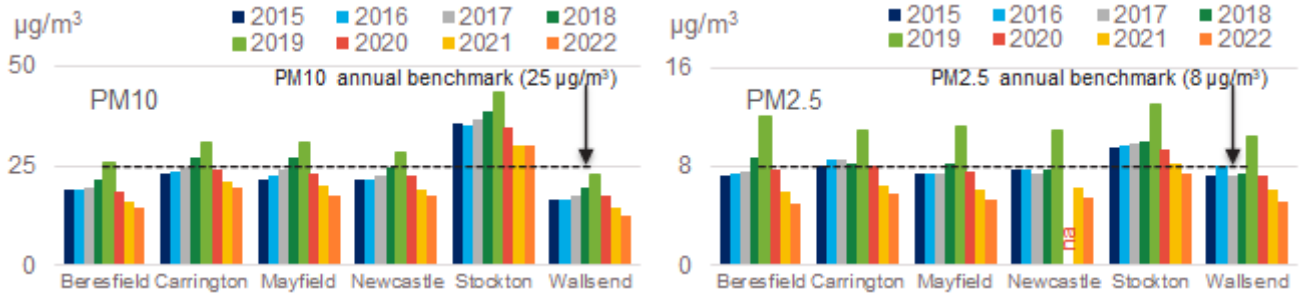
Air quality in Newcastle: Spring 2022

Air quality in the Newcastle region was generally good during spring 2022. Daily particle levels were within national benchmarks from 97% of time at Stockton to 100% of the time at all other stations. Hourly particle levels were in the good to fair air quality categories from 99% at Stockton to 100% of the time at all other stations in the region.

- Levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and ammonia (NH_3) were good, all remaining within national benchmarks and assessment goals.
- Daily average levels of fine particulate matter PM2.5 (particles less than or equal to 2.5 microns in diameter) remained within 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 3 days (8 September, and 6 and 13 October), at Stockton. Regional maximum daily PM10 levels on these days ranged from 56.2 to 57.4 µg/m^3.
  - At Stockton, elevated hourly PM10 levels predominantly occurred under onshore north-easterly to south-easterly winds. 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 below 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.



na = annual average unavailable due to insufficient data availability

Figure 1 PM10 and PM2.5 annual averages – 2015 to 2022

The comparison in Figure 1 shows that particle levels continued to decrease at most stations in 2022. Annual average PM10 and PM2.5 levels were within the benchmarks at all stations in 2022, except Stockton. Levels were the lowest recorded since the establishment of the Newcastle local network, with the exception of Stockton PM10.

Lower particle levels resulted from continuing wet and cooler conditions. At the end of spring 2022, there were no areas in New South Wales that were drought affected (Figure 2), compared to 5% at the end of spring 2021[2] and 10% at the end of spring 2020[3].

[1] Lower Hunter Particle Characterisation Study

[2] Sourced from Department of Primary Industries NSW State seasonal update – November 2021 (accessed February 2023).

[3] Sourced from Department of Primary Industries NSW State seasonal update – November 2020 (accessed February 2023).

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).

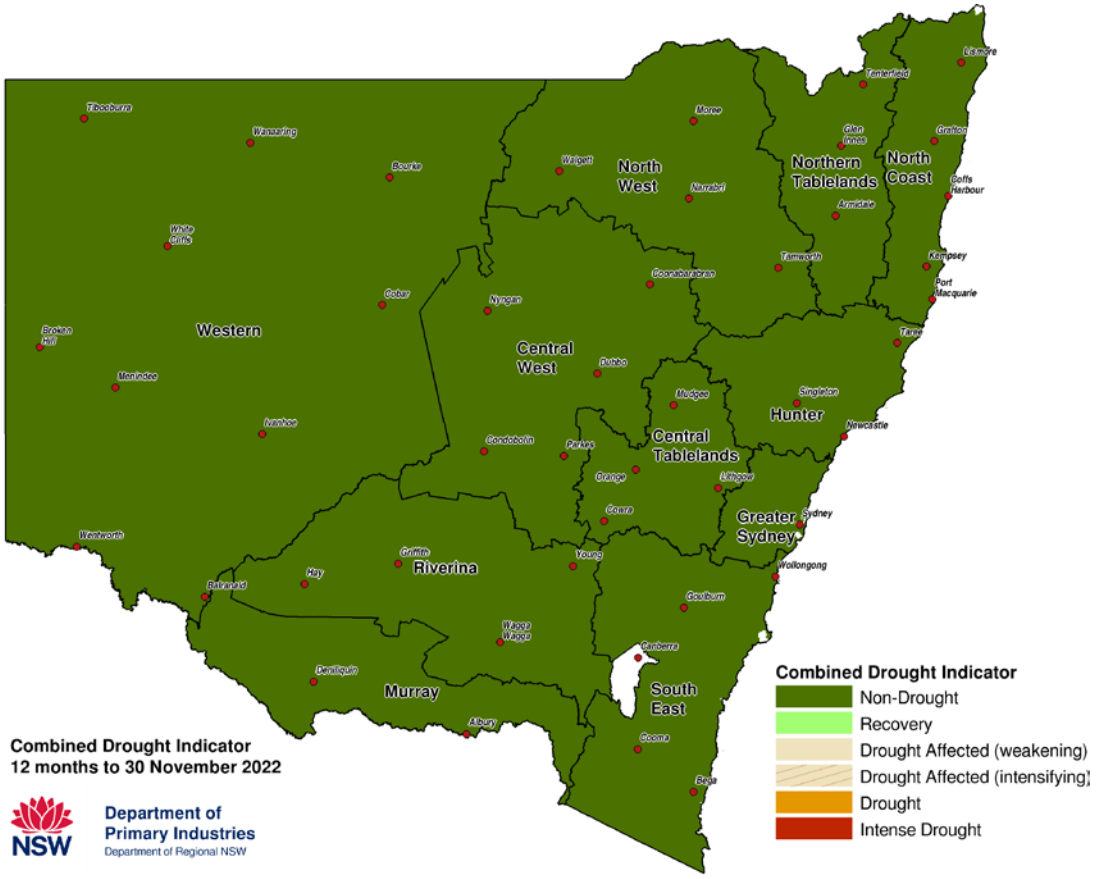


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 30 November 2022[4]

Days above benchmark concentrations

There were 3 days over the PM10 benchmark in spring 2022 at Stockton. Levels of PM2.5, SO_2, NO_2 and NH_3 remained within relevant benchmarks during the season.

Table 1 Number of days above the relevant benchmarks – spring 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	3	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 – November 2022 (accessed February 2023).

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 spring season (Figure 3 to Figure 7).

All parameters remained within the benchmarks and assessment criteria throughout the season, except for Stockton PM10 on 3 days. Stockton PM10 levels were likely affected by sea salt these days due to its proximity to the coast. See Stockton section for further details.

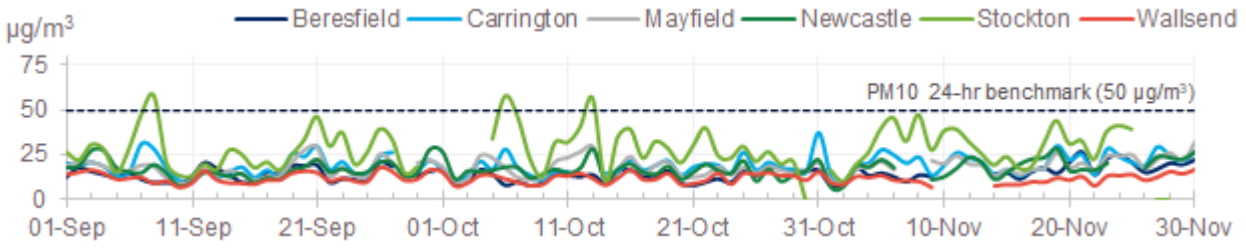


Figure 3 Daily average PM10 during spring 2022

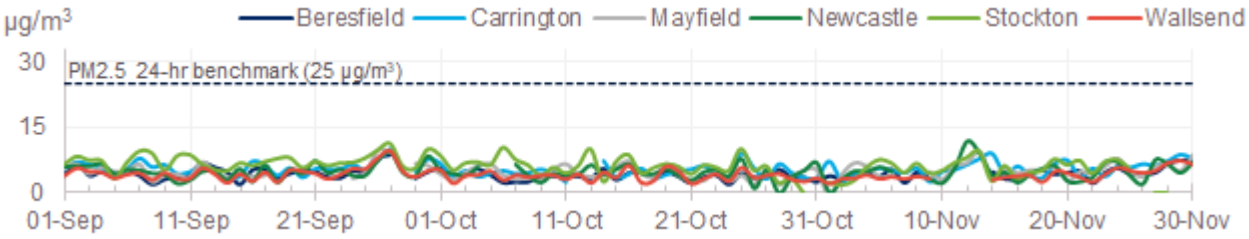


Figure 4 Daily average PM2.5 during spring 2022

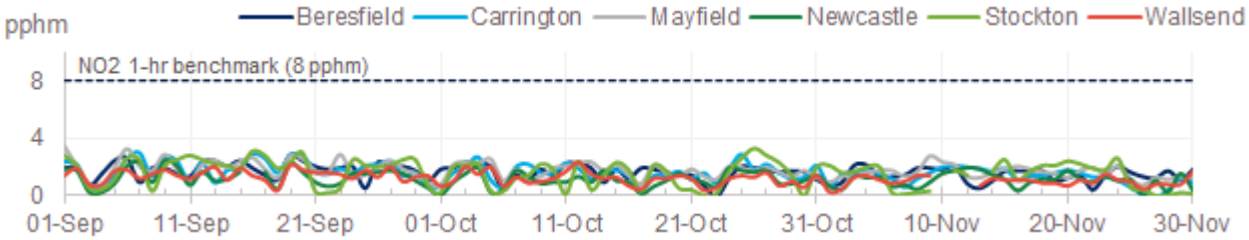


Figure 5 Daily maximum 1-hr NO_2 during spring 2022

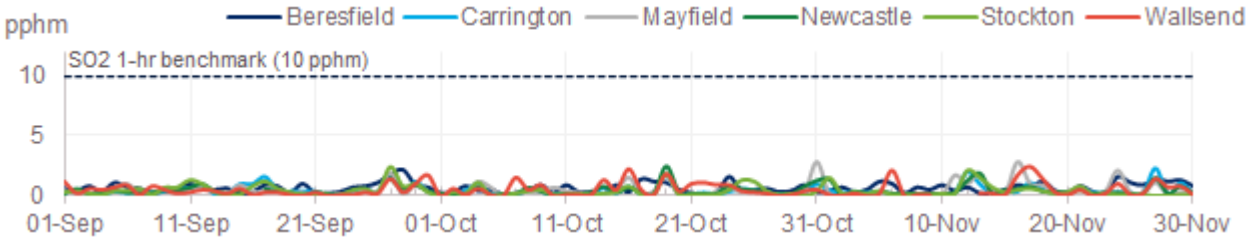


Figure 6 Daily maximum 1-hr SO_2 during spring 2022

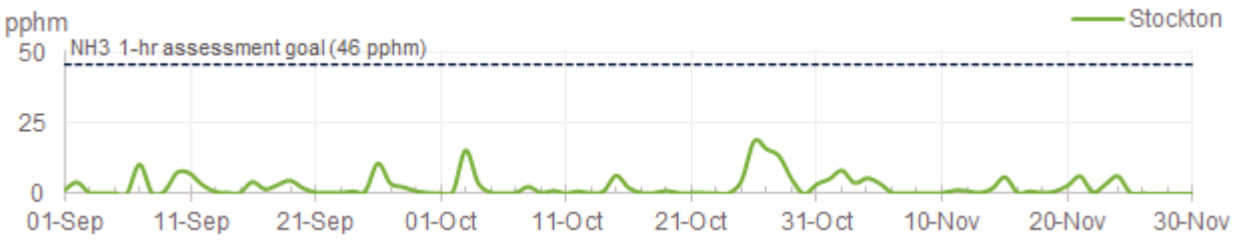


Figure 7 Daily maximum 1-hr NH_3 during spring 2022

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 generally remained low during the season. Stockton recorded some elevated hourly PM10 levels under north-east winds, due predominantly to sea salt (see Stockton section below for more detail).

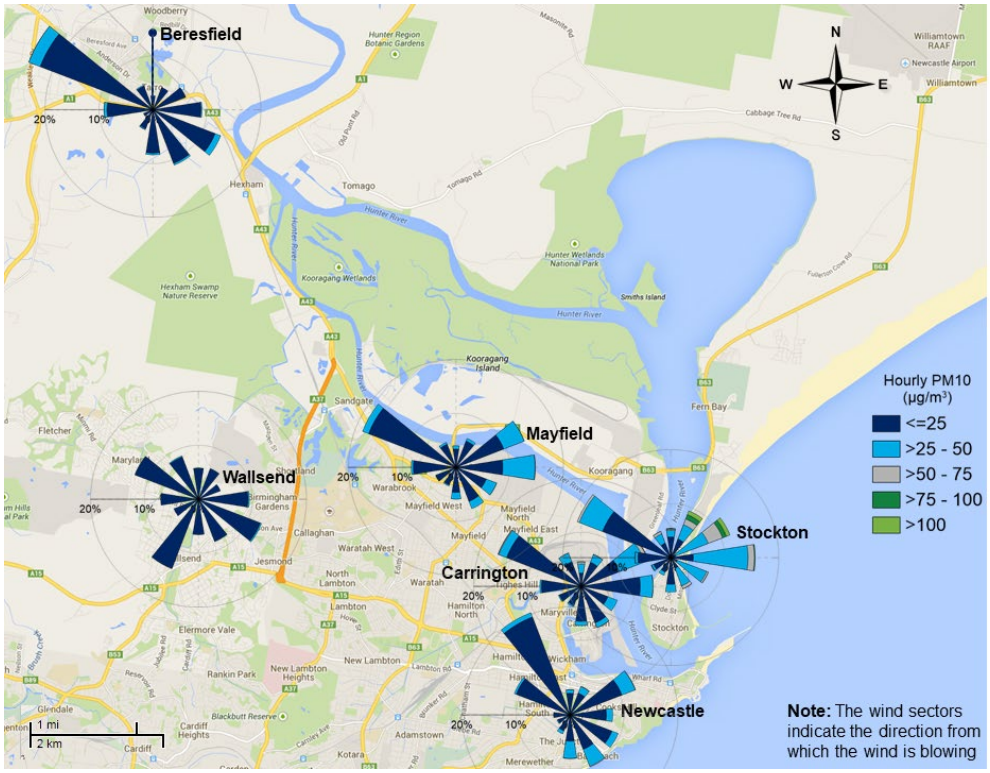


Figure 8 Hourly PM10 pollution roses for the Newcastle region for spring 2022

Figure 9 Hourly PM2.5 pollution roses for the Newcastle region for spring 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 spring 2022 with previous spring seasons, where data were available[7].

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

There were 3 days over the PM10 daily benchmark during spring 2022. This is lower than the previous year, with 6 days over the benchmark in spring 2021. From 2013 to 2020, the region recorded between 6 days (spring 2020) and 42 days (spring 2019) over the PM10 daily benchmark.

There were no days over the PM2.5 daily benchmark during spring 2022. This is the same as spring 2021. From 2013 to 2020, the region recorded between zero days (springs 2015 and 2020) and 20 days (spring 2019) over the PM2.5 daily benchmark.

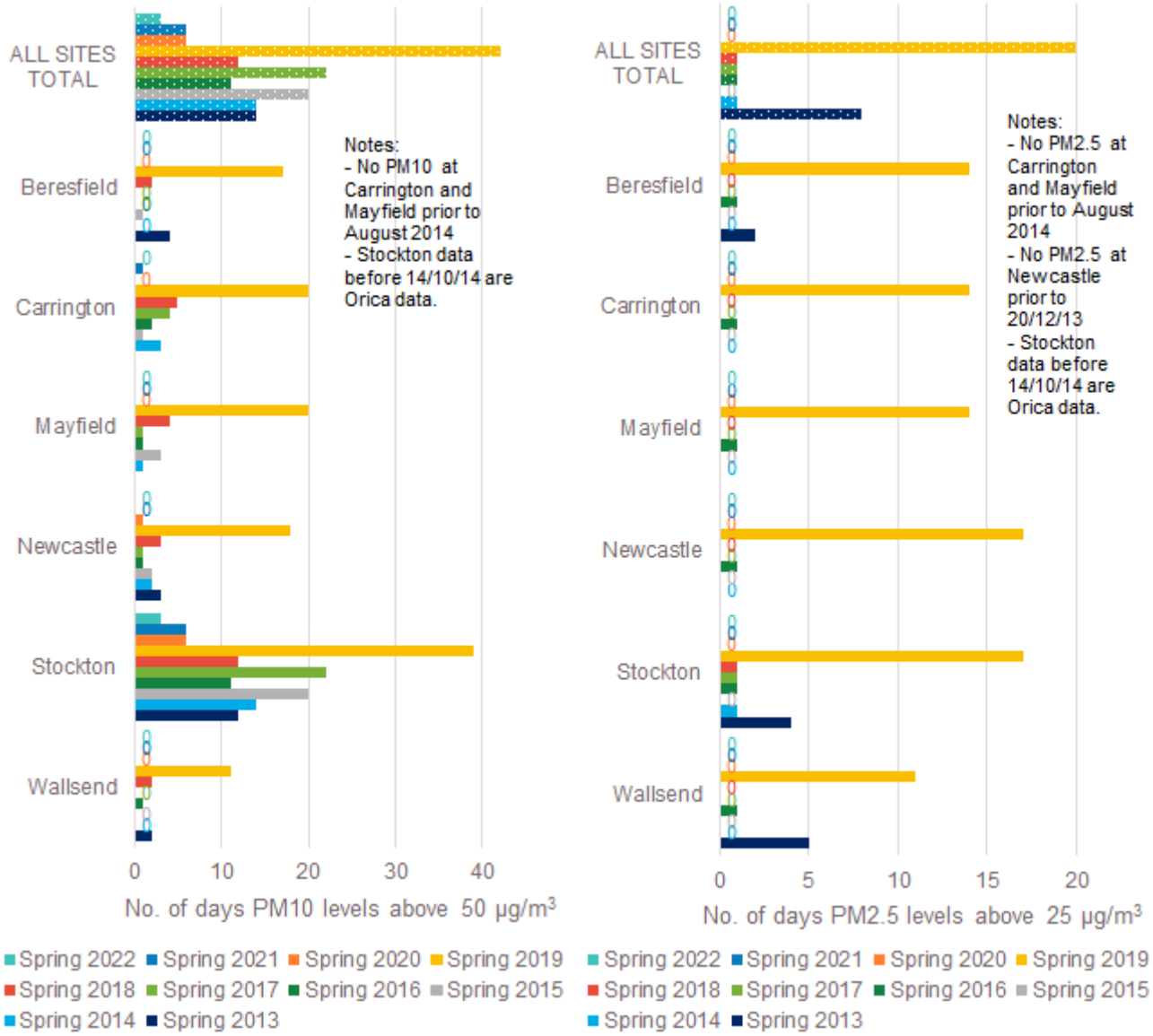


Figure 10 Number of days above the PM10 and PM2.5 daily benchmarks: spring 2013 to 2022

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

Rainfall in Newcastle was average overall during spring (Figure 13), with wetter conditions in September and October.

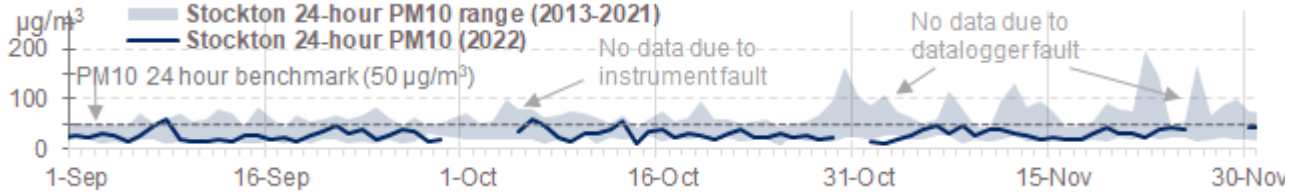


Figure 11 Stockton daily average PM10 during spring 2022 plotted against the daily maximum and minimum PM10 levels from 2013 to 2021

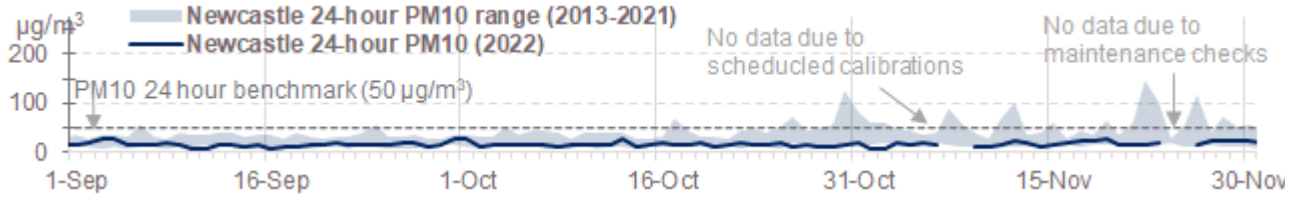


Figure 12 Newcastle daily average PM10 during spring 2022 plotted against the daily maximum and minimum PM10 levels from 2013 to 2021

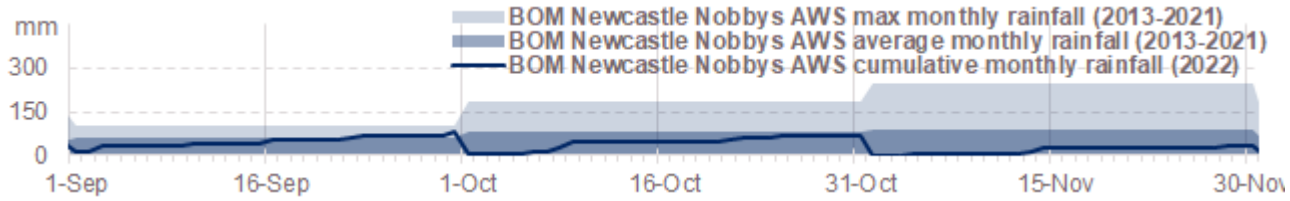


Figure 13 Bureau of Meteorology Newcastle Nobbys Signal Station AWS[8] cumulative rainfall during spring 2022 plotted against maximum and average rainfall from 2013 to 2021

Figure 14 and Figure 15 show daily average PM2.5 during spring 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.

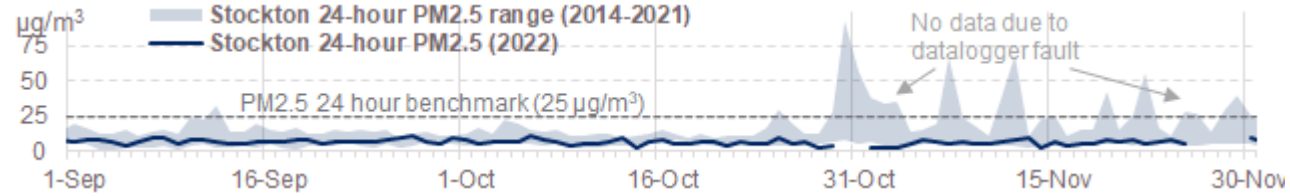


Figure 14 Stockton daily average PM2.5 during spring 2022 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2021

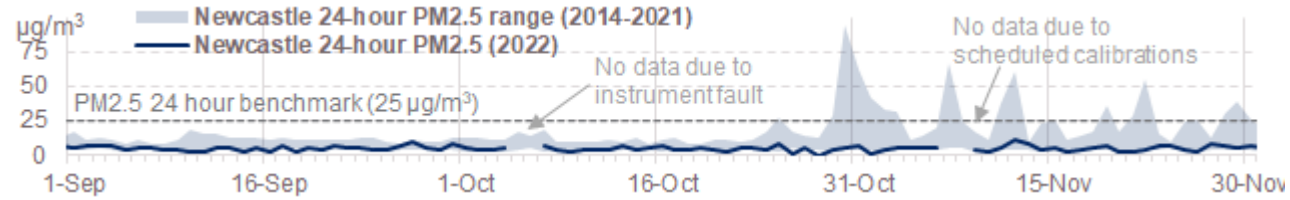


Figure 15 Newcastle daily average PM2.5 during spring 2022 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2021

[8] Data from Bureau of Meteorology Newcastle Nobbys Signal Station AWS monthly rainfall page (accessed February 2023).

Meteorological summary

Rainfall[9]

The Newcastle region experienced average rainfall during spring 2022 compared to long-term records (Figure 16). Monthly rainfall levels during September and October were above average.

Spring 2022 was drier than spring 2021 with 50 to 200 millimetres less rain; similar to spring 2020; and wetter than spring 2019 with 50 to 100 millimetres more rain.

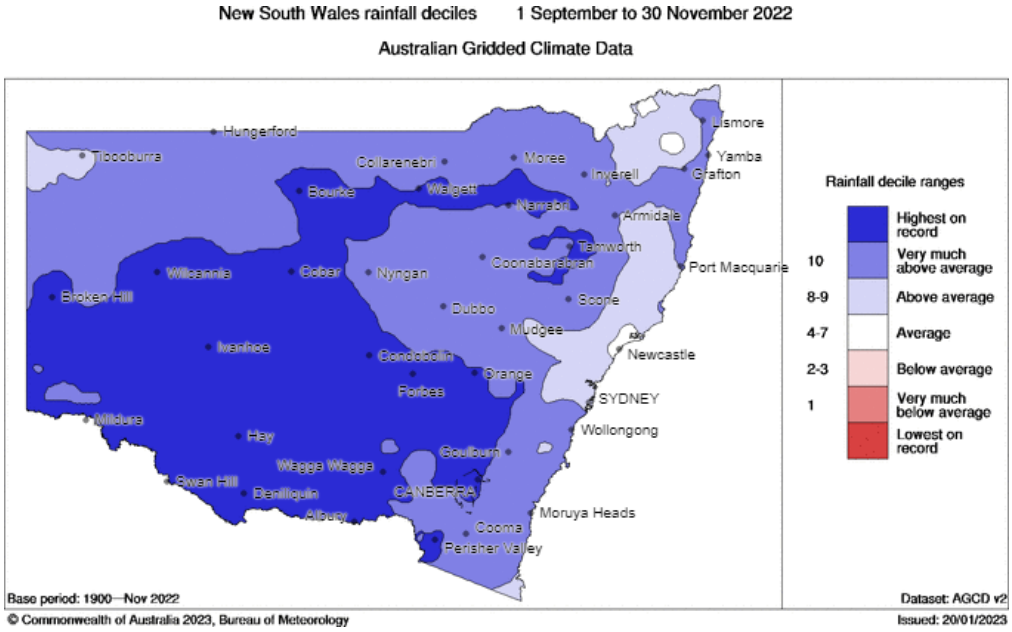


Figure 16 NSW rainfall deciles – spring 2022

Temperatures[9]

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

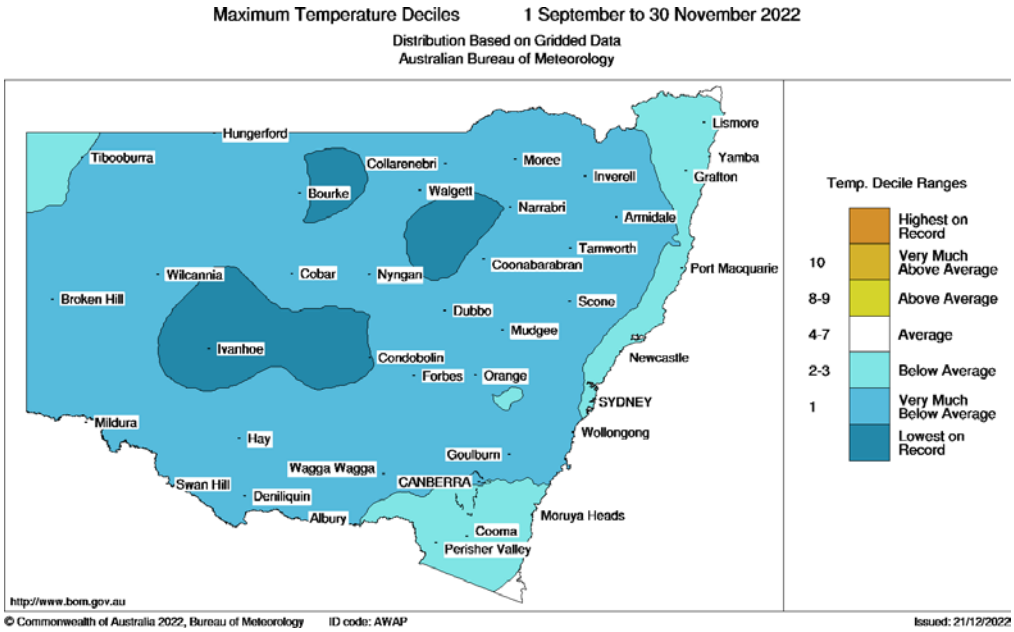


Figure 17 NSW maximum temperature deciles – spring 2022

[9] Rainfall and temperature information is from the Bureau of Meteorology New South Wales spring 2022 climate statement (accessed February 2023) and climate maps (accessed February 2023).

Winds

Winds were variable in the region during spring 2022, which was typical for this transitional season, where predominant winds change from north-westerly in winter to south-easterly in summer.

As an example, Figure 18 shows that north-west winds prevailed 19% of the time at Stockton, with these moderate or stronger (above 5 metres per second) 52% of the time.

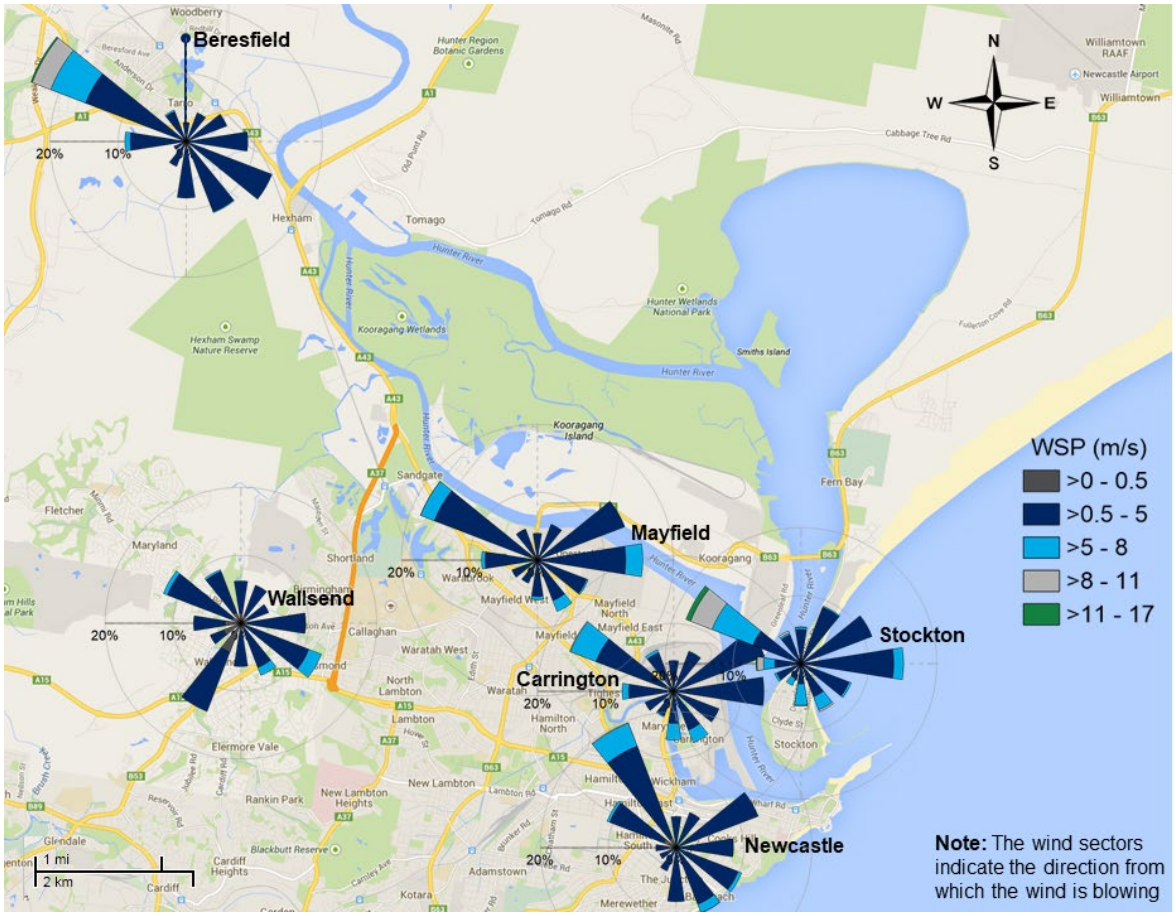


Figure 18 Wind rose map[10] for the Newcastle region for spring 2022

[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 spring 2022

The Stockton monitoring station recorded 3 days over the PM10 daily benchmark during spring 2022 (8 September, and 6 and 13 October). This is the lowest number of days over the PM10 benchmark during spring since Orica began monitoring in October 2012. In comparison, there were 6 days over the PM10 benchmark in spring 2021. From 2013 to 2020, Stockton recorded between 6 days (spring 2020) and 39 days (spring 2019) over the PM10 daily benchmark (Figure 10).

In spring 2022, elevated hourly PM10 levels (>100 µg/m^3)[11] were recorded at Stockton 1.6% of the time (Figure 19). These occurred under onshore north-easterly to south-easterly winds 93% of the time (66 hours, 3.4% total for spring). 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 station under onshore winds.

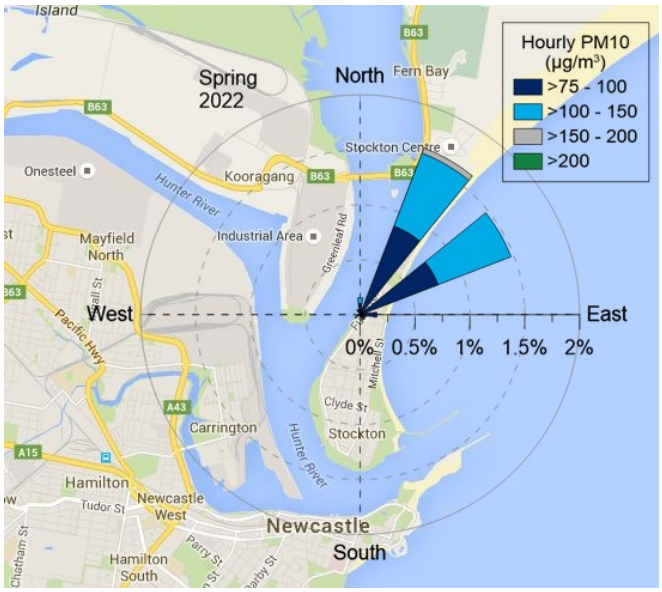


Figure 19 Stockton spring 2022 PM10 pollution rose – proportion of hourly averaged PM10 levels >75 µg/m^3 by wind direction

The Stockton monitoring station did not record any days over the PM2.5 daily benchmark during spring 2022. From 2013 to 2021, there were from zero days (springs 2015, 2020 and 2021) to 17 days (spring 2019) over the PM2.5 daily benchmark (Figure 10). There were no hours with elevated hourly PM2.5 levels (>50 µg/m^3)[11] during spring 2022. The maximum hourly PM2.5 level was 29.6 µg/m^3.

[11] 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 spring 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	96	96	91	87	-	98
Carrington	97	97	94	91	-	99
Mayfield	97	90	95	95	-	97
Newcastle	96	96	89	92	-	100
Stockton	88	93	90	88	90	95
Wallsend	96	96	91	91	-	99

- = not monitored

The reduced online times were mainly due to:

- Stockton all parameters – datalogger fault (6 days), PM10 instrument fault (5 days) and NO_2 calibration checks (1 day)
- Mayfield PM2.5 – instrument fault (6 days), system fault (1 day) and scheduled calibrations (2 days)
- Newcastle SO_2 – instrument fault (4 days)
- Beresfield NO_2 – instrument faults (5 days)

This document was prepared by Loredana Warren and reviewed by Margaret Haak and David Salter.

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Ph: 131 555 Email: info@environment.nsw.gov.au; Web: www.environment.nsw.gov.au

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