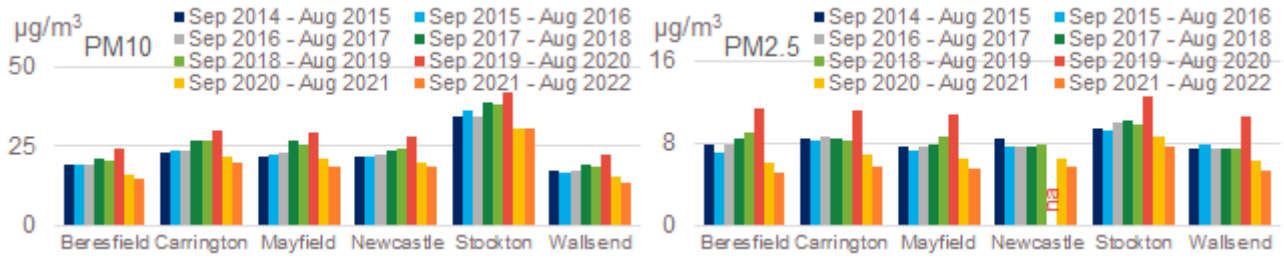
Air quality in Newcastle: Winter 2022

Air quality in the Newcastle region was good during winter 2022. Daily particle levels were within national benchmarks 100% of the time at all stations. Hourly particle levels were in the good to fair air quality categories from 99.9% 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) remained below the 50 µg/m^3 benchmark.
- 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/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[1]. The rolling annual averages are based on the 12-month periods to the end of winter, for 2015 to 2022.



na = rolling annual average unavailable due to insufficient data availability

Figure 1 PM10 and PM2.5 rolling annual averages to end of winter – 2015 to 2022

The comparison in Figure 1 shows that particle levels continued to decrease at most stations in the region during the 12 months to the end of winter 2022, compared to the same 12-month period in previous years (especially compared to the end of winter 2020). Rolling annual average PM10 and PM2.5 levels were below the benchmarks at all stations in the 12 months to the end of winter 2022, except Stockton PM10.

Lower particle levels resulted from wetter than average conditions over the 12-month period. At the end of winter 2022, there were no areas in New South Wales that were drought affected (Figure 2), compared to 7% at the end of winter 2021[2] and 35% at the end of winter 2020[3].

[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.

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

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

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).

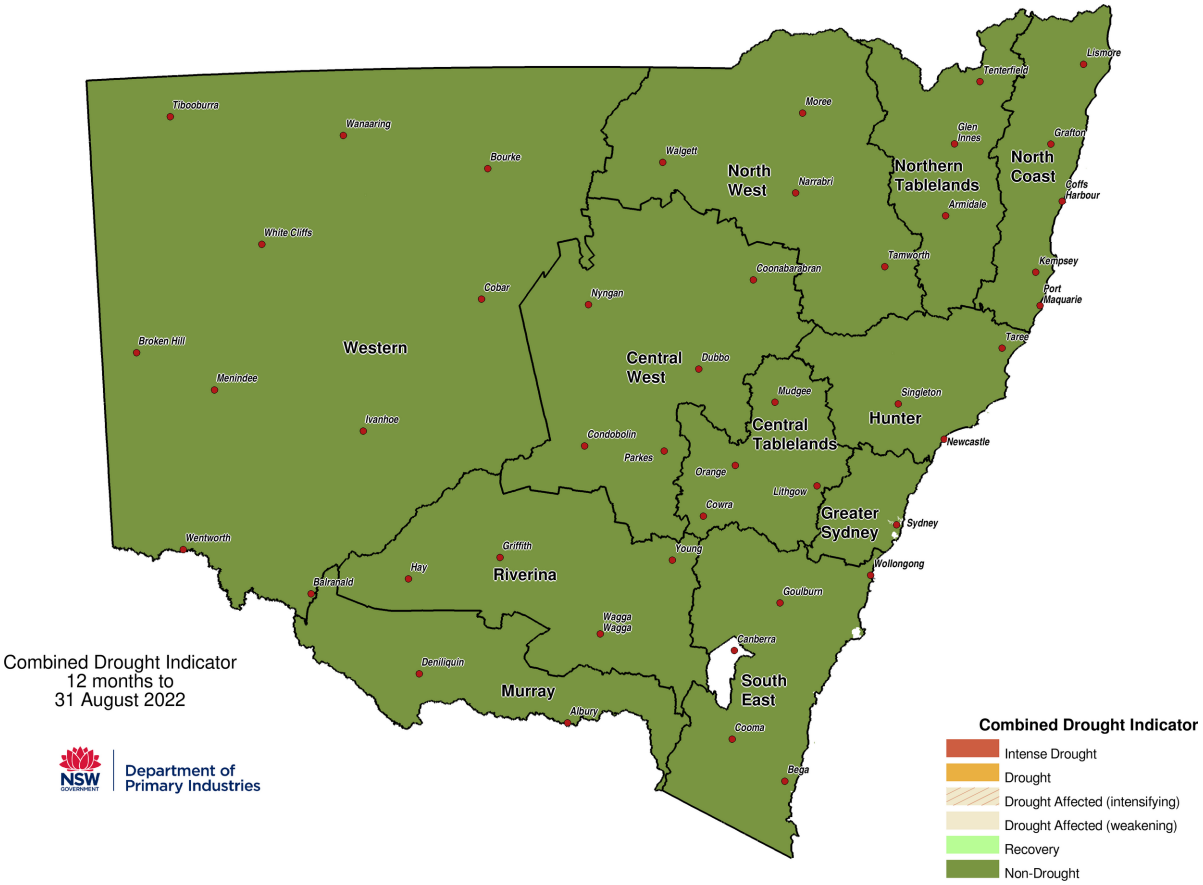


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 August 2022[4]

Days above benchmark concentrations

There were no days over the PM10 and PM2.5 daily benchmark in winter 2022. Concentrations of SO_2, NO_2 and NH_3 remained below relevant benchmarks during the season.

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

Station	PM10 daily [50 µg/m³ benchmark]	PM2.5 daily [25 µg/m³ 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	0	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.

[4] Sourced from Department of Primary Industries NSW State seasonal update – August 2022 (accessed October 2022).

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 winter season (Figure 3 to Figure 7).

All parameters remained below the benchmarks and assessment criteria throughout the season.

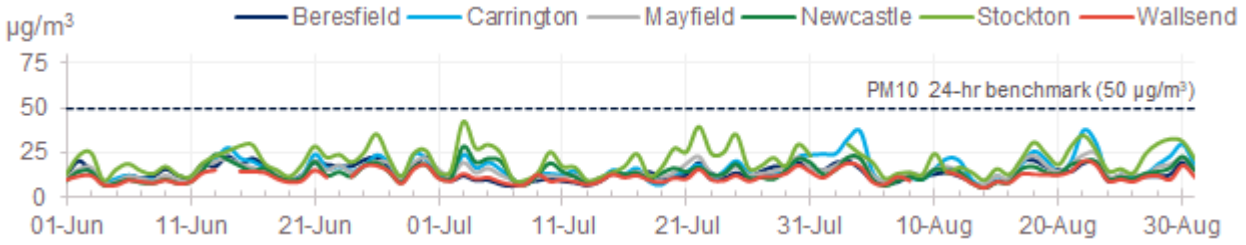


Figure 3 Daily average PM10 during winter 2022

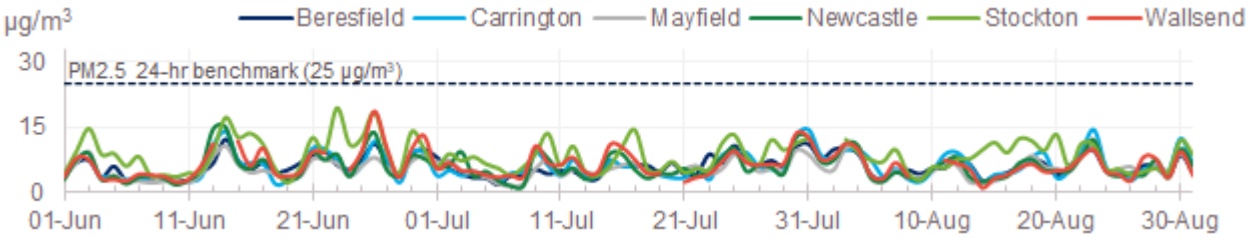


Figure 4 Daily average PM2.5 during winter 2022

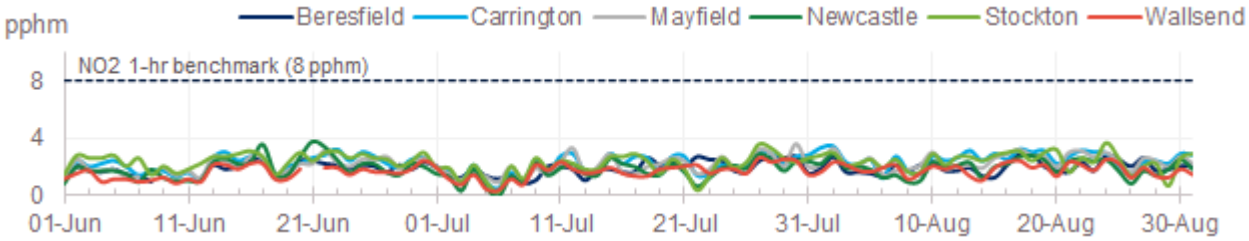


Figure 5 Daily maximum 1-hr NO_2 during winter 2022

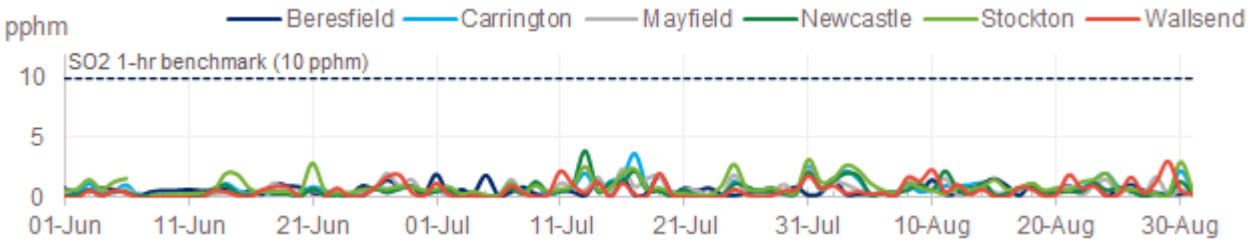


Figure 6 Daily maximum 1-hr SO_2 during winter 2022

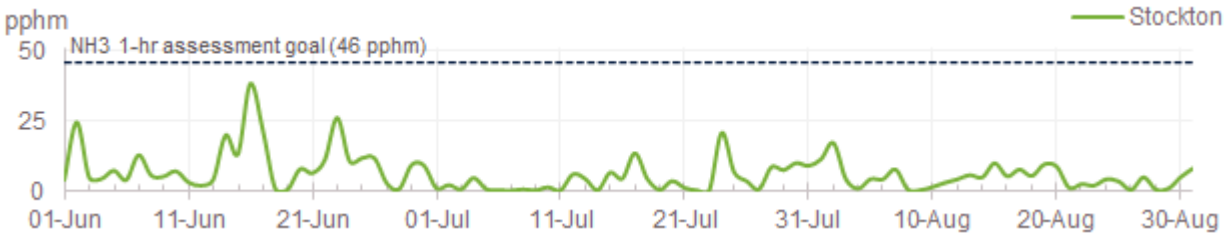


Figure 7 Daily maximum 1-hr NH_3 during winter 2022

Pollution roses from hourly particle data

The seasonal pollution rose maps[5] (Figure 8 and Figure 9) show that hourly[6] PM10 and PM2.5 levels remained low during the season.

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

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

[5] 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.

[6] 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 winter 2022 with previous winter seasons, where data were available[7].

All days were below benchmark concentrations for NO_2 and SO_2 in winter 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 winter during the past 10 years.

There were no days over the PM10 daily benchmark during winter 2022. This is lower than the previous year, with 2 days over the benchmark in winter 2021. From 2013 to 2020, the region recorded between zero days (winters 2013, 2014, 2016 and 2017) and 8 days (winter 2018) over the PM10 daily benchmark.

There were no days over the PM2.5 daily benchmark during winter 2022. This is the same as winter 2021. From 2013 to 2020, the region recorded between zero days (winters 2014, 2016, 2017 and 2018) and 5 days (winter 2015) over the PM2.5 daily benchmark.

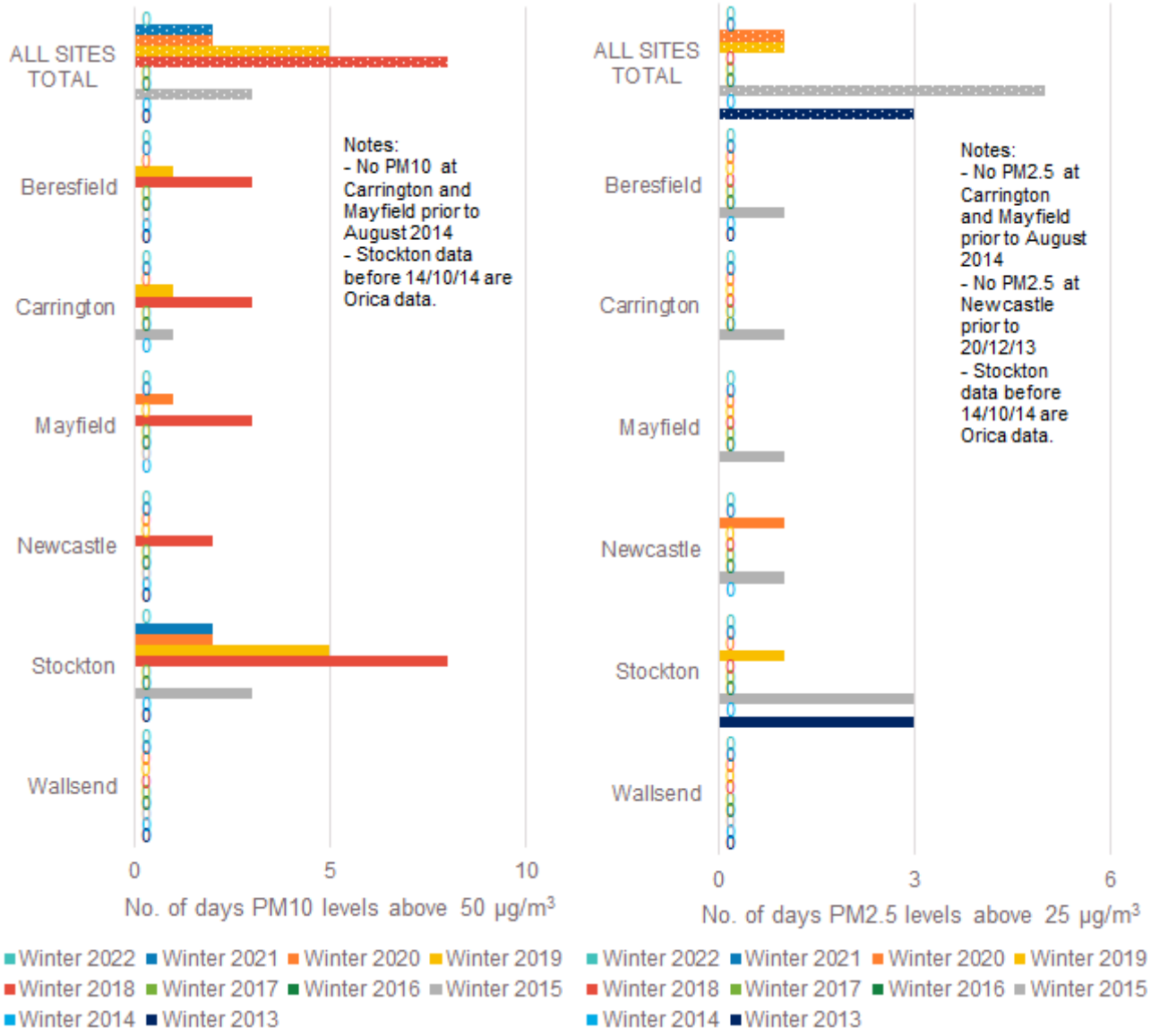


Figure 10 Number of days above the PM10 and PM2.5 daily benchmarks: winter 2013 to 2022

[7] 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 winter 2022, compared to the daily maximum and minimum PM10 levels (shaded range) from 2013 to 2021, at Stockton and Newcastle. Daily PM10 levels were within the historical range throughout the season, and often at the lower levels.

Rainfall in Newcastle was very much above average overall during winter (Figure 13), with dry conditions in June followed by a very wet July.

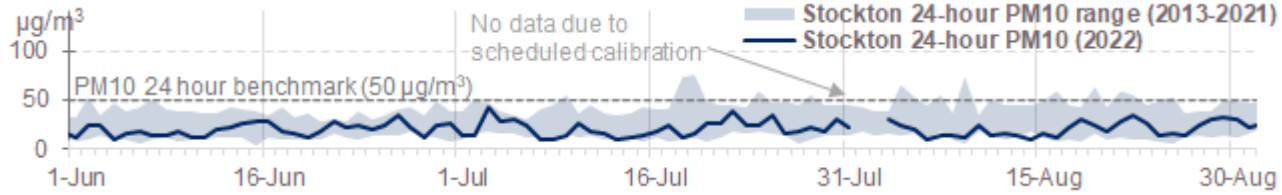


Figure 11 Stockton daily average PM10 during winter 2022 plotted against the daily maximum and minimum PM10 levels from 2013 to 2021

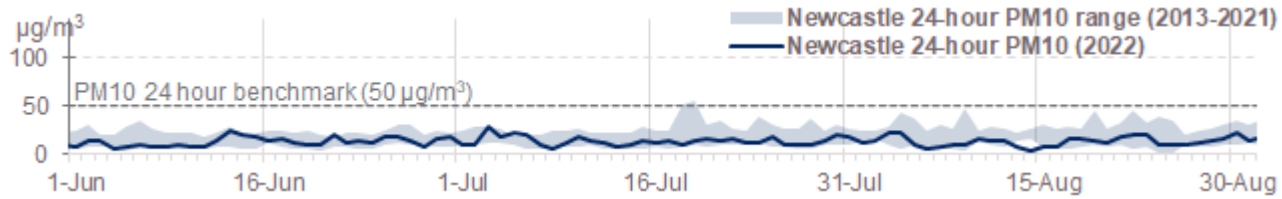


Figure 12 Newcastle daily average PM10 during winter 2022 plotted against the daily maximum and minimum PM10 levels from 2013 to 2021

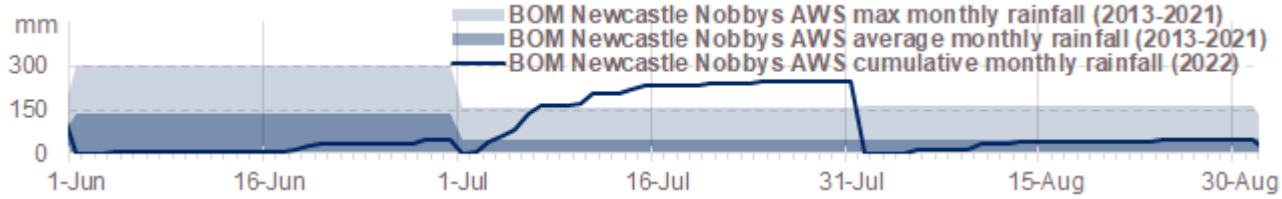


Figure 13 Bureau of Meteorology Newcastle Nobbys Signal Station AWS[8] cumulative rainfall during winter 2022 plotted against maximum and average rainfall from 2013 to 2021

Figure 14 and Figure 15 show daily average PM2.5 during winter 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 within the historical range throughout the season, and often at the lower levels.

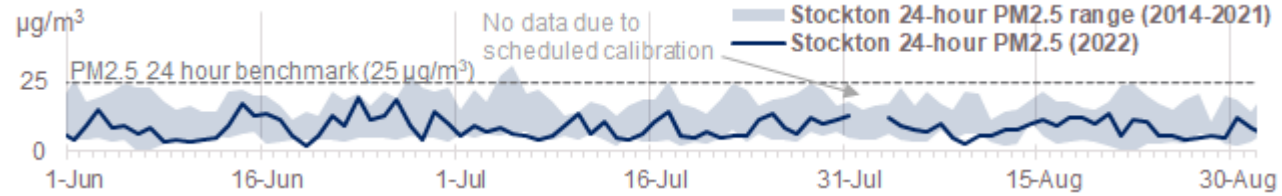


Figure 14 Stockton daily average PM2.5 during winter 2022 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2021

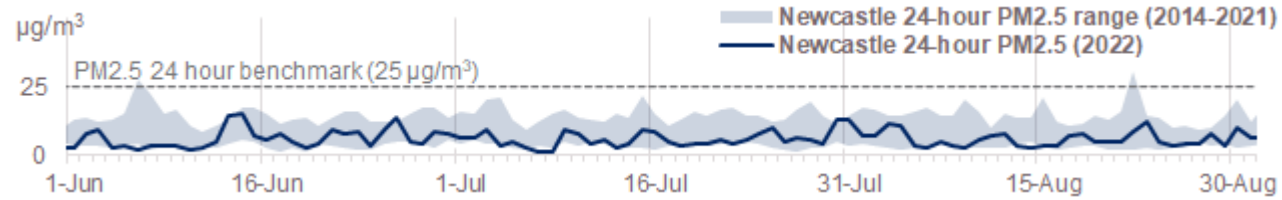


Figure 15 Newcastle daily average PM2.5 during winter 2022 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2021

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

Meteorological summary

Rainfall[9]

The Newcastle region experienced very much above average rainfall overall during winter 2022 compared to long-term records (Figure 16). There was large monthly variability with dry conditions in June, very wet conditions in July, and average rainfall in August.

Winter 2022 was wetter than the previous 3 winters, with 200 to 400 millimetres more rain than winter 2021, 50 to 100 millimetres more than winter 2020, and 100 to 200 millimetres more than winter 2019.

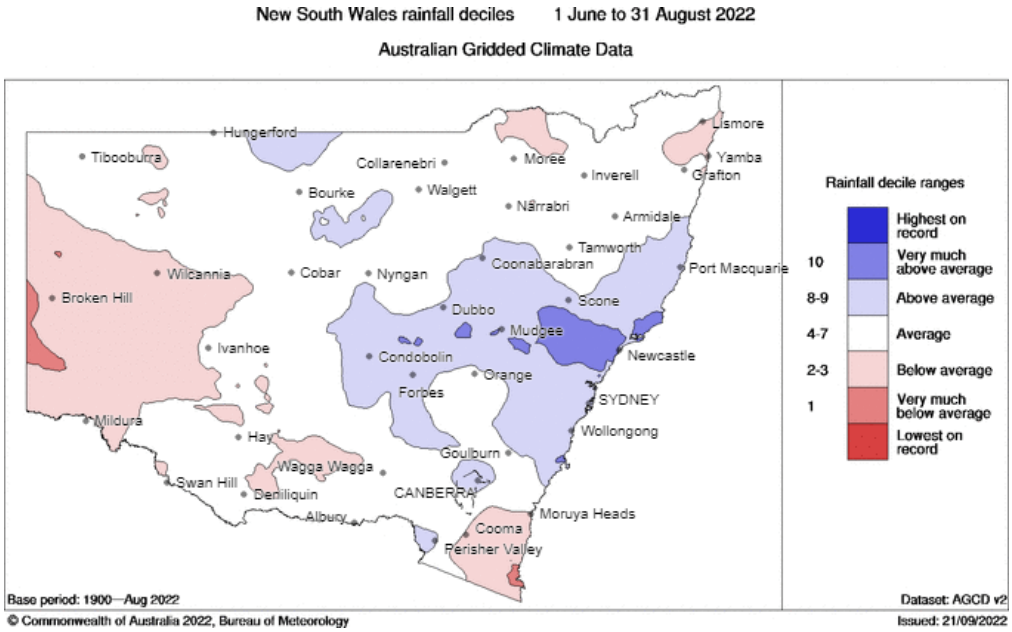


Figure 16 NSW rainfall deciles – winter 2022

Temperatures[9]

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

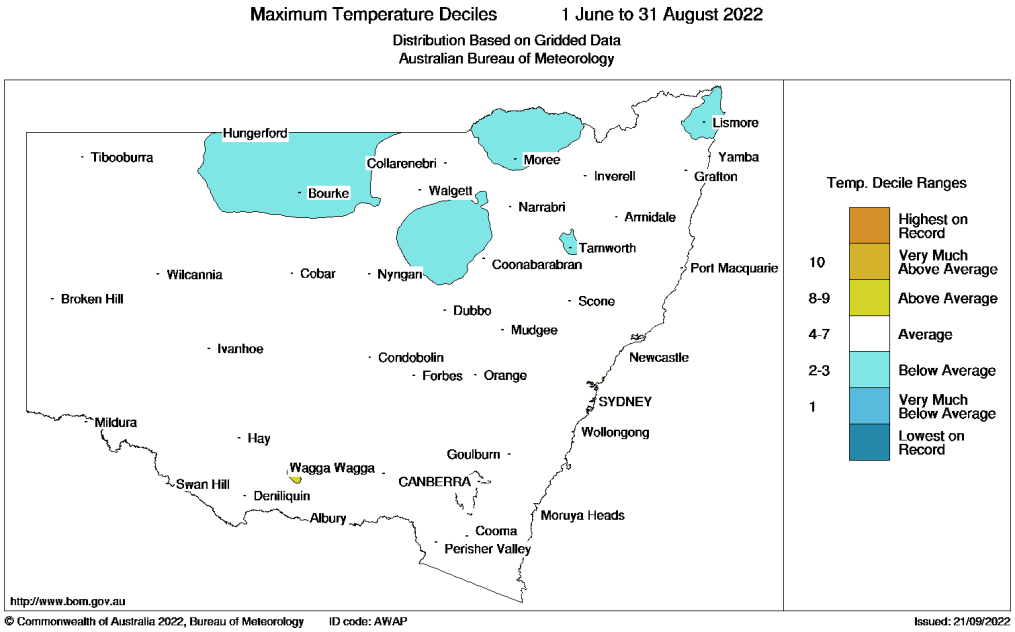


Figure 17 NSW maximum temperature deciles – winter 2022

[9] Rainfall and temperature information is from the Bureau of Meteorology New South Wales winter 2022 climate statement (accessed October 2022) and climate maps (accessed October 2022).

Winds

Winds were predominantly from the north-west region during winter 2022, which was typical for this time of year.

As an example, Figure 18 shows that north-west winds prevailed 42% of the time at Stockton, with these moderate or stronger (above 5 metres per second) 48% of the time.

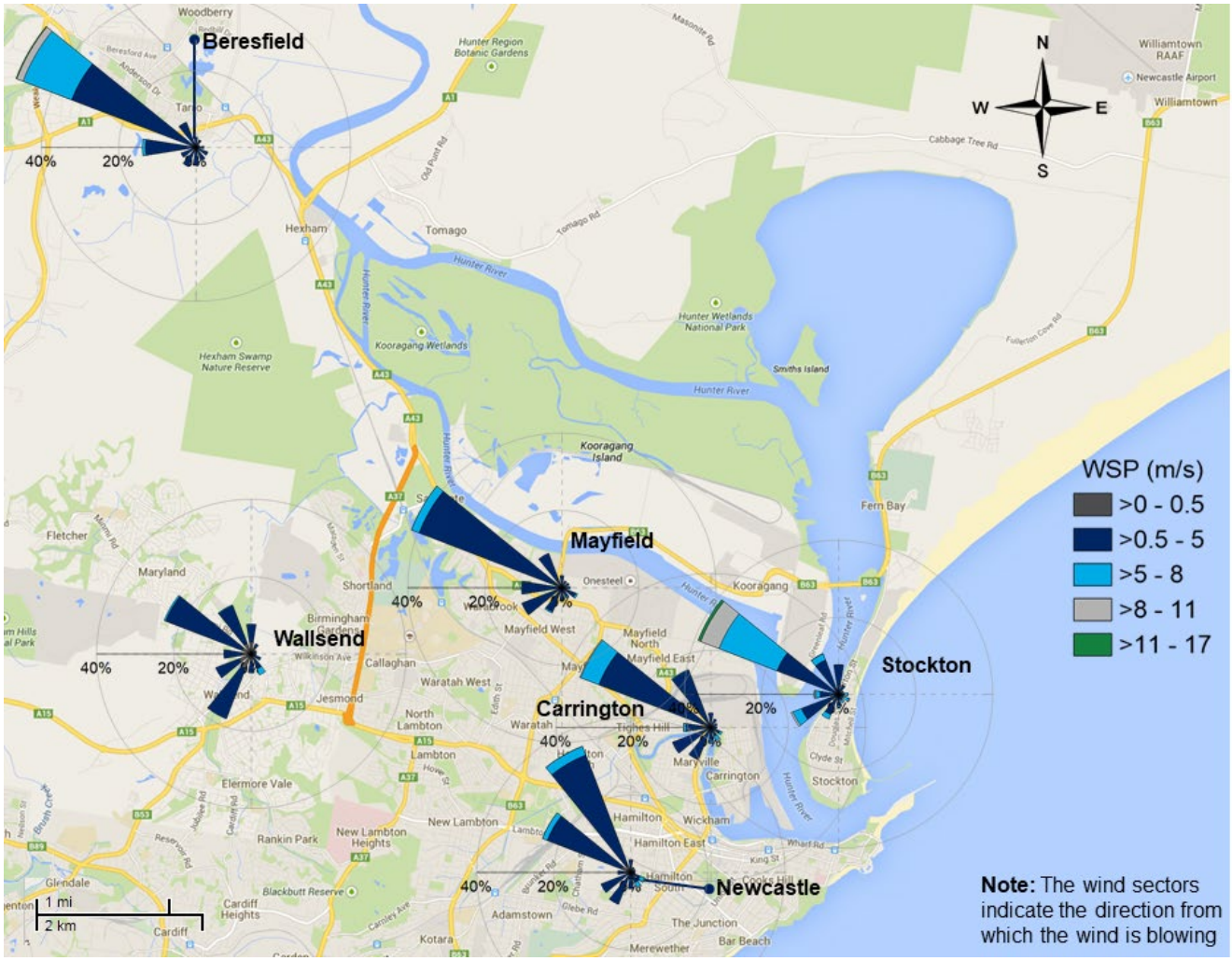


Figure 18 Wind rose map[10] for the Newcastle region for winter 2022

[10] 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 winter 2022

The Stockton monitoring site recorded no days over the PM10 daily benchmark during winter 2022. This is 2 days less than winter 2021. From 2013 to 2020, Stockton recorded between zero days (winters 2013, 2014, 2016 and 2017) and 8 days (winter 2018) over the PM10 daily benchmark (Figure 10).

In winter 2022, elevated hourly PM10 levels (>100 µg/m^3)[11] were recorded at Stockton 0.1% of the time (Figure 19). These occurred under onshore north-easterly to south-easterly winds 67% of the time (2 hours, 0.1% total for winter). There were no hours with elevated hourly PM10 under north-westerly winds.

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.

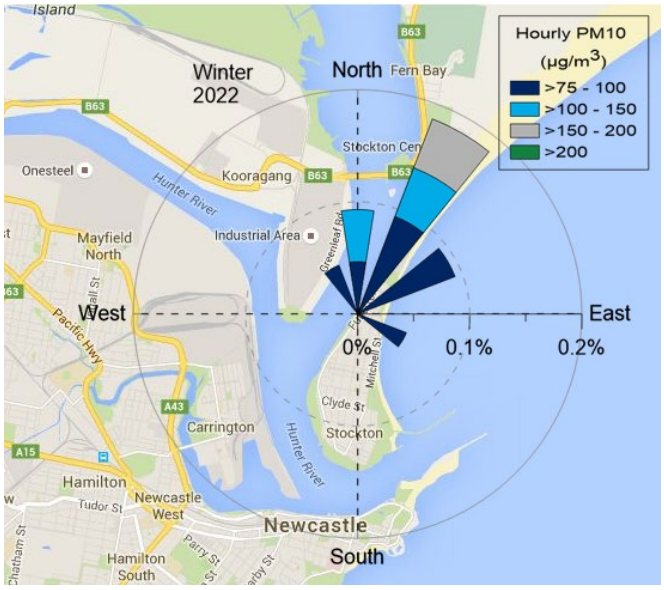


Figure 19 Stockton winter 2022 PM10 pollution rose – proportion of hourly averaged PM10 levels >75 µg/m^3 by wind direction

The Stockton monitoring site did not record any days over the PM2.5 daily benchmark during winter 2022. From 2013 to 2021, there were 3 days over the PM2.5 daily benchmark in the winters 2013 and 2015 and 1 day in winter 2019 (Figure 10). There were no hours with elevated hourly PM2.5 levels (>50 µg/m^3)[11] during winter 2022 (Figure 20).

[11] There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure. The hourly PM10 and PM2.5 thresholds in this section have been updated to make them consistent with the Department of Planning and Environment air quality categories. In previous newsletters, the hourly PM10 threshold reported against was 75 µg/m^3 and the PM2.5 threshold was 40 µg/m^3.

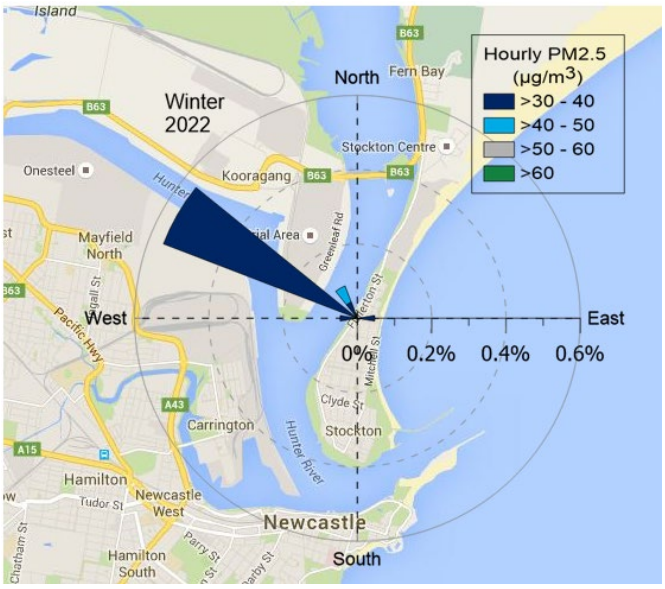


Figure 20 Stockton winter 2022 PM2.5 pollution rose – proportion of hourly averaged PM2.5 levels >30 µg/m^3 by wind direction

Ammonia at Stockton in autumn and winter 2022

There were no days over the hourly NH_3 assessment goal of 46 pphm at Stockton during autumn and winter 2022.

NH_3 levels at Stockton follow a seasonal pattern, with levels increasing in cooler months (when winds are predominantly from the north-west) and decreasing in warmer months (when winds are predominantly onshore easterly) (Figure 21). The primary ammonia source at Stockton is Orica's ammonium nitrate manufacturing facility on Kooragang Island, located to the north-west of the station.

Figure 21 shows that the maximum 1-hour average NH_3 concentrations from 2013 to 2022 were highest in 2013 and lowest in 2016 and 2019.

Figure 22 shows the daily NH_3 1-hour maximum concentrations in 2022, plotted against the daily minimum and maximum levels from 2013 to 2021. This shows that daily 1-hour maximum NH_3 levels in autumn and winter 2022 were generally within the range of the same seasons in earlier years.

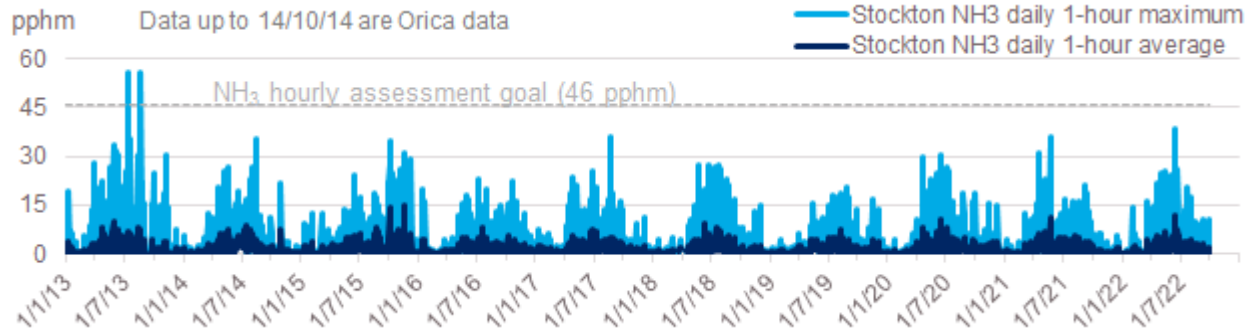


Figure 21 Stockton daily 1-hour maximum and average NH_3 from 2013 to 2022

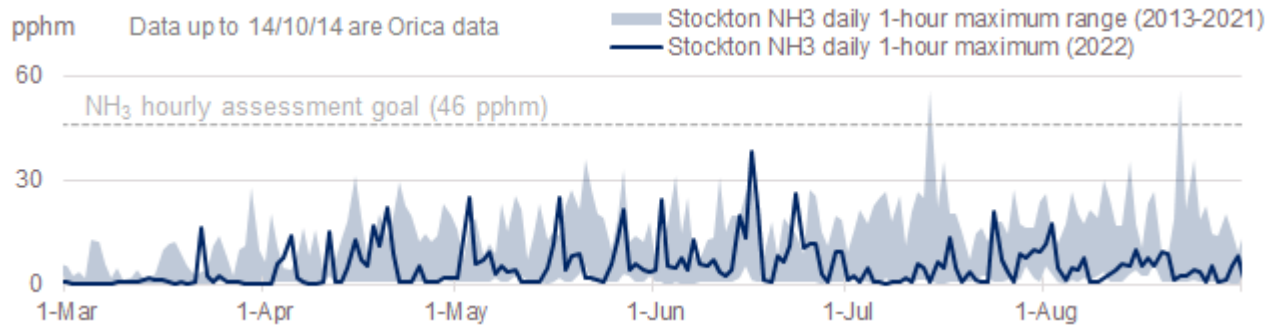


Figure 22 Stockton daily 1-hour maximum NH_3 for autumn and winter 2022 compared to daily levels from autumn and winter 2013 to 2021

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 winter 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	99	99	95	91	-	99
Carrington	96	95	95	95	-	100
Mayfield	100	100	94	94	-	100
Newcastle	100	100	95	95	-	99
Stockton	98	98	94	95	95	99
Wallsend	96	95	93	93	-	99

- = not monitored

This document was prepared by Loredana Warren and reviewed by David Salter and Toan Trieu.

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