Appendix C

Review of Annual Ambient Air Quality Data

Todoroski Air Sciences

TODOROSKI AIR SCIENCES

LAKE MACQUARIE – WYONG

REVIEW OF ANNUAL AMBIENT AIR QUALITY DATA 2016

Delta Electricity & Origin Energy

22 February 2019

Job Number 18120902

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Lake Macquarie – Wyong

Review of Annual Ambient Air Quality Data 2016

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	12/02/2019	I Casasola, K Trahair	D Kjellberg
DRAFT - 002	21/02/2019	K Trahair	D Kjellberg
FINAL - 001	22/02/2019	K Trahair	D Kjellberg

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EXECUTIVE SUMMARY

This report has been prepared by Todoroski Air Sciences for Delta Electricity and Origin Energy and presents ambient air quality monitoring data recorded in the Lake Macquarie - Wyong region for the 2016 calendar year. The results indicate that the air quality was generally good in the Lake Macquarie - Wyong region during 2016.

The data summary (shown below) indicates that the Wallsend and Teralba monitors recorded 24-hour average particulate matter levels above the relevant criteria. The elevated levels occurred on 7 November 2016 and were likely caused by smoke from bushfires near Newcastle. All other data were below the applicable criteria. Further details are provided in the report and the 24-hour average data are provided in the Appendices.

Lake Macquarie - Wyong Air Quality Pictorial Summary – 2016

Short term averages (1-hour and 24-hour)

Long term average (annual)

Lake Macquarie – Wyong Air Quality Tabular Summary - 2016

Site	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2
	Maximum 1-hour average (µg/m³)		Maximum 24-hour average (µg/m³)			Annual average (µg/m³)			
	Air Quality Impact Criteria								
	570	246	50	25*	228	25*	8*	60	62
Wallsend	✓	✓	✗	✗	✓	✓	✓[1]	✓	✓
Wyong	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dora Creek	✓	✓	-	-	✓	-	-	✓	✓
Marks Point	✓	✓	-	-	✓	-	-	✓	✓
Wyee	✓	✓	-	✓	✓	-	✓	✓	✓
Wakefield HVAS	-	-	✓	-	-	✓	-	-	-
Teralba HVAS	-	-	✗	-	-	-	-	-	-

✓ - All data below applicable criteria
✗ - At least one elevated level above applicable criteria
- - Not applicable
HVAS - High Volume Air Sampler
* - Refer to Section 5.1.1
[1] Less than 75% of data were available for the first quarter of the year

1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of Delta Electricity and Origin Energy. It provides a summary and analysis of the available ambient air quality and meteorological data collected in the Lake Macquarie - Wyong region during the 2016 calendar year.

2 PROJECT SCOPE

The following outlines the scope of work for this project.

- Provide an annual summary report for the 2016 calendar year for Lake Macquarie – Wyong. The report will examine compliance with annual average criteria and summarise all of the monthly reported data for the calendar year and include seasonal trends and pollution rose analysis to identify likely source categories for elevated pollution events.
- The report will assess the available data from monitoring stations operated by the NSW Office of Environment and Heritage (OEH) at Wyong and Wallsend, and by industry at Wyee, Marks Point, Dora Creek, Wakefield and Teralba.
- The aim is to provide a simplified report which is accessible and contains results that would be clearly understood by the general public.

3 THE PURPOSE OF AMBIENT MONITORING

It is important to note that the data presented in this report are from both NSW EPA and industry monitoring sites. The NSW EPA and the industry sites collect data for different purposes and this needs to be understood when comparing the data to the criteria.

NSW EPA monitoring sites are specifically designed to measure the likely levels of pollutants that the general population in the area would experience (i.e. an underlying population exposure level), whereas industry monitoring sites are specifically designed to measure maximum levels in a particular location which may be affected by a particular industry.

Data from NSW EPA sites can be compared with national air quality standards. Where the levels measured at NSW EPA monitoring sites are above the national standards on a prolonged and consistent basis, this indicates that some investigation of the potential cause of the issue may be warranted to determine whether any action on a regional level would reduce or better manage the pollutant levels. In the case of PM_{10}, it is noted that the national standards permit five days annually above the criteria to allow for events such as bushfires and dust storms.

Data from industry monitoring sites can be compared with NSW EPA impact assessment criteria. Where the levels measured at industry monitoring sites are above the applicable impact assessment criteria on a prolonged and consistent basis, this indicates that further investigation is warranted to determine the potential cause and what action is required by industry to reduce or better manage the pollutant.

Whether there is any harmful effect on an individual due to an air pollutant will depend on many additional factors, and not just on the measured level of a pollutant. These factors include the total exposure to the pollutant, individual circumstances (age, health, body mass, levels of pollutants at work), levels of other pollutants in the area, and many other factors. Where pollutant levels are below the

criteria generally, harm would not be expected to occur, but it does not follow that harm automatically occurs when pollutant levels are above the criteria.

The criteria serve to highlight potential issues with the levels of pollutants that may warrant more detailed examination. The criteria may also serve to prioritise action in various areas, for example areas with the highest pollutant levels and highest populations or highest exposure would be expected to receive priority action.

3.1 More about air quality

More information about air quality can be found via the following links:

- The Air Quality Index (AQI) was developed by the NSW EPA as an easily understood means of rating the pollutant level relative to its pollutant criteria.
  - https://www.environment.nsw.gov.au/topics/air/understanding-air-quality-data/air-quality-index
- Aqicn.org provides a near real-time AQI values for monitoring locations around the world. It should be noted that the AQI presented on this website is calculated differently to the NSW EPA AQI and is less stringent than those used in Australia, thus a direct comparison may not be valid.
  - http://aqicn.org/map/world/
- The NSW OEH website air quality page provides hourly updates of the AQI and data readings from the NSW EPA monitoring sites, and can provide daily forecasts for Sydney and alerts for elevated levels at Wallsend and Wyong, for example. The web tool also presents near real-time wind and pollutant data readings overlaid on regional maps for the Upper Hunter and Newcastle.
  - http://www.environment.nsw.gov.au/aqms/aqi.htm
- The Lower Hunter Particle Characterisation Study was commissioned to determine the composition of particulate samples collected at monitoring sites at Beresfield, Newcastle, Stockton and Mayfield, and to identify the potential major sources of fine particulates in Newcastle and the Lower Hunter.
  - https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/lower-hunter-particle-characterisation-study-final-report-160243.pdf
- The Air Emissions in My Community web tool presents the estimated emission quantities of various substances and their sources by postcode (and larger) sized areas in an easy to use graphical interface. This is one of the best inventories of emissions that is available, but it is important to appreciate that it cannot include all sources of emissions. It is important to also understand that pollutant emissions are not the same as the pollutant levels that this report presents. Emissions in a given area are one of several important factors that affect pollutant levels in an area, for example the dispersion of the emissions in the atmosphere and how the emissions are released are critical in determining the air quality pollutant levels.
  - https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-my-community/air-emissions-in-my-community-tool

- The NSW Health website provides information on how air pollution affects health and steps for reducing your air pollution and limiting your exposure.
  - http://www.health.nsw.gov.au/environment/air/Pages/default.aspx

4 AIR QUALITY MONITORING SITES

Figure 4-1 and **Table 4-1** summarise the locations and recorded parameters of the monitoring sites in the Lake Macquarie - Wyong region in 2016.

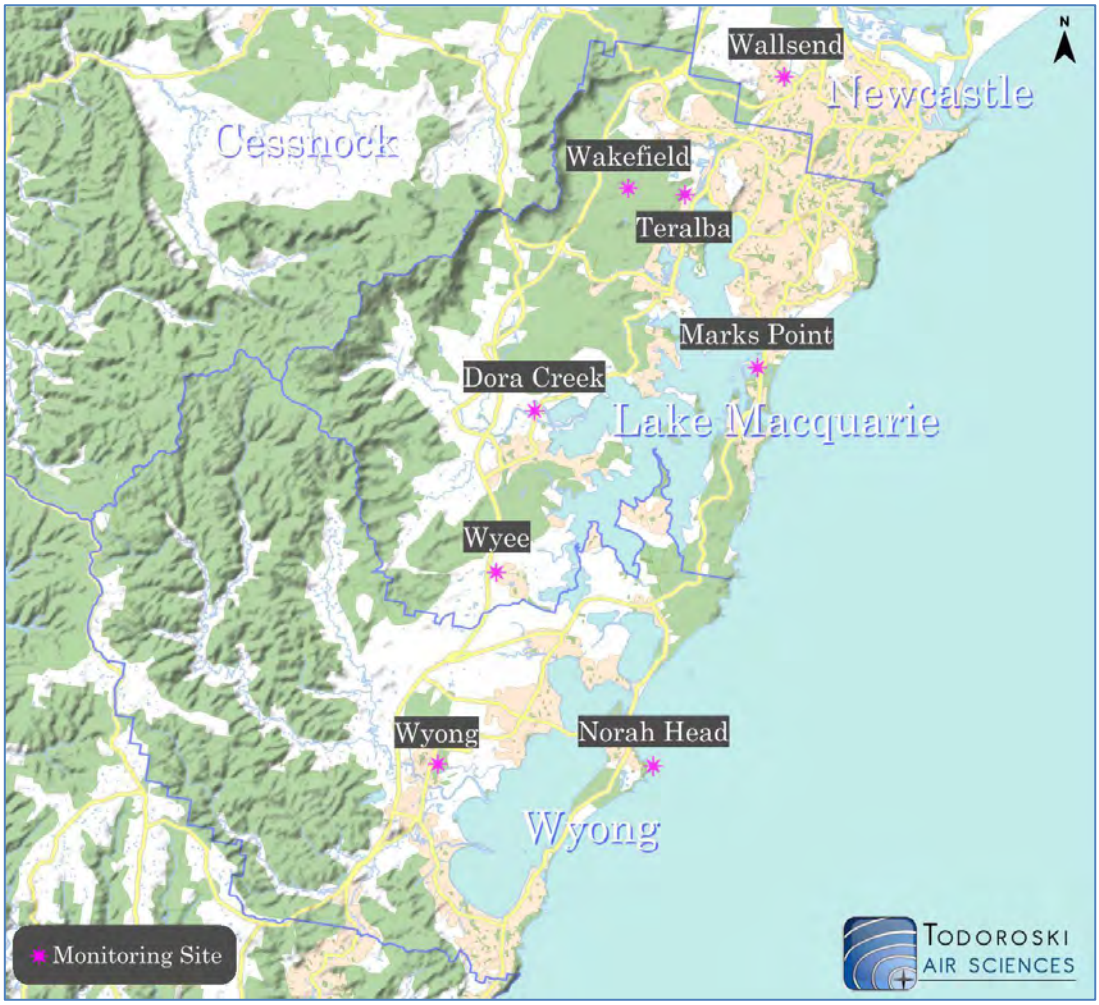

Figure 4-1: Monitoring site locations

Table 4-1: Monitoring sites

Monitoring Station	Type	Recorded Parameters	Recording Periods
Wallsend	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Wyong	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Marks Point	Industry site	NO_2, SO_2, WS, WD	Hourly
Wyee	Industry site	$PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly
Dora Creek	Industry site	NO_2, SO_2, WS, WD	Hourly
Norah Head	BOM weather station	WS, WD	Hourly
Wakefield HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day
Teralba HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day

PM_{10} - Particulate matter < 10µm
$PM_{2.5}$ - Particulate matter < 2.5µm
TEOM - Tapered Element Oscillating Microbalance (which samples air continuously)
NO_2 - Nitrogen dioxide
SO_2 - Sulfur dioxide
HVAS - High volume air sampler (which samples for a 24-hour period every 6 days)
WS - Wind speed
WD - Wind direction
BOM - Bureau of Meteorology

5 AIR QUALITY CRITERIA

The sections below identify the key pollutants currently being monitored at the Lake Macquarie - Wyong air quality monitoring sites and the applicable air quality criteria.

5.1 Particulate matter

Particulate matter consists of particles of varying size and composition. The total mass of all particles suspended in air is defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

The TSP is defined further into two sub-components. They are PM_{10} particles, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

Table 5-1 summarises the air quality goals that are relevant to particulate pollutants as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW EPA, 2017**).

Table 5-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Criterion
Total suspended particulates (TSP)	Annual	90µg/m^3
Particulate Matter < 10µm (PM_{10})	Annual	25µg/m^3
	24-hour	50µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual	8µg/m^3
	24-hour	25µg/m^3

Source: **NSW EPA, 2017**

5.1.1 Particulate criteria updates

The National Environment Protection (Ambient Air Quality) Measure (NEPM) was updated in March 2016 (**NEPC, 2016**). The advisory reporting standards for $PM_{2.5}$ were changed to standards and the annual average PM_{10} standard was changed from 30µg/m^3 to 25µg/m^3. In January 2017 the NSW EPA adopted the updated NEPM standards as impact assessment criteria.

5.2 Other air pollutants

Nitrogen dioxide (NO_2) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called nitrogen oxides (NO_x). These gases form when fuel is burned at high temperatures, and mainly originates from motor vehicles, power generators and industrial boilers (**USEPA, 2013**). NO_x may also be generated by blasting activities. It is important to note that when formed, NO_2 is generally a small fraction of the total NO_x generated.

Sulfur dioxide (SO_2) is a colourless gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulfur content of the fuel. SO_2 can have impacts upon human health and the habitability of the environment for flora and fauna. SO_2 emissions are a precursor to acid rain, which can be an issue in the northern hemisphere; however it is not known to be an issue in NSW.

Table 5-2 summarises the air quality goals for NO_2 and SO_2.

Table 5-2: Air quality impact assessment criteria for air pollutants

Pollutant	Averaging period	Criterion
Nitrogen Dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Sulfur Dioxide (SO_2)	10-minute	712µg/m^3
	1-hour	570µg/m^3
	24-hour	228µg/m^3
	Annual	60µg/m^3

Source: **NSW DEC, 2005**

5.3 Summary of applicable criteria for this review

The particulate and gaseous pollutants monitored in the Lake Macquarie – Wyong region have air quality criteria which are averaged over short and long time periods.

As this report looks at an annual period of ambient air quality data, the annual average criteria are applicable along with those averaged over the shorter time periods (1-hour and 24-hours). The SO_2 10-minute average criterion was not included as 10-minute monitoring data are not available.

Table 5-3 summarises the applicable air quality criteria for this review.

Table 5-3: Air quality criteria used in this review

Pollutant	Averaging Period	Concentration
Particulate Matter < 10µm (PM_{10})	24-hour	50µg/m^3
	Annual	25µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m^3
	Annual	8µg/m^3
Nitrogen Dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Sulfur Dioxide (SO_2)	1-hour	570µg/m^3
	24-hour	228µg/m^3
	Annual	60µg/m^3

6 METEOROLOGICAL MONITORING DATA

Representative wind speed and direction data have been obtained from the Lake Macquarie - Wyong meteorological stations. The data are presented as a series windroses.

For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

Figure 6-1 presents the 2016 annual windroses for Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong. Seasonal windroses for the meteorological stations are presented in **Figure 6-2** and **Figure 6-3**.

The annual windroses show that the meteorological stations recorded winds which varied depending on the local influence of environmental features such as terrain, vegetation and buildings.

The meteorological stations generally recorded winds which originated from the north-westerly quadrant during spring and winter. The recorded wind directions in summer and autumn were more varied, with low wind speeds common at Wyong, Wyee and Dora Creek.

The Norah Head weather station recorded wind speeds which were generally higher than those recorded at the other stations. This is expected as the Norah Head weather station is located in an unsheltered coastal location that would be largely influenced by sea breezes.

There is a lack of data recorded for wind directions from the north, approximately between 350^{o} and 10^{o} at the Wyee meteorological station. This is a historically common, and inherent limitation of some weather sensors that cannot physically measure a segment of the 360 degrees of possible wind directions, (almost always the north segment), but it may also be a software or signal processing issue, and it is recommended that the issue be investigated further and rectified.

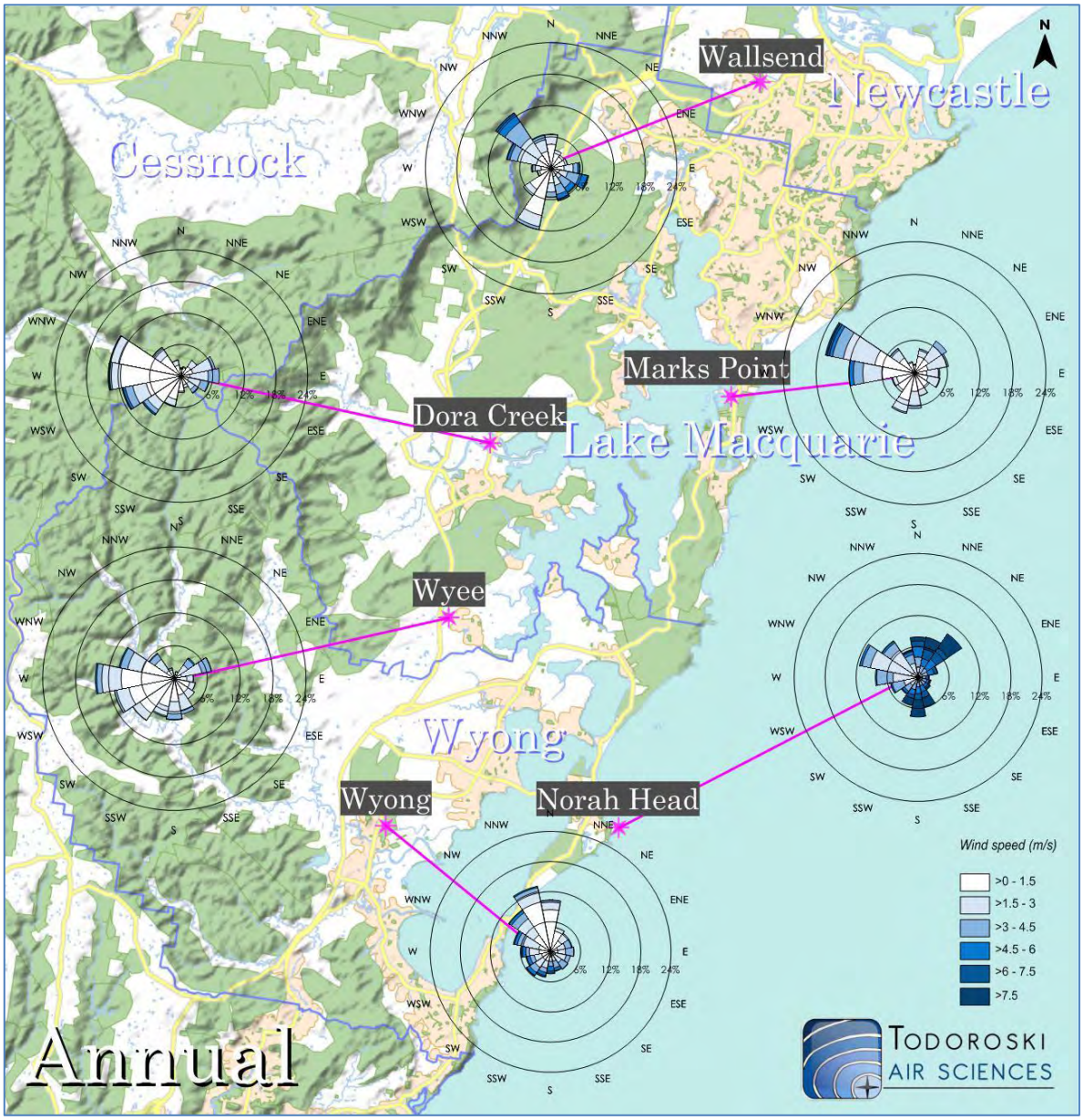

Figure 6-1: Annual 2016 windroses - Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong

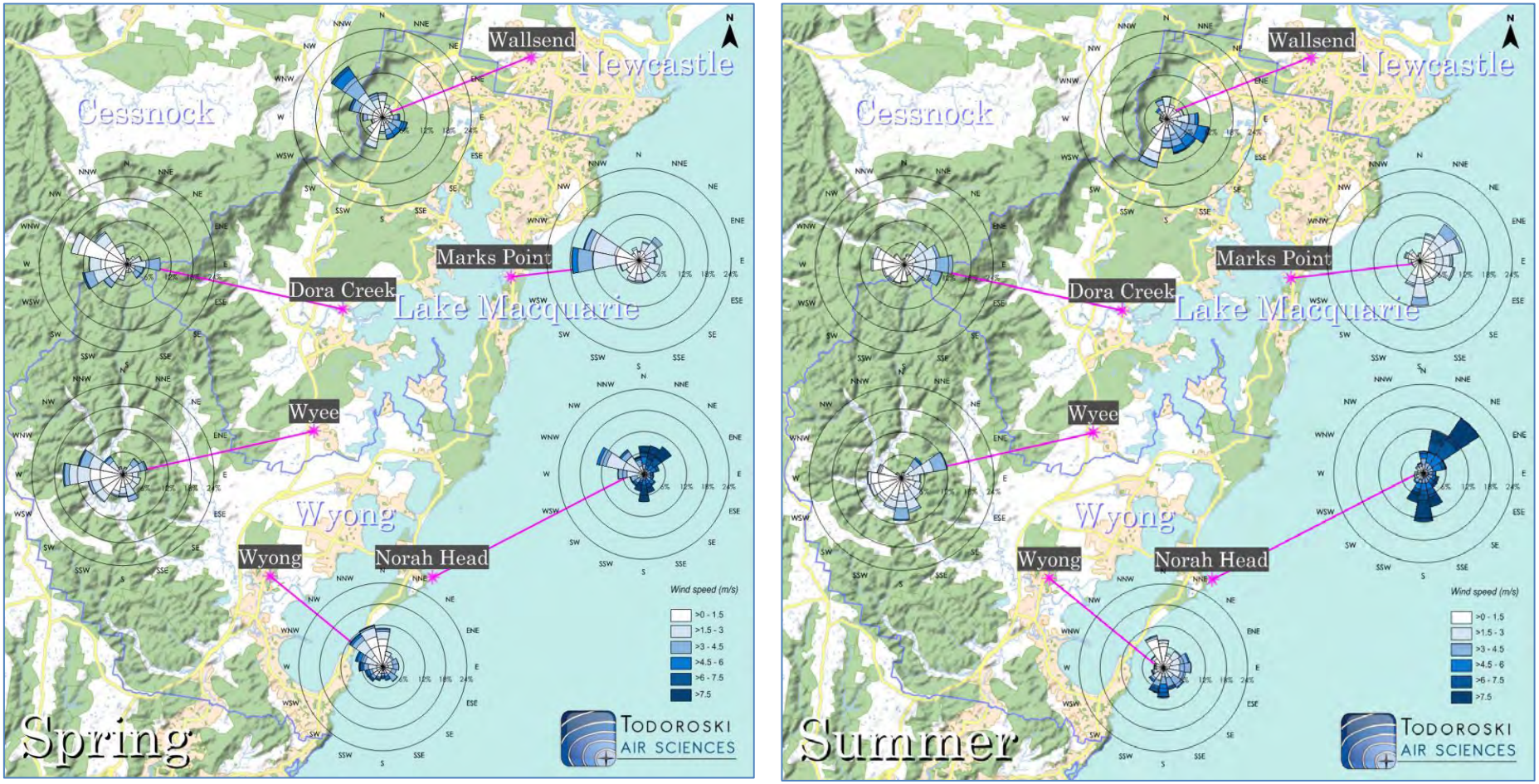

Figure 6-2: Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong windroses – Spring 2016 (left) and Summer 2016 (right)

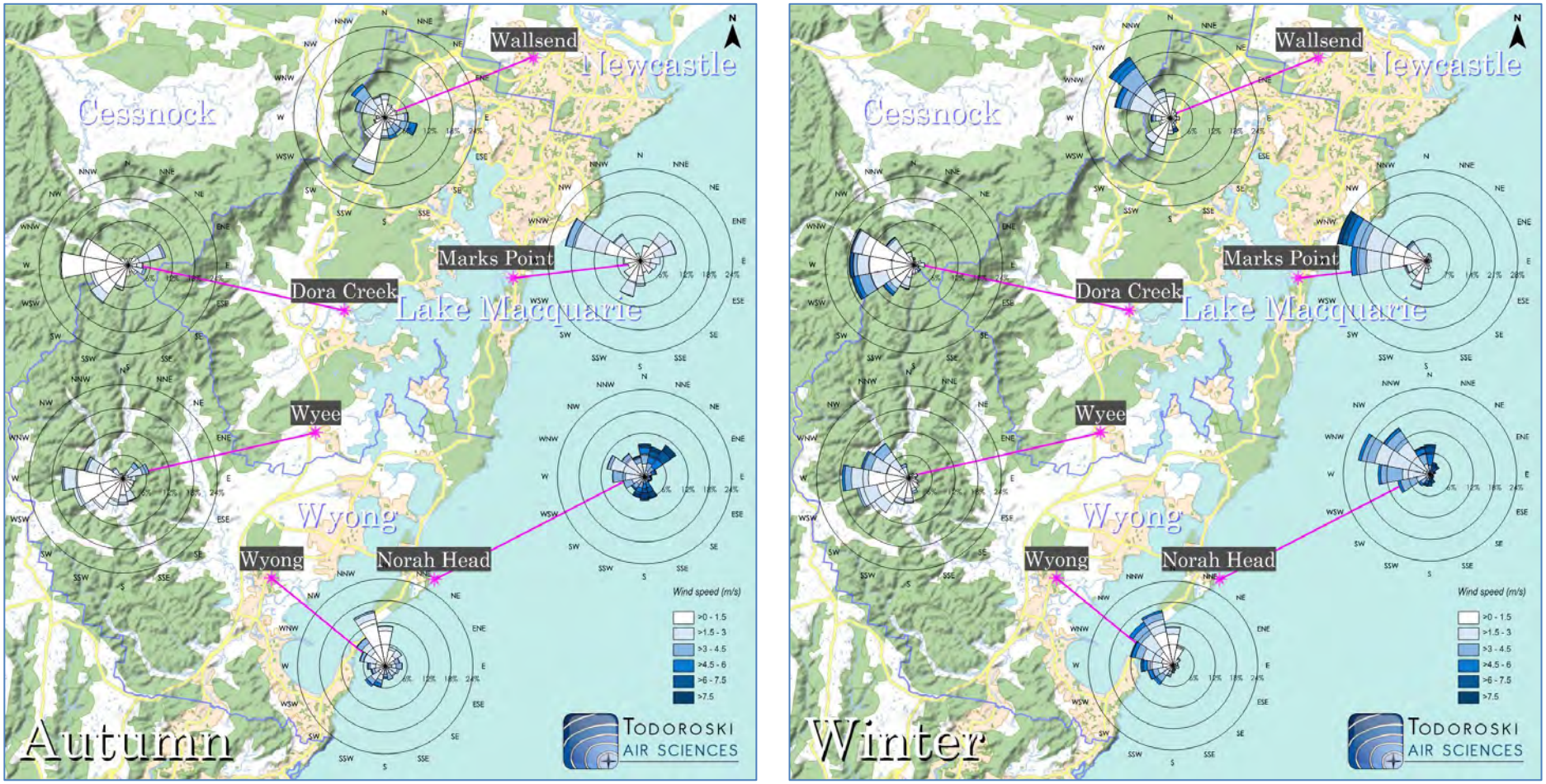

Figure 6-3: Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong windroses – Autumn 2016 (left) and Winter 2016 (right)

7 AMBIENT AIR QUALITY MONITORING DATA

7.1 Preamble

The monitoring data in this report are presented in raw form as provided to Todoroski Air Sciences by Delta Electricity and Origin Energy, or is available publically on industry and EPA websites.

The 24-hour average data presented in this report have been averaged using the 1-hour average readings. Days which contain less than 75% data (less than 18 hours of 1-hour average data) have not been included in this report.

The annual average data presented in this report have been averaged using the 1-hour average readings for SO_2 and NO_2, and 24-hour average readings for PM_{10} and $PM_{2.5}$. Annual averages with less than 75% data in a calendar quarter have been included but have not been assessed.

All of the monitoring data provided to, and obtained by Todoroski Air Sciences are presented in this report. The data are shown in the results and Appendices as relevant. 1-hour, 24-hour and annual average data are presented in a graphical format in **Appendix B** and 24-hour average data are presented in tabulated format in **Appendix C** for pollutants with applicable 24-hour average criteria.

Hourly averaged pollutant monitoring data were combined with wind speed and direction data to provide an understanding of the conditions in which high pollutant levels most frequently occur. The data are presented as pollution roses in **Appendix B**. For an example pollution rose, refer to **Figure A-2** in **Appendix A**.

7.2 Analysis of Monitoring Data

Table 7-1 presents a summary of the pollutant levels measured during 2016. The results indicate that pollutant levels were below the applicable criteria for all monitors, except for the Wallsend and the Teralba monitors.

Table 7-1: Maximum and annual average pollutant levels - 2016

Site	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2
	Maximum 1-hour average (µg/m³)		Maximum 24-hour average (µg/m³)			Annual average (µg/m³)			
	Air Quality Impact Criteria								
	570	246	50	25*	228	25*	8*	60	62
Wallsend	108.5	75.9	**65.5**	**50.7**	16.1	16.6	8.0[1]	3.2	14.8
Wyong	91.4	94.4	46.0	19.8	12.2	15.2	5.7	1.5	9.7
Dora Creek	168.5	53.5	-	-	22.2	-	-	3.8	9.8
Marks Point	86.2	74.1	-	-	11.9	-	-	2.7	9.8
Wyee	139.0	73.5	-	21.1	24.6	-	6.5	2.7	15.8
Wakefield HVAS	-	-	33.0	-	-	10.7	-	-	-
Teralba HVAS	-	-	**55.0**	-	-	14.0	-	-	-

* refer to Section 5.1.1

[1]Less than 75% of data were available for the first quarter of the year

- Not applicable

7.3 PM_{10}

Figure 7-1 presents all of the 24-hour average PM_{10} monitoring results recorded in the Lake Macquarie - Wyong region in 2016.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, PM_{10} levels were generally very good or good at all monitors in 2016. The Wyong and Wallsend monitors recorded fair levels on four days. The Wallsend monitor recorded poor levels on one day in 2016.

All 24-hour average and annual average data recorded at the Lake Macquarie - Wyong monitoring sites were below the applicable PM_{10} criteria in 2016, except on 7 November, 2016, where elevated 24-hour average PM_{10} levels were measured at Wallsend and Teralba.

Figure B-1 to **Figure B-2** in **Appendix B** present the 1-hour average, 24-hour average and annual average PM_{10} data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM_{10} levels and these 1-hour results are not intended to be compared with the PM_{10} criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM_{10} levels will fluctuate more significantly than 24-hour average PM_{10} levels.

Figure B-3 presents pollution roses of the PM_{10} monitoring data collected by the Wallsend and Wyong monitoring sites in 2016.

7.4 $PM_{2.5}$

Figure 7-2 presents all of the 24-hour average $PM_{2.5}$ monitoring data recorded in the Lake Macquarie - Wyong region in 2016.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate that $PM_{2.5}$ levels were generally very good to good in 2016. The Wallsend monitor recorded six days with

fair levels and one day of hazardous levels, the Wyong monitor recorded one day with fair levels and the Wyee monitor recorded two days with fair levels.

All 24-hour average and annual average data recorded at the Lake Macquarie - Wyong monitoring sites were below the applicable $PM_{2.5}$ criteria in 2016 except at Wallsend on 7 November 2016, where high $PM_{2.5}$ levels were measured.

Figure B-4 to **Figure B-6** in **Appendix B** present the 1-hour average, 24-hour average and annual average $PM_{2.5}$ data in graphical form for each individual site. There is no criterion that applies to 1-hour average $PM_{2.5}$ levels and these 1-hour results are not intended to be compared with the $PM_{2.5}$ advisory reporting standard. It is a normal occurrence, and it is expected that in the normal environment 1-hour average $PM_{2.5}$ levels will fluctuate more significantly than 24-hour average $PM_{2.5}$ levels.

We note that the monitoring sites recorded on occasion periods in which $PM_{2.5}$ levels were less than zero. In some situations the concentration of the pollutant being measured may be very close to zero, in which case the measured value (after adjusting for drift of zero and span and any other corrections) may be less than the measurement limit of detection (**NEPC, 2001**), and in these circumstances the output may be negative.

The monitors may also record short term positive or negative values due to instrument faults, the presence of moisture within the instrument or volatile matter (which can register as a solid mass at first, but then evaporates, registering negative mass at a later time).

Figure B-7 to **Figure B-8** present pollution roses of the $PM_{2.5}$ monitoring data collected by the Wallsend, Wyong and Wyee monitoring sites in 2016.

7.5 NO_2

Figure 7-3 presents the 1-hour average NO_2 monitoring data recorded in the Lake Macquarie - Wyong region in 2016.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the measured levels of NO_2 were very good at all monitors at all times with the exception of the Wyong monitor which recorded two hours with good levels. All 1-hour average and annual average data were below the applicable criteria in 2016.

Figure B-9 to **Figure B-11** present pollution roses of the NO_2 monitoring data collected by the monitoring sites in 2016.

7.6 SO_2

Figure 7-4 and **Figure 7-5** present the 1-hour average and 24-hour average SO_2 monitoring data recorded in the Lake Macquarie - Wyong region in 2016 respectively.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the SO_2 levels were very good at all monitors at all times. All 1-hour average and annual average data were below the applicable criteria in 2016.

Figure B-12 to **Figure B-14** present pollution roses of the SO_2 monitoring data collected by the monitoring sites in 2016.

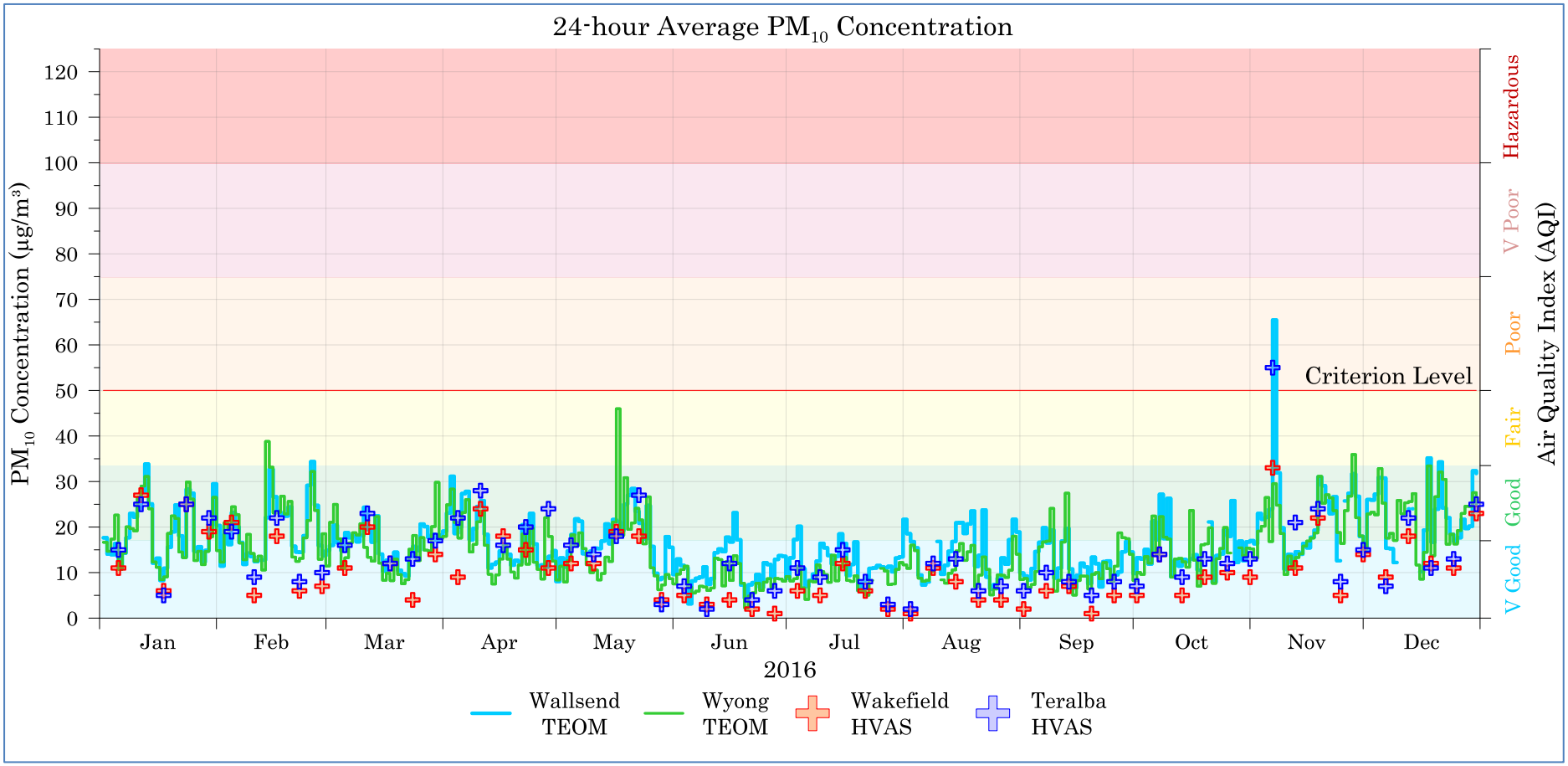

Figure 7-1: Lake Macquarie - Wyong 24-hour average PM_{10} levels – 2016

The recorded PM_{10} levels were generally very good or good at all monitors in 2016. The Wyong and Wallsend monitors each recorded fair levels on four days and the Wallsend monitor recorded poor levels on one day in 2016. All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average criterion of 50µg/m³, except for 7 November, 2016, where elevated levels were measured at the Wallsend and Teralba monitoring sites.

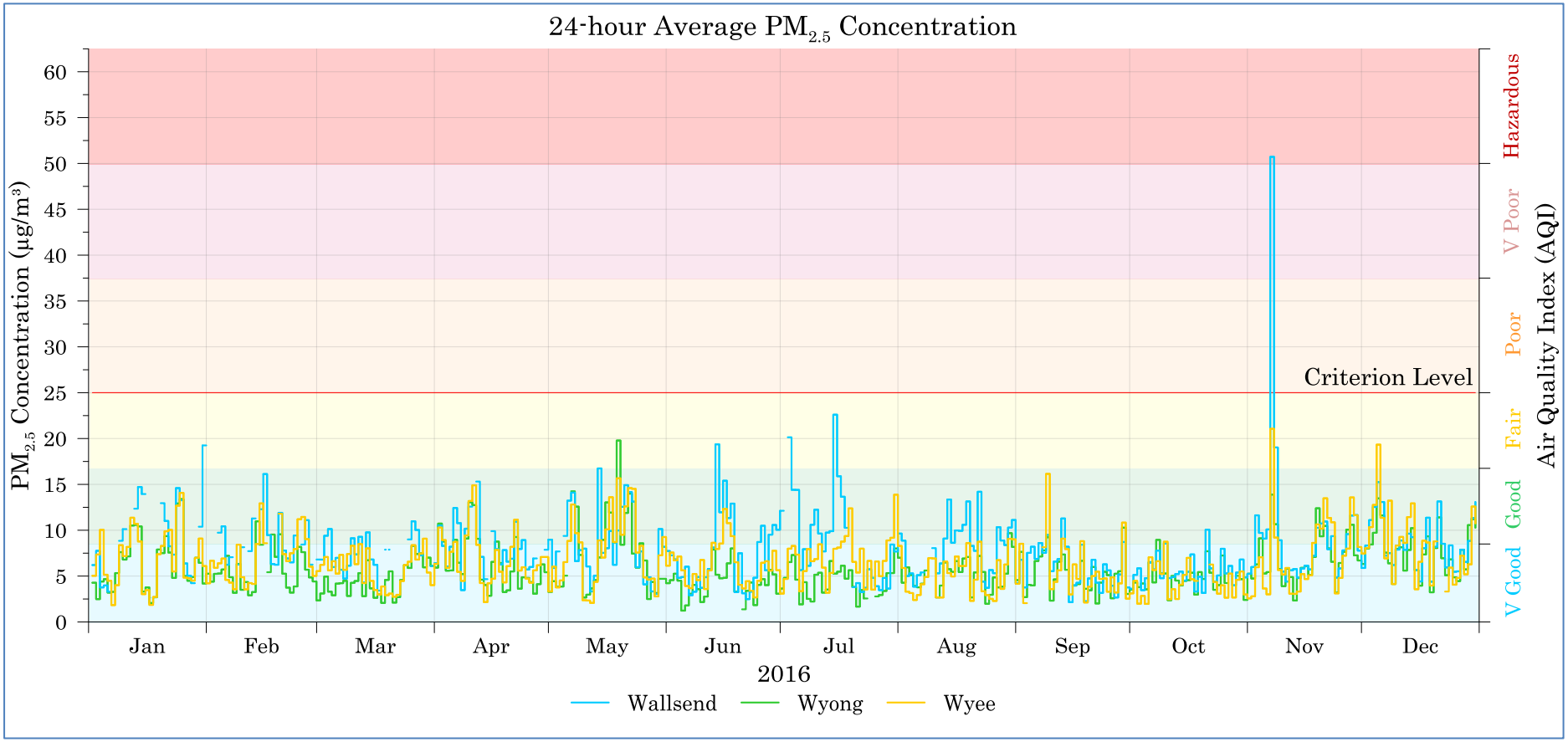

Figure 7-2: Lake Macquarie - Wyong 24-hour average $PM_{2.5}$ levels – 2016

The recorded $PM_{2.5}$ levels were generally very good to good in 2016. The Wallsend monitor recorded six days with fair levels and one day of hazardous levels, the Wyong monitor recorded one day with fair levels and the Wyee monitor recorded two days with fair levels. All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average $PM_{2.5}$ criterion of 25µg/m^3 except for Wallsend on 7 November 2016 where high $PM_{2.5}$ levels were measured.

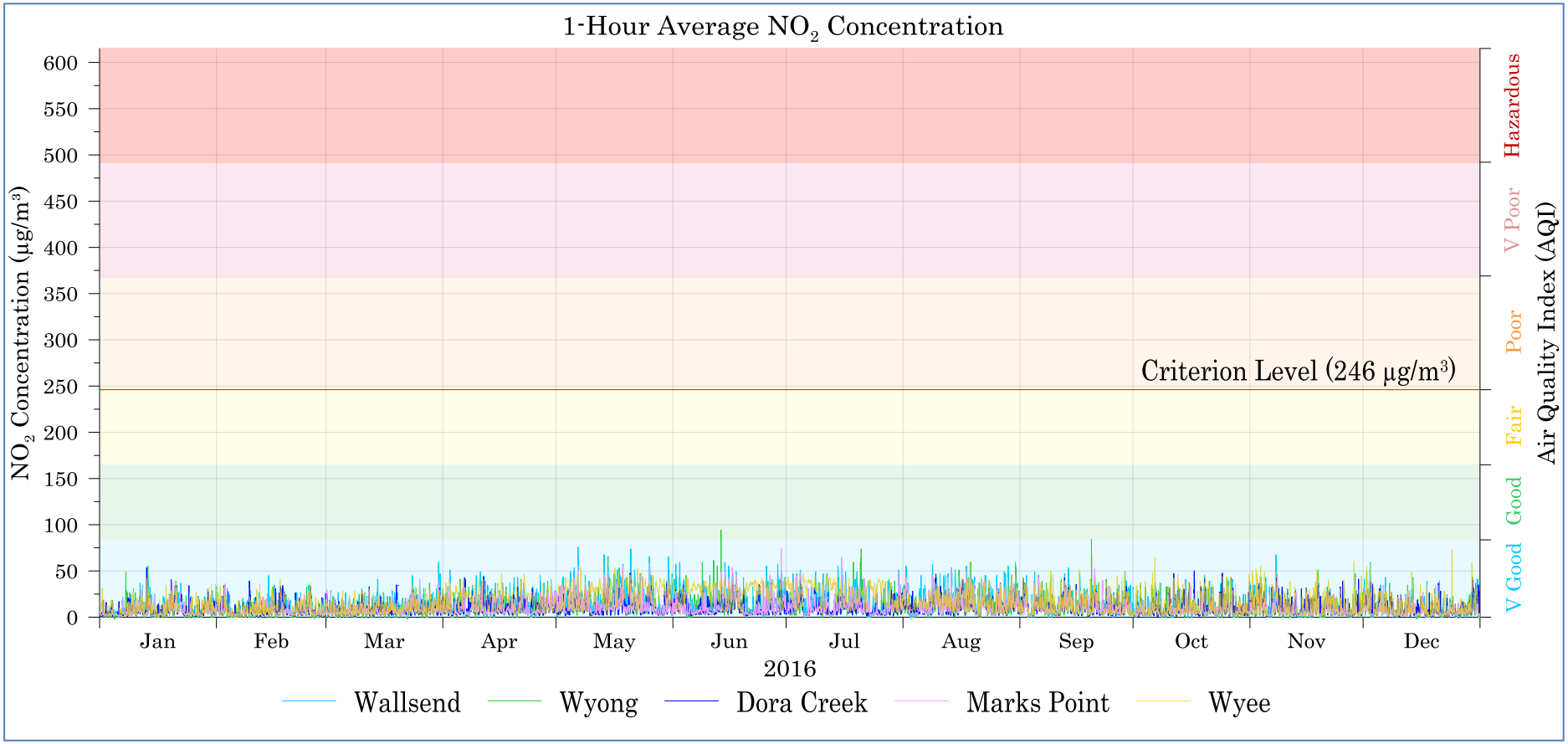

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2016

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average NO_2 criterion level of 246µg/m^3 in 2016. Measured levels of NO_2 were very good at all monitors at all times with the exception of the Wyong monitor which recorded two hours with good levels.

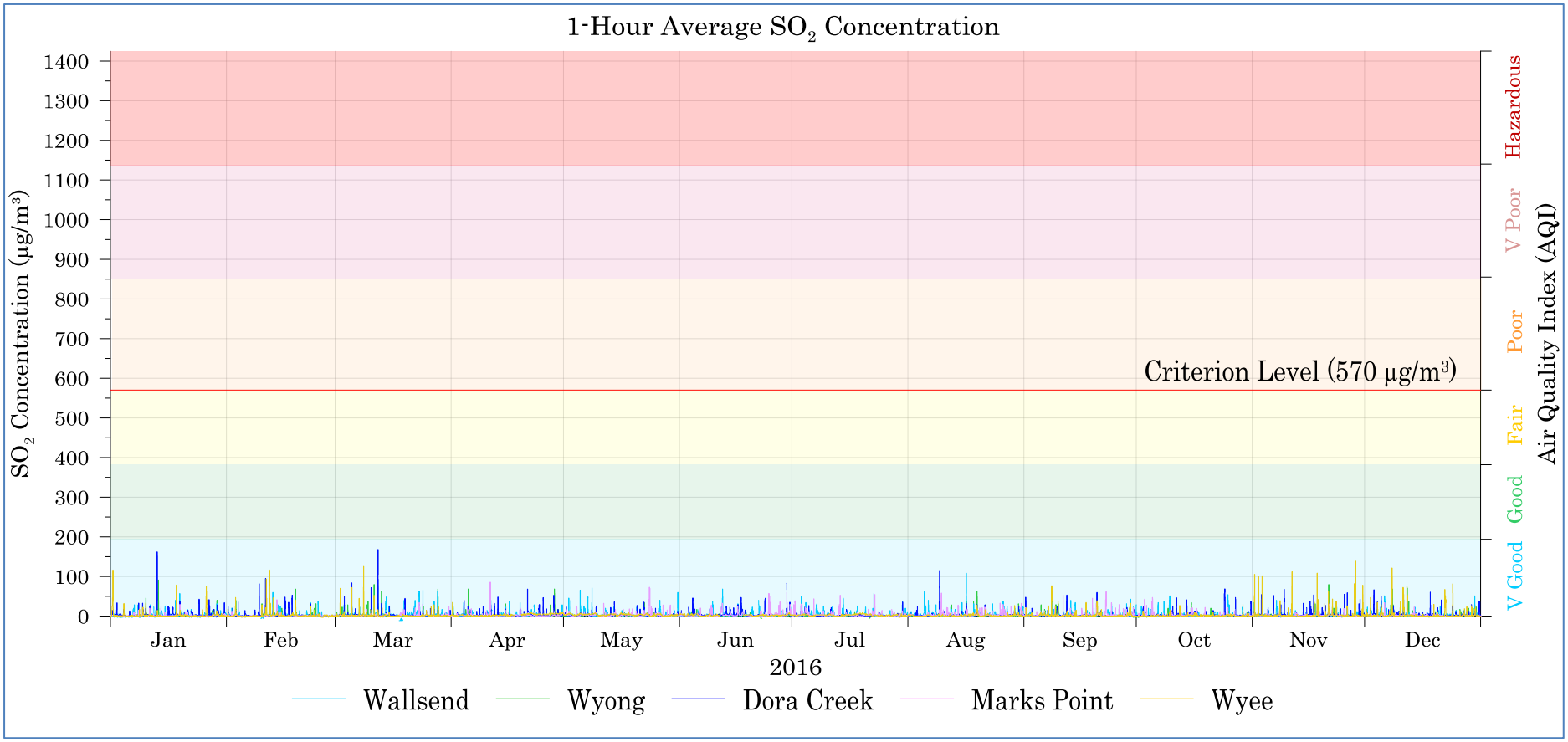

Figure 7-4: Lake Macquarie - Wyong 1-hour average SO_2 levels – 2016

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average SO_2 criterion level of 570µg/m^3 in 2016. Measured levels of SO_2 were very good at all monitors at all times.

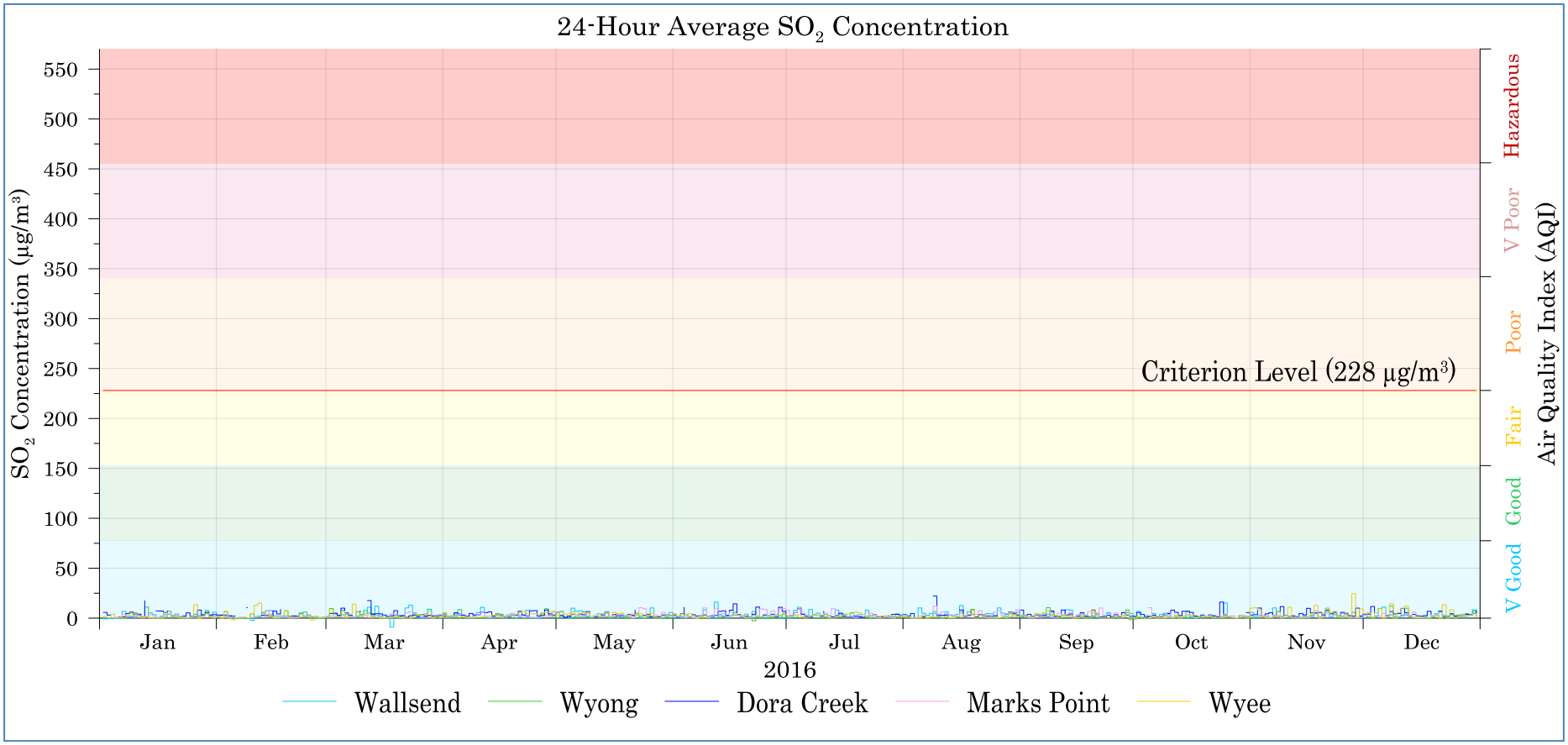

Figure 7-5: Lake Macquarie - Wyong 24-hour average SO_2 levels – 2016

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average SO_2 criterion level of 228µg/m^3 in 2016. Measured levels of SO_2 were very good at all monitors at all times.

8 ANALYSIS OF ELEVATED POLLUTANT LEVELS

There were elevated levels above the applicable 24 hour average criteria on 7 November 2016, these included:

- 24-hour average PM_{10} and $PM_{2.5}$ levels of 65.5µg/m^3 and 50.7µg/m^3, respectively, recorded at the Wallsend monitor; and,
- 24-hour average PM_{10} levels of 55µg/m^3 at the Teralba monitor.

Figure 8-1 presents satellite imagery of the Lake Macquarie-Wyong region on 7 November 2016 at 3:22pm. The figure shows a visible smoke plume originating from a bushfire to the north of Newcastle. A review of NASA satellite imagery indicated that the bushfire activity began on 4 November 2016 and continued until 7 November 2016.

Figure 8-2 shows the wind speed, wind direction and particulate matter concentrations on 7 November 2016 at the Wallsend monitor. The data presented in the figure show that the Wallsend monitor recorded elevated PM_{10} and $PM_{2.5}$ levels from approximately 9:00pm when wind the winds blew from the bushfire towards the monitors. Wind speeds were also low at this time. Both the Wallsend and Teralba monitoring stations would likely to have been impacted by the smoke plume.

It is therefore highly likely that the Wallsend and Teralba monitors were primarily impacted by bushfire smoke on 7 November 2016.

Source: **NASA, 2019**

Figure 8-1: Satellite imagery showing smoke plume from bushfires on 7 November 2016

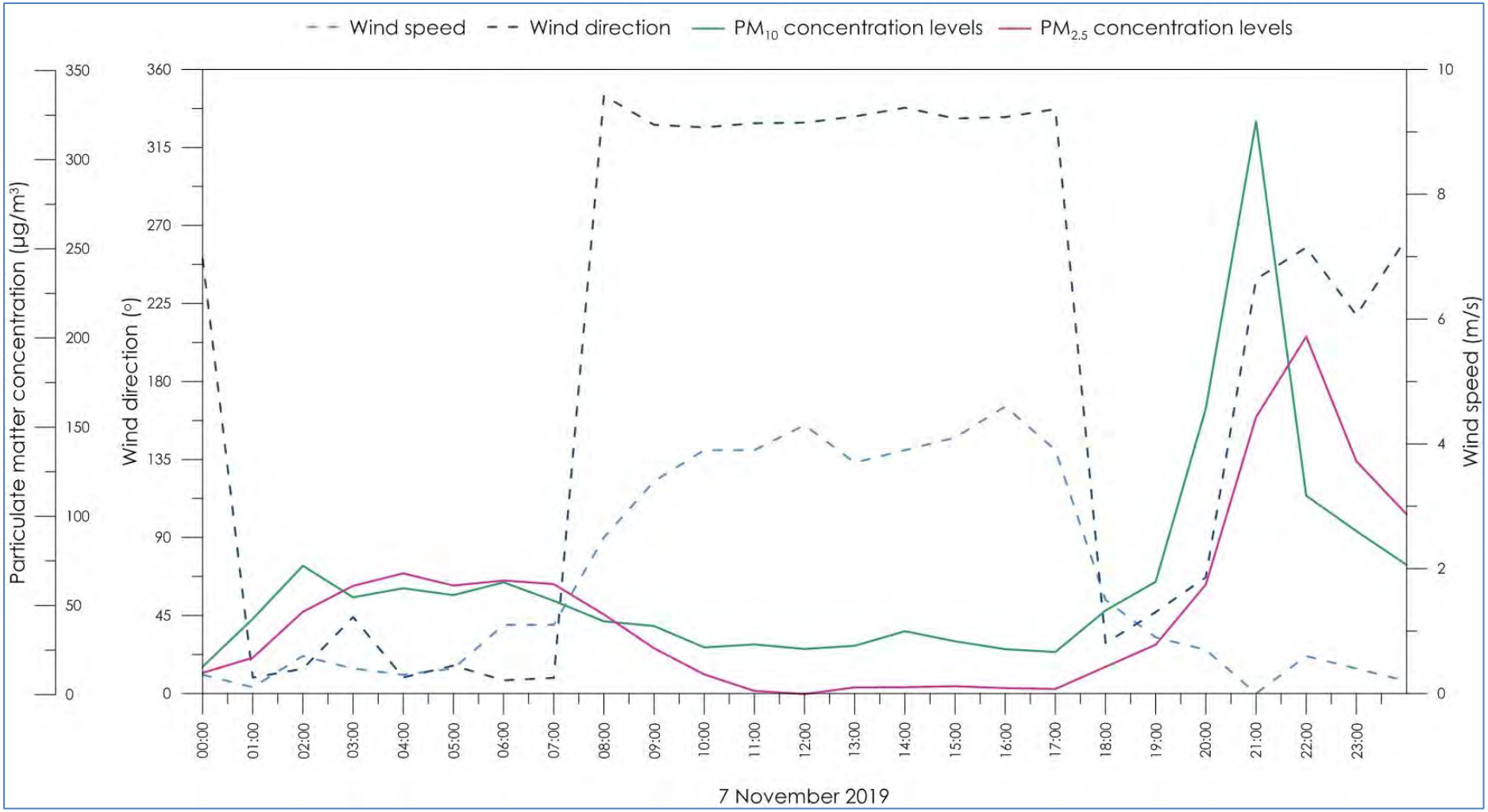

Figure 8-2: Analysis of Wallsend monitoring data on 7 November 2016

9 CONCLUSIONS

The results indicate that the monitoring stations recorded good air quality in 2016.

The Wallsend and Teralba monitors recorded elevated particulate matter levels above the relevant criteria on 7 November 2016, likely due to bushfire smoke.

Relative to the Air Quality Index:

- The measured PM_{10} levels were very good or good. The Wyong and Wallsend monitors recorded fair levels on four days. The Wallsend monitor recorded poor levels on one day in 2016;
- The measured levels of $PM_{2.5}$ were generally very good or good. The Wallsend monitor recorded six days with fair levels, the Wyong monitor recorded one day with fair levels and the Wyee monitor recorded two days with fair levels;
- The measured levels of NO_2 were very good at all monitors at all times with the exception of the Wyong monitor, which recorded two hours with good levels; and;
- The measured levels of SO_2 were very good at all monitors at all times.

On this basis it can be concluded that the air quality in the Lake Macquarie - Wyong region was generally good in 2016.

10 REFERENCES

NASA (2019)

NASA Worldview Alpha website.
https://earthdata.nasa.gov/labs/worldview/, accessed 16 January 2019

NEPC (2001)

"National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 5 Data Collection and Handling", National Environment Protection Council, May 2001.

NEPC (2016)

"National Environment Protection (Ambient Air Quality) Measure", National Environment Protection Council, March 2016.

NSW EPA (2017)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, January 2017.

USEPA (2013)

Health Effects of Pollution, United States Environmental Protection Agency website. <http://www.epa.gov/region07/air/quality/health.htm>, accessed May 2013.

Appendix A

How to read a windrose

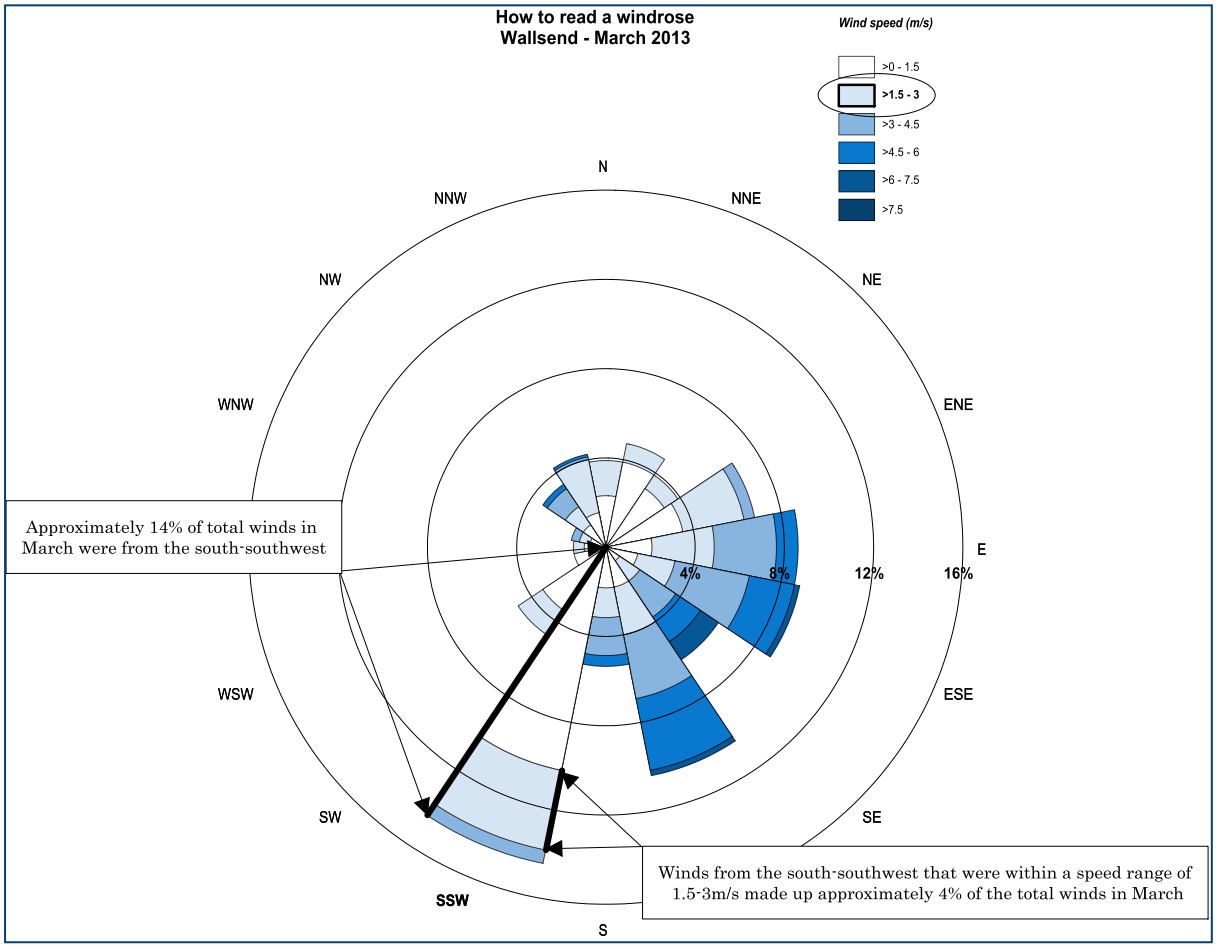

Figure A-1: How to read a windrose

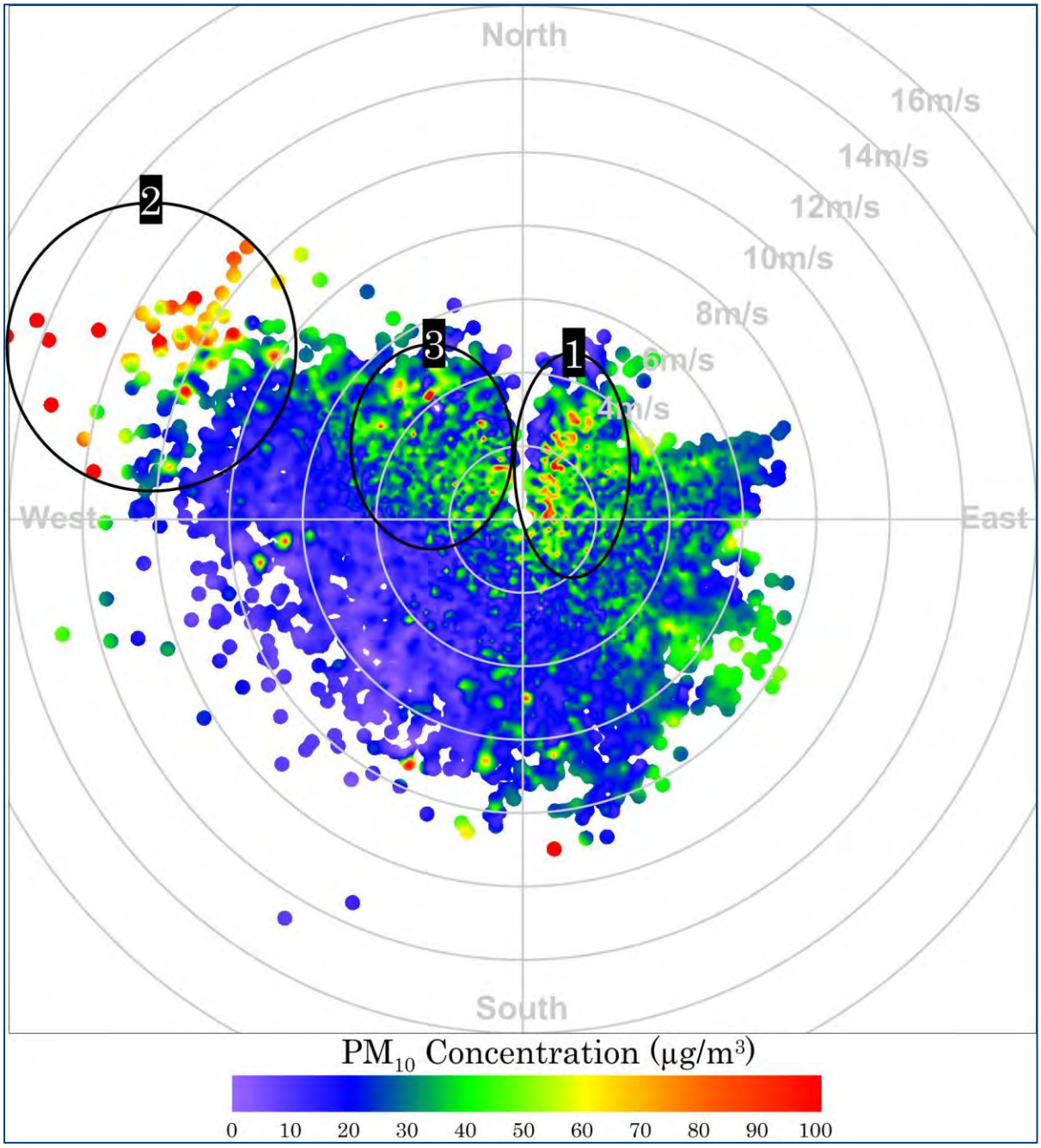

Figure A-2: Example Pollution Rose

- **1** - High PM_{10} levels tended to originate from the north-eastern direction under wind speeds below 4m/s.
- **2** - High PM_{10} levels were also recorded from the northwest and west-northwest direction under high wind speeds (>8m/s).
- **3** - Some high levels were also recorded from the northwest under moderate wind speeds.

Appendix B

Monitoring Data (Graphical)

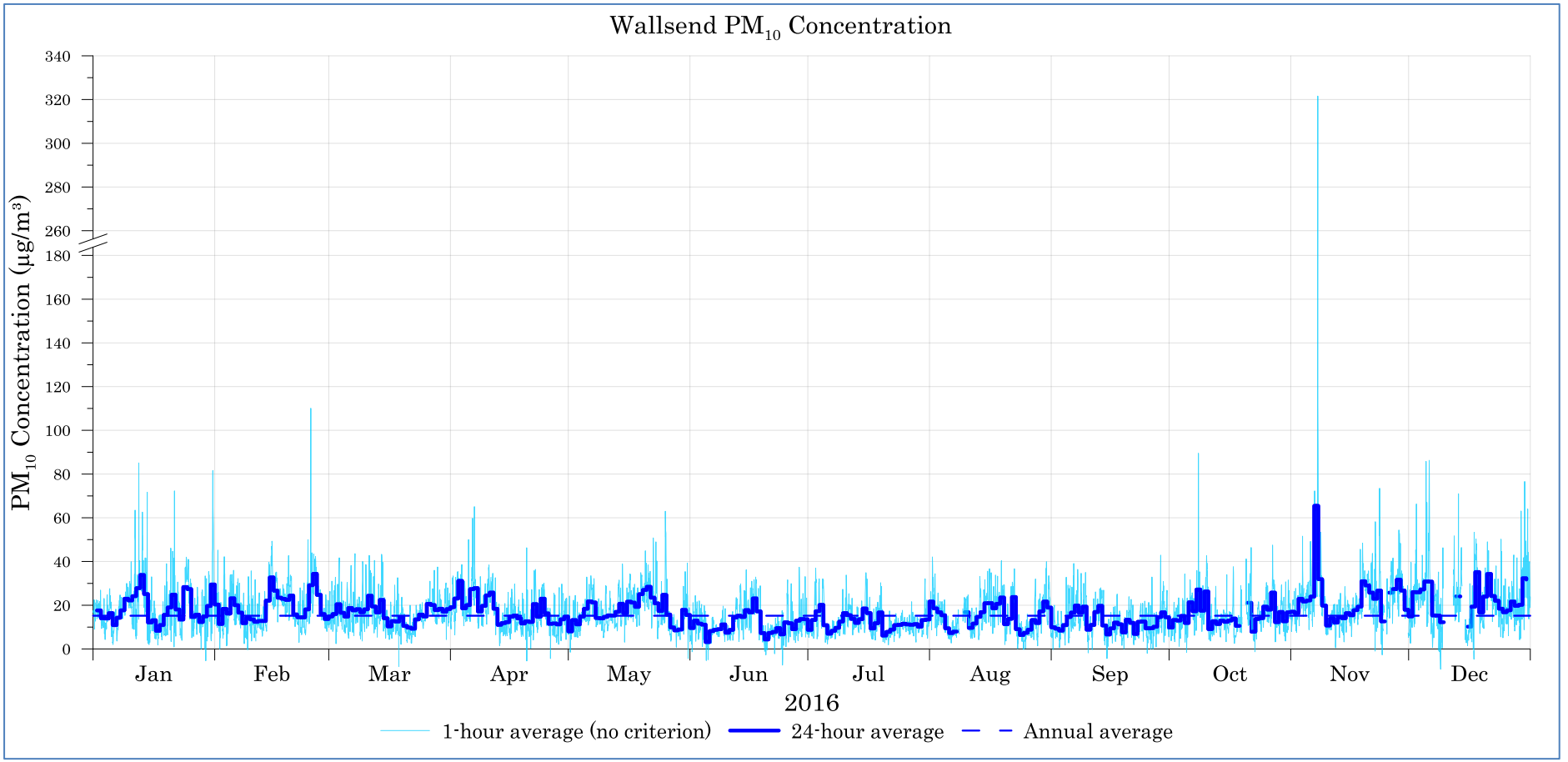

Figure B-1: Wallsend PM_{10} (1-hour, 24-hour and annual average) concentration – 2016

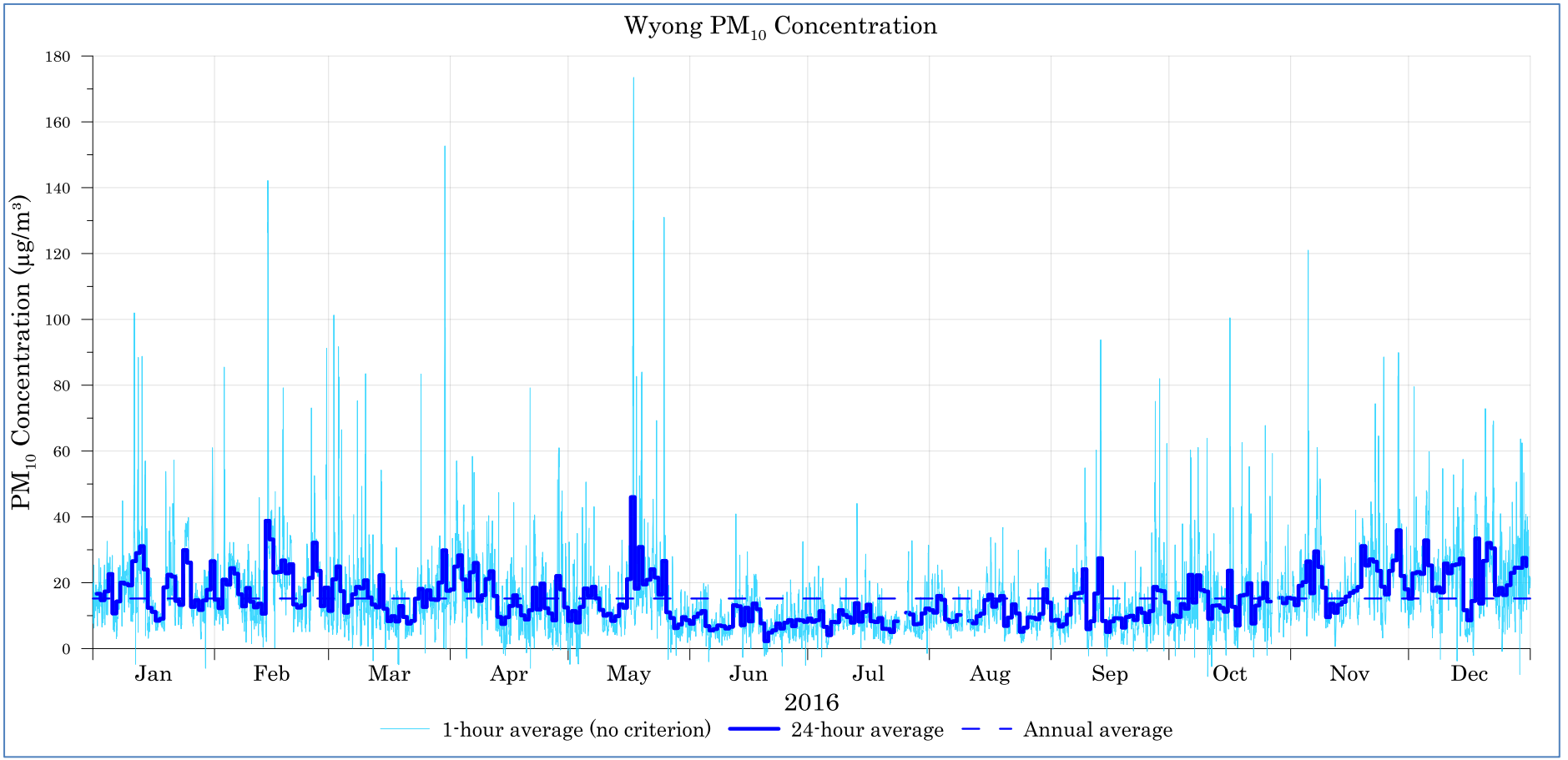

Figure B-2: Wyong PM_{10} (1-hour, 24-hour and annual average) concentration – 2016

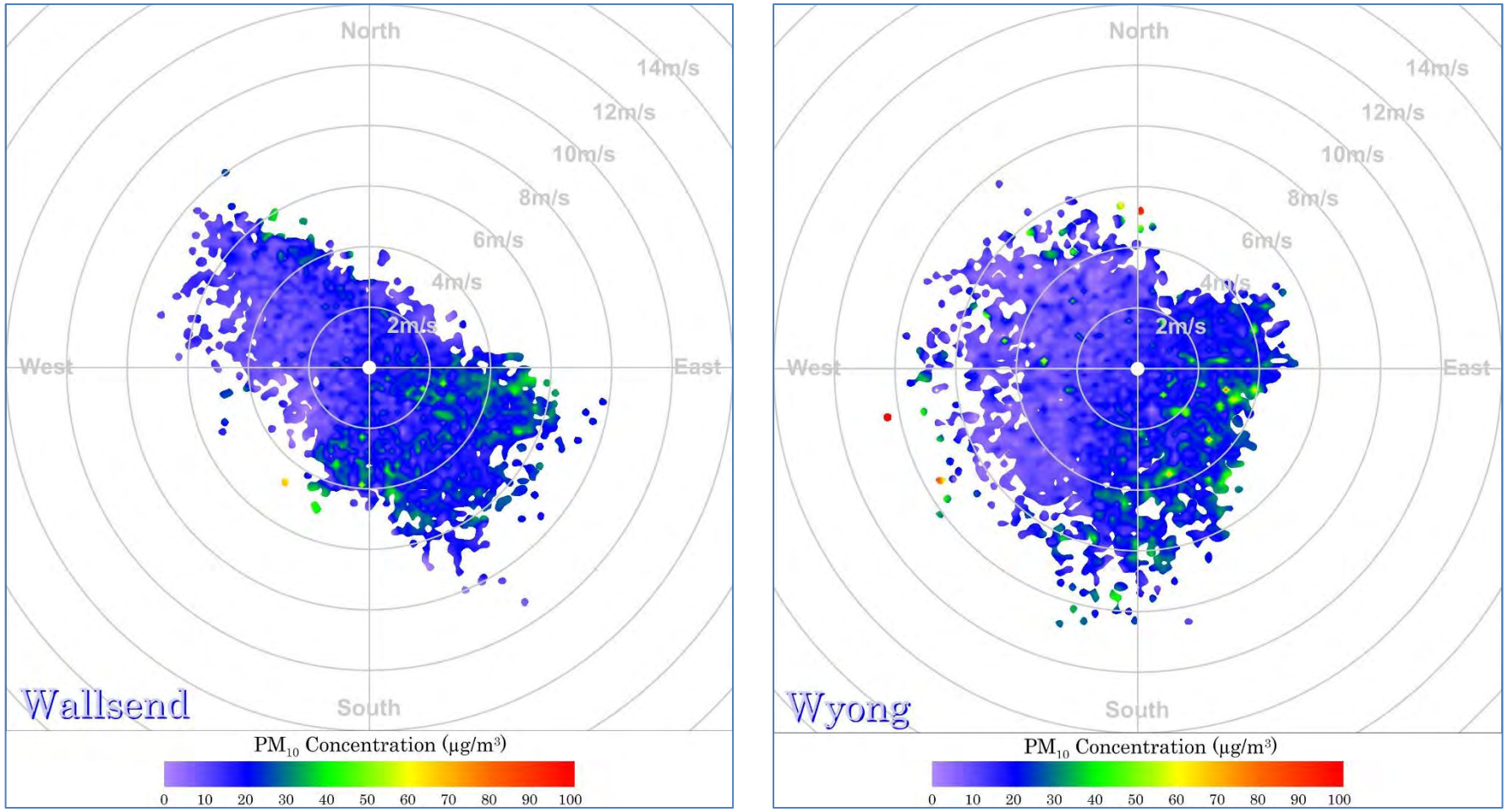

Figure B-3: 2016 hourly PM_{10} pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low PM_{10} levels in 2016. Levels were relatively higher from the southern and eastern directions.

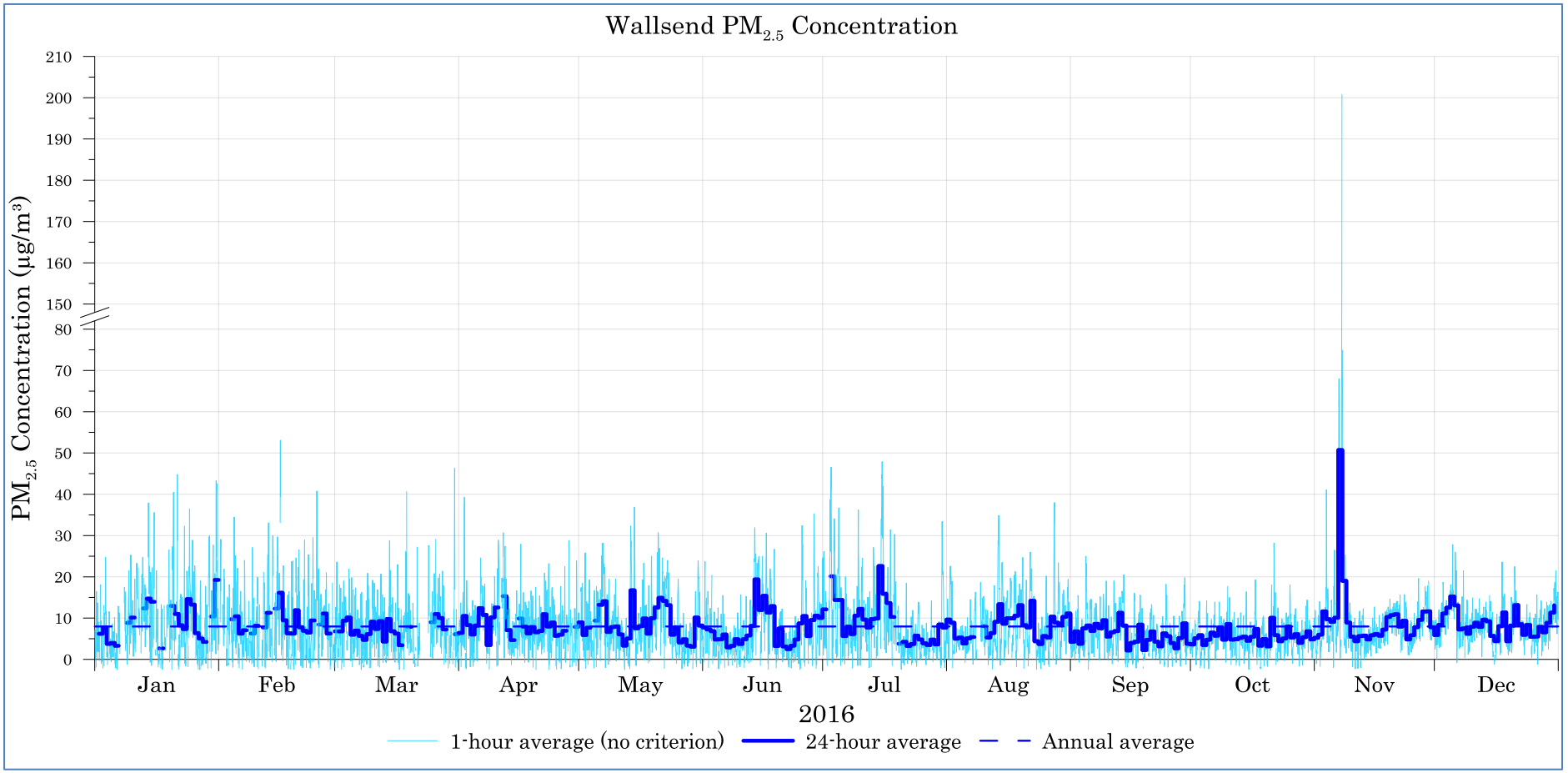

Figure B-4: Wallsend $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2016

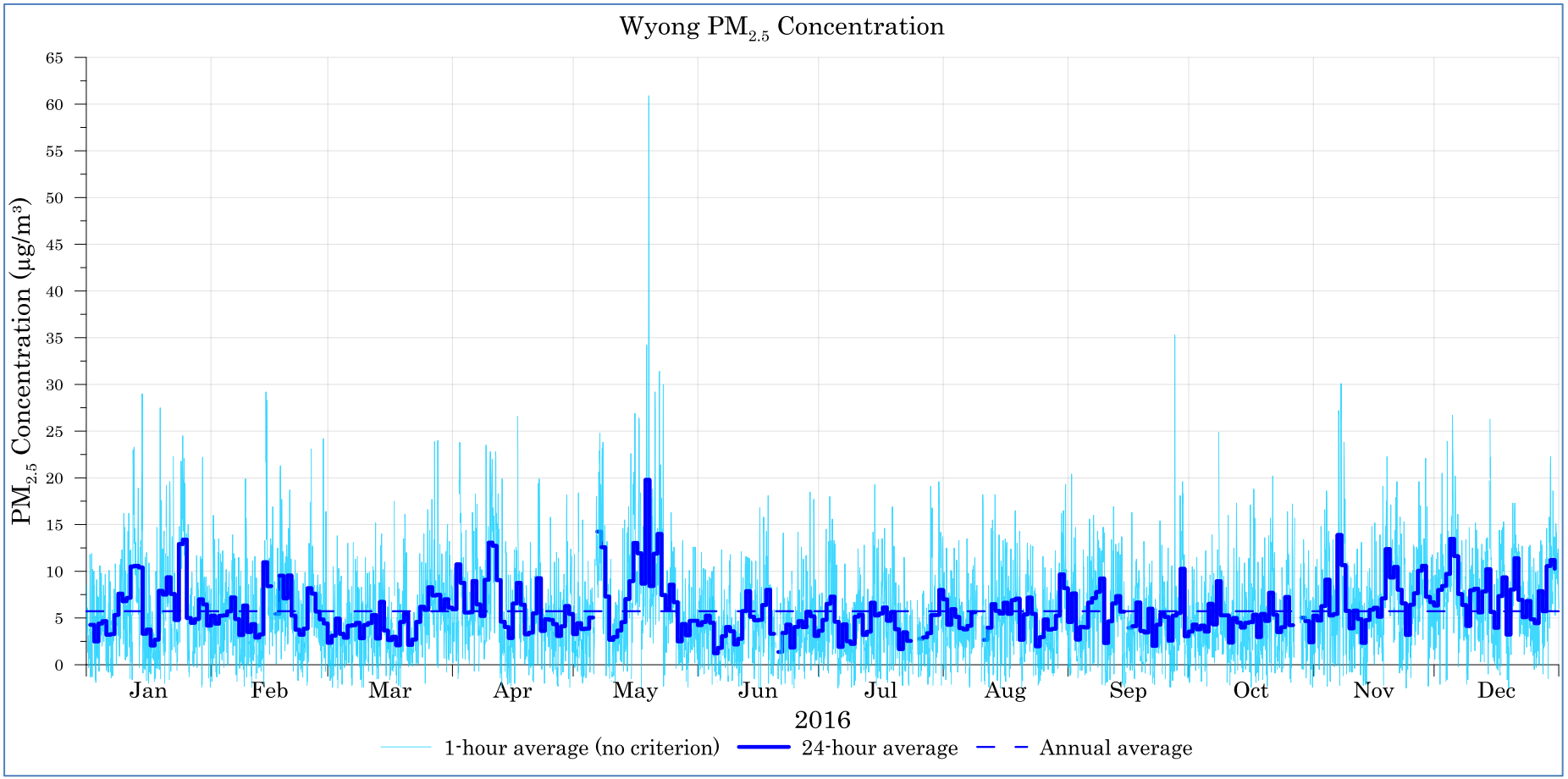

Figure B-5: Wyong $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2016

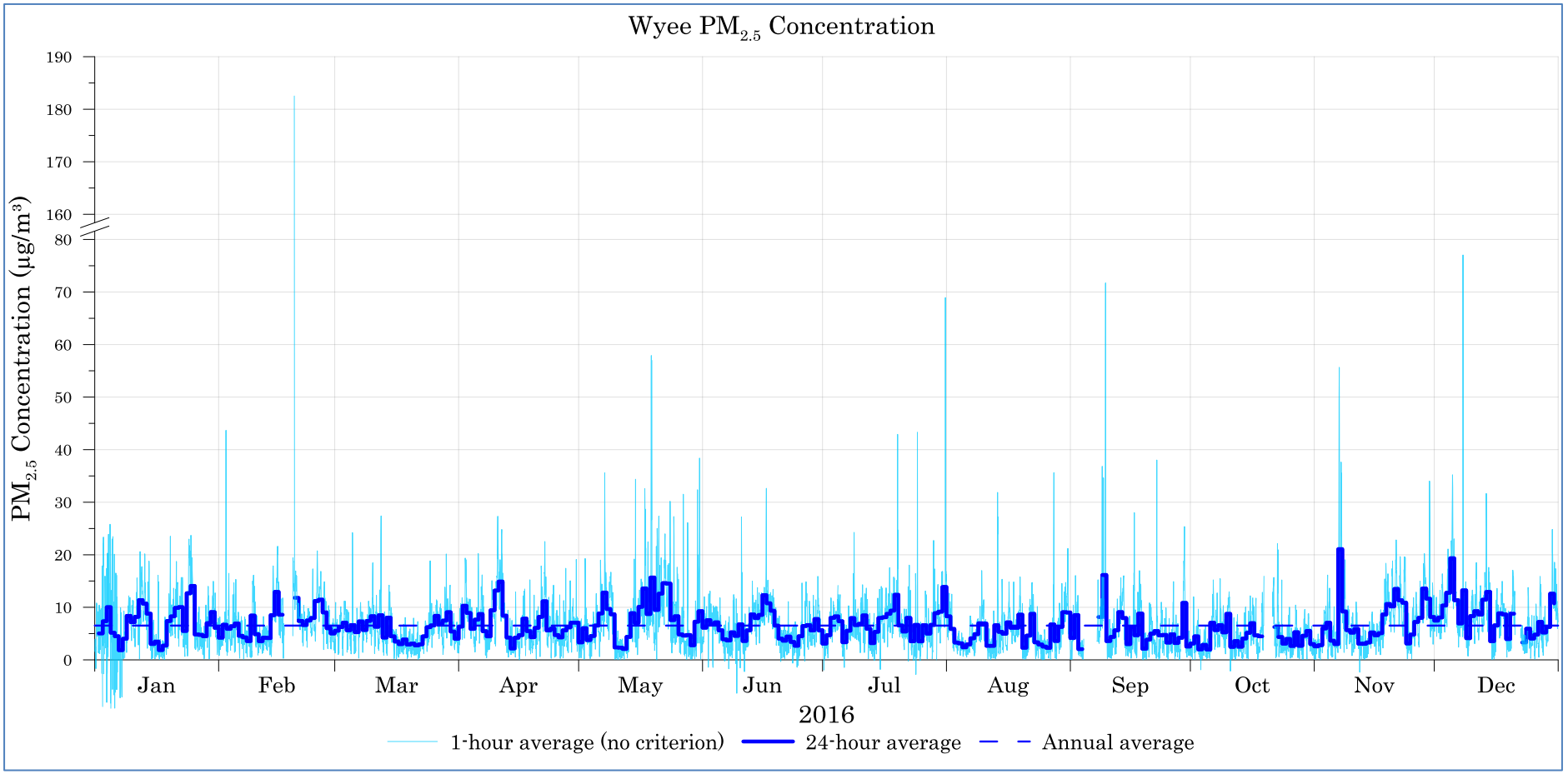

Figure B-6: Wyee $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2016

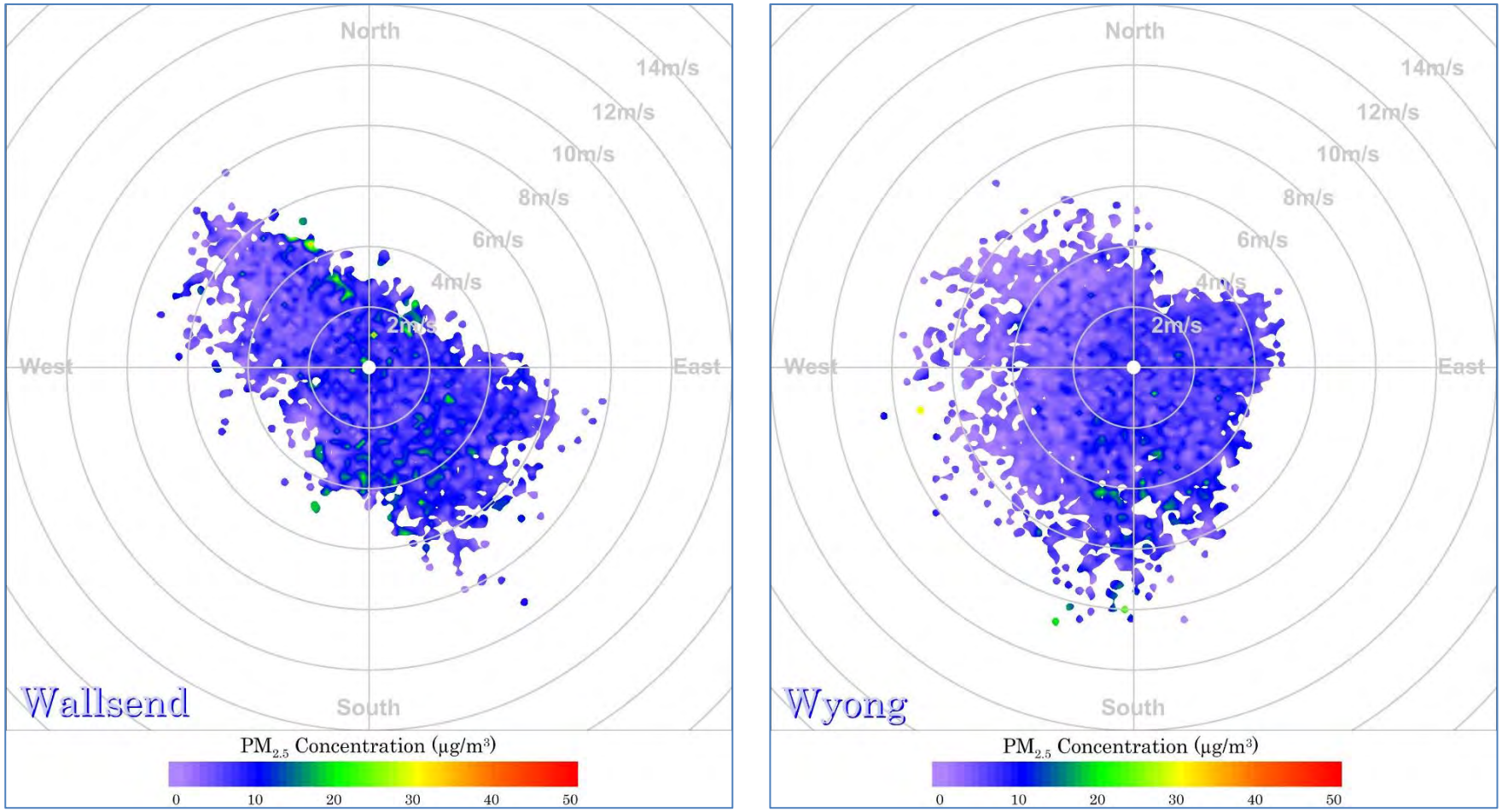

Figure B-7: 2016 hourly $PM_{2.5}$ pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low $PM_{2.5}$ levels in 2016.

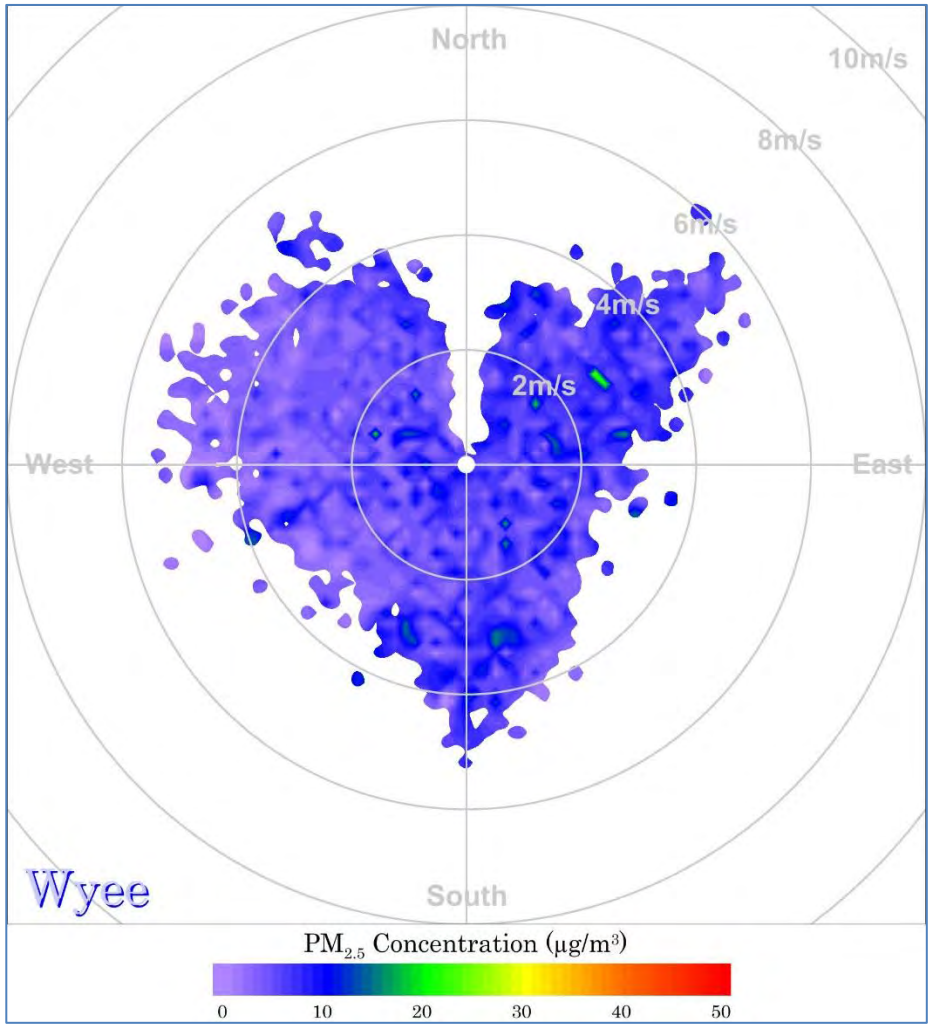

Figure B-8: 2016 hourly $PM_{2.5}$ pollution rose – Wyee

The Wyee monitor generally recorded low $PM_{2.5}$ levels in 2016.

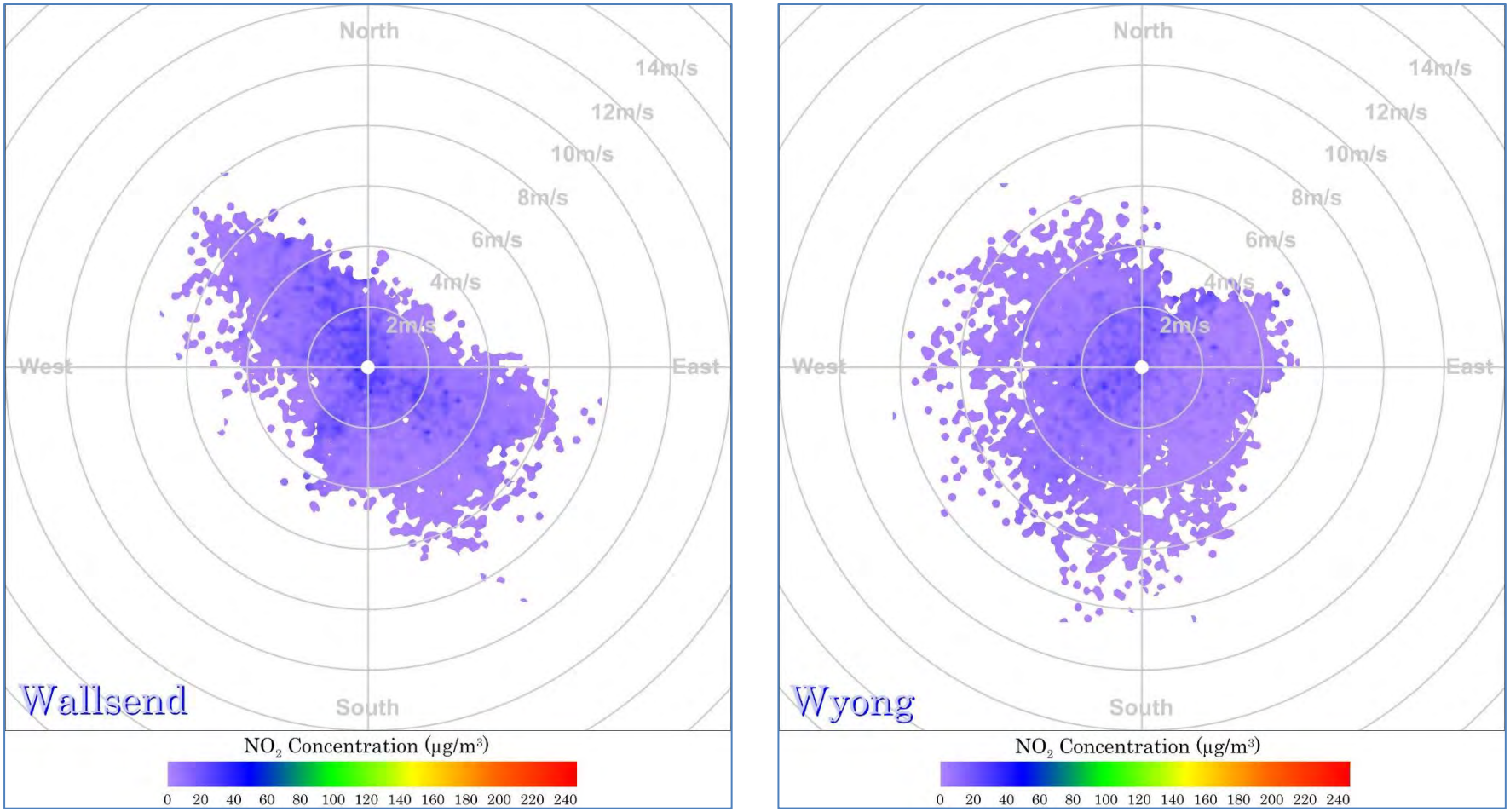

Figure B-9: 2016 hourly NO_2 pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low NO_2 levels in 2016.

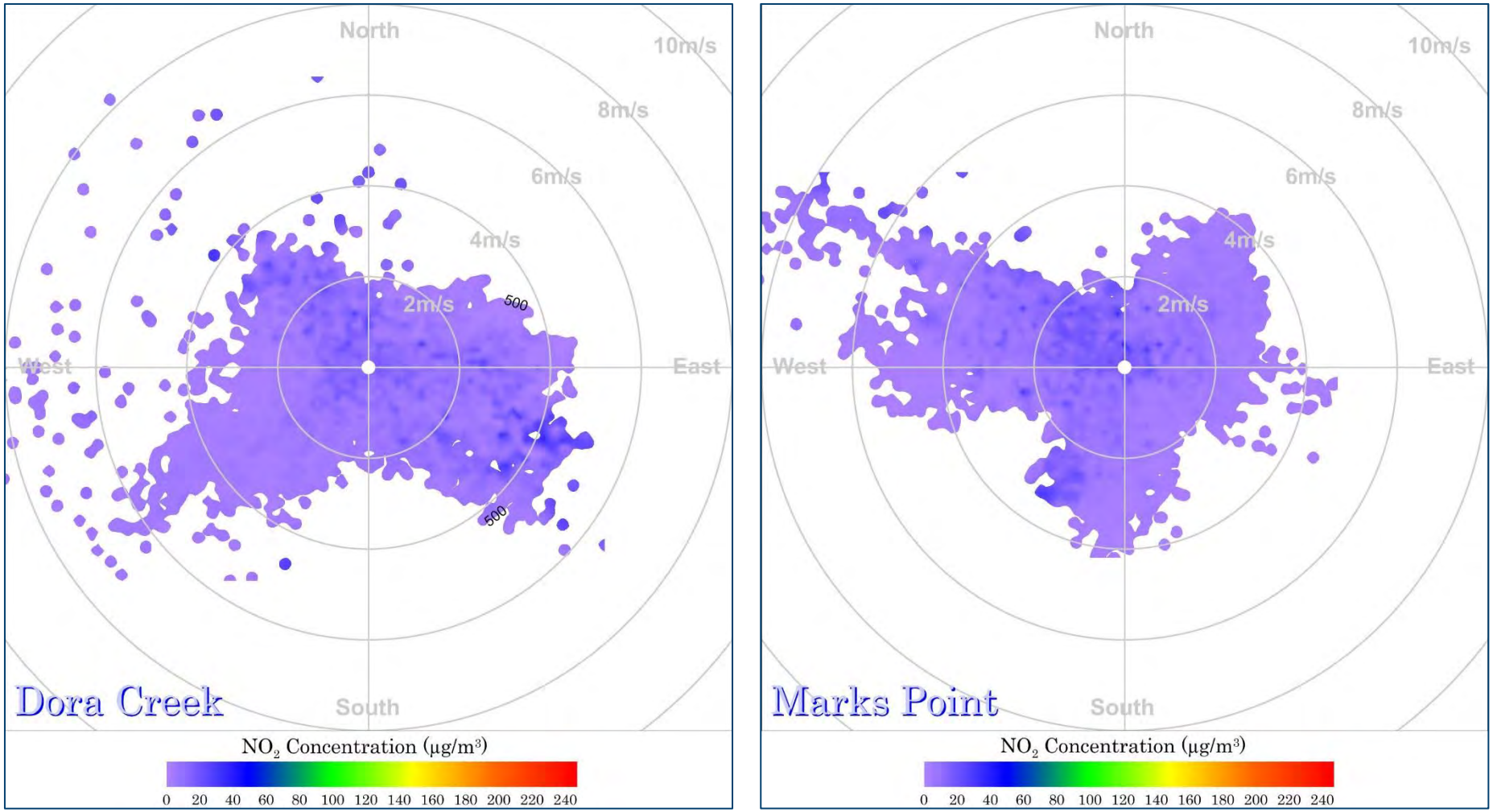

Figure B-10: 2016 hourly NO_2 pollution roses – Dora Creek (left) and Marks Point (right)

The Dora Creek and Marks Point monitors generally recorded low NO_2 levels in 2016.

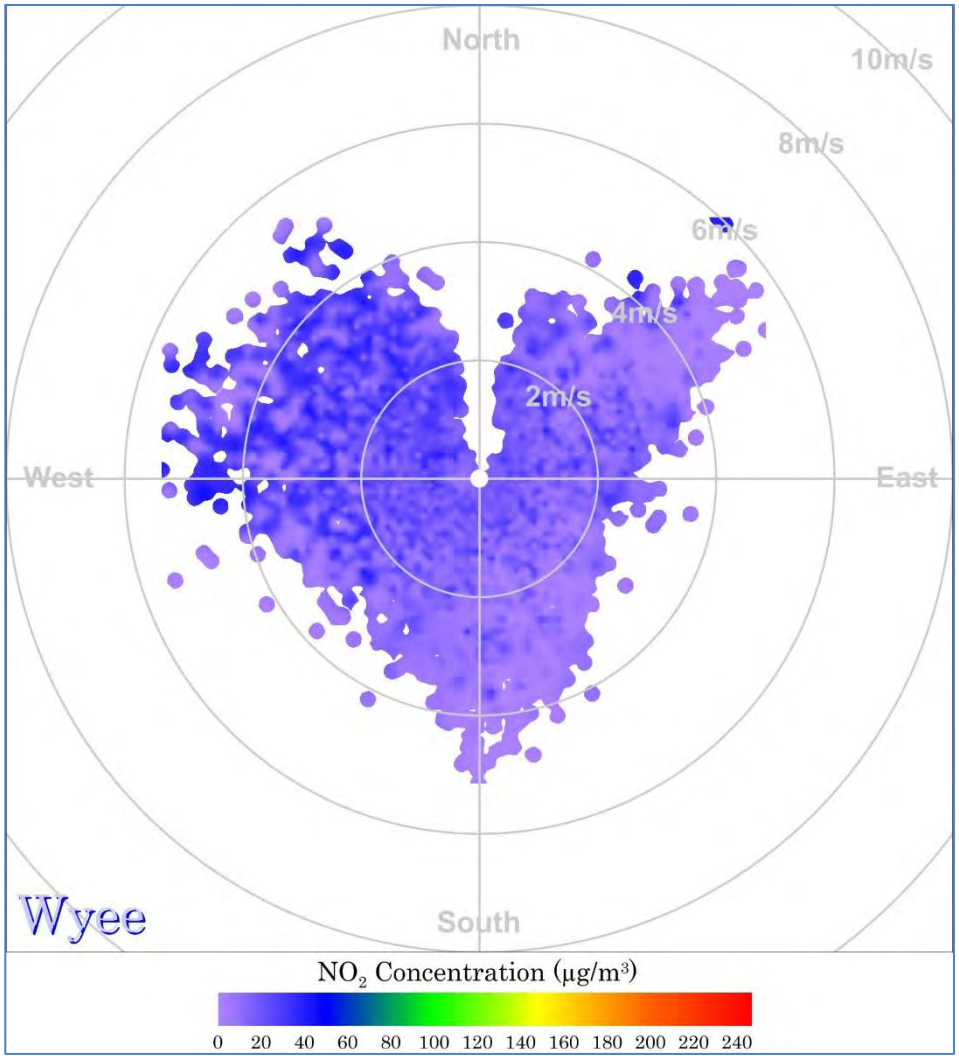

Figure B-11: 2016 hourly NO_2 pollution rose – Wyee

The Wyee monitor generally recorded low NO_2 levels in 2016.

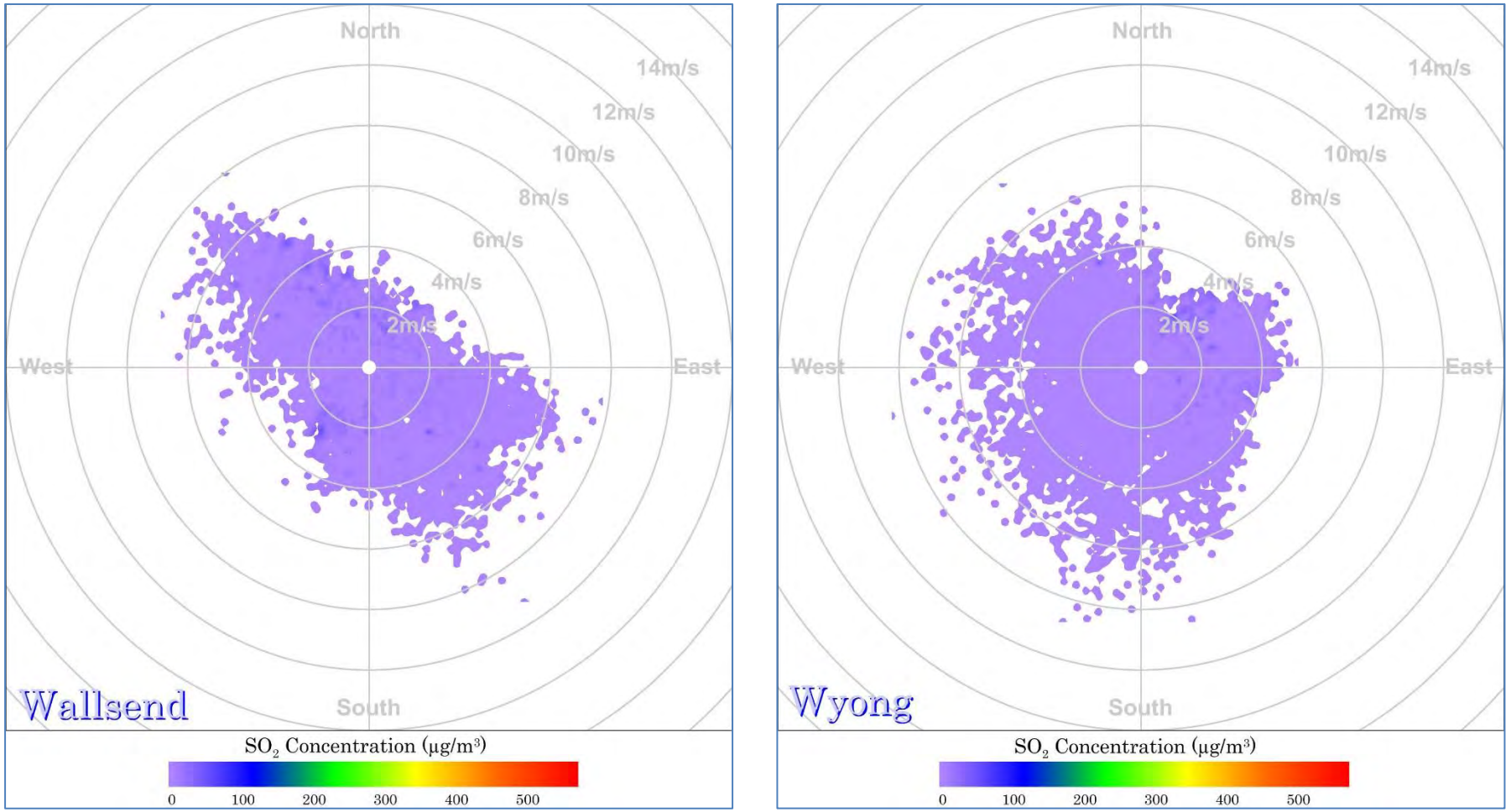

Figure B-12: 2016 hourly SO_2 pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low SO_2 levels in 2016.

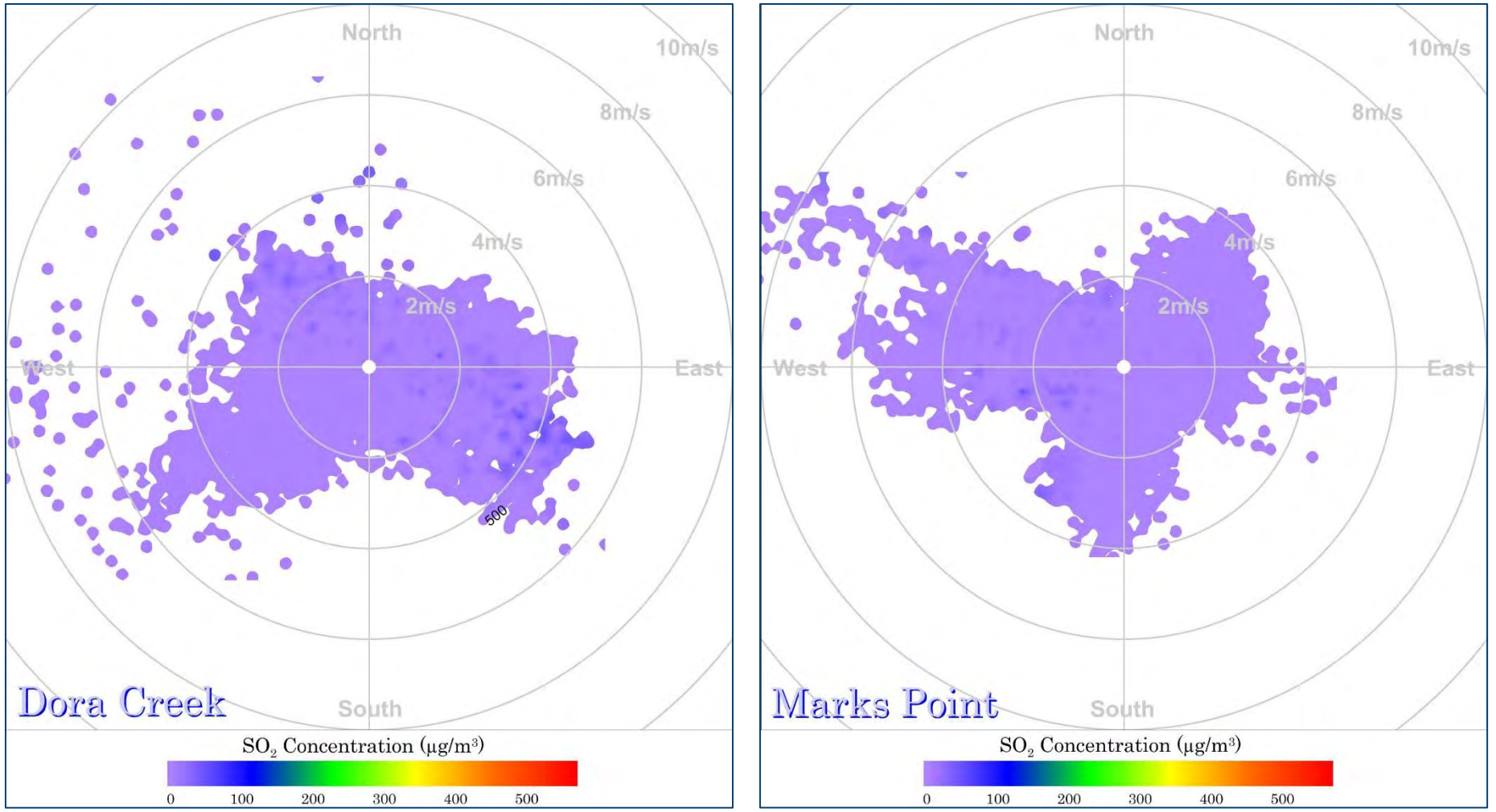

Figure B-13: 2016 hourly SO_2 pollution roses – Dora Creek (left) and Marks Point (right)

The Dora Creek and Marks Point monitors generally recorded low SO_2 levels in 2016.

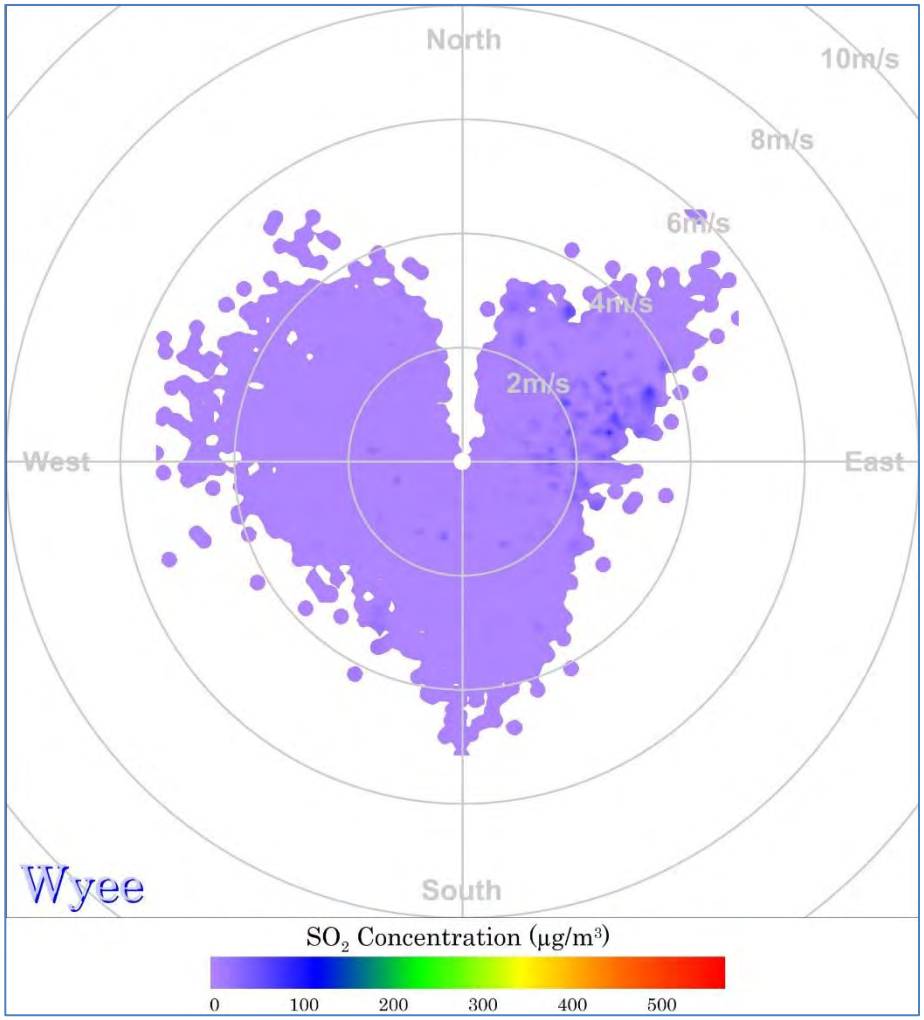

Figure B-14: 2016 hourly SO_2 pollution rose – Wyee

The Wyee monitor generally recorded low SO_2 levels in 2016.

Appendix C

Monitoring Data (Tabulated)

Table C-1: 24-hour average monitoring data

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
01/01/2016	17.5	14.0	5.8	4.2	4.3	1.5	0.0	3.6	1.8	16.4
2/01/2016	17.6	16.6	6.2	4.3	5.0	-0.8	0.0	5.7	0.8	1.2
3/01/2016	14.1	14.7	7.8	2.5	7.3	-0.6	0.0	3.0	0.5	0.4
4/01/2016	13.9	17.4	3.8	4.4	10.0	-0.7	0.2	2.9	0.5	3.9
5/01/2016	16.4	22.6	4.0	4.7	5.2	-0.1	0.0	-	0.8	0.0
6/01/2016	10.9	10.7	3.3	3.2	4.5	-0.5	0.0	1.3	0.6	0.9
7/01/2016	14.3	14.3	-	3.3	1.8	6.8	0.2	1.3	3.5	0.2
8/01/2016	17.7	20.0	-	5.3	4.0	1.3	0.7	4.6	3.1	2.6
9/01/2016	23.0	19.7	8.8	7.6	8.4	1.3	1.9	6.1	2.2	4.6
10/01/2016	22.2	19.2	10.1	6.8	7.2	2.2	5.6	4.2	1.0	5.1
11/01/2016	24.2	26.5	-	7.2	8.2	4.9	3.1	4.0	2.5	1.9
12/01/2016	27.8	29.0	-	10.5	11.4	-	0.2	1.2	1.4	0.4
13/01/2016	33.8	31.1	12.3	10.6	10.7	-	11.2	17.5	1.6	1.4
14/01/2016	25.1	24.0	14.7	10.4	8.8	5.2	0.4	-	3.7	0.4
15/01/2016	12.1	12.3	14.0	3.3	3.0	3.5	0.0	-	2.2	-0.1
16/01/2016	13.1	11.1	-	3.8	3.5	0.0	0.0	7.2	0.7	0.1
17/01/2016	8.3	8.5	2.7	2.1	1.9	1.8	0.0	7.1	1.2	0.0
18/01/2016	11.0	9.1	-	2.7	2.7	3.5	0.6	5.5	1.6	5.9
19/01/2016	15.6	18.6	-	7.9	7.4	7.1	4.1	7.2	4.4	3.7
20/01/2016	19.0	22.4	13.0	7.5	8.3	2.5	1.9	-	3.0	1.1
21/01/2016	24.8	21.9	11.0	9.4	9.9	4.2	1.6	-	2.9	1.2
22/01/2016	18.1	14.5	8.3	7.6	10.0	1.3	0.3	-	1.8	0.0
23/01/2016	13.5	13.3	7.3	4.8	5.5	0.7	0.0	2.1	0.9	0.4
24/01/2016	28.3	29.9	14.6	12.9	12.7	-0.3	0.0	5.3	0.6	0.0
25/01/2016	27.4	26.1	13.3	13.4	14.1	1.9	0.0	1.9	1.0	1.7
26/01/2016	14.6	12.7	6.4	5.0	4.8	3.9	0.0	1.6	0.7	13.5
27/01/2016	15.7	14.7	5.0	4.5	4.8	2.8	1.2	8.1	0.5	-0.2
28/01/2016	12.3	11.7	4.2	4.9	4.5	2.7	3.7	3.1	1.7	2.2
29/01/2016	14.9	14.6	-	7.0	7.0	6.7	7.5	5.3	3.9	4.6
30/01/2016	19.6	17.9	10.4	6.4	9.1	3.3	1.4	2.7	1.4	1.1
31/01/2016	29.5	26.5	19.3	4.2	6.1	5.9	0.7	3.6	2.2	0.4
1/02/2016	20.3	14.8	-	5.3	4.2	2.3	1.6	3.2	2.1	2.0
2/02/2016	11.4	12.3	-	4.4	6.7	3.2	0.0	3.0	2.1	0.0
3/02/2016	18.4	20.9	-	5.3	5.9	2.6	6.3	2.6	3.6	6.8
4/02/2016	16.2	19.4	9.7	5.3	6.4	1.4	0.0	2.5	0.8	0.0
5/02/2016	23.2	24.5	10.4	5.7	6.9	-0.2	-	2.0	0.2	-1.7
6/02/2016	20.0	22.7	6.2	7.2	4.6	-0.1	0.0	2.0	-	0.3
7/02/2016	16.6	16.5	7.1	4.9	4.3	0.0	0.0	-	1.0	-0.1
8/02/2016	11.8	12.8	-	3.2	3.6	0.0	0.0	-	1.0	0.7
9/02/2016	14.3	18.4	6.3	6.3	8.4	0.0	0.0	10.6	0.4	0.1
10/02/2016	13.5	14.2	8.1	3.5	4.9	-2.2	4.5	-	0.7	4.5
11/02/2016	12.4	12.5	-	4.3	3.6	1.4	0.9	-	1.2	12.8
12/02/2016	12.8	13.6	7.7	2.9	4.2	2.3	1.0	-	1.5	14.9
13/02/2016	12.8	10.6	11.3	3.3	4.1	5.9	4.8	2.9	1.0	5.7
14/02/2016	22.1	38.8	-	11.0	8.5	7.4	3.6	2.4	7.6	3.8
15/02/2016	32.7	33.1	12.3	8.4	12.9	7.6	3.4	1.6	2.6	1.4
16/02/2016	26.6	23.1	16.1	-	8.6	2.4	0.1	7.1	0.9	0.1
17/02/2016	23.4	23.2	9.5	5.4	-	2.3	0.0	4.2	0.9	0.3
18/02/2016	22.9	26.8	6.3	9.5	-	0.6	1.0	8.7	1.6	2.5
19/02/2016	22.4	22.9	6.2	7.1	-	2.3	7.2	-	0.8	7.5
20/02/2016	24.4	25.7	11.9	9.6	11.8	1.5	0.2	1.6	1.1	0.0
21/02/2016	15.8	13.4	7.8	5.3	7.4	0.1	0.0	2.3	1.2	0.7
22/02/2016	14.5	12.5	6.9	3.7	6.6	2.2	2.2	1.6	0.9	0.8
23/02/2016	14.4	13.1	6.5	3.2	7.5	4.7	5.2	4.5	1.2	3.9
24/02/2016	18.1	17.6	9.4	3.9	8.0	1.4	6.2	-	2.5	1.8
25/02/2016	29.2	21.5	-	8.2	11.2	3.2	2.2	2.0	2.7	1.8
26/02/2016	34.4	32.2	8.4	7.6	11.5	1.3	0.0	-	1.6	-1.9
27/02/2016	24.7	23.6	11.1	5.7	9.0	0.0	0.0	-	1.5	2.1
28/02/2016	16.0	12.9	6.3	4.9	6.0	0.0	-0.2	-	0.8	0.3
29/02/2016	13.7	18.5	-	4.4	5.0	0.2	0.0	-	1.3	0.7
1/03/2016	14.9	11.4	6.8	2.3	5.5	0.6	1.1	1.4	1.6	1.2
2/03/2016	16.0	21.1	6.8	3.1	6.2	4.8	9.6	4.8	2.0	8.9
3/03/2016	20.5	25.0	9.4	4.9	7.1	4.1	4.6	5.0	1.5	1.9

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
4/03/2016	16.5	17.4	10.1	3.3	5.6	1.9	2.4	3.1	1.2	1.3
5/03/2016	14.8	10.9	6.0	2.9	6.6	8.1	3.2	10.0	0.9	7.0
6/03/2016	18.7	13.3	7.0	4.2	5.3	3.4	0.9	5.1	1.3	0.7
7/03/2016	17.7	16.5	5.7	4.2	7.3	2.5	3.0	2.5	1.7	4.1
8/03/2016	18.2	18.7	4.7	4.5	5.7	0.9	0.9	2.1	1.0	14.1
9/03/2016	16.8	18.3	6.1	2.8	7.4	1.4	6.5	-	2.6	2.3
10/03/2016	18.1	20.7	9.1	4.3	8.3	3.8	2.6	6.8	2.6	1.3
11/03/2016	24.3	15.5	7.4	4.5	6.3	4.8	7.7	-	2.4	4.4
12/03/2016	19.4	13.4	9.3	5.3	8.5	10.9	5.2	17.6	0.6	3.3
13/03/2016	16.7	12.5	4.3	2.8	4.2	2.4	4.6	3.7	1.0	0.8
14/03/2016	22.4	22.3	9.8	6.7	8.0	12.0	2.4	4.5	2.2	2.5
15/03/2016	14.0	12.1	6.8	3.7	4.5	2.4	0.1	4.3	0.5	0.8
16/03/2016	10.3	8.3	6.2	2.6	3.5	0.8	0.0	3.1	0.2	0.0
17/03/2016	12.7	9.9	3.4	3.0	3.0	1.0	0.0	1.7	0.8	0.5
18/03/2016	12.5	8.2	-	2.1	3.9	-8.9	1.1	2.5	4.2	0.3
19/03/2016	14.5	13.0	7.9	4.6	2.9	2.8	0.6	7.5	3.6	1.6
20/03/2016	10.5	9.6	-	5.5	3.1	3.0	0.1	1.7	1.0	0.6
21/03/2016	9.8	7.6	-	2.1	2.7	3.0	0.0	2.4	0.9	0.2
22/03/2016	9.3	8.4	-	2.7	3.0	10.3	0.0	0.8	5.4	0.0
23/03/2016	13.5	15.1	-	4.6	4.5	13.0	0.0	2.4	6.4	0.1
24/03/2016	15.7	18.2	-	6.2	6.2	5.4	3.8	3.2	4.4	1.7
25/03/2016	14.9	12.6	9.0	5.9	6.6	1.4	2.6	1.7	3.7	3.6
26/03/2016	20.6	17.7	11.0	8.3	8.4	0.3	0.0	3.3	1.3	2.8
27/03/2016	20.1	14.9	10.0	7.4	6.8	4.2	1.4	2.0	1.0	3.0
28/03/2016	17.8	14.8	7.3	7.5	7.5	8.8	8.9	2.8	0.8	6.5
29/03/2016	18.4	20.1	-	6.0	9.1	2.5	0.0	2.0	0.9	0.1
30/03/2016	17.0	29.8	-	7.0	5.4	2.6	1.1	2.3	3.1	1.4
31/03/2016	18.2	17.5	6.1	6.1	4.0	3.3	0.0	2.6	3.5	0.7
1/04/2016	19.1	17.9	6.4	5.9	6.3	3.9	4.6	2.3	1.1	5.5
2/04/2016	23.1	24.9	10.5	10.7	10.3	0.9	0.4	1.6	1.7	0.8
3/04/2016	31.1	28.4	8.3	8.8	8.9	1.0	0.0	2.0	2.1	2.8
4/04/2016	18.6	21.0	6.0	5.6	5.9	4.2	2.5	5.4	1.3	1.0
5/04/2016	20.0	17.6	8.2	5.6	7.6	3.0	8.6	4.0	4.0	0.9
6/04/2016	27.4	23.2	12.4	9.0	8.7	3.2	1.4	2.9	3.7	1.2
7/04/2016	27.8	26.0	10.8	6.5	5.5	0.0	0.0	1.9	0.7	0.6
8/04/2016	17.2	14.5	3.5	5.2	4.5	0.5	0.1	4.8	1.1	0.2
9/04/2016	19.7	16.2	10.2	9.1	9.4	2.8	0.0	3.2	1.9	0.7
10/04/2016	24.5	21.2	12.6	13.1	13.2	5.6	0.2	3.3	3.6	0.8
11/04/2016	25.8	23.5	-	12.7	14.9	10.8	0.4	6.2	6.0	1.0
12/04/2016	18.4	16.0	15.3	9.1	8.4	0.6	0.2	5.5	1.0	2.4
13/04/2016	11.0	9.6	7.1	4.6	4.2	0.0	0.4	6.3	0.6	2.2
14/04/2016	11.8	7.5	4.7	4.0	2.2	2.3	0.0	1.8	1.3	3.0
15/04/2016	12.3	9.5	-	2.9	4.2	2.6	4.6	3.4	3.1	3.4
16/04/2016	14.7	13.0	9.9	6.6	4.7	2.8	4.0	2.2	1.9	0.7
17/04/2016	15.3	16.2	7.9	8.8	7.8	0.6	0.0	1.2	0.8	2.6
18/04/2016	14.0	12.9	6.3	6.4	5.5	3.3	0.5	1.0	1.7	2.4
19/04/2016	11.6	10.1	7.8	3.3	4.3	3.4	0.0	2.7	5.0	2.7
20/04/2016	12.7	8.8	6.6	3.4	6.1	0.5	0.0	3.2	0.9	3.9
21/04/2016	12.3	11.7	6.9	5.5	8.2	1.6	3.0	6.9	2.9	5.5
22/04/2016	20.5	18.5	10.9	9.3	11.1	3.2	0.4	3.0	0.9	6.9
23/04/2016	14.7	11.8	8.0	3.6	5.6	7.9	0.0	1.9	2.5	4.3
24/04/2016	23.0	19.8	8.9	4.9	6.0	0.7	0.0	7.3	0.7	4.8
25/04/2016	16.3	12.3	5.7	4.8	4.7	0.0	0.0	7.6	0.7	4.2
26/04/2016	11.5	10.7	6.0	4.3	4.3	0.8	0.0	2.3	0.8	3.9
27/04/2016	11.7	8.6	6.9	3.1	5.6	2.0	4.2	2.7	1.7	5.4
28/04/2016	11.2	22.1	-	4.1	6.2	-	9.4	8.2	2.4	5.7
29/04/2016	13.5	17.9	-	6.3	7.1	-	3.0	4.3	1.5	6.1
30/04/2016	14.8	12.5	7.9	5.4	7.1	4.0	1.6	3.2	6.0	7.0
1/05/2016	8.0	8.4	9.0	3.3	3.3	-	0.1	5.7	5.2	3.0
2/05/2016	13.2	11.4	5.9	4.4	6.0	7.0	2.4	2.6	3.5	6.1
3/05/2016	11.2	7.9	7.7	3.8	3.8	1.4	0.1	0.7	-	3.6
4/05/2016	14.8	12.7	-	3.9	4.5	1.2	0.4	1.8	4.8	2.9
5/05/2016	18.4	18.3	9.4	5.0	6.5	10.0	0.7	3.9	3.3	6.0
6/05/2016	21.8	16.0	13.2	-	8.8	6.9	1.9	3.8	3.7	3.8
7/05/2016	21.3	18.7	14.1	14.3	12.8	7.3	1.9	4.2	2.4	4.8

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
8/05/2016	14.2	15.3	6.6	12.6	9.7	6.2	1.7	3.3	2.6	5.2
9/05/2016	14.0	11.8	7.8	7.3	8.7	1.4	1.7	6.6	4.6	5.7
10/05/2016	14.7	10.0	8.0	2.7	2.4	0.2	0.0	1.1	0.9	1.4
11/05/2016	15.4	10.6	6.0	3.0	2.3	0.3	1.2	1.0	3.1	2.5
12/05/2016	15.3	8.4	3.3	3.7	2.1	4.4	0.6	1.9	2.3	1.7
13/05/2016	16.9	9.8	5.0	4.6	4.4	1.4	1.2	3.3	1.4	4.8
14/05/2016	20.7	13.4	16.7	7.0	8.9	6.6	1.5	5.6	5.3	4.6
15/05/2016	16.3	12.4	7.5	8.9	7.0	0.3	0.2	1.3	1.1	1.4
16/05/2016	21.7	21.1	8.0	13.0	10.1	2.7	1.0	3.5	2.8	5.9
17/05/2016	21.2	46.0	9.9	11.9	13.6	2.3	3.4	2.0	2.6	4.6
18/05/2016	19.2	18.2	6.2	8.7	8.7	1.5	1.4	2.9	3.5	4.9
19/05/2016	25.0	30.8	10.0	19.8	15.7	0.2	1.4	2.3	3.0	2.1
20/05/2016	27.0	19.5	12.6	8.4	9.5	2.3	0.0	3.6	2.7	1.7
21/05/2016	28.4	20.9	14.9	11.9	12.6	2.2	0.4	2.7	0.4	4.3
22/05/2016	23.4	24.1	14.2	14.0	14.6	3.2	5.0	8.1	3.4	2.9
23/05/2016	20.8	21.6	13.1	7.5	14.5	2.2	0.6	-	10.4	4.7
24/05/2016	17.3	16.3	6.0	5.9	7.6	0.7	0.6	2.8	9.5	0.5
25/05/2016	24.7	26.6	7.7	8.6	8.3	2.4	1.4	3.9	3.0	2.8
26/05/2016	15.7	11.0	4.1	6.7	4.8	10.3	0.4	1.2	2.9	5.1
27/05/2016	9.8	9.3	4.9	2.5	4.6	0.3	1.2	0.8	3.0	0.4
28/05/2016	8.5	6.2	3.3	4.4	4.7	1.3	0.7	1.6	2.2	0.4
29/05/2016	8.9	7.3	3.1	3.2	2.8	0.0	0.2	3.3	5.8	1.8
30/05/2016	17.9	9.6	10.1	4.7	7.3	2.6	1.0	3.1	3.1	1.9
31/05/2016	15.5	8.6	8.2	4.7	9.3	5.7	0.0	2.6	1.9	2.5
1/06/2016	9.6	7.5	7.7	4.2	6.1	0.8	0.0	3.3	1.7	4.4
2/06/2016	13.0	9.7	7.3	4.6	7.6	0.6	0.0	1.0	1.8	1.8
3/06/2016	11.6	10.7	6.8	5.3	6.7	1.6	0.2	4.2	1.1	3.7
4/06/2016	11.1	11.4	4.8	4.5	7.1	0.8	3.4	10.8	0.4	3.9
5/06/2016	3.2	6.8	4.9	1.2	5.6	1.3	1.4	-	1.7	4.5
6/06/2016	8.2	5.5	6.0	1.8	3.9	2.8	0.4	3.4	2.6	0.6
7/06/2016	8.7	5.9	2.9	3.1	3.7	0.0	-0.1	2.1	0.6	0.0
8/06/2016	9.0	7.0	3.3	4.0	5.2	1.8	0.4	2.5	1.7	2.7
9/06/2016	11.2	6.8	4.9	3.6	4.6	8.3	0.0	3.3	10.2	0.9
10/06/2016	7.4	6.1	3.7	2.2	6.8	0.5	0.6	2.0	0.6	2.3
11/06/2016	8.7	6.6	4.9	2.8	3.6	1.0	1.2	2.4	2.3	1.8
12/06/2016	14.4	13.2	5.8	5.7	5.6	16.1	0.2	2.6	9.9	-
13/06/2016	15.2	12.9	8.1	7.9	8.6	3.6	2.0	6.8	2.5	-
14/06/2016	14.6	7.1	19.4	5.1	8.0	2.2	1.4	7.4	4.8	-
15/06/2016	17.8	12.4	12.0	4.8	8.6	2.1	0.0	2.8	1.0	-
16/06/2016	16.7	8.3	15.4	4.8	12.3	8.0	2.4	8.0	6.1	-
17/06/2016	23.1	13.7	11.3	6.4	10.8	3.1	6.0	14.3	4.8	2.6
18/06/2016	17.2	12.0	12.9	8.0	9.3	3.2	2.7	3.4	2.5	2.8
19/06/2016	7.3	7.7	3.2	3.3	6.5	0.9	1.4	1.0	1.0	2.9
20/06/2016	4.3	2.3	7.5	-	4.0	4.0	0.1	1.8	0.9	0.6
21/06/2016	7.3	4.9	3.1	1.4	3.6	0.1	0.0	1.0	0.8	0.4
22/06/2016	7.8	5.6	2.5	3.4	4.4	6.7	-2.7	3.9	2.3	2.3
23/06/2016	9.6	7.7	3.3	4.3	3.4	1.4	-0.1	11.1	1.8	2.4
24/06/2016	6.7	6.1	4.8	1.8	2.7	0.6	0.6	1.2	9.2	1.1
25/06/2016	12.2	7.9	8.7	4.0	4.5	0.5	0.0	3.2	8.8	1.8
26/06/2016	11.8	8.7	10.5	4.7	6.5	0.9	0.0	2.7	2.8	2.2
27/06/2016	9.0	6.8	5.6	4.0	6.6	1.7	0.6	3.9	7.3	1.4
28/06/2016	12.9	8.7	9.5	5.7	5.6	3.4	0.1	1.4	2.3	2.5
29/06/2016	13.7	8.6	10.6	5.2	7.8	2.1	0.2	11.0	9.6	2.7
30/06/2016	13.6	8.1	10.0	3.1	5.6	5.0	3.6	6.8	9.7	4.3
1/07/2016	8.7	9.1	12.1	3.6	3.1	0.1	0.1	2.0	7.9	2.3
2/07/2016	13.2	8.2	-	4.8	4.7	0.8	0.7	2.4	2.1	1.3
3/07/2016	17.3	8.6	20.1	6.5	8.0	7.7	0.6	5.5	5.6	3.0
4/07/2016	20.1	11.4	14.4	7.3	8.3	10.8	2.1	9.2	9.0	3.4
5/07/2016	10.9	6.6	14.4	4.6	7.3	4.1	-	3.8	5.0	1.5
6/07/2016	7.0	4.1	5.7	1.9	3.4	2.4	0.4	1.4	3.3	0.6
7/07/2016	8.3	8.1	7.9	4.3	5.5	8.8	0.0	0.9	2.8	2.4
8/07/2016	9.7	8.0	6.1	2.5	7.9	3.4	0.0	1.3	2.4	2.9
9/07/2016	12.5	11.7	10.6	2.2	6.6	5.0	0.1	-	2.3	2.9
10/07/2016	16.4	10.2	12.2	5.1	6.9	3.0	0.1	2.0	1.3	3.0
11/07/2016	15.4	9.5	9.6	5.4	8.5	3.8	1.1	6.9	5.2	3.3

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
12/07/2016	13.8	7.9	7.7	3.2	5.9	2.3	0.0	-	3.0	0.5
13/07/2016	11.9	13.8	9.7	3.5	3.2	0.0	0.0	1.2	9.7	0.0
14/07/2016	13.6	8.2	9.9	6.6	5.3	8.0	1.2	2.6	1.8	1.8
15/07/2016	18.5	11.1	22.6	5.3	8.0	4.3	1.4	4.9	3.0	2.4
16/07/2016	16.4	13.3	15.9	5.5	8.1	4.0	0.7	1.8	2.9	2.9
17/07/2016	9.4	8.3	13.6	6.1	8.8	1.1	1.0	1.2	1.6	4.0
18/07/2016	11.8	8.1	10.3	4.7	9.4	5.4	1.7	1.8	2.1	4.6
19/07/2016	16.7	9.3	-	5.6	12.4	0.9	0.9	2.1	0.7	6.3
20/07/2016	6.1	6.0	3.8	3.8	6.5	3.4	0.6	1.2	2.1	5.4
21/07/2016	7.8	5.9	4.2	1.7	5.4	0.8	-	0.9	3.6	3.4
22/07/2016	8.9	5.0	3.3	3.5	8.0	8.0	0.0	1.6	5.8	1.3
23/07/2016	10.9	8.3	3.7	2.6	3.5	0.3	0.4	2.2	5.0	2.3
24/07/2016	11.0	-	5.7	-	6.7	0.8	-	3.4	3.0	1.0
25/07/2016	11.5	-	4.8	-	3.5	0.7	-	1.4	1.6	0.3
26/07/2016	11.2	10.9	3.9	2.8	6.6	0.2	0.0	1.2	0.5	2.1
27/07/2016	11.1	10.4	3.5	2.9	5.0	1.5	1.1	1.1	2.4	1.2
28/07/2016	11.4	7.4	4.8	3.4	6.7	0.3	0.4	1.4	1.4	2.9
29/07/2016	10.2	7.5	3.6	5.3	8.9	0.7	1.7	3.8	1.7	0.1
30/07/2016	13.2	10.7	8.4	5.3	9.2	4.3	1.0	3.8	2.1	1.6
31/07/2016	13.5	12.2	7.7	8.0	13.9	3.3	1.4	2.5	2.5	1.0
1/08/2016	21.7	11.7	9.6	7.0	8.3	4.0	1.7	3.2	3.0	2.3
2/08/2016	18.5	10.9	8.9	4.3	5.9	2.3	0.1	2.2	1.6	1.2
3/08/2016	16.8	16.0	5.0	6.0	3.3	0.0	0.0	4.6	0.5	0.0
4/08/2016	15.4	14.8	5.3	5.1	3.1	0.5	0.0	1.1	0.6	0.0
5/08/2016	9.4	8.8	3.8	3.9	2.4	10.2	0.0	-	2.2	0.1
6/08/2016	7.3	8.1	5.1	3.8	2.9	4.9	0.2	1.2	3.2	2.3
7/08/2016	7.9	8.3	5.4	4.2	4.1	3.0	0.4	2.3	2.3	0.0
8/08/2016	-	10.2	-	5.6	4.9	4.7	0.0	-	1.3	1.1
9/08/2016	-	-	-	-	7.0	4.7	6.6	22.2	11.9	1.7
10/08/2016	16.8	-	8.1	-	6.9	2.2	1.5	3.2	4.0	1.1
11/08/2016	9.6	8.4	5.3	2.7	2.7	0.9	0.5	2.9	6.3	0.2
12/08/2016	11.6	7.7	6.4	4.0	2.7	6.4	3.4	2.8	4.5	1.4
13/08/2016	14.7	9.9	9.1	6.5	6.6	2.7	0.0	3.1	3.0	0.3
14/08/2016	16.8	10.6	13.4	5.8	5.3	2.1	0.1	3.2	3.3	0.5
15/08/2016	20.9	14.8	8.6	5.5	5.0	3.9	1.2	-	1.5	2.0
16/08/2016	21.0	16.4	10.0	6.6	7.1	12.6	6.2	8.1	4.5	1.9
17/08/2016	18.6	12.7	9.9	5.4	6.1	1.9	1.0	1.8	1.5	2.7
18/08/2016	20.7	14.6	10.6	6.9	6.1	6.5	3.2	2.6	2.0	4.0
19/08/2016	23.5	16.0	13.1	7.1	8.6	3.5	8.8	7.8	4.5	8.0
20/08/2016	11.3	6.9	8.3	2.7	2.3	1.1	0.2	1.1	3.8	0.0
21/08/2016	13.8	9.4	7.8	5.4	4.6	3.3	3.4	3.5	7.5	3.0
22/08/2016	23.7	13.4	14.2	7.2	8.8	3.8	2.2	2.2	2.5	3.3
23/08/2016	9.0	10.7	4.4	5.4	3.3	4.7	0.5	1.8	3.2	0.5
24/08/2016	6.4	5.1	3.7	2.0	2.9	4.4	0.1	1.8	2.6	0.1
25/08/2016	7.4	6.4	5.7	3.0	2.5	1.6	0.0	2.5	6.2	0.1
26/08/2016	8.8	9.5	5.3	4.9	2.3	10.3	0.0	1.9	7.5	0.3
27/08/2016	13.2	9.4	10.3	3.8	6.7	5.0	0.0	-	2.7	1.3
28/08/2016	11.9	8.9	8.9	3.8	3.6	1.8	0.2	4.1	4.5	0.6
29/08/2016	17.2	10.5	8.4	5.3	6.3	5.0	0.7	6.1	3.9	5.6
30/08/2016	21.7	18.0	10.3	9.7	9.1	3.5	5.6	4.8	1.7	3.7
31/08/2016	18.9	14.0	11.1	8.2	9.0	5.9	1.6	3.1	8.3	1.8
1/09/2016	9.9	8.5	4.2	4.6	4.2	2.2	1.0	8.1	2.7	2.9
2/09/2016	9.3	8.7	6.8	7.6	8.5	2.1	3.1	1.9	2.3	2.3
3/09/2016	8.4	6.7	3.8	2.7	2.0	0.2	0.4	3.8	2.0	0.9
4/09/2016	10.9	7.4	7.5	4.1	-	0.2	0.0	1.8	1.4	0.4
5/09/2016	14.6	10.3	8.2	4.0	-	2.6	4.5	3.3	3.4	4.6
6/09/2016	16.6	15.7	6.9	6.6	-	2.1	3.5	2.1	2.7	4.0
7/09/2016	19.9	16.7	8.6	7.1	-	5.0	1.4	3.0	2.0	5.1
8/09/2016	16.5	16.9	7.5	7.8	8.1	3.9	10.4	1.7	2.0	7.3
9/09/2016	19.4	24.1	9.5	9.2	16.1	2.4	6.3	7.2	4.7	3.7
10/09/2016	8.8	5.9	5.5	2.3	3.6	0.9	2.1	1.4	0.6	2.9
11/09/2016	11.0	8.3	6.6	4.6	4.4	1.9	0.3	1.4	4.7	0.9
12/09/2016	16.9	16.7	6.9	6.6	5.6	3.2	0.0	8.1	1.8	3.1
13/09/2016	19.7	27.5	11.3	7.4	9.1	8.4	1.0	3.3	4.1	1.3
14/09/2016	10.8	8.4	8.2	5.7	7.9	8.0	2.5	4.2	5.8	2.2

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
15/09/2016	6.6	5.1	2.2	-	3.0	0.2	0.0	0.7	1.1	0.0
16/09/2016	9.4	8.2	4.0	4.0	6.3	0.5	0.0	2.0	3.7	0.9
17/09/2016	12.1	9.2	4.3	4.1	4.7	4.1	1.7	5.5	4.1	3.3
18/09/2016	11.3	9.2	8.4	6.7	8.8	2.7	1.1	1.7	3.3	0.3
19/09/2016	7.6	6.4	2.2	3.6	2.1	1.3	0.2	1.5	6.6	0.7
20/09/2016	13.4	9.6	4.8	3.5	3.8	2.4	1.1	7.9	5.3	8.6
21/09/2016	12.0	10.0	6.8	6.0	5.0	1.9	5.0	4.2	2.4	4.5
22/09/2016	6.9	8.6	4.3	2.0	5.5	0.0	0.4	1.1	10.2	0.3
23/09/2016	12.4	12.2	3.2	4.3	4.7	2.7	0.0	1.0	2.1	0.1
24/09/2016	12.6	10.8	6.3	5.5	4.7	5.6	0.1	2.9	4.5	0.0
25/09/2016	9.4	8.1	5.6	5.1	3.3	0.8	0.0	1.0	3.3	0.2
26/09/2016	9.5	11.4	4.0	2.6	4.9	1.0	0.0	3.5	5.3	1.6
27/09/2016	10.2	18.7	2.7	5.3	3.2	0.9	0.4	1.0	2.9	0.3
28/09/2016	14.6	17.7	5.2	5.5	4.2	5.5	0.5	5.4	2.5	2.7
29/09/2016	16.8	17.5	8.7	10.3	10.8	8.2	5.5	3.2	3.7	7.2
30/09/2016	14.5	14.0	3.8	3.1	2.5	4.8	-1.6	1.8	3.3	0.0
1/10/2016	9.8	8.2	3.6	3.5	3.1	1.8	-0.7	1.8	-	0.2
2/10/2016	13.3	10.1	5.1	4.3	4.5	6.8	0.6	5.7	3.4	1.7
3/10/2016	13.0	9.6	5.8	3.8	2.0	0.9	0.1	3.6	-	1.0
4/10/2016	15.1	13.5	3.5	4.2	2.8	2.5	0.0	0.9	-	0.0
5/10/2016	11.9	12.1	4.8	3.6	2.0	0.1	0.0	1.9	10.5	0.4
6/10/2016	21.3	22.4	6.5	6.5	7.1	4.7	0.0	3.0	1.3	1.9
7/10/2016	17.2	14.0	5.7	4.3	5.7	0.5	0.1	1.2	0.7	0.1
8/10/2016	27.2	22.3	7.8	9.0	6.6	3.6	0.0	1.4	1.7	0.4
9/10/2016	17.5	17.8	4.8	5.3	5.2	5.0	4.1	2.4	0.5	1.9
10/10/2016	26.3	17.3	8.6	5.3	8.7	3.5	1.5	4.6	5.6	0.8
11/10/2016	9.1	9.0	4.8	2.4	2.5	0.0	0.0	8.0	1.1	0.2
12/10/2016	12.7	13.0	4.9	5.0	3.6	1.7	0.5	5.8	1.4	3.2
13/10/2016	11.4	13.1	5.2	4.5	2.5	1.5	0.0	2.7	2.1	0.0
14/10/2016	12.9	12.4	5.5	4.0	4.1	2.2	0.1	7.0	2.0	1.7
15/10/2016	12.4	11.2	4.5	4.5	5.1	0.5	6.8	6.8	3.3	1.9
16/10/2016	13.0	23.7	5.5	4.6	7.0	0.9	0.7	5.7	2.4	3.1
17/10/2016	13.9	12.7	7.4	5.4	4.7	1.5	0.4	2.2	2.5	0.5
18/10/2016	10.5	7.0	3.3	3.0	4.5	0.5	0.0	1.6	-	1.3
19/10/2016	-	16.1	4.9	5.4	-	1.4	0.0	3.0	3.6	1.5
20/10/2016	-	16.3	3.2	4.7	-	1.0	1.6	0.9	1.0	1.1
21/10/2016	21.1	19.9	10.1	7.7	-	1.8	1.6	3.3	1.7	2.6
22/10/2016	7.9	7.6	5.8	5.4	6.3	2.7	0.0	2.0	1.2	0.7
23/10/2016	13.7	13.1	4.4	3.5	4.4	0.7	0.0	1.1	2.4	0.4
24/10/2016	14.1	15.3	5.1	4.0	3.1	0.8	0.0	16.1	2.1	0.7
25/10/2016	19.3	19.9	8.0	7.2	4.0	15.3	3.7	2.5	4.2	2.7
26/10/2016	18.0	14.3	5.3	4.2	2.6	1.6	0.7	1.8	1.9	1.6
27/10/2016	25.8	-	6.1	-	5.3	0.6	-	-	2.5	0.8
28/10/2016	12.2	-	4.0	-	2.7	0.0	-	-	0.4	0.0
29/10/2016	16.9	15.4	5.4	5.0	4.6	2.8	0.5	1.6	2.0	2.6
30/10/2016	12.7	13.8	6.8	4.7	5.5	1.5	1.0	-	2.7	1.6
31/10/2016	16.7	15.4	4.9	2.4	3.0	1.4	0.1	5.6	2.1	0.2
1/11/2016	17.0	15.2	5.2	5.3	2.6	5.7	0.7	3.1	2.2	10.0
2/11/2016	16.3	13.2	6.0	4.7	2.8	1.6	0.0	3.5	2.8	10.5
3/11/2016	23.0	19.1	11.6	6.3	6.0	2.7	0.7	10.1	1.2	8.1
4/11/2016	21.7	20.2	9.7	9.1	7.1	1.1	1.9	2.1	1.9	1.3
5/11/2016	22.2	26.5	9.1	5.3	3.6	1.8	0.6	4.4	2.6	0.5
6/11/2016	23.9	16.8	10.1	5.4	3.0	0.2	0.1	5.4	0.7	0.5
7/11/2016	65.5	29.5	50.7	13.9	21.1	10.3	1.4	2.8	3.1	1.8
8/11/2016	31.9	24.8	19.0	10.7	9.2	2.2	2.0	6.5	1.6	6.2
9/11/2016	19.8	18.6	8.9	5.8	5.7	1.8	0.0	11.6	0.2	1.3
10/11/2016	10.7	9.6	5.5	3.9	5.2	3.0	0.0	2.1	2.3	2.2
11/11/2016	14.0	13.6	4.4	5.8	5.9	2.1	0.0	-	1.2	10.9
12/11/2016	12.1	10.9	5.6	4.9	3.1	1.8	0.0	2.1	3.1	0.7
13/11/2016	14.6	13.3	5.8	2.3	3.1	0.3	0.1	1.4	1.8	0.0
14/11/2016	14.1	14.1	4.8	4.8	3.3	0.3	0.0	4.6	1.3	0.0
15/11/2016	16.4	15.8	5.8	5.9	5.2	1.9	0.0	3.2	1.3	0.7
16/11/2016	15.4	16.9	6.1	6.1	4.7	0.6	0.4	9.8	1.7	0.8
17/11/2016	17.7	17.6	5.7	5.1	5.1	1.5	3.0	5.2	1.9	4.8
18/11/2016	19.3	18.7	7.2	7.1	8.6	5.1	5.0	5.3	7.4	12.6

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
19/11/2016	31.0	31.1	10.3	12.4	10.6	0.7	0.0	5.7	1.8	0.0
20/11/2016	29.1	25.2	10.7	9.3	10.2	2.5	0.6	3.2	1.8	5.0
21/11/2016	25.7	27.1	10.9	10.5	13.5	6.6	9.9	8.0	5.0	9.6
22/11/2016	22.9	26.4	7.9	8.0	11.3	1.4	4.2	4.1	3.5	5.5
23/11/2016	26.7	23.6	9.4	6.6	10.9	5.5	4.1	6.3	2.6	6.7
24/11/2016	12.6	18.8	4.8	3.2	3.1	2.3	-0.1	2.2	2.0	1.7
25/11/2016	-	16.4	5.8	6.4	4.8	2.1	0.4	5.7	4.6	0.8
26/11/2016	25.7	23.6	7.8	7.6	7.2	3.4	0.5	4.9	1.2	4.2
27/11/2016	27.4	26.8	9.6	10.1	8.0	0.9	0.0	2.5	0.4	0.8
28/11/2016	31.7	36.0	11.6	10.6	13.6	4.3	6.0	2.0	0.9	24.6
29/11/2016	26.7	22.1	11.6	7.3	11.6	-	0.2	10.1	0.3	0.8
30/11/2016	17.9	18.1	7.8	6.7	8.2	1.7	1.6	2.2	0.5	9.3
1/12/2016	14.9	15.2	5.9	6.3	7.5	3.0	4.2	3.9	3.1	4.3
2/12/2016	26.0	22.9	8.3	8.0	8.1	5.4	1.0	3.9	4.7	5.2
3/12/2016	25.9	23.2	11.1	8.4	10.3	0.7	0.0	11.7	1.2	0.7
4/12/2016	27.2	22.7	12.5	9.7	12.8	2.3	2.5	4.5	1.3	5.4
5/12/2016	30.9	32.9	15.2	13.5	19.3	9.7	-	-	2.2	9.4
6/12/2016	30.8	25.2	13.1	11.6	11.4	11.2	-	-	4.7	0.0
7/12/2016	15.3	17.6	7.2	7.6	6.9	1.3	2.2	2.6	1.5	2.0
8/12/2016	15.3	18.6	7.5	6.4	13.2	3.4	12.2	6.6	2.5	14.5
9/12/2016	12.2	17.1	6.2	4.1	4.1	1.3	0.0	4.2	2.2	0.0
10/12/2016	-	25.9	7.9	8.0	8.3	1.1	0.0	4.6	1.5	5.7
11/12/2016	-	22.9	8.9	8.1	9.3	3.0	3.2	9.7	1.7	10.0
12/12/2016	-	25.3	7.9	5.6	8.6	3.1	9.9	5.3	3.7	12.1
13/12/2016	24.0	25.6	9.6	7.8	11.4	1.4	1.9	2.4	2.7	1.9
14/12/2016	-	27.4	9.2	10.2	12.9	5.9	0.4	3.7	6.2	0.7
15/12/2016	-	11.7	5.7	5.6	3.6	-	0.0	2.3	1.1	0.0
16/12/2016	10.2	8.5	4.4	4.0	6.6	-	0.4	1.9	-	0.6
17/12/2016	19.3	14.4	8.0	7.3	8.9	1.4	0.4	2.6	3.2	0.2
18/12/2016	35.2	33.4	11.4	9.3	8.7	0.3	-0.1	7.0	-	0.0
19/12/2016	16.7	13.7	4.4	3.2	4.0	1.4	1.0	3.2	3.1	2.6
20/12/2016	23.9	26.7	8.2	8.1	8.8	4.6	3.5	-	4.1	2.2
21/12/2016	34.3	32.1	13.1	11.4	-	6.2	0.0	7.0	1.2	0.0
22/12/2016	24.2	30.5	8.5	6.9	-	3.1	0.0	1.4	-	13.5
23/12/2016	22.0	16.2	5.9	5.1	3.3	2.4	0.0	0.8	0.5	0.1
24/12/2016	18.4	18.4	8.4	6.8	5.9	3.9	3.4	4.5	1.3	8.3
25/12/2016	16.8	16.3	5.5	4.9	4.1	2.1	1.2	2.2	-	0.6
26/12/2016	17.7	19.3	5.5	4.4	4.8	1.7	3.1	2.2	-	1.8
27/12/2016	21.7	23.0	7.9	7.9	7.2	3.9	1.7	3.2	2.8	3.9
28/12/2016	19.7	24.6	6.5	5.7	5.2	2.1	4.6	3.7	1.5	2.5
29/12/2016	20.2	24.5	8.8	10.6	6.3	3.2	3.4	3.3	-	3.2
30/12/2016	32.4	27.6	11.3	11.2	12.6	8.3	7.3	4.9	-	4.9
31/12/2016	31.8	25.0	13.1	10.3	10.7	5.2	1.6	7.6	-	1.1

- Not applicable

Table C-2: 24-hour average HVAS monitoring data

Date	PM_{10} (HVAS) (µg/m³)		Date	PM_{10} (HVAS) (µg/m³)	
	Wakefield (Westside)	Teralba		Wakefield (Westside)	Teralba
6/01/2016	11	15	10/07/2016	5	9
12/01/2016	27	25	16/07/2016	12	15
18/01/2016	6	5	22/07/2016	6	8
24/01/2016	25	25	28/07/2016	2	3
30/01/2016	19	22	3/08/2016	1	2
5/02/2016	21	19	9/08/2016	11	12
11/02/2016	5	9	15/08/2016	8	13
17/02/2016	18	22	21/08/2016	4	6
23/02/2016	6	8	27/08/2016	4	7
29/02/2016	7	10	2/09/2016	2	6
6/03/2016	11	16	8/09/2016	6	10
12/03/2016	20	23	14/09/2016	7	8
18/03/2016	12	12	20/09/2016	1	5
24/03/2016	4	13	26/09/2016	5	8
30/03/2016	14	17	2/10/2016	5	7
5/04/2016	9	22	8/10/2016	14	14
11/04/2016	24	28	14/10/2016	5	9
17/04/2016	18	16	20/10/2016	9	13
23/04/2016	15	20	26/10/2016	10	12
29/04/2016	11	24	1/11/2016	9	13
5/05/2016	12	16	7/11/2016	33	55
11/05/2016	12	14	13/11/2016	11	21
17/05/2016	19	18	19/11/2016	22	24
23/05/2016	18	27	25/11/2016	5	8
29/05/2016	4	3	1/12/2016	14	15
4/06/2016	5	7	7/12/2016	9	7
10/06/2016	3	2	13/12/2016	18	22
16/06/2016	4	12	19/12/2016	12	11
22/06/2016	2	4	25/12/2016	11	13
28/06/2016	1	6	31/12/2016	23	25
4/07/2016	6	11			

TODOROSKI AIR SCIENCES

LAKE MACQUARIE – WYONG

REVIEW OF ANNUAL AMBIENT AIR QUALITY DATA 2017

Delta Electricity & Origin Energy

22 February 2019

Job Number 18120902

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Lake Macquarie – Wyong

Review of Annual Ambient Air Quality Data 2017

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	12/02/2019	I Casasola, K Trahair	D Kjellberg
DRAFT - 002	21/02/2019	K Trahair	D Kjellberg
FINAL - 001	22/02/2019	K Trahair	D Kjellberg

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EXECUTIVE SUMMARY

This report has been prepared by Todoroski Air Sciences for Delta Electricity and Origin Energy and presents ambient air quality monitoring data recorded in the Lake Macquarie - Wyong region for the 2017 calendar year. The results indicate that the air quality was generally good in the Lake Macquarie - Wyong region during 2017.

The data summary (shown below) indicates that in 2017, the Wyee and Wyong monitoring sites recorded 24-hour particulate levels above the relevant criteria. The Wyee monitor recorded elevated 24-hour average $PM_{2.5}$ levels on 26 and 27 August 2017. The Wyong monitor recorded elevated 24-hour average $PM_{2.5}$ levels on 12 September 2017 and elevated 24-hour average PM_{10} levels on 24 September 2017. All other data were below the applicable criteria. Further details are provided in the report and the 24-hour average data are provided in the Appendices.

Lake Macquarie - Wyong Air Quality Pictorial Summary – 2017

Short term averages (1-hour and 24-hour)

Long term average (annual)

Lake Macquarie – Wyong Air Quality Tabular Summary - 2017

Site	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2
	Maximum 1-hour average (µg/m³)		Maximum 24-hour average (µg/m³)			Annual average (µg/m³)			
	Air Quality Impact Criteria								
	570	246	50	25	228	25	8	60	62
Wallsend	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wyong	✓	✓	×	×	✓	✓	✓	✓	✓
Dora Creek	✓	✓	-	-	✓	-	-	✓	✓
Marks Point	✓	✓	-	-	✓	-	-	✓	✓
Wyee	✓	✓	-	×	✓	-	✓	✓	✓
Wakefield HVAS	-	-	✓	-	-	✓*	-	-	-
Teralba HVAS	-	-	✓	-	-	-	-	-	-

✓ - All data below applicable criteria
× - At least one elevated level above applicable criteria
\- - Not applicable
HVAS - High Volume Air Sampler
* - Less than 75% of data were available for the second and third quarters of the year

1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of Delta Electricity and Origin Energy. It provides a summary and analysis of the available ambient air quality and meteorological data collected in the Lake Macquarie - Wyong region during the 2017 calendar year.

2 PROJECT SCOPE

The following outlines the scope of work for this project.

- Provide an annual summary report for the 2017 calendar year for Lake Macquarie – Wyong. The report will examine compliance with annual average criteria and summarise all of the monthly reported data for the calendar year and include seasonal trends and pollution rose analysis to identify likely source categories for elevated pollution events.
- The report will assess the available data from monitoring stations operated by the NSW Office of Environment and Heritage (OEH) at Wyong and Wallsend, and by industry at Wyee, Marks Point, Dora Creek, Wakefield and Teralba.
- The aim is to provide a simplified report which is accessible and contains results that would be clearly understood by the general public.

3 THE PURPOSE OF AMBIENT MONITORING

It is important to note that the data presented in this report are from both NSW EPA and industry monitoring sites. The NSW EPA and the industry sites collect data for different purposes and this needs to be understood when comparing the data to the criteria.

NSW EPA monitoring sites are specifically designed to measure the likely levels of pollutants that the general population in the area would experience (i.e. an underlying population exposure level), whereas industry monitoring sites are specifically designed to measure maximum levels in a particular location which may be affected by a particular industry.

Data from NSW EPA sites can be compared with national air quality standards. Where the levels measured at NSW EPA monitoring sites are above the national standards on a prolonged and consistent basis, this indicates that some investigation of the potential cause of the issue may be warranted to determine whether any action on a regional level would reduce or better manage the pollutant levels. In the case of PM_{10}, it is noted that the national standards permit five days annually above the criteria to allow for events such as bushfires and dust storms.

Data from industry monitoring sites can be compared with NSW EPA impact assessment criteria. Where the levels measured at industry monitoring sites are above the applicable impact assessment criteria on a prolonged and consistent basis, this indicates that further investigation is warranted to determine the potential cause and what action is required by industry to reduce or better manage the pollutant.

Whether there is any harmful effect on an individual due to an air pollutant will depend on many additional factors, and not just on the measured level of a pollutant. These factors include the total exposure to the pollutant, individual circumstances (age, health, body mass, levels of pollutants at work), levels of other pollutants in the area, and many other factors. Where pollutant levels are below the

criteria generally, harm would not be expected to occur, but it does not follow that harm automatically occurs when pollutant levels are above the criteria.

The criteria serve to highlight potential issues with the levels of pollutants that may warrant more detailed examination. The criteria may also serve to prioritise action in various areas, for example areas with the highest pollutant levels and highest populations or highest exposure would be expected to receive priority action.

3.1 More about air quality

More information about air quality can be found via the following links:

- The Air Quality Index (AQI) was developed by the NSW EPA as an easily understood means of rating the pollutant level relative to its pollutant criteria.
  - https://www.environment.nsw.gov.au/topics/air/understanding-air-quality-data/air-quality-index
- Aqicn.org provides a near real-time AQI values for monitoring locations around the world. It should be noted that the AQI presented on this website is calculated differently to the NSW EPA AQI and is less stringent than those used in Australia, thus a direct comparison may not be valid.
  - http://aqicn.org/map/world/
- The NSW OEH website air quality page provides hourly updates of the AQI and data readings from the NSW EPA monitoring sites, and can provide daily forecasts for Sydney and alerts for elevated levels at Wallsend and Wyong, for example. The web tool also presents near real-time wind and pollutant data readings overlaid on regional maps for the Upper Hunter and Newcastle.
  - http://www.environment.nsw.gov.au/aqms/aqi.htm
- The Lower Hunter Particle Characterisation Study was commissioned to determine the composition of particulate samples collected at monitoring sites at Beresfield, Newcastle, Stockton and Mayfield, and to identify the potential major sources of fine particulates in Newcastle and the Lower Hunter.
  - https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/lower-hunter-particle-characterisation-study-final-report-160243.pdf
- The Air Emissions in My Community web tool presents the estimated emission quantities of various substances and their sources by postcode (and larger) sized areas in an easy to use graphical interface. This is one of the best inventories of emissions that is available, but it is important to appreciate that it cannot include all sources of emissions. It is important to also understand that pollutant emissions are not the same as the pollutant levels that this report presents. Emissions in a given area are one of several important factors that affect pollutant levels in an area, for example the dispersion of the emissions in the atmosphere and how the emissions are released are critical in determining the air quality pollutant levels.
  - https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-my-community/air-emissions-in-my-community-tool

- The NSW Health website provides information on how air pollution affects health and steps for reducing your air pollution and limiting your exposure.
  - http://www.health.nsw.gov.au/environment/air/Pages/default.aspx

4 AIR QUALITY MONITORING SITES

Figure 4-1 and **Table 4-1** summarise the locations and recorded parameters of the monitoring sites in the Lake Macquarie - Wyong region in 2017.

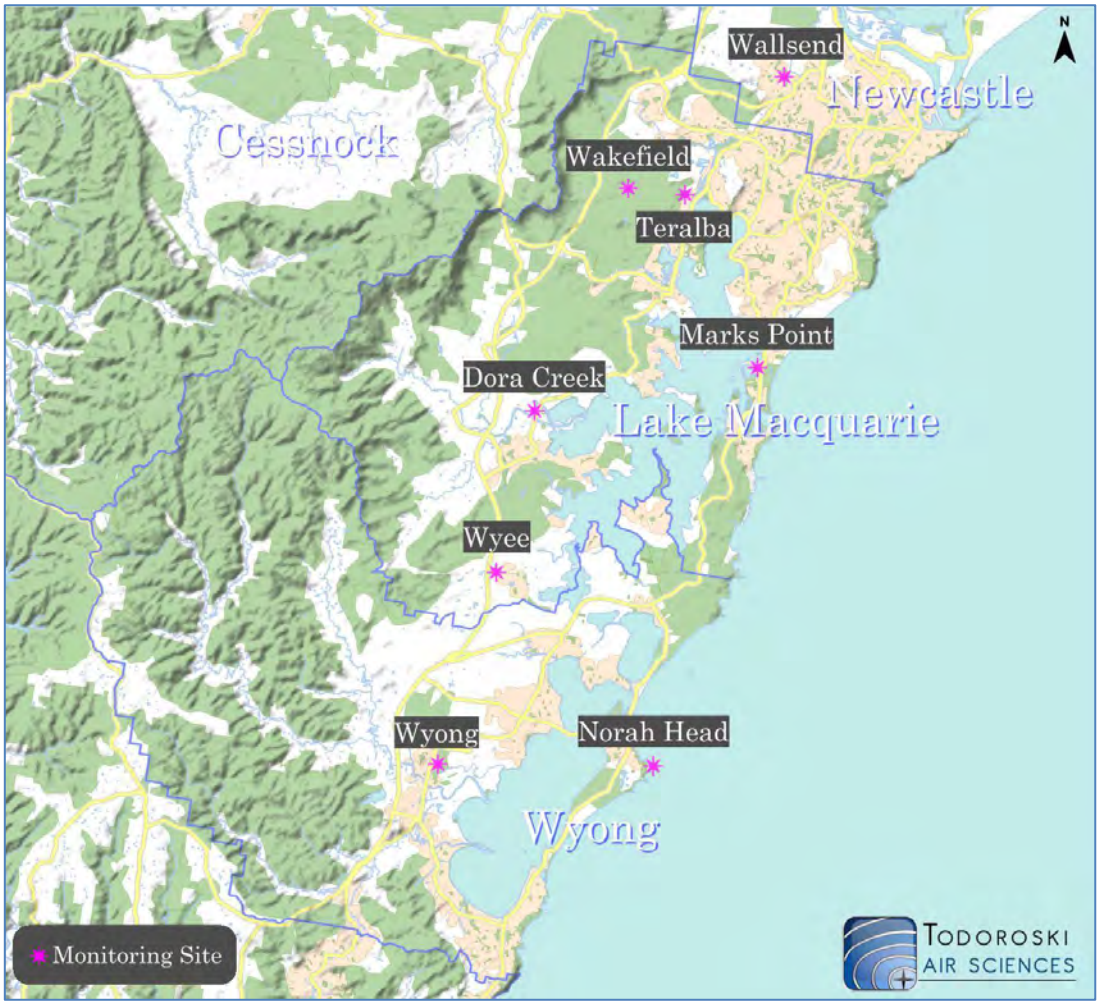

Figure 4-1: Monitoring site locations

Table 4-1: Monitoring sites

Monitoring Station	Type	Recorded Parameters	Recording Periods
Wallsend	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Wyong	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Marks Point	Industry site	NO_2, SO_2, WS, WD	Hourly
Wyee	Industry site	$PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly
Dora Creek	Industry site	NO_2, SO_2, WS, WD	Hourly
Norah Head	BOM weather station	WS, WD	Hourly
Wakefield HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day
Teralba HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day

PM_{10} - Particulate matter < 10µm
$PM_{2.5}$ - Particulate matter < 2.5µm
TEOM - Tapered Element Oscillating Microbalance (which samples air continuously)
NO_2 - Nitrogen dioxide
SO_2 - Sulfur dioxide
HVAS - High volume air sampler (which samples for a 24-hour period every 6 days)
WS - Wind speed
WD - Wind direction
BOM - Bureau of Meteorology

5 AIR QUALITY CRITERIA

The sections below identify the key pollutants currently being monitored at the Lake Macquarie - Wyong air quality monitoring sites and the applicable air quality criteria.

5.1 Particulate matter

Particulate matter consists of particles of varying size and composition. The total mass of all particles suspended in air is defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

The TSP is defined further into two sub-components. They are PM_{10} particles, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

Table 5-1 summarises the air quality goals that are relevant to particulate pollutants as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW EPA, 2017**).

Table 5-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Criterion
Total suspended particulates (TSP)	Annual	90µg/m^3
Particulate Matter < 10µm (PM_{10})	Annual	25µg/m^3
	24-hour	50µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual	8µg/m^3
	24-hour	25µg/m^3

Source: **NSW EPA, 2017**

5.2 Other air pollutants

Nitrogen dioxide (NO_2) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called nitrogen oxides (NO_x). These gases form when fuel is burned at high temperatures, and mainly originates from motor vehicles, power generators and industrial boilers (**USEPA, 2013**). NO_x may also be generated by blasting activities. It is important to note that when formed, NO_2 is generally a small fraction of the total NO_x generated.

Sulfur dioxide (SO_2) is a colourless gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulfur content of the fuel. SO_2 can have impacts upon human health and the habitability of the environment for flora and fauna. SO_2 emissions are a precursor to acid rain, which can be an issue in the northern hemisphere; however it is not known to be an issue in NSW.

Table 5-2 summarises the air quality goals for NO_2 and SO_2.

Table 5-2: Air quality impact assessment criteria for air pollutants

Pollutant	Averaging period	Criterion
Nitrogen Dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Sulfur Dioxide (SO_2)	10-minute	712µg/m^3
	1-hour	570µg/m^3
	24-hour	228µg/m^3
	Annual	60µg/m^3

Source: **NSW EPA, 2017**

5.3 Summary of applicable criteria for this review

The particulate and gaseous pollutants monitored in the Lake Macquarie – Wyong region have air quality criteria which are averaged over short and long time periods.

As this report looks at an annual period of ambient air quality data, the annual average criteria are applicable along with those averaged over the shorter time periods (1-hour and 24-hours). The SO_2 10-minute average criterion was not included as 10-minute monitoring data are not available.

Table 5-3 summarises the applicable air quality criteria for this review.

Table 5-3: Air quality criteria used in this review

Pollutant	Averaging Period	Concentration
Particulate Matter < 10µm (PM_{10})	24-hour	50µg/m^3
	Annual	25µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m^3
	Annual	8µg/m^3
Nitrogen Dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Sulfur Dioxide (SO_2)	1-hour	570µg/m^3
	24-hour	228µg/m^3
	Annual	60µg/m^3

6 METEOROLOGICAL MONITORING DATA

Representative wind speed and direction data have been obtained from the Lake Macquarie - Wyong meteorological stations. The data are presented as a series windroses.

For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

Figure 6-1 presents the 2017 annual windroses for Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong. Seasonal windroses for the meteorological stations are presented in **Figure 6-2** and **Figure 6-3**.

The annual windroses show that the meteorological stations recorded winds which varied depending on the local influence of environmental features such as terrain, vegetation and buildings.

The meteorological stations generally recorded winds which originated from the north-easterly and south-easterly quadrants during summer. The recorded wind directions in spring and autumn were more varied, with low wind speeds from common at Wyong, Wyee and Dora Creek. The meteorological stations generally recorded winds which originated from the north-westerly quadrant during winter.

The Norah Head weather station recorded wind speeds which were generally higher than those recorded at the other stations. This is expected as the Norah Head weather station is located in an unsheltered coastal location that would be largely influenced by sea breezes.

There is a lack of data recorded for wind directions from the north, approximately between 350^{o} and 10^{o} at the Wyee meteorological station. This is a historically common, and inherent limitation of some weather sensors that cannot physically measure a segment of the 360 degrees of possible wind directions, (almost always the north segment), but it may also be a software or signal processing issue, and it is recommended that the issue be investigated further and rectified.

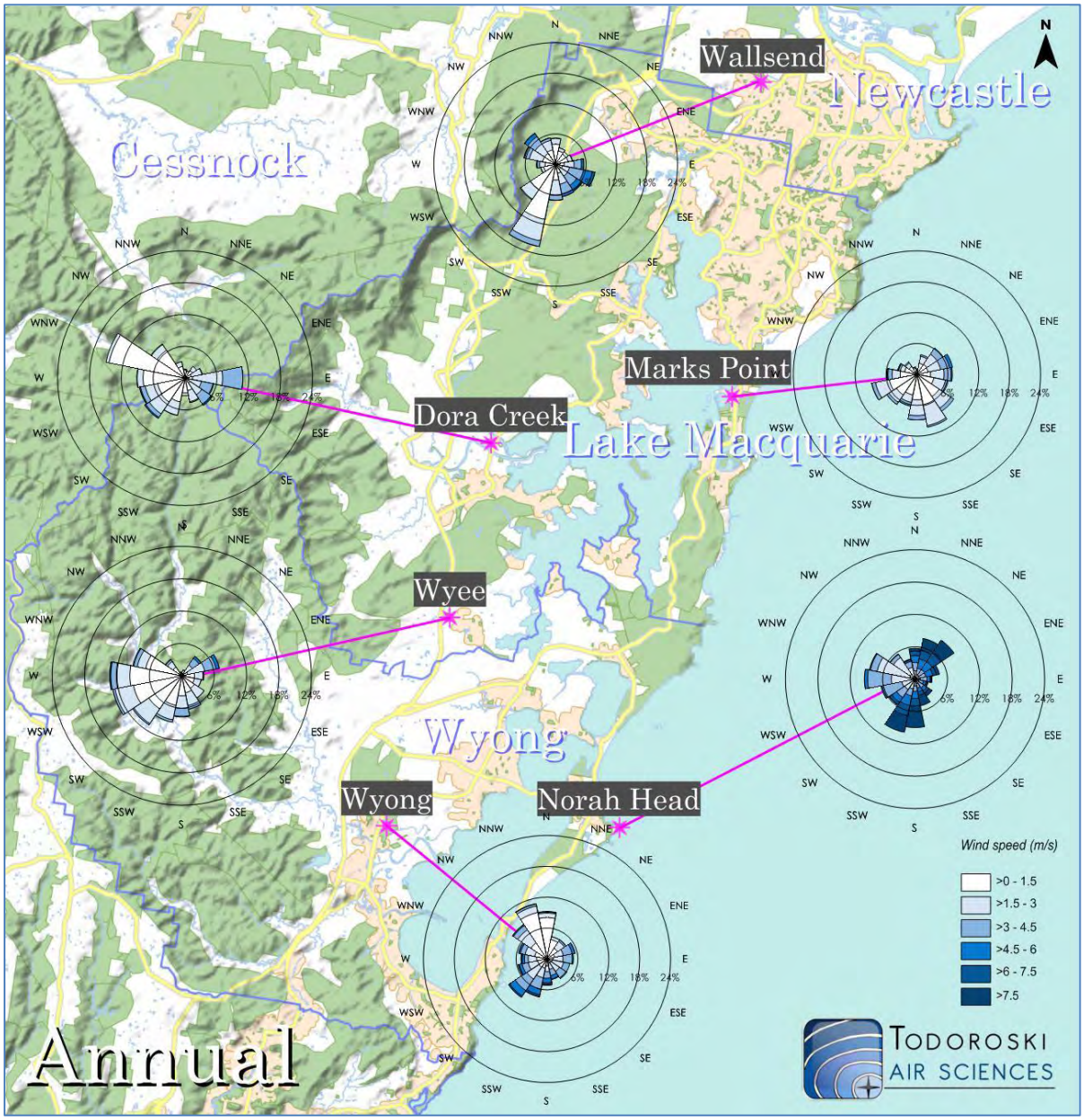

Figure 6-1: Annual 2017 windroses - Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong

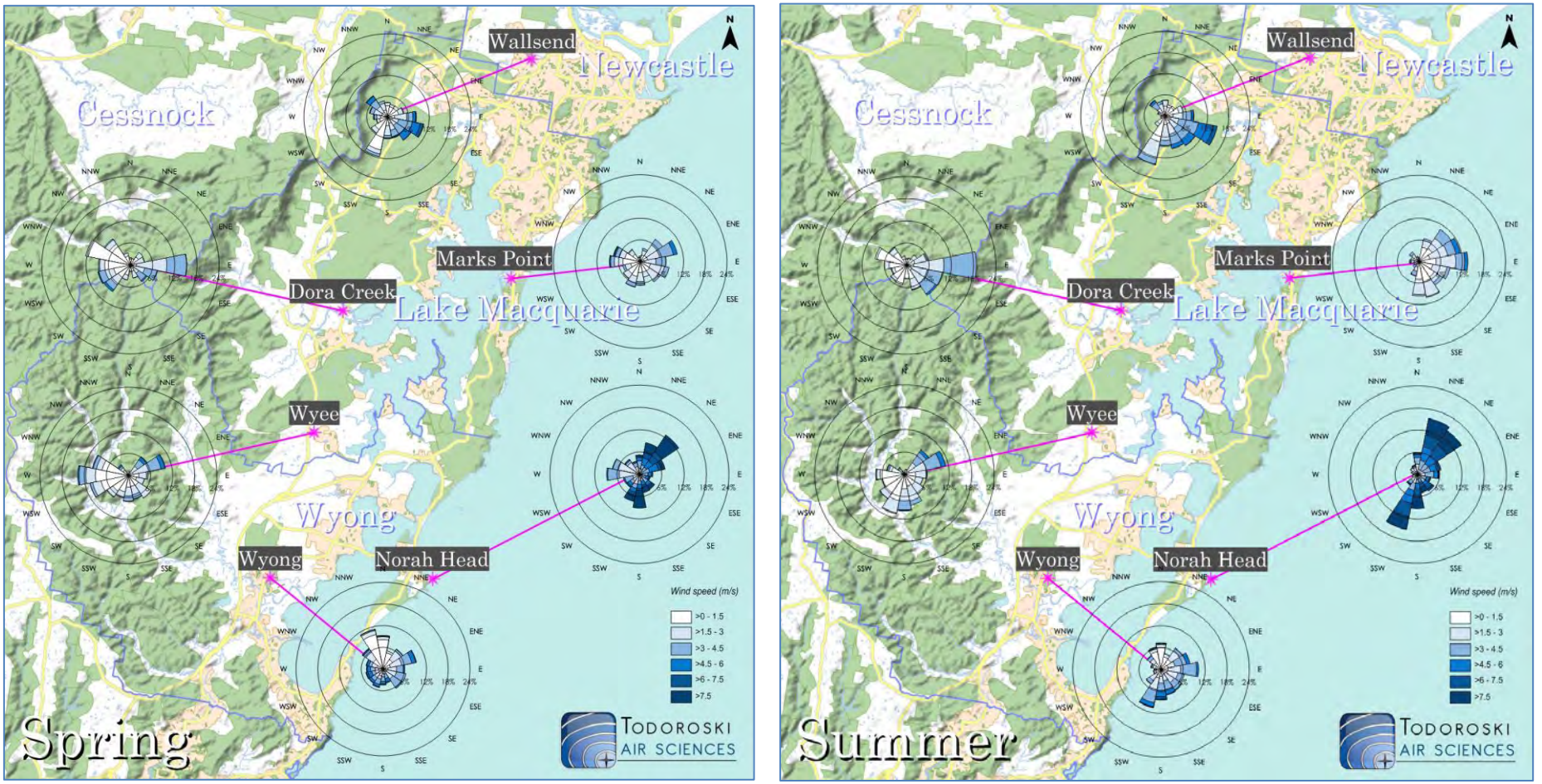

Figure 6-2: Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong windroses – Spring 2017 (left) and Summer 2017 (right)

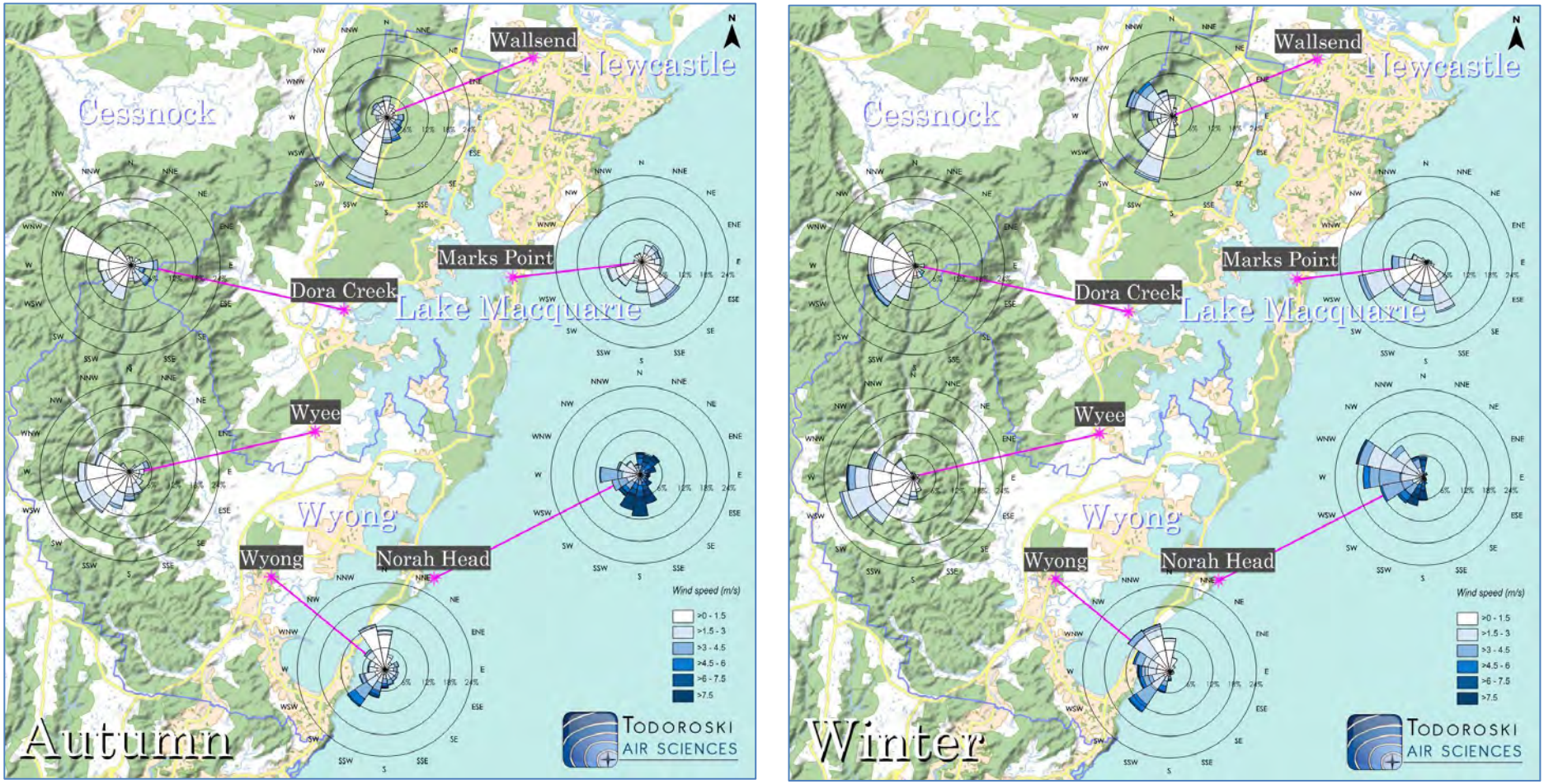

Figure 6-3: Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong windroses – Autumn 2017 (left) and Winter 2017 (right)

7 AMBIENT AIR QUALITY MONITORING DATA

7.1 Preamble

The monitoring data in this report are presented in raw form as provided to Todoroski Air Sciences by Delta Electricity and Origin Energy, or is available publically on industry and EPA websites.

The 24-hour average data presented in this report have been averaged using the 1-hour average readings. Days which contain less than 75% data (less than 18 hours of 1-hour average data) have not been included in this report.

The annual average data presented in this report have been averaged using the 1-hour average readings for SO_2 and NO_2, and 24-hour average readings for PM_{10} and $PM_{2.5}$. Annual averages with less than 75% data in a calendar quarter have been included but have not been assessed.

All of the monitoring data provided to, and obtained by Todoroski Air Sciences are presented in this report. The data are shown in the results and Appendices as relevant. 1 hour, 24-hour and annual average data are presented in a graphical format in **Appendix B** and 24-hour average data are presented in tabulated format in **Appendix C** for pollutants with applicable 24-hour average criteria.

Hourly averaged pollutant monitoring data were combined with wind speed and direction data to provide an understanding of the conditions in which high pollutant levels most frequently occur. The data are presented as pollution roses in **Appendix B**. For an example pollution rose, refer to **Figure A-2** in **Appendix A**.

7.2 Analysis of Monitoring Data

Table 7-1 presents a summary of the pollutant levels measured during 2017. The results indicate that pollutant levels were below the applicable criteria for all monitors, except for the Wallsend and the Teralba monitors.

Table 7-1: Maximum and annual average pollutant levels - 2017

Site	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2
	Maximum 1-hour average (µg/m³)		Maximum 24-hour average (µg/m³)			Annual average (µg/m³)			
	Air Quality Impact Criteria								
	570	246	50	25	228	25	8	60	62
Wallsend	159.9	75.9	47.9	20.4	26.4	17.4	7.3	4.0	15.7
Wyong	134.2	104.7	**63.4**	**27.2**	19.0	16.1	5.8	1.6	10.2
Dora Creek	124.2	103.3	-	-	17.1	-	-	3.4	10.3
Marks Point	110.6	64.0	-	-	17.0	-	-	3.3	10.5
Wyee	134.9	143.7	-	**73.0**	21.0	-	6.7	2.1	20.7
Wakefield HVAS	-	-	33.0	-	-	11.6*	-	-	-
Teralba HVAS	-	-	35.0	-	-	14.3	-	-	-

*Less than 75% of data were available for the second and third quarters of the year

- Not applicable

7.3 PM_{10}

Figure 7-1 presents all of the 24-hour average PM_{10} monitoring results recorded in the Lake Macquarie - Wyong region in 2017.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, PM_{10} levels were generally very good or good at all monitors in 2017. The Wyong and Wallsend monitors recorded fair levels on five and eight days respectively. The Wyong monitor recorded one day with poor levels in 2017.

All 24-hour average and annual average PM_{10} levels recorded at the Lake Macquarie - Wyong monitoring sites were below the applicable PM_{10} criteria in 2017, except at the Wyong monitor which recorded an elevated 24-hour average PM_{10} level on 24 September 2017.

Figure B-1 to **Figure B-2** in **Appendix B** present the 1-hour average, 24-hour average and annual average PM_{10} data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM_{10} levels and these 1-hour results are not intended to be compared with the PM_{10} criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM_{10} levels will fluctuate more significantly than 24-hour average PM_{10} levels.

Figure B-3 presents pollution roses of the PM_{10} monitoring data collected by the Wallsend and Wyong monitoring sites in 2017.

7.4 $PM_{2.5}$

Figure 7-2 presents all of the 24-hour average $PM_{2.5}$ monitoring data recorded in the Lake Macquarie - Wyong region in 2017.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate that $PM_{2.5}$ levels were generally very good to good in 2017. The Wallsend monitor recorded four days with fair levels, the Wyong monitor recorded three days with fair levels and the Wyee monitor recorded five

days with fair levels. The Wyong monitor recorded one day with poor levels and the Wyee monitor recorded one day with poor levels and one day with hazardous levels.

The Wyee monitor recorded elevated $PM_{2.5}$ levels above the criteria of 25µg/m^3 on 26 and 27 August 2017 and the Wyong monitor recorded elevated $PM_{2.5}$ levels on 12 September 2017. All other $PM_{2.5}$ data recorded at the Lake Macquarie - Wyong monitoring sites were below the applicable $PM_{2.5}$ criteria in 2017.

Figure B-4 to **Figure B-6** in **Appendix B** present the 1-hour average, 24-hour average and annual average $PM_{2.5}$ data in graphical form for each individual site. There is no criterion that applies to 1-hour average $PM_{2.5}$ levels and these 1-hour results are not intended to be compared with the $PM_{2.5}$ criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average $PM_{2.5}$ levels will fluctuate more significantly than 24-hour average $PM_{2.5}$ levels.

We note that the monitoring sites recorded on occasion periods in which $PM_{2.5}$ levels were less than zero. In some situations the concentration of the pollutant being measured may be very close to zero, in which case the measured value (after adjusting for drift of zero and span and any other corrections) may be less than the measurement limit of detection (**NEPC, 2001**), and in these circumstances the output may be negative.

The monitors may also record short term positive or negative values due to instrument faults, the presence of moisture within the instrument or volatile matter (which can register as a solid mass at first, but then evaporates, registering negative mass at a later time).

Figure B-7 to **Figure B-8** present pollution roses of the $PM_{2.5}$ monitoring data collected by the Wallsend, Wyong and Wyee monitoring sites in 2017.

7.5 NO_2

Figure 7-3 presents the 1-hour average NO_2 monitoring data recorded in the Lake Macquarie - Wyong region in 2017.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the measured levels of NO_2 were very good or good at all monitors at all times. All 1-hour average and annual average data were below the applicable criteria in 2017.

Figure B-9 to **Figure B-11** present pollution roses of the NO_2 monitoring data collected by the monitoring sites in 2017.

7.6 SO_2

Figure 7-4 and **Figure 7-5** present the 24-hour average SO_2 monitoring data recorded in the Lake Macquarie - Wyong region in 2017 respectively.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the SO_2 levels were very good at all monitors at all times. All 1-hour average and annual average data were below the applicable criteria in 2017.

Figure B-12 to **Figure B-14** present pollution roses of the SO_2 monitoring data collected by the monitoring sites in 2017.

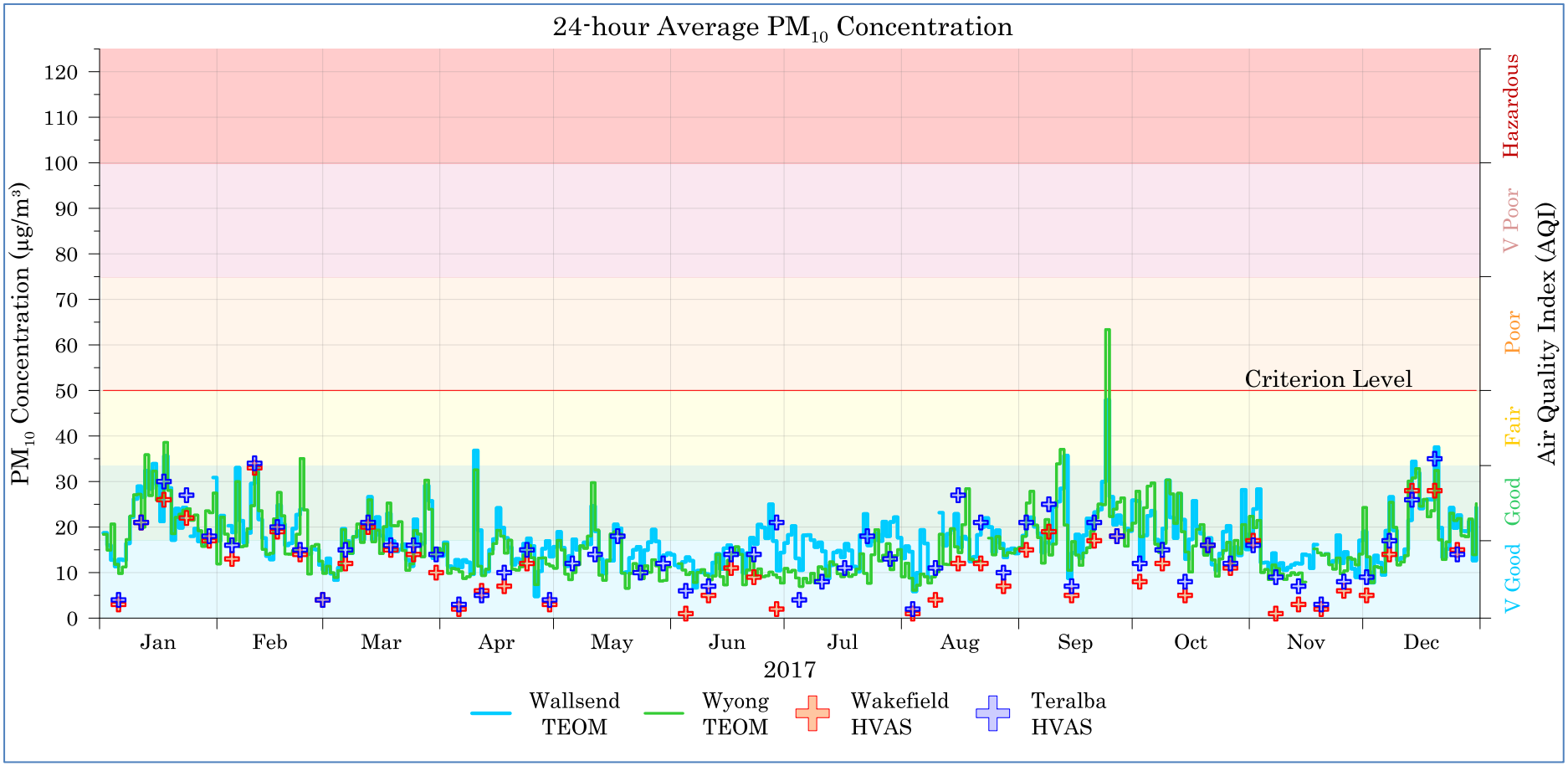

Figure 7-1: Lake Macquarie - Wyong 24-hour average PM_{10} levels – 2017

The recorded PM_{10} levels were generally very good or good at all monitors in 2017. The Wyong, Wallsend and Teralba monitors recorded fair levels on five, eight and two days respectively. The Wyong monitor recorded one day with poor levels in 2017. All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average criterion of 50µg/m³, except at Wyong, which recorded an elevated 24-hour average PM_{10} level on 24 September 2017.

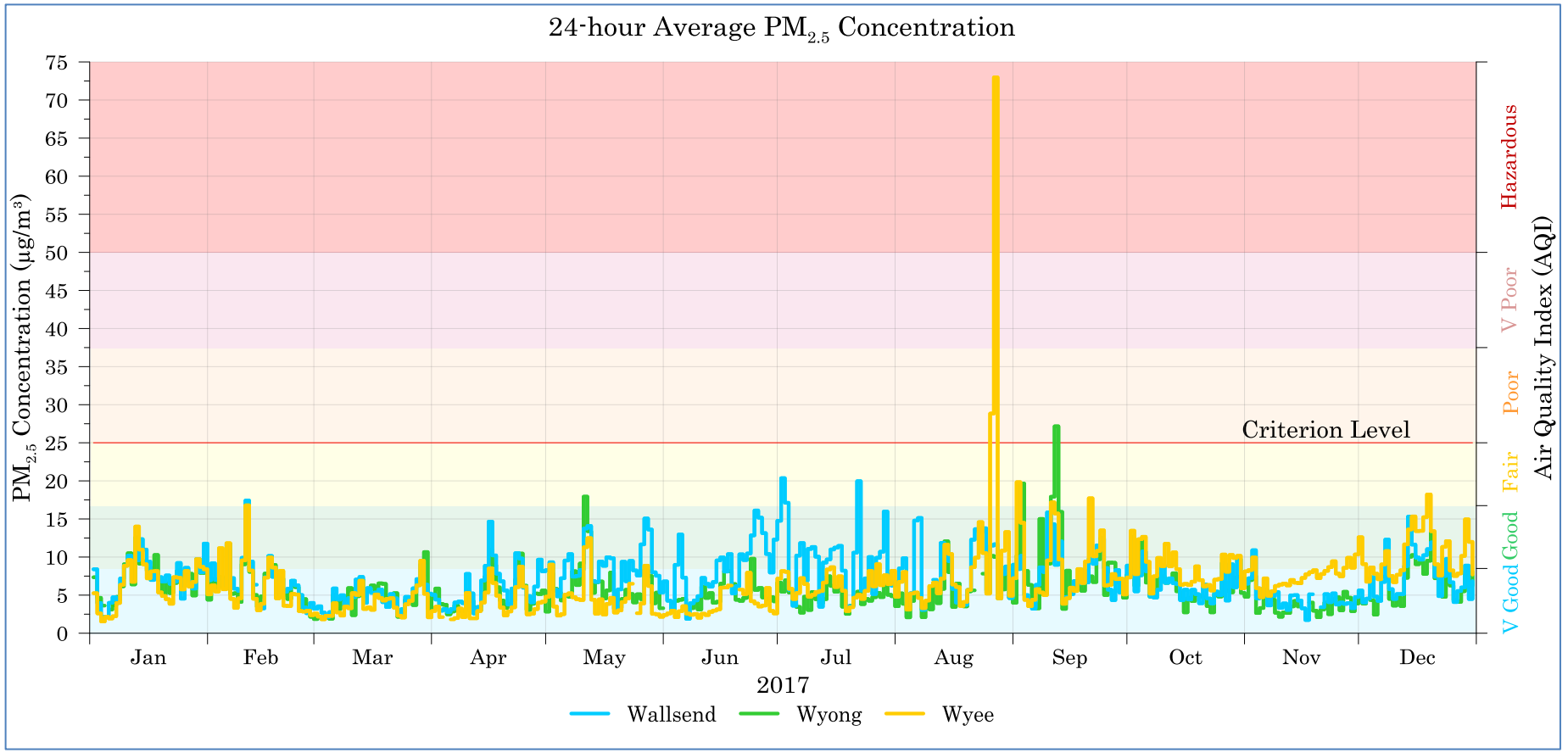

Figure 7-2: Lake Macquarie - Wyong 24-hour average $PM_{2.5}$ levels – 2017

The recorded $PM_{2.5}$ levels were generally very good to good in 2017. The Wallsend monitor recorded four days with fair levels, the Wyong monitor recorded three days with fair levels and the Wyee monitor recorded five days with fair levels. $PM_{2.5}$ levels were above the criterion of 25µg/m^3 on 26 and 27 August 2017 at the Wyee monitor and on 12 September 2017 at the Wyong monitor.

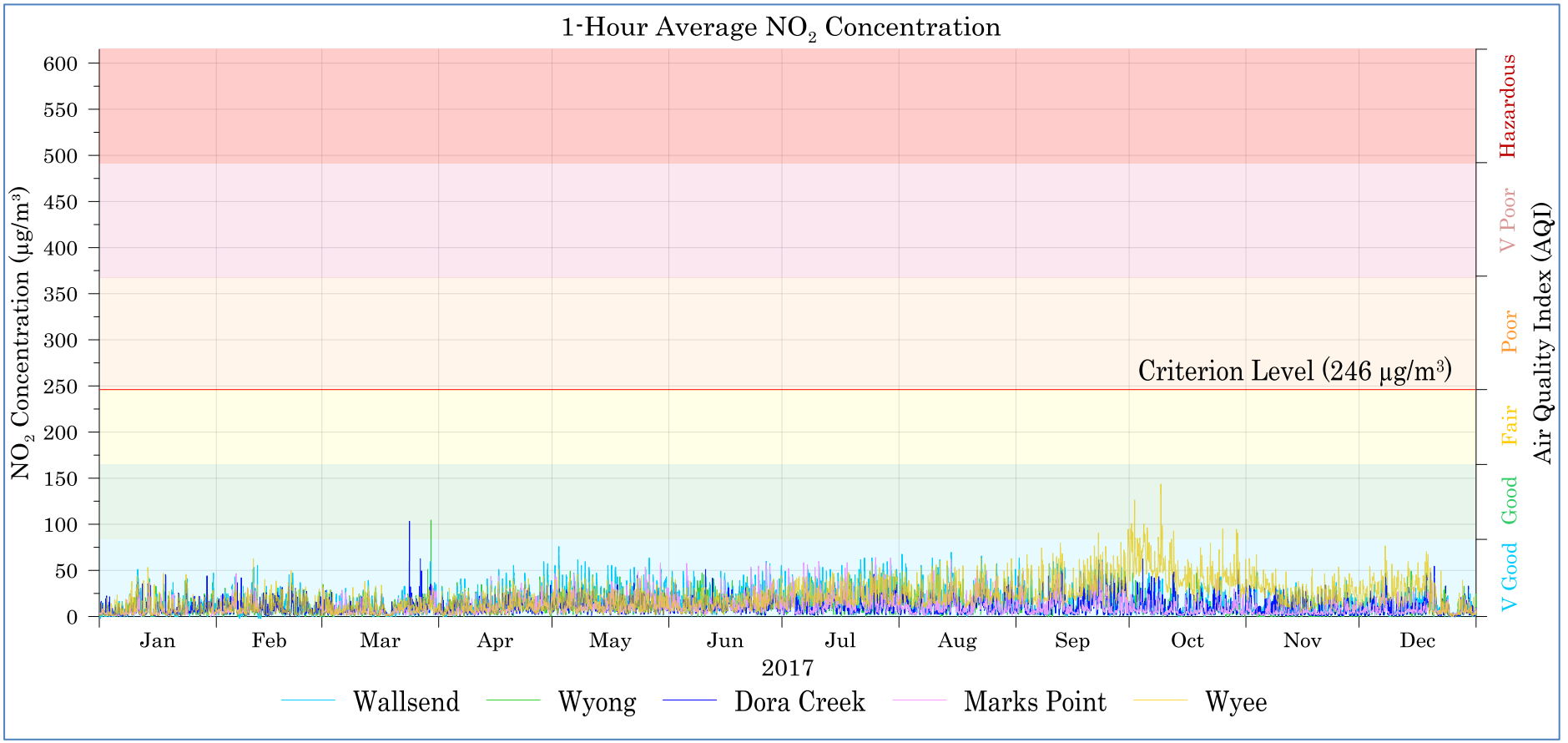

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2017

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average NO_2 criterion level of 246µg/m^3 in 2017. Measured levels of NO_2 were very good or good at all monitors at all times.

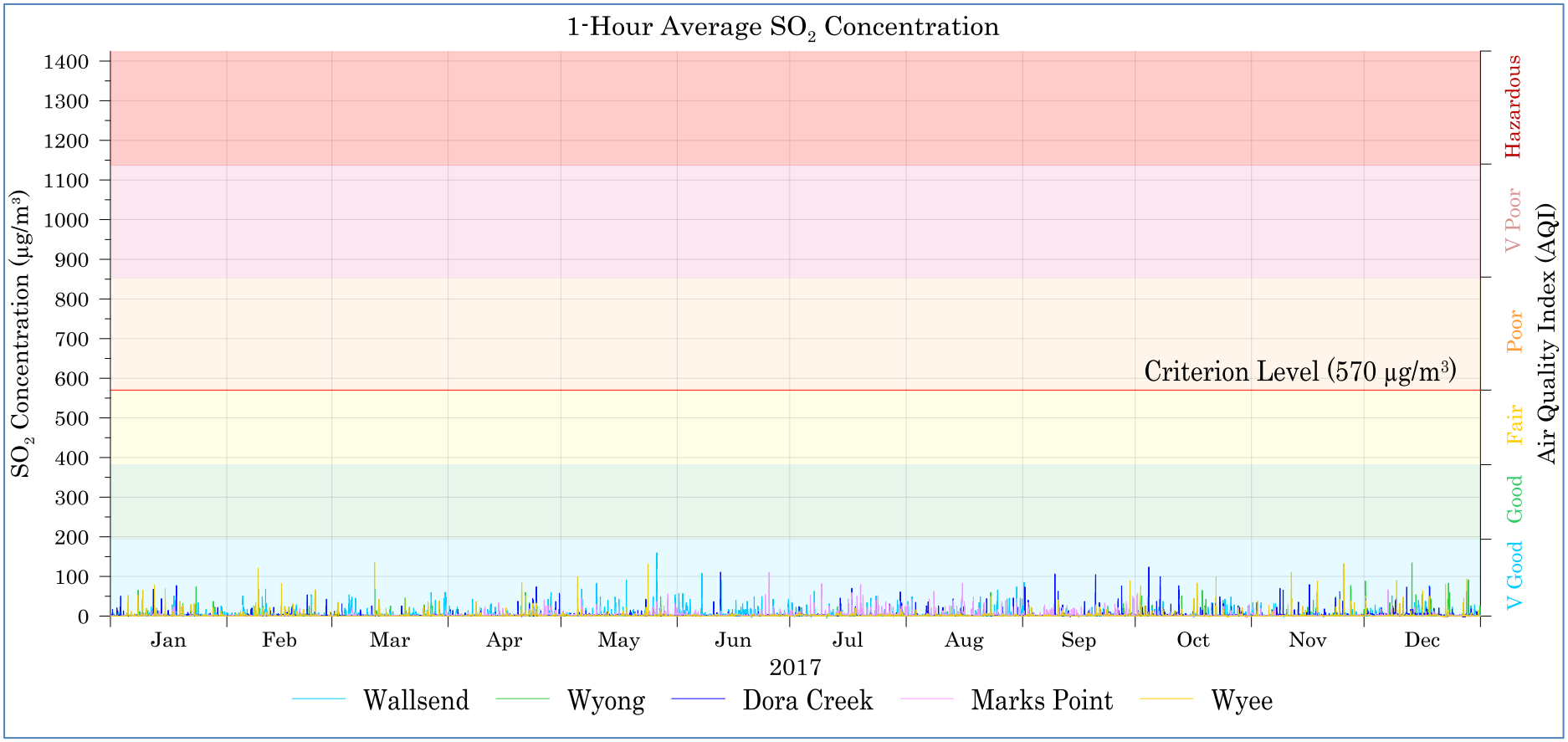

Figure 7-4: Lake Macquarie - Wyong 1-hour average SO_2 levels – 2017

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average SO_2 criterion level of 570µg/m^3 in 2017. Measured levels of SO_2 were very good at all monitors at all times in 2017.

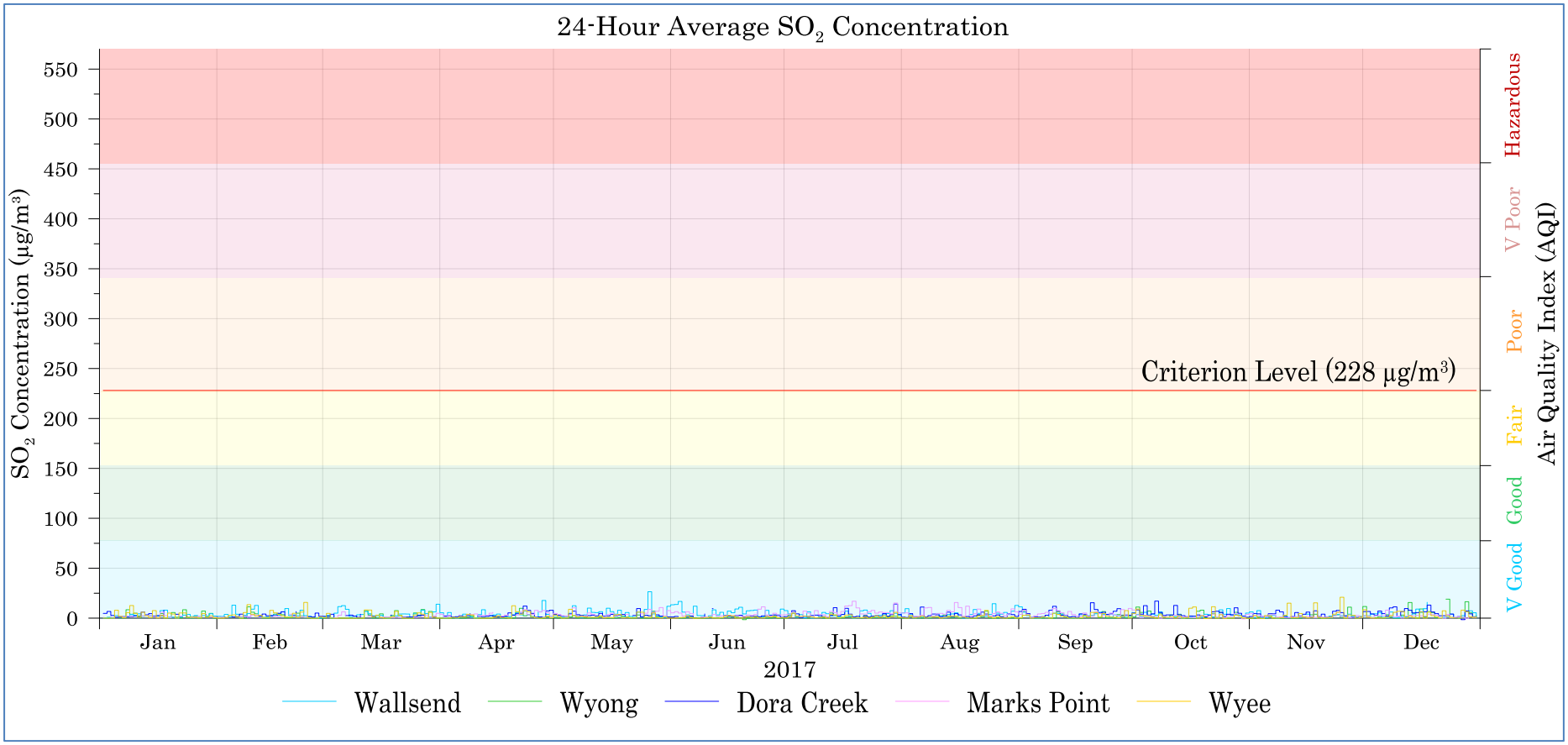

Figure 7-5: Lake Macquarie - Wyong 24-hour average SO_2 levels – 2017

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average SO_2 criterion level of 228µg/m^3 in 2017. Measured levels of SO_2 were very good at all monitors at all times in 2017.

8 ANALYSIS OF ELEVATED POLLUTANT LEVELS

There were four days with elevated levels above the applicable 24-hour average criteria in 2017, these included:

- 24-hour average $PM_{2.5}$ level of 28.8µg/m^3 and 73.0µg/m^3 recorded at Wyee on 26 and 27 August 2017, respectively;
- 24-hour average $PM_{2.5}$ level of 27.2µg/m^3 recorded at Wyong on 12 September 2017; and,
- 24-hour average PM_{10} level of 63.4µg/m^3 recorded at Wyong on 24 September 2017.

8.1 Wyee – 26 and 27 August 2017

Figure 8-1 presents satellite imagery of the Wyee monitor on 26 and 27 August 2017. The figure shows a visible smoke plume and indicates that there was a bushfire just west of the Wyee monitor.

Figure 8-2 presents a plot of the 1-hour average $PM_{2.5}$, wind speed and wind direction data recorded at the Wyee monitoring site on 26 and 27 August 2017.

The data presented in **Figure 8-2** show that the Wyee monitor recorded elevated $PM_{2.5}$ levels at 1:00pm on 26 August 2017 and between 10:00pm on 26 August 2017 and 9:00am on 27 August 2017. The Wyee monitor would have been downwind of the bushfire during the period of highly elevated levels when wind speeds were low and generally ranged from the southwest to northwest directions.

The elevated $PM_{2.5}$ levels recorded at the Wyee monitoring site on 26 and 27 August 2017 were therefore likely caused by bushfire smoke.

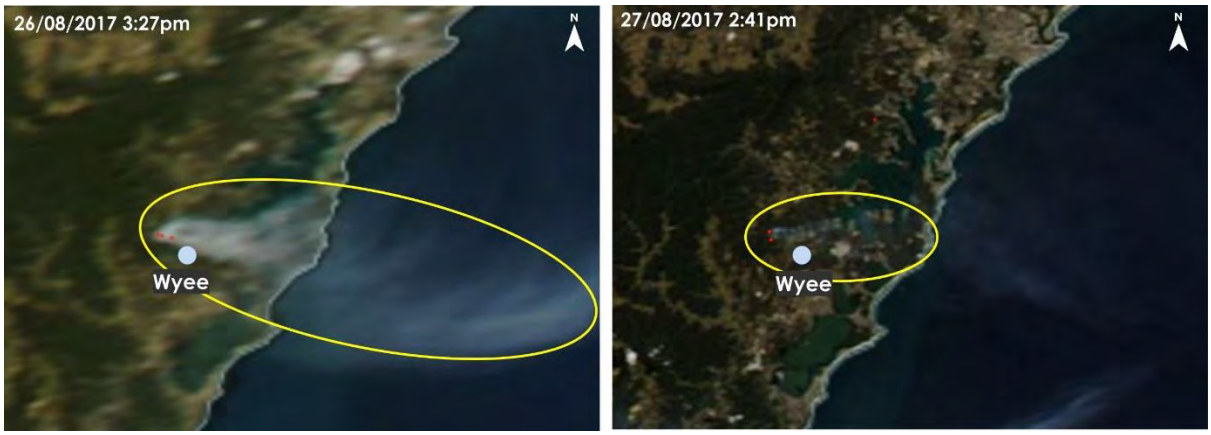

Figure 8-1: Satellite imagery on 26 and 27 August 2017

Source: **NASA, 2019**

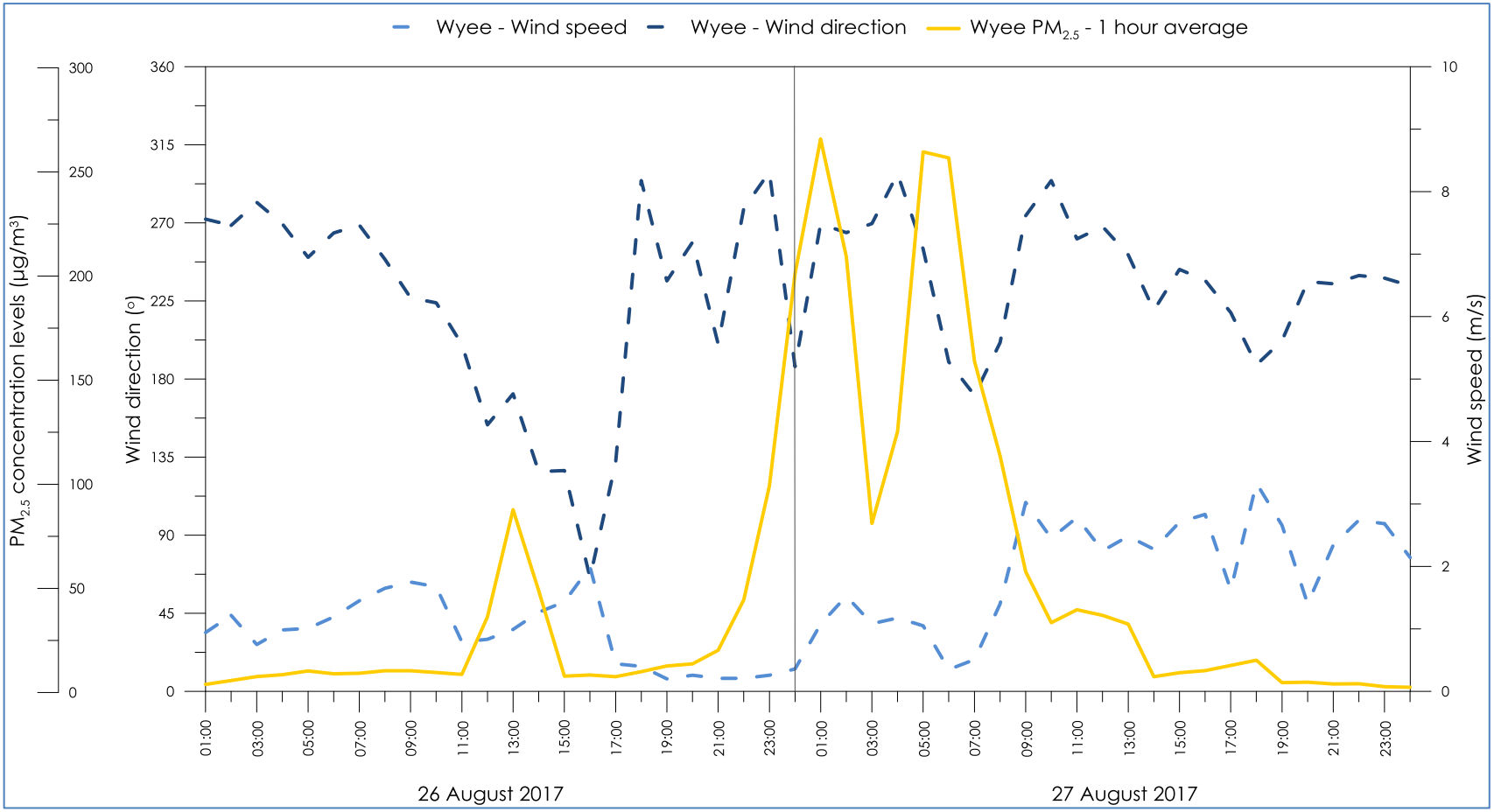

Figure 8-2: Analysis of Wyee monitoring data on 26 and 27 August 2017

8.2 Wyong – 12 September 2017

Figure 8-3 shows satellite imagery of bushfires to the north and southwest of the Wyong monitor on 11 September 2017. It is noted that the Wyong monitoring location is not visible on 12 September 2017 from the available NASA satellite imagery due to cloud cover.

Figure 8-4 shows the wind speed, wind direction and particulate matter concentrations (PM_{10} and $PM_{2.5}$) on 11 and 12 September 2017 at the Wyong monitor. The data show that the Wyong monitor recorded elevated $PM_{2.5}$ levels from 11:00pm on 11 September 2017 until 8:00am on 12 September 2017 during relatively calm wind conditions. It can also be seen that the $PM_{2.5}$ levels during this period were similar to the recorded PM_{10} levels. It is noted that $PM_{2.5}$ is a subset of PM_{10} and cannot actually be higher than PM_{10}. A difference in short term readings can arise when volatile material, as present in bushfire smoke, is collected on the sensor filter leading to higher than actual particle readings, which are then followed by lower than actual readings as the material evaporates of the sensor filter. Differences can also arise when different instruments are used for measuring each size fraction.

It is therefore likely that the elevated levels recorded at the Wyong monitor were caused by the bushfire smoke.

Figure 8-3: Satellite imagery showing smoke plume from bushfires on 11 September 2017

Source: **NASA, 2019**

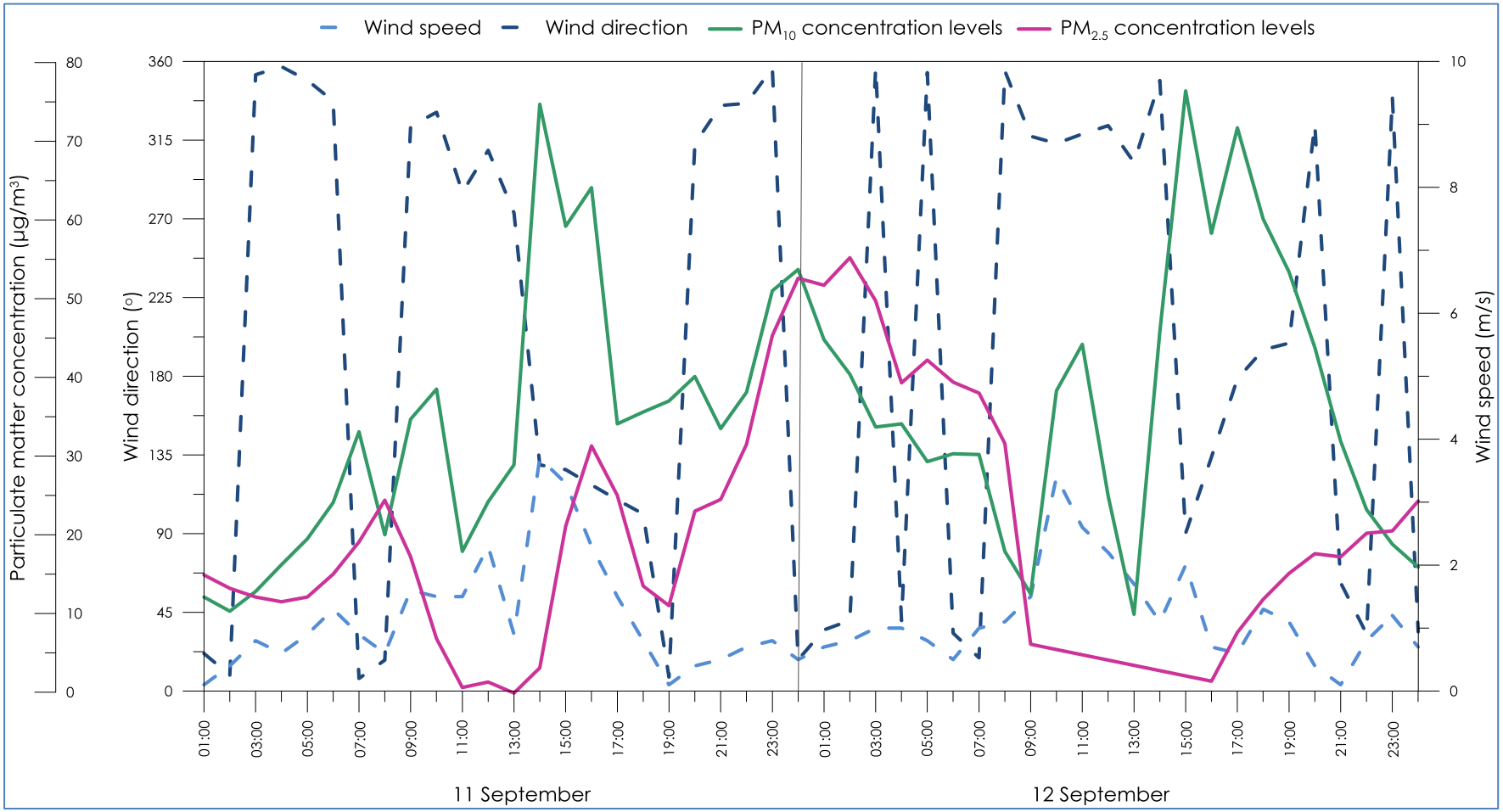

Figure 8-4: Wyong - Wind speed, wind direction and particulate matter concentration on 11 and 12 September 2017

8.3 Wyong – 24 September 2017

Table 8-1 summarises the NSW OEH Central Coast, Lower Hunter and Newcastle local 24-hour average PM_{10} data for 24 September 2017. Elevated PM_{10} levels were recorded at the majority of monitoring stations in the region on this day, suggesting that a regional event may have impacted the area.

Figure 8-5 shows the wind speed, wind direction and PM_{10} concentration levels at the Wyong monitor and the PM_{10} concentration levels at nearby OEH monitors on 24 September 2017. While the Wyong monitor record elevated PM_{10} levels from approximately 4:00pm until approximately 6:00pm on 24 September 2017 under varying wind conditions, generally the monitors recorded a similar underlying trend of elevated PM_{10} levels on 24 September 2017.

It is likely that a regional event contributed to the elevated levels recorded at the majority of the OEH monitoring stations including the Wyong monitor on 24 September 2017.

Table 8-1: NSW OEH PM_{10} 24-hour average data (µg/m^3)

Monitor	24/9/2017
Wyong	**63.4**
Wallsend	47.9
Carrington	**64.0**
Stockton	**82.4**
Newcastle	**55.0**
Mayfield	**70.6**
Beresfield	49.4

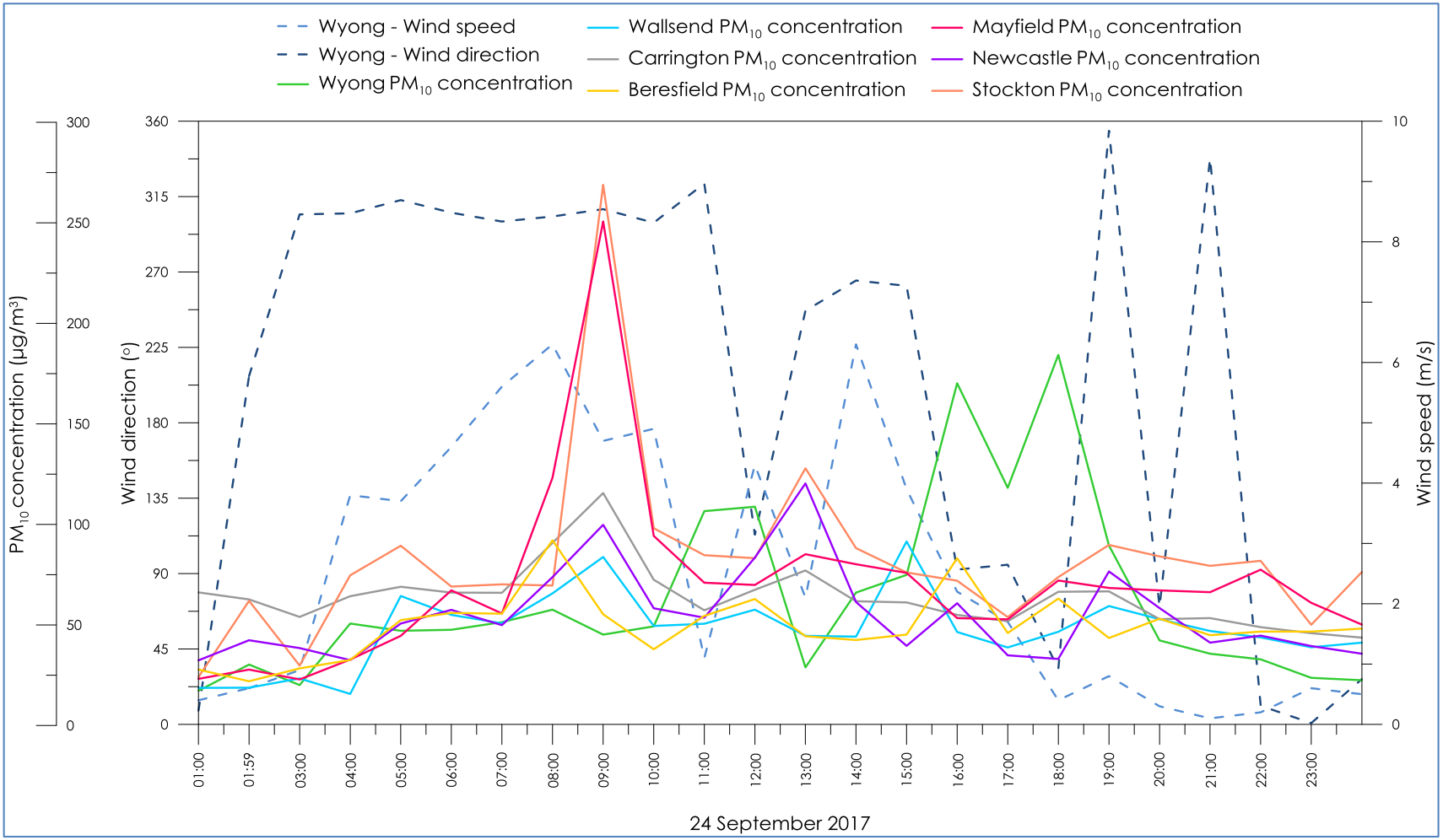

Figure 8-5: Wind speed, wind direction and PM_{10} concentrations on 24 September 2017

9 CONCLUSIONS

The results indicate that the monitoring stations generally recorded good air quality in 2017.

The Wyee monitor recorded 24-hour average $PM_{2.5}$ levels above the criterion of 25µg/m^3 on 26 and 27 August 2017. The elevated $PM_{2.5}$ levels likely originated from bushfire smoke.

The Wyong monitor recorded a 24-hour average $PM_{2.5}$ level above the criterion of 25µg/m^3 on 12 September 2017 which was likely caused by smoke from bushfires.

The Wyong monitor recorded 24-hour average PM_{10} levels above the criterion of 50µg/m^3 on 24 September 2017. These elevated levels were likely caused by a regional event which led to levels above the criteria at most of the monitoring sites in the Lower Hunter and Newcastle area.

All recorded annual average levels were below the applicable annual average criteria in 2017.

Relative to the Air Quality Index:

- The measured PM_{10} levels were very good or good. The Wyong, Wallsend and Teralba monitors recorded fair levels on five, eight and two days respectively. The Wyong monitor recorded one day with poor levels in 2017;
- The measured levels of $PM_{2.5}$ were generally very good or good. The Wallsend monitor recorded four days with fair levels, the Wyong monitor recorded three days with fair levels and the Wyee monitor recorded five days with fair levels. The Wyong monitor recorded one day with poor levels and the Wyee monitor recorded one day with poor levels and one day with hazardous levels;
- The measured levels of NO_2 were very good or good at all monitors at all times; and,
- The measured levels of SO_2 were very good at all monitors at all times.

On this basis it can be concluded that the air quality in the Lake Macquarie - Wyong region was generally good in 2017.

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Appendix A

How to read a windrose

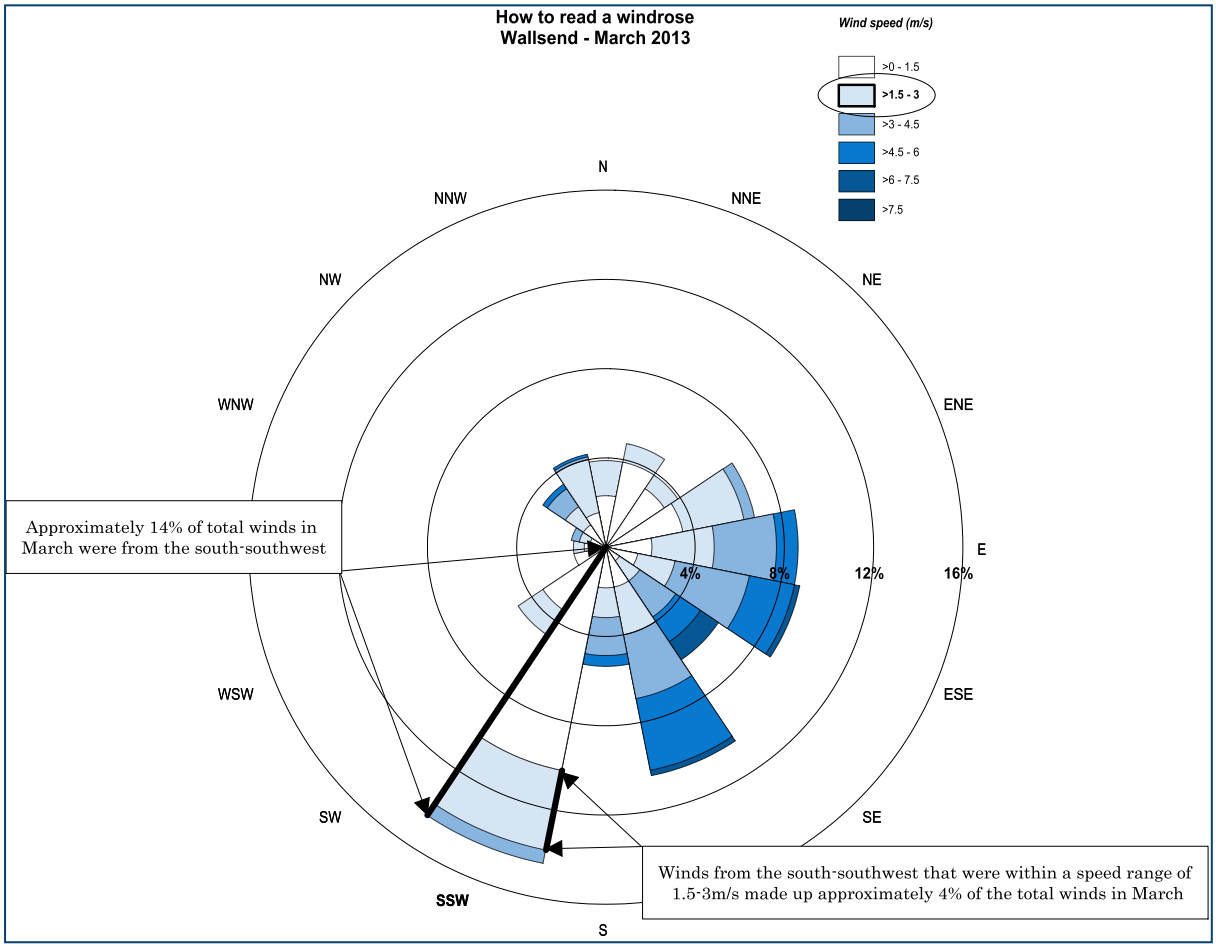

Figure A-1: How to read a windrose

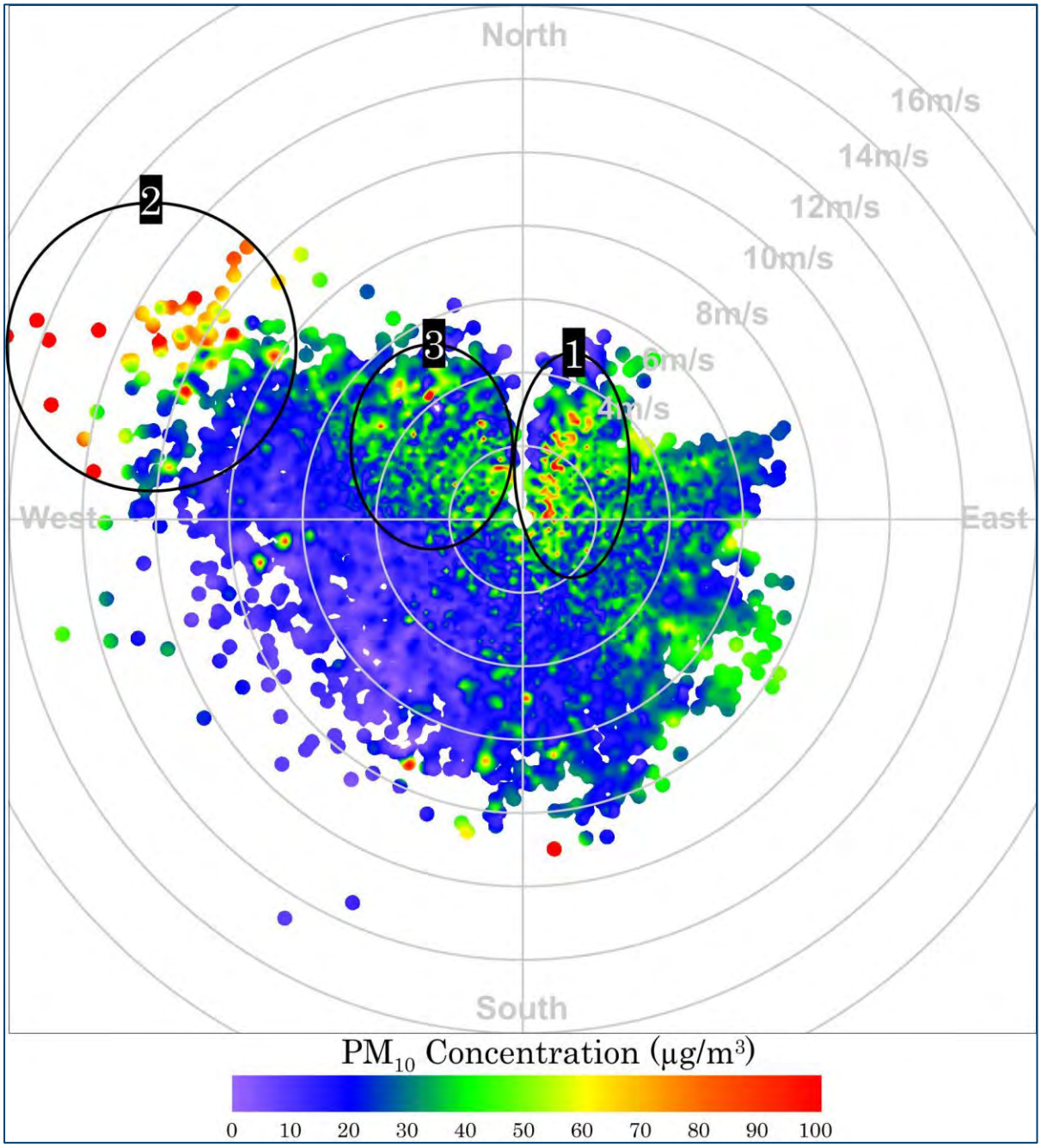

Figure A-2: Example Pollution Rose

- **1** - High PM_{10} levels tended to originate from the north-eastern directions under wind speeds below 4m/s.
- **2** - High PM_{10} levels were also recorded from the northwest and west-northwest direction under high wind speeds (>8m/s).
- **3** - Some high levels were also recorded from the northwest under moderate wind speeds.

Appendix B

Monitoring Data (Graphical)

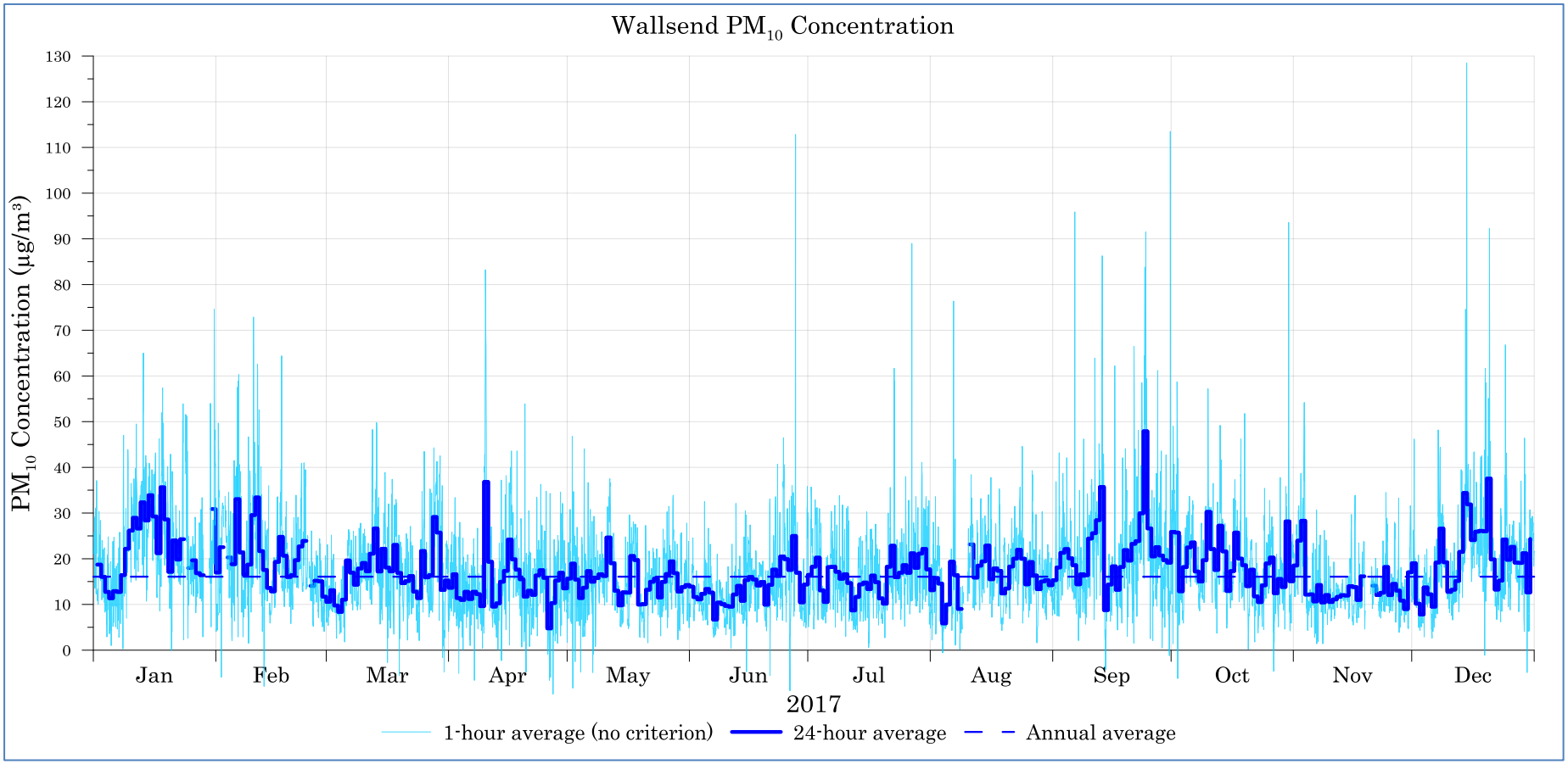

Figure B-1: Wallsend PM_{10} (1-hour, 24-hour and annual average) concentration – 2017

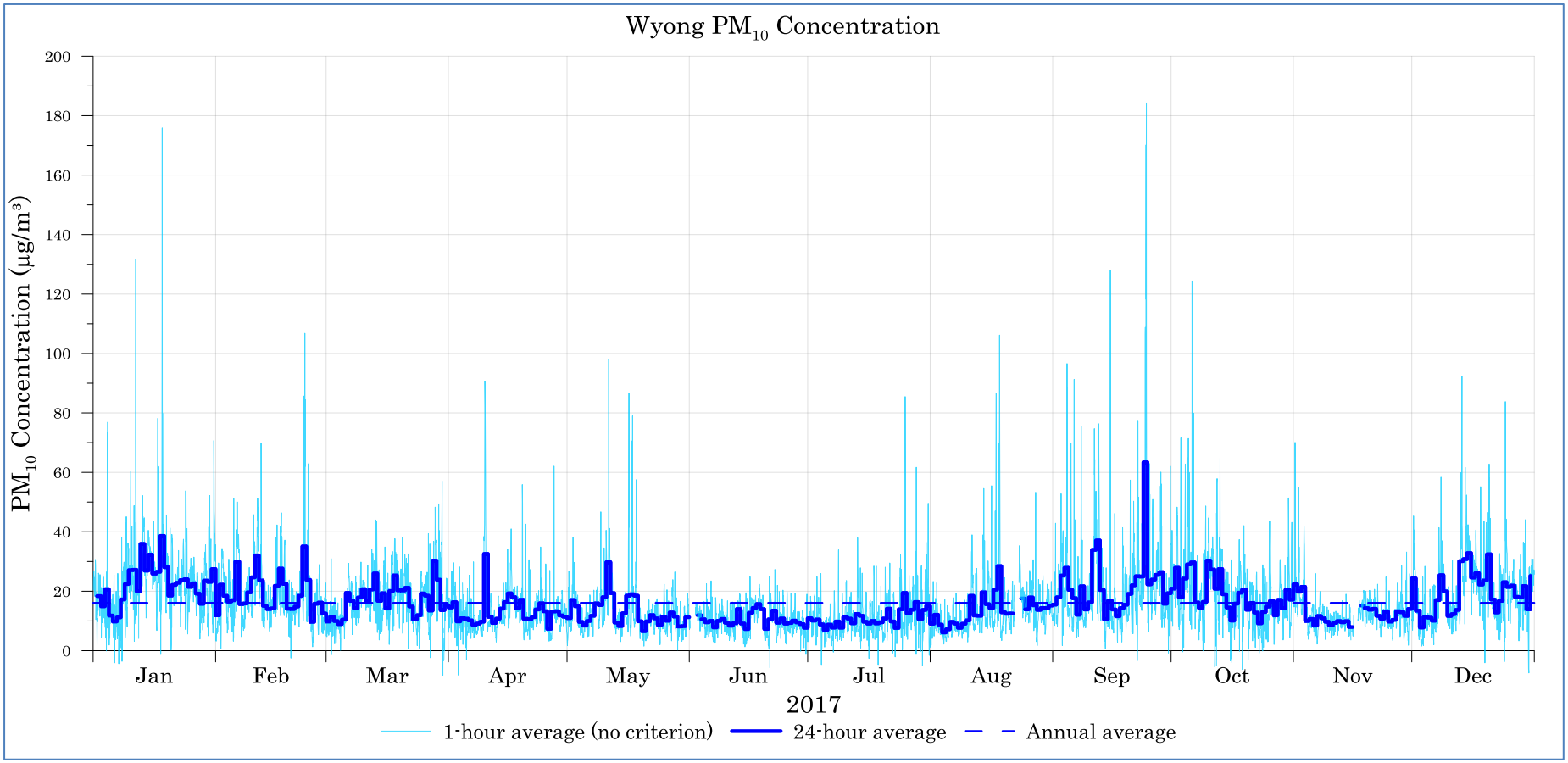

Figure B-2: Wyong PM_{10} (1-hour, 24-hour and annual average) concentration – 2017

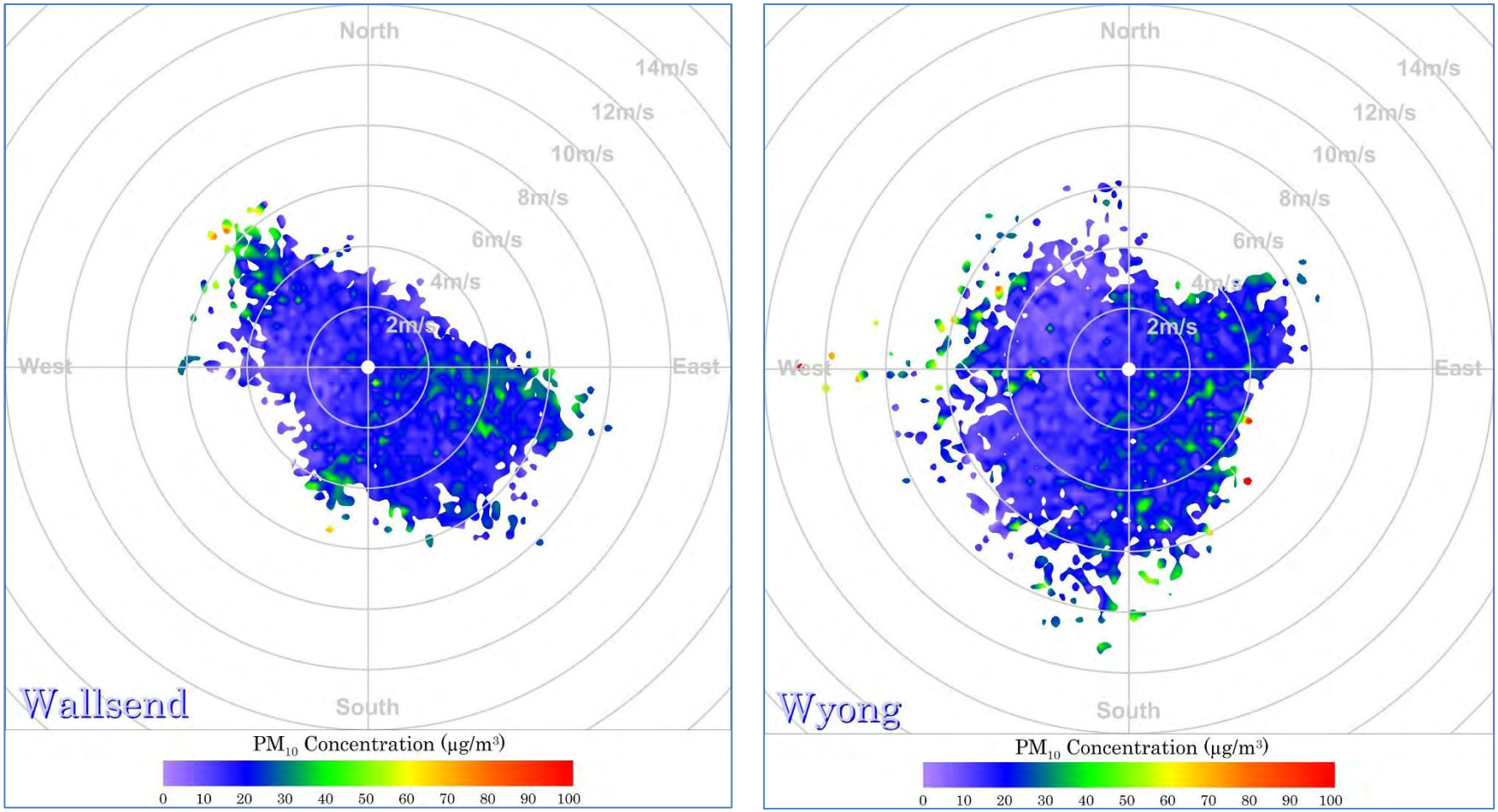

Figure B-3: 2017 hourly PM_{10} pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low PM_{10} levels in 2017. Levels were relatively higher from the north-western and the southern directions. The Wallsend monitor also recorded higher levels from the east under 8m/s winds.

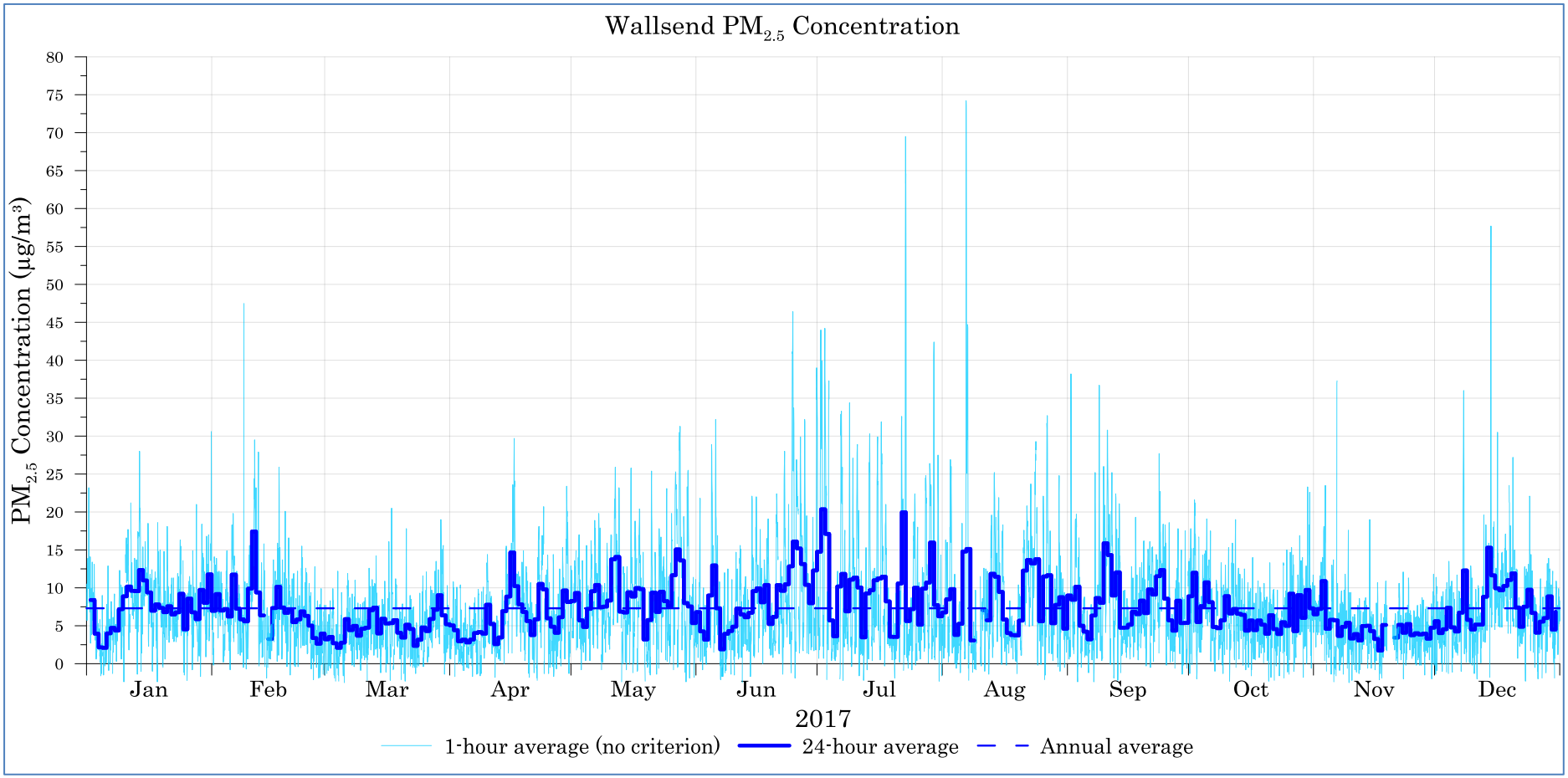

Figure B-4: Wallsend $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2017

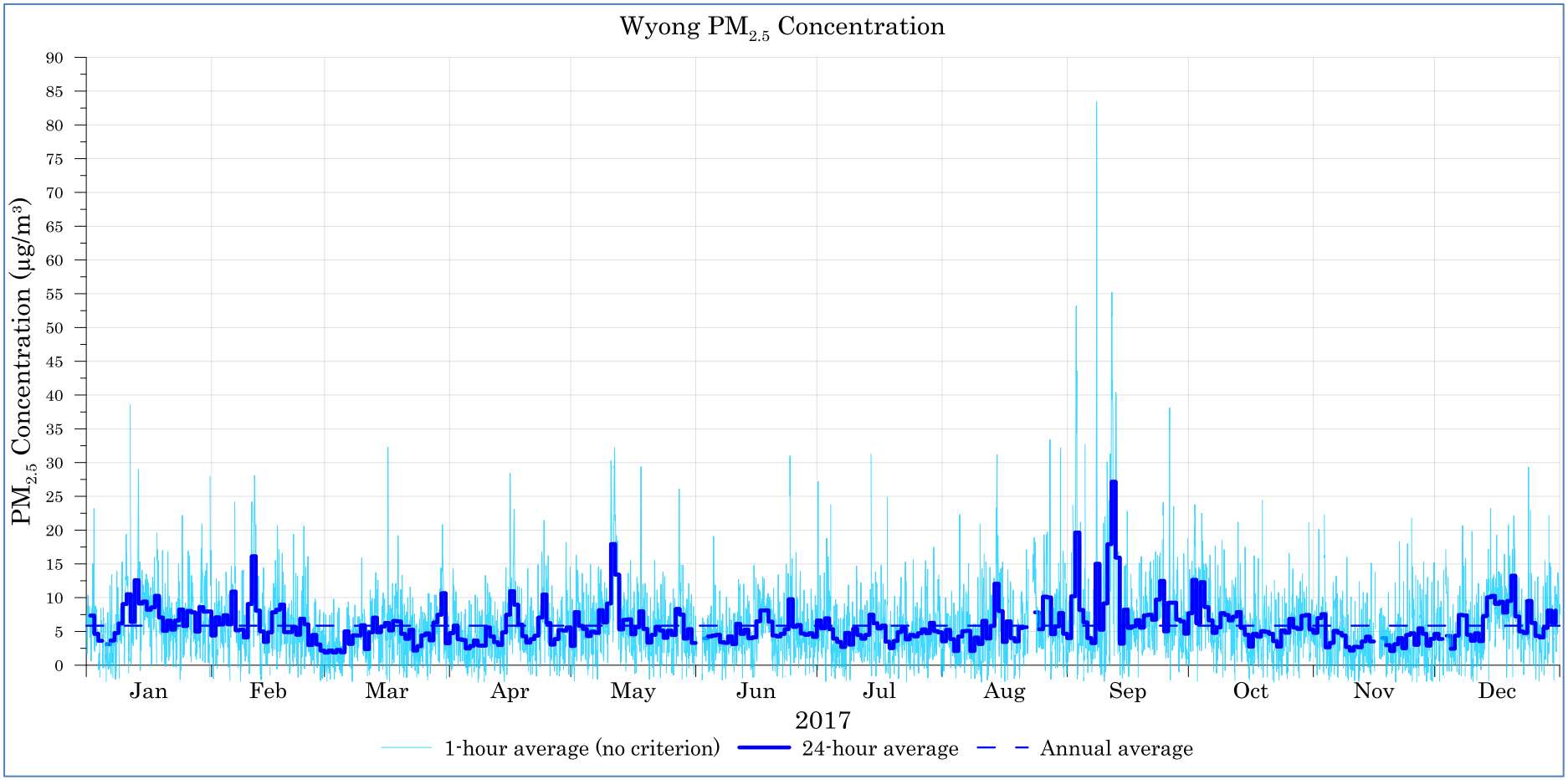

Figure B-5: Wyong $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2017

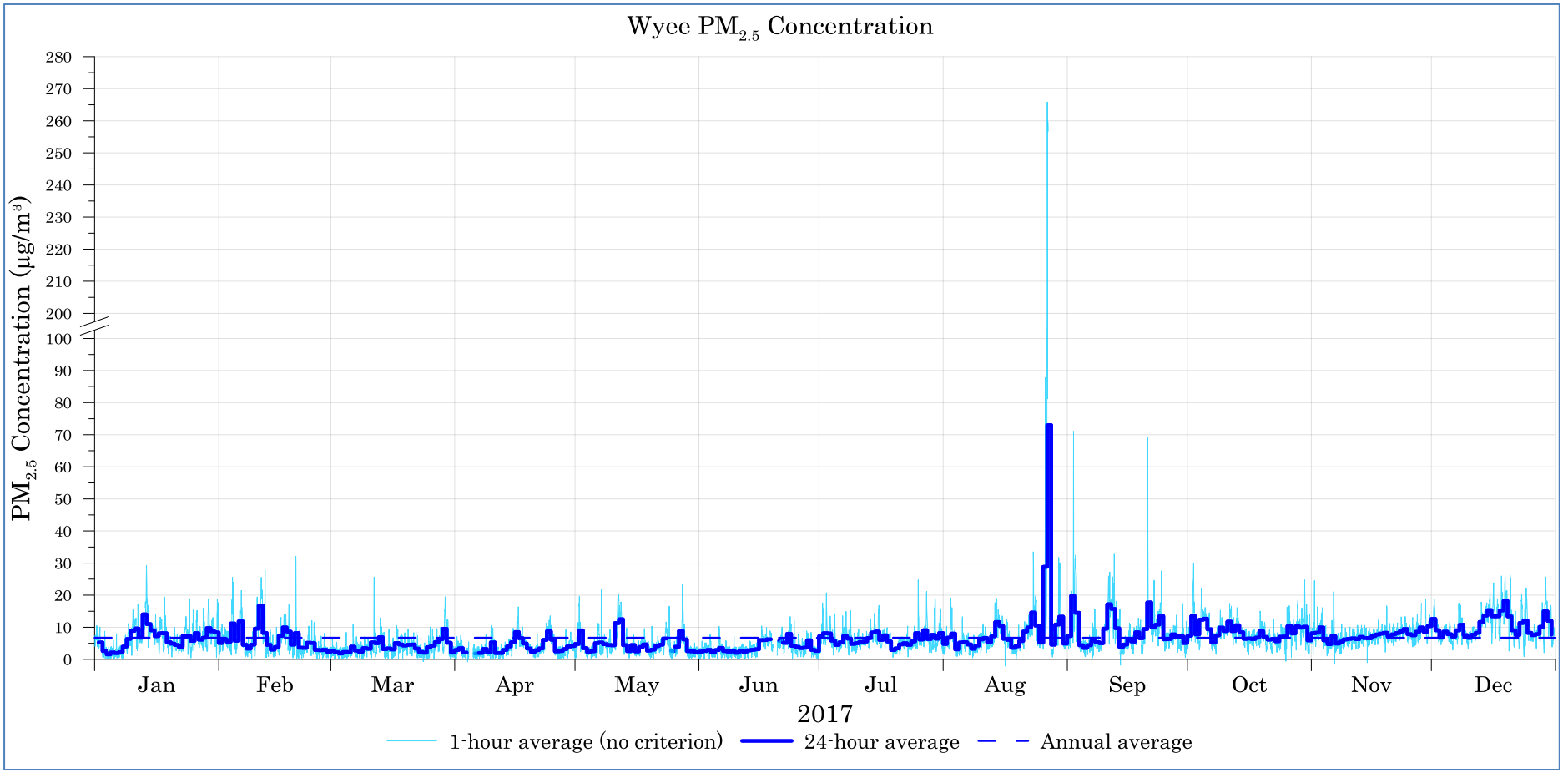

Figure B-6: Wyee $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2017

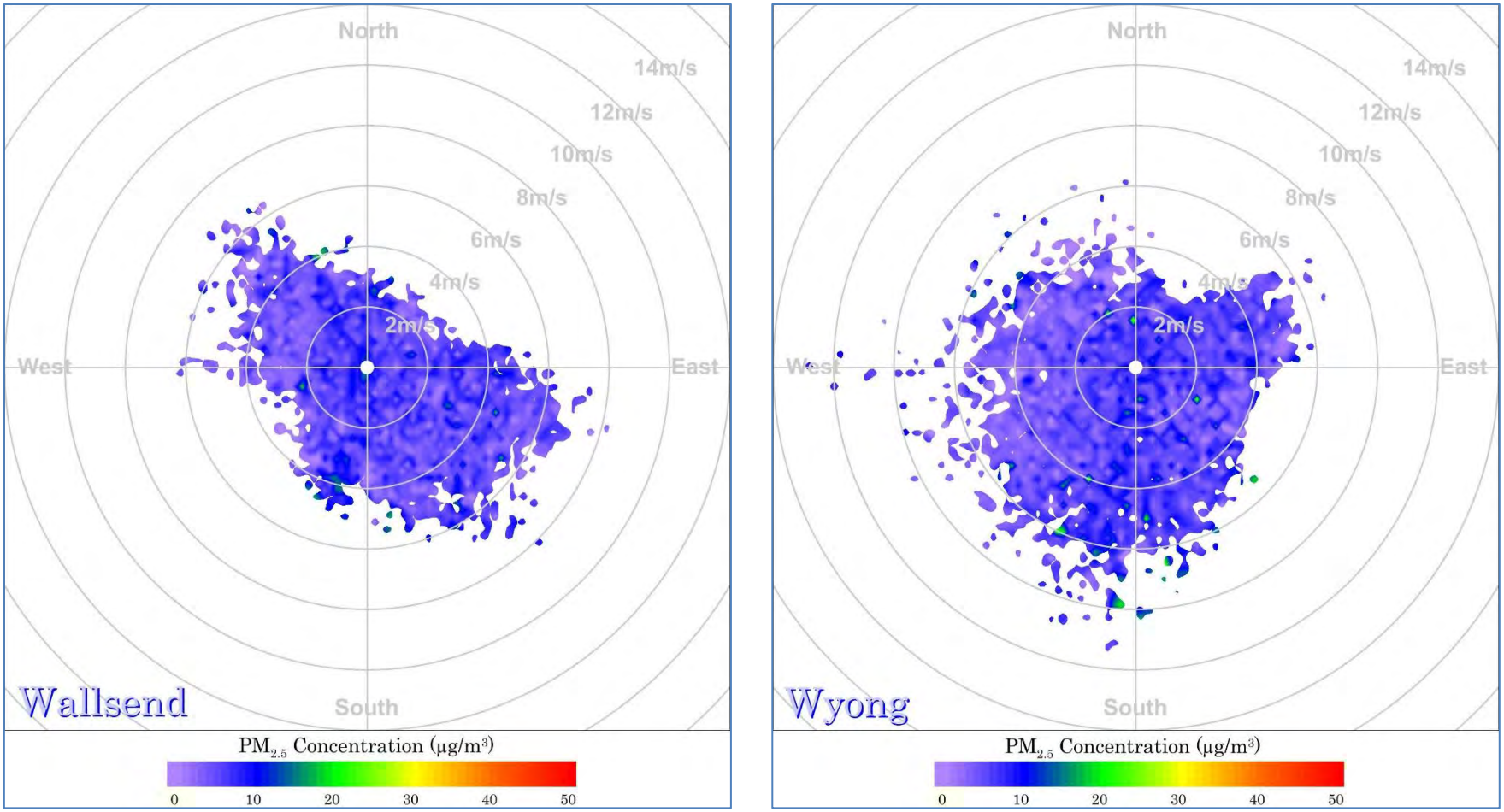

Figure B-7: 2017 hourly $PM_{2.5}$ pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low $PM_{2.5}$ levels in 2017.

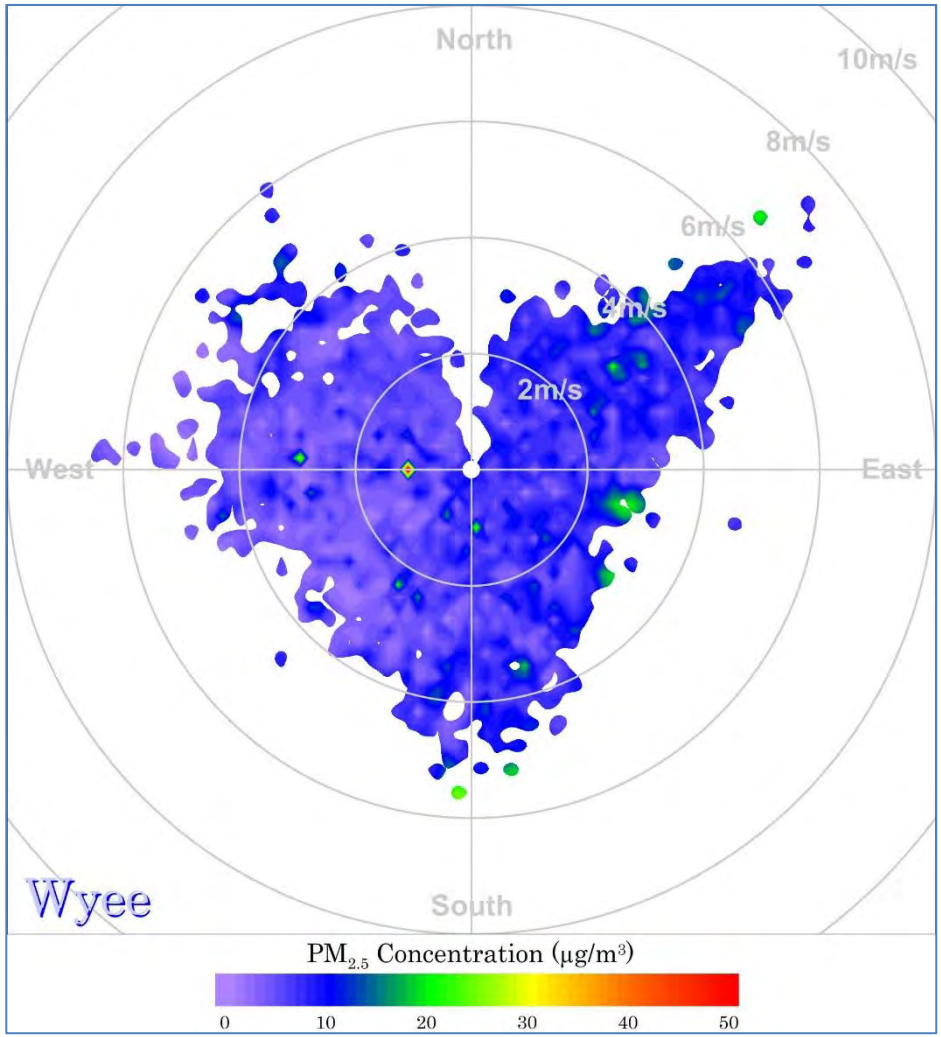

Figure B-8: 2017 hourly $PM_{2.5}$ pollution rose – Wyee

The Wyee monitor generally recorded low $PM_{2.5}$ levels in 2017.

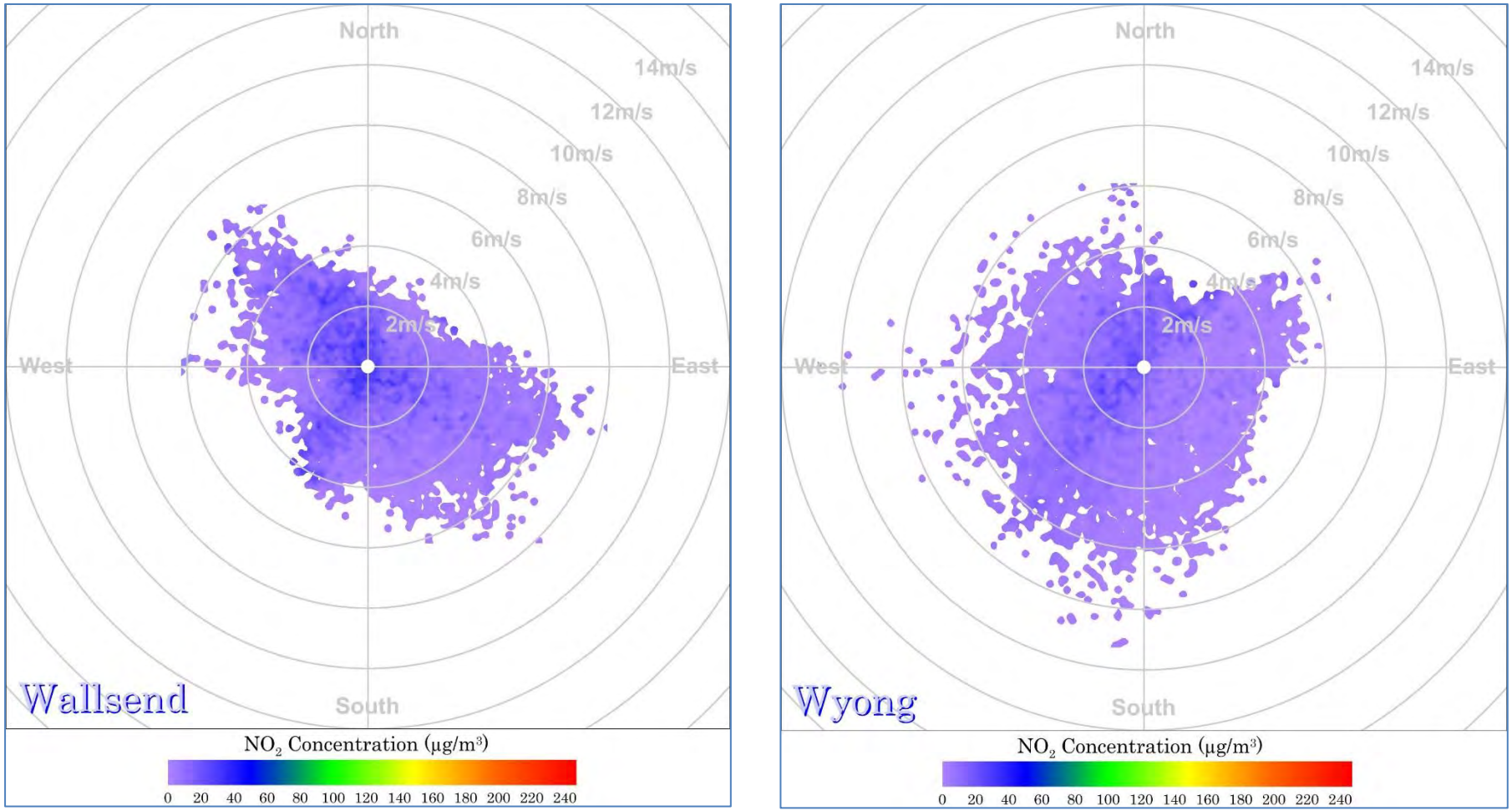

Figure B-9: 2017 hourly NO_2 pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low NO_2 levels in 2017.

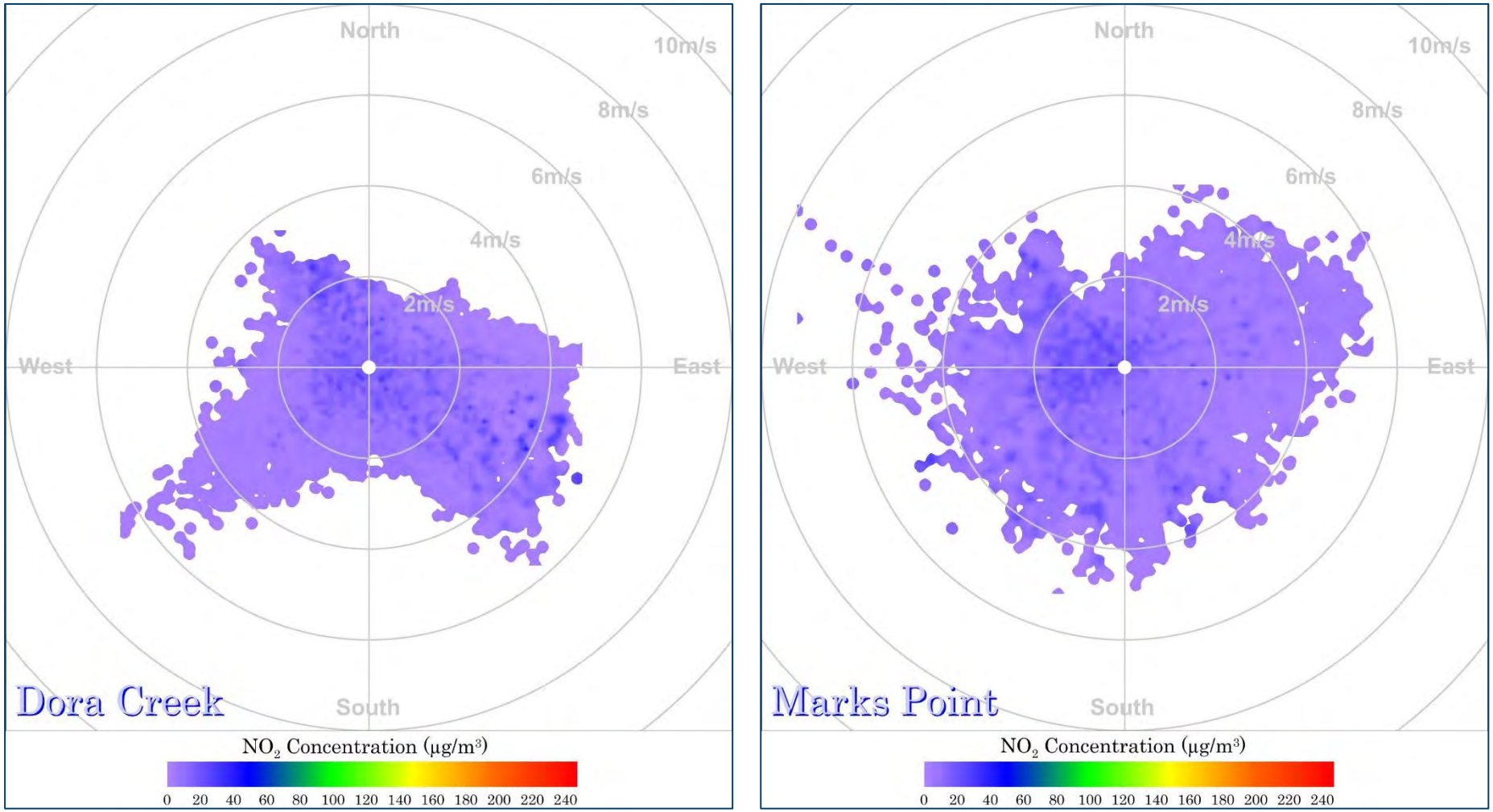

Figure B-10: 2017 hourly NO_2 pollution roses – Dora Creek (left) and Marks Point (right)

The Dora Creek and Marks Point monitors generally recorded low NO_2 levels in 2017.

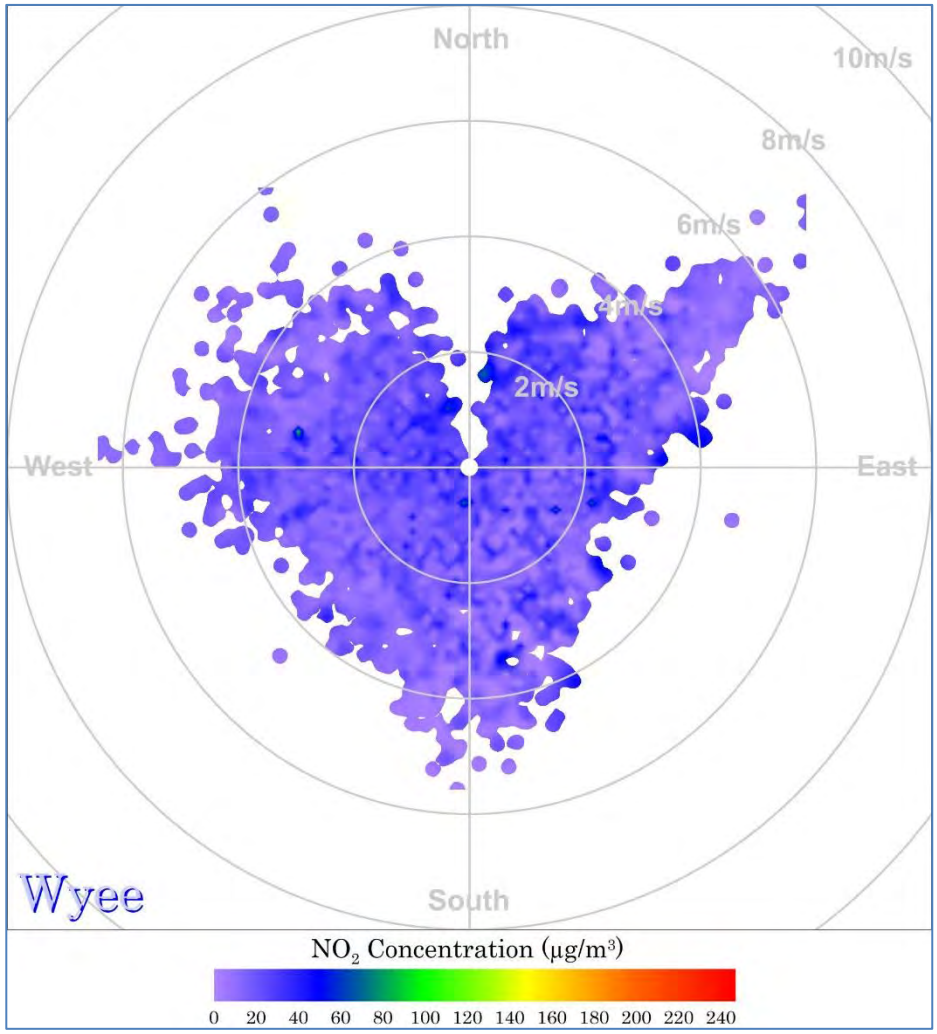

Figure B-11: 2017 hourly NO_2 pollution rose – Wyee

The Wyee monitor generally recorded low NO_2 levels in 2017.

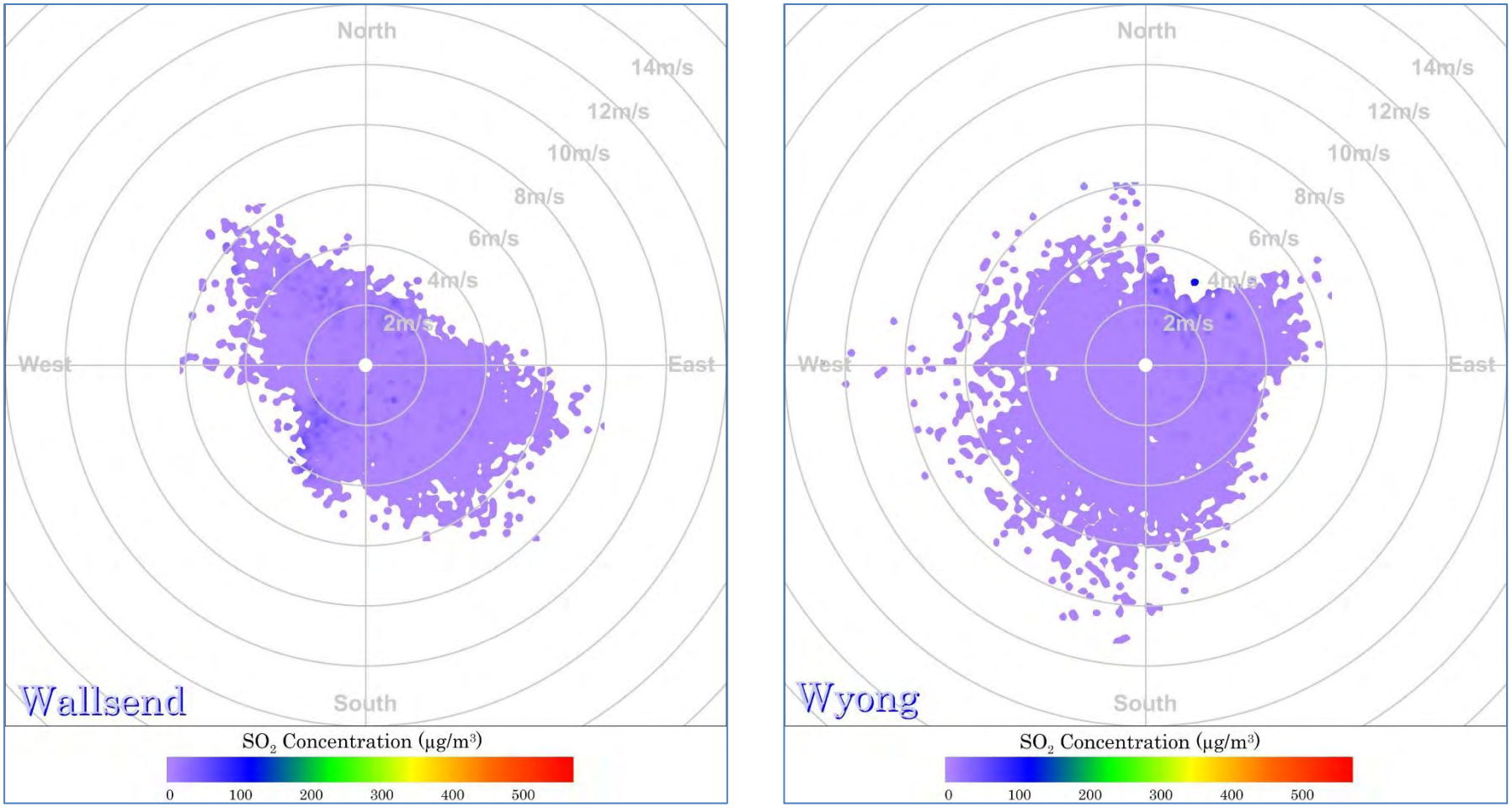

Figure B-12: 2017 hourly SO_2 pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low SO_2 levels in 2017.

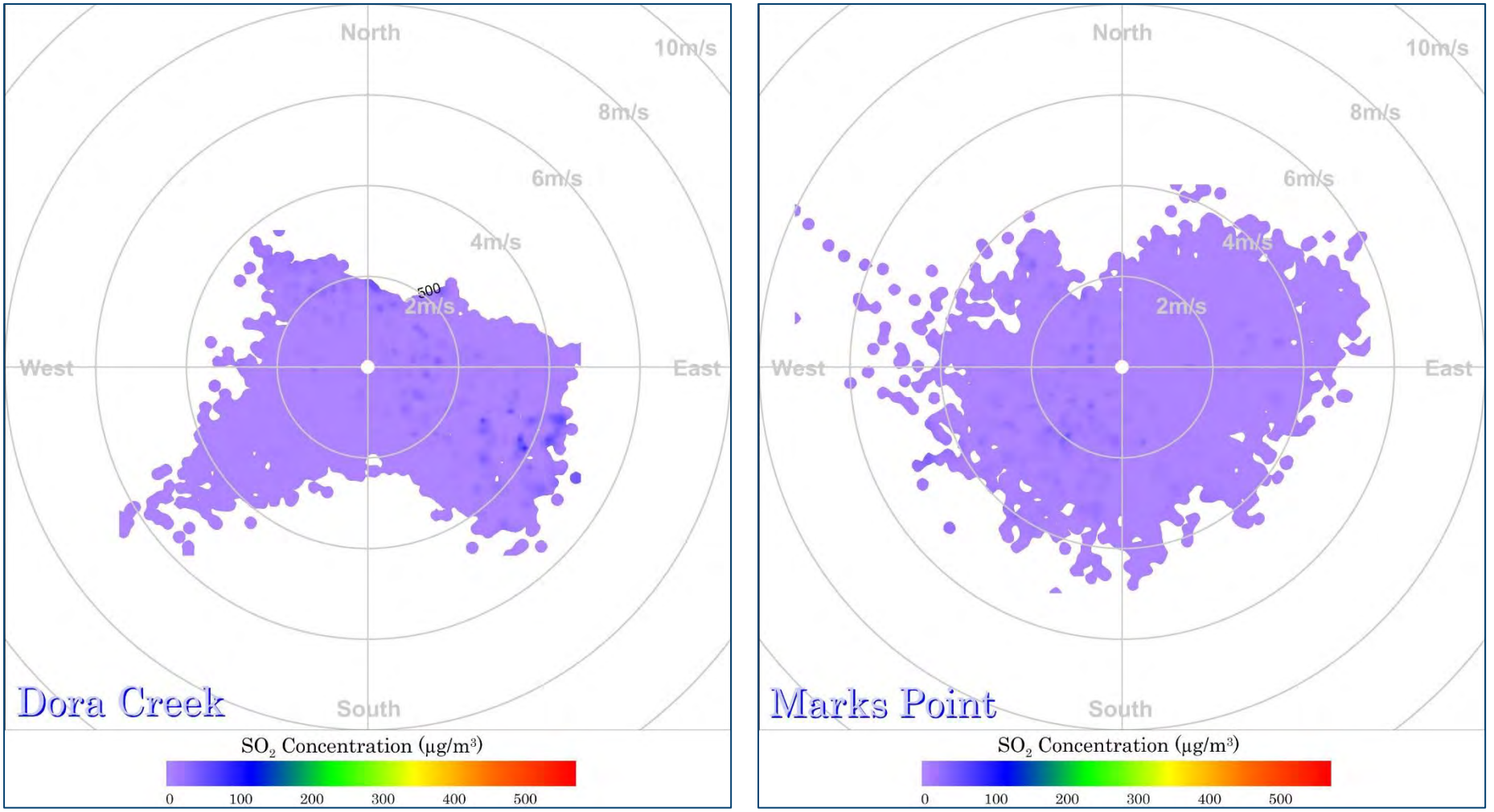

Figure B-13: 2017 hourly SO_2 pollution roses – Dora Creek (left) and Marks Point (right)

The Dora Creek and Marks Point monitors generally recorded low SO_2 levels in 2017.

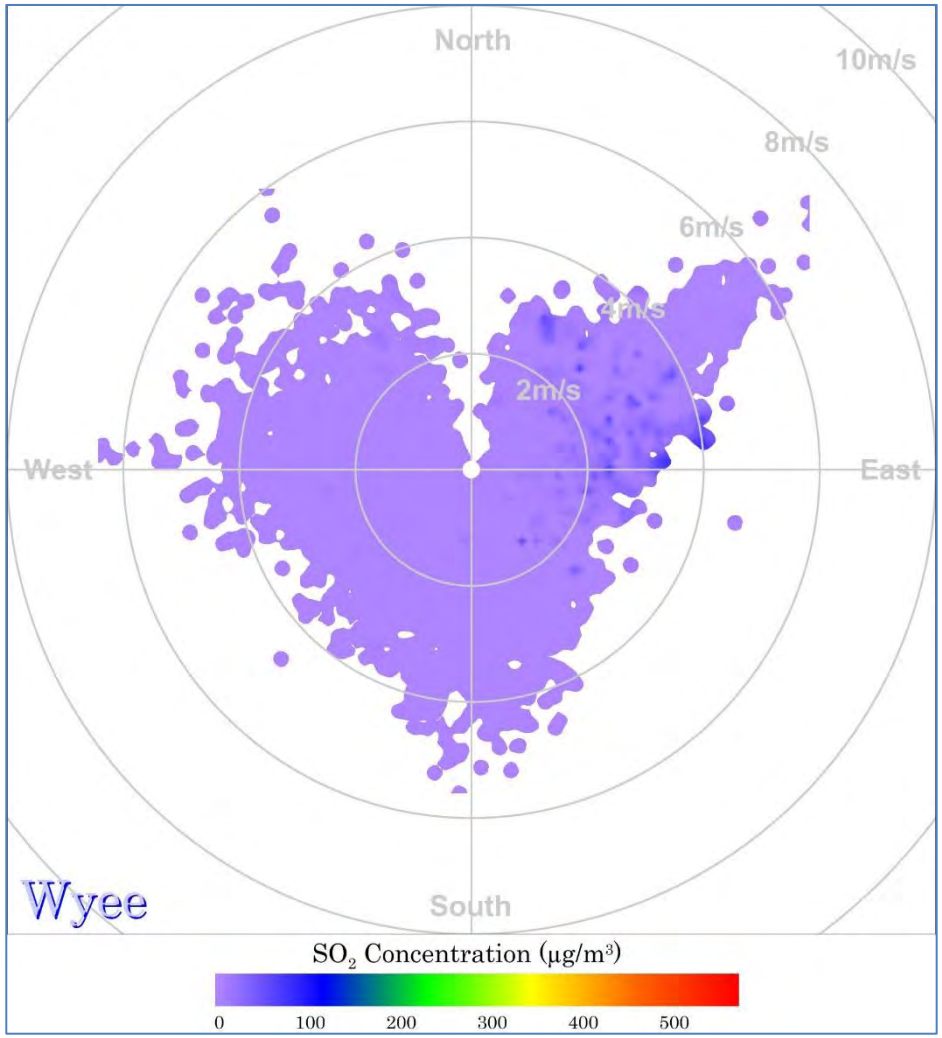

Figure B-14: 2017 hourly SO_2 pollution rose – Wyee

The Wyee monitor generally recorded low SO_2 levels in 2017.

Appendix C

Monitoring Data (Tabulated)

Table C-1: 24-hour average monitoring data

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
01/01/2017	21.3	20.1	10.6	6.5	6.3	1.3	0.1	3.9	0.9	0.0
2/01/2017	18.7	18.4	8.4	7.3	5.3	0.0	0.2	4.7	0.7	0.0
3/01/2017	16.0	14.9	4.0	4.6	2.6	0.9	0.0	6.7	-	0.0
4/01/2017	12.8	20.7	2.1	3.6	1.5	0.1	0.0	2.7	1.4	0.0
5/01/2017	11.4	11.8	2.1	-	2.1	2.5	-	0.9	-	7.8
6/01/2017	12.9	9.8	4.0	3.1	1.9	1.6	0.2	1.1	1.8	1.8
7/01/2017	12.7	11.2	4.7	3.7	2.2	1.3	0.2	1.6	1.1	0.5
8/01/2017	16.4	17.3	4.4	4.8	4.0	1.3	8.4	1.6	2.2	5.5
9/01/2017	22.2	22.4	7.2	6.2	6.3	3.7	3.8	1.8	1.6	12.6
10/01/2017	26.2	27.1	8.9	9.1	8.9	3.0	5.0	2.2	1.6	4.7
11/01/2017	29.0	27.2	10.2	10.5	9.6	4.3	2.1	1.4	-	1.1
12/01/2017	26.6	20.0	9.6	6.4	6.8	1.9	0.0	6.0	2.3	6.0
13/01/2017	32.4	35.9	9.6	12.6	14.0	2.8	-	3.4	2.7	2.3
14/01/2017	28.4	26.9	12.4	9.1	11.0	2.4	-	4.5	2.4	0.6
15/01/2017	33.9	32.3	11.0	9.4	9.0	1.8	-	2.2	1.5	7.5
16/01/2017	29.3	25.9	9.4	8.2	7.2	2.1	-	2.6	0.8	0.1
17/01/2017	21.2	26.5	7.0	8.6	8.1	7.5	4.5	2.5	5.8	2.8
18/01/2017	35.6	38.6	7.8	10.3	8.2	8.0	0.4	7.9	2.5	0.1
19/01/2017	28.6	28.1	7.4	7.1	5.3	1.0	0.0	-	0.6	5.1
20/01/2017	17.1	18.5	6.8	5.1	4.9	1.0	5.6	-	2.4	4.1
21/01/2017	24.0	22.1	7.6	6.6	4.5	0.0	0.9	3.9	-	0.0
22/01/2017	19.8	22.8	6.5	5.3	3.9	1.1	0.1	3.4	2.0	5.2
23/01/2017	24.3	23.7	6.8	6.6	7.4	3.1	8.4	-	2.1	5.2
24/01/2017	-	24.0	9.2	8.2	7.3	3.8	0.5	2.1	-	0.9
25/01/2017	18.0	21.5	4.5	5.8	5.7	1.5	0.0	-	0.8	1.1
26/01/2017	19.7	22.6	8.6	8.0	8.2	2.6	2.0	-	1.4	0.8
27/01/2017	16.8	19.2	6.8	7.8	6.1	1.8	0.0	-	2.0	0.1
28/01/2017	16.4	15.7	5.9	5.0	6.7	2.6	7.1	-	1.7	4.6
29/01/2017	-	23.6	9.7	8.6	9.7	2.2	1.0	3.5	-	1.0
30/01/2017	-	23.1	8.0	7.9	8.7	4.4	4.7	-	1.2	2.3
31/01/2017	30.9	27.5	11.8	8.0	8.4	2.1	0.0	-	0.9	0.6
1/02/2017	17.0	11.9	7.0	4.4	5.1	1.8	0.0	1.3	0.7	0.0
2/02/2017	22.5	22.2	9.2	7.1	6.3	1.7	0.0	-	1.0	0.0
3/02/2017	-	18.4	7.0	6.0	5.5	3.8	-	1.1	0.7	0.7
4/02/2017	20.3	16.5	7.2	7.4	11.2	1.4	-	-	-	2.9
5/02/2017	18.8	17.0	6.2	6.0	5.8	13.0	-	1.2	-	3.3
6/02/2017	33.0	30.0	11.7	10.9	11.8	3.9	-	1.5	-	1.4
7/02/2017	21.4	15.7	7.2	5.2	4.5	0.7	0.0	4.0	1.8	0.0
8/02/2017	16.5	15.9	5.8	5.3	3.3	3.0	0.0	1.8	2.2	5.6
9/02/2017	18.7	19.6	5.6	4.1	4.6	4.7	11.3	0.8	0.8	13.5
10/02/2017	29.6	24.7	9.9	9.0	9.6	9.0	6.0	3.4	3.0	3.9
11/02/2017	33.4	32.0	17.4	16.1	16.8	12.8	4.3	-	3.3	2.1
12/02/2017	21.7	23.6	9.4	8.1	8.2	1.7	1.6	1.8	0.8	2.9
13/02/2017	17.6	15.1	6.4	5.0	4.5	0.8	0.1	4.1	0.8	0.6
14/02/2017	13.6	14.0	-	3.5	3.0	1.2	0.0	2.4	-	0.6
15/02/2017	12.9	14.3	3.2	4.8	3.9	2.1	1.2	2.7	1.1	7.7
16/02/2017	19.3	21.8	7.3	7.8	7.3	3.3	4.0	2.4	2.3	5.3
17/02/2017	24.8	27.6	10.1	8.2	9.9	2.8	4.6	4.9	1.6	3.8
18/02/2017	20.7	22.5	7.4	9.0	8.6	6.3	3.5	6.4	2.6	2.2
19/02/2017	16.0	14.1	6.7	4.9	4.6	9.6	0.4	1.9	-	1.0
20/02/2017	16.4	14.0	7.2	4.9	8.2	2.6	0.6	-	3.9	1.0
21/02/2017	19.7	14.8	5.5	5.6	3.6	3.2	0.6	2.5	1.6	4.9
22/02/2017	22.7	18.4	5.8	4.5	3.6	2.4	5.0	6.6	1.3	0.6
23/02/2017	23.9	35.1	6.9	6.9	5.2	7.9	2.2	-	1.7	6.0
24/02/2017	-	23.8	6.3	6.1	5.1	2.5	0.4	-	0.9	15.7
25/02/2017	14.1	9.7	5.0	3.0	2.9	1.8	0.0	1.5	2.3	0.3
26/02/2017	15.2	15.8	3.4	4.5	2.8	1.0	0.0	1.1	-	0.0
27/02/2017	15.1	16.2	2.6	3.1	3.0	0.5	0.0	5.0	-	0.0
28/02/2017	11.7	12.5	4.0	2.2	2.4	0.1	0.0	1.9	1.4	1.3
1/03/2017	10.6	9.8	3.2	1.9	2.6	1.0	0.0	1.8	1.0	0.6
2/03/2017	13.1	11.4	3.5	2.2	2.2	2.8	1.9	1.9	-	4.8
3/03/2017	9.8	10.0	2.7	1.9	1.8	0.2	0.0	3.9	-	0.0
4/03/2017	8.4	8.9	2.1	2.3	2.3	5.0	0.0	0.6	0.4	0.0

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
5/03/2017	11.1	10.4	2.8	1.9	2.3	11.5	0.0	-	2.9	0.0
6/03/2017	19.6	19.4	5.9	5.0	3.9	12.5	0.0	-	6.3	0.0
7/03/2017	17.0	16.7	4.4	3.2	2.7	8.9	0.0	2.5	2.7	0.0
8/03/2017	14.3	14.2	5.0	4.4	2.3	1.6	0.0	3.0	-	0.0
9/03/2017	17.9	17.9	3.7	4.4	3.5	0.7	0.0	2.2	1.1	0.0
10/03/2017	19.1	20.7	4.6	5.9	3.3	3.3	0.0	0.8	-	0.2
11/03/2017	17.2	16.6	4.7	2.4	5.3	3.6	0.0	4.0	2.3	0.0
12/03/2017	21.1	20.6	7.0	4.9	5.0	6.8	7.3	-	-	8.3
13/03/2017	26.7	26.0	7.4	7.0	6.9	4.4	3.2	2.3	2.1	8.1
14/03/2017	17.2	16.7	4.0	4.9	3.2	2.3	0.1	1.8	0.8	1.4
15/03/2017	22.2	19.3	5.9	5.7	3.4	2.4	0.2	0.8	-	3.1
16/03/2017	18.1	14.2	5.3	6.3	3.1	2.8	4.3	-	1.0	0.6
17/03/2017	17.2	20.1	5.3	5.2	5.1	0.9	0.0	0.6	1.2	0.0
18/03/2017	23.0	25.3	5.7	6.6	4.6	0.0	0.0	-	1.2	0.0
19/03/2017	16.9	20.3	4.1	6.5	4.3	1.5	2.7	3.1	0.6	1.3
20/03/2017	14.7	20.3	3.4	4.6	4.5	2.3	7.6	-	0.9	6.8
21/03/2017	15.1	21.2	5.1	3.9	4.6	4.1	2.5	-	0.6	2.8
22/03/2017	16.2	14.9	4.6	5.3	3.3	4.2	0.0	1.1	0.7	0.1
23/03/2017	12.8	10.5	2.4	2.2	2.3	4.1	0.0	1.1	0.9	0.0
24/03/2017	11.4	11.9	3.2	2.8	2.1	0.7	0.0	1.2	-	0.0
25/03/2017	21.7	19.2	4.8	4.4	3.8	4.3	5.2	1.4	0.8	3.2
26/03/2017	15.9	18.5	4.3	4.7	4.2	2.6	1.7	2.9	1.1	5.3
27/03/2017	16.4	13.5	5.9	3.7	5.4	8.0	8.7	3.0	1.7	4.0
28/03/2017	29.1	30.3	7.1	6.3	6.3	4.6	0.4	3.6	2.6	0.3
29/03/2017	25.7	23.9	9.0	7.5	9.5	1.1	6.7	-	0.8	5.8
30/03/2017	13.2	13.6	6.4	10.7	5.2	6.3	1.1	1.2	2.3	1.0
31/03/2017	15.2	15.3	5.2	3.2	2.1	13.9	0.0	1.3	4.8	0.1
1/04/2017	13.7	14.5	5.0	4.8	2.9	5.4	0.0	-	3.8	0.0
2/04/2017	16.6	16.3	4.4	5.9	3.5	0.1	0.0	2.2	1.2	0.0
3/04/2017	11.4	9.8	3.0	3.8	2.1	5.6	0.0	2.4	2.6	0.0
4/04/2017	11.0	10.9	3.2	3.7	-	0.9	0.0	1.2	2.4	0.8
5/04/2017	12.8	10.8	2.8	2.5	-	0.0	0.2	1.4	-	0.2
6/04/2017	11.2	10.2	3.2	2.9	1.8	1.7	0.0	2.3	3.1	1.5
7/04/2017	12.8	8.7	4.0	3.6	2.0	4.0	0.0	1.5	-	1.3
8/04/2017	12.2	9.1	4.2	2.9	3.2	3.1	1.1	2.6	3.5	3.9
9/04/2017	9.6	9.7	4.0	2.9	2.1	1.0	2.1	4.6	3.7	3.3
10/04/2017	36.8	32.6	7.8	5.6	5.3	0.0	0.0	-	4.2	0.0
11/04/2017	19.3	11.4	5.2	4.3	2.0	3.5	0.0	1.9	2.4	0.0
12/04/2017	9.5	9.3	2.6	3.4	2.0	8.4	0.1	1.6	2.7	0.0
13/04/2017	10.3	10.7	3.5	3.0	2.9	2.8	0.0	1.8	2.9	0.0
14/04/2017	15.0	14.1	6.9	4.9	4.0	2.3	0.0	2.6	4.9	0.1
15/04/2017	17.4	16.4	8.8	7.5	5.3	3.2	2.2	1.9	5.8	1.2
16/04/2017	24.2	19.3	14.7	11.0	8.5	4.1	1.1	1.6	-	2.4
17/04/2017	19.9	18.0	10.2	8.9	6.6	0.1	0.0	1.2	2.0	0.5
18/04/2017	17.6	14.3	7.8	6.0	4.9	1.1	0.0	2.0	3.2	0.5
19/04/2017	15.5	17.1	6.8	4.3	3.4	1.5	0.0	5.3	1.8	0.0
20/04/2017	11.7	10.7	5.6	3.3	2.3	3.4	0.0	2.9	-	12.5
21/04/2017	13.0	10.5	3.8	3.8	2.9	5.2	5.8	4.4	3.2	6.5
22/04/2017	12.1	11.3	5.9	4.4	3.4	3.3	9.8	4.9	6.5	4.0
23/04/2017	16.4	13.9	10.5	7.1	6.1	7.2	2.4	12.1	8.7	7.5
24/04/2017	17.5	16.0	9.8	10.5	8.8	3.5	3.4	7.8	3.4	6.5
25/04/2017	15.8	13.3	6.0	6.2	6.1	1.5	1.2	4.8	3.6	1.5
26/04/2017	4.8	7.3	4.9	3.1	2.5	0.2	0.5	0.9	7.8	0.3
27/04/2017	10.3	13.2	4.1	3.9	2.6	6.4	0.0	1.2	6.2	0.0
28/04/2017	15.2	13.2	6.1	5.2	3.2	17.7	0.0	0.7	7.7	0.3
29/04/2017	16.9	11.9	9.7	5.1	4.0	3.8	1.1	7.3	5.4	2.0
30/04/2017	13.5	11.5	8.1	5.6	4.1	1.9	0.1	7.9	1.9	0.4
1/05/2017	15.7	10.9	8.3	2.8	4.8	2.7	0.7	3.7	4.7	3.2
2/05/2017	18.9	17.1	9.3	7.9	9.0	2.5	0.0	2.8	3.6	1.5
3/05/2017	15.5	15.0	5.7	5.8	3.5	1.0	0.0	2.0	2.3	0.0
4/05/2017	11.4	9.7	4.8	5.4	2.3	0.6	0.0	1.8	2.1	0.2
5/05/2017	13.7	8.4	7.2	4.3	2.5	4.9	1.2	4.3	3.5	8.9
6/05/2017	17.3	10.0	9.5	5.0	5.1	12.4	2.6	7.0	10.4	2.5
7/05/2017	15.0	11.7	10.4	4.8	5.2	2.2	0.1	3.4	1.9	1.1
8/05/2017	15.8	15.9	7.4	8.1	4.7	0.8	0.4	2.7	1.3	1.8

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
9/05/2017	16.6	15.3	7.5	6.3	4.5	3.2	0.0	2.2	2.3	1.1
10/05/2017	16.2	18.0	8.3	9.1	4.4	10.0	0.0	2.6	5.2	0.9
11/05/2017	24.7	29.8	13.8	17.9	11.3	5.7	0.0	3.1	3.8	0.8
12/05/2017	19.0	19.4	14.1	13.4	12.5	5.5	0.2	2.3	2.7	0.9
13/05/2017	13.0	9.4	6.9	5.3	4.4	6.5	1.5	4.7	-	2.2
14/05/2017	9.8	8.3	6.7	6.7	2.6	1.5	0.4	2.2	1.5	0.3
15/05/2017	12.7	12.6	9.4	6.8	4.4	9.9	0.0	2.2	3.6	0.8
16/05/2017	12.6	18.5	8.9	4.6	2.5	6.5	0.0	3.8	4.8	0.4
17/05/2017	20.6	19.0	10.0	5.6	3.9	4.0	0.4	2.3	2.8	3.4
18/05/2017	19.7	18.5	9.8	8.0	4.6	7.9	0.7	3.1	4.2	3.6
19/05/2017	10.0	9.9	3.2	5.4	2.7	0.9	2.0	3.7	-	0.3
20/05/2017	10.1	6.5	5.8	3.3	3.0	5.6	1.1	1.9	3.6	0.7
21/05/2017	13.2	9.8	9.4	4.5	4.1	1.7	0.0	-	3.8	0.3
22/05/2017	15.0	12.0	6.8	5.7	4.6	0.9	0.0	2.7	-	0.3
23/05/2017	15.7	10.9	9.5	5.1	6.5	6.0	3.1	9.6	-	6.1
24/05/2017	11.5	8.6	8.2	4.1	-	1.1	0.0	1.4	4.3	5.9
25/05/2017	14.9	11.5	7.6	5.1	2.6	8.8	0.0	2.9	4.8	0.8
26/05/2017	16.7	10.1	11.7	4.5	3.9	26.4	0.0	2.4	8.8	0.7
27/05/2017	19.4	12.8	15.1	8.3	8.9	4.2	7.0	5.6	5.3	5.2
28/05/2017	16.8	11.5	13.6	7.5	6.2	2.2	1.1	3.4	6.9	0.6
29/05/2017	12.8	8.1	8.0	3.9	2.5	1.0	0.7	2.0	10.6	0.2
30/05/2017	13.8	8.3	7.6	5.3	2.5	0.6	0.9	1.2	2.3	1.3
31/05/2017	14.3	11.2	5.3	3.3	2.2	11.8	0.5	1.2	7.6	0.1
1/06/2017	13.9	-	6.8	-	2.4	13.4	-	1.1	5.3	0.0
2/06/2017	11.6	-	4.3	-	2.6	13.7	-	1.8	6.5	0.1
3/06/2017	11.1	12.0	3.2	4.0	2.9	16.7	0.0	1.4	5.1	0.6
4/06/2017	12.3	10.6	9.0	4.3	2.1	6.0	0.0	-	2.3	0.7
5/06/2017	13.4	9.6	13.0	4.4	2.9	3.2	0.5	1.5	6.3	2.3
6/06/2017	12.6	10.0	7.3	4.5	3.6	1.7	1.5	2.2	4.5	0.6
7/06/2017	6.7	7.8	1.9	3.4	2.6	12.0	0.0	1.1	2.4	-0.2
8/06/2017	10.4	10.0	3.9	3.3	2.4	2.6	0.0	-	-	0.0
9/06/2017	10.1	10.7	4.3	4.3	2.5	2.5	0.0	0.7	1.2	0.1
10/06/2017	9.7	9.4	4.9	3.1	2.0	0.3	0.1	4.2	1.4	0.5
11/06/2017	9.5	8.4	7.3	6.1	2.6	2.4	0.7	-	1.4	1.1
12/06/2017	12.2	9.2	6.5	4.6	2.4	8.3	0.4	9.5	3.7	0.1
13/06/2017	14.1	14.0	6.1	5.3	2.8	3.2	0.5	-	2.0	0.0
14/06/2017	10.8	9.1	6.7	4.0	3.0	5.8	0.1	-	2.3	0.5
15/06/2017	15.4	7.3	9.6	4.1	3.1	2.9	2.0	2.8	2.6	1.9
16/06/2017	16.0	12.7	9.9	6.5	6.0	7.1	0.6	2.0	2.8	2.8
17/06/2017	15.5	14.4	8.1	8.1	6.0	5.4	1.1	1.7	2.3	2.3
18/06/2017	14.1	15.7	10.4	8.1	6.3	9.2	1.1	2.7	2.5	0.1
19/06/2017	14.9	14.0	5.2	6.4	-	10.9	0.4	2.9	1.6	0.0
20/06/2017	10.0	7.3	6.2	4.4	-	4.2	-1.5	1.1	1.8	0.8
21/06/2017	14.3	10.6	10.4	4.3	5.7	7.4	-0.1	1.5	3.2	1.3
22/06/2017	17.6	13.5	9.6	4.6	5.1	7.6	0.1	1.8	2.9	0.7
23/06/2017	16.3	9.4	10.5	5.3	7.9	8.1	1.0	1.9	3.7	1.6
24/06/2017	20.5	10.8	12.8	9.8	4.2	1.0	0.2	1.4	9.0	0.2
25/06/2017	19.9	9.1	16.1	5.7	3.9	1.1	0.5	2.3	11.4	0.4
26/06/2017	17.6	9.3	15.2	5.9	3.5	7.7	0.0	2.0	3.3	1.8
27/06/2017	25.0	10.1	13.1	4.7	3.6	3.1	0.1	2.7	1.8	1.2
28/06/2017	16.9	9.5	10.4	4.5	5.9	2.8	1.1	3.3	4.9	2.0
29/06/2017	10.5	8.9	8.0	4.7	2.9	3.2	0.0	2.6	3.5	0.4
30/06/2017	14.4	7.7	12.3	4.2	2.6	9.1	0.0	0.9	3.1	0.6
1/07/2017	16.5	10.9	14.8	6.6	7.2	7.5	0.0	1.5	3.5	0.1
2/07/2017	18.3	10.1	20.4	5.5	8.2	4.3	3.1	1.6	4.1	1.2
3/07/2017	20.2	10.5	17.1	6.9	8.1	4.7	5.8	7.4	6.0	4.8
4/07/2017	13.1	8.8	5.7	5.3	5.8	1.3	1.0	4.3	2.0	2.2
5/07/2017	10.5	6.9	3.6	3.9	4.5	3.5	0.1	0.6	1.5	1.7
6/07/2017	18.2	8.7	10.2	3.5	5.3	0.3	0.4	1.8	7.0	1.9
7/07/2017	18.3	7.8	11.8	2.7	7.2	6.4	0.0	1.6	4.9	1.7
8/07/2017	17.1	9.8	6.9	4.8	6.5	0.1	0.4	2.7	0.9	1.1
9/07/2017	15.6	7.7	11.1	3.1	4.8	0.2	0.1	3.1	7.5	0.4
10/07/2017	16.6	11.3	11.3	5.4	5.0	1.4	-	2.6	3.5	0.8
11/07/2017	14.7	10.8	10.0	4.5	5.4	5.7	0.0	1.5	3.4	1.2
12/07/2017	8.7	9.2	3.5	3.9	5.5	4.4	0.0	1.0	1.3	0.0

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
13/07/2017	11.6	12.4	9.3	4.5	6.6	2.4	5.2	2.7	6.7	3.9
14/07/2017	14.4	11.7	9.7	7.5	8.4	2.5	3.1	10.4	5.7	3.1
15/07/2017	14.8	9.7	11.0	6.2	8.7	1.1	0.0	2.3	3.5	0.3
16/07/2017	13.4	9.1	11.2	5.4	6.1	3.8	0.2	3.6	6.7	1.0
17/07/2017	16.3	10.0	11.5	5.9	7.5	7.1	1.2	9.8	12.1	3.0
18/07/2017	14.9	9.2	8.2	3.5	5.6	2.3	1.1	4.0	12.5	3.4
19/07/2017	11.3	9.5	3.5	2.5	2.9	0.0	0.1	1.3	17.0	0.4
20/07/2017	10.2	10.8	3.5	3.6	3.4	0.3	0.5	1.9	10.3	0.7
21/07/2017	18.3	14.1	10.6	4.9	4.7	7.3	0.0	0.3	4.2	0.3
22/07/2017	22.9	9.8	20.0	5.5	5.0	8.1	2.6	2.3	4.0	1.2
23/07/2017	16.0	7.6	5.6	3.8	4.5	4.8	0.0	1.1	6.4	0.0
24/07/2017	17.0	13.9	7.2	4.5	5.6	1.3	0.5	1.9	7.8	1.1
25/07/2017	18.6	19.5	10.0	4.3	8.2	2.1	0.6	2.5	5.0	2.2
26/07/2017	16.9	12.6	5.1	4.7	6.2	2.8	0.5	1.4	6.2	0.9
27/07/2017	21.2	13.8	9.9	5.3	9.1	3.4	0.6	4.5	5.7	2.5
28/07/2017	18.0	16.4	10.7	4.7	6.3	4.7	1.2	2.0	5.5	0.3
29/07/2017	21.1	10.6	16.0	6.3	7.6	7.4	2.2	3.7	4.2	1.4
30/07/2017	22.2	13.7	7.7	5.1	6.4	4.9	2.0	14.2	15.2	5.8
31/07/2017	17.7	15.1	6.3	4.9	8.2	2.8	0.5	3.6	5.3	0.9
1/08/2017	13.1	9.1	6.8	3.6	4.8	5.2	0.0	1.1	5.1	0.6
2/08/2017	15.8	12.1	8.5	5.2	6.7	9.5	0.0	0.6	5.3	0.0
3/08/2017	14.6	8.8	9.8	3.9	8.0	3.5	1.4	4.5	2.2	2.6
4/08/2017	5.9	6.1	3.8	2.1	3.1	0.1	0.4	1.4	1.5	0.2
5/08/2017	10.0	7.2	5.3	4.3	5.2	0.3	0.1	1.0	1.8	0.7
6/08/2017	19.4	9.7	14.8	5.1	5.3	1.6	0.0	11.1	3.0	2.0
7/08/2017	16.4	9.1	15.1	5.1	4.6	0.9	0.5	1.2	10.3	0.7
8/08/2017	9.0	7.7	3.1	2.1	3.3	0.7	0.0	2.4	10.7	0.9
9/08/2017	-	9.0	-	4.1	4.3	2.0	1.1	4.1	1.9	1.3
10/08/2017	-	10.2	-	3.1	6.2	4.7	0.9	3.3	4.5	1.6
11/08/2017	23.2	18.4	7.0	6.6	6.7	2.3	2.0	1.7	4.7	0.1
12/08/2017	15.9	11.8	5.7	3.9	5.2	0.2	3.1	1.7	3.9	0.6
13/08/2017	18.5	11.7	11.9	5.8	7.2	3.6	1.9	6.0	7.8	1.5
14/08/2017	19.4	19.6	11.5	12.1	11.6	4.2	0.4	1.5	6.3	2.1
15/08/2017	22.9	15.7	9.5	8.0	10.4	5.2	1.6	4.6	15.7	1.9
16/08/2017	15.5	14.4	5.8	3.4	6.4	0.7	0.0	3.2	10.6	0.7
17/08/2017	17.9	20.5	4.0	6.5	6.1	0.0	0.6	0.9	1.9	1.0
18/08/2017	17.4	28.4	3.8	4.0	3.6	0.0	0.4	1.6	11.9	0.3
19/08/2017	12.4	12.9	3.7	3.5	4.1	3.6	0.0	0.8	2.1	0.0
20/08/2017	13.5	12.4	5.7	5.5	5.7	8.7	0.0	2.2	4.4	0.0
21/08/2017	18.3	12.6	12.3	5.6	8.7	4.8	3.0	3.5	9.1	2.0
22/08/2017	20.0	-	13.7	-	9.9	2.6	1.2	6.0	2.3	2.7
23/08/2017	22.0	-	13.2	-	14.6	2.1	7.0	4.1	3.1	7.8
24/08/2017	20.0	17.6	13.8	7.8	10.5	3.8	0.0	2.1	1.9	1.1
25/08/2017	14.4	13.9	5.6	5.3	5.2	14.5	0.0	2.3	4.7	0.1
26/08/2017	19.3	17.9	11.5	10.1	28.8	5.0	0.1	3.2	6.3	1.5
27/08/2017	16.4	15.3	11.7	10.0	73.0	4.0	1.4	1.2	4.8	0.6
28/08/2017	13.3	13.7	5.3	4.6	4.6	5.7	0.0	0.4	2.3	0.0
29/08/2017	15.0	14.4	7.8	5.8	10.8	3.5	0.0	4.3	4.1	0.8
30/08/2017	15.3	14.3	8.8	7.7	13.3	7.0	0.2	3.5	9.2	1.5
31/08/2017	14.2	15.2	4.6	4.7	4.9	12.8	0.0	1.7	6.2	0.0
1/09/2017	15.3	15.5	9.0	4.0	7.2	11.4	0.0	6.7	3.8	0.4
2/09/2017	18.1	18.0	8.4	10.2	19.8	5.9	6.8	8.9	7.8	2.8
3/09/2017	21.3	25.3	10.2	19.6	14.5	2.7	2.7	4.5	3.3	3.2
4/09/2017	22.1	27.9	5.0	8.2	4.4	0.1	0.5	0.7	0.5	0.0
5/09/2017	20.1	20.4	4.2	6.3	3.5	0.0	0.0	1.3	2.3	0.4
6/09/2017	18.6	17.7	3.2	4.0	4.4	0.0	0.0	1.0	4.2	0.3
7/09/2017	14.4	12.1	6.4	3.3	5.8	1.0	0.0	1.4	4.7	1.1
8/09/2017	16.6	21.7	8.7	15.0	5.3	0.5	0.4	2.9	5.8	0.8
9/09/2017	16.4	13.9	8.0	5.3	5.0	3.9	0.0	8.0	3.8	0.0
10/09/2017	24.4	16.3	15.9	9.2	9.6	4.9	0.1	11.9	9.6	5.0
11/09/2017	25.6	33.9	14.3	17.9	17.2	4.8	6.3	7.1	7.4	3.7
12/09/2017	28.5	37.1	9.0	27.2	15.7	4.0	4.1	2.8	5.4	2.0
13/09/2017	35.7	20.4	12.0	15.9	9.7	2.5	1.1	2.8	3.1	1.2
14/09/2017	8.8	10.5	4.7	3.2	3.9	0.3	0.0	1.2	6.7	0.1
15/09/2017	14.4	16.8	4.8	8.2	4.6	0.0	0.2	1.6	3.6	0.2

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
16/09/2017	18.4	13.9	5.1	5.5	6.0	0.0	0.0	0.7	2.2	0.0
17/09/2017	13.2	11.6	6.9	5.8	5.5	3.5	0.0	4.3	1.9	0.3
18/09/2017	18.2	14.3	6.5	6.7	8.4	3.0	2.1	3.9	5.2	2.7
19/09/2017	21.9	15.5	8.3	5.6	6.6	2.4	0.6	2.0	1.9	1.1
20/09/2017	19.6	19.1	6.7	7.4	9.4	2.4	2.4	15.4	2.0	5.7
21/09/2017	23.3	22.0	9.8	7.5	17.7	4.4	5.2	8.7	6.3	5.6
22/09/2017	23.9	25.1	9.1	6.7	10.1	6.0	0.5	5.1	4.7	1.2
23/09/2017	30.0	24.9	11.5	9.7	10.8	3.9	6.6	5.9	2.6	4.6
24/09/2017	47.9	63.4	12.3	12.5	13.5	3.4	0.2	3.8	2.4	1.8
25/09/2017	26.7	22.3	8.6	5.0	6.3	0.9	0.1	4.3	5.1	1.1
26/09/2017	20.5	23.9	5.7	9.3	6.3	3.2	0.0	6.9	3.1	0.9
27/09/2017	22.6	25.5	4.4	9.3	7.8	2.4	3.6	9.5	2.5	0.4
28/09/2017	20.7	26.4	8.3	6.7	7.1	1.5	3.0	2.3	8.5	1.8
29/09/2017	19.7	15.8	5.3	6.5	7.2	1.9	0.4	3.2	2.4	7.5
30/09/2017	19.1	19.3	5.4	4.7	5.1	0.5	1.7	2.9	9.8	0.1
1/10/2017	25.9	20.9	8.9	7.7	7.3	5.5	1.2	5.0	8.1	4.7
2/10/2017	25.7	27.9	12.0	12.6	13.4	3.6	11.2	8.3	3.3	9.0
3/10/2017	12.9	17.9	5.5	6.2	7.8	1.7	5.7	4.0	0.6	2.7
4/10/2017	18.2	24.2	7.6	12.3	12.3	5.8	2.0	12.5	2.9	2.2
5/10/2017	22.5	29.0	10.7	8.6	12.7	3.2	7.1	2.6	2.5	1.8
6/10/2017	23.6	29.7	8.1	6.7	9.4	3.9	1.4	4.4	1.8	0.8
7/10/2017	17.2	16.2	4.8	4.8	5.2	2.8	0.0	17.1	1.6	0.0
8/10/2017	15.0	14.4	4.7	5.6	7.5	6.4	4.8	5.6	-0.1	3.4
9/10/2017	19.7	16.4	5.7	7.7	9.9	1.8	1.1	2.7	2.0	0.8
10/10/2017	30.3	30.3	8.9	7.4	8.8	0.2	0.0	3.2	0.6	0.9
11/10/2017	22.1	27.3	6.6	6.6	11.7	0.7	3.1	3.1	0.4	1.4
12/10/2017	17.6	20.8	7.2	7.2	8.8	1.5	0.6	12.7	2.9	0.1
13/10/2017	27.2	27.5	6.6	7.9	10.6	1.8	3.8	3.4	0.7	1.9
14/10/2017	21.6	19.0	6.4	5.5	8.4	0.0	0.0	2.5	1.4	0.0
15/10/2017	12.9	14.5	4.3	4.5	6.4	0.6	0.0	1.4	1.5	0.5
16/10/2017	17.3	10.1	5.7	2.7	6.5	1.5	0.0	2.2	0.5	9.9
17/10/2017	25.7	15.8	4.4	4.7	6.3	2.1	0.0	1.9	0.5	11.2
18/10/2017	20.0	19.5	5.7	4.2	6.8	0.7	7.0	3.3	1.9	0.0
19/10/2017	18.6	20.5	5.1	5.1	8.8	0.9	7.9	2.2	2.4	2.5
20/10/2017	14.0	13.8	3.9	4.9	7.0	3.9	0.2	1.3	2.3	-0.4
21/10/2017	17.6	16.1	6.4	4.6	6.1	3.2	0.5	3.0	0.5	0.0
22/10/2017	11.8	12.8	4.6	3.6	6.3	1.1	4.5	6.3	3.9	11.4
23/10/2017	10.5	9.2	3.9	2.7	5.6	0.8	0.0	6.9	1.0	0.0
24/10/2017	14.2	13.0	5.5	5.2	7.0	8.3	5.6	5.8	4.1	3.5
25/10/2017	19.0	14.8	5.0	4.8	7.1	3.9	0.1	1.6	0.3	-0.2
26/10/2017	20.3	16.7	9.2	6.9	10.3	9.6	0.0	3.9	2.3	0.0
27/10/2017	12.5	11.9	4.3	5.6	8.1	2.7	0.0	3.5	1.8	0.0
28/10/2017	15.6	17.1	9.1	5.4	10.3	3.8	5.8	10.3	4.4	2.9
29/10/2017	13.8	14.2	6.0	7.3	9.9	3.2	2.5	4.9	2.2	2.1
30/10/2017	28.2	20.6	9.7	7.4	10.2	1.9	0.1	2.1	-0.8	0.3
31/10/2017	15.1	17.2	7.3	5.3	5.9	5.1	0.0	0.9	3.8	-0.1
1/11/2017	18.5	22.4	6.5	4.8	8.1	6.3	0.0	1.6	4.8	0.1
2/11/2017	24.0	19.8	7.2	7.0	8.3	0.6	0.1	4.7	1.6	2.7
3/11/2017	28.3	21.5	10.9	7.5	9.9	7.5	1.2	4.3	3.1	0.0
4/11/2017	12.2	10.0	4.6	2.7	5.9	0.6	0.0	1.6	1.5	-0.3
5/11/2017	12.2	10.7	5.8	3.3	4.7	0.5	0.0	1.5	1.1	2.6
6/11/2017	10.7	8.4	5.7	5.1	7.2	2.7	1.5	4.4	3.5	2.3
7/11/2017	14.3	11.7	3.7	4.8	4.9	2.7	0.0	4.3	3.4	0.0
8/11/2017	10.4	10.9	4.9	4.4	5.5	0.1	0.0	8.0	0.9	0.0
9/11/2017	12.1	9.7	5.4	2.7	6.2	0.7	0.1	6.3	1.2	0.5
10/11/2017	10.5	8.5	3.3	2.2	6.4	2.2	0.0	1.5	0.6	2.9
11/11/2017	11.1	9.3	3.9	2.7	6.5	0.7	0.0	0.3	0.6	15.0
12/11/2017	11.7	10.0	3.1	2.7	6.3	0.7	0.0	1.6	1.7	0.3
13/11/2017	12.0	9.6	5.0	3.5	7.0	1.3	0.0	5.6	1.1	0.5
14/11/2017	12.0	9.9	5.0	4.2	6.6	1.7	0.0	2.2	1.6	4.6
15/11/2017	14.0	7.9	4.3	3.5	6.6	-	2.9	3.9	1.0	1.3
16/11/2017	13.8	-	3.3	-	7.3	4.0	-	6.0	1.6	0.2
17/11/2017	11.0	-	1.7	-	7.7	1.0	3.4	0.8	1.6	0.7
18/11/2017	16.2	15.2	5.1	4.0	8.0	3.4	3.8	7.3	0.6	15.3
19/11/2017	-	14.3	-	3.0	8.3	-	0.1	1.6	1.7	0.7

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
20/11/2017	-	13.8	-	2.1	7.2	-	-0.1	4.0	1.0	0.0
21/11/2017	14.1	14.1	3.4	3.1	7.8	0.6	0.1	1.0	1.0	0.2
22/11/2017	12.1	11.7	5.1	4.0	8.2	1.9	0.0	1.3	0.7	0.9
23/11/2017	12.6	10.7	4.1	2.5	8.7	2.7	3.0	6.9	2.3	4.0
24/11/2017	18.2	13.2	5.2	4.5	9.4	3.5	3.5	7.7	6.1	5.8
25/11/2017	12.0	9.8	3.8	4.7	7.8	2.4	0.7	5.5	1.7	21.0
26/11/2017	14.5	10.4	4.0	3.0	7.5	1.9	0.2	2.4	0.9	0.0
27/11/2017	13.0	13.3	3.9	5.4	8.6	4.0	11.0	0.6	0.6	3.2
28/11/2017	10.9	12.9	4.0	4.7	9.9	2.3	1.1	0.7	0.8	2.9
29/11/2017	9.0	11.7	3.3	2.9	8.6	0.3	0.0	0.8	2.8	0.0
30/11/2017	17.0	14.1	4.7	3.9	10.3	1.0	1.6	1.3	1.0	0.7
1/12/2017	19.0	24.3	5.6	4.6	12.6	2.2	11.7	6.6	2.6	8.4
2/12/2017	10.2	13.5	4.0	3.9	9.1	2.2	2.2	6.7	1.9	1.0
3/12/2017	7.8	7.8	4.5	-	6.8	4.1	0.5	4.2	0.3	0.1
4/12/2017	13.7	11.3	7.4	4.4	8.6	4.3	0.5	2.9	2.5	0.0
5/12/2017	12.2	11.1	4.8	2.4	7.8	5.5	1.5	7.1	2.5	0.1
6/12/2017	9.5	10.1	4.2	4.4	7.1	0.8	0.2	4.6	2.3	0.2
7/12/2017	19.2	17.0	6.7	7.4	9.0	0.6	3.5	2.1	8.0	1.0
8/12/2017	26.6	25.4	12.3	7.4	10.8	6.2	1.2	10.3	2.7	2.7
9/12/2017	19.2	19.9	5.8	4.5	7.5	0.3	0.0	11.4	1.0	5.9
10/12/2017	12.8	11.7	4.5	3.6	6.7	0.3	0.0	1.9	2.0	6.9
11/12/2017	13.2	12.3	5.1	4.7	7.7	1.4	3.0	6.5	0.2	6.7
12/12/2017	15.1	13.7	5.2	3.6	8.3	1.1	0.9	9.6	1.9	0.3
13/12/2017	21.5	30.1	8.8	7.3	11.7	2.6	15.6	7.9	2.9	2.1
14/12/2017	34.4	30.8	15.3	10.0	13.6	4.2	5.1	5.2	2.3	0.7
15/12/2017	31.9	32.8	11.6	10.3	15.3	9.1	0.0	5.5	2.7	0.0
16/12/2017	24.1	24.6	9.9	9.1	13.4	5.7	9.2	6.4	2.3	6.2
17/12/2017	25.9	26.1	9.7	9.4	13.4	9.5	1.2	6.4	2.0	0.1
18/12/2017	26.1	22.2	10.3	7.8	15.2	15.8	6.6	13.0	4.0	5.9
19/12/2017	26.0	23.6	11.0	9.5	18.2	-	5.6	6.1	3.6	2.5
20/12/2017	37.6	32.4	11.9	13.3	13.4	-	0.5	4.6	3.0	1.4
21/12/2017	19.8	17.2	7.4	7.2	9.0	0.0	0.4	2.4	0.2	0.0
22/12/2017	13.3	12.9	4.9	5.0	7.6	0.5	-	2.4	-0.2	7.3
23/12/2017	15.2	16.7	7.5	4.8	11.3	1.7	19.0	2.3	3.7	2.2
24/12/2017	24.2	23.0	9.8	9.5	12.1	4.0	0.5	4.1	0.3	0.7
25/12/2017	19.8	21.4	6.7	6.3	8.2	0.0	0.0	0.0	1.0	0.0
26/12/2017	22.6	21.9	4.1	4.3	7.5	0.2	0.0	1.5	1.2	0.0
27/12/2017	19.2	18.1	5.5	4.1	7.8	2.5	0.5	-1.5	0.8	7.9
28/12/2017	19.1	17.9	6.0	5.5	10.1	6.5	16.4	7.2	-0.2	6.4
29/12/2017	21.2	21.8	8.9	8.1	14.9	7.3	5.3	4.4	1.4	1.3
30/12/2017	12.6	13.9	4.5	6.2	12.0	5.4	1.5	1.1	0.8	0.6
31/12/2017	24.3	25.2	6.9	8.1	7.7	0.7	2.6	1.6	1.3	1.6

- Not applicable

Table C-2: 24-hour average HVAS monitoring data

Date	PM_{10} (HVAS) (µg/m³)		Date	PM_{10} (HVAS) (µg/m³)	
	Wakefield (Westside)	Teralba		Wakefield (Westside)	Teralba
6/01/2017	3	4	11/07/2017	-	8
12/01/2017	21	21	17/07/2017	-	11
18/01/2017	26	30	23/07/2017	-	18
24/01/2017	22	27	29/07/2017	-	13
30/01/2017	17	18	4/08/2017	1	2
5/02/2017	13	16	10/08/2017	4	11
11/02/2017	33	34	16/08/2017	12	27
17/02/2017	19	20	22/08/2017	12	21
23/02/2017	14	15	28/08/2017	7	10
1/03/2017	4	4	3/09/2017	15	21
7/03/2017	12	15	9/09/2017	19	25
13/03/2017	20	21	15/09/2017	5	7
19/03/2017	15	16	21/09/2017	17	21
25/03/2017	14	16	27/09/2017	18	18
31/03/2017	10	14	3/10/2017	8	12
6/04/2017	2	3	9/10/2017	12	15
12/04/2017	6	5	15/10/2017	5	8
18/04/2017	7	10	21/10/2017	16	16
24/04/2017	12	15	27/10/2017	11	12
30/04/2017	3	4	2/11/2017	17	16
6/05/2017	-	12	8/11/2017	1	9
12/05/2017	-	14	14/11/2017	3	7
18/05/2017	-	18	20/11/2017	2	3
24/05/2017	-	10	26/11/2017	6	8
30/05/2017	-	12	2/12/2017	5	9
5/06/2017	1	6	8/12/2017	14	17
11/06/2017	5	7	14/12/2017	28	26
17/06/2017	11	14	20/12/2017	28	35
23/06/2017	9	14	26/12/2017	15	14
29/06/2017	2	21			
5/07/2017	-	4			

TODOROSKI AIR SCIENCES

LAKE MACQUARIE – WYONG

REVIEW OF ANNUAL AMBIENT AIR QUALITY DATA 2018

Delta Electricity & Origin Energy

22 February 2019

Job Number 18120902

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Lake Macquarie – Wyong

Review of Annual Ambient Air Quality Data 2018

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	12/02/2019	K Trahair	D Kjellberg
DRAFT - 002	21/02/2019	K Trahair	D Kjellberg
FINAL - 001	22/02/2019	K Trahair	D Kjellberg

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EXECUTIVE SUMMARY

This report has been prepared by Todoroski Air Sciences for Delta Electricity and Origin Energy and presents ambient air quality monitoring data recorded in the Lake Macquarie - Wyong region for the 2018 calendar year. The results indicate that the air quality was generally good in the Lake Macquarie - Wyong region during 2018.

The data summary (shown below) indicates that in 2018, The Wyee monitoring site recorded 24-hour average $PM_{2.5}$ levels above the relevant criterion on one day. The Wallsend, Wyong and Teralba monitors recorded 24-hour average PM_{10} levels above the relevant criterion on five days, six days and one day respectively. All other data were below the applicable criteria. Further details are provided in the report and the 24-hour average data are provided in the Appendices.

Lake Macquarie - Wyong Air Quality Pictorial Summary – 2018

Short term averages (1-hour and 24-hour)

Long term average (annual)

Lake Macquarie – Wyong Air Quality Tabular Summary - 2018

Site	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2
	Maximum 1-hour average (µg/m³)		Maximum 24-hour average (µg/m³)			Annual average (µg/m³)			
	Air Quality Impact Criteria								
	570	246	50	25	228	25	8	60	62
Wallsend	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wyong	✓	✓	✗	✗	✓	✓	✓	✓	✓
Dora Creek	✓	✓	-	-	✓	-	-	✓	✓
Marks Point	✓	✓	-	-	✓	-	-	✓	✓
Wyee	✓	✓	-	✗	✓	-	✓	✓	✓
Wakefield HVAS*	-	-	✓	-	-	✓*	-	-	-
Teralba HVAS	-	-	✗	-	-	-	-	-	-

✓ - All data below applicable criteria
✗ - At least one elevated level above applicable criteria
\- - Not applicable
HVAS - High Volume Air Sampler
* - Monitoring site decommissioned, data available until 04/09/2018

1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of Delta Electricity and Origin Energy. It provides a summary and analysis of the available ambient air quality and meteorological data collected in the Lake Macquarie - Wyong region during the 2018 calendar year.

2 PROJECT SCOPE

The following outlines the scope of work for this project.

- Provide an annual summary report for the 2018 calendar year for Lake Macquarie – Wyong. The report will examine compliance with annual average criteria and summarise the monthly reported data for the calendar year and include seasonal trends and pollution rose analysis to identify likely source categories for elevated pollution events.
- The report will assess the available data from monitoring stations operated by the NSW Office of Environment and Heritage (OEH) at Wyong and Wallsend, and by industry at Wyee, Marks Point, Dora Creek, Wakefield and Teralba.
- The aim is to provide a simplified report that is accessible and contains results that would be clearly understood by the general public.

3 THE PURPOSE OF AMBIENT MONITORING

It is important to note that the data presented in this report are from both NSW EPA and industry monitoring sites. The NSW EPA and the industry sites collect data for different purposes and this needs to be understood when comparing the data to the criteria.

NSW EPA monitoring sites are specifically designed to measure the likely levels of pollutants that the general population in the area would experience (i.e. an underlying population exposure level), whereas industry monitoring sites are specifically designed to measure maximum levels in a particular location which may be affected by a particular industry.

Data from NSW EPA sites can be compared with national air quality standards. Where the levels measured at NSW EPA monitoring sites are above the national standards on a prolonged and consistent basis, this indicates that some investigation of the potential cause of the issue may be warranted to determine whether any action on a regional level would reduce or better manage the pollutant levels. In the case of PM_{10}, it is noted that the national standards permit five days annually above the criteria to allow for events such as bushfires and dust storms.

Data from industry monitoring sites can be compared with NSW EPA impact assessment criteria. Where the levels measured at industry monitoring sites are above the applicable impact assessment criteria on a prolonged and consistent basis, this indicates that further investigation is warranted to determine the potential cause and what action is required by industry to reduce or better manage the pollutant.

Whether there is any harmful effect on an individual due to an air pollutant will depend on many additional factors, and not just on the measured level of a pollutant. These factors include the total exposure to the pollutant, individual circumstances (age, health, body mass, levels of pollutants at work), levels of other pollutants in the area, and many other factors. Where pollutant levels are below the

criteria generally, harm would not be expected to occur, but it does not follow that harm automatically occurs when pollutant levels are above the criteria.

The criteria serve to highlight potential issues with the levels of pollutants that may warrant more detailed examination. The criteria may also serve to prioritise action in various areas, for example areas with the highest pollutant levels and highest populations or highest exposure would be expected to receive priority action.

3.1 More about air quality

More information about air quality can be found via the following links:

- The Air Quality Index (AQI) was developed by the NSW EPA as an easily understood means of rating the pollutant level relative to its pollutant criteria.
  - https://www.environment.nsw.gov.au/topics/air/understanding-air-quality-data/air-quality-index
- Aqicn.org provides a near real-time AQI values for monitoring locations around the world. It should be noted that the AQI presented on this website is calculated differently to the NSW EPA AQI and is less stringent than those used in Australia, thus a direct comparison may not be valid.
  - http://aqicn.org/map/world/
- The NSW OEH website air quality page provides hourly updates of the AQI and data readings from the NSW EPA monitoring sites, and can provide daily forecasts for Sydney and alerts for elevated levels at Wallsend and Wyong, for example. The web tool also presents near real-time wind and pollutant data readings overlaid on regional maps for the Upper Hunter and Newcastle.
  - http://www.environment.nsw.gov.au/aqms/aqi.htm
- The Lower Hunter Particle Characterisation Study was commissioned to determine the composition of particulate samples collected at monitoring sites at Beresfield, Newcastle, Stockton and Mayfield, and to identify the potential major sources of fine particulates in Newcastle and the Lower Hunter.
  - https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/lower-hunter-particle-characterisation-study-final-report-160243.pdf
- The Air Emissions in My Community web tool presents the estimated emission quantities of various substances and their sources by postcode (and larger) sized areas in an easy to use graphical interface. This is one of the best inventories of emissions that is available, but it is important to appreciate that it cannot include all sources of emissions. It is important to also understand that pollutant emissions are not the same as the pollutant levels that this report presents. Emissions in a given area are one of several important factors that affect pollutant levels in an area, for example the dispersion of the emissions in the atmosphere and how the emissions are released are critical in determining the air quality pollutant levels.
  - https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-my-community/air-emissions-in-my-community-tool

- The NSW Health website provides information on how air pollution affects health and steps for reducing your air pollution and limiting your exposure.
  - http://www.health.nsw.gov.au/environment/air/Pages/default.aspx

4 AIR QUALITY MONITORING SITES

Figure 4-1 and **Table 4-1** summarise the locations and recorded parameters of the monitoring sites in the Lake Macquarie - Wyong region in 2018.

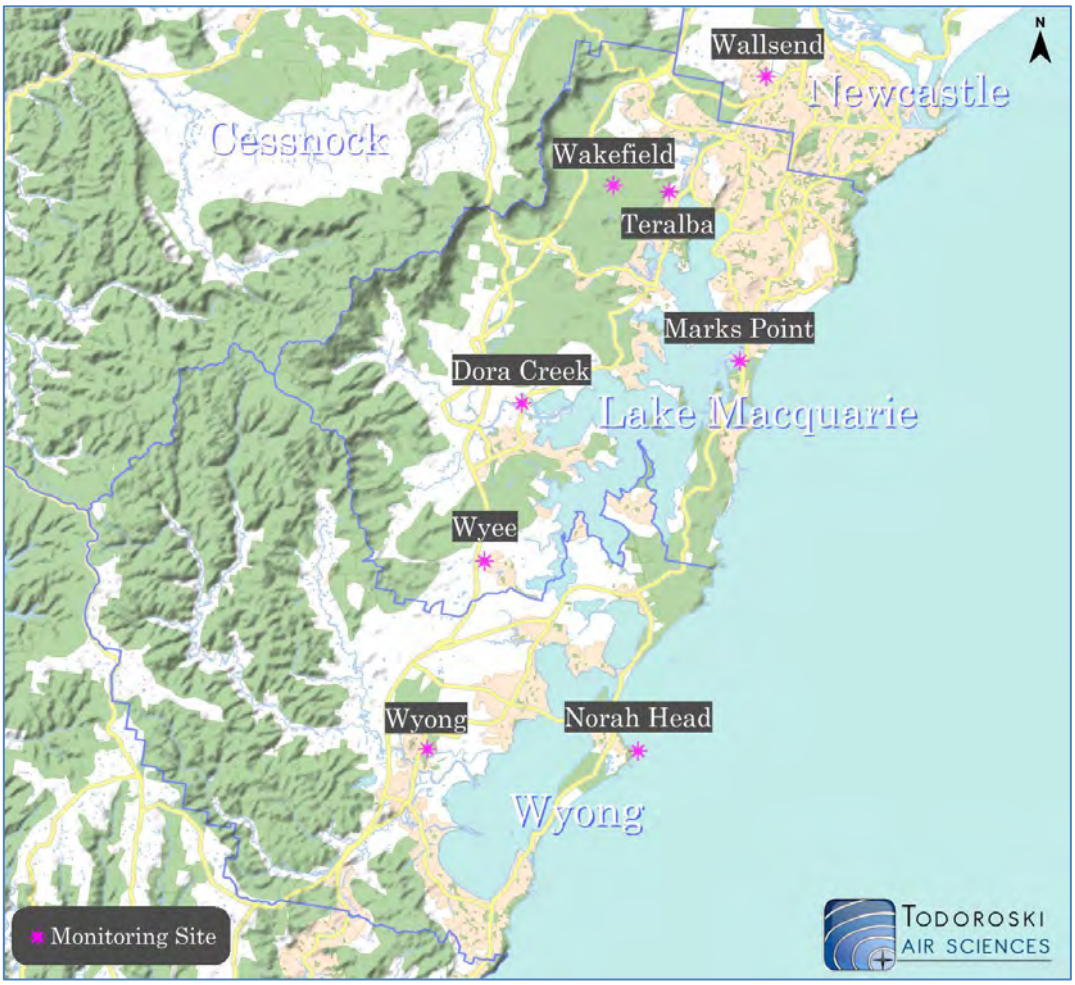

Figure 4-1: Monitoring site locations

Table 4-1: Monitoring sites

Monitoring Station	Type	Recorded Parameters	Recording Periods
Wallsend	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Wyong	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Marks Point	Industry site	NO_2, SO_2, WS, WD	Hourly
Wyee	Industry site	$PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly
Dora Creek	Industry site	NO_2, SO_2, WS, WD	Hourly
Norah Head	BOM weather station	WS, WD	Hourly
Wakefield HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day
Teralba HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day

PM_{10} - Particulate matter < 10µm
$PM_{2.5}$ - Particulate matter < 2.5µm
TEOM - Tapered Element Oscillating Microbalance (which samples air continuously)
NO_2 - Nitrogen dioxide
SO_2 - Sulfur dioxide
HVAS - High volume air sampler (which samples for a 24-hour period every 6 days)
WS - Wind speed
WD - Wind direction
BOM - Bureau of Meteorology

5 AIR QUALITY CRITERIA

The sections below identify the key pollutants currently being monitored at the Lake Macquarie - Wyong air quality monitoring sites and the applicable air quality criteria.

5.1 Particulate matter

Particulate matter consists of particles of varying size and composition. The total mass of all particles suspended in air is defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

The TSP is defined further into two sub-components. They are PM_{10} particles, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

Table 5-1 summarises the air quality goals that are relevant to particulate pollutants as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW EPA, 2017**).

Table 5-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Criterion
Total suspended particulates (TSP)	Annual	90µg/m^3
Particulate Matter < 10µm (PM_{10})	Annual	25µg/m^3
	24-hour	50µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual	8µg/m^3
	24-hour	25µg/m^3

Source: **NSW EPA, 2017**

5.2 Other air pollutants

Nitrogen dioxide (NO_2) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called nitrogen oxides (NO_x). These gases form when fuel is burned at high temperatures, and mainly originates from motor vehicles, power generators and industrial boilers (**USEPA, 2013**). NO_x may also be generated by blasting activities. It is important to note that when formed, NO_2 is generally a small fraction of the total NO_x generated.

Sulfur dioxide (SO_2) is a colourless gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulfur content of the fuel. SO_2 can have impacts upon human health and the habitability of the environment for flora and fauna. SO_2 emissions are a precursor to acid rain, which can be an issue in the northern hemisphere; however it is not known to be an issue in NSW.

Table 5-2 summarises the air quality goals for NO_2 and SO_2.

Table 5-2: Air quality impact assessment criteria for air pollutants

Pollutant	Averaging period	Criterion
Nitrogen Dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Sulfur Dioxide (SO_2)	10-minute	712µg/m^3
	1-hour	570µg/m^3

	24-hour	228µg/m³
	Annual	60µg/m³

Source: **NSW EPA, 2017**

5.3 Summary of applicable criteria for this review

The particulate and gaseous pollutants monitored in the Lake Macquarie – Wyong region have air quality criteria which are averaged over short and long time periods.

As this report looks at an annual period of ambient air quality data, the annual average criteria are applicable along with those averaged over the shorter time periods (1-hour and 24-hours). The SO_2 10-minute average criterion was not included as 10-minute monitoring data are not available.

Table 5-3 summarises the applicable air quality criteria for this review.

Table 5-3: Air quality criteria used in this review

Pollutant	Averaging Period	Concentration
Particulate Matter < 10µm (PM_{10})	24-hour	50µg/m³
	Annual	25µg/m³
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m³
	Annual	8µg/m³
Nitrogen Dioxide (NO_2)	1-hour	246µg/m³
	Annual	62µg/m³
Sulfur Dioxide (SO_2)	1-hour	570µg/m³
	24-hour	228µg/m³
	Annual	60µg/m³

6 METEOROLOGICAL MONITORING DATA

Representative wind speed and direction data have been obtained from the Lake Macquarie - Wyong meteorological stations. The data are presented as a series windroses.

For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

Figure 6-1 presents the 2018 annual windroses for Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong. Seasonal windroses for the meteorological stations are presented in **Figure 6-2** and **Figure 6-3**.

The annual windroses show that the meteorological stations recorded winds which varied depending on the local influence of environmental features such as terrain, vegetation and buildings.

The meteorological stations generally recorded winds which originated from the north-easterly and south-easterly quadrants during summer. The recorded wind directions in spring and autumn were more varied, with low wind speeds from common at Wyong, Wyee and Dora Creek. The meteorological stations generally recorded winds which originated from the north-westerly quadrant during winter.

The Norah Head weather station recorded wind speeds which were generally higher than those recorded at the other stations. This is expected as the Norah Head weather station is located in an unsheltered coastal location that would be largely influenced by sea breezes.

There is a lack of data recorded for wind directions from the north, approximately between 350^{o} and 10^{o} at the Wyee meteorological station. This is a historically common, and inherent limitation of some weather sensors that cannot physically measure a segment of the 360 degrees of possible wind directions, (almost always the north segment), but it may also be a software or signal processing issue, and it is recommended that the issue be investigated further and rectified.

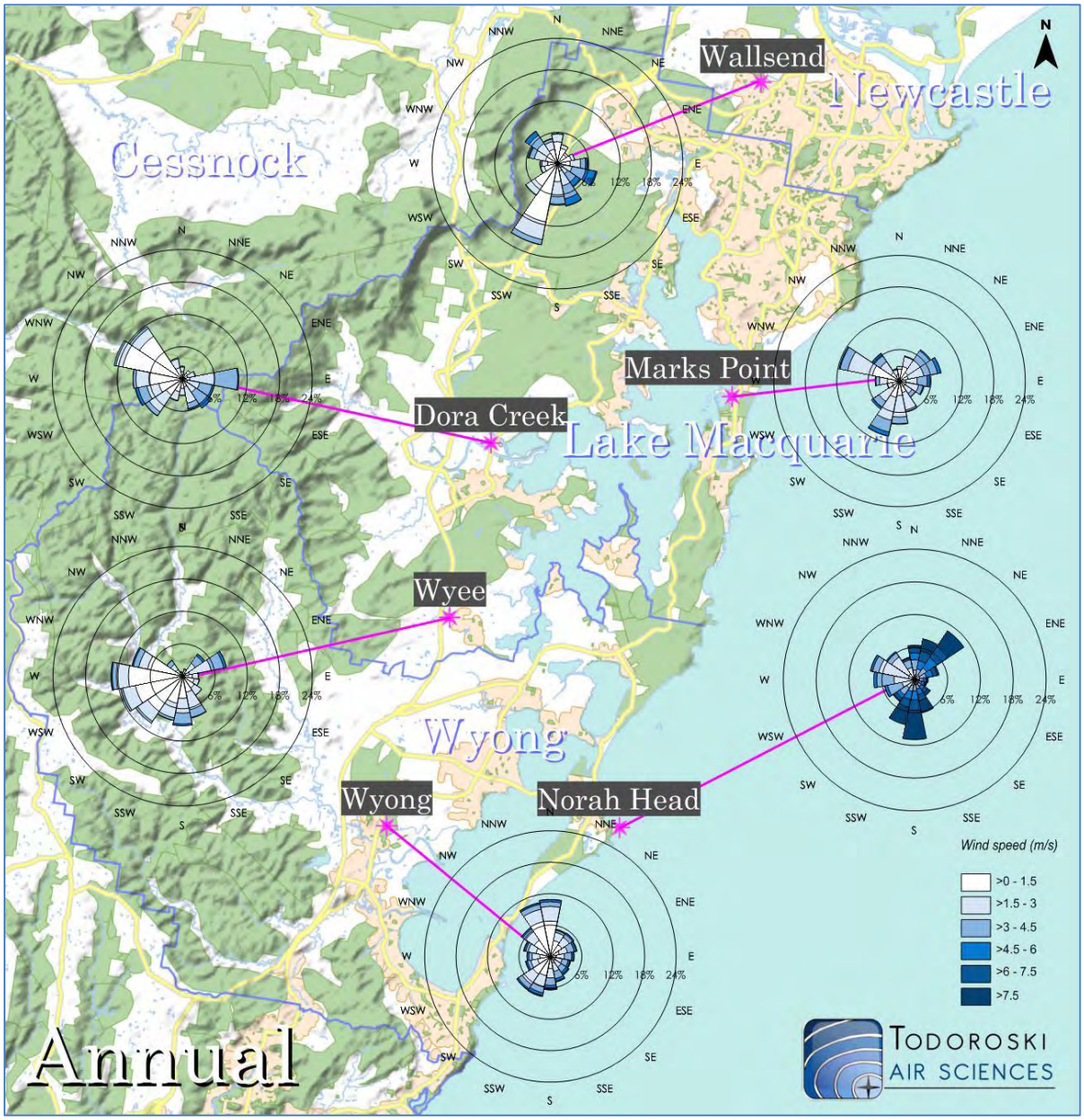

Figure 6-1: Annual 2018 windroses - Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong

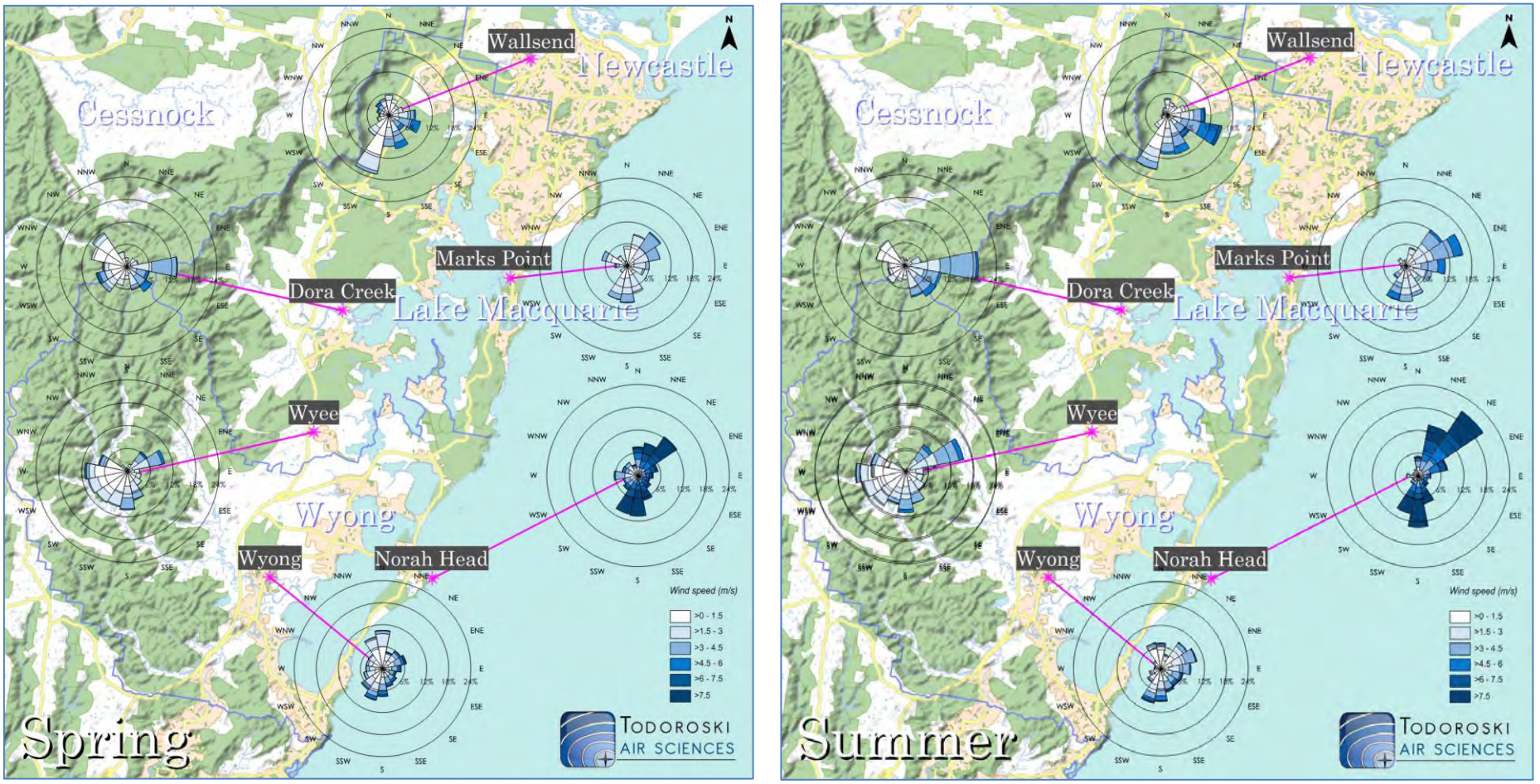

Figure 6-2: Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong windroses – Spring 2018 (left) and Summer 2018 (right)

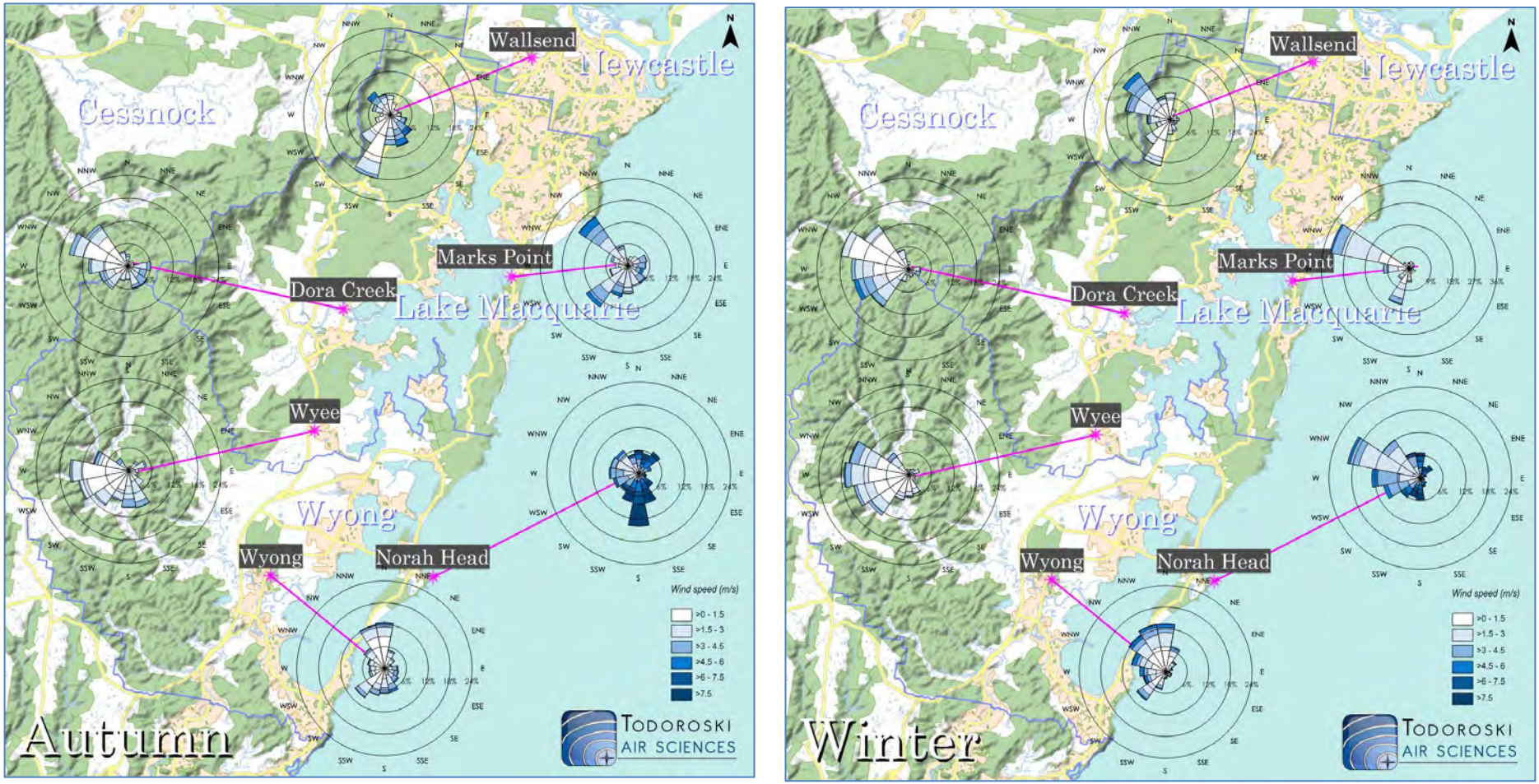

Figure 6-3: Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong windroses – Autumn 2018 (left) and Winter 2018 (right)

7 AMBIENT AIR QUALITY MONITORING DATA

7.1 Preamble

The monitoring data in this report are presented in raw form as provided to Todoroski Air Sciences by Delta Electricity and Origin Energy, or is available publically on industry and EPA websites.

The 24-hour average data presented in this report have been averaged using the 1-hour average readings. Days which contain less than 75% data (less than 18 hours of 1-hour average data) have not been included in this report.

The annual average data presented in this report have been averaged using the 1-hour average readings for SO_2 and NO_2, and 24-hour average readings for PM_{10} and $PM_{2.5}$. Annual averages with less than 75% data in a calendar quarter have been included but have not been assessed.

All of the monitoring data provided to, and obtained by Todoroski Air Sciences are presented in this report. The data are shown in the results and Appendices as relevant. 1 hour, 24-hour and annual average data are presented in a graphical format in **Appendix B** and 24-hour average data are presented in tabulated format in **Appendix C** for pollutants with applicable 24-hour average criteria.

Hourly averaged pollutant monitoring data were combined with wind speed and direction data to provide an understanding of the conditions in which high pollutant levels most frequently occur. The data are presented as pollution roses in **Appendix B**. For an example pollution rose, refer to **Figure A-2** in **Appendix A**.

7.2 Analysis of Monitoring Data

Table 7-1 presents a summary of the pollutant levels measured during 2018. The results indicate that pollutant levels were below the applicable criteria for all monitors, except for the Wallsend, Wyong and the Wyee monitors.

Table 7-1: Maximum and annual average pollutant levels - 2018

Site	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2
	Maximum 1-hour average (µg/m³)		Maximum 24-hour average (µg/m³)			Annual average (µg/m³)			
	Air Quality Impact Criteria								
	570	246	50	25	228	25	8	60	62
Wallsend	225.6	71.8	**136.6**	20.2	20.5	19.4	7.5	3.6	14.1
Wyong	177.0	71.8	**138.3**	18.1	22.0	18.1	6.8	2.0	8.9
Dora Creek	188.1		-	-	21.5	-	-	3.7	10.5
Marks Point	100.9		-	-	19.0	-	-	2.4	10.6
Wyee	221.5	75.6	-	**30.9**	37.1	-	6.1	3.1	13.6
Wakefield HVAS*	-	-	41	-	-	12.6	-	-	-
Teralba HVAS	-	-	**63**	-	-	17.3	-	-	-

* Monitoring site decommissioned, data available until 04/09/2018

\- Not applicable

7.3 PM_{10}

Figure 7-1 presents all of the 24-hour average PM_{10} monitoring results recorded in the Lake Macquarie - Wyong region in 2018.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, PM_{10} levels were generally very good or good at all monitors in 2018. The Wyong monitor recorded seven days of fair levels, four days of poor levels, one day of very poor levels and one day of hazardous levels in 2018. The Wallsend monitor recorded thirteen days of fair levels, three days of poor levels, one day of very poor levels and one day of hazardous levels in 2018.

The 24-hour average data recorded at the Lake Macquarie - Wyong monitoring sites were above the PM_{10} criteria of 50 µg/m^3 for five days at the Wallsend monitor, six days at the Wyong monitor and one day at the Teralba monitor.

Figure B-1 to **Figure B-2** in **Appendix B** present the 1-hour average, 24-hour average and annual average PM_{10} data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM_{10} levels and these 1-hour results are not intended to be compared with the PM_{10} criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM_{10} levels will fluctuate more significantly than 24-hour average PM_{10} levels.

Figure B-3 presents pollution roses of the PM_{10} monitoring data collected by the Wallsend and Wyong monitoring sites in 2018.

7.4 $PM_{2.5}$

Figure 7-2 presents all of the 24-hour average $PM_{2.5}$ monitoring data recorded in the Lake Macquarie - Wyong region in 2018.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate that $PM_{2.5}$ levels were generally very good to good in 2018. The Wallsend and Wyong monitors recorded

one day and three days with fair levels respectively in 2018. The Wyee monitor recorded nine days of fair levels and one day of poor levels in 2018.

The 24-hour average data recorded at the Lake Macquarie - Wyong monitoring sites were above the applicable $PM_{2.5}$ criteria on one day at the Wyee monitor.

Figure B-4 to **Figure B-6** in **Appendix B** present the 1-hour average, 24-hour average and annual average $PM_{2.5}$ data in graphical form for each individual site. There is no criterion that applies to 1-hour average $PM_{2.5}$ levels and these 1-hour results are not intended to be compared with the $PM_{2.5}$ criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average $PM_{2.5}$ levels will fluctuate more significantly than 24-hour average $PM_{2.5}$ levels.

We note that the monitoring sites recorded on occasion periods in which $PM_{2.5}$ levels were less than zero. In some situations the concentration of the pollutant being measured may be very close to zero, in which case the measured value (after adjusting for drift of zero and span and any other corrections) may be less than the measurement limit of detection (**NEPC, 2001**), and in these circumstances the output may be negative.

The monitors may also record short term positive or negative values due to instrument faults, the presence of moisture within the instrument or volatile matter (which can register as a solid mass at first, but then evaporates, registering negative mass at a later time).

Figure B-7 to **Figure B-8** present pollution roses of the $PM_{2.5}$ monitoring data collected by the Wallsend, Wyong and Wyee monitoring sites in 2018.

7.5 NO_2

Figure 7-3 presents the 1-hour average NO_2 monitoring data recorded in the Lake Macquarie - Wyong region in 2018.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the measured levels of NO_2 were very good or good at all monitors at all times. All 1-hour average and annual average data were below the applicable criteria in 2018.

Figure B-9 to **Figure B-11** present pollution roses of the NO_2 monitoring data collected by the monitoring sites in 2018.

7.6 SO_2

Figure 7-4 and **Figure 7-5** present the 1-hour average and 24-hour average SO_2 monitoring data recorded in the Lake Macquarie - Wyong region in 2018 respectively.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the SO_2 levels were very good or good at all monitors at all times. All 1-hour average and annual average data were below the applicable criteria in 2018.

During the review, it was considered that some of the SO_2 data may be anomalous, in so far as it generally showed higher levels of SO_2 than the past typical baseline levels, but with less peaks evident in the data. At the time of preparing this report, the issue was under investigation by the operator, with

the aim of identifying any potential issue and rectifying it. It is important to note that the readings remain low, and there is no indication of any levels above criteria.

Figure B-12 to **Figure B-14** present pollution roses of the SO_2 monitoring data collected by the monitoring sites in 2018.

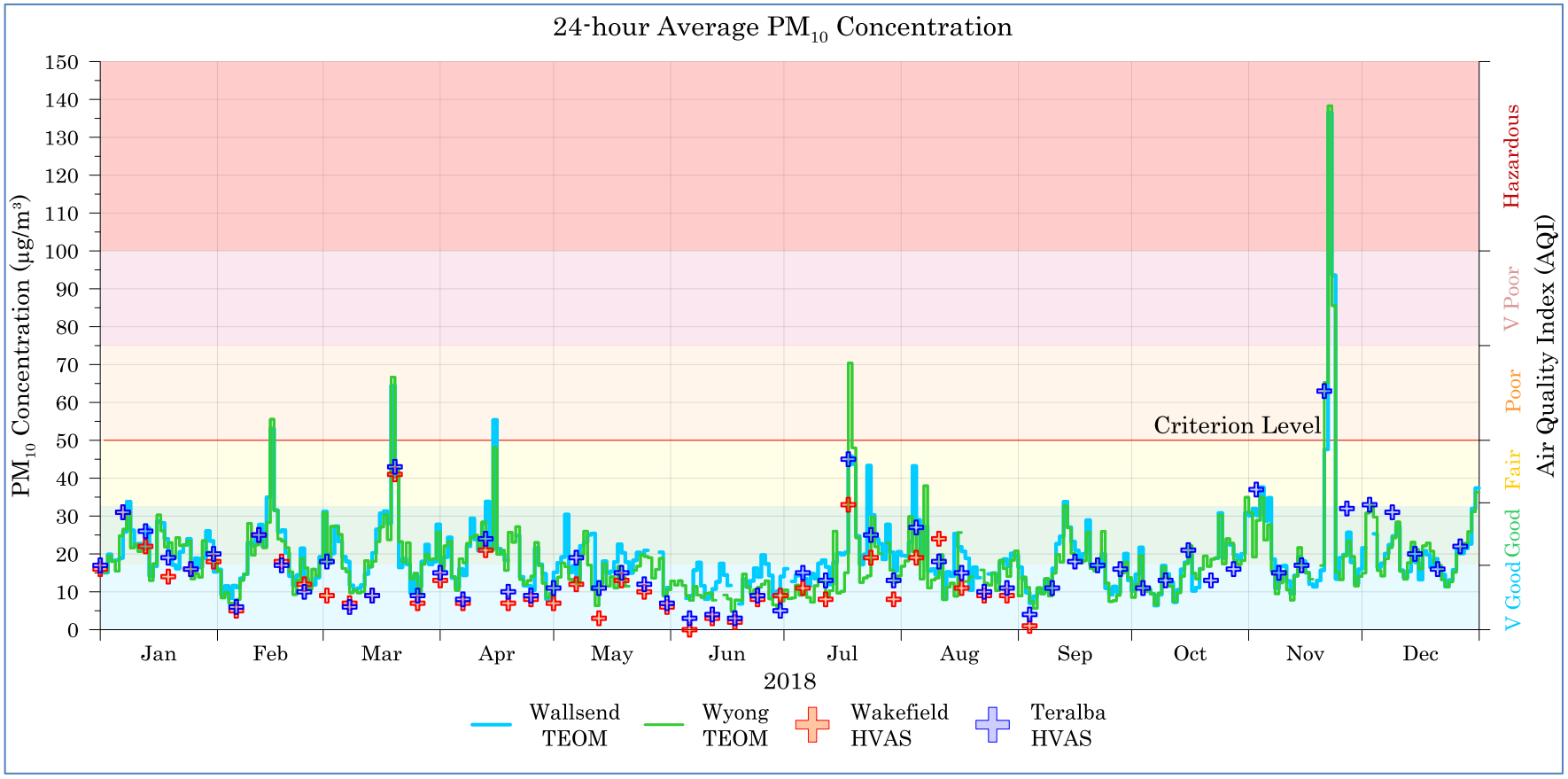

Figure 7-1: Lake Macquarie - Wyong 24-hour average PM_{10} levels – 2018

The recorded PM_{10} levels were generally very good or good at all monitors in 2018. PM_{10} levels were above the criterion of 50µg/m^3 on five days at the Wallsend monitor, six days at the Wyong monitor and one day at the Teralba monitor in 2018.

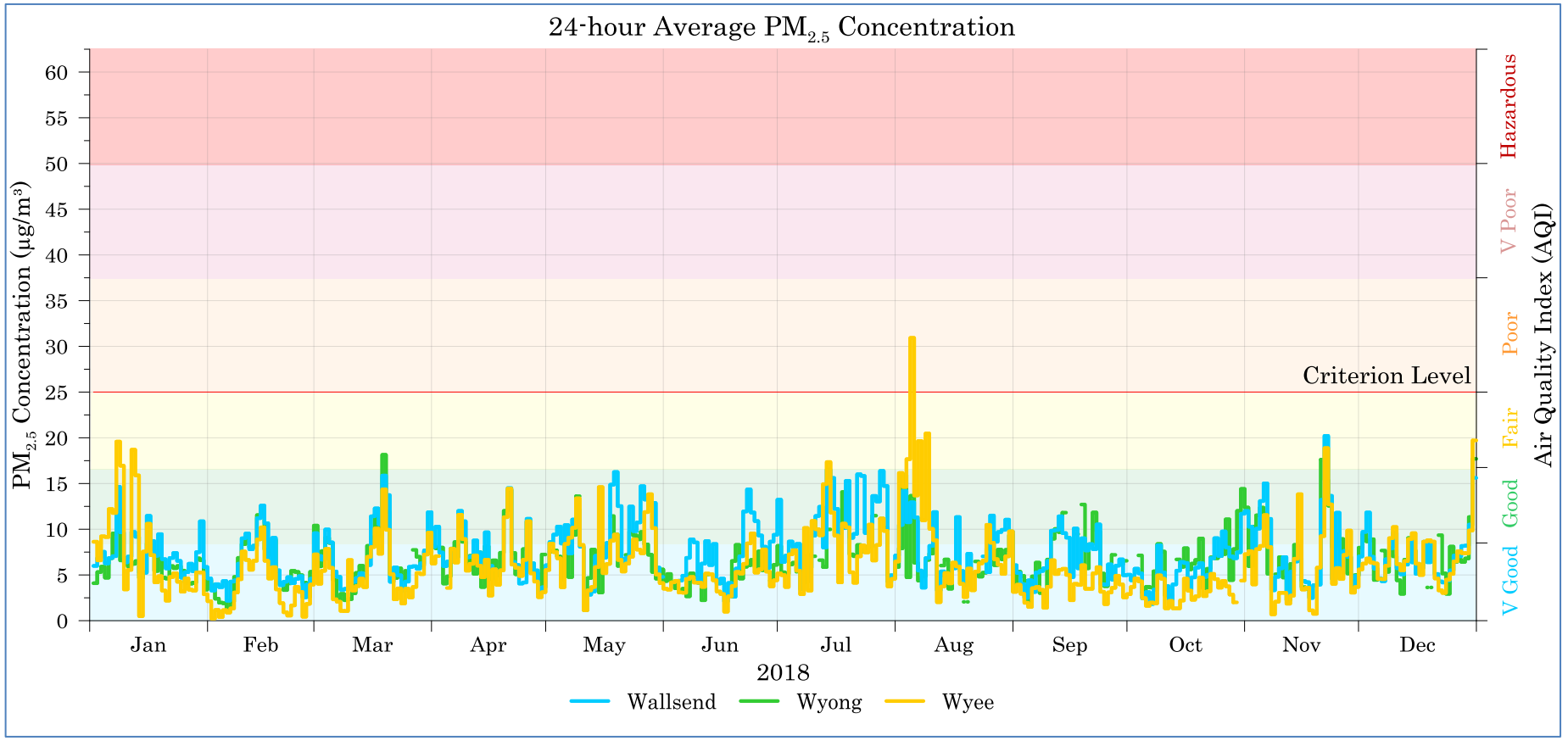

Figure 7-2: Lake Macquarie - Wyong 24-hour average $PM_{2.5}$ levels – 2018

The recorded $PM_{2.5}$ levels were generally very good to good in 2018. $PM_{2.5}$ levels were above the criterion of 25µg/m^3 on 5 August 2018 and 29 November 2018 at the Wyee monitor.

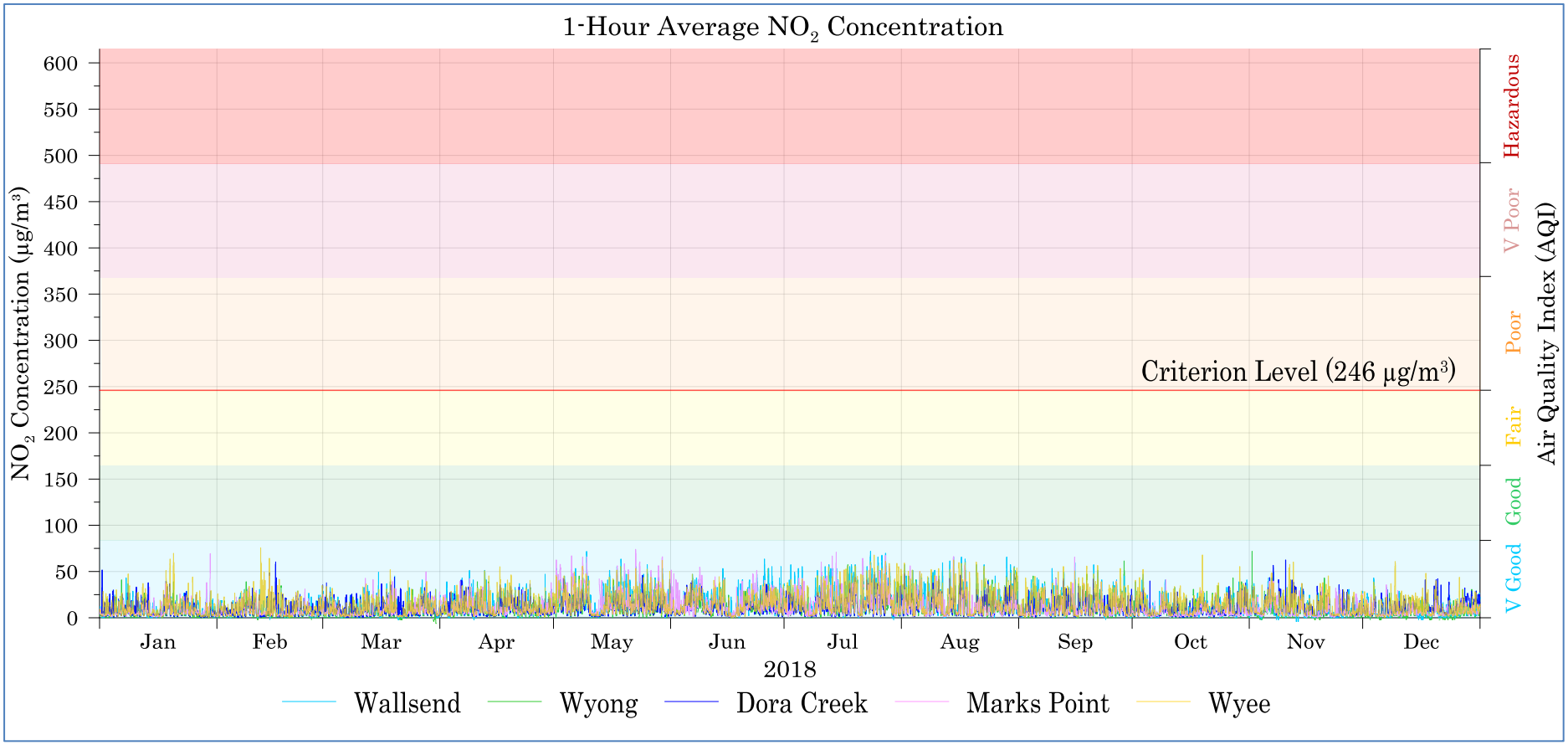

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2018

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average NO_2 criterion level of 246µg/m^3 in 2018. Measured levels of NO_2 were very good or good at all monitors at all times.

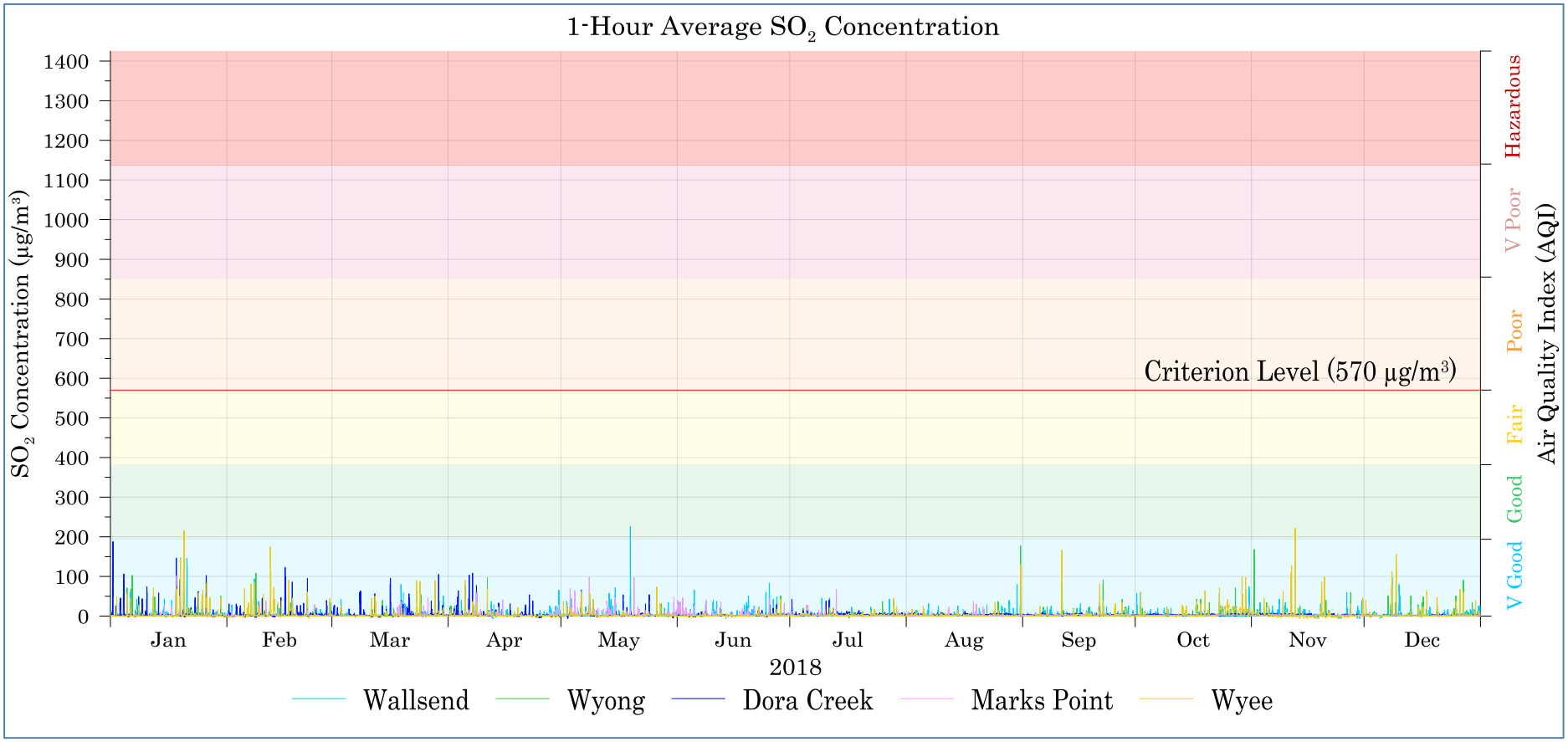

Figure 7-4: Lake Macquarie - Wyong 1-hour average SO_2 levels – 2018

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average SO_2 criterion level of 570µg/m^3 in 2018. Measured levels of SO_2 were very good or good at all monitors at all times in 2018.

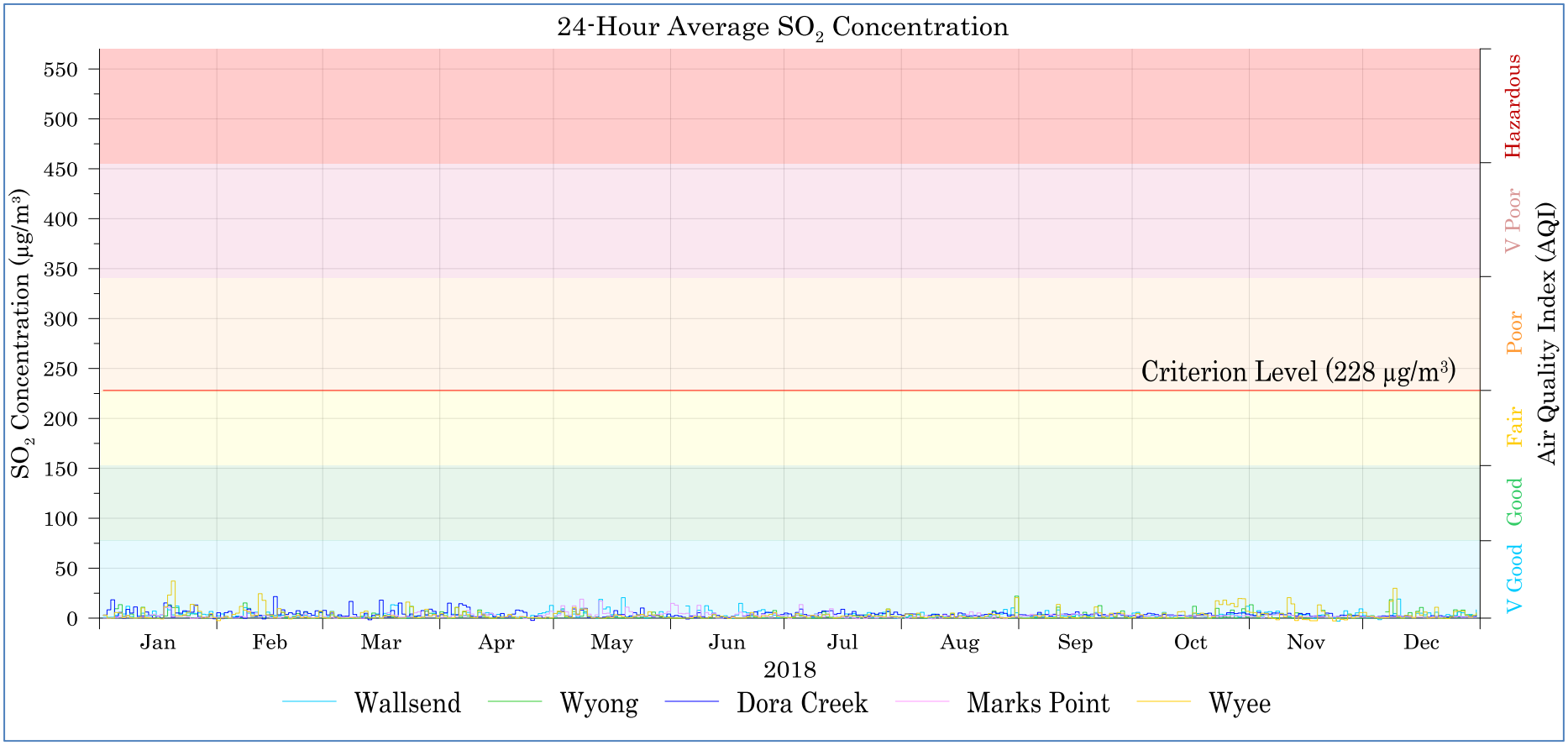

Figure 7-5: Lake Macquarie - Wyong 24-hour average SO_2 levels – 2018

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average SO_2 criterion level of 228µg/m^3 in 2018. Measured levels of SO_2 were very good at all monitors at all times in 2018.

8 ANALYSIS OF ELEVATED POLLUTANT LEVELS

There were eight days with elevated levels above the applicable 24-hour average criteria in 2018, these included:

- 24-hour average PM_{10} levels of 53.1µg/m^3 and 55.5µg/m^3 recorded at Wallsend and Wyong respectively on 15 February 2018;
- 24-hour average PM_{10} levels of 64.4µg/m^3 and 66.7µg/m^3 recorded at Wallsend and Wyong respectively on 19 March 2018;
- 24-hour average PM_{10} level of 55.4µg/m^3 recorded at Wallsend on 15 April 2018;
- 24-hour average PM_{10} level of 70.4µg/m^3 recorded at Wyong on 18 July 2018;
- 24-hour average $PM_{2.5}$ level of 30.9µg/m^3 recorded at Wyee on 5 August 2018;
- 24-hour average PM_{10} level of 65.3µg/m^3 and 63µg/m^3 recorded at Wyong and Teralba on 21 November 2018;
- 24-hour average PM_{10} levels of 136.6µg/m^3 and 138.3µg/m^3 recorded at Wallsend and Wyong respectively on 22 November; and
- 24-hour average PM_{10} levels of 93.6µg/m^3 and 85.6µg/m^3 recorded at Wallsend and Wyong respectively on 23 November.

8.1 Wallsend and Wyong – 15 February 2018

Table 8-1 presents a summary of the 24-hour average PM_{10} levels across the NSW OEH Upper Hunter, Lower Hunter, Newcastle local and Central Coast areas on 15 February 2018. All monitoring stations except Merriwa recorded elevated PM_{10} levels on 15 February 2018, suggesting a regional event, such as a dust storm impacted almost all of the monitors across the region.

Figure 8-1 shows satellite imagery of southeast NSW on 15 February 2018, showing a large smoke plume. It is therefore likely that the levels measured at the Wallsend and Wyong monitors were also impacted by a bushfire smoke on 15 February 2018.

Table 8-1: OEH PM_{10} 24-hour average data – 15 February 2018

Monitor	Measured 24-hour average TEOM PM_{10} level (µg/m^3)	Monitor	Measured 24-hour average TEOM PM_{10} level (µg/m^3)
Wyong	**55.5**	Singleton NW	**63.0**
Wallsend	**53.1**	Mount Thorley	**62.8**
Carrington	**63.5**	Bulga	**66.7**
Stockton	**78.9**	Muswellbrook NW	**69.9**
Newcastle	**60.9**	Wybong	**60.5**
Mayfield	**67.7**	Aberdeen	**62.9**
Beresfield	**55.6**	Singleton South	**64.3**
Muswellbrook	**74.0**	Jerrys Plains	**75.5**
Singleton	**63.9**	Warkworth	**83.9**
Maison Dieu	**68.9**	Merriwa	43.4
Camberwell	**68.0**		

Figure 8-1: Satellite imagery – 15 February 2018

8.2 Wallsend and Wyong – 19 March 2018

Table 8-2 presents a summary of the 24-hour average PM_{10} levels across the NSW OEH monitoring stations on 18 and 19 March 2018. The table shows that majority of the monitoring stations in NSW recorded elevated levels on 19 March 2018.

Figure 8-2 presents satellite imagery of southeast NSW on 18 March 2018, and shows a large dust storm southwest of the Illawarra region at approximately 3pm. The dust storm front was moving northwards. The dust storm was not visible in the satellite images for 19 March 2018, available after midday.

It is therefore highly likely that the Wallsend and Wyong monitors were primarily impacted by a regional dust storm event in the first part of the day on 19 March 2018.

Table 8-2: NSW OEH PM_{10} 24-hour average data – 18 and 19 March 2018

Region	Site	18/03/18	19/03/18	Region	Site	18/03/18	19/03/18
Southwest	Albury	**105.7**	42.2	Lower Hunter	Newcastle	31.4	**69**
	Wagga Wagga Nth	**127.2**	**78.3**		Wallsend	28	**64.4**
Illawarra	Albion Park Sth	49.9	**57.2**		Carrington	37.2	**72.5**
	Kembla Grange	**65.6**	**64.3**		Stockton	46.1	**80.1**
	Wollongong	47.3	**55.6**		Mayfield	32.5	**81.5**
Sydney South-west	Bargo	**60.8**	41.8		Beresfield	33.3	**65.2**
	Bringelly	49.2	**62.2**	Upper Hunter	Muswellbrook	-	-
	Liverpool	49.7	**73.4**		Singleton	41.4	**71.7**
	Oakdale	**52**	43		Maison Dieu	**50.9**	**77.5**
	Campbelltown West	45.6	**58.5**		Camberwell	**56.8**	**72.8**
	Camden	**51.4**	**54.8**		Singleton NW	48.5	**76.5**
Sydney East	Randwick	35.1	**62.4**		Mount Thorley	**65.3**	**77.9**
	Rozelle	-	-		Bulga	28.9	**61.1**
	Lindfield	29.8	**60.7**		Muswellbrook NW	34.4	**69.1**
	Chullora	39.2	**63.8**		Wybong	25.5	39.5
	Earlwood	34.9	**61.3**		Aberdeen	30.2	**54.9**
	Macquarie Park	28.8	**59.6**		Singleton South	40.1	**70.2**
Sydney North-west	Richmond	35.4	**63.9**		Jerrys Plains	28.4	**66.3**
	St Marys	29.9	47.6		Warkworth	**52.7**	**75.3**
	Prospect	47.9	**70.2**		Merriwa	23.7	44.2
	Parramatta North	39.8	**66.3**	Namoi	Narrabri	17.3	16.3
Regional	Bathurst	**67.5**	**68.1**		Gunnedah	23	24.2
Central Coast	Wyong	23.8	**66.7**		Tamworth	28.3	31.6

- No data available

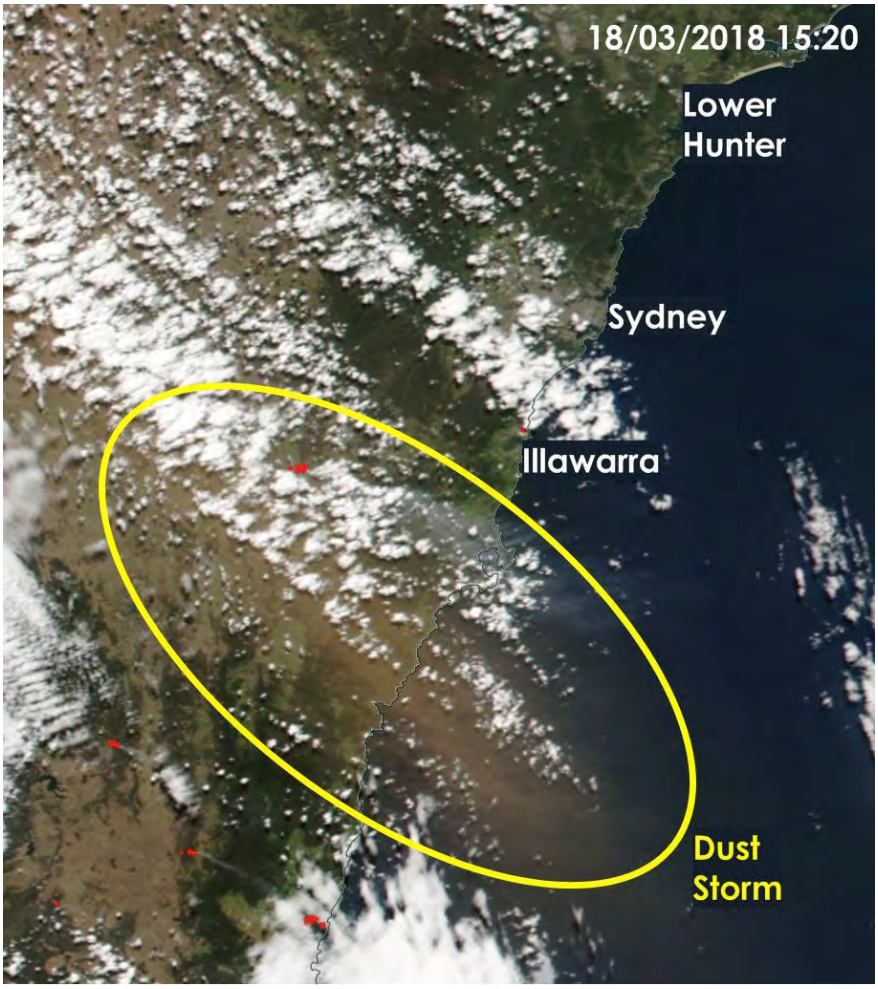

Figure 8-2: Satellite imagery – 18 March 2018

8.3 Wallsend – 15 April 2018

Table 8-3 presents a summary of the 24-hour average PM_{10} levels across the Upper Hunter, Lower Hunter, Newcastle local and Central Coast areas on 15 April 2018. All stations except for Wyong recorded elevated levels above the criteria of 50µg/m^3.

A review of satellite imagery on 15 April 2018 did not indicate the presence of dust storms or bushfires in the vicinity of the Lake Macquarie – Wyong area.

Figure 8-3 presents an analysis of the PM_{10} data recorded at OEH monitors on 15 April 2018. The figure shows that generally all of the monitors recorded elevated levels from approximately midnight to 11:00am on 15 April 2018.

It is therefore highly likely that the Wallsend monitor was primarily impacted by a regional event on 15 April 2018.

Table 8-3: OEH PM_{10} 24-hour average data – 15 April 2018

Monitor	Measured 24-hour average TEOM PM_{10} level (µg/m³)	Monitor	Measured 24-hour average TEOM PM_{10} level (µg/m³)
Wyong	48.0	Singleton NW	**74.7**
Wallsend	**55.4**	Mount Thorley	**75.2**
Carrington	**66.7**	Bulga	**58.9**
Stockton	**85.9**	Muswellbrook NW	**64.8**
Newcastle	**62.5**	Wybong	**58.5**
Mayfield	**68.0**	Aberdeen	**72.9**
Beresfield	**67.6**	Singleton South	**75.4**
Muswellbrook	**66.1**	Jerrys Plains	**61.8**
Singleton	**72.1**	Warkworth	**57.1**
Maison Dieu	**70.3**	Merriwa	**62.9**
Camberwell	**84.0**		

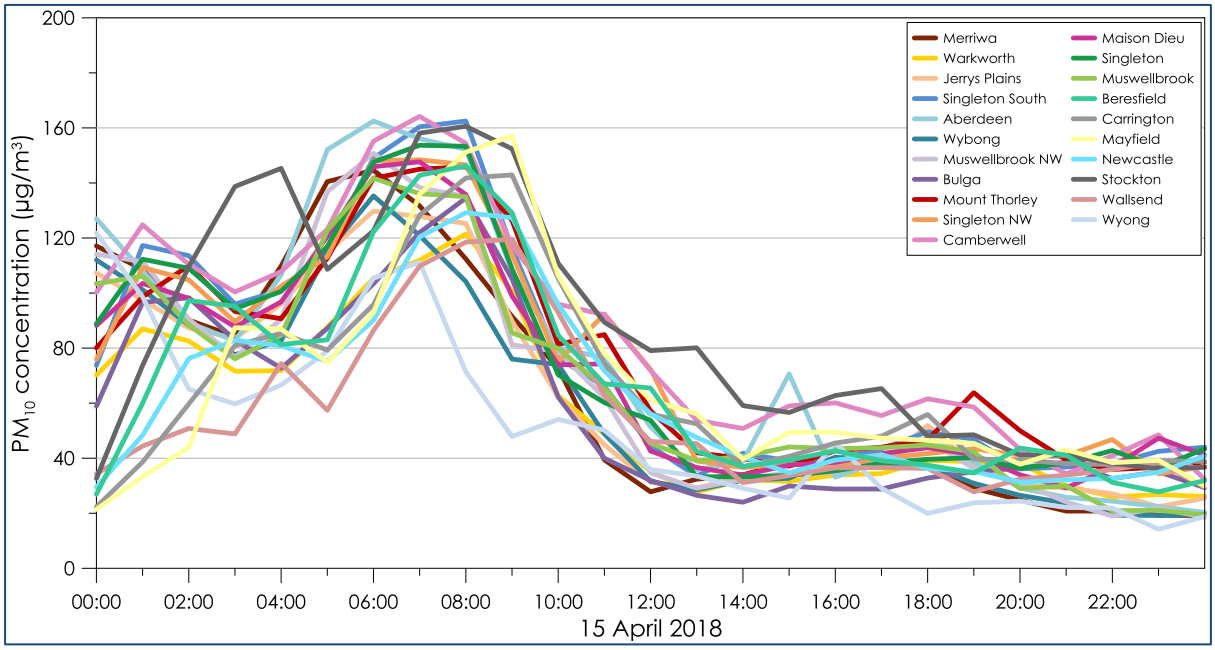

Figure 8-3: PM_{10} analysis – 15 April 2018

8.4 Wyong – 18 July 2018

Table 8-4 presents a summary of the 24-hour average PM_{10} levels across the Upper Hunter, Lower Hunter, Newcastle local and Central Coast areas on 18 July 2018. The majority of the stations recorded elevated levels above the criteria of 50µg/m³ on 18 July 2018.

A review of satellite imagery on 18 July 2018 did not indicate the presence of dust storms or bushfires in the vicinity of the Lake Macquarie – Wyong area.

Figure 8-4 presents an analysis of the PM_{10} data recorded at OEH monitors on 18 July 2018. The figure shows that generally all of the monitors recorded elevated levels from approximately 11:00am until midnight on 18 July 2018.

It is therefore highly likely that the Wallsend monitor was primarily impacted by a regional event on 18 July 2018.

Table 8-4: OEH PM_{10} 24-hour average data – 18 July 2018

Monitor	Measured 24-hour average TEOM PM_{10} level (µg/m³)	Monitor	Measured 24-hour average TEOM PM_{10} level (µg/m³)
Wyong	**70.4**	Singleton NW	**76.1**
Wallsend	45.8	Mount Thorley	**71.4**
Carrington	**61.7**	Bulga	44.8
Stockton	**74.3**	Muswellbrook NW	**51.0**
Newcastle	**52.4**	Wybong	**50.9**
Mayfield	**59.3**	Aberdeen	48.4
Beresfield	**55.7**	Singleton South	**55**
Muswellbrook	**56.5**	Jerrys Plains	49.3
Singleton	**59.4**	Warkworth	41.6
Maison Dieu	**55.3**	Merriwa	**58.2**
Camberwell	**78.3**		

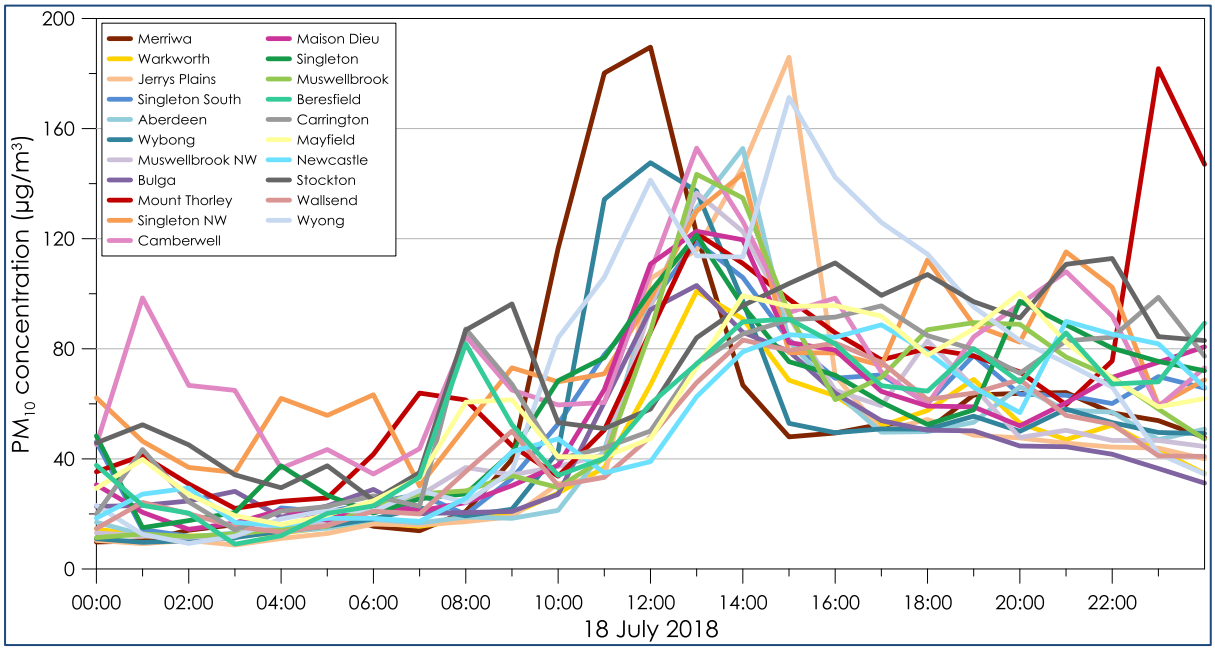

Figure 8-4: PM_{10} analysis – 18 July 2018

8.5 Wyee – 5 August 2018

Table 8-4 presents a summary of the 24-hour average $PM_{2.5}$ levels for the Wyee monitoring station and the NSW OEH Upper Hunter, Lower Hunter, Newcastle local and Central Coast areas on 5 August 2018. The levels recorded at the OEH stations were significantly lower than the levels recorded at the Wyee monitor on this day.

Figure **8**-**5** presents a plot of the 1-hour average $PM_{2.5}$, wind speed and wind direction data recorded at the Wyee monitoring site on 5 August 2018. The data shows that elevated $PM_{2.5}$ levels occurred under calm wind conditions.

A review of satellite imagery on 5 August 2018 did not indicate the presence of dust bushfires in the vicinity of the Lake Macquarie – Wyong area, however a 370 hectare bushfire in the Wyee area at the time was documented by Delta Energy.

Given the recorded levels and observations by Delta Electricity on the day, the impact at the Wyee monitor on this day is primarily attributed to local bushfire smoke on 5 August 2018.

Table 8-5: $PM_{2.5}$ 24-hour average data – 5 August 2018

Monitor	Measured 24-hour average $PM_{2.5}$ level (µg/m³)
Wyee	**30.9**
Wyong	3.2
Wallsend	3.5
Carrington	5.2
Stockton	7.0
Newcastle	7.1
Mayfield	6.7
Beresfield	5.5
Muswellbrook	3.3
Singleton	3.1
Camberwell	3.4

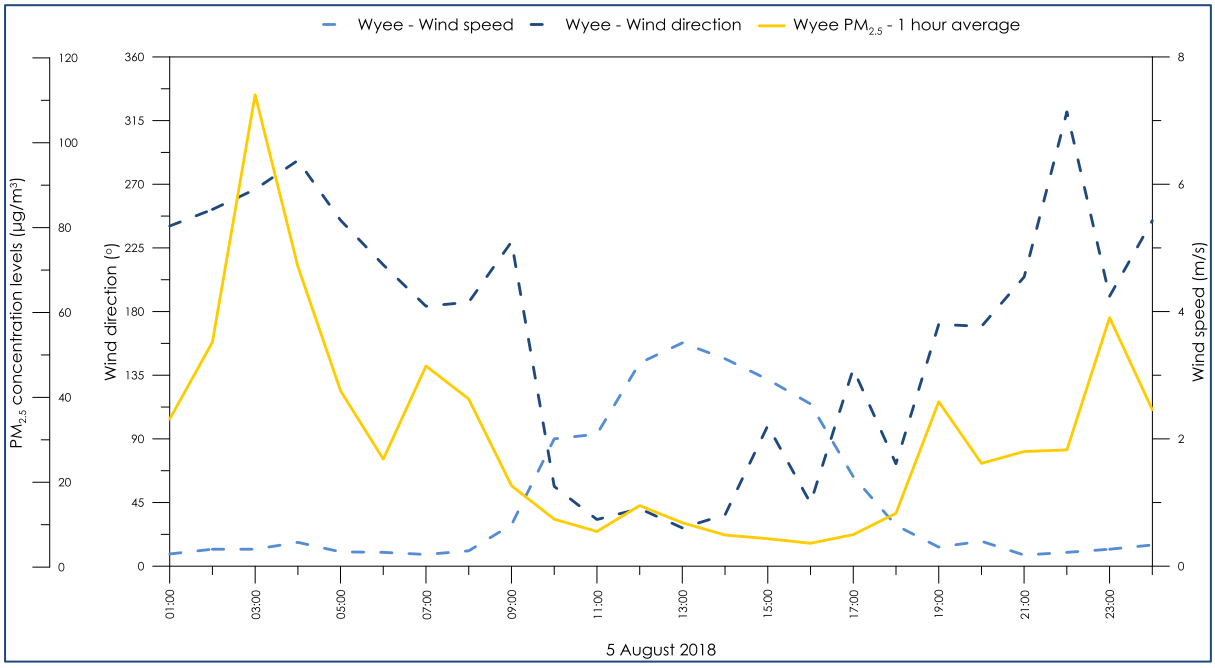

Figure 8-5: Analysis of Wyee monitoring data on 5 August 2018

8.6 Wallsend, Wyong and Teralba – 21, 22 and 23 November 2018

Table 8-6 presents a summary of the 24-hour average PM_{10} levels across the NSW OEH monitoring network. The table shows that approximately half of the monitoring stations in NSW recorded elevated levels on 21 November 2018, the majority of monitoring stations in NSW recorded elevated levels on 22 November 2018 and all stations in the Central Coast, Upper Hunter, Lower Hunter and Namoi regions recorded elevated levels on 23 November 2018.

Table 8-6: NSW OEH PM_{10} 24-hour average data – 21 - 23 November 2018

Region	Monitor	Measured 24-hour average TEOM PM_{10} level (µg/m³)		
		21/11/18	22/11/18	23/11/18
Southwest	Albury	8.8	21.6	8.6
	Wagga Wagga Nth	11.8	34.9	8.7
Illawarra	Albion Park Sth	28.6	49.8	21.9
	Kembla Grange	ND	**71.6**	30.5
	Wollongong	30.8	**59.7**	17.7
Sydney South-west	Bargo	22.0	**56.7**	14.3
	Bringelly	37.3	**92.3**	18.5
	Liverpool	42.4	**101.5**	21.5
	Oakdale	20.3	**70.7**	16.8
	Campbelltown West	30.5	**72.3**	17.4
	Camden	23.4	**68.1**	16.3
Sydney East	Randwick	**67.1**	**95.5**	31.8
	Rozelle	**67.0**	**88.3**	31.4
	Lindfield	**71.7**	**89.7**	31.5
	Chullora	49.7	**90.7**	24.1
	Earlwood	**56.2**	**86.5**	23.9
	Macquarie Park	**70.4**	**85.6**	27.7
Sydney North-west	Richmond	**54.1**	**111.3**	24.7
	St Marys	36.2	**100.5**	20.0
	Prospect	**55.7**	**113.3**	25.3
	Parramatta North	**64.3**	**107.4**	28.1
Regional	Bathurst	26.6	**119.0**	18.6
Central Coast	Wyong	**65.3**	**138.3**	**85.5**
Lower Hunter	Newcastle	**51.3**	**146**	**101.6**
	Wallsend	47.6	**136.5**	**93.6**
	Carrington	**58.0**	**155.2**	**113.7**
	Stockton	**63.5**	**196.6**	**142.3**
	Mayfield	**51.0**	**135.6**	**111.9**
	Beresfield	44.0	**149.1**	**109.3**
Upper Hunter	Muswellbrook	40.3	**185.9**	**125.6**
	Singleton	**58.1**	**198.0**	**131.4**
	Maison Dieu	**63.6**	**191.6**	**130.5**
	Camberwell	**77.1**	**243.9**	**185.2**
	Singleton NW	**60.7**	**200.3**	**130.1**
	Mount Thorley	**73.4**	**231.4**	**153.8**
	Bulga	**63.7**	**171.6**	**88.0**
	Muswellbrook NW	39.7	**195.4**	**128.9**
	Wybong	37.0	**179.6**	**103.4**
	Aberdeen	35.8	**178.9**	**126.0**
	Singleton South	**53.0**	**187.0**	**120.9**
	Jerrys Plains	**54.2**	**201.4**	**108.3**
	Warkworth	**60.4**	**162.4**	**94.8**
	Merriwa	42.8	**197.1**	**109.4**
Namoi	Narrabri	39.3	**131.7**	**97.3**
	Gunnedah	42.5	**117.9**	**96.6**
	Tamworth	22.4	**125.1**	**110.8**

DustWatch[1] alerts (**Dustwatch, 2018a, 2018b & 2018c**) indicated that dust storm activity occurred across NSW for a period of four days, beginning on the 20 November 2018 in western NSW. The dust storm activity was caused by a series of cold fronts and accompanying strong winds moving across the state. Figure **8-6** shows an image of southeast NSW on 22 November 2018. The dust storm front was generally moving eastwards during this time.

It is therefore considered likely that a regional dust storm event was responsible for the elevated 24-hour average PM_{10} levels recorded across NSW including the Lake Macquarie – Wyong region on 21 to 23 November 2018.

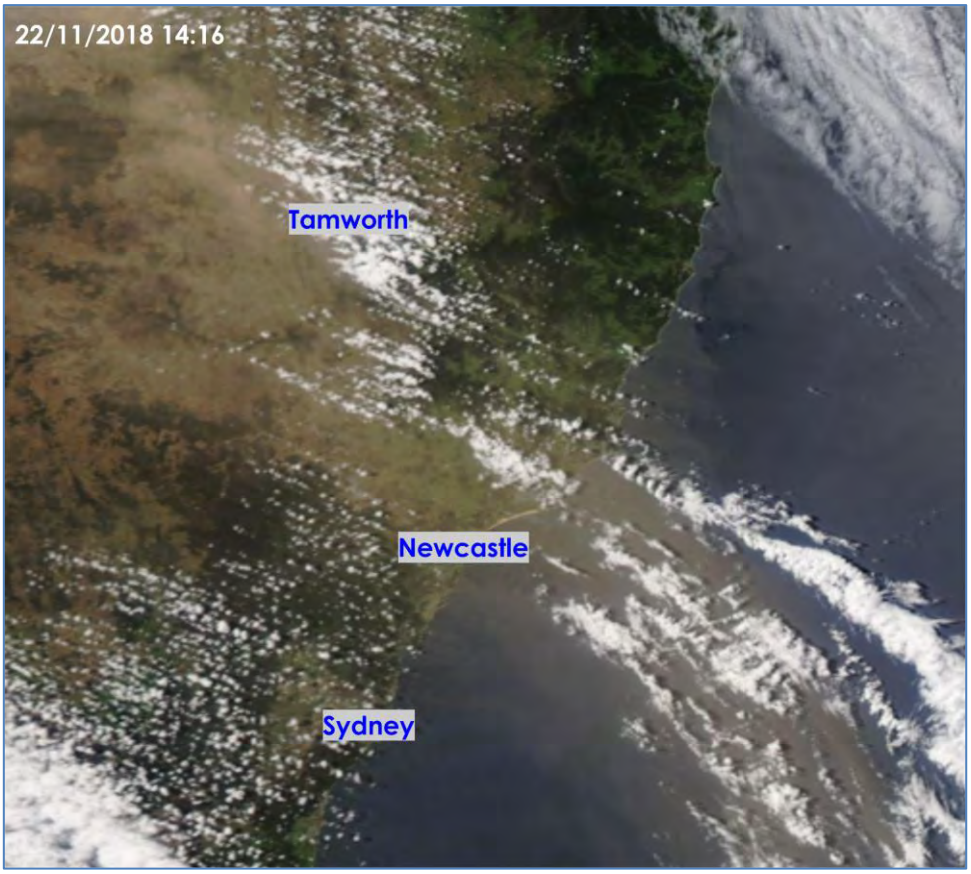

Figure 8-6: Satellite imagery 22 November 2018 (NASA, 2018)

[1] DustWatch is a community dust monitoring network operated by the NSW OEH.

9 CONCLUSIONS

The results indicate that the monitoring stations generally recorded good air quality in 2018.

The Wyee monitor recorded one 24-hour average $PM_{2.5}$ level above the criterion of 25µg/m^3 in 2018. The elevated $PM_{2.5}$ level likely originated from local sources.

The Wallsend monitor recorded five 24-hour average PM_{10} levels above the criterion of 50µg/m^3 in 2018. These elevated levels were likely caused by regional events such as dust storms and bushfires.

The Teralba monitor recorded one 24-hour average PM_{10} level above the criterion of 50µg/m^3 in 2018. This elevated level was likely caused by a regional dust storm event.

The Wyong monitor recorded six 24-hour average PM_{10} levels above the criterion of 50µg/m^3 in 2018. These elevated levels were likely caused by regional events such as dust storms and bushfires.

All recorded annual average levels were below the applicable annual average criteria in 2018.

Relative to the Air Quality Index:

- The measured PM_{10} levels were very good or good. The Wyong monitor recorded seven days of fair levels, four days of poor levels, one day of very poor levels and one day of hazardous levels in 2018. The Wallsend monitor recorded thirteen days of fair levels, three days of poor levels, one day of very poor levels and one day of hazardous levels in 2018.
- The measured levels of $PM_{2.5}$ were generally very good or good. The Wallsend monitor recorded one day with fair levels, the Wyong monitor recorded three days with fair levels and the Wyee monitor recorded nine days with fair levels. The Wyee monitor recorded one day with poor levels;
- The measured levels of NO_2 were very good or good at all monitors at all times; and,
- The measured levels of SO_2 were very good or good at all monitors at all times.

On this basis it can be concluded that the air quality in the Lake Macquarie - Wyong region was generally good in 2018.

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Appendix A

How to read a windrose

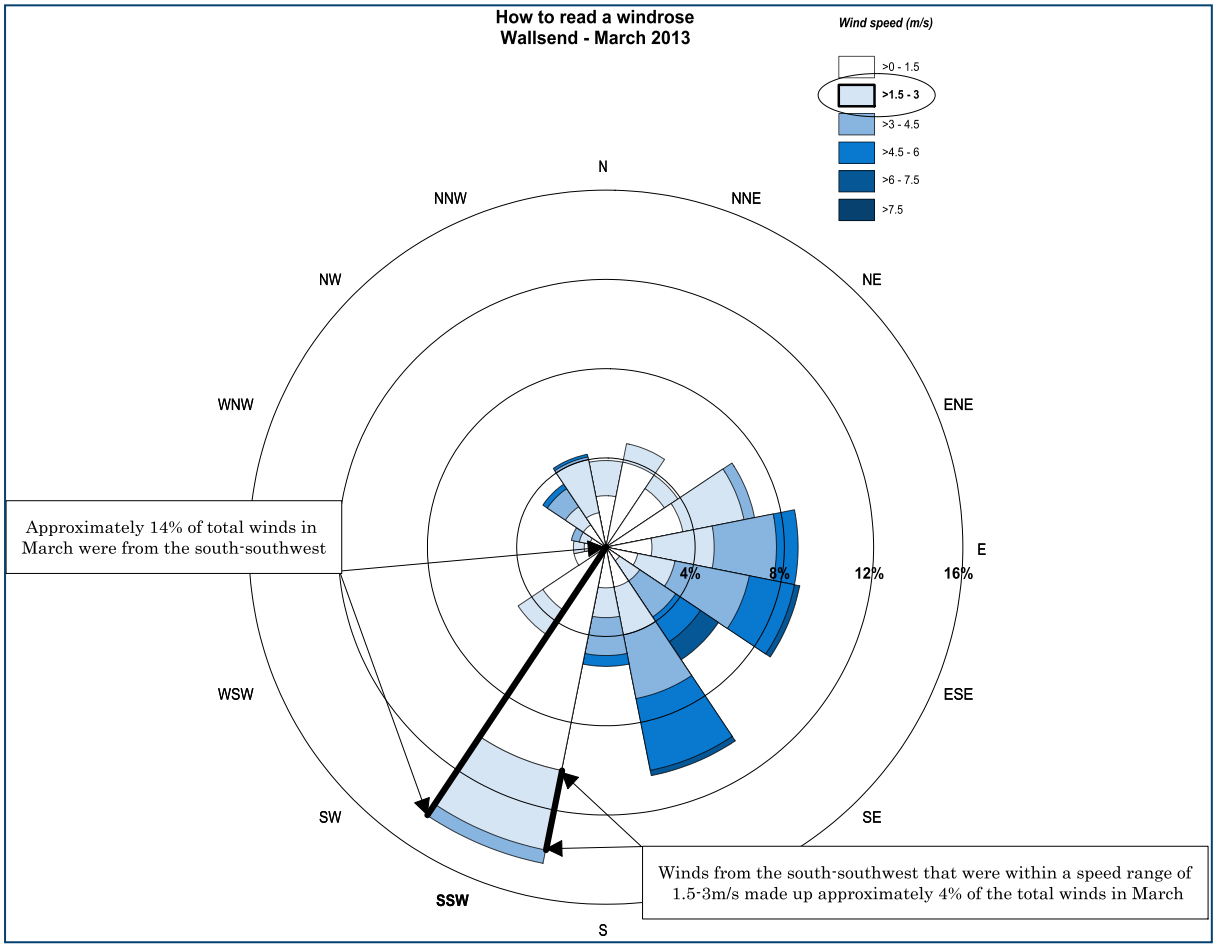

Figure A-1: How to read a windrose

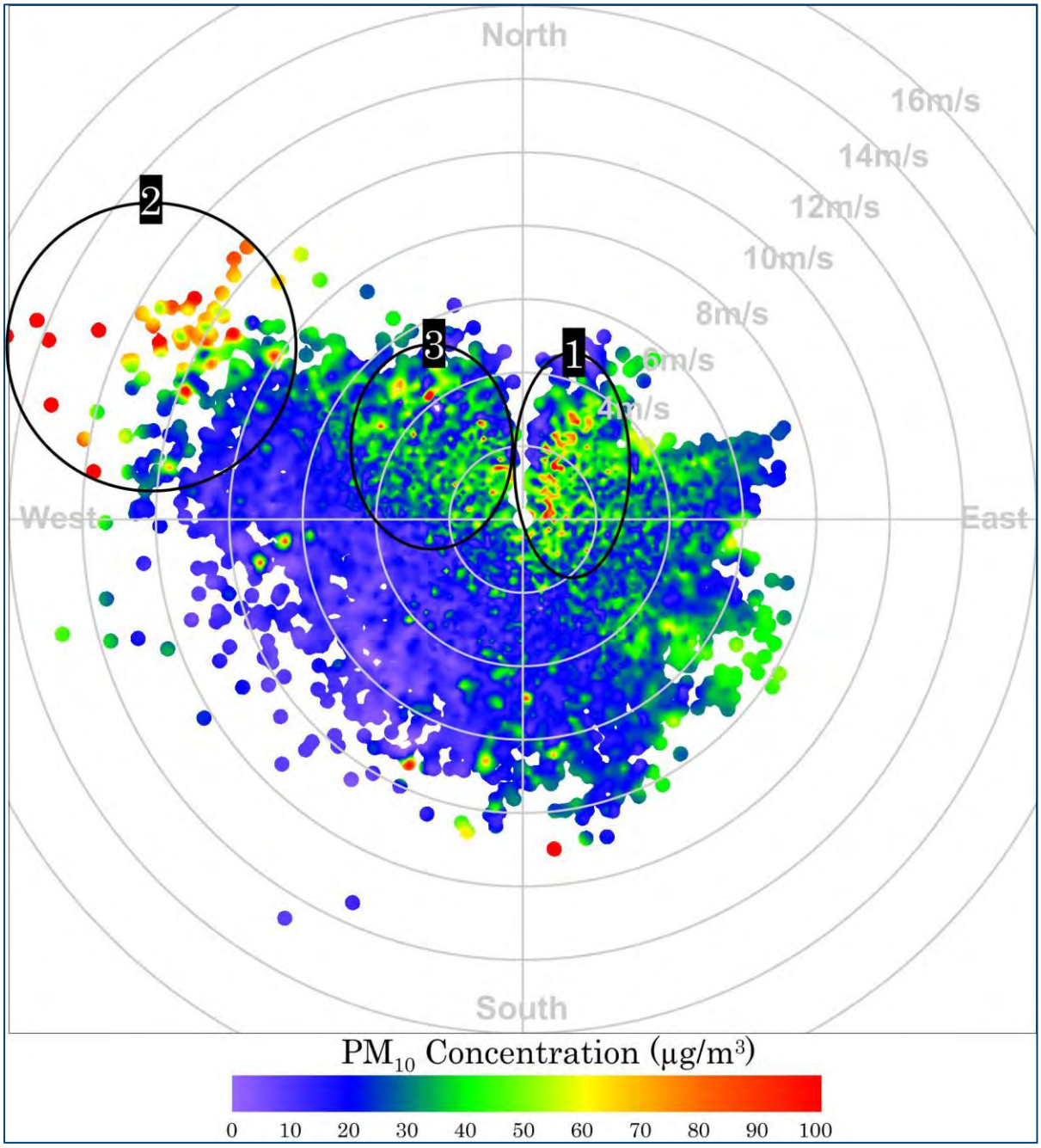

Figure A-2: Example Pollution Rose

- **1** - High PM_{10} levels tended to originate from the north-eastern directions under wind speeds below 4m/s.
- **2** - High PM_{10} levels were also recorded from the northwest and west-northwest direction under high wind speeds (>8m/s).
- **3** - Some high levels were also recorded from the northwest under moderate wind speeds.

Appendix B

Monitoring Data (Graphical)

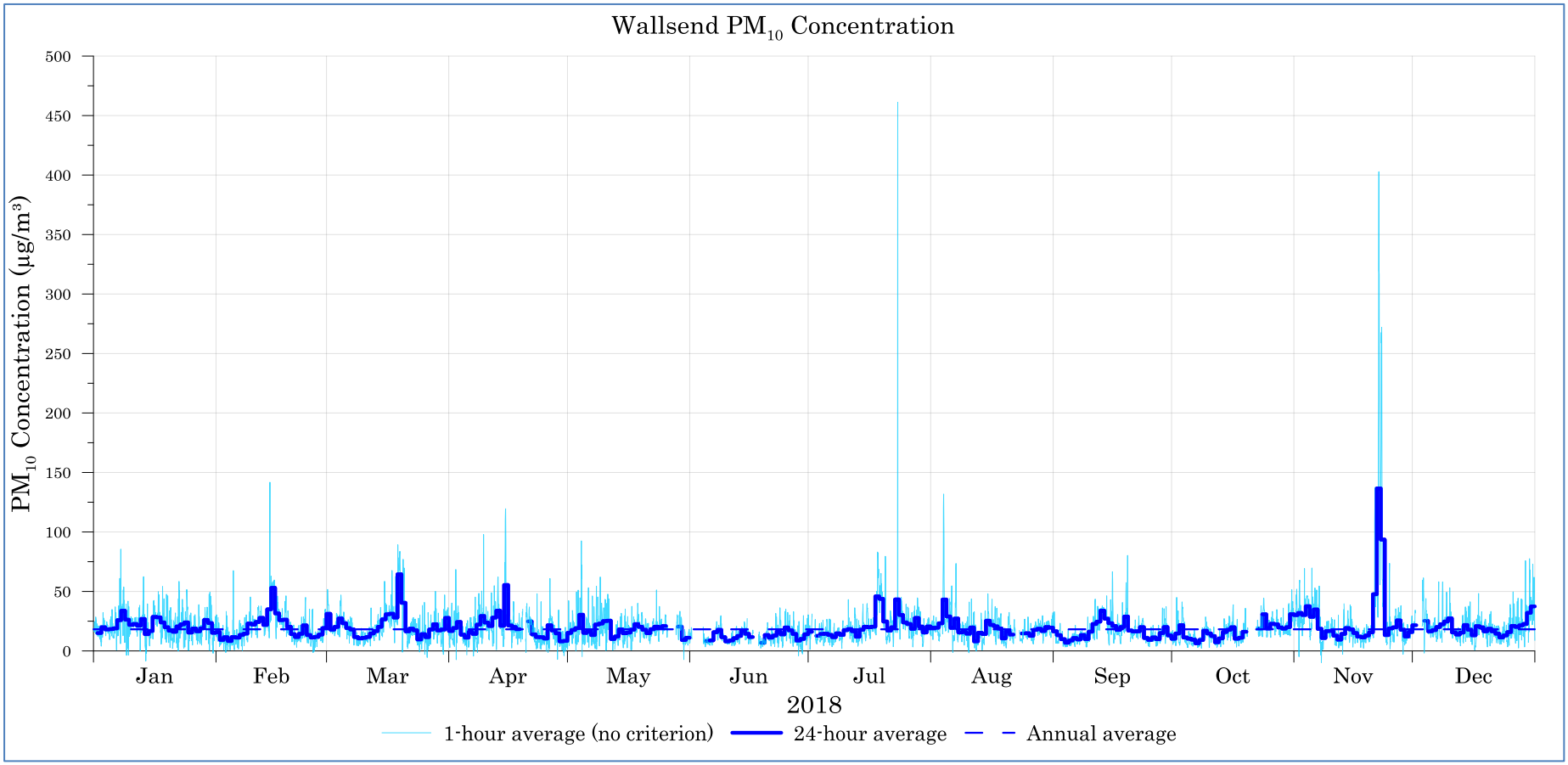

Figure B-1: Wallsend PM_{10} (1-hour, 24-hour and annual average) concentration – 2018

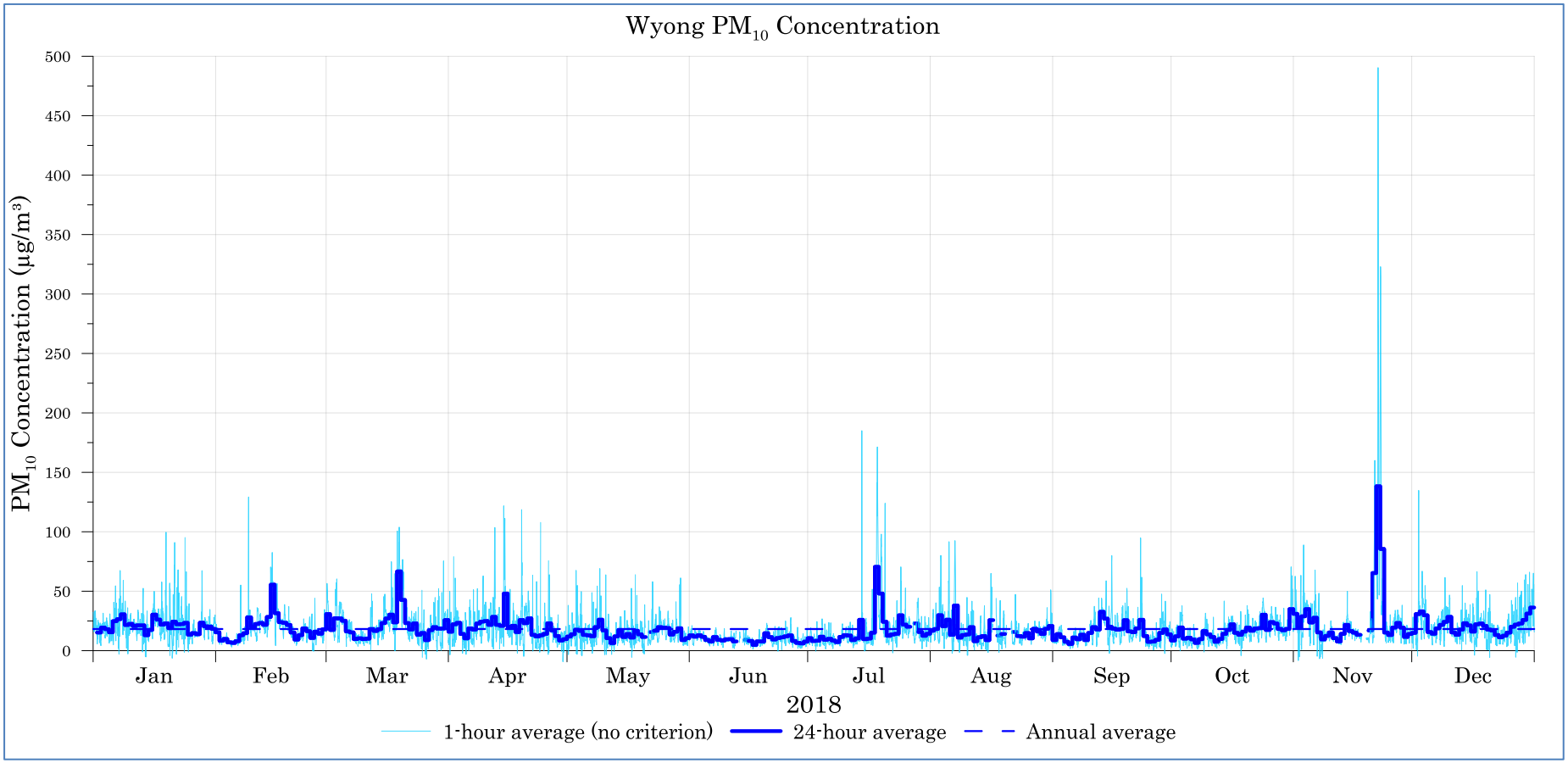

Figure B-2: Wyong PM_{10} (1-hour, 24-hour and annual average) concentration – 2018

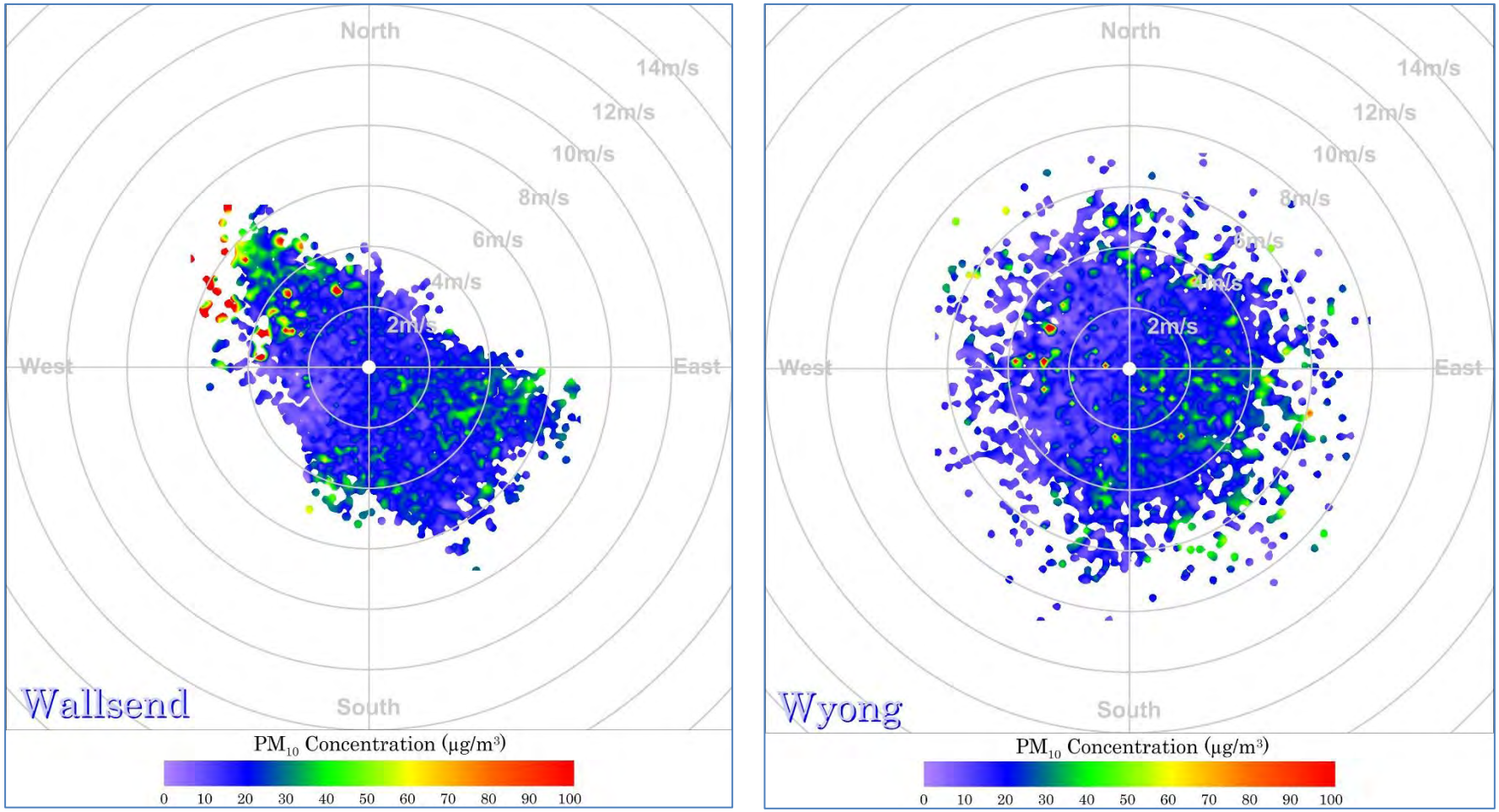

Figure B-3: 2018 hourly PM_{10} pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low PM_{10} levels in 2018. The Wallsend monitor recorded relatively higher levels from the northwest.

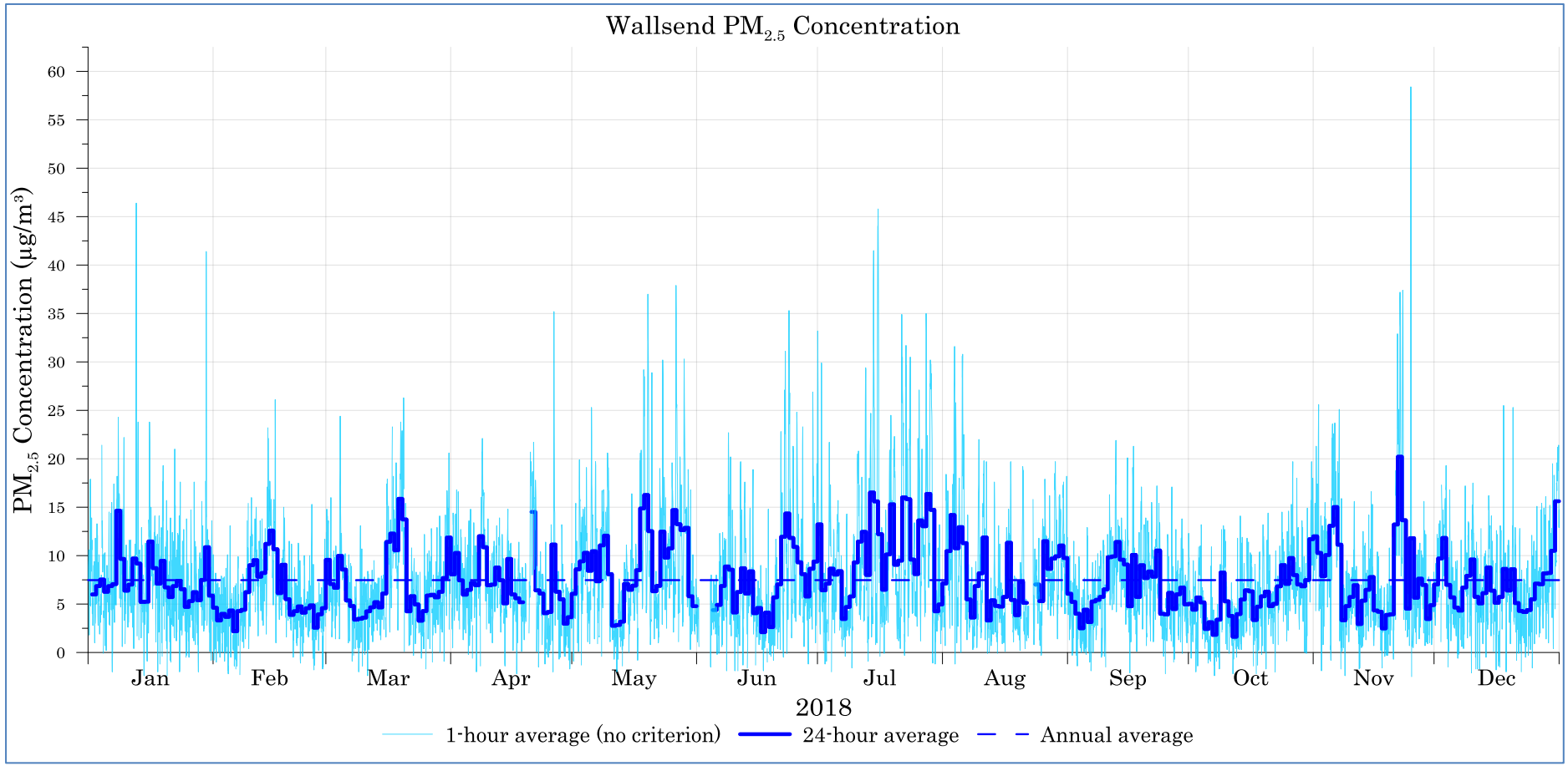

Figure B-4: Wallsend $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2018

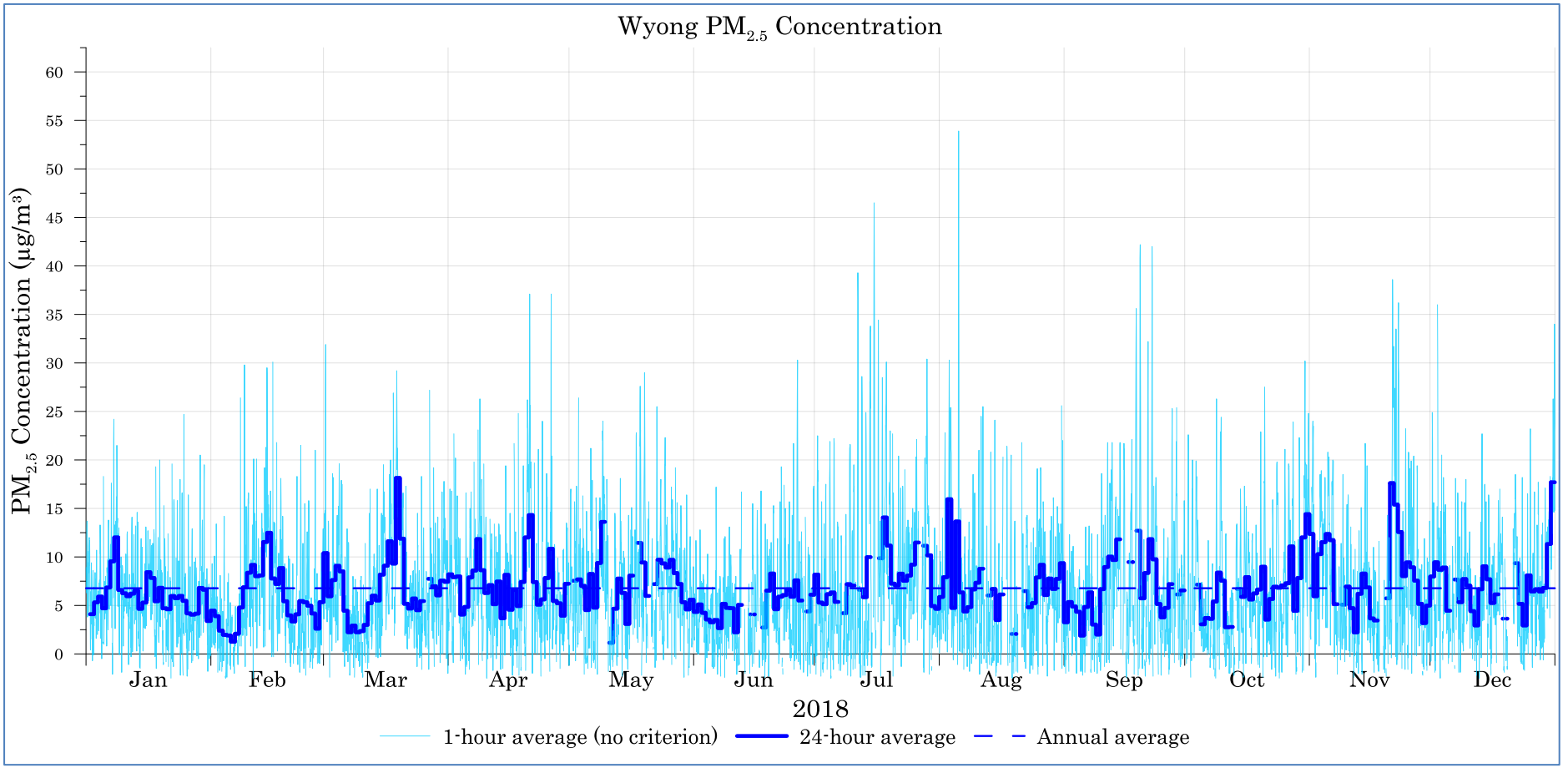

Figure B-5: Wyong $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2018

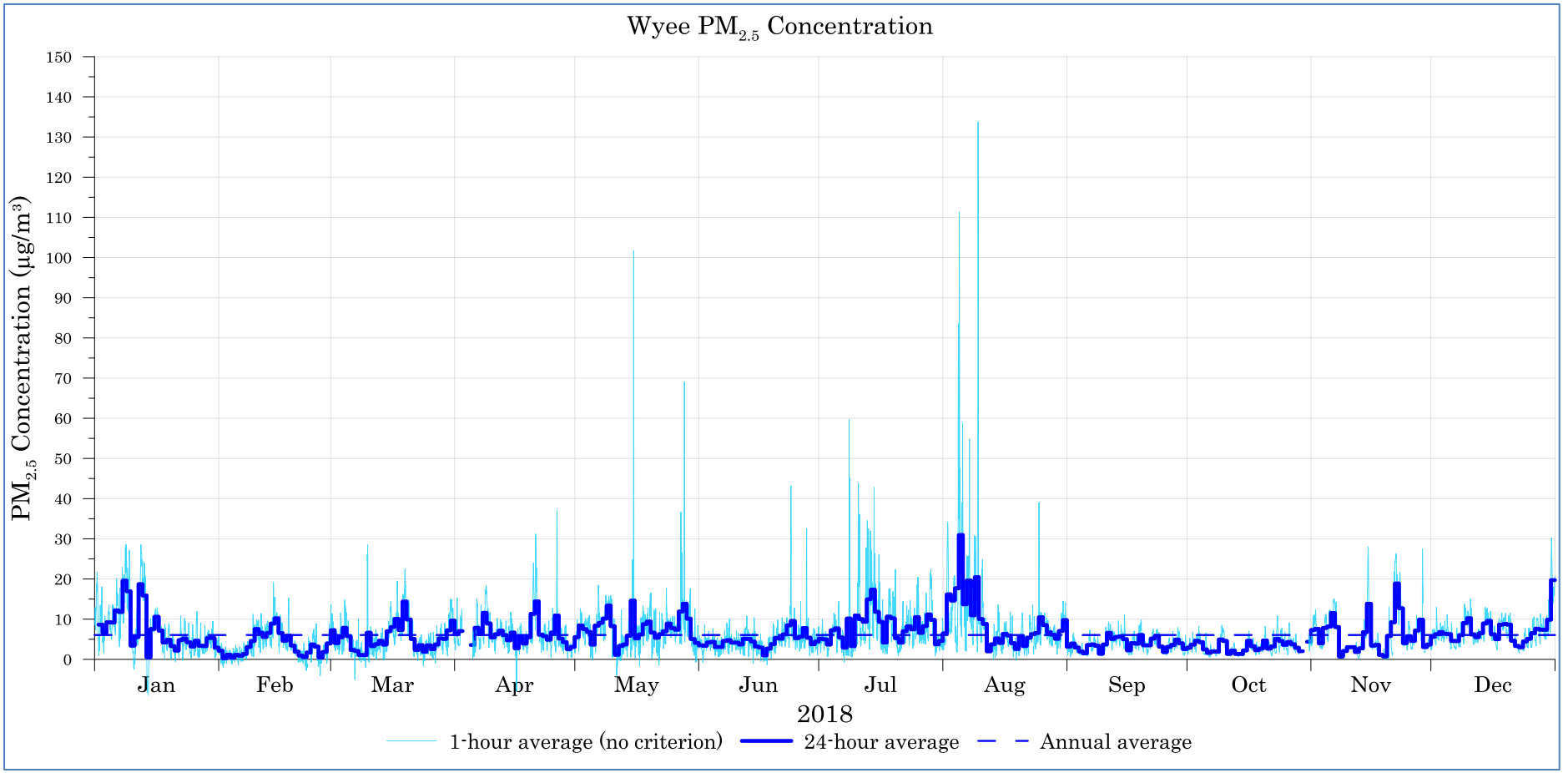

Figure B-6: Wyee $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2018

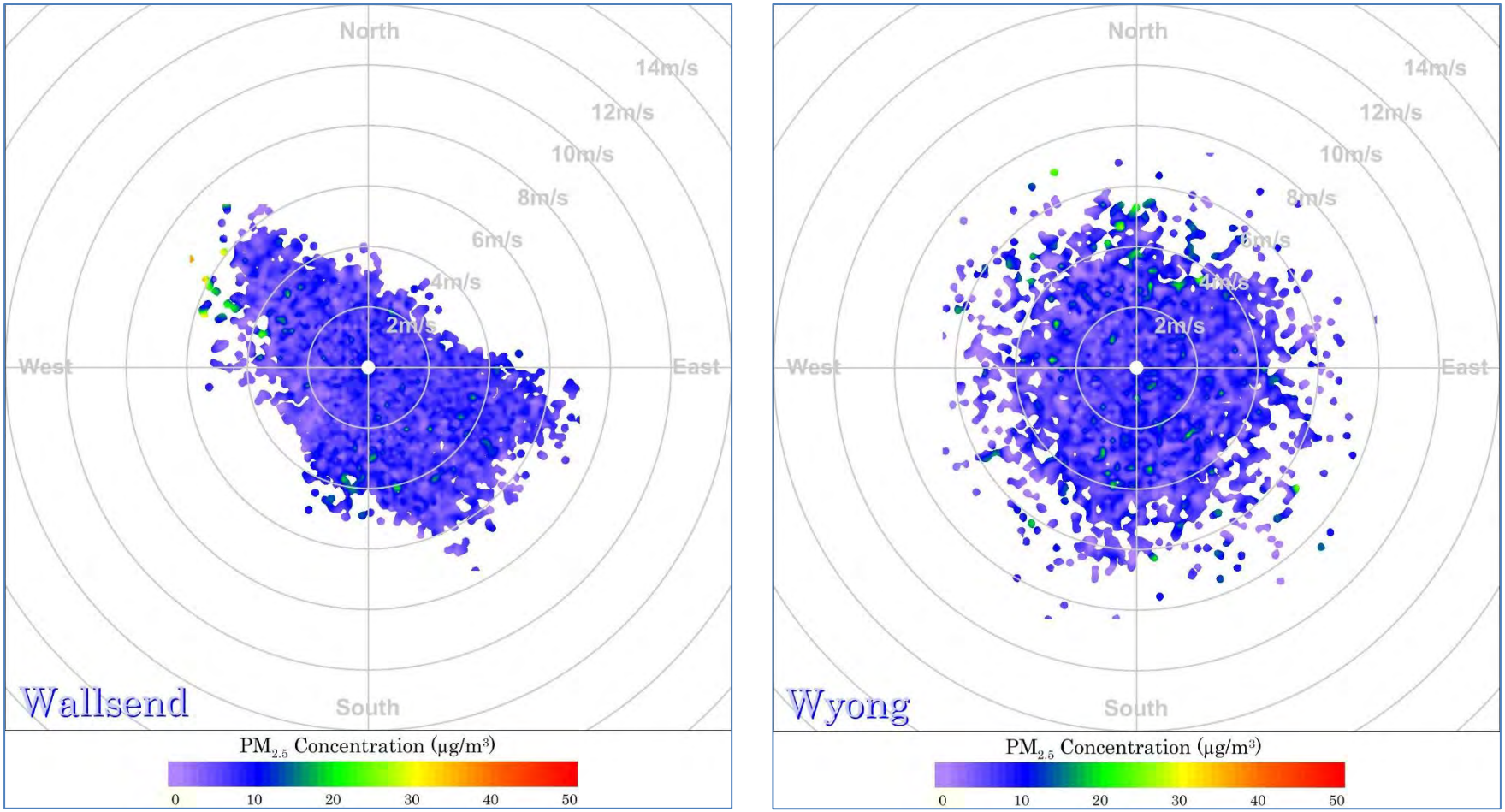

Figure B-7: 2018 hourly $PM_{2.5}$ pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low $PM_{2.5}$ levels in 2018.

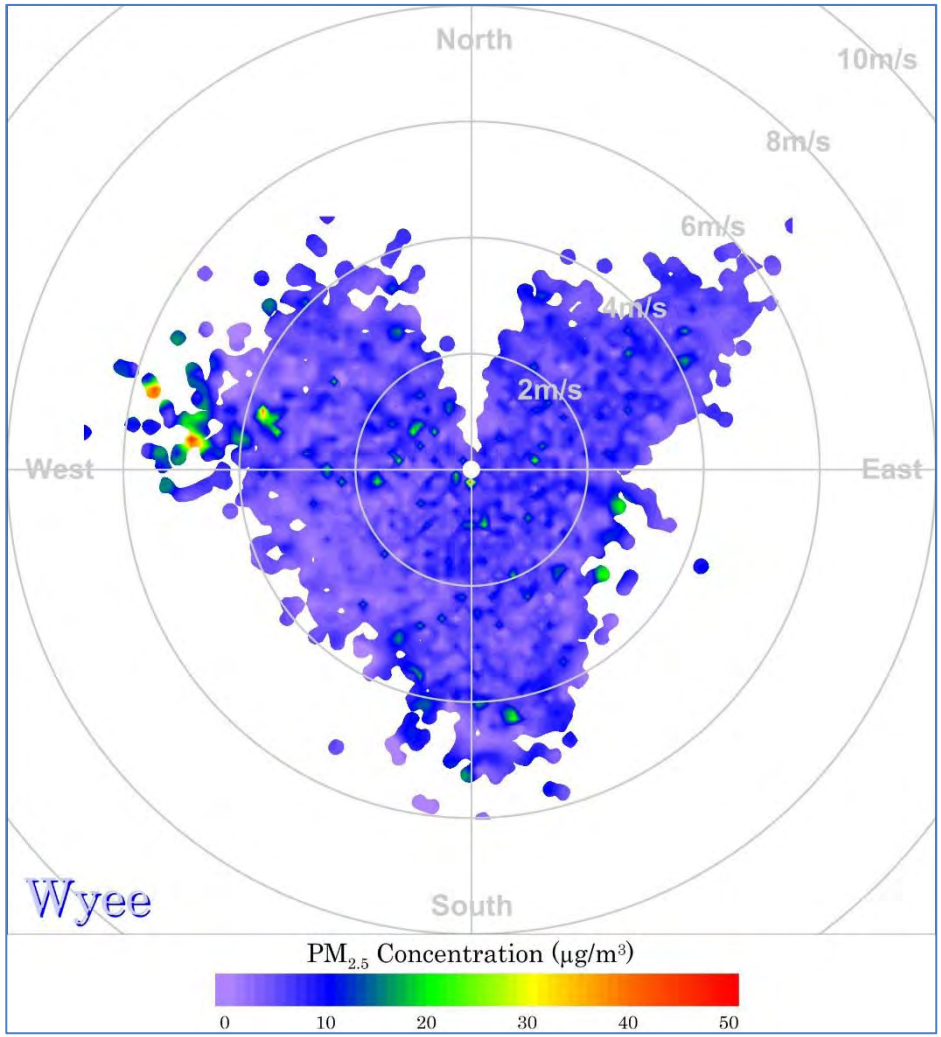

Figure B-8: 2018 hourly $PM_{2.5}$ pollution rose – Wyee

The Wyee monitor generally recorded low $PM_{2.5}$ levels in 2018.

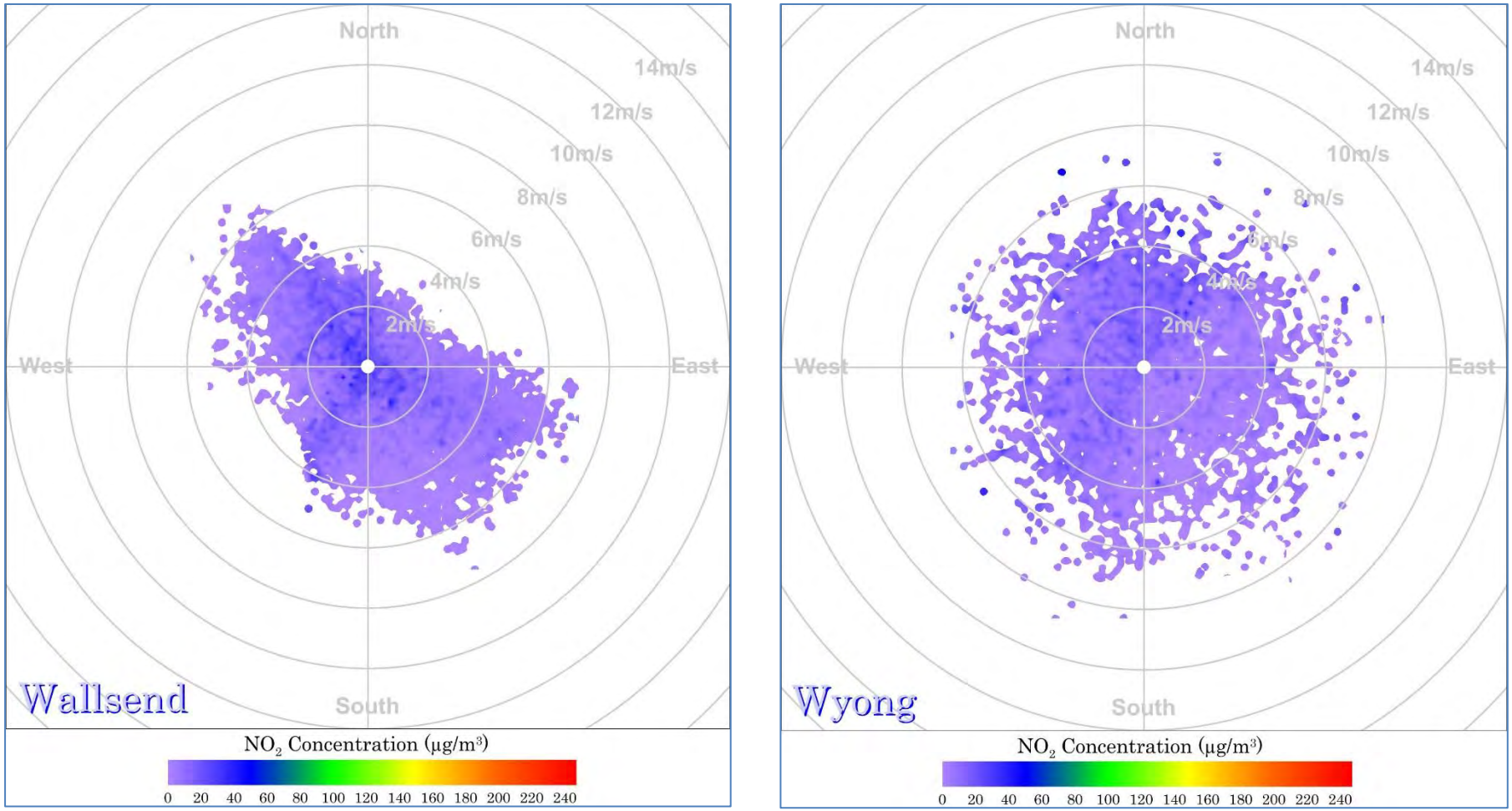

Figure B-9: 2018 hourly NO_2 pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low NO_2 levels in 2018.

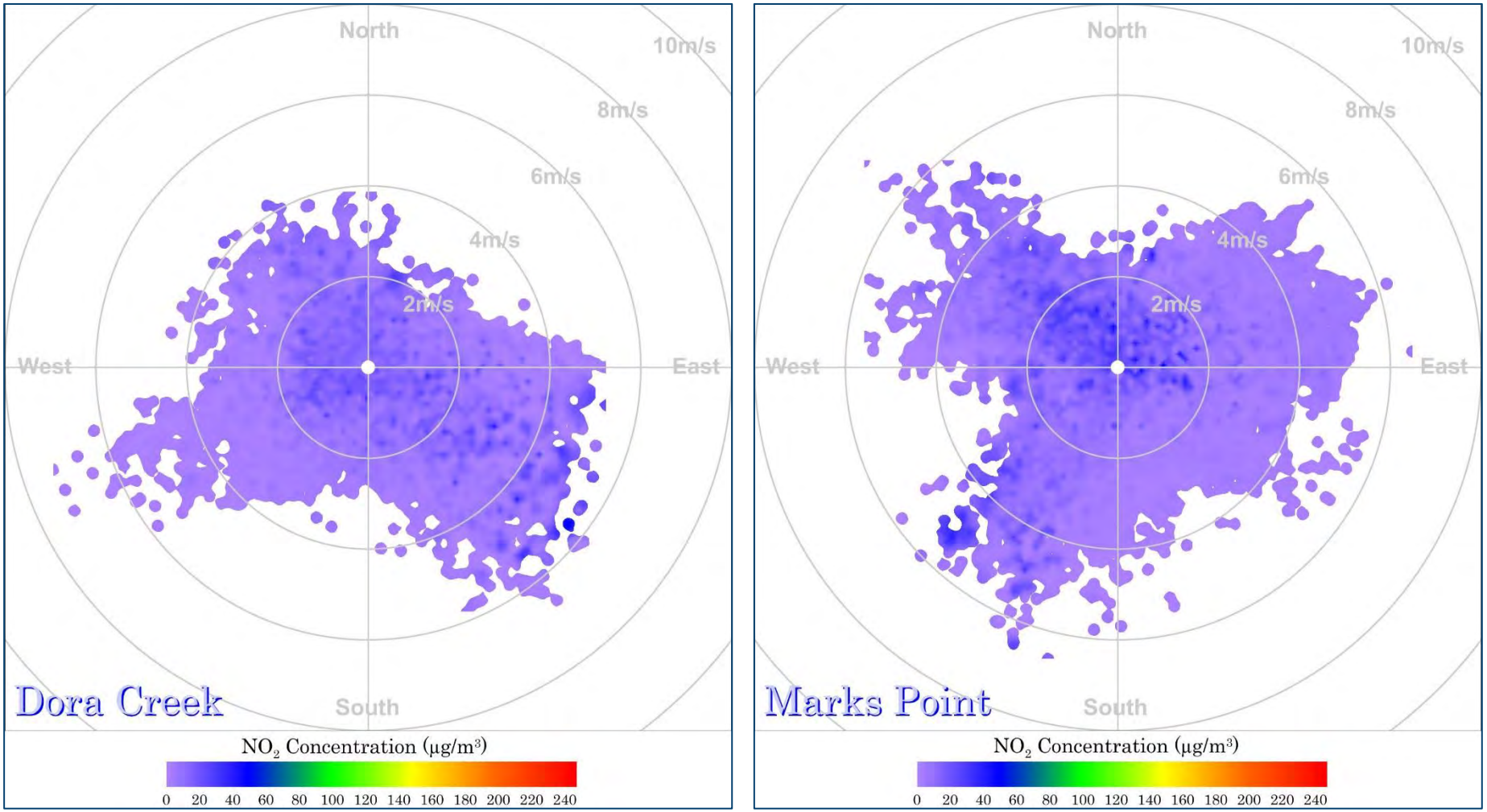

Figure B-10: 2018 hourly NO_2 pollution roses – Dora Creek (left) and Marks Point (right)

The Dora Creek and Marks Point monitors generally recorded low NO_2 levels in 2018.

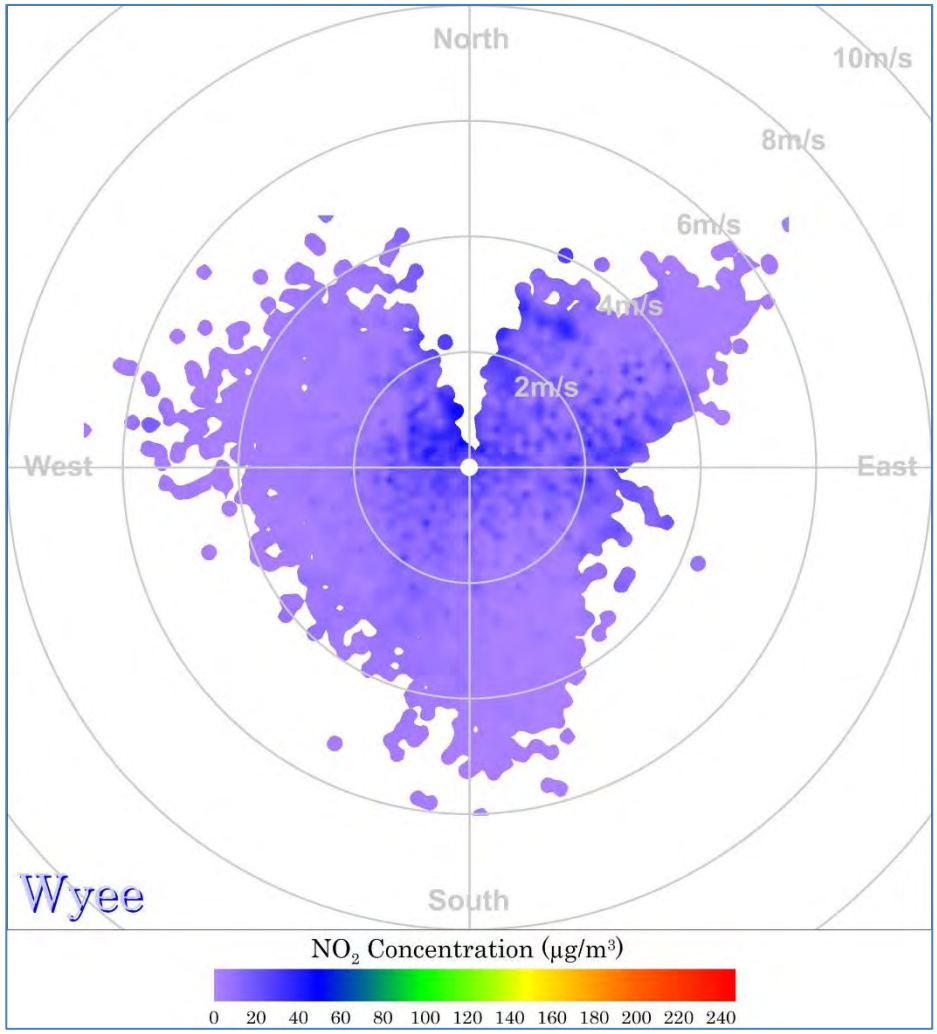

Figure B-11: 2018 hourly NO_2 pollution rose – Wyee

The Wyee monitor generally recorded low NO_2 levels in 2018.

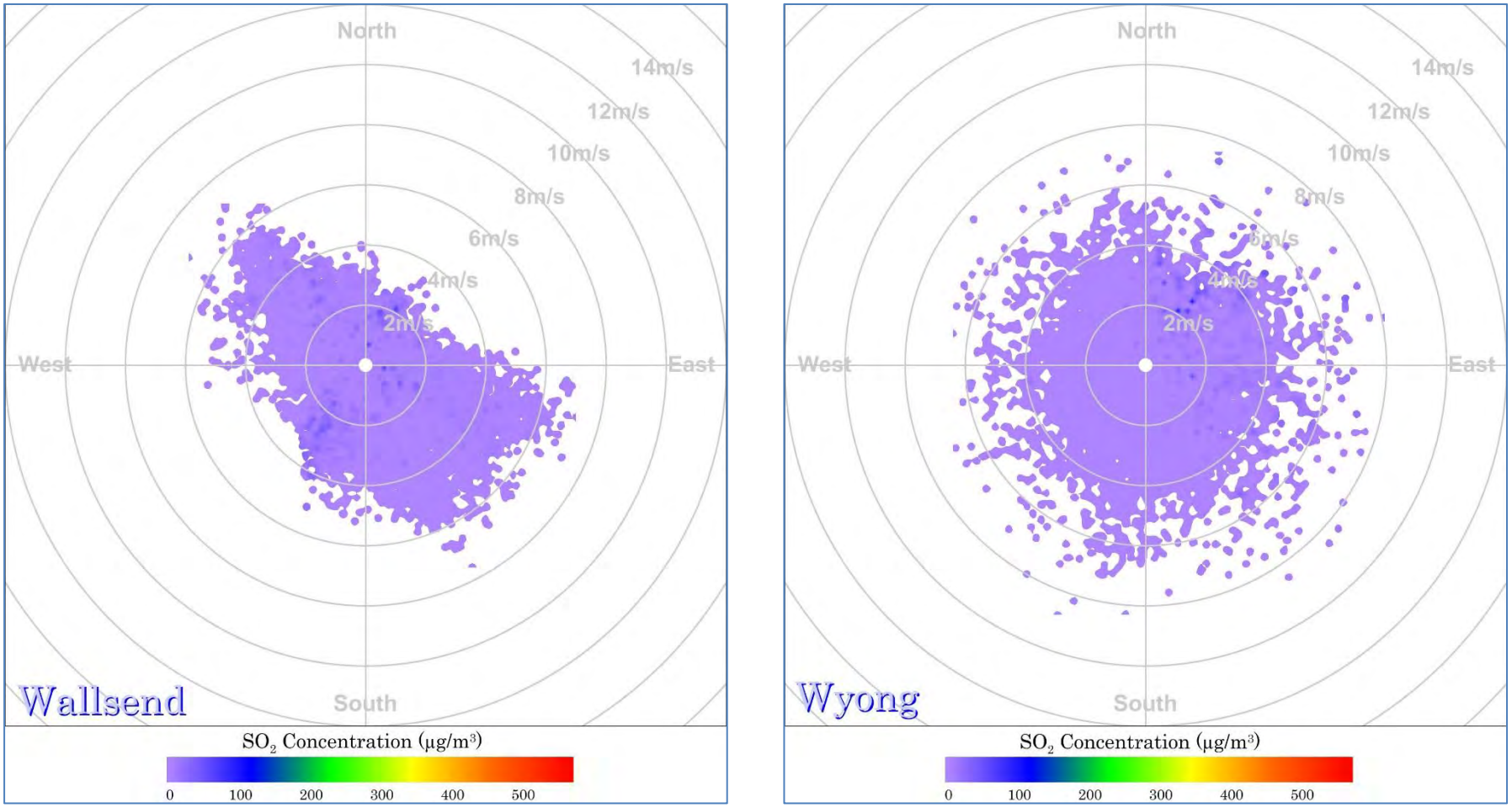

Figure B-12: 2018 hourly SO_2 pollution roses – Wallsend (left) and Wyong (right)

The Wallsend and Wyong monitors generally recorded low SO_2 levels in 2018.

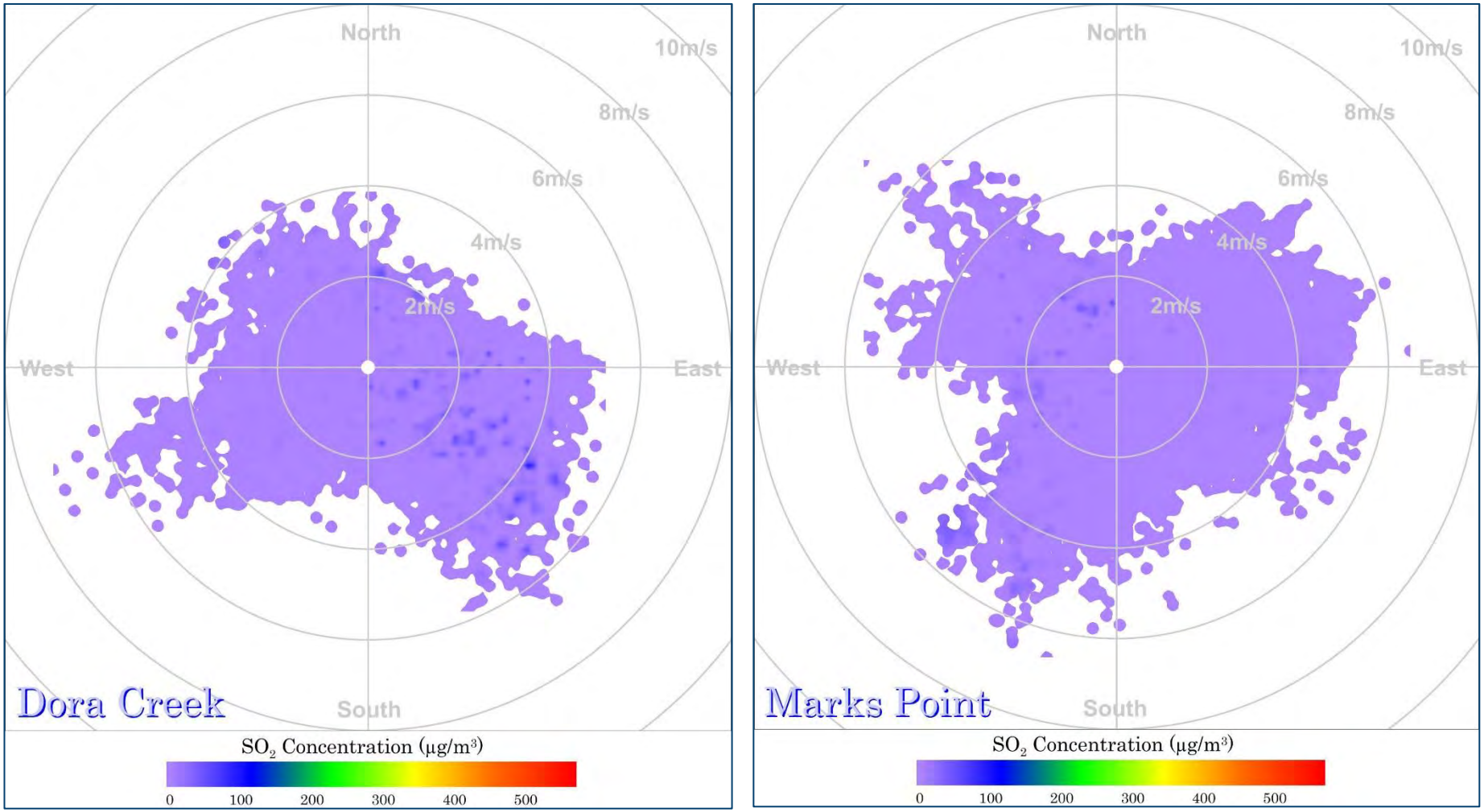

Figure B-13: 2018 hourly SO_2 pollution roses – Dora Creek (left) and Marks Point (right)

The Dora Creek and Marks Point monitors generally recorded low SO_2 levels in 2018.

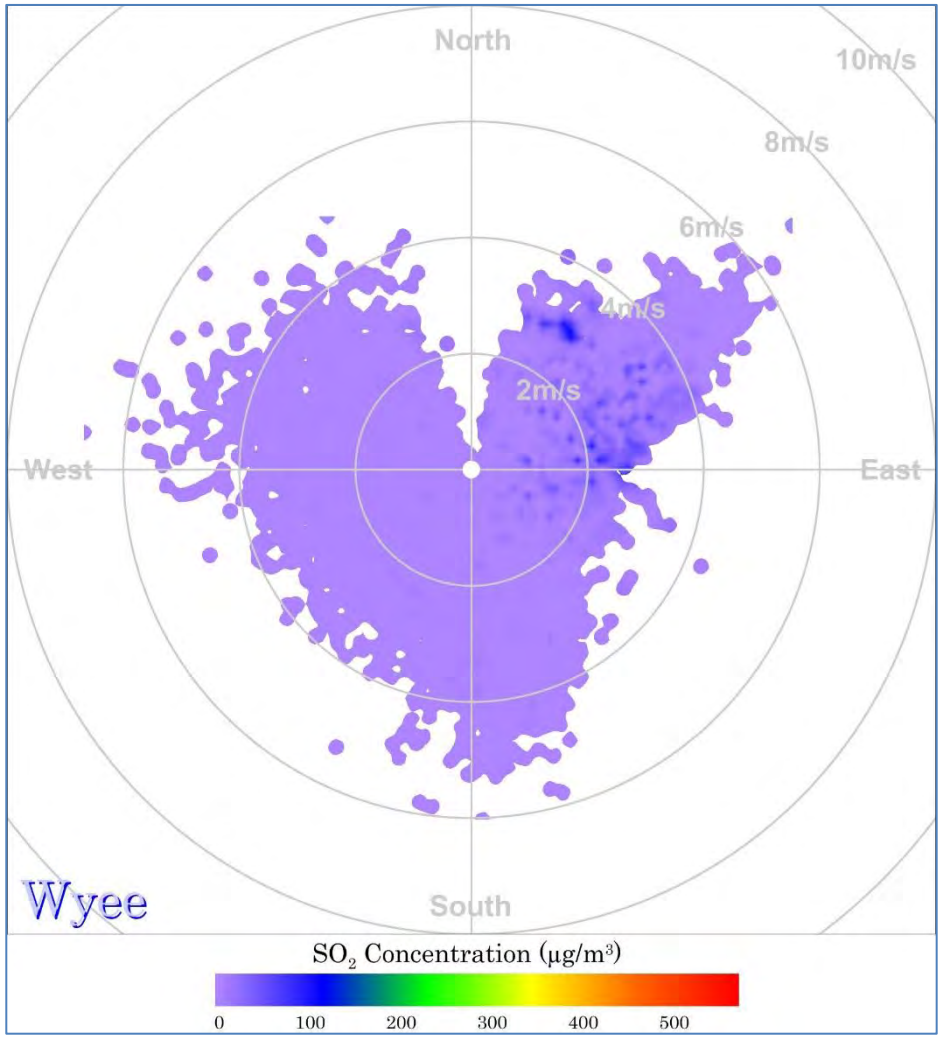

Figure B-14: 2018 hourly SO_2 pollution rose – Wyee

The Wyee monitor generally recorded low SO_2 levels in 2018.

Appendix C

Monitoring Data (Tabulated)

Table C-1: 24-hour average monitoring data

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
01/01/2018	20.4	22.8	9.2	8.9	12.7	2.2	0.5	18.9	1.3	0.1
2/01/2018	15.1	15.3	6.0	4.1	8.6	0.7	0.6	3.0	0.1	3.0
3/01/2018	19.9	19.4	6.9	5.3	6.6	0.8	0.1	8.3	-0.2	0.0
4/01/2018	18.1	18.1	7.5	5.9	9.2	0.8	0.0	18.4	0.2	0.0
5/01/2018	18.4	15.5	6.3	4.7	9.2	3.0	9.3	1.5	0.6	5.6
6/01/2018	18.9	24.8	6.9	6.8	12.2	5.0	13.5	5.7	2.0	5.2
7/01/2018	25.8	26.5	7.1	9.5	11.8	4.1	2.0	-0.1	1.0	0.3
8/01/2018	33.8	30.6	14.6	12.0	19.6	11.8	2.4	8.7	2.5	2.4
9/01/2018	26.2	21.6	9.7	6.6	16.9	1.5	4.2	5.1	0.3	0.6
10/01/2018	21.9	22.6	6.4	6.3	3.4	0.0	0.0	11.2	0.0	0.0
11/01/2018	22.7	20.6	7.0	6.0	5.5	2.4	0.6	1.4	0.9	0.2
12/01/2018	21.2	21.4	9.7	6.2	18.7	5.0	10.9	2.3	1.2	10.3
13/01/2018	26.9	21.3	9.2	6.5	15.9	2.6	0.9	6.2	0.8	0.5
14/01/2018	14.1	13.0	5.2	4.7	0.5	2.3	0.0	3.0	2.7	0.0
15/01/2018	16.7	17.4	5.2	5.3	7.5	7.2	2.7	0.2	3.9	0.0
16/01/2018	28.6	30.3	11.5	8.4	10.6	0.6	0.1	2.1	1.9	0.0
17/01/2018	28.2	26.1	8.7	7.8	7.2	3.3	0.0	-0.3	3.6	-0.7
18/01/2018	24.0	21.8	7.1	5.4	4.2	10.6	2.1	15.2	10.6	11.6
19/01/2018	19.8	23.0	9.5	6.8	4.9	8.3	13.4	12.6	10.4	23.1
20/01/2018	17.1	18.9	6.7	4.7	3.3	3.2	10.6	1.0	1.8	37.1
21/01/2018	16.1	24.3	5.7	4.6	2.2	12.2	10.6	5.2	1.7	2.4
22/01/2018	20.5	22.2	6.9	6.0	4.8	3.5	4.0	4.9	2.3	2.2
23/01/2018	22.4	22.3	7.4	5.7	5.2	6.4	3.0	7.4	2.3	3.2
24/01/2018	23.9	23.4	6.5	6.0	4.3	5.1	2.6	6.8	1.2	5.9
25/01/2018	15.4	13.4	4.7	5.5	3.2	4.3	4.8	5.9	-0.3	13.8
26/01/2018	18.9	14.8	5.3	4.2	4.6	4.8	4.1	13.1	-0.1	12.3
27/01/2018	16.5	13.9	6.2	4.0	3.4	5.2	1.9	0.5	0.7	6.8
28/01/2018	19.0	23.5	5.4	4.2	3.3	3.9	0.0	0.2	1.2	0.0
29/01/2018	26.0	20.5	7.5	6.8	5.3	3.3	0.1	1.0	0.6	0.8
30/01/2018	23.4	20.3	10.9	6.6	5.3	6.7	2.5	3.7	0.4	4.5
31/01/2018	15.3	18.3	5.9	3.4	2.9	0.6	0.0	-0.6	0.8	0.3
1/02/2018	15.9	15.5	4.6	4.5	2.1	2.4	0.0	5.4	1.0	-2.5
2/02/2018	9.2	8.4	3.3	3.9	0.2	4.2	0.1	-0.6	0.8	0.0
3/02/2018	11.5	9.8	4.0	2.4	1.2	1.7	0.0	5.5	0.8	1.9
4/02/2018	8.3	7.0	3.7	2.0	0.4	0.0	0.0	6.8	0.3	0.0
5/02/2018	11.6	6.5	4.3	1.9	1.2	1.4	0.0	0.4	0.0	3.7
6/02/2018	11.1	8.0	2.2	1.3	0.9	2.3	0.4	1.2	0.3	4.9
7/02/2018	13.6	13.0	4.3	2.1	1.3	1.7	0.0	1.0	2.1	11.8
8/02/2018	14.6	14.7	4.4	4.8	3.1	10.6	15.3	-0.2	0.8	8.0
9/02/2018	23.1	28.1	6.2	6.9	4.5	5.0	9.8	9.0	7.5	6.4
10/02/2018	22.2	19.7	9.0	8.4	7.6	4.4	1.6	5.6	1.8	2.6
11/02/2018	24.3	22.4	9.5	9.2	6.6	5.9	2.0	1.7	5.1	2.9
12/02/2018	27.8	23.3	7.8	8.0	5.6	1.7	1.4	2.9	1.0	24.5
13/02/2018	21.8	21.6	8.2	8.1	6.6	2.5	0.0	-0.8	2.5	17.8
14/02/2018	35.0	28.3	11.2	11.5	8.9	6.0	3.1	2.9	2.7	3.4
15/02/2018	53.1	55.5	12.6	12.5	10.2	1.3	1.9	3.5	0.5	3.3
16/02/2018	31.5	31.5	10.7	7.8	6.5	2.8	0.9	21.5	1.9	0.3
17/02/2018	25.8	23.9	6.1	7.2	4.6	2.1	2.2	3.3	0.1	9.5
18/02/2018	26.3	23.4	9.1	8.9	5.8	3.1	5.8	8.3	2.0	5.8
19/02/2018	20.3	21.6	5.5	5.4	3.4	1.3	0.0	3.7	2.3	1.7
20/02/2018	14.2	15.3	3.9	4.0	1.9	0.0	0.0	5.4	0.7	-0.7
21/02/2018	11.7	9.3	4.3	3.3	0.9	2.1	0.0	4.0	0.8	1.0
22/02/2018	14.4	13.1	4.8	4.1	0.6	1.5	4.6	7.5	2.5	3.0
23/02/2018	21.5	18.8	4.1	5.4	1.7	2.2	3.0	3.3	1.8	0.5
24/02/2018	13.4	16.3	4.6	5.3	3.7	3.0	6.1	6.5	4.2	1.3
25/02/2018	11.3	10.7	4.9	5.0	3.1	1.9	0.0	4.6	1.7	0.0
26/02/2018	11.8	16.0	2.6	4.2	0.4	0.0	0.0	2.9	0.6	0.0
27/02/2018	13.8	14.2	3.9	2.6	1.8	2.1	0.0	7.4	1.3	0.3
28/02/2018	19.2	17.9	4.6	5.3	3.9	5.6	6.5	5.7	2.6	7.1
1/03/2018	31.2	30.8	9.6	10.4	7.2	0.7	0.1	7.8	1.5	0.3
2/03/2018	17.9	17.4	7.1	5.9	4.0	1.4	0.0	3.1	0.2	0.0
3/03/2018	20.2	27.3	6.7	7.6	5.4	6.8	3.4	5.1	1.0	6.5
4/03/2018	27.3	27.1	10.0	9.1	7.9	1.6	0.1	0.8	-0.2	1.5

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
5/03/2018	23.3	25.1	8.6	8.5	5.8	2.0	0.0	3.3	1.2	0.0
6/03/2018	19.3	16.2	5.4	4.5	2.3	0.0	0.0	1.8	1.0	0.0
7/03/2018	18.0	15.3	4.8	2.2	2.1	0.0	-0.1	2.0	0.9	0.0
8/03/2018	11.7	9.7	3.4	2.9	1.1	0.0	0.1	16.7	1.0	0.6
9/03/2018	10.5	10.4	3.5	2.2	1.1	0.8	0.0	3.7	1.5	0.0
10/03/2018	10.9	9.7	3.6	2.4	6.6	0.0	0.0	0.8	0.5	0.1
11/03/2018	11.8	10.0	4.3	3.0	3.3	1.0	2.0	0.2	-0.1	5.6
12/03/2018	14.7	18.2	4.7	5.2	3.8	3.4	0.9	4.9	2.0	7.1
13/03/2018	16.7	16.5	5.2	6.0	4.6	0.9	0.0	-1.6	1.5	0.3
14/03/2018	20.3	18.1	4.7	5.5	3.7	0.9	5.1	2.8	-	0.3
15/03/2018	26.5	23.2	6.1	8.2	7.0	4.2	3.1	3.3	-	3.1
16/03/2018	30.7	27.1	11.4	9.1	8.0	0.3	0.0	18.0	0.1	0.0
17/03/2018	31.3	30.3	12.3	11.6	10.1	4.8	2.9	1.3	1.5	2.1
18/03/2018	28.0	23.7	10.6	9.3	7.3	3.6	1.4	1.3	5.5	2.3
19/03/2018	64.4	66.7	15.9	18.1	14.4	13.4	1.2	7.6	3.1	2.6
20/03/2018	40.4	42.6	13.7	11.9	9.9	12.9	1.1	1.0	2.9	0.6
21/03/2018	16.5	23.3	4.3	5.2	5.1	0.0	0.0	15.1	1.0	0.0
22/03/2018	18.7	17.8	5.8	4.7	2.3	0.0	0.0	4.0	1.1	0.0
23/03/2018	17.3	23.0	5.0	5.7	3.5	0.8	0.0	1.7	1.2	16.1
24/03/2018	9.7	13.4	3.3	4.5	1.9	2.4	11.8	4.1	1.7	11.3
25/03/2018	14.1	14.9	4.3	5.4	3.5	1.8	1.1	1.8	5.3	0.6
26/03/2018	11.5	8.8	5.9	-	2.5	2.1	0.1	2.4	6.4	0.3
27/03/2018	18.0	17.3	6.0	7.7	3.7	1.3	0.0	7.6	0.9	0.9
28/03/2018	22.5	19.8	5.7	7.0	5.2	2.7	7.1	3.3	1.6	8.8
29/03/2018	17.2	18.5	6.3	6.0	5.1	2.1	4.8	9.0	1.8	2.2
30/03/2018	18.0	18.7	7.7	7.6	7.2	5.0	4.4	6.7	2.8	3.8
31/03/2018	27.8	25.7	11.9	7.4	9.6	0.2	0.1	2.3	1.0	0.0
1/04/2018	16.7	15.9	8.1	8.2	6.2	4.3	6.3	3.4	0.9	4.5
2/04/2018	19.2	22.1	10.3	7.9	7.1	5.1	2.4	5.3	2.2	2.1
3/04/2018	24.4	23.4	7.5	8.0	-	0.2	0.0	15.0	1.3	0.0
4/04/2018	13.7	14.0	6.0	4.1	-	4.0	0.0	3.3	2.6	0.4
5/04/2018	11.2	10.4	6.5	4.8	3.6	3.1	10.7	3.4	1.7	10.8
6/04/2018	16.1	18.7	7.2	7.9	7.9	2.6	0.9	14.5	3.4	2.6
7/04/2018	14.3	17.7	6.9	8.6	6.4	2.6	6.3	12.9	2.0	7.0
8/04/2018	22.1	22.8	12.0	11.8	11.6	5.7	2.1	11.0	7.8	3.5
9/04/2018	29.4	24.4	10.9	8.6	8.9	2.3	0.9	1.9	4.1	0.9
10/04/2018	23.8	24.9	6.9	6.3	5.5	0.5	0.3	1.4	0.8	0.3
11/04/2018	20.9	21.7	7.0	7.1	6.2	5.7	8.2	1.4	2.2	6.7
12/04/2018	28.0	28.5	8.8	5.1	7.1	4.2	1.6	3.3	5.0	3.3
13/04/2018	33.8	21.7	7.5	7.5	6.0	5.5	1.2	3.1	2.9	1.0
14/04/2018	21.2	20.9	5.1	3.7	4.8	3.8	0.0	4.7	4.6	0.0
15/04/2018	55.4	48.0	9.7	8.2	6.7	1.4	0.0	1.4	3.2	0.0
16/04/2018	21.4	19.9	6.0	4.6	2.7	3.8	0.7	0.7	1.2	1.3
17/04/2018	20.1	20.9	5.6	6.6	5.6	1.4	0.0	4.6	1.0	0.8
18/04/2018	18.3	15.7	5.2	4.9	3.9	0.5	0.0	0.5	1.0	1.6
19/04/2018	-	25.7	-	7.4	5.5	-	3.2	1.7	3.2	3.8
20/04/2018	-	23.1	-	12.0	11.3	-	0.5	4.0	1.6	1.5
21/04/2018	24.9	27.2	14.5	14.3	14.4	0.9	0.2	8.1	0.5	0.0
22/04/2018	14.0	13.3	6.4	7.4	6.1	0.8	0.0	7.5	1.9	1.3
23/04/2018	11.6	11.9	6.1	5.1	5.8	0.8	-0.1	5.9	-0.4	1.2
24/04/2018	11.6	12.9	4.1	5.6	4.9	0.3	0.0	0.5	0.1	0.4
25/04/2018	10.4	14.2	4.2	7.8	6.7	2.7	0.1	-2.3	0.6	0.4
26/04/2018	21.6	23.0	11.1	10.8	10.9	0.9	0.1	2.1	0.5	0.7
27/04/2018	17.3	16.9	6.3	5.5	5.2	4.6	0.0	2.4	2.5	0.0
28/04/2018	14.8	12.3	5.5	5.2	4.3	5.2	0.0	0.3	2.4	0.0
29/04/2018	8.1	8.5	3.0	3.9	2.6	6.5	0.0	0.7	4.1	0.9
30/04/2018	8.4	9.7	3.6	7.2	3.1	12.8	0.0	0.5	6.9	0.1
1/05/2018	15.1	11.8	6.1	-	5.5	1.9	0.0	-	1.4	4.6
2/05/2018	17.7	13.9	8.6	7.5	8.4	4.9	6.5	-	3.2	6.9
3/05/2018	19.2	17.6	9.4	7.7	7.5	9.2	9.1	6.9	12.4	6.1
4/05/2018	30.4	16.6	10.3	7.0	6.8	2.2	0.7	2.2	6.4	2.0
5/05/2018	15.1	13.3	8.4	4.5	3.7	1.5	0.4	1.0	2.9	0.6
6/05/2018	16.8	12.9	10.5	8.2	8.4	4.1	6.6	9.2	12.3	10.7
7/05/2018	13.3	12.1	7.4	4.8	9.1	1.0	4.0	3.6	2.5	3.9
8/05/2018	22.1	19.8	11.1	9.4	10.2	9.8	1.9	8.1	19.0	9.1

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
9/05/2018	23.1	26.0	12.1	13.6	13.4	5.1	6.6	9.8	9.1	9.2
10/05/2018	25.1	17.0	8.1	-	8.3	2.2	1.6	0.7	4.0	1.7
11/05/2018	25.4	10.5	2.8	1.1	1.1	1.0	0.0	-0.1	0.7	0.0
12/05/2018	10.1	6.3	2.8	4.7	3.3	0.0	0.0	1.1	3.2	0.6
13/05/2018	12.1	12.0	3.2	7.8	3.7	18.8	0.0	0.2	17.2	0.0
14/05/2018	18.1	17.3	7.1	6.3	5.9	9.2	0.0	1.0	4.5	0.0
15/05/2018	14.9	11.5	6.5	3.1	14.6	11.2	0.1	1.7	5.0	1.1
16/05/2018	15.4	14.0	6.9	8.1	5.2	3.5	0.1	2.0	0.7	0.8
17/05/2018	17.9	11.0	8.5	-	6.2	1.9	1.4	7.5	2.7	3.3
18/05/2018	22.6	16.7	14.9	11.4	8.8	3.4	0.4	3.3	2.6	2.8
19/05/2018	20.3	13.8	16.3	9.4	9.4	20.5	0.0	3.7	3.1	1.4
20/05/2018	17.8	11.5	12.5	6.0	6.6	1.1	0.6	0.5	11.0	0.4
21/05/2018	15.0	-	6.3	-	5.4	1.5	-	2.3	6.5	0.5
22/05/2018	18.3	15.7	6.9	7.2	6.2	1.4	1.6	5.5	1.7	1.7
23/05/2018	20.4	16.8	12.5	9.7	7.0	2.5	0.0	3.2	1.9	3.1
24/05/2018	19.8	19.8	9.8	9.3	8.9	3.5	1.4	10.1	3.2	3.8
25/05/2018	20.9	19.3	10.7	8.9	7.8	0.1	0.2	1.7	1.3	1.6
26/05/2018	-	19.0	14.7	9.7	7.4	2.5	0.4	2.6	2.3	6.4
27/05/2018	-	13.6	13.2	8.3	11.9	2.8	6.1	1.6	2.2	3.3
28/05/2018	-	15.9	12.6	7.2	13.8	2.3	2.7	3.3	3.6	2.4
29/05/2018	20.5	18.8	12.9	5.3	10.1	6.5	1.2	2.0	4.0	2.2
30/05/2018	9.2	8.9	5.8	4.6	5.1	1.0	0.0	-0.2	4.6	0.0
31/05/2018	11.1	10.6	4.8	5.6	4.1	2.6	1.1	4.1	6.6	0.7
1/06/2018	-	12.9	-	4.3	3.5	-	0.0	1.7	14.8	0.0
2/06/2018	-	11.8	-	5.1	3.4	-	0.0	2.7	12.9	0.0
3/06/2018	-	12.9	-	4.2	4.2	-	0.0	2.0	4.7	0.0
4/06/2018	-	11.6	-	3.6	4.4	-	0.0	0.8	4.3	0.0
5/06/2018	8.3	9.0	4.4	3.3	3.1	12.2	0.0	-0.8	4.9	0.0
6/06/2018	8.9	7.7	4.9	3.5	3.1	1.6	0.0	2.1	1.2	0.3
7/06/2018	15.7	11.4	6.9	2.7	4.6	0.8	1.4	0.5	2.9	1.4
8/06/2018	17.7	9.1	8.9	5.2	4.8	7.9	1.5	5.4	12.9	1.5
9/06/2018	11.6	8.5	8.5	4.7	4.2	0.8	0.0	1.5	2.1	0.0
10/06/2018	8.1	9.6	4.1	4.7	4.2	12.4	0.0	0.3	5.6	0.0
11/06/2018	8.8	9.7	6.2	2.2	3.7	7.7	0.1	1.1	3.6	1.1
12/06/2018	10.7	7.8	8.7	5.1	5.1	3.4	3.5	4.8	4.8	3.6
13/06/2018	12.6	-	6.1	-	5.1	0.2	-	2.7	0.1	0.8
14/06/2018	17.5	-	8.4	-	4.4	0.6	0.6	1.0	0.0	2.0
15/06/2018	14.4	9.1	4.1	4.1	3.2	2.4	0.7	0.0	1.0	0.9
16/06/2018	11.7	8.1	4.6	-	2.9	0.9	0.0	0.5	1.0	-0.4
17/06/2018	-	4.8	2.1	-	1.0	0.0	0.0	1.7	0.6	1.3
18/06/2018	-	7.8	4.1	2.7	2.7	3.2	0.0	1.1	4.0	0.0
19/06/2018	6.8	7.8	2.6	6.5	3.8	14.8	-	-	5.9	0.0
20/06/2018	13.4	14.7	5.7	8.3	5.3	6.3	-	2.0	2.4	0.0
21/06/2018	11.2	11.3	7.1	4.6	5.2	5.2	1.4	2.8	4.3	1.3
22/06/2018	12.9	9.4	12.0	5.9	6.2	2.2	3.0	4.0	3.4	5.6
23/06/2018	16.2	10.6	14.3	6.1	8.5	2.5	0.9	6.3	2.8	1.9
24/06/2018	13.9	11.2	11.8	6.6	9.5	7.3	0.1	0.4	1.7	0.6
25/06/2018	19.7	12.0	10.9	5.9	5.3	8.5	0.4	4.3	3.9	2.2
26/06/2018	17.4	12.9	9.3	7.6	5.6	5.5	0.4	5.8	1.2	2.4
27/06/2018	14.3	8.1	8.1	5.5	7.8	5.7	1.2	5.6	0.6	3.6
28/06/2018	8.7	6.5	5.8	-	5.4	3.1	7.7	4.9	4.6	5.6
29/06/2018	10.1	6.0	8.6	4.4	3.8	0.3	0.5	2.8	3.3	1.5
30/06/2018	14.0	7.6	9.4	6.1	4.4	1.0	0.5	3.5	2.4	0.9
1/07/2018	16.1	10.5	13.2	8.2	5.2	3.4	0.6	5.1	3.2	0.8
2/07/2018	-	8.2	6.4	5.3	5.0	0.5	0.0	4.3	-0.5	0.7
3/07/2018	12.7	8.4	7.1	5.1	3.7	-	0.4	1.8	1.2	1.2
4/07/2018	14.3	11.8	8.7	6.2	7.3	-	3.1	5.8	2.6	4.7
5/07/2018	14.5	9.1	8.0	6.3	7.7	4.0	2.1	9.0	13.6	3.0
6/07/2018	13.5	9.9	8.4	5.4	5.5	1.7	1.6	3.7	1.4	1.9
7/07/2018	11.6	8.5	3.5	-	2.9	0.0	0.1	2.7	2.5	0.1
8/07/2018	14.8	7.2	4.7	4.2	10.1	0.9	0.0	1.9	2.8	2.8
9/07/2018	13.5	11.6	5.8	7.2	3.3	4.2	0.0	2.1	3.9	1.8
10/07/2018	17.5	13.1	9.3	7.0	10.9	1.3	0.0	5.5	3.5	0.9
11/07/2018	18.3	12.7	11.5	-	10.0	3.4	6.3	7.2	1.4	3.4
12/07/2018	16.6	8.9	12.5	6.6	9.3	4.0	1.2	6.9	3.2	4.0

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
13/07/2018	11.9	10.3	8.0	5.9	14.9	0.9	0.4	7.4	9.4	0.8
14/07/2018	17.8	26.0	16.5	10.0	17.4	2.2	0.0	3.9	2.2	0.0
15/07/2018	20.2	9.7	15.6	-	11.8	-	0.7	4.6	0.6	0.5
16/07/2018	19.9	10.1	12.2	-	9.3	-	0.0	8.8	0.9	2.1
17/07/2018	20.3	15.0	6.5	9.9	4.2	4.2	0.6	1.6	0.3	2.3
18/07/2018	45.8	70.4	10.1	14.1	10.6	1.0	0.5	4.2	1.5	2.4
19/07/2018	43.7	48.0	15.3	11.2	10.2	4.7	2.6	6.7	0.2	2.1
20/07/2018	24.7	24.3	9.1	7.2	5.3	1.5	2.9	3.1	-0.7	1.9
21/07/2018	17.2	12.5	9.5	7.1	4.1	1.3	0.0	3.2	1.0	1.4
22/07/2018	19.9	13.7	16.0	8.3	7.0	3.1	3.2	1.1	-0.4	1.5
23/07/2018	43.3	14.2	15.8	7.5	8.2	5.6	1.6	2.0	1.0	3.6
24/07/2018	30.3	29.7	9.6	8.1	7.5	0.8	1.0	4.8	1.7	2.0
25/07/2018	24.0	21.9	8.1	9.2	10.5	0.5	3.9	3.5	0.1	2.0
26/07/2018	22.7	20.0	13.6	11.5	6.6	2.6	0.0	5.0	1.3	2.0
27/07/2018	18.6	-	13.0	-	8.3	5.8	0.0	4.4	0.7	1.5
28/07/2018	27.8	22.9	16.4	11.2	11.2	6.3	9.1	6.9	1.0	9.1
29/07/2018	20.4	15.7	14.7	10.2	9.8	1.3	1.6	3.8	1.5	1.9
30/07/2018	15.5	12.5	4.2	4.9	3.7	0.0	1.5	6.0	0.8	1.2
31/07/2018	20.6	14.2	5.0	4.7	4.6	0.8	0.0	3.5	-0.1	1.1
1/08/2018	19.6	16.7	7.1	5.9	6.5	1.4	0.1	2.9	1.4	2.2
2/08/2018	19.5	18.2	10.5	7.9	16.2	1.0	0.7	4.3	-0.5	4.2
3/08/2018	23.2	29.9	14.2	16.0	14.6	2.2	3.2	4.3	0.8	3.8
4/08/2018	43.2	20.6	10.8	4.7	17.7	0.7	0.5	4.1	2.0	0.2
5/08/2018	29.0	26.1	12.9	13.6	30.9	3.3	4.0	3.7	1.2	4.9
6/08/2018	19.4	13.4	11.3	6.3	13.7	5.8	0.2	-	1.4	1.2
7/08/2018	27.2	38.0	5.5	4.4	19.6	0.1	0.0	-	2.6	0.4
8/08/2018	15.5	11.0	3.6	4.8	11.0	0.6	0.5	2.7	-0.1	1.3
9/08/2018	16.0	13.1	6.9	6.7	20.5	4.1	0.4	3.5	-0.8	2.0
10/08/2018	14.5	13.6	8.2	7.3	10.0	1.3	2.9	3.9	2.1	2.4
11/08/2018	19.7	19.8	11.9	8.8	8.8	1.1	1.1	1.6	0.2	2.1
12/08/2018	8.1	7.9	3.3	-	2.0	1.0	0.7	3.9	3.2	0.5
13/08/2018	15.2	11.3	5.4	6.0	3.7	1.9	0.2	2.1	1.4	0.8
14/08/2018	14.2	12.3	4.8	6.7	5.2	3.9	4.3	3.6	2.7	5.1
15/08/2018	25.4	8.8	4.7	3.5	4.1	0.3	0.0	1.3	0.6	0.2
16/08/2018	21.9	25.7	5.7	6.1	6.4	2.2	0.4	5.2	0.2	2.2
17/08/2018	20.7	-	11.3	-	5.9	2.8	0.1	4.2	2.1	1.5
18/08/2018	18.8	12.7	5.4	-	4.0	0.9	0.4	2.0	3.6	0.9
19/08/2018	10.5	14.0	3.9	2.1	2.6	0.0	0.6	2.2	6.3	-0.1
20/08/2018	16.5	-	7.3	-	5.7	2.6	0.1	2.6	1.6	0.2
21/08/2018	13.7	-	5.1	-	3.3	0.1	1.4	2.0	5.2	1.0
22/08/2018	-	15.8	-	6.5	5.4	1.3	0.2	3.1	0.7	0.2
23/08/2018	-	12.3	-	4.8	6.3	0.8	0.2	3.7	0.5	1.9
24/08/2018	14.7	11.8	7.0	5.2	6.6	2.4	0.9	3.8	0.0	4.5
25/08/2018	14.9	14.9	5.3	7.9	10.5	3.4	7.2	6.1	2.1	3.7
26/08/2018	12.7	10.3	11.5	9.2	8.5	5.0	1.0	4.7	-0.6	3.5
27/08/2018	17.7	18.3	8.6	6.1	6.7	4.1	0.5	5.7	0.8	0.2
28/08/2018	18.6	16.1	9.7	7.8	6.1	8.8	0.0	4.8	-0.6	0.2
29/08/2018	16.7	14.0	9.9	6.7	5.1	3.4	0.0	2.2	0.6	0.5
30/08/2018	20.1	18.3	11.1	7.7	7.0	10.3	0.0	3.2	0.9	1.5
31/08/2018	19.6	20.8	9.8	9.3	9.8	5.4	22.0	1.5	1.3	20.5
1/09/2018	16.5	8.9	6.1	3.3	3.2	0.6	0.6	3.5	2.5	0.1
2/09/2018	13.3	13.9	5.2	5.4	3.9	0.5	0.0	3.4	1.9	0.0
3/09/2018	9.8	11.1	4.0	4.9	2.9	0.6	0.0	2.6	2.5	0.0
4/09/2018	6.9	7.5	2.5	4.3	2.0	1.1	0.2	2.5	3.8	0.6
5/09/2018	8.8	5.6	4.4	1.9	1.5	1.1	0.0	3.1	2.2	2.7
6/09/2018	10.9	11.1	3.1	4.8	3.6	3.4	4.1	5.8	2.9	1.4
7/09/2018	9.6	9.5	5.3	6.3	3.7	1.4	3.6	2.8	2.8	2.4
8/09/2018	13.3	13.5	5.4	3.0	3.4	7.6	0.1	3.6	2.6	0.0
9/09/2018	10.0	8.9	5.7	2.0	1.4	0.8	0.0	2.1	3.6	0.5
10/09/2018	16.2	14.9	6.5	6.7	3.7	1.2	0.0	3.9	2.9	0.4
11/09/2018	22.7	19.8	9.8	9.0	6.6	8.2	11.0	2.8	2.7	13.7
12/09/2018	24.6	17.9	9.9	10.0	5.1	2.6	0.7	3.9	3.8	0.8
13/09/2018	33.8	32.7	11.4	9.7	5.6	2.1	0.4	4.2	3.0	0.2
14/09/2018	27.1	26.9	9.6	11.8	5.7	1.3	2.7	3.7	3.1	1.9
15/09/2018	23.3	20.1	9.1	-	5.0	2.1	1.4	4.1	4.5	0.4

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
16/09/2018	21.0	18.5	4.8	-	2.2	3.4	0.0	6.2	4.0	0.0
17/09/2018	17.7	17.7	10.1	9.5	4.0	1.1	0.7	3.4	3.5	0.9
18/09/2018	20.0	18.2	5.7	-	3.9	3.5	5.8	3.5	4.0	2.2
19/09/2018	28.9	25.7	9.0	12.7	6.1	2.1	0.6	3.2	-	1.2
20/09/2018	17.1	16.2	7.7	5.7	3.5	1.9	0.2	4.0	3.1	0.2
21/09/2018	16.4	15.5	8.4	8.3	3.5	5.6	5.1	4.4	4.9	11.2
22/09/2018	16.5	18.8	7.8	11.8	5.2	2.8	12.5	2.5	5.1	5.3
23/09/2018	20.0	26.0	10.5	9.8	5.8	2.7	0.6	3.5	2.4	1.1
24/09/2018	10.9	12.3	4.0	5.1	3.2	0.8	0.0	2.5	3.0	0.2
25/09/2018	9.3	7.4	3.9	3.8	1.8	0.3	0.0	3.4	1.7	4.8
26/09/2018	11.4	7.6	6.2	4.7	3.1	1.7	1.0	4.7	3.6	1.6
27/09/2018	9.9	9.1	4.5	7.2	3.6	4.6	4.6	4.1	3.5	5.6
28/09/2018	15.1	14.9	6.0	-	4.9	2.5	7.2	3.1	3.5	5.0
29/09/2018	20.1	17.8	6.7	6.1	4.0	2.8	0.0	1.5	3.1	1.1
30/09/2018	13.0	13.7	5.0	6.6	2.5	1.5	0.2	2.7	3.1	0.1
1/10/2018	10.2	8.5	5.0	-	2.9	5.1	2.6	2.8	2.4	0.7
2/10/2018	14.7	12.0	4.4	-	3.7	5.8	5.0	1.1	2.5	4.5
3/10/2018	21.7	19.5	5.7	-	4.6	2.5	2.0	2.0	3.1	3.3
4/10/2018	11.2	10.0	5.2	7.1	4.3	1.7	0.4	3.5	1.7	0.3
5/10/2018	10.4	10.9	2.4	3.1	2.5	1.8	0.0	4.9	2.3	0.0
6/10/2018	9.5	9.5	3.1	3.7	1.6	3.0	0.0	4.3	2.2	0.0
7/10/2018	6.4	6.6	1.8	3.6	2.0	1.4	0.0	3.5	2.5	0.0
8/10/2018	9.2	9.7	3.4	5.4	1.9	2.3	0.0	2.4	2.6	0.8
9/10/2018	16.9	16.5	8.2	8.4	4.9	5.7	4.2	3.7	1.9	5.0
10/10/2018	14.7	13.7	5.3	7.6	4.6	2.4	0.4	3.2	2.4	0.1
11/10/2018	12.5	11.4	3.8	2.8	1.4	0.8	-0.1	3.2	2.3	0.0
12/10/2018	7.3	7.5	1.6	2.8	2.2	1.9	0.0	2.8	2.7	0.4
13/10/2018	10.5	9.8	4.0	-	1.4	1.9	0.0	2.8	2.2	6.4
14/10/2018	15.9	14.1	5.5	6.7	1.3	2.6	0.4	2.3	2.1	6.7
15/10/2018	17.8	17.4	6.4	5.9	2.2	1.7	0.5	2.2	1.8	0.2
16/10/2018	19.9	22.2	6.3	7.9	4.6	0.6	1.2	2.5	2.2	0.0
17/10/2018	10.3	14.9	3.3	5.6	3.3	4.4	11.9	1.7	2.6	5.2
18/10/2018	11.1	13.4	4.7	6.2	2.3	4.6	4.6	3.0	2.3	3.4
19/10/2018	16.1	16.0	5.8	6.6	2.7	3.2	2.2	3.7	2.6	4.9
20/10/2018	-	19.5	6.3	9.0	4.7	1.7	4.3	4.2	2.2	3.4
21/10/2018	-	16.7	4.8	3.5	2.7	0.3	0.0	4.9	2.5	-0.1
22/10/2018	-	18.6	5.0	5.7	3.2	1.1	0.1	2.7	2.3	1.2
23/10/2018	18.9	19.0	6.8	6.9	5.1	2.7	9.8	2.1	2.3	17.4
24/10/2018	30.8	30.2	9.0	6.8	4.5	3.9	0.1	1.9	2.3	13.7
25/10/2018	18.9	17.4	7.1	7.1	3.6	3.3	1.5	2.8	2.7	18.1
26/10/2018	22.8	24.0	9.8	7.3	4.3	3.9	0.9	5.4	2.5	13.4
27/10/2018	22.4	22.8	8.0	11.1	3.8	4.1	8.1	5.4	2.4	14.8
28/10/2018	19.7	18.3	7.0	4.4	2.9	2.3	0.0	4.5	2.6	11.4
29/10/2018	18.8	17.2	6.8	7.8	2.0	1.1	1.1	5.0	2.7	19.7
30/10/2018	20.0	18.2	7.5	12.0	-	6.2	9.4	5.1	2.3	19.5
31/10/2018	30.9	35.0	11.7	14.4	4.4	11.8	1.2	4.1	2.9	6.9
1/11/2018	30.1	30.9	12.0	12.4	7.3	1.9	13.4	3.4	2.0	5.7
2/11/2018	32.0	19.2	10.3	6.0	7.6	2.1	0.9	2.7	1.4	5.5
3/11/2018	30.2	28.9	7.9	10.3	4.0	7.4	0.0	5.7	1.5	1.7
4/11/2018	37.6	35.0	10.1	11.5	7.8	1.1	3.0	3.7	0.5	4.9
5/11/2018	28.7	23.7	13.1	12.4	8.2	5.9	3.6	4.7	3.4	4.6
6/11/2018	34.8	27.7	15.0	11.7	11.5	6.5	3.4	4.0	3.0	0.2
7/11/2018	18.6	15.4	11.1	5.1	8.0	4.0	0.1	5.2	3.2	-0.4
8/11/2018	10.9	9.5	3.3	-	0.7	7.1	0.0	5.0	3.4	-1.6
9/11/2018	16.7	12.4	4.8	5.1	2.1	4.8	4.1	3.9	3.0	4.8
10/11/2018	16.9	15.4	5.7	6.9	3.0	3.5	3.6	3.2	3.1	1.2
11/11/2018	12.8	10.5	6.9	4.7	3.0	1.5	1.5	4.9	3.2	20.5
12/11/2018	9.5	7.8	2.9	2.2	1.9	1.3	0.0	2.8	2.8	14.3
13/11/2018	14.3	14.1	5.4	6.2	2.7	-	5.3	2.1	1.2	-2.4
14/11/2018	19.2	21.7	6.5	8.3	6.8	3.7	4.7	4.7	1.3	1.9
15/11/2018	18.1	16.4	7.8	6.9	13.8	3.3	0.0	3.6	1.2	-1.4
16/11/2018	15.1	15.1	4.3	3.7	3.4	3.5	0.0	4.7	1.8	-1.5
17/11/2018	12.1	13.3	4.2	3.4	3.6	0.9	0.1	1.7	1.1	-2.6
18/11/2018	11.3	-	2.5	-	1.1	-0.6	-	1.8	2.6	-2.6
19/11/2018	13.0	-	3.9	-	0.7	3.0	-	1.9	1.2	13.3

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
20/11/2018	15.7	16.9	3.9	5.7	5.8	3.2	7.8	1.7	1.5	6.7
21/11/2018	47.6	65.3	13.2	17.6	9.2	3.5	0.6	5.0	0.7	3.2
22/11/2018	136.6	138.3	20.2	15.4	18.9	0.3	0.1	4.7	1.1	0.1
23/11/2018	93.6	85.6	13.6	12.6	12.7	0.2	0.6	1.3	1.3	-2.8
24/11/2018	13.4	15.2	4.5	8.0	4.0	-3.1	0.1	1.6	1.6	0.0
25/11/2018	19.0	13.2	11.8	9.4	5.8	1.3	0.7	3.1	1.2	-1.2
26/11/2018	19.8	19.5	5.6	8.9	4.6	7.3	0.0	2.7	1.9	-1.8
27/11/2018	25.7	23.3	7.6	7.5	7.2	3.0	4.1	2.3	2.0	3.2
28/11/2018	17.8	19.3	7.0	5.2	9.9	1.9	0.0	2.7	0.7	0.1
29/11/2018	12.1	11.6	3.5	3.2	3.1	5.2	0.0	2.7	0.8	1.9
30/11/2018	15.9	14.1	4.9	5.0	3.7	9.3	0.2	1.8	1.3	5.5
1/12/2018	21.6	15.0	7.0	8.0	5.6	2.7	0.6	1.3	0.8	5.7
2/12/2018	-	30.8	9.7	9.5	6.2	0.6	0.1	1.9	1.2	1.6
3/12/2018	-	33.0	11.8	8.7	6.8	2.4	2.2	1.7	1.2	2.1
4/12/2018	25.3	29.7	7.0	8.9	6.4	0.9	0.0	1.2	1.3	0.6
5/12/2018	16.5	15.6	5.7	4.5	6.3	-1.5	0.0	1.8	1.6	0.0
6/12/2018	17.5	14.2	4.6	-	4.6	2.1	-	2.2	1.4	0.2
7/12/2018	20.1	18.7	4.3	7.7	4.5	1.5	6.3	2.0	1.2	0.6
8/12/2018	22.4	21.7	6.7	5.3	6.0	2.3	18.5	2.4	1.2	16.9
9/12/2018	24.7	24.3	7.9	7.7	9.0	4.4	4.6	2.2	1.3	29.9
10/12/2018	27.3	28.4	9.6	7.1	10.2	19.1	0.7	2.3	2.5	1.4
11/12/2018	15.7	15.4	5.7	4.4	6.2	0.7	0.0	1.6	1.4	0.0
12/12/2018	13.7	13.3	5.1	2.9	5.5	0.8	0.5	2.4	1.2	2.8
13/12/2018	15.4	17.7	6.1	6.7	6.5	-	5.5	1.9	1.4	2.4
14/12/2018	21.8	23.1	8.8	9.0	8.9	-	0.4	1.1	0.8	0.2
15/12/2018	17.8	21.2	6.4	7.7	9.6	4.9	6.8	-	1.3	5.9
16/12/2018	13.2	16.0	5.1	5.3	6.2	5.0	10.7	-	1.4	3.0
17/12/2018	20.8	22.1	5.7	6.1	5.0	3.2	1.2	-	0.8	6.2
18/12/2018	19.8	22.9	8.6	-	8.6	5.2	0.0	1.2	0.9	0.0
19/12/2018	16.5	20.7	6.4	3.6	8.8	1.0	-	2.4	1.3	0.4
20/12/2018	18.7	17.7	8.6	-	8.6	5.9	-	1.5	1.1	10.9
21/12/2018	16.4	17.0	5.1	-	4.6	0.0	0.0	2.5	1.0	-0.2
22/12/2018	14.5	13.2	4.3	9.4	3.3	2.2	0.0	1.4	1.5	0.0
23/12/2018	11.4	11.3	4.2	5.2	3.0	3.5	0.0	1.3	1.2	-0.4
24/12/2018	13.1	12.6	4.4	2.9	4.5	2.4	1.9	1.5	-	1.5
25/12/2018	15.8	15.2	5.5	8.1	5.1	2.6	8.3	1.5	1.2	6.7
26/12/2018	21.0	20.1	7.1	6.4	6.5	6.3	0.5	1.4	1.8	7.4
27/12/2018	20.2	21.9	7.1	6.7	7.6	5.4	8.1	1.1	0.7	7.1
28/12/2018	21.5	22.8	8.2	6.4	7.4	2.7	3.5	1.4	1.1	2.7
29/12/2018	22.6	25.9	8.2	6.8	7.4	3.6	3.0	1.6	0.7	0.9
30/12/2018	32.0	31.2	10.5	11.3	9.9	3.0	1.4	1.7	0.9	3.0
31/12/2018	37.4	36.3	15.6	17.7	19.7	8.3	3.4	2.6	1.1	5.3

- Not applicable

Table C-2: 24-hour average HVAS monitoring data

Date	PM_{10} (HVAS) (µg/m³)		Date	PM_{10} (HVAS) (µg/m³)	
	Wakefield (Westside)	Teralba		Wakefield (Westside)	Teralba
1/01/2018	16	17	6/07/2018	11	15
7/01/2018	31	31	12/07/2018	8	13
13/01/2018	22	26	18/07/2018	33	45
19/01/2018	14	19	24/07/2018	19	25
25/01/2018	16	16	30/07/2018	8	13
31/01/2018	18	20	5/08/2018	19	27
6/02/2018	5	6	11/08/2018	24	18
12/02/2018	25	25	17/08/2018	11	15
18/02/2018	18	17	23/08/2018	9	10
24/02/2018	12	10	29/08/2018	9	11
2/03/2018	9	18	4/09/2018	1	4
8/03/2018	7	6	10/09/2018	-	11
14/03/2018	9	9	16/09/2018	-	18
20/03/2018	41	43	22/09/2018	-	17
26/03/2018	7	9	28/09/2018	-	16
1/04/2018	13	15	4/10/2018	-	11
7/04/2018	7	8	10/10/2018	-	13
13/04/2018	21	24	16/10/2018	-	21
19/04/2018	7	10	22/10/2018	-	13
25/04/2018	8	9	28/10/2018	-	16
1/05/2018	7	11	3/11/2018	-	37
7/05/2018	12	19	9/11/2018	-	15
13/05/2018	3	11	15/11/2018	-	17
19/05/2018	13	15	21/11/2018	-	63
25/05/2018	10	12	27/11/2018	-	32
31/05/2018	6	7	3/12/2018	-	33
6/06/2018	0	3	9/12/2018	-	31
12/06/2018	3	4	15/12/2018	-	20
18/06/2018	2	3	21/12/2018	-	16
24/06/2018	8	9	27/12/2018	-	22
30/06/2018	9	5			

TODOROSKI AIR SCIENCES

LAKE MACQUARIE – WYONG

REVIEW OF ANNUAL AMBIENT AIR QUALITY DATA 2019

Delta Electricity & Origin Energy

10 December 2020

Job Number 18120902A

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Lake Macquarie – Wyong

Review of Annual Ambient Air Quality Data 2019

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	09/12/2020	D Kjellberg	
FINAL - 001	10/12/2020	D Kjellberg	P Henschke

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EXECUTIVE SUMMARY

This report has been prepared by Todoroski Air Sciences for Delta Electricity and Origin Energy and presents ambient air quality monitoring data recorded in the Lake Macquarie - Wyong region for the 2019 calendar year. The results indicate that the air quality was generally good in the Lake Macquarie - Wyong region until September 2019, but frequently poor to hazardous from late October to December 2019 due to smoke from widespread bushfires.

The data summary (shown below) indicates that in 2019, all particulate monitoring sites recorded 24-hour average concentrations above the applicable $PM_{2.5}$ and PM_{10} criteria. All $PM_{2.5}$ monitoring sites recorded annual average concentrations above the criterion of 8µg/m^3 and the Teralba PM_{10} monitoring site recorded an annual average PM_{10} concentration above the criterion of 25µg/m^3. All NO_2 and SO_2 data were below the applicable criteria. Further details are provided in the report and the 24-hour average data are provided in the Appendices.

Lake Macquarie - Wyong Air Quality Pictorial Summary – 2019

Short term averages (1-hour and 24-hour)

Long term average (annual)

Lake Macquarie – Wyong Air Quality Tabular Summary - 2019

Site	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2
	Maximum 1-hour average (µg/m^3)		Maximum 24-hour average (µg/m^3)			Annual average (µg/m^3)			
	Air Quality Impact Criteria								
	570	246	50	25	228	25	8	60	62
Wallsend	✓	✓	✗	✗	✓	✓	✗	✓	✓
Wyong	✓	✓	✗	✗	✓	✓	✗	✓	✓
Dora Creek	✓	✓	-	-	✓	-	-	✓	✓
Marks Point	✓	✓	-	-	✓	-	-	✓	✓
Wyee	✓	✓	-	✗	✓	-	✗	✓	✓
Teralba HVAS	-	-	✗	-	-	✗	-	-	-

✓ - All data below applicable criteria
✗ - At least one elevated level above applicable criteria
- - Not applicable
HVAS - High Volume Air Sampler

1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of Delta Electricity and Origin Energy. It provides a summary and analysis of the available ambient air quality and meteorological data collected in the Lake Macquarie - Wyong region during the 2019 calendar year.

2 PROJECT SCOPE

The following outlines the scope of work for this project.

- Provide an annual summary report for the 2019 calendar year for Lake Macquarie – Wyong. The report will examine compliance with annual average criteria and summarise the monthly reported data for the calendar year and include seasonal trends and pollution rose analysis to identify likely source categories for elevated pollution events.
- The report will assess the available data from monitoring stations operated by the NSW Department of Planning, Industry and Environment (DPIE) at Wyong and Wallsend, and by industry at Wyee, Marks Point, Dora Creek and Teralba.
- The aim is to provide a simplified report that is accessible and contains results that would be clearly understood by the general public.

3 THE PURPOSE OF AMBIENT MONITORING

It is important to note that the data presented in this report are from both NSW EPA and industry monitoring sites. The NSW EPA and the industry sites collect data for different purposes and this needs to be understood when comparing the data to the criteria.

NSW EPA monitoring sites are specifically designed to measure the likely levels of pollutants that the general population in the area would experience (i.e. an underlying population exposure level), whereas industry monitoring sites are specifically designed to measure maximum levels in a particular location which may be affected by a particular industry.

Data from NSW EPA sites can be compared with national air quality standards. Where the levels measured at NSW EPA monitoring sites are above the national standards on a prolonged and consistent basis, this indicates that some investigation of the potential cause of the issue may be warranted to determine whether any action on a regional level would reduce or better manage the pollutant levels. In the case of PM_{10}, it is noted that the national standards permit five days annually above the criteria to allow for events such as bushfires and dust storms.

Data from industry monitoring sites can be compared with NSW EPA impact assessment criteria. Where the levels measured at industry monitoring sites are above the applicable impact assessment criteria on a prolonged and consistent basis, this indicates that further investigation is warranted to determine the potential cause and what action is required by industry to reduce or better manage the pollutant.

Whether there is any harmful effect on an individual due to an air pollutant will depend on many additional factors, and not just on the measured level of a pollutant. These factors include the total exposure to the pollutant, individual circumstances (age, health, body mass, levels of pollutants at work), levels of other pollutants in the area, and many other factors. Where pollutant levels are below the

criteria generally, harm would not be expected to occur, but it does not follow that harm automatically occurs when pollutant levels are above the criteria.

The criteria serve to highlight potential issues with the levels of pollutants that may warrant more detailed examination. The criteria may also serve to prioritise action in various areas, for example areas with the highest pollutant levels and highest populations or highest exposure would be expected to receive priority action.

3.1 More about air quality

More information about air quality can be found via the following links:

- The Air Quality Index (AQI) was developed by the NSW EPA as an easily understood means of rating the pollutant level relative to its pollutant criteria.
  - https://www.environment.nsw.gov.au/topics/air/understanding-air-quality-data/air-quality-categories
- Aqicn.org provides a near real-time AQI values for monitoring locations around the world. It should be noted that the AQI presented on this website is calculated differently to the NSW EPA AQI and is less stringent than those used in Australia, thus a direct comparison may not be valid.
  - http://aqicn.org/map/world/
- The NSW DPIE website air quality page provides hourly updates of the AQI and data readings from the NSW EPA monitoring sites, and can provide daily forecasts for Sydney and alerts for elevated levels at Wallsend and Wyong, for example. The web tool also presents near real-time wind and pollutant data readings overlaid on regional maps for the Upper Hunter and Newcastle.
  - https://www.dpie.nsw.gov.au/air-quality
- The Lower Hunter Particle Characterisation Study was commissioned to determine the composition of particulate samples collected at monitoring sites at Beresfield, Newcastle, Stockton and Mayfield, and to identify the potential major sources of fine particulates in Newcastle and the Lower Hunter.
  - https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/lower-hunter-particle-characterisation-study-final-report-160243.pdf
- The Air Emissions in My Community web tool presents the estimated emission quantities of various substances and their sources by postcode (and larger) sized areas in an easy to use graphical interface. This is one of the best inventories of emissions that is available, but it is important to appreciate that it cannot include all sources of emissions. It is important to also understand that pollutant emissions are not the same as the pollutant levels that this report presents. Emissions in a given area are one of several important factors that affect pollutant levels in an area, for example the dispersion of the emissions in the atmosphere and how the emissions are released are critical in determining the air quality pollutant levels.
  - https://www.epa.nsw.gov.au/your-environment/air/air-emissions-inventory/air-emissions-my-community/air-emissions-in-my-community-tool

- The NSW Health website provides information on how air pollution affects health and steps for reducing your air pollution and limiting your exposure.
  - http://www.health.nsw.gov.au/environment/air/Pages/default.aspx

4 AIR QUALITY MONITORING SITES

Figure 4-1 and **Table 4-1** summarise the locations and recorded parameters of the monitoring sites in the Lake Macquarie - Wyong region in 2019.

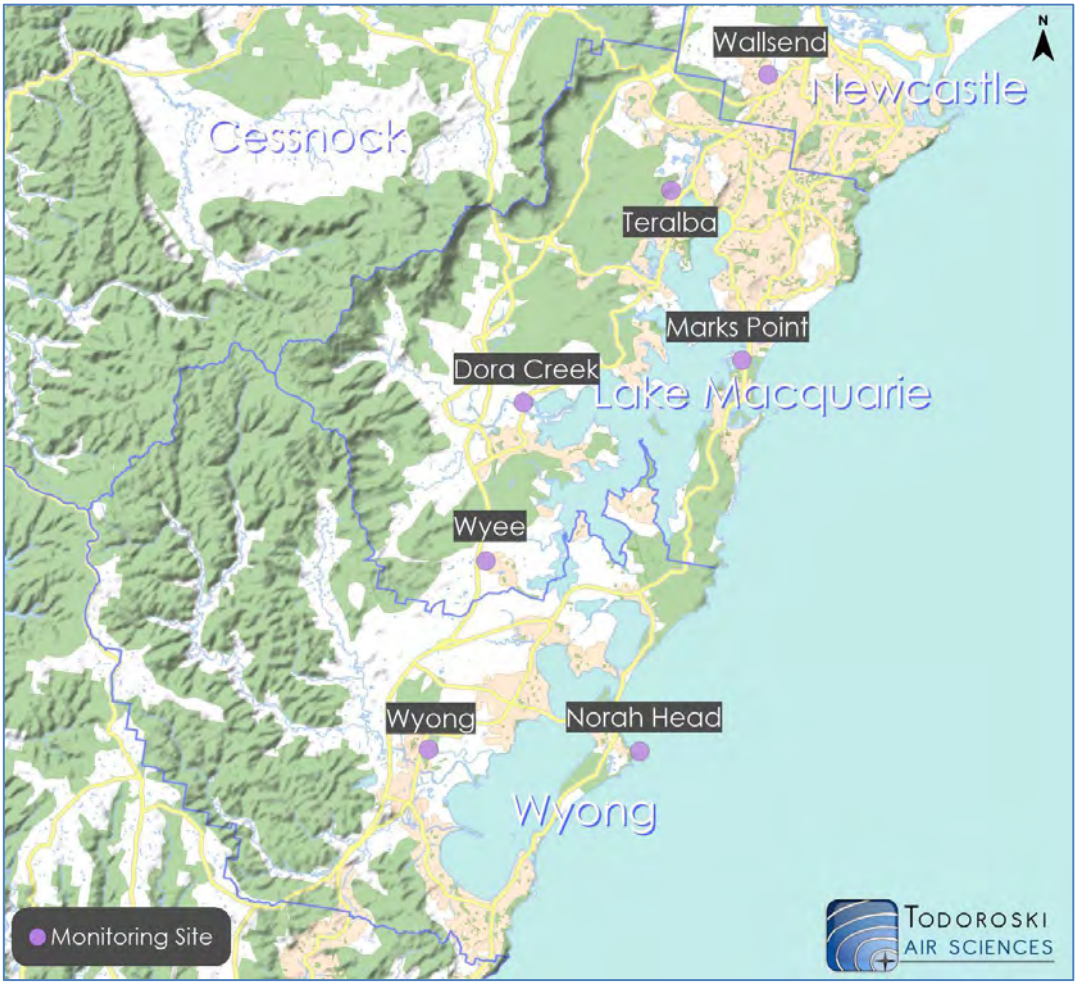

Figure 4-1: Monitoring site locations

Table 4-1: Monitoring sites

Monitoring Station	Type	Recorded Parameters	Recording Periods
Wallsend	NSW DPIE site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Wyong	NSW DPIE site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Marks Point	Industry site	NO_2, SO_2, WS, WD	Hourly
Wyee	Industry site	$PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly
Dora Creek	Industry site	NO_2, SO_2, WS, WD	Hourly
Norah Head	BOM weather station	WS, WD	Hourly
Teralba HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day

PM_{10} - Particulate matter < 10µm
$PM_{2.5}$ - Particulate matter < 2.5µm
TEOM - Tapered Element Oscillating Microbalance (which samples air continuously)
NO_2 - Nitrogen dioxide
SO_2 - Sulfur dioxide
HVAS - High volume air sampler (which samples for a 24-hour period every 6 days)
WS - Wind speed
WD - Wind direction
BOM - Bureau of Meteorology

5 AIR QUALITY CRITERIA

The sections below identify the key pollutants currently being monitored at the Lake Macquarie - Wyong air quality monitoring sites and the applicable air quality criteria.

5.1 Particulate matter

Particulate matter consists of particles of varying size and composition. The total mass of all particles suspended in air is defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

The TSP is defined further into two sub-components. They are PM_{10} particles, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

Table 5-1 summarises the air quality goals that are relevant to particulate pollutants as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW EPA, 2017**).

Table 5-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Criterion
Total suspended particulates (TSP)	Annual	90µg/m^3
Particulate Matter < 10µm (PM_{10})	Annual	25µg/m^3
	24-hour	50µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	Annual	8µg/m^3
	24-hour	25µg/m^3

Source: **NSW EPA, 2017**

5.2 Other air pollutants

Nitrogen dioxide (NO_2) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called nitrogen oxides (NO_x). These gases form when fuel is burned at high temperatures, and mainly originates from motor vehicles, power generators and industrial boilers (**USEPA, 2013**). NO_x may also be generated by blasting activities. It is important to note that when formed, NO_2 is generally a small fraction of the total NO_x generated.

Sulfur dioxide (SO_2) is a colourless gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulfur content of the fuel. SO_2 can have impacts upon human health and the habitability of the environment for flora and fauna. SO_2 emissions are a precursor to acid rain, which can be an issue in the northern hemisphere; however it is not known to be an issue in NSW.

Table 5-2 summarises the air quality goals for NO_2 and SO_2.

Table 5-2: Air quality impact assessment criteria for air pollutants

Pollutant	Averaging period	Criterion
Nitrogen Dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Sulfur Dioxide (SO_2)	10-minute	712µg/m^3
	1-hour	570µg/m^3
	24-hour	228µg/m^3
	Annual	60µg/m^3

Source: **NSW EPA, 2017**

5.3 Summary of applicable criteria for this review

The particulate and gaseous pollutants monitored in the Lake Macquarie – Wyong region have air quality criteria which are averaged over short and long time periods.

As this report looks at an annual period of ambient air quality data, the annual average criteria are applicable along with those averaged over the shorter time periods (1-hour and 24-hours). The SO_2 10-minute average criterion was not included as 10-minute monitoring data are not available.

Table 5-3 summarises the applicable air quality criteria for this review.

Table 5-3: Air quality criteria used in this review

Pollutant	Averaging Period	Concentration
Particulate Matter < 10µm (PM_{10})	24-hour	50µg/m^3
	Annual	25µg/m^3
Particulate Matter < 2.5µm ($PM_{2.5}$)	24-hour	25µg/m^3
	Annual	8µg/m^3
Nitrogen Dioxide (NO_2)	1-hour	246µg/m^3
	Annual	62µg/m^3
Sulfur Dioxide (SO_2)	1-hour	570µg/m^3
	24-hour	228µg/m^3
	Annual	60µg/m^3

6 METEOROLOGICAL MONITORING DATA

Representative wind speed and direction data have been obtained from the Lake Macquarie - Wyong meteorological stations. The data are presented as a series windroses.

For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

Figure 6-1 presents the 2019 annual windroses for Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong. Seasonal windroses for the meteorological stations are presented in **Figure 6-2** and **Figure 6-3**. It is noted that the Marks Point weather station had a large proportion of missing data in 2019, with only 41% data availability.

The annual windroses show that the meteorological stations recorded winds which varied depending on the local influence of environmental features such as terrain, vegetation and buildings.

The meteorological stations generally recorded a higher frequency of winds which originated from the north-easterly and south-easterly quadrants during summer. The recorded wind directions in spring and autumn were more varied, with low wind speeds from common at Wyong, Wyee and Dora Creek. The meteorological stations generally recorded winds which originated from the westerly quadrant during winter.

The Norah Head weather station recorded wind speeds which were generally higher than those recorded at the other stations. This is expected as the Norah Head weather station is located in an unsheltered coastal location that would be largely influenced by sea breezes.

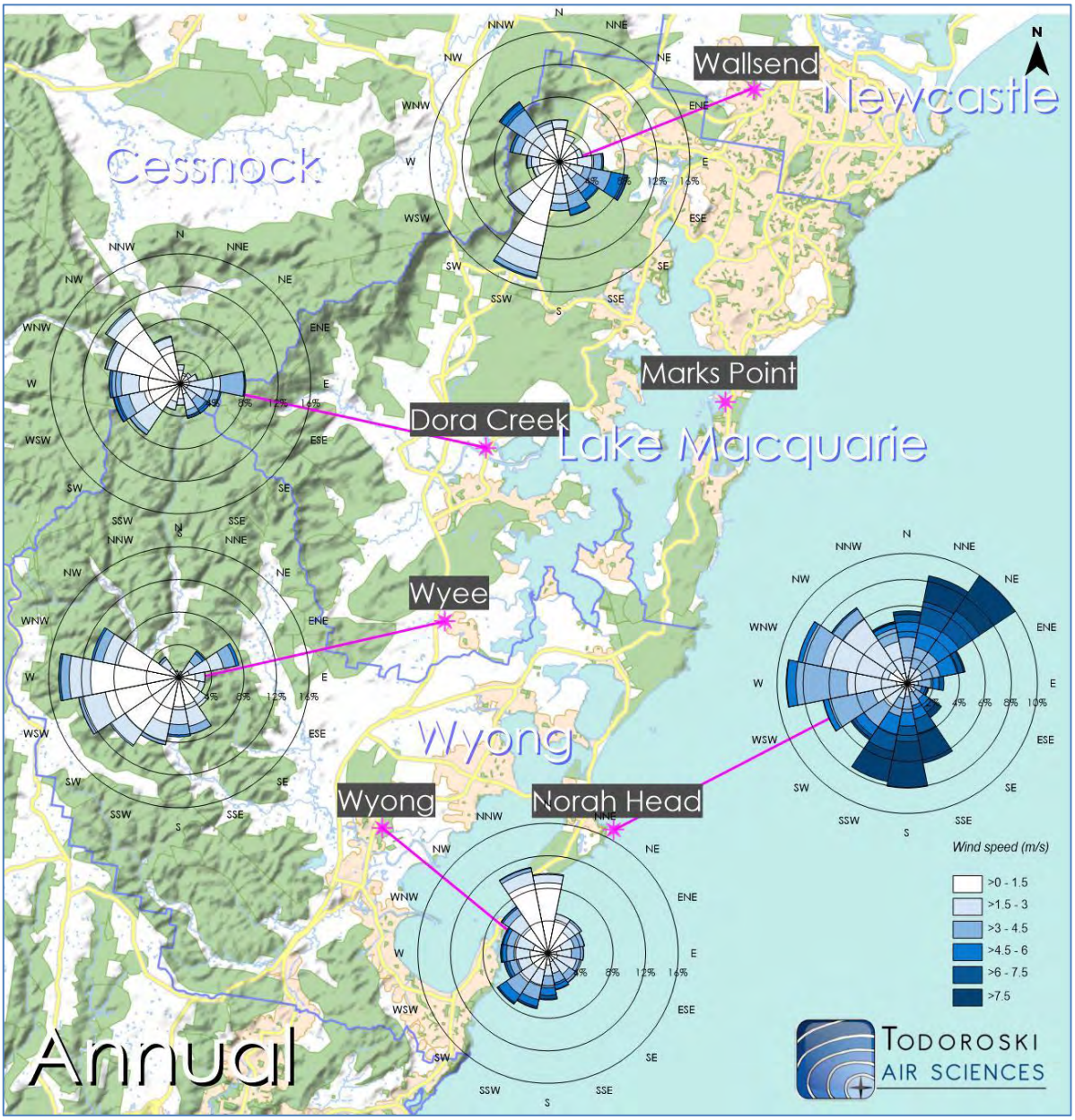

Figure 6-1: Annual 2019 windroses - Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong

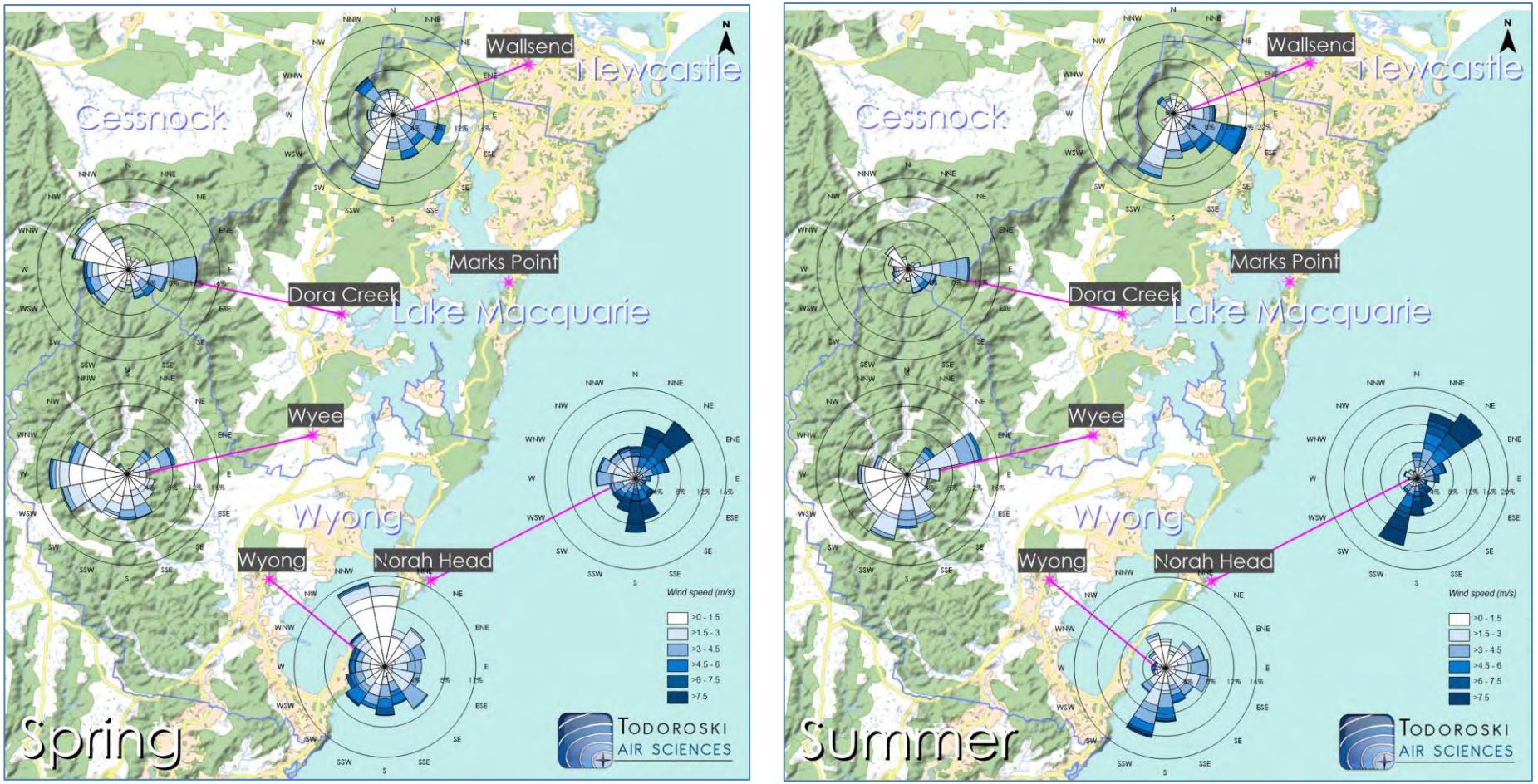

Figure 6-2: Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong windroses – Spring 2019 (left) and Summer 2019 (right)

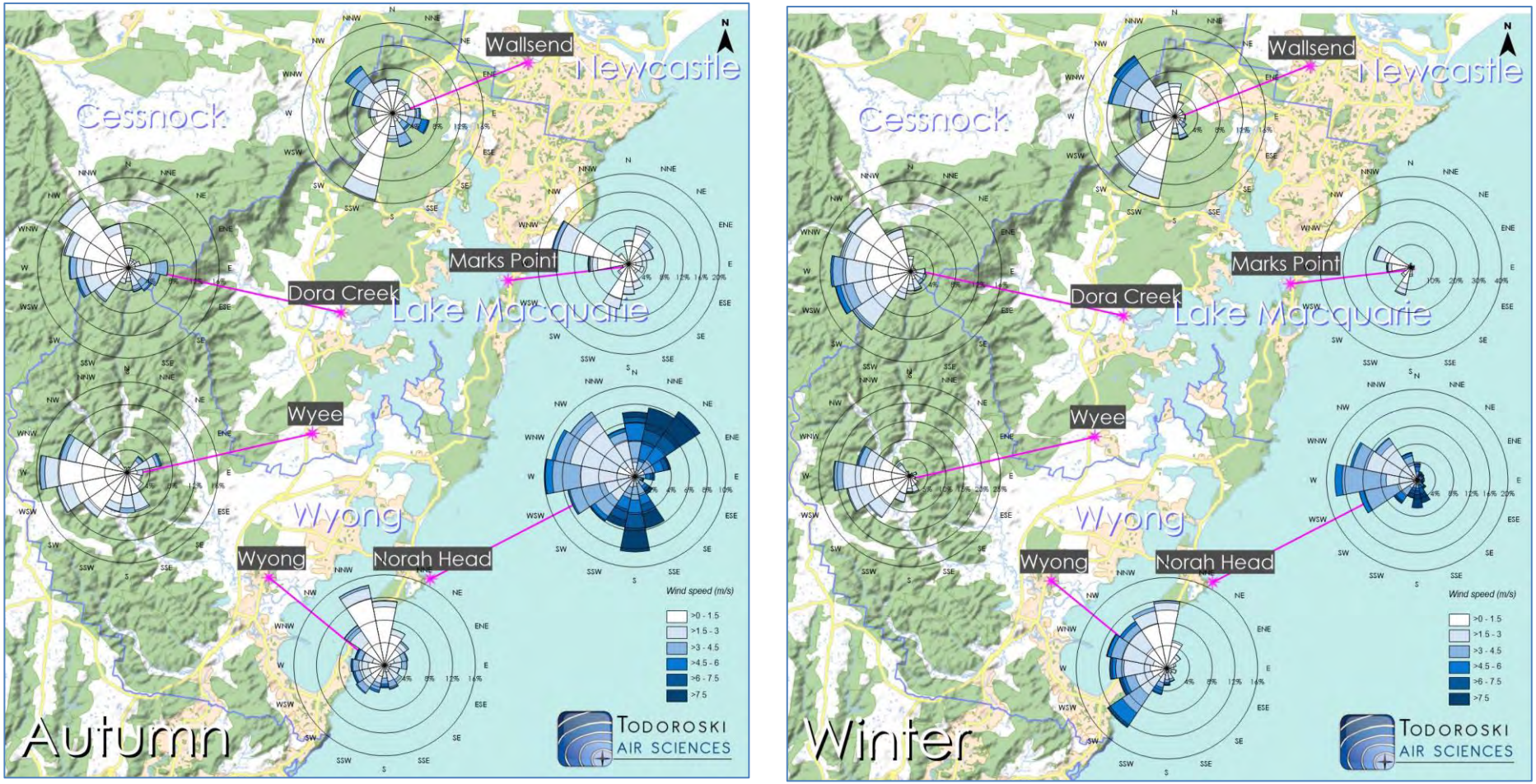

Figure 6-3: Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong windroses – Autumn 2019 (left) and Winter 2019 (right)

7 AMBIENT AIR QUALITY MONITORING DATA

7.1 Preamble

The monitoring data in this report are presented in raw form as provided to Todoroski Air Sciences by Delta Electricity and Origin Energy, or are available publicly on industry and EPA websites.

The 24-hour average data presented in this report have been averaged using the 1-hour average readings. Days which contain less than 75% data (less than 18 hours of 1-hour average data) have not been included in this report.

The annual average data presented in this report have been averaged using the 1-hour average readings for SO_2 and NO_2, and 24-hour average readings for PM_{10} and $PM_{2.5}$. Annual averages with less than 75% data in a calendar quarter have been included but have not been assessed.

All of the monitoring data provided to, and obtained by, Todoroski Air Sciences are presented in this report. The data are shown in the results and Appendices as relevant. 1-hour, 24-hour and annual average data are presented in a graphical format in **Appendix B** and 24-hour average data are presented in tabulated format in **Appendix C** for pollutants with applicable 24-hour average criteria.

Hourly averaged pollutant monitoring data were combined with wind speed and direction data to provide an understanding of the conditions in which high pollutant levels most frequently occur. The data are presented as pollution roses in **Appendix B**. For an example pollution rose, refer to **Figure A-2** in **Appendix A**.

7.2 Analysis of Monitoring Data

Table 7-1 presents a summary of the pollutant levels measured during 2019. The results indicate that PM_{10} and $PM_{2.5}$ monitors recorded levels above the applicable criteria. All NO_2 and SO_2 levels were below the applicable criteria in 2019.

Table 7-1: Maximum and annual average pollutant levels - 2019

Site	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2
	Maximum 1-hour average (µg/m³)		Maximum 24-hour average (µg/m³)			Annual average (µg/m³)			
	Air Quality Impact Criteria								
	570	**246**	**50**	**25**	**228**	**25**	**8**	**60**	**62**
Wallsend	142.8	86.2	**127.9**	**108.3**	24.0	22.9	**10.4**	4.9	14.3
Wyong	174.2	73.9	**128.4**	**202.1**	18.1	21.1	**10.5**	1.9	7.8
Dora Creek	94.7	107.8	-	-	17.2	-	-	3.1*	19.3
Marks Point	96.7	72.1	-	-	33.6	-	-	3.4*	11.1*
Wyee	262.9	93.2	-	**208.3**	45.8	-	**9.9**	3.1	12.1
Teralba HVAS	-	-	**150.0**	-	-	**26.9**	-	-	-

- Not applicable

* Less than 75% data available in 1st quarter of 2019

7.3 PM_{10}

Figure 7-1 presents all of the 24-hour average PM_{10} monitoring results recorded in the Lake Macquarie - Wyong region in 2019.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, PM_{10} levels were generally good until September 2019, however all monitors recorded a large number of poor to hazardous levels between October and December due to widespread bushfires in NSW. The Wyong monitor recorded nine days of poor levels, seven days of very poor levels and three day of hazardous levels. The Wallsend monitor recorded 15 days of poor levels, four days of very poor levels and two days of hazardous levels. The Teralba monitor recorded four days of poor levels, one day of very poor levels and three days of hazardous levels.

The 24-hour average PM_{10} data recorded at the Lake Macquarie - Wyong monitoring sites were above the PM_{10} criteria of 50 µg/m³ for 21 days at the Wallsend monitor, 19 days at the Wyong monitor and eight days at the Teralba monitor.

Figure B-1 to **Figure B-2** in **Appendix B** present the 1-hour average, 24-hour average and annual average PM_{10} data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM_{10} levels and these 1-hour results are not intended to be compared with the PM_{10} criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average PM_{10} levels will fluctuate more significantly than 24-hour average PM_{10} levels.

Figure B-3 presents pollution roses of the PM_{10} monitoring data collected by the Wallsend and Wyong monitoring sites in 2019. The figure shows that the impact of the bushfires was evident in the data. The wind conditions in which bushfire smoke was recorded by the monitors were varied, which is likely due to the long range transport of the smoke, the difference in local and large-scale wind patterns and the varied location of the fires.

7.4 $PM_{2.5}$

Figure 7-2 presents all of the 24-hour average $PM_{2.5}$ monitoring data recorded in the Lake Macquarie - Wyong region in 2019.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate that $PM_{2.5}$ levels were generally good until September 2019, however all monitors recorded a large number of poor to hazardous levels between October and December due to widespread bushfires in NSW. The Wyong monitor recorded 11 days of poor levels, four days of very poor levels and eight day of hazardous levels. The Wallsend monitor recorded seven days of poor levels, eight days of very poor levels and four days of hazardous levels. The Wyee monitor recorded 12 days of poor levels, two days of very poor levels and five days of hazardous levels.

The 24-hour average data recorded at the Lake Macquarie - Wyong monitoring sites were above the criterion of 25µg/m^3 for 19 days at the Wallsend monitor, 23 days at the Wyong monitor and 19 days at the Wyee monitor in 2019.

Figure B-4 to **Figure B-6** in **Appendix B** present the 1-hour average, 24-hour average and annual average $PM_{2.5}$ data in graphical form for each individual site. There is no criterion that applies to 1-hour average $PM_{2.5}$ levels and these 1-hour results are not intended to be compared with the $PM_{2.5}$ criterion. It is a normal occurrence, and it is expected that in the normal environment 1-hour average $PM_{2.5}$ levels will fluctuate more significantly than 24-hour average $PM_{2.5}$ levels.

We note that the monitoring sites recorded on occasion periods in which $PM_{2.5}$ levels were less than zero. In some situations the concentration of the pollutant being measured may be very close to zero, in which case the measured value (after adjusting for drift of zero and span and any other corrections) may be less than the measurement limit of detection (**NEPC, 2001**), and in these circumstances the output may be negative.

The monitors may also record short term positive or negative values due to instrument faults, the presence of moisture within the instrument or volatile matter (which can register as a solid mass at first, but then evaporates, registering negative mass at a later time).

Figure B-7 to **Figure B-8** present pollution roses of the $PM_{2.5}$ monitoring data collected by the Wallsend, Wyong and Wyee monitoring sites in 2019. The wind conditions in which bushfire smoke was recorded by the monitors were varied, which is likely due to the long range transport of the smoke, the difference in local and large-scale wind patterns and the varied location of the fires.

7.5 NO_2

Figure 7-3 presents the 1-hour average NO_2 monitoring data recorded in the Lake Macquarie - Wyong region in 2019.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the measured levels of NO_2 were very good or good at all monitors at all times. All 1-hour average and annual average data were below the applicable criteria in 2019.

Figure B-9 to **Figure B-11** present pollution roses of the NO_2 monitoring data collected by the monitoring sites in 2019.

7.6 SO_2

Figure 7-4 and **Figure 7-5** present the 1-hour average and 24-hour average SO_2 monitoring data recorded in the Lake Macquarie - Wyong region in 2019 respectively.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the SO_2 levels were very good or good at all monitors at all times. All 1-hour average and annual average data were below the applicable criteria in 2019.

Figure B-12 to **Figure B-14** present pollution roses of the SO_2 monitoring data collected by the monitoring sites in 2019. It is noted that due to limited meteorological data availability at the Marks Point weather station, the pollution roses for Marks Point only represent approximately 40% of the year.

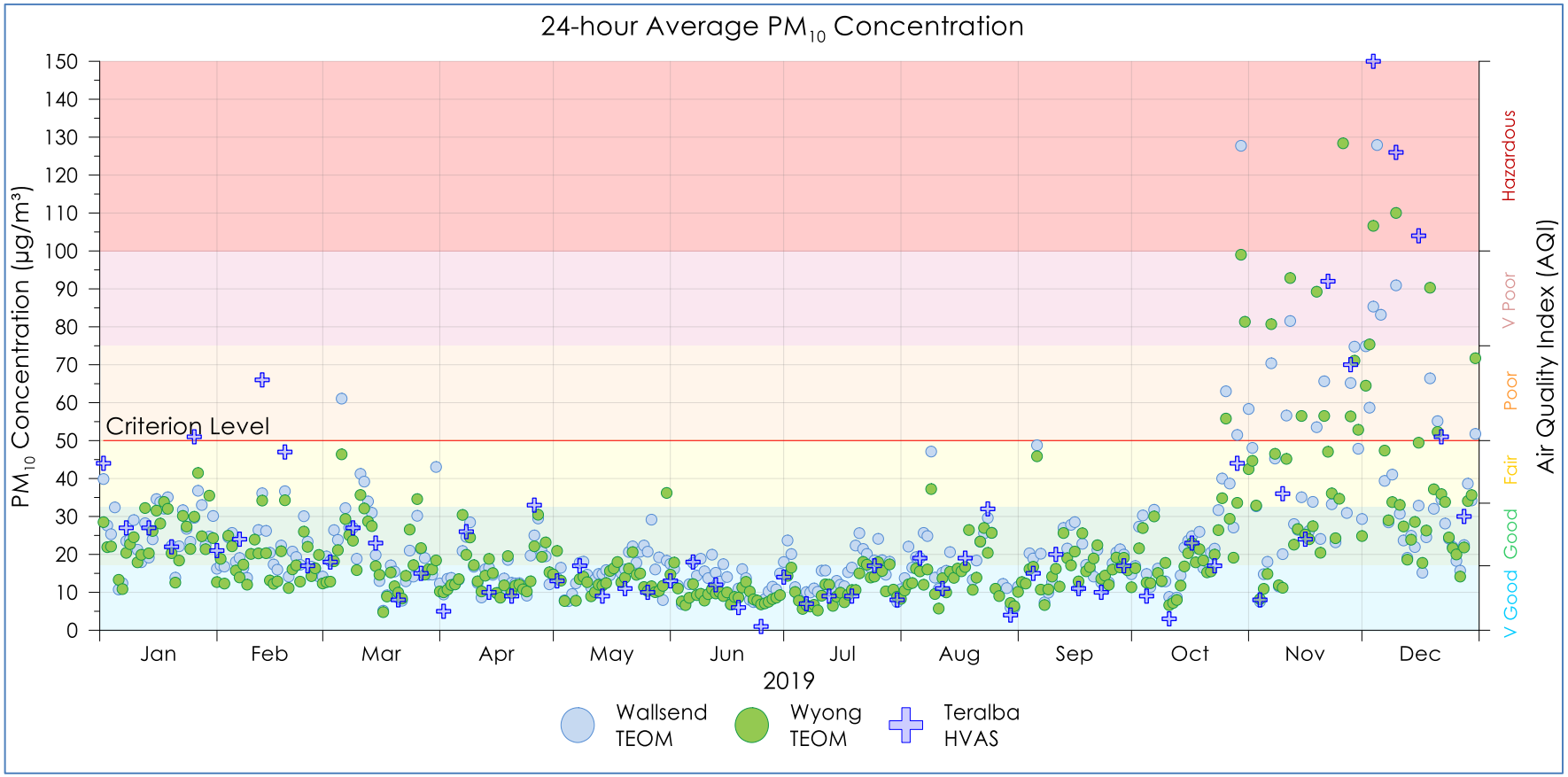

Figure 7-1: Lake Macquarie - Wyong 24-hour average PM_{10} levels – 2019

The recorded PM_{10} levels were generally good in 2019, however all monitors recorded a large number of poor to hazardous levels between October and December due to widespread bushfires in NSW. PM_{10} levels were above the criterion of 50µg/m^3 for 21 days at the Wallsend monitor, 19 days at the Wyong monitor and eight days at the Teralba monitor in 2019.

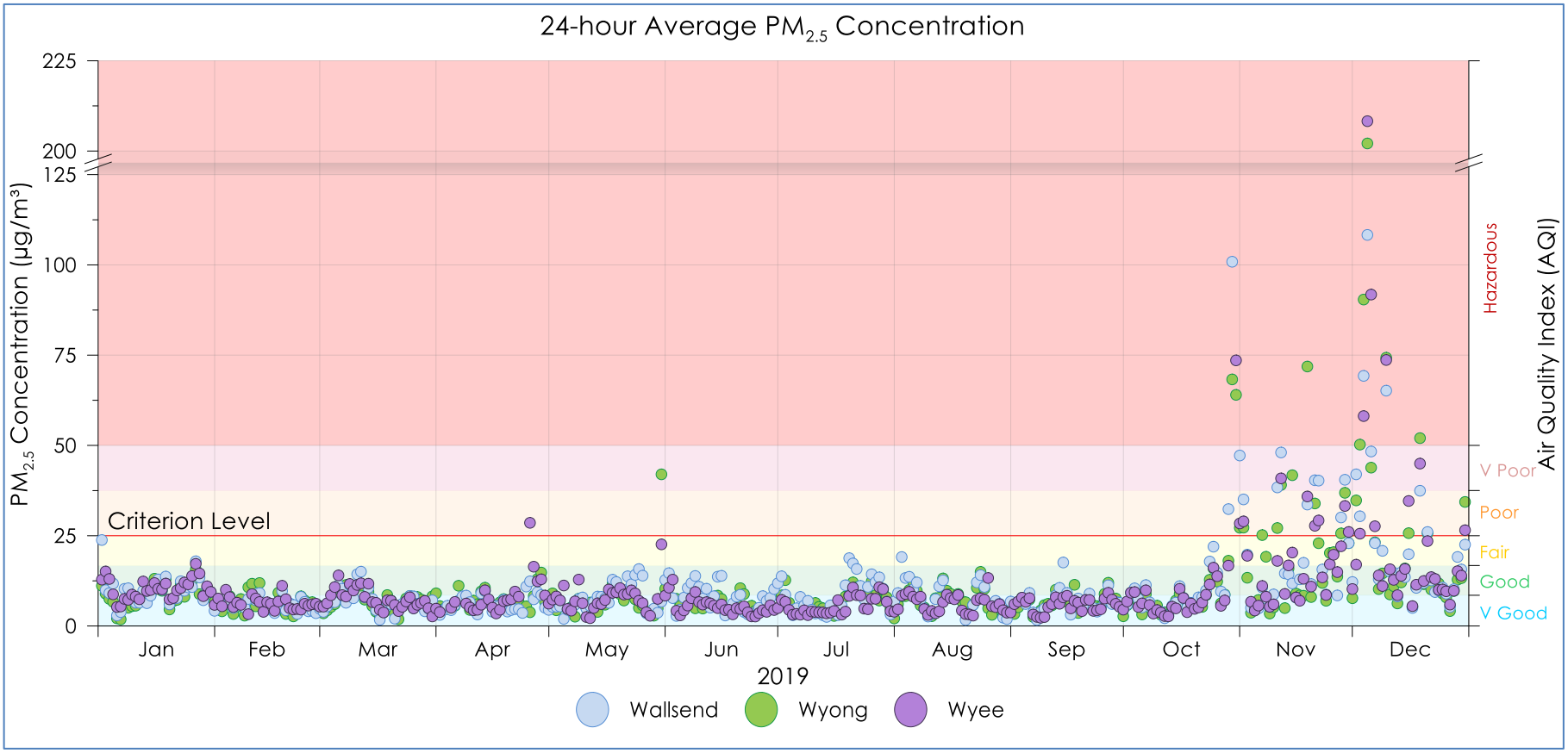

Figure 7-2: Lake Macquarie - Wyong 24-hour average $PM_{2.5}$ levels – 2019

The recorded $PM_{2.5}$ levels were generally good in 2019, however all monitors recorded a large number of poor to hazardous levels between October and December due to widespread bushfires in NSW. $PM_{2.5}$ levels were above the criterion of 25µg/m^3 for 19 days at the Wallsend monitor, 23 days at the Wyong monitor and 19 days at the Wyee monitor in 2019.

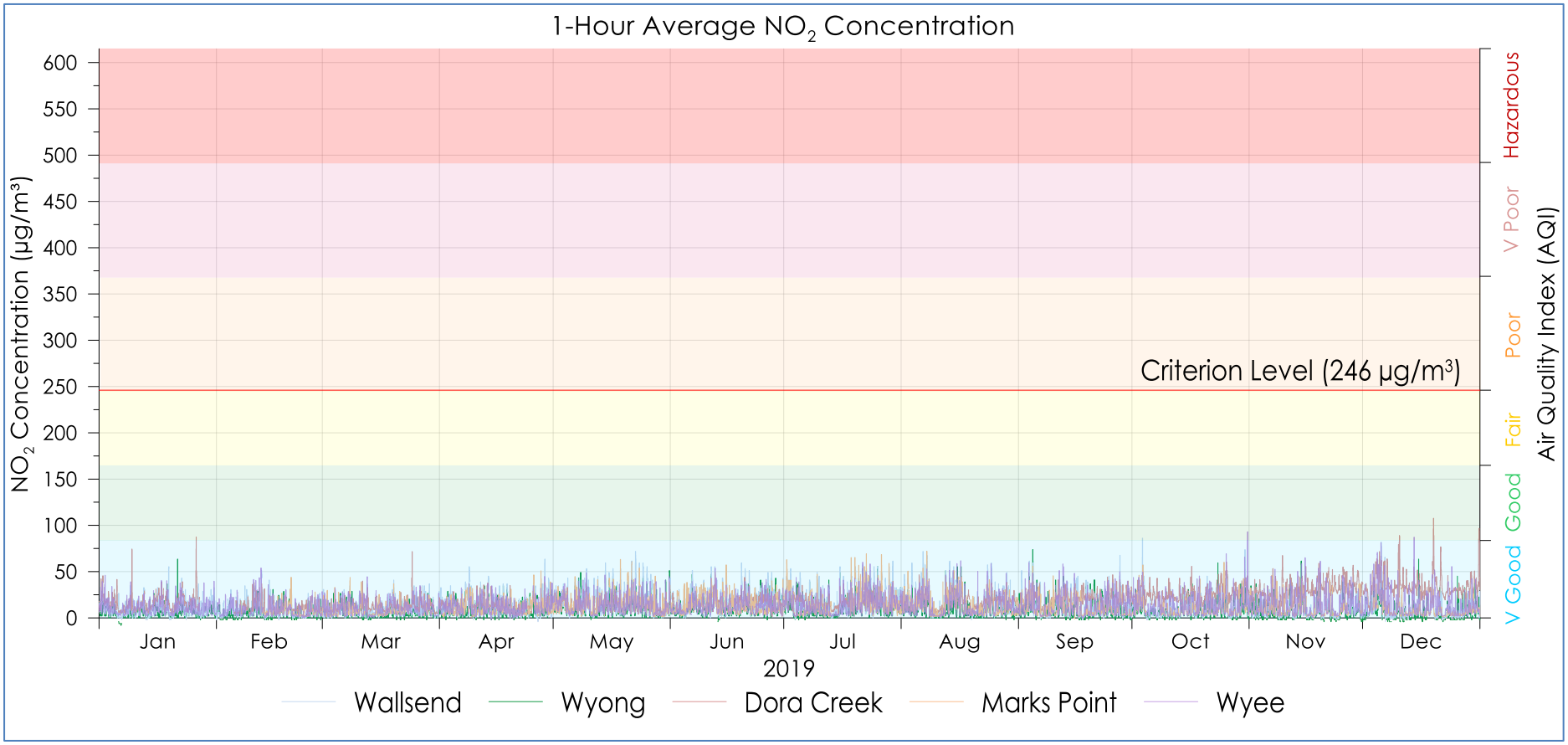

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2019

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average NO_2 criterion level of 246µg/m^3 in 2019. Measured levels of NO_2 were very good or good at all monitors at all times.

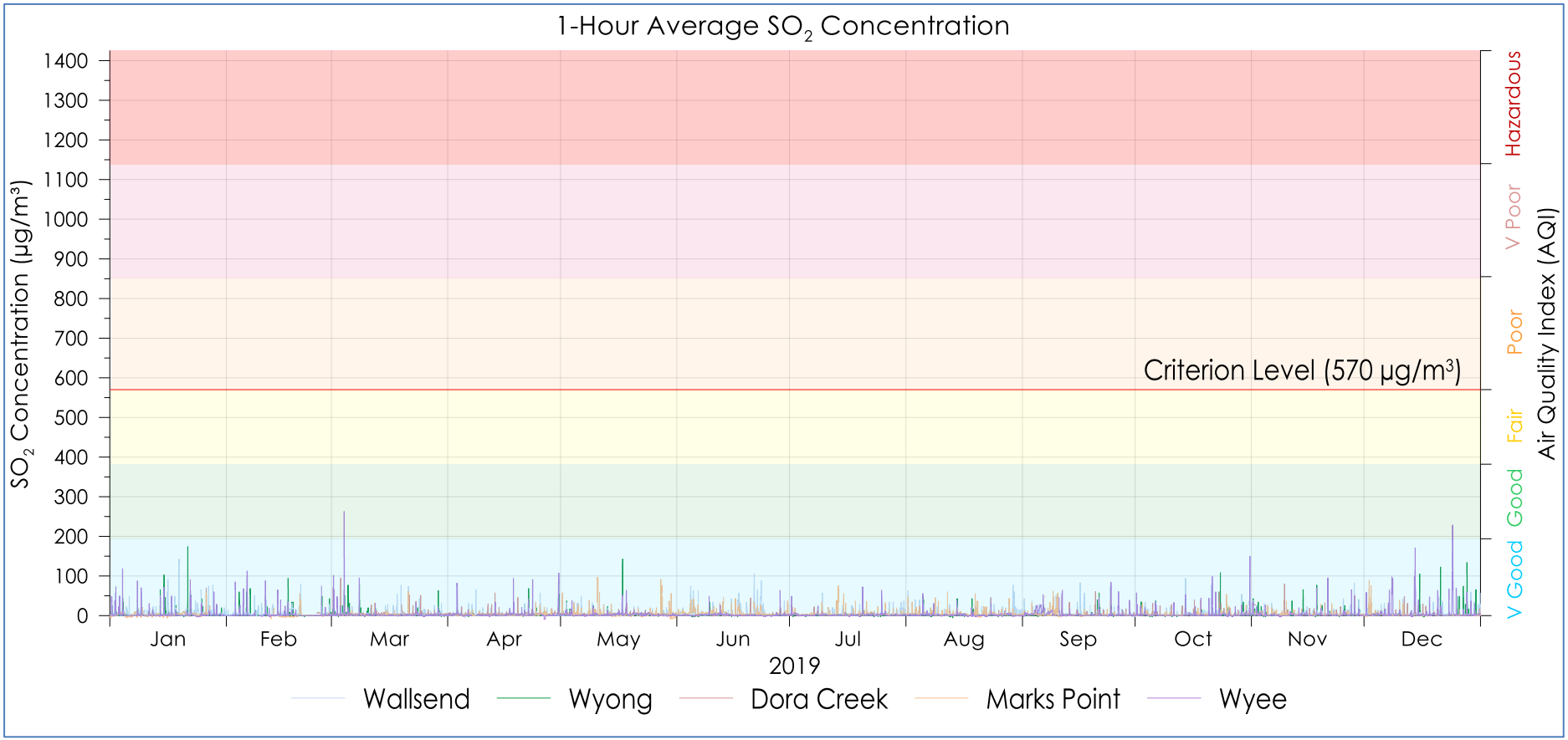

Figure 7-4: Lake Macquarie - Wyong 1-hour average SO_2 levels – 2019

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average SO_2 criterion level of 570µg/m^3 in 2019. Measured levels of SO_2 were very good or good at all monitors at all times in 2019.

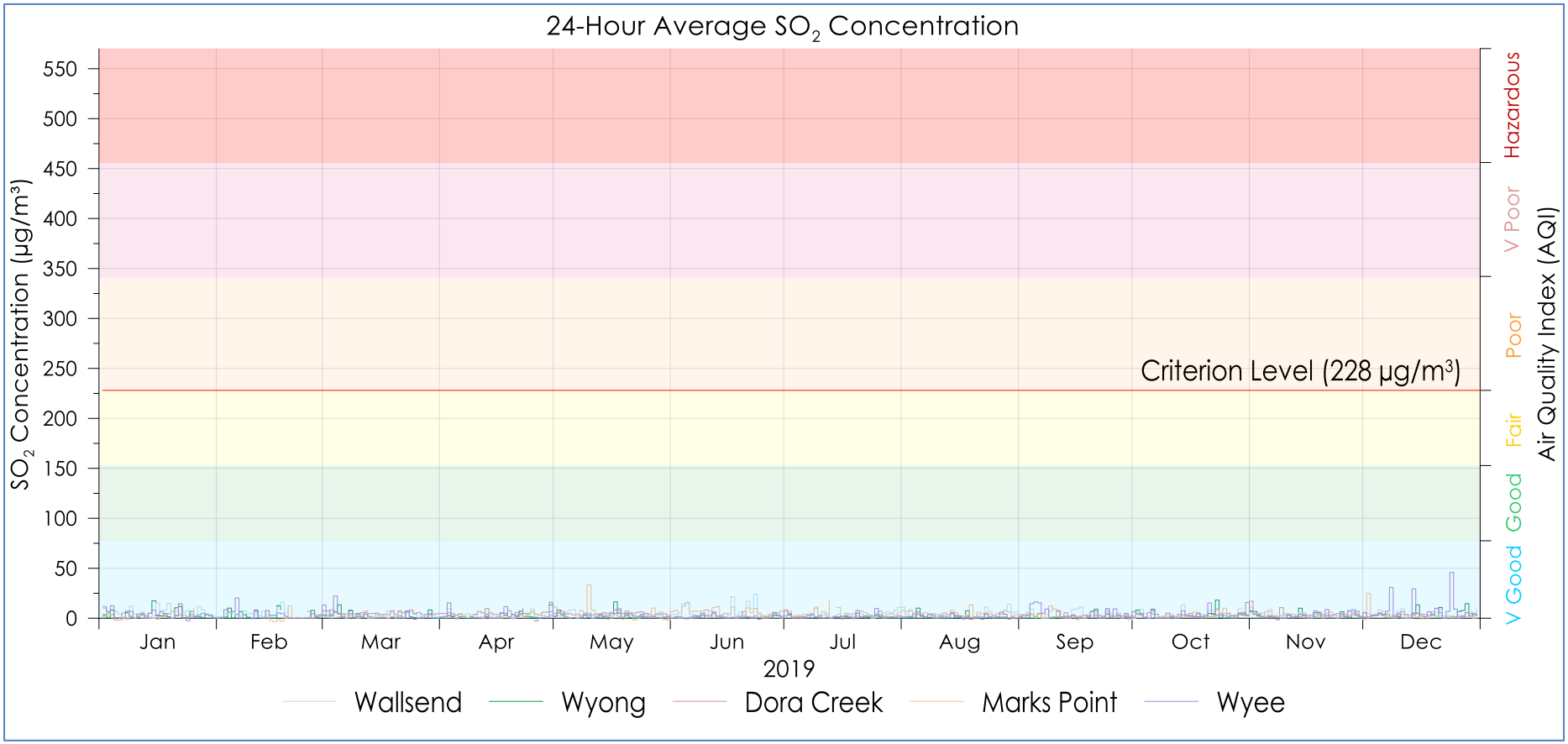

Figure 7-5: Lake Macquarie - Wyong 24-hour average SO_2 levels – 2019

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average SO_2 criterion level of 228µg/m^3 in 2019. Measured levels of SO_2 were very good at all monitors at all times in 2019.

8 ANALYSIS OF ELEVATED POLLUTANT LEVELS

There were 33 days with elevated levels above the applicable 24-hour average criteria in 2019. A full list of these days is presented in **Table 8-1** and a summary of the total number of days with recorded levels above the applicable criteria is presented in **Figure 8-1**.

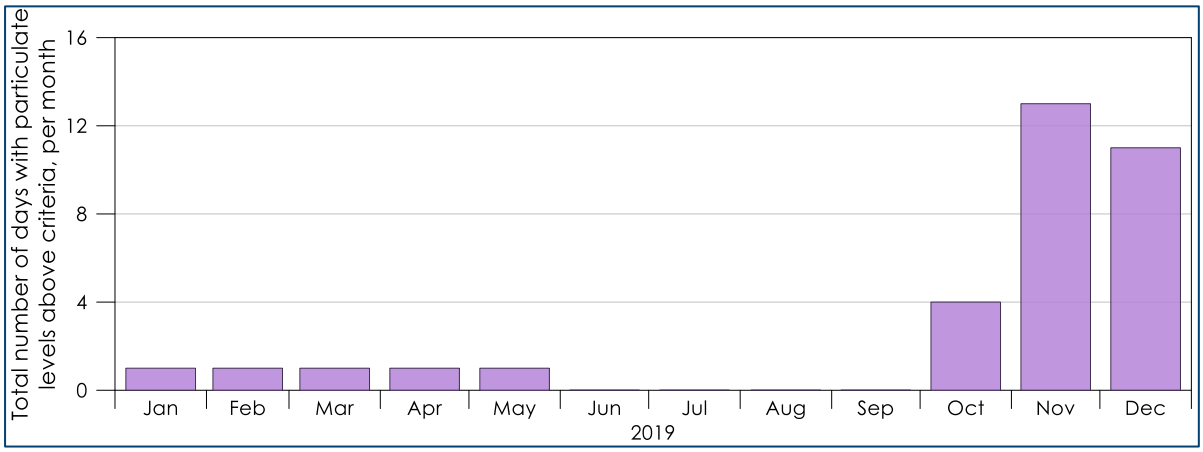

Figure 8-1: Total number of days with particulate levels above applicable criteria per month

Table 8-1: List of days with elevated levels above the applicable criteria in 2019

Date	Monitor	Likely Cause
26/01/2019	Teralba PM_{10}	Bushfire smoke
13/02/2019	Teralba PM_{10}	Dust storm
6/03/2019	Wallsend PM_{10}	Regional event
26/04/2019	Wyee $PM_{2.5}$	Local source
31/05/2019	Wyong $PM_{2.5}$	Bushfire smoke
26/10/2019	Wallsend PM_{10}, Wyong PM_{10}	Bushfire smoke
29/10/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$	Bushfire smoke
30/10/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$	Bushfire smoke
31/10/2019	Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
1/11/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
2/11/2019	Wallsend $PM_{2.5}$, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
7/11/2019	Wallsend PM_{10}, Wyong PM_{10}, Wyong $PM_{2.5}$	Dust storm and bushfire smoke
11/11/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong $PM_{2.5}$	Bushfire smoke
12/11/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
15/11/2019	Wyong PM_{10}, Wyong $PM_{2.5}$	Bushfire smoke
19/11/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
21/11/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
22/11/2019	Wallsend $PM_{2.5}$, Wyee $PM_{2.5}$, Teralba PM_{10}	Bushfire smoke
26/11/2019	Wyong PM_{10}	Dust Storm
28/11/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Teralba PM_{10}	Bushfire smoke
29/11/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
30/11/2019	Wyong PM_{10}, Wyee $PM_{2.5}$	Bushfire smoke
2/12/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$	Bushfire smoke

Date	Monitor	Likely Cause
3/12/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
4/12/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$, Teralba PM_{10}	Bushfire smoke
5/12/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
6/12/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
7/12/2019	Wyee $PM_{2.5}$	Bushfire smoke
10/12/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$, Teralba PM_{10}	Bushfire smoke
16/12/2019	Wyong $PM_{2.5}$, Wyee $PM_{2.5}$, Teralba PM_{10}	Bushfire smoke
19/12/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke
21/12/2019	Wallsend PM_{10}, Wallsend $PM_{2.5}$, Wyong PM_{10}, Wyong $PM_{2.5}$	Bushfire smoke
31/12/2019	Wallsend PM_{10}, Wyong PM_{10}, Wyong $PM_{2.5}$, Wyee $PM_{2.5}$	Bushfire smoke

8.1 26 January 2019 – Teralba PM_{10}

Table 8-2 presents a summary of the 24-hour average PM_{10} and $PM_{2.5}$ levels for the Lake Macquarie – Wyong, Upper Hunter and Lower Hunter monitoring stations 26 January 2019. The levels recorded at the Teralba PM_{10} HVAS monitor were above the criterion of 50µg/m^3 on this day. Elevated PM_{10} levels were also recorded at the Newcastle and Stockton PM_{10} monitors.

Table 8-2: Measured 24-hour average particulate data – 26 January 2019

Region	Monitor	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Lake Macquarie - Wyong	Wyee	-	13.8
	Wyong	29.9	12.5
	Wallsend	29.6	10.8
	Teralba	**51.0**	-
Newcastle - Lower Hunter	Carrington	46.8	12
	Stockton	**64.9**	13.8
	Newcastle	**58.4**	18.7
	Mayfield	42.1	13.7
	Beresfield	30.4	13.8
Upper Hunter	Muswellbrook	41.4	11.8
	Singleton	25.5	12.8
	Maison Dieu	39.1	-
	Camberwell	38.1	11.1
	Singleton NW	37.2	-
	Mount Thorley	31.7	-
	Bulga	32.4	-
	Muswellbrook NW	41.7	-
	Wybong	34	-
	Aberdeen	34.5	-
	Singleton South	32.3	-
	Jerrys Plains	35	-
	Warkworth	32.1	-
	Merriwa	27.7	-

A review of satellite imagery on this day, presented in **Figure 8-2,** shows what appears to be visible smoke which may have impacted the Lake Macquarie – Wyong area. The origin of the smoke (from the red bushfire hotspots) is unclear.

Operational notes from the nearby Metromix quarry indicate that the quarry was not in operation as 26 January 2019 was a public holiday (Australia Day). It is considered likely that the cause of the elevated 24-hour average level recorded at the Teralba HVAS on this day was due to smoke.

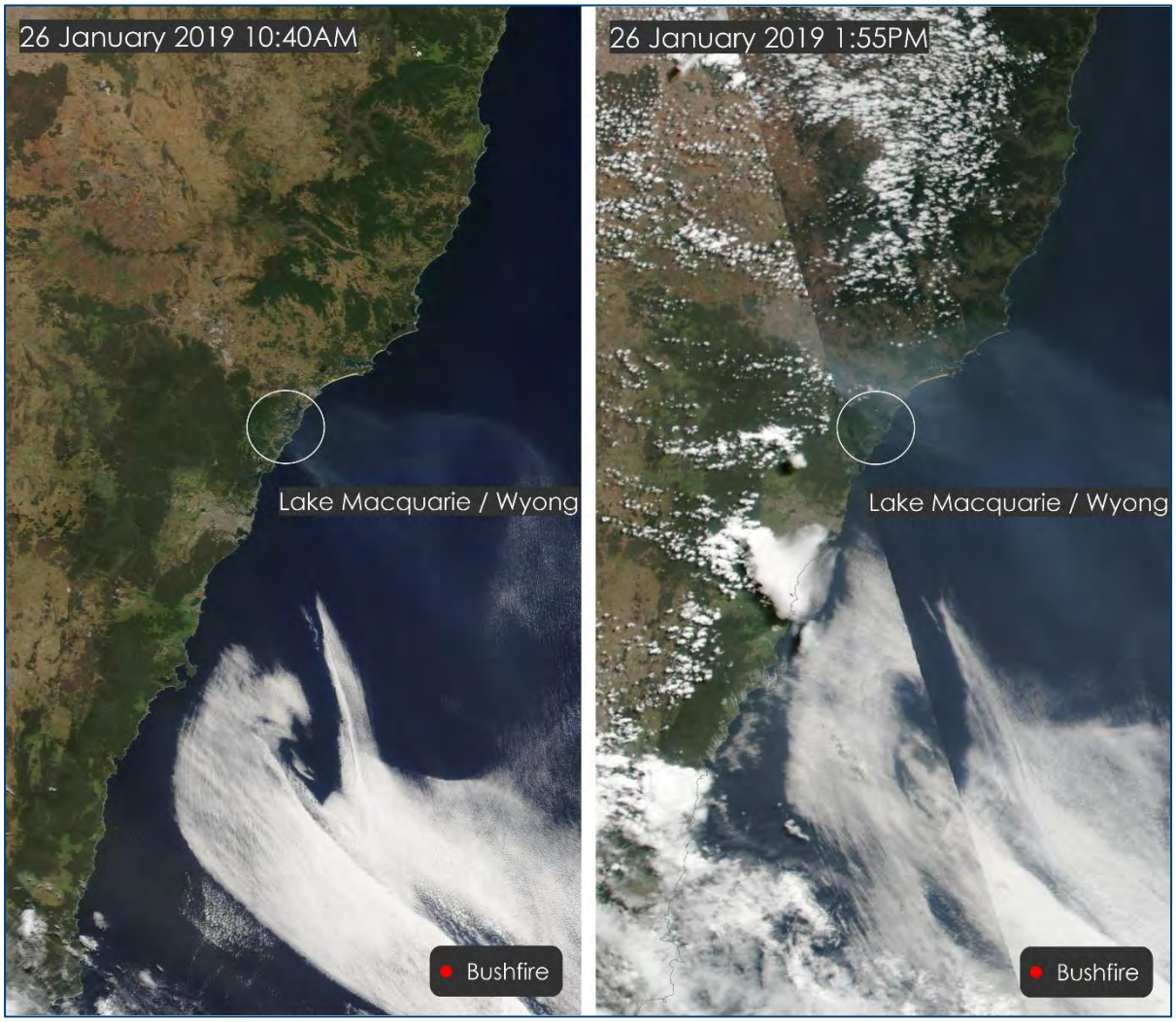

Figure 8-2: Satellite imagery of smoke – 26 January 2019

8.2 13 February 2019 – Teralba PM_{10}

Table 8-3 presents a summary of the 24-hour average PM_{10} and $PM_{2.5}$ levels for the Lake Macquarie – Wyong, Upper Hunter and Lower Hunter monitoring stations on 13 February 2019. The levels recorded at the Teralba monitor, as well as the majority of the Upper Hunter PM_{10} monitors, were above the criterion of 50µg/m^3.

Table 8-3: Measured 24-hour average particulate data – 13 February 2019

Region	Monitor	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)
Lake Macquarie - Wyong	Wyee	-	6.6
	Wyong	34.2	11.9
	Wallsend	36.1	9.1
	Teralba	**66.0**	-
Newcastle - Lower Hunter	Carrington	41.8	9.1
	Stockton	48.7	10.1
	Newcastle	42.7	10.3
	Mayfield	46.7	11
	Beresfield	41.6	12
Upper Hunter	Muswellbrook	**93.2**	11.9
	Singleton	47.5	9.3
	Maison Dieu	**69**	-
	Camberwell	**67.5**	13.2
	Singleton NW	**73**	-
	Mount Thorley	**75.3**	-
	Bulga	**59.3**	-
	Muswellbrook NW	**101.5**	-
	Wybong	**99.6**	-
	Aberdeen	**94.2**	-
	Singleton South	**53.8**	-
	Jerrys Plains	**126.8**	-
	Warkworth	**59**	-
	Merriwa	**128.2**	-

A review of satellite imagery on this 13 February 2019, presented in **Figure 8-3,** shows a significant dust storm which impacted the Lake Macquarie – Wyong region, and was the likely cause of the elevated 24-hour average PM_{10} level recorded at the Teralba HVAS monitor on this day.

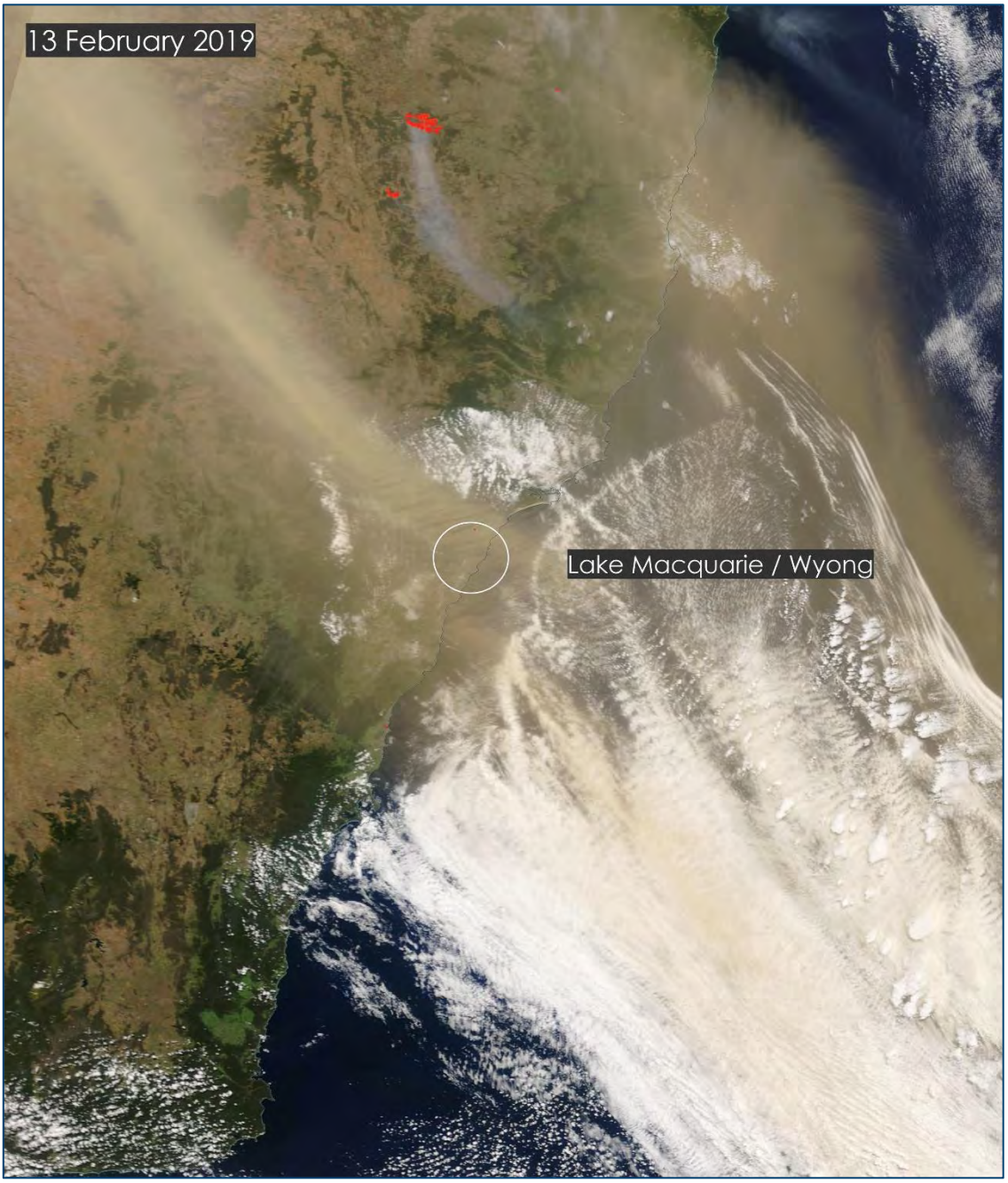

Figure 8-3: Satellite imagery of a dust storm – 13 February 2019

8.3 6 March 2019 – Wallsend PM_{10}

Table 8-4 presents a summary of the 24-hour average PM_{10} and $PM_{2.5}$ levels for the Lake Macquarie – Wyong, Upper Hunter and Lower Hunter monitoring stations on 6 March 2019. The levels recorded at the Wallsend monitor, as well as all Upper Hunter and Lower Hunter PM_{10} monitors, were above the criterion of 50µg/m^3. The Wyong monitor also recorded relatively high PM_{10} levels however the 24-hour average result was below the criterion.

Table 8-4: Measured 24-hour average particulate data – 6 March 2019

Region	Monitor	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)
Lake Macquarie - Wyong	Wyee	-	14.0
	Wyong	46.4	7.5
	Wallsend	**61.1**	11.3
	Teralba	-	-
Newcastle - Lower Hunter	Carrington	**65.4**	14.7
	Stockton	**77.7**	12.7
	Newcastle	**62**	12.9
	Mayfield	**63.3**	-
	Beresfield	**53.7**	12.4
Upper Hunter	Muswellbrook	**56.5**	9.2
	Singleton	**51.8**	9.5
	Maison Dieu	**97.6**	-
	Camberwell	**96.4**	12.5
	Singleton NW	**80.8**	-
	Mount Thorley	**90.3**	-
	Bulga	**61.3**	-
	Muswellbrook NW	**91.1**	-
	Wybong	**87.9**	-
	Aberdeen	**63.5**	-
	Singleton South	**57.9**	-
	Jerrys Plains	**99.3**	-
	Warkworth	**74.9**	-
	Merriwa	**93.5**	-

Figure 8-4 presents a plot of the 1-hour average PM_{10}, wind speed and wind direction data recorded at the Wallsend monitoring site on 6 March 2019. The data show that elevated PM_{10} levels occurred from approximately 8:00am to 5:00pm under wind speeds of approximately 4m/s from the northwest.

A review of satellite imagery on this day did not indicate the presence of dust storms or bushfires in the vicinity of the Lake Macquarie – Wyong area, however the imagery was largely obscured by cloud cover.

Given the similar trends in PM_{10} data recorded by both the Wyong and Wallsend monitors, and the widespread elevated levels in the Upper and Lower Hunter regions, it is likely that the elevated levels recorded at the Wallsend monitor were caused by a regional dust event.

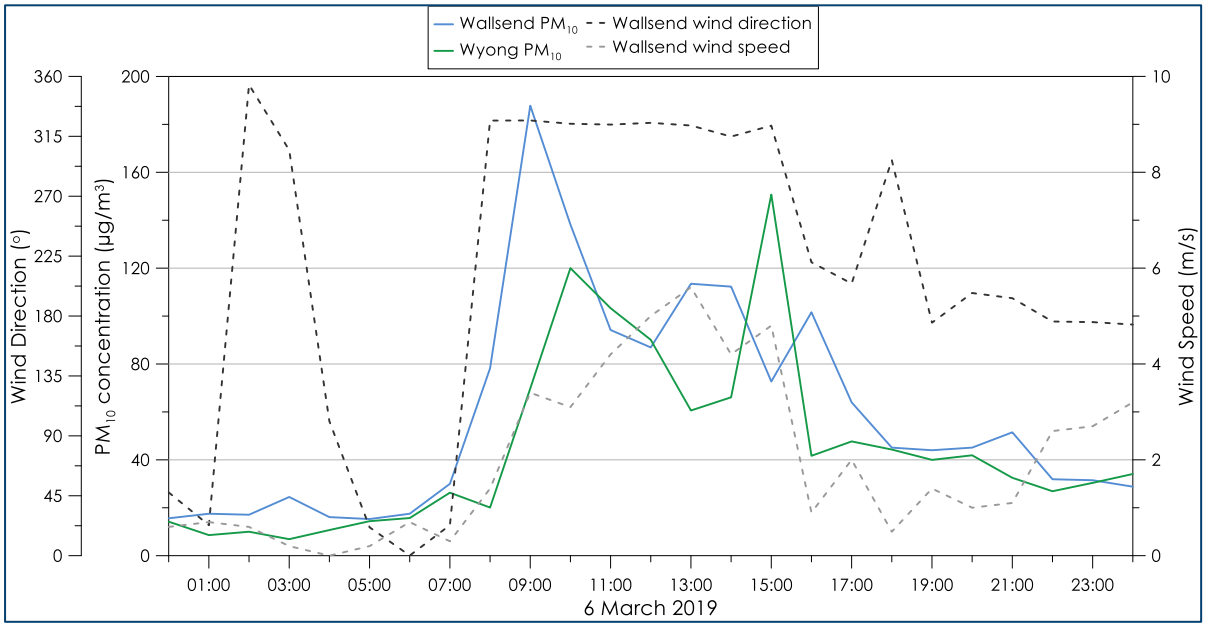

Figure 8-4: Analysis of Wallsend monitoring data on 6 March 2019

8.4 26 April 2019 – Wyee $PM_{2.5}$

Table 8-5 presents a summary of the 24-hour average PM_{10} and $PM_{2.5}$ levels for the Lake Macquarie - Wyong monitoring stations on 26 April 2019. The levels recorded at the Wallsend and Wyong DPIE stations were significantly lower than the levels recorded at the Wyee monitor on this day.

Table 8-5: Measured 24-hour average particulate data – 26 April 2019

Monitor	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)
Wyee	-	**28.6**
Wyong	22.1	3.8
Wallsend	25.0	12.4
Teralba	33.0	-

Figure 8-5 presents a plot of the 1-hour average $PM_{2.5}$, wind speed and wind direction data recorded at the Wyee monitoring site on 26 April 2019. The data show that elevated $PM_{2.5}$ levels occurred from approximately 2:00pm to 7:00pm under wind speeds of approximately 2m/s from the west and southwest directions. After 7:00pm there were no data available from the Wyee monitoring site.

A review of satellite imagery on this day did not indicate the presence of dust storms or bushfires in the vicinity of the Lake Macquarie – Wyong area.

Given the recorded low levels by the other monitoring sites on this day, the impact at the Wyee monitor on this day was likely attributable to a localised source to the west/ southwest of the monitor.

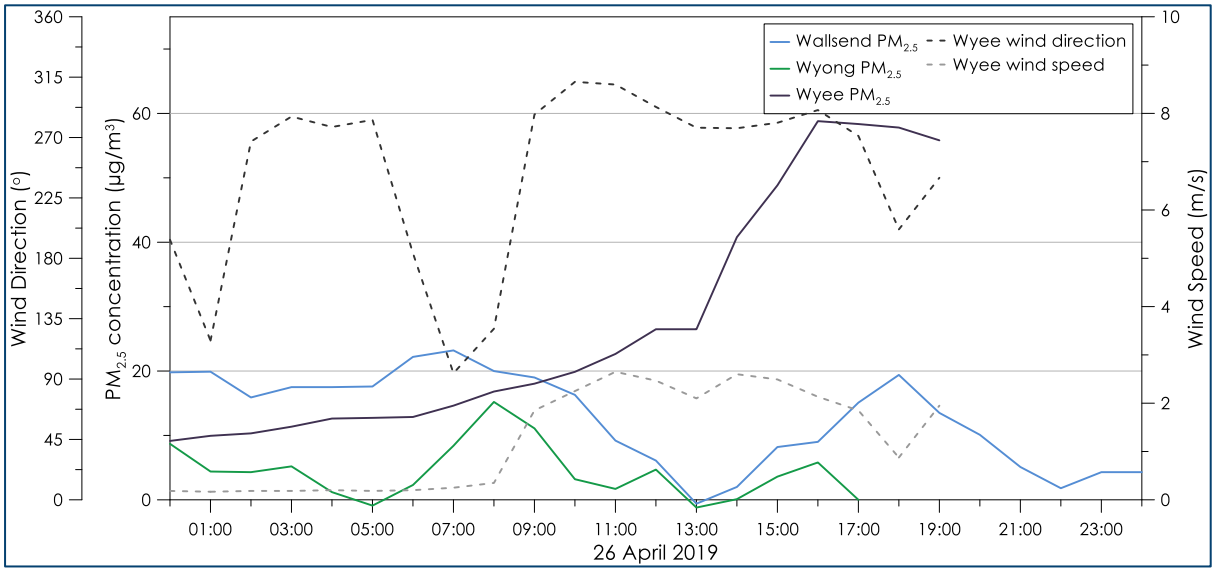

Figure 8-5: Analysis of Wyee monitoring data on 26 April 2019

8.5 31 May 2019 – Wyong $PM_{2.5}$

Table 8-6 presents a summary of the 24-hour average PM_{10} and $PM_{2.5}$ levels for the Lake Macquarie - Wyong monitoring stations on 31 May 2019. The data show that the Wyong monitor recorded a 24-hour average $PM_{2.5}$ level of 42µg/m^3, which was above the criterion of 25µg/m^3, and higher than the recorded PM_{10} level of 36µg/m^3. $PM_{2.5}$ is a subset of PM_{10} and concentrations of $PM_{2.5}$ cannot be higher than PM_{10}. However in this case the $PM_{2.5}$ and PM_{10} measurements at Wyong are taken by separate monitors with different measurement technologies (TEOM for PM_{10} and BAM for $PM_{2.5}$), which can lead to marginally different results as the instruments may react differently to certain types of particles or conditions.

Table 8-6: Measured 24-hour average particulate data – 31 May 2019

Monitor	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Wyee	-	22.6
Wyong	36.2	**42.0**
Wallsend	18.3	6.8
Teralba	-	-

Figure 8-6 presents a plot of the 1-hour average particulate, wind speed and wind direction data recorded at the Wyong monitoring site on 31 May 2019. The data show that elevated PM_{10} and $PM_{2.5}$ levels occurred from approximately 1:00am to 3:00pm under wind speeds of approximately 1-2m/s from the west.

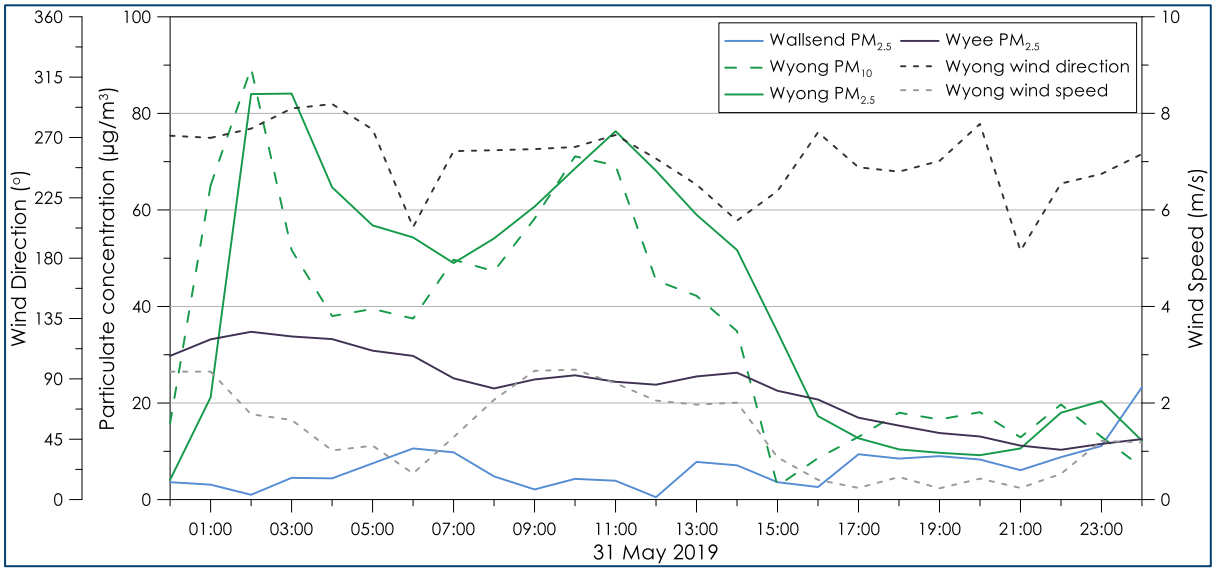

Figure 8-6: Analysis of Wyong monitoring data on 31 May 2019

A review of satellite imagery on this day, presented in **Figure 8-7,** shows a smoke plume which likely impacted the Lake Macquarie – Wyong area from a fire to the west. Given the high proportion of $PM_{2.5}$ to PM_{10} recorded by the Wyong monitors (a typical signature of smoke) and the presence of smoke from the fire to the west, it is likely that the elevated 24-hour average $PM_{2.5}$ level recorded at Wyong on this day was caused by bushfire (or hazard reduction burn) smoke.

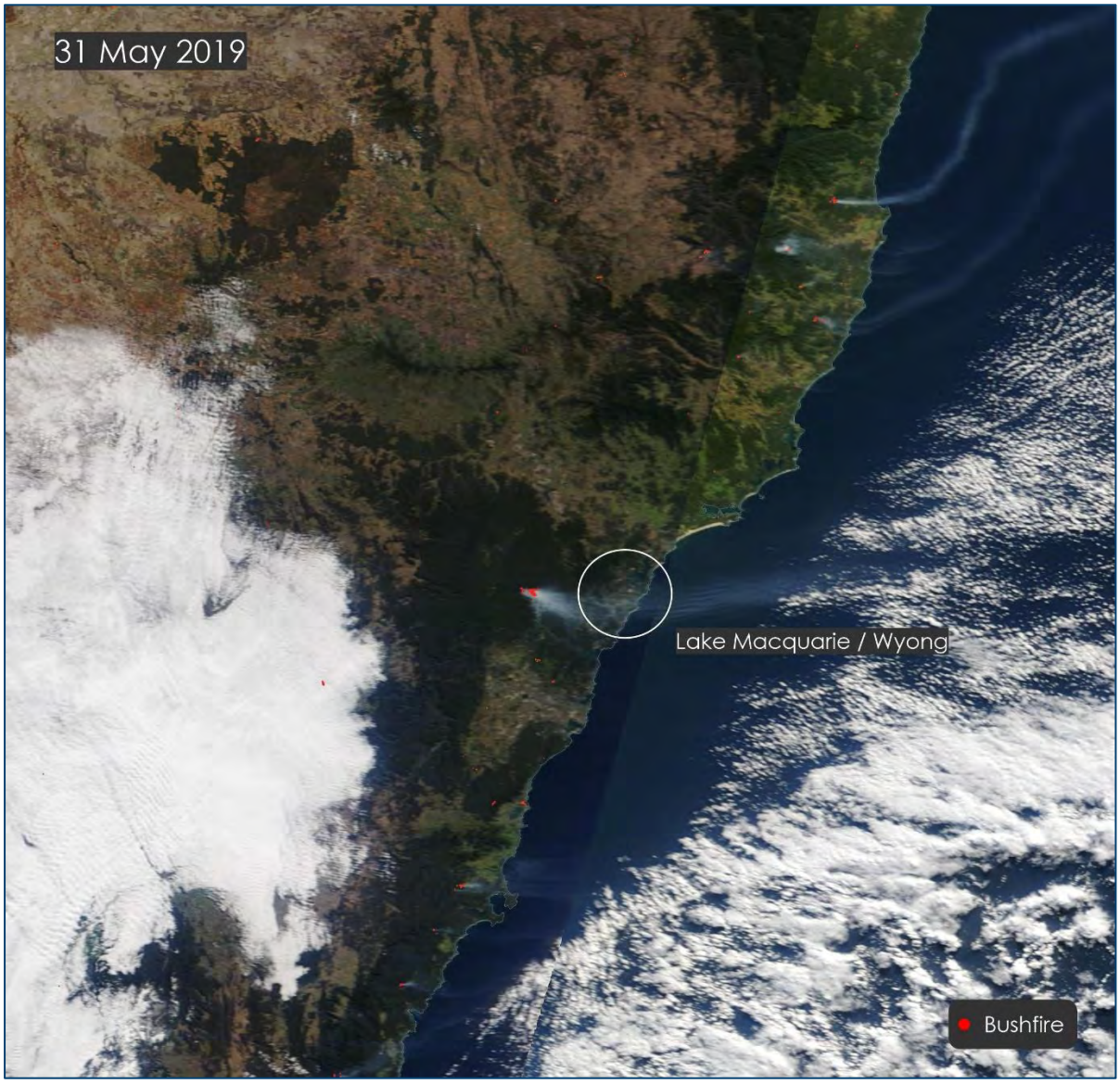

Figure 8-7: Satellite imagery of smoke – 31 May 2019

8.6 October to December 2019 bushfire season

Air quality in the southeast region of Australia in late October 2019 to January 2020 was significantly impacted by prolonged drought and severe bushfire activity. In the Lake Macquarie – Wyong region, 24-hour average PM_{10} and $PM_{2.5}$ concentrations were frequently recorded above the applicable criteria. At the six particulate monitoring sites in this region, there were 104 instances of 24-hour average levels above the applicable criteria which occurred over 28 days, between 26 October 2019 and 31 December 2019. The primary cause of these elevated levels was smoke from widespread bushfires to the north, west and south of the region. Dust storms were also evident on 7 November 2019 and 26 November 2019.

Figure 8-8 and **Figure 8-9** present the 24-hour average PM_{10} and $PM_{2.5}$ levels during the 2019 bushfire season compared with the typical historical levels (minimum, average and maximum levels on equivalent dates) between 2014 and 2018 from the Lake Macquarie – Wyong monitoring sites. The figures show that the levels recorded during the 2019 bushfire season were frequently higher than any of the

maximum levels which occurred at equivalent times in the past five years. It is also noted that days which were not necessarily above the criteria level in late 2019 were still often higher than the historical average or maximum levels. This indicates that the impact from the bushfires was evident during the whole 2019 bushfire period, not just on days in which the criteria were exceeded.

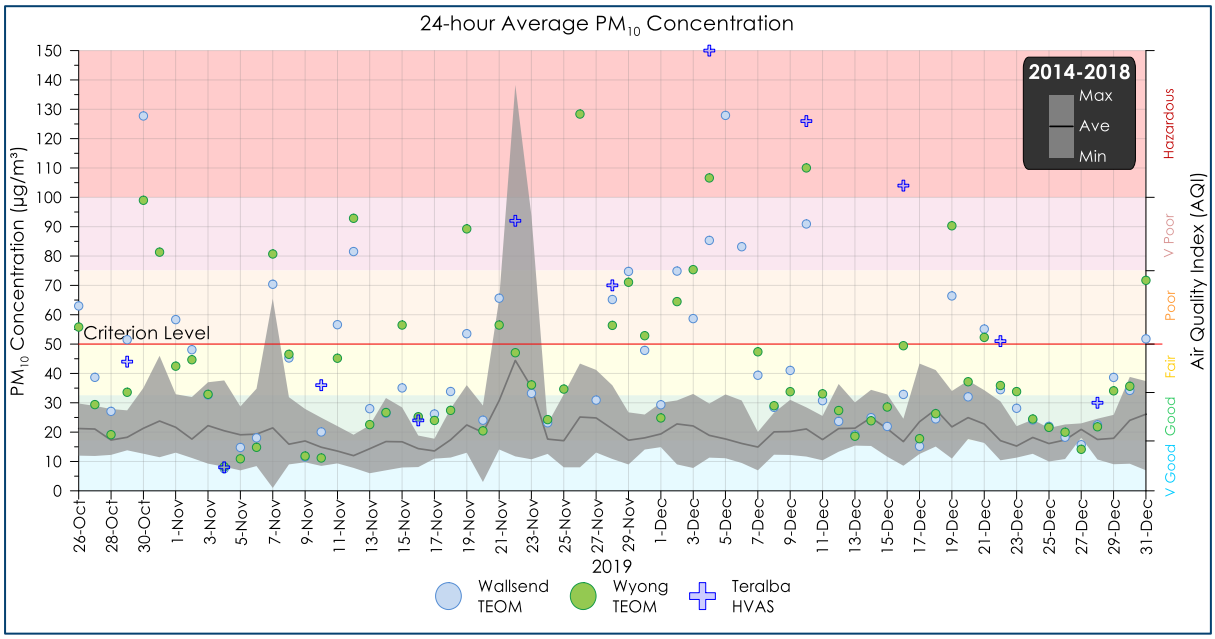

Figure 8-8: Lake Macquarie – Wyong historical PM_{10} levels (2014-2018) compared with 2019 bushfire season

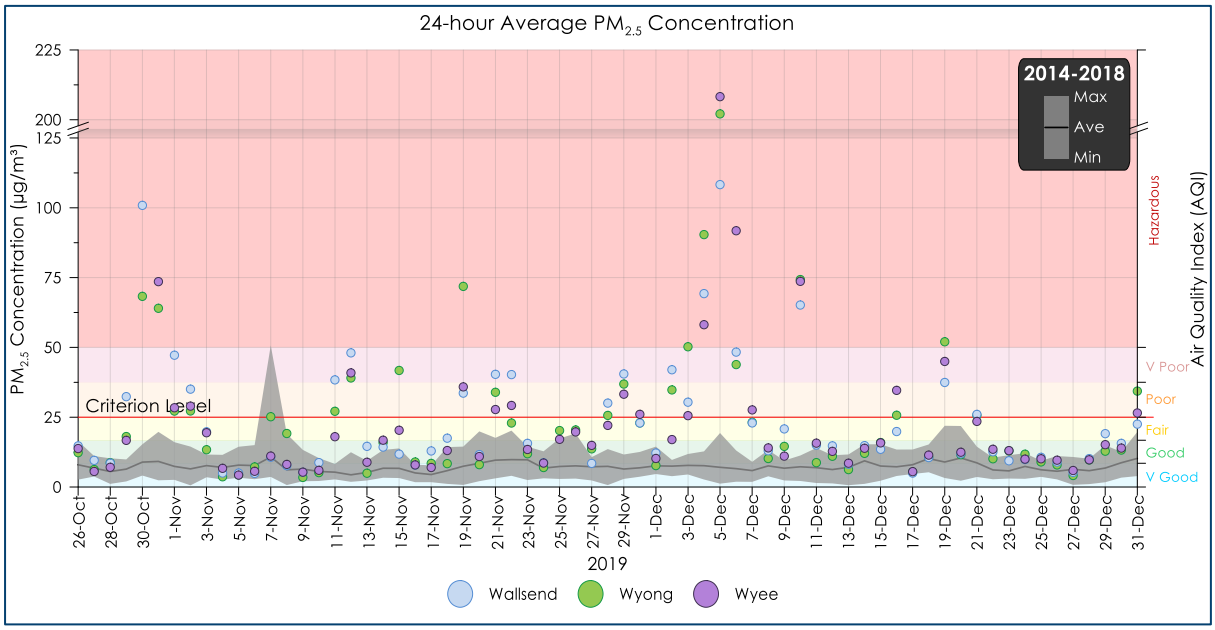

Figure 8-9: Lake Macquarie – Wyong historical $PM_{2.5}$ levels (2014-2018) compared with 2019 bushfire season

Figure 8-10 to **Figure 8-15** present a series of satellite images illustrating the extent of the bushfire smoke impact during 2019 bushfire season.

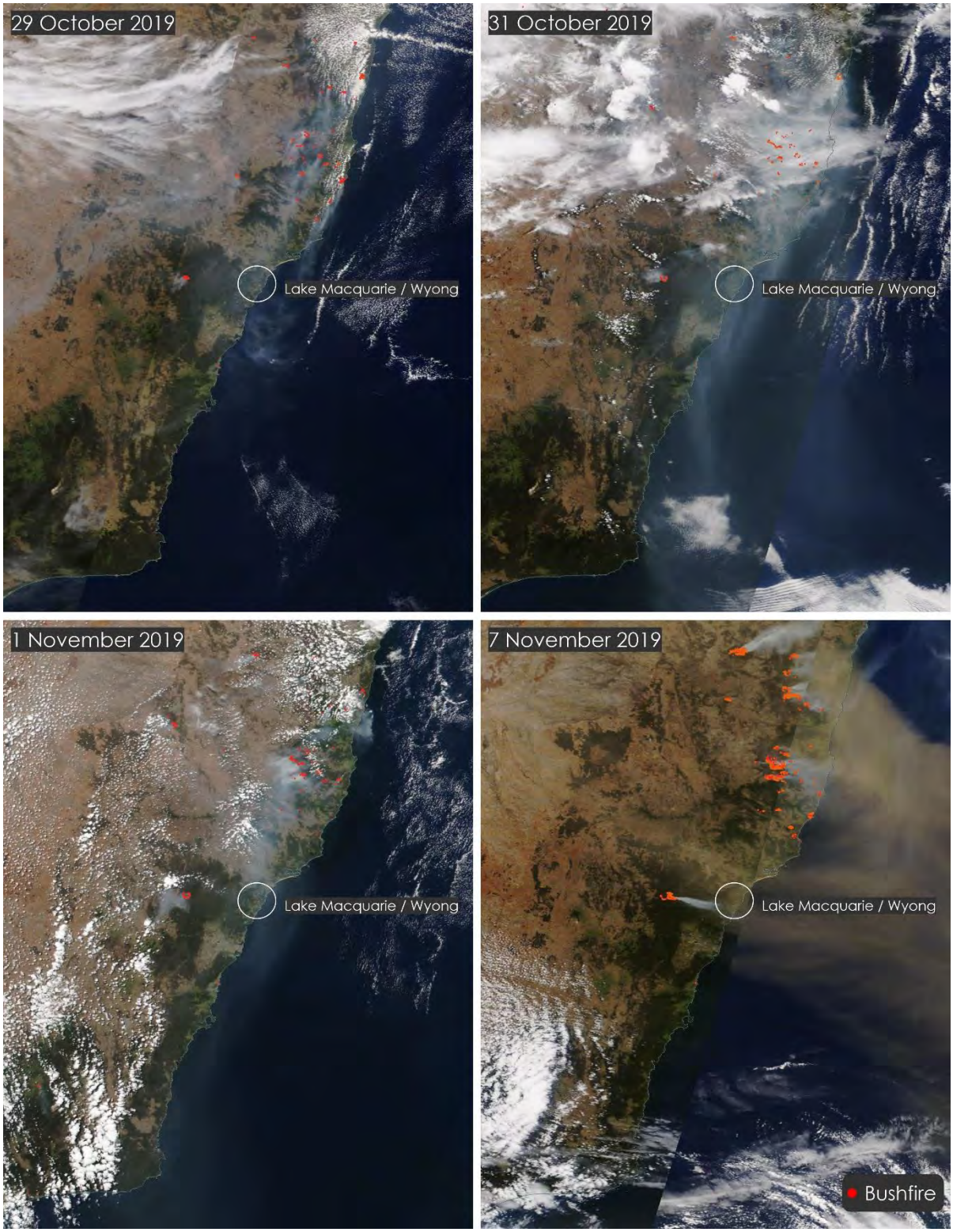

Figure 8-10: Satellite imagery of bushfire smoke and dust storms - 29 October 2019 to 7 November 2019

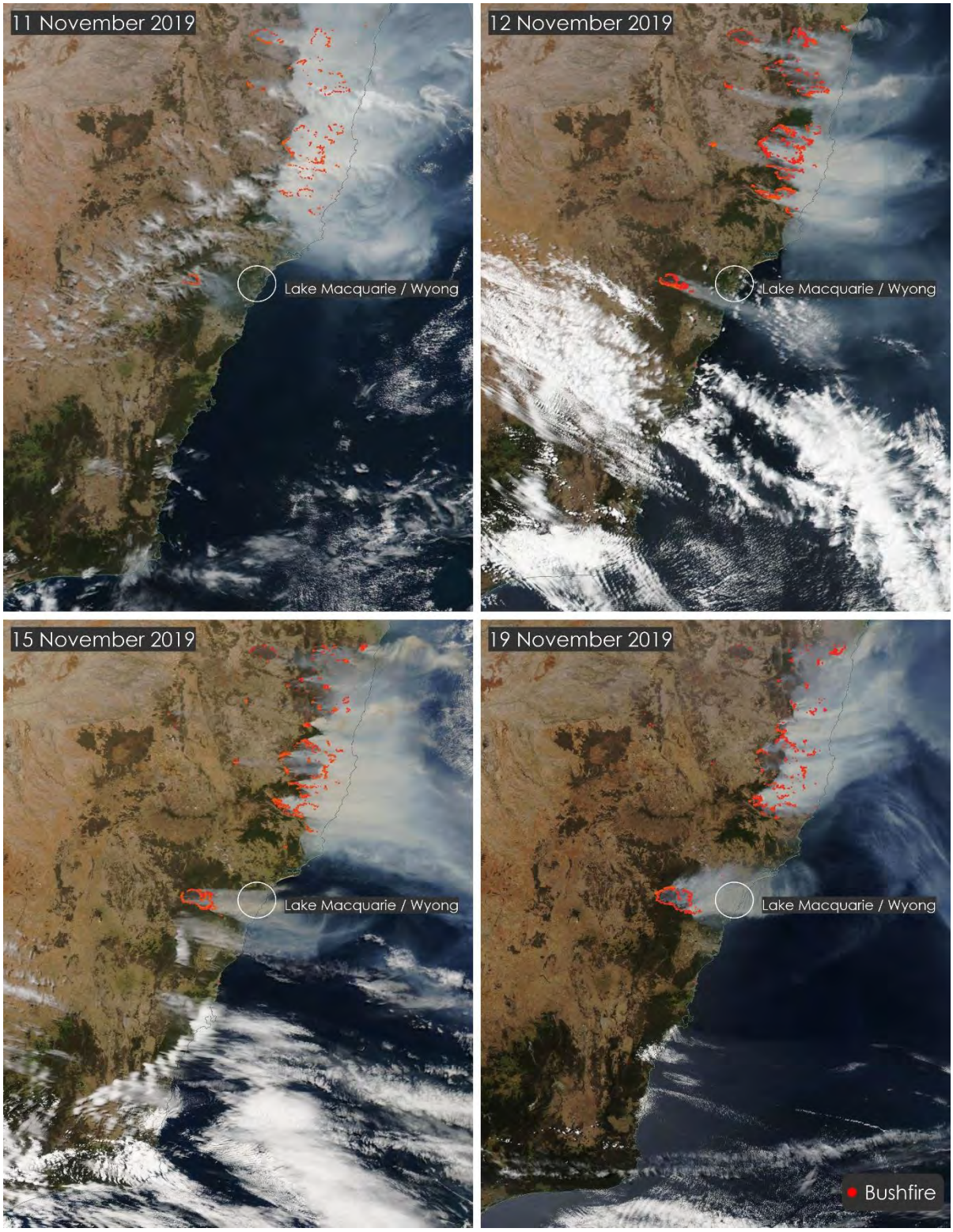

Figure 8-11: Satellite imagery of bushfire smoke and dust storms - 11 November 2019 to 19 November 2019

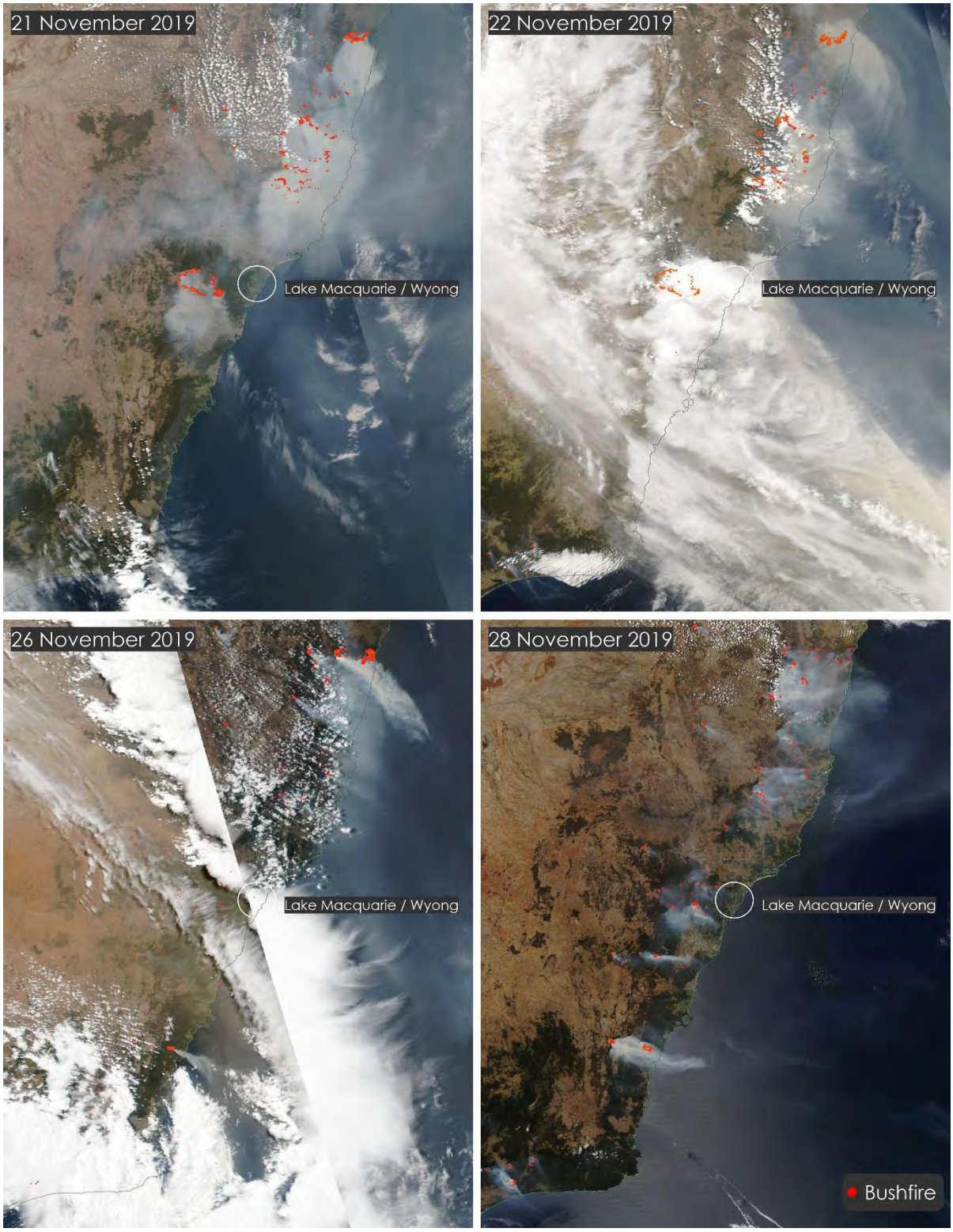

Figure 8-12: Satellite imagery of bushfire smoke and dust storms - 21 November 2019 to 28 November 2019

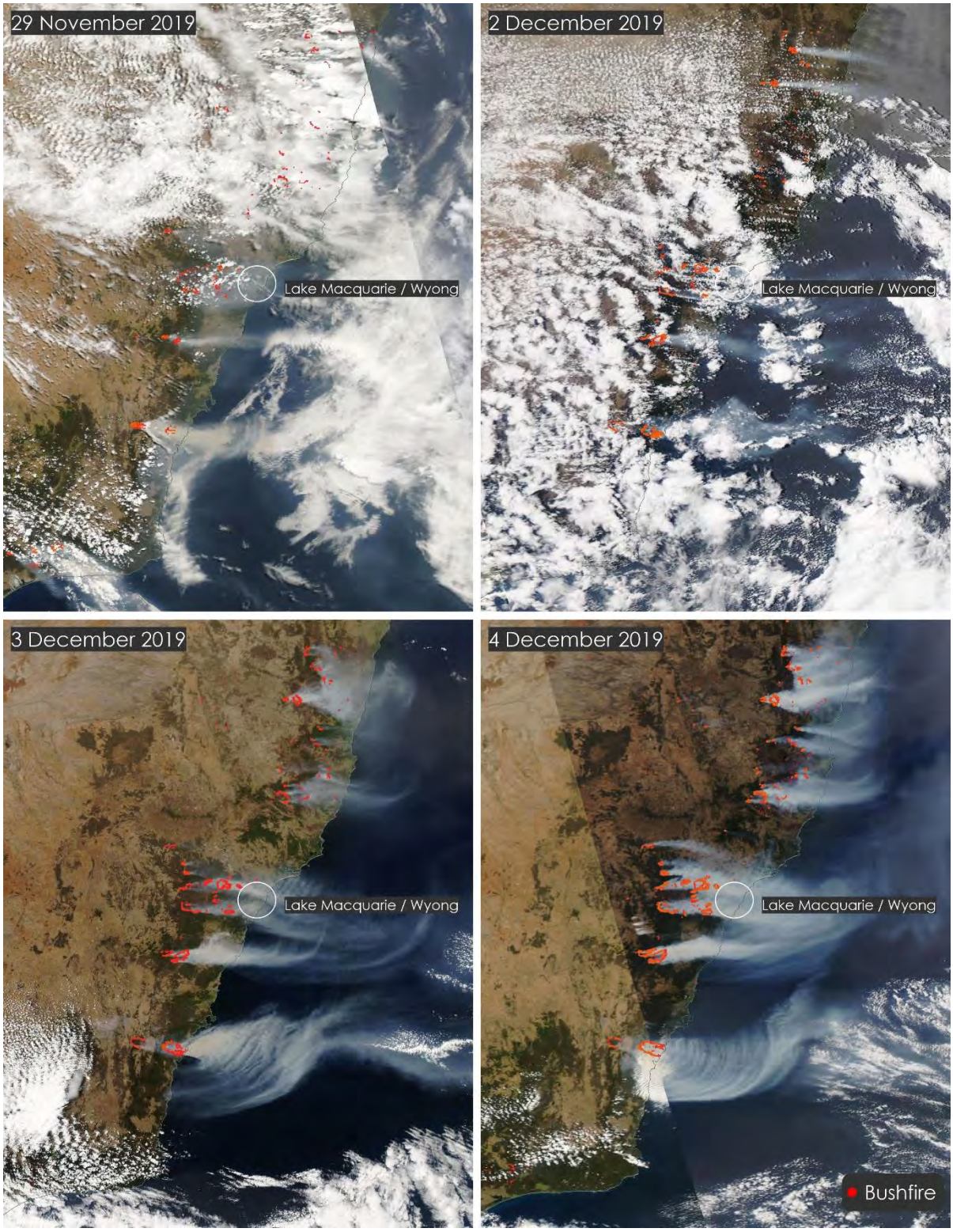

Figure 8-13: Satellite imagery of bushfire smoke and dust storms - 29 November 2019 to 4 December 2019

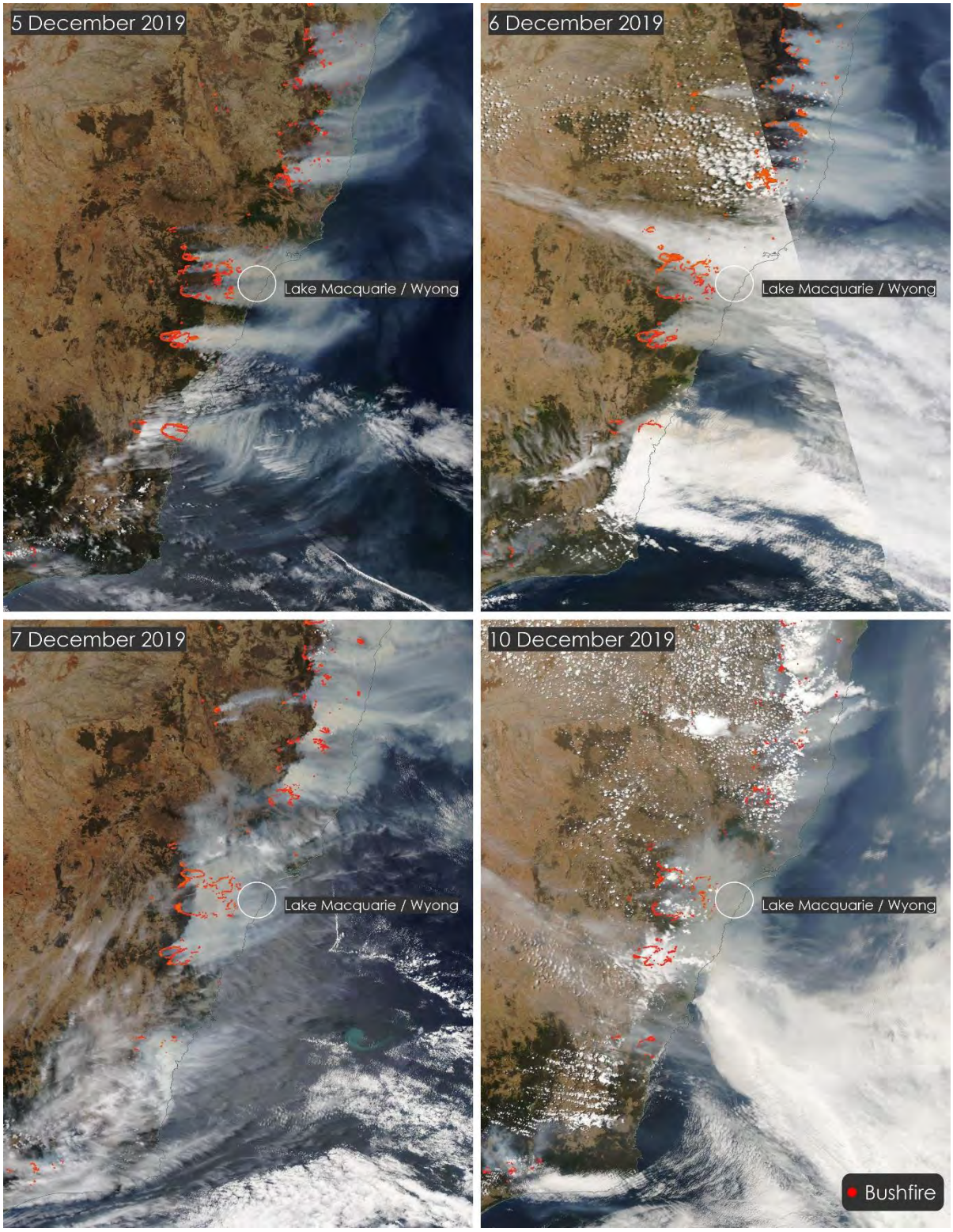

Figure 8-14: Satellite imagery of bushfire smoke and dust storms - 5 December 2019 to 10 December 2019

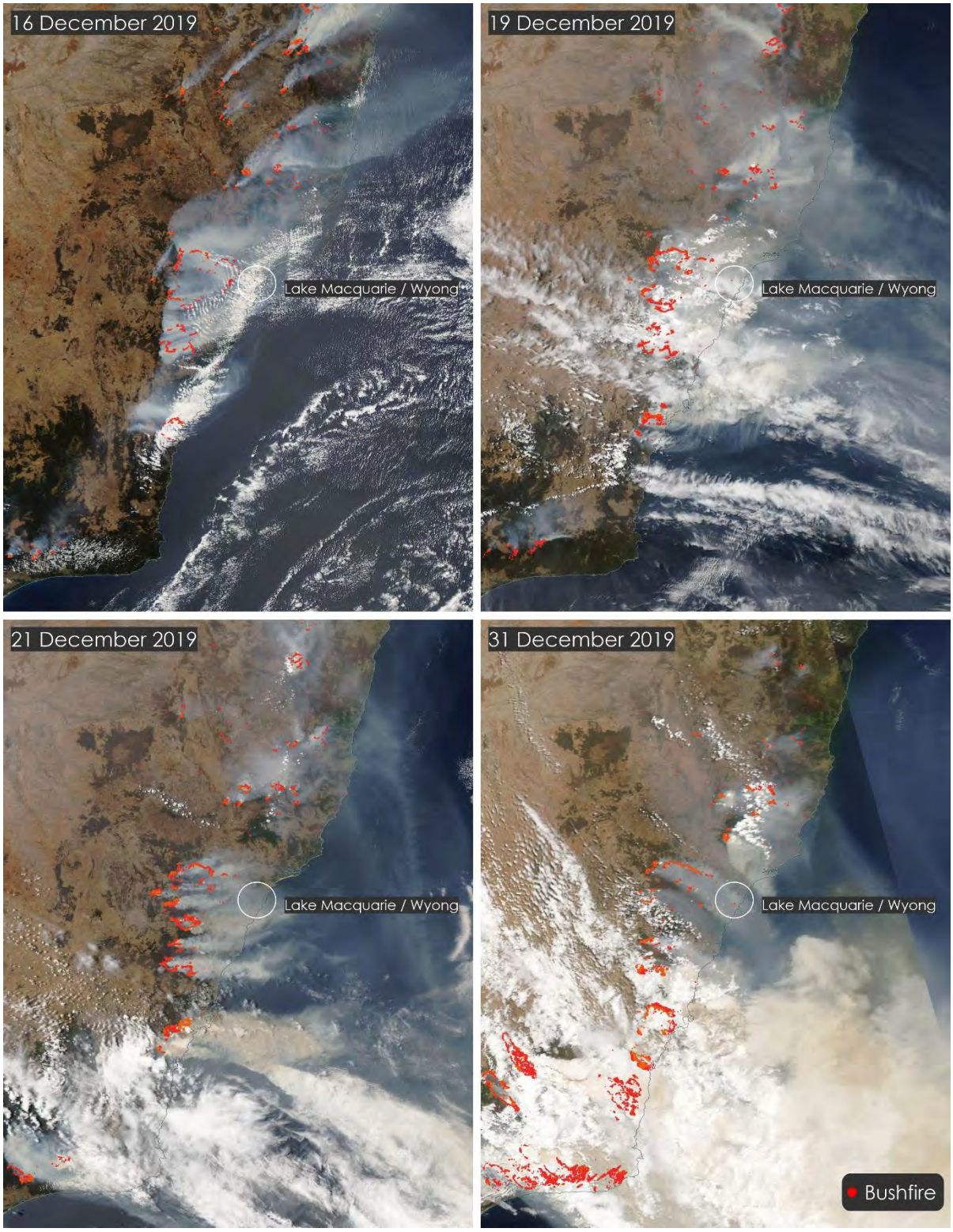

Figure 8-15: Satellite imagery of bushfire smoke and dust storms - 16 December 2019 to 31 December 2019

9 CONCLUSIONS

The results indicate that the air quality was generally good until September 2019, but frequently poor to hazardous in the Lake Macquarie - Wyong region toward the end of 2019 due to smoke from bushfires.

The Wyee $PM_{2.5}$ monitor recorded 19 24-hour average $PM_{2.5}$ levels and an annual average level above the relevant criteria in 2019.

The Wallsend $PM_{2.5}$ monitor recorded 19 24-hour average $PM_{2.5}$ levels and an annual average level above the relevant criteria in 2019. The Wallsend PM_{10} monitor recorded 21 24-hour average PM_{10} levels above the relevant criteria in 2019.

The Wyong $PM_{2.5}$ monitor recorded 23 24-hour average $PM_{2.5}$ levels and an annual average level above the relevant criteria in 2019. The Wyong PM_{10} monitor recorded 19 24-hour average PM_{10} levels above the relevant criteria in 2019.

The Teralba PM_{10} monitor recorded eight 24-hour average $PM_{2.5}$ levels and an annual average level above the relevant criteria in 2019.

All recorded NO_2 and SO_2 levels were below the applicable annual average criteria in 2019.

Relative to the Air Quality Index:

- The Wyong monitor recorded nine days of poor levels, seven days of very poor levels and three days of hazardous levels. The Wallsend monitor recorded 15 days of poor levels, four days of very poor levels and two days of hazardous levels. The Teralba monitor recorded four days of poor levels, one day of very poor levels and three days of hazardous levels.
- The Wyong monitor recorded 11 days of poor levels, four days of very poor levels and eight days of hazardous levels. The Wallsend monitor recorded seven days of poor levels, eight days of very poor levels and four days of hazardous levels. The Wyee monitor recorded 12 days of poor levels, two days of very poor levels and five days of hazardous levels.
- The measured levels of NO_2 were very good or good at all monitors at all times; and,
- The measured levels of SO_2 were very good or good at all monitors at all times.

10 REFERENCES

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USEPA (2013)

Health Effects of Pollution, United States Environmental Protection Agency website. <http://www.epa.gov/region07/air/quality/health.htm>, accessed May 2013.

Appendix A

How to read a windrose

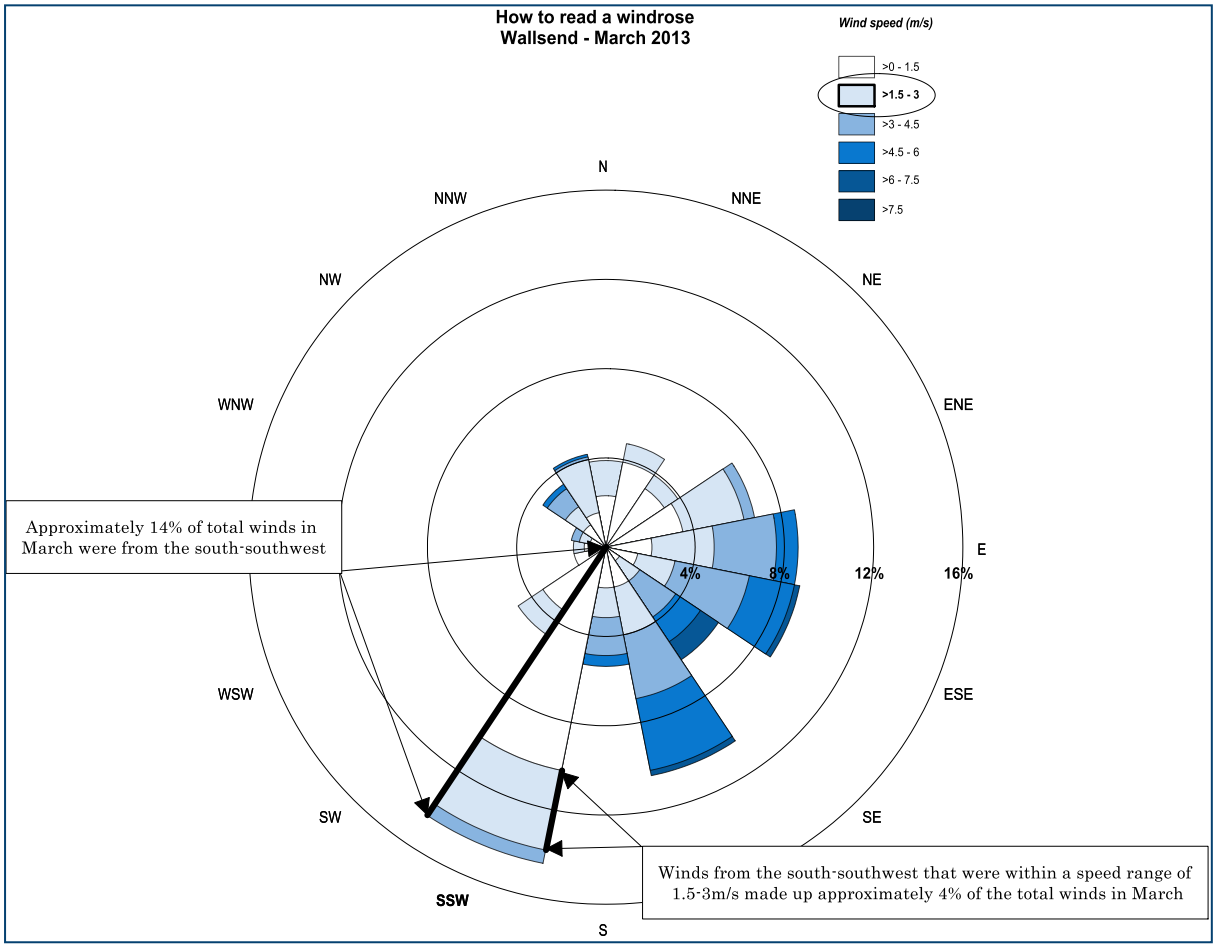

Figure A-1: How to read a windrose

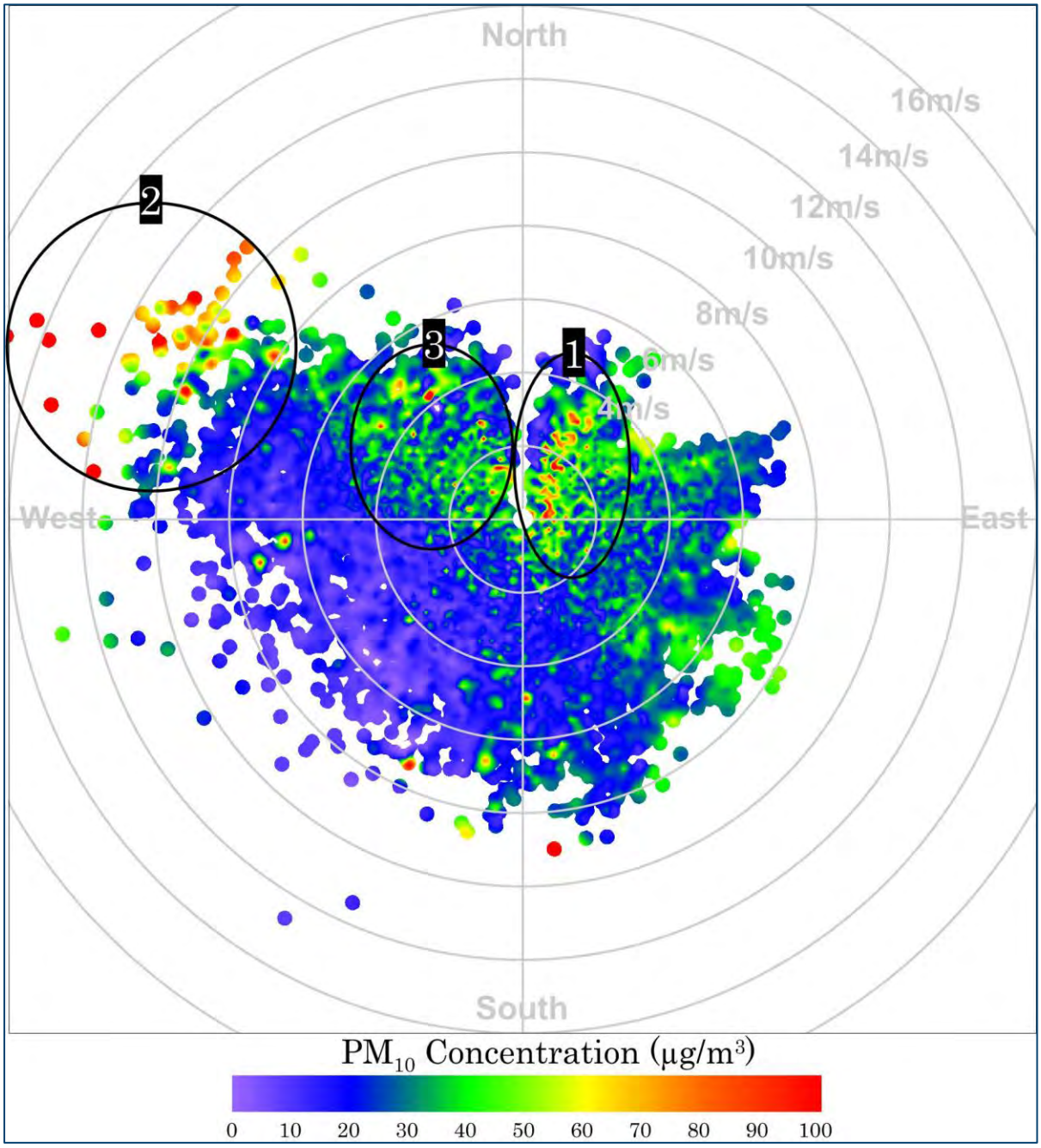

Figure A-2: Example Pollution Rose

- **1** - High PM_{10} levels tended to originate from the north-eastern directions under wind speeds below 4m/s.
- **2** - High PM_{10} levels were also recorded from the northwest and west-northwest direction under high wind speeds (>8m/s).
- **3** - Some high levels were also recorded from the northwest under moderate wind speeds.

Appendix B

Monitoring Data (Graphical)

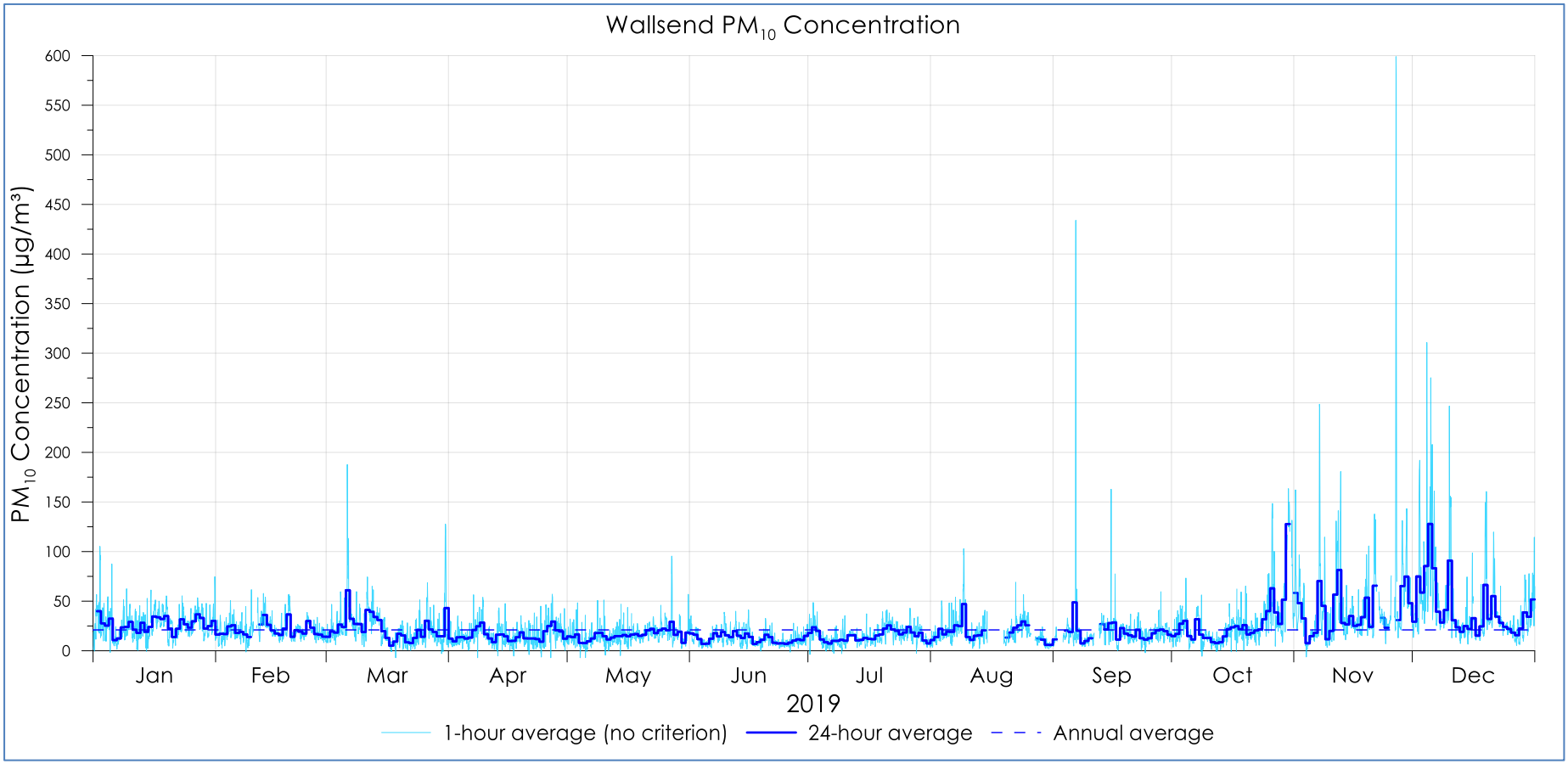

Figure B-1: Wallsend PM_{10} (1-hour, 24-hour and annual average) concentration – 2019

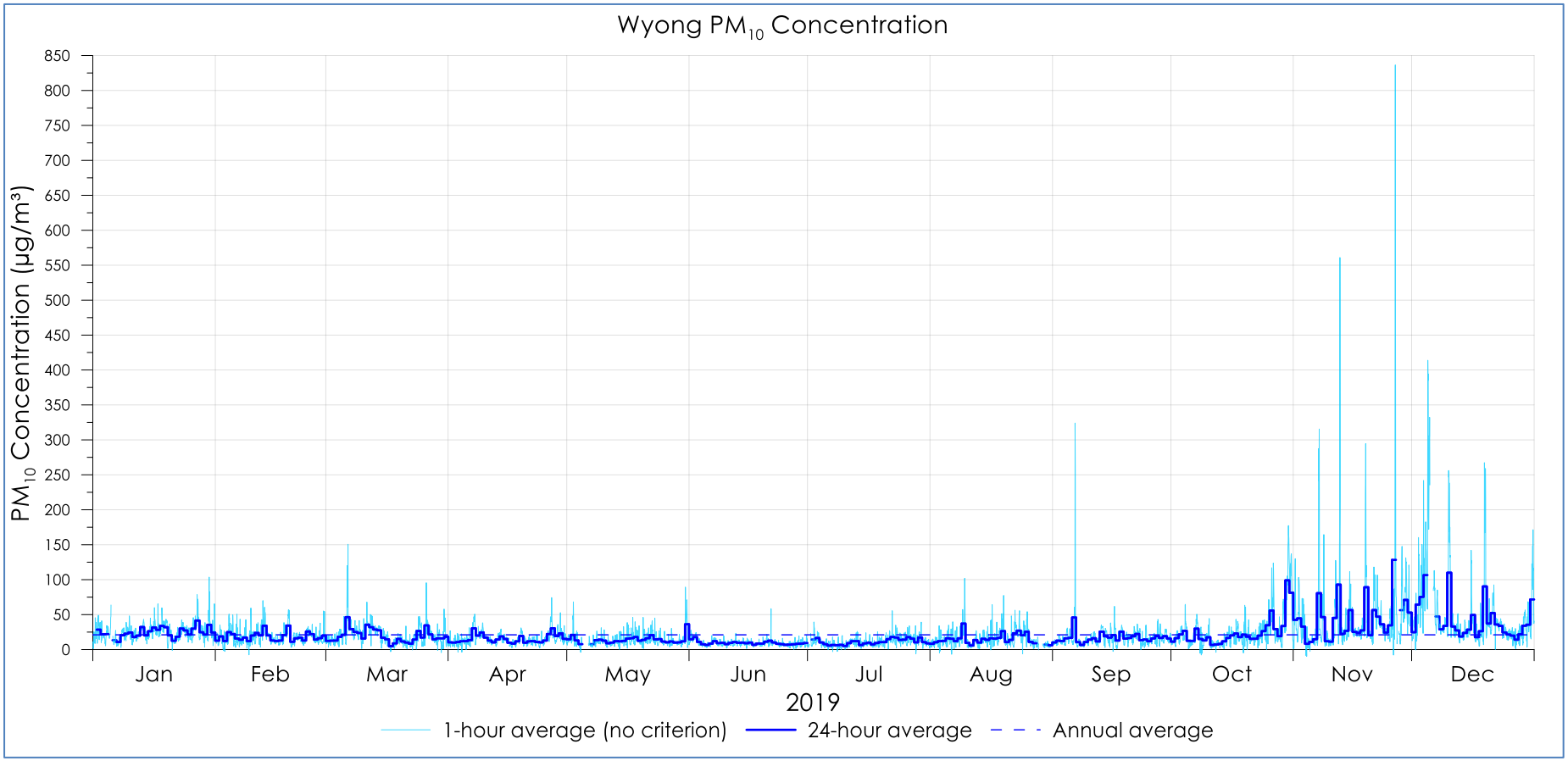

Figure B-2: Wyong PM_{10} (1-hour, 24-hour and annual average) concentration – 2019

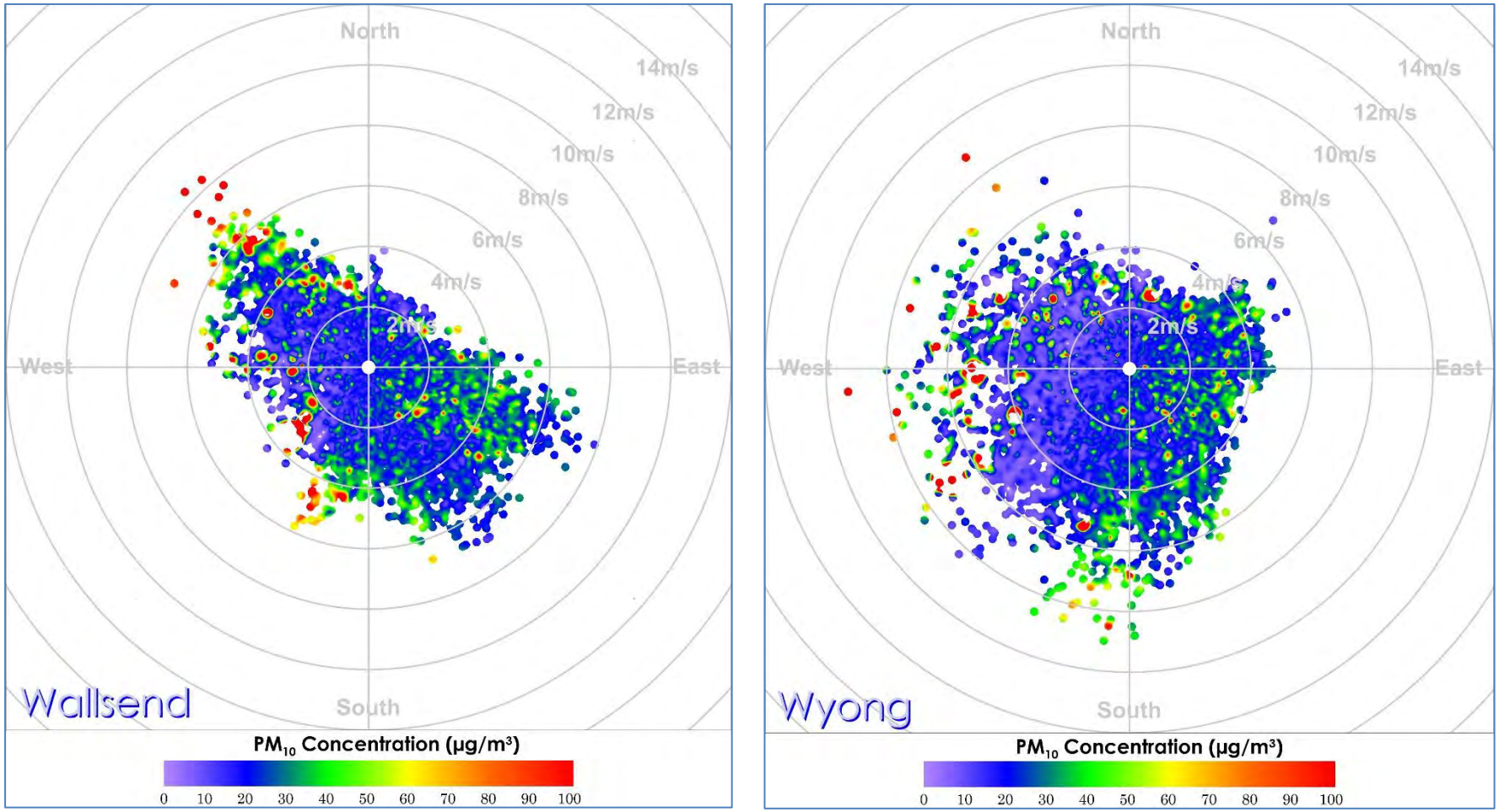

Figure B-3: 2019 hourly PM_{10} pollution roses – Wallsend (left) and Wyong (right)

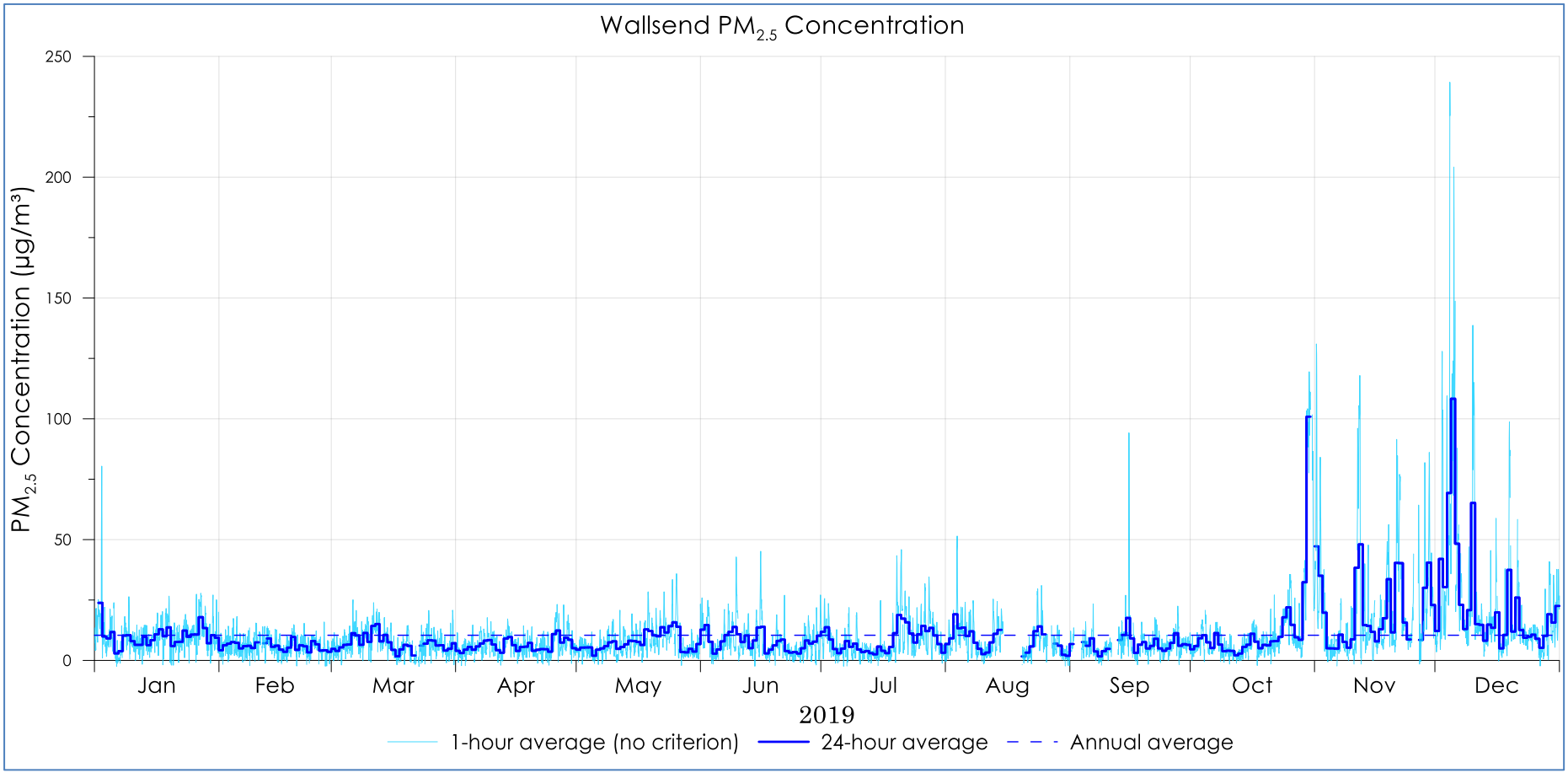

Figure B-4: Wallsend $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2019

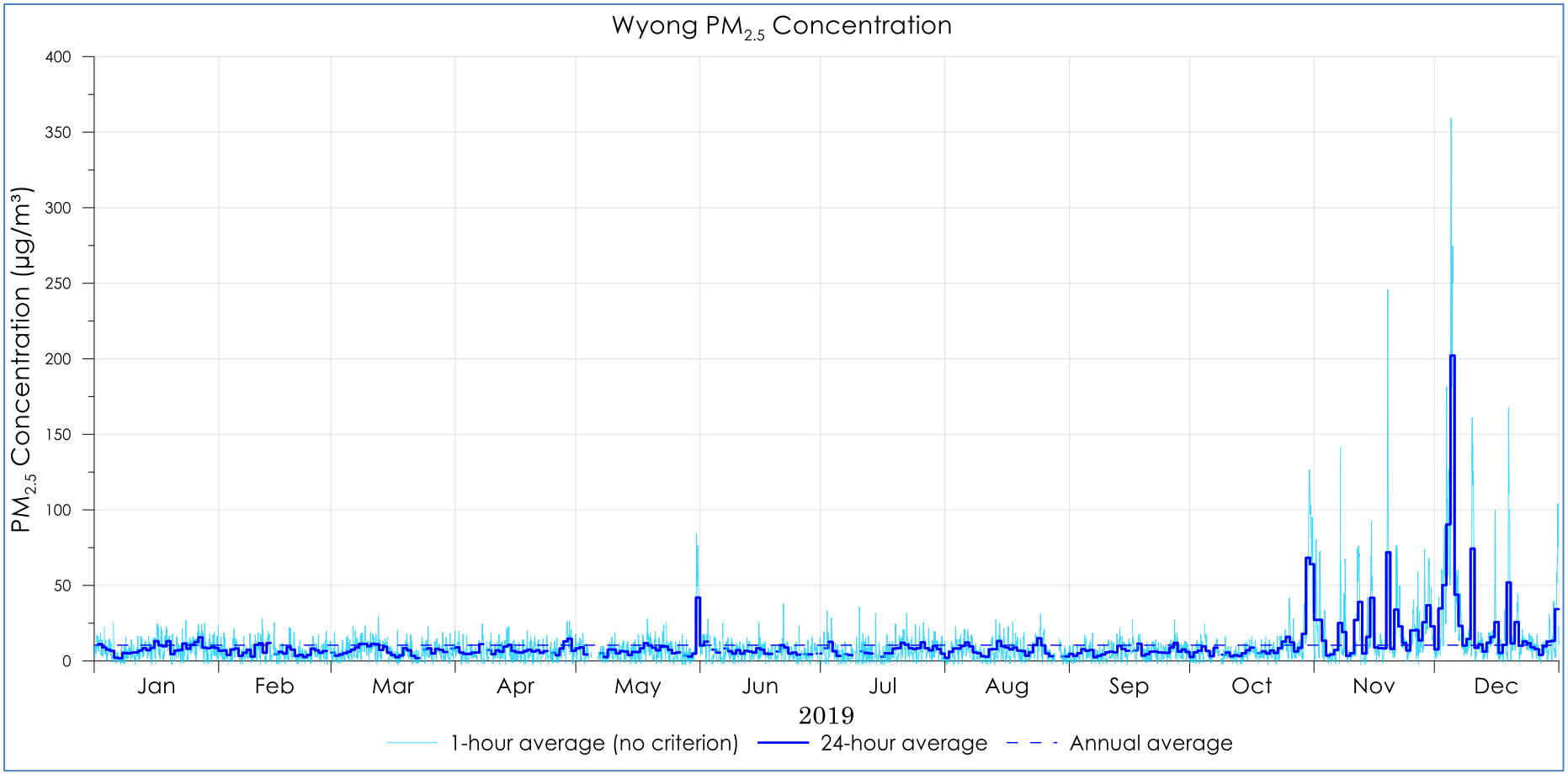

Figure B-5: Wyong $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2019

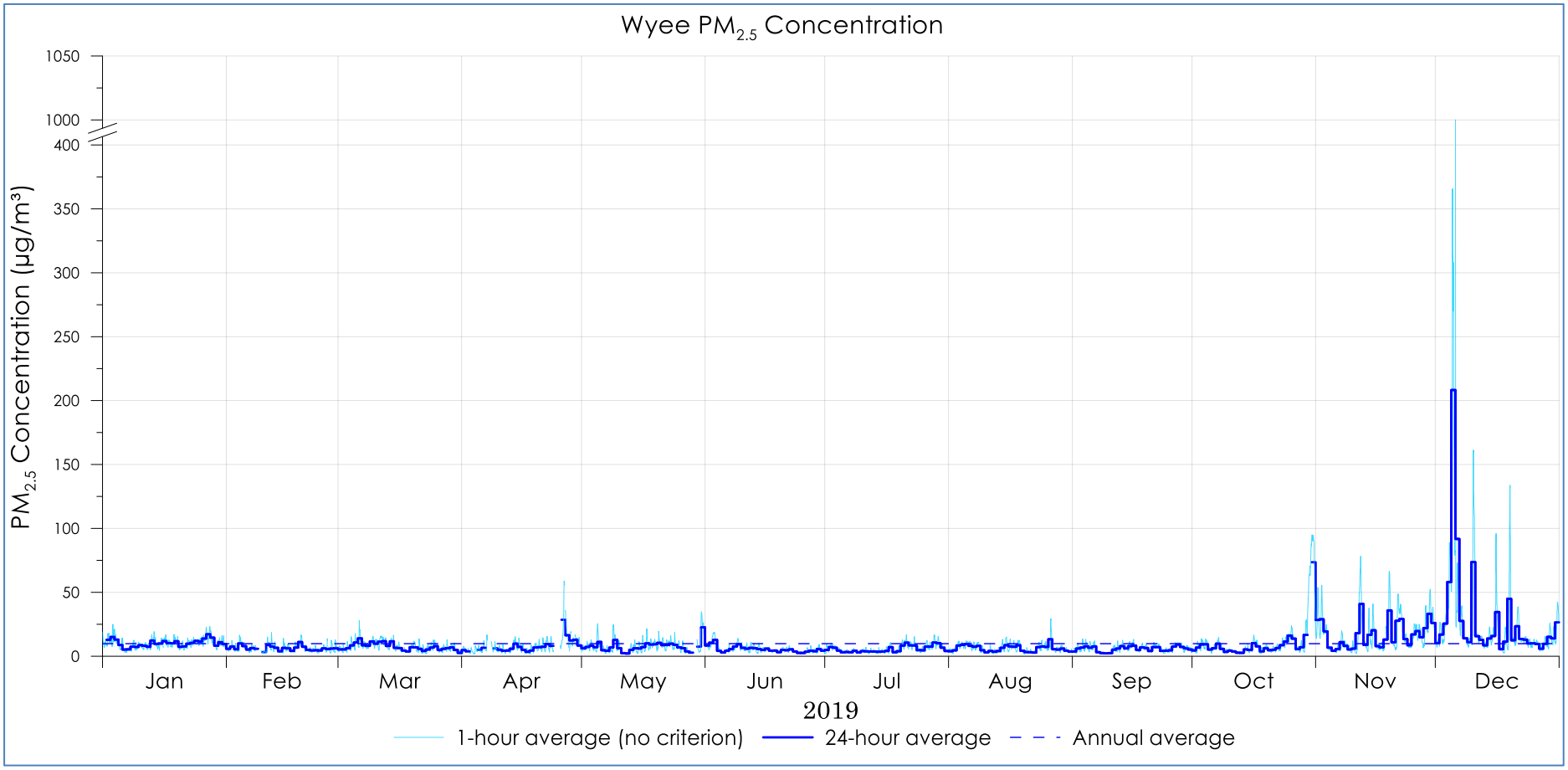

Figure B-6: Wyee $PM_{2.5}$ (1-hour, 24-hour and annual average) concentration – 2019

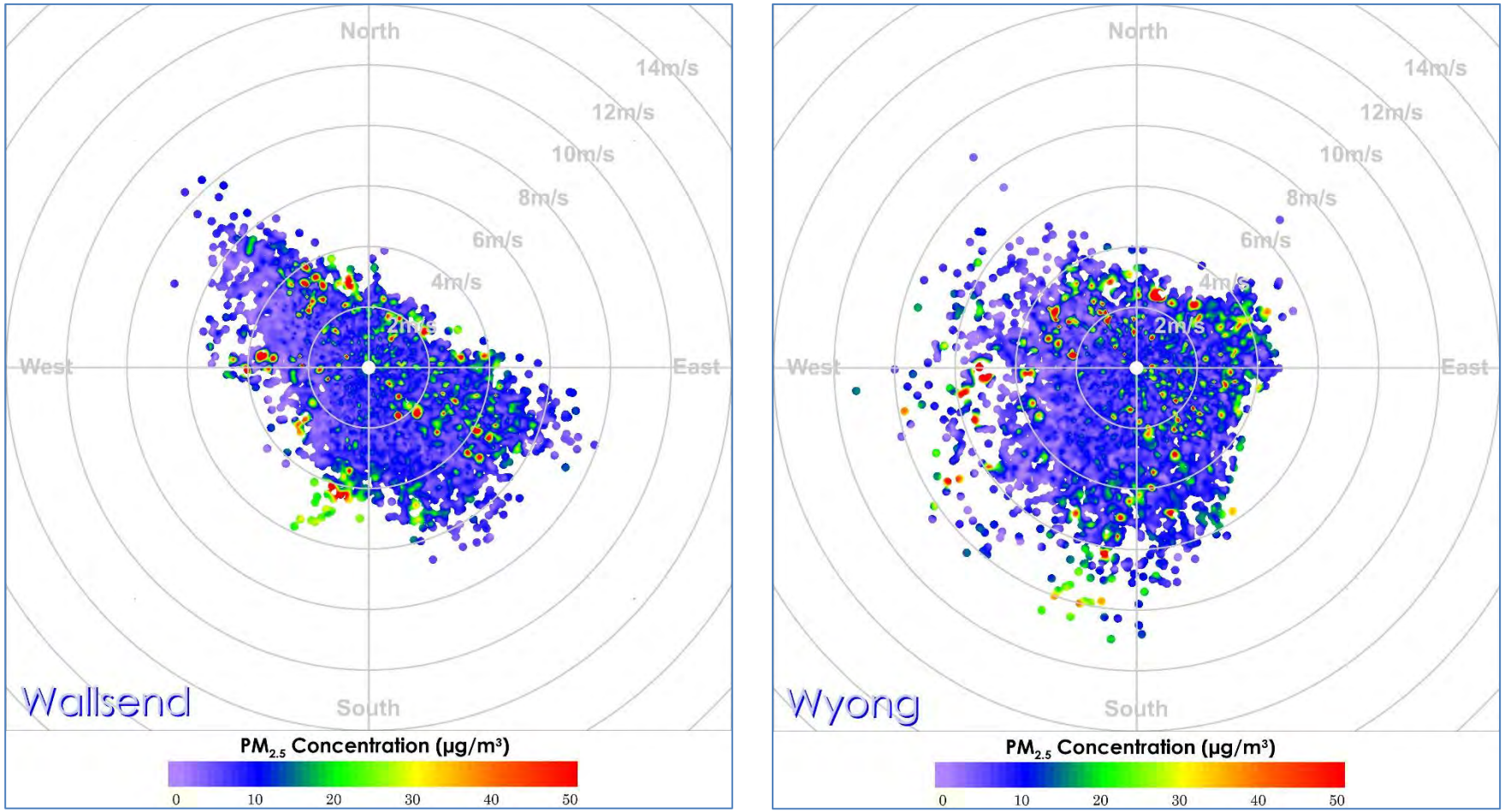

Figure B-7: 2019 hourly $PM_{2.5}$ pollution roses – Wallsend (left) and Wyong (right)

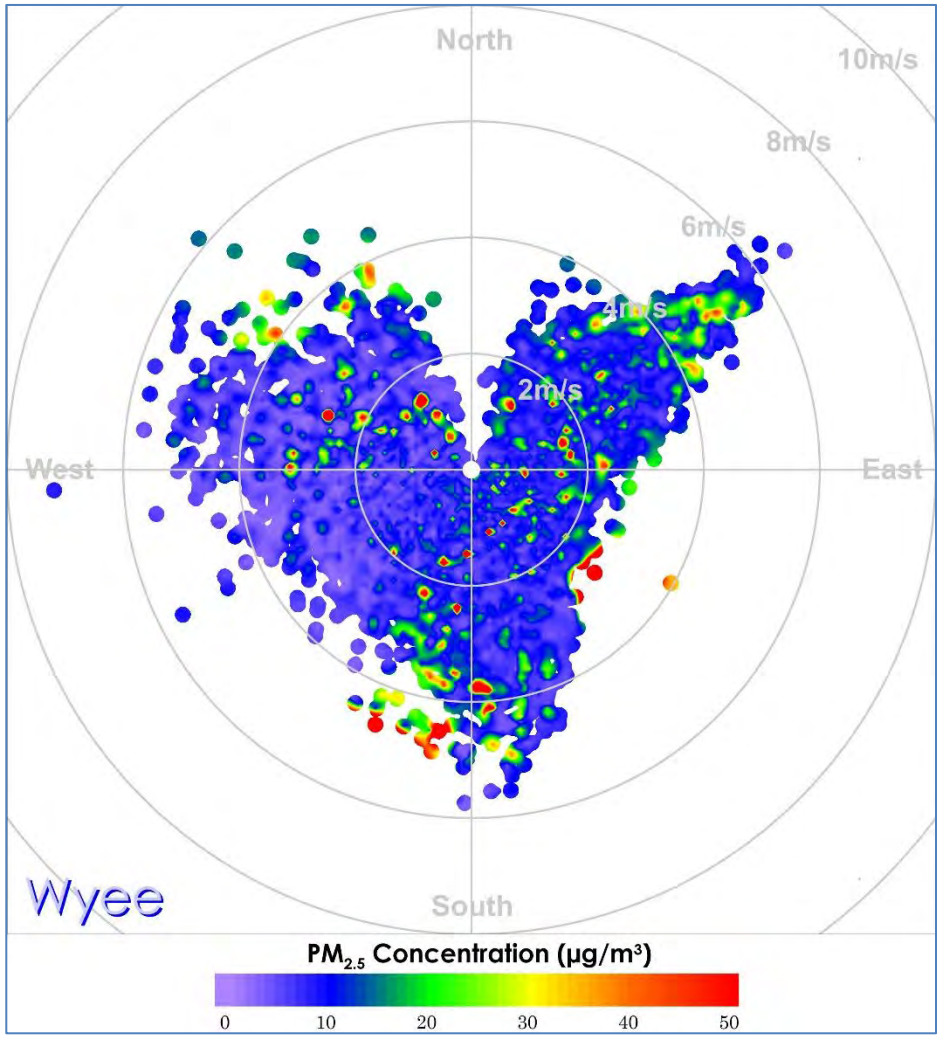

Figure B-8: 2019 hourly $PM_{2.5}$ pollution rose – Wyee

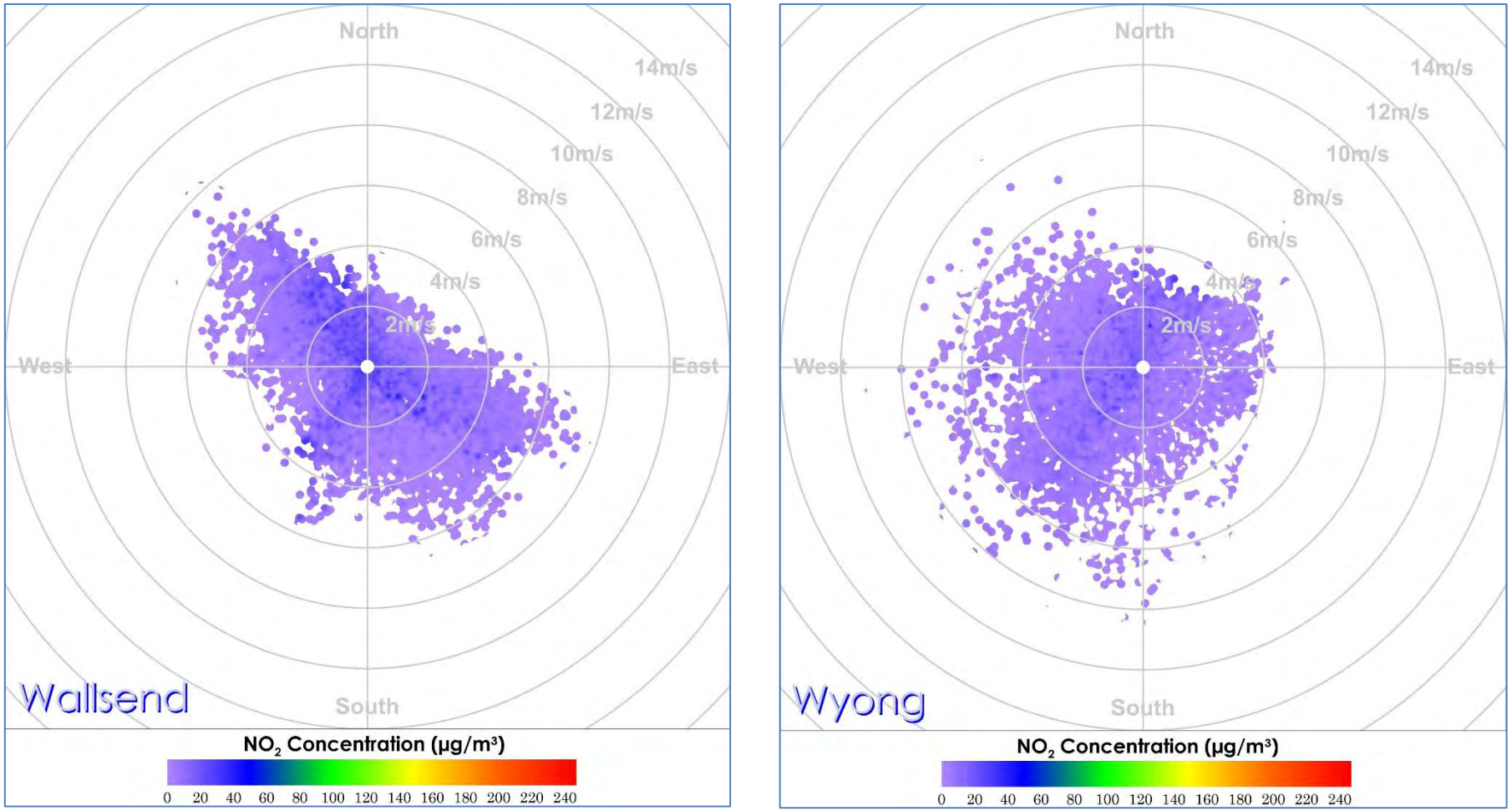

Figure B-9: 2019 hourly NO_2 pollution roses – Wallsend (left) and Wyong (right)

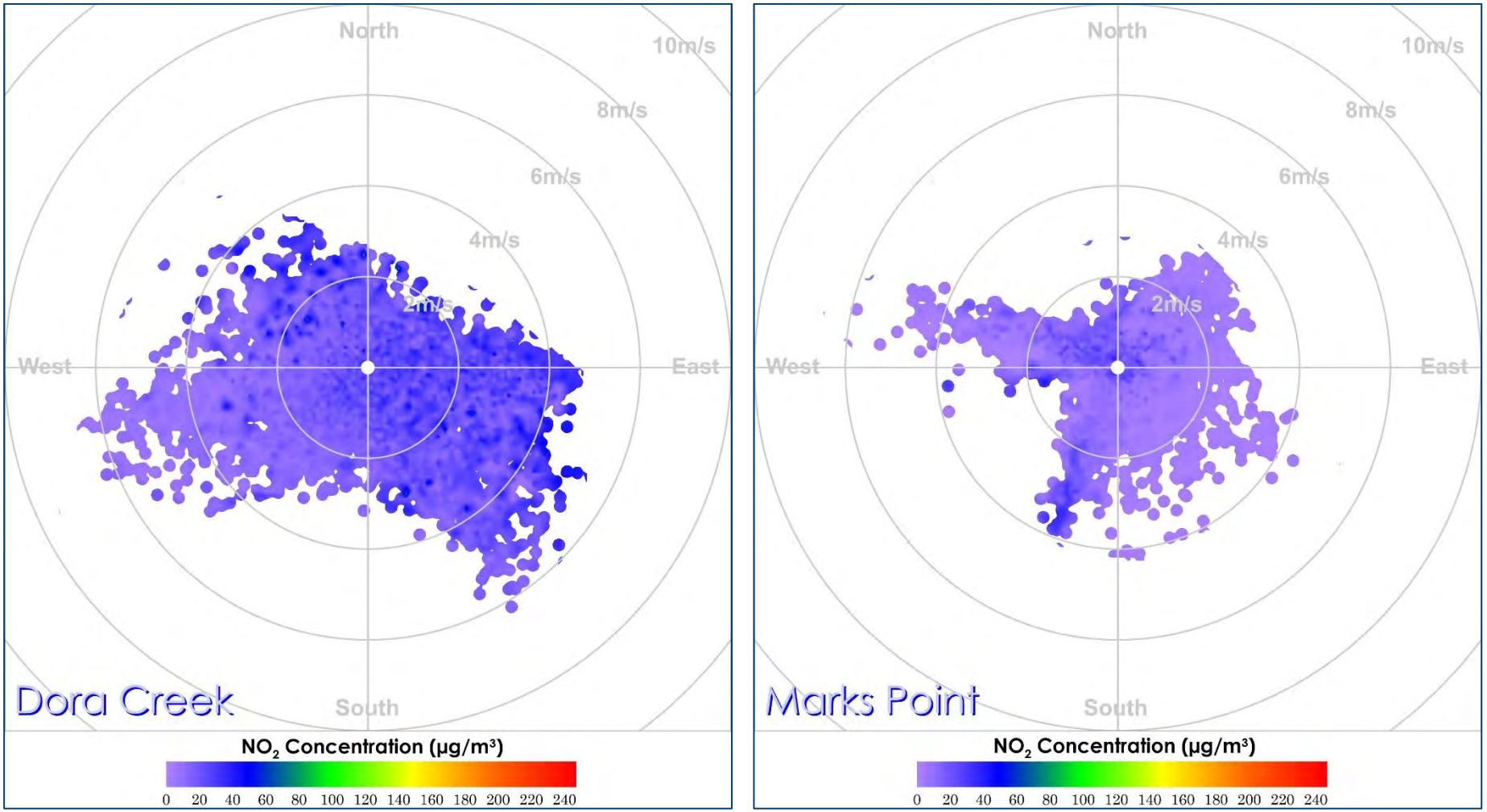

Figure B-10: 2019 hourly NO_2 pollution roses – Dora Creek (left) and Marks Point* (right)

* Only 40% data availability

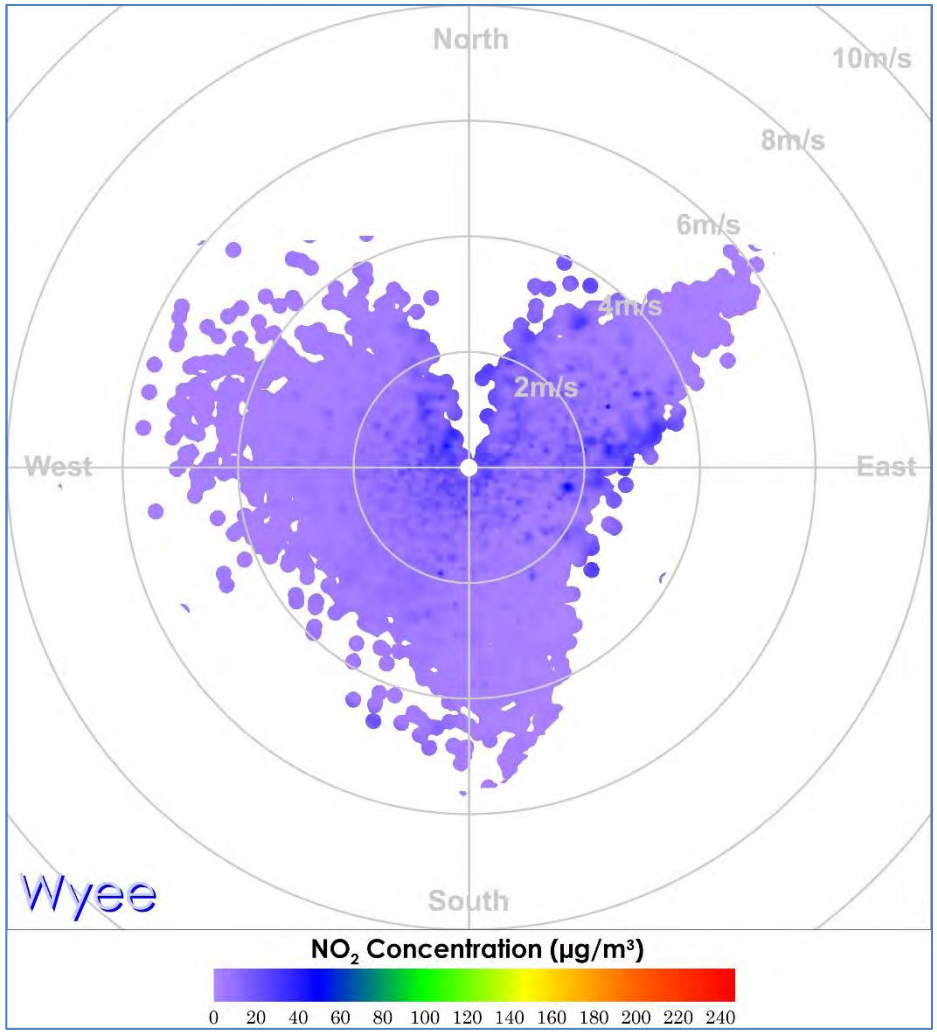

Figure B-11: 2019 hourly NO_2 pollution rose – Wyee

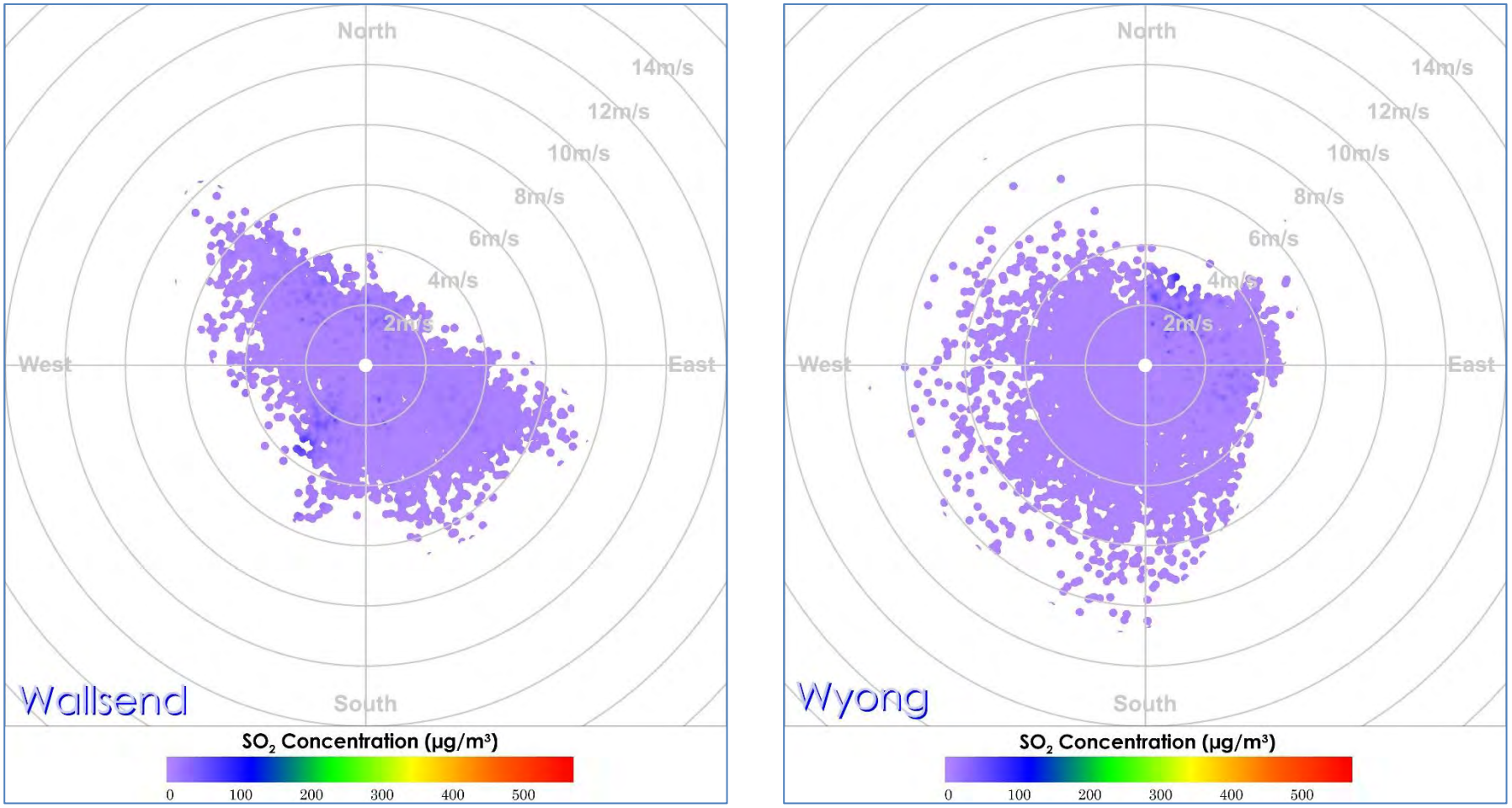

Figure B-12: 2019 hourly SO_2 pollution roses – Wallsend (left) and Wyong (right)

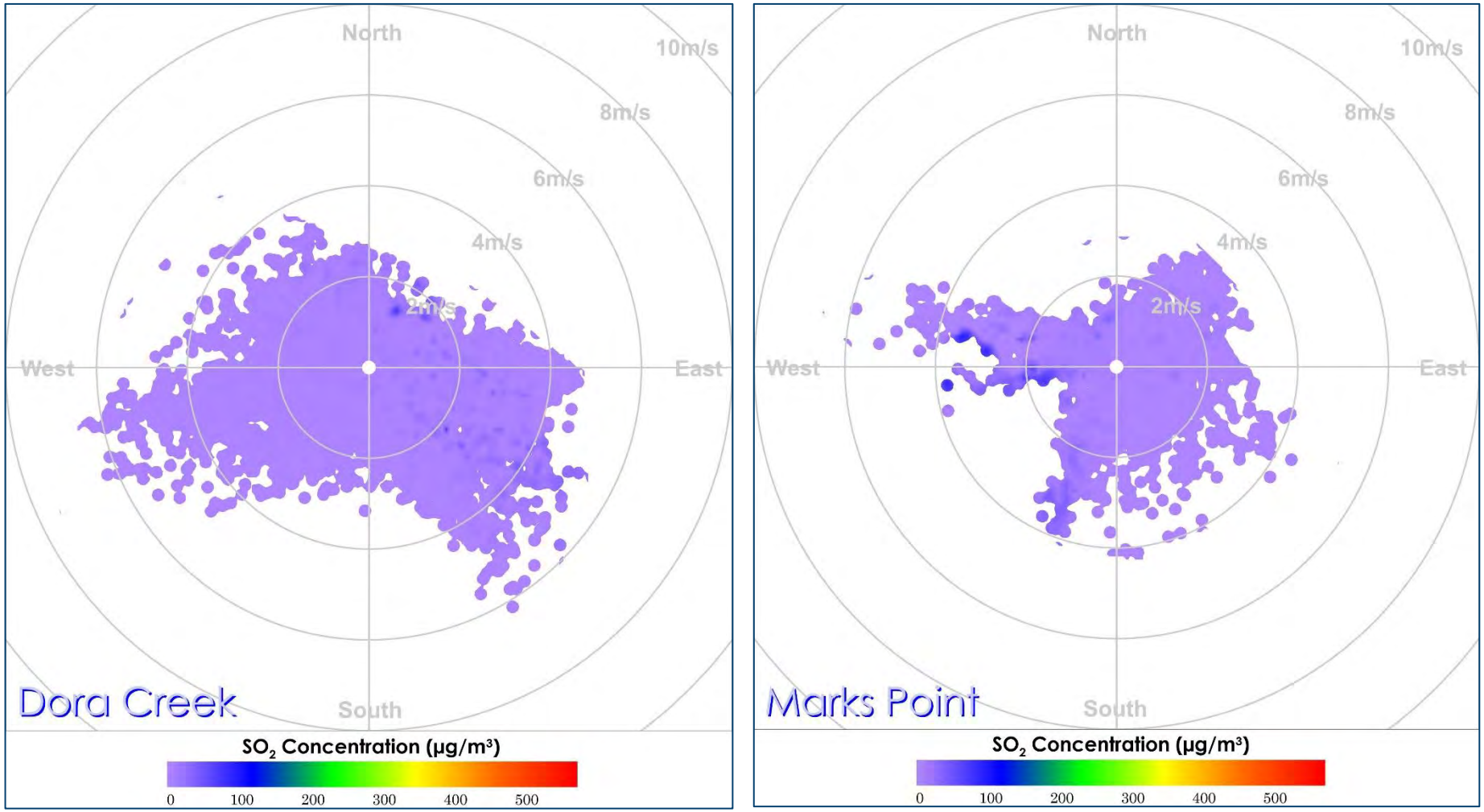

Figure B-13: 2019 hourly SO_2 pollution roses – Dora Creek (left) and Marks Point* (right)

* Only 40% data availability

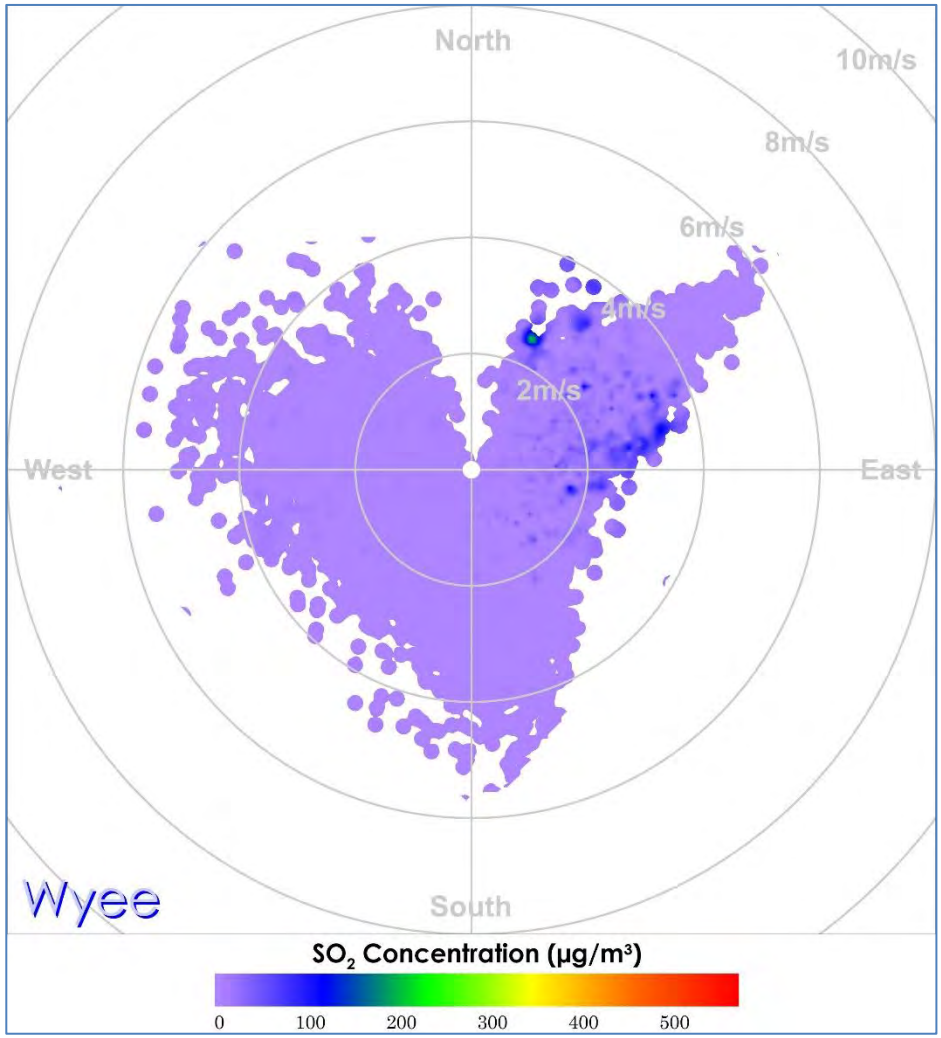

Figure B-14: 2019 hourly SO_2 pollution rose – Wyee

Appendix C

Monitoring Data (Tabulated)

Table C-1: 24-hour average monitoring data

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
01/01/2019	24.2	19.6	13.2	9.3	10.3	6.8	5.7	-1.1	-1.1	9.4
02/01/2019	39.9	28.5	23.8	11.1	12.8	9.8	3.5	1.9	1.8	11.5
03/01/2019	27.6	21.9	9.9	8.9	15.1	3.3	0.8	5.3	5.2	6.7
04/01/2019	25.3	22.1	9.1	7.5	13.0	3.9	8.2	3.7	3.6	12.4
05/01/2019	32.4	-	11.7	6.7	8.8	6.6	0.5	-1.7	-1.4	0.0
06/01/2019	10.7	13.3	2.9	2.1	5.2	4.1	0.0	-1.9	-1.9	0.0
07/01/2019	12.4	10.9	3.8	1.8	5.4	1.0	0.0	5.3	5.0	0.0
08/01/2019	23.5	20.4	10.3	5.4	7.5	4.8	5.7	-0.7	-0.6	7.2
09/01/2019	23.9	22.7	10.4	5.0	7.2	11.8	1.4	1.9	1.8	6.8
10/01/2019	29.0	24.5	8.0	5.5	8.7	4.0	0.0	0.0	0.2	0.0
11/01/2019	21.2	17.9	6.4	5.6	8.1	1.8	1.0	2.2	2.1	4.1
12/01/2019	17.9	19.9	6.4	6.9	7.4	6.4	4.6	0.3	0.4	3.2
13/01/2019	28.2	32.2	9.7	8.4	12.3	1.8	0.1	2.7	2.5	-0.2
14/01/2019	19.1	20.3	6.3	7.1	9.7	1.3	5.0	0.1	0.3	4.9
15/01/2019	24.0	26.2	8.4	8.7	10.0	3.2	17.5	-0.2	-0.3	8.2
16/01/2019	34.6	31.5	10.8	13.1	11.9	15.4	3.0	-0.7	-0.8	2.1
17/01/2019	33.8	28.1	12.9	10.4	10.3	7.3	2.4	0.8	0.8	6.2
18/01/2019	32.0	33.8	10.0	9.7	10.1	8.1	4.6	2.7	2.6	2.1
19/01/2019	35.1	32.0	13.7	13.1	11.8	14.8	1.4	4.5	4.5	0.2
20/01/2019	22.2	20.3	6.0	4.6	7.4	0.7	-0.1	6.7	6.5	0.0
21/01/2019	13.9	12.6	7.6	6.9	7.7	7.3	10.4	2.5	2.6	2.7
22/01/2019	22.1	18.4	7.7	7.2	9.8	4.8	11.8	2.6	3.0	14.5
23/01/2019	31.7	30.2	12.4	11.5	10.5	5.6	0.6	3.2	3.2	0.0
24/01/2019	26.7	27.3	9.7	8.1	12.0	7.9	0.0	1.6	1.7	-2.5
25/01/2019	23.3	21.4	10.7	10.8	11.5	7.1	6.6	1.2	1.2	3.6
26/01/2019	29.6	29.9	10.8	12.5	13.8	2.7	1.6	10.0	9.9	1.0
27/01/2019	36.8	41.5	17.9	15.6	17.2	11.8	1.5	-	-	3.4
28/01/2019	33.0	24.8	13.4	8.8	14.5	8.2	0.6	-	-	4.9
29/01/2019	22.4	21.4	7.1	8.5	8.3	4.2	4.1	-	-	3.4
30/01/2019	24.7	35.5	10.4	9.1	11.0	2.9	3.2	-	-	2.5
31/01/2019	30.1	24.3	9.4	8.6	9.4	2.2	0.0	-	-	0.4
01/02/2019	16.2	12.7	4.2	6.7	5.8	1.3	0.0	-	-	0.0
02/02/2019	17.1	18.8	6.3	6.9	7.6	1.6	0.0	-	-	0.5
03/02/2019	16.8	12.3	6.9	4.1	5.4	4.3	1.1	-	-	8.6
04/02/2019	24.5	24.9	7.6	7.6	10.0	5.2	10.2	-	-	6.2
05/02/2019	25.7	22.1	7.2	8.2	8.0	5.1	0.2	-	-	6.6
06/02/2019	18.0	15.7	5.0	3.3	5.2	3.5	4.0	-	-	20.2
07/02/2019	19.0	13.9	5.9	5.4	6.4	2.2	6.6	-	-	0.2
08/02/2019	16.4	17.3	6.1	7.4	5.8	7.6	3.5	-	-	2.2
09/02/2019	13.8	12.0	5.1	2.9	-	4.7	1.0	-	-	-
10/02/2019	-	20.1	7.5	10.7	3.3	4.4	0.0	-	-	-0.4
11/02/2019	-	23.9	-	11.7	8.8	5.4	7.6	-	-	8.3
12/02/2019	26.4	20.3	7.1	5.4	7.6	2.5	0.2	-	-	0.6
13/02/2019	36.1	34.2	9.1	11.9	6.6	6.9	0.1	-	0.3	0.9
14/02/2019	26.2	20.3	5.6	-	3.9	1.3	0.0	-	3.6	7.7
15/02/2019	20.4	13.1	6.1	4.5	6.6	2.2	0.1	-	-2.4	2.9
16/02/2019	17.3	12.3	4.5	6.0	6.2	2.8	0.1	-	-3.5	3.0
17/02/2019	16.0	12.9	3.6	4.9	4.2	11.5	12.7	-	-1.8	5.3
18/02/2019	22.3	20.8	5.3	9.2	6.8	16.1	8.7	-	-2.7	4.5
19/02/2019	36.6	34.3	9.7	7.5	11.1	5.5	-	-	0.0	2.0
20/02/2019	14.1	11.1	4.3	3.3	7.4	12.0	0.0	-	12.2	0.0
21/02/2019	20.8	16.0	6.2	4.1	4.9	-	-0.1	-	0.6	-0.1
22/02/2019	19.3	17.1	5.8	2.7	4.6	-	0.0	-	0.8	0.0
23/02/2019	17.2	12.8	3.3	4.0	4.7	-	0.0	-	0.3	-0.1
24/02/2019	30.1	26.0	8.1	8.2	4.5	-	0.0	-	0.7	0.1
25/02/2019	23.3	22.0	6.7	7.0	6.2	-	0.0	7.0	0.7	0.1
26/02/2019	16.8	14.3	4.1	5.5	5.6	4.3	7.8	-0.5	1.0	4.5
27/02/2019	16.2	16.3	4.2	6.6	6.0	1.8	0.0	2.7	-	1.6
28/02/2019	14.2	19.9	3.5	-	6.2	2.6	3.1	3.5	-	1.0
01/03/2019	14.1	12.3	4.8	5.6	5.4	1.5	3.0	7.6	-	13.2
02/03/2019	19.5	12.7	3.9	3.5	5.4	2.4	0.4	3.5	0.8	7.3
03/03/2019	18.3	12.8	5.4	4.3	6.3	3.6	3.7	8.4	0.4	2.3
04/03/2019	26.4	18.2	6.4	5.2	8.5	5.8	6.7	6.0	0.8	22.3

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
05/03/2019	23.8	21.1	6.6	6.0	10.8	5.2	13.4	4.8	1.5	4.2
06/03/2019	**61.1**	46.4	11.3	7.5	14.0	3.5	0.1	4.5	3.2	1.4
07/03/2019	32.2	29.3	10.3	8.8	8.5	0.8	0.0	4.1	0.1	0.1
08/03/2019	27.1	25.1	6.4	11.4	8.1	3.7	8.1	4.5	2.1	7.5
09/03/2019	27.0	23.6	11.4	11.3	11.6	1.5	0.7	4.3	1.5	0.0
10/03/2019	18.8	15.8	7.7	9.8	9.8	1.8	4.6	3.3	0.0	1.6
11/03/2019	41.2	35.7	14.3	11.3	11.4	2.8	0.4	5.4	1.0	1.4
12/03/2019	39.2	32.1	15.0	11.2	11.8	5.4	4.0	5.7	7.2	3.9
13/03/2019	34.0	28.7	7.9	7.3	8.0	0.5	0.0	4.5	0.0	1.7
14/03/2019	31.0	27.5	10.6	9.4	11.7	1.1	0.2	4.9	0.4	-0.1
15/03/2019	19.8	16.9	7.5	5.5	6.6	5.5	0.1	4.6	2.6	0.1
16/03/2019	13.0	14.6	4.4	3.9	6.4	2.2	0.0	3.8	1.8	0.2
17/03/2019	5.2	4.8	1.7	2.5	4.5	3.9	0.0	3.7	1.4	0.4
18/03/2019	9.2	8.9	4.6	3.7	3.7	6.9	0.0	3.5	0.7	-0.3
19/03/2019	17.1	15.2	6.5	8.6	7.1	5.9	1.0	7.5	1.6	1.0
20/03/2019	15.5	11.6	6.0	7.0	7.0	1.8	0.0	3.8	0.3	0.4
21/03/2019	8.6	9.9	2.0	3.4	5.8	7.6	0.0	7.1	6.0	2.2
22/03/2019	7.8	8.4	-	1.9	4.1	0.3	0.1	5.5	0.7	0.7
23/03/2019	12.9	14.4	6.1	-	5.3	6.2	6.1	7.4	5.9	7.0
24/03/2019	21.0	26.6	6.9	7.6	6.8	6.8	1.4	8.3	-	1.0
25/03/2019	14.1	17.2	8.3	8.3	7.9	4.0	0.6	4.8	-	-1.0
26/03/2019	30.2	34.6	8.2	4.9	4.8	0.5	0.0	5.7	-	0.3
27/03/2019	21.5	21.7	6.2	8.0	5.9	0.7	0.0	3.7	-	1.2
28/03/2019	19.0	14.7	6.3	7.3	6.3	3.4	0.6	3.8	0.7	0.8
29/03/2019	14.6	16.1	4.1	5.9	6.9	4.0	8.3	3.7	2.4	4.6
30/03/2019	14.7	16.0	4.8	-	4.9	2.8	-0.1	4.2	-	0.3
31/03/2019	43.1	18.4	7.1	8.2	2.6	0.2	-0.1	4.6	-	0.8
01/04/2019	12.3	10.2	4.0	9.0	4.8	1.5	0.0	4.9	-	1.2
02/04/2019	9.4	10.0	3.1	5.5	3.8	1.8	0.0	4.7	0.6	1.6
03/04/2019	13.6	10.7	4.5	4.7	-	9.7	2.7	5.7	0.7	15.4
04/04/2019	13.8	11.9	5.6	4.7	-	4.4	1.4	4.4	0.7	2.3
05/04/2019	12.2	12.1	4.4	5.4	5.0	-0.7	0.0	3.2	0.3	-0.5
06/04/2019	13.3	13.5	5.8	5.6	6.7	3.6	1.2	4.4	3.9	2.2
07/04/2019	20.9	30.4	7.0	11.1	-	3.5	1.7	2.2	1.6	-
08/04/2019	24.6	19.9	8.2	-	-	4.3	0.0	-	0.6	-
09/04/2019	28.4	24.5	8.4	7.3	6.2	1.3	0.0	-	2.8	1.4
10/04/2019	16.7	17.2	6.6	4.4	5.1	3.5	0.2	4.0	0.8	0.6
11/04/2019	12.4	12.9	4.2	7.0	4.3	0.8	0.1	6.8	0.5	0.8
12/04/2019	8.6	10.2	3.2	6.0	4.5	1.8	0.0	5.3	0.8	-0.3
13/04/2019	16.1	14.4	9.0	9.6	5.9	3.1	1.6	9.7	2.3	4.4
14/04/2019	16.5	18.8	9.6	10.6	9.9	2.3	0.4	5.3	0.3	0.1
15/04/2019	14.6	15.1	6.3	6.6	7.4	1.0	0.0	3.8	0.5	0.0
16/04/2019	9.7	9.8	3.9	5.8	5.1	0.7	0.0	3.7	0.3	1.2
17/04/2019	10.0	8.6	5.6	5.6	3.5	1.5	0.1	5.6	0.3	4.6
18/04/2019	13.6	11.8	5.7	6.5	4.5	5.0	3.2	4.8	0.7	11.6
19/04/2019	18.5	19.6	7.3	7.4	6.9	1.3	0.1	7.6	0.6	1.4
20/04/2019	12.5	9.9	4.0	6.3	7.1	0.9	0.2	3.7	-0.4	3.6
21/04/2019	12.4	11.8	4.4	7.1	7.4	3.4	2.7	5.8	0.7	1.5
22/04/2019	12.4	12.0	4.7	5.3	9.5	4.4	7.1	4.1	2.7	4.4
23/04/2019	11.7	10.8	4.7	6.6	8.1	2.7	1.1	4.7	0.5	9.7
24/04/2019	9.1	10.2	3.6	-	-	4.4	1.9	4.9	3.9	-
25/04/2019	19.7	12.9	10.9	5.4	-	9.2	1.2	6.6	6.4	-
26/04/2019	25.0	22.1	12.4	3.8	**28.6**	1.3	0.5	4.1	3.8	-2.8
27/04/2019	29.5	30.5	7.4	8.3	16.4	3.2	0.0	3.3	3.0	0.4
28/04/2019	20.7	19.3	9.4	13.0	12.4	2.3	0.7	5.9	2.6	0.7
29/04/2019	19.5	23.2	8.6	14.8	12.9	1.0	-	6.1	0.9	0.9
30/04/2019	12.1	15.3	5.1	6.7	8.4	3.1	13.4	6.5	2.3	15.9
01/05/2019	14.4	14.7	4.5	8.3	6.2	1.0	1.4	4.6	11.1	2.1
02/05/2019	13.8	20.9	5.3	9.0	7.3	6.0	8.2	6.3	2.4	5.1
03/05/2019	16.5	13.1	5.3	4.3	8.2	2.1	3.5	6.9	3.7	4.5
04/05/2019	7.9	7.7	5.4	-	7.1	5.9	0.4	4.3	4.6	1.8
05/05/2019	7.7	-	2.0	-	11.2	8.1	-	4.4	4.9	0.1
06/05/2019	9.6	-	4.5	-	4.7	8.5	-	3.4	3.2	0.7
07/05/2019	12.4	7.8	5.0	5.2	4.2	0.5	0.0	3.7	0.2	0.0
08/05/2019	17.8	13.5	5.9	2.6	6.8	1.4	0.4	2.4	7.6	0.5

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
09/05/2019	18.1	14.1	7.5	7.5	12.8	5.5	3.6	4.7	4.8	2.8
10/05/2019	14.6	12.7	7.9	7.6	6.3	1.8	0.9	5.1	33.6	3.2
11/05/2019	11.3	8.9	4.8	5.0	2.5	0.3	0.0	3.3	8.3	0.0
12/05/2019	13.4	10.1	5.6	6.5	2.2	4.1	0.0	3.5	4.6	1.4
13/05/2019	14.8	12.0	6.7	6.3	5.0	2.8	4.3	3.9	2.0	2.8
14/05/2019	14.8	11.8	8.1	3.9	6.3	3.9	1.1	5.5	2.7	1.7
15/05/2019	15.9	12.5	8.1	6.0	6.1	1.7	0.4	4.8	-1.0	2.4
16/05/2019	14.5	15.6	7.6	5.9	7.2	2.1	0.6	5.8	0.1	4.5
17/05/2019	16.2	16.3	6.4	8.4	10.1	4.7	16.4	4.9	3.9	8.3
18/05/2019	16.8	18.0	12.8	11.7	9.2	2.1	5.2	7.7	1.4	9.4
19/05/2019	15.1	12.6	12.2	10.3	9.4	1.4	0.1	4.6	-1.1	0.8
20/05/2019	16.0	13.8	10.4	8.8	10.5	5.2	2.9	7.2	4.1	4.9
21/05/2019	20.6	16.3	10.0	7.0	8.7	4.9	0.7	5.5	5.0	3.6
22/05/2019	22.1	20.6	13.7	9.4	8.9	2.5	0.1	4.9	-1.8	2.3
23/05/2019	17.8	14.6	11.5	9.6	9.9	1.7	0.0	6.1	-0.5	1.7
24/05/2019	20.7	15.0	14.2	7.4	9.0	2.8	1.6	6.3	3.9	3.6
25/05/2019	22.3	11.4	15.8	5.0	7.0	3.6	0.2	4.7	1.1	1.3
26/05/2019	20.7	10.3	13.9	5.7	6.3	1.6	1.2	4.2	2.7	0.3
27/05/2019	29.2	11.6	3.5	-	3.8	0.7	0.7	2.5	10.2	1.4
28/05/2019	16.0	10.0	3.3	3.6	2.8	3.0	0.7	4.5	4.2	0.5
29/05/2019	19.2	10.4	4.8	2.8	-	5.0	0.2	3.7	6.2	-0.3
30/05/2019	8.0	11.7	3.7	4.9	7.5	1.4	0.0	4.3	-1.2	1.2
31/05/2019	18.3	36.2	6.8	**42.0**	22.6	0.5	1.4	2.7	-2.0	1.5
01/06/2019	17.5	14.7	12.8	10.3	8.4	3.2	0.0	0.1	6.7	0.1
02/06/2019	16.1	17.8	14.6	12.8	10.6	3.8	0.0	0.3	8.0	1.2
03/06/2019	11.8	11.0	7.7	-	12.8	0.3	0.4	-0.2	5.1	1.6
04/06/2019	6.9	7.6	2.8	7.5	4.2	14.2	-0.1	0.2	12.0	0.0
05/06/2019	7.1	6.6	4.5	5.5	2.9	15.2	-0.9	0.3	15.8	-0.5
06/06/2019	12.1	8.6	7.8	-	4.3	3.8	-	-0.1	6.4	1.0
07/06/2019	17.8	12.2	10.5	8.3	5.7	3.2	0.0	2.2	7.1	2.0
08/06/2019	14.4	9.3	11.9	6.5	7.7	1.5	0.2	1.6	6.8	2.4
09/06/2019	18.8	9.6	13.8	4.9	9.4	4.0	3.7	2.6	7.4	5.2
10/06/2019	15.5	7.8	10.9	7.1	6.6	8.5	0.0	0.6	8.3	2.7
11/06/2019	13.7	9.5	7.6	4.8	5.9	1.0	0.0	0.9	7.4	2.8
12/06/2019	19.9	10.8	10.3	6.7	6.6	5.1	-	5.1	10.6	6.4
13/06/2019	15.1	9.7	5.1	6.3	6.3	1.4	-	0.6	11.6	2.1
14/06/2019	12.8	10.1	8.2	5.6	5.6	2.6	0.2	0.9	3.3	1.9
15/06/2019	17.4	9.0	13.6	8.4	4.9	4.9	0.0	0.2	4.8	1.1
16/06/2019	14.0	10.0	13.9	7.5	6.0	3.0	0.0	0.8	4.8	0.1
17/06/2019	6.8	6.8	2.9	4.9	4.4	21.4	-0.1	0.9	11.1	0.6
18/06/2019	8.7	8.8	4.4	4.7	4.5	2.7	0.0	1.1	3.6	-0.2
19/06/2019	11.0	8.6	6.2	-	3.2	6.0	0.0	2.0	-	0.8
20/06/2019	16.1	11.3	8.1	6.3	4.9	2.1	0.0	6.9	3.5	1.2
21/06/2019	13.7	12.8	8.6	10.5	4.7	17.1	1.0	1.5	10.4	1.2
22/06/2019	8.0	10.2	3.9	8.8	5.4	10.0	0.0	1.1	5.4	0.1
23/06/2019	7.4	8.2	3.2	4.9	3.8	24.0	0.4	2.4	9.9	0.0
24/06/2019	7.5	7.8	3.5	5.6	2.6	5.4	0.1	0.9	3.9	-1.1
25/06/2019	6.9	6.8	2.8	4.2	2.6	0.9	-	1.9	2.6	0.0
26/06/2019	8.2	7.1	5.0	-	3.6	-	0.1	1.3	2.7	-0.2
27/06/2019	10.2	7.5	8.3	4.5	4.4	-	0.1	2.5	4.2	0.8
28/06/2019	11.5	8.2	6.9	4.4	3.9	-	2.9	4.4	5.8	5.9
29/06/2019	10.7	8.6	7.8	-	5.7	6.0	2.7	2.3	4.6	2.4
30/06/2019	15.0	9.3	10.2	4.9	4.4	0.1	1.7	0.6	7.3	1.9
01/07/2019	18.0	-	11.8	-	5.0	2.5	-	2.1	8.9	7.2
02/07/2019	23.7	14.3	13.8	8.5	7.2	4.8	3.4	3.9	7.2	4.8
03/07/2019	20.1	16.5	8.6	12.7	6.7	1.3	0.7	1.7	1.2	0.0
04/07/2019	11.4	10.1	4.7	6.4	4.4	1.1	0.0	1.5	3.1	0.5
05/07/2019	8.7	7.8	3.0	3.3	3.1	1.7	-0.1	1.6	2.8	0.1
06/07/2019	7.3	5.6	4.9	-	3.3	1.9	0.0	1.4	3.9	0.2
07/07/2019	10.1	6.6	8.0	4.5	3.1	3.1	0.4	2.7	4.2	0.6
08/07/2019	10.0	6.2	5.7	3.9	4.3	4.5	0.2	3.3	4.9	3.5
09/07/2019	11.0	6.7	7.0	-	3.0	9.6	0.5	1.3	11.0	1.1
10/07/2019	10.1	5.2	4.5	-	4.0	2.7	0.1	0.8	3.2	2.0
11/07/2019	15.7	9.1	3.4	6.4	3.8	3.4	0.0	0.6	6.7	0.1
12/07/2019	15.7	12.1	3.9	5.3	3.8	5.0	0.0	0.8	2.8	0.9

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
13/07/2019	10.4	12.0	3.0	4.9	3.7	0.0	0.5	0.5	18.3	0.5
14/07/2019	10.9	6.4	2.5	-	3.5	2.3	1.1	1.4	-	1.7
15/07/2019	13.0	8.9	5.7	-	3.7	3.9	0.5	1.1	10.8	1.4
16/07/2019	12.0	9.9	4.0	2.8	4.2	1.2	2.1	1.4	2.0	-0.7
17/07/2019	11.6	7.4	3.0	5.2	7.1	4.2	2.4	1.2	4.9	1.4
18/07/2019	15.3	9.4	5.6	5.0	3.1	2.2	0.4	0.9	4.1	1.0
19/07/2019	16.5	10.6	11.3	8.2	4.0	3.5	0.1	1.0	5.0	-0.5
20/07/2019	22.3	10.6	18.8	8.5	8.3	2.3	5.0	2.0	5.3	7.7
21/07/2019	25.6	15.0	17.3	12.1	10.6	4.0	0.5	1.1	7.2	1.3
22/07/2019	21.4	18.0	15.8	10.8	8.5	2.1	1.1	2.4	5.6	2.1
23/07/2019	20.1	17.3	11.1	8.5	8.4	3.9	0.6	1.6	3.2	1.5
24/07/2019	16.5	13.9	7.4	7.9	4.8	0.0	0.0	2.1	2.4	2.2
25/07/2019	18.4	14.1	10.8	8.5	4.6	5.1	3.2	2.0	3.8	9.9
26/07/2019	24.1	17.9	14.3	12.3	7.5	6.8	1.4	3.1	7.3	3.4
27/07/2019	18.5	15.6	12.1	8.5	7.5	5.4	0.0	1.2	2.3	0.0
28/07/2019	14.6	10.3	13.5	7.0	10.7	6.4	0.0	0.9	3.7	1.3
29/07/2019	18.1	17.4	10.3	10.0	10.2	5.2	0.1	1.5	4.7	1.3
30/07/2019	10.3	10.7	6.8	7.9	6.7	7.9	0.0	0.9	2.9	1.0
31/07/2019	7.4	8.9	3.2	4.8	4.1	10.8	0.0	0.8	5.6	2.4
01/08/2019	10.8	8.3	6.8	2.1	3.9	10.9	0.0	1.6	7.8	0.7
02/08/2019	13.7	10.5	9.1	6.0	4.6	3.5	0.0	1.6	6.5	1.3
03/08/2019	22.1	12.1	19.1	8.2	8.4	8.4	1.2	1.9	7.1	1.2
04/08/2019	16.5	12.4	13.3	8.3	8.8	3.3	0.0	3.9	5.4	1.1
05/08/2019	19.3	16.2	13.6	9.9	9.5	5.0	10.2	3.6	5.2	6.2
06/08/2019	19.1	15.5	10.1	12.2	8.1	4.3	2.0	2.8	4.3	2.6
07/08/2019	25.6	12.0	12.0	9.7	7.4	5.7	0.2	1.1	5.7	1.5
08/08/2019	24.8	16.0	7.3	5.7	8.1	3.6	0.7	3.9	-	4.2
09/08/2019	47.1	37.2	4.8	5.1	4.7	4.8	0.0	0.8	3.9	2.6
10/08/2019	13.9	9.5	2.6	3.2	3.1	1.9	0.0	0.8	3.7	-0.3
11/08/2019	10.9	5.7	3.3	2.7	4.2	2.4	0.0	1.0	4.0	2.3
12/08/2019	15.2	13.7	7.4	7.7	3.5	4.6	-0.4	2.2	5.4	0.7
13/08/2019	15.7	10.0	11.0	7.8	4.1	3.2	0.0	0.8	4.0	1.1
14/08/2019	20.6	15.4	12.6	13.2	6.6	6.9	5.5	5.8	7.9	4.7
15/08/2019	-	13.8	-	9.7	8.7	-	1.0	2.7	5.4	2.7
16/08/2019	-	16.2	-	8.9	7.7	-	0.7	2.7	2.6	1.6
17/08/2019	-	15.5	-	7.6	7.4	-	0.0	2.1	2.4	-0.8
18/08/2019	-	16.7	-	8.9	8.6	-	7.4	1.6	3.6	1.9
19/08/2019	-	26.4	-	6.9	4.3	-	0.0	0.7	13.4	-1.0
20/08/2019	13.3	10.7	1.7	6.6	3.3	1.1	0.5	1.5	-0.6	0.1
21/08/2019	18.4	13.9	3.2	3.5	3.2	3.8	0.0	0.9	5.9	1.1
22/08/2019	23.3	23.4	5.8	5.8	2.9	1.5	0.0	0.9	4.8	-1.1
23/08/2019	25.6	27.0	12.1	10.6	7.2	11.3	0.4	4.7	5.3	4.1
24/08/2019	29.6	20.4	14.1	15.0	7.7	6.7	1.4	1.5	3.9	1.3
25/08/2019	25.7	25.7	10.8	10.3	7.3	1.4	0.2	2.9	2.6	0.3
26/08/2019	-	10.9	-	4.9	13.3	4.4	0.0	1.5	4.3	1.4
27/08/2019	-	9.0	-	3.1	5.5	4.1	0.0	1.3	4.2	6.1
28/08/2019	12.2	-	6.9	-	5.2	8.0	0.0	1.4	7.6	3.8
29/08/2019	11.1	-	6.1	-	6.0	14.0	0.0	0.7	6.2	-0.9
30/08/2019	6.0	7.2	2.3	3.1	4.4	5.9	0.0	1.5	2.7	-0.3
31/08/2019	5.9	6.3	1.9	3.1	3.7	6.2	0.0	0.6	3.7	-0.5
01/09/2019	11.5	10.1	6.8	4.7	3.7	7.9	0.0	2.2	3.9	1.0
02/09/2019	-	12.7	-	3.3	6.0	-	0.0	1.0	3.2	3.1
03/09/2019	-	12.3	-	5.2	6.8	-	0.1	2.8	5.6	3.2
04/09/2019	20.3	16.1	7.6	7.8	7.8	9.2	4.0	3.8	4.3	14.6
05/09/2019	18.9	16.7	6.1	6.7	6.7	5.6	-0.2	1.4	0.8	16.4
06/09/2019	48.8	45.9	9.2	7.3	7.7	-	4.8	4.6	4.4	15.3
07/09/2019	20.2	10.7	3.7	2.5	3.2	0.0	0.2	0.5	0.6	5.0
08/09/2019	7.4	6.7	1.7	3.4	2.5	0.0	0.0	0.7	4.0	9.2
09/09/2019	9.9	10.8	3.8	4.3	2.3	7.2	0.0	0.8	12.2	1.4
10/09/2019	12.6	14.1	4.8	5.8	2.5	12.2	0.0	1.4	9.2	-
11/09/2019	-	16.2	-	6.1	5.2	-	1.1	7.0	1.6	7.7
12/09/2019	-	11.5	-	5.7	6.1	-	0.7	1.5	0.4	1.2
13/09/2019	27.0	25.6	8.4	10.0	7.9	1.5	0.1	5.5	0.1	1.8
14/09/2019	21.5	19.0	10.6	7.9	6.1	1.6	0.1	2.0	-0.1	0.0
15/09/2019	27.8	17.1	17.6	6.8	7.9	8.7	2.9	2.7	3.7	2.6

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
16/09/2019	28.5	20.8	9.2	-	8.4	9.5	0.1	1.7	-1.5	0.6
17/09/2019	11.2	12.9	3.1	6.8	4.9	11.0	0.0	1.6	2.5	0.0
18/09/2019	22.8	25.6	6.5	11.4	7.0	0.0	0.1	3.0	0.1	0.0
19/09/2019	17.2	15.6	7.6	3.6	6.5	3.3	0.5	1.5	1.1	2.4
20/09/2019	15.7	16.6	4.9	4.5	4.1	2.7	6.8	7.1	0.5	0.5
21/09/2019	14.2	18.9	6.0	6.1	7.2	3.9	9.1	2.2	2.8	7.4
22/09/2019	21.2	22.4	9.0	6.3	7.2	3.3	0.1	2.6	2.1	0.0
23/09/2019	12.6	13.6	5.0	5.7	4.2	1.7	0.4	1.3	2.5	-0.2
24/09/2019	11.3	14.4	4.0	5.5	4.3	9.2	4.0	7.0	4.6	9.6
25/09/2019	12.6	12.0	4.9	5.4	4.6	4.7	0.1	2.7	1.7	0.7
26/09/2019	17.6	16.0	7.2	8.9	7.6	2.7	0.1	1.6	0.8	9.4
27/09/2019	20.5	19.1	11.3	12.0	9.2	5.5	2.6	2.1	4.2	2.4
28/09/2019	21.3	16.6	6.1	6.2	7.3	2.1	0.0	2.3	0.0	0.0
29/09/2019	19.9	19.1	6.7	7.6	6.1	4.1	1.4	2.7	2.0	4.9
30/09/2019	16.1	15.8	6.4	5.9	5.3	-2.2	0.0	2.0	1.4	0.4
01/10/2019	14.8	11.3	4.6	2.7	4.5	2.1	0.0	1.9	-0.2	6.7
02/10/2019	16.9	16.4	5.9	5.7	6.8	6.2	8.2	4.3	4.8	4.0
03/10/2019	27.3	21.6	9.2	6.8	9.2	8.9	4.5	2.7	3.4	4.6
04/10/2019	30.3	26.9	10.4	9.7	9.4	4.8	0.1	1.2	1.8	0.5
05/10/2019	14.8	12.6	7.5	6.6	5.3	0.8	-0.2	5.6	-	0.0
06/10/2019	11.4	12.4	5.1	3.2	6.3	6.5	8.2	4.4	-	9.3
07/10/2019	31.8	30.0	11.3	8.8	9.9	1.0	0.0	4.0	-	0.0
08/10/2019	16.2	15.1	6.5	-	5.8	1.5	-0.1	1.0	-	0.0
09/10/2019	12.9	13.0	3.8	4.1	3.4	2.3	0.0	0.8	1.7	0.0
10/10/2019	12.9	17.8	4.0	5.6	4.4	5.0	-0.1	5.0	2.1	0.0
11/10/2019	8.8	6.6	3.9	3.1	3.7	4.2	0.0	1.4	2.0	2.1
12/10/2019	7.8	7.2	2.1	3.8	2.7	1.8	-0.1	1.0	1.2	0.0
13/10/2019	8.6	8.0	2.8	3.2	2.7	2.5	0.0	4.0	1.9	0.2
14/10/2019	14.5	11.8	5.6	5.1	5.3	13.1	11.1	3.4	1.8	7.5
15/10/2019	21.8	16.8	6.5	7.0	4.9	3.5	-	1.8	1.5	2.9
16/10/2019	23.6	20.3	11.0	8.9	10.3	2.6	2.3	4.9	1.4	2.5
17/10/2019	24.8	23.0	7.8	-	7.7	2.1	2.1	1.6	6.3	1.5
18/10/2019	21.8	17.9	5.0	5.2	3.8	3.9	1.4	1.6	5.8	4.6
19/10/2019	25.9	21.4	6.4	6.3	6.2	4.0	0.0	1.4	2.5	0.2
20/10/2019	16.4	18.4	6.2	4.9	4.7	3.4	0.0	2.2	1.1	2.3
21/10/2019	18.1	15.3	7.9	6.9	5.1	7.7	4.7	1.6	1.1	15.4
22/10/2019	20.5	15.5	8.0	5.3	6.5	7.5	3.8	1.9	1.7	4.9
23/10/2019	21.5	20.0	9.8	8.5	8.6	8.2	18.1	9.3	3.8	2.6
24/10/2019	31.7	26.4	17.8	12.8	11.5	5.1	0.6	4.3	4.3	3.4
25/10/2019	40.0	34.8	22.0	15.9	16.1	4.9	4.8	2.8	10.0	0.5
26/10/2019	**63.0**	**55.8**	14.7	12.3	13.8	2.3	0.1	5.1	4.2	1.1
27/10/2019	38.7	29.4	9.6	6.3	5.6	2.6	-0.1	2.3	2.9	2.3
28/10/2019	27.1	19.1	8.5	8.7	7.1	2.8	0.1	3.2	1.7	0.3
29/10/2019	**51.5**	33.6	**32.4**	18.1	16.7	9.3	5.2	3.6	3.1	4.6
30/10/2019	**127.7**	**99.0**	**100.9**	**68.3**	-	10.6	5.1	3.7	6.2	3.1
31/10/2019	-	**81.3**	-	**64.0**	**73.6**	-	2.6	2.8	3.7	15.8
01/11/2019	**58.3**	42.5	**47.2**	**27.2**	**28.4**	8.0	6.6	17.2	10.9	7.1
02/11/2019	48.1	44.7	**35.0**	**27.2**	**29.0**	5.1	6.7	3.7	4.7	3.9
03/11/2019	32.7	32.9	19.8	13.4	19.4	4.2	3.0	4.8	4.5	2.1
04/11/2019	7.5	8.2	5.0	3.7	6.7	5.2	0.0	1.0	2.5	1.3
05/11/2019	14.8	10.9	5.0	4.3	4.3	3.1	0.4	1.2	6.5	0.4
06/11/2019	18.0	14.8	4.9	7.2	5.6	8.5	1.6	2.7	6.6	1.7
07/11/2019	**70.4**	**80.7**	10.7	**25.2**	11.1	2.8	1.0	1.4	2.5	0.7
08/11/2019	45.3	46.5	7.6	19.2	8.1	2.5	1.2	1.7	1.4	-1.6
09/11/2019	11.5	11.9	5.3	3.4	5.3	1.8	0.0	10.6	3.2	0.0
10/11/2019	20.1	11.2	8.7	5.2	6.0	2.1	0.0	4.4	2.7	0.0
11/11/2019	**56.6**	45.2	**38.4**	**27.1**	18.0	3.5	3.6	2.9	4.2	3.4
12/11/2019	**81.5**	**92.9**	**48.0**	**39.1**	**40.9**	4.1	0.0	1.3	3.8	1.0
13/11/2019	28.0	22.6	14.6	4.9	8.9	2.4	0.7	1.1	3.1	1.3
14/11/2019	26.5	26.7	14.3	15.9	16.8	5.6	10.1	1.3	4.7	3.7
15/11/2019	35.1	**56.5**	11.8	**41.7**	20.3	5.6	2.9	2.3	3.6	3.6
16/11/2019	25.1	25.2	7.8	9.0	7.9	1.5	0.0	3.1	0.9	0.2
17/11/2019	26.2	24.0	12.9	8.5	7.0	2.7	-0.1	2.8	2.4	0.0
18/11/2019	33.8	27.4	17.5	8.4	13.1	4.2	5.5	1.7	2.4	7.4
19/11/2019	**53.5**	**89.2**	**33.6**	**71.9**	**35.9**	5.5	5.6	2.2	6.3	4.3

Date	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)			SO_2 (µg/m³)				
	Wallsend	Wyong	Wallsend	Wyong	Wyee	Wallsend	Wyong	Dora Creek	Marks Point	Wyee
20/11/2019	24.1	20.4	11.6	8.0	10.9	-	0.0	3.6	2.0	0.0
21/11/2019	**65.6**	**56.5**	**40.4**	**33.9**	**27.7**	4.8	-	2.0	3.1	8.7
22/11/2019	-	47.1	**40.3**	22.9	**29.2**	2.8	0.1	2.7	6.3	0.9
23/11/2019	33.2	36.1	15.6	11.9	13.4	2.8	0.0	3.9	2.7	0.5
24/11/2019	23.2	24.3	8.7	7.0	8.6	1.9	-0.2	4.7	2.2	0.0
25/11/2019	-	34.7	-	20.2	17.1	-	6.5	2.2	4.1	4.6
26/11/2019	-	**128.4**	-	20.4	19.7	-	1.4	2.7	4.5	1.5
27/11/2019	30.9	-	8.5	13.7	14.9	6.4	0.4	1.8	2.8	7.5
28/11/2019	**65.2**	**56.4**	**30.1**	**25.6**	22.1	9.2	3.4	5.3	3.1	7.6
29/11/2019	**74.8**	**71.1**	**40.5**	**36.9**	**33.2**	7.1	7.1	2.3	4.6	3.6
30/11/2019	47.8	**52.8**	22.9	22.9	**26.0**	2.3	0.4	1.6	2.2	0.1
01/12/2019	29.3	24.8	12.2	7.7	10.2	5.0	0.0	1.1	-1.3	5.8
02/12/2019	**74.9**	**64.5**	**42.0**	**34.8**	17.0	4.4	0.7	1.2	24.8	0.0
03/12/2019	**58.7**	**75.4**	**30.4**	**50.2**	**25.6**	3.1	-	3.4	2.1	2.2
04/12/2019	**85.3**	**106.6**	**69.3**	**90.4**	**58.1**	4.4	2.9	3.4	2.5	2.9
05/12/2019	**127.9**	-	**108.3**	**202.1**	**208.3**	8.7	5.0	3.5	5.9	4.9
06/12/2019	**83.2**	-	**48.3**	**43.8**	**91.8**	6.8	3.4	2.6	2.6	4.1
07/12/2019	39.4	47.4	22.9	23.2	**27.6**	3.2	0.0	4.2	1.5	7.0
08/12/2019	28.4	29.0	13.0	10.2	14.0	3.1	0.0	0.4	1.4	30.9
09/12/2019	41.0	33.8	20.8	14.5	11.1	3.5	-	2.3	0.1	1.0
10/12/2019	**90.9**	**110.0**	**65.2**	**74.3**	**73.7**	6.7	1.4	2.8	4.6	4.9
11/12/2019	30.7	33.1	15.0	8.7	15.7	9.3	0.0	6.6	3.5	0.0
12/12/2019	23.7	27.4	14.7	11.0	12.8	2.5	0.0	3.9	0.2	0.0
13/12/2019	19.1	18.6	8.2	6.2	8.5	3.2	0.0	0.7	0.2	0.3
14/12/2019	24.9	23.9	14.8	12.1	13.9	3.5	5.1	3.3	2.1	29.3
15/12/2019	21.9	28.6	13.5	15.9	15.8	5.2	13.4	4.5	1.3	5.3
16/12/2019	32.9	49.4	19.9	**25.7**	**34.6**	-	-0.4	4.4	0.5	2.4
17/12/2019	15.2	17.8	5.0	5.3	5.5	-	-0.1	3.7	-0.8	1.5
18/12/2019	24.5	26.3	10.5	10.7	11.4	3.5	-	2.1	0.5	6.5
19/12/2019	**66.4**	**90.3**	**37.4**	**52.0**	**45.0**	6.5	-	3.6	4.9	2.9
20/12/2019	32.0	37.2	11.9	11.6	12.5	2.3	0.3	3.4	1.0	9.9
21/12/2019	**55.1**	**52.3**	**26.0**	**25.7**	23.5	9.0	10.8	-	2.4	5.5
22/12/2019	34.5	35.9	12.6	10.1	13.5	2.1	0.0	-	-0.1	0.0
23/12/2019	28.1	33.8	9.4	12.9	13.0	2.4	0.0	-	0.9	6.8
24/12/2019	24.2	24.5	9.8	11.8	10.0	2.6	0.0	1.2	0.3	45.8
25/12/2019	22.0	21.6	10.6	9.0	10.1	1.8	0.7	1.2	0.4	9.0
26/12/2019	18.3	20.0	8.9	7.9	9.6	2.5	6.8	1.7	0.7	0.0
27/12/2019	15.7	14.2	5.2	4.1	5.9	2.7	7.8	2.1	0.6	1.4
28/12/2019	22.5	21.8	10.2	9.7	9.7	4.2	14.5	1.4	1.4	5.7
29/12/2019	38.6	34.1	19.1	12.8	15.2	6.6	2.4	2.5	1.9	4.8
30/12/2019	34.2	35.6	15.6	13.2	13.9	4.4	4.6	2.3	-0.4	4.2
31/12/2019	**51.8**	**71.7**	22.5	**34.3**	**26.5**	9.7	3.0	3.5	1.0	2.6

- No data

Table C-2: 24-hour average HVAS monitoring data (µg/m³)

Date	Teralba HVAS	Date	Teralba HVAS	Date	Teralba HVAS	Date	Teralba HVAS
02/01/2019	44	08/04/2019	26	13/07/2019	9	17/10/2019	23
08/01/2019	27	14/04/2019	10	19/07/2019	9	23/10/2019	17
14/01/2019	27	20/04/2019	9	25/07/2019	17	29/10/2019	44
20/01/2019	22	26/04/2019	33	31/07/2019	8	04/11/2019	8
26/01/2019	**51**	02/05/2019	13	06/08/2019	19	10/11/2019	36
01/02/2019	21	08/05/2019	17	12/08/2019	11	16/11/2019	24
07/02/2019	24	14/05/2019	9	18/08/2019	19	22/11/2019	**92**
13/02/2019	**66**	20/05/2019	11	24/08/2019	32	28/11/2019	**70**
19/02/2019	47	26/05/2019	10	30/08/2019	4	04/12/2019	**150**
25/02/2019	17	01/06/2019	13	05/09/2019	15	10/12/2019	**126**
03/03/2019	18	07/06/2019	18	11/09/2019	20	16/12/2019	**104**
09/03/2019	27	13/06/2019	12	17/09/2019	11	22/12/2019	**51**
15/03/2019	23	19/06/2019	6	23/09/2019	10	28/12/2019	30
21/03/2019	8	25/06/2019	1	29/09/2019	17	-	-
27/03/2019	15	01/07/2019	14	05/10/2019	9	-	-
02/04/2019	5	07/07/2019	7	11/10/2019	3	-	-