

2010 Annual Air Quality Report Prince George Airshed

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PREFACE

The 2010 report cover displays the two winners of the 2012 PG AIR Clean Air Day Poster Contest. Congratulations Audille and Ramirson!

This report presents a summary and assessment of the 2010 ambient air quality and meteorological information from the Prince George airshed. This report is prepared for the Prince George Air Improvement Roundtable Society (PG AIRs), and for the joint government and industry monitoring group, the Prince George Air Quality Monitoring Working Group (PGAQMWG).

The PG AIRs comprises representatives from:

B.C. MINISTRY OF ENVIRONMENT (MoE) – OMINECA AND PEACE REGIONS

REGIONAL DISTRICT - FRASER-FORT GEORGE

CITY OF PRINCE GEORGE

MINISTRY OF TRANSPORTATION & INFRASTRUCTURE

NORTHERN HEALTH

UNIVERSITY OF NORTHERN BC

PRINCE GEORGE CHAMBER OF COMMERCE

PRINCE GEORGE AND DISTRICT MEDICAL SOCIETY

CANFOR PULP LIMITED PARTNERSHIP

CANADIAN FOREST PRODUCTS LIMITED

PRIMARY WOOD PROCESSING

SECONDARY WOOD AND BIOENERGY PROCESSING

ASPHALT, CEMENT AND GRAVEL

ENVIRONMENTAL SOCIETY (PACHA)

FRASER BASIN COUNCIL

FIRST NATIONS

HUSKY ENERGY

CN RAIL

TWO MEMBERS FROM THE PUBLIC

All operational and maintenance costs of the Prince George continuous ambient air monitoring network are funded by the PGAQMWG.

This report was prepared by the Environmental Quality Section of the Environmental Protection Division of the Ministry of Environment, Omineca and Peace Regions. The contributors are:

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The Ministry provides an air quality index that is updated twice daily during the work week, and which is accessible to the public via a telephone voice message (565-6457). Air quality index values for selected pollutants are also provided to the local newspaper, radio and T.V. station on a daily basis, as well as to the Weather Network, and are available on the internet at <http://www.bcairquality.ca/readings/index.html/> . The Ministry of Environment also installed a 24-hour complaint line (250-565-4487) in June 1996 where the public can record reports of poor air quality in their area (with the option of remaining anonymous).

Archived data from previous monitoring programs in Prince George are available at the Ministry of Environment's Regional office in Prince George.

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OBJECTIVES

The purpose of the airshed monitoring program in Prince George is threefold:

- 1) to collect ambient and meteorological data to establish the relationship between air quality, source emissions and meteorological conditions
- 2) to determine the acceptability of air quality based on B.C.'s air quality objectives
- 3) to determine air pollution trends and to assess the effectiveness of air shed management activities to reduce pollution

This report provides a summary of 2010 ambient air quality and meteorological data, and a trend analysis of these data. The appendices contain operating hours of monitoring equipment at the air quality stations, ambient air quality objectives, additional data summary tables, photographs of monitoring sites and a glossary of terms.

EXECUTIVE SUMMARY

This report summarises the ambient air quality and meteorological data collected in the Prince George airshed in 2010.

Nine air quality monitoring stations were in operation to measure seven criteria pollutants. Parameters measured include PM₁₀ (particulate matter less than 10 microns (µm) in diameter), PM_{2.5} (particulate matter less than 2.5 microns in diameter), NO_x (Nitrogen Oxides), O₃ (Ozone), CO (Carbon Monoxide), TRS (Total Reduced Sulphur), and SO₂ (Sulphur Dioxide). VOCs (Volatile Organic Compounds) are also measured at the Plaza monitoring site.

Annual averages of PM₁₀ measured at all three continuous monitoring sites increased in 2010. Record high daily maximum values were recorded at all three sites in August and are attributed to forest fire activity. The maximum daily values recorded at Plaza and Gladstone during the forest fire event were greater than the maximum hourly concentrations recorded at these two sites over the past four years. Exceedances of the Level B 24-hour average PM₁₀ objective (50 µg/m³) ranged from 1.7% at Gladstone to 4.1% at the BCR site. The frequency of level B objective exceedances also increased at all three sites. Gladstone recorded the highest maximum hourly value on record and Plaza recorded the highest value since 1996.

In 2010, the annual average PM_{2.5} concentrations at the Plaza and Gladstone continuous monitoring sites increased considerably. This was due to high concentrations of particulate matter in August that was caused by forest fire activity. In April 2009, the Province of BC adopted new ambient air quality criteria for PM_{2.5} which includes a 24-hour air quality objective of 25 µg/m³ and an annual objective of 8 µg/m³. Prior to this, comparisons were made to the Federal Canada-Wide Standard (CWS) for PM_{2.5} (30 µg/m³), which is based the 98th percentile, averaged over three consecutive years. From 2005 to 2009, the two continuous PM_{2.5} monitors in Prince George did not exceed the CWS. The 98th percentile of the 20082010 average at Plaza was 30 µg/m³ and there were at least nine days that exceeded the new provincial 24-hour objective at Plaza and Gladstone. The maximum daily PM_{2.5} value recorded at Gladstone during the forest fire event was four times higher than the previous maximum daily value on record. The maximum daily PM_{2.5} value recorded in August at both sites exceeded the maximum hourly value records for their respective sites.

The annual average TRS concentrations and frequency of exceedances for Level A 1-hour and Level A and B 24-hour objectives increased at the Plaza and Jail monitoring sites while the frequency of Level B 1-hour objective exceedances decreased. Annual averages and exceedances of the Level A 1-hour and 24-hour objectives at the Plaza site were the highest on record since 1990. In contrast, the frequency of exceedances for Level A 1-hour and 24-hour objectives at Lakewood monitoring site decreased in 2010. Still, the exceedances observed at the Plaza site confirms the need for additional TRS reductions called for in the Prince George Air Quality Management Plan (2006).

Annual average SO₂ levels at Plaza, Jail, and CBC sites increased in 2010, but decreased at Gladstone and Marsulex-BCR sites. The annual average at the CBC site was the highest

recorded since 2005 and during 2010, there were eight exceedances of the ambient SO₂ one hour Level A objective (450 µg/m³) with the maximum one-hour average (667 µg/m³) occurring in September. No other site recorded exceedances of the Level A one-hour objective. None of the SO₂ monitoring sites in Prince George exceeded the daily Level A objective (160 µg/m³) in 2010 but CBC did reach 151 µg/m³ in December.

The annual average ozone level, the number of Level A 1-hour objective exceedances (100 µg/m³), and the number of Level B 24-hour objective exceedances (50 µg/m³) increased at the Plaza site in 2010 relative to the previous year. The maximum hourly value (121 µg/m³), and the majority of the exceedances for the hourly ozone Level A objective occurred in May. There were no exceedances of the provincial one-hour ozone Level B objective (160 µg/m³).

No exceedances of the NO₂ objectives have ever been recorded at the Plaza site. In 2010, the lowest annual average was recorded for this site (20 µg/m³). However, the maximum 1-hour value (178 µg/m³) measured in December, was the highest value recorded since 1997. This value still falls below hourly NO₂ objectives.

The annual average CO concentration at the Plaza site in 2010 was the lowest recorded since monitoring began in 2003 (296 µg/m³). Annual averages have steadily been decreasing at this site since 2003, and no exceedances of the 1-hour (14300 µg/m³) or 8-hour (5500 µg/m³) Level A provincial objectives have ever been recorded.

Six air quality advisories were issued in 2010 due to elevated concentrations of particulate matter. These advisories are listed in Table 4.1 along with the duration of the episode and the maximum PM_{2.5} and PM₁₀ 24-hour rolling averages during each period.

1. PRINCE GEORGE MONITORING NETWORK

Nine air quality monitoring stations and eight meteorological stations were in operation in 2010 (Figure 1.1). Parameters monitored at each site are listed in Table 1.1. Photographs of most of these locations are located in Appendix D. Archived data from discontinued stations and monitors are available at the Ministry of Environment's regional office in Prince George.

Table 1.1 Prince George air quality monitoring program for 2010

Site No.	Location	Parameters
0450322	Regional Correction Centre (Jail)	TRS, SO ₂
0450307	Plaza 400	PM _{2.5} , PM ₁₀ , <i>PM₁₀</i> , <i>PM_{2.5}</i> , TRS, NO _x , SO ₂ , O ₃ , CO
0450232	Van Bien School	<i>PM_{2.5}</i>
0450324	Lakewood Jr. School	<i>PM_{2.5}</i> , TRS
0450270	Gladstone	PM ₁₀ , PM _{2.5} , SO ₂ , WD, T, RH
E224013	BCR Warehouse	<i>PM_{2.5}</i> , PM ₁₀
E209179	CBC Transmitter Site	SO ₂
E259277	PG Western Acres*	<i>PM₁₀</i> , <i>PM_{2.5}</i>
E270963	Marsulex (BCR)	SO ₂
M109912	Plaza 400	WD, T, RH, SR
M109911	P.G. Pulp	WD, T
M109913	Northwood Pulp	WD, T
E224014	Glenview School	WD, T
E278829	Marsulex-BCR station	T, RH, WD
71908	Airport	WD, T, RH, SR, VIS, CC, PRC, PRS
-	UNBC	WD, T, RH, SR, PRS

Note: Non-continuous parameters are italicized

* Sampling concluded in March 2010.

- TRS = Total Reduced Sulphur Compounds (as H₂S)
- SO₂ = Sulphur Dioxide
- NO_x = Nitrogen Oxides (includes nitric oxide (NO) and nitrogen dioxide (NO₂))
- PM₁₀ = Particulate Matter less than 10 microns in size (Continuous)
- PM₁₀* = Particulate Matter less than 10 microns in size (Non-continuous)
- PM_{2.5} = Particulate Matter less than 2.5 microns in size (Continuous)
- PM_{2.5}* = Particulate Matter less than 2.5 microns in size (Non-continuous)
- O₃ = Ozone
- CO = Carbon Monoxide
- T = Temperature
- WD = Wind Direction and Wind Speed
- SR = Solar Radiation
- RH = Relative Humidity
- VIS = Visibility
- CC = Cloud cover as well as cloud type and ceiling heights
- PRC = Precipitation amount and type, including snow on ground
- PRS = Barometric Pressure

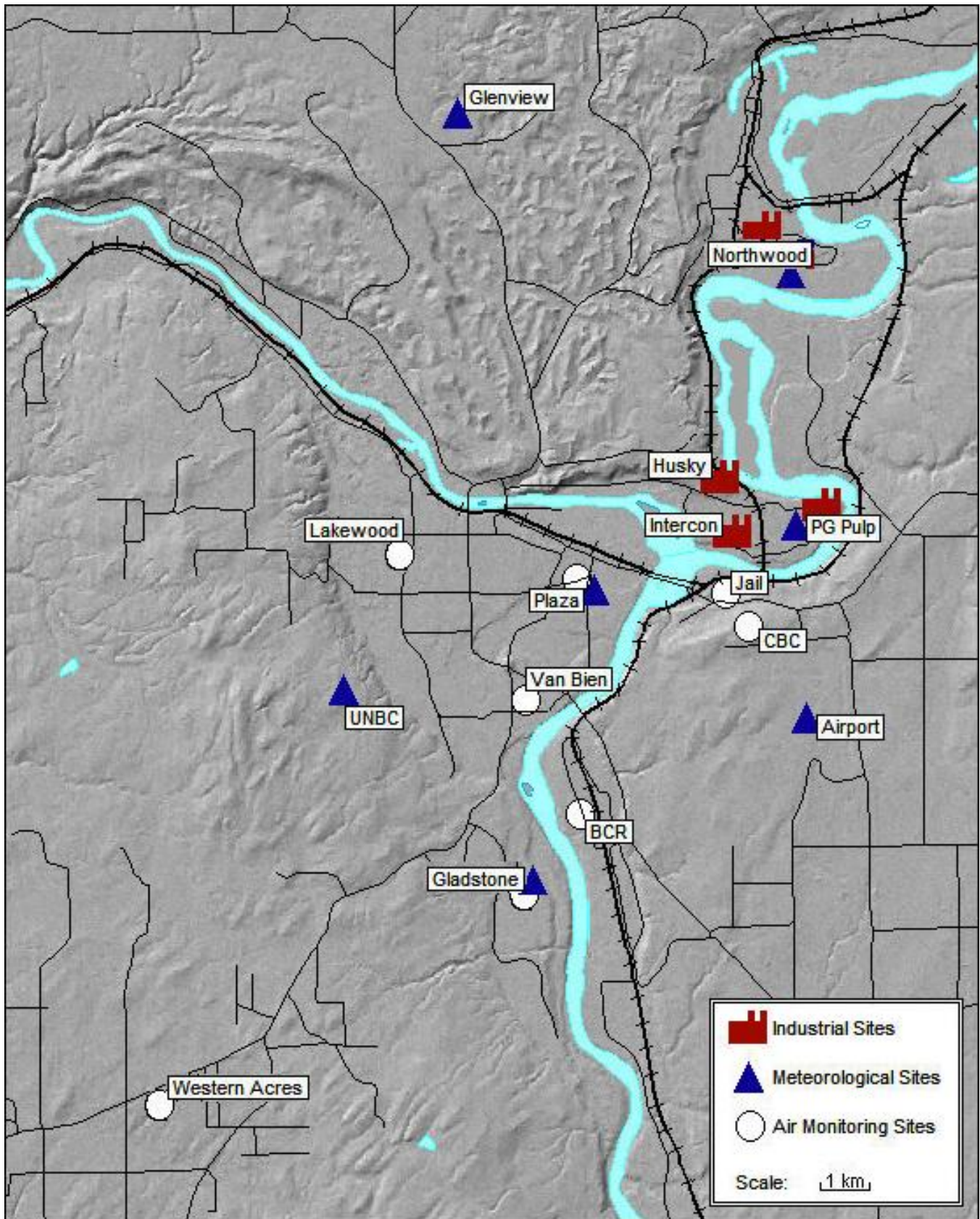


Figure 1.1 Prince George Ambient Air Monitoring Network

2. METEOROLOGICAL INFORMATION

Meteorological data were collected at eight stations in 2010; five operated by the Ministry of Environment, one operated by Environment Canada located at the airport, one operated by the University of Northern B.C. (UNBC) and another site at Marsulex Inc. (located in the BCR industrial area) operated by industry. These stations are listed in Table 2.1 along with their locations, elevations and the percent of valid data recovered for wind direction in 2010. Data recovery ranged from 45.5% (UNBC) to 100.0% (Marsulex and Airport). The low data recovery for UNBC is related to anemometer data alone (data missing from March – September), other meteorological data had recovery of 99.1%.

Table 2.1 2010 meteorological stations with percent valid data

Station Name	Latitude (deg/min/sec)	Longitude (deg/min/sec)	Elevation (metres)	Anemometer height (m)	Percent of Valid Data
Plaza	53 54 53	122 44 32	570	27	94.7%
Northwood	53 58 02	122 41 19	579	13	96.3%
P.G. Pulp	53 55 28	122 41 14	590	22	98.7%
Glenview	53 59 44	122 46 34	736	14	97.7%
Gladstone	53 51 28	122 45 40	618	14	99.2%
Marsulex - BCR	53 50 42	122 44 01	595	3	100.0%
Airport	53 53 20	122 40 30	691	10	100.0%
UNBC	53 53 36	122 48 53	772	30	45.5%

Meteorological data measured at each of the meteorological stations are listed in Table 1.1. All sites monitor wind direction, wind speed and temperature. All data are archived based on hourly averages except the Airport station where the archived data consists of the values recorded about five minutes before each hour. Solar radiation is also monitored at the Plaza and UNBC sites. Relative humidity is recorded at the Plaza, Gladstone, UNBC and Airport sites. Environment Canada also monitors cloud type and cover, precipitation, snow on the ground, visibility, and barometric pressure at the airport site.

Since September 2001, all anemometers used by the MoE in the Prince George airshed are RM Young wind sensors (Fig. 2.1). The RM Young is a more sensitive instrument and has a much lower starting threshold than the older Gill Microvane/3-Cup Aanderaa anemometer that were originally located at the MoE's meteorological stations. In order to compensate for instrument sensitivity, an adjustment of 0.45 m/s was added to all scalar wind speeds at all sites that used the Aanderaa instrument. No adjustment is needed for the RM Young instruments. This change in instruments has made it difficult to assess the long term trend in wind speeds. At the Plaza and the P.G. Pulp sites, the Gill/Aanderaa anemometers were replaced by RM Young monitors in May 2000, at Northwood in August 2001 and at Glenview in September 2001.



Fig. 2.1 Anemometer used in the monitoring program

2.1 Wind

Figure 2.2 illustrates the wind direction (i.e. the direction from which the wind is blowing) at the seven meteorological stations that successfully collected >70% of the data for 2010. As an example, winds at the Plaza site were most frequent from the south followed by winds blowing from the east. The UNBC station data were not included because over half of the data were missing due to instrument problems. All sites showed a high frequency of winds from the south except for the Marsulex site which was aligned with the terrain orientation of the BCR site. All sites except Plaza showed a low frequency (< 1%) of winds from the east. The frequency of calms from the Plaza, Northwood, and Marsulex-BCR sites ranged from 21% to 24%. Calm winds recorded at the Airport were much less frequent (6%). This low frequency may have been due the wind speed being rounded to the nearest integer. The frequency of calms from the Gladstone site was quite high at 31.5% which may indicate poor instrument performance (i.e. bearings in need of replacement).

The frequency distributions of wind directions at the Northwood and P.G. Pulp sites show a classic valley-type flow with the directions being predominantly southerly or northerly, following the orientation of the valley. Stronger and more frequent southwest to west winds observed at the P.G. Pulp site are reflective of the local topography where the two valleys converge creating a larger bowl area. Light winds from the north occurred more frequently than those from the south at Northwood and P.G. Pulp in 2010. This is typical, and is due to down valley (katabatic) winds that occur at night or during winter and are normally less than 2 m/s. The increased frequency of northerly winds is reflective of the drainage effect where, wind speeds diminish at night as the air cools due to radiative loss and lack of solar heating. The cooler air (more dense) sinks and moves down the valley, resulting in the higher frequency of light northerly winds. Valley monitoring sites show this northerly flow, but sites on top of the plateau may report calm or light winds from another direction. The Marsulex-BCR site shows a higher frequency of winds from the south-southeast which are steered by the valley orientation at that location. This is an example of how terrain can have a strong influence on wind patterns.

At the Plaza site, the north/south valley effect is not as evident. Although southerly winds dominate, there are relatively more easterly than northerly winds. This occurs because light north winds (< 4 m/s) are deflected eastward by the hills located south of the pulp mills before reaching the Plaza monitoring site. Stronger winds tend to occur in all sectors with the lowest frequency from the east to southeast sector. The lower frequency of strong winds from the southwest is likely due to the air flow from that direction being blocked by Connaught Hill which is located about 200 metres directly south-southwest of the Plaza monitor. Light winds from the south get deflected around the hill, causing a higher frequency of southwest winds at the Plaza monitoring site.

The Glenview, Airport and Gladstone sites have a lower frequency of northerly winds compared to the Northwood and P.G. Pulp sites. This is reflective of their placement at higher elevations where there is less of an influence from the terrain features, compared to the valley sites. When valley sites are showing a northerly flow, sites on top of the plateau may report calm or light winds from another direction.

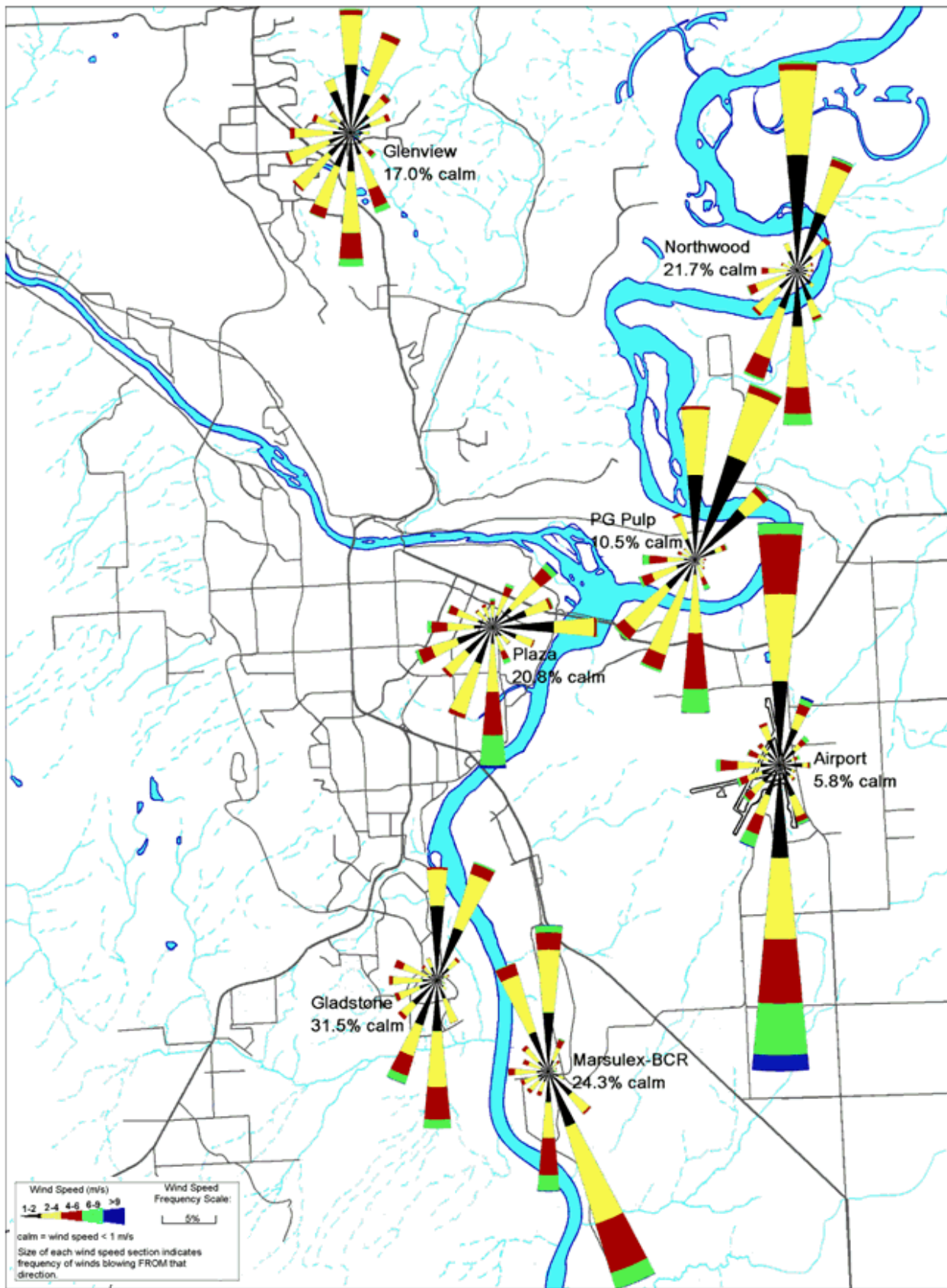


Figure 2.2: Map of Prince George showing the seven wind roses for 2010 (sites with > 70% data capture)

Figure 2.3 shows the monthly average 2010 wind speeds from the Prince George Plaza site compared with the 10 year average (2000-2009). Monthly averages at the Plaza were higher for 2010 than the 10-year mean values from May to November but lower during the winter months.

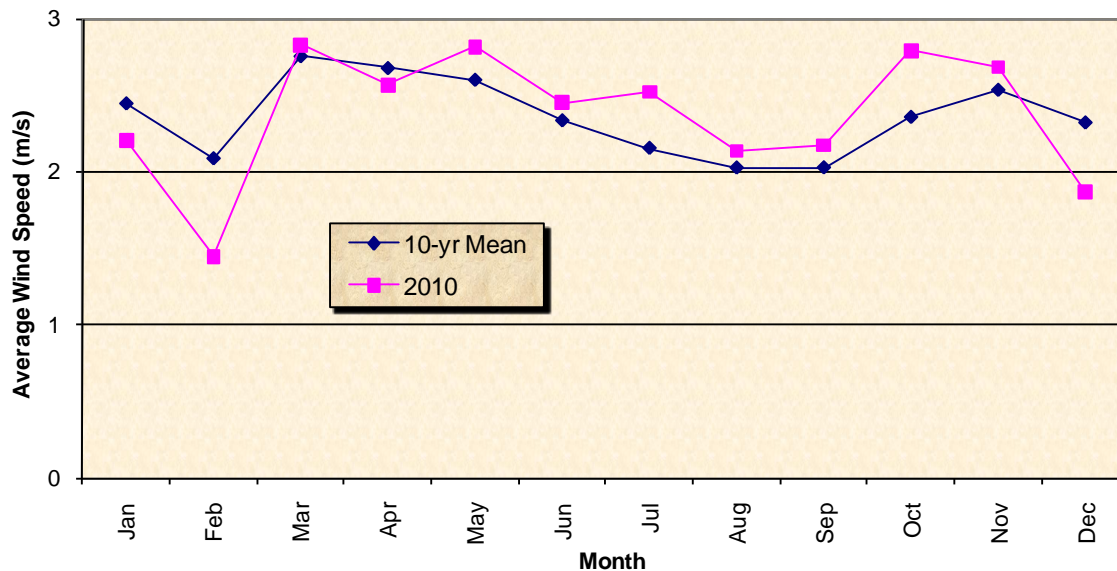


Figure 2.3 Average monthly wind speed (2010 and 10 Year Mean) at the Prince George Plaza site

Meteorological factors such as a frontal passage, movements of high and low-pressure regimes, or cloud cover affect wind flow. Higher wind speeds generally produce better air quality although this is somewhat dependent on wind direction. A clear sunny day normally would produce more daytime mixing and stronger winds than clear skies at night with temperature inversions and calmer winds. On clear nights, the ground surface loses heat to the atmosphere, (radiative cooling) causing cool air to sink and move down the valley resulting in a higher frequency of light northerly winds in Prince George.

2.2 Precipitation

Precipitation plays an important role in air quality. Rain not only washes pollutants out of the air, but it suppresses the amount of surface dust emitted into the airshed. Water droplets can also contribute to faster chemical reactions of pollutants. For example, SO₂ can be readily converted to sulphuric acid in the presence of water droplets.

Figure 2.4 shows the 2010 monthly total precipitation recorded at the airport compared to the 10-year average of 2000-2009. Precipitation was below the ten-year average for 10 out of 12 months.

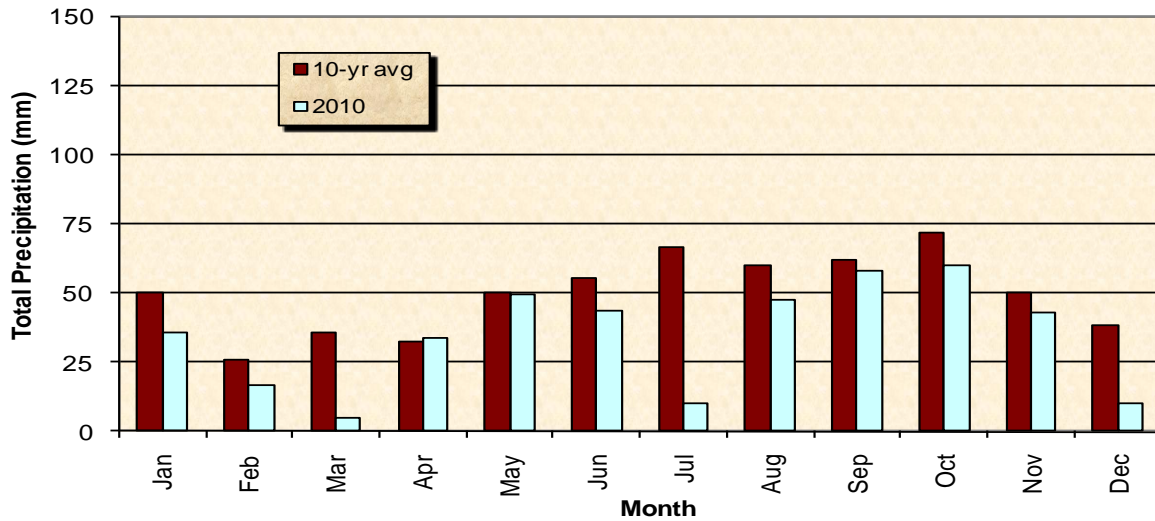


Figure 2.4 Comparison of total monthly precipitation (mm) at the Airport between 2010 and the 10-year average

Figure 2.5 shows the trend in the total annual precipitation recorded at the Prince George Airport. The annual average precipitation in 2010 was the lowest recorded since 1979.

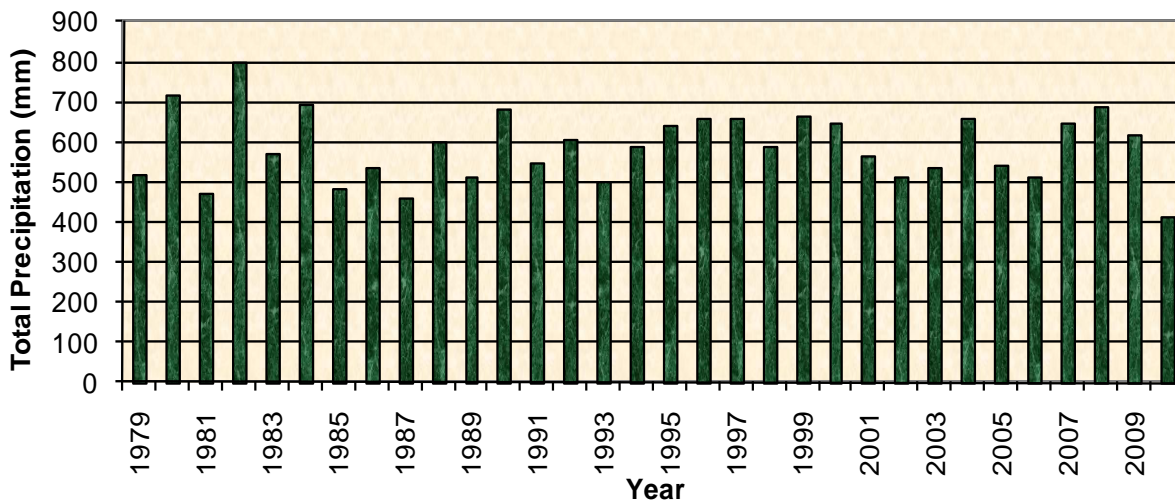


Figure 2.5 Total annual precipitation (mm) at the Prince George Airport

2.3 Temperature

Temperature can influence air pollution levels, both directly and indirectly. Indirectly, cold temperatures are often associated with greater fuel use which translates to increased emissions from sources such as industry and space heating (e.g. residential wood burning). Vehicle emissions can also increase in colder climates due to decreased operating efficiencies. In terms of direct effects, temperature can influence chemical reaction rates of air pollutants such as ozone which can be both produced and destroyed at faster rates in warmer temperatures. It is unknown whether there is a net increase or decrease of ozone with warmer temperatures.

Figure 2.6 shows the daily maximum and minimum temperatures recorded at the Plaza site in 2010 relative to all historical maximum and minimum daily temperatures. Record maximum temperatures were recorded on 17 days in 2010: four days in January and April, three in July, two in November, and one in February, March, June and October. Record minimum temperatures were recorded on 4 days: 2 days in June and two days in September.

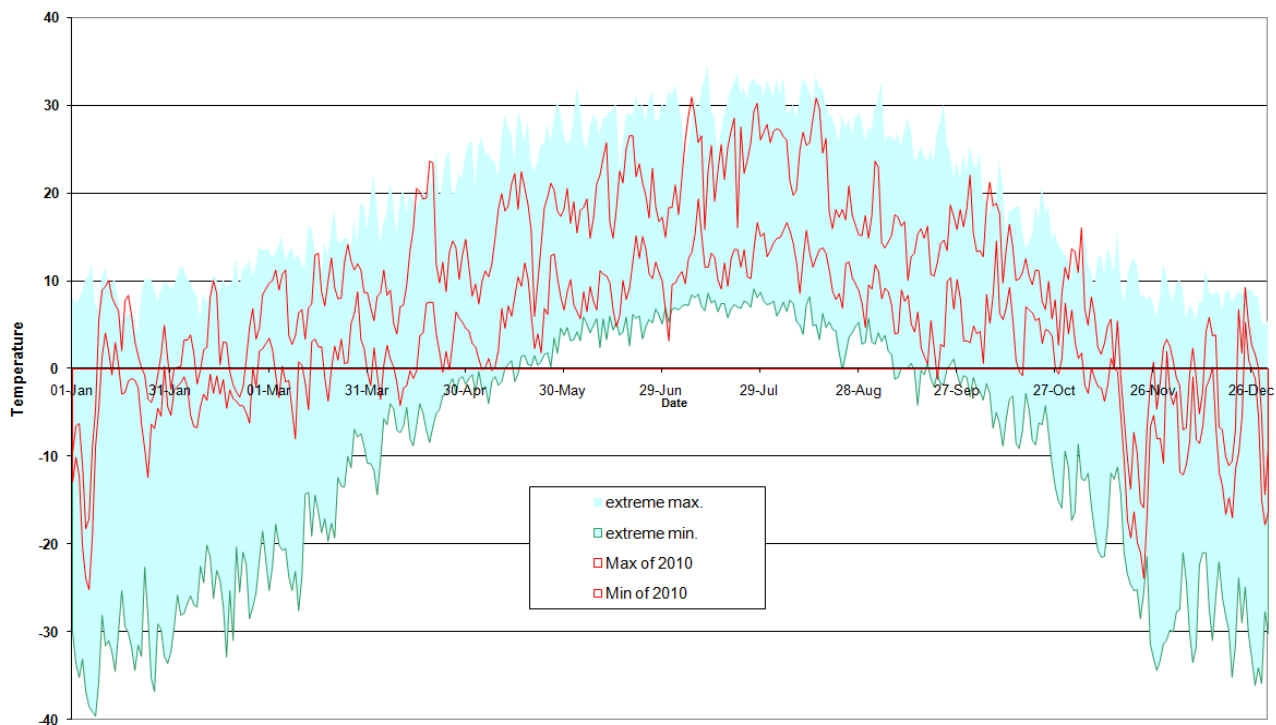


Figure 2.6 2010 maximum and minimum temperatures (°C) at the Prince George Plaza site compared to the 1985-2009 values

Average temperatures at the downtown (Plaza) location tend to be somewhat higher than all other sites. This could be due to the heat island effect in which temperatures in urban areas are typically higher than rural areas because of radiant heat stored in building and road surfaces. Temperatures at higher elevations are normally lower than those at lower elevations because temperatures normally decrease as one ascends in altitude, known as the adiabatic effect. However, temperatures at night are normally lower at low elevations than those at higher elevations because cold air sinks at night, causing valleys to be colder than hill tops.

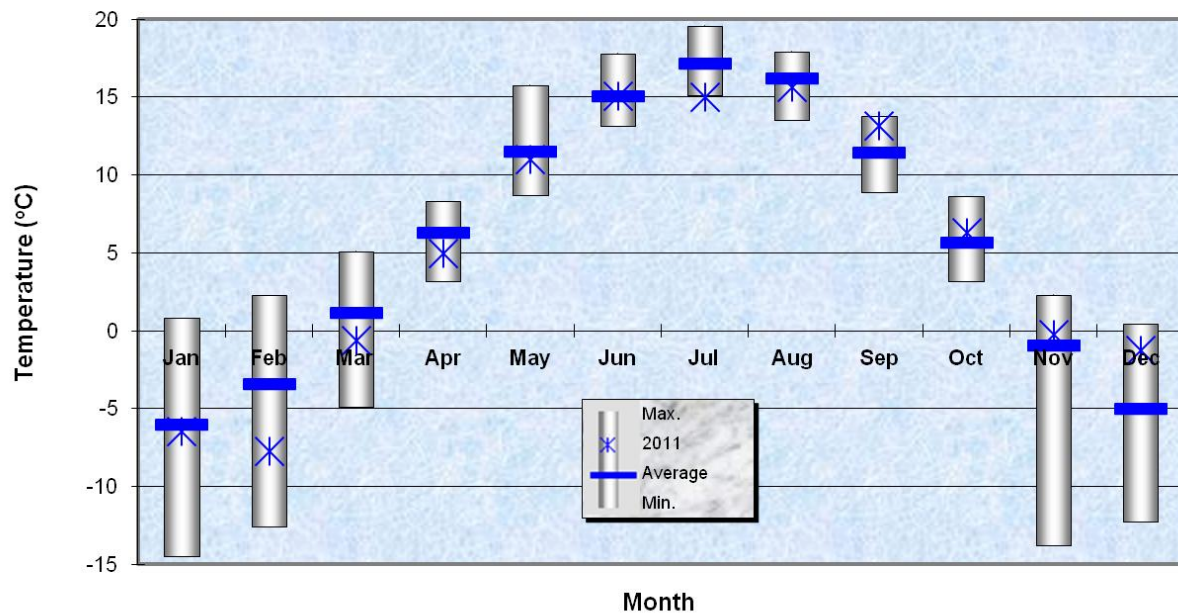


Figure 2.7 Monthly trends in average temperatures (°C) at the Plaza site since 1985

Figure 2.7 shows the range in monthly mean temperatures at the Plaza site since monitoring began in 1985. Monthly mean temperatures in 2010 ranged from a low of -4.6°C (December) to a high of 18.6°C (July). Temperatures were noticeably above normal for four months: January, February, March and October. The range in the average monthly temperature (max – min) is the greatest during the winter (about 15°C) and the least during the summer (about 4°C). The monthly average temperatures in March and October were the warmest recorded for those months at the Plaza site.

3. AMBIENT AIR QUALITY RESULTS AND TRENDS

3.1 Particulate Matter

Particulate matter refers to small particles ranging in size from 0.001 μm to 100 μm (1 million $\mu\text{m} = 1 \text{ m}$). Particles range in chemical composition, size, shape and physical properties. Particles less than 10 μm (PM_{10}) tend to stay suspended longer in the atmosphere than larger particles. The inability of the atmosphere to disperse small particles is often evident during hazy days in the autumn when mixing is weak.

Larger particles ($>10 \mu\text{m}$) may cause a nuisance or irritation, but PM_{10} , either alone or in combination with other pollutants in the air, causes the greatest health effects because it is small enough to be inhaled deep into the lungs (Vedal, 1995). These health effects include premature death, increased hospital admissions, increased respiratory symptoms and disease, and decreased lung function. Recent health and medical studies have shown that very fine particles ($\text{PM}_{2.5}$) may have more serious health impacts than coarser particles. These smaller particles are able to reach deeper into lungs than coarser particles (CEPA/FPAC Working Group, 1998; Pope and Dockery, 2006). As well, smaller particles tend to remain in the atmosphere for longer periods of time (sometimes for weeks). Particulate matter can also impact vegetation by causing reduced growth and productivity due to interference with photosynthesis and phototoxic impacts (Copes & Elliot, 2007).

In Prince George, the major PM_{10} emission sources are pulp mills, sawmills and road dust (Prince George Airshed Technical Management Committee, 1996). $\text{PM}_{2.5}$ sources in Prince George include exhaust from commercial and secondary pollutants from combustion of fuels (e.g., motor vehicles, locomotives, space heaters, industrial facilities). The primary natural source of $\text{PM}_{2.5}$ is forest fires, due to high combustion temperatures. These fine particles can also be formed (as secondary pollutants) by the transformation of gaseous emissions such as SO_2 , NO_x and various hydrocarbon species. Secondary particulates occur predominantly as $\text{PM}_{2.5}$. The generation of these particles can result in acid rain and reduced visibility, components typical of smog conditions. Major natural secondary $\text{PM}_{2.5}$ sources are VOCs released from trees and nitrogen oxides released from soil. The chemical and physical compositions of $\text{PM}_{2.5}$ and PM_{10} vary depending on location, time of year, and meteorology.



Fig. 3.1.1: PM_{10} non-continuous Partisol monitor

The BC Ministry of Environment uses two methods to monitor particulate matter, continuous and non-continuous. The former provide 'real time' data whereas the latter involves collecting samples on filters which are sent to a lab for analysis. Due to the nature of the sampling, data from non-continuous samples are only available several weeks after the sample has been collected. Both instruments operate by drawing air through a size selective inlet prior to collection on a Teflon coated glass fibre filter. Particulate matter is measured non-continuously by drawing air through a size selective inlet prior to collection on a Teflon fibre filter at a rate of about 1 cubic metre per hour (Fig. 3.1.1). Non-continuous samplers run for 24 hours, from midnight to midnight, every three days. The results from these samplers are not available for six to eight weeks due to processing and analysis of the filters.



Figure 3.1.2 PM₁₀ TEOM monitor

Currently, the most common instrument used to measure particulate matter in real-time is the Tapered Element Oscillating Microbalance (TEOM) (Figure 3.1.2). This instrument collects particles on a filter that is seated on the oscillating tapered element. The oscillating frequency of the tapered element changes as particles are loaded onto the filter. The hourly average concentration has a precision of 1.5 $\mu\text{g}/\text{m}^3$. TEOMs can measure PM₁₀ and PM_{2.5}. The main difference between measuring these two size fractions are the inlet head which control the size of particles that pass through to the filter.

In terms of quality assurance, non-continuous PM₁₀ and PM_{2.5} data are assessed by regular measurement of laboratory filter weighing error and by quarterly calibration of the air flow controllers on the samplers. The quality of continuous data are evaluated by bi-weekly field checks and quarterly calibrations, as well as twice annual independent audits.

Audit results for the PM₁₀ TEOMs are located in Appendix B. Table B-1 indicate that both BCR and Plaza had excellent performance in May and October. Gladstone had excellent performance during the May audit and satisfactory performance in October. The quality of the 2010 PM_{2.5} data at Gladstone was excellent during both audits. The Plaza PM_{2.5} instrument failed the May audit but had excellent performance in October. Data recovery was excellent, with valid data ranging from 93.0% to 99.0% at all five continuous monitors.

3.1.1 PM₁₀ Results

PM₁₀ was monitored continuously at the Plaza, Gladstone, and BCR stations in 2010. Figure 3.1.3 and Tables C - 1.1 to C - 1.3 provide the monthly summaries of data from these sites. Figure 3.1.3 shows monthly average levels and the number of days when the 24-hour level B PM₁₀ objective (50 $\mu\text{g}/\text{m}^3$) was exceeded each month. The highest monthly PM₁₀ levels and greatest number of 24-hour exceedances occurred in August due to forest fire activity. The smaller peak in March/April is likely due to an increase in dust from accumulated winter road traction material that is crushed and dispersed by motor vehicles. Precipitation events help to keep PM₁₀ levels low however monthly precipitation in March was well below normal (Figure 2.4).

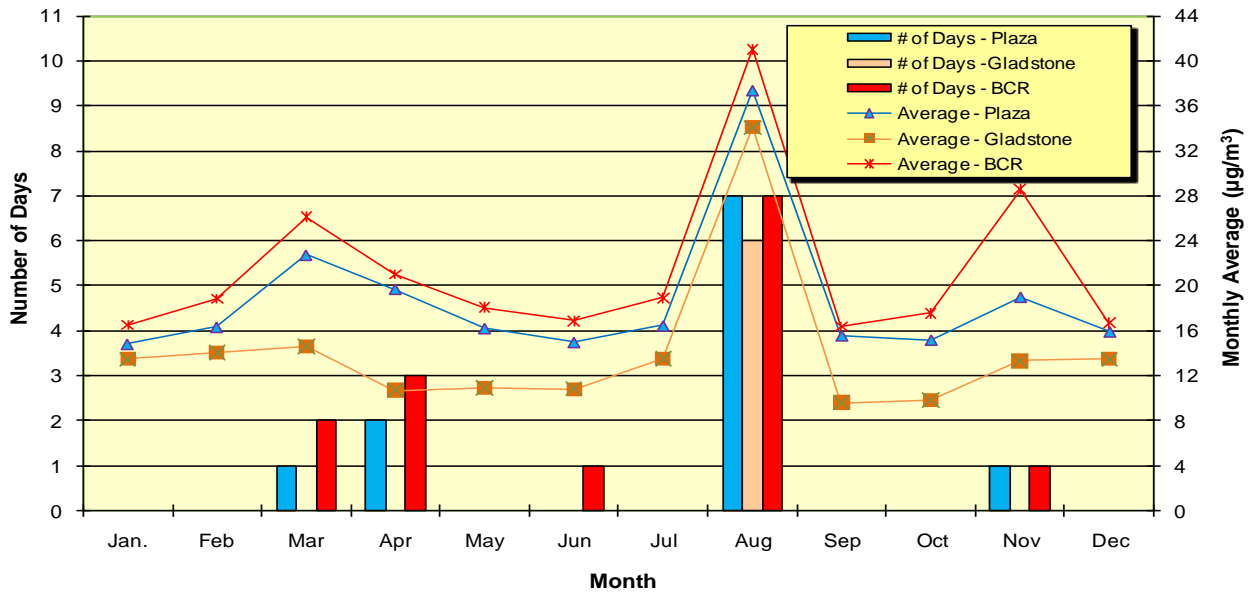


Figure 3.1.3 Monthly average PM_{10} levels ($\mu\text{g}/\text{m}^3$) and the number of days exceeding the Level B 24-hour objective at sites in Prince George

Figures 3.1.4 to 3.1.6 show the range in monthly averages of PM_{10} recorded at the Plaza, Gladstone and BCR stations for the entire data record. Monthly averages ranged from a high of $44.2 \mu\text{g}/\text{m}^3$ (March 1995) to a low of $10.6 \mu\text{g}/\text{m}^3$ (September 2005) at the Plaza site, a high of $34.1 \mu\text{g}/\text{m}^3$ (August 2010) to a low of $8.8 \mu\text{g}/\text{m}^3$ (September 2005) at the Gladstone site, and a high of $51.2 \mu\text{g}/\text{m}^3$ (February 2005) to a low of $11.9 \mu\text{g}/\text{m}^3$ (February 2002) at the BCR site.

It should be noted that the Plaza, Gladstone and BCR monitoring sites are located on high roof tops. Ground-level values are likely higher near roadways. A short term monitoring program was conducted from March to May 1996 to determine the effect of road dust on PM_{10} levels at street level. A site located on a one story building at the same intersection as the Plaza site (a five storey building) measured 24-hour levels that were on average $7 \mu\text{g}/\text{m}^3$ (30%) higher than what was recorded at Plaza. During one occasion, levels at this one story site were 69% higher than at the Plaza site ($16 \mu\text{g}/\text{m}^3$ at Plaza and $27 \mu\text{g}/\text{m}^3$ at the one story building). Since then, with the reduction in road dust and improved street sweeping, it is expected that differences in concentrations between high and low roof top elevations are less than what was shown in 1996.

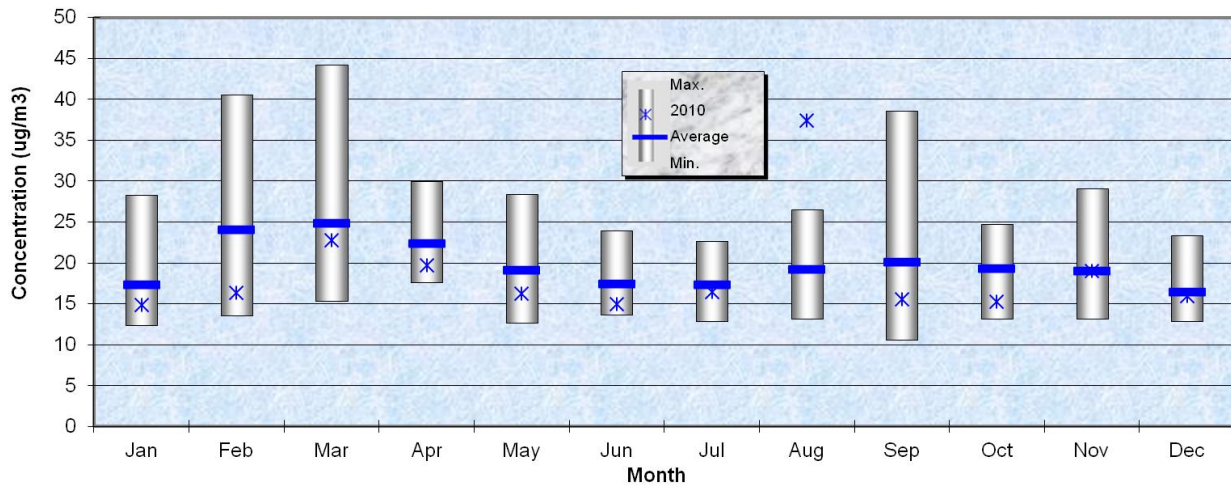


Figure 3.1.4 Comparison of 2010 with long term average monthly PM₁₀ levels (µg/m³) at the Plaza site since 1995

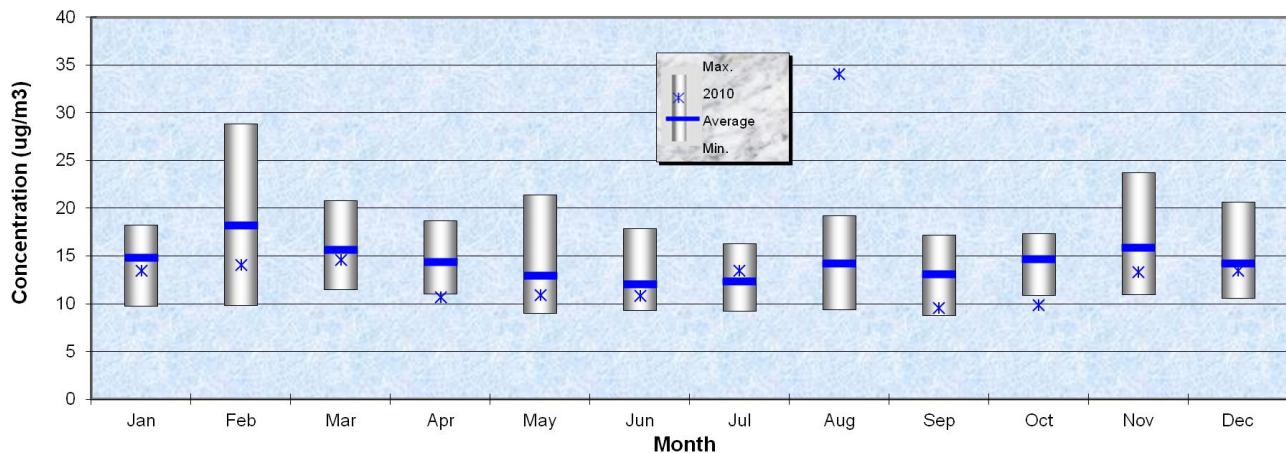


Figure 3.1.5 Comparison of 2010 with long term average monthly PM₁₀ levels (µg/m³) at the Gladstone site since 1996

Historical PM₁₀ monthly averages at the Plaza and Gladstone sites are the highest in February and March likely due to road dust generated by winter sand traction material. Elevated levels in August/September are likely due to forest fire activity, with the lowest values occurring during June and July. Figures 3.1.4, 3.1.5, and 3.1.6 show below average results for 2010 for ten months at both the Gladstone and Plaza monitoring stations, and nine months at the BCR site. Typically the highest PM₁₀ levels at the BCR site occur during April (Fig.3.1.6) and another smaller peak in levels during late summer, likely due to dust. In 2010 the highest PM₁₀ levels at the BCR site occurred in August and other slightly smaller peaks occurred in November and March. August 2010 was a record high monthly average (due to forest fire activity) for all 3 continuous PM₁₀ monitoring sites. BCR and Gladstone had record low PM₁₀ levels for the month of April. Gladstone also had a record low PM₁₀ level for the month of October.

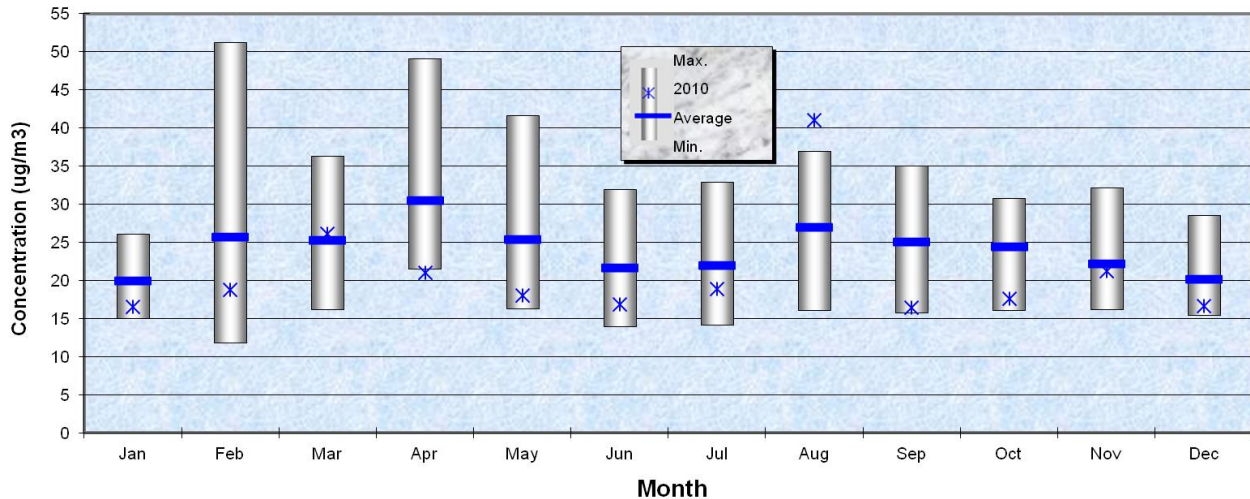


Figure 3.1.6 Comparison of 2010 with long term average monthly PM₁₀ levels (µg/m³) at the BCR site since 1996

Figure 3.1.7 shows the 2010 PM₁₀ pollution rose for the Plaza site based on wind direction (for wind speeds ≥ 1 m/s). Calm winds below 1 m/s are less able to flush pollutants out of the airshed, therefore masking the location of the predominant source. Fig. 3.1.7 indicates the importance of low wind speed and calm conditions on downtown PM₁₀ levels. The mean concentration for wind speeds < 1 m/s was 29.6 µg/m³ which was approximately 1.7 times higher than the annual average. Concentrations greater than 50 µg/m³ (24-hour Level B Objective) occurred mainly when winds were blowing from the east-northeast to southeast sector. PM₁₀ concentrations greater than 50 µg/m³ were also detected from most wind directions in 2010 which could be due to the high levels caused by forest fires in August. One-hour average PM₁₀ levels < 5 µg/m³ seldom occurred when winds were blowing from those directions, but occurred about 30% of the time whenever winds were from the west and south-southeast directions.

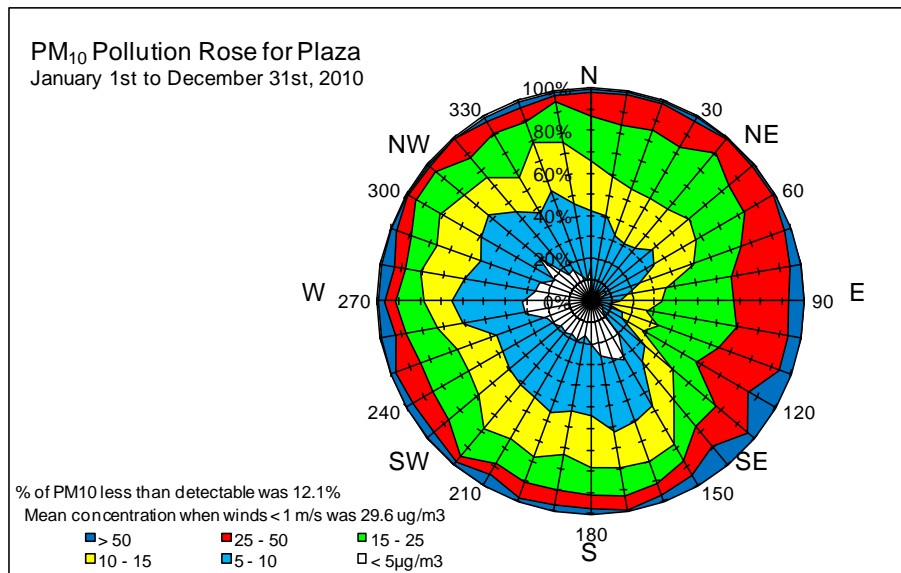


Figure 3.1.7 PM₁₀ Pollution Rose at the Plaza site for 2010

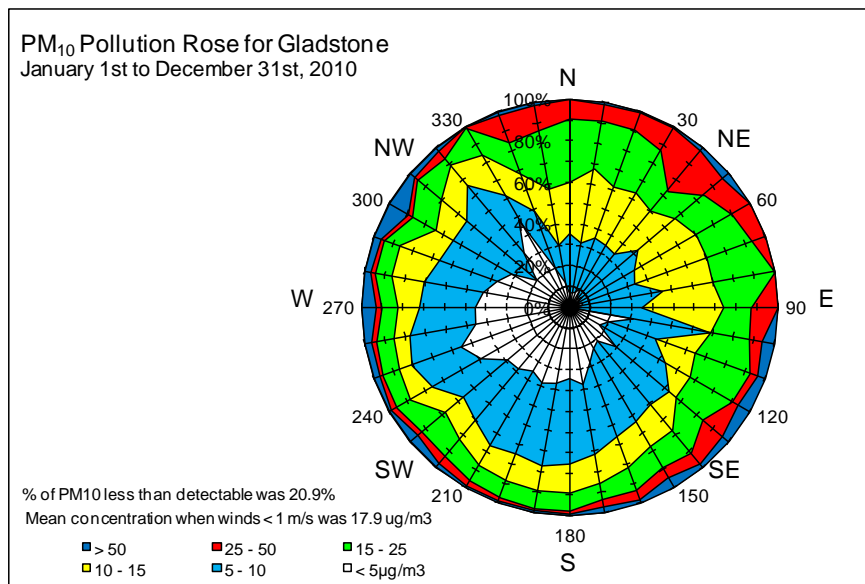


Figure 3.1.8 PM₁₀ Pollution Rose at the Gladstone site for 2010

Figure 3.1.8 shows the 2010 PM₁₀ pollution rose for the Gladstone site using only data for wind speeds ≥ 1 m/s. The mean concentration for wind speeds < 1 m/s was $17.9 \mu\text{g}/\text{m}^3$, approximately 1.4 times higher than the annual average. Concentrations greater than $50 \mu\text{g}/\text{m}^3$ occurred mainly when winds were blowing from the east to south-southeast and from the west to northwest sectors. One-hour average particulate levels below $5 \mu\text{g}/\text{m}^3$ seldom occurred when winds were blowing from the north-northwest to east directions, but occurred about 35-50% of the time whenever winds were from the south to southwest to west-northwest sector.

3.1.2 PM₁₀ Annual Trends

Tables C-2.1 to C-2.8 show the annual trends in PM₁₀ levels for both continuous and non-continuous monitors. The one remaining non-continuous PM₁₀ site (Western Acres) finished operations in March 2010.

Annual PM₁₀ concentrations were higher at all three continuous monitoring sites in 2010 relative to 2009 (Tables C-2.6 to C-2.8). This was due to high concentrations in August from forest fire activity. New record high maximum daily values were set at all three sites and the frequency the level B objective ($50 \mu\text{g}/\text{m}^3$) exceedances increased at all three sites. Additionally, the maximum hourly value recorded at Plaza was the highest recorded since 1996 and at Gladstone it was the highest ever recorded. In fact, the maximum daily value recorded at Plaza and Gladstone during the forest fire event was higher than the maximum hourly value recorded in the past four years at these two sites.

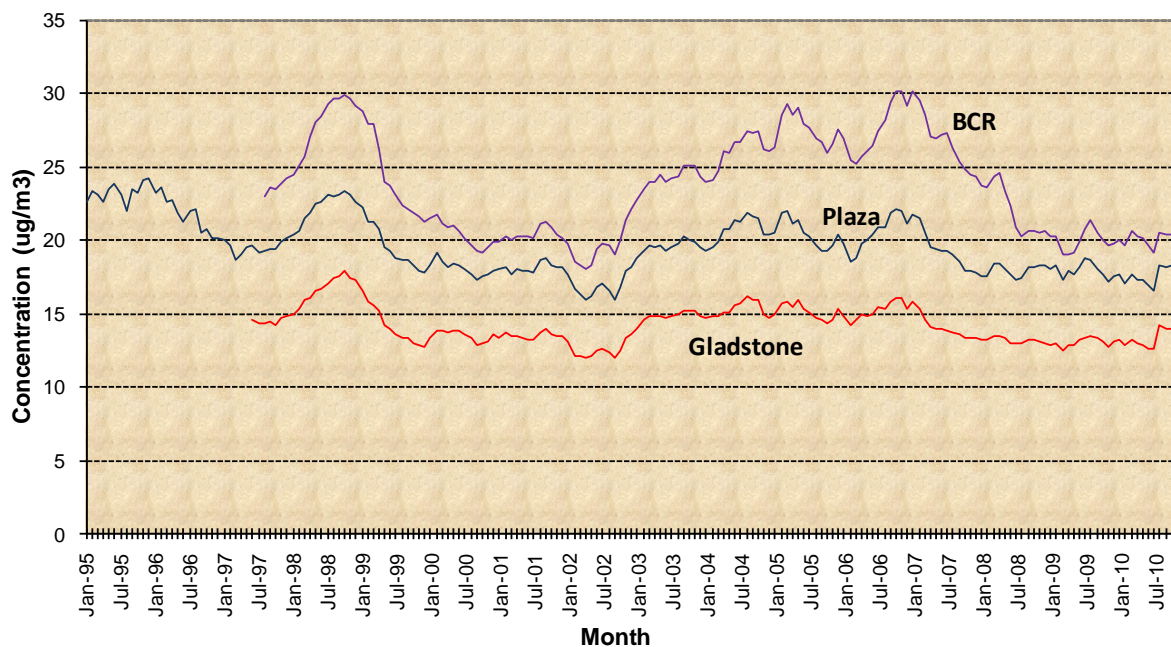


Figure 3.1.9 Rolling average annual PM_{10} levels ($\mu\text{g}/\text{m}^3$) recorded at continuous sites in Prince George

Figure 3.1.9 shows the trend in annual mean PM_{10} levels (1 year rolling average) at continuous sites in Prince George (e.g. the average annual concentration at Plaza on July 8, 1995 is about $25 \mu\text{g}/\text{m}^3$, which covers the period from July 9, 1994 to July 8, 1995). This was done to reduce seasonal variations in the concentrations and make pollutant trends clearer. Levels at all three sites increased considerably from January 1998 to October 1998 and decreased until February 2002. Levels gradually increase from late 2002 until January 2007, then show a decreasing trend.

Overall, annual PM_{10} levels have declined since monitoring began at the Plaza site in 1990. Various source management actions have likely contributed to this trend. These actions include the shutdown of all beehive burners in the airshed, increased removal of fine particulate matter in some of the pulp mill sources, use of coarser winter street traction material and improved street cleaning. Other source reduction actions are identified in the Prince George Air Quality Management Plan – Phase One and Two, (Prince George Airshed Technical Management Committee, 1998; PGAQIC, 2006).

Non-source emission factors, such as meteorology, windier and wetter conditions, a reduction in open burning within the airshed, and the impact from forest fires, helped contribute to the overall change in PM_{10} levels in 2010. In the Prince George forest area, there were 71 significant forest fires (burning 26,626 hectares of forest) reported in 2010 compared to 64 fires (burning 40,211 hectares of forest) reported in 2009. Even though the area burned in the Prince George forest area in 2010 was less than that in 2009, over 174,000 hectares burned in the Cariboo forest area which contributed to PM_{10} levels observed in the city.

A summary of annual percentiles (1996-2010) for 1-hour and 24-hour PM_{10} averages at the three continuous monitoring sites is available in Tables C-3.1 and C-3.2 respectively. The percentiles give a more complete indication of trends than just annual averages, maximum

values, or objective exceedances, and they can provide better insight into the reasons for any trends. From 1999 to 2002 all three sites showed a decreasing trend in hourly values above the 50th percentile, indicating the effect of decreasing levels on the frequency of the higher values (Table C-3.1). There has been an increasing trend from 2002-2006. For the higher one-hour percentiles (> 98th percentile), levels at Plaza and Gladstone were higher than those measured from 2007-2009 and at the BCR site were higher than the higher percentiles from 2008-2009 (Table C-3.1). In 2010 the 24-hour highest percentiles (> 98th percentile) were substantially higher than those recorded in the previous year at all three sites, even though the other percentiles were similar to the 2010 data. The 99th percentile was the highest ever recorded for the BCR and Gladstone sites and at the Plaza site was only lower than the level recorded in 1995 (Table C-3.2). The 98th percentile at the three sites were higher than the 99th percentile in 2008 and 2009.

Due to an instrument upgrade, annual averages of PM₁₀ from the Plaza TEOM were underestimated in 1992 and 1993. In January 1998 the internal temperature for the TEOM monitors was changed from 50°C to 40°C. This temperature was reduced to minimize PM₁₀ loss due to the volatilization of sulphate, nitrate and VOC compounds from the small particles. It is assumed that this adjustment would increase concentrations, but the amount of increase is unknown so no adjustment to the database could be done.

3.1.3 Comparison of Prince George PM₁₀ Levels with Other B.C. Locations

Figure 3.1.10 compares the 2010 annual PM₁₀ averages and the 98th percentile at the Prince George continuous monitoring sites with that from 24 other sites in B.C. (mostly Provincial or Metro Vancouver sites with greater than 90% of data captured). A comparison with other sites in Canada can be obtained in the “National Air Pollution Surveillance (NAPS) Network Annual Data Summary” at http://www.etc-cte.ec.gc.ca/publications/napsreports_e.html. The 11 highest averages in B.C. were recorded at sites in the interior of B.C. The BCR (an industrial site), Plaza (a commercial site) and Gladstone (residential) sites had the second, fourth, and 11th highest annual averages, respectively.

Figure 3.1.11 compares the 2010 PM₁₀ annual averages recorded at the Prince George non-continuous monitoring sites with those from other B.C. non-continuous monitoring sites with greater than 80% data capture. Prince George-Plaza recorded the ninth highest annual average, out of the 21 non-continuous sites. Sites that were operating on the NAPS schedule (monitoring once every six days, for a 24-hour, midnight-to-midnight period) and data for all sites that were operating on the 3-day schedule, were adjusted to include only samples taken based on the NAPS schedule.

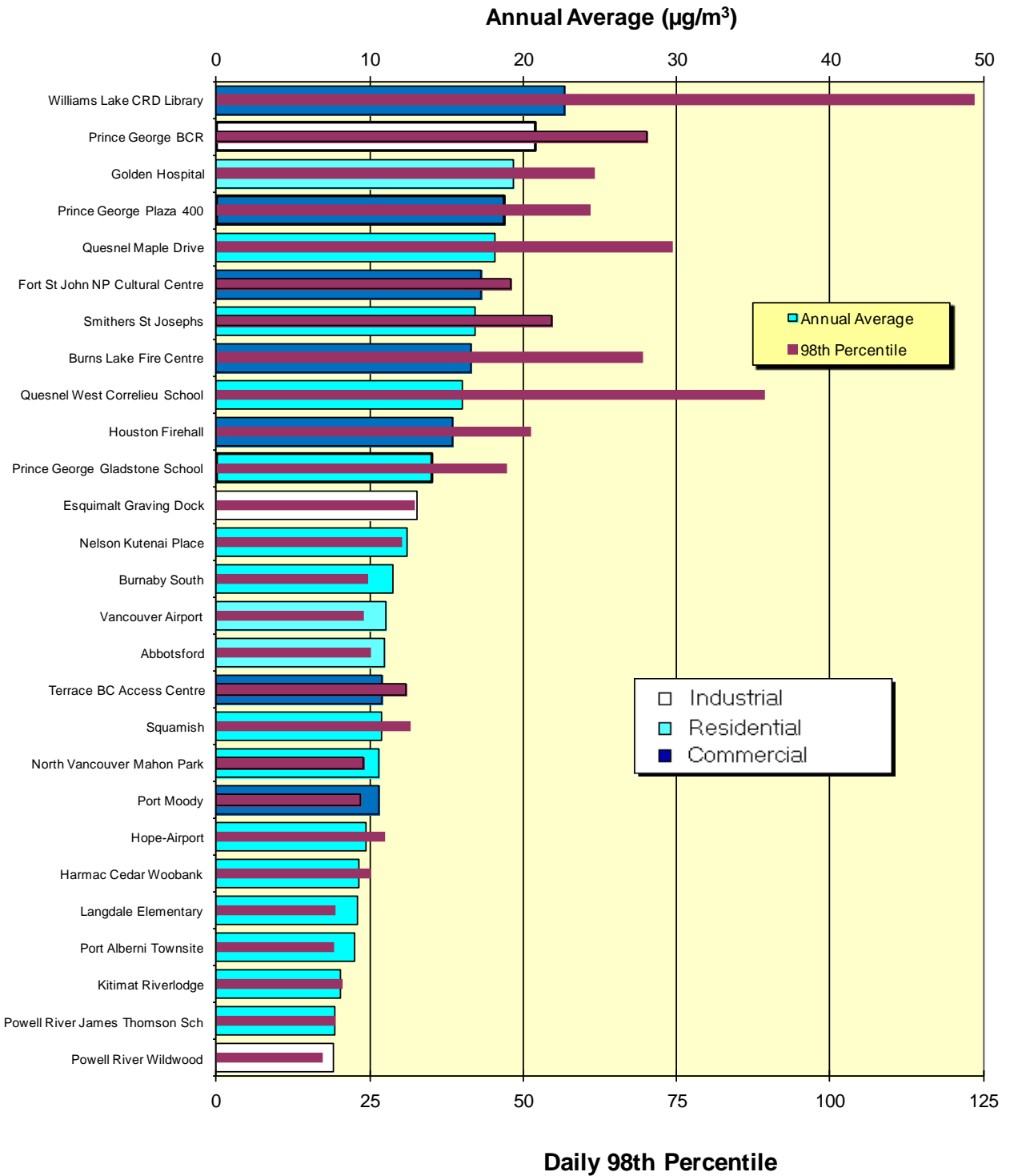


Figure 3.1.10 Comparison of 2010 annual average and daily 98th percentile PM_{10} levels ($\mu\text{g}/\text{m}^3$) in Prince George with other B.C. locations (continuous monitors)

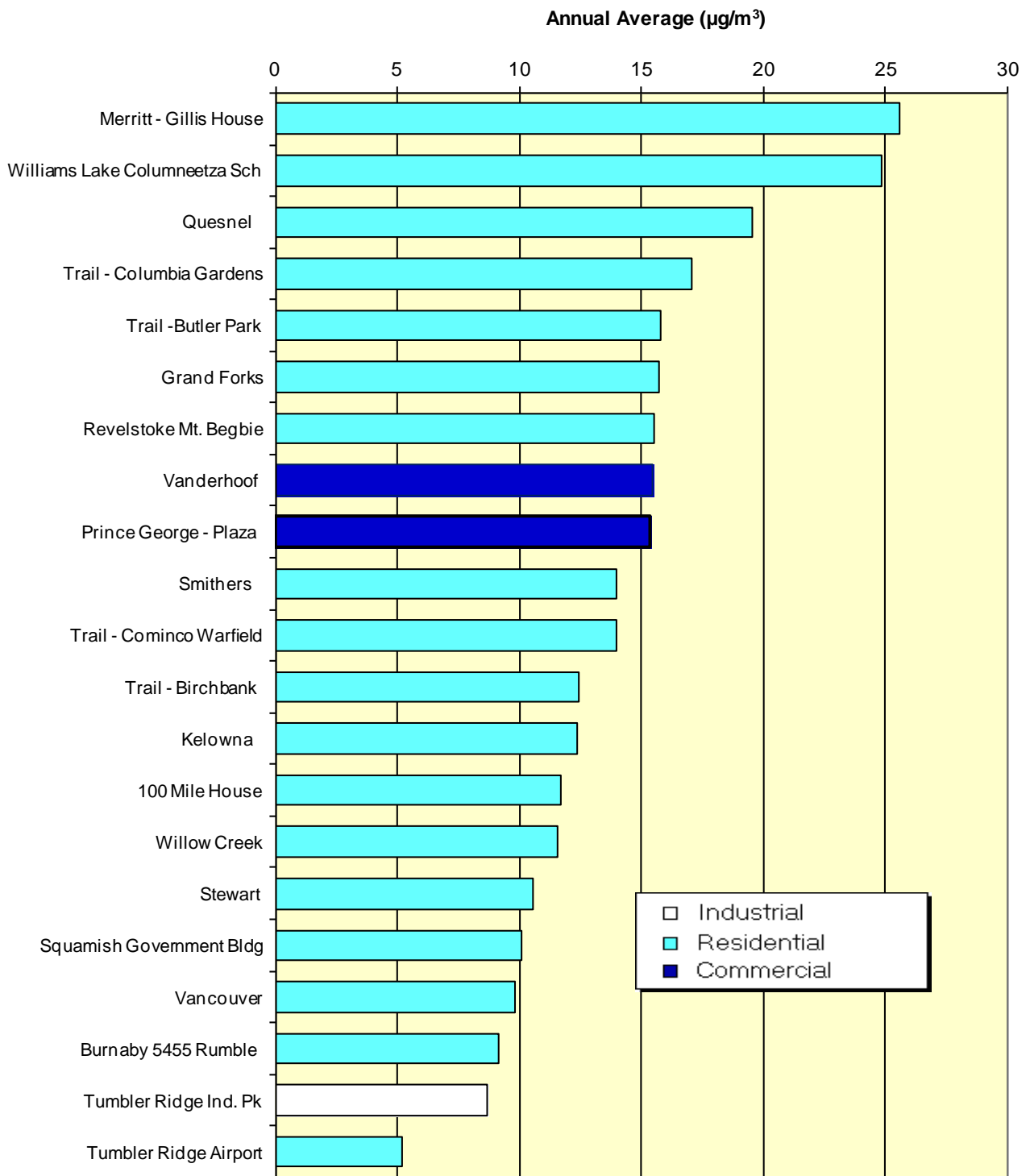


Figure 3.1.11 Comparison of 2010 annual average PM_{10} levels ($\mu\text{g}/\text{m}^3$) in Prince George to other B.C. locations (non-continuous monitors)

3.1.4 $PM_{2.5}$ Results

In 2010, two continuous and four non-continuous $PM_{2.5}$ monitors operated in the Prince George airshed. One of the non-continuous monitors (Western Acres) operated less than four months and was not used in the annual assessment. Both continuous PM_{10} and $PM_{2.5}$ monitoring were conducted at the Plaza and Gladstone sites which is useful for indicating the contribution of different sources, such as combustion and road dust, to ambient levels. Figure 3.1.12 and Tables C – 1.4 and C – 1.5 show the monthly summary of 2010 $PM_{2.5}$ data recorded at the Plaza and Gladstone sites. The highest $PM_{2.5}$ monthly average occurred during August at both sites due to high forest fire activity, and smaller peaks occurred during the winter season. The high $PM_{2.5}$ to PM_{10} ratio during these periods indicates that the peaks were driven by combustion sources rather than crustal/dust sources (which have low $PM_{2.5}$ to PM_{10} ratios). It is also interesting to note that the Gladstone site (residential) and Plaza site (commercial) had similar monthly averages and number of days exceeding $15 \mu\text{g}/\text{m}^3$ despite the difference of land use zoning. Although the Ministry of Environment has an air quality objective for $PM_{2.5}$ of $25 \mu\text{g}/\text{m}^3$ (Table A-1), the maximum limit of this figure was set to $15 \mu\text{g}/\text{m}^3$ because the objective was only exceeded during two months (June and August) of 2010 when forest fires were impacting the city (Table C-1.5).

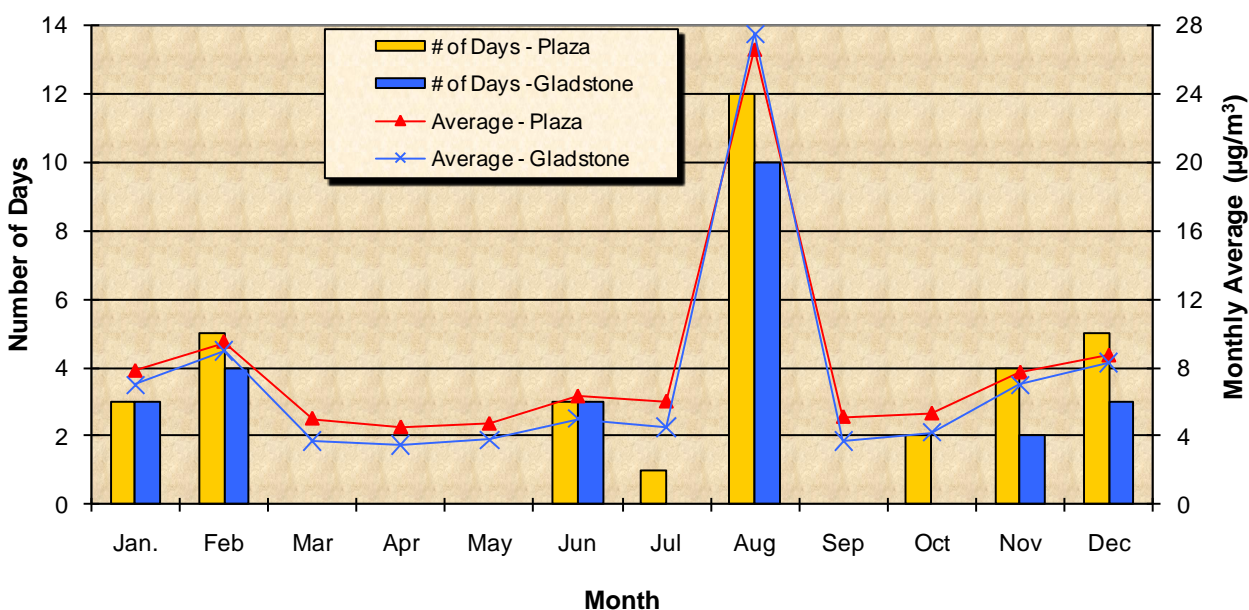


Figure 3.1.12 Monthly average $PM_{2.5}$ levels ($\mu\text{g}/\text{m}^3$) and the number of days exceeding $15 \mu\text{g}/\text{m}^3$ in Prince George

Figure 3.1.13 shows the monthly $PM_{2.5}$ averages of continuous data from the Plaza site since 1997. Monthly averages ranged from a high of $26.6 \mu\text{g}/\text{m}^3$ (August 2010) to a low of $3.1 \mu\text{g}/\text{m}^3$ (May 1999) at the Plaza site. Typically the highest $PM_{2.5}$ levels occur during February and another smaller peak in late autumn which are likely related to residential heating in winter and land clearing in autumn. In 2010 the recorded record high (in August due to major forest fires) and one record low (October) were recorded. For the remaining 10 months, $PM_{2.5}$ levels were below normal for 8 months and near normal for 2 months.

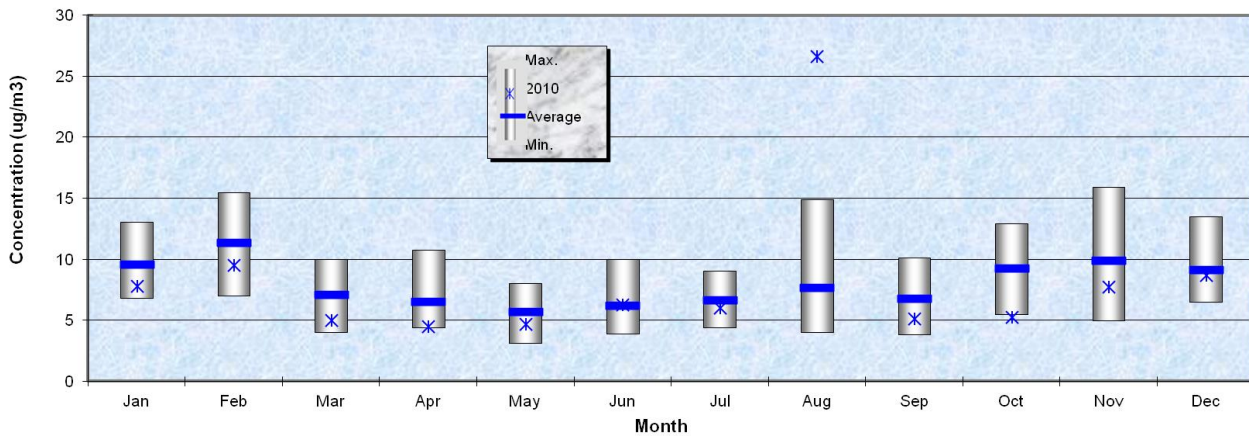


Figure 3.1.13 Comparison of 2010 with long-term average monthly $PM_{2.5}$ levels ($\mu\text{g}/\text{m}^3$) at the Plaza site since 1997

Figure 3.1.14 shows the 2010 $PM_{2.5}$ pollution rose for the Plaza site based on the meteorological data collected at that site. Wind directions were only considered when wind speeds were ≥ 1 m/s. Similar to the PM_{10} pollution rose, one-hour average particulate levels were seldom below $5 \mu\text{g}/\text{m}^3$ when winds were blowing from the east-northeast to east-southeast sector. With winds from the south-southeast and west-northwest sectors, particulate levels below $5 \mu\text{g}/\text{m}^3$ occurred about 80% of the time. Also, similar to the PM_{10} distribution, there was a distinct wind direction from which the highest concentrations occurred. The $PM_{2.5}$ concentration exceeded $25 \mu\text{g}/\text{m}^3$ most often when winds were from the east-northeast (70°) to southeast (140°) sector, but occurred from most other sectors due to forest fires.

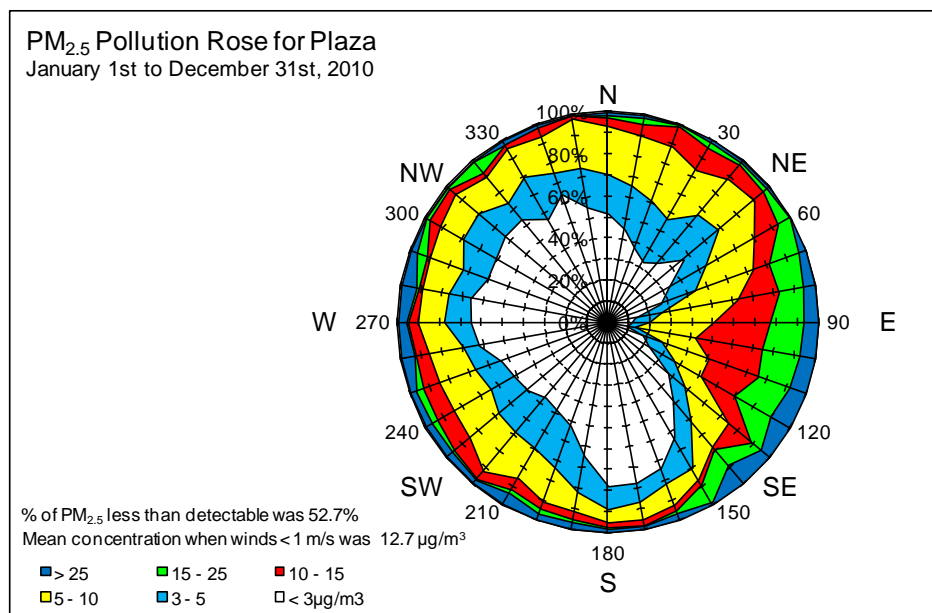


Figure 3.1.14 $PM_{2.5}$ Pollution Rose at the Plaza site for 2010

High concentrations from the east-northeast to southeast sector occur because winds from this direction are generally lighter, providing less dilution, and are associated with major combustion sources. The average concentration during calm conditions (< 1 m/s) was $12.7 \mu\text{g}/\text{m}^3$ which is approximately 43% of the PM_{10} level for light winds. Unlike those for TRS (Fig. 3.2.6) and SO_2 (Fig.3.3.6), the $PM_{2.5}$ pollution rose shows that, although there is a

dominant wind sector, significant contributions originate from other sectors as well. Elevated $PM_{2.5}$ levels can build up in an area under calm conditions and remain high for some time after wind speeds increase. These higher $PM_{2.5}$ levels that occur with winds indicate the direction of flushing rather than the location of sources. However, the localized sources such as residential heating and mobile emissions also have an effect.

Figure 3.1.15 shows the 2010 $PM_{2.5}$ pollution rose for the Gladstone site based on the meteorological data at that site. Wind directions were considered whenever wind speeds were ≥ 1 m/s. One-hour average particulate levels below $5 \mu\text{g}/\text{m}^3$ occurred less often when winds were blowing from the north-northeast sector. With winds from the west-northwest, south and east particulate levels below $5 \mu\text{g}/\text{m}^3$ occurred about 85% of the time. Also, the highest concentrations ($> 15 \mu\text{g}/\text{m}^3$) occurred from most wind directions due to forest fires in the area.

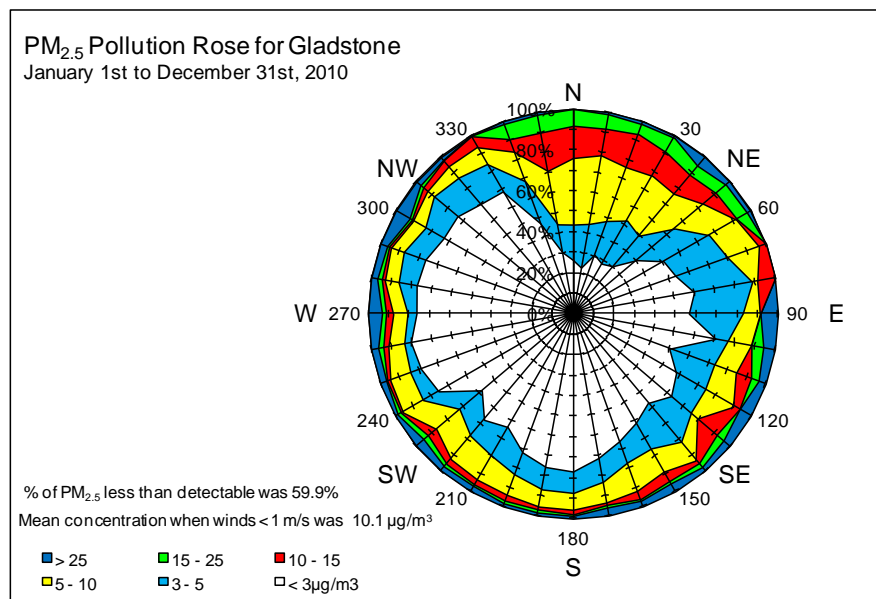


Figure 3.1.15 $PM_{2.5}$ Pollution Rose at the Gladstone site for 2010

Figure 3.1.16 shows the hourly average $PM_{2.5}$ from the continuous monitor at the Plaza and Gladstone stations during January and July. This plot illustrates the seasonal differences in the diurnal trend. Although vehicular traffic is an important source of $PM_{2.5}$, the lack of a morning peak in $PM_{2.5}$ levels at both locations in January indicates that vehicle exhaust is not a major contributor to $PM_{2.5}$ levels measured at these two sites. Levels at the Plaza were generally higher than the Gladstone site except for the evening period in January. This is probably due to the effects from an increase in residential heating during winter evenings. Afternoon concentrations were only slightly higher at Plaza in January and July due to improved mixing at this time of day which results in similar concentrations throughout the air shed.

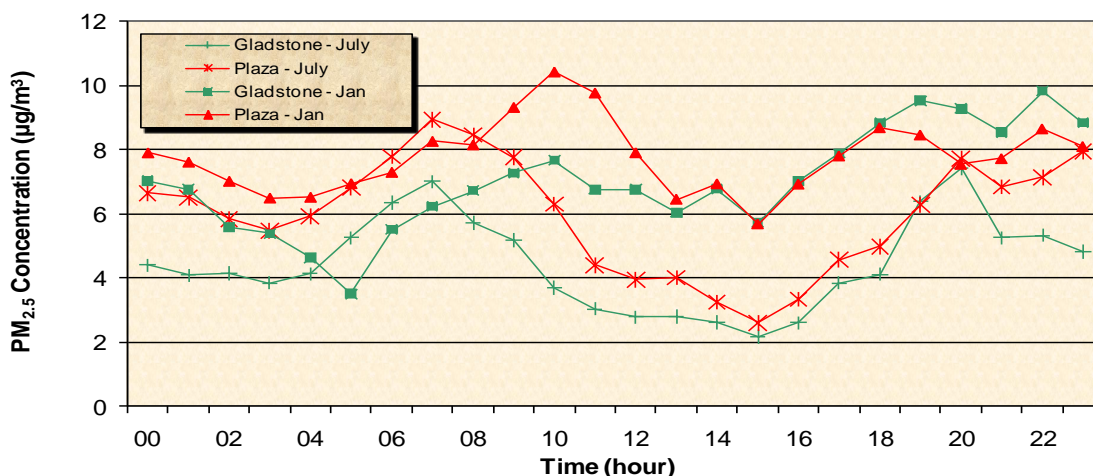


Figure 3.1.1. Diurnal Average PM_{2.5} pattern (µg/m³) in Prince George in 2010

3.1.5 PM_{2.5} Annual Trend

Tables C–2.9 to C–2.12 contain the annual trend summaries of PM_{2.5} data from the continuous and non-continuous monitors in Prince George. The non-continuous data show a slight decrease in PM_{2.5} levels at the Plaza and Van Bien from the previous year however the PM_{2.5} 24-hour air quality objective (25 µg/m³) was more frequently exceeded at both sites. All 3 non-continuous monitors that operated for the full year (Plaza, Van Bien, and BCR), recorded record high daily values in August 2010 that were related to forest fire activity.

Annual trend summaries of PM_{2.5} for the continuous monitors at the Plaza and Gladstone sites are provided in Table C 2.10 and C 2.11 respectively. PM_{2.5} increased at both sites in 2010 relative to 2009. Plaza recorded the highest annual average since 2004 and greatest number of PM_{2.5} 24-hour air quality objective exceedances since 2005. Similar trends were observed at Gladstone with a record high annual average and greatest number 24-hour objective exceedances being recorded at the site.

In July 1999, the federal government released the "National Ambient Air Quality Objectives for Particulate Matter (PM_{2.5})". This established a Canada Wide Standard (CWS) for PM_{2.5} which took effect in 2010. The PM_{2.5} standard is a 24-hour averaged value of 30 µg/m³, with achievement to be based on averaging of the annual 98th percentile over three consecutive years. For 2000-2002, 2001-2003, 2002-2004 and 2003-2005, the CWS for PM_{2.5} was exceeded in Prince George (based on Sharp-Cut Head converted data), with three year average 98th percentiles of 31.3 µg/m³, 35.0 µg/m³, 36.0 µg/m³ and 34.3 µg/m³, respectively. Prince George was the only municipality in B.C. to have exceeded the PM_{2.5} CWS. From 2005-2009 the Plaza site was in compliance with the CWS. The average 98th percentile for 2008-2010 was 30.2 µg/m³ at Plaza and 26.7 µg/m³ at Gladstone.

Table C-3.3 shows the annual percentiles of both the 1-hour and 24-hour PM_{2.5} values based on the continuous monitoring data from the Plaza and Gladstone sites. In 2010, most of the percentiles were similar to those in 2009, but the higher percentiles (greater than 98th) were the highest ever recorded (for both the 1-hour and 24-hour values) at both sites.

3.1.6 Comparison of Prince George PM_{2.5} Levels with Other B.C. Locations

Figure 3.1.17 compares the 2010 PM_{2.5} annual averages at the Prince George (Plaza and Gladstone) sites with annual averages from other continuous monitoring sites in B.C. (only sites with greater than 90% of data captured were included). A comparison with other sites in Canada can be obtained in the “National Air Pollution Surveillance (NAPS) Network Annual Data Summary” at http://www.etc-cte.ec.gc.ca/publications/napsreports_e.html. The Williams Lake Library continuous site recorded the highest PM_{2.5} annual average in 2010. The Prince George Plaza and Gladstone sites were the fifth and seventh highest, respectively, out of the 32 continuous monitoring sites that had greater than 90% of data captured.

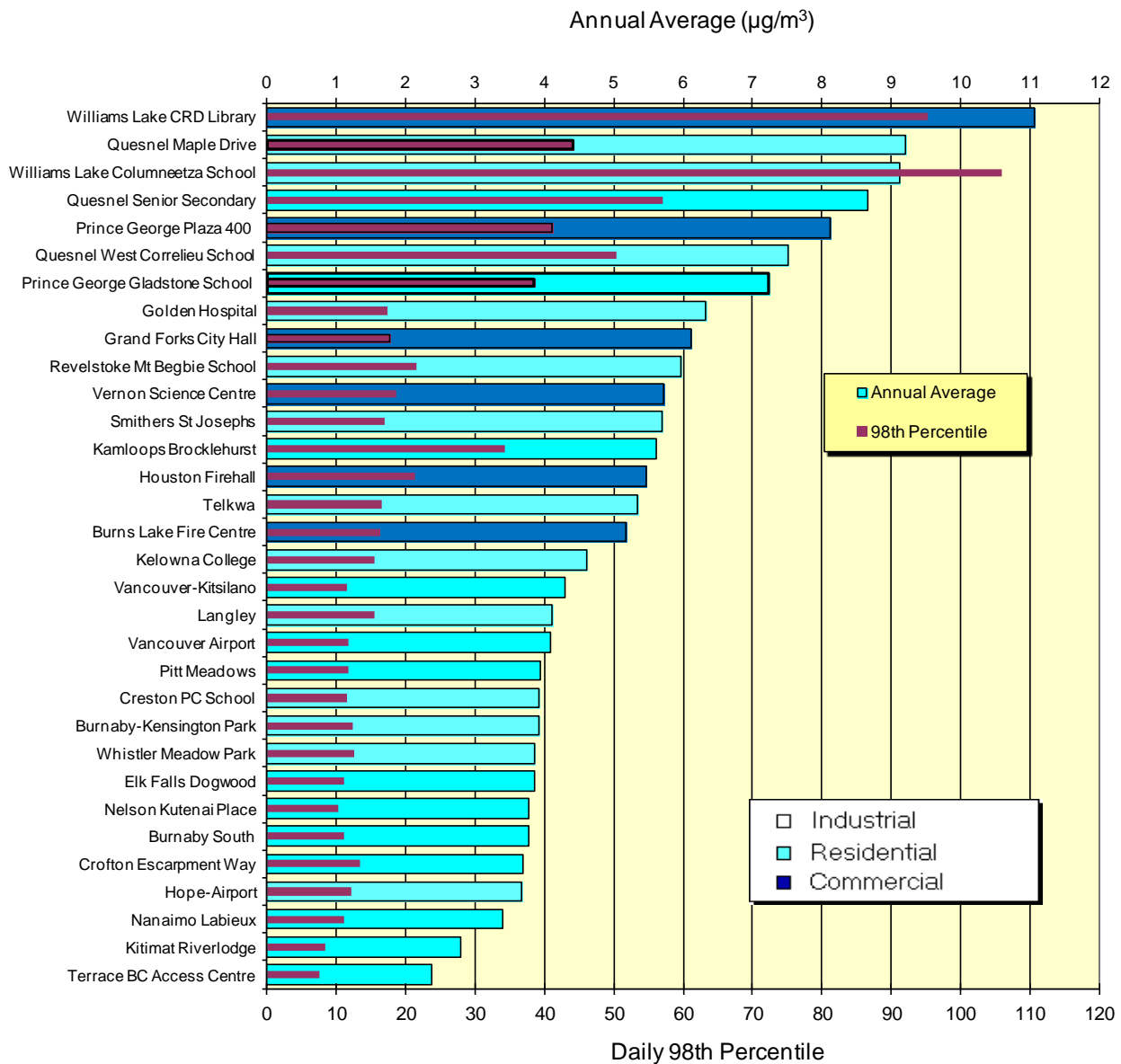


Figure 3.1.17 Comparison of 2010 annual average and daily 98th percentile PM_{2.5} levels (µg/m³) in Prince George with other B.C. locations (continuous monitors).

Figure 3.1.18 is similar to Figure 3.1.17 for non-continuous PM_{2.5} (that includes only sites with greater than 80% of data captured). A comparison with other sites in Canada can be obtained in the “National Air Pollution Surveillance (NAPS) Network Annual Data Summary” at http://www.etc-cte.ec.gc.ca/publications/napsreports_e.html. The Williams Lake - Columneetza School non-continuous site recorded the highest PM_{2.5} annual average in 2010, and Whistler – Meadow Park recorded the lowest annual average. The Prince George Plaza site was the third highest out of the 29 monitoring sites compared.

Sites that were operating on the NAPS schedule (monitoring once every six days, for a 24-hour, midnight-to-midnight period) and data for all sites that were operating on the 3-day schedule, were adjusted to include only samples taken based on the NAPS schedule.

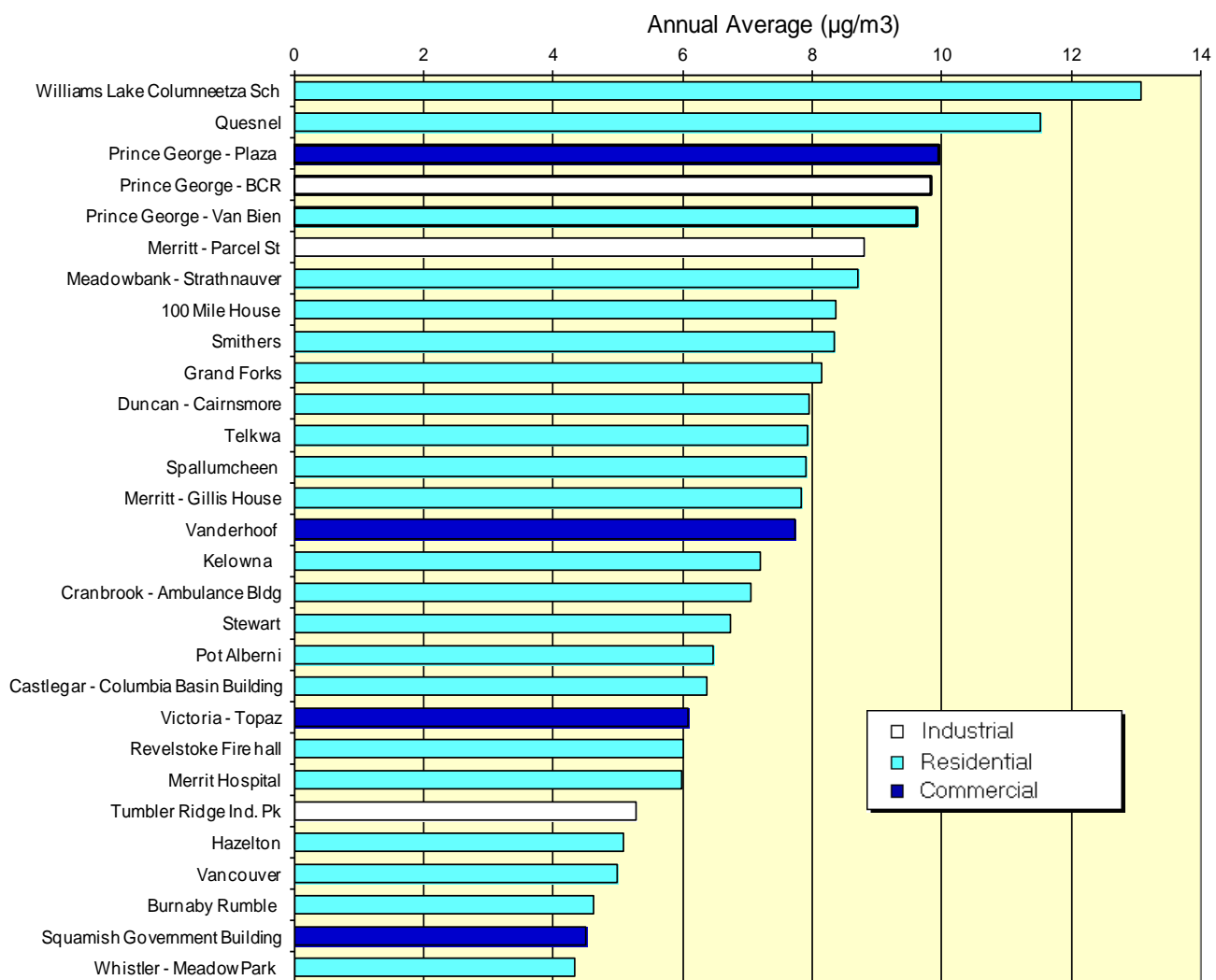


Figure 3.1.18 Comparison of 2010 annual average PM_{2.5} levels (µg/m³) in Prince George with other B.C. locations (non-continuous monitors).

3.2 Total Reduced Sulphur

Total Reduced Sulphur (TRS) is a colourless gas with a characteristic offensive odour similar to rotten eggs or rotten cabbage. TRS describes a group of sulphur compounds containing gases made up primarily of one or more of the following four compounds: dimethyl disulphide (DMDS), dimethyl sulphide (DMS), methyl mercaptan (MESH) and hydrogen sulphide (H_2S). Methyl mercaptan is the most odorous of the four main sulphur compounds that make up TRS and can be detected by a sensitive person in concentrations as low as $0.2 \mu\text{g}/\text{m}^3$ (or about 0.1 parts per billion, ppb). The concentration is expressed in $\mu\text{g}/\text{m}^3$ of pollutant in air as H_2S equivalent.

These compounds are largely by-products of the pulping process. That is, these compounds are not added directly but form because of the use of sulphides in the pulping process. Pulp mills using the kraft process emit the largest amounts of TRS followed by oil and gas processing plants (refining) and to a small extent sewage treatment plants and automobiles (catalytic converters). Natural sources include swamps, bogs, and marshes.

At low levels, TRS is considered to be a nuisance pollutant, causing no adverse health effects, but producing odour problems. However, at levels $> 1000 \mu\text{g}/\text{m}^3$, sensitive individuals may suffer headaches and nausea due to extreme odour. It should be noted that levels as high as this have never been recorded at the monitoring sites in Prince George.

The ultimate end product of any gaseous sulphur compound (TRS or SO_2) is that it is oxidized to form sulphate (a secondary pollutant), which in the presence of moisture, may become sulphuric acid, a component of acid rain. Unlike TRS or SO_2 , sulphates are ultra fine particles, about 0.1 micron in size. The rate at which sulphates are formed is highly variable and can take anywhere from 2 to 48 hours. The rate of conversion appears to be higher in fog or clouds, in summer versus winter, and at noon compared to night time (Finlayson-Pitts and Pitts, 1986). Sulphate has detrimental effects on human health and vegetation over the long term, causing lung and breathing problems which are amplified when weather systems produce humid conditions. High humidity causes more sulphate to be formed for uptake in lung tissues.

The current TRS analyzers have a detection limit of about $1.5 \mu\text{g}/\text{m}^3$ or 1 ppb (Fig 3.2.1). The analyzer measures the total amount of TRS gases by oxidizing these gases in an oven (900°C) to form SO_2 . The SO_2 concentration is then measured using fluorescent excitation by ultra-violet radiation.



Fig. 3.2.1 Teledyne – API 100
TRS monitor

The quality of the TRS data was evaluated through monthly calibrations and independent auditing in May and October. The auditing results in Appendix B, Table B-1 indicate that the Plaza TRS monitor had satisfactory performance in May and all other audits showed excellent performance (Plaza in October and both audits for the Jail and Lakewood monitors). Data quality is considered unsatisfactory if the monitor deviates by 10% or more from the auditing results. Data recovery ranged from 93.3% to 95.5% (Table B-2).

3.2.1 TRS Results

Figure 3.2.2 shows average monthly and maximum TRS concentrations for the three Prince George ambient air monitoring stations in 2010. Values and additional information can be found in Tables C - 1.6 to C - 1.8 in Appendix C. Monthly averages ranged from a high of $5.7 \mu\text{g}/\text{m}^3$ at the Plaza site (in January) to a low of $0.1 \mu\text{g}/\text{m}^3$ at the Lakewood site (during April and June). The Plaza site had the highest annual average ($2.6 \mu\text{g}/\text{m}^3$) and number of exceedances of the Level A and B 1-hour and daily objectives. Lakewood did not exceed the 1-hour Level B objective ($28 \mu\text{g}/\text{m}^3$) in 2010. Exceedances of the 1-hour Level A objective ($7 \mu\text{g}/\text{m}^3$) occurred most often in December at Plaza, and in January at the Lakewood and the Jail sites. Monthly averages at Plaza were higher than the Jail in winter and spring but lower in the summer and autumn.

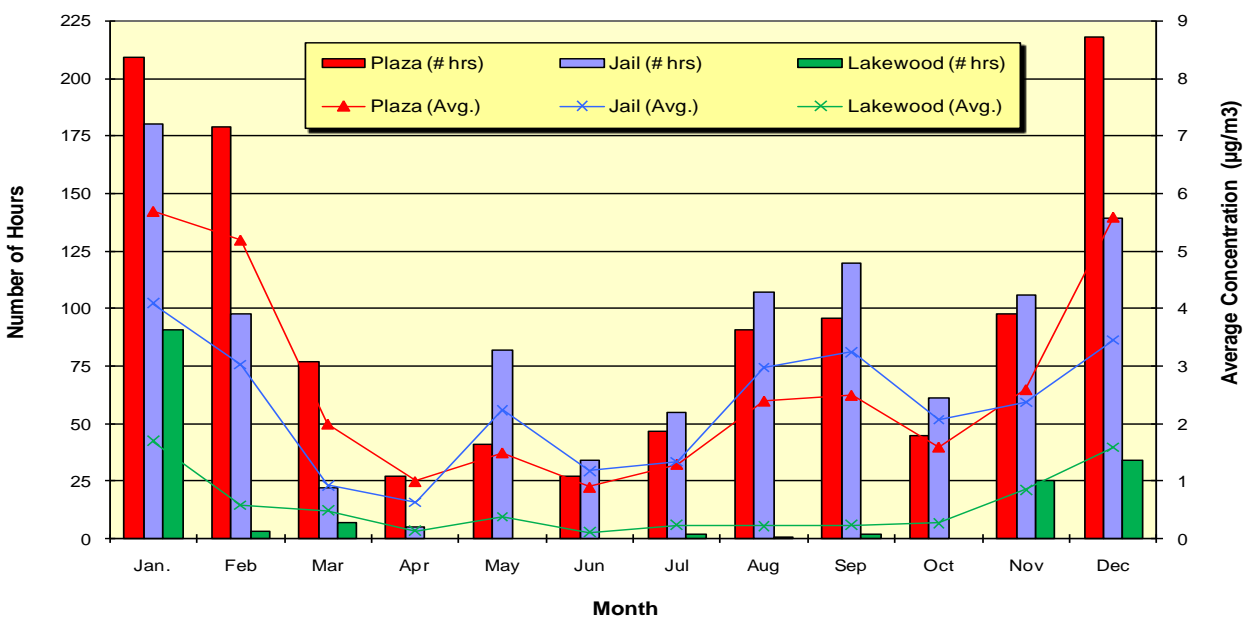


Figure 3.2.2: 2010 monthly average TRS levels ($\mu\text{g}/\text{m}^3$) and the number of hours exceeding the one-hour Level A objective at sites in Prince George

Figures 3.2.3 to 3.2.5 show the range in monthly average TRS levels at the Plaza, Jail and Lakewood sites, respectively, since 1995. Data collected prior to 1995 was not used because the method used to archive that data could produce a lower monthly average. Monthly averages at the Plaza and Lakewood sites tend to be the highest during winter and lowest during early summer, whereas monthly averages at the Jail site tend to be highest during late winter and early autumn, and lowest in late spring. Monthly averages at the Plaza and Lakewood sites have not exceeded $2.6 \mu\text{g}/\text{m}^3$ and $0.6 \mu\text{g}/\text{m}^3$, respectively, from April through July since 1995. Lakewood 2010 monthly averages were below or near normal for the year. Whereas, the Plaza 2010 monthly averages were above or near normal for most of the year. Plaza recorded record high monthly averages in February and December. The Jail recorded record low monthly averages in March and April 2010.

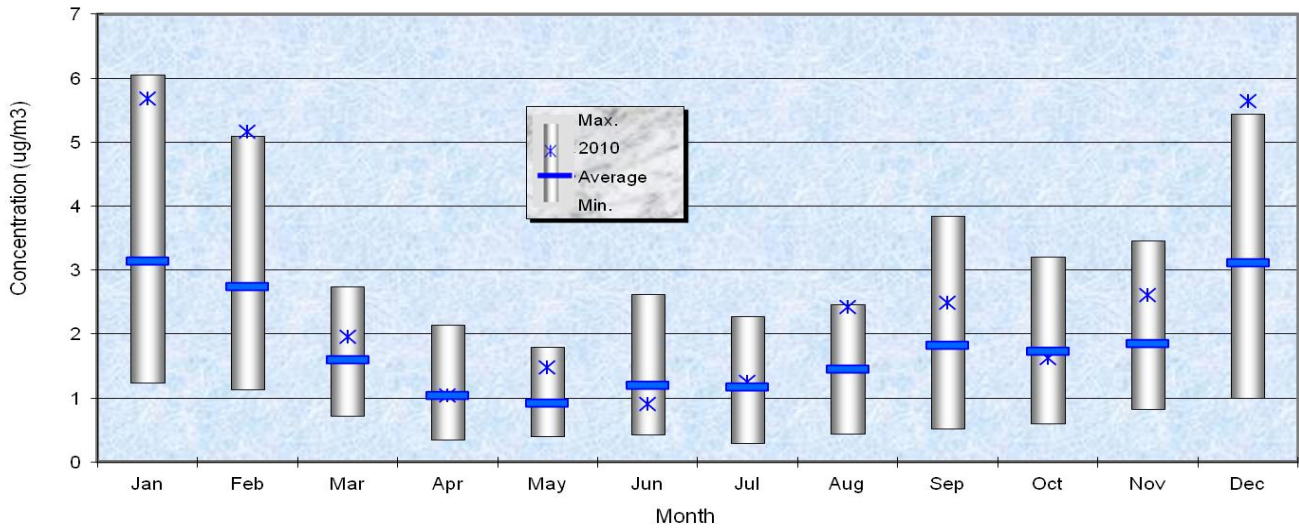


Figure 3.2.3 Comparison of 2010 with long-term average monthly TRS levels ($\mu\text{g}/\text{m}^3$) at the Plaza site since 1995

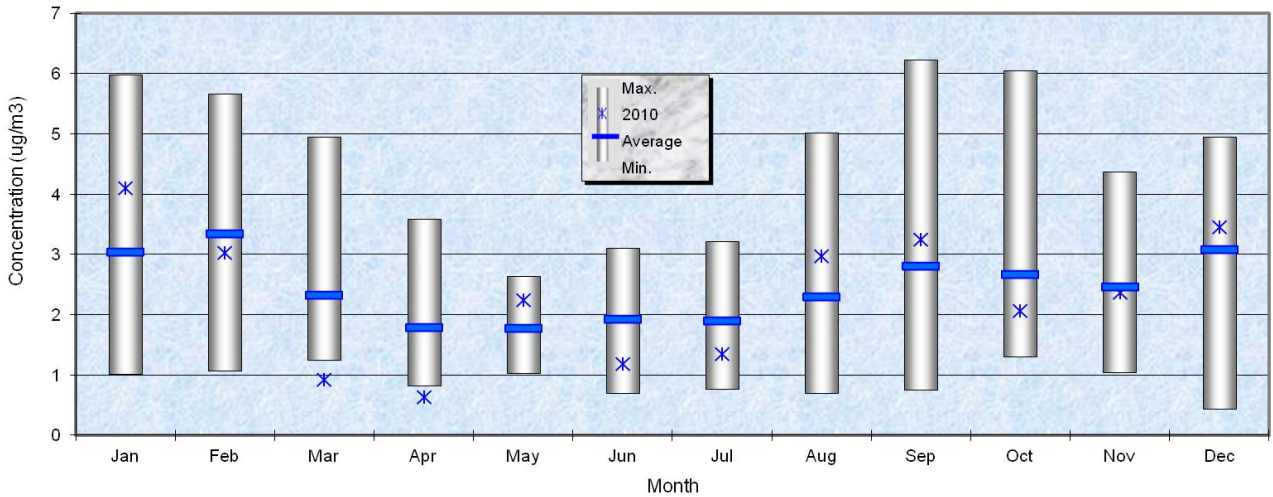


Figure 3.2.4 Comparison of 2010 with long-term average monthly TRS levels ($\mu\text{g}/\text{m}^3$) at the Jail site since 1995

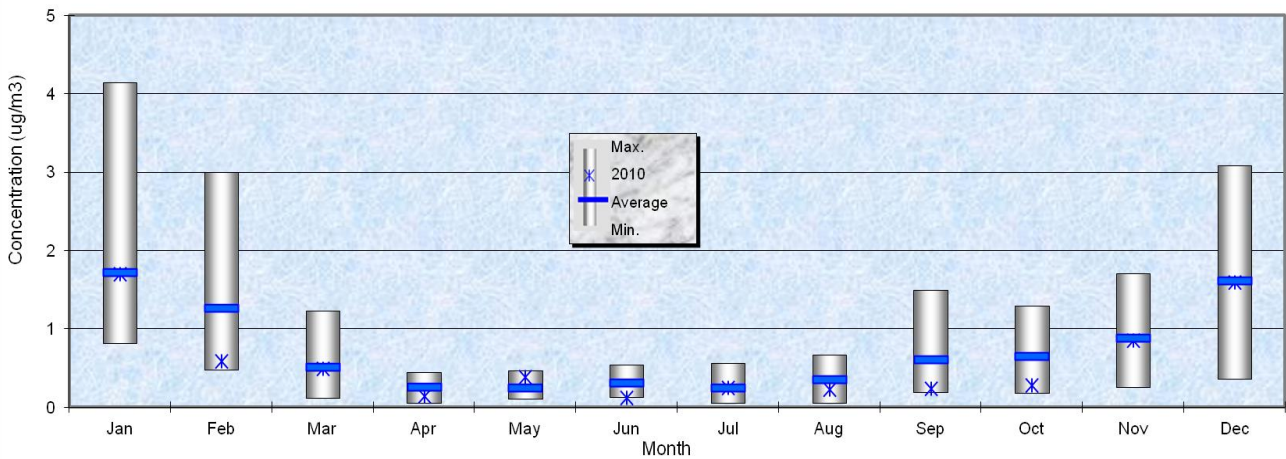


Figure 3.2.5 Comparison of 2010 with long-term average monthly TRS levels ($\mu\text{g}/\text{m}^3$) at the Lakewood site since 1995

Figure 3.2.6 shows the TRS pollution rose for the Plaza site based on the 2010 meteorological data (for wind speeds ≥ 1 m/s). The highest concentrations occurred with winds from the east even though the main sources are located east-northeast of this monitoring site. This is expected since the winds blowing from the northeast are deflected eastward by the hill south of the pulp mills and refinery before reaching the monitoring site (Section 2.2). Detectable TRS levels were recorded at most of the 16 wind sectors. This is not an indication of sources in all sectors, but a result of TRS levels building up in the area under calm conditions, and not having sufficient time to be flushed out of the airshed once wind speeds increase (regardless of direction).

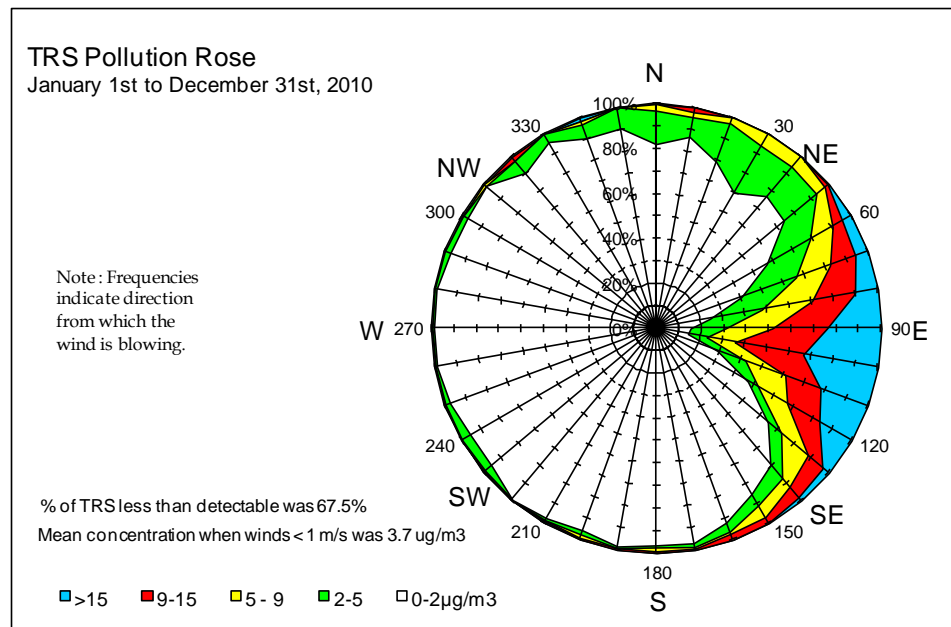


Figure 3.2.6: TRS Pollution Rose at the Plaza site for 2010

Figure 3.2.7 shows the annual average diurnal pattern of TRS levels at each site during for 2010. Levels at both the Plaza and Jail sites start increasing in the early evening, which is an indication of a nocturnal ground level inversion developing. Emissions get trapped in this inversion and gradually build up overnight. Once the inversion breaks in the morning, TRS levels start decreasing. Levels are the lowest in the afternoon when mixing is greatest. Levels at the Jail site are normally higher than those at the Plaza station but in the past three years TRS levels at Plaza tend to be higher than at the Jail. The Lakewood site does not exhibit a discernible diurnal TRS trend.

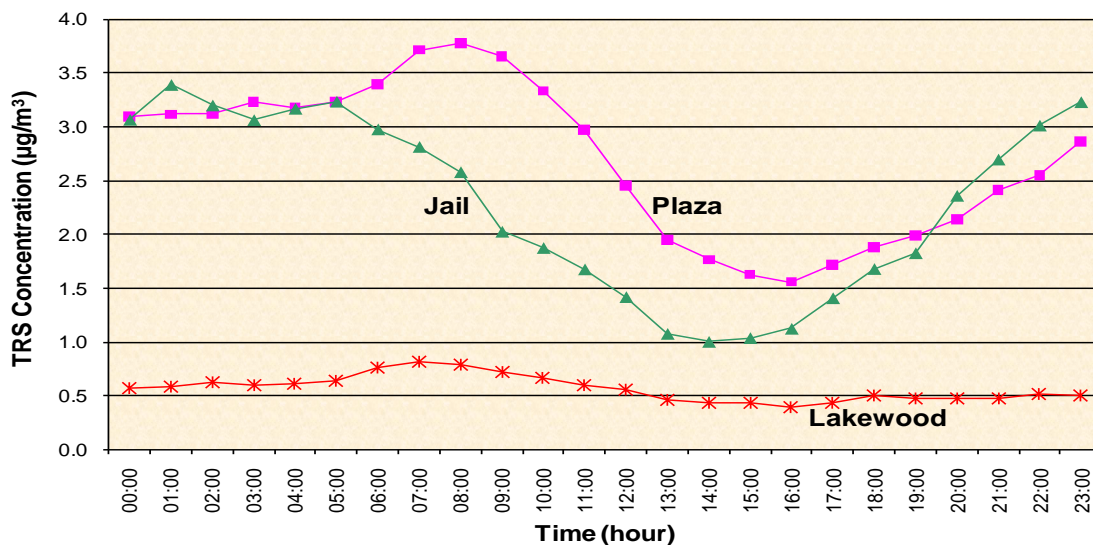


Figure 3.2.7 Diurnal average TRS pattern ($\mu\text{g}/\text{m}^3$) in Prince George in 2010

3.2.2 TRS Annual Trends

Data from the Plaza, Jail and Lakewood stations were examined to show trends in Prince George. Tables C-2.13 to C-2.15 and Figure 3.2.8 summarize the TRS data from the three existing stations over the full monitoring period.

At the Plaza and Jail sites, the 2010 annual average and exceedances of the hourly and daily Level A and daily Level B Objectives have increased considerably from the previous year. The Lakewood site had a decrease in exceedances of the Level A 1-hour and daily objectives in 2010. The frequency of exceedances of the 1-hour and 24-hour Level A objectives at the Plaza site were the highest since 1989 and the highest since 2004 at the Jail site.

The Level B objective is still being exceeded at the Jail and Plaza sites (most frequently at the Jail site), supporting the need for the additional TRS reductions called for in the Prince George Air Quality Management Plan (Prince George Airshed Technical Management Committee, 1998). In order for the odour to be reduced in the Prince George downtown core, the annual average at the Plaza site ($2.6 \mu\text{g}/\text{m}^3$) would likely have to be similar to the Lakewood average ($< 1.0 \mu\text{g}/\text{m}^3$) to diminish these exceedances and number of complaints.

Figure 3.2.8 shows rolling annual average TRS levels recorded at the three monitoring sites in Prince George at one month intervals. The rolling annual average was used to reduce seasonal influences on the trends. A rolling annual average is the average for a 365 consecutive day period (i.e., the average on July 22, 1998 is for the period from July 23, 1997 to July 22, 1998). Annual averages at the Lakewood site remained fairly consistent since late 1993, while the Jail and Plaza site averages have decreased since 1993. The rolling annual averages for the Jail and Plaza sites have increased in the past two years (Figure 3.2.8). The rolling annual average at Plaza are now similar to those in 2003.

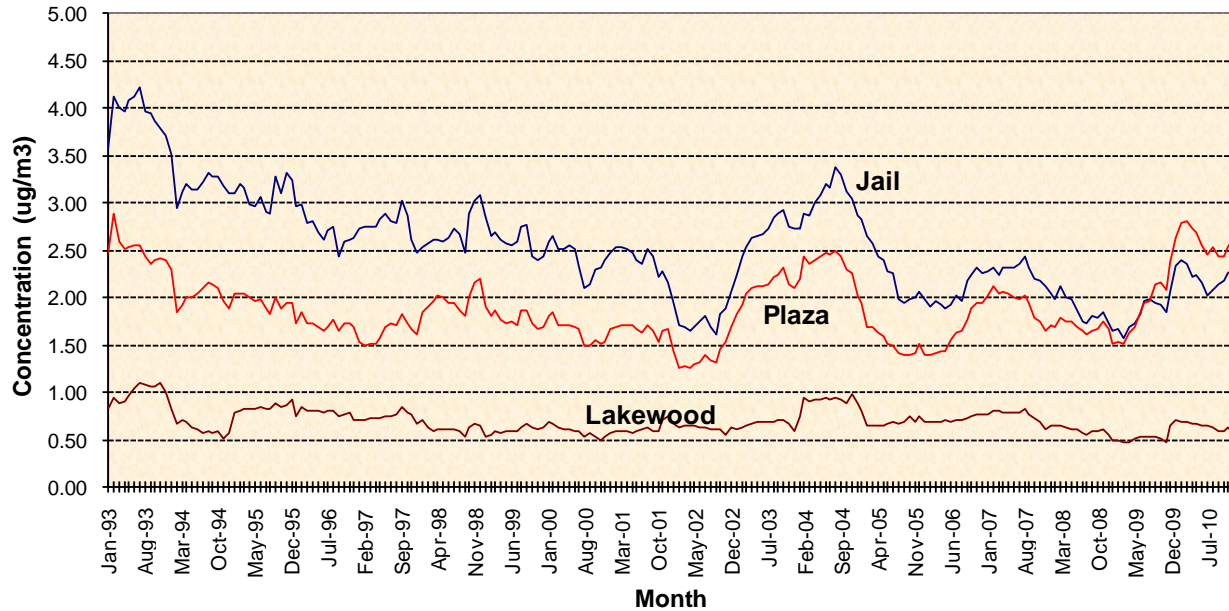
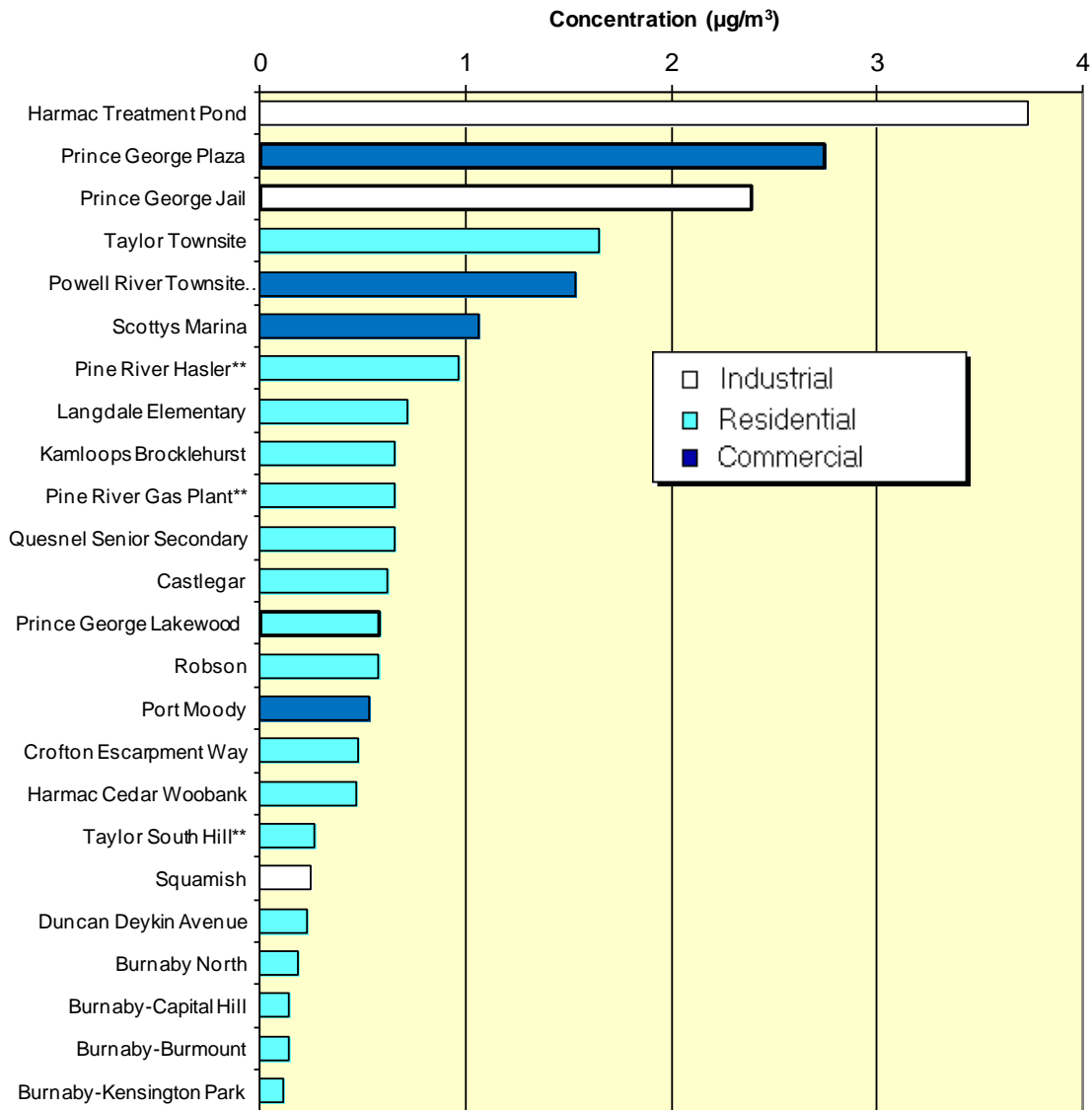


Fig. 3.2.8 Rolling Annual Average TRS levels ($\mu\text{g}/\text{m}^3$) recorded at sites in Prince George

The annual breakdown of percentiles of TRS levels are shown in Table C–3.4 in Appendix C. Annual averages increased slightly at the Plaza and Jail sites in 2010. As well, the 75th to 95th percentiles increased at Plaza and were the highest in the past 15 years. In contrast the higher percentiles decreased at Plaza (98th and 99th percentiles) and the Jail (99th percentile). Percentiles less than 98th were fairly similar to those in 2009 at the Jail and Lakewood sites.

3.2.3 Comparison of Prince George TRS Levels with Other B.C. Locations

Figure 3.2.9 compares the TRS annual averages recorded in Prince George with those at other monitoring sites in B.C. (all sites with greater than 90% of data captured). A comparison with other sites in Canada can be obtained in the “National Air Pollution Surveillance (NAPS) Network Annual Data Summary” at http://www.etc-cte.ec.gc.ca/publications/napsreports_e.html. Harmac Treatment Pond recorded the highest average of 24 TRS monitoring sites in B.C. in 2010. The Prince George Plaza site was the second highest of all TRS monitoring sites and the Prince George Jail site recorded the third highest annual average, which was over twice as high as most other sites that monitor TRS in B.C. The Lakewood site recorded the eight highest annual TRS average of the 17 B.C. residential sites, compared with fifth position in 2008.



** Only monitors H₂S

Figure 3.2.9 Comparison of 2010 Annual Average TRS levels (µg/m³) in Prince George with other B.C. locations

3.3 Sulphur Dioxide

SO₂ is a colourless gas that has a pungent odour at concentrations above 900 µg/m³ (Level B one-hour objective). SO₂ can adversely affect both human and vegetation health. Very high levels of SO₂ can cause breathing discomfort, respiratory illness, alterations in the lung's defences, and aggravation of existing respiratory and cardiovascular diseases. Effects of SO₂ on vegetation depend on the plant species and range from acute to chronic injury.

SO₂ is formed primarily by the combustion of material containing sulphur. At present, the major sources of SO₂ in the Prince George area are the Husky refinery and the three pulp mills. Minor sources include the Marsulex sulphuric acid plant and the railways (Prince George Airshed Technical Management Committee, 1996). Other anthropogenic sources (e.g., residential and commercial space heating) and natural sources (e.g., long range transport of SO₂ from volcanoes and swamps) are very small compared to the emissions produced by the industries.

SO₂ can be oxidized (either photochemically or in the presence of a catalyst) to sulphur trioxide, which in the presence of water vapour, is readily converted to sulphuric acid mist. Sulphuric acid and other sulphates can account for about 5%-20% of the total suspended particulates in some urban airsheds (Dobbin, 1979). Many health problems attributed to SO₂ may be the result of the oxidation of SO₂ to other compounds. Only small amounts of SO₂ gas reach the lower respiratory tract, whereas acid aerosols such as sulphates can be carried into the deeper lung airways. Asthmatics have shown demonstrable health effects when exercising at SO₂ levels as low as 1000 µg/m³ but are also sensitive to acid aerosol concentrations as low as 100 µg/m³ (Brimblecombe, 1996).

The current SO₂ analyzers have a detection limit of 2.5 µg/m³ (Fig 3.3.1). The analyzers measure the total amount of SO₂ gases by fluorescent excitation of SO₂ by ultra-violet radiation.

The quality of the SO₂ data was evaluated through monthly calibrations and independent auditing in May and October. The auditing results in Appendix B, Table B-1 indicate that the SO₂ monitors at the Marsulex, Jail, Plaza and CBC sites had excellent performance in both audits. The SO₂ monitor at Gladstone had excellent performance in May but had satisfactory performance in October. Data recovery ranged from 94.1% at Plaza to 95.5% at the Marsulex site (Table B-2).



Fig 3.3.1 TECO 43i SO₂ monitor

3.3.1 SO₂ Results

The SO₂ data from the Jail, Plaza, Gladstone, CBC and Marsulex-BCR sites are summarized in Figure 3.3.2. Values and additional information can be found in Tables C-1.9 to C-1.13 in Appendix C. In 2010, ambient SO₂ levels exceeded the Level A one-hour provincial objective (450 µg/m³) only at the CBC site (8 exceedances). There were no exceedances of the Level B hourly objective, or the Level A 24-hour objective. The maximum daily value of 151 µg/m³ recorded in December at CBC was the highest daily value recorded at that site since 2003. In 2005, the World Health Organization released a new 24-hour objective for SO₂, 20 µg/m³ (World Health Organization, 2005). The number of days in which this objective was exceeded in Prince George ranged from 0 days at the Marsulex site to 87 days at CBC. The highest monthly concentrations were recorded in January at Plaza, Jail and Marsulex, February at Gladstone and in December at CBC. The highest hourly concentrations occurred during January at Marsulex, July at Jail and Plaza, September at CBC and November at Gladstone.

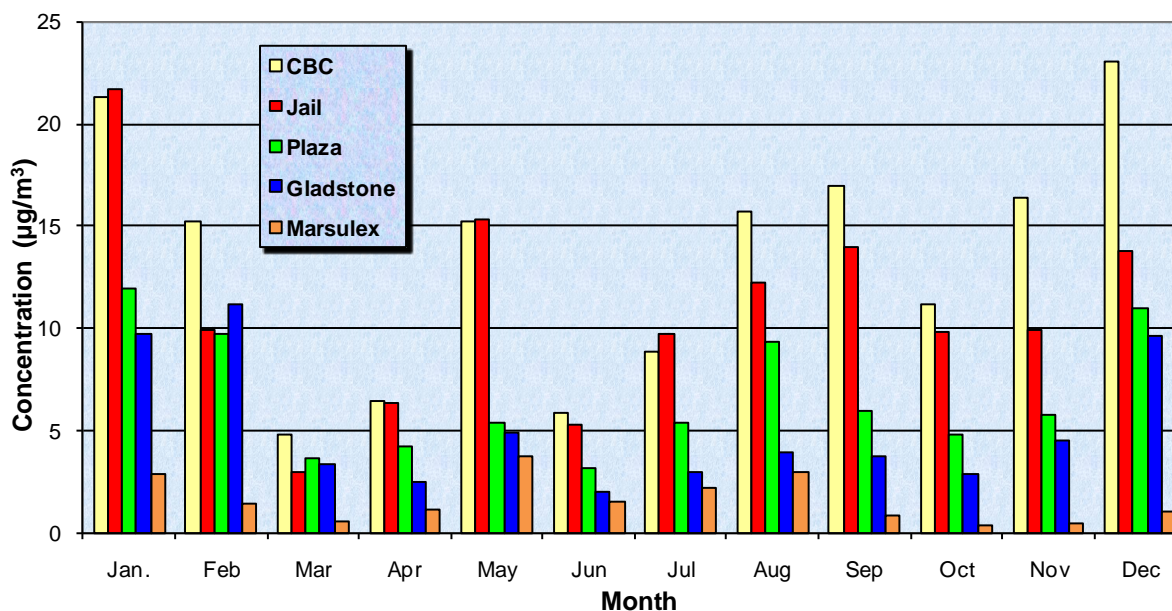


Figure 3.3.2 2010 Monthly Average SO₂ levels (µg/m³) in Prince George

Figures 3.3.3 – 3.3.6 show the trends in monthly SO₂ values at the Plaza, Jail, CBC and Gladstone sites, respectively, since 1995. Marsulex is not included due to a short monitoring record to date. Monthly averages in 2010 were below normal for at least 5 months at all four sites. Lower monthly averages can mainly be attributed to the installation of the Sulphur Recovery Unit at Husky in 1997 and improvements made at the pulp mills. Monthly averages ranged from 2.3 µg/m³ (May 2004) to 35.8 µg/m³ (Feb. 1996) at the Plaza site, 2.1 µg/m³ (Sept. 2007) to 53.9 µg/m³ (March 1996) at the Jail site, 2.6 µg/m³ (Nov. 2009) to 42.1 µg/m³ (Dec. 1996) at the CBC site, and 1.4 µg/m³ (July 2005) to 11.2 µg/m³ (Feb. 2010) at the Gladstone site.

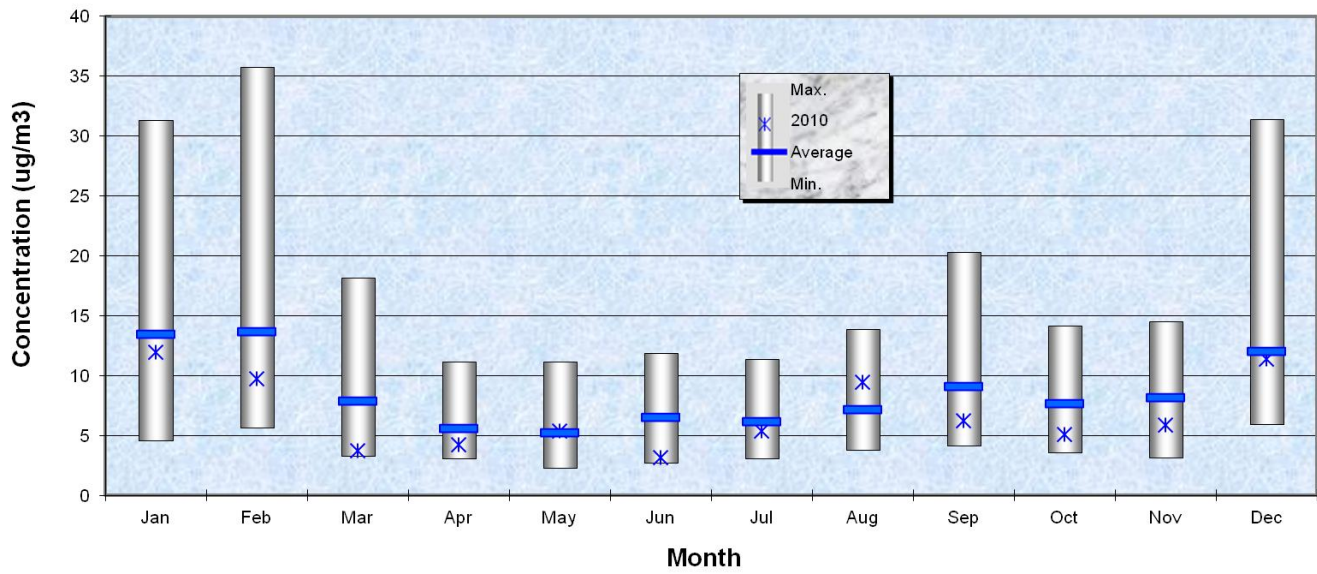


Figure 3.3.3 Comparison of 2010 with long-term average monthly SO₂ levels (µg/m³) at the Plaza site since 1995

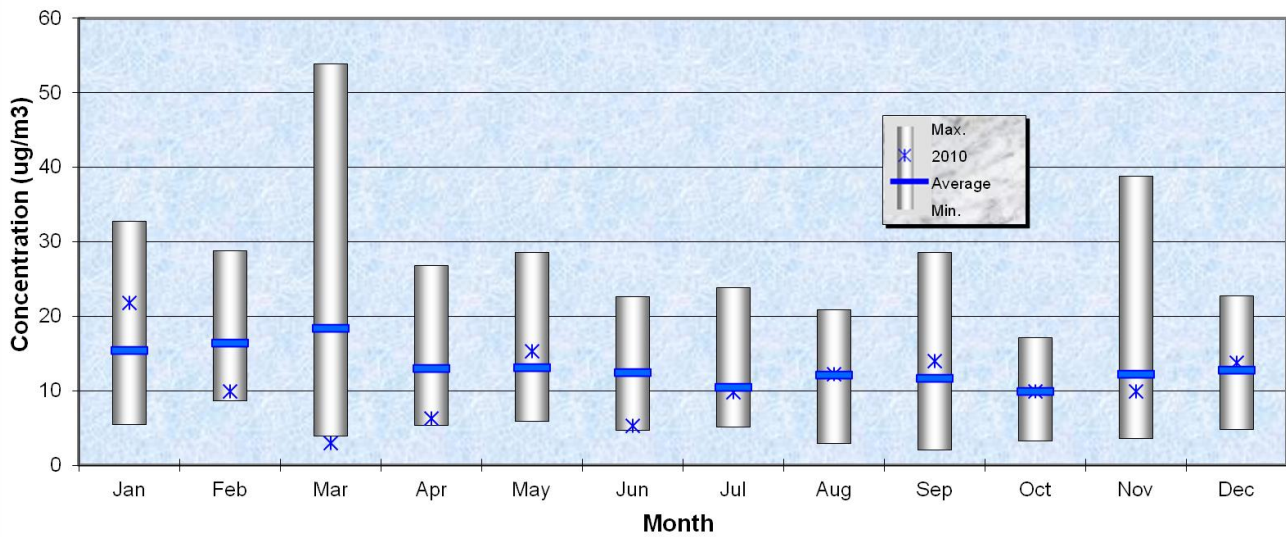


Figure 3.3.4 Comparison of 2010 with long-term average monthly SO₂ levels (µg/m³) at the Jail site since 1995

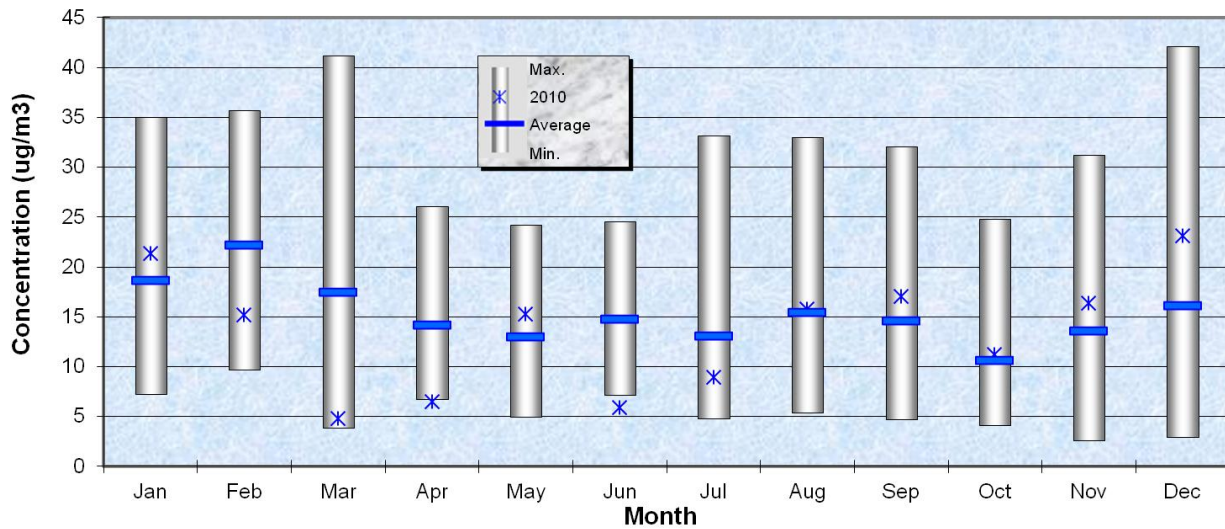


Figure 3.3.5 Comparison of 2010 with long-term average monthly SO₂ levels (µg/m³) at the CBC site since 1995

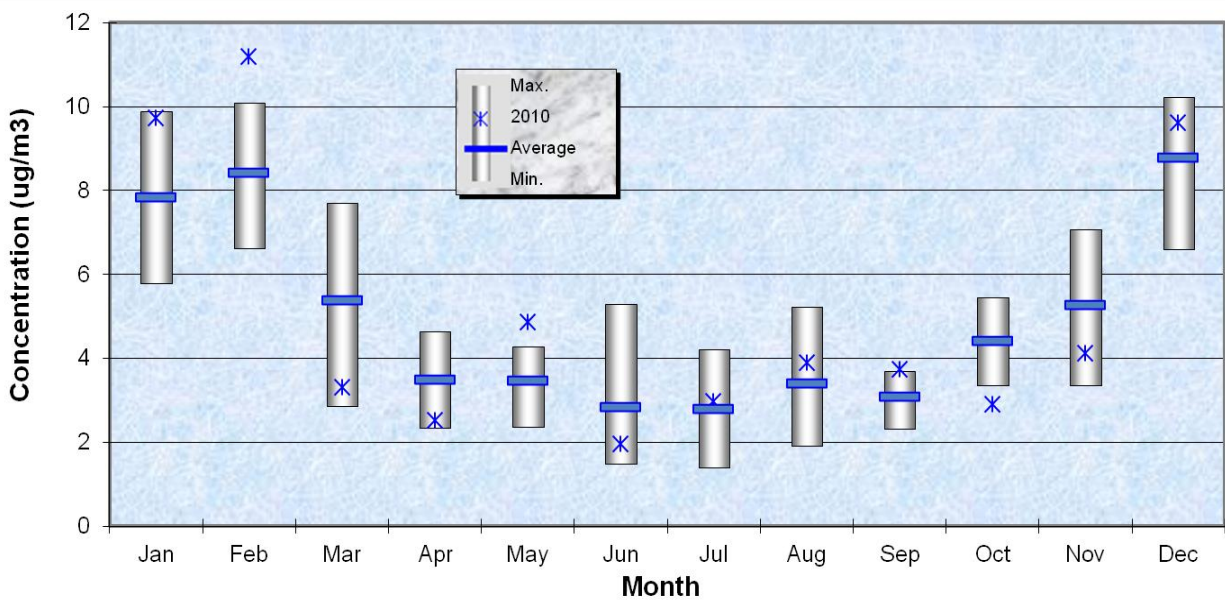


Figure 3.3.6 Comparison of 2010 with long-term average monthly SO₂ levels (µg/m³) at the Gladstone site since 2005

Monthly averages at the Plaza site tend to be highest from December to February and lowest during April through July. Since 1995, monthly averages have not exceeded 12 µg/m³ in April through July at this site. Monthly averages at the Jail site tend to be highest during March and lowest during July and October. At the CBC site they tend to be highest during February and lowest during October. At the Gladstone site, for the 5 years of data available so far, the highest averages are present from December to February and lowest during June and July. Record low monthly averages were recorded in 2010 during March at the Jail, in April and June at CBC, and October at Gladstone. Record high monthly averages were recorded in 2010 during February and May at the Gladstone site.

Figure 3.3.7 and 3.3.8 show the SO₂ pollution roses for the Plaza and Gladstone sites based on the 2010 meteorological data from that site. Wind directions were considered when the wind speed was ≥ 1 m/s. Similar to the TRS pollution rose, at the Plaza site, the highest concentrations occurred with winds from the east. At the Plaza site SO₂ levels were less than 4 $\mu\text{g}/\text{m}^3$ about 14% of the time when the winds were blowing from the east, whereas with winds from the west to northwest and from the south, levels less than 4 $\mu\text{g}/\text{m}^3$ occurred at least 90% of the time. Levels greater than 50 $\mu\text{g}/\text{m}^3$ generally occurred when winds were from the northeast to southeast sector.

Measurable SO₂ was recorded at all of the 16 wind sectors. This is not an indication of sources in all sectors, but a result of SO₂ levels building up in the area under calm conditions, and indicates the direction of flushing winds rather than source winds. A sulphuric acid plant located in the BCR Industrial Park may be the source for the higher frequency of SO₂ levels above 4 $\mu\text{g}/\text{m}^3$ from the west-southwest sector. Levels > 25 $\mu\text{g}/\text{m}^3$ seem to occur only from the northeast-southeast sector.

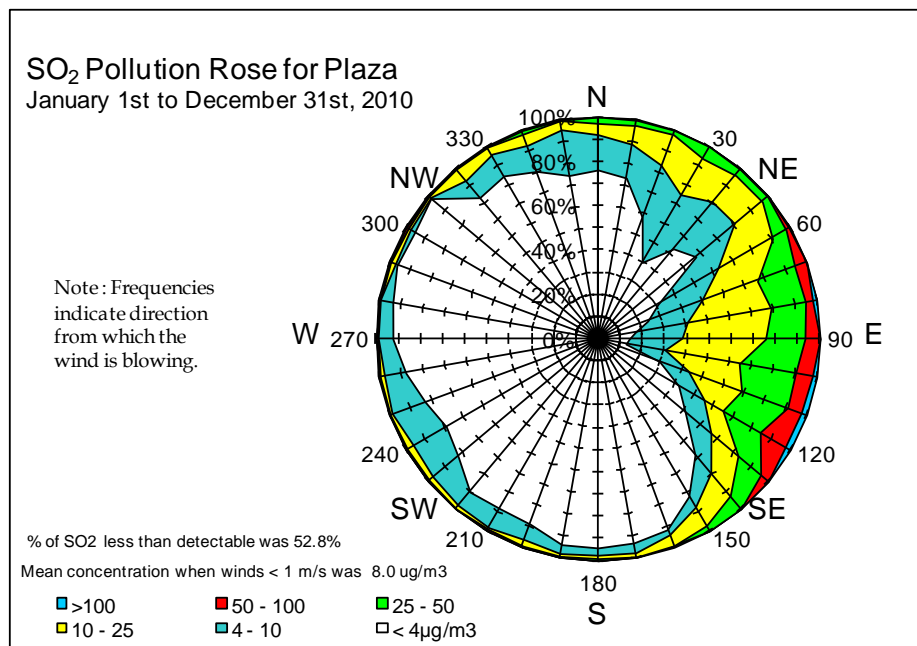


Figure 3.3.7 SO₂ Pollution Rose at the Plaza site for 2010

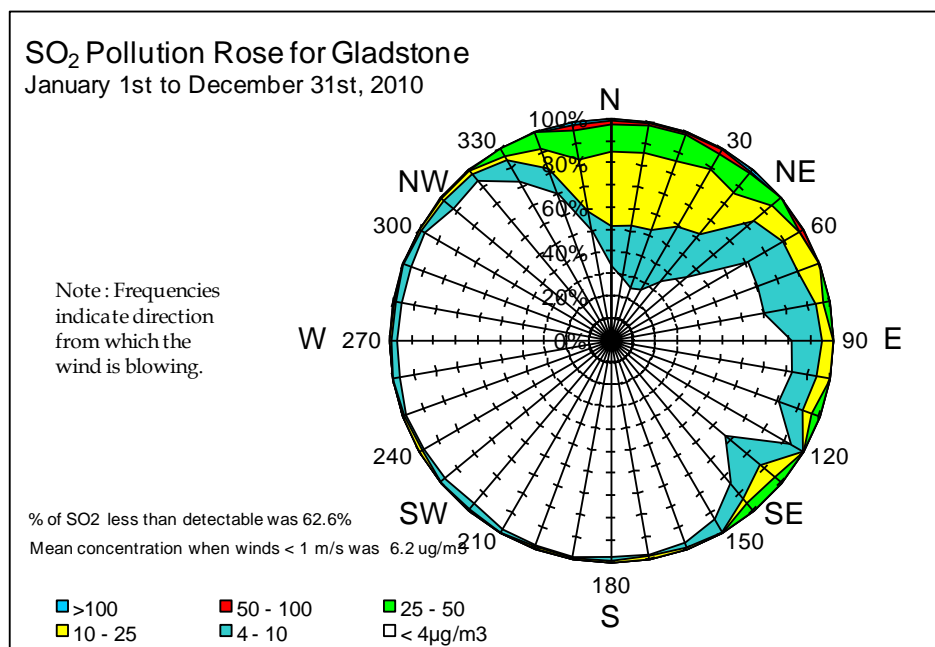


Figure 3.3.8 SO₂ Pollution Rose at the Gladstone site for 2010

Figure 3.3.8 shows the SO₂ pollution rose for the Gladstone site based on the 2010 meteorological data from that site when wind speeds were ≥ 1 m/s. The highest concentrations occurred with winds from the north to northeast sector. SO₂ levels were less than 4 µg/m³ for about 25% of the time when the winds were blowing from the north-northeast sector, whereas with winds from the south to northwest sector, levels were less than 4 µg/m³ at least 95% of the time. The higher concentrations from the southeast sector could be from sources located in the BCR industrial site.

Figure 3.3.9 shows the annual average SO₂ diurnal pattern in 2010 for each hour of the day at all five SO₂ monitoring sites. Unlike TRS, levels of SO₂ at the Plaza site generally do not increase in the evening, but do increase in the morning. These high morning concentrations are caused by fumigation where SO₂ levels build up overnight in the inversion layer then are brought down to the valley surface when the inversion breaks (due to daytime heating). This pattern results from the fact that SO₂ is emitted from high stacks, whereas most TRS is emitted closer to the ground from aeration ponds and low stacks at the pulp mills. The Gladstone site shows a similar pattern with a lower magnitude than the Plaza site. It is interesting to note that between 3:00 p.m. and 9:00 p.m., the SO₂ levels at Gladstone are similar to those at Plaza.

The CBC site does not show this fumigation pattern, but levels start increasing late in the evening until just after midnight and remain high throughout the night (Fig. 3.3.9). The SO₂ emitted from the high elevation stacks gets trapped in the inversion that develops over the plateau. This inversion prevents the plume from spreading vertically and only allows horizontal spread. Thus, the plume is forced to stay well above the Plaza and Jail monitoring sites, but is able to impact the CBC site, which is located at a higher elevation. The Jail site is located at a lower elevation (intermediate between CBC site and the Plaza site) and also experiences fumigation and, on occasion the trapping process.

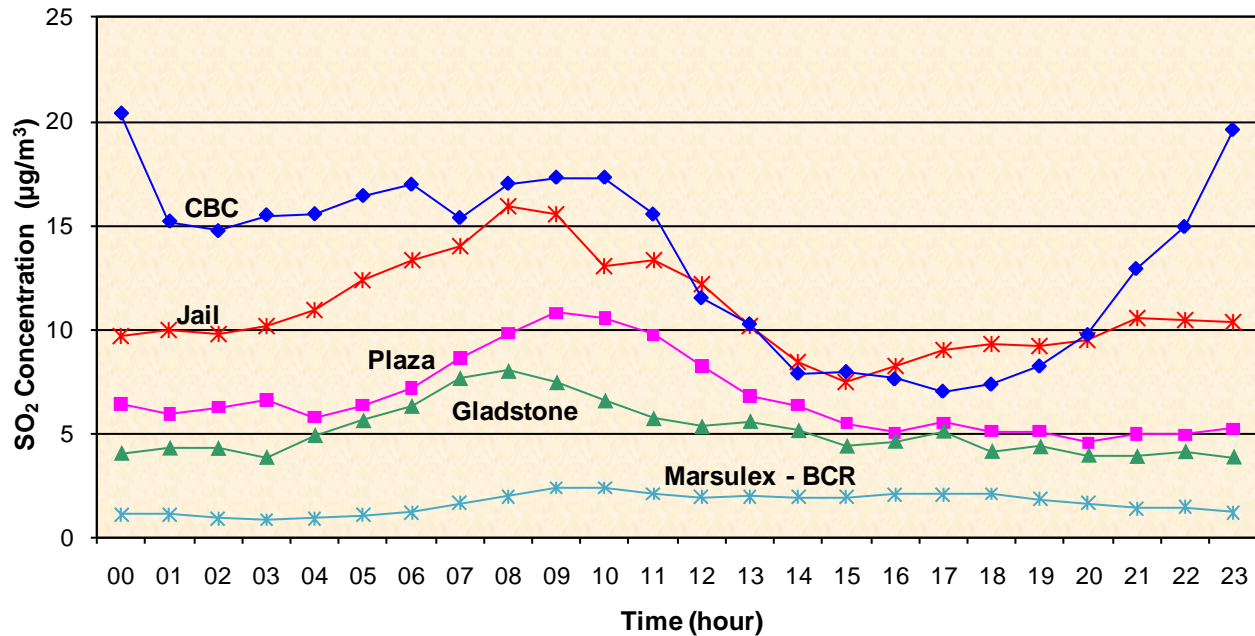


Figure 3.3.9 Diurnal average SO₂ pattern (µg/m³) in Prince George for 2010

3.3.2 SO₂ Annual Trends

Tables C–2.16 to C–2.20 summarize the SO₂ data collected at the Jail, Plaza, CBC, Gladstone and Marsulex stations. Between 1990-1996, the annual SO₂ average and the frequency of exceedances of the hourly Level A objective (450 µg/m³) recorded at the Jail gradually increased. Since then, levels have steadily decreased and are presently at least 50% of the levels recorded in 1996. The annual averages in 2010 have decreased at Gladstone and Marsulex but have increased at CBC, Plaza and the Jail monitoring site. Overall, SO₂ levels have been gradually decreasing at the three long term monitoring sites in Prince George (Figure 3.3.10), but have increased slightly in the past three years.

Table C–3.5 and C–3.6 (Appendix C) show the annual distribution of SO₂ percentiles at all five monitoring sites. The CBC and Plaza sites had percentile levels similar to those measured the previous year. The Jail monitoring site recorded higher levels for the higher percentile levels. The highest percentile values (> 98th percentile) decreased from the previous year at the Gladstone, Marsulex and Plaza sites.

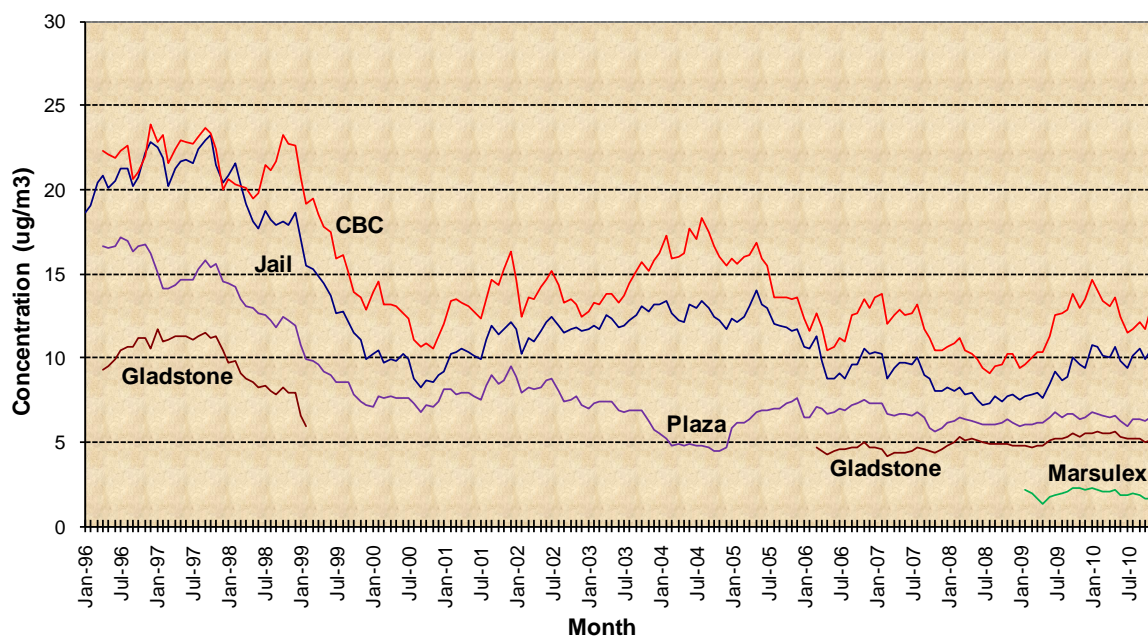


Figure 3.3.10 Rolling average SO_2 level ($\mu\text{g}/\text{m}^3$) at sites in Prince George

The annual trends in SO_2 demonstrate the effect of emissions from higher elevation stack sources at the surface of the valley. Even though the refinery emissions are discharged well above the valley floor with substantial plume rise, a reduction in ambient levels consistent with reduction of that source demonstrates the effectiveness of thermal inversions and subsequent fumigation at transferring these emissions to the valley floor.

3.3.3 Comparison of Prince George SO_2 Levels with Other B.C. Locations

Figure 3.3.10 compares the SO_2 annual averages recorded in Prince George with those at other monitoring sites in B.C. (only sites with greater than 90% of data captured are included). A comparison with other sites in Canada can be obtained in the “National Air Pollution Surveillance (NAPS) Network Annual Data Summary” at http://www.etc-cte.ec.gc.ca/publications/napsreports_e.html. The highest annual average in B.C. was measured at Trail – Butler Park. The Prince George CBC site recorded the seventh highest and the Jail recorded the eighth highest annual average. The Plaza site recorded the 11th highest SO_2 annual average out of the 42 sites. In 2010, the seven sites that recorded the highest SO_2 annual average were the only sites that recorded exceedances of the Level A one-hour objective ($450 \mu\text{g}/\text{m}^3$) with the highest being $1500 \mu\text{g}/\text{m}^3$ at Port Alice.

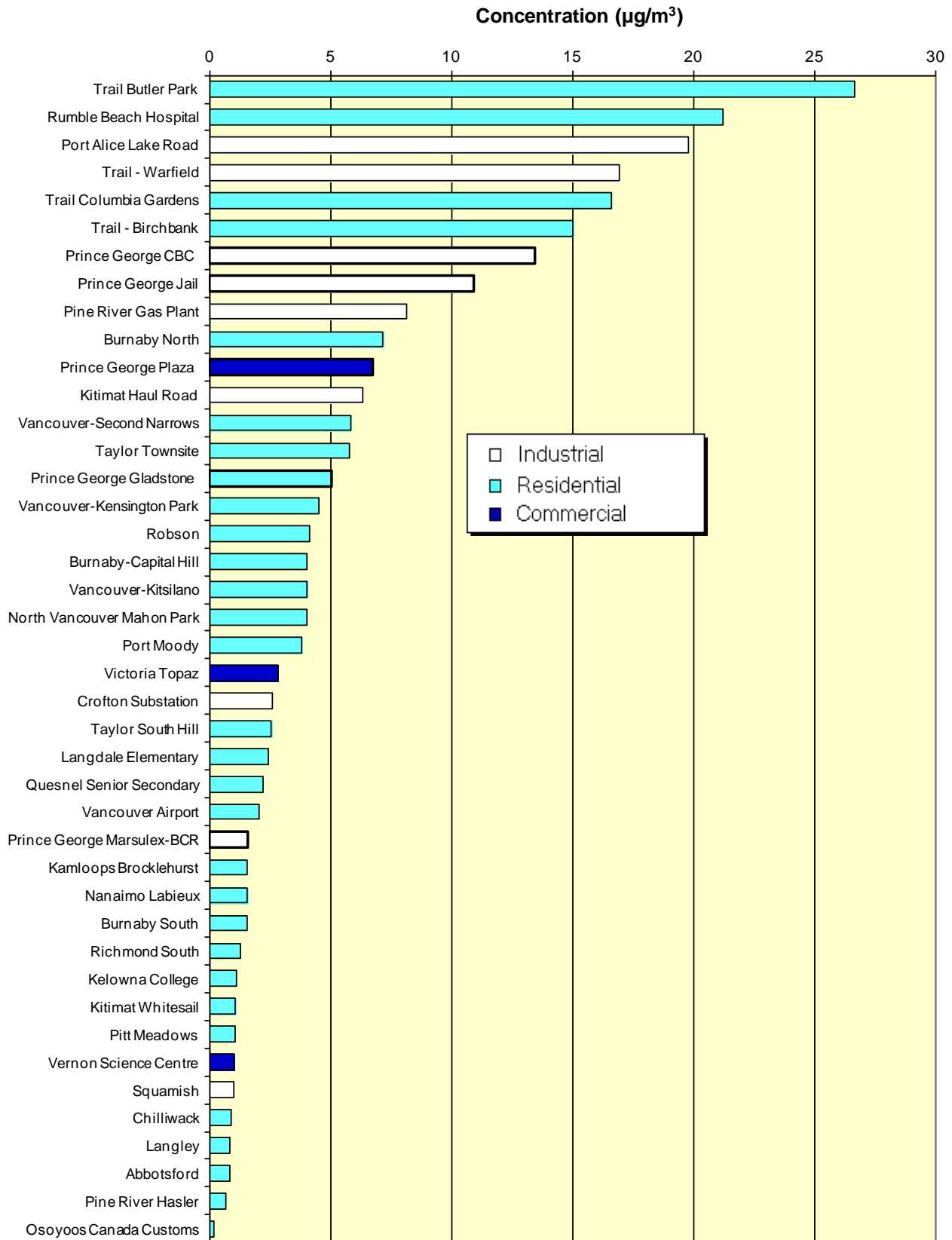


Figure 3.3.10 Comparison of 2010 annual average SO_2 levels ($\mu\text{g}/\text{m}^3$) in Prince George with other B.C. locations

3.4 Ozone

Ground level ozone is termed a secondary pollutant because it is not directly emitted into the atmosphere in significant amounts. It is produced through a complex series of chemical reactions involving oxides of nitrogen and volatile hydrocarbons in the presence of sunlight. As a result, high levels of ozone tend to form downwind of industrial sources and can be produced by local, as well as long-range precursor sources. However, at night, ozone levels downwind from industrial sources can decrease as ozone can be scavenged by nitric oxide to produce nitrogen dioxide. Other pollutants generated by these chemical reactions may include oxygen, ketones, aldehydes, and peroxyacetyl nitrates (PAN).

Ozone is an irritant that affects respiratory function. Exposure to ozone in sensitive people can result in symptoms such as chest tightness, coughing and wheezing (Ontario Ministry of Environment, 2004). It causes eye and throat irritation, and is known to increase mucous production. Long term exposure to ozone presents the possibility of irreversible changes in the lungs, which could lead to premature aging of the lungs and/or chronic respiratory illnesses. It also accelerates the aging of many materials, resulting in cracking of rubber or fading of dyes and paints (Ibid.). Short-term exposures to relatively high concentrations ($> 300 \mu\text{g}/\text{m}^3$) generally result in acute visible foliar injury (Krupa, et. al., 1998) as shown by leaf necrosis (i.e., flecking and discolouration of the leaves). Long term chronic exposures to lower concentrations ($100 - 160 \mu\text{g}/\text{m}^3$) can cause physiological alterations that may result in chlorosis, premature senescence, and in growth and yield reductions (Ibid.).

There is only one ozone monitor in Prince George. An API Model 400E Ozone monitor (Fig. 3.4.1) was installed at the Plaza site in July 2009 replacing the API 400 which had operated since April 1995. This analyzer has a detection limit of $1.2 \mu\text{g}/\text{m}^3$. Monitoring of ozone is based on the absorption of (UV) ultra-violet light (wavelength at 254 nanometres) due to an internal electronic resonance of the ozone molecule. Ozone is a very efficient absorber of UV light and acts to protect life on earth from harmful solar UV radiation.



Fig 3.4.1 Teledyne – API ozone monitor

The quality of the O_3 data was evaluated through monthly calibrations and independent auditing in May and October. The auditing results in Appendix B, Table B-1 indicate that the O_3 monitor at the Plaza site had satisfactory performance in May and excellent performance in October. Data quality is considered unsatisfactory if the monitor deviates by 7% or more from the auditing results. After quality assurance and quality control was applied to the data, 98.0% of hourly O_3 values were valid in 2010.

3.4.1 O₃ Results

Table C-1.14 and Figures 3.4.2 and 3.4.3 summarize the ozone data from the Plaza site in 2010. As typically observed at most sites in North America, the maximum hourly O₃ levels were observed from May to August which is due to the longest hours of daylight and high solar radiation during these months. Exceedances of the one-hour Level A objective (100 µg/m³) occurred from March through September (Table C-1.14). Exceedances of the 24-hour Level A objective (30 µg/m³) can occur during any month, as there is some evidence that this objective is below the background level for ozone (Altshuller, 1996, and Browell, 1994). In 2010, exceedances of the Level B daily objective (50 µg/m³) were recorded during all months except for February. Monthly averages from March to June were higher than the Level B daily objective.

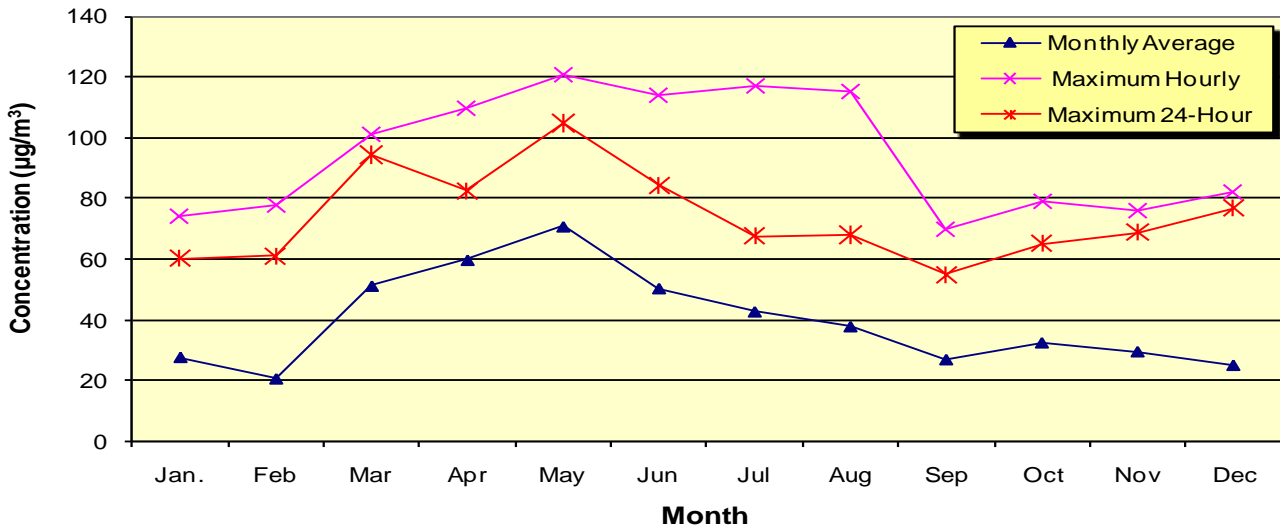


Figure 3.4.2 Monthly ozone levels (µg/m³) at the Plaza site in 2010

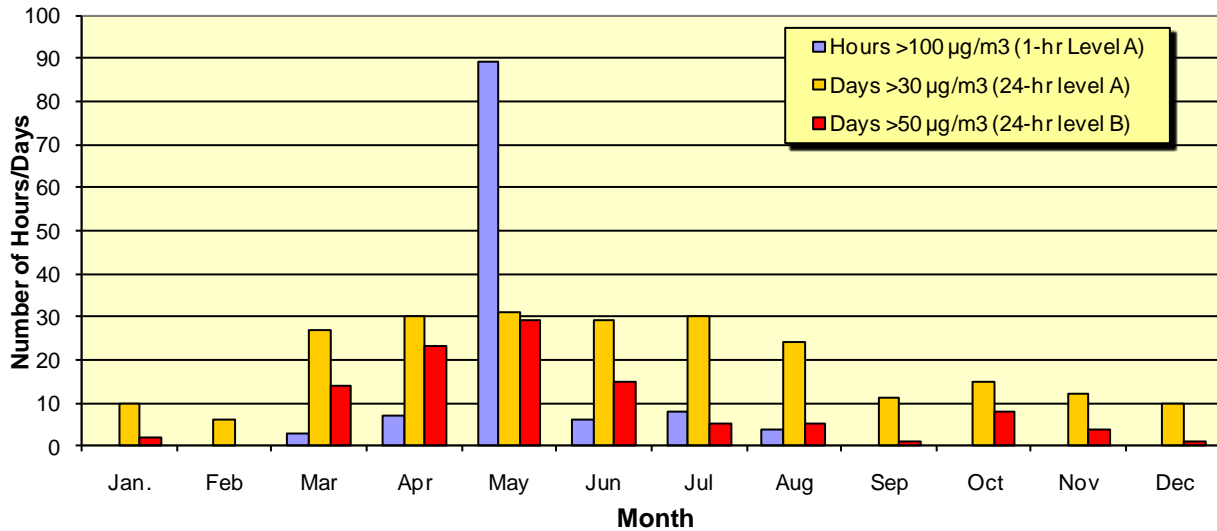


Figure 3.4.3 Number of hours or days ozone levels exceeded the Level A or B objective at the Plaza site in 2010

Figure 3.4.4 shows the range in monthly average ozone levels at the downtown location since monitoring began in 1995. Monthly averages ranged from a high of 71.6 µg/m³ (April 2000)

to a low of 15.6 $\mu\text{g}/\text{m}^3$ (November 1997). February 2010 had record low ozone for that month and May 2010 had a record high monthly average.

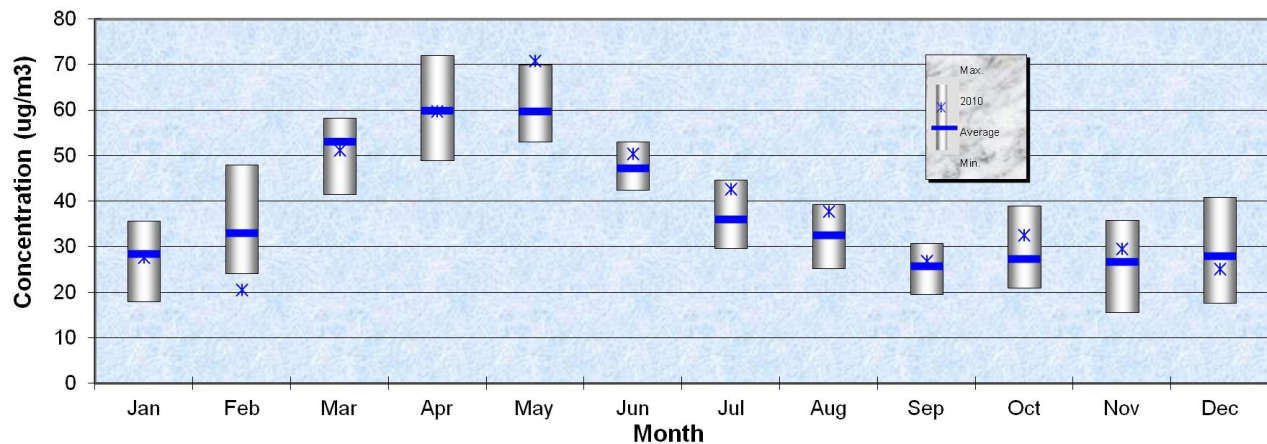


Figure 3.4.4 Comparison of 2010 with long-term average monthly ozone levels ($\mu\text{g}/\text{m}^3$) at the Plaza site since 1995

Figure 3.4.5 shows the O_3 pollution rose for the Plaza site based on the 2010 meteorological data (for wind speeds ≥ 1 m/s). Unlike the TRS and SO_2 pollution roses, low levels ($< 25 \mu\text{g}/\text{m}^3$) occurred quite often (65% of the time) when winds were blowing from the east. This was probably due to ozone being scavenged out of the atmosphere by NO and other pollutants from the industrial sources east-northeast of the monitoring site. Unlike other pollutants that are higher in concentration with calm conditions, the average O_3 concentration during light winds tends to be low ($14.1 \mu\text{g}/\text{m}^3$). This is due to a combination of other pollutants building up in the air shed causing reduced ozone in the absence of sunlight, and to ozone being removed by dry deposition.

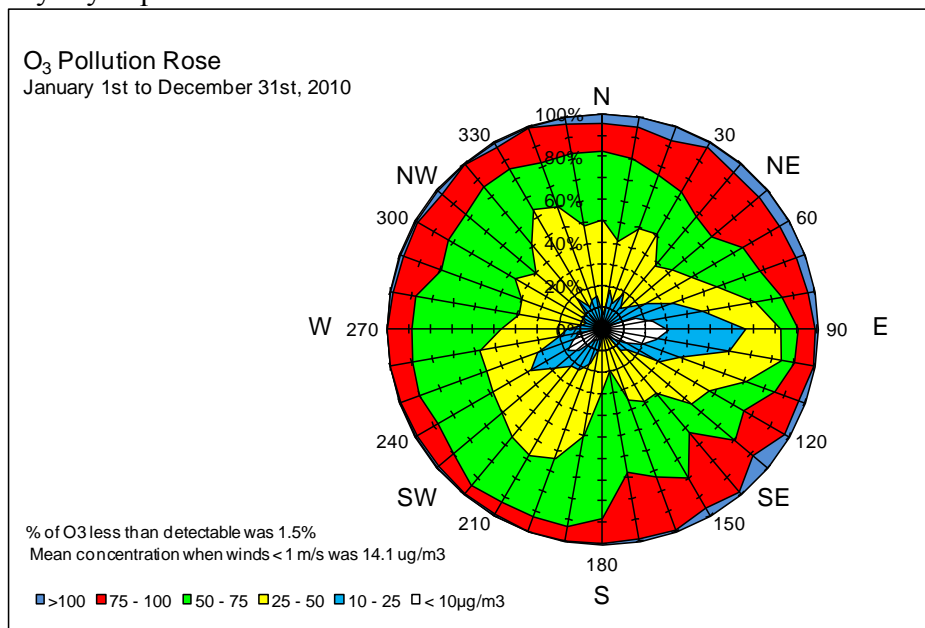


Figure 3.4.5 O₃ pollution rose at the Plaza site for 2010

Although pollutants such as nitrogen dioxide (NO_2) and volatile organics contribute to ozone production in the presence of sunlight, nitric oxide (NO) can destroy it. For areas close to sources of nitric oxide (e.g. vehicles or industry), the reaction tends to be dominated by

destruction. Ozone formation tends to occur further downwind from the sources. It is noticeable that low ozone levels ($< 25 \mu\text{g}/\text{m}^3$) only occurred less than 5% of the time when winds were from the south-southeast (160-180 degrees) (Fig. 3.4.5). This was likely due to the low frequency of light winds from that sector. The average wind speed from this sector was the highest of all sixteen wind sectors. During strong winds background ozone can range from 50-90 $\mu\text{g}/\text{m}^3$.

Figure 3.4.6 shows the diurnal ozone pattern for selected months in 2010. The daytime levels are much higher in spring (March - May) than any other season. Possible reasons could be (1) an increase in ozone precursors in the upper atmosphere, (2) more snow cover at higher elevations increasing the amount of solar radiation reflected back into the atmosphere, (3) an increase in stratospheric intrusion (high levels of ozone originating in the stratosphere being transported to the troposphere) or (4) a combination of these factors. Lower levels during the night were likely due to a net scavenging in the absence of sunlight. The diurnal trend in the winter (January) shows only a slight increase in day-time levels, due to the short duration of daylight and weak solar radiation.

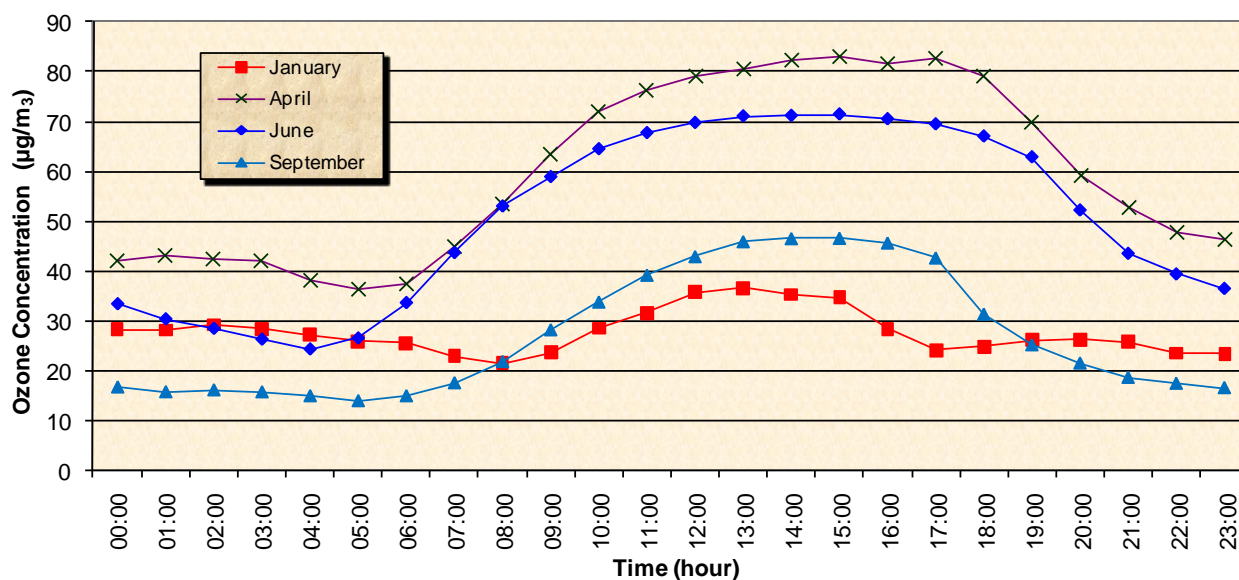


Figure 3.4.6 Daily average ozone pattern ($\mu\text{g}/\text{m}^3$) in Prince George in 2010

3.4.2 O₃ Annual Trend

Table C-2.21 and Figure 3.4.7 summarize the annual O₃ data collected at the Plaza station. 2010 had a slightly higher annual average from the year before. However, the frequency of the one-hour Level A (100 µg/m³) exceedances more than doubled in 2010. The number of 24-hour Level A objective (30 µg/m³) exceedances was similar to 2009. Rolling annual average levels increased from March 1996 to July 2002 (about 26% of the initial value), but have decreased by about 10% since then.

In July 1999, the federal government released the "National Ambient Air Quality Objectives for Ground-Level Ozone", which established a Canada Wide Standard for ozone that takes effect in 2010. The Canada Wide Standard for ozone is 130 µg/m³, which is the annual 4th highest 8-hour value, averaged over three consecutive years. To date, ozone levels in Prince George have not exceeded the Canada Wide Standard. It's believed the UV is not of sufficient strength to drive the photo chemical reaction at this latitude. Only once in the last seven years has a single 8-hour average exceeded 130 µg/m³.

Figure 3.4.7 also shows that monthly averages tend to be the lowest during autumn and early winter, and the highest during spring (similar trend to Figure 3.4.4). Monthly averages during the springs of 2000-2001 and 2010 were the three highest recorded at this site.

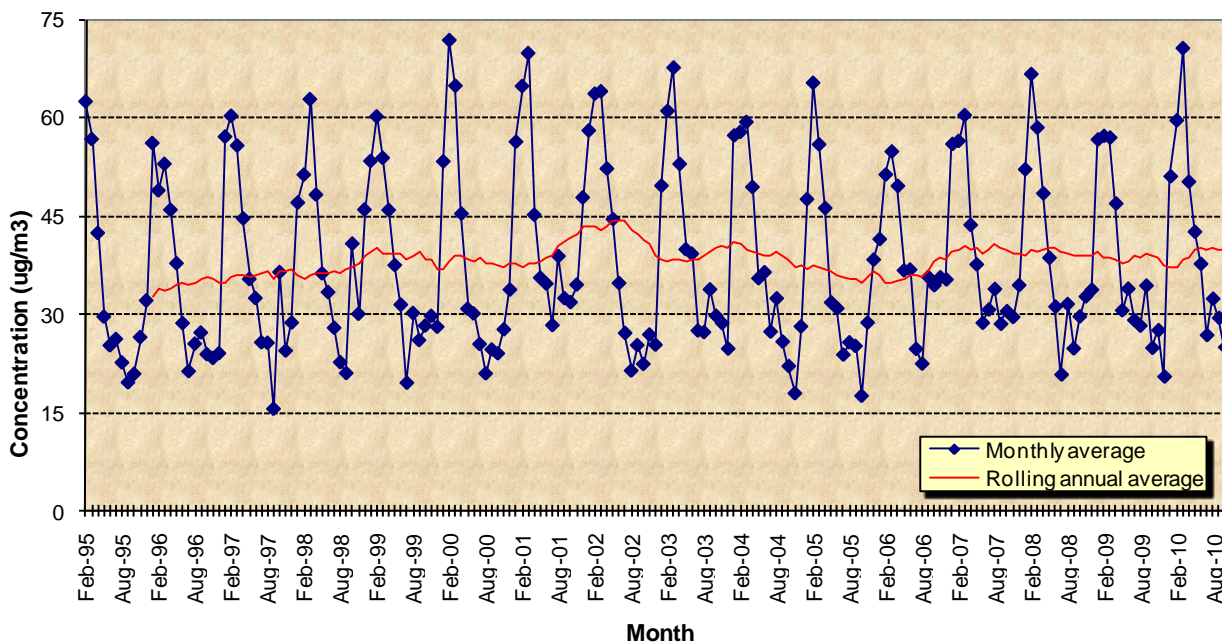


Figure 3.4.7 Rolling average annual and monthly ozone trends (µg/m³) in Prince George

Table C-3.7 lists the annual percentiles of the 1-hour, 8-hour and 24-hour ozone averages since 1996. The percentiles give a more complete indication of trends than just annual averages, maximum values, or the number of objective exceedances. They also give a better understanding of the causes for any trends. Generally, levels of the higher percentiles (> 90th percentile) for the 1-hour, 8-hour and 24-hour values in 2010 were similar to those in 2008. In 2010, the maximum 8-hour and 24-hour values were the highest recorded since 2004 and 2000, respectively.

3.4.3 Comparison of Prince George O₃ Levels with Other B.C. Locations

Figure 3.4.8 compares the 2010 ozone annual average at the Plaza site with other monitoring sites in B.C. (for sites with greater than 90% of data captured). A comparison with other sites in Canada can be obtained in the “National Air Pollution Surveillance (NAPS) Network Annual Data Summary” at http://www.etc-cte.ec.gc.ca/publications/napsreports_e.html. In 2010, there were 32 ozone monitoring sites in B.C. with greater than 90% data capture and most of these sites were located in Metro Vancouver. The lowest annual averages came from sites that had the highest NO₂ annual averages, which is likely due to ozone scavenging. Prince George had the 9th highest annual average O₃ concentration in 2010.

Because of the complexity in the production of ozone, annual average concentrations for ozone may not be an indication of whether a site has ozone concerns. As shown in Figure 3.4.8, the sites with the highest annual averages did not record the highest maximum hourly concentrations.

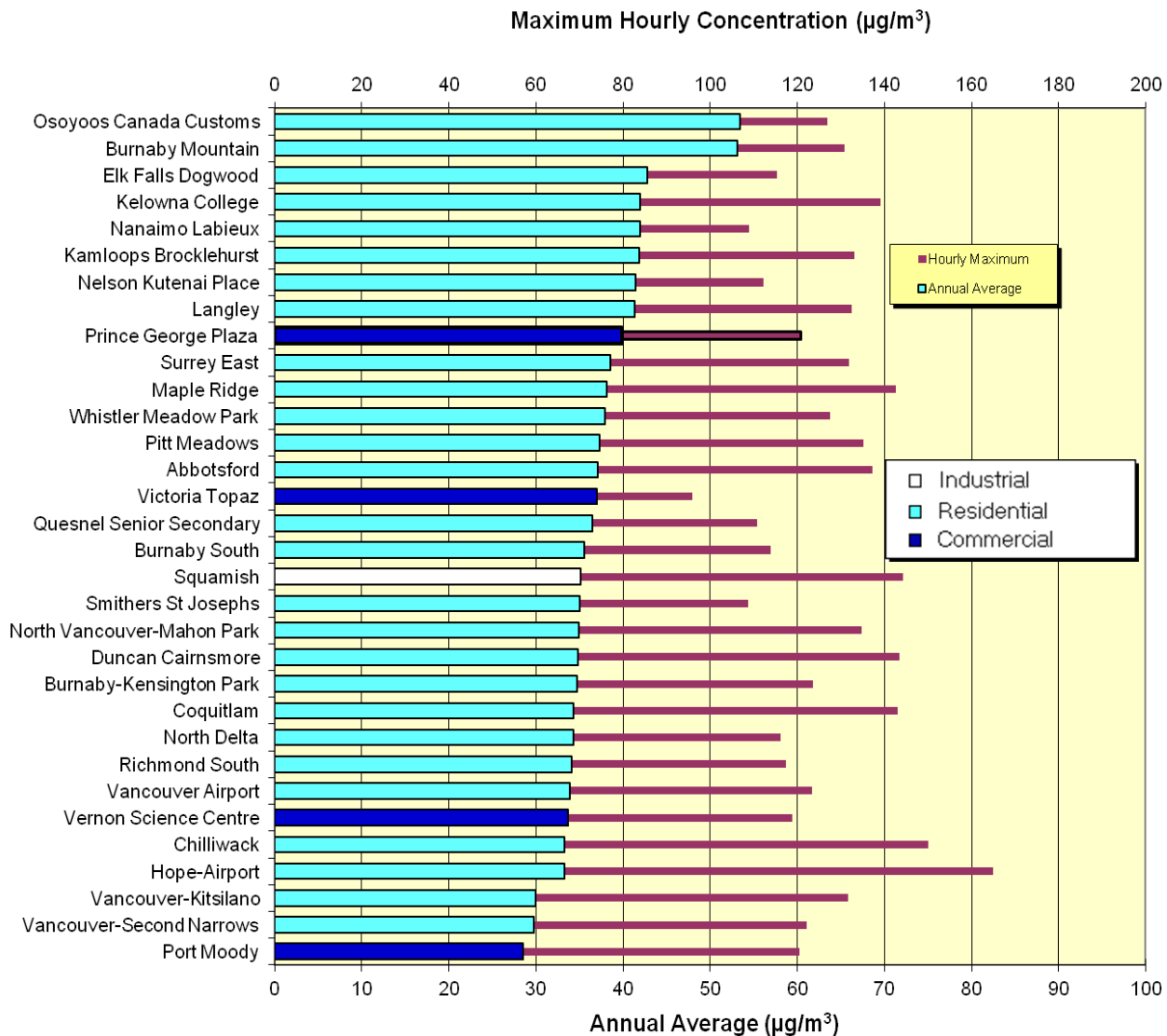


Figure 3.4.8 Comparison of 2010 maximum hourly and annual average ozone levels (µg/m³) in Prince George with other B.C. locations

3.5 Nitrogen Oxides

The atmosphere contains approximately 78% nitrogen and 21% oxygen by volume. Of the five major forms of gaseous nitrogen in the atmosphere: nitrogen (N_2), ammonia (NH_3), nitrous oxide (N_2O), nitrogen dioxide (NO_2), and nitric oxide (NO), only the latter two are monitored in Prince George.

Nitric oxide (NO) is formed during high temperature combustion of nitrogen and oxygen gases, primarily from motor vehicle exhaust and stationary combustion (such as industrial processes, waste incineration, and fuel combustion for heating homes and buildings). Emissions of NO are greater during winter months when use of heating fuels increases. Natural sources of NO include lightning and soil bacteria.

Nitric oxide is easily oxidized to NO_2 (a reddish-brown gas with a pungent and irritating odour at concentrations over $250 \mu g/m^3$) by combining with ozone or certain hydrocarbons. NO_2 in the presence of sunlight produces ozone. The NO_2 absorbs short wave blue light, leaving longer wavelengths that cause it to appear reddish-brown, impairing visibility. The effects of short-term exposure of NO_2 are unclear, but frequent exposure, over the long term to concentrations higher than those normally found in the ambient air, may increase acute respiratory diseases in children (Brimblecombe, 1996). Extremely high concentrations of NO_2 ($> 2000 \mu g/m^3$) can cause both reversible and irreversible effects arising from structural changes of cells in the respiratory system (Ibid). Unlike SO_2 , NO_2 can penetrate directly into the pulmonary region of the lungs (Stern et. al., 1984). NO_2 also degrades materials such as metals, fabrics, and rubber and has an adverse effect on vegetation. At extremely high concentrations of NO there is the potential for visible foliar injury although vegetation injury can occur at concentrations as low as 160 ppb ($300 \mu g/m^3$) or even lower concentrations when combined with SO_2 or O_3 (Bytnerowicz et. al., 1998). The presence of SO_2 can inhibit potential means of detoxification of NO_2 products.

Generally, NO_2 reacts with water to form nitric acid, a component of acid rain. The transformation of NO_2 to nitric acid is much more rapid than of SO_2 to sulphuric acid. Acidification also produces acid aerosols (nitrates) which have been measured in this airshed and data is available at the Ministry's regional office in Prince George.

The current analyzer (Fig. 3.5.1) has a detection limit of $1.2 \mu g/m^3$ for NO . Monitoring of nitric oxides is based on the principle of chemiluminescence involving a gas phase reaction of NO and ozone. For NO_2 , the gas is passed through a catalytic converter where NO_2 is reduced to NO . The concentration of NO in that gas is then measured. The total concentration of NO and NO_2 , converted to NO , is then treated as oxides of nitrogen (NO_x). The difference between the two measured concentrations is considered to be NO_2 .



Fig 3.5.1 Teledyne - API NO_x monitor

The quality of the NO_x data was evaluated through monthly calibrations and independent auditing in May and October 2010. The auditing results in Appendix B, Table B-1 indicate that the NO_x monitor at Plaza had excellent performance in May and satisfactory performance in October. The percent valid data for the year was 93.9%, which is acceptable by Ministry standards for compliance with air quality.

3.5.1 NO_x Results

The nitrogen dioxide data from the Plaza site are summarized in Figure 3.5.2. Actual values and additional information can be found in Table C-1.15 in Appendix C. Ambient NO₂ levels were well within the provincial objectives with no Level B hourly (400 µg/m³) or daily (200 µg/m³) exceedances. The highest maximum hourly average at Plaza occurred in December. January and December recorded the highest monthly averages.

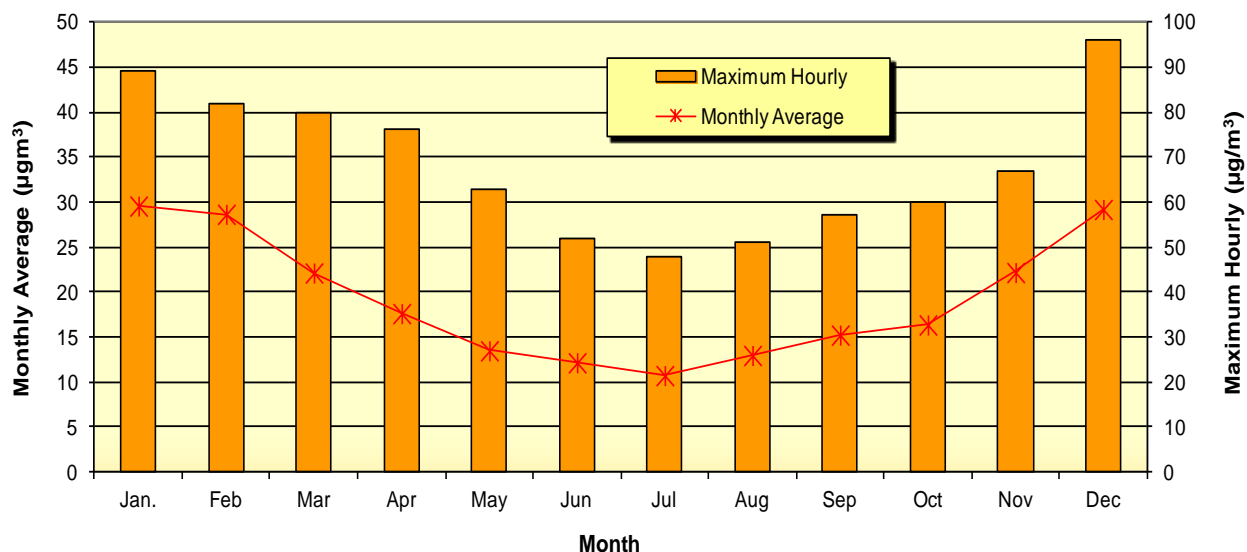


Figure 3.5.2 2010 average and maximum hourly NO₂ levels (µg/m³) by month in Prince George

Figure 3.5.3 shows the range in the average monthly NO₂ levels at the downtown location since 1995. In the long term record, the highest levels have occurred in January and February and the lowest in July. The high winter levels occur because inversions tend to be stronger during winter, there are additional sources in winter (e.g. increased use of heating fuels), and there is less solar radiation to promote the breakdown of NO₂ to NO, which causes NO₂ levels to build up in the troposphere. All 2010 NO₂ monthly averages were below average with April and October setting monthly record lows.

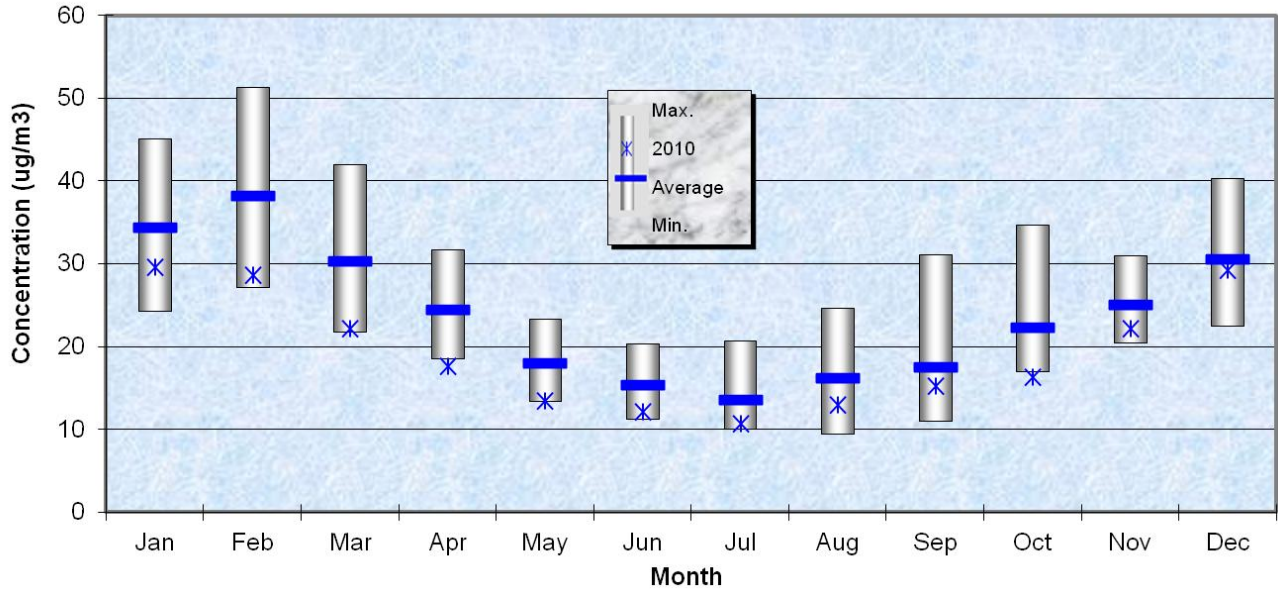


Figure 3.5.3 Comparison of 2010 with long-term average monthly NO₂ levels (µg/m³) at the Plaza site since 1995

Figures 3.5.4 and 3.5.5 show the NO₂ and NO pollution roses, respectively, for the Plaza site for 2010 (wind speeds ≥ 1 m/s). NO values were below detectable 27.5% of the time compared to 0.8% of the NO₂ values. This is probably due to NO reacting with other pollutants such as ozone and quickly being converted to NO₂. Most NO₂ in the Prince George airshed is likely a secondary pollutant (i.e. derived from local NO sources), since it is estimated that about 10% of the NO_x from stacks is emitted as NO₂ and the remaining 90% as NO. Under calm conditions (< 1 m/s), the average NO₂ concentration was 35.0 µg/m³, which was higher than the NO concentration (28.1 µg/m³) under the same conditions.

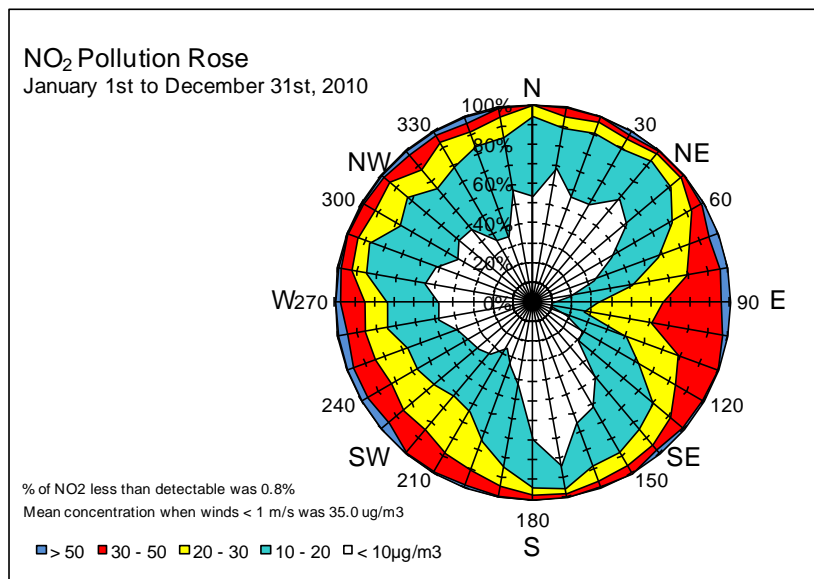


Figure 3.5.4 NO₂ pollution rose at the Plaza site for 2010

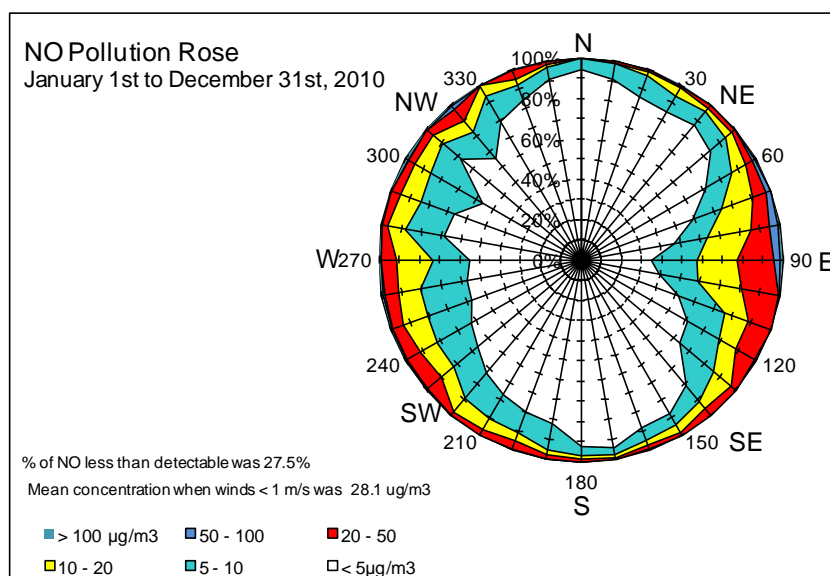


Figure 3.5.5 NO pollution rose at the Plaza site for 2010

These pollution roses show that the higher concentrations of both NO₂ and NO originated from a number of wind directions, not from one predominant sector as shown for TRS and SO₂. This pattern occurs because the major sources of NO_x are dispersed throughout the airshed. Similar to the SO₂ pollution rose, low concentrations (< 20 µg/m³ for NO₂ and < 5 µg/m³ for NO) occurred less frequently (< 40%) with east winds and more commonly (about 70%) from the south-southeast to south sector. This may indicate the influence of meteorology on ambient levels rather than the number of sources from a southerly direction. Wind speeds from the south and north-northeast directions tend to be higher than from any other direction, whereas the wind speeds from the east tend to be lower. Stronger winds usually result in better mixing and lower concentration of industrial pollutants. Therefore, the concentration from a particular wind direction is mainly dependent on the emissions and wind speed. The highest concentrations originated mainly from the east sector, but also from other directions, which indicates contributions from other industrial sources, transportation and space heaters.

Figures 3.5.6 and 3.5.7 show the typical diurnal patterns of NO₂ and NO, respectively, for specified months of the year in 2010. Both figures show higher levels in the evening and morning and lower levels in the late afternoon, although the pattern for NO is far more amplified during autumn and winter. These peaks are likely related to fumigation from industrial sources (similar to SO₂) rather than rush hour traffic which is typically observed in major cities. These peaks occur later during winter than summer days, indicating a later inversion break up in winter. NO₂ levels tend to peak higher in the evening, whereas NO levels tend to peak higher in the morning during most seasons. The evening peak for NO₂ may be the result of NO reacting with O₃ in the absence of sunlight. The highest daytime and nighttime levels typically occur in the winter and the lowest levels occurred in the summer for both NO₂ and NO.

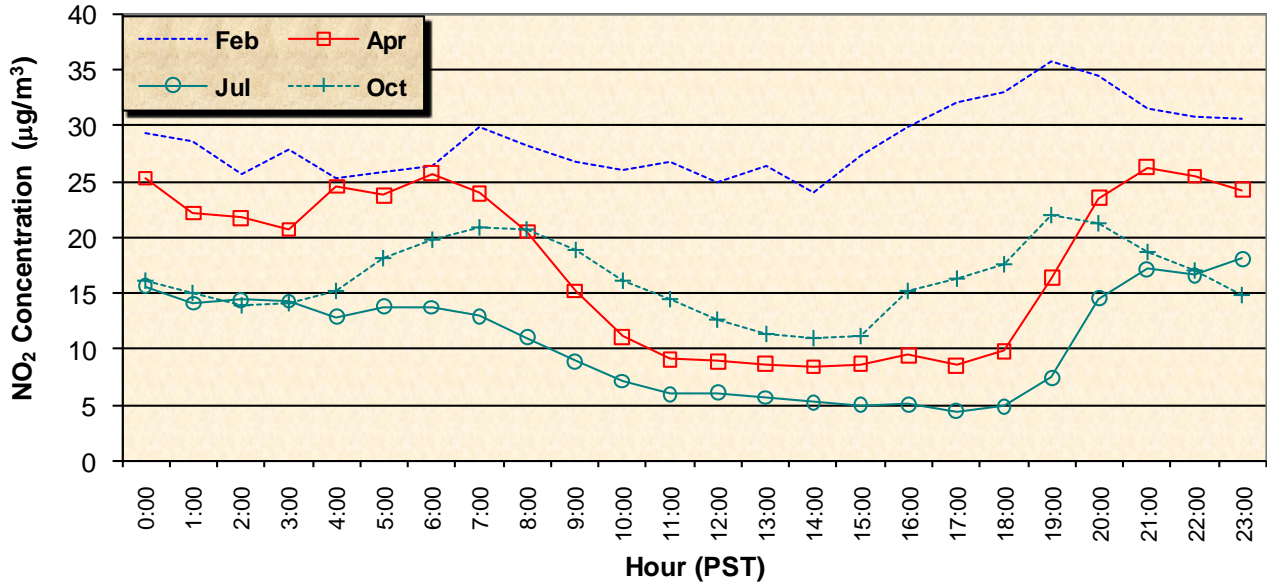


Figure 3.5.6 Diurnal average NO₂ pattern (µg/m³) in Prince George in 2010

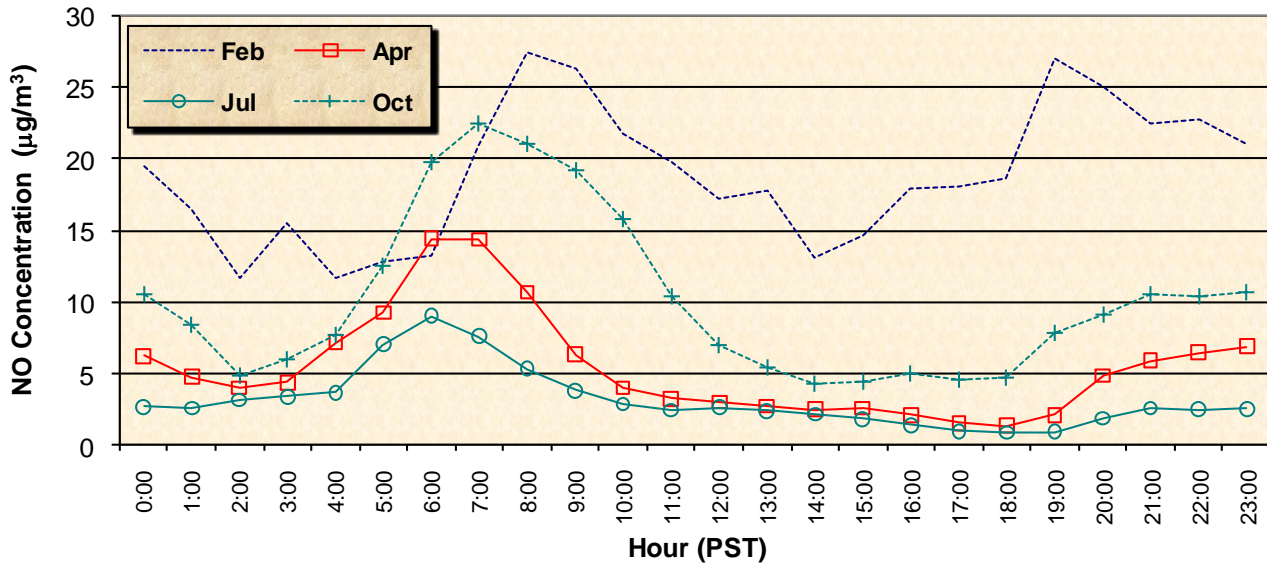


Figure 3.5.7 Diurnal average NO pattern (µg/m³) in Prince George in 2010

3.5.2 NO_x Annual Trend

Table C-2.22 and Figure 3.5.8 summarize the annual NO₂ trend at the Plaza site. Since late 1998 there appears to be a decreasing trend in annual NO₂ levels in the airshed. The highest annual average occurred in 1998. The maximum daily average was recorded in December 1999. So far there have been no exceedances of the provincial NO₂ objectives at Plaza. The maximum hourly value, 186 µg/m³, occurred on Jan. 2, 1997. The annual average in 2010 was the lowest ever recorded. The maximum hourly value (178 µg/m³) was the second highest hourly value ever recorded at that site.

Figure 3.5.8 shows that the rolling annual average has ranged between 19 µg/m³ and 29 µg/m³ since 1996. With the exception of 2006, levels have gradually decreased from 1999 to 2009 and remained steady in 2010. The lowest rolling average on record was recorded in 2010. Monthly averages show that the highest levels occur during the winter, and the lowest in summer. As previously mentioned, this difference is likely due to increased emissions in winter, as well as unfavourable meteorological conditions and reduced solar radiation. The missing 2005 data in the rolling average was due to instrument problems during the winter season, when NO₂ levels tend to be the highest.

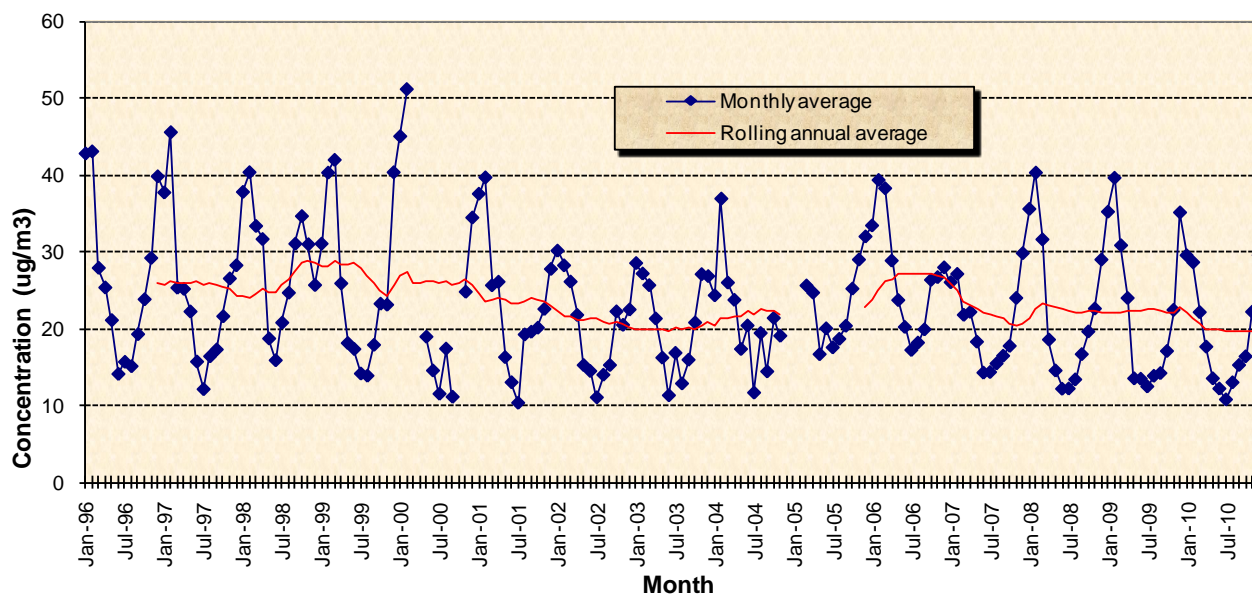


Figure 3.5.8 Rolling annual and monthly NO₂ (µg/m³) trends in Prince George

Table C-3.8 in Appendix C shows the annual percentiles of both the NO₂ and NO values for the past sixteen years. Because NO₂ is seasonally influenced, and due to instrument malfunction from November 2004 to March 2005, NO₂ percentile data for those years could not be compared to other years. NO₂ and NO values were substantially lower in 2010 relative to 2009 although the maximum hourly values were second highest on record for both pollutants.

3.3.3 Comparison of Prince George NO_x Levels with Other B.C. Locations

Figures 3.5.9 and 3.5.10 compare the NO₂ and NO annual averages at the Plaza site with those at other selected monitoring sites in B.C. (for sites with > 90% data capture).

In 2010, there were 32 NO₂ monitoring sites in B.C., more than half of those exist outside of Metro Vancouver. The stations with the ten highest annual average NO₂ levels were located in the Metro Vancouver with Vancouver – Second Narrows recording the maximum one-hour NO₂ concentration. Prince George Plaza ranked 13th across the province and 3rd when excluding Metro Vancouver stations.

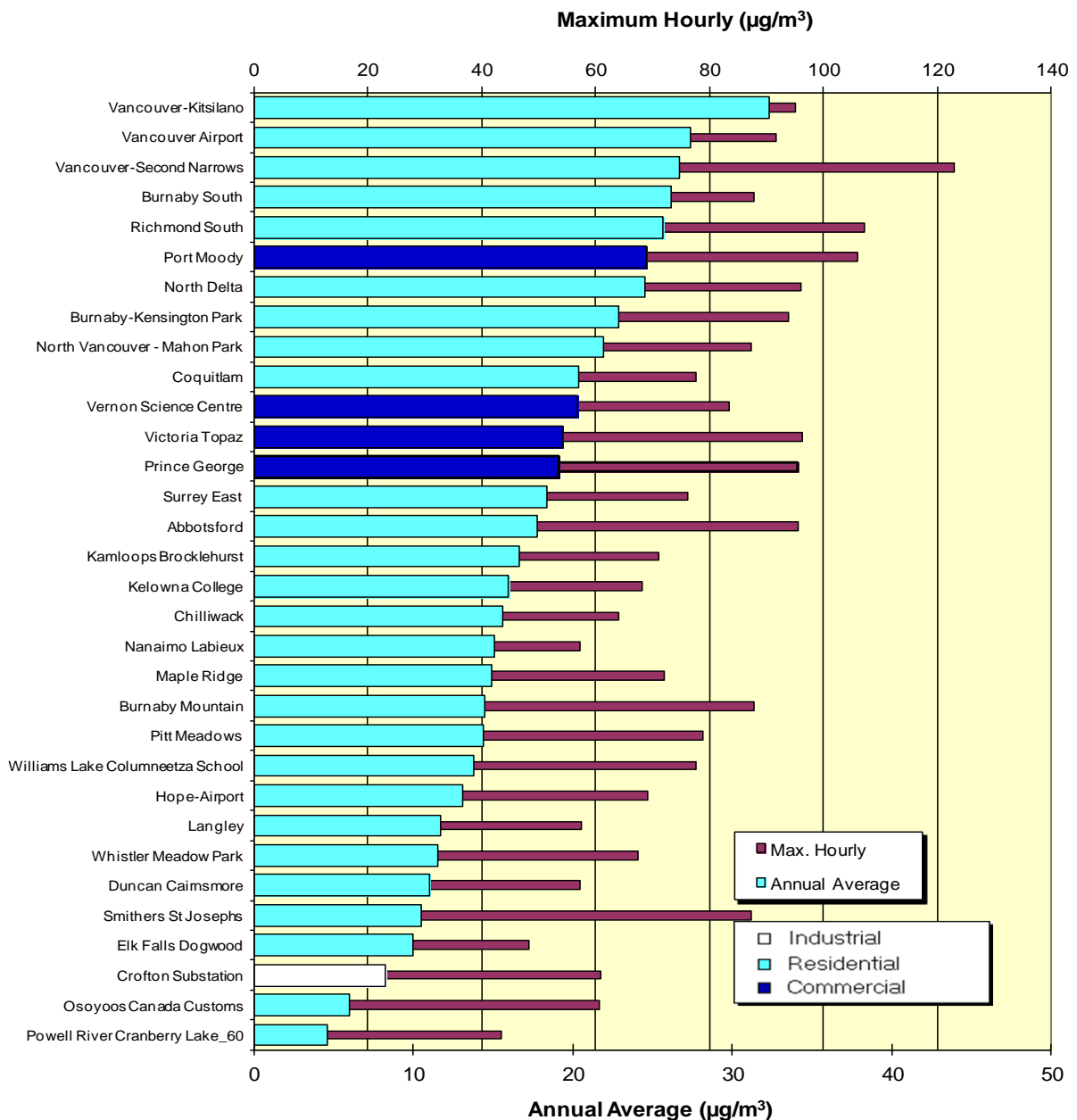


Figure 3.5.9 Comparison of 2010 maximum hourly and annual average NO₂ levels (µg/m³) in Prince George with other B.C. locations

For NO, the annual average at Plaza was the 6th highest across the province and the 2nd highest for sites outside Metro Vancouver. The highest one-hour NO levels in 2010 were recorded at Richmond South followed by the Prince George Plaza site.

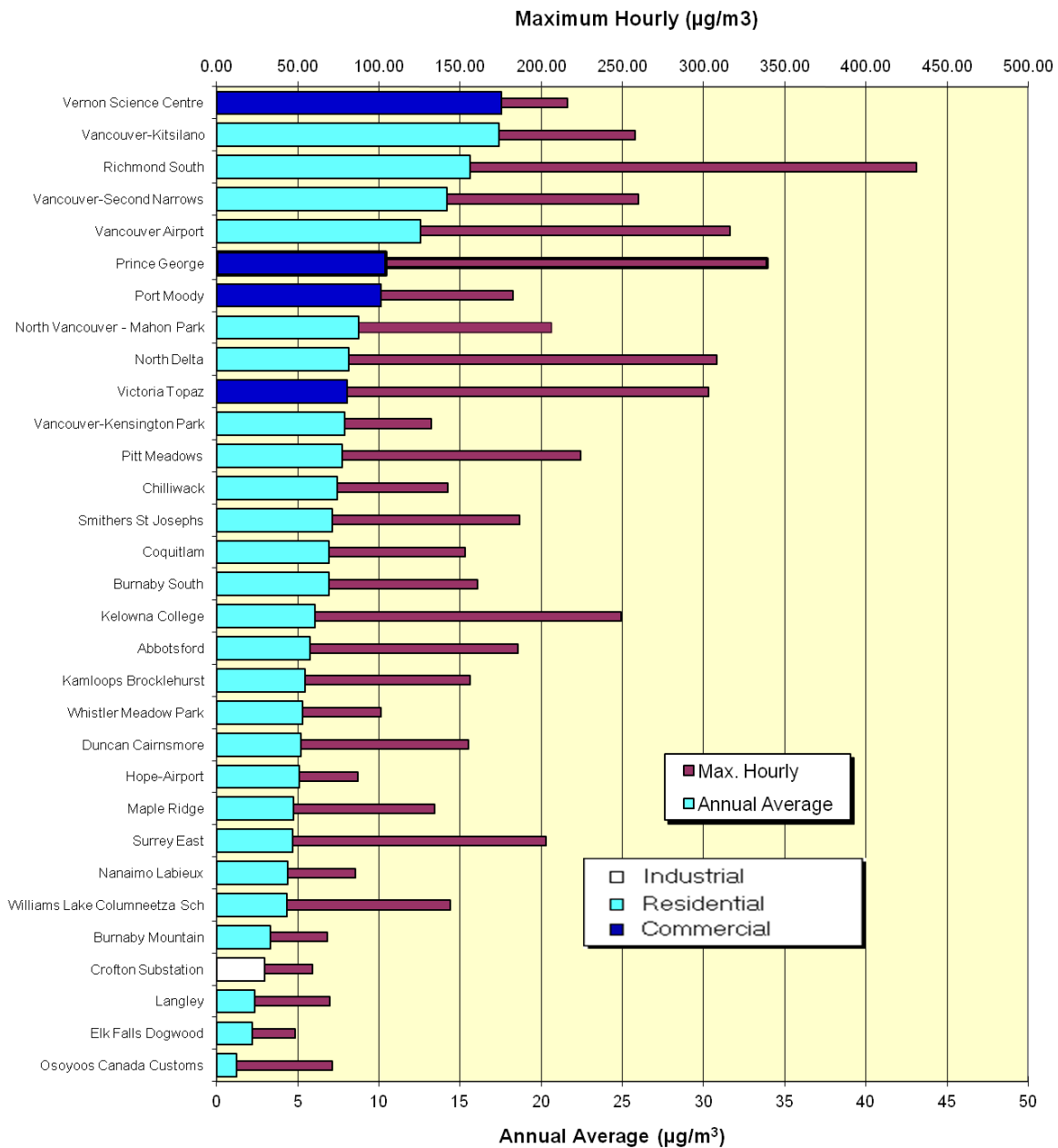


Figure 3.5.10 Comparison of 2010 maximum hourly and annual average NO levels ($\mu\text{g}/\text{m}^3$) in Prince George with other B.C. locations

3.6 Carbon Monoxide

Carbon monoxide is a colourless, odourless and tasteless gas. It is toxic at sufficiently high concentrations and death can result from asphyxiation. Hemoglobin in the blood has an affinity for CO that is about 200 times greater than for oxygen, so the presence of CO reduces the blood's ability to carry oxygen.

In an urban setting, CO levels are typically one hundred percent anthropogenic and result from the incomplete combustion of fossil fuels, mainly in motor vehicles. CO is produced when the oxygen supply is reduced (air to fuel ratio is too low), and when the temperature of combustion is lowered, slowing the oxidation process.

There is only one carbon monoxide monitor in Prince George. The API Model 300A CO monitor (Fig. 3.6.1) was installed at Plaza in late December 2003. This analyzer has a detection limit of $116 \mu\text{g}/\text{m}^3$ (100 ppb) and operates in the range of 0-50 ppm based on the air quality objectives for CO. Monitoring of CO is based on non-dispersive infrared radiation.



Fig 3.6.1 Teledyne - API CO monitor

The quality of the CO data at Plaza was evaluated through monthly calibrations as well as independent auditing in May and October 2010. The audit results were excellent in May, but the instrument failed the October audit due to unstable flow (Table B-1). After quality assurance and quality control were applied to the data, 86.8% of data were valid in 2010.

3.6.1 CO Results

Short term monitoring of CO was done in the Hart Highlands in 1997 and 1998 and at Lakewood in 1997. Data for those two sites are available at the Ministry's regional office in Prince George.

Figure 3.6.2 shows the summary of monthly CO levels recorded at the Plaza site. October 2010 is not included due to missing data. Actual values and additional information can be found in Table C-1.16 of Appendix C. The highest monthly average, the highest 8-hour value and the maximum hourly value occurred in August due to forest fire activity. Typically the highest levels occur during the winter season. No exceedances of the one-hour ($14300 \mu\text{g}/\text{m}^3$) or 8-hour ($5500 \mu\text{g}/\text{m}^3$) Level A objectives have ever been recorded.

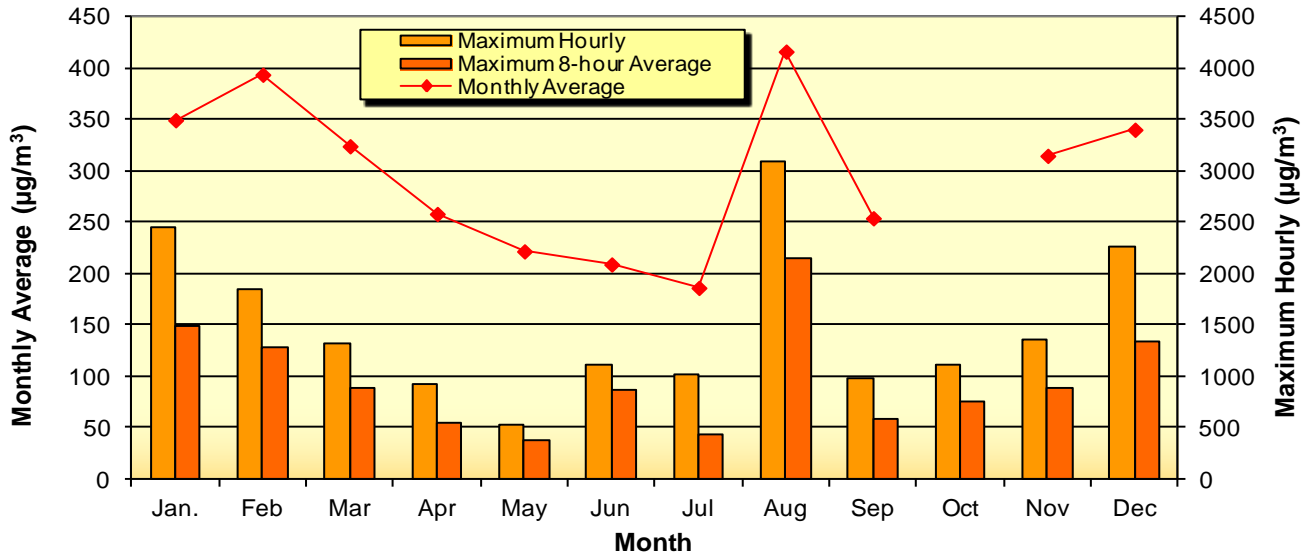


Figure 3.6.2 2010 average and maximum hourly and 8-hour average CO levels ($\mu\text{g}/\text{m}^3$) by month in Prince George

Figure 3.6.3 shows the range in the average monthly CO levels at the downtown location since 2003. October 2010 was excluded due to insufficient data. The long term trend indicates that the highest levels occur during the winter and are the lowest during the summer. High levels of CO are somewhat expected in the winter because inversions tend to be more frequent and longer lasting. As well, the increased usage of heating fuels leads to greater contributions of the pollutant at this time of year. In 2010, CO levels were below average for every month except August. Record low monthly averages were recorded for nine months (January, February, March, May, June, July, September, November and December).

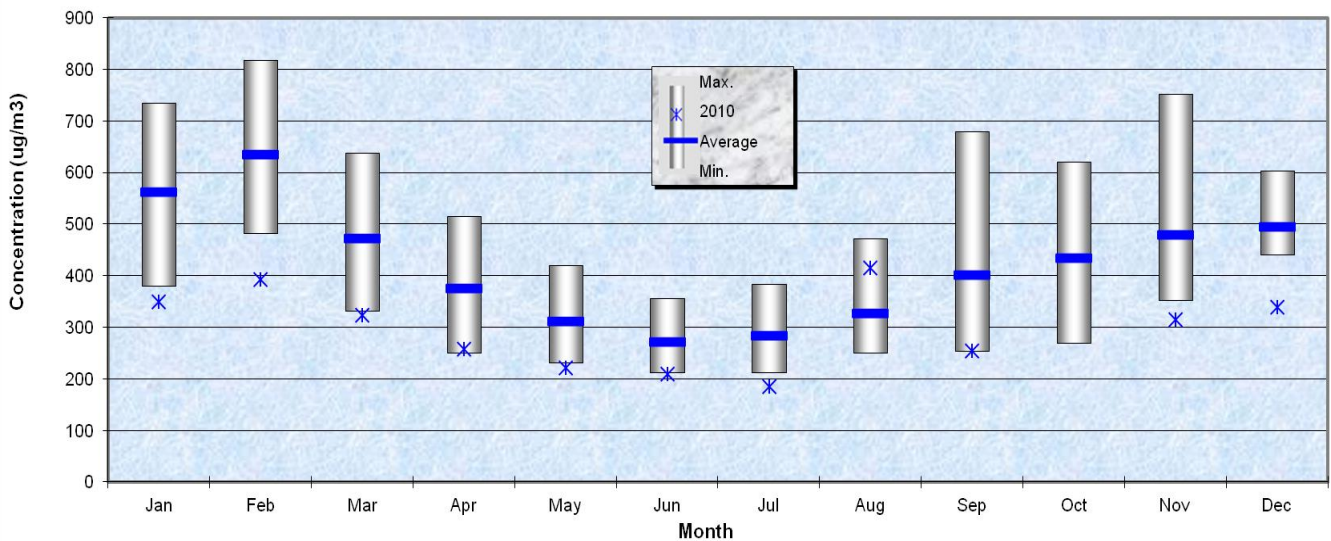


Figure 3.6.3 Comparison of 2010 with long-term average monthly CO levels ($\mu\text{g}/\text{m}^3$) at the Plaza site since 2003

Figure 3.6.4 shows the 2010 CO pollution rose for the Plaza site (wind speeds ≥ 1 m/s). Low levels ($<200 \mu\text{g}/\text{m}^3$) occurred more often (approximately 50-60% of the time) when winds were blowing from the north-northeast and less often (20% of the time) when winds were blowing from the east-southeast. The highest CO levels ($>500 \mu\text{g}/\text{m}^3$) occurred with winds blowing from almost any sector. This is probably due to the many different sources of CO in the air shed. The average concentration during light winds was $445 \mu\text{g}/\text{m}^3$ in 2010 compared to the annual average of $296 \mu\text{g}/\text{m}^3$.

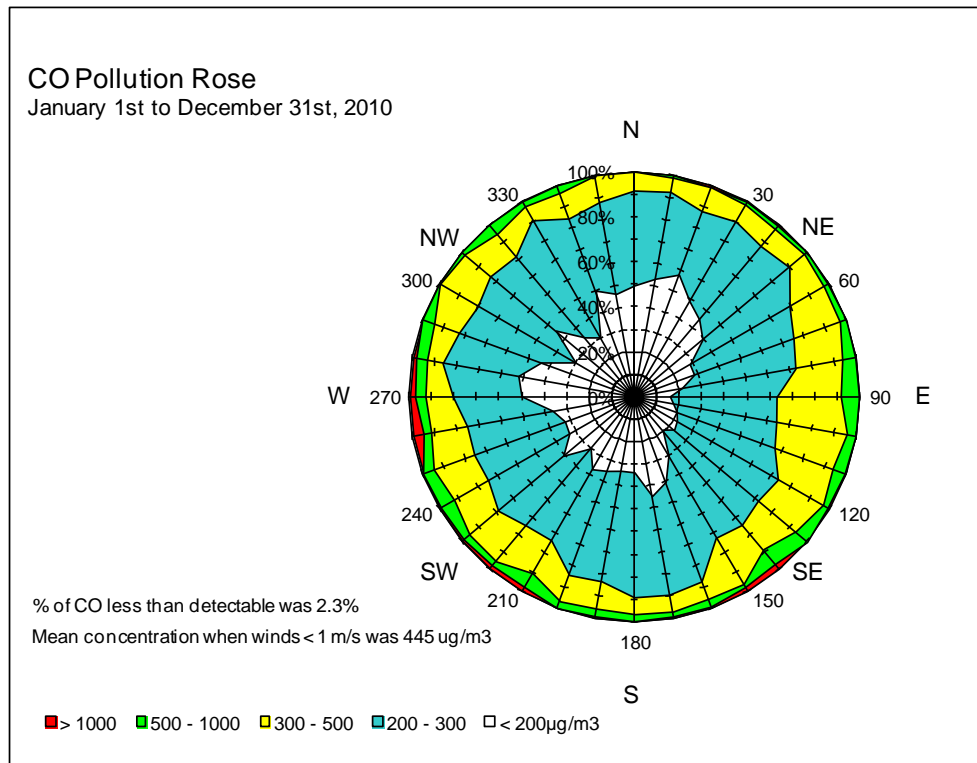


Figure 3.6.4 CO pollution rose at the Plaza site for 2010

Figure 3.6.5 shows the typical diurnal patterns of CO during specified months of the year in 2010. All months were analysed but only selected months are shown to represent the seasonal pattern. Typically, higher levels occur in the evening and morning and lower levels either in the late afternoon or just before sunrise. Higher evening levels occurred in all months but increased earlier in February and later in June. This seems to coincide with sunset and the nocturnal inversion starting to develop. CO peaks occur later in the morning in winter than in the remainder of the year, indicating a later inversion break-up during the winter (Fig 3.6.5). Levels are generally higher in winter compared to other seasons, which is similar to almost all other pollutants.

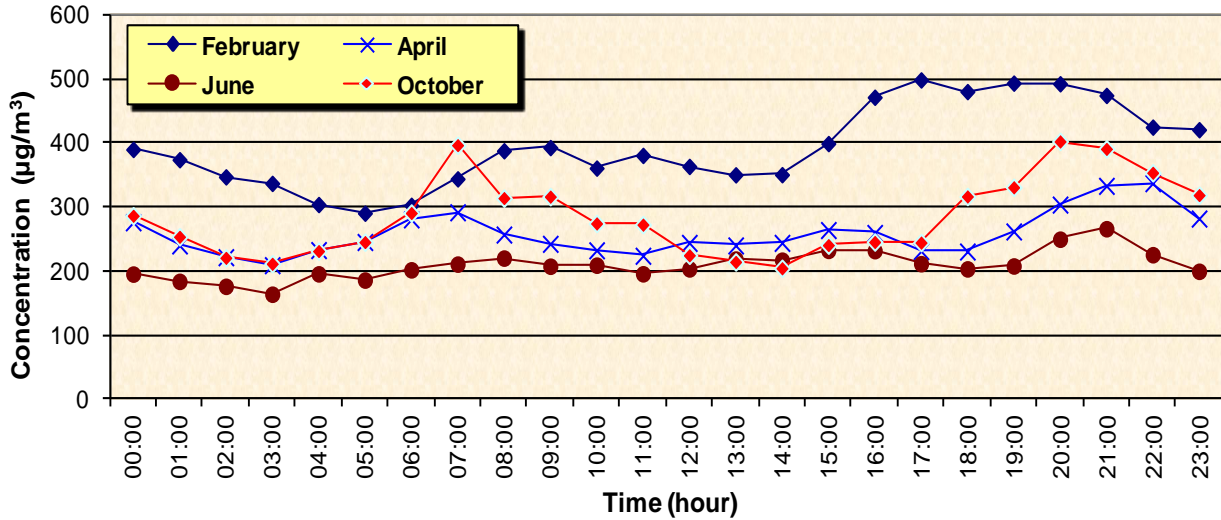


Figure 3.6.5 Diurnal average CO pattern (µg/m³) in Prince George in 2010

3.6.2 CO Annual Trend

Table C-2.23 and Figure 3.6.6 summarize the annual trend for CO data collected at the Plaza site since the monitor was installed in 2003. Throughout the historical record, annual average values have continued to decrease. This is in agreement with global background CO levels which have been decreasing since the 1980s (Novelli, 1994). In contrast, the maximum short term average (1-hour) in 2010 was the highest recorded since 2007.

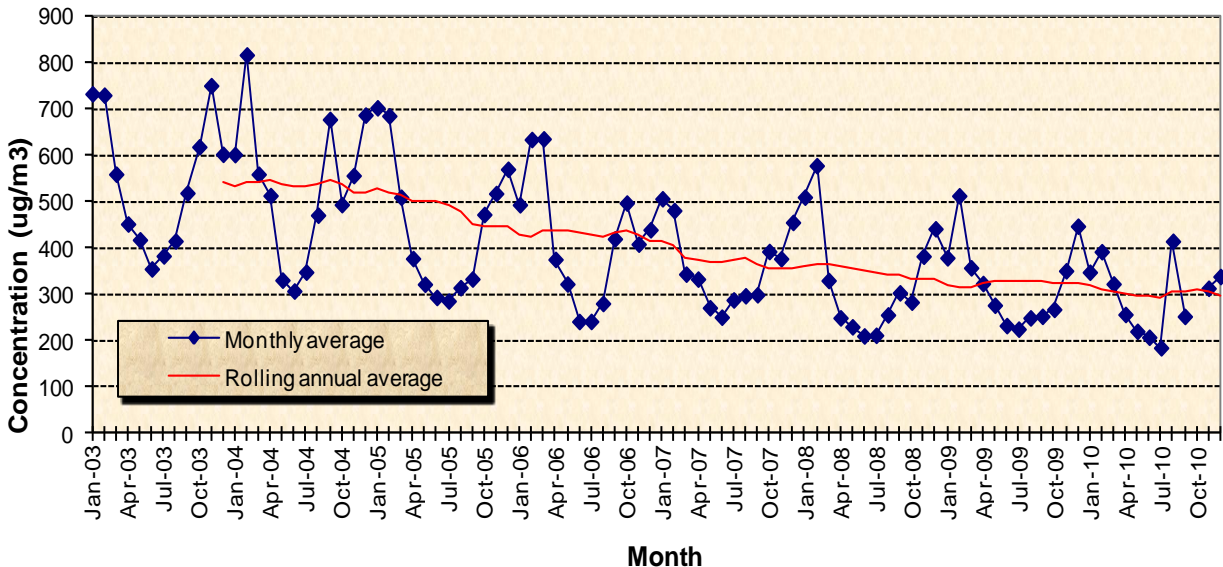


Figure 3.6.6 Rolling annual and monthly CO (µg/m³) trends in Prince George

Table C-3.9 shows the annual percentiles of both the 1-hour and 8-hour CO values at the Plaza site for the eight-year data record. In 2010, all percentiles for both averaging times set record lows.

3.6.3 Comparison of Prince George CO Levels with Other B.C. Locations

Figure 3.6.7 compares the 2010 CO annual averages at the Prince George site with averages from other monitoring sites in B.C. with greater than 90% data capture. A comparison with other sites in Canada can be obtained in the “National Air Pollution Surveillance (NAPS) Network Annual Data Summary” at: http://www.etc-cte.ec.gc.ca/publications/napsreports_e.html. Because of instrument problems with the CO monitor at Plaza, data for Oct 10 – Nov 5 were excluded in the annual average for all sites in Figure 3.6.7. This was done to help remove bias related to seasonal fluctuations in CO concentrations. Vancouver-Kitsilano recorded the highest average in B.C. in 2010. Prince George recorded the 6th highest annual average out of the 23 sites in the province and the highest maximum hourly value. Plaza was one of the three sites that recorded hourly concentrations greater than 3000 $\mu\text{g}/\text{m}^3$ in 2010.

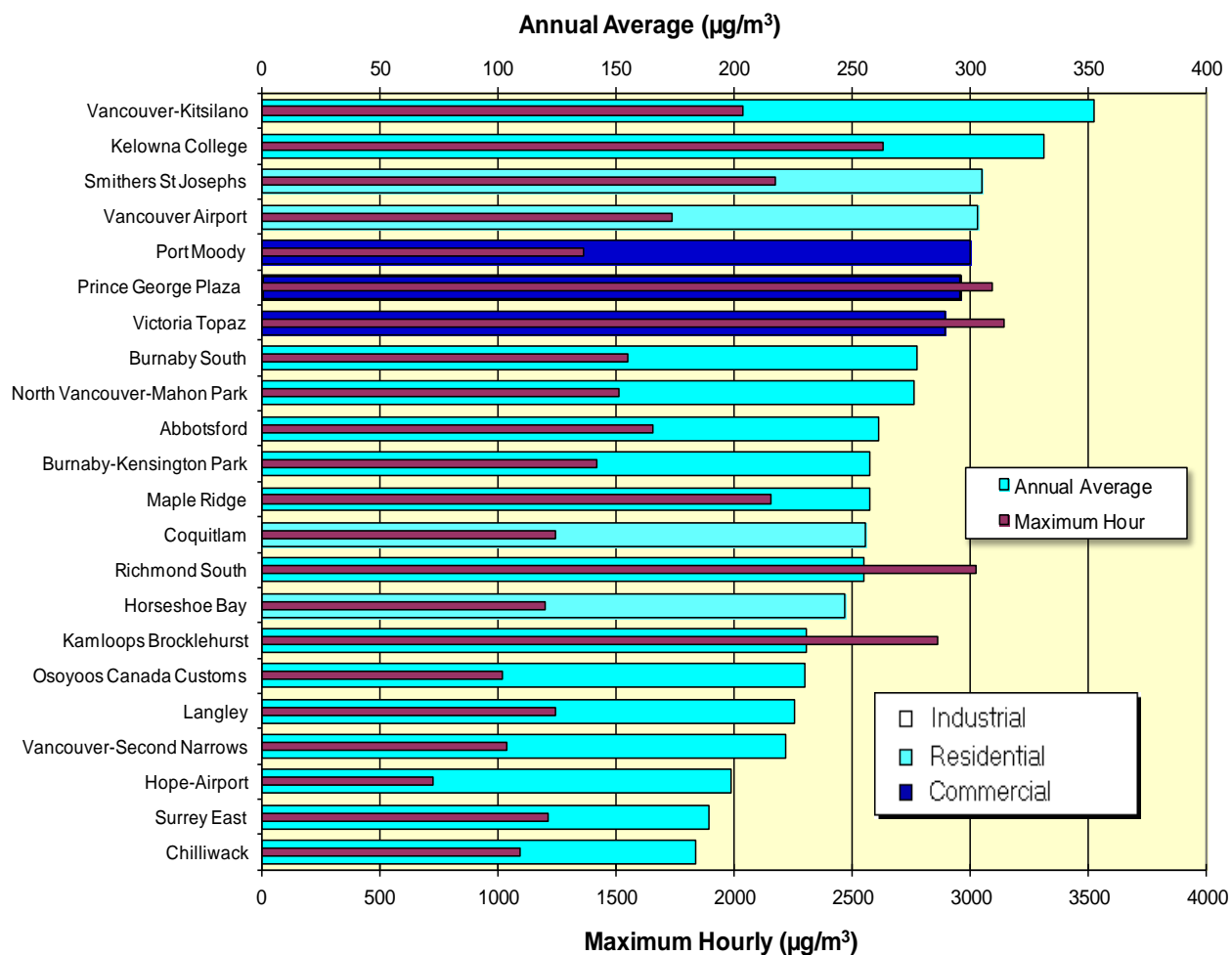


Figure 3.6.7 Comparison of 2010 maximum hourly and annual average CO levels ($\mu\text{g}/\text{m}^3$) in Prince George with other B.C. locations

3.7 Volatile Organic Compounds

Volatile Organic Compounds (VOC) is a general term for a class of organic compounds primarily made up of hydrocarbons. Hydrocarbons contain carbon atoms, as all organic compounds do, and hydrogen atoms. With the exception of methane, the primary sources of VOC are industry, vehicle emissions, refrigerants, and cleansers. Not all VOC are hazardous and most are harmful at high concentrations. The provincial government has not established objectives for any VOCs. VOCs are known to react with other chemicals in the presence of sunlight to produce secondary pollutants such as ozone.

There were about 150 different types of VOC monitored using SUMMA Canisters at the Plaza 400 site. These samples were collected once every six days based on the NAPS schedule. The canisters were sent to the federal laboratory in Ottawa for analysis. Table 3.7 gives the annual average and maximum concentrations of different VOCs monitored for the past five years. Compounds with maximum concentrations that have remained $< 1 \mu\text{g}/\text{m}^3$ since 2005 are listed below.

VOCs max. $< 0.01 \mu\text{g}/\text{m}^3$

Hexachlorobutadiene
Ethylbromide
Vinylchloride
Bromodichloromethane
1,3-Dichlorobenzene
1,1,2-Trichloroethane
Dibromochloromethane
EDB
1,1,2,2-Tetrachloroethane
trans-1,2-Dichloroethylene
1,1-Dichloroethylene
1,1-Dichloroethane
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene

VOCs max. $< 0.1 \mu\text{g}/\text{m}^3$

2,2-Dimethylpropane
tert-Butylbenzene
3-Methyl-1-pentene
Bromoform
Chloroethane
4-Methyl-1-pentene
2,2,5-Trimethylhexane
1,2-Diethylbenzene
Dibromomethane
2,2,3-Trimethylbutane
Cyclohexene
trans-2-Heptene
trans-3-Heptene
1-Methylcyclohexene
1,2-Dichloropropane

trans-4-Methyl-2-pentene
Hexylbenzene
1-Butyne
MTBE
Chlorobenzene
1,2-Dichlorobenzene
Benzylchloride
cis-2-Heptene
trans-1,2-Dimethylcyclohexane
1,4-Dichlorobutane

VOCs max. $< 1 \mu\text{g}/\text{m}^3$

1,2-Dichloroethane
2,2-Dimethylbutane
trans-2-Pentene
2-Methyl-1-butene
2,4-Dimethylpentane
Freon 113
Carbontetrachloride
1,3,5-Trimethylbenzene
1,2,3-Trimethylbenzene
1-Hexene
iso-Butylbenzene
Tetrachloroethylene
4-Ethyltoluene
1-Pentene
1-Propyne
cis-2-Pentene
2,3,4-Trimethylpentane
2-Ethyltoluene
Trichloroethylene
2,4-Dimethylhexane
1,4-Diethylbenzene

Indane
2,2-Dimethylpentane
1-Undecene
4-Methylheptane
n-Propylbenzene
2,5-Dimethylhexane
3-Methyl-1-butene
1-Decene
Chloroform
1-Octene
1-Nonene
cis-2-Hexene
1-Methylcyclopentene
cis-3-Methyl-2-pentene
Freon 114
cis-4-Methyl-2-pentene
Cyclopentene
Bromomethane
1,4-Dichlorobenzene
iso-Propylbenzene
trans-2-Hexene
1,2,4-Trichlorobenzene
n-Butylbenzene
trans-1,4-Dimethylcyclohexane
1,3-Diethylbenzene
1,1,1-Trichloroethane
trans-3-Methyl-2-pentene
trans-3-Methyl-2-pentene
Dimethylcyclohexane
cis-1,4/t-1,3-,3,6-Dimethyloctane
cis-1,2-Dimethylcyclohexane
sec-Butylbenzene

Table 3.7 Annual Average and Maximum VOC concentrations recorded in Prince George in 2005-2010

Compounds	2005 Avg 22 samples	2006 Avg 40 samples	2007 Avg 51 samples	2008 Avg 56 samples	2009 Avg 48 samples	2005-09 Max	2005-09 Min	2010 Avg 40 samples	2010 Max	2010 Min
Propane	5.51	4.99	3.95	5.27	3.85	24.29	0.64	3.62	14.89	0.37
Butane	4.03	4.33	3.51	4.12	3.21	22.5	0.42	2.85	12.21	0.25
a-Pinene	4.26	4.43	3.24	3.38	2.91	20.24	0	3.11	13.48	0
b-Pinene	2.48	2.99	2.34	2.57	2.31	17.98	0	2.35	9.06	0
Isopentane	3.02	3.16	2.9	3.31	2.37	16.65	0.31	2.01	7.93	0.26
Toluene	3.44	3.14	3.03	3	2.13	27.22	0.17	2.22	8.14	0.30
Ethylene	3.35	2.46	1.72	2.14	1.53	14.18	0.23	1.55	6.26	0.31
Isobutane	2.09	2.12	1.84	2.29	1.50	11.68	0.2	1.25	5.98	0.14
Pentane	1.31	1.67	1.33	1.65	1.09	9.48	0.16	0.94	4.73	0.11
Ethane	3.13	3.08	2.62	3.33	3.00	8.76	0.57	2.83	8.08	1.06
Isoprene	0.34	0.76	0.82	0.6	1.43	8.75	0.01	1.21	10.31	0.01
Benzene	1.23	1.1	0.82	1.05	0.68	7.91	0.14	0.65	3.12	0.08
Propylene	1.2	0.98	0.76	1.01	0.68	7.78	0.09	0.64	3.91	0.11
m and p-Xylene	1.73	1.48	1.45	1.46	1.02	7.75	0.03	0.86	4.71	0.13
Hexane	0.65	1.21	0.76	1.04	0.52	6.69	0.07	0.46	2.68	0.05
2,2,4-Trimethylpentane	1.4	1.26	1.27	1.13	0.90	5.33	0.06	0.61	2.01	0.09
2-Methylpentane	0.76	1.11	0.99	1.13	0.75	5.57	0	0.57	2.36	0.06
d-Limonene	0.13	1.4	0.99	1.03	1.12	9.18	0	0.96	4.97	0
p-Cymene	1	1.39	0.9	1.22	0.99	7.06	0.01	0.96	5.62	0
Acetylene	1.88	1.78	1.41	1.23	0.99	13.11	0.19	0.79	3.17	0.14
1-Butene/Isobutene	0.89	0.78	0.59	0.75	0.44	4.05	0.08	0.40	2.03	0.13
Naphthalene	0.41	0.32	0.48	0.6	0.33	3.37	0	0.23	1.36	0
3-Methylpentane	0.62	0.75	0.66	0.78	0.48	3.65	0.07	0.38	1.55	0.05
Freon12	2.69	2.79	2.73	2.63	2.53	3.54	2.16	2.55	2.90	2.16
3-Methylhexane	0.54	0.59	0.56	0.61	0.44	3.3	0	0.42	1.63	0.07
Methylcyclopentane	0.33	0.49	0.37	0.48	0.27	2.87	0.04	0.22	0.90	0.02
Freon22	0.91	0.82	1.38	1.02	1.47	11.47	0.57	1.20	4.69	0.71
Styrene	0.12	0.09	0.09	0.14	0.07	2.74	0	0.09	1.18	0
Heptane	0.45	0.74	0.54	0.61	0.48	6.22	0	0.43	1.53	0.06
2-Methylhexane	0.49	0.53	0.49	0.54	0.36	2.87	0.04	0.33	1.22	0.05
o-Xylene	0.52	0.47	0.47	0.48	0.34	2.51	0.02	0.28	1.53	0.04
trans-2-Butene	0.42	0.42	0.28	0.38	0.24	2.31	0.02	0.21	1.53	0.03
1,2,4-Trimethylbenzene	0.48	0.43	0.41	0.46	0.29	2.25	0	0.24	1.34	0
Freon11	1.49	1.59	1.59	1.66	1.53	3.84	1.19	1.64	1.90	1.44
2,3-Dimethylpentane	0.38	0.32	0.29	0.34	0.28	1.86	0.03	0.25	0.94	0.05
Ethylbenzene	0.48	0.4	0.35	0.38	0.27	1.82	0.02	0.22	1.06	0.04
Camphene	0.67	0.62	0.57	0.56	0.64	3.17	0.02	0.65	2.38	0.03
cis-2-Butene	0.26	0.28	0.21	0.27	0.15	1.6	0.01	0.13	0.94	0.02
1,3-Butadiene	0.21	0.15	0.11	0.16	0.09	1.53	0.01	0.08	0.37	0.01
Chloromethane	1.12	1.12	1.14	1.14	1.24	1.46	0.88	1.11	1.37	0.87
Decane	0.63	0.25	0.22	0.28	0.19	8.4	0.01	0.14	0.65	0.02
2,3-Dimethylbutane	0.21	0.21	0.24	0.25	0.17	1.32	0.02	0.12	0.52	0.02
2-Methyl-2-butene	0.31	0.27	0.21	0.27	0.25	1.95	0.02	0.17	0.77	0.02
Undecane	0.6	0.23	0.22	0.3	0.25	7.95	0	0.13	0.62	0.01
Dodecane	0.23	0.17	0.2	0.28	0.19	1.05	0	0.12	0.44	0
3-Ethyltoluene	0.26	0.23	0.21	0.23	0.16	1.07	0	0.13	0.65	0
Methylcyclohexane	0.19	0.45	0.31	0.3	0.24	5.49	0.02	0.23	0.85	0.03
Nonane	0.22	0.22	0.18	0.21	0.17	1.66	0.01	0.12	0.46	0.02
Dichloromethane	0.22	0.22	0.26	0.29	0.30	1.49	0.13	1.15	22.83	0.18
Cyclohexane	0.22	0.41	0.25	0.27	0.20	3.77	0.02	0.21	0.89	0.02
Octane	0.15	0.3	0.21	0.22	0.18	3.32	0.01	0.14	0.42	0.02
2-Methylheptane	0.15	0.24	0.18	0.18	0.14	2.21	0.01	0.12	0.35	0.02
3-Methylheptane	0.13	0.17	0.15	0.15	0.12	1.07	0.01	0.09	0.31	0.01
trans-2-Octene	0.04	0.09	0.06	0.06	0.05	1	0	0.04	0.13	0
cis-1,3-	0.05	0.1	0.07	0.07	0.06	1.17	0	0.05	0.15	0.01

4. AIR QUALITY ADVISORIES

The Ministry of Environment provides an air quality index that is updated twice daily during the work week that is accessible to the public via telephone voice message (565-6457). Air quality index values for selected pollutants are also provided to the local newspaper, radio and T.V. station on a daily basis. The index is also provided to the Weather Network and is available online at www.bcairquality.ca/readings/index.html

When air quality deteriorates to "poor" or "very poor" the Ministry issues air quality advisories to the public through the local news media, unless circumstances make it unnecessary or impractical. These may include when the objective is exceeded after Ministry's business hours, or when the weather forecast is expected to improve in a short time frame. Advisories have been mainly limited to PM₁₀ or PM_{2.5} levels to date, and are issued when the rolling average 24-hour PM₁₀ level exceeds the 50 µg/m³ objective or the rolling average 24-hour PM_{2.5} level exceeds the 25 µg/m³ objective, and the meteorological forecast shows continuing limited dispersion in the airshed. The Ministry of Environment recognizes that health effects from fine particulates do not show a threshold and therefore effects can occur at levels significantly lower than the provincial objective. Ozone advisories are normally issued whenever ozone levels are expected to exceed the one-hour objective of 160 µg/m³. There were no advisories for ozone issued in 2010.

There were six occurrences in 2010 of the 24-hour rolling average PM₁₀ levels exceeding 50 µg/m³ at the Plaza station (compared to 10 occurrences in 2009), and five occurrences of the 24-hour rolling average PM_{2.5} levels exceeding 25 µg/m³ (compared to 6 occurrences in 2009). The duration of these occurrences ranged from 10 to 158 hours. Out of these exceedances, six air quality advisories were issued. Three of these occurrences lasted less than 30 hours. The maximum 24-hour PM₁₀ rolling average during these advisories was 207.5 µg/m³ and the maximum 24-hour PM_{2.5} rolling average was 177.1 µg/m³. These advisories are listed in Table 4.1 along with the duration of the episode and the maximum 24-hour rolling average recorded during each period. Advisories were not issued for other exceedances, either because the elevated levels occurred at night, on weekends when staff are not on duty, or because improvement in meteorological conditions was expected within 6 hours.

Table 4.1 Air Quality Advisories Issued in 2010

Start Date (PST)	End Date (PST)	Duration (hours)	Max. 24-hour PM ₁₀ Level (µg/m ³)	Max. 24-hour PM _{2.5} Level (µg/m ³)
Jan 6 09:00	Jan 7 09:00	24	40.7	27.2
Apr 15 12:30	Apr 16 15:30	27	57.4	13.6
Jun 21 10:30	Jun 24 08:30	70	51.8	36.2
Aug 5 10:00	Aug 7 11:00	49	82.8	66.4
Aug 16 13:00	Aug 23 09:00	164	207.5	177.1
Dec 22 09:30	Dec 23 07:30	22	49.5	28.0

Figure 4.1 shows the number of advisories issued in Prince George since 1995, as well as the number of days air quality advisories were issued. The duration of air quality advisories in Prince George has ranged from one day to as many as eight days (February, 2005). Historically, air quality advisories in 2005 were the longest in duration but the fewest number of advisories occurred. In contrast, air quality advisories during 2000 were the shortest in duration (maximum 2 days). In 2010, the number of advisories and the duration of the advisories were the third highest in the data record. It is important to note that air quality advisories may not be an indication of air quality trends. Air quality advisories are issued based on a weather forecast and professional judgement.

Therefore, the accuracy of the forecast may determine the number and duration of advisories. Also, if particulate levels exceed the provincial objectives on weekends when staff are unavailable, air quality advisories are not issued.

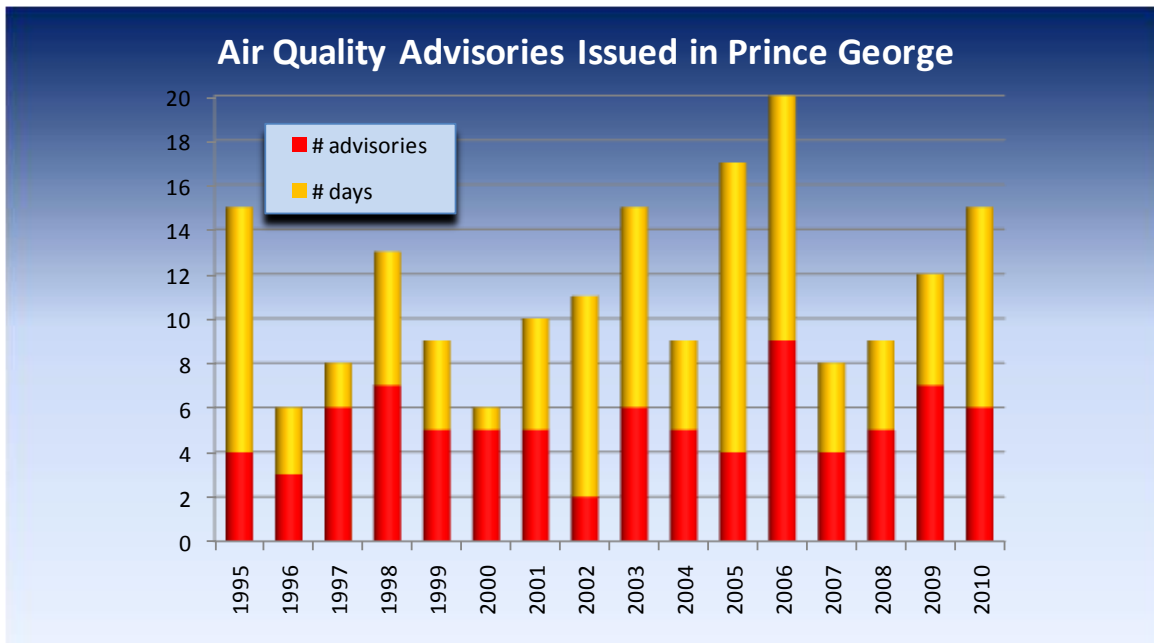


Figure 4.1 Historical trend of air quality advisories issued in Prince George since 1995

5. CONCLUSIONS

Air quality is typically poorest in the winter and fall because meteorological conditions are less favourable for the dispersion of pollutants. This condition is exacerbated by topography, as most emission sources are located in a river valley where the majority of the population resides. This situation is quite common across BC and is typical of the settlement pattern of the province. Communities were built near water sources for travel, drinking water, and irrigation.

The following trends and results were measured in 2010.

PM₁₀

Annual average continuous PM₁₀ levels at all three continuous monitoring sites increased in 2010 from 2009. The maximum daily values were the highest ever recorded at all three sites. This was due to high particulate levels in August from forest fire activity. Exceedances of the Level B 24-hour average PM₁₀ objective (50 µg/m³) ranged from 1.7% at Gladstone to 4.1% at the BCR site. The frequency of exceedances of the level B objective increased at all three sites. The hourly value recorded at Plaza was the highest recorded since 1996 and at Gladstone it was the highest ever recorded. The monthly average in August at all three monitoring sites were the highest ever recorded for that month.

Western Acres (a background monitoring site) was the only site that monitored non-continuous PM₁₀ in 2010 and that monitoring program ended in April 2010. Any discrepancy in the trend between the continuous and non-continuous monitors was mainly due to the sample frequency of the non-continuous monitors.

PM_{2.5}

The annual average PM_{2.5} level in 2010 increased considerably at the two continuous monitors in Prince George. However, the continuous monitor installed in late 1997 has shown a decline in the annual average of about 28% from 2004 to 2009. There were at least nine days in which the new provincial 24-hour objective were exceeded at both sites in 2010. The monthly average in August at both monitoring sites were the highest ever recorded at those sites.

TRS

The annual average TRS concentration and the frequency of exceedances of the Level A 1-hour and the Level A and B 24-hour objectives increased at Plaza and Jail monitoring sites. But the frequency of exceedance of the Level B 1-hour objective decreased at these two sites. The annual averages and exceedances of the Level A 1-hour and 24-hour objectives at the Plaza site was the highest recorded since 1990. The frequency of exceedances of the Levels A 1-hour and 24-hour objectives at Lakewood monitoring site decreased in 2010. The Jail site recorded two months in which monthly averages were the lowest ever recorded for those months in 2010, whereas the Plaza site recorded high monthly averages for two months in 2010.

SO₂

The annual average SO₂ levels at Plaza, Jail, and CBC sites increased in 2010, but decreased at Gladstone and Marsulex-BCR sites. The annual average SO₂ level at the CBC site was the highest recorded at that site since 2005 and is the only site that has exceeded the hourly Level A objective (2009). None of the SO₂ monitoring sites in Prince George exceeded the daily Level A objective in 2010, but CBC did reach 151 µg/m³ in December. Record low monthly averages were recorded for at least one month at the Jail, CBC and Gladstone sites in 2010. The Gladstone site also recorded record high monthly averages for February and May which were due to a shorter monitoring period compared to the other three sites.

O₃

The annual average ozone level increased from 2009 to 2010. The number of Level A 1-hour objective (100 µg/m³) and Level B 24-hour objective (50 µg/m³) exceedances also increased in 2010. Most of the hourly Level A objective exceedances and the maximum hourly value (121 µg/m³) occurred in May. The one-hour Level B objective (160 µg/m³) was not exceeded at any point throughout the year. There was one record high monthly average (May) and one record low monthly average (February) in 2010.

NO₂

The annual average NO₂ level at the Plaza site decreased considerably in 2010 from 2009 and was the lowest annual average ever recorded at that site. However, the maximum 1-hour value (178 µg/m³) recorded in December was the highest value recorded at that site since 1997. No exceedances of the NO₂ objective have ever been recorded. There were two record low monthly averages recorded in 2010 (April and October).

CO

The annual average CO concentration at the Plaza site in 2010 was the lowest recorded since monitoring began in 2003. Annual averages have steadily been decreasing at this site since 2003, and no exceedances of the 1-hour (14300 µg/m³) or 8-hour (5500 µg/m³) Level A provincial objectives have occurred. There were eight months in 2010 that reached record low monthly averages.

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APPENDIX "A"

B.C. Ambient Air Quality Objectives

Air quality objectives of B.C. are generally based on objectives set by the Federal Government in the Clean Air Act. The objectives are based on protecting human health and protecting the environment. Objectives are often set at three levels.

- Level A Maximum Desirable for 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.

Table A -1 Provincial air quality objectives ($\mu\text{g}/\text{m}^3$)

Contaminant	Averaging Period	Level A	Level B	Level C
Total Reduced Sulphur	1 hour	7	28	
	24 hour	3	6	
Sulphur Dioxide	1 hour	450	900	1300
	24 hour	160	260	360
	Annual	25	50	80
Nitrogen Dioxide	1 hour		400	1000
	24 hour		200	300
	Annual	60	100	
Total Suspended Particulate (TSP)	24 hour	150	200	260
	Annual	60	70	75
Particulate Matter (PM₁₀)	24 hour		50	
Fine Particulate Matter (PM_{2.5})	24 hour		25	
	Annual	6	8	
Ozone	1 hour	100	160	300
	24 hour	30	50	
	Annual		30	
Carbon Monoxide	1 hour	14,300	28,000	35,000
	8 hour	5500	11,000	14,300

Appendix "B"

Monitoring Program Notes

i) Continuous Monitor Audit Results

Multi-point (five point) calibrations are performed monthly in addition to audit checks. The continuous monitor audit (the five-point average) results are listed below (instrument calibration drifts are listed in percentages). In 2010, according to the audits performed during May and October, all but two continuous gaseous monitor audits performed within the allowable instrument deviation as determined by an auditor from the Ministry of Environment.

Table B – 1 2010 continuous monitor audit results

Pollutant	Station	May	Oct.
PM ₁₀ (TEOM)	Plaza	0.1%	-0.8%
	BCR	-2.0%	-2.0%
	Gladstone	-3.3%	-5.6%
PM _{2.5} (TEOM)	Plaza	-10.7%	-1.1%
	Gladstone	-2.4%	-3.1%
TRS (TECO 43i) (API 102)	Plaza	-5.3%	-1.4%
	Lakewood School	-4.6%	-1.8%
	Jail	-0.9%	-1.9%
SO ₂ (TECO 43A)	Plaza	-2.0%	-0.6%
	CBC	-1.7%	-0.4%
SO ₂ (TECO 43A) (API 100)	Jail	1.5%	-3.6%
	Gladstone	-2.2%	-6.7%
	Marsulex-BCR	-4.9%	-4.0%
O ₃ (API 400)	Plaza	7.0%	-4.1%
NO _x (API 200)	Plaza	0.6%	-5.4%
CO (API 300)	Plaza	3.0%	* Fail

* Failed audit due to mechanical issues (unstable flow)

Excellent	≤ +5%
Satisfactory	+5% to +10%
Unsatisfactory	≥ +10%

For Ozone monitors

Excellent	≤ +4%
Satisfactory	+4% to +7%
Unsatisfactory	≥ +7%

ii) Instrument Operating Hours

Table B-2 shows the percent of valid monitoring time at each station for continuous instruments. Within the 8760 monitoring hours in a 365-day year, ambient air analyzers require both scheduled and unscheduled maintenance to maintain the instrument's calibration and sensitivity to the appropriate standard. Hours of monitoring are reduced by automated daily calibrations, monthly five point calibrations, semi-annual audits, as well as power failures, instrument malfunction and occasional operator error.

Due to scheduled daily and monthly calibrations, the highest percentage of valid time available would be 96% for all monitors except the O₃ analyzer and TEOMs (PM₁₀ and PM_{2.5}). A monitor with a low percentage of valid time may bias the monitoring results, especially if the pollutant monitored is seasonally dependent. 75% of 8784 hours (6588 hours) is considered acceptable as actual instrument operating hours.

Table B – 2 Instrument percent valid data for 2010

Pollutant	Station	% of Valid Data
PM ₁₀	Plaza	97.9%
	Gladstone	96.5%
	BCR	93.0%
PM _{2.5}	Plaza	98.8%
	Gladstone	99.0%
TRS	Plaza	93.3%
	Lakewood	95.5%
	Jail	94.7%
SO ₂	Plaza	94.1%
	Jail	95.4%
	CBC	95.1%
	Gladstone	94.3%
	Marsulex - BCR	95.5%
O ₃	Plaza	98.0%
NO ₂	Plaza	93.9%
CO	Plaza	86.8%

Appendix "C"

Additional Data Summary

i) Monthly Data Summary Tables:

Tables C – 1.1 through C – 1.15 summarize 2010 ambient air quality data on a monthly basis for all pollutants and monitoring locations included in this report. The summaries include (among other values) monthly averages, maximum hourly averages, exceedances, maximum 24-hour averages and the number of hours the instrument was in operation.

Table C – 1.1 2010 monthly summary of continuous PM₁₀ data from the Plaza site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	Minimum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
			>50 $\mu\text{g}/\text{m}^3$	>100 $\mu\text{g}/\text{m}^3$				
January	14.8	75	0	0	34.3	40.7	2.8	714
February	16.3	61	0	0	31.8	31.8	6.6	669
March	22.7	175	1	0	55.1	61.3	3.2	739
April	19.7	193	2	0	56.7	57.4	5.8	720
May	16.2	72	0	0	30.8	32.8	3.6	661
June	15.0	116	0	0	48.6	51.8	2.4	719
July	16.5	98	0	0	34.1	41.8	2.3	740
August	37.4	365	7	2	194.1	207.5	4.7	744
September	15.6	70	0	0	33.7	35.5	2.9	718
October	15.2	104	0	0	42.0	43.1	2.8	741
November	19.0	91	1	0	53.0	53.5	3.5	687
December	15.9	71	0	0	40.3	49.5	4.9	723
Annual	18.8	365	11	2	194.1	207.5	2.3	8575

Table C – 1.2 2010 monthly summary of continuous PM₁₀ data from the Gladstone site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	Minimum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
			>50 $\mu\text{g}/\text{m}^3$	>100 $\mu\text{g}/\text{m}^3$				
January	13.5	80	0	0	35.9	38.1	2.8	738
February	14.1	51	0	0	29.4	31.3	2.9	667
March	14.6	151	0	0	31.7	37.9	3.8	735
April	10.7	68	0	0	23.7	27.4	3.5	720
May	10.9	41	0	0	19.5	21.6	2.4	741
June	10.8	136	0	0	48.4	50.2	2.4	720
July	13.5	75	0	0	32.8	38.9	3.0	541
August	34.1	337	6	2	203.3	209.8	4.1	719
September	9.6	37	0	0	20.3	21.3	3.0	712
October	9.9	39	0	0	22.7	23.4	1.7	731
November	13.3	71	0	0	28.7	31.2	1.1	682
December	13.5	48	0	0	24.9	29.0	3.3	743
Annual	14.0	337	6	2	203.3	209.8	1.1	8449

Table C – 1.3 2010 monthly summary of continuous PM₁₀ data from the BCR site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	Minimum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
			>50 $\mu\text{g}/\text{m}^3$	>100 $\mu\text{g}/\text{m}^3$				
January	16.5	97	0	0	40.88	41.0	2.7	744
February	18.8	54	0	0	33.58	35.7	4.8	672
March	26.1	248	2	0	66.17	71.7	7.1	744
April	21.0	143	3	0	64.92	73.2	4.8	720
May	18.1	99	0	0	38.08	41.1	2.9	744
June	16.9	144	1	0	56.50	58.6	3.8	720
July	18.9	111	0	0	35.46	40.4	3.5	742
August	41.0	415	7	4	225.18	225.4	5.3	744
September	16.4	79	0	0	32.58	34.6	5.3	720
October	17.6	71	0	0	38.79	39.4	5.2	744
November	28.6	150	1	0	61.17	65.5	8.8	108
December	16.7	62	0	0	29.37	39.3	3.4	742
Annual	20.9	415	14	4	225.18	225.4	2.7	8144

Table C – 1.4 2010 monthly summary of continuous PM_{2.5} data from the Plaza site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	PM _{2.5} /PM ₁₀ Ratio	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
				>15 $\mu\text{g}/\text{m}^3$	>25 $\mu\text{g}/\text{m}^3$			
January	7.8	0.53	47	3	0	23.0	27.2	715
February	9.5	0.58	40	5	0	22.7	23.5	669
March	5.0	0.22	64	0	0	13.4	15.0	739
April	4.5	0.23	42	0	0	12.4	13.6	720
May	4.7	0.29	120	0	0	13.3	13.3	741
June	6.3	0.42	91	3	2	35.0	36.2	719
July	6.0	0.36	62	1	0	15.8	17.6	738
August	26.6	0.71	283	12	9	172.2	177.1	742
September	5.1	0.33	37	0	0	14.5	16.4	715
October	5.3	0.35	70	2	0	18.1	19.4	741
November	7.7	0.41	40	4	0	17.3	18.6	698
December	8.7	0.54	54	5	0	20.5	28.0	719
Annual	8.1	0.43	283	35	11	172.2	177.1	8656

Table C – 1.5 2010 monthly summary of continuous PM_{2.5} data from the Gladstone site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	PM _{2.5} /PM ₁₀ Ratio	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
				>15 $\mu\text{g}/\text{m}^3$	>25 $\mu\text{g}/\text{m}^3$			
January	7.0	0.52	54	3	0	24.8	29.1	744
February	9.0	0.64	41	4	0	23.9	25.9	672
March	3.7	0.25	39	0	0	12.8	14.5	740
April	3.5	0.33	29	0	0	9.0	11.0	720
May	3.8	0.35	22	0	0	8.0	9.0	741
June	5.0	0.46	129	3	1	41.7	42.8	720
July	4.5	0.33	34	0	0	11.7	13.0	740
August	27.5	0.81	325	10	8	197.6	199.1	719
September	3.7	0.39	26	0	0	9.5	10.8	718
October	4.2	0.42	28	0	0	12.8	13.6	736
November	7.0	0.53	40	2	0	17.4	19.8	681
December	8.3	0.61	38	3	0	17.9	20.0	743
Annual	7.2	0.51	325	25	9	197.6	199.1	8674

Table C – 1.6 2010 monthly summary of TRS data from the Plaza site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	No. of 1-Hour Values		Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
		$>7\mu\text{g}/\text{m}^3$	$>28\mu\text{g}/\text{m}^3$		$>3\mu\text{g}/\text{m}^3$	$>6\mu\text{g}/\text{m}^3$			
January	5.7	209	3	31	19	10	14.2	16.6	599
February	5.2	179	5	45	16	9	14.6	16.3	640
March	2.0	77	0	26	9	4	7.8	9.4	707
April	1.0	27	0	18	1	0	4.8	5.1	689
May	1.5	41	0	27	5	0	4.5	6.1	709
June	0.9	27	0	23	2	0	4.9	5.2	685
July	1.3	47	3	38	4	2	7.9	9.6	707
August	2.4	91	2	34	9	6	9.5	11.8	709
September	2.5	96	0	26	10	3	8.6	10.0	685
October	1.6	45	2	50	7	1	9.7	10.0	697
November	2.6	98	1	28	9	6	15.4	15.5	667
December	5.6	218	12	41	18	9	15.5	18.6	680
Annual	2.6	1155	28	50	109	50	15.5	18.6	8174

Table C – 1.7 2010 monthly summary of TRS data from the Jail site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	No. of 1-Hour Values		Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
		$>7\mu\text{g}/\text{m}^3$	$>28\mu\text{g}/\text{m}^3$		$>3\mu\text{g}/\text{m}^3$	$>6\mu\text{g}/\text{m}^3$			
January	4.1	180	0	20	20	5	12.1	12.4	709
February	3.0	98	0	20	11	5	8.8	10.0	642
March	0.9	22	0	26	2	1	6.8	9.1	664
April	0.7	5	0	10	0	0	2.4	3.4	686
May	2.2	82	0	26	10	0	5.8	7.8	707
June	1.2	34	0	21	3	0	5.3	6.3	691
July	1.4	55	0	23	4	1	7.6	10.0	698
August	3.0	107	8	45	11	5	12.4	16.2	711
September	3.2	120	0	27	13	7	8.4	11.1	688
October	2.1	61	1	38	10	3	9.3	9.8	707
November	2.4	106	0	23	10	4	9.7	9.8	687
December	3.5	139	0	26	15	6	9.8	10.1	709
Annual	2.3	1009	9	45	109	37	12.4	16.2	8299

Table C – 1.8 2010 monthly summary of TRS data from the Lakewood site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	No. of 1-Hour Values		Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
		$>7\mu\text{g}/\text{m}^3$	$>28\mu\text{g}/\text{m}^3$		$>3\mu\text{g}/\text{m}^3$	$>6\mu\text{g}/\text{m}^3$			
January	1.7	91	0	20	7	3	14.5	14.6	713
February	0.6	3	0	10	1	0	3.7	3.7	643
March	0.5	7	0	10	0	0	2.5	3.0	710
April	0.1	0	0	4	0	0	1.1	1.2	691
May	0.4	0	0	4	0	0	1.3	1.5	707
June	0.1	0	0	6	0	0	1.0	1.5	691
July	0.2	2	0	7	0	0	1.2	1.4	708
August	0.2	1	0	7	0	0	1.1	1.1	711
September	0.2	2	0	13	0	0	1.8	2.3	688
October	0.3	0	0	6	0	0	1.1	1.2	709
November	0.9	25	0	20	1	1	6.5	6.5	681
December	1.6	34	0	21	5	1	7.4	8.2	711
Annual	0.6	165	0	21	14	5	14.5	14.6	8363

Table C – 1.9 2010 Monthly Summary of SO₂ Data from the Jail site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	No. of 1-Hour Values $>450 \mu\text{g}/\text{m}^3$	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	Maximum 24 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
				$>20 \mu\text{g}/\text{m}^3$	$>160 \mu\text{g}/\text{m}^3$			
January	21.7	0	169	10	0	106.6	115.8	712
February	9.9	0	134	3	0	33.0	34.0	643
March	3.0	0	97	1	0	22.4	28.4	711
April	6.3	0	142	1	0	23.9	33.7	688
May	15.3	0	312	10	0	47.8	52.3	710
June	5.3	0	132	1	0	30.1	46.3	691
July	9.8	0	376	6	0	69.0	76.8	705
August	12.3	0	209	10	0	48.5	59.3	708
September	14.0	0	166	7	0	69.3	80.6	687
October	9.9	0	197	4	0	75.3	79.0	707
November	9.9	0	131	7	0	47.3	49.9	688
December	13.8	0	226	8	0	71.8	71.9	708
Annual	11.0	0	376	68	0	106.6	115.8	8358

Table C – 1.10 2010 Monthly Summary of SO₂ Data from the Plaza site

	Monthly Average (µg/m ³)	No. of 1-Hour Values >450 µg/m ³	Maximum Hourly Average (µg/m ³)	No. of Daily Values		Maximum Daily Average (µg/m ³)	Maximum 24 Hour Average (µg/m ³)	No. of Hours Instrument Operated
				>20 µg/m ³	>160 µg/m ³			
January	11.9	0	71	8	0	30.8	33.8	680
February	9.7	0	115	4	0	26.2	26.7	641
March	3.7	0	83	0	0	11.7	15.7	709
April	4.2	0	74	1	0	22.7	25.4	685
May	5.3	0	164	0	0	13.0	19.0	707
June	3.2	0	125	0	0	13.0	13.1	681
July	5.4	0	191	1	0	43.6	45.6	710
August	9.5	0	164	5	0	49.0	50.8	704
September	6.2	0	122	2	0	24.7	30.8	684
October	5.0	0	170	1	0	36.6	37.7	697
November	5.9	0	72	1	0	22.9	23.0	666
December	11.4	0	133	4	0	41.3	50.2	680
Annual	6.8	0	191	27	0	49.0	50.8	8244

Table C – 1.11 2010 Monthly Summary of SO₂ Data from the CBC Transmitter site

	Monthly Average (µg/m ³)	No. of 1-Hour Values >450 µg/m ³	Maximum Hourly Average (µg/m ³)	No. of Daily Values		Maximum Daily Average (µg/m ³)	Maximum 24 Hour Average (µg/m ³)	No. of Hours Instrument Operated
				>20 µg/m ³	>160 µg/m ³			
January	21.3	0	252	13	0	80.6	85.1	713
February	15.2	1	510	7	0	91.9	101.3	642
March	4.8	0	390	3	0	41.7	64.7	711
April	6.5	0	207	2	0	25.6	35.5	691
May	15.2	0	268	9	0	55.1	55.2	706
June	5.9	0	300	2	0	35.0	35.1	692
July	8.9	0	308	4	0	52.4	57.7	704
August	15.7	0	398	12	0	78.9	89.2	707
September	17.0	3	667	10	0	90.6	116.8	686
October	11.2	2	531	6	0	44.4	120.5	678
November	16.4	0	377	10	0	73.3	91.0	686
December	23.1	2	628	9	0	150.8	246.7	711
Annual	13.4	8	667	87	0	150.8	246.7	8327

Table C – 1.12 2010 Monthly Summary of SO₂ Data from the Gladstone site

	Monthly Average (µg/m ³)	No. of 1-Hour Values >450 µg/m ³	Maximum Hourly Average (µg/m ³)	No. of Daily Values		Maximum Daily Average (µg/m ³)	Maximum 24 Hour Average (µg/m ³)	No. of Hours Instrument Operated
				>20 µg/m ³	>160 µg/m ³			
January	9.7	0	109	3	0	35.3	35.8	711
February	11.2	0	85	5	0	32.0	35.3	639
March	3.3	0	69	0	0	14.7	16.6	708
April	2.5	0	48	0	0	11.3	11.3	691
May	4.9	0	197	0	0	13.9	20.0	710
June	2.0	0	64	0	0	8.3	10.1	691
July	3.0	0	111	0	0	19.9	22.1	704
August	3.9	0	61	0	0	14.2	15.8	699
September	3.7	0	42	0	0	13.3	14.0	689
October	2.9	0	49	0	0	11.6	16.0	703
November	4.1	0	62	0	0	13.8	16.6	609
December	9.6	0	88	3	0	38.0	38.4	704
Annual	5.0	0	197	11	0	38.0	38.4	8258

Table C – 1.13 2010 Monthly Summary of SO₂ Data from the Marsulex – BCR site

	Monthly Average (µg/m ³)	No. of 1-Hour Values >450 µg/m ³	Maximum Hourly Average (µg/m ³)	No. of Daily Values		Maximum Daily Average (µg/m ³)	Maximum 24 Hour Average (µg/m ³)	No. of Hours Instrument Operated
				>20 µg/m ³	>160 µg/m ³			
January	2.9	0	64	0	0	10.8	11.7	711
February	1.4	0	8	0	0	3.5	3.7	639
March	0.6	0	12	0	0	2.3	2.5	712
April	1.1	0	33	0	0	6.0	6.0	687
May	3.7	0	49	0	0	15.1	15.7	710
June	1.5	0	29	0	0	12.2	13.8	691
July	2.2	0	55	0	0	14.9	19.5	707
August	3.0	0	43	0	0	18.1	20.4	711
September	0.8	0	11	0	0	3.2	3.3	688
October	0.4	0	4	0	0	1.4	1.7	710
November	0.5	0	11	0	0	2.5	2.7	689
December	1.0	0	13	0	0	5.3	6.0	710
Annual	1.6	0	64	0	0	18.1	20.4	8365

Table C – 1.14 2010 monthly summary of O₃ data from the Plaza site

	Monthly Average (µg/m ³)	No. of 1-Hour Values		Maximum Hourly Average (µg/m ³)	No. of Daily Values		Maximum 24 Hour Average (µg/m ³)	Minimum 24 Hour Average (µg/m ³)	No. of Hours Instrument Operated
		>100 µg/m ³	>160 µg/m ³		>30 µg/m ³	>50 µg/m ³			
January	27.6	0	0	74	10	2	60.3	9.1	713
February	20.5	0	0	78	6	0	61.0	5.8	672
March	51.0	3	0	101	27	14	94.4	16.9	740
April	59.7	7	0	110	30	23	82.5	33.0	717
May	70.8	89	0	121	31	29	104.8	41.5	744
June	50.4	6	0	114	29	15	84.4	26.1	710
July	42.7	8	0	117	30	5	67.5	26.4	741
August	37.8	4	0	115	24	5	68.1	12.0	735
September	26.9	0	0	70	11	1	55.0	6.7	711
October	32.5	0	0	79	15	8	65.2	2.8	719
November	29.5	0	0	76	12	4	68.8	6.1	692
December	25.0	0	0	82	10	1	76.8	4.3	690
Annual	39.8	117	0	121	235	107	104.8	2.8	8584

Table C – 1.15 2010 monthly summary of NO₂ data from the Plaza site

	Monthly Average (µg/m ³)	No. of 1-Hour Values >400 µg/m ³	Maximum Hourly Average (µg/m ³)	No. of Daily Values >200 µg/m ³	Maximum Daily Average (µg/m ³)	Maximum 24 Hour Average (µg/m ³)	Minimum 24 Hour Average (µg/m ³)	No. of Hours Instrument Operated
January	29.6	0	89	0	60.4	61.5	8.2	668
February	28.7	0	82	0	50.6	56.8	10.1	637
March	22.1	0	80	0	47.5	48.3	3.2	705
April	17.6	0	76	0	34.0	35.5	4.5	687
May	13.5	0	63	0	26.7	27.2	4.5	709
June	12.2	0	52	0	18.9	21.7	4.2	680
July	10.7	0	48	0	23.8	27.4	1.7	704
August	13.0	0	51	0	27.0	28.4	4.4	705
September	15.2	0	57	0	28.6	31.3	5.2	683
October	16.4	0	60	0	28.1	30.2	1.9	693
November	22.2	0	67	0	40.2	42.1	4.4	665
December	29.2	0	96	0	54.3	70.3	4.5	686
Annual	19.1	0	96	0	60.4	70.3	1.7	8222

Table C – 1.16 2010 monthly summary of CO data from the Plaza site

	Monthly Average ($\mu\text{g}/\text{m}^3$)	No. of 1-Hour Values >14300$\mu\text{g}/\text{m}^3$	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of 8-Hr Values >5500$\mu\text{g}/\text{m}^3$	Maximum 8 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
January	349.5	0	2456	0	1482	622
February	393.8	0	1839	0	1284	642
March	324.2	0	1315	0	878	706
April	258.2	0	921	0	550	687
May	221.8	0	524	0	379	710
June	209.1	0	1119	0	859	664
July	186.3	0	1021	0	435	707
August	416.3	0	3092	0	2152	710
September	254.0	0	984	0	574	677
October	284.4	0	1117	0	747	234
November	314.8	0	1350	0	882	565
December	340.2	0	2261	0	1330	681
Annual	295.6	0	3092	0	2152	7605

ii) Annual Trend Summary Tables:

Tables C–2.1 through C–2.22 summarize annual trends in ambient air quality data for all pollutants and monitoring locations included in this report. The summaries include (among other values) annual averages, maximum daily averages, exceedances, maximum hourly averages and the number of hours the instrument was in operation.

Table C – 2.1 Annual trend summary of non-continuous PM₁₀ data from the Van Bien site

Year	Annual Average (µg/m³)	No. (%) of Daily Values > 50 µg/m³	No. (%) of Daily Values > 100 µg/m³	Maximum Daily Value (µg/m³)	Number of Samples
1990	-	7 (26.9%)	0	62	26*
1991	27.6	8 (13.6%)	0	84	59
1992	27.0	7 (12.5%)	0	89	56
1993	27.9	6 (10.2%)	0	99	59
1994	21.8	3 (6.3%)	0	69	48
1995	25.2	6 (10.2%)	1 (1.7%)	106	59
1996	23.9	4 (7.3%)	0	67	55
1997	20.8	3 (5.3%)	0	74	57
1998	28.4	6 (10.9%)	0	91	55
1999	22.7	3 (5.2%)	0	56	58
2000	17.4	2 (3.5%)	0	84	57
2001	17.4	1 (1.7%)	0	61	60
2002	20.4	3 (4.9%)	0	62	61
2003	18.5	2 (3.7%)	0	76	54
2004	19.2	1 (1.6%)	0	51	61
2005	22.8	13 (11.3%)	1 (0.9%)	119	115**
2006	21.3	4 (3.4%)	0	71	117
2007	18.1	3 (2.6%)	0	83	111
2008	18.1	2 (1.7%)	0	89	118***

* Note: TSP (total suspended particulates) sampler converted to PM₁₀ monitor on August 1, 1990.

** Note: Non-continuous sampling schedule changed from 6-day to 3-day.

***Note: Sampling ended Dec. 29, 2008.

Table C – 2.2 Annual trend summary of non-continuous PM₁₀ data from the Lakewood site

Year	Annual Average (µg/m ³)	No. (%) of Daily Values > 50 µg/m ³	No. (%) of Daily Values > 100 µg/m ³	Maximum Daily Value (µg/m ³)	Number of Samples
1990	17.4	0	0	40	24*
1991	21.8	5 (8.5%)	0	89	59
1992	24.8	7 (11.9%)	0	74	59
1993	27.3	4 (7.6%)	1 (1.9%)	129	53
1994	18.9	1 (1.7%)	0	56	58
1995	18.7	4 (7.4%)	0	63	54
1996	16.3	0	0	50	59
1997	15.9	1 (1.7%)	0	51	59
1998	19.8	1 (1.9%)	0	61	54
1999	17.4	1 (1.8%)	0	74	56
2000	14.1	0	0	50	60
2001	13.9	1 (1.7%)	0	52	58
2002	13.2	0	0	45	61
2003	14.4	1 (1.7%)	0	64	59
2004	15.0	0	0	46	60
2005	17.0	5 (4.3%)	0	62	115**
2006	15.3	1 (0.9%)	0	55	113
2007	14.1	3 (2.6%)	0	66	114
2008	14.2	0	0	43	114***

* Note: TSP (total suspended particulates) sampler converted to PM₁₀ monitor on August 1, 1990.

** Note: Non-continuous sampling schedule changed from 6-day to 3-day.

***Sampling ended Dec. 29, 2008.

Table C – 2.3 Annual trend summary of non-continuous PM₁₀ data from the CNR site

Year	Annual Average (µg/m ³)	No. (%) of Daily Values > 50 µg/m ³	No. (%) of Daily Values > 100 µg/m ³	Maximum Daily Value (µg/m ³)	Number of Samples
1991	30.9	5 (13.2%)	2 (5.3%)	124	38*
1992	28.3	6 (10.3%)	1 (1.7%)	103	58
1993	33.3	14 (23.0%)	1 (1.6%)	104	61
1994	25.2	8 (13.6%)	0	75	59
1995	27.5	8 (13.3%)	1 (1.7%)	110	60
1996	28.1	5 (8.3%)	1 (1.7%)	110	60
1997	22.8	2 (3.6%)	0	65	55
1998	34.0	8 (13.8%)	2 (3.4%)	124	58
1999	28.0	8 (13.6%)	1 (1.7%)	106	59
2000	21.3	3 (5.1%)	0	61	59
2001	18.0	3 (4.9%)	0	56	61
2002	20.9	3 (5.1%)	0	73	59
2003	19.5	2 (3.4%)	0	100	59
2004	22.8	4 (6.7%)	0	79	60
2005	26.6	12 (10.1%)	1 (0.8%)	133	119**
2006	23.7	7 (6.0%)	0	90	116
2007	23.6	10 (8.5%)	0	85	117
2008	21.6	10 (8.5%)	0	73	118
2009	21.9	2 (6.7%)	0	95	30***

* Note: Monitoring started May 6, 1991. ** Note: Sampling schedule changed from 6-day to 3-day.

*** Note: Sampling ended April 10, 2009

Table C – 2.4 Annual trend summary of non-continuous PM₁₀ data from Western Acres site

Year	Annual Average (µg/m ³)	No. (%) of Daily Values > 50 µg/m ³	No. (%) of Daily Values > 100 µg/m ³	Maximum Daily Value (µg/m ³)	Number of Samples
2005	12.2	0	0	50	81*
2006	12.1	0	0	42	116
2007	11.3	1 (0.8%)	0	52	120
2008	10.4	0	0	39	118
2009	9.9	0	0	44	107
2010	-	0	0	26	30**

* Note: PM₁₀ monitoring started on April 28, 2005.

** Note: Monitoring program concluded – March 30, 2010

Table C – 2.5 Annual trend summary of non-continuous PM₁₀ data from the Plaza site

Year	Annual Average (µg/m ³)	No. (%) of Daily Values > 50 µg/m ³	No. (%) of Daily Values > 100 µg/m ³	Maximum Daily Value (µg/m ³)	Number of Samples
1990	-	2 (7.7%)	0	90	26*
1991	29.4	7 (11.7%)	1 (1.7%)	217	60
1992	28.6	6 (10.2%)	0	92	59
1993	30.2	10 (16.7%)	0	92	60
1994	24.1	6 (10.0%)	0	85	61
1995	23.6	4 (6.6%)	0	85	61
1996	21.7	2 (3.5%)	0	61	61
1997	20.8	1 (1.7%)	0	56	61
1998	26.9	5 (8.2%)	1 (1.6%)	111	61
1999	21.3	2 (3.3%)	0	73	61
2000	19.0	1 (1.7%)	0	65	61
2001	15.7	2 (3.3%)	0	52	61
2002	18.2	2 (3.3%)	0	62	61
2003	17.0	2 (3.3%)	0	67	61
2004	18.5	3 (4.9%)	0	63	61
2005	22.0	5 (4.4%)	0	86	114**
2006	20.5	2 (1.7%)	0	59	121
2007	19.6	2 (1.7%)	0	73	121
2008	19.6	6 (4.9%)	0	67	122***

* Note: TSP (total suspended particulates) sampler converted to PM₁₀ monitor on August 1, 1990.

** Note: Non-continuous sampling schedule changed from 6-day to 3-day.

***Sampling ended Dec. 29, 2008.

Table C – 2.6 Annual trend summary of continuous PM₁₀ data from the Plaza site

Year	Annual Average (µg/m ³)	Maximum Hourly Average (µg/m ³)	No. (%) of Days > 50 µg/m ³		No. (%) of Days > 100 µg/m ³		Maximum Daily Average (µg/m ³)	Hours Instrument Operated
			No.	(%)	No.	(%)		
1992	21.6	488	18	(6.1%)	0	(0%)	80	7083
1993	22.3	171	11	(4.5%)	0	(0%)	75	5828
1994*	22.3	284	19	(5.6%)	4	(1.2%)	117	8162
1995	24.2	291	33	(9.1%)	2	(0.6%)	108	8686
1996	20.5	373	10	(2.8%)	3	(0.8%)	152	8567
1997	20.2	208	13	(3.6%)	0	(0%)	76	8719
1998	22.7	319	20	(5.5%)	2	(0.5%)	114	8719
1999	17.8	211	10	(2.7%)	0	(0%)	98	8609
2000	18.0	175	9	(2.5%)	0	(0%)	71	8695
2001	18.1	170	9	(2.6%)	1	(0.3%)	110	8442
2002	18.2	154	12	(3.4%)	0	(0%)	75	8495
2003	19.5	199	15	(4.1%)	0	(0%)	100	8669
2004	20.3	170	12	(3.3%)	0	(0%)	69	8713
2005	20.6	202	15	(4.2%)	0	(0%)	78	8532
2006	21.1	201	18	(4.9%)	0	(0%)	82	8723
2007	17.8	166	7	(1.9%)	0	(0%)	66	8688
2008	18.3	180	7	(1.9%)	0	(0%)	70	8751
2009	17.5	167	7	(1.9%)	0	(0%)	82	8603
2010	18.8	365	11	(3.1%)	2	(0.6%)	194	8575

* Monitor returned in January after upgrades.

Table C – 2.7 Annual trend summary of continuous PM₁₀ data from the BCR-Warehouse site

Year	Annual Average (µg/m ³)	Maximum Hourly Average (µg/m ³)	No. (%) of Days > 50 µg/m ³		No. (%) of Days > 100 µg/m ³		Maximum Daily Average (µg/m ³)	Hours Instrument Operated
			No.	(%)	No.	(%)		
1996*	-	125	5	(5.3%)	0	(0%)	68	2263*
1997	24.2	401	32	(8.8%)	2	(0.5%)	111	8705
1998	29.1	582	49	(13.5%)	4	(1.1%)	127	8702
1999	21.3	380	19	(5.5%)	0	(0%)	79	8718
2000	20.0	288	13	(3.6%)	0	(0%)	86	8739
2001	20.1	387	17	(4.7%)	0	(0%)	98	8634
2002	22.1	430	27	(7.4%)	0	(0%)	84	8696
2003	24.4	262	29	(8.1%)	1	(0.3%)	106	8534
2004	25.9	332	50	(14.0%)	0	(0%)	100	8604
2005	27.5	444	43	(11.8%)	3	(0.8%)	114	8666
2006	29.2	455	57	(15.6%)	1	(0.3%)	111	8718
2007	24.3	411	37	(10.2%)	1	(0.3%)	102	8718
2008	20.6	335	18	(4.9%)	0	(0%)	85	8749
2009	19.8	220	12	(3.3%)	0	(0%)	74	8730
2010	20.9	415	14	(4.1%)	4	(1.2%)	225	8144

* Note: Monitoring started September 28, 1996.

Table C – 2.8 Annual trend summary of continuous PM₁₀ data from the Gladstone site

Year	Annual Average (µg/m ³)	Maximum Hourly Average (µg/m ³)	No. (%) of Days > 50 µg/m ³		No. (%) of Days > 100 µg/m ³		Maximum Daily Average (µg/m ³)	Hours Instrument Operated
			No.	(%)	No.	(%)		
1996	15.0	253	7	(1.9%)	1	(0.3%)	102	8688
1997	14.8	155	7	(1.9%)	0	(0%)	61	8673
1998	17.2	207	7	(1.9%)	0	(0%)	74	8642
1999	12.7	127	0	(0%)	0	(0%)	47	8663
2000	13.6	148	4	(1.1%)	0	(0%)	55	8686
2001	13.5	164	2	(0.6%)	0	(0%)	78	8610
2002	13.6	109	4	(1.1%)	0	(0%)	68	8707
2003	14.8	237	5	(1.4%)	0	(0%)	74	8623
2004	14.6	175	1	(0.3%)	0	(0%)	57	8594
2005	15.1	217	6	(1.2%)	0	(0%)	64	8270
2006	15.2	163	1	(0.3%)	0	(0%)	57	8543
2007	13.4	120	4	(1.1%)	0	(0%)	63	8650
2008	13.0	136	0	(0%)	0	(0%)	48	8447
2009	13.0	100	1	(0.3%)	0	(0%)	50	8477
2010	14.0	337	6	(1.7%)	2	(0.6%)	203	8449

Table C – 2.9 Annual trend summary of non-continuous PM_{2.5} data from the Plaza site

Year	Annual Average (µg/m ³)	No. (%) of Daily Values > 15 µg/m ³	No. (%) of Daily Values > 25 µg/m ³	No. (%) of Daily Values > 30 µg/m ³	Maximum Daily Value (µg/m ³)	Number of Samples
1994	-	4 (18.2%)	1 (4.5%)	1 (4.5%)	52	22*
1995	13.3	19 (31.1%)	6 (9.8%)	3 (4.9%)	54	61
1996	12.7	17 (28.3%)	4 (6.7%)	2 (3.3%)	40	60
1997	12.3	16 (26.2%)	6 (9.8%)	5 (8.2%)	43	61
1998	11.3	18 (29.5%)	5 (8.2%)	3 (4.9%)	52	61
1999	9.6	11 (18.3%)	2 (3.3%)	2 (3.3%)	38	60
2000	11.5	12 (19.7%)	5 (8.2%)	5 (8.2%)	52	61
2001	9.9	16 (26.2%)	4 (6.6%)	4 (6.6%)	35	61
2002	11.2	14 (23.0%)	5 (8.2%)	5 (8.2%)	34	61
2003	12.1	15 (24.6%)	4 (6.6%)	3 (4.9%)	38	61
2004	9.5	15 (25.0%)	2 (3.3%)	2 (3.3%)	33	60
2005	10.5	23 (21.3%)	10 (9.3%)	6 (5.6%)	36	108**
2006	9.6	21 (17.2%)	4 (3.3%)	2 (1.6%)	33	122
2007	8.3	11 (9.1%)	3 (2.5%)	3 (2.5%)	53	121
2008	7.9	16 (13.1%)	7 (5.7%)	4 (3.3%)	40	122
2009	10.2	12 (10.4%)	3 (2.6%)	3 (2.6%)	46	115
2010	9.6	9 (12.2%)	3 (4.1%)	2 (2.7%)	95	74 ***

* Instrument installed August 1994

** Sampling schedule changed to 3-day sampling in 2005

*** Sampling schedule changed back to 6-day sampling April 2010

Table C – 2.10 Annual trend summary of the continuous PM_{2.5} data from the Plaza site

Year	Annual Average (µg/m ³)	Maximum Hourly Average (µg/m ³)	No. (%) of Days > 15 µg/m ³	No. (%) of Days > 25 µg/m ³	No. (%) of Days > 30 µg/m ³	Maximum Daily Average (µg/m ³)	Hours Instrument Operated
1997	-	87	14 (28.6%)	8 (16.3%)	5 (10.2%)	52.7	1167*
1998	8.2	119	53 (14.6%)	11 (3.0%)	6 (1.6%)	52.1	8722
1999	6.9	117	33 (9.1%)	7 (1.9%)	3 (0.8%)	31.1	8657
2000	8.5	92	55 (15.2%)	16 (4.4%)	10 (2.8%)	41.1	8634
2001	8.5	139	48 (13.3%)	18 (5.0%)	10 (2.8%)	52.2	8575
2002	8.2	84	42 (11.6%)	13 (3.6%)	8 (2.2%)	58.6	8685
2003	9.8	158	64 (17.7%)	20 (5.5%)	12 (3.3%)	61.4	8614
2004**	9.5	127	68 (18.6%)	22 (6.0%)	12 (3.3%)	60.8	8752
2005	7.8	89	45 (12.5%)	11 (3.1%)	4 (1.1%)	47.5	8488
2006	7.5	119	40 (11.0%)	5 (1.4%)	1 (0.3%)	44.3	8729
2007	6.4	70	23 (6.3%)	3 (0.8%)	1 (0.3%)	43.0	8723
2008	6.8	98	33 (9.0%)	6 (1.6%)	4 (1.1%)	38.6	8765
2009	6.9	104	33 (9.2%)	7 (2.0%)	0 (0%)	45.1	8590
2010	8.1	283	35 (9.7%)	11 (3.1%)	9 (2.5%)	172.2	8656

* Note: Monitoring started Sept. 1997

** Note: Sample intake head was changed from URG to Sharp-Cut on Sept. 15, 2004. Data prior to this date were converted from URG to equivalent Sharp-Cut values

Table C – 2.11 Annual trend summary of the continuous PM_{2.5} data from the Gladstone site

Year	Annual Average (µg/m ³)	Maximum Hourly Average (µg/m ³)	No. (%) of Days > 15 µg/m ³	No. (%) of Days > 25 µg/m ³	No. (%) of Days > 30 µg/m ³	Maximum Daily Average (µg/m ³)	Hours Instrument Operated
2005*	-	104	27 (8.6%)	7 (2.2%)	2 (0.6%)	43.0	7525
2006	6.6	181	35 (9.7%)	7 (1.9%)	1 (0.3%)	30.3	8694
2007	5.6	60	16 (4.7%)	1 (0.3%)	0 (0%)	29.2	8153
2008	5.8	55	23 (6.4%)	2 (0.6%)	0 (0%)	27.1	8604
2009	5.8	53	17 (4.7%)	2 (0.6%)	0 (0%)	33.7	8714
2010	7.2	325	25 (6.9%)	9 (2.5%)	8 (2.2%)	197.6	8674

*Note: Monitoring started Feb. 18th 2005

Table C – 2.12 Annual trend summary of non-continuous PM_{2.5} data from other sites in Prince George

Year	Annual Average (µg/m ³)	No. (%) of Daily Values > 15 µg/m ³	No. (%) of Daily Values > 25 µg/m ³	No. (%) of Daily Values > 30 µg/m ³	Maximum Daily Value (µg/m ³)	Number of Samples
Van Bien						
2005	11.2	27 (24.6%)	12 (10.5%)	8 (7.0%)	47	114
2006	10.1	21 (18.1%)	6 (5.2%)	2 (1.7%)	37	116
2007	8.8	12 (10.8%)	4 (3.6%)	3 (2.7%)	47	111
2008	7.3	15 (13.2%)	4 (3.5%)	1 (0.8%)	31	114
2009	9.9	14 (11.8%)	2 (1.7%)	1 (0.8%)	46	119
2010	9.2	14 (11.8%)	4 (3.4%)	4 (3.4%)	103	119
Gladstone						
2005	10.0	23 (20.4%)	8 (7.1%)	6 (5.3%)	46	113
2006	8.2	19 (16.4%)	1 (0.9%)	0	25	116
2007	7.4	11 (9.1%)	5 (4.1%)	3 (2.5%)	42	121
2008	6.5	13 (10.7%)	1 (0.8%)	1 (0.8%)	34	121
Lakewood						
2005	10.3	24 (22.4%)	10 (9.3%)	4 (3.7%)	52	107
2006	8.0	16 (13.4%)	4 (3.4%)	1 (0.8%)	35	119
2007	7.0	7 (6.0%)	5 (4.3%)	3 (2.6%)	44	116
2008	6.3	12 (10.6%)	3 (2.7%)	1 (0.9%)	31	113
BCR						
2009	9.4	19 (17.3%)	4 (3.6%)	2 (1.8%)	45	110
2010	9.6	13 (10.7%)	4 (3.3%)	2 (1.7%)	102	121
Western Acres						
2005	8.1	10 (13.0%)	4 (5.2%)	1 (1.3%)	32	77
2006	5.6	6 (5.1%)	0	0	21	118
2007	5.7	6 (5.1%)	4 (3.4%)	0	30	117
2008	4.7	3 (2.6%)	0	0	23	115
2009	6.9	4 (3.3%)	1 (0.8%)	0	29	120
2010	6.2	2 (6.9%)	0	0	21	29*

* Note: Western Acres monitoring program concluded March 30, 2010

Table C – 2.13 Annual trend summary of TRS data from the Plaza site

Year	Annual Average ($\mu\text{g}/\text{m}^3$)	No. (%) of 1-Hour Values		Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. (%) of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	No. of hours Instrument Operated
		$>7\mu\text{g}/\text{m}^3$	$>28\mu\text{g}/\text{m}^3$		$>3\mu\text{g}/\text{m}^3$	$>6\mu\text{g}/\text{m}^3$		
1980	5.9	1085 (16.0%)	449 (6.6%)	163	127 (45.0%)	85 (30.1%)	62.4	6772
1981	6.0	1276 (16.9%)	566 (7.5%)	241	136 (43.2%)	101 (32.1%)	53.8	7558
1982	5.3	1241 (15.1%)	445 (5.4%)	198	156 (45.5%)	111 (32.4%)	41.3	8235
1983	8.6	1670 (20.7%)	817 (10.1%)	177	180 (53.4%)	150 (44.5%)	90.5	8082
1984	4.7	978 (11.9%)	372 (4.5%)	227	121 (35.2%)	84 (24.4%)	51.7	8246
1985	4.8	875 (12.3%)	406 (5.7%)	297	106 (35.8%)	78 (26.4%)	81.6	7115
1986	7.9	1295 (20.1%)	677 (10.5%)	289	126 (46.8%)	102 (37.9%)	61.4	6456
1987	9.0	1806 (21.8%)	972 (11.7%)	218	174 (48.2%)	143 (39.6%)	69.0	8280
1988	7.3	1633 (19.7%)	792 (9.5%)	194	159 (44.0%)	121 (33.5%)	69.4	8297
1989	5.9	1376 (16.9%)	594 (7.3%)	184	140 (40.8%)	111 (32.4%)	41.8	8166
1990	2.7	905 (11.0%)	187 (2.3%)	122	100 (28.0%)	57 (16.0%)	47.0	8234
1991	2.2	925 (11.2%)	43 (0.5%)	58	84 (23.3%)	46 (12.8%)	19.4	8256
1992	2.1	882 (10.6%)	34 (0.4%)	69	89 (24.5%)	49 (13.5%)	18.4	8300
1993	2.4	956 (11.4%)	92 (1.1%)	72	89 (24.6%)	54 (14.9%)	29.8	8360
1994	1.9	790 (9.5%)	22 (0.3%)	67	84 (23.3%)	34 (9.4%)	19.1	8295
1995	1.9	757 (9.2%)	20 (0.2%)	44	93 (26.1%)	32 (9.0%)	20.5	8205
1996	1.7	622 (7.5%)	28 (0.3%)	103	71 (19.8%)	25 (7.0%)	27.2	8262
1997	1.6	654 (7.8%)	13 (0.2%)	40	65 (17.9%)	22 (6.0%)	12.9	8371
1998	2.2	958 (11.6%)	9 (0.1%)	50	88 (24.6%)	32 (8.9%)	19.5	8245
1999	1.7	784 (9.5%)	13 (0.2%)	44	71 (19.8%)	24 (6.7%)	18.5	8247
2000	1.5	675 (8.1%)	16 (0.2%)	45	58 (15.9%)	23 (5.5%)	21.8	8314
2001	1.7	882 (10.7%)	5 (0.1%)	35	68 (18.7%)	25 (6.9%)	21.0	8257
2002	1.7	726 (8.9%)	25 (0.3%)	57	61 (17.3%)	25 (7.1%)	16.4	8167
2003	2.1	963 (11.7%)	41 (0.5%)	61	95 (26.6%)	31 (8.7%)	16.5	8220
2004	2.0	918 (10.9%)	36 (0.4%)	41	83 (22.7%)	26 (7.1%)	22.3	8384
2005	1.5	573 (6.9%)	2 (<0.1%)	37	63 (17.4%)	11 (3.0%)	12.0	8333
2006	1.9	718 (8.6%)	11 (0.1%)	47	73 (20.1%)	23 (6.3%)	16.4	8340
2007	1.6	609 (7.3%)	15 (0.2%)	95	58 (15.9%)	20 (5.5%)	17.7	8352
2008	1.7	633 (7.6%)	15 (0.2%)	70	74 (20.3%)	21 (5.8%)	23.2	8373
2009	2.4	885 (10.8%)	46 (0.6%)	53	94 (25.8%)	36 (9.9%)	17.2	8218
2010	2.6	1155 (14.1%)	28 (0.3%)	50	109 (30.8%)	50 (14.1%)	15.5	8174

Table C – 2.14 Annual trend summary of TRS data from the Jail site

Year	Annual Average ($\mu\text{g}/\text{m}^3$)	No. (%) of 1-Hour Values		Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. (%) of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
		$>7\mu\text{g}/\text{m}^3$	$>28\mu\text{g}/\text{m}^3$		$>3\mu\text{g}/\text{m}^3$	$>6\mu\text{g}/\text{m}^3$		
1981	7.2	1673 (21.7%)	638 (8.3%)	177	151 (47.0%)	121 (37.7%)	59.6	7701
1982	-	1169 (23.8%)	519 (10.6%)	149	125 (61.0%)	99 (48.3%)	53.5	4915
1983	11.0	2051 (27.3%)	1066 (14.2%)	156	184 (58.8%)	151 (48.2%)	70.2	7511
1984	6.5	1341 (17.6%)	593 (7.8%)	170	136 (42.8%)	109 (34.3%)	54.8	7638
1985	6.4	1483 (19.1%)	546 (7.0%)	149	145 (44.8%)	117 (36.1%)	44.9	7773
1986	9.8	2404 (29.1%)	1028 (12.4%)	347	197 (57.1%)	169 (49.0%)	68.0	8268
1987	11.6	2268 (29.0%)	1306 (16.7%)	382	200 (59.0%)	175 (51.6%)	86.0	7817
1988	11.6	2307 (27.9%)	1343 (16.2%)	312	197 (54.6%)	166 (46.0%)	94.6	8267
1989	9.2	1852 (25.8%)	793 (11.0%)	212	174 (54.5%)	134 (42.0%)	68.3	7183
1990	5.4	927 (14.3%)	215 (3.3%)	177	91 (32.6%)	66 (23.7%)	46.7	6494
1991	3.1	1195 (14.4%)	138 (1.7%)	126	117 (32.3%)	61 (16.9%)	39.2	8316
1992	3.7	1103 (14.9%)	71 (1.0%)	78	109 (34.0%)	66 (20.6%)	17.7	7387
1993	3.8	1343 (16.7%)	201 (2.5%)	69	123 (35.4%)	86 (24.8%)	37.7	8061
1994	3.1	1214 (15.1%)	108 (1.3%)	57	119 (35.0%)	67 (19.7%)	19.7	8017
1995	3.3	1274 (15.2%)	73 (0.9%)	64	157 (43.1%)	64 (17.6%)	23.0	8359
1996	2.6	1043 (12.5%)	42 (0.5%)	62	112 (30.8%)	53 (14.6%)	18.8	8359
1997	2.5	1157 (13.9%)	42 (0.5%)	55	119 (32.7%)	37 (10.2%)	21.3	8347
1998	3.1	1488 (17.9%)	57 (0.7%)	51	138 (38.2%)	62 (17.2%)	26.1	8314
1999	2.4	1085 (13.4%)	44 (0.5%)	123	107 (30.2%)	43 (12.1%)	26.5	8117
2000	2.4	1079 (13.1%)	37 (0.5%)	62	105 (28.8%)	43 (11.8%)	18.4	8214
2001	2.2	1106 (13.2%)	13 (0.2%)	37	93 (25.7%)	42 (11.6%)	20.2	8352
2002	2.1	894 (10.7%)	35 (0.4%)	44	85 (23.2%)	31 (8.5%)	18.5	8375
2003	2.7	1267 (15.1%)	55 (0.7%)	61	120 (32.9%)	56 (15.3%)	21.7	8374
2004	2.8	1300 (15.7%)	64 (0.7%)	84	119 (32.5%)	61 (16.7%)	18.2	8300
2005	2.1	967 (11.6%)	7 (<0.1%)	34	97 (26.6%)	27 (7.4%)	14.1	8347
2006	2.3	1010 (12.1%)	30 (0.4%)	47	98 (27.3%)	38 (10.6%)	15.1	8324
2007	2.2	867 (10.6%)	42 (0.5%)	81	87 (24.2%)	32 (8.9%)	22.2	8152
2008	1.7	786 (9.4%)	30 (0.4%)	60	81 (22.5%)	26 (7.1%)	12.6	8367
2009	2.1	882 (10.7%)	23 (0.3%)	61	93 (25.5%)	36 (9.9%)	13.3	8276
2010	2.3	1009 (12.2%)	9 (0.1%)	45	109 (30.2%)	37 (10.2%)	12.4	8299

Table C – 2.15 Annual trend summary of TRS data from the Lakewood site

Year	Annual Average ($\mu\text{g}/\text{m}^3$)	No. (%) of 1-Hour Values		Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. (%) of Daily Values		Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	No. of hours Instrument Operated
		$>7\mu\text{g}/\text{m}^3$	$>28\mu\text{g}/\text{m}^3$		$>3\mu\text{g}/\text{m}^3$	$>6\mu\text{g}/\text{m}^3$		
1982	-	176 (3.0%)	22 (0.4%)	85	22 (9.1%)	13 (5.4%)	19.7	5785
1983	2.6	615 (7.9%)	147 (1.9%)	99	79 (24.5%)	43 (13.4%)	40.7	7737
1984	0.9	199 (2.4%)	15 (0.2%)	64	34 (9.9%)	10 (2.9%)	15.4	8269
1985	1.0	216 (2.9%)	28 (0.4%)	50	29 (9.3%)	12 (3.9%)	21.6	7456
1986	1.7	439 (5.6%)	110 (1.4%)	71	51 (15.7%)	32 (9.9%)	27.1	7807
1987	1.6	461 (6.0%)	106 (1.4%)	92	51 (15.6%)	34 (10.4%)	35.7	7680
1988	1.1	270 (3.6%)	38 (0.5%)	64	38 (11.8%)	23 (7.1%)	17.5	7462
1989	0.7	170 (2.8%)	33 (0.5%)	92	22 (8.1%)	8 (2.9%)	28.0	6057
1990	-	66 (1.2%)	3 (< 0.1%)	79	8 (3.4%)	1 (0.4%)	10.5	5484
1991	0.6	173 (2.3%)	3 (< 0.1%)	37	19 (5.7%)	4 (1.2%)	18.7	7667
1992	0.6	214 (2.6%)	0 (0.0%)	27	22 (6.0%)	9 (2.5%)	11.7	8351
1993	0.9	307 (4.4%)	5 (< 0.1%)	50	31 (9.7%)	13 (4.4%)	19.4	6952
1994	0.6	147 (1.8%)	2 (< 0.1%)	74	21 (5.9%)	4 (1.1%)	11.5	8196
1995	0.9	270 (3.2%)	2 (< 0.1%)	37	37 (10.2%)	11 (3.0%)	15.0	8358
1996	0.7	227 (2.7%)	8 (0.1%)	44	27 (7.5%)	7 (1.9%)	15.0	8281
1997	0.7	174 (2.1%)	0 (0.0%)	27	17 (4.8%)	4 (1.1%)	9.8	8211
1998	0.7	215 (2.6%)	0 (0.0%)	18	21 (6.0%)	5 (1.4%)	10.7	8204
1999	0.6	172 (2.1%)	1 (< 0.1%)	28	14 (4.0%)	5 (1.4%)	9.5	8191
2000	0.5	157 (1.9%)	0 (0.0%)	23	15 (4.1%)	3 (0.8%)	12.8	8348
2001	0.7	249 (3.0%)	0 (0.0%)	23	21 (5.8%)	9 (2.5%)	13.0	8345
2002	0.6	191 (2.3%)	0 (0.0%)	23	18 (5.2%)	6 (1.7%)	10.5	8254
2003	0.6	178 (2.1%)	0 (0.0%)	23	12 (3.3%)	2 (0.5%)	8.8	8370
2004	0.8	261 (3.4%)	13 (0.2%)	44	22 (6.0%)	10 (2.7%)	28.2	7621
2005	0.8	133 (1.6%)	0 (0.0%)	16	13 (3.7%)	3 (0.8%)	7.8	8175
2006	0.8	166 (2.0%)	0 (0.0%)	21	15 (4.2%)	3 (0.8%)	12.3	8283
2007	0.6	137 (1.7%)	0 (0.0%)	26	17 (4.9%)	4 (1.2%)	12.9	8010
2008	0.6	128 (1.5%)	6 (0.1%)	45	11 (3.0%)	2 (0.5%)	18.3	8387
2009	0.6	210 (2.5%)	1 (< 0.1%)	28	19 (5.2%)	5 (1.4%)	17.6	8363
2010	0.6	165 (2.0%)	0 (0.0%)	21	14 (3.8%)	5 (1.4%)	14.5	8363

Table C – 2.16 Annual trend summary of SO_2 data from the Marsulex-BCR site

Year	Annual Average ($\mu\text{g}/\text{m}^3$)	No. of 1-Hour Values	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of Daily Values	Maximum Daily Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
		$>450\mu\text{g}/\text{m}^3$		$>160\mu\text{g}/\text{m}^3$		
2008	2.2	0	160	0	39.9	7007*
2009	2.2	0	82	0	24.1	8362
2010	1.6	0	64	0	18.1	8365

* Instrument installed March 2008

Table C – 2.17 Annual trend summary of SO₂ data from the Jail site

Year	Annual Average	No. of 1-Hour Values	Maximum Hourly Average	No. of Daily Values	Maximum Daily Average	No. of Hours Instrument Operated
	(µg/m ³)	>450µg/m ³	(µg/m ³)	>160µg/m ³	(µg/m ³)	
1986	16.9	4	538	0	152.5	8278
1987	12.8	2	666	0	123.0	8348
1988	13.8	8	586	1	173.8	8412
1989	12.0	1	659	0	99.6	8165
1990	5.5	0	283	0	56.7	6719
1991	8.7	1	492	0	118.1	8236
1992	12.1	1	450	0	104.0	8363
1993	10.9	0	363	0	81.8	8225
1994	12.5	1	469	0	123.0	8162
1995	20.5	1	530	0	118.8	8354
1996	23.7	10	735	2	189.8	8368
1997	20.5	4	759	0	143.2	8350
1998	18.6	1	469	0	129.0	7580
1999	10.0	0	306	0	103.9	8358
2000	9.0	0	415	0	96.3	8362
2001	12.1	1	458	1	164.7	8348
2002	11.6	1	519	0	82.3	8367
2003	13.2	0	336	0	91.7	8373
2004	11.7	0	341	0	74.7	8396
2005	11.7	0	339	0	92.9	8360
2006	10.2	0	374	0	80.0	8373
2007	8.0	0	329	0	110.7	8366
2008	7.8	0	434	0	65.4	8381
2009	9.4	0	210	0	101.8	8307
2010	11.0	0	376	0	106.6	8358

Table C – 2.18 Annual trend summary of SO₂ data from the Gladstone site

Year	Annual Average	No. of 1-Hour Values	Maximum Hourly Average	No. of Daily Values	Maximum Daily Average	No. of Hours Instrument Operated
	(µg/m ³)	>450µg/m ³	(µg/m ³)	>160µg/m ³	(µg/m ³)	
2005	-	0	130	0	39.4	6466*
2006	4.7	0	90	0	37.9	8362
2007	4.5	0	160	0	41.0	8357
2008	4.7	0	141	0	38.8	8248
2009	5.3	0	203	0	59.7	8366
2010	5.0	0	197	0	38.0	8258

* Instrument installed March 2005

Table C – 2.19 Annual trend summary of SO₂ data from the CBC site

Year	Annual Average	No. of 1-Hour Values	Maximum Hourly Average	No. of Daily Values	Maximum Daily Average	No. of Hours Instrument Operated
	(µg/m ³)	>450µg/m ³	(µg/m ³)	>160µg/m ³	(µg/m ³)	
1995	-	4	597	0	101.1	5096*
1996	23.9	10	794	4	189.3	8370
1997	20.1	9	778	2	197.7	8312
1998	22.6	10	597	1	224.0	8361
1999	13.0	11	751	1	227.1	8560
2000	-	2	519	0	142.4	6958
2001	16.2	10	969	4	193.7	8347
2002	12.5	4	623	0	104.4	8348
2003	15.9	11	623	1	163.3	8348
2004	15.5	6	703	0	126.8	8371
2005	13.6	6	761	0	146.7	8360
2006	13.0	6	633	0	112.8	8307
2007	10.4	7	615	0	119.3	8072
2008	10.2	5	561	0	110.1	8386
2009	13.3	6	787	0	99.1	8017
2010	13.4	8	667	0	150.8	8327

* Instrument installed May 1995

Table C – 2.20 Annual trend summary of SO₂ data from the Plaza site

Year	Annual Average	No. of 1-Hour Values	Maximum Hourly Average	No. of Daily Values	Maximum Daily Average	No. of Hours Instrument Operated
	(µg/m ³)	>450µg/m ³	(µg/m ³)	>160µg/m ³	(µg/m ³)	
1995	-	2	474	0	156.3	5323*
1996	15.8	13	913	1	167.9	8229
1997	14.6	8	663	0	118.3	8363
1998	11.9	0	399	0	93.5	8220
1999	7.2	1	490	0	105.3	8703
2000	7.4	0	341	0	58.7	8071
2001	9.5	1	455	1	173.0	8340
2002	7.2	1	527	0	68.0	8362
2003	5.7	0	333	0	53.5	8365
2004	4.7	0	349	0	48.2	8348
2005	7.6	1	490	0	101.0	8201
2006	7.2	0	244	0	62.4	8369
2007	5.8	0	131	0	49.8	8356
2008	6.1	0	256	0	51.1	8367
2009	6.5	0	222	0	49.9	8207
2010	6.8	0	191	0	49.0	8244

* Instrument installed May 1995

Table C – 2.21 Annual trend summary of O₃ data from the Plaza site

Year	Annual Avg. (µg/m ³)	No. (%) of 1-Hour Values		Max. Hourly Avg. (µg/m ³)	No. of 8-Hr. Values >130µg/m ³	Max. 8-Hr. Avg. (µg/m ³)	No. (%) of Daily Values		Max. 24-Hr. Avg. (µg/m ³)	No. of Hours Instr. Operated
		>100µg/m ³	>160µg/m ³				>30µg/m ³	>50µg/m ³		
1995	-	30 (0.5%)	0	112	0	104	109 (45.2%)	32 (13.3%)	76.7	5548*
1996	35.7	21 (0.2%)	0	120	0	109	209 (58.2%)	87 (24.2%)	91.1	8632
1997	36.5	84 (1.0%)	0	122	0	109	225 (62.0%)	95 (26.2%)	86.0	8674
1998	37.2	175 (2.0%)	0	158	3	134	223 (61.9%)	89 (24.7%)	99.3	8619
1999	38.5	152 (1.8%)	0	140	0	118	224 (62.2%)	94 (26.1%)	107.7	8583
2000	37.4	182 (2.1%)	0	132	0	115	200 (55.1%)	89 (24.5%)	107.2	8632
2001	41.8	214 (2.5%)	2	169	3	136	243 (67.3%)	127 (35.2%)	101.5	8577
2002	41.4	152 (1.8%)	0	128	0	116	245 (67.5%)	124 (34.2%)	101.5	8610
2003	40.2	136 (1.6%)	0	135	0	120	246 (67.4%)	113 (31.0%)	97.4	8581
2004	38.3	130 (1.5%)	1	174	1	132	224 (61.7%)	88 (24.2%)	96.8	8605
2005	34.9	44 (0.5%)	0	121	0	103	192 (54.1%)	78 (22.0%)	94.3	8436
2006	38.0	35 (0.4%)	0	129	0	112	249 (68.6%)	87 (24.0%)	89.8	8545
2007	39.9	55 (0.7%)	0	128	0	110	244 (62.4%)	112 (31.2%)	100.9	8542
2008	38.9	108 (1.3%)	0	125	0	117	236 (65.0%)	105 (28.9%)	98.8	8598
2009	39.1	50 (0.6%)	0	121	0	113	239 (68.1%)	99 (28.2%)	97.5	8428**
2010	39.8	117 (1.4%)	0	121	0	118	235 (66.0%)	107 (30.1%)	104.8	8584

* Note: API Analyzer installed in late April 1995

** Note: API analyzer replaced July 2009.

Table C – 2.22 Annual trend summary of NO₂ data from the Plaza site

Year	Annual Average (µg/m ³)	No. of 1-Hour Values >400µg/m ³	Maximum Hourly Average (µg/m ³)	No. of Daily Values >200µg/m ³	Maximum Daily Average (µg/m ³)	No. of Hours Instrument Operated
1992	-	0	61	0	97.0	4825*
1993	25.4	0	149	0	83.3	8072
1994	23.7	0	130	0	70.7	7852
1995	-	0	101	0	61.5	4957**
1996	25.9	0	151	0	84.6	7787
1997	24.3	0	186	0	91.5	8242
1998	28.7	0	143	0	67.1	8051
1999	25.6	0	143	0	99.1	8218
2000 (a)	-	0	149	0	81.9	5070**
2001	23.0	0	111	0	81.5	8295
2002	20.2	0	138	0	75.1	8176
2003	20.8	0	105	0	63.4	8297
2004 (b)	-	0	122	0	69.1	7244**
2005	-	0	84	0	56.3	6577**
2006	26.4	0	92	0	58.0	8283
2007	20.6	0	96	0	64.8	8319
2008	22.2	0	131	0	80.4	8314
2009	22.7	0	115	0	79.8	8097
2010	19.1	0	96	0	60.4	8222

* Note: NO₂ Analyzer Installed in June 1992

** Note: NO₂ Operational Problems

(a) Note: NO₂ Analyzer replaced on November 22, 2000

(b) Note: NO₂ Analyzer replaced on April 13, 2004

Table C – 2.23 Annual trend summary of CO data from the Plaza site

	Annual Average ($\mu\text{g}/\text{m}^3$)	No. of 1-Hour Values	Maximum Hourly Average ($\mu\text{g}/\text{m}^3$)	No. of 8-Hr Values	Maximum 8 Hour Average ($\mu\text{g}/\text{m}^3$)	No. of Hours Instrument Operated
		>14300 $\mu\text{g}/\text{m}^3$		>5500 $\mu\text{g}/\text{m}^3$		
2003	536.4	0	5007	0	3668	8349
2004	540.1	0	5128	0	3404	7785*
2005	430.0	0	3243	0	2138	8122
2006	407.1	0	3563	0	2080	8378
2007	358.3	0	3972	0	1908	8310
2008	341.8	0	3036	0	1904	8387
2009	323.7	0	2538	0	1700	8247
2010	295.6	0	3092	0	1483	7605**

* Note: Instrumentation problems from Nov. 15th – Dec. 31st, 2004

** Note: Instrumentation problems from Oct. 10th – Nov. 5th, 2010

iii) Annual Percentile Tables:

Tables C – 3.1 through C – 3.8 summarize annual percentile values for all pollutants and monitoring locations included in this report. The summaries include percentiles, maximum and average values for the averaging period and the number of samples collected for the year. Percentiles are used to describe the distribution of data for each year as the percentage of the data set that lies below the stated value. For example, the 95th percentile indicates that 95% of the data are below that value, or alternatively, that value is exceeded only 5% of the time.

Table C – 3.1 Percentiles of the 1-hour PM_{10} levels ($\mu\text{g}/\text{m}^3$) from the continuous PM_{10} monitoring sites

Site	Year	Hourly Percentile ($\mu\text{g}/\text{m}^3$)									Max. ($\mu\text{g}/\text{m}^3$)	Average ($\mu\text{g}/\text{m}^3$)	No. of Samples
		5	10	25	50	75	90	95	98	99			
Plaza	1995	4	5	10	17	29	52	73	103	130	388	24.6	8662
	1996	3	4	8	15	25	41	56	81	111	373	20.5	8577
	1997	3	5	8	14	26	43	56	76	92	208	20.2	8721
	1998	4	6	9	16	27	46	65	90	110	319	22.7	8719
	1999	2	4	7	13	22	37	51	72	87	211	17.8	8609
	2000	3	4	8	13	22	39	51	67	78	175	18.0	8692
	2001	2	4	7	13	23	39	51	69	85	170	18.2	8683
	2002	2	4	7	13	23	39	52	71	82	154	18.2	8683
	2003	2	4	7	14	25	43	58	78	91	199	19.5	8669
	2004	2	4	8	14	26	45	59	78	95	170	20.3	8713
	2005	2	4	8	15	26	44	59	81	99	202	20.6	8532
	2006	1	3	7	14	27	46	62	86	105	201	21.1	8723
	2007	1	4	7	13	22	38	51	70	84	166	17.8	8689
2008	2	4	7	13	23	40	52	70	84	180	18.3	8751	
2009	1	3	7	12	22	38	53	71	86	167	17.5	8603	
2010	3	4	8	13	22	37	52	81	108	365	18.8	8575	
BCR	1997	3	5	9	17	30	51	70	97	121	401	24.2	8706
	1998	4	6	11	20	36	58	83	126	161	582	29.1	8703
	1999	2	4	8	15	27	46	61	83	100	380	21.3	8719
	2000	2	4	8	15	26	42	55	75	93	288	20.0	8739
	2001	2	4	7	14	26	44	57	81	97	387	20.1	8634
	2002	2	4	8	15	28	48	66	91	112	430	22.1	8707
	2003	3	5	9	17	30	53	72	99	121	262	24.4	8534
	2004	2	4	9	17	32	58	79	113	143	332	25.9	8604
	2005	3	5	10	19	34	61	82	114	136	444	27.5	8666
	2006	1	4	9	18	36	67	94	135	165	455	29.2	8718
	2007	2	4	9	17	31	53	70	95	125	411	24.3	8718
	2008	1	3	8	15	27	45	60	81	97	335	20.6	8749
2009	2	4	8	14	26	43	57	76	90	220	19.8	8730	
2010	3	5	8	15	26	41	55	84	121	415	20.9	8144	
Gladstone	1996	1	3	5	10	19	33	45	65	80	253	15.4	8716
	1997	1	3	5	10	19	34	44	61	73	155	14.8	8644
	1998	2	4	7	12	22	36	48	66	82	207	17.2	8643
	1999	1	2	5	9	16	28	37	50	58	140	12.7	8671
	2000	1	3	5	10	17	29	38	52	61	148	13.6	8686
	2001	1	3	5	9	18	30	40	52	63	164	13.5	8693
	2002	2	3	6	10	17	30	38	52	64	109	13.6	8696
	2003	1	3	6	10	19	32	43	57	68	237	14.8	8623
	2004	1	2	5	10	20	32	42	56	67	175	14.6	8594
	2005	1	3	6	11	19	32	45	62	73	217	15.1	8270
	2006	0	2	5	11	20	34	45	59	71	163	15.2	8543
	2007	0	2	5	10	18	29	39	52	62	120	13.4	8650
	2008	1	2	5	9	17	29	37	46	54	136	13.0	8447
2009	1	2	5	10	17	28	36	48	57	100	13.0	8477	
2010	1	3	6	10	17	27	36	59	90	337	14.0	8449	

Table C – 3.2 Percentiles of the 24-hour PM_{10} levels ($\mu\text{g}/\text{m}^3$) from the continuous PM_{10} monitoring sites

Site	Year	24-hour Percentile ($\mu\text{g}/\text{m}^3$)									Max. ($\mu\text{g}/\text{m}^3$)	Average ($\mu\text{g}/\text{m}^3$)	No. of Samples
		5	10	25	50	75	90	95	98	99			
Plaza	1995	7	9	13	19	30	48	62	83	93	120.8	24.6	8677
	1996	6	8	11	17	25	35	44	61	89	155.4	20.5	8514
	1997	7	8	11	17	26	37	47	57	65	79.1	20.2	8700
	1998	7	9	13	19	29	40	52	66	79	113.7	22.7	8728
	1999	6	7	10	14	22	34	44	53	61	97.6	17.9	8570
	2000	6	7	10	15	23	34	42	52	55	70.5	18.1	8711
	2001	6	7	10	15	23	35	43	52	58	109.6	18.2	8661
	2002	6	7	10	15	23	34	44	55	61	81.1	18.2	8459
	2003	6	8	11	15	24	35	47	62	71	100.3	19.5	8737
	2004	6	7	11	17	26	39	47	55	63	79.8	20.3	8761
	2005	7	8	11	16	26	40	50	65	73	83.5	20.6	8518
	2006	6	7	11	17	28	41	51	63	68	87.4	21.1	8757
	2007	6	7	10	15	22	35	41	49	56	79.6	17.9	8658
	2008	5	7	10	15	24	36	44	51	56	69.9	18.3	8744
2009	5	6	9	14	22	34	42	50	56	85.1	17.5	8599	
2010	6	7	10	15	22	32	42	61	91	207.5	18.8	8522	
BCR	1997	8	10	13	19	30	47	60	73	80	115.1	24.3	8708
	1998	9	11	15	23	36	57	71	92	101	127.1	29.2	8709
	1999	7	8	11	18	28	41	51	58	64	81.8	21.3	8702
	2000	6	7	11	17	26	37	46	55	62	86.3	19.9	8740
	2001	6	7	10	16	27	40	49	60	70	97.8	20.2	8699
	2002	6	8	11	17	29	45	53	61	72	88.5	22.1	8737
	2003	8	10	13	19	30	47	57	69	77	110.0	24.2	8572
	2004	7	9	12	19	35	55	67	78	84	142.0	26.2	8749
	2005	9	10	14	21	35	54	68	87	97	118.2	27.5	8737
	2006	8	10	13	23	39	63	78	88	93	118.5	29.6	8643
	2007	8	9	13	19	31	47	59	72	83	111.3	24.3	8707
	2008	6	8	11	16	27	41	49	57	66	85.2	20.6	8732
2009	6	8	10	17	26	38	46	54	60	76.7	19.8	8720	
2010	6	8	11	17	25	35	45	71	103	225.4	20.9	8117	
Gladstone	1996	5	5	8	12	19	29	38	50	57	107.4	15.4	8720
	1997	4	5	7	12	19	29	39	48	54	71.3	14.9	8611
	1998	5	6	9	15	22	32	39	48	53	74.2	17.3	8636
	1999	4	5	7	11	16	24	30	36	39	46.6	12.7	8702
	2000	4	5	7	11	17	26	31	41	48	55.3	13.5	8715
	2001	4	5	7	10	18	27	33	39	46	78.0	13.5	8737
	2002	4	5	8	11	17	24	32	44	53	74.2	13.6	8737
	2003	6	6	8	12	18	27	34	45	60	78.8	14.8	8685
	2004	5	6	7	12	19	28	34	40	47	70.9	14.7	8671
	2005	5	6	8	12	18	28	39	48	56	68.9	15.1	8038
	2006	5	6	8	12	21	29	35	41	47	69.1	15.2	8511
	2007	4	5	7	11	17	25	30	41	49	68.3	13.3	8659
	2008	4	5	7	11	17	25	31	35	39	49.4	13.0	84.27
2009	5	5	7	11	17	24	28	34	43	57.5	13.0	8456	
2010	4	5	7	11	16	23	28	47	85	209.8	13.9	8383	

Table C – 3.3 Percentiles of 1-hour and 24-hour continuous PM_{2.5} levels (µg/m³) from the Plaza and Gladstone sites

Averaging Time	Year	Percentile (µg/m ³)									Max. (µg/m ³)	Average (µg/m ³)	No. of Samples
		5	10	25	50	75	90	95	98	99			
Plaza													
1-hr	1998	0	1	2	5	11	19	27	39	50	119	8.2	8722
	1999	0	0	1	4	10	17	22	33	43	117	6.9	8657
	2000	0	0	2	5	12	20	29	40	50	92	8.5	8634
	2001	0	0	1	5	12	20	29	41	50	139	8.5	8575
	2002	0	0	2	5	11	20	28	39	49	84	8.2	8685
	2003	0	0	2	6	13	24	33	46	58	158	9.8	8614
	2004	0	0	2	5	13	24	32	45	54	127	9.5	8752
	2005	0	0	1	5	11	19	26	35	43	89	7.8	8618
	2006	0	0	1	5	11	18	24	33	41	119	7.5	8729
	2007	0	0	1	4	9	15	20	28	34	70	6.4	8728
	2008	0	0	1	4	9	17	23	32	38	98	6.8	8765
2009	0	0	1	4	10	16	22	31	41	104	6.9	8590	
2010	0	0	2	4	10	16	23	49	80	283	8.1	8656	
24-hr.	1998	1	2	4	6	11	17	21	27	37	52.1	8.3	8724
	1999	1	2	3	4	9	15	18	23	28	33.4	6.9	8658
	2000	1	2	4	6	12	17	24	31	36	47.1	8.5	8637
	2001	2	3	3	6	11	19	25	32	37	57.9	8.6	8537
	2002	1	2	3	6	11	16	21	31	38	65.3	8.2	8643
	2003	2	3	4	7	12	19	25	42	48	61.9	9.9	8682
	2004	1	2	4	7	12	20	27	35	40	66.0	9.6	8761
	2005	2	2	4	6	10	16	21	26	32	42.9	7.8	8653
	2006	1	2	3	6	10	16	19	23	27	46.1	7.5	8737
	2007	1	2	3	5	8	13	16	21	24	43.1	6.4	8719
	2008	1	2	3	5	9	14	19	25	29	39.4	6.8	8764
2009	1	2	3	5	9	14	18	24	30	47.1	6.9	8557	
2010	1	2	3	5	9	14	18	41	72	177.1	8.1	8640	
Gladstone													
1-hr	2006	0	0	1	4	9	17	23	32	36	181	6.6	8694
	2007	0	0	1	3	8	14	20	26	31	60	5.6	8153
	2008	0	0	1	3	8	15	20	27	31	55	5.7	8765
	2009	0	1	2	4	8	14	18	24	29	53	5.8	8714
	2010	0	0	1	3	8	15	21	38	78	325	7.2	8674
24-hr	2006	1	1	2	5	9	14	18	23	27	37.8	6.6	8686
	2007	1	1	2	4	8	12	15	20	23	29.3	5.6	8099
	2008	1	1	2	4	7	12	16	23	25	28.5	5.7	8146
	2009	1	2	3	4	8	12	15	19	22	33.9	5.8	8700
	2010	1	1	2	4	8	13	18	38	74	199.1	7.2	8652

Table C – 3.4 Percentiles of 1-hour TRS levels ($\mu\text{g}/\text{m}^3$) from the three TRS monitoring sites

Site	Year	Percentile ($\mu\text{g}/\text{m}^3$)									Max. ($\mu\text{g}/\text{m}^3$)	Average ($\mu\text{g}/\text{m}^3$)	No. of Samples	
		50	60	70	75	80	90	95	98	99				
Plaza	1996	0	0	1	1	3	6	10	16	20	103	1.8	8229	
	1997	0	0	1	1	1	6	9	13	17	40	1.6	8372	
	1998	0	1	1	1	3	7	11	16	18	50	2.2	8245	
	1999	0	0	1	1	1	6	10	16	17	44	1.7	8247	
	2000	0	0	0	0	1	1	6	9	14	45	1.5	8314	
	2001	0	0	1	1	3	7	10	13	16	35	1.7	8257	
	2002	0	0	1	1	1	6	10	17	20	57	1.7	8167	
	2003	0	0	1	1	3	9	13	18	23	61	2.1	8220	
	2004	0	0	1	1	1	7	13	18	23	41	2.0	8384	
	2005	0	1	1	1	3	4	7	11	14	37	1.5	8333	
	2006	1	1	1	1	3	6	10	14	18	47	1.9	8340	
	2007	0	1	1	1	1	4	9	14	17	95	1.6	8352	
	2008	0	1	1	1	2	5	8	12	16	70	1.7	8367	
	2009	1	1	1	2	3	7	12	19	23	53	2.4	8218	
	2010	0	1	1	3	4	10	14	18	21	50	2.6	8174	
	Jail	1996	0	1	3	3	4	10	14	20	24	62	2.8	8359
		1997	0	1	1	3	4	9	13	18	23	55	2.5	8347
		1998	0	1	3	4	6	11	16	21	26	51	3.1	8314
		1999	0	1	1	1	4	9	13	18	24	123	2.4	8117
		2000	0	1	1	3	4	9	11	17	23	62	2.4	8214
2001		0	0	1	1	3	9	13	17	20	37	2.2	8352	
2002		0	0	1	1	3	7	11	18	23	44	2.1	8375	
2003		0	1	1	3	4	10	14	20	26	61	2.7	8374	
2004		0	0	1	3	4	10	16	21	26	84	2.8	8300	
2005		0	0	1	1	3	7	11	16	18	34	2.1	8347	
2006		0	1	1	1	3	7	13	18	23	47	2.3	8324	
2007		0	1	1	1	3	7	11	17	23	81	2.2	8296	
2008		0	0	1	1	3	6	10	16	20	60	1.7	8367	
2009	0	1	1	1	3	7	11	17	21	61	2.1	8276		
2010	1	1	1	3	4	7	11	16	18	45	2.3	8299		
Lakewood	1996	0	0	0	1	1	3	4	8	13	44	0.9	8283	
	1997	0	0	0	0	1	1	4	7	9	27	0.7	8211	
	1998	0	0	0	0	1	1	4	9	10	18	0.7	8204	
	1999	0	0	0	0	1	1	3	7	10	28	0.6	8191	
	2000	0	0	0	0	0	1	3	6	10	23	0.5	8348	
	2001	0	0	0	0	1	1	4	7	10	23	0.7	8345	
	2002	0	0	0	0	1	1	3	7	10	23	0.6	8254	
	2003	0	0	0	0	1	1	3	7	9	23	0.6	8370	
	2004	0	0	0	0	1	1	4	10	15	44	0.8	7621	
	2005	0	0	1	1	1	1	4	6	7	16	0.8	8175	
	2006	0	0	1	1	1	1	3	6	9	21	0.8	8283	
	2007	0	0	0	0	1	1	3	6	9	26	0.6	8010	
	2008	0	0	0	0	1	1	3	6	7	45	0.6	8387	
2009	0	0	0	0	1	1	3	7	10	28	0.6	8363		
2010	0	0	0	0	0	1	3	6	10	21	0.6	8363		

Table C – 3.5 Percentiles of 1-hour SO₂ levels (µg/m³) from the Plaza and Jail SO₂ monitoring sites

Site	Year	Percentile (µg/m ³)									Max. (µg/m ³)	Average (µg/m ³)	No. of Samples
		20	25	40	50	75	90	95	98	99			
Plaza	1996	0	0	0	3	8	43	81	151	217	912	16.0	8232
	1997	0	0	3	3	11	37	72	125	182	663	14.6	8364
	1998	0	0	3	3	8	35	61	99	135	399	11.9	8220
	1999	0	0	0	3	5	19	35	61	83	490	7.2	8304
	2000	0	0	0	3	8	21	35	59	77	341	7.4	8071
	2001	0	0	0	3	8	27	45	77	111	455	9.5	8340
	2002	0	0	0	3	5	19	37	59	77	527	7.2	8362
	2003	0	0	0	0	5	16	27	48	64	333	5.7	8365
	2004	0	0	0	0	5	13	21	37	51	349	4.7	8348
	2005	0	0	3	3	5	19	34	58	82	490	7.6	8201
	2006	0	0	3	3	8	16	29	50	75	244	7.2	8369
	2007	1	1	2	2	5	14	26	43	59	131	5.8	8356
	2008	1	1	1	2	5	16	29	48	63	256	6.1	8367
	2009	1	1	1	2	6	16	30	54	71	222	6.5	8207
2010	0	0	1	2	7	19	31	46	61	191	6.7	8244	
Jail	1996	0	0	0	3	16	78	138	210	269	734	24.1	8378
	1997	0	0	3	3	16	61	112	184	224	759	20.5	8350
	1998	0	0	3	3	19	59	93	144	181	469	18.6	7580
	1999	0	0	0	3	5	29	56	91	123	306	10.0	8358
	2000	0	0	0	0	8	27	48	80	104	415	9.0	8362
	2001	0	0	0	3	8	37	64	104	128	458	12.1	8348
	2002	0	0	0	0	8	40	64	99	123	519	11.6	8367
	2003	0	0	0	3	11	42	72	111	137	336	13.2	8373
	2004	0	0	0	0	11	40	67	96	120	341	11.7	8396
	2005	0	0	0	0	8	37	66	101	130	339	11.7	8360
	2006	0	0	0	0	5	32	58	98	125	374	10.2	8373
	2007	0	0	0	0	5	21	45	80	103	329	8.0	8366
	2008	0	0	0	0	5	24	43	72	96	434	7.8	8381
	2009	0	0	0	3	8	27	48	85	112	210	9.4	8307
2010	0	1	1	2	10	34	57	90	111	376	11.0	8358	

Table C – 3.6 Percentiles of 1-hour SO₂ levels (µg/m³) from the CBC, Gladstone and Marsulex SO₂ monitoring sites

Site	Year	Percentile (µg/m ³)									Max. (µg/m ³)	Average (µg/m ³)	No. of Samples
		20	25	40	50	75	90	95	98	99			
CBC	1996	0	0	0	3	19	77	136	218	255	793	23.9	8372
	1997	0	0	3	3	13	56	101	178	242	778	20.1	8320
	1998	0	3	3	5	19	59	109	202	275	597	22.6	8361
	1999	0	0	0	3	5	35	69	123	192	751	13.0	8204
	2000	0	0	0	0	8	35	61	109	160	519	11.6	6958
	2001	0	0	0	0	11	45	88	162	237	969	16.2	8347
	2002	0	0	0	0	8	37	64	109	157	623	12.5	8348
	2003	0	0	0	0	13	45	77	141	210	623	15.9	8348
	2004	0	0	0	0	11	45	77	151	208	703	15.5	8371
	2005	0	0	0	0	8	40	72	119	175	761	13.6	8360
	2006	0	0	0	0	5	37	72	135	193	633	13.0	8307
	2007	0	0	0	0	5	29	56	97	146	615	10.4	8072
	2008	0	0	0	0	3	29	53	96	160	561	10.2	8386
	2009	0	0	0	0	11	40	69	114	160	787	13.3	8017
2010	0	0	1	1	10	39	66	116	169	667	13.4	8327	
Gladstone	2006	0	0	0	3	5	13	21	37	48	90	4.7	8362
	2007	1	1	1	2	4	12	20	34	44	160	4.5	8357
	2008	0	0	1	1	4	14	24	39	50	141	4.7	8247
	2009	0	0	1	1	5	15	27	46	58	203	5.5	8366
	2010	0	0	1	1	5	15	25	38	47	197	5.0	8258
Marsulex-BCR	2009	0	0	0	0	3	5	11	21	29	82	2.2	8362
	2010	0	0	0	0	1	4	8	14	20	64	1.6	8365

Table C – 3.7 Percentiles of 1-hour, 8-hour and 24-hour ozone levels ($\mu\text{g}/\text{m}^3$) from the Plaza site

	Year	Percentile ($\mu\text{g}/\text{m}^3$)									Min ($\mu\text{g}/\text{m}^3$)	Max. ($\mu\text{g}/\text{m}^3$)	No. of Samples
		5	10	25	50	75	90	95	98	99			
1-hour	1996	2	4	10	34	56	74	82	88	94	0	120	8632
	1997	2	3	10	34	58	76	84	94	100	0	122	8674
	1998	2	4	11	33	59	78	88	100	110	0	158	8619
	1999	2	3	11	36	58	81	90	99	104	0	140	8583
	2000	3	4	12	33	58	81	92	101	105	0	131	8632
	2001	2	4	14	40	65	82	92	102	107	0	169	8577
	2002	2	4	12	40	66	84	92	99	104	0	128	8610
	2003	2	4	14	38	62	81	90	98	104	0	135	8581
	2004	2	3	11	35	60	81	91	99	104	0	174	8605
	2005	1	2	7	32	56	76	85	94	97	0	121	8436
	2006	1	3	12	39	59	74	81	89	94	0	129	8544
	2007	2	4	17	40	60	75	83	92	96	0	128	8542
	2008	1	2	13	38	60	77	87	96	101	0	125	8598
	2009	2	4	15	38	59	77	85	93	98	0	121	8428
	2010	3	5	15	38	60	78	87	97	102	0	121	8588
8-hour	1996	3	6	15	34	55	69	77	85	89	0	109	8644
	1997	3	5	15	35	55	72	79	88	92	0	109	8646
	1998	4	7	16	34	55	72	82	93	102	0.4	134	8598
	1999	4	6	17	36	56	75	85	94	100	0.3	118	8569
	2000	4	7	16	33	55	76	88	97	100	0.5	115	8620
	2001	4	7	20	40	61	78	87	97	101	0.3	136	8602
	2002	3	6	19	39	62	80	88	95	100	0.4	116	8644
	2003	4	8	19	38	59	75	85	92	97	0.1	120	8694
	2004	3	6	17	36	57	76	86	93	98	0.4	132	8745
	2005	3	4	12	32	52	72	82	90	94	0.4	103	8489
	2006	3	6	18	38	56	69	76	84	89	0.4	112	8489
	2007	5	9	22	40	56	70	78	86	91	0.3	110	8592
	2008	3	5	18	37	58	74	82	92	98	0.1	117	8694
2009	5	8	19	37	56	73	81	88	93	0.1	113	8449	
2010	5	8	19	38	58	74	84	93	98	0.4	118	8572	
24-hour	1996	9	12	21	34	49	61	69	79	83	3.0	93	8632
	1997	7	10	22	35	50	64	71	78	80	0.3	86	8716
	1998	9	13	23	35	50	64	72	79	85	1.6	99	8641
	1999	11	14	23	36	50	67	76	85	90	1.7	106	8625
	2000	9	12	20	34	51	69	80	88	92	2.8	105	8676
	2001	11	17	26	40	56	72	79	86	89	3.8	101	8666
	2002	7	13	25	40	57	71	79	88	93	1.2	101	8705
	2003	10	15	24	39	54	68	74	82	87	2.1	97	8743
	2004	9	14	23	37	51	64	74	83	87	1.9	97	8691
	2005	7	10	19	32	48	67	75	83	88	1.7	94	8535
	2006	10	15	26	38	50	60	66	73	79	1.7	90	8705
	2007	11	17	26	39	53	64	69	79	84	3.5	101	8598
	2008	8	13	22	38	54	65	73	86	89	1.9	99	8704
2009	12	16	24	38	52	66	73	78	83	2.9	97	8456	
2010	10	13	24	39	54	67	76	83	91	2.8	105	8659	

Table C – 3.8 Percentiles of 1-hour NO₂ and NO levels (µg/m³) from the Plaza site

Year	Percentile (µg/m ³)									Max. (µg/m ³)	No. of Samples
	5	10	25	50	75	90	95	98	99		
NO₂											
1995	4	6	11	23	38	54	61	75	80	101	5182
1996	4	6	10	19	36	55	69	82	92	151	7800
1997	2	4	10	19	34	52	63	78	88	186	8243
1998	4	6	13	25	40	57	67	77	83	143	8051
1999	4	6	10	19	34	56	71	84	94	143	8218
2000	2	4	10	19	36	56	71	88	99	149	5070
2001	2	4	10	17	33	50	61	75	82	111	8295
2002	2	4	8	15	29	42	54	65	75	138	8176
2003	2	4	8	17	29	44	54	63	71	105	8297
2004	2	4	10	17	29	44	54	65	75	122	7244
2005	10	12	16	21	29	38	44	52	59	84	6577
2006	10	11	15	25	34	46	52	59	65	92	8283
2007	4	6	9	16	28	42	52	62	68	96	8319
2008	4	5	9	16	30	49	62	75	82	131	8314
2009	3	4	8	17	32	51	63	76	82	115	8097
2010	3	4	7	15	27	41	50	60	66	96	8222
NO											
1995	-	-	<22	<22	22	55	87	144	187	344	5188
1996	0	1	3	7	24	61	100	162	206	440	7778
1997	0	0	3	8	24	59	97	168	243	544	8181
1998	1	1	4	10	30	74	119	182	241	566	8074
1999	0	1	4	9	24	57	87	126	170	479	8226
2000	0	1	4	9	26	66	110	182	236	447	5070
2001	0	1	3	6	19	51	87	145	189	497	8294
2002	0	1	3	6	18	42	72	120	166	530	8175
2003	0	0	1	5	16	41	69	116	156	358	8297
2004	0	0	3	6	20	47	79	124	166	379	8286
2005	1	1	2	7	24	58	87	123	160	382	8029
2006	0	1	1	6	20	45	69	103	130	276	8283
2007	1	1	2	4	11	28	44	72	96	259	8318
2008	0	1	2	4	13	38	65	117	150	243	8316
2009	0	1	2	4	13	37	68	119	149	232	8097
2010	0	0	1	3	10	28	44	76	104	339	8221

Table C-3.9 Percentiles of the 1-hour and 8-hour CO levels from the Plaza site

Averaging Time	Year	Percentile ($\mu\text{g}/\text{m}^3$)									Max. ($\mu\text{g}/\text{m}^3$)	Average ($\mu\text{g}/\text{m}^3$)	No. of Samples
		5	10	25	50	75	90	95	98	99			
1-hr	2003	219	250	311	418	630	968	1294	1856	2319	5112	547.7	8349
	2004	174	210	280	419	680	1079	1354	1720	2091	5236	551.5	7785
	2005	153	185	247	342	507	787	1088	1502	1803	3311	439.1	8122
	2006	142	179	243	328	496	741	959	1326	1571	3638	415.8	8366
	2007	164	193	240	303	396	568	736	1035	1338	3971	358.3	8310
	2008	126	152	198	265	383	597	819	1225	1476	3036	341.8	8387
	2009	128	156	209	270	357	533	713	996	1249	2538	323.7	8247
	2010	116	128	186	236	326	489	687	980	1217	3092	295.6	7606
8-hr.	2003	249	280	340	449	620	945	1255	1584	1836	3745	548.5	8702
	2004	204	236	314	455	689	1001	1210	1499	1696	3476	551.7	8122
	2005	189	217	271	358	507	771	987	1256	1489	2183	439.1	8402
	2006	157	197	259	347	496	735	883	1129	1343	2124	415.7	8678
	2007	185	210	255	313	399	543	697	929	1138	1908	357.5	8603
	2008	142	165	208	275	392	593	782	1058	1257	1904	341.3	8705
	2009	141	165	220	280	362	514	679	924	1128	1700	323.5	8573
	2010	122	143	196	246	335	486	629	867	1034	1483	296.0	7902

Appendix "D"

Photographs of the Monitoring Sites in Prince George

Lakewood Jr. Secondary looking towards the east



Gladstone Resource Center looking towards the north



CBC Transmitter site looking towards the west



Jail looking towards the north



BCR site looking towards the east



Plaza's ambient and meteorological site looking towards the southwest



Glenview ambient and meteorological site looking towards the west



P.G. Pulp meteorological site looking towards the southeast



Northwood meteorological site looking towards the east.



Appendix "E" Glossary

Airshed:

The mass of air contained within a certain boundary (usually topographical boundary).

Aldehydes:

An organic compound that contains an oxygen atom doubly bonded to a carbon atom and possesses at least one hydrogen atom.

Ambient Air:

The portion of the atmosphere in the receiving environment, external to buildings, to which the general public has access; open air.

Anthropogenic:

Referring to environmental alterations resulting from the presence or activities of humans.

Carcinogen:

An agent that incites development of cancer.

CO:

Carbon monoxide. A colourless, odourless and poisonous gas which is produced as a result of incomplete combustion of fossil fuels.

Detection Limit:

The minimum concentration of a compound contaminant that can be determined by a specific analytical method.

H₂S:

Hydrogen Sulphide. A colourless gas having a characteristic odour of rotten eggs.

HCHO:

Formaldehyde. The simplest member of the aldehyde group.

Inversion:

A meteorological condition in which a layer of warm air resides over a layer of cold air (usually occurring during nights when the sky is clear). Pollution is trapped below this warm air resulting in poor air quality over an area.

Level A Objective:

A criteria established to provide the basis for an anti-degradation policy for undeveloped areas with an adequate safety margin.

Level B Objective:

A criteria established to provide adequate protection against adverse effects on personal health and comfort, animals, vegetation, soil, water, materials and visibility.

Level C Objective:

A criteria established to provide protection against health effects that are specific to each contaminant.

Micron:

Micrometre (μm). $1 \mu\text{m} = 0.001$ millimetres.

MIS:

Meteorological Information Station. Usually measuring continuous wind speed and direction.

NAPS:

National Air Pollution Surveillance. A federal schedule in which pollutants are monitored for a 24 hour period (from midnight to midnight) once every six days.

NO_2 :

Nitrogen Dioxide. A reddish brown gas with a pungent and irritating odour at high concentrations.

NO :

Nitric Oxide. A colourless odourless gas emitted from combustion sources.

NO_x :

Oxides of nitrogen. Emitted from combustion sources. Assumed to be the sum of nitrogen dioxide and nitric oxide concentrations in the atmosphere.

O_3 :

Ozone. The main constituent of smog found in the lower atmosphere and, when found in the upper atmosphere (stratosphere), a filter for ultra violet radiation.

PAH:

Polycyclic Aromatic Hydrocarbons are probable human carcinogens emitted during such processes as the incomplete combustion of biomass.

Percentile:

The percentage of the data set that lies below the stated value. For example, if the 70 percentile value is $10 \mu\text{g}/\text{m}^3$, then 70% of the data are equal to or below $10 \mu\text{g}/\text{m}^3$.

PG AIRs

Prince George Air Improvement Roundtable Society. A society with representatives from Ministry of Environment, Ministry of Health, Ministry of Transportation, Regional District, City of Prince George, University of Northern BC, Chamber of Commerce, environmental group and several major industries.

PM_{10} :

Particulate matter that are less than 10 micrometres (0.00001 metre) in diameter.

$\text{PM}_{2.5}$:

Particulate matter that are less than 2.5 micrometres (0.0000025 metre) in diameter.

PPB:

Parts (of contaminant) per billion (parts of air)

Primary Pollutant:

A contaminant which is directly emitted to the atmosphere.

Secondary Pollutant:

A contaminant which is formed from other pollutants present in the atmosphere.

SO₂:

Sulphur dioxide. A corrosive gas produced mainly from the combustion of fossil fuels that contain sulphur.

TRS:

Total reduced sulphur. Main components include hydrogen sulphide, methylmercaptan, dimethyldisulphide and dimethylsulphide.

TSP:

Total Suspended Particulate matter that ranges in diameter from 0.001 micrometre to 100 micrometre.

VOC:

Volatile organic compounds. Emitted from sources such as oil-based paints, automobiles and dry cleaning fluids. A catalyst in the generation of tropospheric ozone.

µg/m³:

Micrograms (0.000,001 grams) of contaminant per cubic metre.

µm:

Micrometre (0.001 millimetres).