Air quality in Newcastle: Summer 2021–22

Air quality in the Newcastle region was generally good during summer 2021–22. Daily particle levels were within national benchmarks from 69% of the time at Stockton, 99% of the time at Mayfield and 100% of the time 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 97.2% to 100% of the time throughout the region.

- Levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and ammonia (NH_3) were good, all remaining below national benchmark concentrations and assessment goals.
- Daily average levels of fine particulate matter PM2.5 (particles less than or equal to 2.5 microns in diameter) remained below the 25 micrograms per cubic metre (µg/m^3) benchmark.
- Daily average levels of particulate matter PM10 (particles less than or equal to 10 microns in diameter) were above the 50 µg/m^3 benchmark on 28 days (4–7, 11, 14–15, 17–18, 20, 26–27 and 29 January 2022, and 1, 5–7, 9–10, 12–15, 19–20, 24–25 and 28 February 2022). Regional maximum daily PM10 levels on these days ranged from 50.6 to 95.9 µg/m^3.
  - There were no days over the benchmark at Beresfield, Carrington, Newcastle and Wallsend.
  - At Mayfield, PM10 was over the daily benchmark on 27 January, due to an unidentified source. Hourly PM10 levels were elevated morning and afternoon, under moderate easterly winds.
  - At Stockton, PM10 levels were over the daily benchmark on all 28 days. Elevated hourly PM10 levels (> 75 µg/m^3) predominantly occurred under onshore north-easterly to south-easterly winds (92.5% of the time that levels were elevated). Stockton particle levels are influenced by sea salt spray transported by onshore winds[1], which prevail during the warmer months. See Stockton section for further details.
- The Newcastle region recorded average rainfall and maximum temperatures during the season.

Annual air quality 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. Long-term trends in annual average PM10 and PM2.5 levels are compared in Figure 1, showing the PM10 and PM2.5 **rolling** annual averages[2]. The rolling annual averages are based on the 12-month periods to the end of summer, for 2015–16 to 2021–22.

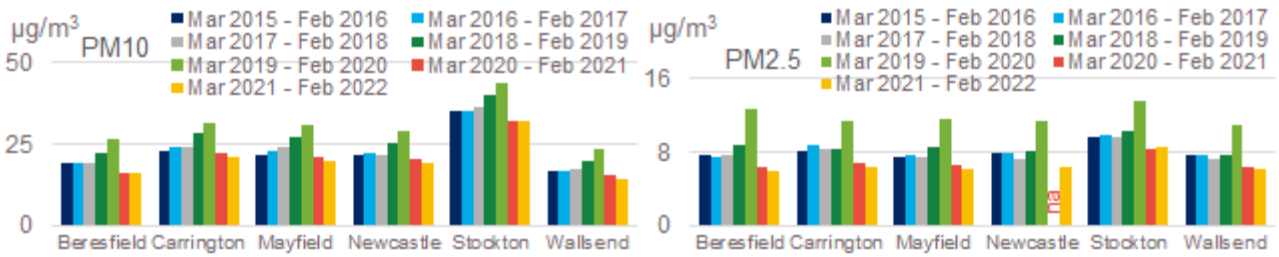

Figure 1 PM10 and PM2.5 rolling annual averages – 2016 to 2022

Note: The Newcastle PM2.5 rolling annual average from March 2020 to February 2021 is not available due to less than 75% data availability.

[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.

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 summer 2021–22, compared to the same 12-month period in previous years (especially compared to the end of summer 2019–20). Annual average PM10 and PM2.5 levels were below the benchmarks at all sites in the 12 months to the end of summer 2021–22, except Stockton.

Lower particle levels resulted from wetter 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 2020–21[3] and 99% at the end of summer 2019–20[4].

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).

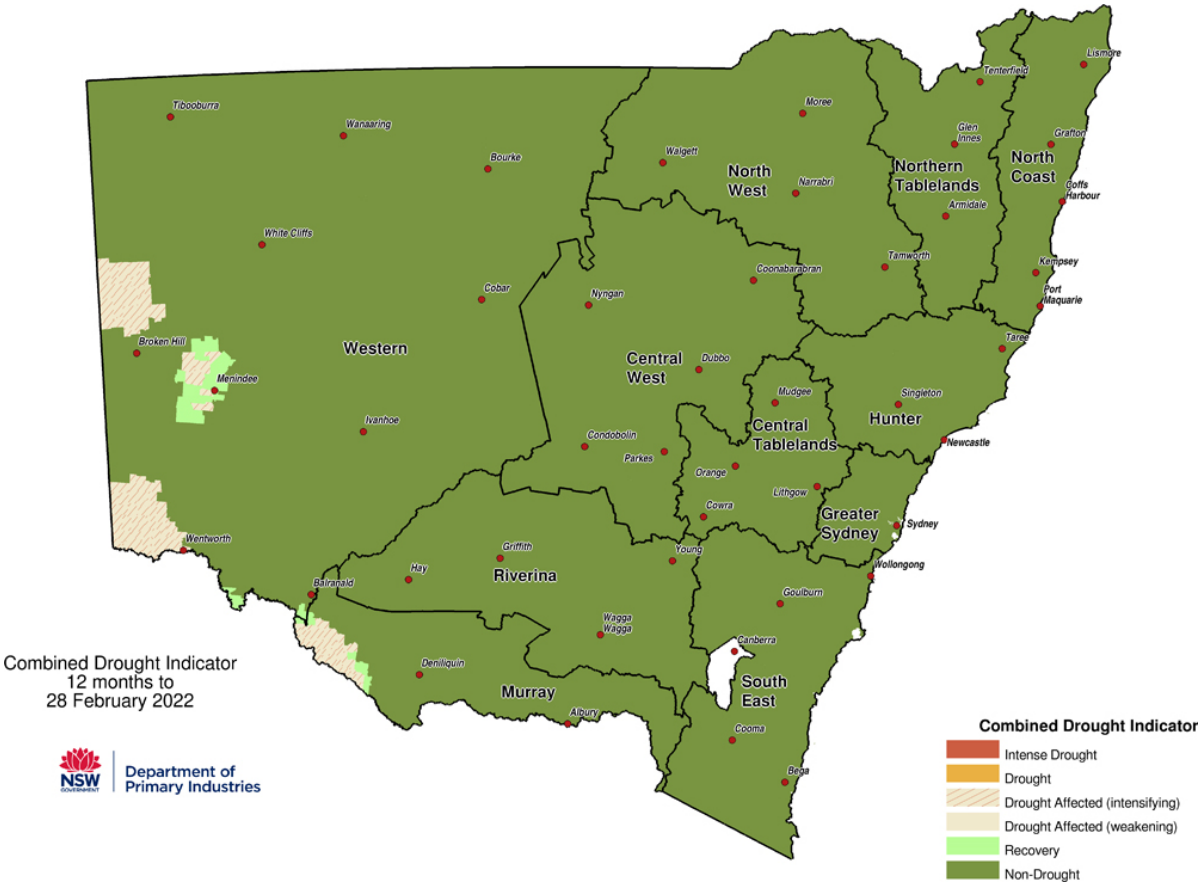

Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 28 February 2022[5]

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

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

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

Days above benchmark concentrations

There were 28 days over the PM10 daily benchmark in summer 2021–22, occurring at Mayfield on one day and Stockton on all 28 days.

There were no days over the PM2.5 daily benchmark in summer 2021–22.

Concentrations of SO_2, NO_2 and NH_3 remained below relevant benchmarks in summer 2021–22.

Table 1 Number of days above the relevant benchmarks – summer 2021–22

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	1	0	0	0	0
Newcastle	0	0	0	0	0
Stockton	28	0	0	0	0
Wallsend	0	0	0	0	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.

Daily time series plots

Daily average time series plots for PM10 and PM2.5 and daily 1–hour maximum plots for NO_2, SO_2 and NH_3 show the concentrations throughout the summer season (Figure 3 to Figure 7).

Levels of PM2.5, NO_2, SO_2 and NH_3 remained below the benchmarks and assessment criteria throughout the season.

PM10 levels remained below the benchmark at most sites, except for one day at Mayfield and 28 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.

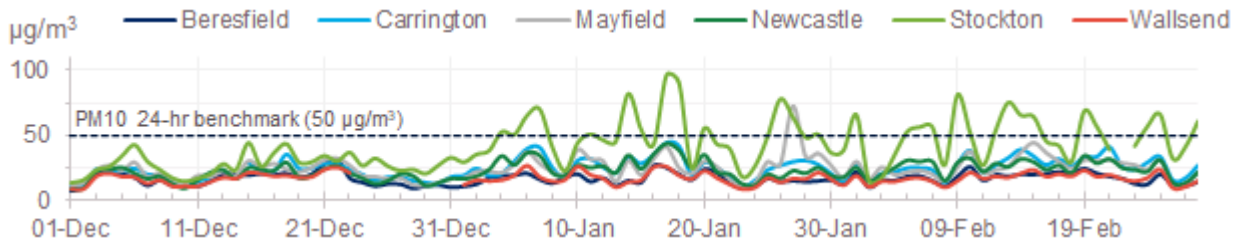

Figure 3 Daily average PM10 during summer 2021–22

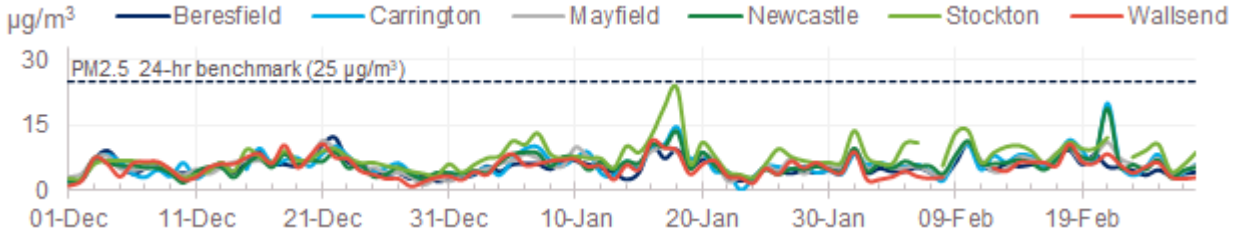

Figure 4 Daily average PM2.5 during summer 2021–22

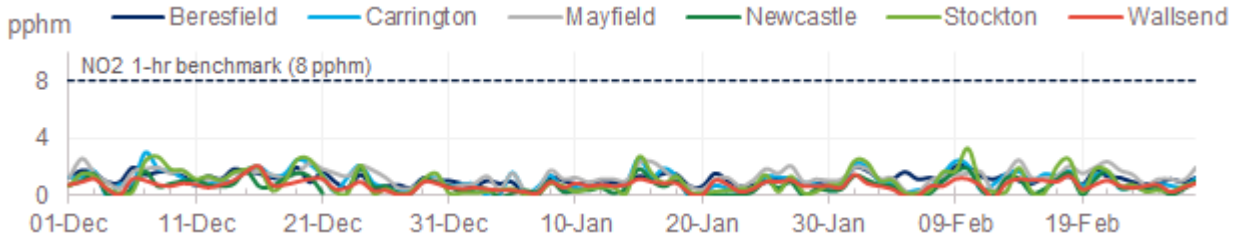

Figure 5 Daily maximum 1-hr NO_2 during summer 2021–22

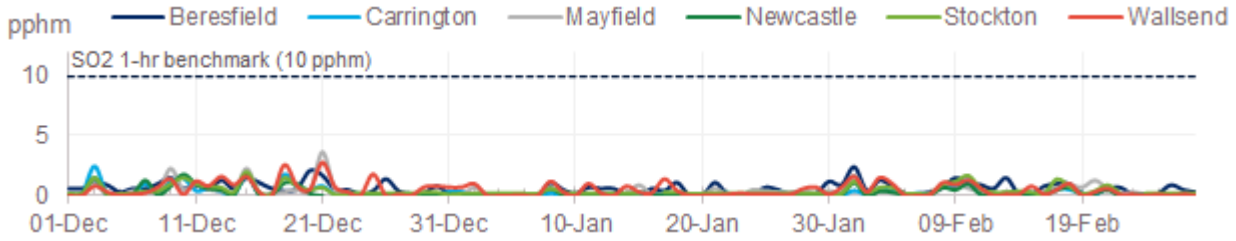

Figure 6 Daily maximum 1-hr SO_2 during summer 2021–22

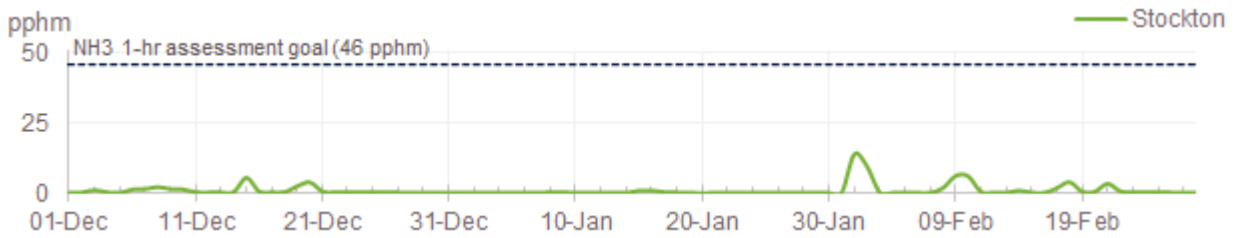

Figure 7 Daily maximum 1-hr NH_3 during summer 2021–22

Pollution roses from hourly particle data

The seasonal pollution rose maps[6] (Figure 8 and Figure 9) show that hourly[7] 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).

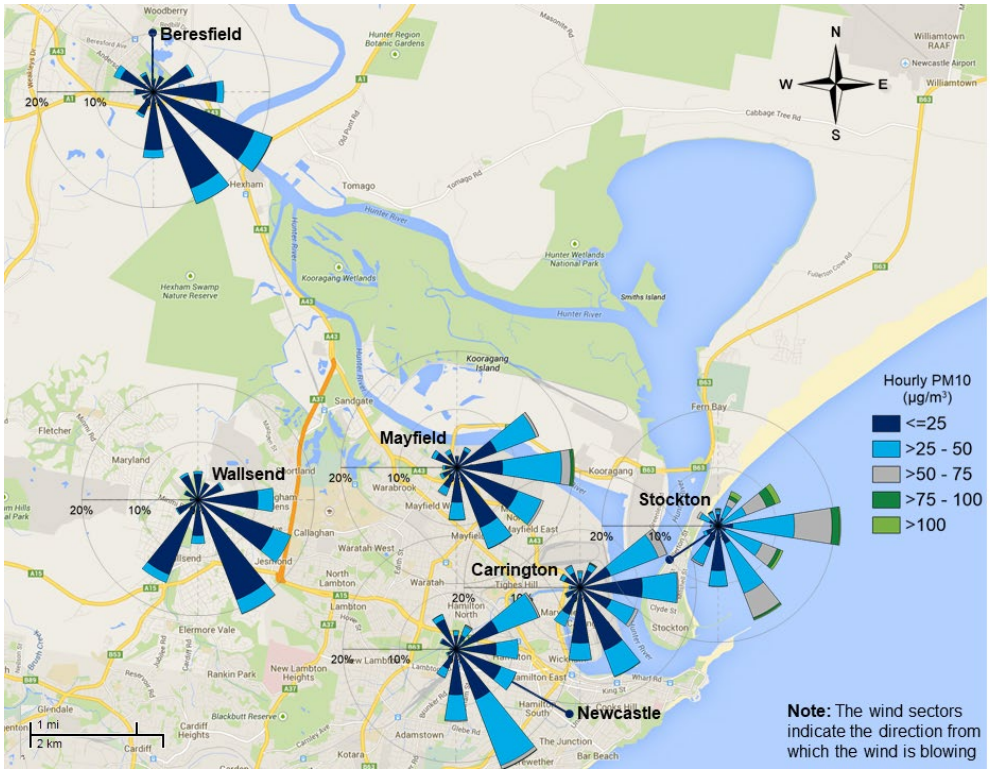

Figure 8 Hourly PM10 pollution roses for the Newcastle region for summer 2021–22

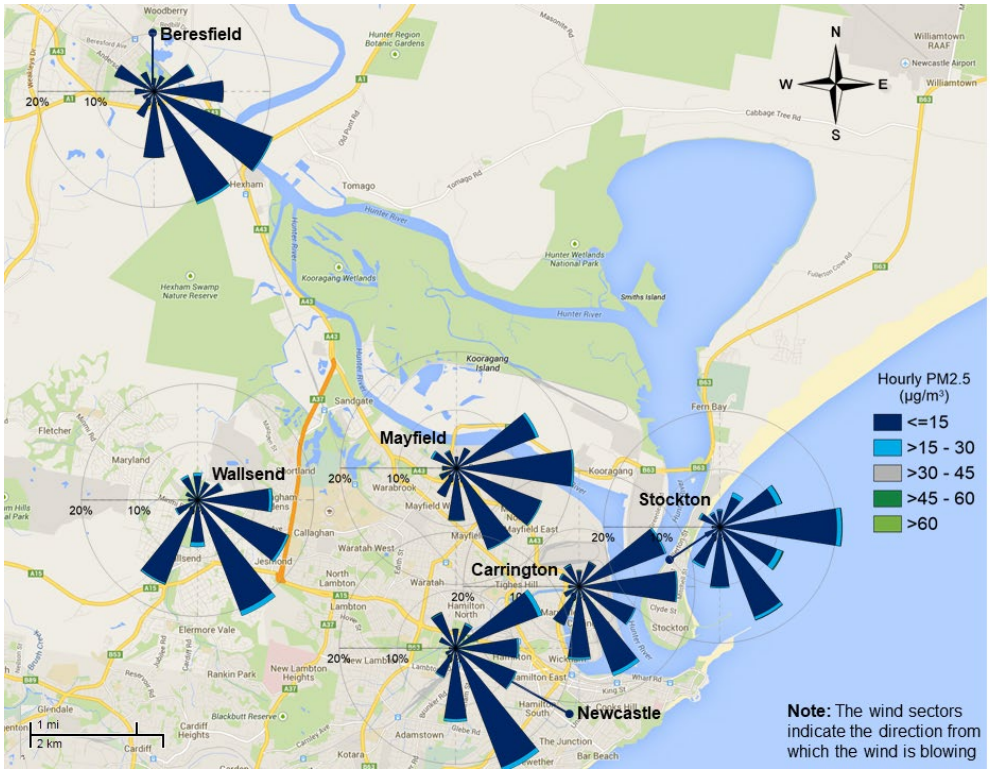

Figure 9 Hourly PM2.5 pollution roses for the Newcastle region for summer 2021–22

[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 summer 2021–22 with previous summer seasons, where data were available[8].

All days were below benchmark concentrations for NO_2 and SO_2 in summer during the past 10 years at Beresfield, Newcastle, Stockton and Wallsend and since monitoring began at Carrington and Mayfield.

For NH_3 at Stockton, there were no days over the assessment criterion in summer during the past 10 years.

There were no days over the PM2.5 daily benchmark during summer 2021–22. This is the same as the previous summer 2020–21. From 2012–13 to 2019–20, the region recorded between zero and 20 days (summer 2019–20) over the PM2.5 daily benchmark. New South Wales was affected by extreme bushfires and dust storms during summer 2019–20.

There were 28 days over the PM10 daily benchmark during summer 2021–22, with no days at Beresfield, Carrington, Newcastle and Wallsend, one day at Mayfield and 28 days at Stockton. This is an increase at Stockton compared to the previous summer 2020–21, when there were 19 days over the benchmark. From 2012–13 to 2019–20, the region recorded between 9 days (summer 2013–14) and 44 days (summer 2019–20) over the PM10 daily benchmark. New South Wales was affected by intense drought conditions and extreme bushfires during summer 2019–20.

Figure 10 Number of days above the PM10 and PM2.5 daily benchmarks: summer 2013 to 2022

[8] Monitoring at Stockton commenced in October 2012 and at Mayfield and Carrington in August 2014. Monitoring of PM2.5 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 summer 2021–22, compared to the daily maximum and minimum PM10 levels (shaded range) from summer 2012–13 to 2020–21, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season and often at the lower levels in December.

Rainfall in Newcastle was average overall during summer, with a wetter February (Figure 13).

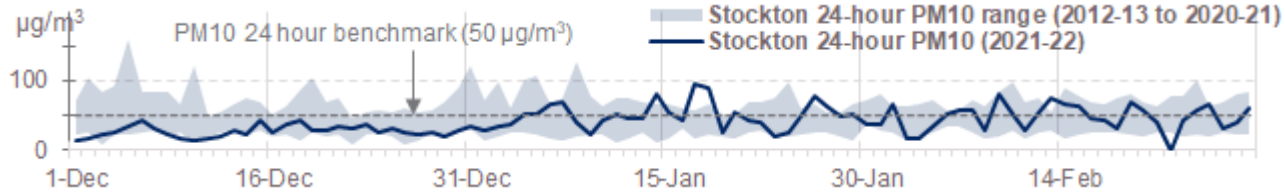

Figure 11 **Stockton daily average PM10 during summer 2021–22 plotted against the daily maximum and minimum PM10 levels from 2013 to 2021**

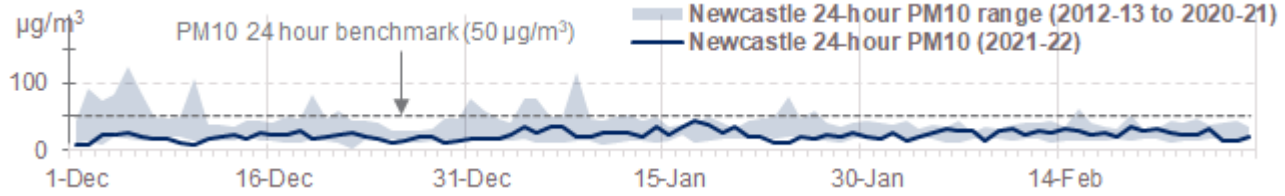

Figure 12 **Newcastle daily average PM10 during summer 2021–22 plotted against the daily maximum and minimum PM10 levels from 2013 to 2021**

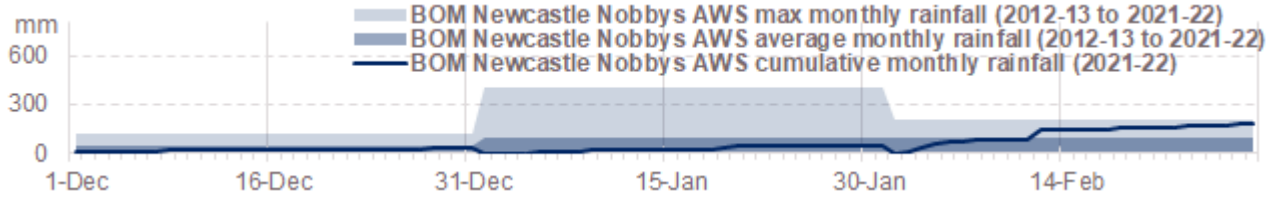

Figure 13 **Bureau of Meteorology Newcastle Nobbys Signal Station AWS[9] cumulative rainfall during summer 2021–22 plotted against maximum and average rainfall from 2013 to 2021**

Figure 14 and Figure 15 show daily average PM2.5 during summer 2021–22, compared to the daily maximum and minimum PM2.5 levels (shaded range) from 2013–14 to 2020–21, at Stockton and Newcastle. Daily PM2.5 levels were generally within the historical range throughout the season, and often at the lower levels.

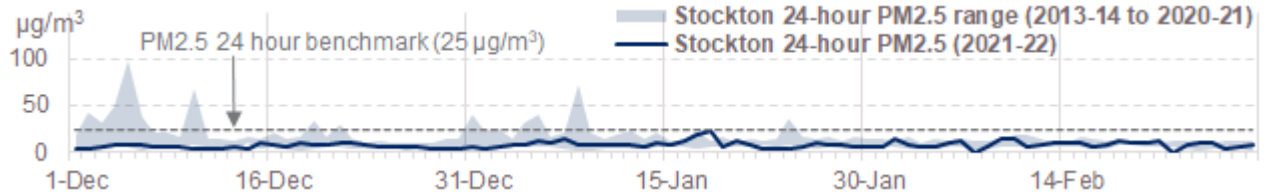

Figure 14 **Stockton daily average PM2.5 during summer 2021–22 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2021**

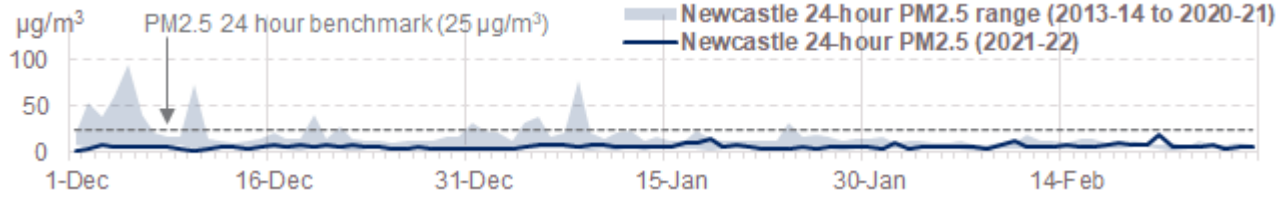

Figure 15 **Newcastle daily average PM2.5 during summer 2021–22 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2021**

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

Meteorological summary

Rainfall[10]

The Newcastle region experienced average rainfall during summer 2021–22 compared to long-term records (Figure 16), with above average rainfall during February 2022.

Summer 2021–22 was drier than summers 2020–21 and 2019–20, with around 50 to 200 millimetres less rain. The season was wetter than summer 2018–19, with around 100 to 200 millimetres more rain.

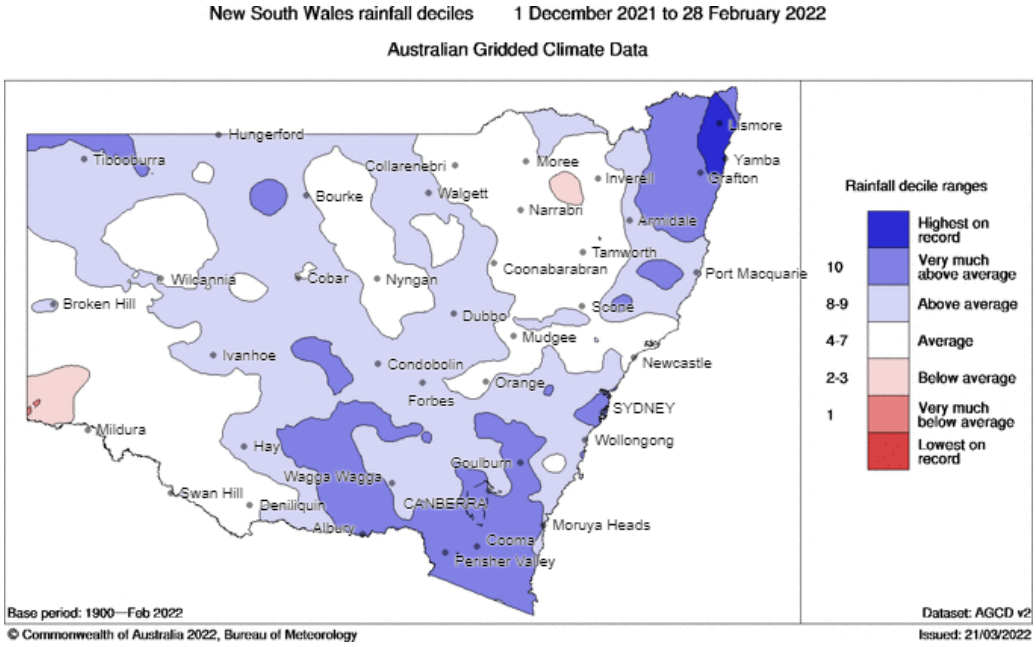

Figure 16 NSW rainfall deciles – summer 2021–22

Temperatures[10]

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

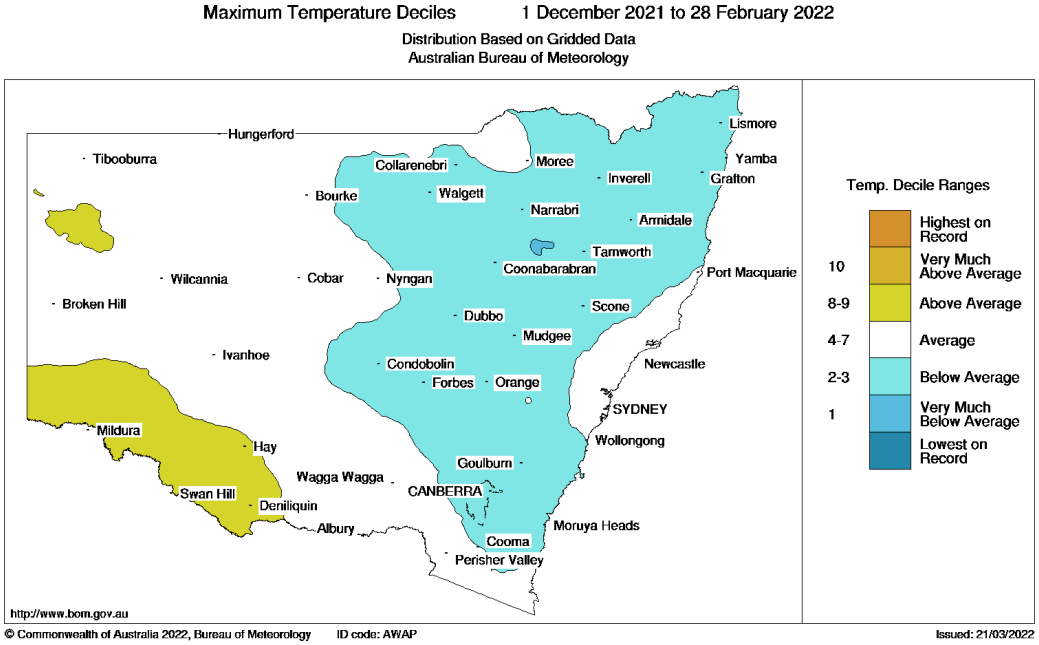

Figure 17 NSW maximum temperature deciles – summer 2021–22

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

Winds

The winds were predominately from north-east to south in the region during summer 2021–22, which was typical for this warmer season. As an example, Figure 18 shows that at Stockton, winds with an easterly component prevailed 64% of the time, with these moderate or stronger (above 5 metres per second) 10% of the time.

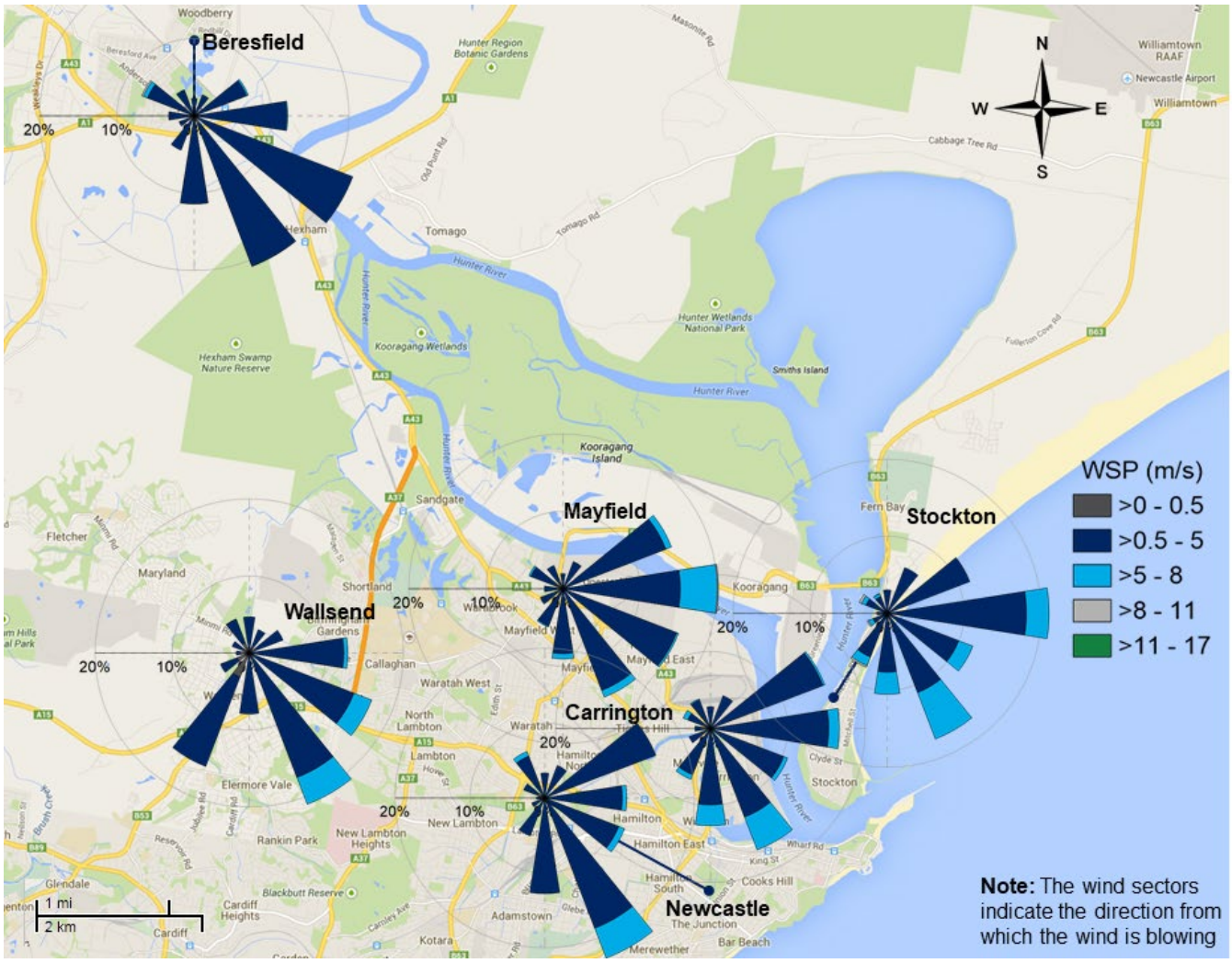

Figure 18 Wind rose map[11] for the Newcastle region for summer 2021–22

[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 summer 2021–22

The Stockton monitoring site recorded 28 days over the PM10 daily benchmark during summer 2021–22 (4–7, 11, 14–15, 17–18, 20, 26–27 and 29 January 2022, and 1, 5–7, 9–10, 12–15, 19–20, 24–25 and 28 February 2022). There were more days over the PM10 daily benchmark in summer 2021–22 compared to summer 2020–21, when there were 19 days over the benchmark. From 2012–13 to 2019–20, Stockton recorded between 9 days (summer 2013–14) and 43 days (summer 2019–20) over the PM10 daily benchmark (Figure 10).

In summer 2021–22, elevated hourly PM10 levels (>75 µg/m^3)[12] were recorded at Stockton 7.5% of the time (Figure 19). These occurred under:

- onshore north-easterly to south-easterly winds 92.5% of the time (148 hours, 6.9% total for summer)
- north-westerly winds 1.9% of the time (11 hours, 0.5% total for summer).

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

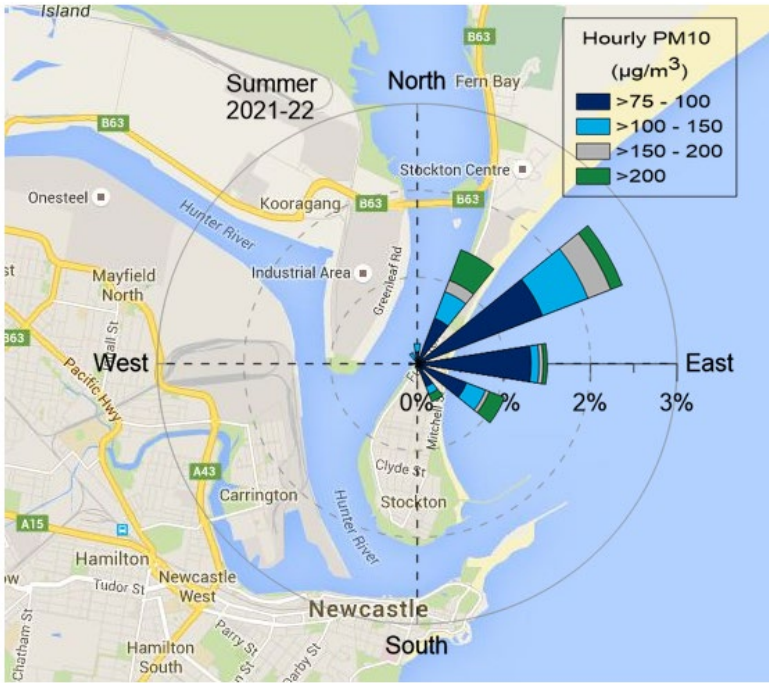

Figure 19 Stockton summer 2021–22 PM10 pollution rose – proportion of hourly averaged PM10 levels >75 µg/m^3 by wind direction

The Stockton monitoring site did not record any days over the PM2.5 daily benchmark during summer 2021–22. This was the same compared to summer 2020–21 (Figure 10). Elevated hours of PM2.5 (>40 µg/m^3)[12] were observed at Stockton 0.4% of the time (8 hours), with the highest portion of these (38%) occurring under north-easterly winds.

[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 NO_2, SO_2 and NH_3, the maximum online time that can be attained is 96% due to 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	Gases NH_3 hourly	Meteorology Wind hourly
Beresfield	100	100	95	91	-	100
Carrington	98	98	95	91	-	94
Mayfield	100	99	95	95	-	94
Newcastle	100	100	91	89	-	100
Stockton	99	98	91	94	94	99
Wallsend	91	97	95	95	-	100

- = not monitored

The reduced online times were mainly due to:

- Wallsend PM10 – instrument fault (8 days)
- Newcastle NO_2 – instrument fault (2 days)
- Carrington wind – instrument fault (5 days)
- Mayfield wind – instrument fault (5 days)

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