Chapter 16

Water Pollution-Control Policy

Water is biologically necessary for life on this planet—but, even beyond this, water resources also play a vital and pervasive role in the health and welfare of a modern economy. Water for direct human consumption is a small but critical part of the domestic system, which also includes water used in food preparation, cleaning, and sewage disposal. Water is an essential element in many industrial and commercial production processes, again both as an input and as a medium of waste disposal. Large amounts of water are used by farmers for irrigation, especially in the Prairie provinces. In-stream, non-consumptive uses of water include water-based sports and recreation as well as simply the enjoyment of a scenic vista.

The water resource system itself consists of a vast array of interconnected components, from the grandiose to the tiny. The surface-water system includes the huge main-stem rivers, the Great Lakes, and other large lakes, such as Okanagan Lake in BC and Lake Winnipeg in Manitoba, as well as the thousands of small neighbourhood streams and ponds. Add to these the innumerable person-made components, from the mill ponds of the first industrial era to the vast reservoirs and canals of today. Wetlands, one of nature's ecosystem rechargers and life supporters abound. And then there is the vast, but unseen, system of groundwater aquifers, typically exceeding surface waters in terms of sheer quantity of water. Saltwater resources are also of vital importance. Marshes and coastal lowlands are critical for fish and wildlife resources; beaches and scenic coasts are important recreational resources; coastal waters provide transportation and pleasure boating services; and saltwater fisheries are a major source of food.

Data on water quality are difficult to summarize as they are collected for specific water bodies at monitoring stations and by intermittent sampling. There is no overall indicator of water quality in Canada. Chapter 2 provided some examples of the types of data available. Provincial environment ministries are the place to start to look for data on water quality in a given region, watershed, or body of water.[1]

1. For example, British Columbia's Ministry of Water, Land, and Air Protection has a number of reports on water quality in the province. See http://www.env.gov.bc.ca/wat/wq/. Environment Canada's providessome water-quality indicators at http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=68DE8F72-1.

This chapter provides examples of federal and provincial water pollution-control policies. The objective is to examine the main elements of these policies with the economic concepts that have been developed in preceding chapters. While the primary focus is on Canadian policies, comparison with those in the United States illustrates contrasts and similarities. Experiments in the United States using economic incentives to help achieve improvements in water quality are also highlighted.

Types of Water Pollutants

One way to categorize waterborne pollutants is by their chemical and physical nature.[2]

- Organic wastes: degradable wastes such as domestic sewage and residuals from pulp mills and food-processing plants; chemicals such as pesticides, detergents, and solvents; oil.
- Inorganic substances: chemicals such as toxic metals, salts, and acids; plant nutrients such as nitrate and phosphorous compounds.
- Non-material pollutants: radioactivity, heat.
- Infectious agents: bacteria, viruses.

2. G. Tyler Miller, Jr. *Resource Conservation and Management* (Belmont, California: Wadsworth Publishing Company, 1990), 201.

Waterborne emissions include all the different types of discharges discussed in Chapter 2. ***Point sources*** include outfalls from industry and domestic wastewater treatment plants. ***Nonpoint*** sources include agricultural runoff of pesticides and fertilizers and the chemicals and oils that are flushed off urban streets by periodic rains. Many sources, especially point sources, have ***continuous emissions***, related to the rate of operation of the industrial plant or the domestic sewer system. There are also many ***episodic emissions***, such as accidental releases of toxic materials, oil tanker accidents, or occasional planned releases of industrial pollutants.

Chapter 2 also differentiated between ***accumulative pollutants*** and ***non-accumulative pollutants***. In water pollution control it is more common to speak of ***persistent pollutants*** and ***degradable pollutants***. Degradable waterborne pollutants undergo a variety of biological, chemical, and physical processes that change their characteristics after emission. Especially important are the oxygen-using chemical processes that rely on the oxygen contained in receiving waters to degrade the wastes.[3] The reason for focusing on oxygen requirements is that oxygen plays a critical role in water quality. High levels of ***dissolved oxygen (DO)*** are usually associated with high-quality water, water that will support high-quality recreational uses and aquatic life and that can be used in domestic water-supply systems.

3. Degradable wastes also include a variety of infectious bacterial agents, parasites, and other micro-organisms that can cause acute gastroenteritis, kidney damage, typhoid, cholera, dysentery, and other nasty diseases. Waste heat is also a degradable pollutant; it comes mostly from large-scale industrial processes that use water for cooling purposes.

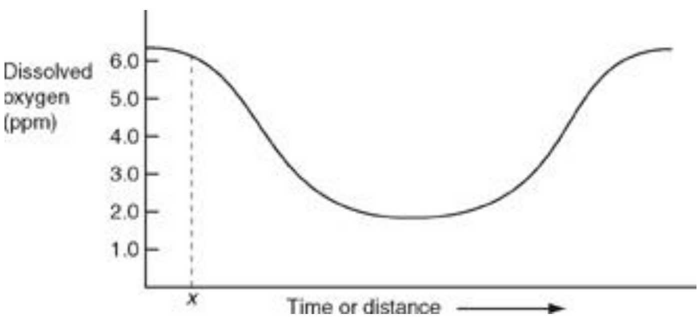
Since DO is used up in the degradation process, one way of measuring the quantity of waste emitted is through ***biochemical oxygen demand (BOD)***, the amount of oxygen required to decompose the organic material under specified conditions of temperature and time.[4] A substantial proportion of the BOD load introduced into the water resources of the country comes from municipal waste treatment plants. Much of this consists of wastewater from treated domestic waste, which contains a variety of degradable organic compounds. Industrial sources also contribute large amounts of BOD, some stemming from the sanitary facilities within the plants, but more importantly from the great variety of water-using steps in the production processes, such as cleaning, product formation, waste removal, and product transport.

[4.] For example, 10 pounds of BOD10 is a quantity of material requiring 10 pounds of oxygen in order to be completely converted to its constituent elements over a period of 10 days and at a temperature of 20 degrees Celsius.

When a BOD load is put into a river or body of water, it produces a temporary reduction in the DO level of that water, as the oxygen is used up to degrade the waste. But over time, through natural aeration processes, the DO content of the water will normally recover. The DO "profile" would thus look like Figure 16-1 (where the time of discharge or point of discharge is marked *x*). This figure could represent the average DO level at various distances downstream from the point at which a BOD load is introduced, or the DO level at various times after a BOD load has been introduced into a lake. This is called a DO "sag," and illustrates the degradation process by which the water body is assimilating the BOD load. The important thing to see is that the DO reduction is reversible. It is also non-accumulative—if the BOD source were stopped, the DO sag would shortly disappear.

Early water-pollution-control efforts were centred on conventional pollutants like BOD, suspended solids, and so on, for which there are common water quality measures such as DO, turbidity, acidity, and coliform count. Attempts to reduce these pollutants were primarily through greater use of sewage treatment plants throughout the country and guidelines for discharges of these conventional pollutants into waterways. However, it became increasingly clear over the 1970s and 1980s that *toxic* pollutants had the potential to become a serious problem for the health of water ecosystems as well as of people making use of them. Toxics include heavy metals such as mercury, pesticides, polychlorinated biphenyls (PCBs), dioxins, and other industrial chemicals. Toxicity is often a matter of concentration; substances that are toxic at high concentrations may not be at low concentrations. This implies that the diluting ability of water is a valuable quality in addition to its capacity to transform degradable substances.

Figure 16-1: Dissolved Oxygen Profile in Water after a BOD Load Has Been Introduced



A time path of dissolved oxygen in water is shown after a one-time emission of a non-accumulative pollutant such as organic waste has been introduced at time *x*. The time path illustrates the assimilative capacity of water—DO first declines, then rises over time as the pollutant is neutralized.

Persistent water pollutants are those that remain for a long period of time, either because they are non-degradable or because the rate of degradation is very slow. This category includes thousands of inorganic and organic chemicals of various descriptions, the wastes of a modern, chemical-based economy. Industrial wastes contain many such persistent pollutants. Wastes from mining operations can contain various metals as well as acid-mine drainage. Agriculture is the source of a variety of pesticides, fertilizers, and soil runoff. The concept of "persistent" does not mean permanent in a technical sense; many chemicals, oils, and solvents do break down, but only over a long period of time. In the process they pose a persistent threat. Radioactive waste is physically degradable over very long periods, but measured in terms of a human scale it is essentially a persistent pollutant. Some viruses may also be in this category. Table 16-1 provides an illustration of the types of persistent contaminants found in the Great Lakes.

Table 16-1: Critical Pollutants in the Great Lakes

CATCH REVISED TABLE 16-1

Comment [NO1]: Add another source for Table 16-1 (will FAX hard copy as well): Human Health and the Great Lakes, http://www.great-lakes.net/humanhealth/fish/critical.html, accessed 10 October 2010.

Example: Trichloroethylene (TCE) in groundwater

The book *A Civil Action* by Jonathan Harr[5] (turned into a movie of the same name) tells the true story of the health impacts of a persistent water pollutant. A cluster of families in Woburn, Massachusetts discovered that many of them were ill with similar conditions (headaches, insomnia, acute tiredness, diseased organs), and that a number of their children had leukemia (16 of whom ultimately died from the disease). The probable cause of these conditions was TCE, a highly volatile liquid compound that is used to degrease metal. TCE was found in the drinking water of the community. Two companies had allegedly been dumping TCE on the ground for a number of years. The TCE percolated into the groundwater and found its way to two of the municipality's wells. The families sued the two companies, and the book details the court battle—which did not end well for the families.[6] The U.S. Environmental Protection Agency (EPA) later took action against the companies and also lowered the maximum allowable limit for TCE in drinking water.

Health Canada, Environmental Contaminants: http://www.hc-sc.gc.ca/ewh-semt/contaminants/index-eng.php

Is TCE a health threat in Canada? At least one town in Ontario thinks so. TCE has been found in the drinking water in Beckwith Township, a community 60 kilometres southwest of Ottawa.[7] The TCE has apparently come from an abandoned municipal dump and contaminates the town's drinking water obtained from a well. TCE may have been present in the drinking water for 20 to 30 years. While TCE is listed as a toxic substance on Canada's Priority Substances List and is monitored under CEPA (see Chapters 15 and 18), the federal standard for TCE is 0.03 milligrams per litre. The U.S. Drinking Water Regulations specify *zero* TCE in drinking water.

5. J. Harr, *A Civil Action* (New York: Vintage Books, 1996).

6. We won't give away all the plot details, and suggest you read the book!

7. See M. MacKinnon, "Ontario Town Fears Tap-Water Tragedy," *The Globe and Mail*, October 12, 2000, p. A7.

This case illustrates a number of points for public policy. First, this is not an isolated incident. All provinces have similar examples. Second, there can be a long lag between discharge of a pollutant and its discovery in water supplies. This knowledge gap makes it very difficult to regulate effectively with any policy instrument. Third, what is a safe level of a compound in our drinking water? Fourth, linking pollutants to sources (those responsible) can also be problematic. This makes it hard to assign liability and prove damages. Market-based policies, such as taxes, are not good policy candidates when the target level of pollution must not be exceeded. Figure 16-2 illustrates that a regulatory approach, either a ban on a compound or explicit limit on emissions is warranted when the marginal damage curve shows very adverse impacts at a particular emission level. Recall Chapter 14; if there is uncertainty about the location of the MD curve, a ban might be the optimal policy. Figure 16-2 illustrates two MD curves. If the regulator is certain that MD_1 reflects damages, then a standard set at E_1 is an appropriate policy. If however, it isn't known what the 'safe minimum level' of emissions is, for example, marginal damages could be MD_2, then a complete ban on the release of the compound is warranted.

CATCH NEW FIGURE 16-2

CATCH NEW CAPTION FOR FIGURE 16-2: A standard is set at E_1 at the point where the MD curve becomes very steep. If the location of the MD curve is not known with certainty, a complete ban on releases of the compound may be warranted because the MD curve could be as shown by MD_2.

Other policy questions to consider: Could transferable discharge permits (TDPs) be assigned in some way? Perhaps for some toxic compounds where "safe" levels of discharge can be identified? Maybe the best short-run policy is for people to protect themselves by buying household water purification equipment. Do you drink bottled water because of fears related to your water's safety, or treat the tap water in your home? These are issues to think about while examining Canadian water policy.

Canadian Federal Policies

The federal government has never played a major role in water-pollution regulation due to constitutional constraints. Its key role has been to

- introduce national standards for some compounds.
- address international and interjurisdictional water-pollution problems.
- establish national guidelines for water quality.

National Standards

The federal *Fisheries Act of 1868* was Canada's first legislation that laid a foundation for environmental regulations. A clause that banned the discharge of substances deleterious to fish has been the basis of much federal water-pollution legislation, beginning with the 1971 amendments to the Act. The discharge into any waterways of a small number of substances has been banned or limited. These include zero discharges of dioxins and furans from pulp and paper mills (see Chapter 18) and emissions from chloralkali plants, which release mercury as a by-product of their production of chlorine and caustic soda. Other regulations exist for processors of meat and poultry products, metal mining operations, and petroleum refining.

The *Fisheries Act* can thus impose a standard set at zero discharges of substances deemed deleterious/toxic. This standard is socially efficient if the marginal damage function lies above the marginal abatement cost function for all possible levels of emissions as was shown in Figure 16-2 with the MD_2 curve. Note that the MAC shown in Figure 16-2 has a positive intercept. This means that it is technically feasible to prevent the discharge of any emissions. This may not be the case in practice.

Interjurisdictional Water Pollution Policies

Federal legislation that addresses interjurisdictional water-quality issues within Canada is the *Canada Water Act*, approved in 1970. The Act had two parts. Part 1 provided funds to assist municipalities in the construction of sewage treatment plants, and to undertake research on water-quality issues. These issues are examined below. Part 2 provided for Water Quality Management Authorities to set up regional water quality boards in co-operation with the provinces, as the federal and provincial governments have shared responsibilities over water quality. These boards were to establish water-quality management plans involving boundary waters (i.e., between provinces). They also had the power to implement these plans, for example by charging fees, monitoring discharges, imposing standards, and so on. A few boards have been established for particular watersheds that cross provincial boundaries, but there is little evidence of the use of economic instruments.

Canada Water Act: **http://laws.justice.gc.ca/en/C-11/.**

Environment Canada, Water Governance and Legislation: **http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=035F6173-1**

The boards appear to have been doomed by the terms of the act. The federal government could act only when water quality had deteriorated to the point of "urgent national concern." Note here the use of the term *national concern* to elicit the federal government's POGG power. Even then, the federal government could intervene only *with the permission of the provinces.* From the provincial point of view, the act threatened their jurisdiction over environmental problems. The federal government would have the right to unilaterally address water quality issues for that region if, after signing an agreement with a province, the two governments could not agree on what standards to impose. The provinces thus felt more threatened if they agreed to joint management than if they did not. Provinces have thus set up their own regional water-quality boards, often associated with a major river; for example, the St. Lawrence River Plan and the Fraser River Action Plan. One board now exists that combines the levels of government. A master agreement for the Mackenzie River Basin came into effect in 1998 with the objective of sustainable management of the water resources. The federal government, British Columbia, Alberta, Saskatchewan, Yukon, and Northwest Territories are the signatories. Time will tell if any substantive policies emerge from this agreement.

Mackenzie River Basin Board: http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=C92D49F5-1

Part 2 of the act was used to enact the Phosphorus Concentration Regulations. This has been a successful program improving water quality in the Great Lakes. High phosphorus concentrations in the Great Lakes were a major concern in the 1960s and early 1970s. As discussed in Chapter 6, phosphorus contributes to eutrophication of lakes. Lake Erie, by the late 1960s, was choked with algae. This eutrophication was destroying fish populations and commercial fishing operations, and generally creating a very odorous lake unappealing for any uses. Phosphorus control in Canada was coordinated with that in the United States through the International Joint Commission, a binational agency that does research on boundary waters, helps resolve border disputes, and, when asked by the governments, investigates and provides policy advice on air- and water-quality issues.[8] Canadian federal regulations were introduced to limit phosphorus concentrations. Subsidies for sewage treatment plants also helped improve water quality. Lake Erie and the other Great Lakes' water quality improved considerably in a relatively short amount of time. (Recall Figure 2-7 in Chapter 2; it shows the steady decline of phosphorus in Lake Ontario since the mid-1970s.)

8. The IJC was established in 1909 as part of the Boundary Water Treaty between Canada and the United States signed in that year. It has six members, three each appointed by the federal governments of the two countries. Its Web site is www.ijc.org. The IJC operates a Great Lakes Water Quality Board. Information about it is available at their web site.

Water Quality Guidelines and Groundwater Protection

Canadians obtain their drinking water from surface water and groundwater.[9] The quality of groundwater resources has been increasingly threatened by nonpoint sources such as agricultural runoff, industrial waste, and landfill leakage. The provinces and federal government through the CCME have established guidelines for Canada's drinking water. These are not binding on any government. Provinces can adopt these or impose their own guidelines or standards. The guidelines were established in 1968 (*Guidelines for Canadian Drinking Water*). Guidelines as of 2004 are illustrated in Table 16-2 for some of the substances covered and compares them to water quality *standards* in the United States.[10] This is not the full list for either country. Note that Canada's guidelines exceed U.S. standards only for barium, fluoride, and mercury (inorganic).

Comment [NO2]: Updated Table 16-2 FAXed. New Sources for Table to read:
Canada: Adapted from Guidelines for Canadian Drinking Water, Federal-Provincial-Territorial Committee on Drinking Water, May 2008, at: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/sum_guide-res_recom/summary-sommaire-eng.pdf, accessed 8 October 2010.
United States: National Primary Drinking Water Standards, accessed at: http://water.epa.gov/drink/contaminants/index.cfm, on 8 October 2010.

9. The proportion of people in Canada consuming groundwater has more than doubled since 1960, from 10 to 26 percent. All of Prince Edward Island, parts of the Prairies, and many rural and some urban municipalities are dependent on groundwater completely or partially. Groundwater is also a source of bottled water. Ironically,

consumption of bottled water has increased in recent years because of concerns about the quality of drinking water from surface-water supplies.

[10.] Guidelines for Canadian Drinking Water, Federal-Provincial-Territorial Committee on Drinking Water, May 2008, at: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/sum_guide-res_recom/summary-sommaire-eng.pdf, accessed 8 October 2010. Health Canada notes that these guidelines are based on an intake of 1.5 litres daily by a 70-kilogram adult. Accommodations for children and pregnant women are made for some compounds.

Guidelines for Canadian Drinking Water Quality: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/sum_guide-res_recom/summary-sommaire-eng.pdf,

Table 16-2: Examples of Water Quality Guidelines in Canada and Standards in the United States

Comment [NO3]: Updated Table 16-2 FAXed. Updated Sources are in Comment NO2 above.

CATCH REVISED TABLE 16-2

CATCH REVISED SOURCE INFORMATION FOR TABLE 16-2

Sources: Adapted from Guidelines for Canadian Drinking Water, Federal-Provincial-Territorial Committee on Drinking Water, May 2008, at: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/sum_guide-res_recom/summary-sommaire-eng.pdf,

United States: National Primary Drinking Water Standards, accessed at: http://water.epa.gov/drink/contaminants/index.cfm, on 8 October 2010.

Nationwide, concern has been expressed with water quality due to deterioration of water treatment infrastructure, contamination of groundwater by toxic compounds, and nonpoint-source contaminants. Examples of how provinces have dealt with these issues appear below. U.S. examples are also provided for contrast and to highlight key points about the types of regulations in place.

Comment [NO4]: See if should reduce the US content as per the referees.

Water Pollution Policies for Point and Nonpoint Sources

Provincial Regulation

Water-quality regulation is primarily a provincial responsibility.

The first environmental legislation[11] was at the provincial rather than the federal level of government, beginning in Ontario. Regulation of water pollution began in Ontario with the creation of the Ontario Water Resources Commission (OWRC) in 1956.[12] Its mandate was to assist municipalities in financing the construction of their sewage and water treatment plants. The OWRC also had the authority to regulate direct discharges of liquid industrial and municipal wastes; that is, those not going through a sewage treatment process. By 1966, most of the other provinces had followed Ontario in setting up an independent commission to regulate water quality, although some used their provincial health departments for this task. OWRC's powers by the end of the 1960s included setting water-quality objectives and working to meet these through the licensing of polluting industries, and by using administrative orders to enforce pollution abatement requirements. The first type of policy implemented was an *emission or discharge standard* imposed in the form of a licence to emit a specific concentration of a compound. By the end of 1971, 497 industries were discharging wastes into Ontario waters under OWRC permits.[13]

11. The *Fisheries Act* was not originally designed as environmental regulation. As noted above, its first use as a legal support for federal environmental policies came in 1971.

12. Pollution-control policy is rife with acronyms. In the text we use acronyms frequently, but have also occasionally included the complete phrase as a reminder. A list of all acronyms appears at the end of the book.

13. Doug Macdonald, *The Politics of Pollution* (Toronto: McClelland & Stewart, 1991), 138.

Enforcement of the standards was negotiated. Even when charges were laid, they were often withdrawn as soon as the polluter agreed to a plan to reduce their emissions. The OWRC estimated that on average 60 percent of those regulated met the effluent guidelines.

The other provinces followed suit with water-quality objectives for a number of compounds. Many based their guidelines on U.S. standards. All provincial governments set up environment ministries in the 1970s, either as stand-alone agencies or combined with others. When environmental responsibilities were combined with ministries for natural resource management and development the potential for conflict arose between economic and environmental objectives. From the 1970s to the 1990s, all the provinces introduced environmental legislation for water pollution and some form of administrative system to deal with environmental regulations. There are few market-based policies. Rather, the provinces rely on command-and-control policies in the form of emission guidelines and standards and technology-based standards. Each province has some form of environmental regulation over water quality and drinking water. Examples of these policies are given below for point- and nonpoint-source pollutants.

Point-Source Emissions

Technology-based Standards in Ontario: The Municipal and Industrial Strategy for Abatement (MISA)

In the mid-1980s, Ontario initiated a major program to deal with all types of water pollutants: conventional discharges, toxics, metals, and organic chemicals. The goal of MISA was "the virtual elimination of toxic contaminants in municipal and industrial discharges into waterways."[14] The primary regulatory instrument is a technology-based standard. MISA is based on the federal water-pollution policy of the United States that began in the early 1970s. The U.S. has now had more than 25 years of experience with a technologically based standard that was set to eliminate pollutants from all waterways. MISA covers 60 substances released from 200 facilities in 9 sectors of the economy.[15] It took Ontario until the mid-1990s to fully implement the policy, and the process was quite expensive. Regulations were to be reviewed every five years, but it appears this has not happened. The result is that companies are typically complying with targets and standards set 20 years ago. Many companies control far more than the standards require, but if the standards are set too low to protect health and the environment, then over-control relative to MISA may be inadequate.

14. Ontario Ministry of Environment, *Municipal-Industrial Strategy for Abatement (MISA)* (Toronto: Ministry of Environment), 7.

15. See information on the Ministry of the Environment's Web site: http://www.ene.gov.on.ca/envision/water/misa/index.htm

MISA entails a significant departure from the type of regulation undertaken previously. The major change is in the regulatory instrument used. Emission and ambient standards are supplanted by limits on maximum allowable concentrations per day that are based on the technology available for pollution control from each type of source. The term used in MISA is "best available technology economically achievable" (BATEA). The intent was to base the standard on technologies for pollution control that take into account economic conditions in each industry. It is unlikely that BATEA will be socially efficient when a standard is based on what is technically feasible, rather than marginal benefits and damages. It is also unclear in practice what role economic achievability plays in establishing the standard. Economic achievability could include the same factors that are measured by the MAC curve. It may also incorporate more politically motivated factors, such as the number of jobs lost in the industry at different levels of environmental control. Without some link to MAC and MD, one cannot tell whether elimination of contaminants is socially efficient, even if it is technically feasible.

BATEAs for MISA were developed as follows:

1. Each plant in the nine industrial sectors covered monitored its effluent for 12 months to measure a wide range of contaminants.
2. Regulations were based on the data gathered and estimates of BATEA.
3. Joint technical committees consisting of government (federal, provincial, and municipal) and industry representatives reviewed the proposed regulations and made recommendations about specific standards that are BATEA.
4. Proposed standards were reviewed by a MISA advisory committee that contained industry and government people plus representatives of public interest groups. The draft regulations were released to the public for comment.
5. Enforcement activities were to be introduced to ensure that compliance occurs.
6. Over time, the standards will be tightened as technological changes permit greater control of emissions.

BATEAs have now been developed for each of the industries covered under the policy. One study has estimated MACs for the facilities regulated under MISA.[16] It found that for a number of the regulated sources MACs were far lower than expected at the initiation of the program. This was due in part to the economic downturn of the early 1990s that reduced production and hence emission levels and to lower costs for the technologies than expected. MISA is no longer a high-profile regulation in Ontario, due to political and budgetary factors.

[16.] J. Donnan (2000).

A technology-based standard (TBS) such as MISA raises many important issues and questions. These include determining

- a definition of "virtual elimination";
- rules for monitoring and interpreting the data obtained;
- which chemicals should be monitored and regulated;
- how to verify industry data;
- how to define BATEA;
- how to translate BATEA into an effluent limit;
- what to do for water bodies of very different initial water quality;
- what constitutes compliance with the regulation;
- when the regulations are to be reviewed and revised and what new compounds should be added to the initial list.

No overall assessment of MISA is available to provide analysis of these issues.[New Footnote #1] A key question is this: Have these reductions been obtained at the lowest costs to society? Examination of the economics of TBS will help illustrate some of the problems with a program such as MISA and some potential solutions.

New Footnote #1: For a critique of the MISA regulations see Alaine MacDonald and Anastasia Lintner of Ecojustice, "Summary of Concerns: Municipal-Industrial Strategy for Abatement (MISA) Regulations", January 2010, accessed at: http://www.ecojustice.ca/publications/submissions/EBR%20AfR%20MISA%20Regulation%20Summary%20of%20Concerns.pdf, on 8 October 2010.

The Economics of Technology-based Effluent Standards

How to Set the Standard

A technology-based effluent standard—or, simply, a technology-based standard (TBS)—is an effluent standard set at the level of emissions that a source would produce if it were employing a particular type of abatement technology. It would require enormous effort to establish effluent standards for each and every individual source. In Ontario, the standard was set under the MISA process. Suppose, for example, the regulator is concerned about vegetable-processing plants. This is a process that uses a large amount of water for cleaning and processing purposes; thus, the wastewater may contain large amounts of suspended solids and BOD. Table 16-3 shows hypothetical costs and emissions performance of five different technology options for plants in this industry. These are not costs and emissions for any particular plant; they are anticipated costs and emissions for a "representative" plant of each type. Each technological option refers to a particular collection of treatment equipment, operating procedures, and fuels that the plants might adopt. After having developed these estimates the Ontario Ministry of the Environment, must now choose a particular level of emissions for the standard.

Table 16-3: Estimated Total Costs and Emissions from Vegetable-Processing Plants Using Alternative Emission Abatement Technology

		Technological option				
	No control	A	B	C	D	E
Emissions (kg/kkg of raw product processed)						
BOD*	5.8	3.6	2.2	1.05	.23	0.0
TSS†	10.2	5.7	2.5	1.02	.30	0.0
Total costs ($ mil/year)	0.0	8.0	14.4	23.40	36.50	78.8

* Biochemicaloxygen demand
† Totalsuspended solids

Lower levels of emissions can be obtained with greater costs; in fact, emissions into water bodies could be reduced to zero at a very high cost. To pick one set of emission levels for the standard requires the use of some sort of criteria. It is typical in setting the regulations that the first emission level set is an interim one, followed by a stricter standard. Initially, standards would be based on the "best practicable technology" (BPT) currently available to the firms. This would be followed in later years by standards based on "best available technology" (BAT).

The determination of BPT or BAT is open to interpretation, since the notions of "practicable" and "available" are certainly not precise. "Practicable" apparently refers to technology that is reasonably well known and readily available without excessive costs. Suppose the regulator decides that technology C, with an estimated cost of $23.4-million per year, represents the best practicable technology for this type of processing industry. Then it would set emission standards at 1.05 kg/kkg for BOD and 1.02 kg/kkg for total suspended solids. All vegetable-processing plants would then be subject to this emission standard. Then it has to determine the best available technology. BAT would appear to imply a more stringent standard than BPT, since all technologies that are available are included whether or not they are practicable. But MISA also specifies that BAT has to be "economically achievable"; that is, BATEA. On this basis, technology E in Table 16-3 might be regarded as the BATEA for vegetable-processing plants. On the other hand, some (especially those in the industry) might argue that technology doesn't realistically exist, that it is too costly to be considered "available" in any economic sense, in which case D is the BATEA.

Setting technology-based effluent standards for an industry is obviously a time-consuming business. It requires large amounts of economic analysis and hinges on an agency judgment about what "available" and "practicable" mean when applied to pollution-control technology, a judgment that can be politically controversial.

Efficiency and Cost-Effectiveness of TBSs

For a TBS policy to be socially efficient, the standard must be set where MAC = MD for a given pollutant and its source. The technology-based effluent standards are designed, however, to be applied on a provincial basis. The same standards for, say, leather-processing plants will be applied to all leather plants in the province, whether they are located on a river just upstream from a large urban area or on a river in some remote part of the province. It is unlikely that MDs are identical across the province or the country, and even more unlikely that MACs are identical for all pollution sources because the imposition of a specific technology may affect firms' abatement costs quite differently depending on their size, product mix, and other factors. A totally technology-based approach to pollution control thus cannot in practice be either cost effective of socially efficient.

Cost-effectiveness examines whether we are getting the maximum effect, in terms of reduced emissions, for the money spent.

A policy will be cost-effective if it is designed so that when sources are in compliance they will have the same marginal abatement costs.

There is nothing in the logic of the TBS process that moves water-pollution sources in the direction of meeting the equimarginal condition. Figure 16-3 illustrates that a TBS will not be cost-effective when the emitters have different MAC curves. The technology standard will lead to different MAC curves, illustrated by MAC_L and MAC_H to represent firms that face different conditions in introducing the technology. With an overall standard set at $\hat{E}$, Firm L will reduce its emissions to E_L, firm H to E_H. At these emission levels, MAC_H exceeds MAC_L, thus violating the equi-marginal principle.

CATCH NEW FIGURE 16-3

CATCH CAPTION FOR FIGURE 16.3 Technology based standards are not cost effective when marginal abatement costs (MACs) differ because the equi-marginal principle is violated. Abatement costs are not equalized across emitters.

A TBS will be cost-effective only if all individual plants in each category have exactly the same marginal abatement costs.

There are thousands of individual industrial water-pollution sources, so some of the subcategories must contain very large numbers of sources. There can be little doubt that the sources in most subcategories are heterogeneous in terms of the production technology they are using, so we would expect them to be heterogeneous in terms of their marginal emission abatement costs. Applying the same emission standards to each firm cannot be cost-effective.

The cost *in*effectiveness of equal treatment-type programs like TBSs has been examined directly in a series of river basin studies in the U.S. carried out by teams of economists and environmental scientists. These use large-scale models of individual river basins, incorporating the different estimated marginal abatement costs of various sources of pollution, together with the main hydrological features of the basins' water resources. They compare the costs of water pollution-control programs in which all sources were treated alike to those where sources are controlled in accordance with relative marginal abatement costs.

Example of cost-ineffectiveness of TBS: A Case Study of the Delaware River

While done many years ago, this very well known study is still relevant today as it clearly illustrates how cost-ineffective TBSs are. The lower Delaware River runs through the heavily industrialized sections around Philadelphia and southwestern New Jersey, then opens out into the broad and shallow Delaware Bay. Wastewater emissions contribute to serious water-quality problems in the estuary, both in the traditional measures of dissolved oxygen (DO) and in other types of organic and inorganic wastes. Investigators used a water-quality model that predicted the effects of changing waste loads in any part of the estuary on water quality elsewhere in the estuary. Superimposed on this was a mathematical model showing the relationship of abatement costs at any of the large effluent outfalls on the estuary to emission levels at those outfalls. By operating these models together researchers could estimate the costs of meeting water-quality goals by controlling emissions at each of the various sources.

The main results are summarized in Table 16-4. These show the abatement costs of reducing BOD emissions from sources on the Delaware estuary so as to achieve given target levels of DO in the waters of the estuary.[18] The exact levels of costs are not as important as the comparison of different types of policy approaches. The table shows two alternative target levels, one at 2 parts per million (ppm) and a higher one at 3–4 ppm of DO. To meet the lower DO target with a uniform treatment approach (reducing emissions at each source in the same proportion) would have cost $5-million per year. The costs of an equal treatment program attaining DO levels of 3–4 ppm would have cost an estimated $20-million annually. Thus MAC curves are an increasing function of emissions controlled.

18. Administrative and enforcement costs are not included in the table.

Table 16-4: Summary of Results of the Delaware Estuary Water Quality Control Study

DO objective	Uniform treatment program	Least-cost program	Effluent charge program	
			Single	Zoned
	Million Dollars per year			
2 ppm	5.0	1.6	2.4	2.4
3–4 ppm	20.0	7.0	12.0	8.6

Source: *Allen V. Kneese and Blair T. Bower,* Managing Water Quality: Economics, Technology, Institutions *(Baltimore, MD.: Johns Hopkins Press for Resources for the Future, 1968), 162.*

The same DO targets could be reached at much lower cost by reducing emissions in a cost-effective way. The costs of a program designed to meet the targets with a set of emission controls satisfying the equimarginal principle were $1.6-million for 2 ppm and $7.0-million for 3–4 ppm DO. Note that these costs are roughly one-third of the costs of the uniform treatment program.[19]

To impose a least-cost approach by specifying allowable emissions at each source would, of course, require an administering agency to have an enormous amount of knowledge about marginal abatement costs at each of the sources. Alternatively, authorities could achieve cost-effective emission reductions by imposing an effluent tax on emissions.

19. Similar results have been obtained in other studies; for example, for the Willamette River: Kenneth D. Kerri, "An Economic Approach to Water Quality Control," *Journal of the Water Pollution Control Federation* 38(12) (December 1966): 1883–1897; the Miami River in Ohio: M. W. Anderson, "Regional Water Quality Management in the Miami Basin" (Ph.D. thesis, Carnegie Mellon University); and the Merrimack Valley of Massachusetts: Alvin S. Goodman and William Dobbins, "Mathematical Model for Water Pollution Control Studies," *Journal of the Sanitary Engineering Division, Proceedings ASCE* 92[SA6], (December 1966): 1–9.

Researchers investigated several approaches to emission taxes in the Delaware study. One was a single emissions tax (in this case a single tax on BOD emissions) levied on all sources throughout the estuary. The annual costs of this single tax approach were estimated at $2.4-million for the 2 ppm target and $12.0-million for the target of 3–4 ppm. Why aren't the costs of the single emissions tax as low as the least-cost program? The simple answer is that the MD curve varies with the location of the polluting sources. The polluters have different transfer coefficients with respect to the various points where water quality was measured. Recall from Chapter 12 that when the MD curves differ, a single emissions tax will not be socially efficient (although it is cost-effective). A unique effluent tax would have to be levied on each source, taking into account both its marginal abatement costs *and* its location relative to other sources. Of course, this would be a totally unrealistic administrative burden, given the hundreds of different BOD sources on the Delaware estuary. There is a trade-off, in other words, between lower control costs on one side and administrative complexity on the other.

As discussed in Chapter 12, one answer to this is to institute a zoned emission tax. Here the sources are grouped into zones, and all sources in the same zone are charged the same tax, while sources in different zones are taxed at different rates. In the Delaware estuary study, the zoned emission charge has the same annual costs as a single tax approach for the lower DO target, but is substantially less costly for the higher DO target of 3–4 ppm. What this shows in effect is that the larger the improvement we want to achieve in water quality the greater the difference it makes to have a cost-effective program. For targets involving small changes in water quality, a TBS may not be a bad approximation to a fully cost-effective and socially efficient policy. But for targets involving large changes, the TBS will be very cost-ineffective.

TBSs and Technological Improvements

Chapter 12 showed that emission standards lead to weaker incentives to innovate in pollution control than economic-incentive-type policies.[20] In the case of TBSs, incentives are made even weaker by linking the emission standards to particular control technologies. When polluters are faced with this type of technology-linked standard, compliance tends to become a matter of adopting the technology the authorities have used to set the standard. Since permanent emissions monitoring is quite costly, administering authorities can check compliance by making periodic inspections to ascertain whether sources are using approved emissions-control technology. In order to minimize the risk of being penalized for non-compliance, polluters have the incentive to adopt the particular technology that the government used to establish the standard. The result is that although the TBSs are nominally just emission standards, they end up tending to dictate the particular effluent control technologies chosen by firms. This substantially undermines any incentives to search for other, cheaper ways to meet the standards.

[20.] Also recall that a TBS can lead to high costs of compliance when a polluter must switch its existing pollution control technology to the one designated in the regulation. Moreover, if the regulator wants to make the policy more stringent over time, it must require how the pollution abatement equipment has to be upgraded or modified to meet increasing standards. This, too, can lead to very high costs of meeting an environmental target.

There is another dimension to these incentive effects. *It is vitally important in designing a pollution-control program to place the control on the right element in the total input–production–emission process*. This goes for any program, whether it uses standards or an incentive approach. The technology-based standards in water pollution control are normally expressed in terms of quantity of emissions per unit of raw material input used in production. But the real pollution-control issue is the total quantity of emissions during a given time period. The connection between these two factors can be shown as follows:

Total emissions = output × [input/output] × [emissions/input]

TBSs apply only to the last expression in this equation. Another way for a firm to reduce its total emissions, however, is to reduce its use of inputs per unit of output; for example, by installing more efficient production equipment or better operating procedures. Still another way of reducing total emissions is to reduce total output, the first term in the expression above. For example, electric power companies can reduce total emissions by promoting energy conservation among their customers. The basic problem, as we can see from the formula, is that the incentive has to be put on the right thing. In this case, expressing the standard in terms simply of total emissions would at least provide incentives to make improvements in all the factors of the equation, not just the last one.

Emissions Permits and Trading in U.S. Water Pollution Control

In recent years, the United States has adopted some innovative programs that try to build in flexibility and adaptability to local conditions. Most have been based on emission permit trading among sources on particular bodies of water. The localized scope of these new programs is appropriate. Most water-pollution problems are local in nature; they centre on the water quality problems of particular rivers or lakes that result from the waste-disposal activities of a geographically limited group of polluters. So it stands to reason that localized programs, on the level of a single river basin or lake or bay, can be designed to take advantage of local conditions in a way that a nationally mandated, technologically oriented policy cannot. As people gain more experience with these new types of programs, we will undoubtedly see a lot more of them, especially if the hoped-for cost savings materialize. Canadian policy-makers can learn from the example noted below.

Example: Emissions trading among point- and nonpoint-source polluters in the United States

The best-developed trading program involves the Dillon Reservoir in Colorado, which is a major water source for Denver. In the early 1980s it was recognized that phosphorus loadings in the reservoir were causing water-quality problems. While some of the phosphorus was of natural origin, about half was from human activity. Somewhat more than half of this was from nonpoint sources—urban runoff, golf courses, construction sites, septic tanks, and so on. The rest was from four municipal waste treatment facilities. A policy designed to control only point-source emissions would still lead to eutrophication; even if municipal phosphorus emissions were reduced to zero.[24] Besides the very high direct abatement costs it would require, this would severely constrain future population growth in the county, which in the 1970s was the fastest growing county in the country.

The answer has been to initiate a phosphorous trading program among point and nonpoint sources of phosphorus. The program allocated baseline phosphorous loads to different polluters and then allowed phosphorous emission permits to be traded. The intention is to allow point sources, especially the municipal treatment plants, to buy phosphorous emission permits from nonpoint-source polluters whose marginal phosphorous abatement costs are lower. Those responsible for nonpoint-source emissions have a variety of means available to reduce their phosphorous loadings, such as sewering housing developments that are now using septic tanks, routing underground storm sewers through a series of storage tanks, and using detention basins. The trading program requires that administrative authorities be able to monitor the nonpoint-source emissions at reasonable cost. Trades have been made and the cost savings from using a TDP system may exceed $1-million a year. Similar point/nonpoint-source trading programs have been initiated in the Cherry Creek reservoir of Colorado and the Tar-Pamlico basin of North Carolina. The idea is also being explored in other regions.[25]

[24.] Lane Wyatt, *A Basinwide Approach to NPS Management* (Northwest Colorado Council of Governments, n.d.).

[25.] David Letson, "Point/Non-Point Source Pollution Reduction Trading: An Interpretive Survey," *Natural Resources Journal* 32(2) (Spring 1992): 219–232.

Municipal Sewage and Water Treatment

Municipalities are responsible for the construction and operation of sewage and water treatment facilities. Gradually over the 1970s and 1980s the proportion of municipal wastewater that is untreated fell from more than 50 percent to less than 20 percent. However, Canada may well be entering a "crisis" stage in water and sewage treatment. Many wastewater treatment plants need replacement and upgrading of treatment capabilities (which is why this was an example in the benefit–cost chapters). These are typically very capital-intensive operations, and continue to represent a large percentage of total (all levels) government environmental expenditures. The federal and provincial governments used to contribute financially to construction of these plants; the federal government under the *Canada Water Act of 1970*, the provinces in block grants to the municipalities. The federal government no longer provides grants to municipalities and many provincial governments have sharply curtailed their funding of treatment plants. As a result, Canadian municipalities may operate equipment that is inadequate for its job. This can endanger health and affect ecosystems, as an example below illustrates. Municipalities are looking for new ways to fund treatment plants and to reduce the pressures on the system by reducing water use. Economic incentives might provide some help.

Many municipalities continue to charge flat rates for water consumption and sewage services. In 2004 (most recent year of data) Canada as a whole had approximately 63percent of its municipal population on water meters. When people are charged per unit of water consumed, total water consumption is substantially less than that for people who pay flat rates independent of water use. For population centres with more than 20,000 people, those with meters consumed approximately 250 litres of water per capita per day. Those without meters consumed around 400 litres per capita per day—over 60 percent more![23] Another study of Canadian water use, found metered homes used 34 percent less water than those without meters. [New Footnote #2] Unit pricing alone won't solve the financial difficulties of providing for sewage and water treatment, but it is a step in the right direction.

[New Footnote #2]: Ken Sharrett "The influence of Water Meters on Residential Use in Canada", June 2001, accessed at http://www.sharrattwatermanagement.ca/pdfs/Sharratt-Influence_Meters.pdf, on 8 October 2010.

[23.] Environment Canada, *The Urban Environment: Water Supply*, State of the Environment Reporting, Environmental Indicator Bulletin No. 93-8 (1993), 4.

Nonpoint-Source Emissions

Nonpoint-source (NPS) emissions account for a substantial amount of the water pollution in Canada. As noted in Section 1, BOD, suspended solids, phosphorus, and nitrogen come from nonpoint sources. Similarly, nonpoint sources contribute large amounts of toxic pollutants to water resources. Major nonpoint sources are agricultural runoff, urban street runoff, and activities related to land clearance and building construction. Canadian policy is predominantly at the provincial level except when nonpoint sources cross provincial or national boundaries, as was the case with phosphorus regulations examined above. This reflects the recognition that a uniform national program cannot address such diverse sources with significant differences in MACs and MDs across each country.

The fact that NPS emissions are diffuse and not concentrated into specific outfalls has made them very difficult to control. NPS pollutants are also normally very weather-related, which makes the runoff patterns more difficult to monitor. Traditional approaches like emission standards are problematic because it is difficult to measure emissions accurately. Emissions taxes would run into the same problem. Taxes could be applied to those activities or materials that lead to the emissions, rather than the emissions themselves. For example, taxes might be put on fertilizer used by farmers, or on lawn chemicals used by suburban dwellers. The objective in this case is to induce a reduction in the use of materials that may ultimately end up in rivers, lakes, or groundwater aquifers.

TBSs that specify technologies or practices that must be followed are commonly used in Canada. Standards that rule out agricultural cultivation on steep, easily eroded land, standards specifying the design of urban storm sewers, and standards requiring home builders to take certain steps to control construction-site runoff are types of design standards. Regulations also prohibit the discharge of oil by motor vehicle repair shops into sewers. This is an example of a practice that is regulated. While TBSs may be seen as one of the only options in the case of NPS emissions, one should keep in mind all difficulties inherent in their use that were examined above. Difficulties of control explain why NPS pollution has not been addressed as vigorously in the past as point-source emissions, despite their importance.

In many areas of each country point sources and nonpoint sources exist in close proximity, essentially contributing to the same water-quality problems. The equimarginal principle would require the control of point and nonpoint sources to be balanced so that the marginal emission reduction costs are the same in the two cases. Historically, however, point sources have been controlled much more vigorously than nonpoint sources. What this means is that there may be many regions of the country where shifting more of the burden onto nonpoint sources would be an effective way of lowering the costs of water-quality improvements. One way of doing this is the trading of emission reduction credits between point sources and nonpoint sources as was illustrated above in the Dillon Reservoir in the United States.

Canadian provinces are responding to the increased awareness of the environmental damages from nonpoint sources and public pressure to ensure safety of drinking water resulting from recent cases of water contamination. Ontario announced plans in June 2001 to bring in regulations governing runoff of manure and other farm fertilizers. The regulations planned are TBSs that cover agricultural practices, focusing particularly on storage of waste and the use of manure on fields.[26] The regulations will be phased in over a five-year period. The proposed regulation follows one of the most publicized Canadian cases of drinking water contamination—bacterial contamination in Walkerton, Ontario. The case illustrates a number of points including the importance of having effective policies to deal with nonpoint sources as well as ensuring compliance with drinking-water standards and establishing policies to transmit important public-health information.

[26.] See R. Brennan, "Ontario Farm Runoff Bill Won't Take Effect for Years," *Toronto Star*, June 14, 2001, p. A8. Other provinces, for example British Columbia, already have similar policies in place.

Case Study: E. Coli Contamination in Walkerton, Ontario.[27]

In mid-May of 2000, people in the small town of Walkerton, Ontario starting falling ill. This wasn't just a few sick people: close to half of the town's 5,000 residents had acute gastroenteritis, with varying degrees of bloody diarrhea. Seven people died.[28] The culprit was the *Escherichia coli* bacteria (E. coli for short) number 0157:H7, one of the most dangerous forms of the bacteria, which had contaminated the town's drinking water. The E. coli apparently came from a nonpoint source—runoff of manure from a dairy herd during a time of heavy rainfall, which flowed into the town's well. The contamination was detected in a sample sent for monitoring prior to the townspeople falling sick, but the local official in charge of the town's water supply did not warn the public or take sufficient action to control the contamination. The town's chlorination equipment had failed and nothing was done to repair it. The private lab that did the monitoring notified the Walkerton water authority—not the Ontario Ministry of the

Environment regulators, who are charged with overseeing water quality for the province, or the chief medical officer for the region.

[27.] Two good sources for details on Walkerton from which the facts of this case have been taken are the *Toronto Star*'s Web site: http://king.thestar.com/editorial/walkerton and the official Web site for the Walkerton inquiry: www.walkertoninquiry.com.

[28.] Ontario's chief coroner attributed seven deaths to the E. coli. However, a total of 21 people from the town died during the outbreak and, while E. coli may not have been the direct cause, it may have been a contributor.

Provincial regulation requires that the lab report contamination to the environment ministry, but does not require notification of the chief medical officer. It was the medical officer for the region who raised the first public alert after he received a report from an alarmed physician treating one of the sick children that she suspected E. coli. The medical officer obtained a water sample and sent it in for testing. When the results came back positive for E. coli 0157:H7, he called the provincial ministry. A "boil water" advisory was issued one week after the first cases emerged and one day before the first death.

The *Canadian Drinking Water Guidelines* discussed above specify zero E. coli in Canadian drinking water. The province of Ontario requires every municipality to regularly monitor its water quality. So what went wrong in Walkerton?

The Walkerton Inquiry: www.attorneygeneral.jus.gov.on.ca/english/about/pubs/walkerton

Several public inquiries followed the Walkerton incident. Blame has been put on the local and provincial governments and the individual in charge of the water supply in Walkerton. Issues highlighted include

- inadequate provincial regulation to help protect drinking-water supplies. For example, prior to Walkerton, Ontario's government did not have an effective policy to help protect water supplies from farm runoff.
- failure of the municipality to ensure compliance with water-quality guidelines and to ensure public safety.
- downsizing budgets for water quality infrastructure, monitoring, and enforcement.
- Ontario's privatization of water-quality monitoring without ensuring that checks and balances were in place to ensure transmittal of information about hazardous contamination.
- inadequate training and education of municipal water officials.
- no checks to see that municipal officials are complying with regulations.
- inadequate budgets to ensure local water treatment plants are operating properly and are maintained, with old or malfunctioning equipment replaced.

Many believe that Walkerton was a disaster waiting to happen. E. coli had been a problem in the system for at least four years, yet the public was never informed by municipal authorities. The operator of the water treatment plant had no formal training for his position, and it is alleged that he did not think chlorination was essential (he didn't like the taste). False samples were sent in for testing. He failed to inform either the province or the medical officer of health about the contamination. The town of Walkerton had also declined to let the Ontario Clean Water Agency, the provincial Crown corporation, come in and operate their system. This agency operates more than 400 facilities for 200 municipalities in the province. Walkerton also failed to authorize increased spending on its antiquated water treatment system, citing too few municipal funds. Municipal water fees collected each year did not even cover the operating costs of the system, let alone provide for capital replacement. The town tried unsuccessfully to get provincial assistance for upgrading its water system.

The Ontario government failed to implement a policy to protect groundwater sources of drinking water, as repeatedly requested by its own environmental commissioner (who was fired in 1999) and strongly suggested by the federal government. During the "Common Sense Revolution" under Premier Mike Harris, the environment ministry's budget was severely cut, the province's three testing labs were closed, and municipalities had to turn to private labs for tests. There was no requirement that these labs have any sort of accreditation for the tests they performed. While in the case of Walkerton, the lab test performed did correctly indicate the presence of the toxic E. coli, this does not mean that an error could not occur in some other instance due to substandard procedures of an uncertified laboratory. The labs were required to inform the environment ministry of cases of contamination, but no enforcement of this regulation occurred. Labs were not required to report to health officials. The government eliminated grants to municipalities for replacing or upgrading their water (and sewage) treatment plants in 1996. It reintroduced a small grant pool of $200-million in 1997. Its own environment ministry had estimated in 1992 that $19-billion was needed over the next decade to replace and upgrade water and sewage systems province-wide.

In August 2000, Ontario issued new drinking water regulations. The regulations cover such items as minimum treatment levels, sampling, reporting, public information, corrective actions, and notices to medical officers of health. In September 2000, the Ontario environment minister announced the formation of a pollution SWAT team to apprehend and charge those who violate provincial regulations with the "toughest fines and largest jail terms in Canada."[29] Many observers believe that the timing of these announcements is not a coincidence, but rather tacit acknowledgement by the Ontario government that it did not meet is regulatory role to help ensure safe drinking water in the province. Some of the policies announced may be somewhat hasty and not consistent with sound economic principles. For example, are the pollution SWAT team, high fines, and jail terms the most cost-effective policies to promote compliance with regulations, or would other incentive-based policies be better?

[29] See the Ministry's announcement of these new initiatives at www.ocwa.com/frpub.htm or www.ene.gov.on.ca.

What lessons can we draw from this case? Walkerton may have been an extreme situation that may never be repeated again, but there are many other parts of Canada with water-quality concerns. For example, a number of municipalities in British Columbia and many areas in Newfoundland are under continual "boil water" advisories due to microbial contamination. Collingwood, Ontario had its water supply contaminated by a parasite, Cryptosporidium, for a number of weeks. North Battleford, Saskatchewan had an E. coli outbreak in its water supply in 2001. Contamination of groundwater plagues parts of the Maritime and Prairie provinces. The case also illustrates the complexity of command-and-control regulation required to ensure drinking-water safety and the importance of monitoring and enforcing for any environmental policy, whether command-and-control or incentive-based.

Questions to ponder:

- Are water-quality guidelines enough?
- What sort of regulatory policies should be adopted now?
- Would any policies using economic incentives be appropriate?

SUMMARY

Canadian environmental regulation is a complex mix of federal and provincial policies that rely primarily on command-and-control instruments in the form of guidelines and objectives. There are few specific standards. Co-operation among the levels of government and between government and industry is sought. Public involvement has been minimal until recently. Most water-pollution policies are at the provincial level. The federal government has introduced national standards for some compounds, addressed some interjurisdictional water pollution problems, and established national guidelines for water quality. Water quality is a problem in parts of Canada and new policy initiatives are needed both federally and provincially to address the problems.

Technology-based standards are examined in detail, as they are the most commonly used policy in Canada. While TBSs are appealing as "technological fixes," they have a number of drawbacks. They are likely to give far less pollution control for the money spent than alternative approaches, because they normally violate the equimarginal principle. They provide fewer incentives than other policies to find better and cheaper ways of controlling waterborne emissions.

KEY TERMS

ANALYTICAL PROBLEMS

1. Controlling the pollutants from the production of bleached paper is about five times costlier than controlling the pollutants from unbleached paper. Illustrate this situation graphically using our standard MAC/MD model. What policy instrument would you use for these water pollutants coming from paper production and why? Specify the criteria you have used to pick the policy.

2. The federal government imposed regulations limiting phosphate emissions to the Great Lakes. Could they have used a tax on phosphates instead? Could the tax have led to an equivalent improvement in water quality at lower total costs to society? Discuss and consider the pros and cons of using a tax in this case.

3. For the Delaware estuary example, illustrate graphically the different pollution policy options presented in Table 16-4. Show which are socially efficient, cost effective, and explain why. Which policy would you recommend adopting and why?

DISCUSSION QUESTIONS

1. Most technology-based effluent standards have focused on “end-of-pipe” treatment technology. What is the reason for this, and what has been the likely impact?

2. Water pollution has been dealt with primarily by the provinces. Would you advocate a larger role for the federal government? If so, what types of policies would you recommend? If not, how do you think water-quality objectives for our major interprovincial waterways, such as the St. Lawrence River, should be achieved?

3. To date, there have been few Canadian policies dealing with water-pollution problems stemming from nonpoint-source emissions. Why is this the case? How might the different types of pollution-control policies be employed in the case of nonpoint-source emissions?