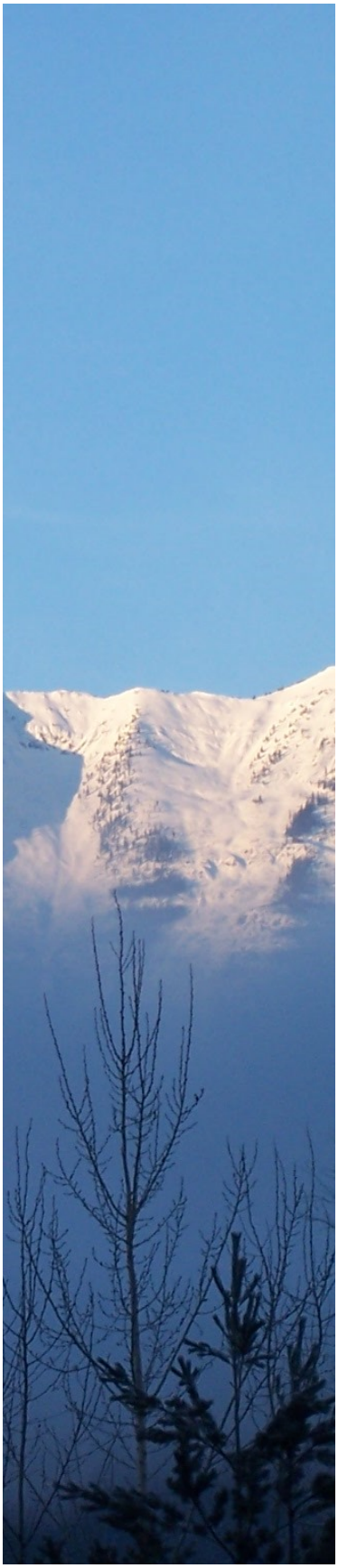

BRITISH COLUMBIA

Ministry of Environment and Climate Change Strategy

Ambient Levels of Particulate Matter in Golden: A Summary of Trends

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Environmental Protection Division
Regional Operations Branch

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Purpose

The purpose of this report is to provide a summary of current and historical particulate matter ($PM_{2.5}$[1] and PM_{10}[2]) concentrations in Golden, with a focus on how levels compare to air quality objectives (AQOs) and other communities across British Columbia.

Introduction

This report presents annual trends in ambient $PM_{2.5}$ and PM_{10} in Golden throughout its monitoring history (1999-2016).

Sources of $PM_{2.5}$ include, but are not limited to: industries, wood stoves, motor vehicles and forest fires. Due to its topography, Golden and many other interior communities in BC are susceptible to high levels of $PM_{2.5}$ during inversions. $PM_{2.5}$ has a broad range of adverse health effects, predominantly to the respiratory and cardiovascular systems (World Health Organization 2006). 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 Golden 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].

Particulate matter ($PM_{2.5}$ and PM_{10}) has been monitored in Golden since 1999: from 1999-2013, monitoring occurred at the Hospital, and in 2013 the monitoring station was re-located to the Helipad site adjacent to the Hospital. For more information on the rich monitoring history in Golden, please refer to the following studies: Willis (2006), Willis et al. (2006), and Evans and Jeong (2007).

Table 1 provides a summary of the AQOs for particulate matter in British Columbia (B.C. Ministry of Environment & Climate Change Strategy). There are two provincial objectives for $PM_{2.5}$, including an annual objective and a 24-hour objective. For PM_{10}, there is a 24-hour objective and there is no provincial annual objective.

Table 1: Summary of provincial AQOs for particulate matter ($PM_{2.5}$ and PM_{10}).

Contaminant	Objective(μgm^{-3})	Averaging Period
$PM_{2.5}$	25	24-hour (98th percentile[3])
	8	Annual
PM_{10}	50	24-hour

$PM_{2.5}$

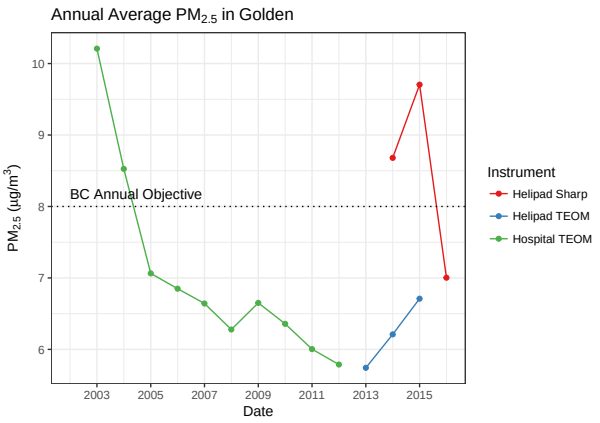

Figure 1: Annual average $PM_{2.5}$ levels in Golden (2003-2016). Shown for comparison is the BC annual $PM_{2.5}$ objective (8 μgm^{-3}).

The annual average[4] $PM_{2.5}$ levels are shown in Figure 1 in Golden between 2003-2016. Also shown for comparison as a horizontal dotted line in Figure 1 is the BC $PM_{2.5}$ annual objective (8 μgm^{-3}). Generally, $PM_{2.5}$ levels have decreased since monitoring began and, with the exception of 2003, 2014, and 2015, in which BC experienced severe wild fires, the annual averages have been below the provincial objective since 2005. Note that the Sharp instrument provides a more complete measurement of $PM_{2.5}$ compared to the TEOM instrument, explaining the difference in levels at the Helipad site in 2014 and 2015.

Comparing levels from 2016 to the previous year, $PM_{2.5}$ levels in Golden decreased significantly: the

[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.

[3] The 98th percentile is the value below which 98% of the data lies. For example, if there were 100 values in a data set and the data was ranked from lowest to highest value, the value with rank 98 would equal the 98th percentile.

[4] The annual average is the average of every valid daily concentration recorded during a calendar year.

annual average from the Sharp instrument was 7 µgm^{-3} in 2016 and 9.7 µgm^{-3} in 2015. This can be accounted for considering the wild fire activity in the Kootenays during the past few years; as mentioned above, 2014 and 2015 were severe wild fire years, with much less wild fire activity occurring in 2016.

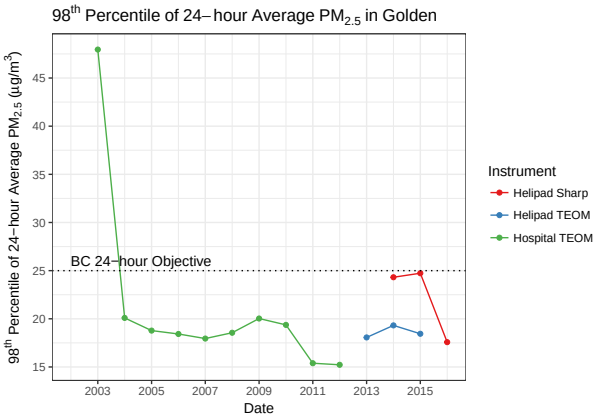

Figure 2: 98th percentile of 24-hour average $PM_{2.5}$ levels in Golden (2003-2016). Shown for comparison is the BC 24-hour $PM_{2.5}$ objective (25 µgm^{-3}).

Figure 2 shows the 24-hour $PM_{2.5}$ levels in Golden from 2003-2016, plotted as the 98th percentile values [3]. Also shown for comparison as a horizontal dotted line in Figure 2 is the BC 24-hour $PM_{2.5}$ objective (25 µgm^{-3}); by definition this objective is given as the 98th percentile. Generally, there has been a decrease in the 98th percentile of the 24-hour $PM_{2.5}$ values since monitoring began. High 98th percentile values were recorded in 2014 and 2015, as expected due to the severe wild fires in the summer of those years. A decrease in the 98th percentile is observed at both stations in 2016 compared to 2015, and with the exception of 2003 and 2015 (severe wild fire years), levels in Golden have remained below the objective since monitoring began.

The number of exceedances of the BC $PM_{2.5}$ 24-hour objective in Golden for the years 2003-2016 is shown in Figure 3. As expected, due to the severe wild fires in 2003, 2014 and 2015, the number of exceedances during those years are amoung the highest. In 2016, the Helipad station did not record any exceedances of the 24-hour objective.

Figure 4 shows the annual average $PM_{2.5}$ across BC for the year 2016, including Golden which is indicated as the dark shaded bar in the figure. Compared to the rest of BC, Golden lies in the top half of $PM_{2.5}$ levels; however, levels are much lower compared to 2015, when Golden was tied with Houston for the highest

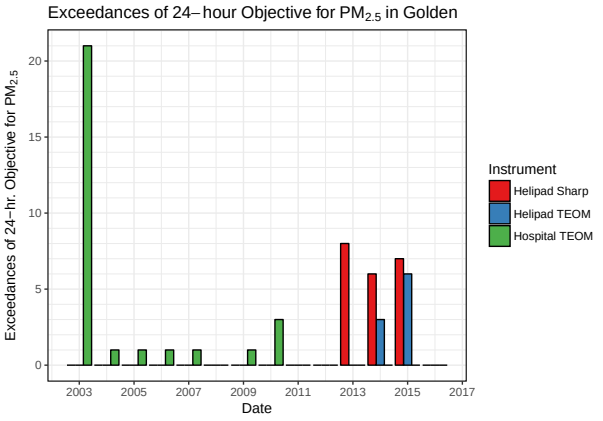

Figure 3: Number of exceedances of the $PM_{2.5}$ 24-hour objective (25 µgm^{-3}) in Golden (2003-2016).

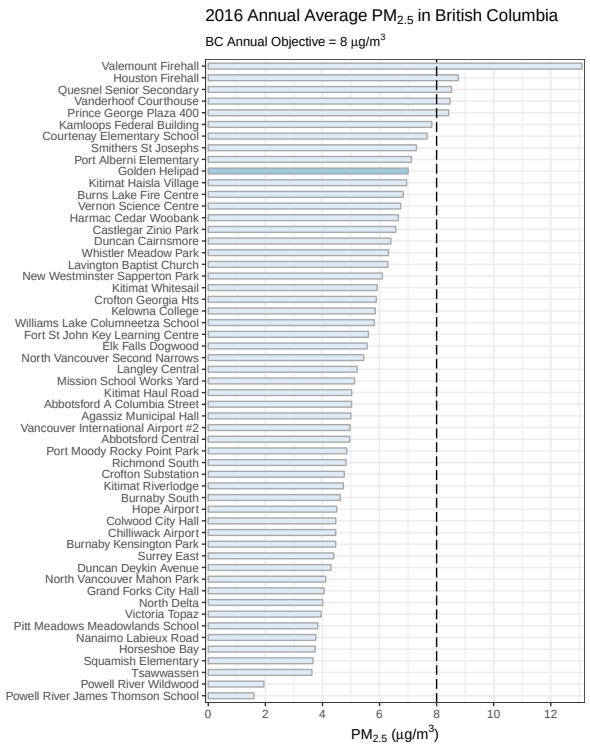

Figure 4: Annual average $PM_{2.5}$ concentrations in BC for the year 2016; average calculated from all available daily concentrations during the year. Shown for comparison is the BC annual $PM_{2.5}$ objective (8 µgm^{-3}).

$PM_{2.5}$ in the province (Biagtan et al. 2016).

PM_{10}

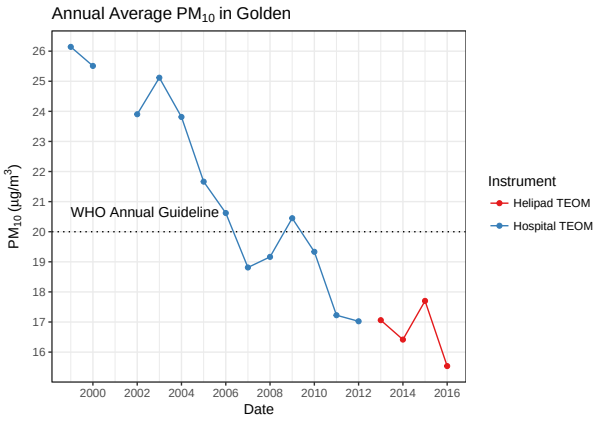

Figure 5: Annual average PM_{10} levels in Golden (1999-2016). Shown for comparison is the WHO annual PM_{10} guideline (20 μgm^{-3}).

Shown in Figure 5 are the annual average[4] PM_{10} levels in Golden for the years 1999-2016. Included for comparison as a dotted horizontal line in Figure 5 is the WHO PM_{10} annual air quality guideline, which is equal to 20 μgm^{-3} (there is no BC annual objective for PM_{10}).

Figure 5 shows an overall decrease in PM_{10} levels in Golden since monitoring began, with the annual averages remaining below the objective since 2010. Additionally, the lowest annual averages on record have been recorded during the past 6 years (2011-2016), with 2016 noted as the lowest annual average to date (15.5 μgm^{-3}).

Shown in Figure 6 is the number of exceedances of the BC PM_{10} 24-hour objective (50 μgm^{-3}) in Golden for the years 1999-2016; a single exceedance of the objective can lead to several days of degraded air quality.

Generally, the number of exceedances of the 24-hour PM_{10} objective has decreased since monitoring began. High numbers of exceedances were observed during severe wildfire years, in particular 2003 and 2015. There were 8 exceedances during 2016, significantly fewer than in 2015 when there were 18 exceedances. Every exceedance in 2016 occurred during February and March, a time of year that is known for high levels of dust from the suspension of winter traction material. For comparison, 13 of the

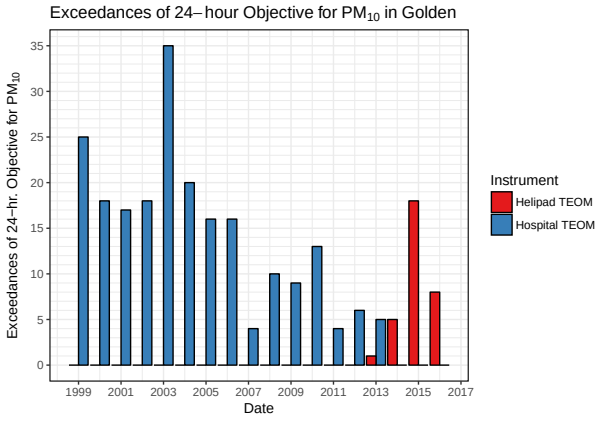

Figure 6: Number of exceedances of the PM_{10} 24-hour objective (50 μgm^{-3}) in Golden (1999-2016).

18 exceedances in 2015 occurred during February and March; the remaining 5 exceedances occurred during a period of severe wild fire smoke at the end of August. Road dust has been identified by the Ministry of Environment & Climate Change Strategy (ENV) as an emissions source in need of management in Golden.

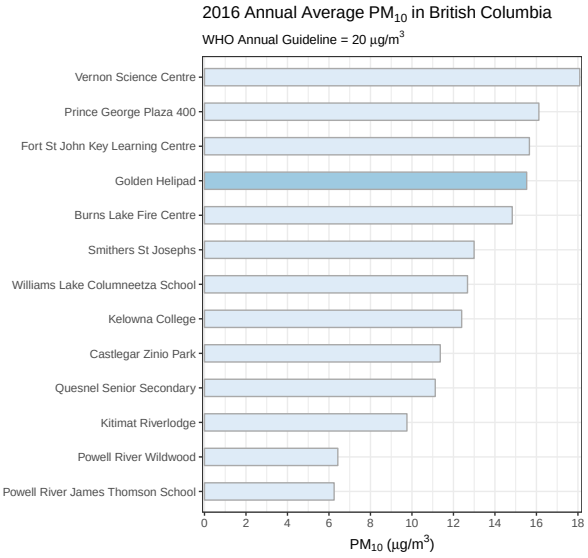

Figure 7: Annual average PM_{10} concentrations in BC for the year 2016; average calculated from all available hourly concentrations during the year. Shown for comparison is the WHO annual PM_{10} guideline (20 μgm^{-3}).

Figure 7 shows the annual average PM_{10} across BC for the year 2016, including Golden which is indicated as the dark shaded bar in the figure. Compared to the rest of BC, Golden lies in the top half of PM_{10} levels;

however, levels are much lower compared to 2015, and were the lowest on record in 2016. As mentioned above, road dust mitigation is expected to reduce PM_{10} levels in Golden.

Summary & Conclusions

$PM_{2.5}$ and PM_{10} levels in Golden have showed an overall decrease since monitoring began in the late 1990's. Various source management actions that have contributed to this decrease in particulate matter include: upgrades to the emission control infrastructure at the local Louisiana Pacific site, on-going air management initiatives by the Golden and District Air Quality Committee[5], improved spring-time street cleaning, and the ENV Wood Stove Exhange Program[6]. 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 Golden.

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