

NorthConnex

NorthConnex

Ambient Air Quality and Weather Monitoring Validated Report

1st December to 31st December 2020

Report No.: DAT16630

Report issue date: 28th January 2021

Maintenance contract: MC1999

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Table of Contents

Customer Details.....	2
Revision History	2
Table of Contents.....	3
List of Figures	4
List of Tables	5
Executive Summary.....	7
1.0 Introduction	8
2.0 Monitoring and Data Collection.....	8
2.1. Siting Details.....	8
2.2. Monitored Parameters	11
2.3. Data Collection Methods	12
2.3.1. Compliance with Standards	14
2.3.2. Data Acquisition	14
2.4. Data Validation and Reporting.....	14
2.4.1. Validation	14
2.4.2. Validation notes	15
2.4.3. Reporting.....	15
3.0 Air Quality Standards and Goals	17
4.0 Calibrations and Maintenance.....	18
4.1. Units and Uncertainties	18
4.2. Maintenance	19
4.2.1. Calibration & Maintenance Summary Tables	19

5.0	Results.....	26
5.1.	Data Capture	26
5.2.	Air Quality Monthly Summary	28
5.3.	Graphic Representations	34
6.0	Valid Data Exception Tables.....	44
7.0	Report Summary	56
	Appendix 1 - Definitions & Abbreviations.....	57
	Appendix 2 - Explanation of Exception Table	59

List of Figures

Figure 1: NorthConnex Project Monitoring Station Locations.....	9
Figure 2: NorthConnex Project Air Monitoring Stations - CO 8 Hour Rolling Averages for December 2020	34
Figure 3: NorthConnex Project Air Monitoring Stations - NO ₂ 1 Hour Averages for December 2020.....	35
Figure 4: NorthConnex Project Air Monitoring Stations - PM ₁₀ 1 Day Averages for December 2020.....	36
Figure 5: NorthConnex Project Air Monitoring Stations - PM _{2.5} 1 Day Averages for December 2020	37
Figure 6: Ashley Avenue – Wind Rose for December 2020	38
Figure 7: Carden Park – Wind Rose for December 2020	39
Figure 8: Headen Park – Wind Rose for December 2020	40
Figure 9: James Park Hornsby – Wind Rose for December 2020.....	41
Figure 10: Larchmont Place – Wind Rose for December 2020	42
Figure 11: Thornleigh Golf Centre – Wind Rose for December 2020	43

List of Tables

Table 1: NorthConnex Project Monitoring Site Locations	8
Table 2. Monitoring Station Siting Audit Against AS/NZS 3580.1.1 2016	10
Table 3. Monitoring Station Siting Audit Against AS/NZS 3580.14 2014	10
Table 4: Parameters Measured at the NorthConnex Project Monitoring Stations	11
Table 5: Methods	12
Table 6: NorthConnex Project - Air Quality Goals.....	17
Table 7: Units and Uncertainties.....	18
Table 8: NorthConnex Project Ashley Avenue Maintenance Table December 2020	20
Table 9: NorthConnex Project Carden Park Maintenance Table December 2020	21
Table 10: NorthConnex Project Headen Park Maintenance Table December 2020	22
Table 11: NorthConnex Project James Park Hornsby Maintenance Table December 2020.....	23
Table 12: NorthConnex Project Larchmont Place Maintenance Table December 2020	24
Table 13: NorthConnex Project Thornleigh Golf Centre Maintenance Table December 2020	25
Table 14: Data Capture for NorthConnex Ambient Air Quality Network	27
Table 15: Percentage of PM _{2.5} Data <0.....	27
Table 16: NorthConnex Project Ashley Avenue Exceedences Recorded for December 2020.....	28
Table 17: NorthConnex Project Carden Park Exceedences Recorded for December 2020.....	29
Table 18: NorthConnex Project Headen Park Exceedences Recorded for December 2020	30
Table 19: NorthConnex Project James Park Hornsby Exceedences Recorded for December 2020	31
Table 20: NorthConnex Project Larchmont Place Exceedences Recorded for December 2020.....	32
Table 21: NorthConnex Project Thornleigh Golf Centre Exceedences Recorded for December 2020.....	33
Table 22: Ashley Avenue Valid Data Exception Table.....	44

Table 23: Carden Park Valid Data Exception Table 47

Table 24: Headen Park Valid Data Exception Table 48

Table 25: James Park Valid Data Exception Table 50

Table 26: Larchmont Place Valid Data Exception Table 52

Table 27: Thornleigh Golf Centre Valid Data Exception Table 54

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 December 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

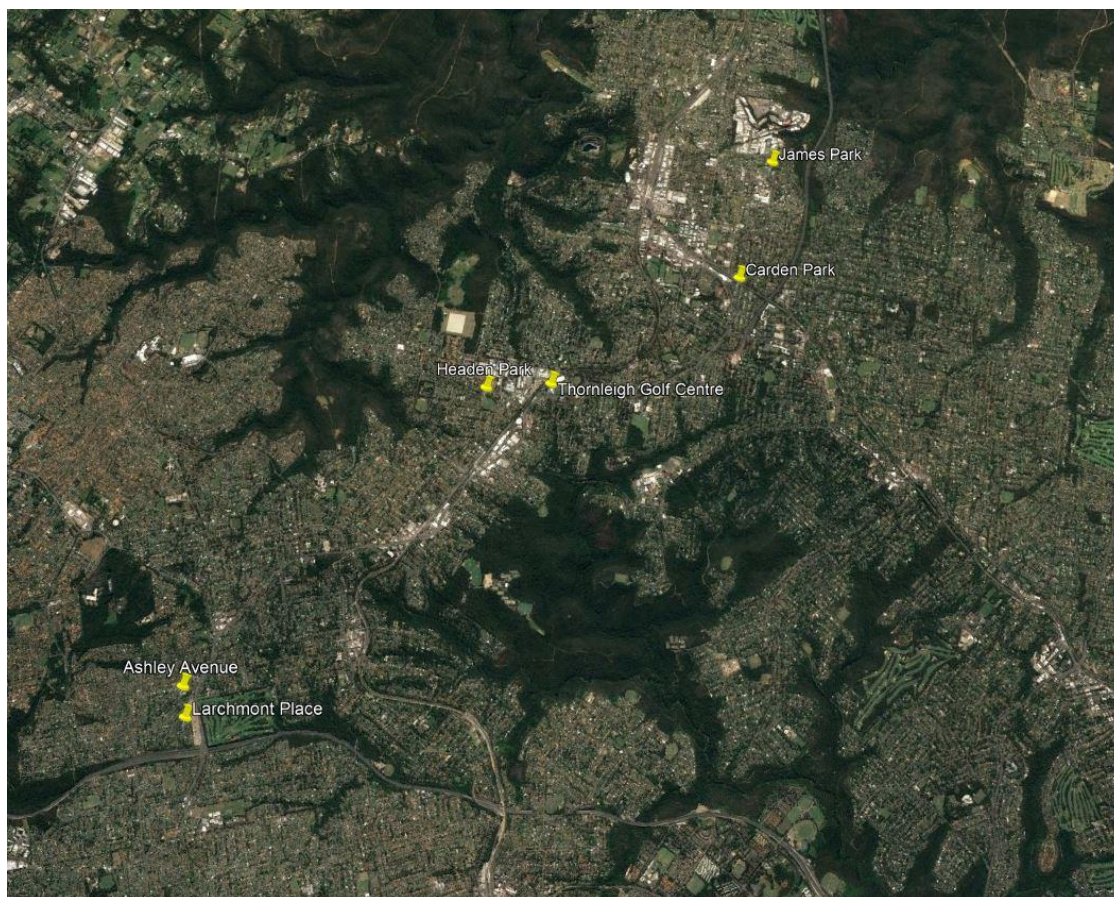


Figure 1: NorthConnex Project Monitoring Station Locations

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	16/12/20	Neighbourhood	Yes	No
Carden Park	16/12/20	Neighbourhood	Yes	No
Headen Park	16/12/20	Neighbourhood	Yes	No
James Park Hornsby	15/12/20	Peak	Yes	No
Larchmont Place	16/12/20	Neighbourhood	No	Trees
Thornleigh Golf Centre	16/12/20	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	16/12/20	Yes	Yes	No
Carden Park	16/12/20	Yes	Yes	No
Headen Park	16/12/20	Yes	Yes	No
James Park Hornsby	15/12/20	Yes	Yes	No
Larchmont Place	16/12/20	Yes	Yes	No
Thornleigh Golf Centre	16/12/20	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 PM₁₀ 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.

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 CO analysers which should stabilise over time. These adjustments are within the zero tolerances of AS/NZS 3580.7.1 –1992⁵ and do not impact the data validity.

When compared to the other sites in the NorthConnex ambient network, the wind direction at Ashley Avenue appears to be out of alignment. This data is currently under investigation and is provided for references purposes only. A review of the data will be undertaken once the investigation is complete

2.4.3. Reporting

Data is reported in six Microsoft Excel format files named

- *NorthConnex_Ashley Avenue_ Monthly Data Report_ December 2020.xls*
- *NorthConnex_Carden Park_ Monthly Data Report_ December 2020.xls*
- *NorthConnex_Headen Park_ Monthly Data Report_ December 2020.xls*
- *NorthConnex_James Park Hornsby_ Monthly Data Report_ December 2020.xls*
- *NorthConnex_Larchmont Place_ Monthly Data Report_ December 2020.xls*
- *NorthConnex_ Thornleigh Golf Centre _ Monthly Data Report_ December 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 exceedances 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/m ³
PM _{2.5}	1 Day	25	µg/m ³

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 PM₁₀ or PM_{2.5} averages associated with “exceptional events” from the total exceedances 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 exceedances are associated with exceptional events and are eligible to be excluded from the exceedance total. Monitoring and reporting of exceedances 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/m ³	1 µg/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) k factor of 2.0	0 to 1000 µg/m ³ LDL _{24hr} =1.0 µg/m ³ LDL _{hr} =4.8 µg/m ³
PM ₁₀ (TEOM)	µg/m ³	0.1 µg/m ³	±5.0 µg/m ³ or 3.6% of reading, whichever is the greater K factor of 2.0	0 µg/m ³ to 1 g/m ³ LDL=5µg/m ³
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 December 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO ₂ , NO _x	23/12/2020	Yearly	23/12/2020	15/11/2020	Monthly
CO	23/12/2020	Yearly	23/12/2020	15/11/2020	Monthly
PM ₁₀	15/12/2020	Yearly	11/12/2020	18/09/2020	3-monthly
PM _{2.5}	16/12/2020	Yearly	4/12/2020	29/10/2020	3-monthly
WS/WD/Sigma ⁸	23/12/2020	Yearly	18/12/2019 OUT (ID: 17-1647)	28/06/2018	2-yearly
			16/12/2020 IN (ID:18-0833)		
Differential Temperature 2m	14/12/2020	Yearly	14/12/2020	22/07/2020	Yearly
Differential Temperature 10m	14/12/2020	Yearly	14/12/2020	22/07/2020	Yearly

⁸ Original wind sensor installed back on the 23rd of December 2020

Table 9: NorthConnex Project Carden Park Maintenance Table December 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO ₂ , NO _x	24/12/2020	Yearly	24/12/2020	11/11/2020	Monthly
CO	24/12/2020	Yearly	24/12/2020	18/11/2020	Monthly
PM ₁₀	9/12/2020	Yearly	8/12/2020	3/09/2020	3-monthly
PM _{2.5}	9/12/2020	Yearly	7/12/2020	12/10/2020	3-monthly
WS/WD/Sigma	26/11/2020	2-yearly	2/10/2020 IN (ID:18-0836) 26/06/2018 OUT (ID:18-0833)	26/06/2018	2-yearly
Differential Temperature 2m	26/11/2020	Yearly	26/11/2020	5/12/2019	Yearly
Differential Temperature 10m	26/11/2020	Yearly	26/11/2020	5/12/2019	Yearly

Table 10: NorthConnex Project Headen Park Maintenance Table December 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO ₂ , NO _x	22/12/2020	Yearly	22/12/2020	24/11/2020	Monthly
CO	22/12/2020	Yearly	22/12/2020	26/11/2020	Monthly
PM ₁₀	10/12/2020	Yearly	9/12/2020	3/09/2020	3-monthly
PM _{2.5}	4/12/2020	Yearly	3/12/2020	29/10/2020	3-monthly
WS/WD/Sigma ⁹	3/12/2020	Yearly	1/09/2020 OUT (ID:17-1645)	27/06/2018	2-yearly
			6/12/2020 IN (ID:18-0837)		
Differential Temperature 2m	3/12/2020	Yearly	3/12/2020	2/12/2019	Yearly
Differential Temperature 10m	3/12/2020	Yearly	3/12/2020	2/12/2019	Yearly

⁹ Original wind sensor installed back on the 3rd of December 2020

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

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO ₂ , NO _x	24/12/2020	Yearly	24/12/2020	15/12/2020	Monthly
CO	24/12/2020	Yearly	24/12/2020	15/12/2020	Monthly
PM ₁₀	9/12/2020	Yearly	9/12/2020	2/09/2020	3-monthly
PM _{2.5}	8/12/2020	Yearly	7/12/2020	12/10/2020	3-monthly
WS/WD/Sigma	15/12/2020	Monthly	5/10/2020 IN (ID:18-0835) 26/06/2018 OUT (ID:18-0834)	26/06/2018	2-yearly
Differential Temperature 2m	15/12/2020	Monthly	30/11/2020	5/12/2019	Yearly
Differential Temperature 10m	15/12/2020	Monthly	30/11/2020	5/12/2019	Yearly

Table 12: NorthConnex Project Larchmont Place Maintenance Table December 2020

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO ₂ , NO _x	23/12/2020	Monthly	23/12/2020	13/11/2020	Monthly
CO	23/12/2020	Monthly	23/12/2020	16/11/2020	Monthly
PM ₁₀	15/12/2020	Yearly	11/12/2020	1/09/2020	3-monthly
PM _{2.5}	16/12/2020	Yearly	4/12/2020	30/10/2020	3-monthly
WS/WD/Sigma	12/11/2020	Monthly	2/09/2020	27/06/2018	2-yearly
Differential Temperature 2m	4/12/2020	Yearly	4/12/2020	3/12/2019	Yearly
Differential Temperature 10m	4/12/2020	Yearly	4/12/2020	3/12/2019	Yearly

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

Parameter	Date of Last Maintenance	Maintenance Type	Date of Last Calibration	Prior Calibration	Calibration Cycle
NO, NO ₂ , NO _x	25/12/2020	Non-scheduled	25/12/2020	21/12/2020 OUT (ID: 18-0140) 21/12/2020 IN (ID: 18-0379)	Monthly
CO	24/11/2020	Non-scheduled	10/11/2020	9/11/2020	Monthly
PM ₁₀	24/12/2020	Yearly	8/12/2020	2/09/2020	3-monthly
PM _{2.5}	24/12/2020	Yearly	4/12/2020	29/10/2020	3-monthly
WS/WD/Sigma	9/11/2020	Monthly	3/09/2020	28/06/2018	2-yearly
Differential Temperature 2m	9/11/2020	Monthly	4/12/2019	1/08/2019	Yearly
Differential Temperature 10m	9/11/2020	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:

$$\text{Valid Data capture} = (\text{Reported air quality data} / \text{Total data}) \times 100\%$$

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 December 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}	91.3	92.9	95.3	94.5	93.4	91.4
PM ₁₀	91.5	95.3	96.0	95.3	93.9	91.7
CO	86.2	90.5	87.9	88.2	93.6	92.6
NO, NO ₂ , NO _x	86.8	93.9	94.2	94.2	94.1	93.4
WS, WD, Sigma	98.4	97.7	98.4	97.7	97.6	97.6
AT 2m	95.3	97.7	44.7	97.7	97.6	97.6
AT 10m	95.3	97.7	98.4	35.2	97.6	97.6

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
1.0	4.6	0.4	9.1	6.5	0.3

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 period¹⁰.

Table 16: NorthConnex Project Ashley Avenue Exceedances Recorded for December 2020

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO ₂ (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM ₁₀ (µg/m ³)	1 Day	-	-
PM _{2.5} (µg/m ³)	1 Day	-	-

¹⁰ 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 December 2020

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO ₂ (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM ₁₀ (µg/m ³)	1 Day	-	-
PM _{2.5} (µg/m ³)	1 Day	-	-

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

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO ₂ (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM ₁₀ (µg/m ³)	1 Day	-	-
PM _{2.5} (µg/m ³)	1 Day	-	-

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

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO ₂ (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM ₁₀ (µg/m ³)	1 Day	-	-
PM _{2.5} (µg/m ³)	1 Day	-	-

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

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO ₂ (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM ₁₀ (µg/m ³)	1 Day	-	-
PM _{2.5} (µg/m ³)	1 Day	-	-

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

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO ₂ (ppm)	1 Hour	-	-
CO (ppm)	8-Hours rolling	-	-
PM ₁₀ (µg/m ³)	1 Day	-	-
PM _{2.5} (µg/m ³)	1 Day	-	-

5.3. Graphic Representations

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

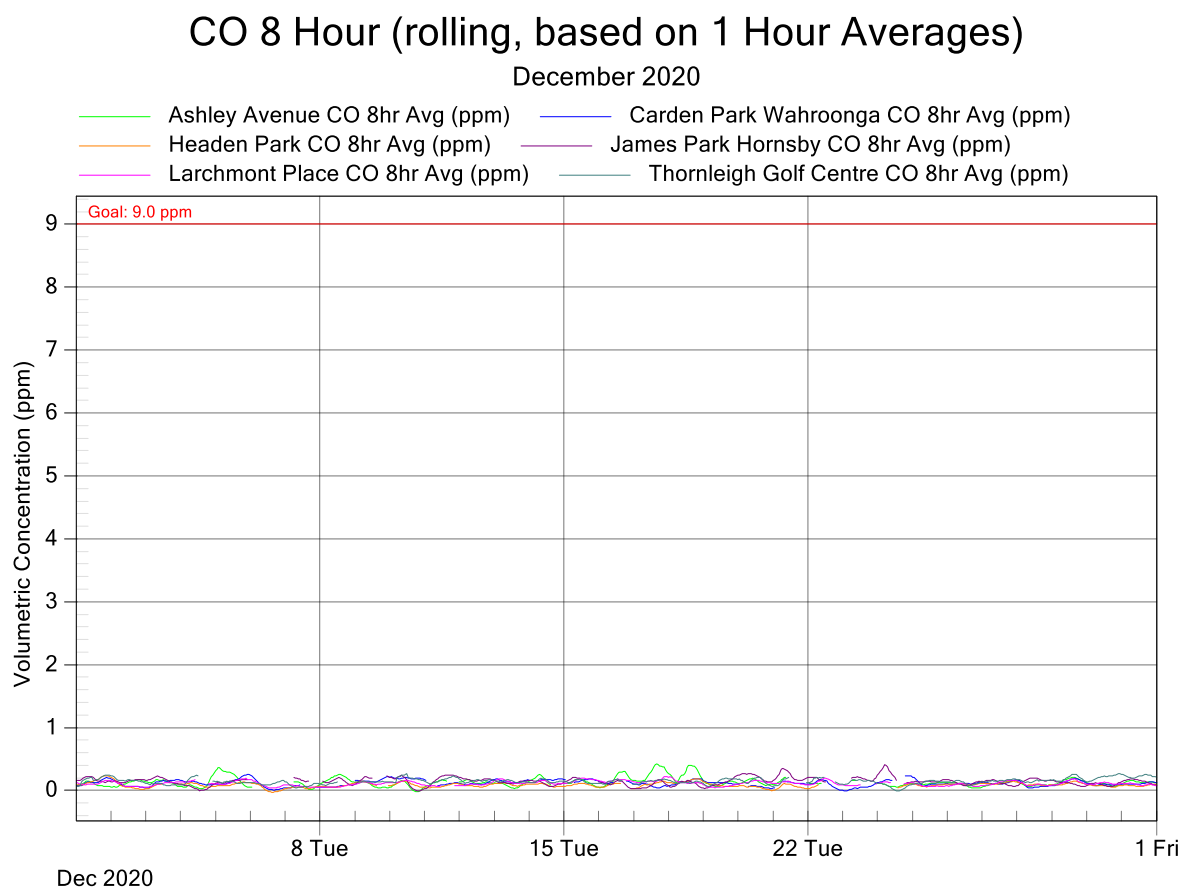


Figure 2: NorthConnex Project Air Monitoring Stations - CO 8 Hour Rolling Averages for December 2020

NO₂ 1 Hour Averages

December 2020

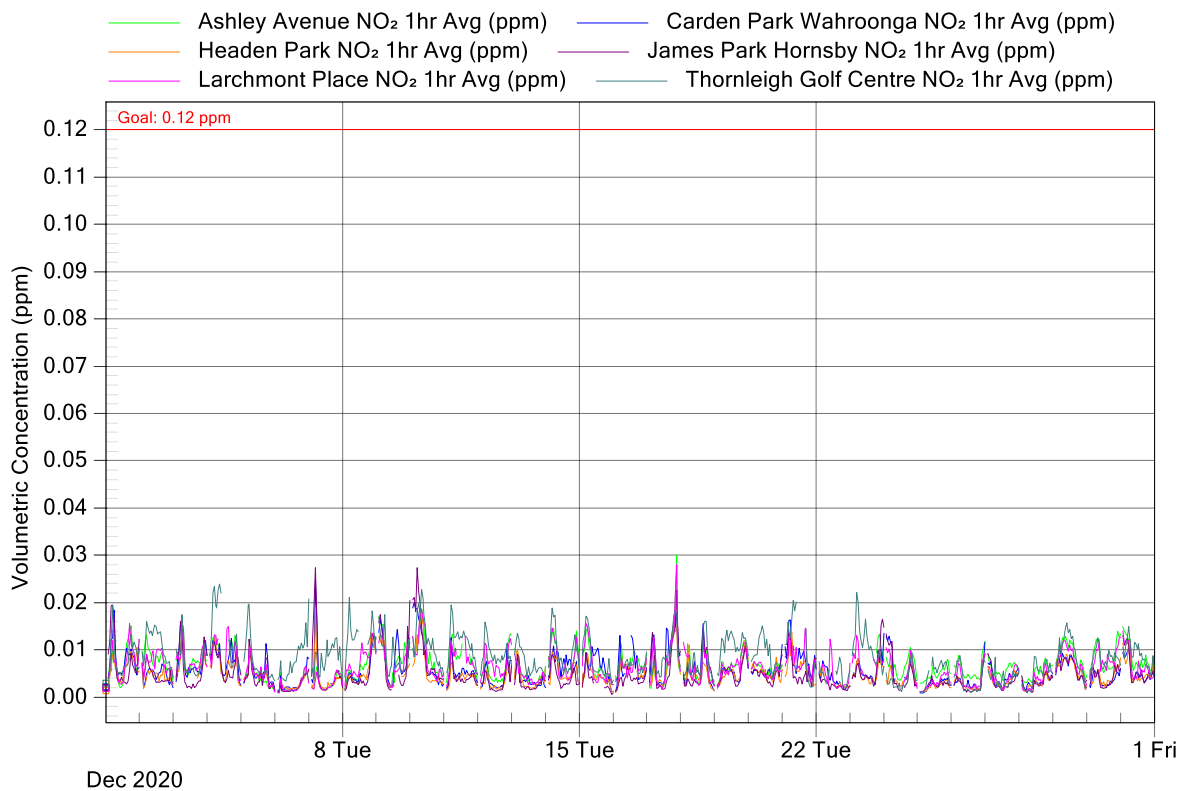


Figure 3: NorthConnex Project Air Monitoring Stations - NO₂ 1 Hour Averages for December 2020

PM₁₀ 1 Day Averages

December 2020

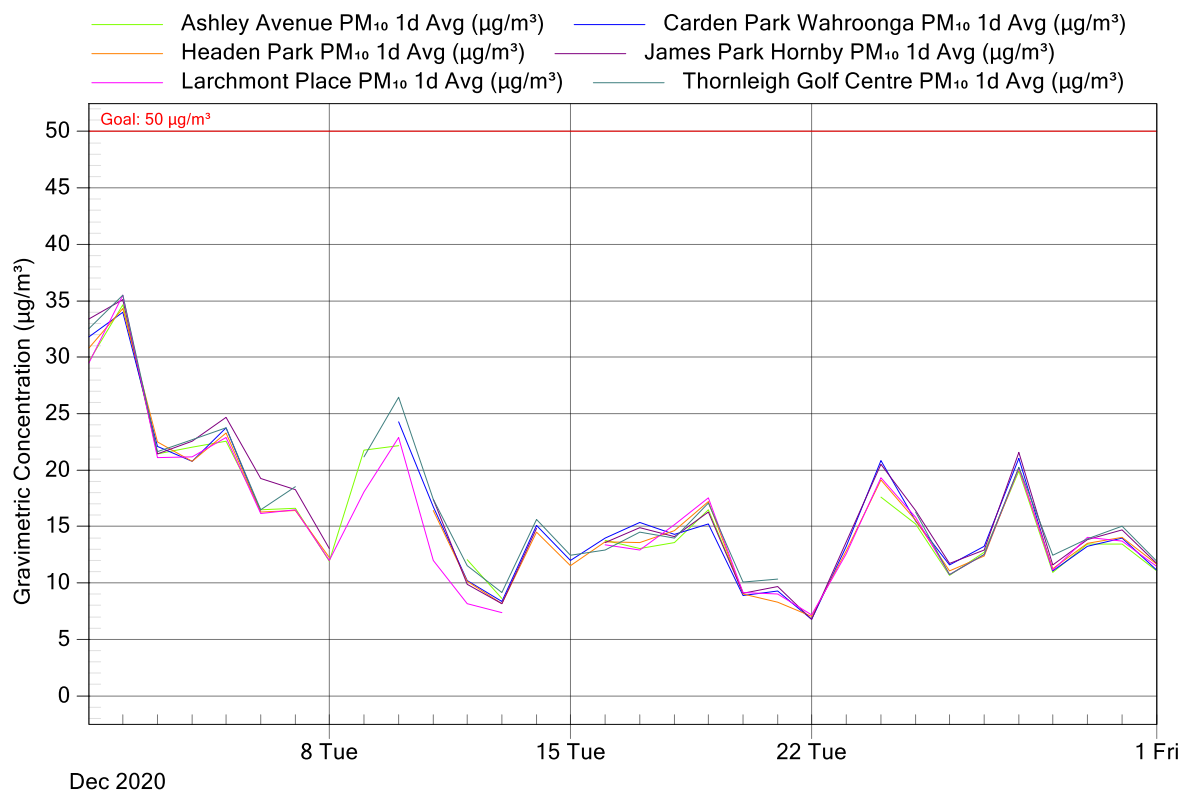


Figure 4: NorthConnex Project Air Monitoring Stations - PM₁₀ 1 Day Averages for December 2020

PM_{2.5} 1 Day Averages

December 2020

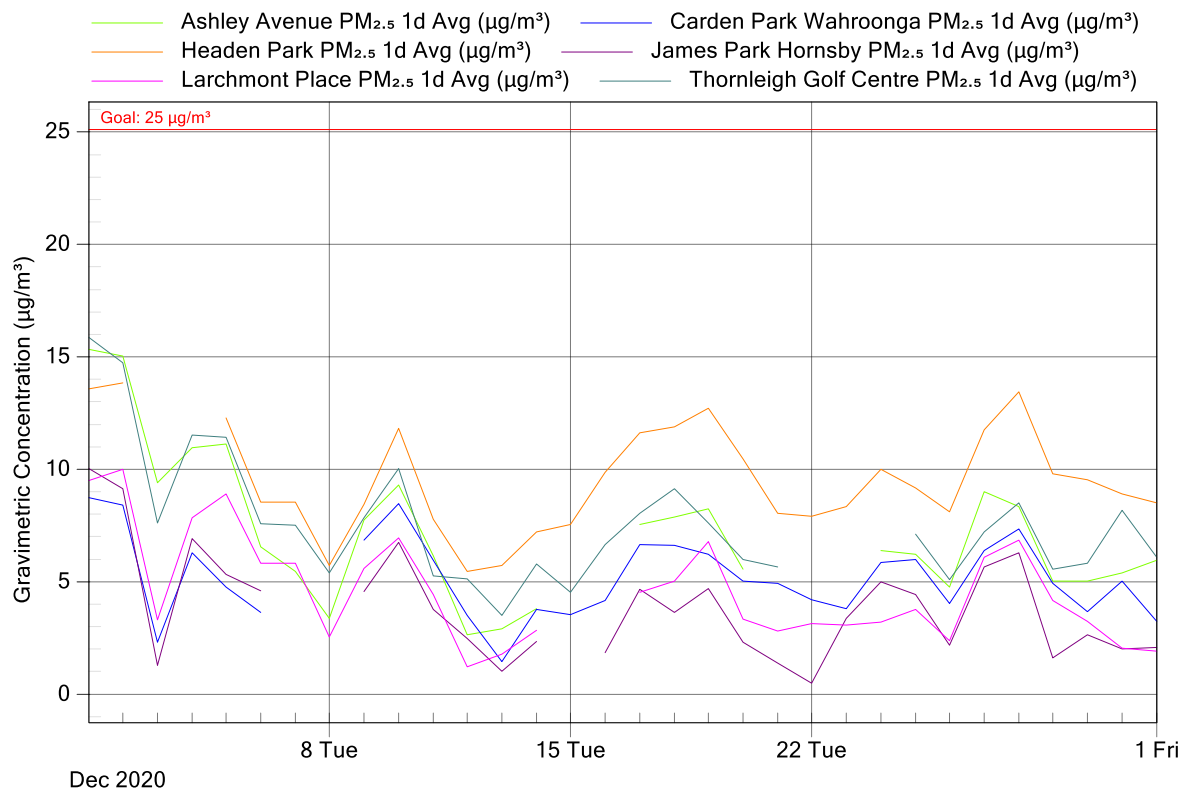


Figure 5: NorthConnex Project Air Monitoring Stations - PM_{2.5} 1 Day Averages for December 2020

Ashley Avenue - Wind Rose (1-Hour Averages)

Wind Rose

December 2020

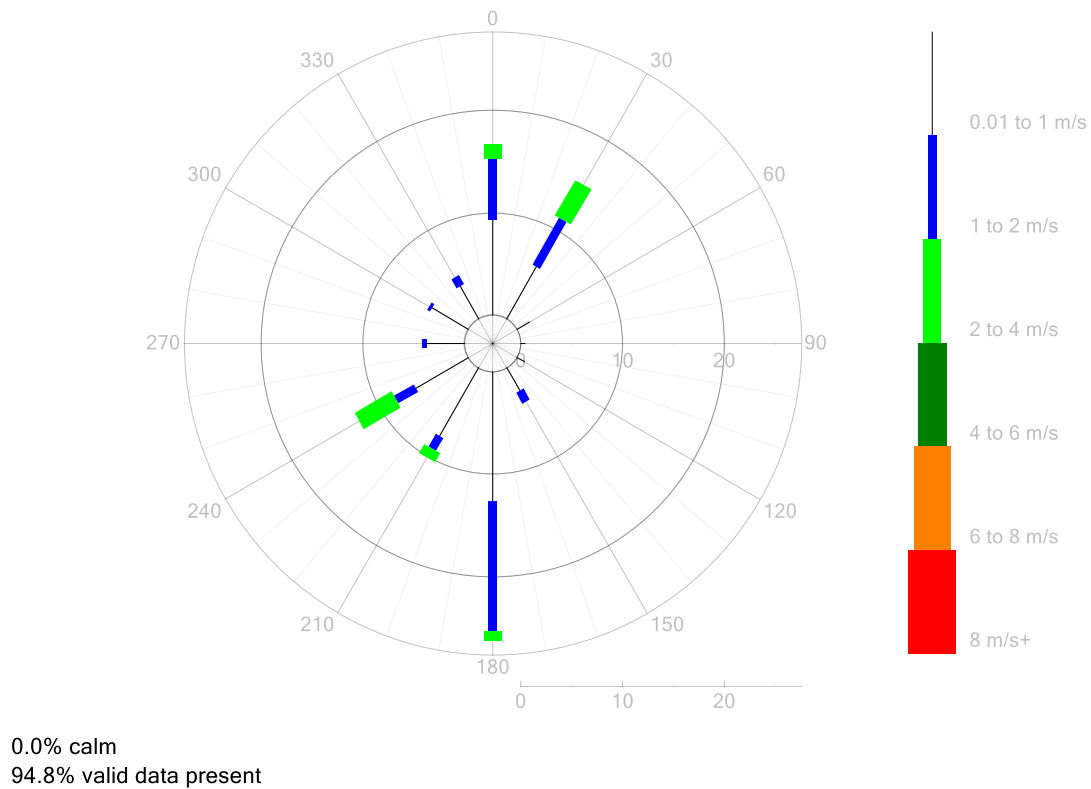


Figure 6: Ashley Avenue – Wind Rose for December 2020

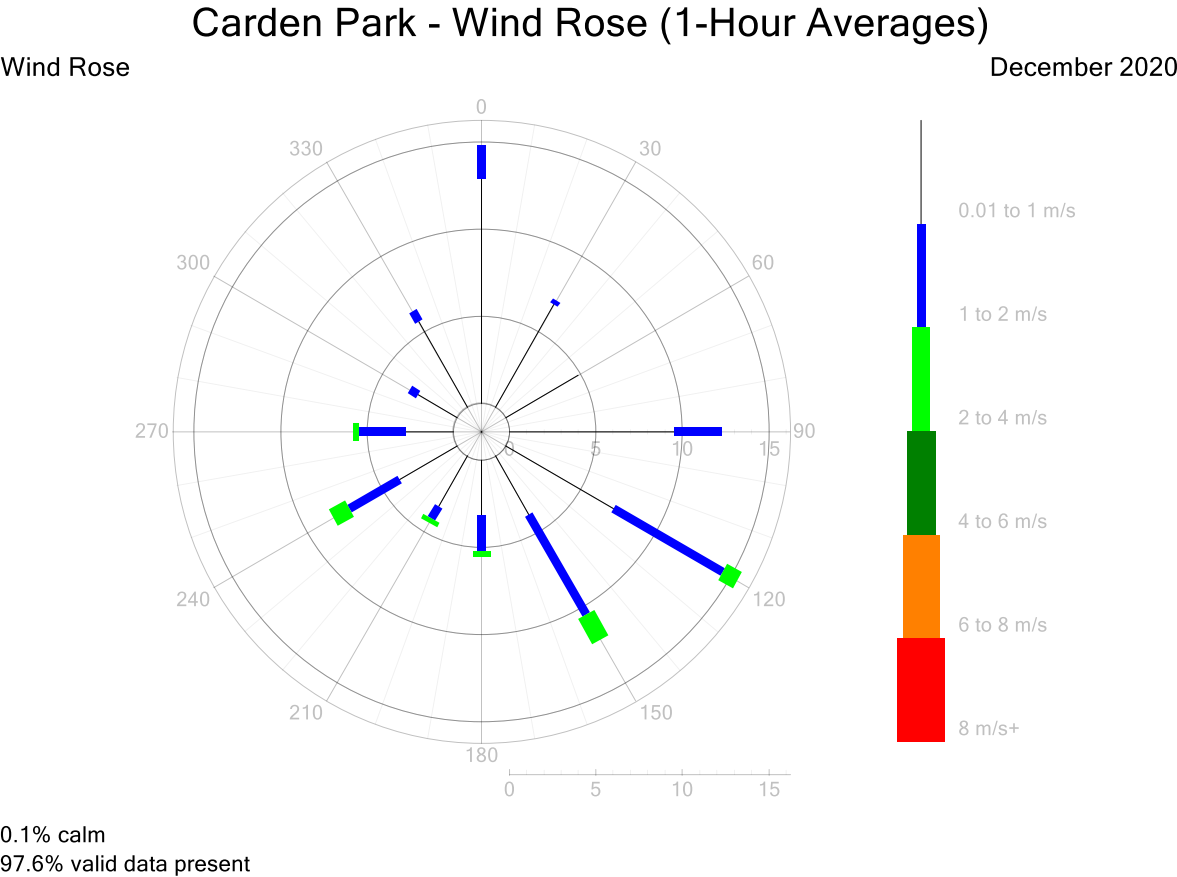


Figure 7: Carden Park – Wind Rose for December 2020

Headen Park - Wind Rose (1-Hour Averages)

Wind Rose

December 2020

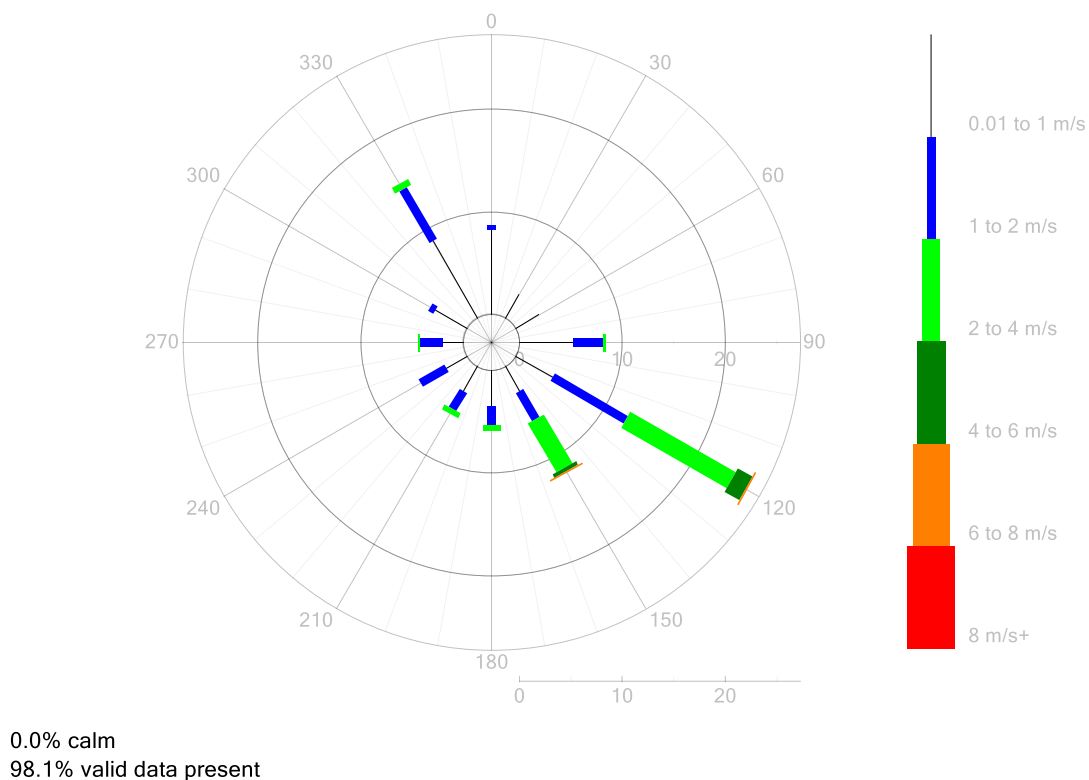
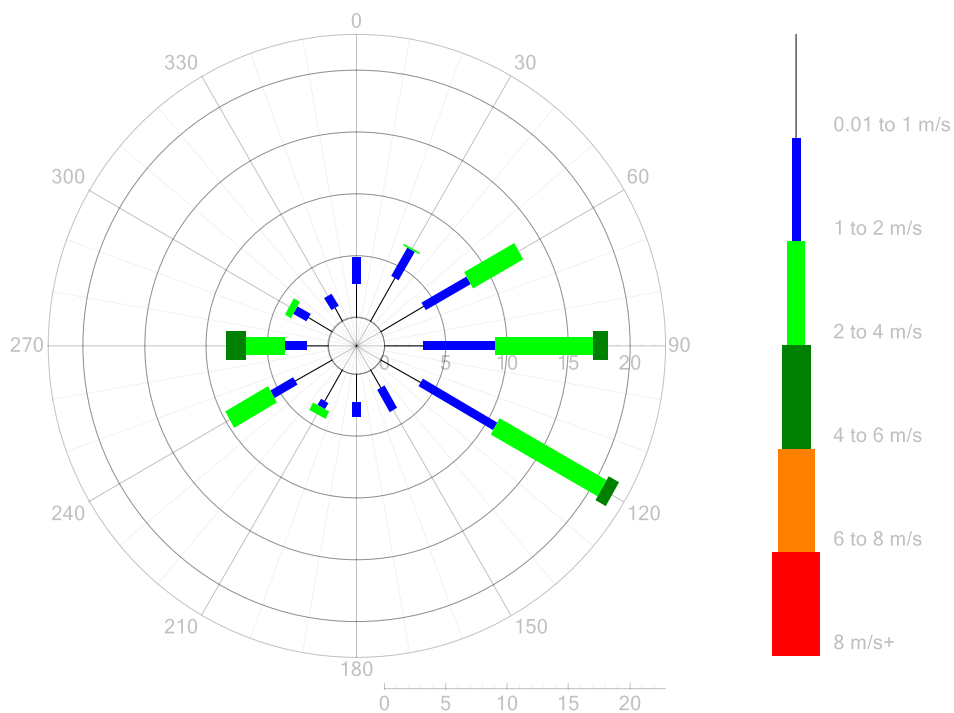


Figure 8: Headen Park – Wind Rose for December 2020

James Park Hornsby - Wind Rose (1-Hour Averages)

Wind Rose

December 2020



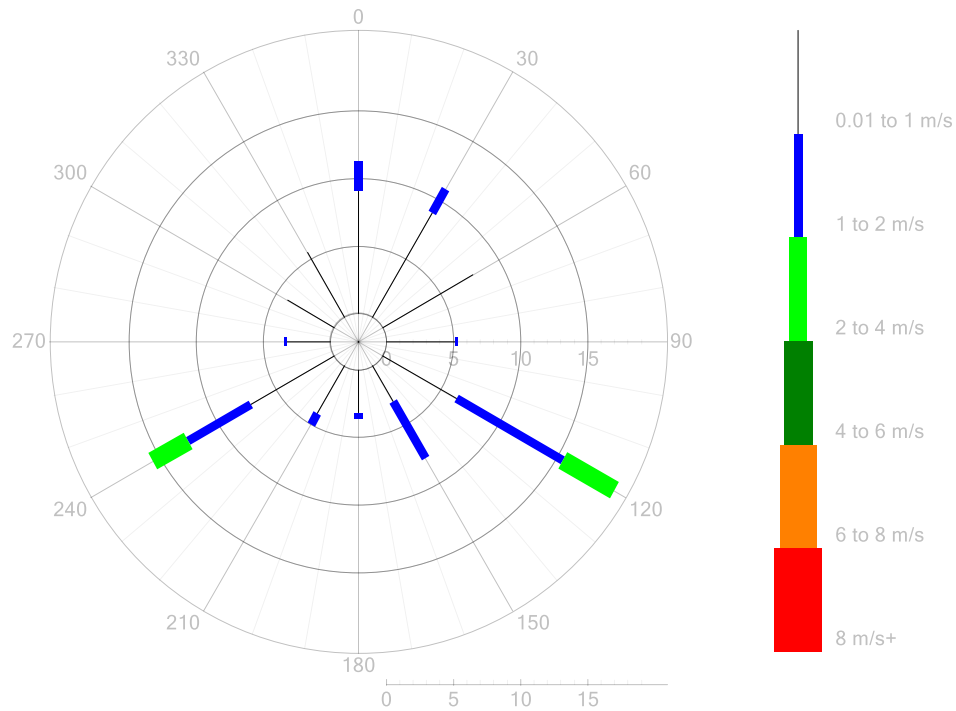
0.0% calm
97.6% valid data present

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

Larchmont Place - Wind Rose (1-Hour Averages)

Wind Rose

December 2020



0.0% calm
97.3% valid data present

Figure 10: Larchmont Place – Wind Rose for December 2020

Thornleigh Golf Centre - Wind Rose (1-Hour Averages)

Wind Rose December 2020

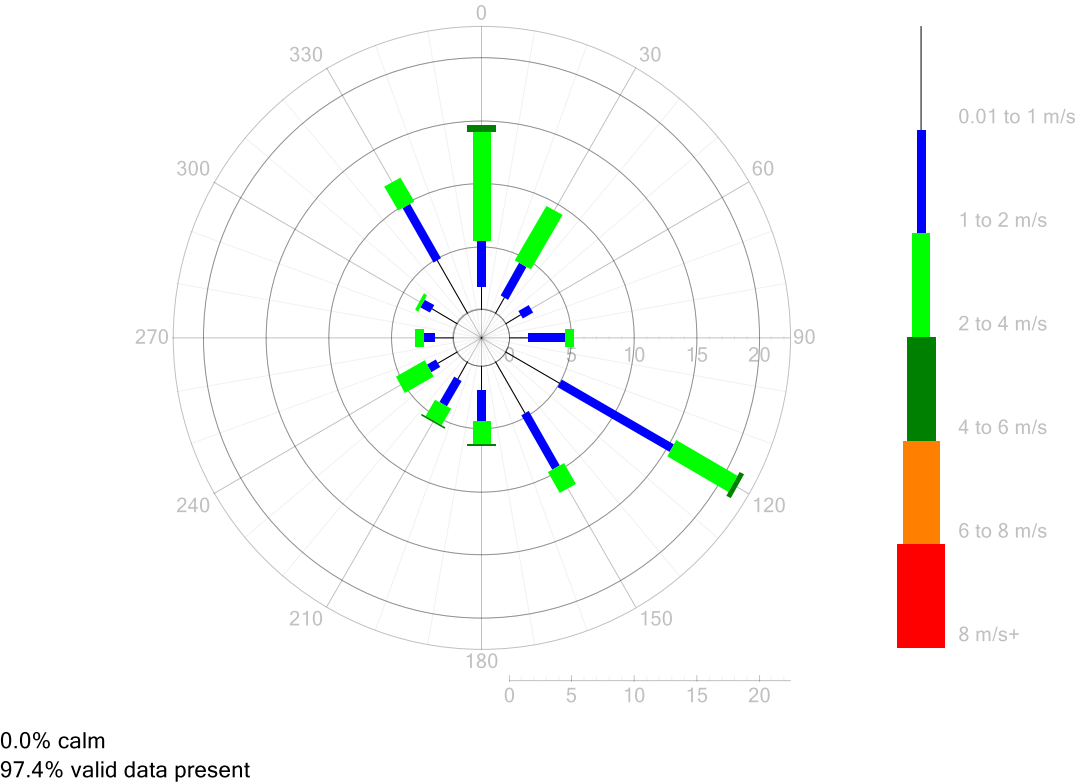


Figure 11: Thornleigh Golf Centre – Wind Rose for December 2020

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
01/12/20 00:00	01/01/21 00:00	When compared to the other sites in the NorthConnex ambient network, the wind direction at Ashley Avenue appears to be out of alignment. This data is currently under investigation and is provided for references purposes only. A review of the data will be undertaken once the investigation is complete	Data under review	LT	14/01/21
01/12/20 00:00	01/01/21 00:00	Intermittent static offsets applied as required to correct daily baseline, values range from -0.40 ppm to -0.05 ppm	CO	LT	14/01/21
01/12/20 01:00	31/12/20 01:45	Automatic span and zero checks once daily for 50 minutes	CO, NO, NO ₂ , NO _x	LT	14/01/21
01/12/20 07:40	28/12/20 17:35	Intermittent instrument fault	CO	LT	14/01/21
01/12/20 17:30	15/12/20 16:55	Intermittent additional CO background checks	CO	LT	14/01/21
01/12/20 23:45	31/12/20 23:45	Background checks once daily for 5 - 15 minutes	CO	LT	14/01/21
02/12/20 01:50	21/12/20 08:25	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values range from -0.50 ppm to 0.00 ppm and B values range from -0.45 ppm to 0.30 ppm	CO	LT	19/01/21

Start Date	End Date	Reason	Change Details	User Name	Change Date
04/12/20 13:00	04/12/20 15:00	Scheduled yearly maintenance (part 1)	All parameters	LT	14/01/21
06/12/20 01:50	06/12/20 23:40	Unrealistic CO drift	CO	LT	14/01/21
11/12/20 14:00	11/12/20 17:50	Scheduled yearly maintenance (part 2)	All parameters	LT	14/01/21
11/12/20 17:55	11/12/20 21:50	Additional instrument stabilisation	PM ₁₀	LT	14/01/21
14/12/20 14:45	14/12/20 18:20	Scheduled yearly maintenance (part 3) - TEOM zero filter installed	All parameters	LT	14/01/21
14/12/20 18:25	15/12/20 16:55	TEOM running with zero filter	PM ₁₀	LT	14/01/21
15/12/20 17:00	15/12/20 17:00	Scheduled yearly maintenance (part 4) - zero filter removed from TEOM and installed on BAM	PM ₁₀ , PM _{2.5}	LT	14/01/21
15/12/20 17:05	15/12/20 18:35	Additional instrument stabilisation	PM ₁₀	LT	14/01/21
15/12/20 18:00	16/12/20 16:00	BAM running with zero filter	PM _{2.5}	LT	14/01/21
16/12/20 16:55	16/12/20 17:50	Scheduled yearly maintenance (part 5) - zero filter removed from BAM	All parameters	LT	14/01/21
21/12/20 01:50	23/12/20 08:20	Instrument fault	NO, NO ₂ , NO _x	LT	14/01/21
21/12/20 08:00	21/12/20 18:55	Scheduled yearly maintenance (part 6)	All parameters	LT	14/01/21
22/12/20 08:00	22/12/20 18:05	Non-scheduled maintenance - s40 faulty NO _x analyser (ID:18-0313) out, spare s40 NO _x (17-0979) in as replacement. Data affected intermittently	All parameters	LT	14/01/21
22/12/20 18:10	22/12/20 23:40	Additional instrument stabilisation	CO	LT	14/01/21

Start Date	End Date	Reason	Change Details	User Name	Change Date
23/12/20 08:00	23/12/20 18:40	Scheduled yearly maintenance (part 7) - spare wind sensor (ID:17-1647) out, original wind sensor (ID:18-0833) installed back	All parameters	LT	14/01/21

Table 23: Carden Park Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/12/20 01:00	31/12/20 01:45	Automatic span and zero checks once daily for 50 minutes	CO, NO, NO ₂ , NO _x	LT	18/01/21
01/12/20 01:50	31/12/20 02:25	Intermittent additional instrument stabilisation following overnight span check (for 15-90 minutes)	CO	LT	18/01/21
01/12/20 01:50	18/12/20 23:40	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values are 0.00 ppm and B values range from -0.20 ppm to 0.20 ppm	CO	LT	18/01/21
07/12/20 09:25	07/12/20 16:10	Scheduled yearly maintenance (part 1) - BAM zero filter installed	All parameters	LT	18/01/21
07/12/20 17:00	08/12/20 14:00	BAM running with zero filter	PM _{2.5}	LT	18/01/21
08/12/20 15:00	08/12/20 18:00	Scheduled yearly maintenance (part 2) - TEOM and BAM zero filters installed	All parameters	LT	18/01/21
08/12/20 18:05	09/12/20 04:55	TEOM running with zero filter	PM ₁₀	LT	18/01/21
08/12/20 19:00	08/12/20 04:00	BAM running with zero filter	PM _{2.5}	LT	18/01/21
09/12/20 05:00	09/12/20 11:40	Scheduled yearly maintenance (part 3) - TEOM and BAM zero filters removed	PM ₁₀ , PM _{2.5}	LT	18/01/21
16/12/20 09:30	16/12/20 13:00	Scheduled yearly maintenance (part 4)	All parameters	LT	18/01/21
18/12/20 23:55	19/12/20 23:40	Static offset of 0.15 ppm applied to correct baseline	CO	LT	18/01/21
24/12/20 09:25	24/12/20 14:25	Scheduled yearly maintenance (part 5)	All parameters	LT	18/01/21

Table 24: Headen Park Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/12/20 00:00	31/12/20 23:45	Background checks once daily for 5 - 10 minutes	CO	LT	20/01/20
01/12/20 01:00	31/12/20 01:45	Automatic span and zero checks once daily for 50 minutes	CO, NO, NO ₂ , NO _x	LT	20/01/20
03/12/20 10:00	03/12/20 16:15	Scheduled yearly maintenance (part 1) - spare wind sensor (ID:17-1645) out, original wind sensor (ID:18-0837) installed back. BAM zero filter installed	All parameters	LT	20/01/20
03/12/20 17:00	04/12/20 11:00	BAM running with zero filter	PM _{2.5}	LT	20/01/20
04/12/20 12:00	04/12/20 12:00	Scheduled yearly maintenance (part 2) - BAM zero filter removed	PM _{2.5}	LT	20/01/20
09/12/20 13:40	09/12/20 17:45	Scheduled yearly maintenance (part 3) - TEOM zero filter installed	All parameters	LT	20/01/20
09/12/20 17:50	10/12/20 08:55	TEOM running with zero filter	PM ₁₀	LT	20/01/20
10/12/20 09:00	10/12/20 11:10	Scheduled yearly maintenance (part 4) - TEOM zero filter removed	PM ₁₀	LT	20/01/20
15/12/20 06:00	01/01/21 00:00	Instrument fault - unrealistic data	DT2m	LT	20/01/20
16/12/20 14:05	16/12/20 16:35	Scheduled yearly maintenance (part 5)	All parameters	LT	20/01/20
18/12/20 01:50	18/12/20 23:50	Linear offset of A=0.00 ppm and B=0.20 ppm applied to correct baseline drift	CO	LT	20/01/20
19/12/20 00:10	19/12/20 23:50	Static offset of 0.10 ppm applied to correct baseline	CO	LT	20/01/20
22/12/20 07:15	22/12/20 12:45	Scheduled yearly maintenance (part 6)	CO, NO, NO ₂ , NO _x	LT	20/01/20

Start Date	End Date	Reason	Change Details	User Name	Change Date
22/12/20 12:50	24/12/20 07:55	Instrument fault - unstable data	CO	LT	20/01/20
24/12/20 08:00	24/12/20 08:45	Non-scheduled maintenance	CO	LT	20/01/20

Table 25: James Park Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/12/20 00:00	01/01/21 00:00	Intermittent static offsets applied as required to correct daily baseline, values range from -0.40 ppm to -0.30 ppm	CO	LT	21/01/21
01/12/20 01:00	31/12/20 01:45	Automatic span and zero checks once daily for 45-50 minutes	CO, NO, NO ₂ , NO _x	LT	21/01/21
01/12/20 01:50	31/12/20 22:55	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values range from -0.50 ppm and -0.10 ppm m and B values range from -0.80 ppm to 0.00 ppm	CO	LT	21/01/21
01/12/20 20:55	23/12/20 23:45	Intermittent additional background checks	CO	LT	21/01/21
01/12/20 23:00	31/12/20 23:05	Background checks once daily for 5 - 15 minutes	CO	LT	21/01/21
05/12/20 19:55	09/12/20 01:50	Intermittent instrument fault - noisy data	AT10m	LT	21/01/21
05/12/20 21:10	22/12/20 22:55	Intermittent instrument fault - unstable baseline	CO	LT	21/01/21
07/12/20 15:00	07/12/20 19:05	Scheduled yearly maintenance (part 1) - BAM zero filter installed	All parameters	LT	21/01/21
07/12/20 20:00	08/12/20 15:00	BAM running with zero filter	PM _{2.5}	LT	21/01/21
08/12/20 16:00	08/12/20 17:00	Scheduled yearly maintenance (part 2) - BAM zero filter removed	PM _{2.5}	LT	21/01/21
09/12/20 11:00	09/12/20 16:10	Scheduled yearly maintenance (part 3) - TEOM zero filter installed	All parameters	LT	21/01/21

Start Date	End Date	Reason	Change Details	User Name	Change Date
09/12/20 16:15	10/12/20 08:55	TEOM running with zero filter	PM ₁₀	LT	21/01/21
10/12/20 09:00	10/12/20 09:20	Scheduled yearly maintenance (part 4) - TEOM zero filter removed	PM ₁₀	LT	21/01/21
14/12/20 07:35	01/01/21 00:00	Instrument fault - unrealistic data	AT10m	LT	21/01/21
15/12/20 10:20	15/12/20 17:50	Scheduled yearly maintenance (part 5)	All parameters	LT	21/01/21
24/12/20 12:00	24/12/20 14:50	Scheduled yearly maintenance (part 6)	All parameters	LT	21/01/21

Table 26: Larchmont Place Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/12/20 01:00	31/12/20 01:45	Automatic span and zero checks once daily for 50 minutes	CO, NO, NO ₂ , NO _x	LT	21/01/21
01/12/20 01:50	22/12/20 23:45	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values are 0.00 ppm and B values range from -0.20 to 0.20 ppm	CO	LT	21/01/21
01/12/20 23:50	31/12/20 23:50	Background checks once daily for 5 - 15 minutes	CO	LT	21/01/21
04/12/20 09:00	04/12/20 14:00	Scheduled yearly maintenance (part 1)	All parameters	LT	21/01/21
07/12/20 01:50	07/12/20 23:45	Static offset of 0.05 ppm applied to correct baseline	CO	LT	21/01/21
11/12/20 10:00	11/12/20 15:05	Scheduled yearly maintenance (part 2)	All parameters	LT	21/01/21
14/12/20 14:35	14/12/20 15:45	Scheduled yearly maintenance (part 3) - TEOM zero filter installed	All parameters	LT	21/01/21
14/12/20 15:50	15/12/20 16:55	TEOM running with zero filter	PM ₁₀	LT	21/01/21
15/12/20 17:00	15/12/20 18:05	Scheduled yearly maintenance (part 4) - zero filter removed from TEOM and installed on BAM	PM ₁₀	LT	21/01/21
15/12/20 19:00	16/12/20 17:00	BAM running with zero filter	PM _{2.5}	LT	21/01/21
16/12/20 18:00	16/12/20 19:00	Scheduled yearly maintenance (part 5) - BAM zero filter removed	PM _{2.5}	LT	21/01/21
23/12/20 11:20	23/12/20 17:00	Scheduled yearly maintenance (part 6)	All parameters	LT	21/01/21

Start Date	End Date	Reason	Change Details	User Name	Change Date
24/12/20 08:40	24/12/20 12:55	Scheduled yearly maintenance (part 7)	All parameters	LT	21/01/21

Table 27: Thornleigh Golf Centre Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/12/20 01:00	31/12/20 01:45	Automatic span and zero checks once daily for 45-50 minutes	CO, NO, NO ₂ , NO _x	LT	22/01/21
01/12/20 23:45	31/12/20 23:45	Background checks once daily for 5 - 15 minutes	CO	LT	22/01/21
04/12/20 11:00	04/12/20 16:00	Scheduled yearly maintenance (part 1)	All parameters	LT	22/01/21
08/12/20 11:45	08/12/20 18:10	Scheduled yearly maintenance (part 2)	All parameters	LT	22/01/21
11/12/20 00:05	24/12/20 05:10	Intermittent unrealistic negative data	NO, NO ₂ , NO _x	LT	22/01/21
16/12/20 15:00	16/12/20 17:30	Scheduled yearly maintenance (part 3)	All parameters	LT	22/01/21
21/12/20 01:50	25/12/20 08:55	Linear multiplier of A=1.05 and B=1.12 applied to correct span out of tolerance	NO, NO ₂ , NO _x	LT	22/01/21
21/12/20 10:50	21/12/20 17:45	Scheduled yearly maintenance (part 4) - s40 NO _x analyser (18-0140) out, original s40 NO _x analyser (18-0140) back from repair	All parameters	LT	22/01/21
21/12/20 17:50	21/12/20 23:40	Static offset of 0.50 ppm applied to correct baseline	CO	LT	22/01/21
22/12/20 01:50	24/12/20 23:40	Intermittent linear offsets applied as required to correct daily baseline drift after overnight span A values are 0.00 ppm and B values range from 0.10 to 0.20 ppm	CO	LT	21/01/21
22/12/20 09:00	22/12/20 14:00	Scheduled yearly maintenance (part 5) - TEOM and BAM zero filters installed	All parameters	LT	22/01/21
22/12/20 13:00	24/12/20 08:55	TEOM and BAM running with zero filter	PM ₁₀ , PM _{2.5}	LT	22/01/21

Start Date	End Date	Reason	Change Details	User Name	Change Date
24/12/20 09:00	24/12/20 09:45	Scheduled yearly maintenance (part 6) - TEOM and BAM zero filters removed	PM ₁₀ , PM _{2.5}	LT	22/01/21
25/12/20 09:00	25/12/20 09:35	Non-scheduled maintenance - NO _x calibrated remotely	All parameters	LT	22/01/21

7.0 Report Summary

- The percentage availability for the following parameters were below 95% for the reporting month:
 - PM₁₀, PM_{2.5}, CO and NO, NO₂, NO_x at Ashley Avenue.
 - PM₁₀, CO and NO, NO₂, NO_x at Carden Park.
 - PM₁₀, CO, NO, NO₂, NO_x and AT 2m at Headen Park.
 - PM₁₀, CO, NO, NO₂, NO_x and AT 10m at James Park.
 - PM₁₀, PM_{2.5}, CO and NO, NO₂, NO_x at Larchmont Place.
 - PM₁₀, PM_{2.5}, CO and NO, NO₂, NO_x at Thornleigh Golf Centre.

All other parameters were above 95% for the reporting month. Refer to Table 14 and Tables 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 was below 10% for all stations on the reporting month. 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/m ³	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.