



Air Noise Environment
Environmental Monitoring and Assessment

Independent Verification: Approval Condition E8

M4 East Tunnel

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**Prepared by:
Air Noise Environment**

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The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Air Noise Environment Pty Ltd for the purposes of this project is both complete and accurate.



Executive Summary

Air Noise Environment was commissioned by the CPB Samsung John Holland Joint Venture to conduct an independent compliance audit (this Audit) against Instrument of Approval (IoA) Conditions governing the M4 East project relating to ambient air quality assurance and quality control as defined in the IoA document SS16307 dated 11 February 2016. Condition E8 of the Approval states that the 'The Proponent must monitor (by sampling and obtaining results by analysis) the pollutants and parameters specified in Table 8 ...Monitoring results must be ... subject to an independent audit at six monthly intervals....The auditor must be approved by the Secretary in consultation with the EPA and the AQCCC And the auditors report must be directly provided to the proponent and the AQCCC.'

Air Noise Environment Pty Ltd has been approved by the Secretary as an Independent Air Quality Specialist for the purposes of completing air quality assessment, auditing and compliance reporting for the M4 East Tunnel project.

The data audit assessing compliance with Condition E8 of the IoA was conducted by Gary Hall, Manager - Air Sampling, Air Noise Environment Pty Ltd. The audit assessed compliance with the ambient air quality monitoring requirements of IoA Condition E8. The data audit consisted of a desktop review of published reports and raw data provided by Ecotech. A site visit was also conducted of the 6 monitoring stations to verify the monitoring positions and the installed instrumentation. Data reported for the period was also audited against the data captured by the data logger.

The data audit methodology consisted of following representative raw data values from the analyser, through collection and storage by the data logger, the raw data validation/review process, calculations and then review of the final reported values. Raw data and the validated data was provided by Ecotech. A sample of the raw data for the month of December 2018 for all stations was reviewed. The raw data was checked against the values used by Ecotech for the validation and for the averaged data ultimately reported for each site for each month. The audit showed the raw data and results calculated from this by the Independent Air Quality Specialist matched very closely with the validated and reported data by Ecotech.

The data results were also compared to the compliance limits for the project. The results show full compliance for carbon monoxide and nitrogen dioxide for the 6 month period. Exceedences for the 24 hour PM_{10} and 24 hour and annual $PM_{2.5}$ were noted on a few occasions over the 6 month period, and may be caused by local or regional events.

The monitoring reports were reviewed for conformance to the reporting requirements of the relevant Australian Standard sampling methods. The ambient air quality monitoring data complied with the majority of the relevant requirements. Exceptions to this relate to the reported quality assured instrument ranges for temperature and $PM_{2.5}$, and reporting of data outside of these ranges.





Limitations of this Report

During the preparation of this audit report, Air Noise Environment has evaluated the monthly ambient air quality reports prepared by Ecotech for the M4E project.

Air Noise Environment has reviewed the December 2018 ambient monitoring report prepared by Ecotech and checked a representative sample of the raw data against the validated data used for the calculations and reporting purposes for the December 2018 report. Whilst the audit has not completed a detailed examination of all of the raw data presented in each of the monthly air quality reports, the adopted approach is considered suitable to verify the dataset, as the same procedures and calculation methodologies are adopted for each month of data collected. Whilst the possibility of calculation errors arising for other months of data cannot be entirely discounted, in our opinion the audit of a sample of data provides a suitable approach for data verification for the first 12 months of ambient air quality data.

The conclusions outlined in this audit report are professional opinions based solely upon Air Noise Environment's review and audit of the monthly reports, inspection of the monitoring stations and the data provided by Ecotech.





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1 Introduction

1.1 Background

The Instrument of Approval (IoA) Conditions governing the M4 East project are defined in the IoA document SS16307 dated 11 February 2016. The IoA includes a number of performance requirements relating to Air Quality, both in-tunnel and ambient. The project Construction Contractor, CPB Samsung John Holland Joint Venture, is contractually responsible for meeting some of these requirements through the design and construction of the tunnel on behalf of the Project Proponent – NSW Roads and Maritime Services (RMS).

The approval conditions also require that the air quality monitoring methodologies and air quality outcomes as defined in the IoA document are subject to verification by an Approved Independent person or organisation. Air Noise Environment Pty Ltd was nominated by RMS to undertake the role of independent specialist in accordance with the IoA for the WestConnex M4 East project. This nomination was subsequently approved by NSW Planning and Environment on 4 December 2017 and 24 May 2018.

As the Approved Independent Specialist, Air Noise Environment will complete review and auditing of compliance with the following air quality related Approval conditions:

- Condition E1 — verification and compliance auditing for in-tunnel air quality monitoring;
- Condition E5 - verification that compliance with in-tunnel limits will not preclude compliance with the outcomes in the EIS and will not result in impacts greater than predicted in the EIS, assess how the ventilation system has been optimised with respect to air quality and energy use;
- Condition E8 — independent audit of ambient air quality monitoring results;
- Condition E13 — audit of ventilation outlet monitoring equipment prior to commencement of monitoring;
- Condition E15 - verification that compliance with the ventilation outlet limits will not preclude compliance with the outcomes in the EIS and will not result in impacts greater than predicted in the EIS, assess how ventilation outlet discharge velocities have been optimised in consideration of energy requirements and air quality impacts;
- Condition E25 — review and, if appropriate, approve the quality assurance and quality control measures for ambient monitoring.





1.2 Scope of Work and Audit Criteria

1.2.1 Condition E8

This report presents the Independent Verification of conformance with the requirements of Approval Condition E8 (see below) relating to the independent audit of ambient air quality data for the initial six months of operation of the ambient monitoring stations.

'Condition E8 - Ambient Air Quality Monitoring

The Proponent must monitor (by sampling and obtaining results by analysis) the pollutants and parameters specified in Column 1 of Table 8 at the following locations as a minimum:

- (a) two ground level receptors near the eastern ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;*
- (b) two ground level receptors near the western ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;*
- (c) one location along Parramatta Road, at a location suitable for detecting any impact on air quality along Parramatta Road; and*
- (d) one location, away from any of the locations at (a), (b) and (c), suitable for providing background ambient air quality reference data for the project area.*

In selecting the monitoring locations, consideration is to be given to the desirability of like-to-like comparison of monitoring results to available pre-construction data, and the requirement in condition E46 for the independent team of experts to review the accuracy of predicted environmental outcomes discussed in the documents listed in conditions A2(b) and A2(c). All monitoring stations must be established subject to the land owner's and occupier's agreement. The Proponent must use the sampling method, units of measure, and sampling frequency specified in Table 8.

The Proponent must commence monitoring for at least twelve continuous months prior to operation. The locations are to be agreed to by the AQCCC. The Proponent must meet all operating costs associated with the stations.

The Proponent, following consultation with the AQCCC, must review the need for the continuation of the ambient monitoring stations after a period of two years from commencement

of operation. Any recommendation to close the stations will require the approval of the Secretary in consultation with the EPA.

The establishment and operation of the stations is to be undertaken in accordance with recognised Australian standards and undertaken by an organisation accredited by NATA for this purpose and approved by the Secretary in consultation with the EPA and the AQCCC. The quality of the monitoring results must be assured through a NATA accredited process prior to the data being considered as a basis for compliance/auditing purposes.





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

1.2.2 Audit of Initial Six Months

An independent audit was completed in September 2018 for the initial six months of monitoring data¹. This audit involved completion of a desktop review of raw data and results, and concluded that the air quality monitoring data complied with the requirements of Condition E8 with one exception. The monitoring reports omitted to include the measurement range as well as the calibrated range of the instruments used in the sampling, and recommended that future reports confirm whether or not the ISO 17025 calibration for each instrument covers all or part of the full range for each instrument.

1.2.3 Current Audit

The scope for this second audit involves:

- confirming the locations of the ambient monitoring positions;
- independent verification of the installed instrumentation;
- independent review of air quality monitoring data for the period July – December 2018, and the annual results were relevant in accordance with the requirements of the final paragraph of Condition E8.

The audit also confirmed that the recommendations of the initial audit had been implemented.

1.3 Audit Objectives

The objective of the audit is to assess compliance with Condition E8 of the IoA in relation to the independent audit of ambient air quality monitoring station results for the months of June – December 2018.

1.4 Audit Team

The verification audit was completed by Gary Hall, Bsc(Hons), Env Sci (Manager - Air Monitoring, Air Noise Environment Pty Ltd). Gary Hall has over 20 years experience in Air Monitoring.

¹ Independent Verification: Approval Condition E8, M4 East Audit - 28 September 2018.



2 Methodology

2.1 Approach Adopted

The audit consisted of two phases. Firstly, a site inspection of the operational monitoring stations was completed. Secondly, a desktop review of published ambient air monitoring reports and analysis of the raw data and validated data provided by Ecotech was completed.

Ambient monitoring data has been published on the M4 East website since 21 December 2017. At the time of preparing this report, 13 reports had been published on the M4 East website. These are:

- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st January 2018 - 31st January 2018 issued 21 March 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st February 2018 - 28th February 2018 issued 21 March 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st March 2018 - 31st March 2018 issued 13 April 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st April 2018 - 30th April 2018 issued 15 May 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st May 2018 - 31st May 2018 issued 15 June 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st June 2018 - 30th June 2018 issued 19 July 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st July 2018 - 31st July 2018 issued 15 August 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st August 2018 - 31st August 2018 issued 18 September 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st September 2018 - 30th September 2018 issued 15 October 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st October 2018 - 31st October 2018 issued 28th November 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st November 2018 - 30th November 2018 issued 14th December 2018.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st December 2018 - 31st December 2018 issued 21st January 2019.
- Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st January 2019 - 31st January 2019 issued 15th February 2019.





2.2 Inspection of Monitoring Stations

A site visit of each of the 6 ambient air monitoring stations was conducted by Gary Hall from Air Noise Environment, on 18 February 2019. The purpose of the site audit was to verify the monitoring positions and confirm the installed instrumentation matches with the details in the report and complies with the requirements of ISO 17025 and the approved sampling methodologies as defined in Table 8 of the Approval.

2.3 Initial Review of Monthly Reports

Based on a review of the six monthly reports from July 2018 to December 2018, it was concluded that there were no obvious errors or areas of concern. The data capture rates for each ambient air monitoring station have been included in Table 12 of each of the monthly reports. The data capture rates for each compound or measurement parameter is listed for each station.

Overall the sites achieved greater than 95 % data capture rates for most periods. The lowest data capture rate for any station was recorded as 57.3 % for the Allen Street site for Air Temperature at 10 meters for the month of November 2018. For the same month, the data capture rate for Temperature at 2 meters was 98.3 % which is a good capture rate and these data can be used to infer the missing temperature values. Also, for the same month, the overall average for all the other data parameters for the station was calculated as 95.2 %.

The lowest data capture rate for the December 2018 monthly report was recorded as 86.6 % for the Haberfield School site for Temperature measurements at the 2 meter and 10 meter levels. However, for the same month, all other parameters at all 6 ambient monitoring stations recorded data capture rates over 95 %.

The overall data capture rate for all parameters for stations for the January to June period was calculated as 97.0 %.

Data is considered complete if there is 75 % of valid data within an hour, 75 % of valid hours within a day, 75 % of valid days within a month, 75 % of valid days within a quarter, and 4 complete quarters within a calendar year.

2.4 Detailed Audit

To allow a more detailed audit of the data to be completed, the six reports were reviewed to determine whether there was any specific period where unusual results occurred that could warrant a more detailed investigation. As there was little difference in the percentage data capture for the July to December 2018 period, the reported values and the number of exceedances, the December 2018 report was selected for the desktop review. In the absence of any specific reason for selecting one of the six monthly reports, the December 2018 report was chosen as it was the most recently available report at the time of completing this audit. The report is numbered DAT14127Rev1 and was issued under NATA accreditation number 14184. Raw data and validated data was provided by Ecotech for the month of December 2018 to allow a detailed examination of the data and





calculations that resulted in the reported air quality concentrations and meteorological parameters.

Ambient station monitoring data should be validated and verified in a consistent manner ensuring the integrity and representativeness of the environmental conditions present at the time of collection. Data reduction is the conversion of raw data into a more ordered, simplified, user-friendly form. Data audits are a means to assure data integrity. The data also needs to be summarised from 5 minute collected averages to hourly or daily (24 hourly) averages for reporting purposes.

As per the Australian Standards AS 3580, 5.1, 7.1, 9.8 and 9.12, the data validation process requires :

- A review of the data by trained personnel using data screening criteria
- Identification of possible incorrect values e.g. data collected during calibration or maintenance procedures.
- Regular review of the data
- An ongoing process of the data review
- Review of calibration information, recorded data, and any status flags that could affect data.
- All data should be considered valid unless evidence or sound scientific principles can be given to support its invalidation
- Copies of the original raw data should be kept for audit purposes

This is the process completed by Ecotech for the on-going data review, analysis and presentation. A methodology consistent with these requirements was adopted for the data audit.

In completing the audit, a data audit trail was used to check for data recording/transfer errors. The data audit trail encompasses a check of data from the raw data through to the summarised validated data and ultimately presented in the report. Data is recorded by the analysers and instruments at the ambient monitoring stations at 5 minute intervals. The data is then validated and checked for errors and faults. Validated data is then converted to hourly and then 24 hourly averages which is presented in the final monthly report for each station. This audit has followed sections of raw data as downloaded from the ambient station instruments, through the validation process and then compared the calculated values determined from the raw data with the results of those reported by Ecotech in the monthly report.

Data listed in the valid data exception tables in the December 2018 report has also been checked to confirm the validity of the exceptions and reasons the data was invalidated.

The standards also specify the data and parameters required for the reporting of measured results. The reporting requirements include:

- Reference to the relevant Standard
- The reporting organisation or company
- The concentration of the components measured in correct units (ppm or $\mu\text{g}/\text{m}^3$)
- The full scale value of the instruments.





- Sampling location—all relevant details, including a coordinate reference including height to within 100 m above ground level.
- The type of instrument.
- Any non-conformances with the standards
- The uncertainty associated with the measurement along with the confidence interval and coverage factor.
- Any other relevant data, e.g. meteorological conditions.

The December 2018 report prepared by Ecotech has been checked against these requirements.





3 Audit Findings

3.1 Site audit

A site visit of each of the 6 ambient air monitoring stations was conducted on 18 February 2019. The purpose of the site audit was to verify the monitoring positions and confirm the installed instrumentation matches with the details in the report and complies with the requirements of Table 8 in Condition E8.

Section 2.1 of the sampling reports identify that Ecotech completed an audit of the monitoring stations to confirm compliance with the requirements of AS/NZS 3580.1.1:2016. The sampling reports do not identify whether full compliance with the requirements of AS 3580.1.1 are achieved for each monitoring position, simply that the audit was completed. The inspection of the monitoring station locations confirmed compliance with the siting requirements defined in AS 3580.1.1 (2016) with the exception of:

- Powells Creek, Concord Oval and Ramsay Street are situated within 10 meters of busy roads;
- Powells Creek has trees growing adjacent to the sampling site and overhanging branches are within about 1 meter of the sampling heads; and
- The Haberfield site is surrounded by tall buildings and trees and all sides.

It is noted that the monitoring locations are situated in a very built up area of Sydney and it may not be possible to find sites that fully comply with siting requirements of AS/NZS 3580.1.1:2016. This is common for these sorts of projects and this type of sampling in built up areas.

The reported GPS co-ordinates were compared to actual measurements conducted at each site. The results of the geographical location audit are displayed in Table 3.1 below.

Table 3.1: Site Locations and co-ordinates

Site Name	Reported Geographical Coordinates	Measured Geographical Coordinates	Comments
Allen Street	33°51'44.21"S, 151° 5'9.79"E	33°51'44"S, 151° 5'10"E	Values match closely
Concord Oval	33°52'8.60"S, 151° 6'28.97"E	33°52'8.60"S, 151° 6'29"E	Values match closely
Haberfield Public School	33°52'45.70"S, 151° 8'4.01"E	33°52'47"S, 151° 8'03"E	Values differ slightly, but within approximately 50 m.





Site Name	Reported Geographical Coordinates	Measured Geographical Coordinates	Comments
Powells Creek	33°51'53.80"S, 151° 5'16.50"E	33°51'54"S, 151° 5'16"E	Values match closely
Ramsay Street	33°52'26.20"S, 151° 8'1.50"E	33°52'24"S, 151° 8'00"E	Values differ slightly, but within approximately 50 m.
Saint Lukes Park	33°51'55.04"S, 151° 6'35.88"E	33°51'55"S, 151° 6'36"E	Values match closely

The installed instrumentation was confirmed to comply with the requirements of the sampling methods identified in Table 8

During the audit, the individual analysers and monitoring instruments were checked and compared to the instrument information reported in the monthly report. Tables 3.2 to 3.7 present the audit results of the site visit to verify that the installed instrumentation at each station matches the details presented in the monthly reports.

Table 3.2: Installed Instrumentation at Allen Street.

Station	Parameter Measured	Instrument and Measurement Technique as per Monthly reports	Elevation	Complies
Allen Street	CO	Ecotech Serinus 30 - NDIR gas filter correlation infrared photometry	2	Yes
	NO, NO ₂ , NO _x	Ecotech Serinus 40 - gas phase chemiluminescence	2	Yes
	PM _{2.5}	Met One BAM 1020 - Beta ray attenuation	2	Yes
	PM ₁₀	Thermo - 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2	Yes
	Differential Temperature (elevation 2m)	Met One 062MP	2	Yes
	Differential Temperature (elevation 10m)	Met One 062MP	10	Yes
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10	Yes
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10	Yes
	Sigma	Calculation	-	Yes



Table 3.3: Installed Instrumentation at Concord Oval.

Station	Parameter Measured	Instrument and Measurement Technique as per Monthly reports	Elevation	Complies
Concord Oval	CO	Ecotech Serinus 30 - NDIR gas filter correlation infrared photometry	2	Yes
	NO, NO ₂ , NO _x	Ecotech Serinus 40 - gas phase chemiluminescence	2	Yes
	PM _{2.5}	Met One BAM 1020 - Beta ray attenuation	2	Yes
	PM ₁₀	Thermo - 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2	Yes
	Differential Temperature (elevation 2m)	Met One 062MP	2	Yes
	Differential Temperature (elevation 10m)	Met One 062MP	10	Yes
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10	Yes
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10	Yes
	Sigma	Calculation	-	Yes

Table 3.4: Installed Instrumentation at Haberfield School.

Station	Parameter Measured	Instrument and Measurement Technique as per Monthly reports	Elevation	Complies
Haberfield Public School	CO	Ecotech Serinus 30 - NDIR gas filter correlation infrared photometry	2	Yes
	NO, NO ₂ , NO _x	Ecotech Serinus 40 - gas phase chemiluminescence	2	Yes
	PM _{2.5}	Met One BAM 1020 - Beta ray attenuation	2	Yes
	PM ₁₀	Thermo - 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2	Yes
	Differential Temperature (elevation 2m)	Met One 062MP	2	Yes
	Differential Temperature (elevation 10m)	Met One 062MP	10	Yes
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10	Yes
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10	Yes
	Sigma	Calculation	-	Yes





Table 3.5: Installed Instrumentation at Powells Creek.

Station	Parameter Measured	Instrument and Measurement Technique as per Monthly reports	Elevation	Complies
Powells Creek	CO	Ecotech Serinus 30 - NDIR gas filter correlation infrared photometry	2	Yes
	NO, NO ₂ , NO _x	Ecotech Serinus 40 - gas phase chemiluminescence	2	Yes
	PM _{2.5}	Met One BAM 1020 - Beta ray attenuation	2	Yes
	PM ₁₀	Thermo - 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2	Yes
	Differential Temperature (elevation 2m)	Met One 062MP	2	Yes
	Differential Temperature (elevation 10m)	Met One 062MP	10	Yes
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10	Yes
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10	Yes
	Sigma	Calculation	-	Yes

Table 3.6: Installed Instrumentation at Ramsay Street.

Station	Parameter Measured	Instrument and Measurement Technique as per Monthly reports	Elevation	Complies
Ramsay Street	CO	Ecotech Serinus 30 - NDIR gas filter correlation infrared photometry	2	Yes
	NO, NO ₂ , NO _x	Ecotech Serinus 40 - gas phase chemiluminescence	2	Yes
	PM _{2.5}	Met One BAM 1020 - Beta ray attenuation	2	Yes
	PM ₁₀	Thermo - 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2	Yes
	Differential Temperature (elevation 2m)	Met One 062MP	2	Yes
	Differential Temperature (elevation 10m)	Met One 062MP	10	Yes
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10	Yes
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10	Yes
	Sigma	Calculation	-	Yes





Table 3.7: Installed Instrumentation at Saint Lukes Park

Station	Parameter Measured	Instrument and Measurement Technique as per Monthly reports	Elevation	Complies
Saint Lukes Park	CO	Ecotech Serinus 30 - NDIR gas filter correlation infrared photometry	2	Yes
	NO, NO ₂ , NO _x	Ecotech Serinus 40 - gas phase chemiluminescence	2	Yes
	PM _{2.5}	Met One BAM 1020 - Beta ray attenuation	2	Yes
	PM ₁₀	Thermo - 1400 ab TEOM (Tapered Element Oscillating Microbalance)	2	Yes
	Differential Temperature (elevation 2m)	Met One 062MP	2	Yes
	Differential Temperature (elevation 10m)	Met One 062MP	10	Yes
	Wind Speed (Horizontal, elevation 10m)	Gill Windsonic Op3	10	Yes
	Wind Direction (elevation 10m)	Gill Windsonic Op3	10	Yes
	Sigma	Calculation	-	Yes

3.2 Verification of Data Processing

Raw data for the December 2018 period was reviewed for both completeness and correctness. Data is considered complete if there is 75% of valid data within an hour, 75% of valid hours within a day, 75% of valid days within a month, 75% of valid days within a quarter, and 4 complete quarters within a calendar year².

Raw data from each station for the month of December 2018 was checked against the validated and processed data used by Ecotech for the reporting requirements. The raw data for each station was compared to the data presented in the validated Ecotech spreadsheet. Comparisons were made and calculation checks were completed to confirm that the raw data matched with the reported results for each station. 5 minute raw and validated data was provided for all parameters except for PM_{2.5} and Sigma Theta. For PM_{2.5}, sampled using the beta attenuation method, the last 10 minutes of each hour are a calibration cycle. Therefore, only one hour average data are provided for PM_{2.5} as sub 1-hour data is not valid. In the case of sigma theta, this is a calculated value determined from the wind directions for the measurements completed during the previous hour.

2 US EPA Quality Assurance Handbook for Air Pollution Measurement Systems Vol II, January 2017 - Table 6.4, and Federal Register Part II Environmental Protection Agency 40 CFR Part 50 / Vol. 71, No. 200 / October 17, 2006 / Rules and Regulations Section 4.1(b))



The audit findings and comparison results of the raw data are shown in Tables 3.8 to 3.13 below. The results of the ANE validation checks are discussed in Section 3.3.

Calibration data was also reviewed, and confirmed that the daily calibration checks were evident in the datasets. Monthly calibration checks were also completed in accordance with the manufacturer's recommendations.

Table 3.8: Verification of Raw Data Compared to Validated Data for Allen Street

Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	PM _{2.5}	Yes. Raw data matched the validated very closely.	The 1 hourly data was provided and this accurately averaged into 24 hour data.
01/12/2018 - 31/12/2018	PM ₁₀	Yes. Raw data matched the validated very closely.	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. All the data for the month is present except the period 20/12/18 14:30 to 20/12/18 17:35 when Ecotech reported scheduled monthly maintenance was carried out.
01/12/2018 - 31/12/2018	CO	Yes. Raw data matched the validated very closely.	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks (01:00 - to 01:20) and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these appear to have been correctly invalidated. A number of baseline drift corrections were also applied on 6 occasions for the month.
01/12/2018 - 31/12/2018	NO	Yes. Raw data matched the validated very closely.	The NO, NO ₂ and NO _x raw data matches the validated data used in the spreadsheet.
01/12/2018 - 31/12/2018	NO ₂	Yes. Raw data matched the validated very closely.	Data was correctly invalidated during the Daily automatic span and zero checks (01:00 - to 01:20) and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these have been correctly invalidated.
01/12/2018 - 31/12/2018	NO _x	Yes. Raw data matched the validated very closely.	The sum of NO and NO ₂ also matches the NO _x values for the raw and validated data.
01/12/2018 - 31/12/2018	WS	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	WD	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	Sigma	Yes.	Average Calculations completed by ANE of raw data matches very closely the validated data Ecotech used for the report.





Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	@ 2 m	Yes. Raw data matched the validated very closely.	No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	@ 10 m	Yes. Raw data matched the validated very closely.	No errors observed between raw data and data used for validation and reporting.

Table 3.9: Verification of Raw Data Compared to Validated Data for Concord Oval

Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	PM _{2.5}	Yes. Raw data matched the validated very closely.	The 1 hourly data was provided and this accurately averaged into 24 hour data. Scheduled monthly maintenance carried out on 19/12/2018 between 12:55 and 14:40 - data correctly invalidated.
01/12/2018 - 31/12/2018	PM ₁₀	Yes. Raw data matched the validated very closely.	Overall, the raw data matches closely the validated data used in the Ecotech spreadsheet for reporting. No Major errors were reported
01/12/2018 - 31/12/2018	CO	Yes. Raw data matched the validated very closely.	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 - to 01:25 and the background checks daily from 23:45 to 23:50. A static offset of 0.15 ppm was applied to correct zero step change after maintenance.
01/12/2018 - 31/12/2018	NO	Yes. Raw data matched the validated very closely.	The NO, NO ₂ and NO _x raw data matches the validated data used in the spreadsheet.
01/12/2018 - 31/12/2018	NO ₂	Yes. Raw data matched the validated very closely.	Data was correctly invalidated during the daily automatic span and zero checks (01:00 - to 01:25) and the background checks daily from 23:45 to 23:50. A few intermittent errors were also noted and these have been correctly invalidated.
01/12/2018 - 31/12/2018	NO _x	Yes. Raw data matched the validated very closely.	The sum of NO and NO ₂ also matches the NO _x values for the raw and validated data. Overall data capture rate was very good.
01/12/2018 - 31/12/2018	WS	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/12/2018 - 31/12/2018	WD	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/12/2018 -	Sigma	Yes.	Calculations made by ANE of raw data matches closely the





Date	Parameter	Raw data matches validated data	Comments
31/12/2018			validated data Ecotech used for the report. 100% of data reported.
01/12/2018 - 31/12/2018	@ 2 m	Yes. Raw data matched the validated very closely.	No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/12/2018 - 31/12/2018	@ 10 m	Yes. Raw data matched the validated very closely.	No errors observed between raw data and data used for validation and reporting. 100% of data reported.

Table 3.10: Verification of Raw Data Compared to Validated Data - Haberfield School

Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	PM _{2.5}	Yes. Raw data matched the validated very closely.	The 1 hourly data was provided and this accurately averaged into 24 hour data. Instrument flow fault reported for 20/12/2018 at 0:00 to 01:00 and data correctly invalidated from results. The PM _{2.5} data was noted to be consistently approximately 5 ug/m ³ higher than the other 5 stations for the month of December 2018. Ecotech have completed a non-conformance investigation to investigate the offset and ANE are in the process of reviewing the outcomes of the investigation.
01/12/2018 - 31/12/2018	PM ₁₀	Yes. Raw data matched the validated very closely.	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. All the data for the month is present.
01/12/2018 - 31/12/2018	CO	Yes. Raw data matched the validated very closely.	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks followed by instrument stabilisation (01:00 - to 01:25) and the background checks daily from 23:05 to 23:45. Overall the data is relatively consistent for the month. Scheduled monthly maintenance performed on 19/12/2018 from 11:45 to 13:30.
01/12/2018 - 31/12/2018	NO	Yes. Raw data matched the validated very closely.	The NO, NO ₂ and NO _x raw data matches the validated data used in the spreadsheet.
01/12/2018 - 31/12/2018	NO ₂	Yes. Raw data matched the validated very closely.	Data was correctly invalidated during the daily automatic span and zero checks (01:00 - to 01:25 and the background checks daily from 23:40 to 23:45. A few intermittent errors were also noted and these have been correctly invalidated.
01/12/2018 - 31/12/2018	NO _x	Yes. Raw data matched the validated very closely.	Scheduled monthly maintenance performed on 19/12/2018 from 11:45 to 13:30.
01/12/2018 - 31/12/2018	WS	Yes. Raw data matched the	Raw data matched the validated data closely. No errors observed between raw data and data used for validation and





Date	Parameter	Raw data matches validated data	Comments
		validated very closely.	reporting.
01/12/2018 - 31/12/2018	WD	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	Sigma	Yes.	Calculations made by ANE of raw data matches very closely the validated data Ecotech used for the report.
01/12/2018 - 31/12/2018	@ 2 m	Yes. Raw data matched the validated very closely.	Intermittent unrealistic data was reported for 13/12/2018 - 21/12/2018 and this has been invalidated and not reported for the month.
01/12/2018 - 31/12/2018	@ 10 m	Yes. Raw data matched validated very closely.	Intermittent unrealistic data was reported for 13/12/2018 - 21/12/2018 and this has been invalidated and not reported for the month.

Table 3.11: Verification of Raw Data Compared to Validated Data for Powells Creek

Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	PM _{2.5}	Yes. Raw data matched the validated very closely.	The 1 hourly data was provided and this accurately averaged into 24 hour data. Data correctly invalidated on 12/12/2018 between 15:00 and 16:00. Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. All the data for the month is present except the invalidated data above.
01/12/2018 - 31/12/2018	PM ₁₀	Yes. Raw data matched the validated very closely.	The raw data matches the validated data used in the Ecotech spreadsheet for reporting. Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. All the data for the month is present.
01/12/2018 - 31/12/2018	CO	Yes. Raw data matched the validated very closely.	The CO raw data matches the validated data used in the spreadsheet. Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. All the data for the month is present. Data was correctly invalidated during the daily automatic span and zero checks followed by instrument stabilisation (01:00 - to 01:25) and the background checks daily from 15:25 to 15:30.
01/12/2018 - 31/12/2018	NO	Yes. Raw data matched the validated very closely.	The NO, NO ₂ and NO _x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 - to 01:30). A few intermittent errors were also noted and these have been correctly invalidated. Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. All the data for the month is present. The sum of NO and NO ₂ also matches the NO _x values for the raw and validated data.
01/12/2018 - 31/12/2018	NO ₂	Yes. Raw data matched the validated very closely.	
01/12/2018 - 31/12/2018	NO _x	Yes. Raw data matched the validated very closely.	





Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	WS	Yes. Raw data matched the validated very closely.	Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. All the data for the month is present. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	WD	Yes. Raw data matched the validated very closely.	Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. All the data for the month is present. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	Sigma	Yes.	Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. All the data for the month is present. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	@ 2 m	Yes. Raw data matched the validated very closely.	Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. Some data for the month is missing – mostly between 02/12/18 20:55 and 12/12/18, 16:00. Reason given as intermittent unrealistic data – readings not tracking with other sites. Note - @10m temperature data is all present. Review of the raw temperature data shows that the temperature difference between the 2m and 10m readings is mostly within about 1°C. For the month of December 2018, for the dates and periods where the data has been invalidated, the temperature difference between the 2 sensors varied by mostly 1 or 2°C with the highest difference being less than 10°C.
01/12/2018 - 31/12/2018	@ 10 m	Yes. Raw data matched the validated very closely.	Scheduled monthly maintenance was performed on 19/12/18 08:00 until 19/12/18 11:05. All the data for the month is present. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.

Table 3.12: Data Verification of Raw Data Compared to Validated Data for Ramsay Street

Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	PM _{2.5}	Yes. Raw data matched the validated very closely.	The 1 hourly data was provided and this accurately averaged into 24 hour data. Missing data for 17/12/18 18:00 to 17/12/18 17:00 – data invalidated due to instrument fault – tape error. Non scheduled maintenance performed on same date at 18:00 to replace tape. Instrument flow fault reported for 20/12/18 at 00:00 and the data has been invalidated. Scheduled monthly maintenance was conducted 19/12/18 08:15 to 19/12/18 12:00.
01/12/2018 - 31/12/2018	PM ₁₀	Yes. Raw data matched the validated very closely.	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. Scheduled monthly maintenance was conducted 19/12/18 08:15 to 19/12/18 12:00. All the data for the month is present except for a few intermittent errors.





Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	CO	Yes. Raw data matched the validated very closely.	<p>The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 - to 01:20 and the Background checks daily from 23:45 to 23:50. Scheduled monthly maintenance was conducted 19/12/18 08:15 to 19/12/18 12:00.</p> <p>A few intermittent errors throughout the month were also noted and reasons given in the exception table and these appear to have been correctly invalidated on the spreadsheets.</p> <p>Non scheduled maintenance was performed on 1/12/2018 between 13:30 and 13:45.</p>
01/12/2018 - 31/12/2018	NO	Yes. Raw data matched the validated very closely.	<p>The NO, NO₂ and NO_x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 - to 01:40 and the Background checks daily from 23:50 to 23:55. A few intermittent errors were also noted and these have been correctly invalidated. Scheduled monthly maintenance was conducted 19/12/18 08:15 to 19/12/18 12:00.</p> <p>The sum of NO and NO₂ also matches the NO_x values for the raw and validated data.</p>
01/12/2018 - 31/12/2018	NO ₂	Yes.	
01/12/2018 - 31/12/2018	NO _x	Yes. Raw data matched the validated very closely.	
01/12/2018 - 31/12/2018	WS	Yes. Raw data matched the validated very closely.	Wind sensor stalled and instrument data correctly invalidated for 20/12/18 15:30 to 21/12/18 11:00. The remaining months data is all reported.
01/12/2018 - 31/12/2018	WD	Yes. Raw data matched the validated very closely.	Wind sensor stalled and instrument data correctly invalidated for 20/12/18 15:30 to 21/12/18 11:00. The remaining months data is all reported.
01/12/2018 - 31/12/2018	Sigma	Yes.	Wind sensor stalled and instrument data correctly invalidated for 20/12/18 15:30 to 21/12/18 11:00. The remaining months data is all reported.
01/12/2018 - 31/12/2018	@ 2 m	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.
01/12/2018 - 31/12/2018	@ 10 m	Yes. Raw data matched the validated very closely.	Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting. 100% of data reported.





Table 3.13: Data Verification of Raw Data Compared to Validated Data for Saint Lukes Park

Date	Parameter	Raw data matches validated data	Comments
01/12/2018 - 31/12/2018	PM _{2.5}	Yes. Raw data matched the validated very closely.	The 1 hourly data was provided and this accurately averaged into 24 hour data. Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period
01/12/2018 - 31/12/2018	PM ₁₀	Yes. Raw data matched the validated very closely.	Overall, the raw data matches the validated data used in the Ecotech spreadsheet for reporting. Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period
01/12/2018 - 31/12/2018	CO	Yes. Raw data matched the validated very closely.	The CO raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the daily automatic span and zero checks (01:00 - to 01:35 and the background checks daily from 23:45 to 23:50. A few intermittent errors throughout the month were also noted and these appear to have been correctly invalidated. Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period.
01/12/2018 - 31/12/2018	NO	Yes. Raw data matched the validated very closely.	The NO, NO ₂ and NO _x raw data matches the validated data used in the spreadsheet. Data was correctly invalidated during the Daily automatic span and zero checks (01:00 - to 01:45 and the Background checks daily from 23:45 to 23:50.
01/12/2018 - 31/12/2018	NO ₂	Yes. Raw data matched the validated very closely.	A few intermittent errors were also noted and these have been correctly invalidated. Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period.
01/12/2018 - 31/12/2018	NO _x	Yes. Raw data matched the validated very closely.	The sum of NO and NO ₂ also matches the NO _x values for the raw and validated data.
01/12/2018 - 31/12/2018	WS	Yes. Raw data matched the validated very closely.	Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	WD	Yes. Raw data matched the validated very closely.	Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	Sigma	Yes.	Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	@ 2 m	Yes. Raw data matched the validated very	Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period. Raw data matched the validated





Date	Parameter	Raw data matches validated data	Comments
		closely.	data very closely. No errors observed between raw data and data used for validation and reporting.
01/12/2018 - 31/12/2018	@ 10 m	Yes. Raw data matched the validated very closely.	Scheduled monthly maintenance was performed on 20/12/18 08:00 until 20/12/18 12:50 and the data has been correctly invalidated for this period. Raw data matched the validated data very closely. No errors observed between raw data and data used for validation and reporting.

3.3 Overall data comparison check

The raw data for December 2018 has been checked against the Ecotech validated data used for the reporting and discussed in Section 3.1 above. Calculations and checks were also performed by Air Noise Environment to verify the Ecotech calculations are correct when converting from 5 minute raw data averages to the reported hourly and 24 hourly averages. This is necessary as the data is downloaded from the instruments in 5 minute averages and converted into hourly averages and then 24 hourly averages for reporting. The exception to this is for the particulate data, where 1 hour data is provided (ie, for PM_{2.5} and sigma theta).

Air Noise Environment used the validated data supplied by Ecotech as part of the reporting process and performed calculations to convert from 5 minute data to 1 hourly averages. The 1 hourly averages were then converted to 24 hourly averages and compared to the 24 hourly average results which Ecotech have reported in the monthly reports. A summary of the calculation results are included in Table 3.14 below.





Table 3.14: ANE Calculated Data Compared to Ecotech Report (% agreement)

Station	PM _{2.5} ug/m ³	PM ₁₀ ug/m ³	CO ppm	NO ppm	NO ₂ ppm	NO _x ppm	WS/WD/ Sigma	Temp@ 2m K	Temp@ 10m K
St Lukes	100	100 ¹	101	101	100	100	100	100	100
Ramsay Street	100	100	100	99	100	100	100	100	100
Powells Creek	101	100	101	99	101	101	100	100	100
Haberfield School	100	100	100	100	100	100	100	100	100
Concord Oval	100	101	100	100	101	101	100	100	100
Allen Street	100	100	100	100	100	101	100	100	103

¹:The correct data is reported in the December report, for the St Lukes site, although the PM₁₀ data was only 79% similar to the calculations performed by ANE based on the spreadsheet data provided by Ecotech, the data reported in the monthly report is correct compared to the ANE calculations audit.

The results from Table 3.14 show a high percentage agreement between the Ecotech calculated averages and the Air Noise Environment calculated averages from the raw data for all parameters.

Based on the comparison of the raw data supplied by Ecotech and the validated spreadsheets used for the reporting of the data, it is the opinion of ANE that the validation process used by Ecotech for the reporting is accurate. It is also the opinion of ANE that the results presented in the December report (Ecotech Ambient Air Quality and Weather Monitoring Validated Report , M4 East Project 1st December 2018 - 31st December 2018 issued 19th January 2019.) match within 3 % of the raw data for all parameters.

3.4 Compliance with Approval Limits

The Instrument of Approval (IoA) Conditions governing the M4 East project are defined in the IoA document SS16307 dated 11 February 2016. The Approval includes a number of performance requirements relating to Air Quality, both in-tunnel and ambient as well as limits.

Condition E9 lists the ambient air pollutants goals as follows:

- (a) CO – 8 hour rolling average of 9.0 ppm (NEPM);
- (b) NO₂ – One hour average of 0.12 ppm (245 µg/m³) (NEPM);
- (c) PM₁₀ – 24 hour average of 50 µg/m³ (NEPM);
- (d) PM_{2.5} – 24 hour average of 25 µg/m³ (proposed NEPM)
- (e) PM₁₀ – annual average of 25 µg/m³ (Meeting of Environment Ministers – Agreed Statement); and
- (f) PM_{2.5} – annual average of 8 µg/m³ (Meeting of Environment Ministers – Agreed Statement).



The air quality goals for PM₁₀ and PM_{2.5} specified in Condition E9 refer to national air quality goals. The National Environmental Protection Measure Ambient Air Quality defines µg/m³ as referenced to a temperature of 0°C and 101.325 kilopascals. The Ecotech reports identifies these conditions in Appendix 1.

Ecotech has included a table in the monthly reports to highlight any exceedences that may occur above the Condition E9 air quality goals. The Ecotech monthly reports clearly identify exceedences of the IoA criteria, and these are reproduced in Tables 3.15 to 3.20 below for the period July - December.

Table 3.15: Allen Street Exceedences for July to December 2018.

Parameter	Averaging Time	July	Aug	Sept	Oct	Nov	Dec
NO ₂ (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM ₁₀ (µg/m ³)	24 hour	64.0 - 19/07/18	-	-	-	59 - 21/11/18 98.2 - 22/11/18	-
	Annual	-	-	-	-	-	-
PM _{2.5} (µg/m ³)	24 Hour	-	-	-	-	-	-
	Annual	-	-	-	-	-	8.1 (2018)

Table 3.16: Concord Oval Exceedences for July to December 2018.

Parameter	Averaging Time	July	Aug	Sept	Oct	Nov	Dec
NO ₂ (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM ₁₀ (µg/m ³)	24 hour	53.6 - 18/07/18 63.7 - 19/07/18	-	-	-	59.0 - 21/11/18 92.2 - 22/11/18-	-
	Annual	-	-	-	-	-	-
PM _{2.5} (µg/m ³)	24 Hour	-	-	-	-	-	-
	Annual	-	-	-	-	-	8.5 2018





Table 3.17: Haberfield Public School Exceedences for July to December 2018.

Parameter	Averaging Time	July	Aug	Sept	Oct	Nov	Dec
NO ₂ (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM ₁₀ (µg/m ³)	24 hour	55.5 18/07/18 54.9 - 19/07/18	-	-	-	59.6 21/11/18 88.7 - 22/11/18	-
	Annual	-	-	-	-	-	-
PM _{2.5} (µg/m ³)	24 Hour	-	27 - 01/08/18	-	-	-	-
	Annual	-	-	-	-	-	11.2 2018

Table 3.18: Powells Creek Exceedences for July to December 2018.

Parameter	Averaging Time	July	Aug	Sept	Oct	Nov	Dec
NO ₂ (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM ₁₀ (µg/m ³)	24 hour	70.7 - 19/07/18	-	-	-	68.4 - 21/11/18 111.3 - 22/11/18	-
	Annual	-	-	-	-	-	25.8 2018
PM _{2.5} (µg/m ³)	24 Hour	-	-	-	-	-	-
	Annual	-	-	-	-	-	10.1 2018

Table 3.19: Ramsay Street Exceedences for July to December 2018.

Parameter	Averaging Time	July	Aug	Sept	Oct	Nov	Dec
NO ₂ (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM ₁₀ (µg/m ³)	24 hour	68.6 - 18/07/18 68.3 - 19/07/18	-	-	-	66.1 21/11/18 100.3 - 22/11/18	-
	Annual	-	-	-	-	-	-
PM _{2.5} (µg/m ³)	24 Hour	-	29 - 01/08/18	-	-	-	-
	Annual	-	-	-	-	-	11.6 2018



Table 3.20: Saint Lukes Park Exceedences for July to December 2018.

Parameter	Averaging Time	July	Aug	Sept	Oct	Nov	Dec
NO ₂ (ppm)	1 Hour	-	-	-	-	-	-
CO (ppm)	1 Hour	-	-	-	-	-	-
PM ₁₀ (µg/m ³)	24 hour	52.2 - 19/07/18	-	-	-	58.2 21/11/18 86.6 - 22/11/18	-
	Annual	-	-	-	-	-	-
PM _{2.5} (µg/m ³)	24 Hour	-	-	-	-	-	-
	Annual	-	-	-	-	-	9.7 2018

3.5 Reporting Requirements

For each parameter sampled, the relevant Australian Standard defines specific reporting requirements for the way data is reported and presented. The Ecotech reports have been reviewed and comparison to the reporting requirements is presented in Table 3.21 below.

Table 3.21: Compliance With Required Reporting Details as Listed in the Relevant Australian Standards.

Reporting Requirements	Report Compliance
Reference to the relevant Standard	The relevant standard for each parameter is noted in Table 3 of the report
The reporting organisation or company address and certification details.	Details of Ecotech are included in the report. The NATA certification number is also included.
The concentration of the components measured in correct units (ppm or ug/m ³)	The concentrations of the components are corrected labelled in the report. NO ₂ and CO are reported as ppm. PM ₁₀ and PM _{2.5} are correctly reported as ug/m ³ (Referenced to 0°C and 101.3kPa as per definition in Appendix 1)
The dates, time and period of sampling	The sampling dates and times and period identified in the report in the various results tables and graphs. (Figures 2 - 11 and Tables 20 - 25). Time is expressed as Eastern standard time. Consideration to the averaging period is also included when referencing the air quality goals in Table 4.
The full scale value of the instruments.	The January to June 2018 audit report identified that the full scale value of the instruments was not being reported. The report recommended that this issue was addressed, and that future reports should identify whether the ISO 17025 calibration for each instrument covers all or part of the instrument range for the reported data. This has not been addressed in the July to December 2018 reports.



Reporting Requirements	Report Compliance
	<p>Specifically, a “Measurement Range” is reported in Table 5 but this relates to the calibrated range not the full scale measurement range of the instruments in some cases. Data is being collected that falls outside these ranges for PM_{2.5} and temperature.</p> <p>The measurement range for the BAM PM_{2.5} is identified in Table 5 as 5 – 1,000 µg/m³ with a resolution of 1 ug/m³. The uncertainty is reported as ±5.0 µg/m³ and given that the measurements are routinely less than 5 µg/m³ and the annual air quality goal is 8 µg/m³, further clarification in relation to the uncertainty and validity of the results should be provided. AS 3580.9.12:2013 specifies a minimum range in Table 1 of 0 – 1,000 µg/m³.</p> <p>The calibrated temperature range is reported as 0°C to 50°C. In winter the temperature falls below 0°C on occasions, but the thermocouples are not calibrated at this low range. Clarification of the uncertainty and validity of the temperature results should be provided.</p>
Sampling location—all relevant details, including a coordinate reference including height to within 100 m above ground level and classification of area .	Site sampling name, geographical location and height above sea level is included in the report in Table 1.
The type of instrument.	The instrument types and brands are detailed in Table 2
Any non-conformances with the standards.	No non conformance are listed. Valid data exception details are provided for each station in Tables 20 to 25.
The uncertainty associated with the measurement along with the confidence interval and coverage factor.	The measurement uncertainties are detailed for each parameter in Table 5.

Based on the analysis presented in Table 3.21, the Ecotech reports do not comply with the reporting requirements in relation to the instrument range, and the validity of data outside of this range.

3.6 Data Drift Error

During the audit, Ecotech identified that a drift or error in the zero calibration of the PM_{2.5} measurements at the Haberfield site had occurred – as identified in Table 3.10. This had not been identified by the routine validation and calibrations completed by Ecotech. A non-conformance investigation was subsequently completed by Ecotech and at the time of writing this report is ongoing. Air Noise Environment have been requested to complete a review of the non-conformance when the report is provided by Ecotech.





4 Conclusions

An audit of the monitoring stations has been completed and the monthly ambient air quality report for December 2018 report has been subject to a detailed review.

A sample of the raw data for the month of December 2018 was checked against the values used by Ecotech for the validation and for the averaged data ultimately reported for each site for each month. The audit showed the raw data matched very closely with the validated and reported data as used by Ecotech. The procedures adopted for the data validation and reporting by Ecotech for the December 2018 report are the same as for the previous eleven months. In our opinion, the sample of data reviewed is representative of the data processing procedures for the preceding months, hence provides a suitable verification approach for the 6 month dataset (July to December 2018).

The data results were also compared to the compliance limits for the project. The results show full compliance for carbon monoxide (CO) and nitrogen dioxide (NO₂) for the 6 month period. Exceedences for the 24 hour PM₁₀ and PM_{2.5} and annual PM_{2.5} were noted on a few occasions over the period and are likely to be related to regional air quality events.

The issue relating to the calibration status of the instruments across the full range of reported data was raised in the January to June 2018 report, and has not been addressed. In particular, PM_{2.5} data is being processed where measured concentrations are below 5 µg/m³ - the lower calibrated range of the instrument. An uncertainty of +/- 5 µg/m³ applies to these data, hence the validity of the results should be justified to confirm the accuracy of the PM_{2.5} sampling data. Similarly, for temperature, the lower limit of the calibrated range does not reflect the range of measurements being completed and this is not clearly identified in the report.





5 References

AS/NZS 3580.9.12:2013 Methods for sampling and analysis of ambient air - Determination of Suspended Particulate Matter - PM_{2.5} Beta Attenuation Monitors.

AS/NZS 3580.5.1-2011 Methods for sampling and analysis of ambient air - Method 5.1: Determination of oxides of nitrogen—Direct-reading instrumental method.

AS/NZS 3580.7.1-2011 Methods for sampling and analysis of ambient air - Method 7.1: Determination of carbon monoxide—Direct-reading instrumental method.

AS/NZS 3580.9.8 - 2008 Methods for sampling and analysis of ambient air - Method 9.8: Determination of suspended particulate matter—PM₁₀ continuous direct mass method using a tapered element oscillating microbalance analyser.

AS 2923-1987 Ambient Air - Guide for the Measurement of Horizontal Wind for Air Quality Applications.

Ecotech Ambient Air Quality and Weather Monitoring Validated Reports, M4 East Project 1st January 2018 - 31st December 2018 (monthly reports).





Appendix A - Air Quality Glossary





APPENDIX B: GLOSSARY OF AIR QUALITY TERMINOLOGY

Conversion of ppm to mg/m ³	Where R is the ideal gas constant; T, the temperature in kelvin (273.16 + T°C); and P, the pressure in mm Hg, the conversion is as follows: $\mu\text{g m}^{-3} = (P/RT) \times \text{Molecular weight} \times (\text{concentration in ppm})$ $= \frac{P \times \text{Molecular weight} \times (\text{concentration in ppm})}{62.4 \times (273.2 + T^{\circ}\text{C})}$
g/s	Grams per second
mg/m ³	Milligrams (10 ⁻³) per cubic metre.
µg/m ³	Micrograms (10 ⁻⁶) per cubic metre.
ppb	Parts per billion.
ppm	Parts per million.
PM ₁₀ , PM _{2.5} , PM ₁	Fine particulate matter with an equivalent aerodynamic diameter of less than 10, 2.5 or 1 micrometres respectively. Fine particulates are predominantly sourced from combustion processes. Vehicle emissions are a key source in urban environments.
50th percentile	The value exceeded for 50 % of the time.
NO _x	Oxides of nitrogen – a suite of gaseous contaminants that are emitted from road vehicles and other sources. Some of the compounds can react in the atmosphere and, in the presence of other contaminants, convert to different compounds (eg, NO to NO ₂).
VOC	Volatile Organic Compounds. These compounds can be both toxic and odorous.

