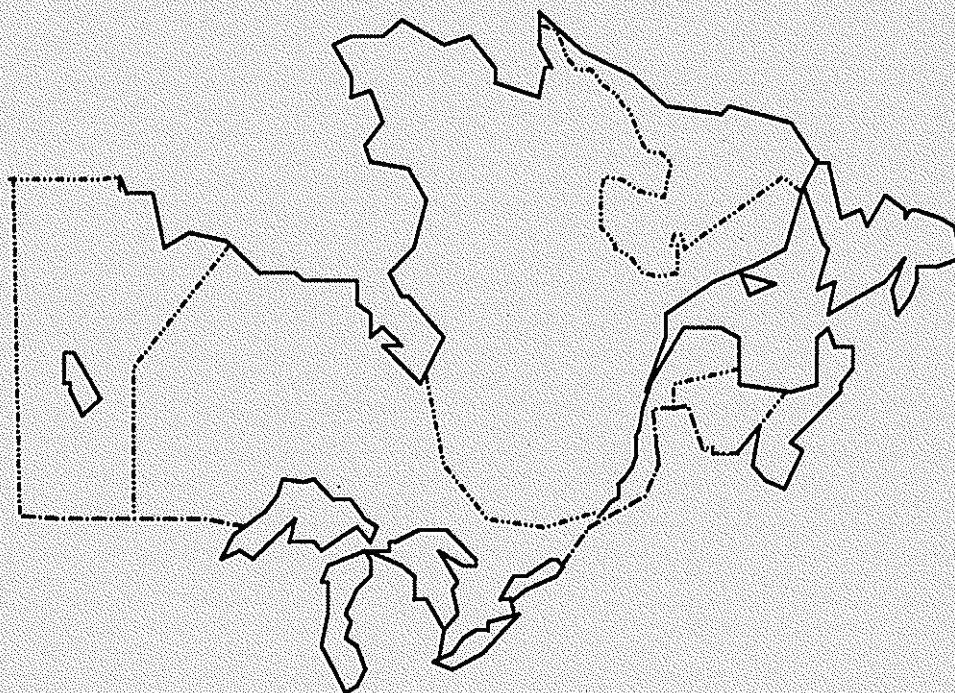


# ANNUAL REPORT ON THE FEDERAL-PROVINCIAL AGREEMENTS FOR THE EASTERN CANADA ACID RAIN PROGRAM

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# **The Eastern Canada Acid Rain Control Program, 1992**

## **Introduction**

This is the fourth report on the implementation of the Eastern Canada Acid Rain Control Program. The program will cut sulphur dioxide (SO<sub>2</sub>) emissions in the seven eastern provinces to below 2.3 million tonnes in 1994, from 3.8 million tonnes emitted in 1980. The report includes emissions data to the end of 1992 and highlights significant milestones and achievements.

The Canadian Program was initiated in 1985 and subsequently formalized in seven federal-provincial agreements. These set out specific SO<sub>2</sub> emission reduction targets and timetables for each of the parties. Participating provinces have agreed to cut their aggregate SO<sub>2</sub> emissions by 40 percent from 1980 levels for 1994, to participate in acid rain effects research, to monitor ecosystems and to report on progress. For its part, the federal government has undertaken to seek reductions in transboundary flows of SO<sub>2</sub> from the United States, to conduct a wide array of research activities, to monitor and model deposition, to support research and development projects for SO<sub>2</sub> reduction technologies, and to reduce emissions from federal facilities.

To date, SO<sub>2</sub> emissions reductions have been achieved at large point sources such as non-ferrous metals smelters and fossil fuelled power plants which accounted for 80 percent of the SO<sub>2</sub> emissions in eastern Canada in 1980. The result has been a wide range of province-specific and source-specific emission reduction measures.

Major emission reduction program elements came into place in 1992. The largest point sources of SO<sub>2</sub> were building or completing emission controls such as power plant scrubbers and smelter acid production facilities; federal and provincial governments negotiated to reaffirm and extend acid rain agreements; and the United States put its program into final regulatory form. Governments continued to support research into acid rain and related environmental effects, into new control technologies and to investigate alternative emission management options such as emissions trading.

The reported emissions, reflecting the most recent provincial estimates, are shown in Table 1. Total eastern Canadian SO<sub>2</sub> emissions were 2,316 kilotonnes in 1992, representing nearly a 40 percent reduction from actual 1980 emissions, and very close to the 1994 program target of 2,300 kilotonnes. Nationally, emissions were slightly below the 3,200 kilotonnes national cap.

Table 2 provides additional SO<sub>2</sub> emissions data from the major sources such as smelters and electric utilities.



TABLE: 1

TOTAL SO<sub>2</sub> EMISSIONS BY PROVINCES (KILOTONNES)

	1980	1989	1990	1991	1992	1994
	(Actual)					(Emissions limits) <sup>4</sup>
<b>MANITOBA</b>						
Primary Metals	463	499	500	543	555	—
Other	21	16	16	16	10	—
Total	484	515	516	559	565	550
<b>ONTARIO</b>						
Primary Metals	1096	776	730	695	506	—
Power Generation	396	305	195	167	157	—
Other	272	252	241	233	239	—
Total	1764	1333	1166	1095	902	885
<b>QUEBEC</b>						
Primary Metals	641	341	189	210	218	—
Other	457	205	202	168	182	500
Total	1098	546	391	378	400	—
<b>NEW BRUNSWICK</b>						
Primary Metals	15	23	6	9	12	—
Power Generation	123	177	141	130	149	—
Other	80	29	34	33	32	—
Total	218	229	181	172	193	175
<b>NOVA SCOTIA</b>						
Power Generation	125	146	143	144	143	—
Other	68	37	35	33	34	—
Total	193	183	178	177	177	189
<b>NEWFOUNDLAND</b>						
Power Generation	18	25	21	14	18	—
Other	38	28	36	48	57	—
Total	56	53	57	62	75	45
<b>PRINCE EDWARD ISLAND</b>						
Total <sup>3</sup>	5	3	3	4	4	5
<b>EASTERN CANADA TOTAL</b>						
Primary Metals	2215	1639	1425	1457	1291	—
Power Generation	662	653	500	455	467	—
Other	941	570	567	535	558	—
Total <sup>2</sup>	3818	2862	2492	2447	2316	2349 <sup>2</sup>

1 Data for 1989 to 1992 are taken from annual reports by the provinces on their SO<sub>2</sub> control programs. The emissions levels represent the best estimate available at the time of writing the report. Note that even historic year estimates may be revised as better inventory data is made available.

2 The 1994 Eastern Canada Program target is 2300 kilotonnes. The total of provincial objectives is currently being renegotiated from 2349 kilotonnes to 2300 kilotonnes. Renegotiated federal-provincial agreements are in place with Quebec, New Brunswick and Nova Scotia.

3 This value includes a component of power generation emissions.

4 The revised emission limit reflects a renegotiated federal-provincial agreement.

TABLE: 2

MINERAL EXTRACTION AND SMELTING: MAJOR SO<sub>2</sub> SOURCES (KILOTONNES)

	1980	1989	1990	1991	1992	1994
	(Actual)					(Emissions limits)
<b>MANITOBA</b>						
INCO (THOMPSON)	215	250	247	250	267	220
HBMS (FLIN FLON)	248	249	253	293	288	220
<b>ONTARIO</b>						
INCO (Copper Cliff)	812	637	617	572	416	265
FALCONBRIDGE (Sudbury)	123	68	70	70	54	100
ALGOMA (Wawa, Iron Ore)	161	71	43	53	36	125
<b>QUEBEC</b>						
NORANDA (Horne)	552	292	146	165	168	272
NORANDA (Murdochville)	91	49	43	45	50	65
<b>NEW BRUNSWICK</b>						
NORANDA (Belledune)	15	23	6	9	12	----

ELECTRIC POWER GENERATION: MAJOR SO<sub>2</sub> SOURCES

	1980	1989	1990	1991	1992	1994
	(Actual)					(Emissions limits)
ONTARIO HYDRO	396	305	195	167	157	175
NEW BRUNSWICK	123	177	141	130	149	123
NOVA SCOTIA POWER	125	146	143	144	143	145



## **Provincial and Industrial Action**

### **Manitoba (1994 target 550 kilotonnes)**

Manitoba has two main sources of SO<sub>2</sub>, accounting for about 98 percent of total provincial SO<sub>2</sub> emissions. These are the INCO Limited smelter at Thompson and the Hudson Bay Mining and Smelting Limited (HBMS) smelter at Flin Flon. Manitoba regulations require that, after January 1, 1994, each smelter not emit more than 220 kilotonnes of SO<sub>2</sub> annually.

Both sources are taking measures to ensure their compliance with the regulations. INCO has been optimising its processes to reject sulphur-bearing ore fraction (pyrrhotite rejection) and will be modifying the metallurgical process to reduce SO<sub>2</sub> production. HBMS is installing a new zinc pressure-leaching system, and evaluating major changes to the copper smelter. As shown in Table 1, SO<sub>2</sub> emissions in 1992 were slightly higher than in 1991 reflecting normal fluctuations in metals production. Other sources, mainly fuel oil use, accounted for most of the province's remaining 10 kilotonnes of emissions.

Manitoba was also active in other acid rain work, including daily precipitation monitoring at three sites, a 22-station snowpack survey and vegetation studies in acid and metals-contaminated soils associated with the smelters.

### **Ontario (1994 limit 885 kilotonnes)**

In 1992, Ontario's major stationary SO<sub>2</sub> sources continued to work towards complying with the regulatory limits imposed on them by the province under its SO<sub>2</sub> Control Program (see Table 2). Since 1990, Ontario has had an emissions verification program for four major emitters which requires an annual SO<sub>2</sub> emissions audit by independent consultants.

INCO Ltd.'s emissions were 156 kilotonnes less than in 1991 due to process changes already in place at the Sudbury operations. The current research and development plan, filed with the province, showed that the company is working on new technologies to further reduce its emissions. The current construction schedule indicated that work will be completed in time to ensure that SO<sub>2</sub> emissions from the plant are below the 265 kilotonne 1994 regulatory limit.

Falconbridge Ltd. continues to emit SO<sub>2</sub> at levels substantially below its 100 kilotonne 1994 regulatory limit, in fact 65 percent less in 1992. The company had reaffirmed its plan to respect its 1994 SO<sub>2</sub> limit of 100 kilotonnes and is implementing operational changes to ensure this. In 1992, the No. 2 fluid bed roaster hearth was enlarged to permit higher sulphur removal rates. As well, tests continued on using lower sulphur calcine in the electric furnace and on increasing sulphur rejection in mineral beneficiation.

At 36 kilotonnes, Algoma Steel Inc.'s 1992 SO<sub>2</sub> emissions for the Wawa sintering plant were again well below its 1994 limit of 125 kilotonnes largely because of production down-sizing. The company plans to use lower sulphur feedstocks in future and expects that emissions will remain below 60 kilotonnes even at full production.

Ontario Hydro is implementing measures to ensure that its SO<sub>2</sub> emissions are below its 175 kilotonne regulatory limit for 1994. 1992 SO<sub>2</sub> emissions were well below the limit due to reduced demand for electricity, the use of low sulphur coal, better than average hydroelectric production and increased electricity purchases. Hydro is building wet scrubbers to capture SO<sub>2</sub> at two units of the Lambton coal-fired plant and has expanded use of low sulphur coal as a means to ensure continuing compliance with provincial regulations.

In Ontario, acid deposition monitoring is conducted under the Acidic Precipitation in Ontario Study (APIOS), using two networks which have been in operation since 1981. In 1992, an extensive redesign of the program was undertaken to reduce costs while maintaining the minimum viable network adequate to define spatial and temporal trends in acidic deposition. The final design, implemented in April and May 1992, allows for 17 cumulative 28-day sampling sites throughout the province with one daily site at Dorset, near Algonquin Park. This network will be maintained for the foreseeable future to monitor the effectiveness of the Canadian and United States SO<sub>2</sub> control programs.

## **Quebec (1994 objective 500 kilotonnes)**

In 1992, Quebec SO<sub>2</sub> emissions totalled 400 kilotonnes, up slightly from 1991 levels but fully 200 kilotonnes below the province's original program target and well below the recently renegotiated provincial annual limit of 500 kilotonnes. The small increase is attributable to emissions from two new aluminium smelters and increased production at the province's copper smelters. Tables 1 and 2 outline the emissions trends for the major source sectors:

- Copper smelting: SO<sub>2</sub> emissions at the Noranda Metals Horne smelter increased by about 8 kilotonnes in 1992 due to higher production levels. However, this level is still 70 percent below 1980 levels and the company has announced its intention to further reduce annual emissions to about 55 kilotonnes by the end of the decade. This will represent a 90 percent drop from pre-control levels. The province's other copper smelter in Murdochville also emitted somewhat more SO<sub>2</sub> in 1992 than in 1991 also due to higher metals production. The facility is still operating well within its permitted limit.
- Aluminium smelting: emissions increased by about 7 kilotonnes in 1992 mainly because of increased production at two new smelters, Luralco and Allouette. This increase now makes aluminium smelting the second highest SO<sub>2</sub> emissions source-sector in Quebec.
- Pulp and paper, and petroleum refining: aggregate emissions have declined relative to 1991 levels. This is partly as a result of reduced economic activity, but also due to restructuring and permanent closure of older, less efficient facilities.
- Electric power sector: a return to more normal precipitation levels has largely eliminated the need for fossil fuel-based production and the associated SO<sub>2</sub> emissions.

In 1992, Quebec continued its broad-based program of acid rain research and monitoring. Six reports and research papers were written on acid deposition aquatic impacts. These document the results obtained from the Quebec lake survey and show that nearly 20 percent or 29,000 of the 160,000 northern shield lakes were acid between 1986 and 1990. While lakes in northern and eastern Quebec are naturally acidic, lakes in the southwest of the province are acid because of man-made pollutants.

Modeling of the Canadian and United States SO<sub>2</sub> control programs indicates that, by 2003, a modest improvement in lake alkalinity and pH is expected for those lakes west of the Saguenay River.

### **New Brunswick (1994 target 175 kilotonnes)**

New Brunswick signed a renewed SO<sub>2</sub> reduction program agreement in March, 1992. This agreement reduces the province's annual emissions limit from 185 to 175 kilotonnes and extends the agreement date to the year 2000. The province has also negotiated further emission reductions from pulp mills and New Brunswick Power.

As shown in Table 1, the province's SO<sub>2</sub> emissions increased by about 21 kilotonnes from 1991, due to increased production at utility power plants. Despite this short-term increase, specific measures are now being implemented at major sources to ensure that the provincial objective will be met.

New Brunswick Power is the largest SO<sub>2</sub> emitter in the province. It operates four major fuel-burning plants and is constructing a 450 Megawatt coal-burning plant at Belledune which will be equipped with a wet limestone SO<sub>2</sub> scrubber. A similar scrubber is also being installed at the 300 Megawatt oil-burning Dalhousie plant as part of a conversion to ORIMULSION™ fuel. Other SO<sub>2</sub> control measures include provision of low sulphur fuel at the Courtenay Bay plant, implementation of conservation and demand management programs and installation of continuous emissions monitoring systems.

Pulp mills were modernized during the 1980's, cutting emissions permanently and ensuring that their SO<sub>2</sub> releases remain below 20 kilotonnes per year. One mill ceased operation in 1992 though the associated steam and power plant continued in use.

The Brunswick Mining and Smelting facility captures over 80 percent of its SO<sub>2</sub> and converts it to acid. Other changes have been made to the plant and more are planned to ensure that ambient air quality limits are consistently met. In 1992, the smelter returned to full operation after two years of reduced production.

New Brunswick operates an extensive acid deposition network in cooperation with NB Power, and Environment Canada. In 1992, existing monitoring sites, monitoring techniques, and siting criteria were reexamined and improved. A much

clearer understanding of wet deposition patterns and levels is now being gained through better monitoring and modelling. Work by New Brunswick and others supports the conclusion that much of the province is very acid-sensitive and that wet sulphate deposition will need to be substantially reduced from current levels if sensitive ecosystems are to be protected.

### **Nova Scotia (1994 target 189 kilotonnes)**

The major source-sector in the province, accounting for 81 percent of 1992 SO<sub>2</sub> emissions in the province is the investor-owned electric utility, Nova Scotia Power Corporation. The company continued its program to limit its annual SO<sub>2</sub> emissions not to exceed 145 kilotonnes after 1994. The utility has also publicly stated its corporate objective of further reducing emissions to about 90 kilotonnes annually, after the year 2000. Nova Scotia Power is completing, in 1993, the world's largest circulating fluidized-bed coal burning power plant (165 MW) at Point Aconi. The plant is designed to capture 90 percent of the sulphur in the fuel and simultaneously reduce nitrogen oxide emissions.

### **Newfoundland (1994 target 45 kilotonnes)**

Newfoundland's major sources of SO<sub>2</sub> are the oil-fired Holyrood electricity generating station and the Come-By-Chance oil refinery. SO<sub>2</sub> emissions from Holyrood are quite variable from year to year because the station supplies energy whenever hydroelectric sources cannot meet demand. Emissions are therefore dependant on precipitation. The province is working with the utility to encourage conservation and to investigate the use of lower sulphur fuel to limit emissions.

The oil refinery's SO<sub>2</sub> emissions have greatly increased in the last five years, largely accounting for the province's emission increase. The sulphur recovery system at the refinery has not been functioning reliably and high-sulphur crude oils are being processed. The province is working with the refinery to resolve these problems and to ensure that the refinery complies with provincial requirements. The consumption of heavy fuel oil by other industries in Newfoundland, notably pulp and paper and fisheries, has fallen due to reduced economic activity.

## **Prince Edward Island (1994 objective 5 kilotonnes)**

Virtually all of Prince Edward Island's SO<sub>2</sub> emissions result from the combustion of fossil fuels. Emissions from all sectors of activity totalled 3.6 kilotonnes in 1992. Industrial and commercial fuel use accounted for 50 percent, power generation 20 percent, and the balance came from the residential and transportation sectors.

Emissions of SO<sub>2</sub> from electrical power generation fluctuate due to the variability of economy energy purchases from New Brunswick, and the resulting need to supplement these purchases with on-island generation. In 1992, electrical generation within the province dropped by 50 percent to 35 GWh. This resulted in a 640 tonne drop in emissions even though overall electricity consumption increased by 1.5 percent to 697 GWh. Maritime Electric, the province's major electrical utility, expects to be able to continue to purchase large quantities of economy energy from New Brunswick Power and, as a result, the company forecasts that, barring unusual conditions or unforeseen circumstances, its emissions will be limited to 840 tonnes per year during the period between 1995 and the year 2000.

The use of biomass fuels at industrial and commercial facilities, and energy conservation programs, will allow the province to maintain its emissions below the 5 kilotonne target in the short-term. The recent introduction of Air Quality Regulations will allow SO<sub>2</sub> emissions to be monitored more closely in the future.

## **Acid Rain Program Highlights for 1992**

The previous sections summarized provincial and industrial actions taken under the acid rain program. As well, federal and provincial government agencies continued to support development and use of new industrial processes and emissions control technologies, promote energy conservation, conduct scientific research, and monitor ecosystems. In consultation with provincial government agencies, industries and other stakeholders, Environment Canada sponsored a first-step evaluation of economic instruments such as emissions trading. These new options hold the promise of achieving environmental goals at minimum cost.

Canada is actively involved with the United States to ensure it meets the requirements set out in the Canada-United States Air Quality Agreement. Environment Canada established a project to monitor the United States progress in implementing their acid rain program and to report on the results obtained under the SO<sub>2</sub> allowance trading program. Canada also continued to work towards a second United Nations Economic Commission for Europe SO<sub>2</sub> Protocol (which was completed and signed June, 1994).

Highlights for 1992 include:

- In March, New Brunswick was the first of the eastern provinces to conclude a renegotiated acid rain agreement with the federal government. Quebec and Nova Scotia signed similar new agreements in 1993, with Quebec reducing its target by 100 kilotonnes to 500 kilotonnes.
- The United States Environmental Protection Agency issued draft regulations to implement their acid rain control program, which is designed to reduce power plant SO<sub>2</sub> emissions by about 10 million tonnes in the next ten years. The proposals also contain a complex emissions trading scheme.
- Environment Canada, Forestry Canada, the Department of Fisheries and Oceans, and Health Canada, in cooperation with United States government agencies, wrote the first bi-annual progress report of the Canada-United States Air Quality Agreement. The report received critical review by the International Joint Commission and was widely distributed in North America in early 1993.
- Environment Canada sponsored two seminars on the US program to prevent significant deterioration in air quality, a major concern in that country. The objectives of the seminars were to familiarize governments and industries with the US program, and to begin discussions on a possible Canadian response.
- Environment Canada sponsored a course on continuous emissions monitoring (CEM). Canada is committed to monitoring power plant emissions using methods of comparable effectiveness to CEM by 1995. The course was well attended by industry and government personnel. Associated with this issue, Canada released its draft Protocols and Specifications for Continuous Emissions Monitoring of Gaseous Emissions from Thermal Power Generation. This document, developed through a multistakeholder process, specifies the design, installation, and operation of automated CEM systems for use at Canadian power plants.



- INCO Ltd. continued a massive modernization program at its Sudbury, Ontario smelter. In 1992, technical problems with the new flash furnace were overcome. Construction of a new flash smelting furnace was also begun. About 89 percent of the \$540 million budgeted for the modernization and SO<sub>2</sub> control program had been expended by the end of 1992.
- While SO<sub>2</sub> emissions are being reduced in North America, nitrogen oxides emissions are remaining fairly constant. There is a serious concern that nitrogen-based acidification in future might erode the benefits obtained by reducing SO<sub>2</sub> emissions. A scientific workshop on nitrogen acidification held at Canada's National Water Research Institute, concluded that the potential for this to occur is significant and led to the undertaking of a quantitative assessment of the current situation.
- Laboratory and field experiments conducted by Forestry Canada demonstrated a linkage between air pollution, exposure to acid deposition, exposure to ozone smog, and damage to the waxy protective coating of tree leaves and needles. This is believed to pre-dispose trees to increased damage from other stresses, such as disease and weather extremes.
- The recent SO<sub>2</sub> emission reductions, exceeding 60 percent, at the Noranda metals smelter in Quebec have resulted in a halving of sulphate concentration in nearby lakes. Although there are as yet no apparent changes in lake acidity, some indicators of water chemistry point towards a possible improving trend in lake water alkalinity.
- In October, Ontario held a workshop to present and review a revised acid deposition monitoring network design, and to discuss objective methods for network design. This was sponsored by the Canadian Institute for Research in Atmospheric Chemistry which published the proceedings.
- Trends data for lakes around Sudbury, Ontario, provided evidence of biological recovery after the local smelters reduced their emissions of SO<sub>2</sub> and trace metals during the 1970s and 1980s. For example, lake trout resumed reproduction when pH increased to 5.6. These studies suggest that many biological populations will recover or can be re-established relatively rapidly (in less than a decade) when acidification is reversed.
- About one-third of Canadian lakes and streams monitored for acid precipitation are recovering, particularly in Nova Scotia and Newfoundland.

- Over the last decade, at the Lac Laflamme calibrated watershed, north of Quebec city, wet sulphate deposition has declined by 26 percent while nitrate deposition has increased by 26 percent. This has resulted in a 12 percent drop in lake water sulphate content between 1986 and 1992 and almost a doubling of the nitrate concentration. In the decade to 1992, Lac Laflamme has lost about 15 percent of its alkalinity, indicating that overall deposition is still too high.
- Within Quebec's 59 lake monitoring network there was a significant reduction in sulphate concentration (from 8 to 33 percent) in 82 percent of sampled lakes. While this is encouraging, 42 percent of these lakes still exhibit a pH below 6.
- Initiated measurements of acid aerosols at sites in eastern Canada to determine regional exposure levels and assess their impact on human health.
- Environment Canada analyzed historical visibility observations from Canadian airports to describe visibility differences across Canada.

## **Conclusion**

The Canadian acid rain program reached an important milestone in 1992, with emissions in eastern Canada substantially meeting the 2.3 million tonne cap, two years ahead of schedule.

Most of the remedial measures are either operating, under construction, or being implemented. Emissions have declined and the first tentative signs of environmental recovery have been detected. The United States is also implementing an aggressive acid gas emissions controls program.

Although the program goals are now being met, many Canadian acid-sensitive ecosystems are still being damaged. Even after all currently planned reductions are in place, some regions may continue to receive excessive acid deposition post-2000. This fact points to the need for renewed and continuing efforts to fully resolve Canada's acid rain problem.