CANADA - UNITED STATES

Acid Rain

Revised July 1989


Canapress

Acid Rain — What is it?

Acid rain is the popular name for the return to earth in rain, snow, fog or dust of sulphur dioxide (SO_2) and nitrogen oxides (NO_x) which have been released into the air.

Where does it come from?

SO_2 emissions are mainly produced by coal-fired power generating stations (the major source in the United States) and non-ferrous ore smelters (the major source in Canada). The primary sources for NO_x emissions are vehicles and fuel combustion. Thus acid rain is mainly produced in areas of heavy industry and/or dense population. In North America the significant producers are located in the American Midwest and the provinces of Ontario and Quebec.

Where does it fall?

Acid rain falls downwind of major emission sources, including areas very far downwind. In North America, Ontario, Quebec and the Atlantic region in Canada, and the New England states are unwilling recipients of millions of tonnes of acid deposition anually.

"There will be a debate and votes on clean air legislation in this Congress. It is clear we have to do something."

Senate Majority Leader Mitchell

"It (legislation) will include a plan to reduce, by date certain, the emissions which cause acid rain—because the time for study alone has passed, and the time for action is now."

President Bush

A Common Problem

The long-range transport of acid rain pollutants and their harmful effects on the environment are established facts.

- Acid rain is a serious environmental problem in both the United States and Canada.
- Acid rain is a serious transboundary problem.

Acid rain does not discriminate; it is destroying the U.S. environment as inexorably as it is destroying Canada's. It is a rapidly escalating ecological tragedy in both the United States and Canada. Urgent action is required to solve the acid rain problem.

Using sophisticated atmospheric computer models and field experiments, Canadian scientists have analyzed the transborder movement of sulphur dioxide. Their calculations show a flow of 3.8 million metric tonnes (one metric tonne equals 1.1 ton) from the United States to Canada in 1980 and 3.2 million tonnes at present. Projections for 1995 suggest an increase to the range of 3.5 to 4.2 million tonnes. Comparable figures for the flow from Canada to the United States are 1.5 million tonnes in 1980 and 1.0 million tonnes at present, with a reduction to 0.8 million tonnes by 1995.

These figures mean that American emissions cause, on average, 50 percent of the acid deposition which falls on Canada. In some particularly vulnerable areas of Canada, up to 75 percent of the acid deposition originates in the United States. Canadian emissions are responsible, on average, for 15 percent of the acid rain falling on the northeastern United States. In some areas, up to 25 percent of the acid deposition originates in Canada.

All figures are in U.S. dollars unless otherwise noted.

A Mutual Obligation

The United States and Canada are obliged by international law and precedent to reduce the transboundary flow of air pollution to an amount that does not cause damage in the territory of the other.

The Boundary Waters Treaty of 1909 established the principle that neither country should pollute boundary waters to the injury of the other, and called for an end to transboundary pollution.

LOCATION OF MAJOR SOURCES OF SO_2 EMISSIONS IN NORTH AMERICA AND PREVAILING WIND PATTERNS

- Areas having SO_2 emissions greater than 100,000 tonnes per year.
- Areas most sensitive to acid precipitation.
- Prevailing wind patterns.

This map clearly illustrates why Canada's efforts to control acid rain are concentrated in the seven eastern provinces, from Manitoba east. Most major Canadian sources of SO_2 emissions are located within this area, which is quite sensitive to acid precipitation. In addition, prevailing winds transport the pollution from the United States into these eastern portions of Canada.

Environment Canada

We acknowledge responsibility for some of the acid rain that falls in the United States, and by the time our program reaches projected targets, our export of acid rain to the United States will have been cut by an amount in excess of 50 percent. We ask nothing more than this, in return, from you.

**Prime Minister Mulroney — Address to Congress
April 17, 1988**

The Trail smelter decision of 1941 established the principle that neither country should pollute the atmosphere to the injury of the other. This was a historic turning point in the development of international environmental law and a giant step forward in the recognition by Canada and the United States of their international environmental obligations. Under the terms of the decision, Canada agreed to control sulphur-dioxide (SO_2) emissions from a smelter in Trail, British Columbia, which the United States claimed were causing damage to Washington State. Canada also paid compensation for damages caused by emissions from the smelter.

Principle 21 of the UN Conference on the Human Environment, reflecting the Trail smelter decision, holds, in part, that all nations have "the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states." Many nations, including Canada and the United States, have endorsed this principle. It is a basic element of the 1986 United States/Mexico agreement on transboundary air pollution.

The UN Convention on Long-Range Transboundary Air Pollution of 1979, which both Canada and the United States have signed, expressed a determination to reduce and prevent long-range transboundary air pollution.

The Helsinki Protocol of 1985, which was signed by 23 European countries and Canada under the UN Convention, committed the signatories to reduce their SO_2 emissions by at least 30 percent by 1993.

The Sofia Protocol of 1988, which was signed by Canada, the United States and 23 European countries, requires countries to freeze their nitrogen-oxide emissions, or their transboundary flows, at 1987 levels and subsequently to reduce them to levels that will not damage the environment.

Good Neighbours

Canada and the United States have a long history of mutually beneficial cooperation to protect our common environment. The Boundary Waters Treaty of 1909, which created the International Joint Commission (IJC), established the basis for joint management of shared boundary waters. For many years the IJC has been one of the primary mechanisms for bilateral cooperation on environmental issues.

In 1916 Canada and the United States signed a Convention to facilitate the care and preservation of migratory birds.

The Great Lakes Water Quality Agreement, signed initially in 1972, provides a framework for dealing with pollution of the Great Lakes. The Agreement was revised in 1978, and again in 1987, to deal with newly emerging pollution problems in the Great Lakes.

In 1982 the two countries signed an Agreement on the Management of Radioactive Waste, and in 1986 they signed a further Agreement on the Transborder Shipment of Hazardous Wastes.

In 1986 Canada and the United States signed the North American Waterfowl Management Agreement to protect and rehabilitate the North American Waterfowl habitat. In 1987 the two countries signed the Porcupine Caribou Herd Management Agreement, which provides for the joint management and conservation of this herd, which migrates annually from Canada into the United States and back to Canada.

Canadian Actions

Canada has launched a substantial emissions control program to reduce both its contribution to acid rain damage in Canada and its export of pollution to the United States. This initiative is in addition to existing, highly successful programs under the Canadian Clean Air Act of 1971 and complementary provincial legislation, which had already established stringent ambient air quality standards in Canadian communities.

Canada's goal is to reduce acid rain deposition to less than 18 pounds an acre each year in all vulnerable areas, a reduction that would, according to scientific assessments, halt the process of acidification and prevent further damage.

The governments of Canada and the seven provinces east of Saskatchewan have signed agreements to reduce SO_2 emissions to 2.3 million tonnes by 1994, a reduction of 50 percent of 1980 allowable levels. The reduction is absolute, requiring offsets in existing sources for any additional emissions from new sources. Canada's control program is working—emissions are already down by almost 40 percent, and it is clear that Canada will achieve its objective of a 50-percent reduction by 1994, or earlier.

The program is designed to let the private sector and provincial utilities choose the most cost-effective means of achieving the required emissions reductions. Experience over the past four years has demonstrated that major reductions are technically and economically feasible. For instance, Ontario Hydro, Canada's largest utility, is forecasting a worst-case electricity rate increase of 2.9 percent. New technology development and demonstration projects have been successfully incorporated into Canada's program without compromising the 1994 deadline for full implementation.

Experience gained since the early 1970s in both Canada and the United States clearly demonstrated the potential for improved energy conservation at relatively low cost. Canadian utilities are using energy productivity improvements as a very cost-effective means of cutting emissions.

Once fully implemented, the Canadian acid rain control program will cost the private sector and provincial utilities about $410 million annually. This is in addition to the (C)$15 billion spent since 1970 to implement Canada's ambient air quality program.

In addition to its sulphur-dioxide control program, Canada's car and truck emission standards are as tough as any national standards in the world and will maintain total national emissions of nitrogen oxides at or below current levels until at least 1995. The federal government has announced its intention to tighten these standards further within the next five years.

Acid Rain, The United States And Canada

Canada's control program is necessary but not, by itself, enough. An American program to reduce the flow of SO_2 emissions into Canada to half the 1980 level, or to about 2 million tonnes per year, is also needed to protect the Canadian environment from further damage by acid rain. Approximately 90 percent

Declining sugar maples in Quebec.

ouvernement du Québec, Ministère de l'Energie et des Ressources of the transboundary flow of sulphur dioxide into eastern Canada is emitted by sources in states within approximately 300 miles of the border. About 50 percent of the transboundary flow comes from the Ohio River Valley. Scientists advise that total U.S. emissions would need to be reduced by 10 million tons to achieve the necessary reduction in the transborder flow, assuming at least three-quarters of the total reductions come from sources within 300 miles of the international border east of Manitoba. If these scientifically derived targets are not met, the result will be continued damage to the Canadian environment.

Under the Clean Air Act of 1970, and major subsequent amendments to it, the United States has made significant improvements in the air quality of many parts of the country and has reduced the transboundary flow of acid rain pollution by 15 percent since 1980. However, U.S. emission forecasts indicate that in the absence of new emission management measures, the transboundary flow will increase by 10 to 30 percent by 1995.

There is as yet no U.S. program designed to reduce emissions to the level necessary to stop the damage being caused in Canada by acid rain originating in the United States. However, there is clear indication that both the Administration and Congress want to institute a U.S. acid rain reduction program. There is an emerging consensus that SO_2 emissions should be reduced by 10 million tons over the next decade. Such a program, with the appropriate distribution of the reductions, should be sufficient to reduce the transborder flow to an acceptable level. This, in conjunction with Canada's own acid rain control program, would stop the acid rain damage in Canada.

The Cost

Conservative estimates, based on scientific analysis, suggest that the damage is enormous. Acid rain pollution, directly or indirectly, affects large areas of North America and touches many aspects of our daily lives. It is damaging basic resources and affecting important industries in both countries, including tourism, fisheries, agriculture and forestry. There is evidence that it is also a threat to human health.

In eastern Canada, some 14,000 lakes are already acidified, with the loss of virtually all indigenous fish species. Another 150,000 have been damaged. According to the Environmental Protection Agency (EPA), in the United States, nearly 3,800 lakes are being damaged and 1,100 are acidified. The damage is also severe to streams in the eastern United States and Canada, where tens of thousands are being acidified.

Acid rain is one of the major contributing factors to the phenomenon of forest decline being experienced in North America, affecting both coniferous and deciduous trees, particularly in eastern North America.

Corrosion and deterioration of materials in buildings and monuments, including structures of great cultural, historic and aesthetic importance, are, at least in part, caused by acid rain pollution.

There are also indications of more ominous costs. Appearing in 1987 before a U.S. Senate panel, health experts from the American Lung Association, the American Public Health Association and the American Academy of Pediatrics testified that scientific knowledge about the health effects of acid rain is sufficient to conclude that, at current levels, it is harmful to human health. These experts reiterated their concerns in 1989 in testimony before the same committee. There is growing evidence of a direct link between exposure to acid rain pollution and respiratory problems in children and asthmatics.

The Bill

Canada's acid rain control program is estimated to cost $410 million annually or about $15 per capita. According to work done by the EPA and the Library of Congress' Congressional Research Service (CRS), comparable reductions in emissions in the United States could cost $2.5 to $4.0 billion annually or $10 to $15 per capita.

The economic benefits of controlling acid rain emissions are difficult to estimate and existing estimates are no doubt conservative. Based on studies done by Environment Canada, the benefits of reducing acid rain in Canada are estimated to be worth about $1 billion annually. A study prepared by the CRS estimates the benefits of controlling acid rain in the United States at $5.5 to $8.2 billion annually. CRS notes that a significant portion of the benefits would occur in urban areas.

The cost of reducing acid rain is substantial but so is the cost of inaction. And it will grow the longer action is delayed.

A North American Solution

Each country must necessarily design its own acid rain reduction program according to its particular circumstances. As indicated by Prime Minister Mulroney in his 1988 address to Congress, Canada's objective is to secure, as quickly as possible, the reduction of the acid rain that crosses the border to a level the environment can safely tolerate. To achieve this goal, Canada believes the two countries should conclude an accord that would acknowledge explicitly the transboundary nature of the problem and establish the obligations and commitments of each side to the other. It would also establish the yardsticks against which progress can be measured and provide a measure of insurance to each side about the other's long-term commitment. Finally, the prospect of an accord could facilitate agreement in the U.S. on a program to reduce emissions.

The accord must:

- ***set specific SO_2 emission target levels so that the transboundary flow from the United States is reduced to two million metric tonnes (about 50 percent of the 1980 level);***
- ***set a timetable to attain these reductions as quickly as possible.***

Canada's own acid rain control program will be fully implemented by 1994 and will reduce the transboundary flow into the United States by 50 percent.

The precedent for this approach has already been set. The 1972 Great Lakes Water Quality Agreement established targets and a timetable for reducing pollution in the Great Lakes.

Canadian Industry & Acid Rain Control

FALCONBRIDGE

Falconbridge's mining and smelting operations in Sudbury and Timmins, Ontario, are among the cleanest in North America. Its Kidd Creek operations at Timmins capture over 98 percent of sulphur in its ores and emit only 5,000 tonnes* a year of sulphur dioxide (SO_2). At Sudbury, 89 percent of the sulphur contained in its nickel and copper ores is captured and emissions have been consistently under control order levels imposed by the Ontario government.

Because much has already been done at Falconbridge, the corporation does not presently have to spend large amounts on SO_2 emission reduction. However, programs and plans are in place to further reduce SO_2 emissions by 1994.

*One metric tonne equals 1.1 ton.

Diversified Mineral Products for Industry

Falconbridge Limited is one of the world's largest mineral corporations, producing a diversified array of metals and industrial minerals. The corporation is the second largest producer of nickel in the western world, from its mines in Sudbury, Canada, and the Dominican Republic and its refinery in Kristiansand, Norway. From its Kidd Creek operations in Timmins, Canada, Falconbridge produces copper, zinc metal and concentrates. The corporation is the largest mine producer of copper in Canada. In addition, the corporation's industrial minerals division is the world's largest producer of nepheline syenite and also produces significant amounts of silica.

The Falconbridge smelter.

Falconbridge's markets for its products encompass the entire industrial spectrum, with nickel being used in applications as diverse as jet engines, stainless steel and plated automobile parts; copper in heat-exchangers and communications systems; zinc for galvanizing and die-casting; and nepheline syenite in glass production.

Concern for the Environment

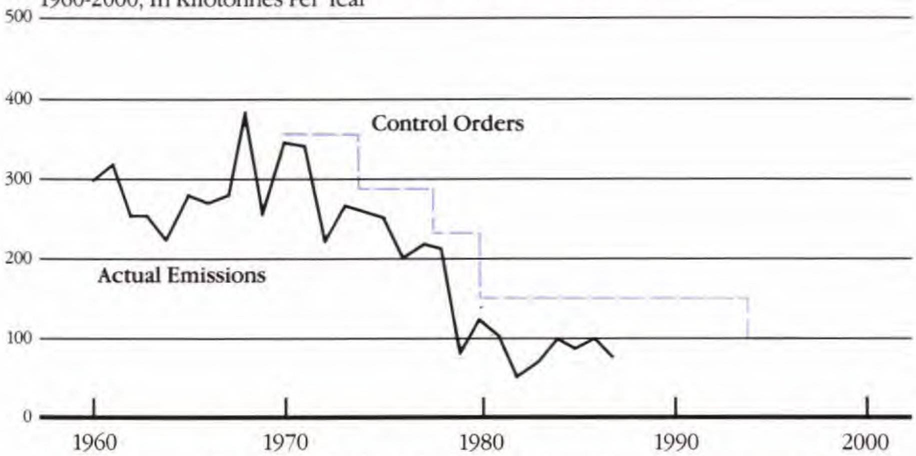
Associated with the metals and minerals that are sought after, most ores contain a variety of elements and substances that are unwanted. These unwanted components may be released and contaminate the environment during the extraction process. This pollution may be either air- or waterborne and may be local or dispersed over large areas.

Falconbridge, like other Canadian mining companies, is concerned to ensure that it protects the environment. All the corporation's employees are required to comply with its environmental policy by incorporating into their planning and daily work the actions necessary to: "Protect and preserve the quality of the environment and obey the environmental laws and regulations of each country in which Falconbridge operates."

Implementation of this policy requires that:

- Facilities are designed, built and maintained in compliance with these laws and regulations.
- All operating procedures are environmentally sound.
- Emergency response systems are formulated and implemented.
- Information is provided to assist governments in the formulation of realistic and practical rules, regulations and guidelines.
- The ability to protect the environment is improved by research and development.
- Employees and agents are advised of this policy.

SUDBURY SMELTER'S ANNUAL SO_2 EMISSIONS
1960-2000, In Kilotonnes Per Year



Annual SO_2 emissions from the Falconbridge smelter have always been within Ontario government control orders. If the smelter had been operating at full capacity in 1988, it would have emitted 105 kt SO_2, well below the current limit, and just slightly above the 1994 limit of 100 kt/y.

Sudbury Operations: Continuous Progress in Reducing SO_2 Emissions

At Sudbury, Falconbridge operates a number of relatively small mines producing about 2.6 million tonnes a year of ore, containing just over 2.6 percent nickel plus copper and 12 percent sulphur. This ore is then concentrated and smelted at Sudbury to produce a matte containing approximately 75 percent nickel plus copper, which is then shipped to the corporation's facility in Kristiansand, Norway, for refining.

Falconbridge's smelting operations in Sudbury have been in production since 1930. For the first few decades, nearly 16 tonnes of SO_2 were produced for every tonne of nickel contained in the matte produced by the smelter. Subsequent investments and technical improvements had brought this ratio down to two to one by 1988. Annual emissions of SO_2 have declined from 300,000 tonnes in 1960, to under 100,000 tonnes in 1988, as shown in the accompanying chart. Some of this reduction is the result of operating at below capacity. If the smelter had been operating at its rated capacity of 88 million pounds of nickel per year, it would have emitted 105,000 tonnes of SO_2 in 1988.

Early efforts at reducing SO_2 emissions centred around rejecting the primary sulphur-bearing mineral (pyrrhotite) in Sudbury ores prior to smelting. By the mid-1970s, this approach had resulted in a decrease of more than half of the sulphur contained in the smelter feed. In 1969 a Smelter Environmental Improvement Project was initiated which led to the commissioning of a new smelter in 1978, incorporating new fluid-bed roasters, electric-furnaces and an acid plant. The installation permitted 50 percent of the sulphur in the smelter feed to be fixed as sulphuric acid, cutting emissions in half.

A continuation of technical improvements made since this complex was commissioned have resulted in further reductions of SO_2 emissions. The long-term target at Sudbury is to decrease sulphur emissions below 75,000 tonnes per year with smelter output at its capacity of 88 million pounds of nickel. A (C)$ 38-million plan was submitted to the Ontario Ministry of the Environment in 1988 that will allow Sudbury Operations to meet the 1994 SO_2 emission limits of 100,000 tonnes per year when operating at full capacity.

Kidd Creek: Building Environmentally Sound Operations

The metallurgical facilities at Kidd Creek have been built to treat the ores from the major zinc silver ore body that was discovered there in 1964. In April 1972, a zinc plant was commissioned, which has a capacity at present of 130,000 tonnes a year. In July 1981, a copper smelter using the Mitsubishi Continuous Smelting Process was placed into production. This smelter now has a current output capacity of 100,000 tonnes of copper a year.

Pollution control systems were built into the zinc plant, which now captures approximately 98.5 percent of the SO_2 produced. The total emission of SO_2 to the atmosphere from the zinc plant was approximately 2,000 tonnes in 1988. Since start-up, over one million tonnes of zinc metal have been produced by the plant and over 2 million tonnes of SO_2 have been captured and made into sulphuric acid. The acid plant at the copper smelter was commissioned in 1981 and captures 99.5 percent of the SO_2 contained in the off-gas.

Without acid plants at Kidd Creek, the emission of SO_2 into the atmosphere would be on the order of 325,000 tonnes a year. In 1988, the Kidd Creek metallurgical complex produced 500,000 tonnes of sulphuric acid and only emitted 5,000 tonnes of SO_2 into the atmosphere.

Falconbridge's Strathcona mine and mill complex in Onaping, Ontario, in the Sudbury Basin.

Canadian Industry & Acid Rain Control

Noranda's CEZinc acid plant.

Noranda Inc. plans to construct a (C)$ 166-million sulphuric acid plant at its Horne smelter in Rouyn-Noranda, Quebec.

The acid plant, a result of Noranda's agreement with the federal and Quebec governments, is being constructed in order to reduce sulphur-dioxide emissions and is part of Quebec's contribution to Canada's acid rain control program. Noranda has been and continues to be committed to a cleaner environment, and this project will enable the Horne smelter to meet mandatory environmental guidelines established by the government of Quebec.

The acid plant will be designed to produce over 350,000 tonnes* per year of sulphuric acid and, at the same time, reduce sulphur-dioxide emissions by 50 percent from 552,000 tonnes per year in 1980 to 276,000 tonnes per year by 1990. This reduction will be achieved four years ahead of the deadline in the Canadian acid rain control program, which requires a 50-percent decrease by 1994.

A voluntary, additional decrease in sulphur-dioxide emissions of 20 percent will be achieved by 1995. This brings the sulphur-dioxide emissions at the Horne smelter down to 165,000 tonnes from the 1980 base year — an overall reduction of 70 percent.

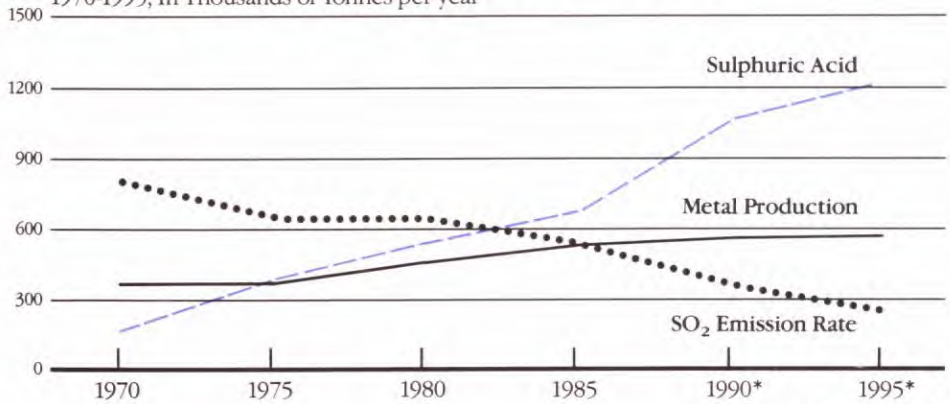
The projected total cost for this project is (C)$ 180 million, including the acid plant, construction overruns, interest charges, acid rail cars and technological changes to achieve the additional 20-percent sulphur-dioxide reduction.

Noranda Inc., through its Noranda Minerals Inc. business unit, operates four smelters in Canada — Rouyn-Noranda (copper), Gaspé (copper), CEZinc (zinc) and Brunswick Mining & Smelting (lead). Significant reductions in sulphur-dioxide emissions have occurred since 1970 even though there has been an increase in total metal production. Expressed as a ratio of annual sulphur-dioxide discharge to total metal production per year, this progressive program is illustrated below.

The decrease in sulphur-dioxide emissions and the increase in metal production over the 1970 to 1985 time period have been realized by the installation of efficient sulphuric acid plants with each expansion and sulphur reduction in feedstocks. Recycling of metallic products has been a significant factor in controlling sulphur input to the smelters.

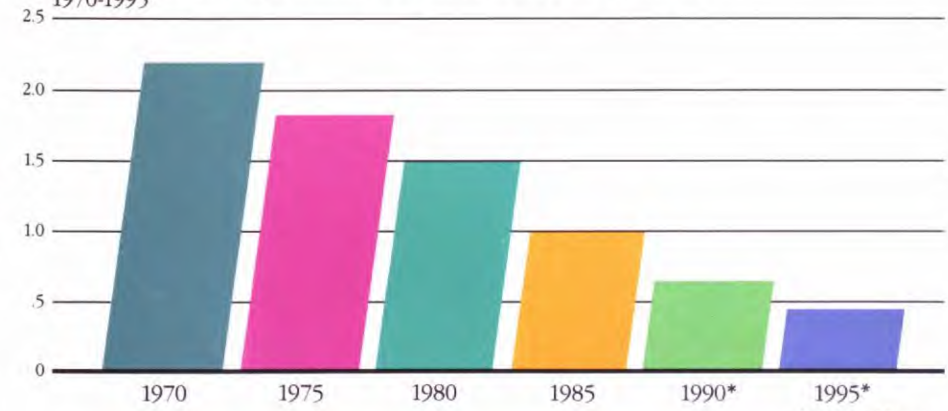
** One metric tonne equals 1.1 ton.*

NORANDA'S SO_2 EMISSIONS & METAL PRODUCTION
1970-1995, In Thousands of Tonnes per year



*projected figures

NORANDA'S SO_2 TO METAL PRODUCTION RATIO
1970-1995



*projected figures

CANADA · UNITED STATES
Acid Rain

Acid Rain and Forest Decline

Gouvernement du Québec, Ministère de l'Énergie et des Ressources

Declining sugar maples in Quebec.

While the precise linkages have yet to be firmly established, acid rain is clearly one of the causes of forest decline in eastern Canada, the eastern United States and Europe.

Acid rain pollution is thought to contribute to forest decline by accelerating the leaching of nutrients from soils and from foliage and by mobilizing toxic metals in soil water. This results in reduced rate of tree growth and a generally weakened condition, which causes trees to be more susceptible to disease, drought and severe climatic conditions.

In Quebec 40 percent of the sugar maples in the areas surveyed show signs of decline. In Atlantic Canada, red maple, yellow birch and beech show symptoms of decline. Throughout the New England states and New York, serious decline is evident in red spruce: in 23 percent of the acreage surveyed, at least 50 percent of the trees have either died or suffered serious damage (that is, the loss of 50 percent or more of foliage from live crowns). In the southeastern United States various pine species are showing signs of a reduced rate of growth.*

Forest decline is not solely an environmental problem. Eastern Canadian forests contribute about $14 billion to the economy and any significant damage to this resource would have economic consequences. One example is Quebec's maple syrup industry, which accounts for 89 percent of Canada's total maple syrup production and is worth nearly (U.S.) $33 million annually. Many of the 10,000 producers in the province are having difficulty maintaining their operations as a result of serious forest decline.

Scientists are pursuing an answer to the problem. The Canadian federal government is spending about (U.S.) $2.1 million per year on multidisciplinary research activities to determine the causes of forest decline. An additional $2.1 million per year in federal expenditures contributes indirectly to

*Joint Report to the Canada-U.S. Bilateral Advisory and Consultative Group.

forest decline studies. Ontario and Quebec have each spent about (U.S.) $1.6 million on research and monitoring.

What is the solution? The only long-term solution is to reduce the levels of acid deposition. For lakes and streams, Canadian scientists have determined, after extensive research, that the critical load of acid deposition for vulnerable areas should be no more than 20 kilograms per hectare (18 pounds per acre) per year. Scientists have not yet determined precisely the critical load which would protect eastern Canada's forests from acid-rain-related damage. Most scientific evidence from Canada, the United States and Europe, however, points to a critical load for vulnerable forest areas similar to that needed to protect lakes and streams, namely 18 pounds per acre per year.

This goal is far from being achieved, as nearly half of eastern Canada's forests receive acid deposition in excess of this level. In the meantime, Canadian scientists are also investigating the extent to which fertilizing and liming can be used to alleviate acid-rain-related stresses on forests. Such palliative remedies may be useful in smaller areas like sugar bushes.

The transborder reductions in sulphur-dioxide flows which Canada has asked of the United States, in combination with Canada's Acid Rain Control Program, should achieve an acid deposition rate of no more than 18 pounds in the most heavily affected areas of eastern Canada (for example, the Muskoka-Haliburton / Quebec City corridor). Achieving this objective in the most affected areas will result in substantially lower deposition rates (perhaps as low as 9 pounds) in many other vulnerable areas. Forests on both sides of the border will benefit.

Canada

Canadian Embassy/Ambassade du Canada

CANADA · UNITED STATES

Acid Rain

Transboundary Flows of Acid Rain Pollution

Government agencies and scientists in Canada and the United States have determined that acid rain emissions originating in the United States are causing damage in Canada.

Work Groups established under the 1980 Canada/U.S. Memorandum of Intent Concerning Transboundary Air Pollution concluded in their final report in 1983 that acid deposition was causing acidification of Canadian and American waters and that pollution being carried long distances from each country was contributing to damage in the other.

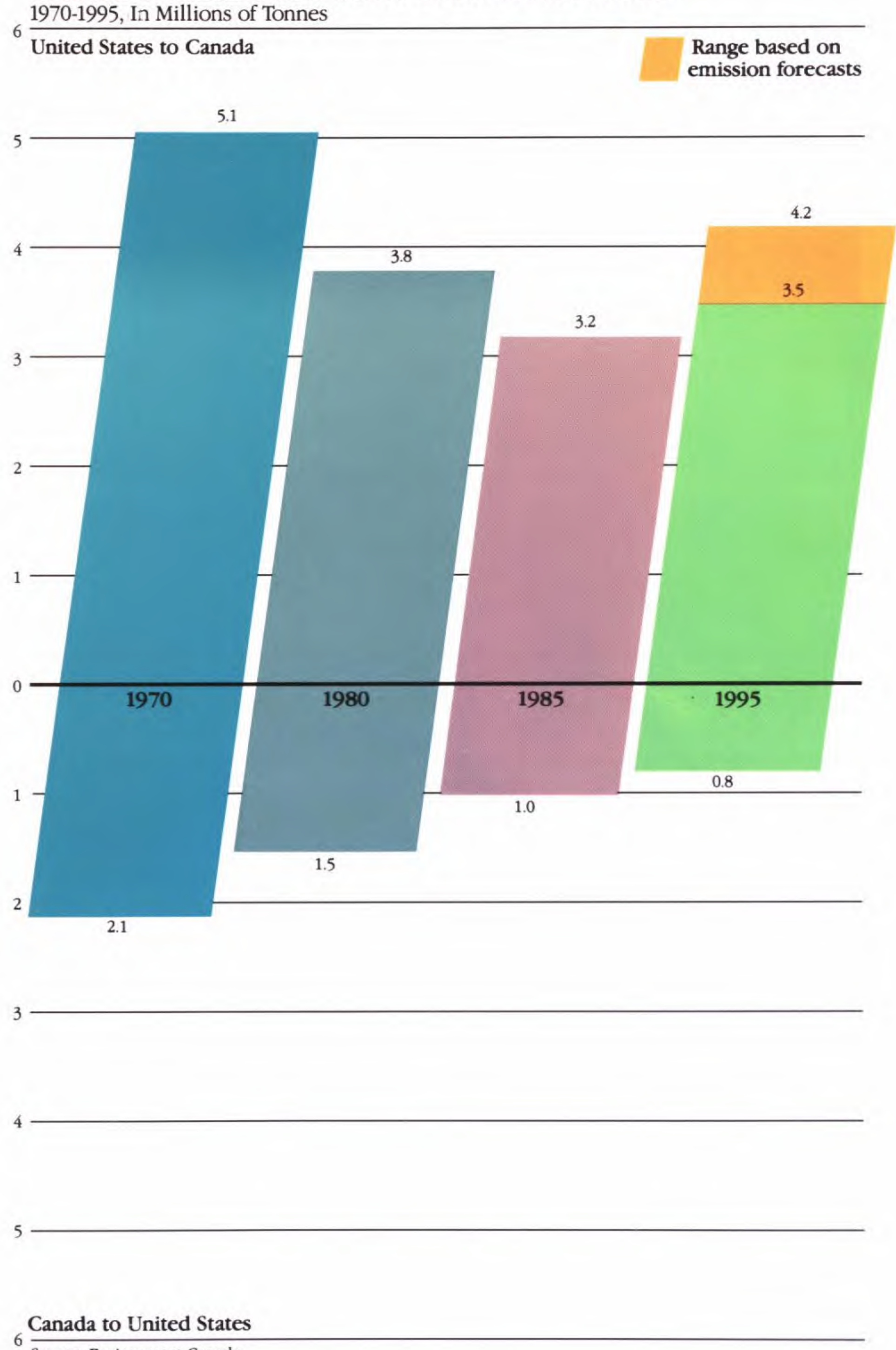
In 1985, the Prime Minister of Canada and the President of the United States appointed Special Envoys to study the acid precipitation problem. The Special Envoys concluded that "acid rain is a serious transboundary problem" and that "acidic emissions transported through the atmosphere undoubtedly are contributing to the acidification of sensitive areas in both countries." The Prime Minister and the President endorsed the conclusions of their Special Envoys.

In 1987, the Joint Report of the Canada-United States Bilateral Advisory and Consultative Group reiterated the fact that the long-range transport of air pollutants is taking place over much of eastern North America.

Using sophisticated atmospheric computer models, which have been verified by field experiments such as the Canada-U.S. Cross Appalachian Trace Experiment, Canadian scientists have calculated the extent to which emissions originating in Canada and the United States cross the border.

TRANSBOUNDARY FLOWS OF SULPHUR DIOXIDE

1970-1995, In Millions of Tonnes



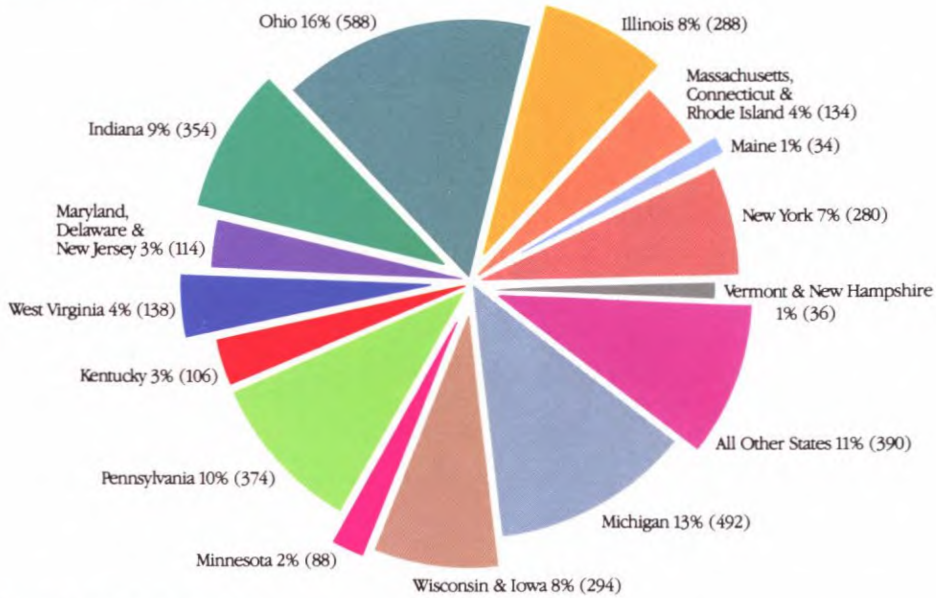
Source: Environment Canada

Canadian scientists have also determined the regions in the United States where emissions are contributing to transboundary air pollution.

In summary, approximately 90 percent of the transboundary flow of sulphur dioxide into eastern Canada is emitted by sources in states within approximately 300 miles of the border. About 50 percent of the transboundary flow comes from the Ohio River Valley.

To stop the acid rain damage occurring in eastern Canada, the transboundary flow of sulphur dioxide from the United States to eastern Canada must be reduced to 2 million tonnes—about 50 percent of the 1980 level.

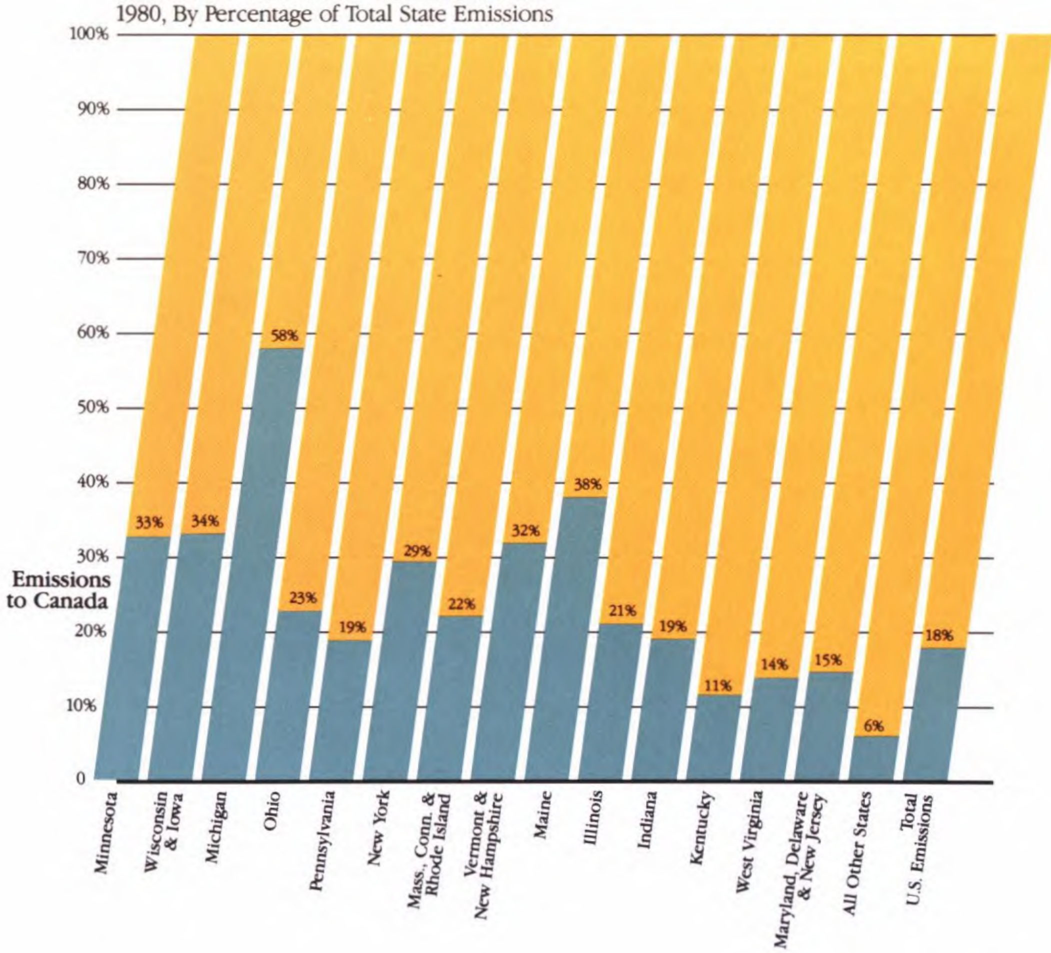
TRANSBOUNDARY FLOWS INTO EASTERN CANADA, BY STATE
1980, In Thousands of Tonnes, By Percentage of Total U.S. Pollution Export



Total U.S. pollution export to Canada: 3,710,000 tonnes.

Source: Environment Canada

STATE EMISSIONS TO CANADA
1980, By Percentage of Total State Emissions



Source: Environment Canada

Canada

Canadian Embassy/Ambassade du Canada

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Acid Rain

Fisheries in Danger

A crisis faces North America's fisheries.

Acid rain is polluting lakes, degrading rivers and killing fish—on a massive scale.

- 150,000 eastern Canadian lakes—one in every seven—have been damaged by acid rain.
- Lakes in 14 eastern states have acid levels high enough to harm fish and other aquatic life.
- More than 80 percent of Canadians live in areas where acid rain exceeds acceptable levels.
- In the eastern United States, acid rain threatens the sport of more than 15 million freshwater anglers.

Why Does Acid Rain Kill Fish?

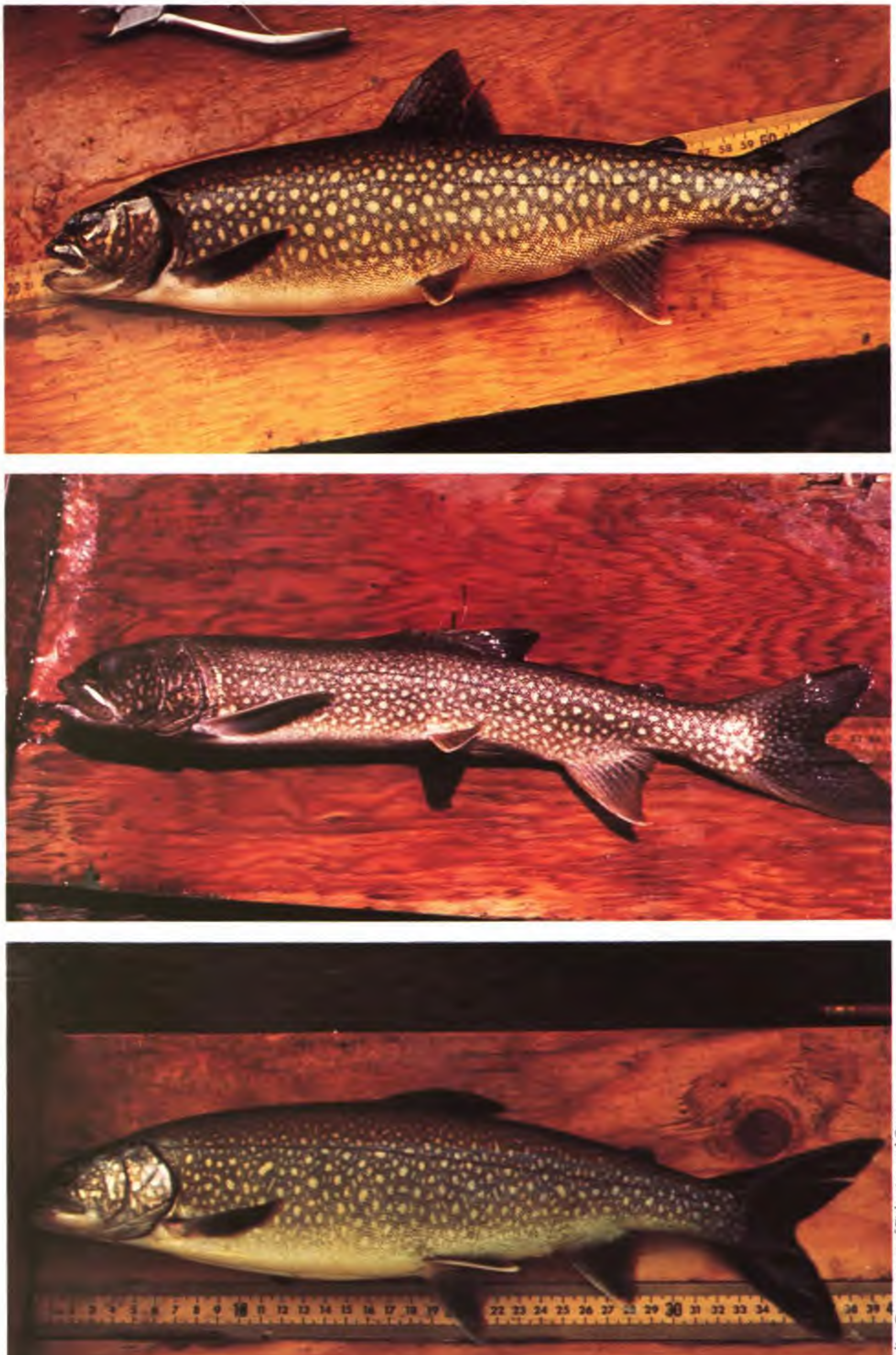
The extent of damage depends on the level of acidification. This level is measured in terms of pH values—the lower the pH, the more acid there is in the water. Acid rain has a pH of 5.5 or less, and values less than 4.7 indicate severe pollution.

The danger is *not* theoretical—acid rain's impact on fisheries is well documented.

Aquatic animals at all levels of the food chain are affected. In extreme cases whole lakes become lifeless.

As acidification worsens, fish suffer progressive damage:

- Food species are destroyed. The process starts at the very bottom of the food chain with destruction of the tiny life forms on which minnows (and other small organisms) feed.
- Below pH 6 some species—and below 4.7 nearly all species—are injured or killed. Acid in the water alters body chemistry, impairs oxygen circulation, attacks gills and interferes with heart action.
- Acid levels which may not harm adult fish can arrest growth or even kill their young.



Canadian Department of Fisheries and Oceans

The photos above show the effects on fish when Canadian scientists dosed a lake for eight years with sulphuric acid to simulate acid rain. Top, a healthy trout in 1979, before the lake has been completely acidified. Middle, an emaciated trout in 1983, showing clear signs of damage. Bottom, a year later, after dosing has stopped, the effects of acidification are being reversed and the trout population is coming back.

Research has commonly focused on adult game fish instead of more sensitive juveniles or organisms lower in the food chain. For this reason, *Science* magazine warns that "estimates of biological damage to aquatic communities by acid rain are unquestionably too low." The danger looks even worse than we had feared.

How a Lake Dies

Lake studies in northwestern Ontario are dramatic proof of acid damage. For eight years, scientists from Canada's Department of Fisheries and Oceans dosed a small wilderness lake with sulphuric acid, simulating the effects of acid rain. *(See photos.)*

- The fathead minnow and the tiny freshwater shrimp, important food for lake trout, were eliminated.
- The population of slimy sculpin declined sharply, and crayfish virtually disappeared.
- As acidification increased, emaciated and deformed fish were found.
- Toxic heavy metals were released from the lake bottom and became concentrated in the water.
- Finally, fish stopped reproducing and the trout population began to die out.

Why Our Lakes Are Vulnerable

The risk of damage to fisheries resources is particularly severe because of the geology of large areas of North America. The lack of rocks or soils with a lime base to "buffer" the acid makes more than half of Canada susceptible. Much of northern Minnesota, Wisconsin and Michigan have soils which make their lakes sensitive to acid rain. Some 2,600 Wisconsin lakes are threatened, and half of the Boundary Waters Canoe Area lakes are susceptible to damage.

The Mounting Toll

Scientists believe that some 150,000 eastern Canadian lakes—one in every seven—have already suffered biological damage from acid rain. In fact, up to 70 percent of the lakes in eastern Canada may be affected.

In the northeastern United States, hundreds of lakes are nearly lifeless. More than 9,000 others may be damaged if acid rain continues at present rates.*

Hardest hit are lakes in New York's Adirondack Mountains. Nearly 11,000 acres of Adirondack waters have reached a critical state of acidification. Fish in more than 200 lakes have disappeared.*

Some 4,600 Florida lakes are sensitive to acid rain, and 2,600 of those qualify as extremely sensitive.* This is of real concern in the state, which has one of the *fastest growing emission levels* of acid-rain-causing pollutants in the nation.

Acid Rain Hurts The Economy

A multi-billion-dollar recreational and commercial fishery is at stake.

Marinas, tackle stores, tourist lodges, guiding or other services—hundreds if not thousands of businesses in Canada and the United States—will suffer if acid rain continues.

In Canada, sportfishing contributed (U.S.)$4.5 billion to the Canadian economy in 1985. In Nova Scotia alone, anglers spent $25 million.

The Sport Fishing Institute estimates that U.S. sport fishermen spend $25 billion annually in pursuit of their pastime.

Economists studying the impact of acidified, fishless lakes estimate that 80,000 angling days a year have been lost in the Adirondack region alone.

How Can We Fight Acid Rain?

In the short term, we can treat the symptoms. In the same way that bicarbonate of soda neutralizes stomach acid, large amounts of slaked lime or other neutralizers can balance acid inputs to lakes and rivers.

But liming cannot bring back dead lakes—it won't restore food chains or replace dead fish. At best, it is an interim measure which may prevent bodies of water from becoming acidic, allowing us time to reduce acid emissions.

Over the past 15 years, sulphur-dioxide emissions in eastern North America have declined substantially. Lakes and rivers in areas where deposition has been reduced show signs of recovery. Without a guarantee of continued reductions, this downward trend could be reversed.

*Source: EPA National Lake Levels Survey.

CANADA - UNITED STATES

Acid Rain

The Great Lakes Water Quality Agreement

A Model for Controlling Acid Rain?

Cooperation between Canada and the United States in protecting the Great Lakes points the way for cooperation to reduce transborder flows of acid rain.

Canada and the United States take pride in sharing the world's longest undefended border. One consequence of this extensive contact is that transboundary environmental problems and concerns are a fact of life for Canada and the United States. Given these circumstances, the two countries have created a number of successful mechanisms to manage such problems. The Boundary Waters Treaty of 1909 and the International Joint Commission created by the Treaty illustrate how the two governments can cooperate in dealing with transboundary environmental issues.

More recently, pollution in the Great Lakes provided both the challenge and the opportunity for the two governments to further this process of cooperation and joint management of a transboundary environmental problem. By the late 1960s it had become clear that pollution of the Lakes was becoming a serious problem. Vast growths of algae appeared which depleted the oxygen and effectively choked the Lakes, severely threatening aquatic life. The culprit was phosphorus, a substance widely used in laundry detergents.

While the calls for remedial action grew louder, it was clear that pollution respects no boundaries and that if the Lakes were to be saved, local and even national action alone would not be enough. In recognition of the need for international cooperation Canada and the United States negotiated the Great Lakes Water Quality Agreement of 1972. This historic document established general and specific objectives, as well as specific programs and measures, to restore and enhance the quality of Great Lakes waters.

Most importantly, however, the Great Lakes Water Quality Agreement established a regime of targets and schedules for the reduction of phosphorus entering the Lakes. Loadings of phosphorus from municipal, industrial and agricultural sources into Lakes Erie and Ontario, the most severely affected, were to be cut by approximately 50 percent by 1976. Although the original target date of 1976 proved to be ambitious, the desired reductions in phosphorus loadings were largely achieved by the early 1980s.

The 1972 Agreement showed that it was possible for two sovereign governments to cooperate in solving a very difficult transboundary environmental problem, a valuable lesson for the even greater challenges that lay ahead. By the mid-1970s, it was apparent that the Great Lakes were under attack from another, more deadly menace: toxic chemical buildup.

Canada and the United States concluded that the Agreement should be amended to deal with the emerging threat from toxic chemicals, and in 1978 a revised Great Lakes Water Quality Agreement was signed. Under it the two governments adopted the policies of "virtual elimination" of persistent toxic substances from the Great Lakes, and zero discharge as a means of controlling the introduction of these substances into the Lakes. The revised Agreement also contained an important new concept: a commitment to protect the *ecosystem* of the Great Lakes basin.

A Protocol was attached in 1987 to strengthen and update the Agreement in the areas of atmospheric pollution, groundwater, land runoff (non-point sources) and sediments. Provisions were also added for the cleanup of pollution "hot-spots" around the Lakes and for the development of management plans for open-lake waters, designed to reduce the most critical pollutants found in the Great Lakes.

The concept of ecosystem protection adopted by Canada and the United States a decade ago in managing the Great Lakes is fully in keeping with the principle recently accepted by the United Nations of economic growth through sustainable development. National responsibility to control transboundary pollution is also based on principles of international law such as Principle 21 of the Stockholm Declaration on the Human Environment, which holds, in part, that all nations have "the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states."

While much work lies ahead, the framework of formal and informal cooperation through which Canada and the United States implement the Great Lakes Water Quality Agreement will help to ensure that its goals and requirements are met. The Agreement, with its commitment to a joint effort to control a transboundary environmental problem and to specific pollution reduction targets and schedules, is a valuable model for the resolution of common environmental problems, such as acid rain.

Canada and the United States have, over the last 80 years, achieved an enviable record in dealing cooperatively and successfully with shared environmental problems. Acid rain is the one anomaly in this otherwise outstanding record.

The Governments of the United States and Canada have agreed that acid rain is a serious environmental problem and a transboundary problem. In recognition of this fact, Canada has put in place an acid rain control program that, by 1994, will reduce Canadian sulphur-dioxide emissions by 50 percent from 1980 base-case levels. Both the Canadian and American environments will benefit from these reductions, which will result in reduced long-range transport of the emissions throughout eastern Canada and the northeastern United States. To date, the United States does not have a comparable program to reduce its emissions of sulphur dioxide, and the Canadian environment continues to suffer from cross-border air-borne pollutants as a consequence.

As with the problem of pollution of the Great Lakes, what is needed is to deal with the acid rain problem cooperatively and to establish commitments to reduce the sulphur-dioxide emissions which cause acid rain, on the basis of agreed targets and a timetable. Such commitments would be set out in a bilateral accord between Canada and the United States. Negotiation of such an accord would be a very important step in solving this serious problem.

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CANADA · UNITED STATES
Acid Rain

Acid Rain Damage

Federal Ministry for Food, Agriculture and Forests, Federal Republic of Germany

Example of extreme forest dieback.

Government agencies and scientists in Canada and the United States have documented the magnitude and severity of acid rain pollution damage in both countries. Acid rain pollution directly or indirectly affects large areas of North America and touches many aspects of our daily lives.

In vulnerable lakes and streams acid rain gradually depletes the ability of drainage basins to neutralize the acid being deposited. The acidity of the water bodies subsequently increases, causing disruption in the food chain and ultimately losses in the number and types of fish. In eastern Canada about 300,000 lakes are vulnerable (that is, they have limited ability to neutralize acid deposition and they are located in areas where acid deposition exceeds environmentally tolerable levels); 150,000 lakes are in the process of being damaged; and about 14,000 have already been acidified, which means that their acidity level has reached the point where virtually all the normal indigenous fish species are gone.[1]

In the eastern United States, about 11,000 lakes are vulnerable, 3,800 are being damaged and about 1,100 have been acidified. Streams, which make up a large portion of the aquatic resources in the eastern United States, are also being affected. More than 25,000 streams are being damaged and about 3,300 have been acidified.[2]

While the precise mechanism by which it works has yet to be irrefutably established, acid rain pollution is one of the causes of the forest decline being experienced in eastern Canada and the eastern United States. Surveys of red spruce in New England and New York have shown serious decline: In 23 percent of the acreage surveyed, at least 50 percent of the trees have either died or suffered serious damage (that is, the loss of 50 percent or more of foliage from live crowns). Various pine species in the U.S. Southeast are showing a reduced rate of growth. There is major sugar maple dieback in Quebec, and, to a lesser extent, in Ontario. Surveys of beech, red maple and yellow birch in Atlantic Canada have shown decline symptoms. Acid rain pollution is thought to be implicated through accelerated nutrient leaching from soils and foliage, mobilization of toxic metals in soil water and increased tree susceptibility to disease, drought and other climatic stresses.[3]

Corrosion and deterioration of materials in buildings, including structures important to cultural heritage, are, in part, caused by acid rain pollution. The primary effect of acid deposition is to accelerate naturally occuring decay processes. The formation of crusts and black deposits is highly visible evidence of the interaction of acid rain pollution with stone. Limestone and marble, the materials used in many Canadian and American monuments and buildings, including the Parliament buildings in Ottawa and the Capitol in Washington, are particularly vulnerable to damage.

There is growing evidence of a direct link between exposure to acid rain pollution and respiratory problems in children and asthmatics. Recent studies in Canada and the United States have found a strong association between changes in respiratory mortality and frequency of respiratory problems and elevated levels of sulphur dioxide, sulphates and sulphuric acid aerosols. Acid deposition can also pose an indirect health hazard by increasing the levels of toxic metals in the untreated drinking water storage and distribution systems.[4]

Finally, acid rain pollution is one of the major contributors to reduced visibility in the atmosphere over much of eastern North America during the summer months.

The economic benefits of controlling acid rain emissions are difficult to estimate. Based on studies done by Environment Canada, the benefits of reducing acid rain pollution in Canada are conservatively estimated to be about (U.S.)$800 million annually. A study authored by the U.S. Congressional Research Service (CRS) estimates the benefits of acid rain controls in the United States at $5.5 to $8.2 billion annually. CRS notes that a significant portion of the benefits would occur in urban areas.

For comparative purposes, Canada's acid rain control program is estimated to cost (U.S.) $400 million annually or about (U.S.)$15 per capita. While costs in the United States vary dramatically, depending on the approach chosen, a program similar to Canada's has been forecast by CRS to cost $2.5 to $4.0 billion annually or $10 to $15 per capita.

[1]Jeffries, D.S., *et al*, 1986. *Regional Chemical Characteristics of Lakes in North America, Part 1: Eastern Canada, Water, Air and Soil Pollution*, Vol.31, pages 551-567.

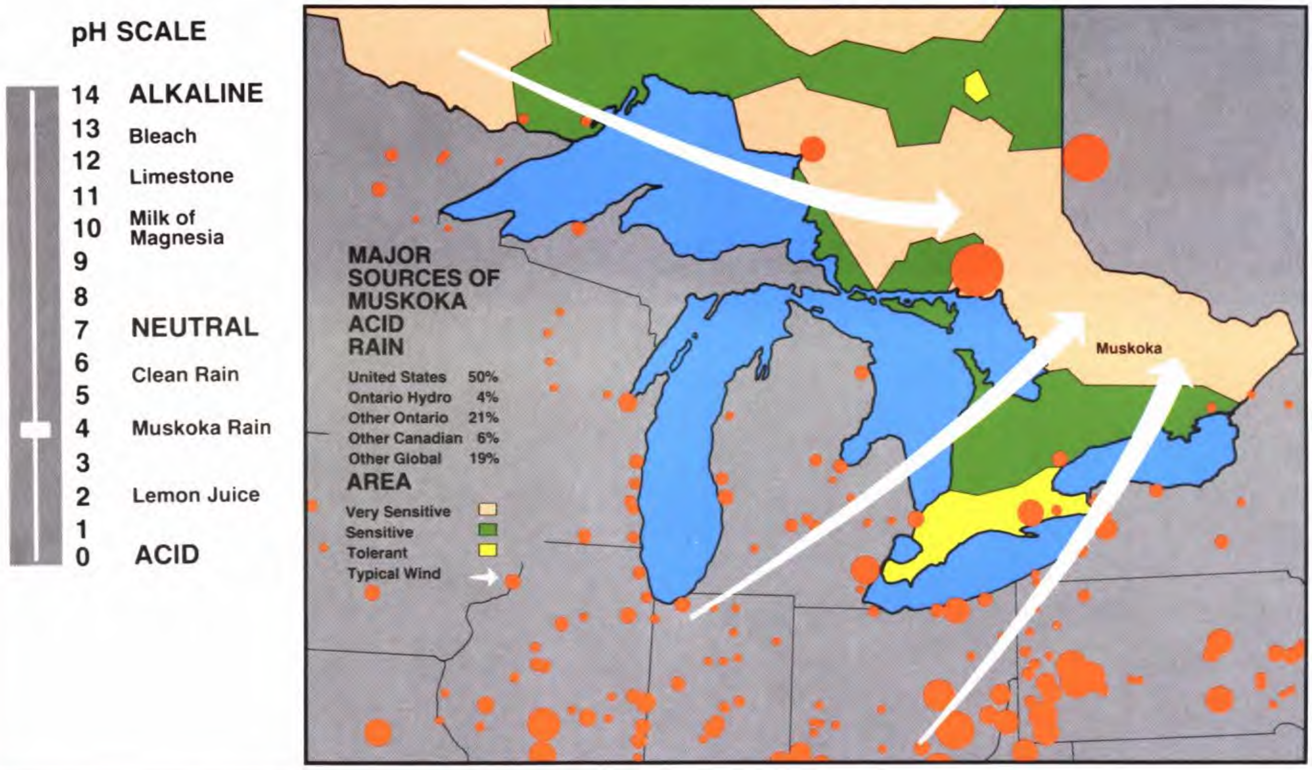
[2]EPA National Lake and Stream Surveys.

[3]Joint Report to the Canada-U.S. Bilateral Advisory and Consultative Group.

[4]See testimony on February 3, 1987, before the Senate Environmental Protection Subcommittee on "The Health Effects of Precursors of Acid Deposition," by representatives of the American Academy of Pediatrics, American Lung Association, American Public Health Association and Mount Sinai Medical Center (Environmental and Occupational Medicine), for details on health effects.

Curbing Acid Rain

SOURCES AND SENSITIVE AREAS



The pH scale is from 0 (strong acid) to 14 (strong alkaline) with 7 being neutral. Normal rain has a pH of 5.6, but rain in Muskoka – because of acid gas emissions – now has a pH of 4. Acid rain damage depends on the "sensitivity" of the lakes and soils where it falls. Areas where both the bedrock and the soil are alkaline are relatively tolerant of acid rain. A large part of Ontario lacks this natural alkalinity and is "sensitive" to acid rain. (Orange dots in the drawing indicate sources of acid gas emissions.)

What is acid rain?

Acid rain is a "catch-all" term for any type of precipitation – rain, snow, sleet, etc. – that is more acidic than normal. It is caused when sulphur oxides and nitrogen oxides are given off when metal ore is smelted, when coal and oil are burned or when gasoline or diesel engines operate. These oxides of sulphur and nitrogen are often called "acid gas."

In the atmosphere, acid gas undergoes chemical changes that form dilute solutions of sulphuric acid and nitric acid. These compounds fall back to earth and can seriously affect the natural and human environment.

What damage does acid rain cause?

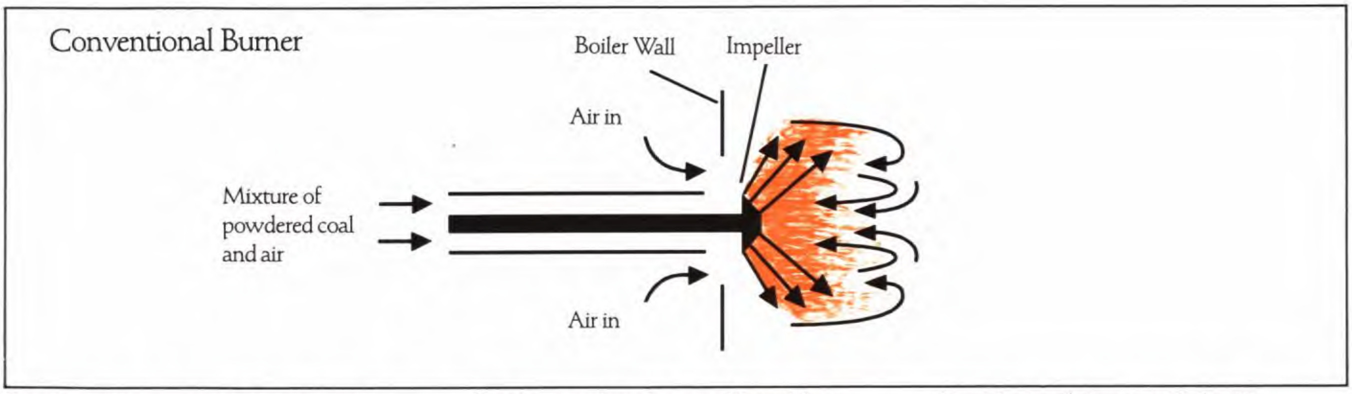
In Ontario, the major concern about acid rain has been its effect on lakes. Acid rain can increase the acidity of lakes so that fish and other aquatic life can no longer survive. Acid rain can also contribute to the destruction of forests as well as increase the corrosion of metal and stonework. Finally, there is evidence that acid rain can be harmful to human health.

How does Ontario Hydro contribute to acid rain?

Ontario Hydro operates five coal-fired generating stations and one oil-fired station. They cause a little over 20 per cent of Ontario's acid gas and about one per cent of North America's.

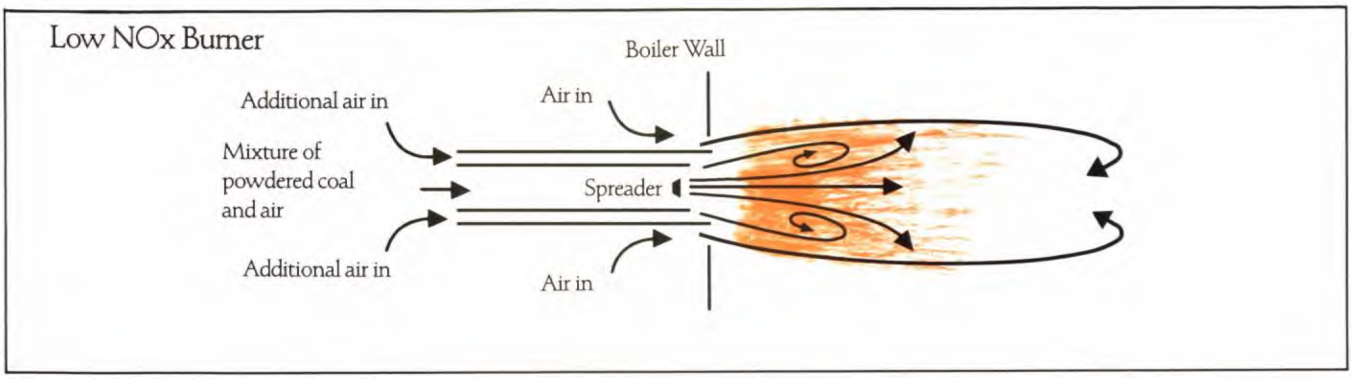
Because acid gas can be carried long distances by winds, emissions from one source can cause acid rain over a broad area. The result is that Ontario Hydro's emissions account for about four per cent of the acid rain that falls in the sensitive areas of Southern Ontario. Emissions from the United States account for about 50 per cent of the acid rain in these sensitive areas. In addition, 21 per cent comes from other sources in Ontario, six per cent comes from other sources in Canada and 19 per cent comes from other sources throughout the world.

Special burners create less nitrogen oxides



Large impeller in conventional burner forces the coal/air mixture to spread out quickly. This results in a short, intensely hot flame. The high flame temperature increases the production of nitrogen oxides.

New burner replaces the normal burner's large impeller with a small spreader. It also has an additional source of combustion air. The result is a much longer flame that burns cooler and reduces the production of nitrogen oxides by 35%. Ontario Hydro has spent $13 million to modify all 320 burners at its largest coal-fired generating station at Nanticoke.



What is Ontario Hydro doing about it?

Ontario Hydro is reducing its share of acid rain by using as much nuclear and hydraulic generation as possible and burning coal that contains less sulphur.

We have also modified all 320 burners on our Nanticoke coal-fired generating station to reduce the production of nitrogen oxides. This was originally done to make the gases from the Nanticoke station less noticeable. However, it has had the desirable side-effect of reducing emissions of nitrogen oxides by 35 per cent.

Finally, because Ontario is located far from the coal mines in Canada and the United States, Ontario Hydro has for many years purchased only washed coal. The washing process removes dirt and rock that get mixed with the coal during mining. The dirt and rock are heavy, and the shipping cost of coal is calculated by weight. So Hydro has saved a considerable amount over the years by not transporting this extra dirt and rock.

The washing process also removes iron pyrite from the coal, and iron pyrite is rich in sulphur. In this way, washing further reduces the sulphur content of the coal and reduces sulphur oxides.

Ontario Hydro has reduced acid gas emissions from a peak of 531,000 tonnes in 1982 to 381,000 tonnes in 1988. This is well within current emission limits set by the provincial government and has been accomplished despite the fact that demand for electricity in Ontario has increased by more than 20 per cent over the same period.

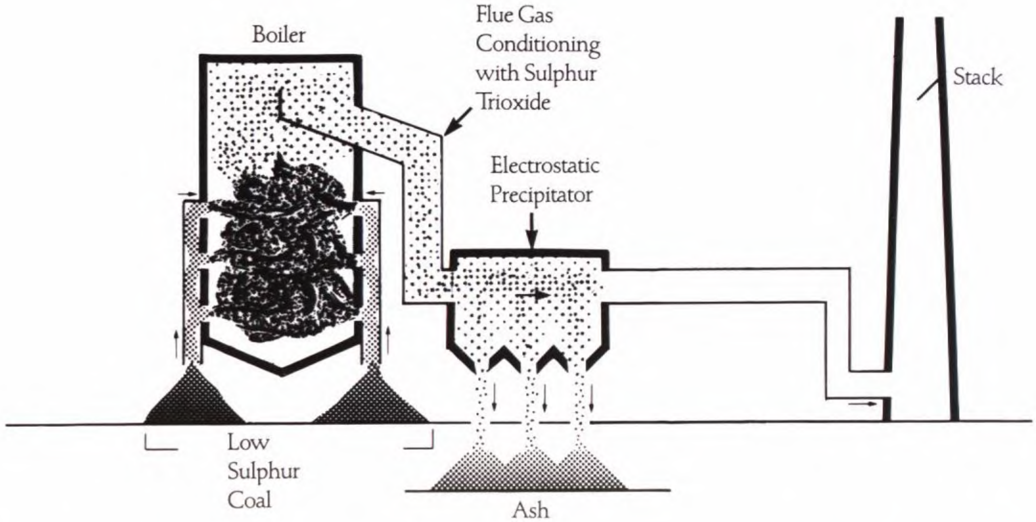
Emissions to be cut 60%

Ontario Hydro will continue to reduce its acid gas emissions so that in 1994 it can meet the new provincial regulations that will limit its total acid gas emissions to 215,000 tonnes per year – 60 per cent below our 1982 peak.

To accomplish this, Ontario Hydro will rely on the four large nuclear reactors that we are now building at our Darlington Nuclear Generating Station to replace a significant amount of energy from our coal-fired stations.

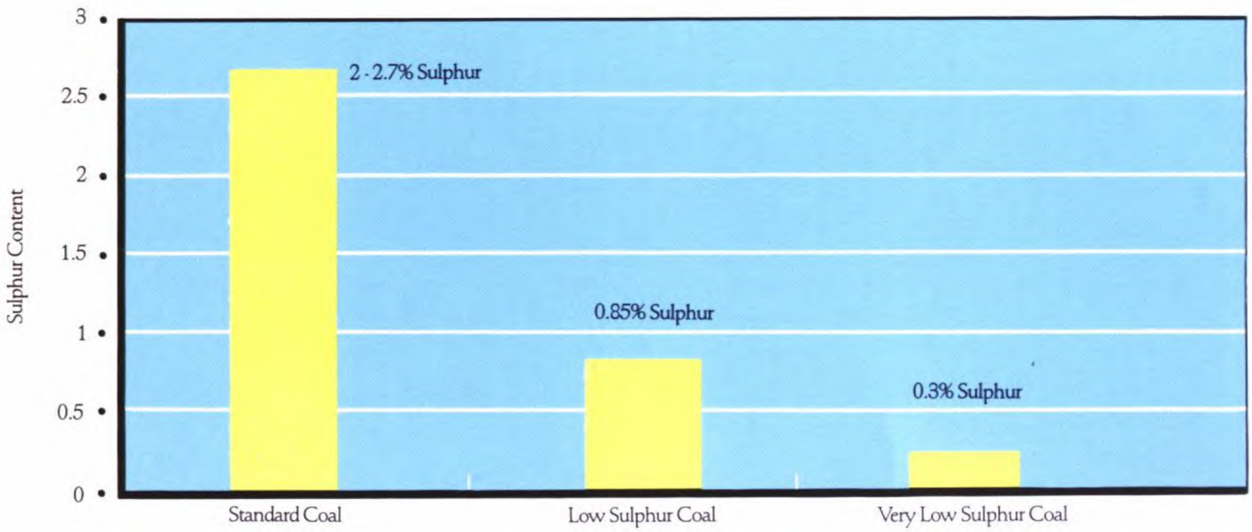
In addition, we will increase our purchases of low-sulphur coal and install flue gas conditioning equipment that will enable us to burn this extra low-sulphur coal (see diagram). We will also pursue programs to manage the growth in the demand for electricity. Finally, Ontario Hydro will install scrubbers on some of its largest coal-fired generating units.

Flue gas conditioning cuts ash emissions



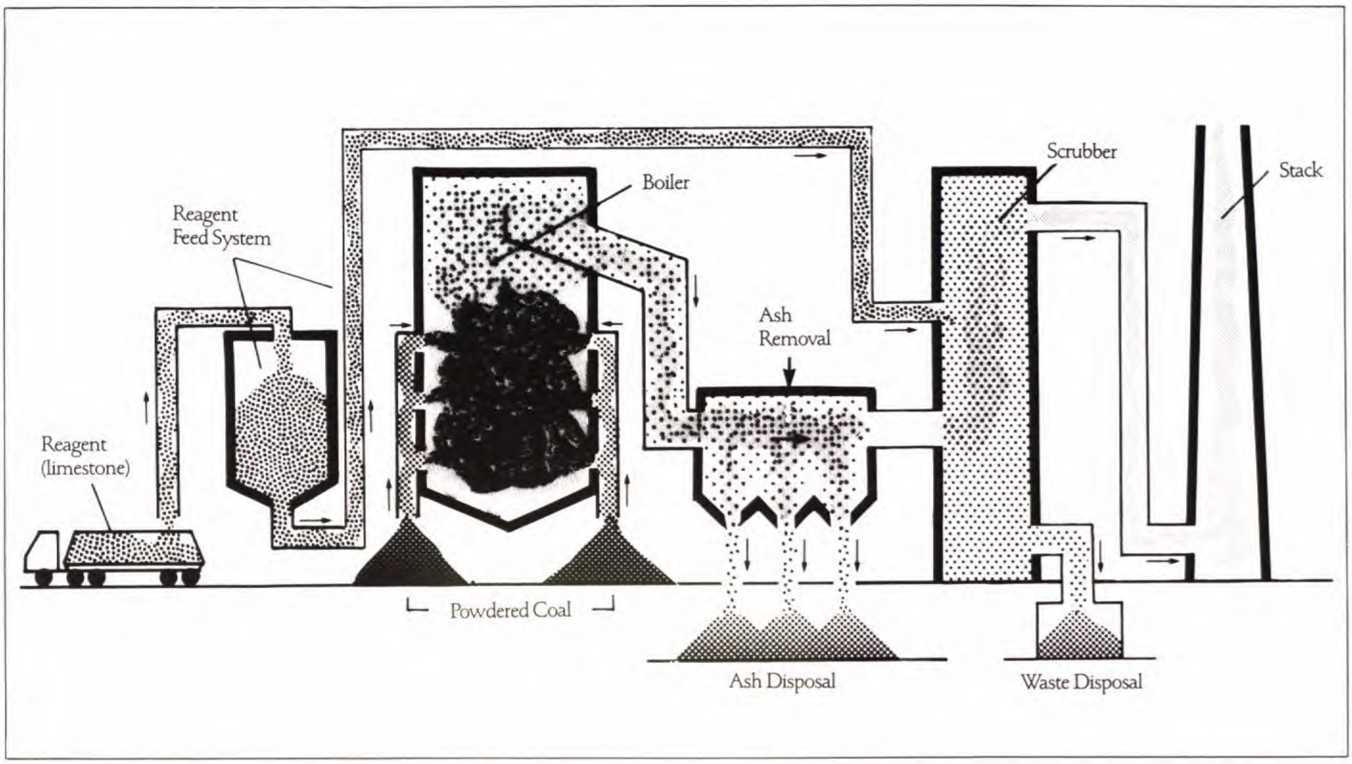
Burning lower sulphur coal reduces acid gas emissions, but in the process it increases the amount of ash emitted from the stack. The reason for this is that electrostatic precipitators that remove ash particles before they go up the stack need a certain amount of sulphur trioxide in the flue gas to operate efficiently. When we burn lower sulphur coal, less sulphur trioxide is produced. This means that fewer ash particles are collected by the electrostatic precipitators and more are released to the environment. By conditioning the flue gas with very small amounts of sulphur trioxide, we let the electrostatic precipitators do their job.

Low sulphur coal reduces emissions of sulphur oxides



By using much more low-sulphur coal, Ontario Hydro has reduced the average sulphur content of the coal it burns from 2.4 per cent in 1976 to 1.3 per cent in 1988. This reduces emissions of sulphur oxides by greatly reducing the amount of sulphur that enters the burner in the first place. Unfortunately, we cannot burn the lowest sulphur coal exclusively because it burns with an unstable flame in our burners. It must be blended with higher sulphur coals before it can be burned safely.

How scrubbers work



Scrubbers remove sulphur oxides from the flue gases given off by coal-fired generating stations. They do this by mixing the flue gases with an alkaline substance, such as finely crushed limestone, that reacts with the sulphur oxides to form solid compounds. These compounds are then collected and disposed of safely.

Despite their ordinary sounding name, scrubbers are massive structures that are expensive to build and run. Over the next ten years, Ontario Hydro plans to spend 1.3 billion dollars installing scrubbers on its largest coal-fired generating stations.

What Are Scrubbers?

"Scrubbers" is a general term that refers to various types of equipment that remove sulphur oxides from the gases that are produced when coal is burned. Ontario Hydro has submitted a $1.25 million environmental assessment to the government which requests permission to install any one of four different types of scrubbers at its Lambton, Nanticoke and Lakeview generating stations.

Subject to government approval, Ontario Hydro's current plan is to install scrubbers on two generating units at its Lambton coal-fired generating station, near Sarnia, by 1994. Two more Lambton units will have operating scrubbers by 1996. At Ontario Hydro's Nanticoke generating station, near Simcoe, two units will have scrubbers in operation by 1997, and another two units will have operating scrubbers by 1998. In total, this will give Ontario Hydro 4,000 megawatts of scrubbed coal-fired generating capacity. To put this figure in perspective, this is about the same as the 1988 peak demand of Metropolitan Toronto.

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CANADA - UNITED STATES
Acid Rain

Canada's Acid Rain Control Program

In March 1985, Prime Minister Brian Mulroney announced that Canada would implement a comprehensive acid rain control program. The objectives of the program are essentially threefold. First, the Canadian house must be in order if Canada is to expect the United States to take action. Second, Canadian emission reductions will reduce some of the acid rain damage occurring in Canada. And, third, Canada has a responsibility to eliminate any damage it is contributing to in the northeastern United States.

Canada's acid rain control program and Canada's demands for reductions in the U.S. transboundary flow of acid rain pollutants are based on a scientifically derived environmental objective. Based on extensive observations of acid fallout levels and resulting damages in eastern Canada, Canadian scientists have found that damage occurs in vulnerable areas when acid fallout (measured as wet sulphate) exceeds 18 pounds per acre per year (20 kilograms per hectare). They have also determined that when acid fallout drops below this threshold number, damage does not occur and recovery of the environment starts to take place. Canada's objective is to reduce acid fallout in all vulnerable areas to less than 18 pounds per acre per year. This objective is also consistent with observations and studies of the effects of acid fallout in Europe and the United States.

Canadian scientists have gone through the calculations to determine how many tonnes of sulphur dioxide can be emitted into the atmosphere and from what areas in order to achieve the 18-pound-per-acre-per-year objective. (One metric tonne equals 1.1 ton.) They reached two conclusions: First, total annual sulphur-dioxide emissions from the Saskatchewan/Manitoba border eastward must be reduced to 2.3 million tonnes per year (about 50 percent of the 1980 allowable level). Second, the transboundary flow of sulphur dioxide from the United States into eastern Canada must be reduced to about 2 million tonnes per year (again, about 50 percent of the 1980 level).

Falconbridge Limited

Falconbridge's Sudbury operations

Canada is well on the way to reducing emissions to an acceptable level. More than 90 percent of the emission reductions required to reach the 2.3-million-tonne level have been incorporated in the provincial regulations and air pollution control programs and have been ratified in federal/provincial agreements. Under the Canadian acid rain control program, these reductions will be achieved by 1994 at the latest. The emission reductions are absolute and emissions from any new source, no matter how stringently controlled, must be offset by additional reductions from existing sources. Currently, sulphur-dioxide emissions in eastern Canada are about 2.8 million tonnes—almost 40 percent less than in 1980. The full reductions required under Canada's program will be achieved on or ahead of schedule.

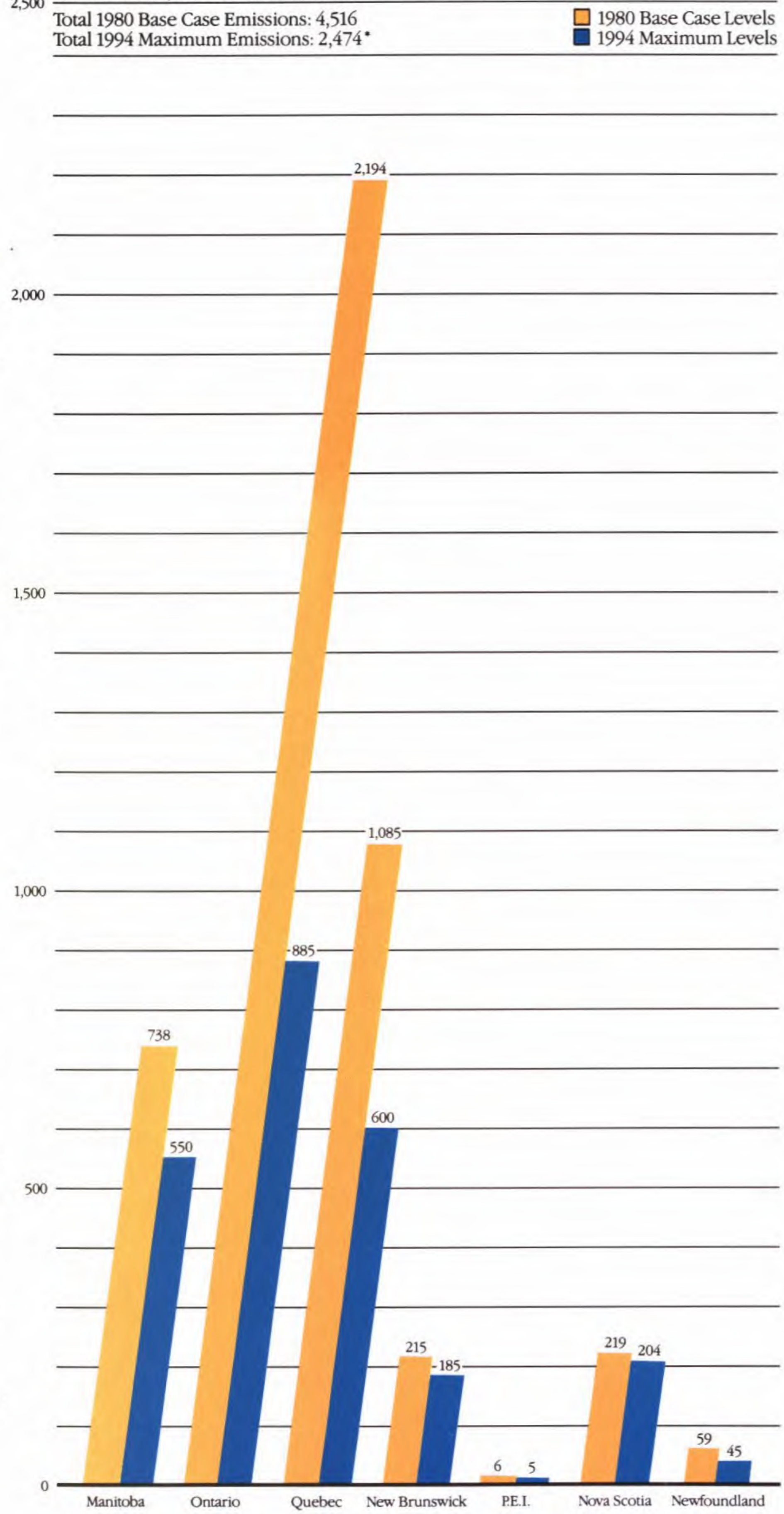
The northeastern United States is benefitting from Canadian actions. Canada has already reduced the amount of acid rain pollution it exports by one-third. When Canada's program is completed, it will have cut its exports by more than 50 percent.

The sources of sulphur-dioxide emissions in Canada are very different from those in the United States. In eastern Canada, 60 percent of sulphur-dioxide emissions come from non-ferrous smelters, 15 percent from thermal power plants, 15 percent from non-utility fuel combustion and the remainder from miscellaneous sources. By contrast, in the United States, about 70 percent of sulphur-dioxide emissions come from thermal power plants. This means that the nature and scope of actions taken to reduce emissions from the sources in the two countries will be quite different.

The Canadian acid rain control program is the result of a genuine partnership involving all levels of government, industry and environmental interest groups. The experience gained over the past four years has demonstrated that major emission reduction measures are both technically and economically feasible. Cleaning up pollution does not have to cripple an industry's competitiveness. In fact, environmental cleanup can be part of an industry's future strategy. Technical innovation and plant modernization can reduce emissions and improve productivity even when the emission reductions must be accomplished within a tight time frame.

SULPHUR-DIOXIDE EMISSIONS IN EASTERN CANADA

1980 and 1994, In Thousands of Tonnes



*Governments are committed to allocating the remaining 174,000 tonnes of emission reductions in time to have them in place by 1994.

The following are some highlights of the Canadian acid rain control program which, once fully implemented, will cost Canadian industry and provincial utilities about US$410 million annually.

Ontario

The province is reducing its total sulphur-dioxide emissions by 60 percent by 1994.

About 80 percent of Ontario's sulphur-dioxide emissions come from four corporate sources: Ontario Hydro, Inco's and Falconbridge's smelters and Algoma Steel's iron ore plant. Ontario has issued regulations requiring a 65-percent reduction in emissions from these sources by 1994.

■ Inco, which was responsible for almost half of Ontario's sulphur-dioxide emissions, has already lowered emissions about 40 percent from its 1980 level by rejecting sulphur in its ore (similar to coal cleaning) and converting sulphur dioxide into sulphuric acid (analogous to the use of a scrubber on a power plant). It has achieved a containment rate of more than 70 percent of the sulphur in its ore. By 1994, Inco will reject more sulphur from its ore, use new smelting technology (similar to the development of new clean coal technologies) and increase the amount of sulphur dioxide converted to sulphuric acid to raise its containment rate to more than 90 percent.

■ Falconbridge has already achieved a containment rate of 85 percent through sulphur rejection and sulphuric acid production. The company will make further refinements to increase its containment rate to over 90 percent by 1994.

■ Ontario Hydro, which is responsible for 20 percent of Ontario's sulphur-dioxide emissions, has already reduced its emissions by about 25 percent. The company will use scrubbers, low-sulphur coal, load management and conservation measures to achieve a 60-percent reduction in emissions by 1994. By 1994, Ontario Hydro's average SO_2 emission rate will be 0.8 lbs/million BTUs heat input.

■ Algoma Steel's iron ore plant's current emissions are below its 1994 requirement.

Quebec

The province has issued regulations which will reduce its total emissions by 45 percent by 1990, four years ahead of the national deadline.

■ Noranda, which is responsible for over half of Quebec's total SO_2 emissions, has begun construction of a plant to convert sulphur dioxide into sulphuric acid and will reduce its emissions by 50 percent by 1990. Further process changes will allow Noranda to reduce its emissions by an additional 20 percent by 1995, and bring its overall containment rate to 70 percent. These additional reductions will bring Quebec's overall emission reductions to 50 percent by 1995.

■ The province has also instituted measures to reduce emissions from non-utility fuel use and other sources.

■ Hydro Quebec does not produce electricity from coal.

Manitoba

The province has issued regulations that will reduce emissions from its two largest sources, which together are responsible for more than 95 percent of Manitoba's sulphur-dioxide emissions.

■ Hudson Bay Mining and Smelting is converting its zinc circuit from a pyrometallurgical process to a hydrometallurgical process with no sulphur-dioxide emissions.

■ Inco is optimizing sulphur rejection to reduce its emissions by 45 percent.

New Brunswick

The province will reduce its emissions by about 15 percent by 1994.

■ New Brunswick Power is planning a mixture of scrubbers, advanced combustion technologies and low-sulphur coal to further manage its emissions.

■ Emissions from other sources are also being reduced.

Nova Scotia

The province will reduce its emissions by about 7 percent by 1994.

■ Nova Scotia Power is evaluating the use of a mix of scrubbers, advanced combustion technologies and low sulphur to further manage its emissions.

Prince Edward Island and Newfoundland

Prince Edward Island and Newfoundland have already reduced their emissions by 16 percent and 25 percent respectively.

Western Canada

The three western provinces are not part of the Canadian acid rain control program because acid fallout is not a problem in the region. However, all three provinces have taken steps to further manage sulphur-dioxide emissions.

For instance, power plants in western Canada have an average emission rate of 0.96 lbs. SO_2/million BTUs heat input, compared with 1.24 lbs. in a similar area in the western United States. In total, power plants in the western United States produce about 2.5 times the total emissions of their Canadian counterparts.

Any new power plants must meet stringent emission standards that will limit SO_2 emissions to 0.6 lbs/million BTUs.

Canadä
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