REPORT

Ambient Air Quality Monitoring (AAQM) Report November 2018

West Gate Tunnel Project

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Executive Summary

Air quality monitoring for the West Gate Tunnel Project has been specifically established to develop a "baseline" of data from current local conditions. This baseline will be used to measure any changes once the tunnel opens in 2022. When the project opens, air quality monitoring will continue for up to 5 years.

The results of the West Gate Tunnel Project Ambient Air Quality Monitoring (AAQM) program for the period of 1 November 2018 to 30 November 2018 are presented below.

The following tables present the maximum measured concentration for each parameter at Stations 1, 2, 3, 4, 5 and 6 during the reporting period. The maximum concentration for each parameter is compared with the respective criteria.

Station 1 Summary November 2018

Parameter	Units	Averaging period	Maximum concentration	Air quality objective[A]	Exceedances
$PM_{2.5}$	ug/m^3	24 hour	12	25	Nil
PM_{10}	ug/m^3	24 hour	41	50	Nil

Note:
A - SEPP(AAQ) objective

Station 2, Station 3, Station 5 and Station 6 Summary November 2018

Parameter	Units	Averaging period	Maximum concentration				Air quality objective[A]	Exceedances
			Station 2	Station 3	Station 5	Station 6		
$PM_{2.5}$	ug/m^3	24 hour	13	10	12	11	36	Nil
PM_{10}	ug/m^3	24 hour	39	32	43	61	60	1

Note:
A - SEPP(AQM) Intervention level

Station 4 Summary November 2018

Parameter	Units	Averaging period	Maximum concentration	Air quality objective	Exceedances
$PM_{2.5}$	ug/m^3	24 hour	12	36[A]	Nil
PM_{10}	ug/m^3	24 hour	52	60[A]	Nil
NO_2	ppb	1 hour	40	140[A]	Nil
CO	ppm	1 hour	1.1	29[A]	Nil
Benzene	ppb	24 hour	1.8	3.0[B]	Nil
Toluene	ppb	24 hour	2.4	1000[B]	Nil
Total xylene isomers	ppb	24 hour	<1	250[B]	Nil

Note:
A - SEPP(AQM) Intervention level
B - Air NEPM Monitoring investigation level

The November ambient air quality monitoring programme results were less than the respective air quality objectives for all parameters measured at stations 1 to 5. Station 6 (Millers Road) exceeded the PM_{10} air quality objective on one day (2/11/2018), all other parameters monitored at station 6 were less than the respective air quality objectives.

Data capture statistics for November 2018 were above 90 percent for all parameters at AAQMS 1, 2, 3, 5 and 6. However, data loss for all parameters, was observed at AAQMS 4 (Primula Avenue) from 27/11/2018 08:00 to the end of the reporting month due to the power supply to the site being disconnected by the power supply company.

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1.0 INTRODUCTION

Air quality monitoring for the West Gate Tunnel Project has been specifically established to develop a "baseline" of data from current local conditions. This baseline will be used to measure any changes once the tunnel opens in 2022. When the project opens, air quality monitoring will continue for up to 5 years.

The results of the West Gate Tunnel Project West Gate Tunnel Project Ambient Air Quality Monitoring (AAQM) program for the period of 1 November 2018 to 30 November 2018 are contained in the following report.

The AAQM program was conducted in accordance with the Environmental Performance Requirement (EPR) AQP4 for the Project and consists of six AAQM stations (AAQMS) monitoring the following ambient air quality indicators:

- continuous measurement of particulate matter with an equivalent aerodynamic diameter less than 10 microns (PM_{10})
- continuous measurement of particulate matter with an equivalent aerodynamic diameter less than 2.5 microns ($PM_{2.5}$)
- continuous measurement of ambient temperature and relative humidity
- continuous measurement of wind speed and wind direction (Stations 1 to 5).

Additionally, one of the specified AAQMS (Primula Avenue) monitors the following additional air quality indicators in combination with PM_{10} and $PM_{2.5}$:

- continuous monitoring of oxides of nitrogen ([NO_x] comprising of nitrogen dioxide (NO_2) and nitric oxide [NO])
- continuous monitoring of carbon monoxide (CO)
- one in six day monitoring of benzene, toluene, ethylbenzene and xylene isomers (BTEX)
- continuous measurement of atmospheric pressure.

AAQMS Station 1 to Station 6 were installed and commissioned during the period 22/08/2018 to 12/10/2018. Specific installation dates can be found below in Section 2.1.

Details of the air quality indicators monitored at each AAQMS are provided in Table 1.

Table 1: AAQMS monitoring details

Site name	Location	Coordinates	Monitoring parameters
Station 1	Barbara Beyer Reserve, 2 Harris Street, Yarraville	-37.812730°S 144.900017°E	PM_{10} and $PM_{2.5}$ Ambient temperature, relative humidity, wind speed and wind direction
Station 2	51-53 Francis Street	-37.821800°S 144.894383°E	PM_{10} and $PM_{2.5}$ Ambient temperature, relative humidity, wind speed and wind direction
Station 3	Railway Lot 64, (part) 15 Goulburn Street, Yarraville	-37.814063°S 144.891320°E	PM_{10} and $PM_{2.5}$ Ambient temperature, relative humidity, wind speed and wind direction

Site name	Location	Coordinates	Monitoring parameters
Station 4	44 Primula Avenue, Brooklyn	-37.824284°S 144.846425°E	PM_{10} and $PM_{2.5}$ NO, NO_2, NOx and CO BTEX – one in six day sampling (24 hour average) Ambient temperature, relative humidity, atmospheric pressure, wind speed and wind direction
Station 5	Donald McLean Reserve, Spotswood	-37.826442°S 144.882133°E	PM_{10} and $PM_{2.5}$ Ambient temperature, relative humidity, wind speed and wind direction
Station 6	44 Millers Road Brooklyn	-37.821252°S 144.848878°E	PM_{10} and $PM_{2.5}$ Ambient temperature and relative humidity

2.0 AAQMS DETAILS

2.1 Site locations

AAQMS Station 1 to Station 5 were installed and commissioned during the period 22/08/2018 to 31/08/2018. AAQMS Station 6 (Millers Road) was commissioned on 12/10/2018. Wind sensors (wind speed and direction) were installed later due to delays in calibration from the instrument supplier. The wind sensor at Station 6 does not meet the siting criteria specified in AS 3580.14 due to the proximity of buildings, large trees and power lines, therefore, the data has not been reported. AAQMS commissioning dates are provided in Table 2. Figure 1 presents the locations of the AAQMS.

Table 2: AAQMS commissioning dates

Parameter	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
AAQMS	23/08/2018	22/08/2018	22/08/2018	22/08/2018	31/08/2018	12/10/2018
Wind speed & direction	07/09/2018	20/09/2018	14/09/2018	10/09/2018	17/09/2018	NA

NA: Not applicable - wind sensor is not compliant with siting criteria specified in AS 3580.14

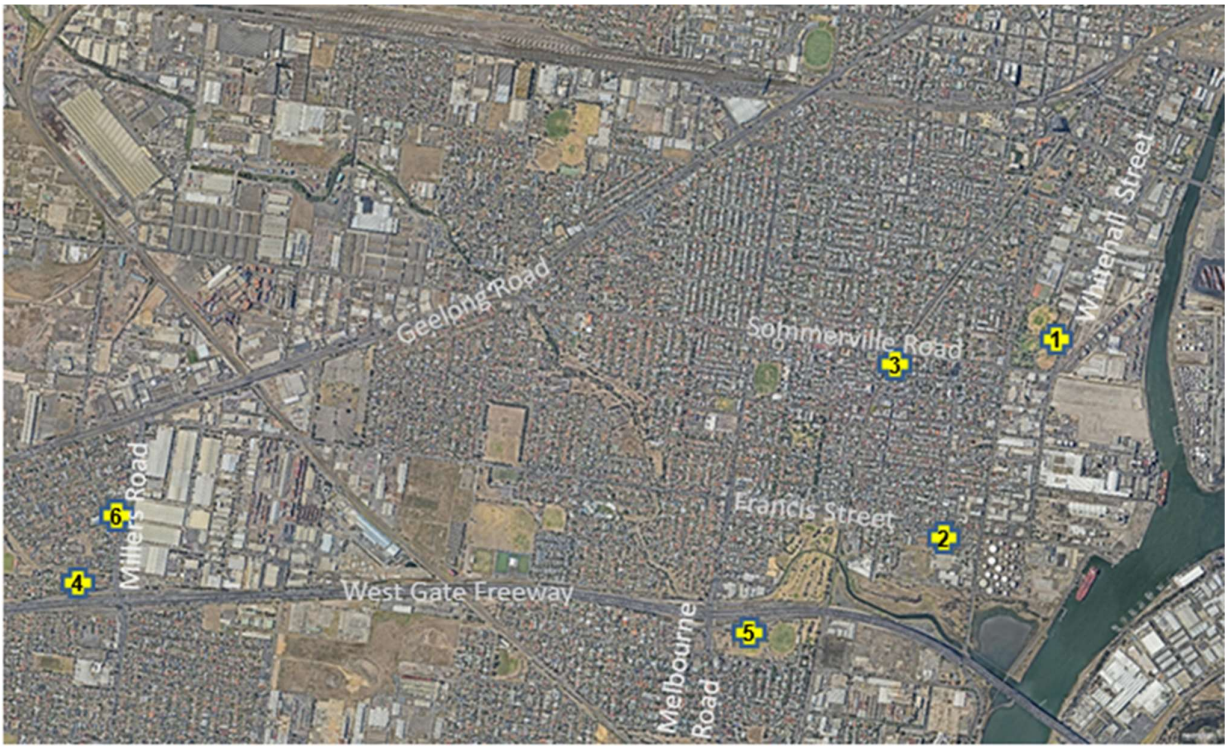

Figure 1: West Gate Tunnel AAQMS site locations

2.2 Siting assessment

Australian Standard AS/NZS 3580.1.1 *"Methods for Sampling and Analysis of Ambient Air – Part 1.1. Guide to Siting Air Monitoring Equipment"* provides general guidance for the siting of ambient air monitoring equipment and specific siting parameters for individual air pollutants. Table 3 provides a comparison between recommended criteria contained in the Standard for the parameters monitored at neighbourhood and peak monitoring stations with actual conditions at each AAQMS.

Table 3: Australian standard AAQMS siting criteria compliance

Station	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Station type	Neighbourhood	Peak	Peak	Peak	Peak	Peak
Inlet height above ground level 1.0 m – 15 m	✓	✓	✓	✓	✓	✓
Clear sky angle 120° (Neighbourhood)	✓	-	-	-	-	-
Unrestricted 270° airflow around inlet (Neighbourhood)	✓	-	-	-	-	-
Unrestricted 180° airflow around inlet (Peak)	-	✓	✓	✓	✓	✓
Distance to supporting structure ≥ 1 m	✓	✓	✓	✓	✓	✓

Station	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Station type	Neighbourhood	Peak	Peak	Peak	Peak	Peak
10 m from drip line of trees	✓	✓	✓	✓	✓	✗[A]
No extraneous sources nearby	✓	✓	✓	✓	✓	✗[B]
Greater than 50 m from road (≤ 10,000 vehicles/day)	✓	-	-	-	-	-
Greater than 2 m from road (Peak station)	-	✓	✓	✓	✓	✓

Note:
A Tree drip line is <3 m from sampler inlets and meteorological monitoring equipment
B Residential chimney is <5 m from the sampler inlet.

2.3 Equipment specifications

Table 4 provides a list of the monitoring equipment installed at the AAQMS.

Table 4: AAQMS instrumentation

Parameter	Equipment item	Manufacturer	Model
$PM_{2.5}$	Beta Attenuation Monitor (BAM)	Thermo Fisher Scientific Inc.	5014i
PM_{10}	Beta Attenuation Monitor (BAM)	Thermo Fisher Scientific Inc.	5014i
Oxides of Nitrogen	Chemiluminescence	Thermo Fisher Scientific Inc.	42i
Carbon Monoxide	Infra-red gas filter correlation	Thermo Fisher Scientific Inc.	48i
Temperature	Pt100 resistive platinum sensor	Thermo Fisher Scientific Inc.	5014i
BTEX	Summa canister	Restek	6 litre
Relative humidity	Capacitive thin film sensor	Thermo Fisher Scientific Inc.	5014i
Atmospheric Pressure	Beta Attenuation Monitor (BAM)	Thermo Fisher Scientific Inc.	5014i
Wind speed and wind direction	Ultrasonic anemometer	RM Young	Model 86000

3.0 AIR QUALITY CRITERIA

The ambient air quality criteria applicable to the West Gate Tunnel Project are derived from the following legislation:

- State Environment Protection Policy (Ambient Air Quality) [SEPP(AAQ)]
- State Environment Protection Policy (Air Quality Management) [SEPP(AQM)].
- National Environment Protection (Air Toxics) Measure Monitoring Investigation Levels (MILs)

SEPP(AAQ)

The SEPP(AAQ) adopts the requirements of the National Environment Protection (Ambient Air Quality) Measure (Air NEPM) and its environmental quality objectives (EQOs) for CO, NO_2, and particles (as PM_{10} and $PM_{2.5}$). The SEPP(AAQ) EQOs apply to air quality within a region or sub-region considered to be representative of exposure of the general population in Victoria. These objectives have been adopted for the purposes of comparison with results from background/ neighbourhood monitoring stations for the West Gate Tunnel Project and are relevant to Station 1 (Yarraville Gardens).

SEPP(AQM)

The SEPP(AQM) sets out legislative requirements for managing and assessing air emissions in Victoria. The aim of the SEPP(AQM) is to ensure that prescribed air quality objectives are met and protect the beneficial uses of the air environment. Schedule B lists intervention levels which are used in the assessment of local or neighbourhood air monitoring data. Consistent with assessment of impacts described in the Environment Effects Statement for the West Gate Tunnel Project, the intervention levels have been adopted for purposes of comparison with results from peak monitoring stations for the West Gate Tunnel Project and are applicable to Station 2 (Francis Street), Station 3 (Railway Reserve), Station 4 (Primula Avenue), Station 5 (Donald McLean Reserve) and Station 6 (Millers Road).

NEPM (Air Toxics)

The aim of the Air Toxics NEPM is to gain a greater understanding of the levels of air toxics at specific locations where elevated concentrations are likely to occur and where the potential for significant human exposure exists. The Air Toxics NEPM established monitoring investigation levels (MILs) relevant for the West Gate Tunnel Project for benzene, toluene and xylene isomers. The MILs are used purposes of comparison with results from the air toxics monitored at Station 4 (Primula Avenue).

Table 5 presents the air quality indicators and objectives for each AAQMS for the West Gate Tunnel Project.

Table 5: Air quality indicators and objectives

Location	Pollutant	Units	Air Quality Objective	Averaging period
Station 1	PM_{10}	$\mu g/m^3$	50	24 hour
			20	Annual
	$PM_{2.5}$		25	24 hour
			8	Annual

Location	Pollutant	Units	Air Quality Objective	Averaging period
Station 2 Station 3 Station 4 Station 5 Station 6	PM_{10}	$\mu g/m^3$	60	24 hour
	$PM_{2.5}$		36	
Station 4	CO	ppm	29	1 hour
	NO_2	ppb	140	1 hour
	Benzene	ppb	3	Annual
	Toluene	ppb	1000	24 hour
			100	Annual
	Ethylbenzene	ppb	NA	24 hour
	Xylene isomers	ppb	250	24 hour
			200	Annual

4.0 TEST METHODS

4.1 Particulate matter ($PM_{2.5}$)

$PM_{2.5}$ concentrations are determined using a Beta Attenuation Monitor (BAM).

Suspended particulate matter in ambient air is measured using the attenuation of beta rays as a surrogate for continuous mass determination. Beta rays are high energy electrons generated from the radioactive decay of the radon isotope Rn-222. When contacting particulate matter beta rays are either absorbed or their energy level is diminished. The relationship between the attenuation of beta rays between the source and detector is used to determine the mass density.

The BAM is equipped with a flow control and measurement system. The flow control system volumetrically controls the flowrate to 16.7 l/min. The flowrate is used with the mass density to calculate the particulate matter concentration.

The sampler is fitted with a size selective inlet, which separates particles with an equivalent aerodynamic diameter greater than 10 microns from the sample stream. An in-line $PM_{2.5}$ particle size separator is also fitted to further separate particles; only those with an equivalent aerodynamic diameter less than 2.5 microns can pass through the particle size separator to the filter for mass determination.

The $PM_{2.5}$ monitoring method is based on the requirements contained within Australian Standard AS/NZS 3580.9.12 "*Methods for Sampling and Analysis of Ambient Air – Method 9.12: Determination of Suspended Particulate Matter – $PM_{2.5}$ Beta Attenuation Monitors*" (NATA Laboratory Accreditation No. 1910).

4.2 Particulate matter (PM_{10})

PM_{10} concentrations are determined using a continuous BAM without an in-line $PM_{2.5}$ particle size separator. All other measurement processes remain the same as for the $PM_{2.5}$ test method.

The PM_{10} monitoring method is based on the requirements contained within Australian Standard AS/NZS 3580.9.11:2016 "*Methods for Sampling and Analysis of Ambient Air – Method 9.11: Determination of Suspended Particulate Matter – PM_{10} Beta Attenuation Monitors"* (NATA Laboratory Accreditation No. 1910).

4.3 Nitrogen dioxide (NO_2)

Oxides of nitrogen concentrations were determined using a 42i Thermo Scientific chemiluminescence gas analyser.

Automatic calibrations are carried out daily against a NATA certified reference gas mixture. Manual calibrations are conducted at one month intervals.

The oxides of nitrogen (NO, NO_2 and NO_x) monitoring method is based on the requirements of Australian Standard AS 3580.5.1, *"Determination of Oxides of Nitrogen – Chemiluminescence Method"*.

4.4 Carbon monoxide (CO)

Carbon monoxide concentrations are determined using a 48i Thermo Scientific infra-red gas filter correlation analyser.

Automatic calibrations are carried out daily against a NATA certified reference gas mixture. Manual calibrations are conducted at one month intervals.

The carbon monoxide monitoring method is based on the requirements of Australian Standard AS 3580.7.1, "*Determination of Carbon Monoxide – Direct Reading Instrumental Method"*.

4.5 Volatile organic compounds (BTEX)

A sample is collected in an evacuated electro-polished and passivated stainless steel canister. Analysis involves separation by gas chromatography (GC) and measurement by mass selective (MS) detector.

The procedure for sampling Volatile Organic Compounds (VOCs) using evacuated canisters, and for the subsequent analysis, is described in USEPA Method TO-15 "Determination of Volatile Organic Compounds (VOCs) in air collected in specially-prepared canisters and analysed by Gas Chromatography/Mass Spectrometry (GC/MS)".

Samples were analysed by Queensland Health (NATA Laboratory Accreditation No. 41) based on USEPA method TO-15. The test method used was in accordance with Golder Source Test Method C9, "Canister (Evacuated) Sampling for VOC: In Ambient Air and Source Emissions".

4.6 Meteorological parameters

Monitoring of meteorological parameters; wind speed/direction, temperature, relative humidity and atmospheric pressure was conducted in accordance with Australian Standard AS 3580.14 "*Methods for Sampling and Analysis of Ambient Air – Part 14: Meteorological Monitoring for Ambient Air Quality Monitoring Applications"* (NATA Laboratory Accreditation No. 1910).

5.0 MEASUREMENT UNCERTAINTY

5.1 $PM_{2.5}$

The measurement uncertainty for $PM_{2.5}$ by BAM is published by Thermo-Fisher as ±2 µg/m^3 (24 hour average).

5.2 PM_{10}

The measurement uncertainty for $PM_{2.5}$ by BAM is published by Thermo-Fisher as ±2 µg/m^3 (24 hour average).

5.3 NO_2

The measurement uncertainty for NO, NO2 and NOx by Chemiluminescence is published in AS3580.5.1 as ±10% (24 hour average).

5.4 CO

The measurement uncertainty for CO by Infra-red gas filter correlation is published in AS3580.7.1 as ±10% (24 hour average).

5.5 Benzene

USEPA Method TO-15 cites the accuracy and precision for two ambient air quality studies conducted in the United States of America. The average replicate precision for a range of 16 compounds in both studies was 15%. Replicate precision was defined as the ratio of the average difference between replicates to the average value of replicates.

The reported accuracies for both studies ranged between ± 4 % and ± 31%. The average accuracy for both studies for the range of 16 compounds was ± 11%. Accuracy is defined as the ratio of the difference between expected and observed audit results to the expected audit result.

5.6 Meteorological parameters

The estimated measurement uncertainty for each of the parameters is presented in Table 6.

Table 6: Meteorological parameters measurement uncertainty

Parameter	Measurement uncertainty [A]
Wind speed	Greater of ±0.6 m/s or 5%
Wind direction	±5°
Atmospheric pressure	±3 hPa
Temperature	±6%
Relative humidity	±5 – 7%RH

Note:

A Measurement uncertainty estimates are as published in AS3580.14 "*Methods for Sampling and Analysis of Ambient Air – Part 14 Meteorological Monitoring for Ambient Air Quality Monitoring Applications".*

5.7 Calibration and maintenance

Sample flow rate calibration was conducted on a monthly basis using a NATA calibrated primary standard flowmeter. Calibration details for the reporting period are presented in Table 7.

Table 7: Calibrations

Location	Parameter	Last Calibration Date	Calibration Type
Station 1	PM_{10}	3/11/2018	Monthly
	$PM_{2.5}$	3/11/2018	Monthly
	Wind speed and direction	9/08/2018	Two yearly
Station 2	PM_{10}	3/11/2018	Monthly
	$PM_{2.5}$	3/11/2018	Monthly
	Wind speed and direction	7/08/2018	Two yearly
Station 3	PM_{10}	3/11/2018	Monthly
	$PM_{2.5}$	3/11/2018	Monthly
	Wind speed and direction	10/08/2018	Two yearly
Station 4	PM_{10}	3/11/2018	Monthly
	$PM_{2.5}$	3/11/2018	Monthly
	NO/ NO_2 / NOx	30/10/2018	Monthly
	CO	3/11/2018	Monthly
	BTEX	NA	Flow-controllers and canisters certified by lab
	Wind speed and direction	7/08/2018	Two yearly
Station 5	PM_{10}	3/11/2018	Monthly
	$PM_{2.5}$	3/11/2018	Monthly
	Wind speed and direction	10/08/2018	Two yearly
Station 6	PM_{10}	29/10/2018	Monthly
	$PM_{2.5}$	29/10/2018	Monthly

6.0 RESULTS

The monitoring results for 1 November 2018 to 30 November 2018 are presented in the following sections.

6.1 Particulate matter (BAM $PM_{2.5}$ & PM_{10})

$PM_{2.5}$ and PM_{10} were continuously monitored and 5-minute averages logged. The 5-minute average data was transformed to 24 hour averages for reporting.

$PM_{2.5}$ and PM_{10} concentration statistics from the reporting period for Station 1 to Station 6 are presented in Table 8 to Table 13. The 24 hour average plots for Station 1 to Station 6 are presented in Figure 2 to Figure 7.

6.1.1 Station 1 – Yarraville Gardens

Table 8: Station 1 (Yarraville Gardens AAQMS) $PM_{2.5}$ and PM_{10} percentiles (24 hour average)

Parameter	Concentration (µg/m³)[A]							Air quality objective[B]
	Maximum	99th	98th	95th	90th	75th	50th	(µg/m³)
$PM_{2.5}$	12	12	12	11	11	9.4	7.5	25
PM_{10}	41	41	41	37	31	28	22	50

Note:
A Micrograms per cubic metre at 0°C and 101.3 kPa
B SEPP(AAQ) Objective

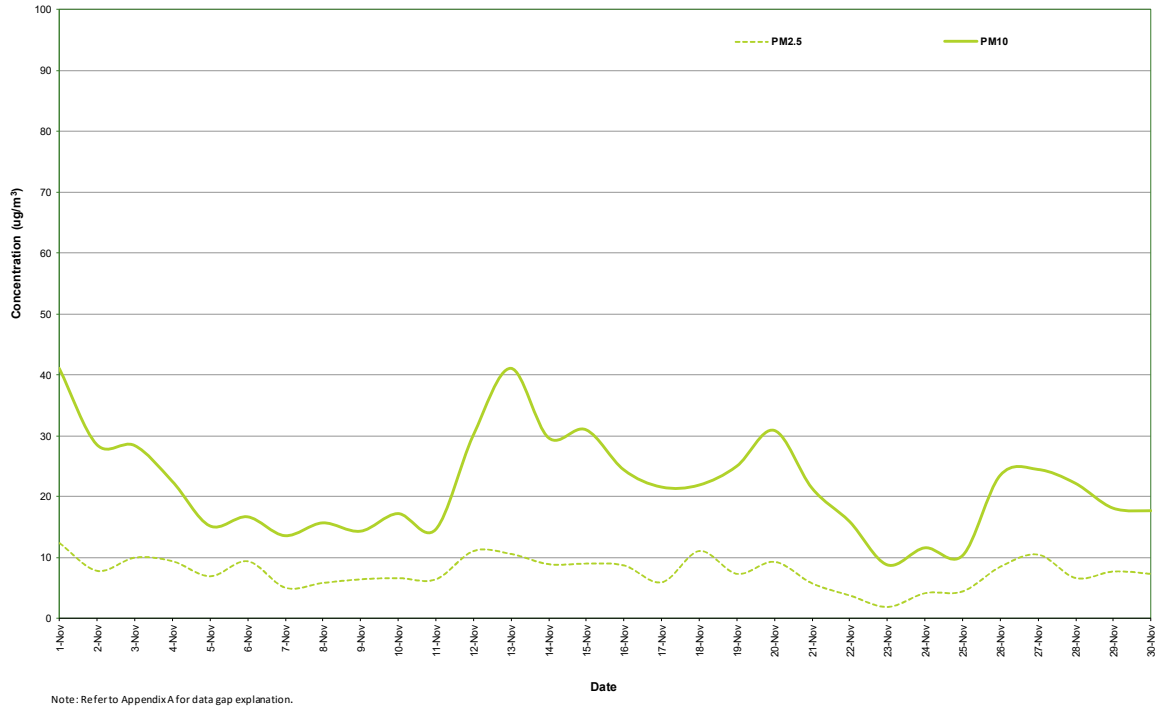

Figure 2: Station 1 $PM_{2.5}$ and PM_{10} concentration (24 hour average) – November 2018

6.1.2 Station 2 – Francis Street

Table 9: Station 2 (Francis Street AAQMS) $PM_{2.5}$ and PM_{10} percentiles (24 hour average)

Parameter	Concentration (µg/m³)[A]							Air quality objective[B]
	Maximum	99th	98th	95th	90th	75th	50th	(µg/m³)
$PM_{2.5}$	13	12	12	12	11	8.1	7.0	36
PM_{10}	39	39	38	36	33	25	17	60

Note:
A Micrograms per cubic metre at 0°C and 101.3 kPa
B SEPP(AQM) Intervention level

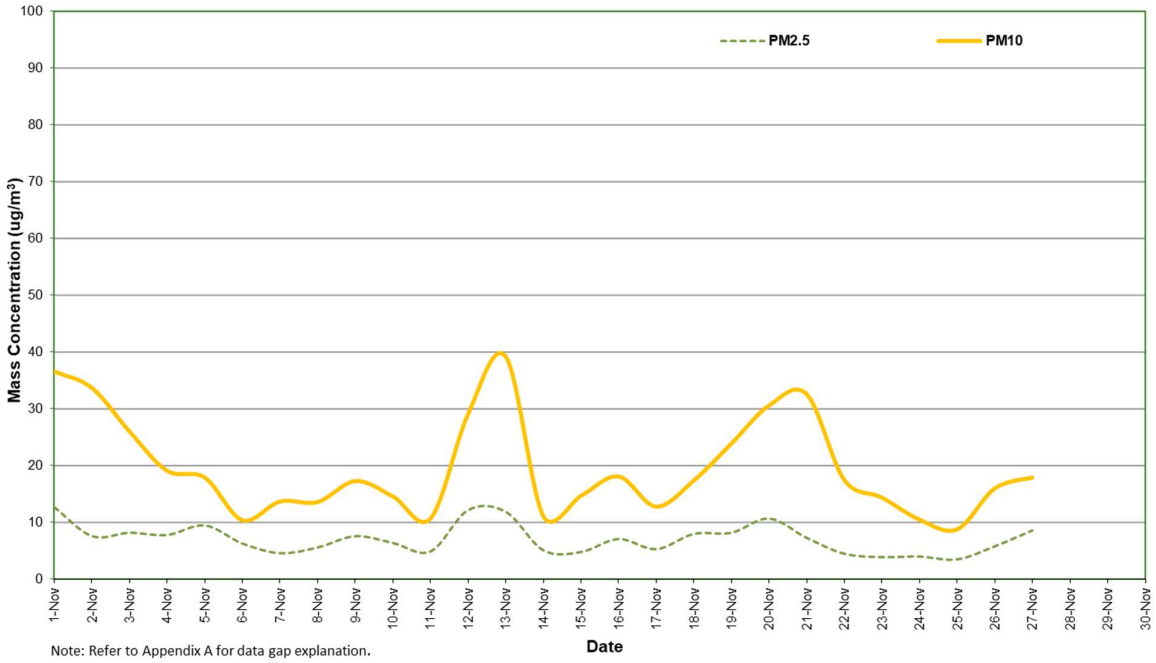

Figure 3: Station 2 $PM_{2.5}$ and PM_{10} concentration (24 Hour Average) – November 2018

6.1.3 Station 3 – Railway Reserve

Table 10: Station 3 (Railway Reserve AAQMS) $PM_{2.5}$ and PM_{10} percentiles (24 hour average)

Parameter	Concentration (µg/m³)[A]							Air quality objective[B]
	Maximum	99th	98th	95th	90th	75th	50th	(µg/m³)
$PM_{2.5}$	10	9	9	8	8.2	6.9	5.6	36
PM_{10}	32	32	32	30	27	19	13	60

Note:
A Micrograms per cubic metre at 0°C and 101.3 kPa
B SEPP(AQM) Intervention level

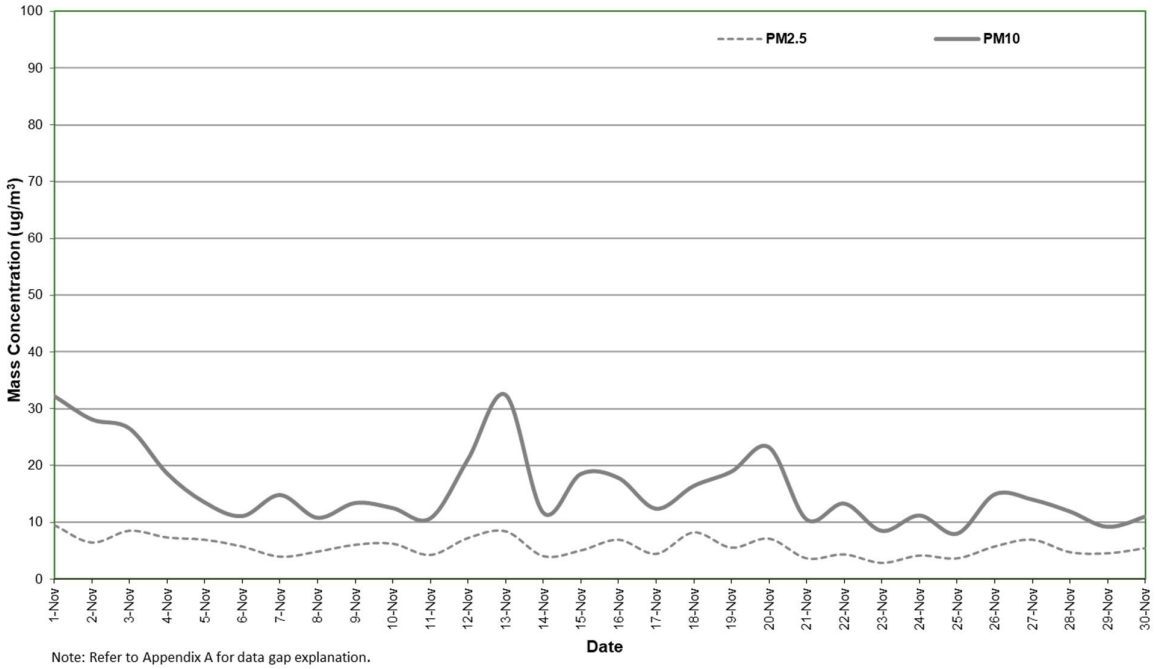

Figure 4: Station 3 $PM_{2.5}$ and PM_{10} concentration (24 hour average) – November 2018

6.1.4 Station 4 – Primula Avenue

Table 11: Station 4 (Primula Avenue AAQMS) $PM_{2.5}$ and PM_{10} percentiles (24 hour average)

Parameter	Concentration (µg/m³)[A]							Air quality objective[B]
	Maximum	99th	98th	95th	90th	75th	50th	(µg/m³)
$PM_{2.5}$	12	11	11	11	9	8.2	6.2	36
PM_{10}	52	52	52	51	48	34	19	60

Note:
A Micrograms per cubic metre at 0°C and 101.3 kPa
B SEPP(AQM) Intervention level

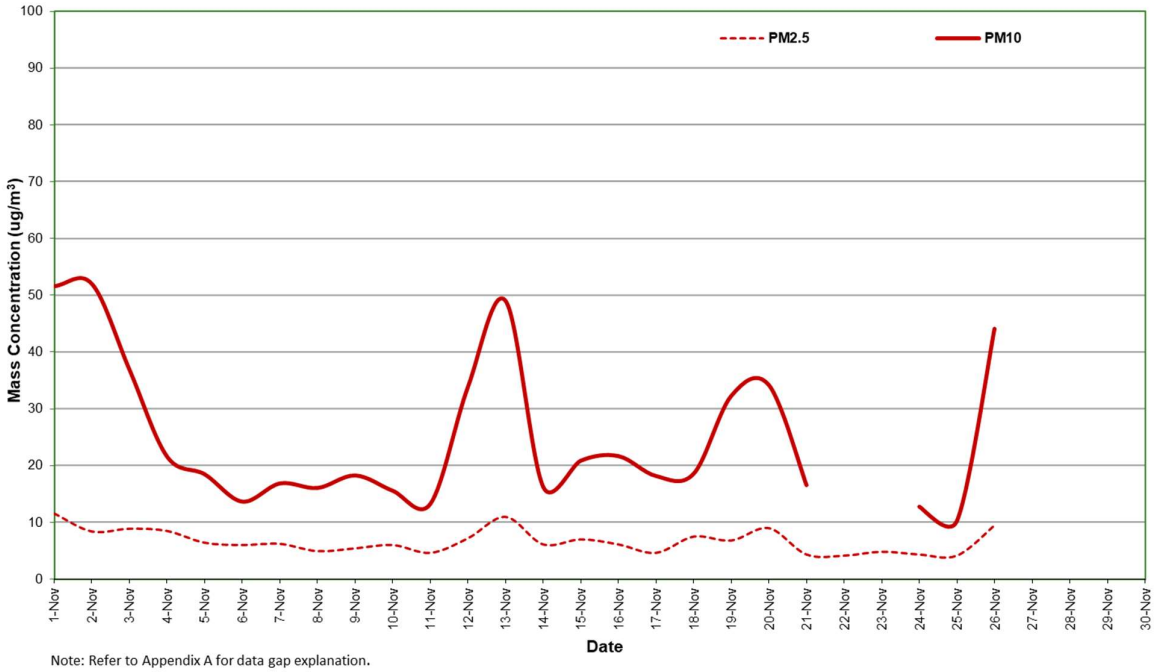

Figure 5: Station 4 $PM_{2.5}$ and PM_{10} concentration (24 hour average) – November 2018

6.1.5 Station 5 – Donald McLean Reserve

Table 12: Station 5 (Donald McLean Reserve AAQMS) $PM_{2.5}$ and PM_{10} percentiles (24 hour average)

Parameter	Concentration (µg/m³)[A]							Air quality objective[B]
	Maximum	99th	98th	95th	90th	75th	50th	(µg/m³)
$PM_{2.5}$	12	12	11	10	10	8.0	4.9	36
PM_{10}	43	42	41	38	30	20	14	60

Note:
A Micrograms per cubic metre at 0°C and 101.3 kPa
B SEPP(AQM) Intervention level

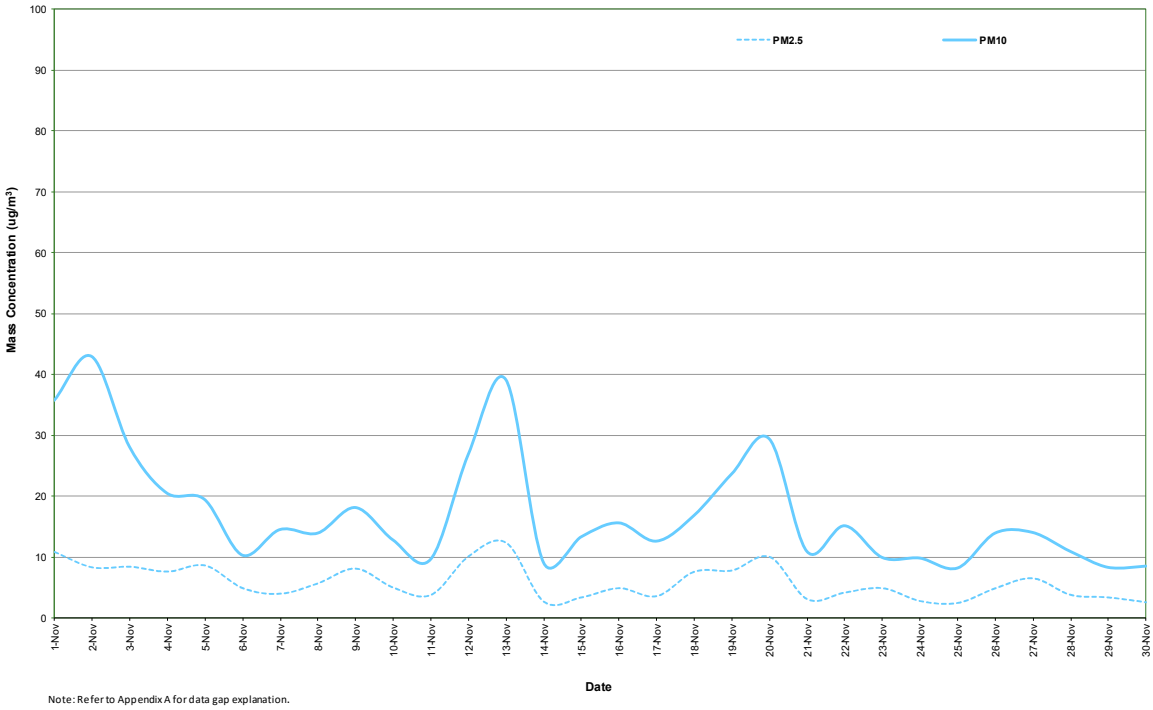

Figure 6: Station 5 $PM_{2.5}$ and PM_{10} concentration (24 hour average) – November 2018

6.1.6 Station 6 – Millers Road

Table 13: Station 6 (Millers Road AAQMS) $PM_{2.5}$ and PM_{10} percentiles (24 hour average)

Parameter	Concentration (µg/m³)[A]							Air quality objective[B]
	Maximum	99th	98th	95th	90th	75th	50th	(µg/m³)
$PM_{2.5}$	11	11	11	10.8	9.8	7.7	6.6	36
PM_{10}	61	59	56	51	40	22	18	60

Note:
A Micrograms per cubic metre at 0°C and 101.3 kPa
B SEPP(AQM) Intervention level

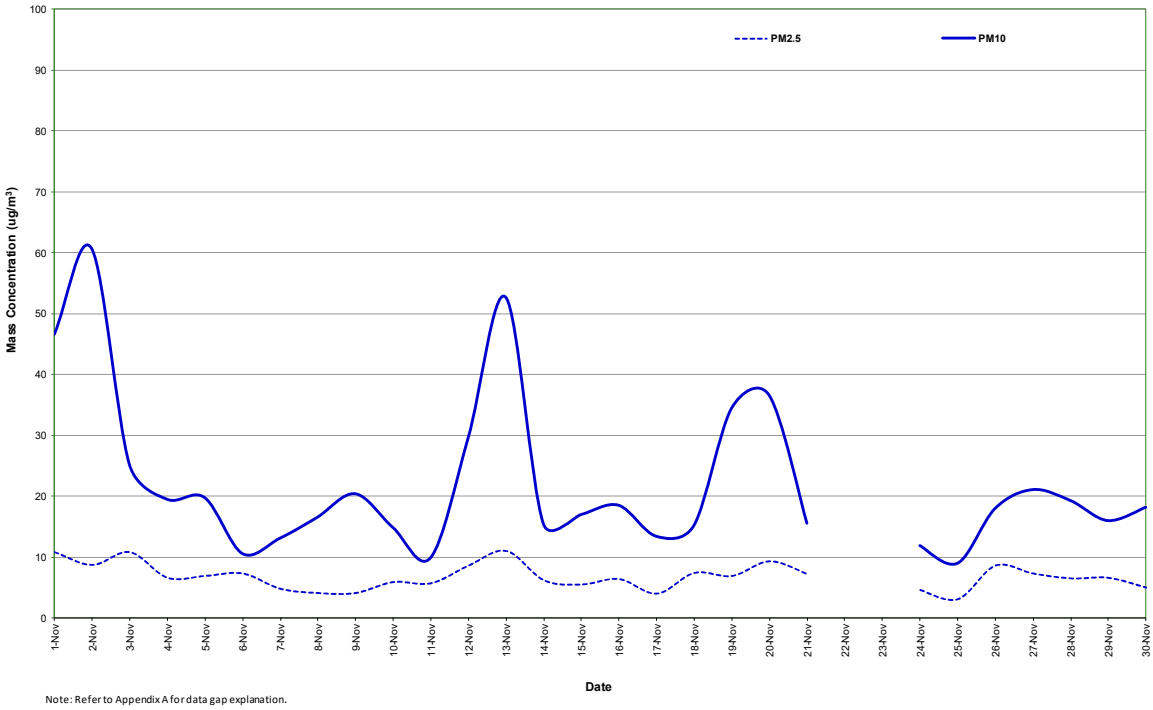

Figure 7: Station 6 $PM_{2.5}$ and PM_{10} concentration (24 hour average) – November 2018

6.1.7 Combined $PM_{2.5}$ mass concentrations

Combined plots of the AAQMS $PM_{2.5}$ and PM_{10} are presented in Figure 8 and Figure 9 respectively.

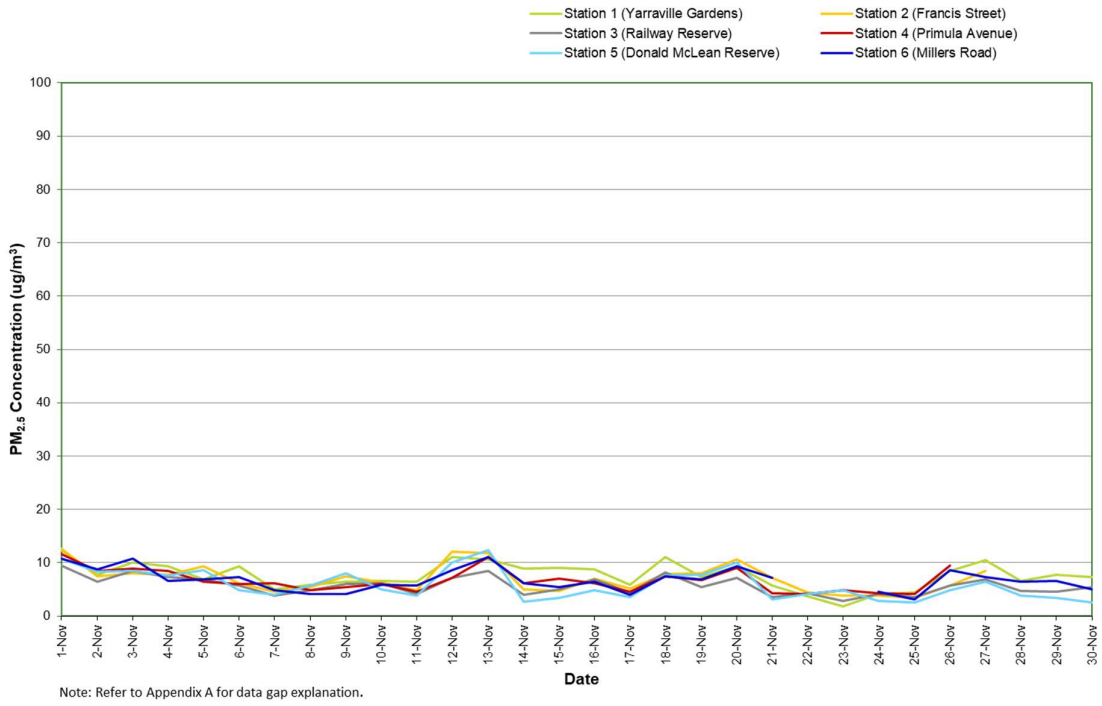

Figure 8: Combined $PM_{2.5}$ concentration (24 hour average) – November 2018

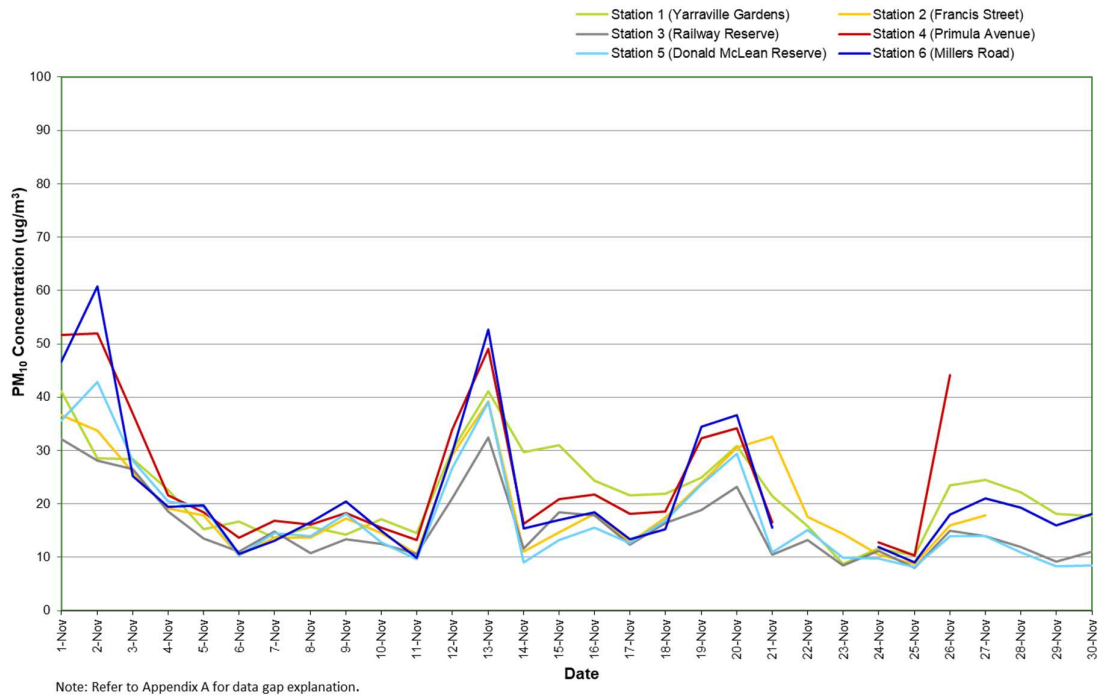

Figure 9: Combined PM_{10} concentration (24 hour average) – November 2018

6.2 Nitrogen dioxide (NO_2)

NO_2 (1 hour average) mass concentration statistics for the reporting period are given in Table 14. A plot of NO_2 (1 hour average) mass concentration for the reporting period is presented in Figure 10.

Table 14: Station 4 (Primula Avenue AAQMS) NO_2 percentiles (1 hour average)

Parameter	Concentration (ppb)[A]							SEPP (AQM) intervention level
	Maximum	99th	98th	95th	90th	75th	50th	(ppb)
NO_2	40	33	30	24	23	17	13	140

Note:
A Parts per billion

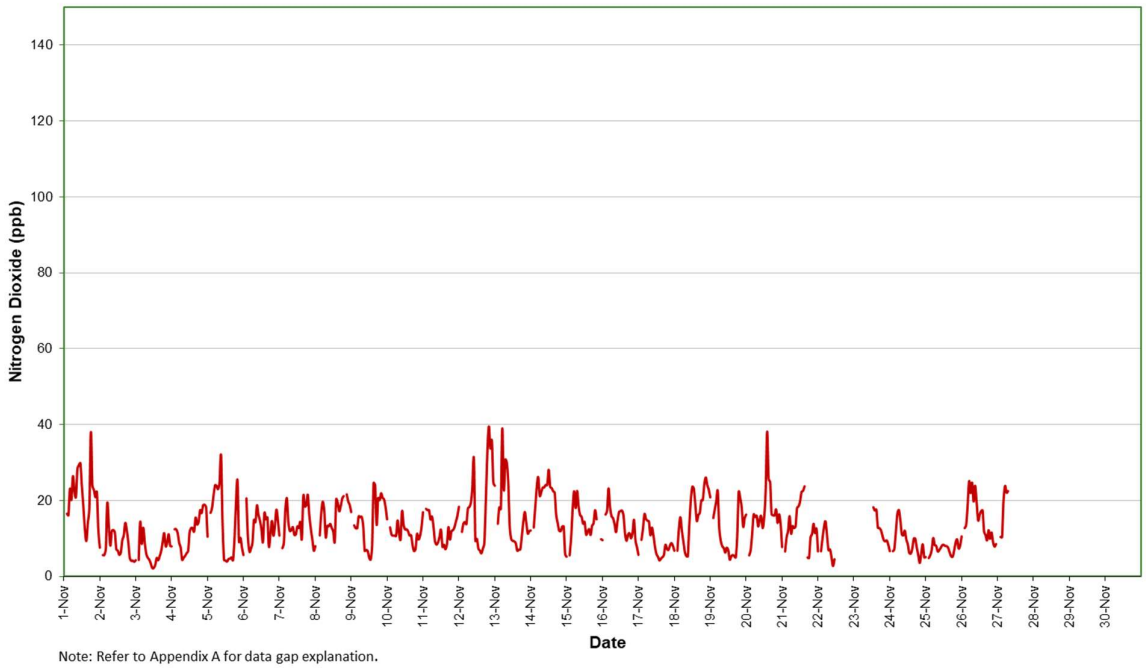

Figure 10: Station 4 NO_2 concentration (1 hour average) – November 2018

6.3 Carbon monoxide (CO)

CO (1 hour average) mass concentration statistics for the reporting period are given in Table 15. A plot of CO (1 hour average) concentration for the reporting period is presented with the SEPP(AQM) Schedule B CO Intervention Level of 29 ppm (1 hour average) in Figure 11.

Table 15: Station 4 (Primula Avenue AAQMS) CO percentiles (1 hour average)

Parameter	Concentration (ppm)[A]							SEPP (AQM) intervention level
	Maximum	99th	98th	95th	90th	75th	50th	(ppm)
CO	1.1	0.7	0.6	0.5	0.5	0.3	0.3	29

Note:
A Parts per million

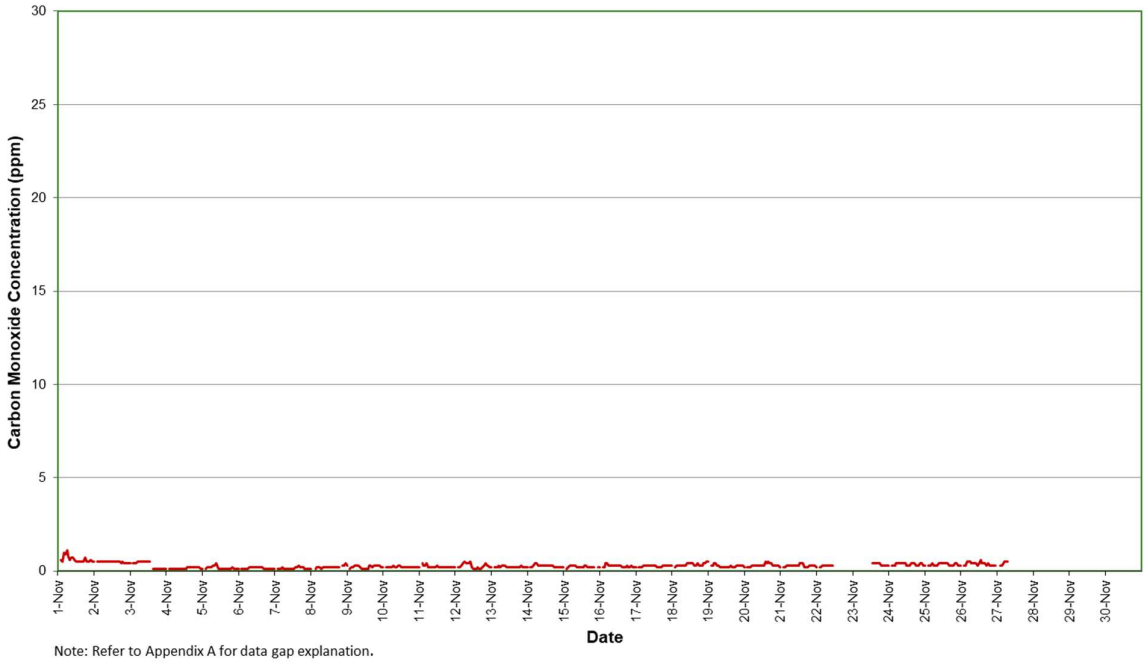

Figure 11: Station 4 CO concentration (1 hour average) – November 2018

6.4 Volatile organic compounds (BTEX)

VOC samples were collected from Station 4 (Primula Avenue), in an evacuated electro-polished and passivated stainless steel canister. Analysis involves separation by gas chromatography (GC) and measurement by mass selective (MS) detector.

The procedure for sampling Volatile Organic Compounds (VOCs) using evacuated canisters, and for the subsequent analysis, is described in USEPA Method TO-15 ”Determination of Volatile Organic Compounds (VOCs) in air collected in specially-prepared canisters and analysed by Gas Chromatography/Mass Spectrometry (GC/MS)”.

Samples were analysed by Queensland Health (NATA Laboratory Accreditation No. 41) based on USEPA method TO-15 (Laboratory Report Nos. SSP62195 and SSP62474).

The test method used was in accordance with Golder Source Test Method C9, "Canister (Evacuated) Sampling for VOC: In Ambient Air and Source Emissions".

BTEX (24 hour average) concentration statistics for the reporting period are given in Table 16. Laboratory certificates are presented in Appendix B.

Table 16: Station 4 - Primula Avenue AAQMS BTEX concentrations (24 hour average)

Date	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Total xylene isomers (ppb)
4/11/2018	<0.5	0.7	<0.5	<1
10/11/2018	0.7	1.4	<0.5	<1
16/11/2018	0.5	0.8	<0.5	<1
22/11/2018	<0.5	2.4	<0.5	<1
29/11/2018	1.8	<0.5	<0.5	<1
NEPM MIL[A]	3.0[B]	1000	NA	250

Note:

A National Environment Protection Measure (Air Toxics) Monitoring Investigation Level
B Annual average
Sample analysis conducted by Queensland Health, NATA Accreditation No. 41

6.5 Meteorological parameters

6.5.1 Temperature

Ambient Temperature data for all AAQMS sites are presented in Figure 12 for the reporting period.

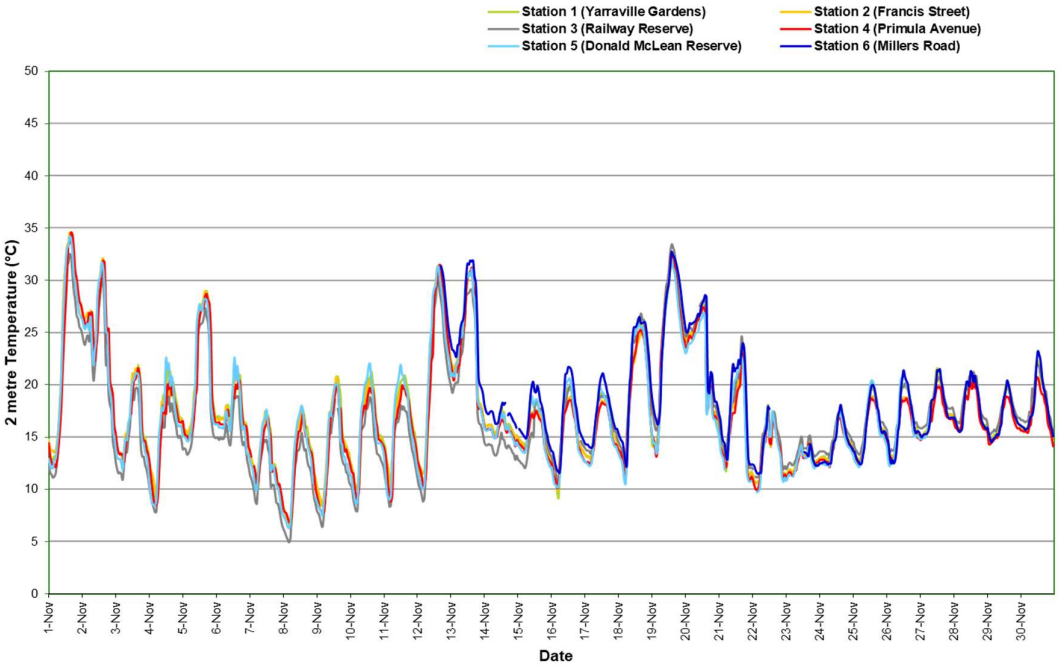

Figure 12: Ambient temperature (1 hour average) All AAQMS – November 2018

6.5.2 Relative humidity

Relative Humidity data for all AAQMS sites are presented in Figure 13 for the reporting period.

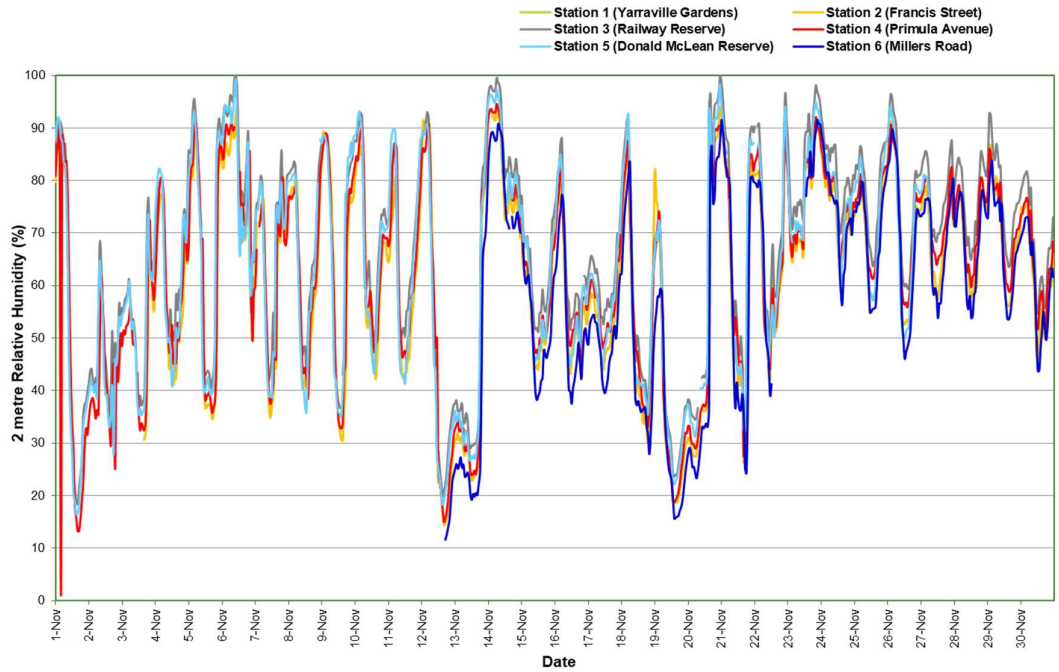

Figure 13: Relative humidity (1 hour average) All AAQMs – November 2018

6.5.3 Wind speed

Wind Speed data for all AAQMS sites are presented in Figure 14 for the reporting period.

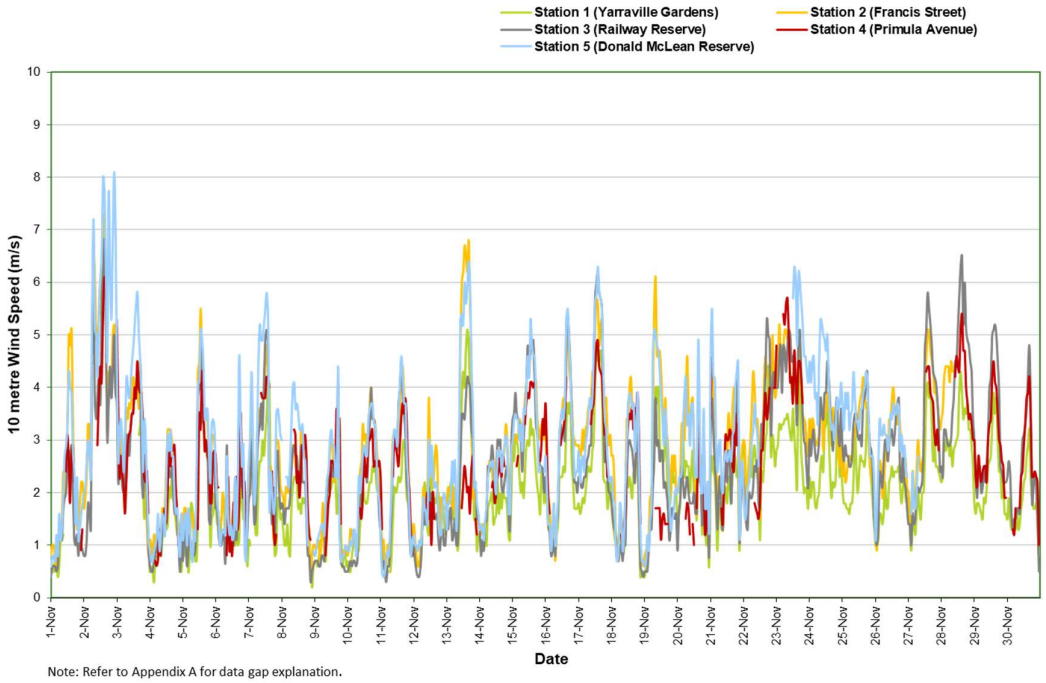

Figure 14: Wind speed (1 hour average) All AAQMs – November 2018

6.5.4 Wind rose – Station 1 (Yarraville Gardens)

A wind rose (1 hour average) for Station 1 (Yarraville Gardens AAQMS) is presented in Figure 15.

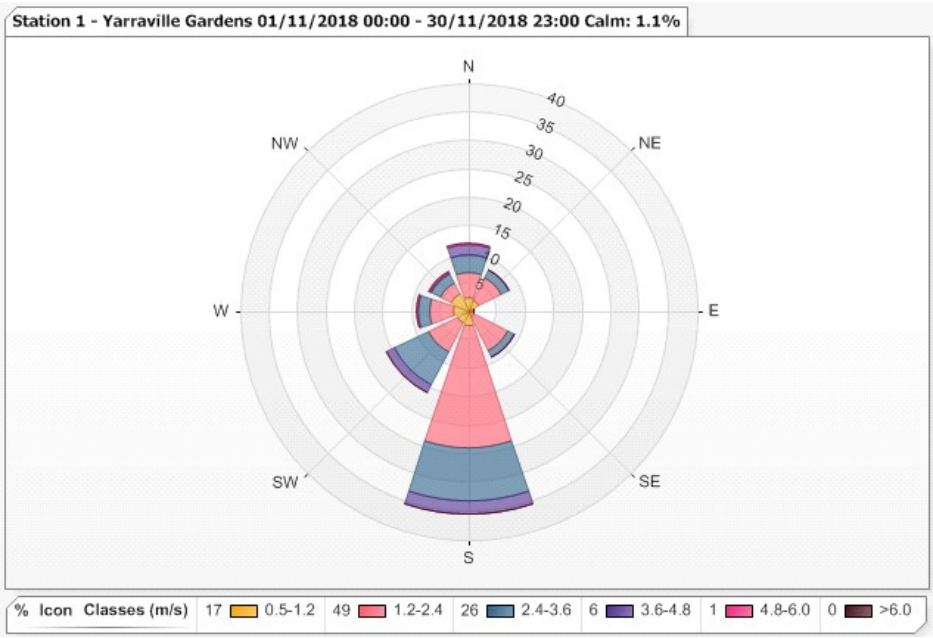

Figure 15: Wind speed (1 hour average) Station 1 Yarraville Gardens AAQMs

6.5.5 Wind rose – Station 2 (Francis Street)

A wind rose (1 hour average) for Station 2 (Francis Street AAQMS) is presented in Figure 16.

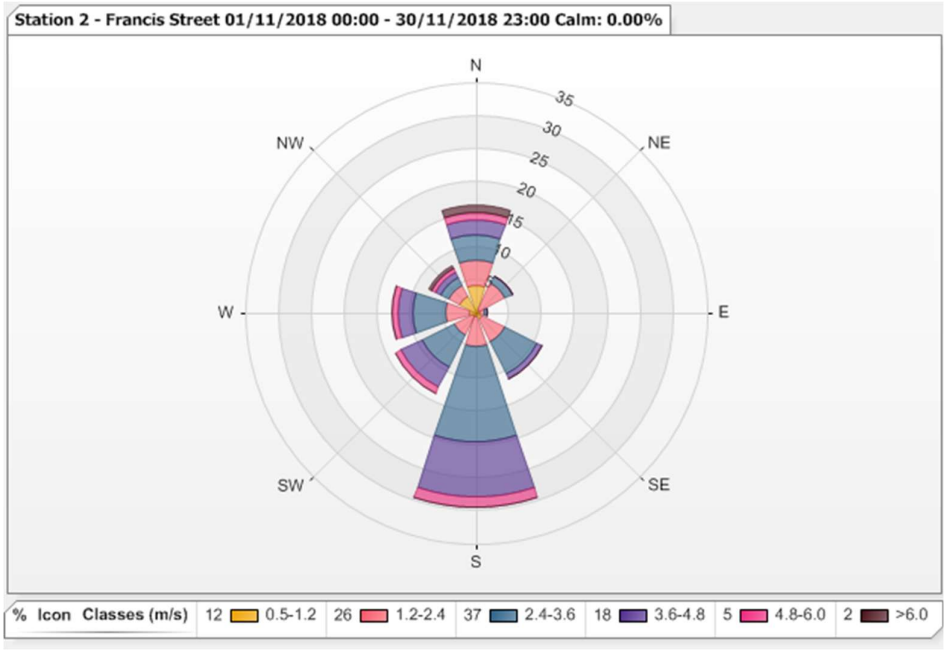

Figure 16: Wind speed (1 hour average) Station 2 Francis Street AAQMs

6.5.6 Wind rose – Station 3 (Railway Reserve)

A wind rose (1 hour average) for Station 3 (Railway Reserve AAQMS) is presented in Figure 17.

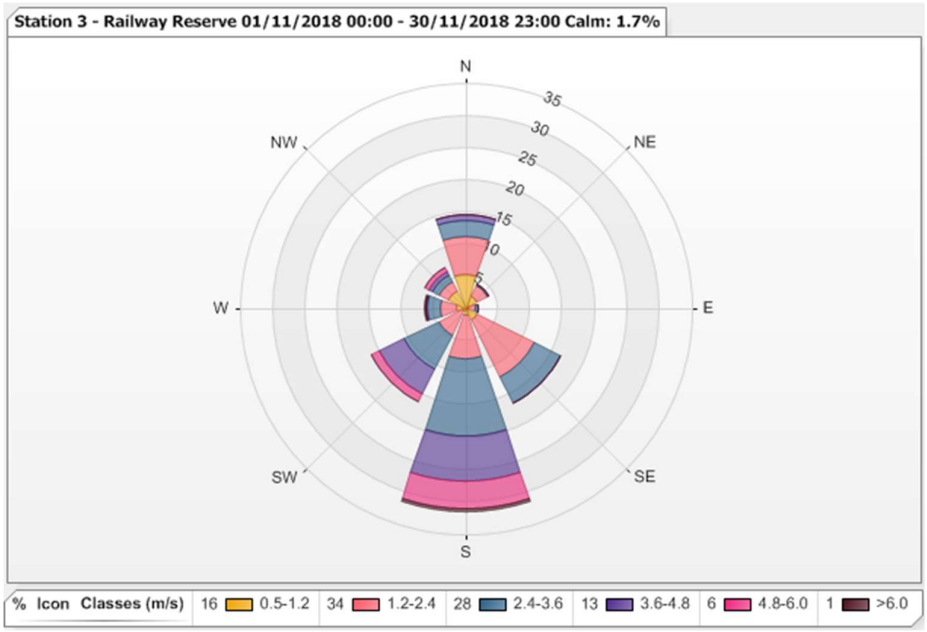

Figure 17: Wind speed (1 hour average) Station 3 Railway Reserve AAQMs

6.5.7 Wind rose – Station 4 (Primula Avenue)

A wind rose (1 hour average) for Station 4 (Primula Avenue AAQMS) is presented in Figure 18.

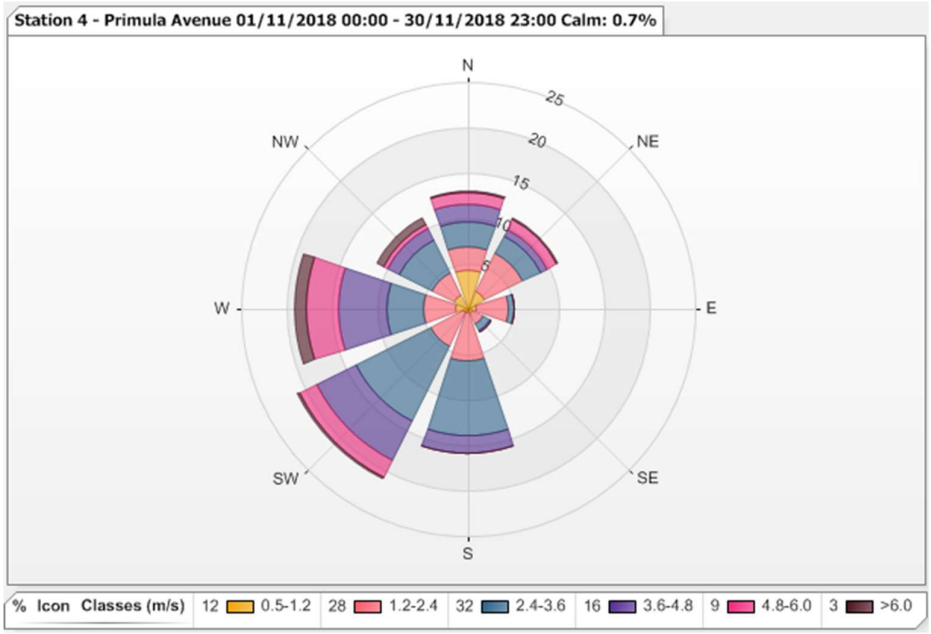

Figure 18: Wind speed (1 hour average) Station 4 Primula Avenue AAQMs

6.5.8 Wind rose – Station 5 (Donald McLean Reserve)

A wind rose (1 hour average) for Station 5 (Donald McLean Reserve AAQMS) is presented in Figure 19.

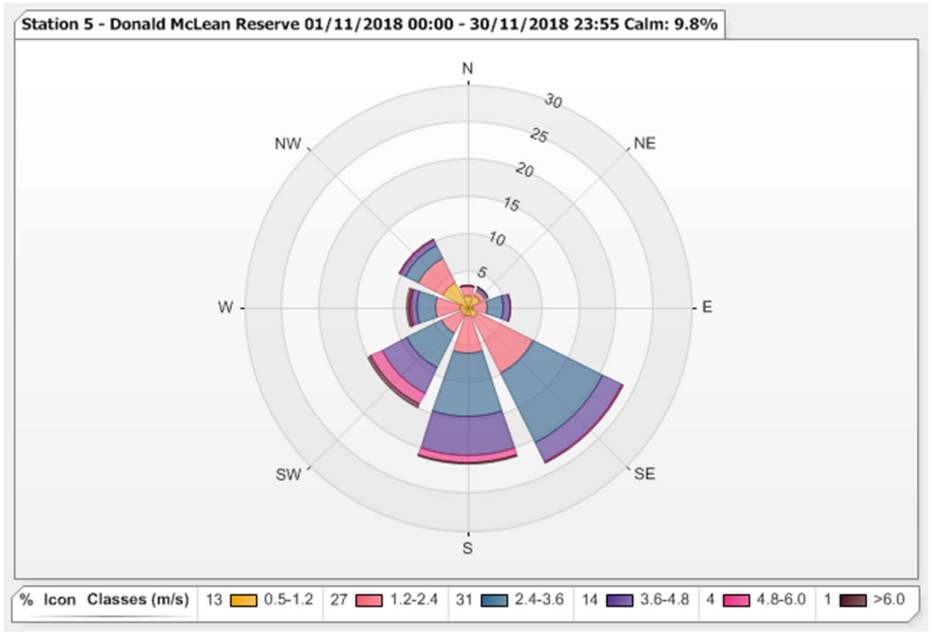

Figure 19: Wind speed (1 hour average) Station 5 Donald McLean Reserve AAQMs

7.0 QUALITY ASSURANCE

7.1 Data capture

Data capture is defined as the number of valid data periods collected divided by the number of available data periods. Valid data excludes periods where the instrument is unavailable due to calibration and maintenance and excludes periods where the data has been rejected due to quality assurance/data validation procedures.

Automatic calibrations are conducted for NO_2 and CO daily to monitor and correct instrument drift where necessary. NO_2 and CO automatic calibrations are conducted once per day between 01:00 and 01:45 hours.

Data capture statistics for the reporting period 1 November to 30 November 2018 are shown in Table 17. Averages were only collected for those periods where the 5 minute data constituted 75% data capture.

Data capture statistics for November 2018 were above 90 percent for all parameters at AAQMS 1, 2, 3, 5 and 6. However, data loss for all parameters, was observed at AAQMS 4 (Primula Avenue) from 27/11/2018 08:00 to the end of the reporting month due to the power supply to the site being disconnected by the power supply company.

Table 17: Data capture

Parameter	Averaging period	Station	Collected periods	Available periods	Data capture
$PM_{2.5}$	24 hour	1 – Yarraville Gardens	30	30	100%
	24 hour	2 – Francis Street	27	30	90%
	24 hour	3 – Railway Reserve	30	30	100%
	24 hour	4 – Primula Avenue	26	30	87%
	24 hour	5 – Donald McLean Reserve	30	30	100%
	24 hour	6 – Millers Road	28	30	93%
PM_{10}	24 hour	1 – Yarraville Gardens	30	30	100%
	24 hour	2 – Francis Street	27	30	90%
	24 hour	3 – Railway Reserve	30	30	100%
	24 hour	4 – Primula Avenue	24	30	80%
	24 hour	5 – Donald McLean Reserve	30	30	100%
	24 hour	6 – Millers Road	28	30	93%
NO_2	1 hour	4 – Primula Avenue	575	720	80%
CO	1 hour	4 – Primula Avenue	575	720	80%
Ambient temperature & relative humidity	1 hour	1 – Yarraville Gardens	720	720	100%
	1 hour	2 – Francis Street	656	720	91%
	1 hour	3 – Railway Reserve	720	720	100%
	1 hour	4 – Primula Avenue	632	720	88%
	1 hour	5 – Donald McLean Reserve	714	720	99%

	1 hour	6 – Millers Road	695	720	97%
Wind speed and direction	1 hour	1 – Yarraville Gardens	720	720	100%
	1 hour	2 – Francis Street	657	720	91%
	1 hour	3 – Railway Reserve	720	720	100%
	1 hour	4 – Primula Avenue	601	720	84%
	1 hour	5 – Donald McLean Reserve	709	720	99%

7.2 Data validation

Data contained in this report has been validated against performance and calibration requirements for each instrument. Data during commissioning, maintenance and calibration periods has been removed from the validated data sets. Appendix A lists the data exceptions for all AAQMS. Missing data periods during automatic calibrations of the gaseous atmospheric contaminants NO_2 and CO are not shown.

8.0 DISCUSSION

Table 18 presents the maximum measured concentration during the reporting period at Station 1 for $PM_{2.5}$ and PM_{10} compared with the respective criteria.

Table 18: Station 1 Summary – November 2018

Parameter	Units	Averaging period	Maximum concentration	Air quality objective[A]	Exceedances
$PM_{2.5}$	ug/m^3	24 hour	12	25	Pass
PM_{10}	ug/m^3	24 hour	41	50	Pass

Notes:
A - SEPP(AAQ) objective

Table 19 presents the maximum measured concentration during the reporting period at Station 2, Station 3, Station 5 and Station 6 for $PM_{2.5}$ and PM_{10} compared with the respective criteria.

Table 19: Station 2, Station 3, Station 5 and Station 6 Summary – November 2018

Parameter	Units	Averaging period	Maximum concentration				Air quality objective[A]	Exceedances
			Station 2	Station 3	Station 5	Station 6		
$PM_{2.5}$	ug/m^3	24 hour	13	10	12	11	36	Nil
PM_{10}	ug/m^3	24 hour	39	32	43	61	60	1

Notes:
A- SEPP(AQM) Intervention level

Table 20 presents maximum measured concentration during the reporting period at Station 4 for $PM_{2.5}$, PM_{10}, NO_2, CO and BTEX compared with the respective criteria.

Table 20: Station 4 Summary – November 2018

Parameter	Units	Averaging period	Maximum concentration	Air quality objective	Exceedances
$PM_{2.5}$	ug/m^3	24 hour	12	36[A]	Nil
PM_{10}	ug/m^3	24 hour	52	60[A]	Nil
NO_2	ppb	1 hour	40	140[A]	Nil
CO	ppm	1 hour	1.1	29[A]	Nil
Benzene	ppb	24 hour	1.8	3.0[B]	Nil
Toluene	ppb	24 hour	2.4	1000[B]	Nil
Total xylene isomers	ppb	24 hour	<1	250[B]	Nil

Notes:
A - SEPP(AQM) Intervention level
B - Air NEPM Monitoring investigation level

The November ambient air quality monitoring programme results were less than the respective air quality objectives for all parameters measured at stations 1 to 5. Station 6 (Millers Road) exceeded the PM_{10} air quality objective on one day (2/11/2018), all other parameters monitored at station 6 were less than the respective air quality objectives.

9.0 IMPORTANT INFORMATION RELATING TO THIS REPORT

Your attention is drawn to the document - “Important Information Relating to this Report” (LEG04, RL2), which is included in Appendix C of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing. We would be pleased to answer any questions the reader may have regarding this document.

Signature Page

Golder Associates Pty Ltd

Anthony Myszka
Environmental Technician

Marl Tulau
Senior Environmental Scientist

CVB/MDT/cvb

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APPENDIX A

Data Exceptions

Data exceptions - November 2018

Date from	Date to	Station	Parameters	Reason
03/11/2018 10:15	03/11/2018 11:05	5	Temperature/ RH	Maintenance / calibration
03/11/2018 10:25	03/11/2018 11:05	5	$PM_{2.5}$	Maintenance / calibration
03/11/2018 10:45	03/11/2018 10:50	2	$PM_{2.5}$	Maintenance / calibration
03/11/2018 11:00	03/11/2018 11:10	2	PM_{10}	Maintenance / calibration
03/11/2018 11:15	03/11/2018 11:20	5	PM_{10}	Maintenance / calibration
03/11/2018 12:15	03/11/2018 12:25	3	$PM_{2.5}$	Maintenance / calibration
03/11/2018 12:35	03/11/2018 12:35	1	$PM_{2.5}$	Maintenance / calibration
03/11/2018 12:35	03/11/2018 12:45	3	PM_{10}	Maintenance / calibration
03/11/2018 12:45	03/11/2018 12:55	1	PM_{10}	Maintenance / calibration
03/11/2018 13:50	03/11/2018 14:10	4	NO, NO_2, NO_x	Maintenance / calibration
03/11/2018 13:50	03/11/2018 14:30	4	CO	Maintenance / calibration
03/11/2018 14:10	03/11/2018 14:20	4	PM_{10}, $PM_{2.5}$	Maintenance / calibration
03/11/2018 14:10	03/11/2018 14:35	6	Temperature/ RH	Maintenance / calibration
03/11/2018 14:15	03/11/2018 17:05	6	$PM_{2.5}$	Maintenance / calibration
03/11/2018 14:30	03/11/2018 14:35	6	PM_{10}	Maintenance / calibration
06/11/2018 08:55	06/11/2018 11:20	4	PM_{10}	Communication error
06/11/2018 10:40	06/11/2018 12:35	5	Temperature/ RH	Logger error
08/11/2018 00:00	08/11/2018 02:15	4	PM_{10}	Communication error
08/11/2018 11:45	08/11/2018 11:45	6	PM_{10}	Logger error
08/11/2018 11:50	08/11/2018 12:00	6	Temperature/ RH	Logger error
08/11/2018 11:55	08/11/2018 11:55	6	$PM_{2.5}$	Logger error
08/11/2018 19:50	08/11/2018 20:35	4	PM_{10}, CO, NO, NO_2, NO_x	Logger error
11/11/2018 06:45	11/11/2018 06:50	2	Wind speed and direction	Maintenance / calibration
14/11/2018 00:00	14/11/2018 07:50	4	PM_{10}	Communication error
15/11/2018 21:40	16/11/2018 00:00	4	PM_{10}	Logger error
15/11/2018 21:40	15/11/2018 22:25	4	CO, NO, NO_2, NO_x	Logger error
20/11/2018 15:25	20/11/2018 16:15	4	PM_{10}	Communication error
20/11/2018 22:30	21/11/2018 00:15	4	PM_{10}	Communication error
20/11/2018 22:45	21/11/2018 00:25	5	Temperature/ RH	Logger error
21/11/2018 15:45	21/11/2018 16:15	4	NO, NO_2, NO_x	Maintenance / calibration

Date from	Date to	Station	Parameters	Reason
22/11/2018 12:00	23/11/2018 12:30	4	PM_{10}, CO, NO, NO_2, NO_x	Logger error
22/11/2018 12:00	23/11/2018 12:30	4	Meteorological parameters	Logger error
22/11/2018 13:00	23/11/2018 11:35	6	All parameters	Power outage
23/11/2018 20:05	23/11/2018 20:25	4	PM_{10}	Logger error
27/11/2018 00:40	27/11/2018 01:25	4	PM_{10}	Logger error
27/11/2018 08:00	30/11/2018 23:55	4	All parameters	Power outage
28/11/2018 09:05	30/11/2018 23:55	2	All parameters	Power outage

APPENDIX B

Laboratory Certificates

Queensland Government

Forensic and Scientific Services

HealthSupport Queensland

CERTIFICATE OF ANALYSIS

CLIENT:

Golder Associates
Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond VIC 3121

ATTN: Carl Van Brink

Laboratory Reference	: SSP63012
Client Order Number	: PO 13960
Quote Number	: n/a
Client Project	: 1789878
Client Batch Reference	: n/a
Date Received	: 20-Dec-2018
Date Commenced	: 20-Dec-2018
Laboratory Number/s	: 18KS1517-1520

CC:

Submitting Authority : Golder Associates

Number of Samples : Four (4) Summa canisters

Reason for Analysis : Analysis of Volatile Organic Compounds (VOCs) in air

Method/s of Analysis : QIS28237 V3.0 – Identification, Confirmation and Quantitation by GCMS Using the Shimadzu 2010+ and the EnTech 7200 Preconcentrator system

Remarks : Sample details and results are summarised in Table 1.

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David Pass
Senior Chemist, Organics Laboratory
7th January 2019

NATA Accredited Laboratory 41
Accredited for compliance with ISO/IEC 17025 - Testing

SSP63012

Enquiries **David Pass**
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Table 1: Results for Summa canister analysis

Client Reference				18-1065	18-1066	18-1067	18-1068
Sample Type				Silco Canister #2400	Silco Canister #1940	Silco Canister #1992	Silco Canister #1939
Sampling Time / Date				00:00 10/11/2018	14:50 16/11/2018	13:40 22/11/2018	14:10 29/11/2018
Sample Description				ambient air	ambient air	ambient air	ambient air
Method	Volatile Organic Compounds (VOCs) by GCMS	Units	Reporting Limit	18KS1517	18KS1518	18KS1519	18KS1520
28237	Benzene	ppbv	0.5	**0.7**	**0.5**	< LOR	< LOR
28237	Toluene	ppbv	0.5	**1.4**	**0.8**	**2.4**	**1.8**
28237	Ethylbenzene	ppbv	0.5	< LOR	< LOR	< LOR	< LOR
28237	m- & p-Xylene	ppbv	0.5	**0.7**	< LOR	**0.5**	< LOR
28237	o-Xylene	ppbv	0.5	< LOR	< LOR	< LOR	< LOR

APPENDIX C

Important Information Relating to this Report

IMPORTANT INFORMATION RELATING TO THIS REPORT

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

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