



TODOROSKI
AIR SCIENCES

NORTHCONNEX AMBIENT AIR QUALITY MONITORING INDEPENDENT AUDIT

Lendlease Bouygues Joint Venture

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NorthConnex

Ambient Air Quality Monitoring

Independent Audit

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1 INTRODUCTION

Todoroski Air Sciences have conducted an independent audit of the ambient air quality monitoring data collected for the NorthConnex Motorway (hereafter referred to as the Project).

This independent audit reviews the available ambient air quality and meteorological data collected for the Project during 1 May 2020 to 31 October 2020. A brief examination of a full year of data, including the previous six months, is also provided.

The auditor has previously conducted an independent review of the NorthConnex Project Air Quality Impact Assessment report for the NSW Department of Planning and Environment, and also independently reviewed the suitability of various monitoring locations for placement of the ambient monitoring equipment, and presented the findings to the Air Quality Community Consultative Committee (AQCCC) for this Project.

2 SCOPE OF WORK

Condition E7 of Infrastructure Approval SS1-6136 requires an audit of the monitoring data collected for the Project. The relevant part of the condition reads as follows:

The Ambient Air Quality - Monitoring

E7 ...

Monitoring results shall be made publicly available and shall be subject to an independent audit at six-monthly intervals (or at a longer interval, if approved by the Secretary). The auditor shall be approved by the Secretary in consultation with the EPA and the AQCCC, and the auditor's report shall be directly provided to the Proponent and the AQCCC.

2.1 Project Requirements

Under Condition E7 of Infrastructure Approval SS1-6136, the Project is required to monitor the following ambient air quality pollutants and parameters set out in **Table 2-1** below, following the specified sampling method, units of measure, and sampling frequency.

Monitoring locations are required to be conducted at a minimum at;

- ✦ two ground level receptors near the northern ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;
- ✦ two ground level receptors near the southern ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;
- ✦ one location along Pennant Hills Road, at a location suitable for detecting any impact on air quality along Pennant Hills Road; and,
- ✦ one location away from any of the locations set out above suitable for providing background ambient air quality reference data for the project area.

The quality of the monitoring results shall be assured through a NATA accredited process and results should comply with the ambient air quality goals set out for the Project under condition E8.

Under condition E9, should the monitoring results exceed any of the air quality goals for any given event, excluding extraordinary events such as bushfires, dust storms, the Project will immediately notify the Secretary, EPA and Ministry of Health.

The monitoring results shall be made publicly available and shall be subject to an independent audit at six-monthly intervals, which is the purpose of this report.

Table 2-1: Ambient air quality monitoring methodologies required under Condition E7

Pollutant/Parameter	Unit of measurement	Averaging Period	Frequency	Method
NO	pphm	1-hour	Continuous	AM-12 (AS/NZS 3580.5.1 –1993)
NO ₂	pphm	1-hour	Continuous	AM-12 (AS/NZS 3580.5.1 –1993)
NO _x	pphm	1-hour	Continuous	AM-12 (AS/NZS 3580.5.1 –1993)
PM ₁₀	µg/m ³	24-hour	Continuous	AS 3580.9.8-2008
PM _{2.5}	µg/m ³	24-hour	Continuous	AS 3580.9.13-2013
CO	ppm	1-hour, 8-hour	Continuous	AM-2 (AS/NZS 2923-1987) & AM-6 (AS 3580.7.1-1992)
Wind speed at 10m	m/s	1-hour	Continuous	AM-2 (AS/NZS 2923-1987) & AM-4 (USEPA (2000) EPA 454/R-99-005)
Wind direction at 10m	degrees	1-hour	Continuous	AM-2 (AS/NZS 2923-1987) & AM-4 (USEPA (2000) EPA 454/R-99-005)
Sigma theta	degrees	1-hour	Continuous	AM-2 (AS/NZS 2923-1987) & AM-4 (USEPA (2000) EPA 454/R-99-005)
Temperature at 2m	K	1-hour	Continuous	AM-4 (USEPA (2000) EPA 454/R-99-005)
Temperature at 10m	K	1-hour	Continuous	AM-4 (USEPA (2000) EPA 454/R-99-005)
Siting	-	-	-	AM-1 (AS 2922-1987) & AM-4 (USEPA (2000) EPA 454/R-99-005)

ppm = parts per hundred million

ppm = parts per million

µg/m³ = micrograms per cubic metre

3 AIR QUALITY MONITORING SITES

Ambient air quality monitoring, data collection and reporting was conducted by Ecotech Pty Ltd (Ecotech), a NATA accredited organisation. Monthly ambient air quality and weather monitoring validation reports are prepared by Ecotech (**Ecotech, 2020a-f**).

Figure 3-1 presents the location of the ambient air quality monitoring sites for the Project.

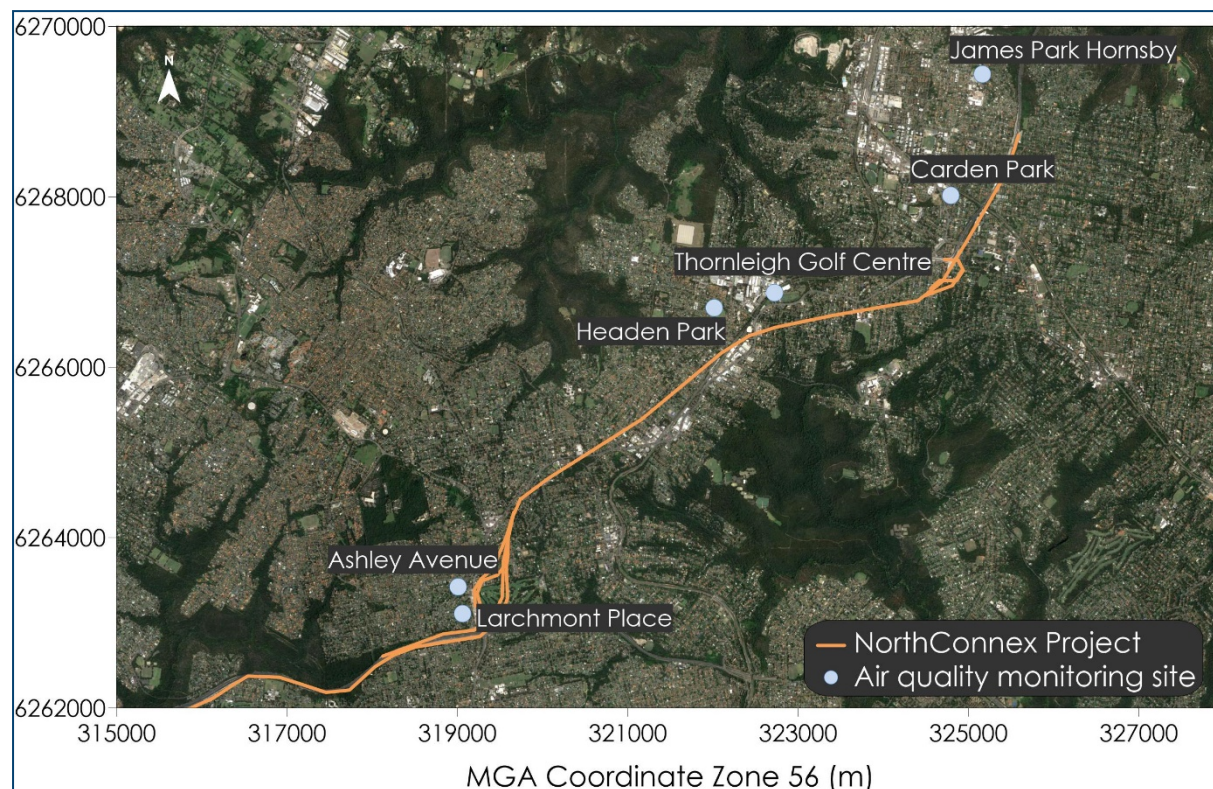


Figure 3-1: Monitoring site locations

Table 3-1 outlines the various pollutants and parameters recorded at each of the air quality monitoring sites for the Project.

The monitoring locations and recorded parameters meet the requirements per Condition E7 as set out in **Table 2-1** and have been assured through a NATA accredited process.

It is noted that the method of sampling PM_{2.5}, AS 3580.9.12-2013 (refer to **Table 3-1**), is equivalent to that listed in Table 8 per Condition E7 and on 8 September 2017 was approved for use by the Department of Planning and Environment (**Ecotech, 2020a-f**).

The approved method for the Guide to Siting of Sampling Units AM-1 (AS 2922-1987) was superseded by AS/NZS 3580.1.1-2016 and the current method has been adopted. This is appropriate and is in keeping with good practice (however it is noted that there is minimal difference between the old and new standard, essentially the figures are now printed with better clarity/ resolution).

The method of sampling for CO monitoring in the monthly validation monitoring reports lists method AM-6 and does not include AM-2. This is correct as Method AM-2 refers to the guide for measurement of horizontal wind and is not related to CO measurements.

The method of sampling for wind speed, wind direction and sigma theta lists AM-2 in monthly validation monitoring reports and does not refer to AM-4, which is used for temperature measurement.

Table 3-2 presents units and uncertainties for the monitoring equipment as outlined in the monthly validation monitoring reports (**Ecotech 2020a-f**).

Table 3-1: Monitoring sites measured parameters

Monitoring Station	Recorded Pollutant/Parameters	Unit of measurement	Recording Periods	Elevation	Method
Ashley Avenue	PM _{2.5} (BAM)	µg/m ³	Hourly/Daily	2	AS3580.9.12-2013
	PM ₁₀ (TEOM)	µg/m ³	5 minute/Hourly/Daily	2	AS3580.9.8-2008
Carden Park	NO, NO ₂ , NO _x	ppm	5 minute/Hourly/Daily	2	AS/NZS 3580.5.1 – 1993
Headen Park	CO	ppm	5 minute/Hourly/8-Hourly (based on 1-hour averages)/Daily	2	AS/NZS 3580.7.1 – 1992
James Park Hornsby	Temperature	K	5 minute/Hourly/Daily	2 & 10	USEPA (2000) EPA 454/R-99-005
Larchmont Place	WS	m/s	5 minute/Hourly/Daily	10	AS 2923-1987
	WD	degrees	5 minute/Hourly/Daily	10	AS 2923-1987
	Sigma	degrees	5 minute/Hourly/Daily	10	AS 2923-1987
Thornleigh Golf Centre	Siting	-	-	-	AS/NZS 3580.1.1-2016

PM10 - Particulate matter < 10µm

PM2.5 - Particulate matter < 2.5µm

TEOM - Tapered Element Oscillating Microbalance (which samples air continuously)

NO – Nitrogen monoxide

NO₂ – Nitrogen dioxide

NO_x – oxides of nitrogen

CO – Carbon monoxide

WS – Wind speed

WD – Wind direction

K = kelvin

m/s = metres per second

ppm = parts per million,

µg/m³ = micrograms per cubic metre

Table 3-2: Units and uncertainties

Monitoring Station	Recorded Pollutant/Parameters	Instrument and Measurement Technique	Resolution	Uncertainty ^a	K factor	Measurement Range ^b
Ashley Avenue	PM _{2.5}	Met One BAM 1020 – Beta ray attenuation	1µg/m ³	24hr: ±(5.5 % of reading + 4.0 µg/m ³) (in range 0 - 100 µg/m ³) hr: ±(8 % of reading + 8.0 µg/m ³)	2	0-1000µg/m ³ LDL _{24hr} = 1.0µg/m ³ LDL _{hr} = 4.8µg/m ³
Carden Park	PM ₁₀	Thermo – 1405 TEOM (Tapered Element Oscillating Microbalance)	0.1µg/m ³	±5.0µg/m ³ or 3.6% of reading ^c	2	0µg/m ³ - 1g/m ³
Headen Park	NO, NO _x	Ecotech Serinus 40 – gas phase chemiluminescence	0.001ppm	±(6% of reading + 0.011 ppm)	2	0-0.5 ppm LDL=0.0004 ppm
James Park Hornsby	NO ₂		0.001ppm	±(6% of reading + 0.011 ppm)	2	0-0.5 ppm LDL=0.0004 ppm
Larchmont Place	CO	Ecotech Serinus 30 – NDIR gas filter correlation infrared photometry	0.1ppm	±(7% of reading + 0.8ppm)	2	0-50 ppm LDL=0.04 ppm
Thornleigh Golf Centre	Temperature	Met One 062MP	0.1K	±0.6K	2	263.15-323.15K
	WS	Gill Windsonic Op3	0.1m/s	±0.4m/s or 2 % of reading ^c	2	0-30m/s
	WD	Gill Windsonic Op3	1 deg	±4 deg	2	0-360 deg ^d

Monitoring Station	Recorded Pollutant/Parameters	Instrument and Measurement Technique	Resolution	Uncertainty ^a	K factor	Measurement Range ^b
	Sigma	Calculation	-	-		-
	Siting	-	-	-		-

^aUncertainties are calculated based on the full measurement range unless stated otherwise

^bThe max measurement range for gas analysers is defined as the full scale (FS=Span/0.8)

^cWhichever is greater

^dStarting threshold = 0 m/s

Table 3-3 summarises the schedule of calibration conducted during the review period. Calibration for all instruments generally followed their calibration schedule.

It is noted that a calibration for windspeed, wind direction and sigma was due in June 2020 for all monitors. The Headen Park, Larchmont Place and Thornleigh Golf Centre monitors conducted an overdue calibration for windspeed, wind direction and sigma in September 2020. The Carden Park and James Hornsby Park monitors have still not completed a calibration for windspeed, wind direction and sigma in this review period. It is understood that a calibration for the wind sensor (ID:18-0882) was required at the Ashley Avenue monitor in June 2020. This instrument was replaced in July 2020 with wind sensor ID:17-1647 and the next suitable wind tunnel calibration for the wind sensor currently at the Ashley Avenue monitor is December 2021.

Note that some inconsistencies in the calibration dates were identified in an earlier version of the July 2020 monthly validation monitoring report, and Ecotech have since reissued an amended report with the correct information as outlined below. Please be sure that you are referring to most recent version if examining these reports.

Table 3-3: Calibration schedule

Site	Recorded Pollutant/Parameters	Calibration Cycle	May	June	July	August	September	October
Ashley Avenue	PM _{2.5}	3 Monthly		✓	✓	✓		✓
	PM ₁₀	3 Monthly		✓			✓	
	NO, NO ₂ , NO _x	Monthly	✓	✓	✓	✓	✓	✓
	CO	Monthly	✓	✓	✓	✓	✓	✓
	Temperature	Yearly			✓			
	WS	2 yearly		Overdue*				
	WD	2 yearly		Overdue*				
	Sigma	2 yearly		Overdue*				
Carden Park	PM _{2.5}	3 Monthly		✓		✓		✓
	PM ₁₀	3 Monthly		✓			✓	
	NO, NO ₂ , NO _x	Monthly	✓	✓	✓	✓	✓	✓
	CO	Monthly	✓	✓	✓	✓	✓	✓
	Temperature	Yearly						
	WS	2 yearly		Overdue				
	WD	2 yearly		Overdue				
	Sigma	2 yearly		Overdue				

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Site	Recorded Pollutant/Parameters	Calibration Cycle	May	June	July	August	September	October
Headen Park	PM _{2.5}	3 Monthly		✓		✓		✓
	PM ₁₀	3 Monthly		✓			✓	
	NO, NO ₂ , NO _x	Monthly	✓	✓	✓	✓	✓	✓
	CO	Monthly	✓	✓	✓	✓	✓	✓
	Temperature	Yearly						
	WS	2 yearly		Overdue			✓	
	WD	2 yearly		Overdue			✓	
	Sigma	2 yearly		Overdue			✓	
James Hornsby Park	PM _{2.5}	3 Monthly		✓		✓		✓
	PM ₁₀	3 Monthly		✓			✓	
	NO, NO ₂ , NO _x	Monthly	✓	✓	✓	✓	✓	✓
	CO	Monthly	✓	✓	✓	✓	✓	✓
	Temperature	Yearly						
	WS	2 yearly		Overdue				
	WD	2 yearly		Overdue				
	Sigma	2 yearly		Overdue				
Larchmont Place	PM _{2.5}	3 Monthly		✓		✓	✓	✓
	PM ₁₀	3 Monthly		✓			✓	
	NO, NO ₂ , NO _x	Monthly	✓	✓	✓	✓	✓	✓
	CO	Monthly	✓	✓	✓	✓	✓	✓
	Temperature	Yearly						
	WS	2 yearly		Overdue			✓	
	WD	2 yearly		Overdue			✓	
	Sigma	2 yearly		Overdue			✓	
Thornleigh Golf Centre	PM _{2.5}	3 Monthly		✓		✓		✓
	PM ₁₀	3 Monthly		✓			✓	
	NO, NO ₂ , NO _x	Monthly	✓	✓	✓	✓	✓	✓
	CO	Monthly	✓	✓	✓	✓	✓	✓
	Temperature	Yearly						
	WS	2 yearly		Overdue			✓	
	WD	2 yearly		Overdue			✓	
	Sigma	2 yearly		Overdue			✓	

*The wind sensor (ID:18-0882) was replaced at the Ashley Avenue monitor in July 2020. The next suitable wind tunnel calibration for the wind sensor (ID:17-1647) currently at the Ashley Avenue monitor is December 2021.

4 AIR QUALITY GOALS

4.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Two classes of particulate matter include PM₁₀, particulate matter with equivalent aerodynamic diameters of 10µm or less, and PM_{2.5}, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

PM₁₀ particles are generated through various sources, which include but are not limited to, the abrasion or crushing of rock, the general disturbance of dusty material and from pollen generated by trees. Finer particulates, such as PM_{2.5}, are more often generated through combustion processes such as wood burning and vehicle exhaust, or chemical processes in the atmosphere.

4.2 Nitrogen dioxide

Nitrogen dioxide (NO₂) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO₂ belongs to a family of reactive gases called oxides of nitrogen (NO_x). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**US EPA, 2011**). It is important to note that when formed, NO₂ is generally a small fraction of the total NO_x generated in a combustion process.

4.3 Carbon monoxide

Carbon monoxide (CO) is an odourless, colourless gas. CO can be produced during incomplete combustion of carbon based materials such as fuel, coal or wood etc. It can inhibit the capacity of blood to transport oxygen in humans resulting in symptoms of headache, nausea and fatigue.

4.4 NorthConnex ambient air quality goals

Table 4-1 summarises the ambient air quality goals set out for the Project per Condition E8.

Table 4-1: NorthConnex ambient air quality goals

Pollutant	Averaging Period	Air quality goal
PM ₁₀	24-hour	50 µg/m ³
PM _{2.5}	24-hour	25 µg/m ³
NO ₂	1-hour	0.12 ppm
CO	8-hour rolling	9 ppm

ppm = parts per million

µg/m³ = micrograms per cubic metre

5 METEOROLOGICAL MONITORING DATA

Representative wind speed and direction data have been obtained from the Project's ambient monitoring stations. The data are presented as a series of windroses. For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

Figure 5-1 presents the windroses for the Project's monitoring stations during the review period. Detailed windroses are provided in **Appendix B**.

It is noted that most of the monitoring stations are positioned in sheltered locations which generally results in calmer wind distributions.

The Ashley Avenue monitoring station recorded predominate winds ranging from the south to west-southwest.

The Carden Park monitoring station recorded a high proportion of winds ranging from the southeast to west.

The predominate wind directions at the Headen Park monitoring station were recorded from the north-northwest with few winds from the southwest quadrant.

The James Park Hornsby monitoring station recorded predominant winds from the west-southwest, southwest and west sectors. Wind speeds at the James Park Hornsby monitoring station were typically higher than at the other ambient monitoring stations. This would be expected given the low grassy ground cover nearby that is less sheltered from the prevailing winds relative to the other monitoring locations.

The Larchmont Place monitoring station experienced predominant winds from the west-southwest and southwest.

Thornleigh Golf Centre monitoring station experiences varied winds, predominantly from the south-south and north-northwest.

Figure 5-1 shows the differences between the distributions of winds at each of the ambient monitoring stations. The variation in localised winds is clear to see, however the locations also display a similar underlying trend in the wind distribution patterns, with the winds tending to originate more from the south to western quadrant during the review period.

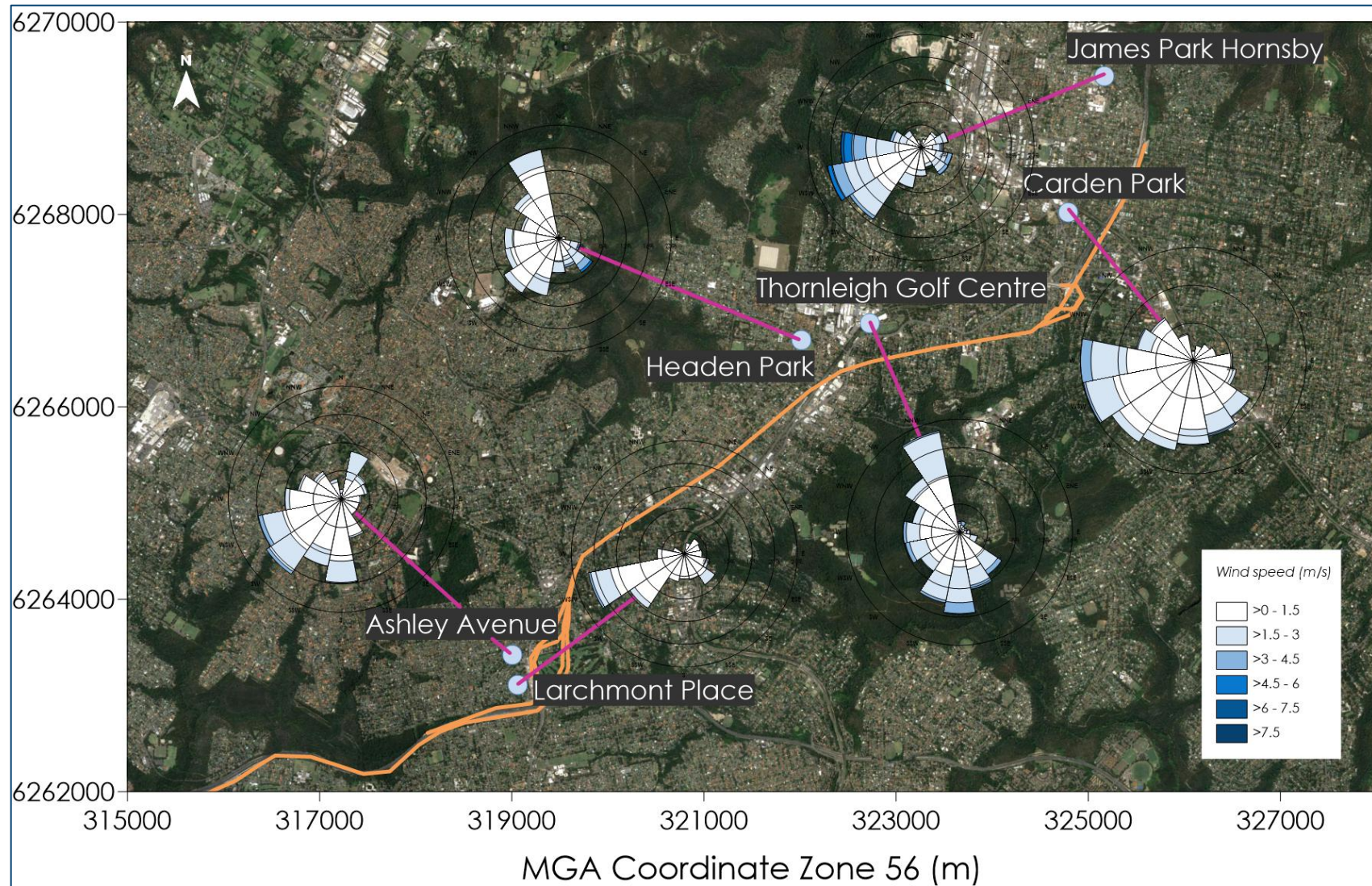


Figure 5-1: Windroses – 1 May 2020 to 31 October 2020



6 AMBIENT AIR QUALITY MONITORING DATA

The monitoring data in this report are presented as provided to Todoroski Air Sciences.

All of the monitoring data provided to Todoroski Air Sciences are presented in graphical format in **Appendix C**.

It is noted that small negative concentration readings recorded are due to the instrument noise at low/zero concentration levels and are a normal part of the operation of gas and particulate analysers and are thus considered to be valid data for reporting purposes.

Table 6-1 presents a summary of the measured pollutant levels occurring during the review period from 1 May 2020 and 31 October 2020.

The data in **Table 6-1** indicates:

- The recorded NO₂ and CO levels were below the relevant air quality goal during the review period.
- Most monitors recorded 24-hour average PM_{2.5} levels above the respective daily air quality goal of 25µg/m³ on occasion during the review period. This occurred on zero to three days depending on the monitor.
- Two monitors recorded 24-hour average PM₁₀ levels above the respective daily air quality goal of 50µg/m³ on one occasion during the review period.

Table 6-2 presents the percentage of data capture available over the review period. There was greater than 90% capture rate for all pollutants at all monitors over the review period with the exception of NO₂ at the Thornleigh Golf Centre which over the six month review period only recorded approximately 87%.

Review of the monitoring data indicates a proportion of missing data during July, August, and September. The lower percentage of data capture available over the review period has been noted in the monthly validation reports due to instrument faults or maintenance of the monitor.

Table 6-1: Summary of measured pollutant levels for review period

Site	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	NO ₂ (ppm)	CO (ppm)
	24-hour average	24-hour average	1-hour average	8-hour rolling average
	NorthConnex Ambient Air Quality Goal			
	25	50	0.12	9
Maximum pollutant level				
Ashley Avenue	24.0	32.0	0.05	0.8
Carden Park	28.7	35.4	0.05	0.7
Headen Park	152.2	109.1	0.06	2.4
James Park Hornsby	30.5	38.0	0.04	0.7
Larchmont Place	25.5	31.2	0.04	0.8
Thornleigh Golf Centre	93.9	90.0	0.06	1.3
Minimum pollutant level				
Ashley Avenue	-0.5	3.2	0.001	-0.1
Carden Park	-1.8	3.6	0.001	0.00
Headen Park	-2.9	3.0	0.001	0.05
James Park Hornsby	-1.1	3.0	0.000	-0.14
Larchmont Place	-0.9	3.0	0.001	-0.07
Thornleigh Golf Centre	-0.8	5.6	0.001	0.04
Number of times recorded above criterion				
Ashley Avenue	0	0	0	0
Carden Park	1	0	0	0
Headen Park	3	1	0	0
James Park Hornsby	1	0	0	0
Larchmont Place	1	0	0	0
Thornleigh Golf Centre	2	1	0	0
6 Month average pollutant level				
Ashley Avenue	5.7	12.3	0.01	0.2
Carden Park	5.3	12.6	0.01	0.2
Headen Park	5.3	12.5	0.01	0.3
James Park Hornsby	4.8	12.4	0.01	0.2
Larchmont Place	5.1	12.1	0.01	0.2
Thornleigh Golf Centre	9.0	17.3	0.02	0.2
Rolling Annual Average				
Ashley Avenue	10.7	20.8	0.01	0.2
Carden Park	10.0	21.2	0.01	0.2
Headen Park	9.7	20.8	0.01	0.3
James Park Hornsby	9.3	21.2	0.01	0.2
Larchmont Place	9.9	21.0	0.01	0.2
Thornleigh Golf Centre	12.3	24.5	0.01	0.2

Table 6-2: Percentage of data capture available for the review period

Site	Data Capture %			
	PM _{2.5}	PM ₁₀	NO ₂	CO
Ashley Avenue	98.4	97.8	94.9	98.5
Carden Park	100.0	99.5	95.2	94.3
Headen Park	99.5	98.4	95.1	98.8
James Park Hornsby	98.9	98.4	94.3	96.2
Larchmont Place	100.0	98.9	95.6	93.7
Thornleigh Golf Centre	100.0	100.0	86.6	98.9



6.1 PM_{2.5} monitoring data

Figure 6-1 presents the 24-hour average PM_{2.5} monitoring data recorded during the review period. The data indicate that 24-hour average PM_{2.5} levels were above the respective air quality goal of 25µg/m³ on occasion during the review period at most of the monitors.

These elevated results occurred on zero to three days depending on the monitor and spanned across the 29 August 2020 to the 31 August 2020. The 24-hour average level exceedances have been reported in their respective monthly validation monitoring reports.

It is evident from **Figure 6-1** that most monitors recorded high readings on the days when there was a level recorded above the goal, indicating that regional events such as bushfires, hazard reduction burns or dust storms which affected most of the monitors were the likely cause of the elevated readings above the goal. Inspection of NSW DPIE monitoring data in the Sydney region during this period further confirms that these elevated readings are the result of regional events as most NSW DPIE monitors in the Sydney region also experienced elevated 24-hour average PM_{2.5} levels.

6.1.1 Low and negative PM_{2.5} values

It is noted that some of the monitoring stations at the Project (specifically Headen Park and James Park Hornsby) exhibit a relatively high proportion of low/zero and negative PM_{2.5} values.

As previously noted, some negative concentration readings can be expected to arise for various reasons including instrument noise at low/zero concentration levels and such results are a normal part of the operation of gas and particulate analysers. For example, Section 10 of the AS/NZ 3580.9.12:2013 (**Standards Australia & Standards New Zealand, 2013**) states that;

"Occasionally BAMs may record short-term (<24 h) negative PM_{2.5} concentrations. This is often associated with the loss of moisture or semi-volatile compounds in the collected particulate matter from the filter media that can occur during the measurement process. Short term negative values resulting from such loss should be considered to be real data and should not be invalidated from the dataset."

A comparison of the PM_{2.5} data recorded at the Project and the corresponding period of NSW DPIE monitoring data in the Sydney region is presented below in **Table 6-3**. The table presents a summary of negative PM_{2.5} values from the recorded hourly and 24-hour average data over a 12-month period, (inclusive of the review period and the previous 6 months). Note that where no data have been recorded at a monitor, this is presented as a blank value.

The hourly PM_{2.5} data recorded at the Project appears generally consistent with DPIE PM_{2.5} data. The percentage of negative values recorded from the Project range from 1.7% to 11.5% and the DPIE data shows a range between 3.0% to 14.3%. The percentage of blank values recorded from the Project ranges from 0.6% to 2.0% and the DPIE data shows a range between 1.4% to 14.8%.

Analysis of the hourly NSW DPIE PM_{2.5} data over the 12-month period shows that the negative values reported between 1 November 2019 to the 31 December 2019 have a threshold of -2.5µg/m³. From 1 January 2020 the hourly NSW DPIE PM_{2.5} data have a threshold of -10µg/m³. It appears that DPIE removes negative values below the respective threshold at the monitors during the review period. It is noted that the minimum value recorded by any monitor at the Project is -8 µg/m³. This difference would explain both the higher proportion of negative and blank values in the DPIE PM_{2.5} data set. The

maximum percentage of blank and negative results from the Project (12.9%) is approximately half of the maximum percentage of blank and negative results from the DPIE data (22.3%).

It is not possible to make direct comparisons between the 24-hour average data sets, as it appears that DPIE discount days with less than 75% data capture and periods where there may be some instrumental faults not apparent from examination of the hourly data.

It is in our opinion that, based on the available information, and consideration of the requirements of the standard, but also our understanding of DPIE monitoring practices, the PM_{2.5} data recorded at the Project are adequate and are commensurate with the requirements of the standard. As outlined further below, the frequency of calibrations is recommended at the Project.

It is understood that the PM_{2.5} BAM monitors used for the Project have an internal reference value programmed into the instrument which is verified annually to consider instrumental and site specific climatic variables which are subtracted from the raw hourly measured data. As required by the AS/NZS 3580.9.12:2013 (**Standards Australia & Standards New Zealand, 2013**) zero checks are required to undergo system calibrations at least every 12 months.

Additional checks may be warranted at times of high dust, smoke or other factors that may affect instrument performance.

Table 6-3: Summary of negative PM_{2.5} values at the Project (1 November 2019 to 31 October 2020)

Monitoring station	Hourly average					24-hour averages			
	% negative	% blank	% negative or blank	average of negative (µg/m ³)	Rolling Annual Average PM _{2.5} (µg/m ³)	% negative	% blank	% negative or blank	average of negative (µg/m ³)
Ashley Avenue	4.6%	1.1%	5.8%	-1.74	10.6	1.1%	1.4%	2.5%	-0.25
Carden Park	4.0%	0.7%	4.7%	-1.63	10.0	0.3%	0.5%	0.8%	-1.83
Headen Park	11.5%	1.4%	12.9%	-2.09	9.6	6.0%	1.6%	7.7%	-0.87
James Park Hornsby	8.4%	2.0%	10.4%	-1.86	9.2	3.6%	2.2%	5.7%	-0.40
Larchmont Place	6.1%	0.9%	6.9%	-1.77	9.8	2.5%	0.5%	3.0%	-0.29
Thornleigh Golf Centre	1.7%	0.6%	2.3%	-1.74	12.4	0.3%	0.5%	0.8%	-0.79
Randwick (DPIE)	12.8%	5.5%	18.3%	-2.94		0.0%	4.4%	4.4%	-
Rozelle (DPIE)	5.1%	1.4%	6.6%	-1.81		0.0%	1.6%	1.6%	-
Chullora (DPIE)	3.5%	1.7%	5.2%	-1.90		0.0%	5.2%	5.2%	-
Earlwood (DPIE)	3.4%	2.9%	6.3%	-1.69		0.0%	2.7%	2.7%	-
Macquarie Park (DPIE)	6.9%	2.4%	9.3%	-2.07		0.0%	1.9%	1.9%	-
Cook and Phillip (DPIE)	7.1%	14.8%	21.9%	-2.57		0.5%	16.7%	17.2%	-0.25
Liverpool (DPIE)	7.1%	4.4%	11.6%	-2.05		0.0%	4.9%	4.9%	-
Bringelly (DPIE)	7.1%	4.6%	11.7%	-2.54		0.0%	3.6%	3.6%	-
Richmond (DPIE)	10.0%	8.4%	18.4%	-3.18		0.3%	5.5%	5.7%	-0.70
St Marys (DPIE)	12.0%	10.4%	22.3%	-2.78		0.0%	12.6%	12.6%	-
Parramatta North (DPIE)	3.9%	3.3%	7.2%	-1.60		0.0%	3.0%	3.0%	-
Oakdale (DPIE)	14.3%	4.8%	19.2%	-2.81		0.3%	3.6%	3.8%	-0.70
Prospect (DPIE)	3.0%	2.7%	5.8%	-1.78		0.0%	2.7%	2.7%	-
Campbelltown West (DPIE)	11.2%	2.4%	13.6%	-2.48		0.3%	1.6%	1.9%	-0.10
Camden (DPIE)	11.0%	3.3%	14.2%	-2.60		0.0%	2.5%	2.5%	-
Rouse Hill (DPIE)	7.5%	2.6%	10.1%	-2.00		0.3%	2.5%	2.7%	-0.60

6.2 PM₁₀ monitoring data

Figure 6-2 presents the 24-hour average PM₁₀ monitoring results recorded during the review period. The data indicate that 24-hour PM₁₀ levels were above the respective air quality goal of 50µg/m³ on one occasion during the review period at two of the monitors.

These elevated results occurred on the 30 August 2020 at the Headen Park and Thornleigh Golf Centre monitors. The 24-hour average level exceedances have been reported in the latest versions of the August monthly validation monitoring report. Please be sure that you are referring to most recent version if examining these reports.

These elevated readings occurred during the same period of elevated 24-hour average PM_{2.5} levels (noted in **Section 6.1**). This indicates that the likely cause of the elevated 24-hour PM₁₀ levels above the goal are also linked to regional events such as bushfires, hazard reduction burns or dust storms.

6.3 NO₂ monitoring data

Figure 6-3 presents the 1-hour average NO₂ monitoring data recorded for the Project during the review period. The data indicate the NO₂ levels were below the relevant air quality goal of 0.12ppm during the review period.

6.4 CO monitoring data

Figure 6-4 presents the 8-hour rolling average CO monitoring data recorded for the Project during the review period. The data indicate the CO levels were well below the relevant air quality goal of 9ppm during the review period.

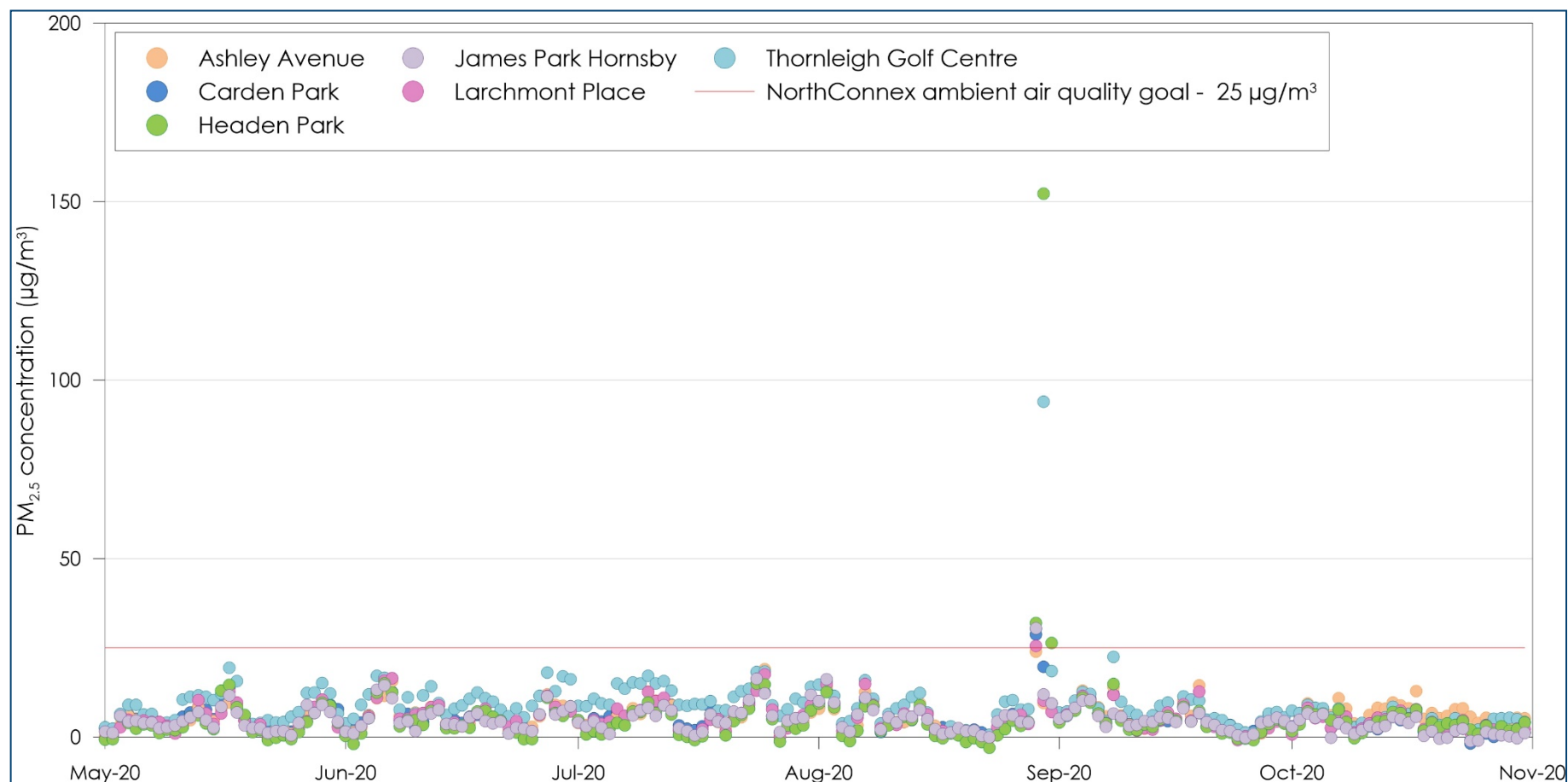


Figure 6-1: 24-hour average PM_{2.5} levels



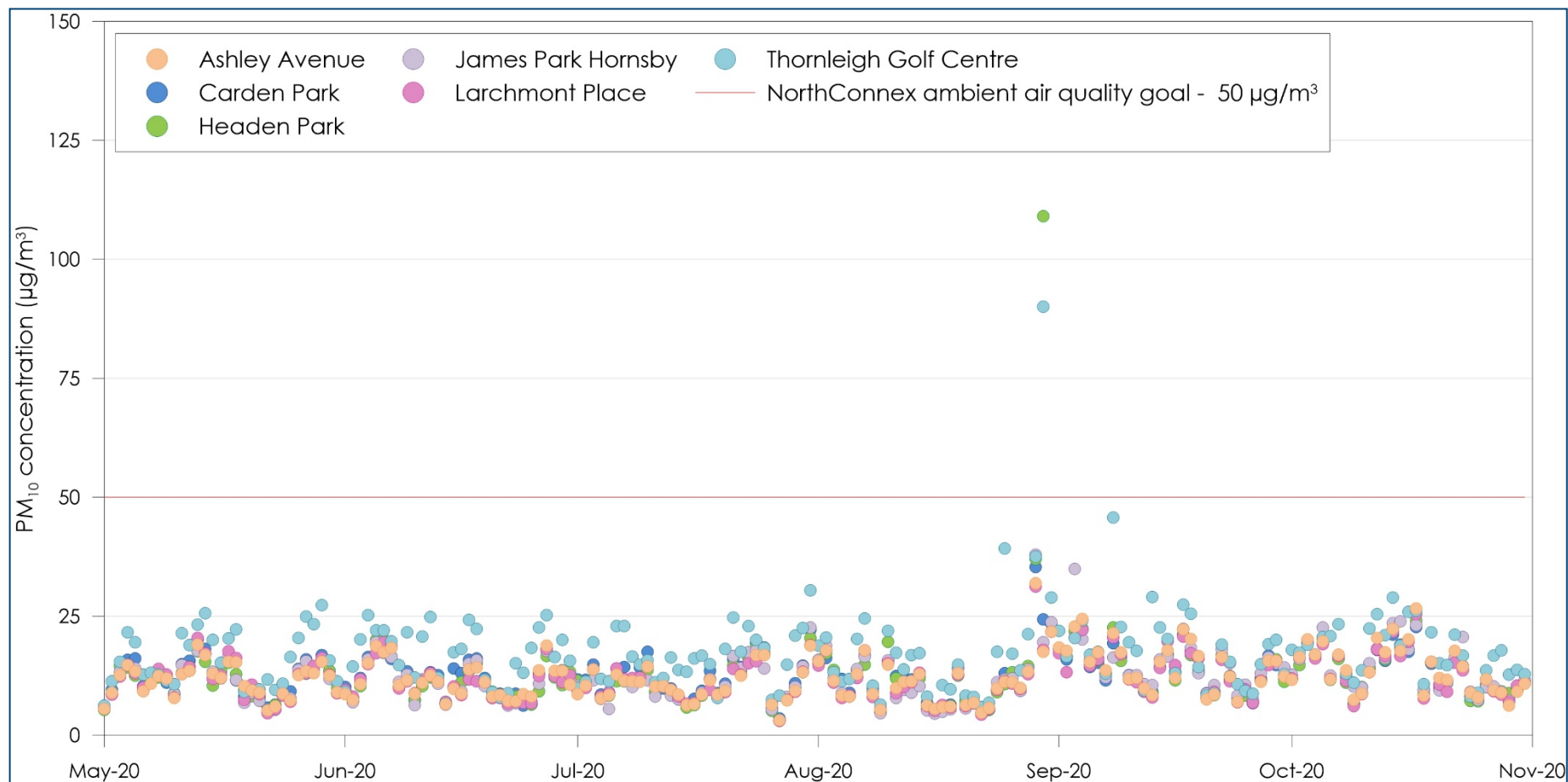


Figure 6-2: 24-hour average PM₁₀ levels



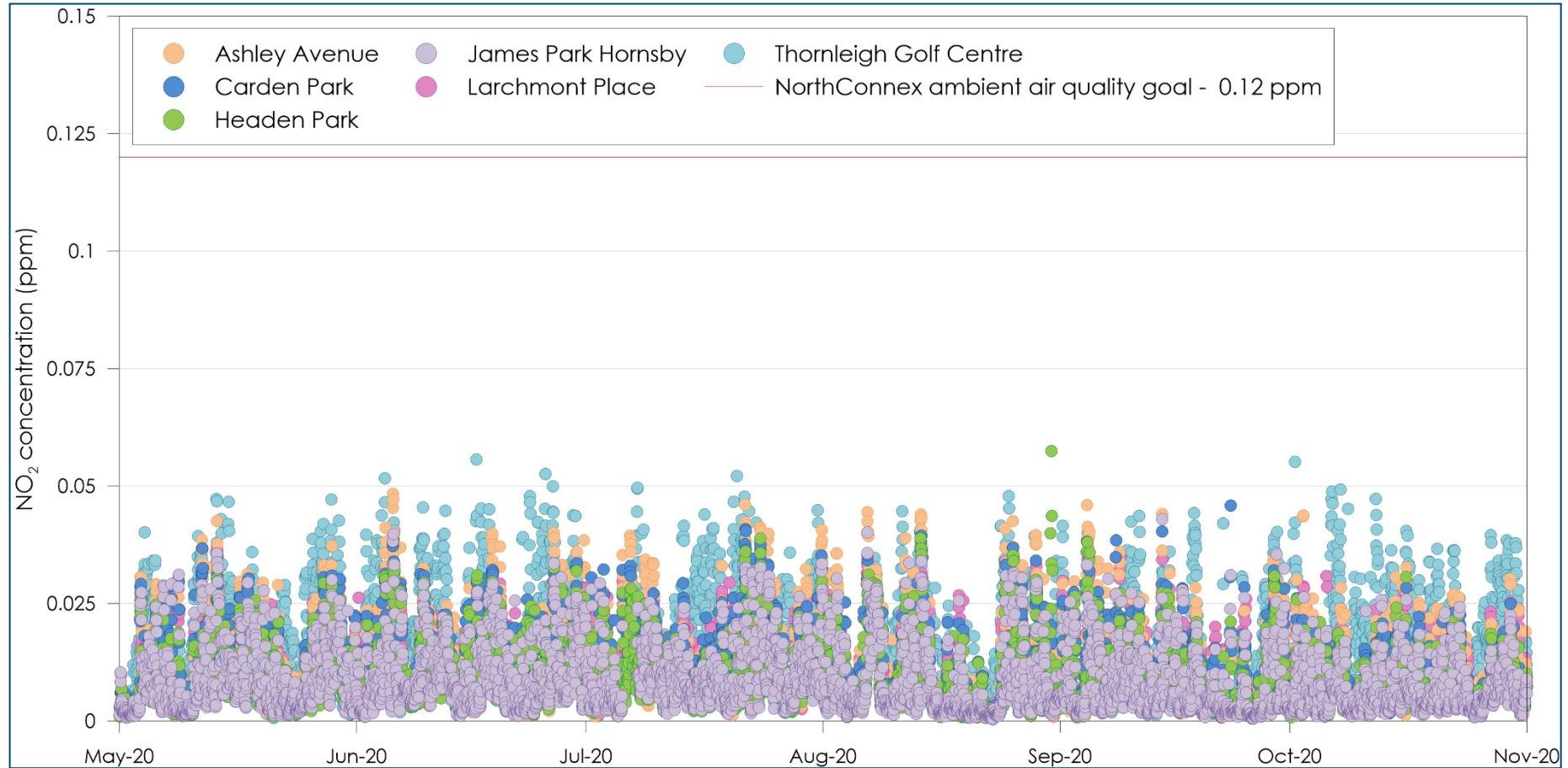


Figure 6-3: 1-hour average NO₂ levels



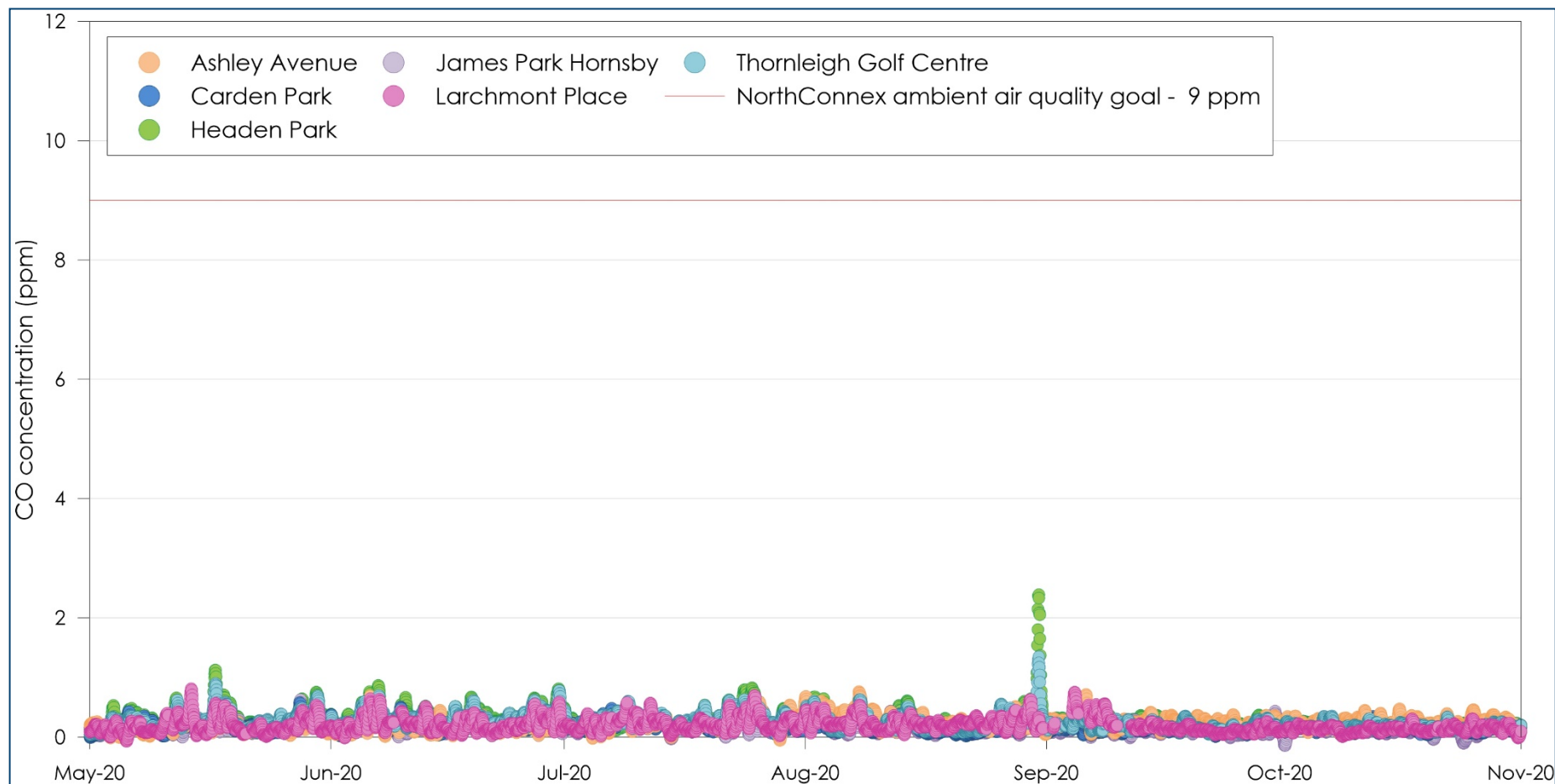


Figure 6-4: 8-hour rolling average CO levels



7 DISCUSSION AND RECOMMENDATIONS

Todoroski Air Science have conducted an independent audit of the ambient air quality monitoring data collected for the NorthConnex Project.

Monitoring and meteorological data were collected from six monitoring sites at the Project. The monitoring was found to be in general accordance with the requirements set out under the Planning Approval Condition E7 and have been assured by a NATA accredited process.

The required minimum calibration schedule was generally followed for all instruments with the exception of the windspeed, wind direction and sigma instruments. It is noted that calibrations for the windspeed, wind direction and sigma instruments was due in June 2020 for all monitors. The Headen Park, Larchmont Place and Thornleigh Golf Centre monitors conducted an overdue calibration for windspeed, wind direction and sigma in September 2020. The Carden Park and James Hornsby Park monitors have still not completed a calibration for windspeed, wind direction and sigma in this review period and the next suitable wind tunnel calibration for the wind sensor currently at the Ashley Avenue monitor would be December 2021.

The recorded ambient air quality monitoring data between 1 May 2020 and 31 October 2020 were generally below their respective ambient air quality goals as outlined in **Table 4-1**.

It is noted on the days where a particulate level was recorded above the relevant goal most monitors generally recorded relatively high readings indicating that regional events such as bushfires, hazard reduction burns or dust storms that affect most of the monitors are the main cause of the elevated readings above the goal.

These exceedances for the 24-hour average particulate levels have been reported in the latest versions of the respective monthly validation monitoring report.

1-hour average NO₂ levels and 8-hour rolling CO levels during the review period were below their respective air quality goals.

The current data checks and calibration processes appear to operate well, and the data quality is good.



8 REFERENCES

Ecotech (2020a)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st May to 31st May 2020", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, June 2020

Ecotech (2020b)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st June to 30th June 2020", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, July 2020

Ecotech (2020c)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st July to 31st July 2020", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, December 2020

Ecotech (2020d)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st August to 31st August 2020", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, December 2020

Ecotech (2020e)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st September to 30th September 2020", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, October 2020

Ecotech (2020f)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st October to 31st October 2020", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, November 2020.

Standards Australia & Standards New Zealand (2013)

Australian/New Zealand Standard, "Methods for sampling and analysis of ambient air, Method 9.12: Determination of suspended particulate matter—PM_{2.5} beta attenuation monitors", Standards Australia Limited & Standards New Zealand, June 2013.

US EPA (2011)

"Health Effects of Pollution", United States Environmental Protection Agency website <http://www.epa.gov/region07/air/quality/health.htm>, 2011



Appendix A

How to Read a Windrose



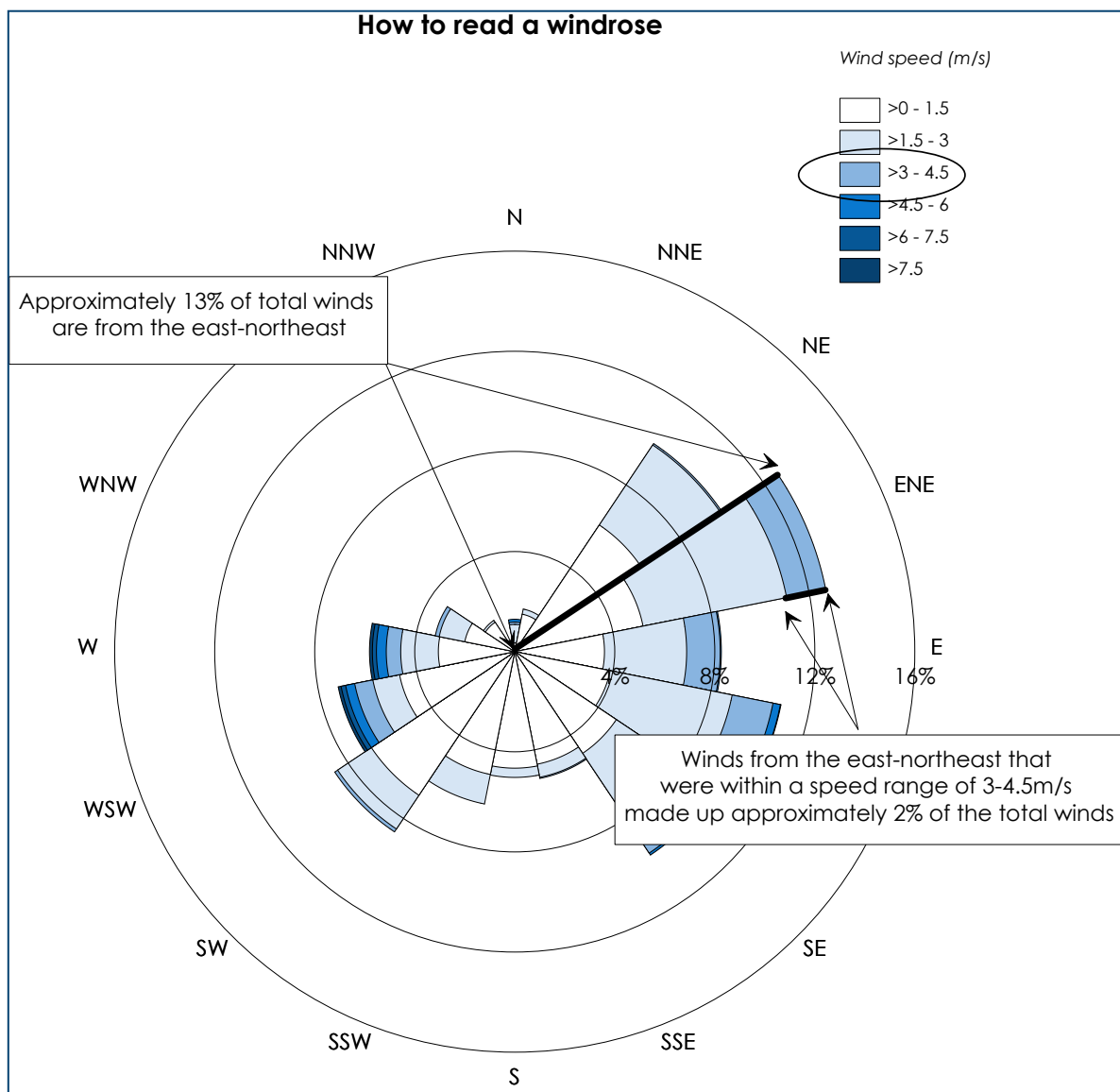


Figure A-1: How to read a windrose

Appendix B

Windroses



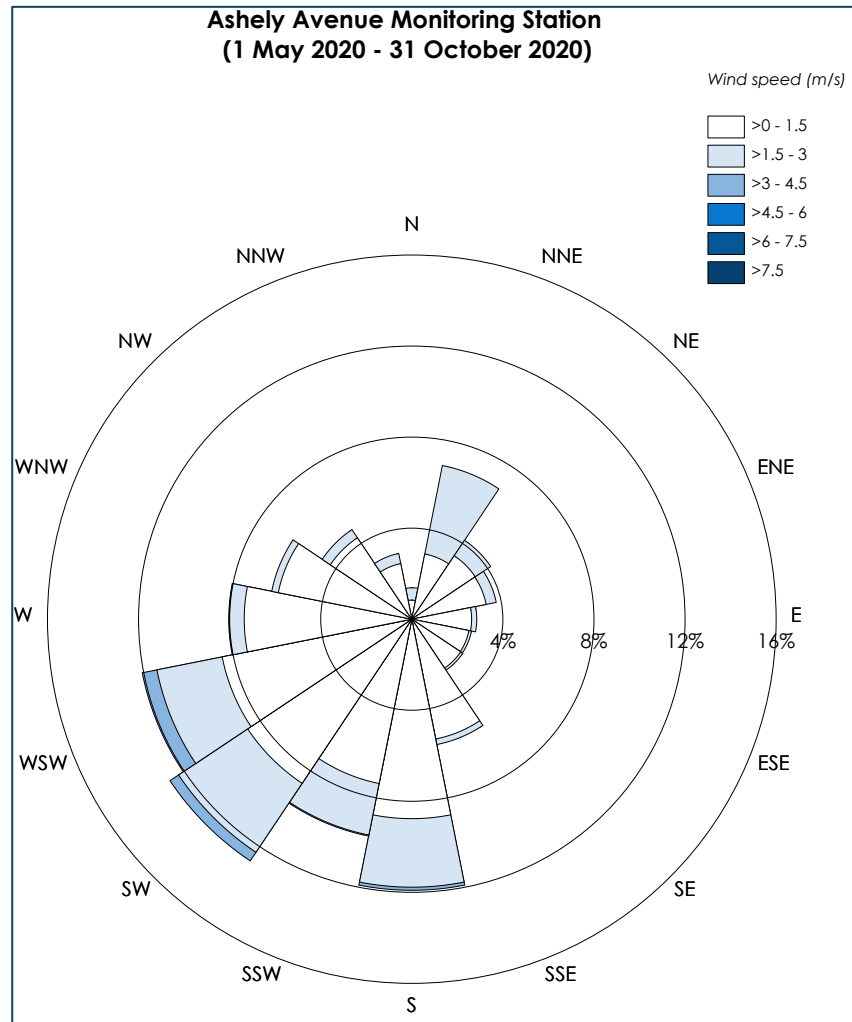


Figure B-1: Ashely Avenue windrose – 1 May 2020 to 31 October 2020

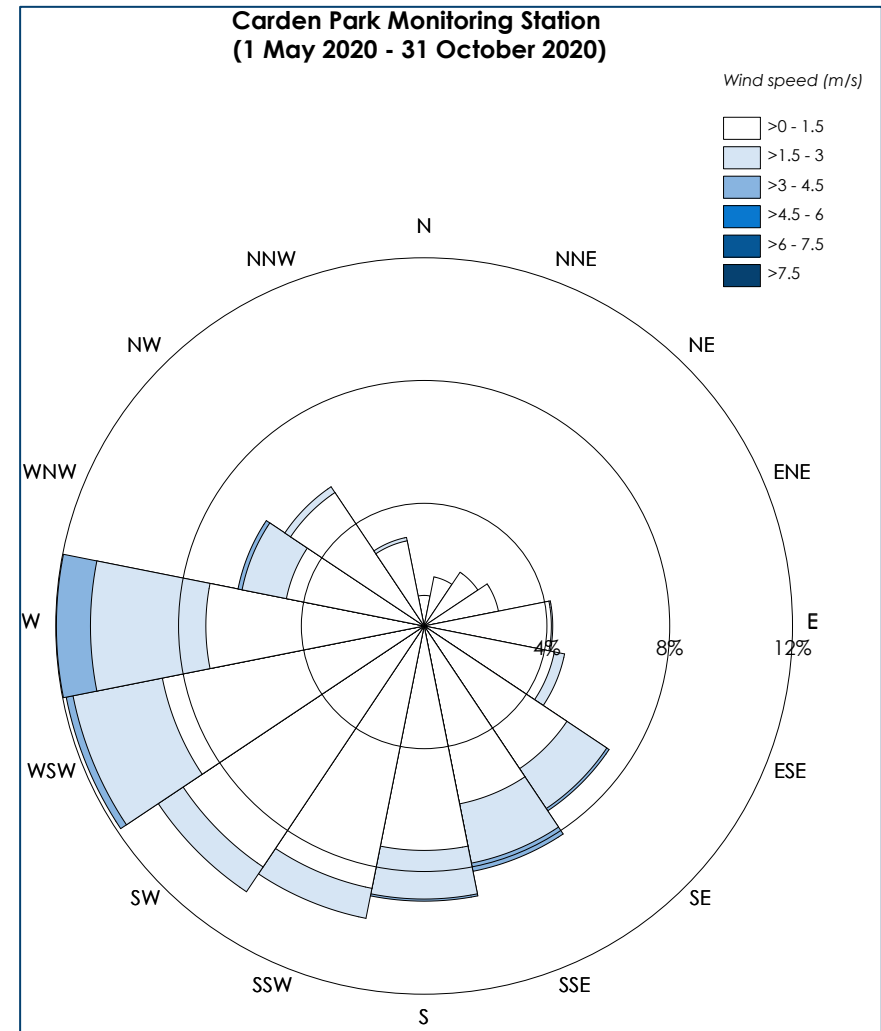


Figure B-2: Carden Park windrose – 1 May 2020 to 31 October 2020



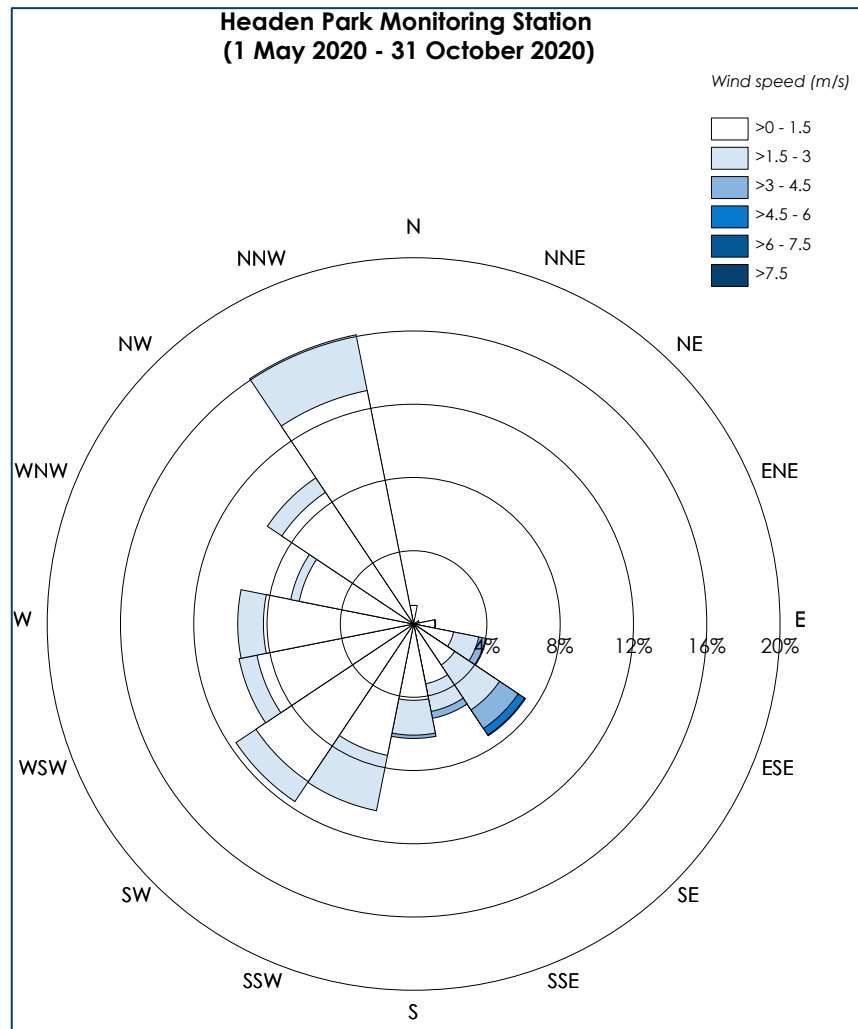


Figure B-3: Headen Park windrose – 1 May 2020 to 31 October 2020

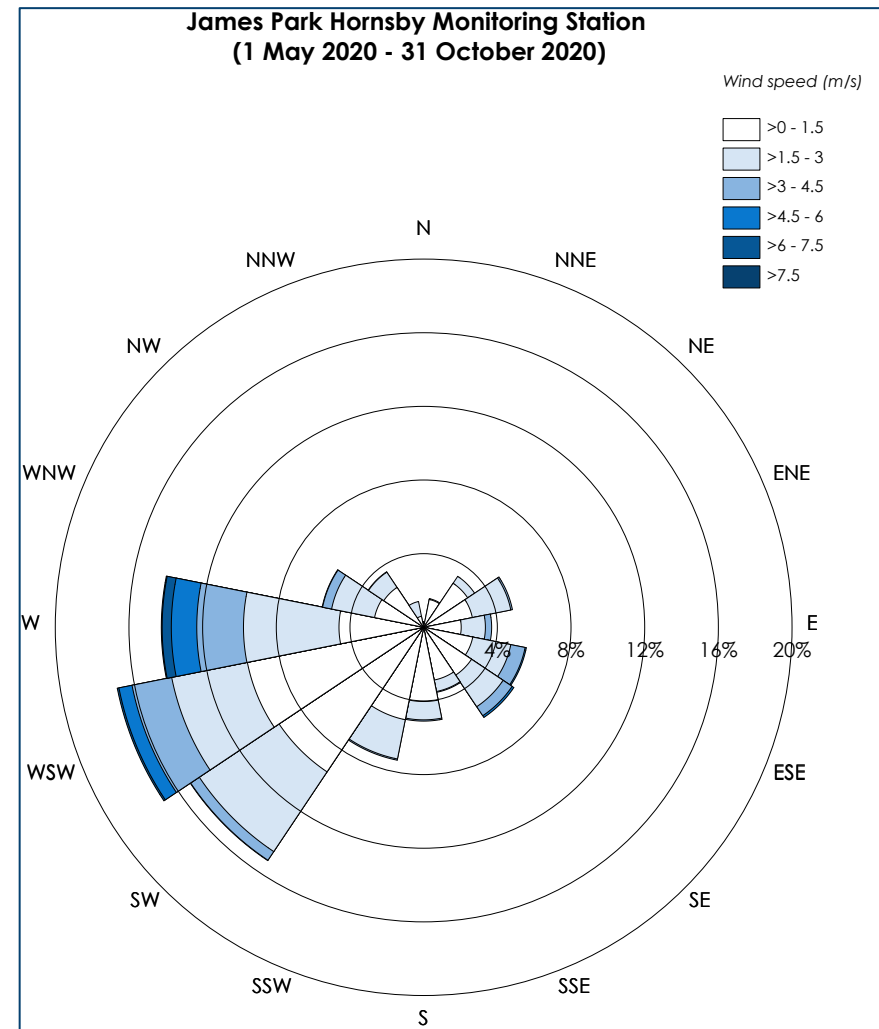


Figure B-4: James Park Hornsby windrose – 1 May 2020 to 31 October 2020



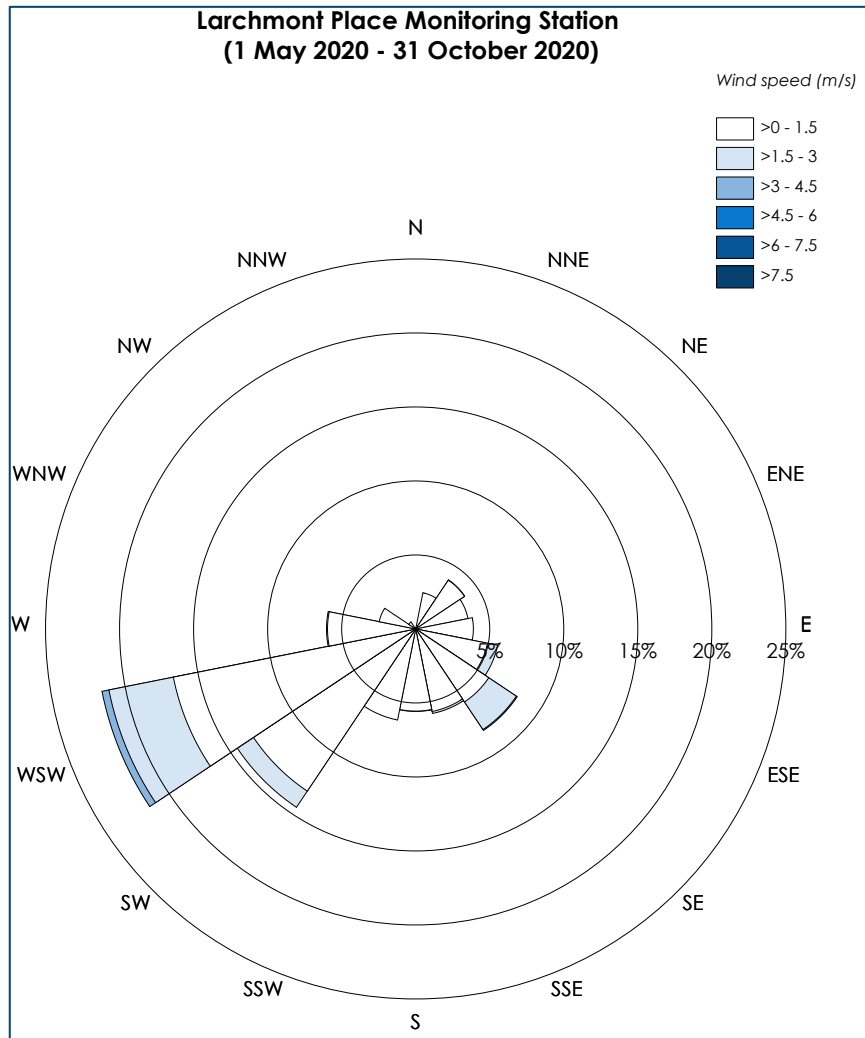


Figure B-5: Larchmont Place windrose – 1 May 2020 to 31 October 2020

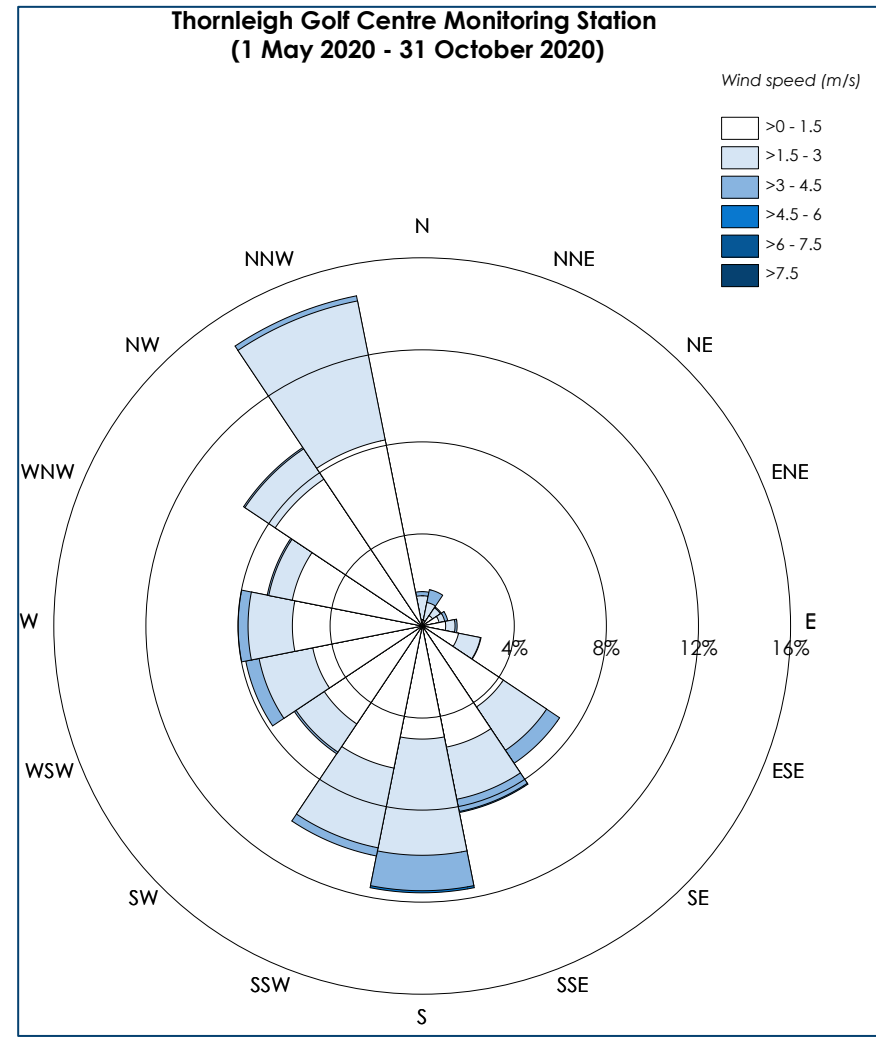


Figure B-6: Thornleigh Golf Centre windrose – 1 May 2020 to 31 October 2020



Appendix C

Monitoring Data (Graphical)



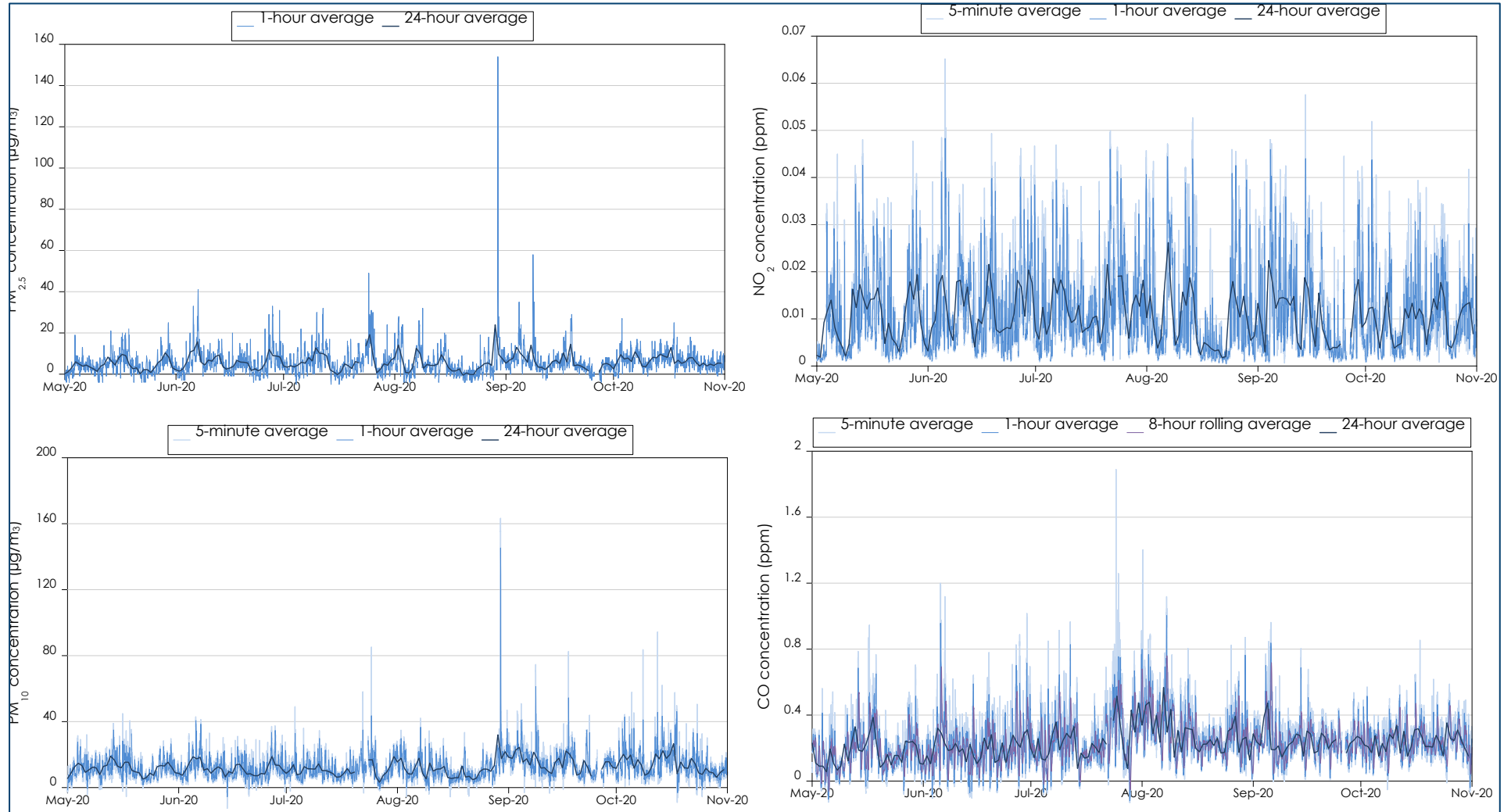


Figure C-1: Ashley Avenue monitoring data



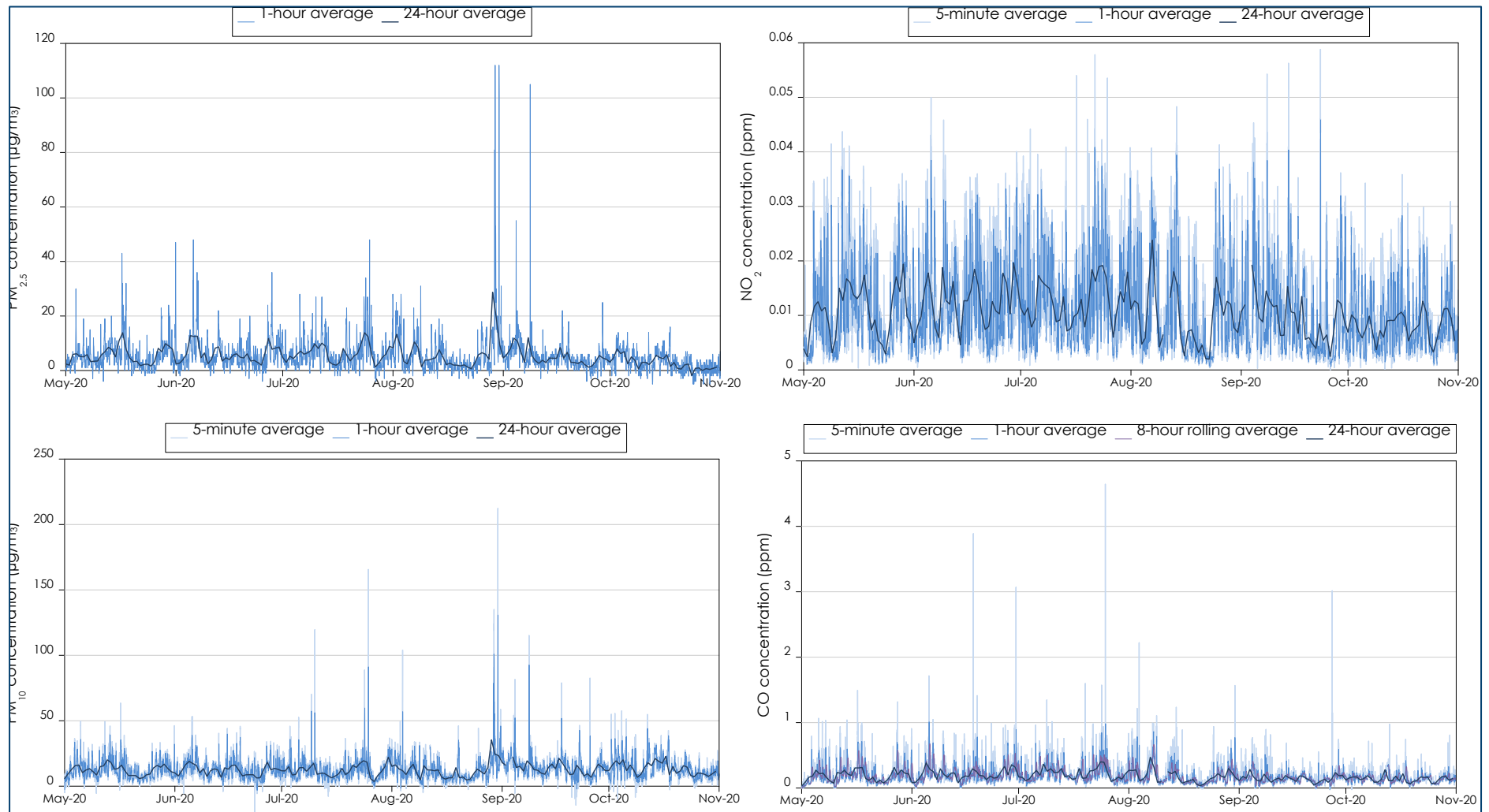


Figure C-2: Carden Park monitoring data



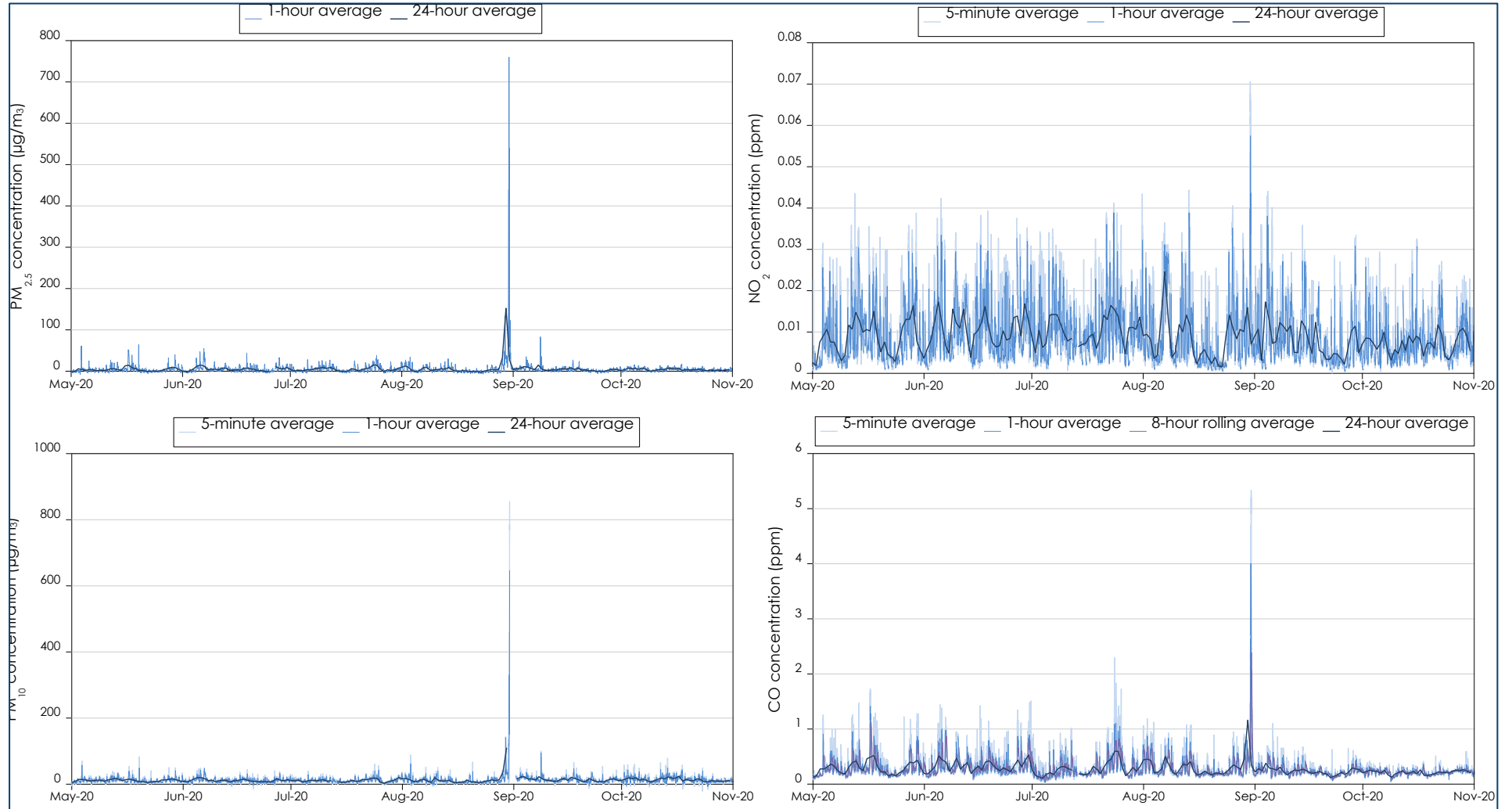


Figure C-3: Headen Park monitoring data

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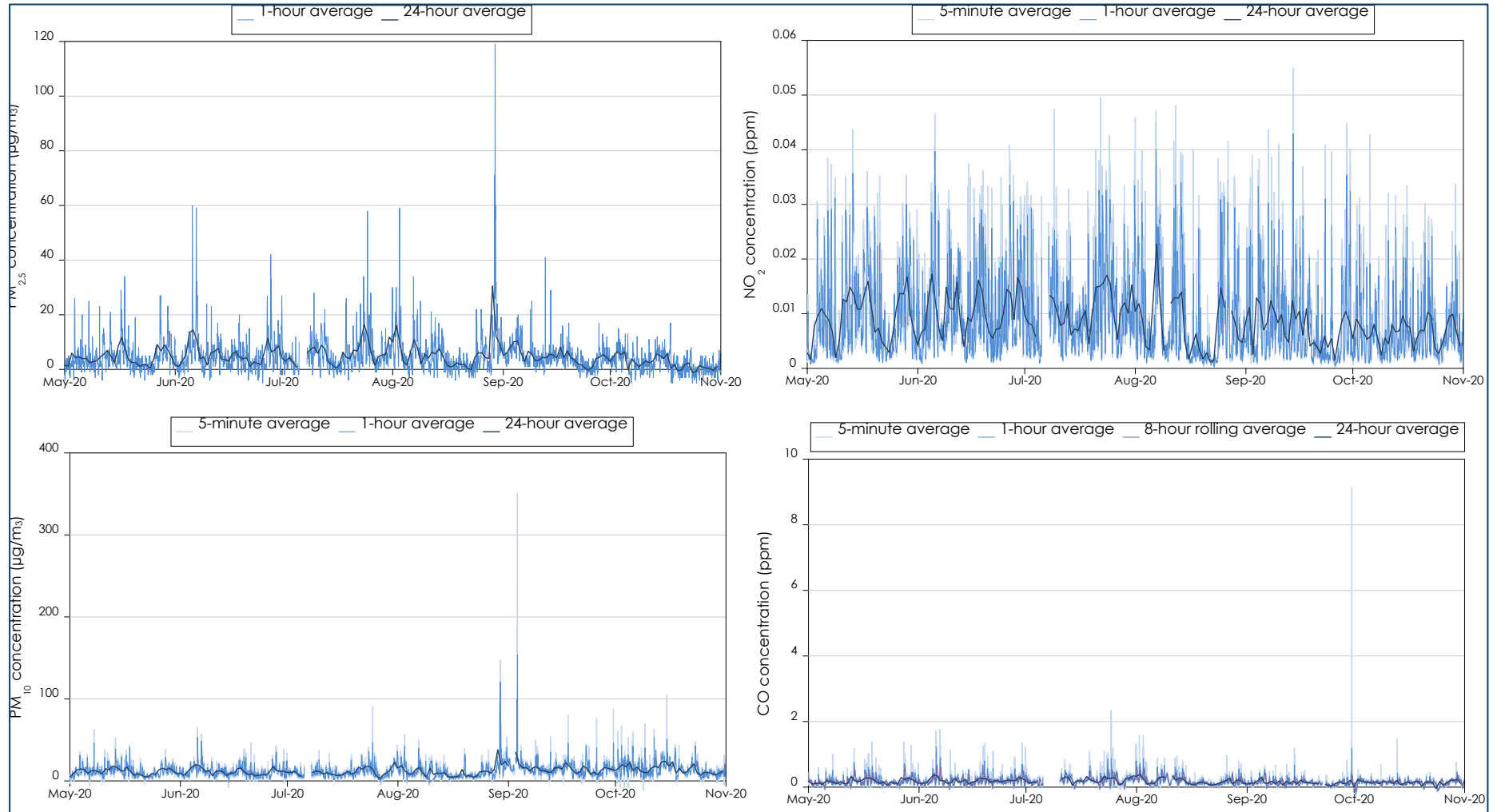


Figure C-4: James Park Hornsby monitoring data



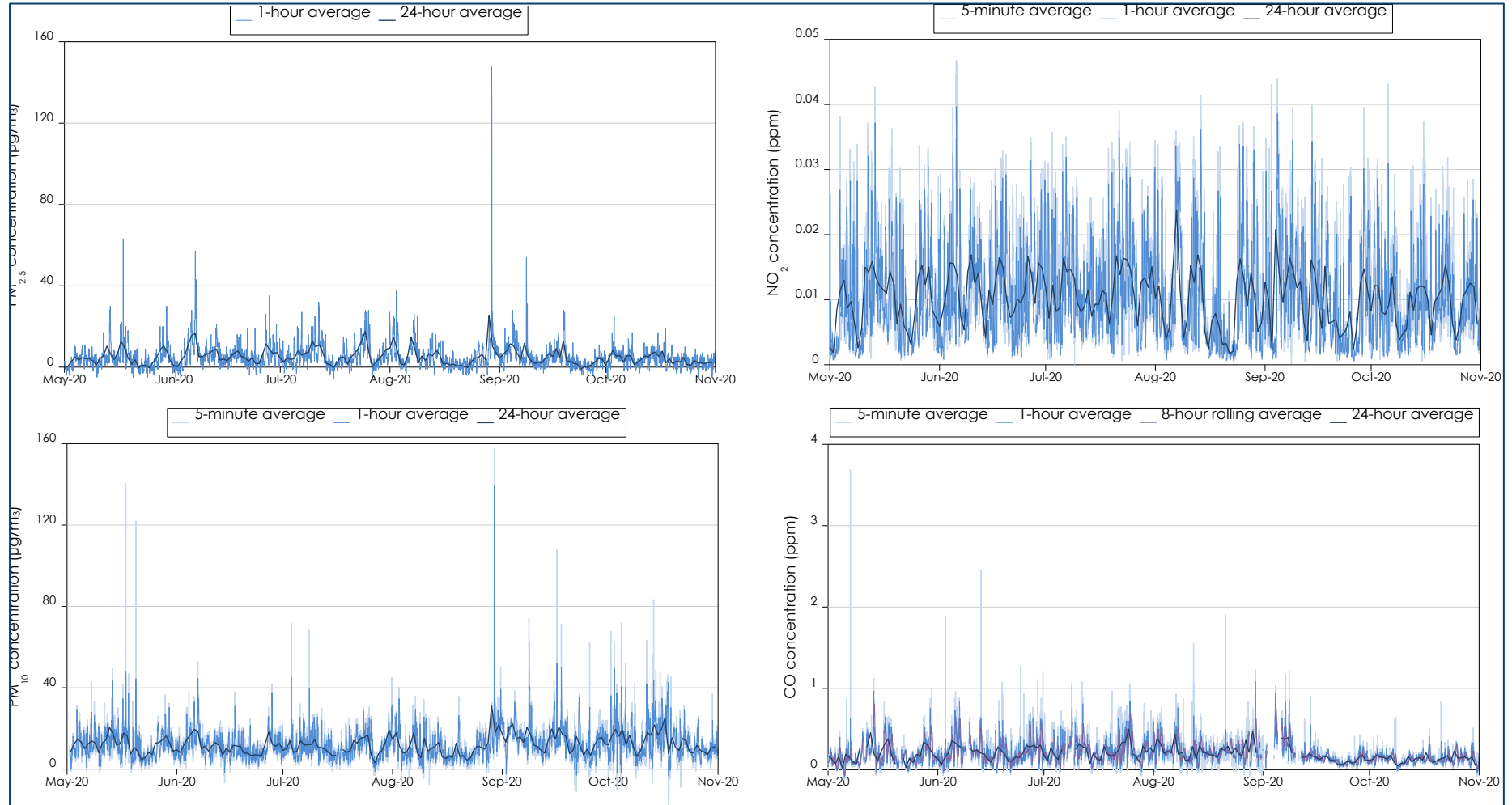


Figure C-5: Larchmont Place monitoring data



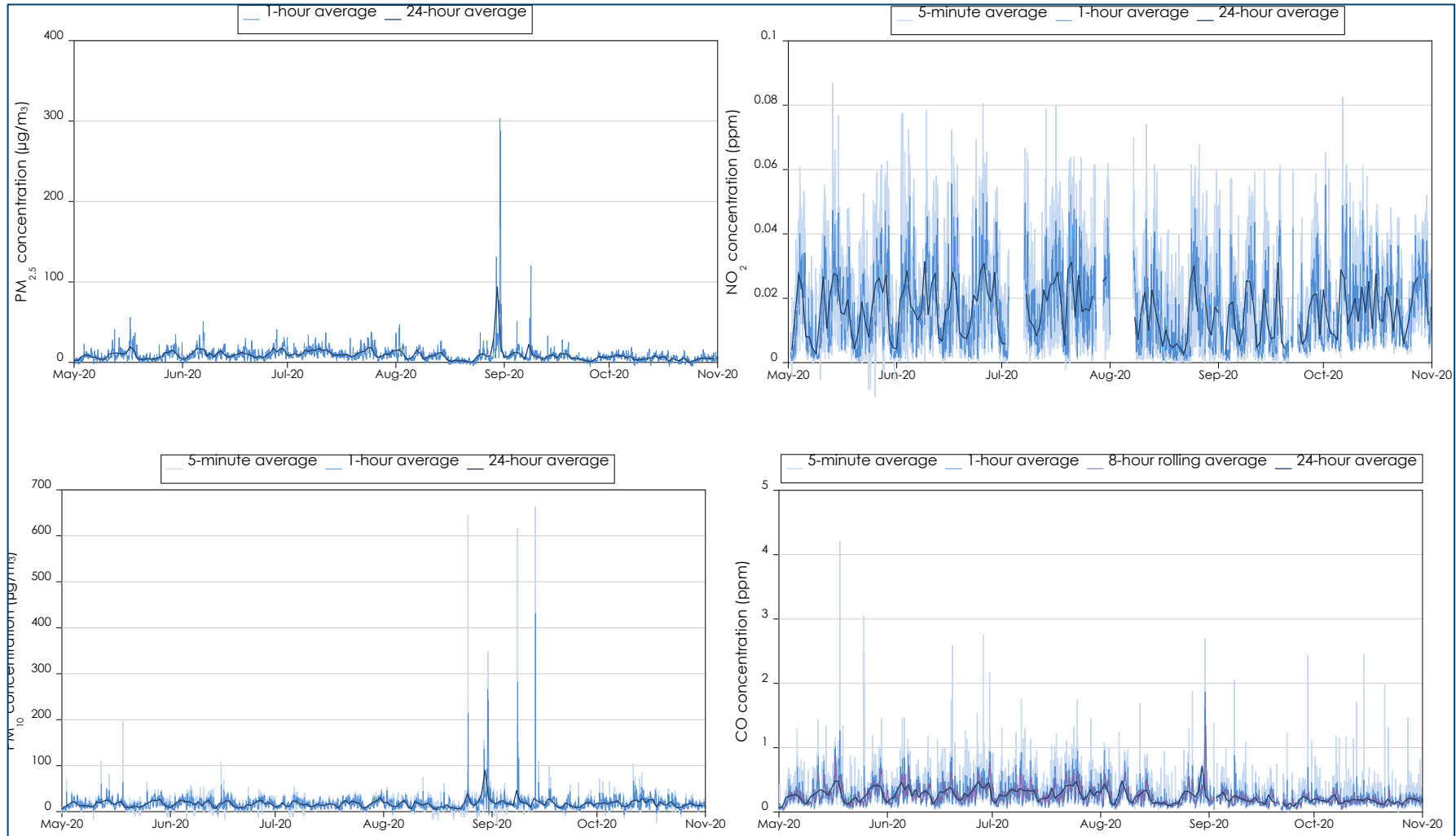


Figure C-6: Thornleigh Golf Centre monitoring data

