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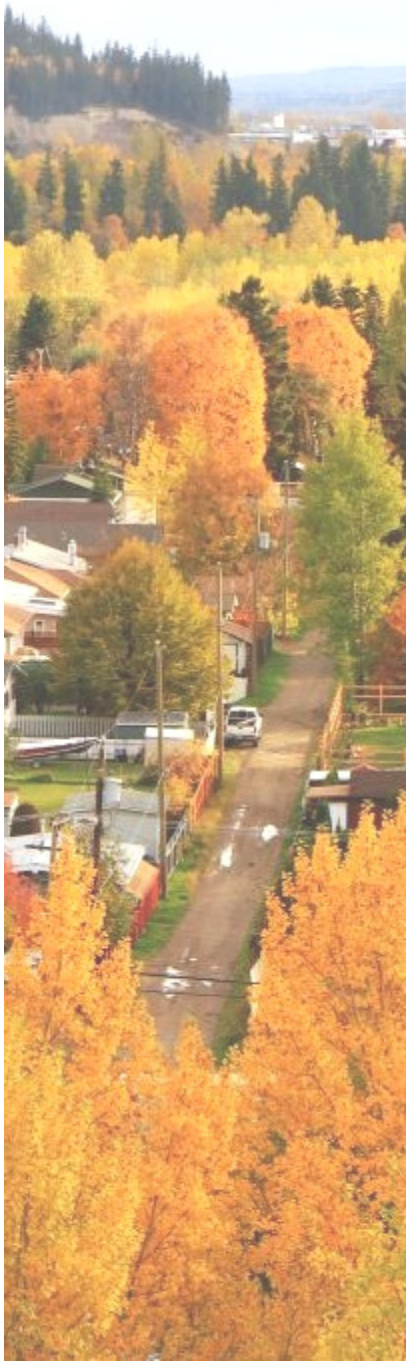

AMBIENT LEVELS OF PARTICULATE MATTER IN PRINCE GEORGE: A SUMMARY OF TRENDS

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Environmental Protection Division
Regional Operations Branch

Introduction

This report presents annual trends in ambient $PM_{2.5}$[1] and PM_{10}[2] in Prince George.

Sources of $PM_{2.5}$ include, but are not limited to: industries, wood stoves, motor vehicles and forest fires. Due to its topography, Prince George and many other interior communities in BC are susceptible to high levels of $PM_{2.5}$ during atmospheric temperature inversions. $PM_{2.5}$ has a broad range of adverse health effects, predominantly to the respiratory and cardiovascular systems. Research has not identified thresholds below which adverse health effects do not occur, and both short-term and long-term $PM_{2.5}$ exposures are associated with adverse health effects.

Another pollutant of concern in Prince George is PM_{10}. Significant sources of PM_{10} include winter traction material, dust from unpaved roads and unvegetated surfaces, and emissions from the wood processing industries. Generally, PM_{10} exceedances occur during late winter/early spring when loose winter traction material becomes exposed on road surfaces. Measurements of PM_{10} include $PM_{2.5}$ (based on the definitions given below[1,2]); however, the main causes behind PM_{10} exceedances are not the same as the causes behind $PM_{2.5}$ exceedances.

Particulate matter ($PM_{2.5}$ and PM_{10}) is monitored at three stations in Prince George: Plaza, BC Rail Warehouse (BCR), and Gladstone School (Gladstone). The locations of these three stations are shown in Figure 1.

Figure 1: Map showing the locations of the particulate matter monitoring stations in Prince George.

[1] $PM_{2.5}$: particulate matter with aerodynamic diameters less than or equal to 2.5 micrometers.
[2] PM_{10}: particulate matter with aerodynamic diameters less than or equal to 10 micrometers.

Table 1 provides a summary of the air quality objectives for particulate matter in British Columbia. There are two provincial objectives for $PM_{2.5}$, including an annual objective and a 24-hour objective. For PM_{10} there is a provincial 24-hour objective and there is no provincial annual objective.

Table 1: Summary of provincial air quality objectives for particulate matter ($PM_{2.5}$ and PM_{10})

Contaminant	Objective	Averaging period
$PM_{2.5}$	25 µg/m^3	24 hours (based on the 98th percentile[3])
$PM_{2.5}$	8 µg/m^3	Annual
PM_{10}	50 µg/m^3	24 hours

Annual Trends

PM_{10}

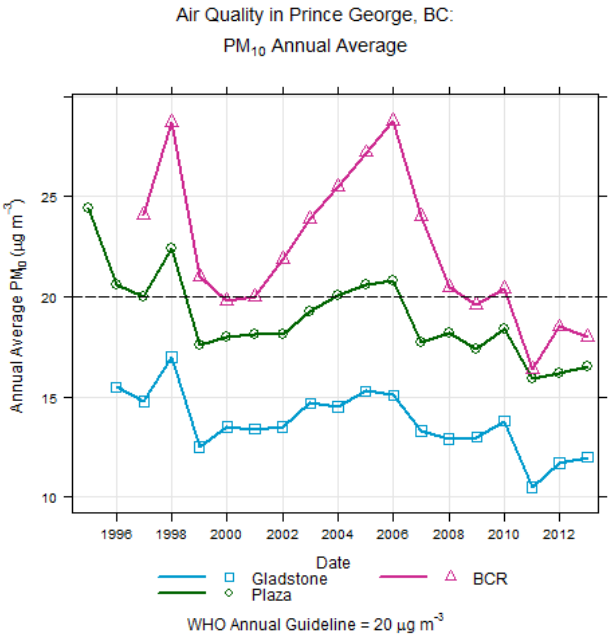

Figure 2: Annual Average PM_{10} levels at the Gladstone (1996-2013), Plaza (1995-2013) and BCR (1997-2013) stations. Shown for comparison is the WHO annual PM_{10} guideline (20 µg/m^3).

Shown in Figure 2 are the annual average[4] PM_{10} levels at the Plaza (1995-2013), Gladstone (1996-2013), and British Columbia Rail (BCR) (1997-2013) stations. Included for

[3] The 98th percentile is the value below which 98 % of the data lies. For example, if there were 100 values in a dataset, the 98th highest values would equal the 98th percentile.
[4] The annual average is the arithmetic mean of every valid hourly concentration recorded during a calendar year.

comparison as a dashed horizontal line in Figure 2 is the World Health Organization (WHO) PM_{10} annual air quality guideline, which is equal to 20 µg/m^3 (there is no BC annual objective for PM_{10}).

Figure 2 shows a similar trend for all three stations, with an overall decrease in PM_{10} levels in Prince George since monitoring began in the 1990's. At all three stations, the annual averages for the past three years (2011-2013) were the lowest recorded since monitoring began in the late 1990's. The influence of the land use for each station is also apparent in Figure 2, with PM_{10} levels being the highest at BCR (industrial), lower at Plaza (commercial), and the lowest at Gladstone (residential).

Figure 2 also shows that the 2013 annual average PM_{10} levels increased slightly at the Plaza compared to the previous two years (2011-2012). For the remaining two stations, in 2013 the annual average PM_{10} levels at BCR decreased compared to 2012, and at Gladstone the PM_{10} levels were similar to 2012.

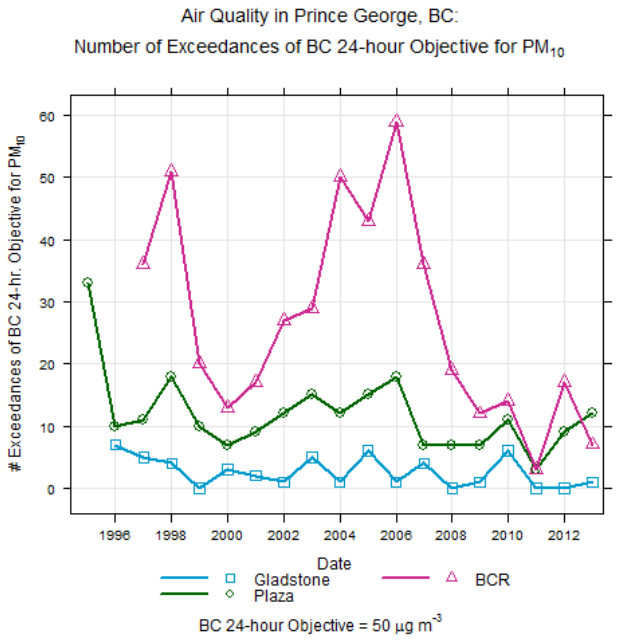

Figure 3: Number of exceedances of the PM_{10} 24-hour objective (50 µg/m)^3 at the Gladstone (1996-2013), Plaza (1995-2013) and BCR stations (1997-2013).

Shown in Figure 3 is the number of exceedances of the BC PM_{10} 24-hour objective (50 µg/m^3); a single exceedance of the objective can lead to several days of degraded air quality. At all three stations, the number of exceedances has decreased since monitoring began in the late 1990's.

As expected based on the land use of the three stations in Prince George, the fewest number of exceedances have been recorded at the Gladstone station (residential), with an increased number of exceedances at the Plaza station (commercial), and the highest number of exceedances were recorded at the BCR station (industrial). The severe wild fire season of 2010 led to an increased number of exceedances at all three stations. Since 2010, there has only been one exceedance at the Gladstone station (in 2013); the number of exceedances at Plaza in 2013 was the highest recorded since 2006; and at BCR there were seven exceedances of the BC PM_{10} 24-hour objective in 2013.

$PM_{2.5}$

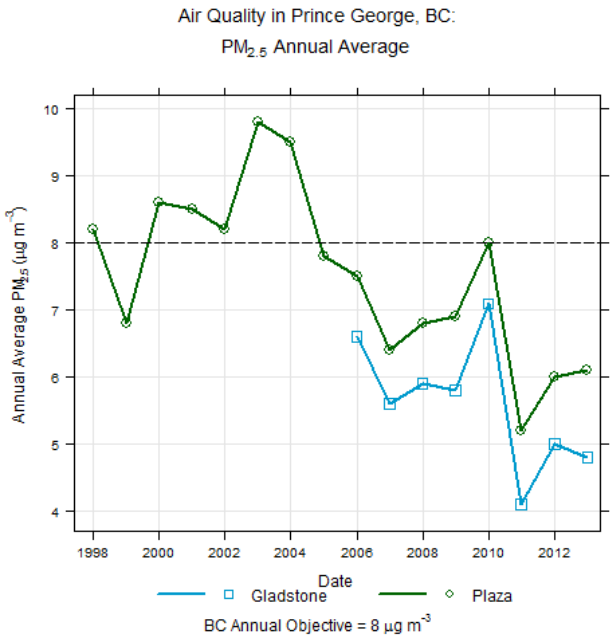

Figure 4: Annual Average $PM_{2.5}$ levels at the Gladstone (2006-2013) and Plaza (1998-2013) stations. Shown for comparison is the BC annual $PM_{2.5}$ objective (8 µg/m^3).

The annual average $PM_{2.5}$ levels are shown in Figure 4 for the Gladstone (2006-2013) and Plaza (1998-2013) stations. Also shown for comparison as a horizontal dashed line in Figure 4 is the BC $PM_{2.5}$ annual objective (8 µg/m3). Generally, $PM_{2.5}$ levels have decreased since monitoring began and, with the exception of the Plaza station in 2010 (i.e. the severe wild fire year), the annual averages have been below the provincial objective since 2005 at the Plaza station, and since 2006 for the Gladstone station. As was the case with PM_{10}, the land use of the two stations is reflected in the $PM_{2.5}$ levels in that the Plaza station (commercial) recorded higher levels compared to the Gladstone station (residential).

Comparing levels from 2013 to the previous year, Gladstone's $PM_{2.5}$ levels decreased slightly and Plaza's $PM_{2.5}$ levels increased slightly from 2012 levels. For both

sites, the annual averages in the past three years (2011-2013) were the three lowest annual averages recorded since monitoring began.

Figure 5 shows the 24-hour average $PM_{2.5}$ levels at the Gladstone (2006-2013) and Plaza (1998-2013) stations, plotted as the 98th percentile values[3]. Also shown for comparison as a horizontal dashed line in Figure 5 is the BC 24-hour $PM_{2.5}$ objective (25 µg/m^3); by definition this objective is given as the 98th percentile. Both stations show a decrease in the 98th percentile of the 24-hour average $PM_{2.5}$ values since monitoring began. High 98th percentiles were recorded in 2010, as expected due to the severe wild fires that summer. Decreases in the 98th percentiles are observed at both stations in 2013 compared to 2012, and both stations have been below the provincial objective since 2011.

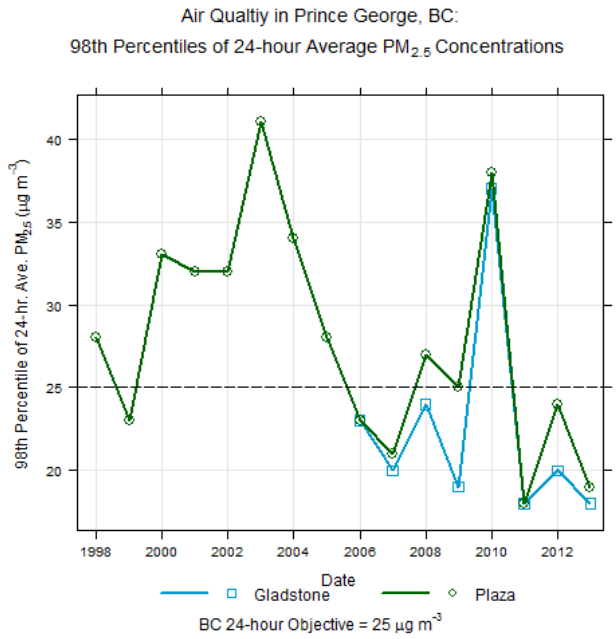

Figure 5: 98th percentile of 24-hour average $PM_{2.5}$ levels at the Gladstone (2006-2013) and Plaza (1998-2013) stations. Shown for comparison is the BC 24-hour objective (25 µg/m^3).

The number of exceedances of the BC $PM_{2.5}$ 24-hour objective for the Gladstone (2006-2013) and Plaza (1998-2013) stations is shown in Figure 6. As expected due to the severe wild fires in 2010, the number of exceedances during this year was the second highest on record. In 2013, Gladstone did not record any exceedances of the $PM_{2.5}$ 24-hour air quality objective and Plaza recorded four exceedances of the objective. Both stations had a decreased number of exceedances in 2013 compared to 2012, and generally, the number of exceedances has decreased at both stations since monitoring began.

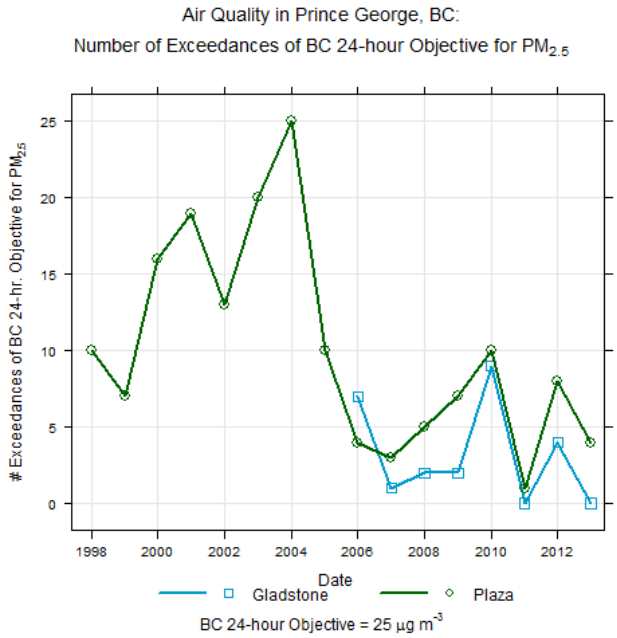

Figure 6: Number of exceedances of the $PM_{2.5}$ 24-hour objective (25 µg/ m^3) at the Gladstone (1996-2013), Plaza (1995-2013) and BCR stations (1997-2013).

Summary & Conclusions

PM_{10} and $PM_{2.5}$ levels at all three air quality stations in Prince George (Gladstone, Plaza, and BCR) showed an overall decrease since monitoring began in the 1990's. Various source management actions that have contributed to this decrease in particulate matter include: the shutdown of all beehive burners, increased removal of fine particulate matter from industrial sources, use of coarser winter street traction material, and improved street cleaning. Other factors, such as reduction in open burning within the airshed, have also likely contributed to the overall improvements in particulate matter levels over time in Prince George.