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Accreditation No. 14184.

NorthConnex

NorthConnex

Ambient Air Quality and Weather Monitoring

Validated Report

1st September to 30th September 2020

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Revision History			
Revision	**Report ID**	**Date**	**Analyst**
0	DAT16326	28/10/2020	Laura Torres

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Executive Summary

NorthConnex is a new multi-lane road link project, joining the M1 Pacific Motorway (formerly known as the F3 Sydney-Newcastle Expressway) at North Wahroonga and the Hills M2 Motorway at Baulkham Hills.

The Project has the following purposes:

- Construction and operation of two road tunnels for traffic traveling north - south between the M1 Pacific Motorway and the Hills M2 Motorway.
- M2 integration works.
- Construction of access points and improvements to intersections and interchanges in the vicinity of NorthConnex.
- Construction of ventilation facilities.
- Motorway control Centre.
- 11 temporary construction facilities to support the construction of the proposal.

Ecotech Pty Ltd has been commissioned by Lendlease Bouygues Joint Venture for air quality monitoring, data collection and reporting at six external ambient air quality monitoring stations: Ashley Avenue AQM (Air Quality Monitoring), Carden Park AQM, Headen Park AQM, James Park AQM, Larchmont Place AQM and Thornleigh Golf Centre AQM.

1.0 Introduction

Ecotech Pty Ltd was commissioned by Lendlease Bouygues Joint Venture to provide monitoring and data reporting for the NorthConnex ambient air quality and weather monitoring network, located as detailed in Table 1. Ecotech commenced data collection in October 2018.

This report presents the available data for September 2020.

The data presented in this report:

- Describes air quality measurements;
- Compares monitoring results;
- Has been quality assured;
- Conforms with NATA accreditation requirements, where applicable.

2.0 Monitoring and Data Collection

2.1. Siting Details

The NorthConnex Project monitoring network consists of six ambient air quality and weather monitoring stations. The stations location and siting details are described below.

Table 1: NorthConnex Project Monitoring Site Locations

Site Name	Geographical Coordinates	Height Above Sea Level (m)
Ashley Avenue	33˚45’13.87” S, 151 ˚2’45.11” E	126
Carden Park	33˚42’48.15” S, 151˚ 6’33.10” E	187
Headen Park	33˚43’29.42” S, 151˚ 4’ 44.38” E	175
James Park Hornsby	33˚42’2.28” S, 151˚6’48.59” E	175
Larchmont Place	33˚45’24.12” S, 151˚2’46.97” E	110
Thornleigh Golf Centre	33˚43’28.06” S, 151˚5’11.99” E	182

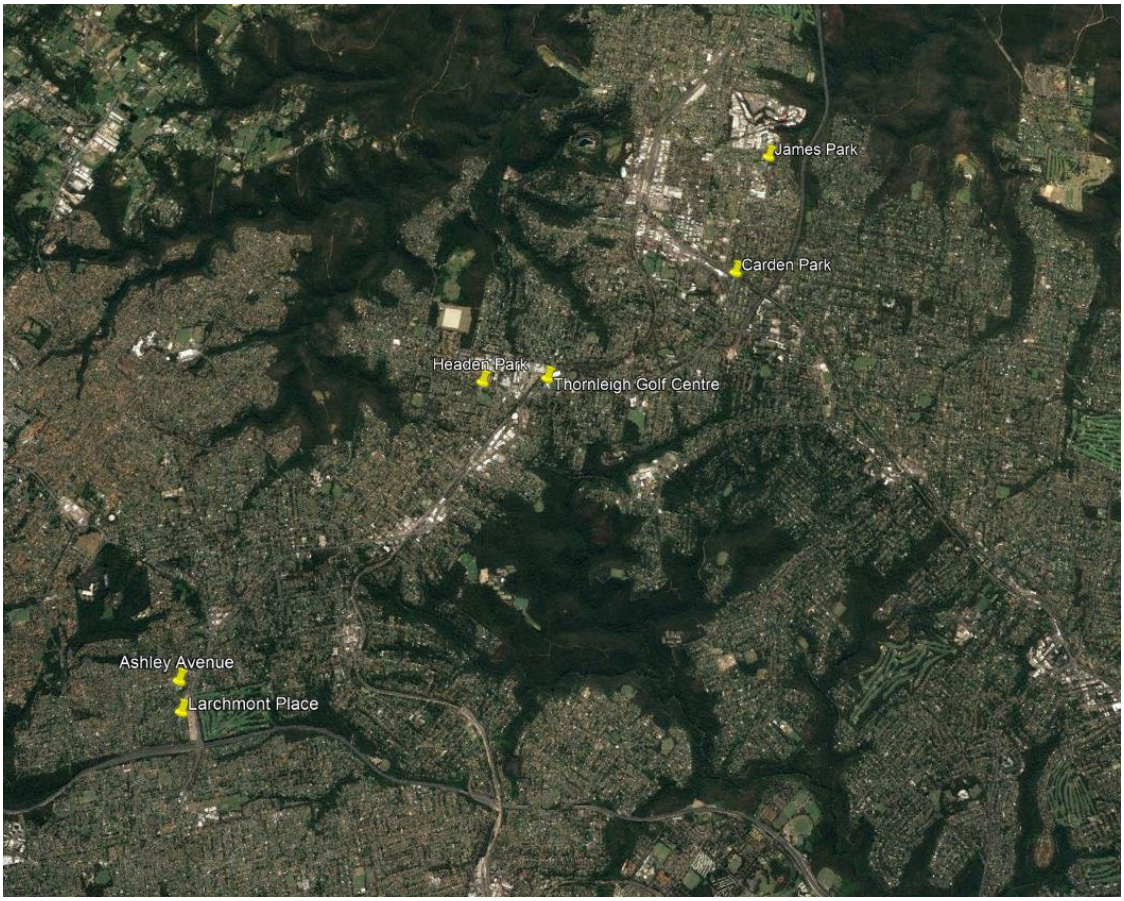


Figure 1: NorthConnex Project Monitoring Station Locations

Stations are audited against the guidelines and mandatory requirements in the standards below, as relevant:

- *AS/NZS 3580.1.1:2016 "Methods for sampling and analysis of ambient air – guide to siting air monitoring equipment".*
- AS/NZS 3580.14:2014 *"Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring applications*".

Audits against *AS/NZS 3580.1.1 2016* were conducted at all sites. Audit results are detailed in Table 2.

Table 2. Monitoring Station Siting Audit Against AS/NZS 3580.1.1 2016

Site Name	Audit date	Site classification	All guidelines met?	Deviations from guidelines
Ashley Avenue	22/11/19	Neighbourhood	Yes	No
Carden Park	3/09/20	Neighbourhood	Yes	No
Headen Park	26/06/20	Neighbourhood	Yes	No
James Park Hornsby	18/07/19	Peak	Yes	No
Larchmont Place	3/12/19	Neighbourhood	No	Trees
Thornleigh Golf Centre	4/12/19	Peak	No	Trees

Audits against AS/NZS 3580.14 2014 were conducted at all sites. Audit results are detailed in Table 3.

Table 3. Monitoring Station Siting Audit Against AS/NZS 3580.14 2014

Site Name	Audit date	All requirements met	All guidelines met?	Deviations from guidelines
Ashley Avenue	22/11/19	Yes	Yes	No
Carden Park	8/07/19	Yes	Yes	No
Headen Park	1/08/19	Yes	Yes	No
James Park Hornsby	18/07/19	Yes	Yes	No
Larchmont Place	3/12/19	Yes	Yes	No
Thornleigh Golf Centre	4/12/19	Yes	Yes	No

2.2. Monitored Parameters

Table 4 below details the parameters monitored and the instruments used at the NorthConnex Project monitoring stations. Sampling of all parameters is continuous. For meteorological sensors, the elevation given in the table below is the height above ground level at the monitoring station. For gaseous and particulate parameters, the elevation given in the table below is the sample inlet height above ground level at the monitoring station. Appendix 1 defines any abbreviated parameter names used throughout the report.

Table 4: Parameters Measured at the NorthConnex Project Monitoring Stations

Station(s)	Parameter Measured	Instrument and Measurement Technique	Elevation
Ashley Avenue Carden Park Headen Park James Park Larchmont Place Thornleigh Golf Centre	CO	Ecotech Serinus 30 – NDIR gas filter correlation infrared photometry	2 m
	NO, NO_2, NO_x	Ecotech Serinus 40 – gas phase chemiluminescence	2 m
	$PM_{2.5}$	Met One BAM 1020 – Beta ray attenuation	2 m
	PM_{10}	Thermo – 1405 TEOM (Tapered Element Oscillating Microbalance)	2 m
	Differential Temperature	Met One 062MP	2 m
	Differential Temperature	Met One 062MP	10 m
	Wind Speed (horizontal)	Gill Windsonic Op3	10 m
	Wind Direction	Gill Windsonic Op3	10 m
	Sigma	Calculation	-

2.3. Data Collection Methods

Table 5 below shows the methods used for data collection.

Table 5: Methods

Parameter Measured	Data Collection Methods Used	Description of Method
NO, NO_2, NO_x	AS/NZS 3580.5.1 –1993[1]	Methods for sampling and analysis of ambient air - Method 5.1: Determination of oxides of nitrogen-Chemiluminescence method
	Ecotech Laboratory Manual	In-house method 6.1 - Oxides of nitrogen by chemiluminescence
CO	AS/NZS 3580.7.1 –1992[2]	Methods for sampling and analysis of ambient air. Method 7.1: Determination of carbon monoxide—Direct-reading instrumental method
	Ecotech Laboratory Manual	In-house method 6.3 – Carbon monoxide by gas filter correlation spectrophotometry
PM_{10} (TEOM)	AS 3580.9.8-2008	Methods for sampling and analysis of ambient air. Method 9.8: Determination of suspended particulate matter - PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser.
	Ecotech Laboratory Manual	In-house method 7.3- Particulates - $PM_{2.5}$, PM_{10} by TEOM
$PM_{2.5}$ (BAM 1020)	AS/NZS 3580.9.12-2013[3]	Methods for sampling and analysis of ambient Air - Method 9.12: Determination of suspended particulate matter—$PM_{2.5}$ beta attenuation monitors
	Ecotech Laboratory Manual	In-house method 7.5 – Measurement of PM_{10}, $PM_{2.5}$ and TSP using Beta Attenuation Monitor

[1] Superseded by AS 3580.5.1 – 2011 but specifically referenced in ministerial conditions.

[2] Superseded by AS 3580.7.1 – 2011 but specifically referenced in ministerial conditions.

[3] As approved by the Department of Planning and Environment on 8th September 2017.

Parameter Measured	Data Collection Methods Used	Description of Method
Vector Wind Speed (Horizontal)	AS 2923-1987[4]	Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications
	Ecotech Laboratory Manual	In-house method 8.1 - Wind speed (Horizontal) by anemometer
Vector Wind Direction	AS 2923-1987[4]	Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications
	Ecotech Laboratory Manual	In-house method 8.3 - Wind direction by anemometer
Sigma	AS 2923-1987[4]	Methods of sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications
	Ecotech Laboratory Manual	In-house method 8.3 Wind direction by anemometer
Ambient Temperature	USEPA (2000) EPA 454/R-99-005[5]	Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications
	Ecotech Laboratory Manual	In-house method 8.4 – Temperature ambient by thermoelectric techniques

Note: Two different measurement techniques are used for monitoring PM_{10} and $PM_{2.5}$ at the NorthConnex Project Stations. Studies conducted in Canada, the United States and other countries have found that the Tapered Element Oscillating Microbalance (TEOM) monitors can under report concentrations compared to the Beta Attenuation Monitors (BAM), especially when the air contains a large proportion of semi-volatile particulate matter, which may be the case during cooler seasons when the air contains less coarse dust and a greater proportion of semi-volatile organic compounds such as those associated with wood smoke. As a result, it is normal

[4] Superseded by AS/NZS 3580.14 2014 but specifically referenced in ministerial conditions.

[5] Superseded by AS/NZS 3580.14 2014 but specifically referenced in ministerial conditions.

to see occasional periods where PM_{10} < $PM_{2.5}$ and this situation does not necessarily indicate a fault with either instrument.

2.3.1. Compliance with Standards

Unless stated below, parameters are monitored at the NorthConnex Project monitoring stations according to the methods detailed in Table 5.

- Measurement of Wind does not fully conform with *AS 2923-1987* and is not covered by Ecotech's NATA scope of accreditation due to overdue wind tunnel calibrations at James Park and Carden Park. Ecotech are currently in the process of swapping out and returning each sensor to the laboratory for biannual calibration.
- Siting audit checks at Carden Park station was out of date from 17/07/2020 and will be re-scheduled at then next suitable maintenance visit.

2.3.2. Data Acquisition

Data acquisition is performed using a PC based Congrego logger (using Congrego®) situated at each of the monitoring sites. Each logger is equipped with a 3G modem for remote data collection. The recorded data is remotely collected from the Air Quality Monitoring Station (AQMS) loggers on a daily basis (using Airodis™ version 5.1.0) and stored at Ecotech's Environmental Reporting Services (ERS) department in Melbourne, Australia. Data samples are logged in 5-minute intervals.

2.4. Data Validation and Reporting

2.4.1. Validation

The Ecotech ERS department performs daily data checks to ensure maximum data capture rates are maintained. Any equipment failures are communicated to the responsible field engineers for urgent rectification. Ecotech ERS maintains two distinct databases containing non-validated and validated data respectively.

The validated database is created by duplicating the non-validated database and then flagging data affected by instrument faults, calibrations and other maintenance activities. The data validation software requires the analyst to supply a valid reason (e.g. backed by maintenance notes, calibration sheets etc.) in the database for flagging any data as invalid.

Details of all invalid or missing data are recorded in the Valid Data Exception Tables.

Validation is performed by the analyst, and the validation is reviewed. Graphs and tables are generated based on the validated five minutes and one-hour data as appropriate.

When considering negative values recorded by the BAM instruments in accordance with the guidelines stated in *AS/NZS 3580.9.12:2013:* "*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".*

2.4.2. Validation notes

Small daily offset adjustments have been made to correct for zero reference drift in the new CO analysers which should stabilise over time. These adjustments are within the zero tolerances of AS/NZS 3580.7.1 –1992[5] and do not impact the data validity.

2.4.3. Reporting

Data is reported in six Microsoft Excel format files named

- *NorthConnex_Ashley Avenue_ Monthly Data Report_ September 2020.xls*
- *NorthConnex_Carden Park_ Monthly Data Report_ September 2020.xls*
- *NorthConnex_Headen Park_ Monthly Data Report_ September 2020.xls*
- *NorthConnex_James Park Hornsby_ Monthly Data Report_ September 2020.xls*
- *NorthConnex_Larchmont Place_ Monthly Data Report_ September 2020.xls*
- *NorthConnex_ Thornleigh Golf Centre _ Monthly Data Report_ September 2020.xls*

Each Excel file consists of 6 worksheets:

1. Cover
2. Contents
3. 5 Minute Data
4. 1 Hour Data
5. 24-hour Data
6. Valid Data Exception Report

The data contained in this report is based on Australian Eastern Standard Time.

All averages are calculated from the five-minute and the one-hour data. Averages are based on a minimum of 75% valid readings within the averaging period. Where data capture is low for a particular parameter, summary values (e.g. monthly maximum and minimum) may be based on less than 75% valid samples. The reader should use caution when interpreting these values as they may not be representative of conditions for the entire sample period.

[5] Superseded by AS/NZS 3580.7.1 – 2011 but specifically referenced in ministerial conditions.

Averaging periods of eight hours or less are reported for the end of the period, i.e. the hourly average 02:00am is for the data collected from 1:00am to 2:00am. One-hour averages are calculated based on a clock hour. One day averages are calculated based on calendar days.

3.0 Air Quality Standards and Goals

The air quality goals and criteria for pollutants monitored at the NorthConnex project ambient monitoring sites are based on SSI 6136 Planning Approval Condition E9. The air quality goals and criteria are shown in Table 6 below.

Note: The measurement uncertainty (as outlined in Table 7) is not considered when assessing exceedences of the air quality standards/goals. Exceedances are only reported for above goal values, based on the decimal places reported. Daily averages for $PM_{2.5}$ are calculated from integer 1 hour measurements and expressed to one decimal place

Table 6: NorthConnex Project - Air Quality Goals

Parameter	Time Period	Goal Level	Units
CO	8 Hours (rolling, based on 1-Hour averages)	9.0	ppm
NO_2	1 Hour	0.12	ppm
PM_{10}	1 Day	50	µg/m³
$PM_{2.5}$	1 Day	25	µg/m³

Note:

This table includes all valid data points that exceed the defined air quality standards. The Ambient Air Quality NEPM includes a provision for excluding 1-day PM_{10} or $PM_{2.5}$ averages associated with "exceptional events" from the total exceedences of the Air Quality standard. The definition of an "exceptional event" is included below for reference. It is the responsibility of the end user of this data to evaluate whether any reported exceedences are associated with exceptional events and are eligible to be excluded from the exceedence total. Monitoring and reporting of exceedences during the operational project will be in accordance with the Planning Approval Conditions E7, E8 and E9.

As per the Ambient Air Quality NEPM, ***Exceptional event*** means a fire or dust occurrence that adversely affects air quality at a particular location, and causes an exceedance of 1 day average standards in excess of normal historical fluctuations and background levels, and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust.

4.0 Calibrations and Maintenance

4.1. Units and Uncertainties

The uncertainties for each parameter have been determined by the manufacturer's tolerance limits of the equipment's parameters, and by the data collection standard method.

The reported uncertainties are expanded uncertainties, calculated using coverage factors which give a level of confidence of approximately 95%.

Table 7: Units and Uncertainties

Parameter	Units	Resolution	Uncertainty[6]	Measurement Range[7]
NO, NO_x (S40)	ppm	0.001 ppm	± (6% of reading + 0.011 ppm) K factor of 2.0	0 to 0.5 ppm LDL= 0.0004 ppm
NO_2 (S40)	ppm	0.001 ppm	± (6% of reading + 0.011 ppm) K factor of 2.0	0 to 0.5 ppm LDL= 0.0004 ppm
CO (S30)	ppm	0.1 ppm	± (7% of reading + 0.8ppm) K factor of 2.0	0 to 50 ppm LDL=0.04 ppm
$PM_{2.5}$ (BAM1020)	µg/m³	1 µg/m³	24Hr: ± (5.5 % of reading + 4.0 µg/m³) (in range 0 - 100 µg/m³) Hr: ± (8 % of reading + 8.0 µg/m³) k factor of 2.0	0 to 1000 µg/m³ LDL_{24hr}=1.0 µg/m³ LDL_{hr}=4.8 µg/m³
PM_{10} (TEOM)	µg/m³	0.1 µg/m³	±5.0 µg/m³ or 3.6% of reading, whichever is the greater K factor of 2.0	0 µg/m³ to 1 g/m³ LDL=5µg/m³
Vector Wind Speed	m/s	0.1 m/s	±0.4 m/s or 2 % of reading, whichever is greater K factor of 2.0	0 to 30 m/s
Vector Wind Direction	deg	1 deg	±4 deg K factor of 2.0	0 to 360 deg Starting threshold: 0 m/s

[6] Uncertainties are calculated based on the full measurement range unless stated otherwise

[7] The max measurement range for gas analysers is defined as the full scale (FS=Span/0.8)

Parameter	Units	Resolution	Uncertainty[6]	Measurement Range[7]
Ambient Temperature	K	0.1 K	± 0.6 K K factor of 2.0	263.15 to 323.15 K

4.2. Maintenance

4.2.1. Calibration & Maintenance Summary Tables

The last calibrations for the following parameters were performed on the indicated dates. Data supplied after this time is subject to further validation, to be performed at the next calibration cycle.

Note: Maintenance and calibration dates may differ, as calibrations may be less frequent than scheduled maintenance visits.

Table 8-13 indicate when the particulate and gas and meteorological equipment were last maintained/calibrated.

“Calibration cycle” refers to the frequency of calibrations and intermediate calibration checks. The most frequent check or calibration is listed here.

Table 8: NorthConnex Project Ashley Avenue Maintenance Table September 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO_2, NO_x	18/09/2020	3-monthly	18/09/2020	11/08/2020	Monthly
CO	18/09/2020	Monthly	18/09/2020	11/08/2020	Monthly
PM_{10}	18/09/2020	3-monthly	18/09/2020	29/06/2020	3-monthly
$PM_{2.5}$	18/09/2020	Monthly	7/08/2020	21/07/2020	3-monthly
WS/WD/Sigma	18/09/2020	3-monthly	18/12/2019	28/06/2018	2-yearly
Differential Temperature 2m	18/09/2020	3-monthly	22/07/2020	9/08/2019	Yearly
Differential Temperature 10m	18/09/2020	3-monthly	22/07/2020	9/08/2019	Yearly

Table 9: NorthConnex Project Carden Park Maintenance Table September 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO_2, NO_x	4/09/2020	Non-scheduled	4/09/2020	3/09/2020	Monthly
CO	3/09/2020	Monthly	3/09/2020	11/08/2020	Monthly
PM_{10}	3/09/2020	3-monthly	3/09/2020	23/06/2020	3-monthly
$PM_{2.5}$	3/09/2020	Monthly	7/08/2020	3/06/2020	3-monthly
WS/WD/Sigma	3/09/2020	3-monthly	26/06/2018	26/06/2018	2-yearly
Differential Temperature 2m	3/09/2020	3-monthly	5/12/2019	19/08/2019	Yearly
Differential Temperature 10m	3/09/2020	3-monthly	5/12/2019	19/08/2019	Yearly

Table 10: NorthConnex Project Headen Park Maintenance Table September 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO_2, NO_x	3/09/2020	3-monthly	3/09/2020	10/08/2020	Monthly
CO	3/09/2020	Monthly	3/09/2020	10/08/2020	Monthly
PM_{10}	3/09/2020	Monthly	3/09/2020	26/06/2020	3-monthly
$PM_{2.5}$	3/09/2020	Monthly	10/08/2020	7/08/2020	3-monthly
WS/WD/Sigma	18/09/2020	Yearly	1/09/2020 IN (ID:17-1645) 27/06/2018 OUT (ID:18-0836)	27/06/2018	2-yearly
Differential Temperature 2m	3/09/2020	3-monthly	2/12/2019	1/08/2019	Yearly
Differential Temperature 10m	3/09/2020	3-monthly	2/12/2019	1/08/2019	Yearly

Table 11: NorthConnex Project James Park Hornsby Maintenance Table September 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO_2, NO_x	2/09/2020	3-monthly	2/09/2020	10/08/2020	Monthly
CO	2/09/2020	Monthly	2/09/2020	10/08/2020	Monthly
PM_{10}	2/09/2020	3-monthly	2/09/2020	25/06/2020	3-monthly
$PM_{2.5}$	2/09/2020	Monthly	10/08/2020	3/06/2020	3-monthly
WS/WD/Sigma	2/09/2020	3-monthly	26/06/2018	26/06/2018	2-yearly
Differential Temperature 2m	2/09/2020	3-monthly	5/12/2019	19/08/2019	Yearly
Differential Temperature 10m	2/09/2020	3-monthly	5/12/2019	19/08/2019	Yearly

Table 12: NorthConnex Project Larchmont Place Maintenance Table September 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO_2, NO_x	1/09/2020	3-monthly	1/09/2020	11/08/2020	Monthly
CO	11/09/2020	Non-scheduled	1/09/2020 OUT (ID:18-0345) 11/09/2020 IN (ID:13-1090)	17/07/2020 OUT (ID:17-0982) 1/09/2020 IN (ID:18-0345)	Monthly
PM_{10}	1/09/2020	3-monthly	1/09/2020	17/06/2020	3-monthly
$PM_{2.5}$	25/09/2020	Non-scheduled	25/09/2020	27/08/2020	3-monthly
WS/WD/Sigma	21/09/2020	Yearly	2/09/2020 IN (ID:17-1649) 27/06/2018 OUT (ID:18-0835)	27/06/2018	2-yearly
Differential Temperature 2m	1/09/2020	3-monthly	3/12/2019	9/08/2019	Yearly
Differential Temperature 10m	1/09/2020	3-monthly	3/12/2019	9/08/2019	Yearly

Table 13: NorthConnex Project Thornleigh Golf Centre Maintenance Table September 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO_2, NO_x	21/09/2020	Non-scheduled	21/09/2020 OUT (ID: 18-0379) 21/09/2020 IN (ID:18-0140)	11/09/2020	Monthly
CO	2/09/2020	Monthly	2/09/2020	10/08/2020	Monthly
PM_{10}	2/09/2020	3-monthly	2/09/2020	18/06/2020	3-monthly
$PM_{2.5}$	10/08/2020	Monthly	10/08/2020	3/06/2020	3-monthly
WS/WD/Sigma	11/09/2020	Yearly	3/09/2020 IN (ID:8-0882) 28/06/2018 OUT (ID:18-0837)	28/06/2018	2-yearly
Differential Temperature 2m	2/09/2020	3-monthly	4/12/2019	1/08/2019	Yearly
Differential Temperature 10m	2/09/2020	3-monthly	4/12/2019	1/08/2019	Yearly

5.0 Results

5.1. Data Capture

Valid data capture refers to the amount of valid data collected during the report period. It is based on 5-minute data, for gaseous and meteorological parameters and 1-hour data for particulate parameters.

The percentage of valid data captured is calculated using the following equation:

Valid Data capture = (Reported air quality data / Total data) x 100%

Where:

- Reported air quality data = Number of samples (instrument readings) which have been validated through a quality assured process and excludes all data errors, zero data collection due to calibration, equipment failures, planned and unplanned maintenance.
- Total data = Total number of samples (instrument readings) expected for the sampling period. Total data is calculated based on the same averaging period as "reported air quality data" and the duration of the corresponding report period. e.g. for 5-minute data collected over a month of 31 days, the total data would be equal to 12 (5-minute samples in an hour) x 24 (hours in a day) x 31 (days in a month) = 8928 samples.

Table 14 below displays data capture statistics for September 2020. **Bold** values in the table indicate data capture below 95%.

Table 15 below displays the percentage of negative values in the valid $PM_{2.5}$ data provided.

Details of all invalid or missing data affecting data capture are included in the Valid Data Exception Tables, see section 6.0/ attached Excel file.

Table 14: Data Capture for NorthConnex Ambient Air Quality Network

Parameter	Data Capture (%)					
	Ashley Avenue	Carden Park	Headen Park	James Park	Larchmont Place	Thornleigh Golf Centre
$PM_{2.5}$	95.3	99.9	100.0	100.0	99.7	100.0
PM_{10}	96.1	99.0	97.9	98.9	99.6	99.5
CO	**92.1**	**92.5**	96.1	**92.3**	**79.5**	**92.2**
NO, NO_2, NO_x	**93.1**	**94.7**	96.5	96.3	96.3	**87.7**
WS, WD, Sigma	100.0	99.9	100.0	100.0	99.6	99.7
AT 2m	96.9	99.9	99.5	100.0	100.0	100.0
AT 10m	96.9	99.9	99.5	100.0	100.0	100.0

Table 15: Percentage of $PM_{2.5}$ Data <0

Percentage of $PM_{2.5}$ Data <0 (%)					
Ashley Avenue	Carden Park	Headen Park	James Park	Larchmont Place	Thornleigh Golf Centre
4.9	3.8	10.1	5.3	9.7	1.8

5.2. Air Quality Monthly Summary

Table 16-21 below include a summary of any exceedances recorded at the NorthConnex Project stations during the reported period[8].

Table 16: NorthConnex Project Ashley Avenue Exceedences Recorded for September 2020

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM_{10} (µg/m³)	1 Day	-	-
$PM_{2.5}$ (µg/m³)	1 Day	-	-

[8] Exceedances are reported for above goal values, based on the decimal places reported. Daily averages for $PM_{2.5}$ are calculated from integer 1-hour measurements and expressed to one decimal place.

Table 17: NorthConnex Project Carden Park Exceedences Recorded for September 2020

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM_{10} (µg/m³)	1 Day	-	-
$PM_{2.5}$ (µg/m³)	1 Day	-	-

Table 18: NorthConnex Project Headen Park Exceedences Recorded for September 2020

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM_{10} (µg/m³)	1 Day	-	-
$PM_{2.5}$ (µg/m³)	1 Day	-	-

Table 19: NorthConnex Project James Park Hornsby Exceedences Recorded for September 2020

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM_{10} (µg/m³)	1 Day	-	-
$PM_{2.5}$ (µg/m³)	1 Day	-	-

Table 20: NorthConnex Project Larchmont Place Exceedences Recorded for September 2020

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM_{10} (µg/m³)	1 Day	-	-
$PM_{2.5}$ (µg/m³)	1 Day	-	-

Table 21: NorthConnex Project Thornleigh Golf Centre Exceedences Recorded for September 2020

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM_{10} (µg/m³)	1 Day	-	-
$PM_{2.5}$ (µg/m³)	1 Day	-	-

5.3. Graphic Representations

This section displays graphs of the pollutants and meteorological parameters monitored at the NorthConnex sites for September 2020. The graphs are based on validated 5 minute or 1-hour data as applicable.

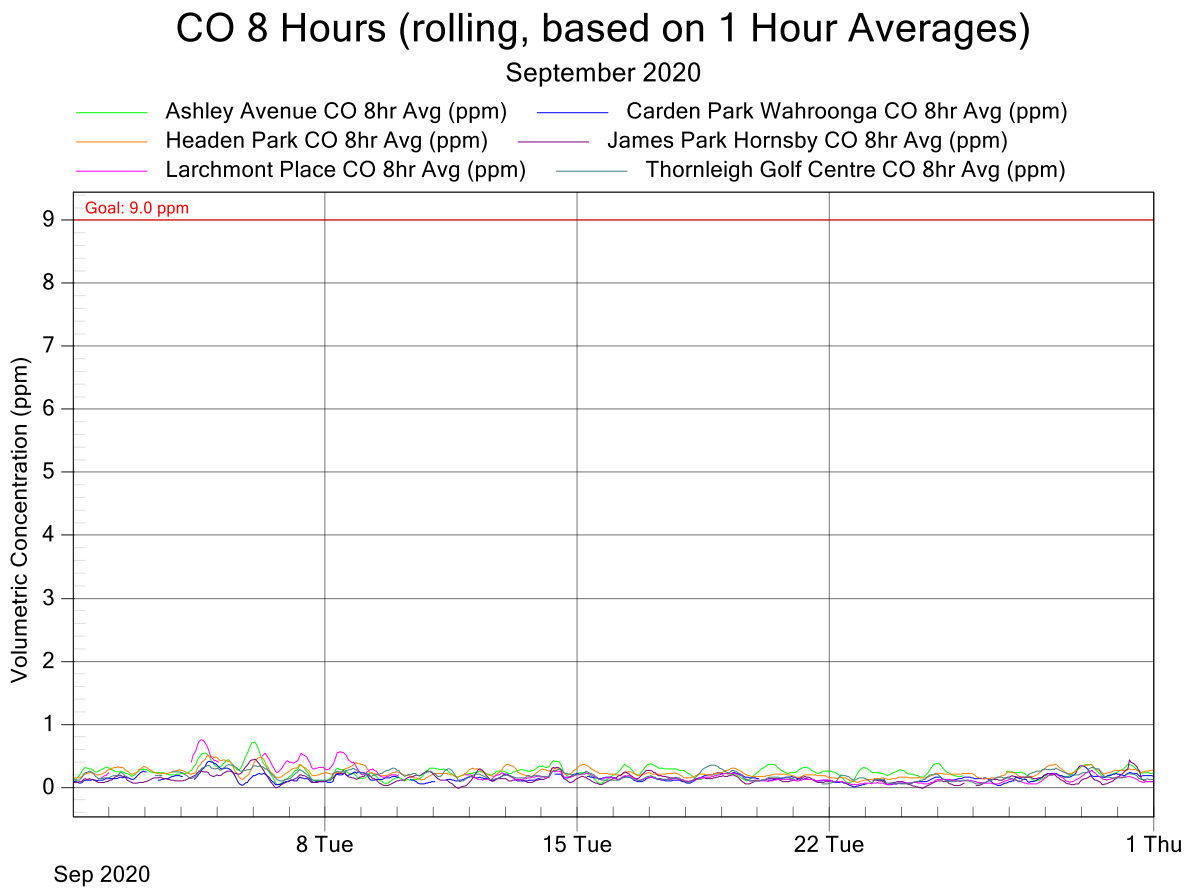


Figure 2: NorthConnex Project Air Monitoring Stations - CO 8 Hours Rolling Averages for September 2020

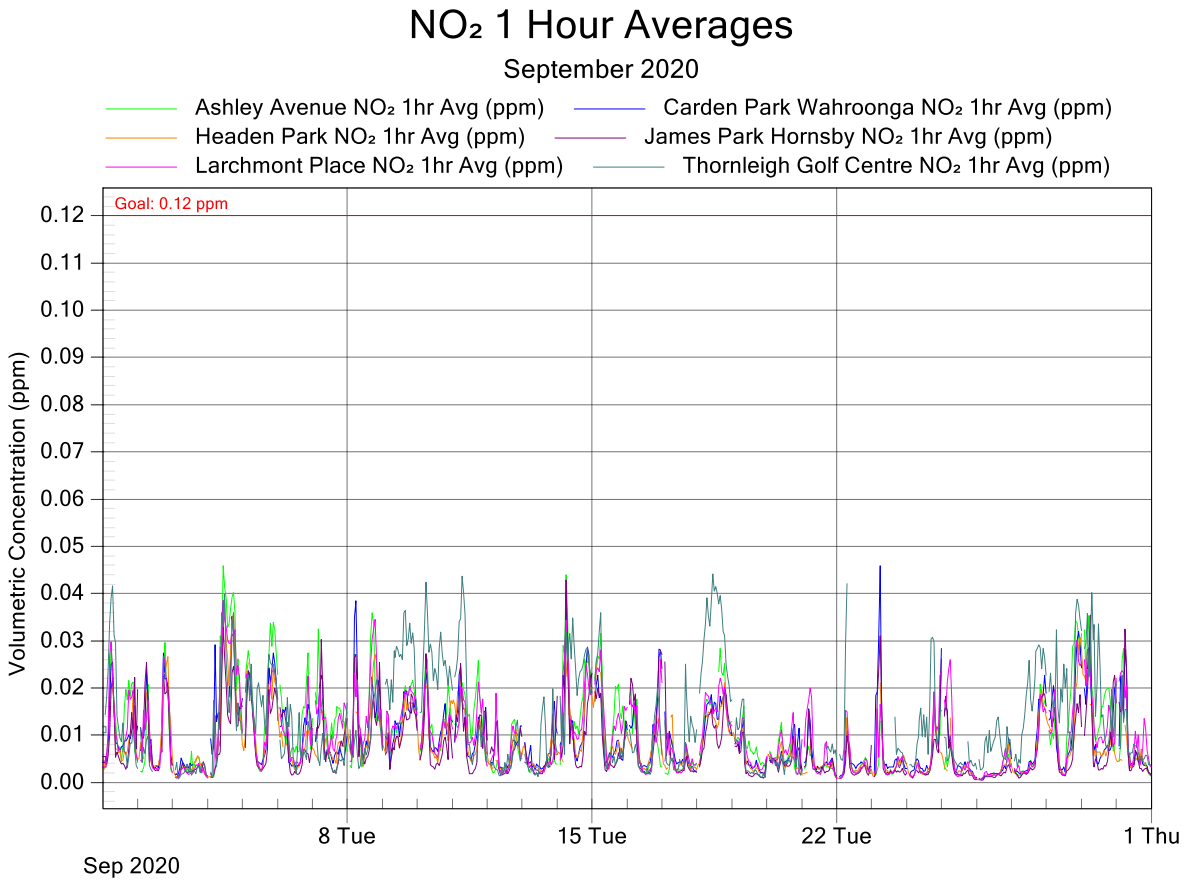


Figure 3: NorthConnex Project Air Monitoring Stations - NO_2 1 Hour Averages for September 2020

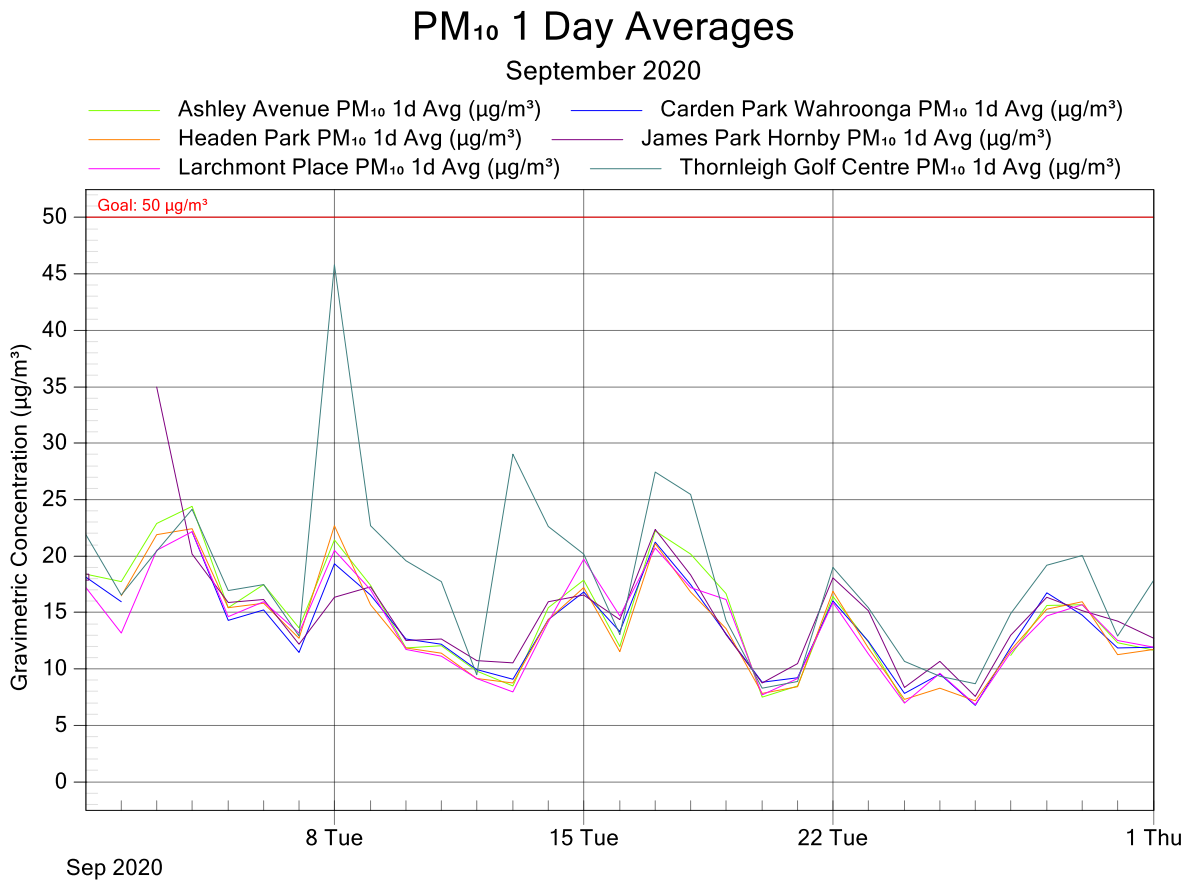


Figure 4: NorthConnex Project Air Monitoring Stations - PM_{10} 1 Day Averages for September 2020

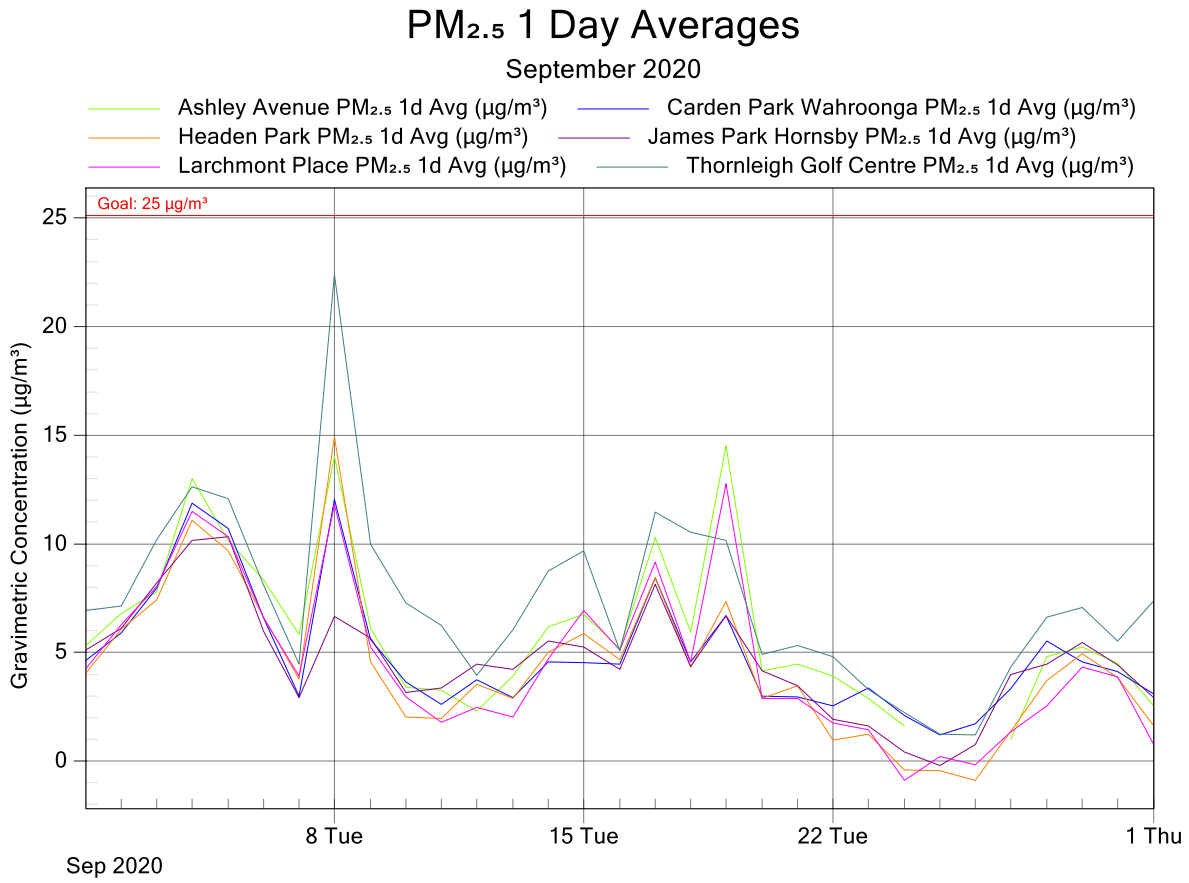


Figure 5: NorthConnex Project Air Monitoring Stations - $PM_{2.5}$ 1 Day Averages for September 2020

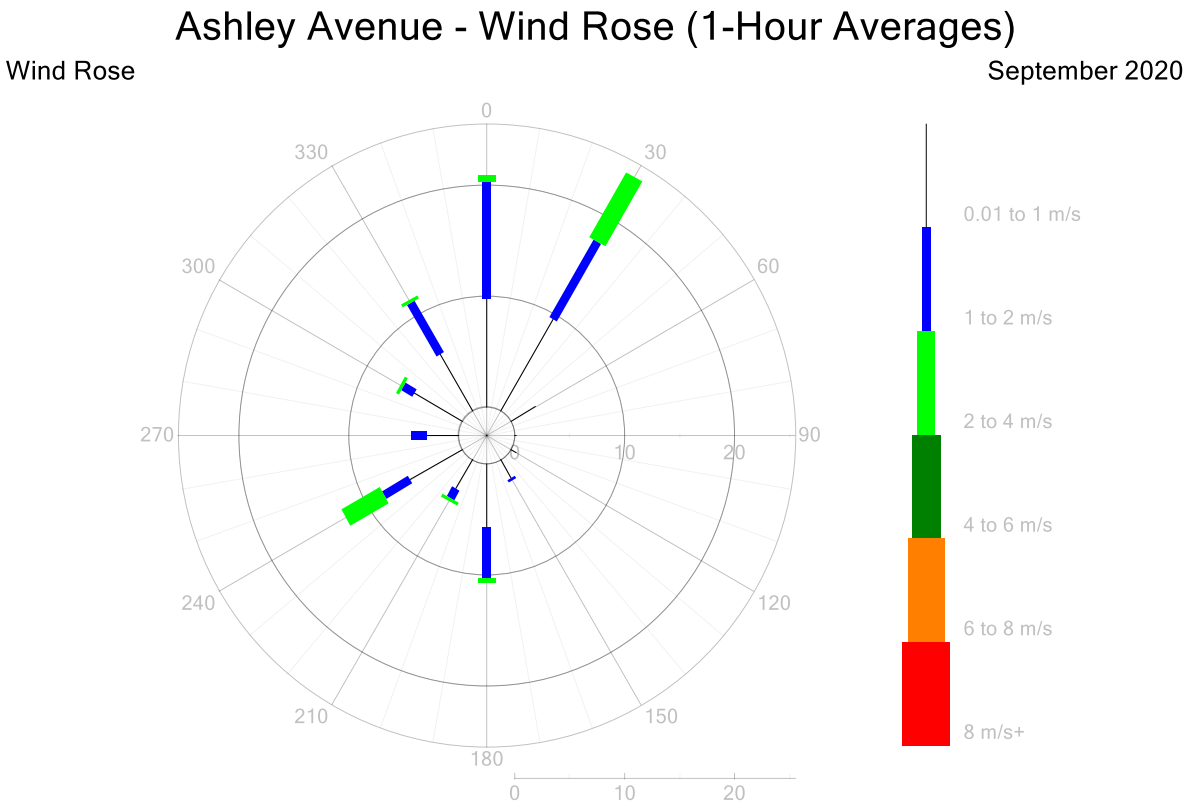
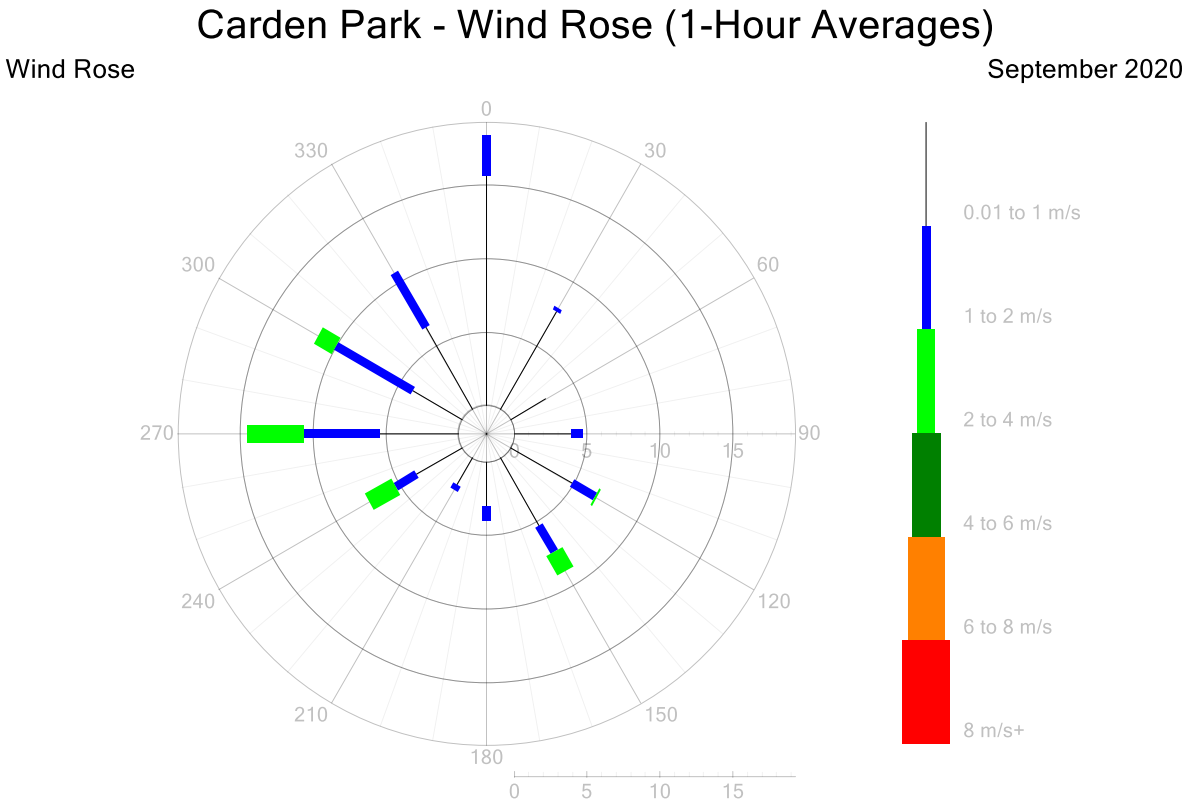
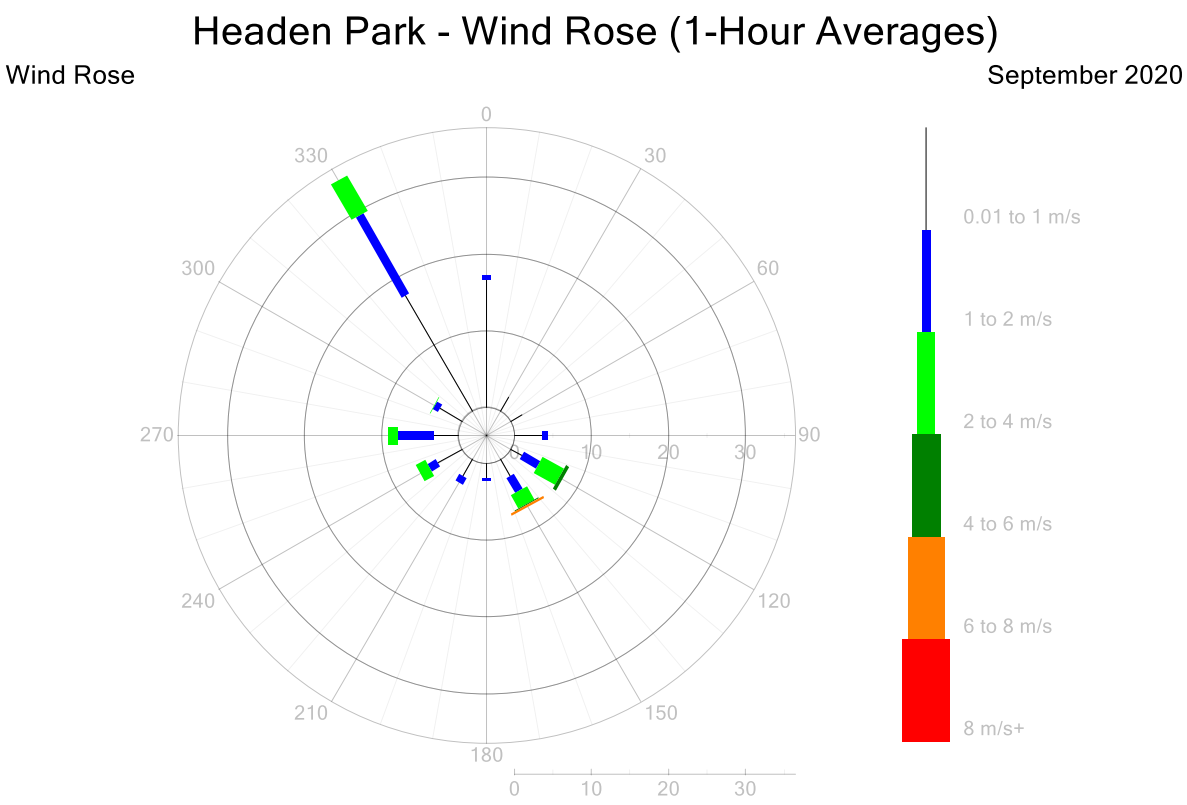


Figure 6: Ashley Avenue – Wind Rose for September 2020



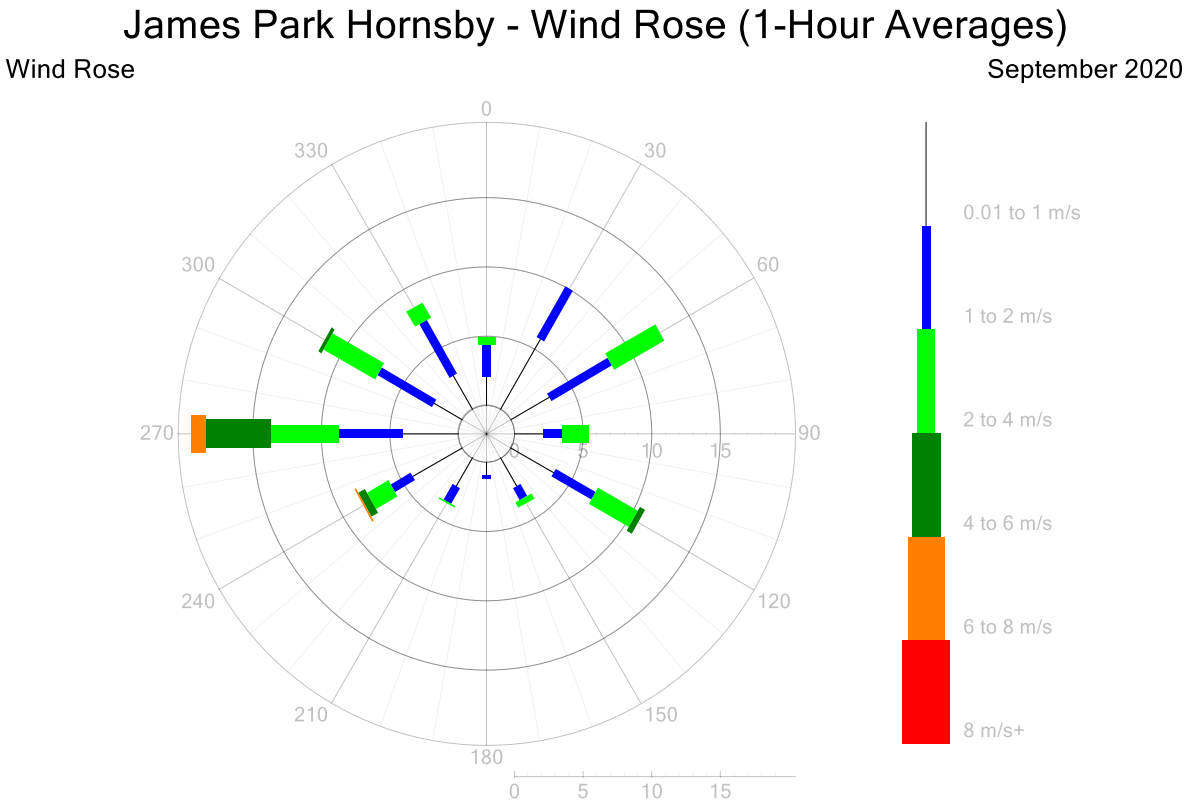
0.1% calm
100.0% valid data present

Figure 7: Carden Park – Wind Rose for September 2020



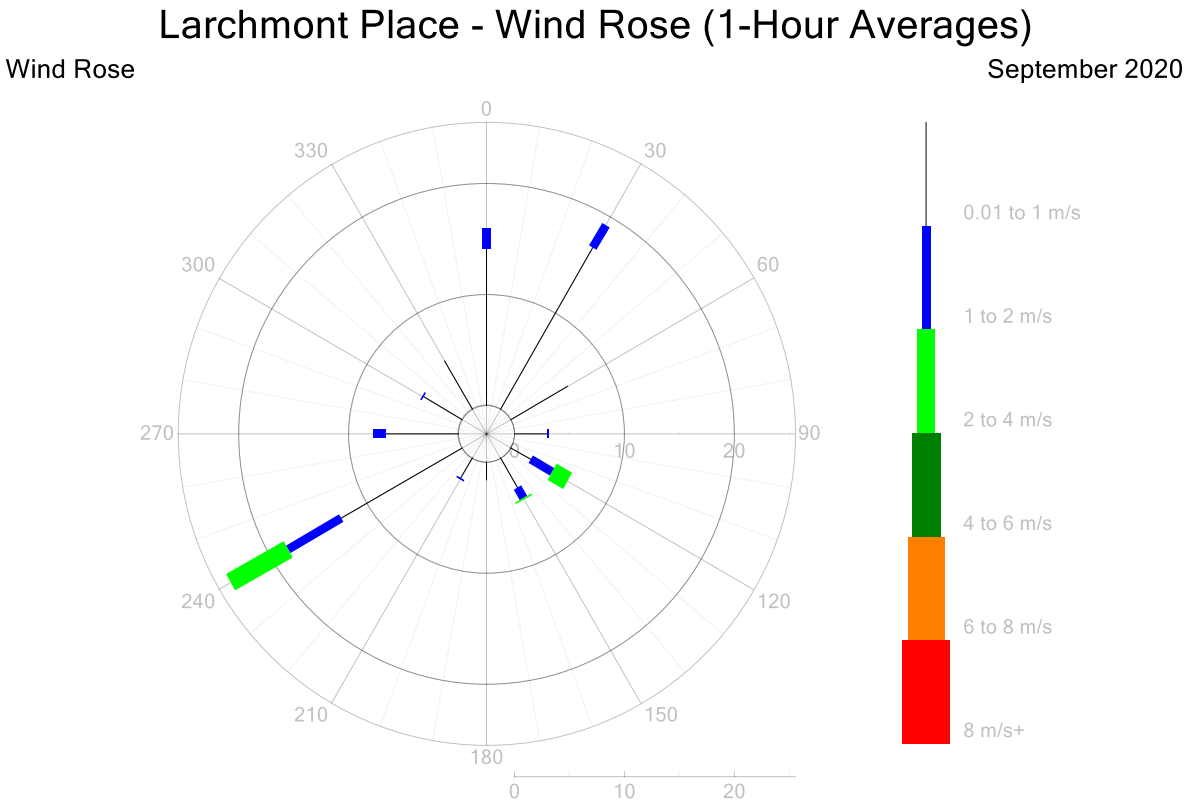
0.0% calm
99.4% valid data present

Figure 8: Headen Park – Wind Rose for September 2020



0.0% calm
100.0% valid data present

Figure 9: James Park Hornsby – Wind Rose for September 2020



0.6% calm
99.6% valid data present

Figure 10: Larchmont Place – Wind Rose for September 2020

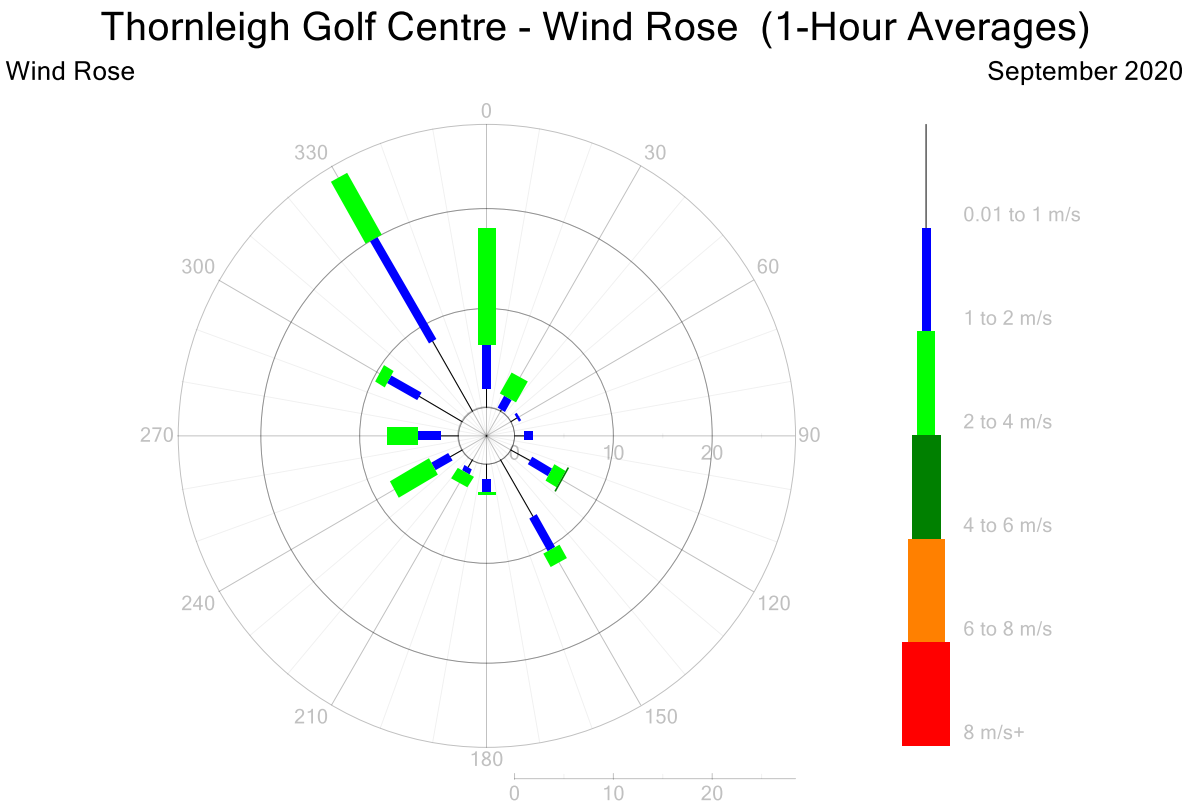


Figure 11: Thornleigh Golf Centre – Wind Rose for September 2020

6.0 Valid Data Exception Tables

Table 22-27 below detail all changes made to the raw data set during the validation process. An explanation of reasons given in the table can be found in Appendix 2.

Table 22: Ashley Avenue Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/09/20 01:00	30/09/20 01:45	Automatic span and zero checks once daily for 50 minutes	CO, NO, NO_2, NO_x	LT	19/10/20
01/09/20 23:45	30/09/20 23:50	Background checks once daily for 5 - 15 minutes	CO	LT	19/10/20
02/09/20 01:50	27/09/20 23:40	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values range from -0.50 to 0.00 ppm and B values range from -0.50 to 0.40 ppm	CO	LT	19/10/20
18/09/20 10:30	18/09/20 15:30	Scheduled 3-monthly maintenance	CO, NO, NO_2, NO_x, PM_{10}, $PM_{2.5}$	LT	19/10/20
19/09/20 23:55	01/10/20 00:00	Intermittent static offsets applied as required to correct daily baseline, values range from -0.80 to -0.15 ppm	CO	LT	19/10/20
25/09/20 16:40	26/09/20 15:10	Power outage	All parameters	LT	19/10/20
26/09/20 15:15	26/09/20 17:05	Non-scheduled maintenance - communication restored	All parameters	LT	19/10/20
26/09/20 17:00	26/09/20 22:00	Additional instrument stabilisation	$PM_{2.5}$	LT	19/10/20

Table 23: Carden Park Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/09/20 01:00	30/09/20 01:45	Automatic span and zero checks once daily for 50-60 minutes	CO, NO, NO_2, NO_x	LT	19/10/20
01/09/20 23:45	30/09/20 23:45	Background checks once daily for 5 - 95 minutes	CO	LT	19/10/20
01/09/20 01:50	30/09/20 02:35	Intermittent additional instrument stabilisation following overnight span check (for 5-110 minutes)	CO	LT	19/10/20
02/09/20 10:20	25/09/20 10:25	Intermittent unrealistic negative data	NO, NO_2, NO_x	LT	19/10/20
03/09/20 15:05	03/09/20 16:00	Scheduled 3-monthly maintenance	CO, NO, NO_2, NO_x, PM_{10}	LT	19/10/20
03/09/20 16:05	03/09/20 21:35	Additional instrument stabilisation after maintenance	PM_{10}	LT	19/10/20
03/09/20 16:05	04/09/20 00:55	Instrument fault	NO, NO_2, NO_x	LT	19/10/20
04/09/20 12:00	04/09/20 14:30	Non-scheduled maintenance - ran NO_x calibration and leak check	NO, NO_2, NO_x	LT	19/10/20
15/09/20 01:45	30/09/20 03:15	Intermittent data gaps	CO, NO, NO_2, NO_x, AT2m, AT10m, WS, WD, Sigma, PM_{10}, $PM_{2.5}$	LT	19/10/20
22/09/20 02:55	27/09/20 23:40	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values range from 0.00 to 0.10 ppm and B values range from -0.15 to 0.10 ppm	CO	LT	19/10/2020

Table 24: Headen Park Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/09/20 00:00	01/09/20 09:40	Instrument fault	PM_{10}	LT	19/10/20
01/09/20 00:00	01/10/20 00:00	Static offset of -0.10 ppm applied to correct baseline	CO	LT	19/10/20
01/09/20 05:00	30/09/20 01:45	Automatic span and zero checks once daily for 50 minutes	CO, NO, NO_2, NO_x	LT	19/10/20
01/09/20 23:55	30/09/20 23:45	Background checks once daily for 5 - 10 minutes	CO	LT	19/10/20
01/09/20 09:45	01/09/20 13:25	Non-scheduled maintenance	PM_{10}	LT	19/10/20
03/09/20 16:50	03/09/20 18:05	Scheduled 3-monthly maintenance	CO, NO, NO_2, NO_x, PM_{10}	LT	19/10/20
18/09/20 10:50	18/09/20 15:10	Non-scheduled maintenance - wind sensor (ID=18-0836) out for annual maintenance, wind sensor (ID=17-1645) in as replacement	AT2m, AT10m, WS, WD, Sigma	LT	19/10/20
25/09/20 16:20	25/09/20 16:20	Unrealistic negative drop	NO, NO_2, NO_x	LT	19/10/20

Table 25: James Park Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/09/20 01:00	30/09/20 01:45	Automatic span and zero checks once daily for 45-50 minutes	CO, NO, NO_2, NO_x	LT	20/10/20
01/09/20 23:00	30/09/20 23:05	Background checks once daily for 5 - 15 minutes	CO	LT	20/10/20
02/09/20 16:10	02/09/20 18:55	Scheduled 3-monthly maintenance	CO, NO, NO_2, NO_x, PM_{10}	LT	20/10/20
02/09/20 18:00	02/09/20 22:55	Static offset of 0.20 ppm to correct baseline	CO	LT	20/10/20
02/09/20 19:00	02/09/20 23:45	Additional instrument stabilisation after maintenance	PM_{10}	LT	20/10/20
04/09/20 01:50	29/09/20 22:55	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values range from -0.10 to 0.00 ppm and B values range from -0.25 to 0.30 ppm	CO	LT	20/10/20
04/09/20 11:50	09/09/20 09:55	Intermittent data gaps	CO, NO, NO_2, NO_x, AT2m, AT10m, WS, WD, Sigma, PM_{10}	LT	20/10/20
22/09/20 01:50	22/09/20 22:55	Instrument fault - unrealistic drift	CO	LT	20/10/20
25/09/20 17:05	25/09/20 19:50	Instrument fault - unrealistic drift	CO	LT	20/10/20
25/09/20 19:55	25/09/20 20:00	Additional background check	CO	LT	20/10/20

Table 26: Larchmont Place Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/09/20 00:00	30/09/20 23:55	Background checks once daily for 5 - 15 minutes	CO	LT	20/10/20
01/09/20 00:10	01/09/20 00:55	Static offset of 0.20 ppm applied to correct baseline	CO	LT	20/10/20
01/09/20 01:00	30/09/20 01:45	Automatic span and zero checks once daily for 50-70 minutes	CO, NO, NO_2, NO_x	LT	20/10/20
01/09/20 01:50	01/09/20 10:55	Instrument fault- electronic zero adjust	CO	LT	20/10/20
01/09/20 11:00	01/09/20 16:45	Scheduled 3-monthly maintenance - CO S30 faulty instrument (ID=17-0982) out, CO S30 instrument (ID=18-0345) in as replacement		LT	20/10/20
01/09/20 14:00	11/09/20 23:45	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values range from -0.20 to 0.20 ppm and B values range from -0.50 to 0.20 ppm	CO	LT	20/10/20
02/09/20 00:00	10/09/20 23:45	Intermittent instrument fault - unrealistic drift	CO	LT	20/10/20
11/09/20 01:50	11/09/20 12:55	Instrument fault	CO	LT	20/10/20
11/09/20 13:00	11/09/20 15:55	Non-scheduled maintenance CO S30 faulty instrument (ID=18-0345) out, CO S30 instrument (ID=17-1649) in as replacement	CO	LT	20/10/20
21/09/20 09:00	21/09/20 12:00	Non-scheduled maintenance - wind sensor (ID=18-0835) out for annual maintenance, wind sensor (ID=17-1649) in as replacement	AT10m, AT2m, WS, WD, Sigma	LT	20/10/20

Start Date	End Date	Reason	Change Details	User Name	Change Date
25/09/20 13:00	25/09/20 14:00	Non-scheduled maintenance - leak and flow check	$PM_{2.5}$	LT	20/10/20

Table 27: Thornleigh Golf Centre Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/09/20 01:00	30/09/20 01:45	Automatic span and zero checks once daily for 45-50 minutes	CO, NO, NO_2, NO_x	LT	20/10/20
01/09/20 11:30	28/09/20 10:45	Intermittent unrealistic negative data	NO, NO_2, NO_x	LT	20/10/20
01/09/20 23:45	30/09/20 23:45	Background checks once daily for 5 - 15 minutes	CO	LT	20/10/20
02/09/20 11:40	02/09/20 15:55	Scheduled 3-monthly maintenance	CO, NO, NO_2, NO_x, PM_{10}	LT	20/10/20
02/09/20 16:00	03/09/20 00:55	Instruments left in calibration mode after maintenance	CO, NO, NO_2, NO_x	LT	20/10/20
03/09/20 10:00	03/09/20 12:00	Non-scheduled maintenance - test run calibration gases	CO, NO, NO_2, NO_x	LT	20/10/20
08/09/20 01:50	11/09/20 16:05	Static multiplier of 1.06 applied to correct overnight span out of tolerance	NO, NO_2, NO_x	LT	20/10/20
11/09/20 14:00	11/09/20 16:00	Non-scheduled maintenance - wind sensor (ID=18-0837) out for annual maintenance, wind sensor (ID=18-0882) in as replacement	AT10m, AT2m, WS, WD, Sigma	LT	20/10/20
11/09/20 16:10	11/09/20 17:15	Non-scheduled maintenance - calibrated NO_x	CO, NO, NO_2, NO_x	LT	20/10/20
21/09/20 01:30	21/09/20 12:35	Instruments stuck in calibration mode after automatic span and zero checks	CO, NO, NO_2, NO_x	LT	20/10/20
21/09/20 12:40	21/09/20 16:00	Non-scheduled maintenance - NO_x S40 analyser (ID=18-0379) out, NO_x S40 analyser (ID=18-0140) in as replacement	CO, NO, NO_2, NO_x	LT	20/10/20
22/09/20 08:40	23/09/20 16:10	Instrument fault	NO, NO_2, NO_x	LT	20/10/20
25/09/20 16:40	25/09/20 18:00	Non-scheduled maintenance	NO, NO_2, NO_x	LT	20/10/20

7.0 Report Summary

- Percentage availability for most parameters at NorthConnex Project was above 95%, except:
  - CO and NO, NO_2, NO_x at Ashley Avenue
  - CO and NO, NO_2, NO_x at Carden Park
  - CO at James Park
  - CO at Larchmont Place
  - CO and NO, NO_2, NO_x at Thornleigh Golf Centre

Refer to Table 14 and Table 22-27 for details.

- There were no exceedances of the air quality goals at the NorthConnex Ambient Air Quality Monitoring Network for the reporting month. Please refer to Table 14-19 in Section 5.2 – Air Quality Monthly Summary for further information.

- It is noted that the percentage of negative $PM_{2.5}$ readings recorded for Headen Park was 10.1% Refer to table 15 for further details.

Appendix 1 - Definitions & Abbreviations

ERS	Environmental Reporting Services
AQMS	Air Quality Monitoring Station
AQM	Air Quality Monitor
BAM	Beta Attenuation Monitors
TEOM	Tapered Element Oscillating Microbalance
°	Degrees (True North)
K	Kelvin
LDL	Lower detectable limit
µg/m³	Micrograms per cubic metre at standard temperature and pressure (0°C and 101.3 kPa)
AT	Ambient Temperature
calm	Wind conditions where the wind speed is below the operating range of the wind sensor
CO	Carbon monoxide
mm	Millimeters
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
PM_{10}	Particulate less than 10 microns in equivalent aerodynamic diameter
$PM_{2.5}$	Particulate less than 2.5 microns in equivalent aerodynamic diameter
ppb	Parts per billion

ppm	Parts per million
WD	Vector Wind Direction
WS	Vector Wind Speed

Appendix 2 - Explanation of Exception Table

Automatic background check refers to when analyser samples zero air and measures the level of the concentration voltage. This voltage is taken as the zero-signal level and this value is subtracted from any subsequent readings as an active zero compensation. This is the analyser's fine zero measurement.

Beta count failure refers to a fault in the functioning of the EBAM. A one-minute beta count was less than the maximum acceptable counts during operation.

Calibration check outside tolerance refers to when the calibration values are outside the tolerance limits set for the precision check.

Calibration correction factor applied to data refers to an offset or multiplier applied to the data. This operation may be performed for a number of reasons including: (a) when a clear trend / drift outside the tolerance limit can be demonstrated by repeated operation precision checks, (b) when a correction is required on previously logged data due to a calibration check being outside the allowable tolerance

Commissioning refers to the initial setup and calibration of the instrument when it is first installed. For some instruments there may be a stabilisation period before normal operation commences.

Data transmission error refers to a period of time when the instrument could not transmit data. This may be due to interference, or a problem with the phone line or modem.

Equipment malfunction/instrument fault refers to a period of time when the instrument was not in the normal operating mode and did not measure a representative value of the existing conditions.

Gap in data/data not available refers to a period of time when either data has been lost or could not be collected.

Instrument Alarm refers to an alarm produced by the instrument. A range of alarms can be produced depending on how operation of the instrument is being affected.

Instrument out of service refers to a lack of data due to an instrument being shut down for repair, maintenance, or factory calibration.

Linear offset or multiplier refers to when an offset or multiplier has been applied between two points where the values of the offset or multiplier are different and the correction is interpolated between the two points.

Logger error refers to when an error occurs and instrument readings are not correctly recorded by the logger.

Maintenance refers to a period of time when the logger/instrument was switched off due to maintenance.

Overnight span/zero out of tolerance refers to when the span/zero reading measured by the analyser during an automatic precision check falls outside of the expected concentration limits.

Power Interruption refers to no power to the station therefore no data was collected at this time.

Remote Calibration refers to when a technician remotely connects to the station and manually performs a span check.

Stabilisation after power interruption refers to the startup period of an instrument after power has been restored.

Static offset or multiplier refers to when a single offset or multiplier has been applied to the data between two points either to increase or decrease the measured value.

Tape break refers to the breaking of the EBAM/BAM sample tape during operation.