

Air quality in the Upper Hunter was generally good in 2023. There was an increase in particle levels compared to recent record low years, following a return to drier, warmer conditions and developing drought. Daily particle levels at Muswellbrook and Singleton population centres were, respectively, 99% and 100% of days during 2023 within national benchmarks.

- Nitrogen dioxide (NO₂) levels remained below relevant benchmarks.
- Sulfur dioxide (SO₂) levels were below relevant benchmarks at Merriwa and Singleton. At Muswellbrook, there were 2 days above the benchmarks, likely due to power station emissions.
- Daily levels of PM_{2.5}¹ were above the 25 µg/m³ benchmark on 19 December at Merriwa and Muswellbrook. This was an exceptional event due to a bushfire², reaching 27.1 µg/m³ at Merriwa.
- Daily levels of PM₁₀¹ were above the 50 µg/m³ benchmark on 48 days. Most of these (32 days, 67%) occurred from mid-September onwards (Table 3), following a dry, hot winter. Regional maximum daily levels on PM₁₀ event days ranged from 50.2 to 93.6 µg/m³.
 - Days over the PM₁₀ daily benchmark ranged from no days at Aberdeen, Merriwa and Singleton to 42 days at Warkworth, predominantly due to dust from local industrial sources.
 - There were 2 days over the PM₁₀ benchmark at the Muswellbrook population centre on 2 and 22 October, likely due to dust within the region.
- Annual PM₁₀ and PM_{2.5} levels remained below annual benchmarks, except PM₁₀ at Warkworth with a PM₁₀ annual average of 32.5 µg/m³, likely due to nearby industrial mining activities.

Annual air quality trends

Figure 1 and Figure 2 show the annual average PM₁₀ and PM_{2.5} particle levels from 2011 to 2023.

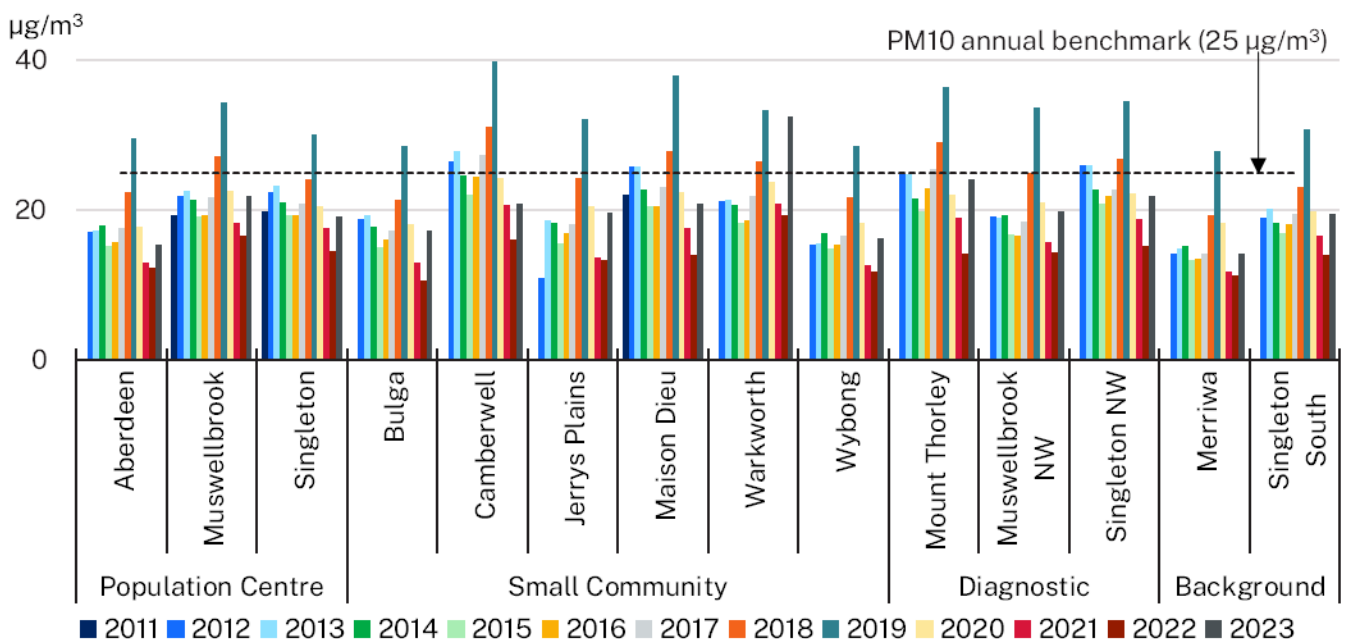


Figure 1 PM10 annual averages from 2011 to 2023

Note: The tabulated PM₁₀ annual average data are listed in Table 5 in Appendix A: Annual averages

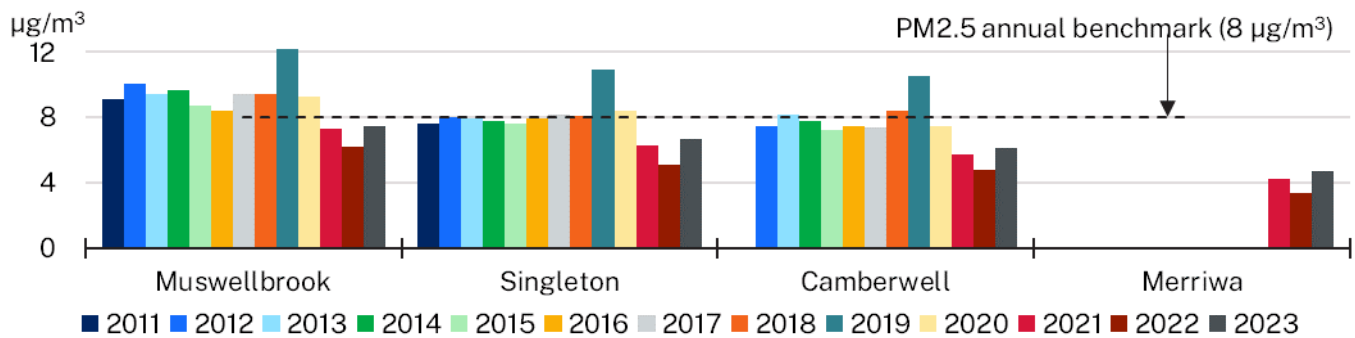


Figure 2 PM2.5 annual averages from 2011 to 2023

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

The tabulated PM2.5 annual average data are listed in Table 6 in Appendix A: Annual averages

- Annual average PM10 and PM2.5 levels increased throughout the region, compared to recent record low years. Low rainfall levels, warmer-than-average temperatures, developing drought and some bushfire smoke all contributed to these increases.

At the end of 2023, 63% of New South Wales was drought-affected, including the Upper Hunter region (Figure 3). In comparison, there were no drought-affected areas in 2022³, while only 7% of the state was drought-affected in 2021⁴, mostly in the western regions.

- Annual average PM10 levels were below the benchmark at all stations in 2023, except for PM10 at Warkworth. Annual levels ranged from 14.2 µg/m³ at Merriwa to 32.5 µg/m³ at Warkworth. Mount Thorley recorded the second-highest annual PM10 level, measuring 24.1 µg/m³.

Warkworth and Mount Thorley are located close to open-cut coal mines and were likely impacted by emissions from these local industrial sources, exacerbated by the drier conditions. The United Wambo Joint Venture Open Cut mine started operating in 2020.

From 2011 to 2022, maximum annual PM10 levels ranged from 19.3 µg/m³ in 2022 to 39.9 µg/m³ in 2019. Annual PM10 levels exceeded the benchmark in 2012, 2013, 2017, 2018 and 2019. In 2012 and 2013, this occurred at the Camberwell and Maison Dieu smaller community stations and Singleton NW diagnostic station. In 2017, this occurred at the Camberwell smaller community station and Mount Thorley diagnostic station. In 2018, this occurred at Muswellbrook large population centre, Camberwell, Maison Dieu and Warkworth smaller community stations and Mount Thorley and Singleton NW diagnostic stations. In 2019, this occurred at all 14 stations, during extreme drought and bushfire conditions.

- Annual average PM2.5 levels were below the benchmark at all stations in 2023, ranging from 4.7 µg/m³ at Merriwa to 7.5 µg/m³ at Muswellbrook.

From 2011 to 2022, maximum annual PM2.5 levels ranged from 6.2 µg/m³ in 2022 to 12.2 µg/m³ in 2019. Annual PM2.5 levels were over the benchmark each of the 10 years prior to 2021 at Muswellbrook, 3 years at Camberwell in 2013, 2018 and 2019, and 4 years at Singleton in 2017, 2018, 2019 and 2020. Smoke from domestic wood heaters contributes significantly to particle levels at larger population centres⁵

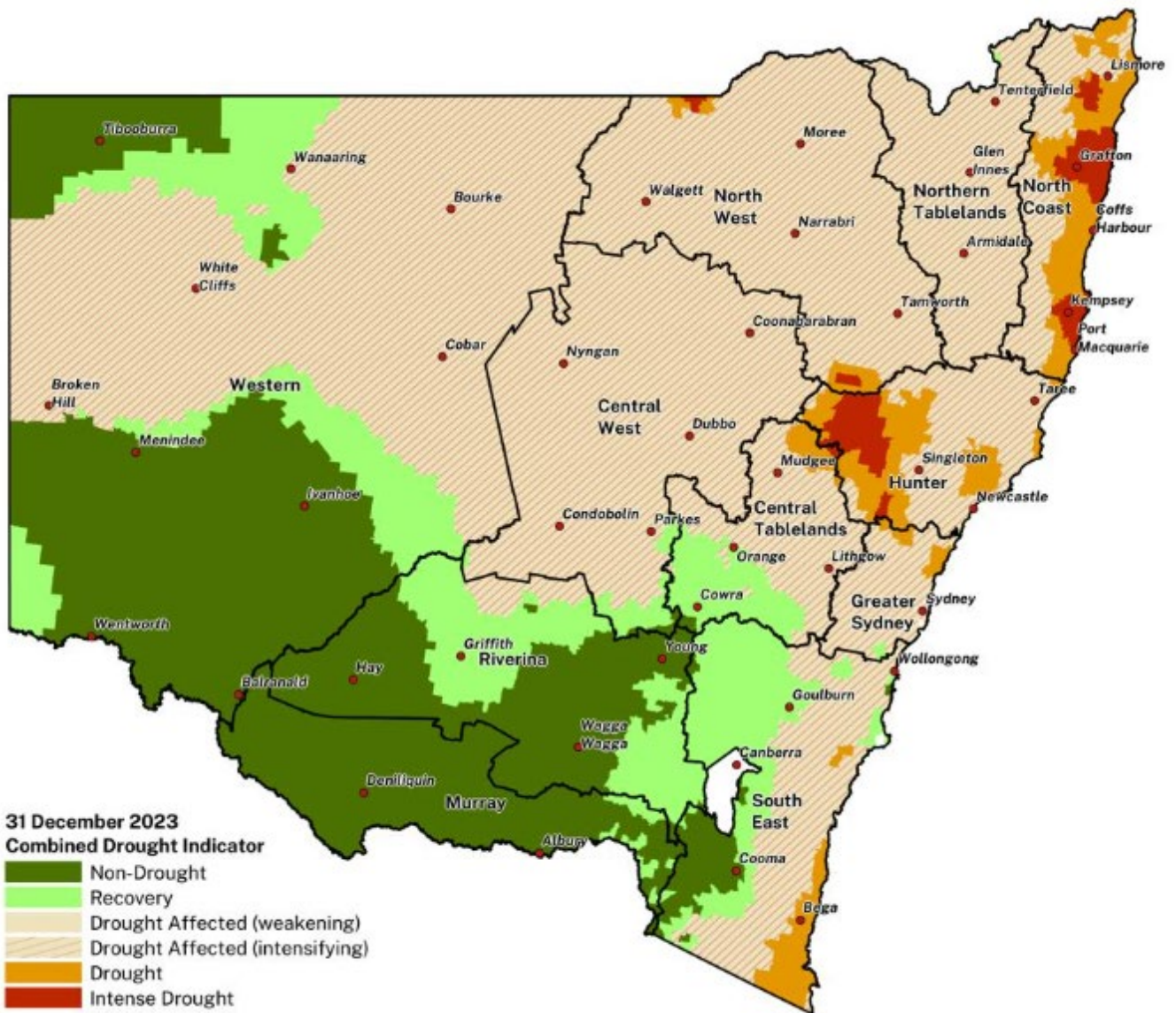


Figure 3 NSW combined drought indicator map at the end of December 2023⁶
 Figure produced by the NSW Department of Primary Industries © State of New South Wales EDIS v2.2

Days above benchmark concentrations

There were 48 days over the daily PM10 benchmark and one day over the PM2.5 benchmark in 2023 (Table 1 to Table 3). Of these particle events, 90% (43 days) occurred exclusively at stations designated as small community and diagnostic stations, particularly at Warkworth and Mount Thorley. This was due to the dry, hot conditions and developing drought, combined with local dust sources.

Particle levels were within national benchmarks, ranging from 88% of days at Warkworth to 100% of days at Aberdeen and Singleton (Figure 4).

Gases are measured at Merriwa, Muswellbrook and Singleton in the Upper Hunter.

- All days were below the NO₂ 8 pphm hourly benchmark at all stations. The maximum hourly NO₂ level in the region was 4.1 pphm, measured at Muswellbrook on 14 September.
- All stations recorded annual NO₂ levels below the 1.5 pphm annual benchmark. The maximum annual NO₂ level in the region was 0.8 pphm, measured at Muswellbrook.
- All days were below the SO₂ 10 pphm hourly benchmark at Merriwa and Singleton. At Muswellbrook, there were 2 days over the SO₂ hourly benchmark, likely from power station emissions. These occurred on 2 January (with 2 hours over the benchmark and a maximum of 12.4 pphm) and 24 March (with 1 hour over the benchmark, measuring 11.3 pphm).
- All days were below the SO₂ 2 pphm daily benchmark at Merriwa and Singleton. At Muswellbrook, there was 1 day over the SO₂ daily benchmark on 2 January, measuring 2.5 pphm.

Table 1 Number of days above the relevant national benchmarks in 2023

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	2	1	2	1	0
Population centre	Singleton	0	0	0	0	0
Smaller community	Bulga	2	-	-	-	-
Smaller community	Camberwell	6	0	-	-	-
Smaller community	Jerrys Plains	2	-	-	-	-
Smaller community	Maison Dieu	3	-	-	-	-
Smaller community	Warkworth	42	-	-	-	-
Smaller community	Wybong	2	-	-	-	-
Diagnostic	Mount Thorley	18	-	-	-	-
Diagnostic	Muswellbrook NW	4	-	-	-	-
Diagnostic	Singleton NW	6	-	-	-	-
Background	Merriwa	0	1	0	0	0
Background	Singleton South	2	-	-	-	-

µg/m³ = 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 'Definitions: Upper Hunter monitoring station types' at the end of the report

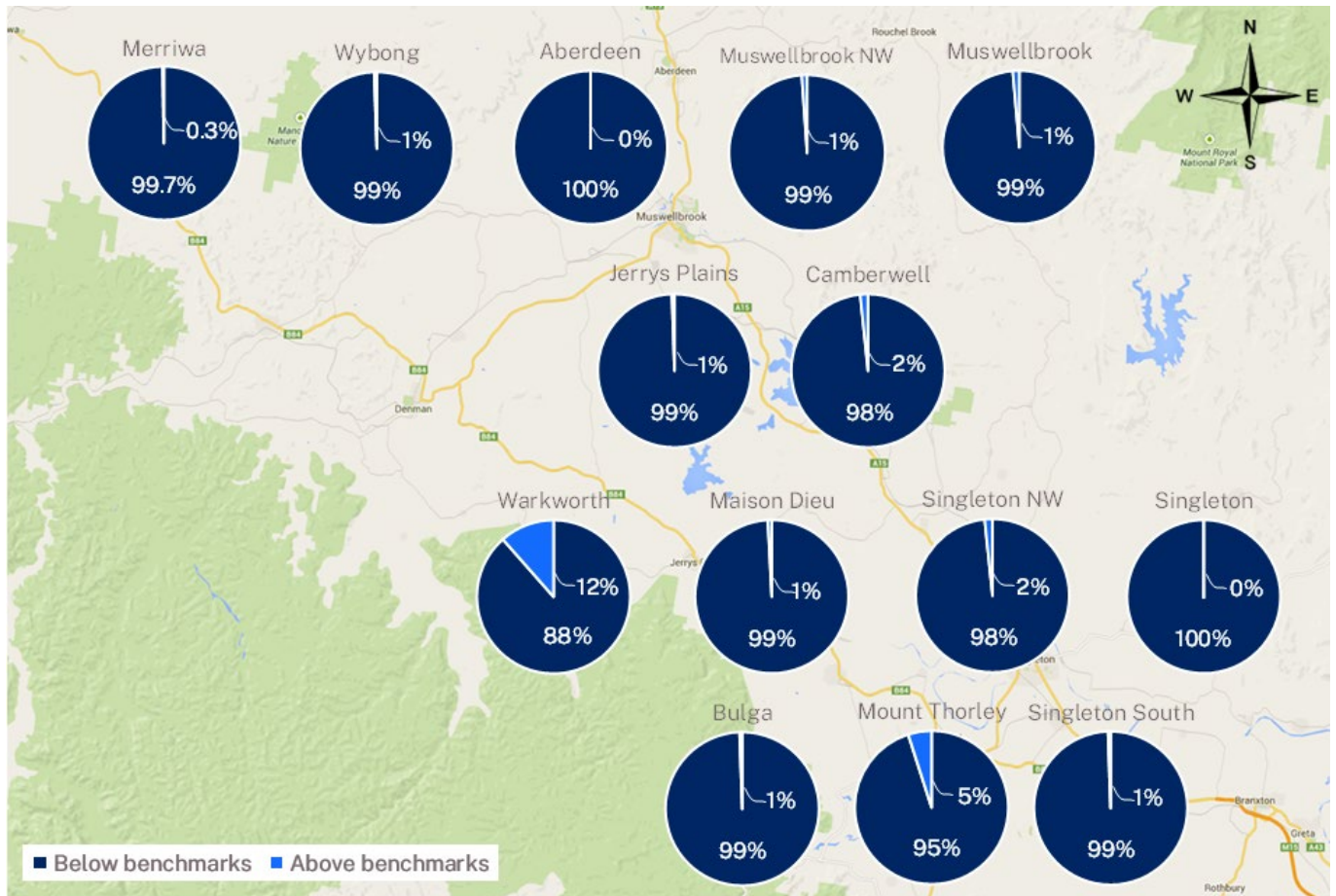


Figure 4 Percentage of days above and below PM10, PM2.5 and SO₂ benchmarks at each station in 2023

PM2.5 particle events

PM2.5 particles are measured at Camberwell, Merriwa, Muswellbrook and Singleton.

In 2023, there were no days over the daily PM2.5 benchmark at Camberwell and Singleton. At Merriwa and Muswellbrook, daily PM2.5 levels were over the benchmark on 1 day, 19 December (Table 2). This was an exceptional event due to smoke from an extensive bushfire at Narrabri, with over 120,000 hectares burnt between 8 and 19 December².

Table 2 Days and stations above the PM2.5 daily benchmark in 2023

Date	Max daily PM2.5 (µg/m ³)	Number of stations	Station and daily PM2.5 (µg/m ³) for each station type		
			Population centre	Smaller community	Background
19/12/23	27.1	2	Muswellbrook (25.2)	-	Merriwa (27.1)

- = no stations over the benchmark in that station type category

PM10 particle events

In 2023, many PM10 particle events (28 days, 58%) occurred at only 1 station (Warkworth on 23 days, Mount Thorley on 4 days and Bulga on 1 day) (Table 3). The remaining events had between 2 stations over the benchmark (on 10 days) to 7 stations (on 1 day).

The most widespread PM10 event occurred on 25 October, when 7 stations in the regions' south-east recorded levels over the daily benchmark. This was likely due to dust from long-range transport, and smoke from a large grass fire⁷.

Table 3 Days and stations above the PM10 daily benchmark in 2023

Date	Max daily PM10 ($\mu\text{g}/\text{m}^3$)	Number of stations	Station and daily PM10 ($\mu\text{g}/\text{m}^3$) for each station type			
			Population centre	Smaller community	Diagnostic	Background
24/01/23	54.6	1	-	Warkworth (54.6)	-	-
27/01/23	50.3	1	-	Warkworth (50.3)	-	-
6/02/23	55.5	1	-	Warkworth (55.5)	-	-
6/03/23	54.1	2	-	Warkworth (54.1)	Mount Thorley (53.4)	-
7/03/23	63.1	1	-	Warkworth (63.1)	-	-
8/03/23	72.5	4	-	Camberwell (72.5), Warkworth (56.5)	Mount Thorley (66.0), Singleton NW (61.5)	-
9/03/23	54.1	1	-	-	Mount Thorley (54.1)	-
20/03/23	60.7	1	-	Warkworth (60.7)	-	-
24/05/23	56.0	1	-	-	Mount Thorley (56.0)	-
25/05/23	54.8	2	-	Warkworth (54.8)	Mount Thorley (52.3)	-
31/05/23	50.8	1	-	Warkworth (50.8)	-	-
26/06/23	50.7	1	-	Warkworth (50.7)	-	-
29/07/23	55.7	1	-	Warkworth (55.7)	-	-
12/08/23	54.5	2	-	-	Muswellbrook NW (53.4)	Singleton South (54.5)
30/08/23	57.1	1	-	-	Mount Thorley (57.1)	-
7/09/23	53.5	2	-	Bulga (51.0), Warkworth (53.5)	-	-
16/09/23	61.5	2	-	Warkworth (59.2)	Mount Thorley (61.5)	-
17/09/23	51.9	1	-	Warkworth (51.9)	-	-
18/09/23	86.7	2	-	Warkworth (50.6)	Mount Thorley (86.7)	-

Date	Max daily PM10 (µg/m ³)	Number of stations	Station and daily PM10 (µg/m ³) for each station type			
			Population centre	Smaller community	Diagnostic	Background
19/09/23	93.6	3	-	Warkworth (93.6)	Mount Thorley (88.1), Singleton NW (62.5)	-
20/09/23	93.5	5	-	Camberwell (50.9), Maison Dieu (54.2), Warkworth (93.5)	Mount Thorley (65.1), Singleton NW (50.1)	-
1/10/23	74.7	2	-	Warkworth (74.7)	Mount Thorley (50.7)	-
2/10/23	63.6	4	Muswellbrook (50.4)	Jerrys Plains (63.6), Warkworth (63.5), Wybong (52.5)	-	-
3/10/23	63.3	1	-	Warkworth (63.3)	-	-
4/10/23	55.8	1	-	Warkworth (55.8)	-	-
15/10/23	53.1	1	-	-	Mount Thorley (53.1)	-
16/10/23	60.1	3	-	Camberwell (50.8), Warkworth (54.8)	Mount Thorley (60.1)	-
21/10/23	55.1	2	-	Jerrys Plains (50.7), Warkworth (55.1)	-	-
22/10/23	69.7	4	Muswellbrook (59.4)	Camberwell (52.5), Warkworth (69.7)	Muswellbrook NW (52.6)	-
23/10/23	55.1	2	-	Warkworth (55.1)	Mount Thorley (51.7)	-
24/10/23	60.6	3	-	Warkworth (52.1)	Mount Thorley (52.6), Singleton NW (60.6)	-
25/10/23	90.6	7	-	Camberwell (57.2), Maison Dieu (57.0), Warkworth (64.9)	Mount Thorley (90.6), Muswellbrook NW (57.5), Singleton NW (60.0)	Singleton South (53.3)
30/10/23	54.9	1	-	Warkworth (54.9)	-	-

Date	Max daily PM10 (µg/m ³)	Number of stations	Station and daily PM10 (µg/m ³) for each station type			
			Population centre	Smaller community	Diagnostic	Background
31/10/23	73.8	4	-	Camberwell (55.2), Warkworth (73.8)	Mount Thorley (51.4), Singleton NW (53.1)	-
12/11/23	57.8	1	-	Warkworth (57.8)	-	-
14/11/23	52.0	1	-	Warkworth (52.0)	-	-
19/11/23	55.1	1	-	Warkworth (55.1)	-	-
6/12/23	52.8	1	-	Warkworth (52.8)	-	-
7/12/23	53.2	1	-	Bulga (53.2)	-	-
9/12/23	51.3	1	-	Warkworth (51.3)	-	-
10/12/23	57.4	1	-	Warkworth (57.4)	-	-
11/12/23	55.5	1	-	Warkworth (55.5)	-	-
14/12/23	53.5	1	-	Warkworth (53.5)	-	-
15/12/23	50.2	1	-	Warkworth (50.2)	-	-
16/12/23	58.4	1	-	Warkworth (58.4)	-	-
17/12/23	54.9	2	-	Warkworth (54.9), Wybong (50.1)	-	-
18/12/23	57.7	1	-	Warkworth (57.7)	-	-
19/12/23	60.1	4	-	Maison Dieu (54.5), Warkworth (60.1)	Mount Thorley (52.3), Muswellbrook NW (51.8)	-

- = no stations over the benchmark in that station type category

Pollution roses

The PM10 and PM2.5 pollution rose maps (Figure 5 and Figure 6) show hourly PM10 and PM2.5 levels⁸ generally remained low across the region in 2023. Elevated hourly PM10 levels (above 100 $\mu\text{g}/\text{m}^3$) were predominantly recorded at stations closer to mines, in particular at Warkworth.

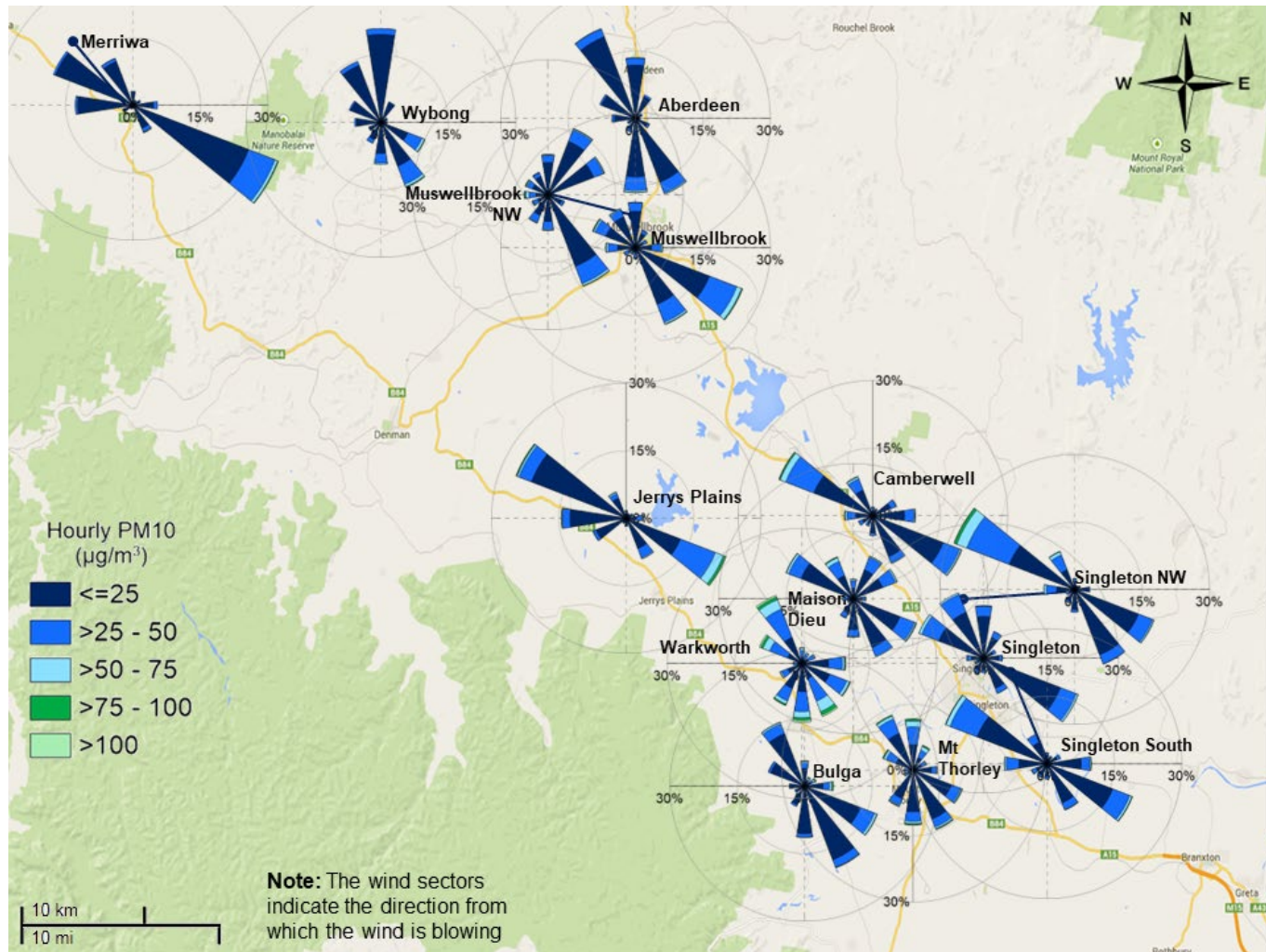


Figure 5 Hourly PM10 pollution rose⁹ map for the Upper Hunter region in 2023



Figure 6 Hourly PM2.5 pollution rose⁹ map for the Upper Hunter region in 2023

Daily time series graphs

The time series plots (Figure 7 to Figure 14) show the highest particle levels were mainly seen from mid-September, while highest SO₂ levels were seen in the first few months of the year.

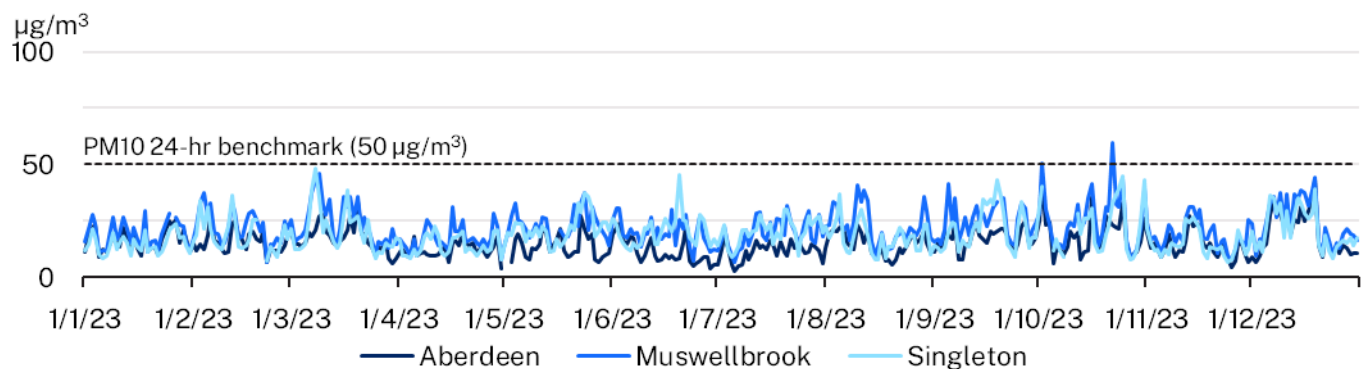


Figure 7 Daily average PM10 at population centre stations in 2023

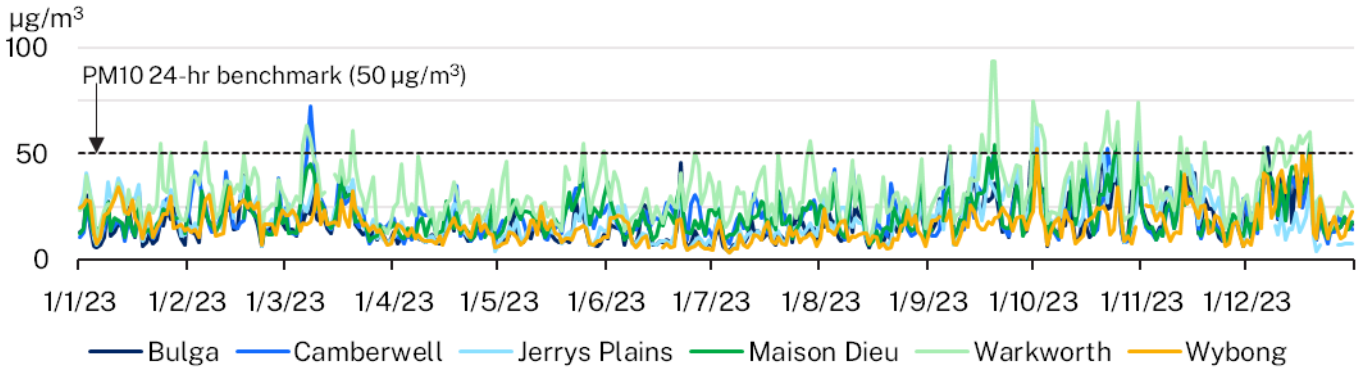


Figure 8 Daily average PM10 at smaller community stations in 2023

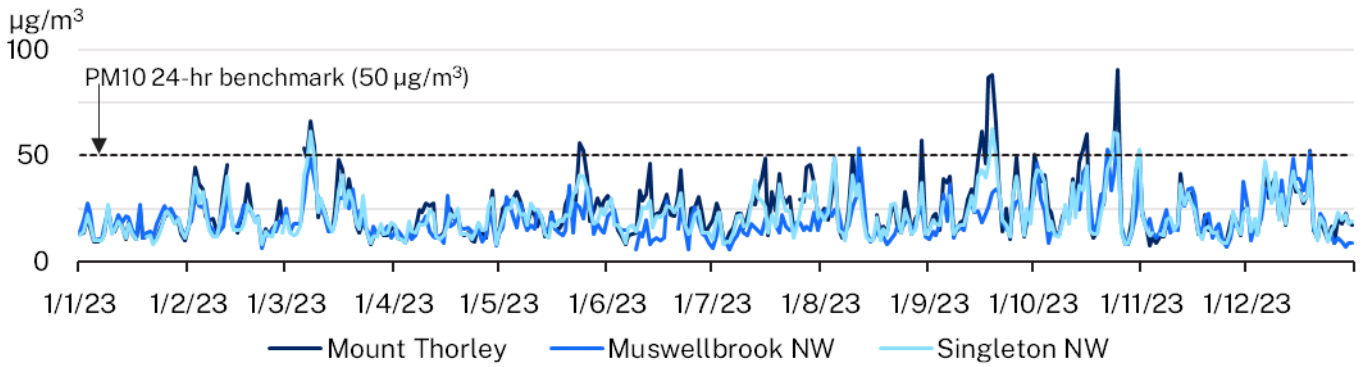


Figure 9 Daily average PM10 at diagnostic stations in 2023

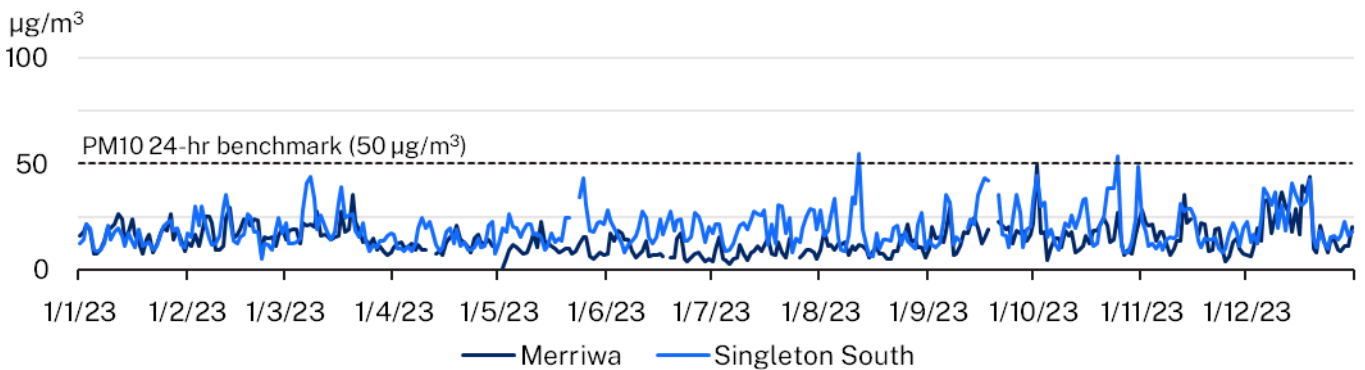


Figure 10 Daily average PM10 at background stations in 2023

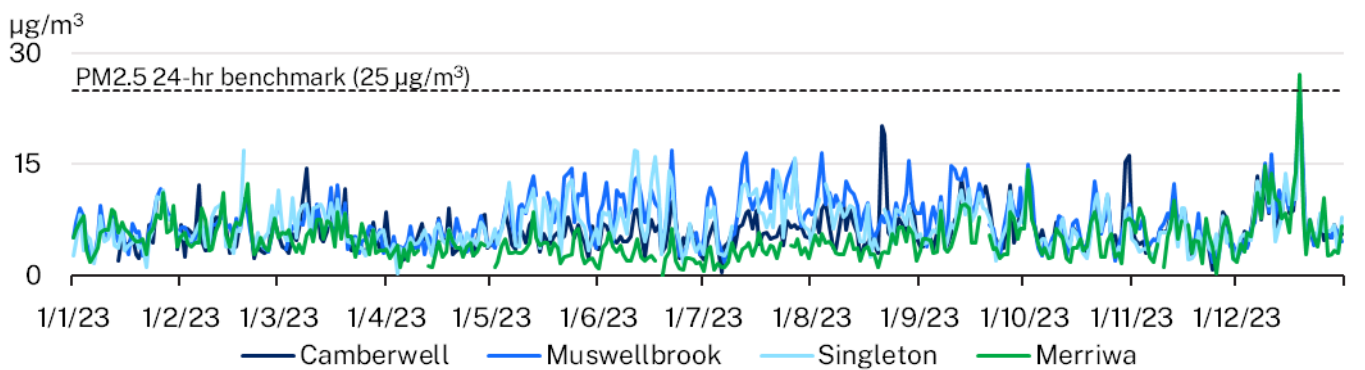


Figure 11 Daily average PM2.5 in 2023

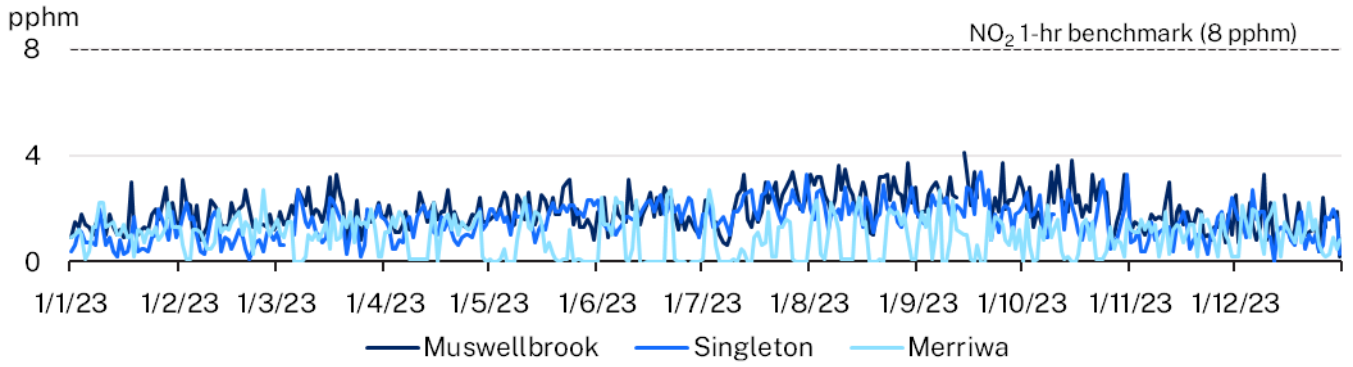


Figure 12 Daily 1-hour maximum NO₂ in 2023

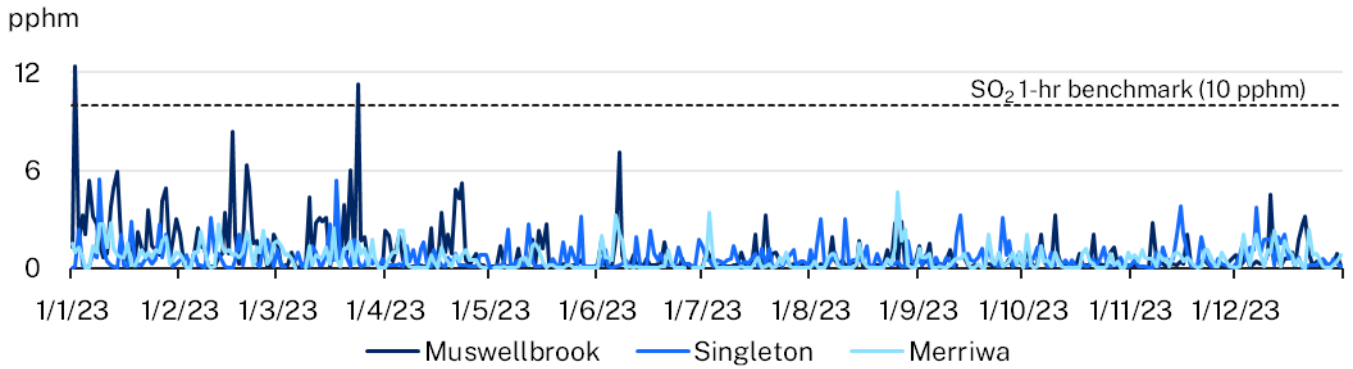


Figure 13 Daily 1-hour maximum SO₂ in 2023

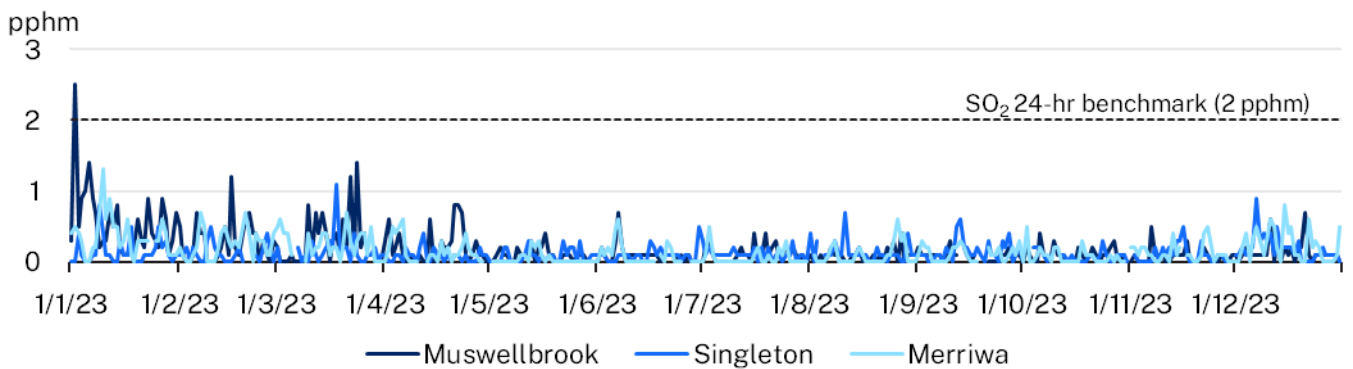


Figure 14 Daily average SO₂ in 2023

Annual comparisons 2012 to 2023

Gases

Hourly and annual NO₂ levels were below benchmarks in 2023, as in all previous years.

Hourly and daily SO₂ levels were below benchmarks in 2023 at Merriwa and Singleton, as in all previous years. At Muswellbrook, there were 3 hours over the SO₂ hourly benchmark, occurring over 2 days. In previous years, there were up to 6 days over the current hourly benchmark, in 2016 (Figure 15). There was also one day over the daily SO₂ benchmark at Muswellbrook in 2023. In previous years, there were up to 2 days over the current daily benchmark, in 2013 (Figure 16).

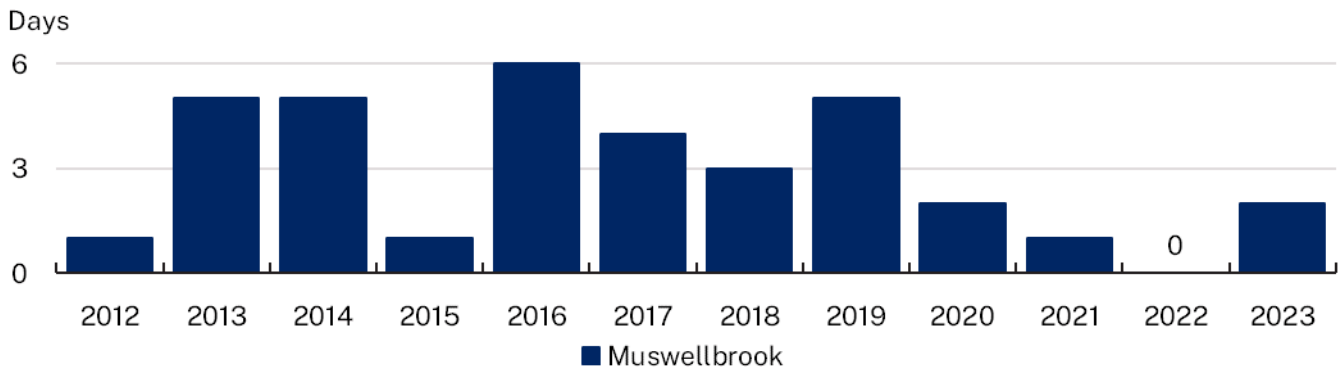


Figure 15 Number of days above the hourly SO₂ benchmark from 2012 to 2023

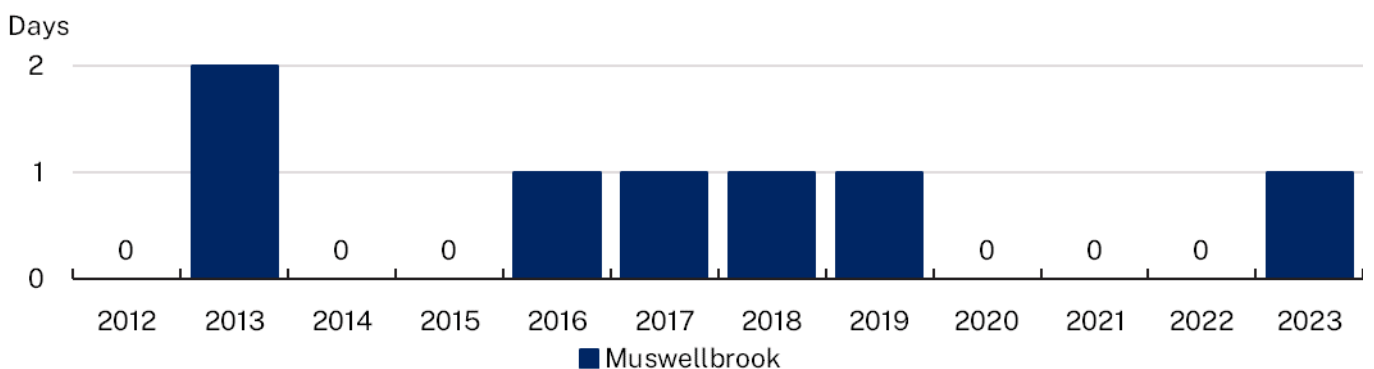


Figure 16 Number of days above the daily SO₂ benchmark from 2012 to 2023

Particles

In 2023, the region recorded 48 days over the PM₁₀ benchmark (Figure 17 to Figure 21). This is more than 2022, when there were 2 days over the benchmark. The most evident increases occurred at Warkworth, followed by Mount Thorley, likely due to nearby industrial mining activities. The number of days over the PM₁₀ benchmark from 2012 to 2021 ranged from 6 days in 2021 to 120 days in 2019, due to prolonged intense drought, extreme bushfires and dust storms.

At the larger population centres, Aberdeen and Singleton levels remained below the PM₁₀ benchmark in 2023, while Muswellbrook recorded 2 days over the benchmark. The most days over the benchmark at these stations occurred in 2019, with 40 days at Singleton, 51 days at Aberdeen and 58 days at Muswellbrook.

For PM2.5, there was 1 day over the benchmark in 2023 (Figure 22 and Figure 23). From 2012 to 2022, there were up to 32 days over the benchmark in 2019. Excluding the 2019–20 bushfire period, Muswellbrook generally records the most days over the benchmark, due to domestic woodsmoke¹⁰.

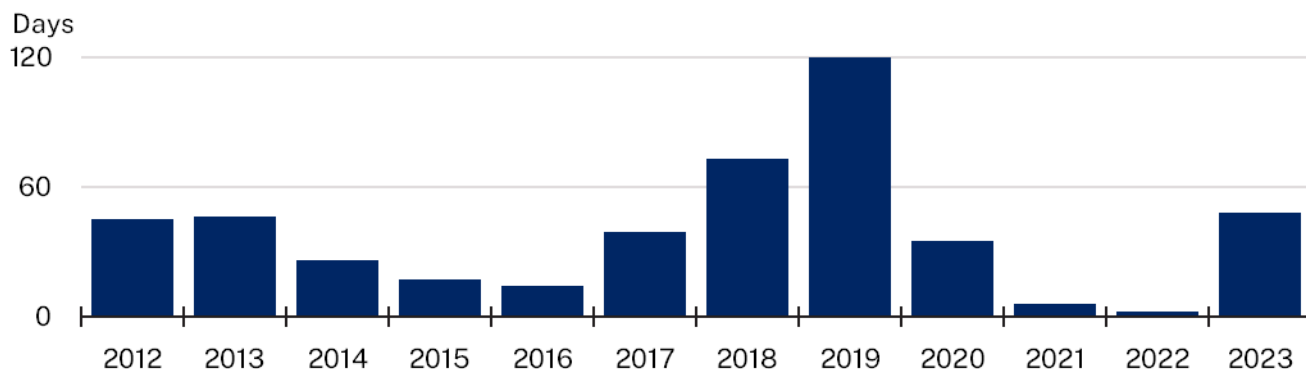


Figure 17 Number of days above the daily PM10 benchmark in the Upper Hunter from 2012 to 2023

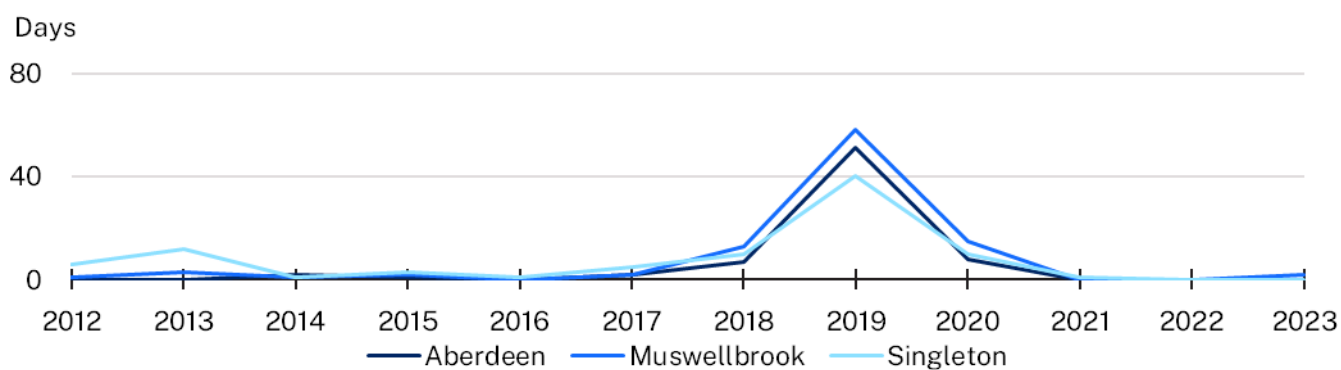


Figure 18 Number of days above the daily PM10 benchmark at population centres from 2012 to 2023

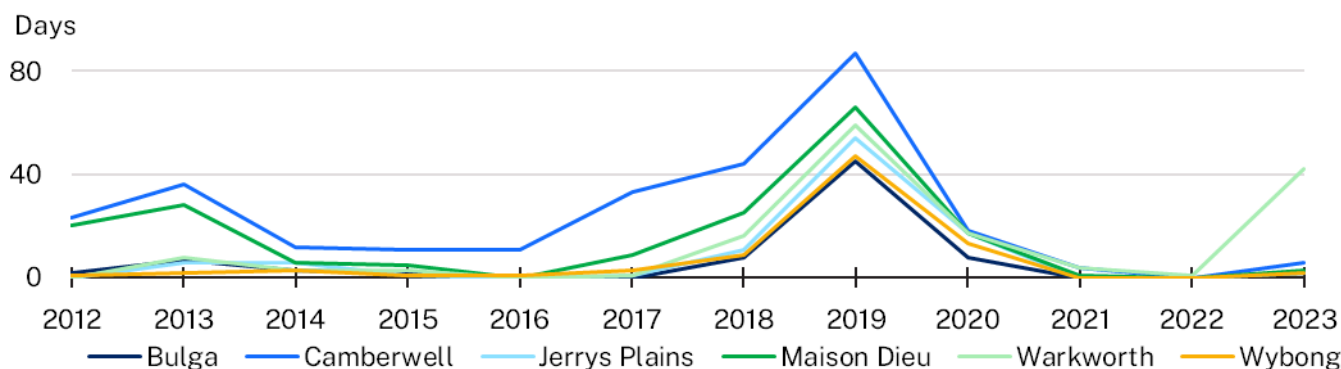


Figure 19 Number of days above the daily PM10 benchmark at smaller communities from 2012 to 2023

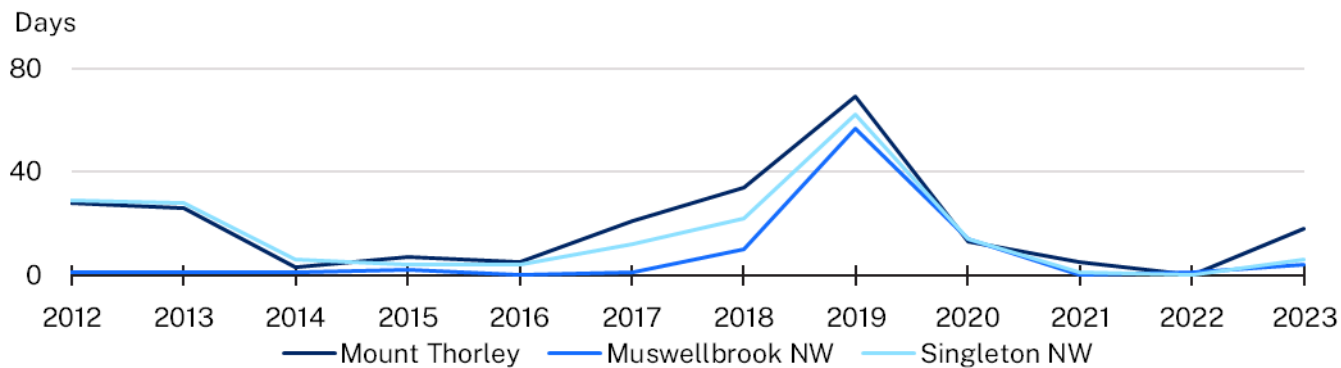


Figure 20 Number of days above the daily PM10 benchmark at diagnostic stations from 2012 to 2023

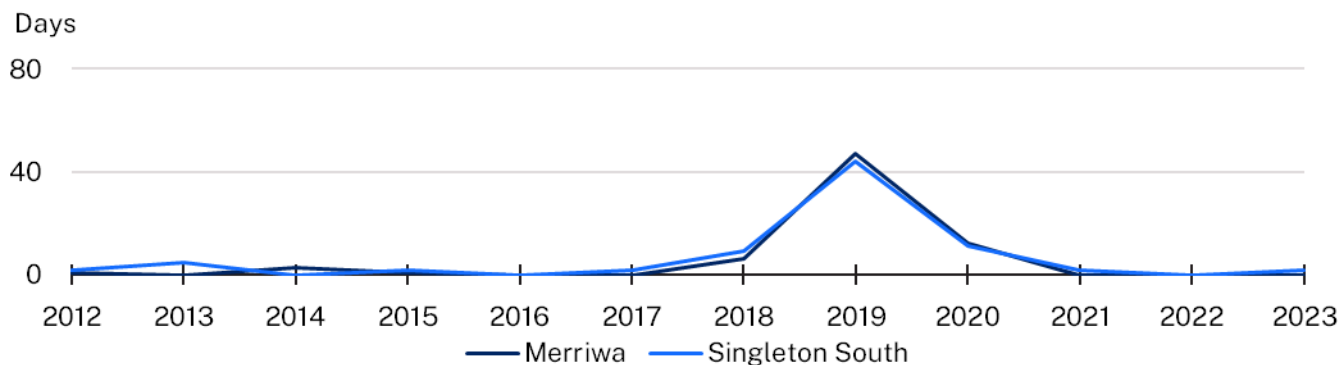


Figure 21 Number of days above the daily PM10 benchmark at background stations from 2012 to 2023

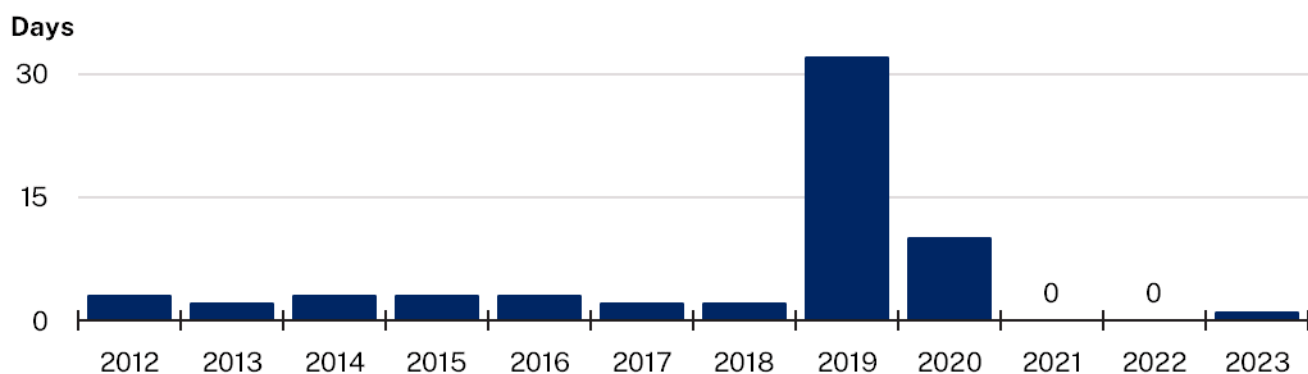


Figure 22 Number of days above the daily PM2.5 benchmark in the Upper Hunter from 2012 to 2023

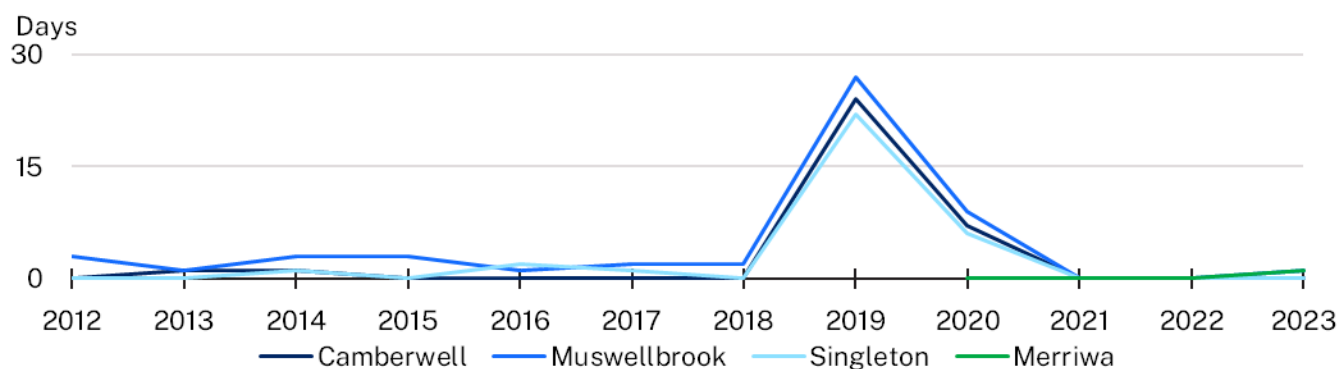


Figure 23 Number of days above the daily PM2.5 benchmark at each station from 2012 to 2023

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

Meteorological summary¹¹

Rainfall and temperature

New South Wales experienced hot and dry conditions overall in 2023. The Upper Hunter saw below-average rainfall (Figure 24), drier than the 3 previous years, with 400 to 800 millimetres less rain than 2022 and 2021 and 200 to 400 millimetres less than 2020.

The dry conditions occurred in the cooler months (Figure 25). The rest of the year saw average monthly rainfall.

Maximum temperatures were well above average (Figure 26) and minimum temperatures were above average.



Figure 24 NSW rainfall deciles 1 January to 31 December 2023

Figure credit: ©Commonwealth of Australia 2024, Bureau of Meteorology. Base period: 1900-Dec 2023. Dataset: AGCD v2. Issued 20/09/2024

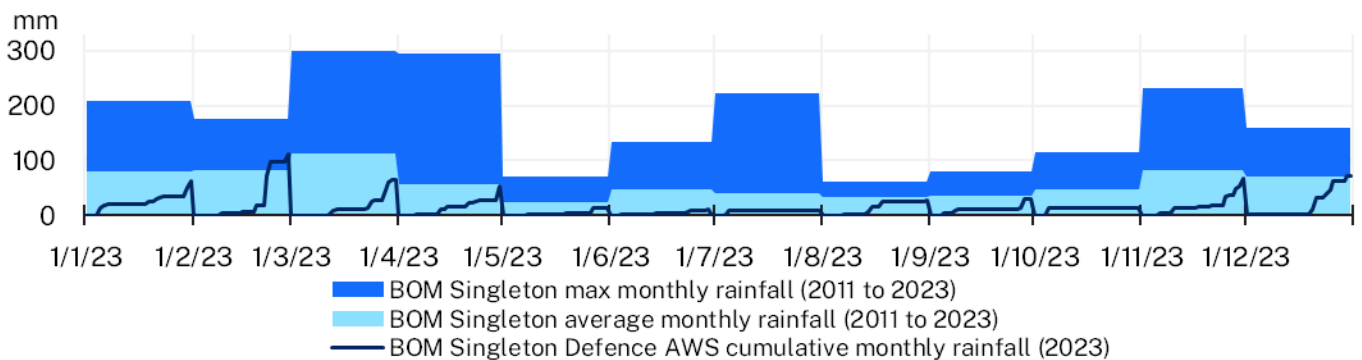


Figure 25 Singleton cumulative monthly rainfall in 2023 (dark blue) against maximum monthly rainfall¹² (medium blue) and average monthly rainfall (light blue) from 2011 to 2023¹³

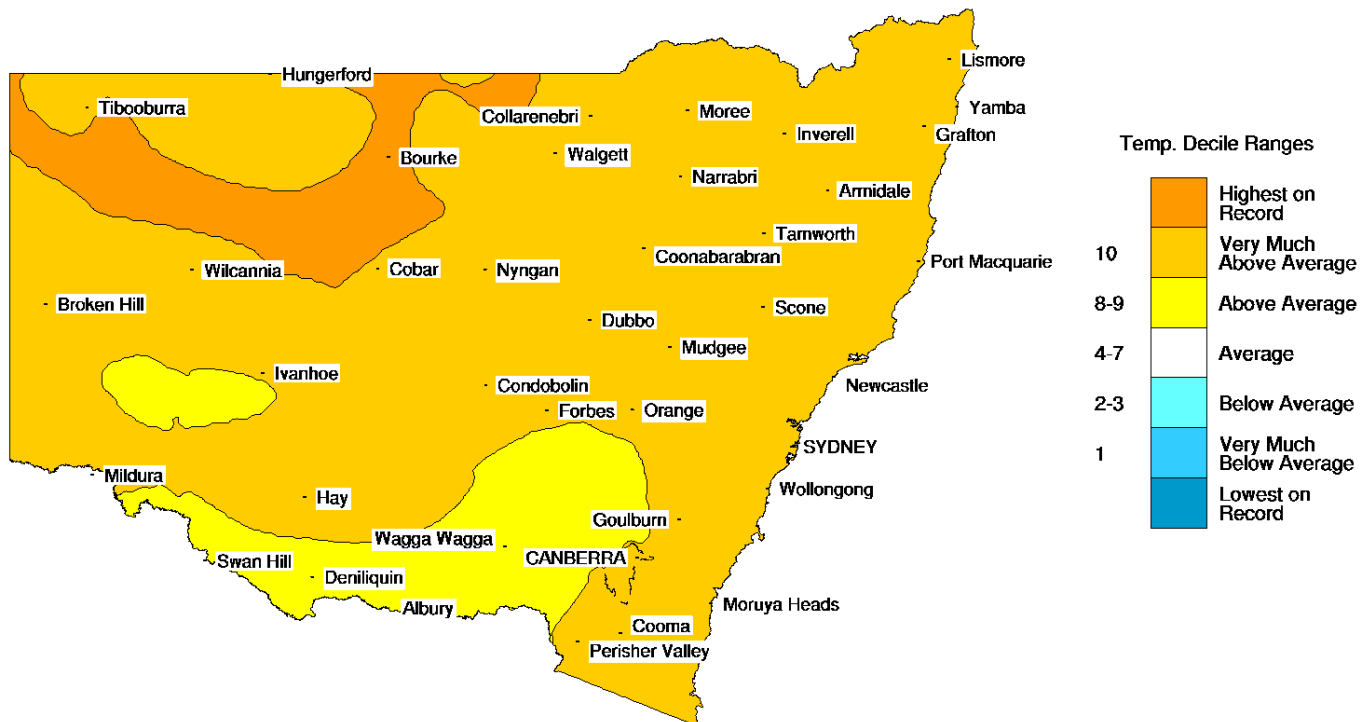


Figure 26 NSW maximum temperature deciles 1 January to 31 December 2023

Figure credit: ©Commonwealth of Australia 2024, Bureau of Meteorology. ID code: AWAP. Issued 26/06/2024

Winds

Upper Hunter winds were predominantly from the south-east in summer and north-west in winter in 2023 (Figure 27). During autumn and spring, winds were variable as they turned from south-easterly to north-westerly in autumn and vice versa in spring. There was a lower proportion of south-easterly winds and a higher proportion of north-westerly winds in 2023 compared to 2022.

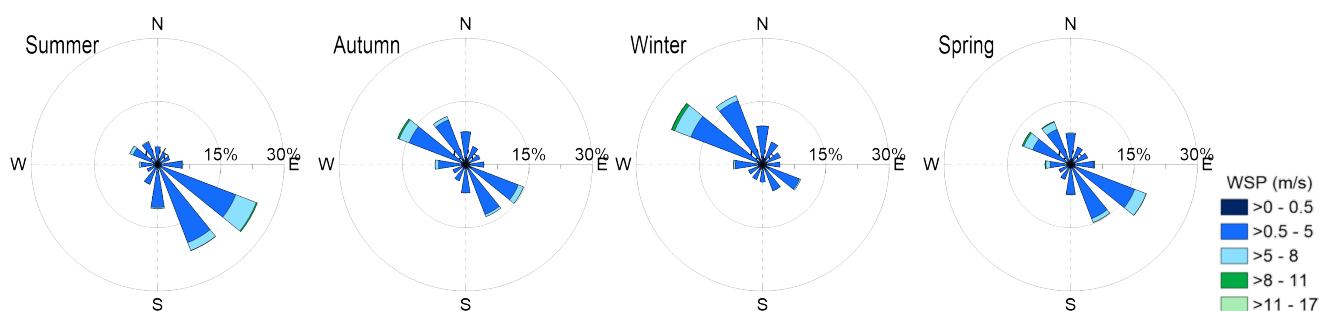


Figure 27 Seasonal wind roses using pooled wind data from all Upper Hunter stations in 2023

Network performance

The target network performance is at least 95% available data. Due to daily calibrations, the maximum online time that can be attained for NO₂ and SO₂ is 96%.

In 2023, particle and meteorological parameters at all stations met the 95% target (Table 4).

Table 4 Online performance (%) during 2023

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO ₂ hourly	Gases NO ₂ hourly	Meteorology Wind hourly
Aberdeen	99	-	-	-	100
Bulga	99	-	-	-	99
Camberwell	99	95	-	-	100
Jerrys Plains	98	-	-	-	99
Maison Dieu	96	-	-	-	98
Merriwa	97	97	92	93	99
Mount Thorley	97	-	-	-	98
Muswellbrook	99	99	94	94	100
Muswellbrook NW	98	-	-	-	95
Singleton	98	98	93	92	99
Singleton NW	99	-	-	-	100
Singleton South	99	-	-	-	100
Warkworth	98	-	-	-	99
Wybong	98	-	-	-	100

- = not monitored

Definitions: Upper Hunter monitoring station types

The 14 monitoring stations in the Upper Hunter (Figure 28) serve different purposes.

Population centres: stations monitor air quality in larger population centres.

Smaller communities: stations monitor air quality in smaller communities.

Diagnostic: stations provide data to help diagnose likely sources and movement of particles across the region; they do not provide information about air quality in population centres.

Background: stations at Merriwa and Singleton South are at both ends of the valley. They provide background data by measuring the quality of air entering and leaving the Upper Hunter valley under predominant winds (from the south-east and north-west).

The Upper Hunter Air Quality Monitoring Network is operated by the NSW Government and funded by Upper Hunter coal and power industries, in accordance with the Protection of the Environment Operations (General) Regulation 2022.

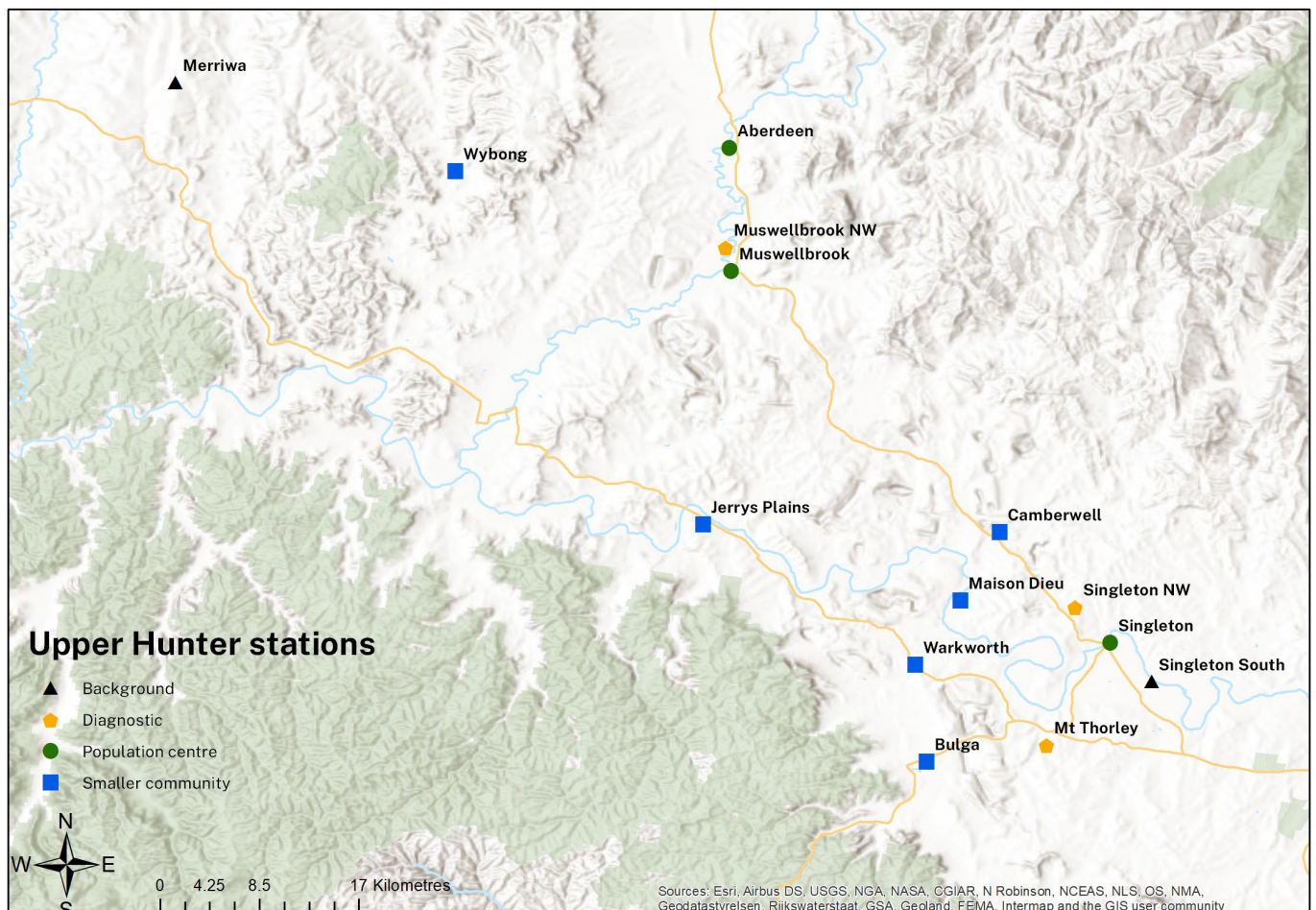


Figure 28 Upper Hunter air quality monitoring stations

Appendix A: Annual averages

Table 5 PM10 annual averages ($\mu\text{g}/\text{m}^3$) from 2011 to 2023

Station type*	Station	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Population centre	Aberdeen	–	17	17.3	17.9	15.2	15.6	17.6	22.3	29.5	17.8	12.9	12.3	15.3
Population centre	Muswellbrook	19.3	21.8	22.6	21.4	19.1	19.2	21.7	27.2	34.4	22.5	18.2	16.6	21.9
Population centre	Singleton	19.8	22.3	23.3	21	19.3	19.3	20.8	24	30.1	20.5	17.5	14.5	19.1
Smaller community	Bulga	–	18.7	19.2	17.7	15	16.1	17.2	21.3	28.6	18.1	12.9	10.6	17.3
Smaller community	Camberwell	–	26.4	27.8	24.6	22	24.5	27.4	31.1	39.9	24.3	20.6	16	20.9
Smaller community	Jerrys Plains	–	10.8	18.6	18.2	15.5	16.8	18	24.3	32.1	20.5	13.6	13.3	19.7
Smaller community	Maison Dieu	22.1	25.8	25.8	22.7	20.4	20.4	23.1	27.9	38	22.3	17.6	14	20.9
Smaller community	Warkworth	–	21.1	21.4	20.6	18.2	18.6	21.8	26.4	33.4	23.7	20.8	19.3	32.5
Smaller community	Wybong	–	15.4	15.5	16.9	14.8	15.3	16.6	21.6	28.5	18.2	12.6	11.7	16.2
Diagnostic	Mount Thorley	–	24.8	24.7	21.5	19.8	22.8	25.4	29.1	36.4	22	19	14.2	24.1
Diagnostic	Muswellbrook NW	–	19.1	18.9	19.2	16.7	16.6	18.5	25	33.7	21	15.6	14.3	19.8
Diagnostic	Singleton NW	–	25.9	25.9	22.7	20.9	21.9	22.7	26.9	34.6	22.2	18.8	15.2	21.9
Background	Merriwa	–	14.2	14.9	15.2	13.2	13.5	14.2	19.2	27.9	18.2	11.7	11.2	14.2
Background	Singleton South	–	19	20.2	18.3	16.9	18	19.4	23	30.7	19.8	16.5	14	19.4

– = stations were being established during 2011

* For explanation, refer to 'Definitions: Upper Hunter monitoring station types' at the end of the report

Averages in bold are over the PM10 annual benchmark

Table 6 PM2.5 annual averages from 2011 to 2023

Station type*	Station	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Population centre	Muswellbrook	9.1	10.1	9.4	9.7	8.7	8.4	9.4	9.4	12.2	9.3	7.3	6.2	7.5
Population centre	Singleton	7.6	8	7.9	7.8	7.6	7.9	8.2	8.1	10.9	8.4	6.3	5.1	6.7
Smaller community	Camberwell	-	7.5	8.2	7.8	7.2	7.5	7.4	8.4	10.5	7.5	5.7	4.8	6.1
Background	Merriwa	-	-	-	-	-	-	-	-	-	-	4.2	3.4	4.7

- = Camberwell was established in August 2011 and Merriwa was upgraded in July 2020 to also monitor PM2.5

* For explanation, refer to 'Definitions: Upper Hunter monitoring station types' at the end of the report

Averages in bold are over the PM2.5 annual benchmark

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¹ PM10 and PM2.5 refer to airborne particles, less than or equal to 2.5 and 10 micrometres in diameter, respectively, measured in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$).

² Narrabri 'Duck Creek Pilliga' fire from 8 December 2023 to 8 January 2024 with a total of 138,554 hectares burnt. Sourced from Rural Fire Services ICON database (incident reference number 23120827537).

³ NSW Department of Primary Industries [NSW State seasonal update - December 2022](#) (accessed April 2024).

⁴ NSW Department of Primary Industries [NSW State seasonal update - December 2021](#) (accessed April 2024).

⁵ The [Upper Hunter Fine Particle Characterisation Study](#) found smoke from domestic heaters contributes significantly to PM2.5 levels in Muswellbrook and Singleton during the cooler months.

⁶ NSW Department of Primary Industries [NSW State seasonal update - December 2023](#) (accessed April 2024).

⁷ 'New England Hwy, Ravensworth' grass fire from 25 to 29 October with a total of 447 hectares burnt. Sourced from Rural Fire Services ICON database (incident reference number 23102521547).

⁸ There are no standards for hourly PM10 or PM2.5 in the [National Environment Protection \(Ambient Air Quality\) Measure](#). The Department of Climate Change, Energy, the Environment and Water [air quality categories](#) are defined as poor when hourly PM10 levels are higher than $100 \mu\text{g}/\text{m}^3$ or hourly PM2.5 levels are higher than $50 \mu\text{g}/\text{m}^3$.

⁹ Pollution roses show the wind direction and particle levels at a location. The length of each bar shows the percentage of time the wind blows from that compass direction. The colours along the bars indicate the particle levels, as presented in the key.

¹⁰ The [Upper Hunter Fine Particle Characterisation Study](#) found smoke from domestic wood heaters contributes significantly to PM2.5 levels in Muswellbrook and Singleton during the cooler months.

¹¹ Information in this section sourced from the Bureau of Meteorology [NSW 2023 annual climate summary and climate maps](#) (accessed March 2024).

¹² The maximum monthly rainfall for July is based on the Department of Climate Change, Energy, the Environment and Water Singleton rainfall totals, as no Bureau of Meteorology Singleton Defence AWS data was available from 20 April to 12 July 2022.

¹³ The Bureau of Meteorology Singleton STP station was decommissioned in January 2019. Historical trend data are calculated by combining monthly rainfall data from [Singleton STP](#) (January 2011 to March 2017) and [Singleton Defence AWS](#) (from April 2017).