Latrobe Valley Air Monitoring Network

LVAMN Inc.

LVAMN Air Monitoring Report 2018

IW148800-NN-RPT-003 | Final

8 September 2020

Document history and status

Revision	Date	Description	By	Review	Approved
V.6 (Rev 0)	29 April 2019	Draft report	Matt Pickett & Andrew Boyd	Greg Simes	29 April 2019
V.7 (Rev 0)	12 May 2019	Draft report	Matt Pickett & Andrew Boyd	Greg Simes	14 May 2019
V.8 (Rev 1)	8 Sep 2020	Final report	Matt Pickett & Andrew Boyd	Greg Simes	8 Sep 2020

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
V.6 (Rev 0)	29 April 2019	29 April 2019	Morgan Thomas, Ecotech	Draft report for client review
V.7 (Rev 0)	14 May 2019	14 May 2019	Morgan Thomas, Ecotech	Incorporating LVAMN review of 2017 report
V.8 (Rev 1)	8 Sept 2020	8 Sept 2020	Eben Nel, Ecotech	Final report approved by LVAMN 3 Sept 2020

Latrobe Valley Air Monitoring Network

Jacobs Project No:	IW148800
Document Title:	LVAMN Air Monitoring Report 2018
Document No.:	IW148800-NN-RPT-003 | Final
Revision:	Rev 1
Date:	8 September 2020
Client Name:	LVAMN Inc.
Project Manager:	Greg Simes
Author:	Matt Pickett
File Name:	LVAMN Summary 2018 v8

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
33 Kerferd Street
Tatura VIC 3616 Australia
PO Box 260
Tatura VIC 3616
T +61 3 5824 6400
F +61 3 5824 6444
www.jacobs.com

Contents

List of Tables

List of Figures

Executive Summary

Overview

Ecotech operated and maintained the Jeeralang Hill and Rosedale South air quality monitoring stations on behalf of the Latrobe Valley Air Monitoring Network Incorporated (LVAMN), in 2018. Ecotech conducted Quality Assurance checks on the monitoring data in accordance with NATA procedures, and provided monthly monitoring data and reports to Jacobs and LVAMN, setting out details such as equipment and monitoring specifications and data capture rates.

The purpose of this annual report is to provide an independent review of the 2018 air quality monitoring data acquired at the LVAMN Jeeralang Hill and Rosedale South monitoring stations, focussing on data interpretation.

In 2018, capture of hourly average data at Jeeralang Hill was very good, with data capture for most parameters at that site greater than 92% (the benchmark being 90%). At Rosedale South, data capture was poor at approximately 60% due to measurements not commencing until May 2018, after an upgrade was completed over 2017-2018. Further details are provided in the main part of this report.

Sulfur Dioxide

In 2018, the SEPP(AAQ) objectives for hourly average sulfur dioxide (SO_2) were met for 99.96% of the measurements at Jeeralang Hill and for all measurements at Rosedale South. The 24-hour and annual average objectives were met throughout the year at both stations. There were three exceedences of the SEPP(AAQ) objective for hourly average SO_2 (200 ppb). At Jeeralang Hill there were two exceedences of the goal to achieve no more than one day of exceedences per year. The three highest hourly-average SO_2 concentrations at Jeeralang Hill occurred on these dates at these times: 6/01/2018 3:00-4:00 (307 ppb); 19/04/2018 0:00-1:00 (270 ppb); 23/02/2018 0:00-1:00 (232 ppb). These maxima tended to occur during easterly wind conditions, for a range of wind speeds up to approximately 4 m/s. These and other higher SO_2 concentrations were most likely due to plumes from coal fuelled power stations intercepting high ground in the Strzelecki Ranges, including at Jeeralang Hill.

The three highest hourly average SO_2 concentrations at Rosedale South occurred in the hours: 25/12/2018 10:00-11:00 (49 ppb); 25/12/2018 11:00-12:00 (44 ppb); and 23/12/2018 13:00-14:00 (35 ppb). The higher Rosedale South concentrations tended to occur during west-southwesterly winds, with wind speeds in the range 3–4 m/s.

The maximum 24-hour average SO_2 concentrations at Jeeralang Hill (31.8 ppb) and Rosedale South (7.2 ppb) were less than the SEPP(AAQ) objective of 80 ppb.

Annual average SO_2 concentrations at Jeeralang Hill (2.1 ppb) and Rosedale South (1.3 ppb) were less than the SEPP(AAQ) objective of 20 ppb.

Comparisons of results: as expected, the Latrobe Valley's larger SO_2 sources; e.g., the brown coal-fuelled power stations, led to higher SO_2 concentrations at Jeeralang Hill. Plume strikes may occur at Jeeralang Hill on a few hours in a year. However, the SO_2 results for the floor of the Latrobe Valley were relatively low; comparable with those for Altona North located in an industrial area of Melbourne.

Nitrogen Dioxide

In 2018, oxides of nitrogen (NO_x) measurements including nitrogen dioxide (NO_2) were undertaken at Jeeralang Hill and Rosedale South; NO_2 is the only NO_x component with air quality standards. There were no recorded exceedences of the SEPP(AAQ) objective for maximum hourly average nitrogen dioxide (NO_2, 120 ppb), at the two sites.

At Jeeralang Hill, the median hourly average NO_2 concentration was 0.7 ppb. The highest hourly average NO_2 concentration was 41 ppb (data capture 94.3%).

At Rosedale South, the median hourly average NO_2 concentration was 1.6 ppb, the highest hourly average NO_2 concentration recorded was 18.7 ppb (data capture 60.3%).

Comparisons of results: Concentrations of NO_2 measured by the EPA in the Melbourne Airshed were slightly worse than measured NO_2 concentrations in the Latrobe Valley in 2018. The primary reason for this is assumed to be the higher amounts of NO_x emitted from Melbourne's road traffic.

Further analysis of the NO_x data from the LVAMN stations was undertaken by investigating the ratios between the NO_2 and NO_x concentrations (NO_2/NO_x). Lower values of NO_2/NO_x can be indicative of local NO_x sources in cases where some NO has had insufficient time to convert to NO_2. The data showed that as NO concentrations increased the NO_2/NO_x ratios decreased, typical of NO_x emissions from road vehicle traffic, for example. The median NO_2/NO_x ratio was approximately 36% at Jeeralang Hill for NO concentrations greater than 20 ppb, and a similar trend was found for Rosedale South.

Ozone

In 2018, there were no recorded exceedences of the SEPP(AAQ) objectives for maximum hourly average ozone (100 ppb) and maximum 4-hourly average ozone (80 ppb), at the two sites.

At Jeeralang Hill, the median one-hour average O_3 concentration was 24 ppb. The highest hourly average O_3 concentration was 72 ppb (data capture 90.1%), and highest 4-hour O_3 concentration 67 ppb (data capture 93.7%).

At Rosedale South, the median one-hour average O_3 concentration was 21 ppb. The highest hourly average O_3 concentration was 49 ppb (data capture 60.3%), and highest 4-hour concentration 45 ppb (data capture 62.8%).

Comparisons of results: Unfortunately there were no O_3 monitoring stations in the Melbourne region with data capture greater than 50% (EPA data provided 8 April 2019). However, comparisons of the available data indicated O_3 levels on the floor of the Latrobe Valley were slightly better than those of the Melbourne region.

Further analysis of the NO_x and O_3 results for both LVAMN sites show the familiar pattern of higher O_3 levels being associated with smaller NO_x concentrations, and vice versa. This is due to a photochemical effect where O_3 is formed in the presence of ultraviolet radiation in sunlight. In the Latrobe Valley, likely sources of higher O_3 levels during the summer months were bushfires and emissions from road vehicle traffic, and controlled burns during autumn and spring. Levels of O_3 were low during the winter months.

Particulate Matter

In 2018, the very good correlation between the PM_{10} measurements at Jeeralang Hill and Rosedale South, which are located 31 kilometres apart, and 430 metres apart in elevation, indicated that for the majority of days the PM_{10} was due to regional influences rather than local sources. There were similar findings in previous years; e.g., Jacobs (2018b).

There were no recorded exceedances of the SEPP(AAQ) 24-hour average objective for PM_{10} (50 µg/m^3) at Jeeralang Hill and Rosedale South; the Rosedale South data were limited to 219 days. The SEPP(AAQ) annual average objective for PM_{10} (20 µg/m^3), was met at both monitoring stations. The annual averages were: 8.0 µg/m^3 (Jeeralang Hill–data capture 99.1%); and 11.8 µg/m^3 (Rosedale South–data capture 60%).

There were no recorded exceedences of the SEPP(AAQ) standards for maximum 24-hour average $PM_{2.5}$ (25 µg/m^3) at Jeeralang Hill and Rosedale South monitoring sites. There were two recorded exceedences of the 24-hour average $PM_{2.5}$ standard at Traralgon; on 2nd May (30.1 µg/m^3) and 2nd April (25.6 µg/m^3). The SEPP(AAQ) annual average objective for $PM_{2.5}$ (8 µg/m^3), was met at both monitoring stations. The annual averages were: 6.2 µg/m^3 (Jeeralang Hill–data capture 97%); and 4.4 µg/m^3 (Rosedale South–data capture 61%).

Comparisons of results: Particulate matter concentrations as PM_{10} were found to be higher in Melbourne than in the Latrobe Valley, even considering the potential for plume strikes at Jeeralang Hill and the Latrobe Valley's large, open-cut coal mines. Higher particulate matter levels in Melbourne would be due in part at least to road traffic emissions. Other potential sources of particulate matter that would affect Melbourne more than the Latrobe Valley would include: raised dust from dry, exposed areas in western and northern Victoria, and 'secondary' (chemically formed) particle formation in smog.

Local Visual Distance (Rosedale South)

In 2018, in situ nephelometer measurements of an atmospheric scattering coefficient were obtained at Rosedale South. For the record, the Ecotech results for Local Visual Distance (LVD) were used to calculate a light backscatter coefficient (B_{sca}) in accordance with the Victorian Government procedure set out in the *State Environment Protection Policy, The Air Environment* (VG, 1982). The Ecotech results for visibility (LVD) indicated visibility did not reduce below the minimum of 20 km in 2018.

Summary of LVAMN Results

A summary of results for each of the air pollutants and objectives with respect to the SEPP(AAQ) ambient air quality standards and goals is set out in the table below. In the right-hand columns of the table, results are provided for maximum concentrations (ppb) and exceedences of the goals for exceedences [days per year], for Jeeralang Hill and Rosedale South.

Indicator	Statistic & averaging period	Objective	Goal (Exceedence)	Jeeralang Hill [Exceedences of Goal]	Rosedale South [Exceedences of Goal] *
SO_2	Max. 1 hour	200 ppb	1 day/year	307 ppb [3]	49.4 ppb [0]
	Max. daily	80 ppb	1 day/year	32 ppb [0]	7.2 ppb [0]
	Annual	20 ppb	None	2.1 ppb [0]	1.3 ppb [0]
O_3	Max. 1 hour	100 ppb	1 day/year	72 ppb [0]	49 ppb [0]
	Max. 4 hour	80 ppb	1 day/year	67 ppb [0]	45 ppb [0]
NO_2	Max. 1 hour	120 ppb	1 day/year	41 ppb [0]	19 ppb [0]
	Annual	30 ppb	None	1.7 ppb [0]	2.0 ppb [0]
Particles as PM_{10}	Max. 24 hour	50 µg/m^3	None	28.8 µg/m^3 [0]	33.5 µg/m^3 [0]
	Annual	20 µg/m^3	None	8 µg/m^3 [0]	11.8 µg/m^3 [0]
Particles as $PM_{2.5}$	Max. 24 hour	25 µg/m^3	None	22.6 µg/m^3 [0]	18.4 µg/m^3 [0]
	Annual	8 µg/m^3	None	6.2 µg/m^3 [0]	4.4 µg/m^3 [0]
Local Visual Distance	Minimum 1 hour	20 km	3 days/year	N/A	26.8km [0 days]

* Note data capture for Rosedale South was 59%-60% for all parameters in 2018 (May-December only).

Regional Air Quality Comparison: Latrobe Valley vs. Melbourne/Geelong

Key LVAMN and EPA air quality monitoring results from the Latrobe Valley were compared with corresponding EPA data for parts of Melbourne and Geelong, to place the Latrobe Valley's 2018 air quality situation in context. In general, in comparison with Melbourne and Geelong, air quality in the Latrobe Valley was found to be relatively good due to the lower concentrations of PM_{10} and NO_2.

As expected, the Latrobe Valley's larger SO_2 sources lead to higher SO_2 concentrations. However, the SO_2 results for the Latrobe Valley floor were reasonably good, with Traralgon comparable to Altona North.

It was determined O_3 levels in the Latrobe Valley's urban areas are comparable with parts of Melbourne and Geelong.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to provide data interpretation for Ecotech's 2018 Jeeralang Hill and Rosedale South air quality monitoring data in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

Some of the 2018 Jeeralang Hill and Rosedale South data were invalidated by Ecotech and the causes were detailed in Ecotech's 2018 reports. Any further data removed from the analysis by Jacobs are described in this report. An assumption for this report was that all the reports and data provided by Ecotech were of sufficient accuracy for the purpose of data interpretation.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

The Latrobe Valley Air Monitoring Network Incorporated (LVAMN) has undertaken ambient air quality monitoring in the Latrobe Valley since the 1980s; e.g., see CSIRO (1989), and Aurecon (2012) provides a review of some statistics for monitoring data acquired over 1980–2011. The LVAMN produces annual summary reports, which are placed on-line (LVAMN, 2019), the two most recent examples being Jacobs (2017) and Jacobs (2018).

Ecotech Pty Ltd (Ecotech) has provided monitoring and data reporting for the LVAMN since 2012. The Ecotech monitoring station locations Jeeralang Hill and Rosedale South included

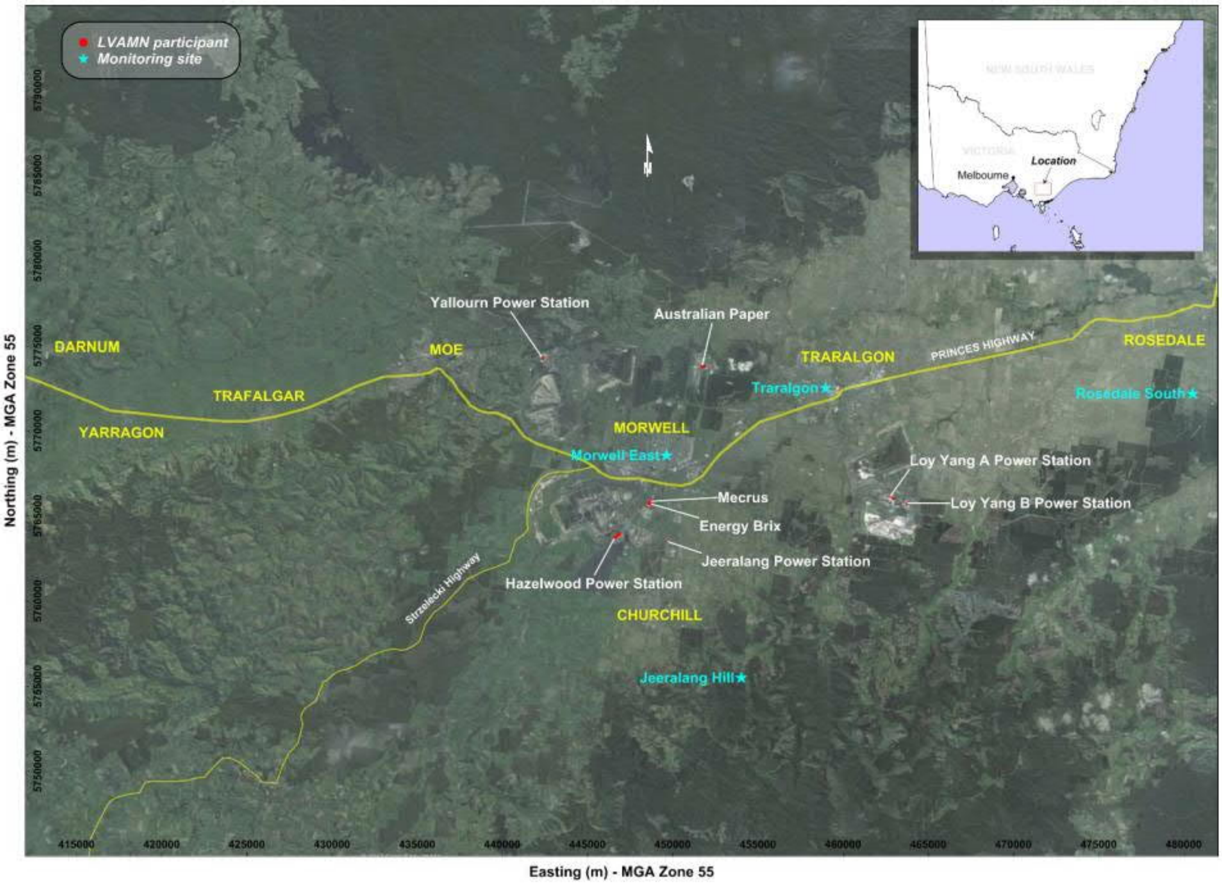
- Jeeralang Hill, a rural site in the Strzelecki Ranges approximately 11 km southeast of Hazelwood Power Station and 13.5 km southwest of Loy Yang Power Stations.
- Rosedale South, a rural site south of the town of Rosedale approximately 5 km south of the Rosedale township and 19 km east-north-east of Loy Yang Power Stations.

LVAMN data capture was affected by some maintenance and logistics issues in 2017-2018. LVAMN directed Ecotech to replace the air monitoring shelter at Rosedale South in June, 2017. Power was disconnected and the shelter removed in July, 2017. Re-connection of supply cables to a new shelter was completed in August 2017. However, further delays to recommissioning were experienced over several months due to problems associated with power supply to the site. The new Rosedale South power connection was completed on 13th April, 2018 (LVAMN communication, 24th April, 2018).

A map of the Latrobe Valley is provided in **Figure 1-1** showing the locations of towns and the larger industrial facilities; i.e. those of the LVAMN participants. Some facilities shown in **Figure 1-1** are no longer operating: the Hazelwood Power Station ceased operations on 31st March, 2017 (Engie, 2018); Morwell Power Station ceased operations on 8th September 2014; and the adjacent briquette factory closed in August 2014 (EBAC, 2018). It is noted the Snowy Hydro Valley Power Station is a gas turbine power station located adjacent to the Loy Yang B Power Station – Snowy Hydro is not a member of the LVAMN.

The two LVAMN monitoring locations, Jeeralang Hill and Rosedale South, are shown plotted in **Figure 1-1**. Also shown are the Traralgon and Morwell East stations, operated by Victoria's Environment Protection Authority (EPA). The data from the EPA stations were compared with the LVAMN data for this report. The LVAMN and EPA stations are used for collecting information on air quality and meteorological conditions. The analysis of data acquired over many years from all these monitoring stations enables conclusions to be drawn about whether certain aspects of Latrobe Valley's air quality are worsening, or improving, over the longer term.

Figure 1-1 Latrobe Valley, LVAMN and EPA Air Monitoring Locations



1.1 Ecotech Monthly Reports

The monthly air monitoring reports for 2018 are detailed in the series of reports; Ecotech (2018a–2018k) and Ecotech (2019a). The reports include details such as:

- Monitoring equipment, methods, and measured parameters.
- Data collection methods and compliance with monitoring standards.
- Data capture rates and key statistics for the measurement parameters.
- Recording of measured exceedences of ambient air quality standards and levels.

1.2 Purpose of this Report

The purpose of this report was to interpret the 2018 ambient air monitoring data from the Ecotech-operated LVAMN sites, Jeeralang Hill and Rosedale South; this included comparisons with Victoria's air quality objectives and goals.

The Ecotech measurement parameters reviewed for this report focus on the air pollutants for which objectives and goals are listed in the Victoria Government (VG) *State Environment Protection Policy (Ambient Air Quality)* or 'SEPP(AAQ)' (VG, 1999); i.e., sulfur dioxide (SO_2); nitrogen dioxide (NO_2); ozone (O_3); particulate matter comprising particles with aerodynamic diameters less than 10 microns (µm) in size (PM_{10}); and visibility reducing particles measured as Local Visual Distance (LVD).

The *State Environment Protection Policy (Air Quality Management)* or 'SEPP(AQM)' (VG, 2001), varied the SEPP(AAQ) by removing the 8-hour average standards for O_3.

VG (2016) sets out a variation to the SEPP(AAQ) introducing new air quality objectives for PM_{10} and $PM_{2.5}$ (for definitions see Section 1.3); these new objectives were applied in this annual summary.

Victoria's ambient air quality standards are set out in more detail in **Section 2**.

1.3 Abbreviations & Definitions

Abbreviation	Definition
AQI	Air Quality Index
CO	Molecular formula for carbon monoxide
CPF	Conditional Probability Function
DELWP	Department of Environment, Land, Water and Planning (Victoria)
EPA	Environment Protection Authority (Victoria)
LVAMN	Latrobe Valley Air Monitoring Network
µm	micron (thousandth of a millimetre)
NEPC	National Environment Protection Council
NEPM	*National Environment Protection (Ambient Air Quality) Measure*
NO	Molecular formula for nitric oxide
NO_2	Molecular formula for nitrogen dioxide
NO_x	Oxides of nitrogen
O_3	Molecular formula for ozone
$PM_{2.5}$	Particulate Matter 2.5; particulate matter comprising particles with aerodynamic diameters less than 2.5 microns (µm) in size
PM_{10}	Particulate Matter 10; particulate matter comprising particles with aerodynamic diameters less than 10 microns (µm) in size
SEPP(AAQ)	*State Environment Protection Policy (Ambient Air Quality)* (VG, 1999; VG, 2016)
SEPP(AQM)	*State Environment Protection Policy (Air Quality Management)* (VG, 2001)
SO_2	Molecular formula for sulfur dioxide
USEPA	United States Environmental Protection Agency
VG	Victoria Government

2. Objectives and Goals

2.1 SEPP(AAQ) Objectives and Goals

A purpose of the SEPP(AAQ) was to adopt National Environment Protection Council (NEPC) objectives and goals set out in the *National Environment Protection (Ambient Air Quality) Measure* (NEPM) (NEPC, 2003). The SEPP(AAQ) (1999) objectives and goals that were used to review the air quality monitoring data for this report are listed in **Table 2-1**; minus the 8-hour average O_3 standards, in accordance with the SEPP(AQM).

Table 2-1 SEPP(AAQ) 1999 Objectives and Goals

Environmental Indicator	Averaging Period	Objective	Goal (exceedences)*
NO_2 (maximum conc.)	1 hour	120 ppb	1 day/year
	1 year	30 ppb	None
O_3 (maximum conc.)	1 hour	100 ppb	1 day/year
	4 hours#	80 ppb	1 day/year
SO_2 (maximum conc.)	1 hour	200 ppb	1 day/year
	1 day	80 ppb	1 day/year
	1 year	20 ppb	None
Particles as PM_{10}	1 day	50 µg/m^3	5 days/year
Visibility reducing particles (minimum visual distance)	1 hour	20 km	3 days/year

*Goals are maximum allowable exceedences of objective.

#Rolling 4-hour average based on 1 hour averages.

"Day" and "Year" mean “calendar day” and “calendar year”.

2.2 Variation to SEPP(AAQ) 28 July 2016

The national NEPM was updated in 2016 with new standards for particles (NEPC, 2016). Subsequently the Victorian Government issued a 28 July 2016 variation to the SEPP(AAQ) including new standards for particles, and further 2025 objectives for $PM_{2.5}$ (VG, 2016); these are listed in **Table 2-2**.

Table 2-2 SEPP(AAQ) 2016 Objectives for Particles and 2025 Objectives for $PM_{2.5}$

Environmental Indicator	Averaging Period	Objective	Goal (exceedences)*
Particles as PM_{10}	1 day	50 µg/m^3	Nil
	Annual	20 µg/m^3	Nil
Particles as $PM_{2.5}$	1 day	25 µg/m^3	Nil
	Annual	8 µg/m^3	Nil
Particles as $PM_{2.5}$ – goals by 2025	1 day	20 µg/m^3	Nil
	Annual	7 µg/m^3	Nil

3. Measured Parameters

3.1 Overview

This section describes the air pollution parameters measured by the LVAMN in 2018.

3.2 Sulfur Dioxide

The most significant sources of sulfur dioxide (SO_2) emissions in the Latrobe Valley are the brown coal-fuelled power stations, and the Maryvale Paper Mill. As a result, the highest SO_2 concentrations detected at the LVAMN monitoring stations can be attributed to, primarily, SO_2 emissions from these sources; their locations were plotted in **Figure 1-1**.

3.3 Oxides of Nitrogen

Oxides of nitrogen (NO_x) emissions are produced by the burning of fuels; e.g., by road vehicle fleets associated with cities and larger towns, bushfires and planned burns, and power stations. On combustion, usually NO_x comprises mostly nitric oxide (NO), and smaller amounts of NO_2. In the atmosphere, NO may be oxidised to NO_2 by the reaction with ozone (O_3): $O_3 + NO \rightarrow NO_2 + O_2$; e.g., Seinfeld and Pandis (2016).

3.4 Ozone

A significant source of O_3 in the atmosphere is caused by the photolysis of NO_2 in sunlight, involving ultraviolet photons ($h\nu$) with wavelengths less than 424 nanometres; described by the (simplified) pair of reactions:

$$NO_2 + h\nu \rightarrow NO + O\text{; and} \quad (1)$$

$$O + O_2 \rightarrow O_3 \quad (2)$$

Other pollutants such as carbon monoxide and hydrocarbons are involved in O_3 production; e.g., Seinfeld and Pandis (2016). Therefore, an understanding of the precursor pollutants and their sources is required to understand O_3 levels. In the Latrobe Valley, local sources of NO_x and hydrocarbons associated with O_3 production include: bushfires and controlled burns, road vehicle traffic, and power stations; e.g., see EPA (2007); EPA (2016). It is noted forests are a natural source of hydrocarbons; e.g., eucalyptus trees emit isoprene, which is involved in O_3 production (Emmerson et al., 2016). Also, modelling by Azzi et al. (2014) has shown that on some occasions Melbourne's air pollutants can be transported by winds into the Latrobe Valley, which would affect O_3 production in the Latrobe Valley.

3.5 Particulate Matter

Potential sources of small airborne particles measured as Particulate Matter 10 (PM_{10}) and Particulate Matter 2.5 ($PM_{2.5}$) in the Latrobe Valley include: controlled burning and bushfires; open cut coal mining; power stations; wheel generated dust on unpaved roads; domestic wood heaters and open fireplaces, road vehicle traffic (locomotives would be a minor source), and other industries. Occasionally measurements of PM_{10} and $PM_{2.5}$ in the Latrobe Valley would include significant components transported from well outside the region such as particles from air pollution sources in Melbourne, raised dust from regional areas, and sea salt aerosols from Bass Strait and beyond.

3.6 Local Visual Distance

Air pollution can affect amenity by forming a visibility-reducing haze, caused by light scattering by small particles suspended in the atmosphere (aerosols). Sources of the particulate matter aerosol include: open cut coal mining; domestic wood heaters and open fireplaces; and planned burns and bushfires. In humid conditions, fog and mist also reduce visibility – in this case hygroscopic aerosols grow due to the condensation of water vapour on particle surfaces. Particle sizes of approximately 1-10 microns are significant with respect to light scattering, thereby affecting visibility.

The SEPP(AAQ) sets out an objective for minimum visibility of 20 km. In Victoria, compliance with the visibility objective is determined by nephelometer measurements of light scattering properties of ambient air, conditioned to a relative humidity of 70%. The *Victorian Government Gazette No. 120* (VG, 1982), sets out the following equation for determination of the Local Visual Distance (LVD) from a nephelometer-measured parameter:

$$LVD = 47 \times (10{,}000 \times B_{sca})^{-1},$$

where B_{sca} is the atmospheric light scattering coefficient (units m^{-1}), measured by an integrating nephelometer. For example, using a light scattering coefficient of 4.7×10^{-5} m^{-1}, the calculated LVD is 100 km.

4. Ecotech LVAMN Operations 2018

4.1 Overview

This section sets out the results of the interpretation of measurements of air pollutants and meteorological parameters undertaken at Jeeralang Hill and Rosedale South in 2018. Some of the monitoring data were invalidated by Ecotech due to a variety of non-compliances, and the causes were detailed in the Ecotech monthly reports. Further details about equipment, specifications and data capture may be found in the monthly reports Ecotech (2018a) through to Ecotech (2018k), and Ecotech (2019a).

LVAMN data capture was affected by some maintenance and logistics issues in 2017-2018. In 2018, a delay in recommissioning Rosedale South was experienced due to problems associated with power supply to the site. The new Rosedale South power connection was completed on 13th April, 2018 (LVAMN communication, 24th April, 2018). The monitoring station resumed operations on 15th May 2018.

4.2 Ecotech LVAMN Data Capture for In Situ Measurements

A statistical summary of most of the hourly average data for the air pollutants and wind parameters measured at Jeeralang Hill for 2018 is provided in **Table 4-1**, and similarly for Rosedale South in **Table 4-2**.

Table 4-1 Summary of Jeeralang Hill Monitoring Data for 2018 (Hourly Averages)

Parameter (units)	No. Hourly Average Records	Data Capture 2018 (1h avg.)
SO_2 (ppb)	8359	95.4%
NO (ppb)	8263	94.3%
NO_2 (ppb)	8263	94.3%
NO_x (ppb)	8263	94.3%
O_3 (ppb)	7897	90.1%
PM_{10} (µg/m^3)	8683	99.1%
$PM_{2.5}$ (µg/m^3)	8521	97.3%
WS_a (m/s)	8063	92.0%
WD_b (deg)	8063	92.0%
$\sigma\theta_c$ (deg)	8063	92.0%

a. Wind Speed; b. Wind Direction; c. Sigma-theta, or standard deviation of the horizontal wind direction.

Table 4-2 Summary of Rosedale South* Monitoring Data for 2018 (Hourly Averages)

Parameter (units)	No. Hourly average records	Data Capture 2018 (1h avg.)
SO_2 (ppb)	5286	60.3%
NO (ppb)	5284	60.3%
NO_2 (ppb)	5284	60.3%
NO_x (ppb)	5284	60.3%
O_3 (ppb)	5285	60.3%
PM_{10} (µg/m^3)	5257	60.0%
$PM_{2.5}$ (µg/m^3)	5328	60.8%
WS_a (m/s)	5173	59.1%
WD_b (deg)	5173	59.1%
$\sigma\theta_c$ (deg)	5173	59.1%

Parameter (units)	No. Hourly average records	Data Capture 2018 (1h avg.)
LVD_d (km)	4473	51.1%

a. Wind Speed; b. Wind Direction; c. Sigma-theta, or standard deviation of the horizontal wind direction; d. Local Visual Distance

* Rosedale South resumed operations on 15th May, 2018.

Wind roses created from the wind speed and direction data for 2018 are provided in **Appendix C.1** (Jeeralang Hill), and **Appendix C.2** (Rosedale South–no wind data before 15th May). The wind patterns for 2018 were similar to those reported for 2017 (Jacobs, 2018b). At Jeeralang Hill, light south-westerly winds are dominant throughout most of the year, with stronger easterly winds dominant in the summer months and to a lesser extent in autumn. At Rosedale South, south-south westerly winds are dominant throughout the year, with lighter easterly winds having more of an influence in the summer months; for a more complete picture of the wind patterns at Rosedale South, see Jacobs (2018b).

5. LVAMN Results 2018

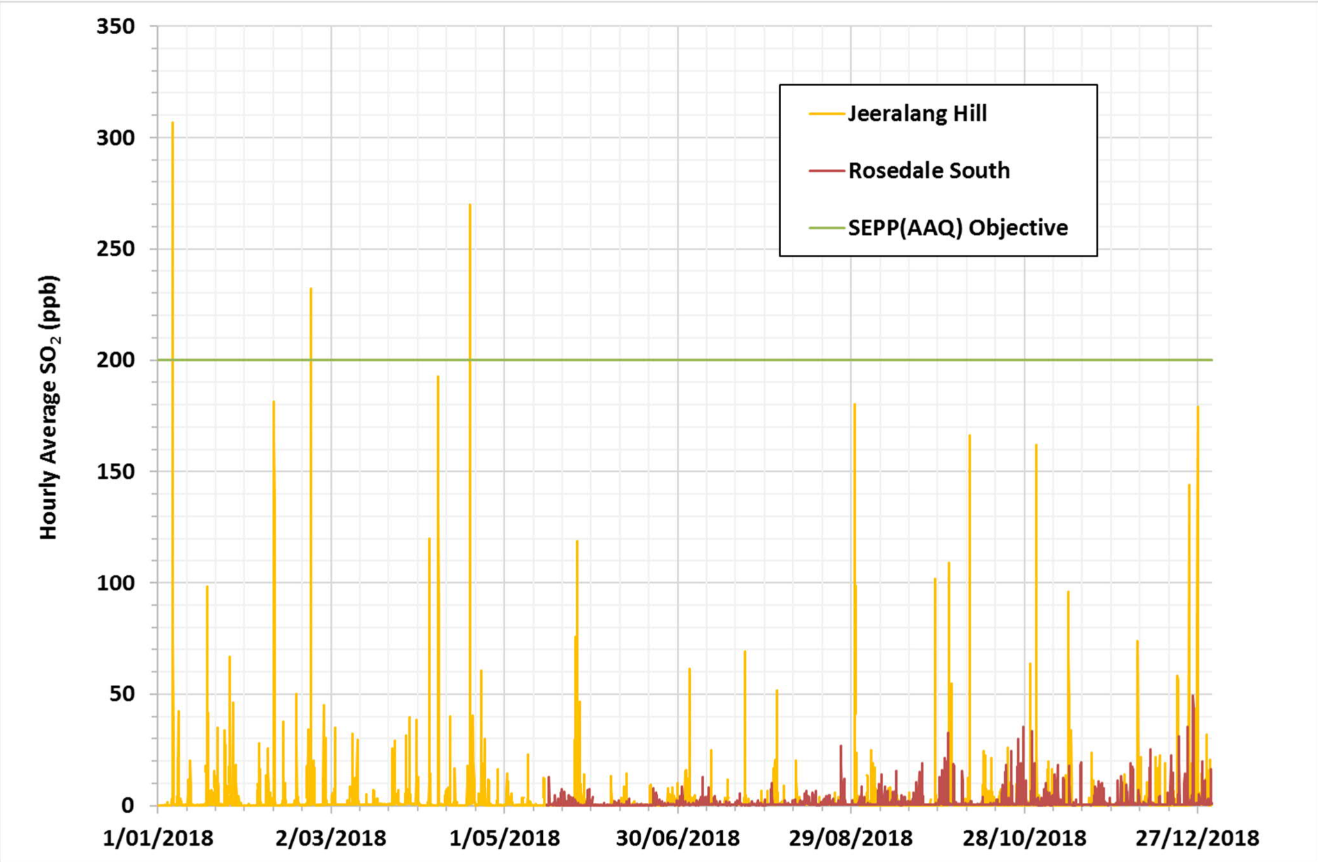
5.1 Overview

This section provides the results of data interpretation for the LVAMN air monitoring data acquired in 2018 at the air monitoring stations Jeeralang Hill and Rosedale South. Ecotech's reported 1-hour and 24-hour averages were based on a minimum of 80% valid readings within the averaging period. The same fraction was adopted for the calculations undertaken for this report. Comparisons are provided with EPA data from monitoring stations in the Latrobe Valley and Melbourne regions.

5.2 Sulfur dioxide

The LVAMN 2018 results for hourly average SO_2 concentrations (ppb) measured at Jeeralang Hill and Rosedale South are provided in **Figure 5-1**.

Figure 5-1 LVAMN Results for Hourly Average SO_2 Concentration (ppb)



A summary of results of the analysis of the hourly average SO_2 concentrations acquired from Jeeralang Hill in 2018 is set out in **Table 5-1**. Daily averages were calculated for days where 80% of hourly average data were available for that day.

Table 5-1 Summary of Results: Jeeralang Hill SO_2 Concentrations 2018

Parameter	Hourly Averages	Daily Averages	Annual Average
Number of records	8359	361	1
Total records possible	8760	365	1
Data capture	95.4%	98.9%	95.4%

Parameter	Hourly Averages	Daily Averages	Annual Average
Median	0.3 ppb	0.5 ppb	–
Annual average	2.1 ppb	2.1 ppb (avg. of 24h avgs.)	2.1 ppb
70th percentile	0.5 ppb	1.6 ppb	–
Maximum	306.8 ppb	31.8 ppb	–
SEPP(AAQ) Objective	200 ppb	80 ppb	20 ppb
Percentage of time Objective met (of measured data)	99.96%	100%	–
Exceedences of Objective	3 hours on 3 days	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	Exc. 1 day/year	No exceedence
Exceedences of Goal	3 days	0	0

The eight highest hourly-average SO_2 concentrations at Jeeralang Hill occurred during night or early morning hours: 6/01/2018 3:00-4:00 (307 ppb); 19/04/2018 0:00-1:00 (270 ppb); 23/02/2018 0:00-1:00 (232 ppb); 8/04/2018 3:00-4:00 (193 ppb); 10/02/2018 6:00-7:00 (181 ppb); 30/08/2018 7:00-8:00 (180 ppb); 26/12/2018 23:00-24:00 (179 ppb); and 9/10/2018 0:00-1:00 (166 ppb). All these higher concentrations occurred during east-northeasterly wind conditions with wind speeds in the range approximately 2–3 m/s. These were most likely due to plumes from the Loy Yang complex intercepting high ground in the Strzelecki Ranges, including at Jeeralang Hill.

A summary of results of the analysis of the hourly average SO_2 concentrations acquired at Rosedale South in 2018 (results after 15th May only), is set out in **Table 5-2**.

Table 5-2 Summary of Results: Rosedale South SO_2 Concentrations 2018

Parameter	Hourly Averages	Daily Averages	Annual Average
Number of records	5286	229	1
Total records possible	8760	365	1
Data capture	60.3%	62.7%	60.3%
Median	0.5 ppb	0.6 ppb	–
Annual average	1.3 ppb	1.3 ppb (avg. of 24h avgs.)	1.3 ppb
70th percentile	0.6 ppb	1.2 ppb	–
Maximum	49.4 ppb	7.2 ppb	–
SEPP(AAQ) Objective	200 ppb	80 ppb	20 ppb
Percentage of time Objective met (of measured data)	100%	100%	100%
Exceedences of Objective	0	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	Exc. 1 day/year	No exceedences
Exceedences of Goal	0	0	0

The three highest hourly average SO_2 concentrations at Rosedale South occurred in the hours: 25/12/2018 10:00-11:00 (49 ppb); 25/12/2018 11:00-12:00 (44 ppb); and 23/12/2018 13:00-14:00 (35 ppb). These higher SO_2 concentrations occurred during west south-westerly winds with wind speeds 3–4 m/s, pointing to the coal-fuelled power stations and Maryvale paper mill as probable SO_2 sources.

The LVAMN hourly SO_2 data are compared with EPA's results in **Table 5-3**. In general, (noting the differences in data capture), air quality with respect to SO_2 emissions is approximately the same for all locations on the valley floor: Morwell, Traralgon, and further east at Rosedale South.

Table 5-3 Comparisons of Hourly Average SO_2 Results 2018: LVAMN and EPA

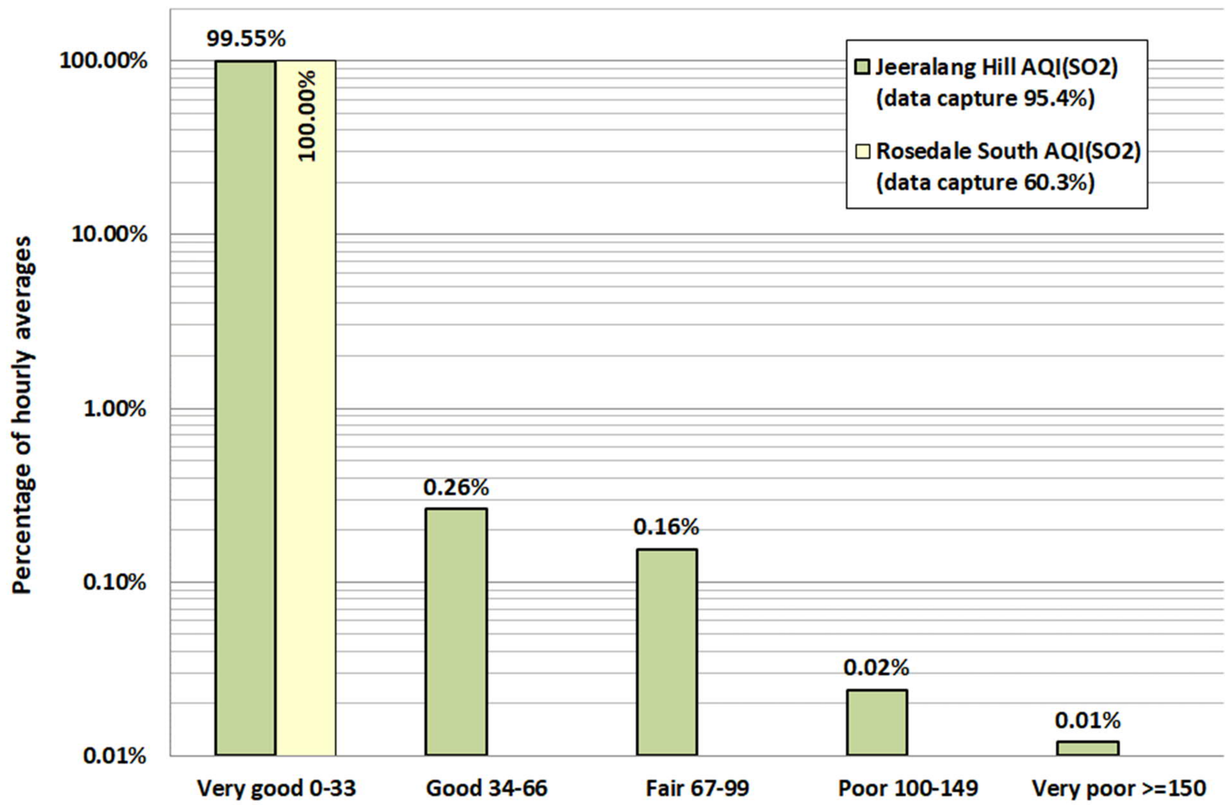
Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell East (EPA)	Morwell South (EPA)	Traralgon (EPA)
Data capture (hourly averages)	95.4%	60.3%	74.0%	52.0%	85.0%
Annual average (ppb)	2.1	1.3	0.7	0.5	0.7
Median (ppb)	0.3	0.5	0	0	0
70^{th} percentile (ppb)	0.5	0.6	1	1	2
90^{th} percentile (ppb)	2.9	2.5	1	1	2
99.9^{th} percentile (ppb)	162.6	32.1	29.5	28.0	30.3
Maximum (ppb)	307	49.4	90.0	78.0	79.0

5.3 Air Quality Indices from LVAMN SO_2 Concentrations

Air Quality Indices (AQI) based on EPA procedures were calculated using the Jeeralang Hill and Rosedale South hourly average SO_2 data. The AQI is a concentration expressed as a percentage of the relevant air quality objective (200 ppb in this case). The Jeeralang Hill and Rosedale South SO_2 results are provided as frequency distributions in **Figure 5-2** (logarithmic plots). Inspection of the figure clearly shows that air quality based on SO_2 levels at Jeeralang Hill and Rosedale South was very good for the majority of the time; i.e., more than 98% of the time for both locations.

As expected, Jeeralang Hill experienced slightly worse results for AQI using the hourly average SO_2 data, due to the proximity of the coal fuelled power stations and its higher elevation. The elevation of Jeeralang Hill is 510 metres above sea level, whereas Rosedale South is 52 metres above sea level.

Figure 5-2 Frequency Distributions of Air Quality Indices as Logarithmic Plot – Hourly Average SO_2



5.4 Oxides of Nitrogen

Figure 5-3 provides the LVAMN 2018 results for hourly average nitrogen dioxide (NO_2) concentrations (ppb). There were no exceedences of the SEPP(AAQ) objective of 120 ppb for maximum hourly NO_2 concentration at Jeeralang Hill and Rosedale South (no data for Rosedale South before 15th May).

Figure 5-3 LVAMN Results for Hourly Average NO_2 Concentration (ppb)

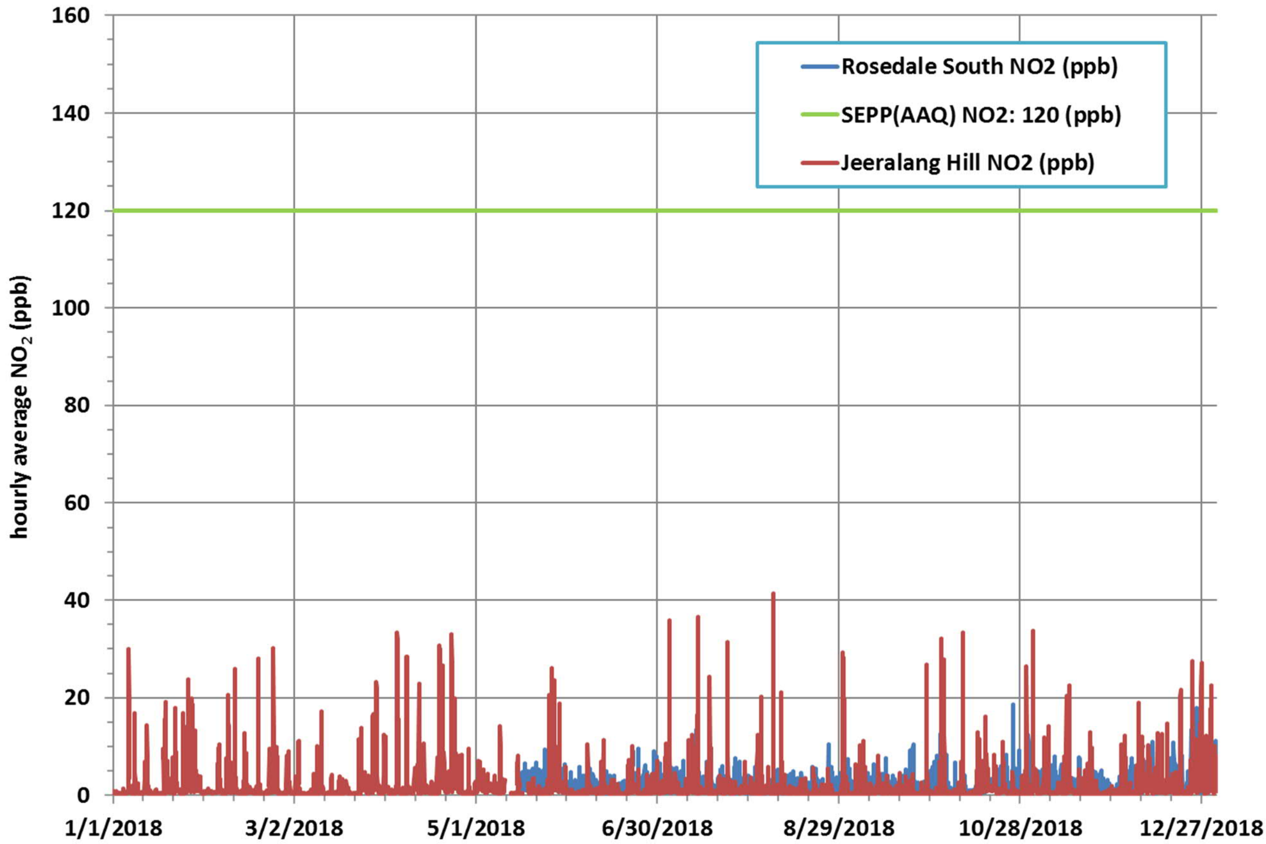


Table 5-4 sets out a summary of results of the analysis of the Jeeralang Hill hourly average NO_2 concentrations. There were no exceedences of the SEPP(AAQ) objectives and goals for NO_2.

Table 5-4 Summary of Results: Jeeralang Hill NO_2 Concentrations

Parameter	Hourly Averages	Annual Average
No. records	8263	1
Total possible	8760	1
Data capture	94.3%	94.3%
Median	0.7 ppb	–
Annual average	1.7 ppb	1.7 ppb
70th percentile	1.3 ppb	–
Maximum	41 ppb	–
SEPP(AAQ) Objective	120 ppb	30 ppb
Percentage of time Objective met	100%	100%
Exceedences of Objective	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	No exceedences

Parameter	Hourly Averages	Annual Average
Exceedences of Goal	0	0

A statistical summary for all the NO_x components measured at Jeeralang Hill is provided in **Table 5-5**.

Table 5-5 Statistical Summary for All NO_x Components – Jeeralang Hill

Air Pollutant	Median Conc. (ppb)	Average Conc. (ppb)	70^{th} Percentile Conc. (ppb)	Maximum Conc. (ppb)
NO	0.1	0.6	0.2	122
NO_2	0.7	1.7	1.3	41
NO_x	0.8	2.3	1.4	150

A summary of results of the analysis of the Rosedale South hourly average NO_2 concentrations is set out in **Table 5-6**. There were no exceedences of the SEPP(AAQ) objectives and goals for NO_2.

Table 5-6 Summary of Results: Rosedale South NO_2 Concentrations

Parameter	Hourly Averages	Annual Average
No. records	5284	1
Total possible	8760	1
Data capture	60.3%	60.3%
Median	1.6 ppb	–
Annual average	2.0 ppb	2.0 ppb
70^{th} percentile	2.3 ppb	–
Maximum	19 ppb	–
SEPP(AAQ) Objective	120 ppb	30 ppb
Percentage of time Objective met	100%	100%
Exceedences of Objective	Nil exceedences likely	Nil exceedences likely
SEPP(AAQ) Goal	Exc. 1 day/year	No exceedences
Exceedences of Goal	Nil exceedences likely	Nil exceedences likely

A statistical summary for all the NO_x components measured at Rosedale South is provided in **Table 5-7**.

Table 5-7 Statistical Summary for All NO_x Components – Rosedale South

Air Pollutant	Median Conc. (ppb)	Average Conc. (ppb)	70^{th} Percentile Conc. (ppb)	Maximum Conc. (ppb)
NO	0.2	0.4	0.4	18
NO_2	1.6	2.0	2.3	19
NO_x	1.8	2.4	2.7	33

The LVAMN hourly NO_2 data are compared with EPA's results for Morwell South and Traralgon, in **Table 5-8**. Analysis of these data was limited by the low data capture in 2018.

Table 5-8 Comparisons of Hourly Average NO_2 Results: LVAMN and EPA

Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell South (EPA)	Traralgon (EPA)
Data capture	94.3%	60.3%	15.3%	54.9%
Median (ppb)	0.7	1.6	3.0	5.0
70^{th} percentile (ppb)	1.3	2.3	4.0	7.0
Maximum (ppb)	41	19	21	53

5.5 Analysis of LVAMN NO_2/NO_x Ratios

Analysis of the NO_x data was undertaken by investigations of the ratios between the NO_2 and NO_x concentrations (NO_2/NO_x). Lower values of NO_2/NO_x can be indicative of local NO_x sources in cases where the NO has had insufficient time to convert to NO_2. A select few of the NO_x data were used in this analysis to remove large numerical errors associated with small measured quantities. Data were selected by the removal of the following data: (1) Negative and zero results for NO_x concentration; (2) NO_2/NO_x ratios greater than unity and less than or equal to zero; and (3) NO concentrations less than 1 ppb. The results are listed in **Table 5-9**.

Table 5-9 Summary of Calculated NO_2/NO_x Ratios

NO Range (ppb)	Median NO_2/NO_x Ratio	No. Hourly Records	Percentage of Hourly Data Used for Ratio
Jeeralang Hill			
$1 \leq [NO] < 5$	72%	352	68%
$5 \leq [NO] < 10$	61%	61	12%
$10 \leq [NO] < 20$	51%	54	10%
$[NO] \geq 20$	36%	52	10%
Rosedale South			
$1 \leq [NO] < 5$	64%	732	93%
$5 \leq [NO] < 10$	51%	49	6%
$10 \leq [NO] < 20$	44%	6	1%
[NO] >= 20	-	0	0%

Inspection of the results listed in **Table 5-9** indicates that as the NO concentrations increase the NO_2/NO_x ratios decrease, which is typical for large NO_x sources e.g. from the combustion of fossil fuels. The NO_2/NO_x ratios ranged between 18% and 25% for the five NO concentrations greater than 100 ppb (all measured at Jeeralang Hill). There was an upwards trend in the NO_2/NO_x ratios as the NO concentrations decreased, indicative of NO_x that has been in the atmosphere for longer periods allowing more time for NO_2 to form. These results for NO_2/NO_x are similar to those determined for previous LVAMN reports; e.g., Jacobs (2018b).

5.6 Ozone

The LVAMN 2018 results for hourly average O_3 concentrations for Jeeralang Hill and Rosedale South are provided in **Figure 5-4**. The results are shown with the SEPP(AAQ) hourly average objective; all the hourly O_3 data were less than the objective of 100 ppb. The peak O_3 concentrations during the summer were most likely due to emissions from fires, and road vehicle traffic.

Summaries of results of the analysis of the hourly average O_3 concentrations are set out in **Table 5-10** (Jeeralang Hill); and **Table 5-11 (**Rosedale South).

Figure 5-4 Ecotech LVAMN Results for Hourly Average O_3 Concentration (ppb)

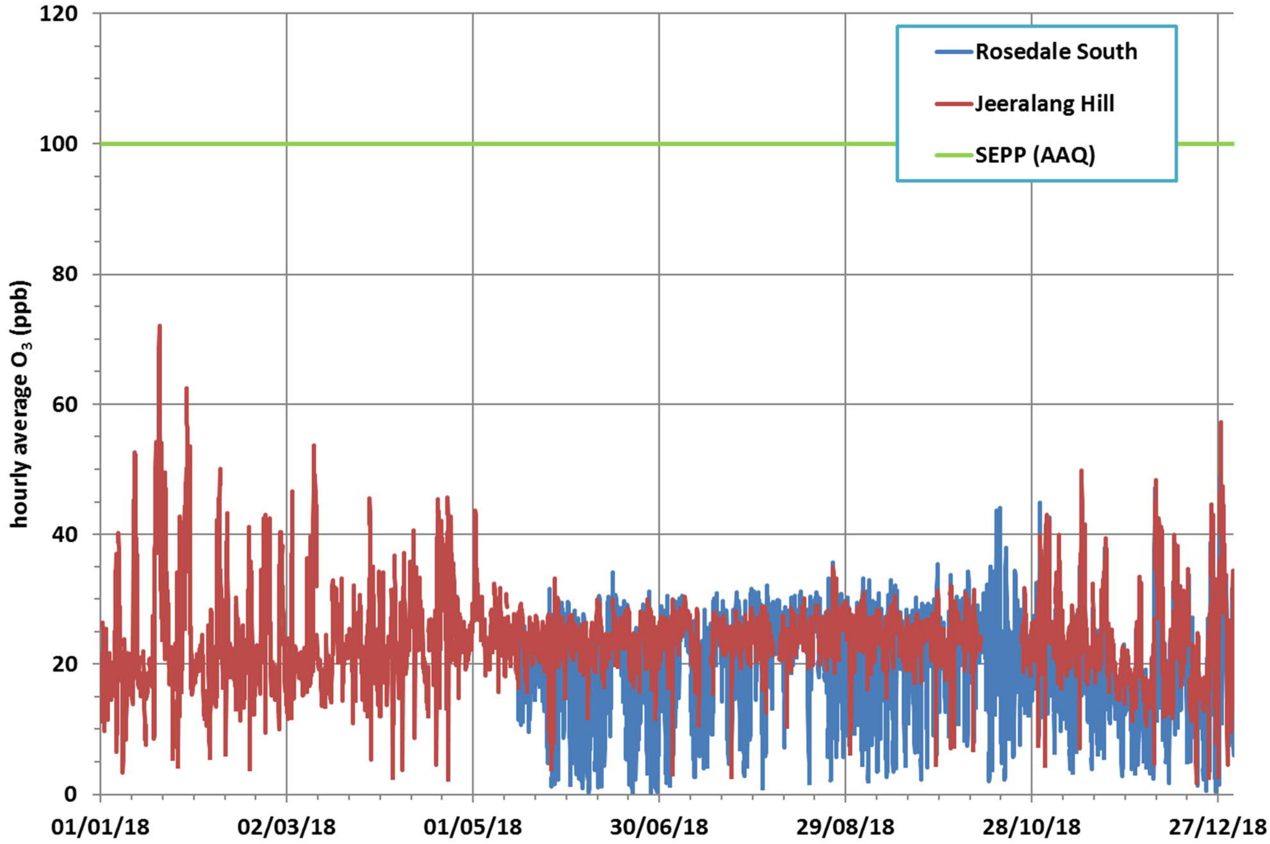


Table 5-10 Summary of Results: Jeeralang Hill O_3 Concentrations

Parameter (Jeeralang Hill)	1h Average	4h Rolling Average
No. records	7897	8204
Total possible	8760	8757
Data capture	90.1%	93.7%
Median (ppb)	24	24
Annual average (ppb)	24	24
70^{th} percentile (ppb)	26	26
Maximum (ppb)	72	67
SEPP(AAQ) Objective (ppb)	100	80
Percentage of time Objective met	100%	100%
Exceedences of Objective	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	Exc. 1 day/year
Exceedences of Goal	0	0

Note: VG (2001) varied VG (1999) by removing the 8-hour average objectives for O_3.

Table 5-11 Summary of Results: Rosedale South O_3 Concentrations

Parameter (Rosedale South)	1h Average	4h Rolling Average
No. records	5285	5503
Total possible	8760	8757
Data capture	60.3%	62.8%
Median (ppb)	21	20
Annual average (ppb)	20	19
70^{th} percentile (ppb)	25	24
Maximum (ppb)	49	45
SEPP(AAQ) Objective (ppb)	100	80
Percentage of time Objective met	0	0
Exceedences of Objective	Exc. 1 day/year	Exc. 1 day/year
SEPP(AAQ) Goal	0	0
Exceedences of Goal	0	0

Note: VG (2001) varied VG (1999) by removing the 8-hour average objectives for O_3.

The LVAMN hourly O_3 data are compared with EPA results for Morwell South and Traralgon in **Table 5-12**. While these comparisons are limited by the low data capture for Rosedale South, Morwell South and Traralgon, the statistics indicate that air quality effects due to O_3 are slightly worse at Jeeralang Hill. The reason for this may be NO_x emissions from road vehicle traffic in the urban areas of Morwell and Traralgon have a quenching effect on O_3 levels.

Table 5-12 Comparisons of Hourly Average O_3 Results: LVAMN and EPA

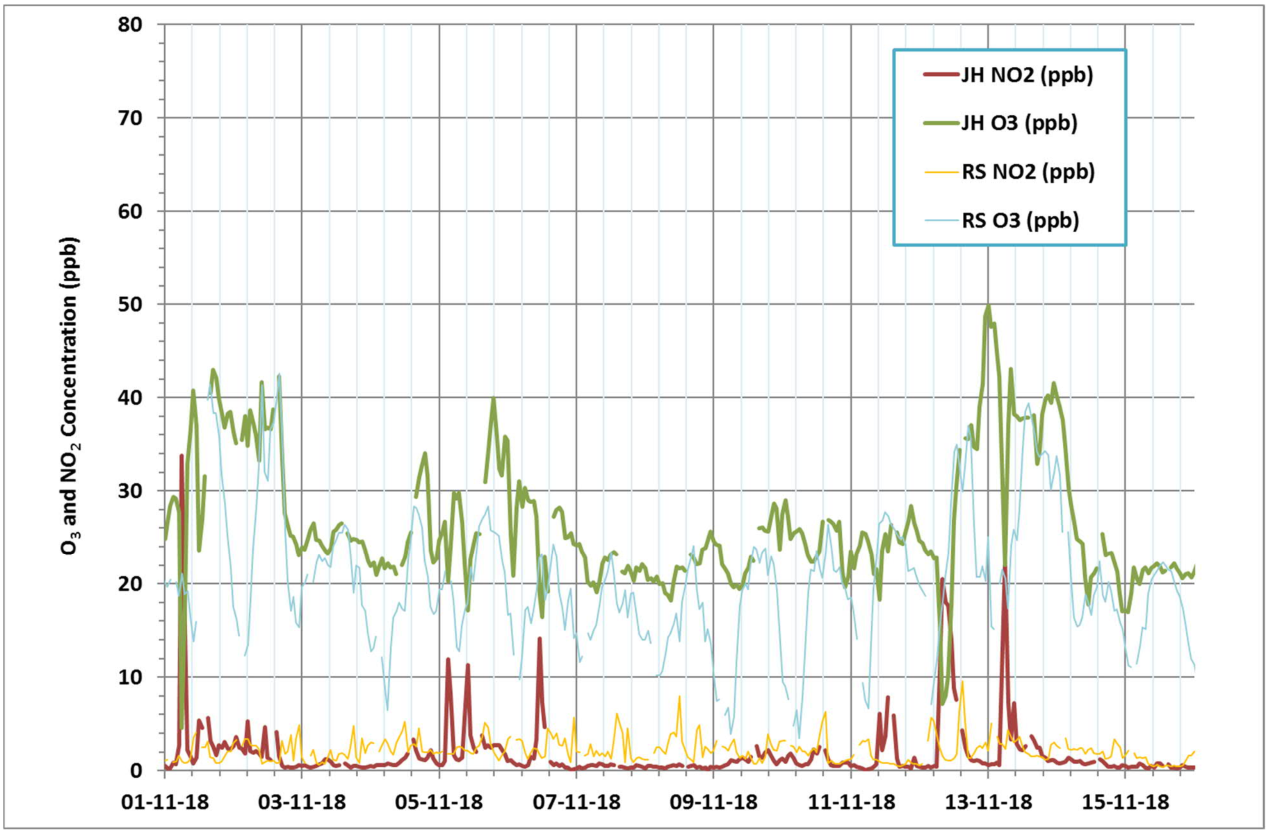
Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell South (EPA)	Traralgon (EPA)
Data capture	90.1%	60.3%	31.2%	49.1%
Median	24	21	17	17
70^{th} percentile	26	25	21	21
Maximum	72	49	69	67

5.7 Products of Photolysis – O_3 and NO_2

This section provides a sample of results for concurrent hourly average O_3 and NO_2 concentrations measured by the LVAMN. In general, there was clear evidence of photolysis occurring at Jeeralang Hill and Rosedale South (see **Section 3.3** and **Section 3.4**), with several well defined O_3 peaks occurring around midday during the summer. For example, the hourly average data for 1-15 November 2018 are shown in **Figure 5-5**.

In the November 2018 example shown in **Figure 5-5**, the higher NO_2 concentrations that occurred earlier in the mornings, in the presence of sunlight, would have provided the oxygen atoms needed for the formation of O_3. Spikes of NO_2 that occurred reduced O_3 levels at those times. Also, emissions from fires would have contributed to O_3 peaks in the summer months, and during the burning season during autumn and spring (Department of Environment, Land, Water and Planning, 2016).

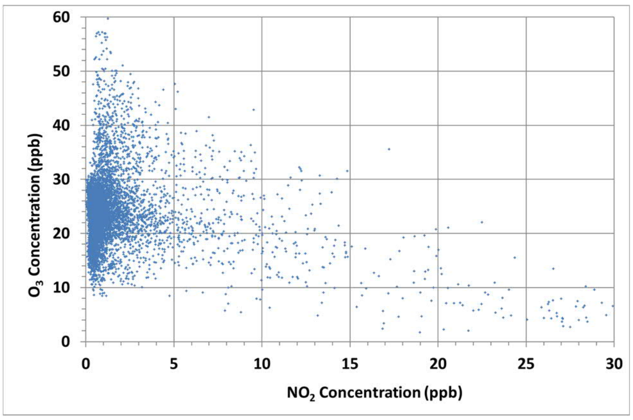
Figure 5-5 Example of O_3 and NO_2 Measurements at Jeeralang Hill and Rosedale South: 1/11/18–16/11/18



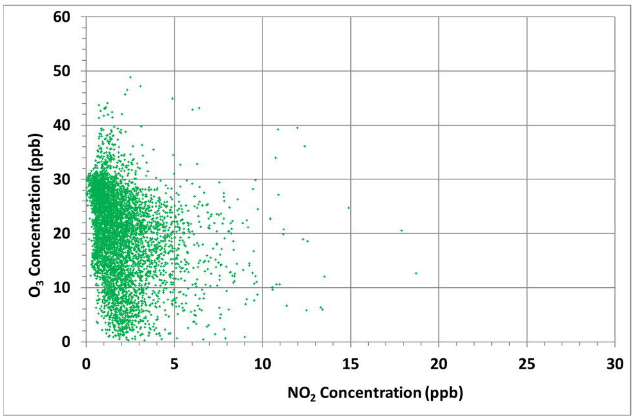
- Note: Relevant SEPP (AAQ) Objectives are 100 ppb (O_3) and 120 ppb (NO_2).

Some of the O_3 concentrations measured at Jeeralang Hill and Rosedale South matched very well, which is indicative of the homogeneity of photochemical smog across the Latrobe Valley region at those times. The hourly average O_3 and NO_2 data pairs are shown in **Figure 5-6** as scatter plots for Jeeralang Hill (left), and Rosedale South (right). While these comparisons are limited by the 60% data capture for NO_2 and O_3 at Rosedale South, the greater number of occurrences of NO_2 in the range 10-30 ppb at Jeeralang Hill is a similar pattern to that observed in previous years; e.g., Jacobs (2018).

Figure 5-6 Hourly Average O_3 and NO_2: Jeeralang Hill (left) and Rosedale South (right)



Jeeralang Hill; more occurrences of higher NO_2

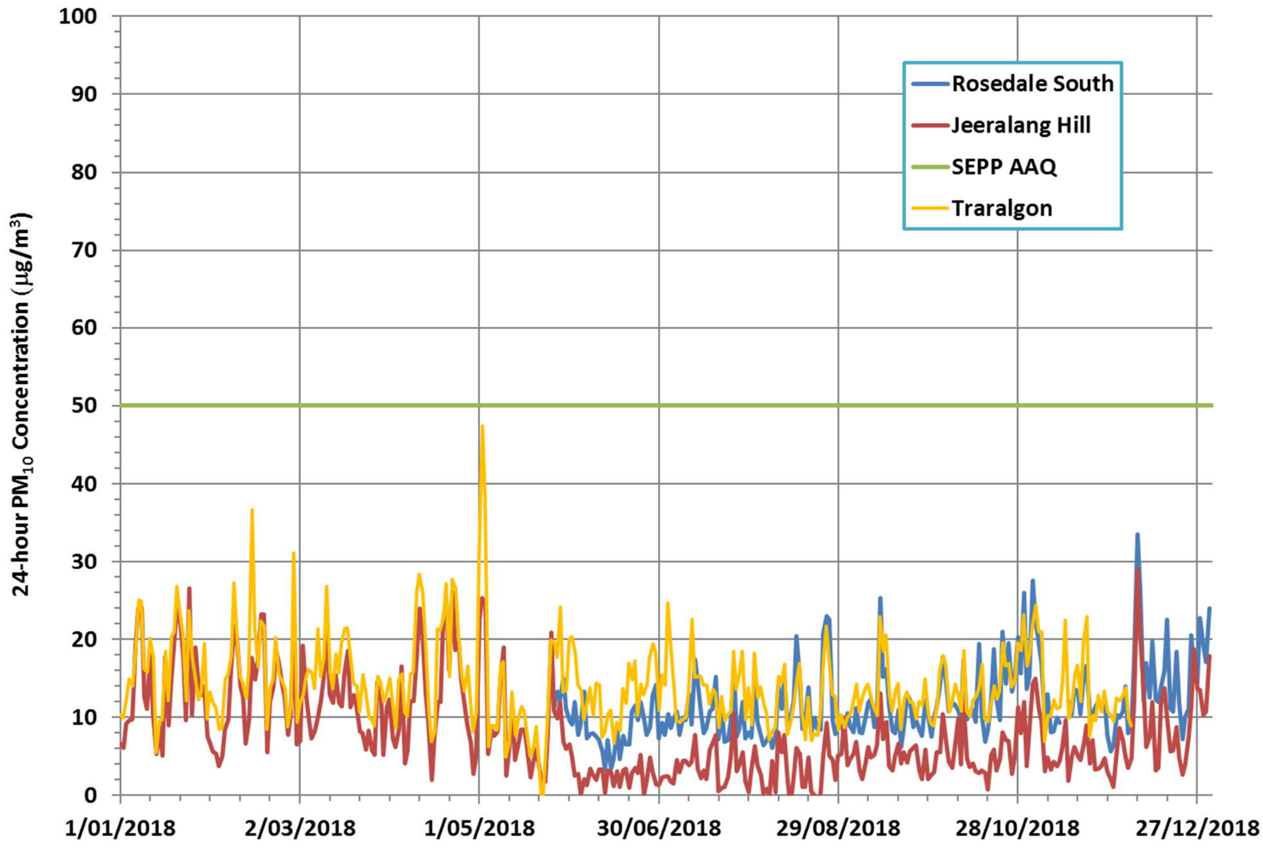


Rosedale South; fewer occurrences of higher NO_2

5.8 Particulate Matter as PM_{10} – Jeeralang Hill and Rosedale South

The LVAMN Jeeralang Hill and Rosedale South results for daily average PM_{10} concentrations (µg/m^3) are provided in **Figure 5-7**. Also shown are the EPA Traralgon results, and the SEPP(AAQ) objective (50 µg/m^3); there were no detected exceedences of this objective in 2018. There are excellent correlations between the three datasets. The linear correlation coefficients between the (24-hour average) data were: between Rosedale South and Jeeralang Hill, 0.76 (219 data pairs); and between Traralgon and Jeeralang Hill, 0.72 (339 data pairs). This means most of the variability in the PM_{10} that can be seen in **Figure 5-7** was characteristic of conditions across much of the Latrobe Valley region; i.e., not due to local sources such as, for example, bushfires or stacks causing plume strikes. The well correlated results for Traralgon and Rosedale South are higher than for Jeeralang Hill during winter, indicating the main PM_{10} sources causing these effects were located on the valley floor. In winter, wood smoke from domestic fires would be significant on the valley floor, and the presence of temperature inversions would further concentrate the PM_{10}. The levels of PM_{10} become more homogeneous in the summer and autumn probably due to smoke from bushfires covering wider areas.

Figure 5-7 LVAMN Results for 24-Hour Average PM_{10} Concentration (µg/m^3)



A summary of results for PM_{10} data acquired at Jeeralang Hill and Rosedale South is set out in **Table 5-13**. There were no recorded exceedances of the SEPP(AAQ) 24-hour average objective of 50 µg/m^3 for PM_{10} for 2018 (no PM_{10} data were recorded at Rosedale South until 24th May).

Table 5-13 Summary of Results for PM_{10} Concentrations (µg/m^3) – Jeeralang Hill and Rosedale South

Parameter	Jeeralang Hill	Rosedale South
No. of hourly averages	8683	5257
Data capture (hourly data)	99.1%	60.0%
Median of hourly averages	6.0 µg/m^3	10.0 µg/m^3

Parameter	Jeeralang Hill	Rosedale South
Maximum hourly average	148 µg/m^3	188 µg/m^3
Annual average of hourly averages	8.0 µg/m^3	11.8 µg/m^3
SEPP(AAQ) Objective – annual average	20 µg/m^3 (not exceeded)	20 µg/m^3 (not exceeded)
No. of daily averages	365	219
70th percentile of 24h averages	9.8 µg/m^3	12.7 µg/m^3
Maximum daily average	28.8 µg/m^3	33.5 µg/m^3
SEPP(AAQ) Objective – 24h average	50 µg/m^3 (not exceeded)	50 µg/m^3 (not exceeded)
Exceedences of Objective	0	0
Percentage of measurement time 24h Objective met	100%	100%
Days of exceedences and values	Nil exceedences	Nil exceedences

Table 5-14 provides comparisons between the LVAMN results for 24-hour and annual average PM_{10} and corresponding results from EPA Traralgon. Inspection of the plotted and tabled results indicates air quality effects due to PM_{10} were approximately the same across the Latrobe Valley, although slightly better at Jeeralang Hill. It is surmised the lower-lying areas such as Morwell, Traralgon and Rosedale South, were affected more by PM_{10} due to smoke and road vehicle traffic, than Jeeralang Hill. The smoke particles would be better dispersed at higher levels, and less likely to be trapped by temperature inversions.

The SEPP(AAQ) standards for maximum 24-hour average PM_{10} (50 µg/m^3), and annual average PM_{10} (20 µg/m^3), were met at the three monitoring sites.

Table 5-14 Comparisons of PM_{10} Results: LVAMN and EPA–Latrobe Valley

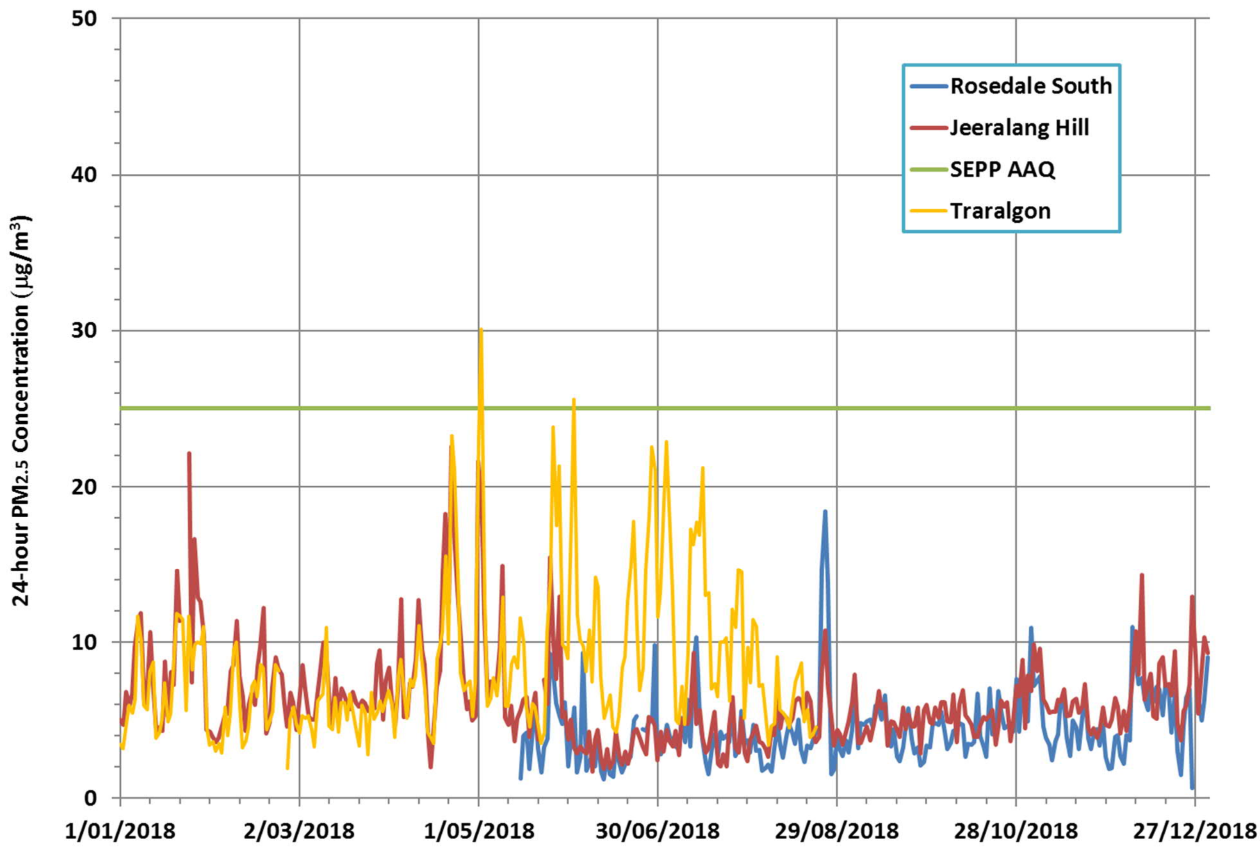
Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Traralgon (EPA)
Data capture, 24h averages	100%	60%	93%
Median 24h PM_{10}	6.1 µg/m^3	10.5 µg/m^3	13.5 µg/m^3
70th percentile 24h PM_{10}	9.8 µg/m^3	12.7 µg/m^3	15.8 µg/m^3
Maximum 24h PM_{10}	28.8 µg/m^3	33.5 µg/m^3	47.4 µg/m^3
Annual average PM_{10} (1h avgs.)	8.0 µg/m^3	11.8 µg/m^3	14.4 µg/m^3

5.9 Particulate Matter as $PM_{2.5}$ – Jeeralang Hill and Rosedale South

The LVAMN Jeeralang Hill and Rosedale South results for daily average $PM_{2.5}$ concentrations (µg/m^3) are provided in **Figure 5-8**. Also shown are the EPA Traralgon results, and the SEPP(AAQ) objective (25 µg/m^3); there were two detected exceedences of this objective in 2018 at Traralgon, but no exceedances recorded at Jeeralang Hill or Rosedale South.

There were good correlations between the three $PM_{2.5}$ datasets, except for winter. This means most of the variability in the $PM_{2.5}$ that can be seen in **Figure 5-8** was characteristic of conditions across much of the Latrobe Valley region in summer, autumn and spring; i.e., not due to local sources such as, for example, bushfires or stacks causing plume strikes. The higher $PM_{2.5}$ values detected at Traralgon during winter are assumed to be due to wood smoke from domestic fires, which can be trapped in a shallow atmospheric mixing layer, at night. The levels of $PM_{2.5}$ become more homogeneous in the summer and autumn probably due to smoke from bushfires covering wider areas.

Figure 5-8 LVAMN Results for 24-Hour Average $PM_{2.5}$ Concentration (µg/m³)



A summary of results for $PM_{2.5}$ data acquired at Jeeralang Hill and Rosedale South is set out in **Table 5-15**. There were no recorded exceedances of the SEPP(AAQ) 24-hour average objective of 25 µg/m³ for $PM_{2.5}$ for 2018 (no $PM_{2.5}$ data were recorded at Rosedale South until 24th May).

Table 5-15 Summary of Results for $PM_{2.5}$ Concentrations (µg/m³) – Jeeralang Hill and Rosedale South

Parameter	Jeeralang Hill	Rosedale South
No. of hourly averages	8520	5328
Data capture (hourly data)	97.3%	60.8%
Median of hourly averages	5.5 µg/m³	4.0 µg/m³
Maximum hourly average	86.4 µg/m³	48.4 µg/m³
Annual average of hourly averages	6.2 µg/m³	4.4 µg/m³
SEPP(AAQ) Objective – annual average	8 µg/m³ (not exceeded)	8 µg/m³ (not exceeded)
No. of daily averages	362	229
70th percentile of 24h averages	6.7 µg/m³	4.9 µg/m³
Maximum daily average	22.6 µg/m³	18.4 µg/m³
SEPP(AAQ) Objective – 24h average	25 µg/m³ (not exceeded)	25 µg/m³ (not exceeded)
Exceedences of Objective	0	0
Percentage of measurement time 24h Objective met	100%	100%
Days of exceedences and values	Nil exceedences	Nil exceedences

Table 5-16 provides comparisons between the LVAMN results for 24-hour and annual average $PM_{2.5}$ and corresponding results from EPA Traralgon. The SEPP(AAQ) standards for maximum 24-hour average $PM_{2.5}$ (25 $\mu g/m^3$), and annual average $PM_{2.5}$ (8 $\mu g/m^3$), were met at the Jeeralang Hill and Rosedale South monitoring sites. There were two recorded exceedances of the 24-hour average $PM_{2.5}$ standard at Traralgon; on 2nd May (30.1 $\mu g/m^3$) and 2nd April (25.6 $\mu g/m^3$). The annual average $PM_{2.5}$ standard was just exceeded, at Traralgon.

Table 5-16 Comparisons of $PM_{2.5}$ Results: LVAMN and EPA–Latrobe Valley

Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Traralgon (EPA)
Data capture, 24h averages	99%	63%	64%
Median 24h $PM_{2.5}$	5.5 $\mu g/m^3$	4.1 $\mu g/m^3$	7.2 $\mu g/m^3$
70th percentile 24h $PM_{2.5}$	6.7 $\mu g/m^3$	4.9 $\mu g/m^3$	9.7 $\mu g/m^3$
Maximum 24h $PM_{2.5}$	22.6 $\mu g/m^3$	18.4 $\mu g/m^3$	30.1 $\mu g/m^3$
Annual average $PM_{2.5}$ (1h avgs.)	6.2 $\mu g/m^3$	4.4 $\mu g/m^3$	8.6 $\mu g/m^3$

5.10 Local Visual Distance (Rosedale South)

This section sets out the LVAMN results for Local Visual Distance (LVD) in 2018, measured only at Rosedale South (4473 hourly averages; data capture 51.1%). The Ecotech results for LVD were used with the VG (1982) procedure to calculate hourly average B_{sca} (m^{-1}); see **Section 3.6**. A statistical summary of the results is provided in **Table 5-17**.

Table 5-17 Summary of results: LVD and Calculated B_{sca}; Rosedale South 2018

Statistic	LVD (Ecotech)	B_{sca} (calculated)
Maximum hourly average LVD	269 km	1.7×10^{-5} m^{-1}
Median hourly average LVD	131 km	3.6×10^{-5} m^{-1}
30th percentile hourly average LVD	115 km	4.1×10^{-5} m^{-1}
Minimum hourly average LVD	26.8 km	1.8×10^{-4} m^{-1}
Number of exceedences of the minimum hourly average LVD; 20 km	Nil	N/A
Exceedences of goal (not >3 days)	Nil	N/A

6. Air Quality: Latrobe Valley vs. Melbourne-Geelong

The purpose of this section is to place the Latrobe Valley's air quality situation in context by comparing air quality monitoring data for 2018 with results from EPA's monitoring network around Melbourne. While the EPA results provided here are expected to be reliable, they should be checked after the publication of EPA's *Air Monitoring Report 2018 – Compliance with NEPM* (publication expected in the second half of 2019).

The focus of this section is on key air pollutants measured by the LVAMN: SO_2, PM_{10}, NO_2, and O_3. Where possible, data were compared for monitoring stations with capture rates for hourly average data equal to or better than 85%. Data from Rosedale South were not included in these comparisons due to that station's low data capture in 2018.

The comparisons are provided as the following tables of results:

- **Table 6-1 Comparisons of SO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne** – As expected, the Latrobe Valley's larger SO_2 sources; e.g., the brown coal-fuelled power stations, lead to higher SO_2 concentrations at Jeeralang Hill. Plume strikes may occur at Jeeralang Hill on a few hours in a year. However, the SO_2 results for the floor of the Latrobe Valley are comparable with those for Altona North, which is located in an industrial area of Melbourne.

- **Table 6-2 Comparisons of PM_{10} Monitoring Data (µg/m^3): Latrobe Valley vs. Melbourne** – Comparisons of these statistics indicate that particulate pollution is worse in Melbourne than in the Latrobe Valley, even considering the potential for plume strikes at Jeeralang Hill and the Latrobe Valley's large, open-cut coal mines. Higher particulate matter levels would be due in part at least to Melbourne's road traffic over the broader Melbourne region. Other potential sources of particulate matter that would affect Melbourne more than the Latrobe Valley would include: particulate formation in smog, and raised dust from dry, exposed areas in western and northern Victoria.

- **Table 6-3 Comparisons of NO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne** – The NO_2 results for 2018 were affected by poor data capture (except Jeeralang Hill). However, the comparisons indicate NO_2 is slightly worse in the Melbourne Airshed than in the Latrobe Valley. The primary reason for this would be NO_x emissions from road traffic over the wider Melbourne region.

- **Table 6-4 Comparisons of O_3 Monitoring Data (ppb): Latrobe Valley vs. Melbourne** – The O_3 results for 2018 were affected by poor data capture also (except Jeeralang Hill). Results for O_3 are presented for three of the best stations in Melbourne Airshed for data capture: Alphington, Dandenong, and Point Cook. Comparisons of the available data indicate that O_3 levels on the floor of the Latrobe Valley are slightly better than those of Melbourne. Higher O_3 levels in Melbourne would be due to the greater amounts of pollution overall: particularly NO_x and hydrocarbons. O_3 is elevated at Jeeralang Hill probably due to the lack of NO_x sources in this more remote area to quench production of O_3 in the daytime. Also, the Jeeralang Hill results may be indicative of O_3 forming in higher levels in the boundary layer, rather than near ground-level.

In general, in comparison with the Melbourne Airshed, the air quality situation in the Latrobe Valley is good due to the lower concentrations of PM_{10}, NO_2, and O_3. The comparisons highlighted the main issue for the Latrobe Valley; higher SO_2 levels.

Further improvements to O_3 data capture in Melbourne and Latrobe Valley are needed to better understand O_3 levels in both airsheds.

Table 6-1 Comparisons of SO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2018

		Latrobe Valley				Melbourne/Geelong		
Statistic, SO_2	**SEPP (AAQ) Objective**	**LVAMN Jeeralang Hill**	**EPA Morwell East**	**EPA Morwell South**	**EPA Traralgon**	**EPA Alphington**	**EPA Altona North**	**EPA Geelong South**
Data capture, 1h avg.	--	95.4%	74.0%	52.0%	85.0%	91.1%	79.2%	89.7%
1h, median	--	0.3	0	0	0	0	0	0
1h, 70th percentile	--	0.5	1	1	1	0	1	0
1h, maximum	200	306.8	90	78	79	13	53	29
24h, median	--	0.5	0.5	0.3	0.4	0.3	1.0	0.2
24h, 70th percentile	--	1.6	1.0	0.6	0.8	0.5	1.7	0.5
24h, maximum	80	31.8	10.7	8.0	9.6	3.7	15.6	3.5
Annual avg. from 1h avgs.	20	2.1	0.7	0.5	0.7	0.4	1.5	0.4

Table 6-2 Comparisons of PM_{10} Monitoring Data (µg/m³): Latrobe Valley vs. Melbourne 2018

		Latrobe Valley				Melbourne/Geelong		
Statistic, PM_{10}	**SEPP (AAQ) Objective**	**LVAMN Jeeralang Hill**	**EPA Morwell East**	**EPA Morwell South**	**EPA Traralgon**	**EPA Alphington**	**EPA Footscray (no data AN)**	**EPA Geelong South**
Data capture, 1h avg.	--	99.1%	--	--	91.6%	92.4%	67.9%	84.1%
1h, median	--	6.0	--	--	12.5	14.85	15.2	14.8
1h, 70th percentile	--	10.0	--	--	16.5	20.5	21.4	21.6
1h, maximum	--	148	--	--	129.2	228.4	274.2	563.7
24h, median	--	6.1	--	--	13.5	15.9	16.4	17.0
24h, 70th percentile	--	9.8	--	--	15.8	19.7	21.5	21.6
24h, maximum	50	28.8	--	--	47.4	73.5	58.0	97.1
Annual avg. from 1h avgs.	20	8.0	--	--	14.4	18.2	18.7	19.4

Table 6-3 Comparisons of NO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2018

	Latrobe Valley				Melbourne/Geelong		
Statistic, NO_2	**SEPP (AAQ) Objective**	**LVAMN Jeeralang Hill**	**EPA Morwell South**	**EPA Traralgon**	**EPA Alphington**	**EPA Dandenong**	**EPA Geelong South**
Data capture, 1h avg.	--	94.3%	15.3%	54.9%	54.7%	54.2%	46.5%
1h, median	--	0.74	3	5	8	8	4
1h, 70^{th} percentile	--	1.3	4	7	12	13	7
1h, maximum	120	41	21	53	50	49	41
Annual avg. from 1h avgs.	30	1.7	3.7	6.2	10.3	10.4	6.0

Table 6-4 Comparisons of O_3 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2018

	Latrobe Valley				Melbourne/Geelong		
Statistic, O_3	**SEPP (AAQ) Objective**	**LVAMN Jeeralang Hill**	**EPA Morwell South**	**EPA Traralgon**	**EPA Alphington**	**EPA Dandenong**	**EPA Point Cook**
Data capture, 1h avg.	--	90%	31.2%	49.1%	49.0%	47.0%	48.5%
1h, median	--	24	17	17	16	17	19
1h, 70^{th} percentile	--	26	21	21	23	22	23
1h, maximum	100	72	69	67	81	94	82
Annual avg. from 1h avgs.	20	24	17	17	18	18	20

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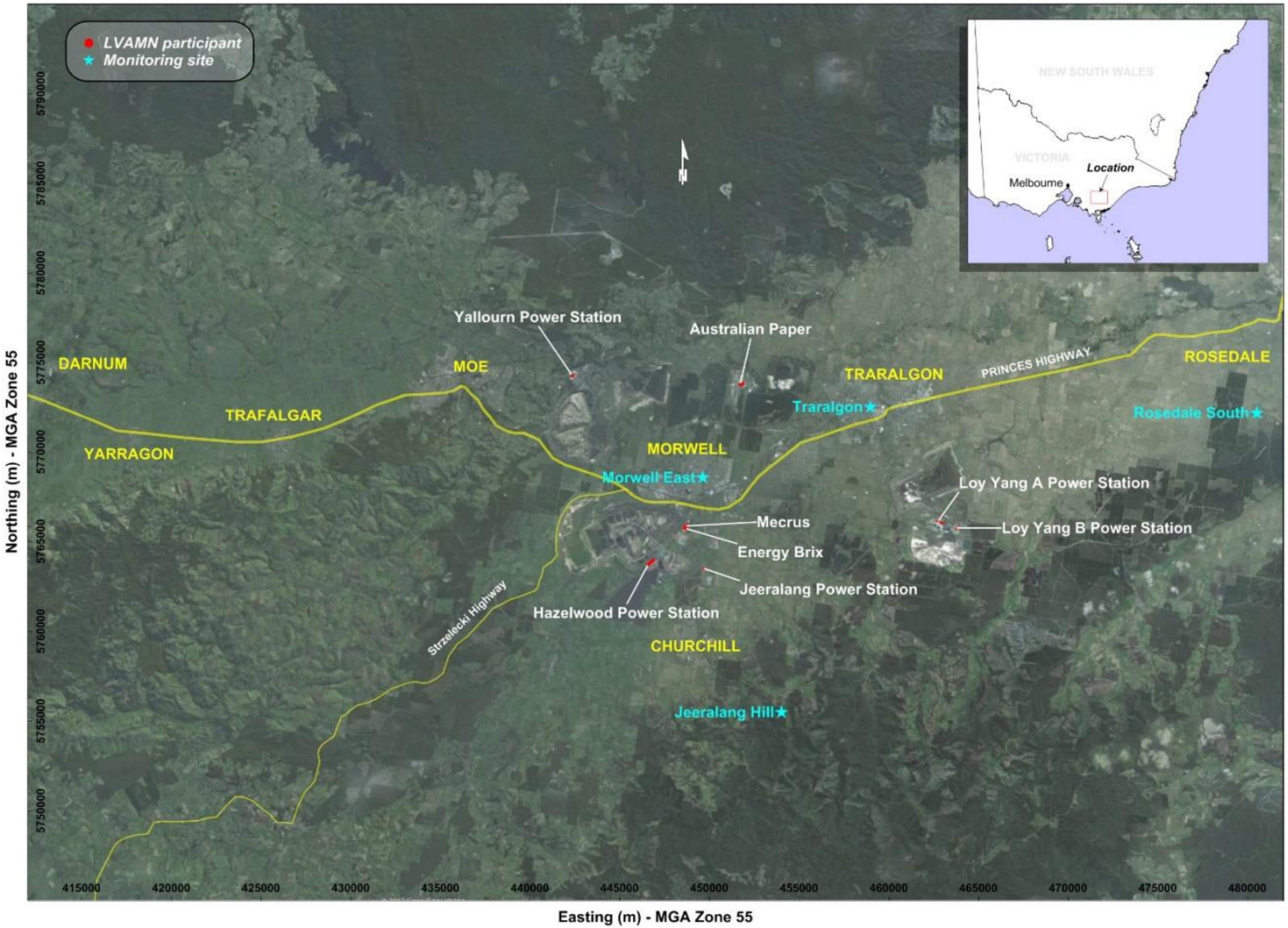
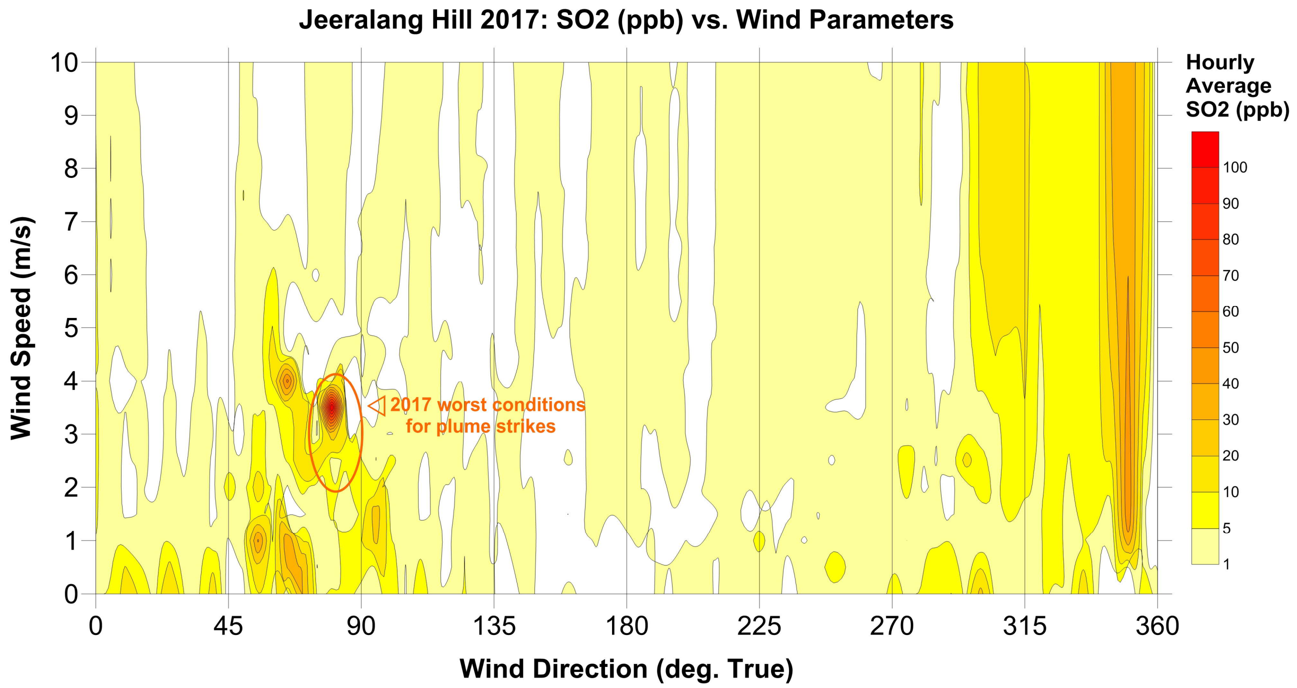
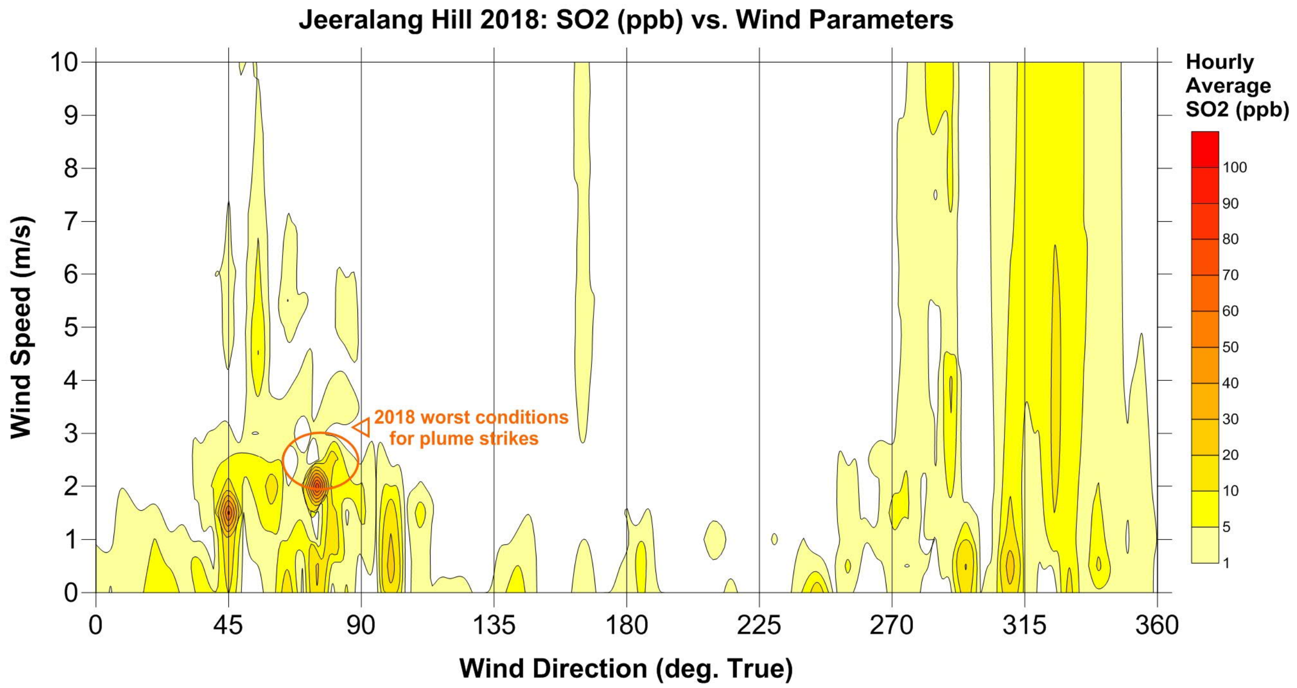
Appendix A. Map of Latrobe Valley


LVAMN participant
Monitoring site
NEW SOUTH WALES
VICTORIA
Location
Melbourne
Yallourn Power Station
Australian Paper
DARNUM
MOE
TRARALGON
PRINCES HIGHWAY
ROSEDALE
Traralgon
Rosedale South
TRAFALGAR
YARRAGON
MORWELL
Morwell East
Loy Yang A Power Station
Mecrus
Loy Yang B Power Station
Energy Brix
Jeeralang Power Station
Hazelwood Power Station
Strzelecki Highway
CHURCHILL
Jeeralang Hill
Northing (m) - MGA Zone 55
5790000
5785000
5780000
5775000
5770000
5765000
5760000
5755000
5750000
415000
420000
425000
430000
435000
440000
445000
450000
455000
460000
465000
470000
475000
480000
Easting (m) - MGA Zone 55

Appendix B. Jeeralang Hill 2017-2018: SO_2 and Winds

The SO_2-wind maps for 2017 (Jacobs, 2018b) and 2018 (bottom figure), were created from hourly average SO_2 concentrations measured at Jeeralang Hill in 2017-2018, versus concurrent hourly average wind direction, and wind speed. The results highlight the complexity of air pollutant dispersion in the Strzelecki Ranges of the Latrobe Valley. In 2018, the highest SO_2 concentrations at Jeeralang Hill occurred during easterly winds with wind speeds in the range 3-4 m/s, which is similar to the 2017 case; see **Section 5.2**.

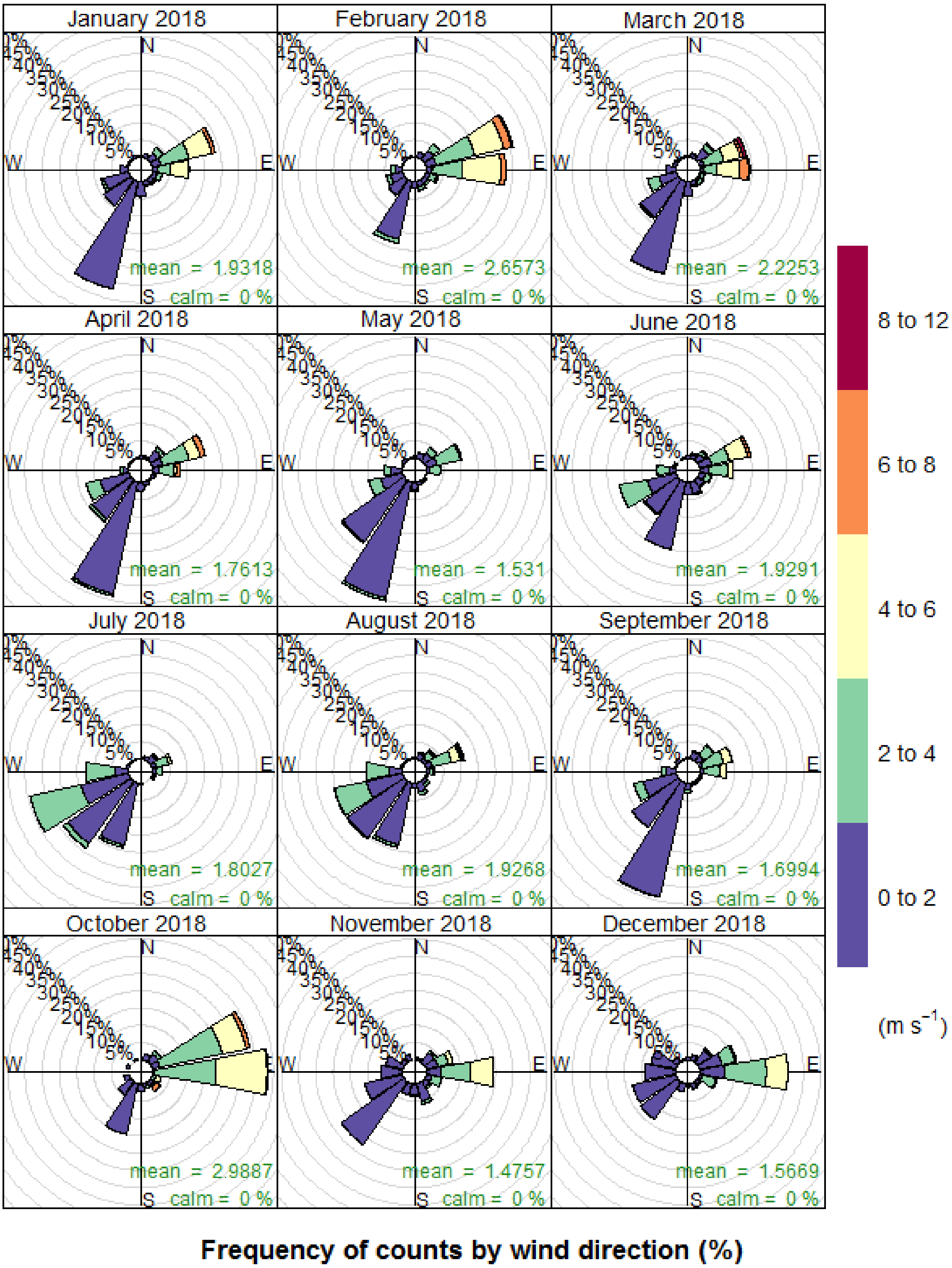




Appendix C. Wind Roses

C.1 Jeeralang Hill 2018 Wind Roses

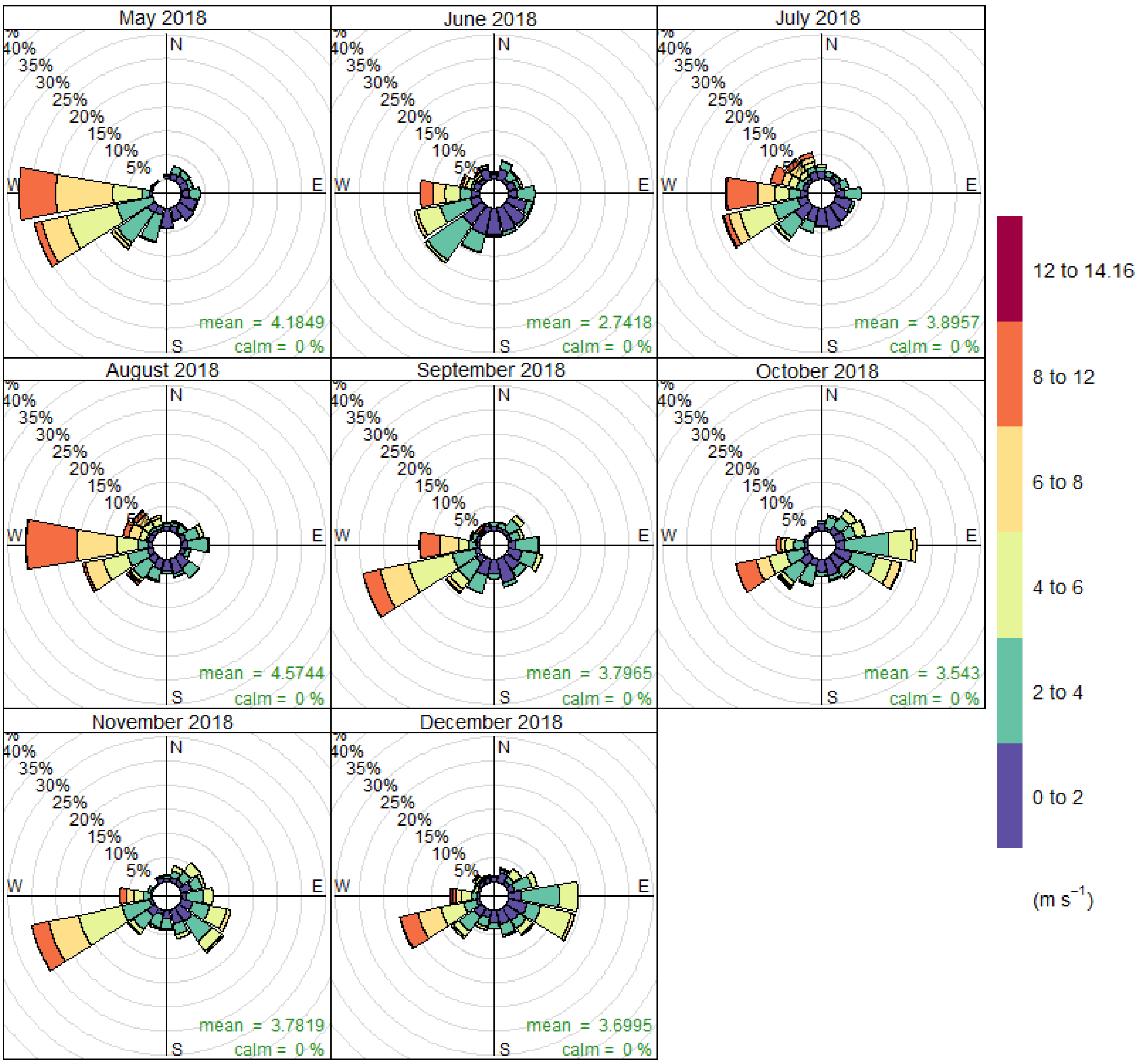
The Jeeralang Hill 2018 monthly wind rose plots were created using 8063 records of hourly average wind speed and wind direction data (for data capture see **Section 4.2**).



C.2 Rosedale South 2018 Wind Roses

The Rosedale South 2018 monthly wind rose plots, for May-December only, were created using 3747 records of hourly average wind speed and wind direction data.

Note data capture for May was 52%, and no wind data were acquired in Jan-April; see **Section 4.2**.



Frequency of counts by wind direction (%)