DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

NSW Annual Compliance Report 2019

National Environment Protection (Ambient Air Quality) Measure

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Information in Section C, assessment of progress towards achieving the goal, was provided by the Climate Change and Sustainability Division.

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Contents

Acronyms, abbreviations and glossary ix

Overview 1

- Compliance with NEPM goals by pollutant 1
- Description of compliance against standards and goals 5

Section A – Monitoring summary 8

- Air quality monitoring in New South Wales 8
- Air quality reporting in New South Wales 8
- NSW AAQ NEPM Compliance Monitoring Network 9
- Monitoring methods 16
- NATA accreditation 17

Section B – Assessment of compliance with standards and goals 18

- Overview of assessment against standards and goals 18
- Compliance summaries 22

Section C – Analysis of air quality 31

- Data availability rates 31
- Air quality data tables 32
- Assessment of progress towards achieving the goals 54

Section D – Data analysis 61

- Carbon monoxide 61
- Nitrogen dioxide 63
- Ozone 66
- Sulfur dioxide 70
- Particles as PM10 75
- Particles as PM2.5 81

Section E – Episode analysis 87

- Bushfire smoke and dust storms, spring–summer 2019–20 87
- Ozone pollution episode summary, summer 2018–19 87
- Particle pollution episode summary, summer 2018–19 88
- Particle pollution episode summary, autumn–winter 2019 89

Section F – PM2.5 population exposure 90

- NSW approach to PM2.5 exposure assessment 90
- NSW annual PM2.5 concentration exposure maps 2019 92
- 2019 CAM expressed as an index 95

Appendix 98

List of tables

Table 1	Summary of compliance[1] with AAQ NEPM goals for particles by station/region in the NSW Greater Metropolitan Region (GMR)	2
Table 2	Summary of compliance[1] with AAQ NEPM goals for particles by station/region in regional New South Wales	3
Table 3	Summary of compliance[1] with AAQ NEPM goals for gases by station/region	4
Table 4	NSW AAQ NEPM Compliance Monitoring Network 2019	13
Table 4	NSW AAQ NEPM Compliance Monitoring Network 2019 (continued)	14
Table 5	Stations not complying with all siting and exposure criteria	15
Table 6	Instruments used in the NSW AAQ NEPM Compliance Monitoring Network	16
Table 7	Air quality standards and goals specified in Schedule 2 of the AAQ NEPM	18
Table 8	2019 compliance summary for carbon monoxide	22
Table 9	2019 compliance summary for nitrogen dioxide	23
Table 10	2019 compliance summary for ozone	24
Table 11	2019 compliance summary for sulfur dioxide	25
Table 12	2019 compliance summary for particles as PM10	26
Table 12	2019 compliance summary for particles as PM10 (continued)	27
Table 13	2019 compliance summary for particles as PM2.5	28
Table 13	2019 compliance summary for particles as PM2.5 (continued)	29
Table 14	2019 compliance summary for particles as PM2.5 measured using federal reference method (FRM)	29
Table 15	2019 summary of CO: daily maximum rolling 8-hour average concentrations	32
Table 16	2019 summary of NO_2: daily maximum 1-hour average concentrations	33
Table 17	2019 summary of ozone: daily maximum 1-hour average concentrations	35
Table 18	2019 summary of ozone: daily maximum rolling 4-hour average concentrations	36
Table 19	2019 days exceeding ozone 1-hour and 4-hour AAQ NEPM standard	37
Table 20	2019 summary of SO_2: daily maximum 1-hour average concentrations	41
Table 21	2019 summary of SO_2: maximum 24-hour average concentrations	42
Table 22	2019 summary of PM10: maximum 24-hour average concentrations	43

Table 22 2019 summary of PM10: maximum 24-hour average concentrations (continued) 44
Table 23 2019 summary of PM10 exceptional exceedance days by region by time of year 45
Table 24 2019 days exceeding PM10 24-hour AAQ NEPM standard (non-exceptional events) excluding Wagga Wagga North 47
Table 25 2019 summary of PM2.5: maximum 24-hour average concentrations 49
Table 25 2019 summary of PM2.5: maximum 24-hour average concentrations (continued) 50
Table 26 2019 summary of PM2.5 by FRM: maximum 24-hour average concentrations 50
Table 27 2019 summary of PM2.5 exceptional exceedance days by region by time of year 51
Table 28 2019 days exceeding PM2.5 24-hour AAQ NEPM standard (non-exceptional events) excluding Armidale 53
Table 29 2019 statistical summary for CO: daily maximum rolling 8-hour average concentrations 61
Table 30 Annual maximum rolling 8-hour average concentrations for CO (ppm) 62
Table 31 2019 statistical summary for NO_2: daily maximum 1-hour average concentrations 63
Table 32 Annual maximum 1-hour average concentrations for NO_2 (ppm) 64
Table 33 Annual average concentrations for NO_2 (ppm) 65
Table 34 2019 statistical summary for ozone: daily maximum 1-hour average concentrations 66
Table 35 2019 Statistical summary for ozone: daily maximum rolling 4-hour average concentrations 67
Table 36 Annual maximum 1-hour average concentrations for ozone (ppm) 68
Table 37 Annual maximum rolling 4-hour average concentrations for ozone (ppm) 69
Table 38 2019 statistical summary for SO_2: daily maximum 1-hour average concentrations 70
Table 39 2019 statistical summary for SO_2: daily (24-hour) average concentrations 71
Table 40 Annual maximum 1-hour average concentrations for SO_2 (ppm) 72
Table 41 Annual maximum 24-hour average concentrations for SO_2 (ppm) 73
Table 42 Annual average concentration for SO_2 (ppm) 74
Table 43 2019 statistical summary for PM10: 24-hour average concentrations 75
Table 43 2019 statistical summary for PM10: 24-hour average concentrations (continued) 76

Table 44 Annual maximum 24-hour average concentrations for PM10 (µg/m^3) 77
Table 44 Annual maximum 24-hour average concentrations for PM10 (µg/m^3) (continued) 78
Table 45 Annual average PM10 concentrations (µg/m^3) 79
Table 46 2019 statistical summary for PM2.5: 24-hour average concentrations 81
Table 46 2019 statistical summary for PM2.5: 24-hour average concentrations (continued) 82
Table 47 2019 statistical summary for PM2.5: 24-hour average concentration by federal reference method 82
Table 48 Annual maximum 24-hour average concentrations PM2.5 (µg/m^3) 83
Table 48 Annual maximum 24-hour average concentrations PM2.5 (µg/m^3) 84
Table 49 Annual maximum 24-hour average concentrations PM2.5 (µg/m^3) by federal reference method 84
Table 50 Annual average concentrations for PM2.5 (µg/m^3) 85
Table 51 Annual average concentration for PM2.5 (µg/m^3) by federal reference method 86
Table 52 CAM expressed as population-weighted PM2.5 concentration, and as population-weighted PM2.5 index for the NSW GMR and the Greater Sydney Region 2019 95

List of figures

Figure 1 AAQ NEPM compliance reporting air quality monitoring stations in the NSW GMR (Sydney, Illawarra, Central Coast and Lower Hunter regions) 2019 10

Figure 2 AAQ NEPM compliance reporting air quality monitoring stations in regional NSW 2019 11

Figure 3 PM10 exceedance days at Wagga Wagga and Wagga Wagga North station compared with ‘bare ground’ coverage 46

Figure 4 PM2.5 rolling 24-hour average compared to temperature range at Armidale 52

Figure 5 Spatial distribution of PM2.5 annual average concentration for 2019 92

Figure 6 Population density (population/km^2) for the NSW GMR and Greater Sydney Region for 2019 93

Figure 7 PM2.5 exposure for NSW GMR and Greater Sydney Region during 2019 94

Figure 8 CAM time series expressed as index for Greater Sydney Region 1996 to 2019 96

Figure 9 CAM time series expressed as index for the NSW GMR 1996 to 2019 97

Acronyms, abbreviations and glossary

Following is a list of acronyms, abbreviations and terms used in this report.

AAQ NEPM	Ambient Air Quality National Environment Protection Measure
ABS	Australian Bureau of Statistics
Ambient air	The external air environment (does not include the air environment inside buildings or structures)
AQMN	air quality monitoring network
AS/NZS	Australian Standard/New Zealand Standard
BAM	beta attenuation monitor
BHELP	Broken Hill Environment Lead Program
CAM	Clean Air Metric
CBD	central business district
CO	carbon monoxide
EPA	NSW Environment Protection Authority
EU	European Union
FDMS	filter dynamics measurement system
FRM	federal reference method (USEPA)
GIS	geographic information system
GMR	Greater Metropolitan Region
GREP	Government Resource Efficiency Policy
KOALA	knowing our ambient local air quality (low-cost sensors)
LBL	load-based licensing
Monitoring station	A facility for measuring the concentration of one or more pollutants in the ambient air in a region or subregion. Also referred to as ‘monitoring site’.
NATA	National Association of Testing Authorities
ND	Not determined. This means that 75% availability of data in at least one yearly quarter was not demonstrated at this monitoring station.
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NO_2	Nitrogen dioxide
O_3	Ozone
Pb	Lead
PM2.5	Particulate matter with an aerodynamic diameter of 2.5 micrometres or less
PM10	Particulate matter with an aerodynamic diameter of 10 micrometres or less

POEO	Protection of the Environment Operations
ppm	parts per million – parts of pollutant per million parts of air by volume
SO_2	sulfur dioxide
TEOM	tapered element oscillating microbalance
TSP	total suspended particles
USEPA	United States Environmental Protection Agency
$\mu g/m^3$	microgram of pollutant (1 millionth of a gram) per cubic metre of air, referenced to temperature of 0°C (273.15 K) and absolute pressure of 101.325 kilopascals (kPa)
VOCs	Volatile organic compounds – chemical species that have high enough vapour pressure to exist at least partially as a gas at standard atmospheric temperature and pressure

Overview

The National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM or NEPM) sets national standards and air quality goals. This measure is implemented under the *Protection of the Environment Operations Act 1997* (POEO Act), the Protection of the Environment Operations (Clean Air) Regulation 2010 and the Protection of the Environment Operations (General) Regulation 2009.

This annual compliance report is required under clause 18 of the AAQ NEPM. It presents NSW air quality monitoring data for 2019, assessed against the requirements of the AAQ NEPM. The data are available on the NSW Department of Planning, Industry and Environment public website.

The AAQ NEPM (amended February 2016) sets requirements for the monitoring and reporting of air quality, including:

- air quality standards, as levels of pollutants against which air quality can be assessed
- goals for air pollutant levels, to achieve the air quality standards
- a description of the circumstances which led to exceedances of standards, including the influence of natural events and fire management on airborne particulate matter, measured as PM10 (particles of diameter less than 10 microns) and PM2.5 (particles of diameter less than 2.5 microns)
- a requirement to report population exposures to PM2.5 annually from June 2018.

In 2019, the NSW AAQ NEPM Compliance Monitoring Network (the network) comprised 32 air quality monitoring stations. The network is a part of the NSW Government's ambient air quality monitoring network.

The network was operated by the NSW Government, in accordance with the NSW Air Quality Monitoring Plan, the AAQ NEPM Technical Papers and the Department's accreditation by the National Association of Testing Authorities (NATA).

Compliance with NEPM goals by pollutant

Compliance with NEPM goals and standards in 2019 is outlined in Table 1 and Table 2 for particulate matter measured as PM10 and PM2.5, and Table 3 for the gaseous pollutants ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2).

Monitoring for lead (Pb) in New South Wales ceased in 2004 as ambient lead concentrations fell well below existing standards following the introduction of unleaded motor fuel.

Table 1 Summary of compliance[1] with AAQ NEPM goals for particles by station/region in the NSW Greater Metropolitan Region (GMR)

Station count	Region/station	PM10 1-day	PM10 1-year	PM2.5 1-day	PM2.5 1-year
	Sydney East[2]				
1	Chullora	C	C	ND	ND
2	Earlwood	C	C	C	N-C
3	Macquarie Park	C	C	C	N-C
4	Randwick	C	C	C	N-C
5	Rozelle	C	C	C	N-C
	Sydney North West[2]				
6	Parramatta North	C	N-C	C	N-C
7	Prospect	C	N-C	C	N-C
8	Richmond	C	C	ND	ND
9	Rouse Hill[3]	ND	ND	ND	ND
10	St Marys	C	C	C	N-C
	Sydney South West[2]				
11	Bargo	C	C	C	N-C
12	Bringelly	C	C	C	N-C
13	Camden	C	C	C	N-C
14	Campbelltown West	C	C	ND	ND
15	Liverpool	N-C	N-C	N-C	N-C
16	Oakdale	N-C	C	C	N-C
	Illawarra				
17	Albion Park South	C	C	C	N-C
18	Kembla Grange	N-C	N-C	C	N-C
19	Wollongong	ND	ND	C	N-C
	Central Coast				
20	Wyong	C	C	C	N-C
	Lower Hunter				
21	Beresfield	C	N-C	C	N-C
22	Newcastle	C	N-C	C	N-C
23	Wallsend	C	C	C	N-C

Notes

1 C = compliant with goal; N-C = not-compliant with goal; ND = not demonstrated.

2 These three subregions are defined within the NEPM as a single region, but are split here into public reporting subregions as they were in 2019.

3 Rouse Hill online from May 2019.

Table 2 Summary of compliance[1] with AAQ NEPM goals for particles by station/region in regional New South Wales

Station Count	Region/Station	PM10 1-day	PM10 1-year	PM2.5 1-day	PM2.5 1-year
	Central Tablelands[2]				
24	Bathurst	C	N-C	C	N-C
25	Orange	N-C	N-C	N-C	N-C
	North West Slopes[2]				
26	Gunnedah	C	C	N-C	N-C
27	Narrabri	C	C	C	C
28	Tamworth	C	N-C	C	N-C
	Northern Tablelands[2]				
29	Armidale	C	N-C	N-C	N-C
	South West Slopes[2]				
30	Albury	N-C	C	C	N-C
31	Wagga Wagga North	N-C	N-C	C	N-C
	Southern Tablelands[2]				
32	Goulburn[3]	ND	ND	ND	ND

Notes

1 C = compliant with goal; N-C = not-compliant with goal; ND = not demonstrated.

2 The regions as defined here are the overall NSW air quality monitoring regions, as they were active in 2019. In contrast, for compliance against NEPM standards, each of these nine stations defines only the air quality in that urban area.

3 Goulburn online from November 2019.

Table 3 Summary of compliance[1] with AAQ NEPM goals for gases by station/region

Station count	Region/station	Ozone 1-hour	Ozone 4-hour	NO_2 1-hour 1-year	CO 8-hour	SO_2 1-hour 1-day 1-year
	Sydney					
1	Chullora	N-C	N-C	C	C	C
2	Earlwood	N-C	N-C	C	-	-
3	Macquarie Park	N-C	N-C	C	C	C
4	Randwick	N-C	N-C	C	-	C
5	Rozelle	N-C	N-C	C	C	C
6	Parramatta North	N-C	N-C	C	C	C
7	Prospect	N-C	N-C	C	C	C
8	Richmond	N-C	N-C	C	-	C
9	Rouse Hill[2]	N-C	N-C	ND	ND	ND
10	St Marys	N-C	N-C	C	-	-
11	Bargo	N-C	N-C	C	-	C
12	Bringelly	N-C	N-C	C	-	C
13	Camden	N-C	N-C	C	C	-
14	Campbelltown West	N-C	N-C	C	C	ND
15	Liverpool	N-C	N-C	C	C	C
16	Oakdale	N-C	N-C	C	-	-
	Illawarra					
17	Albion Park South	C	C	C	-	C
18	Kembla Grange	C	N-C	C	-	-
19	Wollongong	C	N-C	C	C	C
	Central Coast					
20	Wyong	C	N-C	C	C	C
	Lower Hunter					
21	Beresfield	C	N-C	C	-	C
22	Newcastle	N-C	N-C	C	C	C
23	Wallsend	N-C	N-C	C	-	C
	North West Slopes					
26	Gunnedah	C	N-C	C	-	-
	Southern Tablelands					
32	Goulburn[3]	N-C	N-C	ND	-	-

Notes

1 C = compliant with goal; N-C = not-compliant with goal; '-' = not monitored; ND = not demonstrated.

2 Rouse Hill online from May 2019.

3 Goulburn online from November 2019.

Description of compliance against standards and goals

Compliance against AAQ NEPM standards and goals are summarised below for ozone and particles as PM2.5 and PM10.

Ozone

Ozone 1-hour standard

The NEPM 1-hour standard was exceeded on 16 calendar days in 2019, eight days during January 2019 in Western Sydney; and eight days between October and December 2019 during the 2019–20 bushfires across all regions where ozone was measured, except the North West Slopes.

Twenty-one of 25 stations exceeded the 1-hour standard: two stations with one allowable exceedance day and 19 stations with between two and 11 exceedance days.

Ozone 1-hour goal

The NEPM goal for the 1-hour ozone standard allows one exceedance day per year.

Six of 25 stations met the NEPM 1-hour ozone goal: four stations with no exceedance days and two stations with one allowable exceedance day.

Nineteen of 25 stations did not comply with the NEPM 1-hour ozone goal. All 16 stations in Sydney were non-compliant, as were Goulburn in the Southern Highlands and Newcastle and Wallsend in the Lower Hunter.

Ozone 4-hour standard

The NEPM 4-hour standard was exceeded on 31 calendar days in 2019. Ten calendar days occurred during January and February 2019 in Western Sydney. The other 21 days occurred between October and December 2019 across regions where ozone was measured, due to the impact of smoke from bushfires.

Twenty-four of 25 stations exceeded the 4-hour standard, with two to 18 exceedance days recorded at any given station. Only Albion Park South in Illawarra recorded no exceedance days during 2019.

Ozone 4-hour goal

The NEPM goal for the 4-hour ozone standard allows one exceedance day per year.

Only one of 25 stations met the NEPM 4-hour ozone goal: Albion Park South in Illawarra which recorded no exceedance days.

The other 24 stations did not comply with the NEPM 4-hour ozone goal.

Nitrogen dioxide, carbon monoxide and sulfur dioxide

A single nitrogen dioxide (NO_2) exceedance was observed in Goulburn on 31 December 2019 due to bushfire smoke, the first such exceedance recorded in New South Wales since the late-1990s. For the AAQ NEPM goal, one allowable exceedance day is allowed, meaning that nitrogen dioxide met the AAQ NEPM 1-hour goal at all monitored locations. The NO_2 annual average goal was not exceeded at any monitoring site.

Gaseous carbon monoxide (rolling 8-hour) and sulfur dioxide (1-hour, 24-hour and annual average) standards or goals were not exceeded at any site where they were monitored for NEPM compliance monitoring purposes.

Particles summary

In summary, PM10 and PM2.5 levels increased significantly at all measurement locations across the State in 2019. The major influence on elevated particle pollution was from the bushfires during the 2019–20 spring and summer seasons, with the smoke impacting air quality across New South Wales during this period. Widespread dust storms also significantly impacted air quality during the year. Drought and low rainfall resulted in poor ground cover in central and western parts of the State, significantly contributing to increased dust levels under high winds. Other influences which led to elevated particle concentrations on specific days during the year were hazard reduction burning, wood smoke from domestic heating, and relatively smaller bushfires (compared to the 2019–20 ‘black summer’ bushfires). These occurred in the far north and south of the State in early 2019.

Particles as PM10

Thirty-two stations in the NSW AAQ NEPM Compliance Monitoring Network monitored PM10 levels in 2019, compared with 28 in 2018. Twenty-nine stations met the requirement for at least 75% data availability.

PM10 24-hour standard

The PM10 24-hour standard was exceeded on 129 calendar days in 2019.

Events on 110 days were attributable to exceptional events. The major causes were widespread dust storms, which occurred in eight out of 12 months during the year, and smoke during the 2019–20 bushfires which contributed to exceedances on at least 64 days. There were multiple days when both bushfire smoke and widespread dust storms contributed to particle exceedances at the same location. Between January and March 2019, there were seven days where bushfire smoke was a contributor to exceedances. During cooler months, there were nine days when hazard reduction burns were a contributing factor.

There were 32 exceedance events over 30 calendar days identified as non-exceptional due to the impact of particles from local sources. Most of these were related to elevated dust levels, which were not directly attributable to continental-scale dust events. The number of these increased compared to previous years due to the impact of drought on local or regional sources, particularly at Wagga Wagga in regional NSW. The categorisation of what constituted a continental-scale dust event was challenging in 2019. This was associated with reduced ground cover across the State, particularly in semi-arid and agricultural areas in western and central NSW, and parts of the eastern seaboard.

Six stations exceeded the PM10 24-hour standard due to non-exceptional particle events from local sources: Liverpool and Oakdale in Sydney South West, Wagga Wagga North and Albury in the Riverina Region, Kembla Grange in the Illawarra Region and Orange in the Central Tablelands.

PM10 24-hour goal

Twenty-one of 29 stations met the 24-hour PM10 goal of zero exceedances excluding exceptional events. Six stations did not comply with the 24-hour PM10 goal, due to exceedance days related to local particle sources (non-exceptional events), as noted above. Three stations did not comply as they did not have sufficient data coverage during 2019.

PM10 annual standard

Eighteen of 29 stations recorded annual average concentration below the annual standard of 25.0 micrograms per cubic metre (µg/m^3). For the annual standard no goal is applied. All valid data (including exceptional event days) are included in the calculation of the annual averages.

In the Greater Metropolitan Region (GMR) there were six stations which exceeded the annual standard: Liverpool, Parramatta North and Prospect in Sydney, Beresfield and Newcastle in the Lower Hunter, and Kembla Grange in Illawarra.

In regional NSW, five of the eight stations (where annual averages are available) exceeded the annual standard: Armidale in the Northern Tablelands, Bathurst and Orange in the Central Tablelands, Wagga Wagga North in the South West Slopes and Tamworth in the North West Slopes. Wagga Wagga North recorded the highest annual average of 35.3 µg/m^3.

Particles as PM2.5

Thirty-two stations in the NSW AAQ NEPM Compliance Monitoring Network monitored PM2.5 levels in 2019, compared with 28 in 2018. Twenty-seven stations met the requirement for at least 75% data availability.

PM2.5 24-hour standard

The PM2.5 24-hour standard was exceeded on 116 calendar days in 2019.

The 2019–20 bushfires contributed to 69 exceedance days between 12 September and 31 December, including the last consecutive 51 days of the year starting from 11 November. In contrast, the 2018–19 bushfires led to only five exceedances in 2019, one in Narrabri, one (partial contribution) in Armidale, and three in Albury. Hazard reduction burns also contributed to exceedances of the 24-hour standard in the GMR and the South West Slopes and Central Tablelands, between April and August.

Non-exceptional particle events were observed at four sites due to smoke generated by domestic wood heating. Two of these sites, Armidale and Orange, are reported against the NEPM for the first time in 2019.

PM2.5 24-hour goal

Twenty-three of 27 stations met the NEPM 24-hour PM2.5 goal of zero exceedances, excluding exceptional events.

Four stations did not meet the goal, with all non-exceptional exceedance days affected by wood smoke generated from domestic wood heating. These occurred on 24 days at Armidale in the Northern Tablelands, four days at Orange in the Central Tablelands, two days at Gunnedah in the North West Slopes and one day at Liverpool in Sydney South West.

PM2.5 annual standard

Only one of 27 stations, Narrabri, recorded an annual average concentration (7.8 µg/m^3) below the 8 µg/m^3 standard. The other 26 stations recorded annual averages above the standard, ranging from 9.2-13.2 µg/m^3 in the GMR to 10.1–17.2 µg/m^3 in regional NSW, with Armidale measuring the highest annual average of 17.2 µg/m^3. For the annual standard no goal is applied. All valid data (including data from exceptional event days) are included in the calculation of the annual averages.

Section A – Monitoring summary

Air quality monitoring in New South Wales

The NSW Government operated a network of 86 monitoring stations as of 31 December 2019. This network comprised 51 air quality monitoring stations in metropolitan and regional centres, which are accredited by NATA, and 35 rural indicative air quality monitoring stations:

- 25 stations in the GMR
  - 18 stations in the Greater Sydney Region
  - three stations in the Lower Hunter Region
  - three stations in the Illawarra Region
  - one station on the Central Coast
- nine stations in NSW regional centres
  - three stations in the North West Slopes
  - two stations in the South West Slopes
  - two stations in the Central Tablelands
  - one station in the Northern Tablelands
  - one station in the Southern Tablelands
- 17 stations in NSW Government-operated, industry-funded networks, monitoring specific air pollutants generated by industry. These networks comprised:
  - 14 stations in the Upper Hunter Air Quality Monitoring Network, monitoring air quality affected by coalmining and coal-fired power generation
  - three stations in the Newcastle Local Air Quality Monitoring Network, monitoring air quality affected by industrial activity around the port of Newcastle
- 35 stations in the NSW Rural Air Quality Monitoring Network, monitoring dust and smoke levels in rural NSW and across state borders into South Australia and Victoria
  - These stations provide indicative monitoring of airborne particulate matters, as PM10 and PM2.5 and total suspended particles (TSP). The indicative monitoring does not comply with Australian Standards, and PM10 and PM2.5 data recorded are not intended for comparison with national air quality standards for PM2.5 or PM10.

Air quality reporting in New South Wales

NSW air quality monitoring network (AQMN) data are available on the Department's website and updated hourly, including the:

- NSW AAQ NEPM Compliance Monitoring Network (metropolitan and regional centres)
- Upper Hunter Air Quality Monitoring Network map
- Lower Hunter and Newcastle Local Area Network map
- Rural Air Quality Monitoring Network.

More information about the networks and current and historic data can be found on the Department's website: Air quality monitoring network.

NSW AAQ NEPM Compliance Monitoring Network

The AAQ NEPM requires the NSW Government to report annually on compliance with the national standards and goals for air quality measured at designated monitoring stations.

The NSW AAQ NEPM Compliance Monitoring Network comprised 32 stations for assessing the exposure of the general population to air pollution in 2019 (Table 4). This network comprised the following NATA-accredited stations:

- 23 stations in the GMR (Figure 1)
  - 16 stations in Greater Sydney
  - three stations in Illawarra
  - one station on the Central Coast
  - three stations in the Lower Hunter
- nine stations in NSW regional centres (Figure 2)
  - two stations in the Central Tablelands
  - three stations in the North West Slopes
  - one station in the Northern Tablelands
  - two stations in the South West Slopes
  - one station in the Southern Tablelands.

The NSW AAQ NEPM Compliance Monitoring Network is designed to measure air quality experienced by the general population and capture pollution events that impact population centres. This means the location of monitoring stations in each region was selected to optimise both population coverage and representation of the occurrences of higher pollutant concentrations. Constraints that limit the availability of suitable sites include security, representativeness, and certainty for the availability of long-term monitoring.

Types of monitoring stations

The NSW Government assesses the air quality to which the general population is exposed in a region by monitoring all air pollutants of interest across a network of stations. The AAQ NEPM clause 14 allows for fewer monitoring stations where it can be demonstrated that pollutant levels are reasonably expected to be consistently lower than the AAQ NEPM standards. These screening criteria were used for carbon monoxide, nitrogen dioxide, ozone and sulfur dioxide at several regions in New South Wales and determined the AAQ NEPM monitoring network design.

In 2019, the 32-station NSW AAQ NEPM Compliance Monitoring Network comprised a mixture of trend and performance stations, as determined for each pollutant (Table 4). Parameters for trend stations include having been operating at that location for greater than a decade, and capturing most pollution events that occur across the region. Performance stations may either have been monitored for less than a decade, measure criteria pollutants not monitored at trend stations, or may be sited to measure pollutants at the upper bounds of the concentrations likely to be experienced in a region. This ensures that all major pollution events are captured and reported.

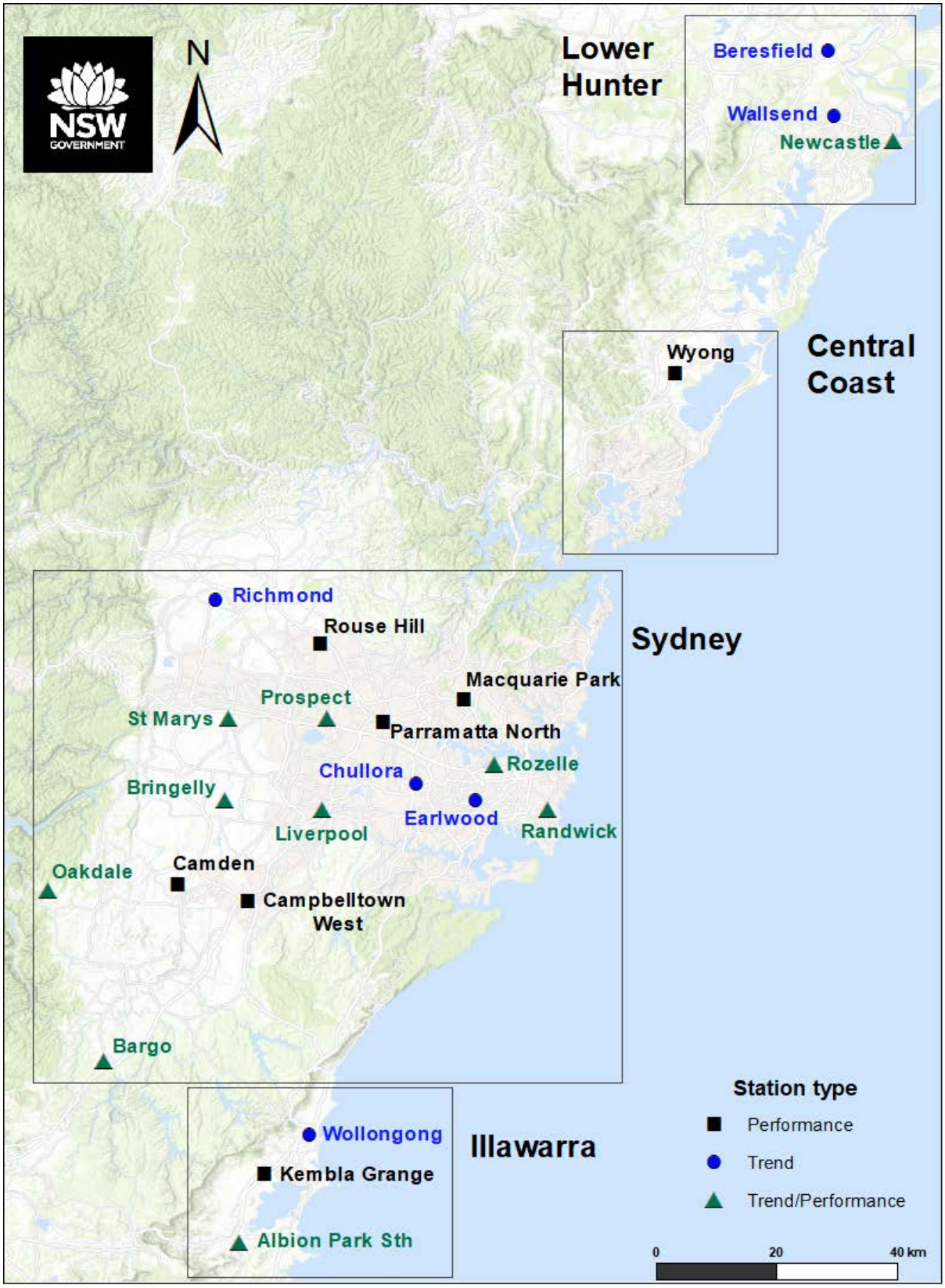

Figure 1 **AAQ NEPM compliance reporting air quality monitoring stations in the NSW GMR (Sydney, Illawarra, Central Coast and Lower Hunter regions) 2019**

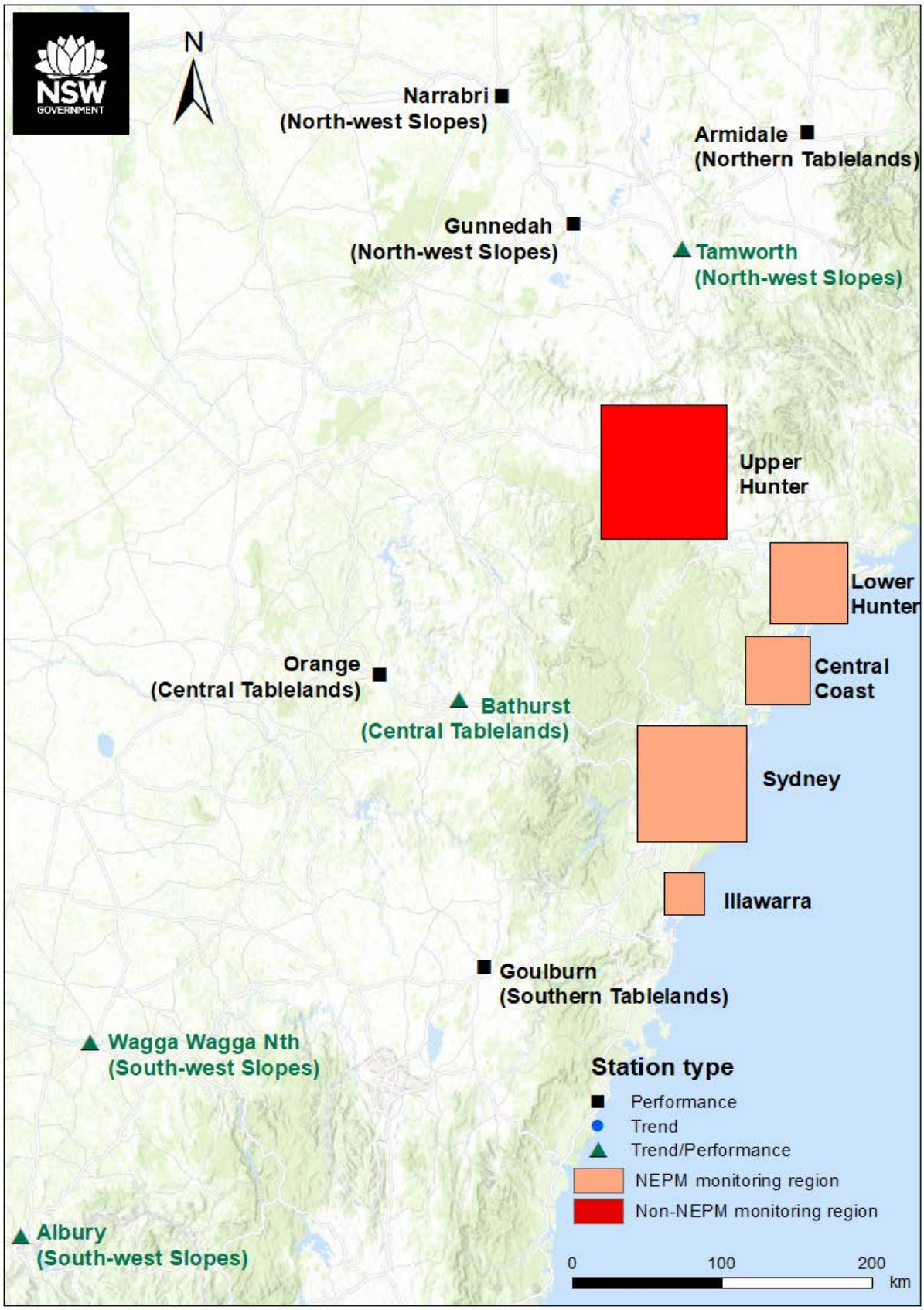

Figure 2 **AAQ NEPM compliance reporting air quality monitoring stations in regional NSW 2019**

New sites and new pollutants in 2019

The Department's review of the NSW air quality monitoring plan identified additional stations and updated the classification of station types, when compared to the NSW Air Quality Monitoring Plan 2001. This was reflected in the New South Wales Annual Compliance Report 2018.

For 2019, four stations in the NSW AQMN were added to the NSW AAQ NEPM Compliance Monitoring Network:

- Rouse Hill in Sydney (North West subregion)
- Orange in the Central Tablelands
- Armidale in the Northern Tablelands
- Goulburn in the Southern Tablelands.

Data for both Rouse Hill and Goulburn are reported in this NSW Annual Compliance Report 2019, despite being established during the calendar year. Rouse Hill was included because the station was a continuation of the Vineyard station which was decommissioned in 2016. Goulburn was included given the high pollutant readings observed in the eight weeks of operation in late 2019, which were due to the impact of bushfire smoke on air quality in the broader region.

Additionally, SO_2 monitoring, which has been undertaken at Liverpool since 2016, has been included for the first time in the 2019 compliance report.

Table 4 NSW AAQ NEPM Compliance Monitoring Network 2019

Count	Region/ monitoring station	Start year	Overall[1]	PM10	PM2.5	Ozone and NO_2	CO	SO_2
	Sydney East							
1	Chullora[2]	2003	T	T	T	T	T	T
2	Earlwood	1998	T	T	T	T	-	-
3	Macquarie Park[3]	2017	P	P	P	P	P	P
4	Randwick	1995	T/P	T	P	T	-	T
5	Rozelle	1978	T/P	T	P	T	T	P
	Sydney North West							
6	Parramatta North[4]	2017	P	P	P	P	P	P
7	Prospect[5]	2007	T/P	T	P	T	T	T
8	Richmond	1992	T	T	T	T	-	T
9	Rouse Hill[6]	2019	P	P	P	P	P	P
10	St Marys	1992	T/P	T	P	T	-	-
	Sydney South West							
11	Bargo	1996	T/P	T	P	T	-	T
12	Bringelly	1992	T/P	T	P	T	-	T
13	Camden	2012	P	P	P	P	P	-
14	Campbelltown West[7]	2012	P	P	P	P	P	P
15	Liverpool	1990	T/P	T	T	T	T	P
16	Oakdale	1996	T/P	T	P	T	-	-
	Illawarra							
17	Albion Park South[8]	2005	T/P	T	P	T	-	T
18	Kembla Grange	1994	P	P	P	P	-	-
19	Wollongong	1993	T	T	T	T	T	T
	Central Coast							
20	Wyong	2012	P	P	P	P	P	P
	Lower Hunter							
21	Beresfield	1993	T	T	T	T	-	T
22	Newcastle	1992	T/P	T	P	T	T	T
23	Wallsend	1992	T	T	T	T	-	T

Table 4 NSW AAQ NEPM Compliance Monitoring Network 2019 (continued)

Count	Region/ monitoring station	Start year	Overall[1]	PM10	PM2.5	Ozone and NO_2	CO	SO_2
	Central Tablelands							
24	Bathurst	2000	T/P	T	P	-[9]	-	-
25	Orange[10]	2019	P	P	P	-	-	-
	North West Slopes							
26	Gunnedah	2017	P	P	P	P	-	-
27	Narrabri	2017	P	P	P	-	-	-
28	Tamworth	2000	T/P	T	P	-	-	-
	Northern Tablelands							
29	Armidale	2018	P	P	P	-	-	-
	South West Slopes							
30	Albury	2000	T/P	T	P	-	-	-
31	Wagga Wagga North[11]	2011	T/P	T	P	-	-	-
	Southern Tablelands							
32	Goulburn[12]	2019	P	P	P	P	-	-

Notes

1 P denotes performance; T denotes trend (>10 years monitoring), '-' indicates monitoring for this pollutant has not been undertaken at this location. 'Overall' describes the mixture of pollutant monitoring as completely performance (P), completely trend (T) or a mixture of both (T/P). No stations are currently designated as campaign (C) stations.

2 Chullora replaced the Lidcombe (1972–2002) monitoring station in 2003.

3 Macquarie Park replaced the Lindfield (1994–2019) monitoring station in 2019. Due to siting non-conformance (specifically clear sky angle and wind movement), Lindfield data is not included in trend analysis.

4 Parramatta North is located at the same location as Westmead monitoring station, operating between 1980 and 2004.

5 Prospect replaced the Blacktown (1992–2004) monitoring station in 2007.

6 Rouse Hill was commissioned in May 2019. It replaced the Vineyard (1994–2016) monitoring station.

7 Campbelltown West replaced the Macarthur (2004–2012) monitoring station from September 2012.

8 Albion Park South replaced the Albion Park (1997–2005) monitoring station from 2005.

9 Ozone was measured at Bathurst as campaign monitoring between 2001 and 2006.

10 Orange monitoring station was commissioned in January 2019.

11 Wagga Wagga North replaced the Wagga Wagga (2000–2011) monitoring station in 2011.

12 Goulburn monitoring station was commissioned in November 2019.

Station siting and exposure

All stations operating within the network in 2019, except for Chullora, Earlwood, Gunnedah and Rozelle, met AAQ NEPM siting and exposure criteria (see Table 5 for further details). Some stations used in trend analyses did not comply with siting requirements during some of the period between 2010 and 2018; where information is available it is included.

Table 5 Stations not complying with all siting and exposure criteria

Station	Period	Siting criteria not met	Comments
Chullora	2010–now	Clear sky angle > 120°	Trees have grown since establishment of station
	2017–now	Distance to nearby tree > 10 m	
Earlwood	2010–now	Distance to road > 50 m Distance to nearby tree > 10 m	Site is in a car park and approximately 35 m from the road
	2010–16	Clear sky angle > 120°	Trees had grown since establishment of station
Gunnedah	2017–now	Distance to road > 50 m	Site is within 10 m of a suburban road, and just within 50 m of the highway
Liverpool	2010–11	Clear sky angle > 120°	Trees had grown since establishment of station
Rozelle	2010–now	Clear sky angle > 120° Distance to nearby tree > 10 m	Established trees in a heritage area
Tamworth	2010–16	Distance to nearby tree > 20 m	Trees already in established area, site location moved < 50 m in 2016

Monitoring methods

The NSW AQMN uses instruments in accordance with relevant Australian Standards, specified in Schedule 3 of the AAQ NEPM (Table 6).

Table 6 Instruments used in the NSW AAQ NEPM Compliance Monitoring Network

Pollutant	Standard	Title (Methods for sampling and analysis of ambient air:)	Method used
Carbon monoxide	AS 3580.7.1:2011	Method 7.1: Determination of carbon monoxide – Direct-reading instrumental method	Gas filter correlation/ infrared
Nitrogen dioxide	AS 3580.5.1:2011	Method 5.1: Determination of oxides of nitrogen – Direct-reading instrumental method	Gas-phase chemiluminescence
Photochemical oxidant (ozone)	AS 3580.6.1:2016	Method 6.1: Determination of ozone – Direct-reading instrumental method	Non-dispersive ultraviolet
Sulfur dioxide	AS 3580.4.1:2008	Method 4.1: Determination of sulfur dioxide – Direct-reading instrumental method	Pulsed fluorescence
Particles as PM10	AS 3580.9.8:2008	Method 9.8: Determination of suspended particulate matter – PM10 continuous direct mass method using a tapered element oscillating microbalance analyser	Tapered element oscillating microbalance (TEOM)
	AS/NZS 3580.9.13:2013	Method 9.13: Determination of suspended particulate matter – PM2.5 continuous direct mass method using a tapered element oscillating microbalance monitor	(TEOM-FDMS)[1]
Particles as PM2.5	AS 3580.9.10:2017	Method 9.10: Determination of suspended particulate matter – PM2.5 low volume sampler – Gravimetric method	Federal reference method (FRM) sampler
	AS/NZS 3580.9.12:2013	Method 9.12: Determination of suspended particulate matter – PM2.5 beta attenuation monitors	Beta attenuation monitor (BAM)
	AS/NZS 3580.9.13:2013	Method 9.13: Determination of suspended particulate matter – PM2.5 continuous direct mass method using a tapered element oscillating microbalance monitor	(TEOM-FDMS)[1]

Notes

1 TEOM-FDMS (filter dynamics measurement system) instruments were used at Armidale, Goulburn, Gunnedah, Narrabri and Orange stations, simultaneously measuring PM2.5 and PM10.

NATA accreditation

The NSW Government is accredited by NATA for the measurement of all AAQ NEPM parameters (accreditation number 14209), as required under Clause 12 of the AAQ NEPM. The last reassessment of the Air Quality Monitoring Laboratory and associated monitoring stations by NATA was completed in July 2019.

Section B – Assessment of compliance with standards and goals

Overview of assessment against standards and goals

Air quality is assessed against the standards and goals as specified in Schedule 2 of the AAQ NEPM (column 3, Table 7).

The goals of the AAQ NEPM are to achieve the standards, to the extent expressed as the maximum allowable number of exceedances per year (column 4, Table 7).

Table 7 Air quality standards and goals specified in Schedule 2 of the AAQ NEPM

Pollutant	Averaging period	AAQ NEPM standard (maximum concentration)	AAQ NEPM goal[1] (maximum number of allowable exceedances)
Carbon monoxide	8-hour rolling average	9.0 parts per million (ppm)	1 day a year
Nitrogen dioxide	1-hour average	0.120 ppm	1 day a year
	1-year average	0.030 ppm	None
Photochemical oxidants – as ozone	1-hour average	0.100 ppm	1 day a year
	4-hour rolling average	0.080 ppm	1 day a year
Sulfur dioxide	1-hour average	0.200 ppm	1 day a year
	1-day average	0.080 ppm	1 day a year
	1-year average	0.020 ppm	None
Particles as PM10	1-day average	50.0 µg/m^3	None[1]
	1-year average	25.0 µg/m^3	None
Particles as PM2.5	1-day average	25.0 µg/m^3	None[1]
	1-year average	8.0 µg/m^3	None
Lead	1-year average	0.5 µg/m^3	None

Notes

1 The maximum allowable number of exceedance days for particles as PM2.5 and as PM10 exclude days which are attributable to an exceptional particulate event, explained in further detail below.

Compliance with the AAQ NEPM standards by pollutant is summarised in Table 8 through to Table 14. The following statistics are provided for each pollutant monitored at each station:

- data availability rate (quarterly and annual)
- annual mean concentration (where 1-year average standard exists)
- assessment of compliance, including the number of days where standards were exceeded.

Categories used to assess compliance

The categories 'Met', 'Not met' and 'ND' (not demonstrated) are used to indicate assessment of compliance.

A station's performance is assessed as **complying with the NEPM** (i.e. '**Met**') if the number of exceedances is no more than the number specified in Schedule 2 of the AAQ NEPM.

The station is assessed as **not compliant with the NEPM** (i.e. '**Not met**') if there are more than the number of exceedances specified in Schedule 2 of the AAQ NEPM.

A station's performance is assessed as **ND** (i.e. '**not demonstrated**') if it has data availability rates less than 75% in any quarter, even if it records no exceedances or the number of exceedance days is allowable. Data losses may be due to instrument failures, closures to allow relocation or upgrading of the station, or because the station was established during the reporting year.

A region demonstrates compliance with the NEPM either when all stations in the region demonstrate compliance or when the region meets approved pollutant screening criteria.

For all tables in Section B and C, exceedances of the standards and goals are represented by bold text. This is applied to:

- maximum or second highest annual concentrations and the date on which they occurred
- number of exceedance days where that number exceeds the goal specified for that pollutant.

Calculation and reporting methods

The calculation and reporting methods used comply with the requirements described in *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 8: Annual Reports* (NEPC Peer Review Committee 2002).

Daily averages are calculated from hourly averages, as described in *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 5: Data Collection and Handling* (NEPC Peer Review Committee 2001).

An internal correction factor for United States Environmental Protection Agency (USEPA) equivalency has been applied to PM10 tapered element oscillating microbalance (TEOM) data, but there has been no subsequent treatment or temperature adjustment. PM2.5 measurements were made by using beta attenuation monitor (BAM) or TEOM-FDMS (filter dynamics measurement system) instruments. In this report, PM2.5 data collected pre-2012 by using TEOMs do not include the internal correction for USEPA PM10 equivalency or any subsequent treatment or adjustment for temperature. PM2.5 measurements using the USEPA federal reference method (FRM) are reported for the Chullora monitoring station.

All days when a pollutant standard was exceeded are listed in the tables below for ozone. Due to the high number of PM10, PM2.5 and ozone exceedances in 2019, the list of individual station exceedances is replaced with shorter summaries for PM10 and PM2.5. A full list of days per station and region is supplied in the Appendix to this report.

Exceptional events

An exceptional event means a fire or dust occurrence that adversely affects air quality at a particular location and causes an exceedance of 1-day average standards in excess of normal historical fluctuations and background levels. This is directly related to bushfire, jurisdiction-authorised hazard reduction burning, or continental-scale windblown dust (AAQ NEPM, February 2016, Clause 2).

The AAQ NEPM Clause 18 (3C) requires that jurisdictions exclude monitoring data determined as being directly associated with an exceptional event when assessing goal compliance against PM10 and PM2.5 1-day average standards. However, in accordance with Clause 18 (3A), all measured data are included when reporting compliance against 1-year average standards, including that directly associated with an exceptional event.

In this report, 1-day particulate exceedances clearly influenced by exceptional events such as natural bushfires, hazard reduction burning and widescale regional windblown dust storms are classified as exceptional events. PM10 1-day exceedances influenced by local dust sources are classified as non-exceptional events.

A brief comment describing the cause of events is given where possible. The absence of a comment does not necessarily indicate the absence of such influences; instead, no clear information may be available. In some cases, such as Wagga Wagga North, it is likely there has been an influence of widespread airborne dust contributing to the exceedance. However, the scale of transport of windblown dust in these events could not be shown to be in accordance with the wording of the standard regarding continental-scale events. Such cases have been classified as non-exceptional events, due to dust sources that may be local or perhaps regional in nature.

Section E provides links to detailed air pollution episode analyses for selected exceptional PM10 and PM2.5 events.

Population exposure to PM2.5

The AAQ NEPM clause 17 (2A) requires each participating jurisdiction to evaluate and report population exposures to particles as PM2.5 annually from June 2018. The NSW approach to PM2.5 exposure mapping is included in Section E.

A nationally consistent agreement between participating jurisdictions does not yet exist on the population exposure evaluation and reporting procedure or method.

Data availability during 2019

Twenty-six of 32 monitoring stations with continuous real-time monitors complied with the data coverage requirement for all pollutants measured at those sites (at least 75% data availability per quarter).

Rouse Hill and Goulburn stations were established during the 2019 calendar year, so full annual and quarter coverages were not possible.

Four additional monitoring stations did not meet the requirement of at least 75% data availability in any one quarter for one or more measured pollutants:

- Campbelltown West did not meet the 75% data availability requirement for two pollutants:
  - SO_2: less than 75% data availability in Q1 due to instrument issues
  - PM2.5: less than 75% data availability in Q1 due to instrument issues.
- Wollongong did not meet the 75% data availability requirement for PM10 in Q2 due to instrument issues.
- Richmond did not meet the 75% data availability requirement for PM2.5 in Q2 due to a combination of instrument issues and site mains power issues.
- Chullora did not meet the 75% data availability requirement for PM2.5 in Q4 due to an identified leak during a compliance check in November, requiring invalidation of data back to a previous successful leak check.

In addition, the high levels of particle pollution observed between September and December meant that particle instrument operation was compromised more frequently than during normal operation, due to issues related to high particle concentrations. This resulted in some likely exceptional particle exceedance days being missed. A list of likely exceedances is included in the Appendix to this report.

Compliance summaries

Carbon monoxide

Table 8 2019 compliance summary for carbon monoxide

Region/monitoring station	Data availability rate (% of hours)					Number of exceedance days	Performance against the standard and goal
	Q1	Q2	Q3	Q4	Year		
Sydney							
Camden	93.9	93.9	91.4	91.8	92.8	0	Met
Campbelltown West	92.8	95.7	93.9	95.3	94.4	0	Met
Chullora	95.4	95.5	95.7	93.2	94.9	0	Met
Liverpool	92.9	95.5	92.3	93.8	93.6	0	Met
Macquarie Park	95.4	95.7	93.8	87.6	93.1	0	Met
Parramatta North	95.7	94.1	95.5	92.9	94.6	0	Met
Prospect	95.3	95.7	94.0	94.6	94.9	0	Met
Rouse Hill	0.0	34.2	90.4	94.8	55.2	0	ND
Rozelle	92.2	93.1	95.3	95.1	93.9	0	Met
Central Coast							
Wyong	95.6	92.9	95.5	93.6	94.4	0	Met
Illawarra							
Wollongong	95.3	92.3	93.3	95.1	94.0	0	Met
Lower Hunter							
Newcastle	94.3	85.9	93.7	95.3	92.3	0	Met

Nitrogen dioxide

Table 9 2019 compliance summary for nitrogen dioxide

Region/ monitoring station	Data availability rate (% of hours)					Number of exceed-ance days	Annual mean (ppm)	Performance against standards and goals	
	Q1	Q2	Q3	Q4	Year			1-hour	1-year
Sydney									
Bargo	95.4	92.5	93.6	93.8	93.8	0	0.006	Met	Met
Bringelly	93.1	95.1	91.0	94.7	93.5	0	0.005	Met	Met
Camden	95.1	93.9	91.4	91.9	93.1	0	0.005	Met	Met
Campbelltown West	91.7	95.7	93.9	95.3	94.1	0	0.011	Met	Met
Chullora	95.5	95.5	95.6	93.1	94.9	0	0.012	Met	Met
Earlwood	92.1	95.6	91.4	94.1	93.3	0	0.010	Met	Met
Liverpool	94.3	95.4	94.9	93.7	94.6	0	0.012	Met	Met
Macquarie Park	95.4	95.7	93.8	87.5	93.1	0	0.005	Met	Met
Oakdale	95.7	93.6	92.7	88.4	92.6	0	0.002	Met	Met
Parramatta North	95.6	95.5	95.2	81.4	91.9	0	0.010	Met	Met
Prospect	95.0	95.7	94.0	93.4	94.5	0	0.009	Met	Met
Randwick	95.7	93.8	92.8	92.5	93.7	0	0.007	Met	Met
Richmond	93.6	95.5	94.9	92.5	94.1	0	0.005	Met	Met
Rouse Hill	0.0	34.3	93.8	95.0	56.1	0	-	ND	ND
Rozelle	90.6	93.5	95.3	95.2	93.7	0	0.010	Met	Met
St Marys	94.4	93.9	95.3	91.9	93.9	0	0.004	Met	Met
Central Coast									
Wyong	95.7	92.7	95.4	92.5	94.0	0	0.004	Met	Met
Illawarra									
Albion Park South	95.5	93.8	95.3	94.3	94.7	0	0.004	Met	Met
Kembla Grange	95.2	88.7	95.5	94.7	93.5	0	0.005	Met	Met
Wollongong	94.0	91.0	93.2	94.4	93.1	0	0.006	Met	Met
Lower Hunter									
Beresfield	89.0	89.1	92.3	89.4	89.9	0	0.008	Met	Met
Newcastle	95.0	95.0	93.7	94.3	94.5	0	0.008	Met	Met
Wallsend	95.3	95.1	88.0	92.1	92.6	0	0.007	Met	Met
North West Slopes									
Gunnedah	93.5	95.6	94.3	95.0	94.6	0	0.005	Met	Met
Southern Tablelands									
Goulburn	0.0	0.0	0.0	54.8	13.8	1	-	ND	ND

Ozone

Table 10 2019 compliance summary for ozone

Region/ monitoring station	Data availability rate (% of hours)					Number of exceedance days		Performance against standards and goals	
	Q1	Q2	Q3	Q4	Year	1-hour	4-hour	1-hour	4-hour
Sydney									
Bargo	95.5	93.7	92.1	94.4	93.9	**6**	**15**	**Not Met**	**Not Met**
Bringelly	90.6	95.0	92.1	94.8	93.2	**7**	**17**	**Not Met**	**Not Met**
Camden	94.3	95.2	91.6	92.0	93.2	**11**	**17**	**Not Met**	**Not Met**
Campbelltown West	92.1	95.6	85.2	92.6	91.4	**9**	**18**	**Not Met**	**Not Met**
Chullora	95.5	95.5	95.6	94.4	95.2	**2**	**4**	**Not Met**	**Not Met**
Earlwood	92.1	95.6	92.5	95.4	93.9	**2**	**4**	**Not Met**	**Not Met**
Liverpool	93.7	95.5	92.5	94.8	94.1	**4**	**9**	**Not Met**	**Not Met**
Macquarie Park	95.3	95.7	93.7	82.4	91.8	**2**	**4**	**Not Met**	**Not Met**
Oakdale	95.5	95.1	91.5	87.3	92.3	**7**	**13**	**Not Met**	**Not Met**
Parramatta North	95.4	95.5	95.5	93.1	94.9	**2**	**10**	**Not Met**	**Not Met**
Prospect	95.3	95.7	94.0	92.3	94.3	**4**	**10**	**Not Met**	**Not Met**
Randwick	95.6	93.8	93.7	94.4	94.4	**2**	**5**	**Not Met**	**Not Met**
Richmond	93.6	95.4	94.8	92.4	94.1	**4**	**8**	**Not Met**	**Not Met**
Rouse Hill	0.0	36.5	94.9	94.9	57.0	**2**	**5**	**Not Met**	**Not Met**
Rozelle	92.2	93.5	95.4	95.1	94.1	**2**	**4**	**Not Met**	**Not Met**
St Marys	95.4	93.0	94.4	94.9	94.4	**8**	**14**	**Not Met**	**Not Met**
Central Coast									
Wyong	95.6	92.9	95.5	89.2	93.3	0	**3**	Met	**Not Met**
Illawarra									
Albion Park South	95.2	92.5	95.3	94.5	94.3	0	0	Met	Met
Kembla Grange	95.4	90.8	95.5	94.6	94.1	0	**2**	Met	**Not Met**
Wollongong	95.1	94.8	93.2	95.1	94.5	1	**2**	Met	**Not Met**
Lower Hunter									
Beresfield	94.6	95.1	92.5	95.2	94.3	1	**4**	Met	**Not Met**
Newcastle	95.0	94.9	93.6	94.9	94.6	**2**	**2**	**Not Met**	**Not Met**
Wallsend	95.4	95.1	88.3	92.1	92.7	**2**	**4**	**Not Met**	**Not Met**
North West Slopes									
Gunnedah	93.5	95.4	95.1	94.9	94.7	0	**2**	Met	**Not Met**
Southern Tablelands									
Goulburn	0.0	0.0	0.0	57.3	14.4	**2**	**4**	**Not Met**	**Not Met**

Sulfur dioxide

Table 11 2019 compliance summary for sulfur dioxide

Region/ monitoring station	Data availability rate (% of hours)					Number of exceedance days		Annual mean (ppm)	Performance against standards and goals		
	Q1	Q2	Q3	Q4	Year	1-hour	24-hour		1-hour	24-hour	1-year
Sydney											
Bargo	95.3	94.0	93.1	92.5	93.7	0	0	0.000	Met	Met	Met
Bringelly	93.1	95.0	90.8	94.8	93.4	0	0	0.001	Met	Met	Met
Campbelltown West	63.9	95.6	93.3	95.3	87.1	0	0	*0.001*[1]	ND	ND	ND
Chullora	95.5	95.5	95.6	86.9	93.4	0	0	0.001	Met	Met	Met
Liverpool	94.4	95.4	95.0	93.7	94.6	0	0	0.001	Met	Met	Met
Macquarie Park	91.2	95.7	93.8	87.6	92.1	0	0	0.001	Met	Met	Met
Parramatta North	95.6	95.3	95.4	93.1	94.9	0	0	0.001	Met	Met	Met
Prospect	95.3	95.7	93.2	94.6	94.7	0	0	0.001	Met	Met	Met
Randwick	95.7	93.9	93.9	88.5	93.0	0	0	0.001	Met	Met	Met
Richmond	92.5	95.5	94.5	91.1	93.4	0	0	0.000	Met	Met	Met
Rouse Hill	0.0	34.6	91.2	93.7	55.2	0	0	-	ND	ND	ND
Rozelle	92.2	93.5	95.3	94.8	94.0	0	0	0.001	Met	Met	Met
Central Coast											
Wyong	95.7	92.9	95.4	93.6	94.4	0	0	0.001	Met	Met	Met
Illawarra											
Albion Park South	95.6	92.9	95.3	92.3	94.0	0	0	0.001	Met	Met	Met
Wollongong	95.1	90.9	91.7	90.8	92.1	0	0	0.001	Met	Met	Met
Lower Hunter											
Beresfield	94.5	95.2	93.1	95.1	94.5	0	0	0.002	Met	Met	Met
Newcastle	95.0	94.9	93.6	95.4	94.7	0	0	0.001	Met	Met	Met
Wallsend	90.1	92.1	87.8	92.2	90.6	0	0	0.002	Met	Met	Met

Notes

1 Italicised annual mean is included where yearly data availability was greater than the 75% requirement, but where data availability in at least one quarter did not meet the 75% requirement. In these examples, performance against the 1-year standard cannot be determined.

Particles as PM10

Table 12 2019 compliance summary for particles as PM10

Region/ monitoring station	Data availability rate (% of days)					Number of exceed-ance days[1]		Annual mean (µg/m^3)	Performance against standards and goals	
	Q1	Q2	Q3	Q4	Year				24-hour	1-year
Sydney										
Bargo	100	97.8	97.8	96.7	98.1	21	(0)	21.2	Met	Met
Bringelly	100	100	96.7	97.8	98.6	24	(0)	23.6	Met	Met
Camden	100	97.8	94.6	95.7	97.0	27	(0)	22.5	Met	Met
Campbelltown West	100	97.8	97.8	96.7	98.1	24	(0)	22.3	Met	Met
Chullora	100	95.6	100	97.8	98.4	20	(0)	24.6	Met	Met
Earlwood	93.3	100	100	100	98.4	17	(0)	23.0	Met	Met
Liverpool	100	100	100	95.6	98.9	28	**(1)**	**27.7**	**Not Met**	**Not Met**
Macquarie Park	100	100	100	94.5	98.6	16	(0)	19.9	Met	Met
Oakdale	100	100	94.5	93.5	97.0	28	**(1)**	22.4	**Not Met**	Met
Parramatta North	100	97.8	100	100	99.5	22	(0)	**25.5**	Met	**Not Met**
Prospect	100	100	97.8	98.9	99.2	25	(0)	**26.0**	Met	**Not Met**
Randwick	100	100	93.5	96.7	97.5	19	(0)	24.1	Met	Met
Richmond	96.7	97.8	98.9	98.9	98.1	28	(0)	24.2	Met	Met
Rouse Hill	0.0	38.5	100	97.8	59.5	24	(0)	-	ND	ND
Rozelle	93.3	97.8	97.8	97.8	96.7	18	(0)	22.7	Met	Met
St Marys	98.9	100	97.8	96.7	98.4	26	(0)	24.6	Met	Met
Central Coast										
Wyong	98.9	97.8	96.7	96.7	97.5	19	(0)	21.1	Met	Met
Illawarra										
Albion Park South	94.5	97.8	98.9	80.4	92.9	14	(0)	19.5	Met	Met
Kembla Grange	100	94.5	100	79.4	93.4	21	**(3)**	**25.5**	**Not Met**	**Not Met**
Wollongong	97.8	61.6	96.7	97.8	88.5	17	(0)	*22.6*[2]	ND	ND
Lower Hunter										
Beresfield	98.9	97.8	100	97.8	98.6	30	(0)	**25.9**	Met	**Not Met**
Newcastle	98.9	100	100	94.6	98.4	29	(0)	**28.4**	Met	**Not Met**
Wallsend	97.8	100	88.0	95.7	95.3	21	(0)	22.9	Met	Met

Table 12 2019 compliance summary for particles as PM10 (continued)

Region/ monitoring station	Data availability rate (% of days)					Number of exceed-ance days[1]		Annual mean (µg/m^3)	Performance against standards and goals	
	Q1	Q2	Q3	Q4	Year				24-hour	1-year
Central Tablelands										
Bathurst	100	100	100	96.7	99.2	40	(0)	**27.4**	Met	**Not Met**
Orange	81.1	100	97.8	96.7	94.0	35	**(1)**	**28.3**	**Not Met**	**Not Met**
North West Slopes										
Gunnedah	88.9	100	97.8	80.5	91.8	30	(0)	24.8	Met	Met
Narrabri	100	97.8	98.9	97.8	98.6	31	(0)	23.2	Met	Met
Tamworth	97.8	100	100	97.8	98.9	52	(0)	**33.7**	Met	**Not Met**
Northern Tablelands										
Armidale	94.5	92.3	83.7	98.9	92.3	41	(0)	**27.9**	Met	**Not Met**
South West Slopes										
Albury	100	100	100	94.6	98.6	25	**(2)**	23.4	**Not Met**	Met
Wagga Wagga North	93.3	90.1	95.6	100	94.8	63	**(24)**	**35.3**	**Not Met**	**Not Met**
Southern Tablelands										
Goulburn	0.0	0.0	0.0	58.7	14.8	24	(0)	-	ND	ND

Notes

1 Non-exceptional exceedance days are shown in brackets. These days are considered assessable events. This number is non-additive, for example, '21 (3)' for Kembla Grange means there were 21 exceedance days in total recorded, of which 3 were non-exceptional and the remainder (18) were exceptional events.

2 Italicised annual mean is included where yearly data availability was greater than the 75% requirement, but where data availability in at least one quarter did not meet the 75% requirement. In these examples, performance against the 1-year standard cannot be determined.

Particles as PM2.5

Table 13 2019 compliance summary for particles as PM2.5

Region/ monitoring station	Data availability rate (% of days)					Number of exceed-ance days[1]		Annual mean (µg/m^3)	Performance against standards and goals	
	Q1	Q2	Q3	Q4	Year				24-hour	1-year
Sydney										
Bargo	98.9	92.3	95.7	94.5	95.3	21	(0)	**10.4**	Met	**Not Met**
Bringelly	100	97.8	95.7	98.9	98.1	27	(0)	**11.3**	Met	**Not Met**
Camden	97.8	96.7	93.5	93.5	95.3	28	(0)	**11.8**	Met	**Not Met**
Campbelltown West	68.9	90.1	97.8	100	89.3	27	(0)	*11.8*[2]	ND	ND
Chullora	91.1	94.5	88.0	52.1	81.4	18	(0)	*11.7*[2]	ND	ND
Earlwood	93.3	93.4	97.8	97.8	95.6	22	(0)	**10.5**	Met	**Not Met**
Liverpool	90.0	100	100	94.6	96.2	32	**(1)**	**12.8**	**Not Met**	**Not Met**
Macquarie Park	100	100	100	94.5	98.6	18	(0)	**9.2**	Met	**Not Met**
Oakdale	93.3	100	94.5	95.7	95.9	28	(0)	**13.2**	Met	**Not Met**
Parramatta North	100	97.8	100	100	99.5	21	(0)	**10.5**	Met	**Not Met**
Prospect	96.6	93.4	88.0	91.3	92.3	25	(0)	**11.9**	Met	**Not Met**
Randwick	96.7	97.8	88.0	81.5	91.0	18	(0)	**10.8**	Met	**Not Met**
Richmond	95.6	72.5	84.7	93.5	86.6	32	(0)	*13.1*[2]	ND	ND
Rouse Hill	0.0	37.4	98.9	97.8	58.9	24	(0)	-	ND	ND
Rozelle	93.3	98.9	92.4	97.8	95.6	21	(0)	**10.3**	Met	**Not Met**
St Marys	98.9	100	96.7	93.5	97.3	21	(0)	**9.8**	Met	**Not Met**
Central Coast										
Wyong	95.6	87.9	90.2	97.8	92.9	23	(0)	**10.5**	Met	**Not Met**
Illawarra										
Albion Park South	95.6	81.3	95.6	98.9	92.9	12	(0)	**8.6**	Met	**Not Met**
Kembla Grange	98.9	90.1	97.8	96.7	95.9	12	(0)	**8.8**	Met	**Not Met**
Wollongong	96.7	95.6	100	98.9	97.8	14	(0)	**9.0**	Met	**Not Met**
Lower Hunter										
Beresfield	92.2	97.8	96.8	97.8	96.2	23	(0)	**12.1**	Met	**Not Met**
Newcastle	96.6	100	100	97.8	98.6	26	(0)	**10.9**	Met	**Not Met**
Wallsend	97.8	100	88.0	96.7	95.6	19	(0)	**10.4**	Met	**Not Met**

Table 13 2019 compliance summary for particles as PM2.5 (continued)

Region/ monitoring station	Data availability rate (% of days)					Number of exceed-ance days[1]		Annual mean (µg/m^3)	Performance against standards and goals	
	Q1	Q2	Q3	Q4	Year				24-hour	1-year
Central Tablelands										
Bathurst	98.9	100	100	95.7	98.6	24	(0)	**11.3**	Met	**Not Met**
Orange	81.1	100	97.8	96.7	94.0	31	**(4)**	**15.8**	**Not Met**	**Not Met**
North West Slopes										
Gunnedah	88.9	100	97.8	90.2	94.2	24	**(2)**	**11.2**	**Not Met**	**Not Met**
Narrabri	100	97.8	98.9	97.8	98.6	20	(0)	7.8	Met	Met
Tamworth	94.4	100	97.8	98.9	97.8	32	(0)	**14.4**	Met	**Not Me**t
Northern Tablelands										
Armidale	94.5	92.3	97.8	98.9	95.9	60	**(24)**	**17.2**	**Not Met**	**Not Met**
South West Slopes										
Albury	100	100	100	96.7	99.2	19	(0)	**10.1**	Met	**Not Met**
Wagga Wagga North	93.3	89.0	96.7	100	94.8	17	(0)	**11.3**	Met	**Not Met**
Southern Tablelands										
Goulburn	0.0	0.0	0.0	58.7	14.8	28	(0)	-	ND	ND

Notes

1 Non-exceptional exceedance days are shown in brackets. These days are considered assessable events. This number is non-additive, for example, '21 (3)' for Kembla Grange means there were 21 exceedance days in total recorded, of which 3 were non-exceptional and the remainder (18) were exceptional events.

2 Italicised annual mean is included where yearly data availability was greater than the 75% requirement, but where data availability in at least one quarter did not meet the 75% requirement. In these examples, performance against the 1-year standard cannot be determined.

Table 14 2019 compliance summary for particles as PM2.5 measured using federal reference method (FRM)

Region/ monitoring station	Data availability rate[1] (% of days)					Number of exceed-ance days[2]		Annual mean (µg/m^3)	Performance against standards and goals	
	Q1	Q2	Q3	Q4	Year				24-hour	1-year
Sydney										
Chullora	96.7	85.7	75.0	88.0	86.4	7	(0)	**10.4**	Met	**Not Met**

Notes

1 Data availability rates are based on a 1-day-in-3 sampling regime.

2 Non-exceptional exceedance days are shown in brackets. These days are considered assessable events.

Lead

Compliance monitoring for lead (Pb) in New South Wales ceased in 2004, as ambient concentrations fell to levels well below the standard following the introduction of unleaded motor fuel.

Historical note on PM2.5 monitoring and reporting

A background to PM2.5 monitoring and reporting of FRM data in New South Wales is provided in the NSW Annual Compliance Report 2018.

Section C – Analysis of air quality

Data availability rates

Data availability rates are presented as either percentages of valid data or numbers of valid days.

When presented as a percentage, the value is the number of averaging periods in which the data are valid, divided by the total number of averaging periods in the year (or quarter, as appropriate).

When presented as the number of valid days, the value represents the number of days during the year when at least 75% of averaging periods during the day are valid. In other words, a valid day has at least 18 valid hours.

Calibration hour

For gaseous pollutants, the calibration hour is included in the calculation of data availability rates.

The Department does daily automated instrument calibration checks for carbon monoxide, nitrogen dioxide, ozone and sulfur dioxide during the early morning. Hourly data obtained during the calibration checks are considered invalid for reporting purposes. Hence for these pollutants the maximum number of valid 1-hour averages in a day is 23. However, all calculations for data availability given in this report include the invalid calibration hour (i.e. calculations assume there are 24 possible valid hours in a day). Therefore, for gaseous pollutants, the maximum annual 1-hour data availability is 96%.

Data availability rates and reporting periods

Each reporting period (e.g. quarter) and AAQ NEPM standard averaging period must have at least 75% data availability.

For example, the carbon monoxide AAQ NEPM standard is based on 8-hour rolling averages. A valid 8-hour rolling average is calculated as the average of the valid 1-hour averages over the preceding 8 hours (from the time point), when at least six of those hours (75%) hold valid data.

Data availability rates for pollutants reported against more than one standard

For pollutants reported against more than one AAQ NEPM standard, data availability rates may not be the same for each standard.

For instance, when ozone is measured, one hour of each day is lost during calibration checks. This affects data availability rates for reporting against the 1-hour standard for the associated hour, but it may not affect data availability rates for reporting against the 4-hour standard. Thus, the maximum data availability rate is only 96% for the 1-hour standard, but it can be 100% for the 4-hour standard.

Daily maxima

As an AAQ NEPM requirement for standards with averaging periods of less than 24 hours, the daily maxima are reported regardless of the number of valid hours in the day.

For example, the daily highest 1-hour average for NO_2 during a given year at a site may have occurred on a day on which the 75% data requirement was not met.

However, in reporting percentile distributions of the daily 1-hour maxima for the site for the year, at least 75% of valid hours must be available for the associated day. If not, the subsequent day with the highest 1-hour average from the year's dataset that meets the 75% data requirement will be used.

Air quality data tables

Data availability and maximum values recorded in 2019 are summarised below.

For ozone, PM2.5 and PM10, additional tables are provided to summarise exceedance events.

For ozone and carbon monoxide pollutant standards which are calculated against rolling averages, the second highest values are those which:

- occur on a different calendar day than the highest value
- for which the underlying averaging periods do not overlap with the highest value.

Carbon monoxide

Table 15 2019 summary of CO: daily maximum rolling 8-hour average concentrations

Region/ monitoring station	Number of valid days	Maximum values (ppm)			
		Highest	Highest (date:hour)	2nd highest	2nd highest (date:hour)
Sydney					
Camden	350	2.0	Dec19:15	1.8	Dec05:18
Campbelltown West	356	2.9	Dec19:15	1.8	Dec05:18
Chullora	358	1.4	Dec10:17	1.3	Nov19:09
Liverpool	351	1.8	Dec03:17	1.7	Dec10:16
Macquarie Park	351	3.5	Dec10:15	1.9	Dec19:15
Parramatta North	355	3.2	Dec10:16	2.4	Nov19:09
Prospect	359	2.8	Nov19:09	2.5	Dec10:16
Rouse Hill	204	3.6	Nov19:09	3.5	Dec10:14
Rozelle	351	2.2	Dec10:13	1.7	Dec19:16
Central Coast					
Wyong	356	2.4	Dec05:08	1.4	Nov19:12
Illawarra					
Wollongong	353	2.3	Dec19:13	2.2	Oct03:18
Lower Hunter					
Newcastle	341	1.5	Nov12:06	1.3	Dec10:16

Nitrogen dioxide

Table 16 2019 summary of NO_2: daily maximum 1-hour average concentrations

Region/ monitoring station	Number of valid days	Maximum values (ppm)			
		Highest	Highest (date:hour)	2nd highest	2nd highest (date:hour)
Sydney					
Bargo	356	0.066	Dec31:07	0.060	Dec30:22
Bringelly	358	0.034	Dec04:16	0.029	Aug06:18
Camden	352	0.030	Oct31:08	0.030	Aug14:20
Campbelltown West	357	0.059	Oct31:01	0.053	May21:19
Chullora	360	0.070	Nov19:08	0.054	Dec06:17
Earlwood	352	0.061	Nov19:08	0.045	Oct30:13
Liverpool	359	0.050	Oct03:21	0.050	Dec06:15
Macquarie Park	352	0.026	Jul22:11	0.025	Sep18:20
Oakdale	352	0.028	Dec01:22	0.027	Dec20:05
Parramatta North	345	0.070	Nov19:08	0.057	Jul22:07
Prospect	358	0.049	Nov19:07	0.044	Jul26:19
Randwick	353	0.051	Nov19:08	0.035	Apr29:11
Richmond	358	0.030	Aug14:20	0.027	May22:19
Rouse Hill	214	0.050	Nov19:08	0.037	Oct31:01
Rozelle	354	0.090	Dec19:15	0.053	Dec10:12
St Marys	358	0.033	Jan18:21	0.032	May21:12
Central Coast					
Wyong	356	0.036	Sep04:19	0.031	Jan21:18
Illawarra					
Albion Park South	359	0.041	Dec31:15	0.035	Dec30:17
Kembla Grange	354	0.042	Dec19:07	0.030	Aug01:09
Wollongong	351	0.040	Oct30:23	0.039	Dec19:07
Lower Hunter					
Beresfield	335	0.056	Dec05:20	0.038	Oct30:22
Newcastle	359	0.044	Dec05:24	0.040	Oct03:23
Wallsend	350	0.042	Oct03:19	0.040	Dec05:21
North West Slopes					
Gunnedah	358	0.036	May28:07	0.029	Oct26:20
Southern Highlands					
Goulburn	51	**0.161**	Dec31:19	0.118	Dec21:18

NO_2 exceedance at Goulburn

A single NO_2 exceedance was observed during 2019, occurring 31 December at the new Goulburn monitoring station in the Southern Tablelands (monitoring commenced 6 November 2019). This was the first recorded exceedance of the NO_2 standard since an exceedance on 26 February 1998, which occurred at Lidcombe in Sydney.

The hourly average NO_2 levels at Goulburn reached 0.161 ppm at 7pm (Australian Eastern Standard Time). This event was related to a southerly wind change, which concentrated smoke from the NSW South Coast bushfires and moved it through the Southern Tablelands and further inland. This event occurred at the same hour when the second highest nephelometer (reduced visibility) reading since the mid-2000s was recorded in the NSW network (with the highest being an atypical high reading at Earlwood in 2011 due to a car fire adjacent to the monitoring station).

The highest values of NO_2 recorded at two sites in the Australian Capital Territory in 2019, 0.084 ppm and 0.062 ppm, occurred between 8pm and 10pm on the same evening (ACT Government 2020). Canberra is located further inland, and approximately 80 kilometres south-west of Goulburn.

A similar southerly wind change on 21 December 2019 resulted in NO_2 levels close to the hourly standard, reaching 0.118 ppm at Goulburn. This occurred at the same hour when the third highest nephelometer (reduced visibility) reading recorded across the NSW network was recorded at Goulburn.

The two events were very similar, with the high pollution levels associated with a southerly change, showing the significant impact of smoke on air quality in Southern Tablelands during December 2019 – not just on particle pollution but gaseous pollution as well.

Ozone

Table 17 2019 summary of ozone: daily maximum 1-hour average concentrations

Region/ monitoring station	Number of valid days	Maximum values (ppm)			
		Highest	Highest (date:hour)	2nd highest	2nd highest (date:hour)
Sydney					
Bargo	356	**0.128**	Jan15:17	**0.126**	Nov21:15
Bringelly	356	**0.144**	Dec10:13	**0.110**	Dec19:13
Camden	352	**0.138**	Jan16:15	**0.121**	Nov21:13
Campbelltown West	347	**0.131**	Dec19:11	**0.129**	Dec21:14
Chullora	362	**0.176**	Dec10:12	**0.154**	Dec19:12
Earlwood	355	**0.179**	Dec10:12	**0.157**	Dec19:12
Liverpool	357	**0.157**	Dec10:12	**0.114**	Jan26:11
Macquarie Park	346	**0.122**	Dec10:12	**0.112**	Dec19:11
Oakdale	349	**0.147**	Nov21:15	**0.116**	Jan16:16
Parramatta North	360	**0.157**	Dec10:13	**0.132**	Dec19:11
Prospect	357	**0.132**	Dec10:12	**0.131**	Dec19:11
Randwick	356	**0.150**	Dec19:12	**0.112**	Dec05:14
Richmond	357	**0.137**	Jan16:15	**0.120**	Nov21:12
Rouse Hill	216	**0.112**	Dec10:12	**0.108**	Dec19:12
Rozelle	356	**0.179**	Dec19:12	**0.125**	Dec10:11
St Marys	360	**0.137**	Jan16:14	**0.123**	Dec10:13
Central Coast					
Wyong	354	0.100	Dec31:14	0.098	Dec05:12
Illawarra					
Albion Park South	358	0.099	Nov21:11	0.089	Nov19:14
Kembla Grange	355	0.100	Nov19:14	0.096	Nov29:17
Wollongong	358	**0.111**	Dec19:13	0.099	Dec04:14
Lower Hunter					
Beresfield	359	**0.126**	Dec21:15	0.096	Nov29:15
Newcastle	361	**0.104**	Dec19:12	**0.102**	Dec05:13
Wallsend	349	**0.110**	Dec21:14	**0.105**	Dec19:13
North West Slopes					
Gunnedah	360	0.094	Dec20:17	0.088	Dec24:17
Southern Highlands					
Goulburn	55	**0.147**	Dec20:13	**0.116**	Dec27:17

Table 18 2019 summary of ozone: daily maximum rolling 4-hour average concentrations

Region/ monitoring station	Number of valid days	Maximum values (ppm)			
		Highest	Highest (date:hour)	2nd highest	2nd highest (date:hour)
Sydney					
Bargo	356	**0.125**	Nov21:17	**0.107**	Jan15:18
Bringelly	356	**0.111**	Dec10:14	**0.099**	Nov21:13
Camden	352	**0.115**	Nov21:14	**0.111**	Jan16:16
Campbelltown West	346	**0.117**	Dec21:16	**0.108**	Dec19:13
Chullora	362	**0.121**	Dec19:14	**0.119**	Dec10:14
Earlwood	355	**0.125**	Dec19:14	**0.112**	Dec10:13
Liverpool	357	**0.115**	Dec10:14	**0.096**	Dec19:14
Macquarie Park	347	**0.105**	Dec19:14	**0.103**	Dec10:13
Oakdale	350	**0.130**	Nov21:16	**0.102**	Jan16:18
Parramatta North	359	**0.122**	Dec10:14	**0.119**	Dec19:13
Prospect	358	**0.122**	Dec19:13	**0.116**	Dec10:14
Randwick	356	**0.111**	Dec19:13	**0.103**	Dec05:17
Richmond	356	**0.120**	Jan16:17	**0.114**	Nov21:14
Rouse Hill	216	**0.101**	Dec10:14	**0.098**	Dec19:14
Rozelle	357	**0.149**	Dec19:13	**0.095**	Dec10:13
St Marys	360	**0.118**	Jan16:16	**0.114**	Dec10:14
Central Coast					
Wyong	353	**0.090**	Dec05:14	**0.090**	Dec31:14
Illawarra					
Albion Park South	358	0.078	Nov19:16	0.077	Dec31:14
Kembla Grange	355	**0.092**	Nov19:16	**0.090**	Nov29:18
Wollongong	359	**0.094**	Dec19:13	**0.091**	Nov19:15
Lower Hunter					
Beresfield	359	**0.107**	Dec21:16	**0.087**	Dec19:14
Newcastle	360	**0.097**	Dec19:15	**0.092**	Dec05:13
Wallsend	351	**0.097**	Dec19:15	**0.084**	Dec21:15
North West Slopes					
Gunnedah	360	**0.087**	Dec20:18	**0.082**	Dec24:18
Southern Highlands					
Goulburn	55	**0.137**	Dec20:16	**0.094**	Dec27:19

Ozone exceedances

A list of the ozone exceedances observed at sites in New South Wales across 33 days during 2019 is shown in Table 19. These were comprised of 82 station exceedances of the 1-hour standard, and 180 station exceedances of the 4-hour standard. The cause of the exceedances can be divided into those which occurred during the 2018–19 summer, and those that occurred during the 2019–20 spring–summer period:

- **January–February 2019**: there were heatwave conditions across New South Wales, driven by a stable high-pressure system in the Tasman sea. This resulted in still conditions overnight and very hot conditions during the day, resulting in strong north-easterly breezes in the Sydney basin. This transported 'aged' air from Sydney CBD towards the west and south-west. The combination of high temperatures and emissions from the broader metropolitan area resulted in secondary formation of ozone in the afternoon in the downwind areas.
- **October–December 2019**: bushfire-related exceedances occurred due to the impact of smoke on ozone precursors, specifically volatile organics and nitrogen oxides. Where possible, the fires directly causing the exceedances on those days are identified, however, the large number of fires burning concurrently in New South Wales at the time meant that attributing exceedances to a single complex of fires was not always possible.

Further details are provided on the Department's website:

- Air Quality Monitoring Network – Ozone episodes in summer 2018–19
- Air quality special statement spring–summer 2019–20: gases – Ozone pollution.

Table 19 2019 days exceeding ozone 1-hour and 4-hour AAQ NEPM standard

Day count	Date	Regions[1]	Stations exceeded[2]	Notes
1	04/01/2019	Syd SW	Bi,Bo,Cd,CW,Ok	Refer to NSW Air Quality Monitoring ozone episode analysis for 2018–19 summer[3]. This report found conditions during summer were conducive to ozone production in Western Sydney, including: • heatwave conditions (on exceedance days maximum temperature was greater than 35°C) • stable synoptic and wind conditions limiting atmospheric dispersion in the mornings • high-pressure system in the Tasman sea generating a north-east sea breeze towards south-west of Sydney. As such, exceedances were concentrated in the south-west of Sydney. This is a regular feature of high ozone days in summer. The larger number of exceedances than normally seen were attributable to January 2019 heatwave conditions.
2	15/01/2019	Syd NW Syd SW	Pr,SM Bo,Cd,CW,Ok	
3	16/01/2019	Syd NW Syd SW	PN,Pr,Ri,SM Bo,Cd,CW,Li,Ok	
4	17/01/2019	Syd NW Syd SW	Pr,SM Bo,Cd,CW,Ok	
5	18/01/2019	Syd SW	Bi,Bo,CW,Li,Ok	
6	22/01/2019	Syd SW	Bi,Bo,Cd,CW,Ok	
7	25/01/2019	Syd SW	Bi,Bo	
8	26/01/2019	Syd East Syd NW Syd SW	MP PN,Pr,SM Bi,Cd,CW,Li,Ok	
9	29/01/2019	Syd NW Syd SW	SM Bi,Cd,CW	
10	18/02/2019	Syd SW	Bi,Bo,Cd,CW	
11	31/10/2019	Syd East Syd NW Syd SW	Ch PN,Pr,RH,SM Bi,Bo,Cd,CW,Li	Bushfire smoke: A high-pressure system in the Tasman directed smoke from multiple fires on the

Day count	Date	Regions[1]	Stations exceeded[2]	Notes
12	1/11/19	Syd NW Syd SW	PN,Pr,SM Bi,Bo,Cd,CW,Ok	Mid North Coast into Sydney on a north-east breeze. There was some impact from smoke from the Gospers Mountain fire (north-west of Sydney) in Sydney North West sites, and through smoke build-up in the west of the Sydney basin overnight.
13	18/11/19	Syd NW	Ri,RH,SM	Bushfire smoke: Smoke was transported into Sydney from the north-west (Gospers Mountain fire complex). On 19 November smoke was recirculated back into coastal Sydney and Illawarra by north-east breezes. Some impact from the north coast fires was possible on 21 November, but the Gospers Mountain fire was the primary driver.
14	19/11/19	Syd East Illawarra	Ra,Ro KG,Wo	
15	21/11/19	Syd NW Syd SW	PN,Ri,SM Bi,Bo,Cd,CW,Ok	
16	28/11/19	Syd NW	Ri	Bushfire smoke: Richmond (Ri) was impacted by smoke from the Gospers Mountain fire. Parramatta (PN) was impacted by general smoke build-up in Sydney overnight. South-west Sydney and Illawarra were impacted due to the Green Wattle Creek fire (around Warragamba) which began a few days earlier.
17	29/11/19	Syd NW Syd SW Illawarra	PN,Ri Bi,Cd KG	
18	03/12/19	Syd East Syd SW	Ea,Ra Bi,CW,Li	Bushfire smoke: Impacts in south-west and eastern Sydney were due to smoke from the Green Wattle Creek fire in the Warragamba area. This was transported under constant strong west-by-south-west winds.
19	04/12/19	Syd East Syd SW	Ch,Ea,Ra Bi,Li	
20	05/12/19	Syd E	Ra	
		C Coast L Hunter	Wy Nw,Wa	Bushfire smoke: Strong westerly winds brought smoke from the Gospers Mountain complex fires to the Central Coast and Lower Hunter.
21	07/12/19	Syd NW	Ri	Bushfire smoke: From the Gospers Mountain and Green Wattle Creek fires.
22	09/12/19	Syd NW Syd SW Sth Tbl	SM Bo Go	Bushfire smoke: Impacts from Gospers Mountain and Green Wattle Creek fires: • in Sydney due to the passage of smoke through during the day • in Goulburn by recirculation of smoke under westerly winds in the afternoon.

Day count	Date	Regions[1]	Stations exceeded[2]	Notes
23	10/12/19	Syd E Syd NW Syd SW L Hunter	Ch,Ea,MP,Ro PN,Pr,Ri,RH,SM Bo,Bi,Cd,CW,Li Be,Wa	Bushfire smoke: Significant impact in Sydney due to the accumulation of smoke from the Blue Mountains fires, in front of a strong southerly wind change in the afternoon. Lower Hunter: similar accumulation from the Gospers Mountain and some North Coast fire influence, primarily during morning hours under north-easterly winds.
24	19/12/19	Syd East Syd NW Syd SW Illawarra L Hunter	Ch,Ea,MP,Ra,Ro PN,Pr,RH,SM Bi,Cd,CW,Li,Ok Wo Be,Nw,Wa	Bushfire smoke: Strong westerly and north-westerly winds brought smoke from the combined Blue Mountains fires to all of Sydney, Central Coast (instrument offline), Illawarra and Lower Hunter.
25	20/12/19	NW-Sl	Gu	Bushfire smoke: Gunnedah experienced high particle conditions during the day under south-east winds. Smoke was primarily from fires east of Gunnedah, but there was some influence from long-range transport.
		Sth Tbl	Go	Bushfire smoke: Smoke from the Palerang and Currowan fires on the NSW South Coast was transported via a strong southerly off-coast wind, which moves as an easterly through the inland in that region. Downwind of Goulburn, Canberra in the ACT also recorded ozone exceedances at all three stations (ACT Government 2020).
26	21/12/19	Syd NW Syd SW	Pr,SM Bi,Cd,CW,Li,Ok	Bushfire smoke: Westerly winds in the morning transported smoke from both major Blue Mountains fires towards the coast. An afternoon summer north-easterly breeze concentrated some smoke back towards Western Sydney, in front of a southerly change.
		L Hunter	Be,Wa	Bushfire smoke: Strong westerly winds blew smoke from the Gospers Mountain fire towards the Hunter.
27	23/12/19	Sth Tbl	Go	See comment for 20/12/19.
28	24/12/19	NW-Sl	Gu	Bushfire smoke: South-easterly winds transported smoke from multiple fires in the Mid North Coast, possibly also from Gospers Mountain. There was higher ozone on this day compared to surrounding days with similar conditions, as there was a small wind recirculation in the morning.

Day count	Date	Regions[1]	Stations exceeded[2]	Notes
29	27/12/19	Sth Tbl	Go	Bushfire smoke: Smoke overnight from the South Coast fires caused increased ozone formation during the day. A southerly front at 4pm brought increased smoke and led to exceedance.
30	28/12/19	Syd SW	Bo,CW	Bushfire smoke and high pressure: There was smoke influence in Western Sydney, albeit it reduced compared to previous days. A high-pressure system in the Tasman Sea led to smoke concentration on an easterly breeze, and 4-hour exceedances at 2 sites.
31	29/12/19	L Hunter	Be	Bushfire smoke: Smoke from fires in Barrington Tops was blown through on a north-east through east breeze, with high particles during day.
32	30/12/19	Syd NW Syd SW	PN,Pr,Ri,RH,SM Bi,Bo,Cd,Ok	Bushfire smoke: Smoke moved into Western Sydney from the combined Blue Mountains fires in the early morning. A high-pressure system in the Tasman caused an afternoon sea breeze to concentrate smoke back towards both the south-west and north-west.
33	31/12/19	Syd SW C Coast	Cd,CW,Ok Wy	Bushfire smoke: A strong north-west breeze brought smoke from Warragamba Dam fires to parts of south-west Sydney, and from Gospers Mountain fire to Wyong during the day.

Notes

1 Sites are included by 2-letter code based on region:

Syd SW (Sydney South West): Bi = Bringelly; Bo = Bargo; Cd = Camden; CW = Campbelltown West; Li = Liverpool; Ok = Oakdale

Syd NW (Sydney North West): PN = Parramatta North; Pr = Prospect; Ri = Richmond; RH = Rouse Hill; SM = St Marys

Syd East (Sydney East): Ch = Chullora; Ea = Earlwood; MP = Macquarie Park; Ra = Randwick; Ro = Rozelle

Illawarra: KG = Kembla Grange; Wo = Wollongong

L Hunter (Lower Hunter): Be = Beresfield; Nw = Newcastle; Wa = Wallsend

C Coast (Central Coast): Wy = Wyong

NW-Sl (North West Slopes): Gu = Gunnedah

Sth Tbl (Southern Tablelands): Go = Goulburn.

2 Sites shown in underline exceeded both the 1-hour and 4-hour rolling average ozone standards on that given day. Sites in **black exceeded the 4-hour rolling average ozone standard only**. No sites exceeded the 1-hour standard without exceeding the 4-hour rolling standard on the same day during 2019.

3 Further details are provided on the Department's website: Air Quality Monitoring Network – Ozone episodes in summer 2018–19.

Sulfur dioxide

Table 20 2019 summary of SO_2: daily maximum 1-hour average concentrations

Region/ monitoring station	Number of valid days	Maximum values (ppm)			
		Highest	Highest (date:hour)	2nd highest	2nd highest (date:hour)
Sydney					
Bargo	354	0.020	Oct31:04	0.011	Dec30:11
Bringelly	357	0.028	Mar25:16	0.014	Jan22:20
Campbelltown West	330	0.020	Apr22:11	0.016	May13:12
Chullora	354	0.026	Aug18:21	0.020	Mar04:10
Liverpool	358	0.016	Mar08:11	0.016	Jan22:19
Macquarie Park	348	0.029	Nov01:09	0.024	Dec30:21
Parramatta North	360	0.030	Jan30:21	0.030	Mar29:22
Prospect	359	0.021	Jan30:21	0.019	Apr30:22
Randwick	351	0.029	Feb17:09	0.029	Aug14:13
Richmond	353	0.023	Jan18:21	0.018	Jan17:19
Rouse Hill	209	0.033	Jul01:16	0.015	Oct03:21
Rozelle	356	0.032	Feb03:10	0.020	Apr30:23
Central Coast					
Wyong	357	0.061	Jan21:18	0.050	May17:13
Illawarra					
Albion Park South	356	0.025	Jan22:18	0.024	Feb04:15
Wollongong	348	0.034	Dec19:22	0.028	Jan02:24
Lower Hunter					
Beresfield	361	0.068	Oct24:13	0.047	Nov29:16
Newcastle	359	0.046	Jun29:12	0.032	Feb08:09
Wallsend	341	0.050	Jan19:10	0.037	Jun21:14

Table 21 2019 summary of SO_2: maximum 24-hour average concentrations

Region/ monitoring station	Number of valid days	Maximum values (ppm)			
		Highest	Highest (date)	2nd highest	2nd highest (date)
Sydney					
Bargo	354	0.006	Oct-31	0.004	Dec-30
Bringelly	357	0.004	Jan-02	0.003	Jan-01
Campbelltown West	330	0.004	Oct-30	0.004	Oct-31
Chullora	354	0.004	Mar-04	0.003	Feb-26
Liverpool	358	0.004	Mar-29	0.003	Jan-25
Macquarie Park	348	0.004	Dec-30	0.004	Jan-25
Parramatta North	360	0.006	Mar-29	0.004	Jan-25
Prospect	359	0.004	Jan-30	0.004	Jan-25
Randwick	351	0.005	May-09	0.004	Aug-14
Richmond	353	0.004	Jul-23	0.004	Jan-18
Rouse Hill	209	0.005	Jul-01	0.004	Dec-30
Rozelle	356	0.005	May-01	0.004	Feb-18
Central Coast					
Wyong	357	0.006	Oct-23	0.006	Jan-15
Illawarra					
Albion Park South	356	0.008	Dec-28	0.007	Jan-22
Wollongong	348	0.006	Dec-19	0.005	Dec-24
Lower Hunter					
Beresfield	361	0.009	Jan-24	0.008	Jan-27
Newcastle	359	0.006	Feb-08	0.006	Jun-29
Wallsend	341	0.009	Jun-23	0.008	Jun-17

Particles as PM10

Table 22 2019 summary of PM10: maximum 24-hour average concentrations

Region/ monitoring station	Number of valid days	Highest 24-hour average (µg/m^3)	Highest date
Sydney			
Bargo	358	**188.9**	**Dec-30**
Bringelly	360	**134.0**	**Dec-03**
Camden	354	**139.2**	**Dec-03**
Campbelltown West	358	**132.0**	**Dec-05**
Chullora	359	**140.4**	**Dec-10**
Earlwood	359	**129.4**	**Nov-26**
Liverpool	361	**178.9**	**Dec-03**
Macquarie Park	360	**187.3**	**Dec-10**
Oakdale	354	**216.8**	**Dec-21**
Parramatta North	363	**195.3**	**Dec-10**
Prospect	362	**182.8**	**Nov-26**
Randwick	356	**127.7**	**Nov-26**
Richmond	358	**193.4**	**Nov-26**
Rouse Hill	217	**216.2**	**Dec-10**
Rozelle	353	**142.7**	**Dec-10**
St Marys	359	**159.8**	**Dec-10**
Central Coast			
Wyong	356	**128.4**	**Nov-26**
Illawarra			
Albion Park South	339	**104.3**	**Feb-12**
Kembla Grange	341	**115.8**	**Nov-12**
Wollongong	323	**117.6**	**Dec-19**
Lower Hunter			
Beresfield	360	**136.7**	**Nov-26**
Newcastle	359	**125.8**	**Oct-30**
Wallsend	348	**127.9**	**Dec-05**

Table 22 2019 summary of PM10: maximum 24-hour average concentrations (continued)

Region/ monitoring station	Number of valid days	Highest 24-hour average (µg/m^3)	Highest date
Central Tablelands			
Bathurst	362	**296.6**	**Dec-20**
Orange	343	**423.7**	**Dec-22**
North West Slopes			
Gunnedah	335	**205.2**	**Nov-26**
Narrabri	360	**232.6**	**Nov-26**
Tamworth	361	**240.2**	**Nov-27**
Northern Tablelands			
Armidale	337	**309.7**	**Nov-27**
South West Slopes			
Albury	360	**222.4**	**Dec-24**
Wagga Wagga North	346	**251.7**	**Dec-20**
Southern Tablelands			
Goulburn	54	**494.1**	**Dec-31**

Across 32 reporting sites, 859 individual station exceedances were recorded across 129 calendar days, making a full table of exceedances an impractical undertaking. Instead, these are divided into a broad overview of days classified as exceptional events by region (Table 23), and a list of explicitly shown non-exceptional assessable events (Table 24).

The exceptional events summary shows a considerable number of days occurred during the last few months of 2019. A full breakdown of the classification is provided in the Appendix to this report.

Table 23 2019 summary of PM10 exceptional exceedance days by region by time of year

Region (number of sites)	Summer: Jan–Feb	Autumn: Mar-May	Winter: Jun-Aug	Spring: Sep-Oct	Spring: Nov	Summer: Dec
Sydney East (5)	-	2 (2)	-	3 (15)	9 (31)	10 (42)
Sydney North West (5)	-	2 (3)	1 (1)	4 (17)	11 (45)	13 (59)
Sydney South West (6)	1 (4)	4 (9)	-	4 (18)	11 (46)	21 (73)
Central Coast (1)	-	-	-	3 (3)	9 (9)	7 (7)
Illawarra (3)	2 (4)	-	3 (3)	4 (11)	7 (12)	8 (20)
Lower Hunter (3)	1 (1)	2 (4)	1 (1)	6 (14)	13 (32)	10 (28)
Central Tablelands (2)	4 (5)	2 (2)	-	5 (8)	12 (21)	23 (38)
North West Slopes (3)	4 (6)	1 (2)	2 (4)	15 (27)	17 (37)	18 (37)
Northern Tablelands (1)	1 (1)	1 (1)	1 (1)	10 (10)	16 (16)	12 (12)
South West Slopes (2)	8 (10)	9 (9)	-	2 (3)	5 (8)	17 (31)
Southern Tablelands (1)	NA	NA	NA	NA	5 (5)	19 (19)
Total calendar days exceeded (exceptional) across network	**14**	**15**	**5**	**20**	**25**	**31**
% days of exceptional exceedances across NSW network	**24%**	**16%**	**5%**	**33%**	**83%**	**100%**

Notes

The first number represents the number of days where at least one site in that region recorded an exceedance due to an exceptional event. For example: 8 (10) for South West Slopes in summer (Jan–Feb) means during 1 January to 28 February there were 8 exceedance days, each having at least one site in the region exceeding the national standard. If individual exceedances at each of the 2 sites are counted, there are 10 station exceedance events in that period.

PM10 exceedances in Wagga Wagga

Of the 32 non-exceptional exceedance observations over 30 calendar days, 24 of these events occurred in Wagga Wagga North in the South West Slopes/Riverina area of New South Wales. The site recorded 63 exceedance days both exceptional and non-exceptional in total in 2019, which was higher than the previous record of 37 days recorded in 2006 at the Wagga Wagga site.

Two causes of particle exceedances in Wagga Wagga are windblown soil and smoke from bushfires, which are both impacted by warmer weather in periods of reduced rainfall. This is reflected in the months where exceedances occur. Over 18 years of monitoring, 72% of Wagga Wagga's exceedances occur in the five months between December and April, with minimal exceedances in winter or early spring.

Figure 3 shows a comparison of particle exceedances across calendar years in the warmer months for the Wagga Wagga area. These are compared against bare ground cover statistics calculated from satellite reflections in a 100-kilometre radius around the Wagga Wagga site.

A greater number of exceedances occur in seasons where the amount of ‘bare’ or exposed ground is higher. This is indicative of lower rainfall, and subsequently, more generation of airborne particles under high wind from the exposed soil. Additionally, lower rainfall will also increase the likelihood of particle exceedances from bushfires, which occurred to a large

extent in the 2002-03, 2006-07 and 2019-20 summer seasons. Following the Millennium drought, in the 2010 to 2016 period, a much lower number of exceedances were observed.

Figure 3 **PM10 exceedance days at Wagga Wagga and Wagga Wagga North station compared with 'bare ground' coverage**

Exceedance days per financial year, compared against monthly maximum and annual average 'bare ground' calculated from MODIS satellite in a 100-km radius around the Wagga Wagga North station.

For the 2019 calendar year at Wagga Wagga North, many exceedances deemed non-exceptional occurred in the January–May period and in October, which follows an increasing trend observed in the 2018 calendar year. Most of the elevated PM10 in the area was observed under north-westerly winds, with the areas north-west of Wagga Wagga in significant drought during these months. Rainfall and cooler conditions in early May led to a reduction in dust during winter. However, there were further dust events recorded during the second half of the year.

The impact of very local dust-generating activity cannot be ruled out for several exceedance days. For an event to be classed as exceptional, it was determined that high levels of PM10 were required at a combination of the Albury, Bathurst, Orange or rural indicative sites in the Riverina area to definitively identify the event as exceptional, with events seen in areas further afield being additional confirmation of this categorisation. In many of the non-exceptional events, increased PM10 was seen at these sites but not at a high enough concentration to be definitive about a widespread source. Therefore, this list may include events that might be considered exceptional but cannot be definitively defined as such. In early 2020, particle instruments at the rural indicative sites in the surrounding Riverina area were upgraded to represent particles by size better than the previous indicative instruments. This upgrade is expected to make classification of air pollution events in the Riverina–Murray area more rigorous in future years.

Non-exceptional exceedances in Wagga Wagga North in 2019

- Summer 2018–19 January–February (11 days):
  - 1, 2, 5, 23, 25, 26, 30 January
  - 15, 23, 26, 27 February.
- Autumn 2019 March–May (5 days):
  - 4, 11 March
  - 9, 30 April
  - 20 May.
- Winter 2019 June–August (0 days):
- Spring 2019 September–November (7 days):
  - 2, 24, 29, 30, 31 October
  - 25, 29 November.
- Summer 2019–20 December (1 day):
  - 30 December.

Non-exceptional PM10 exceedances outside of Wagga Wagga

The other seven non-exceptional PM10 events were spread across the State. For these events, there was not enough information available to determine whether they were at the 'continental scale'. Therefore, such pollution events were considered due to local or regional sources.

The drought was undoubtedly a contributing factor to almost all these exceedances, through the impact on poor ground cover and therefore loose soil in agricultural and semi-arid regions of New South Wales. However, this also impacted soil and dust in urban areas as well. The low soil moisture conditions meant the occurrence of airborne dust was much more frequent in 2019, with greater levels of dust generated further east in the region than had been seen over the past 15 years. This has made the separation of continental-scale dust events from local sources a difficult task.

Table 24 2019 days exceeding PM10 24-hour AAQ NEPM standard (non-exceptional events) excluding Wagga Wagga North

Date	Region	Site	Daily average and notes
Jan-25	South West Slopes	Albury	56.2 µg/m^3. Dust/wind event also seen in Wagga Wagga.
Jan-31	Illawarra	Kembla Grange	51.2 µg/m^3. Dust pick-up due to a trough sitting over Illawarra before a strong wind change.
Feb-28	South West Slopes	Albury	56.2 µg/m^3. A local dust event in the evening caused by high wind. Some fires in the Snowy Mountains may have also contributed, but not enough to cause a total exceedance value.
Aug-07	Sydney South West	Liverpool	57.4 µg/m^3. High levels observed under westerly winds between 7pm and 9pm. Local source attributed to a dirt road approximately ~100 m from site, and coincident on Wednesday nights in winter.

Date	Region	Site	Daily average and notes
Aug-09	Illawarra	Kembla Grange	66.6 µg/m^3. Strong north-west winds indicate a nearby dust source, possibly construction or a dirt road. Other sites in Illawarra showed minimal PM10.
Oct-03	Illawarra	Kembla Grange	52.0 µg/m^3. Passage of a low-pressure trough and cold front, slightly elevated elsewhere in Illawarra, but the impact of a very local source (dirt road) under westerly winds also contributed.
Nov-14	Sydney South West	Oakdale	108.6 µg/m^3. Source not determined, but it is likely dust was generated by local agricultural activity, due to low PM2.5 and no other high-dust activity elsewhere in network.
Nov-25	Central Tablelands	Orange	53.6 µg/m^3. Winds from north-west direction, high values in the afternoon and evening. Impact minimal in Bathurst (~100 km east of Orange).

Particles as PM2.5

Table 25 2019 summary of PM2.5: maximum 24-hour average concentrations

Region/ monitoring station	Number of valid days	Highest 24-hour average (µg/m^3)	Highest date
Sydney			
Bargo	348	**170.7**	**Dec-31**
Bringelly	358	**178.0**	**Dec-04**
Camden	348	**155.3**	**Dec-03**
Campbelltown West	326	**106.0**	**Dec-05**
Chullora	297	**97.6**	**Dec-10**
Earlwood	349	**86.2**	**Dec-05**
Liverpool	351	**156.0**	**Dec-03**
Macquarie Park	360	**152.0**	**Dec-10**
Oakdale	350	**250.2**	**Dec-10**
Parramatta North	363	**130.1**	**Dec-10**
Prospect	337	**134.1**	**Nov-19**
Randwick	332	**95.2**	**Dec-10**
Richmond	316	**141.2**	**Nov-21**
Rouse Hill	215	**183.5**	**Nov-19**
Rozelle	349	**101.8**	**Dec-10**
St Marys	355	**88.3**	**Dec-09**
Central Coast			
Wyong	339	**202.1**	**Dec-05**
Illawarra			
Albion Park South	339	**49.4**	**Oct-31**
Kembla Grange	350	**70.1**	**Jun-03**
Wollongong	357	**81.5**	**Dec-19**
Lower Hunter			
Beresfield	351	**100.5**	**Oct-30**
Newcastle	360	**95.5**	**Dec-05**
Wallsend	349	**108.3**	**Dec-05**

Table 25 2019 summary of PM2.5: maximum 24-hour average concentrations (continued)

Region/monitoring station	Number of valid days	Highest 24-hour average (µg/m^3)	Highest date
Central Tablelands			
Bathurst	360	**199.5**	**Dec-17**
Orange	343	**387.4**	**Dec-22**
North West Slopes			
Gunnedah	344	**94.1**	**Nov-18**
Narrabri	360	**87.7**	**Dec-17**
Tamworth	357	**164.2**	**Dec-08**
Northern Tablelands			
Armidale	350	**267.3**	**Nov-20**
South West Slopes			
Albury	362	**167.1**	**Dec-24**
Wagga Wagga North	346	**239.6**	**Dec-20**
Southern Tablelands			
Goulburn	54	**333.7**	**Dec-31**

Table 26 2019 summary of PM2.5 by FRM: maximum 24-hour average concentrations

Region/ monitoring station	Number of valid days	Highest 24-hour average (µg/m^3)	Highest date
Sydney			
Chullora	105	**87.5**	**Dec-10**

PM2.5 exceptional exceedances

As with PM10, the large number of exceedance events made a full list impractical. (Across 32 reporting sites there were 767 individual site exceedances across 116 calendar days, excluding the FRM measurements.) These were divided into exceptional events summarised by season or month (Table 27), with a list of non-exceptional events shown in Table 28.

For classifying exceptional events, there were 17 days where planned hazard reduction burning was a contributing factor to an exceedance. This includes all the autumn and winter exceedance days in Sydney, Central Coast, Illawarra and Central Tablelands, and three of six days in the South West Slopes in autumn.

A single event (21 September in Orange, Central Tablelands) was attributable to a widespread dust storm.

All other events in September through to December were due to bushfires, some in combination with dust storms concurrent on the same day. The single bushfire-influenced PM2.5 exceedance in January–February was due to a short-lived fire burning very close to the Narrabri site (North West Slopes). There were three PM2.5 exceedance events in March 2019 recorded at Albury (South West Slopes), due to the impact of bushfires in the Alps regions.

Table 27 2019 summary of PM2.5 exceptional exceedance days by region by time of year

Region (sites)	Summer: Jan–Feb	Autumn: Mar-May	Winter: Jun-Aug	Spring: Sep-Oct	Spring: Nov	Summer: Dec
Sydney East (5)	-	4 (9)	-	2 (8)	10 (37)	11 (43)
Sydney North West (5)	-	4 (7)	2 (2)	2 (10)	13 (49)	14 (55)
Sydney South West (6)	-	8 (20)	-	3 (13)	11 (44)	23 (85)
Central Coast (1)	-	1 (1)	-	2 (2)	10 (10)	10 (10)
Illawarra (3)	-	-	1 (2)	2 (2)	5 (12)	6 (18)
Lower Hunter (3)	-	-	-	4 (9)	14 (33)	11 (26)
Central Tablelands (2)	-	1 (1)	-	1 (1)	9 (15)	21 (34)
North West Slopes (3)	1 (1)	-	-	8 (11)	13 (26)	17 (36)
Northern Tablelands (1)	-	-	-	8 (8)	14 (14)	14 (14)
South West Slopes (2)	-	6 (6)	-	-	1 (2)	15 (28)
Southern Tablelands (1)	NA	NA	NA	NA	4 (4)	24 (24)
Total calendar days exceeded (exceptional) across network	**1**	**17**	**3**	**14**	**24**	**31**
% days of exceptional exceedances across NSW network	**2%**	**18%**	**3%**	**23%**	**77%**	**100%**

Notes

The first number represents the number of days where at least one site in that region recorded an exceedance due to an exceptional event. For example, 8 (20) for Sydney South West in autumn (March–May) means there were 8 exceedance days during 1 March to 31 May, each with at least one site in the region exceeding the national standard. If the individual exceedances at each of the 6 sites are counted, there are 20 exceedance events in that period for that region.

PM2.5 non-exceptional exceedances

The major cause of all non-exceptional PM2.5 exceedances in New South Wales during 2019 was wood smoke from domestic heating facilities in cooler months.

Armidale had 24 exceedances attributable to domestic wood smoke, with nine days in June, 10 days in July and five days in August. The Armidale site was not reported in the NSW 2018 NEPM compliance report, as it was commissioned in April that year. The number of exceedances is comparable to 2018, where 32 days were attributable to domestic-generated wood smoke between late May and early September.

As wood smoke impacts occur overnight across separate calendar days, analysis is best suited to comparing 24-hour periods midday to midday. The rolling 24-hour PM2.5 average at midday each day is shown in Figure 4. This is compared to the temperature variation observed in the previous 24 hours, that is, the difference between maximum and minimum temperatures from 12pm the previous day to 12pm the current day.

There is a visually identifiable trend between these two parameters in the June to August period. For 24-hour periods where this temperature difference is greatest, the night-time conditions are typically characterised by still conditions and high relative humidity. In contrast, where the difference is lower, during that day either the meteorological conditions were characterised by higher wind speeds, rainfall, or changing weather conditions. In May this relationship is not as obvious, as the daytime temperatures were typically higher.

September analysis is not shown in this example due to the impacts of the bushfires during this month.

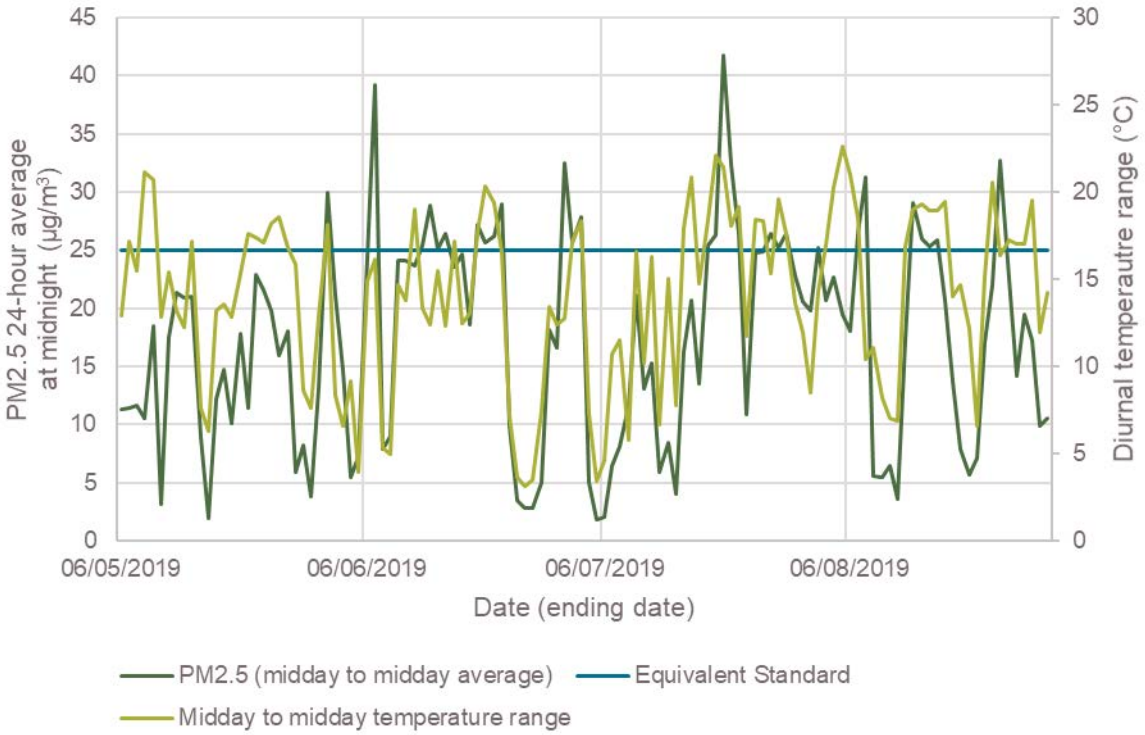

Figure 4 **PM2.5 rolling 24-hour average compared to temperature range at Armidale**

PM2.5 rolling 24-hour average at midday compared to the NEPM (equivalent) standard level of 25 µg/m^3, and the midday to midday (diurnal-type) temperature range.

In 2019 three other sites observed exceedances related to domestic wood smoke (Table 27). The Orange station, established in early 2019, recorded four exceedances during winter. Gunnedah reported two days in July, compared to four days in 2018. All of these exceedances occurred on Saturday or Sunday. Woodsmoke impacts at some stations in New South Wales tend to be higher on weekends. However, this weekday–weekend difference has not been observed at Armidale, where the wood smoke impacts are observed on most days.

A single exceedance was observed in Liverpool (Sydney South West). This event occurred during a long weekend with cooler than average conditions and a strong inversion during the early morning hours, as well as a strong inversion that had persisted through the entire of the previous calendar day. Other sites in Sydney recorded elevated PM2.5 levels during this weekend, but generally only those stations located at lower elevations.

Table 28 2019 days exceeding PM2.5 24-hour AAQ NEPM standard (non-exceptional events) excluding Armidale

Date	Region	Site	Notes
Sunday 02 June	Central Tablelands	Orange	Hourly PM2.5 > 60 µg/m^3 between 5pm and midnight, with minimal wind recorded. Temperature between 4–7°C.
Sunday 09 June	Sydney South West	Liverpool	Hourly PM2.5 44 µg/m^3 at midnight dropping to 25 µg/m^3 at 9am; temperature 8–10°C. PM2.5 increased from 12 µg/m^3 at 6pm to 37 µg/m^3 at midnight (10 July). This was the Sunday of a long weekend, and the previous day was characterised by low temperatures (daily maximum 13°C), with elevated levels noted at other Western Sydney sites lower than 50 m altitude, indicating low boundary layer height impact.
	Central Tablelands	Orange	Hourly PM2.5 > 30 µg/m^3 between midnight and 5am, minimal wind, and temperature < 6°C. PM2.5 increased from 15 µg/m^3 at 6pm to 76 µg/m^3 at midnight (10 June), again minimal wind speed and high humidity.
Saturday 20 July	North West Slopes	Gunnedah	Hourly PM2.5 > 44 µg/m^3 between 7pm and midnight. Temperature dropping to 4°C. Previous evening (19–20 July) had some high PM2.5 hours and temperatures 0–5°C.
Sunday 21 July	Central Tablelands	Orange	Hourly PM2.5 50 µg/m^3 at midnight dropping to 25 µg/m^3 at 9am, temperature < 2°C. PM2.5 increased from 25 µg/m^3 at 7pm to 70 µg/m^3 at midnight (22 July), temperature 5°C.
Saturday 27 July	North West Slopes	Gunnedah	Hourly PM2.5 > 23 µg/m^3 between midnight and 9am, and 7pm to midnight (28 July), reaching 74 µg/m^3 at 11pm. Temperature minimum of 3.5°C at 7am.
Saturday 24 August	Central Tablelands	Orange	Hourly PM2.5 60 µg/m^3 at midnight dropping to 30 µg/m^3 at 8am, temperature < 2°C. PM2.5 increased from 23 µg/m^3 at 8pm to > 50 µg/m^3 at midnight (25 August), temperature 5°C.

Assessment of progress towards achieving the goals

The AAQ NEPM is implemented under the *Protection of the Environment Operations Act 1997* (POEO Act), the Protection of the Environment Operations (Clean Air) Regulation 2010 and the Protection of the Environment Operations (General) Regulation 2009.

The POEO Act sets the statutory framework for managing air quality in New South Wales. The Protection of the Environment Operations (Clean Air) Regulation 2010 provides measures to control industry emissions, motor vehicles and fuels, domestic solid fuel heaters and open burning. The Protection of the Environment Operations (General) Regulation 2009 establishes the licensing scheme for major industrial premises and economic incentives for licensed businesses and industry to reduce pollution, including emissions to air.

The NSW Department of Planning, Industry and Environment and the NSW Environment Protection Authority (EPA) work together to reduce the impacts of air pollution. The Department develops policies and programs to improve compliance with NEPM goals and protect public health. It operates a comprehensive air quality monitoring network and undertakes air quality forecasting to provide timely information so people can reduce their risk of exposure. The NSW EPA develops and implements regulation, conducts compliance activities, and provides expert technical advice on air quality issues. Both agencies work closely with stakeholders to inform, educate and involve stakeholders in improving air quality management.

Air quality in New South Wales in 2019 was greatly affected by intense drought conditions across the entire year, leading into and contributing to the unprecedented extensive bushfires during the second half of the calendar year. This resulted in poorer air quality measured throughout the State compared to previous years.

The NEPM goals are a driver for air quality management strategies and a benchmark against which progress in managing air quality can be assessed.

Air quality management in the GMR and regional New South Wales

The Department and the NSW EPA deliver numerous actions that target the pollutants of most concern in New South Wales, namely particles in the GMR and some regional centres, and ground-level ozone. These actions are designed to improve knowledge about air emissions, air quality and the impacts of air pollution; inform and engage the community and other stakeholders; and reduce air quality impacts from industry, vehicles and commercial and domestic activities.

At 31 December 2019, the Department operated 86 monitoring stations in the NSW air quality monitoring network, which comprised several smaller networks. Air quality data and information are made publicly available on the Department's website and updated hourly. Automated text messages and emails are sent to subscribers when the recorded air quality is measured as exceeding national air quality standards. A daily forecast for the Greater Sydney Region is also sent to subscribers and published on the Department's website. The Department also collaborates with the NSW EPA, other agencies and science partners to conduct research that informs air policies and programs.

The following is an outline of the key mechanisms for managing air quality and the activities implemented in 2019–20.

Air emissions inventory

The Air Emissions Inventory for the NSW GMR is a detailed technical snapshot of major sources of air pollution. The inventory estimates emissions for hundreds of substances released to the atmosphere from natural and human-made sources within the GMR and has

been updated every five years. The inventory is created retrospectively based on collected and modelled data from a broad range of government, industry, commercial, household and technical sources. The latest available inventory for the 2013 calendar year was finalised in December 2019.

Detailed inventory data are available in a technical report available from the NSW EPA webpage 2013 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW. The 2013 inventory data is also available in two Excel workbooks.

The community can access inventory information about local sources of air pollution via the Air Emissions in my Community web tool. The tool presents aggregated data and charts for different geographic areas within the GMR, down to local council and postcode level. The community web tool was also updated in 2019, and inventory data for the 2003, 2008 and 2013 inventories can now be shown, and the trends over the 10-year period spanning the three inventories displayed.

Air quality monitoring

At 31 December 2019, the NSW air quality monitoring network totalled 86 stations, consisting of 51 NATA-accredited stations plus 35 indicative rural monitoring sites. The network provides detailed air quality information that is available online and updated hourly. Information about the network and current and historic data can be found on the Department's website: Air quality monitoring network.

Fine-particle monitoring was further extended across the NSW air quality monitoring network in 2019. This monitoring supports air quality and health analysis and compliance assessments against national standards for PM2.5 (particles 2.5 micrometres and smaller in diameter). In 2019, new monitoring stations commenced operation in Goulburn and Orange in regional NSW, at Rouse Hill in north-west Sydney, and at Cook and Phillip Park in Sydney CBD. Data from a roadside monitoring station beside the Bradfield Highway at Milsons Point in Sydney is now also reported in near real time. During 2019, the number of rural network sites which provide indicative information on both PM2.5 and PM10, apart from total suspended particles (TSP), increased from five to 20 sites.

Air incident monitoring and modelling capabilities have been established for incidents where the community may experience air quality impacts for a period of several days or longer. This includes two portable monitoring pods, each equipped with compliance air quality monitors that meet Australian Standards and the AAQ NEPM requirements, and other non-compliance instruments and meteorological monitors. The pods are fitted with telemetry and communications systems coupled with web-reporting capabilities for rapid transfer of information to a publicly accessible website.

Deployment of emergency monitoring was a major factor in responding to air quality issues arising from the significant bushfire emergency which impacted New South Wales in the 2019–20 bushfire season. In late July, one pod was deployed to Port Macquarie to monitor air quality impacts from an underground peat fire, which later contributed to bushfires in the region. Due to the increasing intensity of the bushfires, a small station and a pod were deployed in Coffs Harbour and Lismore, respectively, in November 2019. Additionally, due to the availability of indicative sensors being tested for the rural network upgrade, seven emergency sites were established during the summer. Three of these were deployed on the North Coast in November (Grafton, Taree, Coffs Harbour), two on the South Coast in December 2019 (Batemans Bay and Ulladulla), and one each on the far South Coast (Merimbula) and Snowy Mountains (Cooma) in January 2020.

Review of the NSW air quality monitoring plan

A review of the NSW air quality monitoring plan was conducted from 2017 to 2019. The review was undertaken to ensure the current monitoring network is meeting community needs and the objectives of the AAQ NEPM. The revised plan was released in December 2020.

Blue Mountains and Lithgow Air Watch

Blue Mountains and Lithgow Air Watch was a 12-month, NSW EPA-led, local air quality monitoring project established to provide a better picture of air quality in the region. The project began in May 2019 and concluded in May 2020. Air Watch was undertaken in partnership with a range of Blue Mountains community groups and volunteers, the Department, Blue Mountains City and Lithgow councils, Doctors for the Environment, Western Sydney University and the Nepean Blue Mountains Local Health District.

Air Watch comprised:

- One air quality monitoring station located at Katoomba, which measured particles (PM10 and PM2.5), sulfur dioxide, carbon monoxide, ozone, oxides of nitrogen, visibility and meteorology. Monitoring was undertaken in accordance with Standards Australia methods and can be compared to the national AAQ NEPM standards.
- Twelve low-cost sensors, known as KOALAs (knowing our ambient local air quality), were located at schools and businesses in Wentworth Falls, Springwood, Katoomba and Lithgow. The KOALAs are indicative instruments and measure particles (PM2.5, PM10) and carbon monoxide (CO) in real time, demonstrating trends in air quality only.

The data was available in near real time via links from the EPA website.

Quarterly reports of the data by season (winter, spring, summer and autumn), have been published on the EPA website. They show that air quality within the Blue Mountains and Lithgow area is generally of good quality outside natural events such as bushfire and dust storms. The final project interpretation report, analysing the full 12 months of data, was published on the EPA website in November 2020.

Air emissions and health impacts research

Broken Hill Environmental Lead Study

The Broken Hill Environmental Lead Study continued in 2019, with sampling concluding in March 2020. This four-year study was commissioned by the Broken Hill Environmental Lead Program (BHELP) and the EPA in 2016 to inform remediation efforts underway as part of a program to address lead contamination and exposures. This collaborative study by BHELP and the Department aims to monitor airborne and deposited lead and assess contributions of current emissions from mining leases and emissions from non-mining areas.

Sydney Air Quality Study

The multi-year Sydney Air Quality Study commenced in 2016 to improve understanding of air quality and the impacts of air pollution in the Greater Sydney Region. The study will extend the evidence base for air policies and programs, providing information on past, current and future air quality and its impacts on public health and the environment in the Greater Sydney Region. The study will support evidence-based air policies and programs by identifying persistent and emerging issues and highlighting opportunities to improve air quality and realise public health and economic benefits.

The air quality, exposure and health impact modelling capabilities were established during the study. The initial results from the study were published in 2019 in a peer-reviewed journal.

Enhancing air quality forecasting in New South Wales

This program – Enhancing air quality forecasting in New South Wales – was established to expand the scope and increase NSW air quality forecasting accuracy. The Department issues a daily air quality forecast for the Greater Sydney Region, and the overall accuracy of forecasts is currently considered to be moderate. Through this program the Department will work towards more accurately forecasting air quality for Greater Sydney and its subregions, and will progressively expand forecasting to the whole of the NSW Greater Metropolitan Region and major regional areas. The program involves several projects to develop specific advanced tools and capabilities, some involving collaboration with science partners.

A trajectory and dispersion modelling system has been in operation for New South Wales. This system, named HYSPLIT in NSW, has produced daily plume forecasts since July 2019. During the 2019–20 bushfire season, major improvements were made in smoke emissions modelling to better characterise smoke impacts from the unprecedented scale of wildfires on regional air quality.

Industry emissions

In 2019 the EPA continued to implement its regulatory responsibilities, including licensing scheduled industry activities and conducting compliance and enforcement programs. The *Protection of the Environment Operations Act 1997*, the Protection of the Environment Operations (Clean Air) Regulation 2010 and the Protection of the Environment Operations (General) Regulation 2009, set the framework for managing air pollution from major industries in New South Wales.

Load-based licensing

The EPA Load-Based Licensing (LBL) Scheme requires some environment protection licensees to pay part of their annual licence fees based on the load of certain air and water pollutants their activities release to the environment. By tying the fees payable to pollutant loads, the scheme aims to provide an ongoing economic incentive for licensees to improve their environmental performance beyond the levels required by regulation or licence conditions alone. In 2019 the EPA continued to progress a review of the LBL scheme, which aims to improve the scheme's efficiency and effectiveness.

Emissions from coal-fired power stations

In 2018 the EPA completed a detailed compliance review: *Coal Fired Power Stations Air Emissions and Monitoring* (available on the NSW EPA website: Industrial emissions). The review involved detailed analysis of large amounts of monitoring data and operating information. In 2019 the EPA continued to work with power station licensees to further standardise and strengthen environmental licence conditions, and consulted with industry on proposed environment protection licence variations. Licence variations were finalised in July 2020.

Non-road diesel and marine emissions

The EPA Diesel and Marine Emissions Management Strategy sets out NSW actions to address emissions from non-road diesel equipment, diesel locomotives operating in New South Wales, and shipping.

In 2019 the Department continued to administer the NSW Government Resource Efficiency Policy (GREP). GREP includes requirements to address non-road diesel engine emissions through government procurement and contracts. The Department reviewed GREP in 2017–18 to analyse whole-of-government progress towards implementation, identify challenges faced by agencies, and determine if reforms are required. The updated GREP was published in February 2019.

For non-road diesel engines, government agencies must comply with European Union (EU) or USEPA standards when purchasing or leasing such equipment. Agencies must also consider air emissions from contractor-supplied equipment in tender processes for construction projects over $10 million. The tender selection process either incorporates a weighting for air emission standards in conjunction with other environmental considerations, or a statement by contractors on how they will reduce emissions from their equipment. Air emission standards of engines are aligned with the current EU and USEPA levels which are accepted internationally, with a lead time of two years compared to the introduction dates overseas.

Locomotives

Amendments to the POEO Act to regulate railway rolling stock operations, in addition to railway infrastructure operators, came into effect in July 2019. The regulatory amendments mean that operators of rolling stock are required to hold an environment protection licence and are directly accountable for their environmental performance, including management of air emissions.

During 2019–20 the EPA developed the conditions of the licences following extensive consultation with the rail industry and input from community and other relevant stakeholders, to enable licences to come into effect in August 2020.

Vehicle and fuel emissions

Regulation of motorway tunnel ventilation stacks

In July 2019, the POEO Act was amended to include changes to how road tunnel ventilation stacks are regulated. In 2019 the EPA developed the conditions of the licences following consultation with industry and relevant government agencies to enable licences to come into effect in early 2020. The licences will place strict operating requirements on air emissions from ventilation stacks, and require air quality monitoring of tunnel ventilation stacks. The monitoring data will be publicly available through tunnel operators' websites and provided to the EPA for review.

Smoky vehicles program

In New South Wales it is an offence for a vehicle to emit excessive air impurities for a continuous period of more than 10 seconds. Penalty notices may be issued to the registered owners of vehicles emitting excessive air impurities. The public can also report smoky vehicles via the EPA's Environment Line website or mobile phone application. An average of 183 smoky vehicle reports are received each month from the public (more than 2200 public reports over the year), indicating a high level of awareness in the community of the unacceptability of excessive visible emissions.

In the 2019–20 financial year the EPA issued 804 advisory letters based on public reports, of which 621 advisory letters were to diesel vehicle owners.

In addition, 49 defective vehicle notices were issued in 2019–20 of which 38 were for diesel vehicles. A defective vehicle notice requires the vehicle owner to carry out any necessary

repairs so the vehicle no longer emits excessive smoke, and to provide evidence to the EPA those repairs were carried out. Failure to provide evidence the vehicle is no longer emitting excessive smoke may result in the vehicle registration being suspended.

Vapour recovery at service stations

Vapour Recovery Stage 1 technology (VR1) captures displaced vapours from storage tanks when a tanker delivers fuel to a service station, while Vapour Recovery Stage 2 technology (VR2) captures vapours displaced at the bowser when a motorist refuels.

The EPA's Vapour Recovery Compliance Program was completed in 2017. Regulatory responsibility for vapour recovery at service stations across Sydney, Wollongong, Newcastle and the Central Coast metropolitan areas, as well as the Lower Hunter and Illawarra regions, transitioned from the EPA to local councils in 2017. At that time, 99% of petrol service stations required to have VR1 equipment installed and operating were compliant, and 98% of petrol service stations required to install VR2 equipment were compliant.

Implementation of vapour recovery at these service stations has reduced emissions of volatile organic compounds (VOCs) by an estimated 5750 tonnes per year.

Summer low-volatility petrol

To manage ozone formation in the Greater Sydney Region, regulatory requirements limit petrol volatility to 62 kilopascals (a measure of vapour pressure) over the summer period from 15 November to 15 March each year. Petrol importers and blenders must test and report to the EPA on batch volatility. The petrol volatility limits reduce VOC emissions in the Sydney region by an estimated 4000 tonnes each summer.

National vehicle and fuel standards

The Australian Government manages fuel quality and vehicle emission standards for new road vehicles. In 2017 NSW made submissions to the Australian Government supporting early introduction of tighter national vehicle emission and fuel standards. These proposed standards will more closely harmonise with international best practice for national vehicle emissions and fuel quality standards and will improve health outcomes. Over time, the impact of improved emission and fuel standards is detailed in the report Technical Paper TP01 – Trends in Motor Vehicle Emissions (NSW EPA 2018).

New South Wales has consistently supported tighter national vehicle and fuel standards. In 2019 the Department represented New South Wales on the national Fuel Standards Consultative Committee.

Wood smoke management

The EPA supports local councils across New South Wales in managing wood smoke through periodic wood smoke reduction programs and providing community education materials for use by councils. Previous social research undertaken for the EPA identified lack of awareness of wood smoke impacts on health as the key barrier to changing people's wood heater use.

Based on recommendations in the 2016 Upper Hunter Wood Smoke Community Research Project, the EPA developed a new package of wood smoke education materials to raise awareness about wood smoke impacts on people's health and the environment: Wood smoke isn't good smoke – Council resource kit. During winter 2017, the EPA trialled the education package in two regional centres in the Upper Hunter – Singleton and Muswellbrook – before rolling it out to councils across New South Wales for the winter of

2018. The materials are now available in English and five community languages: Arabic, Cantonese, Hindi, Mandarin and Vietnamese.

The EPA also regulates the sale of wood heaters. All appliances must meet minimum emission and efficiency standards as set out in the Protection of the Environment (Clean Air) Regulation 2010. From 1 September 2019, all new wood heaters sold in New South Wales must comply with tighter efficiency and emission standards under Australia/New Zealand Standards *AS/NZS 4012:2014 Domestic solid fuel burning appliances – Method for determination of power output and efficiency* and *AS/NZS 4013:2014 Domestic solid fuel burning appliances – Method for determination of flue gas emission*.

Hunter Region coal mines dust management

Throughout spring and summer of the 2019–20 financial year, the EPA implemented Operation Bust the Dust to ensure open cut coal mines in the Upper Hunter minimised particle emissions. The EPA inspected mines on days most likely to have adverse weather conditions, using Bureau of Meteorology weather predictions. Using drones, most mines were observed implementing best practice dust controls. However, due to the extremely hot, dry and windy weather, dust was observed blowing off exposed areas of mine sites. During the program excessive dust was generated in the Hunter Valley on 10 days; this was a 50% reduction on earlier drought-impacted years from 2012 to 2014.

Section D – Data analysis

Section D provides an overview of the longer term statistical summaries by pollutant for each NEPM pollutant standard. Site summaries for pollutant trends are provided in an Appendix to this report.

For all tables, note that italicised entries mean the annual coverage for that year was between 15% and 75%. Values that are not italicised have greater than 75% coverage for the year. However, the requirement for 75% in each quarter has not been applied to previous years' data. For that requirement, the specific NEPM reports for those years should be consulted.

For all tables in Section D, exceedances of the standards and goals are represented by bold text. This is applied to:

- maximum or percentile concentrations
- number of exceedance days where that number exceeds the goal specified for that pollutant at that time.

Carbon monoxide

Table 29 2019 statistical summary for CO: daily maximum rolling 8-hour average concentrations

Region/ monitoring station	Maximum (ppm)	Percentile (ppm)					
		99th	98th	95th	90th	75th	50th
Sydney							
Camden	2.0	1.5	1.2	0.7	0.4	0.3	0.2
Campbelltown West	2.9	1.6	1.2	0.8	0.6	0.4	0.4
Chullora	1.4	1.1	0.9	0.6	0.5	0.3	0.1
Liverpool	1.8	1.4	1.2	1.0	0.8	0.5	0.3
Macquarie Park	3.5	1.2	1.0	0.6	0.5	0.4	0.3
Parramatta North	3.2	1.2	0.9	0.8	0.7	0.5	0.3
Prospect	2.8	1.3	0.9	0.7	0.6	0.3	0.2
Rouse Hill	*3.6*	*3.1*	*1.6*	*0.9*	*0.6*	*0.3*	*0.2*
Rozelle	2.2	1.0	0.8	0.7	0.6	0.4	0.3
Central Coast							
Wyong	2.4	1.1	0.7	0.4	0.3	0.2	0.2
Illawarra							
Wollongong	2.3	1.7	0.9	0.6	0.5	0.4	0.3
Lower Hunter							
Newcastle	1.5	1.1	0.9	0.7	0.6	0.4	0.3

Table 30 Annual maximum rolling 8-hour average concentrations for CO (ppm)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Camden	-	-	*0.3*	1.9	0.6	0.5	0.5	0.5	0.7	2.0
Campbelltown West/Macarthur	0.9	1.1	0.7	**9.1**	0.9	1.0	1.2	0.8	1.5	2.9
Chullora	2.3	1.5	2.0	2.5	1.7	1.4	1.6	1.2	3.4	1.4
Liverpool	2.1	2.4	1.9	2.1	2.2	1.8	1.9	1.8	1.9	1.8
Macquarie Park	-	-	-	-	-	-	-	*0.5*	2.5	3.5
Parramatta North	-	-	-	-	-	-	-	-	1.1	3.2
Prospect	1.9	1.7	1.8	1.6	1.3	1.5	1.5	1.1	1.1	2.8
Rozelle	1.8	1.4	2.2	1.8	1.1	1.1	1.2	0.9	*0.7*	2.2
Central Coast										
Wyong	-	-	*0.4*	0.8	0.5	0.4	0.6	0.6	0.9	2.4
Illawarra										
Wollongong	1.5	1.2	1.2	2.7	0.9	0.8	0.9	0.7	0.9	2.3
Lower Hunter										
Newcastle	1.4	1.5	1.3	1.4	2.4	1.5	1.4	1.1	1.0	1.5

Nitrogen dioxide

Table 31 2019 statistical summary for NO_2: daily maximum 1-hour average concentrations

Region/ monitoring station	Maximum (ppm)	Percentile (ppm)					
		99th	98th	95th	90th	75th	50th
Sydney							
Bargo	0.066	0.056	0.049	0.036	0.030	0.024	0.017
Bringelly	0.034	0.028	0.024	0.022	0.019	0.015	0.012
Camden	0.030	0.026	0.024	0.020	0.018	0.015	0.011
Campbelltown West	0.059	0.049	0.047	0.040	0.036	0.030	0.025
Chullora	0.070	0.052	0.045	0.038	0.035	0.029	0.024
Earlwood	0.061	0.040	0.038	0.035	0.032	0.027	0.022
Liverpool	0.050	0.048	0.042	0.037	0.035	0.031	0.025
Macquarie Park	0.026	0.024	0.024	0.022	0.019	0.017	0.013
Oakdale	0.028	0.023	0.021	0.015	0.011	0.007	0.004
Parramatta North	0.070	0.048	0.043	0.037	0.033	0.028	0.023
Prospect	0.049	0.039	0.037	0.035	0.032	0.027	0.021
Randwick	0.051	0.034	0.033	0.031	0.028	0.024	0.019
Richmond	0.030	0.025	0.023	0.022	0.019	0.014	0.010
Rouse Hill	*0.050*	*0.036*	*0.035*	*0.030*	*0.028*	*0.023*	*0.015*
Rozelle	0.090	0.044	0.040	0.036	0.033	0.027	0.021
St Marys	0.033	0.029	0.027	0.024	0.021	0.016	0.011
Central Coast							
Wyong	0.036	0.030	0.027	0.023	0.020	0.016	0.012
Illawarra							
Albion Park South	0.041	0.031	0.029	0.025	0.022	0.016	0.010
Kembla Grange	0.042	0.029	0.028	0.025	0.022	0.017	0.013
Wollongong	0.040	0.038	0.036	0.032	0.029	0.022	0.017
Lower Hunter							
Beresfield	0.056	0.038	0.032	0.029	0.026	0.023	0.018
Newcastle	0.044	0.039	0.036	0.033	0.031	0.026	0.018
Wallsend	0.042	0.035	0.032	0.029	0.026	0.020	0.015
North West Slopes							
Gunnedah	0.036	0.029	0.027	0.025	0.023	0.018	0.013

Table 32 Annual maximum 1-hour average concentrations for NO_2 (ppm)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	0.059	0.046	0.044	0.068	0.036	0.048	0.046	0.066	0.048	0.066
Bringelly	0.037	0.029	0.038	0.037	0.025	0.027	0.030	0.036	0.036	0.034
Camden	-	-	*0.022*	0.036	0.032	0.026	0.029	0.044	0.029	0.030
Campbelltown West/Macarthur	0.042	0.045	0.049	0.054	0.055	0.062	0.054	0.061	0.054	0.059
Chullora	0.057	0.051	0.059	0.055	0.064	0.054	0.046	0.060	0.057	0.070
Earlwood	0.038	0.046	0.051	0.048	0.040	0.053	0.043	0.067	0.050	0.061
Liverpool	0.053	0.046	0.046	0.056	0.044	0.060	0.047	0.064	0.062	0.050
Macquarie Park	-	-	-	-	-	-	-	*0.037*	0.030	0.026
Oakdale	0.023	0.027	0.022	0.019	0.026	0.024	0.022	0.022	0.029	0.028
Parramatta North	-	-	-	-	-	-	-	-	0.064	0.070
Prospect	0.043	0.039	0.050	0.049	0.047	0.053	0.053	0.060	0.051	0.049
Randwick	0.050	0.053	0.041	0.046	0.047	0.043	0.044	0.041	0.040	0.051
Richmond	0.033	0.029	0.046	0.032	0.028	0.024	0.030	0.026	0.030	0.030
Rouse Hill/ Vineyard	0.029	0.037	0.050	0.038	0.033	0.031	0.032	-	-	*0.050*
Rozelle	0.049	0.050	0.062	0.070	0.055	0.060	0.050	0.061	*0.057*	0.090
St Marys	0.036	0.036	0.043	0.037	0.031	0.032	0.042	0.037	0.037	0.033
Central Coast										
Wyong	-	-	*0.029*	0.041	0.034	0.032	0.046	0.051	0.035	0.036
Illawarra										
Albion Park South	0.041	0.040	0.037	0.039	0.038	0.047	0.043	0.038	0.039	0.041
Kembla Grange	0.036	0.037	0.039	0.036	0.031	0.034	0.039	0.037	0.037	0.042
Wollongong	0.052	0.043	0.049	0.050	0.038	0.060	0.043	0.057	0.043	0.040
Lower Hunter										
Beresfield	0.032	0.042	0.044	0.041	0.039	0.049	0.041	0.040	0.040	0.056
Newcastle	0.038	0.038	0.038	0.042	0.046	0.044	0.038	0.037	0.045	0.044
Wallsend	0.038	0.037	0.034	0.043	0.034	0.042	0.037	0.037	0.035	0.042
North West Slopes										
Gunnedah	-	-	-	-	-	-	-	-	0.034	0.036

Table 33 Annual average concentrations for NO_2 (ppm)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.006	0.006
Bringelly	0.005	0.005	0.005	0.005	0.004	0.004	0.005	0.005	0.006	0.005
Camden	-	-	*0.005*	0.004	0.004	0.004	0.004	0.005	0.005	0.005
Campbelltown West/Macarthur	0.009	0.008	0.009	0.010	0.010	0.010	0.010	0.011	0.011	0.011
Chullora	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.012	0.012	0.012
Earlwood	0.010	0.009	0.009	0.010	0.008	0.008	0.010	0.011	0.010	0.010
Liverpool	0.011	0.010	0.009	0.011	0.010	0.010	0.012	0.012	0.012	0.012
Macquarie Park	-	-	-	-	-	-	-	*0.005*	0.006	0.005
Oakdale	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.002
Parramatta North	-	-	-	-	-	-	-	-	0.011	0.010
Prospect	0.012	0.010	0.010	0.011	0.010	0.011	0.010	0.010	0.009	0.009
Randwick	0.007	0.007	0.006	0.007	0.006	0.008	0.008	0.007	0.007	0.007
Richmond	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.005	0.005	0.005
Rouse Hill/Vineyard	0.006	0.006	0.006	0.005	0.005	0.005	0.005	-	-	*0.006*
Rozelle	0.011	0.011	0.012	0.011	0.011	0.011	0.011	0.011	*0.010*	0.010
St Marys	0.006	0.006	0.005	0.005	0.004	0.004	0.004	0.004	0.005	0.004
Central Coast										
Wyong	-	-	*0.004*	0.005	0.005	0.005	0.005	0.005	0.004	0.004
Illawarra										
Albion Park South	0.003	0.002	0.004	0.004	0.004	0.003	0.004	0.004	0.004	0.004
Kembla Grange	0.003	0.004	0.005	0.005	0.004	0.005	0.005	0.004	0.005	0.005
Wollongong	0.009	0.008	0.009	0.008	0.008	0.008	0.006	0.006	0.007	0.006
Lower Hunter										
Beresfield	0.007	0.009	0.009	0.009	0.009	0.009	0.008	0.009	0.009	0.008
Newcastle	0.008	0.007	0.008	0.008	0.007	0.007	0.008	0.007	0.007	0.008
Wallsend	0.009	0.008	0.008	0.008	0.008	0.008	0.007	0.008	0.007	0.007
North West Slopes										
Gunnedah	-	-	-	-	-	-	-	-	0.005	0.005

Ozone

Table 34 2019 statistical summary for ozone: daily maximum 1-hour average concentrations

Region/ monitoring station	Maximum (ppm)	Percentile (ppm)					
		99th	98th	95th	90th	75th	50th
Sydney							
Bargo	**0.128**	**0.114**	0.099	0.083	0.067	0.044	0.032
Bringelly	**0.144**	**0.104**	0.100	0.087	0.071	0.044	0.034
Camden	**0.138**	**0.115**	**0.105**	0.089	0.075	0.045	0.034
Campbelltown West	**0.131**	**0.115**	**0.107**	0.092	0.071	0.042	0.032
Chullora	**0.176**	0.088	0.079	0.071	0.055	0.037	0.029
Earlwood	**0.179**	0.092	0.081	0.062	0.050	0.034	0.028
Liverpool	**0.157**	**0.106**	0.092	0.080	0.068	0.041	0.031
Macquarie Park	**0.122**	0.091	0.084	0.072	0.058	0.039	0.031
Oakdale	**0.147**	**0.109**	**0.101**	0.085	0.066	0.044	0.034
Parramatta North	**0.157**	0.098	0.092	0.081	0.068	0.042	0.033
Prospect	**0.132**	**0.111**	0.095	0.082	0.066	0.042	0.033
Randwick	**0.150**	0.093	0.075	0.056	0.047	0.036	0.031
Richmond	**0.137**	**0.102**	0.093	0.080	0.066	0.043	0.034
Rouse Hill	***0.112***	***0.102***	*0.093*	*0.081*	*0.065*	*0.042*	*0.034*
Rozelle	**0.179**	0.090	0.074	0.057	0.045	0.035	0.029
St Marys	**0.137**	**0.115**	**0.106**	0.084	0.069	0.045	0.035
Central Coast							
Wyong	0.100	0.087	0.076	0.056	0.049	0.037	0.031
Illawarra							
Albion Park South	0.099	0.083	0.069	0.053	0.043	0.035	0.030
Kembla Grange	0.100	0.078	0.070	0.056	0.045	0.035	0.030
Wollongong	**0.111**	0.085	0.077	0.058	0.047	0.037	0.031
Lower Hunter							
Beresfield	**0.126**	0.093	0.081	0.068	0.057	0.039	0.031
Newcastle	**0.104**	0.086	0.070	0.054	0.044	0.036	0.030
Wallsend	**0.110**	0.091	0.080	0.064	0.054	0.039	0.031
North West Slopes							
Gunnedah	0.094	0.078	0.073	0.067	0.057	0.045	0.036

Table 35 2019 Statistical summary for ozone: daily maximum rolling 4-hour average concentrations

Region/ monitoring station	Maximum (ppm)	Percentile (ppm)					
		99th	98th	95th	90th	75th	50th
Sydney							
Bargo	**0.125**	**0.096**	**0.089**	0.075	0.059	0.041	0.031
Bringelly	**0.111**	**0.096**	**0.087**	0.078	0.063	0.041	0.032
Camden	**0.115**	**0.102**	**0.094**	0.078	0.068	0.041	0.032
Campbelltown West	**0.117**	**0.106**	**0.092**	**0.081**	0.062	0.039	0.030
Chullora	**0.121**	**0.081**	0.070	0.062	0.050	0.034	0.028
Earlwood	**0.125**	**0.081**	0.070	0.057	0.046	0.032	0.027
Liverpool	**0.115**	**0.094**	**0.086**	0.074	0.061	0.037	0.030
Macquarie Park	**0.105**	**0.084**	0.074	0.065	0.052	0.037	0.030
Oakdale	**0.130**	**0.097**	**0.092**	0.075	0.060	0.041	0.033
Parramatta North	**0.122**	**0.086**	**0.082**	0.073	0.060	0.039	0.031
Prospect	**0.122**	**0.095**	**0.087**	0.073	0.060	0.040	0.031
Randwick	**0.111**	**0.084**	0.065	0.051	0.042	0.034	0.030
Richmond	**0.120**	**0.098**	**0.083**	0.070	0.059	0.040	0.032
Rouse Hill	**0.101**	**0.096**	**0.083**	0.074	0.061	0.039	0.032
Rozelle	**0.149**	**0.081**	0.065	0.049	0.042	0.032	0.028
St Marys	**0.118**	**0.107**	**0.094**	0.076	0.059	0.041	0.033
Central Coast							
Wyong	**0.090**	0.077	0.068	0.051	0.044	0.035	0.030
Illawarra							
Albion Park South	0.078	0.070	0.064	0.047	0.040	0.033	0.029
Kembla Grange	**0.092**	0.073	0.063	0.052	0.042	0.033	0.029
Wollongong	**0.094**	0.074	0.066	0.051	0.044	0.034	0.029
Lower Hunter							
Beresfield	**0.107**	**0.082**	0.072	0.060	0.049	0.037	0.029
Newcastle	**0.097**	0.070	0.061	0.050	0.042	0.034	0.029
Wallsend	**0.097**	**0.081**	0.073	0.059	0.047	0.036	0.030
North West Slopes							
Gunnedah	**0.087**	0.074	0.068	0.064	0.055	0.043	0.034

Table 36 Annual maximum 1-hour average concentrations for ozone (ppm)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	**0.110**	**0.126**	0.091	0.095	**0.105**	0.083	**0.105**	0.095	**0.102**	**0.128**
Bringelly	**0.104**	**0.125**	0.088	**0.108**	**0.124**	0.087	0.094	0.098	**0.110**	**0.144**
Camden	-	-	*0.095*	**0.110**	**0.123**	0.086	0.097	**0.122**	**0.112**	**0.138**
Campbelltown West/Macarthur	**0.119**	**0.131**	0.080	0.094	**0.124**	0.086	0.091	0.094	**0.110**	**0.131**
Chullora	0.083	**0.114**	0.080	**0.105**	0.079	0.093	0.090	**0.114**	0.092	**0.176**
Earlwood	0.085	0.099	0.082	**0.101**	0.069	0.093	0.092	**0.109**	0.072	**0.179**
Liverpool	0.091	**0.103**	0.079	**0.117**	**0.103**	0.087	0.095	**0.135**	**0.111**	**0.157**
Macquarie Park	-	-	-	-	-	-	-	*0.091*	0.087	**0.122**
Oakdale	0.099	**0.126**	0.089	0.095	**0.110**	0.084	0.083	0.095	0.097	**0.147**
Parramatta North	-	-	-	-	-	-	-	-	**0.102**	**0.157**
Prospect	**0.104**	**0.126**	0.080	**0.111**	**0.103**	0.085	**0.104**	**0.123**	**0.105**	**0.132**
Randwick	0.084	0.073	0.066	0.075	0.066	**0.113**	0.099	**0.116**	0.073	**0.150**
Richmond	0.089	**0.116**	0.085	0.095	0.090	0.094	0.081	0.093	**0.103**	**0.137**
Rouse Hill/Vineyard	0.090	0.094	0.080	**0.105**	**0.112**	0.088	0.076	-	-	***0.112***
Rozelle	0.073	0.093	0.069	0.073	0.067	0.099	0.089	**0.114**	*0.078*	**0.179**
St Marys	0.095	**0.136**	0.085	**0.110**	0.100	0.082	**0.101**	**0.110**	**0.105**	**0.137**
Central Coast										
Wyong	-	-	*0.078*	0.079	0.076	0.097	0.086	**0.121**	0.075	0.100
Illawarra										
Albion Park South	0.093	**0.118**	0.067	**0.120**	0.094	0.079	**0.104**	**0.117**	0.076	0.099
Kembla Grange	0.081	**0.121**	0.068	**0.126**	0.094	**0.104**	**0.114**	**0.122**	0.070	0.100
Wollongong	0.082	0.084	0.065	**0.112**	0.077	0.092	0.095	**0.107**	0.066	**0.111**
Lower Hunter										
Beresfield	0.088	0.071	0.070	0.077	0.090	0.077	0.085	0.083	**0.107**	**0.126**
Newcastle	0.086	0.066	0.071	0.081	0.065	0.074	0.077	0.086	0.067	**0.104**
Wallsend	0.067	0.071	0.080	0.084	0.087	0.071	0.086	**0.106**	0.086	**0.110**
North West Slopes										
Gunnedah	-	-	-	-	-	-	-	-	0.063	0.094

Table 37 Annual maximum rolling 4-hour average concentrations for ozone (ppm)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	**0.086**	**0.098**	**0.083**	**0.082**	**0.093**	0.074	0.080	**0.086**	**0.084**	**0.125**
Bringelly	**0.089**	**0.118**	0.072	**0.102**	**0.113**	0.078	0.080	**0.089**	**0.092**	**0.111**
Camden	-	-	***0.084***	**0.090**	**0.110**	0.072	0.075	**0.108**	**0.094**	**0.115**
Campbelltown West/Macarthur	**0.103**	**0.122**	0.073	**0.082**	**0.111**	0.079	0.077	**0.091**	**0.098**	**0.117**
Chullora	0.072	**0.096**	0.068	**0.094**	0.073	0.078	0.077	**0.110**	**0.082**	**0.121**
Earlwood	0.074	**0.088**	0.068	**0.082**	0.065	**0.081**	**0.082**	**0.087**	0.065	**0.125**
Liverpool	**0.081**	**0.095**	0.071	**0.110**	**0.087**	0.077	**0.086**	**0.117**	**0.093**	**0.115**
Macquarie Park	-	-	-	-	-	-	-	***0.087***	0.080	**0.105**
Oakdale	**0.088**	**0.098**	**0.081**	**0.081**	**0.088**	0.070	0.067	0.080	**0.082**	**0.130**
Parramatta North	-	-	-	-	-	-	-	-	**0.095**	**0.122**
Prospect	**0.097**	**0.114**	0.073	**0.104**	**0.097**	0.070	0.078	**0.106**	**0.091**	**0.122**
Randwick	0.077	0.069	0.063	0.067	0.061	**0.085**	**0.090**	**0.102**	0.069	**0.111**
Richmond	**0.082**	**0.088**	0.070	0.076	0.073	0.074	0.070	**0.085**	**0.087**	**0.120**
Rouse Hill/Vineyard	0.079	0.075	0.070	**0.090**	0.075	0.071	0.064	-	-	***0.101***
Rozelle	0.067	0.080	0.054	0.063	0.060	0.079	0.075	**0.109**	*0.066*	**0.149**
St Marys	**0.083**	**0.121**	0.072	**0.101**	**0.085**	0.071	**0.081**	**0.096**	**0.094**	**0.118**
Central Coast										
Wyong	-	-	*0.066*	0.072	0.069	**0.091**	0.079	**0.105**	0.067	**0.090**
Illawarra										
Albion Park South	0.073	**0.099**	0.064	**0.100**	0.079	0.075	**0.098**	**0.102**	0.073	0.078
Kembla Grange	0.078	**0.105**	0.061	**0.103**	0.080	0.079	**0.102**	**0.098**	0.059	**0.092**
Wollongong	0.073	0.078	0.061	**0.091**	0.068	**0.083**	**0.085**	**0.094**	0.061	**0.094**
Lower Hunter										
Beresfield	**0.082**	0.064	0.067	0.074	0.077	0.067	0.068	0.079	**0.089**	**0.107**
Newcastle	0.076	0.063	0.057	0.075	0.056	0.066	0.069	0.073	0.058	**0.097**
Wallsend	0.063	0.059	0.070	0.078	0.065	0.062	0.078	**0.097**	0.068	**0.097**
North West Slopes										
Gunnedah	-	-	-	-	-	-	-	-	0.058	**0.087**

Sulfur dioxide

Table 38 2019 statistical summary for SO_2: daily maximum 1-hour average concentrations

Region/ monitoring station	Maximum (ppm)	Percentile (ppm)					
		99th	98th	95th	90th	75th	50th
Sydney							
Bargo	0.020	0.008	0.007	0.005	0.003	0.002	0.001
Bringelly	0.028	0.010	0.009	0.007	0.005	0.002	0.001
Campbelltown West	0.020	0.012	0.010	0.007	0.005	0.002	0.001
Chullora	0.026	0.016	0.012	0.009	0.006	0.003	0.002
Liverpool	0.016	0.014	0.011	0.008	0.005	0.003	0.002
Macquarie Park	0.029	0.019	0.015	0.009	0.007	0.003	0.001
Parramatta North	0.030	0.018	0.015	0.010	0.006	0.004	0.002
Prospect	0.021	0.017	0.014	0.010	0.006	0.003	0.002
Randwick	0.029	0.022	0.015	0.013	0.008	0.005	0.003
Richmond	0.023	0.013	0.009	0.006	0.004	0.002	0.001
Rouse Hill	0.033	0.015	0.012	0.009	0.005	0.003	0.001
Rozelle	0.032	0.016	0.015	0.011	0.008	0.004	0.002
Central Coast							
Wyong	0.061	0.043	0.034	0.023	0.015	0.005	0.001
Illawarra							
Albion Park South	0.025	0.020	0.017	0.015	0.012	0.006	0.001
Wollongong	0.034	0.025	0.018	0.013	0.011	0.007	0.004
Lower Hunter							
Beresfield	0.068	0.027	0.025	0.019	0.017	0.012	0.007
Newcastle	0.046	0.024	0.023	0.016	0.013	0.009	0.005
Wallsend	0.050	0.032	0.029	0.023	0.018	0.011	0.006

Table 39 2019 statistical summary for SO_2: daily (24-hour) average concentrations

Region/ monitoring station	Maximum (ppm)	Percentile (ppm)					
		99th	98th	95th	90th	75th	50th
Sydney							
Bargo	0.006	0.003	0.002	0.002	0.001	0.001	0.000
Bringelly	0.004	0.002	0.002	0.002	0.001	0.001	0.000
Campbelltown West	0.004	0.003	0.003	0.002	0.002	0.001	0.000
Chullora	0.004	0.003	0.003	0.002	0.002	0.001	0.000
Liverpool	0.004	0.003	0.002	0.002	0.002	0.001	0.001
Macquarie Park	0.004	0.003	0.003	0.002	0.001	0.001	0.000
Parramatta North	0.006	0.004	0.003	0.002	0.002	0.001	0.001
Prospect	0.004	0.003	0.003	0.002	0.002	0.001	0.001
Randwick	0.005	0.004	0.003	0.002	0.002	0.001	0.001
Richmond	0.004	0.003	0.002	0.002	0.001	0.001	0.000
Rouse Hill	*0.005*	*0.004*	*0.003*	*0.003*	*0.002*	*0.001*	*0.000*
Rozelle	0.005	0.004	0.004	0.003	0.002	0.001	0.001
Central Coast							
Wyong	0.006	0.005	0.005	0.003	0.002	0.001	0.000
Illawarra							
Albion Park South	0.008	0.007	0.006	0.004	0.003	0.001	0.000
Wollongong	0.006	0.005	0.004	0.003	0.002	0.001	0.001
Lower Hunter							
Beresfield	0.009	0.007	0.006	0.004	0.003	0.002	0.001
Newcastle	0.006	0.005	0.004	0.004	0.003	0.002	0.001
Wallsend	0.009	0.006	0.006	0.004	0.003	0.002	0.001

Table 40 Annual maximum 1-hour average concentrations for SO_2 (ppm)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	0.008	0.010	0.009	0.017	0.010	0.009	0.010	0.010	0.010	0.020
Bringelly	0.008	0.011	0.015	0.011	0.009	0.007	0.006	0.009	0.011	0.028
Campbelltown West/Macarthur	0.010	0.014	0.008	0.009	0.012	0.011	0.016	0.011	0.016	0.020
Chullora	0.021	0.026	0.025	0.012	0.019	0.014	0.014	0.014	0.021	0.026
Liverpool	-	-	-	-	-	-	*0.007*	0.011	0.020	0.016
Macquarie Park	-	-	-	-	-	-	-	*0.023*	0.044	0.029
Parramatta North	-	-	-	-	-	-	-	-	0.021	0.030
Prospect	0.018	0.014	0.012	0.020	0.019	0.027	0.021	0.023	0.025	0.021
Randwick	0.023	0.023	0.023	0.027	0.026	0.031	0.034	0.029	0.021	0.029
Richmond	0.009	0.010	0.013	0.010	0.009	0.032	0.025	0.034	0.017	0.023
Rouse Hill/ Vineyard	0.020	0.013	0.011	0.011	0.010	0.017	0.014	-	-	*0.033*
Rozelle	-	-	-	-	-	0.028	0.020	0.024	*0.030*	0.032
Central Coast										
Wyong	-	-	*0.030*	0.029	0.040	0.069	0.032	0.047	0.062	0.061
Illawarra										
Albion Park South	0.032	0.035	0.027	0.039	0.016	0.036	0.022	0.030	0.031	0.025
Wollongong	0.027	0.018	0.017	0.040	0.019	0.019	0.020	0.047	0.039	0.034
Lower Hunter										
Beresfield	0.047	0.060	0.037	0.031	0.031	0.082	0.033	0.054	0.070	0.068
Newcastle	0.027	0.033	0.034	0.052	0.064	0.036	0.055	0.050	0.039	0.046
Wallsend	*0.031*	0.044	0.035	0.050	0.046	0.034	0.038	0.056	0.079	0.050

Table 41 Annual maximum 24-hour average concentrations for SO_2 (ppm)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	0.001	0.002	0.002	0.003	0.002	0.002	0.004	0.002	0.002	0.006
Bringelly	0.002	0.002	0.002	0.002	0.003	0.001	0.002	0.002	0.003	0.004
Campbelltown West/Macarthur	0.003	0.002	0.002	0.002	0.004	0.002	0.002	0.003	0.004	0.004
Chullora	0.004	0.005	0.004	0.003	0.004	0.003	0.003	0.003	0.003	0.004
Liverpool	-	-	-	-	-	-	*0.002*	0.003	0.004	0.004
Macquarie Park	-	-	-	-	-	-	-	*0.003*	0.007	0.004
Parramatta North	-	-	-	-	-	-	-	-	0.005	0.006
Prospect	0.004	0.003	0.003	0.004	0.005	0.003	0.004	0.004	0.005	0.004
Randwick	0.006	0.005	0.005	0.004	0.004	0.004	0.003	0.008	0.004	0.005
Richmond	0.002	0.003	0.002	0.002	0.002	0.003	0.002	0.004	0.005	0.004
Rouse Hill/ Vineyard	0.003	0.003	0.002	0.003	0.002	0.002	0.003	-	-	*0.005*
Rozelle	-	-	-	-	-	0.005	0.005	0.003	*0.005*	0.005
Central Coast										
Wyong	-	-	*0.004*	0.005	0.004	0.009	0.004	0.007	0.008	0.006
Illawarra										
Albion Park South	0.011	0.010	0.010	0.009	0.005	0.007	0.006	0.008	0.008	0.008
Wollongong	0.008	0.009	0.005	0.008	0.005	0.004	0.004	0.005	0.009	0.006
Lower Hunter										
Beresfield	0.008	0.012	0.009	0.005	0.007	0.008	0.008	0.008	0.007	0.009
Newcastle	0.005	0.009	0.007	0.007	0.006	0.007	0.007	0.006	0.007	0.006
Wallsend	*0.007*	0.007	0.005	0.005	0.008	0.007	0.006	0.010	0.008	0.009

Table 42 Annual average concentration for SO_2 (ppm)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bringelly	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Campbelltown West/Macarthur	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.001
Chullora	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Liverpool	-	-	-	-	-	-	*0.001*	0.001	0.001	0.001
Macquarie Park	-	-	-	-	-	-	-	*0.000*	0.001	0.001
Parramatta North	-	-	-	-	-	-	-	-	0.001	0.001
Prospect	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Randwick	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Richmond	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rouse Hill/ Vineyard	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	*0.001*
Rozelle	-	-	-	-	-	0.001	0.001	0.001	*0.001*	0.001
Central Coast										
Wyong	-	-	*0.001*	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Illawarra										
Albion Park South	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Wollongong	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Lower Hunter										
Beresfield	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.002	0.002
Newcastle	0.001	0.002	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.001
Wallsend	*0.001*	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002

Particles as PM10

Table 43 2019 statistical summary for PM10: 24-hour average concentrations

Region/ monitoring station	Maximum (µg/m^3)	Percentile (µg/m^3)					
		99th	98th	95th	90th	75th	50th
Sydney							
Bargo	**188.9**	**129.5**	**96.5**	**54.4**	36.3	23.9	15.4
Bringelly	**134.0**	**112.3**	**87.7**	**63.9**	39.9	27.5	18.8
Camden	**139.2**	**120.2**	**108.6**	**68.7**	41.0	25.1	16.0
Campbelltown West	**132.0**	**116.6**	**94.0**	**60.5**	37.5	25.4	16.9
Chullora	**140.4**	**103.1**	**89.7**	**53.4**	39.5	27.4	20.3
Earlwood	**129.4**	**100.1**	**79.7**	48.9	36.6	26.5	19.2
Liverpool	**178.9**	**128.5**	**93.0**	**61.0**	43.9	31.4	23.2
Macquarie Park	**187.3**	**94.1**	**78.1**	46.2	32.9	22.7	15.1
Oakdale	**216.8**	**168.3**	**143.1**	**81.5**	39.5	22.4	12.9
Parramatta North	**195.3**	**126.1**	**92.8**	**59.3**	40.9	29.6	20.3
Prospect	**182.8**	**129.1**	**93.4**	**63.5**	41.1	29.9	20.4
Randwick	**127.7**	**89.7**	**79.2**	**52.8**	38.6	28.3	20.1
Richmond	**193.4**	**123.2**	**101.5**	**65.4**	43.8	26.8	17.4
Rouse Hill	***216.2***	***165.2***	***125.7***	***86.3***	***59.2***	*31.0*	*18.2*
Rozelle	**142.7**	**89.7**	**76.7**	**50.1**	35.9	26.5	18.6
St Marys	**159.8**	**119.8**	**90.2**	**65.2**	43.3	29.7	19.5
Central Coast							
Wyong	**128.4**	**99.8**	**85.6**	**52.8**	35.6	24.4	16.1
Illawarra							
Albion Park South	**104.3**	**73.9**	**65.1**	44.1	35.9	23.3	16.1
Kembla Grange	**115.8**	**89.4**	**78.2**	**55.1**	44.8	32.5	21.1
Wollongong	**117.6**	**91.2**	**75.8**	**51.7**	40.7	27.0	17.5
Lower Hunter							
Beresfield	**136.7**	**106.2**	**84.1**	**63.7**	40.7	29.6	21.0
Newcastle	**125.8**	**107.0**	**86.1**	**62.7**	46.3	33.9	23.7
Wallsend	**127.9**	**86.4**	**74.8**	**55.5**	38.3	26.3	18.7

Table 43 2019 statistical summary for PM10: 24-hour average concentrations (continued)

Region/ monitoring station	Maximum ($\mu g/m^3$)	Percentile ($\mu g/m^3$)					
		99th	98th	95th	90th	75th	50th
Central Tablelands							
Bathurst	**296.6**	**201.0**	**159.0**	**103.0**	**51.7**	26.0	16.0
Orange	**423.7**	**236.1**	**174.6**	**90.8**	**50.8**	27.4	18.4
North West Slopes							
Gunnedah	**205.2**	**123.6**	**102.5**	**72.5**	41.8	27.6	18.9
Narrabri	**232.6**	**156.4**	**128.8**	**79.6**	46.2	23.6	13.9
Tamworth	**240.2**	**199.1**	**169.2**	**111.1**	**67.7**	33.2	22.7
Northern Tablelands							
Armidale	**309.7**	**187.1**	**134.2**	**106.0**	**58.9**	31.0	17.3
South West Slopes							
Albury	**222.4**	**134.1**	**83.1**	**56.3**	43.0	26.1	16.5
Wagga Wagga North	**251.7**	**206.4**	**142.5**	**103.2**	**69.3**	42.9	24.4

Table 44 Annual maximum 24-hour average concentrations for PM10 (µg/m^3)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	34.9	**89.7**	45.2	**208.9**	**50.8**	**52.2**	**58.4**	**53.5**	**60.8**	**188.9**
Bringelly	41.1	**86.0**	40.1	**97.2**	42.6	**57.0**	**61.6**	**83.7**	**92.9**	**134.0**
Camden	-	-	*35.6*	**98.1**	41.4	**62.4**	43.6	48.4	**68.1**	**139.2**
Campbelltown West/Macarthur	**58.7**	38.1	39.3	**56.9**	49.4	**69.7**	**50.1**	**53.1**	**72.3**	**132.0**
Chullora	42.1	**65.2**	**52.4**	**69.4**	40.0	**64.6**	**63.5**	**63.0**	**90.7**	**140.4**
Earlwood	47.8	**124.9**	44.2	**63.1**	45.2	**66.5**	42.9	**59.8**	**86.5**	**129.4**
Liverpool	41.1	***68.8***	42.5	**98.5**	40.8	**68.6**	**68.7**	**73.6**	**101.5**	**178.9**
Macquarie Park	-	-	-	-	-	-	-	*49.6*	**85.6**	**187.3**
Oakdale	33.3	**54.7**	38.9	**99.0**	**56.3**	**61.7**	**75.9**	46.8	**105.1**	**216.8**
Parramatta North	-	-	-	-	-	-	-	-	**107.4**	**195.3**
Prospect	40.1	41.5	38.7	**81.8**	44.3	**68.7**	**110.1**	**61.1**	**113.3**	**182.8**
Randwick	42.7	40.1	43.7	**55.3**	46.1	**77.4**	44.1	**56.1**	**95.5**	**127.7**
Richmond	37.0	46.2	**99.2**	**112.7**	40.0	49.3	**102.8**	**51.5**	**116.3**	**193.4**
Rouse Hill/ Vineyard	39.7	32.7	34.3	**67.8**	41.9	**59.0**	**105.4**	-	-	***216.2***
Rozelle	37.6	39.4	40.7	**58.5**	43.8	**60.3**	**58.8**	**54.1**	***88.3***	**142.7**
St Marys	**52.1**	**73.9**	34.3	**93.0**	45.0	**53.0**	**100.2**	49.8	**100.5**	**159.8**
Central Coast										
Wyong	-	-	*37.4*	**70.2**	41.9	**58.6**	46.0	**63.4**	**138.3**	**128.4**
Illawarra										
Albion Park South	41.8	**51.0**	43.9	**69.0**	48.3	41.2	43.1	44.6	**94.4**	**104.3**
Kembla Grange	47.5	**55.5**	**57.2**	**102.2**	**99.2**	**62.8**	**56.3**	**67.7**	**71.8**	**115.8**
Wollongong	49.6	48.5	47.5	**94.3**	45.3	45.8	**52.9**	**55.2**	**59.7**	**117.6**
Lower Hunter										
Beresfield	50.0	42.8	**50.8**	**55.3**	45.4	**64.9**	48.0	49.4	**149.1**	**136.7**
Newcastle	**57.1**	49.2	48.7	**69.0**	**53.7**	**70.4**	**89.1**	**55.0**	**146.0**	**125.8**
Wallsend	32.8	38.9	38.1	***52.5***	43.4	**77.5**	**65.5**	47.9	**136.5**	**127.9**

Table 44 Annual maximum 24-hour average concentrations for PM10 (µg/m^3) (continued)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Central Tablelands										
Bathurst	43.3	24.3	**55.5**	**145.0**	42.8	**94.6**	34.1	49.9	**274.1**	**296.6**
North West Slopes										
Gunnedah	-	-	-	-	-	-	-	-	**234.9**	**205.2**
Narrabri	-	-	-	-	-	-	-	-	**221.7**	**232.6**
Tamworth	29.1	**50.9**	**55.1**	47.5	**66.6**	**52.7**	**51.7**	**54.1**	**145.4**	**240.2**
Northern Tablelands										
Armidale	-	-	-	-	-	-	-	-	***157.5***	**309.7**
South West Slopes										
Albury	**60.8**	28.0	**54.4**	**59.2**	**159.6**	**92.5**	**51.0**	48.8	**107.8**	**222.4**
Wagga Wagga North/Wagga Wagga	**64.9**	**56.3**	**67.2**	**110.7**	**88.2**	**145.1**	**114.7**	**171.6**	**127.2**	**251.7**

Table 45 Annual average PM10 concentrations (µg/m^3)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	12.9	12.9	14.3	15.3	14.3	13.2	14.3	13.9	16.9	21.2
Bringelly	15.5	15.9	15.7	17.0	16.6	15.8	16.9	19.8	21.3	23.6
Camden	-	-	*20.1*	15.4	15.6	13.8	14.4	14.7	17.5	22.5
Campbelltown West/Macarthur	14.0	13.2	15.1	15.5	17.0	15.6	16.1	15.7	17.9	22.3
Chullora	17.7	19.8	18.1	18.3	18.1	17.5	18.1	20.1	21.9	24.6
Earlwood	17.9	18.0	19.5	19.9	18.3	17.2	17.6	18.0	19.8	23.0
Liverpool	17.0	*18.1*	19.8	20.9	19.0	18.4	19.5	20.6	24.2	**27.7**
Macquarie Park	-	-	-	-	-	-	-	*15.2*	17.2	19.9
Oakdale	10.7	10.7	11.7	13.6	13.1	11.4	12.2	12.1	15.4	22.4
Parramatta North	-	-	-	-	-	-	-	-	21.6	**25.5**
Prospect	15.4	15.8	17.2	19.2	17.6	17.6	18.9	18.9	21.9	**26.0**
Randwick	16.0	16.0	17.9	18.8	18.1	18.6	18.0	19.2	21.2	24.1
Richmond	13.1	13.2	15.1	17.4	15.4	12.8	16.0	16.0	18.7	24.2
Rouse Hill/ Vineyard	14.5	14.0	14.4	16.1	16.3	15.9	17.0	-	-	***27.3***
Rozelle	16.1	16.6	16.9	18.3	17.9	16.7	16.8	18.1	*18.4*	22.7
St Marys	15.1	14.7	14.5	16.0	16.7	15.0	16.1	16.2	19.4	24.6
Central Coast										
Wyong	-	-	*21.9*	16.6	15.1	14.9	15.2	16.1	18.0	21.1
Illawarra										
Albion Park South	14.0	13.6	13.6	14.7	16.2	14.0	14.9	15.3	17.8	19.5
Kembla Grange	17.7	16.8	18.3	18.5	17.3	17.7	20.0	20.5	22.7	**25.5**
Wollongong	17.8	17.0	18.0	17.6	17.7	16.9	17.3	18.1	19.8	22.6
Lower Hunter										
Beresfield	16.6	17.2	21.3	21.4	19.4	18.8	19.1	19.6	21.6	**25.9**
Newcastle	18.6	19.1	20.6	22.7	21.4	21.4	21.6	22.4	24.5	**28.4**
Wallsend	14.7	14.2	14.9	*17.4*	16.9	16.7	16.6	17.4	19.4	22.9

Table 45 Annual average PM10 concentrations (µg/m^3) (continued)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Central Tablelands										
Bathurst	9.4	11.0	13.4	15.1	14.6	13.4	13.3	14.1	18.8	**27.4**
North West Slopes										
Gunnedah	-	-	-	-	-	-	-	-	18.9	24.8
Narrabri	-	-	-	-	-	-	-	-	14.3	23.2
Tamworth	12.0	13.1	15.9	16.6	15.8	14.1	15.3	15.3	20.1	**33.7**
Northern Tablelands										
Armidale	-	-	-	-	-	-	-	-	*17.6*	**27.9**
South West Slopes										
Albury	12.6	12.3	14.3	15.8	15.9	14.6	15.1	15.8	19.8	23.4
Wagga Wagga North/Wagga Wagga	17.2	15.5	18.8	22.1	20.7	19.9	20.6	20.6	**27.4**	**35.3**

Particles as PM2.5

Table 46 2019 statistical summary for PM2.5: 24-hour average concentrations

Region/ monitoring station	Maximum (µg/m^3)	Percentile (µg/m^3)					
		99th	98th	95th	90th	75th	50th
Sydney							
Bargo	**170.7**	**107.4**	**69.3**	**28.5**	16.0	9.7	6.4
Bringelly	**178.0**	**67.2**	**55.2**	**35.4**	19.0	11.9	7.5
Camden	**155.3**	**111.6**	**66.9**	**41.6**	20.1	11.2	7.1
Campbelltown West	**106.0**	**82.2**	**63.9**	**38.1**	21.4	11.9	8.0
Chullora	**97.6**	**71.5**	**53.6**	**31.4**	18.5	12.1	9.0
Earlwood	**86.2**	**68.3**	**47.2**	**29.6**	17.5	11.5	7.7
Liverpool	**156.0**	**84.4**	**60.9**	**34.0**	21.4	13.6	9.4
Macquarie Park	**152.0**	**61.9**	**42.7**	25.0	15.3	9.7	6.2
Oakdale	**250.2**	**158.6**	**124.0**	**55.5**	18.2	9.8	5.7
Parramatta North	**130.1**	**66.6**	**41.5**	**26.7**	17.5	11.3	7.5
Prospect	**134.1**	**72.7**	**51.5**	**33.9**	19.2	13.2	8.5
Randwick	**95.2**	**53.8**	**42.8**	**27.5**	16.7	11.1	8.6
Richmond	**141.2**	**83.8**	**61.4**	**43.7**	**26.2**	12.9	8.7
Rouse Hill	***183.5***	***108.0***	***69.3***	***44.1***	***29.8***	*12.2*	*6.8*
Rozelle	**101.8**	**53.5**	**50.6**	**28.3**	16.4	11.2	7.8
St Marys	**88.3**	**64.8**	**40.9**	**29.2**	16.4	10.8	7.2
Central Coast							
Wyong	**202.1**	**72.5**	**51.8**	**27.2**	15.4	10.0	7.3
Illawarra							
Albion Park South	**49.4**	**39.1**	**33.6**	20.2	15.0	10.0	6.9
Kembla Grange	**70.1**	**47.7**	**38.9**	21.8	15.3	9.9	6.4
Wollongong	**81.5**	**50.9**	**36.5**	22.9	15.5	10.1	6.6
Lower Hunter							
Beresfield	**100.5**	**61.5**	**51.8**	**32.4**	18.9	13.1	9.2
Newcastle	**95.5**	**62.5**	**53.6**	**31.2**	17.0	11.7	8.0
Wallsend	**108.3**	**65.9**	**45.5**	**30.1**	16.9	11.3	7.6

Table 46 2019 statistical summary for PM2.5: 24-hour average concentrations (continued)

Region/ monitoring station	Maximum (µg/m^3)	Percentile (µg/m^3)					
		99th	98th	95th	90th	75th	50th
Central Tablelands							
Bathurst	**199.5**	**126.9**	**83.7**	**42.1**	14.6	9.0	6.3
Orange	**387.4**	**186.5**	**113.3**	**42.2**	23.8	14.7	7.7
North West Slopes							
Gunnedah	**94.1**	**83.4**	**58.9**	**29.0**	22.1	13.5	7.4
Narrabri	**87.7**	**69.4**	**39.0**	**25.7**	16.4	7.3	4.6
Tamworth	**164.2**	**122.7**	**97.4**	**43.5**	24.5	13.4	9.0
Northern Tablelands							
Armidale	**267.3**	**144.3**	**111.5**	**63.5**	**31.4**	21.0	9.6
South West Slopes							
Albury	**167.1**	**89.4**	**51.9**	**25.1**	14.6	10.2	7.1
Wagga Wagga North	**239.6**	**90.8**	**57.3**	**25.5**	15.9	11.4	7.6

Table 47 2019 statistical summary for PM2.5: 24-hour average concentration by federal reference method

Region/ monitoring station	Maximum (µg/m^3)	Percentile (µg/m^3)					
		99th	98th	95th	90th	75th	50th
Sydney							
Chullora	**87.5**	**74.5**	**60.8**	**27.5**	17.0	10.8	7.1

Table 48 Annual maximum 24-hour average concentrations PM2.5 (µg/m^3)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	-	-	-	-	-	-	-	20.9	**38.1**	**170.7**
Bringelly	-	-	-	-	-	-	*21.6*	**55.7**	**55.6**	**178.0**
Camden	-	-	*19.5*	**69.9**	18.5	25.0	**36.0**	**27.7**	**37.0**	**155.3**
Campbelltown West	-	-	-	-	-	*15.7*	**35.8**	25.0	**45.4**	**106.0**
Chullora	24.2	23.9	23.4	**49.1**	23.1	**37.2**	**49.4**	**44.7**	**29.1**	**97.6**
Earlwood	22.5	23.6	20.7	**37.3**	22.7	**28.0**	**33.3**	**50.9**	**28.5**	**86.2**
Liverpool	21.8	**38.0**	24.9	**73.8**	24.3	**32.2**	**50.8**	**59.2**	**45.4**	**156.0**
Macquarie Park	-	-	-	-	-	-	-	*24.1*	**58.4**	**152.0**
Oakdale	-	-	-	-	-	-	-	**33.0**	**75.4**	**250.2**
Parramatta North	-	-	-	-	-	-	-	-	**42.1**	**130.1**
Prospect	-	-	-	-	-	**29.6**	**84.9**	**30.1**	**47.5**	**134.1**
Randwick	-	-	-	-	-	-	-	***48.7***	**31.8**	**95.2**
Richmond	20.8	**42.9**	**116.7**	**97.6**	**29.1**	24.5	**83.4**	**34.3**	**123.9**	**141.2**
Rozelle	-	-	-	-	-	**36.0**	**49.4**	**36.3**	*19.2*	**101.8**
St Marys	-	-	-	-	-	-	**93.2**	**38.2**	**80.5**	**88.3**
Central Coast										
Wyong	-	-	*14.7*	**55.8**	19.7	13.2	19.8	**27.2**	18.1	**202.1**
Illawarra										
Albion Park South	-	-	-	-	-	21.1	**30.7**	19.3	**29.4**	**49.4**
Kembla Grange	-	-	-	-	-	*23.8*	**32.0**	21.3	21.9	**70.1**
Wollongong	23.5	17.7	15.6	**118.7**	17.3	**31.6**	**33.7**	24.7	**47.6**	**81.5**
Lower Hunter										
Beresfield	**25.9**	18.8	22.4	**40.8**	19.0	**25.9**	**27.9**	18.7	24.9	**100.5**
Newcastle	-	-	-	-	21.2	**30.2**	**66.1**	18.0	20.2	**95.5**
Wallsend	18.8	16.2	16.2	**37.0**	18.0	24.0	**50.7**	20.4	20.2	**108.3**

Table 48 Annual maximum 24-hour average concentrations PM2.5 (µg/m^3)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Central Tablelands										
Bathurst	-	-	-	-	-	-	*15.0*	17.5	**40.5**	**199.5**
North West Slopes										
Gunnedah	-	-	-	-	-	-	-	-	**50.7**	**94.1**
Narrabri	-	-	-	-	-	-	-	-	**26.3**	**87.7**
Tamworth	-	-	-	-	-	-	*17.6*	21.6	24.2	**164.2**
Northern Tablelands										
Armidale	-	-	-	-	-	-	-	-	***40.0***	**267.3**
South West Slopes										
Albury	-	-	-	-	-	-	-	18.7	**30.4**	**167.1**
Wagga Wagga North	-	*15.4*	23.2	**29.9**	**27.6**	24.2	**28.1**	**32.5**	21.6	**239.6**

Table 49 Annual maximum 24-hour average concentrations PM2.5 (µg/m^3) by federal reference method

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Chullora	**28.2**	16.7	*12.4*	**53.9**	18.9	**38.6**	*21.0*	***27.9***	**39.6**	**87.5**

Table 50 Annual average concentrations for PM2.5 (µg/m^3)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Bargo	-	-	-	-	-	-	-	6.3	6.8	**10.4**
Bringelly	-	-	-	-	-	-	*7.6*	7.5	8.0	**11.3**
Camden	-	-	*7.8*	6.5	6.3	6.2	6.4	6.7	7.2	**11.8**
Campbelltown West	-	-	-	-	-	*7.9*	7.9	7.4	**8.4**	**11.8**
Chullora	5.7	5.9	6.0	**8.4**	**9.0**	8.0	8.0	**9.5**	**8.6**	**11.7**
Earlwood	5.7	5.4	5.6	7.9	7.8	**8.5**	**8.1**	7.3	7.8	**10.5**
Liverpool	6.3	5.9	**8.5**	**9.4**	**8.6**	**8.5**	**8.8**	**8.9**	**10.1**	**12.8**
Macquarie Park	-	-	-	-	-	-	-	*6.3*	7.0	**9.2**
Oakdale	-	-	-	-	-	-	-	6.1	6.9	**13.2**
Parramatta North	-	-	-	-	-	-	-	**-**	**9.2**	**10.5**
Prospect	-	-	-	-	-	**8.2**	**8.7**	7.7	**8.5**	**11.9**
Randwick	-	-	-	-	-	-	-	*6.9*	7.6	**10.8**
Richmond	4.2	4.7	5.3	**8.4**	6.7	7.7	7.9	7.0	**8.1**	**13.1**
Rozelle	-	-	-	-	-	7.2	7.4	7.2	*7.3*	**10.3**
St Marys	-	-	-	-	-	-	7.9	7.0	7.8	**9.8**
Central Coast										
Wyong	-	-	*7.3*	6.7	5.5	5.2	5.7	5.8	6.8	**10.5**
Illawarra										
Albion Park South	-	-	-	-	-	6.4	7.2	6.6	6.8	**8.6**
Kembla Grange	-	-	-	-	-	*6.7*	6.6	6.9	7.0	**8.8**
Wollongong	5.1	4.6	4.6	7.8	7.0	7.6	7.4	7.1	7.3	**9.0**
Lower Hunter										
Beresfield	6.0	5.5	7.9	**8.2**	7.5	7.3	7.4	7.6	**8.7**	**12.1**
Newcastle	-	-	-	-	**8.1**	7.8	7.8	7.4	7.8	**10.9**
Wallsend	4.6	4.8	5.1	7.7	6.7	7.3	8.0	7.3	7.5	**10.4**

Table 50 Annual average concentrations for PM2.5 (µg/m^3) (continued)

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Central Tablelands										
Bathurst	-	-	-	-	-	-	*5.9*	6.1	7.0	**11.3**
North West Slopes										
Gunnedah	-	-	-	-	-	-	-	-	**9.0**	**11.2**
Narrabri	-	-	-	-	-	-	-	-	4.9	7.8
Tamworth	-	-	-	-	-	-	*7.6*	7.8	**8.3**	**14.4**
Northern Tablelands										
Armidale	-	-	-	-	-	-	-	-	***11.6***	**17.2**
South West Slopes										
Albury	-	-	-	-	-	-	-	7.3	7.3	**10.1**
Wagga Wagga North	-	*7.0*	**8.7**	7.9	7.5	7.6	7.4	**8.1**	**8.4**	**11.3**

Table 51 Annual average concentration for PM2.5 (µg/m^3) by federal reference method

Region/ monitoring station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sydney										
Chullora	6.5	6.2	-	*7.2*	7.2	6.9	6.9	*7.4*	7.8	**9.3**

Section E – Episode analysis

In New South Wales, concentrations of particles (as PM10 and PM2.5) and ozone can sometimes exceed national standards.

The NSW Government has published detailed analyses of typical NSW air pollution episodes, when PM10, PM2.5 and ozone concentrations exceeded national standards.

Episode analyses of significant air pollution events from January to September 2019 may be viewed on the Department's website: Air pollution episodes in New South Wales. Given the significant bushfire impact on air quality during the second half of the calendar, a separate special statement was prepared and published, and is available on the Department's website: Air quality special statement spring–summer 2019–20.

Bushfire smoke and dust storms, spring–summer 2019–20

Air quality special statement spring–summer 2019–20:

New South Wales experienced record high temperatures, well-below-average rainfall, heatwaves, strong westerly winds and low humidity during spring and summer of 2019 and 2020. The extreme weather conditions, combined with prolonged intense drought, brought dangerous bushfire conditions across the eastern half of the State and record levels of dust storm activity.

Bushfires began in the north-east as early as winter 2019 and spread south through eastern NSW. The extent of the burnt area in the NSW bushfire season 2019–20 was 5.5 million hectares, nearing the total area burnt in the combined bushfire seasons from 1993–94 to 2018–19. Extensive bushfire smoke and dust storms led to extreme levels of air pollution across the entire State.

During the bushfires, the Department implemented an emergency response in collaboration with public health and fire and land management authorities. Our integrated air quality monitoring, forecasting and reporting systems provided hourly updated information on air pollution levels and health risks to support decision-making on emergency management responses by relevant authorities. The interagency collaboration enhanced the delivery of consistent messaging on the status of air quality, and on measures to minimise exposure for individuals and service providers in smoke-affected communities.

Ozone pollution episode summary, summer 2018–19

Air Quality Monitoring Network – Ozone episodes in Summer 2018–19:

Summer 2018–19 was the hottest on record across New South Wales, with temperatures well above average in Sydney and across the State. Several heatwaves occurred during December 2018 and January 2019.

The Greater Sydney Region recorded the highest number of days over the ozone national standards in 2018–19 since the 2006–07 warm season. There were similarities in the meteorological conditions on many of the episode days during this season, with high temperatures (greater than 35°C), similar synoptic conditions, stable conditions limiting atmospheric dispersion, and sea breeze formation typically travelling toward south-west Sydney. All exceedances during January and February 2019 occurred in Western Sydney, with one exceedance at Macquarie Park in the eastern half of Sydney on 26 January.

Particle pollution episode summary, summer 2018–19

Air Quality Monitoring Network – Particle episodes in summer 2018–19:

During the 2018–19 summer the air quality monitoring network, which includes NEPM stations and industry-funded stations in the Hunter Valley, recorded 34 days with PM10 concentrations above the benchmark of 50 µg/m^3. The number of days over the benchmark was much higher than the previous four summers. This was attributed to ongoing drought conditions in New South Wales, which led to numerous widespread and localised dust events. Only one PM2.5 exceedance was noted in January and February, from a local fire in Narrabri.

A larger number of PM10 exceedances were recorded in inland regional centres near agricultural regions, where drought conditions had reduced available ground cover and increased windblown dust. For regional NSW, the number of days above the PM10 benchmark in summer 2018–19 was not unprecedented, with five previous summers since 2002 recording a comparable number of days. However, these previous seasons were due to a combination of dust and bushfire events, whereas the 2018–19 summer was affected almost entirely by dust events.

The largest such event during the summer was a dust storm occurring during 12 and 13 February, where 14 NEPM stations recorded PM10 exceedances. These ranged from Wagga Wagga North in the south of the State, to Armidale and Narrabri in the north. Additionally, all 14 stations in the industry-funded Upper Hunter Air Quality Monitoring Network recorded PM10 exceedances from dust on 13 February. The highest concentration recorded was 222 µg/m^3 at Wagga Wagga North on 12 February.

Some bushfire impacts were noted as impacting PM10 readings above the elevated background levels during the season. Specifically noted are:

- Wollongong on 5 January, from long-range transport of bushfire smoke from southern Victoria
- Newcastle on 26 January, where a small nearby fire contributed to elevated particles
- Armidale on 13 February, where elevated PM10 from the large statewide dust storm was mixed with fine particles from transported smoke from intense bushfires in the Tingha Plateau area, north of Armidale. This smoke was transported west of the fires, then transported in a south-easterly direction by a trough in front of the dust storm. Smoke from this fire also contributed to a PM10 exceedance at Narrabri on 14 February.

Particle pollution episode summary, autumn–winter 2019

Air Quality Monitoring Network – Particle episodes in autumn–winter 2019:

Autumn and winter 2019 continued to be dominated by severe drought across much of New South Wales. A few key contributing sources were identified:

- Elevated dust storms continued to impact air quality, particularly for inland regional areas. One of the larger events (detailed in Case Study 1) was on 5–6 March. Other widespread dust storms were noted on 25 March, 31 March, 8 August and 19 August.
- Localised dust impact exceedances, outside widespread dust storms, were noted frequently at Wagga Wagga in March, April and August. The intervening months saw a reduction due to cooler and calmer wind conditions, and rain in early May which increased ground cover.
    - Dust impacts noted at Liverpool and Kembla Grange were due to local sources.
- Bushfires in the Snowy Mountains and Victoria contributed to particle exceedances in Albury and Wagga Wagga between 7 and 15 March.
- Hazard reduction burns contributed to PM2.5 particles exceedances in cooler months in multiple regions:
    - Sydney, with exceedances between 28 April–2 May, 20–25 May, and 14–15 August
    - Wagga Wagga during 18–20 April and 15–17 May
    - Orange on 19 May
    - Central Coast on 31 May
    - Illawarra on 3 June.
- Wood-smoke-related exceedances were observed at four stations: Armidale (24 days), Orange (4 days), Gunnedah (2 days) and Liverpool in Sydney (1 day).

Case Study 1: Major dust event 5–6 March 2019

Air Quality Monitoring Network – Particle episodes in autumn–winter 2019: Dust event case study:

New South Wales experienced a large dust storm event when a cold front and a pre-frontal trough moved over the NSW east coast during 5–6 March 2019. On 5 March, strong north-westerly winds entrained dust in Central NSW and the Riverina, with elevated PM10 pollution first detected at the Wagga Wagga North monitoring station. This event was later observed overnight at stations in the Central Tablelands, and then during the early morning on 6 March in the Hunter and Greater Sydney regions. Detailed description of the event is provided, and modelling is used to determine a possible source region of the dust.

Section F – PM2.5 population exposure

Clause 17 of the AAQ NEPM requires every jurisdiction to report annual performance against air quality standards and goals, from June 2018, by evaluating population exposures to particles as PM2.5.

This section sets out the approach adopted by New South Wales for assessing PM2.5 population exposure, and presents PM2.5 population exposure for 2019. At the time of this report, there is no agreed approach between participating jurisdictions on the procedures or methods to ensure nationally consistent evaluation and reporting. The inter-jurisdictional Expert Working Group, advising the AAQ NEPM review, has endorsed the NSW approach to reporting population exposure, pending the finalisation of a more detailed assessment method.

NSW approach to PM2.5 exposure assessment

The NSW Government developed a method to account for population exposure when tracking changes in average annual PM2.5 concentrations. The NSW method focuses on a PM2.5-based metric, rather than a multi-pollutant metric. The method combines population data from the Australian Bureau of Statistics (ABS) and air quality data from all NSW monitoring stations in the NSW GMR, including Greater Sydney, the Lower Hunter, Central Coast and Illawarra regions.

The NSW method generates population exposure to PM2.5 at two different spatial scales: Greater Sydney Region and NSW GMR. The approach was described in the background paper, Clean Air Metric, published for the NSW Clean Air Summit, in June 2017.

The method involves two main steps:

1. Maps of annual population exposure to PM2.5 pollution are generated using a spatial interpolation method. The maps summarise spatial distributions of annual population exposure to PM2.5 pollution, expressed as product of population density (population per square kilometre) and annual average PM2.5 concentrations (µg/m^3).
2. The Clean Air Metric (CAM) is calculated for the selected region or area from PM2.5 data (only). The CAM values provide annual population-weighted air pollution levels, as population-weighted PM2.5 concentrations, and as a population-weighted PM2.5 index against the equivalent NEPM standards.

The benefit of this method is it is a means to help track whether air quality management is delivering the greatest positive health outcomes for the people of New South Wales.

How annual PM2.5 exposure is calculated and mapped

Annual PM2.5 exposure is calculated through a series of steps involving spatial mapping techniques. The steps are summarised below and illustrated with reference to the NSW GMR and Greater Sydney Region in Figure 5 to Figure 7:

- Gather air quality data measured as the annual average PM2.5 concentrations (µg/m^3), for all NSW air quality monitoring stations in the defined region or study area.
- Allocate an annual average PM2.5 concentration to each 1-km² area (i.e. 1-km^2 grid cell) across the region, using a spatial interpolation technique called kriging. This creates a grid across the region of PM2.5 concentrations in µg/m^3, one value per 1 km² (Figure 5).
- Gather ABS Usual Resident Population Data, as density per 1-km² grid cell for the defined region (population density, expressed as number of people per square kilometre) (Figure 6).

- Generate a map of annual PM2.5 exposure, as follows: for each 1-km^2 grid cell, multiply the cell's PM2.5 value (µg/m^3) by the cell's population density value. The product (resulting value) for the cell is the population exposure to PM2.5 concentration (Figure 7).

Annual population exposure to PM2.5 pollution is assessed by analysing the spatial distribution of the exposure map, generated at the 1 km by 1 km resolution, or to the scale of a chosen study area. The Department generates maps for the Greater Sydney Region and the NSW GMR.

How the CAM for PM2.5 is calculated

The CAM is calculated for annual averaged PM2.5, as both concentration and indexed against the NEPM standard, where an index value of 100 is equivalent to the annual average PM2.5 standard of 8 µg/m^3. This is done by applying the following steps to a chosen region:

- Sum the annual population exposure to PM2.5 pollution (based on the method described above) for all grid cells across the region of interest.
- Divide the result by the total population of the region. The resulting CAM value is referred to as the region's annual average population-weighted PM2.5 concentration (µg/m^3).
- The CAM can also be presented as the region's annual average population-weighted index if divided by the annual NEPM standard for PM2.5.

Air quality can vary significantly from year to year due to 'exceptional events' such as bushfires, dust storms and climatological events like El Niño. The CAM uses three-year rolling averages to smooth out this natural variability. This aligns with reporting approaches used in the EU and the USEPA exposure. It allows us to focus on assessing progress in addressing human sources contributing to poor air quality.

Further information on the CAM method can be found in the following references:

- Riley M, Scorgie Y, Jiang N, Capnerhurst J & Salter D 2017, A metric for assessing population-weighted average air quality exposure in New South Wales, *23rd International Clean Air and Environment Conference*, Brisbane, 15–18 October 2017
- NSW Government 2017, *Clean Air Metric*, background paper prepared for the NSW Clean Air Summit, Sydney, June 2017: www.epa.nsw.gov.au/your-environment/air/clean-air-nsw.

The calculation of NSW population exposure to PM2.5 pollution and the CAM values for 2019, for NSW GMR and Greater Sydney Region (Sydney) are discussed in further detail below.

NSW annual PM2.5 concentration exposure maps 2019

Spatial distribution of PM2.5 annual average concentration

For NSW GMR and Greater Sydney Region during 2019:

Figure 5 presents the estimated distribution of PM2.5 annual average concentrations, across the GMR and the Greater Sydney Region, for 2019. PM2.5 annual average concentrations above the AAQ NEPM standard of 8 µg/m^3 were estimated across the whole GMR. This was due to the significant impact of the 2019–20 bushfire season towards the end of 2019.

The NSW Air Emissions Inventory reported the main sources of anthropogenic PM2.5 emissions in 2013 in Sydney were household activity (primarily residential wood heating), natural sources including prescribed burning, road and non-road transport, and licensed industrial sources. In Newcastle, prescribed burning, licensed industrial sources, non-road transport and residential wood heating are the major direct emissions of PM2.5. This excludes PM2.5 that can be formed through secondary processes in the atmosphere.

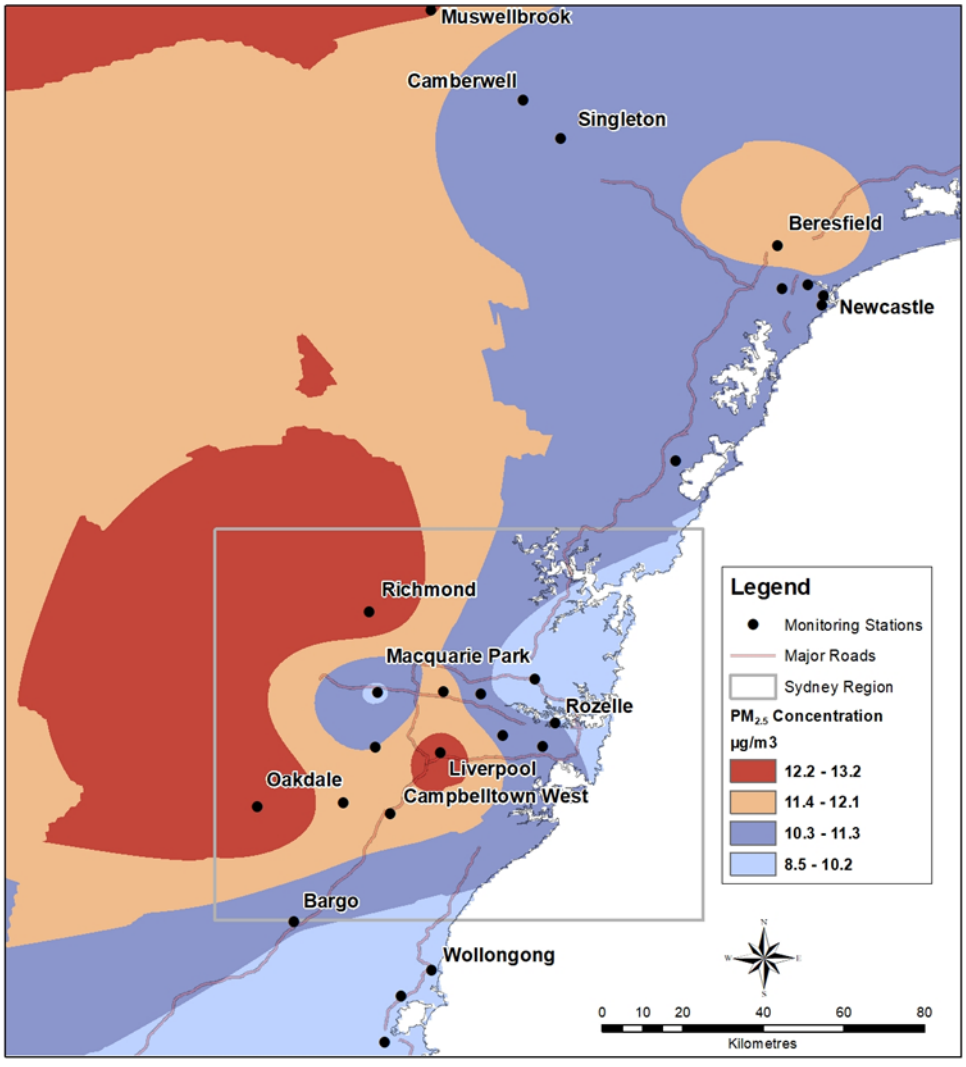

Figure 5 **Spatial distribution of PM2.5 annual average concentration for 2019**

For NSW GMR and the Greater Sydney Region (inset)

The air quality monitoring stations measuring PM2.5 concentrations and which are used in the analysis are shown as black dots.

Figure 5 was generated using the method outlined above, with further details below:

1. The annual average PM2.5 concentration (µg/m^3) for 2019 at each NSW air quality monitoring station in the GMR was plotted on a map of the region.
2. The GIS mapping technique known as kriging was applied to shade areas in proportion to the estimated annual average PM2.5 concentrations across the region at the 1-km^2 resolution.

This technique created a grid of PM2.5 concentrations in µg/m^3, one value per 1 km^2 across the region for 2019.

Population density for the NSW GMR and Greater Sydney Region in 2019

Figure 6 presents the population density for the GMR and Greater Sydney Region for 2019, at a resolution of 1 km^2, projected from the ABS Census 2016. The higher population densities are in Central, North West, South West and East Sydney regions and along major transport corridors in all NSW regions.

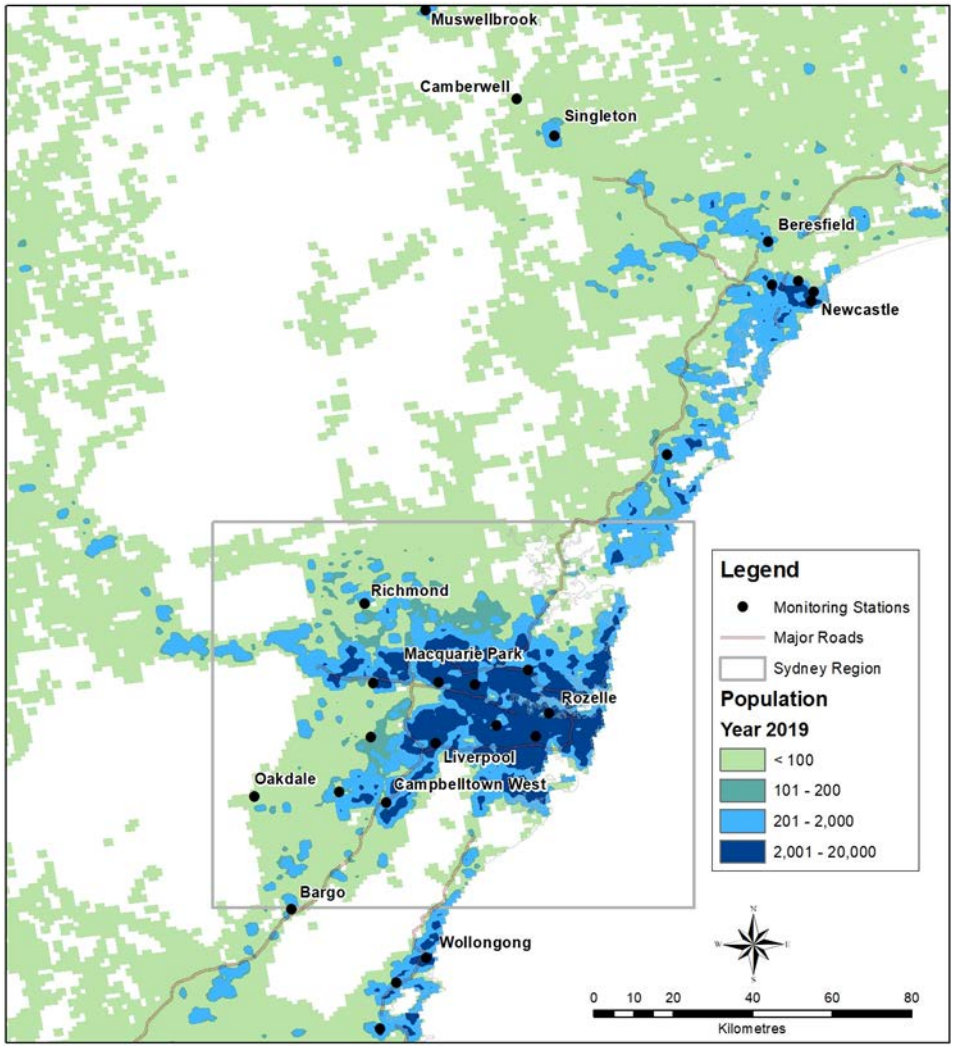

Figure 6 **Population density (population/km^2) for the NSW GMR and Greater Sydney Region for 2019**

Projected from the ABS Census 2016.

These population density values were used to calculate the population exposure to PM2.5 concentrations for the region and the CAM, as described below.

PM2.5 population exposure for the NSW GMR and Greater Sydney Region for 2019

Figure 7 presents an estimate of the population's exposure to PM2.5 concentrations in 2019, represented by the product of annual average PM2.5 concentration and population density at 1-km^2 resolution. The main points are summarised below:

- The highest population exposure to PM2.5 pollution in the GMR during 2019 was in Sydney's CBD and along inner and central Sydney transport corridors (red shading).
- Within the Greater Sydney Region, population exposure to PM2.5 was generally lower in regions outside the Sydney CBD and transport corridors (yellow/orange shading).
- The population exposure to PM2.5 in Greater Western Sydney, the Central Coast and Lower Hunter (green and grey shading) was much lower than in the Sydney CBD and Sydney transport corridors.

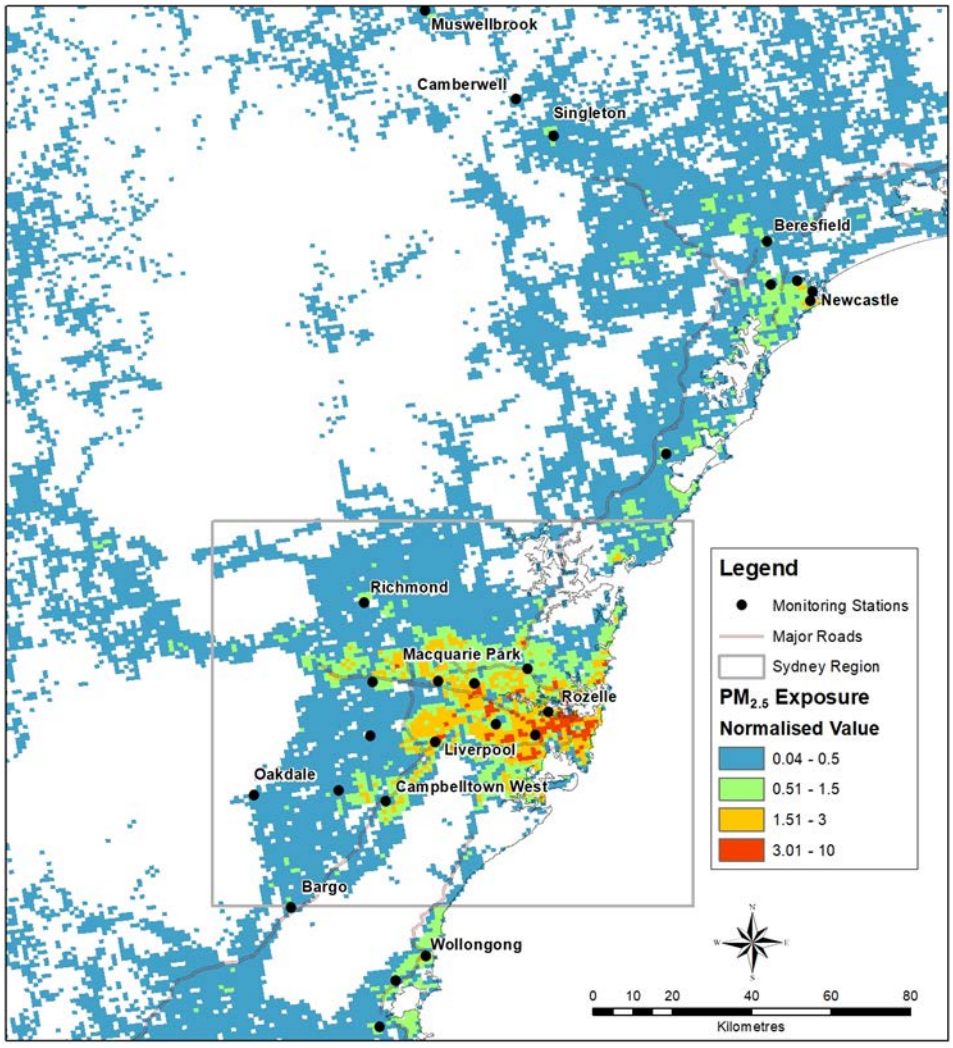

Figure 7 PM2.5 exposure for NSW GMR and Greater Sydney Region during 2019

Exposure is expressed as values scaled to between 0 and 10, derived as the product of population and annual average PM2.5 concentration (population/km^2 x PM2.5).

The values of population exposure to PM2.5, referred to above, were used to calculate the CAM, expressed as an index (below).

2019 CAM expressed as an index

Table 52 shows the PM2.5 exposure for 2019 for the NSW GMR and the Greater Sydney Region. The CAM values are presented in Column 3 and Column 4 as the PM2.5 population-weighted concentration and the population-weighted index (percentage of the annual PM2.5 standard), respectively.

The CAM for the NSW GMR and the Greater Sydney Region were calculated using the method outlined above, with further details below:

- Gather data and calculate the three-year rolling average PM2.5 concentrations for 2019 for each NSW air quality monitoring station in the NSW GMR. The three-year rolling average is based on data for 2017 to 2019.
- Calculate and map the three-year rolling average population exposure to PM2.5 concentrations for each 1-km^2 grid cell across the region based on the mapping methods described above.
- Sum the three-year average population exposure to PM2.5 concentration for all grid cells across the region.
- Divide the result by the total population of the region. The resulting value is referred to as the region's three-year rolling average population-weighted PM2.5 concentration (µg/m^3).
- Convert the region's three-year rolling average population-weighted PM2.5 concentration (µg/m^3) to a three-year rolling average population-weighted index. That is, multiply the region's three-year average population-weighted PM2.5 concentration by 100/8. The value eight is used because the AAQ NEPM standard for the annual average PM2.5 concentration is 8 µg/m^3.

Table 52 CAM expressed as population-weighted PM2.5 concentration, and as population-weighted PM2.5 index for the NSW GMR and the Greater Sydney Region 2019

Region	Population 3-year average	CAM as 3-year average, population-weighted PM2.5 concentration (µg/m^3)	CAM as 3-year average, populated-weighted PM2.5 index (against annual standard)
Greater Sydney	4,962,149	8.69	109
NSW GMR	6,106,487	8.61	108

Analysis of Table 52 shows:

- The CAM for the Greater Sydney Region in 2019 was 109. This means the population-weighted average exposure of residents to PM2.5 was 109% of the NEPM annual standard for PM2.5.
- The CAM for the NSW GMR in 2019 was 108. This means the population-weighted average exposure of residents to PM2.5 was 108% of the NEPM annual standard for PM2.5.

The NSW Government commissioned ABS to provide 1-km² resolution population data for all years from 1996 to 2019, based on the ABS Estimated Resident Population. This allowed

calculation of the metric for historic years, to track changes in population exposure to air pollution.

Figure 8 and Figure 9 show the CAM time series for Greater Sydney Region and the NSW GMR, respectively, for 1998 to 2019.

Figure 8 shows the following recent trends:

- The population-weighted average exposure of residents to PM2.5 in the Greater Sydney Region rose slightly from 98% in 2016 to 99% of the NEPM standard in 2018. It rose to 132% in 2019 due primarily to the 2019–20 bushfire season.
- The level of exposure to PM2.5 in 2019 was the highest for the 1996–2019 period, eclipsing the 1998 levels, which were also bushfire impacted.

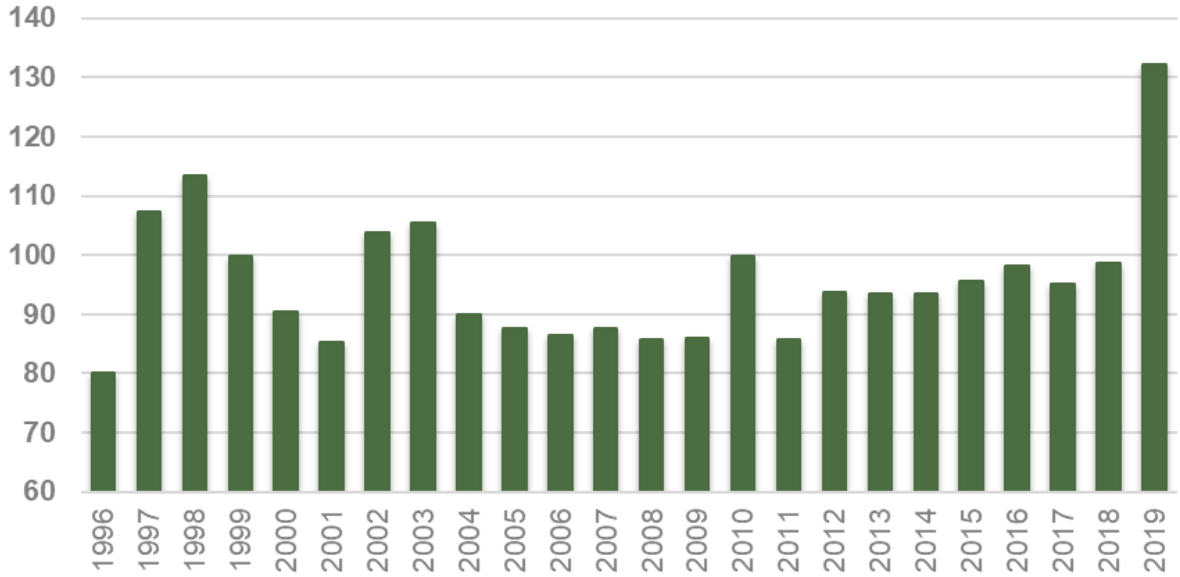

Figure 8 CAM time series expressed as index for Greater Sydney Region 1996 to 2019

Figure 9 shows the following recent trends:

- The population-weighted average exposure of residents to PM2.5 in the NSW GMR rose from 96% in 2016 to 132% of the NEPM standard in 2019.
- The level of exposure to PM2.5 in 2019 was the highest for the 1996–2019 period.

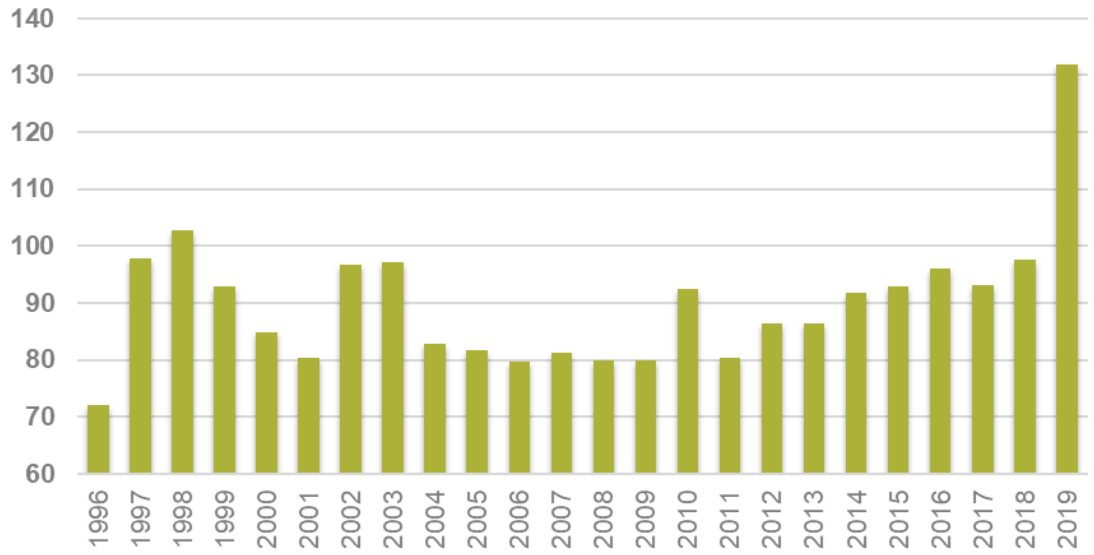

Figure 9 CAM time series expressed as index for the NSW GMR 1996 to 2019

Appendix

This annual report is accompanied by an Appendix report which summarises:

- site-by-site trend analysis tables by pollutant
- a list of 24-hour particles as PM10 and PM2.5 exceedance events, organised by region and source
- an overview of minor changes to exceedance counts since the 2018 report for reporting years before 2019
- a list of particle exceedance days potentially missed during the bushfire emergency period at the end of the year due to various reasons, usually related to high particle load and its impact on ongoing instrument operation.