

Air quality in the Upper Hunter: Summer 2021–22

Air quality in the Upper Hunter was good during summer 2021–22. 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 (NO₂) and sulfur dioxide (SO₂) levels were good, remaining below national benchmarks.
 - Muswellbrook gases were offline for 2 months. This is important to note as, based on historical data, SO₂ levels are usually higher during summer at this station.
- Daily average levels of PM₁₀ (particles less than or equal to 10 microns in diameter) and PM_{2.5} (particles less than or equal to 2.5 microns in diameter) remained below national benchmarks at all stations.
- The region experienced average to above average rainfall and below average maximum temperatures during summer.

Annual air quality trends in the Upper Hunter

A comparison of annual average PM₁₀ and PM_{2.5} levels shows the long-term trends. The national annual average benchmarks are 25 µg/m³ for PM₁₀ and 8 µg/m³ for PM_{2.5}, based on a calendar year.

Figure 1 shows the PM₁₀ and PM_{2.5} **rolling** annual averages¹, based on the 12-month periods from summer 2012–13 to summer 2021–22.

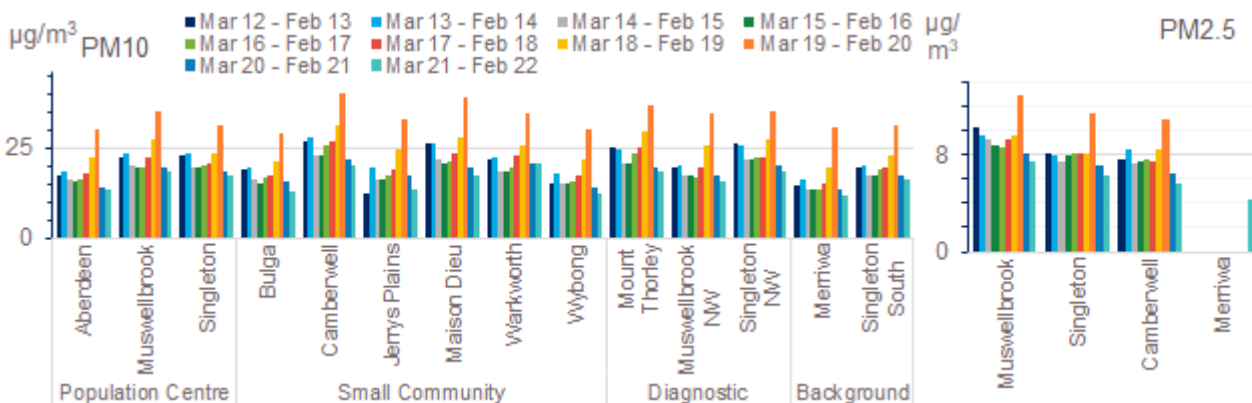


Figure 1 PM10 and PM2.5 rolling annual averages: to the end of summer 2012–13 to 2021–22

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor particles such as PM_{2.5}, visibility, ozone, nitrogen oxides, carbon monoxide and sulfur dioxide.

The comparison in Figure 1 shows that particle levels continued to decrease during the 12-month period to the end of summer 2021–22, compared to the same 12-month period in previous years (especially compared to the end of summer 2019–20). All stations recorded rolling annual average PM₁₀ and PM_{2.5} levels below the annual benchmarks, with most recording the lowest since the network began

¹ 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.

operation. The Muswellbrook PM2.5 rolling annual average to the end of summer 2021–22 was below the annual benchmark for the first time in the last 10 years.

Lower particle levels resulted from wetter and cooler than average conditions over the 12-month period. At the end of summer 2021–22, 3% of New South Wales was drought affected (Figure 2), compared to 6% at the end of summer 2020–21² and 99% at the end of summer 2019–20³.

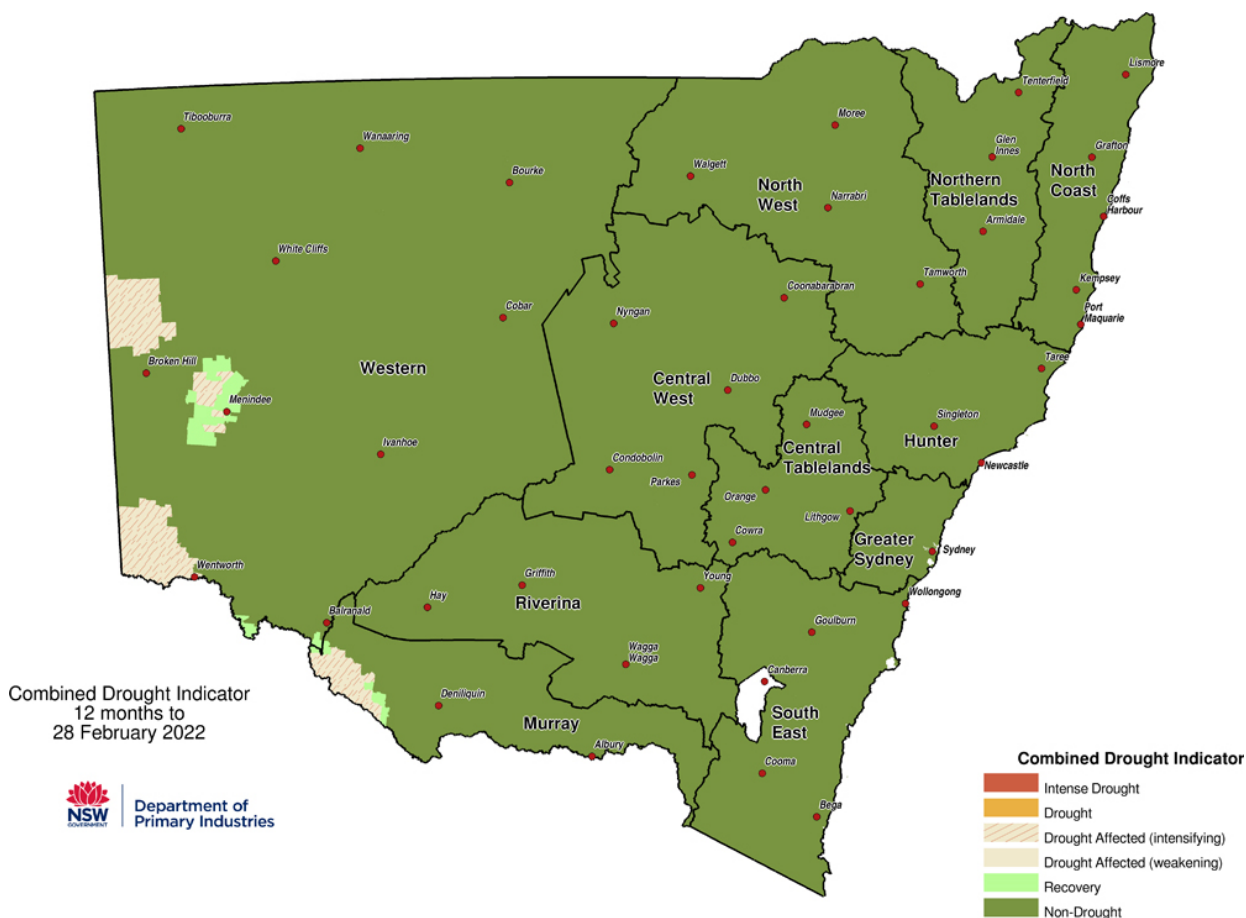


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 28 February 2022⁴

² Sourced from Department of Primary Industries [NSW State seasonal update – February 2021](#) (accessed April 2022).

³ Sourced from Department of Primary Industries [NSW State seasonal update – February 2020](#) (accessed April 2022).

⁴ Sourced from Department of Primary Industries [NSW State seasonal update – February 2022](#) (accessed April 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 – summer 2021–22

Station type*	Station	PM10 daily [50 µg/m ³ benchmark]	PM2.5 daily [25 µg/m ³ benchmark]	SO ₂ hourly [10 ppm benchmark]	SO ₂ daily [2 ppm benchmark]	NO ₂ hourly [8 ppm 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/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 the end of the report Definitions: Upper Hunter monitoring station types.

Pollution roses from hourly particle data

The seasonal pollution rose maps⁵ (Figure 3 and Figure 4) show that hourly PM10 and PM2.5 levels⁶ were predominantly low during the season.

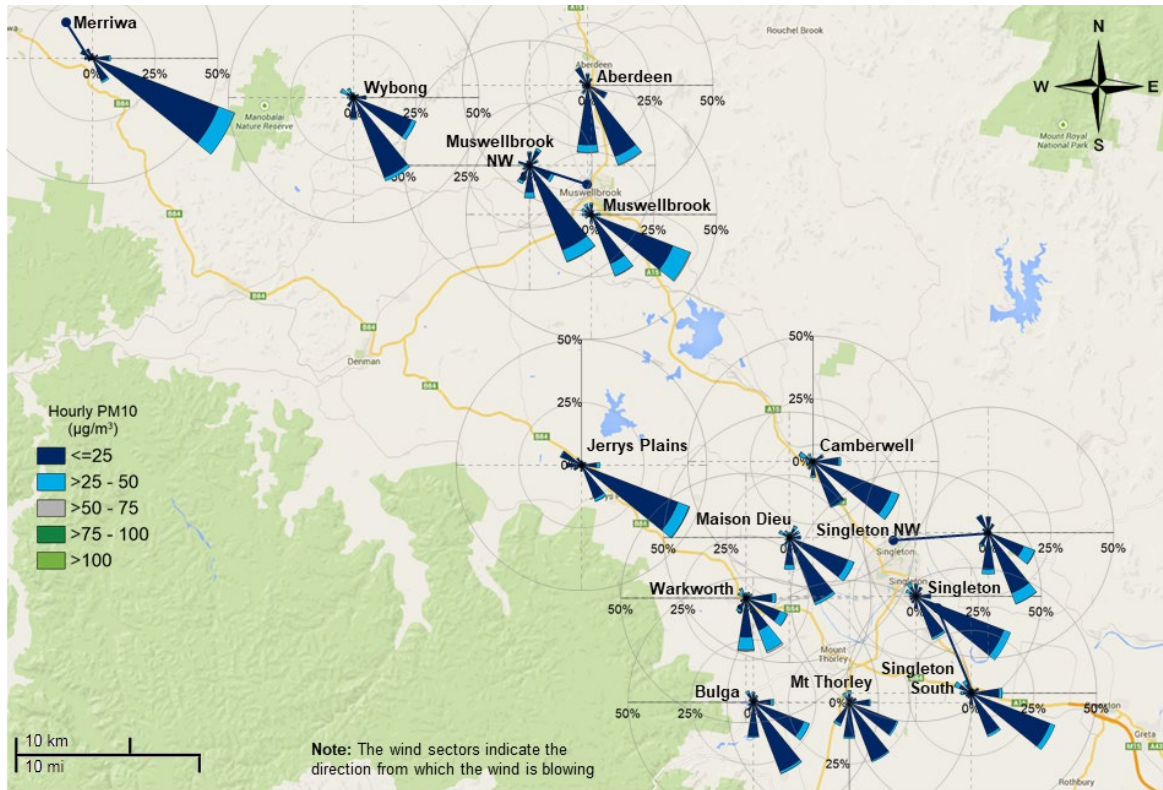


Figure 3 Hourly PM10 pollution rose map for the Upper Hunter region for summer 2021–22

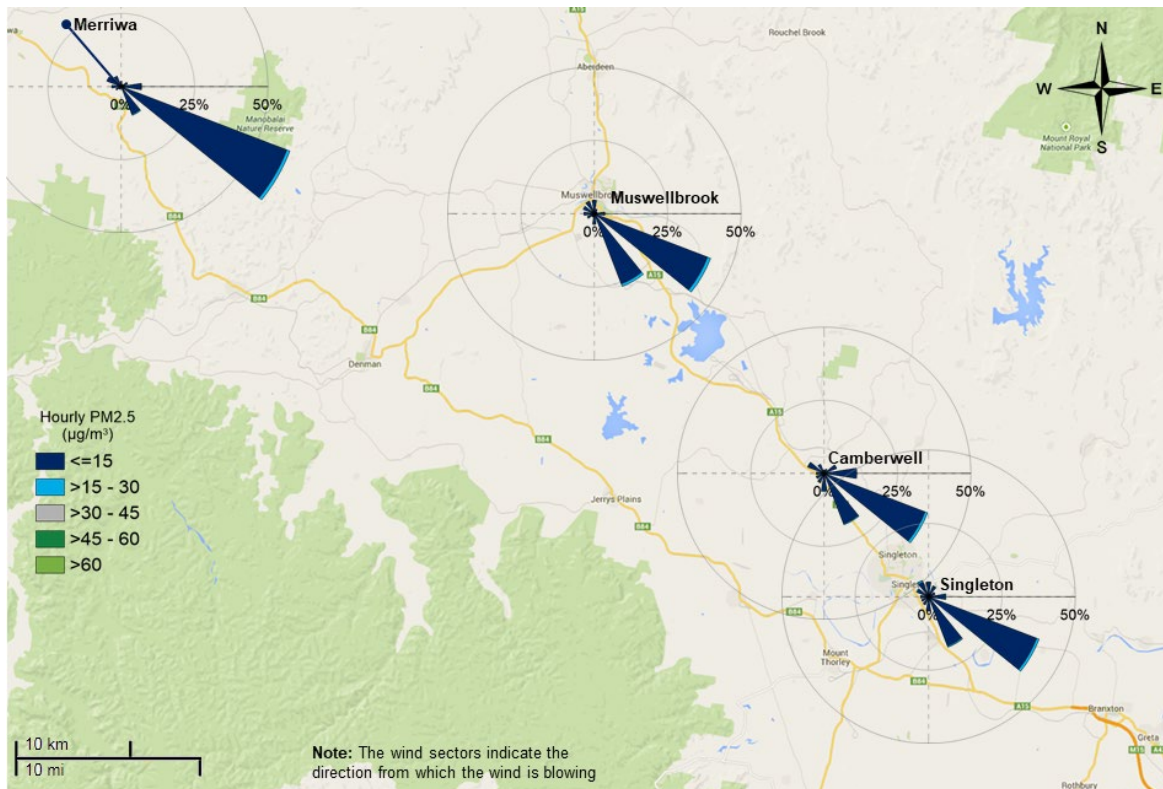


Figure 4 Hourly PM2.5 pollution rose map for the Upper Hunter region for summer 2021–22

⁵ 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.

⁶ 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 NO₂ and SO₂ show the concentrations throughout summer (Figure 5 to Figure 11). All parameters remained below the benchmarks.

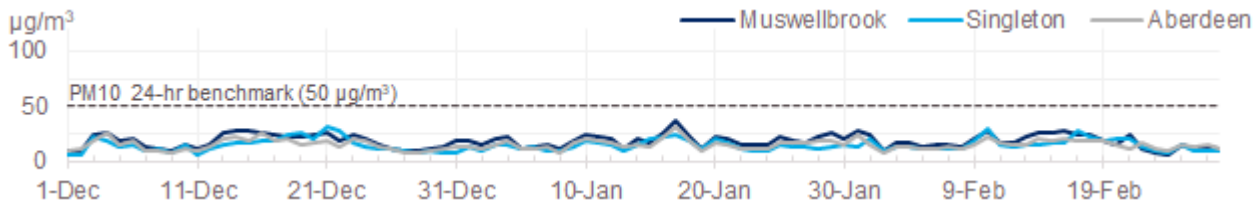


Figure 5 Population centre stations: daily average PM10 – summer 2021–22

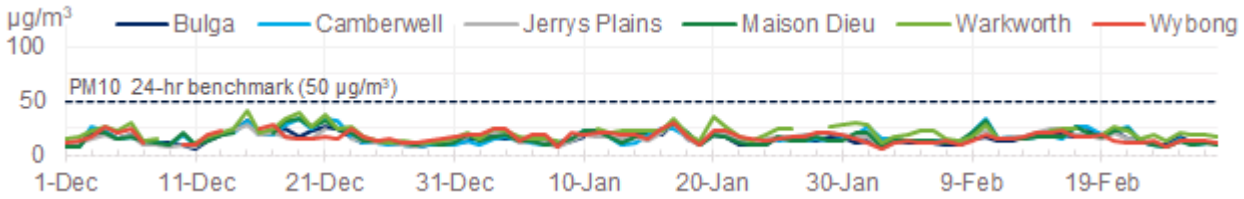


Figure 6 Smaller community stations: daily average PM10 – summer 2021–22

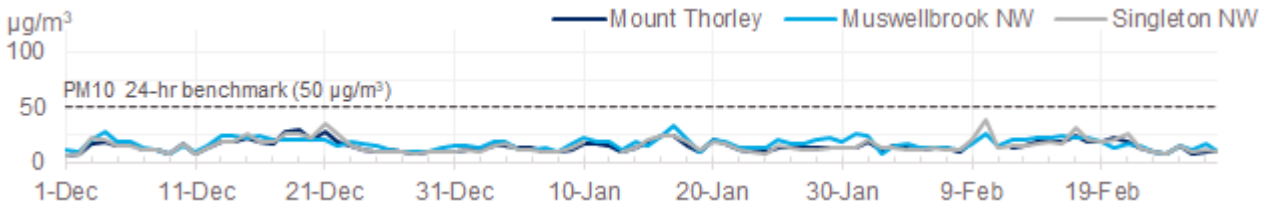


Figure 7 Diagnostic stations: daily average PM10 – summer 2021–22

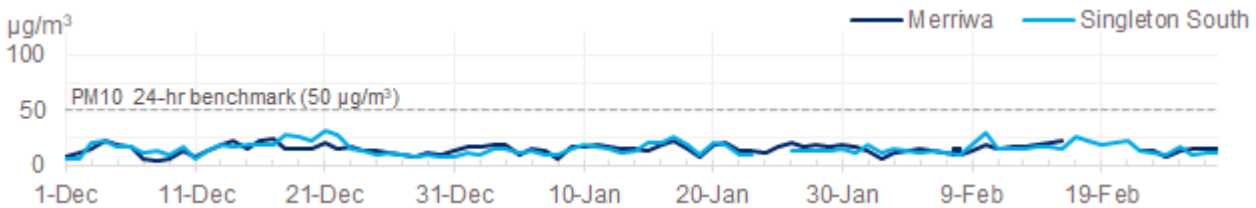


Figure 8 Background stations: daily average PM10 – summer 2021–22

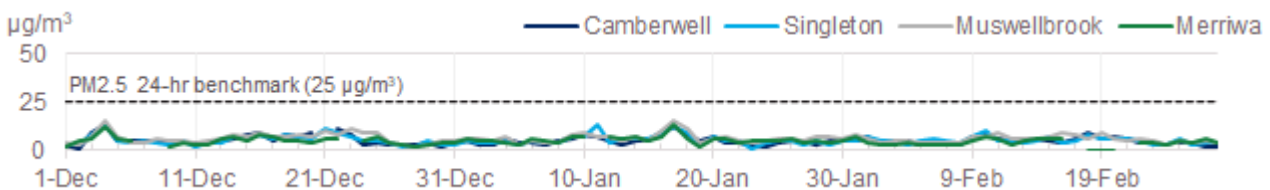


Figure 9 Daily average PM2.5 – summer 2021–22

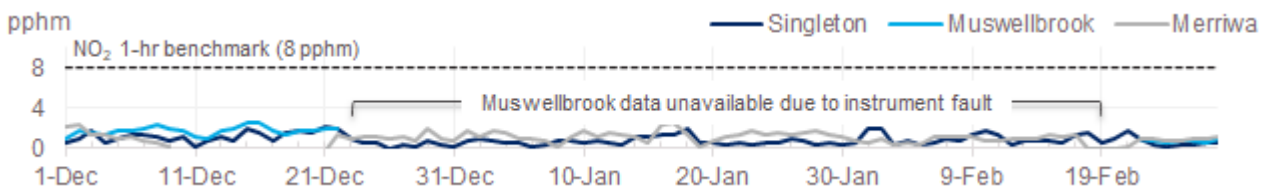


Figure 10 Daily 1-hr maximum NO₂ – summer 2021–22

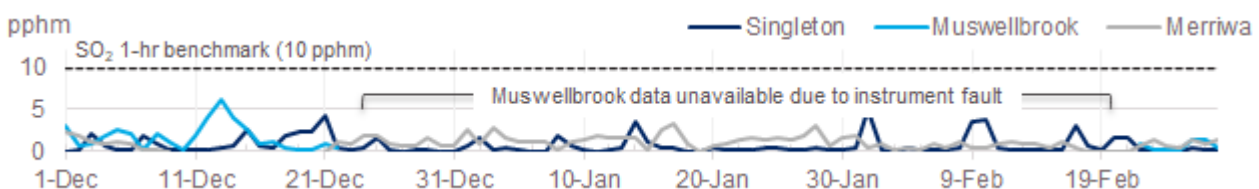


Figure 11 Daily 1-hr maximum SO₂ – summer 2021–22

Seasonal comparisons

This section compares air quality in summer 2021–22 with previous summer seasons (Figure 12).

There were no days over the current national benchmarks for NO₂ and SO₂ in summer 2021–22. From summers 2012–13 to 2020–21, under the more stringent standards (applied from May 2021 onwards), Muswellbrook would have recorded 18 hours over 15 days above the current hourly SO₂ standard of 10 parts per hundred million (pphm). There would have also been 3 days above the current daily SO₂ standard of 2 pphm at Muswellbrook.

The number of days over the particle benchmarks in summer 2021–22 was generally similar compared to summer 2020–21.

- There were no days over the PM10 daily benchmark during summer 2021–22. From 2012–13 to 2020–21, the region recorded between one day (summer 2014–15) and 51 days (summer 2019–20) over the PM10 benchmark. High particle levels occurred in summer 2019–20 due to intense drought conditions and extreme bushfires.
- There were no days over the PM2.5 daily benchmark during summer 2021–22. From 2012–13 to 2020–21, the region did not record any days over the PM2.5 benchmark during summer, except during 2019–20. In summer 2019–20, the region recorded 23 days over the PM2.5 benchmark, due to extreme bushfires.

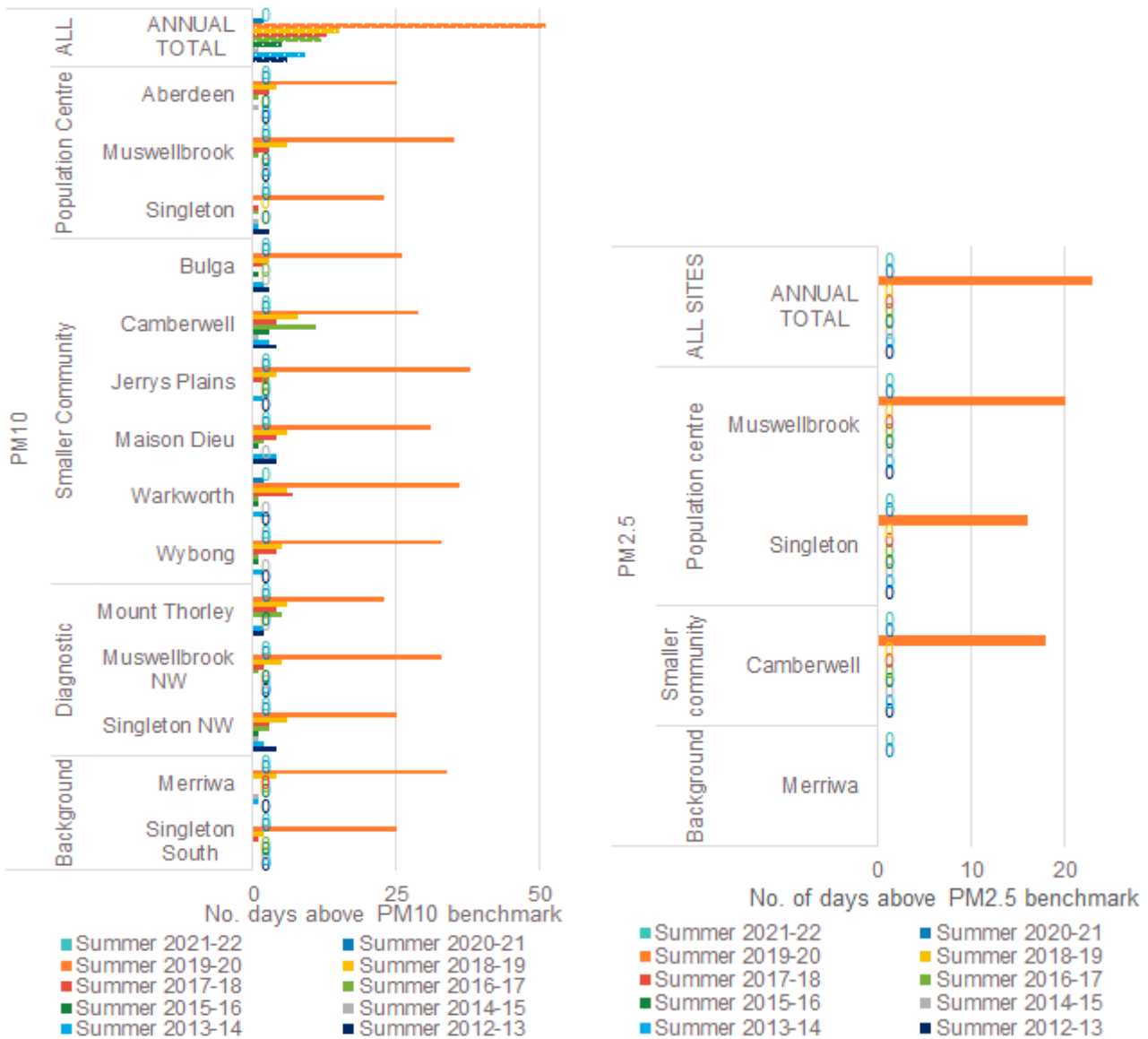


Figure 12 Number of days above the PM10 and PM2.5 daily benchmarks: summer 2012–13 to 2021–22

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 summer 2021–22, compared to the daily maximum and minimum levels (i.e. shaded range) for summer periods from 2011–12 to 2020–21, at Singleton and Muswellbrook. Daily PM10 levels were within or below the historical range throughout the season. Regional rainfall levels were average to above average, with particularly good falls at Singleton during late February 2022 (Figure 15), corresponding with low particle levels.

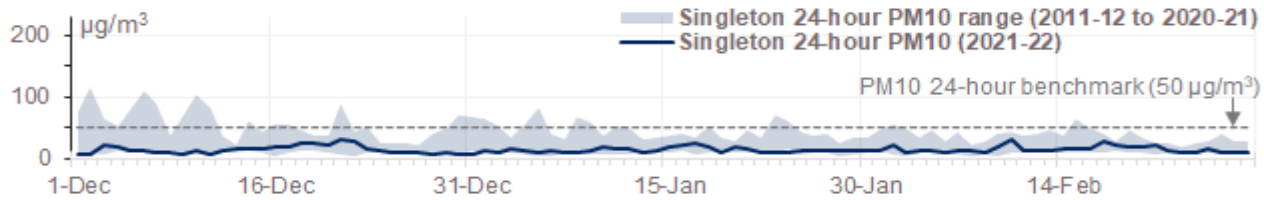


Figure 13 Singleton daily average PM10 during summer 2021–22 plotted against the daily maximum and minimum PM10 levels from 2011–12 to 2020–21

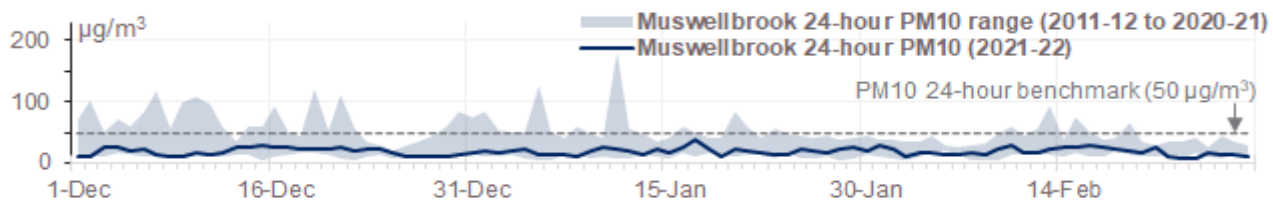


Figure 14 Muswellbrook daily average PM10 during summer 2021–22 plotted against the daily maximum and minimum PM10 levels from 2011–12 to 2020–21

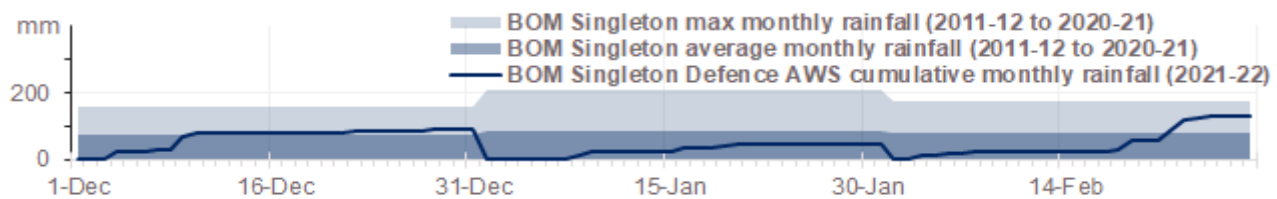


Figure 15 Bureau of Meteorology Singleton Defence AWS⁷ cumulative monthly rainfall in summer 2021–22 against maximum and average monthly rainfall from 2011–12 to 2020–21⁸

Figure 16 and Figure 17 show daily average PM2.5 levels during summer 2021–22, compared to the daily maximum and minimum levels (shaded range) for summer periods from 2011–12 to 2020–21, at Singleton and Muswellbrook. Daily PM2.5 levels were within or below the historical range in the season.

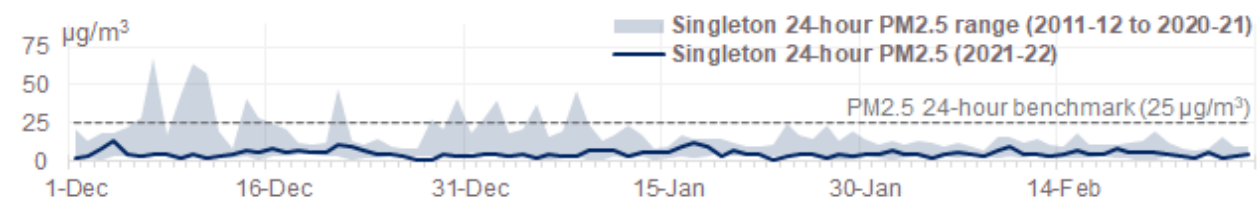


Figure 16 Singleton daily average PM2.5 during summer 2021–22 plotted against the daily maximum and minimum PM2.5 levels from 2011–12 to 2020–21

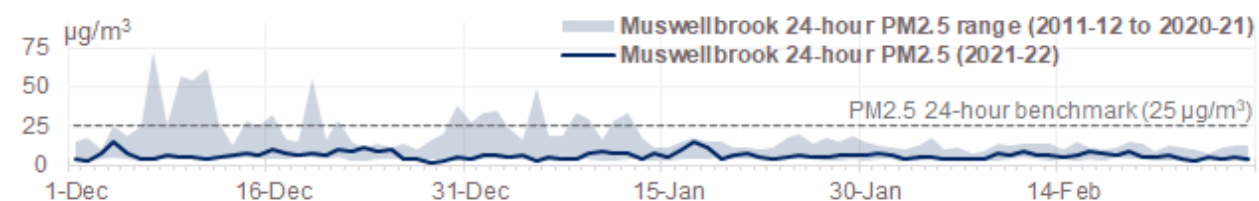


Figure 17 Muswellbrook daily average PM2.5 during summer 2021–22 plotted against the daily maximum and minimum PM2.5 levels from 2011–12 to 2020–21

⁷ Data obtained from the Bureau of Meteorology [Singleton Defence AWS monthly rainfall data](#) (accessed May 2022).

⁸ 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 temperature⁹

The Upper Hunter experienced average to above average rainfall during summer 2021–22 (Figure 18). Summer 2021–22 was drier than summer 2020–21, with up to 100 millimetres less rain. Summer 2021–22 was wetter than the earlier 2 summers, with up to 50 millimetres more rain in the southern part of the region in summer 2019–20 and 50 to 200 millimetres more rain than summer 2018–19.

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

New South Wales rainfall deciles 1 December 2021 to 28 February 2022
Australian Gridded Climate Data

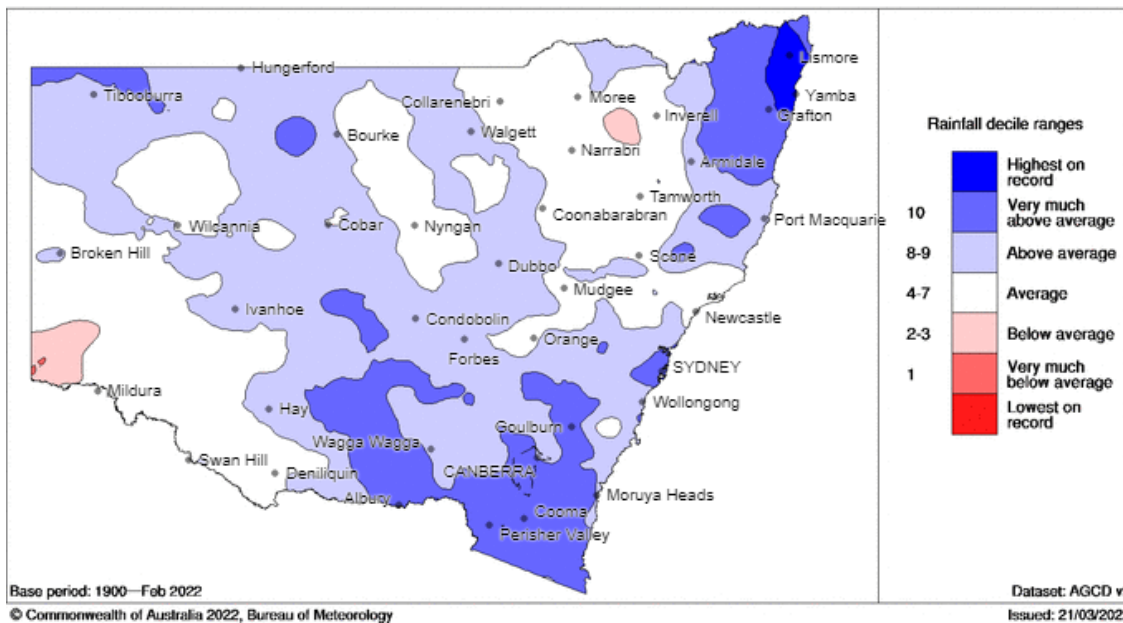


Figure 18 NSW rainfall deciles – summer 2021–22

Maximum Temperature Deciles 1 December 2021 to 28 February 2022
Distribution Based on Gridded Data
Australian Bureau of Meteorology

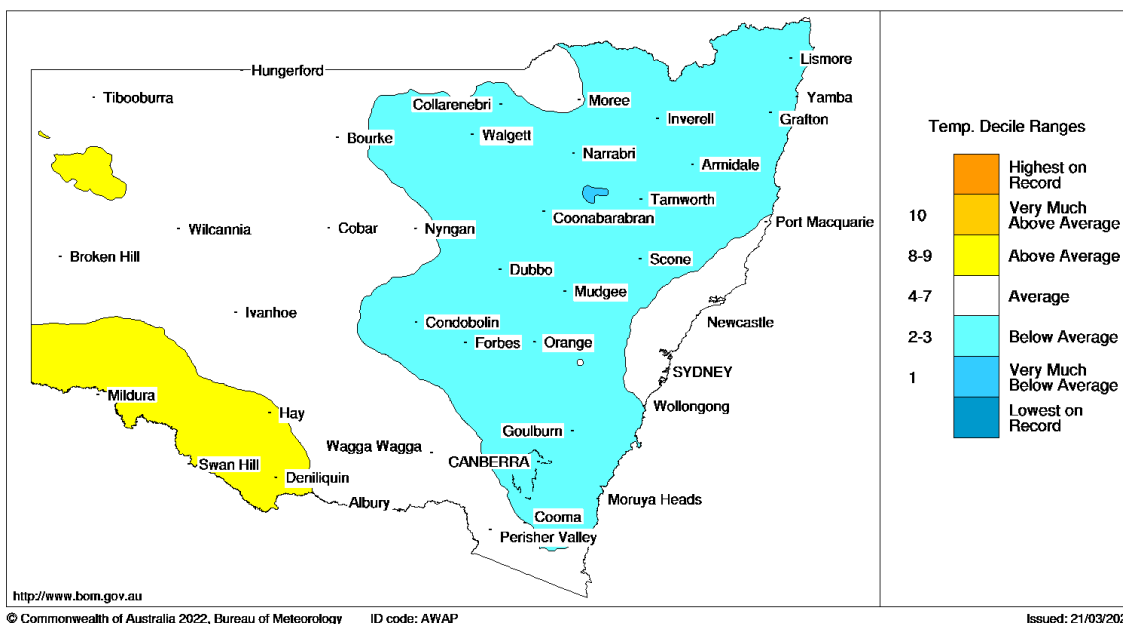


Figure 19 NSW maximum temperature deciles – summer 2021–22

⁹ Rainfall and temperature information is from the Bureau of Meteorology [New South Wales summer 2021-22 climate statement](#) (accessed April 2022) and [climate maps](#) (accessed April 2022).

Wind

Winds were predominately from the south-east in the region during summer 2021–22 (Figure 20), which was typical for this time of year. Overall, regional wind speeds in summer 2021–22 were lower compared to summer 2020–21.

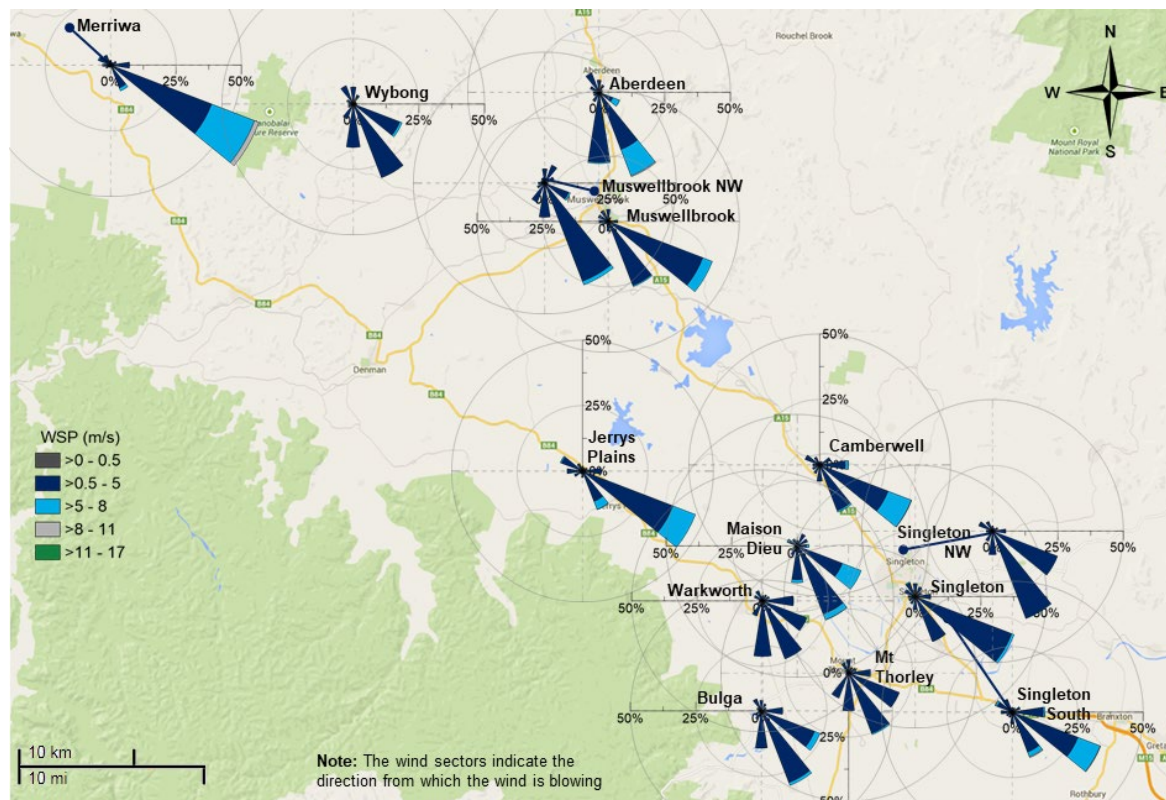


Figure 20 Wind rose map¹⁰ for the Upper Hunter region for summer 2021–22

¹⁰ 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 NO₂ and SO₂ is 96%, due to daily calibrations.

Table 2 Online performance (%) during summer 2021–22

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO ₂ hourly	Gases NO ₂ hourly	Meteorology Wind hourly
Aberdeen	100	-	-	-	100
Bulga	98	-	-	-	100
Camberwell	97	97	-	-	100
Jerrys Plains	99	-	-	-	100
Maison Dieu	98	-	-	-	100
Merriwa	94	90	77	76	92
Mount Thorley	98	-	-	-	100
Muswellbrook	100	100	29	29	98
Muswellbrook NW	100	-	-	-	100
Singleton	100	100	93	87	100
Singleton NW	98	-	-	-	100
Singleton South	98	-	-	-	99
Warkworth	89	-	-	-	99
Wybong	96	-	-	-	99

- = not monitored

The overall reduced online times were mainly due to:

- Merriwa PM10 – power fault (5 days)
- Merriwa PM2.5 – instrument stabilisation after re-starts (4 days) and power fault (5 days)
- Merriwa SO₂ and NO₂ – instrument fault (14 days) and power fault (5 days)
- Merriwa wind – instrument fault following power fault (7 days)
- Muswellbrook NO₂ and SO₂ – instrument fault (2 months)
- Singleton NO₂ – negative data (7 days)
- Warkworth PM10 – datalogger faults (9 days) and power fault (1 day).

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).

© 2022 State of NSW and Department of Planning and Environment

The State of NSW and the Department of Planning and Environment are pleased to allow this material to be reproduced in whole or in part for educational and non-commercial use, provided the meaning is unchanged and its source, publisher and authorship are acknowledged.

Department of Planning and Environment has compiled this report in good faith, exercising all due care and attention. No representation is made about the accuracy, completeness or suitability of the information in this publication for any particular purpose. The department shall not be liable for any damage which may occur to any person or organisation taking action or not on the basis of this publication. Readers should seek appropriate advice when applying the information to their specific needs.

This document was prepared by Loredana Warren and reviewed by Stephen White, Margaret Haak and David Salter

Published by: Department of Planning and Environment, Locked Bag 5022, Parramatta NSW 2124. Ph: 131 555 (environment information and publications requests). TTY: (02) 9211 4723. Email: info@environment.nsw.gov.au;

Web: www.environment.nsw.gov.au.

ISSN 2206-0391 EHG 2022/0270 June 2022