3 March 2016

# ANALYSIS OF DATA REQUESTED BY PEER REVIEWER FOR THE MOUNT OWEN CONTINUED OPERATIONS PROJECT

## 1 BACKGROUND

Pacific Environment (PE) completed an Air Quality Impact Assessment (AQIA) for Glencore's Mount Owen Continued Operations Project (the Project) in October 2014. The Project was then placed on exhibition, after which a Response to Submissions (RTS) report was prepared to address issues raised by the relevant agencies, community groups and the general public. The RTS report was submitted to the NSW Department of Planning and Environment (DP&E) in June 2015.

The DP&E then commissioned a peer review of the AQIA and RTS report. The first peer review report was submitted to the DP&E on 30 October 2015, and was provided to Pacific Environment for comment on 4 November 2015. A meeting was held at the DP&E on 10 November to discuss and clarify a number of issues raised by DP&E's reviewer. Following this meeting an amended peer review report was issued on 20 November 2015 which included revised comments and statements. The amended peer review report concluded that the assessment of the Project was sound, however a further response was requested to address some residual issues. A further submission was prepared by PE to respond to this amended peer review, and this was provided to DP&E on 14 December 2015, prior to the commencement of the Planning Assessment Commission (PAC) public hearing into the Project.

There was no further response from the peer reviewer to this additional submission, before the PAC hearing. DP&E called another meeting on 12th February 2016 to determine how the outstanding issues might be resolved. These issues were:

- the representativeness of the meteorological data used in the AQIA, with particular reference to the perceived lack of north-northwesterly winds,
- the background (or monitored) $PM_{10}$ concentration values used in the AQIA, and
- how the meteorological and monitored data were brought together to arrive at the conclusions drawn in the AQIA.

PE believes that these outstanding issues can be resolved by answering the following questions:

- Are the meteorological data "representative"?
- What are the meteorological conditions which lead to high $PM_{10}$ concentrations?
- Under what conditions does the model predict high $PM_{10}$ concentrations and are these consistent with the monitored patterns?

The reviewer requested that a package of meteorological, monitoring and modelling data be supplied so that he could conduct an additional analysis of this information and address the issues listed above.

The purpose of this document is to describe the data to be issued to the peer reviewer and to provide an analysis of the data in order to assist with resolving the issues listed above.



Pacific Environment Operations Pty Ltd
246 Arthur Street
North Sydney NSW 2060
(ASX: PEH) ABN: 86 127 101 642
www.pacific-environment.com
Ph: +61 2 9870 0900

## 2 RESPONSES TO REQUEST FOR DATA

The following information was requested by the peer reviewer on 12th February 2016. Comments have been added in blue by PE for clarification:

1. The ambient air quality monitoring data from SX10 and PM10-2 stations (1-hourly format), for all years available after approx. 2008/9.

   We have provided monitoring data from both the TEOM SX9 and SX10 analysers in 1-hour average format (locations of monitors are shown in Figure 1). TEOM SX9 is located closer to residences to the south east of the proposed North Pit Continuation than TEOM SX10, and is therefore also considered to be relevant to the 24-hour cumulative assessment. PM10-2 is a high-volume air sampler (HVAS), and so data are not available in 1-hour average format. Data in the 24-hour average format have been provided for PM10-2. The HVAS PM10-3-iii is located closer to residences to the south east of the proposed North Pit Continuation, and is therefore considered to be more relevant than PM10-2; data from PM10-3-iii have therefore also been provided. Monitoring data are only available from 2009 onwards.

2. Meteorological data from SX8 and SX13 weather stations (1-hourly format), for all years available after approx. 2008/9.

   Data from 2009 have been provided.

3. An extracted CALMET file for a location to the SE of the Project (1-hourly format), for the modelled 2011 to 2012 period (if this is available for other years e.g. calendar year 2012 say, please provide this further data as it may help expedite any analysis done).

   An extracted CALMET file covering the focus area to the SE of the mine for the chosen modelling year has been provided (September 2011 – August 2012). There are no CALMET extracts for years other than the modelled year.

4. The time series modelling results for $PM_{10}$ concentrations (1-hourly format) at the following nine receptor locations: 41, 38, 19, 23, 112, 114, 116, 127c, 133. The time series data should be raw (uncalibrated) data provided electronically for each modelled year (i.e. baseline 2011/12, Year 1, Year 5 and Year 10), and as a separate time series modelling result for the Project alone (i.e. Mt Owen) and for each of the other individual mines. It is understood that there may not be separate data available for each individual other mine, but if it is available this should be provided.

   1-hour time series $PM_{10}$ concentrations are provided at residences for Year 1, Year 5 and Year 10 predictions. However, 1-hour time series $PM_{10}$ concentrations are not available for 2011/2012. This is because models for individual (non-project) mines were run for annual averages at monitoring sites only, in order to determine the calibration factors used for the annual average cumulative assessment. Other mines were not run for individual residential receivers in 2011/2012.

5. The calibration factor values applicable to each receptor listed at point 4.

   This has been provided. However, please note that these values only apply to annual averages and only the ‘other mines’ component.

6. Any other data or analysis, or comments not listed at points 1 to 5 which the proponent feels may be relevant or helpful. This can be provided after the data requested at points 1 to 5).

   Further data analysis and comments not listed in points 1 to 5 which are relevant and helpful, are the subject of this report.

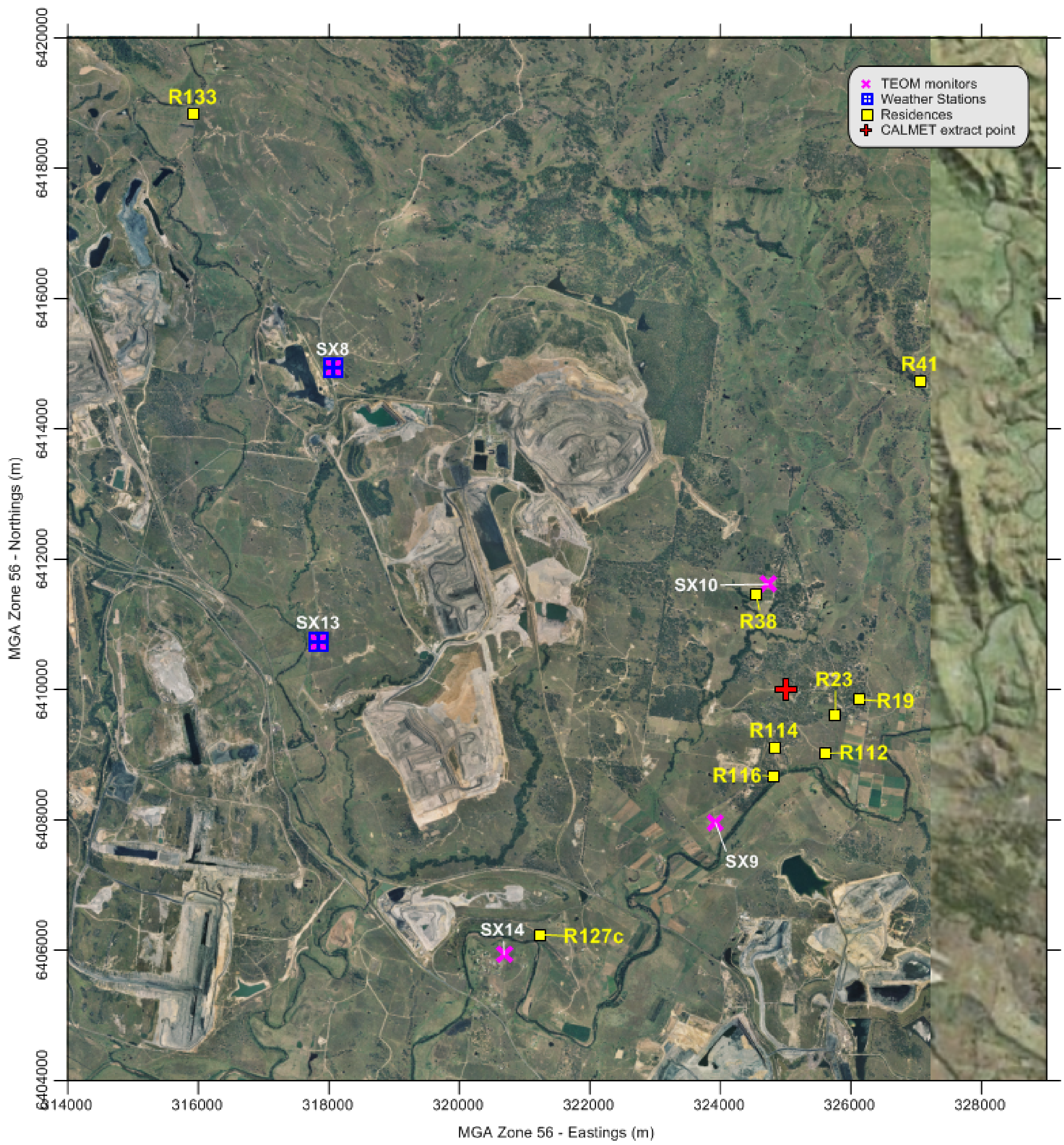



**Figure 1: Location of monitoring points and receptors of interest**

# 3 DATA ANALYSIS

Based on the information requested and the outcomes of the meeting on 12 February 2016, there are three questions we believe need answering in order to satisfy the reviewer's concerns. These are summarised as follows:

1. Are the meteorological data "representative"?
2. What are the meteorological conditions which lead to high $PM_{10}$ concentrations?
3. Under what conditions does the model predict high $PM_{10}$ concentrations and are these consistent with the monitored patterns?

The following analysis addresses these questions as well as other issues which may be helpful.

## 3.1 Representativeness of the meteorological data chosen for the assessment

Both the AQIA and the December 2015 Response to the Peer Review contain an analysis of the representativeness of the meteorological data used in the assessment. The analyses provided in the December 2015 Response was prepared following discussions with the Peer Reviewer and DP&E, as previously requested by the Peer Reviewer. The author believes that the analyses provided to-date show that the met data is representative.

The representativeness of the meteorological data used in the assessment has now been further examined by analysing the six years of available data from 2009 to 2014 (inclusive) and determining the frequency distribution of wind direction (Figure 2) and wind speed (Figure 3) during those six years. The meteorological station at SX13 has been used for this analysis as this is closer to the majority of residences nominated for study. It should be noted that much of this analysis was undertaken as part of the preparation of the AQIA in identifying an appropriate year of meteorological data for use in the assessment but, consistent with accepted modelling practice, was not documented in the original AQIA.

Figure 2 shows the frequency distribution of wind directions. It can be seen from this figure that the frequency of wind directions for the modelling year were within the minimum and maximum frequencies of other years for all wind direction categories, except for 160-180º. The winds from 160-180º (that is, winds from the south) are not critical for influencing air quality impacts from the Project since there are no potentially affected private properties to the north. Therefore, the wind direction data for the modelling year is considered to be representative of wind directions over the six year data period.

The analysis also showed that 2009 was an outlier year in regards to an unusually large proportion of winds in the north – north eastern segment (0-20º: see Figure 2). The modelling year is considered to be representative of the wind conditions observed from this sector in the five most recent years of data analysed.

Years 2009 and 2010 also contained a higher prevalence of winds from the 320-340º and particularly the 340-360º segment than more recent years (refer to Figure 2). It is noted that both 2009 and 2010 are possible outliers in this range and the modelling year is more consistent with the longer term records. The modelling year is representative in all other wind direction ranges for all years.

The modelling year is also representative of wind speeds over the six year data period, as shown in Figure 3. For all wind speed categories, the frequency for the chosen modelling year were within the minimum and maximum frequencies of other years. Therefore, the wind speed data for the chosen modelling year is representative of wind speeds over the six year data period.

Overall, the frequency of wind speeds and directions in the chosen year are within approximately 3.5% of the frequency for all years of data. The year chosen for the air quality assessment is therefore considered representative of conditions over time and expected conditions in this part of the Hunter Valley.

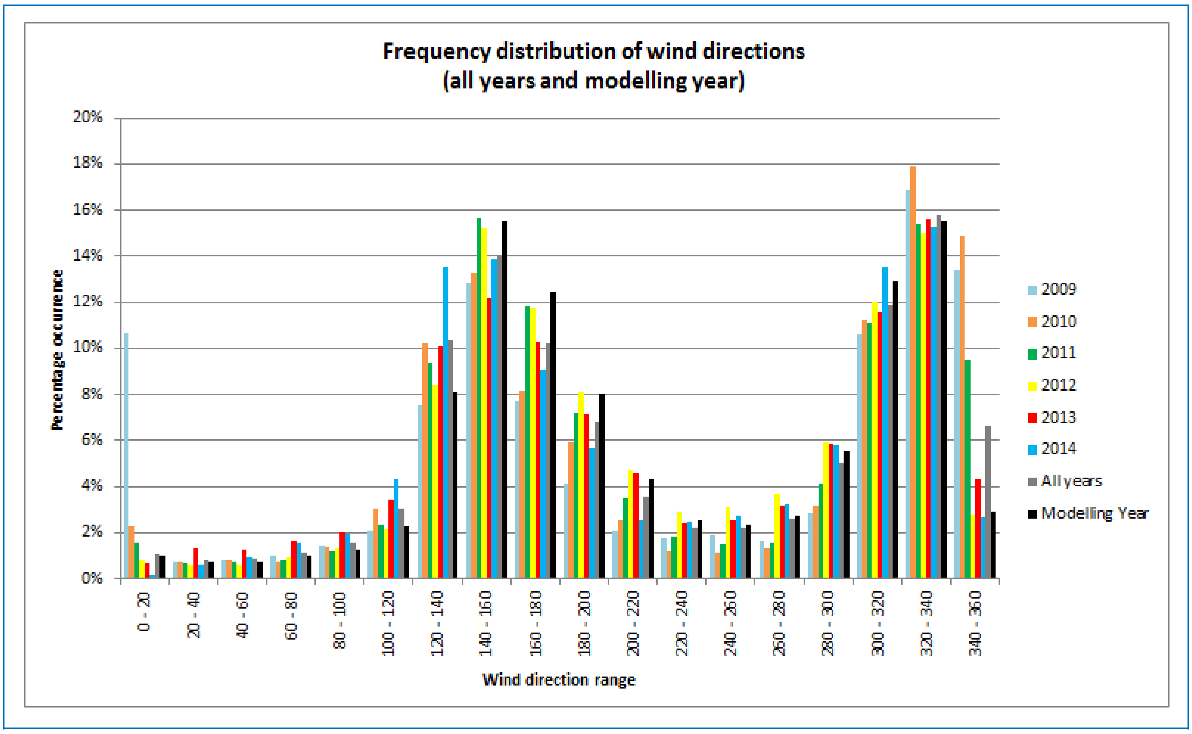



Figure 2: Frequency distribution of wind direction for individual years

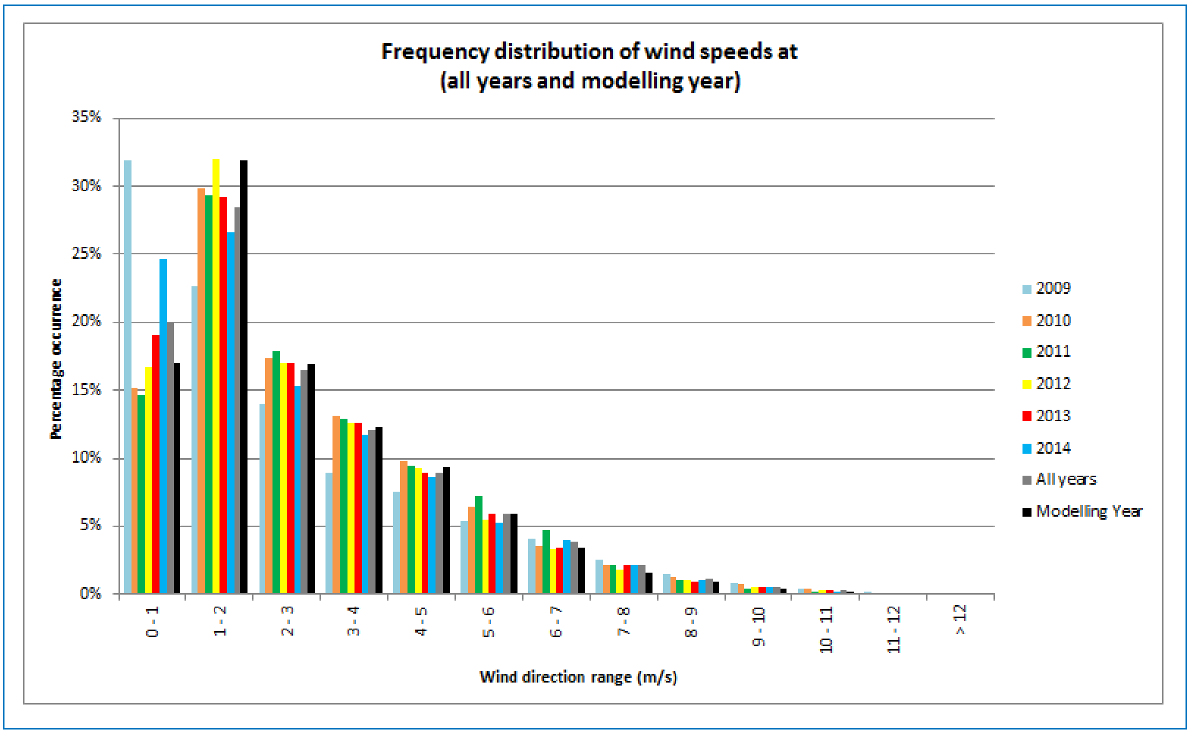



Figure 3: Frequency distribution of wind speed for individual years

### 3.2 Meteorological conditions leading to high measured $PM_{10}$ concentrations

Noting that winds from the 340–360º range differ in the modelling year compared to 2009-2010, further analysis was done to determine whether this presented any risk to the assessment in potentially underestimating predicted concentrations to the south and southeast. The following bi-variate polar plots (Figures 4 – 7) present 1-hour average $PM_{10}$ concentrations measured at both TEOMs SX9 and SX10 (southeast of the Project) with corresponding 1-hour average wind speed and direction data measured at each meteorological station.

Bi-variate polar plots are presented to show the wind speed and direction conditions under which the maximum $PM_{10}$ (1-hour average) concentrations occur at both TEOM sites. Figures 4 and 5 show these conditions for SX9, using all meteorological measurements from SX8 and SX13, respectively. The top plot is using all data from 2009 – 2014 and the bottom plots shows each individual year. It should be noted that extreme events (such as the dust storms in September 2009) have been removed and only 1-hour average values less than 500 µg/m³ are presented.

Figures 6 and 7 show the same comparisons at SX10 using all meteorological measurements from SX8 and SX13, respectively.

These plots show that winds from the north-northwest are not the drivers for the high $PM_{10}$ levels in the area of interest southeast of the Project.

It is also noted that there are seasonal variations in measured concentrations, with the highest levels occurring during spring and winter. This is shown in Figure 8, which shows the measured concentrations at SX9 for each season over the six year monitoring period.

*Note: All values in Figures 4 – 8 are 1-hour averages. $PM_{10}$ concentrations are in micrograms per cubic metre (µg/m³), wind speeds are in metres/second (m/s) and wind directions are in degrees.*

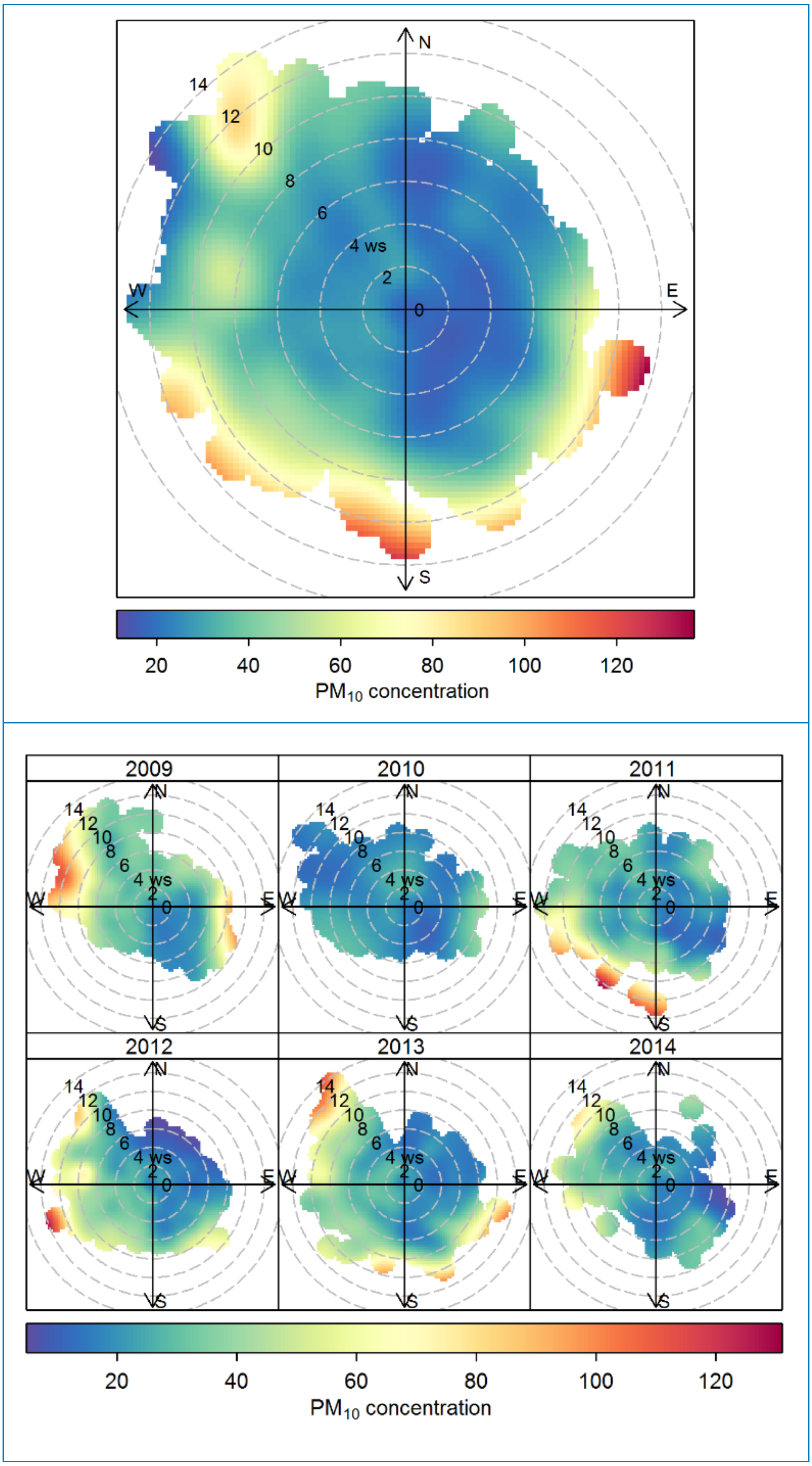



**Figure 4: Bi-variate polar plots of $PM_{10}$ concentrations at SX9 with wind speed and direction at SX8**

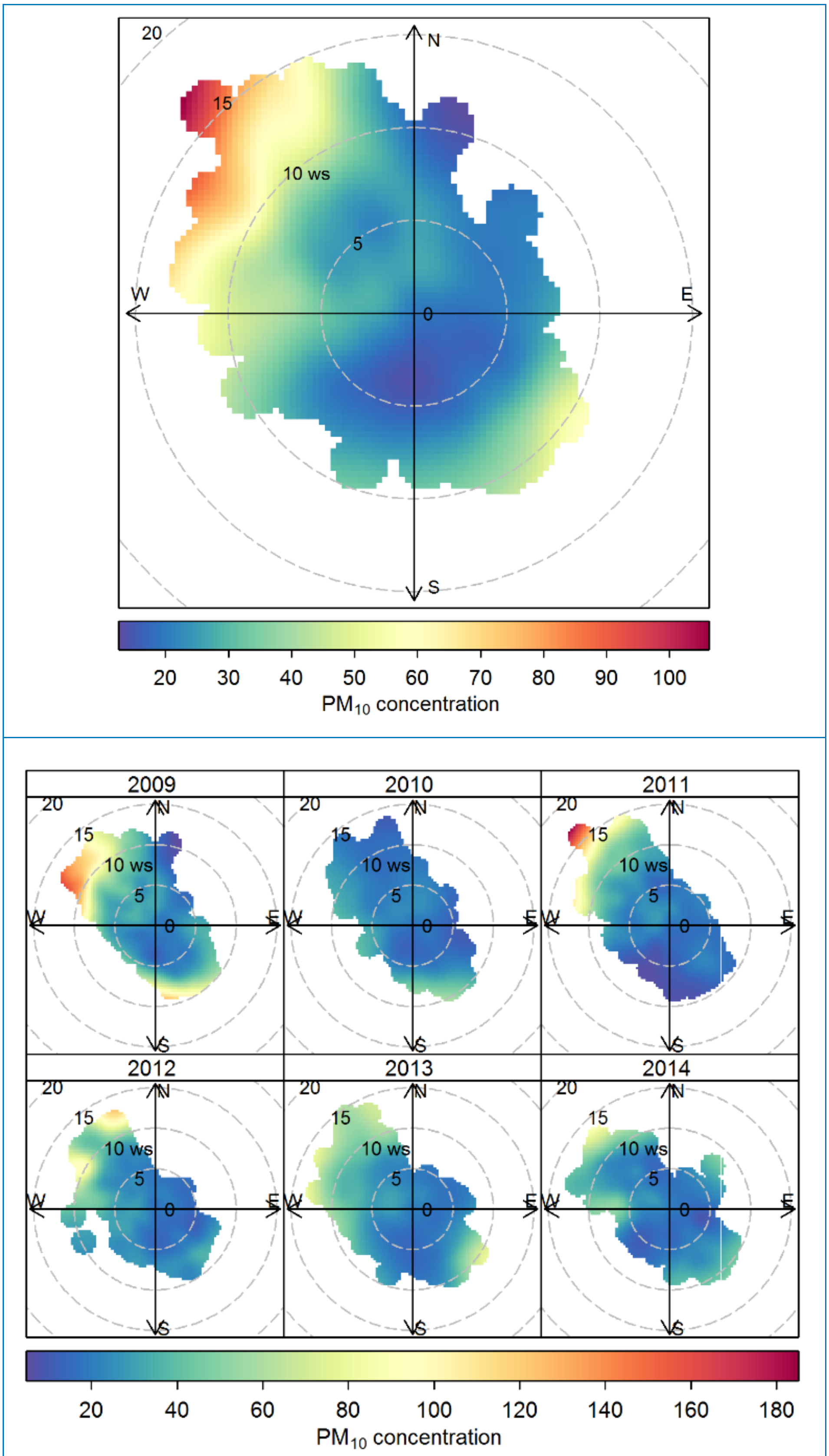
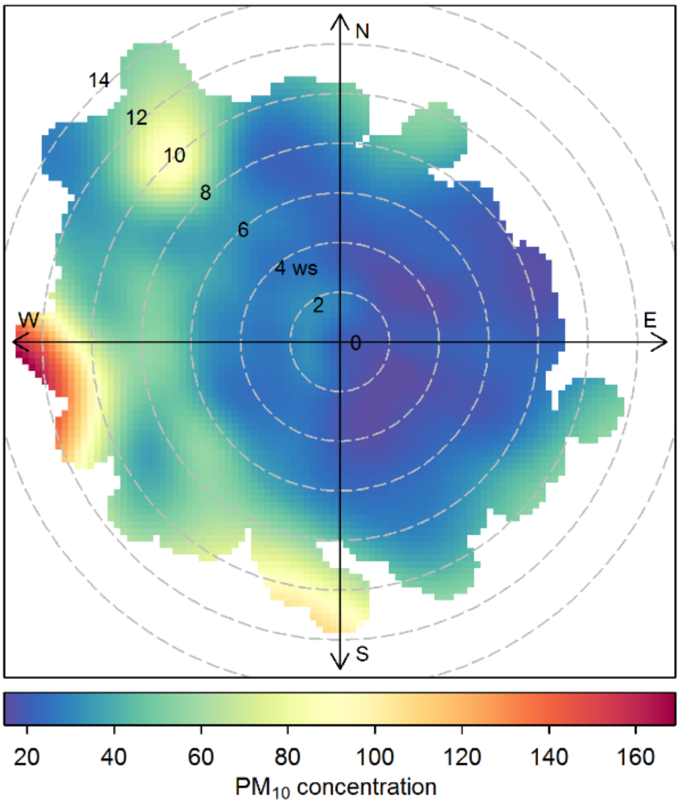



**Figure 5: Bi-variate polar plots of $PM_{10}$ concentrations at SX9 with wind speed and direction at SX13**



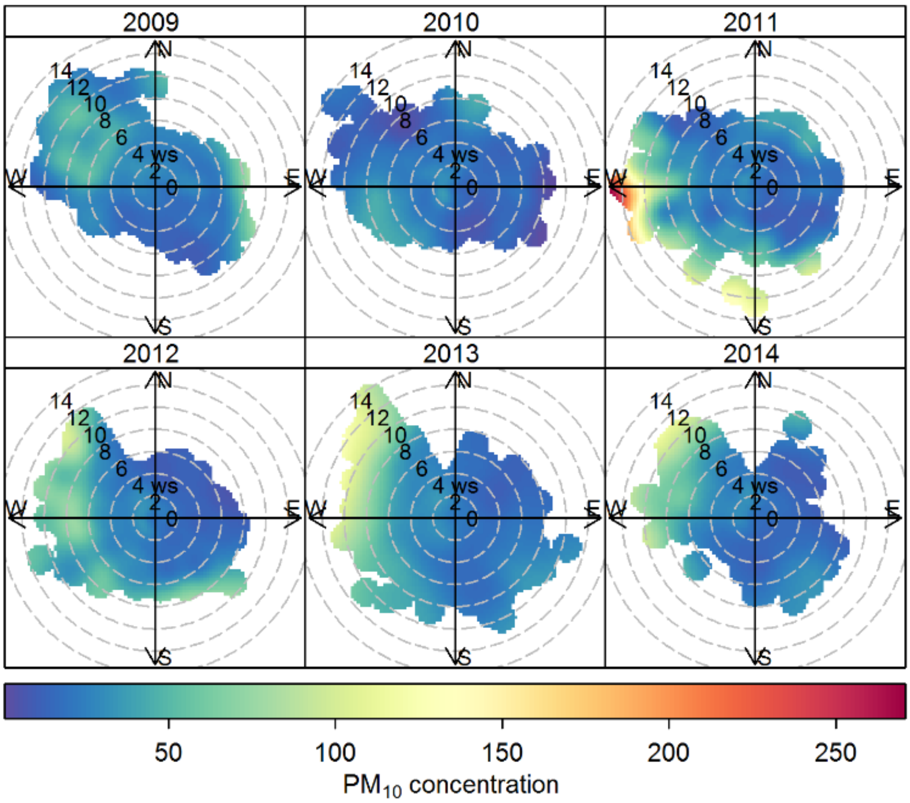
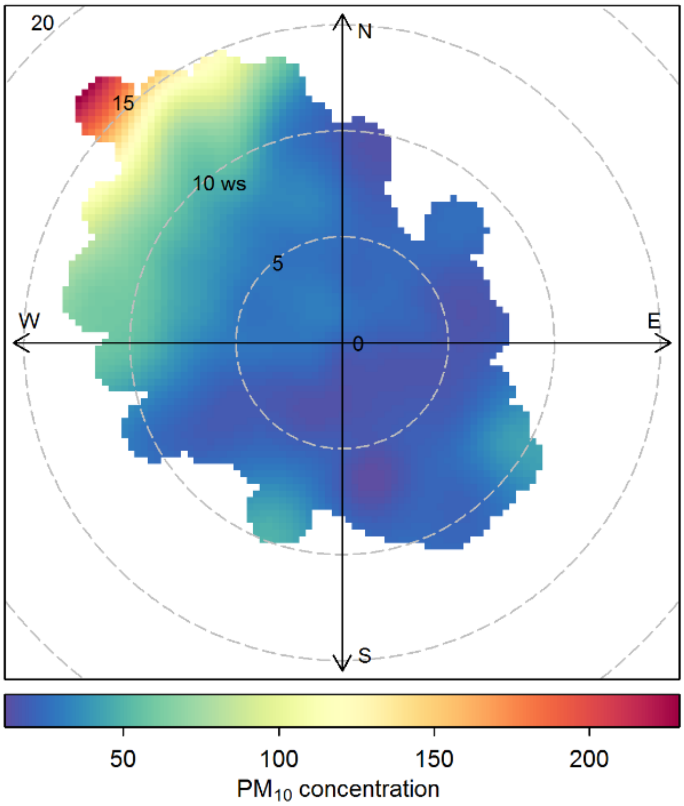




**Figure 6: Bi-variate polar plots of $PM_{10}$ concentrations at SX10 with wind speed and direction at SX8**



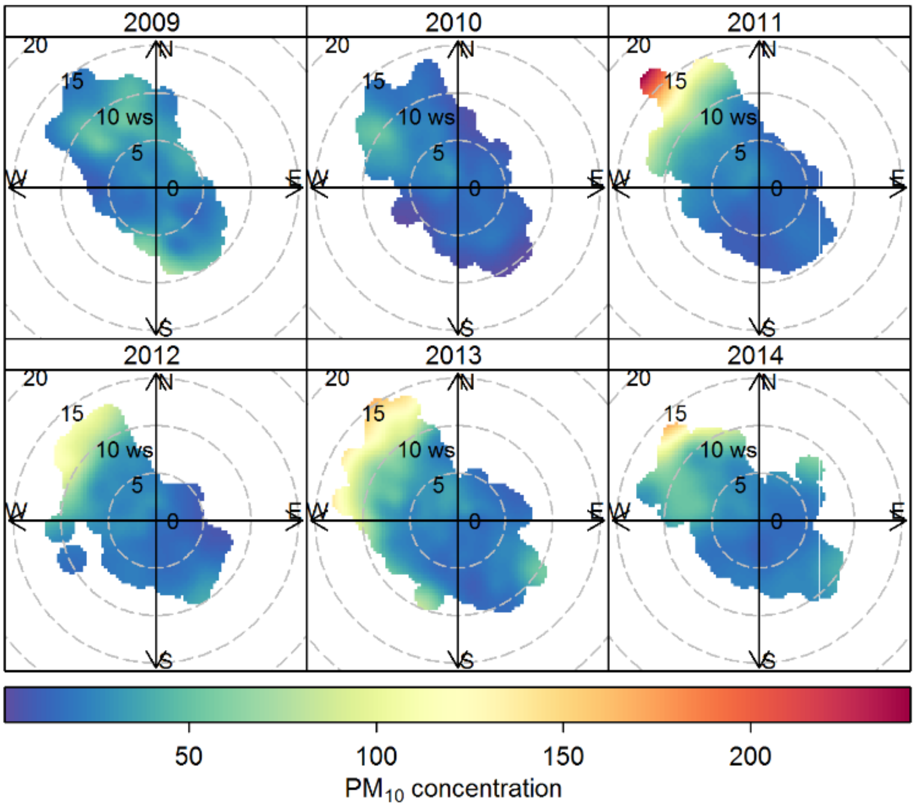




**Figure 7: Bi-variate polar plots of $PM_{10}$ concentrations at SX10 with wind speed and direction at SX13**

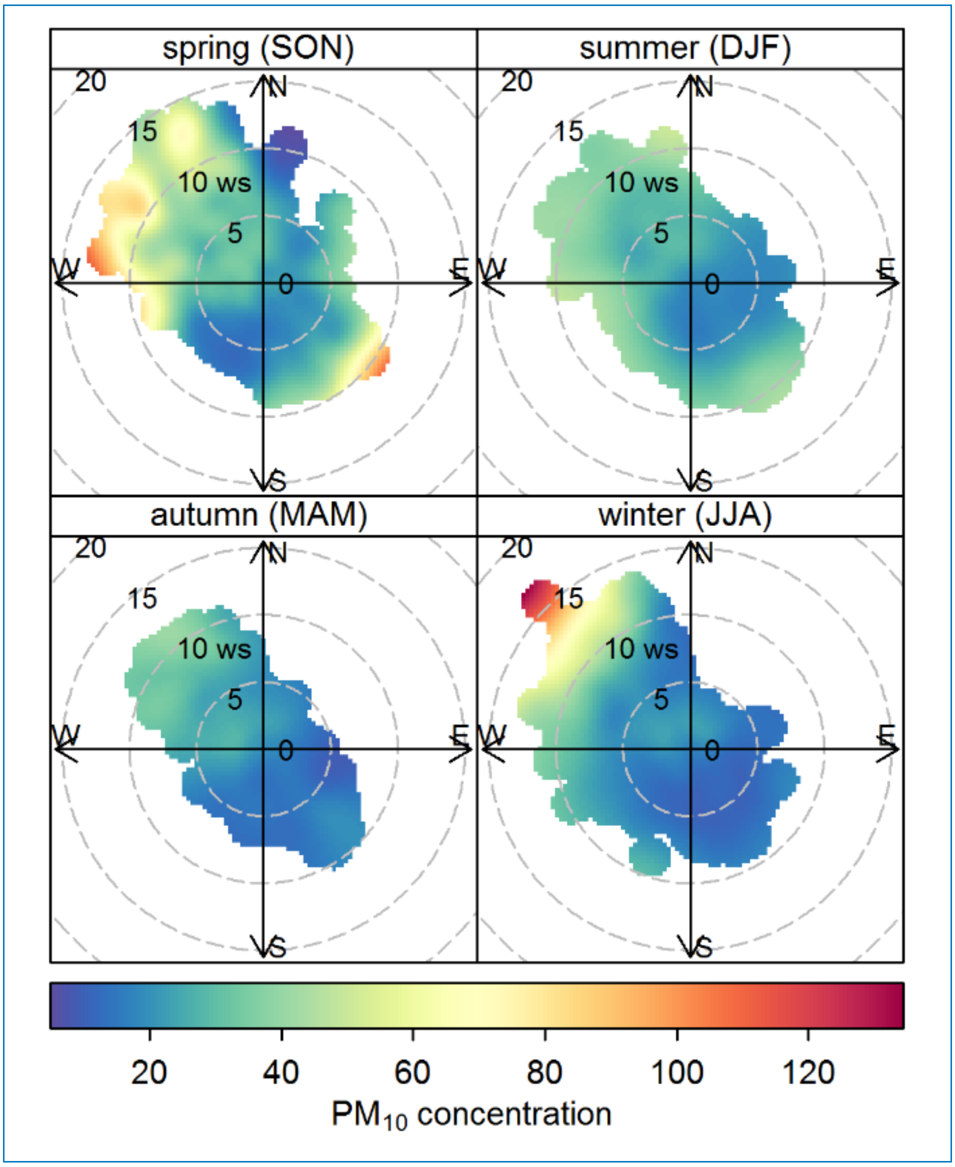



Figure 8: Seasonal bi-variate polar plots of $PM_{10}$ data at SX9 with wind speed and direction

With regard to locations south of the Project, some further analysis has been done using the EPA $PM_{10}$ monitor at Camberwell Village. Only 24-hour $PM_{10}$ data are available for this monitor, so a slightly different approach was required. All values recorded since monitoring began in 2011 were ranked from highest to lowest. The 1-hour average wind speed and direction for days where the 24-hour average $PM_{10}$ concentration was over 50 µg/m³ is plotted in Figure 9. This presents the wind speeds and directions from both SX8 and SX13 and shows that, notwithstanding the presence of the Mount Owen Complex to the north, the highest concentrations at Camberwell do not occur under the northerly wind conditions. This is perhaps not unexpected given the local terrain in that area and also the other significant mining operations to the west, east and south of Camberwell.

The same analysis was done for the data collected since 2009 at the two HVAS monitors, PM10-2 and PM10-3iii, southeast of the Project (see Figure 10). Again, the results indicate that northerlies do not contribute significantly when considering high $PM_{10}$ days at those locations, but rather winds from the northwest and southeast.

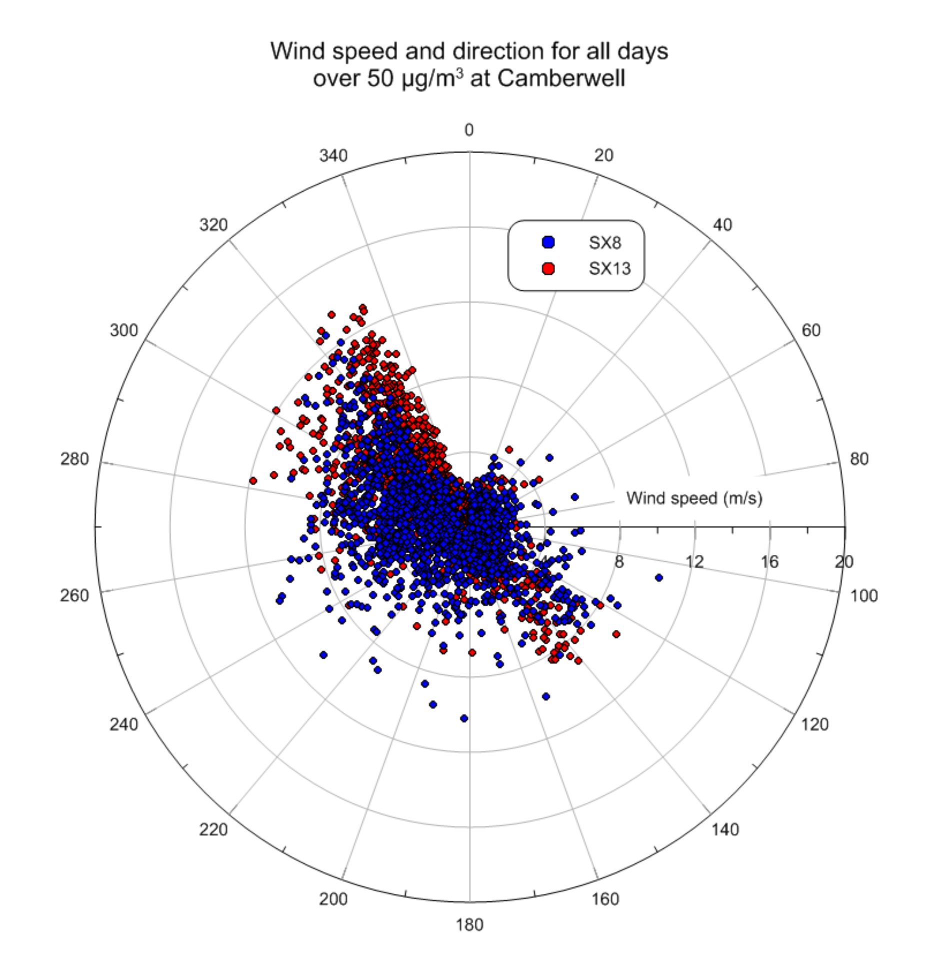



**Figure 9: Wind speed and directions on highest $PM_{10}$ days at Camberwell**

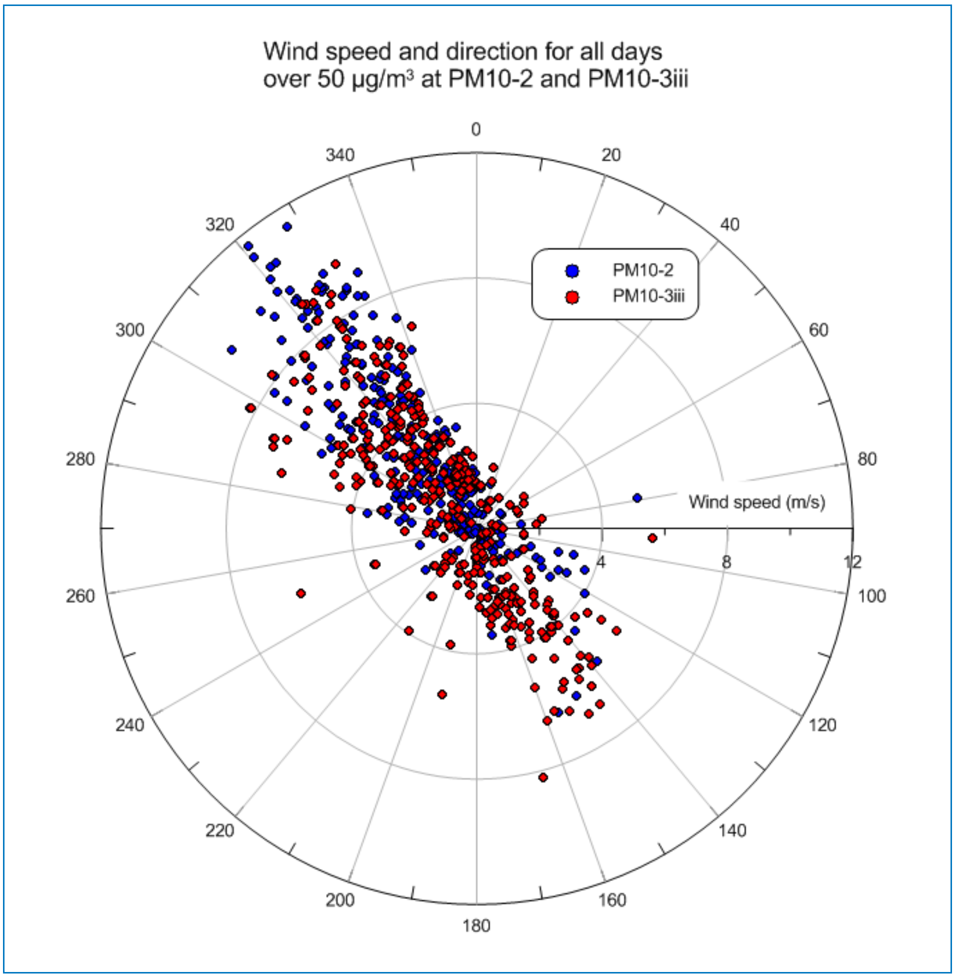



**Figure 10: Wind speed and directions on highest $PM_{10}$ days at PM10-2 and PM10-3iii**

From the above analysis, it is apparent that the metrological conditions which lead to high $PM_{10}$ concentrations are winds from the northwest and southeast. In addition, the highest $PM_{10}$ concentrations tend to occur during stronger (> 6m/s) winds and typically occur in winter and spring. These conditions are well represented in the modelling year chosen for the assessment.

### 3.3 Meteorological conditions leading to high modelled $PM_{10}$ concentrations

Having established that winds from the north do not drive the elevated $PM_{10}$ levels experienced at the nearest private residences to the Project, the next step was to check if the model was reproducing the monitored patterns.

Figure 11 presents a number of bi-variate polar plots positioned near the residences they represent, and includes modelled results from all surrounding mines used in the air quality assessment (Year 1). The figure shows that the wind directions which result in the highest $PM_{10}$ concentrations are not from the north. It is noted that this is also the case for Camberwell Village, which has significant mining activity to the north. At Camberwell residence R127c, the elevated $PM_{10}$ concentrations are much more dependent on winds from the southwest, southeast and northwest, conditions which are well represented in the modelling year (±2% difference in frequency across all these directions between the chosen year and all other years).

The main difference between the bi-variate plots based on monitoring data and those based on model results relates to the wind speed conditions under which the $PM_{10}$ maxima occur. In other words, when considering monitoring data it is the higher wind speeds that are associated with the highest $PM_{10}$ concentrations, whereas with the model results it is the lower wind speeds that are associated with the highest concentrations. Models tend to over-predict PM concentrations under low wind speed and stable conditions, particularly for sources close to receptors.

This is not unexpected, however, as the modelling can obviously only consider sources which are specifically modelled. That is, when wind speeds are elevated there are many other windblown sources which have not been modelled and which are unrelated to the project or other mines within the domain. These will include $PM_{10}$ from significant distances outside the modelling domain which are recirculated in the atmosphere and can travel larger distances in shorter time frames because wind speeds are high.

Model results cannot account for all other windblown sources of dust beyond the model domain that will be blown towards a residence under these high wind speed conditions. In an impact assessment, this is where the non-modelled background values become important for annual average concentrations and why a conservative $PM_{10}$ value was chosen to represent this background.

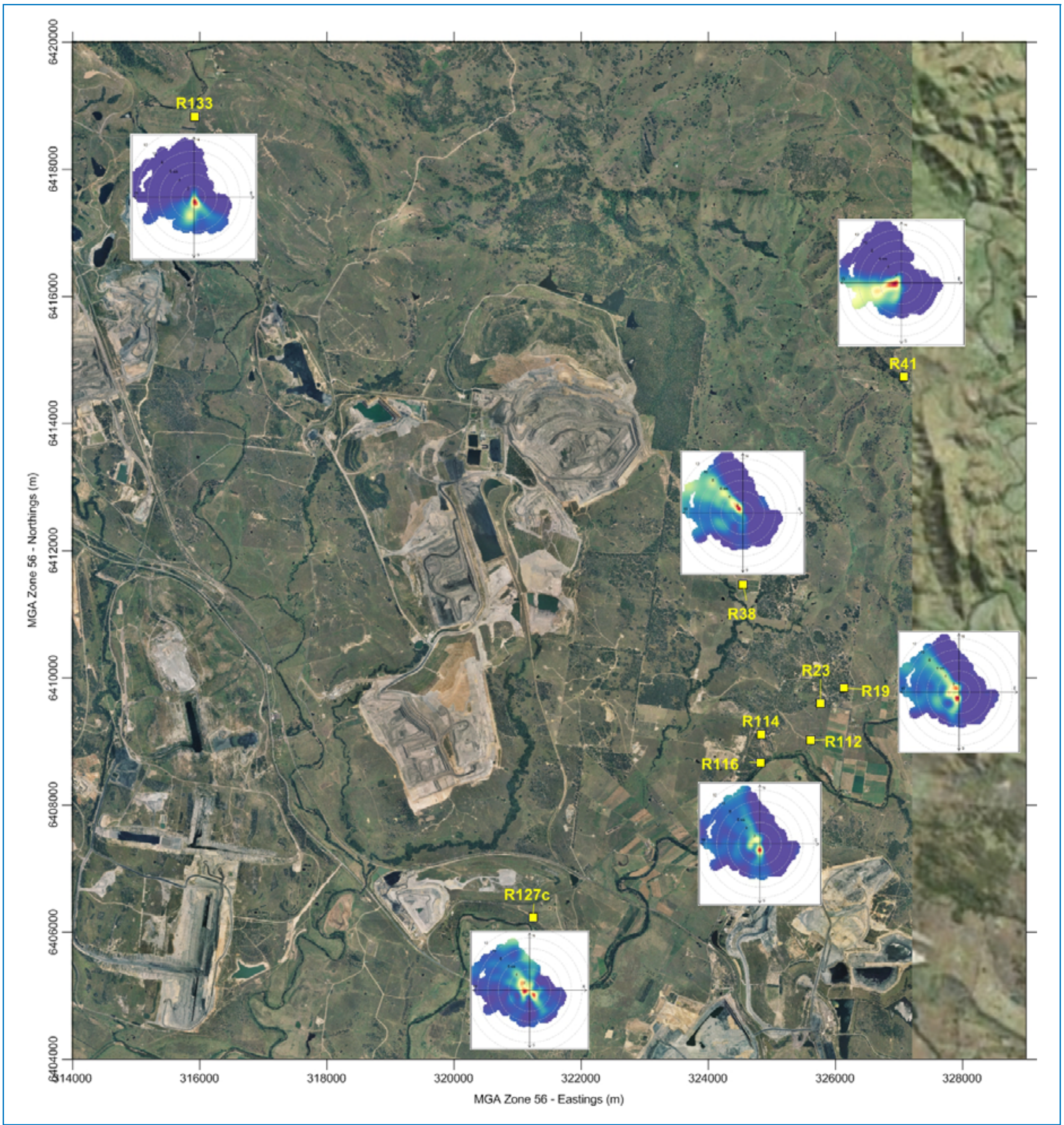



**Figure 11: Bi-variate polar plots of $PM_{10}$ concentration with wind speed and direction at residences including all mining operations in the domain (Year 1)**

# 4 CONCLUSIONS FROM DATA ANALYSIS

The following conclusions have been made from the analysis presented above:

- ***Are the meteorological data representative?***

  Yes. The analysis demonstrates that the wind conditions present in the modelling year used in the assessment are representative of the conditions observed in the vicinity of the Project over the 6 years of data analysed. While the observed wind conditions in 2009 and 2010 both included a higher prevalence of winds from the north-northwest to north-northeast regions (340º - 20º) these conditions are not present in the more recent years of observations analysed and more importantly, further analysis of monitoring data indicates these conditions do not drive elevated $PM_{10}$ levels. The meteorological year chosen for use in the assessment is therefore considered to be representative of the wind conditions observed over time and is fit for purpose.

- ***What are the meteorological conditions which lead to high $PM_{10}$ concentrations?***

  The highest $PM_{10}$ concentrations observed over the 6 years analysed occur predominantly with strong winds from the northwest and southeast and typically in winter and spring. The winds from these directions contained in the year of meteorological data used in the assessment are consistent with all other years analysed. The under representation of winds from the north-northwest in the model year (when compared to 2009 and 2010 only, not subsequent years), does not change the outcomes of the assessment.

- ***Under what conditions does the model predict high $PM_{10}$ concentrations and are these consistent with the monitored patterns?***

  The analysis shows that the model predicts the highest $PM_{10}$ concentrations when winds are from the northwest or southeast at all locations around the mine (except R41, discussed further below). This aligns with the prevailing wind axis in the Hunter Valley and is consistent with monitoring data, although the model appears to over-predict during light winds (stable) conditions. Even for residences to the south of the Project in Camberwell Village, both monitoring data and model results demonstrate that northerly winds do not significantly contribute to high $PM_{10}$ concentrations.

  Residence R41 shows a different pattern as all the nearest mine sources are located southwest of that location. As expected, highest concentrations occur at R41 when winds are from the southwest.

Based on the above analysis of the data requested, the conclusions above indicate there would be no changes to the outcomes of the original air quality assessment with regard to potential impacts on private properties.