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WestConnex

M4 East Project

Ambient Air Quality and Weather Monitoring

Validated Report

1st January 2019 – 31st January 2019

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Revision History			
Revision	**Report ID**	**Date**	**Analyst**
0	DAT14232	15/02/2019	Adriana Alvarez
1	DAT14232	04/06/2019	Adriana Alvarez

Refer to Appendix 3 for details of any amendments.

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Approved Signatory: Jon Alexander 

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Executive Summary

The M4 East project is a component of the WestConnex scheme, a NSW Government initiative to connect Sydney's west and south-west with the Sydney Airport and the Port Botany precinct. The project includes the widening of the existing M4 between Homebush Bay Drive and Underwood Road. Two new three-lane tunnels of approximately 5.5 km will extend from west of Pomeroy Street, Homebush to Alt Street at Haberfield. Interchanges or ramps will be upgraded or installed to allow access to/from the tunnel at the following locations: Homebush Bay Drive, Concord Road, Wattle Street and Parramatta Road at Ashfield/Haberfield. Tunnel ventilation facilities will be installed within the existing M4 road reserve near Underwood Road, Homebush and at the corner of Parramatta Road and Wattle Street at Haberfield. Operational ancillary facilities will be installed at Cintra Park. Associated road works, particularly at Parramatta Road to the M4 at Powells Creek and modification of the intersection of the existing M4 and Parramatta Road will also be undertaken as part of the works.

Ecotech Pty Ltd has been commissioned by CPB Samsung John Holland Joint Venture for air quality monitoring, data collection and reporting at six external ambient air quality monitoring stations: Allen Street AQM (Air Quality Monitoring), Powells Creek AQM, St Lukes Park AQM, Concord Oval AQM, Ramsay Street AQM and Haberfield Public School AQM.

1.0 Introduction

Ecotech Pty Ltd was commissioned by CPB Samsung John Holland Joint Venture to provide monitoring and data reporting for the M4 East Project ambient air quality and weather monitoring network, located as detailed in Table 1. Ecotech commenced data collection in December 2017.

This report presents the available data for January 2019.

The data presented in this report:

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

2.0 Monitoring and Data Collection

2.1. Siting Details

The WestConnex M4 East Project monitoring network consists of six ambient air quality and weather monitoring stations. The stations location and siting details are described below.

Table 1: WestConnex M4 NSW East Project monitoring sites locations

Site Name	Geographical Coordinates	Height Above Sea Level (m)
Allen Street	33°51'44.21"S, 151° 5'9.79"E	3
Concord Oval	33°52'8.60"S, 151° 6'28.97"E	7
Haberfield Public School	33°52'45.70"S, 151° 8'4.01"E	26
Powells Creek	33°51'53.80"S, 151° 5'16.50"E	10
Ramsay Street	33°52'26.20"S, 151° 8'1.50"E	5
Saint Lukes Park	33°51'55.04"S, 151° 6'35.88"E	4

A siting audit to assess sites for compliance with *AS/NZS 3580.1.1:2016* has been completed as follows:

- Allen Street on 14/11/2018
- Concord Oval on 14/11/2018
- Haberfield Public School on 02/10/2018
- Powells Creek on 14/11/2018
- Ramsay Street on 02/10/2018
- Saint Lukes Park on 09/11/2018

Figure 1: M4 East Project Monitoring Station Locations

2.2. Monitored Parameters

Table 2 below details the parameters monitored and the instruments used at the M4 East Project monitoring stations. Appendix 1 defines any abbreviated parameter names used throughout the report.

Table 2: Parameters measured at the M4 East Project monitoring stations

Station(s)	Parameter Measured	Instrument and Measurement Technique	Elevation
Allen Street Concord Oval Haberfield Public School Powells Creek Ramsay Street Saint Lukes Park	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 – 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2m
	Differential Temperature (elevation 2m)	Met One 062MP	2 m
	Differential Temperature (elevation 10m)	Met One 062MP	10 m
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10 m
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10 m
	Sigma	Calculation	-

2.3. Data Collection Methods

Table 3 below shows the methods used for data collection.

Table 3: Methods

Parameter Measured	Data Collection Methods Used	Description of Method
NO, NO_2, NO_x	AS 3580.5.1 - 2011	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 3580.7.1 - 2011	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/NZ 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[1]	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
Vector Wind Speed (Horizontal)	AS 2923-1987[2]	Methods for sampling and analysis of ambient air. Method 14: Meteorological monitoring for ambient air quality monitoring applications

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

[2] Superseded by AS/NZ 3580.14 2014 but specifically referenced in ministerial conditions.

Parameter Measured	Data Collection Methods Used	Description of Method
	Ecotech Laboratory Manual	In-house method 8.1 - Wind speed (Horizontal) by anemometer
Vector Wind Direction	AS 2923-1987[3]	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[3]	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
Atmospheric Temperature	USEPA (2000) EPA 454/R-99-005[3]	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 M4 East 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 to see occasional periods where $PM_{10} < PM_{2.5}$ and this situation does not necessarily indicate a fault with either instrument.

[3] Superseded by AS/NZ 3580.14 2014 but specifically referenced in ministerial conditions.

2.3.1. Data Acquisition

Data acquisition is performed using a PC based WinAQMS logger (using WinAQMS® Version 2.0) 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.

2.4.2. Reporting

Data is reported in six Microsoft Excel format files named

- *WestConnex_M4_Allen St_ Monthly Data Report_ January 2019.xls*
- *WestConnex_M4_Concord Oval_ Monthly Data Report_ January 2019.xls*
- *WestConnex_M4_Haberfield School_ Monthly Data Report_ January 2019 Rev1.xls*
- *WestConnex_M4_Powells Creek_ Monthly Data Report_ January 2019.xls*
- *WestConnex_M4_Ramsay St_ Monthly Data Report_ January 2019.xls*
- *WestConnex_M4_St Lukes Park _Monthly Data Report_ January 2019.xls*

Each Excel file consists of 5 worksheets:

1. Cover
2. 5 Minute Data
3. 1 Hour Data
4. 24-hour Data
5. 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.

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 Goals

The air quality goals and criteria for pollutants monitored at the M4 East project ambient monitoring sites are based on SSI 6307 Planning Approval Condition E9. The air quality goals and criteria are shown in Table 4 below.

Table 4: M4 East 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
	1 year	25	µg/m³
$PM_{2.5}$	1 day	25	µg/m³
	1 year	8	µg/m³

Note:

Exceptional events are excluded from this standard. 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 authorized hazard reduction burning; or continental scale windblown dust.

Ecotech will include any valid data identified as being associated with an exceptional event in all report tables and graphic representations. For this reason, and as the project monitoring results are part of the baseline monitoring regime, 1-day averages associated with exceptional events will not be counted as exceedences of the Air Quality goals. Monitoring and reporting of exceedences during the operational project will be in accordance with the Planning Approval Conditions E10, E11 and E12.

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 5: Units and Uncertainties

Parameter	Units	Resolution	Uncertainty	Measurement Range[4]
NO, NO_x (S40)	ppm	0.001 ppm	±1.3 ppm or 10% of reading, whichever is the greater k factor of 2.0	0 to 50 ppm
NO_2 (S40)	ppm	0.001 ppm	± 1.7 ppm k factor of 2.0	0 to 50 ppm
CO (S30)	ppm	0.1 ppm	± 1 ppm or 10% of reading, whichever is the greater k factor of 2.0	0 to 50 ppm
$PM_{2.5}$ (BAM1020)	µg/m³	1 µg/m³	±5.0 µg/m³ + 5.4% of reading K factor of 2.0	5 to 1000 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
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

[4] Uncertainties may not be calculated based on the full measurement range.

Parameter	Units	Resolution	Uncertainty	Measurement Range[4]
Atmospheric Temperature	K	0.1 K	±0.6 K K factor of 2.0	273.15 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.

Tables 6-11 indicate when the particulate and gas and meteorological equipment were last maintained/calibrated.

Table 6: M4 East Project Allen Street Maintenance Table January 2019

Parameter	Date of Last Maintenance	Maintenance Type[5]	Date of Last Calibration	Calibration Cycle
NO, NO_2, NO_x	10/01/2019	Monthly	22/01/2019	Monthly
CO	10/01/2019	Monthly	22/01/2019	Monthly
PM_{10}	10/01/2019	Monthly	13/11/2018	6 Monthly
$PM_{2.5}$	10/01/2019	Monthly	13/11/2018	Yearly
WS/WD/Sigma	10/01/2019	Monthly	06/10/2017	2 yearly
Differential Temperature 2m	10/01/2019	Monthly	13/11/2018	6 Monthly
Differential Temperature 10m	10/01/2019	Monthly	13/11/2018	6 Monthly

[5] Additional visits may have been made as required

Table 7: M4 East Project Concord Oval Maintenance Table January 2019

Parameter	Date of Last Maintenance	Maintenance Type[6]	Date of Last Calibration	Calibration Cycle
NO, NO_2, NO_x	08/01/2019	Monthly	08/01/2019	Monthly
CO	08/01/2019	Monthly	08/01/2019	Monthly
PM_{10}	08/01/2019	Monthly	14/11/2018	6 Monthly
$PM_{2.5}$	08/01/2019	Monthly	14/11/2018	Yearly
WS/WD/Sigma	08/01/2019	Monthly	06/10/2017	2 yearly
Differential Temperature 2m	08/01/2019	Monthly	19/11/2018	6 Monthly
Differential Temperature 10m	08/01/2019	Monthly	19/11/2018	6 Monthly

[6] Additional visits may have been made as required.

Table 8: M4 East Project Haberfield Public School Maintenance Table January 2019

Parameter	Date of Last Maintenance	Maintenance Type[7]	Date of Last Calibration	Calibration Cycle
NO, NO_2, NO_x	09/01/2019	Monthly	09/01/2019	Monthly
CO	09/01/2019	Monthly	09/01/2019	Monthly
PM_{10}	09/01/2019	Monthly	09/11/2018	6 Monthly
$PM_{2.5}$	09/01/2019	Monthly	09/11/2018	Yearly
WS/WD/Sigma	09/01/2019	Monthly	05/10/2017	2 yearly
Differential Temperature 2m	09/01/2019	Monthly	19/11/2018	6 Monthly
Differential Temperature 10m	09/01/2019	Monthly	19/11/2018	6 Monthly

[7] Additional visits may have been made as required.

Table 9: M4 East Project Powells Creek Maintenance Table January 2019

Parameter	Date of Last Maintenance	Maintenance Type[8]	Date of Last Calibration	Calibration Cycle
NO, NO_2, NO_x	11/01/2019	Monthly	11/01/2019	Monthly
CO	11/01/2019	Monthly	26/01/2019	Monthly
PM_{10}	11/01/2019	Monthly	15/11/2018	6 Monthly
$PM_{2.5}$	11/01/2019	Monthly	15/11/2018	Yearly
WS/WD/Sigma	11/01/2019	Monthly	06/10/2017	2 yearly
Differential Temperature 2m	11/01/2019	Monthly	20/11/2018	6 Monthly
Differential Temperature 10m	11/01/2019	Monthly	20/11/2018	6 Monthly

[8] Additional visits may have been made as required.

Table 10: M4 East Project Ramsay Street Maintenance Table January 2019

Parameter	Date of Last Maintenance	Maintenance Type[9]	Date of Last Calibration	Calibration Cycle
NO, NO_2, NO_x	07/01/2019	Monthly	07/01/2019	Monthly
CO	07/01/2019	Monthly	09/01/2019	Monthly
PM_{10}	07/01/2019	Monthly	13/11/2018	6 Monthly
$PM_{2.5}$	07/01/2019	Monthly	12/11/2018	Yearly
WS/WD/Sigma	07/01/2019	Monthly	05/10/2017	2 yearly
Differential Temperature 2m	07/01/2019	Monthly	19/11/2018	6 Monthly
Differential Temperature 10m	07/01/2019	Monthly	19/11/2018	6 Monthly

[9] Additional visits may have been made as required.

Table 11: M4 East Project Saint Lukes Park Maintenance Table January 2019

Parameter	Date of Last Maintenance	Maintenance Type[10]	Date of Last Calibration	Calibration Cycle
NO, NO_2, NO_x	08/01/2019	Monthly	08/01/2019	Monthly
CO	08/01/2019	Monthly	08/01/2019	Monthly
PM_{10}	08/01/2019	Monthly	09/08/2018	6 Monthly
$PM_{2.5}$	08/01/2019	Monthly	12/11/2018	Yearly
WS/WD/Sigma	08/01/2019	Monthly	09/10/2017	2 yearly
Differential Temperature 2m	08/01/2019	Monthly	20/11/2018	6 Monthly
Differential Temperature 10m	08/01/2019	Monthly	20/11/2018	6 Monthly

[10] Additional visits may have been made as required.

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 12 below displays data capture statistics for January 2019. **Bold** values in the table indicate data capture below 95%.

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

Table 12: Data Capture for M4 East Project Ambient Air Quality Network

Parameter	Data Capture (%)					
	Allen Street	Concord Oval	Haberfield School	Powells Creek	Ramsay Street	Saint Lukes Park
$PM_{2.5}$	98.8	99.6	**0.0**	97.4	98.7	99.5
PM_{10}	99.1	94.4	99.6	98.1	99.2	99.7
CO	97.1	96.7	95.6	**65.1**	**92.7**	95.4
NO, NO_2, NO_x	97.0	97.3	96.1	96.3	**94.6**	**92.6**
WS, WD, Sigma	99.7	99.7	99.6	98.5	**93.9**	99.7
AT 2m	**80.4**	99.7	99.6	96.0	99.4	99.7
AT 10m	99.8	99.7	93.4	98.5	99.4	99.7

5.2. Air Quality Monthly Summary

Tables 13-18 below include a summary of any exceedances recorded at the M4 East Project stations during the reported period[11].

Table 13: M4 East Project Allen Street Exceedences Recorded for January 2019

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM_{10} (µg/m³)	24-hour	-	-
	Annual	-	-
$PM_{2.5}$ (µg/m³)	24-hour	-	-
	Annual[12]	-	-

[11] Exceedances are based on the decimal places reported.

[12] Insufficient data to report annual average, any exceedences will be reported in December 2019.

Table 14: M4 East Project Concord Oval Exceedences Recorded for January 2019

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM_{10} (µg/m³)	24-hour	-	-
	Annual	-	-
$PM_{2.5}$ (µg/m³)	24-hour	-	-
	Annual[13]	-	-

[13] Insufficient data to report annual average, any exceedences will be reported in December 2019.

Table 15: M4 East Project Haberfield Public School Exceedences Recorded for January 2019

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM_{10} (µg/m³)	24-hour	-	-
	Annual	-	-
$PM_{2.5}$ (µg/m³)	24-hour	-	-
	Annual[14]	-	-

[14] Insufficient data to report annual average, any exceedences will be reported in December 2019.

Table 16: M4 East Project Powells Creek Exceedences Recorded for January 2019

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM_{10} (µg/m³)	24-hour	-	-
	Annual	-	-
$PM_{2.5}$ (µg/m³)	24-hour	-	-
	Annual[15]	-	-

[15] Insufficient data to report annual average, any exceedences will be reported in December 2019.

Table 17: M4 East Project Ramsay Street Exceedences Recorded for January 2019

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM_{10} (µg/m³)	24-hour	-	-
	Annual	-	-
$PM_{2.5}$ (µg/m³)	24-hour	-	-
	Annual[16]	-	-

[16] Insufficient data to report annual average, any exceedences will be reported in December 2019.

Table 18: M4 East Project Saint Lukes Park Exceedences Recorded for January 2019

Parameter	Time Period	Value of Exceedence	Date of Exceedence
NO_2 (ppm)	1 hour	-	-
CO (ppm)	8-hour rolling	-	-
PM_{10} (µg/m³)	24-hour	-	-
	Annual	-	-
$PM_{2.5}$ (µg/m³)	24-hour	-	-
	Annual[17]	-	-

[17] Insufficient data to report annual average, any exceedences will be reported in December 2019.

5.3. Tabulated data

5.3.1. Annual average

Table 19 displays monthly averages of the $PM_{2.5}$ and PM_{10} parameters collected at M4 East project ambient air monitoring stations for 2019. Averages shown are for the 2019 calendar year, up to the current reported month. Table requires at least 75% valid data to display a monthly average. Footer values are based on all available data for 2019 rather than the average of individual months. This gives an indication of performance against the annual objectives.

Table 19: PM_{10} and $PM_{2.5}$ averages at the WestConnex M4 ambient air monitoring stations 2019

Month	Allen Street		Concord Oval		Haberfield school		Powells Creek		Ramsay Street		Saint Lukes Park	
	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)
Jan/19	24.6	10	26.1	9	24.2	-	30.1	12	27.4	11	23.9	9
Average	**24.6**	**10.5**	**26.1**	**9.0**	**24.2**	**-**	**30.1**	**11.5**	**27.4**	**10.5**	**23.9**	**8.8**

5.4. Graphic Representations

This section displays graphs of the pollutants and meteorological parameters monitored at the M4 East sites for January 2019. The graphs are based on validated 5 minutes or 1-hour data as appropriate.

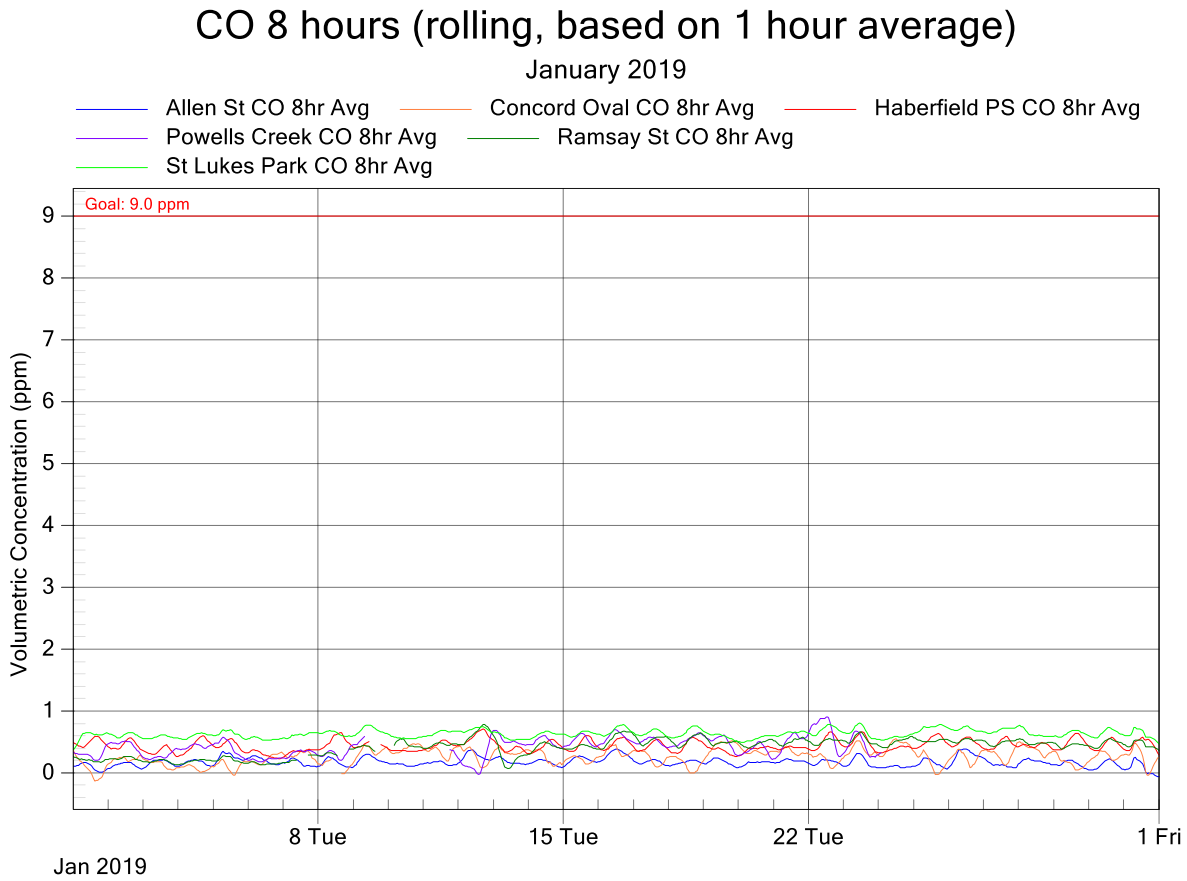


Figure 2: M4 East Project Air Monitoring Stations - CO 8 hours Rolling graph for January 2019

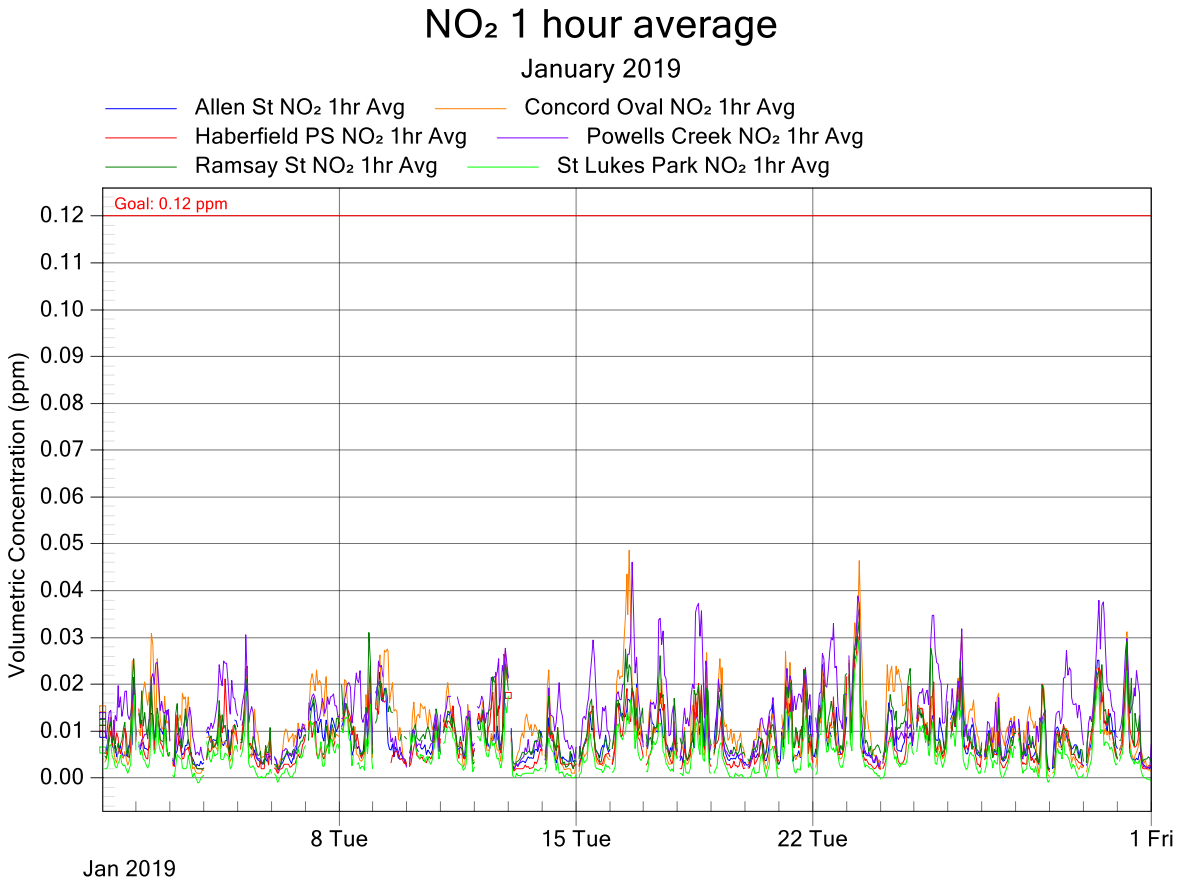


Figure 3: M4 East Project Air Monitoring Stations - NO_2 graph for January 2019

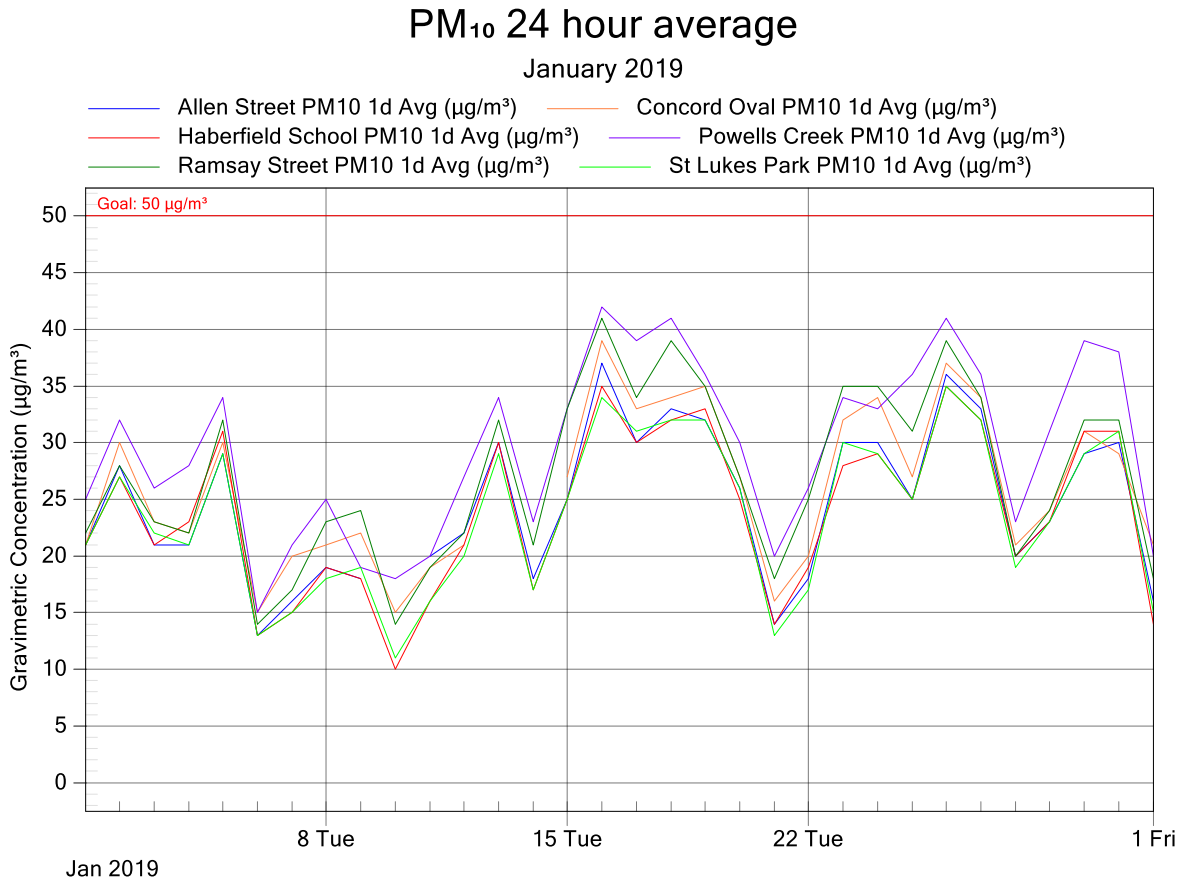


Figure 4: M4 East Project Air Monitoring Stations - PM_{10} 24 Hour graph for January 2019

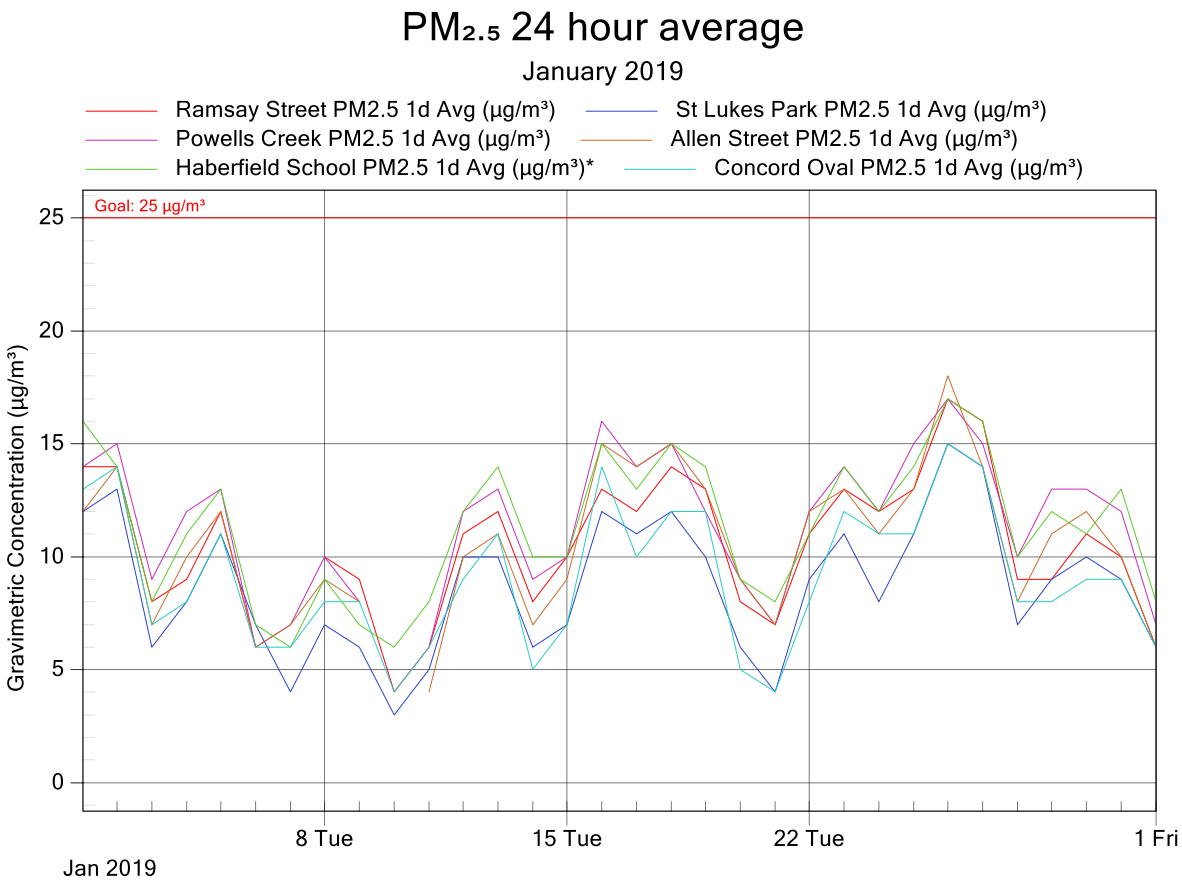
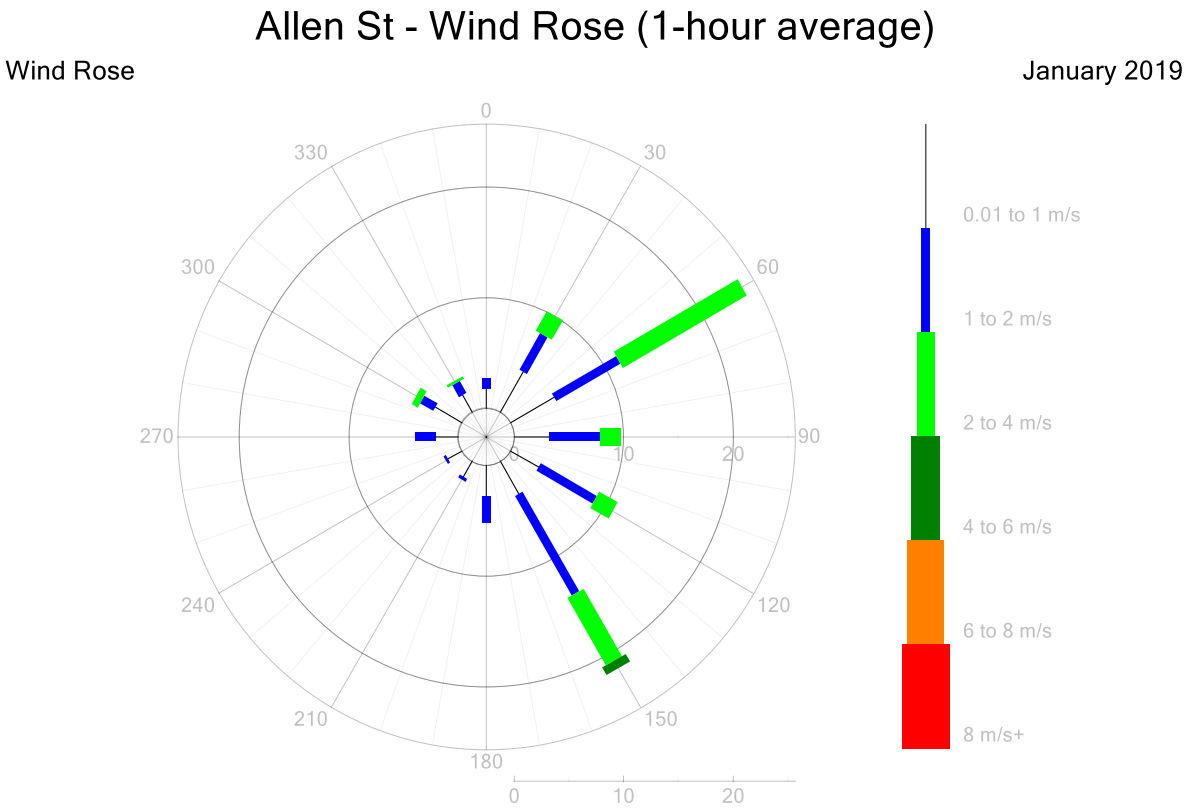


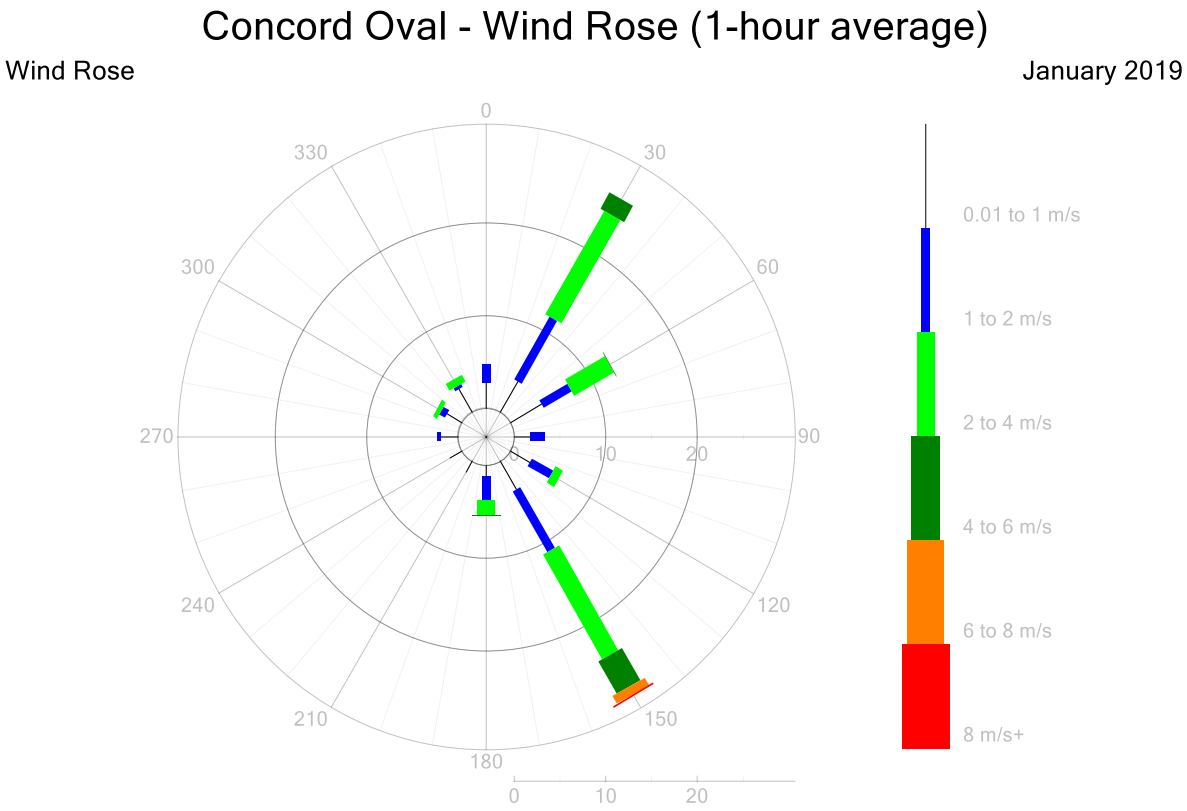
Figure 5: M4 East Project Air Monitoring Stations - $PM_{2.5}$ 24 Hour graph January 2019

*Data for Haberfield School station has been included in this figure for reference purposes only. Refer to Appendix 3 for details.



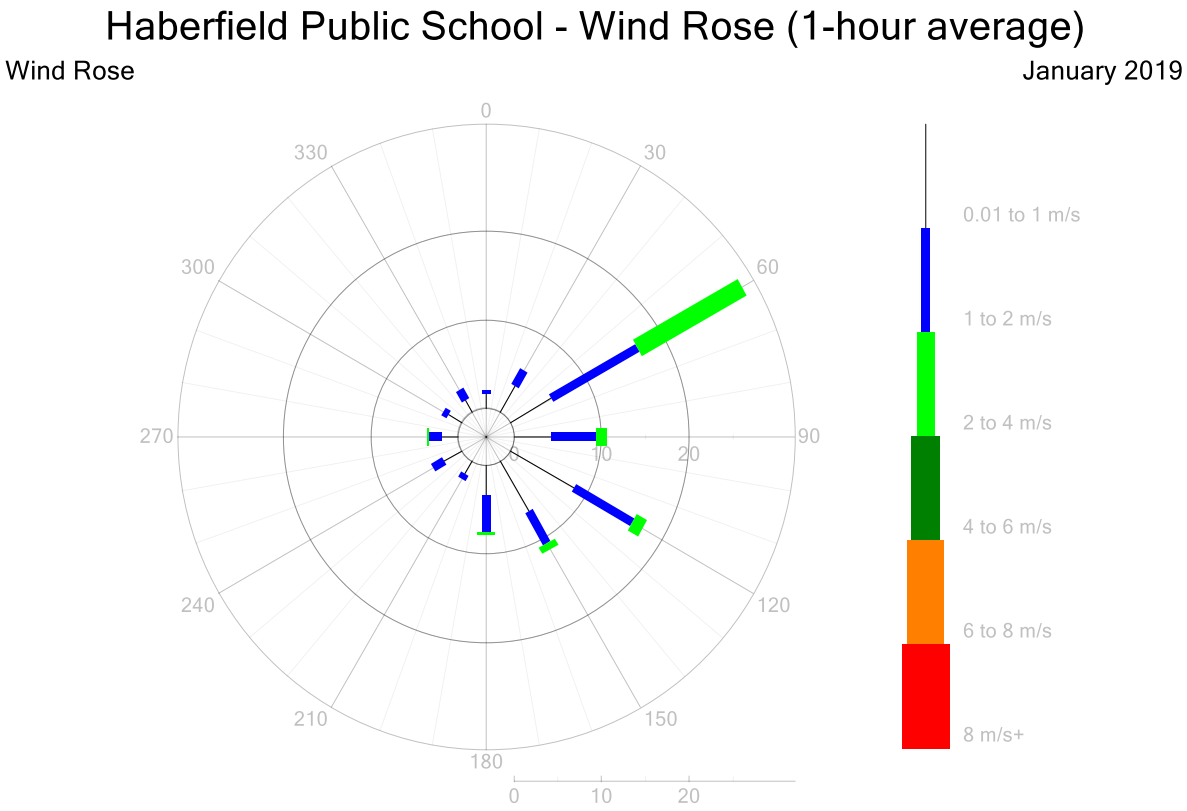
0.0% calm
99.7% valid data present

Figure 6: Allen Street – Wind Rose for January 2019



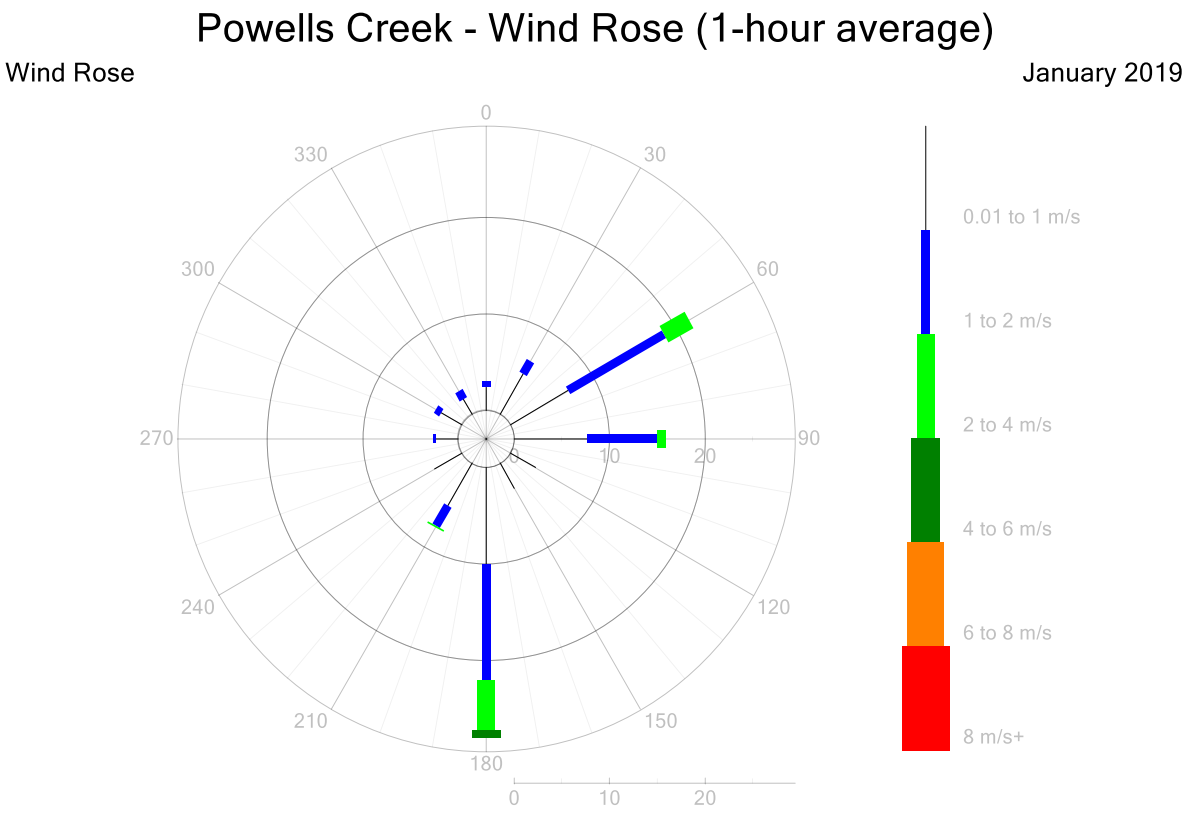
0.0% calm
99.7% valid data present

Figure 7: Concord Oval – Wind Rose for January 2019



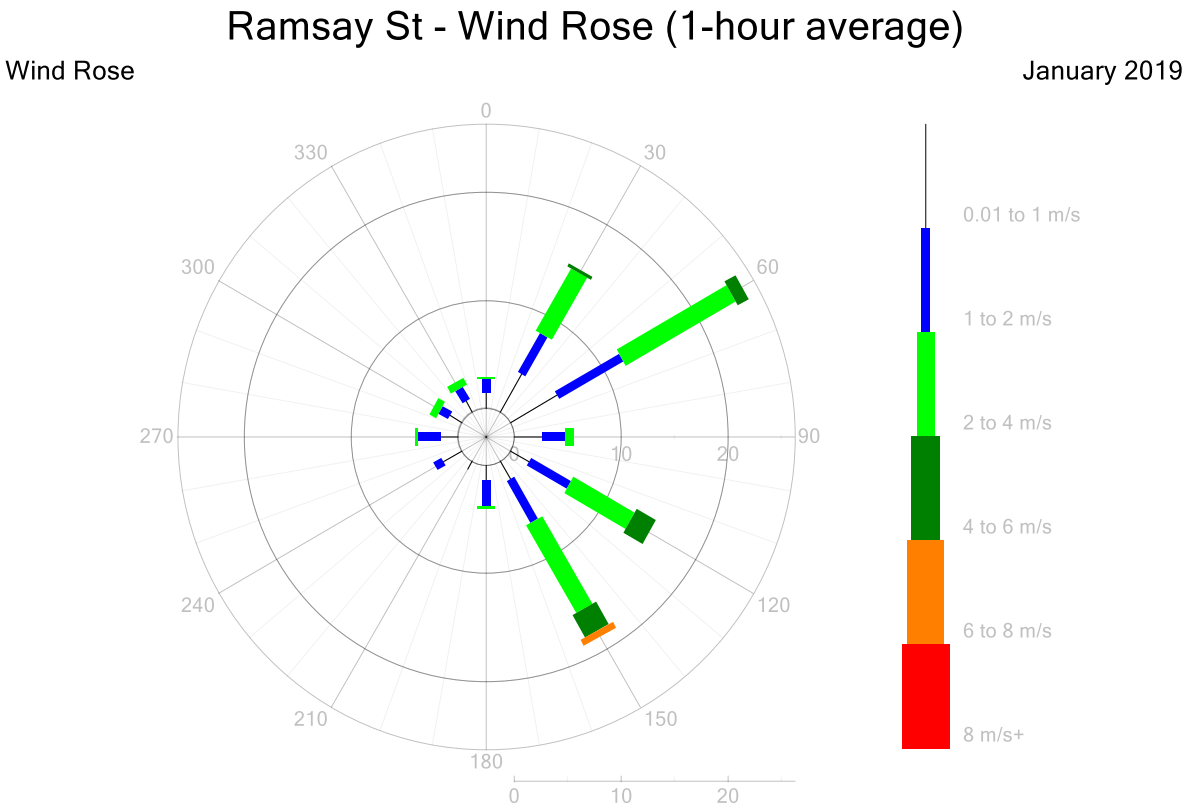
0.0% calm
99.6% valid data present

Figure 8: Haberfield Public School – Wind Rose for January 2019



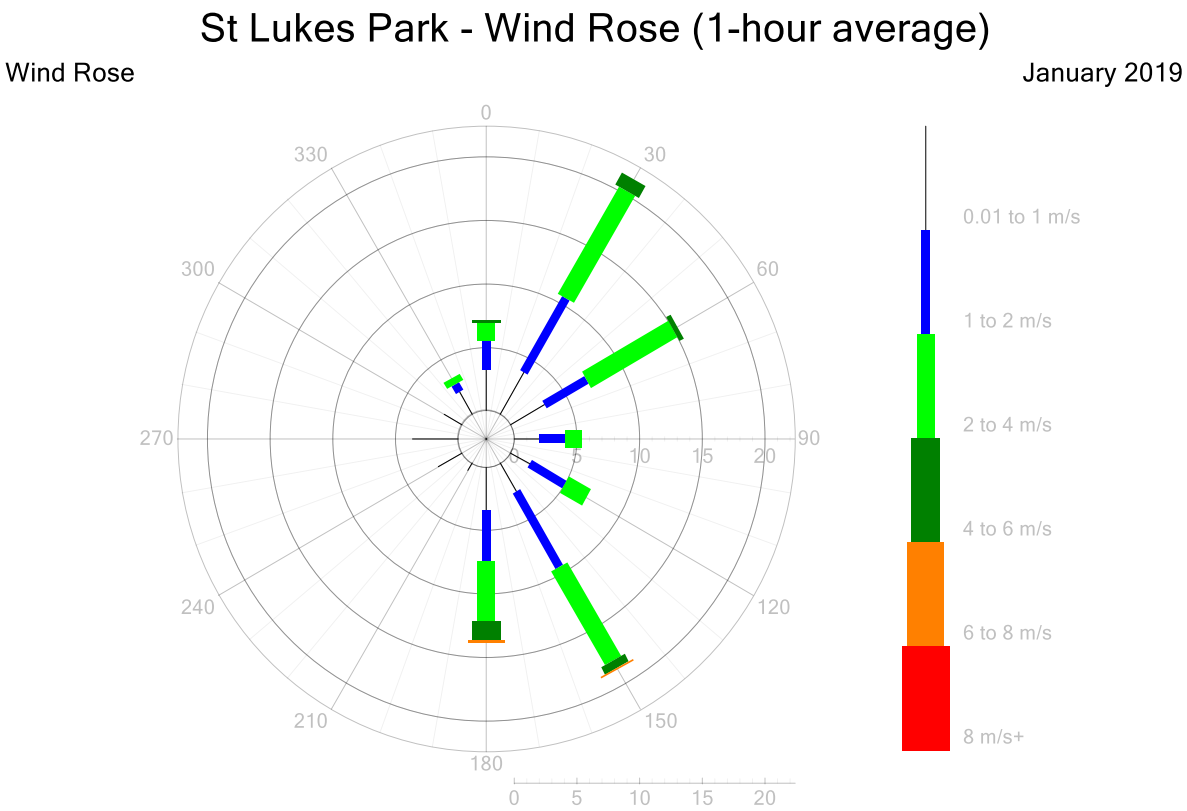
0.0% calm
98.5% valid data present

Figure 9: Powells Creek – Wind Rose for January 2019



0.0% calm
93.7% valid data present

Figure 10: Ramsay Street – Wind Rose for January 2019



0.0% calm
99.7% valid data present

Figure 11: Saint Lukes Park – Wind Rose for January 2019

6.0 Valid Data Exception Tables

Tables 20 to 25 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 20: Allen Street Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/01/19 01:00	31/01/19 01:30	Automatic span and zero checks once daily for 30 - 35 minutes	CO, NO, NO_2, NO_X	AA	8/02/2019
01/01/19 07:15	31/01/19 14:40	Intermittent data transmission errors	CO, NO, NO_2, NO_X, PM_{10}, AT 2m, AT 10m, WS, WD, Sigma	AA	8/02/2019
01/01/19 23:45	31/01/19 23:55	Background checks once daily for 5 - 10 minutes	CO	AA	8/02/2019
09/01/19 01:30	09/01/19 23:40	Linear offset of A=0ppm and B=0.15ppm applied to correct baseline drift	CO	AA	8/02/2019
10/01/19 08:00	10/01/19 14:55	Scheduled monthly maintenance performed followed by instrument stabilisation	All parameters	AA	8/02/2019
10/01/19 10:30	10/01/19 10:30	Unrealistic negative reading	NO, NO_2, NO_X	AA	8/02/2019
13/01/19 00:00	13/01/19 01:00	Instrument fault - flow fault followed by instrument stabilisation	$PM_{2.5}$	AA	8/02/2019
17/01/19 01:30	17/01/19 23:45	Linear offset of A=0ppm and B=0.15ppm applied to correct baseline drift	CO	AA	8/02/2019
19/01/19 00:40	19/01/19 00:50	Suspected brief power interruption	CO, NO, NO_2, NO_X, PM_{10}, AT 2m, AT 10m, WS, WD, Sigma	AA	8/02/2019
21/01/19 02:00	31/01/19 07:50	Intermittent unrealistic data - Readings not tracking with other sites	AT 2m	AA	8/02/2019
22/01/19 14:00	22/01/19 14:30	Non-scheduled maintenance performed	CO, NO, NO_2, NO_X, PM_{10}, AT 2m, AT 10m, WS, WD, Sigma	AA	8/02/2019
23/01/19 01:35	23/01/19 23:45	Linear offset of A=0ppm and B=0.15ppm applied to correct baseline drift	CO	AA	8/02/2019

Start Date	End Date	Reason	Change Details	User Name	Change Date
29/01/19 15:25	29/01/19 15:25	Additional background check	CO	AA	8/02/2019

Table 21: Concord Oval Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/01/19 01:00	31/01/19 01:30	Automatic span and zero checks once daily for 30 - 35 minutes	CO, NO, NO_2, NO_x	AA	11/02/2019
01/01/19 05:45	31/01/19 15:30	Intermittent data transmission errors	CO, NO, NO_2, NO_x, WS, WD, Sigma, AT10m, AT2m, PM_{10}	AA	11/02/2019
01/01/19 23:45	31/01/19 23:50	Background checks once daily for 10 minutes	CO	AA	11/02/2019
03/01/19 05:15	31/01/19 23:35	Intermittent unrealistic negative readings	NO, NO_2, NO_x	AA	11/02/2019
08/01/19 08:00	08/01/19 10:50	Scheduled monthly maintenance followed by instrument stabilisation	All parameters	AA	11/02/2019
13/01/19 01:20	14/01/19 13:20	Instrument fault	PM_{10}	AA	11/02/2019
14/01/19 13:25	14/01/19 15:40	Unscheduled maintenance - Instrument fault fixed	PM_{10}	AA	11/02/2019

Table 22: Haberfield Public School Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
1/01/2019 0:00	1/02/2019 0:00	Data does not meet traceability requirements of AS/NZS 3580.9.12-2013 and has been deemed as invalid	$PM_{2.5}$	AA	17/05/2019
1/01/2019 1:00	31/01/2019 1:25	Automatic span and zero checks once daily for 25 - 35minutes	CO, NO, NO_2, NO_x	AA	13/02/2019
1/01/2019 7:05	31/01/2019 20:25	Intermittent data transmission errors	CO, NO, NO_2, NO_x, WS, WD, Sigma, AT2m, AT10m	AA	13/02/2019
1/01/2019 23:45	31/01/2019 23:50	Background checks once daily for 10 - 15 minutes	CO	AA	13/02/2019
3/01/2019 1:30	3/01/2019 23:45	Static offset of -3.20ppm applied to correct baseline drift	CO	AA	13/02/2019
5/01/2019 15:55	11/01/2019 9:20	Intermittent unrealistic data - Readings not tracking with other sites	AT 10m	AA	13/02/2019
9/01/2019 10:00	9/01/2019 13:00	Scheduled monthly maintenance	CO, NO, NO_2, NO_x, WS, WD, Sigma, AT2m, AT10m, PM_{10}	AA	13/02/2019

Table 23: Powells Creek Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/01/19 01:00	31/01/19 01:25	Automatic span and zero check, once daily for 30 - 35 minutes	CO, NO, NO_2, NO_X	AA	12/02/2019
01/01/19 08:40	31/01/19 19:35	Intermittent data transmission errors	CO, NO, NO_2, NO_X, PM_{10}, AT 2m, AT 10m, WS, WD, Sigma	AA	12/02/2019
01/01/19 15:25	30/01/19 15:35	Background checks, once daily for 5 - 15 minutes	CO	AA	12/02/2019
05/01/19 21:40	12/01/19 07:00	Intermittent unrealistic data - Readings not tracking with other sites	DT 2m	AA	12/02/2019
09/01/19 07:00	09/01/19 11:30	Power interruption followed by instrument stabilisation	All parameters	AA	12/02/2019
09/01/19 11:35	10/01/19 12:20	Instrument fault following power interruption	CO	AA	12/02/2019
09/01/19 11:35	09/01/19 13:45	Additional instrument stabilisation following power interruption	PM_{10}	AA	12/02/2019
09/01/19 18:15	10/01/19 11:15	Intermittent unrealistic negative readings	NO, NO_2, NO_X	AA	12/02/2019
10/01/19 11:00	10/01/19 17:00	Power interruption followed by instrument stabilisation	All parameters	AA	12/02/2019
10/01/19 15:40	11/01/19 07:40	Instrument fault following power interruption	CO	AA	12/02/2019
11/01/19 07:00	11/01/19 12:10	Scheduled monthly maintenance	All parameters	AA	12/02/2019
11/01/19 12:10	11/01/19 15:20	Static offset of -0.60ppm applied to correct baseline step change after maintenance	CO	AA	12/02/2019
22/01/19 13:40	22/01/19 15:25	Step change in baseline, readings no tracking with other sites	CO	AA	12/02/2019
24/01/19 01:30	01/02/19 00:00	Readings became unstable and instrument was found out of calibration during maintenance visit performed in February	CO	AA	12/02/2019
26/01/19 16:00	26/01/19 17:00	Unscheduled maintenance performed followed by instrument stabilisation	$PM_{2.5}$, CO, NO, NO_2, NO_X	AA	12/02/2019

Table 24: Ramsay Street Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/01/19 01:00	31/01/19 01:40	Automatic span and zero checks, once daily for 40 - 45 minutes	CO, NO, NO_2, NO_X	AA	13/02/2019
01/01/19 05:15	31/01/19 02:40	Intermittent data transmission errors	CO, NO, NO_2, NO_X, AT2m, AT10m, WS, WD, Sigma, PM_{10}	AA	13/02/2019
01/01/19 23:50	31/01/19 23:50	Background checks, once daily for 5 - 10 minutes	CO	AA	13/02/2019
05/01/19 15:40	07/01/19 08:10	Instrument fault - Wind sensor stalled	WS, WD, Sigma	AA	13/02/2019
07/01/19 08:00	07/01/19 14:00	Scheduled maintenance performed followed by instrument stabilisation	All parameters	AA	13/02/2019
07/01/19 11:45	08/01/19 09:32	Static offset of -0.4ppm applied to correct step change in baseline after maintenance	CO	AA	13/02/2019
08/01/19 12:15	08/01/19 15:15	Unscheduled maintenance performed followed by instrument stabilisation. CO instrument swapped out (IN: 17-2060, OUT: 13-1090)	All parameters	AA	13/02/2019
08/01/19 15:20	08/01/19 23:40	Linear offset of A= 0.152ppm and B= 0.700ppm applied to correct baseline drift after maintenance	CO	AA	13/02/2019
08/01/19 23:55	09/01/19 00:55	Static offset of -0.630ppm applied to correct step change in baseline after reference check	CO	AA	13/02/2019
09/01/19 01:45	09/01/19 15:15	Static offset of -0.600ppm applied to correct zero step change	CO	AA	13/02/2019
09/01/19 15:20	09/01/19 18:15	Unscheduled remote maintenance commenced	CO, NO, NO_2, NO_X	AA	13/02/2019
09/01/19 18:20	09/01/19 20:40	Static offset of -0.750ppm applied to correct step change in baseline after remote maintenance	CO	AA	13/02/2019
09/01/19 20:45	09/01/19 21:50	Unscheduled remote maintenance continued	CO, NO, NO_2, NO_X	AA	13/02/2019
10/01/19 01:45	10/01/19 23:40	Linear offset of A= 0.000ppm and B= -0.540ppm applied to correct baseline drift	CO	AA	13/02/2019

Start Date	End Date	Reason	Change Details	User Name	Change Date
11/01/19 01:45	11/01/19 23:40	Linear offset of A= 0.000ppm and B= -0.410ppm applied to correct baseline drift	CO	AA	13/02/2019
13/01/19 01:45	13/01/19 23:40	Linear offset of A= 0.000ppm and B= -0.410ppm applied to correct baseline drift	CO	AA	13/02/2019
14/01/19 01:45	14/01/19 23:40	Linear offset of A= 0.000ppm and B= -0.520ppm applied to correct baseline drift	CO	AA	13/02/2019
15/01/19 01:45	15/01/19 23:40	Linear offset of A= 0.000ppm and B= -0.360ppm applied to correct baseline drift	CO	AA	13/02/2019

Table 25: Saint Lukes Park Valid Data Exception Table

Start Date	End Date	Reason	Change Details	User Name	Change Date
01/01/19 01:00	31/01/19 01:55	Automatic span and zero checks, once daily for 25 - 60 minutes	CO, NO, NO_2, NO_x	AA	13/02/2019
01/01/19 10:40	31/01/19 08:55	Intermittent data transmission errors	CO, NO, NO_2, NO_x, WS, WD, Sigma, AT 2m, AT 10m, PM_{10}	AA	13/02/2019
01/01/19 23:45	31/01/19 23:50	Background checks, once daily for 5 - 10 minutes	CO	AA	13/02/2019
08/01/19 11:00	08/01/19 13:25	Scheduled maintenance followed by instrument stabilisation	All parameters	AA	13/02/2019
09/01/19 01:00	10/01/19 00:55	Instrument fault - instrument stuck in calibration mode	NO, NO_2, NO_x	AA	13/02/2019
13/01/19 00:00	13/01/19 01:00	Instrument fault - flow fault followed by instrument stabilisation	$PM_{2.5}$	AA	13/02/2019
31/01/19 08:25	31/01/19 08:35	Suspected brief power interruption	CO, NO, NO_2, NO_x, WS, WD, Sigma, AT 2m, AT 10m, PM_{10}	AA	13/02/2019

7.0 Report Summary

- Percentage availability for some parameters at M4 East Project was below 95%, refer to Table 12, and Tables 20-25 for details.
- There were no recorded readings over the Exceedence Levels for the reporting period. Please refer to Table 13-18 in Section 5.2 – Air Quality Monthly Summary for further information.

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
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
mg/m^3	Milligrams per cubic metre at standard temperature and pressure (0°C and 101.3 kPa)
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
RH	Relative Humidity
WD	Vector Wind Direction
WS	Vector Wind Speed

Appendix 2 - Explanation of Exception Table

Automatic filter tape advance refers to the movement of the filter paper by the analyser to an un-used spot.

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.

Automatic span/zero check. The E-Sampler is programmed to perform a zero calibration check whereby air is passed through filter element, removing particulates, before entering the sensor in the analyser. Data is invalidated when these checks occur.

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.

Overnight zero out of tolerance refers to when the automatic zero reading measured by the analyser falls outside the expected 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.

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.

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

Appendix 3 - Amendments

This amended report supersedes previously issued versions of the report. Refer to the revision history table on page 2 for details of previous revisions. The following modifications have been made in this version:

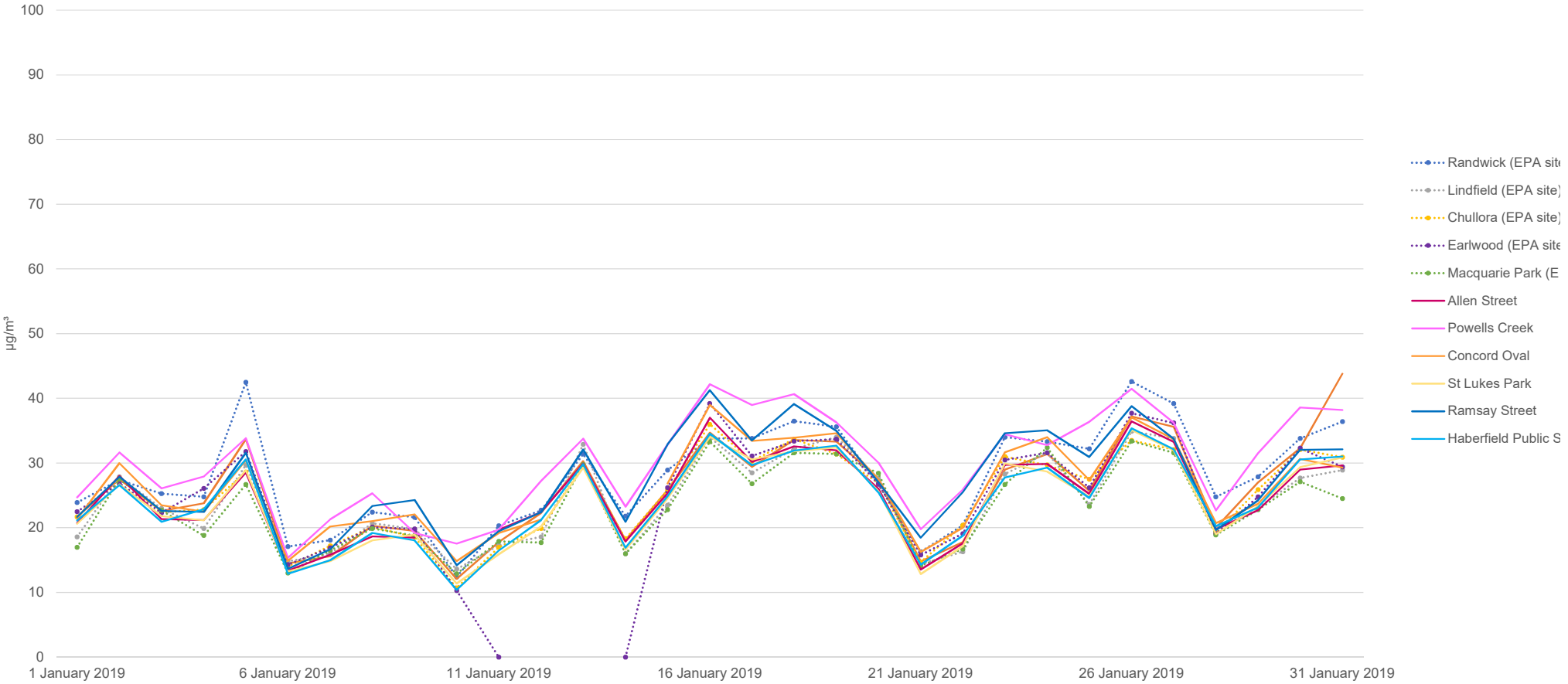
- Following an investigation into elevated $PM_{2.5}$ readings at Haberfield School station, data shown in figure 5 has had a correction applied based on the internal background setting observed in a visit in March 2019.

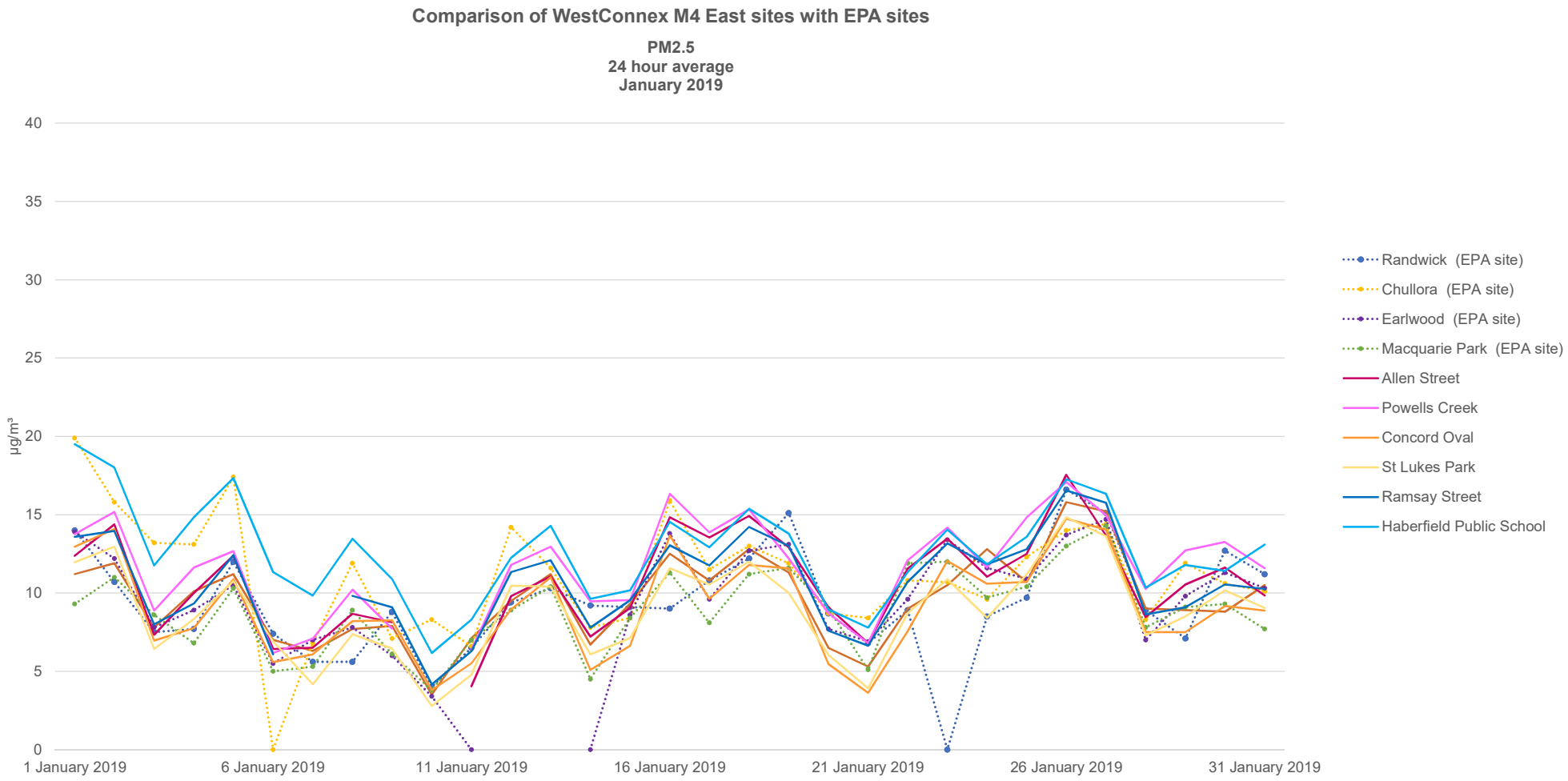
  Although this correction gives plausible $PM_{2.5}$ data that tracks closely with other sites, it was concluded that the data does not meet the traceability requirements of AS/NZS 3580.9.12-2013 due to the lack of documented evidence. $PM_{2.5}$ data for Haberfield School should, therefore, be considered for reference only. No correction was required for the data from 09/01/2019 at 14:00 although the same lack of documentation means the background value in the BAM at the time cannot be verified and the data should be considered for reference only.

  This data has not been used to compile stations statistics.

Comparison of WestConnex M4 East sites with EPA sites

PM10
24 hour average
January 2019




Comparison of WestConnex M4 East sites with EPA sites
PM2.5
24 hour average
January 2019
µg/m³
40
35
30
25
20
15
10
5
0
1 January 2019
6 January 2019
11 January 2019
16 January 2019
21 January 2019
26 January 2019
31 January 2019
Randwick (EPA site)
Chullora (EPA site)
Earlwood (EPA site)
Macquarie Park (EPA site)
Allen Street
Powells Creek
Concord Oval
St Lukes Park
Ramsay Street
Haberfield Public School