Craig Milton
Policy Manager
NSW Minerals Council

Via Email: cmilton@nswmining.com.au

9 December 2021

RE: Upper Hunter Air Quality Monitoring Network Analysis Project – Annual Review

Dear Craig,

1 Introduction

Zephyr Environmental has been commissioned by the NSW Minerals Council (NSWMC) Upper Hunter Mining Dialogue to provide an update on previous work on air quality trends across NSW (*Air Quality Monitoring Data Analysis Project*, dated 16 November 2020; 'the AQ Data Analysis Project').

Specifically, we have been requested to provide an update to the AQ Data Analysis Project to include data from the calendar year 2020.

Section 1 of the AQ Data Analysis Project provides background and context to the work, and confirms that the project was designed to answer two specific air quality questions:

1. Has the air quality in the Upper Hunter Valley changed since monitoring began?; and

2. Is the air quality in the Upper Hunter Valley measured at the monitoring stations different from air quality measured at other locations in NSW?

Section 2 of the AQ Data Analysis Project provides an overview of particulate matter size fractions and ambient air quality criteria, including definitions of the terms PM_{10} and $PM_{2.5}$ (particulate matter less than 10 and 2.5 micrometres in aerodynamic diameter, respectively).

Section 3 of the AQ Data Analysis Report provides detail on the 14 air quality monitoring stations that comprise the Upper Hunter Air Quality Monitoring Network (UHAQMN) and their grouping to reflect the following purposes:

- Larger populations (Muswellbrook, Singleton and Aberdeen)
- Smaller communities (Bulga, Camberwell, Jerrys Plains, Maison Dieu, Warkworth, Wybong)
- Diagnostic (Mount Thorley, Muswellbrook NW, Singleton NW); and
- Background (Merriwa, Singleton South)

Section 4 and Section 5 of the AQ Data Analysis Report provide a summary of the air quality monitoring data collected to date and their analysis respectively.

It is these aspects that require update to include data from the calendar year 2020, which is the focus of this letter.

2 Monitoring Data Update

The NSW Department of Planning, Industry and the Environment (DPIE) makes available ambient air quality monitoring data for NSW via their data download facility. The DPIE notes that full data validation has been completed up to 30 June 2020. Later records have passed an initial, automated validation process for online display. While this is a limitation of the 2020 reanalysis, it is not anticipated that validated data will deviate significantly from the values presented over annual average timeframes.

Trends in annual and period average PM_{10} and $PM_{2.5}$ by region are presented in Table 2.1 and Table 2.2 respectively. These reflect Table 4.3 and Table 4.8 within the AQ Data Analysis Project, updated to include 2020 data. Table 2.1 and Table 2.2 present a summary of annual and period average PM_{10} and $PM_{2.5}$ monitoring results (respectively) that have been averaged into regions/groups.

Results have been shaded using a green to red colour relative gradient scheme with lowest values shown in green, and highest values shown in red, with the median value shown in yellow. This gradient scheme has been applied to the annual data and 'all years' result groups separately.

Table 2.1: Annual and period average PM_{10} concentrations by region/group and year (µg/m³)

Region / Group	Year								All years
	2013	2014	2015	2016	2017	2018	2019	2020	
Central Tablelands	15.1	14.6	13.4	13.3	14.1	18.8	27.4	17.0	16.7
Illawarra	16.9	17.1	16.2	17.4	18.0	20.1	22.5	19.1	18.4
Lower Hunter & Central Coast	20.2	18.2	21.7	22.0	22.9	25.2	29.1	22.3	22.7
North West Slopes	16.6	15.8	14.1	15.3	15.3	20.1	33.7	16.8	18.5
South West Slopes	10.0	18.3	17.3	17.9	18.2	23.6	29.4	21.7	19.5
Sydney East	17.9	17.3	16.8	17.2	18.3	20.2	23.6	19.2	18.8
Sydney North West	17.5	16.6	15.1	17.0	17.0	20.3	24.9	18.7	18.4
Sydney South West	16.3	16.0	14.8	15.6	16.1	18.9	23.3	17.2	17.3
UHAQMN - BG	17.6	16.8	15.1	15.8	16.8	21.1	29.3	19.0	18.9
UHAQMN - DG	23.2	21.1	19.1	20.4	22.2	29.0	34.9	21.7	24.0
UHAQMN - LP	21.1	20.1	17.9	18.0	20.0	24.5	31.3	20.3	21.6
UHAQMN - SC	21.4	20.1	17.7	18.6	20.7	25.4	33.4	21.2	22.3

Colour Coding by Percentile

0% (min.)	10%	20%	30%	40%	50% (median)	60%	70%	80%	90%	100% (max.)

Note: colour coding is applied to annual data by region (horizontally), whereas 'All years' colour coding is applied vertically, to allow comparison of data between regions.

Table 2.2: Annual and period average $PM_{2.5}$ concentrations by region/group and year (µg/m³)

Region / Group	Year								All years
	2013	2014	2015	2016	2017	2018	2019	2020	
Illawarra	7.7	7.0	7.0	7.3	6.9	7.1	11.1	7.2	7.7
Lower Hunter & Central Coast	7.5	7.0	7.5	7.8	7.7	8.2	17.3	7.6	8.8
South West Slopes	7.9	7.5	7.6	7.4	8.1	8.4	11.3	10.9	8.6
Sydney East	8.2	8.4	8.3	8.1	8.4	8.2	16.5	8.0	9.3
Sydney North West	8.3	6.7	8.0	8.3	7.4	8.3	20.5	8.2	9.5
Sydney South West	8.0	7.5	7.4	7.6	7.8	8.7	18.9	7.9	9.2
UHAQMN - LP	8.7	8.8	8.2	8.2	8.8	8.8	18.0	8.9	9.8
UHAQMN - SC	8.2	7.8	7.2	7.5	7.4	8.4	17.3	7.5	8.9

Colour Coding by Percentile

0% (min.)	10%	20%	30%	40%	50% (median)	60%	70%	80%	90%	100% (max.)

Note: colour coding is applied to annual data by region (horizontally), whereas 'All years' colour coding is applied vertically, to allow comparison of data between regions.

These data, now updated to include 2020, show that concentrations are elevated across all regions during 2018 and 2019.

Across all years, the highest concentrations of PM_{10} are measured at the UHAQMN Diagnostic stations, with the next highest observed at the Lower Hunter & Central Coast stations. The highest concentrations of $PM_{2.5}$ are measured at the UHAQMN Large Population stations, with the next highest observed at the Sydney North West stations. The lowest concentrations are measured at the Central Tablelands and Illawarra groups for PM_{10} and $PM_{2.5}$ respectively.

As can be seen, the 2020 data indicates that annual average PM concentrations have seen a significant improvement across all regions / groups compared with observations during 2019. The 2020 data indicate that for half of the station groups, annual average PM_{10} concentrations have reverted to levels below the 'all year' average. With the exception of South West Slopes region, all annual average $PM_{2.5}$ concentrations have now reverted to levels below the 'all year' average.

3 Analysis Update

Provided below are revisions of some of the key data tables and figures from the AQ Data Analysis Project, updated to include data from the 2020 calendar year. Additional commentary is provided as it relates to the inclusion of the 2020 data.

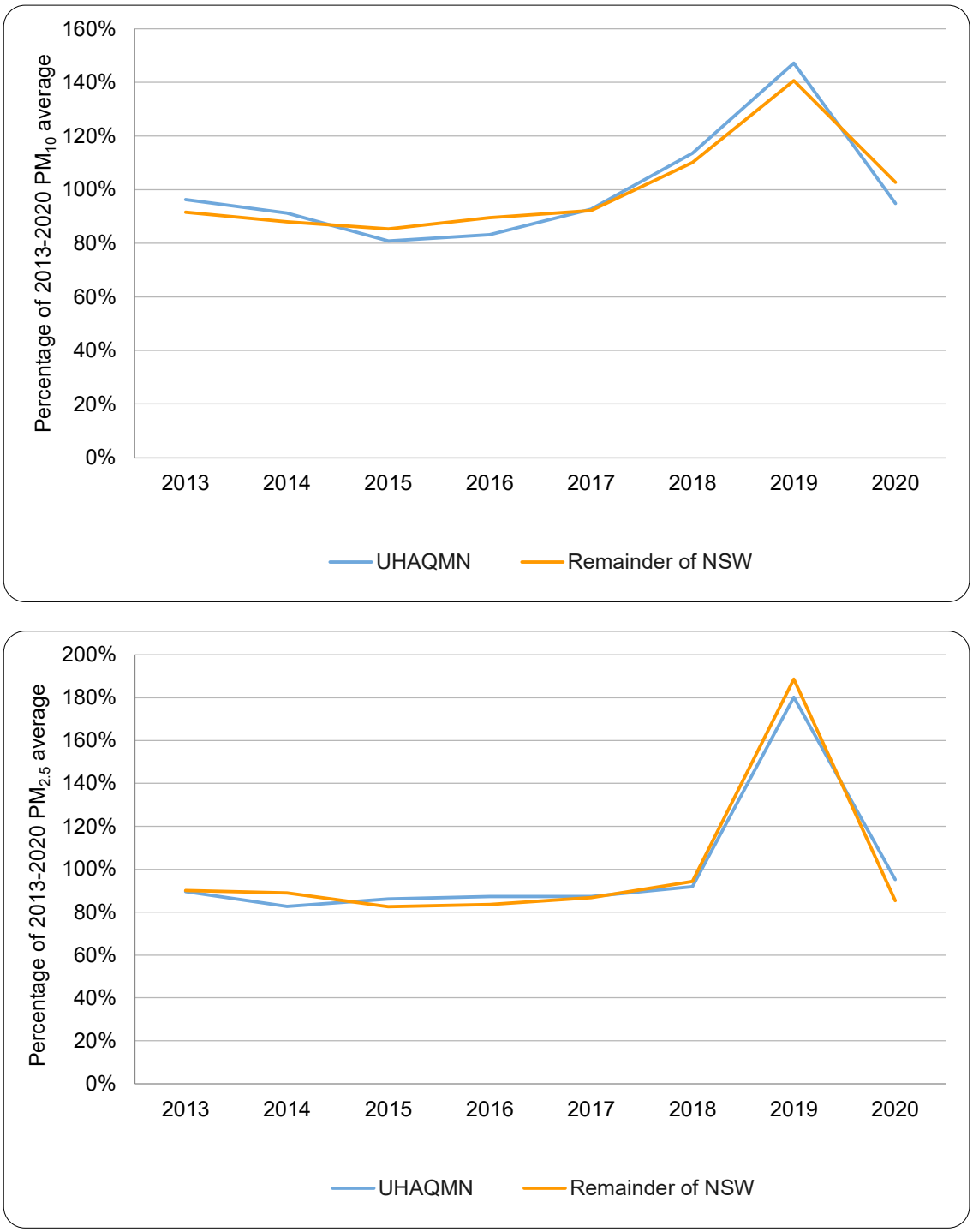
Table 3.1 (Table 5.3 in the AQ Data Analysis Project) presents a comparison of average PM_{10} concentrations measured across NSW, with the UHAQMN and the remainder of NSW shown separately. Annual data have also been presented as a percentage of the respective 2013-2020 average.

This relationship has also been shown for $PM_{2.5}$ which has a lesser association with mechanically generated particulate emissions such as those from mining. Figure 3.1 (Figure 5.5 in the AQ Data Analysis Project) provides a graphical representation of these data.

Table 3.1: Comparison of PM_{10} and $PM_{2.5}$ variability – UHAQMN vs remainder of NSW regions

Monitoring subset	Parameter	Year								All Years
		2013	2014	2015	2016	2017	2018	2019	2020	
PM_{10}										
UHAQMN*	Concentration (µg/m³)	21.2	20.1	17.8	18.3	20.4	25	32.4	20.9	22.0
	% of average (all years)	96%	91%	81%	83%	93%	114%	147%	95%	-
Remainder of NSW	Concentration (µg/m³)	17.4	16.7	16.2	17	17.5	20.9	26.7	19.5	19.0
	% of average (all years)	92%	88%	86%	90%	92%	110%	141%	103%	-
$PM_{2.5}$										
UHAQMN*	Concentration (µg/m³)	7.9	7.3	7.6	7.7	7.7	8.1	15.9	8.4	8.8
	% of average (all years)	90%	83%	86%	87%	87%	92%	180%	95%	-
Remainder of NSW	Concentration (µg/m³)	8.4	8.3	7.7	7.8	8.1	8.8	17.6	8.0	9.3
	% of average (all years)	90%	89%	83%	84%	87%	94%	189%	85%	-

Note: *Larger Populations and Smaller Communities station groups.



Note: UHAQMN data relates to Larger Populations and Smaller Communities station groups.

Figure 3.1: Comparison of PM_{10} (top) and $PM_{2.5}$ (bottom) variability – UHAQMN vs remainder of NSW regions

As noted within the AQ Data Analysis Project, and reinforced with the inclusion of 2020 data, the consistency of temporal trends in the UHAQMN and 'Remainder of NSW' monitoring subsets show that the changes in PM_{10} concentrations within the Upper Hunter are generally consistent with changes experienced across the rest of NSW. This in turn indicates that the changes in annual average PM_{10}

concentrations are associated with regional particulate sources and that the contribution of mining operations on the UHAQMN to these trends is not discernible.

Notably, the 2020 PM_{10} data for the UHAQMN is below the 'all years' average, reversing the anomalously high values experienced in 2019. This is despite the data set being significantly impacted by 'Black Summer' bushfire activity up to March 2020.

A similar pattern is also observed in $PM_{2.5}$, indicating that changes in $PM_{2.5}$ (less likely to be attributed to mining operations) are generally consistent with those observed elsewhere in NSW. As with the PM_{10} data set, the values for 2020 emphasise that the annual average for 2019 was anomalously high.

For each station group, Table 3.2 (Table 5.5 in the AQ Data Analysis Project) shows the annual variance against the 2013 – 2020 average for that particular station group. This is instructive in showing changes in the difference between station groups across the study period, and into 2020. The same data are shown graphically in Figure 3.2 (Figure 5.7 in the AQ Data Analysis Project).

Table 3.2: Annual variance against 2013 – 2020 station group average (µg/m³)

Station Group	Year							
	2013	2014	2015	2016	2017	2018	2019	2020
Larger Population	-1	-2	-4	-4	-2	3	10	-1
Smaller Communities	-1	-2	-5	-4	-2	3	11	-1
Diagnostic	-1	-3	-5	-3	-2	3	11	-2
Background	-1	-2	-4	-3	-2	2	10	0

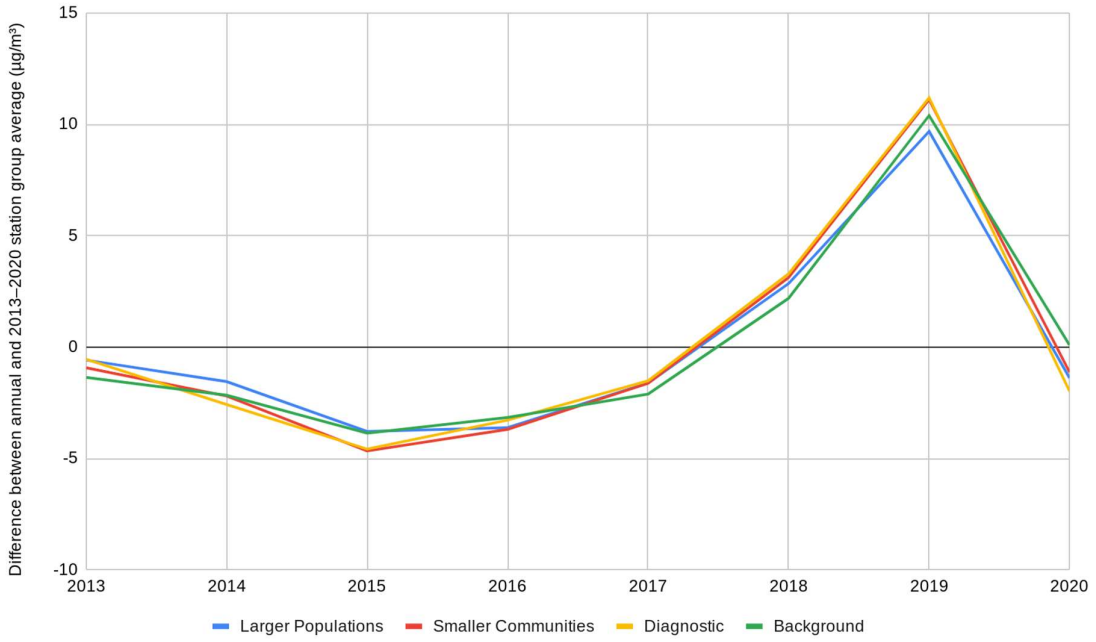


Figure 3.2: Comparison of trends between each UHAQMN station group

Figure 3.2 shows that the differences between PM_{10} concentrations at Background stations and Diagnostic stations are near identical across 2013-2020 (i.e. up to 2µg/m³ variability), while the range in annual average concentrations across this period is in the order of 15µg/m³. This reinforces that changes in Upper Hunter PM_{10} concentrations are associated with regional conditions and are indicative of a minimal change in the contribution from local emission sources inclusive of mining.

As before, inclusion of data for 2020 emphasises that the annual average for 2019 was anomalously high across all station groups.

Appendix A1.1 of the AQ Data Analysis Project demonstrated that, over the period 2013-2019, the relationship between annual coal production and annual average PM_{10} is not statistically significant. Similarly, Appendix A1.2 shows that the relationship between annual National Pollutant Inventory (NPI) reported PM_{10} emissions and annual average PM_{10} is not statistically significant. For this reason, further update of these data analyses are not provided within this update.

Conversely, Appendix A1.4 of the AQ Data Analysis Project concludes that there is a statistically significant relationship between NSW mean annual rainfall and annual average PM_{10}. This relationship is thus explored further through the inclusion of additional data for the calendar year 2020.

Table 3.3 (Table 5.6 in the AQ Data Analysis Project) presents NSW/ACT annual rainfall and UHAQMN annual average PM_{10} over the period 2013-2020. These data are shown in Figure 3.3 (Figure 5.9 in the AQ Data Analysis Project).

Table 3.3: NSW/ACT annual rainfall and UHAQMN annual average PM_{10}

Parameter	Year							
	2013	2014	2015	2016	2017	2018	2019	2020
UHAQMN PM_{10} (µg/m³)	21	20	18	18	20	25	32	21
NSW Rainfall (mm)	464	467	541	661	453	333	250	639

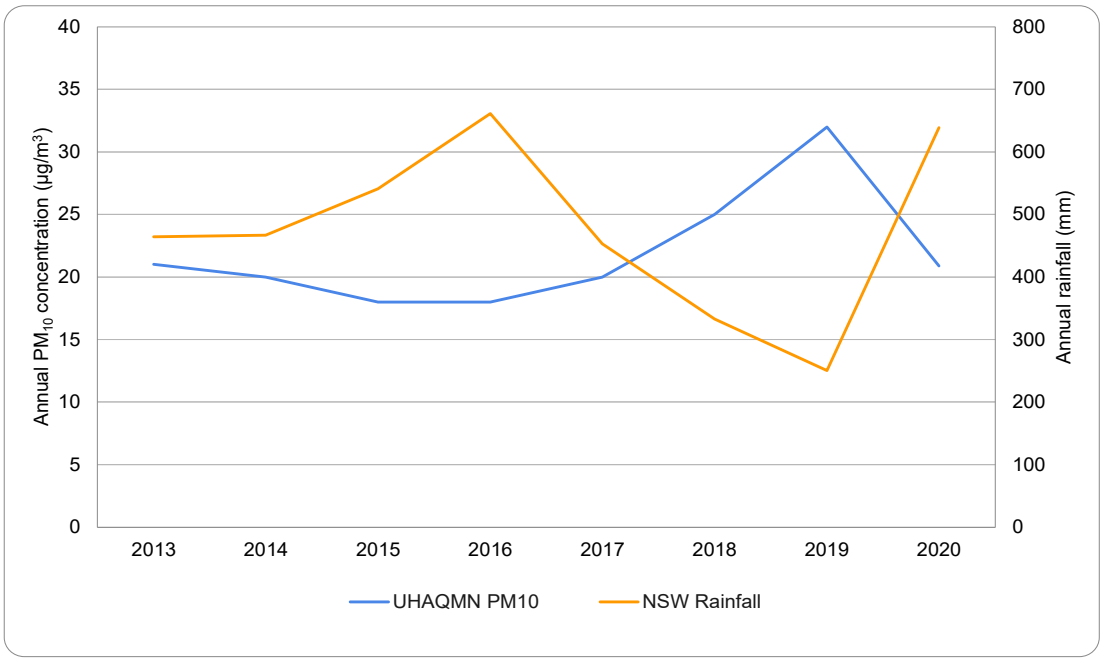


Figure 3.3: NSW/ACT annual rainfall and UHAQMN annual average PM_{10}

Figure 3.3 clearly shows that there is a negative correlation between rainfall and particulate matter concentrations across the UHAQMN. Given the consistency between PM_{10} trends across NSW and the UHAQMN (refer Figure 3.1), this relationship also holds for NSW PM_{10} concentrations more broadly.

Inclusion of annual average PM_{10} concentration and rainfall data for 2020 further supports the negative correlation between rainfall and particulate matter concentration. In contrast with 2019, 2020 shows a significant increase in annual rainfall, and a corresponding decrease in annual PM_{10} concentrations.

4 Closure

The responses to the AQ Data Analysis Project are reproduced (in italics) below, along with additional commentary as a result of this update:

1. Has the air quality in the Upper Hunter Valley changed since monitoring began?

   Yes, concentrations have varied significantly over the period reviewed, but in a manner that is generally consistent with monitoring data collected at DPIE stations across the remainder of NSW.

   While correlations with mining emissions and coal production were not identified, a correlation with regional average rainfall was observed. Lower than average rainfall is associated with above average particulate matter concentrations. The mechanisms for this are associated with progression of drought conditions, including increased prevalence of wind erosion/dust storms and bushfire activity.

   An increase in the contribution from mining operations would be expected to produce an increasing difference between the concentrations measured at Diagnostic stations and those measured at Background stations. Such a trend was not observed, with the differences between PM_{10} concentrations at Background stations and Diagnostic stations found to be near identical across 2013-2019 (i.e. up to 2 µg/m³ variability). The range in annual average concentrations across this period is of the order of 15 µg/m³. In this respect, the trends in Upper Hunter PM_{10} concentrations are not considered indicative of an increased contribution from mining operations.

Inclusion of data for the calendar year 2020 further supports the above response. Namely, that the consistency of temporal trends in the UHAQMN and 'Remainder of NSW' monitoring subsets show that the changes in PM_{10} concentrations within the Upper Hunter are generally consistent with changes experienced across the rest of NSW (Figure 3.1).

While lower than average rainfall is associated with above average particulate matter concentrations, inclusion of the 2020 data demonstrates that the converse is also true (above average rainfall is associated with below average particulate matter concentrations; Figure 3.3).

The observed similarity between PM_{10} concentrations at Background stations and Diagnostic stations remains with the inclusion of 2020 data (i.e. up to 2 µg/m³ variability; Table 3.2, Figure 3.2).

2. Is the air quality in the Upper Hunter Valley measured at the monitoring stations different from air quality measured at other locations in NSW?

   Yes, the UHAQMN data does feature higher PM_{10} concentrations than a range of regions across NSW, but is also broadly consistent with concentrations measured within the Lower Hunter and Central Coast. In addition, the difference between the Upper Hunter and the remainder of NSW is small in scale relative to the variability in concentrations across NSW. $PM_{2.5}$ concentrations are higher than elsewhere in NSW, and are likely to be influenced by wood smoke, as identified in CSIRO (2013).

The broad consistency between the air quality experienced in the Upper Hunter Valley and the Lower Hunter and Central Coast region is further supported through the inclusion of 2020 data (Table 2.1 and Table 2.2).

We trust that the above provides an appropriate level of detail to meet your request for review. Do not hesitate to contact the undersigned if you have any queries on the above.

Yours sincerely

Damon Roddis
Principal - Air Quality and Carbon
Zephyr Environmental
damon.roddis@zephyrenviro.com