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Air quality in Kelowna:
1994 report

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AIR QUALITY IN KELOWNA

1994 REPORT

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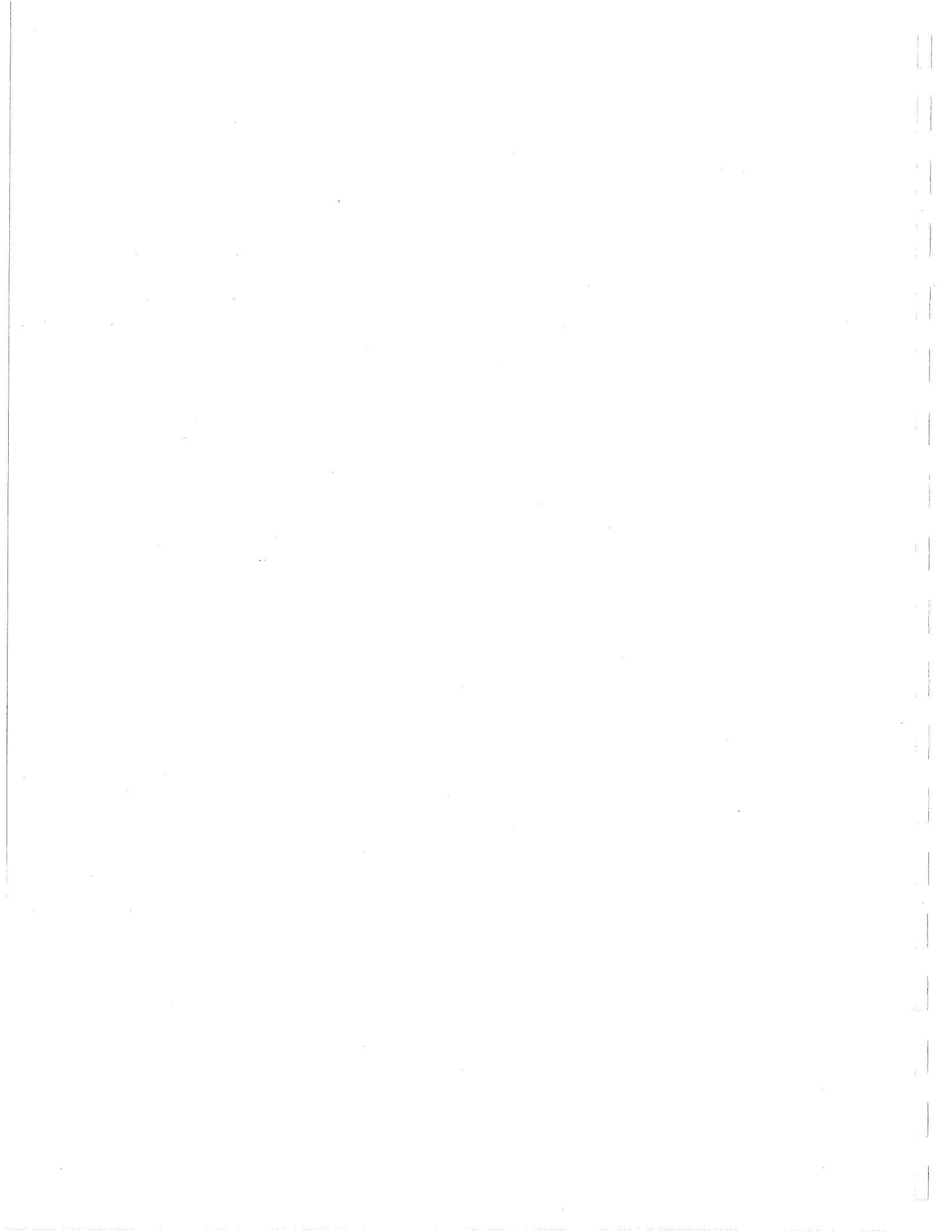
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1.0 EXECUTIVE SUMMARY

This report is a summary of air quality monitored in the City of Kelowna during 1994. It describes BC Environment's air quality monitoring program and includes analyses of the gaseous and particulate air pollutant data gathered during the year. The report is organized by air pollutant, with special emphasis placed on those that occasionally exceed air quality objectives.

Of the six air pollutants continuously monitored in 1994 only inhalable particulate (PM₁₀) and ozone (O₃) exceeded Provincial air quality objectives.

The PM₁₀ exceedances show some cause for concern. Analyses of the 1994 data reveal that woodsmoke accumulations under stagnating weather conditions accounted for most of the 14 times the Level B PM₁₀ 24-hour criteria were exceeded. This smoke originated from the burning of debris in rural areas, wood burning for home heating or forest fires. Other contributors to total PM₁₀ include: road dust, wind-blown soil and aerosol of various descriptions (sea salt, secondary particles such as sulfate and nitrate). A growing body of international studies conclude that PM₁₀ pollution contributes significantly to health problems. With the exceedances observed in Kelowna it is reasonable to conclude that residents of the Okanagan valley are being adversely affected by PM₁₀ pollution.

The ozone data are typical for a City the size of Kelowna; not pristine but not heavily polluted. The ozone concentration marginally exceeded the Level B 1-hour O₃ criteria for 2 hours on August 2nd. This number of ozone exceedances is well within the 10 year norm.

The concentrations of nitrogen oxide (NO), nitrogen dioxide (NO₂), carbon monoxide (CO) and sulfur dioxide (SO₂), are low, and remain well below air quality objectives.

2.0 INTRODUCTION

This is the first annual report of air quality monitored on a continuous basis in the City of Kelowna during 1994. With the exception of ground-level ozone which has been monitored in Kelowna on a continuous basis since 1983, intermittent particulate monitoring stations were sited near industrial areas. With the recent growth in population, vehicles and industry in the Okanagan Valley, the need for the continuous monitoring of urban pollutants generated over a much larger area by an abundance of point and mobile sources was realized.

The air pollution potential, or the inability of the atmosphere to disperse and dilute pollutants which may be emitted into it, is enhanced in the Okanagan Valley due to the physical and meteorological characteristics of the region. The wide, deep valley terrain, low wind speeds and numerous low-level thermal inversions regularly trap pollutants near the valley floor where the majority of the population lives. Although Kelowna is not heavily industrialized, several small industrial and agricultural operations emit a variety of pollutants into the air. The majority of pollutants and associated air pollution experienced throughout the region arise from emissions from the general public and their activities, such as the operation of automobiles, open burning of debris and wood burning stoves.

Given that air pollution has no boundaries, it is important to provide municipal governments and the public with timely information on air quality and identify trends that may be developing for specific pollutants. Through thoughtful planning it may be possible to significantly reduce harmful air emissions and air pollution episodes despite the growth expected within the Okanagan Valley over the next decade.

2.1 AIR QUALITY MONITORING NETWORK

The Central Okanagan air quality monitoring station is located in Kelowna at the KLO campus of Okanagan University College. The site was originally established in 1983 to continuously record ozone (O_3) concentrations. In 1994, nitrogen oxide (NO), nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and inhalable particulate (PM_{10}) continuous air analyzers were installed to monitor the impact of increasing urbanization on air quality in Kelowna. Most of these substances are found naturally in the air in low concentrations and only become a pollutant when the concentration increase above acceptable levels.

Each analyzer automatically measures air quality on a 24 hour, 365 day per year basis. The data output from these analyzers is made available in digital format over conventional telephone lines. Air samples used for analyses are extracted through an inlet located approximately 20 meters above ground-level. The rationale for sampling at this level is to differentiate between pollutants generated in the immediate vicinity (ie. major transportation routes, parking lots, etc.) and pollutants emitted from, and transported over, a much larger area. Because of this differentiation, air quality data generated at this monitoring station are truly representative of the city and may be used for long-term trend analyses.

The Central Okanagan air quality monitoring station was constructed to meet strict site selection criteria and represents a location where certain pollutants are of concern or need to be defined. All results presented in this report meet quality assurance/quality control standards set forth by the Atmospheric Reporting and Monitoring Section of the Air Resources Branch in Victoria. On-site QA/QC protocol include daily zero and span checks. Multi-point calibrations are undertaken four times each year on all air monitoring and data acquisition equipment. Bi-annual performance audits by an independent team of auditors are also completed.

2.2 AIR QUALITY OBJECTIVES

Air quality objectives are concentrations below which a pollutant is deemed to have minimal impact. Objectives are designed to ensure air quality remains at a level conducive to good health and maintenance of a quality environment. BC Environment has established objectives for a number of air pollutants through a process of scientific investigation and critical review. For most objectives there are three levels of concern. They are defined thus:

Level A Maximum Desirable is the long term goal for air quality and forms the basis for anti-degradation policy for the pristine parts of the country and for continuing development of control technology.

Level B Maximum Acceptable is intended to provide adequate protection against the effects of pollution on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being.

Level C Maximum Tolerable denotes time based concentrations of air contaminants beyond which, due to diminishing margins of safety, appropriate action is required without delay to protect the health of the general population.

An exceedance of an air quality objective is usually the result of air stagnation coinciding with a period of high emissions of pollutants into the atmosphere. In the Okanagan Valley brief periods of stagnation are frequently; prolonged periods of stagnation are the exception. The valley is normally ventilated by two mechanisms; wind and convective activity. Wind disperses pollutants laterally while convection moves pollutants from ground-level to upper reaches of the troposphere and in return brings cleaner air from aloft down to ground level. Cessation of horizontal wind is called a calm. An extended period of dead calm is rare, however long-term meteorological records indicate wind speed in Kelowna is less than 5 km/hr an average of 41% of the year. Cessation of convective activity is usually the result of a low-level inversion, an atmospheric state where an inverted thermal profile suppresses upward air motions. Inversions are normal to all seasons and occur usually

at night but are most frequent during the cold weather months. Brief periods of inversions are normal, however extended inversions are relatively rare.

When very calm conditions coincide with a state of inversion, air pollutants that normally disperse into the atmosphere may accumulate to concentrations which exceed air quality objectives. This is the usual scenario for exceedances, however high winds and resultant dust storms can elevate PM_{10} concentrations. At times a large or widespread release of pollutants can overwhelm the atmosphere's dispersive capability, even in the best dispersion conditions. Examples of this include spills of volatile materials, widespread biomass burning, or when roadway traction material is raised by motor vehicles.

3.0 AIR QUALITY MONITORING RESULTS FOR 1994

In this section the air quality results logged at the Central Okanagan air quality monitoring station are summarized by pollutant. Special attention is afforded to ozone (O_3) and inhalable particulate (PM_{10}) since they were the only two monitored pollutants that routinely exceed Provincial air quality objectives. Results are also made available in graph and tabular form in the appendices section of the report.

The completeness of the air quality record varied from analyzer to analyzer during 1994. Ozone and PM_{10} concentrations were monitored throughout the year. Data capture from the carbon monoxide (CO) analyzer, although installed in January, was restricted due to technical problems. The monitoring of nitrogen oxide (NO) and nitrogen dioxide (NO₂) began in May, and sulphur dioxide (SO₂) monitoring came on-line in August.

3.1 OZONE

- **Characteristics**

Ozone is a colourless gas, a major component of photochemical oxidant compounds formed as the result of chemical reactions between nitrogen oxides and reactive hydrocarbons in the presence of sunlight.

- **Sources**

The majority of O_3 detected at ground level is produced by photochemical reactions and not directly emitted into the atmosphere. Since it is formed down wind of NO_x and hydrocarbon sources and capable of traveling long distances throughout the atmosphere, O_3 is a major manifestation of the long range transport of air pollution. Its formation and transport are dependent on meteorological factors. Occasionally, during intense frontal activity, naturally occurring stratospheric O_3 reaches the earth's surface. The frequency of occurrence varies from year to year but the concentration rarely exceed $80 \mu\text{g}/\text{m}^3$. Therefore it is safe to conclude that all Level B 1-hour exceedances ($>160 \mu\text{g}/\text{m}^3$) are the product of photochemistry.

- **Atmospheric Background Concentration**

20-80 $\mu\text{g}/\text{m}^3$

- **Calculated Residence Time in the Atmosphere**

1-2 hours (depending on the presence or absence of ozone precursors)

- **Removal Reactions and Sinks**

Most O_3 produced in the atmosphere is removed by chemical processes, typically involving reactions with NO_x . Nighttime reactions with NO_2 is one of the principal scavengers of O_3 . To a limited extent, O_3 will be broken down by reactions with the surface of plants, soil and a variety of man-made materials.

- **Effects (1 Hour Average Concentration)**

- Less than 100 $\mu\text{g}/\text{m}^3$ - No known effects.
- 160 $\mu\text{g}/\text{m}^3$ - Injurious to many species of vegetation.
- 240 $\mu\text{g}/\text{m}^3$ - Decreased performance by persons exercising heavily, chest irritation, cough.
- 400 $\mu\text{g}/\text{m}^3$ - Decrease in lung function in exercising subjects, chest discomfort.

- **British Columbia Air Quality Criteria**

Units - $\mu\text{g}/\text{m}^3$	Avg. Period	Level-A	Level-B
	1-hour	100	160
	24-hour	30	50

- **Method of Monitoring**

The concentration of O_3 in the air sample is determined by measuring the amount of ultraviolet light absorbed by the sample. This is accomplished by measuring the UV light first in the absence of O_3 to determine a reference light intensity. The UV light is then measured in the presence of the ozone sample to determine the intensity of light after absorption.

- **Ozone Monitoring Results For 1994**

The provincial air quality objective most frequently exceeded in Kelowna was that for O_3 . The Level A 1-hour objective was exceeded 218 times during 1994. Ninety-seven percent of the total number of exceedances in this category were logged from May through September. Level A 24-hour objectives were exceeded 181 times. There were 2 Level B 1-hour objective exceedances, both logged during August. Level B 24-hour exceedances were logged 82 times.

The annual average O_3 concentration in Kelowna during 1994 was $37.6 \mu\text{g}/\text{m}^3$. This represents a slight increase from $31.3 \mu\text{g}/\text{m}^3$ observed in 1993. Results of the O_3 monitoring program are presented in Table 1. Figure 1 details in

graphic format monthly average O_3 concentrations. Figure 2 presents the frequency of O_3 exceedances logged throughout the same period.

It is uncertain the number of Level A and Level B 24-hour exceedances that resulted from stratospheric ozone intrusions, and how many were the product of photochemistry. Further work in this area may resolve this question.

• Discussion of Ozone Results

Air quality deteriorates as the atmosphere is unable to cleanse itself. Several factors contribute to this deterioration in the Okanagan Valley. The complex terrain effectively traps the air and often prevent dispersion of pollutants. Local weather conditions also contribute to the air quality problem. During the summer months, an abundance of intense sunlight hours, low wind speeds and frequent sharp, low-level inversions are normal. With the addition of NO_x and volatile organic compound precursor emissions into the atmosphere, elevated concentrations of ozone can result.

When interpreting O_3 results, most jurisdictions use the Level B 1-hour exceedance as their indicator of ozone pollution. Level A criteria are more representative of pristine environments, while Level B provides adequate protection against the effects of pollution. The Level B 1-hour criteria of $160 \mu\text{g}/\text{m}^3$ (82 ppb) was exceeded only 2 hours in 1994, a relatively inconsequential impact. The historical range at this station is from 0 to 4 exceedances per year. A major city could expect to experience between 10 and 100 O_3 exceedances annually.

• Historical Ozone Monitoring Results For 1984 - 1994

To put the O_3 results from 1994 into perspective, historical monitoring results are displayed in figures 3 and 4. It is apparent from these figures that annual O_3 concentrations are variable on a year to year basis. The variability may be related not only to annual variations in emissions, but also to variations in

meteorological conditions. Variability has major implications on the length of time required to determine long-term trends in O_3 concentrations.

Ozone concentrations showed no significant trend upward or downward from 1984 through 1989, a marked decrease from 1990-91 and a return to mid-80's levels from 1992 to the present. The results of the 1994 monitoring program indicates that O_3 concentrations were at their highest level since 1988.

3.2 INHALABLE PARTICULATE

- **Characteristics**

Suspended particulate less than 10 µm in diameter made up of airborne particles including smoke, dust, fly ash and pollen. Composition varies with place and season but normally include soil particulates, organic matter, sulphur and nitrogen compounds.

- **Sources**

Natural - Forest fires, wind blown soil and plant pollen.

Anthropogenic - Combustion, incineration, construction, mining, metals smelting and processing, grinding processes, agricultural activity and transportation.

- **Atmospheric Background Concentrations**

0-10 µg/m³ in clean air; 1000-1500 µg/m³ in very dirty air.

- **Calculated Residence Time in the Atmosphere**

Depends on particle size. Large, dense particles will settle much faster than light, small ones. Particles of less than 1 µm diameter can remain in the atmosphere for several weeks and are subject to long-range transport well beyond their point of origin.

- **Removal Reaction and Sinks**

Primary sinks for small particles from the atmosphere are wet deposition (washout by rain and snow) and dry deposition (settling).

- **Effects**

Particulate less than 10 µm in diameter can penetrate deep into the lungs and contribute to respiratory disease. The Provincial Health Officer has concluded that PM₁₀ levels in excess of 20 µg/m³ have been associated with adverse health effects, including respiratory conditions. More serious health effects may be associated with particulate matter which contains a toxic particulate

component or which has adsorbed a gaseous pollutant on the surface of the particles. Corrosion, soiling, damage to vegetation and reduction in visibility are additional effects of PM_{10} .

- **British Columbia Air Quality Criteria**

Units - $\mu\text{g}/\text{m}^3$	Avg. Period	Level-B
	24-hour	50

- **Method of Monitoring**

Gravimetric device draws ambient air through a filter at a constant flow rate, continuously weighing the filter and calculation real time mass concentrations.

- **Results of Inhalable Particulate Monitoring**

There were 14 Level B 24-hour exceedances logged throughout the year. One exceedance was recorded in late January, March accounted for 8 and 4 occurred in late July and early August when smoke from the Garnet forest fire near Penticton was dispersing throughout most of the Okanagan Valley (for a detailed report on the Garnet fire see Reid and Josefowich, 1995). With the exception of those exceedances recorded during the Garnet fire, the majority occurred on days when the valley was affected by smoke produced by rural residents burning prunings and other debris on days when dispersion of pollutants in the atmosphere was restricted by low-level atmospheric inversions and reduced wind speeds.

The average yearly PM_{10} concentration in Kelowna was $19 \mu\text{g}/\text{m}^3$, slightly lower than the 24-hour average concentration of $24 \mu\text{g}/\text{m}^3$ for regions located outside the Greater Vancouver Regional District. PM_{10} concentrations logged at Kelowna monitoring station are presented in Table 2. Figure 5 presents monthly average concentrations and the timing and frequency of exceedances.

3.3 NITROGEN DIOXIDE

- **Characteristics**

A colored gas ranging in color from light yellowish orange at relatively low concentrations to reddish brown at high concentrations. It has a pungent, irritating odour. At elevated concentrations it is relatively toxic, and because of its high oxidation rate it is extremely corrosive.

- **Sources**

Natural - Forest fires; electrical storms.

Anthropogenic - Combustion of oil, gas and coal; atmospheric transformation of NO.

- **Atmospheric Background Concentration**

1 - 8 $\mu\text{g}/\text{m}^3$

- **Calculated Residence Time in the Atmosphere**

5 days

- **Removal Reactions and Sinks**

The major sink process for nitrogen dioxide is its conversion to nitric acid. Nitrogen dioxide is also converted into nitric acid by night-time chemical reactions involving O_3 .

- **Effects (1 Hour Average Concentration)**

Less than 190 $\mu\text{g}/\text{m}^3$	- No known effects.
190 $\mu\text{g}/\text{m}^3$	- Odour threshold.
480 $\mu\text{g}/\text{m}^3$	- Some increase in bronchia reactivity in asthmatics.
995 $\mu\text{g}/\text{m}^3$	- Increase sensitivity of asthmatics and bronchitics.

• **British Columbia Air Quality Criteria**

Units - $\mu\text{g}/\text{m}^3$	Avg. Period	Level-A	Level-B
	1-hour	400	1000
	24-hour	200	300

• **Method of Monitoring**

Based on the principal of chemiluminescence involving a gas phase reaction of NO with O_3 . For NO_2 , the sample stream is passed through a catalytic converter where NO_2 is reduced to NO.

• **Summary of Nitrogen Dioxide Monitoring**

The NO_2 analyzer was installed in April of 1994. The average NO_2 concentration from April through December at the Kelowna monitoring site was $17 \mu\text{g}/\text{m}^3$. There were no exceedances of the Provincial air quality criteria. The steady rise in concentration observed throughout the end of the year may be attributable in part to an increase in the operation of home heating appliances and the increased use of automobiles during the cold weather months. Table 3 outlines by month the results of the monitoring program.

3.4 NITROGEN OXIDE

- **Characteristics**

An colourless, odourless, tasteless, relatively non-toxic gas.

- **Sources**

Natural - Forest fires; anaerobic processes in soil and water; electrical storms;
Anthropogenic - Combustion of oil, gas and coal.

- **Atmospheric Background Concentrations**

0.25 - 3 $\mu\text{g}/\text{m}^3$

- **Calculated Residence Time in the Atmosphere**

5 days

- **Removal Reaction and Sinks**

The principal sink process for NO is its conversion by both direct oxidation and photochemical processes to NO₂.

- **Effects**

No known effects at ambient levels.

- **British Columbia Air Quality Criteria**

None.

- **Method of Monitoring**

Same as for NO₂.

- **Summary of Nitrogen Oxide Monitoring**

The NO analyzer was installed in April of 1994. The average NO concentration from April through December at the Kelowna monitoring site was 7 $\mu\text{g}/\text{m}^3$. Table 4 outlines by month the results of the monitoring program.

3.5 CARBON MONOXIDE

- **Characteristics**

A colorless, odourless and tasteless gas.

- **Sources**

Natural - Oxidation of natural methane, oceans, forest fires.

Anthropogenic - Incomplete combustion of wood, oil, gas and coal; motor vehicles; industrial processes including blast furnaces.

- **Atmospheric Background Concentration**

120 $\mu\text{g}/\text{m}^3$

- **Calculated Residence Time in the Atmosphere**

Less than 3 years

- **Removal Reactions and Sinks**

Removed from the atmosphere by the action of soil microorganisms which convert CO to CO₂. Reactive sink mechanisms in the atmosphere can lead to the production of O₃ in the troposphere.

- **Effects (1 Hour Average Concentration)**

Less than 35000 $\mu\text{g}/\text{m}^3$ - No known effects.

35000 $\mu\text{g}/\text{m}^3$ - Increased cardiovascular symptoms on smokers with heart disease.

58200 $\mu\text{g}/\text{m}^3$ - Increased cardiovascular symptoms on non-smokers with heart disease, some visual impairment.

- **British Columbia Air Quality Criteria**

Units - $\mu\text{g}/\text{m}^3$	Avg. Period	Level-A	Level-B
	1-hour	14300	28000
	8-hour	5500	11000

- **Method of Monitoring**

Gas filter correlation based upon comparison of the detailed structure of the infrared absorption spectrum of carbon monoxide gas to that of other gases present in the sample being analyzed. The technique is implemented by using a high concentration sample of CO as a filter for the infrared radiation transmitted through the analyzer.

- **Summary of Carbon Monoxide Monitoring**

Carbon monoxide monitoring came on-line in March. The average concentration of CO from March through December at the Kelowna monitoring site was 2561 $\mu\text{g}/\text{m}^3$. There were no exceedances of the Provincial air quality criteria. Table 5 outlines by month the results of the monitoring program.

3.6 SULPHUR DIOXIDE

- **Characteristics**

A colorless gas with a strong, pungent odour at concentrations greater than $900 \mu\text{g}/\text{m}^3$.

- **Sources**

Natural - Oxidation of hydrogen sulfide; volcanic activity.

Anthropogenic - Combustion of coal and oil.

- **Atmospheric Background Concentration**

$0.30 \mu\text{g}/\text{m}^3$

- **Calculated Residence Time in the Atmosphere**

Approximately 4 days.

- **Removal Reactions and Sinks**

Sulphur Dioxide is removed from the atmosphere in both dry and wet deposition processes. During dry deposition aerosol particles settle out or impact on surfaces. Plants are responsible for most SO_2 removal attributable to dry depositions. During wet deposition sulfate aerosol are removed from the atmosphere in the form of rain droplets. Sulphur dioxide can also dissolve in water to form a dilute solution of sulphurous acid.

- **Effects (1 Hour Average Concentration)**

Less than $425 \mu\text{g}/\text{m}^3$	- No know effects.
$665 \mu\text{g}/\text{m}^3$	- Injurious to sensitive species of vegetation.
$905 \mu\text{g}/\text{m}^3$	- Odourous, increasing damage to vegetation.
Greater than $5325 \mu\text{g}/\text{m}^3$	- Increased sensitivity of asthmatics and bronchitics and individuals with cardiovascular disease.

- **British Columbia Air Quality Criteria**

Units - $\mu\text{g}/\text{m}^3$	Avg. Period	Level-A	Level-B
	1-hour	450	900
	24-hour	160	260

- **Methods of Monitoring**

Fluorescent excitation of SO_2 molecules by pulsed ultra-violet radiation.

- **Summary of Sulphur Dioxide Monitoring**

The SO_2 analyzer was installed in July of 1994. The average SO_2 concentration for the latter half of the year at the Kelowna monitoring site was $0.1 \mu\text{g}/\text{m}^3$. There were no exceedances of the Provincial air quality criteria. Table 6 summarizes by month the results of the monitoring program.

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5.0 APPENDIX

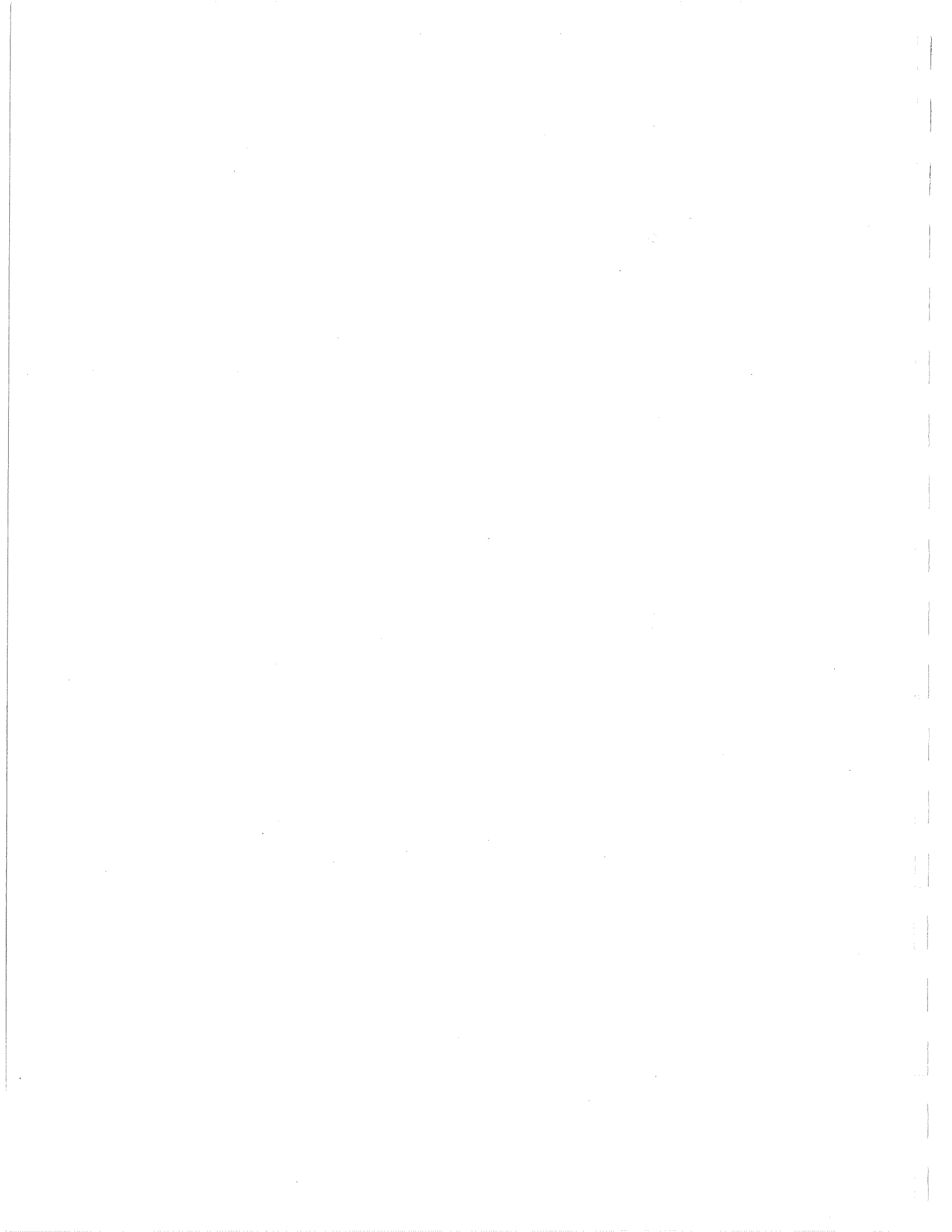


Table 1: Ozone Results for 1994. Central Okanagan Air Quality Monitoring Station.

Unit: $\mu\text{g}/\text{m}^3$

Monthly Summary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
% Data Capture	88	95	95	60	66	91	72	95	95	95	94	95	87
% Data Below Detectable Limit	48	26	18	12	6	2	4	8	21	45	32	47	22
Max. Hourly Concentration	46	78	82	112	140	124	144	178	128	82	78	76	106
Min. Hourly Concentration	0	0	0	0	0	0	0	0	0	0	0	0	0
Monthly Average	14	31	36	48	52	56	60	55	37	22	22	17	37
Standard Deviation	15	21	27	27	31	25	34	34	31	24	20	19	26
Standard Error of Mean	1	1	1	1	1	1	1	1	1	1	1	1	1

Percentiles	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PCT 10	0	0	0	0	12	22	16	12	0	0	0	0
PCT 25	0	12	12	22	32	38	30	30	12	0	0	0
PCT 50	10	34	32	44	62	58	54	56	30	14	20	12
PCT 75	26	48	62	62	88	72	80	74	60	40	38	32
PCT 90	36	58	74	68	102	88	102	98	78	60	50	44
PCT 99	44	76	80	106	129	115	136	152	110	72	66	66

Number of Exceedances	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Level A 1-Hour ($100 \mu\text{g}/\text{m}^3$)	0	0	0	7	55	20	56	60	20	0	0	0	218
Level B 1-Hour ($160 \mu\text{g}/\text{m}^3$)	0	0	0	0	0	0	0	2	0	0	0	0	2
Level A 24-Hour ($30 \mu\text{g}/\text{m}^3$)	3	12	17	15	20	28	21	28	21	5	6	5	181
Level B 24-Hour ($50 \mu\text{g}/\text{m}^3$)	0	2	6	5	14	17	15	18	3	1	1	0	82

Table 2: Continuous Inhalable Particulate Results for 1994. Central Okanagan Air Quality Monitoring Station.

Unit: $\mu\text{g}/\text{m}^3$

Monthly Summary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
% Data Capture	29	99	99	99	99	97	96	99	100	100	99	99	101
% Data Below Detectable Limit	3	6	5	5	7	10	4	1	5	3	8	4	5
Max. Hourly Concentration	113	94	221	112	84	78	91	114	123	56	66	103	114
Min. Hourly Concentration	11	6	7	4	2	5	4	9	6	7	4	9	7
Monthly Average	33	17	33	19	14	12	21	21	20	16	15	18	22
Standard Deviation	12	12	29	14	10	9	16	18	15	10	11	15	16
Standard Error of Mean	0	0	1	1	0	0	1	1	1	0	0	1	1
Percentiles	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Dec Total
PCT 10	n/a	5	7	6	6	0	6	8	6	6	5	7	7
PCT 25	n/a	9	13	9	8	6	10	11	9	9	8	9	9
PCT 50	n/a	14	25	16	12	9	17	16	16	13	13	13	13
PCT 75	n/a	23	45	25	18	15	27	25	27	20	20	21	21
PCT 90	n/a	34	70	35	26	24	46	44	39	28	30	36	36
PCT 99	n/a	58	152	70	49	42	78	93	71	46	52	74	74
Number of Exceedances	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Level B 24-Hour ($50 \mu\text{g}/\text{m}^3$)	1	0	8	0	0	0	2	3	0	0	0	0	14

Table 3: Nitrogen Dioxide Results for 1994. Central Okanagan Air Quality Monitoring Station.

Unit: $\mu\text{g}/\text{m}^3$

Monthly Summary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
% Data Capture	-	-	-	-	93	96	95	97	96	95	96	95	95
% Data Below Detectable Limit	-	-	-	-	76	88	69	57	42	35	28	23	52
Max. Hourly Concentration	-	-	-	-	80	50	75	73	107	69	73	86	77
Min. Hourly Concentration	-	-	-	-	0	0	0	0	0	0	0	0	0
Monthly Average	-	-	-	-	8	3	10	13	20	21	27	31	17
Standard Deviation	-	-	-	-	14	9	16	16	20	18	20	21	17
Standard Error of Mean	-	-	-	-	1	0	1	1	1	1	1	1	1

Percentiles	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PCT 10	-	-	-	-	0	0	0	0	0	0	0	0
PCT 25	-	-	-	-	0	0	0	0	0	0	0	19
PCT 50	-	-	-	-	0	0	0	0	21	23	29	33
PCT 75	-	-	-	-	0	0	21	25	33	33	44	46
PCT 90	-	-	-	-	31	21	33	36	46	44	54	57
PCT 99	-	-	-	-	52	36	61	63	76	59	67	75

Number of Exceedances

No Exceedances Logged

Table 4: Nitrogen Oxide Results for 1994. Central Okanagan Air Quality Monitoring Station.

Unit: $\mu\text{g}/\text{m}^3$

Monthly Summary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
% Data Capture	-	-	-	-	93	96	95	97	96	99	96	95	96
% Data Below Detectable Limit	-	-	-	-	97	99	97	95	84	66	65	54	82
Max. Hourly Concentration	-	-	-	-	36	20	32	47	120	131	125	369	110
Min. Hourly Concentration	-	-	-	-	0	0	0	0	0	0	0	0	0
Monthly Average	-	-	-	-	1	0	1	1	5	12	12	25	7
Standard Deviation	-	-	-	-	4	2	3	5	14	22	22	41	14
Standard Error of Mean	-	-	-	-	0	0	0	0	1	1	1	2	1

Percentiles

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PCT 10	-	-	-	-	0	0	0	0	0	0	0	0
PCT 25	-	-	-	-	0	0	0	0	0	0	0	0
PCT 50	-	-	-	-	0	0	0	0	0	0	0	0
PCT 75	-	-	-	-	0	0	0	0	0	19	17	36
PCT 90	-	-	-	-	0	0	0	0	19	40	41	74
PCT 99	-	-	-	-	25	1	19	25	70	98	104	187

Number of Exceedances

No Provincial Air Quality Objectives

Table 5: Carbon Monoxide Results for 1994. Central Okanagan Air Quality Monitoring Station.

Unit: $\mu\text{g}/\text{m}^3$

Monthly Summary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
% Data Capture	-	-	99	63	97	96	96	93	97	96	94	95	93
% Data Below Detectable Limit	-	-	36	26	70	42	42	93	20	18	51	37	44
Max. Hourly Concentration	-	-	3492	1164	1164	1164	2328	1164	3492	3492	3492	4656	2561
Min. Hourly Concentration	-	-	0	0	0	0	0	0	0	0	0	0	0
Monthly Average	-	-	807	529	354	672	682	83	970	1030	632	923	668
Standard Deviation	-	-	661	492	536	576	590	299	539	570	696	865	582
Standard Error of Mean	-	-	24	21	20	22	22	11	20	21	27	34	22

Percentiles	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PCT 10	-	-	0	0	0	0	0	0	0	0	0	0
PCT 25	-	-	0	0	0	0	0	0	1164	1164	0	0
PCT 50	-	-	1164	1164	0	1164	1164	0	1164	1164	0	1164
PCT 75	-	-	1164	1164	1164	1164	1164	0	1164	1164	1164	1164
PCT 90	-	-	1164	1164	1164	1164	1164	0	1164	1164	1164	1164
PCT 99	-	-	2328	1164	1164	1164	1164	1164	2328	2328	2328	3492

Number of Exceedances

No Exceedances Logged

Table 6: Sulphur Dioxide Results for 1994. Central Okanagan Air Quality Monitoring Station.

Unit: $\mu\text{g}/\text{m}^3$

Monthly Summary	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
% Data Capture	-	-	-	-	-	-	-	100	100	100	100	100	100
% Data Below Detectable Limit	-	-	-	-	-	-	-	100	100	100	100	100	100
Max. Hourly Concentration	-	-	-	-	-	-	-	0	0	0	0	0	0
Min. Hourly Concentration	-	-	-	-	-	-	-	0	0	0	0	0	0
Monthly Average	-	-	-	-	-	-	-	0.1	0.1	0.1	0.1	0.1	0.1
Standard Deviation	-	-	-	-	-	-	-	0.1	0.1	0.1	0.1	0.1	0.1
Standard Error of Mean	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0

Percentiles	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PCT 10	-	-	-	-	-	-	-	0	0	0	0	0
PCT 25	-	-	-	-	-	-	-	0	0	0	0	0
PCT 50	-	-	-	-	-	-	-	0	0	0	0	0
PCT 75	-	-	-	-	-	-	-	0	0	0	0	0
PCT 90	-	-	-	-	-	-	-	0	0	0	0	0
PCT 99	-	-	-	-	-	-	-	0	0	0	0	0

Number of Exceedances

No Exceedances Logged

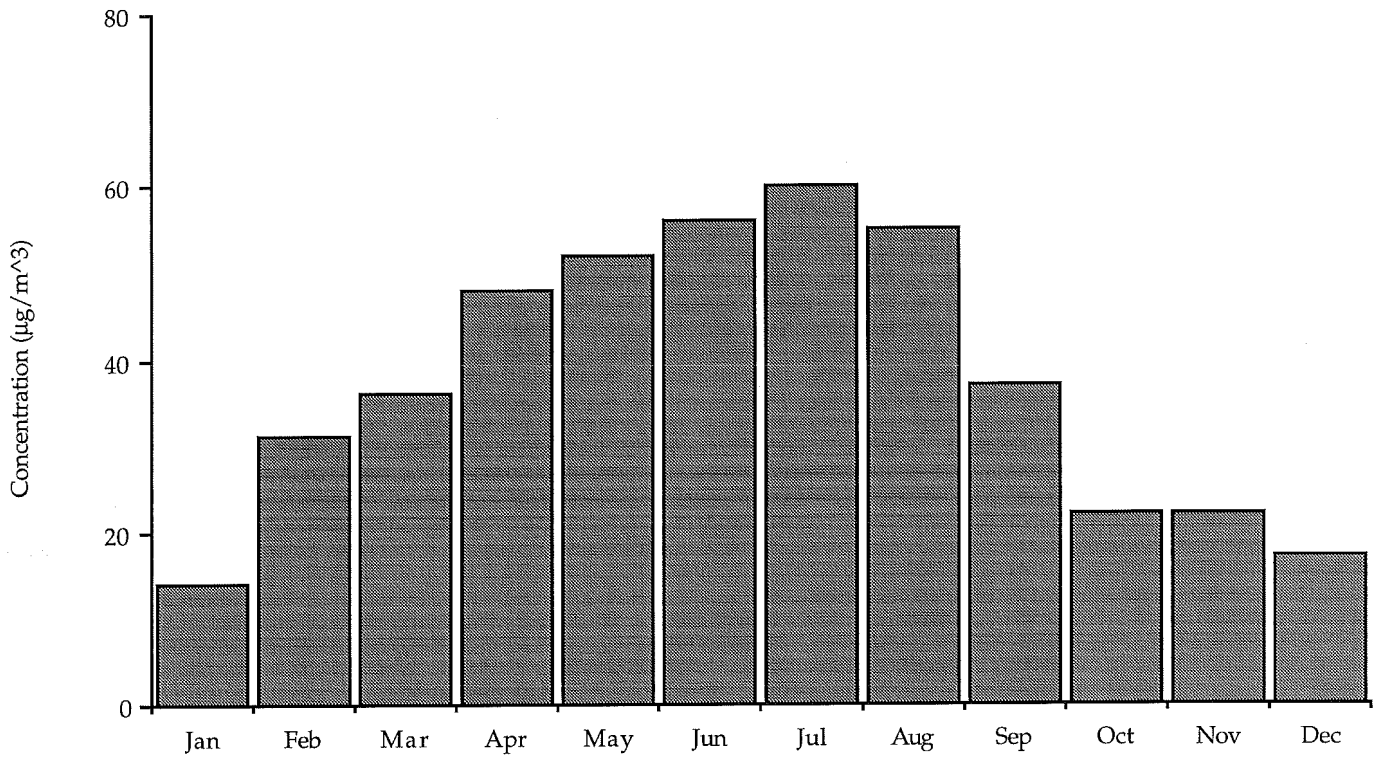


Figure 1
Monthly Average Ozone Concentrations During 1994:
Central Okanagan Air Quality Monitoring Station

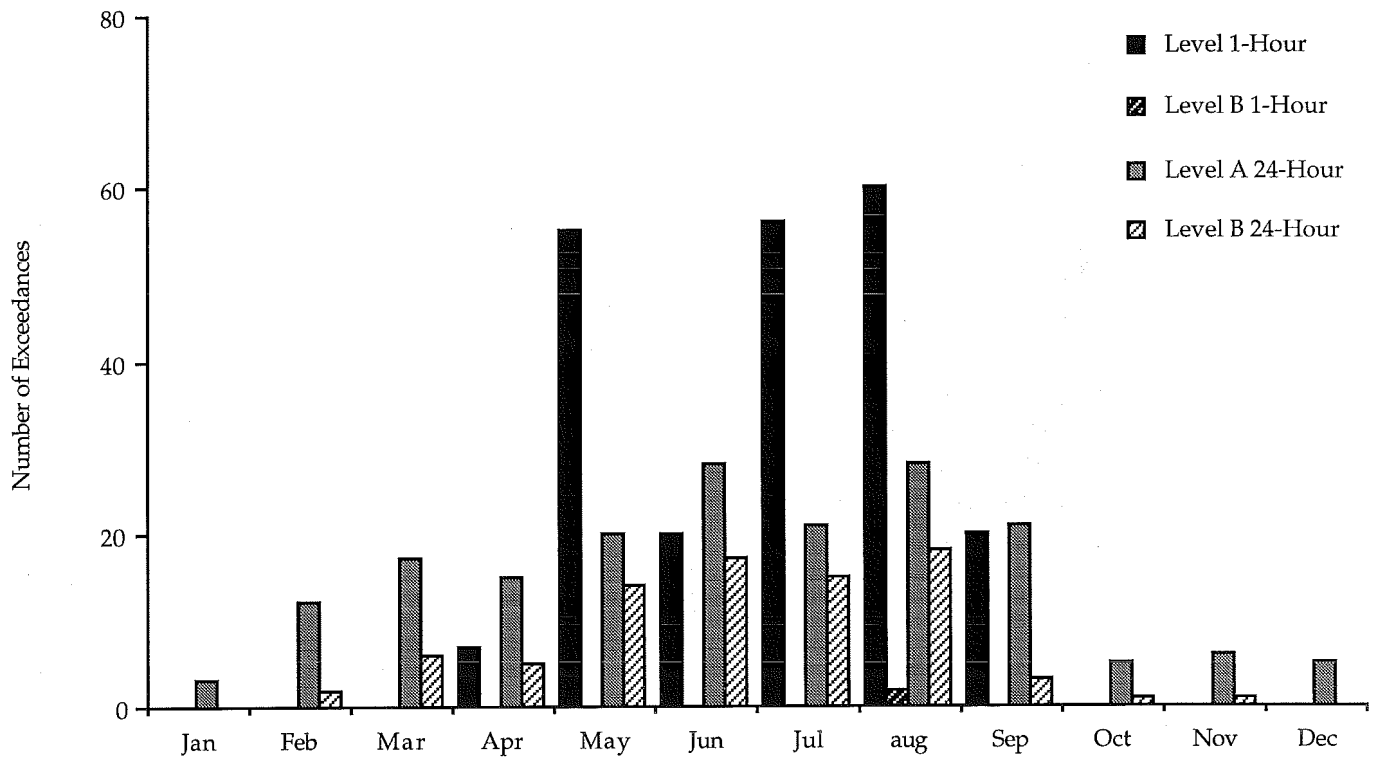


Figure 2
Ozone Exceedance Frequency During 1994:
Central Okanagan Air Quality Monitoring Station

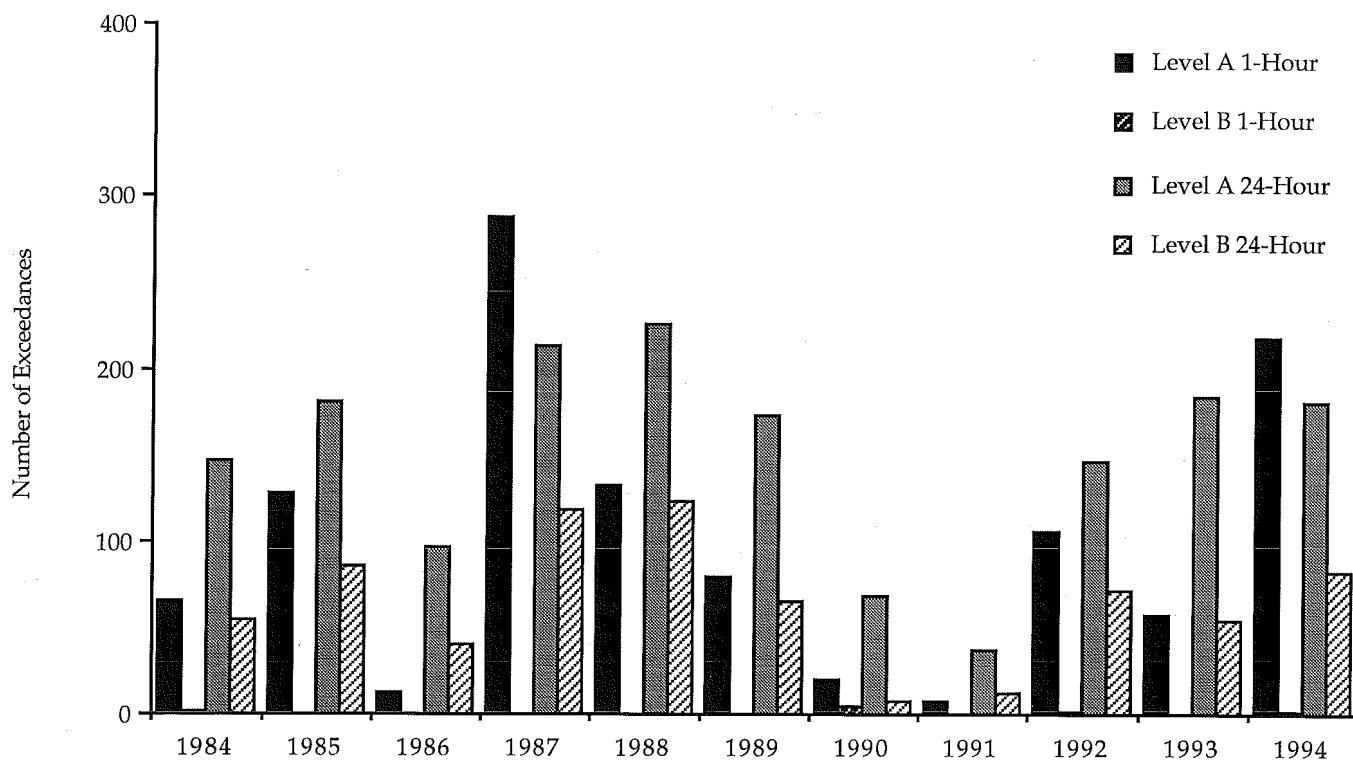


Figure 3
Historical Trend of Ozone Exceedances from 1984 to 1994:
Central Okanagan Air Quality Monitoring Station

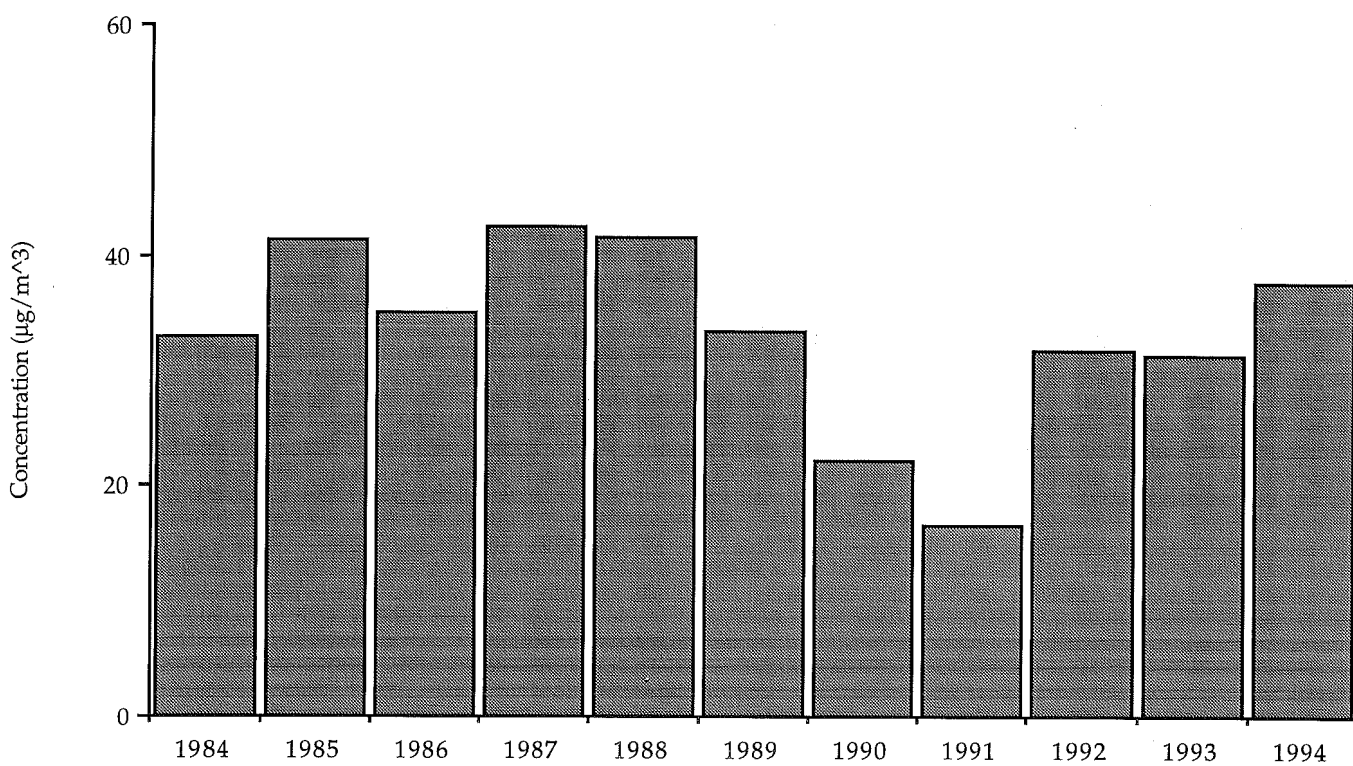


Figure 4
Yearly Average Ozone Results from 1984 to 1994:
Central Okanagan Air Quality Monitoring Station

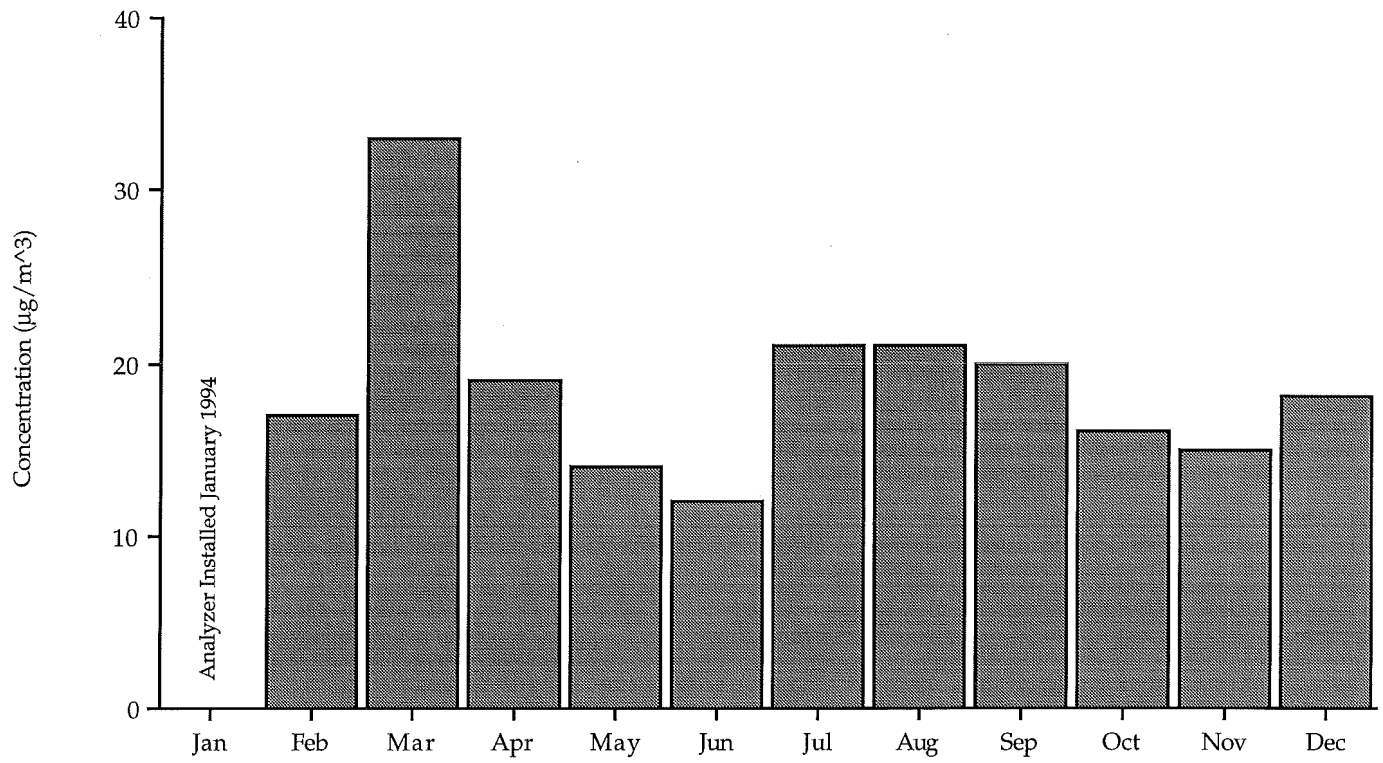


Figure 5
Monthly Average Continuous Inhalable Particulate Concentration During 1994:
Central Okanagan Air Quality Monitoring Station