

18 July 1994

DISTRIBUTION

1991/92 Yellowknife Air Quality Monitoring Data

Enclosed please find a copy of the *Yellowknife Air Quality Monitoring 1991 and 1992 Data Report*.

High levels of dust (Total Suspended Particulate - TSP) were again experienced in Yellowknife during the spring and summer, although levels did not climb as high as during some years in the late 1980's. In 1992, 9 of the 49 samples collected had levels above $120 \mu\text{g}/\text{m}^3$, the NWT 24 hour TSP standard. The 1992 annual geometric mean was $50 \mu\text{g}/\text{m}^3$, below the NWT annual geometric mean standard of $60 \mu\text{g}/\text{m}^3$.

Sulphur dioxide levels during August to November 1992 were above the NWT one hour sulphur dioxide standard of $450 \mu\text{g}/\text{m}^3$ nearly 1% of the time. Sulphur dioxide and arsenic levels shown in this report were previously described in a 1993 report titled *An Investigation of Atmospheric Emissions from the Royal Oak Giant Yellowknife Mine*.

Total arsenic levels in Yellowknife air in 1991 and 1992 remained well below the standard set in Ontario, the only Canadian jurisdiction with an arsenic standard.

Acid rain monitoring conducted at the Snare Rapids hydro site (150 kilometres northwest of Yellowknife) measured negligible acid rain in precipitation. The levels detected are considered to be typical background levels associated with unpolluted areas.

Yellowknife air quality data reports are also available for 1989 and 1990 from the Environmental Protection Division. For further information or copies of reports, please contact me at (403) 873-7654.



Emery Paquin
Director
Environmental Protection Division

Enclosure



YELLOWKNIFE AIR QUALITY MONITORING

1991 and 1992 DATA

The Department of Renewable Resources monitors air quality in the Yellowknife area. Participation in the National Air Pollution Sampling Network (NAPS) since 1974 provides long-term monitoring of trends in Yellowknife air quality. The Canadian Air and Precipitation Monitoring Network (CAPMoN) station, located at the Snare Rapids hydro-electric site, was established in 1986 to monitor the level of acid rain transported into the area by weather systems. Continuous sulphur dioxide (SO₂) monitoring in downtown Yellowknife was started in 1992 by Renewable Resources.

WHAT WERE THE RESULTS FROM THE YELLOWKNIFE NAPS STATION?

Samples are taken in downtown Yellowknife on the roof of a two story building. Every six days a sample is collected over a 24 hour period using a high volume air sampler. A measured volume of air is drawn through a filter to collect the suspended particulate (dust). The filters are sent to Environment Canada's National Air Pollution Sampling (NAPS) laboratory in Ottawa for analysis. The samples are analyzed to determine Total Suspended Particulate (TSP) and for chemical content to determine the lead, arsenic, nitrate and sulphate levels in the dust.

Total Suspended Particulate

Total Suspended Particulate is a general term which applies to a wide variety of solid or liquid particles which, because of their size and shape, tend to remain suspended in the air. A significant source of the TSP in Yellowknife is dust from roads, parking lots and other unpaved areas. A smaller percentage of the total comes from sources that include mining activities, combustion products from vehicles, heating and electricity generation and woodsmoke. Each source contributes particulate with a unique chemical make-up. Natural sources such as forest fires and pollen can also contribute to TSP levels.

Dust (TSP) levels in Yellowknife cannot be entirely defined on the basis of measurements made at the single monitoring station. Some of the highest dust levels in Yellowknife occur near the downtown monitoring station but, based on complaints made to the Department of Renewable Resources, sources of suspended particulate are found throughout or affect large portions of the city.

1991 YELLOWKNIFE AIR QUALITY DATA

EXPOSURE	LEAD	ARSENIC	NITRATE	SULPHATE	TSP
highest (24 hr.)	0.04	0.037	3.0	3.7	*
lowest (24 hr.)	0.0	0.002	0.2	0.0	9
Annual geometric mean	0.02	0.006	0.49	1.5	*

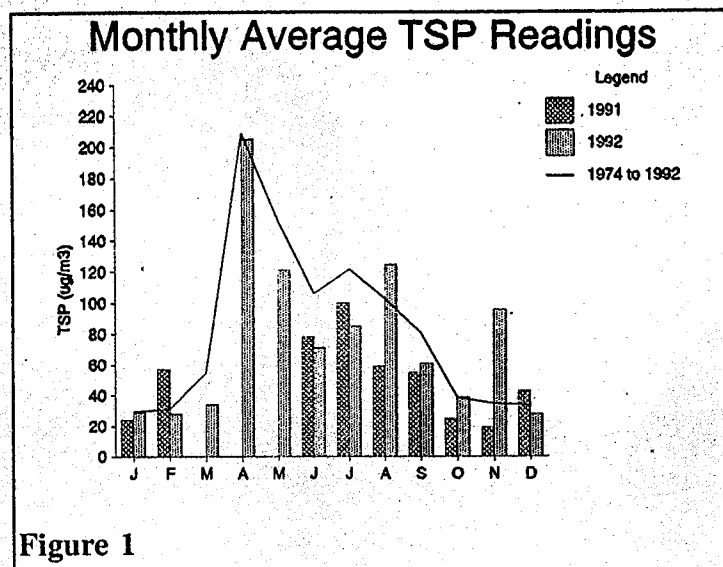
Note: all units in micrograms per cubic metre.

* TSP measurements for highest (24 hour) and annual geometric mean are not available for 1991.

1992 YELLOWKNIFE AIR QUALITY DATA

EXPOSURE	LEAD	ARSENIC	NITRATE	SULPHATE	TSP
highest (24 hr.)	0.20	0.083	0.8	4.3	386
lowest (24 hr.)	0.02	0.002	0.1	0.7	9
Annual geometric mean	0.04	0.008	0.26	1.9	50

Note: all units in micrograms per cubic metre.



Yellowknife dust levels in 1991 and 1992 were similar to those in previous years. The increase in TSP levels in April and May shown in Figure 1 coincides with spring snowmelt. Levels fluctuate during the summer and fall, keeping the monthly averages higher than those experienced on snow covered winter days. The springtime rise in TSP levels appears to be caused principally by road dust raised by traffic and wind. Windblown dust from unpaved areas and forest fire smoke also raise TSP levels.

Data for March, April and May of 1991 is not available because the samples were lost while in transit to the Ottawa laboratory.

An air quality guideline under the Northwest Territories' *Environmental Protection Act* sets standards for TSP levels in ambient air. Ambient air is the air found in the general environment that people breath and to which plants, animals and materials are exposed.

The NWT 24 hour (daily) TSP standard is 120 micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) and the annual geometric mean standard is 60 $\mu\text{g}/\text{m}^3$. These are consistent with standards or objectives in other parts of Canada.

The 1992 annual geometric mean for TSP in Yellowknife was 50 $\mu\text{g}/\text{m}^3$. Figure 2 shows the annual geometric means measured in Yellowknife since measurements began in 1974. Data is not shown for years when insufficient samples were collected.

The highest 24 hour TSP level in 1992 was 386 $\mu\text{g}/\text{m}^3$ on April 24. The second highest was 309 $\mu\text{g}/\text{m}^3$ on November 2, even though the week before the level was 9 $\mu\text{g}/\text{m}^3$ on October 27, the lowest in 1992.

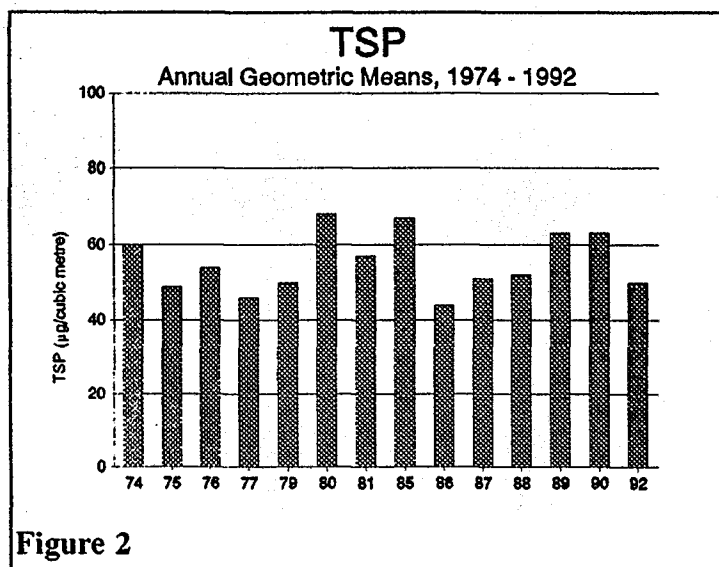


Figure 2

TSP levels exceeded the 24 hour standard of 120 $\mu\text{g}/\text{m}^3$ in 9 of the 49 samples (18 %) collected during 1992, which is similar to the number of exceedances recorded in previous years. There were no exceedances of the federal 24 hour tolerable objective for TSP of 400 $\mu\text{g}/\text{m}^3$. Levels above 400 $\mu\text{g}/\text{m}^3$ have historically been measured one or two times a year during the period 1986 to 1990.

Figure 3 shows the number of days that levels exceeded 120 $\mu\text{g}/\text{m}^3$ in Yellowknife compared to the average number of exceedances at NAPS stations in over 50 urban centres across Canada. Canadian cities have in general experienced a decline in the number of exceedances per year since 1979. Yellowknife levels have not followed this national trend.

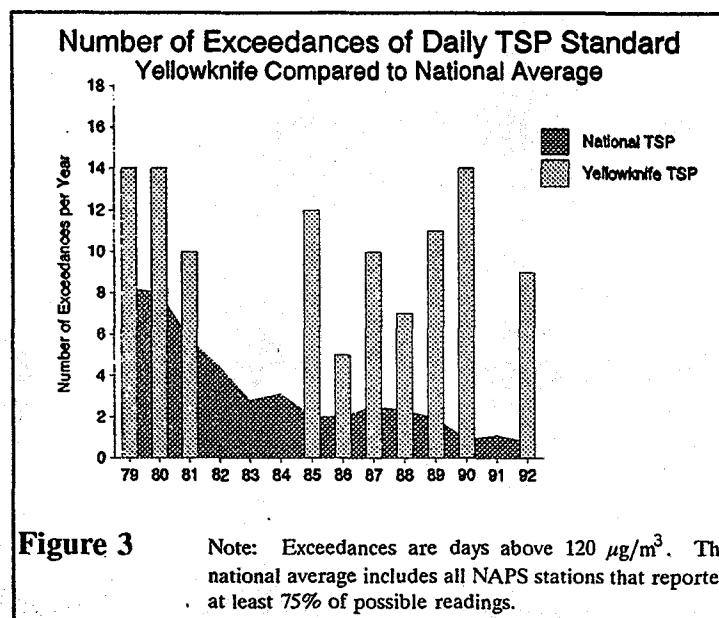


Figure 3

Note: Exceedances are days above 120 $\mu\text{g}/\text{m}^3$. The national average includes all NAPS stations that reported at least 75% of possible readings.

Lead

Lead levels in air measured in Yellowknife and the rest of Canada have declined since the introduction of lead free gasoline during the mid 1970's.

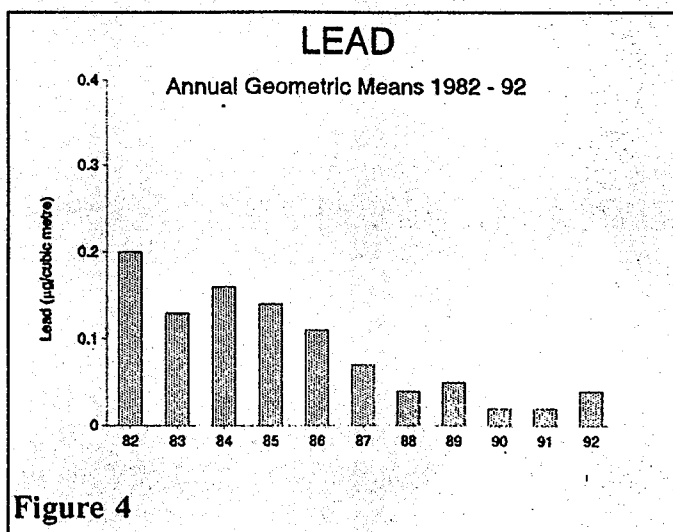


Figure 4

The decline in Yellowknife lead levels is shown in Figure 4. Annual levels reached an all time low in 1990 and 1991 but increased slightly in 1992. The source of this increase is unknown.

There are no Northwest Territories or federal standards for ambient levels of lead in the atmosphere. Ontario has set a 24 hour limit of $5.0 \mu\text{g}/\text{m}^3$ and recently proposed to reduce that to $2.0 \mu\text{g}/\text{m}^3$. The highest 24 hour lead level measured in Yellowknife during 1991 and 1992 was $0.2 \mu\text{g}/\text{m}^3$.

Arsenic

The major source of arsenic in Yellowknife air is the Royal Oak Giant Yellowknife Mine, located about 5 kilometres north of the city. Arsenopyrite, a common mineral in the Yellowknife area, is closely associated with the gold bearing ore. Arsenic trioxide is released when this ore is "roasted" at the mine. An investigation of arsenic and sulphur dioxide roaster stack emissions was undertaken by Renewable Resources in 1991 and 1992. A report completed in 1993 is available from the Environmental Protection Division.

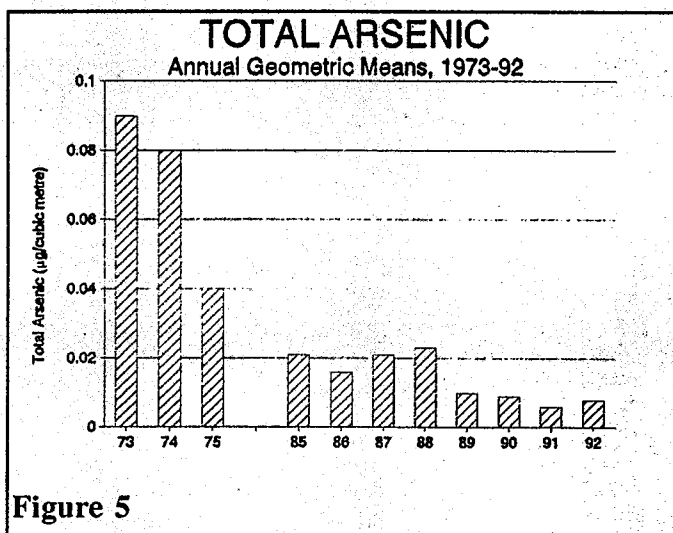


Figure 5

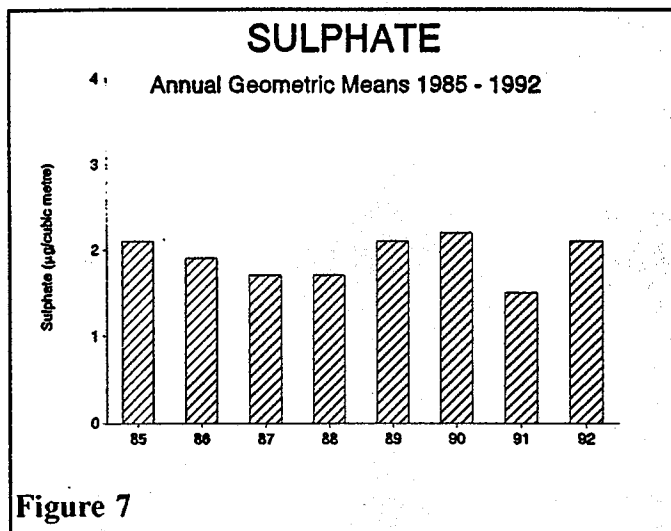
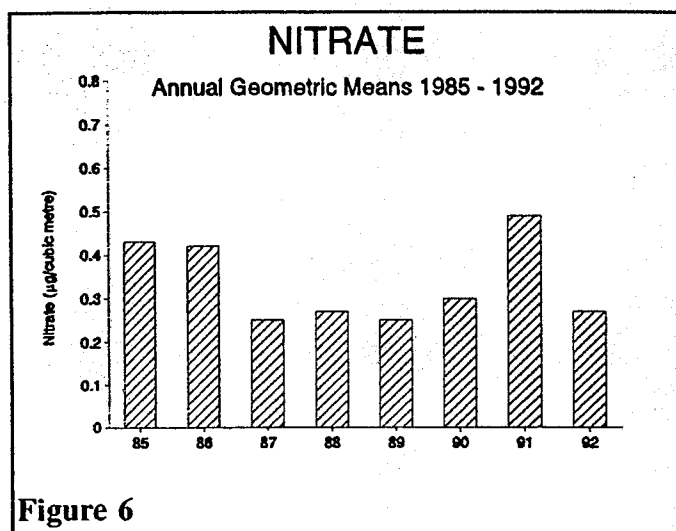
Levels of total arsenic in Yellowknife air have declined considerably since measurements were first made in 1973. Figure 5 shows the annual geometric means of total arsenic levels measured in downtown Yellowknife. The highest daily arsenic level measured in Yellowknife during 1991 and 1992 was $0.083 \mu\text{g}/\text{m}^3$, well below the Ontario standard of $0.3 \mu\text{g}/\text{m}^3$. There are no Northwest Territories or federal standards for arsenic in air.

Nitrate and Sulphate

When nitrogen oxides and sulphur dioxide gases are emitted to the air from combustion sources such as automobile engines or furnaces, they react with other chemicals in the atmosphere to form particulates containing nitrate and sulphate. Because of these chemical changes, nitrate and sulphate are considered to be "secondary pollutants".

The annual geometric means from 1985 to 1992 for nitrate are shown in Figure 6 and for sulphate in Figure 7. There have been no evident annual trends in the levels of these contaminants in Yellowknife since 1985.

There are no established air quality standards for nitrate or sulphate levels in Canadian jurisdictions. Levels detected in Yellowknife are considered to be well within an acceptable range and are lower than in most Canadian cities.



WHAT WERE THE SULPHUR DIOXIDE LEVELS IN 1992?

Continuous monitoring of sulphur dioxide (SO_2) was carried out in downtown Yellowknife during August, September, October and November of 1992. This survey was taken in conjunction with an investigation of arsenic and SO_2 emissions from the Royal Oak Giant Yellowknife Mine roaster stack. A detailed description of the investigation can be found in a 1993 report available on request from the Environmental Protection Division.

An air quality guideline under the Northwest Territories' *Environmental Protection Act* sets a standard for maximum acceptable levels of SO_2 in ambient air. The standard is set at levels that would protect vegetation because, in general, plants are more sensitive to SO_2 exposure than people. The one hour standard is $450 \mu\text{g SO}_2/\text{m}^3$, the 24 hour (daily) standard is $150 \mu\text{g SO}_2/\text{m}^3$ and the annual standard is $30 \mu\text{g SO}_2/\text{m}^3$.

The following table shows the frequency distribution of levels detected in Yellowknife air during the 4 months in 1992. This table shows that for 80 percent of the time when measurements were made, there was no SO_2 detected at the monitoring station. 99 percent of the time levels were below $359 \mu\text{g}/\text{m}^3$, or above that level 1 percent of the time.

1992 YELLOWKNIFE SULPHUR DIOXIDE DATA								
SO_2	Min	80%	90%	95%	98%	99%	99.9%	Max
ppm	0.00	0.00	0.00	0.02	0.08	0.14	0.40	0.57
$\mu\text{g}/\text{m}^3$	0	0	3	47	204	359	1040	1490

Note: This table shows the frequency distribution of one hour sulphur dioxide levels detected in Yellowknife air during August to November, 1992, in parts per million (ppm) and in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$).

During August to November 1992, the NWT one hour standard was exceeded at the monitoring station on 20 occasions (less than 1 percent of the time). On 4 of those occasions the level measured over one hour rose above $900 \mu\text{g}/\text{m}^3$, the level above which mild and reversible impacts on human health from exposure to SO_2 are considered to begin. The NWT 24 hour standard was exceeded once.

The highest SO_2 levels were most often detected when winds carried emissions directly from the Royal Oak roaster stack. SO_2 was less frequently detected and was only above the NWT one hour standard of $450 \mu\text{g}/\text{m}^3$ twice when winds blew from directions other than north. Background levels during cold months tended to be slightly higher than during warmer months and appear to have originated from the sulphur content in furnace and vehicle fuels.

ARE ACID RAIN LEVELS STILL LOW?

A Canadian Air and Precipitation Monitoring Network (CAPMoN) station was established in 1986 at the Snare Rapids hydro site (150 km northwest of Yellowknife) by Renewable Resources and Environment Canada to measure "acid rain". Rain and snow samples are collected on a daily basis by NWT Power Corporation personnel and are sent to the CAPMoN laboratory in Toronto for chemical analysis. Data from 1992 is shown below. The station was not operated in 1991.

Acidity in precipitation is compared based on the measurement of pH, with lower values indicating greater acidity. Sulphate and nitrate dissolved in precipitation, the main cause of "acid rain" problems, result from emissions from industry and automobiles. Chloride, sodium and calcium generally come from natural sources and are measures of the acid-neutralizing capacity of the atmosphere.

1992 SNARE RAPIDS ACID RAIN DATA

	pH	SULPHATE	NITRATE	CHLORIDE	SODIUM	CALCIUM
Geometric Mean	5.06	0.2	0.15	0.03	0.02	0.03
Minimum	3.85	<0.01	<0.04	<0.01	<0.01	<0.01
Maximum	6.4	10.18	3.1	5.06	1.6	0.66
Deposition	-	0.96	0.5	0.18	0.07	0.11

Note: This summary of 1992 daily precipitation quality at the Snare Rapids hydroelectric site is expressed in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) except pH. Annual deposition is measured in kilograms per hectare in a year.

Generally, the pH and levels of other compounds measured at Snare Rapids show, as they have in past years, that there is negligible acid rain in precipitation. The levels detected in this part of the Northwest Territories are considered to be typical background levels associated with unpolluted areas. In July of 1992, a small thundershower at Snare Rapids produced rain that had a pH of 3.85. Because the volume of rain that fell during the shower was very low, there was very little deposition of sulphate or other compounds.

Annual sulphate deposition at Snare Rapids in 1992 was 0.96 kilograms per hectare per year (kg/ha/yr). This is well below 7 kg/ha/yr, the level considered to protect even the most sensitive ecosystems in the Northwest Territories. In eastern Canada where acid rain is a serious environmental problem, sulphate deposition is well in excess of 20 kg/ha/yr.

For further information contact:

*Environmental Protection Division
NWT Renewable Resources
600, 5102 - 50 Avenue
Yellowknife, NT X1A 3S8*

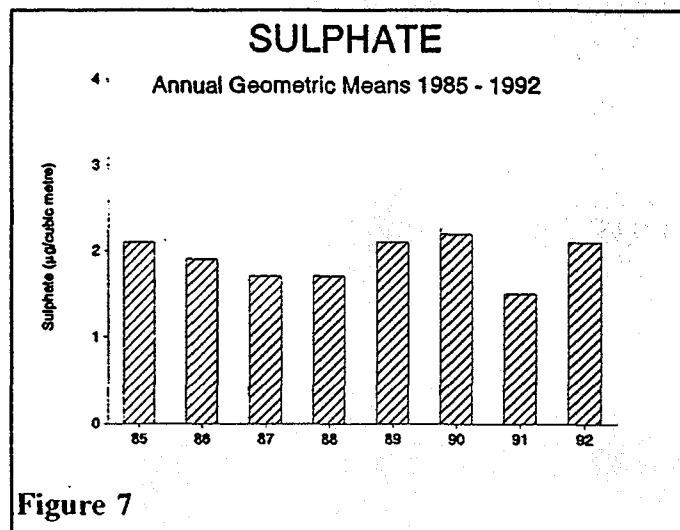
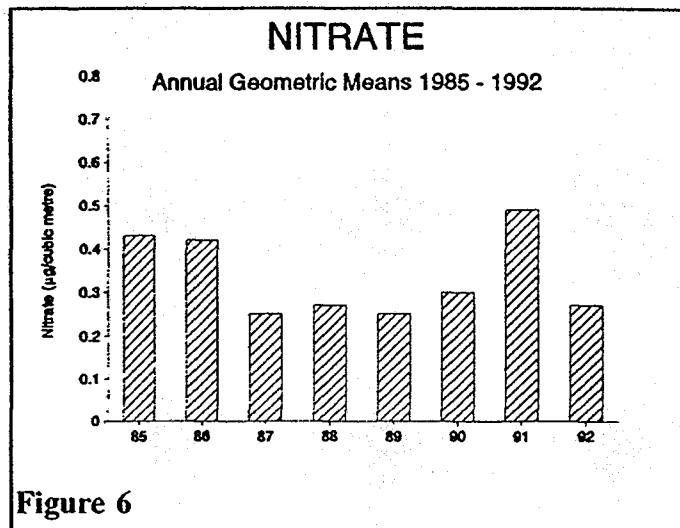
*Telephone (403) 873-7654
Facsimile (403) 873-0221*

Nitrate and Sulphate

When nitrogen oxides and sulphur dioxide gases are emitted to the air from combustion sources such as automobile engines or furnaces, they react with other chemicals in the atmosphere to form particulates containing nitrate and sulphate. Because of these chemical changes, nitrate and sulphate are considered to be "secondary pollutants".

The annual geometric means from 1985 to 1992 for nitrate are shown in Figure 6 and for sulphate in Figure 7. There have been no evident annual trends in the levels of these contaminants in Yellowknife since 1985.

There are no established air quality standards for nitrate or sulphate levels in Canadian jurisdictions. Levels detected in Yellowknife are considered to be well within an acceptable range and are lower than in most Canadian cities.



WHAT WERE THE SULPHUR DIOXIDE LEVELS IN 1992?

Continuous monitoring of sulphur dioxide (SO_2) was carried out in downtown Yellowknife during August, September, October and November of 1992. This survey was taken in conjunction with an investigation of arsenic and SO_2 emissions from the Royal Oak Giant Yellowknife Mine roaster stack. A detailed description of the investigation can be found in a 1993 report available on request from the Environmental Protection Division.

An air quality guideline under the Northwest Territories' *Environmental Protection Act* sets a standard for maximum acceptable levels of SO_2 in ambient air. The standard is set at levels that would protect vegetation because, in general, plants are more sensitive to SO_2 exposure than people. The one hour standard is $450 \mu\text{g SO}_2/\text{m}^3$, the 24 hour (daily) standard is $150 \mu\text{g SO}_2/\text{m}^3$ and the annual standard is $30 \mu\text{g SO}_2/\text{m}^3$.

The following table shows the frequency distribution of levels detected in Yellowknife air during the 4 months in 1992. This table shows that for 80 percent of the time when measurements were made, there was no SO_2 detected at the monitoring station. 99 percent of the time levels were below $359 \mu\text{g}/\text{m}^3$, or above that level 1 percent of the time.

1992 YELLOWKNIFE SULPHUR DIOXIDE DATA								
SO_2	Min	80%	90%	95%	98%	99%	99.9%	Max
ppm	0.00	0.00	0.00	0.02	0.08	0.14	0.40	0.57
$\mu\text{g}/\text{m}^3$	0	0	3	47	204	359	1040	1490

Note: This table shows the frequency distribution of one hour sulphur dioxide levels detected in Yellowknife air during August to November, 1992, in parts per million (ppm) and in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$).

During August to November 1992, the NWT one hour standard was exceeded at the monitoring station on 20 occasions (less than 1 percent of the time). On 4 of those occasions the level measured over one hour rose above $900 \mu\text{g}/\text{m}^3$, the level above which mild and reversible impacts on human health from exposure to SO_2 are considered to begin. The NWT 24 hour standard was exceeded once.

The highest SO_2 levels were most often detected when winds carried emissions directly from the Royal Oak roaster stack. SO_2 was less frequently detected and was only above the NWT one hour standard of $450 \mu\text{g}/\text{m}^3$ twice when winds blew from directions other than north. Background levels during cold months tended to be slightly higher than during warmer months and appear to have originated from the sulphur content in furnace and vehicle fuels.

ARE ACID RAIN LEVELS STILL LOW?

A Canadian Air and Precipitation Monitoring Network (CAPMoN) station was established in 1986 at the Snare Rapids hydro site (150 km northwest of Yellowknife) by Renewable Resources and Environment Canada to measure "acid rain". Rain and snow samples are collected on a daily basis by NWT Power Corporation personnel and are sent to the CAPMoN laboratory in Toronto for chemical analysis. Data from 1992 is shown below. The station was not operated in 1991.

Acidity in precipitation is compared based on the measurement of pH, with lower values indicating greater acidity. Sulphate and nitrate dissolved in precipitation, the main cause of "acid rain" problems, result from emissions from industry and automobiles. Chloride, sodium and calcium generally come from natural sources and are measures of the acid-neutralizing capacity of the atmosphere.

1992 SNARE RAPIDS ACID RAIN DATA

	pH	SULPHATE	NITRATE	CHLORIDE	SODIUM	CALCIUM
Geometric Mean	5.06	0.2	0.15	0.03	0.02	0.03
Minimum	3.85	<0.01	<0.04	<0.01	<0.01	<0.01
Maximum	6.4	10.18	3.1	5.06	1.6	0.66
Deposition	-	0.96	0.5	0.18	0.07	0.11

Note: This summary of 1992 daily precipitation quality at the Snare Rapids hydroelectric site is expressed in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) except pH. Annual deposition is measured in kilograms per hectare in a year.

Generally, the pH and levels of other compounds measured at Snare Rapids show, as they have in past years, that there is negligible acid rain in precipitation. The levels detected in this part of the Northwest Territories are considered to be typical background levels associated with unpolluted areas. In July of 1992, a small thundershower at Snare Rapids produced rain that had a pH of 3.85. Because the volume of rain that fell during the shower was very low, there was very little deposition of sulphate or other compounds.

Annual sulphate deposition at Snare Rapids in 1992 was 0.96 kilograms per hectare per year ($\text{kg}/\text{ha}/\text{yr}$). This is well below 7 $\text{kg}/\text{ha}/\text{yr}$, the level considered to protect even the most sensitive ecosystems in the Northwest Territories. In eastern Canada where acid rain is a serious environmental problem, sulphate deposition is well in excess of 20 $\text{kg}/\text{ha}/\text{yr}$.

For further information contact:

*Environmental Protection Division
NWT Renewable Resources
600, 5102 - 50 Avenue
Yellowknife, NT X1A 3S8*

*Telephone (403) 873-7654
Facsimile (403) 873-0221*