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Environmental Management and Technologies in the Business Sector

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Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
e	estimate
p	preliminary figures
r	revised figures
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
E	use with caution
F	too unreliable to be published

Preface

Federal and provincial governments are increasingly interested in understanding business practices regarding the environment in order to develop policies aimed at promoting pollution prevention or eco-efficiency. Such practices may range from the adoption of international environmental management standards such as ISO 14000 and green procurement policy to recycling, energy conservation and use of specific technologies to reduce contaminants.

Environmental Management and Technologies in the Business Sector presents, for the first time, an overview of business environmental practices and technologies from the *Survey of Environmental Protection Expenditures*. Section 1 outlines broad environmental management practices employed by primary and manufacturing industries. Section 2 presents an overview of pollution prevention activities of businesses. Section 3 focuses on the business use of specific environmental technologies.

Beginning with the 1998 reference year, the *Survey of Environmental Protection Expenditures* has been changed from an annual to a biennial survey, partly in an effort to reduce response burden.

Additional information on the expenditures made by businesses for a variety of environmental activities is available in *Environmental Protection Expenditures in the Business Sector, 1998.*[1] This report presents statistics from the *Survey of Environmental Protection Expenditures* on capital and operating expenditures made by businesses in order to anticipate or to respond to an environmental regulation, environmental convention or voluntary agreement.

The data presented in this report do not reflect the **1999 Nunavut boundaries** since all data refer to the period before April 1, 1999. Therefore, where data on the Northwest Territories are shown, these data refer to the Northwest Territories (including Nunavut), as defined before April 1, 1999.[2]

1. Catalogue No. 16F0006XIE, November 2001, available free of charge on Statistics Canada's web site (www.statcan.ca).
2. On April 1, 1999 the Territory of Nunavut was officially established through the **Nunavut Land Claim Agreement** and the **Nunavut Act.**

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The cooperation of survey respondents were critical to the successful completion of this publication and are gratefully acknowledged.

Funding for the *Survey of Environmental Protection Expenditures* was provided in part by Natural Resources Canada through the Policy Research Initiative and Industry Canada through the Action Plan 2000 on Climate Change.

This report was prepared by the Environment Accounts and Statistics Division under the direction of Claude Simard, Director and Alice Born, Chief, Environmental Protection Accounts and Surveys. Data collection for this survey was conducted by the Operations and Integration Division.

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Introduction and Highlights

Introduction

Environmental Management and Technologies in the Business Sector is an analytical report that features detailed information on environmental management practices and pollution prevention activities undertaken by business and the specific technologies used to achieve environmental goals. This report is complementary to *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised),* as well as *Environmental Protection in the Business Sector, 1998*[1].

Since 1994, the *Survey of Environmental Protection Expenditures* (SEPE) has collected statistics on the capital and operating expenditures of business establishments on various types of environmental goods, services and activities (e.g., site reclamation, end-of-pipe processes, and integrated process changes). The SEPE has shown that gradually businesses have moved from large investments on end-of-pipe processes toward investments on integrated processes and other pollution prevention practices.[2] This shift has been recognised by the Federal Government. Indeed, one of the main features of the new *Canadian Environmental Protection Act*, passed into legislation in 2000, is the promotion of pollution prevention.

The 1997 SEPE broadened the coverage and the scope of environmental projects in order to get a more complete profile of business environmental practices and of the apparent shift from pollution abatement to pollution prevention. In addition, the SEPE was modified to capture statistics on resource conservation and renewable energy technologies as part of a project to provide federal government departments with improved measurements of the use of resource conservation and renewable energy technologies. *Environmental Management and Technologies in the Business Sector* provides an overview of the following new or improved features contained in the 1997 and 1998 SEPE:

- Environmental management practices such as environmental management systems, environmental certification programs (e.g. ISO 14000), participation in an environmental voluntary program, eco-labelling of products, and use of life cycle analysis (Section 1);
- Pollution prevention methods such as product design, modification of production processes, recycling, energy conservation, substitution of solvent or material and prevention of leaks and spills (Section 2);
- Technologies used for pollution prevention and abatement: gas and liquid waste treatment, solid waste management, site reclamation and decommissioning, reduction of noise, vibration and radiation, and energy conservation (Section 3)[3].

This report is a national study. It is an introductory tool to help policy-makers, producers of environmental goods and services and academics to identify measures that businesses adopt to improve their environmental performance. It can be used to understand the characteristics of business demand for environmental technologies. Businesses can also use the report to benchmark their environmental actions with those of the rest of the industry. Readers are invited to provide comments and feedback on the information presented in this report.

Highlights

- Establishments are involved in a variety of environmental management practices. For instance, 64% of establishments that responded used an environmental management system in 1998. This figure was even higher (over 80%) in the Oil and Gas Extraction, Natural Gas Distribution, and Pipeline Transportation industries. More than one third of establishments participated in environmental voluntary programs although there were significant variations in participation depending on the industry. Almost 34% of establishments reported producing an environmental performance report (Tables 1.1 and 1.2).
- Recirculation, recovery, recycling or reuse was the most widespread pollution prevention method used by establishments (66% of all establishments reporting). Almost 60% of establishments reporting indicated they took measures to prevent leaks and spills in 1998. Over 90% of establishments in Pipeline Transportation and over 80% of establishments in Logging, Oil and Gas Extraction and Electric Power Generation, Transmission and Distribution used this pollution prevention measure. Fifty-three percent of establishments planned to use energy conservation in 1999-2000. The use of this method has increased steadily since 1995 (37%) (Table 2.1).

1. These reports are available free of charge on Statistics Canada's Website (www.statcan.ca).
2. The sole purpose of end-of-pipe processes is to abate or to control undesirable substances resulting from production. In contrast, modifications to integrated production processes (for environmental purposes) are one example of pollution prevention practice. For more information, please see Section 2 - **Pollution Prevention Methods**.
3. Section 3 of the report contains1998 reference year data only. The survey question related to the use of specific environmental technologies and processes used by business was added to the SEPE for the first time in 1997. Concerns regarding the quality of the 1997 results, and the marked improvement in data quality in the 1998 reference year, has led Statistics Canada to restrict the data to 1998 results (please see Section 4 - **Concepts, Methodology and Data Quality**).

- Almost 87% of all establishments reported using a process or technology to manage solid waste, and close to three-quarters of establishments indicated they treated liquid or gaseous wastes. Just under 65% of establishments indicated they used an energy conservation process in 1998. (Section 3).
- Overall, more respondents were using these five environmental technologies or processes than any other listed: solid waste management by container (68%); followed by energy efficient equipment (44%); the physical treatment of noise using mufflers (37%); the physical treatment of gas by bag house (34%); and finally, the physical treatment of gas by gravity deposition dust collector systems.
- While close to half of the respondents indicated they used energy efficient equipment in 1998, between 10 and 20 percent indicated they used waste-to-energy systems, fuel substitution, clean fuel systems or other energy conservation methods.

1 Environmental Management Practices[1]

Businesses may be involved in various environmental management practices aimed at achieving global and/or specific environmental goals. These practices are designed to take into account environmental issues or the impact of their activities on the environment in their day to day operations. Examples of environmental management practices range from the implementation of specific management tools to participation in national and international environmental initiatives and programs.

A process is a series of operations while a practice is an applied action.

The 1998 *Survey of Environmental Protection Expenditures* (SEPE) included a question on environmental management practices adopted by industry (Text Box 1.1). The information provided by this question will track the progress of industry in implementing environmental management practices such as environmental management systems, ISO 14000 certification, and participation in voluntary programs.

In 1998, almost 1 500 establishments answered the question on the type of environmental management practice they used, representing close to 80% of all establishments that were sent a questionnaire.[2] Slightly less than 82% of the establishments that provided a response indicated they used at least one environmental management practice (Table 1.1). The most common practice was the use of an environmental management system (64% of establishments representing 79% of the employment share), followed by the participation in an environmental voluntary agreement (37% of establishments representing 58% of the employment share) and the publication of an environmental performance or sustainable development report (34% of establishments representing 52% of the employment share).

In many cases, establishments that indicated they used environmental management practices listed in the *Survey of Environmental Protection Expenditures* were likely to use more than one. For example, if an establishment had obtained, or was in the process of obtaining, ISO 14000 certification (for a description, see **ISO 14000 certification** on page 4), it was likely that it would also report using an

1. Includes reported data only.
2. See Text Box 1.1, **Environmental Management Practices and Comparability of 1997 and 1998 Results.**

Text Box 1.1

Note to Readers: Environmental Management Practices and Comparability of 1997 and 1998 Results

For the first time, *Survey of Environmental Protection Expenditures* included a question on environmental management practices for the 1997 survey year. Respondents were asked to report on the following[1]:

- does the establishment use an environment management system?
- is the establishment ISO 14000 certified or equivalent?
- has the establishment implemented any environmental voluntary initiative or participated in any voluntary environmental program?
- does the establishment have a "green" procurement policy?
- are any goods produced by the establishment certified by an environmental program, such as "Eco-Logo"?
- has the establishment published an annual report on environmental performance or sustainable development?
- does the establishment use life cycle analysis for decision-making?

Readers should be aware that the 1997 and 1998 estimates provided represent reported data only. No estimation was done for non-response and non-surveyed establishments. The 1998 SEPE realized a significant increase in the response rate for the question on environmental management practices over 1997. There was an associated increase in the quality of the 1998 estimates. Therefore, comparisons between 1997 and 1998 provide a general view but should be treated with caution.

In 1997, approximately 1 000 establishments answered the question on the type of environmental management practice they used. This represented 62% of all establishments that were sent a questionnaire. In 1998, the number of establishments that answered the question rose to almost 1 500, representing close to 80% of all establishments that were sent a questionnaire. The 1997 tables are provided in the Annex at the end of this report.

1. This question was also asked in the 1998 *Survey of Environmental Protection Expenditures*. For further detail, please see *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised)*, and *Statistics Canada, and Environmental Protection Expenditures in the Business Sector, 1998***,** Statistics Canada, Catalogue no. 16F0006XIE (available on Statistics Canada Web site www.statcan.ca).

environmental management system or life cycle analysis, both of which are components of ISO 14000. If an establishment had adopted a "green" procurement policy, or had eco-labelled its products, the establishment was most likely to have used life cycle analysis to assist in the development of its environmental policies and environmentally-sensitive products.

Environmental management system

The Standards Council of Canada defines an environmental management system as "a management structure that allows an organisation to assess and control the environmental impact of its activities, products or services".[1] According to the Standards Council of Canada, an environmental management system has six key elements:

- develop and establish an environmental policy;
- environmental impact planning;
- development of processes and practices to reach environmental goals and objectives;
- monitoring and measurement system to assess if goals and objectives are being met;
- develop a management review process;
- continual improvement.

Overall, almost 64% of the establishments (79% of the employment share) indicated they employed an environmental management system at their establishment[2] in 1998 (Table 1.1). However, the use of an environmental management system varied among industries. For example, over 90% of (responding) establishments in the Natural Gas Distribution and Pipeline Transportation industries indicated that they employed a system, followed by Oil and Gas Extraction (88%), compared to 50% in the Wood Products and Food industries (Table 1.2).

On a provincial basis, Newfoundland and Labrador (78%), Alberta (75%) and New Brunswick (74%) reported the highest environmental management system participation rate while Prince Edward Island (50%), Quebec (54%) and Nova Scotia (55%) reported the lowest (Table 1.3).

Life cycle analysis

Life cycle analysis or assessment (LCA) is a tool used to identify and measure direct and indirect environmental, energy and resource impacts associated with a product, process or service through its design, production, usage and final disposal.[3] This type of analysis originated from the global modelling studies and energy audits of the late 1960s and early 1970s. It has grown in importance as environmental awareness on the part of governments, industry and the public has increased.[4]

Approximately one-fifth of the reporting establishments indicated that they used life-cycle analysis for decision-making in 1998 (Table 1.1). These establishments were generally larger (based on employment), representing 32% of the total employment of all establishments reporting. Establishments in the natural resource sector generally reported the highest use of life cycle analysis. For example, over 50% of the establishments that reported in the Petroleum and Coal Products industry indicated they used life cycle analysis, followed by the Oil and Gas Extraction (47%) and Pipeline Transport (43%) industries (Table 1.2).

Not surprisingly, given the significance of these industries in that province and territories, Yukon and Northwest Territories (38%)[5] and Alberta (30%) had the highest percentage of establishments indicating they used life cycle analysis, followed by Manitoba (22%) and Ontario (22%) (Table 1.3).

ISO 14000 certification

ISO 14000 was developed by the International Organization for Standardization as an internationally-recognized set of standards and guidelines primarily concerned with environmental management systems. The goal of ISO 14000 is to "ensure a product will have the least harmful impact on the environment, either during production or disposal, either by polluting or by depleting natural resources."[6] These guidelines are an environmental management system based on three sets of tools: 1) life-cycle analysis of products and services,[7] 2) environmental performance evaluation, and 3) environmental labelling of products and services.[8] Using the ISO 14000 guidelines yields a number of benefits, from waste minimization to energy savings, while offsetting the costs of reducing environmental impacts.

1. Standards Council of Canada, *Questions and Answers About ISO 14000,* <www.scc.ca/standards/iso14000/infobref_e.html>, (accessed March 27, 2002).
2. The implementation of an environmental management system (EMS) does not necessarily mean ISO 14000 certification. In fact, the majority of establishments were not ISO 14000 certified, but indicated they employed EMS at their establishment.
3. International Institute for Sustainable Development, 1996, *Global Green Standards, ISO 14000 and Sustainable Development,* Winnipeg.
4. World Resource Foundation, *Life cycle analysis and assessment*, <http://www.gdrc.org/uem/waste/life-cycle.html>, (accessed March 27, 2002).
5. Given the small number of establishments reporting in the Territories, the results should be viewed with caution.
6. International Organization for Standardization, *ISO 9000 and ISO 14000 in Plain Language*, <http://www.iso.ch/iso/en/iso9000-14000/tour/plain.html>, (accessed March 27, 2002).
7. Please see the section on life cycle analysis on page 4.
8. Please see the section on eco-labelling of products, page 5.

Overall, 10% of establishments indicated that they were ISO 14000 or equivalent[1] certified in 1998 (Table 1.1). These establishments were generally larger (based on employment), representing 24% of the total employment of all establishments reporting. Over one-quarter of establishments in the Electric Power Generation, Transmission and Distribution and 23% in the Transportation Equipment industry indicated they were ISO 14000 or equivalent certified. The next highest proportions were found in the Chemicals and Pulp, Paper and Paperboard Mills industries, each with 17% (Table 1.2).

ISO 14000 certification or its equivalent was most prevalent in Ontario and British Columbia (almost 13%), followed by New Brunswick (11%), Alberta (11%) and Nova Scotia (10%) (Table 1.3).

Environmental voluntary agreements

In recent years, industry and governments have opted to participate in voluntary programs as an alternative to environmental regulations and mandatory programs.[2] Voluntary actions include codes of environmental management practice, environmental guidelines, emission and waste reduction targets, as well as agreements with governments. The best known environmental voluntary programs are Environment Canada's Accelerated Reduction/Elimination of Toxics Program (ARET), the Voluntary Challenge and Registry Program (VCR)[3] and the Canadian Chemical Producers' Association Responsible Care© program.

Over one-third of the reporting establishments indicated they were involved in an environmental voluntary program or participated in some form of environmental program such as Responsible Care©[4] (Table 1.1). Participation in such programs varied widely according to the type of industry. For example, in 1998, the Natural Gas Distribution industry (91%), Pipeline Transportation (86%) reported the highest participation in voluntary programs, while the Food (12%), Wood Products (14%) and Non-Metallic Mineral Products (11%) reported the lowest participation rates (Table 1.2). Fifty percent of the establishments in New Brunswick and almost 60% in Alberta indicated they participated in a voluntary program (Table 1.3).

Green procurement policy

Green procurement (or supply management) is the procurement of goods and services that minimize environmental impacts compared with goods and services with similar performance requirements.[5] When an establishment is purchasing a particular good or service, the costs and environmental impacts of the product at various stages of its life cycle are taken into consideration, such as the process used to manufacture the product (including raw materials), transportation, storing, handling and operating and disposal.[6]

Overall, just over 14% of establishments indicated that they used a green procurement policy in 1998 (Table 1.1). On an industry basis, several industries reported higher use of a green procurement policy than the average, such as Natural Gas Distribution (42%), Oil and Gas Extraction (24%), and Beverage and Tobacco Products (23%) (Table 1.2). With the exception of Newfoundland and Labrador (22%) most provinces reported that between 10% and 20% of businesses used a green procurement policy in 1998 (Table 1.3).

Eco-labelling of products

Eco-labelling programs are designed to encourage manufacturers and suppliers to develop environmentally preferable products and services and to help consumers identify products and services that are less harmful to the environment.[7] Eco-labelling programs such as Environmental Choice (managed by TerraChoice Environmental Services Inc. for Environment Canada) are one element of ISO 14000 (see below).

Overall, just under 6% of establishments that responded indicated that they produced goods certified by an environmental program such as Environmental Choice. The most prevalent use of "Eco-Logo" certification was in the Beverage and Tobacco Products industry (18%), followed by the Pulp, Paper and Paperboard Mills industry (16%) (Table 1.2).

Annual environmental performance report

The publication of an annual report on environmental performance or sustainable development is one indicator of

1. Respondents were asked to indicate if they were ISO 14000 or if they had an environmental management system in place that was equivalent to ISO 14000.
2. Saint-Laurent Vision 2000, 1996, *La réduction des rejets liquides toxiques des 50 établissements industriels prioritaires du plan d'action Saint-Laurent*, Rapport synthèse, 1988–1995, Montréal.
3. VCR Inc. is a non-profit partnership between Industry and governments across Canada.
4. It is mandatory for businesses who join the Canadian Chemical Producers' Association to participate in Responsible Care.
5. Treasury Board of Canada Secretariat, *Green Procurement Reporting Framework*, <http://www.tbs-sct.gc.ca/cmp/green-vert/grnproc_e.asp>, (accessed March 27, 2002).
6. International Institute for Sustainable Development, *Implementation Toolbox; Green Procurement*, <http://iisd1.iisd.ca/business/gprocurement.htm>, (accessed May 25, 2000).
7. TerraChoice Environmental Services Inc., *Environmental Choice Program*, <http//:www.environmentalchoice.com/index_main.cfm>, (accessed March 27, 2002).

a business' commitment to the environment. Almost 34% of the reporting establishments declared that they published an environmental or sustainable development report in 1998 (representing more than half of the employment) (Table 1.1).

On an industry basis, the proportion of establishments that produced an environmental report varied between industries. For example, over 60% of the establishments in the Natural Gas Distribution and Pulp, Paper and Paperboard Mills industries produced an environmental report, while establishments in the Food, and in the Beverage and Tobacco Products industries reported 13% and 14%, respectively (Table 1.2).

Provincially, the highest proportions of establishments that produced an environmental performance report were found in the western provinces. Indeed, more than 40% of establishments in Saskatchewan, Alberta and British Columbia reported they produced an environmental or sustainable development report (Table 1.3).

Environmental management practices and firm size

Table 1.1 provides some evidence that establishments with larger numbers of employees are also more likely to have at least one environmental management practice in place. Table 1.4 provides further evidence by grouping establishments into four different size categories based on employment and providing the proportion of establishments in each category that used the environmental management practice.

Overall, the proportion of establishments using an environmental management practice increased by each increasing employment class. Establishments with less than 100[1] employees, which reported the use of at least one environmental management practice, represented 75% of the total number of employees in that employment category. The proportion was 85% for establishments with 100 to 499 employees, 91% for those with 500 to 999 employees and 97% for establishments with over 999 employees (Table 1.4).

Eco-labelling, and to a lesser extent, life cycle analysis were the only practices for which the proportion of firms using them did not increase with firm size. In other words, smaller establishments were just as likely to eco-label their products as the largest establishments. However, larger establishments are more likely to participate in the other environmental management practices. For example, almost one quarter of establishments with more than 999 employees indicated they were ISO 14000 or equivalent certified. In comparison, less than 10% of establishments with up to 100 employees[1] indicated they were ISO 14000 or equivalent certified. The adoption of environmental management practices can involve significant changes in the way a company operates and may require large investments that can be made more readily by large firms.

1. Establishments in this range had between 50 and 99 employees.

Table 1.1
Environmental Management Practices by Businesses, 1998

Environmental management practice	Establishments using the practice	Proportion of establishments using the practice[1]	Employment share of establishments using the practice
	number	percent	
Environmental management system	888	64	79
Life cycle analysis	263	19	32
ISO 14000 Certification	145	10	24
Environmental voluntary agreements	514	37	58
Green procurement policy	198	14	22
Eco-labelling of products	81	6	8
Annual environmental performance report	478	34	52
Other	71	20	35
Total	**1 455**	**82[2]**	**91[2]**

Notes:
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Number of establishments indicating they used at least one environmental practice as a percentage of the total number of establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 1.2
Distribution of Environmental Management Practices by Industry, 1998

Industry	Environmental management system	Life cycle analysis	ISO 14000 certification	Environmental voluntary agreements	Green procurement policy	Eco-labelling of products	Annual environmental performance report	Other	**Total[2]**
	percent[1]								
Logging	59	10	17	16	3	5	50	10	**72**
Oil and Gas Extraction	88	47	3	77	24	6	40	20	**93**
Mining	72	22	5	51	18	--	54	38	**91**
Electric Power Generation, Transmission and Distribution	74	27	27	68	8	12	52	50	**93**
Natural Gas Distribution	92	25	8	91	42	--	67	--	**100**
Food	51	9	4	12	12	2	13	8	**63**
Beverage and Tobacco Products	54	14	3	25	23	18	14	7	**78**
Wood Products	50	9	5	14	9	6	28	12	**69**
Pulp, Paper and Paperboard Mills	70	11	17	65	11	16	63	21	**95**
Petroleum and Coal Products	74	52	7	58	11	11	48	50	**88**
Chemicals	69	28	17	46	17	9	34	28	**89**
Non-Metallic Mineral Products	61	17	5	11	14	3	31	14	**75**
Primary Metals	58	13	6	28	11	--	18	13	**82**
Transportation Equipment	62	19	22	26	19	2	23	17	**81**
Pipeline Transportation	90	43	5	86	14	--	52	33	**100**
Total[2]	**64**	**19**	**10**	**37**	**14**	**6**	**34**	**20**	**82**

Notes:
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Number of establishments indicating they used at least one environmental practice as a percentage of the total number of establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 1.3
Distribution of Environmental Management Practices by Province and Territory, 1998

Province/Territory	Environmental management system	Life cycle analysis	ISO 14000 certification	Environmental voluntary agreements	Green procurement policy	Eco-labelling of products	Annual environmental performance report	Other	**Total[2]**
	percent[1]								
Newfoundland and Labrador	78	10	9	41	22	4	23	17	**87**
Prince Edward Island	50	17	--	--	--	--	--	--	**57**
Nova Scotia	55	3	10	28	10	3	20	36	**77**
New Brunswick	74	19	11	50	9	9	40	33	**89**
Quebec	54	12	7	31	8	5	32	9	**77**
Ontario	64	22	13	34	18	6	28	22	**84**
Manitoba	57	22	2	31	15	2	17	36	**89**
Saskatchewan	63	17	4	42	17	4	50	33	**83**
Alberta	74	30	11	58	19	9	44	25	**86**
British Columbia	67	16	13	30	12	5	45	12	**81**
Yukon and Northwest Territories[3]	67	38	--	38	11	--	38	100	**89**
Total[2]	**64**	**19**	**10**	**37**	**14**	**6**	**34**	**20**	**82**

Notes:
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Number of establishments indicating they used at least one environmental practice as a percentage of the total number of establishments that provided a response.
3. Includes Nunavut.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 1.4

Distribution of Environmental Management Practices by Establishment Size, 1998[1]

Number of employees per establishment	Environmental management system	Life cycle analysis	ISO 14000 certification	Environmental voluntary agreements	Green procurement policy	Eco-labelling of products	Annual environment performance report	Other	**Percentage of total employees**
				percent[1]					percent[2]
<100	52	17	9	26	10	4	26	19	**75**
100 - 499	64	18	10	34	13	7	33	17	**85**
500 - 999	76	18	16	53	19	6	43	28	**91**
>999	88	34	24	77	32	4	59	31	**97**

Notes:
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Employment of establishments indicating they used at least one environmental practice, as a percentage of total employment of establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

2 Pollution Prevention Methods[1]

Pollution prevention is the elimination of the causes of pollution rather than the treatment of waste or pollution after it is generated (Text Box 2.1). It involves continuous improvement through changes in product design, technology, operations and behaviour. Pollution prevention is seen as a more effective way of protecting the environment than the traditional end-of-pipe[2] methods and can even lead to lower production costs.[3] In preparation of the renewed 1999 *Canadian Environmental Protection Act* (CEPA), pollution prevention was the underlying principal of the Act. The Preamble declares that "the protection of the environment is essential to the well-being of Canadians and that the primary purpose of this Act is to contribute to sustainable development through pollution prevention".[4]

Text Box 2.1
Pollution Prevention

The federal government defines pollution prevention as: "the use of processes, practices, materials, products or types of energy that hinder or minimize production of pollutants, wastes and wastage, while providing a general decrease in threats to human and environmental well-being."[1] Based on this definition, the S*urvey of Environmental Protection Expenditures* (SEPE) asked businesses to indicate which of the following pollution prevention methods they used and which ones they were planning to use during the next two years:[2]

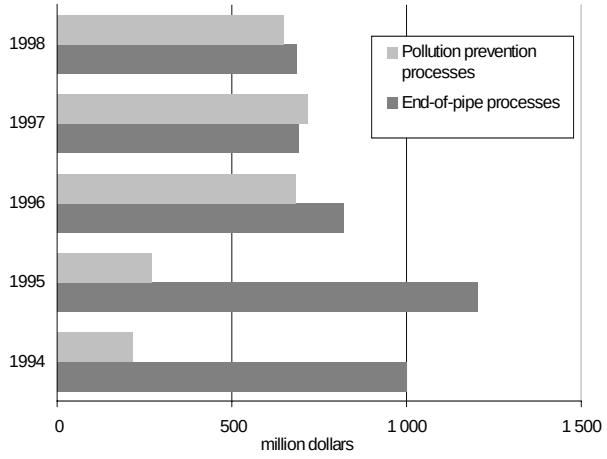
- product design or reformulation
- substitution or modification of production process
- on site recirculation, recovery, reuse or recycling
- energy conservation
- material or solvent substitution
- prevention of leaks and spills.

Pollution prevention is sometimes characterized by economic as well as environmental benefits. For instance, energy conservation practices allow businesses to cut energy costs while reducing the use of energy resources, thus reducing the emissions of greenhouse gases.[3]

1. Government of Canada,1995, *Pollution Prevention - A Federal Strategy*, Ottawa.
2. The question on pollution prevention methods differs slightly in 1997 and 1998 compared with the 1995 and 1996 question (see Table 2.1). Therefore, comparisons across time should be treated with caution.
3. For specific examples of pollution prevention efforts by Canadian businesses, visit Environment Canada, *The Canadian Pollution Prevention Information Clearinghouse* at <<http://www3.ec.gc.ca/cppic/en/index.cfm>>.

Since 1994, businesses have generally reduced their investment in traditional pollution abatement and control (PAC) mechanisms. After large increases in pollution prevention processes in 1995 and 1996, investment levels remained steady in 1997 and 1998. Investment spending for end-of-pipe processes (i.e., to abate or to control undesirable substances resulting from production) reached $828.1 million in 1994, but had fallen to $684.6 million in 1998. Over the same time period, investment shifted from end-of-pipe processes to pollution prevention (the prevention of pollution generation resulting from production) For example, investment in pollution prevention was $186.2 million in 1994, rising to $648.6 million by 1998 (Figure 2.1).

Figure 2.1
Investment in PAC End-of-pipe Processes versus Investment in Pollution Prevention, 1994-1998



Note:
Before 1997, the investment category "pollution prevention" was titled "PAC integrated processes".
Source:
Statistics Canada, 2000, *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised)*, Catalogue No 16F0006XIE, Ottawa.

1. Includes reported data only.

2. End-of-pipe processes are separately identifiable processes whose sole purpose is to abate or control undesirable substances emitted during normal production activities without any incidence on the production process itself.
3. Government of Canada, 2000, *Progress in Pollution Prevention, 4th Annual Report*, Ottawa.
4. Environment Canada, 1999, CEPA Annual Report: April 1998 to March 1999, Ottawa.

Results from the *Survey of Environmental Protection Expenditures* (SEPE) showed that businesses used methods related to reuse and recycling of materials[1] more than any other pollution prevention method between 1995 and 2000[2] (Table 2.1). Over 65% of establishments reporting used recycling and reuse methods, followed by prevention of leaks and spills (almost 60%) and energy conservation (over 40%, except in 1995).[3] With respect to plans for 1999-2000, establishments reported an increase in the use of each pollution prevention method, with the exception of the "Other" category (Table 2.3).

Table 2.1
Pollution Prevention Practices, 1995-2000

	1995	1996	1997	1998	1999/2000[1]
	percent[2]				
On-site recirculation, recovery, reuse or recycling	64	66	64	66	66
Prevention of leaks and spills	..	..	51	59	60
Energy conservation	37	42	42	45	53
Material or solvent substitution	33	36	37	31	37
Substitution or modification of production process	32	31	24	23	31
Product design or reformulation	10	11	15	17	21
Other	5	8	10	10	7

Notes:
The question on pollution prevention methods differed in the reference years 1995 and 1996. Establishments were asked to report not only pollution prevention practices but also end-of-pipe processes. Therefore, comparisons between 1995-1996 and 1997, 1998 or 1999/2000 should be treated with caution.
1. The 1998 *Survey of Environmental Protection Expenditures* asked establishments to forecast the use of pollution prevention practices for the years 1999/2000.
2. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

On-site recirculation, recovery, recycle and reuse

Sixty-five percent of all businesses used the "4Rs" as a means to reduce their use of natural resources and substances as well as their waste output in 1998, up 2% from a year earlier but still below its peak in 1996 (66%) (Table 2.2). Businesses overall did not plan to increase further the use of this pollution prevention method in 1999-2000. With the exception of the Logging and Natural Gas Distribution industries, between 50% and 82% of all establishments used on-site recirculation, recovery, recycling or reuse.

1. Includes recirculation, reuse, recovery or recycling of water, materials or substances generated during production, excluding materials transferred or recycled off site. Examples include vapour recovery, recovery of sludge, water recirculation, reuse of water for refrigeration condenser operations.
2. The 1998 *Survey of Environmental Protection Expenditures* asked establishments to forecast the use of pollution prevention methods for the years 1999/2000.
3. The information in this section includes data reported only. The results do not take into account non-response. The result is likely an under-estimation of the use of pollution prevention methods.

Text Box 2.2
Examples of Energy Conservation Processes

The 1997 and 1998 SEPE classifies energy conservation processes according to the following:

- co-generation
- energy efficiency
- fuel substitution
- waste-to-energy systems
- clean-fuel systems
- renewable energy sources (e.g., solar and wind power, and geothermal and biomass energy).

Note:
Statistics on the use of energy conservation processes by category are available in **Section 3 - Use of Environmental Technologies.**
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Prevention of leaks and spills

Excluding the "Other manufacturing" category, just over 65% of businesses indicated they used equipment and practices that prevented leaks and spills (Table 2.2). The proportion fell to just over 58% when the "Other manufacturing" category was included. However, the proportion of businesses using these methods was higher than in 1997 (51%). In fact, the prevention of leaks and spills has grown in usage more than any other pollution prevention method. Over 80% of businesses in the Logging, Oil and Gas Extraction, Electric Power Generation, Transmission and Distribution and Pipeline Transportation industries used this method.

Energy conservation

The proportion of respondents that adopted energy conservation at their establishment reached 45% in 1998, up from 37% in 1995 (Table 2.1). The proportion of businesses preventing pollution through energy conservation increased for the fourth consecutive year. The Pipeline Transportation (75%), Oil and Gas Extraction (75%) and Electric Power Generation, Transmission and Distribution (74%) industries reported the largest proportion of businesses using energy conservation methods. Most industry groups indicated they would increase the use of energy conservation to prevent pollution in 1999-2000 (Table 2.3) (see Text Box 2.2 for examples of energy conservation processes).[4]

4. More information on the use of energy conservation processes is available in **Section 3 - Use of Environmental Technologies**.

Substitution or modification of production process

The popularity of substitution or modification of production processes (e.g. integrated production processes) has declined since 1995. While 23% of businesses indicated they used this process in 1998, this was down from 32% in 1995 (Table 2.1). On an industry basis, the largest proportions of establishments reporting substitution or modification of production processes were in Oil and Gas Extraction (35%) and Refined Petroleum and Coal Products (32%). All industry groups reported that they would increase the use of substitution or modification of production processes as a method of preventing pollution in 1999-2000 (Tables 2.2 and 2.3).

Material or solvent substitution

Businesses may also reduce pollution by substituting materials or solvents used in production with less harmful ones, or with ones that require less natural resources or energy to produce or use. After increasing from 1995 to 1997, the proportion of businesses that used material or solvent substitution as a method of pollution prevention fell from 37% in 1997 to 31% in 1998 (Table 2.1). Over 50% of the businesses in the Electric Power Generation, Transmission and Distribution and Transportation Equipment industries indicated they used this method in 1998 (Table 2.2). All industry groups reported that they would increase the use of material and solvent substitution as a method of preventing pollution in 1999-2000 (Table 2.3).

Product design or reformulation

The least reported pollution prevention method was product design or reformulation with just under 17% of respondents using this method in 1998. Within the industry groups, there was a wide range of adoption, from 6% in the Mining industry to just under 30% in the Chemicals industry (Table 2.2). This activity kept increasing in popularity with the proportion of establishments using product redesign steadily increasing from 10% in 1995 to 17% in 1998 (and a forecast of 21% for 1999-2000).

Pollution prevention methods and firm size

Table 2.4 groups establishments into four different size categories based on employment and provides the proportions of establishments in each category that used the pollution prevention method. Although smaller establishments with less than 100 employees[1] were as likely to be using certain pollution prevention methods as larger establishments, methods such as material or solvent substitution, energy efficiency and substitution or modification of production process were more likely to be in use in the larger establishments. For example, almost two thirds of establishments with 1 000 or more employees indicated they substituted materials or solvents in 1998 compared with one quarter of establishments with less than 100 employees[2].

Text Box 2.3
OECD List of Technologies for Sustainable Development

Clean car technologies: cars with alternative batteries, lightweight materials, direct injection engines, fuel cells and/or enhanced recyclability - leading to lower fuel consumption and emissions.

Photovoltaics: buildings, automobiles and decentralizing power units using photovoltaics or light-based energy.

Biotechnology: bioprocessing reduces resource inputs, pollutants and wastes from manufacturing.

Advanced sensors: sensors to monitor air and water quality, stratospheric ozone layer, marine environments and other ecosystems.

New materials: advanced material technologies will facilitate recycling of consumer goods and manufacturing inputs and further implementation of life-cycle concepts.

Smart-water treatment: membrane technologies and biological treatments to purify wastewater by removing organic compounds.

Smart-waste treatment: reducing waste and cleaning up hazardous waste based on new enzymes, catalysts and other advanced techniques.

Renewable energy: improved power storage technology and combined conversion systems will increase the use of electricity from renewable sources such as solar and wind power and biomass.

Source:
OECD, 1999: "Technology and Sustainable Development", Special Issue on Sustainable Development, STI Review, No. 25, Box 3, p. 19.

1. Between 50 and 99 employees.

2. *Ibid*.

Pollution prevention by province and territory

Although the “4Rs” was the most frequent pollution prevention method adopted by businesses overall, in Newfoundland and Labrador, Saskatchewan and Alberta, a larger proportion of establishments (over 66%) reported the prevention of leaks and spills than any other pollution prevention method in 1998 (Table 2.5). Energy conservation was the second most popular pollution prevention method used in Newfoundland and Labrador (63%), Nova Scotia (55%), Manitoba (55%) and Saskatchewan (62%), above the Canadian average proportion of 45%.

Table 2.2
Pollution Prevention Methods by Industry, 1998

Industry	Product design or reformulation	Substitution or modification of production process	Recirculation, recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Proportion of respondents who reported
				percent[1]				percent
Logging	-	15	33	12	3	82	3	43
Oil and Gas Extraction	27	35	71	75	40	88	6	76
Mining	6	18	67	42	21	53	8	64
Electric Power Generation, Transmission and Distribution	13	22	65	74	52	87	4	82
Natural Gas Distribution	-	25	38	62	25	75	-	67
Food	13	26	72	61	34	54	3	54
Beverage and Tobacco Products	8	16	50	50	24	63	10	53
Wood Products	23	25	62	40	22	58	12	46
Pulp, Paper and Paperboard Mills	10	24	76	54	38	73	7	64
Petroleum and Coal Products	26	32	74	63	26	79	-	51
Chemicals	30	24	72	33	27	71	4	70
Non-Metallic Mineral Products	18	20	67	51	27	49	9	64
Primary Metals	14	28	82	54	31	55	6	59
Transportation Equipment	21	25	69	56	51	69	8	65
Pipeline Transportation	25	25	58	75	33	92	-	54
Total	**17**	**24**	**69**	**49**	**31**	**65**	**6**	**60**
Other manufacturing[2]	15	20	56	34	31	39	20	60
Total including Other manufacturing	**17**	**23**	**66**	**45**	**31**	**59**	**10**	**60**

Notes:
This table includes reported data only.
1. Number of establishments indicating they used the pollution prevention method as a percentage of all establishments that provided a response.
2. 'Other Manufacturing' includes all other manufacturing industries not already specified.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 2.3
Planned Pollution Prevention Methods by Industry, 1999-2000[1]

Industry	Product design or reformulation	Substitution or modification of production process	Recirculation, recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Proportion of respondents who reported
				percent[2]				percent
Logging	-	18	30	7	11	82	7	35
Oil and Gas Extraction	36	44	71	80	49	91	4	71
Mining	8	24	69	46	27	50	6	65
Electric Power Generation, Transmission and Distribution	12	33	71	71	58	83	4	86
Natural Gas Distribution	-	25	38	62	25	88	-	67
Food	17	32	67	62	32	59	5	57
Beverage and Tobacco Products	2	13	66	62	19	68	6	65
Wood Products	28	34	73	46	28	57	13	50
Pulp, Paper and Paperboard Mills	12	25	72	60	33	71	8	72
Petroleum and Coal Products	32	41	73	64	23	68	-	60
Chemicals	29	31	67	42	42	68	8	74
Non-Metallic Mineral Products	26	38	74	53	32	49	4	67
Primary Metals	17	32	74	61	31	54	5	61
Transportation Equipment	31	34	65	69	58	69	11	65
Pipeline Transportation	31	31	62	62	38	92	-	59
Total	**20**	**30**	**68**	**55**	**35**	**64**	**7**	**63**
Other manufacturing[3]	24	32	60	47	42	46	6	59
Total including Other manufacturing	**21**	**31**	**66**	**53**	**37**	**60**	**7**	**62**

Notes:
This table includes reported data only.
1. 'Pollution prevention methods' planned in the next two years.
2. Number of establishments indicating they used the pollution prevention method as a percentage of all establishments that provided a response.
3. 'Other Manufacturing' includes all other manufacturing industries not already specified.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 2.4
Distribution of Pollution Prevention Methods by Establishment Size, 1998

Number of employees per establishment	Product design or reformulation	Substitution or modification of production process	Recirculation, recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Share of total employment
				percent[1]				
<100	18	22	62	36	25	61	5	5
100 - 499	17	23	70	47	28	64	7	33
500 - 999	15	38	70	69	32	71	4	19
>999	23	40	80	69	57	77	8	43

Notes:
This table reports values only for those establishments that indicated the use of at least one pollution prevention method.
1. Number of establishments indicating they used the pollution prevention method as a percentage of all establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 2.5
Pollution Prevention Methods by Province and Territory, 1998

Province/Territory	Product design or reformulation	Substitution or modification of production process	Recirculation, recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Proportion of respondents who reported
				percent[1]				percent
Newfoundland and Labrador	6	12	56	62	25	69	6	64
Prince Edward Island	17	-	67	50	50	67	-	60
Nova Scotia	14	32	77	54	18	50	-	49
New Brunswick	4	13	87	48	48	61	9	51
Quebec	14	22	66	38	28	52	9	56
Ontario	20	22	66	45	34	58	12	62
Manitoba	8	26	67	55	33	47	10	64
Saskatchewan	17	38	71	62	26	60	7	66
Alberta	17	23	66	55	29	71	7	64
British Columbia	14	27	57	40	23	68	7	56
Yukon and Northwest Territories[2]	12	25	50	25	25	50	25	67
Canada	**17**	**23**	**66**	**45**	**31**	**59**	**10**	**60**

Notes:
This table includes reported data only.
This table includes the 'Other Manufacturing' industries category.
1. Number of establishments indicating they used the pollution prevention method as a percentage of all establishments that provided a response.
2. Includes Nunavut.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 2.6
Planned Pollution Prevention Methods by Province and Territory, 1999-2000[1]

Province/Territory	Product design or reformulation	Substitution or modification of production process	Recirculation, recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Proportion of respondents who reported
				percent[2]				percent
Newfoundland and Labrador	6	19	56	56	19	81	6	64
Prince Edward Island	17	-	83	50	67	67	-	60
Nova Scotia	17	29	79	62	38	54	-	53
New Brunswick	3	33	73	57	43	63	10	67
Quebec	16	28	64	44	33	54	7	56
Ontario	26	32	67	54	40	58	6	66
Manitoba	16	38	70	60	38	52	6	65
Saskatchewan	19	35	70	60	33	60	9	67
Alberta	22	30	66	58	39	71	5	64
British Columbia	22	28	63	54	27	66	9	58
Yukon and Northwest Territories[3]	17	33	50	33	33	50	17	50
Canada	**21**	**31**	**66**	**53**	**37**	**60**	**7**	**62**

Notes:
This table includes reported data only.
This table includes the 'Other Manufacturing' industries category.
1. 'Pollution prevention methods' planned in the next two years.
2. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
3. Includes Nunavut.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

3 Use of Environmental Technologies

Businesses use a number of technologies aimed at preventing or abating pollution. Examples include technologies to reduce gaseous emissions, liquid waste, noise, radiation and vibration, technologies to clean up soil (site reclamation technologies and solid waste management treatment), and energy conservation technologies.

The 1998 edition of the *Survey of Environmental Protection Expenditures* (SEPE) included a question on business use of environmental technologies (Text Box 3.1). This section provides a profile of the use of environmental technologies used by industry. It focuses on the use of pollution abatement technologies but also looks at examples of pollution prevention technologies such as energy conservation.

The SEPE asked respondents to indicate the type of technology used by the establishment to mitigate three main types of emissions: gaseous emissions, liquid waste and solid waste management. The survey also included technologies related to site reclamation and decommissioning, energy conservation and the control of noise, vibration and radiation. And where appropriate, the technologies were further broken down into physical, chemical, biological and thermal technologies (Text Box 3.1).

Approximately 80% of the respondents sent a questionnaire indicated they used at least one of the environmental technologies listed on the questionnaire.[1]

Text Boxes 3.2 to 3.6 provide examples of industrial emissions to air, water and land, as well as explanations of energy conservation technologies. Detailed data tables are located at the end of the section. Readers should refer to these if more information is needed beyond that which is found in the text.

1. The other 20% of respondents either did not treat pollution, or used other technologies than those listed or did not respond. For more detail on response rates, see Section 4 **– Concepts, Methodology and Data Quality**.

Text Box 3.1
Environmental Technologies

The *1998 Survey of Environmental Protection Expenditures* included a question on the use of technologies to prevent or abate pollution resulting from normal production. The question was also included on the 1997 survey. Respondents were asked to select environmental technologies from a list of approximately 100. In previous years, respondents were asked to describe their main pollution prevention and pollution abatement and control (end-of-pipe) technologies with the help of a short list of examples.

The question listed environmental technologies according to the following categories of treatment[1]:

Type of treatment	Physical treatment	Chemical treatment	Biological treatment	Thermal treatment
Gaseous emissions treatment	X	X	X	X
Liquid waste treatment	X	X	X	X
Noise, vibration and radiation	X			
Site reclamation and decommissioning	X		X	X
Solid waste management	X		X	X
Energy conservation	X			

Readers should be aware that the 1997 and 1998 estimates represent reported data only. No estimation was done for non-response and non-surveyed establishments. The 1998 SEPE realized a significant increase in the response rate for the question on environmental technologies over 1997 (Question 12 in the questionnaire).

In 1997, approximately 1 000 establishments answered the question on what environmental technologies they used. This represented 62% of all establishments that were sent a questionnaire. In 1998, the number of establishments that answered the question rose to almost 1 500, representing close to 80% of all establishments that were sent a questionnaire. The difference in the quality of the data between the two years make comparisons questionable. For this reason, this report contains the 1998 reference year data only.[2]

1. For a complete list of environmental technologies, please see Question 12 of the survey questionnaire found at the end of this report. Table 3.14 also provides a detailed breakdown of environmental technologies.
2. See Section 4 – **Concepts, Methodology and Data Quality** for more detail.

3.1 Environmental technologies by emissions treated

Businesses may use more than one environmental technology. They may use several technologies aimed at reducing one particular group of pollutants or they may use various technologies in order to deal with different types of pollutants.[1] Almost 1 080 establishments indicated they treated gaseous (air) emissions. Three-quarters of these establishments employed physical treatment technologies, such as a bag house (a chamber for holding bag filters used to filter gas steams from a furnace); or a dust collector system (Table 3.14). Establishments were less likely to employ other physical treatments. Biological treatment was reported by 8% of establishments, chemical treatment by 35% and thermal treatment by 36%.

Just over 1 060 establishments indicated they used one or more of the environmental technologies to treat liquid waste. About 85% of these also used physical treatment technologies, such as primary clarification, gravity oil/water separation and screening. Half of the establishments reported using chemical treatment for liquid wastes, such as neutralisation and flocculation - a process bringing destabilized or coagulated particles together to form larger masses for settling. Forty percent indicated the use of biological treatments such as anaerobic treatment (septic tank) and aerobic lagoons or activated sludge dewatering.

Of the 1 262 establishments that reported solid waste management, over 90% used a physical treatment process, primarily containers and compactors. Of those establishments that reported biological treatment for solid waste treatment, 57% used landfarming and 23% composting.

Almost 600 establishments reported site reclamation and decommissioning. The majority of these establishments (65%) indicated they employed physical treatment and technologies such as excavation and underground storage tanks. Less than 30% reported a biological treatment method such as biological degradation by aeration or bioventilation[2], and bioremediation[3].

1. The number of technologies used varies according to the nature of the environmental problem, the complexity of the solution required (for instance, a filtration system may require the simultaneous use of a membrane filter and an activated carbon filter), the type of production process, the industry, or the technological expertise or availability.
2. Biological degradation by aeration or bioventilation is the injection of air into the contaminated layer to encourage biodegradation of organic contaminants (light hydrocarbons, gasoline, diesel) and draw them out with the gaseous effluent.
3. Bioremediation uses naturally occurring or genetically modified micro-organisms to breakdown hazardous substances into less hazardous substances.

Text Box 3.2
Examples of Substances Emitted to Air

Greenhouse gas (GHG) emissions: the most important GHGs produced by economic activity are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs). The main emitting industries are those that use energy with high intensity: mining; crude petroleum; cement; smelting and refining of metal ores; pulp and paper; and electricity production.

Dioxins and furans: Waste incineration is a major source of release of these chemicals to air. Industrial sources include iron manufacturing (sintering plants), pulp and paper (combustion of salt-laden wood) and steel manufacturing (electric arc furnaces).

NPRI substances[1] - Top on-site releases to air in 1998 were:

- ammonia
- sulphuric acid
- methanol
- hydrochloric acid
- xylene
- toluene

Criteria air contaminants[2]: total particulate matter (mining, iron ore), fine particulate matter (wood, pulp and paper) and suspended particulate matter (mining, thermal power generation); sulphur oxides (oil and gas processing, ore smelting); nitrogen oxides (NOx) (upstream oil and gas industry); volatile organic compounds (VOCs) (upstream oil and gas industry); carbon monoxide (CO) (wood, iron and steel and aluminium processes).
Particulates, VOCs and NO_x cause smog.

Ozone-depleting substances: CFCs and halons.

Notes:
1 The National Pollutant Release Inventory (NPRI) was established in 1993 by Environment Canada to monitor the release of 176 substances by facilities in Canada. For more information, see <http://www.ec.gc.ca/pdb/npri/>.
2. The 1995 National Emissions Inventory of Criteria Air Contaminants is compiled by Environment Canada and the provincial/territorial ministries of the environment and energy. It contains estimates of criteria air contaminant emissions for more than 60 industrial and non-industrial activities. Criteria contaminants are those for which ambient air quality standards have been established by government.

Source:
Statistics Canada, 2000, *Human Activity and the Environment 2000*, Catalogue No. 11-509-XPE, Ottawa.
Environment Canada, Pollution Data Branch, *National Pollutant Release Inventory 1998*.

Table 3.1
Type of Treatment by Industry, 1998

Industry	Physical treatment[1]	Chemical treatment[2]	Biological treatment[3]	Thermal treatment[4]
		percent[5]		
Logging	80	x	48	14
Oil and Gas Extraction	100	58	80	86
Mining	96	63	54	10
Electric Power Generation, Transmission and Distribution	92	42	54	19
Natural Gas Distribution	92	x	58	58
Food	96	38	21	24
Beverage and Tobacco Products	96	49	10	6
Wood Products	93	12	24	22
Pulp, Paper and Paperboard Mills	98	72	83	44
Petroleum and Coal Products	100	68	43	68
Chemicals	94	56	20	42
Non-Metallic Mineral Products	100	29	32	19
Primary Metals	94	51	16	34
Transportation Equipment	94	47	10	28
Pipeline Transportation	100	68	77	54
Total	**95**	**47**	**34**	**32**

Notes:
This table includes reported data only.
1. Includes physical treatment processes for gaseous emissions, liquid waste, solid waste and site reclamation and decommissioning.
2. Includes chemical treatment processes for gaseous emissions and liquid waste.
3. Includes biological treatment processes for gaseous emissions, liquid waste, solid waste and site reclamation and decommissioning.
4. Includes thermal treatment processes for gaseous emissions, liquid waste, solid waste and site reclamation and decommissioning.
5. Number of establishments indicating they used at least one process as a percentage of all establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Across all the major categories, physical treatment was the most widely used - ninety-five percent of those establishments that provided a response indicated they used at least one physical treatment process. With the exception of the Logging industry (80%), between 92% and 100% of establishments in each industry indicated they used a physical process (Table 3.1).

Overall, less than half of establishments (47%) indicated they used chemical treatment. Just over a third (34%) used biological treatment. However, 88% in the Oil and Gas Extraction industry, over 80% of the establishments in the Pulp, Paper and Paperboard Mills industry, and 77% in the Pipeline Transportation industry used at least one biological process. Thermal treatment was the least used (32%) overall, but were heavily used in the Oil and Gas Extraction industry, where 86% of establishments used a thermal treatment process (Table 3.1).

Energy conservation technologies

Question 12 of the SEPE also included a section where respondents could report the energy conservation technologies they used. This section was added as a way for federal policy departments to measure the use of and to identify the opportunities for innovation related to resource conservation and renewable energy technologies. In addition, the information collected on energy conservation technologies will serve as benchmark data for future surveys that will address data gaps related to the use of technologies to reduce greenhouse gas emissions by Canadian industry.

Overall, 70% of establishments indicated they used at least one energy conservation technology in 1998 (Table 3.3). The most frequently reported energy conservation technology was the use of energy efficient equipment (44% of establishments), followed by waste-to-energy systems (18%) and fuel substitution (15%). The most frequently reported renewable energy technology was biomass (6% of establishments), followed by solar (3%) and wind power (1%).[1]

3.2 Environmental technologies used by business

The use of environmental technologies is characterized by the nature of the industry concerned. For instance, environmental biotechnologies are more prevalent in industries such as the Pulp, Paper and Paperboard Mills, Oil and Gas Extraction and Pipeline Transport industries since microorganisms are good at treating specific types of waste like oil or sludge. Site reclamation and decommissioning tends to be industry-specific as well, concentrated in such industries as Oil and Gas Extraction, Pipeline Transportation, Electric Power Generation, Transmission and Distribution and Mining.

1. For more detailed information related to energy conservation technologies used by industry, see Table 3.14 and **Section 3.2.1 - Profile of selected industries**.

In contrast, the management of solid waste was common across most industries. Between 82% and 100% of establishments within each industry group surveyed (with the exception of the Logging industry) indicated they used some kind of solid waste management process or technology (Table 3.2). This is not surprising, given that virtually all establishments have to deal with some kind of solid waste. This homogeneity was not as prevalent when comparing industries and the types of treatment for gaseous emissions and liquid wastes.

3.2.1 Profile of selected industries[1]

Logging

The majority of establishments (between 55% and 71%) in the Logging industry indicated they treated liquid and solid waste or used a process for site reclamation and decommissioning (Table 3.2). Approximately one-third of establishments used anaerobic treatment (septic tank) and gravity oil/water separation to treat liquid waste. To a lesser extent, oilphylic pads and coalescing separators were also used (Table 3.4).

Just under 30% of establishments used excavation for site reclamation and decommissioning. The next most frequently used treatment methods were underground storage tanks (9% of establishments), followed by two biological treatment methods (biological degradation by aeration or bioventilation and bioremediation) and incineration (7% of establishments).

Less than one-quarter of establishments indicated they employed at least one energy conservation process (Table 3.3 and Table 3.5) such as the use of energy efficient equipment (16%).

Oil and Gas Extraction

Not surprisingly, given the nature of the Oil and Gas Extraction industry, all establishments indicated they used technologies for site reclamation and decommissioning (Table 3.2). The majority of establishments used excavation (83%), bioremediation (69%) and/or underground storage handling tanks (59%). Over 90% of establishments indicated they managed solid waste, the most common treatment method being the use of container (86%) and landfarming (68%). About one-third of establishments indicated they used biopiles (a biological treatment)[2] and/or modified or prepared the solid waste for landfill or for a waste treatment site (Table 3.5).

Close to 90% of establishments indicated they treated gas. By far the most heavily used gas treatment technology was a flare system, used by over 80% of establishments. This was followed by desulfurisation (32%), activated carbon filters and vapour condensers (31% respectively).

Eighty percent of establishments treated liquid waste, and as with gas treatment, one technology dominated the treatment method. Over 70% of establishments used gravity oil/water separation. The next most frequently used technology (anaerobic treatment - septic tank) was used by 46% of establishments.

The Oil and Gas Extraction industry was one of the most frequent users of biological treatment for liquid waste (53%), solid waste management (68%) and site reclamation and decommissioning (76%). The most heavily used biological technologies included aerobic treatment (aeration pond and lagoon), biopiles, composting technology, bioremediation and biological degradation by aeration or bioventilation (Table 3.5).

Text Box 3.3
Examples of Substances Emitted to Water

- Five-day biochemical oxygen demand (BOD_5) which is an indicator of the effects of the effluents on the availability of oxygen to aquatic plants and animals
- Total suspended solids (TSS)
- Dioxins and furans

Pulp and paper manufacturing is an example of an industry regulated for the discharge of these effluents.

NPRI substances - Top five on-site releases to water in 1998**:**

- Ammonia (total)
- Nitrate ion (in solution at pH 6.0)
- Methanol
- Manganese (and its compounds)
- Zinc (and its compounds)

Sources:
Statistics Canada, 2000, *Human Activity and the Environment 2000*, Catalogue No. 11-509-XPE, Ottawa.
Environment Canada, Pollution Data Branch, *National Pollutant Release Inventory 1998*.

1. The industry groups in the sections that follow were selected to be profiled, in part, to fulfil Statistics Canada's memorandum of understanding (MOU) with Natural Resources Canada. These industries were also chosen because of their past environmental protection expenditures and pollutant emissions.

2. Excavated soils are mixed with soil amendments and placed in above ground enclosures. The piles are aerated with blowers or vacuum pumps so that compost is formed.

The Oil and Gas Extraction industry had the third highest proportion of establishments (85%) that used one or more energy conservation technologies. Energy efficient equipment (69%) was the most widely used energy conservation method, followed by fuel substitution (44%), clean fuel systems (37%), solar technologies (36%), waste-to-energy systems (31%) and cogeneration (25%). A higher proportion of establishments in the Oil and Gas industry reported using cogeneration, fuel substitution and clean fuel systems than any other industry. The industry also indicated they used technology to mitigate noise, vibration or radiation (80%) more than any other industry.

Mining

The management of solid waste was the most frequently reported process by the Mining industry (88% of establishments). Physical treatment, such as containers and the modification or preparation of materials for landfill or waste treatment site, was the most common method (81%), while just over 20% of establishments used biological treatment. Landfarming was the most popular biological treatment method (Table 3.6).

The Mining industry was also one of the most frequent reporters of site reclamation of decommissioning (75% of establishments). Excavation and underground storage tanks handling were the two most frequent treatment methods used. The treatment of gaseous emissions was dominated by four technologies: bag houses, gravity deposition dust collector systems, wet scrubbing systems and inertial cyclone separators.

Over half of establishments indicated they used primary clarification to treat liquid waste. One third of establishments used gravity oil/water separation and flocculation. Several biological treatment methods were also used, such as anaerobic treatment (septic tank) and aeration system.

Sixty-two percent of establishments indicated they used energy conservation technologies in 1998, below the overall average of 70%. Almost half of the establishments indicated the use of energy efficient equipment. Less than 10% of establishments used each of the remaining energy conservation technologies (Table 3.3).

Electric Power Generation, Transmission and Distribution

Over 90% of the facilities in the Electric Power Generation, Transmission and Distribution industry used physical treatment to manage their solid waste, mainly through the use of containers (77% of establishments). Over 80% treated liquid waste, mainly using primary clarification (sedimentation, gravity setting chamber), oil/water separation (gravity), disinfection through chlorination,

Text Box 3.4
Examples of Substances Emitted to Soil

Large-scale and long-range contamination of soil

- Petroleum products and polycyclic aromatic hydrocarbons: the transport and use of fossil fuels have resulted in the release of petroleum products in to the environment due to oil spills, urban run-off and wastewater emissions;
- Polychlorinated biphenyls (PCBs): this is a group of at least 50 human-made, industrial organochlorine chemicals used as insulators in electrical equipment. They do not break down easily in the environment and there is concern that they may be harmful to biota and that some PCBs cause cancer and may contribute to other subtle effects in unborn children. The use of PCBs was banned in many countries, including Canada, in the 1970s;
- Pesticide DDT: endocrine disrupters;
- Acid precipitation (nitrogen oxides): affects soil by reducing availability of essential plant nutrients and increasing solubility of toxic metals.

Local contamination of soil

- Dioxins and furans: the leaching of chemicals into the soil come from utility poles and railroad ties (in use and out-of-service) and from pulp and paper manufacturing (ash from salt-laden wood).

NPRI substances - Top five on-site releases to land in 1998:

- Zinc (and its compounds)
- Asbestos (friable form)
- Ethylene glycol
- Manganese (and its compounds)
- Chromium (and its compounds)

NPRI substances - Top five NPRI releases to underground injection[1] in 1998:

- Ammonia
- Methanol
- Arsenic (and its compounds)
- Diethanolamine (and its salts)
- Ethylene glycol

Sources:
Statistics Canada, 2000, *Human Activity and the Environment 2000*, Catalogue No. 11-509-XPE, Ottawa.
Environment Canada, Pollution Data Branch, *National Pollutant Release Inventory 1998*.

1. Releases to Underground Injection are materials injected on-site into underground wells.

neutralisation and anaerobic treatment (septic tank) (Table 3.7).

Facilities within the Electric Power Generation, Transmission and Distribution industry were the second most likely users of energy efficient equipment (88% of facilities) after the Pipeline Transportation industry (91%). A similar proportion of facilities indicated they used energy efficient equipment while a quarter of facilities used fuel substitution and waste-to-energy systems. Fifteen percent used solar and wind power to produce electricity (Table 3.3).

Natural Gas Distribution

Over 80% of facilities in the Natural Gas Distribution industry indicated they treated gaseous emissions, with one third doing so with a flare system. Almost 60% of establishments reported they used gravity oil/water separation to treat liquid waste and excavation for site reclamation and decommissioning. Over 80% of establishments managed their solid waste using containers, landfarming and packaging (Table 3.8).

Three-quarters of facilities indicated they used one of the energy conservation technologies. The most common were the use of energy efficient equipment and fuel substitution.

Pulp, Paper and Paperboard Mills

Ninety-four percent of establishments in the Pulp, Paper and Paperboard Mills industry indicated they treated liquid waste using a variety of technologies (Table 3.9). This is not surprising since the industry uses water in many of its processes. Examples of water pollutants produced by this industry include total suspended solids, chlorinated organic compounds and concentrated BOD (Biological Oxygen Demand). The most frequently used technology was primary clarification, reported by 80% of establishments. Activated sludge dewatering (a biological treatment) and screening were used by almost half of the establishments.

A high proportion of pulp, paper and paperboard establishments (90%) also indicated that they treated solid waste. Almost two thirds of establishments reported using containers while approximately one-third used compacting and/or modification or preparation of materials for landfill or waste treatment site.

Over 40% of establishments in this industry indicated they used an inertial separator cyclone (physical treatment) to treat gaseous emissions. Forty percent reported using an electrostatic precipitator (40%). Common air pollutants emitted by the industry include fine particulates, course particulates, sulphur oxides, volatile organic compounds, reduced sulphur gases, and nitrogen oxides.

Text Box 3.5
Energy conservation technologies

Cogeneration: this is a process that converts a fuel into both thermal and electrical energy.

Energy efficient equipment: any equipment that reduces energy requirements.

Fuel substitution: substitution of one fuel source for another, such as coal for natural gas or renewable energy.

Waste-to-energy systems: this process recovers the heat value of combusted waste to generate steam and electric power.

Clean fuel system: refers to electric, hybrid, fuel cell, natural gas, and other clean or alternative fuels.

Renewable energy sources:

- *Solar:* the direct conversion of sunlight into electricity using technologies such as photovoltaics, passive solar heating and cooling.
- *Wind power:* the production of electricity through technologies such as wind turbines.
- *Geothermal:* energy recovered from the heat of the earth's core.
- *Biomass:* wastes and the by-products (such as organic residues from plants and animals obtained primarily from harvesting and processing agricultural and forestry crops) that are utilized as fuels for producing energy.

Over 80% of the establishments in the Pulp, Paper and Paperboard Mills industry indicated that they used at least one energy conservation process or technology. A variety of technologies were reported, such as the use of energy efficient equipment (43%), waste-to-energy systems (40%) and biomass as a renewable energy source (39%). Fuel substitution was reported by a third of establishments, while 23% used clean fuel systems and 21% used cogeneration. Pulp, paper and paperboard mills were the most likely to use biomass as a renewable energy source, and were second most likely to use cogeneration, waste-to-energy systems and clean fuel systems.

Petroleum and Coal Products

Over 80% of the establishments in the Petroleum and Coal Products industry indicated they treated gaseous emissions. Over 40% of establishments used flare systems (physical process) and wet scrubbing systems - a technology that removes entrained liquid droplets, dust or other gaseous emissions from process gas streams (chemical process). Desulfurisation was used by a third of establishments.

The physical treatment of liquid waste was reported by three-quarters of the establishments while over 40% indicated they used chemical and biological treatment. Four out of the five of the top technologies used were physical technologies (gravity oil/water separation; primary clarification; flotation and equalization ponds).

Half of the establishments reported using energy efficient equipment, while 21% used clean fuel systems and 18% used cogeneration. Proportionally, the Petroleum and Coal Products industry was the third highest user of cogeneration. Overall, 75% of establishments indicated they used one or more energy conservation technologies.

Chemicals

Of the 85% of the establishments in the Chemicals industry that indicated they treated gaseous emissions (such as ammonia and methanol), the majority used a physical treatment process, such as a bag house, dust collector system or cyclone inertial separator. Less than 40% used chemical treatment (36% reported the use of a wet scrubbing system) and 37% used thermal treatment (such as a flare system, cooling tower or thermal oxidation).

Just over three-quarters of establishments in this industry treated liquid waste such as ammonia, nitrate ion and maganese. Both physical (58%) and chemical (41%) treatment were predominately used.

Respondents in the Chemicals industry reported the second smallest proportion of establishments (57%) using at least one energy conservation process or technology in 1998. Only establishments in the Logging industry reported using energy conservation less. The most frequently reported method was energy efficient equipment, used by 40% of the establishments. Next was waste-to-energy systems (13%), followed by clean fuel systems (10%).

Primary Metals

The Primary Metals industry predominately used physical treatment methods to treat gas, liquid and solid waste. Less than half of the establishments indicated that they used chemical treatment for gas and liquid waste. Over half of the establishments indicated they used a bag house for the treatment of gas, followed by gravity deposition dust collector system (46%). Examples of key air emissions produced by this industry include greenhouse gases, sulphuric acid, sulphur oxides and carbon monoxide.

Over 30% of the establishments in the Primary Metals industry used primary clarification and gravity oil/water separation technologies to treat liquid wastes, while flocculation was used by 26% and neutralisation by 24%. Nitrates and zinc and compounds were examples of contaminants to water produced by the industry.

Establishments in the Primary Metals industry reported one of the lowest proportions of establishments that used as least one energy conservation process or technology (58%). Just under 40% indicated they used energy efficient equipment. Fuel substitution (17%) and clean fuel systems (12%) were the second and third most reported.

Pipeline Transportation

Like the Oil and Gas Extraction and Natural Gas Distribution industries, the Pipeline Transportation industry was one of the heaviest users of biological technologies in the treatment of liquid and solid waste, as well as site reclamation and decommissioning. Approximately three-quarters of the establishments indicated that they used biological technologies, such as landfarming, biopiles and bioremediation to treat solid waste and for site reclamation and decommissioning.

Over 80% of the establishments in the Pipeline Transportation industry reported using physical treatment methods to treat liquid waste (e.g. oil/water separation using gravity, coalescing separators and oilphylic pads). Sixty four percent reported using biological methods, such as anaerobic and aerobic treatment. As with the Oil and Gas Extraction industry, a very high percentage of establishments indicated that they were involved in site reclamation and decommissioning (95%). Almost 70% indicated using bioremediation and 55% indicated using biological degradation by aeration or bioventilation.

The Pipeline Transportation industry reported the highest proportion of establishments that used at least one energy conservation process or technology (95%). The industry reported the highest proportion of energy efficient equipment use (91%), and the third highest proportion that used fuel substitution (41%).

Table 3.2
Emission Type by Treatment Method and Industry, 1998

Industry	Physical treatment	Chemical treatment	Thermal treatment	Biological treatment	Other	**Total**
	percent[1]					
Logging						
Treatment of gaseous emissions	x	0	x	x	23	**32**
Treatment of liquid waste	39	x	x	36	5	**55**
Solid waste management	63	.	11	x	11	**71**
Site reclamation and decommissioning	32	.	7	20	29	**63**
Control of noise, vibration and radiation	20	.	.	.	.	**20**
Oil and Gas Extraction						
Treatment of gaseous emissions	49	54	83	17	x	**88**
Treatment of liquid waste	76	41	32	53	x	**80**
Solid waste management	88	.	20	68	7	**93**
Site reclamation and decommissioning	86	.	31	76	19	**100**
Control of noise, vibration and radiation	80	.	.	.	.	**80**
Mining						
Treatment of gaseous emissions	54	31	8	5	12	**73**
Treatment of liquid waste	69	52	3	44	8	**84**
Solid waste management	81	.	8	21	6	**88**
Site reclamation and decommissioning	49	.	-	21	32	**75**
Control of noise, vibration and radiation	44	.	.	.	.	**44**
Electric Power Generation, Transmission and Distribution						
Treatment of gaseous emissions	38	15	x	0	19	**50**
Treatment of liquid waste	62	42	15	42	x	**81**
Solid waste management	92	.	x	15	0	**92**
Site reclamation and decommissioning	50	.	12	31	23	**77**
Control of noise, vibration and radiation	62	.	.	.	.	**62**
Natural Gas Distribution						
Treatment of gaseous emissions	x	x	50	0	x	**83**
Treatment of liquid waste	58	8	x	42	0	**67**
Solid waste management	67	.	x	50	0	**83**
Site reclamation and decommissioning	58	.	x	50	0	**67**
Control of noise, vibration and radiation	50	.	.	.	.	**50**
Food						
Treatment of gaseous emissions	44	16	24	8	9	**63**
Treatment of liquid waste	63	31	5	20	x	**71**
Solid waste management	88	.	x	13	8	**91**
Site reclamation and decommissioning	7	.	0	x	7	**15**
Control of noise, vibration and radiation	40	.	.	.	.	**40**
Beverage and Tobacco Products						
Treatment of gaseous emissions	28	9	6	x	10	**41**
Treatment of liquid waste	45	45	x	10	x	**65**
Solid waste management	84	.	x	x	6	**88**
Site reclamation and decommissioning	9	.	0	0	7	**16**
Control of noise, vibration and radiation	29	.	.	.	.	**29**
Wood Products						
Treatment of gaseous emissions	56	3	12	x	15	**70**
Treatment of liquid waste	42	11	10	19	4	**51**
Solid waste management	85	.	12	10	3	**88**
Site reclamation and decommissioning	19	.	x	12	11	**36**
Control of noise, vibration and radiation	38	.	.	.	.	**38**
Pulp, Paper and Paperboard Mills						
Treatment of gaseous emissions	64	39	36	16	13	**77**
Treatment of liquid waste	92	57	13	83	4	**94**
Solid waste management	79	.	16	37	11	**90**
Site reclamation and decommissioning	20	.	3	9	13	**37**
Control of noise, vibration and radiation	42	.	.	.	.	**42**
Petroleum and Coal Products						
Treatment of gaseous emissions	71	61	64	x	x	**82**
Treatment of liquid waste	75	46	x	43	x	**75**
Solid waste management	82	.	x	21	14	**96**
Site reclamation and decommissioning	25	.	x	x	32	**57**
Control of noise, vibration and radiation	46	.	.	.	.	**46**
Chemicals						
Treatment of gaseous emissions	67	39	37	5	13	**85**
Treatment of liquid waste	58	41	16	19	7	**76**
Solid waste management	76	.	11	10	5	**82**
Site reclamation and decommissioning	23	.	2	4	10	**34**
Control of noise, vibration and radiation	47	.	.	.	.	**47**

Table 3.2
Emission Type by Treatment Method and Industry, 1998 (continued)

Industry	Physical treatment	Chemical treatment	Thermal treatment	Biological treatment	Other	**Total**
	percent[1]					
Non-Metallic Mineral Products						
Treatment of gaseous emissions	85	9	15	0	x	**87**
Treatment of liquid waste	60	24	7	26	10	**71**
Solid waste management	91	.	0	x	x	**91**
Site reclamation and decommissioning	13	.	0	6	15	**31**
Control of noise, vibration and radiation	60	.	.	.	.	**60**
Primary Metals						
Treatment of gaseous emissions	71	33	28	6	14	**86**
Treatment of liquid waste	64	42	14	11	5	**72**
Solid waste management	79	.	5	3	7	**82**
Site reclamation and decommissioning	23	.	x	4	12	**33**
Control of noise, vibration and radiation	54	.	.	.	.	**54**
Transportation Equipment						
Treatment of gaseous emissions	54	14	20	x	16	**77**
Treatment of liquid waste	59	46	11	7	9	**69**
Solid waste management	87	.	4	x	x	**88**
Site reclamation and decommissioning	23	.	0	x	10	**31**
Control of noise, vibration and radiation	40	.	.	.	.	**40**
Pipeline Transportation						
Treatment of gaseous emissions	45	50	55	0	32	**86**
Treatment of liquid waste	82	55	32	64	x	**86**
Solid waste management	95	.	32	73	0	**100**
Site reclamation and decommissioning	95	.	x	77	0	**95**
Control of noise, vibration and radiation	68	.	.	.	.	**68**

Notes:
This table includes reported data only.
1. Number of establishments indicating they used the treatment method as a percentage of all establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.3
Energy Conservation Processes and Technologies by Industry, 1998

Industry	Cogeneration	Energy efficient equipment	Fuel substitution	Waste-to-energy system	Clean fuel system	Renewable energy source: Solar power	Renewable energy source: Wind power	Renewable energy source: Geothermal	Renewable energy source: Biomass	Renewable energy source: Other renewable energy source	Other	Proportion of establishments that used at least one energy conservation process or technology
	percent[1]											
Logging	x	16	x	x	x	x	x	x	x	x	x	21
Oil and Gas Extraction	25	69	44	31	37	36	x	x	x	0	12	85
Mining	3	47	7	16	8	8	x	0	0	0	8	62
Electric Power Generation, Transmission and Distribution	x	81	23	23	x	15	15	x	x	0	19	88
Natural Gas Distribution	x	50	42	x	x	x	0	0	0	0	x	75
Food	6	49	9	7	10	x	0	0	x	x	11	62
Beverage and Tobacco Products	x	45	x	x	6	0	0	0	0	0	7	57
Wood Products	7	28	21	48	7	0	0	x	21	x	5	68
Pulp, Paper and Paperboard Mills	21	43	31	40	23	0	0	0	39	x	4	81
Petroleum and Coal Products	18	50	14	18	21	0	0	0	0	0	14	75
Chemicals	9	40	9	13	10	x	0	0	0	0	8	53
Non-Metallic Mineral Products	0	53	13	10	x	0	0	0	0	x	7	62
Primary Metals	2	39	17	9	12	0	0	0	0	x	9	54
Transportation Equipment	7	51	12	5	9	5	0	0	0	0	8	59
Pipeline Transportation	x	91	41	27	x	x	0	0	0	x	x	95
Total[2]	**8**	**44**	**15**	**18**	**12**	**3**	**1**	**x**	**6**	**1**	**8**	**69**

Notes:
This table includes reported data only.
1. Number of establishments indicating they used the process or technology as a percentage of all establishments that provided a response.
2. Number of establishments that indicated they used at least one environmental process or technology as a percentage of the total number of establishments who provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.4
Environmental Technologies Used in Logging Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of liquid waste	
Anaerobic treatment (Septic tank)	34
Oil/Water separation (Gravity)	30
Oil/Water separation (Oilphylic pads)	11
Oil/Water separation (Coalescing separators)	7
Treatment of noise, vibration or radiation	
Mufflers	18
Energy conservation	
Energy efficient equipment	16
Site reclamation and decommissioning	
Excavation	27
Underground storage tanks	9
Biological degradation by aeration or bioventilation	7
Bioremediation	7
Incineration	7
Solid waste management	
Container	46
Modification or preparation of materials for landfill or waste treatment site	32
Incineration	11
Packaging	7

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.5
Environmental Technologies Used in the Oil and Gas Extraction Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Flare system	83
Desulfurisation	32
Filtration (Activated carbon filter)	31
Vapour condenser	31
Scrubbing (Wet scrubbing system)	29
Adsorption (Activated carbon adsorption)	27
Incineration (Thermal recuperative incineration)	25
Cooling tower	20
Catalytic reduction	17
Inertial separator (Cyclone)	15
Filtration (Bag house)	15
Incineration (Catalytic incineration)	15
Gravity deposition (Precipitation chamber)	14
Chemical oxidation	12
Dryer	12
Oxidation (Thermal oxidation)	12
Phytoremediation	10
Thermal regenerative incineration	10
Gravity deposition (Dust collector system)	8
Inertial separator (Vortex)	8
Filtration (Membrane filter)	8
Activated sludge	8
Scrubbing (Air scrubbing)	8
Incineration (Fluidised bed)	8
Inertial separator (Centrifugal precipitator)	7
Adsorption (Other media)	7
Biological filtration	7
Treatment of liquid waste	
Oil/water separation (Gravity)	73
Anaerobic treatment (Septic tank)	46
Oil/water separation (Coalescing separators)	36
Adsorption system (Activated carbon adsorption)	32
Aerobic treatment (Aeration pond)	27

Table 3.5
Environmental Technologies Used in the Oil and Gas Extraction Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Primary clarification (Sedimentation, gravity settling chamber)	24
Filtration (Bed filtration system)	24
Equalisation pond	22
Incineration	22
Evaporation	22
Aerobic treatment (Aerobic lagoon)	20
Screening	19
Contact system (Air stripping)	19
Filtration (Pressure)	19
Neutralisation	19
Flocculation	19
Disinfection (Chlorination)	17
Oil/water separation (Oilphylic pads)	15
Flotation	15
Ion exchange	15
Demineralisation	14
Aerobic treatment (Aeration system)	14
Centrifugal precipitator	12
Aerobic treatment (Activated sludge dewatering)	12
Coagulation	10
Biosystem (Biological reactor)	10
Degritting	8
Precipitator	8
Adsorption system (Other media)	7
Contact system (Steam stripping)	7
Filtration (Membrane)	7
Drying	7
Distillation	7
Thermal oxidation	7
Aerobic treatment (Biological polishing or biofiltration)	7
Treatment of noise, vibration or radiation	
Mufflers	80
Acoustic barriers	61
Energy conservation	
Energy efficient equipment	69
Fuel substitution	44
Clean fuel system	37
Renewable energy source (Solar power)	36
Waste-to-energy system	31
Cogeneration	25
Site reclamation and decommissioning	
Excavation	83
Bioremediation	69
Underground storage tanks handling	59
Biological degradation by aeration or bioventilation	46
Vapour extraction systems	39
Soil washing	29
Incineration	22
Geomembrane	20
Thermal desorption technology	20
Renaturalisation	17
Reduction	15
Bioslurping	8
Phytoremediation	8
Thermal oxidation system	8
Solid waste management	
Container	86
Landfarming method	68
Biopiles	34
Modification or preparation for landfill or waste treatment site	32
Composting technology	27
Packaging	25
Compacting	22

Table 3.5
Environmental Technologies Used in the Oil and Gas Extraction Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Incineration	20
Shredding	19
Screening	15
Dehydration	12
Crushing	8

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.6
Environmental Technologies Used in the Mining Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Filtration (Bag house)	40
Gravity deposition (Dust collector system)	35
Scrubbing (Wet scrubbing system)	30
Inertial separator (Cyclone)	16
Electrostatic precipitator	7
Gravity deposition (Precipitation chamber)	5
Inertial separator (Impingement eliminator)	5
Catalytic reduction	4
Activated sludge	3
Scrubbing (Air scrubbing)	3
Desulfurisation	3
Cooling tower	3
Treatment of liquid waste	
Primary clarification (Sedimentation, Gravity settling chamber)	53
Oil/water separation (Gravity)	34
Flocculation	34
Neutralisation	27
Anaerobic treatment (Septic tank)	21
Disinfection (Chlorination)	16
Aerobic treatment (Aerobic lagoon)	11
Oxidation (Chemical oxidation)	10
Precipitator	9
Aerobic treatment (Aeration system)	9
Coagulation	8
Oil/water separation (Coalescing separators)	5
Aerobic treatment (Biological polishing or biofiltration)	5
Screening	4
Adsorption system (Other media)	4
Filtration (Bed filtration system)	4
Equalisation pond	4
Aerobic treatment (Activated sludge dewatering)	4
Aerobic treatment (Aeration pond)	4
Anaerobic treatment (Anaerobic digester reactor)	4
Degritting	3
Adsorption system (Activated carbon adsorption)	3
Flotation	3
Filtration (Vacuum)	3
Ion exchange	3
Demineralisation	3
Biosystem (Biological reactor)	3
Treatment of noise, vibration or radiation	
Mufflers	34
Acoustic barriers	21

Table 3.6
Environmental Technologies Used in the Mining Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Energy conservation	
Energy efficient equipment	47
Waste-to-energy system	16
Clean fuel system	8
Renewable energy source (solar power)	8
Fuel substitution	7
Cogeneration	3
Site reclamation and decommissioning	
Excavation	39
Underground storage tanks handling	17
Reduction	11
Bioremediation	11
Geomembrane	10
Biological degradation by aeration or bioventilation	8
Renaturalisation	8
Vapour extraction systems	6
Injection grouting technology	3
Soil washing	3
Solid waste management	
Container	64
Modification or preparation for landfill or waste treatment site	36
Landfarming method	20
Shredding	18
Compacting	14
Crushing	10
Packaging	9
Incineration	8
Screening	5

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.7
Environmental Technologies Used in the Electric Power Generation, Transmission and Distribution Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Electrostatic precipitator	31
Filtration (Bag house)	15
Treatment of liquid waste	
Primary clarification	38
Oil/Water separation (Gravity)	38
Disinfection (Chlorination)	31
Neutralisation	31
Aerobic treatment (Aerobic lagoon)	23
Anaerobic treatment (Septic tank)	23
Screening	19
Filtration (Bed filtration system)	15
Equalisation pond	15
Flocculation	15
Coagulation	15
Aerobic treatment (Aeration system)	15
Treatment of noise, vibration or radiation	
Acoustic barriers	42
Mufflers	35
Energy conservation	
Energy efficient equipment	81
Fuel substitution	23
Waste-to-energy system	23
Renewable energy source (solar power)	15
Renewable energy source (wind power)	15

Table 3.7
Environmental Technologies Used in the Electric Power Generation, Transmission and Distribution Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Site reclamation and decommissioning	
Underground storage tanks	23
Excavation	46
Biological degradation by aeration or bioventilation	15
Bioremediation	23
Solid waste management	
Container	77
Modification or preparation for landfill or waste treatment site	35
Compacting	23
Shredding	15
Landfarming method	15

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.8
Environmental Technologies Used in the Natural Gas Distribution Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Flare system	33
Treatment of liquid waste	
Oil/water separation (Gravity)	58
Anaerobic treatment (Septic tank)	33
Treatment of noise, vibration or radiation	
Acoustic barriers	42
Mufflers	42
Energy conservation	
Energy efficient equipment	50
Fuel substitution	42
Site reclamation and decommissioning	
Excavation	58
Bioremediation	33
Solid waste management	
Container	58
Landfarming method	42
Packaging	33

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.9
Environmental Technologies Used in the Pulp, Paper and Paperboard Mills Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Inertial separator (Cyclone)	41
Electrostatic precipitator	40
Scrubbing (Wet scrubbing system)	37
Gravity deposition (Dust collector system)	19
Activated sludge	16
Filtration (Bag house)	13
Incineration (Catalytic incineration)	13
Oxidation (Thermal oxidation)	9
Vapour condenser	7
Cooling tower	6
Incineration (Thermal regenerative incineration)	5
Gravity deposition (Precipitation chamber)	4
Flare system	4
Inertial separator (Impingement eliminator)	4
Chemical oxidation	4
Scrubbing (Air scrubbing)	3
Treatment of liquid waste	
Primary clarification	80
Aerobic treatment (Activated sludge dewatering)	49
Screening	49
Degritting	34
Neutralisation	31
Flocculation	30
Aerobic treatment (Aeration system)	29
Flotation	28
Oil/water separation (Gravity)	26
Aerobic treatment (Aeration pond)	20
Equalisation pond	16
Coagulation	16
Aerobic treatment (Aerobic lagoon)	16
Filtration (Pressure)	15
Biosystem (Biological reactor)	15
Contact system (Steam stripping)	12
Disinfection (Chlorination)	12
Filtration (Gravity)	11
Filtration (Bed filtration system)	10
Aerobic treatment (Biological polishing or biofiltration)	9
Incineration	7
Anaerobic treatment (Septic tank)	7
Filtration (Vacuum)	7
Evaporation	7
Oil/water separation (Oilphylic pads)	5
Adsorption system (Polymer)	4
Precipitator	3
Adsorption system (Activated carbon adsorption)	3
Oxidation (Chemical oxidation)	3
Anaerobic treatment (Anaerobic digester reactor)	3
Treatment of noise, vibration or radiation	0
Mufflers	33
Acoustic barriers	22
Energy conservation	
Energy efficient equipment	43
Waste-to-energy system	40
Renewable energy source (Biomass energy)	39
Fuel substitution	31
Clean fuel system	23
Cogeneration	21
Site reclamation and decommissioning	
Excavation	13
Underground storage tanks handling	6
Bioremediation	5
Reduction	3
Incineration	3

Table 3.9
Environmental Technologies Used in the Pulp, Paper and Paperboard Mills Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Solid waste management	
Container	60
Compacting	33
Modification or preparation for landfill or waste treatment site	31
Landfarming method	29
Dehydration	23
Composting technology	19
Incineration	13
Screening	10
Degritting	10
Packaging	8
Shredding	8
Grinding	4
Crushing	4
Fluidised bed incineration	3

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.10
Environmental Technologies Used in the Petroleum and Coal Products Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Flare system	46
Scrubbing (Wet scrubbing system)	43
Inertial separator	36
Desulfurisation	29
Catalytic reduction	29
Cooling tower	21
Filtration (Bag house)	18
Vapour condenser	18
Gravity deposition (Dust collector system)	14
Treatment of liquid waste	
Oil/water separation (Gravity)	68
Primary clarification (Sedimentation, Gravity settling chamber)	46
Flotation	39
Equalisation pond	36
Flocculation	32
Aerobic treatment (Aeration pond)	25
Aerobic treatment (Aeration system)	21
Screening	18
Adsorption system (Activated carbon adsorption)	18
Contact system (Steam stripping)	18
Neutralisation	18
Oil/water separation (Coalescing separators)	14
Contact system (Air stripping)	14
Disinfection (Chlorination)	14
Coagulation	14
Anaerobic treatment (Septic tank)	14
Biosystem (Biological reactor)	14
Treatment of noise, vibration or radiation	
Mufflers	46
Acoustic barriers	29
Energy conservation	
Energy efficient equipment	50
Clean fuel system	21
Cogeneration	18
Waste-to-energy system	18
Fuel substitution	14

Table 3.10
Environmental Technologies Used in the Petroleum and Coal Products Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Site reclamation and decommissioning	0
Excavation	18
Vapour extraction systems	14
Solid waste management	
Container	71
Compacting	25
Modification or preparation for landfill or waste treatment site	21
Packaging	18
Landfarming method	18
Shredding	14

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.11
Environmental Technologies Used in the Chemicals Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Filtration (Bag house)	46
Gravity deposition (Dust collector system)	40
Scrubbing (Wet scrubbing system)	36
Inertial separator (Cyclone)	22
Flare system	14
Cooling tower	13
Oxidation (Thermal oxidation)	11
Adsorption (Activated carbon absorption)	11
Vapour condenser	11
Filtration (Membrane filter)	10
Filtration (Activated carbon filter)	9
Incineration (Thermal recuperative incineration)	7
Scrubbing (Air scrubbing)	6
Inertial separator (Impingement eliminator)	4
Activated sludge	4
Adsorption (Other media)	3
Inertial separator (Vortex)	3
Chemical oxidation	2
Catalytic reduction	2
Gravity deposition (Precipitation chamber)	2
Oxidation (Catalytic oxidation)	2
Treatment of liquid waste	
Neutralisation	30
Primary clarification	29
Oil/Water separation (Gravity)	27
Flocculation	11
Filtration (Bed filtration system)	11
Screening	9
Filtration (Pressure)	9
Disinfection (Chlorination)	9
Adsorption system (Activated carbon adsorption)	8
Incineration	8
Contact system (Stream stripping)	8
Equalisation pond	8
Ion exchange	7
Aerobic treatment (Aeration system)	7
Reduction system (Dechlorination)	7
Coagulation	7
Aerobic treatment (Activated sludge dewatering)	7
Distillation	6
Contact system (Air stripping)	6
Aerobic treatment (Aeration pond)	6
Anaerobic treatment (Septic tank)	6

Table 3.11
Environmental Technologies Used in the Chemicals Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Oil/Water separation (Coalescing separators)	5
Aerobic treatment (Aerobic lagoon)	5
Flotation	4
Precipitator	4
Oil/Water separation (Oilphylic pads)	3
Filtration (Membrane)	3
Biosystem (Biological reactor)	3
Degritting	2
Filtration (Vacuum)	2
Demineralisation	2
Aerobic treatment (Biological polishing or biofiltration)	2
Drying	2
Thermal oxidation	2
Anaerobic treatment (Anaerobic digester reactor)	2
Treatment of noise, vibration or radiation	
Mufflers	38
Acoustic barriers	26
Energy conservation	
Energy efficient equipment	40
Waste-to-energy system	13
Clean fuel system	10
Cogeneration	9
Fuel substitution	9
Site reclamation and decommissioning	
Excavation	15
Underground storage tanks	5
Solvent extraction system	3
Geomembrane	2
Soil washing	2
Bioremediation	2
Vapour extraction system	2
Reduction	2
Solid waste management	
Container	57
Compacting	37
Packaging	20
Shredding	19
Incineration	11
Modification or preparation for landfill or waste treatment site	7
Dehydration	7
Crushing	6
Landfarming method	6
Grinding	6
Composting technology	3
Biopiles	2
Screening	2

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.12
Environmental Technologies Used in the Primary Metal Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Filtration (Bag house)	57
Gravity deposition (Dust collector system)	46
Scrubbing (Wet scrubbing system)	29
Inertial separator (Cyclone)	27
Cooling tower	18
Electrostatic precipitator	12
Gravity deposition (Precipitation chamber)	11
Filtration (Membrane filter)	9
Inertial separator (Impingement eliminator)	7
Flare system	7
Scrubbing (Air scrubbing)	6
Vapour condenser	5
Filtration (Activated carbon filter)	5
Desulfurisation	5
Incineration (Thermal recuperative incineration)	5
Activated sludge	4
Chemical oxidation	4
Oxidation (Thermal oxidation)	4
Adsorption (Other media)	3
Inertial separator (Centrifugal precipitator)	3
Adsorption (Activated carbon adsorption)	3
Incineration (Thermal regenerative incineration)	3
Inertial separator (Vortex)	2
Catalytic reduction	2
Dryer	2
Treatment of liquid waste	
Primary clarification	31
Oil/water separation (Gravity)	31
Flocculation	26
Neutralisation	24
Filtration (Pressure)	18
Oil/water separation (Coalescing separators)	15
Filtration (Bed filtration system)	13
Coagulation	11
Screening	10
Disinfection (Chlorination)	9
Precipitator	8
Evaporation	8
Equalisation pond	8
Oil/water separation (Oilphylic pads)	6
Adsorption system (Polymer)	6
Flotation	6
Ion exchange	5
Anaerobic treatment (Septic tank)	5
Degritting	5
Filtration (Membrane)	5
Centrifugal precipitator	4
Oxidation (Chemical oxidation)	4
Filtration (Vacuum)	4
Filtration (Gravity)	4
Distillation	4
Aerobic treatment (Aeration system)	4
Drying	3
Adsorption system (Activated carbon adsorption)	3
Aerobic treatment (Activated sludge dewatering)	3
Contact system (Steam stripping)	2
Demineralisation	2
Aerobic treatment (Aeration pond)	2
Treatment of noise, vibration or radiation	
Mufflers	42
Acoustic barriers	36

Table 3.12
Environmental Technologies Used in the Primary Metal Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Energy conservation	
Energy efficient equipment	39
Fuel substitution	17
Clean fuel system	12
Waste-to-energy system	9
Cogeneration	2
Site reclamation and decommissioning	
Excavation	14
Underground storage tanks handling	6
Geomembrane	5
Bioremediation	3
Solid waste management	
Container	72
Compacting	21
Packaging	12
Shredding	11
Modification or preparation for landfill or waste treatment site	10
Screening	6
Dehydration	5
Crushing	4
Incineration	3
Grinding	3
Landfarming method	3
Pyrolysis	2

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.13
Environmental Technologies Used in the Pipeline Transportation Industry, 1998

Technology	Proportion of total establishments that used each technology
	percent
Treatment of gaseous emissions	
Flare system	41
Vapour condenser	36
Desulfurisation	32
Catalytic reduction	32
Dryer	32
Inertial separator (Vortex)	27
Filtration (Membrane filter)	27
Adsorption (Activated carbon adsorption)	27
Chemical oxidation	27
Cooling tower	27
Inertial separator (Centrifugal precipitator)	23
Incineration (Thermal regenerative incineration)	23
Treatment of liquid waste	
Oil/water separation (Gravity)	77
Oil/water separation (Coalescing separators)	59
Adsorption system (Activated carbon adsorption)	59
Oil/water separation (Oilphylic pads)	55
Flocculation	55
Anaerobic treatment (Septic tank)	55
Primary clarification	50
Adsorption system (Other media)	50
Contact system (Air stripping)	50
Filtration (Bed filtration system)	45
Equalisation pond	45
Disinfection (Chlorination)	45
Aerobic treatment (Aeration pond)	45
Adsorption system (Polymer)	41
Oxidation (Chemical oxidation)	41
Coagulation	41

Table 3.13
Environmental Technologies Used in the Pipeline Transportation Industry, 1998 (continued)

Technology	Proportion of total establishments that used each technology
	percent
Screening	27
Filtration (Gravity)	27
Neutralisation	27
Evaporation	27
Aerobic treatment (Aerobic lagoon)	27
Contact system (Steam stripping)	23
Filtration (Pressure)	23
Oxidation (Wet oxidation system)	23
Ion exchange	23
Distillation	23
Aerobic treatment (Aeration system)	23
Flotation	18
Filtration (Membrane)	18
Treatment of noise, vibration or radiation	
Acoustic barriers	59
Mufflers	59
Energy conservation	
Energy efficient equipment	91
Fuel substitution	41
Waste-to-energy system	27
Site reclamation and decommissioning	
Excavation	86
Underground storage tanks handling	73
Bioremediation	68
Biological degradation by aeration or bioventilation	55
Vapour extraction systems	41
Renaturalisation	27
Geomembrane	23
Reduction	18
Phytoremediation	18
Solid waste management	
Container	95
Landfarming method	68
Biopiles	59
Packaging	55
Shredding	50
Modification or preparation for landfill or waste treatment site	41
Compacting	41
Incineration	32
Dehydration	27
Composting technology	27
Crushing	23

Note:
This table includes reported data only.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table 3.14
Distribution of Environmental Technology Use, 1998

Technology	Number of establishments	Proportion of establishments that used each technology	Proportion of total establishments that used each technology by treatment method
		percent	
Treatment of gas			
Physical treatment	Number of establishments that used each physical treatment technology	Proportion of establishments that used each physical treatment technology	
Gravity deposition			
Precipitation chamber	86	10	
Dust collector system	477	58	
Inertial separator			
Cyclone	360	44	
Vortex	49	6	
Centrifugal precipitator	31	4	
Impingement eliminator	52	6	
Electrostatic precipitator	139	17	
Filtration			
Bag house	493	60	
Activated carbon filter	90	11	
Membrane filter	101	12	
Adsorption			
Activated carbon absorption	79	10	
Other media	39	5	
Total - physical treatment	**820**		**76**
Biological treatment	Number of establishments that used each biological treatment technology	Proportion of establishments that used each biological treatment technology	
Biological filtration	21	24	
Activated sludge	65	76	
Phytoremediation	9	10	
Total - biological treatment	**86**		**8**
Chemical treatment	Number of establishments that used each chemical treatment technology	Proportion of total establishments that used each chemical treatment technology	
Scrubbing			
Wet scrubbing system	309	82	
Air scrubbing	57	15	
Desulfurisation	59	16	
Catalytic reduction	45	12	
Chemical oxidation	48	13	
Ozonation	10	3	
Total - chemical treatment	**378**		**35**
Thermal treatment	Number of establishments that used each thermal treatment technology	Proportion of establishments that used each thermal treatment technology	
Flare system	139	36	
Vapour condenser	91	24	
Dryer	39	10	
Incineration			
Thermal recuperative incineration	79	21	
Catalytic incineration	21	5	
Thermal regenerative incineration	32	8	
Fluidised bed	19	5	
Oxidation			
Thermal oxidation	71	19	
Catalytic oxidation	9	2	
Cooling tower	151	39	
Total - thermal treatment	**383**		**36**
Total - all other treatment of gas	**187**		**17**
Total, treatment of gas	**1 078**		
Treatment of liquid waste			
Physical treatment	Number of establishments that used each physical treatment technology	Proportion of establishments that used each physical treatment technology	
Screening	245	27	
Degritting	101	11	
Primary clarification	473	52	
Precipitator	77	9	
Centrifugal precipitator	40	4	
Oil/Water separation			
Gravity	442	49	
Oilphylic pads	72	8	
Coalescing separators	134	15	

Table 3.14
Distribution of Environmental Technology Use, 1998 (continued)

Technology	Number of establishments	Proportion of establishments that used each technology	Proportion of total establishments that used each technology by treatment method
		percent	
Adsorption system			
Activated carbon absorption	90	10	
Polymer	54	6	
Other media	37	4	
Contact system			
Air stripping	53	6	
Stream stripping	60	7	
Flotation	135	15	
Filtration			
Bed filtration system (e.g. sand filter)	131	14	
Pressure (press filter, filter leaf)	128	14	
Vacuum (rotary, drum, centrifugal)	43	5	
Membrane (dialysis, reverse osmosis, ultrafiltration, electrodialysis, piezodialysis, pervaporation)	53	6	
Gravity belt	53	6	
Equalisation pond	116	13	
UV disinfection	20	2	
Total - physical treatment	**904**		**85**
Chemical treatment	Number of establishments that used each chemical treatment technology	Proportion of establishments that used each chemical treatment technology	
Oxidation			
Wet oxidation system	15	3	
Chemical oxidation	57	10	
Electrochemical oxidation	x	x	
Disinfection			
Chlorination	143	26	
Ozonation	11	2	
Reduction system			
Dephosphating	24	4	
Denitrification	16	3	
Dechlorination	29	5	
Neutralisation	319	58	
Ion exchange	70	13	
Flocculation	265	48	
Coagulation	126	23	
Demineralisation	43	8	
Nitrification	16	3	
Total - chemical treatment	**551**		**52**
Thermal treatment	Number of establishments that used each thermal treatment technology	Proportion of establishments that used each thermal treatment technology	
Incineration	74	45	
Drying	28	17	
Evaporation	72	44	
Distillation	42	26	
Fluidised Bed	8	5	
Thermal oxidation	12	7	
Total - thermal treatment	**164**		**15**
Biological treatment	Number of establishments that used each biological treatment technology	Proportion of establishments that used each biological treatment technology	
Aerobic treatment			
Activated sludge dewatering	118	28	
Biological polishing or biofiltration	41	10	
Aeration pond	104	25	
Aerobic lagoon	110	26	
Aeration system	126	30	
Anaerobic treatment			
Septic tank	179	43	
Anaerobic digester reactor	27	6	
Biosystem			
Biological reactor	51	12	
Multiplate reactor	4	1	
Other			
Total - biological treatment	**420**		**40**
Total - all other treatment of liquid waste	**79**		**7**
Total - treatment of liquid waste	**1 063**		

Table 3.14
Distribution of Environmental Technology Use, 1998 (continued)

Technology	Number of establishments	Proportion of establishments that used each technology	Proportion of total establishments that used each technology by treatment method
		percent	
Treatment of noise, vibration and radiation			
Physical treatment	Number of establishments that used each physical treatment technology	Proportion of establishments that used each physical treatment technology	
Noise/vibration suppression equipment			
Acoustic barriers	409	62	
Mufflers	534	81	
Other	49	7	
Total - treatment of noise, vibration and radiation	**663**		**100**
Energy conservation and efficiency			
Physical treatment	Number of establishments that used each physical treatment technology	Proportion of establishments that used each physical treatment technology	
Cogeneration	112	12	
Energy efficiency	644	69	
Fuel substitution	223	24	
Waste-to-energy system	255	27	
Clean fuel system	169	18	
Renewable energy source			
Solar power	50	5	
Wind power	8	1	
Geothermal	x	x	
Biomass	84	9	
Other	161	17	
Total - energy conservation and efficiency	**938**		**100**
Site reclamation and decommissioning			
Physical treatment	Number of establishments that used each physical treatment technology	Proportion of establishments that used each physical treatment technology	
Underground storage tanks	160	41	
Excavation	286	74	
Solvent extraction system	28	7	
Vapour extraction system	57	15	
Geomembrane	63	16	
Injection grouting technology	10	3	
Soil washing	37	10	
Reduction	44	11	
Total - physical treatment	**387**		**65**
Biological treatment	Number of establishments that used each biological treatment technology	Proportion of establishments that used each biological treatment technology	
Biological degradation by aeration or bioventilation	76	45	
Bioslurping	6	4	
Bioremediation	115	68	
Renaturalization	46	27	
Phytoremediation	16	9	
Total - biological treatment	**170**		**29**
Thermal treatment	Number of establishments that used each thermal treatment technology	Proportion of establishments that used each thermal treatment technology	
Thermal desporption technology	14	33	
Thermal oxidation system	12	28	
Incineration	32	74	
Total - thermal treatment	**43**		**7**
Total - all other site reclamation and decommissioning	**201**		**34**
Total, site reclamation and decommissioning	**595**		

Table 3.14
Distribution of Environmental Technology Use, 1998 (continued)

Technology	Number of establishments	Proportion of establishments that used each technology	Proportion of total establishments that used each technology by treatment method
		percent	
Solid waste management			
Physical treatment	Number of establishments that used each physical treatment technology	Proportion of establishments that used each physical treatment technology	
Container	986	83	
Dehydration	89	7	
Packaging	211	18	
Modification or preparation for landfill or waste treatment site	226	19	
Pozzolanic treatment method	5	0	
Compacting	455	38	
Shredding	286	24	
Grinding	68	6	
Crushing	102	9	
Screening	93	8	
Degritting	25	2	
Total - physical treatment	**1 189**		**94**
Thermal treatment	Number of establishments that used each thermal treatment technology	Proportion of establishments that used each thermal treatment technology	
Fluidised bed incineration	8	7	
Pyrolysis	7	6	
Incineration	108	89	
Total - thermal treatment	**121**		**10**
Biological treatment	Number of establishments that used each biological treatment technology	Proportion of establishments that used each biological treatment technology	
Biopiles	47	12	
Composting technology	84	23	
Landfarming method	186	57	
Total - biological treatment	**224**		**18**
Total - all other waste management	**86**		**7**
Total, solid waste management	**1 262**		

Source:
Statistics Canada, Environment Accounts and Statistics Division.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4 Concepts, Methodology and Data Quality[1]

Introduction

The following information should be used to ensure a clear understanding of the basic concepts that define the data provided in this product, of the underlying methodology of the survey, and of key aspects of the data quality. This information will provide the user with a better understanding of the strengths and limitations of the data, and of how they can be effectively used and analysed. The information may be of particular importance when making comparisons with data from other surveys or sources of information, and in drawing conclusions regarding change over time.

4.1 Data sources and methodology

Data presented in this report are derived from the *Survey of Environmental Protection Expenditures* (SEPE), 1997 and 1998. Conducted on an annual basis from 1994 to 1998, the SEPE provides a measure of the cost imposed on industry in order to comply with or to anticipate compliance with environmental regulations, conventions and voluntary agreements. The 1997 and 1998 surveys also collected new information related to businesses' environmental management practices, pollution prevention practices and use of environmental technologies.

The 1997 and 1998 SEPE did not cover the entire business sector (i.e., agriculture, construction, distributive trades, and services industries were not surveyed). Rather, the survey targeted a number of industries for which environmental protection spending was likely to constitute a relatively large proportion of total expenditures.

The data reported in this study are based upon a survey of 2 459 establishments in 1997 and 2 543 establishments in 1998 in primary industries (resource extraction industries) and manufacturing industries, electric power and gas distribution industries and the pipeline transport industry. In order to be selected in the survey, an establishment generally had to have more than 49 employees[2].

Selection of target industries

1997

A number of industries were targeted for increased survey coverage based on 2-digit and 3-digit Standard Industrial Classification (SIC) industries (Text Box 4.1). Target industries were selected based on the likelihood that they faced or anticipated high levels of environmental expenditures. The selection was based upon previous survey results and additional information obtained from annual reports of companies and Statistics Canada's annual *Capital and Repair Expenditure Survey*[3].

Selected establishments that belonged to these target industries each received a detailed questionnaire (long form), from which they provided information on the three specific questions that are the object of this report: the adoption of environmental management methods; the use of pollution prevention practices; and the use of environmental technologies.

For most of these target industries, a census of establishments with more than 49 employees was taken.[4] A sample of establishments (with more than 49 employees) in other, non-target manufacturing industries was done. In general, target industries were identified as those reporting more than $1 000 of environmental expenditures per employee in 1996.

1998

A total of 15 industry groups were targeted for increased survey coverage in 1998 based on 4, 5, and 6-digit NAICS industries (Text Box 4.2). Previous survey results determined that these targeted industries are more likely to have high levels of environmental expenditures. Typically, target industries were identified as those reporting more than $1 000 of environmental expenditures per employee in 1997. Additional information obtained from the annual reports of companies and Statistics Canada's annual *Capital and Repair Expenditure Survey* was also used in making this designation.

The following target industries were included in the census (take-all) portion of the survey: Logging (excluding contract logging); Mining (excluding quarrying); Oil and Gas Extraction; Beverages and Tobacco Products; Pulp, Paper

1. For more detailed information on methodology, please see Statistics Canada, *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (Revised)*, Catalogue No. 16F0006XIE, Ottawa, August 2000 and Statistics Canada, *Environmental Protection Expenditures in the Business Sector, 1998*, Catalogue No. 16F0006XIE, November 2001, available free of charge on Statistics Canada's Web site (www.statcan.ca).
2. In some provinces and territories, in order to maintain minimum coverage, the employment thresholds were reduced.
3. The *Capital and Repair Expenditure Survey* provided information on industries that had relatively high capital expenditures on assets associated with pollution abatement and control (PAC). In the past, information from surveys in other countries was also used to help determine target industries.
4. In smaller provinces and in the territories, the employee threshold was decreased.

and Paperboard Mills; Primary Metals; Petroleum and Coal Products; Electric Power Generation, Transmission, and Distribution; Pipeline Transportation; and Natural Gas Distribution.

1998 Industry classification

In previous years establishments were selected based on the 1980 Standard Industrial Classification System (SIC). However, beginning with reference year 1998 industry selection was based on the North American Industry Classification System (NAICS).

This new classification system was developed as a cooperative effort between the statistical agencies of Canada, Mexico and the United States. Created against the background of the North American Free Trade Agreement, it is designed to provide common definitions of the industrial structure of the three countries and a common statistical framework to facilitate the analysis of the three economies.[1]

The establishments that were surveyed in both 1997 and 1998 were compared to examine any differences in industry classification resulting from the switch to NAICS. It was found that an insignificant number of establishments were reclassified into different industry groups, thus allowing for comparisons with previous survey years.[2]

Sample selection

1997

The survey included a census strata (take-all) and a sample strata (take-some). Target industries (manufacturing and non-manufacturing industries) were included in the census portion of the survey, with the exception of the following industries: Food, Wood, Non-Metallic Mineral Products, Transportation Equipment and Chemical and Chemical Products.

For these 5 manufacturing industries, a stratified sample (including some take-all and take-some strata) was taken at the 3-digit SIC level because of their low environmental expenditure per employee ratio and their large number of small and medium-sized establishments. However, these five manufacturing industries remained target industries because the environmental expenditure to employee ratio was higher than $1 000 at the 2-digit SIC level. Consequently, establishments in these industries received a long form.

Text Box 4.1
1997 List of Selected Targeted Industries

- Logging (SIC 041)
- Mining (SICs 061, 062, 063)
- Crude Petroleum and Natural Gas (SIC 071)
- Food (SICs 101-109) and Tobacco Products (SICs 121-122)
- Beverage (SICs 111-114)
- Wood (SICs 251, 252, 254 and 259)
- Pulp and Paper (SIC 271)
- Primary Metals (2-digit SIC 29)
- Transportation Equipment (SICs 321-329)
- Non-Metallic Mineral Products (2-digit SIC 35)
- Refined Petroleum and Coal Products (2-digit SIC 36)
- Chemical Products (2-digit SIC 37)
- Pipeline Transport (SIC 461)
- Gas Distribution Systems (SIC 492)
- Electric Power (SIC 491)

The non-targeted manufacturing industries were sampled at the 3-digit SIC level and grouped into an “other manufacturing” category. Establishments (with more than 49 employees) in these industries received a short questionnaire and therefore did not provide information on their use of environmental technologies nor environmental management practices.[3]

The take-some strata were selected by ranking establishments within each 3-digit SIC by total employment. If there were 50 or more establishments in the 3-digit SICs, the top 15% of establishments were selected. If there were between 15 and 49 establishments, the top 20% were selected. Where the total number of establishments fell below 15, all establishments were selected. In some provinces and territories, in order to obtain minimum coverage, the employment thresholds were reduced. The sample selected the largest establishments in order to minimise response burden.

1. Statistics Canada, 1997, *North American Industry Classification System,* Catalogue No. 12-501-XPE, Ottawa.
2. For additional information on the impact of the conversion to a NAICS-based classification system from SIC80, please see: Statistics Canada, September 1999, *Private and Public Investment in Canada, Revised Intentions, 1999*, pp. 11-14, Catalogue No. 61-206-XIB.
3. For more information on the survey methodology, please consult Statistics Canada, 2000, *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised)*, Catalogue No. 16F0006XIE, August, Ottawa, available free of charge on Statistics Canada’s Web site (www.statcan.ca).

Text Box 4.1
1998 List of Selected Targeted Industries

- Logging (NAICS 113311, 113312)
- Oil and Gas Extraction (NAICS 211)
- Mining (NAICS 2121, 2122, 21239)
- Electric Power Generation, Transmission and Distribution (NAICS 2211)
- Natural Gas Distribution (NAICS 2212)
- Food (NAICS 311)
- Beverage and Tobacco Products (NAICS 312)
- Wood Products (NAICS 321)
- Pulp, Paper, and Paperboard Mills (NAICS 3221)
- Petroleum and Coal Products (NAICS 324)
- Chemicals (NAICS 325)
- Non-Metallic Mineral Products (NAICS 327)
- Primary Metals (NAICS 331)
- Transportation Equipment (NAICS 336)

1998

The manufacturing sample was a stratified sample based upon employment. This employment-based stratified sample was used to determine a take-all portion and a take-some portion. The take-all strata contained the following industries: Beverage and Tobacco Products; Pulp, Paper, and Paperboard Mills; Primary Metals; and Petroleum and Coal Products. All establishments with over 49 employees in these target manufacturing industries were surveyed as take-all using a more detailed (long) questionnaire (non-targeted manufacturing industries received a shorter version of the questionnaire).

The remaining target manufacturing industries (Food; Wood Products; Non-metallic Mineral Products; Transportation Equipment; and Chemicals) were sampled using a combination of the take-all and take-some strata. These industries were sampled because of their low environmental expenditure per employee ratio (at the 4, 5 or 6-digit NAICS level, depending on the industry) and their large number of small and medium-sized establishments. However, these six manufacturing industries remained target industries because the environmental expenditure to employee ratio was higher than $1 000 at the 3-digit NAICS level. Consequently, establishments in these industries received a long form.

The non-targeted manufacturing industries were sampled at the 4-digit NAICS level and grouped into an "other manufacturing" category. To minimize response burden, sampled establishments (with more than 49 employees) in these industries received a short questionnaire.

The take-some strata were selected by ranking establishments within each 4, 5, or 6-digit NAICS (again depending on the industry group) by total employment. If there were 50 or more establishments in the 4-digit NAICS, the top 15% of establishments were selected. If there were between 15 and 49 establishments, the top 20% were selected. Where the total number of establishments fell below 15, all establishments were selected. In some provinces and territories, in order to obtain minimum coverage, the employment thresholds were reduced. The sample selected the largest establishments in order to minimise response burden.

All establishments with more than 49 employees in Logging; Mining; Oil and Gas Extraction; Electric Power Generation, Transmission and Distribution; Natural Gas Distribution; and Pipeline Transportation industries were selected. All establishments were surveyed using the long (more detailed) questionnaire.

Analysis had shown that there was no correlation between the environmental expenditure to employment ratio and employment size. Therefore, it was assumed that no bias was introduced by surveying the largest establishments in an industry group.

4.2 Concepts and variables measured

The survey questionnaire was originally designed in consultation with key public and private sector groups and by looking at the experience of other countries who have conducted similar surveys. The scope of the survey was to include all expenditures that are required to meet environmental regulation, convention or voluntary agreement[1] (see the questionnaire for further explanation). As mentioned above, there were two questionnaires, a long form for target industries and a short form for other manufacturing industries. The mail out of the 1997 survey took place in November 1998. The 1998 mail out took place in November 1999.

This report focuses on three questions from the 1997 and 1998 SEPE: 1) the adoption of global environmental management practices such as life cycle analysis; 2) the methods used to prevent pollution; and 3) the technologies used to reduce pollution.

1. Environmental voluntary agreements were added as a specific criterion (in addition to the convention criterion) for the 1997 SEPE.

Environmental management practices

For the first time, the 1997 SEPE, in its long version, included a question on environmental management practices and programs (Question 13). Respondents were asked to report on the following:

- Does the establishment use an environment management system?
- Is the establishment ISO 14000 certified or equivalent?
- Has the establishment implemented any environmental voluntary agreement or participated in any voluntary environment program?
- Does the establishment have a "green" procurement policy?
- Are any goods produced by the establishment certified by an environmental Program, such as "Eco-Logo"?
- Has the establishment reported to the National Pollutant Release Inventory (NPRI)?
- Has the establishment published an annual report on environmental performance or sustainable development?
- Does the establishment use life cycle analysis for decision-making?

Only those establishments belonging to target industries provided this new type of information.

Pollution prevention methods

Previous survey cycles included a question on methods or practices used to reduce pollution during reference year and in the next two years. These practices included end-of-pipe processes as well as pollution prevention methods such as recycling. This question was available in both short forms and long forms.

In the 1997 questionnaire, this section was modified in order to put emphasis on pollution prevention, as defined by the Federal Government. The list of practices was modified in order to be more consistent with Environment Canada's pollution prevention categories. The long form focused on pollution prevention methods (Question 7c).[1] Pollution prevention categories were listed as follows:

- product design or reformulation
- substitution or modification of production process (integrated process)
- recirculation, recovery, on-site recycling or reuse of materials or substances
- energy conservation
- material substitution, solvent reduction, elimination or substitution
- prevention of leaks and spills

Use of environmental technologies

The 1997 long questionnaire introduced a new question asking establishments to choose from a list of over 100 environmental technologies those that they used (Question 12). Only establishments that were part of the target industries were surveyed by this question. Previous SEPE cycles had asked respondents to describe their most significant environmental projects with respect to end-of-pipe processes and integrated process changes.[2] The question was repeated on the 1998 long questionnaire and incorporated changes to improve the accuracy of the data as well as to make the question easier for respondents to understand.

Technologies were grouped according to the following categories: treatment of gas; treatment of liquid waste; treatment of noise, vibration and radiation; energy conservation; site reclamation and decommissioning; solid waste management. They were also grouped according to the following treatment categories: physical, biological, chemical or thermal. Those technologies dealt for the most part with pollution abatement, with the exception of energy conservation, which is a pollution prevention alternative.

4.3 Data Quality

Data collection for the 1997 and 1998 reference year took place during the first quarter of 1999 and the first quarter of 2000 respectively. Survey questionnaires were mailed to specific establishments identified in the frame and the responses were returned by mail. The surveys were addressed to a contact person who was either responsible for, or had knowledge of, the environmental operations of the company. In the case of some multi-establishment firms, the survey was mailed to the head office, which either forwarded the questionnaire to the appropriate establishment or provided a combined report for all targeted establishments.

1. In contrast, Question 6 in the short form not only included a breakdown of pollution prevention categories but also included an "end-of-pipe" category in order to distinguish use of end-of-pipe processes from pollution prevention practices.

2. Summary tables were published in the 1994 and 1995 versions of *Environmental Protection Expenditures in the Business Sector*, Item 16F0006XIE, Statistics Canada and in *Human Activity and the Environment 2000*, Catalogue No. 11-509-XPE, section 7.4.6, Statistics Canada.

Follow-ups via fax and/or telephone were carried out after the due date to remind respondents to return their surveys.

Questionnaires were edited in two steps. First, validity edits were applied to ensure that responses to particular questions fell within a limited range of possible values. Second, consistency edits were then applied. Cases where responses in one section of the questionnaire were inconsistent with those given in other sections were identified and edited. These edits were done on an ongoing basis throughout the data collection phase.

Additional follow-ups were carried out to collect missing data and to resolve inconsistencies.

For the 1997 reference year, there were 1 881 reports received for 2 459 surveyed establishments. The response rate obtained by the 1997 survey was 76%, based on the number of reporting establishments, and 85% based on employment covered. This represented an improvement over 1996.[1]

For the 1998 reference year, there were 2 108 reports received for 2 543 surveyed establishments. The response rate for the 1998 survey was 83%, based on the number of reporting establishments, and 88% based on employment covered.

Specific questions

There were 1 743[2] questionnaires mailed to individual establishments for the 1997 reference year. Over 1 000 establishments answered the question on the type of environmental management practices they used (Question 13). This represents a response rate of 62%. The response rate for Question 7c, pollution prevention methods, is the same as the overall response rate for the 1997 survey (76%).

There were 1 831[3] questionnaires mailed to individual establishments for the 1998 reference year. One thousand four hundred and fifty four returned the questionnaire with at least one environmental technology chosen. The assumption was made that every establishment would indicate the use of at least one process or technology listed in Question 12[4]. Given this assumption, the response rate was 79% (Table 4.1). The number of establishments that answered the question on the type of environmental management practice they used was virtually identical (1 455). The response rate for pollution prevention methods was 83%.

The results presented in this report include reported data only. There was no imputation nor estimation done for non-response. Given the large number of possible responses and the cross-sectional nature of the *Survey of Environmental Protection Expenditures*, estimating for non-response would not have resulted in improved results.

When interpreting the results, users must also take into consideration that the *Survey of Environmental Protection Expenditures* was sent to those establishments with 50 or more employees. In addition, establishments in the sampled industry codes were selected based on employment rank (the establishments with the largest number of employees were chosen). The largest establishments are more likely to have the means to adopt environmental management and pollution prevention practices.

Sampling and non-sampling errors

There are two general categories of error in surveys. The first one arises from the fact that a sample or subset of the target population is used to represent the population. This is referred to as sampling error and its size is quantifiable. The other category is referred to as non-sampling error and is not as easily quantified because of its nature. Non-sampling error refers to all the other kinds of error that arise in surveys - incomplete or inaccurate lists of the general population, respondent misinterpretation of questions, provision of erroneous information, failure or refusal to respond, information processing errors, and so on.

Typically the sampling error is measured by the coefficient of variation, that is the standard deviation or expected variability of the estimate as a percentage of the estimate. In the case of the *Survey of Environmental Protection Expenditures*, the sample of establishments to be surveyed was not randomly selected. Rather, a minimal sample number was calculated, and the establishments with the largest number of employees were chosen. This methodology was used in order to survey the largest proportion of employment in each target industry while keeping response burden to a minimum.

Every attempt was made to eliminate the non-sampling errors from the results of both surveys. Establishments brought into the survey for the first time were researched and it was verified that the contact information was accurate. The returned questionnaires were verified and validated before data capture. The data were edited and tabulated automatically. Extensive follow-up was carried out for incomplete responses and for non-response. Instructions and definitions were further refined.

1. For further detail on response rates and data quality, please see *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised)*, Statistics Canada, Catalogue No. 16F0006XIE (available free of charge on Statistics Canada Web site www.statcan.ca).
2. This does not include out of scope, out of business, amalgamations or sales of operations etc.
3. *Ibid*.
4. For example, it can be assumed that every respondent must manage some form of solid waste.

The 1997 and 1998 survey represented the fourth and fifth time the annual survey had been conducted. Many of the establishments have received the questionnaire in the past and have therefore become familiar with the concepts and definitions of the survey. They are, as a result, more able to avoid errors of interpretation in their responses.

The most common difficulty reported by respondents with respect to questions 7c, 12 and 13 was the degree of knowledge required by the respondent to complete both the environmental expenditure portion, and the environmental technology portion of the survey. In some instances, the questionnaire needed to be completed by more than one individual, leading to increased response time and difficulty in providing all of the information.

4.4 Comparability of data

Readers should be aware that the 1997 and 1998 estimates represent reported data only. No estimation was done for non-response and non-surveyed establishments. The 1998 SEPE realized a significant increase in the response rate for the question on environmental management practices over 1997 (Section 1). There was an associated increase in the quality of the 1998 estimates. Therefore, any comparisons made between 1997 and 1998 results should be done so with caution. For the benefit of our users, 1997 tables on environmental management practices are provided in the Annex of this report.

The data on pollution prevention methods in this report (Section 2) have been collected for a number of survey cycles. Respondents have become more familiar with reporting pollution prevention and the corresponding response rates have been consistently high. Although the data represent reported values only, overall comparability between years is possible.

For the first time, 1997 SEPE included the question (Question 12) on the use of environmental technologies to abate or prevent pollution by numerous media (Section 3). The response rate attained for Question 12 was 62%, well below the overall response rate of 76%. The were also numerous non-sampling errors found in the data.

The 1998 SEPE included the same question again with numerous improvements. A higher response rate (79.5%) was achieved (only slightly below the overall response rate of 83%) and there were fewer non-sampling errors. These improvements, increased the quality of the Question 12 results over 1997. The difference in the quality of the data between the two years make comparisons questionable. For this reason, this report contains the 1998 reference year data only. The 1997 results on the use of environmental technologies are only available through special request.

Table 4.1
Number of Establishments Using at Least One Environmental Technology by Industry, 1998

Industry	Responses[1]	Total[2] establishments	Response as a percentage of total[2]
Logging	56	90	62.2
Oil and Gas Extraction	131	151	86.8
Mining	59	77	76.6
Electric Power Generation, Transmission and Distribution	169	207	81.6
Natural Gas Distribution	69	83	83.1
Food	134	159	84.3
Beverage and Tobacco Products	195	240	81.3
Wood Products	105	124	84.7
Pulp, Paper & Paperboard	136	202	67.3
Petroleum and Coal Products	68	100	68.0
Chemicals	28	41	68.3
Non-Metallic Mineral Products	245	293	83.6
Primary Metals	26	29	89.7
Transportation Equipment	22	22	100.0
Pipeline Transport	12	13	92.3
Total	**1 455**	**1 831**	**79.5**

Notes:
1. Includes only establishments that indicated they used at least one environmental technology.
2. Total excludes out of scope establishments, merges, closed and/or sold establishments, etc.

Source:
Statistics Canada, Environment Accounts and Statistics Division.

Annex A: Statistical Tables


ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

Table A.1

Expenditures on Environmental Protection by Industry and Type of Activity, 1998

Industry	Environmental monitoring	Environmental assessments and audits	Reclamation and decommissioning	Wildlife and habitat protection	Pollution abatement and control processes (end of pipe)[1]	Pollution prevention processes	Fees, fines and licences	Other	**Total**
	million dollars								
Operating expenditures									
Logging	3.0	5.0	19.1	70.4	5.4	4.4	1.4	7.8	116.5
Oil and Gas Extraction	16.0	8.6	110.2	1.3	55.0	26.4	9.2	31.7	258.4
Mining	20.6	4.8	55.8	2.3	104.9	38.7	4.6	17.2	248.8
Electric Power Generation, Transmission and Distribution	6.6	34.2	5.7	12.0	x	5.3	32.7	x	295.6
Natural Gas Distribution	0.3	1.6	0.6	0.1	2.4	0.7	0.1	3.2	8.9
Food	11.0	2.6	0.2	3.7	78.4	14.2	9.6	4.0	123.7
Beverage and Tobacco Products	0.8	0.5	0.9	..	13.3	1.6	2.3	1.8	21.2
Wood Products	8.5	2.4	15.8	29.4	x	21.4	5.6	x	137.6
Pulp, Paper and Paperboard Mills	43.7	3.6	3.3	11.4	241.9	62.8	8.0	12.8	387.5
Petroleum and Coal Products	7.3	2.4	4.1	..	101.5	56.4	1.1	14.4	187.3
Chemicals	25.0	6.5	42.3	1.3	101.5	34.5	2.5	18.3	231.9
Non-Metallic Mineral Products	2.5	3.3	2.8	1.0	20.8	5.9	2.8	4.1	43.2
Primary Metals	37.2	5.8	16.9	5.8	275.7	61.4	2.7	13.6	419.2
Transportation Equipment	5.8	2.3	18.0	0.1	89.8	10.8	0.9	11.7	139.4
Pipeline Transportation	2.0	0.7	4.2	0.3	8.1	4.4	1.4	11.2	32.2
Other manufacturing	..	..	..	..	..	..	..	..	338.8
Total operating expenditures, excluding other manufacturing[3]	**190.2**	**84.3**	**300.1**	**139.2**	**1 304.8**	**348.8**	**84.9**	**199.1**	**2 651.4**
Total	**..**	**..**	**..**	**..**	**..**	**..**	**..**	**..**	**2 990.2**
	million dollars								
Capital expenditures									
Logging	0.5	0.1	0.2	3.0	1.5	2.1	…	…	7.4
Oil and Gas Extraction	4.3	9.9	69.4	0.9	55.5	46.5	…	…	186.5
Mining	2.1	5.8	8.1	3.8	33.4	28.1	…	…	81.2
Electric Power Generation, Transmission and Distribution	4.9	19.2	1.7	20.7	56.5	21.0	…	…	124.0
Natural Gas Distribution	0.1	0.6	0.6	0.2	1.0	14.5	…	…	16.8
Food	2.5	0.9	1.3	5.8	37.6	12.7	…	…	60.8
Beverage and Tobacco Products	1.0	0.2	0.1	0.2	2.6	1.5	…	…	5.5
Wood Products	3.1	0.6	6.4	2.4	66.0	17.8	…	…	96.3
Pulp, Paper and Paperboard Mills	13.2	0.5	4.6	1.1	89.1	179.2	…	…	287.7
Petroleum and Coal Products	0.5	3.0	5.4	1.2	82.2	48.6	…	…	141.0
Chemicals	18.6	3.3	7.0	0.4	65.7	94.3	…	…	189.2
Non-Metallic Mineral Products[2]	4.0	0.1	2.5	..	32.6	15.1	…	…	54.3
Primary Metals	4.6	0.4	1.4	1.3	102.9	73.4	…	…	184.0
Transportation Equipment	0.7	0.2	1.0	0.2	16.3	30.4	…	…	48.7
Pipeline Transportation	0.6	6.4	2.9	0.5	41.6	63.7	…	…	115.6
Other manufacturing	..	..	..	..	..	..	…	…	135.0
Total capital expenditures, excluding other manufacturing[3]	**60.7**	**51.0**	**112.5**	**41.6**	**684.6**	**648.7**	**…**	**…**	**1 599.1**
Total capital expenditures	**..**	**..**	**..**	**..**	**..**	**..**	**…**	**…**	**1 734.2**

Notes:
Figures may not add up to totals due to rounding.
1. Purchases of 'Waste management and sewerage services' are included with operating expenditures for 'Pollution abatement and control processes' (end-of-pipe).
2. Capital expenditures on 'Wildlife and habitat protection' are included with the capital expenditures on 'Reclamation and decommissioning.'
3. Detail of the expenditure breakdown by type of environmental activity is only available for the listed industries.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table A.2
Environmental Management Practices by Businesses, 1997

Environmental management practice	Establishments using the practice	Proportion of establishments using the practice[1]	Employment share of establishments using the practice
	number	percent	
Environmental management system	663	64	77
Life cycle analysis	207	20	31
ISO 14000 Certification	92	9	14
Environmental voluntary agreements	397	38	58
Green procurement policy	184	18	34
Eco-labelling of products	59	6	11
Annual environmental performance report	353	34	53
Other	54	19	33
Total[2]	**912**	**84**	**93**

Notes:
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Number of establishments indicating they used at least one environmental practice as a percentage of the total number of establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table A.3
Distribution of Environmental Management Practices by Industry, 1997

Industry	Environmental management system	Life cycle analysis	ISO 14000 Certification	Environmental voluntary agreement	Green procurement policy	Eco-labelling of products	Annual environmental performance report	Other	**Total[2]**
	percent[1]								
Logging	39	6	2	11	4	2	25	11	**43**
Mining	71	21	1	44	18	-	51	40	**88**
Crude Petroleum and Natural Gas	90	36	10	79	20	5	44	25	**95**
Food and Tobacco Products	65	13	5	10	16	1	19	19	**77**
Beverage	51	10	-	24	26	25	12	-	**74**
Wood	44	10	7	19	9	2	32	17	**67**
Pulp and Paper	77	19	9	62	23	14	64	29	**96**
Primary Metals	57	14	9	34	10	-	23	18	**91**
Transportation Equipment	62	24	20	28	27	4	29	17	**88**
Non-Metallic Mineral Products	61	16	2	10	18	5	13	20	**74**
Refined Petroleum and Coal Products	65	50	6	70	20	10	40	50	**90**
Chemical Products	65	30	15	47	19	9	32	10	**90**
Pipeline Transport and Gas Distribution Systems[1]	74	37	15	61	35	10	61	50	**95**
Electric Power Systems	83	21	7	83	24	7	54	29	**90**

Notes:
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Number of establishments indicating they used at least one environmental practice as a percentage of the total number of establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table A.4
Distribution of Environmental Management Practices by Establishment Size, 1997[1]

Number of employees per establishment	Environmental management system	Life cycle analysis	ISO 14000 Certification	Environmental voluntary agreement	Green procurement policy	Eco-labelling of products	Annual environment performance report	Other	**Percentage of total employees**
	percent[1]								percent[2]
<100	49	18	8	29	12	4	21	11	76
100 - 499	64	20	8	33	16	7	33	21	87
500 - 999	74	19	8	51	26	5	44	26	93
>999	86	28	17	69	32	7	58	38	98

Notes:
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Number of establishments indicating they used at least one environmental practice as a percentage of the total number of establishments that provided a response.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table A.5

Distribution of Environmental Management Practices, by Province and Territory, 1997

Province/Territory	Environmental management system	Life cycle analysis	ISO 14000 Certification	Environmental voluntary agreement	Green procurement policy	Eco-labelling of products	Annual environmental performance report	Other	**Total[2]**
	percent[1]								
Newfoundland and Labrador	71	25	6	31	41	7	20	50	**89**
Prince Edward Island	x	-	-	-	-	-	-	x	**x**
Nova Scotia	68	4	4	23	9	5	18	25	**83**
New Brunswick	63	28	6	52	13	10	33	30	**81**
Quebec	57	14	6	33	11	6	32	15	**76**
Ontario	64	22	12	35	22	6	29	16	**87**
Manitoba	38	13	2	20	21	-	16	22	**82**
Saskatchewan	70	14	5	40	23	-	49	44	**91**
Alberta	78	31	9	59	16	8	46	25	**91**
British Columbia	65	18	8	35	14	6	45	7	**77**
Yukon and Northwest Territories[3]	67	17	-	33	33	-	50	100	**100**

Notes:
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Number of establishments indicating they used at least one environmental practice as a percentage of the total number of establishments that provided a response.
3. Includes Nunavut.
Source:
Statistics Canada, Environment Accounts and Statistics Division.

Table A.6

Frequency of Pollution Prevention Methods by Industry, 1997

Industry	Product design of reformulation	Substitution or modification of production process	Recirculation. recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Proportion of respondents who reported
	percent[1]							percent
Logging	9	3	34	6	14	80	6	30
Mining	4	22	59	54	24	50	2	73
Crude Petroleum and Natural Gas	34	40	74	66	49	94	6	80
Food and Tobacco Products	14	30	67	59	30	63	6	61
Beverage	25	18	57	32	21	50	14	57
Wood	16	21	58	35	35	60	9	45
Pulp and Paper	8	27	72	41	31	58	12	79
Primary Metals	11	43	70	54	37	51	2	61
Transportation Equipment	18	32	64	56	56	57	5	79
Non-Metallic Mineral Products	12	25	75	33	31	38	8	65
Refined Petroleum and Coal Products	39	44	72	61	50	78	-	78
Chemical Products	27	23	61	39	36	68	5	68
Other manufacturing	12	18	63	33	41	30	18	77
Pipeline Transport and Gas Distribution Systems	17	11	50	72	44	78	11	82
Electric Power Systems	7	20	53	73	53	93	13	65
Total	**15**	**24**	**64**	**42**	**37**	**51**	**10**	**67**

Notes:
Figures may not add up to totals due to rounding.
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
Source:
Statistics Canada, *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised)*, catalogue no. 16F0006XIE, August 2000, Ottawa.

Table A.7
Planned Pollution Prevention Methods by Industry, 1998-1999[1]

Industry	Product design of reformulation	Substitution or modification of production process	Recirculation, recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Proportion of respondents who reported
	percent[2]							percent
Logging	9	12	34	9	16	69	9	27
Mining	5	30	59	56	23	53	3	58
Crude Petroleum and Natural Gas	37	54	80	74	37	91	6	80
Food and Tobacco Products	16	35	69	65	26	60	6	68
Beverage	10	16	58	68	19	45	3	63
Wood	14	19	67	23	40	56	7	45
Pulp and Paper	14	34	79	60	33	65	9	75
Primary Metals	16	45	74	54	39	54	3	59
Transportation Equipment	30	47	74	68	66	63	10	74
Non-Metallic Mineral Products	10	25	81	48	33	50	6	60
Refined Petroleum and Coal Products	53	67	80	67	53	93	-	65
Chemical Products	34	30	66	42	41	62	4	70
Other manufacturing	17	28	63	47	47	40	7	63
Pipeline Transport and Gas Distribution Systems	18	24	65	71	41	82	6	77
Electric Power Systems	13	20	47	67	53	87	13	65
Total	**19**	**32**	**67**	**52**	**40**	**56**	**6**	**62**

Notes:
Figures may not add up to totals due to rounding.
This table includes data reported only.
1. Pollution prevention methods planned in the next two years.
2. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
Source:
Statistics Canada, *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised)*, catalogue no. 16F0006XIE, August 2000, Ottawa.

Table A.8
Frequency of Pollution Prevention Methods by Province and Territory, 1997

Province/Territory	Product design of reformulation	Substitution or modification of production process	Recirculation, recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Proportion of respondents who reported
	percent[1]							percent
Newfoundland and Labrador	12	29	53	29	24	71	6	77
Prince Edward Island	25	-	100	25	50	75	-	57
Nova Scotia	4	18	73	36	32	59	18	60
New Brunswick	8	38	58	62	58	67	4	65
Quebec	11	26	64	40	34	44	10	63
Ontario	17	23	63	43	42	48	11	70
Manitoba	14	28	74	28	38	34	16	77
Saskatchewan	19	42	64	67	25	72	8	74
Alberta	17	23	62	45	29	70	7	70
British Columbia	12	17	60	36	29	57	4	61
Yukon and Northwest Territories[2]	-	29	71	43	29	43	-	70
Canada	**15**	**24**	**64**	**42**	**37**	**51**	**10**	**67**

Notes:
Figures may not add up to totals due to rounding.
This table includes data reported only.
1. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
2. Includes Nunavut.
Source:
Statistics Canada, *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised)*, catalogue no. 16F0006XIE, August 2000, Ottawa.

Table A.9
Planned Pollution Prevention Methods by Province and Territory, 1998-1999[1]

Province/Territory	Product design of reformulation	Substitution or modification of production process	Recirculation, recovery, reuse or recycling	Energy conservation	Material or solvent substitution	Prevention of leaks and spills	Other	Proportion of respondents who reported
	percent[2]							percent
Newfoundland and Labrador	28	28	61	39	28	56	6	82
Prince Edward Island	25	-	100	25	50	75	-	57
Nova Scotia	29	48	76	52	48	52	5	57
New Brunswick	13	26	70	61	48	61	-	62
Quebec	12	32	72	52	36	53	8	56
Ontario	23	33	65	51	46	52	7	66
Manitoba	20	39	83	58	54	46	2	63
Saskatchewan	18	49	62	72	31	64	10	80
Alberta	23	29	66	57	32	72	5	70
British Columbia	13	21	60	39	26	62	3	50
Yukon and Northwest Territories[3]	-	-	80	40	-	40	-	50
Canada	**19**	**32**	**67**	**52**	**40**	**56**	**6**	**62**

Notes:
Figures may not add up to totals due to rounding.
This table includes reported data only.
1. Pollution prevention methods planned in the next two years.
2. Number of establishments indicating they used the practice as a percentage of all establishments that provided a response.
3. Includes Nunavut.
Source:
Statistics Canada, *Environmental Protection Expenditures in the Business Sector, 1996 and 1997 (revised)*, catalogue no. 16F0006XIE, August 2000, Ottawa.