment Act (1983-84)
Pesticides Control Act (1970)
Storage and Handling of Gasoline and Associated Products Regulations (1982)
Department of the Environment Act (1981)
The Department of Health Act (1970)
Dangerous Goods Transportation Act (1982)

New Brunswick: There are two recent developments of note in New Brunswick involving hazardous substances and wastes. In August 1986 a public consultation report concerning waste and, in particular, hazardous waste management, was presented to the legislature by the Environmental Council

(1) Castrilli (1982), p. 46.

(2) ECO/LOG (1985), p. 122-123.

of New Brunswick. The report was originally commissioned by the Minister and contains three statements of principles and 18 recommendations. There is, however, no obligation for response.(1)

The explosions and fires caused by underground gasoline storage tank leakages in the city of Saint John in April 1986 provided the spark for a ministerial order to register all underground and above ground storage tanks capable of containing 2,000 litres or more, or 200 litres in the case of marine storage tanks. The deadline for registration was 10 December 1986. This appears to be the first step towards legislation concerning storage tanks.(2) The enormity of the problem surfaced when documentation was presented in June 1986 indicating that about 5 million litres of gasoline had leaked into groundwater between 1965 and 1980 throughout the province, generally through the negligence of major oil companies.(3)

Under the Clean Environment Act (1973), the Minister of the Department of the Environment (now the Department of Municipal Affairs and Environment) has broad powers regarding the discharge of wastes or contaminants into the environment. Within the Act, water and air quality regulations and permit requirements have recently been passed, but low financial support has restricted their application to non-hazardous wastes. Also, as of 1983, amendments have provided a legislative framework for environmental impact assessments. These assessments, carried out by the proponent, involve public consultation on both ecological and socio-economic issues and involve a substantial review process. There are no regulations specific to the transport of hazardous substances within the province.(4)

Other legislation, which is of less significance but can be employed:

Public Health Act (1973) and Regulations
Pesticides Control Act (1973) and Regulations

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(1) Personal communication, Ministry of Municipal Affairs and Environment, New Brunswick, 30 October 1986.

(2) Ibid.

(3) The Citizen (Ottawa), 5 June 1986.

(4) ECO/LOG (1985), p. 111-115.

Prince Edward Island: In this province there is no legislation or plan for legislation dealing strictly with hazardous wastes, although the Environment Protection Act (1975) does set out general pollution provisions which could include hazardous wastes. The Department of Transportation did, however, adopt those federal TDG Regulations that did not duplicate areas addressed by their own regulations. Since all drinking water in P.E.I. comes from groundwater, drinking water quality is inevitably linked to groundwater quality and small amounts of hazardous wastes can have serious effects. Recently passed regulations require the registration of all underground petroleum storage tanks and specify the quality of their construction with respect to corrosion resistance.(1) Domestic and municipal waste and pesticides also threaten groundwater in P.E.I.

Other legislation:(2)

Pesticides Control Act (1984)
Dangerous Goods Transportation Act (1981)

Nova Scotia: Nova Scotia has no legislation specifically dealing with hazardous waste management, although the Environment Protection Act (1973), which prevails over all Acts, including municipal by-laws, does set out procedures for licensing and standards for waste management systems and pollution abatement programs. Standards of compliance and penalties for non-compliance are detailed. The province adopted the TDG Regulations in February 1986 for interprovincial transportation and passed a Dangerous Goods and Hazardous Wastes Management Act in July 1986.(3)

Other legislation:

Water Act (1973)
Dangerous Goods Transportation Act (1982)

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(1) Personal communication, Department of Community and Cultural Affairs, P.E.I., 4 November 1986.

(2) ECO/LOG (1985), p. 119.

(3) Personal communication, Department of the Environment, Nova Scotia, November 1986.

Quebec: The new Hazardous Waste Regulation under the Environment Quality Act (1977), came into force on 15 October 1985 and is the most comprehensive set of regulations governing hazardous waste management in Quebec. The regulations incorporate requirements for a previously tested manifest system, and the prenotification of waste shipments, and address waste definition, classification, storage, transport and disposal.(1,2) Prior to these regulations, the Environmental Quality Act had few specific provisions governing the disposal of hazardous wastes, although Division VII of the Act does set out provisions for issuing licences and permits for waste management systems and imposes standards of compliance which must be met before the operations are approved by the Minister. Some provisions relating to certain industrial sectors, however, have been delayed.

Other regulations:

Quality of the Atmosphere Regulation (1981)
Regulation Respecting Liquid Waste (1983)
Regulation Respecting the Transport of Waste (1981)

Ontario: It can readily be seen that policy, regulations and legislation in some provinces, but in Ontario in particular, are rapidly changing and are being strengthened. This should be expected to continue as the problems involved in controlling and regulating hazardous substances and wastes unfold. The most recent evidence of such a trend is legislation introduced on 3 July 1986 to strengthen the enforcement provisions of three existing Acts: (Environmental Protection Act (1980), Ontario Water Resources Act (1980) and the Pesticides Act (1980). The legislation will provide for jail sentences, increased fines from two to five times their present amounts, and "gives the courts the power to strip polluters of ill-gotten gains"; that is, if, after paying the fines, polluters still have net gain from polluting rather than using proper treatment and/or disposal, additional fines can be imposed "to deprive

(1) ECO/LOG (1985), p. 116-117.

(2) Ibid., p. 103-108.

lawbreakers of any financial gain achieved by polluting Ontario's environment".(1,2)

The principal statute governing waste management in Ontario is the aforementioned Environmental Protection Act (1980). Part V of the Act provides definitions, requirements and procedures for acquiring certificates of approval for operating and altering existing waste management systems and disposal sites, as well as proposed systems and sites. The Act also specifies when public hearings must be held with regard to issuing certificates of approval. The Act provides the Director responsible with considerable power over waste management in general and establishes a Waste Disposal Security Fund to pay for compensation claims. Amendments in 1983 permitted a greater "preventive" stance to be taken by monitoring and controlling waste problems on private land which eventually may threaten others.

The main regulation of the Environmental Protection Act is the Environmental Protection (General-Waste Management) Regulation 309. This defines, classifies, and sets standards for wastes, management systems, disposal sites and transfer vehicles. The second major regulation was the "Way-Bill" or Transfer of Liquid Industrial Waste Regulation 313; in essence this is a manifest system, but it has effectively been replaced by the amended Regulation 309. In 1983, an in-depth review had produced a document called the "Blueprint for Waste Management", which set forth policy and legislative and regulatory proposals relating to virtually every phase of waste management.(3) The amended Regulation 309, based on this policy paper, was announced 17 June 1985 and came into effect 17 September 1985.

> Under the regulation, companies producing hazardous waste must register all wastes within 12 months of production, fill out a manifest for shipments of waste,

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(1) Personal communication, Ministry of Environment, Ontario, November 1986.

(2) Jim Bradley, Minister of Environment, Ontario, A Statement to the Legislature on Enforcement of Environment Laws, Ontario Legislature, 3 July 1986, 3 p.

(3) ECO/LOG (1985), p. 54-62.

and ensure the wastes are recycled, treated or disposed of properly.(1)

As well, the controversial "Spills Bill" (part IX of the Environmental Protection Act) was proclaimed in force 29 November 1985. This bill places onerous financial responsibilities on those who own or use toxic materials, particularly in the event of a spill.

Other legislation and regulations:

Waste Management: PCB Regulation (1980)
Dangerous Goods Transportation Act (1981)
Environmental Assessment Act (1980)
Consolidated Hearings Act (1981)
Municipal Act (1980)
Planning Act (1980)
Ontario Waste Management Corporation Act (1981)

Manitoba: A three-phase waste management strategy for Manitoba is being carefully constructed with substantial public consultation and review. It includes various pieces of legislation to manage hazardous wastes in particular and, on a broader scale, all environmental impacts. A Hazardous Waste Management Corporation Act, proclaimed on 15 November 1986, provides a mandate to establish an appropriate collection, treatment and disposal system for the province.

As well, a discussion paper for a new Environment Act was tabled in September 1986. This act will replace the Clean Environment Act (1972) and be much broader in scope, as any social-environmental impact will be considered under it. (2)

Other recent legislation concerning hazardous wastes, the Dangerous Goods Handling and Transportation Act, was passed in the summer of 1984.

Other legislation and regulations:

Clean Environment Act (1972)
Public Health Act (Sanitation Regulations; 1971)
Pesticide and Fertilizer Control Act (1976)

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(1) Globe and Mail (Toronto), 18 June 1985.

(2) Personal communication, Department of Environment and Workplace Safety and Health, Manitoba, January 1987.

Waste Disposal Grounds Regulations (1976)
Regulation Respecting the Designation of Certain Substances as Hazardous Materials (1981)

Saskatchewan: Saskatchewan has recently restructured its Environment Department through the Department of Environment Act (1984) with details of its mandate in the Environmental Management and Protection Act (1984).(1) Regulations for this Act, which will control the designation, transportation, storage, processing, disposal and recycling of hazardous wastes, have been redrafted but are awaiting a national definition and scheduling of hazardous wastes before being introduced.(2)

Additionally, Saskatchewan has a pesticide container disposal program, which has been successful in accounting for the return of at least 50% of the agricultural containers sold, and a low-level PCB waste treatment facility for oil detoxification that is capable of treating oils containing less than 500 ppm PCBs.

Other legislation and regulations:

Environmental Spill Control Regulations (1983)
Mineral Resources Act, Pollution Prevention Regulations for the Mineral Industry (1969)
Pest Control Products (Saskatchewan) Act (1976)
Public Health Act (1972) -- Waste Management Regulations

Alberta: Within the Alberta Department of Environment, the Environmental Protection Service is the main branch responsible for controlling and preventing pollution, while the Alberta Special Waste Management Corporation (ASWMC) is chiefly responsible for control of waste management facilities.

The Acts predominantly responsible for the management of hazardous wastes are the Hazardous Chemicals Act (1978) and the Special Waste Management Corporation Act (1982).(3) As of 13 March 1984, both

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(1) ECO/LOG (1984), p. 35-37.

(2) Personal communication, Department of Environment, Saskatchewan, October 1985.

(3) ECO/LOG (1985), p. 32-44.

were updated and amended, to provide a more complete set of regulations. The Hazardous Chemicals Act now provides regulations for a manifest system similar to that of the TDGA although Alberta's more recently proclaimed Transportation of Dangerous Goods Control Act (1986) is more specifically designed to control the movement of both special wastes and dangerous goods. The Hazardous Chemicals Act also gives power to the Director responsible to ensure wastes are properly managed and it assigns responsibility for remedial action "to the person responsible for the chemical".(1) The same regulations formalized the power of the ASWMC for controlling waste management facilities in the province.(2)

The extensive development of the oil and gas industry in Alberta has provided special advantages in waste management but has also given rise to special problems. Special regulations, the Oil and Gas Conservation Regulations (1971), were amended in 1983 to ensure proper handling and disposal of wastes from oil and gas exploration and production activities. A necessary emphasis is placed on disposal of large-scale liquid and solid waste generated by the oil sands plants. Licensing and approval of deep well injection disposal facilities must be obtained from the Energy Resources Conservation Board, which permits their use only in suitable geological conditions.

Other legislation and regulations:

Agricultural Chemicals Act (1970)
Pesticides Sales Use and Handling Regulations (1980)
Clean Air Act (1971)
Clean Water Act (1971)
Department of the Environment Act (1971)
Oil and Gas Conservation Act (1970) and Regulations (1971)
Energy Resources Conservation Act (1971)
Public Health Act (1971) and Regulations Respecting the Control of Refuse Disposal Systems

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(1) ECO/LOG (1984), p. 30.

(2) Personal communication, Waste Management Branch, Department of Environment, Alberta, June 1985.

British Columbia: In this province, the Waste Management Act (1982) (WMA) and its supplements give authority to the Waste Management Branch concerning the regulation of hazardous wastes. In general, the WMA allows participation by the province in the development of waste management plans for municipalities, and in the control and storage of hazardous wastes. It also regulates the permitting of discharges into the environment and gives the Ministry the authority to require spill prevention, assessment and contingency plans.(1) The provincial Transportation of Dangerous Goods Act (1985) adopted the federal TDG regulations, but no regulatory controls explicitly cover the registration of special waste generators, nor the handling, treatment and disposal of hazardous wastes.(2)

Other legislation and regulations:

Pesticide Control Act (1979) and Regulation
British Columbia Health Act (1979)
Waste Management Regulation (1983)

DISCUSSION

As the basic concept and initial stages of hazardous waste management in Canada evolve, so does the decision-making process. Involvement of the public, primarily due to a concern generated by the media, will continue to grow. A common theme stressed at the Toxics and Environment Conference in Ottawa in May 1985 was the need for truth to instill trust. Particularly at a provincial level, people's faith and trust in government and industry had by then reached an all-time low, which is requiring both time and care to rebuild. As well, the public is more scientifically aware now than in the past and requires more complete explanations and answers to its questions. The federal government,(3) many provinces, and industry understand this and, for the most part, are beginning to respond.

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(1) Personal communication, Ministry of Environment, British Columbia, October 1986.

(2) ECO/LOG (1985), p. 29.

(3) Buccinni (1985).

Recent changes in Ontario, where a more comprehensive hazardous substances (including wastes) program is being developed and enforced, provide a good example of response to pressure for change.(1) In this province, the largest generator of hazardous wastes, the environmental debate was brought to the fore by a couple of environmental accidents at the time of a provincial election. The issue was firmly entrenched during a subsequent election and change of government.

Problems, however, still abound. The industries involved, which feel the "buck stops at them", would like to see an end to the provincial-federal struggle -- which only tends to erode any progress -- and recognize that there must be mutual trust and credibility.(2) In some respects the provinces also feel they are in the disadvantaged "tail end Charlie position". Although they still feel they should control management, their major complaint is the lack of adequate information. For example, the federal government has access to proprietary information from pesticide industries which the provinces are lacking, although they are responsible for provincial regulation.(3)

The national scope of the problem should be evident. Most industrialized countries recognize the need for uniformity and centralized control of hazardous waste management, as well as international co-operation.(4) The TDGA, was a step in the right direction for Canada, although TDG Regulations were slow to be enforced and even now the Act does not provide a comprehensive management package. Although there were provincial-federal complications in the establishment of the TDGA, public pressure may expedite similar ventures which require cooperative effort

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(1) For further details see the section "Provincial Legislation and Programs, - Ontario", in this paper.

(2) B. Boldt, Dow Chemical, "Industrial Perspectives on Managing Chemicals", Toxics and the Environment Conference, Ottawa, 12-13 June 1985.

(3) W. Solodzuk, "Provincial Perspectives on Managing Chemicals", Toxics and the Environment Conference, Ottawa, 12-13 June, 1985.
Note: Solodzuk made a disclaimer and attributes the statements to his personal view.

(4) OECD (1983).

(e.g., CCREM meetings, 1985 and 1986, see p. 30 and p. 32). As public pressure develops, the provinces may turn even more to the federal government as an advocate, if consensus is difficult to achieve.

Research and development are required at most stages of management. Although industry may be capable of conducting research, the role indicated for it in the "New Science Policy",(1) some direction and incentives directly related to toxics and the environment are needed. Uniformity in inventories and non-partisan evaluation of chemicals' toxicities (as previously conducted by the Environmental Secretariat of the NRC) could only help us in deciphering this complex issue, which we are just beginning to understand.

It appears that the provinces and the federal government do perceive the need for changes; future developments at CCREM meetings will illustrate the depth of their understanding. Even now, further federal involvement is indicated by proposed amendments to the Environmental Contaminants Act and an Environmental Protection Act, proposed in the Speech from the Throne (1 October 1986), that:

> will be introduced to improve my government's capacity, in concert with the provinces to deal effectively with pollution focusing on toxic chemicals.(2)

But does it address the problems associated with existing waste sites and improper use of municipal sewers? Although commendable

> it is just a step, but a significant one, in the right direction. I hope that, having begun the journey, we will, someday complete it.(3)

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(1) Voyer (MOSST), "Our New Science Policy, R&D", Toxics and the Environment Conference, Ottawa, 12-13 June, 1985.

(2) Canada, House of Commons, 2nd Session, 33rd Parliament, Speech from the Throne, Debates, 1 October 1986, p. 14.

(3) Tom McMillan, Minister of Environment, Notes for an Address to the Fourth Environmental Government Affairs Seminar, Ottawa, 20 October 1986, p. 7.

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