

Air quality in Newcastle: Autumn 2022

Air quality in the Newcastle region was generally good during autumn 2022. Daily particle levels were within national benchmarks from 93% of the time at Stockton and 100% at all other sites. Stockton particle levels are affected by sea salt due to its proximity to the coast. Hourly particle levels were in the good to fair air quality categories from 98.6% to 100% of the time throughout the region.

- Levels of nitrogen dioxide (NO₂), sulfur dioxide (SO₂) and ammonia (NH₃) were good, all remaining below national benchmark concentrations and assessment goals.
- Daily average levels of fine particulate matter PM_{2.5} (particles less than or equal to 2.5 microns in diameter) remained below the 25 micrograms per cubic metre (µg/m³) benchmark.
- Daily average levels of particulate matter PM₁₀ (particles less than or equal to 10 microns in diameter) were above the 50 µg/m³ benchmark on 6 days at Stockton (2–5 March and 9–10 April). Regional maximum daily PM₁₀ levels on these days ranged from 50.5 to 70.1 µg/m³.
 - There were no days over the benchmark at Beresfield, Carrington, Mayfield, Newcastle and Wallsend.
 - At Stockton, elevated hourly PM₁₀ levels (> 75 µg/m³) predominantly occurred under onshore north-easterly to south-easterly winds (88% of the time that levels were elevated). Stockton particle levels are influenced by sea salt spray transported by onshore winds¹, which prevail during the warmer months. See Stockton section for further details.
- The Newcastle region recorded very much above average rainfall and average maximum temperatures during the season.

Annual air quality 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. Long-term trends in annual average PM₁₀ and PM_{2.5} levels are compared in Figure 1, showing the PM₁₀ and PM_{2.5} **rolling** annual averages². The rolling annual averages are based on the 12-month periods to the end of autumn, from 2016 to 2022.

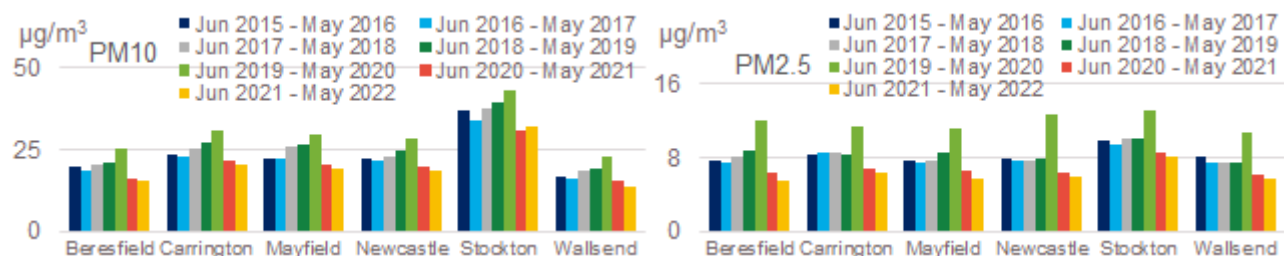


Figure 1 PM₁₀ and PM_{2.5} rolling annual averages to end of autumn – 2016 to 2022

The comparison in Figure 1 shows that particle levels continued to decrease at most sites in the region during the 12 months to the end of autumn 2022, compared to the same 12-month period in previous years (especially compared to the end of autumn 2020). Rolling annual average PM₁₀ and PM_{2.5} levels were below the benchmarks at all sites in the 12 months to the end of autumn 2022, except Stockton.

¹ Lower Hunter Particle Characterisation Study.

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.

Lower particle levels resulted from wetter than average conditions over the 12-month period. 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 2021³ and 91% at the end of autumn 2020⁴.

The higher PM10 and PM2.5 annual averages at Stockton were consistent with the Lower Hunter Particle Characterisation Study. This study found two and a half times higher PM10 at Stockton compared to Mayfield, mainly due to fresh sea salt. It also found 40% more PM2.5 at Stockton compared to Mayfield, Beresfield and Newcastle. This was due to more sea salt in onshore winds and primary ammonium nitrate in north-west winds, particularly in winter (and very likely due to Orica’s ammonium nitrate manufacturing facility on Kooragang Island).

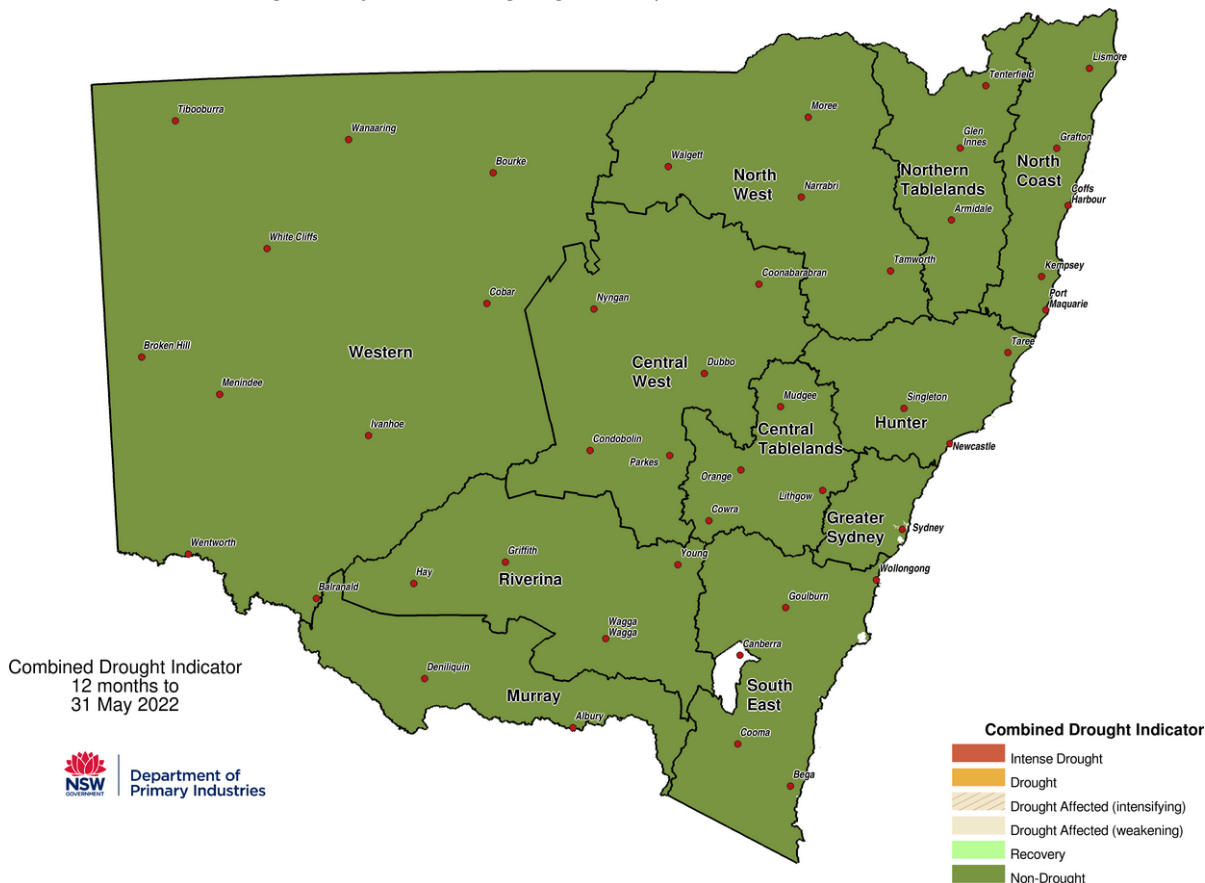


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 May 2022⁵

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

There were 6 days over the PM10 daily benchmark in autumn 2022, occurring only at Stockton.

There were no days over the PM2.5 daily benchmark in autumn 2022.

Concentrations of SO₂, NO₂ and NH₃ remained below relevant benchmarks in autumn 2022.

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

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]
Beresfield	0	0	0	0	0
Carrington	0	0	0	0	0
Mayfield	0	0	0	0	0
Newcastle	0	0	0	0	0
Stockton	6	0	0	0	0
Wallsend	0	0	0	0	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.

Daily time series plots

Daily average time series plots for PM10 and PM2.5 and daily 1-hour maximum plots for NO₂, SO₂ and NH₃ show the concentrations throughout the autumn season (Figure 3 to Figure 7).

Levels of PM2.5, NO₂, SO₂ and NH₃ remained below the benchmarks and assessment criteria throughout the season.

PM10 levels remained below the benchmark at most sites, except for 6 days at Stockton. Stockton PM10 levels were likely affected by sea salt on most of these days due to its proximity to the coast. See [Stockton](#) section for further details.

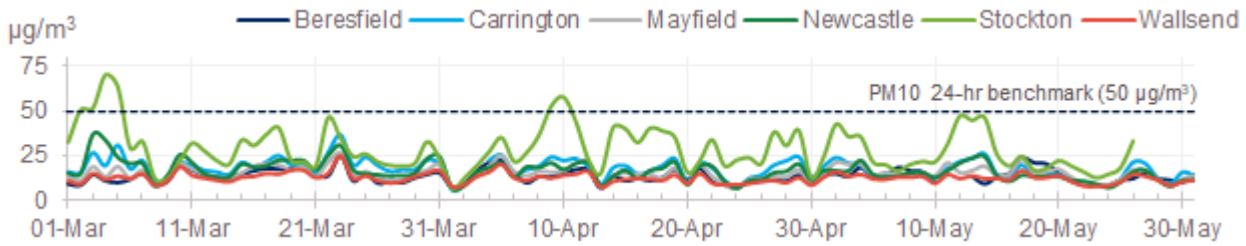


Figure 3 Daily average PM10 during autumn 2022

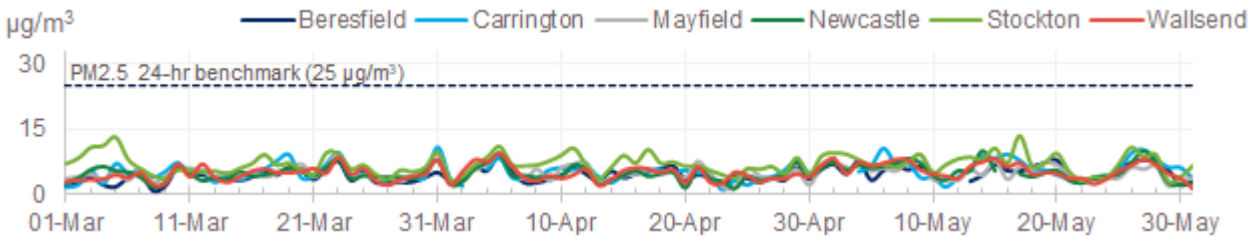


Figure 4 Daily average PM2.5 during autumn 2022

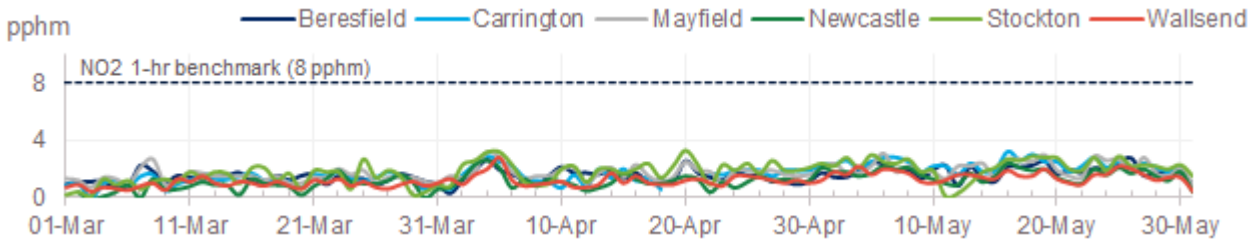


Figure 5 Daily maximum 1-hr NO₂ during autumn 2022

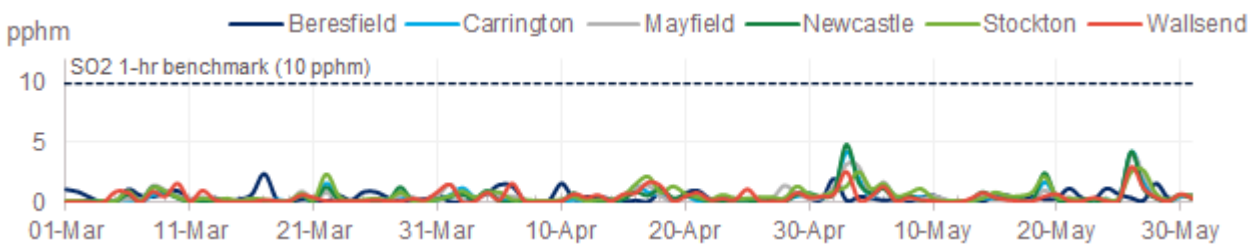


Figure 6 Daily maximum 1-hr SO₂ during autumn 2022

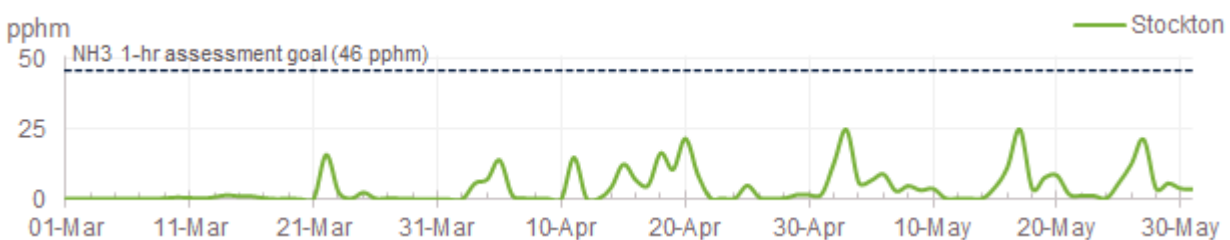


Figure 7 Daily maximum 1-hr NH₃ during autumn 2022

Pollution roses from hourly particle data

The seasonal pollution rose maps⁶ (Figure 8 and Figure 9) show that hourly⁷ PM10 and PM2.5 levels generally remained low during the season. Stockton recorded some elevated hourly PM10 levels under easterly winds, due predominantly to sea salt (see Stockton section below for more detail).

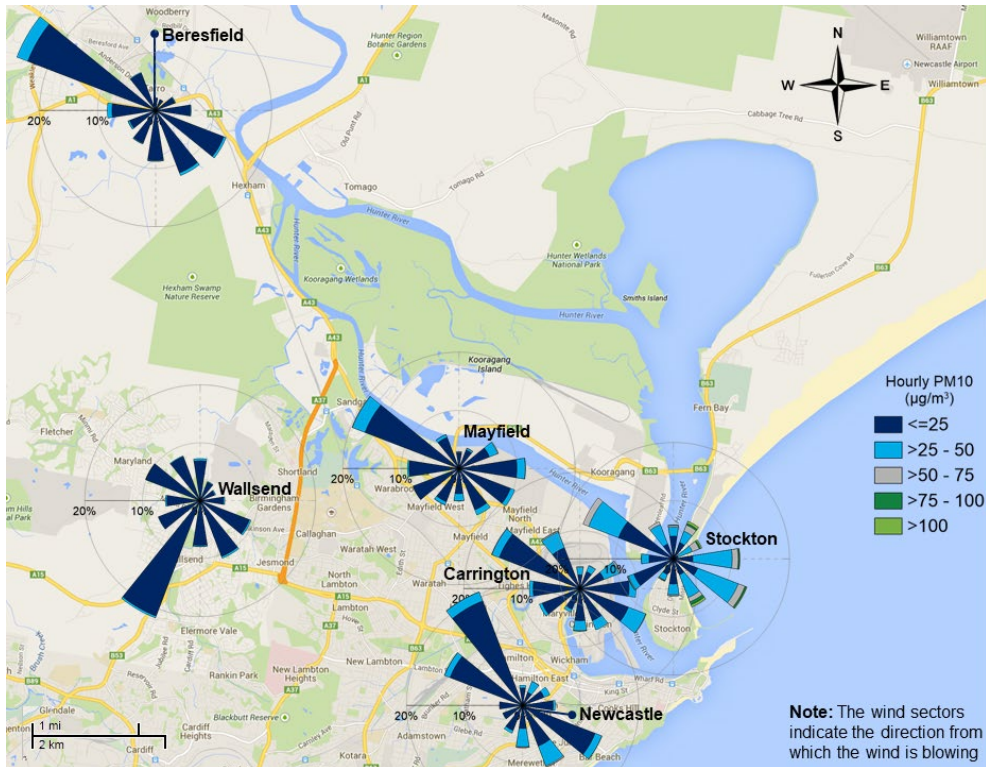


Figure 8 Hourly PM10 pollution roses for the Newcastle region for autumn 2022



Figure 9 Hourly PM2.5 pollution roses for the Newcastle region for autumn 2022

⁶ Pollution roses show the 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 (Air NEPM).

Seasonal trends

This section compares air quality levels in autumn 2022 with previous autumn seasons, where data were available⁸.

All days were below benchmark concentrations for NO₂ and SO₂ in autumn during the past 10 years at Beresfield, Newcastle, Stockton and Wallsend and since monitoring began at Carrington and Mayfield. For NH₃ at Stockton, there were no days over the assessment criterion in autumn during the past 10 years. There were no days over the PM_{2.5} daily benchmark during autumn 2022. In earlier years, Wallsend recorded 1 day above the PM_{2.5} benchmark during autumn 2013.

There were 6 days over the PM₁₀ daily benchmark during autumn 2022, at Stockton alone. This is 3 days more than autumn 2021. From 2013 to 2020, the region recorded between 1 day (autumn 2013) and 20 days (autumn 2016) over the PM₁₀ daily benchmark.

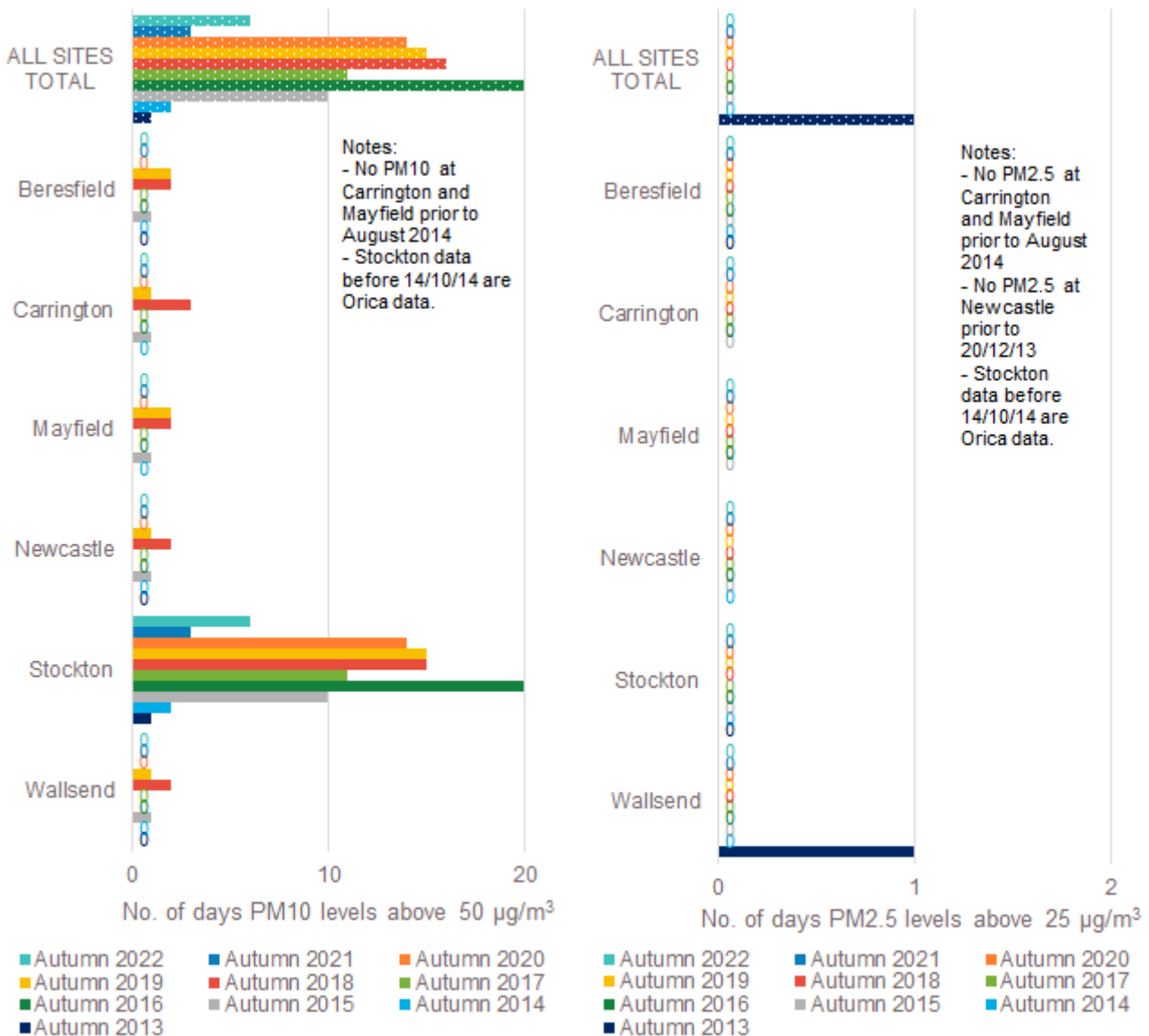


Figure 10 Number of days above the PM₁₀ and PM_{2.5} daily benchmarks: autumn 2013 to 2022

⁸ Monitoring at Stockton commenced in October 2012 and at Mayfield and Carrington in August 2014. Monitoring of PM_{2.5} at Newcastle commenced in December 2013. Stockton air quality monitoring was undertaken by Orica from October 2012 to October 2014. From October 2014 it was undertaken by the NSW government as part of the Newcastle Local Air Quality Monitoring Network.

Particle air quality trends

Figure 11 and Figure 12 show daily average PM10 during autumn 2022, compared to the daily maximum and minimum PM10 levels (shaded range) from autumn 2013 to 2021, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season.

Rainfall in Newcastle was very much above average during autumn (Figure 13).

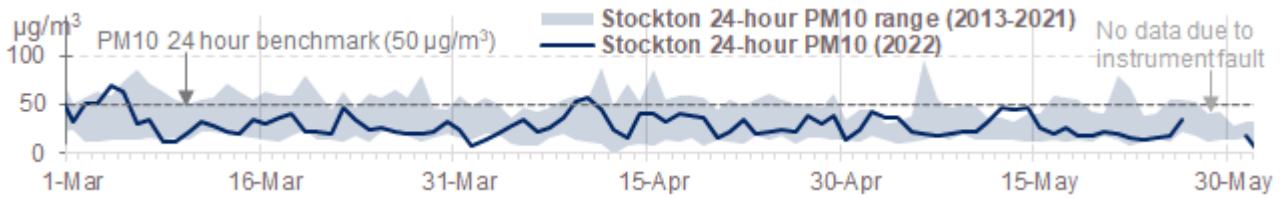


Figure 11 Stockton daily average PM10 during autumn 2022 plotted against the daily maximum and minimum PM10 levels from 2013 to 2021

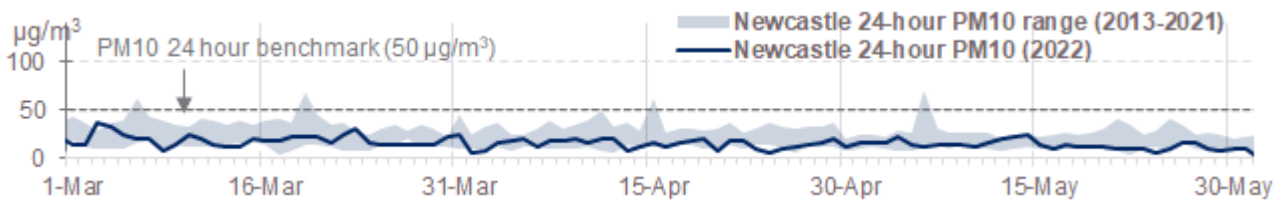


Figure 12 Newcastle daily average PM10 during autumn 2022 plotted against the daily maximum and minimum PM10 levels from 2013 to 2021

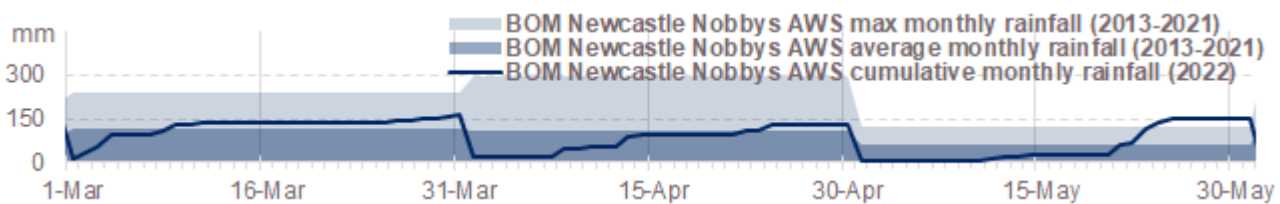


Figure 13 Bureau of Meteorology Newcastle Nobbys Signal Station AWS⁹ cumulative rainfall during autumn 2022 plotted against maximum and average rainfall from 2013 to 2021

Figure 14 and Figure 15 show daily average PM2.5 during autumn 2022, compared to the daily maximum and minimum PM2.5 levels (shaded range) from 2014 to 2021, at Stockton and Newcastle. Daily PM2.5 levels were generally within the historical range throughout the season, and often at the lower levels.

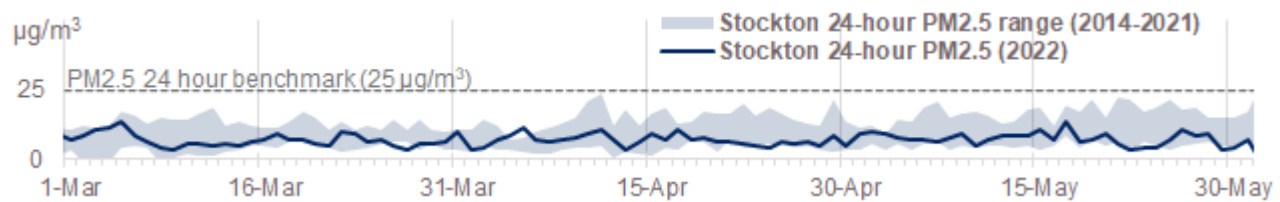


Figure 14 Stockton daily average PM2.5 during autumn 2022 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2021

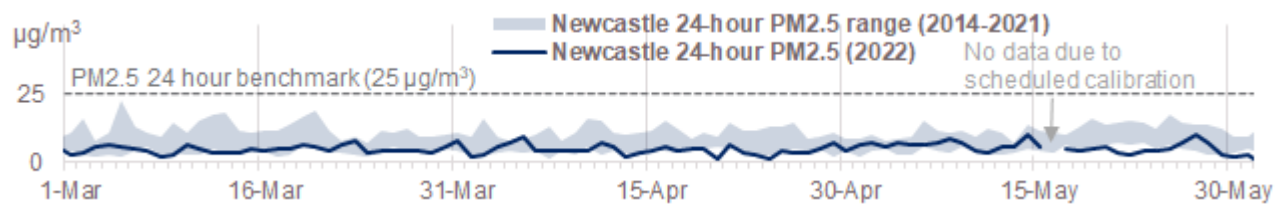


Figure 15 Newcastle daily average PM2.5 during autumn 2022 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2021

⁹ Data from Bureau of Meteorology [Newcastle Nobbys Signal Station AWS monthly rainfall](#) page (accessed July 2022).

Meteorological summary

Rainfall¹⁰

The Newcastle region experienced much above-average rainfall during autumn 2022 compared to long-term records (Figure 16).

Rainfall levels in autumn 2022 were generally similar to autumn 2021. The season was wetter than autumn 2019 and 2020, with 200 to 400 millimetres more rain.

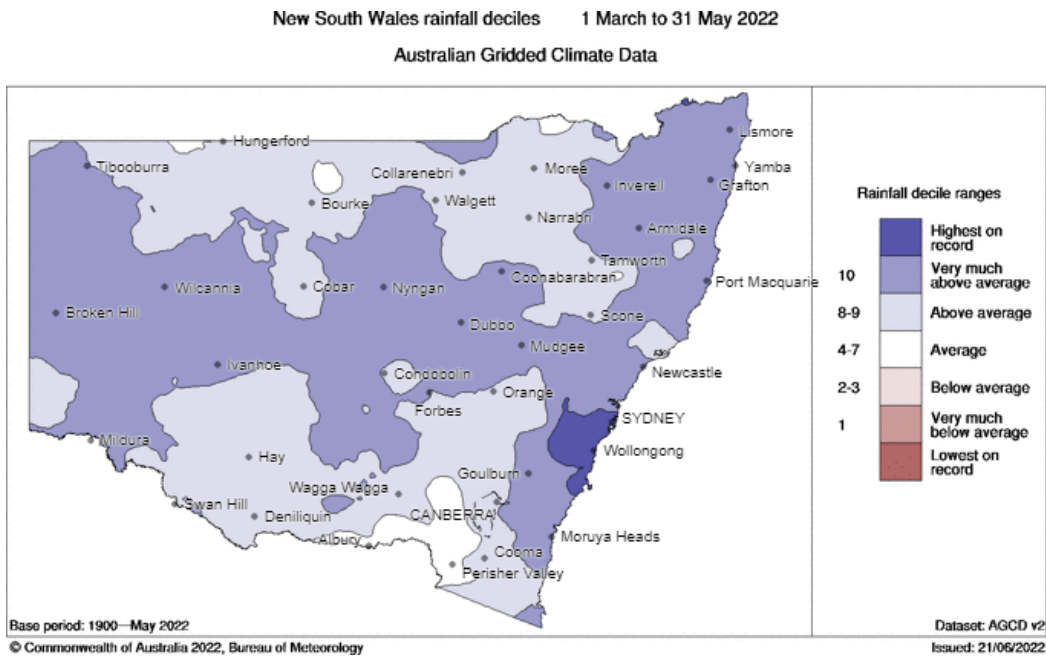


Figure 16 NSW rainfall deciles – autumn 2022

Temperatures¹⁰

Maximum temperatures were average during the season (Figure 17), while minimum temperatures were very much above average.

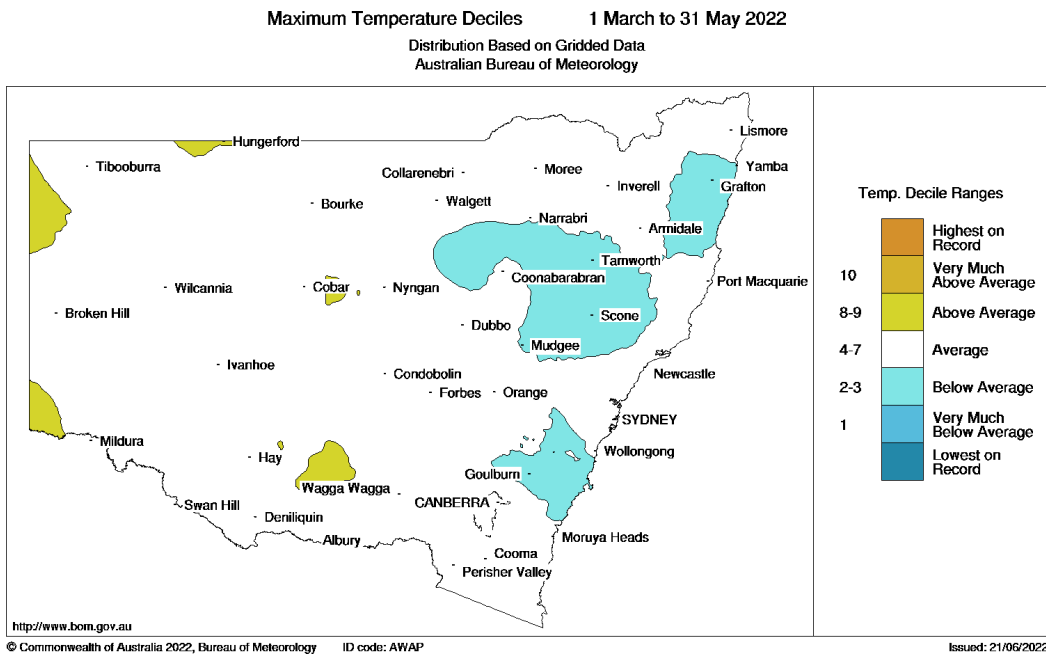


Figure 17 NSW maximum temperature deciles – autumn 2022

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).

Winds

The winds were variable during autumn 2022, with an increasing percentage of north-westerly winds. Winds typically shift from onshore easterly flows during the warmer months to offshore westerly flows as temperatures cool.

As an example, Figure 18 shows that at Stockton, winds with an easterly component prevailed 41% of the time, with these moderate or stronger (above 5 metres per second) 11% of the time.

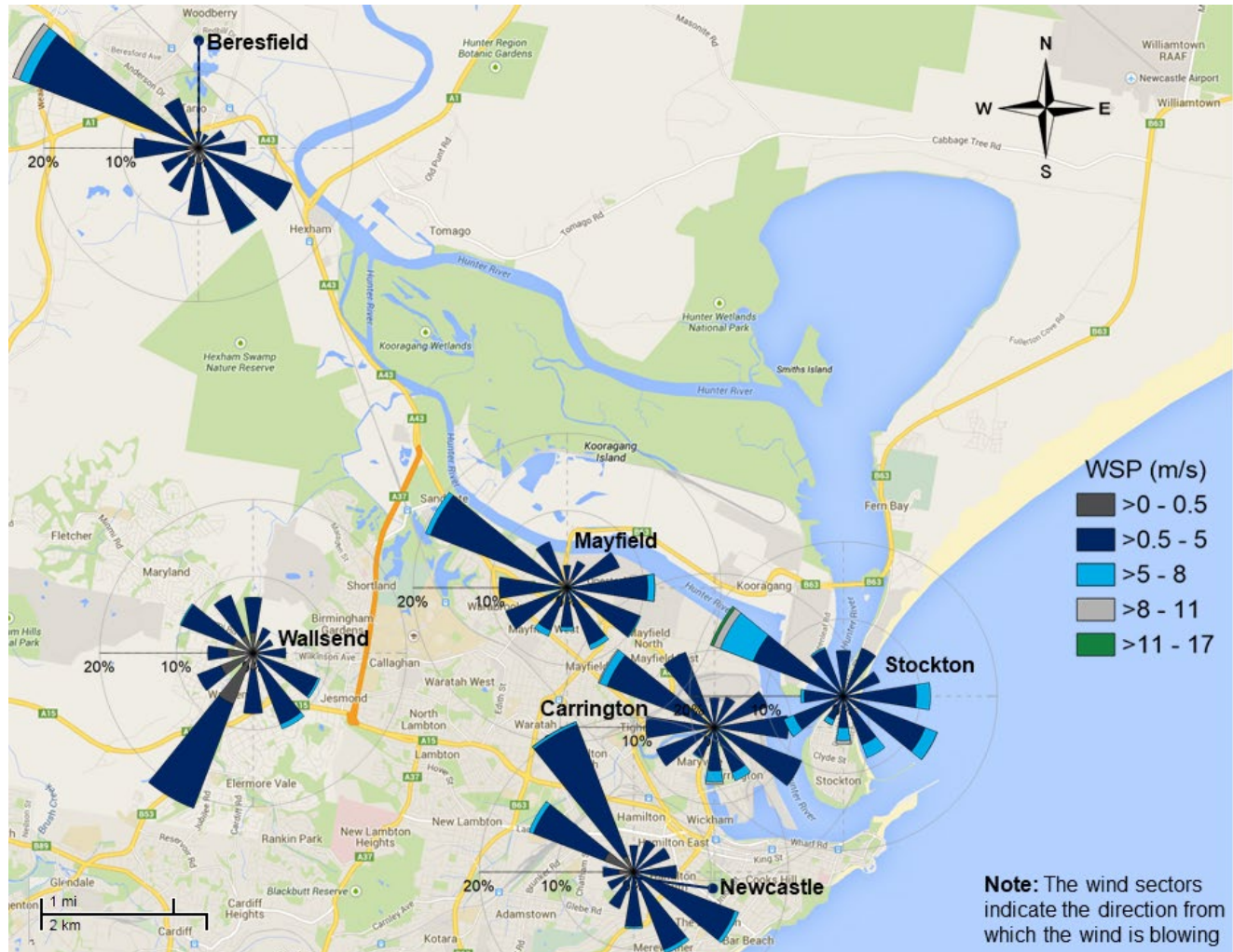


Figure 18 Wind rose map¹¹ for the Newcastle region for autumn 2022

¹¹ Wind roses show the wind direction and speed at a location. The length of each bar around the circle in these wind roses shows the percentage of time the wind blows from a particular direction. The colours along the bars indicate the wind speeds.

Stockton

Particles at Stockton in autumn 2022

The Stockton monitoring site recorded 6 days over the PM10 daily benchmark during autumn 2022 (2–5 March and 9–10 April). This is 3 days more than autumn 2021. From 2013 to 2020, Stockton recorded between 1 day (autumn 2013) and 20 days (autumn 2016) over the PM10 daily benchmark (Figure 10).

In autumn 2022, elevated hourly PM10 levels ($>75 \mu\text{g}/\text{m}^3$)¹² were recorded at Stockton 3.1% of the time (Figure 19). These occurred under onshore north-easterly to south-easterly winds 87.9% of the time (58 hours, 2.7% total for autumn). There were no hours with elevated hourly PM10 under north-westerly winds during autumn.

Elevated PM10 levels under predominant onshore winds at Stockton indicate the potential contribution of sea salt. The Lower Hunter Particle Characterisation Study found sea salt was a major contributor of particles at the site under onshore winds.

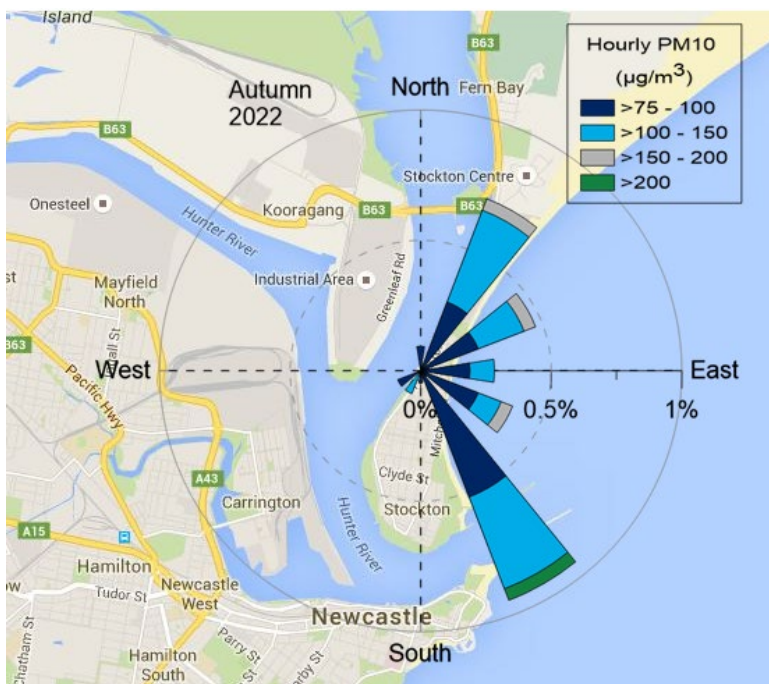


Figure 19 Stockton autumn 2022 PM10 pollution rose – proportion of hourly averaged PM10 levels $>75 \mu\text{g}/\text{m}^3$ by wind direction

The Stockton monitoring site did not record any days over the PM2.5 daily benchmark during autumn 2022. This was the same as all previous years during autumn (Figure 10). There were also no elevated hours of PM2.5 ($>40 \mu\text{g}/\text{m}^3$)¹² observed at Stockton during autumn 2022.

¹² There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure.

Network performance

The target network performance is at least 95% available data for all parameters. For NO₂, SO₂ and NH₃, the maximum online time that can be attained is 96% due to calibrations.

Table 2 Online performance (%) during autumn 2022

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO ₂ hourly	Gases NO ₂ hourly	Gases NH ₃ hourly	Meteorology Wind hourly
Beresfield	98	98	94	94	-	99
Carrington	96	95	93	87	-	100
Mayfield	100	99	96	96	-	100
Newcastle	100	99	94	89	-	100
Stockton	96	100	95	95	95	100
Wallsend	100	100	96	96	-	94

- = not monitored

The reduced online times were mainly due to:

- Carrington NO₂ – scheduled calibration (2 days) and negative data fault (5 days)
- Newcastle NO₂ – scheduled calibration (1 day) and negative data fault (3 days)
- Wallsend wind – instrument fault (5 days)

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