Clearing the Air

Air Quality Trends In Sudbury

Final January 24, 2005

Clean Air pur Sudbury

ABOUT CLEARING THE AIR

Clearing the Air was prepared by **Clean Air Sudbury**, a non-profit, community-based organization that is primarily focused on improving local air quality and also reducing greenhouse gas emissions in the Sudbury area.

Clearing the Air conveys the highlights of **Air Quality Trends, City of Greater Sudbury, 1953 – 2002**, a technical report prepared for Clean Air Sudbury by Potvin Air Management Consulting in June 2004.

Clearing the Air was developed as a tool to improve community awareness of air quality issues and engage the public in activities to further improve the quality of Sudbury's air.

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Welcome

In these times when so much environmental news is doom and gloom, we'd like to share a little good news with you – good news about the air that we breathe. A report recently released by Clean Air Sudbury confirms that Sudbury's air quality has vastly improved in the last thirty years. The report prepared by Potvin Air Management Consulting -- Air Quality Trends, City of Greater Sudbury, 1953–2002 – examines a wealth of data on six different pollutants and documents the dramatic changes that have taken place. One of the most visible symbols of this improved air quality is the re-greening of Sudbury's landscape that has been made possible in part because of the continued and significant reduction of sulphur dioxide emissions.

This document -- Clearing the Air -- provides an overview of the Potvin report. First, it describes the pollutants that are measured in the Sudbury area, where they come from, what their potential health effects are, and how they are regulated. Second, it summarizes the trends in air pollution and how pollutant levels have changed in Sudbury over the last 40 years. Third, it looks outside our municipality and compares Sudbury's air quality with that in similar Ontario cities. And finally – because the job of cleaning up Sudbury's air is by no means complete – it provides links to websites where Sudbury residents can get information on what they can do at home, work and play to help improve our air quality.

Clean air is vital to our existence and strongly linked to our quality of life. As this report reveals, we have much to celebrate in Sudbury about the quality of our air, and still more work left to be done.

Air Pollutants:

What Matters And Why

At any time, there can be hundreds of pollutants in our air, most of which are found in trace amounts. Regulators focus much of their effort on six major air pollutants that, at high levels, can affect human health and the environment.

Sulphur dioxide

Sulphur dioxide (SO2) is a colourless gas that is created naturally from volcanoes, forest fires and oceans. In Ontario, more than two thirds of the sulphur dioxide emitted annually comes from smelters, utilities and petroleum refineries, with smelters being the largest source, both province-wide and in Sudbury. Other sources include steel mills, pulp and paper mills, and residential, commercial and industrial heating.

Exposure to high levels of sulphur dioxide can cause breathing problems, respiratory illness, changes in the lung's defences and worsening respiratory and cardiovascular disease. People with asthma, chronic lung disease and heart disease are believed to be most sensitive. Under certain weather conditions sulphur dioxide can damage trees and crops; in the atmosphere, it changes to sulphuric acid, a major constituent of acid rain.

Nitrogen oxides

Nitrogen oxides (NOx) are a family of reactive gases containing nitrogen and oxygen. One of these compounds – nitrogen dioxide (or NO2) – changes in the air to form nitric acid (a component of acid rain) and nitrates (a component of fine particulate matter). Nitrogen dioxide also plays a major role in the atmospheric reactions that produce ground-level ozone (smog). Nitrogen oxides are created naturally (but in relatively small amounts) from lightning and the aerobic activity of soil bacteria. Almost 90% of all nitrogen oxide emissions in Sudbury come from vehicles, with 7.7% coming from the industrial sector and 3% from fuel combustion.

Nitrogen oxides continued

Nitrogen dioxide is a lung irritant and can increase the risk of respiratory illness by lowering resistance to infection. Those with asthma and bronchitis have increased sensitivity. Nitric acid, when deposited, contributes to lake acidification. It can also corrode metals, fade fabrics, degrade rubber and damage trees and crops.

Carbon monoxide

Carbon monoxide (CO) is a colourless, odourless and tasteless gas that is poisonous at high concentrations. It is produced primarily by the incomplete combustion of fossil fuels. In Sudbury, virtually all (99.6%) of the emissions of carbon monoxide comes from vehicles, with the rest coming from incineration and industrial processes.

At high concentrations, carbon monoxide enters the bloodstream and interferes with oxygen delivery to the organs and tissues. People with heart disease are particularly sensitive to exposure to the pollutant.

Total reduced sulphur

Total reduced sulphur (TRS) compounds are sulphur-containing gases that produce an offensive odour similar to rotten eggs or cabbage. Swamps, bogs and marshes are natural sources of TRS compounds, and major human sources include Kraft-type pulp and paper mills, steel mills, petroleum refineries and occasionally from sewage treatment plants. There are no significant sources of TRS compounds in Sudbury.

At the concentrations normally found in ambient air, TRS compounds are not a health hazard. At higher concentrations, however, sensitive individuals may experience nausea and headaches.

Ground level ozone

Ozone (O3) is a colourless gas that occurs naturally in the upper atmosphere, where it shields the earth from the sun's harmful UV radiation. Ground-level ozone is found at the earth's surface and is the prime ingredient in the eye-stinging mix we call "smog". It is formed in the lower atmosphere when nitrogen oxides react with volatile organic compounds in the presence of sunlight. In Ontario, elevated concentrations of ground-level ozone are typically found on hot, sunny days from May to September. It has been estimated that more than half of the ground-level ozone present during widespread smog episodes comes from long-range transport from sources in the US.

Ozone irritates the eyes and respiratory tract, causing chest tightness, coughing and wheezing in sensitive individuals. Children playing outdoors and individuals with pre-existing respiratory disorders, such as asthma and chronic obstructive lung disease are at greatest risk. High levels of ground-level ozone have been linked to increases in hospital admissions and premature mortality. Ground-level ozone also causes damage to trees, garden plants and crops.

Particulate matter

Particulate matter (PM) is the mixture of solid particles found in air, ranging in size from less than 0.1 micron to over 100 microns. (A micron is a unit of length equal to one millionth of a metre. A human hair is about 50 microns thick). In Sudbury, most (78%) of the particulate matter comes from "open sources" such as construction, unpaved roads, forest fires, mine tailings, and eroding soil. About 20% is contributed by industrial sources and the rest comes from vehicles and fuel combustion. Like ground-level ozone, it is estimated that over half of the smallest fraction of particulate is transported long range from the US.

Regulating Air Pollution: Who Does What

The health effects of particulate matter are mostly associated with "inhalable particulate" -- finer particles, less than 10 microns in size, which can penetrate further into the respiratory system. Exposure to these finer particles is linked to increased hospital admissions and premature mortality. Most at risk are those with asthma, cardiovascular or lung disease, children and the elderly. In 2002, the Ontario Ministry of the Environment began monitoring "respirable particulate" which is less than 2.5 microns in size, and which is of still greater concern for human health.

In Canada, the federal and provincial governments share responsibility for regulating air pollution. The federal government deals with transboundary air issues, such as the Kyoto accord on greenhouse gas emissions, and emissions deemed to be toxic. It has the power to set Canada-wide standards for air pollutants, such as those recently announced for ground-level ozone and respirable particulate, and has recently drafted legislation dealing with emissions from metal smelters and refiners. The federal government sets standards for vehicles and other polluting equipment that is manufactured or sold in Canada.

The Ontario Ministry of the Environment (MOE) regulates and enforces air pollution legislation in the province. The MOE also sets air standards for a large number of air pollutants. These standards are used in the issuance of the Certificates of Approval to new or existing facilities that emit air pollutants. The Ministry audits monitoring stations operated by industry, reports on air quality and regulates vehicle emissions through the Drive Clean program.

Tools for Measuring Air Quality

The MOE runs a network of air monitoring stations in a number of urban and rural locations and reports to the public on air quality.

Ambient Air Quality Criteria

The province has developed Ambient Air Quality Criteria (AAQC) for over three hundred air pollutants. These criteria reflect desirable concentrations for acceptable air quality. They are expressed as concentrations (e.g., parts per billion) averaged over periods of time, commonly for 1 hour, 24 hours, or 1 year.

Air Pollution Index Ontario's Air Pollution Index (API) has been used since 1971 as an "alert and control system" to warn about deteriorating air quality and initiate remedial action, if necessary. The API is based on levels of sulphur dioxide and suspended particulate matter. When certain threshold levels are reached, the Minister of the Environment can order major sources of these pollutants to curtail or shut down their operations.

Air Quality Index

The Air Quality Index (AQI) was developed by the MOE in 1988 as a way of providing information on a range of common air pollutants. It provides the public with "real-time" air quality information from the province's 29 continuous air monitoring stations. The AQI is determined from measures of sulphur dioxide, nitrogen dioxide, ground-level ozone, total reduced sulphur compounds, carbon monoxide and particulate matter. The index translates concentrations of these pollutants into a sliding scale of air quality (i.e., very good, good, moderate, poor and very poor). AQI values are released daily to the public.

Smog Alerts

The MOE developed the Smog Advisory Program in 1993 jointly with Environment Canada. Smog advisories are issued when concentrations of ground-level ozone and particulate matter are expected to be high, widespread and persistent.

Taking The Measure of Sudbury's Air

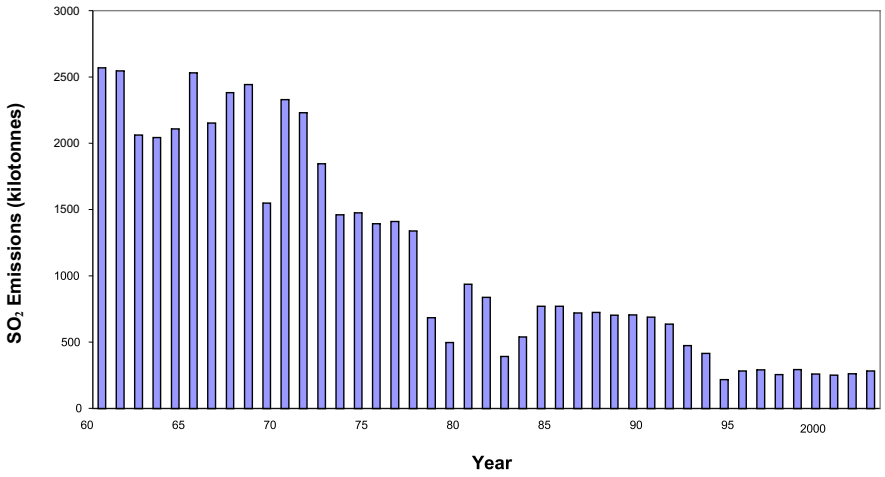
Sulphur Dioxide

Of all the air pollutants in Sudbury's air, none has received more attention than sulphur dioxide. Since the early 1900s, more than 100 million tonnes of sulphur dioxide have been released into the atmosphere from the Sudbury Basin due to the mining and smelting of its copper and nickel-rich ores. By the middle of the last century, it was clear that these emissions were causing poor local air quality and extensive damage to vegetation in the areas surrounding Sudbury. In the 1950s and 1960s, there were widespread and frequent exceedances of the provincial ambient air quality criteria.

To address these problems, Sudbury's smelters developed extensive programs to reduce the emissions of sulphur dioxide, programs that included removing sulphur from ore before smelting, increasing the efficiency of the roasting and smelting processes, and containing sulphur through the production of sulphuric acid which is then sold. These abatement actions led to an 88% reduction in emissions between 1960 and 2002. Emissions are expected to continue to fall in response to the MOE's requirements to further reduce the annual limit of emissions from 365 kilotonnes to 241 kilotonnes by 2007 (see Figure1) and to meet the provincial half-hour standard of 300 parts per billion by 2015. (1 part per billion is equal to 1 part chemical in a billion parts of air.)

The impact of these abatement activities, along with the closure of obsolete plants and the increased dispersal of pollution due to the construction in 1972 of the world's tallest smokestack in Copper Cliff has been dramatic. The data from Sudbury's air monitoring stations show a steady decline in the annual average concentration of sulphur dioxide in the ambient air. Where the average annual concentration in 1971 was 54 parts per billion, in 2002 it was 5 parts per billion. As illustrated in Figure 2, this has been accompanied by an even more dramatic decline in the frequency at which the provincial ambient air quality criteria have been exceeded.

Figure 1
Sulphur Dioxide Emissions from Sudbury Area Smelters (1960-2002)



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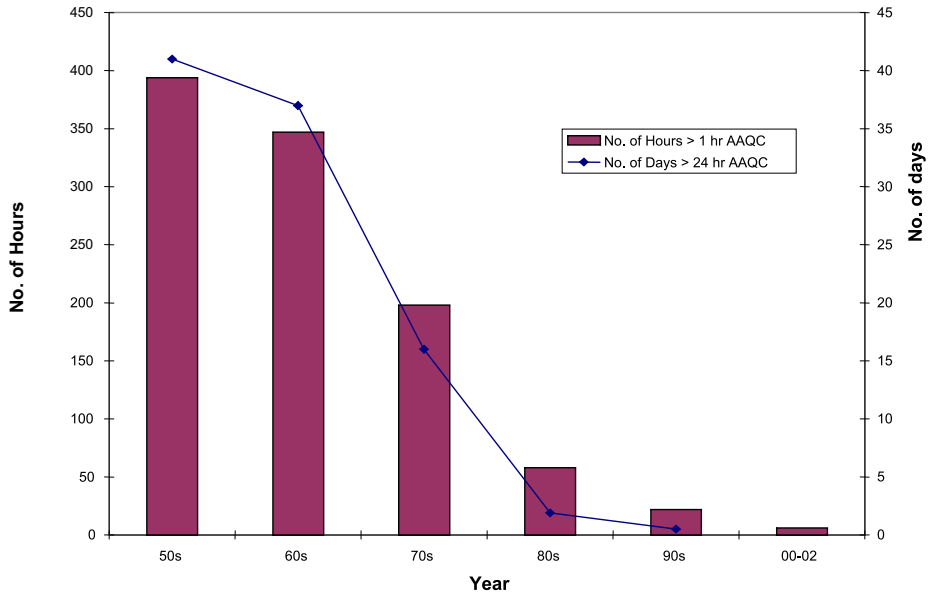
Sulphur dioxide exceedances still take place in Sudbury occasionally, as a result of local weather conditions -- the "looping plume" phenomenon --, which causes sulphur dioxide emitted from stacks to drop down to the ground.

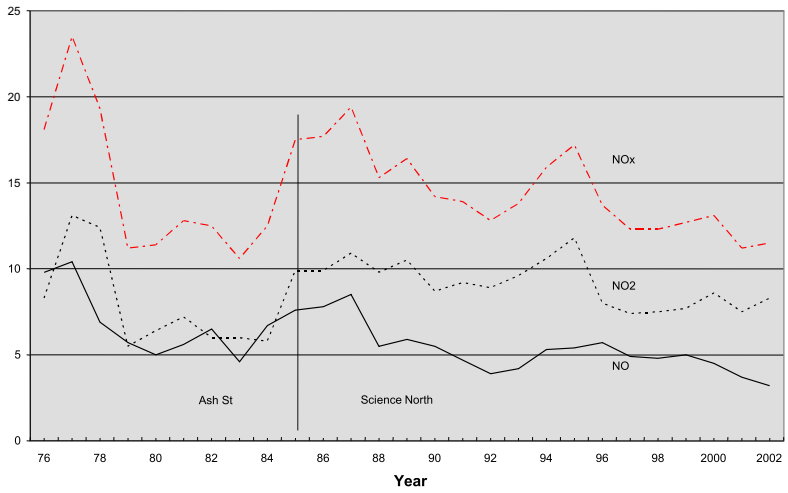
Figure 2
Frequency of Exceedances of the Sulphur Dioxide AAQC at Skead and Garson



Nitrogen Oxides

Nitrogen oxides have been monitored in Sudbury's air since 1976. Since the late 1980s, the levels of nitrogen oxide (NO) and nitrogen dioxide (NO2) have steadily declined. These reductions are attributed to stricter emission controls on automobiles. During the period in which data are available (1976 to 2002), the 24-hour ambient air quality criterion has never been exceeded (see Figure 3).

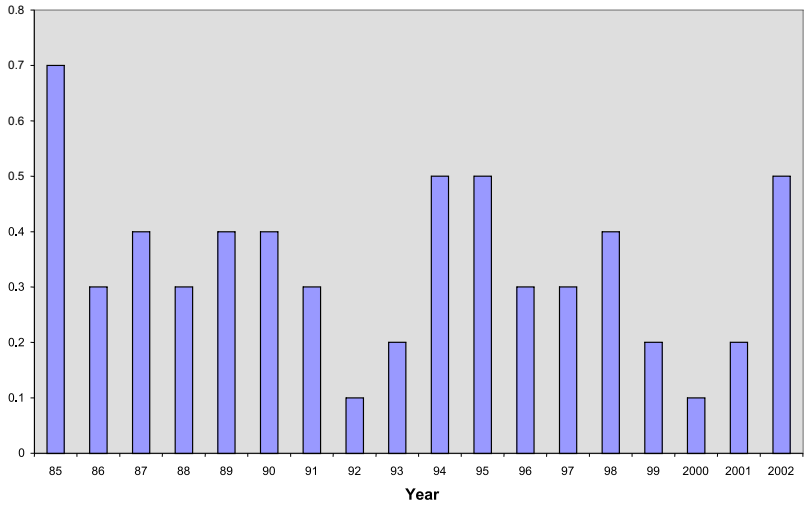
Figure 3
Trend of Nitrogen Oxides Concentrations (1976-2002)



Carbon Monoxide

Carbon monoxide has been measured at Sudbury's air monitoring stations since 1976. Figure 4 shows the maximum concentrations of carbon monoxide recorded between 1990 and 2002. The 1-hour maximum concentrations were lower in the second half of this time period, while the 8-hour maximum concentrations show no discernable trend. Importantly, the 1-hour (30 parts per million) and 8-hour (13 parts per million) provincial criteria were never exceeded.

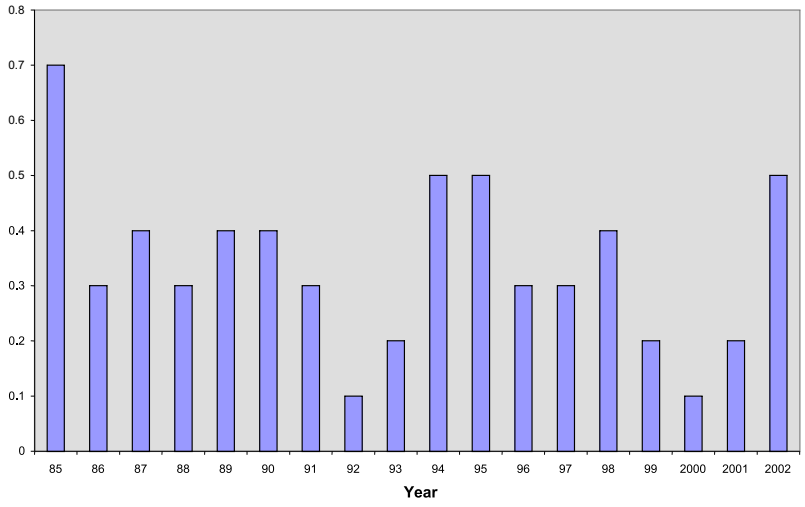
Figure 4
Maximum Concentrations of Carbon Monoxide (1990-2002)



Total Reduced Sulphur

Monitoring for Total Reduced Sulphur began in 1984 in Sudbury. As depicted in Figure 5, the annual average concentrations for the period were quite variable, ranging from 0.1 to 0.7 parts per billion. The provincial 1-hour criterion of 27 parts per billion was never exceeded during this 18-year period.

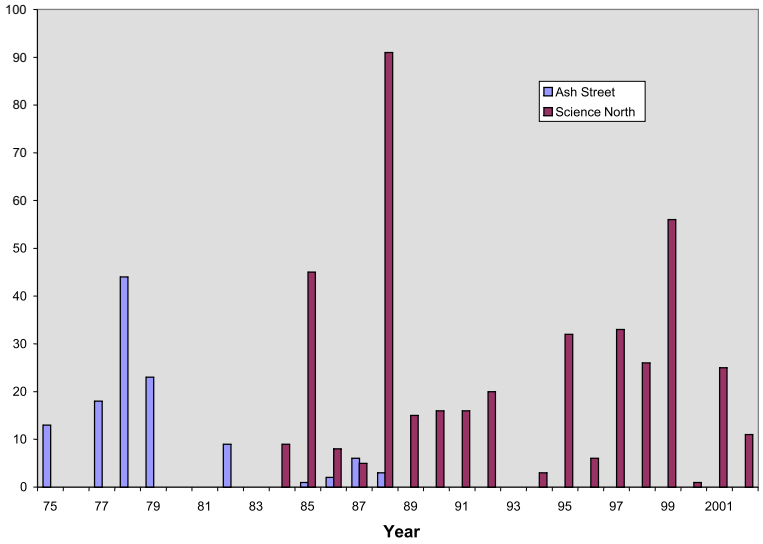
Figure 5
Average Annual Concentrations of Total Reduced Sulphur (1985-2002)



Ground-Level Ozone

Monitoring of ground-level ozone in Sudbury began in 1975, first at the Ash Street station, and then at Science North. Analysis of the average annual concentrations shows no definitive trend. Looking at Figure 6, the frequency of exceedances of the 1-hour criterion for ozone (80 parts per billion) was quite variable, as it is strongly dependent on weather conditions.

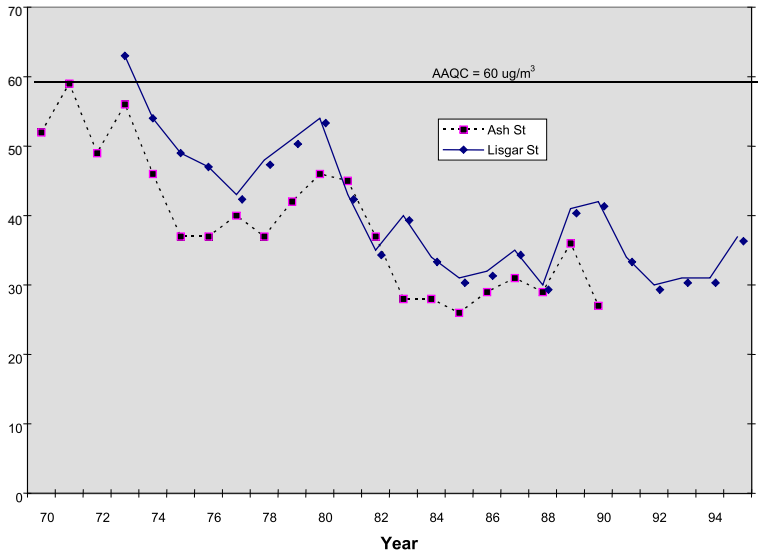
Figure 5
Average Annual Concentrations of Total Reduced Sulphur (1985-2002)



Particulate Matter

Particulate matter has been measured in Sudbury in different ways since 1970. The 24-hour criterion has been marginally exceeded on only six occasions since monitoring began. Total suspended particulate (TSP) has been measured since 1970. Average annual concentrations are well below the provincial criterion and have been falling since the mid-1970s. This downward trend is attributed to reductions in emissions from smelting operations and improved management of road dust, wind blown soil and mine tailings.

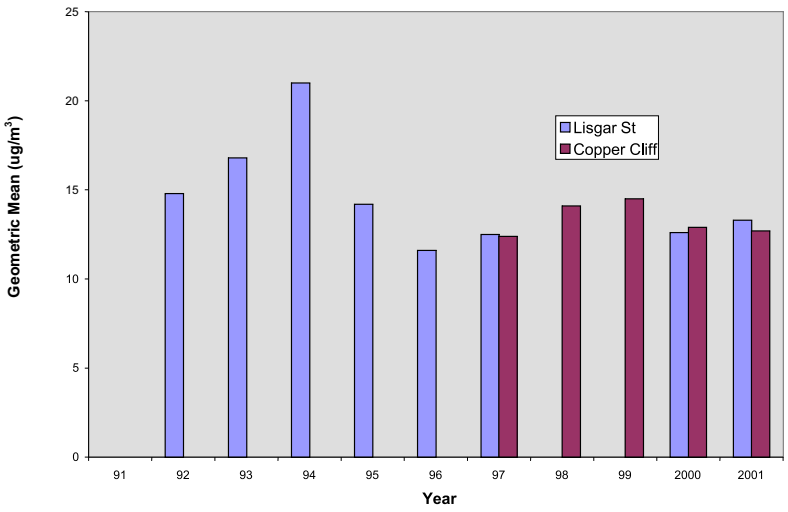
Figure 7
Average Total Suspended Particulate Concentrations (1970-1995)



Particulate Matter continued

Levels of inhalable particulate have only been monitored since 1991. The annual average concentration appears to have declined since 1996. Only on rare occasions (less than 1% of the time) have exceedances of the interim 24-hour criterion been observed.

Figure 8
Average Concentrations of Inhalable Particulate at Lisgar Street and Copper Cliff (1992-2001)



Air Pollution Index (API)

During the early 1970s, a number of API values in the moderate (>32) and poor (> 50) categories were recorded in Sudbury. For example, in 1971 the API was recorded in the moderate category 26 times and in the poor category 3 times. The construction of the tall stack in Copper Cliff in 1972 and the Supplementary Control Program resulted in an immediate reduction in the frequency of API events. Only 8 API events have been recorded since 1975, most of them marginally over the moderate index value of 32. The last known API event recorded in Sudbury took place in 1983.

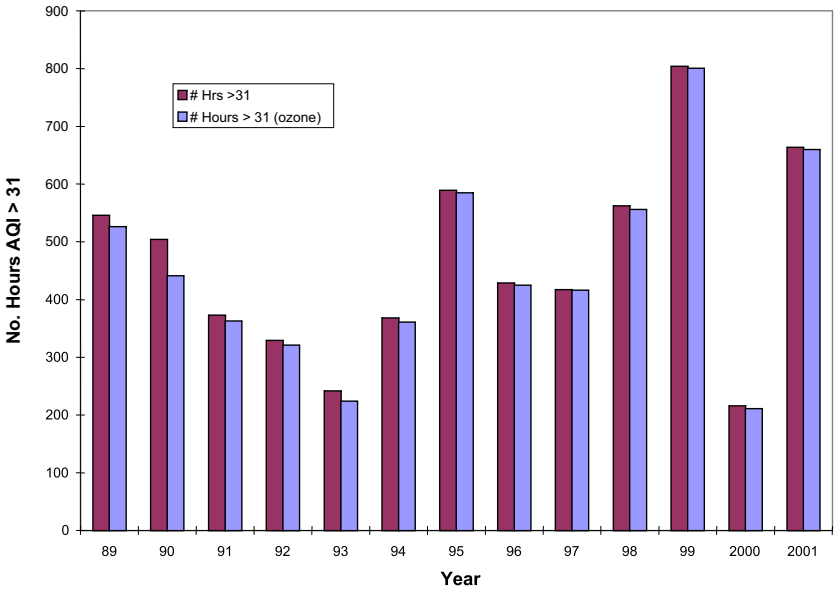
Air Quality Index (AQI)

Air Quality Index monitoring has taken place since 1988. From 1989 to 2001, the AQI measurements were very good or good 94% of the time. Moderate to poor values occurred only 5% of the time, and very poor values were never found. As shown in Table 1, the predominant cause of these readings is ground-level ozone.

Pollutant	Parameter Responsible for Moderate to Poor Air Quality	Parameter Responsible for Poor Air Quality
Ground-level ozone	97.5%	85%
Sulphur dioxide	1.6%	15%
Suspended particulate	0.3%	0%

As illustrated in Figure 9, there is no long term trend in the number of hours when AQI values were greater than 31 (i.e., when the air quality was moderate or worse). This is because of the influence and great variability of regional weather patterns. The low values seen in 1993 and 2000 coincide with "low ozone years" in which there were fewer sunny and hot days in the summer.

Figure 9
Number of Hours with AQI > 31 (1989-2001)



Sudbury

How Do We Stack Up?

For the period 1990 to 2002, Sudbury's air quality was compared with a number of other Ontario cities with similar populations and industrial bases. These include: Hamilton, Ottawa, Sault Ste. Marie, Thunder Bay, Toronto and Windsor. Relative rankings are shown in Table 2, where "1" indicates the best air quality and "7" indicates the worst for any particular category.

Pollutant/Index	Ranking (out of 7 cities)	Description	Number of Exceedances of AAQC
Sulphur dioxide	4	Fourth lowest annual average	Only city with exceedances
Nitrogen oxides	1	Lowest annual average	None
Carbon monoxide	1 2	Lowest 1-hour maximum Second lowest annual average	None
Total reduced sulphur	2	Second lowest annual average	None
Ground-level ozone	7	Highest annual average	Fourth highest
Suspended particulate	1	Lowest annual average	Lowest
Total suspended particulate	3	Third lowest annual average	None
Particulate matter	1	Lowest annual average	Lowest
Air Pollution Index	3	Third lowest (API = moderate to poor)	
Air Quality Index	6	Second highest (AQI = moderate to poor)	

It can be seen that for a number of pollutants – nitrogen oxides, carbon monoxide, suspended particulate and inhalable particulate, Sudbury ranks at or very near the top of these Ontario cities in terms of air quality. This is a part of the good news about Sudbury's air.

However Table 2 also shows that ground-level ozone and sulphur dioxide are of concern for Sudbury's air quality. It is ground-level ozone that most often triggers values of moderate to poor under the Air Quality Index, with sulphur dioxide being of lesser importance in this regard. Of the seven cities, Sudbury experiences the highest annual average concentrations of ground-level ozone. However it is important to note that Sudbury experiences lower concentrations in the summer and higher concentrations in the winter than in the other cities. For this reason, ground-level ozone is a greater concern in southern Ontario during the summer 'smog season'.

Notable progress has been made in reducing emissions of sulphur dioxide. Nevertheless, it remains an air quality issue because of the "looping plume" phenomenon that triggers exceedances of the provincial 1-hour criterion. Further improvements in the concentrations of sulphur dioxide are expected over time as government and industry work together to achieve further reductions in emissions.

Air Pollution

What You Can Do To Reduce Air Pollution

We all contribute to air pollution every day through our actions. Unwittingly perhaps, we pollute the air every time we turn the ignition key on our car, light up the woodstove, flick on the lights or turn up the furnace to heat our homes. In many cases, however, we have options – ways in which we can reduce the amount of pollution that we create. The websites at the links below can tell you how you can make a difference and help to improve Sudbury's air quality.

Environment Canada

At the Environment Canada website, users can find a wealth of information on air pollution and the health effects of pollutants. Documents such as "The Clean Air Consumer Guide", "The Commuter Challenge" and "Let's Drive Green" can be found at the "What You Can Do" section of the website:

http://www.ec.gc.ca/air/you-can-do_e.html

Government of Canada

Information on the "One Tonne Challenge" issued to all Canadians to reduce their emissions of greenhouse gases – can be found at:

http://www.climatechange.gc.ca/onetonne

Information on the Energuide Program can be found at:
http://oee.nrcan.gc.ca/energuide/home.cfm

Ontario Ministry of the Environment

The MOE website contains lots of information on climate change, smog and the provincial Drive Clean Program. Documents can be downloaded from the following site:

http://www.ene.gov.on.ca/cons/index.htm#AIR

Clean Air Sudbury

Clean Air Sudbury's website will provide users with relevant information on local air quality issues, and offer simple actions that anyone can take to reduce their own emissions, through its programs and activities.

www.greatersudbury.ca/cleanairsudbury

EarthCare Sudbury

EarthCare Sudbury is our own unique partnership involving the City of Greater Sudbury, over 90 agencies, organizations and businesses, and hundreds of individuals. EarthCare Sudbury is focused on enhancing our environment, creating a healthier community, and strengthening the local economy. At the link below, you can find information on how to reduce vehicle emissions through the Idle Free Program:

www.greatersudbury.ca/earthcare

Sudbury & District Health Unit

At the link below, the public can find information about SO^2 and Human Health, Health and Smog, mould and indoor air quality and other community health related topics. Links are also provided to Air Quality Ontario and to Inco's and Falconbridge's websites that provide current SO^2 dispersion forecasts and SO^2 readings throughout the City of Greater Sudbury.

http://www.sdhu.com/content/health_hazards/

ABOUT CLEAN AIR SUDBURY

Clean Air Sudbury is a non-profit, community based organization that was founded in 1999 with a primary goal of further improving local air quality and also reducing emissions of greenhouse gases in Greater Sudbury. To meet this aim, Clean Air Sudbury:

- acts as a forum for citizens to bring forward questions related to community air quality;
- disseminates data on air quality;
- forms partnerships with businesses, industries, government and public sector organizations, including EarthCare Sudbury; and
- promotes awareness and action on community air quality issues.

The benefits of bringing together stakeholders and engaging the public in dialogue and action on air issues are many. They include improved local air quality, greater community awareness of air pollutants, and increased opportunities for business, industry and individuals to contribute to improving our air quality.

The Clean Air Sudbury Steering Committee includes representatives from:

- City of Greater Sudbury;
- MIRARCO;
- Falconbridge Limited:
- INCO Limited;
- Ontario Ministry of the Environment;
- Science North;
- NORCAT;
- Golder Associates Ltd;
- Potvin Air Management Consulting;
- Sudbury and District Health Unit; and
- Laurentian University