Air Quality Monitoring:

Sherwood Park

January 2008 - January 2009 **Final Report**

Overview

A study was initiated to evaluate the concentration of fine particulate matter ($PM_{2.5}$) at two sites in Sherwood Park, east of Edmonton. The data presented in this report were collected between January 2008 and January 2009. Alberta has a 24-hour average[1] ambient air quality objective (AAAQO) of 30 $\mu g/m^3$ for particulate matter with aerodynamic diameter less than 2.5 micrometer ($PM_{2.5}$). This objective was exceeded six times during the study. All exceedances occurred during the winter months. In addition, Alberta has ambient air quality *guideline* for $PM_{2.5}$, which is used to assess local concerns and as a general performance indicator. The one-hour $PM_{2.5}$ *guideline* of 80 $\mu g/m^3$ was surpassed 31 times during this study; these elevated concentrations formed less than 1 percent of the data collected at the two sites. Overall, particulate concentrations at the two sites were comparable. Concentrations were generally higher during the winter months and for periods of low wind speeds. This is likely due to limited dispersion of particles, and a larger semi-volatile fraction forming the sampled particles during the winter months. No strong dependence of $PM_{2.5}$ concentration was found on wind direction or day of the week, an indication that the sites were not influenced by localized source(s). The most likely particulate matter sources impacting the two monitoring sites are diffuse urban sources including transportation and home heating. Compared to monitoring conducted in the City of Edmonton, particulate matter concentrations in Sherwood Park show no notable difference for much of the year. Differences found during the winter months (December to February) were likely due to differences in sampling methods.

[1] Averaged from midnight to midnight

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Monitoring Method and Location

Two Electronic Beta Attenuation mass Monitors (model E-BAM), were used to perform the measurements. The E-BAM provides hourly fine particulate matter concentrations as well as recording meteorological parameters such as temperature, wind speed and direction. The samplers were installed at two monitoring sites (Figure 1). Site A is located in a residential area at an established air quality monitoring site (Strathcona Industrial Association's Sherwood Park station) west of Broadmoor Boulevard. Site B is located on the Canadian Broadcasting Corporation (CBC) compound north of Wye road (Hwy 630); this site is surrounded by residential neighbourhoods. In addition to being representative of the study area, the sites needed to be secure with a reliable power supply and accessible to monitoring staff. Photographs of the two monitoring locations can be found in the appendix (Figure A1). Data collection started in January 2008 and ended January 2009.

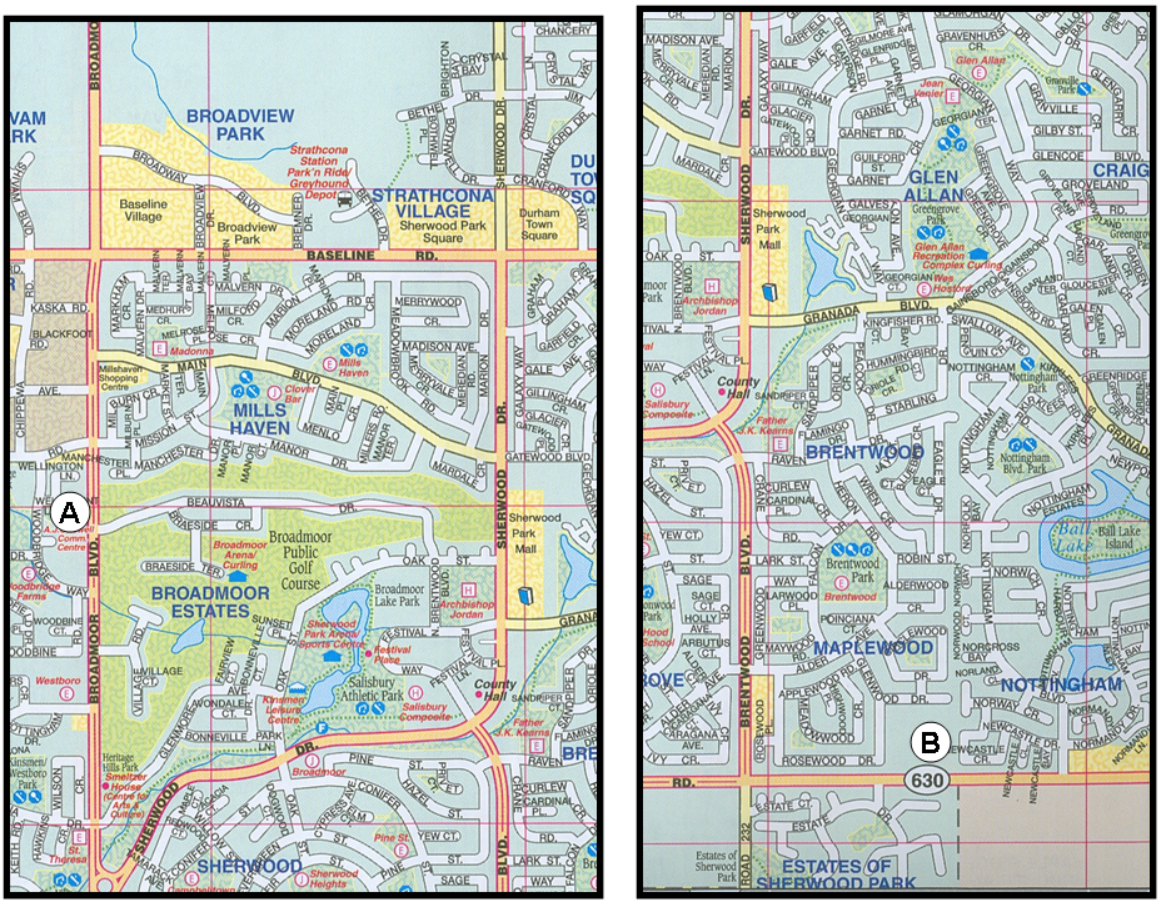

Figure 1: Map of sample sites. The base map for this figure was obtained from *Rand McNally 5th Edition Edmonton and Northern Alberta Communities.*

Results and discussion

Particulate matter less than 2.5 μm in aerodynamic diameter ($PM_{2.5}$) are particles small enough to penetrate into the lungs. They may form in the atmosphere and/or be emitted through combustion processes. Sources include vehicles, industrial processes and wood burning. In addition to the general $PM_{2.5}$ concentrations at the two sites, the study also examined possible association between particle concentration and wind direction and speed, as well as the sample month and day.

Descriptive statistics for $PM_{2.5}$ concentrations at the two monitoring sites are presented in Table 1. Overall, concentrations at the two sites were comparable. This being said, the frequency of elevated concentrations was higher at Site A than Site B. The one-hour $PM_{2.5}$ *guideline*[2] of 80 micrograms per cubic meter ($\mu g/m^3$) was surpassed 25 times at Site A and 6 times at Site B. At Site A, concentrations greater than 80 $\mu g/m^3$ were observed in the winter months (December, January and February) for periods of low wind speed (on average 3 kilometres per hour (km/hr)). At Site B, elevated concentrations were observed in March and April; on average the wind speed at these times was 7 km/hr. These elevated concentrations comprised less than 1 percent of the data collected at these sites. Alberta also has a 24-hour average[3] ambient air quality objective (AAAQO) of 30 $\mu g/m^3$. The distributions of 24-hour average $PM_{2.5}$ concentrations at the two sites are shown in Figure 2. A large number of the measured concentrations fell between 3 and 9 $\mu g/m^3$, well below the AAAQO. However, the air quality objective of 30 $\mu g/m^3$ was exceeded five times at Site A and once at Site B. The higher frequency of elevated concentrations at Site A could be due to proximity of sources to the site.

Alberta Environment conducts annual assessment of particulate matter and ozone data collected at permanent monitoring stations through out the province. These assessments compare $PM_{2.5}$ and ozone data to action triggers defined in the *Clean Air Strategic Alliance (CASA) Particulate Matter and Ozone Management Framework*. The framework has the following $PM_{2.5}$ action triggers: Surveillance (15 $\mu g/m^3$), Planning (20 $\mu g/m^3$) and Canada Wide Standard (30 $\mu g/m^3$). The assessment excludes background and trans-boundary influences, and is based on 98th percentile ambient concentration annually averaged over three consecutive years.

[2] Alberta's air quality guidelines may be used to assess local concerns, as general performance indicators, and for Airshed planning and management.
[3] Averaged from midnight to midnight (MST)

The 98th percentile concentrations at Site A and B were 27 μg/m^3 and 21 μg/m^3, respectively. The calculation included data collected in 2008, note that the $PM_{2.5}$ assessment[4] uses three years of data. Background and trans-boundary influences on the data collected at the two sites were not expected to be significant, this being said it should be noted that the data were not treated to remove background influences. The 98th percentile at Site A and B were higher than the 2005-2007 analysis at the Edmonton East site. The three year average 98th percentile at Edmonton East was 16.2 μg/m^3, with annual values of 15.2, 18.0 and 15.5 μg/m^3 for 2005, 2006 and 2007, respectively. Higher concentration at Site A and B could be the result of instrumentation differences and the capturing of semi-volatile fraction of particulate matter. This is discussed in more detail below.

Table 1: $PM_{2.5}$ concentrations at Site A and B.

Concentration	Units	Site	
		A	B
Average	μg/m^3	9	8
25th percentile	μg/m^3	2	2
50th percentile	μg/m^3	6	6
75th percentile	μg/m^3	12	11
90th percentile	μg/m^3	20	17
Maximum	μg/m^3	123	134
Greater than 80 μg/m^3	count	25	6

Note:
A definition of percentiles is given in the appendix.

[4] Performed for comparison with the *CASA Particulate Matter and Ozone Management Framework*

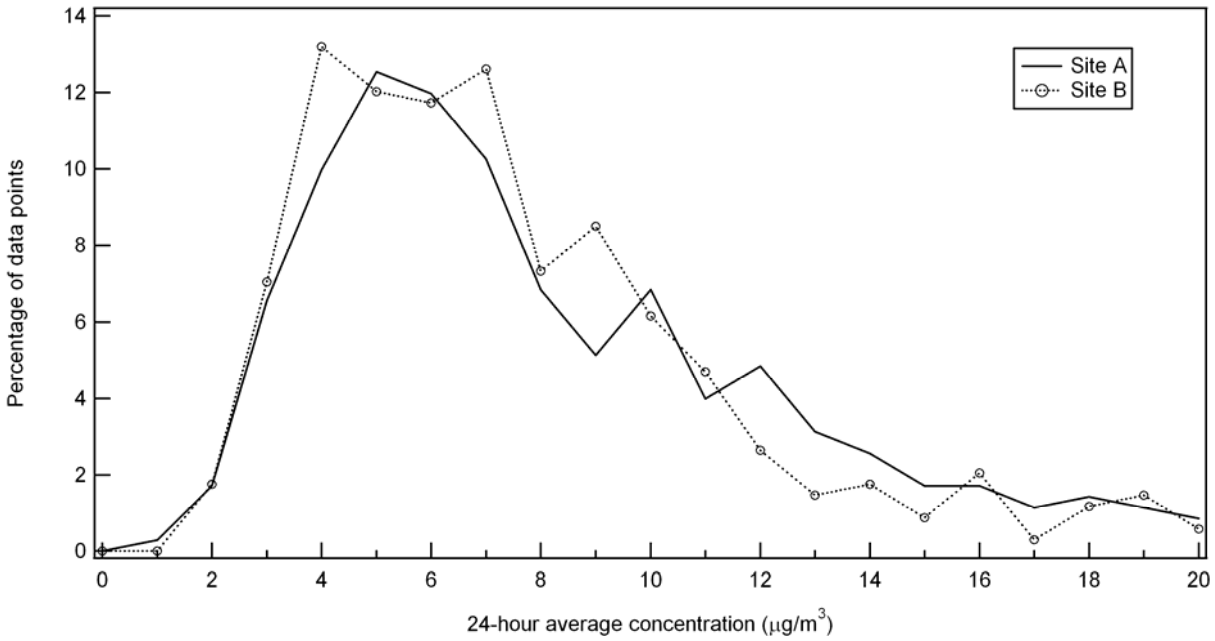

Figure 2: Histogram of 24-hour average concentrations observed at Site A and B. For clarity shown are the number data points for concentrations equal to or lower than 20 μg/m^3. These data formed greater than 94% of the data collected.

The median[5] concentration for each sample month is presented in Figure 3. At the two Sherwood Park sites, $PM_{2.5}$ concentrations were higher during the winter months (December to March). This was likely due to atmospheric conditions that did not promote dispersion, increased combustion and/or greater contribution from semi-volatile material to $PM_{2.5}$ mass concentration. Lower vertical mixing heights during the winter months can lead to the build up of pollutants closer to the ground. The colder temperatures during the winter may also have promoted condensation of semi-volatile material (e.g. semi-volatile organics and nitrates).

Figure 3 also presents $PM_{2.5}$ concentrations at Edmonton Central and East monitoring stations. At the Edmonton monitoring stations, $PM_{2.5}$ is monitored using Tapered Element Oscillating Microbalance (TEOM) where the sample is heated to 30°C. This is done to remove particle bound water and provide instrument stability. However, heating the sample can result in full or partial evaporation of semi-volatile fraction of the particle mass. During the spring, summer and fall sample months (April – October); concentrations at the Edmonton monitoring stations are comparable to those in Sherwood Park. This implies that at these times there appear to be little evaporation loss for samples collected using the TEOM (relative to the E-BAM

results). In the winter months however, there is a noticeable difference (especially for the sample collected in February). At these times concentrations measured at the Edmonton monitoring sites are lower. Monthly concentration measured using TEOMs showed little seasonal variation. These observations imply that higher concentration measured at Site A and B during the winter time *may at least partially* be due to increased contribution from semi-volatile compounds[6]. In an effort to standardize particulate matter monitoring and reporting, Alberta Environment working with Environment Canada is upgrading particulate monitors at stations forming the National Air Pollution Surveillance (NAPS) network[7].

Figure 4 presents the 99th percentile concentration for each of the samples month at the two Sherwood Park sites. These concentrations show a similar trend to those observed for the median values. No noticeable day of the week dependence was noted for $PM_{2.5}$ concentrations at either of the sample sites. Median concentrations for each day of the week ranged from 5 to 6 $\mu g/m^3$.

Particulate concentrations at Sites A and B were influenced by wind speed at these sites. The median concentrations for various wind speeds are presented in Figure 5a. The median concentrations for periods when the wind speed was less than 3.6 km/hr are noticeably greater than for higher wind speeds. Higher concentrations during periods of low wind speed is likely due to the limited dispersion of locally emitted particles. Figure 5b illustrates that wind speeds less than 3.6 km/hr were observed about thirty three percent of the time. Fifty percent of the time the wind speed was greater than 5 km/hr.

$PM_{2.5}$ concentrations measured at the two sites showed no strong dependence on wind direction. Median concentrations for various wind directions are presented in Figure 6. $PM_{2.5}$ concentrations were marginally higher for samples collected when wind direction was north-easterly and south-easterly. The data presented in Figure 6 were collected when the wind speed was greater than or equal to 3.6 km/hr (periods classified as having some wind).

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[5] Definition of median is given in the appendix
[6] The use of different instruments to conduct monitoring will also contribute to differences
[7] There are 14 stations within Alberta providing data to NAPS network.

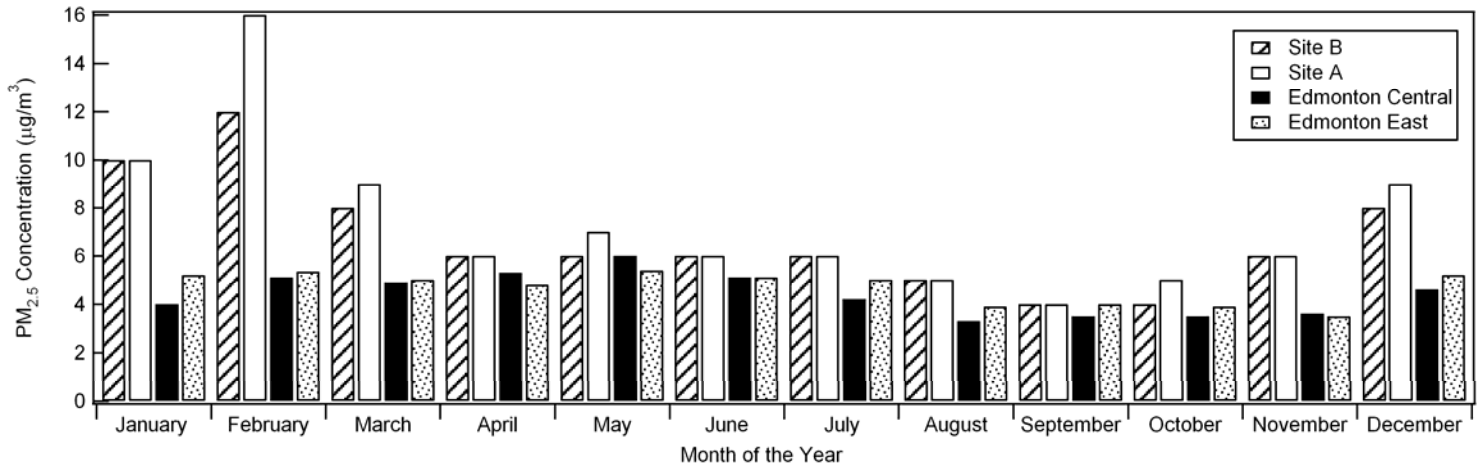


Figure 3: Monthly median 1-hr $PM_{2.5}$ concentrations at the two sample sites in Sherwood Park and two comparison stations. Due to instrument malfunction only 18 % of the data was available for the month of February.

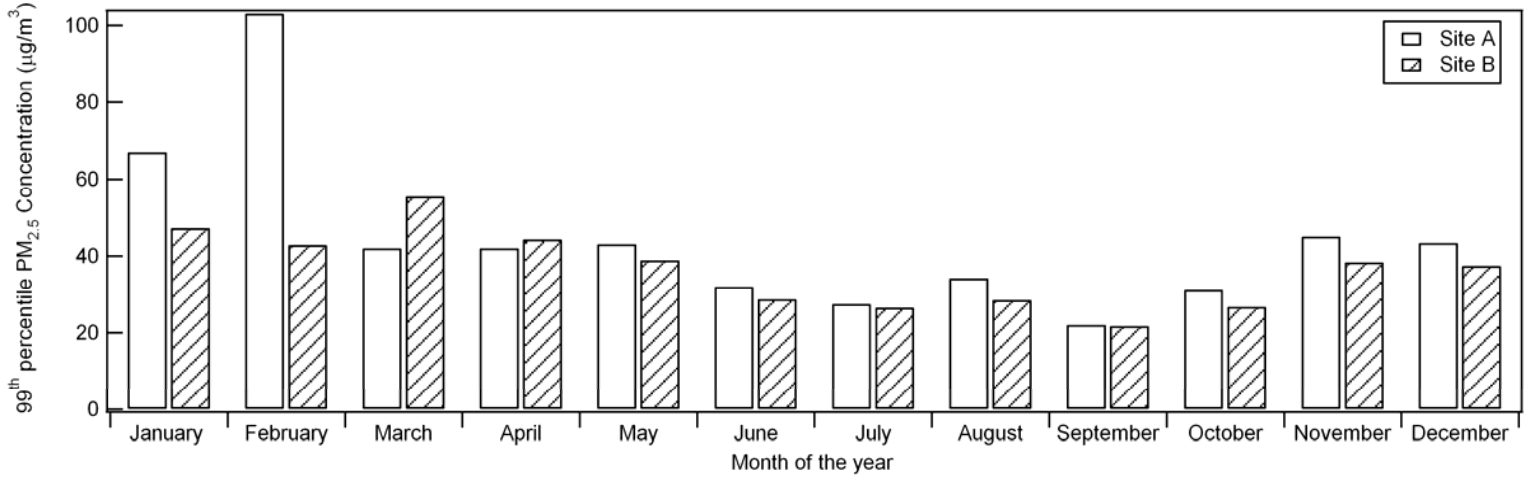
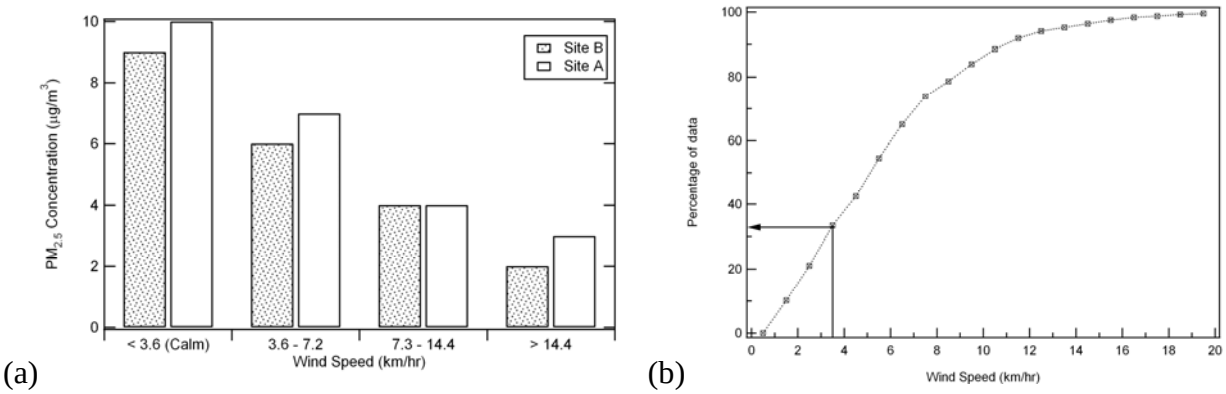


Figure 4: 99th percentile 1-hour $PM_{2.5}$ concentrations at the two sample sites in Sherwood Park. Due to instrument malfunction only 18 % of the data was available for the month of February.



(a) (b)

Figure 5: (a) Median $PM_{2.5}$ concentration associated with wind speed at the monitoring sites. Calm conditions appear to promote the build up of particulate matter at these sites. (b) Distribution of wind speed measured. Wind speeds less than 3.6 km/hr made up about thirty three percent of the data.

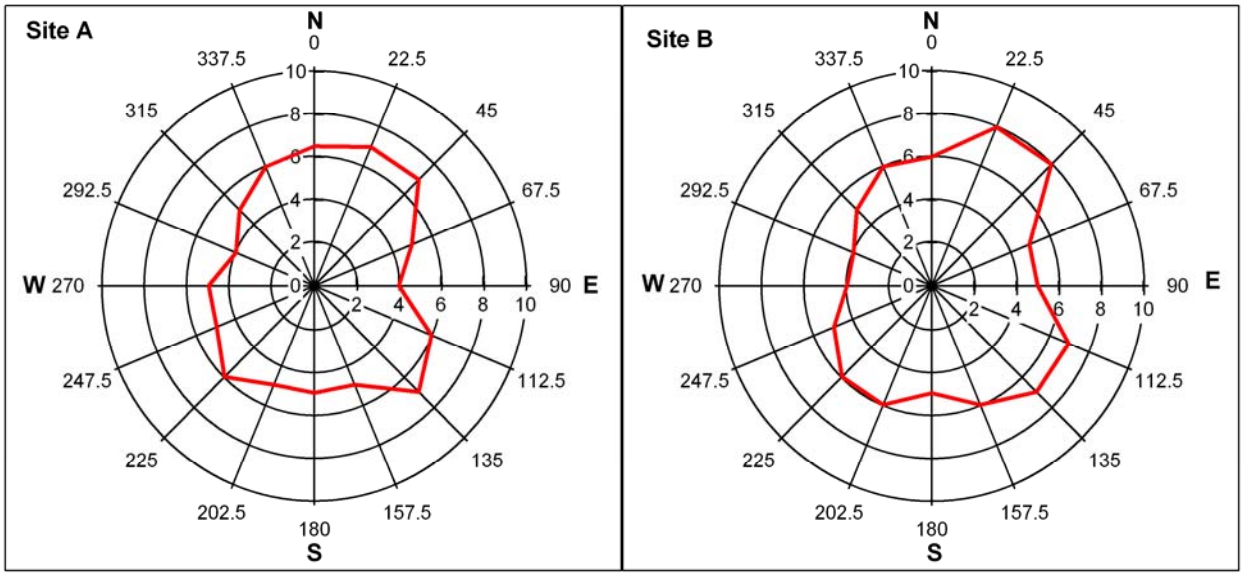


Figure 6: Median $PM_{2.5}$ concentrations associated with wind direction at the two monitoring sites in Sherwood Park. The numerical values on the radial axis are $PM_{2.5}$ concentration in µg/m^3. Data presented is for periods when the wind speed was greater than or equal to 3.6 km/hr.

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Appendix

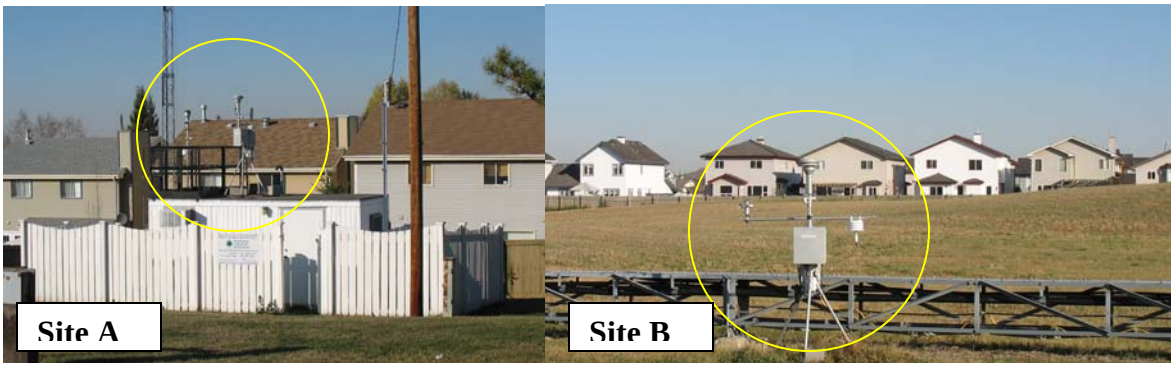

Figure A 1: Photographs of the two monitoring locations. Highlighted are the two E-BAMs used to monitor particulate matter concentrations.

The median concentration

The median concentration is a common way of representing the central value for environmental data. Most environmental data consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. For such data sets, the arithmetic mean will be biased by the high concentrations; the resulting value may not be representative of the central value for the data set. For example, a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median is the middlemost value in the data set; thus more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

Percentiles

A percentile concentration is a value below which a certain percent of the observations fall. For example, 75^{th} percentile particulate concentration at a site was 39 $\mu g/m^3$ indicates 75% (or ¾) of all the data collected at this site are below the indicated concentration. Percentiles provide additional information on the variation of concentration for a data set.