Latrobe Valley Air Monitoring Network

LVAMN Air Monitoring Report 2019

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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 2019. 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 2019 air quality monitoring data acquired at the LVAMN Jeeralang Hill and Rosedale South monitoring stations, focussing on data interpretation.

In 2019, capture of hourly average data at Jeeralang Hill was very good with data capture for most parameters at that site greater than or equal to 95% (the benchmark was 90%); except for ozone, with data capture 73%. At Rosedale South, data capture was very good with data capture for all parameters greater than 93%.

The 2019-2020 summer fire season was particularly severe and impacted all states of Australia. Air pollutants from bushfires and controlled burns in 2019 affected air pollutant measurements in the Latrobe Valley.

Sulfur Dioxide

In 2019, the SEPP(AAQ) objectives for hourly average sulfur dioxide (SO_2) were met for 99.83% 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 14 exceedences of the SEPP(AAQ) objective for hourly average SO_2 (200 ppb), with the three highest concentrations at Jeeralang Hill occurring: 28/2/2019 4:00-5:00 (346 ppb); 25/2/2019 5:00-6:00 (447 ppb); 9/12/2019 2:00-3:00 (459 ppb). These maxima occurred during easterly wind conditions, with wind speeds ranging between approximately 2-4 m/s; a similar pattern to the previous year. 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: 10/12/2019 14:00-15:00 (65 ppb); 21/10/2019 12:00-13:00 (59 ppb); and 22/10/2019 13:00-14:00 (57 ppb); i.e., there were no exceedences of the objective. The higher Rosedale South concentrations occurred during westerly to south-westerly winds, with wind speeds in the range 4–8 m/s.

The maximum 24-hour average SO_2 concentrations at Jeeralang Hill (76 ppb) and Rosedale South (20 ppb) were less than the SEPP(AAQ) objective of 80 ppb.

Annual average SO_2 concentrations at Jeeralang Hill (2.9 ppb) and Rosedale South (2.5 ppb) were less than the SEPP(AAQ) objective of 20 ppb.

The LVAMN results were compared with EPA's results for SO_2 in the Latrobe Valley, Melbourne, and Geelong. 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 several hours over the course of a year. However, the SO_2 results for the floor of the Latrobe Valley were relatively low, and comparable with some parts of Melbourne.

Nitrogen Dioxide

In 2019, 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 0.8 ppb. The highest hourly average NO_2 concentration was 45.2 ppb (data capture 95.0%). At Rosedale South, the median hourly average

NO_2 concentration was 2.0 ppb, the highest hourly average NO_2 concentration recorded was 22.7 ppb (data capture 93.5%).

Concentrations of NO_2 measured by the EPA in the Melbourne Airshed were comparable or slightly worse than measured NO_2 concentrations in the Latrobe Valley in 2019. The primary reason for this is assumed to be the higher amounts of NO_x emitted from Melbourne's road traffic.

Ozone

In 2019, 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 ozone (O_3) concentration was 25 ppb. The highest hourly average O_3 concentration was 80 ppb (data capture 72.9%), and highest 4-hour O_3 concentration 70 ppb (data capture 75.8%). At Rosedale South, the median one-hour average O_3 concentration was 19 ppb. The highest hourly average O_3 concentration was 73 ppb (data capture 94.6%), and highest 4-hour concentration 69 ppb (data capture 98.7%). Comparisons with EPA monitoring data indicated O_3 levels on the floor of the Latrobe Valley were similar to those from the Melbourne region, except for higher peaks observed around Melbourne.

Particulate Matter

In 2019, the good correlation between the PM_{10} measurements at Jeeralang Hill and Rosedale South, located 31 kilometres apart and 430 metres apart in land elevation, indicated for the majority of days the PM_{10} was due to regional influences such as widespread smoke from fires, rather than local sources.

There were exceedances of the SEPP(AAQ) 24-hour average objective for PM_{10} (50 µg/m^3) at Jeeralang Hill (7 exceedences) and Rosedale South (5 exceedences), likely due to smoke from fires. The SEPP(AAQ) annual average objective for PM_{10} (20 µg/m^3), was met at both monitoring stations: 10.6 µg/m^3 (Jeeralang Hill–data capture 94.8%); and 16.6 µg/m^3 (Rosedale South–data capture 95.3%).

There were exceedences of the SEPP(AAQ) standards for maximum 24-hour average $PM_{2.5}$ (25 µg/m^3) at Jeeralang Hill (10 exceedences) and Rosedale South (8 exceedences), again likely due to smoke from fires. The SEPP(AAQ) annual average objective for $PM_{2.5}$ (8 µg/m^3), was met at both monitoring stations: 6.3 µg/m^3 was determined for both sites: Jeeralang Hill (data capture 98.4%); and Rosedale South (data capture 95.3%).

In general, concentrations of PM_{10} were found to be higher in the Melbourne-Geelong regions than in the Latrobe Valley (apart from some Latrobe Valley maxima due to smoke). Concentrations of $PM_{2.5}$ on the floor of the Latrobe Valley were comparable to Melbourne and Geelong. 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 for example from drier, exposed areas in western and northern Victoria, and the formation of particles in smog.

Local Visual Distance (Rosedale South)

In 2019, in situ nephelometer measurements of an atmospheric scattering coefficient were obtained at Rosedale South. The SEPP(AAQ) objective of minimum Local Visual Distance of 20km was exceeded on 77 hours across 20 days in 2019, likely due to smoke from bushfires and controlled burns.

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	459 ppb [7]	65 ppb [0]
	Max. daily	80 ppb	1 day/year	76 ppb [0]	20 ppb [0]
	Annual	20 ppb	None	2.9 ppb [0]	2.5 ppb [0]
O_3	Max. 1 hour	100 ppb	1 day/year	80 ppb [0]	73 ppb [0]
	Max. 4 hour	80 ppb	1 day/year	70 ppb [0]	69 ppb [0]
NO_2	Max. 1 hour	120 ppb	1 day/year	45 ppb [0]	23 ppb [0]
	Annual	30 ppb	None	1.7 ppb [0]	2.6 ppb [0]
Particles as PM_{10}	Max. 24 hour	50 µg/m^3	None	110 µg/m^3 [7]	110 µg/m^3 [5]
	Annual	20 µg/m^3	None	10.6 µg/m^3 [0]	16.6 µg/m^3 [0]
Particles as $PM_{2.5}$	Max. 24 hour	25 µg/m^3	None	95 µg/m^3 [0]	42 µg/m^3 [0]
	Annual	8 µg/m^3	None	6.3 µg/m^3 [0]	6.3 µg/m^3 [0]
Local Visual Distance	Minimum 1 hour	20 km	3 days/year	17 days	2.6km [17]

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

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 2019 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 lower concentrations of particulate matter and NO_2; apart from occasional higher daily PM_{10} and $PM_{2.5}$ concentrations, which could be attributed to smoke from bushfires and controlled burns.

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 some parts of Melbourne and Geelong.

Concentrations of O_3 in the Latrobe Valley's urban areas were 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 2019 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.

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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), at the time of writing the two most recent online examples being Jacobs (2018) and Jacobs (2019).

Commencing in 2012, Ecotech Pty Ltd was commissioned by LVAMN Incorporated to provide monitoring and data reporting for the LVAMN stations Jeeralang Hill and Rosedale South. The monitoring station locations for calendar year 2019 were unchanged and included:

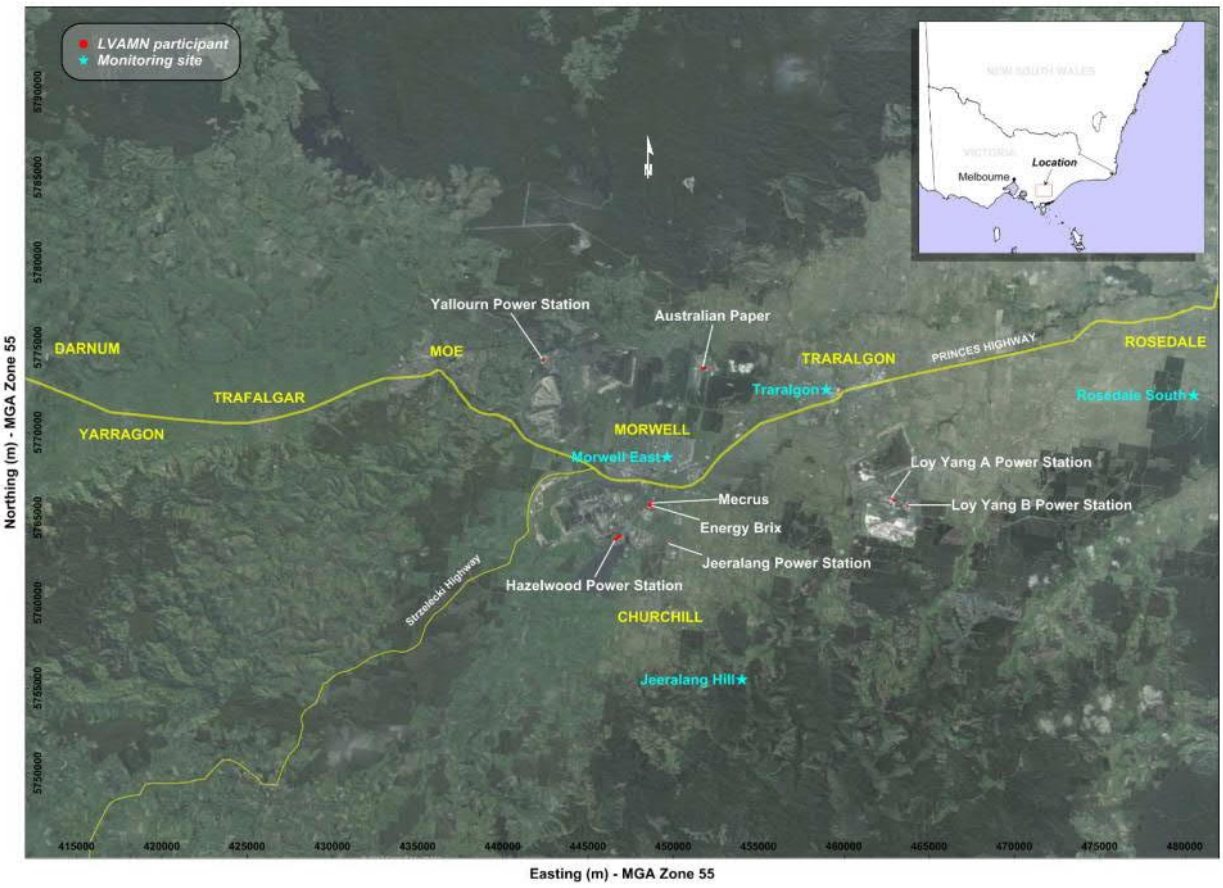
- Jeeralang Hill, a rural site in the Strzelecki Ranges approximately 11 km southeast of Hazelwood Power Station and 13.5 km southwest of Loy Yang Power Stations.

- Rosedale South, a rural site south of the town of Rosedale approximately 5 km south of the Rosedale township and 19 km east-northeast of Loy Yang Power Stations.

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, Morwell South 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 2019 are detailed in the series of reports; Ecotech (2019a–2019k) and Ecotech (2020a). 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 2019 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) and amendments; 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).

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) and consolidating earlier variations incorporated into the *State Environment Protection Policy (Air Quality Management)* or 'SEPP(AQM)' (VG, 2001).

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
B_{sca}	Atmospheric light scattering coefficient (units m^{-1})
CO	Molecular formula for carbon monoxide
EPA	Environment Protection Authority (Victoria)
LVAMN	Latrobe Valley Air Monitoring Network
LVD	Local Visual Distance
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)
$\sigma\theta$	Sigma theta – standard deviation of wind direction
SO_2	Molecular formula for sulfur dioxide
VG	Victoria Government
WD	Wind Direction
WS	Wind Speed

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) (2016) objectives and goals that were used to review the air quality monitoring data for this report are listed in Table 2-1.

Table 2-1 SEPP(AAQ) 2016 Objectives and Goals

Environmental Indicator	Averaging Period[1]	Objective	Goal (exceedences)[2]
NO_2 (maximum conc.)	1 hour	120 ppb	1 day/year
	1 year	30 ppb	Nil
O_3 (maximum conc.)	1 hour	100 ppb	1 day/year
	4 hours[3]	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	Nil
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
Visibility reducing particles (minimum visual distance)	1 hour	20 km	3 days/year

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 the new standards for particles (included in Table 2-1), and further 2025 objectives for $PM_{2.5}$ (VG, 2016); the 2025 objectives are listed in Table 2-2.

Table 2-2 SEPP(AAQ) Objectives for $PM_{2.5}$ by 2025

Environmental Indicator	Averaging Period	Objective	Goal (exceedences)[2]
Particles as PM2.5 – goals by 2025	Annual	7 µg/m^3	Nil

[1] "Day" and "Year" mean “calendar day” and “calendar year”.
[2] Goals are maximum allowable exceedences of objective.
[3] Rolling 4-hour average based on 1-hour averages.

3. Measured Parameters and Sources

3.1 Overview

This section describes the air pollution parameters measured by the LVAMN in 2019, and likely sources.

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 shown 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 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, O_3 precursors include NO_x and hydrocarbons, with their sources including: 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 concentrations 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 in comparison), 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 aerosols 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:

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

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 2019

4.1 Overview

This section sets out the results and interpretation of measurements of air pollutants and meteorological parameters undertaken at Jeeralang Hill and Rosedale South in 2019. 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 (2019a) through to Ecotech (2019k), and Ecotech (2020a).

4.2 Ecotech LVAMN Data Capture for In Situ Measurements

A statistical summary of the hourly average data for the air pollutants and wind parameters measured at Jeeralang Hill for 2019 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 2019 (Hourly Averages)

Parameter (units)	No. Hourly Average Records	Data Capture 2019 (1h avg.)
SO_2 (ppb)	8348	95.3%
NO (ppb)	8320	95.0%
NO_2 (ppb)	8320	95.0%
NO_x (ppb)	8320	95.0%
O_3 (ppb)	6386	72.9%
PM_{10} (µg/m^3)	8366	95.5%
$PM_{2.5}$ (µg/m^3)	8591	98.1%
Wind Speed (WS) (m/s)	8734	99.7%
Wind Direction (WD) (deg)	8734	99.7%
$\sigma\theta$[4] (deg)	8734	99.7%

Table 4-2 Summary of Rosedale South* Monitoring Data for 2019 (Hourly Averages)

Parameter (units)	No. Hourly average records	Data Capture 2019 (1h avg.)
SO_2 (ppb)	8340	95.2%
NO (ppb)	8187	93.5%
NO_2 (ppb)	8187	93.5%
NO_x (ppb)	8187	93.5%
O_3 (ppb)	8288	94.6%
PM_{10} (µg/m^3)	8420	96.1%
$PM_{2.5}$ (µg/m^3)	8553	97.6%
Wind Speed (WS) (m/s)	8211	93.7%

[4] Sigma-theta, or standard deviation of the horizontal wind direction.

Parameter (units)	No. Hourly average records	Data Capture 2019 (1h avg.)
Wind Direction (WD) (deg)	8211	93.7%
$\sigma\theta^4$ (deg)	8211	93.7%
LVD_d (km)	8077	92.2%

Wind roses created from the wind speed and direction data for 2019 are provided in Appendix B.1 (Jeeralang Hill), and Appendix B.2 (Rosedale South). The wind patterns for 2019 were similar to those reported for 2018 (Jacobs, 2020). 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.

5. LVAMN Results 2019

5.1 Overview

This section provides the results of data interpretation for the LVAMN air monitoring data acquired in 2019 at the air monitoring stations Jeeralang Hill and Rosedale South. The reported 1-hour and 24-hour averages are based on a minimum of 75% valid readings within the respective averaging periods. For annual averages, a minimum of 75% valid data is necessary for each calendar quarter. Comparisons are provided with EPA data from monitoring stations in the Latrobe Valley and Melbourne regions.

5.2 Sulfur dioxide

The LVAMN 2019 results for hourly average and 24-hour average SO_2 concentrations (ppb) measured at Jeeralang Hill and Rosedale South are provided in Figure 5-1 and Figure 5-2 respectively. The several exceedences of the 200 ppb objective are investigated in some detail later in this section.

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

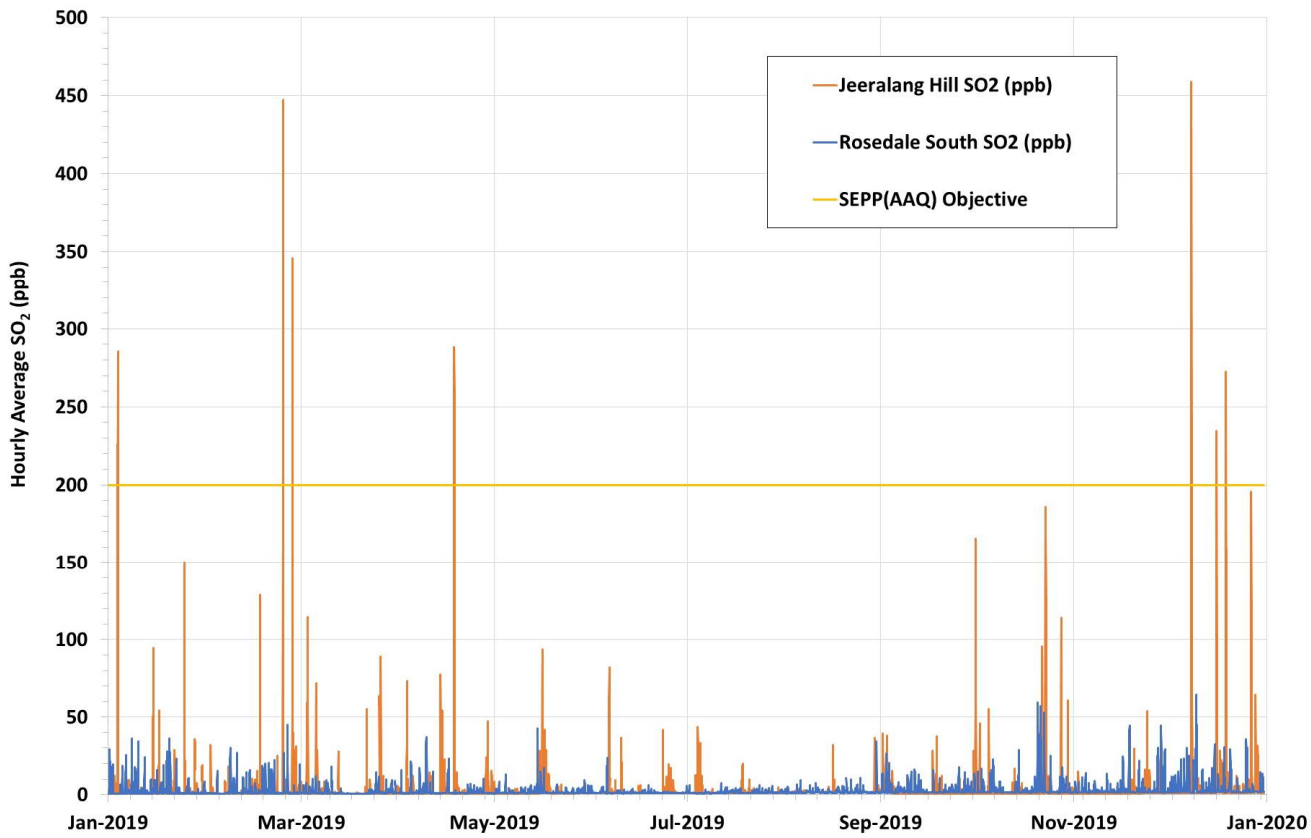
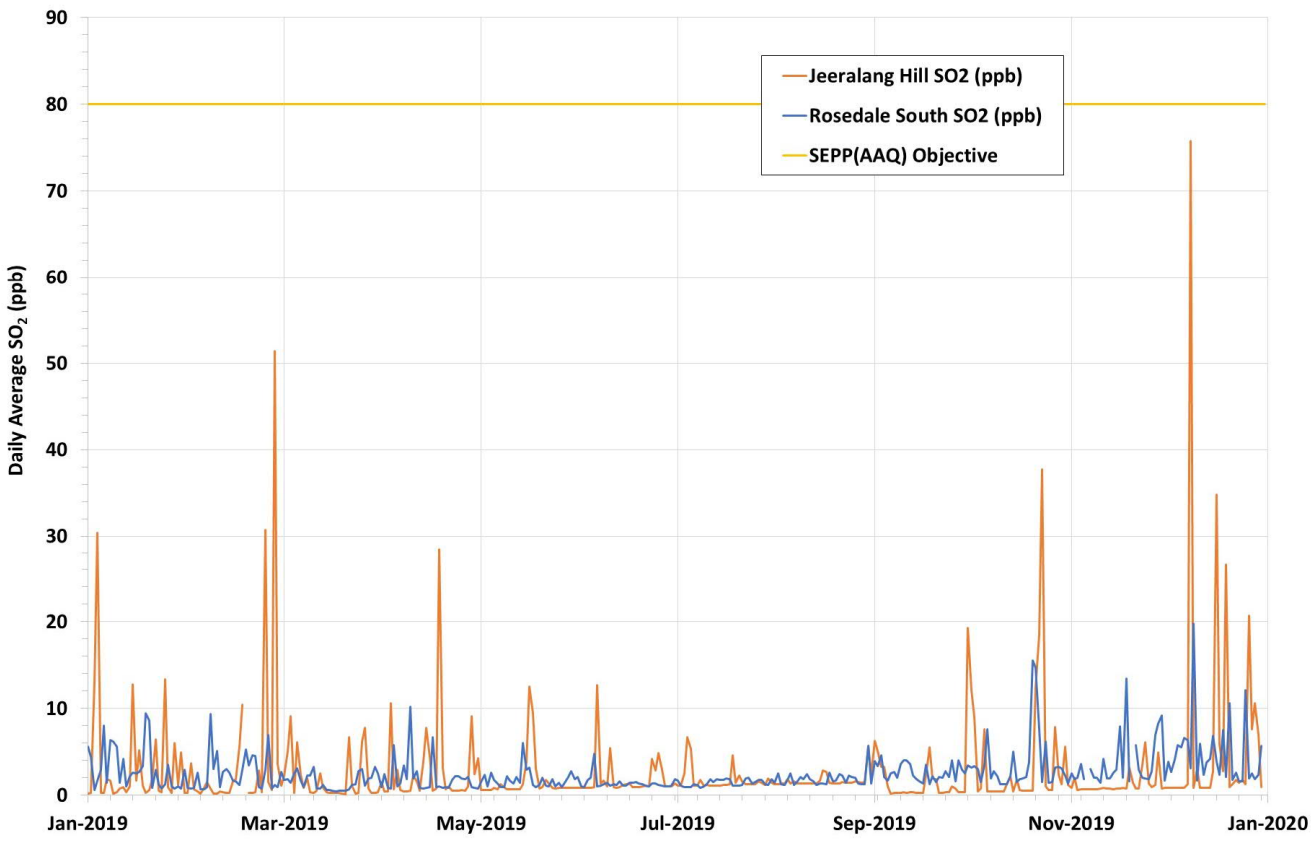


Figure 5-2 LVAMN Results for 24-Hour Average SO_2 Concentration (ppb)



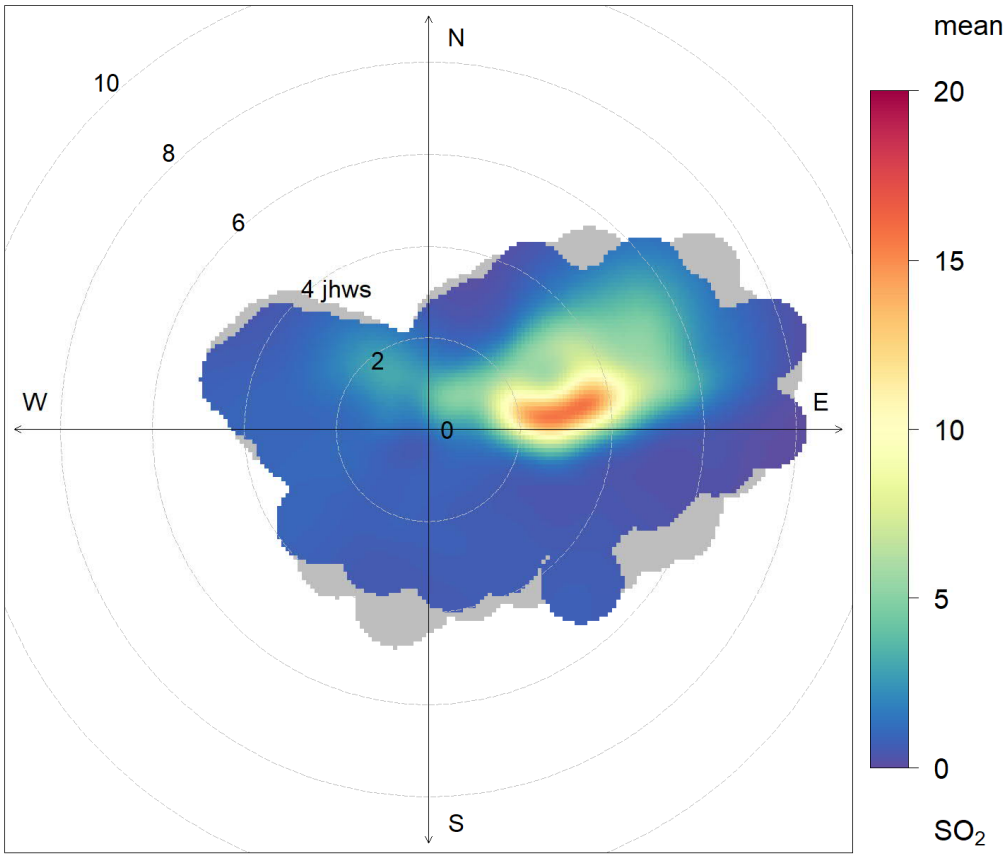
A summary of results of the analysis of the hourly average SO_2 concentrations acquired from Jeeralang Hill in 2019 is set out in Table 5-1.

Table 5-1 Summary of Results: Jeeralang Hill SO_2 Concentrations 2019

Parameter	Hourly Averages	Daily Averages	Annual Average
Number of records	8348	364	1
Total records possible	8760	365	1
Data capture	95.3%	99.7%	95.3%
Median	0.8 ppb	1.0 ppb	–
Annual average	2.9 ppb	2.9 ppb	2.9 ppb
70th percentile	1.2 ppb	1.6 ppb	–
Maximum	458.8 ppb	75.8 ppb	–
SEPP(AAQ) Objective	200 ppb	80 ppb	20 ppb
Percentage of time Objective met (of measured data)	99.83%	100.00%	–
Exceedences of Objective	14 hours on 8 days	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	Exc. 1 day/year	No exceedence
Exceedences of Goal	7 days	0	0

There were 14 exceedences of the SEPP hourly objective across 8 days at Jeeralang Hill. Figure 5-3 shows mean SO_2 concentrations for the year in a polar plot. The polar plot shows mean concentrations (µg/m^3) in colour coding for the observed wind direction and speed, and in this case indicated higher mean concentrations localised to the east-northeast of Jeeralang Hill and dominance during 4–6 m/s wind speeds. These were most likely due to plumes from the Loy Yang complex intercepting high ground in the Strzelecki Ranges, including at Jeeralang Hill.

Figure 5-3 Polar Plot of Jeeralang Hill SO_2 data



A summary of results of the analysis of the hourly average SO_2 concentrations acquired at Rosedale South in 2019, is set out in Table 5-2.

Table 5-2 Summary of Results: Rosedale South SO_2 Concentrations 2019

Parameter	Hourly Averages	Daily Averages	Annual Average
Number of records	8340	363	1
Total records possible	8760	365	1
Data capture	95.2%	99.5%	95.2%
Median	1.3 ppb	1.8 ppb	–
Annual average	2.5 ppb	2.5 ppb	2.5 ppb
70th percentile	1.7 ppb	2.6 ppb	–

Parameter	Hourly Averages	Daily Averages	Annual Average
Maximum	64.7 ppb	19.8 ppb	–
SEPP(AAQ) Objective	200 ppb	80 ppb	20 ppb
Percentage of time Objective met (of measured data)	100.00%	100.00%	–
Exceedences of Objective	0	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	Exc. 1 day/year	No exceedence
Exceedences of Goal	0	0	0

There were no exceedences of the SEPP objectives at Rosedale South.

The LVAMN hourly SO_2 data are compared with EPA's results in Table 5-3. On average, air quality with respect to SO_2 is reasonably good for all locations, however due to its elevation, Jeeralang Hill appears more susceptible to plume strikes.

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

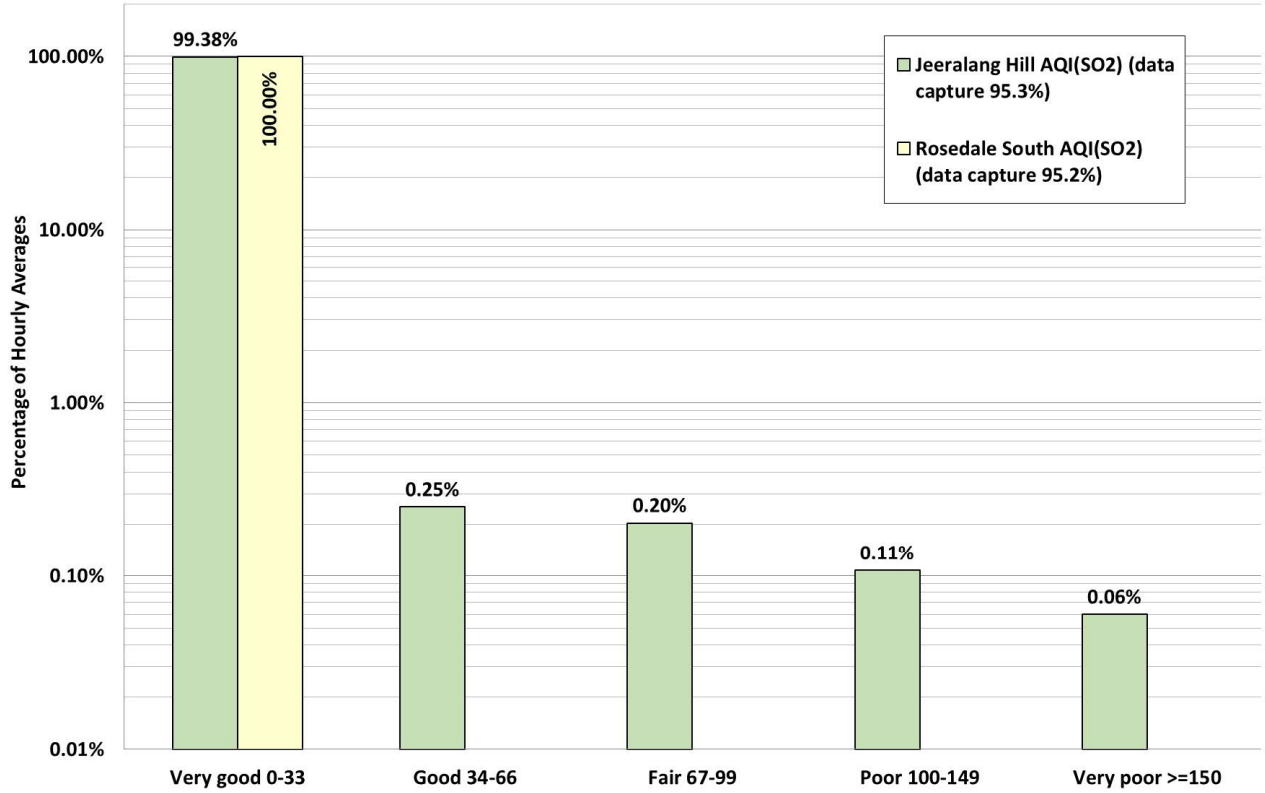
Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell East (EPA)	Morwell South (EPA)	Traralgon (EPA)
Data capture	95.3%	95.2%	95.2	93.9	94.1
Annual average (ppb)	2.9	2.5	0.32	0.48	0.79
Median (ppb)	0.8	1.3	0.0	0.0	0.0
70th percentile (ppb)	1.2	1.7	0.0	0.0	1.0
90th percentile (ppb)	2.6	4.5	1.0	1.0	2.0
99.9th percentile (ppb)	251.7	45.2	34	29.5	27.5
Maximum (ppb)	458.8	64.7	92.0	125	50

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 5-4 (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 99% at Jeeralang Hill and 100% of the time at Rosedale South.

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 5-4 Frequency Distributions of Air Quality Indices as Logarithmic Plot – Hourly Average SO_2



5.4 Oxides of Nitrogen

Figure 5-5 provides the LVAMN 2019 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.

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

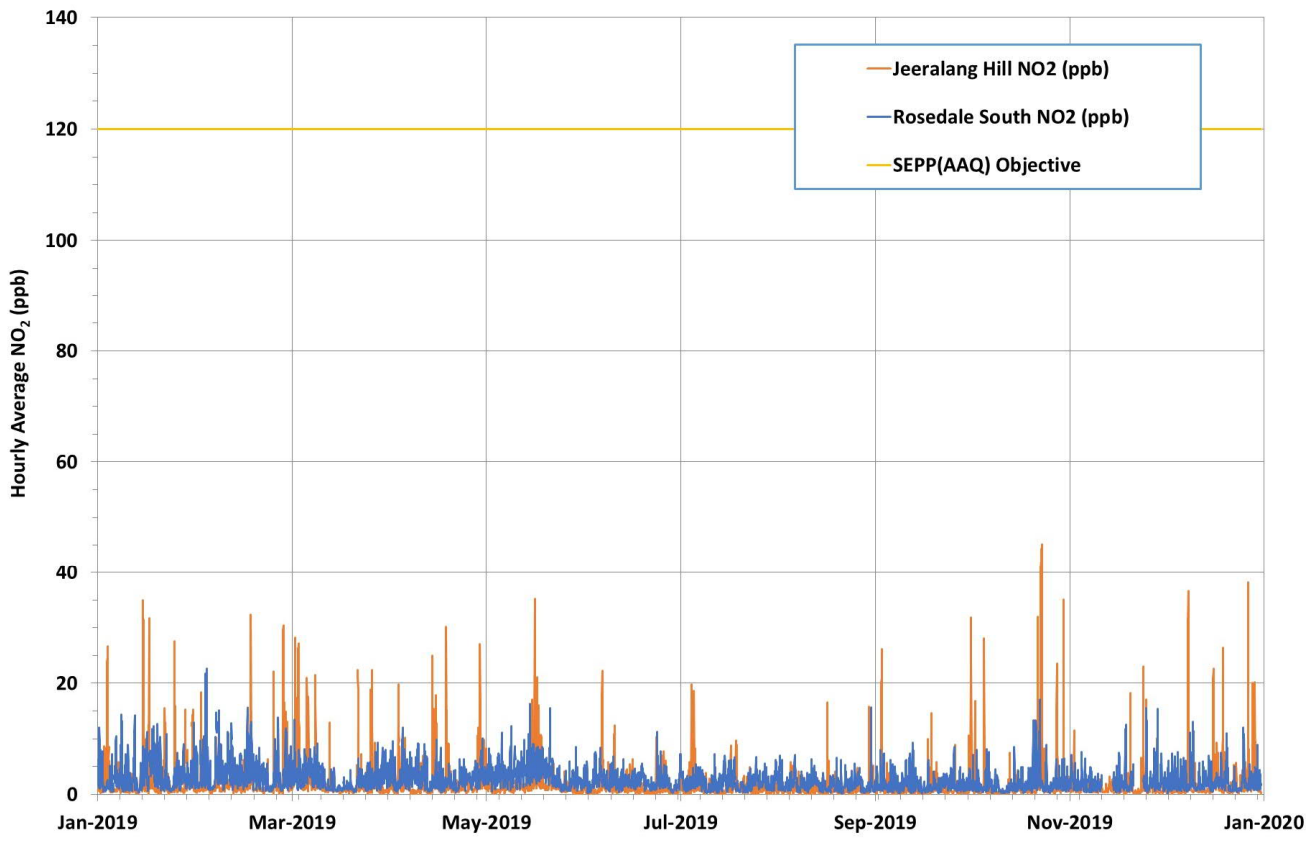


Table 5-4 sets out a summary of results of the analysis of the Jeeralang Hill hourly average NO_2 concentrations. There were no exceedences of the SEPP(AAQ) objectives and goals for NO_2.

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

Parameter	Hourly Averages	Annual Average
Number of records	8320	1
Total records possible	8760	1
Data capture	95.0%	95.0%
Median	0.8 ppb	-
Annual average	1.7 ppb	1.7 ppb
70th percentile	1.3 ppb	-
Maximum	45.2 ppb	-
SEPP(AAQ) Objective	120 ppb	30 ppb
Percentage of time Objective met (of measured data)	100%	100%
Exceedences of Objective	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	No exceedences
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)	70th Percentile Conc. (ppb)	Maximum Conc. (ppb)
NO	0.1	0.7	0.2	234.6
NO_2	0.8	1.7	1.3	45.2
NO_x	0.9	2.4	1.4	266.2

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
Number of records	8187	1
Total records possible	8760	1
Data capture	93.5%	93.5%
Median	2.0 ppb	-
Annual average	2.6 ppb	2.6 ppb
70th percentile	3.0 ppb	-
Maximum	22.7 ppb	-
SEPP(AAQ) Objective	120 ppb	30 ppb
Percentage of time Objective met (of measured data)	100%	100%
Exceedences of Objective	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	No exceedences
Exceedences of Goal	0	0

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)	70th Percentile Conc. (ppb)	Maximum Conc. (ppb)
NO	0.3	0.9	0.6	36.5
NO_2	2.0	2.6	3.0	22.7
NO_x	2.4	3.4	3.7	47.8

The LVAMN hourly NO_2 data are compared with EPA's results for Morwell South and Traralgon, in Table 5-8.

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	95.0%	93.5%	94.4%	85.8%

Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell South (EPA)	Traralgon (EPA)
Median (ppb)	0.8 ppb	2.0 ppb	4 ppb	5 ppb
70th percentile (ppb)	1.3 ppb	3.0 ppb	6 ppb	8 ppb
Maximum (ppb)	45.2 ppb	22.7 ppb	27 ppb	35 ppb

5.5 Ozone

The LVAMN 2019 results for hourly average and 4-hour rolling average O_3 concentrations for Jeeralang Hill and Rosedale South are provided in Figure 5-6 and Figure 5-7 respectively. The results are shown with the SEPP(AAQ) hourly average and 4-hour rolling average objectives; all the hourly O_3 data were less than the objectives of 100 ppb and 80 ppb respectively. Some of the peak O_3 concentrations during the summer would be due to precursor emissions from fires, and road vehicle traffic; other peaks would be due to larger scale regional influences.

Summaries of results of the analysis of the hourly average O_3 concentrations are set out in Table 5-9 (Jeeralang Hill); and Table 5-10 (Rosedale South).

Figure 5-6 Ecotech LVAMN Results for Hourly Average O_3 Concentration (ppb)

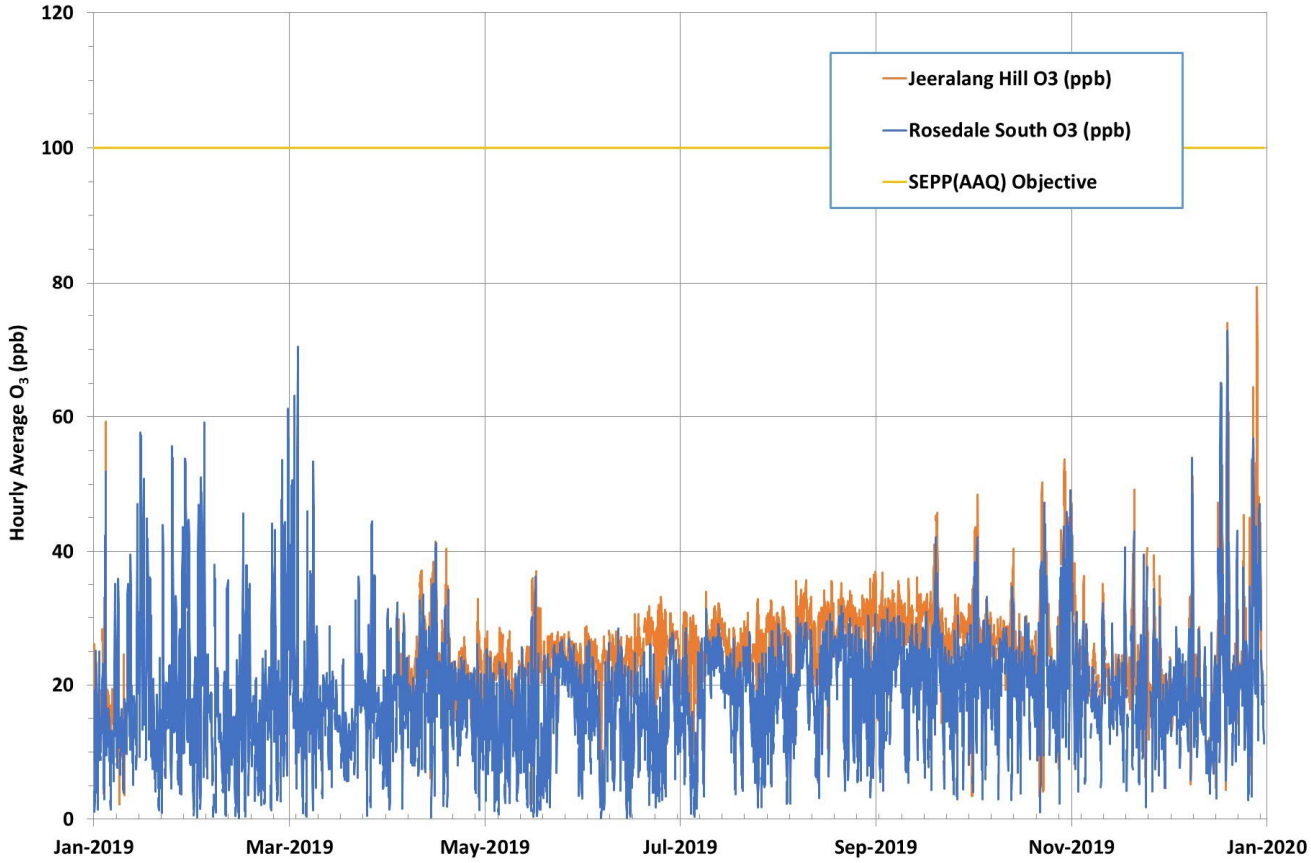


Figure 5-7 Ecotech LVAMN Results for 4-Hour Rolling Average O_3 Concentration (ppb)

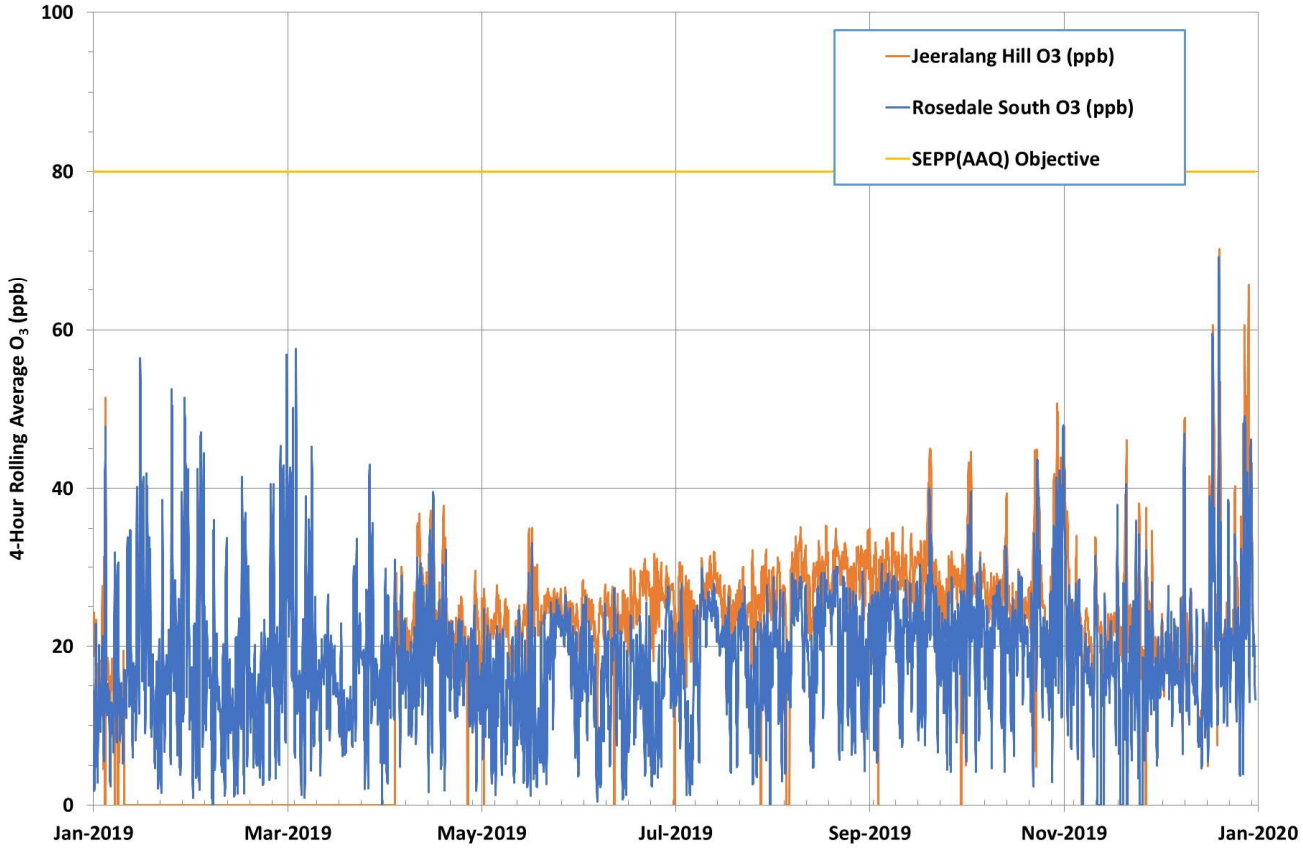


Table 5-9 Summary of Results: Jeeralang Hill O_3 Concentrations

Parameter	Hourly Averages	4-Hour Rolling Average
Number of records	6386	6640
Total records possible	8760	8760
Data capture	72.9%	75.8%
Median	25.1 ppb	25.2 ppb
Annual average	25.6 ppb	25.6 ppb
70th percentile	28.0 ppb	27.9 ppb
Maximum	79.5 ppb	70.3 ppb
SEPP(AAQ) Objective	100 ppb	80 ppb
Percentage of time Objective met (of measured data)	100%	100%
Exceedences of Objective	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	No exceedences
Exceedences of Goal	0	0

Table 5-10 Summary of Results: Rosedale South O_3 Concentrations

Parameter	Hourly Averages	4-Hour Rolling Average
Number of records	8288	8649
Total records possible	8760	8760
Data capture	94.6%	98.7%
Median	18.5 ppb	18.2 ppb
Annual average	18.6 ppb	18.4 ppb
70th percentile	22.5 ppb	22.1 ppb
Maximum	72.8 ppb	69.3 ppb
SEPP(AAQ) Objective	100 ppb	80 ppb
Percentage of time Objective met (of measured data)	100%	100%
Exceedences of Objective	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	No exceedences
Exceedences of Goal	0	0

The LVAMN hourly O_3 data are compared with EPA results for Morwell South and Traralgon in Table 5-11. 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 resulting in a quenching effect on local O_3 levels.

Table 5-11 Comparisons of Hourly Average O_3 Results: LVAMN and EPA

Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell South (EPA)	Traralgon (EPA)
Data capture	72.9%	94.6%	90.9%	92.4%
Median	25 ppb	19 ppb	18 ppb	17 ppb
70th percentile	28 ppb	23 ppb	22 ppb	21 ppb
Maximum	80 ppb	73 ppb	92 ppb	89 ppb

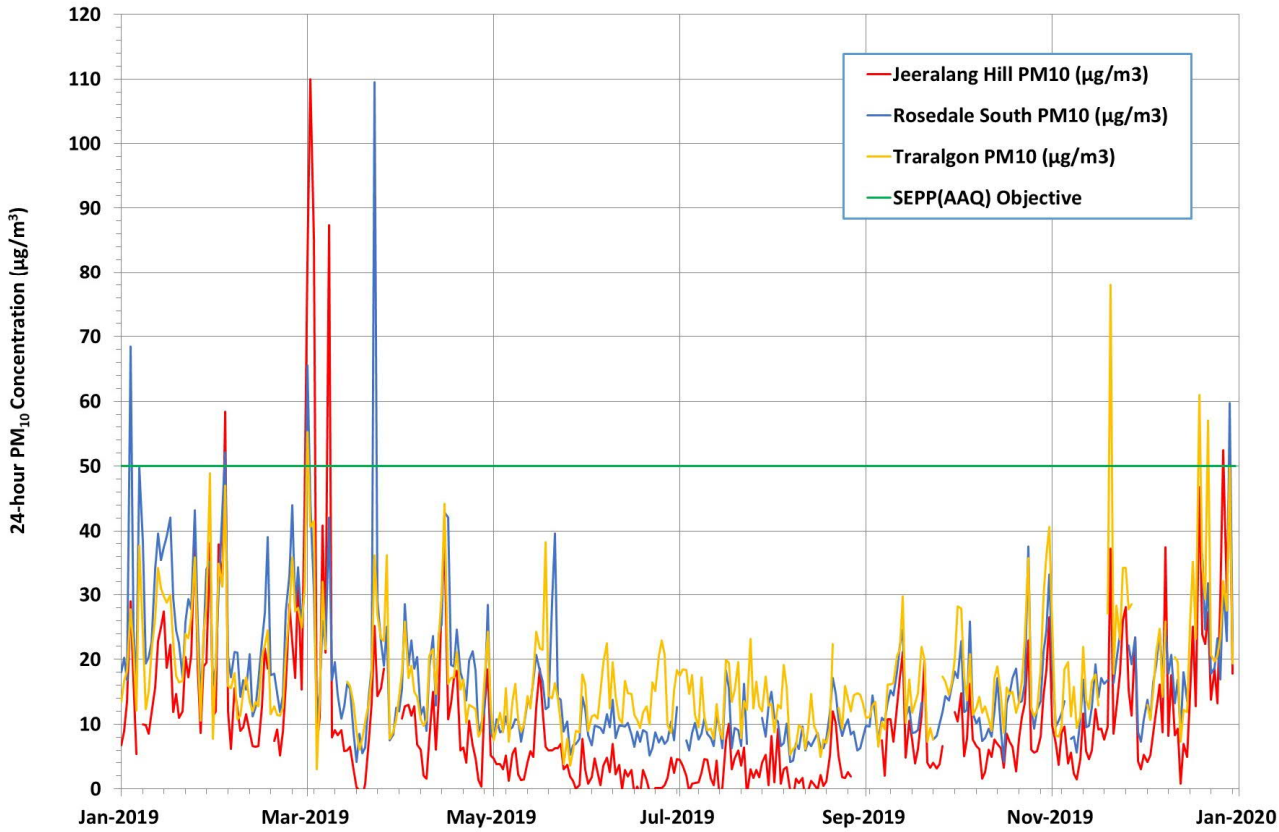
5.6 Particulate Matter as PM_{10} – Jeeralang Hill and Rosedale South

The LVAMN Jeeralang Hill and Rosedale South results for daily average PM_{10} concentrations (µg/m^3) are provided in Figure 5-8. Also shown are the EPA Traralgon results, and the SEPP(AAQ) objective (50 µg/m^3); there were a number of exceedences of this objective in 2019. Results are typically higher during summer and autumn. In 2019, many of the higher daily PM_{10} concentrations would have been due to smoke from bushfires and controlled burns. The 2019-2020 summer fire season was particularly severe across Australia, including for eastern Victoria (VG, 2020). Two examples of NASA (2020) imagery of smoke from fires across Eastern Victoria are provided in Appendix C.

Also, during 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}. This is evidenced by the higher concentrations for Traralgon in winter, and lower concentration for the more elevated Jeeralang Hill site. The levels of PM_{10}

become more homogeneous in the summer and autumn probably due to smoke from bushfires, and potentially also windblown dust covering wider areas.

Figure 5-8 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 5-12. There were 12 exceedences of the SEPP(AAQ) 24-hour average objective of 50 µg/m^3 for PM_{10} for 2019, seven at Jeeralang Hill and five at Rosedale South.

Table 5-12 Summary of Results for PM_{10} Concentrations (µg/m^3) – Jeeralang Hill and Rosedale South

Parameter	Jeeralang Hill		Rosedale South	
	Daily Average	Annual Average	Daily Average	Annual Average
Number of records	346	1	348	1
Total records possible	365	1	365	1
Data capture	94.8%	94.8%	95.3%	95.3%
Median	6.8 µg/m^3	-	13.5 µg/m^3	-
Annual average	10.6 µg/m^3	10.6 µg/m^3	16.6 µg/m^3	16.6 µg/m^3
70th percentile	11.7 µg/m^3	-	18.6 µg/m^3	-
Maximum	109.9 µg/m^3	-	109.5 µg/m^3	-
SEPP(AAQ) Objective	50 µg/m^3	20 µg/m^3	50 µg/m^3	20 µg/m^3
Percentage of time Objective met (of measured data)	97.98%	100%	98.56%	100%

Parameter	Jeeralang Hill		Rosedale South	
	Daily Average	Annual Average	Daily Average	Annual Average
Exceedences of Objective	7	0	5	0
SEPP(AAQ) Goal	No exceedences	No exceedences	No exceedences	No exceedences
Exceedences of Goal	7	0	5	0

Table 5-13 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 wood-burner 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.

There were five exceedences of the 24-hr objective at Traralgon in 2019. None of the sites exceeded the annual average objective.

Table 5-13 Comparisons of PM_{10} Results: LVAMN and EPA–Latrobe Valley

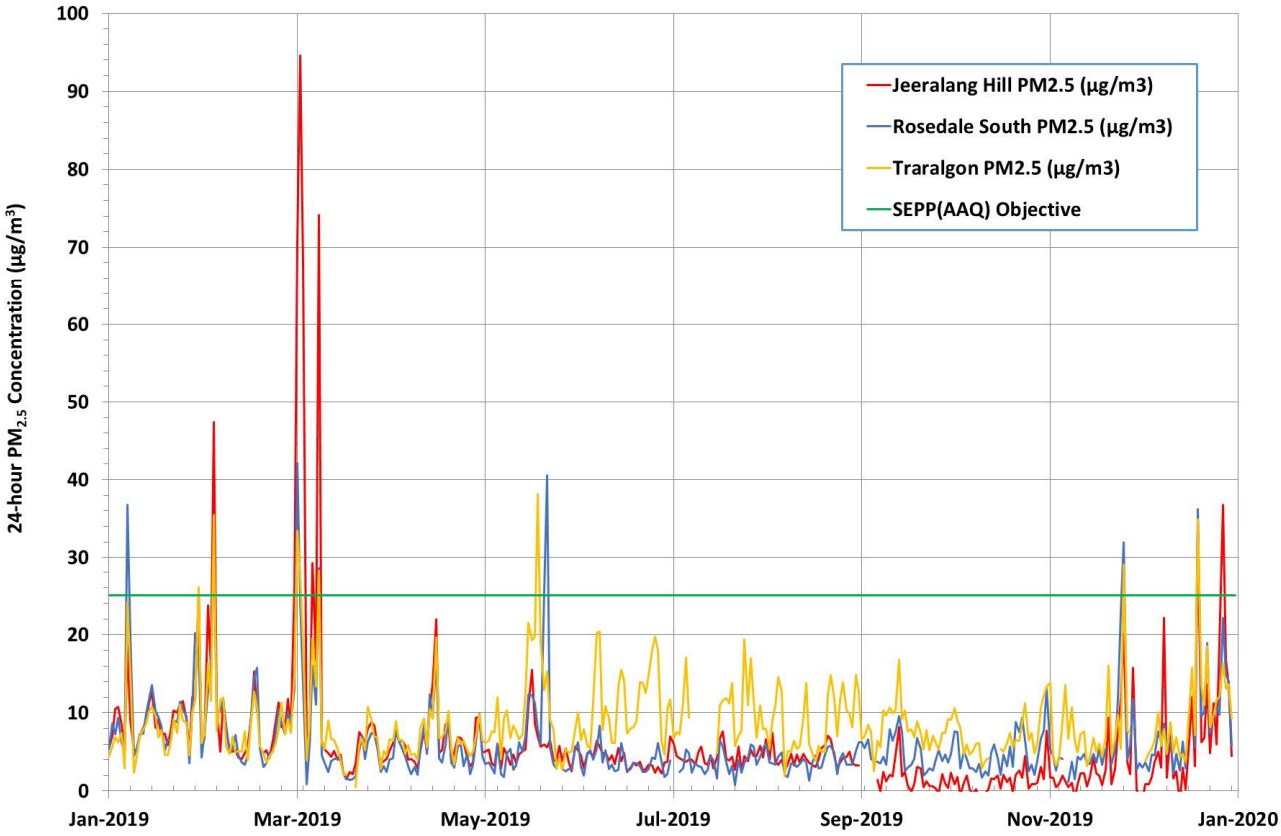
Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Traralgon
Data capture, 24h averages	94.8%	95.3%	95.3 %
Median 24h PM_{10}	6.8 µg/m^3	13.5 µg/m^3	15.2 µg/m^3
70th percentile 24h PM_{10}	11.7 µg/m^3	18.6 µg/m^3	19.6 µg/m^3
Maximum 24h PM_{10}	109.9 µg/m^3	109.5 µg/m^3	78.0 µg/m^3
Annual average PM_{10}	10.6 µg/m^3	16.6 µg/m^3	17.6 µg/m^3

5.7 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 5-9. Also shown are the EPA Traralgon results, and the SEPP(AAQ) objective (25 µg/m^3); there were eight exceedences of this objective in 2019 at Traralgon, ten exceedences recorded at Jeeralang Hill and eight exceedences recorded at Rosedale South.

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. Conversely, observations at Jeeralang Hill are lower in winter due to the elevated location of this site. The levels of $PM_{2.5}$ become more homogeneous in the summer and autumn probably due to smoke from bushfires and controlled burns covering wider areas; see also Section 5.6, and Appendix C provides two NASA (2020) examples of smoke from fires across eastern Victoria in 2019.

Figure 5-9 LVAMN Results for 24-Hour Average $PM_{2.5}$ Concentration (µg/m^3)



A summary of results for $PM_{2.5}$ data acquired at Jeeralang Hill and Rosedale South is set out in Table 5-14. There were no recorded exceedences of the SEPP(AAQ) annual average objective of 8 µg/m^3 for $PM_{2.5}$ for 2019 at Jeeralang Hill or Rosedale South, however the annual average for Traralgon of 8.9 µg/m^3 exceeded the objective.

Table 5-14 Summary of Results for $PM_{2.5}$ Concentrations (µg/m^3) – Jeeralang Hill and Rosedale South

Parameter	Jeeralang Hill		Rosedale South	
	Daily Average	Annual Average	Daily Average	Annual Average
Number of records	359	1	359	1
Total records possible	365	1	365	1
Data capture	98.4%	94.8%	98.4%	95.3%
Median	4.5 µg/m^3	-	4.6 µg/m^3	-
Annual average	6.3 µg/m^3	6.3 µg/m^3	6.3 µg/m^3	6.3 µg/m^3
70th percentile	5.9 µg/m^3	-	6.2 µg/m^3	-
Maximum	94.6 µg/m^3	-	42.1 µg/m^3	-
SEPP(AAQ) Objective	25 µg/m^3	8 µg/m^3	25 µg/m^3	8 µg/m^3
Percentage of time Objective met (of measured data)	97.21%	100%	97.77%	100%
Exceedences of Objective	10	0	8	0

Parameter	Jeeralang Hill		Rosedale South	
	Daily Average	Annual Average	Daily Average	Annual Average
SEPP(AAQ) Goal	No exceedences	No exceedences	No exceedences	No exceedences
Exceedences of Goal	10	0	8	0

Table 5-15 provides comparisons between the LVAMN results for 24-hour and annual average $PM_{2.5}$ and corresponding results from EPA Traralgon, Moe, Morwell East and Morwell South. The SEPP(AAQ) standards for maximum 24-hour average $PM_{2.5}$ (25 µg/m^3), and annual average $PM_{2.5}$ (8 µg/m^3), were met at the 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 annual average $PM_{2.5}$ standard was just exceeded, at Traralgon.

Table 5-15 Comparisons of $PM_{2.5}$ Results: LVAMN and EPA–Latrobe Valley

Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Traralgon (EPA)	Moe (EPA)	Morwell East (EPA)	Morwell South (EPA)
Data capture, 24h averages	94.8%	98.4%	95.3%	96.4%	36.4%	97.0%
Median 24h $PM_{2.5}$	4.5 µg/m^3	4.6 µg/m^3	7.6 µg/m^3	6.2 µg/m^3	6.4 µg/m^3	5.8 µg/m^3
70th percentile 24h $PM_{2.5}$	5.9 µg/m^3	6.2 µg/m^3	10.0 µg/m^3	8.6 µg/m^3	8.8 µg/m^3	7.7 µg/m^3
Maximum 24h PM2.5	94.6 µg/m^3	42.1 µg/m^3	38.2 µg/m^3	45.6 µg/m^3	33.1 µg/m^3	51.4 µg/m^3
Annual average $PM_{2.5}$	6.3 µg/m^3	6.3 µg/m^3	8.9 µg/m^3	7.5 µg/m^3	7.9 µg/m^3	7.2 µg/m^3

5.8 Local Visual Distance (Rosedale South)

This section sets out the LVAMN results for Local Visual Distance (LVD) in 2019, measured only at Rosedale South (8077 hourly averages; data capture 92.2%). 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 5-16.

The SEPP(AAQ) objective of minimum 20km LVD was exceeded on 77 hours across 20 days in 2019.

Table 5-16 Summary of results: LVD and Calculated B_{sca}; Rosedale South 2019

Parameter	LVD	B_{sca} (calculated)
Maximum hourly average LVD	245.6 km	1.9×10^{-5} m^{-1}
Median hourly average LVD	124.1 km	3.8×10^{-5} m^{-1}
30th percentile hourly average LVD	102.3 km	4.6×10^{-5} m^{-1}
Minimum hourly average LVD	2.6 km	1.8×10^{-3} m^{-1}
Number of exceedences of the minimum hourly average LVD; 20 km	77	N/A
Exceedences of goal (not >3 days)	17	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 2019 with results from EPA's monitoring network around Melbourne. The EPA results provided here are calculated from validated hourly average data supplied by the EPA and are expected to be reliable, however some discrepancies may be found in comparison to the publication of EPA's *Air Monitoring Report 2019 – Compliance with NEPM* (EPA, 2020).

The focus of this section is on key air pollutants measured by the LVAMN: SO_2, PM_{10}, $PM_{2.5}$, 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%.

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 in the Latrobe Valley. Annual averages are low across all sites, however plume strikes are evident at the Latrobe Valley sites, for several hours in a year. Unfortunately, Altona North SO_2 data capture was low in 2019, so the data were not included in this report.

- Table 6-2 and Table 6-3 Comparisons of PM_{10} and $PM_{2.5}$ Monitoring Data (µg/m^3): Latrobe Valley vs. Melbourne – Monitoring statistics show similar trends for PM_{10} and $PM_{2.5}$. 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 6-4 Comparisons of NO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne – The results for 2019 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 6-5 Comparisons of O_3 Monitoring Data (ppb): Latrobe Valley vs. Melbourne – The results for 2019 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 similar to those of Melbourne, however the Melbourne sites have higher peak concentrations. Higher peak 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}, $PM_{2.5}$, NO_2, and O_3. The comparisons highlighted the main issue for the Latrobe Valley; higher SO_2 levels.

Table 6-1 Comparisons of SO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2019

Statistic SO_2	SEPP (AAQ) Objective	Latrobe Valley					Melbourne/Geelong	
		Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell East (EPA)	Morwell South (EPA)	Traralgon (EPA)	Alphington (EPA)	Geelong South (EPA)
Data capture, 1h avg.	-	95.3%	95.2%	95.2	93.9	94.1	94.1	93.2
1h, median	-	0.8	1.3	0	0	0	0	0
1h, 70th percentile	-	1.2	1.7	0	0	1	0	0
1h, maximum	200	458.8	64.7	92	125	50	10	47
24h, median	-	1.0	1.8	0.0	0.2	0.5	0.2	0.1
24h, 70th percentile	-	1.6	2.6	0.3	0.6	1.0	0.4	0.4
24h, maximum	80	75.8	19.8	92	125	10	10	47
Annual avg. from 1hr avg.	20	2.9	2.5	0.3	0.5	0.8	0.4	0.4

Table 6-2 Comparisons of PM_{10} Monitoring Data ($\mu g/m^3$): Latrobe Valley vs. Melbourne 2019

Statistic PM_{10}	SEPP (AAQ) Objective	Latrobe Valley			Melbourne/Geelong		
		Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Traralgon (EPA)	Alphington (EPA)	Dandenong (EPA)	Geelong South (EPA)
Data capture, 24h avg.	-	94.8%	95.3%	96.7	95.9	94.8	88.8
24h, median	-	6.8	13.5	15.2	15.8	15.5	15.7
24h, 70th percentile	-	11.7	18.6	19.6	20.5	20.7	21.0
24h, maximum	50	109.9	109.5	78.0	69.8	65.4	101.5
Annual avg. from 24hr ave	20	10.6	16.6	17.6	18.2	19.1	19.6

Table 6-3 Comparisons of $PM_{2.5}$ Monitoring Data (µg/m^3): Latrobe Valley vs. Melbourne 2019

Statistic $PM_{2.5}$	SEPP (AAQ) Objective	Latrobe Valley					Melbourne/Geelong		
		Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Moe (EPA)	Morwell South (EPA)	Traralgon (EPA)	Alphington (EPA)	Foots-cray (EPA)	Geelong South (EPA)
Data capture, 24h avg.	-	98.4%	98.4%	96.4	97.0	95.3	67.7	98.4	95.9
24h, median	-	4.5	4.6	6.2	5.8	7.6	-	6.6	5.6
24h, 70th percentile	-	5.9	6.2	8.6	7.7	10.0	-	8.0	7.0
24h, maximum	25	94.6	42.1	45.6	51.4	38.2	-	31.3	32.7
Annual avg. from 24hr avg.	8	6.3	6.3	7.5	7.2	8.9	-	7.5	6.5

Table 6-4 Comparisons of NO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2019

Statistic NO_2	SEPP (AAQ) Objective	Latrobe Valley				Melbourne/Geelong		
		Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell South (EPA)	Traralgon (EPA)	Alphington (EPA)	Foots-cray (EPA)	Geelong South (EPA)
Data capture, 1h avg.	-	95.0	93.5%	94.4	85.8	91.8	94.5	92.8
1h, median	-	0.8	2.0	4	5	7	8	3
1h, 70th percentile	-	1.3	3.0	6	8	11	13	6
1h, maximum	120	45.2	22.7	27	35	42	55	38
Annual avg. from 1h avgs.	30	1.7	2.6	5.3	6.7	9.0	10.4	5.5

Table 6-5 Comparisons of O_3 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2019

Statistic O_3	SEPP (AAQ) Objective	Latrobe Valley				Melbourne/Geelong		
		Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell South (EPA)	Traralgon (EPA)	Alphington (EPA)	Dande-nong (EPA)	Point Cook (EPA)
Data capture, 1h avg.	-	72.9%	94.6%	90.9%	92.4%	94.4%	92.9%	73.0%
1h, median	-	25.1	18.5	18	17	17	17	-

Statistic O_3	SEPP (AAQ) Objective	Latrobe Valley				Melbourne/Geelong		
		Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell South (EPA)	Traralgon (EPA)	Alphington (EPA)	Dande-nong (EPA)	Point Cook (EPA)
1h, 70th percentile	-	28.0	22.5	22	21	22	22	-
1h, maximum	100	79.5	72.8	92	89	109	110	-
Annual avg. from 1h avgs.	-	25.6	18.6	17.5	16.5	16.6	17.1	-

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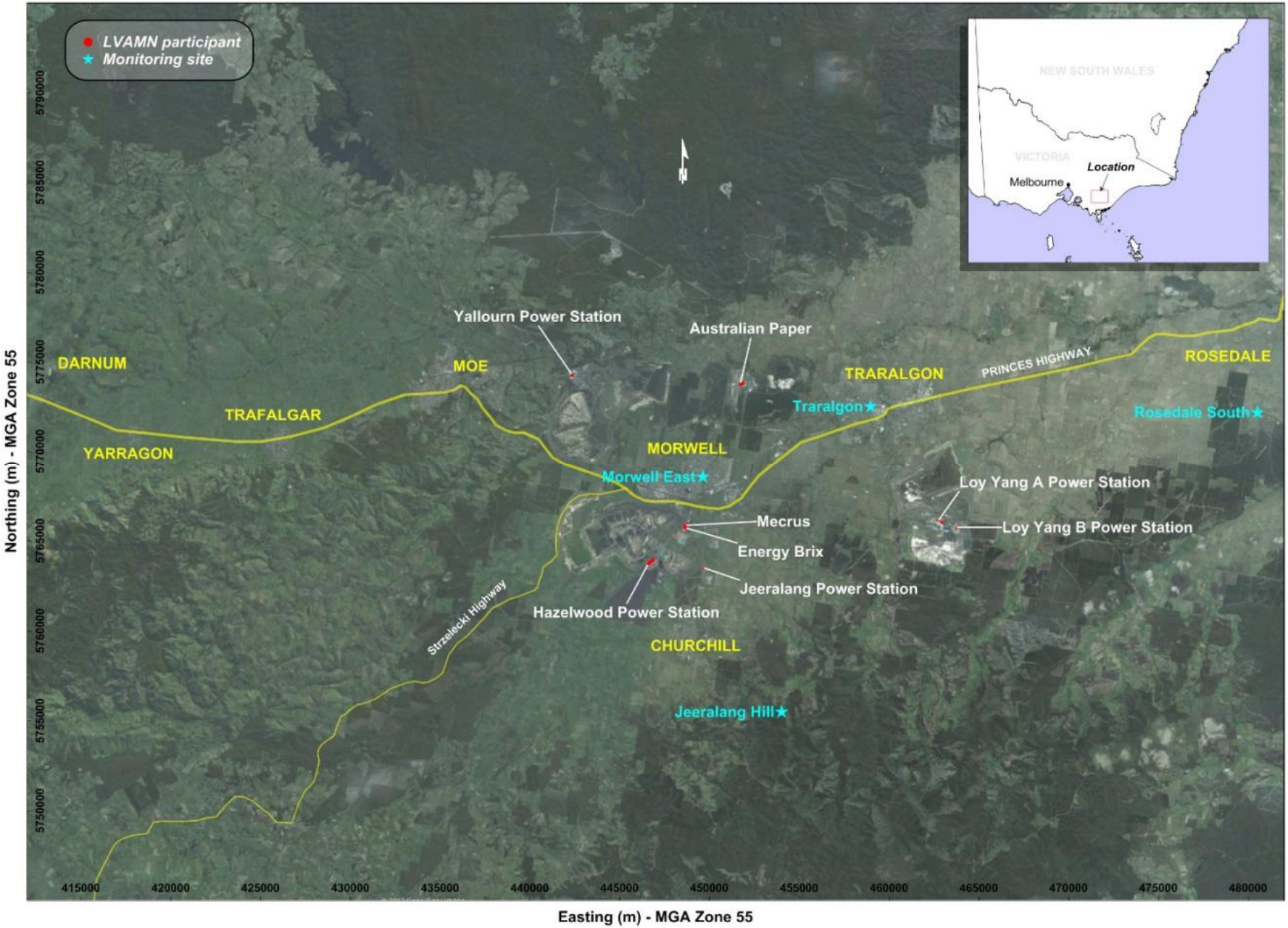
Appendix A. Map of Latrobe Valley


LVAMN participant
Monitoring site
NEW SOUTH WALES
VICTORIA
Location
Melbourne
Yallourn Power Station
Australian Paper
DARNUM
MOE
TRARALGON
PRINCES HIGHWAY
ROSEDALE
TRAFALGAR
Traralgon
Rosedale South
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
Easting (m) - MGA Zone 55
5790000
5785000
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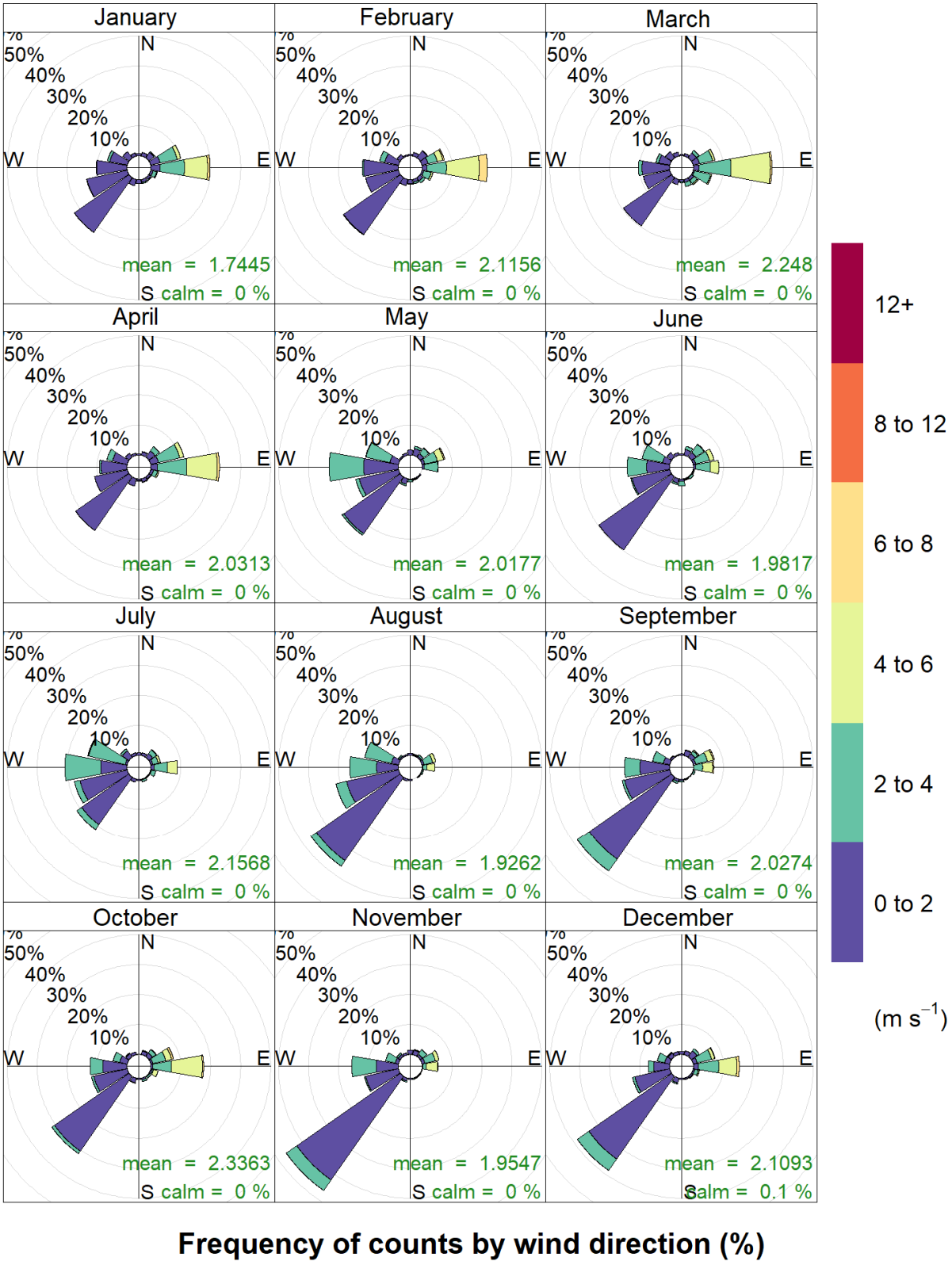
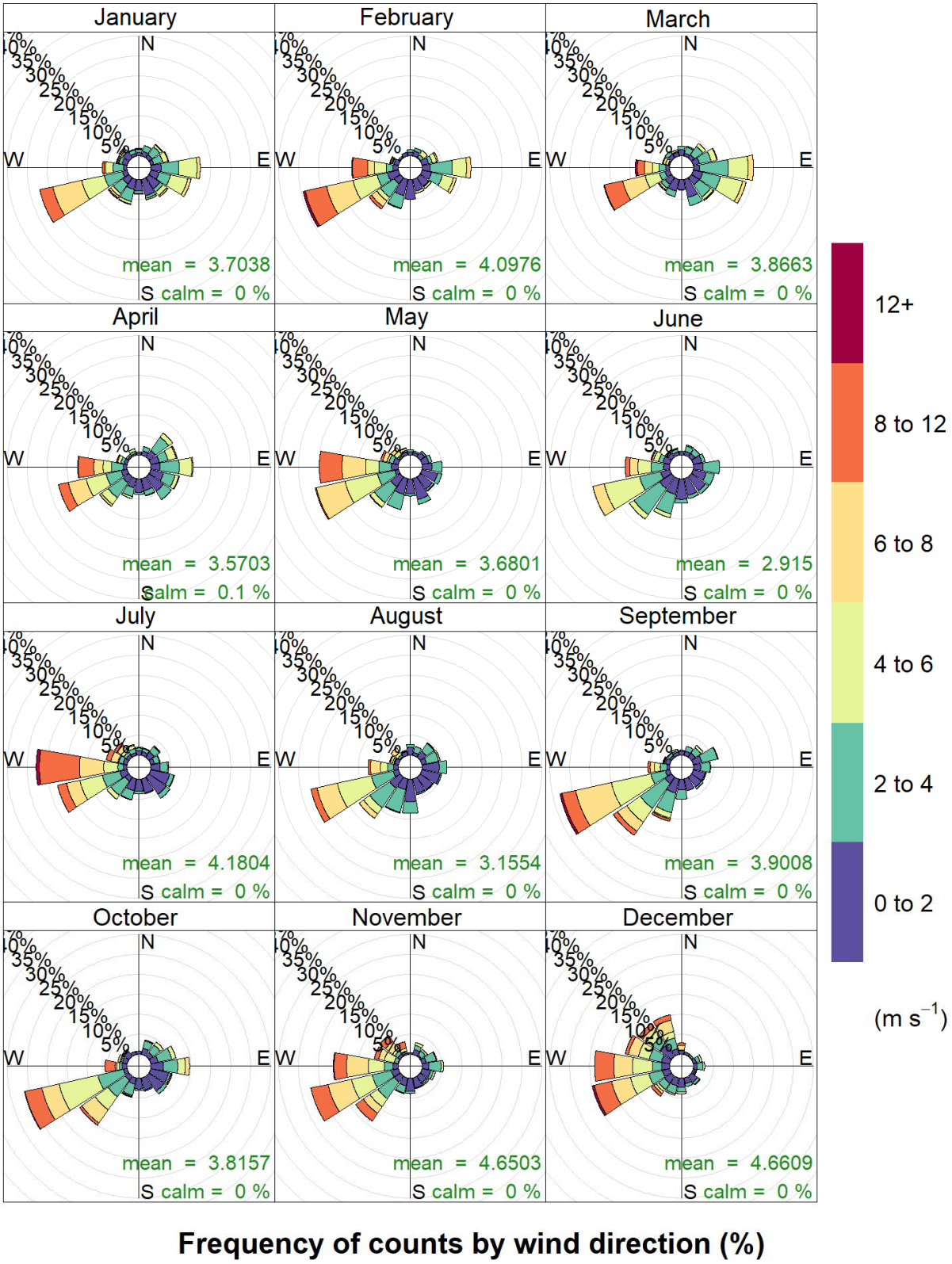
Appendix B. Wind Roses

B.1 Jeeralang Hill Wind Roses



B.2 Rosedale South Wind Roses



Appendix C. 2019 Bushfire Smoke Examples

NASA (2020) examples from: https://worldview.earthdata.nasa.gov, accessed 11 Dec 2020.

C.1 Bushfire Smoke 3 March 2019 (NASA)

C.2 Bushfire Smoke 26 December 2019 (NASA)