

Air Quality Evaluation - Miramichi

Final Report

New Brunswick Department of Environment and Local Government

**Air and Water Sciences Branch,
Air Sciences Section**

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1.0 Executive Summary

In 2019 an air quality evaluation was initiated in Miramichi in response to ongoing citizen complaints related to air pollution emissions from the Arbec Forest Products mill.

Air quality monitoring equipment was deployed to the area on November 7, 2019, with the goal of collecting data for a period of one year. However, due to logistical issues caused by the Covid-19 pandemic in early 2020, the equipment remained in place and data collection continued until July 28, 2021 (approximately 21 months).

Monitoring focussed on air contaminants associated with the mill, based on available emissions data. This entailed the use of continuous monitoring equipment where feasible. Integrated sampling (with laboratory analysis of sample media) was required for the remaining contaminants. This report provides results and analysis of the findings from this monitoring work.

It was found that air contaminant concentrations in the area remained below applicable standard and guideline values for all contaminants monitored for the duration of the project. Although not constituting an exceedance of standards or guidelines, it was found that the area occasionally experiences short-lived respirable particulate matter (PM₁₀) events that may be aesthetically objectionable to some.

The Arbec Forest Products mill is one of several contributing PM₁₀ sources in the area.

2.0 Introduction

2.1 Background

The Department of Environment and Local Government (DELG) has, over many years, received complaints from citizens of Miramichi related to emissions from the Arbec Forest Products mill and the resulting impact on local air quality. Visual (smoke) and odour impacts are described.

Key air quality contaminants related to the mill (fine particulate matter (PM_{2.5}) and Total Suspended Particulate (TSP)) are monitored near the mill via permanent, facility-operated, air quality monitoring stations. Data from these stations are reported annually by DELG via its annual air quality monitoring results report, and the PM_{2.5} data is reported in real-time via DELG's online air quality data portal. In addition, in 2001 DELG conducted an air quality evaluation in the area via its mobile air quality monitoring unit. Results to date from the permanent stations, and the 2001 evaluation, have revealed no significant air quality issues.

In response to the continuing citizen complaints from the area, DELG has now undertaken a new air quality evaluation in the area, with an expanded list of monitored contaminants.

2.2 Area Emission Sources

Air pollution sources in Miramichi include the Arbec Forest Products mill and a variety of other, smaller, industries. Air quality in Miramichi is also affected by typical urban sources (automobile exhaust, boiler plant exhaust, residential wood smoke, etc.)

As is the case for all of New Brunswick, Miramichi also experiences long-range (transboundary) air pollution impacts (primarily fine particulates and ground level ozone) from pollution sources elsewhere in the World.

Emissions from the Arbec Forest Products mill include combustion products, exhaust gases from the oriented strand board drying process, vehicle (trucking) exhaust, and windblown dust from the property. It should be noted that the mill is subject to regulation under the *Air Quality Regulation* (N.B. Regulation 97-133) - *Clean Air Act*, and operates a variety of pollution control equipment to reduce air pollution emissions from the facility.

2.3 Project Design and Location

Based on a review of emissions data for the Arbec Forest Products mill, and consideration of other nearby emission sources, a selection of air contaminants were chosen for the evaluation. A list of the included pollutant parameters is provided in Appendix A along with the rationale for the inclusion of each.

The work was carried out on Avanti Boulevard, Miramichi, New Brunswick. This is an urban, moderately populated, commercial area.

The monitoring location was selected to be representative of a “highly impacted” area with respect to emissions from the Arbec Forest Products mill. This was determined based on assessment of available wind data and feedback from local residents and DELG regional personnel.

The DELG mobile air quality monitoring unit was positioned at the project site (approximately 47°01'18.62"N 65°29'18.62"W), which is approximately 1,600 meters northeast of the Arbec Forest Products mill. The site is within the river valley of Miramichi River, which runs approximately southwest to northeast at this location. The project site and surrounding area is pictured in Figure 1.

2.4 Project Timing

DELG deployed its mobile air quality monitoring unit to the Avanti Boulevard location on November 7, 2019 and concluded operations on July 28, 2021.

3.0 Methodology

3.1 Meteorology Equipment

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

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



Figure 1. Project Site and Surrounding Area (Image courtesy of Google Earth)

3.2 Continuous Air Quality Monitoring Equipment

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 drawn through the monitors.

Continuous monitoring equipment was deployed to measure ambient (outside air) concentrations of nitrogen dioxide (NO₂), ground level ozone (O₃), fine particulate matter (PM_{2.5}), respirable particulate (PM₁₀), and total suspended particulate (TSP).

All continuously monitored parameters, with the exception of TSP, were logged as one-minute averages. TSP was logged as hourly averages. Data for all continuously monitored parameters was retrieved automatically on an hourly basis.

Technical specifications for all continuous instruments are provided in Appendix B.

3.3 Integrated Sampling

Integrated sampling involves the collection of a single sample over an extended period of time. These samples are subsequently analyzed by a laboratory. The collected values represent the “average” concentration of the monitored contaminant experienced over the exposure period.

Integrated sampling was undertaken via three methods:

i) Passive Absorption

UMEX[®] 100 Monitoring Samplers (with rain shelter) were deployed to collect formaldehyde concentration samples from ambient air via passive absorption (to 2,4-dinitrophenylhydrazine (DNPH) treated tape). Samplers were deployed for one-week exposure periods between May 20, 2021 and July 14, 2021 (a total of eight samples, providing nearly continuous coverage for 8 weeks). And one-day exposure periods between June 21, 2021 and June 27, 2021 (a total of six daily samples collected over six days).

Collected samples were analyzed for formaldehyde concentration by Bureau Veritas Laboratories using Occupational Health and Safety Administration (OSHA) method 1007 by High Pressure Liquid Chromatography (HPLC) (method equivalent to United States Environmental Protection Agency (EPA) Method TO-11).

ii) DNPH Cartridge

Carbonyl samples were collected using an R M Environmental Systems Inc. Model 926 Carbonyl Sampler. Samples were collected by actively drawing air through DNPH-coated silica-gel cartridges at a constant rate (total sample volume of 1000 cubic centimeters) over a 24 hour period. Samples were drawn daily between June 16, 2021, and June 30, 2021 (a total of 15 samples, providing nearly continuous coverage for 15 days). The following aldehyde/carbonyl compounds were analyzed from these samples:

- Acetaldehyde
- Acetone
- Acrolein
- Benzaldehyde
- Butyraldehyde-Isobutyraldehyde
- Crotonaldehyde
- Dimethylbenzaldehyde
- Formaldehyde
- Hexanal
- Isovaleraldehyde
- Methyl Ethyl Ketone
- Methy Isobutyl Ketone
- Pentanal/Valeraldehyde
- Propionaldehyde
- m-Tolualdehyde
- o-Tolualdehyde
- p-Tolualdehyde

Analysis of samples was provided by the Environment and Climate Change Canada (ECCC) National Air Pollution Surveillance (NAPS) laboratory via high-pressure liquid chromatography (EPA Method TO-11A).

iii) Summa Cannister

Volatile Organic Compounds (VOC) were sampled by drawing air into Summa cannisters via negative pressure/vacuum at a constant flow (regulated via 30 micrometer critical orifice). Samples were drawn over 24 hour periods between June 21, 2021 and June 26, 2021 (a total of 6 samples, providing nearly continuous coverage for 6 days). The following compounds were analyzed from these samples:

- Acrylonitrile
- Benzene
- Ethylene Oxide
- Ethylbenzene
- Isoprene
- m and p-Xylene
- Methanol
- Methyl tert-Butyl Ether
- o-Xylene
- Propylene Oxide
- Toluene

Sample analysis was provided by the ECCC NAPS laboratory using a combined gas chromatography/mass selective detector system (EPA Method TO-15).

3.4 Quality Assurance

Data collection and validation for continuous air quality monitoring equipment was conducted in accordance with the Canadian Council of Ministers of Environment (CCME) *Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines, 2019* (ISBN 978-1-77202-056-4 PDF).

Integrated sampling was undertaken in accordance with the quality assurance and validation requirements prescribed for each method (see subsection 3.3).

4.0 Results

4.1 Meteorology - Wind at Project Site

Winds at the project site originated generally from the West during the study period. South and Southeasterly winds were infrequent. Winds originating from the direction of the Arbec Forest Products mill (and following the approximate orientation of the river valley) occurred approximately 15% of the time. Average wind conditions for the project period is further illustrated in Appendix C.

Winds during the integrated sampling period (May 20, 2021 to July 14, 2021) originated predominantly from the West Southwest (following the orientation of the river valley), indicating that the samplers were well placed during this period to receive impacts from the mill.

For the portion of the integrated sampling period when daily samples were drawn (June 16, 2021 to June 30, 2021), winds frequently originated from the West Southwest to South Southwest (following the orientation of the river valley). On 9 of the 15 sampling days winds originated from these directions >50% of the time. This suggests that the samplers were well placed during this period to receive impacts from the mill.

4.2 Continuous Monitors at Project Site

Summary statistics for each of the continuously monitored parameters at the project site are provided in Table 1.

Additional data for each parameter is illustrated graphically in Appendix D.

4.3 Integrated Sampling at Project Site

Summary statistics for parameters monitored via integrated sampling methods are provided in Tables 2, 3, and 4.

Table 1: Summary Statistics - Continuously Monitored Parameters at Project Site

Parameter	Average Concentration (21 Month)	Peak Concentration (24-hour average)	Peak Concentration (1-hour average)
Nitrogen Dioxide (NO ₂)	1 ppb ¹	10 ppb	27 ppb
Ground Level Ozone (O ₃)	30 ppb	55 ppb	64 ppb
Fine Particulate (PM _{2.5})	6 µg/m ³	22 µg/m ³	53 µg/m ³
Respirable Particulate (PM ₁₀)	12 µg/m ³	42 µg/m ³	420 µg/m ³
Total Suspended Particulate (TSP)	12 µg/m ³	79 µg/m ³	551 µg/m ³

¹ Only 16 months of data available for NO₂ due to instrument failure during a portion of the project.

Table 2: Summary Statistics - Integrated Sampling of Formaldehyde via Passive Absorption

Parameter	Average Concentration (8 weeks)	Peak Concentration (1-week average)	Peak Concentration (24-hour average)
Formaldehyde	2.6 µg/m ³	3.4 µg/m ³	3.7 µg/m ³

Table 3: Summary Statistics - Integrated Sampling of Aldehydes via DNPH Cartridge

Parameter	Average Concentration (15 days)	Peak Concentration (24-hour average)
Acetaldehyde	0.38 µg/m ³	0.91 µg/m ³
Acetone	0.56 µg/m ³	1.96 µg/m ³
Acrolein	0.01 µg/m ³	0.04 µg/m ³
Benzaldehyde	0.10 µg/m ³	0.21 µg/m ³
Butyraldehyde-Isobutyraldehyde	0.04 µg/m ³	0.10 µg/m ³
Crotonaldehyde	<0.01 µg/m ³	0.03 µg/m ³
Dimethylbenzaldehyde	0.01 µg/m ³	0.02 µg/m ³
Formaldehyde	1.66 µg/m ³	3.43 µg/m ³
Hexanal	0.13 µg/m ³	0.27 µg/m ³
Isovaleraldehyde	0.02 µg/m ³	0.07 µg/m ³
Methyl Ethyl Ketone	0.05 µg/m ³	0.17 µg/m ³
Methy Isobutyl Ketone	0.04 µg/m ³	0.07 µg/m ³
Pentanal/Valeraldehyde	0.04 µg/m ³	0.07 µg/m ³
Propionaldehyde	0.12 µg/m ³	0.25 µg/m ³
m-Tolualdehyde	0.02 µg/m ³	0.04 µg/m ³
o-Tolualdehyde	0.04 µg/m ³	0.12 µg/m ³
p-Toluadlehyde	0.04 µg/m ³	0.32 µg/m ³

Table 4: Summary Statistics - Integrated Sampling of Volatile Organic Compounds via Summa Cannister

Parameter	Average Concentration (6 days)	Peak Concentration (24-hour average)
Acrylonitrile	0.01 µg/m ³	0.01 µg/m ³
Benzene	0.08 µg/m ³	0.10 µg/m ³
Ethylene Oxide	0.07 µg/m ³	0.14 µg/m ³
Ethylbenzene	0.05 µg/m ³	0.08 µg/m ³
Isoprene	0.89 µg/m ³	1.18 µg/m ³
m and p-Xylene	0.12 µg/m ³	0.17 µg/m ³
Methanol	3.15 µg/m ³	3.65 µg/m ³
Methyl tert-Butyl Ether	0.02 µg/m ³	0.02 µg/m ³
o-Xylene	0.05 µg/m ³	0.08 µg/m ³
Propylene Oxide	0.04 µg/m ³	0.06 µg/m ³
Toluene	0.28 µg/m ³	0.35 µg/m ³

5.0 Analysis

5.1 Comparisons to Standards and Guidelines

The following analysis compares the monitored values 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 some contaminants. However, the Regulation does not address all contaminants. In these cases, concentrations are evaluated against standard or guideline values that have been adopted by policy (e.g., national standards, standards adopted by other jurisdictions, or guidelines adopted by various national or international agencies).

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

In order to compare results against regulated standards and guidelines the data must be converted into the correct form. For instance, by averaging 24 one-hour averages together to create a 24-hour average. In some cases, the data collected cannot be converted into the appropriate form. However, approximations can sometimes be applied (e.g., comparing data collected over several months against a standard that is based on annual average conditions).

Continuous monitoring results from the project site are compared against standards and guideline values in Table 5. Results from integrated sampling are compared against standards and guideline values in Table 6.

Please note that standards/guidelines are not available (or are not comparable to the averaging periods for the collected data) for all contaminants.

Table 5: Comparisons to Standards and Guidelines - Continuous Monitors

Parameter	Standard/Guideline Value	Standard/Guideline Source	Monitored Value	Notes
Nitrogen Dioxide (NO₂)	210 ppb (1-hour average)	N.B. Reg. 97-133, <i>Clean Air Act</i>	27 ppb (Highest 1-hour value recorded)	
	105 ppb (24-hour average)	N.B. Reg. 97-133, <i>Clean Air Act</i>	10 ppb (Highest 24-hour value recorded)	
	52 ppb (Annual average)	N.B. Reg. 97-133, <i>Clean Air Act</i>	1 ppb (16-month average) ¹	
Ground Level Ozone (O₃)	80 ppb (1-hour average)	Ontario Ambient Air Quality Criteria ¹	64 ppb (Highest 1-hour value recorded)	These standards are based on statistics that require three complete years of data collection, whereas only 21 months of data is available.
	63 ppb (Fourth worst daily 8-hour average, averaged over three years)	Canadian Ambient Air Quality Standard	46 ppb (Fourth worst daily 8-hour average for 2020 monitoring year) ²	
Fine Particulate (PM_{2.5})	27 µg/m ³ (98th percentile daily average)	Canadian Ambient Air Quality Standard	14 µg/m ³ 98th percentile daily average (2020 monitoring year) ²	
	8.8 µg/m ³ (3-year average)	Canadian Ambient Air Quality Standard	5.8 µg/m ³ (Annual average for 2020 monitoring year) ²	
Respirable Particulate (PM₁₀)	50 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	42 µg/m ³ (Highest 24-hour value recorded)	
Total Suspended Particulate (TSP)	120 µg/m ³ (24-hour average)	N.B. Reg. 97-133, <i>Clean Air Act</i>	79 µg/m ³ (Highest 24-hour value recorded)	
	70 µg/m ³ (Annual geometric mean)	N.B. Reg. 97-133, <i>Clean Air Act</i>	9 µg/m ³ (Annual geometric mean for 2020) ²	

¹ There were no complete monitoring years for NO₂ due to lost data (five months) caused by instrument failure.

² 2020 was the only complete and usable calendar year for the purposes of calculating the required statistic. Data completeness criteria (75%) was not met for the other years (2019 and 2021) due to the start and stop dates for the project.

Table 6: Comparisons to Standards and Guidelines - Integrated Sampling

Parameter	Standard/Guideline Value	Standard/Guideline Source	Monitored Value	Notes
Formaldehyde (via UME ^x 100 passive absorption sampling)	65 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	3.7 µg/m ³ (Highest 24-hour value recorded)	
Formaldehyde (via DNPH cartridge)			3.43 µg/m ³ (Highest 24-hour value recorded)	
Acetaldehyde (via DNPH cartridge)	500 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.91 µg/m ³ (Highest 24-hour value recorded)	
Acetone (via DNPH cartridge)	11,880 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	1.96 µg/m ³ (Highest 24-hour value recorded)	
Acrolein (via DNPH cartridge)	0.4 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.04 µg/m ³ (Highest 24-hour value recorded)	
Acrylonitrile (via Summa Cannister)	0.12 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.01 µg/m ³ (Highest 24-hour value recorded)	
Benzaldehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	Available guidelines are not comparable (different averaging periods).
Benzene (via Summa Cannister)	2.3 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.10 µg/m ³ (Highest 24-hour value recorded)	
Butyraldehyde/ Isobutyraldehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	Available guidelines are not comparable (different averaging periods).
Crotonaldehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	
Dimethylbenzaldehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	

Table 6: Comparisons to Standards and Guidelines - Integrated Sampling Continued

Parameter	Standard/Guideline Value	Standard/Guideline Source	Monitored Value	Notes
Ethylene Oxide (via Summa Cannister)	0.2 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.14 µg/m ³ (Highest 24-hour value recorded)	
Ethylbenzene (via Summa Cannister)	1000 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.08 µg/m ³ (Highest 24-hour value recorded)	
Hexanal (via DNPH cartridge)	Not available	Not available	Not Applicable	Available guidelines are not comparable (different averaging periods).
Isoprene (via Summa Cannister)	Not available	Not available	Not Applicable	
Isovaleraldehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	
m and p-Xylene (via Summa Cannister)	730 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.17 µg/m ³ (Highest 24-hour value recorded)	
Methanol (via Summa Cannister)	4,000 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	3.65 µg/m ³ (Highest 24-hour value recorded)	
Methyl Ethyl Ketone (via DNPH cartridge)	1,000 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.17 µg/m ³ (Highest 24-hour value recorded)	
Methyl Isobutyl Ketone (via DNPH cartridge)	1,200 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.07 µg/m ³ (Highest 24-hour value recorded)	
Methyl tert-Butyl Ether (via Summa Cannister)	7,000 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.02 µg/m ³ (Highest 24-hour value recorded)	
o-Xylene (via Summa Cannister)	730 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.08 µg/m ³ (Highest 24-hour value recorded)	
Pentanal/Valeraldehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	Available guidelines are not comparable (different averaging periods).
Propionaldehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	

Table 6: Comparisons to Standards and Guidelines - Integrated Sampling Continued

Parameter	Standard/Guideline Value	Standard/Guideline Source	Monitored Value	Notes
Propylene Oxide (via Summa Cannister)	1.5 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.06 µg/m ³ (Highest 24-hour value recorded)	
m-Tolualdehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	Available guidelines are not comparable (different averaging periods).
o-Tolualdehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	
p-Tolualdehyde (via DNPH cartridge)	Not available	Not available	Not Applicable	
Toluene (via Summa Cannister)	7,000 µg/m ³ (24-hour average)	Ontario Ambient Air Quality Criteria ¹	0.35 µg/m ³ (Highest 24-hour value recorded)	

¹ Human Toxicology and Air Standards Section, Technical Assessment and Standards Development Branch, Ontario Ministry of the Environment, Conservation and Parks (MECP). 2020. Ambient Air Quality Criteria. MECP, Toronto, ON, Canada. ISBN: 978-1-4868-4498-2. (Online). <https://files.ontario.ca/mecp-ambient-air-quality-criteria-list-en-2020-05-01.pdf>

6.0 Conclusions

For all pollutants monitored, concentrations detected at Avanti Boulevard, Miramichi were found to be within (better than) applicable standards and guidelines, where suitable standards or guidelines exist.

The pollutant that reached the closest to the guideline value (Ontario Air Quality Criterion) was respirable particulate (PM₁₀). With a peak 24-hour average value of 42 µg/m³, it reached 84% of the applicable guideline value of 50 µg/m³. Further, as illustrated in Appendix D (Figure D4) there were several short-lived peaks of much higher values. These peaks do not constitute exceedances of any standard or guideline as there is no standard or guideline value available for hourly averages. However, they illustrate the potential for brief episodes of qualitatively poorer air quality which may be noticeable by a human observer. This is in agreement with citizen complaints from the area that describe smoke impacts. However, it should be noted that the mill is not the only contributing source of PM₁₀ in the area. Other potentially significant sources of PM₁₀ in the area include residential woodstove emissions, windblown dust, and automobile exhaust.

The monitoring did not identify a pollutant (or pollutants) that would explain citizen complaints of odour impacts. However, this does not preclude the existence of odorous contaminants in the area, as the current work was not exhaustive in its attempt to identify or quantify aesthetic odour impacts.

7.0 Data Limitations

The data collected represents conditions during the evaluation period and does not reflect all possible variations in ambient air quality conditions that may be possible at this location.

This project 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 evaluation period.

The project analyzed air quality at a fixed location. As such, the results provide a quantitative assessment of air quality at this location only. Inferences can be made about air quality at other nearby locations, but certainty decreases with distance from the monitoring site.

The project location may have been impacted by air pollutants from multiple sources during the evaluation period. Meteorology data can suggest likely sources for the contaminants detected during a given period. However, the data is insufficient for comprehensive “source apportionment” (i.e., it is not sufficient for discerning and quantifying the impacts of individual pollution sources).

Data was collected for a period of 21 months. However, some comparisons are made to standard or guideline values that require a longer observation period (e.g., 3 years).

8.0 Glossary of Abbreviations

DELG	Department of Environment and Local Government
km/hr	Kilometers per hour
NAPS	National Air Pollution Surveillance (program)
NO ₂	Nitrogen dioxide
O ₃	Ozone (ground level ozone)
PM _{2.5}	Fine particulate (particulates with a diameter ≤ 2.5 microns)
PM ₁₀	Respirable Particulate (particulates with a diameter ≤ 10 microns)
PPB	Parts per billion
TSP	Total Suspended Particulates
µg/m ³	Micrograms per cubic meter
VOC	Volatile Organic Compound

Appendix A: Pollutant Parameters

Table A1: Rationale for Inclusion of Monitored Parameters

Air Contaminant	Rationale for Inclusion
Nitrogen Dioxide (NO ₂)	Emissions monitoring (stack testing) for the mill indicates that NO ₂ is being emitted from the facility. Inclusion of this parameter in the study provides quantification of off-site impacts from these emissions.
Ground Level Ozone (O ₃)	Ozone is not directly emitted by pollution sources. Rather, it is formed in the air by reactions between certain pollutants (principally volatile organic compounds and nitrogen dioxide). Ground level ozone concentrations change in predictable ways in response to the presence of these other contaminants. Monitoring this parameter along with NO ₂ allows inferences to be made about local volatile organic compound emissions.
Particulate Matter (TSP, PM ₁₀ , and PM _{2.5})	Emissions monitoring (stack testing) for the mill indicates that particulates are being emitted from the facility. Inclusion of these parameters in the study provides quantification of off-site impacts from these emissions and determination of the size-distribution of the particles. Also, citizen complaints from the area refer to smoke impacts, which are the result of particulates suspended in air.
Formaldehyde (and related compounds)	Emissions monitoring (stack testing) for the mill indicates that formaldehyde (which is a product of heating wood) is being emitted from the facility. A variety of related “aldehyde” compounds were also assessed as the potential also exists for their emission from the facility. Also, many of these “aldehyde” compounds can result in odour impacts, which may relate to the odours mentioned in citizen complaints.
Volatile Organic Compounds (VOC)	The mill relies on combustion of organic materials to provide heat for their drying process. Combustion of organics can result in emissions of a variety of VOCs. The monitored subset of VOC species provide an indication of how these emissions are impacting the local community.

Appendix B: Technical Specifications - Continuous Monitors

Table B1: Technical Specifications of Continuous Air Quality Monitors

Parameter	Instrument	Lower Detection Limit	Resolution
Nitrogen Dioxide (NO ₂)	Thermo Environmental Instruments Chemiluminescence NO-NO ₂ -NO _x Analyzer, Model 42 <i>i</i> .	0.4 ppb	± 0.2 ppb (noise) ± 0.4 ppb (precision)
Ground Level Ozone (O ₃)	Thermo Environmental Instruments Ultraviolet Photometric Ozone Gas Analyzer, Model 49 <i>i</i> .	0.5 ppb	± 0.25 ppb (noise) ± 1.0 ppb (precision)
Fine and Respirable Particulate Matter (PM _{2.5} and PM ₁₀)	Teledyne API Model T640 Mass Monitor	0.1 µg/m ³ (hourly)	± 0.5 µg/m ³
Total Suspended Particulate (TSP)	Met-One Instruments Inc. Continuous Particle Monitor, model BAM-1020, outfitted with a total suspended particulate head.	4.8 µg/m ³ (hourly) 1.0 µg/m ³ (daily)	± 0.2 µg/m ³

Appendix C: Wind Rose

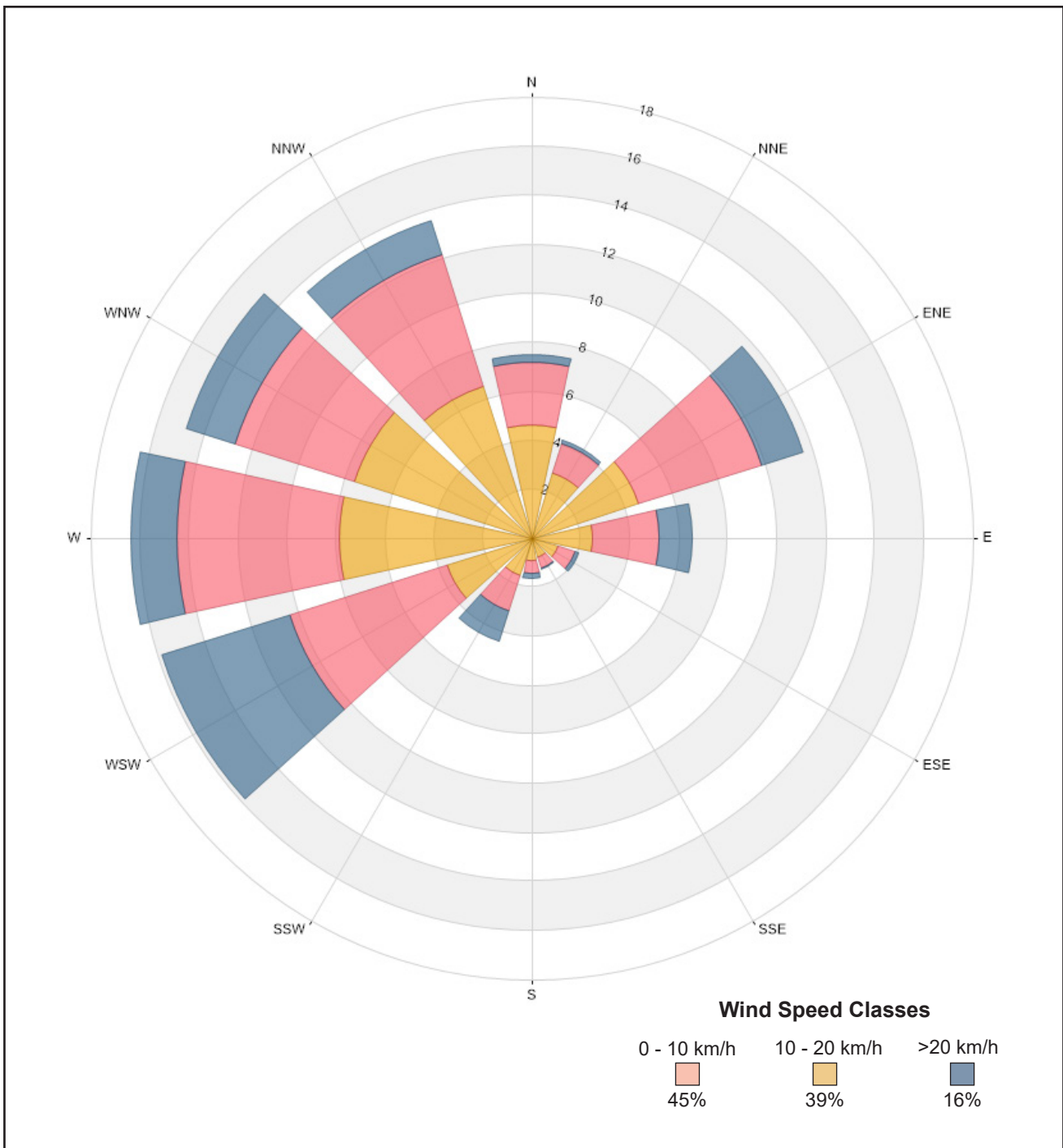


Figure C1: Wind Rose Diagram (Direction of Wind Origin) - Avanti Boulevard, Miramichi, November 7, 2019 to July 28, 2021.

Appendix D: Project Site Continuous Monitors - Additional Data

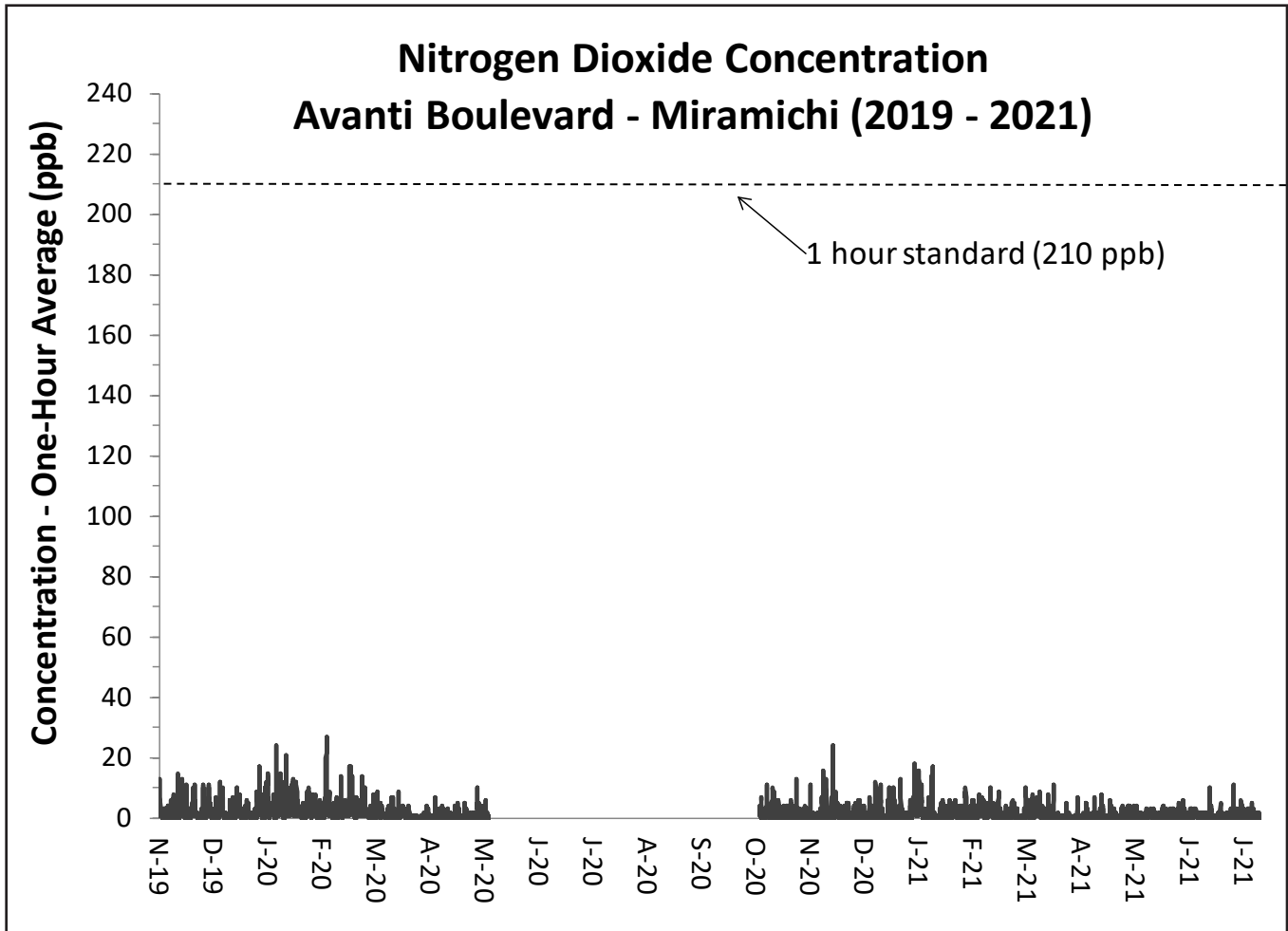


Figure D1: Hourly Average Nitrogen Dioxide Concentration - Avanti Boulevard, Miramichi, November 7, 2019 to July 28, 2021.

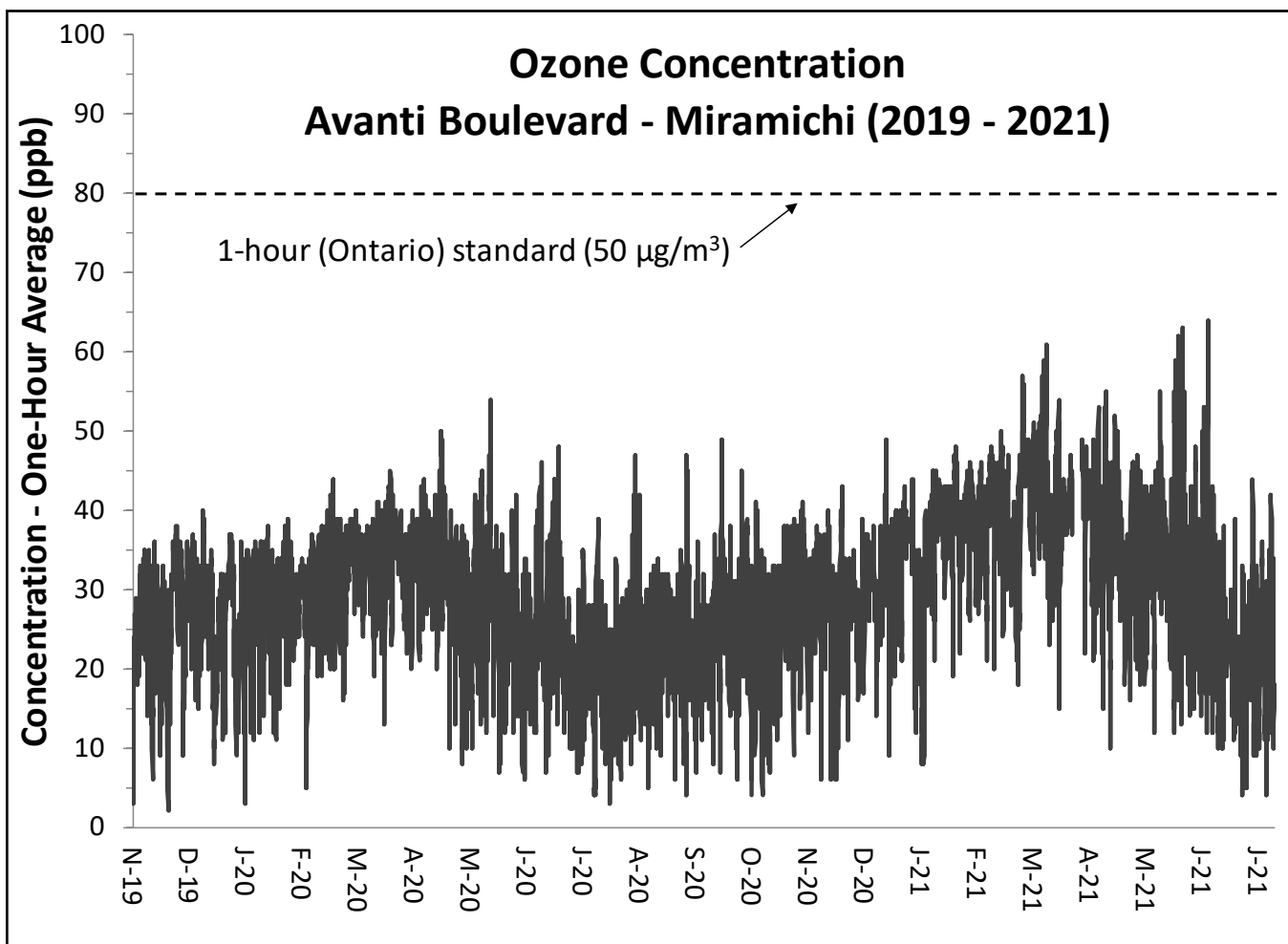


Figure D2: Hourly Average Ozone Concentration - Avanti Boulevard, Miramichi, November 7, 2019 to July 28, 2021.

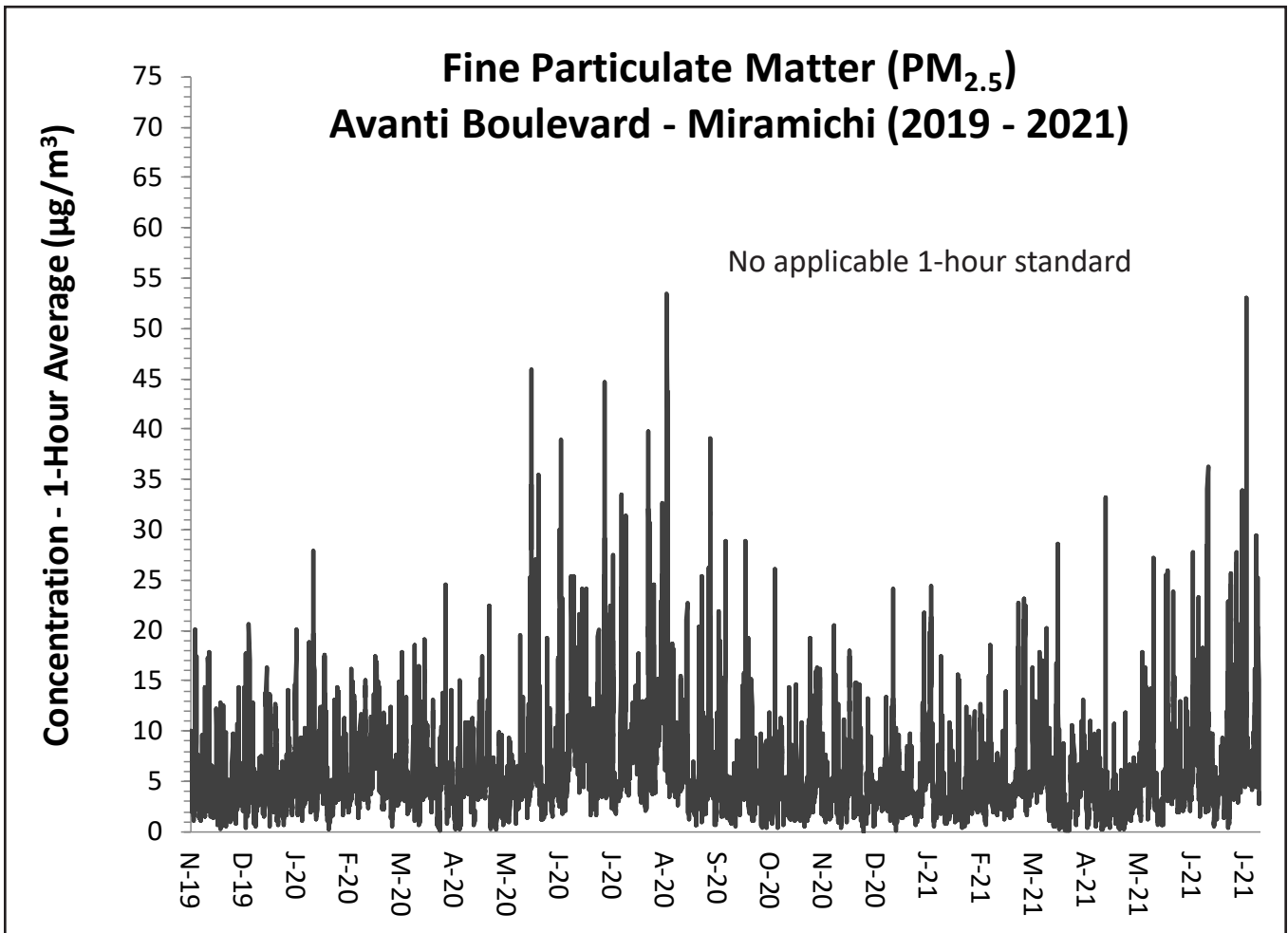


Figure D3: Hourly Average Fine Particulate Matter Concentration - Avanti Boulevard, Miramichi, November 7, 2019 to July 28, 2021.

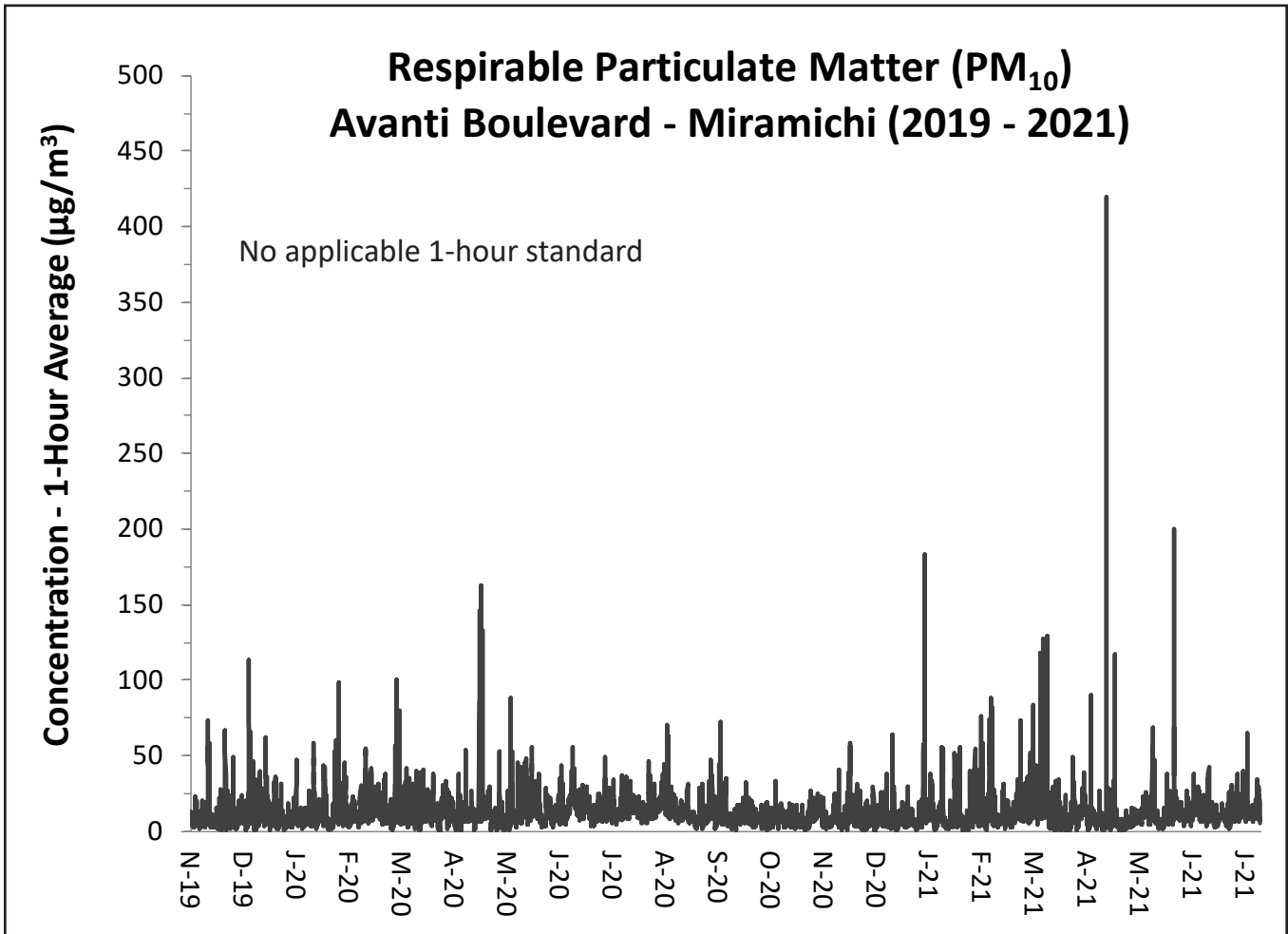


Figure D4: Hourly Respirable Particulate Matter Concentration - Avanti Boulevard, Miramichi, November 7, 2019 to July 28, 2021.

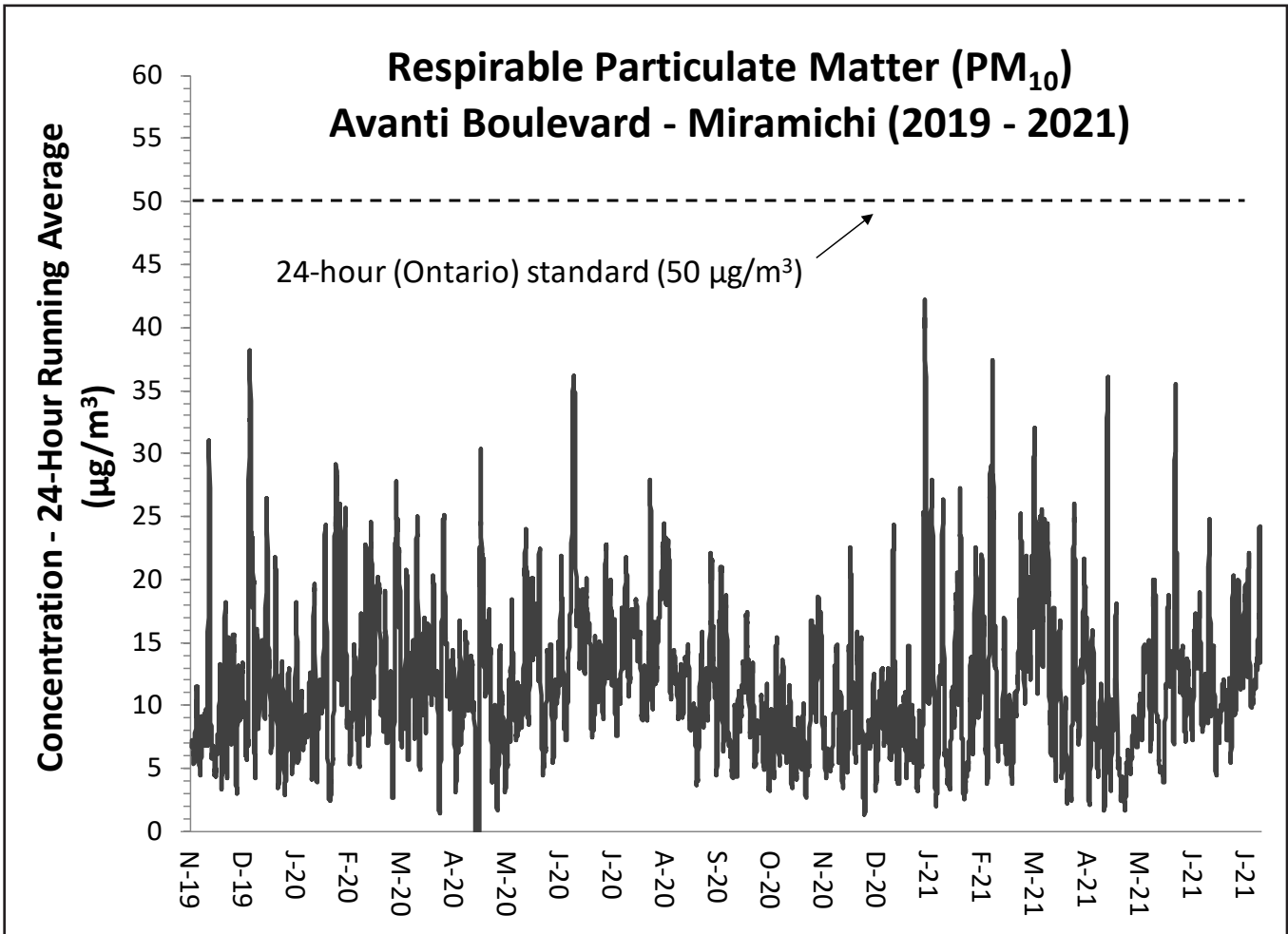


Figure D5: 24-Hour Running Average Respirable Particulate Matter Concentration - Avanti Boulevard, Miramichi, November 7, 2019 to July 28, 2021.

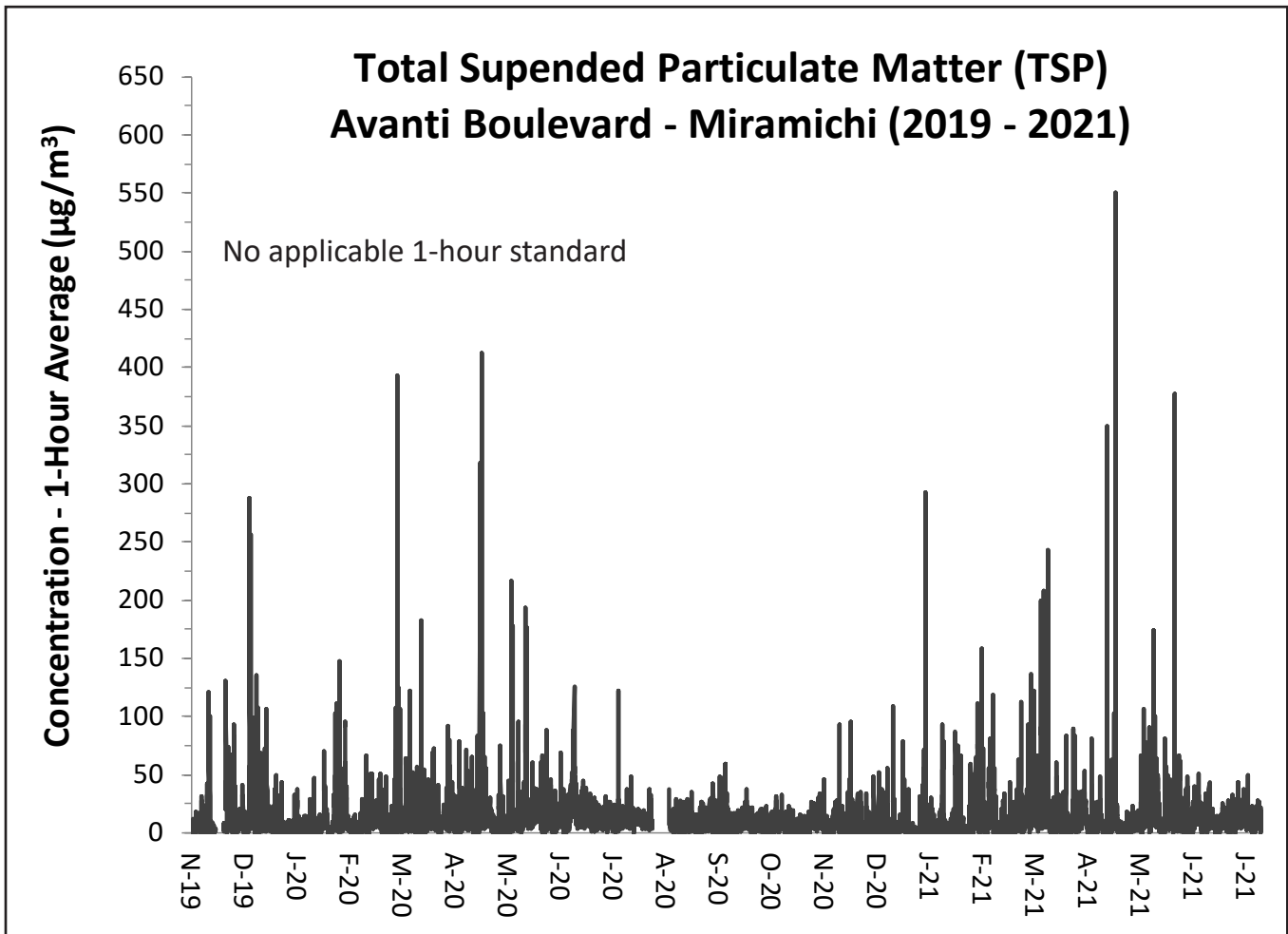


Figure D6: 1-Hour Average Total Suspended Particulate Matter Concentration - Avanti Boulevard, Miramichi, November 7, 2019 to July 28, 2021.

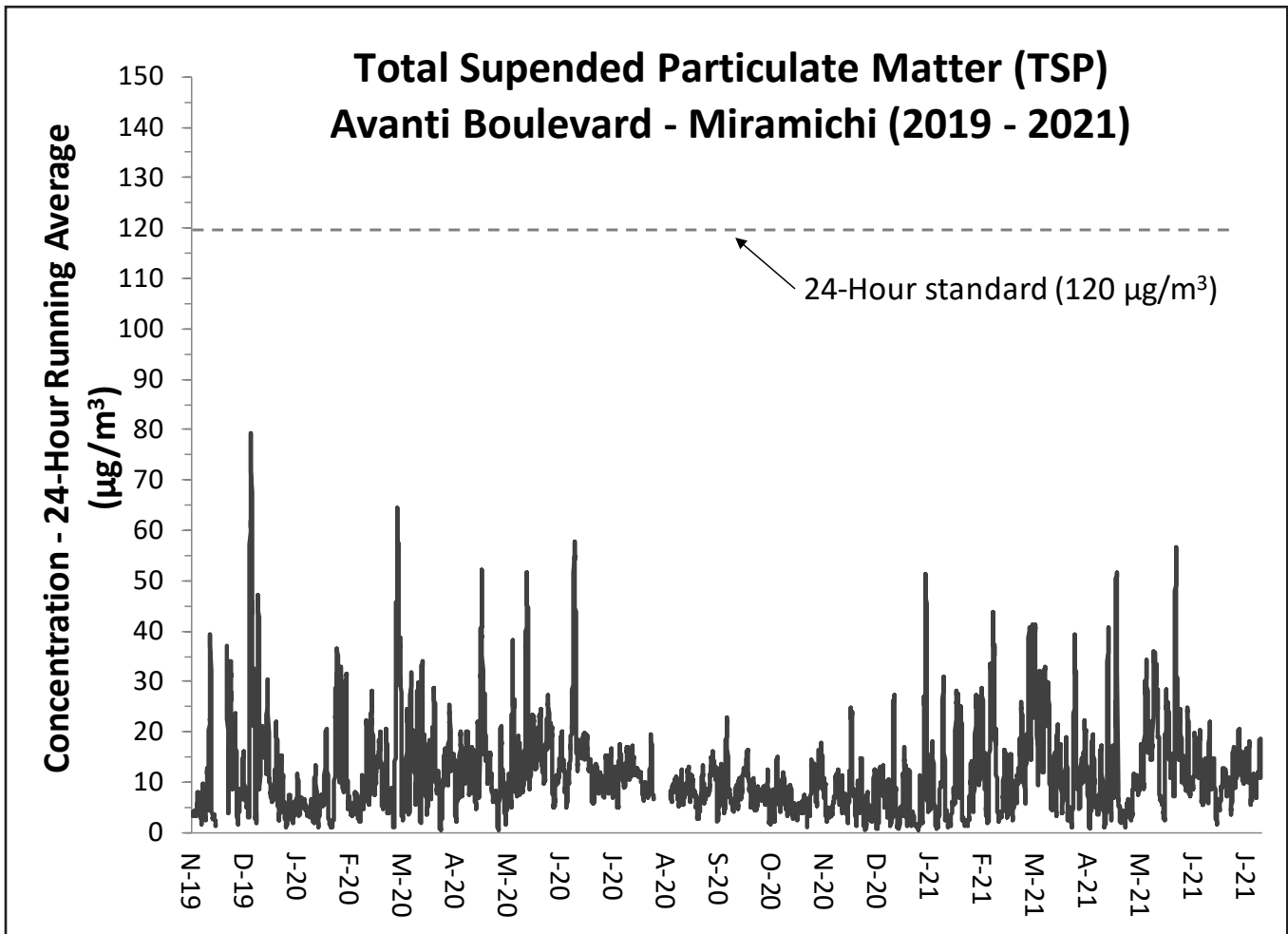


Figure D7: 24-Hour Running Average Total Suspended Particulate Matter Concentration - Avanti Boulevard, Miramichi, November 7, 2019 to July 28, 2021.