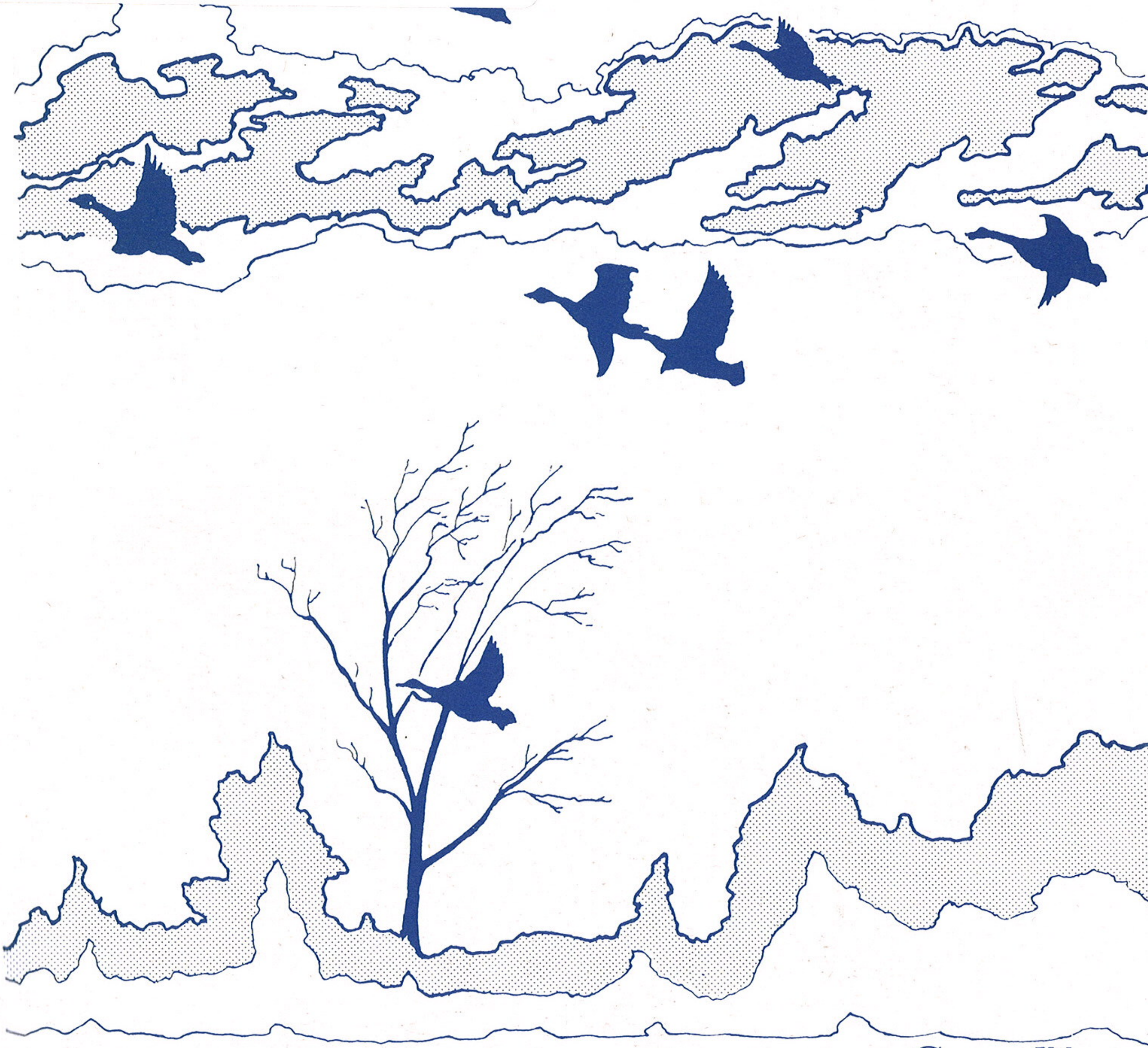
The Clean Air Act Report 1985-1986



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THE CLEAN AIR ACT REPORT
1985-1986

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1 INTRODUCTION

The nature of Canada's air pollution problems has changed over time.

Some of the first air pollution problems to be recognized in Canada were nuisance odours, respiratory tract irritation, reduced visibility, soiling by dust, and corrosion of materials. These problems were particularly noticeable in large, densely populated urban centres. Away from urban centres, clearly identifiable problems were associated with certain heavy industries.

By the 1950s and 1960s, rapid growth of cities and unprecedented industrial expansion had created many intolerable air pollution situations. An increasingly knowledgeable public demanded better air quality. Initially, many of the most obvious sources of air pollution -- such as abattoirs, municipal waste disposal sites, quarries and unpaved roads -- were significantly controlled. Industry and government, working co-operatively to protect the health of workers, also took steps to improve occupational air quality, which contributed indirectly to improved outdoor air quality. Technological advances, modifications to industrial processes and modernization of facilities have also decreased air pollution from some heavy industries, such as steel milling.

Despite these accomplishments, it was recognized that more could be done since the quality of the air in many places remained unsatisfactory. There was a need for air pollution legislation as a means to achieve uniform air quality for all citizens and regions of the country, to provide better mechanisms and institutions to address air pollution problems in Canada, and to establish federal leadership. Consequently, the *Clean Air Act* was brought into effect in 1971.

Enactment of the *Clean Air Act* in 1971 has led to much cleaner air today.

The first major air pollutants to be addressed under the *Clean Air Act* in the 1970s were some large volume, readily identified, well characterized substances which were unique to the air environment. Most notable were sulphur dioxide, nitrogen dioxide, carbon monoxide and particulate matter. These originated mainly from fuel combustion to meet the energy requirements of residences, industrial facilities and commercial enterprises; and from transportation. Many of the sub-lethal human health effects of these pollutants were considered to be reversible, and levels in the atmosphere which would not be threatening could be identified. This knowledge enabled federal and provincial regulatory agencies, working together, to establish objectives for air quality in Canada. Significant progress has been made towards achieving these objectives, to the extent that the annual average levels of many pollutants in cities are now believed to be low enough to adequately protect sensitive groups in the population from adverse effects. Moreover, this improvement in air quality has continued throughout 1985-86.

There have been other accomplishments under the *Clean Air Act*. The lead content in urban air has declined substantially following regulation of the lead content in gasoline. Emissions of contaminants such as mercury and vinyl chloride from some regulated heavy industries have declined significantly. These successes have provided a solid basis for the future. Both opportunities and challenges are foreseen, since important air pollution problems remain to be resolved. As the resources available to address these problems are finite, we must be selective. The opportunity at hand is to concentrate more heavily on some intransigent problems, such as high ozone levels in some parts of Canada, and also to move into some new areas of investigation. The challenge is to do this without compromising past accomplishments. While levels of many contaminants have declined at a fairly steady pace since 1975, this momentum must be maintained. The air is cleaner now than in the past, but it can be cleaner still.

Some recently recognized air pollution problems present a challenge for the future.

This *Clean Air Act* report, for the fiscal year 1985-86, looks at the progress that has been made in resolving the major concerns of the 1970s, and highlights some air pollution problems that have been recognized more recently and are now the subject of investigation by Environment Canada and other agencies. Foremost among those newer problems are the long-range transport of air pollutants; the threat of climate modification, such as through the greenhouse effect and by changing levels of some trace gases in the global atmosphere; emissions of some potentially dangerous chemicals from waste incineration; and the multiple threats to human health and the environment as contaminants move continuously among air, water, soil and plants, and thus to animal and human life.

Authorities Under the Act

The *Clean Air Act* of 1971 specifies measures that Environment Canada may take to achieve wholesome and uniform air quality across the country.

National ambient air quality objectives have been established, reflecting ranges of quality for specific contaminants. Achieving these objectives affords varying degrees of protection to human health and the environment.

The *Clean Air Act* provides the authority for Environment Canada's air pollution control activities.

Environment Canada has set national emission standards for air contaminants from stationary sources where the contaminant could constitute a significant danger to human health or where emissions could lead to the violation of an international obligation. Emission standards for mobile sources of air contaminants, however, are prescribed under the *Motor Vehicle Safety Act* administered by Transport Canada. The provinces have primary responsibility for regulating emissions of air contaminants where human health is not significantly endangered.

National emission guidelines have been set to recommend limits to the quantities and concentrations of contaminants emitted to the ambient air from both mobile and stationary sources.

The content of lead and of phosphorus in fuels has been regulated under the *Clean Air Act*. The Act also encourages air pollution monitoring and research, the formulation of plans and designs for the control and abatement of pollution, and the establishment and demonstration of air pollution control and abatement projects.

With the passage of Bill C-27 in October 1985, the *Clean Air Act* was amended to separate the search and inspection functions of inspectors designated by the Minister of the Environment under the Act. This was not a substantive amendment.

Emissions

Studies of emissions reveal how much of a pollutant is being emitted to the air.

Environment Canada compiles information on emissions of contaminants to the environment to verify compliance with federal emissions standards, to identify where there is a need for further control of emissions, and to enable correlations to be made between reductions in emissions and changes in the levels of contaminants in the air we breathe.

In 1985-86, reports were published on the sources and releases of lead, and of dioxins and furans, to the environment. Some of the information contained in these reports was highlighted in the 1984-85 *Clean Air Act* report. A report was also published on ambient air particulate lead concentrations in Canada from 1975 to 1983, which indicated a 55 per cent decrease in annual average lead levels over that period. This decrease was accounted for by the decrease in the lead content in gasoline, an increased demand for lead-free gasoline, and a lower demand for gasoline. A comparison with United States data confirms this conclusion and indicates that further improvement in particulate lead concentrations can be achieved by continuing to reduce the lead content of gasoline.

Estimates of the emissions of sulphur dioxide and nitrogen oxides (the two main contributors to acid precipitation) in Eastern Canada* were updated and are shown in Figures 1 and 2.

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* Manitoba, Ontario, Quebec and the Atlantic Provinces.

Sulphur dioxide emissions declined between 1970 and 1984.

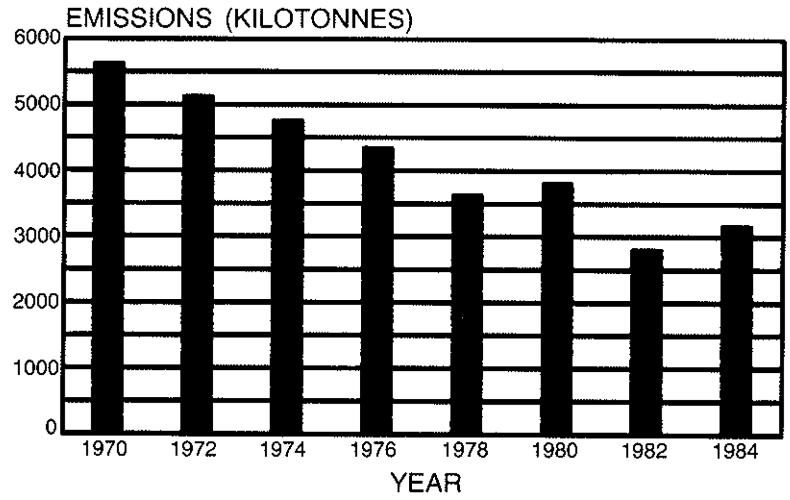

Figure 1 **Estimated Sulphur Dioxide Emissions in Eastern Canada**

Nitrogen oxides emissions remain essentially unchanged since 1974.

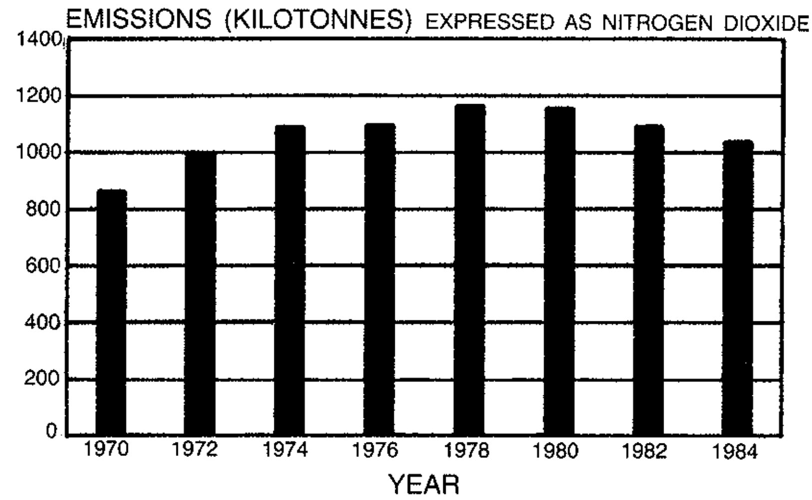

Figure 2 **Estimated Nitrogen Oxides Emissions in Eastern Canada (expressed as nitrogen dioxide)**

Between 1970 and 1984, total emissions of sulphur dioxide in eastern Canada decreased by about 44 per cent. Emissions of nitrogen oxides rose between 1970 and 1978. Since 1978 emissions have tended to level off, indicating a slight decline since 1980.

Sulphur dioxide and nitrogen oxides emissions are also a concern in Western Canada. Under the auspices of the Western Canada Air Emissions Inventory Working Group, comprising representatives from the federal government and the governments of the four western provinces, a "Western Canada Sulphur Dioxide and Nitrogen Oxides Atmospheric Emission Inventory Methods Manual" was produced. The use of the procedures in this manual will ensure that these jurisdictions generate comparable emissions data.

Some emissions studies have led to recommendations for controls.

In another initiative Environment Canada, with the British Columbia Ministry of Environment, and Energy Mines and Resources Canada, completed a study to measure and characterize the sources of malodorous emissions from oil and gas well heads in the Fort St. John area of British Columbia. Fugitive emissions of odorous compounds, principally hydrogen sulphide and hydrocarbons, have been a nuisance problem for communities and residents located near the oil and gas fields. The study found that, in many cases, emissions can be reduced or minimized through better equipment maintenance and operation and by proper incineration of vent gases.

Emissions of coal dust from coal trains have posed a soiling problem for years for people living near certain railway lines in British Columbia and Alberta. In 1985, Environment Canada concluded a number of years of study on methods for controlling these coal dust emissions. A technical review group, with representatives from British Columbia and Alberta coal producers, railway companies, terminal operators and the federal, provincial, and municipal levels of government, has recommended design and operating practices for controlling coal dust emissions. These will be published in 1986-87.

National Ambient Air Quality Objectives

Through the Federal Provincial Advisory Committee on Air Quality, air quality objectives defining the three ranges of air quality specified in the Clean Air Act -- tolerable, acceptable and desirable -- have been developed for five air contaminants. The five are sulphur dioxide, nitrogen dioxide, ozone, carbon monoxide and total suspended particulates. Air quality objectives are being developed for two other contaminants, hydrogen fluoride and total reduced sulphur (the latter generally being present in air as a mixture of sulphur-containing compounds).

Each range of air quality is quantified by prescribing the maximum contaminant level for each range. The significance of these maximum levels is as follows

1) The maximum tolerable level.
   Concentrations of air contaminants exceeding this level could threaten the health of the general population.

Canada's national air quality objectives are a unique three-tiered system.

2) The maximum acceptable level.
   Concentrations at or below this level are intended to provide adequate protection against adverse effects on the most sensitive receptors in the environment.
3) The maximum desirable level.
   This level of air quality is a long-term goal: it forms the basis for a policy governing the protection of pristine areas of the country.

Air Quality Monitoring

Instruments for measuring air pollutants have been in place throughout Canada for a number of years in several air monitoring networks. These networks are useful as a means of keeping track of air pollutants, of indicating levels of intense air pollution and of providing a record of levels over time. Knowledge of the nature and extent of air pollution across Canada is also fundamental to the sound planning of pollution abatement programs.

Federal and provincial governments jointly operate the National Air Pollution Surveillance Network to monitor urban air quality.

In urban areas, the federal and provincial governments fulfill the need for monitoring by sharing responsibility for operating the National Air Pollution Surveillance (NAPS) network. As of December 1985, the network consisted of approximately 400 monitors operating around the clock generating ambient air quality data at 135 stations in 55 cities. Monitoring stations are located in most Canadian cities with populations over 100 000. The specific contaminants that are routinely monitored by the NAPS network fall into two categories. The first category is gaseous pollutants and includes sulphur dioxide, nitrogen dioxide, carbon monoxide and ozone. The other category is solids, which are measured as total suspended particulate. In addition, lead in the atmosphere, which is absorbed onto suspended particulate, as well as sulphate and nitrate, are also routinely monitored by NAPS. National Ambient Air Quality Objectives are the benchmarks for evaluating the NAPS network data (see Figures 3 and 4). Measurements at each monitoring station do not necessarily represent the air quality in the entire region, but rather the quality of the air in the vicinity of the station.

Composite NAPS network annual means for particulate, sulphur dioxide and nitrogen dioxide are compared to the national ambient air quality annual objectives.

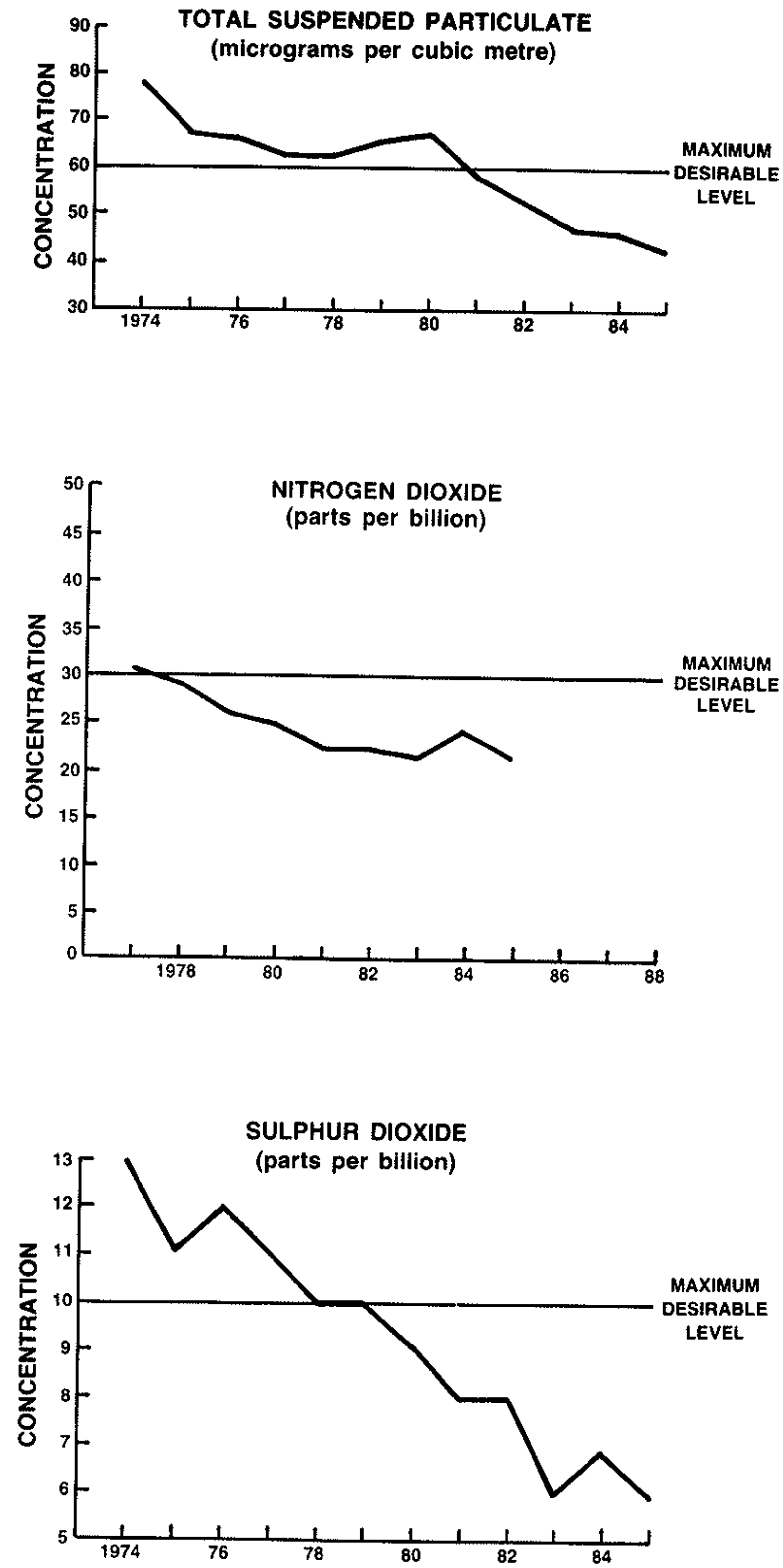

Figure 3 Air Quality Trends - Particulate, Nitrogen Dioxide and Sulphur Dioxide

The composite averages of the measured one-hour ozone and eight-hour carbon monoxide values that are exceeded by only two per cent of the total readings are compared to the national ambient air quality objectives.

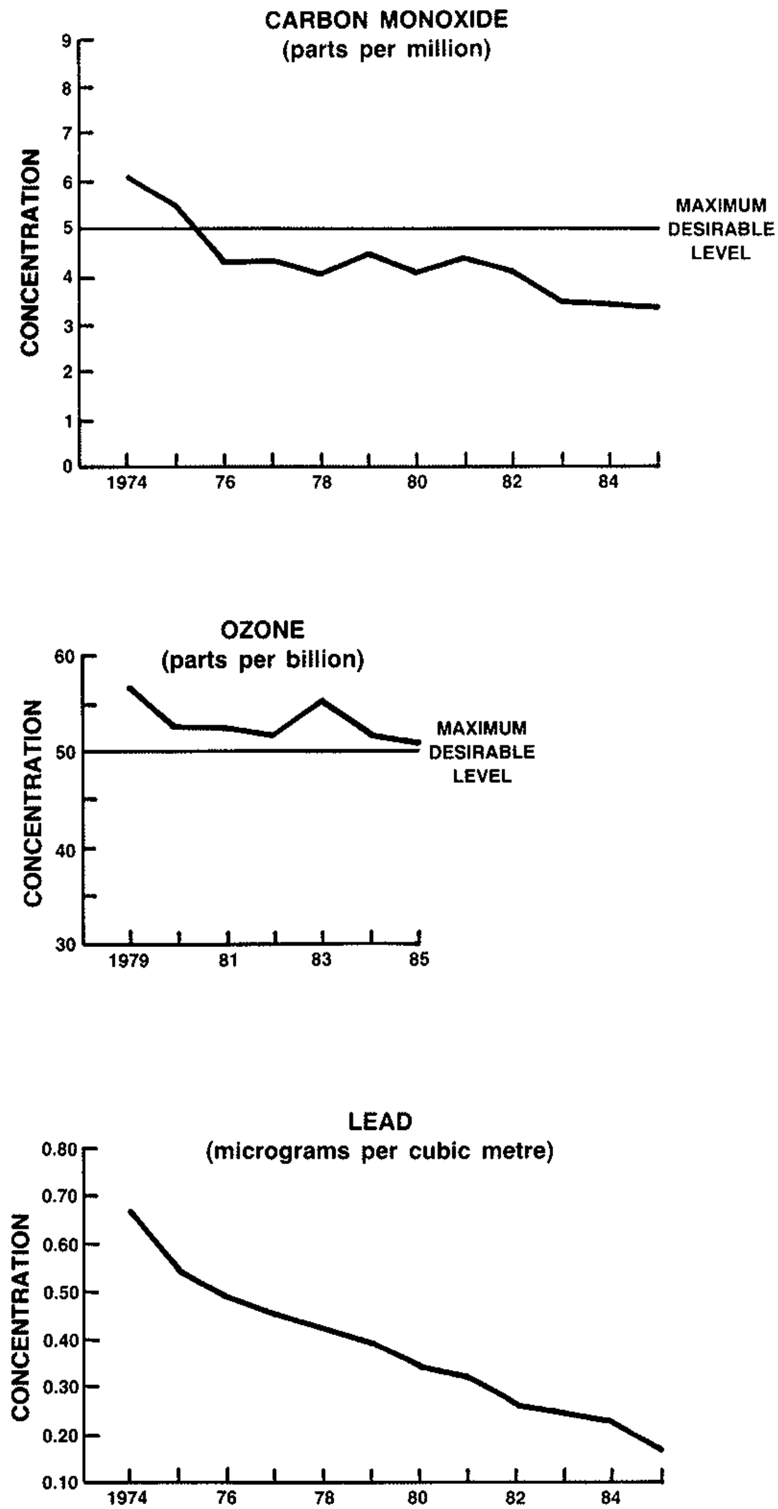

Figure 4 Air Quality Trends - Carbon Monoxide, Ozone and Lead

Air quality trends are established using data generated by the NAPS network. One meaningful way of looking at the trends data is to compare them to the National Ambient Air Quality Objectives (NAAQOs) maximum desirable level (see Figures 3 and 4). It should be noted that there is no national air quality objective for lead. None has been prescribed because the available scientific evidence suggests that a wiser course of action is to control to the extent possible the sources of the lead found in urban air. Environment Canada is taking this course. The annual mean, generally considered a good indicator of pollutant trends, correlates well with changes in emissions resulting from control actions or economic pressures such as the cost of energy or materials. Table 1 quantifies the substantial decreases achieved in the annual average levels of five air contaminants including lead.

Table 1 Trends in Air Pollution

Pollutant	Decrease in Annual Average Levels	Period
sulphur dioxide	54%	1974-75
nitrogen dioxide	29%	1977-85
suspended particulates	45%	1974-85
carbon monoxide	58%	1974-85
lead	74%	1974-85

For ozone and carbon monoxide, however, more meaningful indicators than the annual mean are the composite averages of the measured one-hour ozone and eight-hour carbon monoxide concentrations that are exceeded by only two per cent of the total hourly readings recorded at any given NAPS station. When the composite average for ozone is compared to the maximum desirable one-hour air quality objective (see Figure 4), no general trend in ozone levels is apparent.

Air quality index values show that, overall, the air quality in many Canadian cities is improving.

Environment Canada converts complex monitoring data for all contaminants, except lead and coefficient of haze, into a single number called the air quality index (see Table 2 for the index values for some Canadian cities). As an indicator of air quality, these numbers allow comparisons to be made among cities and among areas of the same city, and reveal trends in overall air pollution. The index is calculated using methods recommended by the World Health Organization.

Inhalable airborne particles and a variety of organic air pollutants are now being monitored by the NAPS network.

The pollutants measured by the NAPS network -- principally those for which national air quality objectives exist -- are not the only ones of present or possible future concern in Canada. A variety of projects have therefore been undertaken to develop and apply new or improved measurement techniques for other air pollutants, either because of their toxic nature or because of their relationship to the long range transport of air pollutants (LRTAP), or both. Most projects are carried out in consultation with the Federal Provincial Advisory Committee on Air Quality and with the help of provincial agencies. Newly developed methods are phased into the NAPS network at selected stations. Already, the application of new methods at some Canadian urban sites has produced a substantial data base. During 1986-87 data on inhalable particulate and some organics will be integrated into the main NAPS network data base. Data on organics are also being supplied to the U.S. Environmental Protection Agency for inclusion in a North American data base.

Table 2 Annual Air Quality Index Values for Some Canadian Cities from 1977 to 1985

Index		Category
0-25	------	Good
26-50	------	Fair
51-100	------	Poor
100 +	------	Very Poor

City	Station Location	'77	'79	'81	'83	'85
Halifax	Barrington & Duke (C)	22	26	27	21	14
Saint John	Post Office (C)	X	X	34	23	21
Montreal	Jardin Botanique (R)	39	34	26	22	17
Montreal	Duncan & Decarie (C)	43	51	47	46	40
Quebec	Parc Cartier Breboeuf (C)	-	-	-	-	22
Hull	Gamelin & Joffre (R)	X	28	20	22	25
Ottawa	88 Slater Street (C)	42	38	24	33	28
Toronto	Breadalbane (C)	40	44	41	40	27
Toronto	Evans & Arnold (I)	40	40	40	38	39
Windsor	471 University (C)	46	33	42	39	40
London	King & Rectory (C)	44	44	41	36	34
Hamilton	Barton & Sanford (C)	51	48	43	45	37
St. Catherines	North & Geneva (C)	46	38	40	43	34
Winnipeg	Jefferson & Scotia (R)	34	44	35	28	19
Regina	1620 Albert Street (C)	X	40	52	33	34
Edmonton	127th St. & 133rd Ave. (R)	39	45	39	33	34
Calgary	39th St. & 29th Ave. N.W. (R)	36	37	36	33	33
Vancouver	Robson & Hornby (C)	36	37	42	18	29
Vancouver	Rocky Point Park (I)	X	32	43	25	27
Victoria	1250 Quadra (C)	29	23	22	17	27

Notes: 1) X = insufficient data to calculate an index.

2) Each station is categorized by the dominant activity at the site: commercial (C), residential (R), or industrial (I).

3) The air quality measured at a monitoring station represents the condition of the air within 0.5 to 4 km of the site and may not necessarily represent community-wide air quality.

4) The 'good' category corresponds to the desirable range of air quality; the 'fair' category corresponds to the acceptable range of air quality; and the 'poor' quality corresponds to a range of air quality above the maximum acceptable level but below the maximum tolerable level.

Many potentially harmful substances can be inhaled with particulates.

Airborne particulates less than 10 μm in diameter are small enough to penetrate the lower respiratory system and are referred to as inhalable particulate matter. It is this fraction of suspended particulate matter that is of primary concern to human health. Inhalable particulate matter can be separated into fine and coarse fractions. These fractions have quite different chemical compositions and generally originate from different sources. Some results from the monitoring of coarse and fine particulates across Canada are shown in Figure 5. Many potentially harmful substances such as lead, arsenic and sulphate are concentrated in the fine fraction.

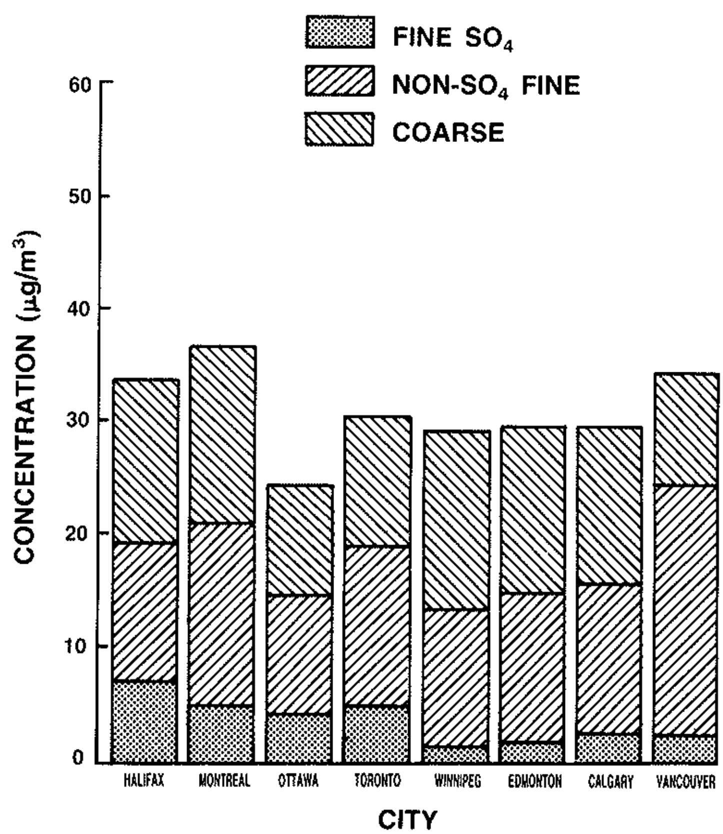

Figure 5 **Mean Concentrations in the Atmosphere of Sulphate (in fine particulate matter), non-sulphate-containing fine particulate matter, and coarse particulate matter at Selected Sites in Canada (May 1984 - March 1985)**

In urban areas, the transportation sector is a major source of emissions of volatile organic compounds.

The use and distribution in the environment of man-made organic compounds has increased dramatically since the early 1950's. In many cases, virtually all of an organic chemical that is manufactured is ultimately released into the environment as a result of its use. Some of these compounds are suspected of endangering human health, and sampling programs are in place in Toronto, Vancouver and Montreal for volatile organic compounds.

Many airborne organic compounds are unstable and in the presence of light react to form secondary organic compounds or act as catalysts in the formation of air pollutants such as ozone and nitrogen dioxide. The photochemical reaction products often are of more concern than the original organic compounds. A knowledge of ambient air concentrations of organic precursors and reaction products is therefore of great interest to Environment Canada.

Many organic compounds exist both in the vapour state and adsorbed on particulate matter; they are often referred to as semi-volatile organics. Sampling for these organic compounds in urban air is also underway in Toronto and Montreal. These potentially hazardous organic pollutants are emitted during the combustion of organic fuels in mobile or stationary sources and during the incineration of wastes. Categories of semi-volatile compounds include polycyclic aromatic hydrocarbons, polychlorinated biphenyls, dioxins and pesticides. These are some of the most environmentally significant organic compounds. The recent interest in energy-from-waste projects, the use of wood as a residential fuel and the increasing use of diesel-fuelled engines in automobiles and trucks, all of which are sources of semi-volatile organic compounds in the atmosphere, reinforces the need to measure these pollutants.

Table 3 is a chronology of Environment Canada's measurement programs for organic compounds from 1982 to 1985.

Table 3 Environment Canada's Measurement Programs for Volatile and Semi-volatile Organic Compounds

Volatile Organic Compound Measurement Programs

1) Aug. 83 - Nov. 83 - Three sites in Sarnia, Montreal, Vancouver
2) Aug. 84 - present - Junction Triangle, Toronto
3) Oct. 84 - present - Pte-aux-Trembles, Montreal
4) May 85 - Aug. 85 - Assessment of a toxic waste site in Montreal, including indoor air quality
5) Dec. 85 - present - Port Moody (Vancouver)

Semi-volatile Organic Compound Measurement Programs

1) Dec. 82 - Mar. 84 - Whitehorse
2) Aug. 82 - Dec. 82 - Sydney
3) Feb. 84 - Mar. 84 - Kitimat
4) Aug. 84 - present - Toronto
5) Oct. 84 - present - Montreal

Emissions from wood burning in homes create an air pollution problem, especially in the winter in some parts of Canada.

In 1985, Environment Canada continued a special study at Whitehorse, begun in 1982, to assess the effects on air quality of residential wood burning. Significant amounts of wood burning in residential areas of that city has led to some of the highest measured particulate levels in Canada. Instrumentation was installed at a residential site to provide information on air quality conditions during the heating season. Results of the study are available to the public and plans are being developed jointly with the Yukon Territorial and municipal governments to use the air quality monitoring information to advise the public when to curtail wood burning.

Acid Rain

CAPMoN, the Canadian Air and Precipitation Monitoring Network, monitors acid rain in Canada.

Acid rain is a complex problem. Its main causes are gaseous emissions of sulphur dioxide from smelters and power stations, and nitrogen oxides from automobiles. Through chemical reactions in the atmosphere these gases are transformed to strong acids and, in North America, are transported by air masses moving across provincial, state and international boundaries. A significant portion of the acid rain in eastern Canada, for example, is caused by emissions in the United States.

Environment Canada continues to manage the operation and maintenance of the Canadian Air and Precipitation Monitoring Network (CAPMoN), including the training of site operators and inspectors, overseeing laboratory analyses, instituting quality control and assurance procedures, and publishing data. Precipitation is monitored at eighteen CAPMoN sites and air quality is measured at eight CAPMoN sites (Figure 6). In 1985-86, all sites in the CAPMoN monitoring network were visited for annual inspection and maintenance. CAPMoN data for 1983-84 have been published by the Atmospheric Environment Service of Environment Canada. Figure 7 shows some of the findings.

The political, economic and scientific dimensions of the acid rain problem have made it particularly difficult to solve. Nevertheless, Canada's program to combat acid rain has led to steady progress. The program is of necessity multifaceted, and the federal government has involved itself with a variety of issues.

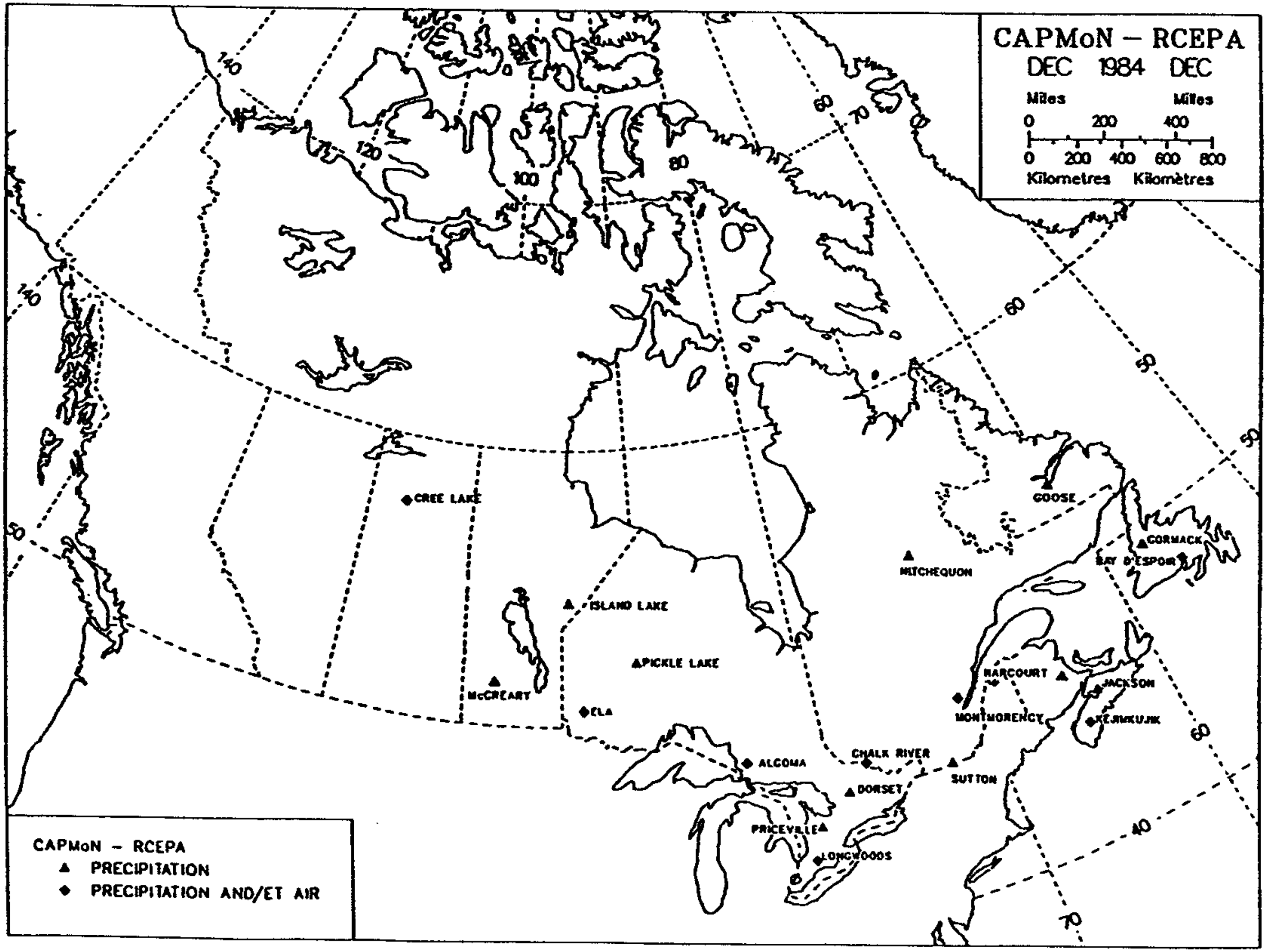

Figure 6 The CAPMoN Network

Annual Sulphate Deposition (kg/hectare) for 1984

Longwoods, Ont.	36.0	******************** ****************	Highest Deposition
Sutton, Que.	30.7	******************** ***********	
Priceville, Ont.	29.0	******************** *********	
Dorset, Ont.	26.8	******************** *******	
Montmorency, Que.	23.9	******************** ****	
Chalk River, Ont.	23.2	******************** ***	
Target Loading	**20.0**	********************	
Jackson, N.S.	16.2	****************	
Harcourt, N.B.	15.6	****************	Increasing Deposition
Kejimkujik, N.S.	14.7	***************	
Cormack, Nfld.	14.0	**************	
Bay D'Espoir, Nfld.	13.1	*************	
Ela, Ont.	7.8	********	
Goose, Nfld.	7.5	********	
Nitchequon, Que.	7.2	*******	
McCreary, Man.	6.3	******	
Pickle Lake, Ont.	6.1	******	
Island Lake, Man.	4.8	*****	Lowest Deposition
Cree Lake, Sask.	4.3	****	

Precipitation-weighted Mean pH for 1984

Longwoods, Ont.	4.2	************	Highest Acidity
Sutton, Que.	4.3	*************	
Dorset, Ont.	4.3	*************	
Chalk River, Ont.	4.3	*************	
Priceville, Ont.	4.3	*************	
Montmorency, Que.	4.4	**************	
Harcourt, N.B.	4.6	****************	
Jackson, N.S.	4.7	*****************	
Kejimkujik, N.S.	4.7	*****************	Increasing Acidity
Cormack, Nfld.	4.8	******************	
Goose, Nfld.	4.8	******************	
Nitchequon, Que.	4.9	*******************	
Bay D'Espoir, Nfld.	5.0	********************	
Ela, Ont.	5.0	********************	
Pickle Lake, Ont.	5.0	********************	
Cree Lake, Sask.	5.0	********************	
Island Lake, Man.	5.1	*********************	Lowest Acidity
McCreary, Man.	5.3	***********************	

Note: Priceville operated only for 7 months in 1984. The annual deposition is estimated. The mean pH is for that period.

Figure 7 **CAPMoN Network Data**

The program in 1985 encompassed federal-provincial co-operative efforts to reduce sulphur dioxide emissions; development and evaluation of technology to minimize sulphur dioxide production and emissions; promotion of the use of low sulphur coal from western Canada in Ontario; automotive emissions controls; exchange of scientific information at an "International Symposium on Acidic Precipitation" (Muskoka '85); negotiations between the Prime Minister of Canada and the President of the United States, leading to the acid rain Special Envoys' report in January 1986; and the signing July 9, 1985 in Helsinki, Finland, of the Protocol to the Convention on Long-Range Transboundary Air Pollution.

A variety of activities is being undertaken to combat acid rain.

Oxidants

Oxidants in the atmosphere can be thought of as highly reactive chemical substances with the capacity to transfer oxygen to other chemicals by reacting with them. There are many oxidants in the atmosphere, but ozone is usually the most prevalent and the most easily measured. As such, ozone often serves as a surrogate for all atmospheric oxidants. At low levels, oxidants help cleanse the air, but at high levels, human health and the environment may be endangered. Ozone is not normally emitted to the atmosphere, but is formed when other pollutants, notably nitrogen dioxide and hydrocarbons, react with sunlight. Ozone control, therefore, generally focuses on control of nitrogen dioxide and hydrocarbons. As long-range transport of ozone may be involved, determining where to apply controls is a problem. Some ozone in Canada's atmosphere may originate in the United States.

High ozone concentrations in some areas in Canada, especially in summer, continues to be a problem.

In Canada, high ozone levels are found in a number of urban and rural areas. Three areas of the country have ozone levels which more frequently exceed air quality objectives than the rest of the country. The British Columbia lower mainland experiences high ozone levels principally as a result of local sources of nitrogen dioxide and hydrocarbons. Long-range transport is not an important factor there. A co-operative lower mainland oxidants study program involving Environment Canada, the British Columbia Ministry of the Environment and the Greater Vancouver Regional District is now underway. Environment Canada is contributing to the program through:

a) measurement of the concentration of hydrocarbons in the air and, through mathematical models, their potential for ozone formation;
b) its participation with Transport Canada in the development of new light duty motor vehicle emissions standards, to take effect in September 1987;
c) its campaign to combat misfuelling of automobiles;
d) participation on an intergovernmental team examining the feasibility of introducing a motor vehicle inspection and maintenance program in British Columbia;
e) participation in an inventory of stationary and mobile sources of ozone precursors; and
f) provision of financial support for a study by the University of British Columbia on the effects of ozone on agricultural crops.

In addition, a study was begun in 1985-86 to examine the apparent decline during recent years in the number of days when ozone levels exceeded the acceptable level air quality objective in Vancouver. Data analysis has shown that there was a marked decrease in annual mean ozone concentrations, in the frequency with which high ozone levels occurred and in ambient levels of nitrogen oxides in Vancouver when the years 1982-1984 were compared with the years 1978 to 1981 (see Table 4).

In Vancouver in recent years, the number of days when ozone levels were high has decreased markedly.

Table 4 Number of Days on which the Acceptable Air Quality Objective for Ozone (82 ppb) was Exceeded at Selected Vancouver Stations

	Year							
Location	78	79	80	81	82	83	84	85
Confederation Park	5	4	8	12	5	0	1	3
Anmore School	30	25	49	46	22	2	1	5
Rocky Point Park	11	22	19	23	11	8	5	9
Eagle Ridge	10	1	1	10	5	2	5	4

The decrease did not appear to be entirely due to meteorological influences. The development of an accurate historical emissions inventory is currently underway in order to identify potential decreases in emissions that could have contributed to the decline.

High ozone levels are also experienced in the corridor between Windsor, Ontario, and Quebec City, Quebec. The federal government is participating in two studies in this region of Canada. The first is a study of the effects of ozone on forests in Quebec. The second is a study of the frequency and severity of elevated atmospheric ozone levels in Ontario between 1978 and 1985, in order to determine the extent to which long-range transport contributes to these high levels and to damage to agricultural crops. Some of the findings are presented in Table 5.

Table 5 Growing Season 7-h (0900-1600 Daily) Average Ozone Concentrations at Selected Rural Ontario and U.S. Stations 1980 - 1984

City, Town or State	Ozone Concentration (parts per billion)				
	1980	1981	1982	1983	1984
<u>Ontario</u>					
Huron Park	35.6	38.8	34.2	41.4	40.0
Petrolia	32.4	38.3	32.6	29.5	44.9
Tiverton	30.7	38.8	32.8	36.5	35.1
Simcoe	40.0	44.8	46.9	48.3	44.2
Stouffville	35.7	27.8	33.9	33.1	31.2
Dorset	--	32.5	34.5	37.1	36.2
<u>U.S. (State Average)</u>					
Michigan	37.6	37.9	39.4	--	--
Pennsylvania	45.1	38.2	40.9	--	--
New York	40.9	37.1	36.7	--	--
Ohio	42.8	41.0	43.9	--	--
California	52.0	50.4	46.3	--	--

Clean air has a natural background level of ozone of about 25 parts per billion. A seven-hour seasonal mean of 40 parts per billion can result in significant yield losses in sensitive crops such as soybeans and white beans.

In Atlantic Canada, long-range transport is the reason for most episodes of high ozone levels. The problem appears to be less severe than in the other two regions described above.

In both Canada and the United States, oxidants control has focused primarily on the control of motor vehicle emissions, which are the major single source of both hydrocarbons and oxides of nitrogen.

Motor Vehicle Emissions Control

Environment Canada and Transport Canada have developed new emissions standards for light duty motor vehicles. The proposed new standards were published in the *Canada Gazette*, Part I, on August 3, 1985 and promulgated April 16, 1986, to become effective on September 1, 1987.

On July 6, 1985 the two departments also published a notice of intent to prepare a social and economic impact assessment of more stringent emissions standards for hydrocarbons, carbon monoxide, oxides of nitrogen, diesel particulate, and fuel vapour for heavy duty motor vehicles and engines. The proposed standards would be comparable to those which will come into effect in the United States for model year 1988. The effective date in Canada is anticipated to be December 1, 1988. The new standards are expected to achieve annual reductions in heavy duty vehicle emissions by the year 2000 of 31.1 per cent for oxides of nitrogen; 18.8 per cent for particulates; 15.6 per cent for unburnt hydrocarbons; and 4.4 per cent for carbon monoxide. Canadian standards should be promulgated in the summer of 1987.

Emissions from heavy duty motor vehicles are to be reduced under new standards.

Even more stringent standards may be introduced in Canada when the technology to meet these standards has been fully developed.

On March 25, 1986, Environment Canada announced a public awareness campaign to discourage misfuelling and convince the Canadian public of the economic, health and environmental benefits of proper fuelling, operation and maintenance of motor vehicles. Misfuelling is the use of leaded gasoline when lead-free gasoline should be used.

The goals of the campaign are:

a) to reduce the incidence of misfuelling in Canada;
b) to discourage the practice of tampering with or removing anti-pollution equipment on motor vehicles;
c) to increase awareness among Canadians of the economic, health and environmental benefits of properly maintained and operated vehicles;
d) to encourage the motoring public to assume individual responsibility for their vehicles, and to do their part in reducing the health and environmental risks associated with automobile emissions while at the same time saving dollars; and
e) to improve the level of air quality in Canadian cities.

In 1986, Environment Canada introduced its automobile public awareness campaign.

Provinces will be encouraged to develop and enforce regulations on gasoline pump nozzle switching, misfuelling and tampering with pollution control equipment.

As part of the automobile public awareness program, the province of Quebec and the federal government is producing a video presentation for car mechanics. In addition, Environment Canada conducted an automobile emissions test clinic in Halifax during Environment Week in June 1985; over 500 motor vehicles were tested. An inspection clinic was also held in Ottawa the same week. Clinics in a number of major cities are planned for Environment Week 1986.

Lead in Gasoline

The lead content of leaded gasoline has been regulated since 1976. After January 1, 1987, tighter regulations will reduce the maximum allowable lead content in gasoline to 0.29 grams per litre.

Environment Canada has as one of its goals the elimination of the environmental and health hazards posed by the presence of lead in gasoline. Its public awareness campaign includes a three-point program aimed at achieving this goal. The first element of the program is intended to enhance public awareness of the lead issue and is being sponsored jointly by Environment Canada and the Petroleum Association for the Conservation of the Environment. One million dollars will be devoted to advertising and providing public information on the automobile. It will concentrate in the first year on discouraging misfuelling, and in the second year on promoting proper automobile maintenance and operation.

The government has pledged to virtually eliminate lead emissions from gasoline use by 1992.

In the second element of the program, the public will be receiving information in the mail outlining the dangers associated with leaded gasoline. The program's third element is a pledge to eliminate virtually all lead emissions from gasoline use by the end of 1992.

This course of action is consistent with the conclusions reached by the Royal Society of Canada's Commission on Lead in the Environment in its September 1985 interim report to Environment Canada, which confirms the danger of lead. As well, it is consistent with the Commission's advice in its report on "Lead in Gasoline: Alternatives to Lead in Gasoline", which was submitted to Environment Canada in February 1986, wherein a cautious approach to the selection of alternatives to lead is advocated.

The National Incinerator Testing and Evaluation Program (NITEP)

One tonne of municipal solid waste can be burned to produce slightly more than the energy equivalent of one barrel of crude oil, at the same time reducing the volume of waste that must be placed in landfill sites. Environmental issues, principally fear of incinerator emissions, stand in the way of many efforts to select suitable incinerator sites. One goal of the National Incinerator Testing and Evaluation Program is to define the best operating conditions and incinerator designs to minimize or, ideally, eliminate such emissions. Under the program, both conventional incinerator technologies and add-on control technologies are being evaluated.

The National Incinerator Testing and Evaluation Program is identifying technology that minimizes emissions from municipal waste incinerators.

Following successful testing of an energy-from-waste facility at Parkdale, Prince Edward Island, in 1984, Phase II of the NITEP program began with the modification of the furnace of an incinerator in Quebec City in early 1986. Testing of the incinerator was to be completed in the summer of 1986. This same incinerator was used in September 1985 as a source of incinerator emissions to test the performance of a dry emission control unit installed at an adjacent pilot plant. A report on the pilot plant study was released in September 1986.

Intergovernmental Activities

The stratospheric ozone layer, which shields the earth from receiving too much ultra-violet radiation from the sun, is threatened with depletion by ozone-modifying substances. Many nations, in particular Canada, have been actively pursuing a solution to this problem. Canada played a lead role in developing the Vienna Convention for the Protection of the Ozone Layer and, in June 1986, became the first nation to ratify the convention. The convention commits its signatories to protect human health and the environment from the consequences of ozone layer depletion. In 1985-86, Canada worked actively with other nations to negotiate a protocol defining equitable measures

Canada was the first nation to ratify the Vienna Convention for the Protection of the Ozone Layer in June 1986.

to control ozone-modifying substances, notably chlorofluorocarbons. A consensus on the protocol is expected in 1987.

As air pollutants do not respect political boundaries, international co-operation to control pollution is essential.

Environment Canada continued its involvement with the Organization for Economic Co-operation and Development (OECD) Air Management Policy Group (AMPG). A major program of AMPG is the Control Strategies for Major Air Pollutants program, which at present is focused mainly on ozone. Components of the program include identification of significant sources of emissions, collection of control technology and cost data, comparison of controls and costs across industries, development of alternative control scenarios and their use in modelling to estimate changes in air quality, and economic evaluation of costs and effects. Other topics being addressed by the AMPG include asbestos and cadmium in the atmosphere. Canada has taken a major role in the asbestos study.

The OECD Waste Management Policy Group, of which Canada is also a member, has expressed concern about dioxin issues associated with incineration of municipal solid waste. Member countries have been asked for information on programs and activities in their jurisdictions.

The International Joint Commission carries out independent assessments of Environment Canada's programs.

The International Air Quality Advisory Board advises the International Joint Commission on matters of direct relevance to the transboundary aspects of air quality in the United States and Canada. In discharging its duties the Board must be aware of air quality or atmospheric deposition problems involving both countries, and commissions air quality studies when necessary. The Board comprises six persons, three from each country. Environment Canada employees play a critical assessment role for the IJC independent of the government. A study was undertaken during the review period for the Board on all environmental monitoring activities within 250 miles of the Canada-U.S. border. This included ambient air and water quality monitoring, precipitation monitoring, forest and vegetation monitoring and research, as well as soil and ecosystem studies. The Board now intends to develop methods to integrate monitoring data that could be used to report to governments on the state of the environment within the entire transboundary region; to recommend the need for new or modified networks which optimize components of existing networks; and to define, if a new or modified network is desirable, its purpose, structure, size, activities, and costs.

The Federal-Provincial Advisory Committee on Air Quality, established in 1969, continued to fulfill its role as the principal intergovernmental forum for the discussion and resolution of air pollution matters in Canada. In 1985-86, the Committee concerned itself with several important areas of national interest, namely: the review of Canada's national ambient air quality objectives; the practice of burning waste oil as a means of disposal; the evaluation of risk assessment methodology; the sponsorship of a workshop on emissions from residential wood burning; the study of the potential benefits to Canada of a system of air pollutant emissions trading, such as is now in place in the United States; indoor air quality; long-range transport of air pollution; monitoring for air pollutants across the country; and the identification of potential future problems.

Strong interest was expressed by the public in a brochure on "Safe Wood Burning", produced cooperatively by Environment Canada and the four maritime provinces. More than 100 000 copies were distributed.

Emerging Problems

Research continues on global and regional air pollution problems.

In contrast to some of the air pollution problems discussed earlier in this report, which are relatively well understood, a number of more recently recognized problems are the subject of research by Environment Canada because the knowledge base is less complete. These include the long range transport of air pollutants (LRTAP) and the greenhouse effect.

In 1984-85, a broad study of the Canadian and American LRTAP data bases was begun. The purpose of the study is to learn more about the relative contribution of sulphate and nitrate to the acidity of precipitation; the relative importance of wet and dry deposition of pollutants in eastern Canada; the movement of air masses through comparison of predictive mathematical models to results of actual field experiments using tracer gases; and seasonal variation in acid deposition in eastern North America.

This work also encompasses the continuing analysis of the acid rain knowledge base under the LRTAP program; a review of atmospheric nitrogen compounds in Eastern North America for the Economic Commission for Europe; a statistical analysis of the pollutant data base, including a search for trends; and an examination of the origin of air masses in relation to pollutant levels measured at monitoring sites.

Dry deposition of pollutants is being monitored in response to recommendations made in the acid rain envoy's report.

Apart from the study outlined above, some site-specific studies were also conducted. At Borden, Ontario, in a study begun in August 1985, ozone and sulphur dioxide levels and fluxes were monitored in relation to the potential for forest damage by these pollutants. This study has already revealed greater deposition to forests during daytime, and during February and March. At North Bay, Ontario, a study of seasonal and temporal variations in the sulphate to nitrate ratio in aerosols showed that the contribution of nitrate to acidity can be as significant as sulphate during the winter.

The role of cloud and fog as carriers of pollutants to high elevation forested regions is being investigated in a cooperative program with United States authorities. Preliminary observations indicate that mountains in Quebec, with summits at an elevation of about 1000 metres may be in cloud as much as 44 per cent of the year, compared with 23 per cent at altitudes of 530 metres. On two mountain summits, the mean pH value of fog water was shown to be 3.7-3.8, lower than the mean pH for precipitation at the same elevation.

The phenomenon of Arctic haze is being studied in relation to pollution originating from the Eurasian land mass. Enough data are now available to study the sulphur budget and fluxes in the Arctic using mathematical models constructed in 1986.

Several projects now underway focus on the study of toxic air pollutants. Mosses and lichens, which accumulate pollutants, are being used as biomonitors. Deposition of toxic air pollutants to the Great Lakes is difficult to monitor, so mathematical models are being developed and tested against the limited measurement data available. Investigation of the various forms in which mercury is found in the air continues, as the chemical state in which mercury occurs strongly influences its fate and toxicity.

Environment Canada is studying the greenhouse effect and its socio-economic implications.

The greenhouse effect is the subject of continuing research by Environment Canada. Worldwide, carbon dioxide levels in the atmosphere have increased significantly in this century, and as a result a warming of the global atmosphere is predicted. Research into this phenomenon during 1985-86 has focused on identifying the sources of the carbon dioxide measured at sampling sites at Alert, Sable Island and Cape St-James, and on improving measurement capability. Cooperative research with the United States National Centre for Atmospheric Research and with Japan in this area is planned.

Work is also underway to learn more about the flux of carbon dioxide between the atmosphere and the terrestrial environment. As well, research is ongoing on global biogeochemical cycles and the effect that climate change has on these, to predict what effects might occur as atmospheric carbon dioxide levels increase.

4 FURTHER READING

Certain accomplishments under the Clean Air Act that are outlined in this report are presented and explained in more detail in formal departmental publications. These publications are:

Environment Canada. Status Report on Compliance with Secondary Lead Smelter Regulations - 1984. Report EPS 1/MM/1. June 1985.

Environment Canada. Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs): Sources and Releases. Report EPS 5/HA/2. July 1985.

Environment Canada. National Inventory of Sources and Releases of Lead (1982). Report EPS 5/HA/3. September 1985.

Environment Canada. Ambient Air Particulate Lead Concentrations in Canada (1975-1983). Report EPS 7/AP/15. September 1985.

The Royal Society of Canada: The Commission on Lead in the Environment. Lead in Gasoline: A Review of the Canadian Policy Issue. Interim Report. September 1985.

Environment Canada. The National Incinerator Testing and Evaluation Program: Two-Stage Combustion (Prince Edward Island). Report EPS 3/UP/1. September 1985.

Environment Canada. National Air Pollution Surveillance. Annual Summary for 1984. Report EPS 7/AP/16. October 1985.

The Royal Society of Canada: The Commission on Lead in the Environment. Lead in Gasoline: Alternatives to Lead in Gasoline. February 1986.

Environment Canada. Atmospheric Environment Service. Air Quality and Inter-Environmental Research Branch Annual Report 1985-86. 1986.

Environment Canada. Western and Northern Region. Western Canada Sulphur Dioxide and Nitrogen Oxides Atmospheric Emission Inventory Methods Manual. Edmonton, 1986.