Air Quality Monitoring Network

Upper Hunter autumn 2024

Air quality in the Upper Hunter was exceptionally good during autumn 2024. At Muswellbrook and Singleton population centres, daily particle levels were consistently below national benchmarks[1] 100% of the time, while hourly particle levels were in the good to fair air quality categories[2] 100% of the time.

- Nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) levels were good, remaining below hourly and daily national benchmarks at all stations.
- Daily average PM2.5[3] levels remained below the benchmark at all stations.
- Daily average PM10[4] levels remained below the benchmark, except for one day each at 2 stations. Jerrys Plains recorded a daily average PM10 level of 51.2 µg/m^3 [5] on 13 March and Warkworth recorded 54.0 µg/m^3 on 31 May.
- The region experienced above-average rainfall, as well as above-average maximum and minimum temperatures during the season.

Annual air quality trends in the Upper Hunter

Figure 1 and Figure 2 show the PM10 and PM2.5 rolling annual averages[6], based on 12–month periods for autumn 2013 to autumn 2024.

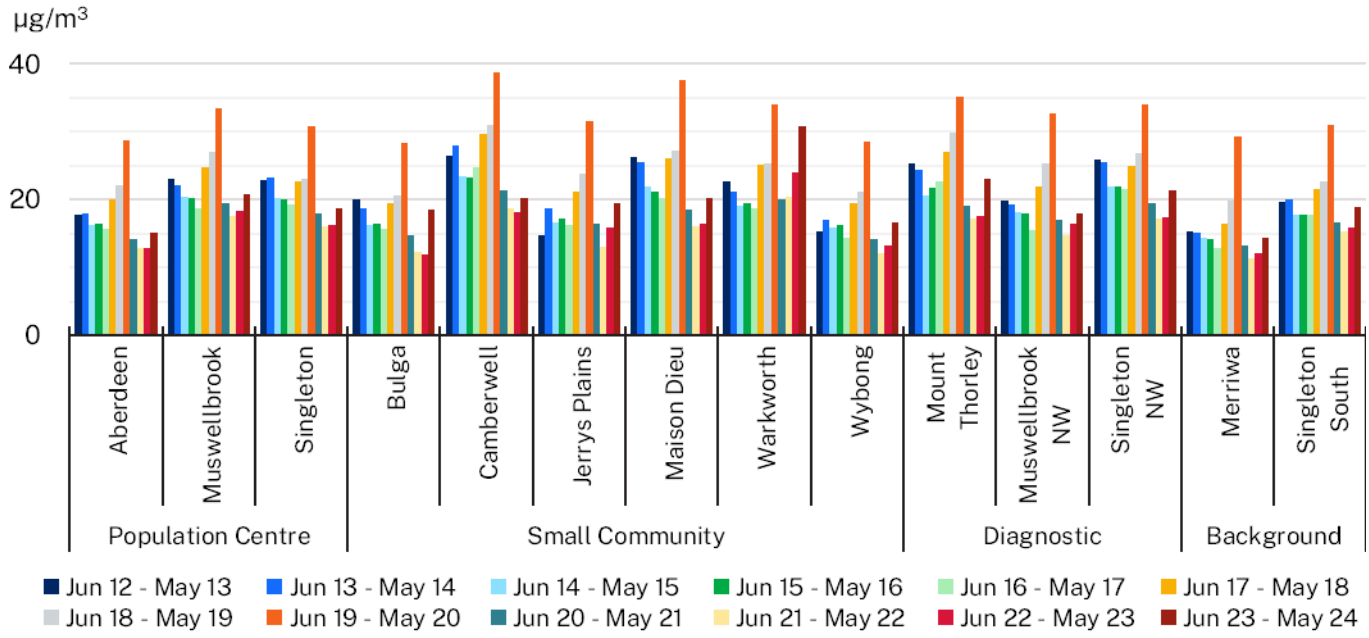

Figure 1 PM10 rolling annual averages from the end of autumn 2013 to 2024

Note: Data in this figure are listed in Table 3, Appendix A: Rolling annual averages.

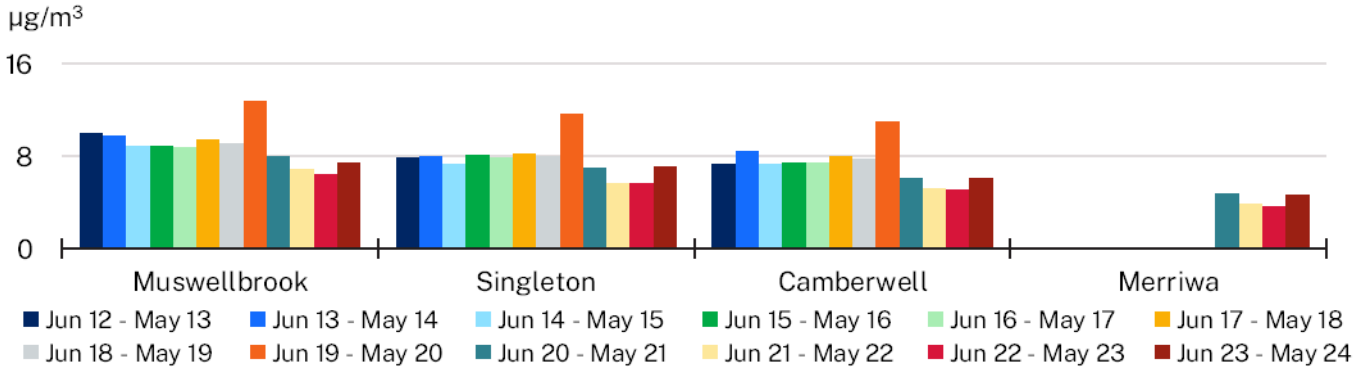

Figure 2 PM2.5 rolling annual averages from the end of autumn 2013 to 2024

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor PM2.5.
The data in this figure are listed in Table 4, Appendix A: Rolling annual averages.

PM10 rolling annual average levels for autumn 2024 increased throughout the region, compared to recent record low years (Figure 1). This was most evident at Warkworth, which had the highest rolling annual average (30.8 µg/m^3), and was the only station exceeding 25 µg/m^3. Warkworth was likely impacted by emissions from nearby mining operations[7], exacerbated by drier conditions over the previous 12 months.

PM2.5 rolling annual average levels to the end of autumn 2024 increased compared to the previous 12-month period but remained below 8 µg/m^3 and were similar to those recorded to the end of autumn 2021 (Figure 2).

At the end of autumn 2024, 34% of New South Wales was drought–affected (Figure 3)[8] compared to only 1% of New South Wales at the end of autumn 2023[9], no areas at the end of autumn 2022[10], and 16% at the end of autumn 2021[11].

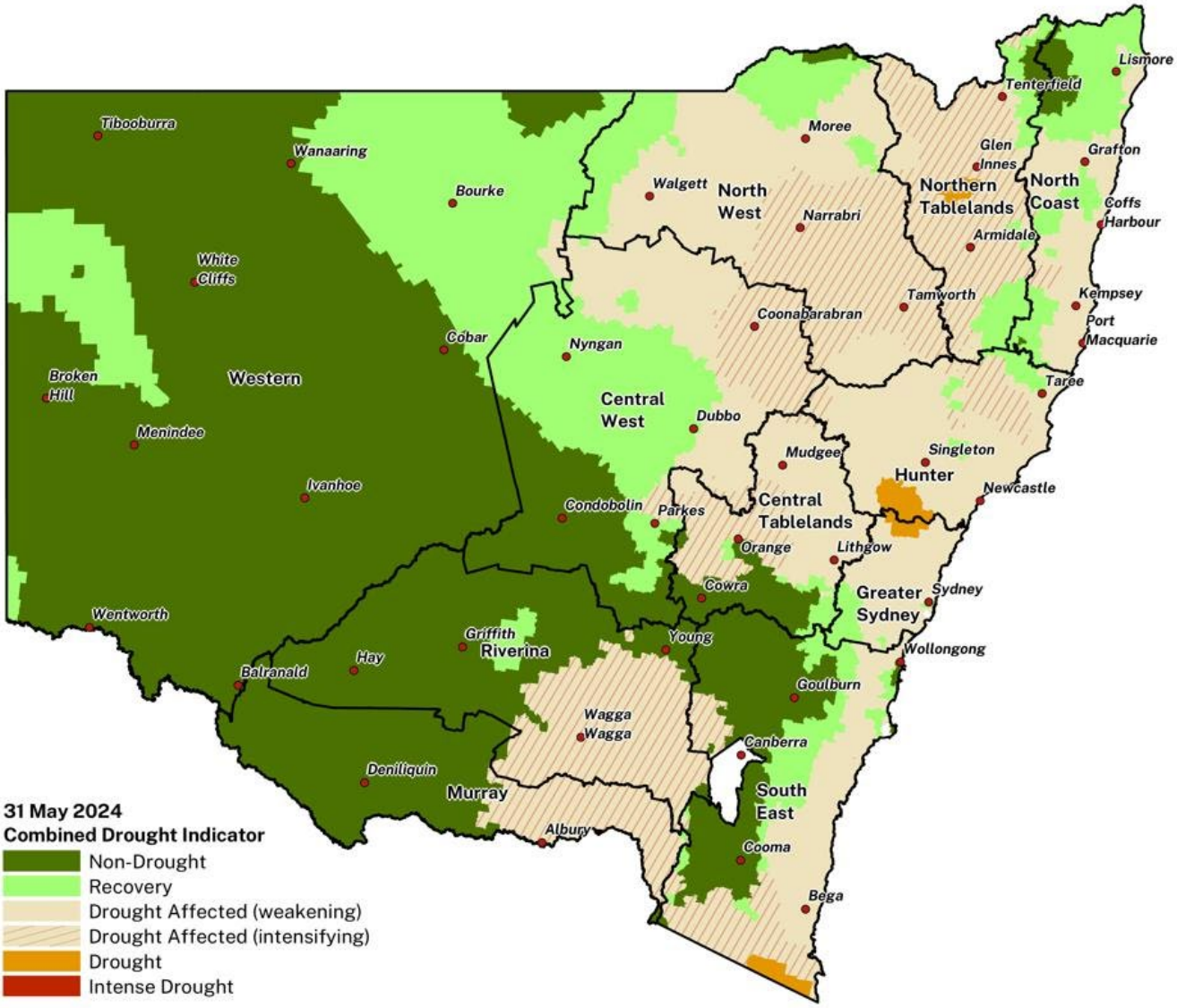

Figure 3 NSW combined drought indicator to 31 May 2024[8]

Credit: NSW Department of Primary Industries and Regional Development © State of New South Wales EDIS v2.2

Days above benchmark concentrations

Daily PM10 levels were above the benchmark in the Upper Hunter on 2 days during autumn 2024 (Table 1). These occurred at Jerrys Plains on 13 March and Warkworth on 31 May. PM2.5, SO_2 and NO_2 remained below the national benchmarks at all stations throughout the season.

Table 1 Number of days above the relevant national benchmarks autumn 2024

Station type[12]	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	1	–	–	–	–
Smaller community	Maison Dieu	0	–	–	–	–
Smaller community	Warkworth	1	–	–	–	–
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 (that is, parts of pollutant per hundred million parts of air)

– = not monitored

Seasonal trends

This section compares air quality in autumn 2024 with previous autumn seasons from 2012 to 2023 (Figure 4 to Figure 12).

- NO_2 gaseous: there were no days over the national benchmark for NO_2 in autumn 2024 or in previous autumns.
- SO_2 gaseous: there were no days over the national benchmarks for SO_2 in autumn 2024. In previous autumns, only Muswellbrook recorded 15 hours above the current SO_2 hourly benchmark of 10 pphm, occurring over 14 days (Figure 4). There was one autumn day at Muswellbrook in 2019 above the current SO_2 daily benchmark of 2 pphm (Figure 5).
- PM10 particles: there were 2 days over the PM10 daily benchmark in autumn 2024, observed at Jerrys Plains and Warkworth (Figure 6 to Figure 10). During previous autumns, the region recorded between zero days (2022) and 17 days (2018) over the benchmark. Autumn 2024 was an improvement compared to autumn 2023 when there were 8 days over the PM10 daily benchmark.
- PM2.5 particles: there were no days over the PM2.5 daily benchmark during autumn 2024 (Figure 11 and Figure 12). Previously, the region recorded 3 days over the benchmark, occurring over 2 autumn seasons (2016 and 2017).

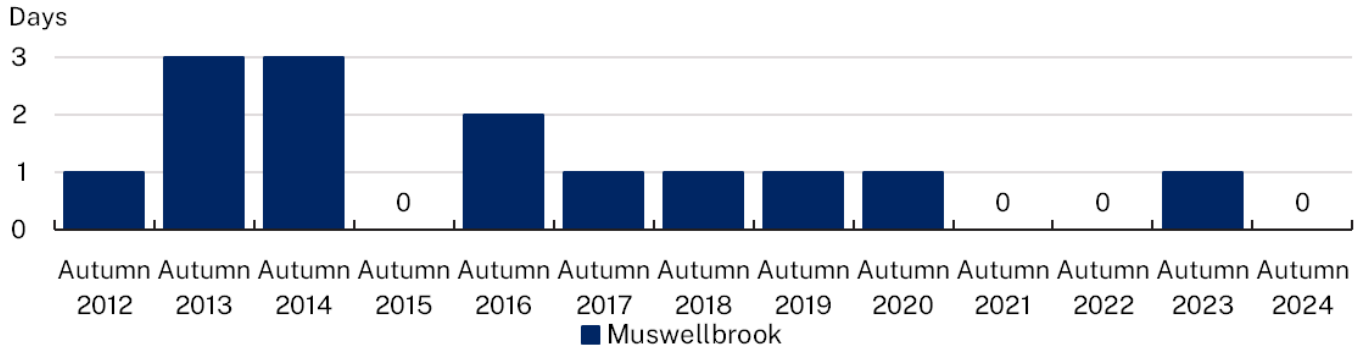

Figure 4 **Number of days above the SO_2 hourly benchmark in the Upper Hunter: autumn 2012 to 2024**

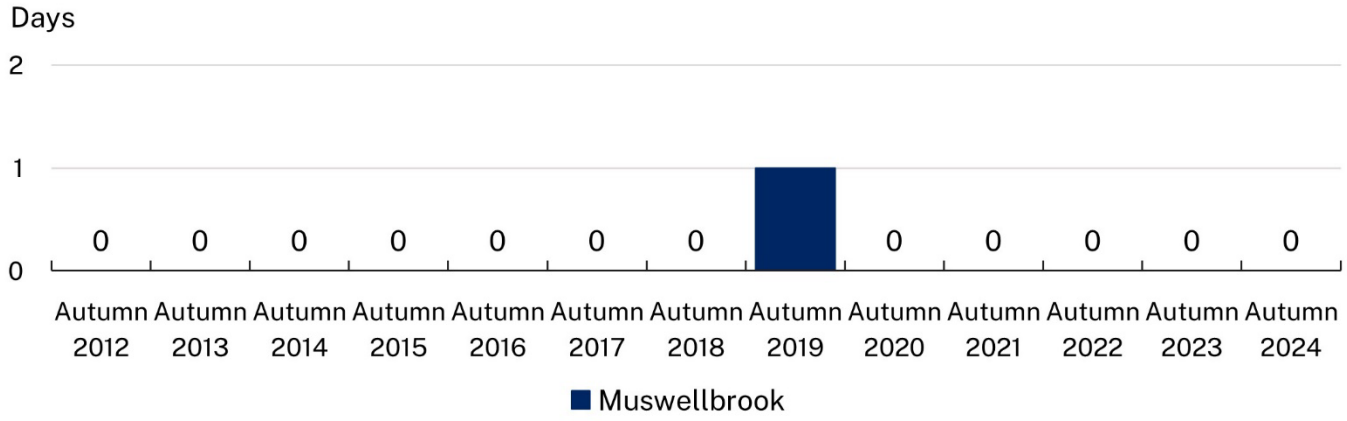

Figure 5 **Number of days above the SO_2 daily benchmark in the Upper Hunter: autumn 2012 to 2024**

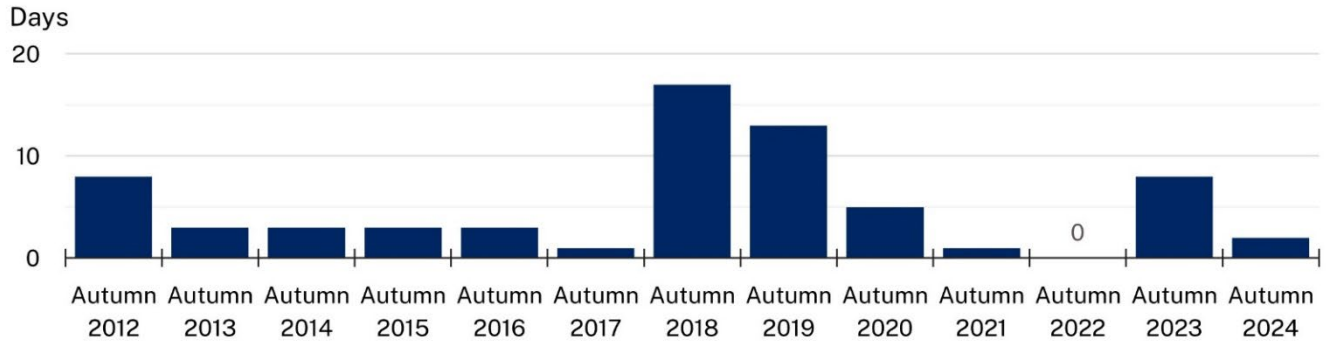

Figure 6 **Number of days above the PM10 daily benchmark in the Upper Hunter: autumn 2012 to 2024**

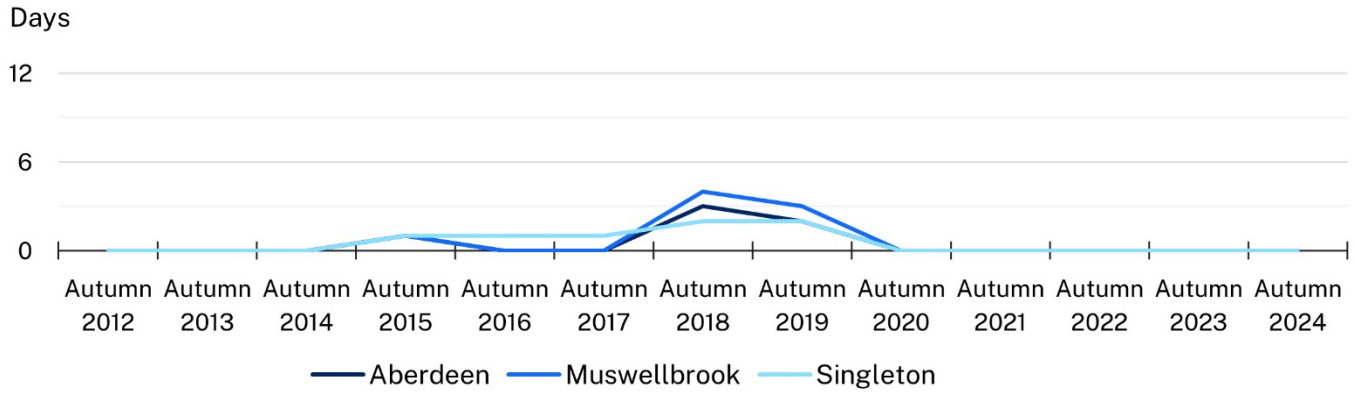

Figure 7 **Number of days above the PM10 daily benchmark at population centres: autumn 2012 to 2024**

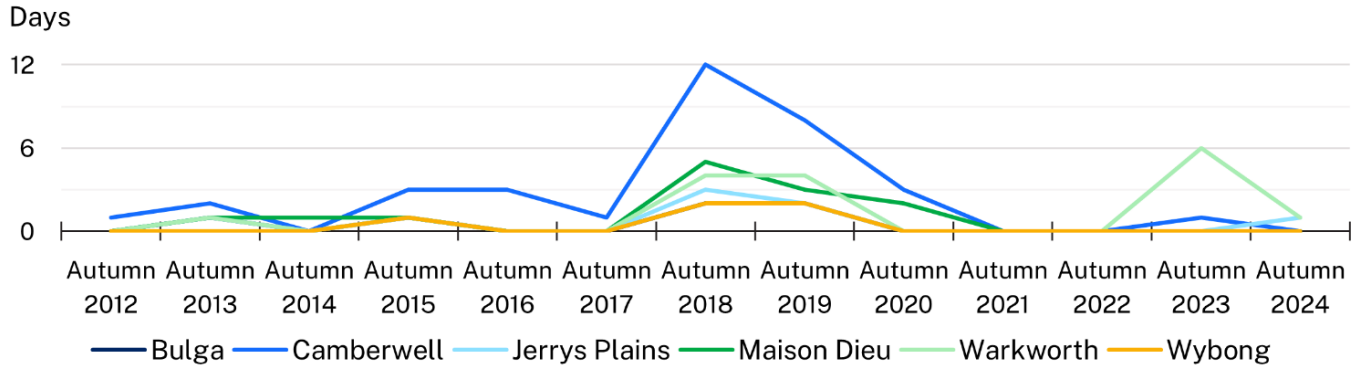

Figure 8 **Number of days above the PM10 daily benchmark at smaller communities: autumn 2012 to 2024**

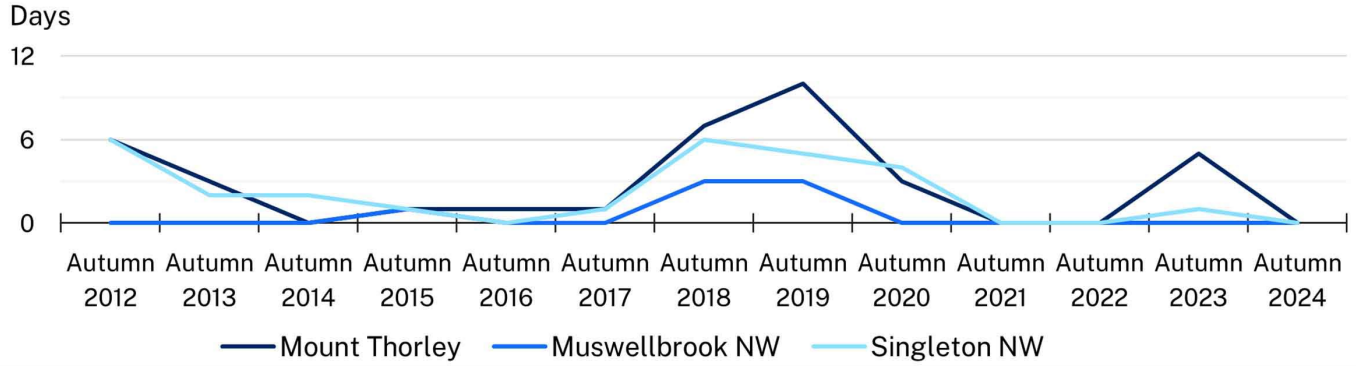

Figure 9 **Number of days above the PM10 daily benchmark at diagnostic stations: autumn 2012 to 2024**

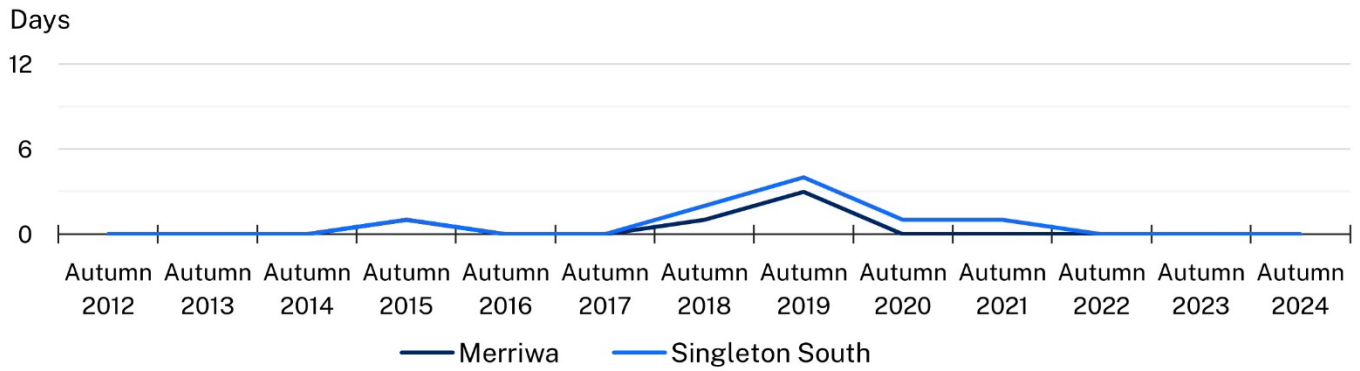

Figure 10 **Number of days above the PM10 daily benchmark at background stations: autumn 2012 to 2024**

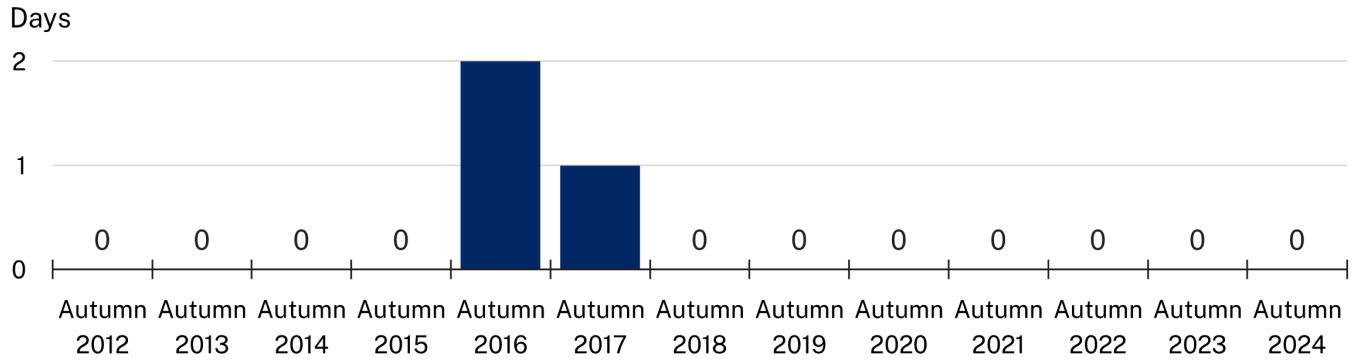

Figure 11 **Number of days above the PM2.5 daily benchmark in the Upper Hunter: autumn 2012 to 2024**

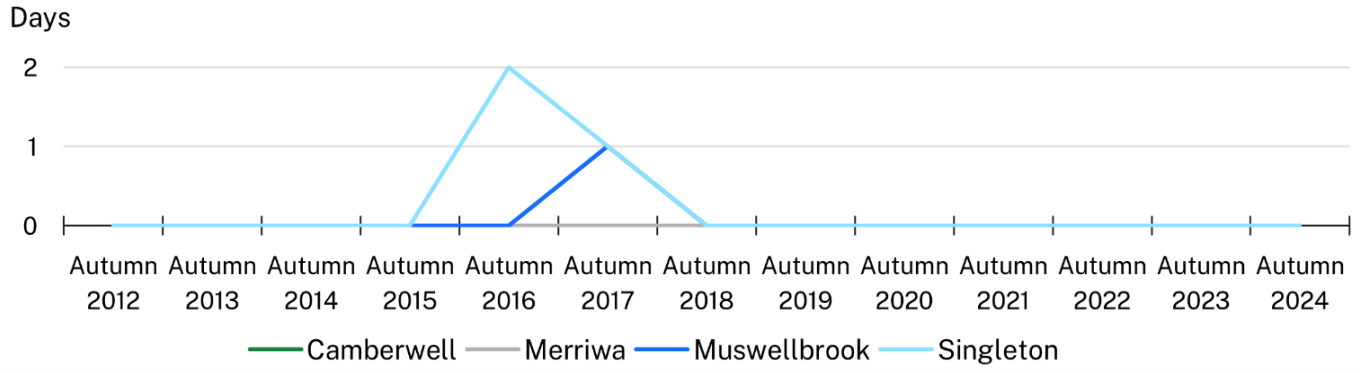

Figure 12 **Number of days above the PM2.5 daily benchmark at each station: autumn 2012 to 2024**

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor PM2.5.

Daily time series plots

Figure 13 to Figure 20 show daily average time series plots for PM10, PM2.5 and SO_2 and daily 1-hour maximum time series plots for NO_2 and SO_2.

The highest levels of PM10 particles were observed at the smaller community stations, and mostly during March. Most stations saw their lowest PM10 levels in early May during wet weather. Levels of PM10 were above the daily benchmark on 2 occasions: once in March at Jerrys Plains and once in late May at Warkworth.

Levels of PM2.5 particles were in the good category throughout most of the season.

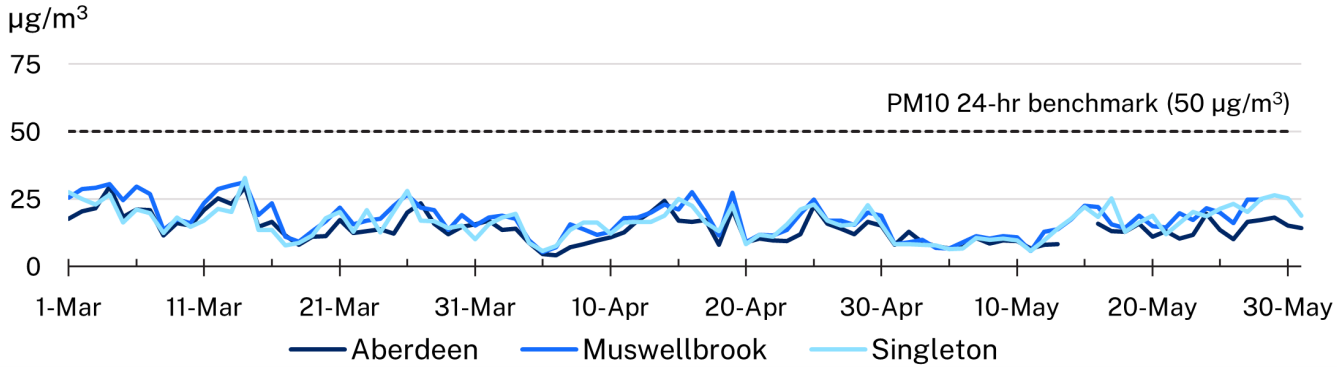

Figure 13 **Population centre stations: daily average PM10 autumn 2024**

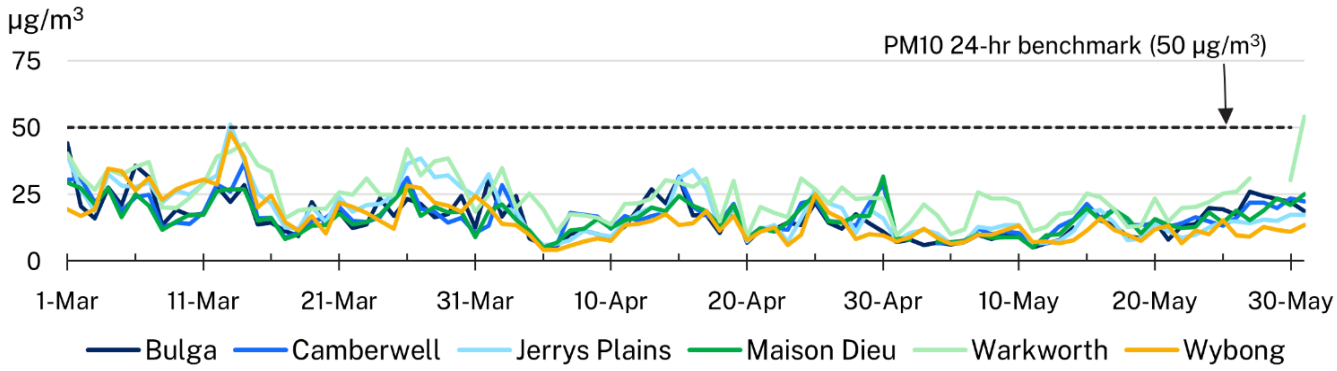

Figure 14 **Smaller community stations: daily average PM10 autumn 2024**

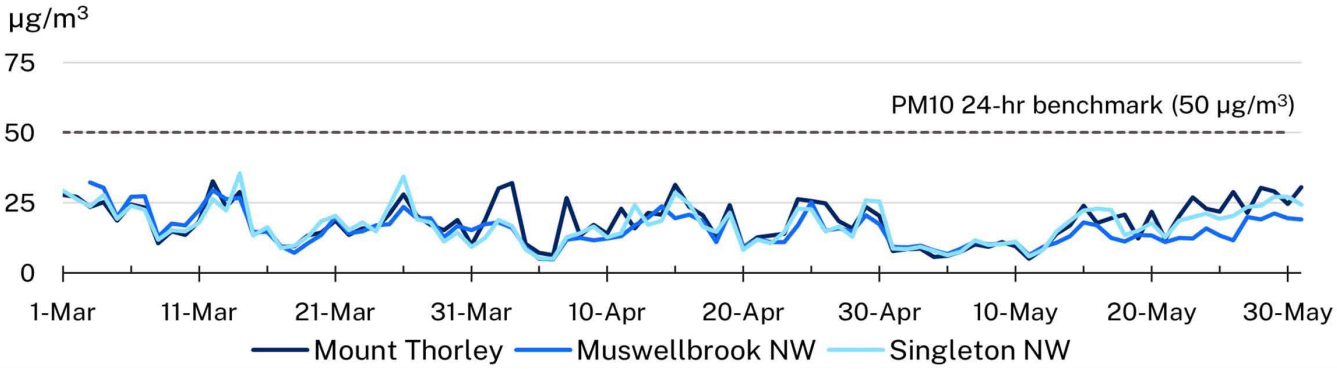

Figure 15 **Diagnostic stations: daily average PM10 autumn 2024**

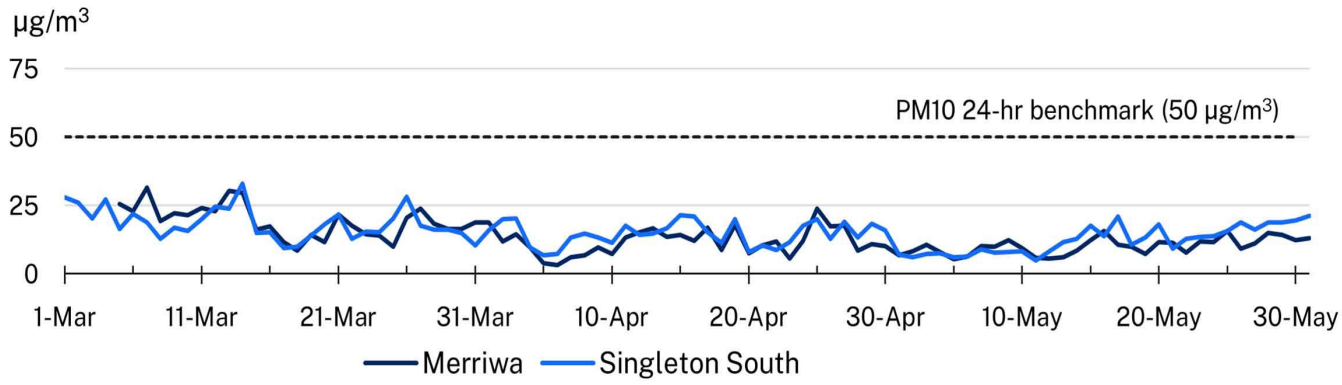

Figure 16 **Background stations: daily average PM10 autumn 2024**

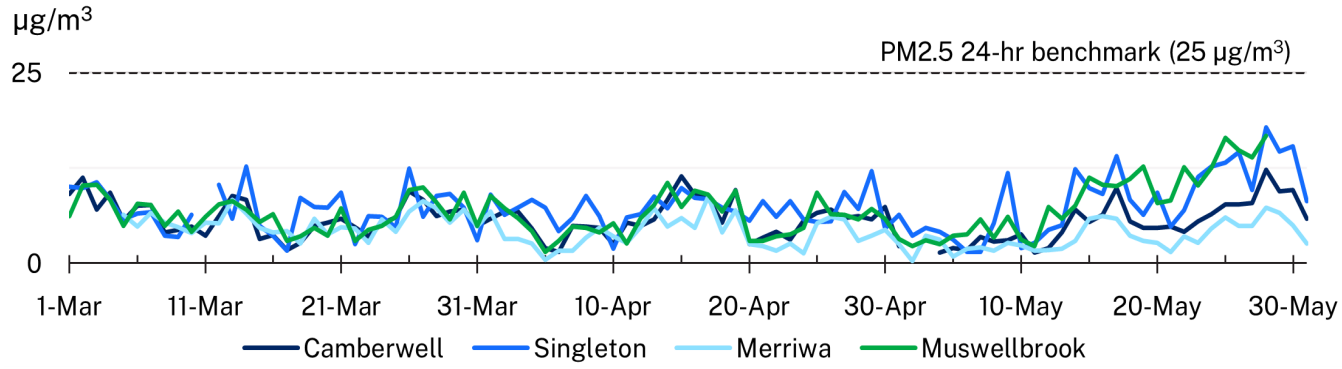

Figure 17 **Daily average PM2.5 autumn 2024**

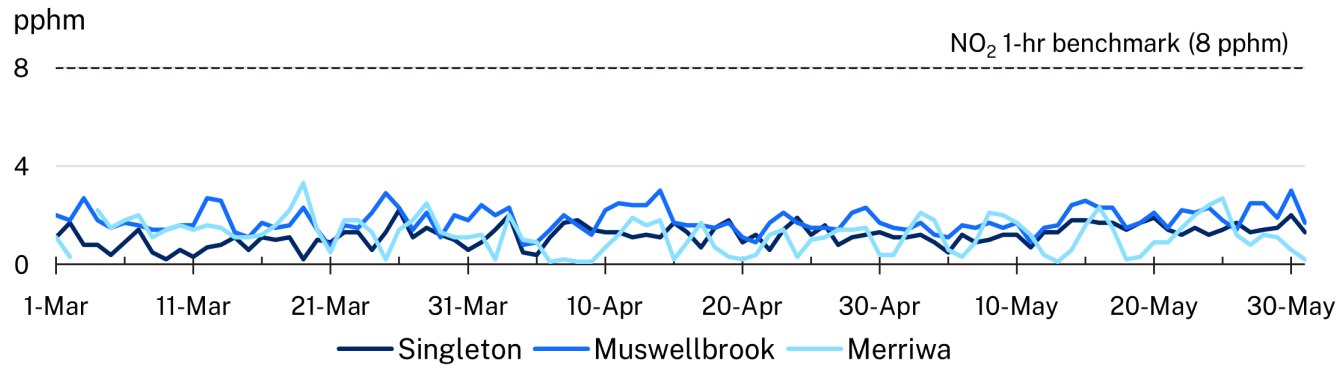

Figure 18 **Daily 1–hr maximum NO_2 autumn 2024**

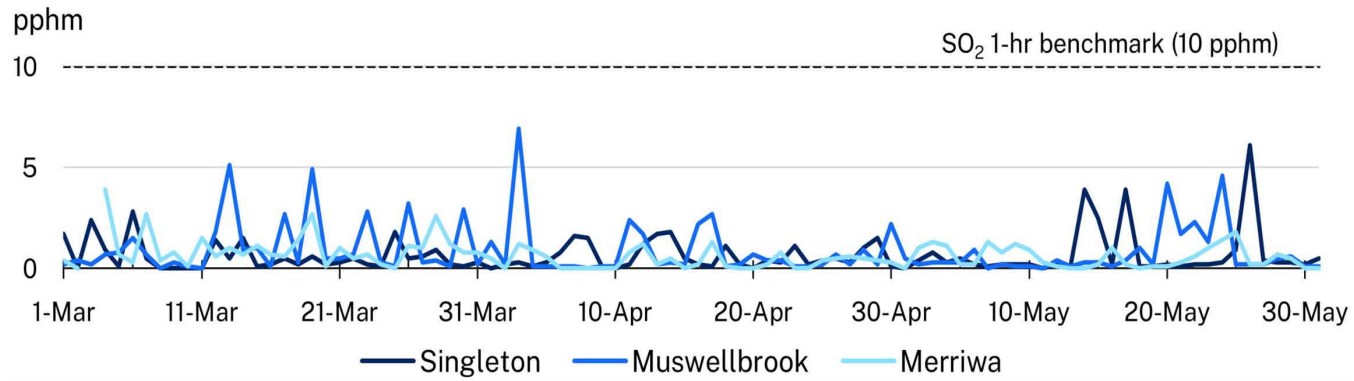

Figure 19 **Daily 1–hr maximum SO_2 autumn 2024**

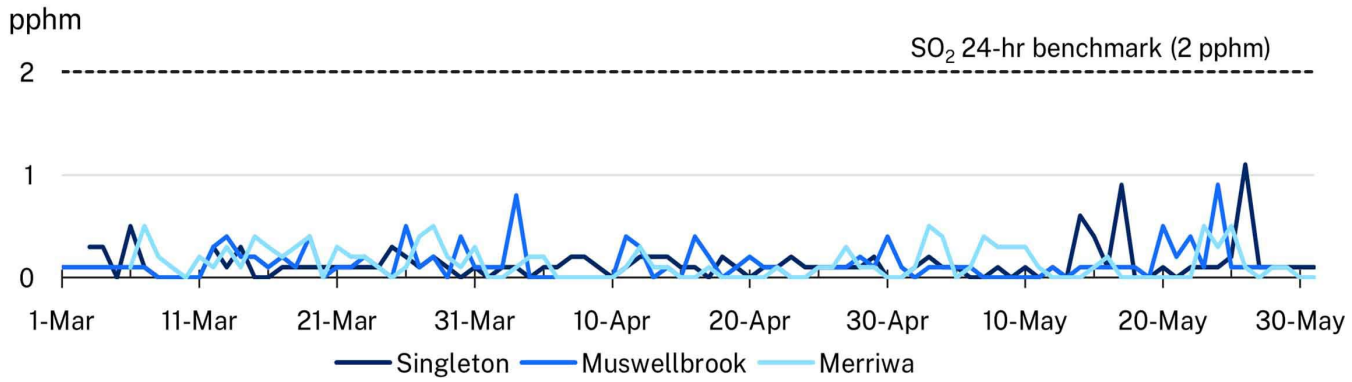

Figure 20 **Daily average SO_2 autumn 2024**

Particle air quality trends in the Upper Hunter

Figure 21 and Figure 22 show daily average PM10 levels during autumn 2024, compared to the daily maximum and minimum levels (the shaded range) for autumn seasons from 2011 to 2023, at Singleton and Muswellbrook.

Daily PM10 levels were generally within the historical range throughout the season at both stations.

Regional rainfall levels were average for March, very much above average in April and above average in May[13] (Figure 23).

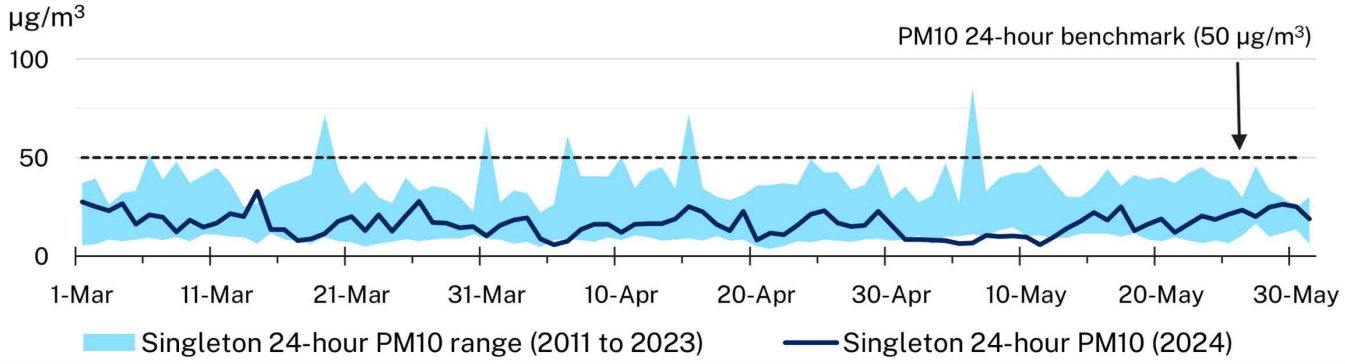

Figure 21 **Singleton daily average PM10 during autumn 2024 plotted against the daily maximum and minimum PM10 levels from 2011 to 2023**

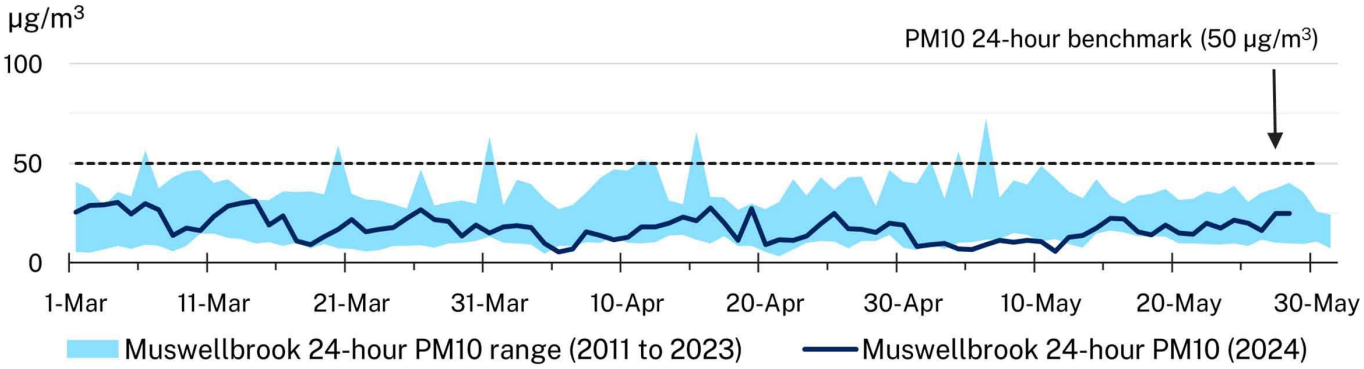

Figure 22 **Muswellbrook daily average PM10 during autumn 2024 plotted against the daily maximum and minimum PM10 levels from 2011 to 2023**

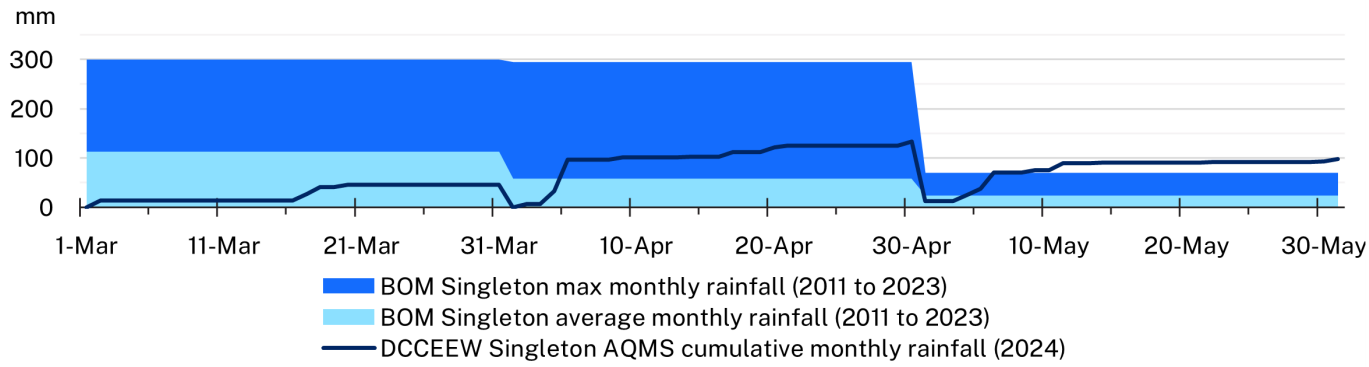

Figure 23 **DCCEEW Singleton AQMS[14] cumulative monthly rainfall in autumn 2024 against Bureau of Meteorology Singleton Defence AWS[15] maximum and average monthly rainfall from 2011 to 2023[16]**

Figure 24 and Figure 25 show daily average PM2.5 levels during autumn 2024, compared to the daily maximum and minimum levels (shaded range) for autumns 2011 to 2023, at Singleton and Muswellbrook. Daily PM2.5 levels were mostly within historical range.

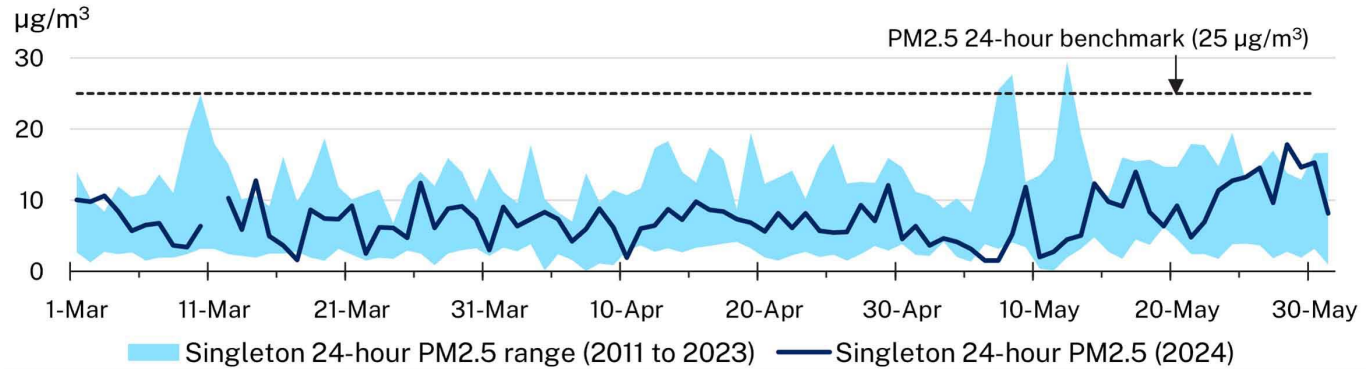

Figure 24 **Singleton daily average PM2.5 during autumn 2024 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2023**

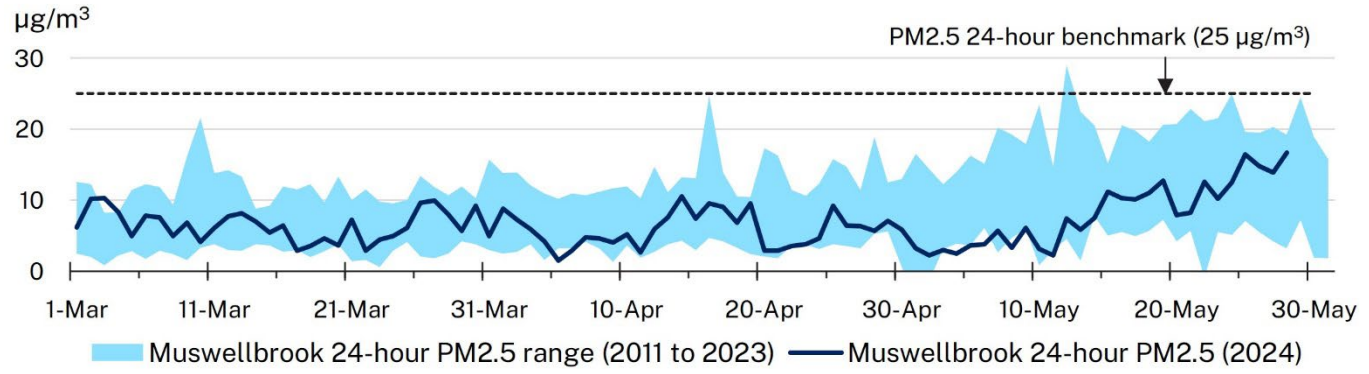

Figure 25 **Muswellbrook daily average PM2.5 during autumn 2024 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2023**

Pollution roses from hourly particle data

The seasonal pollution rose maps[17] (Figure 26 and Figure 27) show that during the season, hourly PM10 and PM2.5 levels[18] were predominantly in the good air quality category.

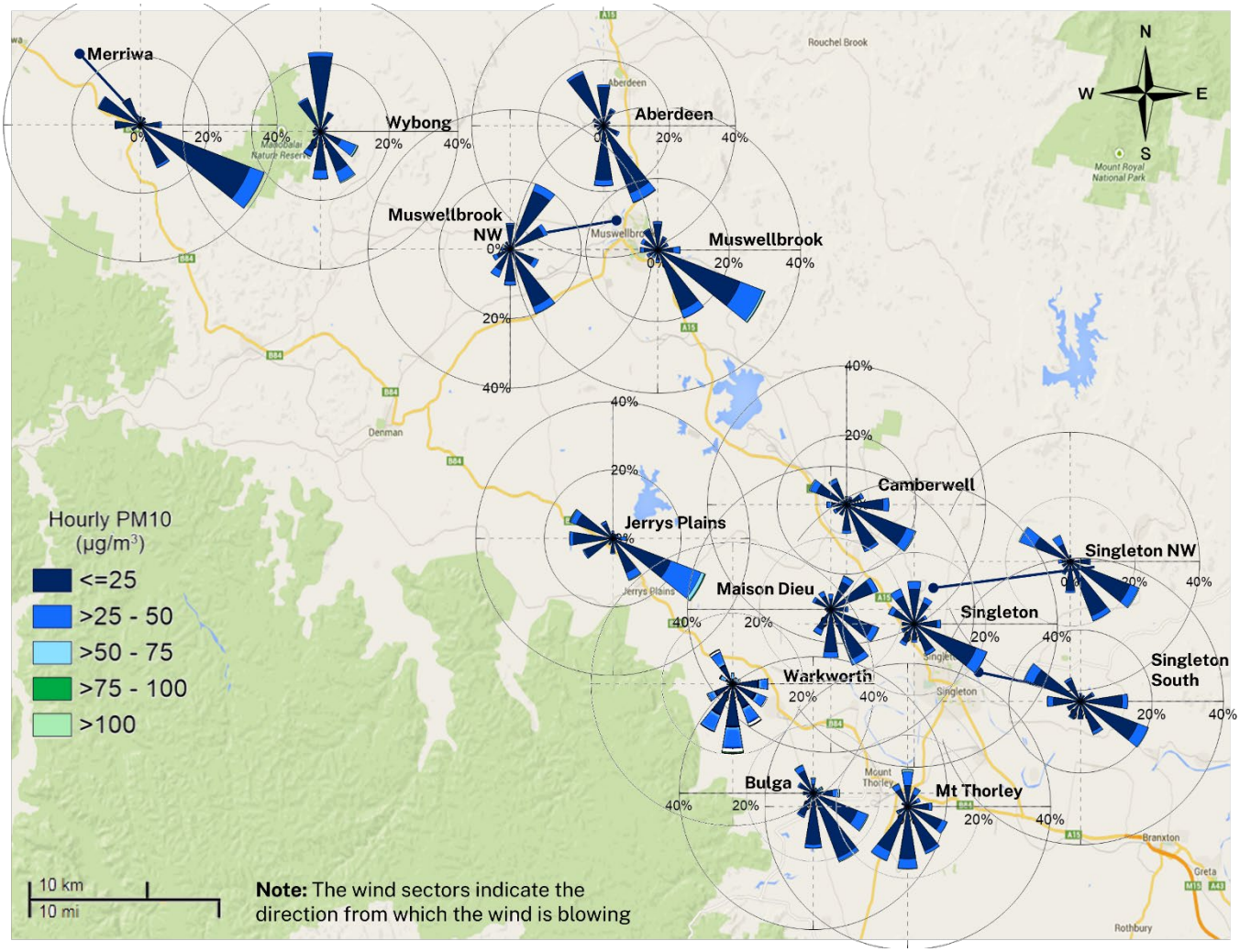

Figure 26 **Hourly PM10 pollution rose map for the Upper Hunter region autumn 2024**

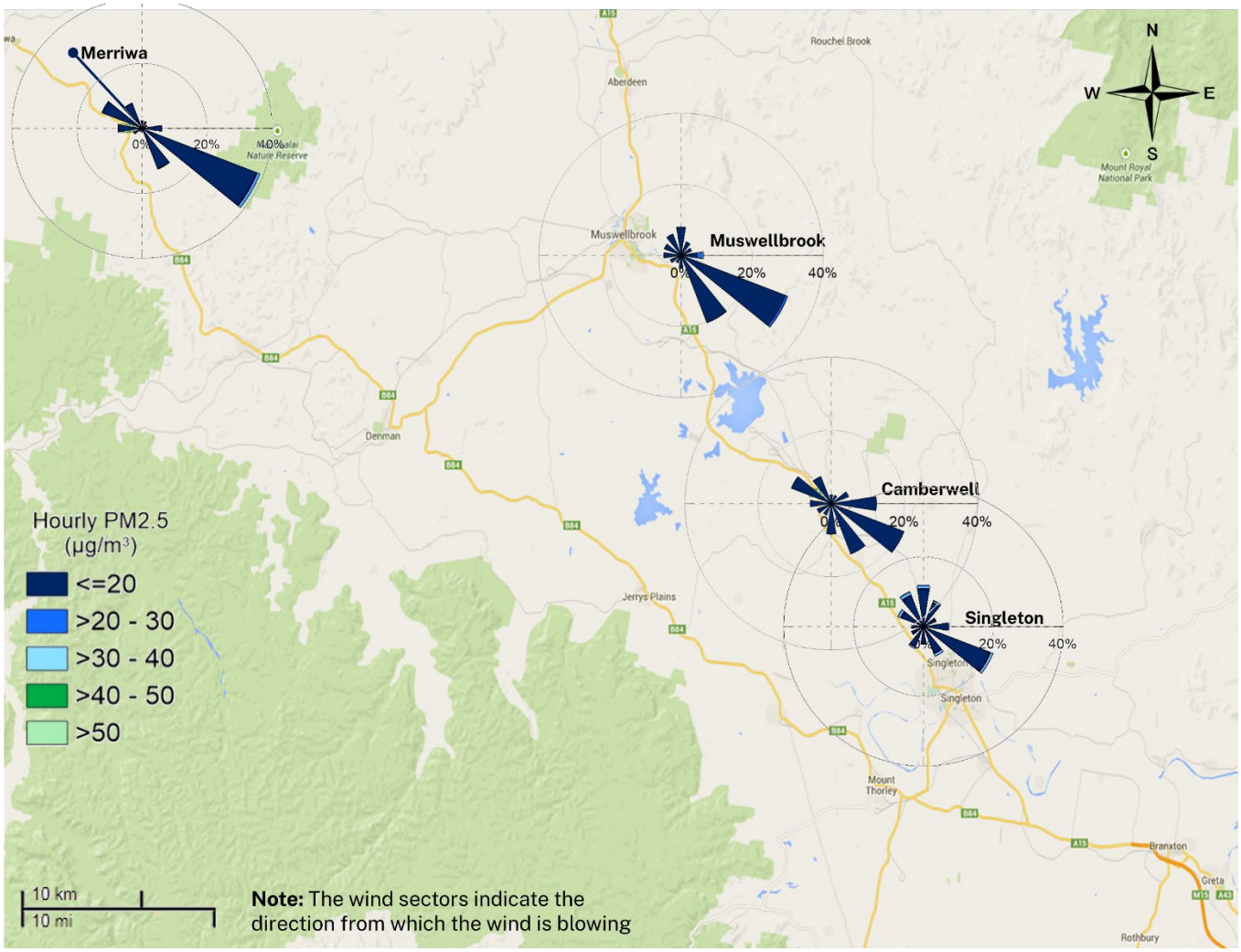

Figure 27 **Hourly PM2.5 pollution rose map for the Upper Hunter region autumn 2024**

Meteorological summary

Rainfall and temperature[19]

The Upper Hunter had more rain than usual during autumn 2024 (Figure 28), with significantly higher-than-average falls in April and above average in May. Autumn 2024 had more rain than autumn 2023, but less than autumn 2022, and was similar to autumn 2021.

Maximum temperatures were above average for the season (Figure 29), same as minimum temperatures.

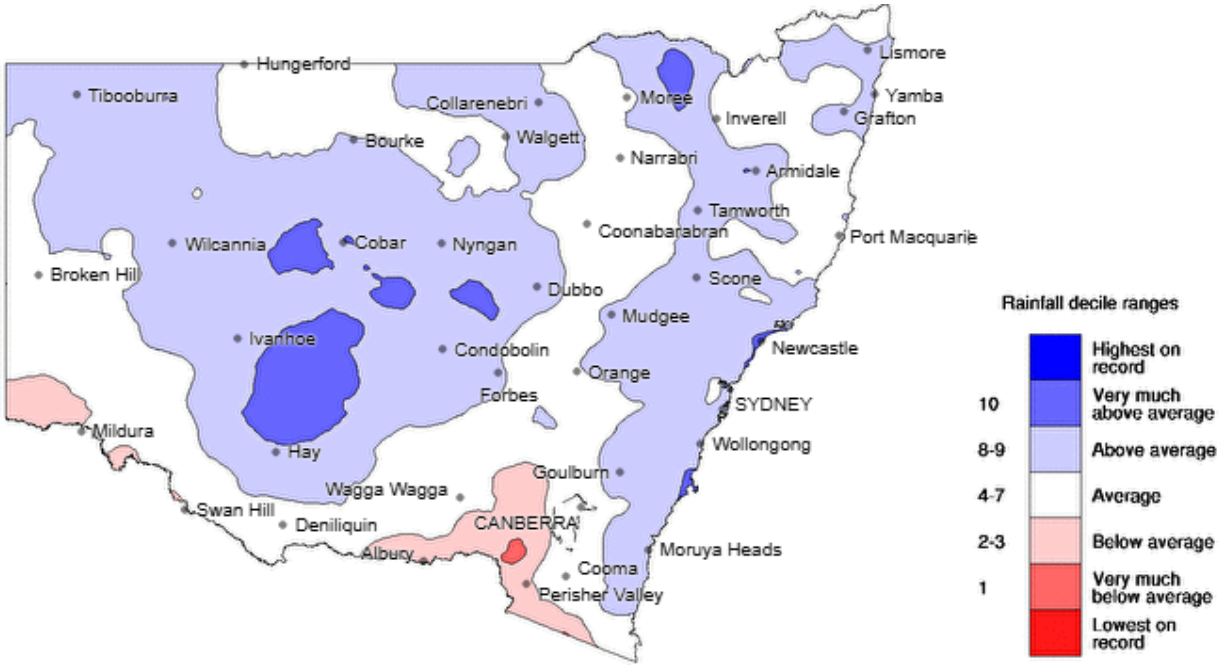

Figure 28 NSW rainfall deciles autumn 2024

Credit: ©Commonwealth of Australia 2024, Bureau of Meteorology. Base period: 1900–May 2024
Dataset: AGCD v2. Issued 20/05/2025

Figure 29 NSW maximum temperature deciles autumn 2024

Credit: ©Commonwealth of Australia 2024, Bureau of Meteorology. Base period: 1900–May 2024
Dataset: AGCD v2. Issued 27/11/2024

Wind

Winds were variable in the region during autumn 2024, although tending more south-easterly at some stations (Figure 30). This was typical for this transitional season of autumn when winds gradually change from south-easterly in summer to north-westerly in winter.

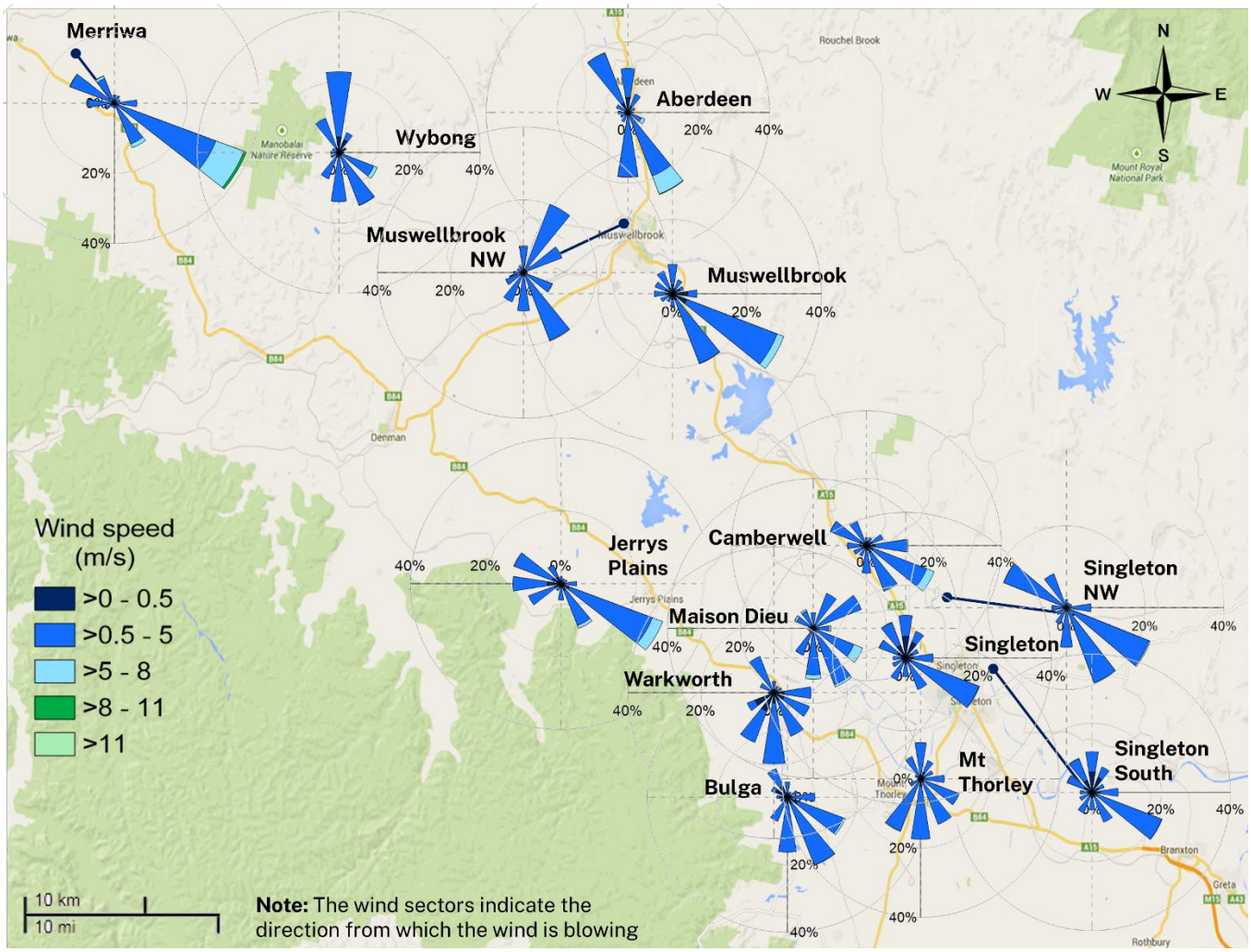

Figure 30 **Wind rose map[20] for the Upper Hunter region autumn 2024**

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 (%)autumn 2024

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO_2 hourly	Gases NO_2 hourly	Meteorology wind hourly
Aberdeen	98	–	–	–	100
Bulga	99	–	–	–	100
Camberwell	98	98	–	–	100
Jerrys Plains	100	–	–	–	100
Maison Dieu	99	–	–	–	97
Merriwa	97	97	93	91	86
Mount Thorley	100	–	–	–	100
Muswellbrook	97	97	94	94	84
Muswellbrook NW	99	–	–	–	100
Singleton	100	99	94	85	100
Singleton NW	100	–	–	–	100
Singleton South	100	–	–	–	100
Warkworth	98	–	–	–	99
Wybong	100	–	–	–	85

– = not monitored

The overall reduced online times were mainly due to:

- Merriwa wind – sensor damage
- Muswellbrook wind – sensor malfunction
- Singleton NO_2 – intermittent negative data
- Wybong wind – sensor malfunction.

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Appendix A: Rolling annual averages

Table 3 PM10 rolling annual averages (µg/m^3) from end of autumn 2013 to end of autumn 2024

Station type[12]	Station	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24
Population centre	Aberdeen	17.7	18.0	16.3	16.5	15.7	20.0	22.2	28.7	14.1	12.9	12.8	15.2
Population centre	Muswellbrook	23.0	22.1	20.5	20.3	18.8	24.8	27.0	33.4	19.5	17.5	18.4	20.8
Population centre	Singleton	22.8	23.2	20.2	20.1	19.2	22.6	23.0	30.8	17.9	16.0	16.2	18.7
Smaller community	Bulga	20.0	18.8	16.3	16.4	15.7	19.5	20.7	28.4	14.8	12.3	12.0	18.5
Smaller community	Camberwell	26.5	27.9	23.5	23.3	24.8	29.6	30.9	38.8	21.3	18.7	18.1	20.2
Smaller community	Jerrys Plains	14.7	18.7	16.7	17.2	16.2	21.2	23.9	31.5	16.5	13.0	15.8	19.5
Smaller community	Maison Dieu	26.3	25.5	21.9	21.1	20.3	26.1	27.2	37.6	18.6	16.0	16.4	20.3
Smaller community	Warkworth	22.6	21.2	19.1	19.4	18.8	25.1	25.3	34.1	20.0	20.4	24.0	30.8
Smaller community	Wybong	15.4	17.1	15.8	16.2	14.4	19.5	21.2	28.5	14.2	12.1	13.3	16.7
Diagnostic	Mount Thorley	25.3	24.3	20.6	21.8	22.6	27.0	29.9	35.1	19.1	17.2	17.5	23.1
Diagnostic	Muswellbrook NW	19.9	19.2	18.2	18.0	15.6	22.0	25.3	32.7	17.1	14.7	16.4	17.9
Diagnostic	Singleton NW	25.8	25.6	21.9	21.9	21.6	25.0	26.8	34.1	19.4	17.2	17.4	21.4
Background	Merriwa	15.4	15.2	14.3	14.1	12.8	16.5	19.8	29.3	13.3	11.3	12.1	14.4
Background	Singleton South	19.6	20.1	17.8	17.8	17.8	21.6	22.7	31.0	16.6	15.4	15.9	19.0

Note: the rolling annual averages are calculated from 1 June to 31 May each year

Table 4 PM2.5 rolling annual averages (µg/m³) from end of autumn 2013 to end of autumn 2024

Station type[12]	Station	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24
Population centre	Muswellbrook	10.0	9.8	8.9	8.9	8.8	9.5	9.2	12.8	8.0	6.9	6.5	7.5
Population centre	Singleton	7.9	8.0	7.4	8.2	7.9	8.3	8.0	11.7	7.0	5.7	5.7	7.1
Smaller community	Camberwell	7.4	8.5	7.4	7.5	7.5	8.0	7.8	11.0	6.2	5.3	5.1	6.2
Background	Merriwa	–	–	–	–	–	–	–	–	4.8	3.9	3.7	4.7

Note: the rolling annual averages are calculated from 1 June to 31 May each year
The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor PM2.5

[1] The national benchmarks can be found at National Environment Protection (Ambient Air Quality) Measure.
[2] Information on the categories can be found at Air quality categories.
[3] PM2.5 refers to airborne particles less than or equal to 2.5 micrometres in diameter.
[4] PM10 refers to airborne particles less than or equal to 10 micrometres in diameter.
[5] Micrograms per cubic metre.
[6] Rolling annual averages use 12-months of data to the end of a season. These are used indicatively to assess long-term trends using the most recent data and are not intended for comparison to the calendar year annual benchmarks of 25 µg/m^3 for PM10 and 8 µg/m^3 for PM2.5.
[7] The United Wambo Joint Venture Open Cut mine started operations in 2020.
[8] Sourced from Department of Primary Industries and Regional Development NSW State seasonal update – May 2024 (accessed March 2025).
[9] Sourced from Department of Primary Industries and Regional Development NSW State seasonal update – May 2023 (accessed March 2025).
[10] Sourced from Department of Primary Industries and Regional Development NSW State seasonal update – May 2022 (accessed March 2025).
[11] Sourced from Department of Primary Industries and Regional Development NSW State seasonal update – May 2021 (accessed March 2025).
[12] The 14 monitoring stations in the Upper Hunter serve different purposes.
Larger population stations monitor air quality in those centres.
Smaller community stations monitor the air quality at those community locations.
Diagnostic stations provide data that can help diagnose the likely sources and movement of particles across the region; they do not provide information about air quality at population centres.
Background 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).
[13] There may be some variation in rainfall levels due to the different locations of the Department of Climate Change, Energy, the Environment and Water (DCCEEW) sensor (used for the cumulative rainfall) and Bureau of Meteorology (BOM) sensor (used for the longer term averages and maximums).
[14] Department of Climate Change, Energy, the Environment and Water Singleton Air Quality Monitoring Station
[15] Data obtained from the Bureau of Meteorology Singleton Defence AWS monthly rainfall data (accessed August 2024).
[16] 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 from January 2011 to March 2017 (accessed March 2020) and Singleton Defence AWS monthly rainfall data from April 2017. Data from the Bureau's Singleton Defence AWS was incomplete for the autumn 2024 season, hence Singleton AQMS data have been used instead for this seasonal report.
[17] 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.
[18] There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure.

[19] Rainfall and temperature information is from the Bureau of Meteorology New South Wales autumn 2024 climate statement (accessed September 2024) and climate maps (accessed May 2025).

[20] Wind roses show the wind direction and speed 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 the wind speed categories.