DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

Air Quality Monitoring Plan for the Lower Hunter Region 2021–25

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Environment, Energy and Science
Department of Planning, Industry and Environment
Locked Bag 5022, Parramatta NSW 2124
Phone: +61 2 9995 5000 (switchboard)
Phone: 1300 361 967 (Environment, Energy and Science enquiries)
TTY users: phone 133 677, then ask for 1300 361 967
Speak and listen users: phone 1300 555 727, then ask for 1300 361 967
Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

Report pollution and environmental incidents
Environment Line: 131 555 (NSW only) or info@environment.nsw.gov.au
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1. About this document

1.1 Purpose

The purpose of this document is to explain how the NSW Government intends to monitor ambient air quality in the Lower Hunter Region during the next five-year period: 2021 to 2025.

This air quality monitoring plan meets the requirement of National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM), Part 4 Section 10, that each jurisdiction must have a plan setting how it proposes to monitor air quality for the purposes of this measure.

1.2 Target audiences

Concerned citizens and advocates

This document is for those who wish to learn about the methods and systems used to monitor air quality in their region so they can take informed action to reduce pollutants and populations' exposure to them. They can learn how certain types of pollutants, landforms and weather patterns might result in higher localised air pollution, and how nearby activities such as industry and traffic may affect amenity, and public and environmental health.

Industry

For businesses with activities subject to air quality regulation and licensing, this document explains how the NSW Government uses industry monitoring as part of an integrated and rigorous air quality monitoring system. Monitoring helps local industry understand the community's concerns.

NSW Government policymakers

This information can help Ministers and senior public servants to assess the adequacy of monitoring and pollution control for managing public health. Monitoring helps policymakers allocate and prioritise resources for air quality and make decisions about the adequacy of policies, programs and regulations to manage air pollution.

National Environment Protection Council

This regional plan describes monitoring in the Lower Hunter Region for National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM).

1.3 Plan update and review

This monitoring plan will be updated annually and reviewed every five years.

Table 1 Changes to the plan since 2001

Version	Release date	Purpose
Version 1.0 (original plan)	2001	Initial monitoring plan required under NEPM 1998.
Major periodic reviews 2017–18	2018	To evaluate how well NSW is meeting the AAQ NEPM requirements, what is monitored for non-NEPM purposes, and where available resources could best be deployed to gather required and additional information about air quality. The reviews identified extra monitoring requirements due to growing populations, new sources of air pollution, new technologies and specific community concerns.
Version 2.0	December 2020	Major plan update based on the 2017–18 major periodic reviews.
Version 2.01	April 2021	Minor corrections
Version 2.1	December 2021	Next scheduled annual update.
Version 3.0	December 2025	Next scheduled five-year review.

2. Recommended air quality monitoring plan for the Lower Hunter Region

Air quality is monitored to assess if the air we breathe poses a risk to human health. Monitoring information provides evidence to the public, health professionals and policymakers when choosing short-term and long-term actions to reduce harm. Risk of harm is a function of the number of people exposed (population), and the level of exposure – pollutant types, concentrations, and durations.

2.1 Region definition

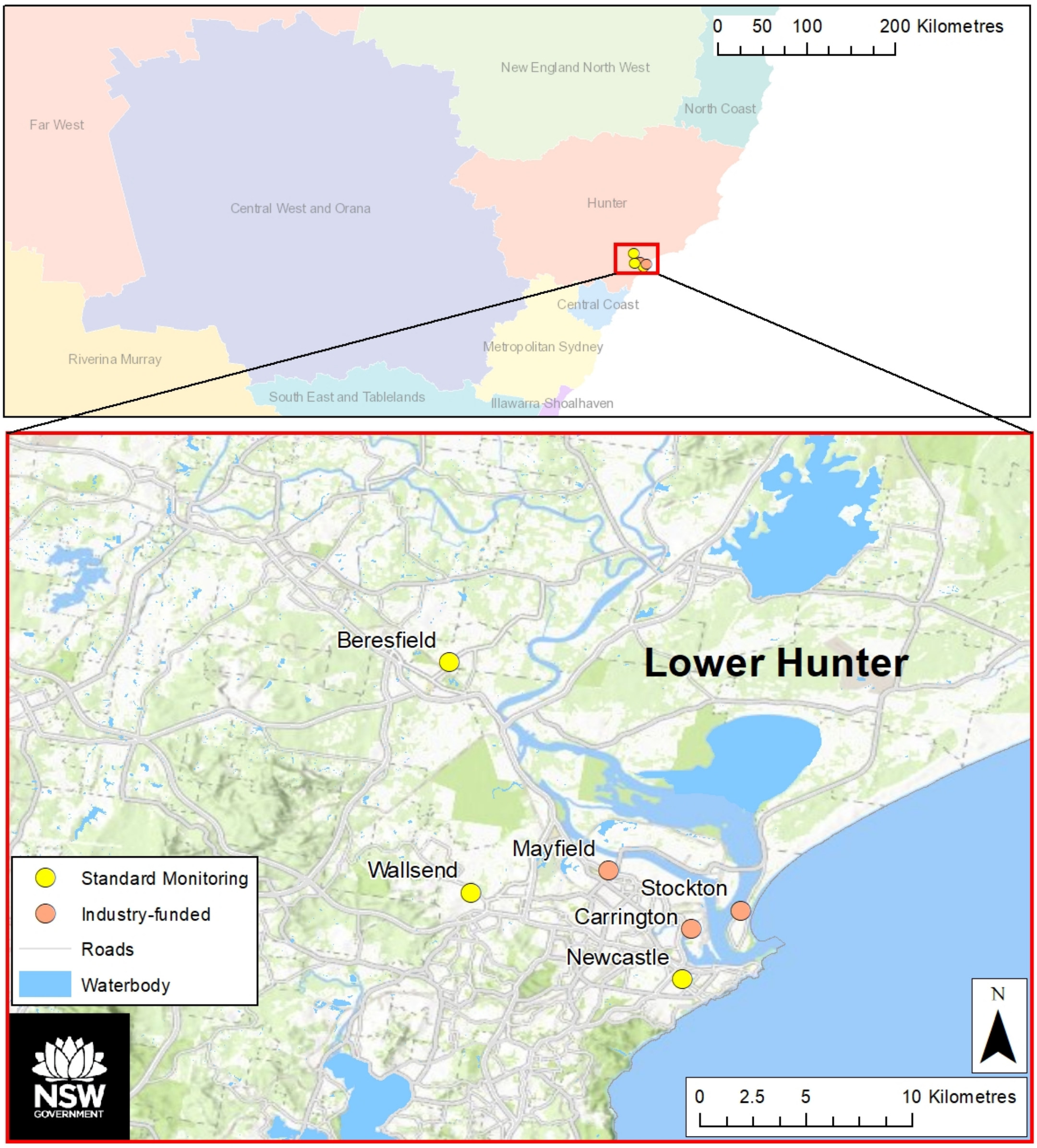

Figure 1 Air quality monitoring in the Lower Hunter air quality region (as of 1 January 2021)

Shown in the top insert is the location within the Hunter planning region.

This plan is presented by air quality monitoring region, based on NSW strategic planning regions, an administrative boundary determined by the Department of Planning, Industry and Environment, broadly in line with population centres and human land-uses. Human activities (such as burning fossil fuels for energy and transport) and land-use patterns (such as population density, travel patterns, location of polluting industries and their proximity to vulnerable types of people such as children, and urban heat-island effect) influence air quality and its effect on the population.

The Lower Hunter air quality region is defined broadly by the Newcastle–Maitland significant urban area (SUA) as defined in 2016 by the Australian Bureau of Statistics (ABS). This covers the southern populated areas of the Hunter planning region around Newcastle, extending down Lake Macquarie to the border of the Central Coast planning region. The northern part of the Lower Hunter Region extends north-west up the Hunter Valley to Maitland, and south-west from there to Kurri Kurri. Cessnock, although categorised within the Newcastle–Maitland SUA, has not been traditionally associated with the Lower Hunter air quality region. This is for reasons mentioned in Section 3.3 'Terrain', as the local air quality may be substantially different due to local topography.

Within the broader Hunter planning region are other SUAs which are not part of the Lower Hunter Region specifically. These are referenced here as they may be influenced by activity in the Lower Hunter Region, or vice versa. Taree, Nelson Bay and Forster–Tuncurry are coastal urban areas located north of Newcastle. Both Taree and Nelson Bay have populations which exceed 25,000 people. Inland from Newcastle, the Muswellbrook and Singleton SUAs are populations smaller than 25,000 but have local emission sources which warrant permanent air quality monitoring in the area. Air quality monitoring has been undertaken in the Upper Hunter Valley area since 2010 through the Upper Hunter Air Quality Monitoring Network. The Upper Hunter monitoring and reporting requirements are not addressed within the Lower Hunter Region but are referenced within the overall NSW Air Quality Monitoring Plan.

As described in the Central Coast Region Air Quality Monitoring Plan, the Morisset–Cooranbong SUA is included in the Central Coast air quality monitoring region. This area is often defined in different regions depending on the purpose of the underlying region definition. By ABS definitions, the Morisset–Cooranbong SUA is a distinct urban area located between the geographically larger Central Coast and Newcastle–Maitland SUAs. When considered by the Department for planning purposes, Morisset is included within the southern tip of the NSW Hunter planning region. The entire Central Coast–Lower Hunter area exists as one continuous air quality airshed, and as such it is important that when planning air quality monitoring near the boundaries of these regions, the monitoring needs in adjacent regions are examined in a strategical manner.

Underlying atmospheric and pollution analysis is based on natural boundaries, mainly airsheds, which are a function of terrain and climate. Smoke, dust and gaseous chemical pollutants are moved by thermal currents and blown by the wind. Natural convection causes hot air to rise, taking pollution with it. Landscape features – such as hills and valleys – are natural barriers that limit the dispersal of pollutants and can result in pollution pools with higher pollutant concentrations. Winds and air movement patterns often follow a diurnal and seasonal pattern – for example, sea breezes in the afternoon. Changes to the climate mean historically typical meteorological patterns might change in future.

2.2 Regional monitoring plan 2021–25

AAQ NEPM compliance statement

The region requires two stations based on population considerations.

For NEPM compliance, the plan for 2021–25 sets three current sites to monitor ozone, nitrogen dioxide, sulfur dioxide, particles as PM2.5 and particles as PM10. Carbon monoxide is monitored in one location, with the Newcastle site selected as it is considered likely to have the highest representative concentration, as it is closest to higher traffic volumes.

Monitoring outside NEPM compliance

Three monitoring stations in the Newcastle local area measure pollution in areas with potential impact from industrial pollution sources, meeting the legislative requirement under the NSW Protection of the Environment Operations (General) Regulation 2009.

Table 2 Monitoring stations in the Lower Hunter Region

Station	Station type†	Year est.	O_3§	NOx	PM_{10}	$PM_{2.5}$*	Vis	CO	SO_2	Met§	NH_3
Beresfield	T	1993	✓	✓	✓	✓(2012)	✓		✓	✓	
Newcastle	T	1992	✓	✓	✓	✓(2015)	✓	✓	✓	✓	
Wallsend	T	1992	✓	✓	✓	✓(2012)	✓		✓	✓	
Carrington	S	2014		✓	✓	✓			✓	✓	
Mayfield	S	2014		✓	✓	✓			✓	✓	
Stockton	S	2014		✓	✓	✓			✓	✓	✓

† P = performance station (NEPM compliant); T = trend station (NEPM compliant); S = source/industry non-NEPM station

§ O_3 = Ozone; NOx = oxides of nitrogen which includes nitrogen dioxide (NO_2); Vis = visibility as measured by nephelometer; Met = meteorology (such as wind, temperature)

* Denotes the year in which beta attenuation monitors (BAM) were installed at monitoring sites to measure PM2.5.

‡ Ammonia (NH_3) is monitored at Stockton due to its proximity to the Orica Kooragang Island (KI) plant.

Planned monitoring technologies

The current monitoring technologies, including instrumentation for each pollutant, are described in 'Schedule 2 – Register of NSW monitoring stations' of *NSW Air Quality Monitoring Plan – Methods for creating plans* (DPIE 2020), and this information is also accessible on the Sharing and Enabling of Environmental Data in NSW (SEED) portal. This schedule is updated regularly by the Department's Climate and Atmospheric Science Branch.

Planned reporting of air quality monitoring results

Table 3 Reporting plan 2021–25

Reporting period	Plan for 2021-25	Scheduled
Current/live results by station and region	Publish live air quality monitoring results for the region on the Department's website. Website improvements are scheduled for release in 2020 and 2021.	Website upgrade Part 1 November 2020 Website upgrade Part 2 March 2021 Website upgrade Part 3 July 2022
Seasonal/quarterly summary	A seasonal newsletter is published for the Newcastle area every quarter on the Department's website. This analysis also includes a summary of monitoring undertaken in the Lower Hunter NEPM stations.	Quarterly
NSW annual compliance with AAQ NEPM	Meet AAQ NEPM requirements to report annually on compliance with the goals and standard. Publish an annual compliance report on the Department's website.	Second half of each calendar year

Reporting period	Plan for 2021-25	Scheduled
NSW annual air quality statement	Report annually on air quality over the past year. Publish air quality statements on the Department's website.	Annual in each January
Special air quality report	Publish special air quality analysis reports of selected air pollution episodes and events on the Department's website.	Quarterly when applicable
Inventory of pollution sources within GMR*	An inventory of pollution sources was published every five years, but is now published as required.	To be determined

* GMR refers to the Greater Metropolitan Region, as defined for NSW air emissions inventory. This includes Greater Sydney, as well as Illawarra, Lower Hunter and Central Coast.

2.3 Changes since the 2001 monitoring plan

Key changes to monitoring stations since 2001

In general, changes made to the network have been documented in annual NEPM compliance reports. The full list of stations is available on the Sharing and Enabling of Environmental Data in NSW (SEED) portal. This schedule is updated regularly by the Department's Climate and Atmospheric Science Branch.

Regarding NEPM compliance stations, the Lower Hunter network remains largely unchanged since 2001. The three monitoring stations operating in 2001 continue to operate at the same locations in 2021. All three stations now report particles as PM2.5 since its implementation for NEPM purposes, consistent with the rest of the compliance network.

The Newcastle site additionally reports compliance with sulfur dioxide, which it did not in 2001. The original plan to combine the Beresfield and Wallsend stations to a monitoring station at Maitland was not realised, and the two original stations remain as trend stations now having operated for over 25 years.

The Newcastle industry network has been integrated into NSW Government operations and reporting since 2014. The network involves three industry-funded stations in and around the Port of Newcastle, which measure particles as PM10 and PM2.5, nitrogen oxides and sulfur dioxide. Additionally, the Stockton station measures ammonia, given its proximity to a nearby ammonia production facility. It is the only station currently in the NSW network where ammonia is routinely monitored.

Given the location of two of these sites near source areas (Carrington, Mayfield) and the high influence of sea salt on particle measurements at the third site (Stockton), these are not currently being considered for NEPM compliance monitoring. Their importance in monitoring source emissions and community levels means they will be continued to operate as required.

Key changes to monitoring technologies since 2001

The AAQ NEPM legislation was updated in 2016, with monitoring of fine particles as PM2.5 now a mandated process. The high particle levels measured statewide during the bushfire crisis in the 2019–20 summer season has reinforced the necessity and the health benefits of measuring PM2.5 routinely at multiple locations, with live reporting of those results helping people to actively manage their exposure.

The 2001 NSW Air Quality Monitoring Plan did not mention PM2.5 specifically, however, at the time PM2.5 monitoring was undertaken at both the Wallsend and Beresfield stations, using tapered element oscillating microbalance instruments (TEOM). This was based on available instrumentation, and in the absence of available standard methods at the time, these were run in accordance with United States Environmental Protection Agency (USEPA) equivalence methods. Since 2012 these have gradually been replaced in New South Wales with beta attenuation monitor (BAM) instruments. BAM instruments were further deployed across the network to most locations between 2012 and 2017, given the importance of measuring these smaller particles.

Ammonia (NH_3) is monitored at Stockton due to its proximity to the Orica Kooragang Island (KI) plant. This is the only location where gas-phase ammonia monitoring is routinely undertaken in the NSW air quality monitoring network as of January 2021.

3. Key factors analysis

This regional monitoring plan has been prepared by analysing the following key factors, as defined in *NSW Air Quality Monitoring Plan – Methods for creating plans*.

3.1 Geographic extent and boundary

The region and its population density are shown in Figure 2.

3.2 Population

The Lower Hunter Region is the second most heavily populated region in New South Wales (Figure 2). The Newcastle–Maitland urban area has a population of around 463,000 reported in ABS 2016 census data.

The population has grown significantly since the first air quality monitoring plan was prepared in 2001. The Department publishes NSW population and household projections. For the combined population of the Newcastle, Cessnock, Lake Macquarie and Maitland local government areas (LGAs), it is projected that by 2026 the combined population will be equal to 0.55 million people (NSW Department of Planning Industry and Environment, 2019). This is an increase from an estimate of 0.50 million in 2016.

These combined areas also include the Morisset–Cooranbong SUA, located in Lake Macquarie LGA, which had a population in 2016 of just under 24,000. While this SUA is located within the Hunter planning region, for air quality purposes it is currently included in the Central Coast air quality region.

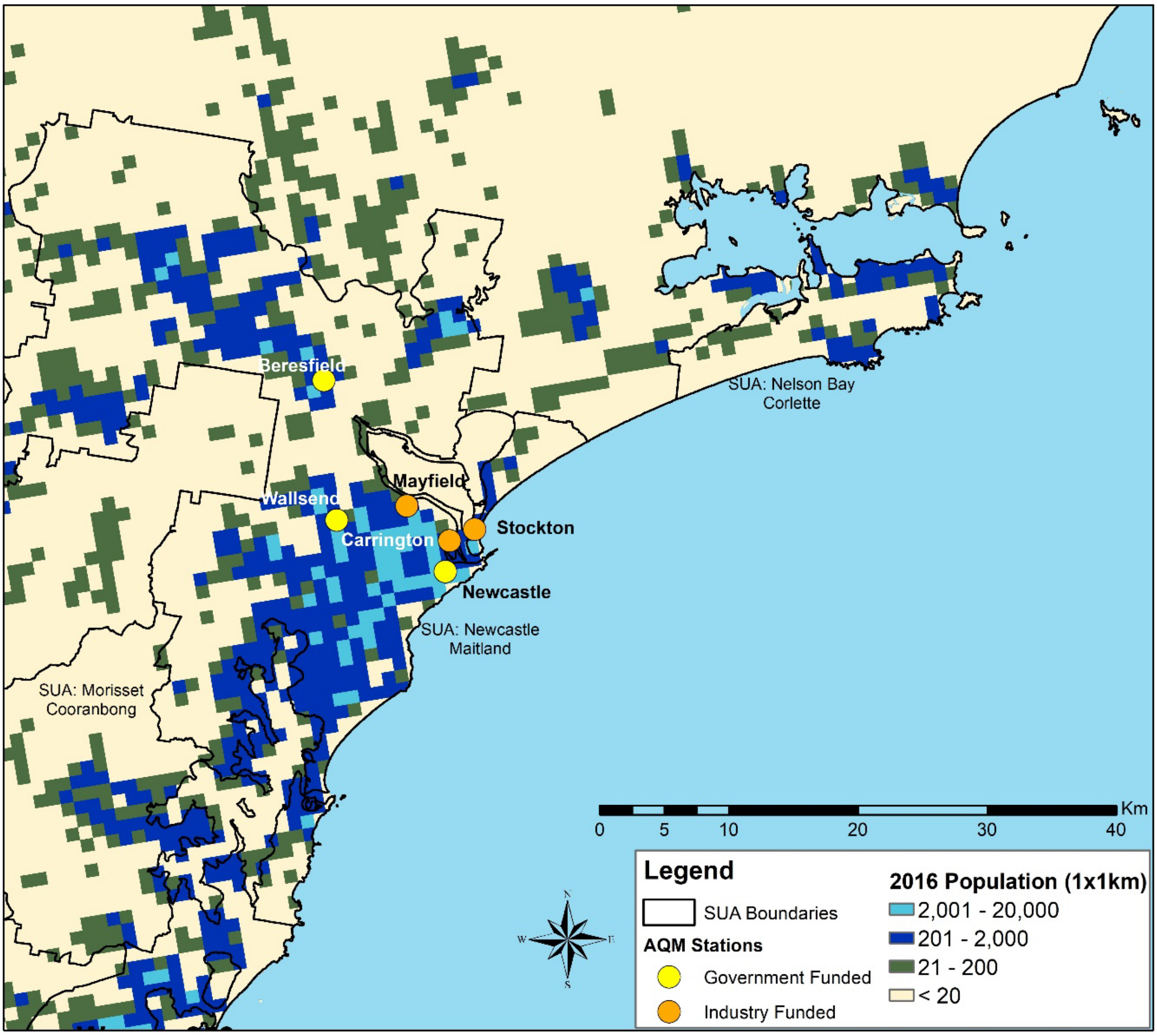

Figure 2 **Population density in the Lower Hunter Region**

NEPM requirements for monitoring based on population

Applying the formula in Clause 14(1) of the NEPM to Lower Hunter's estimated population, the number of monitoring stations required is currently two stations. Based on NSW Population Projections (see Table 4), in 2026 the number of stations required will remain at two within the combined urban area.

Six monitoring stations are operating in the region, three of which are reported as NEPM compliance stations. The remaining three stations are industry-funded stations, operated by the Department, and located in and around the Port of Newcastle area.

Table 4 Stations required according to population

Year and population calculation method	Population (millions)	Number of stations based on NEPM calculation[1]
2016 (ABS census data)	0.463	2
2016 (NSW planning assumptions)	0.50	2
2026 (NSW planning assumptions)	0.55	2

Conclusions and recommendations for monitoring

The current number of monitoring stations meets AAQ NEPM requirements based on overall region population. No change is anticipated in future years.

3.3 Terrain

Newcastle, and its satellite towns Kurri Kurri and Maitland, all lie in the Lower Hunter Region. The region is located on a coastal plain bordered by mountain ranges, all of which are part of the Hunter River system catchment. The Hunter River flows out onto the coastal plain that extends to the south, and into the northern part of the Central Coast.

The region coastal plain is bounded by the higher terrain of various mountain ranges, as shown in Figure 3. These include the Watagan Mountains which border the south and south-east, and the Hunter Range which borders the south-west and west. To the north-west of Maitland, located 20 kilometres upstream of Newcastle on the Hunter River, the river valley floor rises to form a natural boundary with the Upper Hunter Valley.

Cessnock is not usually included in the Lower Hunter Region, because it is separated from Newcastle and the Hunter River by several relatively high ridges.

3.4 Regional climate and meteorology

Newcastle has a mild climate with a maximum average temperature of almost 26°C in January and an overnight average minimum of 8.5°C in July. Annual rainfall for the Lower Hunter's most populous city is 1118 mm, with March being the wettest month on average and November the driest.

Diurnal wind patterns

Under fine and stable meteorological conditions, air flows in the Lower Hunter Valley generally follow the same daily pattern. Overnight, air flows in a north-westerly direction down the Hunter Valley towards the Tasman Sea. In the afternoon, sea breezes cause air to flow up the Hunter Valley in a south-easterly direction. This basic pattern greatly affects how pollutants from local sources are dispersed around the region.

[1] Section 14(1) of the AAQ NEPM: (1) Subject to subclauses (2) and (3) below, the number of performance monitoring stations for a region with a population of 25,000 people or more must be the next whole number above the number calculated in accordance with the formula: 1.5P + 0.5, where P is the population of the region (in millions). (2) Additional performance monitoring stations may be needed where pollutant levels are influenced by local characteristics such as topography, weather, or emission sources. (3) Fewer performance monitoring stations may be needed where it can be demonstrated that pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this measure.

Small wind variations can alter this basic pattern. For example, a more north-easterly wind or sea breeze can blow emissions from the Newcastle area down to the Central Coast and beyond to Sydney. North-westerly winds that are associated with cold fronts can transport dust from dust storms down the Hunter Valley into Newcastle.

Seasonal wind patterns

Winds typically change from onshore easterly flows during the warmer months to offshore westerly flows as conditions cool.

Table 5 Seasonal prevailing winds

Season	Predominant wind
Spring	North-west
Summer	North-east to south
Autumn	Variable
Winter	North-west

The annual wind roses for the Lower Hunter Region are shown in Figure 3.

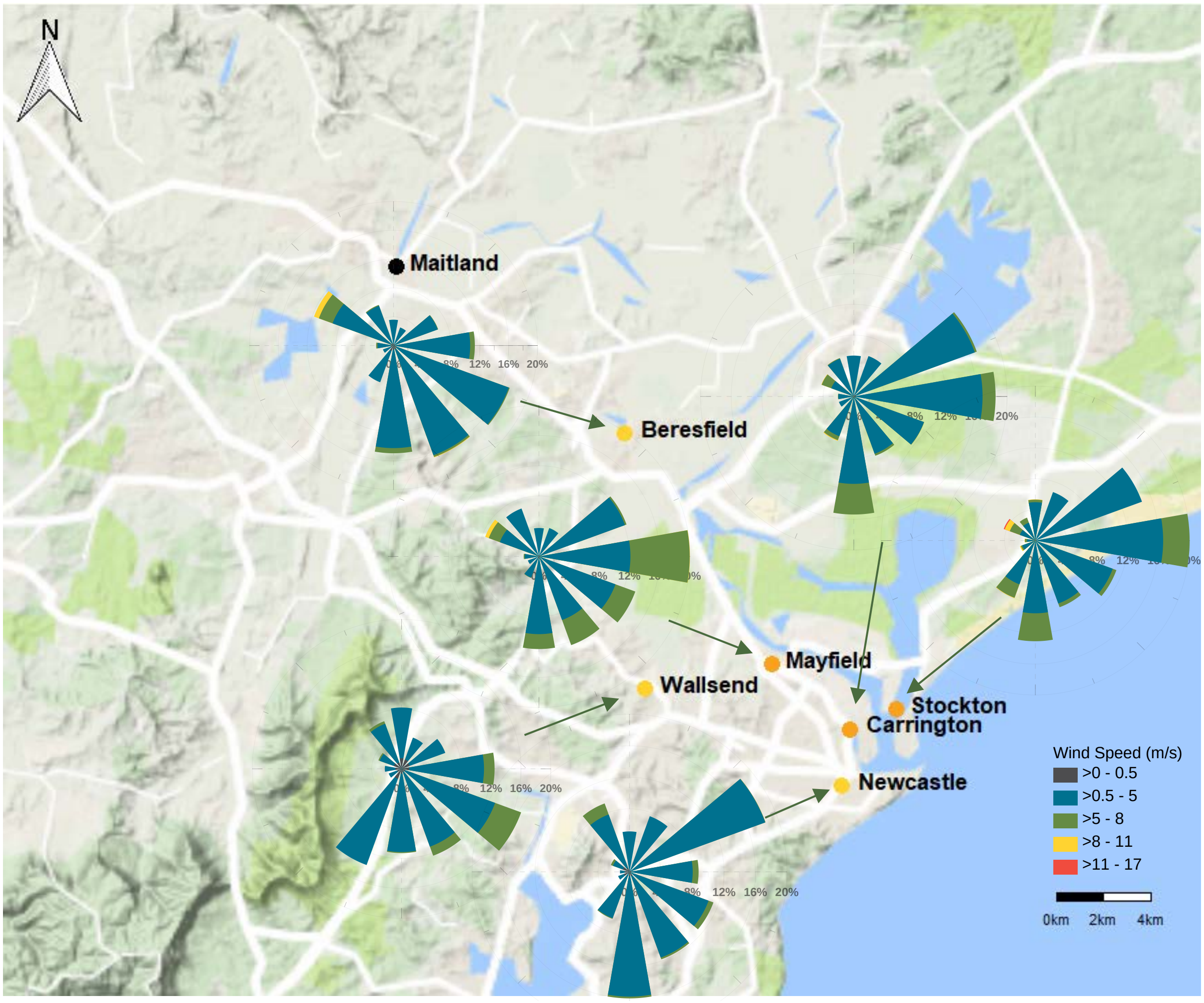

Figure 3 **Topography and annual average wind rose map for the Lower Hunter Region[2]**

3.5 Emission sources

The 2013 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region (NSW EPA, 2019) identified sources contributing to pollutant emissions in the region.

Table 6 presents the top three emission activities contributed to PM2.5, PM10, SO_2, NOx and CO emissions in 2013 for the Newcastle region (NSW EPA 2019). Prescribed burning and bushfires are the top source for particle emissions in the region and contribute 44.8% and 28.1% to PM2.5 and PM10 emissions respectively. Residential wood heating and coal mining are the second biggest sources for particle emissions contributing 9.8% and 20.4% to PM2.5 and PM10 emissions respectively.

Basic non-ferrous metal manufacturing contributes 80.3% of SO_2 emissions, followed by shipping that contributes 16.7% in the region. Shipping contributes 23.2% of NOx emissions while diesel vehicle exhaust and fertiliser and pesticide manufacturing contribute 17% and 13.2%.

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[2] 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 specific direction. The colours along the bars indicate wind speeds. Wind speed in shown in metres per second (m/s).

The CO emissions arise mainly from basic non-ferrous metal manufacturing (50.2%), prescribed burning and bushfires (25%) and petrol vehicle exhaust (7.6%).

Table 6 Top three emission activities contributing to PM2.5, PM10, SO_2, NOx and CO emissions in 2013 in the Newcastle region

Substance	Top three emission activities in the region		
$PM_{2.5}$	Natural	Domestic–commercial	Commercial
	Prescribed burning and bushfires 44.8%	Residential wood heating 9.8%	Basic non-ferrous metal manufacturing 9.4%
PM_{10}	Natural	Natural	Industrial
	Prescribed burning and bushfires 28.1%	Coal mining 20.4%	Petroleum and coal product manufacturing 12.7%
SO_2	Commercial	Off-Road	Natural
	Basic non-ferrous metal manufacturing 80.3%	Shipping 16.7%	Prescribed burning and bushfires 1.8%
NOx	Off-road	On-road	Industrial
	Shipping 23.2%	Diesel vehicle exhaust 17.0%	Fertiliser and pesticide manufacturing 13.2%
CO	Commercial	Natural	On-road
	Basic non-ferrous metal manufacturing 50.2%	Prescribed burning and bushfires 25.0%	Petrol vehicle exhaust 7.6%

3.6 Historical air quality monitoring in the Lower Hunter Region

The Lower Hunter Region has been subject to intensive, continuous air quality monitoring since 1992 with funding from NSW Government Consolidated Revenue, as shown in Table 2.

A comprehensive list of metadata for the air quality monitoring stations, including location, commissioning and decommissioning dates, is available on the Department's website: Air quality monitoring network.

Long-term trend analysis results are available at numerous sources, so are not replicated here. These include:

- annual NEPM compliance reports, which give a comprehensive summary of air quality trends and statistical data for this region against the NEPM air quality standards and goals: Air quality annual reports
- NSW State of the Environment Reports (Air Quality), which are published on three-year cycles

- NSW annual air quality statements, which summarise air quality across the network by calendar year
- seasonal reports for the Newcastle area which give a comprehensive summary of air quality trends and statistical data.

Summary

Since 1994, air quality has been ‘very good’ or ‘good’ for 70–85% of days in the Lower Hunter Region. Lower Hunter experienced ‘poor or worse’ air quality days due to ozone and particle (PM10 and PM2.5) pollution.

Particle and ozone pollution remain as the main air quality issues for the region. The NEPM standards were exceeded from time to time for ozone and particles (as PM10 or PM2.5) levels.

Further descriptions on regional pollution are given below, with information on other studies presented in Section 4.

Further details by pollutant

Particles

Particle pollution consists of both primary particles (released directly from sources) and secondary particles (produced by chemical reactions between gases or between gases and other particles in the air).

Sources of primary particle emissions include residential wood heaters in winter, bushfires, construction work, motor vehicle exhaust, mining activities and occasional regional dust storms.

Gaseous pollutants such as SO_2, VOC, NOx and ammonia contribute to the formation of secondary particles in the air. Rates of formation of secondary inorganic and organic aerosol (SIA and SOA) increase during the summer, when increased solar radiation enhances chemical reaction rates.

Major dust storms, bushfire and hazard-reduction burn days from 2000 to 2020 that affected particle levels in the Lower Hunter Region were:

- November 2019 to January 2020 – ‘black summer’ bushfires impacted south-east Australia and burnt 18 million hectares
- October 2013 – NSW ‘state of emergency’ bushfire
- September 2009 – the ‘red dawn’ dust event.

PM10

Since 1994, PM10 concentrations and the number of exceedance days have varied across the years due to climatic conditions and there is no discernible trend. However, in 2018 and 2019 there was a marked increase in the number of PM10 exceedance days. Higher concentrations and more exceedances occurred in years with more-frequent bushfires, hazard-reduction burns and dust storms. Dry El Niño years (e.g. 2002–07) are generally characterised by higher concentrations and a greater number of exceedance days, with lower levels occurring during wetter La Niña years, such as 1998–2001 and 2010–11. In 2019, due to the ‘black summer’ bushfires, the Lower Hunter Region recorded its highest number of exceedance days (33) since 1994.

Higher PM10 levels were recorded at the Newcastle Local Air Quality Monitoring Network near the Port of Newcastle, with local peaks not measured at the Lower Hunter Air Quality Monitoring Network stations. Relatively high PM10 concentrations were measured at Stockton. This was due to the greater sea salt contributions in summer, as reported in the *Lower Hunter Particle Characterisation Study* (OEH 2017).

PM2.5

Long-term trends for PM2.5 are difficult to discern since approved PM2.5 monitoring instrumentation was not deployed across the Lower Hunter Region until 2012. Since then, there has been no discernible trend, with exceedances remaining at fewer than seven days up to 2018. However, in 2019, due to the ‘black summer’ bushfires, the Lower Hunter Region and the Newcastle Local Air Quality Monitoring Network recorded their highest number of exceedance days (29 and 28 respectively) since 2012.

Ozone

Ground-level ozone is a secondary pollutant produced by the reaction of NOx and volatile organic compounds (VOCs) in sunlight. High ozone concentrations in the Lower Hunter Region can result from local precursor emissions, or the transport of ozone or precursor compounds from other regions by the sea breeze.

Since 1994, the number of ozone exceedance days in the Lower Hunter, in general, has declined. Since 2009, exceedance days have remained stable, with fewer peak ozone events occurring between 2009 and 2019, despite this period including the hottest years on record. However, in 2019 the total number of exceedances increased sharply due to the ‘black summer’ bushfires, to a record number since 1994 of five exceedance days.

Carbon monoxide, nitrogen dioxide, sulfur dioxide and ammonia

Since 1994, there have been significant reductions in the ambient concentrations of CO, NO_2, SO_2 and lead. There have been few exceedances for these pollutants since that time. Over recent years, the reductions in the concentrations of these pollutants have tailed off, potentially indicating that the benefits of emission reduction measures are being offset by growth in emissions activities.

Although not an AAQ NEPM criteria pollutant, ammonia (NH_3) concentrations are monitored at Stockton as a measure of emissions from the nearby Orica ammonium nitrate production facility.

3.7 Community engagement

Monitoring must serve community needs. The NSW Government listens and learns from communities, pursuing the best outcomes and creating opportunities that benefit all. Monitoring must always be done for the sake of people’s wellbeing and the prosperity of NSW. The NSW EPA leads engagement activities to identify and respond to community needs. It produces a range of draft policies, agreements and reports that call for community involvement, engagement and consultation.

In 2011, the Minister for the Environment established the Newcastle Community Consultative Committee on the Environment. The committee’s role is to advise the Minister for the Environment, the EPA and other relevant NSW Government agencies on matters of environmental concern in the Newcastle local government area. The committee enables people living in the Newcastle LGA to identify important environmental and amenity issues associated with nearby industrial activities. It also helps local industry understand the community’s concerns.

The committee advised on the establishment of the Newcastle Local Air Quality Monitoring Network and nominated locations for monitoring stations. The network stations were set up in August 2014, following studies by NSW Office of Environment and Heritage and the NSW EPA with advice from the NSW Health Air Pollution Expert Advisory Committee.

NSW Government Air Program scientists participate in community engagement activities and panels administered by the NSW EPA. There are several continuous feedback channels for the public to discuss air quality monitoring and reporting. These include

- website feedback forms
- Environment Line online, or email info@environment.nsw.gov.au, or phone 131 555
- correspondence arising from email newsletters and reports.

Feedback and queries from these channels have resulted in a number of actions for improving air quality monitoring and reporting. Examples include:

- Community feedback during the NSW 2019–20 bushfire period demonstrated a need to improve our public information services. The NSW Government is working with other jurisdictions, through the National Air Technical Advisory Group (NATAG), to ensure a nationally consistent approach to air quality data reporting and to deliver health information that is easier to understand. NSW Government has agreed to and implemented the Environmental Health Standing Committee (enHealth) recommendation for hourly PM2.5 reporting and related health messaging on its website in November 2020.
- The Enhance Website and Data Delivery (EWADD) project, commissioned in 2019, is implementing a system for managing, reporting and delivering air quality data to meet changing business needs and customer expectations. A new website will deliver enhanced public-facing air quality data and information services and replace the data management and reporting system that has operated since 2008.

3.8 Overall analysis

Conclusions from analysis of other factors and recommendations for air quality monitoring

Based on analysis of factors, the current monitoring regime will be maintained for the next five years. The plan will be updated annually, with a major review in 2025.

Air quality monitoring within the overall Lower Hunter Region is sufficient to cover community needs regarding NEPM compliance monitoring. Currently, there are three long-term compliance stations and three additional industry-funded source stations monitoring air quality around the major industrial area.

Ozone exceedances in the region are infrequent, however, it is noted they can occur more frequently at Wallsend and Beresfield, in keeping with the trends seen in the Greater Sydney Region regarding inland sites recording greater number of exceedances. With a change to ozone standards possible in the near future, the likelihood of ozone exceedance, of photochemically aged air further north into populated areas of the region, may need to be considered. Further analysis is suggested, to determine whether northern areas around Maitland need to be screened for ozone.

The significant bushfire crisis of 2019–20 across Australia, and the consistently high levels of air pollution measured across New South Wales, highlighted the dual purposes of an active air quality monitoring network: monitoring air quality impacts across long time periods, and providing information to help members of the public manage impacts on their health in real time. To perform the second task adequately, monitors (whether fully NEPM compliant or not) need to be located in areas where they can provide accurate information to the widest cohort of the community as possible.

The NSW Government is considering providing monitoring in locations with large populations and which are not significantly close to existing monitoring stations, or where unique terrain or emission sources mean the expected air quality cannot be inferred from other monitoring stations. Deployment of new monitoring must also be considered against available resources, geographic equity across the entire State and frequency of pollution events expected.

Staged updates to the air quality website will be undertaken during the 2021–25 period. We are working with the Australian Government and other jurisdictions to ensure a nationally consistent approach to reporting air quality and associated health advice. A new, dedicated air quality website is under development, with its official launch expected in 2022.

Within the Lower Hunter air quality monitoring region, there may be benefit from positioning lower-cost monitoring options for live air quality reporting of occasional air pollution events in populated areas not sufficiently close to the existing stations in the Newcastle or Beresfield areas. These include areas such as Maitland, and communities around the northern part of Lake Macquarie. As previously identified, Cessnock has slightly different characteristics than other nearby areas, and similar monitoring could be of benefit.

Outside the Lower Hunter Region, such monitoring could be done in the coastal urban areas identified in the Hunter planning region, such as Nelson Bay, Taree and Forster. Overall air pollution levels are expected to be quite low in these locations, as they are coastal areas with minimal local emissions sources. Under conditions where nearby bushland is burnt, particle levels will occasionally but infrequently be high enough to warrant appropriate monitoring and health messaging for the community. Emergency monitoring, such as that done in Taree between November 2019 and March 2020, may be an appropriate option where such a source can be identified.

4. Further information

Recent air quality studies for the Lower Hunter Region

The *Lower Hunter Particle Characterisation Study* (OEH 2017) was commissioned by the NSW EPA in 2013 to investigate the composition and major sources of particle pollution in the Lower Hunter. The study was done by scientists from the Department, CSIRO and the Australian Nuclear Science and Technology Organisation (ANSTO), with oversight from NSW Health. The study period was March 2014 to February 2015.

The study aimed to determine the composition and major sources of fine (PM2.5) and coarse particles (PM10).

Fine particles were monitored at four sites, including two sites representative of regional population exposures (Newcastle and Beresfield) and two sites near the Port of Newcastle (Mayfield and Stockton). Coarse particles were monitored at Mayfield and Stockton.

Annual average fine particle concentrations were very similar at Newcastle, Mayfield and Beresfield (6.4–6.7 micrograms per cubic metre [$\mu g/m^3$]). However, particle concentrations were about 40% higher at Stockton (9.1 $\mu g/m^3$). The higher levels at Stockton were mainly due to more sea salt and primary ammonium nitrate. Ammonium nitrate contributed on average 19% of the fine particle mass at Stockton (and 40% in winter) and was most likely due to emissions from the ammonium nitrate manufacturing facility on Kooragang Island.

Other than the ammonium nitrate, the fine particle composition and the sources of particles were found to be reasonably similar across the four sites.

The source factors and their contributions to fine particles over the study period were:

- fresh sea salt particles: 24% at Newcastle, decreasing to 13% at Beresfield
- pollutant-aged sea salt: about 23% at all sites (this is sea salt reacted with industrial, commercial, road and non-road transport emissions from local and regional sources)
- wood smoke: 15% at Beresfield, decreasing to 6% at Stockton
- secondary ammonium sulfate: about 10% at all sites
- soil dust: about 10% at all sites
- vehicles: about 10% at three sites, and about 5% at Stockton
- industry factors: about 12% at three sites and 24% at Stockton
- mixed shipping and industry: about 3% at all sites
- nitrate: 19% ammonium nitrate at Stockton and 6–11% secondary nitrate at other sites.

On an annual average basis, there is an approximately 50:50 split between primary and secondary particles at three sites (Newcastle, Beresfield and Mayfield) and a 65:35 split at Stockton because of the significant contribution from the primary ammonium nitrate.

Coarse particle composition and sources were determined at the sites near the Port of Newcastle. The annual average coarse particle concentration was two-and-a-half times higher at Stockton (21.5 $\mu g/m^3$) than at Mayfield (8.3 $\mu g/m^3$), mainly due to fresh sea salt.

The source factors and their contributions to coarse particles over the year were:

- fresh sea salt: 13.6 $\mu g/m^3$ at Stockton, 3.3 $\mu g/m^3$ at Mayfield
- industry plus pollutant-aged sea salt: 2.4 $\mu g/m^3$ at both sites
- light-absorbing carbon: 2.2 $\mu g/m^3$ at Stockton, 0.9 $\mu g/m^3$ at Mayfield
- soil: 2.3 $\mu g/m^3$ at Stockton, 1.2 $\mu g/m^3$ at Mayfield
- bioaerosols: 1.1 $\mu g/m^3$ at Stockton, 0.5 $\mu g/m^3$ at Mayfield.

Most coarse particles are primary particles, or physical combinations of primary emissions, but there is evidence of chemical reactions in the pollutant-aged sea salt factor.

Light-absorbing carbon was found to account for about 10% of the coarse particle mass at Mayfield and Stockton. Coal particles could contribute to light-absorbing carbon, and so contribute a small percentage of the coarse particle mass.

In addition to the main study, computer modelling was used to understand the distribution of particles over the broader region. This chemical transport modelling confirmed that the levels and composition of fine particles across the region, including Lake Macquarie and Maitland, are similar to those at the sites studied. This is because fine particles stay in the air for long periods and can travel long distances.

Coal grain analysis

A supplementary study (Hibberd et al. 2016) was done to better understand the contribution of coal particles to the coarse particle mass. Particulate matter at Stockton was analysed to see how much coal dust it included. The study used a new imaging technique called coal grain analysis or CGA, which accurately distinguishes coal particles from other particles and provides information on particle sizes of about one to 50 micrometres (μm).

Total suspended particles (TSP) were sampled at Stockton in winter 2015. Samples were taken on days with no rainfall, high levels of particulate matter and frequent north-westerly winds. Under these conditions coal particles were more likely to be generated and transported over the Stockton monitoring site from coal operations on Kooragang Island and nearby areas at the Port of Newcastle.

The key findings of the study were:

- Coal particles accounted for 25% of the mass of insoluble TSP in the samples analysed. When both insoluble and soluble (including salt) particles were considered, on average 12% of TSP were coal particles.
- Coal particles made up 63% of the mass of insoluble PM2.5–10 in the samples analysed. When both insoluble and soluble particles were considered, on average 10% of PM2.5–10 were coal particles. This was consistent with the findings of the *Lower Hunter Particle Characterisation Study* that on average 10% of the PM2.5–10 was 'light-absorbing carbon' and that most of this was probably coal particles.
- Coal particles were found to make up on average 83% of the mass of insoluble particles in the 1–2.5-µm size fraction (PM1– 2.5). (The coal grain technique could identify only particles greater than about 1µm in size.) When both insoluble and soluble particles were considered, on average 1.8% of PM1– 2.5 mass was found to be coal particles.
- PM1–2.5 typically makes up 30% of total PM2.5 in urban samples. If all coal particles are assumed to be larger than 1µm, then the results indicate that coal particles make up on average about 0.5% of PM2.5. This upper limit of 0.5% further refines the estimate of an upper limit of 4% of coal particles in PM2.5 in the *Lower Hunter Particle Characterisation Study*, based on the amount of carbon in the soil factor fingerprint.

When winds blow from the north-west, the likely sources of coal particles are the coal export facilities located to the west and north-west of Stockton. Another possible source is the re-suspension of previously deposited coal particles in the ambient environment around Stockton.

Fly ash and similar materials were also found to be significant components of the samples analysed, comprising up to 42% of TSP. Fly ash is generated by the high-temperature combustion of coal and heavy oil, and is sold commercially for use in concrete products. Fly ash particles were generally found to have large diameters, indicating local sources rather than airborne transport from distant power station stacks.

5. References

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