

Air Quality Evaluation - Royal Road, New Brunswick

Final Report

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Table of Contents

1.0	Executive Summary.....	1
2.0	Introduction.....	2
2.1	Background.....	2
2.2	Area Emission Sources.....	2
2.3	Study Design.....	2
3.0	Methodology.....	3
3.1	Meteorology Equipment.....	3
3.2	Continuous Air Quality Monitoring Equipment.....	3
3.3	Respirable Particulate (PM ₁₀) and Silicate Collection Procedures.....	3
3.4	Study Location.....	4
3.5	Other Data Sources.....	4
3.6	Quality Assurance.....	4
4.0	Results and Discussion.....	6
4.1	Meteorology - Wind.....	6
4.2	Suspended Particulates - Continuous Monitors.....	6
4.2.1	Peak Hourly Total Suspended Particulate (TSP).....	8
4.2.2	“Day of the Week” Effect on Total Suspended Particulate (TSP) Concentration.....	8
4.2.3	Comparisons to Aberdeen Street (Fredericton) Station.....	9
4.3	Suspended Particulate - Filter-Based.....	10
4.4	Respirable Particulate (PM ₁₀) and Crystalline Silicates.....	11
4.5	Data Limitations.....	12
5.0	Glossary of Abbreviations.....	13

Appendices

Appendix A:	Technical Specifications - Continuous Monitors.....	14
Appendix B:	Data Plots and Tables.....	15

1.0 Executive Summary

In 2015 the Department of Environment and Local Government (DELG) received a number of air quality complaints from homeowners in the Royal Road area of the Local Service District of Estey's Bridge, New Brunswick concerning dust. A rock quarry had recently opened in the community and it was identified by the complainants as the source of this issue.

The DELG mobile air quality monitoring unit was deployed to the area from May 30 to December 2, 2016 to assess the air quality. Continuous air quality measurements were undertaken to obtain airborne dust (total suspended particulate and fine particulate) concentrations. These were compared to particulate levels at other sites in the province and with guidelines and regulated standards.

Silicate samples were also collected every second day from September 24 to October 24, 2016. 24-hour samples were collected on filter media. These samples were analyzed to determine the amount of crystalline silica present in the dust.

There were no recorded exceedances of air quality objectives or guidelines throughout the study period.

Although no objectives or guidelines were exceeded, peak hourly total suspended particulate (TSP) concentrations appear to have been influenced by quarry activities.

Average TSP levels were calculated for each day of the week, and it was found that concentrations are highest midweek, and lowest on the weekends.

Study results for fine particulates ($PM_{2.5}$) were compared to data collected at the nearby Aberdeen Street (Fredericton) air quality monitoring station for the same period. Fine particulate levels at the study location were found to be generally lower (i.e., better) than the Aberdeen Street location.

2.0 Introduction

2.1 Background

In 2015 the Department of Environment and Local Government (DELG) received air quality complaints from homeowners in the Royal Road area of the Local Service District of Estey's Bridge, New Brunswick. The primary issue was dust accumulations and visible dust in the air. Residents indicated that the dust issue began with the opening of a nearby quarry in late 2014.

The noted quarry conducts blasting and crushing activities to produce construction aggregate from a deposit of sedimentary rock, which is comprised mostly of greywacke and siltstone.

2.2 Area Emission Sources

The Royal Road area is characterized as lightly populated, rural, and residential. There is significant forest cover in the area.

The previously mentioned quarry is the only active industrial emissions source in the immediate area (within 1 kilometer). Other emissions sources in the area include vehicle traffic, and various residential activities (all-terrain vehicle traffic, wood smoke, etc.).

There are two other aggregate quarries east of the area, one of which is inactive, and the other semi-active. There is a semi-active lumber mill to the south. These facilities are considered unlikely to be impacting air quality currently at this location.

The site could potentially receive long-range pollution impacts from small industrial facilities operating in Fredericton (approximately 6 kilometers southeast). There is also a pulp mill in Nackawic (approximately 40 kilometers west of the site) that can periodically influence air quality in the area.

2.3 Study Design

A consultation meeting was held with area residents on April 29, 2016. Particulates (coarse and fine) were identified as the key concern. Also, the concentration of airborne respirable crystalline silica was identified as an issue. Consequently, these parameters were selected for the study. Area residents also provided insight with respect to prevailing wind patterns in the area and the point of greatest impact, which was selected as the study site.

DELG deployed its mobile air quality monitoring unit to the study area in late May 2016 to conduct an assessment of total suspended particulate (TSP) and fine particulate ($PM_{2.5}$) levels.

Monitoring was carried out for a period of approximately six months (May 30 – December 2, 2016) to ensure that a wide variety of air quality and weather conditions were captured.

From September 24 to October 24 an instrument was deployed to gather respirable particulate (PM_{10}) samples on filter media. These samples were subsequently analyzed for PM_{10} concentration and for concentrations of the three common forms of crystalline silica (quartz, cristobalite, and tridymite).

3.0 Methodology

3.1 Meteorology Equipment

Meteorological equipment (Vaisala model WXT520) was deployed at the site to provide wind speed and wind direction data to inform data analysis. The meteorological unit also collected relative humidity, temperature, and barometric pressure parameters.

All monitored meteorological parameters were logged as five minute averages and retrieved automatically on an hourly basis.

3.2 Continuous Air Quality Monitoring Equipment

Monitoring equipment was deployed to continuously measure ambient (outside air) concentrations of total suspended particulate (TSP), and fine particulate (PM_{2.5}). Technical specifications for these instruments are provided in Appendix A.

Monitoring of continuous parameters began on May 30, 2016 and concluded on December 2, 2016.

Both air quality parameters were logged as hourly averages. Data was retrieved automatically on an hourly basis.

3.3 Respirable Particulate (PM₁₀) and Silicate Collection Procedures

A Mesa Laboratories, Inc. BGI PQ100 Air Sampler, outfitted with a PM₁₀ inlet head, was deployed to the study location to collect respirable particulate (PM₁₀) samples from ambient (outside) air.

Sample collection began on September 24, 2016 and concluded on October 24, 2016.

Samples were drawn over 24 hour periods (midnight to midnight) on alternating days. Sample volumes were recorded for each sample. A total of 16 samples were collected.

Collected samples were analyzed for PM₁₀ mass by pre and post weighing of filters (United States Environmental Protection Agency Method IO 3.1) by Maxxam Laboratories, Inc.

Collected samples were analyzed for crystalline silicate fractions (quartz, cristobalite, and tridymite) by x-ray powder diffraction (United States National Institute for Occupational Safety and Health Method 7500) by Maxxam Laboratories, Inc.

Airborne PM₁₀ and crystalline silicate concentrations were calculated from the measured masses (see above) and the measured sample volumes obtained from the BGI PQ100 Air Sampler.

3.4 Study Location

The work was carried out in the Royal Road area, which is part of the Local Service District of Estey's Bridge, in York County, New Brunswick. It is northwest of, and adjacent to, the city of Fredericton, New Brunswick. This is a rural, forested, and lightly populated area. The study area is within the river valley of the Nashwaaksis Stream, which runs approximately north to south at this location. The study area is pictured in Figure 1.

The DELG mobile air quality monitoring unit was positioned at the study site (approximately 46°00'01.2"N 66°41'43.7"W), which is approximately 200 meters west of the previously mentioned aggregate quarry. The access road for the quarry runs from west to north of the site. These features are illustrated in Figure 1.

3.5 Other Data Sources

A surveillance camera was affixed to the mobile air quality monitoring unit for the purposes of monitoring the operational status of the quarry.

Data (TSP) was also collected by Stantec Consulting Ltd. at two locations north of the study site during the study period, on behalf of the quarry operator. The northernmost site (Site #1) collected TSP data from May 5, 2016 until July 21, 2016. The equipment was then relocated approximately 300 meters south of that location (Site #2) and was operated until October 31, 2016. These locations are illustrated in Figure 1.

For comparison purposes, PM_{2.5} data was also collected from the nearest permanent air quality monitoring station to the study site, which is located approximately 6 kilometers southeast of the study site, on Aberdeen Street, Fredericton.

3.6 Quality Assurance

Data collection and validation for DELG-operated equipment was conducted in accordance with the *National Air Pollution Surveillance network quality assurance and quality control guidelines. Environment Canada Report No. AAQD 2004-1*. DELG is periodically audited by Environment and Climate Change Canada to ensure that operations throughout its network remain consistent with these guidelines.

On September 7, 2016 a DELG technician audited the equipment and procedures in use at the Stantec Consulting Ltd. monitoring station (Site #2) and confirmed the adequacy of their methods.

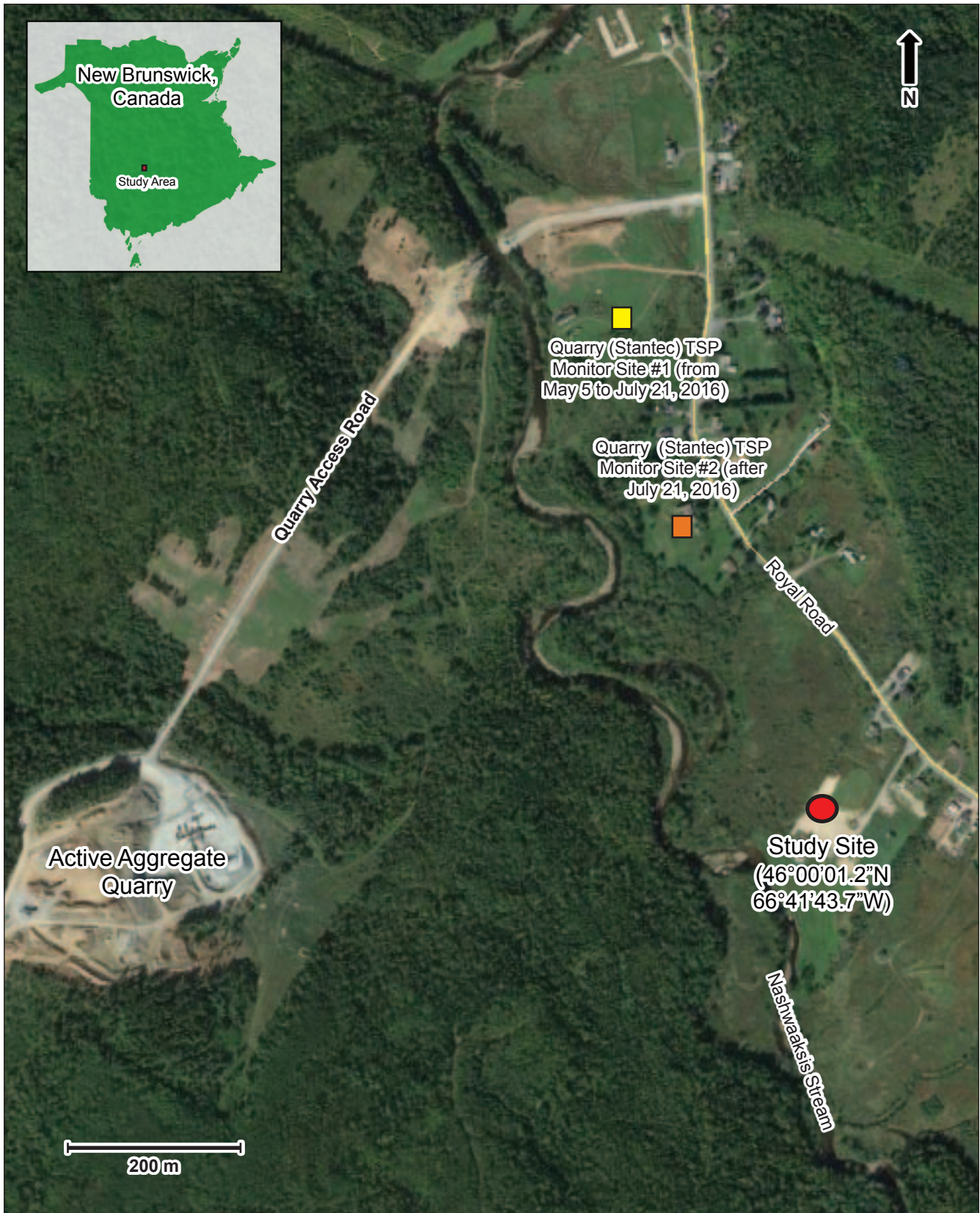


Figure 1. Location of Study (Image courtesy of Google Earth)

4.0 Results and Discussion

The following analysis will rely heavily on comparisons against objective ambient air quality standards. New Brunswick has adopted “Maximum Permissible Ground Level Concentrations” under the *Air Quality Regulation* (New Brunswick Regulation #97-133) - *Clean Air Act* for several contaminants. However, not all contaminants are included. In these cases, concentrations are evaluated against standard or guideline values that have been adopted by policy.

Note that air quality standards take a variety of statistical forms (e.g., hourly averages, daily averages, annual averages, etc.). These various forms have been crafted to achieve specific environmental or public health goals. However, it is beyond the scope of this report to explore each in detail. Rather, this analysis will focus on a simple comparison against the standards and guidelines that are relevant to the study.

4.1 Meteorology - Wind

Winds at the study site originated generally from north/northwesterly directions during the study period, which corresponds with the location of the quarry access road. Westerly winds (i.e., blowing from the direction of the quarry toward the study site) were less frequent, occurring 7% of the time.

Westerly and Northwesterly winds (i.e., originating from the direction of the quarry and access road) were moderate, averaging 7.1 km/hr and 8.3 km/hr, respectively.

Wind data is further illustrated in Appendix B.

4.2 Suspended Particulates - Continuous Monitors

The following analysis examines the results of continuously monitored parameters. Continuous monitors provide objective measurements of air quality at all times, and do not rely on modelling or statistical approximations. With the exception of brief, intermittent, calibration cycles and occasional malfunctions, there are no gaps in coverage. Air is constantly being drawn through the monitors.

Although these instruments monitor air quality on a continuous basis, in order to compare results against regulated standards and guidelines, the results must be converted into the correct form. For instance, by averaging 24 hourly averages together to create a 24-hour average.

Average and maximum concentrations observed for each of the continuously monitored parameters are provided in Table 1. Results are then compared against regulated standards and guideline values in Table 2. As indicated, contaminant levels remained well below the regulated limits and guideline values throughout the study period.

As reflected in Table 1, the peak hourly TSP average reached 234 $\mu\text{g}/\text{m}^3$. However, there is no relevant standard to compare hourly TSP levels against.

The full data set for each parameter is illustrated graphically in Appendix B.

Table 1: Summary Statistics - Continuously Monitored Parameters

Parameter	Average Concentration (6 Month)	Peak Concentration (24-hour average)	Peak Concentration (1-hour average)
Total Suspended Particulate (TSP)	14 µg/m ³	49 µg/m ³ (June 19, 2016)	234 µg/m ³ (October 11, 2016)
Fine Particulate (PM_{2.5})	4 µg/m ³	10 µg/m ³ (August 25, 2016 and October 16, 2016)	39 µg/m ³ (October 16, 2016)

Table 2: Comparison to Standards and Guidelines - Continuously Monitored Parameters

Parameter	Standard/Guideline Value	Study Result	Notes
Total Suspended Particulate (TSP)	120 µg/m ³ (24 hour average)*	49 µg/m ³ (maximum 24 hour average measured)	None
	70 µg/m ³ (annual geometric mean)*	12 µg/m ³ (6 month geometric mean)	Provided for illustration purposes.
Fine Particulate (PM_{2.5})	28 µg/m ³ (98 th percentile daily maximum 24 hour average, averaged over three years)**	10 µg/m ³ (maximum 24 hour average measured)	Provided for illustration purposes.
	10 µg/m ³ (3 year average)**	4 µg/m ³ (6 month average)	Provided for illustration purposes.

* New Brunswick's Maximum Permissible Ground Level Concentrations, as prescribed under *New Brunswick Regulation 97-133, Clean Air Act*.

** Canadian Ambient Air Quality Standard.

4.2.1 Peak Hourly Total Suspended Particulate (TSP)

As indicated in Table 1, the maximum hourly average for TSP was 234 $\mu\text{g}/\text{m}^3$, which was observed on Tuesday, October 11, 2016. As illustrated in Figure 2, TSP levels on this day began to rise at 4:00 PM, peaked at the 234 $\mu\text{g}/\text{m}^3$ level during the 6:00 PM to 7:00 PM hour, and then decreased back to ambient levels by 10:00 PM. During this period winds originated primarily from the north-northwest and the northwest, which is the approximate direction of the access road for the nearby quarry.

Weather conditions appear to have influenced dust levels during this time period by reducing moisture levels in the area. This is reflected in the measured humidity levels. Relative humidity began declining from 89% at 7:00 AM on October 11, 2016, and reached a low of 40% by 4:00 PM. It then rose back to 86% by 9:00 PM.

Imagery from the surveillance camera over the period in question revealed a cloud of dust originating from the area of the quarry, which then proceeded to move along the valley toward the study site.

It should be noted that while these observations demonstrate the capacity for quarry operations to influence TSP levels at the study location, there is no relevant standard to compare hourly TSP levels against.

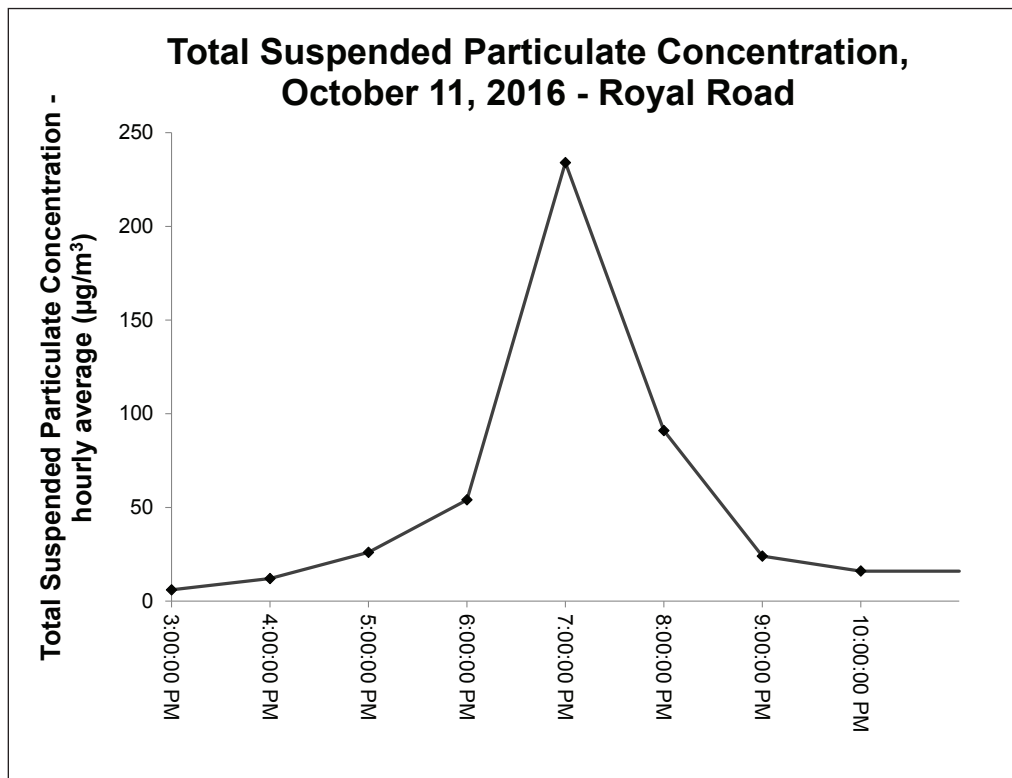


Figure 2. Peak Hourly Average Total Suspended Particulate Concentration, Royal Road

4.2.2 “Day of the Week” Effect on Total Suspended Particulate (TSP) Concentration

Average TSP concentrations observed each weekday are illustrated in Figure 3. As indicated, the average TSP concentrations were highest mid-week and lowest during the weekends.

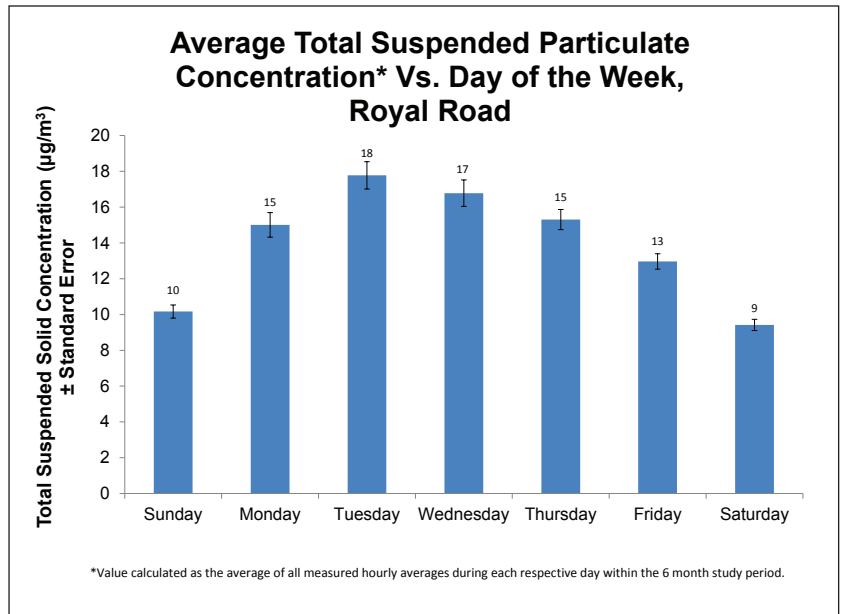


Figure 3. Total Suspended Particulate Average Concentration - “Day of the Week” Comparison

4.2.3 Comparisons to Aberdeen Street (Fredericton) Station

Fine particulate (PM_{2.5}) results from the study site are compared to results from the nearby Aberdeen Street, Fredericton, air quality monitoring station in Figure 4. This comparison provides an indication of the air quality at the study site versus typical, or “normal”, values for a light urban area in this region.

As illustrated in Figure 4 the hourly maximum PM_{2.5} level was higher at the study site than at Aberdeen Street station over the same period. However, average (24-hour average, and 6 month average) PM_{2.5} concentrations were higher at the Aberdeen Street station.

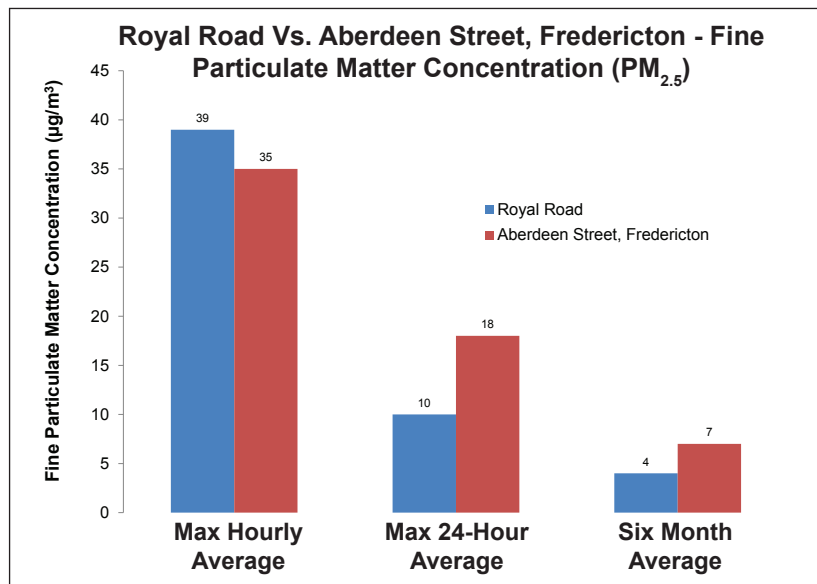


Figure 4. Fine Particulate Matter Concentration - Site Comparison

4.3 Suspended Particulate - Filter-Based

The average and maximum TSP concentration observed by Stantec Consulting Ltd. on behalf of the quarry operator are provided in Table 3. Results are then compared against regulated standards in Table 4. As indicated, contaminant levels remained well below the regulated limits at the Stantec Consulting Ltd. sampling locations.

The full data set for the Stantec Consulting Ltd. work is provided in Appendix B.

Table 3: Summary Statistics - Filter-Based TSP

Parameter	Average Concentration (5 Month)	Peak Concentration (24-hour average)	Notes
Total Suspended Particulate (TSP)	19.4 µg/m ³	36 µg/m ³	Peak 24-hour concentration occurred on July 6, 2016 (Site #1)

Table 4: Comparison to Standards and Guidelines - Filter-Based TSP

Parameter	Standard Value	Study Result	Notes
Total Suspended Particulate (TSP)	120 µg/m ³ (24 hour average)*	36 µg/m ³ (maximum 24 hour average measured)	None
	70 µg/m ³ (annual geometric mean)*	17 µg/m ³ (5 month geometric mean)	Provided for illustration purposes.

* New Brunswick's Maximum Permissible Ground Level Concentrations, as prescribed under *New Brunswick Regulation 97-133, Clean Air Act*.

A comparison of Table 2 and Table 4 reveals similar findings at the DELG study site and the Stantec Consulting Ltd. location. Note that values are not identical, but this would not be expected given the different monitoring technologies deployed and the slightly different locations of the monitors relative to the area emission sources.

4.4 Respirable Particulate (PM₁₀) and Crystalline Silicates

Respirable particulate (PM₁₀) and crystalline silicate results are compared against guideline values in Table 5. As indicated, contaminant levels were below (i.e., better than) the guideline values.

The full data sets for PM₁₀ and the quartz fractions are provided in Appendix B.

Table 5: Comparison to Standards and Guidelines - Respirable Particulate (PM₁₀) and Crystalline Silicates

Parameter	Standard/ Guideline Value	Study Result	Notes
Respirable Particulate (PM₁₀)	50 µg/m ³ (24-hour average, not to be exceeded more than three times per year)*	18.1 µg/m ³ (maximum 24 hour average detected)	Provided for illustration purposes.
	20 µg/m ³ (annual average)*	8.5 µg/m ³ (1-month average)	Provided for illustration purposes.
Quartz (From PM₁₀ Fraction)	5 µg/m ³ (24-hour average)**	3.6 µg/m ³ (maximum 24 hour average detected)	None
Cristobalite (From PM₁₀ Fraction)	5 µg/m ³ (24-hour average)**	<0.2 µg/m ³ (maximum 24 hour average detected)	All samples were below the detection limit for the monitoring method employed (0.2 µg/m ³).
Tridymite (From PM₁₀ Fraction)	5 µg/m ³ (24-hour average)**	<0.4 µg/m ³ (maximum 24 hour average detected)	All samples were below the detection limit for the monitoring method employed (0.4 µg/m ³).

* World Health Organization Air Quality Guideline

**Ontario Ambient Air Quality Criteria (for each of the three silicate species, as measured from the PM₁₀ fraction)

4.5 Data Limitations

The data collected represents conditions at the time of sampling and does not capture all possible variations in ambient air conditions that may be possible at this location.

This study involved the collection of ambient air quality data under field conditions. Consequently, unforeseen and unavoidable disruptions (e.g., weather, electrical power failures, equipment malfunctions, etc.) resulted in brief data interruptions at various points throughout the study period.

The study analyzed air quality at three fixed locations. These locations may have been impacted by air pollutants from multiple sources during this period. As such, the results provide a quantitative assessment of air quality at those locations. However, this type of study does not provide a basis for quantifying the impacts from individual emission sources.

Data was collected for a period of six months. However, some comparisons are made to standard or guideline values that require a longer observation period (i.e., 1 year or 3 years). These comparisons are for illustrative purposes only. In each case the study values provide a likely “worst case” comparison to the standard, as lengthening the study period to match the appropriate averaging period may result in a lower value. This is due to the study covering the relatively dust prone summer months, and excluding winter conditions.

5.0 Glossary of Abbreviations

DELG	New Brunswick Department of Environment and Local Government
km/hr	Kilometers per hour
NAPS	National Air Pollution Surveillance program
PM _{2.5}	Fine particulate (particulates with a diameter < 2.5 microns)
PM ₁₀	Respirable particulate (particulates with a diameter < 10 microns)
TSP	Total suspended particulate
µg/m ³	Micrograms per cubic meter

Appendix A: Technical Specifications - Continuous Monitors

Table A1: Technical Specifications of Continuous Air Quality Monitors

Parameter	Instrument	Lower Detection Limit	Resolution
Total Suspended Particulate (TSP)	Met-One Instruments Inc. Continuous Particle Monitor, model BAM-1020, outfitted with a TSP sampling head.	4.8 µg/m ³ (hourly) 1.0 µg/m ³ (daily)	± 0.2 µg/m ³
Fine Particulate (PM _{2.5})	Met-One Instruments Inc. Continuous Particle Monitor, model BAM-1020, outfitted with a fine particulate sampling head and cyclone.	4.8 µg/m ³ (hourly) 1.0 µg/m ³ (daily)	± 0.2 µg/m ³

Appendix B: Data Plots and Tables

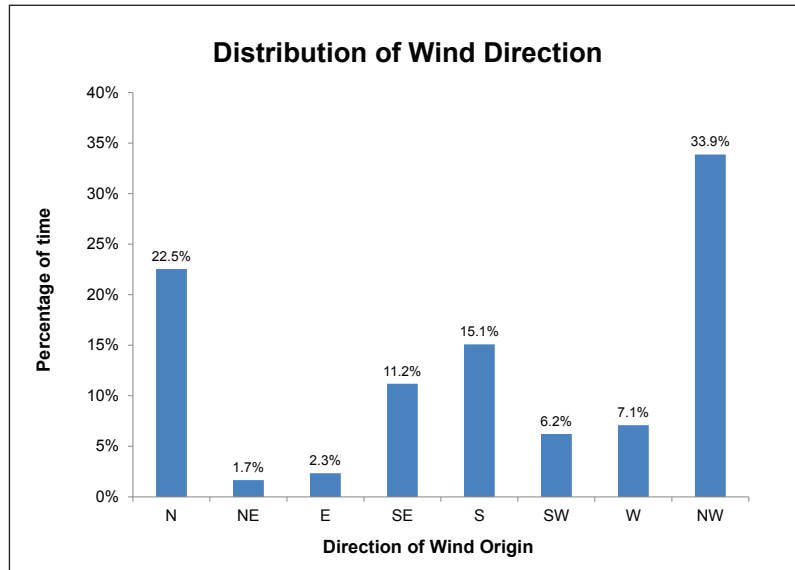


Figure B1. Direction of Wind Origin at Royal Road

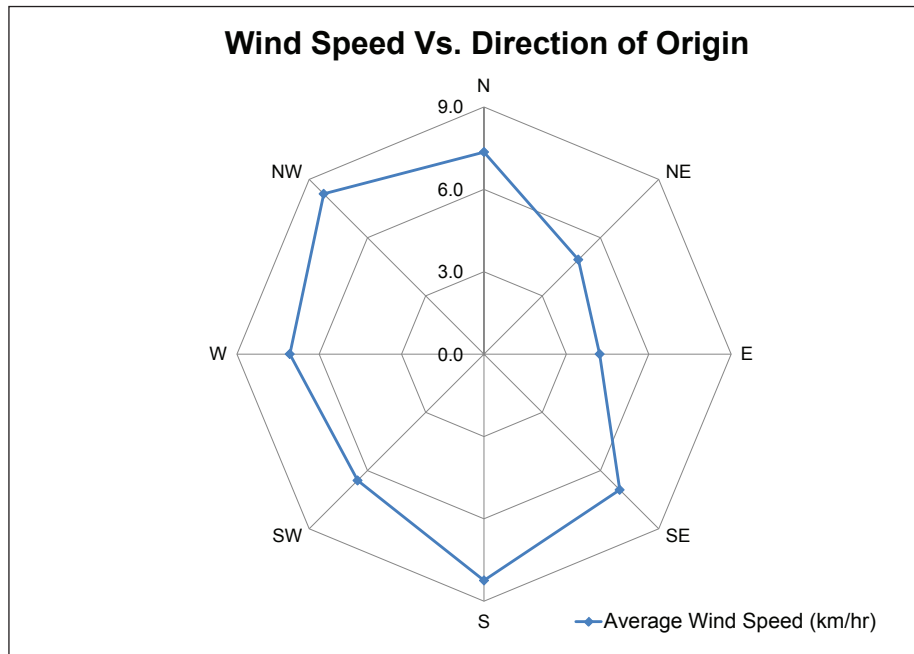


Figure B2. Wind Speed Distribution at Royal Road

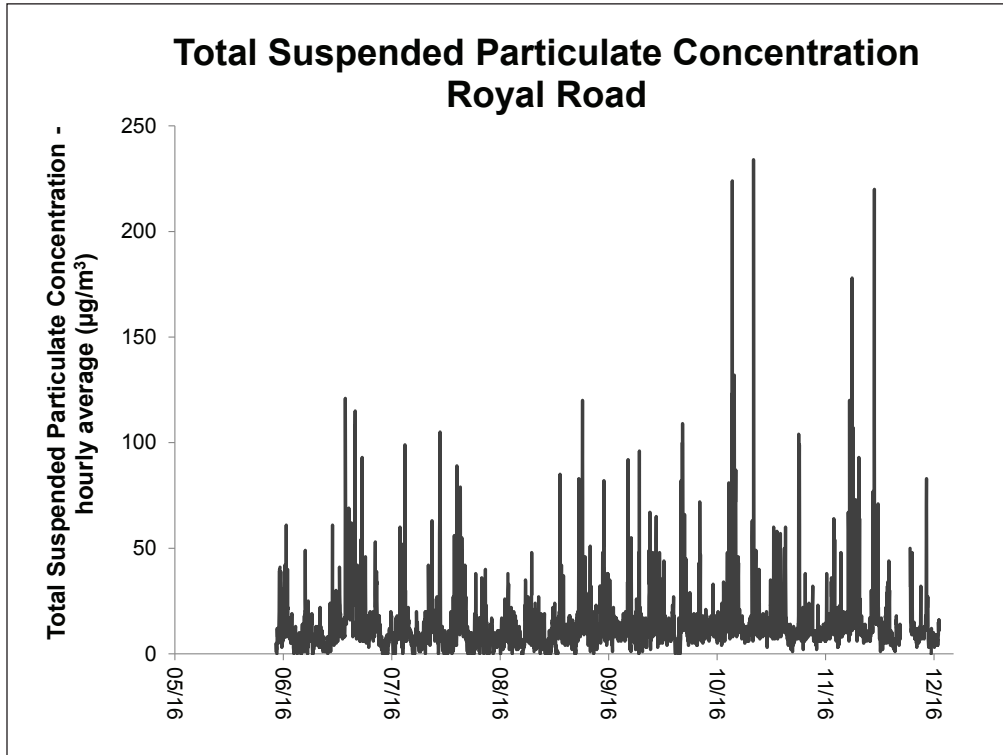


Figure B3. Total Suspended Particulate Concentration at Royal Road-Hourly Average

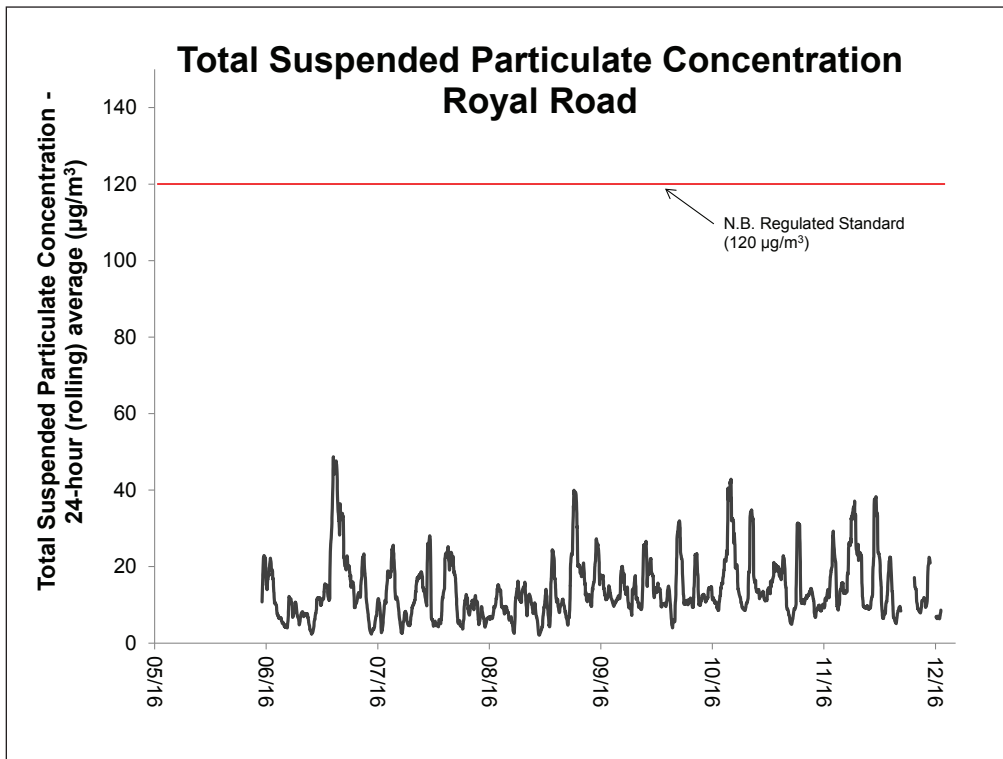


Figure B4. Total Suspended Particulate Concentration at Royal Road-24-hour Rolling Average

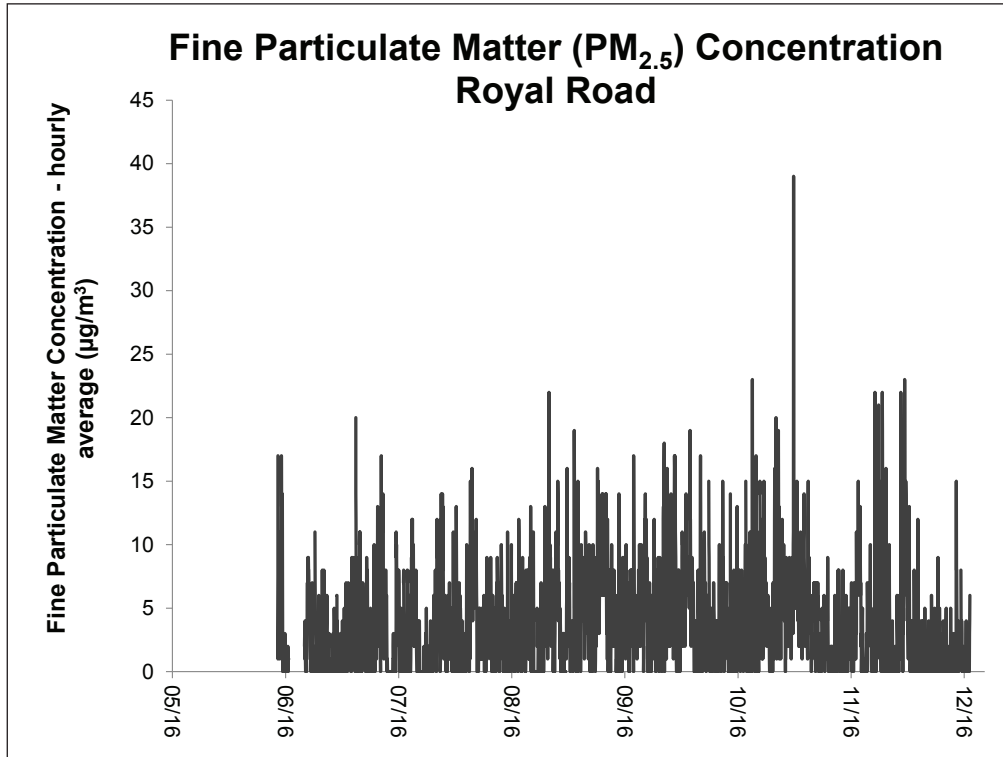


Figure B5. Fine Particulate Matter Concentration at Royal Road - Hourly Average

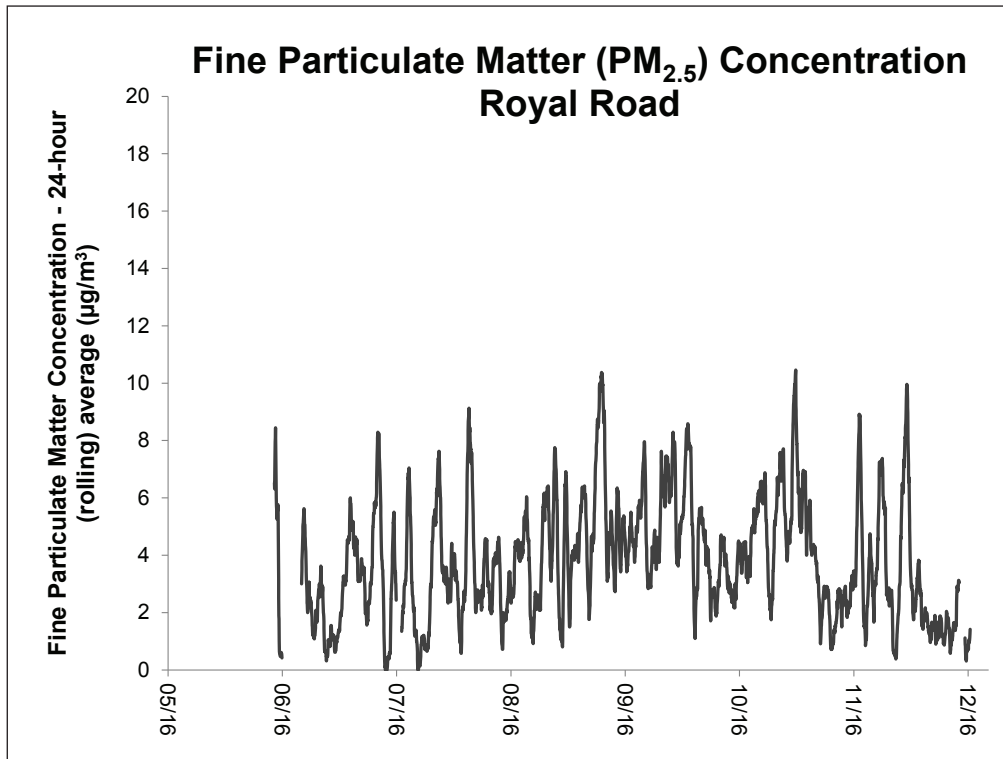


Figure B6. Fine Particulate Matter Concentration at Royal Road - 24-Hour Rolling Average

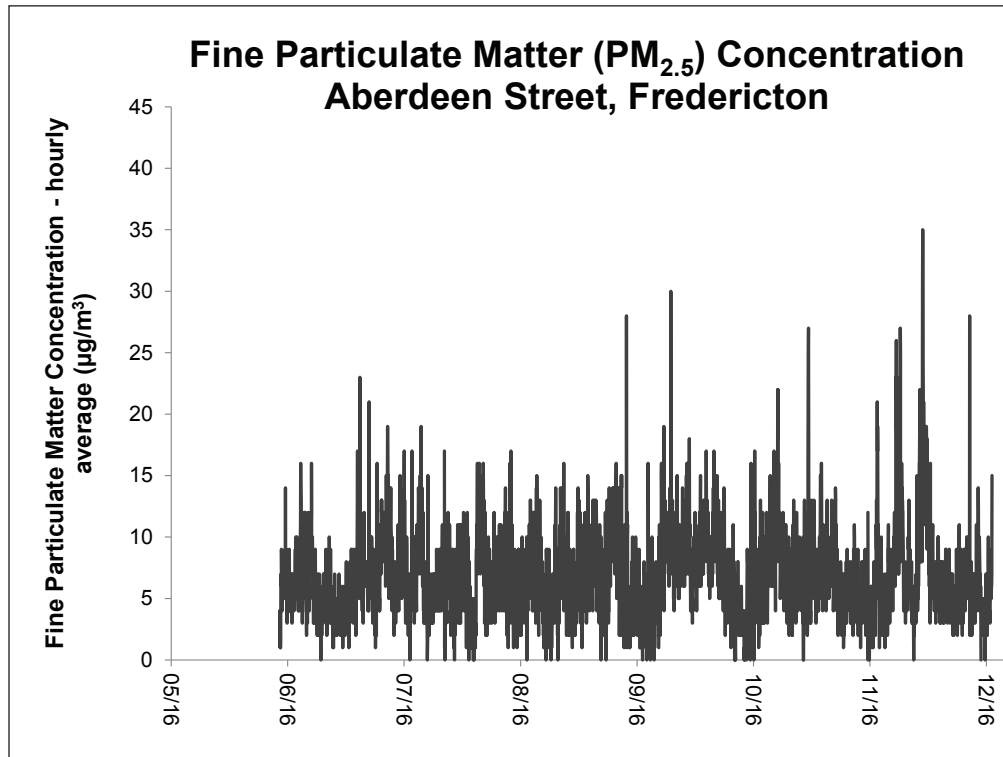


Figure B7. Fine Particulate Matter Concentration at Aberdeen Street, Fredericton - Hourly Average

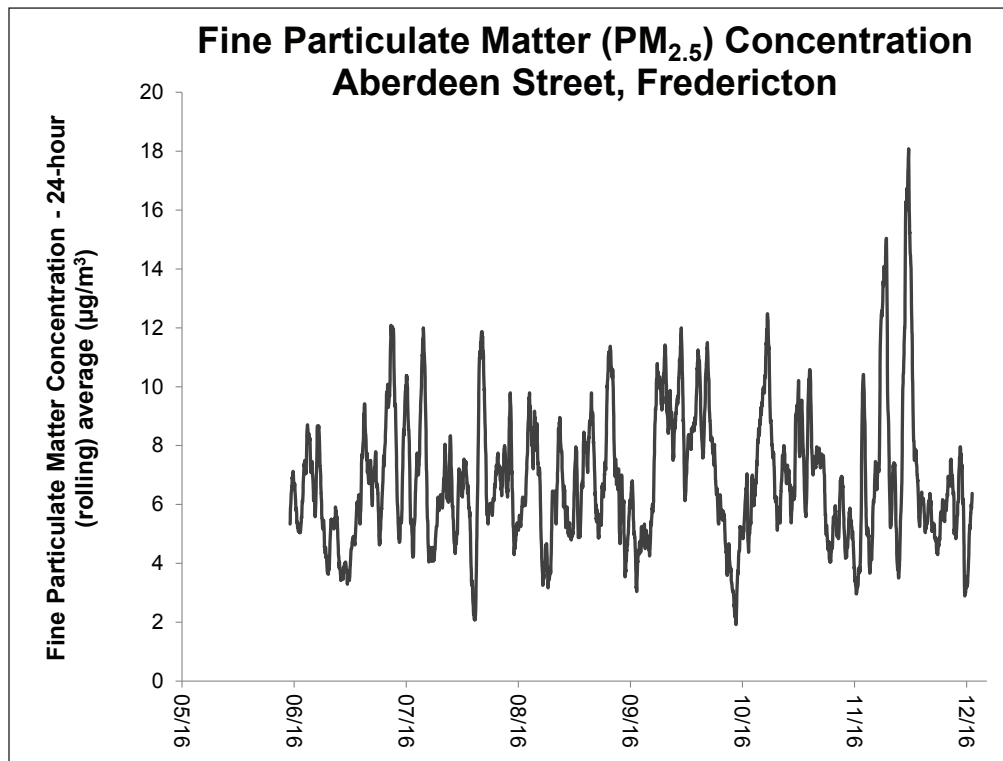


Figure B8. Fine Particulate Matter Concentration at Aberdeen Street, Fredericton - 24-Hour Rolling Average

Table B1. Total Suspended Particulate (TSP) Concentration, from Filter-based Samples - Daily (24 hour) Average, Royal Road. Data Provided by Stantec Consulting Ltd.

Date/Time (24-hour ending)	TSP ($\mu\text{g}/\text{m}^3$) - 24-Hour average	Monitor Location	Notes
2016/05/06 7:00	2.1	Site 1	Below detect (<2.1)
2016/05/12 7:00	9.7	Site 1	
2016/05/18 7:00	10.3	Site 1	
2016/05/24 7:00	12.9	Site 1	
2016/05/28 10:00	22.7	Site 1	
2016/06/03 7:00	24.3	Site 1	
2016/06/09 7:00	15.2	Site 1	
2016/06/15 7:00	21.3	Site 1	
2016/06/21 7:00	34.6	Site 1	
2016/06/27 7:00	21.8	Site 1	
2016/07/03 7:00	14.4	Site 1	
2016/07/06 7:00	36.1	Site 1	
2016/07/09 7:00	12.6	Site 1	
2016/07/12 7:00	25.3	Site 1	
2016/07/15 7:00	29.9	Site 1	
2016/07/18 7:00	16.4	Site 1	
2016/07/21 7:00	20.8	Site 1	
2016/07/24 7:00	12.6	Site 2	
2016/07/27 7:00	17	Site 2	
2016/07/30 7:00	18	Site 2	
2016/08/02 7:00	12.4	Site 2	
2016/08/05 7:00	25.1	Site 2	
2016/08/08 7:00	7.4	Site 2	
2016/08/11 7:00	19.6	Site 2	
2016/08/14 7:00	12.5	Site 2	
2016/08/17 7:00	27.4	Site 2	
2016/08/20 7:00	19.1	Site 2	
2016/08/23 7:00	12.9	Site 2	
2016/08/26 7:00	31.6	Site 2	
2016/08/29 1:30	14.2	Site 2	19.5 hour sample
2016/09/01 7:00	32.1	Site 2	
2016/09/04 7:00	10	Site 2	
2016/09/07 11:43	24.8	Site 2	
2016/09/10 7:00	35.1	Site 2	25.75 hour sample
2016/09/13 7:00	35.7	Site 2	
2016/09/16 7:00	20.3	Site 2	
2016/09/19 7:00	15.5	Site 2	
2016/09/22 7:00	28.2	Site 2	
2016/09/25 7:00	10.3	Site 2	
2016/09/28 7:00	12.6	Site 2	
2016/10/01 7:00	15.2	Site 2	
2016/10/07 7:00	32.7	Site 2	
2016/10/13 7:00	10.6	Site 2	
2016/10/19 7:00	17.9	Site 2	
2016/10/25 7:00	7.7	Site 2	
2016/10/31 7:00	5	Site 2	

**Table B2. Respirable Particulate (PM₁₀)
Concentration - Daily (24 hour) Average, Royal
Road**

Sample Date	PM ₁₀ Concentration - 24-hour Average (µg/m ³)
2016/09/24	7.1
2016/09/26	10.8
2016/09/28	7.7
2016/09/30	7.5
2016/10/02	6.6
2016/10/04	9.5
2016/10/06	18.1
2016/10/08	9.4
2016/10/10	4.2
2016/10/12	8.0
2016/10/14	4.6
2016/10/16	9.8
2016/10/18	10.8
2016/10/20	13.3
2016/10/22	2.6
2016/10/24	6.8

**Table B3. Quartz Particle Concentration, from
PM₁₀ Fraction- Daily (24 hour) Average, Royal
Road**

Sample Date	Quartz Concentration - 24-hour Average (µg/m ³)
2016/09/24	1.0
2016/09/26	2.6
2016/09/28	0.7
2016/09/30	1.5
2016/10/02	0.5
2016/10/04	1.4
2016/10/06	3.6
2016/10/08	0.5
2016/10/10	0.3
2016/10/12	1.0
2016/10/14	0.5
2016/10/16	0.5
2016/10/18	2.1
2016/10/20	1.8
2016/10/22	<0.2 (Below Detection)
2016/10/24	1.8