



LAKE MACQUARIE – WYONG  
REVIEW OF MONTHLY AMBIENT  
AIR QUALITY DATA  
OCTOBER 2015

NSW Environment Protection Authority

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## TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	PROJECT SCOPE.....	1
3	THE PURPOSE OF AMBIENT MONITORING.....	1
3.1	More about air quality .....	2
4	AIR QUALITY MONITORING SITES .....	3
5	AIR QUALITY CRITERIA.....	4
5.1	Particulate matter.....	4
5.1.1	PM <sub>2.5</sub> concentrations .....	4
5.2	Other air pollutants .....	4
5.3	Summary of applicable criteria for this review.....	5
6	METEOROLOGICAL MONITORING DATA.....	6
7	AMBIENT AIR QUALITY MONITORING DATA .....	8
7.1	Preamble.....	8
7.2	Analysis of Monitoring Data .....	8
7.3	PM <sub>10</sub> .....	8
7.4	PM <sub>2.5</sub> .....	9
7.5	NO <sub>2</sub> .....	9
7.6	SO <sub>2</sub> .....	9
7.7	O <sub>3</sub> .....	10
8	ANALYSIS OF ELEVATED POLLUTANT LEVELS.....	17
8.1	Wyong – 6 October 2015.....	17
9	CONCLUSIONS.....	20
10	REFERENCES .....	21

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## LIST OF TABLES

Table 4-1: Monitoring sites .....	3
Table 5-1: NSW EPA air quality impact assessment criteria .....	4
Table 5-2: Advisory standard for PM <sub>2.5</sub> concentrations.....	4
Table 5-3: Air quality impact assessment criteria for air pollutants .....	5
Table 5-4: Air quality criteria used in this review .....	5
Table 7-1: Maximum pollutant levels - October 2015.....	8

## LIST OF FIGURES

Figure 4-1: Monitoring site locations .....	3
Figure 6-1: October windroses – Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong...	7
Figure 7-1: Lake Macquarie - Wyong 24-hour average PM <sub>10</sub> levels – October 2015 .....	11
Figure 7-2: Lake Macquarie - Wyong 24-hour average PM <sub>2.5</sub> levels – October 2015.....	12
Figure 7-3: Lake Macquarie - Wyong 1-hour average NO <sub>2</sub> levels – October 2015 .....	13
Figure 7-4: Lake Macquarie - Wyong 1-hour average SO <sub>2</sub> levels – October 2015 .....	14
Figure 7-5: Lake Macquarie - Wyong 1-hour average O <sub>3</sub> levels – October 2015.....	15
Figure 7-6: Lake Macquarie - Wyong rolling 4-hour average O <sub>3</sub> levels – October 2015 .....	16
Figure 8-1: Analysis of elevated PM <sub>2.5</sub> levels on 13 September 2015 – Wyee .....	18

## LIST OF APPENDICES

Appendix A – How to read a windrose	
Appendix B – Monitoring Data (Graphical)	
Appendix C – Monitoring Data (Tabulated)	

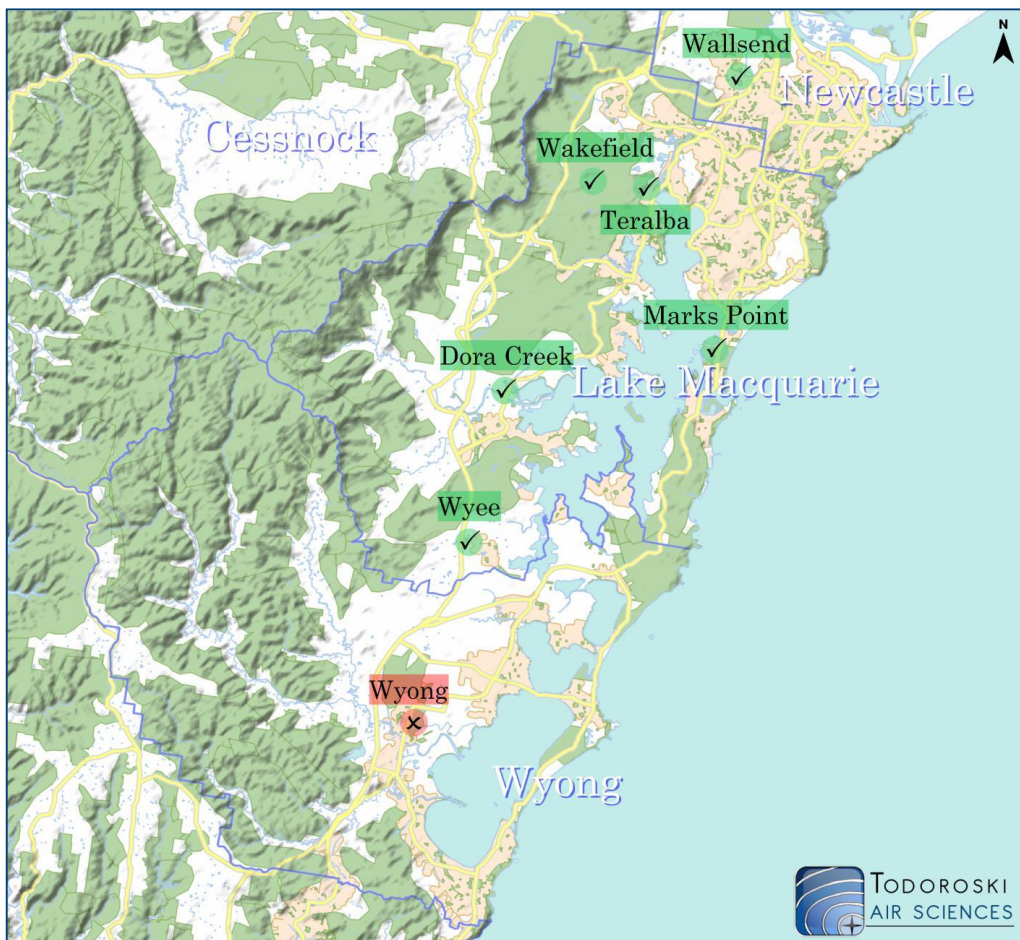
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## EXECUTIVE SUMMARY

This report has been prepared by Todoroski Air Sciences for the NSW Environment Protection Authority (NSW EPA) and presents ambient air quality monitoring data recorded in the Lake Macquarie - Wyong region for the month of October 2015. The results indicate that the air quality was generally good in the Lake Macquarie - Wyong region during October.

The data summary (shown below) indicates that in October, the Wyong monitor recorded a three hour period of rolling 4-hour average ozone levels above the criterion of  $171\mu\text{g}/\text{m}^3$  ( $182\mu\text{g}/\text{m}^3$ ,  $194\mu\text{g}/\text{m}^3$  and  $186\mu\text{g}/\text{m}^3$ ) on 6 October 2015. All other data were below the applicable criteria. Further details are provided in the report.

Lake Macquarie - Wyong Air Quality Pictorial Summary - October 2015



Lake Macquarie – Wyong Air Quality Tabular Summary - October 2015

Site	PM <sub>10</sub> ( $\mu\text{g}/\text{m}^3$ )	PM <sub>2.5</sub> ( $\mu\text{g}/\text{m}^3$ )	SO <sub>2</sub> ( $\mu\text{g}/\text{m}^3$ )	O <sub>3</sub> ( $\mu\text{g}/\text{m}^3$ )	O <sub>3</sub> ( $\mu\text{g}/\text{m}^3$ )	NO <sub>2</sub> ( $\mu\text{g}/\text{m}^3$ )	SO <sub>2</sub> ( $\mu\text{g}/\text{m}^3$ )
	24-hour average			4-hour average <sup>1</sup>	1-hour average		
	Air Quality Impact Criteria						
	50	25*	228	171	214	246	570
Wallsend	✓	✓	✓	✓	✓	✓	✓
Wyong	✓	✓	✓	x	✓	✓	✓
Dora Creek	-	-	✓	-	-	✓	✓
Marks Point	-	-	✓	-	-	✓	✓
Wyee	-	✓	✓	-	-	✓	✓
Wakefield HVAS	✓	-	-	-	-	-	-
Teralba HVAS	✓	-	-	-	-	-	-

✓ - All data below applicable criteria  
 x - At least one elevated level above applicable criteria

- - Not applicable  
 HVAS - High Volume Air Sampler

\* - Advisory reporting standard for PM<sub>2.5</sub> concentrations (refer to Section 5.1)

<sup>1</sup> - Rolling average

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## 1 INTRODUCTION

This report has been prepared by Todoroski Air Sciences on behalf of the NSW EPA. It provides a summary and analysis of the available ambient air quality and meteorological data collected in the Lake Macquarie - Wyong region during October 2015.

## 2 PROJECT SCOPE

The following outlines the scope of work for this project.

- ✦ Provide a monthly report written in plain English to the NSW EPA summarising and analysing available air quality data and meteorological information.
- ✦ The report will be published on the NSW EPA's website and 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.

The work is for the period from September 2013 to June 2016.

## 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 that 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<sub>10</sub>, 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.

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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.
  - o <http://www.environment.nsw.gov.au/AQMS/aboutaqi.htm>
- + Aqicn.org provides 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.
  - o <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.
  - o <http://www.environment.nsw.gov.au/aqms/aqi.htm>
- + The Lower Hunter Particle Characterisation Study aims 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. Progress reports are published on the OEH website provided below.
  - o <http://www.environment.nsw.gov.au/aqms/lowhunterparticle.htm>
- + 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.
  - o <http://www.epa.nsw.gov.au/air/airemissionsapp/airemissionswebtool.aspx>
- + The NSW Health website provides information on how air pollution affects health and steps for reducing your air pollution and limiting your exposure.
  - o <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 October 2015.

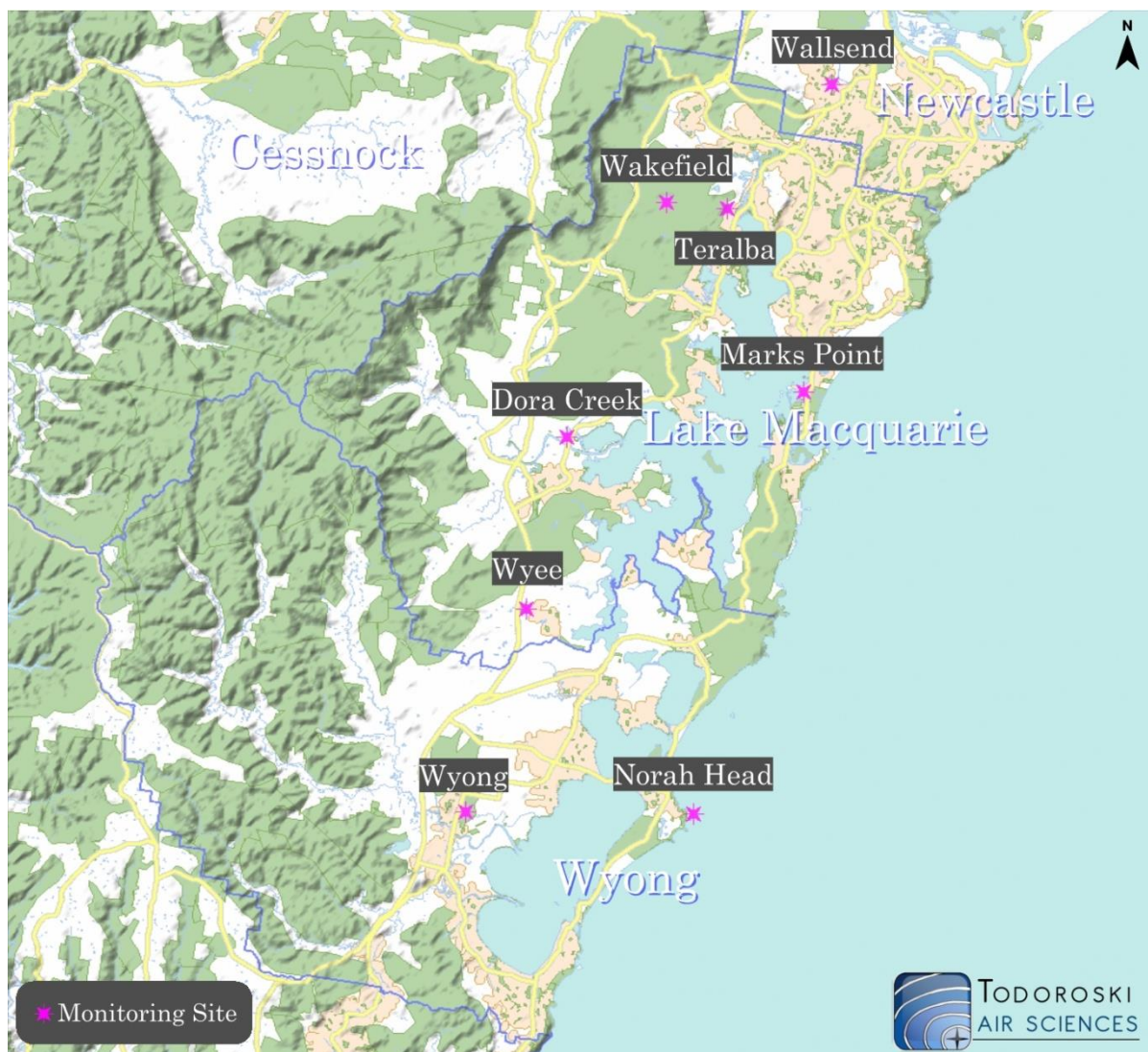


Figure 4-1: Monitoring site locations

Table 4-1: Monitoring sites

Monitoring Station	Type	Recorded Parameters	Recording Periods
Wallsend	NSW EPA site	PM <sub>10</sub> (TEOM), PM <sub>2.5</sub> , NO <sub>2</sub> , SO <sub>2</sub> , O <sub>3</sub> , WS, WD	Hourly/Daily
Wyong	NSW EPA site	PM <sub>10</sub> (TEOM), PM <sub>2.5</sub> , NO <sub>2</sub> , SO <sub>2</sub> , O <sub>3</sub> , WS, WD	Hourly/Daily
Marks Point	Industry site	NO <sub>2</sub> , SO <sub>2</sub> , WS, WD	Hourly
Wyee	Industry site	PM <sub>2.5</sub> , NO <sub>2</sub> , SO <sub>2</sub> , WS, WD	Hourly
Dora Creek	Industry site	NO <sub>2</sub> , SO <sub>2</sub> , WS, WD	Hourly
Norah Head	BOM weather station	WS, WD	Hourly
Wakefield HVAS	Industry site	PM <sub>10</sub> (HVAS)	Every 6th Day
Teralba HVAS	Industry site	PM <sub>10</sub> (HVAS)	Every 6th Day

PM<sub>10</sub> - Particulate matter < 10µm

PM<sub>2.5</sub> - Particulate matter < 2.5µm

TEOM - Tapered Element Oscillating Microbalance  
(which samples air continuously)

NO<sub>2</sub> - Nitrogen dioxide

SO<sub>2</sub> - 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 ( $\mu\text{m}$ ) as in practice particles larger than 30 to 50 $\mu\text{m}$  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  $\text{PM}_{10}$  particles, particulate matter with aerodynamic diameters of 10 $\mu\text{m}$  or less, and  $\text{PM}_{2.5}$ , particulate matter with aerodynamic diameters of 2.5 $\mu\text{m}$  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 DEC, 2005)*.

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

Pollutant	Averaging Period	Criterion
Total suspended particulates (TSP)	Annual	90 $\mu\text{g}/\text{m}^3$
Particulate Matter < 10 $\mu\text{m}$ ( $\text{PM}_{10}$ )	Annual	30 $\mu\text{g}/\text{m}^3$
	24-hour	50 $\mu\text{g}/\text{m}^3$

Source: NSW DEC, 2005

#### 5.1.1 $\text{PM}_{2.5}$ concentrations

The NSW EPA currently do not have impact assessment criteria for  $\text{PM}_{2.5}$  concentrations, however the National Environment Protection Council (NEPC) has released a variation to the National Environment Protection Measure (NEPM) (NEPC, 2003) to include advisory reporting standards for  $\text{PM}_{2.5}$  (see Table 5-2). As with the NEPM goals, the advisory reporting standards apply to the average, or general exposure of a population, rather than to "hot spot" locations such as industry monitoring sites.

Table 5-2: Advisory standard for  $\text{PM}_{2.5}$  concentrations

Pollutant	Averaging Period	Concentration
Particulate Matter < 2.5 $\mu\text{m}$ ( $\text{PM}_{2.5}$ )	24-hour	25 $\mu\text{g}/\text{m}^3$
	Annual	8 $\mu\text{g}/\text{m}^3$

Source: NEPC, 2003

### 5.2 Other air pollutants

Nitrogen dioxide ( $\text{NO}_2$ ) 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.  $\text{NO}_2$  belongs to a family of reactive gases called nitrogen oxides ( $\text{NO}_x$ ). These gases form when fuel is burned at high temperatures, and mainly originates from motor vehicles, power generators and industrial boilers (USEPA, 2013).  $\text{NO}_x$  may also be generated by blasting activities. It is important to note that when formed,  $\text{NO}_2$  is generally a small fraction of the total  $\text{NO}_x$  generated.

Sulfur dioxide ( $\text{SO}_2$ ) is a colourless, toxic gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulfur content of the fuel.  $\text{SO}_2$  can have impacts upon human health

and the habitability of the environment for flora and fauna. SO<sub>2</sub> 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.

Ozone (O<sub>3</sub>) has a slight blue colour and is a reactive gas comprised of three oxygen atoms. It is typically found in the upper atmosphere, and forms what is referred to as the ozone layer which filters harmful ultraviolet radiation from the sun, and the near ground level in the troposphere. Tropospheric ozone forms through reactions between nitrogen oxides and volatile organic compounds (VOCs) in the presence of ultraviolet radiation. Tropospheric ozone is the main component of photochemical smog and can impact human health.

**Table 5-3** summarises the air quality goals for NO<sub>2</sub>, SO<sub>2</sub> and O<sub>3</sub>.

**Table 5-3: Air quality impact assessment criteria for air pollutants**

Pollutant	Averaging period	Criterion
Nitrogen Dioxide (NO <sub>2</sub> )	1-hour	246µg/m <sup>3</sup>
	Annual	62µg/m <sup>3</sup>
Sulfur Dioxide (SO <sub>2</sub> )	10-minute	712µg/m <sup>3</sup>
	1-hour	570µg/m <sup>3</sup>
	24-hour	228µg/m <sup>3</sup>
	Annual	60µg/m <sup>3</sup>
Ozone (O <sub>3</sub> )	1-hour	214µg/m <sup>3</sup>
	Rolling 4-hour	171µg/m <sup>3</sup>

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. Annually averaged criteria require a full year of data.

As this report only looks at one month of ambient air quality data, the annual average criteria are not applicable. The SO<sub>2</sub> 10-minute average criterion was not included as 10-minute monitoring data are not available. Therefore the criteria relevant to this assessment are those averaged over the shorter time periods (1-hour and 24-hours).

**Table 5-4** summarises the applicable air quality criteria for this review.

**Table 5-4: Air quality criteria used in this review**

Pollutant	Averaging Period	Type	Concentration
Particulate Matter < 10µm (PM <sub>10</sub> )	24-hour	Criterion	50µg/m <sup>3</sup>
Particulate Matter < 2.5µm (PM <sub>2.5</sub> )	24-hour	Advisory Reporting Standard	25µg/m <sup>3</sup>
Nitrogen Dioxide (NO <sub>2</sub> )	1-hour	Criterion	246µg/m <sup>3</sup>
Sulfur Dioxide (SO <sub>2</sub> )	1-hour	Criterion	570µg/m <sup>3</sup>
	24-hour	Criterion	228µg/m <sup>3</sup>
Ozone (O <sub>3</sub> )	1-hour	Criterion	214µg/m <sup>3</sup>
	Rolling 4-hour	Criterion	171µg/m <sup>3</sup>

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## 6 METEOROLOGICAL MONITORING DATA

Representative wind speed and direction data have been obtained from the Lake Macquarie - Wyong air quality monitoring stations. The data are presented as a series of windroses. For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

**Figure 6-1** presents the October 2015 windroses for Wallsend, Dora Creek, Marks Point, Wye, Norah Head and Wyong.

The figure shows that the meteorological stations recorded winds which varied depending on the local influence of environmental features such as terrain, vegetation and buildings. Overall the stations recorded winds which typically originated from the northeast and southwest quadrants with the coastal stations indicating winds predominantly from the northeast.

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.

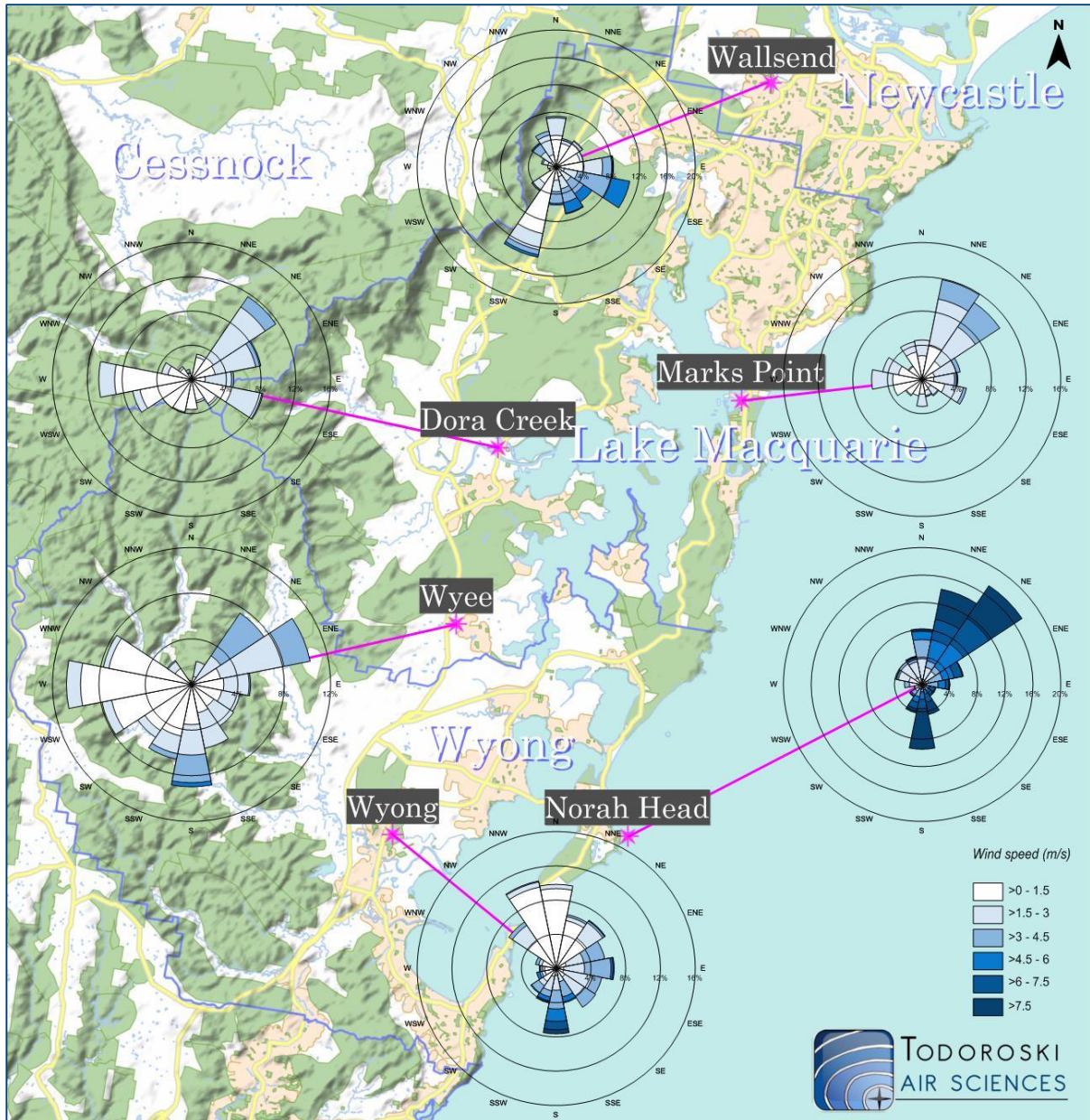


Figure 6-1: October windroses – Wallsend, Dora Creek, Marks Point, Wyee, Norah Head and Wyong

Overall the stations recorded winds which typically originated from the northeast and southwest quadrants with the coastal stations indicating winds predominantly from the northeast.

## 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 the NSW EPA.

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.

All of the monitoring data provided to Todoroski Air Sciences are presented in this report. The data are shown in the results and Appendices as relevant. 1-hour, 24-hour average and rolling 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**.

### 7.2 Analysis of Monitoring Data

**Table 7-1** presents a summary of the maximum pollutant levels measured during October 2015. The results indicate that pollutant levels were below the applicable criteria for all monitors at all times.

Table 7-1: Maximum pollutant levels - October 2015

Site	PM <sub>10</sub> (µg/m <sup>3</sup> )	PM <sub>2.5</sub> (µg/m <sup>3</sup> )	SO <sub>2</sub> (µg/m <sup>3</sup> )	O <sub>3</sub> (µg/m <sup>3</sup> )	O <sub>3</sub> (µg/m <sup>3</sup> )	NO <sub>2</sub> (µg/m <sup>3</sup> )	SO <sub>2</sub> (µg/m <sup>3</sup> )
	24-hour average	24-hour average	24-hour average	Rolling 4- hour average	1-hour average	1-hour average	1-hour average
	Air Quality Impact Criteria						
	50	25*	228	171	214	246	570
Wallsend	33.1	14.2	21.1	131.7	152.0	86.2	88.5
Wyong	36.8	10.8	9.0	194.9	207.7	53.4	48.5
Dora Creek	-	-	11.8	-	-	61.3	87.1
Marks Point	-	-	10.4	-	-	76.3	66.6
Wyee	-	17.9	14.3	-	-	87.9	82.3
Wakefield HVAS	28.5	-	-	-	-	-	-
Teralba HVAS	28.0	-	-	-	-	-	-

\* Advisory reporting standard for PM<sub>2.5</sub> concentrations (refer to Section 5.1)

- Not applicable

### 7.3 PM<sub>10</sub>

**Figure 7-1** presents all of the 24-hour average PM<sub>10</sub> monitoring results recorded in the Lake Macquarie - Wyong region in October 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, PM<sub>10</sub> levels were very good or good at all monitors at all times, with the exception of the Wyong monitor which recorded two days with fair levels.

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the PM<sub>10</sub> criterion level in October.

**Figure B-1** to **Figure B-2** in **Appendix B** present the 1-hour average, 24-hour average and rolling annual average PM<sub>10</sub> data in graphical form for each individual site. There is no criterion that applies to 1-hour average PM<sub>10</sub> levels and these 1-hour results are not intended to be compared with the PM<sub>10</sub>

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-1** to **Figure B-2** show the rolling annual average  $PM_{10}$  levels recorded at the Wallsend and Wyong monitors were  $17.1\mu\text{g}/\text{m}^3$  and  $15.2\mu\text{g}/\text{m}^3$  respectively at the end of October 2015. The rolling annual average levels can be compared to the annual average criterion of  $30\mu\text{g}/\text{m}^3$ , however typically a calendar year of data are used to determine whether the annual average goal has been met.

#### 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 October 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate that the recorded  $PM_{2.5}$  levels were very good to good at all monitors at all times with the exception of the Wyee monitor which recorded one day with fair levels.

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the advisory reporting standard of  $25\mu\text{g}/\text{m}^3$  in October 2015.

**Figure B-3** to **Figure B-5** in **Appendix B** present the 1-hour average, 24-hour average and rolling 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.

**Figure B-3** to **Figure B-5** show the rolling annual average  $PM_{2.5}$  levels recorded at the Wallsend, Wyong and Wyee monitors were  $7.3\mu\text{g}/\text{m}^3$ ,  $5.4\mu\text{g}/\text{m}^3$  and  $6.0\mu\text{g}/\text{m}^3$  respectively at the end of October 2015. The rolling annual average levels can be compared to the annual average advisory reporting standard of  $8\mu\text{g}/\text{m}^3$ , however typically a calendar year of data is used to determine whether the annual average advisory reporting standard goal has been met.

#### 7.5 $NO_2$

**Figure 7-3** presents the 1-hour average  $NO_2$  monitoring data recorded in the Lake Macquarie - Wyong region in October 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figure, the data indicate the  $NO_2$  levels were very good at all monitors with the exception of the Wyee and Wallsend monitors which recorded two and one hours with good levels respectively.

All data were below the applicable criterion on all days.

#### 7.6 $SO_2$

**Figure 7-4** presents the 1-hour average  $SO_2$  monitoring data recorded in the Lake Macquarie - Wyong region in October 2015.

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.

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All data were below the applicable criterion on all days.

### 7.7 O<sub>3</sub>

**Figure 7-5** presents the 1-hour average O<sub>3</sub> monitoring data recorded in the Lake Macquarie - Wyong region in October 2015.

**Figure 7-6** presents the rolling 4-hour average O<sub>3</sub> monitoring data recorded in the Lake Macquarie - Wyong region in October 2015.

Relative to the Air Quality Index, as shown by the coloured bands in the figures, the data indicate the 1-hour average O<sub>3</sub> levels were generally very good or good at both locations. The Wyong and Wallsend monitors recorded eight and one hours with fair levels respectively.

The measured rolling 4-hour average levels were generally very good or good. The Wyong and Wallsend monitors recorded fair levels approximately 1% of the time. The Wyong monitor also recorded a three hour period of poor ozone levels.

The Wyong monitor recorded a period of levels above the rolling 4-hour average O<sub>3</sub> criterion level of 171µg/m<sup>3</sup> in October 2015. All other data were below the applicable criterion on all days.

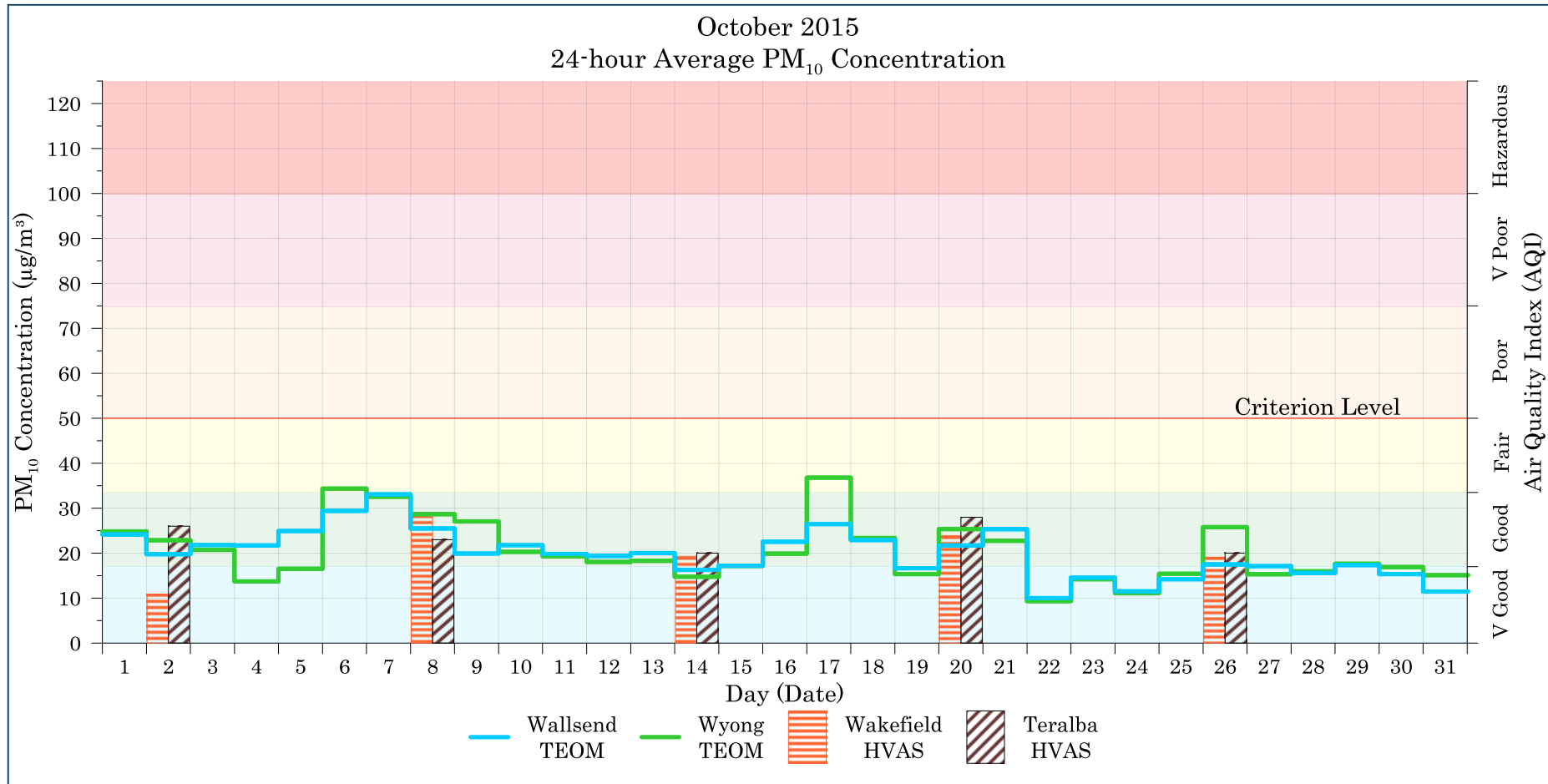


Figure 7-1: Lake Macquarie - Wyong 24-hour average PM<sub>10</sub> levels – October 2015

The recorded PM<sub>10</sub> levels were very good or good at all monitors at all times, with the exception of the Wyong monitor which recorded two days with fair levels. All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 24-hour average criterion of 50µg/m<sup>3</sup> in October 2015.



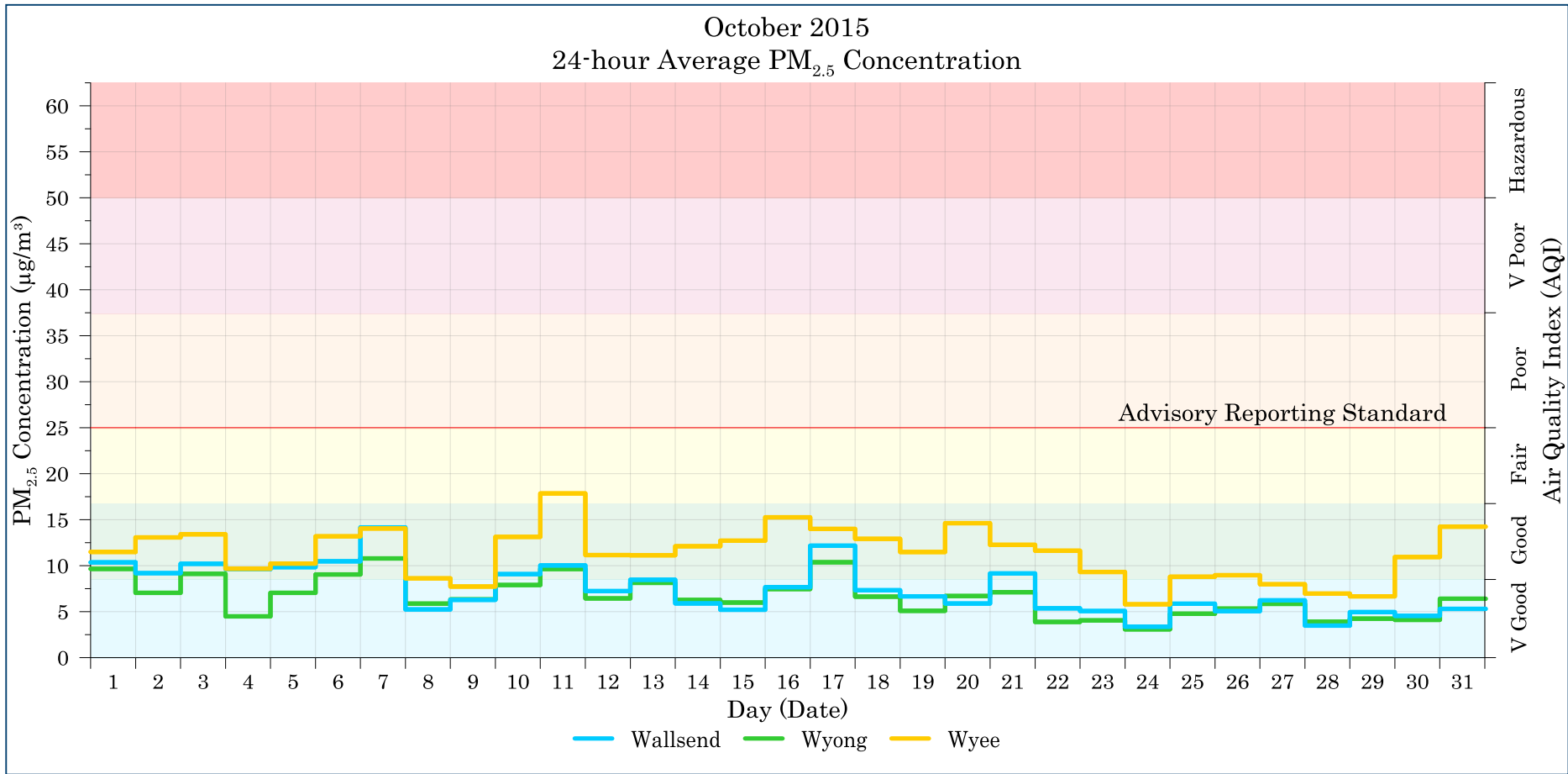


Figure 7-2: Lake Macquarie - Wyong 24-hour average PM<sub>2.5</sub> levels – October 2015

The recorded PM<sub>2.5</sub> levels were very good to good at all monitors at all times with the exception of the Wye monitor which recorded one day with fair levels. All data recorded at the Lake Macquarie - Wyong monitoring sites were below the advisory reporting standard of 25µg/m<sup>3</sup> in October 2015.

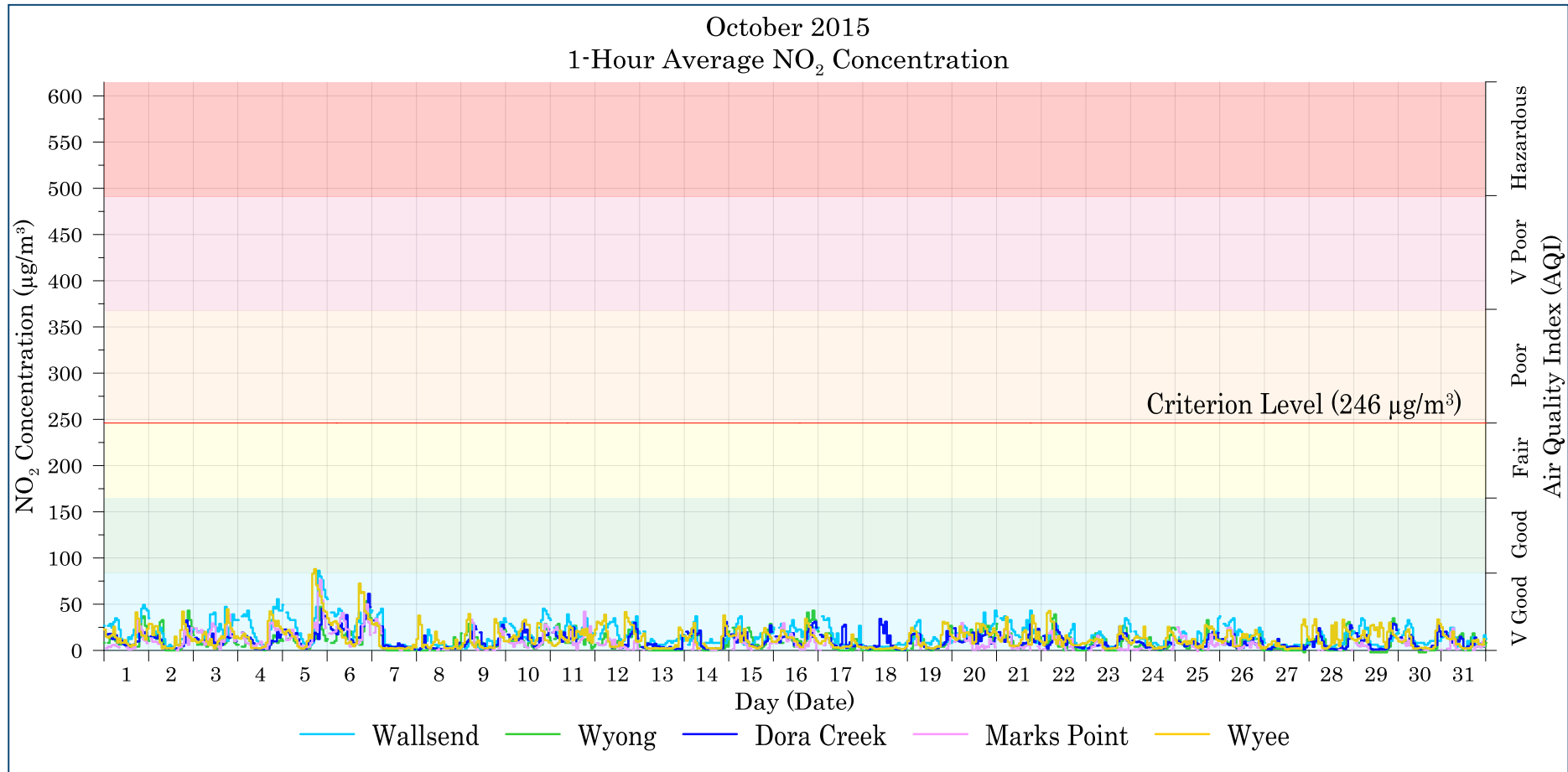


Figure 7-3: Lake Macquarie - Wyong 1-hour average NO<sub>2</sub> levels – October 2015

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average NO<sub>2</sub> criterion level of 246µg/m<sup>3</sup> in October 2015. Measured levels of NO<sub>2</sub> were very good at all monitors with the exception of the Wye and Wallsend monitors which recorded two and one hours with good levels respectively.

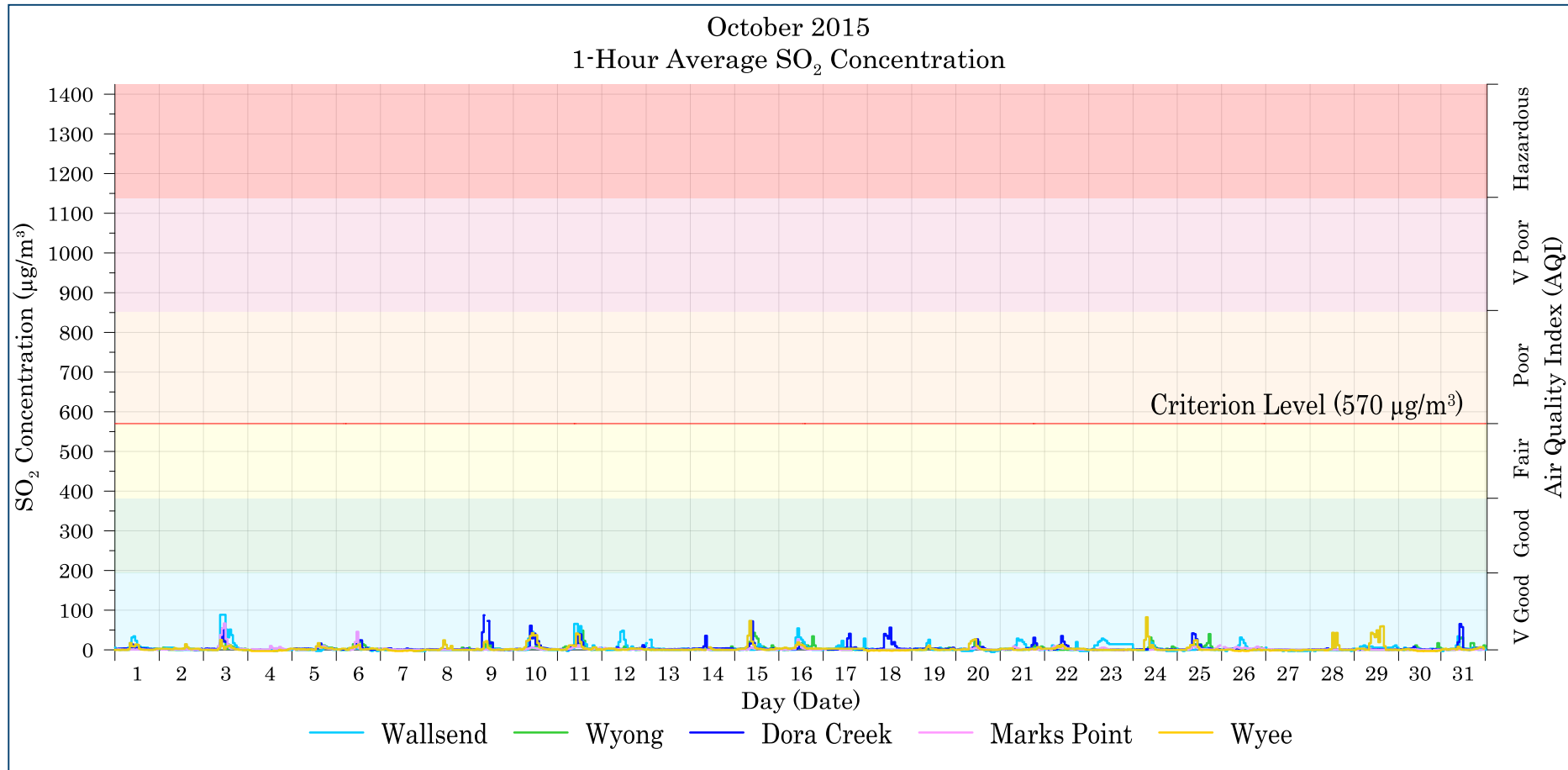


Figure 7-4: Lake Macquarie - Wyong 1-hour average SO<sub>2</sub> levels – October 2015

All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average SO<sub>2</sub> criterion level of 570µg/m<sup>3</sup> in October 2015. Measured levels of SO<sub>2</sub> were very good at all monitors at all times.

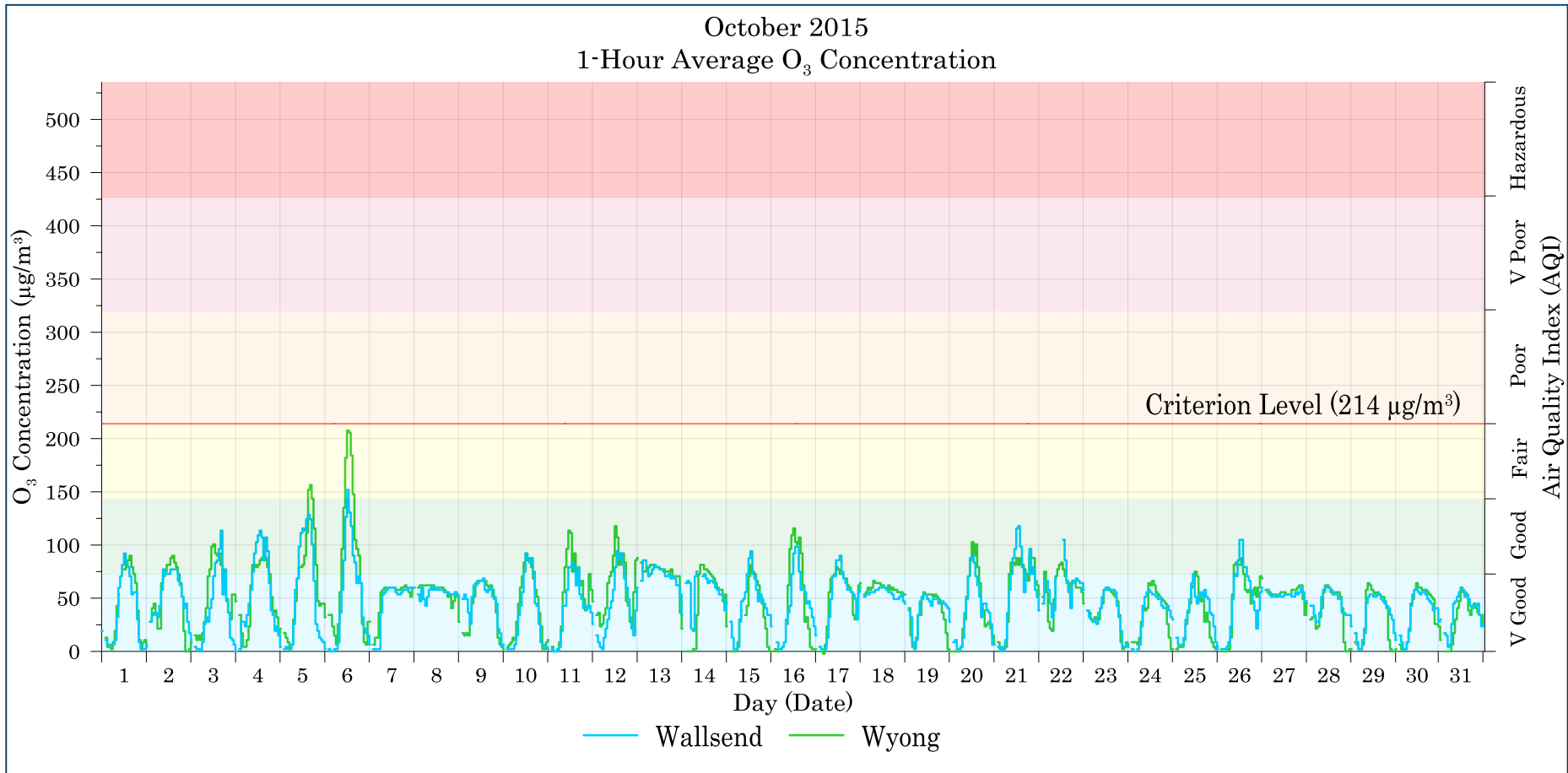


Figure 7-5: Lake Macquarie - Wyong 1-hour average O<sub>3</sub> levels – October 2015

The measured 1-hour average levels of O<sub>3</sub> were generally very good or good. The Wyong and Wallsend monitors recorded eight and one hours with fair levels respectively. All data recorded at the Lake Macquarie - Wyong monitoring sites were below the 1-hour average O<sub>3</sub> criterion level of 214µg/m<sup>3</sup> in October 2015.

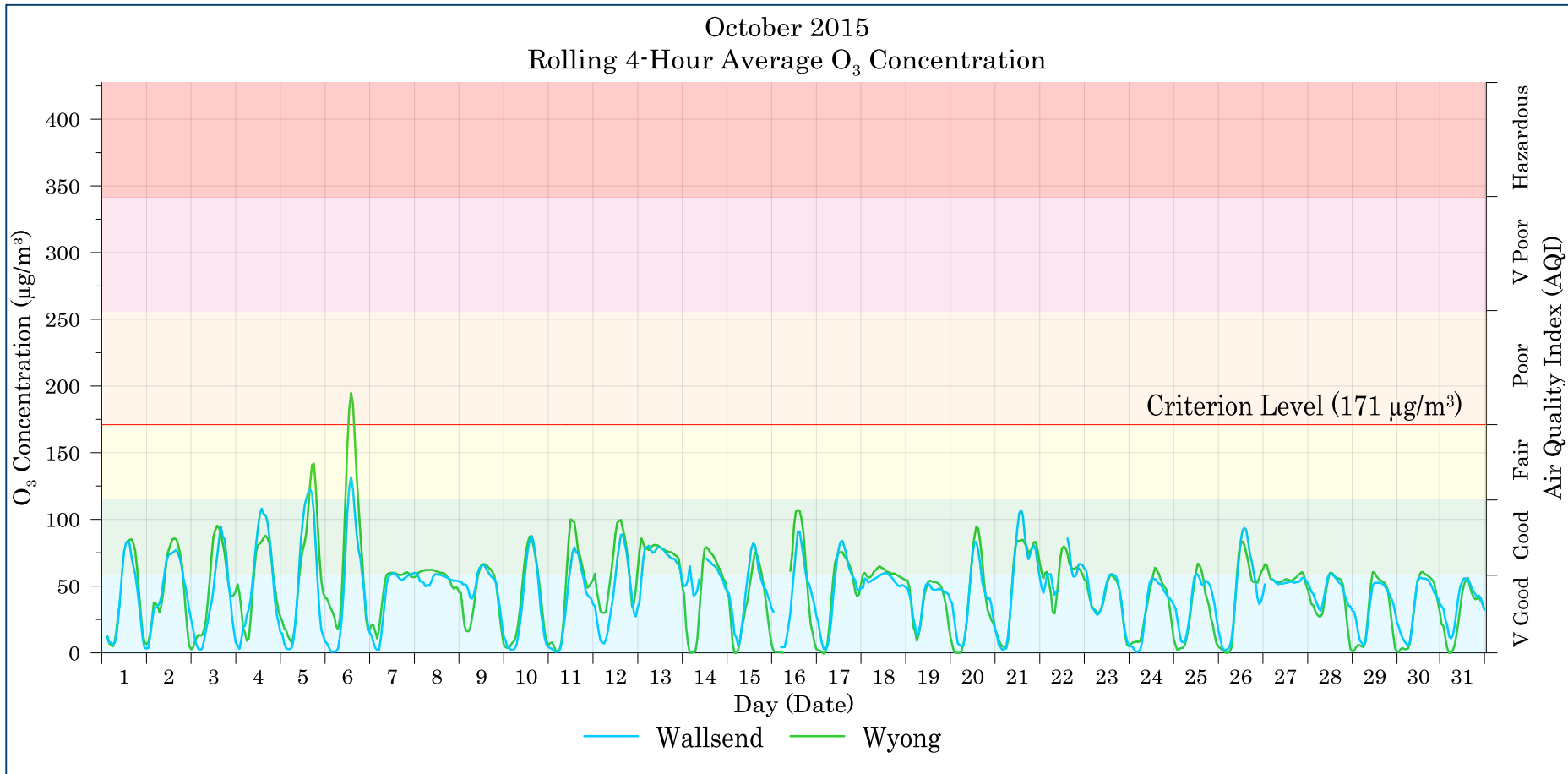


Figure 7-6: Lake Macquarie - Wyong rolling 4-hour average O<sub>3</sub> levels – October 2015

The measured rolling 4-hour average levels were generally very good or good. The Wyong and Wallsend monitors recorded fair levels approximately 1% of the time. The Wyong monitor also recorded a three hour period of poor ozone levels above rolling 4-hour average O<sub>3</sub> criterion level of 171µg/m<sup>3</sup> in October 2015. All other data were below the criterion.

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## 8 ANALYSIS OF ELEVATED POLLUTANT LEVELS

### 8.1 Wyong – 6 October 2015

**Figure 8-1** presents a plot of the 1-hour average and 4-hour average O<sub>3</sub> concentration, wind speed and wind direction, temperature and 1-hour average NO<sub>x</sub> concentration data recorded at the Wyong monitoring site on 6 October 2015. The 1-hour and 4-hour average O<sub>3</sub> levels recorded at Wallsend have also been included in the plot.

The data presented in **Figure 8-1** show that the Wyong monitor recorded elevated 4-hour average O<sub>3</sub> levels from 2pm until 4pm on 6 October. The elevated levels were recorded during hot conditions with temperatures up to 33.5°C and southeasterly winds with speeds up to 3.5m/s. Warm calm northerly wind conditions and higher levels of ambient NO<sub>x</sub> concentrations preceded the event. The figure also shows that the Wallsend monitor recorded similar O<sub>3</sub> trends as the Wyong monitor although the levels were not as elevated.

The weather conditions on the day were conducive to ozone formation with high temperatures and favourable wind conditions (**NSW DECCW, 2010**). Ambient levels of NO<sub>x</sub> at the Wyong monitor decreased when the ozone levels increased and vice-versa. The rate of ozone production is dependent on the ratio of the precursor pollutants (NO<sub>x</sub> and VOCs) as ozone is a secondary photochemical pollutant formed when two precursor pollutants react in the presence of sunlight.

**Figure 8-2** presents data from all of the available NSW EPA (O<sub>3</sub>) monitoring sites and shows that O<sub>3</sub> levels were elevated at other locations in the Sydney Greater Metropolitan Region (GMR) on 6 October 2015. The Randwick, Wollongong and Lindfield monitoring sites recorded elevated 4-hour average O<sub>3</sub> levels above the relevant criterion on 6 October 2015 with the Rozelle and Earwood monitoring sites recording levels close to the criterion.

The elevated levels recorded at other locations in the Sydney GMR suggest that the levels recorded at Wyong may have been due to a regional ozone event. This event is unusual as the highest ozone levels were recorded at monitoring stations near to the coast. In the Sydney Basin, elevated ozone concentrations are more frequently recorded further inland in western Sydney. They are typically NO<sub>x</sub> limited and generally occur with sea-breezes (easterly winds) which transport photochemical pollutants across the basin (**NSW DECCW, 2010**).

The elevated levels on 6 October 2015 were recorded during Australia's warmest October on record. Extreme heat in the first ten days of October set new records for early-season warmth across southern Australia. The hot air's trajectory across the southern part of the continent was somewhat in contrast with many historical heatwaves in southern Australia, in which the extreme heat originates in the continental interior (**BoM, 2015**). This unusual heatwave may have increased the likelihood of an elevated ozone event to occur as weather conditions conducive to ozone formation, such as high temperatures and high solar radiation, would have been more common during this period.

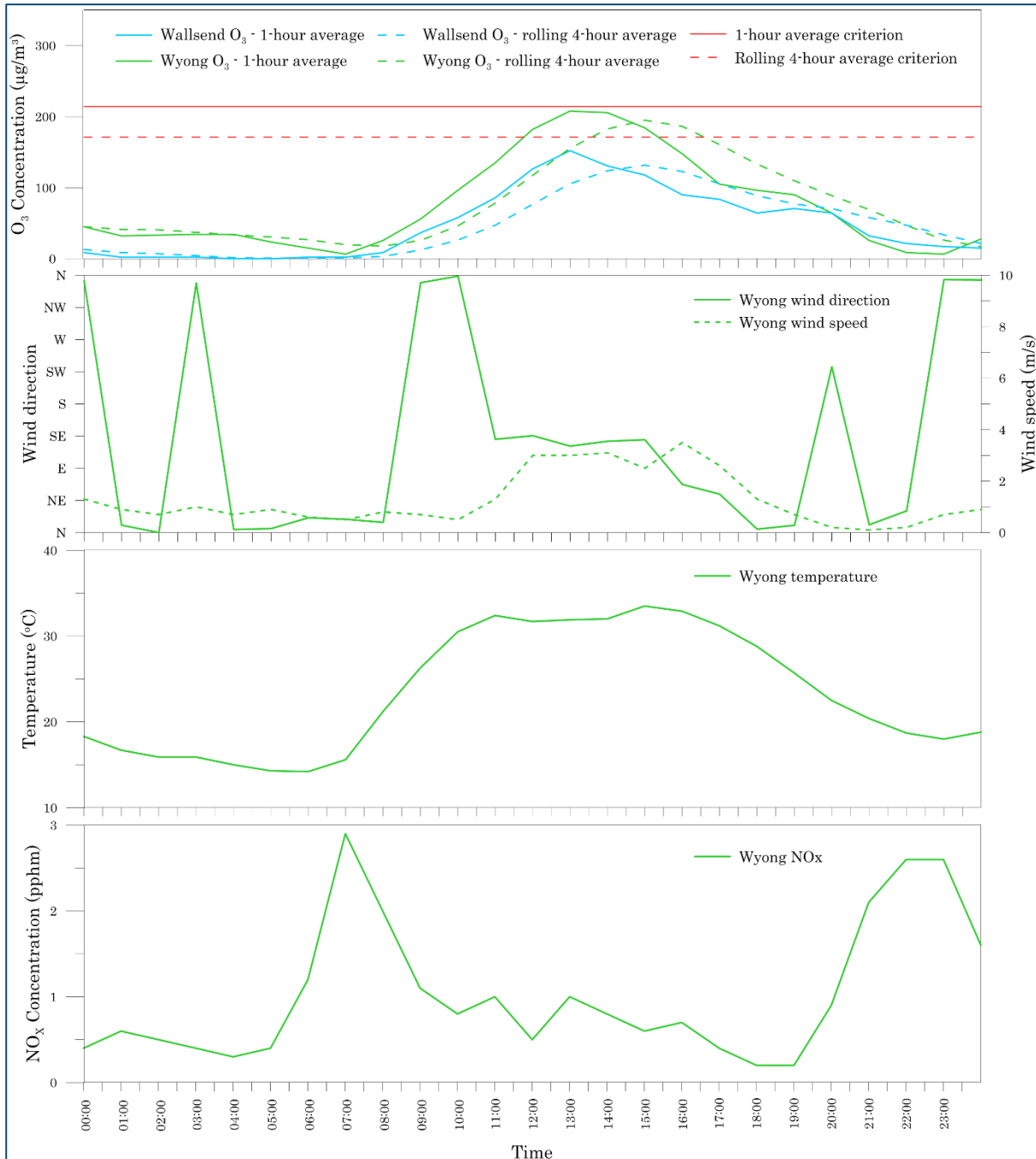


Figure 8-1: Analysis of elevated O<sub>3</sub> levels on 6 October 2015 – Wyong

The Wyong monitor recorded elevated 4-hour O<sub>3</sub> levels from 2pm until 4pm during hot conditions with temperatures up to 33.5°C and southeasterly winds with speeds up to 3.5m/s.

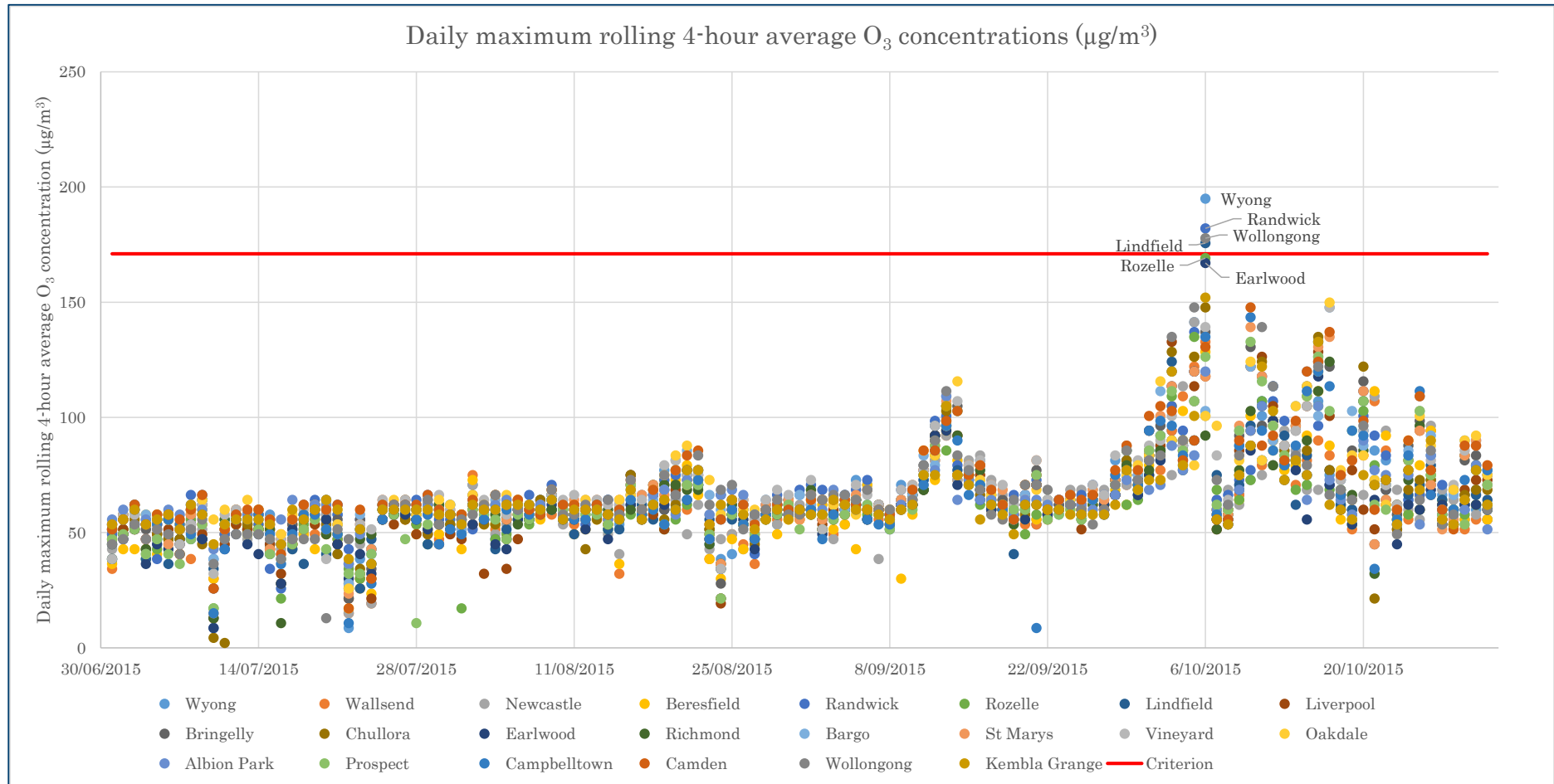


Figure 8-2: Regional O<sub>3</sub>—Daily maximum rolling 4-hour average O<sub>3</sub> concentrations

The figure presents data from all of the available NSW EPA (O<sub>3</sub>) monitoring sites and shows that O<sub>3</sub> levels were elevated in the Sydney GMR on 6 October 2015. In addition to Wyong the Randwick, Wollongong and Lindfield sites also recorded elevated 4-hour average O<sub>3</sub> levels above the criterion of 171µg/m<sup>3</sup>.



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## 9 CONCLUSIONS

The results indicate that the monitoring stations recorded good air quality during October 2015.

The Wyong monitor recorded a three hour period of poor ozone levels above the rolling 4-hour average O<sub>3</sub> criterion level of 171µg/m<sup>3</sup> (182µg/m<sup>3</sup>, 194µg/m<sup>3</sup> and 186µg/m<sup>3</sup>) from 2pm to 4pm on 6 October 2015. The elevated levels were recorded during hot conditions with temperatures up to 33.5°C and southeasterly winds with speeds up to 3.5m/s.

Relative to the Air Quality Index:

- ✦ The measured levels of NO<sub>2</sub> were very good at all monitors with the exception of the Wyee and Wallsend monitors which recorded two and one hours with good levels respectively;
- ✦ The measured levels of SO<sub>2</sub> were very good at all monitors at all times;
- ✦ The measured levels of O<sub>3</sub> were generally very good or good. The Wyong and Wallsend monitors recorded fair levels approximately 1% of the time. The Wyong monitor also recorded a three hour period of poor levels on one day (6 October);
- ✦ The measured PM<sub>2.5</sub> levels were very good to good at all monitors at all times with the exception of the Wyee monitor which recorded one day with fair levels; and,
- ✦ The measured PM<sub>10</sub> levels were very good or good at all monitors at all times, with the exception of the Wyong monitor which recorded two days with fair levels.

All recorded rolling annual average levels were below the applicable annual (calendar year) criteria in October 2015.

On this basis it can be concluded that the air quality in the Lake Macquarie - Wyong region was generally good in October 2015.

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## 10 REFERENCES

BOM (2015)

"Special Climate Statement 52 (update) – Australia's warmest October on record" Bureau of Meteorology, 3 December 2015

NEPC (2001)

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

NEPC (2003)

"Variation to the National Environment Protection (Ambient Air Quality) Measure for Particles as PM<sub>2.5</sub>", National Environment Protection Council, May 2003.

NSW DEC (2005)

"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW", Department of Environment and Conservation (NSW), August 2005.

NSW DECCW (2010)

"State of Knowledge: Ozone", Department of Environment, Climate Change and Water (NSW), September 2010.

USEPA (2013)

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

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## **Appendix A**

### ***How to read a windrose***

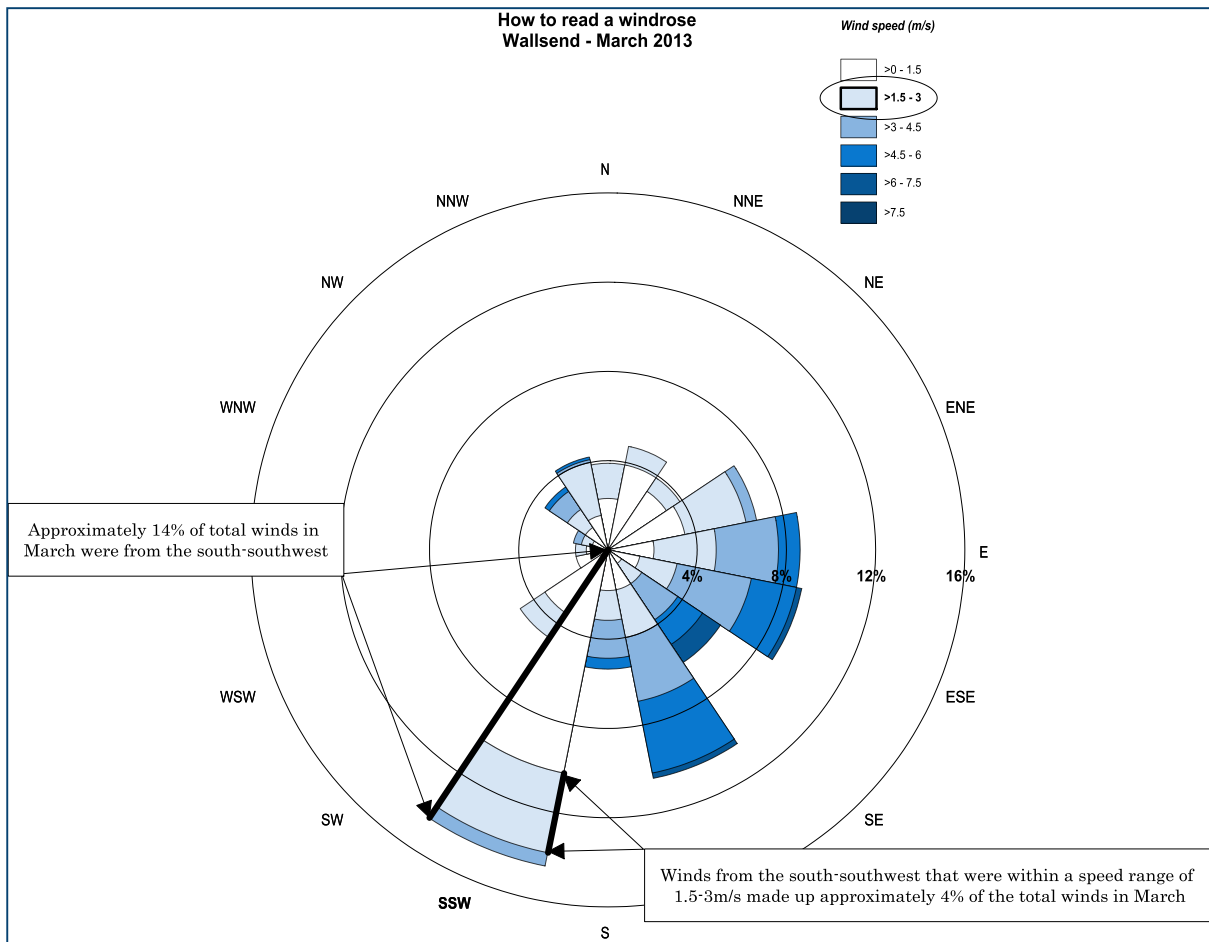


Figure A-1: How to read a windrose

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## **Appendix B**

### ***Monitoring Data (Graphical)***

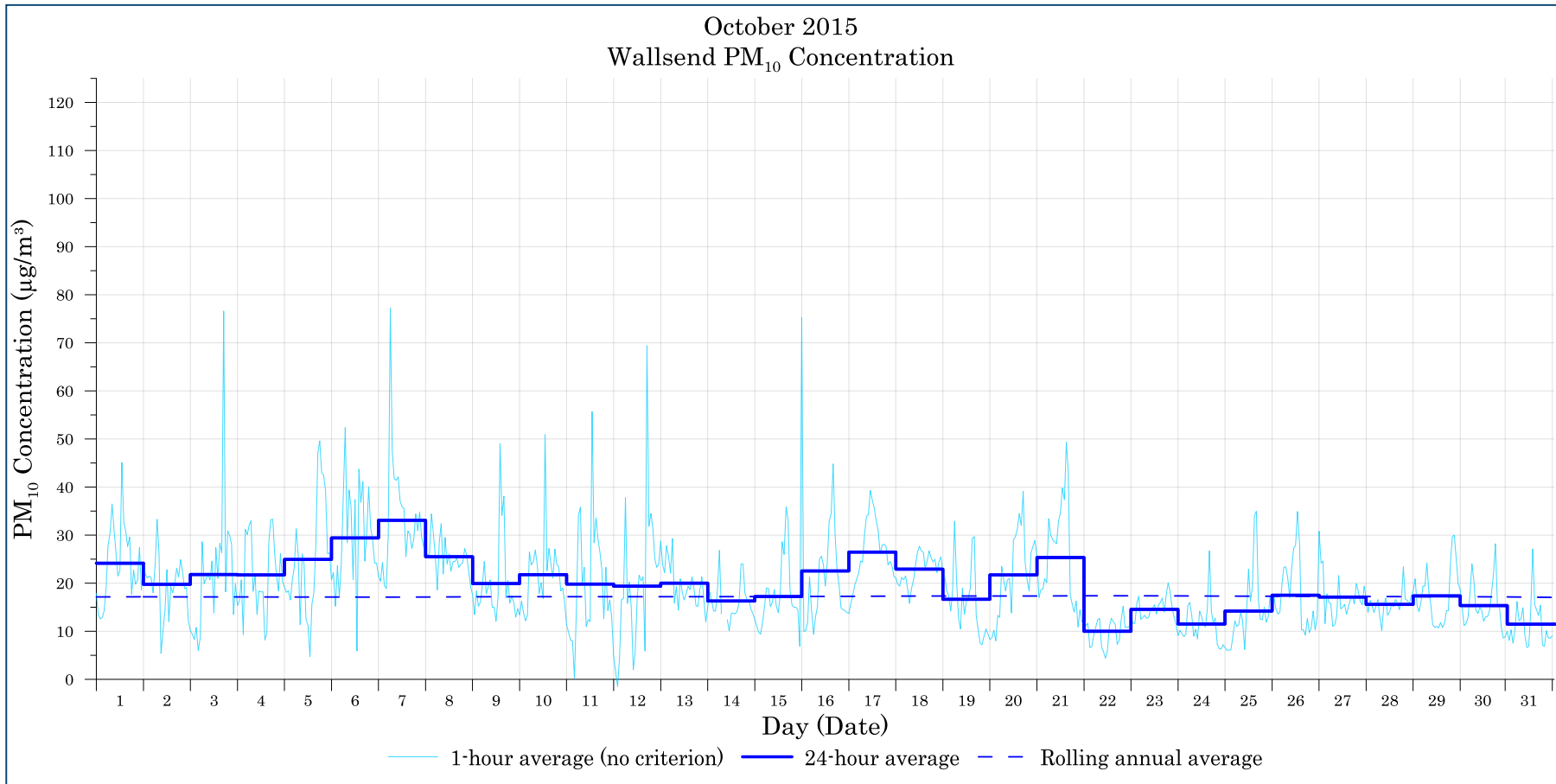


Figure B-1: Wallsend PM<sub>10</sub> (1-hour, 24-hour and rolling annual average) concentration - October

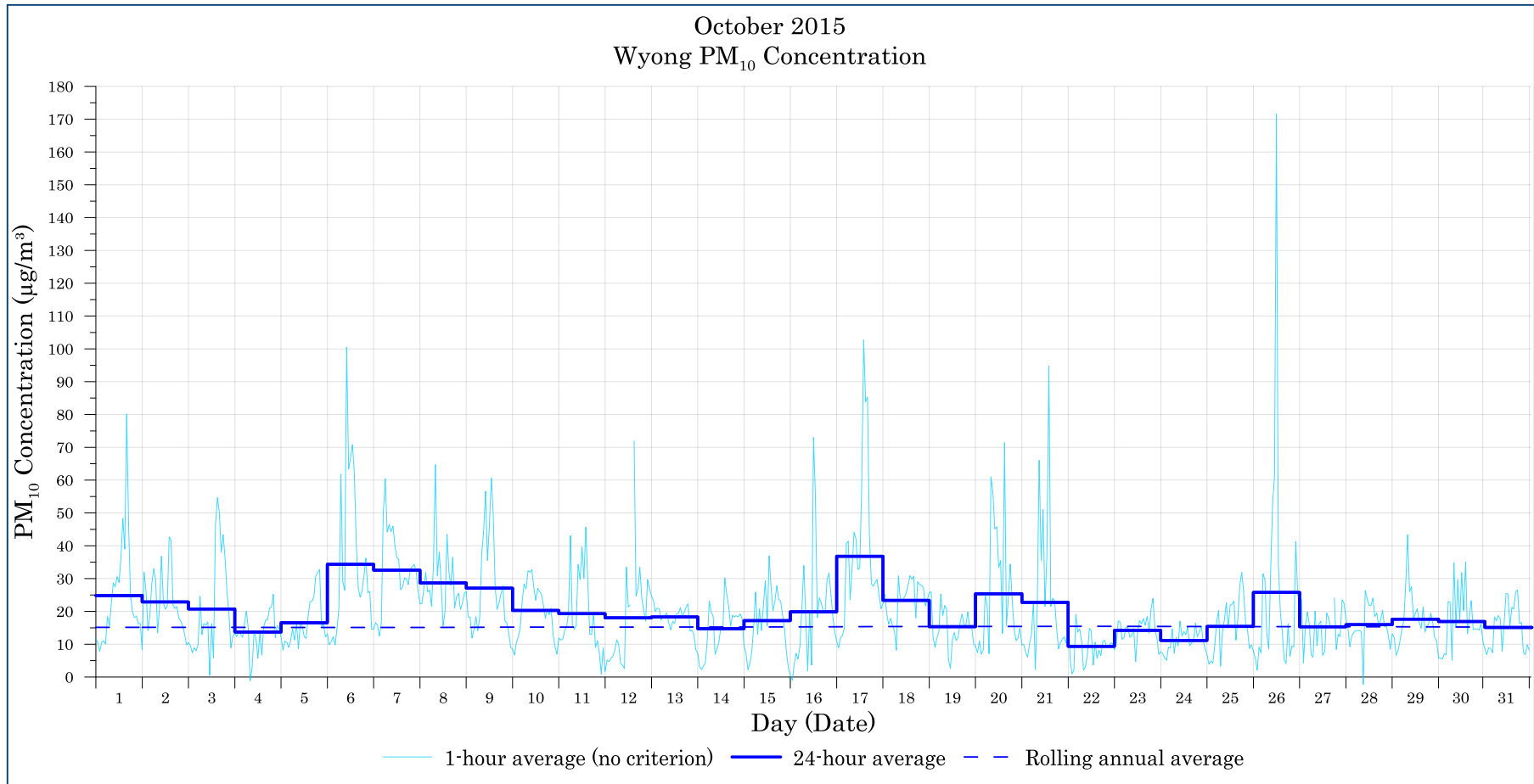


Figure B-2: Wyong PM<sub>10</sub> (1-hour, 24-hour and rolling annual average) concentration – October

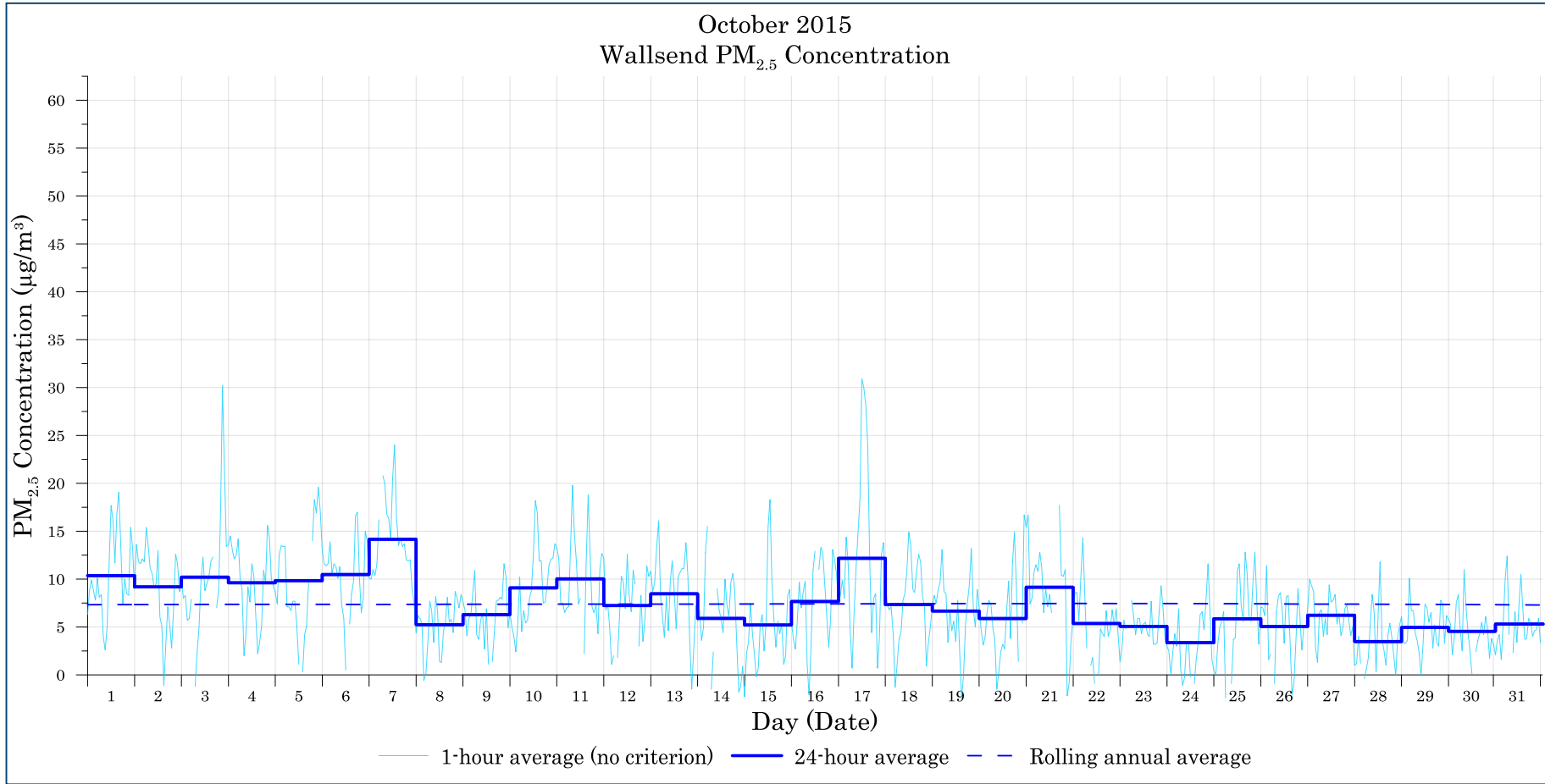


Figure B-3: Wallsend PM<sub>2.5</sub> (1-hour, 24-hour and rolling annual average) concentration – October



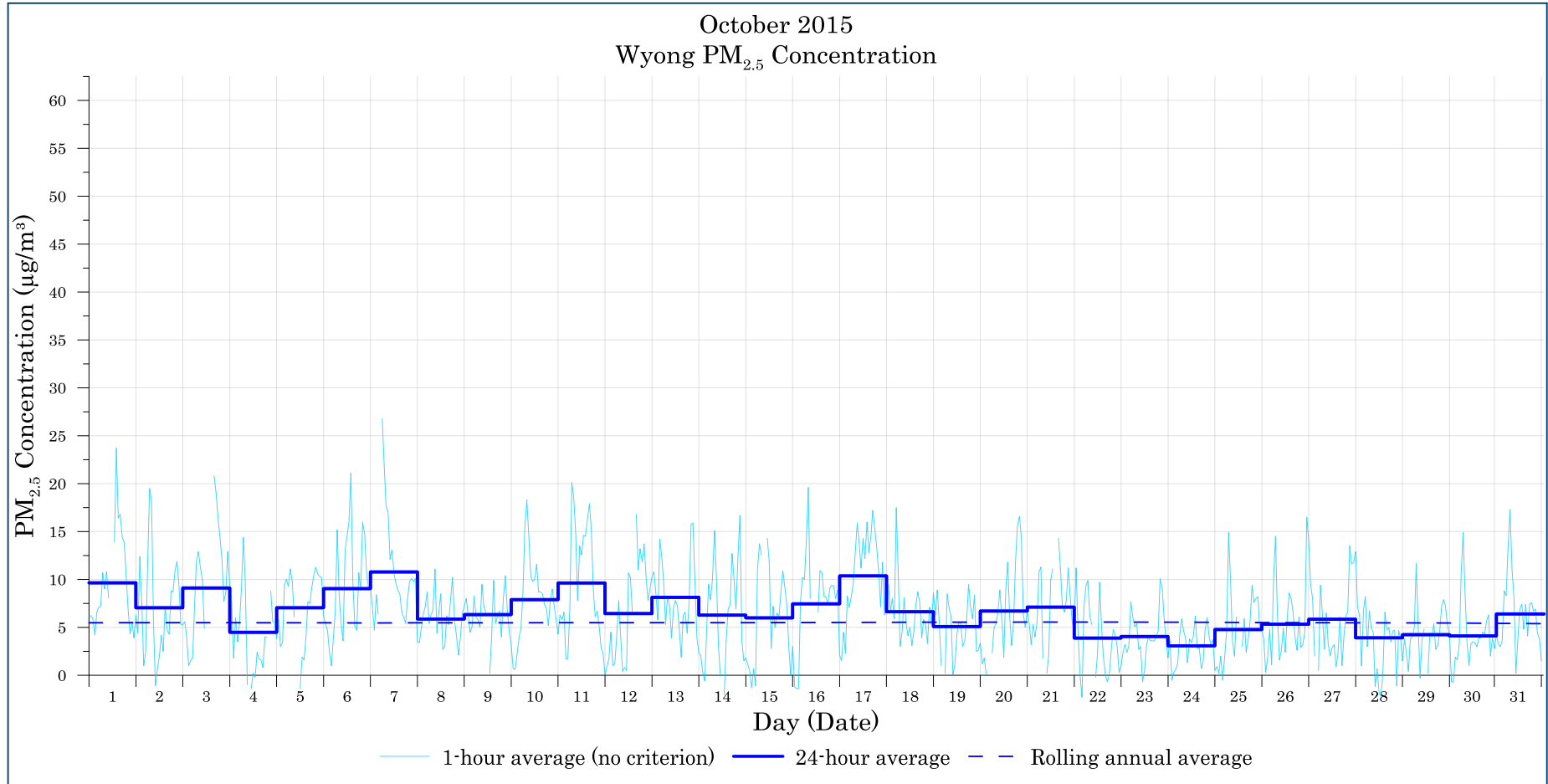


Figure B-4: Wyong PM<sub>2.5</sub> (1-hour, 24-hour and rolling annual average) concentration – October

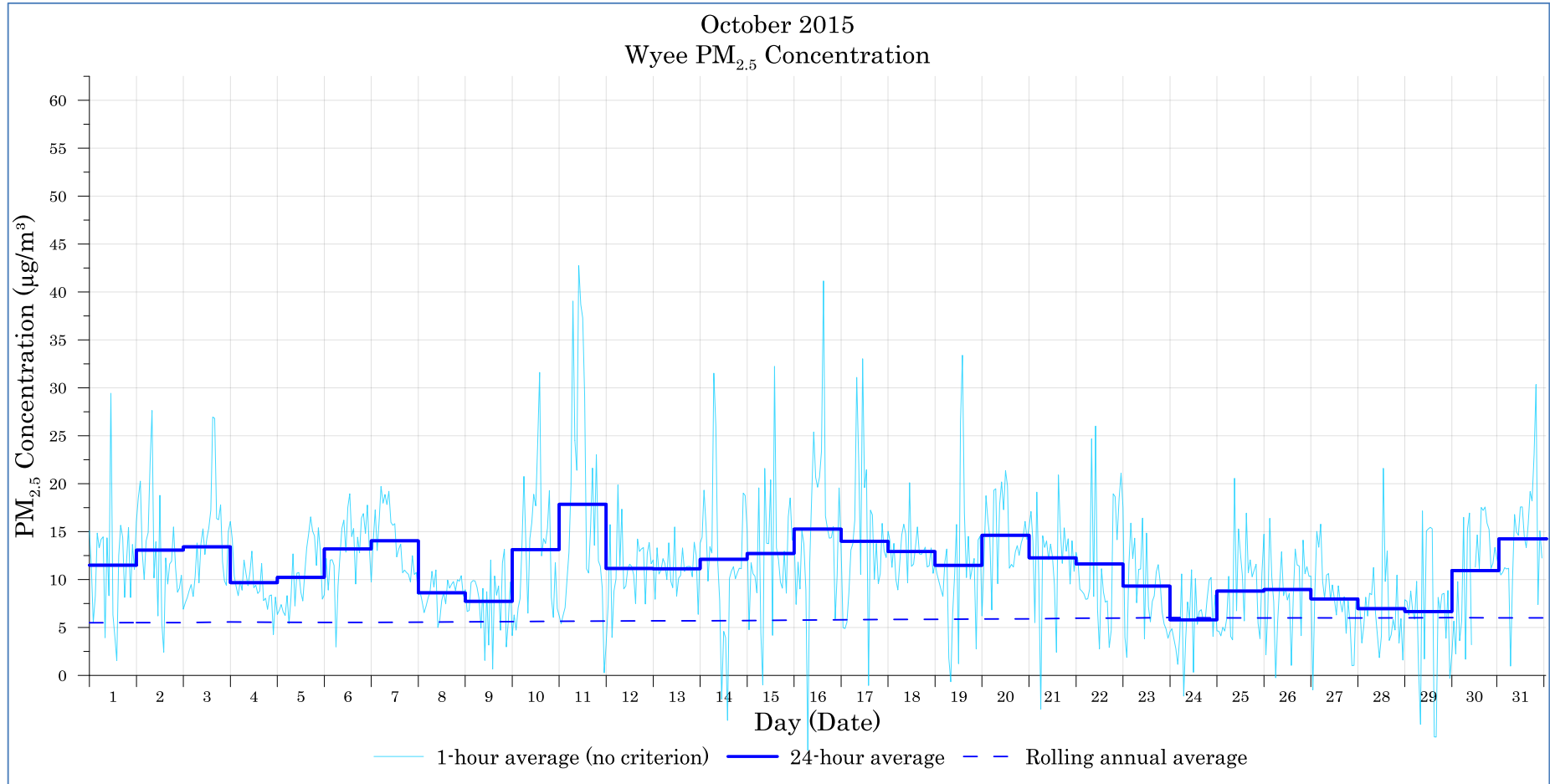


Figure B-5: Wye PM<sub>2.5</sub> (1-hour, 24-hour and rolling annual average) concentration - October

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## **Appendix C**

### ***Monitoring Data (Tabulated)***

Table C-1: October 24-hour average monitoring data

Date	PM <sub>10</sub> (µg/m <sup>3</sup> )		PM <sub>2.5</sub> (µg/m <sup>3</sup> )			SO <sub>2</sub> (µg/m <sup>3</sup> )				
	Wallsend	Wyong	Wallsend	Wyong	Wye	Wallsend	Wyong	Dora Creek	Marks Point	Wye
1/10/2015	24.2	24.8	10.4	9.7	11.5	8.3	2.3	3.9	0.7	3.1
2/10/2015	19.8	22.9	9.2	7.0	13.1	1.9	1.0	1.2	0.9	3.2
3/10/2015	21.8	20.7	10.2	9.1	13.4	21.1	5.8	7.6	10.4	3.3
4/10/2015	21.7	13.7	9.6	4.5	9.7	-0.2	0.0	-	2.6	-1.7
5/10/2015	24.9	16.5	9.8	7.0	10.2	0.7	3.0	4.2	2.8	3.6
6/10/2015	29.4	34.4	10.5	9.0	13.2	1.4	5.6	4.9	-	3.4
7/10/2015	33.1	32.6	14.2	10.8	14.0	-0.6	0.1	1.5	0.9	-1.4
8/10/2015	25.5	28.7	5.3	5.9	8.6	-0.1	0.4	1.6	0.4	2.5
9/10/2015	19.9	27.1	6.3	6.3	7.7	0.9	3.1	11.8	0.5	2.6
10/10/2015	21.8	20.3	9.1	7.9	13.1	9.3	2.2	9.8	1.7	10.6
11/10/2015	19.8	19.3	10.0	9.6	17.9	13.7	7.0	-	3.7	7.7
12/10/2015	19.4	18.1	7.2	6.4	11.2	8.7	1.6	-	1.9	1.9
13/10/2015	20.0	18.3	8.5	8.1	11.1	3.2	0.0	1.9	0.5	0.2
14/10/2015	16.3	14.7	5.9	6.3	12.1	0.5	1.1	5.3	0.3	0.8
15/10/2015	17.2	17.2	5.2	6.0	12.7	2.4	9.0	7.0	1.4	7.8
16/10/2015	22.5	19.9	7.7	7.5	15.3	8.4	6.4	2.6	3.5	5.7
17/10/2015	26.5	36.8	12.2	10.4	14.0	5.6	0.6	5.2	-	2.6
18/10/2015	22.9	23.4	7.3	6.6	12.9	0.2	0.0	10.5	0.4	-1.3
19/10/2015	16.6	15.4	6.7	5.1	11.5	3.2	1.1	3.3	-	1.4
20/10/2015	21.7	25.4	5.9	6.7	14.6	-1.0	3.8	4.1	1.4	4.8
21/10/2015	25.3	22.8	9.2	7.1	12.3	7.4	2.7	4.5	2.0	2.1
22/10/2015	10.0	9.3	5.4	3.9	11.6	2.1	0.2	5.2	2.8	3.9
23/10/2015	14.6	14.2	5.1	4.1	9.3	15.1	0.0	0.5	1.3	0.1
24/10/2015	11.5	11.1	3.4	3.1	5.8	1.7	4.2	1.6	-	6.9
25/10/2015	14.2	15.4	5.9	4.8	8.8	1.6	6.7	7.2	3.2	3.8
26/10/2015	17.5	25.8	5.1	5.3	9.0	5.1	1.6	-	4.4	-0.8
27/10/2015	17.1	15.3	6.2	5.8	8.0	-1.2	0.0	-	0.8	-0.8
28/10/2015	15.6	16.0	3.5	3.9	7.0	-0.2	0.0	1.2	0.7	4.4
29/10/2015	17.4	17.6	4.9	4.2	6.7	6.7	0.2	1.3	0.3	14.3
30/10/2015	15.3	16.9	4.5	4.1	10.9	1.1	2.5	1.9	0.4	-1.3
31/10/2015	11.5	15.1	5.3	6.4	14.2	3.8	6.8	8.3	0.4	2.4

- Not applicable

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

Date	PM <sub>10</sub> (HVAS) (µg/m <sup>3</sup> )	
	Wakefield (Westside)	Teralba
2/10/2015	10.9	26.0
8/10/2015	28.5	23.0
14/10/2015	19.3	20.0
20/10/2015	23.9	28.0
26/10/2015	19.1	20.0

- Not applicable