DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

Air Quality Monitoring Plan for the Illawarra Region 2021–25

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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 Illawarra 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 Illawarra Region for the 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 Illawarra 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

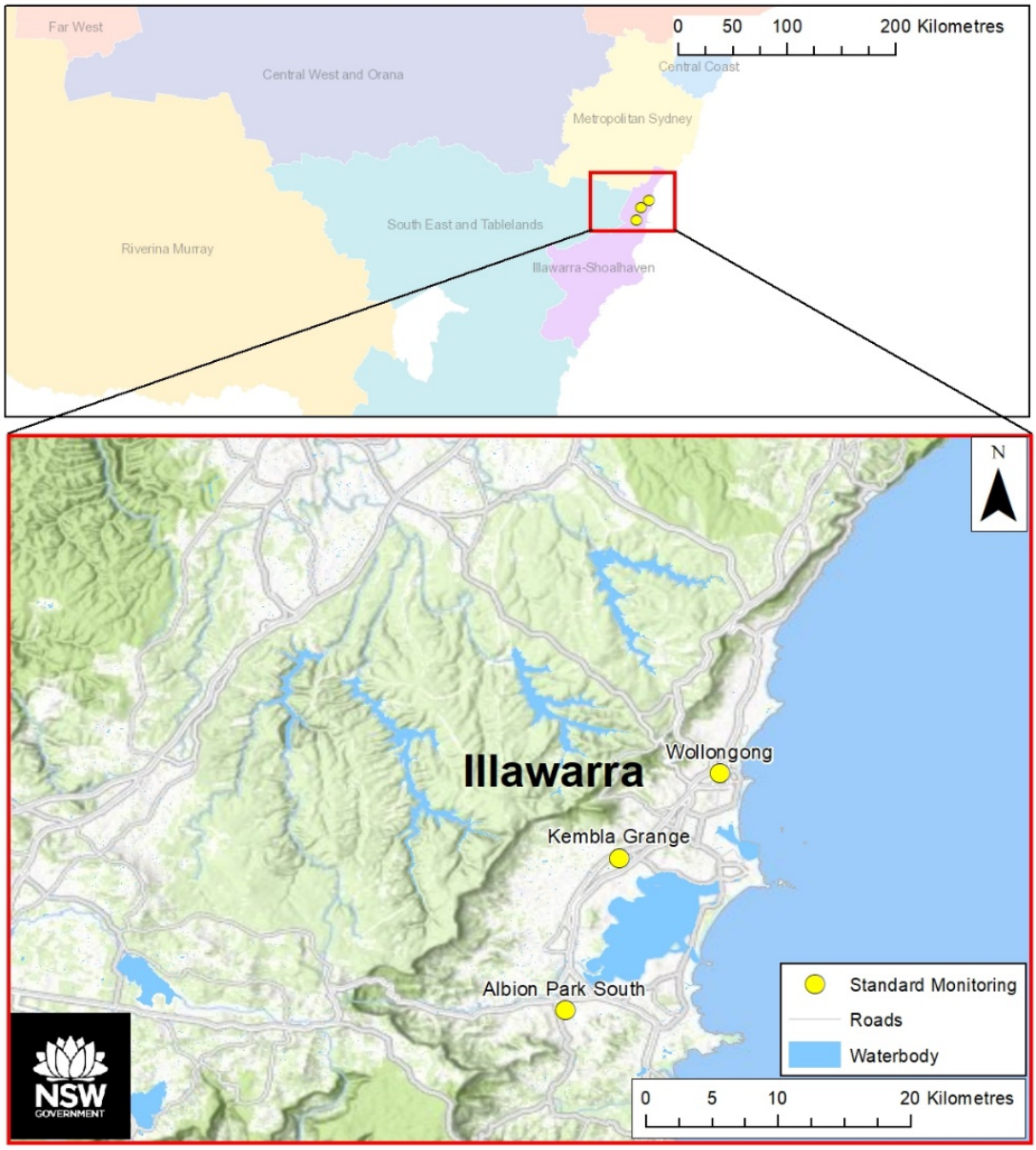

Figure 1 **Air quality monitoring in the Illawarra Region (as of 1 January 2021)**

Shown in the top insert is the Illawarra–Shoalhaven 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 Illawarra air quality region is based on the Wollongong significant urban area (SUA) defined in 2016 by the Australian Bureau of Statistics (ABS). This encompasses most of the Wollongong local government area (LGA), the entire Shellharbour LGA, and the town of Kiama within the Kiama LGA.

The Illawarra–Shellharbour NSW planning region extends past the Illawarra SUA and through three SUAs: Nowra–Bomaderry (population 36,000), St Georges Basin – Sanctuary Point (population 18,000) and Ulladulla (population 15,000). These areas are not currently considered within the Illawarra air quality region, but an analysis of expected air quality in the Nowra-Bomaderry region is included in this report.

Underlying atmospheric and pollution analysis is based on natural boundaries, mainly airshed, which is 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 pollution 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 one monitoring station based on current population considerations, increasing to two stations within the next five years, based on population growth.

For NEPM compliance, the plan for 2021–25 sets three sites to monitor for ozone, nitrogen dioxide, particles as PM2.5 and particles as PM10. Two stations will monitor sulfur dioxide, and one station will monitor carbon monoxide.

Table 2 Monitoring stations in the Illawarra Region

Station	Station type[†]	Year est.	O_3[§]	NOx	PM_{10}	$PM_{2.5}$*	Vis.	CO	SO_2	Met.
Albion Park South[‡]	T	2005	✓	✓	✓	✓(2015)	✓		✓	✓
Kembla Grange	P	1994	✓	✓	✓	✓(2015)	✓			✓
Wollongong	T	1993	✓	✓	✓	✓(2012)	✓	✓	✓	✓

[†] P = performance station; T = trend station.

[§] O3 = 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.

[‡] Monitoring has been conducted in the Albion Park area since December 1992. The monitoring station has been relocated twice.

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 type	Plan for 2021–25	Scheduled
Current/live	Publish live air quality monitoring results for the region on the Department's website. Website improvements are scheduled for release in 2020, 2021 and 2022.	Website upgrade Part 1 November 2020 Website upgrade Part 2 March 2021 Website upgrade Part 3 July 2022
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
NSW annual air quality statement	Report annually on air quality over the past year. Publish an air quality statement on the Department's website.	Annually 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 the 2001 monitoring plan, regular monitoring of air pollutants was undertaken at four stations within the Illawarra area. Additional sampling for lead was undertaken in the Port Kembla area.

In 2020, as with monitoring in all other regions, monitoring of fine particles as PM2.5 is undertaken at all existing stations, which was not the case in 2001. Other changes since 2001, site by site, are:

- Wollongong – no major change of pollutant monitoring has occurred.
- Albion Park – no change in pollutants monitored, but the site was moved to a new location in 2005 (now Albion Park South).
- Kembla Grange – nitrogen dioxide monitoring is now also undertaken for NEPM compliance.
- Warrawong – this site was decommissioned in 2004. It monitored for SO_2 and lead for NEPM compliance reporting.
- Port Kembla sites – these are no longer used, as lead monitoring has been discontinued. Occasional short-term monitoring is undertaken in the Port Kembla area for pollutants where short-term changes to industrial emission sources around the area

are considered possible. This was most recently undertaken during the first six months of 2020, as detailed on the NSW Environment website.

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 Wollongong and Warrawong (until 2006) in the Illawarra network 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 been gradually replaced in New South Wales with beta attenuation monitor (BAM) instruments. BAM instruments were further deployed across the network to Albion Park and Kembla Grange in 2015 and 2017 respectively, given the importance of measuring these smaller particles.

Since the introduction of unleaded petrol in 1986, and the phasing out of leaded petrol in 1993, lead levels in the region have declined. After undertaking a screening process, the NSW Government phased out ambient lead monitoring for the AAQ NEPM during 2004. The case for discontinuing lead monitoring was approved by the National Environment Protection Council (NEPC).

3. Key factors analysis

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

3.1 Geographic extent and boundary

The Illawarra Region is located on a thin coastal strip, stretching some 100 kilometres from Stanwell Park in the north to the Shoalhaven River in the south. The region and its population density are shown in Figure 2.

3.2 Population

Wollongong lies in a distinct region called the Illawarra, with a population of around 286,000 reported in ABS 2016 census data. The Illawarra is the fourth largest major population centre in New South Wales.

The population has increased since the first air quality monitoring plan was prepared in 2001. The Department publishes NSW population and household projections. The population projection forecasts that by 2026, the entire Illawarra–Shoalhaven region population will have grown to 0.45 million people (NSW Department of Planning Industry and Environment, 2019). Within the Wollongong, Kiama and Shellharbour LGAs, which make up most of the Wollongong SUA, the forecast population by 2026 is 0.34 million people, up from 0.30 million in 2016.

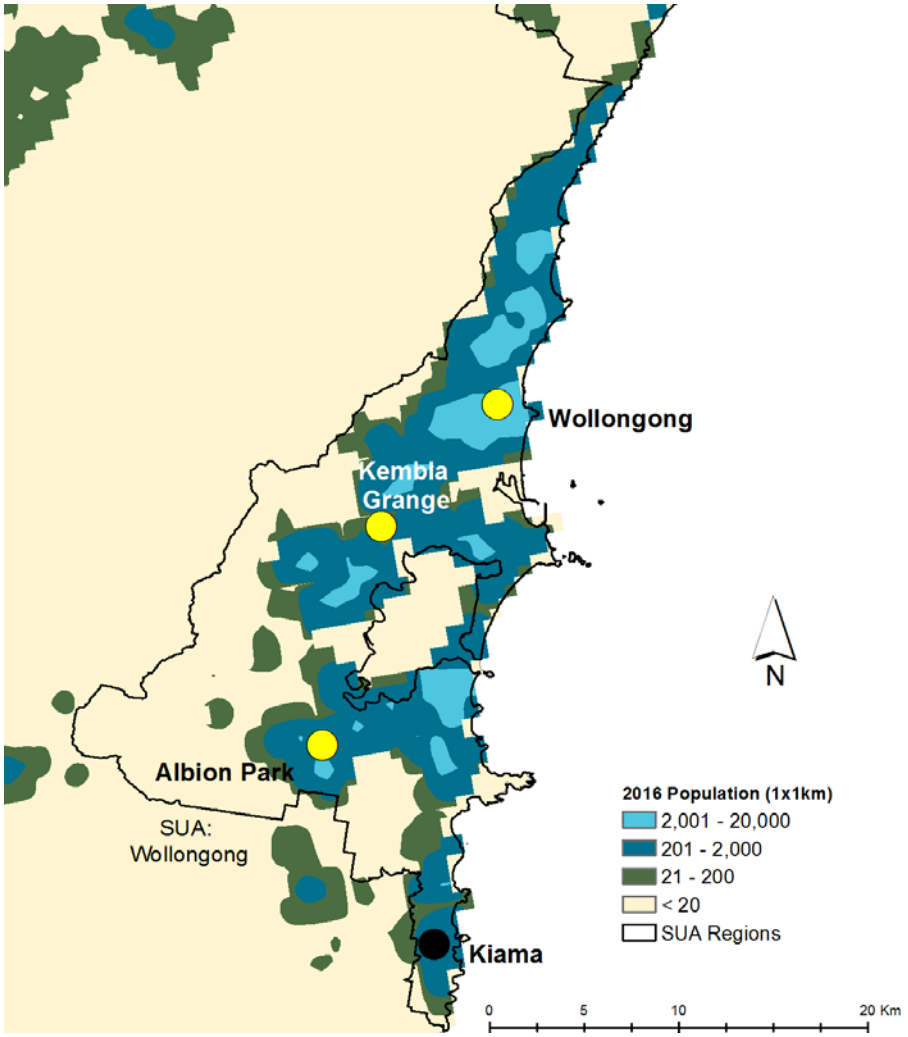

Figure 2 **Population density in the Illawarra Region**

Yellow dots indicate monitoring stations, black dots indicate towns without monitoring

NEPM requirements for monitoring based on population

The population criterion in Clause 14(1) of the AAQ NEPM suggests at least one monitoring station is required in the region based on current population (see Table 4). Based on the NSW Population Projections, in 2026 the number of stations required will rise to two for the combined LGAs.

There are three monitoring stations currently operating in the region.

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)	0.286	1
2016 (NSW planning assumptions) (Wollongong, Shellharbour and Kiama LGAs)	0.30	1
2026 (NSW planning assumptions) (Wollongong, Shellharbour and Kiama LGAs)	0.34	2

Conclusions and recommendations for monitoring

The current number of monitoring stations meets AAQ NEPM requirements based on overall region population. As the requirement increases to two stations in upcoming years, a screening justification for monitoring carbon monoxide in one location should be undertaken and documented.

3.3 Terrain

The Illawarra Region is enclosed by a long and steep cliff running along the west of the coastal strip, known as the Illawarra escarpment (Figure 3). The escarpment runs for 120 kilometres from the junction of the Shoalhaven and Kangaroo rivers in the south to the Royal National Park in the north. The escarpment rises from 300 metres above sea level in the north, to 700 metres in the south around Albion Park. The coastal strip widens from north to south until it terminates in a ridge of hills running from the escarpment to the sea. The coastline is characterised by long sandy beaches and small coastal bays protected by large Hawkesbury sandstone headlands.

[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.

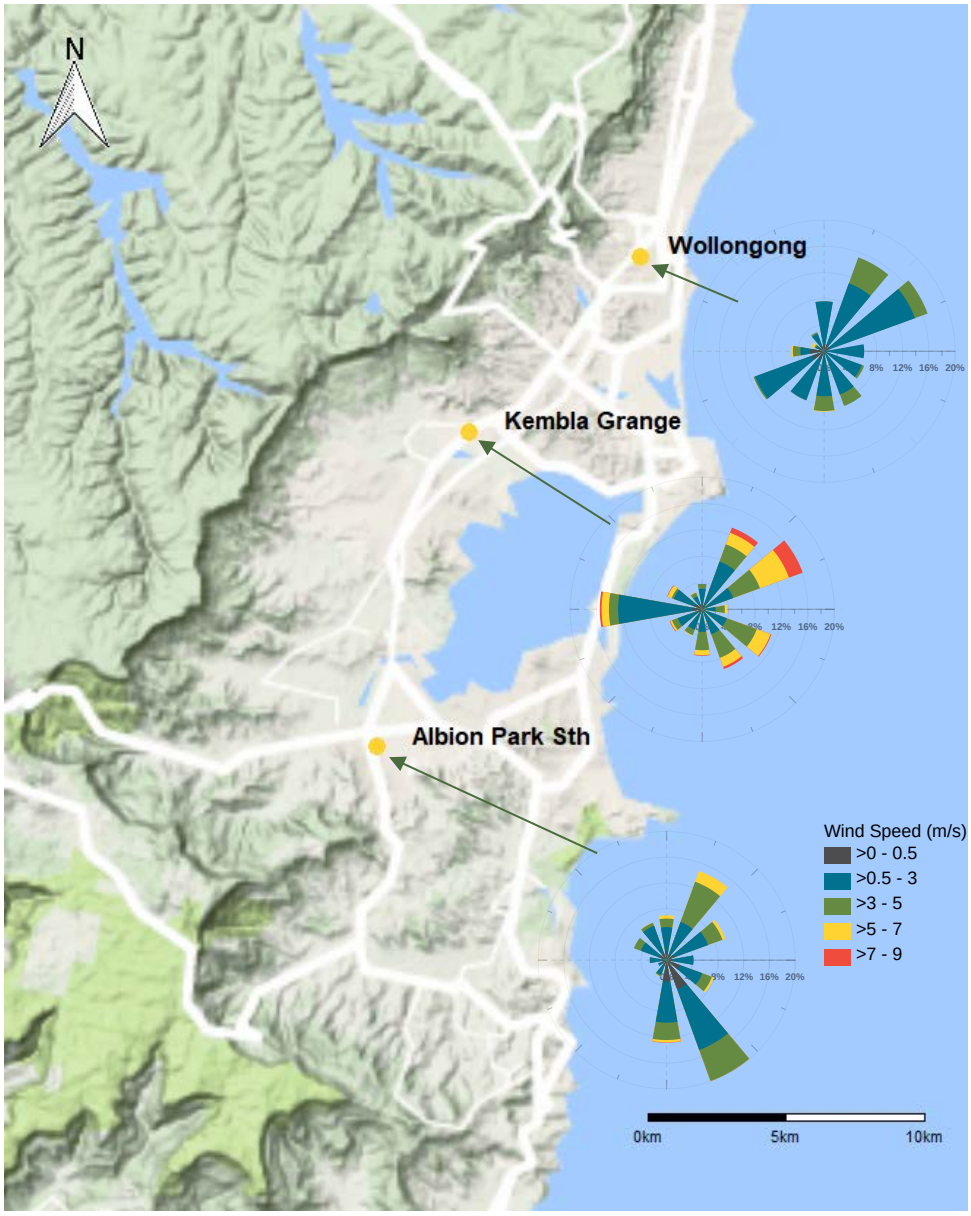

Figure 3 **Topography and annual average wind rose map for the Illawarra Region**[2]

3.4 Regional climate and meteorology

Along the coast, average maximum summer temperatures in the Illawarra Region range from 22–28°C and average winter minimums range from 8–10°C. Elevated areas near the Southern Highlands are often cooler. The Illawarra receives between 1200–1600 mm of rainfall throughout the year with more rainfall occurring in summer and autumn than the rest of the year.

Proximity to the coast and the Illawarra escarpment are significant terrain features that influence meteorology and air quality in the Illawarra Region. The escarpment can steer or deflect winds, thus changing their direction at surface. It can also lead to the decoupling of wind and temperature conditions above and below the escarpment, where one layer of the

[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).

atmosphere stops interacting with an adjacent layer. As a result, an inversion can form at the top of the escarpment, limiting the dispersion of pollutants in the Illawarra Region (Hyde et al. 1997).

Annual average wind roses (Figure 3) indicate the prevailing winds are largely aligned with the orientation of the coast at monitoring sites. North-easterly winds are prevalent at Wollongong, Kembla Grange and Albion Park South while westerly to south-westerly airflow is the next most prominent flow quadrant at Wollongong and Kembla Grange. The Illawarra Region is only 80 kilometres south of the Sydney region. On occasion, pollutants will be transported from Sydney to the Illawarra.

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 Illawarra Region.

Table 5 presents the top three emission activities contributing to PM2.5, PM10, SO_2, NOx and CO emissions in 2013 for the Illawarra Region (NSW EPA 2019). For PM2.5, 35.9% and 21.4% of emissions arise from basic ferrous metal manufacturing and residential wood heating. For PM10, the basic ferrous metal manufacturing and residential wood heating are still two main sources that contribute 45.1% and 11.5% respectively to the total PM10 emissions in the region. Basic ferrous metal manufacturing contributes 86.1%, 57.9% and 89.7% to SO_2, NOx and CO emissions in the region respectively.

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

Substance	Top three emission activities in the region		
$PM_{2.5}$	Commercial	Domestic–commercial	Natural
	Basic ferrous metal manufacturing 35.9%	Residential wood heating 21.4%	Prescribed burning and bushfires 8.8%
PM_{10}	Commercial	Domestic–commercial	Industrial
	Basic ferrous metal manufacturing 45.1%	Residential wood heating 11.5%	Petroleum and coal product manufacturing 6.9%
SO_2	Commercial	Off-Road	Natural
	Basic ferrous metal manufacturing 86.1%	Shipping 13.2%	Prescribed burning and bushfires 0.2%
NOx	Commercial	On-Road	Off-Road
	Basic non-ferrous metal manufacturing 57.9%	Diesel vehicle exhaust 9.7%	Non-road vehicles equipment 9.4%
CO	Commercial	On-road	Domestic–commercial
	Basic ferrous metal manufacturing	Petrol Vehicle Exhaust	Residential lawn mowing & garden equipment Vehicle exhaust

Substance	Top three emission activities in the region		
	89.7%	2.8%	1.6%

3.6 Historical air quality monitoring in the Illawarra Region

The Illawarra Region is subject to intensive, continuous air quality monitoring, 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 analyses of pollutants 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.

Summary

Since 1994, air quality has been 'very good' or 'good' for 83–91% of days in the Illawarra Region. Illawarra experienced 'poor or worse' air quality days due to ozone and particle (PM10 and PM2.5) pollution.

Monitoring over the past 20 years reveals exceedances of the NEPM standard concentrations for ozone and particles (PM10 and PM2.5).

Further description of regional pollution is given below.

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, volatile organic compounds (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 Illawarra 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
- December 2001 – the ‘black Christmas’ bushfires.

PM10

Since 1994, PM10 concentrations and the number of exceedance days vary 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 Illawarra Region recorded its highest number of exceedance days (26) since 1994.

PM2.5

Long-term trends for PM2.5 are difficult to discern since approved PM2.5 monitoring instrumentation was not deployed across the Illawarra Region until 2012. Since then there has been no discernible trend. However, in 2019, due to the ‘black summer’ bushfires, the Illawarra Region recorded its highest number of exceedance days (14) since 2012.

Ozone

Ground-level ozone is a secondary pollutant produced by the reaction of NOx and VOCs in sunlight. High ozone concentrations in the Illawarra 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 Illawarra in general, has declined. Since 2009 exceedance days have decreased considerably, with fewer peak ozone events occurring between 2009 and 2019, despite this period including the hottest years on record.

Carbon monoxide, nitrogen dioxide and sulfur dioxide

Since 1994, there have been significant reductions in the ambient concentrations of CO, NO_2, SO_2 and lead. There have been no exceedances for these pollutants since that time. Over recent years, the reductions in the concentrations of these pollutants have tailed off, potentially indicating the benefits of emission reduction measures are being offset by growth in emissions activities.

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. For example, in 2017 the NSW Government invited air quality stakeholders to complete an online survey to help inform the development of a clean air policy for New South Wales. Survey respondents called for more monitoring stations. The survey findings are available on the NSW EPA website.

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. The NSW Government 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 any 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 monitoring plan will be updated annually, with a major review in 2025.

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 which have a large population base 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 Illawarra air quality region, current monitoring is considered sufficient in both geographic spread and pollutants measured. In addition to continual air quality monitoring, industrial monitoring and targeted research monitoring is undertaken periodically around the Port Kembla facilities, which represent the major industrial emission sources in the area.

Indicative monitoring for particles in the southern part of the Illawarra–Shoalhaven region (around Nowra, and further south to Ulladulla) should be considered in any future expansion of these facilities in New South Wales, given the population growth in the area and significant population already present in Nowra and Kiama.

4. Further analysis

Nowra–Bomaderry SUA analysis

The Nowra–Bomaderry SUA has a population of 36,000. It is located on the south coast, approximately 160 kilometres south of Sydney where mild winters prevail, and is within the broader Illawarra–Shoalhaven NSW planning region. The most significant anthropogenic source of emissions in this area is the Shoalhaven starch plant in Bomaderry (Australian Government 2020) which produces NOx, SO_2 and PM2.5. The area is classified as a Type 3 region[3] for NEPM air quality monitoring purposes.

Before 2001, particulate monitoring was undertaken in Nowra using a high-volume sampler on a six-day cycle over a number of years (NSW EPA 2001). The particle concentrations never exceeded the AAQ NEPM standard, rarely reaching half the standard. However, the population of Nowra–Bomaderry in 2001 was 24,000, therefore pollutant concentrations may need to be reassessed with campaign measurements. Additionally, monitoring for PM2.5 has not been undertaken in this location.

5. References

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NSW EPA 2001, *National Environment Protection Measure for Ambient Air Quality: Monitoring Plan for New South Wales*, NSW Office of Environment and Heritage, Sydney.

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[3] Type 3 – a region with a population of 25,000 people or more but with no significant point or area-based emissions, so that ancillary data can be used to infer that direct monitoring is not required.