Air quality in the Upper Hunter: Autumn 2022

Air quality in the Upper Hunter was generally good during autumn 2022. Daily particle levels were within national benchmarks 100% of the time at Muswellbrook and Singleton. Hourly particle levels were in the good to fair air quality categories 100% of the time at Singleton and Muswellbrook.

- Nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) levels were good to fair, remaining below hourly and daily national benchmarks.
  - Muswellbrook hourly SO_2 levels were close to exceeding the benchmark on a few days during the season. The highest hourly levels occurred on 17 and 28 March, under light south-easterly winds. The main sources of SO_2 at Muswellbrook are from the Bayswater and Liddell coal-fired power stations[1] located approximately 15 kilometres south-east of Muswellbrook.
- Daily average levels of PM10 (particles less than or equal to 10 microns in diameter) and PM2.5 (particles less than or equal to 2.5 microns in diameter) remained below national benchmarks at all stations.
- The region experienced very much above average rainfall and below average maximum temperatures during autumn.

Annual air quality trends in the Upper Hunter

A comparison of annual average PM10 and PM2.5 levels shows the long-term trends. The national annual average benchmarks are 25 µg/m^3 for PM10 and 8 µg/m^3 for PM2.5, based on a calendar year.

Figure 1 shows the PM10 and PM2.5 **rolling** annual averages[2], based on the 12-month periods from autumn 2013 to autumn 2022.

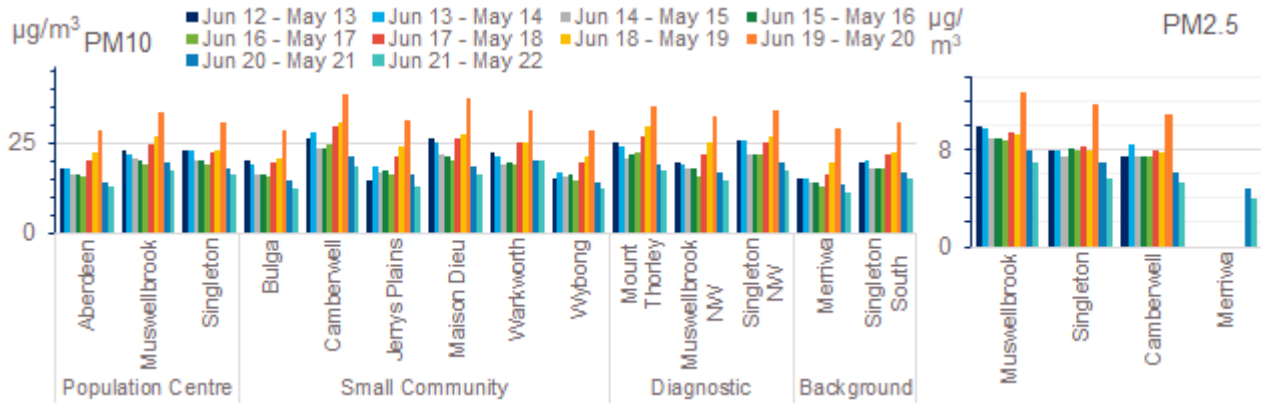

Figure 1 PM10 and PM2.5 rolling annual averages: to the end of autumn 2013 to 2022

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor particles such as PM2.5, visibility, ozone, nitrogen oxides, carbon monoxide and sulfur dioxide.

[1] Environment Protection Authority Air Emissions in My Community web tool.

[2] Rolling averages are not intended to be compared to benchmarks. The rolling annual averages provide a guide to long-term trends, using the most up to date monitoring data.

The comparison in Figure 1 shows that particle levels continued to decrease during the 12 months to the end of autumn 2022 at most stations, compared to the same 12-month period in previous years (especially compared to the end of autumn 2020). Warkworth PM10 levels did not show the same decreasing trend, with levels to the end of autumn 2022 similar to the previous 12-month period. This is likely due to nearby mining operations, with the United Wambo Joint Venture Open Cut mine starting operations in 2020.

All stations recorded rolling annual average PM10 and PM2.5 levels below the annual benchmarks, with most recording the lowest since the network began operation.

Lower particle levels resulted from wetter than average conditions over the 12 months. At the end of autumn 2022, there were no areas in New South Wales that were drought affected (Figure 2), compared to 16% at the end of autumn 2021[3] and 91% at the end of autumn 2020[4].

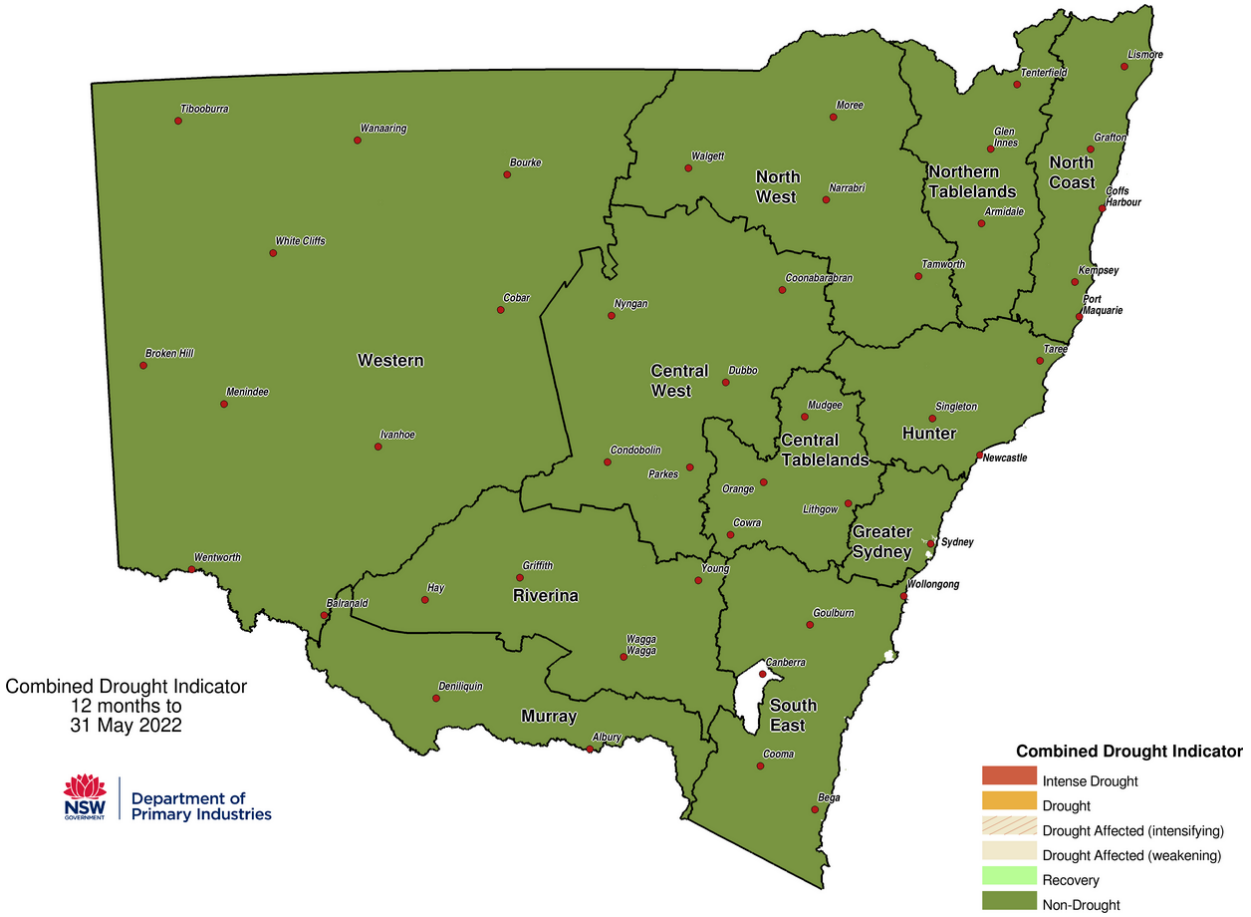

Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 May 2022[5]

[3] Sourced from Department of Primary Industries NSW State seasonal update – May 2021 (accessed July 2022).

[4] Sourced from Department of Primary Industries NSW State seasonal update – May 2020 (accessed July 2022).

[5] Sourced from Department of Primary Industries NSW State seasonal update – May 2022 (accessed July 2022).

Days above benchmark concentrations

All parameters remained below the national benchmarks throughout the season.

Table 1 Number of days above the relevant national benchmarks – autumn 2022

Station type*	Station	PM10 daily [50 µg/m^3 benchmark]	PM2.5 daily [25 µg/m^3 benchmark]	SO_2 hourly [10 pphm benchmark]	SO_2 daily [2 pphm benchmark]	NO_2 hourly [8 pphm benchmark]
Population centre	**Aberdeen**	0	-	-	-	-
Population centre	**Muswellbrook**	0	0	0	0	0
Population centre	**Singleton**	0	0	0	0	0
Smaller community	**Bulga**	0	-	-	-	-
Smaller community	**Camberwell**	0	0	-	-	-
Smaller community	**Jerrys Plains**	0	-	-	-	-
Smaller community	**Maison Dieu**	0	-	-	-	-
Smaller community	**Warkworth**	0	-	-	-	-
Smaller community	**Wybong**	0	-	-	-	-
Diagnostic	**Mount Thorley**	0	-	-	-	-
Diagnostic	**Muswellbrook NW**	0	-	-	-	-
Diagnostic	**Singleton NW**	0	-	-	-	-
Background	**Merriwa**	0	0	0	0	0
Background	**Singleton South**	0	-	-	-	-

µg/m^3 = micrograms per cubic metre.
pphm = parts per hundred million by volume (i.e. parts of pollutant per hundred million parts of air)
- = not monitored.
* For explanation, refer to the end of the report Definitions: Upper Hunter monitoring station types.

Pollution roses from hourly particle data

The seasonal pollution rose maps[6] (Figure 3 and Figure 4) show that hourly PM10 and PM2.5 levels[7] were predominantly low during the season.

Figure 3 **Hourly PM10 pollution rose map for the Upper Hunter region for autumn 2022**

Figure 4 **Hourly PM2.5 pollution rose map for the Upper Hunter region for autumn 2022**

[6] Pollution roses show wind direction and particle levels at a location. The length of each bar around the circle shows the percentage of time the wind blows from a particular direction. The colours along the bars indicate categories of particle levels.

[7] There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure.

Daily time series plots

Daily average time series plots for PM10 and PM2.5 and daily one-hour maximum plots for NO_2 and SO_2 show the concentrations throughout autumn (Figure 5 to Figure 11). All parameters remained below the benchmarks. Muswellbrook hourly SO_2 levels were close to exceeding the benchmark on a couple of days in the season, especially 17 and 28 March, occurring under light south-easterly winds.

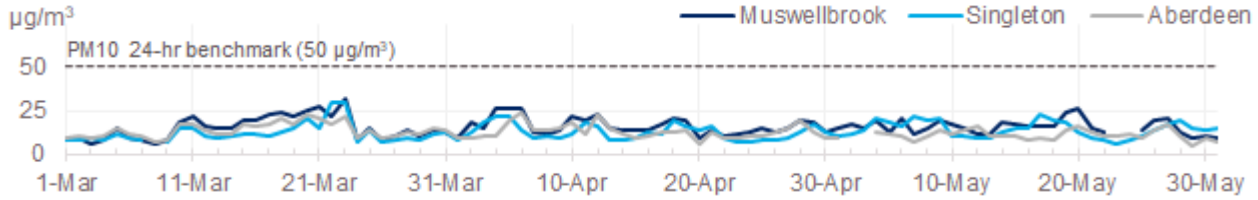

Figure 5 **Population centre stations: daily average PM10 – autumn 2022**

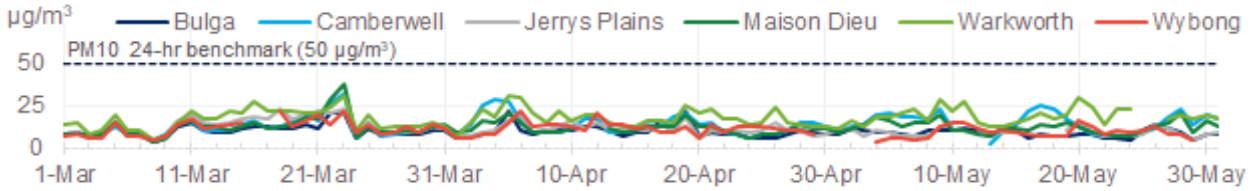

Figure 6 **Smaller community stations: daily average PM10 – autumn 2022**

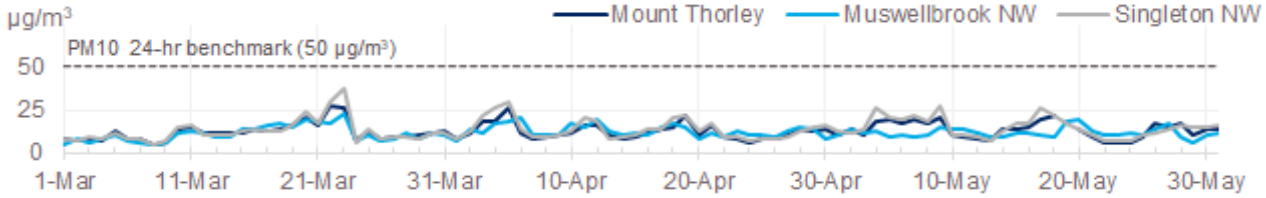

Figure 7 **Diagnostic stations: daily average PM10 – autumn 2022**

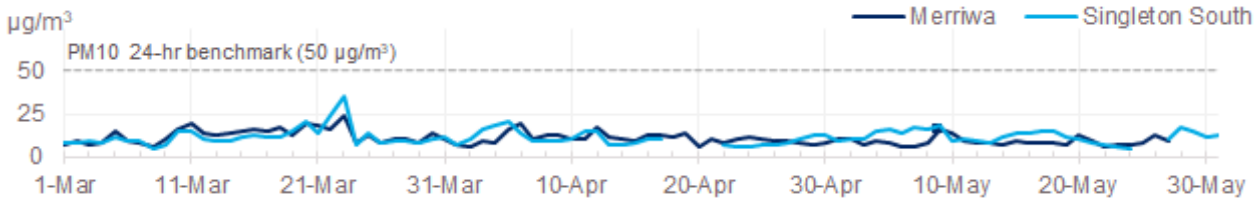

Figure 8 **Background stations: daily average PM10 – autumn 2022**

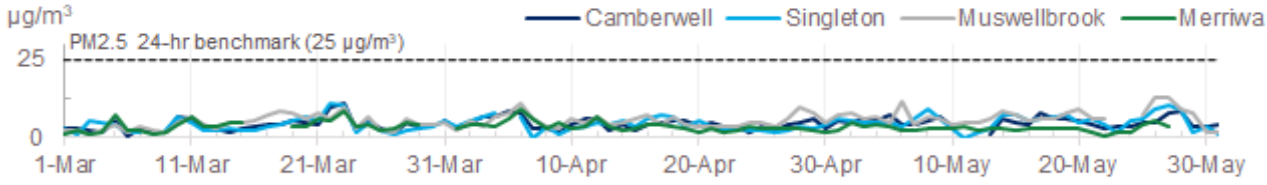

Figure 9 **Daily average PM2.5 – autumn 2022**

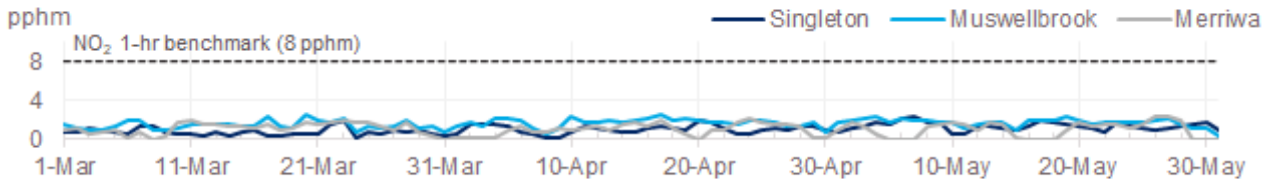

Figure 10 **Daily 1-hr maximum NO_2 – autumn 2022**

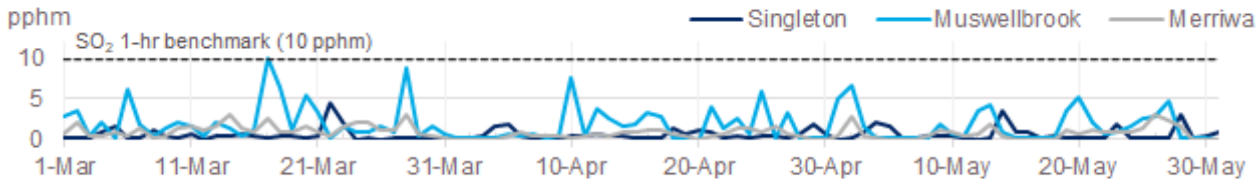

Figure 11 **Daily 1-hr maximum SO_2 – autumn 2022**

Seasonal comparisons

This section compares air quality in autumn 2022 with previous autumn seasons (Figure 12).

There were no days over the current national benchmarks for NO_2 and SO_2 in autumn 2022. From 2012 to 2021 in autumn, under the more stringent standards (applied from May 2021 onwards), Muswellbrook would have recorded 14 hours over 13 days above the current hourly SO_2 standard of 10 parts per hundred million (pphm). There would have also been one day above the current daily SO_2 standard of 2 pphm at Muswellbrook.

There were no days over the PM10 daily benchmark during autumn 2022. From 2012 to 2021, the region recorded between one day (autumns 2017 and 2021) and 17 days (autumn 2018) over the PM10 benchmark. Higher particle levels occurred in the autumn of 2018 and 2019 due to drought conditions.

There were no days over the PM2.5 daily benchmark during autumn 2022. From 2012 to 2021, the region only recorded days over the PM2.5 benchmark during the autumns of 2016 (2 days) and 2017 (1 day).

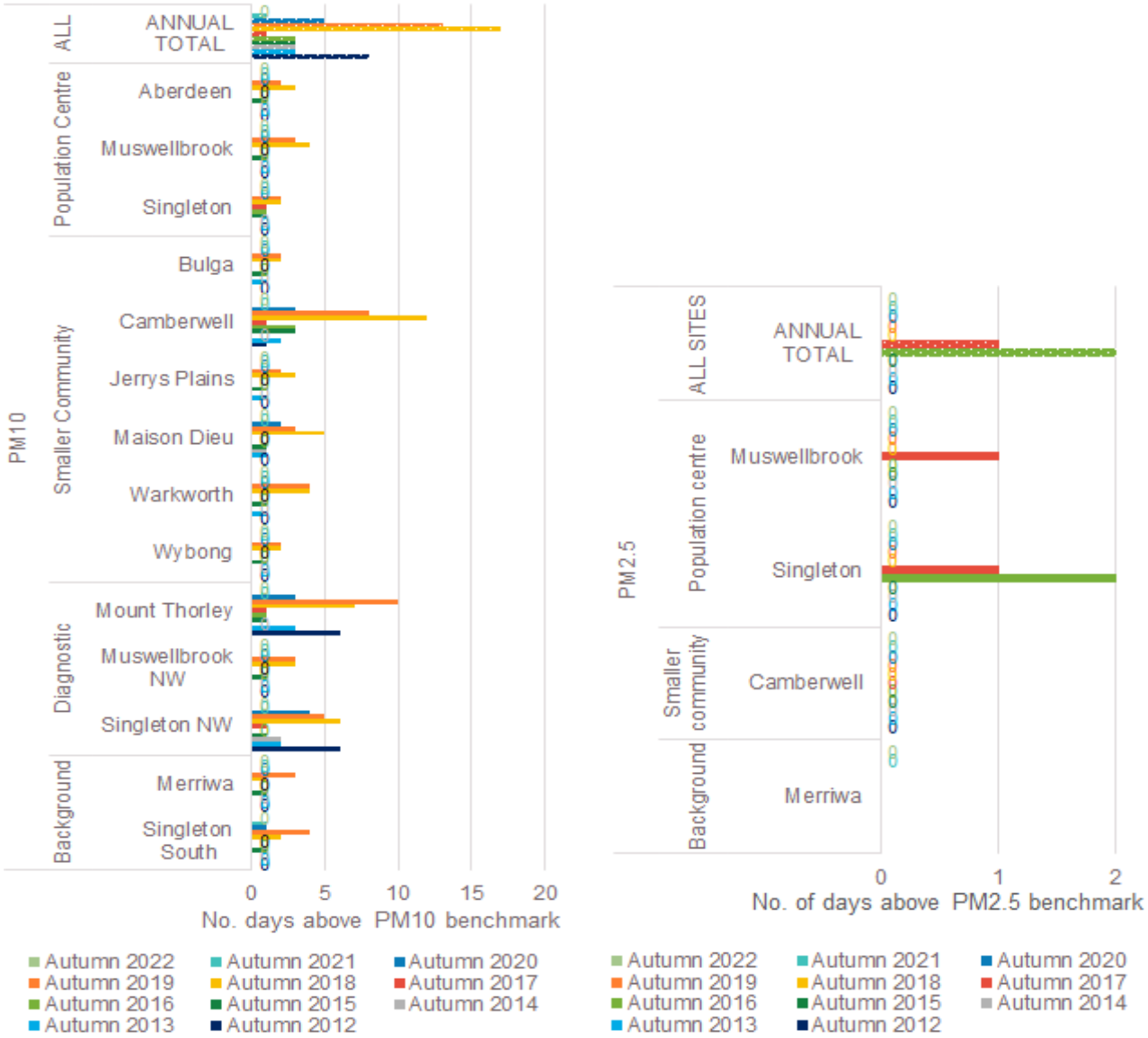

Figure 12 Number of days above the PM10 and PM2.5 daily benchmarks: autumn 2012 to 2022

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to monitor particles such as PM2.5, visibility, ozone, nitrogen oxides, carbon monoxide and sulfur dioxide.

Particle air quality trends in the Upper Hunter

Figure 13 and Figure 14 show daily average PM10 levels during autumn 2022, compared to the daily maximum and minimum levels (i.e. shaded range) for autumn periods from 2011 to 2021, at Singleton and Muswellbrook. Daily PM10 levels were within or below the historical range throughout the season. Regional rainfall levels were very much above average, predominantly due to a very wet March (Figure 15).

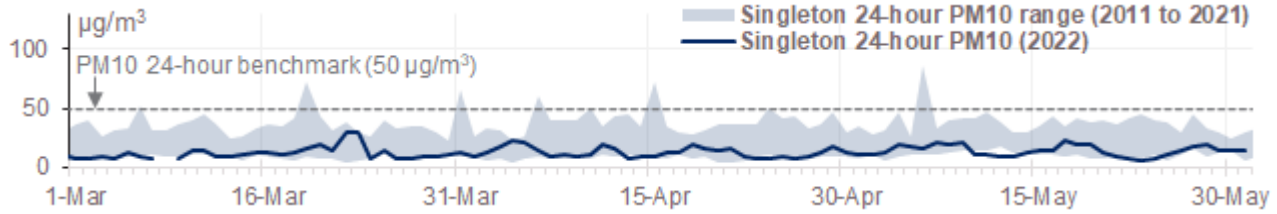

Figure 13 **Singleton daily average PM10 during autumn 2022 plotted against the daily maximum and minimum PM10 levels from 2011 to 2021**

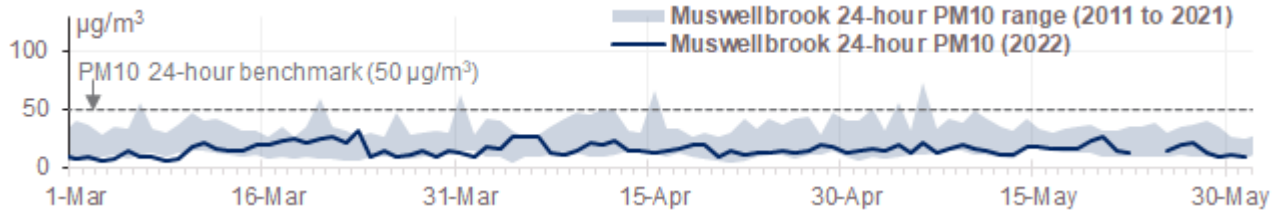

Figure 14 **Muswellbrook daily average PM10 during autumn 2022 plotted against the daily maximum and minimum PM10 levels from 2011 to 2021**

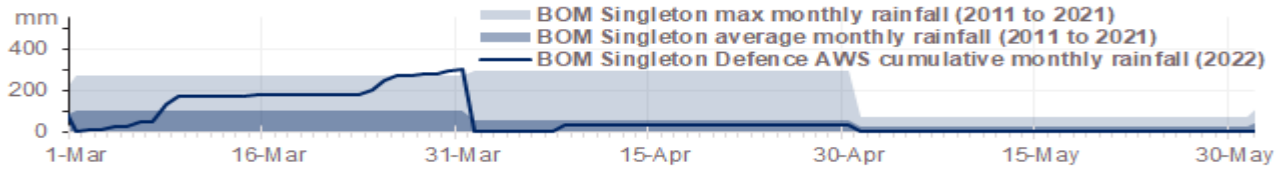

Figure 15 **Bureau of Meteorology Singleton Defence AWS[8] cumulative monthly rainfall in autumn 2022 against maximum and average monthly rainfall from 2011 to 2021[9]**

Figure 16 and Figure 17 show daily average PM2.5 levels during autumn 2022, compared to the daily maximum and minimum levels (shaded range) for autumn periods from 2011 to 2021, at Singleton and Muswellbrook. Daily PM2.5 levels were within or below the historical range in the season.

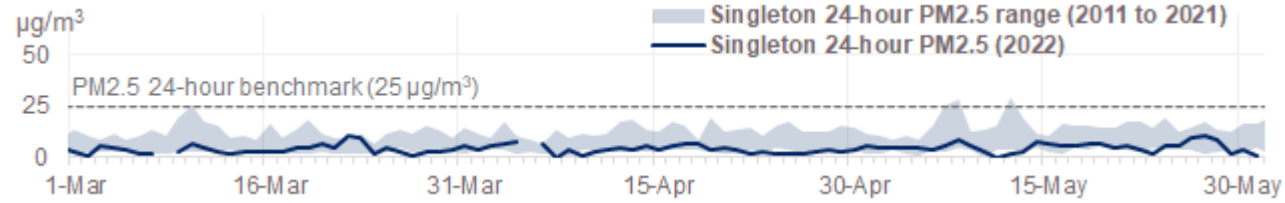

Figure 16 **Singleton daily average PM2.5 during autumn 2022 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2021**

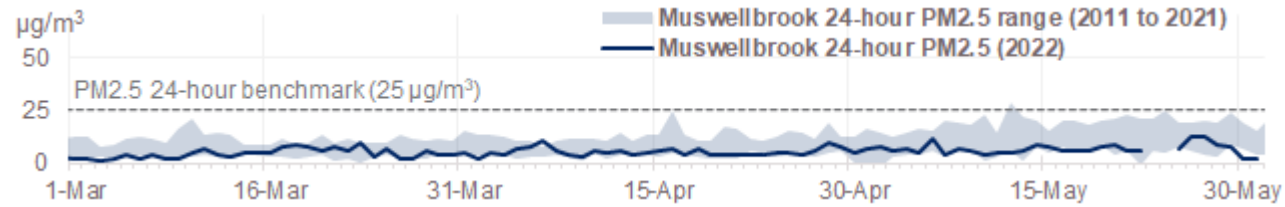

Figure 17 **Muswellbrook daily average PM2.5 during autumn 2022 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2021**

[8] Data obtained from the Bureau of Meteorology Singleton Defence AWS monthly rainfall data (accessed August 2022).

[9] The Bureau of Meteorology STP station was decommissioned in January 2019. Therefore, statistics have been calculated from a combination of the Singleton STP monthly rainfall data (accessed March 2020) from January 2011 to March 2017 and Singleton Defence AWS monthly rainfall data from April 2017.

Meteorological summary

Rainfall and temperature[10]

The Upper Hunter experienced very much above average rainfall during autumn 2022 (Figure 18), with high rainfall during March. Autumn 2022 was wetter than the 3 previous autumns, with around 25 to 100 millimetres more rain than autumn 2021, up to 200 millimetres more rain than autumn 2020 and 50 to 200 millimetres more rain than autumn 2019.

Maximum temperatures were below average (Figure 19), and minimum temperatures were very much above average during the season.

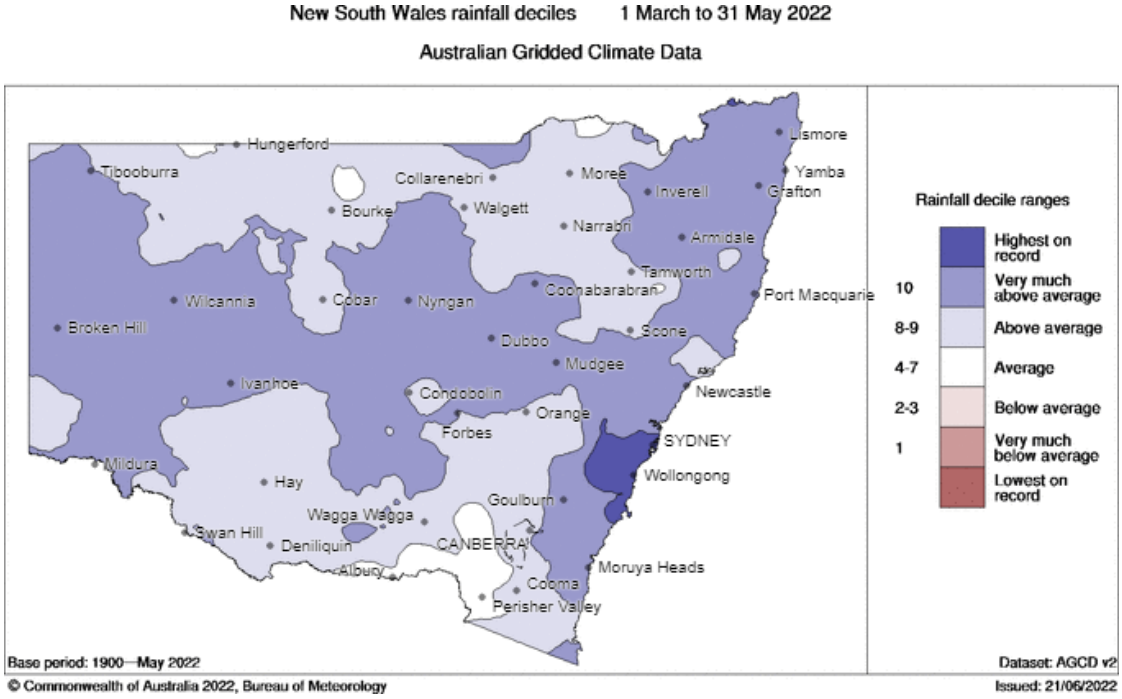

Figure 18 NSW rainfall deciles – autumn 2022

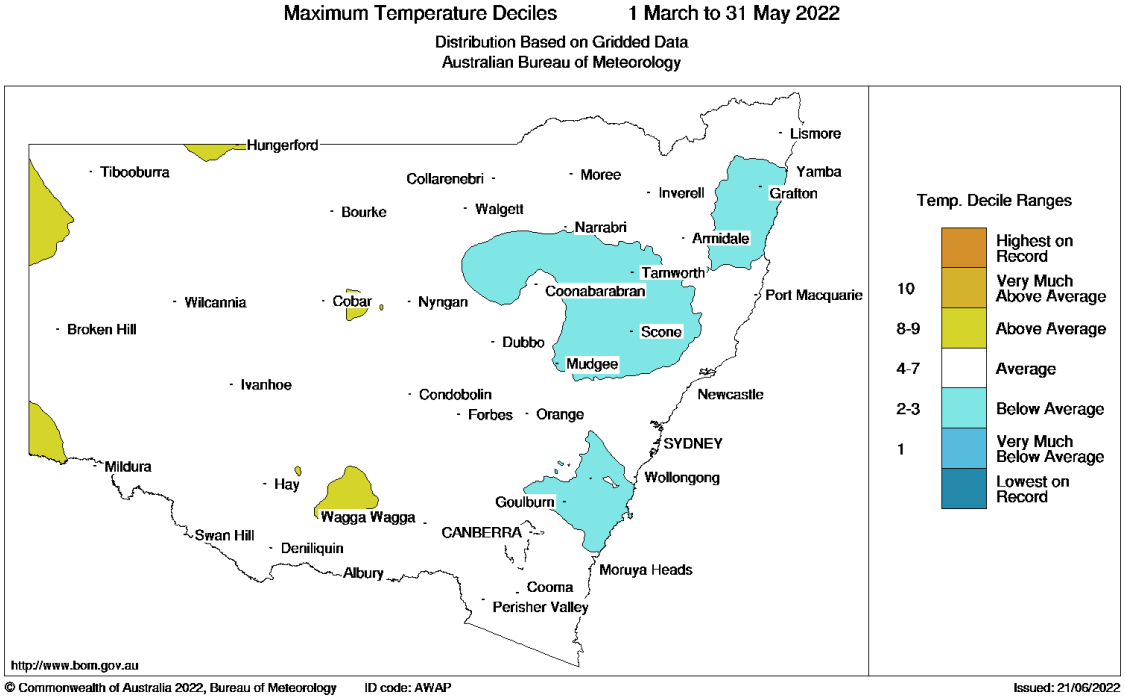

Figure 19 NSW maximum temperature deciles – autumn 2022

[10] Rainfall and temperature information is from the Bureau of Meteorology New South Wales autumn 2022 climate statement (accessed July 2022) and climate maps (accessed July 2022).

Wind

Winds were variable during autumn 2022 (Figure 20), which was typical for this time of year. Winds tend to shift from a south-easterly direction during the warmer months towards a more north-westerly direction as temperatures cool. Overall, regional wind speeds in autumn 2022 were similar compared to autumn 2021, and lower than in earlier years.

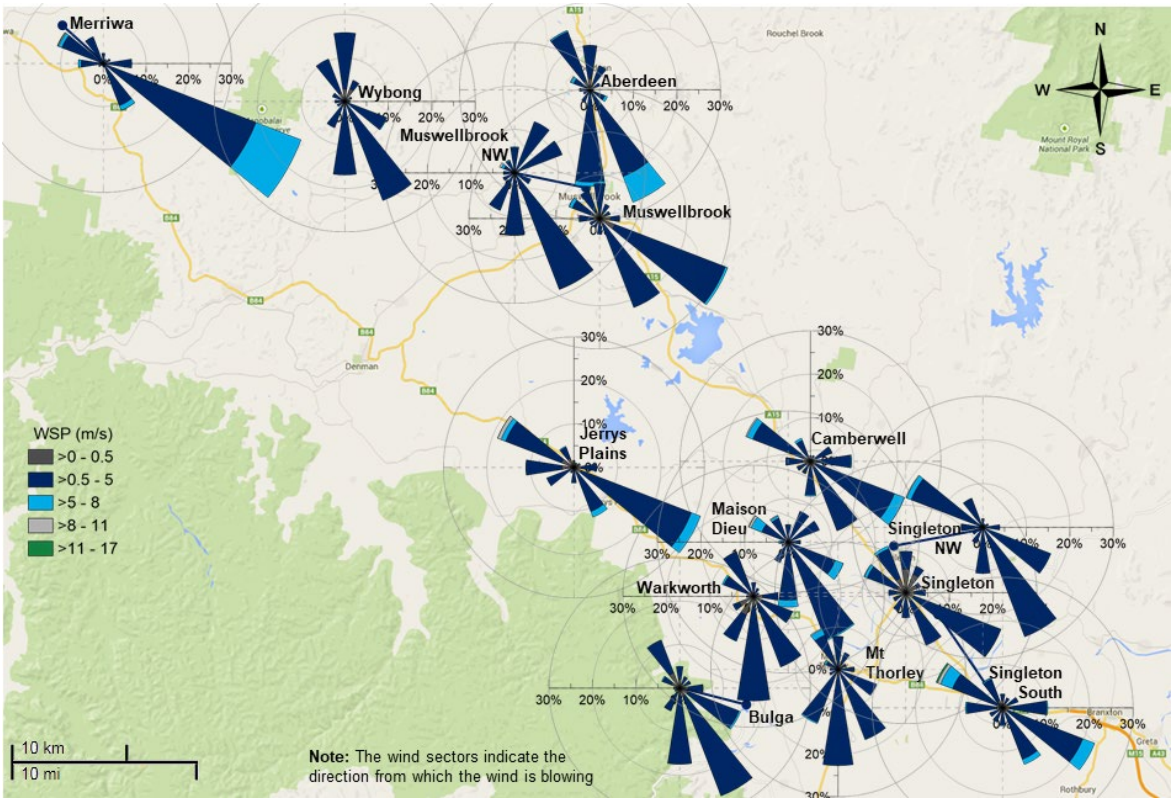

Figure 20 Wind rose map[11] for the Upper Hunter region for autumn 2022

[11] Wind roses show the wind direction and speed at a location. The length of each bar around the circle show the percentage of time that the wind blows from a particular direction. The colours along the bars indicate the wind speed categories.

Network performance

The target network performance is at least 95% available data for all parameters. The maximum online time that can be attained for NO_2 and SO_2 is 96%, due to daily calibrations.

Table 2 Online performance (%) during autumn 2022

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO_2 hourly	Gases NO_2 hourly	Meteorology Wind hourly
Aberdeen	98	-	-	-	100
Bulga	100	-	-	-	99
Camberwell	98	97	-	-	100
Jerrys Plains	95	-	-	-	96
Maison Dieu	98	-	-	-	98
Merriwa	96	90	93	92	97
Mount Thorley	99	-	-	-	99
Muswellbrook	98	98	96	95	99
Muswellbrook NW	100	-	-	-	92
Singleton	99	98	95	89	99
Singleton NW	100	-	-	-	97
Singleton South	93	-	-	-	98
Warkworth	98	-	-	-	100
Wybong	91	-	-	-	98

- = not monitored

The overall reduced online times were mainly due to:

- Singleton South PM10 – power outage (4 days) and scheduled calibration (2 days)
- Singleton NO_2 – intermittent negative data (4 days)
- Wybong PM10 – instrument fault (2 days) and power outages (6 days)
- Merriwa PM2.5 – sensor replacement (3 days), scheduled calibration (2 days) and datalogger fault (4 days)
- Muswellbrook NW wind – sensor damage (7 days).

Definitions: Upper Hunter monitoring station types

The 14 monitoring stations in the Upper Hunter serve different purposes:

Larger population: stations near the larger population centres monitor the air quality in these centres.

Smaller communities: stations near smaller communities monitor the air quality at those locations.

Diagnostic: provide data that can help diagnose the likely sources and movement of particles across the region as a whole; they do not provide information about air quality at population centres.

Background: the stations near Merriwa and Singleton South are at both ends of the valley and provide background data, measuring the quality of air entering and leaving the Upper Hunter Valley under predominant winds (south-easterlies and north-westerlies).

This document was prepared by Loredana Warren and reviewed by Stephen White

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