ACT AIR QUALITY REPORT 2019

Environment Protection Authority | June 2020

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LIST OF DEFINITIONS AND ABBREVIATIONS

Term	Definition
AAQ NEPM	National Environment Protection (Ambient Air Quality) Measure
ACT	Australian Capital Territory
CO	Carbon Monoxide
BAM	Beta Attenuation Monitor
Exceptional event	Exceptional event means a fire or dust occurrence that adversely affects air quality at a particular location and causes an exceedance of one (1) day average standards in excess of normal historical fluctuations and background levels and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust
NATA	National Association of Testing Authorities
ND	Not Demonstrated
NO_2	Nitrogen Dioxide
O_3	Ozone
PMS	Performance Monitoring Station
$PM_{2.5}$	Particles with an equivalent aerodynamic diameter less than or equal to 2.5 micrometres
PM_{10}	Particles with an equivalent aerodynamic diameter less than or equal to 10 micrometres
ppm	Parts per million by volume – parts of pollutant per million parts of air
Q	Quarter (e.g. Q1 means the first quarter of the year)
SO_2	Sulfur Dioxide
$\mu g/m^3$	micrograms per cubic metre

OVERVIEW

The ACT Air Quality Report 2019 (the Report) presents the results of ambient air quality monitoring in the ACT for 2019 and assesses the results in accordance with the requirements of the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) made by the National Environment Protection Council on 26 June 1998.

Air quality in this Report is assessed against the AAQ NEPM standards shown in Table 3. In accordance with its agreed policy position, the ACT assesses its compliance for the annual average for particulate matter less than 10 microns (PM_{10}) against a lower standard of 20 µg/m^3 rather than the 25 µg/m^3 standard introduced in 2016.

The ACT monitors four of the six NEPM pollutants:

- carbon monoxide (CO)
- nitrogen dioxide (NO_2)
- photochemical oxidants as ozone (O_3)
- particulate matter (as PM_{10}, particles less than 10 microns in diameter and $PM_{2.5}$, particles less than 2.5 microns in diameter).

The ACT has never monitored sulfur dioxide (SO_2) as it is primarily an industrial pollutant and the ACT does not have much heavy industry. In 2002, lead monitoring ceased with the phase out of leaded petrol.

A summary of the 2019 Report is:

- monitoring was performed in accordance with the ACT's monitoring plan, AAQ NEPM Technical Papers and ACT Health's accreditation by the National Association of Testing Authorities (NATA);
- air quality in the ACT was generally good in the first ten months of the year. However, it was severely impacted in November and December 2019 by the unprecedented bushfire activity in south eastern Australia;
- bushfires caused the 8-hour CO standard to be exceeded on 31 December 2019 across the ACT, the first such exceedance since the implementation of the AAQ NEPM in 1998;
- ozone levels exceeded both 1-hour and 4-hour standards on 20 December 2019 across the ACT due to extreme bushfire smoke;
- Ozone levels above the 4-hour standard were recorded two more times at Florey on 17 January and 9 December 2019, due to hotter weather increasing the conversion of vehicle emissions to ozone and bushfires respectively;
- particle pollution (both PM_{10} and $PM_{2.5}$) increased dramatically during the bushfire crisis, which peaked in December 2019;
- the daily PM_{10} standard was exceeded on 29 days at one or more monitoring stations, compared to six days in 2018. All of the PM_{10} exceedances occurred outside the winter season and were due to bushfires and dust storms;

- the daily $PM_{2.5}$ standard was exceeded on 32 days at one or more monitoring stations, compared to five days in 2018. Only two exceedances (18 and 19 May 2019) were attributed to emissions from domestic wood heaters. All other exceedances were due to bushfires and dust storms; and
- in the case of PM_{10} and $PM_{2.5}$, all exceedances associated with an exceptional event were not considered when determining compliance with the relevant daily goal.

MONITORING SUMMARY

Performance Monitoring Stations

The ACT Government has been undertaking ambient air quality monitoring in Canberra since the early 1990's. The Health Directorate is responsible for the Government's ambient air quality monitoring network. The Environment Protection Authority (EPA) within the Chief Minister, Treasury and Economic Development Directorate is responsible for annual reporting under the AAQ NEPM.

The AAQ NEPM monitoring network in the ACT consists of three monitoring stations located at:

- Monash – approximately 300 metres west of Cockcroft Avenue in the Monash district playing fields
- Civic – at the northern end of the carpark on the western side of the Olympic swimming pool adjacent to Allara Street
- Florey – at the end of Neumann Place, on public land.

The compliance and non-compliance criteria for the monitoring stations against the siting standard AS/NZS 3580.1.1:2008 are listed in Table 1 below.

Table 1: Summary of stations' siting compliance with AS 3580.1.1:2008

Station	Height above ground	Minimum distance to support structure	Clear sky angle of 120°	Unrestricted airflow of 270°/360°	20m from trees	No boilers or incinerators nearby	Minimum distance from road or traffic
Monash	☑	☑	☑	☑	☑	☑	☑
Civic	☑	☒	☒	☒	☒	☑	☑
Florey	☑	☑	☑	☑	☑	☑	☑

The Monash and Florey stations contain instrumentation that continuously monitors carbon monoxide, nitrogen dioxide, ozone and particles as PM_{10} and $PM_{2.5}$. Following the establishment of the Florey station on 28 February 2014, the Civic station only monitors ozone and particles as PM_{10} and $PM_{2.5}$.

Monitoring Methods

The ACT monitoring is conducted in accordance with the relevant Australian Standards as shown in Table 2. Data not meeting the requirements of these Standards are identified as invalid and not included in this report.

Table 2: Methods used for monitoring AAQ NEPM pollutants

Pollutant	Standard	Title	Method Used
Carbon monoxide	AS 3580.7.1-2011	Methods for sampling and analysis of ambient air - Determination of carbon monoxide - Direct-reading instrumental method	Gas filter correlation/ Infrared
Nitrogen dioxide	AS 3580.5.1-2011	Methods for sampling and analysis of ambient air - Determination of oxides of nitrogen - Direct-reading instrumental method	Gas phase chemiluminescence
Photochemical oxidant (ozone)	AS 3580.6.1-2016	Methods for sampling and analysis of ambient air - Determination of ozone - Direct-reading instrumental method	Non-dispersive ultraviolet
PM_{10}	AS/NZS 3580.9.11-2016	Method for sampling and analysis of ambient air Method – Determination of suspended particles matter – PM_{10} beta attenuation monitors	Beta Attenuation Monitor
$PM_{2.5}$	AS/NZS 3580.9.12:2013	Methods for sampling and analysis of ambient air - Method 9.12: Determination of suspended particulate matter - PM2.5 beta attenuation monitors	Beta Attenuation Monitor

NATA Accreditation Status

The ACT Government monitoring network is accredited by NATA for the measurement of all AAQ NEPM pollutants except sulfur dioxide and lead as required under Clause 12 of the AAQ NEPM.

ASSESSMENT OF COMPLIANCE WITH STANDARDS AND GOALS

For the purpose of this Report, air quality is assessed against the AAQ NEPM standards as specified in Schedule 2 of the AAQ NEPM and ACT policy position. The figures are reproduced in Table 3 below.

The standards against which air quality is assessed are concentrations in parts per million (ppm) or micrograms per cubic metre (µg/m^3) (refer to Table 3, column 3).

The goal of the AAQ NEPM is to achieve the NEPM standards as assessed in accordance with the monitoring protocol to the extent specified in Schedule 2 of the AAQ NEPM.

The extent is expressed as a maximum allowable number of exceedances for each standard (shown in column 4, Table 3).

In accordance with its agreed policy position, the ACT assesses its compliance for the annual average for PM_{10} against a lower standard of 20 µg/m^3 rather than the AAQ NEPM standard of 25 µg/m^3. There is an additional goal to further reduce $PM_{2.5}$ concentrations to below a daily concentration of 20 µg/m^3 and an annual concentration of 7 µg/m^3 by 2025.

Table 3: AAQ NEPM standards and ACT policy position

Pollutant	**Averaging Period**	**Maximum concentration**	**Maximum allowable exceedances**	**Monitoring Station**
Carbon monoxide	8 hours	9.0 ppm	1 day a year	Monash Florey
Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year None	Monash Florey
Photochemical oxidants	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year	Monash Florey Civic
Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year None	Not monitored
Lead	1 year	0.50 µg/m^3	None	Not monitored
Particles as PM_{10}	1 day 1 year	50 µg/m^3 20 µg/m^3	None None	Monash Florey Civic
Particles as $PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3	None None	Monash Florey Civic

Tables 4 to 8 summarise compliance with the standards of the AAQ NEPM and ACT policy position. For each pollutant, the data availability (quarterly and annual), the number of days when standards were exceeded, the annual mean (where an annual standard exists) and an assessment of compliance, are given for each monitoring station.

Air quality is assessed as complying with the AAQ NEPM (i.e. '*MET*') if the number of exceedances is no more than the number specified in Table 3 and data availability was at least 75 percent in each quarter of the year.

Air quality is assessed as not complying with the AAQ NEPM (i.e. '*NOT MET*') if there is more than the number of exceedances specified in Table 3. For the purpose of reporting compliance against PM_{10} and $PM_{2.5}$ daily average standards, monitoring data that has been determined as being directly associated with an exceptional event has been excluded.

Air quality is assessed as '*NOT DEMONSTRATED*' (i.e. *'ND'*) if there has been insufficient data collected to demonstrate that the standards and goal have been met or not met.

These categories (i.e. MET, NOT MET and ND) are used in Tables 4 to 8 on the following pages.

Carbon monoxide

During 2019, there was one exceedance of the carbon monoxide standard at Monash due to bushfire smoke. Compliance was demonstrated at Florey. Due to instrument failure, insufficient data was collected at Monash to demonstrate the compliance.

Table 4: 2019 compliance summary for CO

AAQ NEPM standard - 9.0 ppm (8-hour average)

Performance monitoring station	Data availability rates (% of hours)					Number of exceedances (days)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual		
Monash	91.7	23.6	77.4	95.7	72.1	1	ND
Florey	95.6	94.2	95.7	95.6	95.3	0	MET

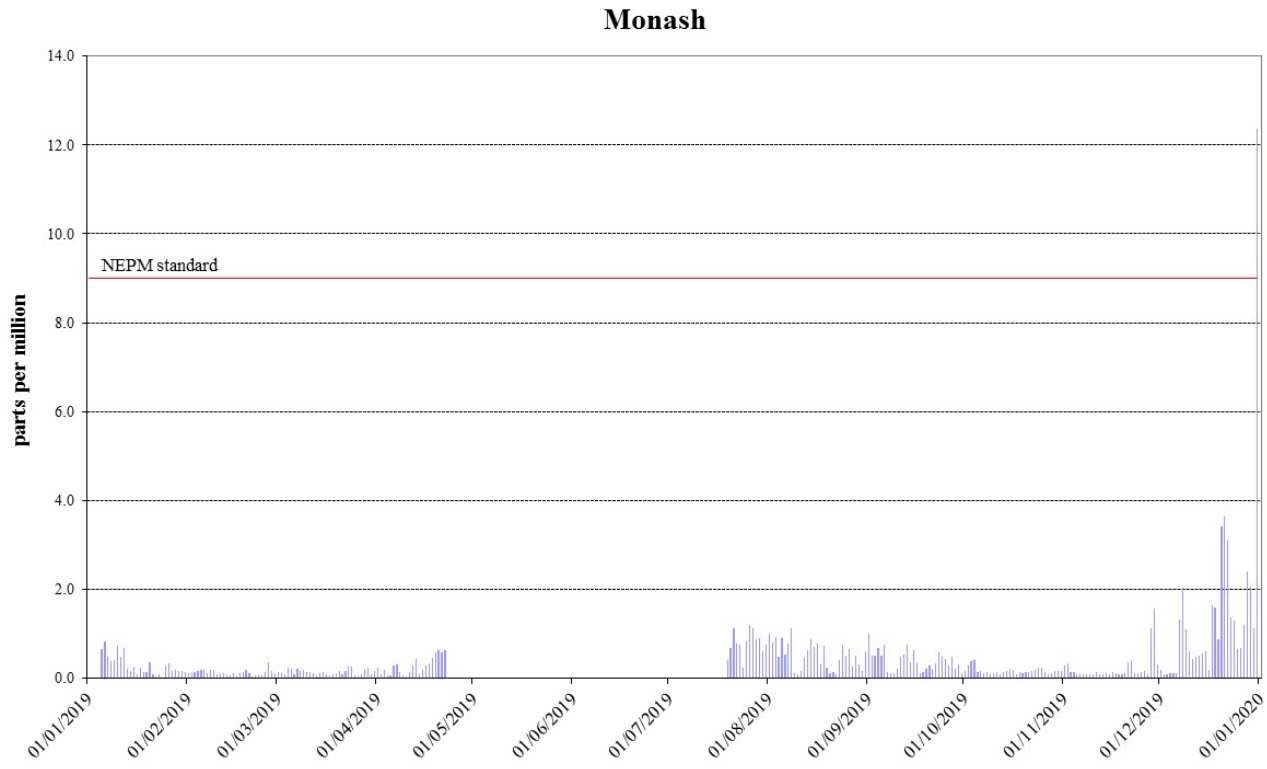

Figure 1: Daily maximum for CO 8-hour average – Monash

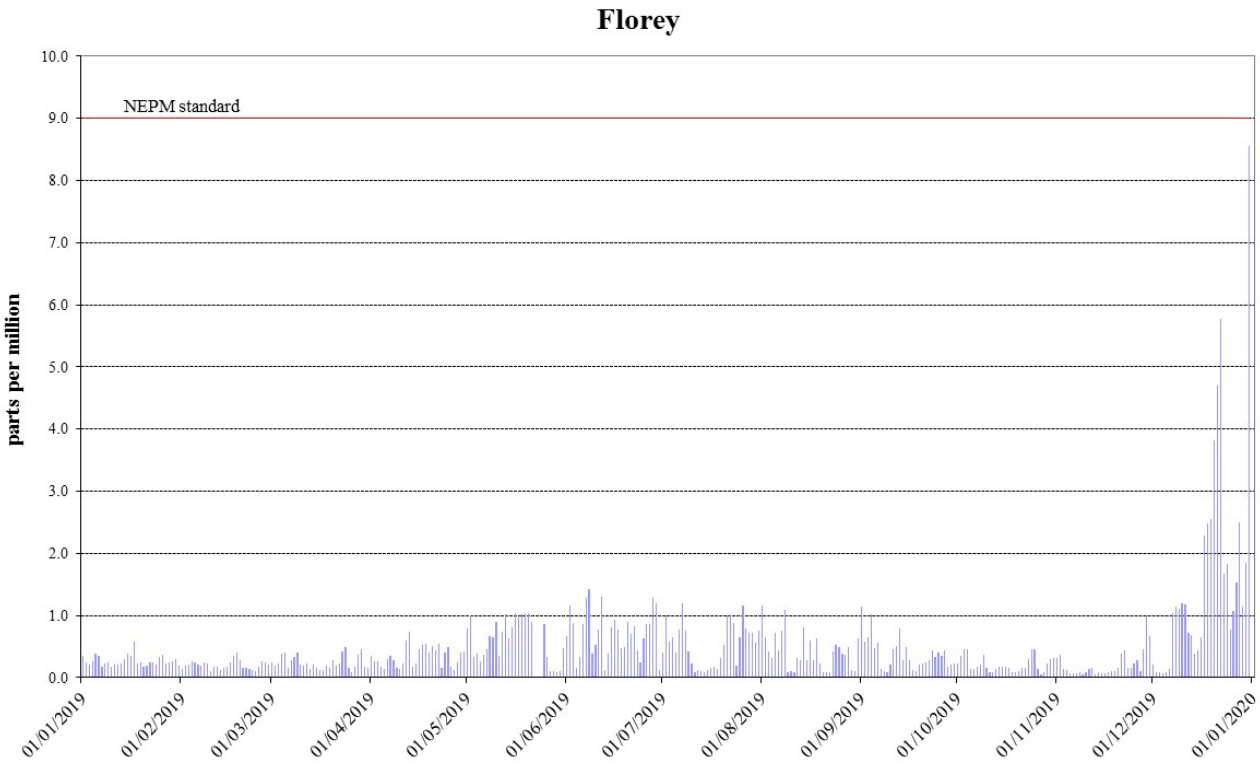

Figure 2: Daily maximum for CO 8-hour average – Florey

Nitrogen dioxide

During 2019, no exceedances of the nitrogen dioxide standards were recorded and compliance was demonstrated at Monash and Florey.

Table 5: 2019 compliance summary for NO_2

AAQ NEPM standard – 0.12 ppm (1-hour average), 0.03 ppm (1-year average)

Performance monitoring station	Data availability rates (% of hours)					Annual mean Concentration (ppm)	Number of 1 hour exceedances (days)	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual			1 hour	1 year
Monash	95.6	95.7	92.4	95.7	94.9	0.005	0	MET	MET
Florey	95.5	91.0	95.7	87.6	92.4	0.005	0	MET	MET

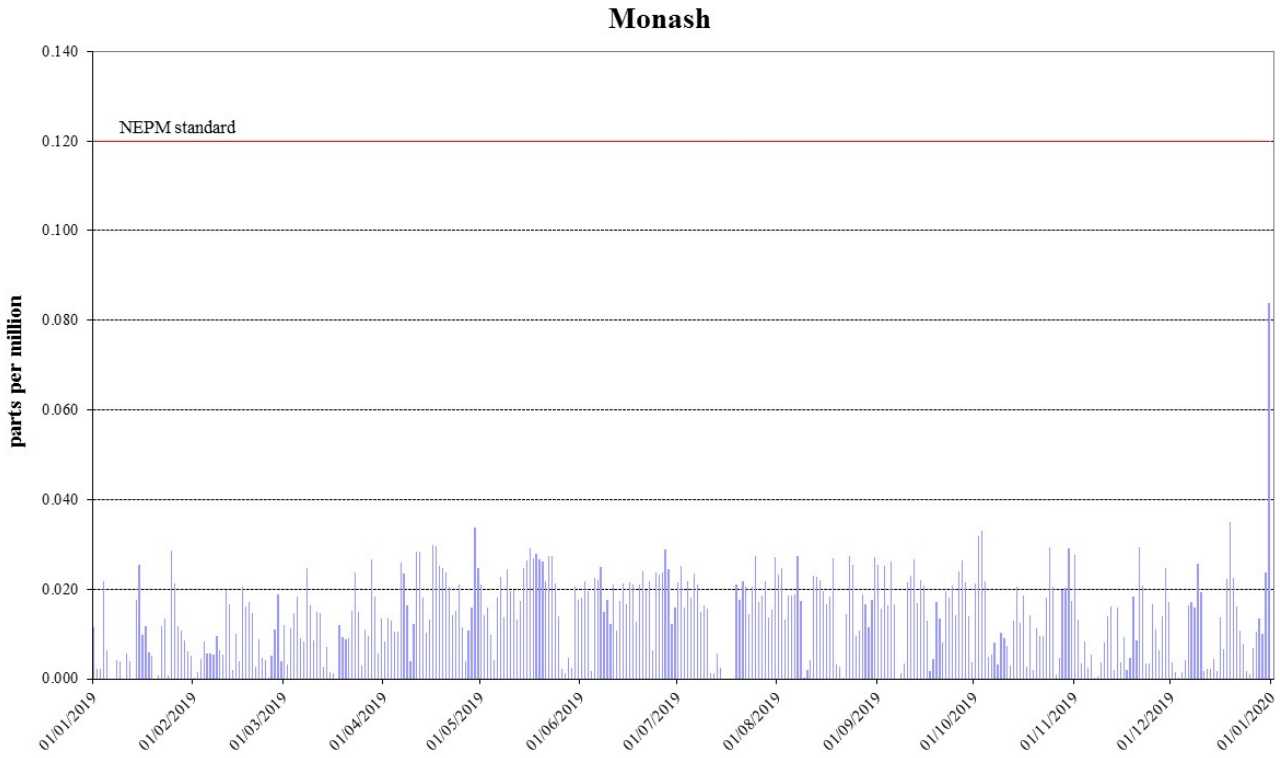

Figure 3: Daily maximum for NO_2 – Monash

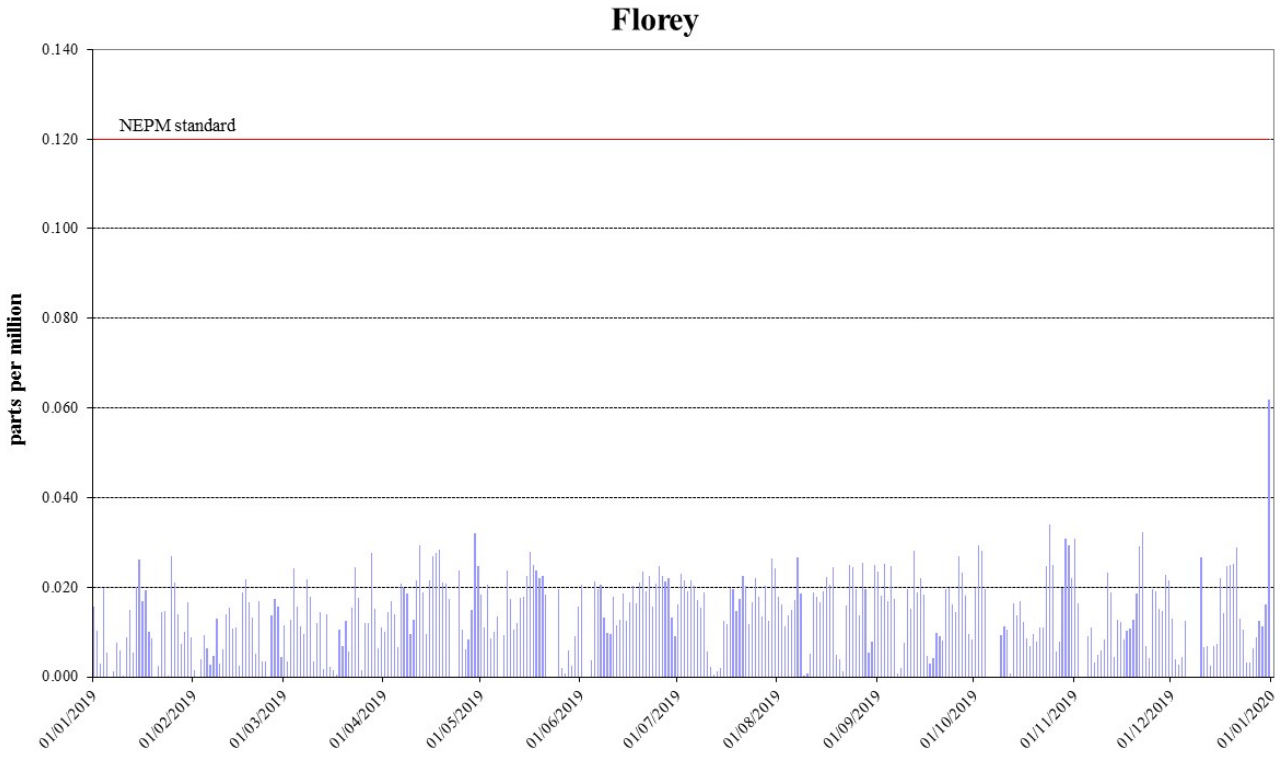

Figure 4: Daily maximum for NO_2 – Florey

Ozone

On 20 December 2019, ozone levels above the 1-hour and 4-hour standards were recorded at all stations due to the bushfire impact. Despite this exceedance, compliance was demonstrated at Monash and Civic. The 4-hour standard was exceeded two more times at Florey on 17 January and 9 December. As a result, compliance for 4-hour ozone standard was not met at Florey.

Table 6: 2019 compliance summary for O_3

AAQ NEPM standard – 0.10 ppm (1-hour average), 0.08 ppm (4-hour average)

Performance monitoring station	Data availability rates (% of hours)					Number of exceedances (days)		Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual	1 hour	4 hours	1 hour	4 hours
Monash	95.8	95.7	95.7	95.8	95.8	1	1	MET	MET
Civic	95.8	96.0	95.8	95.7	95.8	1	1	MET	MET
Florey	95.8	94.1	95.7	95.6	95.3	1	3	MET	NOT MET

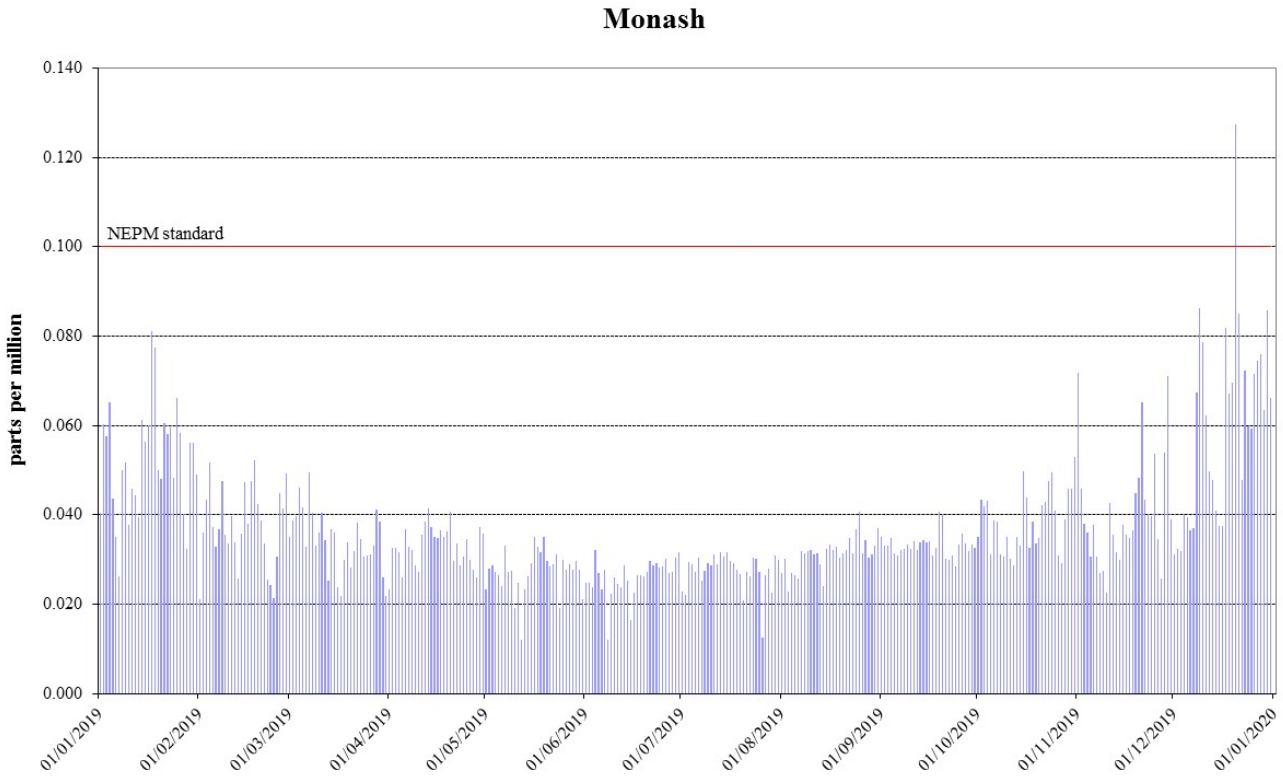

Figure 5: Daily maximum for 1 hour O_3 – Monash

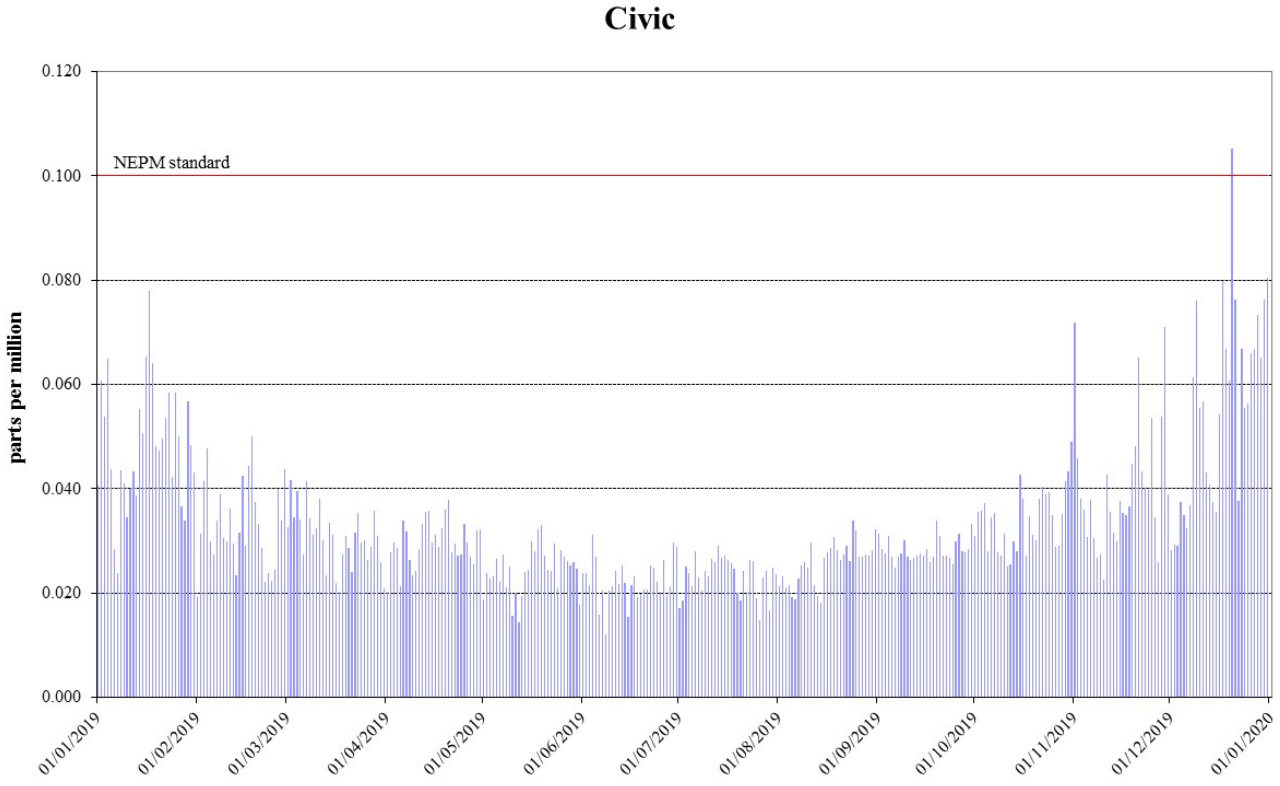

Figure 6: Daily maximum for 1 hour O_3 – Civic

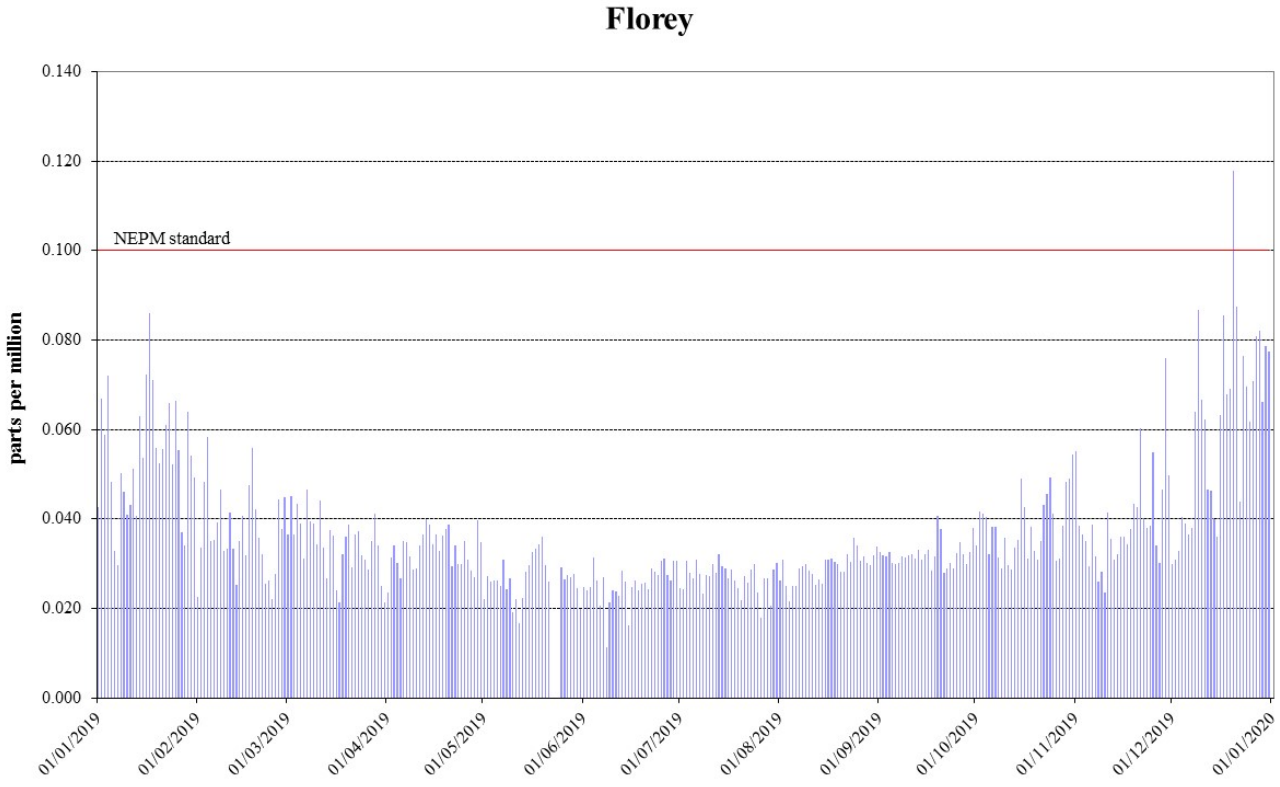

Figure 7: Daily maximum for 1 hour O_3 – Florey

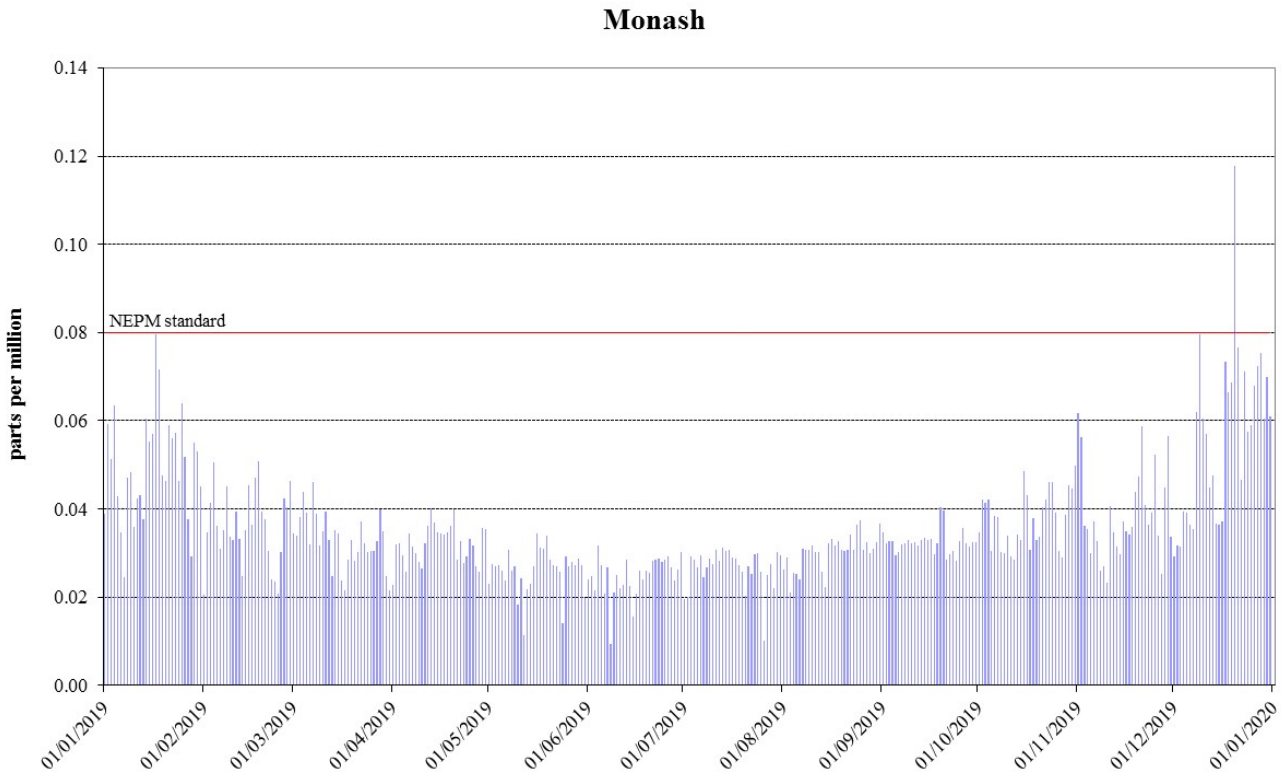

Figure 8: Daily maximum for 4 hours O_3 - Monash

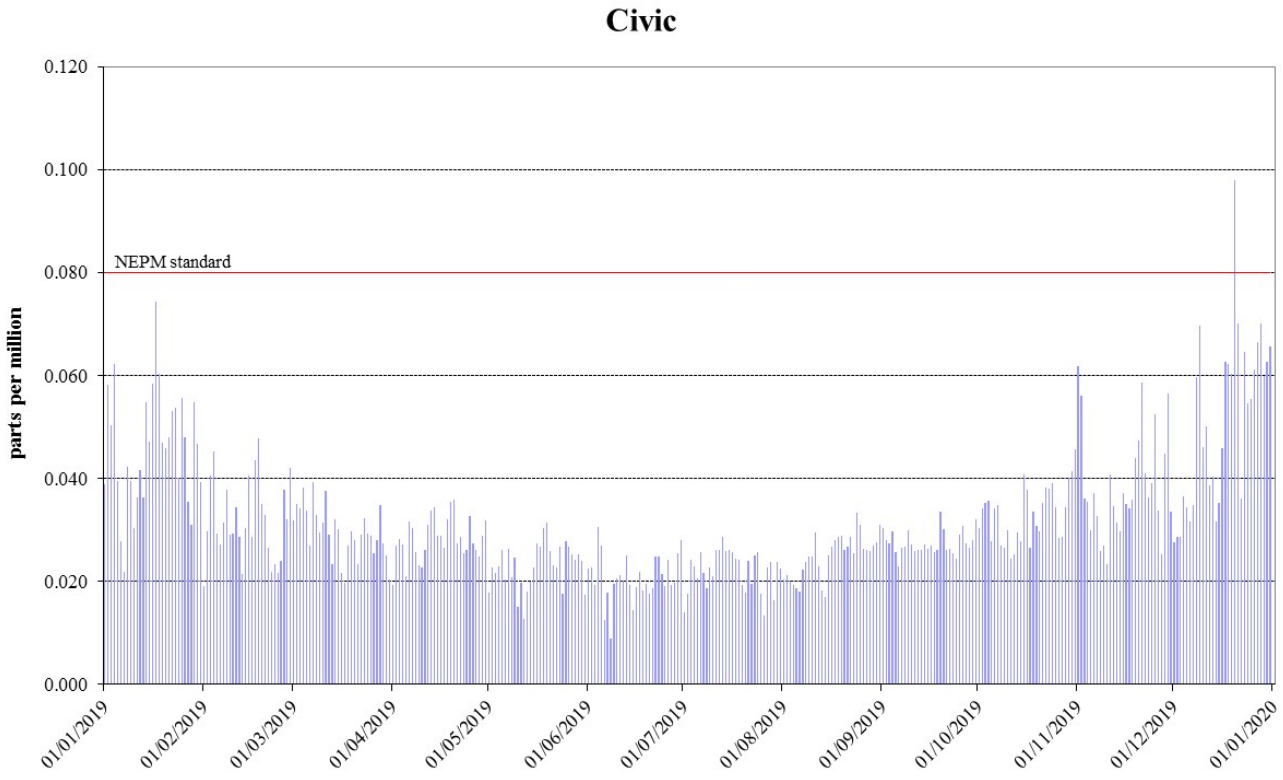

Figure 9: Daily maximum for 4 hours O_3 – Civic

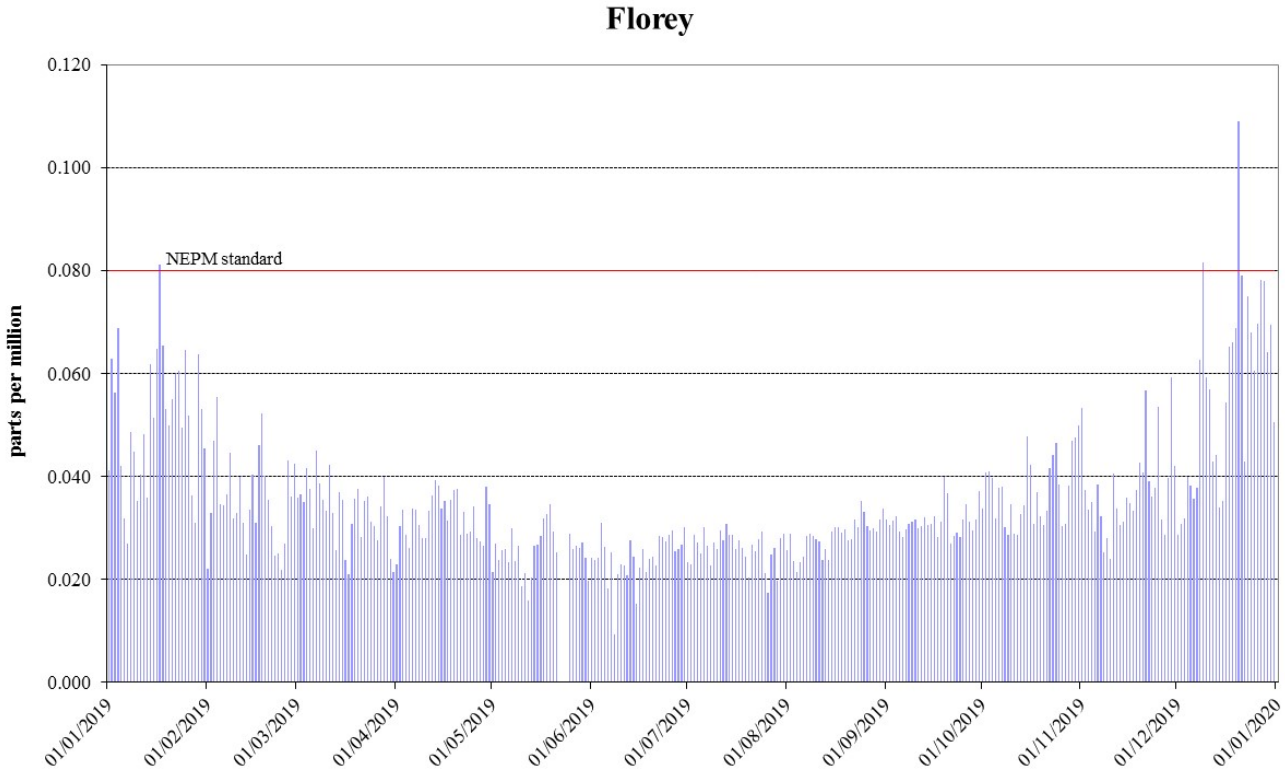

Figure 10: Daily maximum for 4 hours O_3 – Florey

PM_{10}

During 2019, there were exceedances of daily PM_{10} standard on 29 days outside the winter season due to bushfires (21 days) and dust storms (8 days). Compliance against the daily PM_{10} standard was demonstrated at all stations as theses exceedances being exceptional events are removed. While annual average PM_{10} data at all monitoring stations met the 25 μg/m^3 AAQ NEPM standard, annual average levels at Civic and Florey slightly exceeded the 20 μg/m^3 ACT policy position.

Table 7: 2019 compliance summary for PM_{10}

AAQ NEPM standard 50 μg/m^3 1-day average, 20 μg/m^3 (1-year average)*

Performance monitoring station	Data availability rates (% of days)					Annual mean Concentration (μg/m^3)	Number of exceedances (total/EE**)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual			
Monash	95.6	100	98.9	98.9	98.4	19.1	22/22	MET
Civic	92.2	97.8	100	98.9	97.3	22.9	29/29	NOT MET*
Florey	95.6	97.8	98.9	100	98.1	23.8	28/28	NOT MET*

* ACT policy position 20 μg/m^3 not AAQ NEPM standard of 25 μg/m^3. ** Exception event.

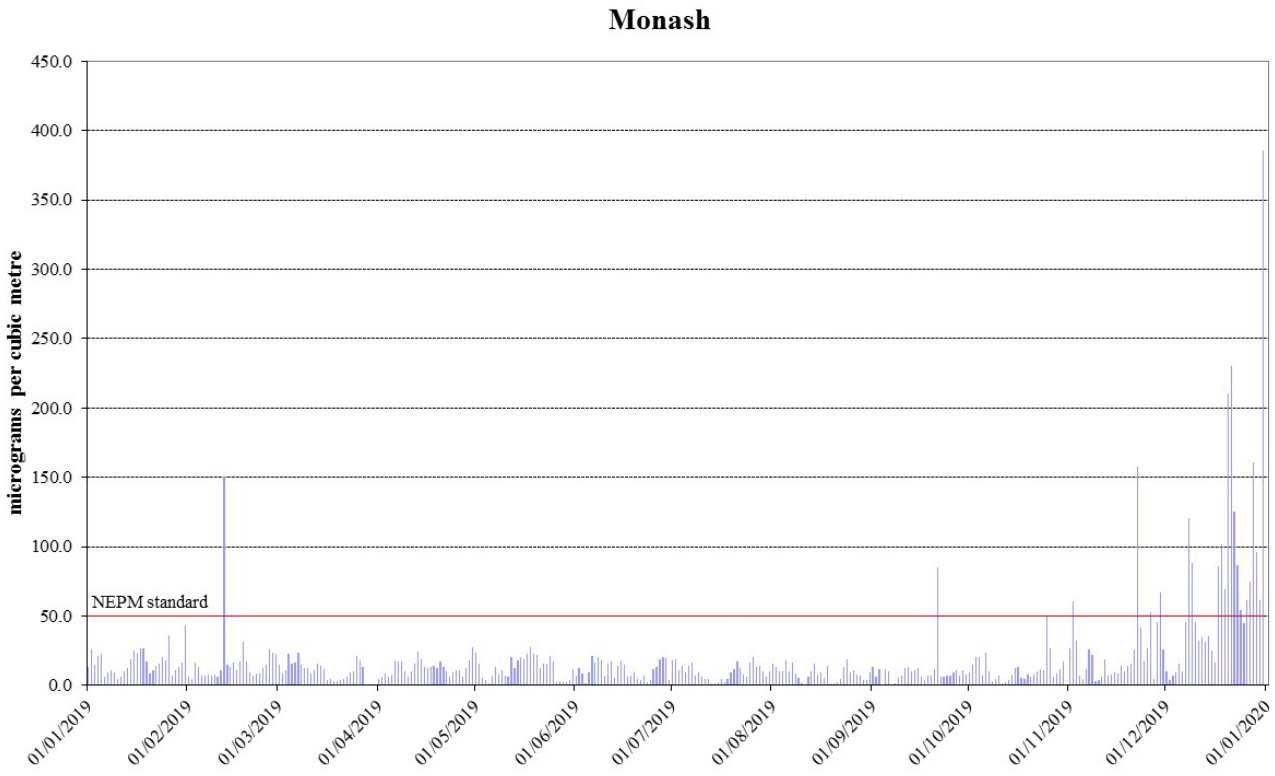

Figure 11: Daily maximum for PM_{10} – Monash

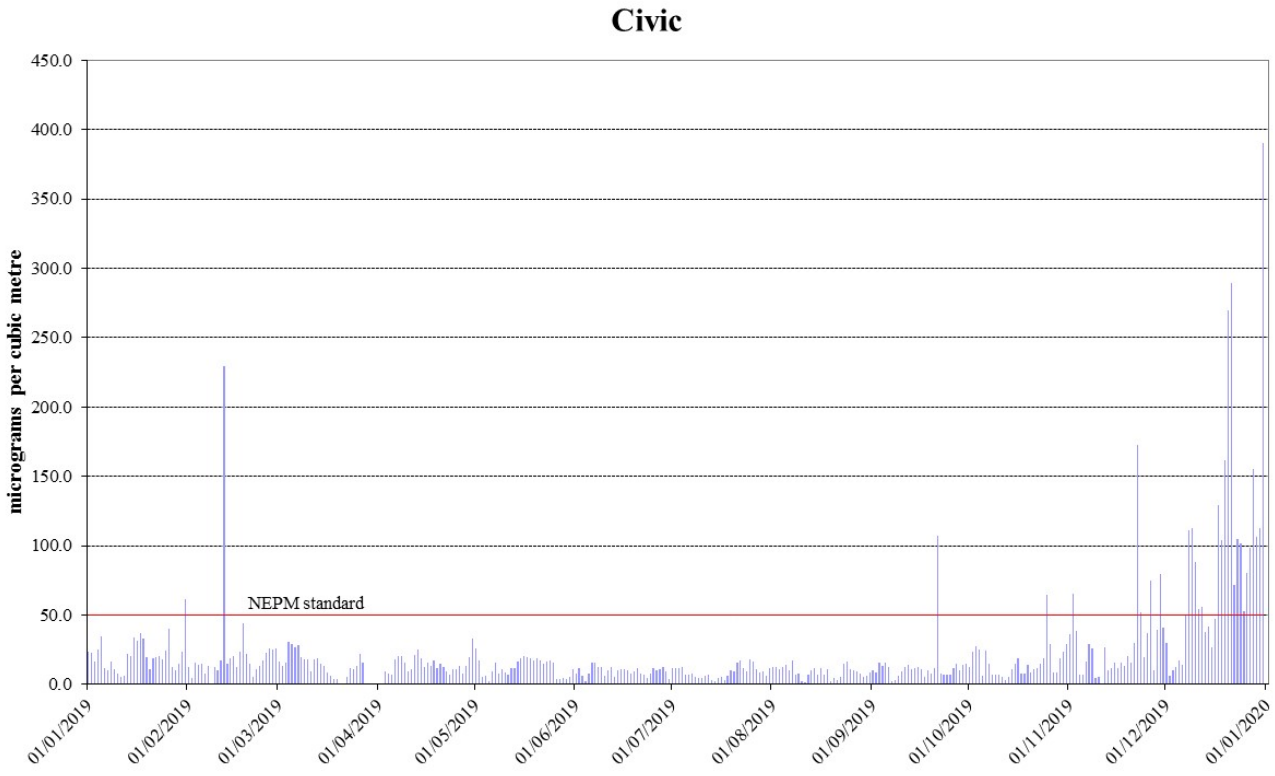

Figure 12: Daily maximum for PM_{10} – Civic

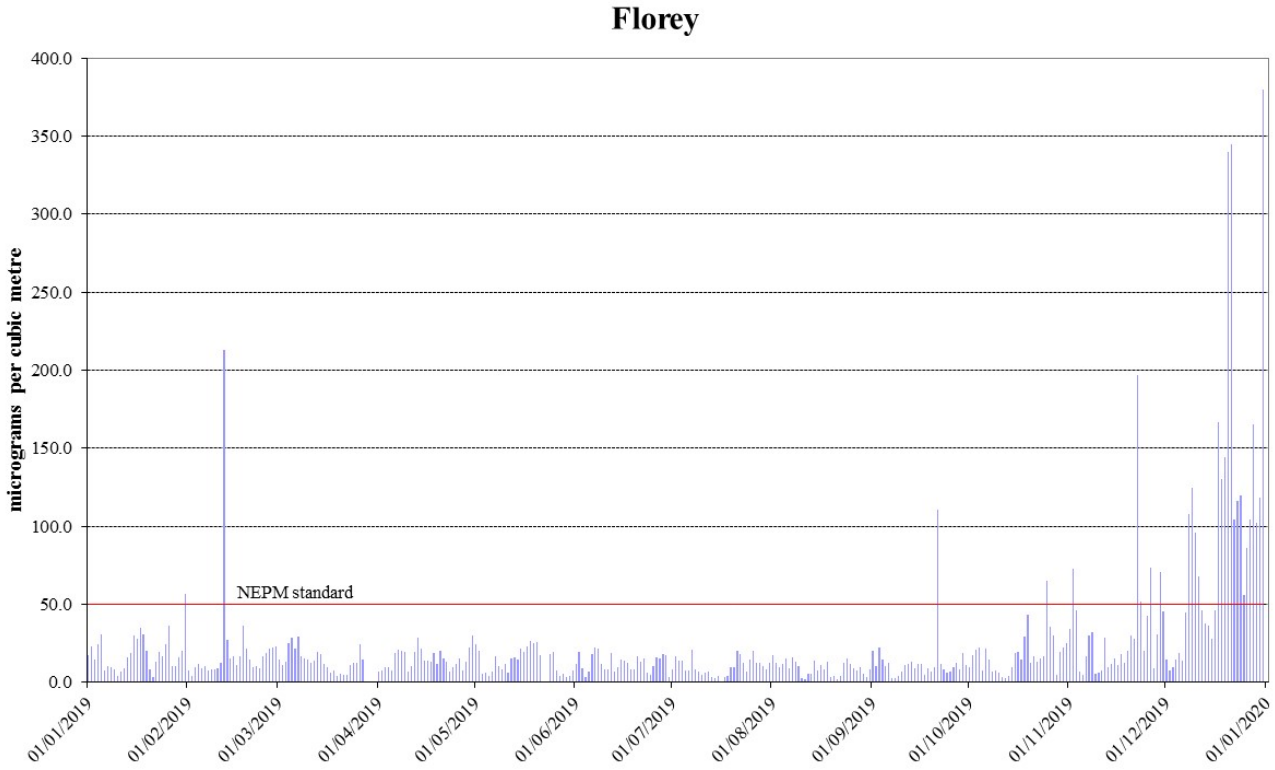

Figure 13: Daily maximum for PM_{10} – Florey

$PM_{2.5}$

During 2019, there were exceedances of daily $PM_{2.5}$ standard on 32 days which primarily occurred outside the winter season and were due to bushfires (27 days) and dust storms (3 days). Compliance against the daily $PM_{2.5}$ standard was demonstrated at Civic when the exceptional events were removed. Compliance against the AAQ NEPM $PM_{2.5}$ standards was not met at Monash due to two wood heater related exceedances on 18 and 19 May 2019.

Annual average $PM_{2.5}$ data at all monitoring stations did not met the 8 μg/m^3 AAQ NEPM standard.

Table 8: 2019 compliance summary for $PM_{2.5}$

AAQ NEPM standard – 25 μg/m^3 (1-day), 8 μg/m^3 (1-year)

Performance monitoring station	Data availability rates (% of days)					Annual mean Concentration (μg/m^3)	Number of exceedances (total/EE*)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual			
Monash	100	100	98.9	96.7	98.9	14.1	28/26	NOT MET
Civic	91.1	96.7	100	97.8	96.4	12.8	29/29	NOT MET
Florey	97.8	96.7	100	98.9	98.4	14.8	29/29	NOT MET

* Exception event

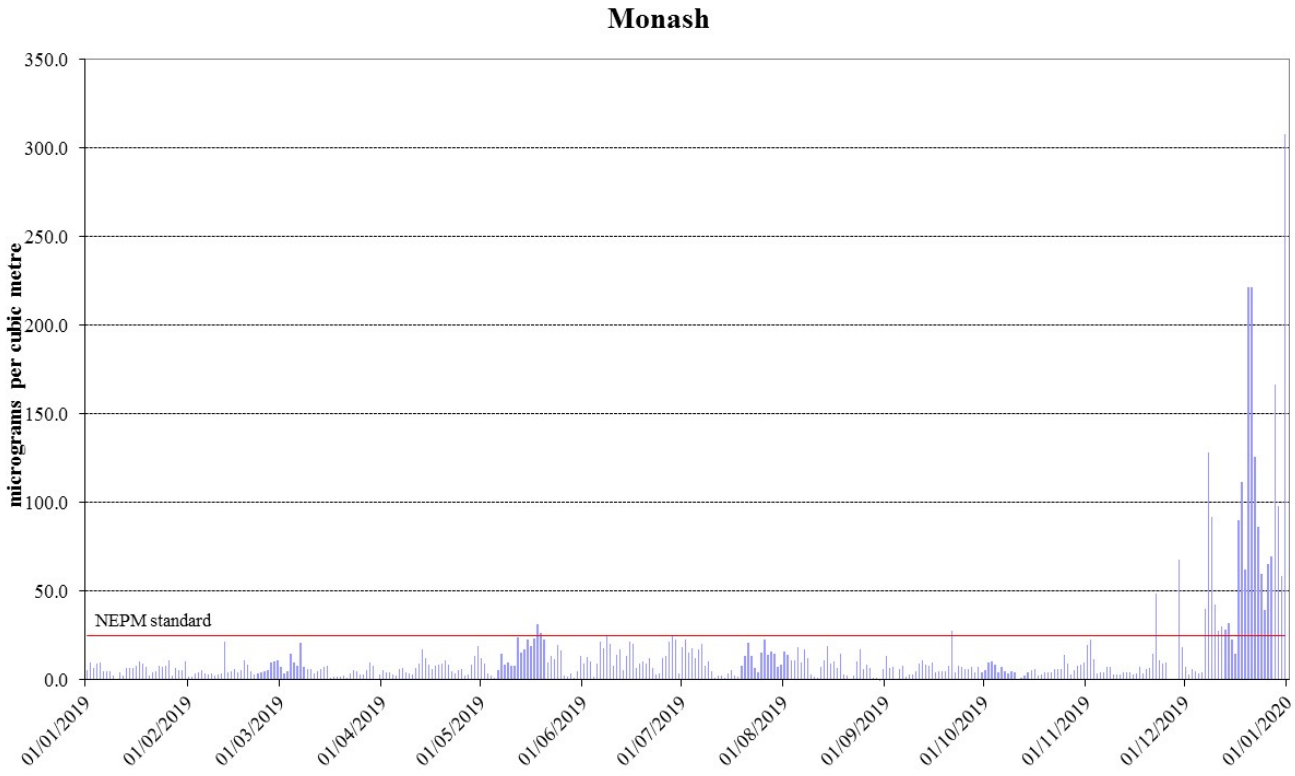

Figure 14: Daily maximum for $PM_{2.5}$ – Monash

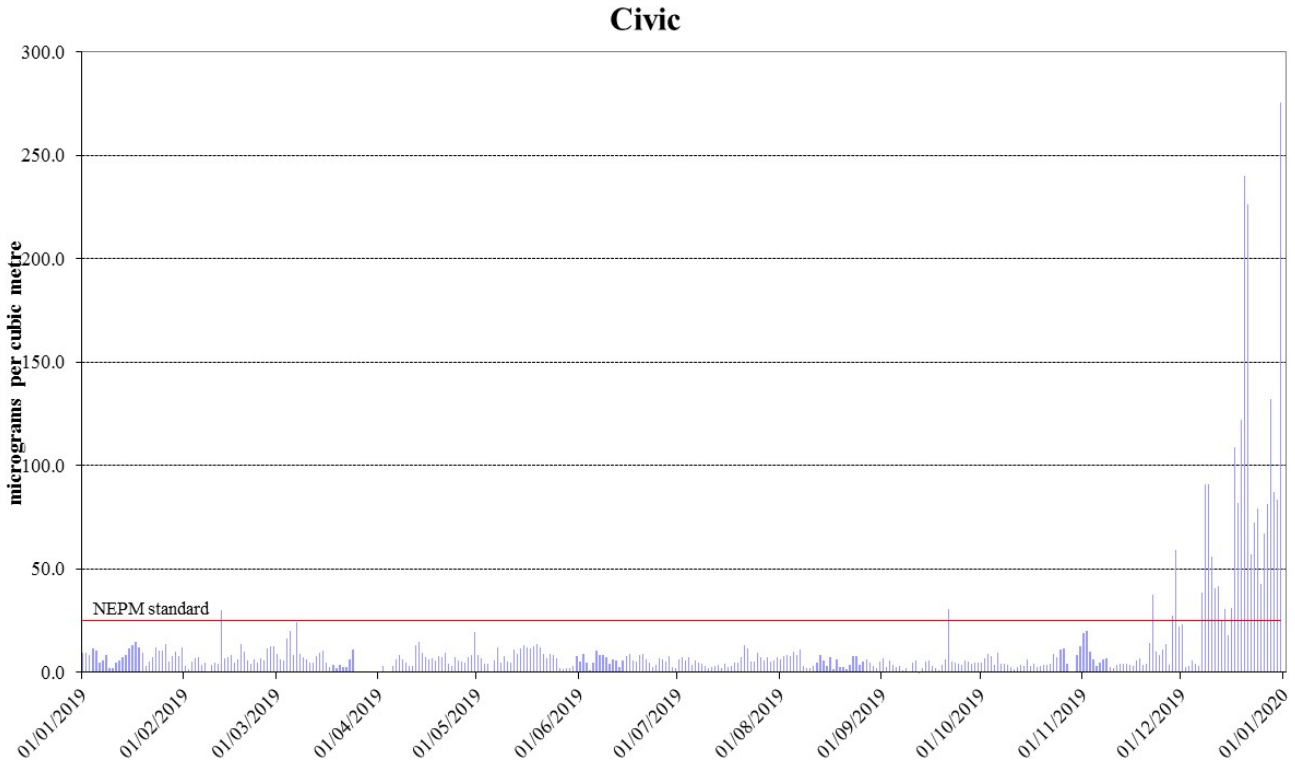

Figure 15: Daily maximum for $PM_{2.5}$ – Civic

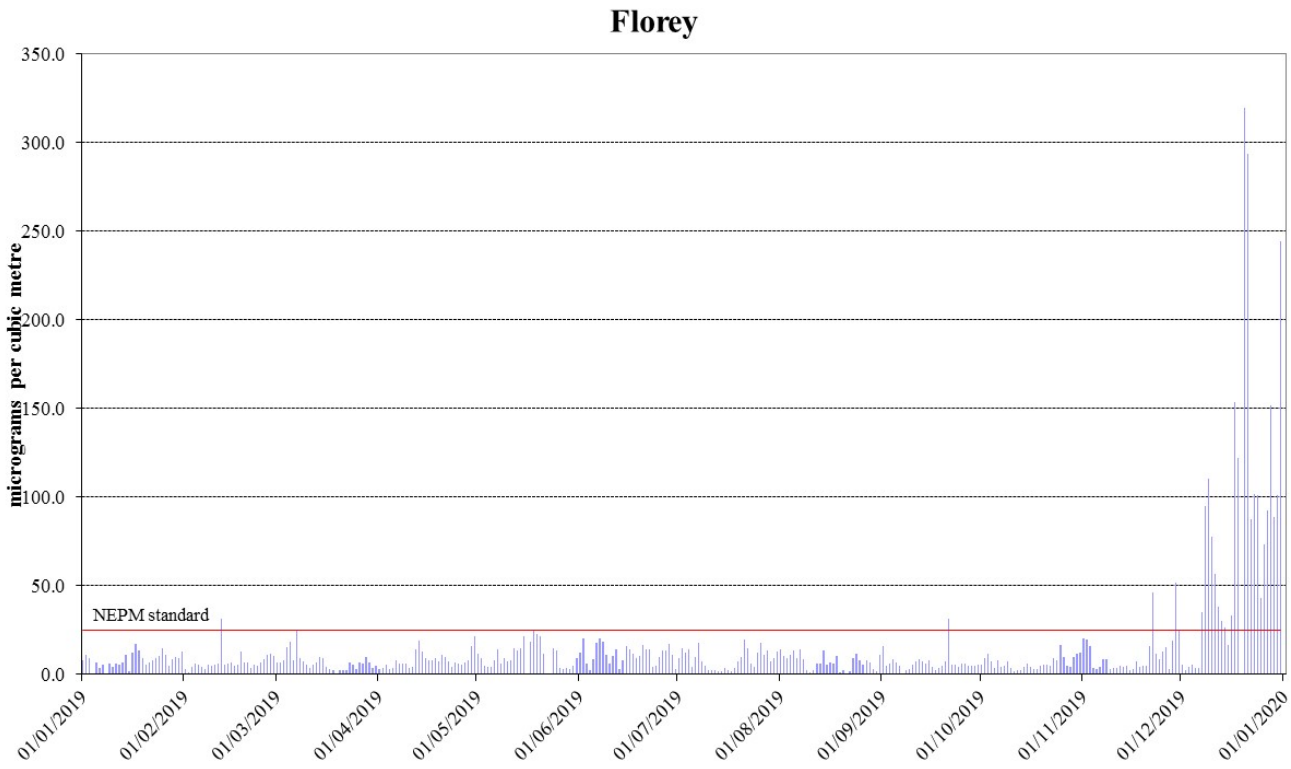

Figure 16: Daily maximum for $PM_{2.5}$ – Florey

ANALYSIS OF AIR QUALITY MONITORING

Annual summary statistics contained in Table 9 to Table 14 below assess air quality against the standards and the extent of compliance with the goal. Instances where the standard has been exceeded are highlighted in bold.

Carbon monoxide

Carbon monoxide levels significantly increased across the ACT in December 2019 due to bushfires. One exceedance was measured at Monash on 31 December 2019, with a new record of 12.4 ppm. This was the first exceedance of the carbon monoxide standard since the commencement of air quality monitoring in the ACT.

Table 9: 2019 summary statistics for daily peak 8-hour CO

AAQ NEPM standard - 9.0 ppm (8-hour average)

Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date/time)	2nd Highest (ppm)	2nd Highest (date/time)
Monash	273	**12.4**	31 Dec 00:00	3.6	21 Dec 01:00
Florey	362	8.6	31 Dec 00:00	5.8	22 Dec 03:00

Nitrogen dioxide

While the bushfire smoke adversely impacted the nitrogen dioxide levels, no exceedances were recorded across the ACT. The highest recorded 1-hour value during 2019 was 0.084 ppm at Monash. Annual average remained well below the standard in 2019. The annual average in 2019 was 0.005ppm at both Monash and Florey. This is 17% of the annual standard 0.03ppm.

Table 10: 2019 summary statistics for daily peak 1-hour NO_2

AAQ NEPM standard 0.12 ppm (1-hour average)

Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date/time)	2nd Highest (ppm)	2nd Highest (date/time)
Monash	361	0.084	31 Dec 22:00	0.035	19 Dec 7:00
Florey	347	0.062	31 Dec 21:00	0.034	24 Oct 21:00

Ozone

Ozone levels were higher this year compared with the previous year due to effects of the extensive bushfire smoke, coupled with warm and dry weather in 2019. There were three days in 2019 when ozone levels were above the standards. On 20 December 2019 the most extensive ozone event for 2019 occurred. On this day, all monitoring stations recorded ozone levels over the 1-hour and 4-hour standards. Ozone levels above the 4-hour standard were recorded two more times at Florey on 17 January and 9 December 2019, due to hotter weather increasing the conversion of vehicle emissions to ozone and bushfires respectively. The highest recorded 1-hour value in the ACT during 2019 was 0.127 ppm at Monash. The highest recorded 4-hour value in the ACT during 2019 was 0.118 ppm at Monash.

Table 11: 2019 summary statistics for daily peak 1-hour O_3

AAQ NEPM standard 0.10 ppm (1-hour average)

Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date/time)	2nd Highest (ppm)	2nd Highest (date/time)
Monash	365	**0.127**	20 Dec 13:00	0.086	09 Dec 12:00
Civic	365	**0.105**	20 Dec 12:00	0.080	31 Dec 20:00
Florey	362	**0.118**	20 Dec 12:00	0.087	21 Dec 11:00

Table 12: 2019 summary statistics for daily peak 4-hour O_3

AAQ NEPM standard 0.08 ppm (4-hour average)

Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date/time)	2nd Highest (ppm)	2nd Highest (date/time)
Monash	365	**0.118**	20 Dec 15:00	0.080	17 Jan 16:00
Civic	365	**0.098**	20 Dec 15:00	0.074	17 Jan 16:00
Florey	362	**0.109**	20 Dec 15:00	**0.082**	09 Dec 15:00

PM_{10}

There were 29 days when daily PM_{10} standard was exceeded in 2019. The highest daily PM_{10} level was 390.2µg/m^3 which was recorded at Civic on 31 December 2019.

The high number of daily PM_{10} exceedances was primarily attributed to the extensive bushfires throughout New South Wales (21 days) impacting the ACT and the increasing frequency of widespread dust storms (8 days). Under the exceptional event rule they have been excluded when assessing compliance against the daily standard.

Whilst monitoring data from exceptional events is excluded for reporting compliance for daily averaging standards it is still included for one year averaging standards, which has led to an abrupt increase in the annual averages.

The highest recorded annual average in 2019 was 23.8μg/m^3 at Florey (refer to Table 7) up from a maximum of 13.5μg/m^3 (Civic) in 2018. This is below the national annual standard of 25μg/m^3, but was slightly over the ACT annual standard of 20μg/m^3.

Table 13: 2019 summary statistics for daily PM_{10}

AAQ NEPM daily standard 50 μg/m^3

Performance monitoring station	Number of valid days	Highest (μg/m^3)	Highest (date)
Monash	359	**385.7**	31 December
Civic	355	**390.2**	31 December
Florey	358	**379.7**	31 December

$PM_{2.5}$

The daily standard for $PM_{2.5}$ was exceeded on 32 days in 2019. Only two of the exceeding days, which occurred on 18 and 19 May 2019, were a result of domestic wood heater emissions in winter. The other exceedances were due to bushfire smoke (27 days) and dust storms (3 days).

The highest daily $PM_{2.5}$ level was 319.6μg/m^3 which was recorded at Florey on 20 December 2019.

Whilst monitoring data from exceptional events is excluded for reporting compliance for daily averaging standards it is still included for one year averaging standards. Given the length of time the Canberra airshed was affected by bushfire smoke there was an abrupt increase in annual average $PM_{2.5}$ levels in 2019, compared with previous years.

All monitoring stations recorded annual average $PM_{2.5}$ concentrations above the national standard 8 μg/m^3. The highest recorded annual average in 2019 was 14.8μg/m^3 at Florey (refer to Table 8) up from a maximum of 7.1μg/m^3 (Florey) in 2018.

Table 14: 2019 summary statistics for daily $PM_{2.5}$

AAQ NEPM daily standard 25 μg/m^3

Performance monitoring station	Number of valid days	Highest (μg/m^3)	Highest (date)
Monash	361	**307.9**	31 December
Civic	352	**275.5**	31 December
Florey	359	**319.6**	20 December

ASSESSMENT OF PROGRESS TOWARDS ACHIEVING THE GOAL

Historical monitoring results indicate that the only AAQ NEPM pollutant of concern in the ACT air shed is particulate matter, which increases significantly during winter because of emissions from domestic wood heaters. In more recent years exceedances of the particulate matter standards have also been attributed to dust storms and smoke from hazard reduction burns and bushfires.

However, 2019 will go down on record as one of our worst years for air pollution due to the ACT being impacted by smoke from the bushfires burning in south-eastern New South Wales which started in November 2019 and continued into early 2020.

Concentrations of carbon monoxide and nitrogen dioxide met the AAQ NEPM standards, with the exception of one exceedance of the 8-hour carbon monoxide standard at Monash during the bushfire period.

Ozone levels increased compared with 2018, because of the bushfire crisis together with warm and dry weather in 2019, meeting the AAQ NEPM standards on 99% of all days.

Daily maximum and annual average particulate matter levels (PM_{10} and $PM_{2.5}$) dramatically increased due to the unprecedented levels of the bushfire smoke. Additionally, Bureau of Meteorology data shows that rainfall was well below average and daytime maximum temperatures were well above average in 2019. The record breaking drought conditions also led to an increase in widespread dust events throughout the year.

Ironically, these warmer temperatures resulted in one of the best winters the ACT has experienced for wood heater pollution with only two $PM_{2.5}$ exceedance days related to emissions from domestic wood heaters.

Notwithstanding this result, the ACT Government acknowledges that wood heater emissions are a problem and will continue to implement an integrated program to address this including:

- implementing the 'Burn Right Tonight' public education campaign;
- regulating of the sale of firewood; and
- administering the Wood Heater Replacement Program.

Bushfire smoke and dust storms continue to present a threat to future air quality in the ACT, particularly as climate change is set to exacerbate the frequency and intensity of bushfire events, coupled with rising temperatures and prolonged dry weather. Similarly, rising temperatures will also result in an increase in the ACTs ozone levels because as temperature increase so does the conversion of vehicle emissions to ozone

APPENDIX A: STATISTICAL SUMMARY AND TRENDS

The following section provides a basic statistical summary, using percentiles, for Monash, Florey and Civic stations and for each standard in the past ten years. Percentiles for daily maximum values are presented.

Carbon monoxide

Table 15: Statistical summary for daily maximum 8-hour CO Monash 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2010	99.2	0	1.8	1.4	0.6	0.3
2011	98.6	0	2.2	1.5	0.5	0.2
2012	99.7	0	1.8	1.2	0.6	0.3
2013	95.9	0	2.1	1.5	0.6	0.3
2014	94.0	0	1.8	1.4	0.7	0.4
2015	94.8	0	1.9	1.4	0.6	0.3
2016	95.8	0	1.7	1.0	0.4	0.2
2017	95.4	0	1.6	1.2	0.6	0.2
2018	92.3	0	1.5	1.2	0.5	0.2
2019	72.1	1	12.4	1.1	0.4	0.1

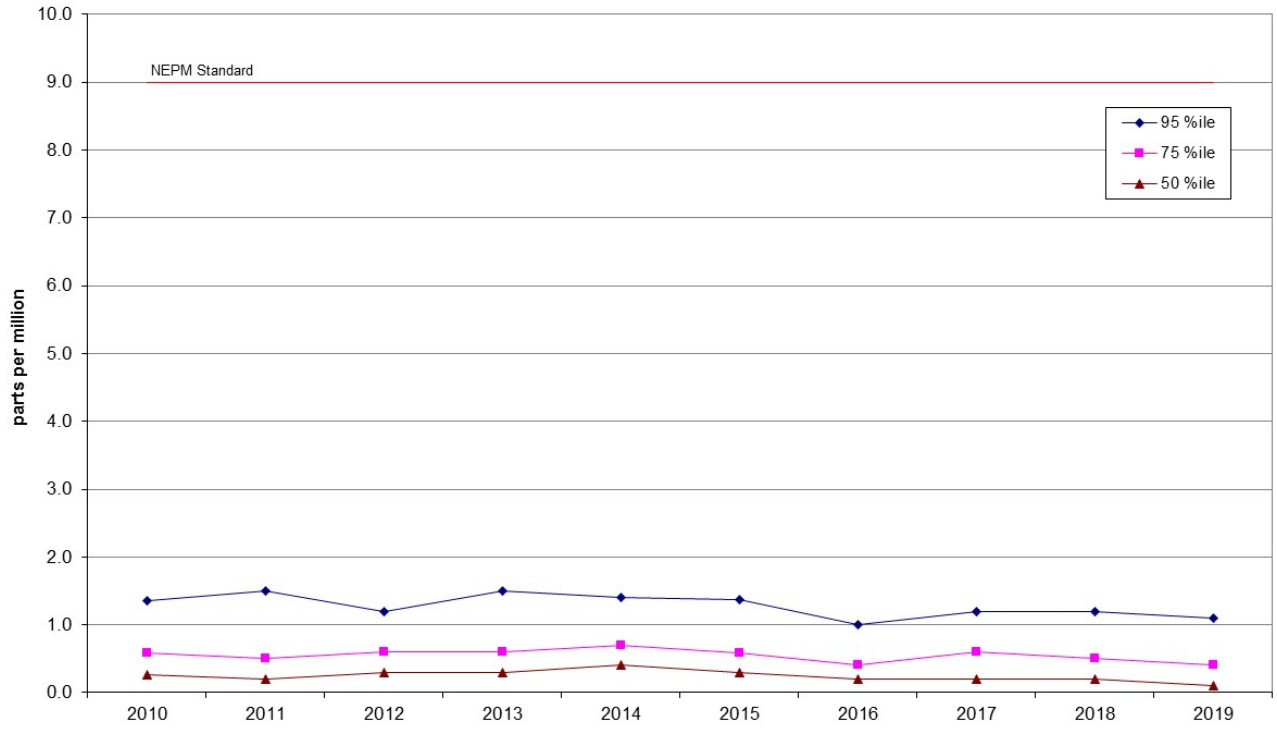

Figure 17: Statistical summary for daily maximum 8-hour CO Monash 2010 – 2019

Table 16: Statistical summary for daily maximum 8-hour CO Florey 2014 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2014	79.2	0	2.2	1.4	0.7	0.3
2015	94.9	0	2.0	1.5	0.6	0.3
2016	95.5	0	1.9	1.2	0.5	0.3
2017	94.7	0	1.8	1.4	0.5	0.2
2018	94.7	0	1.5	1.1	0.5	0.3
2019	95.3	0	8.6	1.2	0.6	0.3

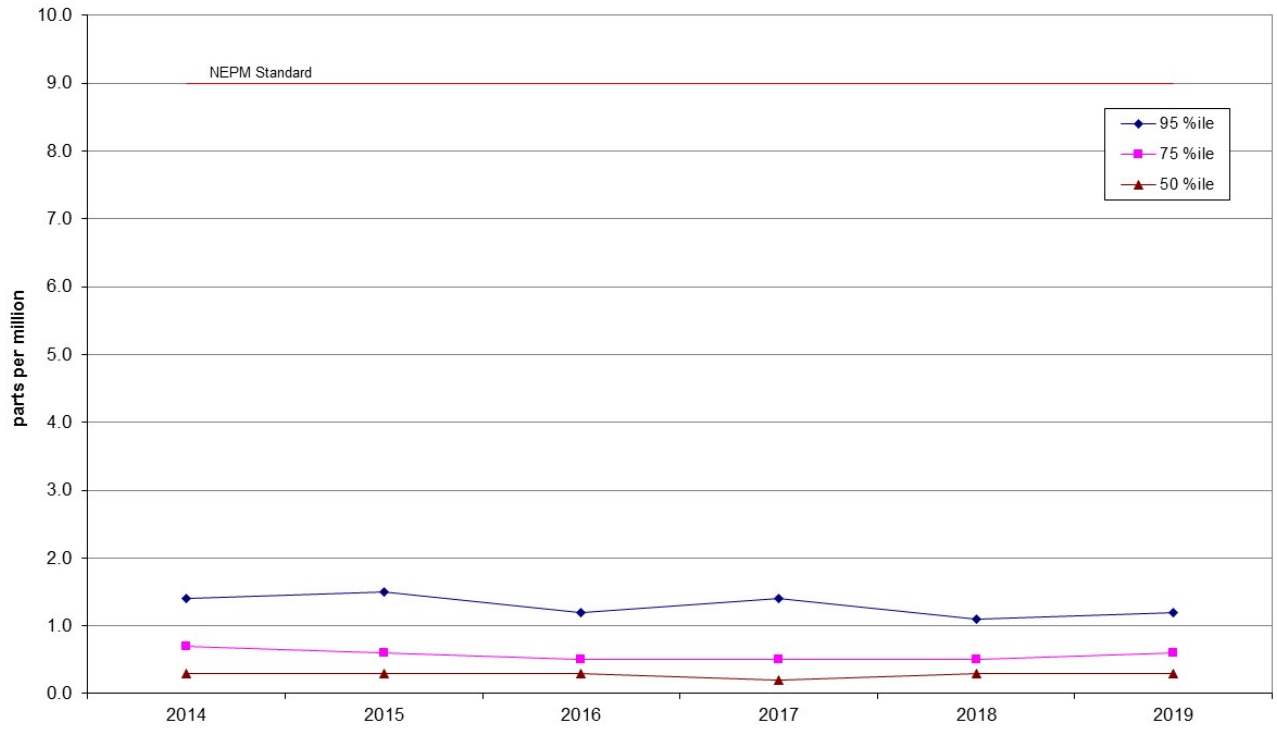

Figure 18: Statistical summary for daily maximum 8-hour CO Florey 2014 – 2019

Nitrogen dioxide

Table 17: Statistical summary for daily maximum 1-hour NO_2 Monash 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	Annual average (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2010	89.1	0	0.037	0.006	0.025	0.021	0.017
2011	96.7	0	0.043	0.005	0.029	0.022	0.015
2012	97.5	0	0.033	0.006	0.026	0.021	0.014
2013	97.5	0	0.037	0.005	0.027	0.021	0.014
2014	94.1	0	0.036	0.005	0.027	0.020	0.015
2015	94.8	0	0.032	0.004	0.026	0.020	0.014
2016	95.6	0	0.036	0.004	0.027	0.019	0.012
2017	95.6	0	0.031	0.004	0.027	0.021	0.013
20198	95.5	0	0.039	0.004	0.028	0.020	0.014
2019	94.9	0	0.084	0.005	0.027	0.021	0.014

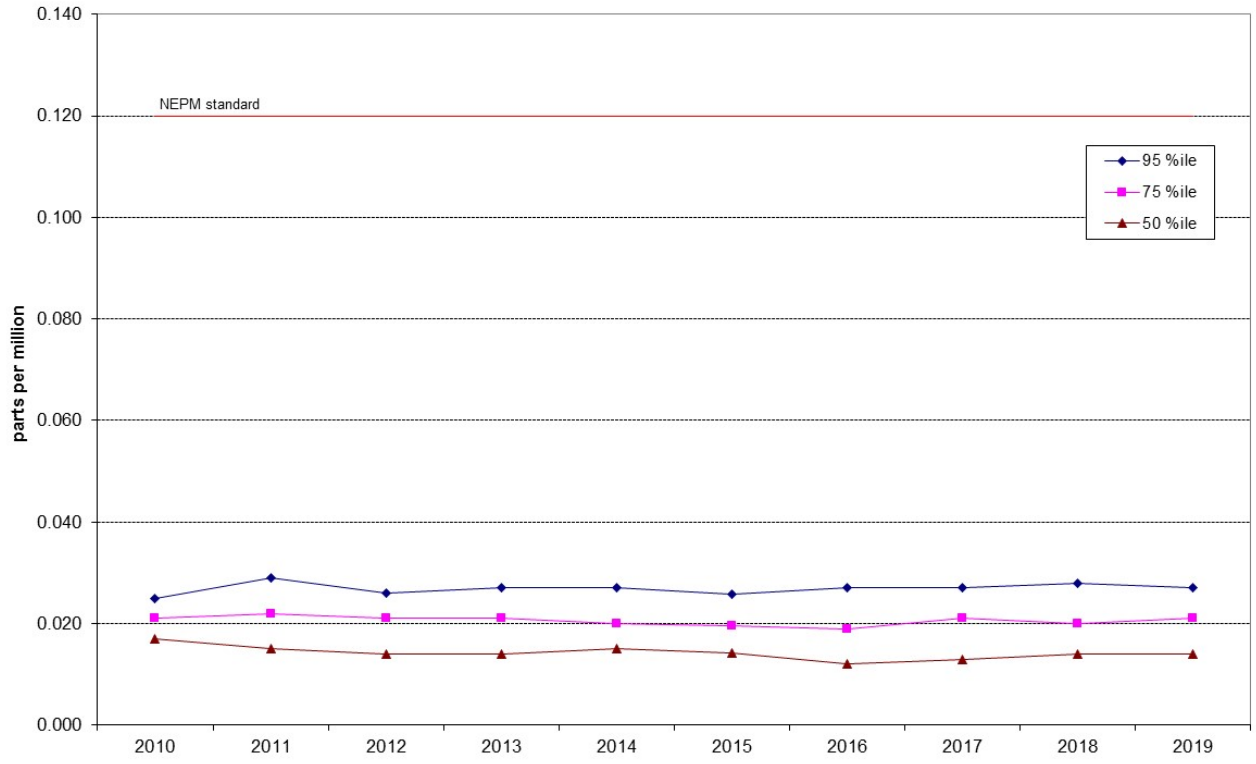

Figure 19: Statistical summary for daily maximum 1-hour NO_2 Monash 2010 – 2019

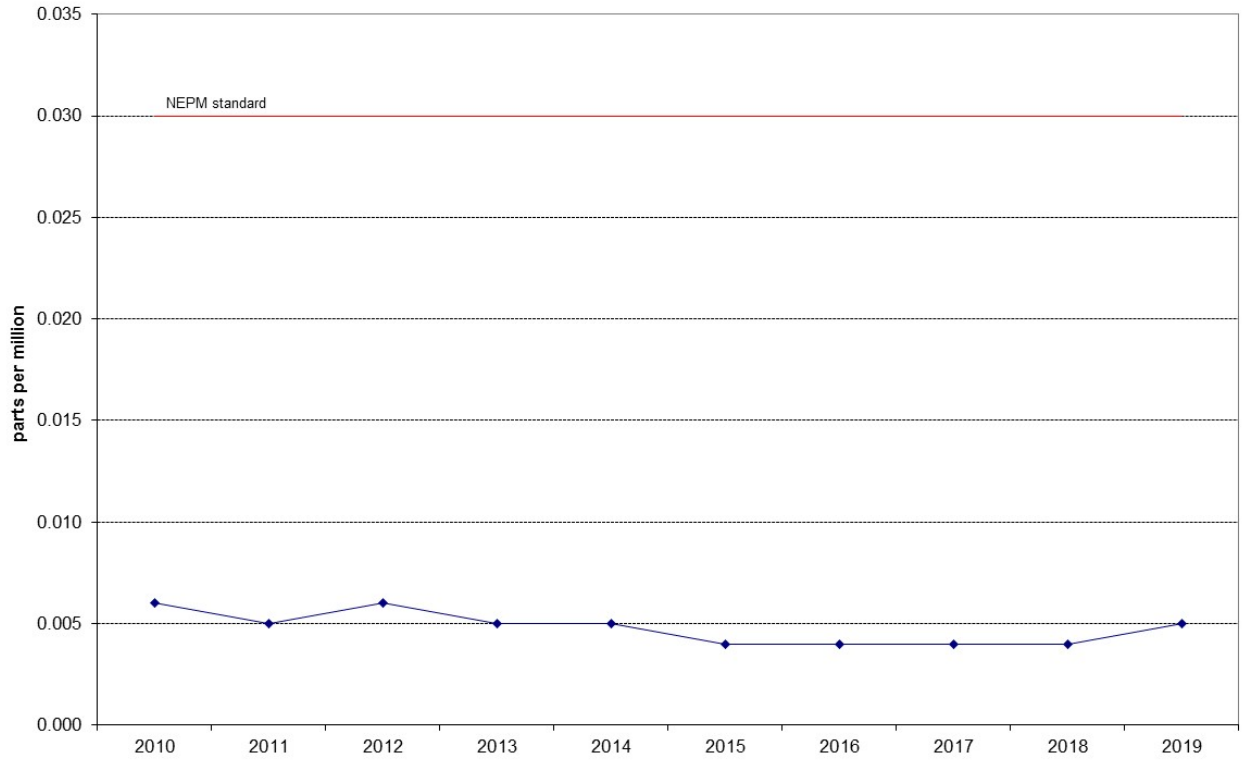

Figure 20: Annual average 1-hour NO_2 Monash 2010 – 2019

Table 18: Statistical summary for daily maximum 1-hour NO_2 Florey 2014 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	Annual average (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2014	78.3	0	0.045	0.006	0.027	0.020	0.015
2015	91.5	0	0.033	0.005	0.027	0.020	0.014
2016	94.7	0	0.034	0.004	0.027	0.019	0.013
2017	93.7	0	0.033	0.005	0.025	0.020	0.015
2018	93.3	0	0.039	0.005	0.028	0.022	0.015
2019	92.4	0	0.062	0.005	0.027	0.020	0.014

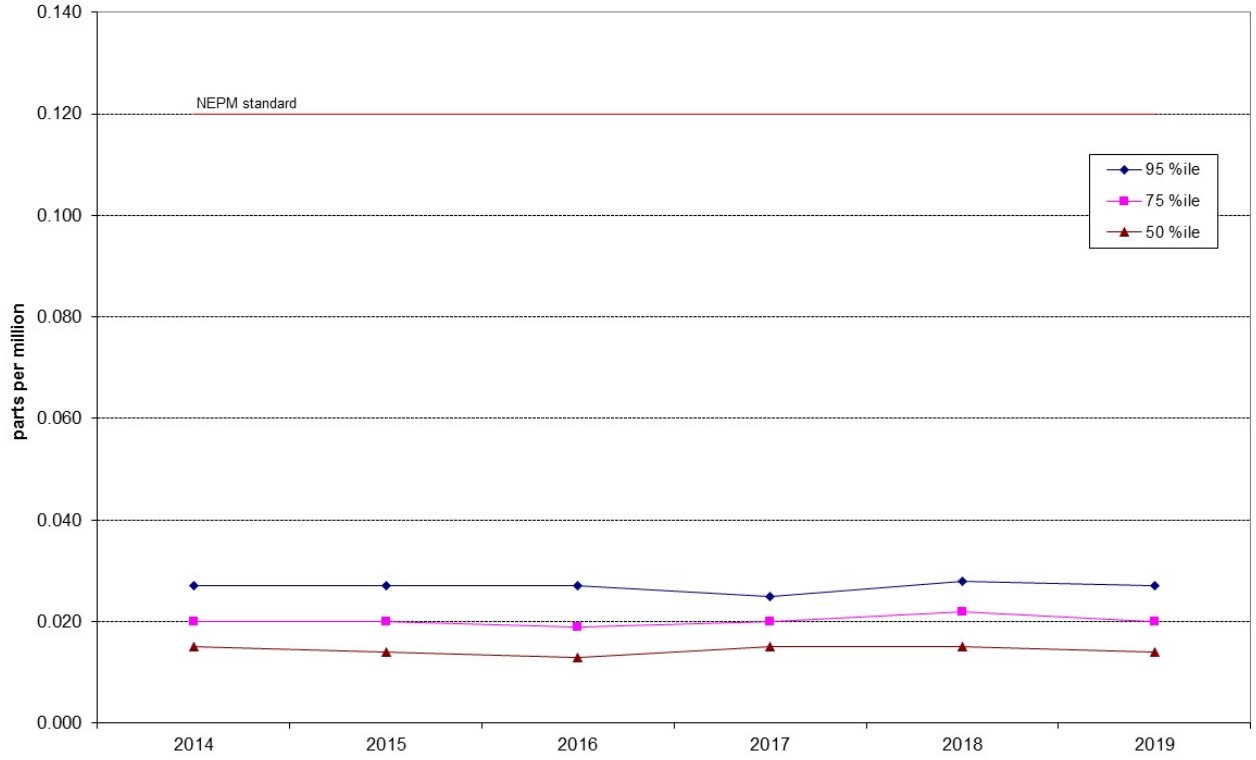

Figure 21: Statistical summary for daily maximum 1-hour NO_2 Florey 2014 – 2019

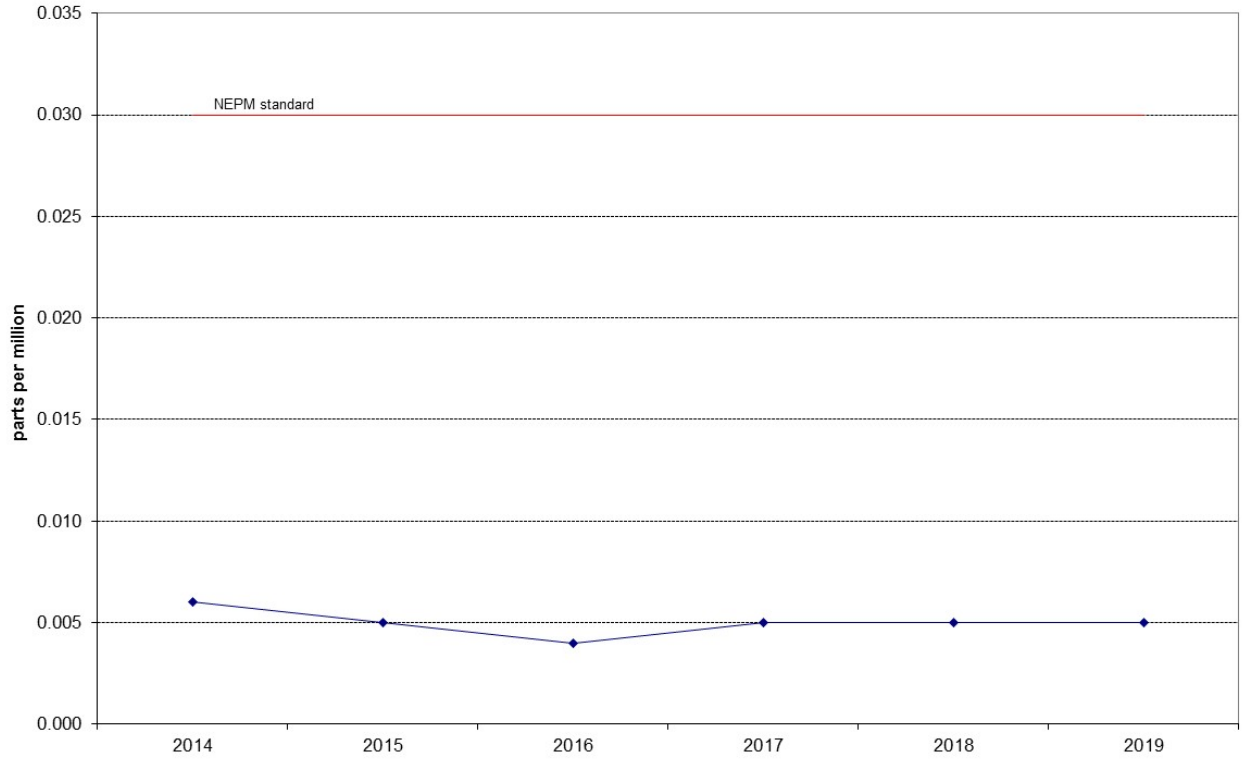

Figure 22: Annual average 1-hour NO_2 Florey 2014 – 2019

Ozone

Table 19: Statistical summary for daily maximum 1-hour O_3 Monash 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2010	86.6	0	0.051	0.042	0.033	0.030
2011	99.2	0	0.056	0.044	0.033	0.028
2012	100	0	0.055	0.043	0.034	0.029
2013	97.8	0	0.062	0.045	0.035	0.029
2014	94.8	0	0.087	0.050	0.036	0.030
2015	92.8	0	0.065	0.044	0.034	0.026
2016	95.2	0	0.057	0.044	0.032	0.026
2017	95.5	0	0.060	0.049	0.038	0.032
2018	95.8	0	0.062	0.050	0.039	0.032
2019	95.8	1	0.127	0.066	0.040	0.033

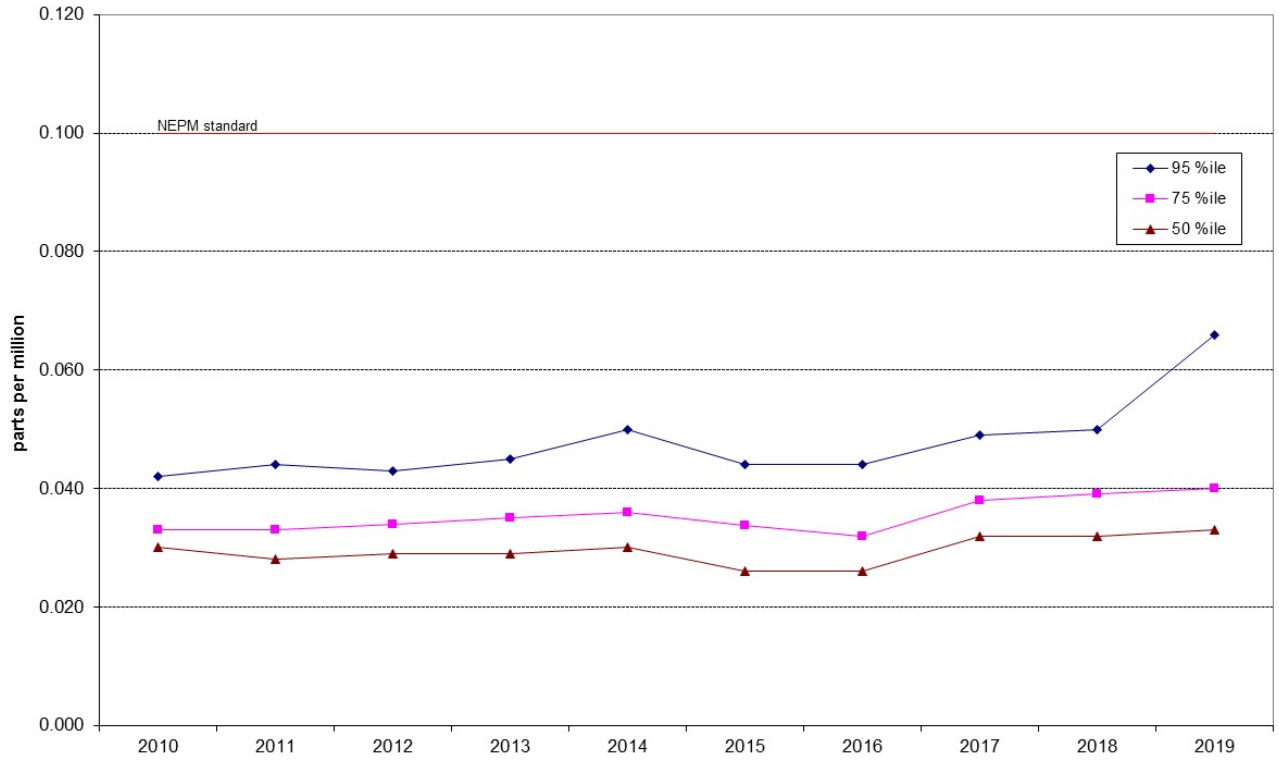

Figure 23: Statistical summary for daily maximum 1-hour O_3 Monash 2010 – 2019

Table 20: Statistical summary for daily maximum 1-hour O_3 Civic 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2010	99.2	0	0.058	0.040	0.029	0.025
2011	96.4	0	0.052	0.041	0.030	0.026
2012	100	0	0.053	0.034	0.024	0.020
2013	92.1	0	0.060	0.036	0.028	0.024
2014	94.0	0	0.060	0.039	0.028	0.022
2015	89.0	0	0.042	0.034	0.026	0.022
2016	95.8	0	0.047	0.036	0.028	0.024
2017	95.8	0	0.053	0.045	0.034	0.028
2018	95.2	0	0.056	0.046	0.032	0.028
2019	95.8	4	0.169	0.065	0.037	0.029

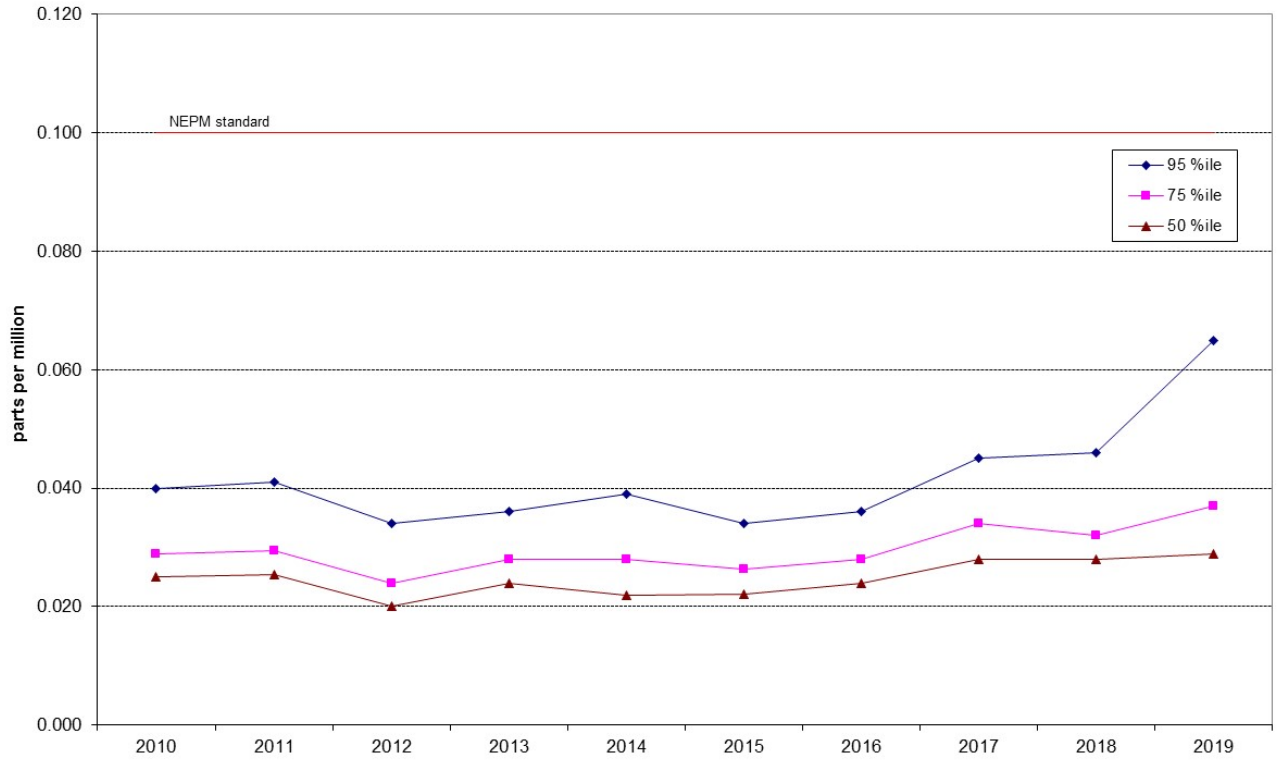

Figure 24: Statistical summary for daily maximum 1-hour O_3 Civic 2010 – 2019

Table 21: Statistical summary for daily maximum 1-hour O_3 Florey 2014 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2014	79.4	0	0.074	0.034	0.027	0.023
2015	94.2	0	0.040	0.032	0.025	0.021
2016	95.8	0	0.050	0.040	0.031	0.027
2017	95.5	0	0.057	0.048	0.038	0.032
2018	95.2	0	0.059	0.050	0.038	0.032
2019	95.3	1	0.118	0.067	0.039	0.032

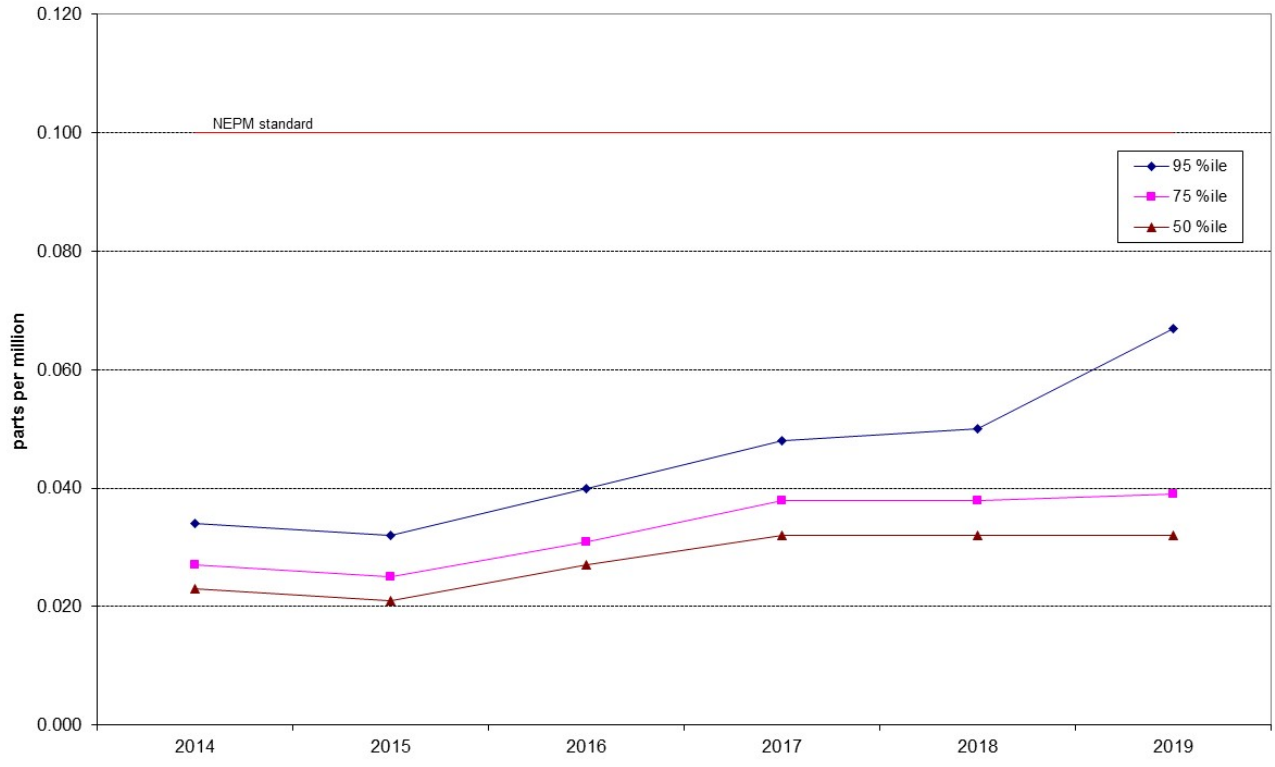

Figure 25: Statistical summary for daily maximum 1-hour O_3 Florey 2014 – 2019

Table 22: Statistical summary for daily maximum 4-hour O_3 Monash 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2010	86.6	0	0.049	0.040	0.032	0.029
2011	98.9	0	0.054	0.041	0.032	0.027
2012	99.7	0	0.052	0.043	0.034	0.029
2013	97.8	0	0.059	0.042	0.033	0.028
2014	94.8	0	0.060	0.046	0.034	0.029
2015	92.8	0	0.050	0.041	0.033	0.025
2016	95.2	0	0.055	0.042	0.030	0.025
2017	95.5	0	0.055	0.047	0.036	0.031
2018	95.8	0	0.057	0.049	0.038	0.032
2019	95.8	1	0.118	0.061	0.039	0.032

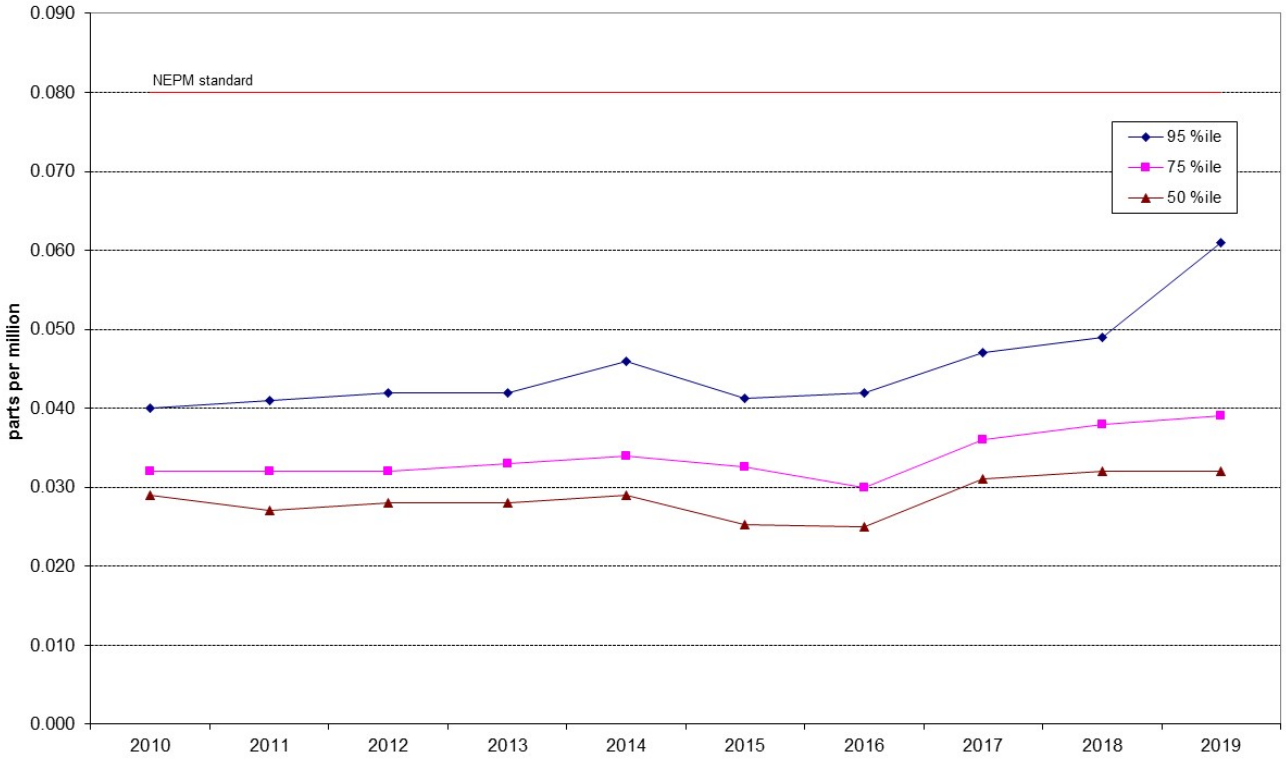

Figure 26: Statistical summary for daily maximum 4-hour O_3 Monash 2010 – 2019

Table 23: Statistical summary for daily maximum 4-hour O_3 Civic 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2010	99.2	0	0.056	0.037	0.028	0.024
2011	96.4	0	0.050	0.038	0.029	0.025
2012	100	0	0.042	0.032	0.023	0.019
2013	91.8	0	0.057	0.034	0.027	0.023
2014	94.0	0	0.047	0.036	0.026	0.020
2015	89.0	0	0.041	0.031	0.025	0.021
2016	95.8	0	0.045	0.035	0.027	0.023
2017	95.8	0	0.049	0.042	0.033	0.027
2018	95.2	0	0.053	0.044	0.031	0.026
2019	95.8	1	0.098	0.060	0.036	0.029

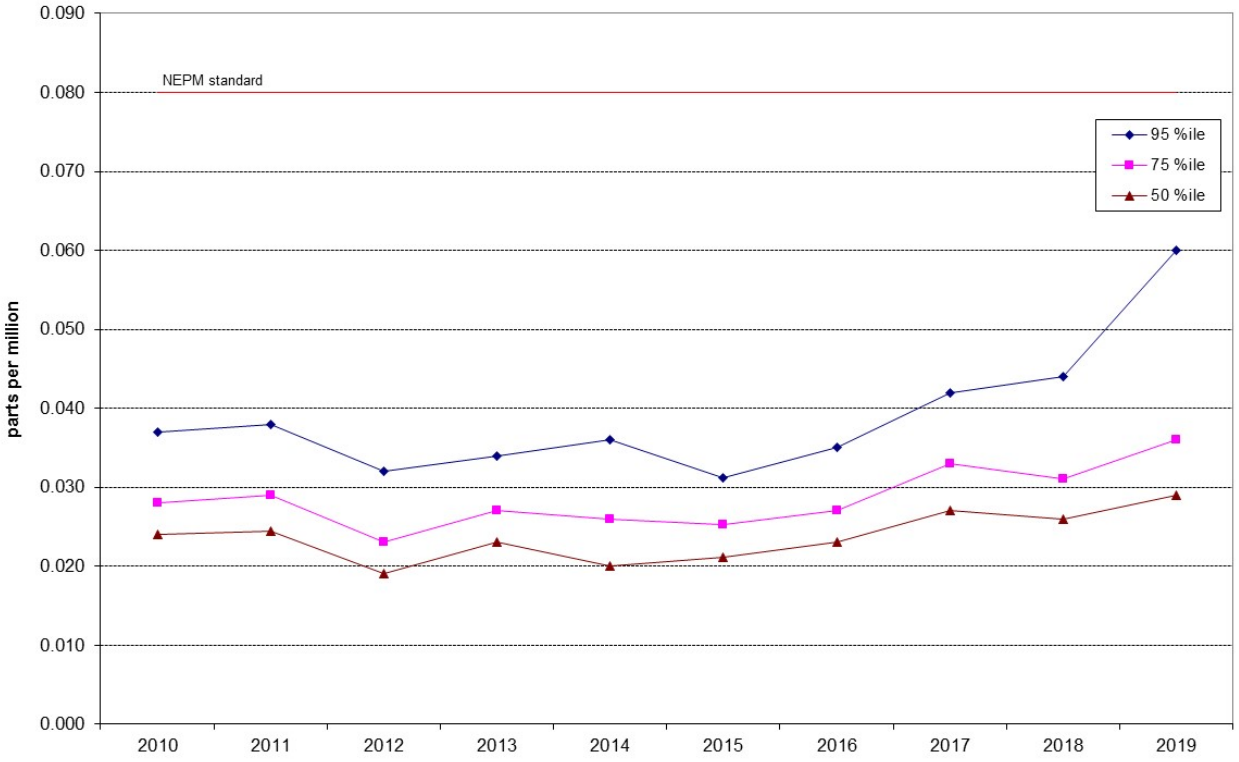

Figure 27: Statistical summary for daily maximum 4-hour O_3 Civic 2010 – 2019

Table 24: Statistical summary for daily maximum 4-hour O_3 Florey 2014 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (ppm)	95th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
2014	79.4	0	0.040	0.031	0.026	0.022
2015	94.2	0	0.037	0.031	0.025	0.020
2016	95.8	0	0.050	0.038	0.029	0.026
2017	95.5	0	0.054	0.046	0.037	0.031
2018	95.2	0	0.057	0.048	0.037	0.031
2019	95.3	3	0.109	0.064	0.038	0.031

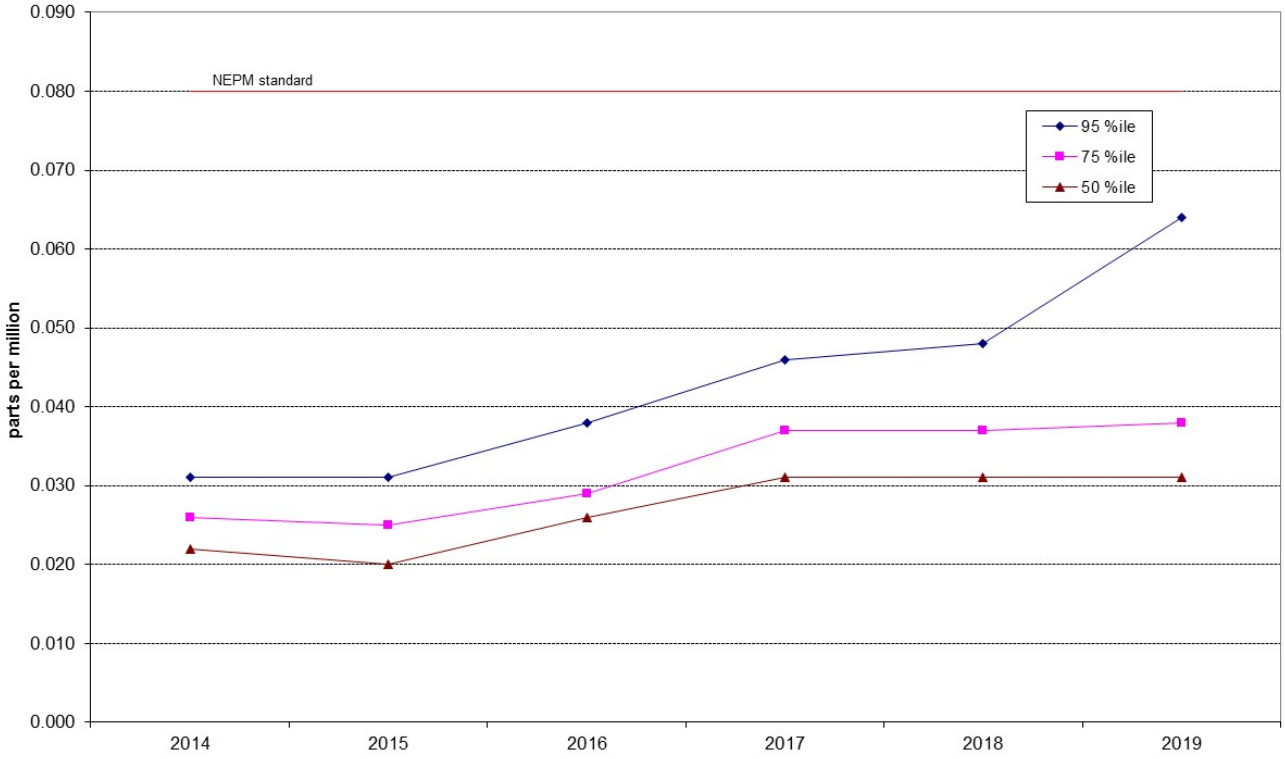

Figure 28: Statistical summary for daily maximum 4-hour O_3 Florey 2014 – 2019

PM_{10}

Table 25: Statistical summary for daily maximum daily PM_{10} Monash 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. ($\mu g/m^3$)	Annual average ($\mu g/m^3$)	95th percentile ($\mu g/m^3$)	75th percentile ($\mu g/m^3$)	50th percentile ($\mu g/m^3$)
2010	95.4	0	48.4	11.1	23.5	14.7	10.0
2011	99.2	0	40.0	10.4	22.8	13.2	8.7
2012	98.6	0	41.0	10.4	19.7	13.7	9.7
2013	95.6	0	43.5	9.8	20.2	13.1	8.9
2014	97.8	0	39.3	10	19.1	12.9	9.6
2015	98.4	0	49.4	9.9	19.5	13.1	9.5
2016	99.5	0	31.9	9.7	21.5	12.7	9.0
2017	98.9	0	28.3	9.8	20.5	12.3	9.0
2018	99.2	4	139.2	11.8	23.0	14.8	10.4
2019	98.4	22	385.7	19.1	61.1	17.8	11.4

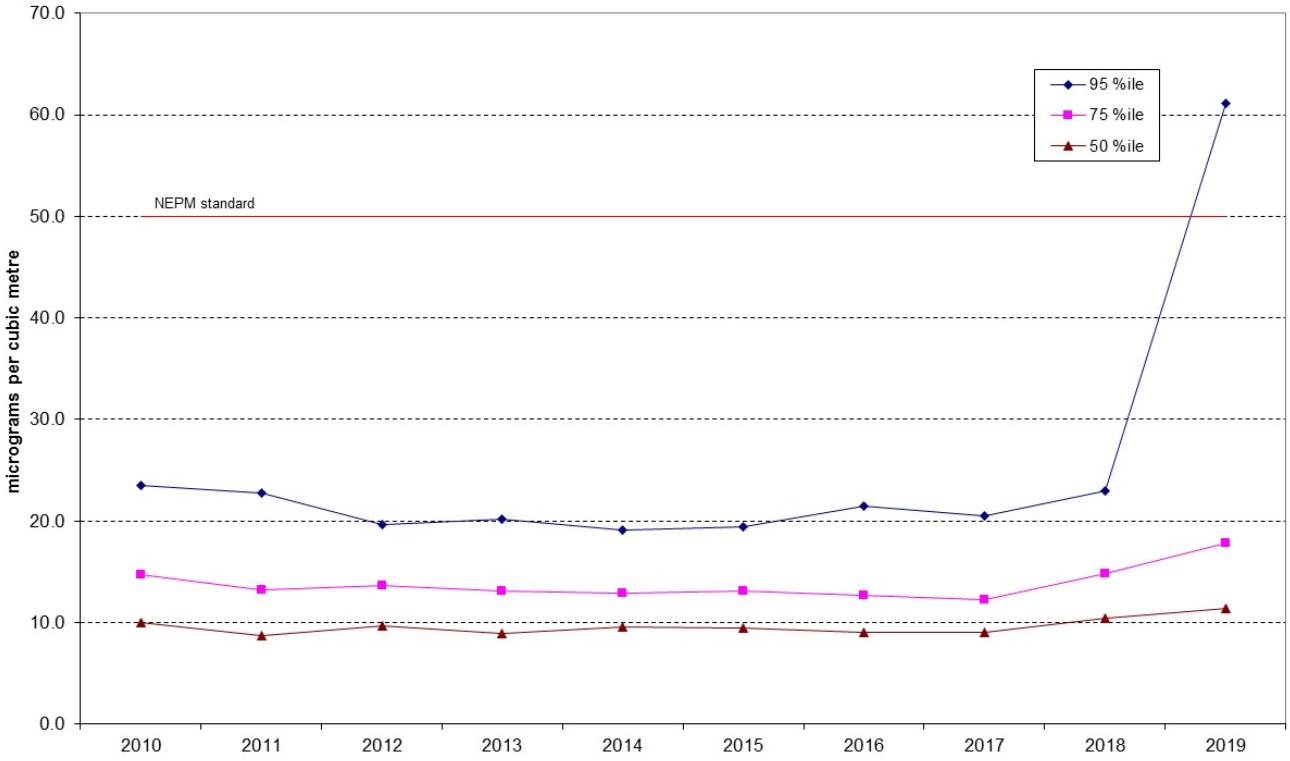

Figure 29: Statistical summary for daily PM_{10} Monash 2010 – 2019

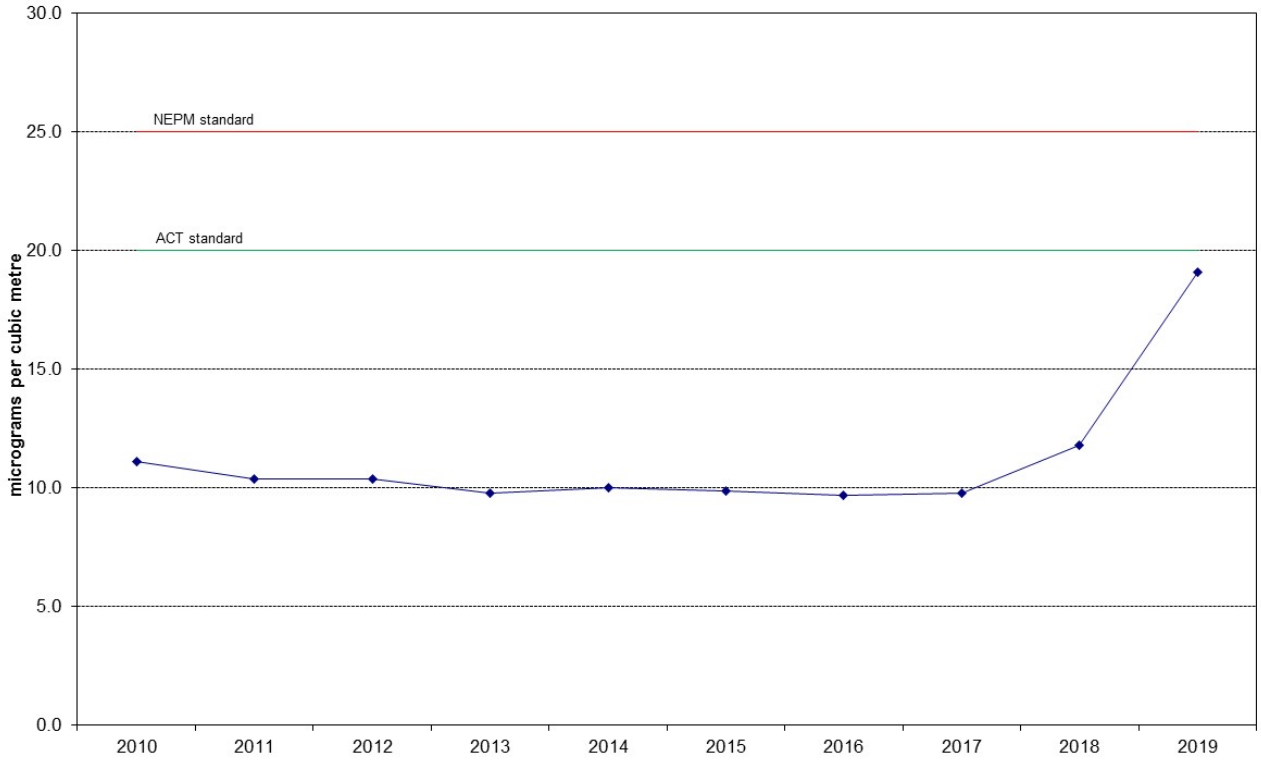

Figure 30: Annual average daily PM_{10} Monash 2010 – 2019

Table 26: Statistical summary for daily maximum daily PM_{10} Civic 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. ($\mu g/m^3$)	Annual average ($\mu g/m^3$)	95th percentile ($\mu g/m^3$)	75th percentile ($\mu g/m^3$)	50th percentile ($\mu g/m^3$)
2010	57.6	0	23.8	8.5	14.7	11.1	8.4
2011	97.0	0	29.2	8.7	16.9	11.0	7.9
2012	95.1	0	49.5	9.4	17.0	12.1	8.7
2013	92.9	1	57.8	9.7	19.9	12.0	8.6
2014	95.1	0	31.4	9.8	17.7	12.6	9.3
2015	97.5	1	64.3	11.1	20.9	14.1	10.4
2016	100	0	36.6	10.7	20.6	14.3	9.7
2017	83.6	1	53.0	9.68	10.8	7.1	5.2
2018	97.8	1	179.8	13.5	24.1	16.1	11.3
2019	97.3	29	390.2	22.9	82.5	19.5	12.7

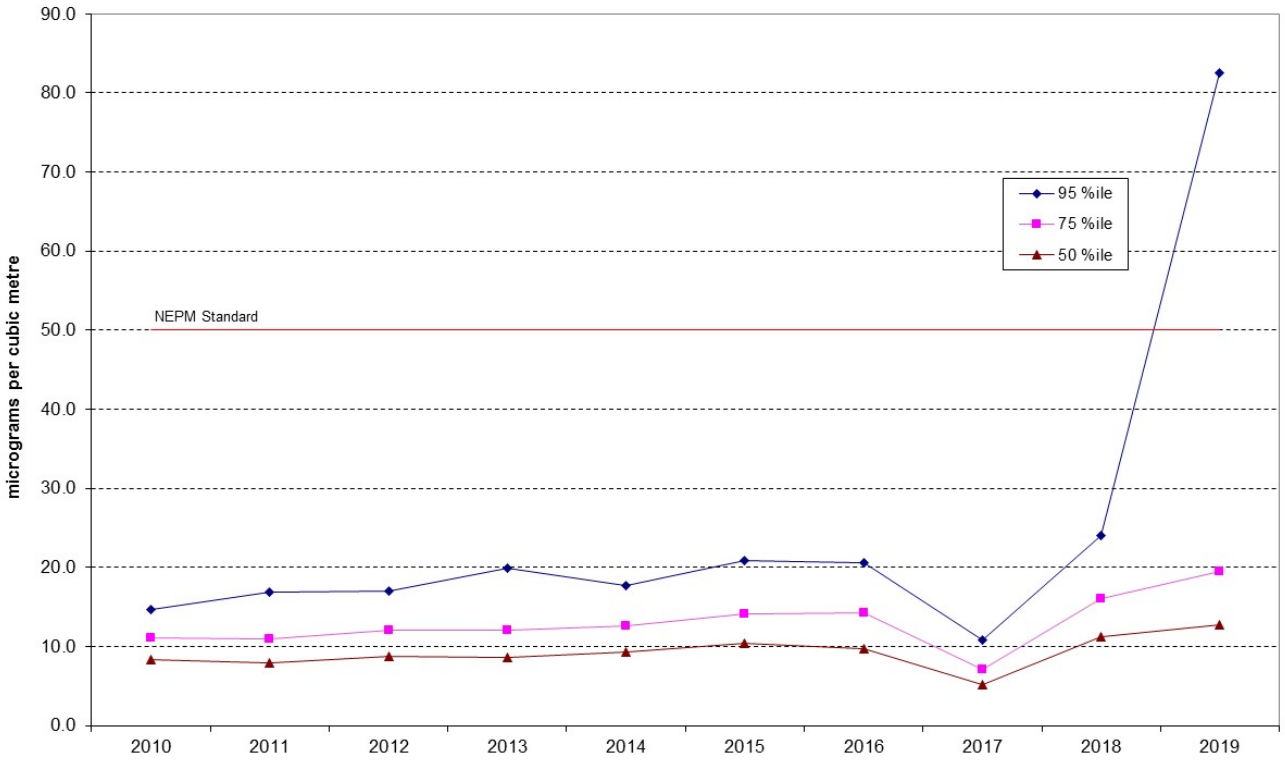

Figure 31: Statistical summary for daily PM_{10} Civic 2010 – 2019

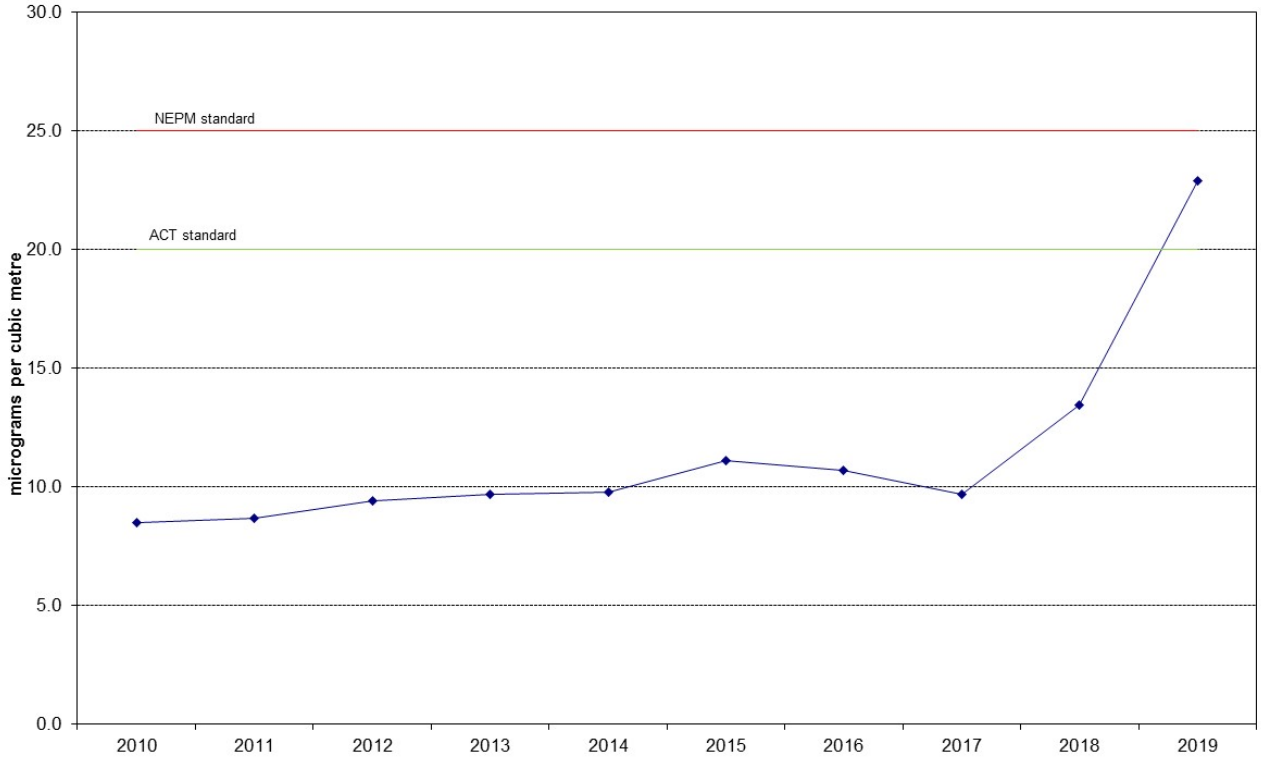

Figure 32: Annual average daily PM_{10} Civic 2010 – 2019

Table 27: Statistical summary for daily maximum daily PM_{10} Florey 2014 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. ($\mu g/m^3$)	Annual average ($\mu g/m^3$)	95th percentile ($\mu g/m^3$)	75th percentile ($\mu g/m^3$)	50th percentile ($\mu g/m^3$)
2014	83.3	0	30.2	10.4	21.5	13.0	9.4
2015	95.6	0	70.8	10.7	21.8	13.7	9.4
2016	98.9	0	28.8	10.1	20.6	13.1	9.2
2017	98.4	0	28.1	9.84	21.8	12.8	8.5
2018	89.9	3	158.6	12.0	23.8	15.3	10.1
2019	98.1	28	379.7	23.8	96.8	20.6	13.4

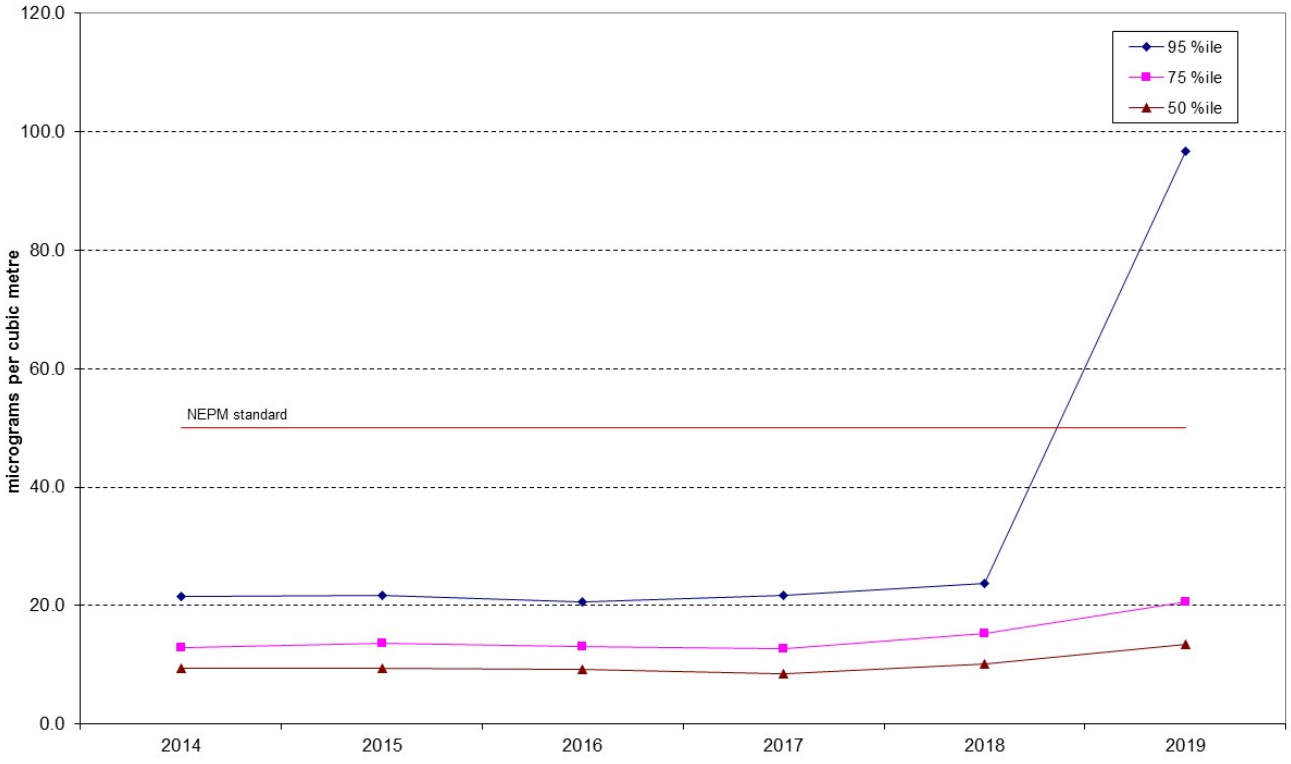

Figure 33: Statistical summary for daily PM_{10} Florey 2014 – 2019

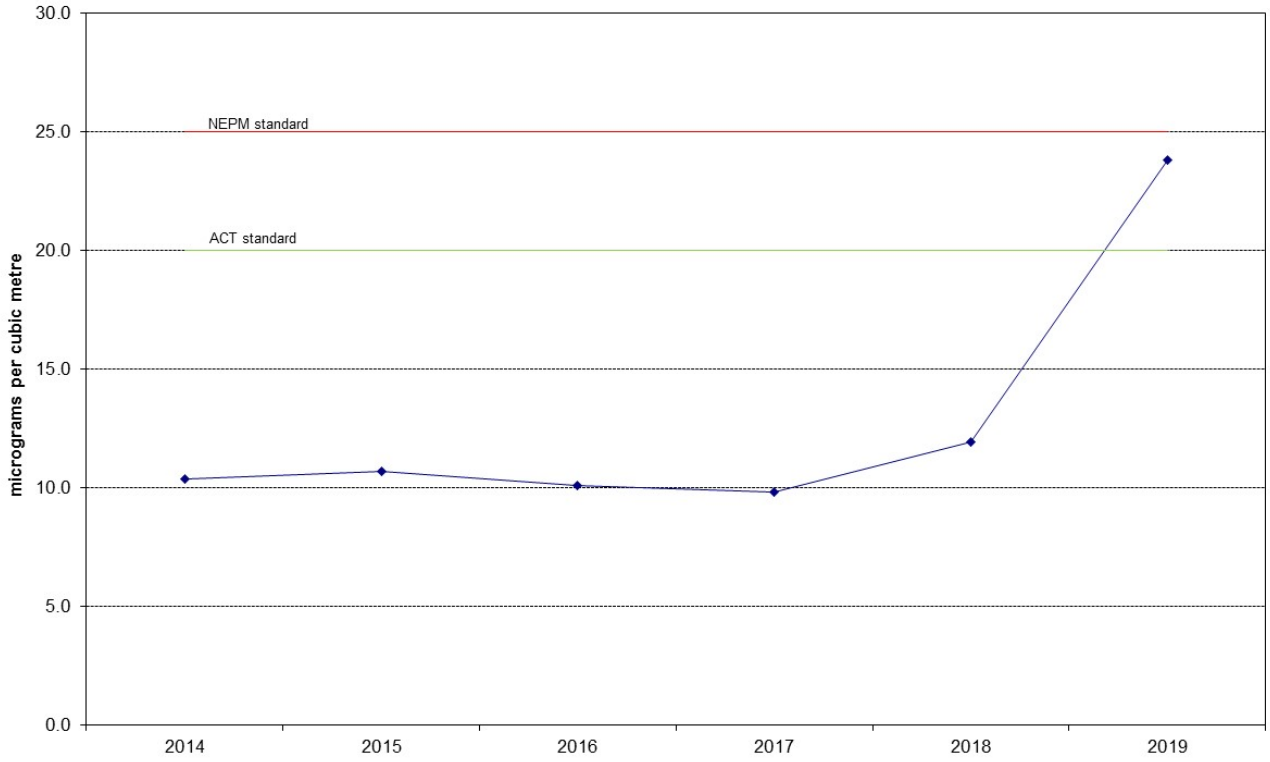

Figure 34: Annual average daily PM_{10} Florey 2010 – 2019

$PM_{2.5}$

Table 28: Statistical summary for daily maximum daily $PM_{2.5}$ Monash 2010 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. (µg/m^3)	Annual average (µg/m^3)	95th percentile (µg/m^3)	75th percentile (µg/m^3)	50th percentile (µg/m^3)
2010	95.1	2	52.4	6.7	17.4	7.8	4.4
2011	92.1	4	32.8	6.5	20.0	7.0	4.5
2012	95.1	3	29.2	7.1	16.5	8.3	5.0
2013	98.6	6	38.4	6.9	19.2	8.1	5.2
2014	87.7	4	31.5	6.8	18.7	8.6	5.6
2015	96.4	6	33.8	7.4	19.0	8.2	5.6
2016	98.1	8	32.7	7.4	20.7	8.2	5.4
2017	98.6	12	35.2	7.7	22.5	9.3	5.3
2018	99.2	2	32.0	6.8	19.2	8.6	5.3
2019	98.9	28	307.9	14.1	42.7	12.5	7.2

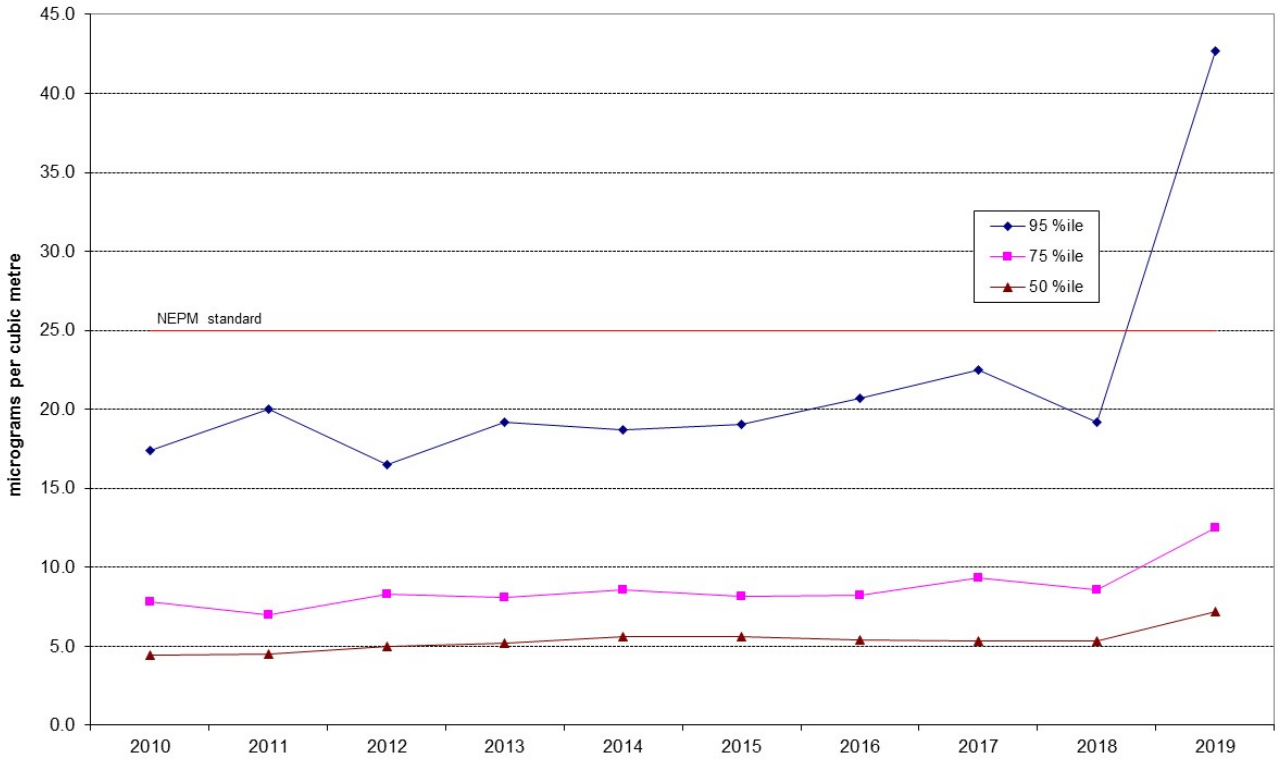

Figure 35: Statistical summary for daily $PM_{2.5}$ Monash 2010 – 2019

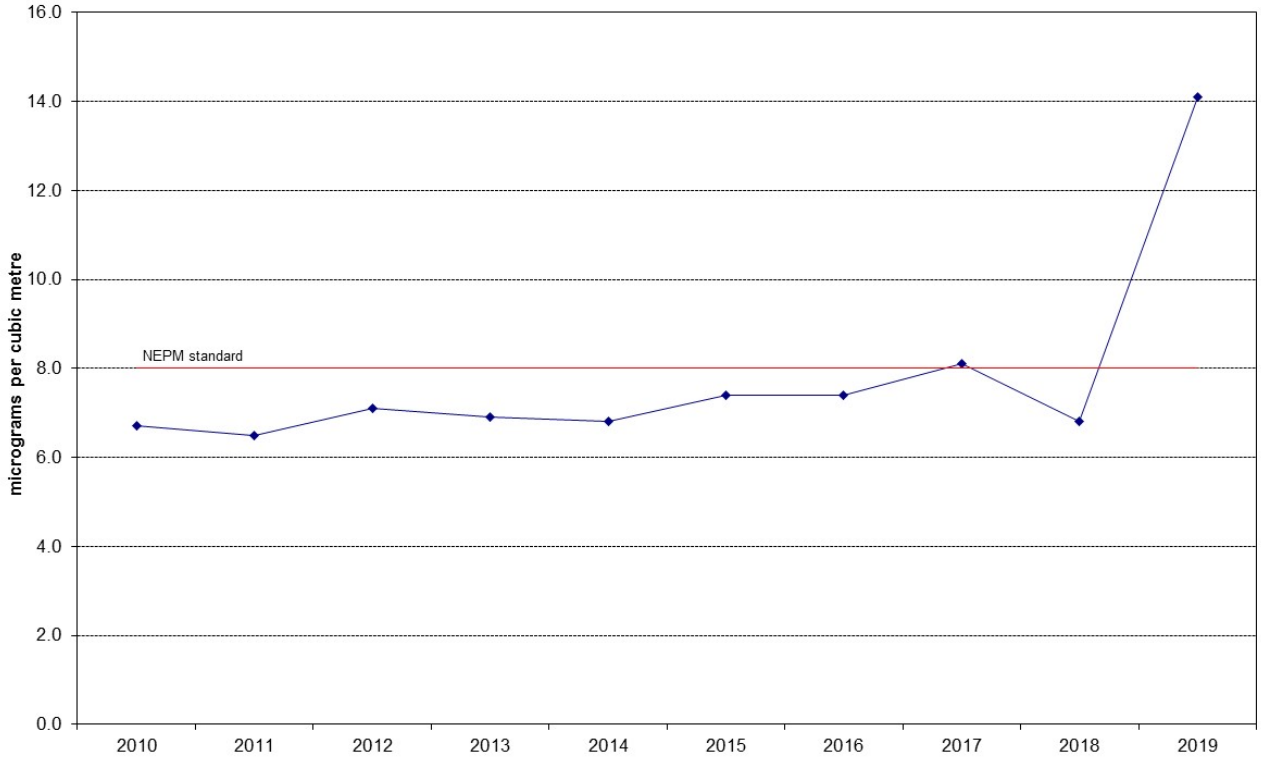

Figure 36: Annual average daily $PM_{2.5}$ Monash 2010 – 2019

Table 29: Statistical summary for daily maximum daily $PM_{2.5}$ Civic 2016 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. ($\mu g/m^3$)	Annual average ($\mu g/m^3$)	95^{th} percentile ($\mu g/m^3$)	75^{th} percentile ($\mu g/m^3$)	50^{th} percentile ($\mu g/m^3$)
2016	98.6	0	22.1	5.5	11.0	7.1	4.8
2017	94.2	1	53.8	5.9	10.8	7.1	5.2
2018	98.6	1	36.1	6.5	12.1	8.1	6.1
2019	96.4	29	390.2	22.9	82.5	19.5	12.7

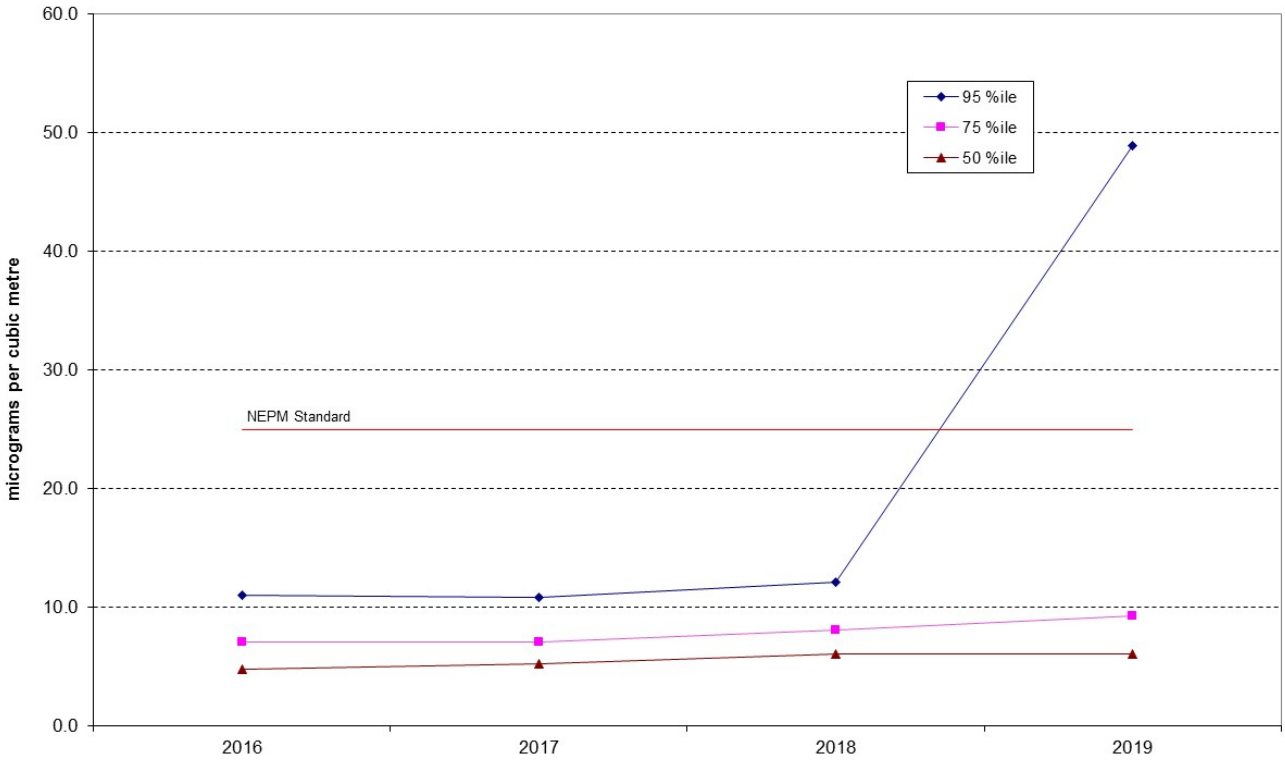

Figure 37: Statistical summary for daily $PM_{2.5}$ Civic 2016 – 2019

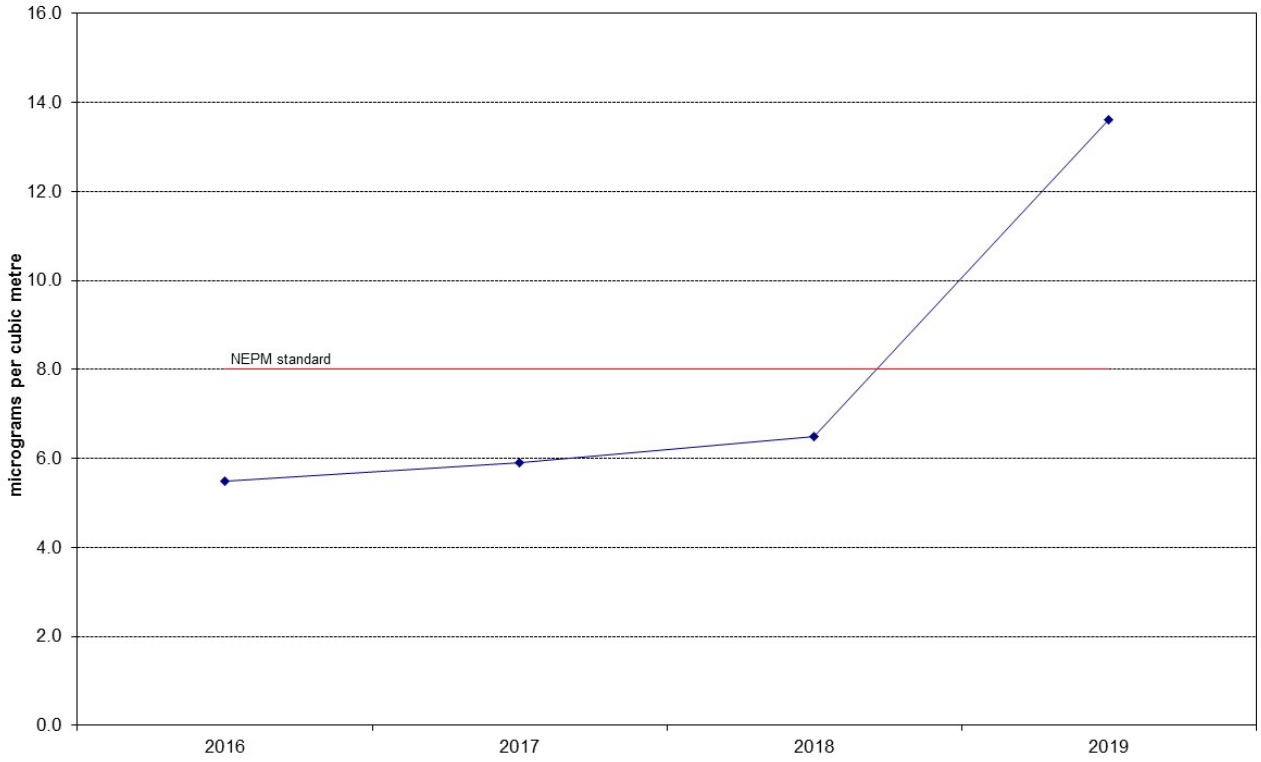

Figure 38: Annual average daily $PM_{2.5}$ Civic 2016 – 2019

Table 30: Statistical summary for daily maximum daily $PM_{2.5}$ Florey 2014 – 2019

Year	Data Availability (%)	No. of Exceedances (days)	Max conc. ($\mu g/m^3$)	Annual average ($\mu g/m^3$)	95th percentile ($\mu g/m^3$)	75th percentile ($\mu g/m^3$)	50th percentile ($\mu g/m^3$)
2014	74.2	0	22.8	5.8	15.0	7.1	4.9
2015	96.2	0	24.3	6.5	17.1	7.4	4.8
2016	98.6	1	27.2	7.3	17.4	8.6	5.8
2017	94.2	0	23.8	7.2	17.9	8.7	5.6
2018	97.3	2	26.4	7.4	17.0	8.7	5.9
2019	98.4	29	319.6	14.8	46.9	12.3	7.2

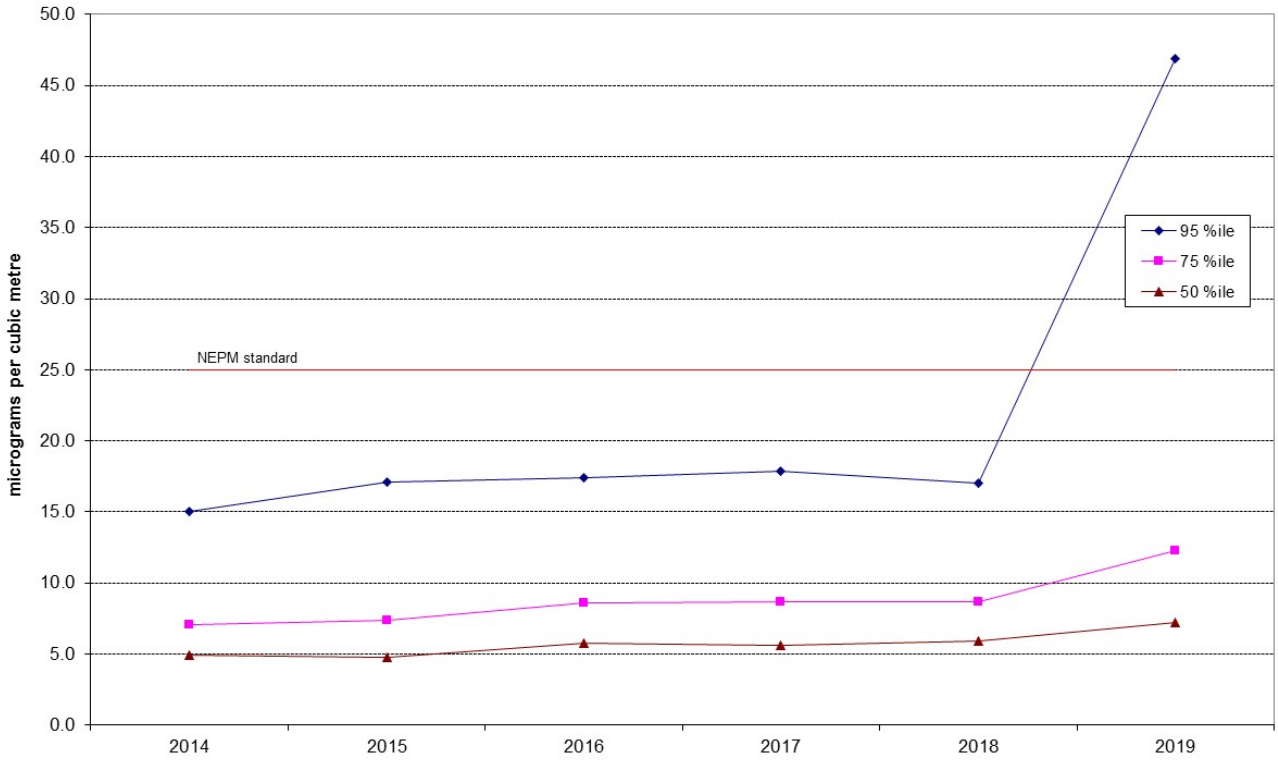

Figure 39: Statistical summary for daily $PM_{2.5}$ Florey 2014 – 2019

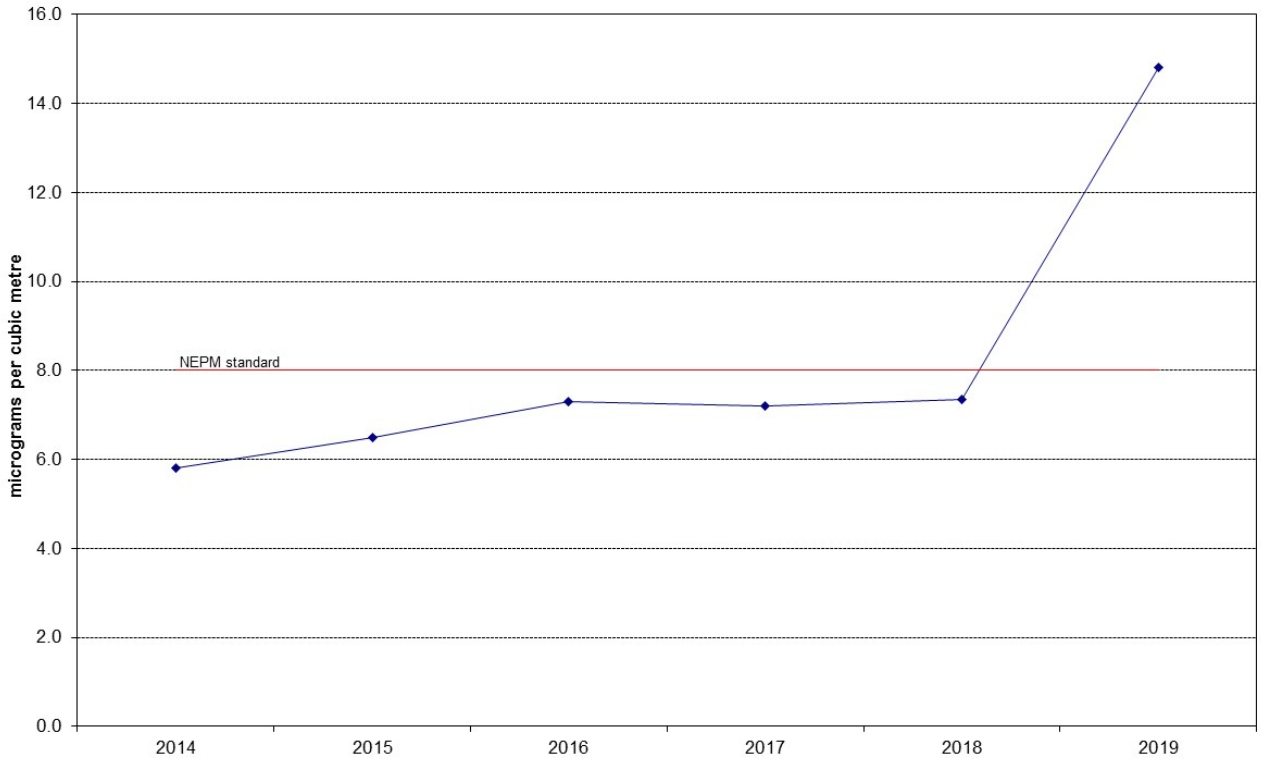

Figure 40: Annual average daily $PM_{2.5}$ Florey 2014 – 2019