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Department of **Environment Regulation**

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(Ambient Air Quality) Measure*

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Executive Summary

As signatory to the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM), Western Australia is required to report annually on results of air monitoring.

The Department of Environment Regulation (DER) is responsible for the operation and maintenance of 13 air quality monitoring sites in Western Australia with a total capital cost of \$1.5M. Eight of these sites — Caversham (Ca), Duncraig (Du), Quinns Rocks (QR), Rolling Green (RG), Rockingham (Ro), South Lake (SL), Swanbourne (Sw) and Wattleup (Wt) — are within the Perth Metropolitan Region and the remaining five are located in Albany (Al), Bunbury (Bn), Busselton (Bs), Collie (Co) and Geraldton (Ge).

During 2015 the AAQ NEPM goal was not met for PM₁₀ particles at Duncraig, due to one exceedence caused by local heavy machinery operations, and at Geraldton on two occasions due to unknown causes.

Across all monitoring sites there was a total of 55 exceedences in 2015, comprising four of ozone, 23 of PM₁₀ (including 20 exceptional events) and 28 of PM_{2.5}, (all due to exceptional events).

Of the 48 particle exceedences that were classed as exceptional events and therefore not included in the NEPM goal assessment, 24 were due to bushfires and 24 were due to prescribed burning activities.

The PM_{2.5} goal of no exceedences other than those caused by exceptional events was met.

The ozone, nitrogen dioxide and sulfur dioxide goal of no more than one exceedence was met.

Section A – Monitoring summary

Current monitoring stations

The Department of Environment Regulation (DER) monitoring network shown in Figure A1 was the subject of careful design for the purposes of the Perth Photochemical Smog Study, the Perth Haze Study and the management of sulfur dioxide in the Kwinana area.

The network's design was based on the knowledge of emissions sources, pollutant chemistry and important features of the meteorology.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) Atmospheric Research provided advice on monitoring site locations for the Perth Photochemical Smog Study and Perth Haze Study.

The Bunbury station shown in Figure A2 was established in the south-west of the state to monitor fuel reduction burns, and stations in Busselton and Collie were also in operation for that purpose.

The Geraldton station shown in Figure A3 was established in the mid-west of the state to monitor windblown crustal material and smoke from bushfires, hazard reduction or stubble burning and possibly wood-fired home heaters. A particle monitoring station was also established in Albany (Figure A4). Table A1 indicates the pollutants monitored at each site.

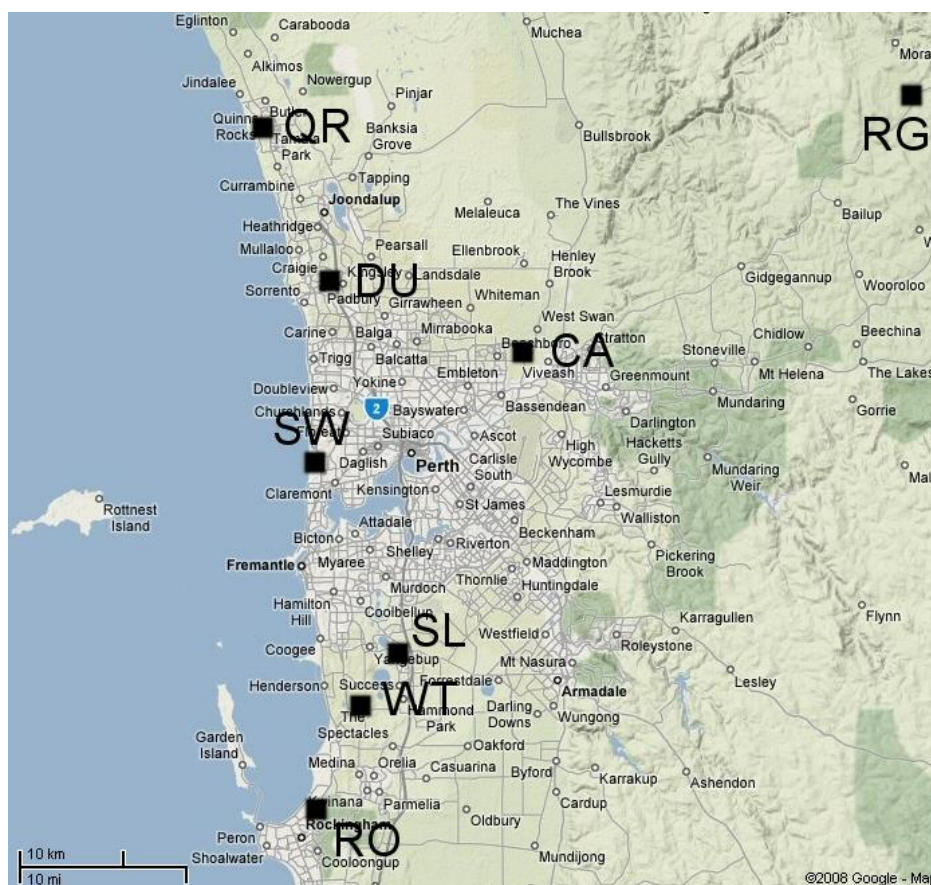


Figure A1: DER air quality monitoring stations operating in the Perth Metropolitan Region.



Figure A2: DER air quality monitoring stations operating in Bunbury, Busselton and Collie.



Figure A3: DER air quality monitoring station operating in Geraldton.

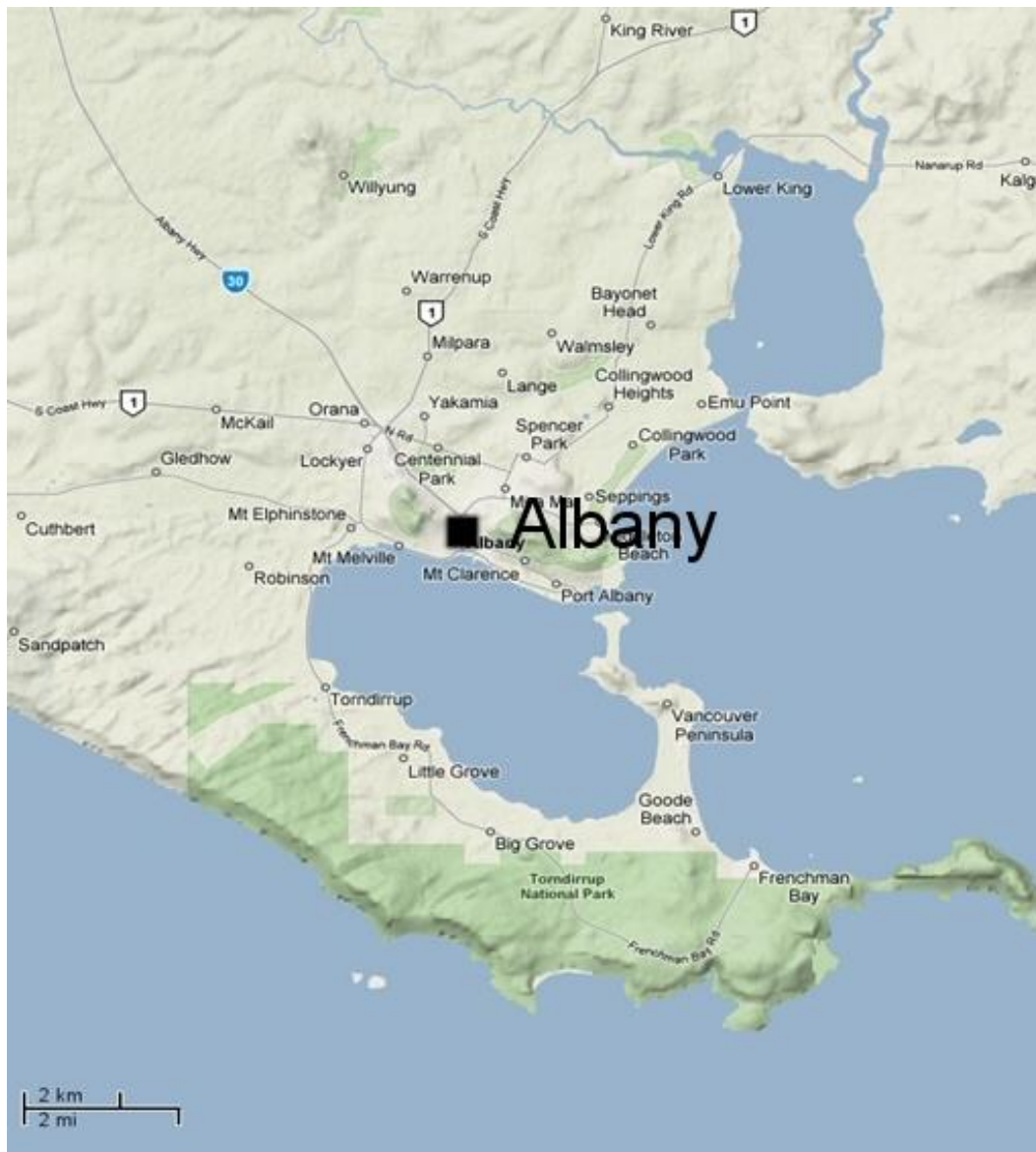


Figure A4: DER air quality monitoring station operating in Albany.

Table A1: Air quality parameters measured at DER monitoring stations.

Monitoring site	CO	O ₃	NO ₂	SO ₂	PM ₁₀ TEOM	PM _{2.5} TEOM
AL Albany					07/06 to present	
BN Bunbury					06/99 to present	04/97 to present
BS Busselton						11/06 to present
CA Caversham	08/93 to present	11/89 to present	09/90 to present		01/04 to present	03/94 to present
CO Collie					02/08 to present	
DU Duncraig	08/95 to present		08/95 to present		06/96 to present	01/95 to present
GE Geraldton					09/05 to present	
QR Quinns Rock		11/92 to present	11/92 to present			07/06 to present
RO Rockingham		12/95 to present	12/95 to present	07/88 to present		
RG Rolling Green		01/93 to present	01/93 to present			
SL South Lake	03/00 to present	03/00 to present	03/00 to present	03/00 to present	03/00 to present	04/06 to present
SW Swanbourne		01/93 to present	03/93 to present			
WT Wattleup				01/88 to present		

DER has from time to time performed campaign monitoring for various projects. While these short-term projects are not reported within this document, detailed reports and/or data can be obtained from www.der.wa.gov.au, by emailing airquality@der.wa.gov.au or telephoning (08) 6467 5000.

Table A2: Methods used to monitor air quality at DER monitoring stations.

Pollutant	Standard	Method
Carbon monoxide	AS/NZS 3580.7.1 2011 – Methods for sampling and analysis of ambient air – Determination of carbon monoxide – Direct-reading instrumental method	Gas filter correlation spectrophotometry
Ozone	AS 3580.6.1 2011 – Methods for sampling and analysis of ambient air – Determination of ozone – Direct-reading instrumental method	Ultraviolet absorption
Nitrogen dioxide	AS 3580.5.1 2011 – Methods for sampling and analysis of ambient air – Determination of oxides of nitrogen – Chemiluminescence method	Chemiluminescence
Sulfur dioxide	AS 3580.4.1 2008 – Methods for sampling and analysis of ambient air – Determination of sulfur dioxide – Direct-reading instrumental method	Ultraviolet fluorescence
Particles as PM ₁₀	AS 3580.9.8 2008 – Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM ₁₀ continuous direct mass method using a tapered element oscillating microbalance analyser	Tapered element oscillating microbalance ¹
Particles as PM _{2.5}	AS/NZS 3580.9.13 2013 – Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM _{2.5} continuous direct mass method using a tapered element oscillating microbalance analyser	Tapered element oscillating microbalance ¹

1: TEOMs within the DER network are not fitted with filter dynamic measurement systems (FDMS).

Table A3: Monitoring in Western Australia.

Site	CO	O ₃	NO ₂	SO ₂	PM ₁₀	PM _{2.5}
AL – Albany					P/T	
BN – Bunbury					P/T	P/T
BS – Busselton						DER
CA – Caversham	DER	P/T	P/T		P/T	P/T
CO - Collie					DER	
DU - Duncraig	P/T		DER		P/T	P/T
GE – Geraldton					P/T	
QR - Quinns Rocks		DER	DER			DER
RG - Rolling Green		DER	DER			
RO - Rockingham		DER	DER	DER		
SL - South Lake	P/T	P/T	P/T	P	P/T	P/T
SW - Swanbourne		P/T	P/T			
WT - Wattleup				DER		

Key to symbols:**P** Performance monitoring station**T** Trend performance monitoring station**DER** Instrument will be maintained by DER for the foreseeable future**Table A4: Standards for pollutants**

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedences (goals)
Carbon monoxide	8 hours	9.0 ppm	1 day a year
Nitrogen dioxide	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	None
Photochemical oxidants (as ozone)	1 hour	0.10 ppm	1 day a year
	4 hours	0.08 ppm	1 day a year
Sulfur dioxide	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	None
Lead	1 year	0.05 µg/m ³	None
Particles as PM ₁₀	1 day	50 µg/m ³	None
	1 year	25 µg/m ³	None
Particles as PM _{2.5}	1 day	25 µg/m ³	None
	1 year	8 µg/m ³	None

Table A5: Monitoring site description

Site	Description
AL – Albany	Large rural town located 380 kilometres south south-west of Perth with moderate density housing and typical local traffic flows.
BN – Bunbury	Large rural town located 145 kilometres south of Perth with moderate density housing and typical local traffic flows.
BS – Busselton	Small rural town located 185 kilometres south of Perth with moderate density housing and typical local traffic flows.
CA – Caversham	Semi-rural north-east metropolitan suburb located in the Swan Valley – a grape growing region next to the Perth foothills – 14 kilometres north-east of the Perth CBD. The region mainly comprises low density housing and paddocks. Some brick manufacturing occurs in the region.
CO – Collie	Small rural town located within a forested region 152 kilometres south of Perth with moderate density housing and typical traffic flows. Coal mining and power generation industries are located within the region.
DU – Duncraig	North metropolitan suburb located 16 kilometres north north-west of the Perth CBD with moderate/high density housing and moderate to high traffic flow. The site is located 200 metres west of the Mitchell freeway, a main north-south arterial road carrying approximately 98,000 vehicles daily.
GE – Geraldton	Large rural town located 377 kilometres north of Perth in the mid-west with moderate density housing and typical traffic flows.
QR – Quinns Rocks	Outer north coastal suburb located 35 kilometres north of Perth with moderate density housing and typical local traffic flows
RG – Rolling Green	Outer east rural suburb located 56 kilometres north-east of Perth with low density rural housing and low traffic flows. The closest road is 80 metres east of the site supporting a traffic flow of 3,200 vehicles per day.
RO – Rockingham	A south coastal site located 35 kilometres south of Perth with moderate density housing and typical traffic flows and adjacent to the southern border of the Kwinana Industrial Area. A major arterial road carrying 34,700 vehicles per day runs 1km east of the site.
SL – South Lake	South east metropolitan site located 17 kilometres south of Perth with moderate/high density housing and moderate to high traffic flow. The site is located 1.6 kilometres west of the Kwinana freeway, a main north-south arterial road carrying approximately 87,000 vehicles daily and is 4 kilometres north-east of the northern border of the Kwinana industrial area.
SW – Swanbourne	An inner coastal site located on coastal sand dunes 9 kilometres west of the Perth CBD, and 150 metres west of a major north-south arterial road carrying approximately 27,200 per day.
WT – Wattleup	A south metro site located 25 kilometres south of Perth within a defined buffer area for the Kwinana Industrial Area. Surrounding land uses are retail outlets and market gardens.

Table A6: Screening procedures used to demonstrate whether pollutants are consistently below standards.

Screening procedures
A. Campaign monitoring at a Generally Representative Upper Bound (GRUB) monitoring location (with no significant deterioration expected over 5–10 years).
B. Use of historical data within a region which will contain one or more GRUB monitoring stations to demonstrate that the full number of stations is not required, either to detect exceedences or gain a more representative depiction of pollutant distribution.
C. Use of modelling within a region which will contain one or more GRUB monitoring stations to demonstrate that the full number of stations is not required, either to detect exceedences or gain a more representative depiction of pollutant distribution.
D. In a region with no performance monitoring, use of validated (1) modelling with detailed and reliable estimates of emissions and meteorological data.
E. In a region with no performance monitoring, and in the absence of emissions and detailed meteorological data, use of generic model results based on gross emissions estimates, 'worst case' meteorology estimates and other conservative assumptions.
F. In a region with no performance monitoring, comparison with a NEPM compliant region with greater population, emissions and pollution potential.
P. Performance monitoring.
T. Trend monitoring.
M. Campaign monitoring.

Table A7: Screening procedures satisfied at each station.

Site	Pop'n ^a	CO	O ₃	NO ₂	SO ₂	Pb	PM ₁₀
Perth and Rockingham	1,740,000				B&C	A	
Mandurah ^b	69,000	P	P	P	F	F	P
Albany	31,000	F	F	F	F	F	
Bunbury	65,000	A&F	E&F	E&F	D&F	F	
Kalgoorlie–Boulder ^c	31,000	M	E&F	E&F	T	F	P
Geraldton	36,000	F	E&F	E&F	D&F	F	

Grey shaded cells represent Performance, Trend or Campaign sites where monitoring is currently underway.

a – 2011 data (www.abs.gov.au)

b – Mandurah station has yet to be established

c – Kalgoorlie station has yet to be established

Details of screening procedures are given in the monitoring plan available at <http://www.scew.gov.au/files/resources/9947318f-af8c-0b24-d928-04e4d3a4b25c/files/aaqprctp04screeningprocedures200705final.pdf>

Table A8: Stations site compliance with AS/NZ 3580.1.1 - 2007

	Height above ground	Min. distance to support structures	Clear sky angle of 120°	Unrestricted airflow of 270°/360°	20m from trees	No extraneous sources nearby	Minimum distance from road or traffic	Sample line material	Sample line length	Comments
Perth region										
Caversham	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Duncraig	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	6 metres to medium sized trees and presence of power pole.
Quinns Rocks	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	15 metres to small to medium size trees. Surrounding area dominated by low scrub.
Rockingham	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	12 metres to trees. Northern vector dominated by grain storage facility.
Rolling Green	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
South Lake	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Swanbourne	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Wattleup	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Southwest region										
Albany	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Bunbury	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	15 metres to small to medium eucalyptus trees.
Busselton	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	5 metres to small to medium eucalyptus trees.
Collie	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Some trees and shipping containers nearby
Midwest region										
Geraldton	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

Carbon monoxide

Duncraig monitoring station is an upper bound site for monitoring the combined effects of emissions from vehicles on the nearby Mitchell Freeway, and from domestic wood fires.

The site is located approximately 200 metres west of the Mitchell freeway, so it is well beyond the distance of roadside measurement. By Perth's standards the site is representative of dense population, and lies in a dunal depression through which the freeway passes, hence the effect of stable air pooling in the depression is likely to lead to elevated concentrations. This feature would be found in many other places across the coastal plain.

South Lake monitoring station lies in a growing urban area and is likely to see moderate levels of CO from wood fires in particular. It is not as close to major roads as the Duncraig site, and is therefore more typical of a population-average site.

Caversham monitoring station is located in a region of low population density and is therefore not considered a performance monitoring station.

In summary, WA maintained performance monitoring of CO at nominated trend stations of Duncraig and South Lake.

Trend analysis for each of these sites shows that overall the maximum of the eight-hourly averages at each site have consistently declined between 0.1 and 0.03 ppm per year as shown in Figure A5.

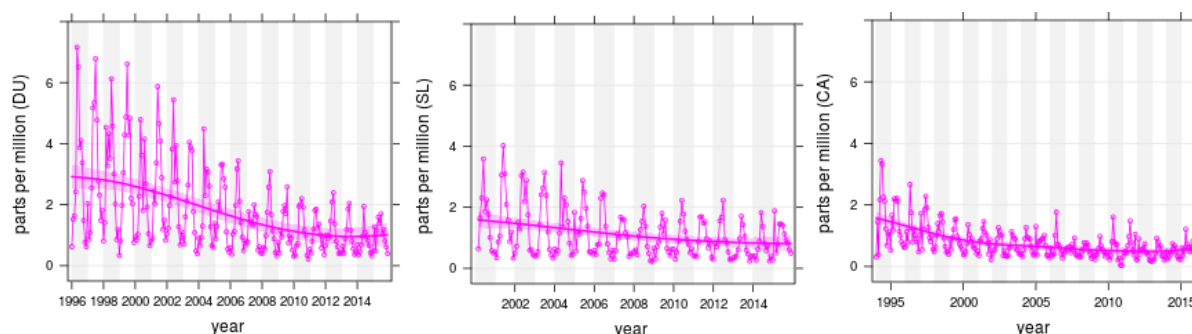


Figure A5: Smoothed trend (dark lines) for CO at Duncraig(left), South Lake (centre) and Caversham (right).

Photochemical oxidants as ozone

Statistics for the coastal sites of Quinns Rocks, Swanbourne and Rockingham indicate there is little difference between each station over the long-term. Swanbourne was selected as a performance monitoring station, while monitoring stations at Quinns Rocks and at or near Rockingham were maintained to provide additional information on ozone events.

Given its location, there is reason to be confident that Caversham monitoring station represents an upper bound, middle distance, inland site. Accordingly, Caversham was selected as a performance monitoring station site.

A third performance monitoring station was located at South Lake. It has the following desirable attributes:

- it provides spatial spread of stations (it will measure ozone returning on shore in the southern part of the metropolitan area);
- it is a moderate distance inland in a growing urban area, hence it is well classed as a population average station; and

- it may occasionally detect the interactions of O₃-rich air with the NO_x-rich plumes from Kwinana industry (potentially giving elevated NO₂ concentrations).

Caversham, Swanbourne and South Lake sites are all nominated as trend stations.

DER will continue to maintain the stations at Rockingham, Quinns Rocks and Rolling Green as part of its wider ozone network to enable a better understanding of ozone events.

Long-term analysis is presented in Figure A6. The number of periods when the one hour ozone concentration exceeded the long-term average at Swanbourne has increased for every five year period with the ratio climbing from 0.46 in 1996–00 to 0.54 in 2011–15.

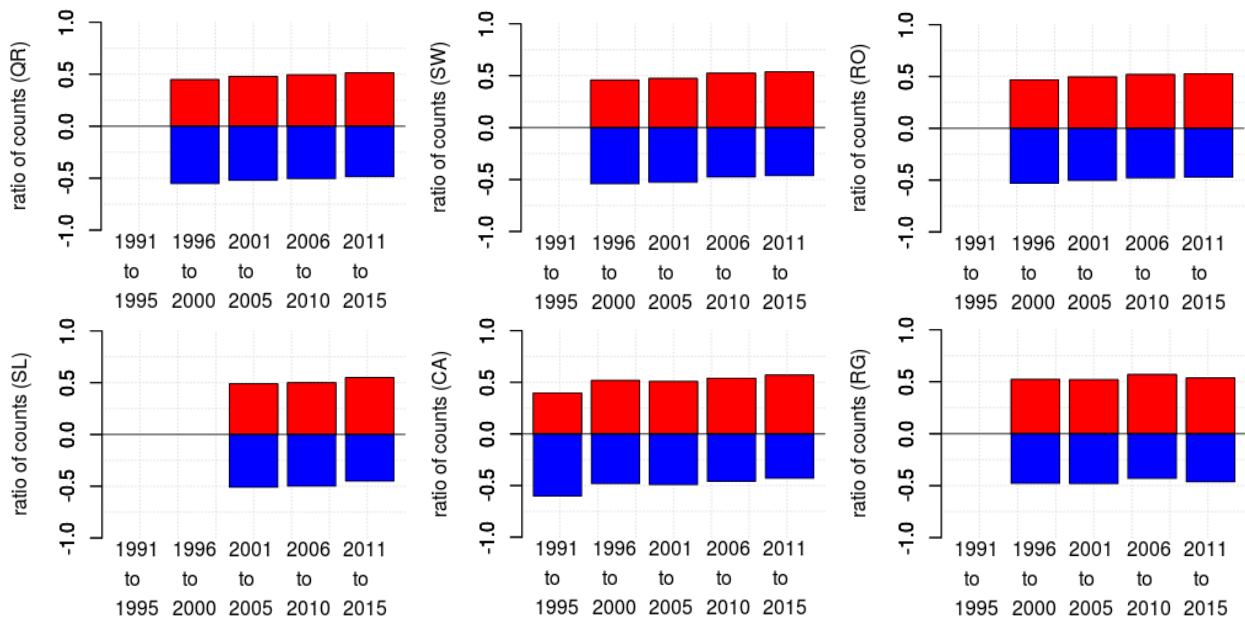


Figure A6: Ratio of the number of hourly averaged ozone concentrations at Quinns Rocks, Swanbourne and Rockingham (top panel) and South Lake, Caversham and Rolling Green (lower panel) that was higher (red) or equal to or lower (blue) than the 20 year average concentration for that site.

A similar pattern is evident at the two other coastal sites of Quinns Rocks and Rockingham. The inland sites of Caversham and Rolling Green have a less distinct pattern. South Lake commenced in February 2000 and therefore cannot be directly compared with the others, but is shown in the figure for completeness.

Nitrogen dioxide

Owing to the close chemical reactivity relationship, NO₂ is currently being monitored at all stations where O₃ is monitored. Caversham, Swanbourne and South Lake sites were chosen as performance monitoring stations for NO₂ as they provided a good spatial distribution.

Caversham, Swanbourne and South Lake sites are also trend stations.

DER will continue to measure NO₂ at Quinns Rocks, Rolling Green and Duncraig as part of its wider network to enable a better understanding of photochemical smog formation.

Figure A7 demonstrates how NO_x (NO + NO₂) monthly means have decreased at all sites. The median of the daily one hour NO maximum has also seen a general decrease over time with Duncraig experiencing an average of 1.9 ppb per annum decrease since 1996.

A possible unintended result of these decreasing concentrations of oxides of nitrogen is the inability to fully suppress ozone formation by (typically) producing NO₂ (NO + O₃ → NO₂ + O₂). The general build-up in O₃ therefore commences earlier (and therefore closer to populated areas) than it otherwise would.

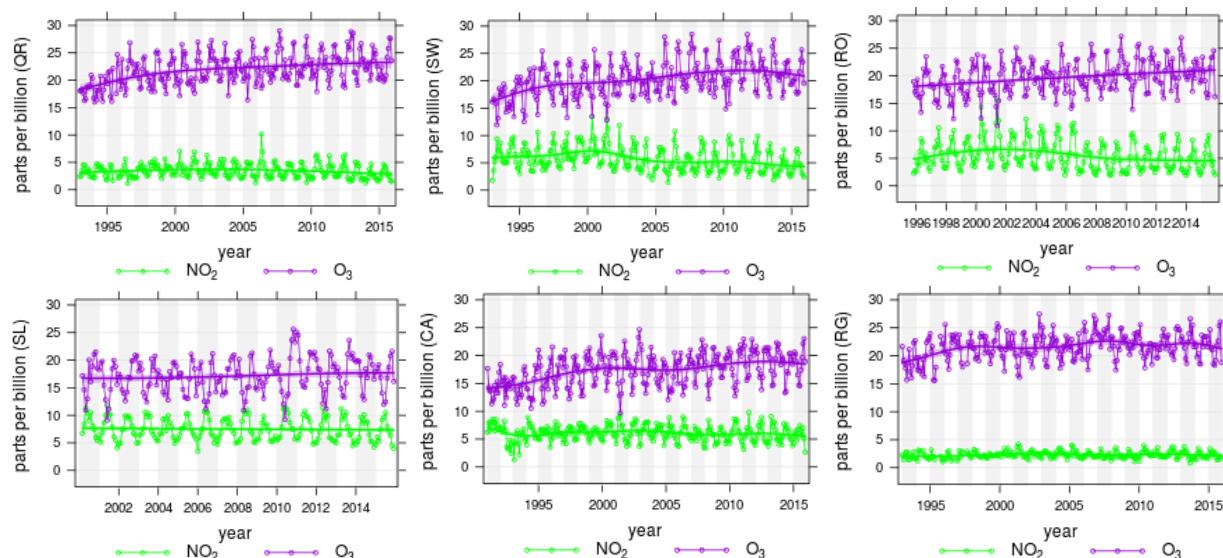


Figure A7: Smoothed trend (dark lines) at Quinns Rocks, Swanbourne and Rockingham (top panel) and South Lake, Caversham and Rolling Green (lower panel) using the monthly mean concentration of NO_x (green) and O₃ (violet).

Sulfur dioxide

DER operates one performance monitoring station at South Lake for sulfur dioxide, while maintaining a source management network which includes Wattleup and Rockingham monitoring stations.

South Lake site is an upper bound performance monitoring station for sulfur dioxide, and a trend station. South Lake is near the southern extent of the main urban population and downwind of Kwinana in sea breeze conditions.

Heavy industries in Kwinana are the only significant sources of sulfur dioxide in the Perth/Kwinana/Rockingham region. Concentrations of sulfur dioxide have reduced markedly since the late 1970's due to the conversion from high to low sulfur fuels and the installation of sulfur dioxide control technologies. Emissions are controlled through conditions of licences issued by the department under Part V of the *Environmental Protection Act 1986* in concert with the *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999* (EPP), to ensure ambient concentrations do not exceed ambient standards set in the EPP.

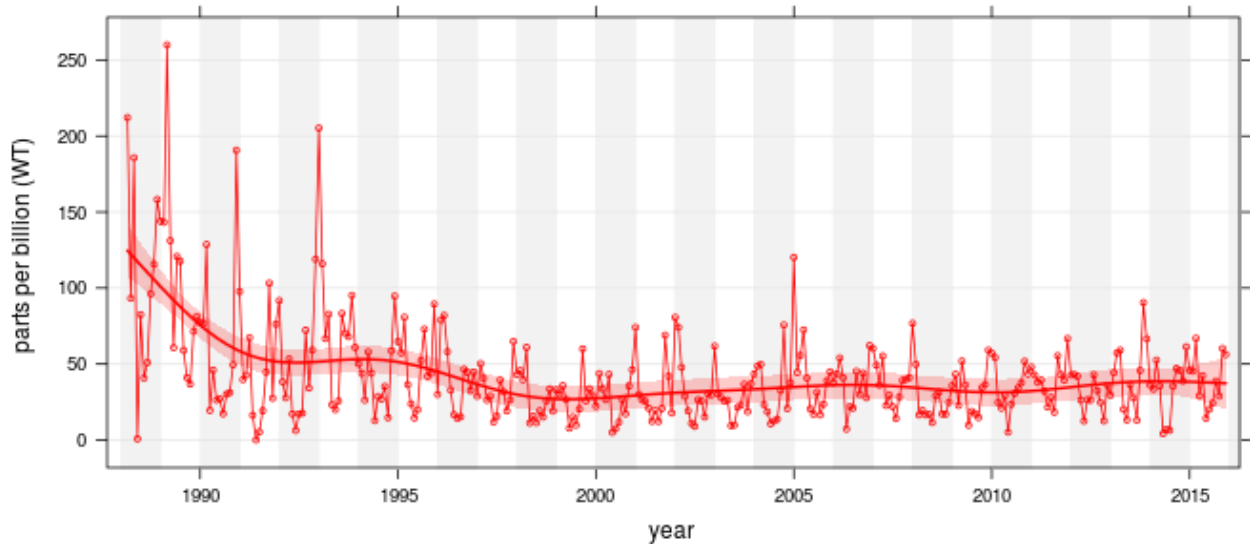


Figure A8: Trend line for maximum hourly averaged sulfur dioxide concentration at Wattleup, located within the Kwinana Industrial Buffer.

Lead

Since 1995, lead levels within the Perth CBD have been below 60 per cent of the 0.5 $\mu\text{g}/\text{m}^3$ annual NEPM standard. In 2001, the average lead level in Perth was 0.022 $\mu\text{g}/\text{m}^3$, less than 5 per cent of the NEPM standard.

In accordance with National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 4, Screening Procedures, and the WA Monitoring Plan, a performance monitoring station for lead has not been maintained since 2001.

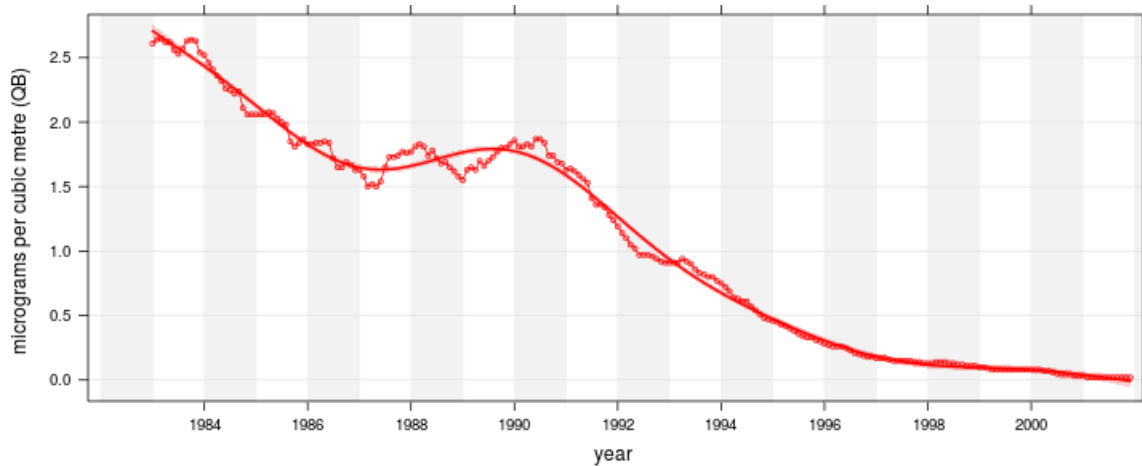


Figure A9: Trend line for annual moving averaged lead concentration within the Perth CBD.

Particles as PM₁₀

Dun Craig site is an upper-bound performance monitoring station site for PM₁₀. High levels of PM₁₀ here are caused by a combination of vehicle and domestic wood heater emissions during strongly stable meteorological conditions.

Likewise, the site at South Lake measures significant PM₁₀ concentrations arising from wood fires.

Dun Craig and South Lake sites are both nominated as trend stations.

Campaign monitoring stations were established at Geraldton in September 2005, Albany in July 2006 and Collie in February 2008.

All Tapered Element Oscillating Microbalances (TEOMs) used by DER are operated continuously and unadjusted for temperature. All TEOM data presented in this report has the manufacturer’s recommended equivalency factor of $1.03x + 3.00$ applied.

A frequency distribution, such as that shown in Figure 10, can indicate how the ratio of $PM_{2.5}:PM_{10}$ differs over three metropolitan sites and also provide some information as to the source of the pollutant. A high ratio of $PM_{2.5}:PM_{10}$ indicates a high proportion of smaller particles and is generally caused by particles originating from smoke or fumes, while a lower ratio of $PM_{2.5}:PM_{10}$ may indicate anthropogenic dust or crustal materials.

The lower (blue) plots in Figure A10 represent periods where the one hour averaged PM_{10} exceeded an arbitrary concentration of $50 \mu g/m^3$. This cut-off was chosen to limit the analysis to those at the higher end of the spectrum. Whereas Duncraig exhibits a higher number of high-ratio events, both Caversham and South Lake display a higher number of low-ratio events. These differences can be explained based on the site locations.

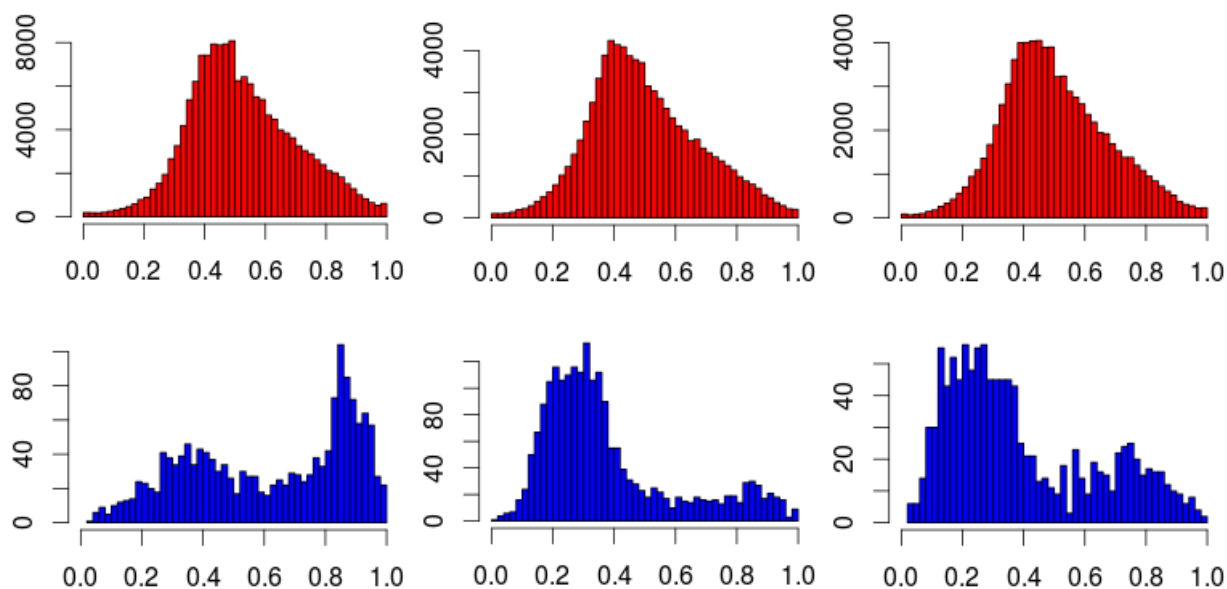


Figure A10: Frequency distribution of $PM_{2.5}:PM_{10}$ ratios of hourly averages at Duncraig (left), South Lake (centre) and Caversham (right) since installation using all data (top) and data where PM_{10} was greater than or equal to $50 \mu g/m^3$ (bottom).

Duncraig is located 3.5 km from the coast within a moderate/high density housing area with no industry close by and will therefore be predominantly influenced by vehicles, sea salt and smoke from the occasional bush fire. One would therefore expect to see a larger proportion of high $PM_{2.5}:PM_{10}$ ratio. Caversham is in a semi-rural setting north-east of Perth CBD and has a number of vine yards and some brick manufacturing close by. These two industries combine to more likely produce coarse fraction particles. South Lake is also located within a moderate/high density housing area and is close to the Kwinana Industrial Area and a cement manufacturing plant, providing more opportunity to be influenced by lower $PM_{2.5}:PM_{10}$ ratios.

Particles as $PM_{2.5}$

To make assessments against the NEPM standard, four $PM_{2.5}$ TEOMs were installed in the greater Perth Metropolitan Area at Quinns Rocks, Caversham, Duncraig and South Lake and one each in Bunbury and Busselton. All will remain in use at these locations indefinitely with the intention of developing trend data.

All Tapered Element Oscillating Microbalances (TEOMs) used by DER are operated continuously (unadjusted for temperature).

All TEOM data presented in this report has the manufacturer's recommended equivalency factor of $1.03x + 3.00$ applied.

Variations to the NEPM

In February 2016, the AAQ NEPM was varied to, among other things:

- provide for a PM_{10} annual standard of $25 \mu\text{g}/\text{m}^3$;
- create two standards for $PM_{2.5}$ of $25 \mu\text{g}/\text{m}^3$ averaged over 24 hours and $8 \mu\text{g}/\text{m}^3$ averaged over one year;
- remove the five allowable exceedences for PM_{10} one day average standards when determining compliance with the NEPM goal; and
- allow for exceptional events when determining compliance for one day PM_{10} and $PM_{2.5}$ with the NEPM goal. An exceptional event means a fire or dust occurrence that adversely affects air quality at a particular location, and causes an exceedence of one 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. For the purpose of reporting compliance against PM_{10} and $PM_{2.5}$ one day average standards, jurisdictions are required to exclude monitoring data that has been determined as being directly associated with an exceptional event. For the purpose of reporting compliance against PM_{10} and $PM_{2.5}$, one year average standards, jurisdictions are required to include all measured data, including monitoring data that is directly associated with an exceptional event.

This report has been prepared to comply with these NEPM reporting requirements.

Exceedence Summary

There were a number of exceedences of O₃, PM_{2.5} and PM₁₀ in 2015. The NEPM goal for particles was not met at Geraldton and Duncraig. Detailed summaries of all exceedences are provided in Attachment 2.

Table A9: Air NEPM standard exceedences recorded during 2015

Site	Pollutant	Concentration ^{1,2}	Date/Time	Event Cause
Albany	PM ₁₀	56.9 µg/m ³	13/11/2015	PB
Albany	PM ₁₀	76.7 µg/m ³	14/11/2015	PB
Bunbury	PM _{2.5}	34.9 µg/m ³	06/02/2015	BF
Bunbury	PM ₁₀	62.9 µg/m ³	10/02/2015	BF
Bunbury	PM _{2.5}	52.1 µg/m ³	10/02/2015	BF
Bunbury	PM _{2.5}	39.9 µg/m ³	24/04/2015	PB
Bunbury	PM _{2.5}	34.8 µg/m ³	09/10/2015	PB
Bunbury	PM _{2.5}	25.4 µg/m ³	10/10/2015	PB
Bunbury	PM _{2.5}	30.6 µg/m ³	11/10/2015	PB
Bunbury	PM ₁₀	50.8 µg/m ³	28/10/2015	PB
Bunbury	PM _{2.5}	44.8 µg/m ³	28/10/2015	PB
Bunbury	PM _{2.5}	35.1 µg/m ³	04/11/2015	PB
Bunbury	PM ₁₀	50.2 µg/m ³	05/11/2015	PB
Bunbury	PM _{2.5}	31.6 µg/m ³	12/11/2015	PB
Busselton	PM _{2.5}	37.8 µg/m ³	07/02/2015	BF
Busselton	PM _{2.5}	35.5 µg/m ³	10/02/2015	BF
Busselton	PM _{2.5}	27.3 µg/m ³	27/11/2015	PB
Busselton	PM _{2.5}	26.4 µg/m ³	28/11/2015	PB
Caversham	PM _{2.5}	27.6 µg/m ³	06/02/2015	BF
Caversham	O ₃	0.103 ppm (1hr av.)	10/02/2015 1400	AS
Caversham	PM _{2.5}	29.7 µg/m ³	10/02/2015	BF
Caversham	O ₃	0.084 ppm (4 hr av.)	10/02/2015 1500	AS
Caversham	PM _{2.5}	28.3 µg/m ³	10/05/2015	PB
Caversham	PM _{2.5}	26.8 µg/m ³	10/10/2015	PB
Caversham	PM _{2.5}	30.0 µg/m ³	23/11/2015	BF
Collie	PM ₁₀	53.9 µg/m ³	03/02/2015	BF
Collie	PM ₁₀	56.1 µg/m ³	06/02/2015	BF
Collie	PM ₁₀	79.4 µg/m ³	09/02/2015	BF
Collie	PM ₁₀	68.5 µg/m ³	10/02/2015	BF
Collie	PM ₁₀	82.7 µg/m ³	22/04/2015	PB
Collie	PM ₁₀	55.7 µg/m ³	26/09/2015	PB
Collie	PM ₁₀	66.6 µg/m ³	08/10/2015	PB
Collie	PM ₁₀	111.9 µg/m ³	10/10/2015	PB
Collie	PM ₁₀	53.7 µg/m ³	13/10/2015	PB
Collie	PM ₁₀	52.2 µg/m ³	22/11/2015	PB
Duncraig	PM _{2.5}	35.8 µg/m ³	06/02/2015	BF

Site	Pollutant	Concentration ^{1,2}	Date/Time	Event Cause
Duncraig	PM _{2.5}	28.2 µg/m ³	10/02/2015	BF
Duncraig	PM _{2.5}	26.2 µg/m ³	10/10/2015	PB
Duncraig	PM ₁₀	82.7 µg/m ³	03/12/2015	AS
Geraldton	PM ₁₀	57.7 µg/m ³	09/01/2015	BF
Geraldton	PM ₁₀	52.5 µg/m ³	08/02/2015	BF
Geraldton	PM ₁₀	68.1 µg/m ³	10/02/2015	BF
Geraldton	PM ₁₀	63.1 µg/m ³	23/02/2015	AS
Geraldton	PM ₁₀	62.3 µg/m ³	24/02/2015	AS
Quinns Rocks	PM _{2.5}	37.9 µg/m ³	06/02/2015	BF
Quinns Rocks	PM _{2.5}	35.8 µg/m ³	10/02/2015	BF
Rolling Green	O ₃	0.105 ppm (1hr av.)	10/02/2015 1600	AS
Rolling Green	O ₃	0.093 ppm (4 hr av.)	10/02/2015 1700	AS
South Lake	PM ₁₀	53.2 µg/m ³	06/02/2015	BF
South Lake	PM _{2.5}	34.5 µg/m ³	06/02/2015	BF
South Lake	PM _{2.5}	28.9 µg/m ³	09/02/2015	BF
South Lake	PM ₁₀	51.0 µg/m ³	10/02/2015	BF
South Lake	PM _{2.5}	30.8 µg/m ³	10/02/2015	BF
South Lake	PM _{2.5}	33.6 µg/m ³	11/05/2015	PB
South Lake	PM _{2.5}	32.9 µg/m ³	14/05/2015	PB

1. All concentrations are 24 hour averages (midnight to midnight) unless otherwise stated.

2. All Tapered Element Oscillating Microbalances (TEOMs) used by DER are operated continuously (unadjusted for temperature) and have the manufacturer's recommended equivalency factor of 1.03x + 3.00 applied. All particle concentrations are displayed as a daily average.

AS Assessable event

BF Bushfire (Exceptional Event)

PB Prescribed burning activities (Exceptional Event)

Section B – Assessment of compliance with standards and goals

Table B1: 2015 compliance summary for carbon monoxide

AAQ NEPM Standard
9.0 ppm (eight-hour average)

Regional Performance Monitoring Station	Data availability rates (% of hours)					Number of exceedences (days)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual		
Perth region							
Caversham (North East Metro)	85.9	95.6	98	96.7	94.1	0	met
Duncraig (North Metro)	99.3	99.8	99.9	99.1	99.5	0	met
South Lake (South East Metro)	98.9	97.1	99.6	98.3	98.5	0	met

Performance against the standards and goal: “met”, “not met”, “not demonstrated”.

Table B2: 2015 compliance summary for nitrogen dioxide

AAQ NEPM Standard
0.12 ppm (one-hour average)
0.03 ppm (one-year average)

Regional Performance Monitoring Station	Data availability rates (% of hours)					Annual mean (ppm)	Number of exceedences (days)	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual			1-hour	1-year
Perth region									
Caversham (North East Metro)	85.9	99	95.9	97.3	94.6	0.006	0	met	met
Duncraig (North Metro)	99.2	96.8	97	99.9	98.2	0.006	0	met	met
Quinns Rocks (Outer North Coast)	99.7	99.1	100	96.4	98.8	0.003	0	met	met
Rockingham (South Coast)	98.5	98.8	99.3	98.7	98.8	0.005	0	met	met
Rolling Green (Outer East Rural)	99.8	100	97.9	94.2	98.0	0.002	0	met	met
South Lake (South East Metro)	98.8	98.2	99.5	98.4	98.7	0.007	0	met	met
Swanbourne (Inner West Coast)	99.9	98.2	99.9	99.8	99.5	0.005	0	met	met

Performance against the standards and goal: “met”, “not met”, “not demonstrated”.

Table B3: 2015 compliance summary for ozone

AAQ NEPM Standard
 0.10 ppm (one-hour average)
 0.08 ppm (four-hour average)

Regional Performance Monitoring Station	Data availability rates (% of hours)					Number of exceedences (days)		Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual	1-hour	4-hour	1-hour	4-hour
Perth region									
Caversham (North East Metro)	85.9	99	99	97.3	95.4	1	1	met	met
Quinns Rocks (Outer North Coast)	99.9	99.4	100	96.4	98.9	0	0	met	met
Rockingham (South Coast)	99.2	98.9	99.4	98.3	98.9	0	0	met	met
Rolling Green (Outer East Rural)	99.4	100	98.1	99.5	99.2	1	1	met	met
South Lake (South East Metro)	98.8	98.3	99.5	98.4	98.8	0	0	met	met
Swanbourne (Inner West Coast)	99.9	99.9	100	99.8	99.9	0	0	met	met

Performance against the standards and goal: "met", "not met", "not demonstrated".

Table B4: 2015 compliance summary for sulfur dioxide

AAQ NEPM Standard
 0.20 ppm (one-hour average)
 0.08 ppm (24-hour average)
 0.02 ppm (one-year average)

Regional Performance Monitoring Station	Data availability rates (% of hours)					Annual mean (ppm)	Number of exceedences (days)		Performance against the standards and goal		
	Q1	Q2	Q3	Q4	Annual		1-hour	24-hour	1-hour	24-hour	1-year
Perth region											
Rockingham (South Coast)	95.7	93.4	94.1	95.2	94.6	0.001	0	0	met	met	met
South Lake (South East Metro)	94.7	95.7	96.4	95.4	95.5	0.002	0	0	met	met	met
Wattleup (South Metro)	95.7	92.5	97.1	97.0	95.6	0.002	0	0	met	met	met

Performance against the standards and goal: "met", "not met", "not demonstrated".

Table B5: 2015 compliance summary for particles as PM₁₀

AAQ NEPM Standard
 50 µg/m³ (24-hour average)
 25 µg/m³ (annual average)

Regional Performance Monitoring Station	Data availability rates (% of days)					Number of exceedences (days)	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual		24-hour	annual
Perth region								
Caversham (North East Metro)	87.7	98.8	99.2	97.1	95.7	0	met	met
Duncraig (North Metro)	98.8	99.8	99.7	99.5	99.4	1	not met	met
South Lake (South East Metro)	98.7	98.1	94.9	98.1	97.4	2	met	met
Southwest region								
Albany	99.7	99.9	97.2	99.5	99.1	2	met	met
Bunbury	99.5	99.5	99.8	99.8	99.7	3	met	met
Collie	98.4	99.6	98.7	99.3	99.0	10	met	met
Midwest region								
Geraldton	96.5	99.9	99.6	99.7	98.9	5	not met	met

Performance against the standards and goal: "met", "not met", "not demonstrated".

Table B6: 2015 compliance summary for particles as PM_{2.5}

AAQ NEPM Standard
 25 µg/m³ (24-hour average)
 8 µg/m³ (annual average)

Regional Performance Monitoring Station	Data availability rates (% of days)					Number of exceedences (Days)	Performance against the standards and goal	
	Q1	Q2	Q3	Q4	Annual		24-hour	annual
Perth region								
Caversham (North East Metro)	87.9	98.9	99	97.2	95.8	5	met	met
Duncraig (North Metro)	99.1	99.9	99.8	99.9	99.6	3	met	met
Quinns Rocks (Outer North Coast)	99.7	99.6	100	96.2	98.9	2	met	met
South Lake (South East Metro)	98.7	96.1	94.9	98.2	97.0	5	met	met
Southwest region								
Bunbury	98.7	99.6	92.7	99.5	97.6	9	met	met
Busselton	99.6	99.7	99.6	97.5	99.1	4	met	met

Section C – Analysis of air quality monitoring

Carbon monoxide

The NEPM standard for carbon monoxide of 9.0 ppm averaged over eight hours was not exceeded at any site during 2015. The NEPM goal of no more than one exceedence at each site was met. Table C1 contains the summary statistics for daily peak eight-hour CO in Western Australia.

Table C1: 2015 summary statistics for daily peak eight-hour carbon monoxide

*AAQ NEPM Standard
9.0 ppm (eight-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest (ppm)	2nd highest	
			(date)	(time)		(date)	(time)
Perth region							
Caversham (North East Metro)	94.1	1.2	05/05/2015	1000	0.9	09/05/2015	0900
Duncraig (North Metro)	99.5	1.7	04/07/2015	0500	1.6	23/05/2015	0700
South Lake (South East Metro)	98.5	1.9	02/02/2015	0700	1.5	15/05/2015	0100

Nitrogen dioxide

The NEPM standard for nitrogen dioxide of 0.12 ppm averaged over one hour and the 0.03 ppm annual average were not exceeded at any site during 2015. The NEPM goal of no more than one exceedence at each site was met. Table C2 contains the summary statistics for daily peak one-hour NO₂ in Western Australia.

Table C2: 2015 summary statistics for daily peak one-hour nitrogen dioxide

*AAQ NEPM Standard
0.12 ppm (one-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Highest (ppm)	Highest (date)	Highest (time)	2nd highest (ppm)	2nd highest (date)	2nd highest (time)
Perth region							
Caversham (North East Metro)	94.6	0.041	12/03/2015	2000	0.038	01/10/2015	2000
Duncraig (North Metro)	98.2	0.036	13/03/2015	1900	0.036	23/09/2015	2000
Quinns Rocks (Outer North Coast)	98.8	0.030	07/09/2015	2100	0.029	01/10/2015	2000
Rockingham (South Coast)	98.8	0.062	09/04/2015	2400	0.043	04/06/2015	2200
Rolling Green (Outer East Rural)	98.0	0.023	05/01/2015	2200	0.023	02/02/2015	2100
South Lake (South East Metro)	98.7	0.043	23/09/2015	2100	0.037	22/04/2015	2200
Swanbourne (Inner West Coast)	99.5	0.036	15/08/2015	2200	0.035	28/04/2015	1900

Photochemical smog as ozone

The NEPM standard for ozone of 0.10 ppm averaged over one hour was exceeded twice during 2015. The NEPM goal of no more than one exceedence at each site was met. Table C3 contains the summary statistics for daily peak one-hour O₃ in Western Australia.

Table C3: 2015 summary statistics for daily peak one-hour ozone

*AAQ NEPM Standard
0.10 ppm (one-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Highest (ppm)	Highest (date)	Highest (time)	2nd highest (ppm)	2nd highest (date)	2nd highest (time)
Perth region							
Caversham (North East Metro)	95.4	0.103	10/02/2015	1400	0.086	18/02/2015	1300
Quinns Rocks (Outer North Coast)	98.9	0.083	22/12/2015	1300	0.079	10/02/2015	1200
Rockingham (South Coast)	98.9	0.069	14/11/2015	1300	0.065	05/01/2015	1300
Rolling Green (Outer East Rural)	99.2	0.105	10/02/2015	1600	0.089	19/02/2015	1600
South Lake (South East Metro)	98.8	0.067	05/01/2015	1500	0.066	28/01/2015	1400
Swanbourne (Inner West Coast)	99.9	0.074	12/10/2015	1700	0.073	27/01/2015	1500

Bold numerals indicate where a relevant standard has been exceeded.

The NEPM standard for ozone of 0.08 ppm averaged over four hours was exceeded twice during 2015. The NEPM goal of no more than one exceedence at each site was met. Table C4 contains the summary statistics for daily peak four-hour O₃ in Western Australia.

Table C4: 2015 summary statistics for daily peak four-hour ozone

*AAQ NEPM Standard
0.08 ppm (four-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Highest (ppm)	Highest (date) (time)		2nd highest (ppm)	2nd highest (date) (time)	
Perth region							
Caversham (North East Metro)	95.4	0.084	10/02/2015	1500	0.074	20/01/2015	1800
Quinns Rocks (Outer North Coast)	98.9	0.071	22/12/2015	1400	0.067	28/12/2015	1500
Rockingham (South Coast)	98.9	0.064	14/11/2015	1500	0.062	05/01/2015	1600
Rolling Green (Outer East Rural)	99.2	0.093	10/02/2015	1700	0.070	19/02/2015	1800
South Lake (South East Metro)	98.8	0.060	28/01/2015	1500	0.060	08/02/2015	1600
Swanbourne (Inner West Coast)	99.9	0.067	12/10/2015	1800	0.063	27/01/2015	1600

Bold numerals indicate where a relevant standard has been exceeded.

Sulfur dioxide

The NEPM standard for sulfur dioxide of 0.20 ppm averaged over one hour was not exceeded at any site during 2015. The NEPM goal of no more than one exceedance at each site was met. Table C5 contains the summary statistics for daily peak one-hour SO₂ in Western Australia.

Table C5: 2015 summary statistics for daily peak one-hour sulfur dioxide

*AAQ NEPM Standard
0.20 ppm (one-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest (ppm)	2nd highest	
			(date)	(time)		(date)	(time)
Perth region							
Rockingham (South Coast)	94.6	0.051	16/05/2015	0200	0.039	02/06/2015	0100
South Lake (South East Metro)	95.5	0.037	08/02/2015	2000	0.036	10/03/2015	1600
Wattleup (South Metro)	95.6	0.067	09/03/2015	1600	0.060	16/11/2015	1700

The NEPM standard for sulfur dioxide of 0.08 ppm averaged over 24 hours was not exceeded at any site during 2015. The NEPM goal of no more than one exceedance at each site was met. Table C6 contains the summary statistics for daily peak 24-hour SO₂ in Western Australia.

Table C6: 2015 summary statistics for 24-hour sulfur dioxide

*AAQ NEPM Standard
0.08 ppm (24-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Highest (ppm)	Highest		2nd highest (ppm)	2nd highest	
			(date)	(time)		(date)	(time)
Perth region							
Rockingham (South Coast)	94.6	0.013	16/05/2015	2400	0.011	01/06/2015	2400
South Lake (South East Metro)	95.5	0.007	13/01/2015	2400	0.007	10/03/2015	2400
Wattleup (South Metro)	95.6	0.009	09/03/2015	2400	0.007	17/12/2015	2400

The NEPM standard for sulfur dioxide of 0.02 ppm averaged over one year was not exceeded at any site during 2015. Table C7 contains the summary statistics for annual SO₂ in Western Australia.

Table C7: 2015 summary statistics for annual sulfur dioxide

*AAQ NEPM Standard
0.02 ppm (annual average)*

Regional Performance Monitoring Station	Data availability rates (%)	Annual average (ppm)
Perth region		
Rockingham (South Coast)	93.9	0.001
South Lake (South East Metro)	94.5	0.002
Wattleup (South Metro)	95.1	0.002

Particles as PM₁₀

The NEPM standard for particles as PM₁₀ of 50 µg/m³ averaged over 24 hours was exceeded a number of times as detailed in Table A9 during 2015. The NEPM goal was not met at Duncraig and Geraldton. Table C8 contains the summary statistics for daily peak 24-hour PM₁₀ in Western Australia.

Table C8: 2015 summary statistics for 24-hour particles as PM₁₀

AAQ NEPM Standard
50 µg/m³ (24-hour average)

Regional Performance Monitoring Station	Data availability rates (%)	Highest (µg/m ³)	Highest (date) (time)	6 th Highest (µg/m ³)	6 th Highest (date) (time)
Perth region					
Caversham ¹ (North East Metro)	95.7	46.8	23/11/2015 2400	39.9	10/10/2015 2400
Duncraig ¹ (North Metro)	99.4	82.7	03/12/2015 2400	37.8	23/11/2015 2400
South Lake ¹ (South East Metro)	97.4	53.3	06/02/2015 2400	43.0	14/05/2015 2400
Southwest region					
Albany ¹	99.1	76.7	14/11/2015 2400	36.6	06/01/2015 2400
Bunbury ¹	99.7	62.9	10/02/2015 2400	42.8	06/02/2015 2400
Collie ¹	99.0	111.9	10/10/2015 2400	56.2	06/02/2015 2400
Midwest region					
Geraldton ¹	98.9	68.1	10/02/2015 2400	47.6	06/02/2015 2400

1. Tapered Element Oscillating Microbalance (TEOM) operating continuously (unadjusted for temperature) and includes the manufacturer's recommended equivalency factor of 1.03x + 3.00.

Bold numerals indicate where a relevant standard has been exceeded.

The NEPM standard for particles as PM₁₀ of 25 micrograms per cubic metre averaged over one year was met at all sites during 2015. Table C8a contains the summary statistics for annual PM_{2.5} in Western Australia.

Table C8a: 2015 summary statistics for annual particles as PM₁₀

*AAQ NEPM Standard
25 µg/m³ (annual average)*

Regional Performance Monitoring Station	Data availability rates (%)	Annual average (µg/m ³)
Perth region		
Caversham ¹ (North East Metro)	95.7	16.7
Duncraig ¹ (North Metro)	99.4	16.5
South Lake ¹ (South East Metro)	97.4	17.9
Southwest region		
Albany ¹	99.1	15.8
Bunbury ¹	99.7	17.5
Collie ¹	99.0	22.4
Midwest region		
Geraldton ¹	98.9	20.2

1. Tapered Element Oscillating Microbalance (TEOM) operating continuously (unadjusted for temperature) and includes the manufacturers recommended equivalency factor of 1.03x + 3.00.

Particles as PM_{2.5}

The NEPM standard for particles as PM_{2.5} of 25 micrograms per cubic metre averaged over 24 hours was exceeded a number of times as detailed in Table A9 during 2015. The NEPM goal was met at all sites. Table C9 contains the summary statistics for daily peak 24-hour PM_{2.5} in Western Australia.

Table C9: 2015 summary statistics for 24-hour particles as PM_{2.5}

*AAQ NEPM Standard
25 µg/m³ (24-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Highest (µg/m ³)	Highest		6 th highest (µg/m ³)	6th highest	
			(date)	(time)		(date)	(time)
Perth region							
Caversham ¹ (North East Metro)	95.8	30.0	23/11/2015	2400	24.5	09/05/2015	2400
Duncraig ¹ (North Metro)	99.6	35.8	06/02/2015	2400	21.6	23/11/2015	2400
Quinns Rocks ¹ (Outer North Coast)	98.9	37.9	06/02/2015	2400	21.6	11/11/2015	2400
South Lake ¹ (South East Metro)	97.0	34.5	06/02/2015	2400	24.2	10/10/2015	2400
Southwest region							
Bunbury ¹	97.6	52.1	10/02/2015	2400	34.8	09/10/2015	2400
Busselton ¹	99.1	37.8	07/02/2015	2400	22.4	04/02/2015	2400

1. Tapered Element Oscillating Microbalance (TEOM) operating continuously (unadjusted for temperature) and includes the manufacturer's recommended equivalency factor of 1.03x + 3.00.

Bold numerals indicate where a relevant standard has been exceeded.

The NEPM standard for particles as PM_{2.5} of 8 micrograms per cubic metre averaged over one year was not met at all sites during 2015. Table C10 contains the summary statistics for annual PM_{2.5} in Western Australia.

Table C10: 2015 summary statistics for annual particles as PM_{2.5}

*AAQ NEPM Standard
8 µg/m³ (annual average)*

Regional Performance Monitoring Station	Data availability rates (%)	Annual average (µg/m ³)
Perth region		
Caversham ¹ (North East Metro)	95.8	8.5
Duncraig ¹ (North Metro)	99.6	8.4
Quinns Rocks ¹ (Outer North Coast)	98.9	8.3
South Lake ¹ (South East Metro)	97.0	8.8
Southwest region		
Bunbury ¹	97.6	9.3
Busselton ¹	99.1	8.6

1. Tapered Element Oscillating Microbalance (TEOM) operating continuously (unadjusted for temperature) and includes the manufacturer's recommended equivalency factor of 1.03x + 3.00.

Bold numerals indicate where a relevant standard has been exceeded.

Section D – Data analysis

Maxima and percentiles by pollutant in 2015

Table D1: 2015 percentiles of daily peak eight-hour carbon monoxide concentrations

*AAQ NEPM Standard
9.0 ppm (eight-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Caversham (North East Metro)	94.1	1.2	0.8	0.7	0.6	0.5	0.3	0.2
Duncraig (North Metro)	99.5	1.7	1.4	1.3	1.0	0.7	0.5	0.3
South Lake (South East Metro)	98.5	1.9	1.3	1.2	0.9	0.8	0.5	0.3

Table D2: 2015 percentiles of daily peak one-hour nitrogen dioxide concentrations

*AAQ NEPM Standard
0.12 ppm (one-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Caversham (North East Metro)	94.6	0.041	0.035	0.032	0.027	0.025	0.020	0.014
Duncraig (North Metro)	98.2	0.036	0.034	0.032	0.028	0.026	0.021	0.016
Quinns Rocks (Outer North Coast)	98.8	0.030	0.028	0.026	0.024	0.020	0.013	0.009
Rockingham (South Coast)	98.8	0.062	0.032	0.029	0.026	0.023	0.018	0.012
Rolling Green (Outer East Rural)	98.0	0.023	0.018	0.017	0.016	0.013	0.010	0.006
South Lake (South East Metro)	98.7	0.043	0.034	0.031	0.028	0.026	0.022	0.016
Swanbourne (Inner West Coast)	99.5	0.036	0.034	0.030	0.027	0.023	0.017	0.012

Table D3: 2015 percentiles of daily peak one-hour ozone concentrations

*AAQ NEPM Standard
0.10 ppm (one-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Caversham (North East Metro)	95.4	0.103	0.080	0.077	0.062	0.052	0.037	0.030
Quinns Rocks (Outer North Coast)	98.9	0.083	0.070	0.064	0.057	0.049	0.038	0.032
Rockingham (South Coast)	98.9	0.069	0.062	0.061	0.052	0.045	0.035	0.030
Rolling Green (Outer East Rural)	99.2	0.105	0.078	0.073	0.062	0.055	0.039	0.031
South Lake (South East Metro)	98.8	0.067	0.063	0.060	0.051	0.042	0.033	0.028
Swanbourne (Inner West Coast)	99.9	0.074	0.066	0.061	0.056	0.044	0.035	0.030

Bold numerals indicate where a relevant standard has been exceeded.

Table D4: 2015 percentiles of daily peak four-hour ozone concentrations

*AAQ NEPM Standard
0.08 ppm (four-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Caversham (North East Metro)	95.4	0.084	0.070	0.067	0.054	0.046	0.034	0.029
Quinns Rocks (Outer North Coast)	98.9	0.071	0.063	0.059	0.053	0.042	0.035	0.031
Rockingham (South Coast)	98.9	0.064	0.056	0.055	0.047	0.041	0.034	0.029
Rolling Green (Outer East Rural)	99.2	0.093	0.068	0.063	0.054	0.049	0.036	0.030
South Lake (South East Metro)	98.8	0.060	0.055	0.053	0.045	0.037	0.031	0.027
Swanbourne (Inner West Coast)	99.9	0.067	0.058	0.056	0.049	0.039	0.033	0.029

Bold numerals indicate where a relevant standard has been exceeded.

Table D5: 2015 percentiles of daily peak one-hour sulfur dioxide concentrations

*AAQ NEPM Standard
0.20 ppm (one-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Rockingham (South Coast)	94.6	0.051	0.033	0.023	0.018	0.012	0.005	0.002
South Lake (South East Metro)	95.5	0.037	0.031	0.029	0.020	0.016	0.008	0.004
Wattleup (South Metro)	95.6	0.067	0.046	0.045	0.039	0.031	0.019	0.006

Table D6: 2015 percentiles of daily peak 24-hour sulfur dioxide concentrations

*AAQ NEPM Standard
0.08 ppm (24-hour average)*

Regional Performance Monitoring Station	Data availability rates (%)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)	75th percentile (ppm)	50th percentile (ppm)
Perth region								
Rockingham (South Coast)	94.6	0.013	0.007	0.006	0.004	0.003	0.002	0.001
South Lake (South East Metro)	95.5	0.007	0.006	0.005	0.005	0.004	0.003	0.002
Wattleup (South Metro)	95.6	0.009	0.007	0.006	0.006	0.005	0.003	0.002

Table D7: 2015 percentiles of daily peak 24-hour particles as PM₁₀ concentrationsAAQ NEPM Standard
50 µg/m³ (24-hour average)

Regional Performance Monitoring Station	Data availability rates (%)	Max conc. (µg/m ³)	99 th percentile (µg/m ³)	98 th percentile (µg/m ³)	95 th percentile (µg/m ³)	90 th percentile (µg/m ³)	75 th percentile (µg/m ³)	50 th percentile (µg/m ³)
Perth region								
Caversham (North East Metro)	95.7	46.8	40.7	37.4	30.4	26.3	20.2	15.3
Duncraig (North Metro)	99.4	82.7	40.1	36.7	28.0	25.2	20.2	15.0
South Lake (South East Metro)	97.4	53.3	45.7	41.7	34.4	28.5	21.9	15.6
Southwest region								
Albany	99.1	76.7	37.3	34.7	28.4	24.5	19.4	14.4
Bunbury	99.7	62.9	48.6	40.6	35.6	27.2	20.9	15.3
Collie	99.0	111.9	67.4	53.9	41.9	37.8	26.4	20.1
Midwest region								
Geraldton	98.9	68.1	54.5	44.4	39.8	35.2	26.2	17.5

Bold numerals indicate where a relevant standard has been exceeded.

Table D8: 2015 percentiles of daily peak 24-hour particles as PM_{2.5} concentrationsAAQ NEPM Standard
25 µg/m³ (24-hour average)

Regional Performance Monitoring Station	Data availability rates (%)	Max conc. (µg/m ³)	99 th percentile (µg/m ³)	98 th percentile (µg/m ³)	95 th percentile (µg/m ³)	90 th percentile (µg/m ³)	75 th percentile (µg/m ³)	50 th percentile (µg/m ³)
Perth region								
Caversham (North East Metro)	95.8	30.0	27.2	22.4	16.1	12.8	10.3	7.3
Duncraig (North Metro)	99.6	35.8	22.9	18.3	15.2	12.9	9.9	7.6
Quinns Rocks (Outer North Coast)	98.9	37.9	22.2	20.9	14.8	12.4	9.7	7.4
South Lake (South East Metro)	97.0	34.5	29.8	22.8	17.0	13.4	10.5	7.6
Southwest region								
Bunbury	97.6	52.1	35.0	30.2	20.2	14.4	9.9	7.6
Busselton	99.1	37.8	24.4	21.3	18.6	13.9	9.6	7.2

Bold numerals indicate where a relevant standard has been exceeded.

Maxima and percentiles by site 2006–2015

Table D9: Daily peak eight-hour carbon monoxide at Caversham (2006–2015)
Trend station/region: Caversham

 AAQ NEPM Standard
 9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.7	0	1.8	0.9	0.9	0.6	0.5
2007	98.2	0	0.9	0.6	0.6	0.5	0.4
2008	99.5	0	0.8	0.7	0.7	0.6	0.5
2009	99.2	0	1.0	0.6	0.5	0.4	0.4
2010	85.0	0	1.6	0.8	0.7	0.6	0.5
2011	98.2	0	1.5	1.2	1.0	0.6	0.5
2012	98.0	0	0.9	0.7	0.6	0.5	0.4
2013	97.5	0	0.9	0.7	0.6	0.5	0.4
2014	96.1	0	0.7	0.7	0.6	0.5	0.4
2015	94.1	0	1.2	0.8	0.7	0.6	0.5

Table D10: Daily peak eight-hour carbon monoxide at Duncraig (2006–2015)
Trend station/region: Duncraig

 AAQ NEPM Standard
 9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.3	0	3.4	2.8	2.3	1.8	1.3
2007	99.5	0	2.0	1.6	1.4	1.2	0.8
2008	99.0	0	3.1	1.9	1.7	1.4	1.0
2009	98.2	0	2.6	1.7	1.4	1.0	0.7
2010	87.5	0	2.3	2.0	1.8	1.5	1.1
2011	99.3	0	1.9	1.3	1.2	1.0	0.7
2012	99.5	0	2.4	1.9	1.5	1.1	0.9
2013	99.5	0	2.1	1.8	1.6	1.2	0.8
2014	99.7	0	1.9	1.4	1.0	0.8	0.7
2015	99.5	0	1.7	1.4	1.3	1.0	0.7

Table D11: Daily peak eight-hour carbon monoxide at South Lake (2006–2015)
Trend station/region: South Lake

 AAQ NEPM Standard
 9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.6	0	2.5	2.4	2.2	1.6	1.0
2007	99.3	0	1.7	1.4	1.2	1.0	0.8
2008	99.6	0	2.0	1.6	1.4	1.2	0.9
2009	99.3	0	1.8	1.4	1.1	0.9	0.7
2010	87.8	0	2.2	1.6	1.5	1.2	0.9
2011	98.3	0	1.7	1.5	1.3	1.0	0.8
2012	98.9	0	2.2	1.6	1.4	1.0	0.8
2013	98.5	0	1.7	1.3	1.2	1.0	0.6
2014	99.5	0	1.8	1.4	1.0	0.8	0.7
2015	98.5	0	1.9	1.3	1.2	0.9	0.8

Table D12: Daily peak one-hour nitrogen dioxide at Caversham (2006–2015)
Trend station/region: Caversham

 AAQ NEPM Standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.3	0	0.084	0.037	0.034	0.031	0.028
2007	98.5	0	0.044	0.037	0.033	0.028	0.026
2008	99.5	0	0.036	0.033	0.032	0.028	0.026
2009	99.3	0	0.044	0.034	0.033	0.028	0.026
2010	84.9	0	0.054	0.040	0.037	0.032	0.029
2011	99.5	0	0.035	0.031	0.029	0.027	0.025
2012	97.0	0	0.037	0.033	0.032	0.029	0.025
2013	97.5	0	0.043	0.034	0.032	0.029	0.025
2014	94.2	0	0.033	0.031	0.030	0.026	0.024
2015	94.6	0	0.041	0.035	0.032	0.027	0.025

Table D13: Daily peak one-hour nitrogen dioxide at Duncraig (2006–2015)
Trend station/region: Duncraig

 AAQ NEPM Standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.5	0	0.056	0.037	0.036	0.032	0.030
2007	99.6	0	0.053	0.034	0.032	0.030	0.028
2008	97.7	0	0.038	0.034	0.030	0.029	0.027
2009	98.5	0	0.042	0.037	0.034	0.030	0.027
2010	87.5	0	0.038	0.035	0.033	0.030	0.028
2011	99.3	0	0.035	0.032	0.030	0.028	0.027
2012	96.8	0	0.047	0.037	0.033	0.030	0.027
2013	97.9	0	0.040	0.031	0.030	0.028	0.026
2014	99.3	0	0.048	0.029	0.028	0.026	0.024
2015	98.2	0	0.036	0.034	0.032	0.028	0.026

Table D14: Daily peak one-hour nitrogen dioxide at Quinns Rocks (2006–2015)
Trend station/region: Quinns Rocks

 AAQ NEPM Standard
 0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	96.9	0	0.065	0.051	0.042	0.035	0.029
2007	99.5	0	0.035	0.031	0.029	0.028	0.025
2008	96.1	0	0.037	0.033	0.032	0.028	0.025
2009	99.0	0	0.034	0.032	0.031	0.027	0.024
2010	88.8	0	0.040	0.032	0.032	0.030	0.027
2011	99.0	0	0.031	0.028	0.027	0.025	0.022
2012	97.3	0	0.041	0.032	0.031	0.027	0.024
2013	97.9	0	0.032	0.026	0.026	0.023	0.020
2014	99.6	0	0.031	0.026	0.024	0.020	0.017
2015	98.8	0	0.030	0.028	0.026	0.024	0.020

Table D15: Daily peak one-hour nitrogen dioxide at Rockingham (2006–2015)

Trend station/region: RockinghamAAQ NEPM Standard
0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.9	0	0.054	0.040	0.036	0.034	0.031
2007	99.4	0	0.040	0.034	0.030	0.028	0.025
2008	99.3	0	0.031	0.028	0.027	0.025	0.024
2009	98.6	0	0.031	0.029	0.028	0.026	0.024
2010	88.7	0	0.036	0.032	0.030	0.028	0.026
2011	96.6	0	0.034	0.028	0.027	0.025	0.022
2012	96.4	0	0.053	0.030	0.030	0.027	0.024
2013	97.8	0	0.035	0.031	0.029	0.027	0.025
2014	98.7	0	0.034	0.027	0.026	0.024	0.021
2015	98.8	0	0.062	0.032	0.029	0.026	0.023

Table D16: Daily peak one-hour nitrogen dioxide at Rolling Green (2006–2015)**Trend station/region: Rolling Green**AAQ NEPM Standard
0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.0	0	0.026	0.020	0.019	0.017	0.015
2007	98.8	0	0.020	0.019	0.018	0.016	0.014
2008	99.3	0	0.023	0.020	0.019	0.016	0.015
2009	99.5	0	0.035	0.023	0.019	0.017	0.015
2010	87.5	0	0.030	0.022	0.019	0.017	0.016
2011	97.1	0	0.023	0.019	0.018	0.015	0.013
2012	91.9	0	0.029	0.019	0.017	0.016	0.014
2013	96.5	0	0.030	0.018	0.017	0.015	0.013
2014	97.2	0	0.021	0.017	0.015	0.013	0.013
2015	98.0	0	0.023	0.018	0.017	0.016	0.013

Table D17: Daily peak one-hour nitrogen dioxide at South Lake (2006–2015)**Trend station/region: South Lake**AAQ NEPM Standard
0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.0	0	0.045	0.039	0.037	0.032	0.029
2007	99.1	0	0.057	0.041	0.038	0.032	0.029
2008	99.6	0	0.044	0.040	0.038	0.033	0.030
2009	99.3	0	0.048	0.039	0.036	0.033	0.029
2010	87.8	0	0.058	0.045	0.040	0.036	0.030
2011	96.1	0	0.041	0.033	0.032	0.030	0.028
2012	98.7	0	0.046	0.038	0.035	0.031	0.028
2013	97.1	0	0.043	0.037	0.033	0.031	0.027
2014	99.5	0	0.034	0.032	0.029	0.028	0.026
2015	98.7	0	0.043	0.034	0.031	0.028	0.026

Table D18: Daily peak one-hour nitrogen dioxide at Swanbourne (2006–2015)**Trend station/region: Swanbourne**AAQ NEPM Standard
0.12 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.5	0	0.043	0.034	0.033	0.031	0.028
2007	98.7	0	0.038	0.033	0.032	0.030	0.027
2008	98.2	0	0.035	0.034	0.033	0.031	0.029
2009	99.2	0	0.037	0.034	0.032	0.028	0.026
2010	86.6	0	0.038	0.033	0.032	0.031	0.029
2011	99.4	0	0.032	0.029	0.028	0.026	0.024
2012	98.4	0	0.045	0.033	0.032	0.030	0.027
2013	99.6	0	0.037	0.033	0.031	0.027	0.025
2014	99.8	0	0.036	0.029	0.028	0.024	0.022
2015	99.5	0	0.036	0.034	0.030	0.027	0.023

Table D19: Daily peak one-hour ozone at Caversham (2006–2015)**Trend station/region: Caversham**AAQ NEPM Standard
0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.6	0	0.080	0.072	0.067	0.058	0.049
2007	98.6	0	0.085	0.073	0.066	0.059	0.047
2008	99.5	0	0.083	0.067	0.066	0.053	0.046
2009	99.3	1	0.104	0.072	0.067	0.056	0.050
2010	84.5	0	0.082	0.069	0.059	0.055	0.046
2011	99.2	0	0.077	0.070	0.067	0.054	0.045
2012	97.5	0	0.098	0.078	0.064	0.052	0.047
2013	95.7	1	0.101	0.074	0.070	0.056	0.051
2014	96.3	0	0.091	0.065	0.058	0.052	0.047
2015	95.4	1	0.103	0.080	0.077	0.062	0.052

Bold numerals indicate where a relevant standard has been exceeded.

Table D20: Daily peak one-hour ozone at Quinns Rocks (2006–2015)**Trend station/region: Quinns Rocks**AAQ NEPM Standard
0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.0	0	0.085	0.065	0.063	0.052	0.045
2007	98.8	0	0.081	0.061	0.057	0.050	0.045
2008	99.4	0	0.083	0.073	0.060	0.052	0.043
2009	94.3	0	0.070	0.063	0.061	0.053	0.045
2010	88.7	0	0.091	0.061	0.058	0.054	0.048
2011	99.1	0	0.083	0.068	0.057	0.051	0.045
2012	95.7	1	0.130	0.073	0.069	0.058	0.048
2013	99.2	0	0.087	0.077	0.066	0.058	0.050
2014	99.3	0	0.073	0.065	0.062	0.052	0.045
2015	98.9	0	0.083	0.070	0.064	0.057	0.049

Bold numerals indicate where a relevant standard has been exceeded.

Table D21: Daily peak one-hour ozone at Rockingham (2006–2015)
Trend station/region: Rockingham

 AAQ NEPM Standard
 0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.9	0	0.072	0.061	0.056	0.050	0.041
2007	99.5	0	0.084	0.065	0.056	0.049	0.042
2008	99.4	0	0.077	0.063	0.053	0.045	0.038
2009	99.0	0	0.078	0.064	0.054	0.048	0.041
2010	88.2	0	0.067	0.060	0.057	0.052	0.044
2011	94.9	0	0.065	0.062	0.057	0.048	0.043
2012	99.0	0	0.095	0.073	0.064	0.053	0.044
2013	98.8	0	0.084	0.068	0.065	0.052	0.044
2014	99.0	0	0.076	0.060	0.053	0.047	0.039
2015	98.9	0	0.069	0.062	0.061	0.052	0.045

Table D22: Daily peak one-hour ozone at Rolling Green (2006–2015)
Trend station/region: Rolling Green

 AAQ NEPM Standard
 0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.6	0	0.093	0.075	0.072	0.060	0.053
2007	98.9	0	0.095	0.081	0.078	0.062	0.053
2008	99.5	0	0.087	0.080	0.071	0.056	0.047
2009	99.5	1	0.103	0.081	0.069	0.059	0.052
2010	85.6	0	0.088	0.077	0.070	0.056	0.046
2011	95.9	0	0.073	0.068	0.060	0.052	0.043
2012	91.8	1	0.103	0.074	0.066	0.055	0.045
2013	96.8	0	0.099	0.078	0.071	0.061	0.049
2014	98.1	0	0.080	0.069	0.063	0.056	0.047
2015	99.2	1	0.105	0.078	0.073	0.062	0.055

Bold numerals indicate where a relevant standard has been exceeded.

Table D23: Daily peak one-hour ozone at South Lake (2006–2015)
Trend station/region: South Lake

 AAQ NEPM Standard
 0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.6	0	0.066	0.057	0.054	0.045	0.040
2007	99.4	0	0.067	0.056	0.053	0.047	0.040
2008	99.6	0	0.082	0.061	0.056	0.044	0.037
2009	99.4	0	0.065	0.057	0.053	0.045	0.039
2010	88.0	0	0.070	0.067	0.062	0.052	0.045
2011	99.4	0	0.076	0.064	0.057	0.050	0.044
2012	98.2	0	0.085	0.065	0.062	0.051	0.041
2013	98.6	0	0.087	0.074	0.062	0.054	0.043
2014	99.4	0	0.065	0.059	0.056	0.046	0.041
2015	98.8	0	0.067	0.063	0.060	0.051	0.042

Table D24: Daily peak one-hour ozone at Swanbourne (2006–2015)**Trend station/region: Swanbourne**AAQ NEPM Standard
0.10 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.7	0	0.075	0.066	0.060	0.050	0.044
2007	99.3	0	0.077	0.064	0.057	0.051	0.044
2008	98.2	0	0.076	0.067	0.060	0.048	0.042
2009	99.6	0	0.068	0.063	0.059	0.053	0.044
2010	86.6	0	0.066	0.059	0.056	0.050	0.044
2011	99.6	0	0.085	0.069	0.061	0.051	0.046
2012	98.2	1	0.128	0.074	0.067	0.056	0.047
2013	99.8	0	0.083	0.069	0.064	0.052	0.045
2014	97.8	0	0.066	0.056	0.053	0.048	0.042
2015	99.9	0	0.074	0.066	0.061	0.056	0.044

Bold numerals indicate where a relevant standard has been exceeded.

Table D25: Daily peak four-hour ozone at Caversham (2006–2015)**Trend station/region: Caversham**AAQ NEPM Standard
0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.6	0	0.072	0.063	0.058	0.049	0.043
2007	98.6	0	0.073	0.062	0.058	0.049	0.042
2008	99.5	0	0.076	0.061	0.056	0.047	0.041
2009	99.3	1	0.092	0.067	0.057	0.051	0.043
2010	84.5	0	0.072	0.056	0.052	0.047	0.041
2011	99.2	0	0.063	0.061	0.056	0.049	0.041
2012	97.5	2	0.086	0.070	0.056	0.047	0.041
2013	95.7	0	0.075	0.065	0.060	0.049	0.044
2014	96.3	0	0.073	0.055	0.050	0.046	0.041
2015	95.4	1	0.084	0.070	0.067	0.054	0.046

Bold numerals indicate where a relevant standard has been exceeded.

Table D26: Daily peak four-hour ozone at Quinns Rocks (2006–2015)**Trend station/region: Quinns Rocks**AAQ NEPM Standard
0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.0	0	0.074	0.059	0.055	0.046	0.041
2007	98.8	0	0.075	0.056	0.053	0.046	0.041
2008	99.4	0	0.073	0.061	0.055	0.046	0.041
2009	94.3	0	0.062	0.056	0.054	0.048	0.040
2010	88.7	0	0.065	0.056	0.052	0.048	0.042
2011	99.1	0	0.075	0.060	0.052	0.047	0.041
2012	95.7	2	0.108	0.065	0.061	0.051	0.043
2013	99.2	0	0.079	0.068	0.061	0.051	0.045
2014	99.3	0	0.062	0.057	0.051	0.046	0.042
2015	98.9	0	0.071	0.063	0.059	0.053	0.042

Bold numerals indicate where a relevant standard has been exceeded.

Table D27: Daily peak four-hour ozone at Rockingham (2006–2015)**Trend station/region: Rockingham**AAQ NEPM Standard
0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.9	0	0.067	0.056	0.051	0.046	0.038
2007	99.5	0	0.079	0.057	0.052	0.046	0.038
2008	99.4	0	0.072	0.058	0.049	0.042	0.036
2009	99.0	0	0.066	0.058	0.051	0.045	0.039
2010	88.2	0	0.064	0.054	0.053	0.046	0.041
2011	94.9	0	0.061	0.058	0.053	0.045	0.040
2012	99.0	0	0.079	0.065	0.060	0.048	0.040
2013	98.8	0	0.075	0.064	0.057	0.047	0.042
2014	99.0	0	0.067	0.051	0.048	0.043	0.037
2015	98.9	0	0.064	0.056	0.055	0.047	0.041

Table D28: Daily peak four-hour ozone at Rolling Green (2006–2015)**Trend station/region: Rolling Green**AAQ NEPM Standard
0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.6	0	0.079	0.065	0.059	0.053	0.046
2007	98.9	0	0.080	0.070	0.066	0.053	0.046
2008	99.5	0	0.075	0.065	0.062	0.051	0.043
2009	99.5	2	0.083	0.064	0.057	0.051	0.043
2010	85.6	0	0.080	0.065	0.056	0.049	0.042
2011	95.9	0	0.061	0.055	0.051	0.045	0.040
2012	91.8	1	0.081	0.064	0.058	0.049	0.042
2013	96.8	1	0.083	0.065	0.059	0.051	0.045
2014	98.1	0	0.070	0.058	0.054	0.048	0.042
2015	99.2	1	0.093	0.068	0.063	0.054	0.049

Bold numerals indicate where a relevant standard has been exceeded.

Table D29: Daily peak four-hour ozone at South Lake (2006–2015)**Trend station/region: South Lake**AAQ NEPM Standard
0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.6	0	0.063	0.051	0.049	0.041	0.036
2007	99.4	0	0.059	0.051	0.048	0.042	0.037
2008	99.6	0	0.067	0.051	0.046	0.040	0.034
2009	99.4	0	0.057	0.053	0.048	0.040	0.036
2010	88.0	0	0.061	0.055	0.053	0.046	0.042
2011	99.4	0	0.064	0.056	0.051	0.046	0.039
2012	98.2	0	0.080	0.060	0.054	0.046	0.037
2013	98.6	0	0.074	0.063	0.057	0.048	0.039
2014	99.4	0	0.058	0.053	0.049	0.042	0.037
2015	98.8	0	0.060	0.055	0.053	0.045	0.037

Table D30: Daily peak four-hour ozone at Swanbourne (2006–2015)
Trend station/region: Swanbourne

 AAQ NEPM Standard
 0.08 ppm (four-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.7	0	0.069	0.060	0.052	0.045	0.040
2007	99.3	0	0.067	0.054	0.051	0.048	0.042
2008	98.2	0	0.070	0.060	0.053	0.045	0.039
2009	99.6	0	0.063	0.058	0.054	0.046	0.039
2010	86.6	0	0.055	0.053	0.050	0.044	0.040
2011	99.6	0	0.073	0.059	0.056	0.047	0.043
2012	98.2	1	0.108	0.064	0.061	0.051	0.042
2013	99.8	0	0.068	0.063	0.056	0.048	0.042
2014	97.8	0	0.057	0.050	0.049	0.043	0.038
2015	99.9	0	0.067	0.058	0.056	0.049	0.039

Bold numerals indicate where a relevant standard has been exceeded.

Table D31: Daily peak one-hour sulfur dioxide at Rockingham (2006–2015)
Trend station/region: Rockingham

 AAQ NEPM Standard
 0.20 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.9	0	0.040	0.031	0.022	0.013	0.008
2007	98.6	0	0.041	0.025	0.020	0.013	0.008
2008	98.3	0	0.079	0.026	0.019	0.015	0.008
2009	98.7	0	0.032	0.022	0.017	0.010	0.007
2010	89.9	0	0.037	0.022	0.019	0.013	0.009
2011	93.7	0	0.040	0.029	0.024	0.017	0.010
2012	94.4	0	0.040	0.020	0.018	0.011	0.008
2013	94.5	0	0.037	0.028	0.022	0.016	0.011
2014	93.9	0	0.036	0.024	0.021	0.013	0.008
2015	94.6	0	0.051	0.033	0.023	0.018	0.012

Table D32: Daily peak one-hour sulfur dioxide at South Lake (2006–2015)
Trend station/region: South Lake

 AAQ NEPM Standard
 0.20 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.5	0	0.060	0.044	0.032	0.028	0.022
2007	99.4	0	0.040	0.032	0.028	0.019	0.012
2008	99.6	0	0.046	0.025	0.020	0.014	0.010
2009	98.4	0	0.036	0.033	0.029	0.018	0.015
2010	87.8	0	0.073	0.036	0.033	0.025	0.017
2011	95.7	0	0.044	0.029	0.026	0.017	0.012
2012	94.0	0	0.039	0.027	0.019	0.014	0.010
2013	93.3	0	0.044	0.034	0.031	0.020	0.015
2014	94.5	0	0.051	0.028	0.024	0.016	0.012
2015	95.5	0	0.037	0.031	0.029	0.020	0.016

Table D33: Daily peak one-hour sulfur dioxide at Wattleup (2006–2015)**Trend station/region: Wattleup**AAQ NEPM Standard
0.20 ppm (one-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.0	0	0.062	0.046	0.043	0.035	0.028
2007	93.3	0	0.060	0.045	0.040	0.034	0.025
2008	89.6	0	0.077	0.034	0.028	0.022	0.016
2009	95.6	0	0.059	0.039	0.036	0.029	0.022
2010	86.8	0	0.057	0.049	0.043	0.036	0.023
2011	94.3	0	0.067	0.049	0.042	0.032	0.026
2012	94.7	0	0.043	0.039	0.034	0.025	0.017
2013	92.5	0	0.090	0.059	0.047	0.037	0.027
2014	95.1	0	0.061	0.046	0.037	0.031	0.024
2015	95.6	0	0.067	0.046	0.045	0.039	0.031

Table D34: Daily peak 24-hour sulfur dioxide at Rockingham (2006–2015)**Trend station/region: Rockingham**AAQ NEPM Standard
0.08 ppm (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	98.9	0	0.007	0.004	0.004	0.002	0.002
2007	98.6	0	0.012	0.005	0.004	0.003	0.002
2008	98.3	0	0.007	0.005	0.004	0.002	0.001
2009	98.7	0	0.008	0.003	0.002	0.001	0.001
2010	89.9	0	0.007	0.004	0.003	0.002	0.002
2011	93.7	0	0.008	0.006	0.006	0.003	0.002
2012	94.4	0	0.006	0.005	0.003	0.002	0.002
2013	94.5	0	0.007	0.005	0.004	0.003	0.002
2014	93.9	0	0.007	0.005	0.004	0.003	0.002
2015	94.6	0	0.013	0.007	0.006	0.004	0.003

Table D35: Daily peak 24-hour sulfur dioxide at South Lake (2006–2015)**Trend station/region: South Lake**AAQ NEPM Standard
0.08 ppm (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.5	0	0.009	0.006	0.005	0.004	0.003
2007	99.4	0	0.006	0.004	0.003	0.002	0.002
2008	99.6	0	0.005	0.003	0.003	0.002	0.001
2009	98.4	0	0.006	0.005	0.003	0.003	0.002
2010	87.8	0	0.009	0.005	0.004	0.003	0.002
2011	95.7	0	0.006	0.004	0.003	0.002	0.002
2012	94.0	0	0.006	0.004	0.003	0.003	0.002
2013	93.3	0	0.014	0.005	0.004	0.003	0.002
2014	94.5	0	0.010	0.005	0.004	0.003	0.003
2015	95.5	0	0.007	0.006	0.005	0.005	0.004

Table D36: Daily peak 24-hour sulfur dioxide at Wattleup (2006–2015)**Trend station/region: Wattleup**AAQ NEPM Standard
0.08 ppm (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2006	99.0	0	0.009	0.007	0.006	0.004	0.004
2007	93.3	0	0.010	0.008	0.007	0.005	0.004
2008	89.6	0	0.011	0.005	0.004	0.003	0.002
2009	95.6	0	0.008	0.005	0.005	0.004	0.003
2010	86.8	0	0.010	0.008	0.006	0.005	0.003
2011	94.3	0	0.008	0.006	0.005	0.004	0.003
2012	94.7	0	0.008	0.005	0.004	0.003	0.002
2013	92.5	0	0.010	0.008	0.006	0.005	0.004
2014	95.1	0	0.008	0.007	0.006	0.005	0.004
2015	95.6	0	0.009	0.007	0.006	0.006	0.005

Table D37: Daily peak 24-hour particles as PM10 at Caversham (2006–2015)**Trend station/region: Caversham**AAQ NEPM Standard
50 $\mu\text{g}/\text{m}^3$ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. ($\mu\text{g}/\text{m}^3$)	99th percentile ($\mu\text{g}/\text{m}^3$)	98th percentile ($\mu\text{g}/\text{m}^3$)	95th percentile ($\mu\text{g}/\text{m}^3$)	90th percentile ($\mu\text{g}/\text{m}^3$)
2006	97.3	0	42.6	38.4	35.3	29.3	26.4
2007	98.4	1	58.8	39.7	35.9	30.3	26.1
2008	99.3	0	39.1	37.0	32.5	26.1	22.5
2009	99.4	0	45.7	37.2	32.4	29.0	25.8
2010	99.5	1	63.4	40.7	36.1	30.5	26.3
2011	99.1	1	76.1	33.2	30.2	27.3	23.8
2012	97.8	4	68.7	49.2	36.7	27.2	24.4
2013	97.4	1	62.4	34.4	30.7	26.2	23.6
2014	97.2	1	52.6	37.3	34.5	27.2	24.8
2015	95.7	0	46.8	40.7	37.4	30.4	26.3

Bold numerals indicate where a relevant standard has been exceeded.

Table D38: Daily peak 24-hour particles as PM10 at Duncraig (2006–2015)**Trend station/region: Duncraig**AAQ NEPM Standard
50 $\mu\text{g}/\text{m}^3$ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. ($\mu\text{g}/\text{m}^3$)	99th percentile ($\mu\text{g}/\text{m}^3$)	98th percentile ($\mu\text{g}/\text{m}^3$)	95th percentile ($\mu\text{g}/\text{m}^3$)	90th percentile ($\mu\text{g}/\text{m}^3$)
2006	99.1	0	40.6	32.9	30.5	27.3	24.0
2007	99.7	0	40.3	31.8	29.4	25.8	22.0
2008	99.2	0	46.9	34.4	31.1	25.8	21.9
2009	99.2	0	45.5	36.2	30.4	24.5	22.6
2010	99.4	0	47.9	33.1	30.8	25.1	22.7
2011	99.3	1	65.9	30.1	29.5	25.7	23.2
2012	99.4	2	89.5	35.5	28.3	26.1	23.0
2013	99.3	0	37.6	32.1	28.1	25.6	22.8
2014	99.4	1	53.0	31.2	28.1	25.1	22.4
2015	99.4	1	82.7	40.1	36.7	28.0	25.2

Bold numerals indicate where a relevant standard has been exceeded.

Table D39: Daily peak 24-hour particles as PM₁₀ at South Lake (2006–2015)**Trend station/region: South Lake**AAQ NEPM Standard
50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	97.0	0	45.3	39.8	37.0	34.4	29.0
2007	97.9	1	56.7	37.7	36.0	32.9	26.7
2008	99.6	1	55.0	39.9	36.1	30.3	25.8
2009	99.5	0	49.0	38.7	34.3	30.8	27.5
2010	99.7	4	61.0	46.7	39.8	33.9	28.5
2011	99.2	1	66.2	35.8	31.5	28.1	24.8
2012	99.1	2	81.5	36.6	30.3	28.5	24.1
2013	98.6	0	38.8	34.4	32.3	28.9	25.9
2014	99.4	0	44.5	38.2	34.0	29.4	26.3
2015	97.4	2	53.3	45.7	41.7	34.4	28.5

Bold numerals indicate where a relevant standard has been exceeded.

Table D40: Daily peak 24-hour particles as PM₁₀ at Bunbury (2006–2015)**Trend station/region: Bunbury**AAQ NEPM Standard
50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	99.2	3	123.5	45.6	38.8	28.3	25.8
2007	99.6	0	46.5	32.8	29.6	27.1	24.5
2008	99.4	0	39.1	31.4	30.3	27.3	23.7
2009	99.5	1	53.8	40.3	36.0	29.5	25.4
2010	99.1	2	134.0	37.6	36.0	29.3	25.3
2011	99.6	2	68.4	39.3	33.8	28.0	23.8
2012	99.5	2	53.5	40.0	32.9	26.5	24.1
2013	98.9	0	46.8	38.1	33.5	26.8	22.6
2014	98.1	0	44.5	31.7	26.2	24.6	22.8
2015	99.7	3	62.9	48.6	40.6	35.6	27.2

Bold numerals indicate where a relevant standard has been exceeded.

Table D41: Daily peak 24-hour particles as PM₁₀ at Albany (2006–2015)**Trend station/region: Albany**AAQ NEPM Standard
50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	52.4	0	39.4	35.4	33.0	26.6	24.6
2007	99.8	1	55.7	31.3	28.0	24.7	22.1
2008	99.2	2	56.3	34.1	32.8	26.1	22.7
2009	97.7	0	36.7	32.3	28.7	24.5	21.4
2010	99.8	1	52.5	36.1	33.2	27.3	25.3
2011	99.3	0	37.3	33.6	30.6	26.3	22.0
2012	99.5	0	37.0	34.6	31.1	27.4	23.6
2013	98.1	3	110.8	43.3	36.0	29.1	23.8
2014	98.6	0	43.5	35.5	31.4	28.1	24.4
2015	99.1	2	76.7	37.3	34.7	28.4	24.5

Bold numerals indicate where a relevant standard has been exceeded.

Table D42: Daily peak 24-hour particles as PM₁₀ at Geraldton (2006–2015)**Trend station/region: Geraldton**AAQ NEPM Standard
50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	99.4	4	78.0	48.6	45.8	40.0	35.4
2007	99.7	10	116.3	87.2	67.9	44.7	36.4
2008	98.9	10	150.7	105.2	58.1	45.9	38.6
2009	99.6	14	128.9	69.2	58.6	48.5	40.3
2010	97.7	4	55.6	49.3	47.8	41.6	37.9
2011	98.6	3	63.0	45.4	40.2	35.8	32.2
2012	99.6	3	61.5	47.0	45.3	40.2	33.8
2013	99.3	2	63.1	45.9	42.1	38.9	34.6
2014	98.8	4	55.7	49.7	47.1	41.4	37.5
2015	98.9	5	68.1	54.5	44.4	39.8	35.2

Bold numerals indicate where a relevant standard has been exceeded.

Table D43: Daily peak 24-hour particles as PM₁₀ at Collie (2006–2015)**Trend station/region: Collie**AAQ NEPM Standard
50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	0.0						
2007	0.0						
2008	87.6	7	85.9	56.7	50.1	37.4	30.5
2009	99.5	3	80.4	47.3	46.2	38.0	31.3
2010	99.7	16	163.0	86.7	67.3	46.1	34.9
2011	97.6	4	61.5	52.1	40.4	32.0	29.2
2012	99.4	6	91.7	54.9	46.9	35.1	30.1
2013	99.0	3	61.6	46.0	41.3	36.0	32.0
2014	99.3	2	73.3	42.2	38.8	34.0	29.8
2015	99.0	10	111.9	67.4	53.9	41.9	37.8

Bold numerals indicate where a relevant standard has been exceeded.

Table D44: Daily peak 24-hour particles as PM_{2.5} at Caversham (2006–2015)**Trend station/region: Caversham**AAQ NEPM Standard
25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	63.8	1	34.0	18.6	15.6	13.4	12.0
2007	98.4	0	24.5	15.1	14.0	12.1	10.7
2008	99.4	1	26.3	15.2	14.0	11.7	10.6
2009	99.5	2	25.5	19.4	17.3	12.9	11.0
2010	99.1	3	45.2	21.9	16.2	13.7	12.1
2011	99.4	1	41.5	12.4	11.7	10.8	9.8
2012	96.9	3	45.9	19.2	15.9	12.3	10.6
2013	97.4	0	22.6	17.2	16.4	13.6	11.6
2014	97.0	1	39.3	16.2	15.2	14.1	11.9
2015	95.8	5	30.0	27.2	22.4	16.1	12.8

Bold numerals indicate where a relevant standard has been exceeded.

Table D45: Daily peak 24-hour particles as PM_{2.5} at Duncraig (2006–2015)
Trend station/region: Duncraig

 AAQ NEPM Standard
 25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	99.0	2	33.4	18.7	16.2	13.4	11.9
2007	99.6	0	19.6	14.2	13.5	11.6	10.1
2008	99.3	1	38.3	18.0	15.9	12.6	11.1
2009	99.4	3	32.7	22.1	17.5	13.2	11.5
2010	99.3	3	36.4	20.1	15.9	13.7	12.0
2011	99.4	1	52.1	14.7	13.4	11.5	10.4
2012	97.5	3	77.3	22.0	14.4	12.7	11.0
2013	98.5	0	18.7	15.6	14.4	12.7	11.4
2014	99.7	1	47.6	16.8	15.3	13.0	11.0
2015	99.6	3	35.8	22.9	18.3	15.2	12.9

Bold numerals indicate where a relevant standard has been exceeded.

Table D46: Daily peak 24-hour particles as PM_{2.5} at Quinns Rocks (2006–2015)
Trend station/region: Quinns Rocks

 AAQ NEPM Standard
 25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	55.3	1	63.9	17.0	14.3	13.2	11.0
2007	99.7	0	19.9	15.4	13.7	12.1	10.1
2008	99.3	1	53.3	17.3	15.4	12.8	11.3
2009	99.8	2	31.3	20.7	15.2	12.7	11.3
2010	99.6	3	33.7	17.6	14.5	12.0	10.9
2011	99.0	2	43.2	17.3	14.6	11.6	10.1
2012	96.5	4	74.5	22.7	14.3	11.9	10.6
2013	98.5	0	19.3	16.6	15.0	13.1	10.9
2014	98.8	2	39.5	15.8	14.5	13.4	11.7
2015	98.9	2	37.9	22.2	20.9	14.8	12.4

Bold numerals indicate where a relevant standard has been exceeded.

Table D47: Daily peak 24-hour particles as PM_{2.5} at South Lake (2006–2015)
Trend station/region: South Lake

 AAQ NEPM Standard
 25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	76.7	1	30.5	21.5	17.2	14.6	12.8
2007	98.9	0	21.2	15.6	12.9	11.8	10.5
2008	99.4	1	45.2	18.2	14.1	12.7	11.2
2009	99.3	3	32.0	22.8	19.1	14.1	11.7
2010	99.5	2	40.0	22.0	19.2	15.9	13.2
2011	99.2	1	48.2	16.2	15.3	13.1	11.5
2012	99.0	4	71.6	25.0	19.3	14.6	13.2
2013	98.6	0	17.1	15.2	14.9	14.0	11.7
2014	98.7	2	29.8	17.7	15.0	13.4	11.5
2015	97.0	5	34.5	29.8	22.8	17.0	13.4

Bold numerals indicate where a relevant standard has been exceeded.

Table D48: Daily peak 24-hour particles as PM_{2.5} at Bunbury (2006–2015)**Trend station/region: Bunbury**AAQ NEPM Standard
25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	99.3	8	113.5	32.4	26.0	14.8	13.0
2007	99.4	3	34.5	21.2	17.8	13.2	10.7
2008	99.7	2	27.8	21.0	18.6	13.2	11.4
2009	99.5	7	40.0	26.6	22.3	16.9	12.6
2010	98.6	7	115.3	28.4	24.2	14.8	12.2
2011	98.9	5	45.5	26.6	18.7	13.2	11.2
2012	99.6	7	43.0	26.3	21.0	14.9	12.8
2013	99.3	1	38.3	16.6	15.7	14.0	11.5
2014	98.4	1	34.6	16.1	15.0	13.3	11.7
2015	97.6	9	52.1	35.0	30.2	20.2	14.4

Bold numerals indicate where a relevant standard has been exceeded.

Table D49: Daily peak 24-hour particles as PM_{2.5} at Busselton (2006–2015)**Trend station/region: Busselton**AAQ NEPM Standard
25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m ³)	99th percentile (µg/m ³)	98th percentile (µg/m ³)	95th percentile (µg/m ³)	90th percentile (µg/m ³)
2006	16.7	0	12.7	11.9	11.3	10.8	10.1
2007	99.4	2	51.1	15.6	14.3	11.7	9.9
2008	99.3	3	35.6	20.5	15.5	11.9	10.5
2009	99.8	12	69.0	45.0	31.6	17.7	14.0
2010	99.4	7	62.5	31.6	22.9	15.7	11.6
2011	99.8	6	85.2	36.7	20.5	13.9	11.4
2012	99.6	5	78.0	27.1	21.4	13.4	11.8
2013	98.6	0	17.9	16.6	15.5	12.9	10.9
2014	99.6	1	25.1	13.2	12.4	11.1	10.2
2015	99.1	4	37.8	24.4	21.3	18.6	13.9

Bold numerals indicate where a relevant standard has been exceeded.

Maxima by pollutant 2006–2015

Table D50: Annual daily peak eight-hour carbon monoxide concentrations (ppm) for 2006–2015

Regional Performance Monitoring Station	AAQ NEPM Standard 9.0 ppm (eight-hour average)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Caversham (North East Metro)	1.8	0.9	0.8	1.0	1.6	1.5	0.9	0.9	0.7	1.2
Duncraig (North Metro)	3.4	2.0	3.1	2.6	2.3	1.9	2.4	2.1	1.9	1.7
South Lake (South East Metro)	2.5	1.7	2.0	1.8	2.2	1.7	2.2	1.7	1.8	1.9

Table D51: Annual daily peak one-hour nitrogen dioxide concentrations (ppm) for 2006–2015

Regional Performance Monitoring Station	AAQ NEPM Standard 0.12 ppm (one-hour average)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Caversham (North East Metro)	0.084	0.044	0.036	0.044	0.054	0.035	0.037	0.043	0.033	0.041
Duncraig (North Metro)	0.056	0.053	0.038	0.042	0.038	0.035	0.047	0.040	0.048	0.036
Quinns Rocks (Outer North Coast)	0.065	0.035	0.037	0.034	0.040	0.031	0.041	0.032	0.031	0.030
Rockingham (South Coast)	0.054	0.040	0.031	0.031	0.036	0.034	0.053	0.035	0.034	0.062
Rolling Green (Outer East Rural)	0.026	0.020	0.023	0.035	0.030	0.023	0.029	0.030	0.021	0.023
South Lake (South East Metro)	0.045	0.057	0.044	0.048	0.058	0.041	0.046	0.043	0.034	0.043
Swanbourne (Inner West Coast)	0.043	0.038	0.035	0.037	0.038	0.032	0.045	0.037	0.036	0.036

Table D52: Annual daily peak one-hour ozone concentrations (ppm) for 2006–2015

*AAQ NEPM Standard
0.10 ppm (one-hour average)*

Regional Performance Monitoring Station	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Caversham (North East Metro)	0.080	0.085	0.083	0.104	0.082	0.077	0.098	0.101	0.091	0.103
Quinns Rocks (Outer North Coast)	0.085	0.081	0.083	0.070	0.091	0.083	0.130	0.087	0.073	0.083
Rockingham (South Coast)	0.072	0.084	0.077	0.078	0.067	0.065	0.095	0.084	0.076	0.069
Rolling Green (Outer East Rural)	0.093	0.095	0.087	0.103	0.088	0.073	0.103	0.099	0.080	0.105
South Lake (South East Metro)	0.066	0.067	0.082	0.065	0.070	0.076	0.085	0.087	0.065	0.067
Swanbourne (Inner West Coast)	0.075	0.077	0.076	0.068	0.066	0.085	0.128	0.083	0.066	0.074

Bold numerals indicate where a relevant standard has been exceeded.

For explanation of exceedences in previous years, please refer to the relevant year report.

Table D53: Annual daily peak four-hour ozone concentrations (ppm) for 2006–2015

*AAQ NEPM Standard
0.08 ppm (four-hour average)*

Regional Performance Monitoring Station	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Caversham (North East Metro)	0.072	0.073	0.076	0.092	0.072	0.063	0.086	0.075	0.073	0.084
Quinns Rocks (Outer North Coast)	0.074	0.075	0.073	0.062	0.065	0.075	0.108	0.079	0.062	0.071
Rockingham (South Coast)	0.067	0.079	0.072	0.066	0.064	0.061	0.079	0.075	0.067	0.064
Rolling Green (Outer East Rural)	0.079	0.080	0.075	0.083	0.080	0.061	0.081	0.083	0.070	0.093
South Lake (South East Metro)	0.063	0.059	0.067	0.057	0.061	0.064	0.080	0.074	0.058	0.060
Swanbourne (Inner West Coast)	0.069	0.067	0.070	0.063	0.055	0.073	0.108	0.068	0.057	0.067

Bold numerals indicate where a relevant standard has been exceeded.

For explanation of exceedences in previous years, please refer to the relevant year report.

**Table D54: Annual daily peak one-hour sulfur dioxide concentrations (ppm)
for 2006–2015**

Regional Performance Monitoring Station	AAQ NEPM Standard 0.20 ppm (one-hour average)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Rockingham (South Coast)	0.040	0.041	0.079	0.032	0.037	0.040	0.040	0.037	0.036	0.051
South Lake (South East Metro)	0.060	0.040	0.046	0.036	0.073	0.044	0.039	0.044	0.051	0.037
Wattleup (South Metro)	0.062	0.060	0.077	0.059	0.057	0.067	0.043	0.090	0.061	0.067

**Table D55: Annual daily peak 24-hour sulfur dioxide concentrations (ppm)
for 2006–2015**

Regional Performance Monitoring Station	AAQ NEPM Standard 0.08 ppm (24-hour average)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Rockingham (South Coast)	0.007	0.012	0.007	0.008	0.007	0.008	0.006	0.007	0.007	0.013
South Lake (South East Metro)	0.009	0.006	0.005	0.006	0.009	0.006	0.006	0.014	0.010	0.007
Wattleup (South Metro)	0.009	0.010	0.011	0.008	0.010	0.008	0.008	0.010	0.008	0.009

Table D56: Annual daily peak 24-hour particles as PM₁₀ concentrations (µg/m³) for 2006–2015

Regional Performance Monitoring Station	AAQ NEPM Standard 50 µg/m ³ (24-hour average)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Caversham (North East Metro)	42.6	58.8	39.1	45.7	63.4	76.1	68.7	62.4	52.6	46.8
Duncraig (North Metro)	40.6	40.3	46.9	45.5	47.9	65.9	89.5	37.6	53.0	82.7
South Lake (South East Metro)	45.3	56.7	55.0	49.0	61.0	66.2	81.5	38.8	44.5	53.3
Southwest region										
Bunbury	123.5	46.5	39.1	53.8	134.0	68.4	53.5	46.8	44.5	62.9
Collie	-	-	85.9	80.4	163.0	61.5	91.7	61.6	73.3	111.9
Albany	39.4	55.7	56.3	36.7	52.5	37.3	37.0	110.8	43.5	76.7
Midwest region										
Geraldton	78.0	116.3	150.7	128.9	55.6	63.0	61.5	63.1	55.7	68.1

Bold numerals indicate where a relevant standard has been exceeded.

For explanation of this year's exceedences, please see [Table A9](#) of this report.

For explanation of exceedences in previous years, please refer to the relevant year report.

Table D57: Annual daily peak 24-hour particles as PM_{2.5} concentrations (µg/m³) for 2006–2015

Regional Performance Monitoring Station	AAQ NEPM Standard 25 µg/m ³ (24-hour average)									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Caversham (North East Metro)	34.0	24.5	26.3	25.5	45.2	41.5	45.9	22.6	39.3	30.0
Duncraig (North Metro)	33.4	19.6	38.3	32.7	36.4	52.1	77.3	18.7	47.6	35.8
Quinns Rocks (Outer North Coast)	63.9	19.9	53.3	31.3	33.7	43.2	74.5	19.3	39.5	37.9
South Lake (South East Metro)	30.5	21.2	45.2	32.0	40.0	48.2	71.6	17.1	29.8	34.5
Southwest region										
Bunbury	113.5	34.5	27.8	40.0	115.3	45.5	43.0	38.3	34.6	52.1
Busselton	12.7	51.1	35.6	69.0	62.5	85.2	78.0	17.9	25.1	37.8

Bold numerals indicate where a relevant standard has been exceeded.

For explanation of this year's exceedences, please see [Table A9](#) of this report.

For explanation of exceedences in previous years, please refer to the relevant year report.

Table D58: Annual averaged particles as PM₁₀ concentrations (µg/m³) for 2006–2015

 AAQ NEPM Standard
 25 µg/m³ (annual average)

Regional Performance Monitoring Station	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Caversham (North East Metro)	16.9	16.4	14.5	17.1	17.0	16.2	16.8	15.4	17.4	16.7
Duncraig (North Metro)	16.1	15.3	15.0	15.9	15.8	15.3	16.2	15.5	15.5	16.5
South Lake (South East Metro)	19.3	17.7	16.3	17.7	19.0	16.3	16.9	16.6	17.4	17.9
Southwest region										
Bunbury	18.6	17.2	15.8	17.6	17.6	17.0	17.5	16.8	16.1	17.5
Collie	-	-	19.2	20.0	22.8	19.6	20.0	20.1	19.5	22.4
Albany	15.8	14.2	14.6	14.3	15.9	14.3	15.0	15.4	16.0	15.9
Midwest region										
Geraldton	22.2	23.0	22.4	23.9	21.7	19.6	21.3	20.9	22.3	20.2

Table D58a: Annual averaged particles as PM_{2.5} concentrations (µg/m³) for 2006–2015

 AAQ NEPM Standard
 8 µg/m³ (annual average)

Regional Performance Monitoring Station	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Perth region										
Caversham (North East Metro)	8.1	7.5	7.1	7.8	8.2	7.0	7.8	7.9	8.1	8.5
Duncraig (North Metro)	8.2	7.3	7.7	8.2	8.2	7.8	8.2	7.6	7.6	8.4
Quinns Rocks (Outer North Coast)	7.8	6.9	7.2	7.8	7.8	7.2	7.9	7.8	8.0	8.3
South Lake (South East Metro)	8.7	7.6	7.7	8.2	8.7	7.8	8.9	8.0	8.1	8.8
Southwest region										
Bunbury	8.7	7.8	7.6	8.3	9.2	8.0	8.6	7.8	7.8	9.3
Busselton	6.9	7.4	7.3	9.0	8.5	8.5	8.6	7.7	7.2	8.6

Bold numerals indicate where a relevant standard has been exceeded.

Attachment 1 – Graphical trends

This attachment provides graphical representations of tables D9 to D49 of Section D.

Each graph shows the maximum, 99th percentile, 98th percentile, 95th percentile and 90th percentile of daily maximum concentration for all pollutants monitored by the Department of Environment Regulation (DER) in Western Australia. The nominated percentiles can also be expressed as an Nth highest concentration.

Based on 100 per cent data recovery and a normal year (i.e. 365 days), the following table gives each percentile an equivalent Nth highest ordinal value. The bracketed numbers represent the exact (as calculated) value of the ordinal number.

Percentile	Nth highest
100	1 (maximum)
99	5 (4.65)
98	8 (8.3)
95	19 (19.25)
90	38 (37.5)

Carbon monoxide

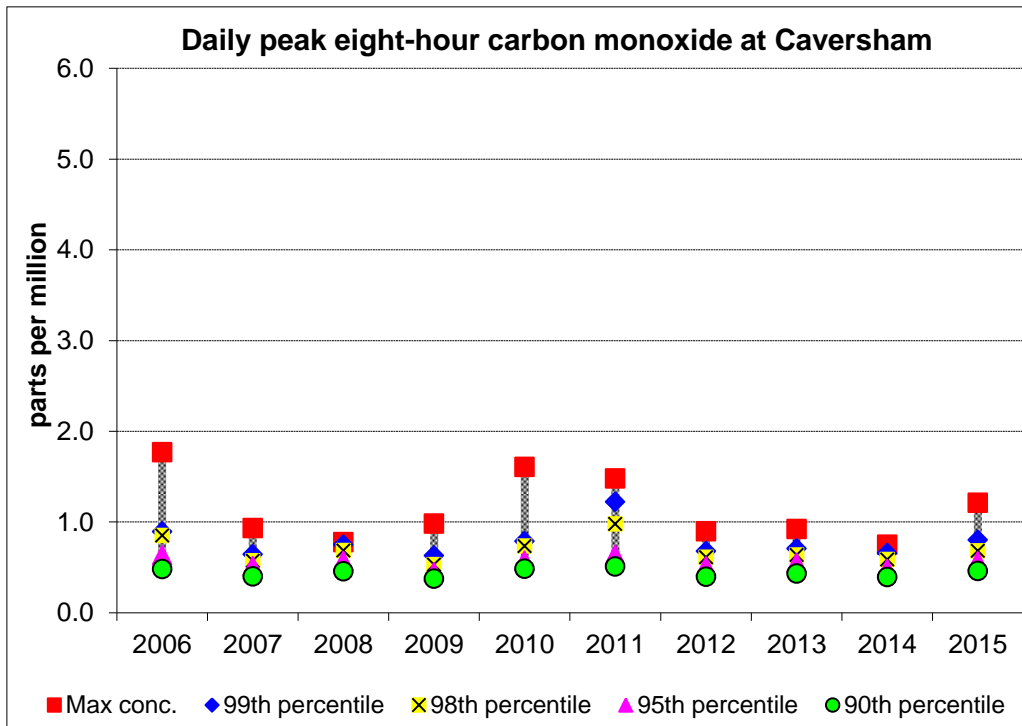


Figure A1-1 - eight-hour carbon monoxide at Caversham

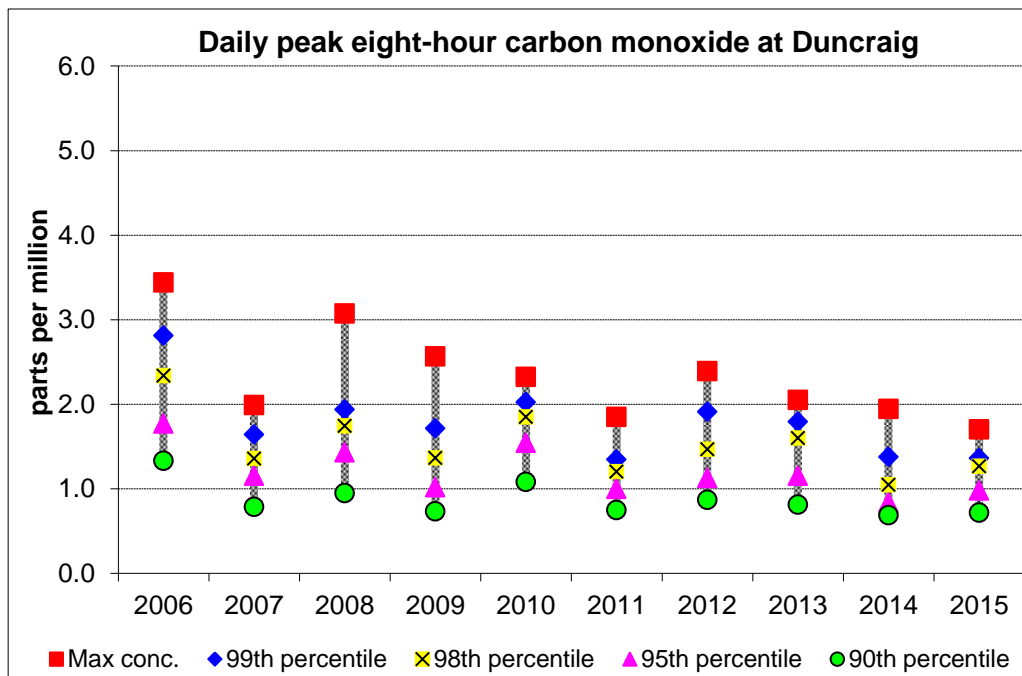


Figure A1-2 - eight-hour carbon monoxide at Duneraig

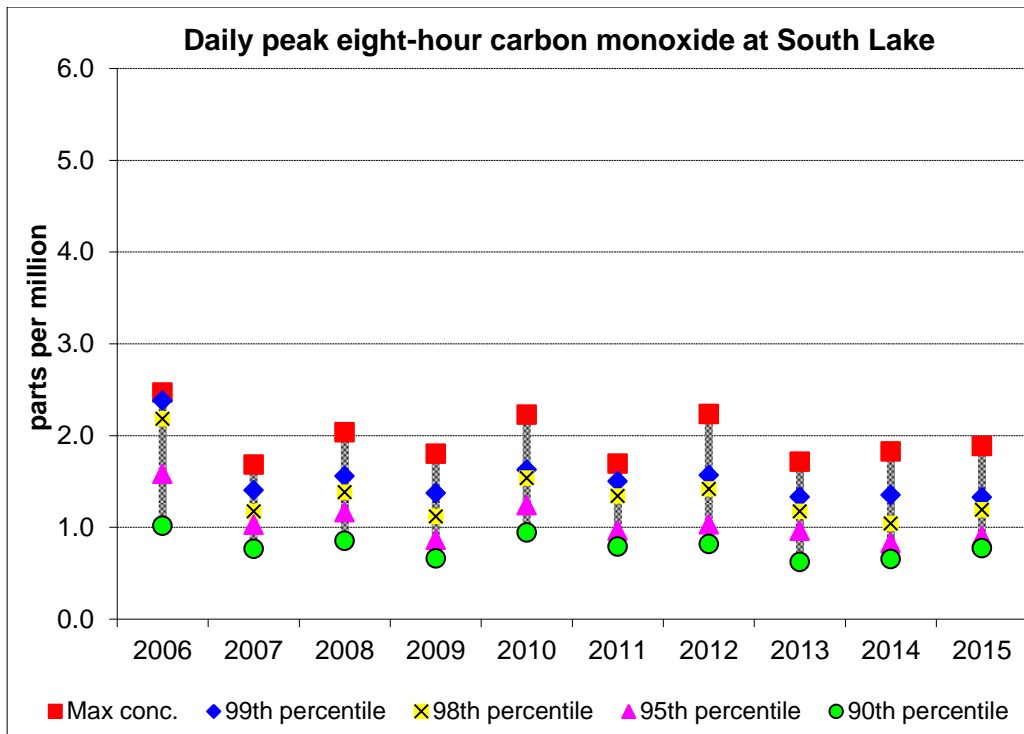


Figure A1-3 - eight-hour carbon monoxide at South Lake

Nitrogen dioxide

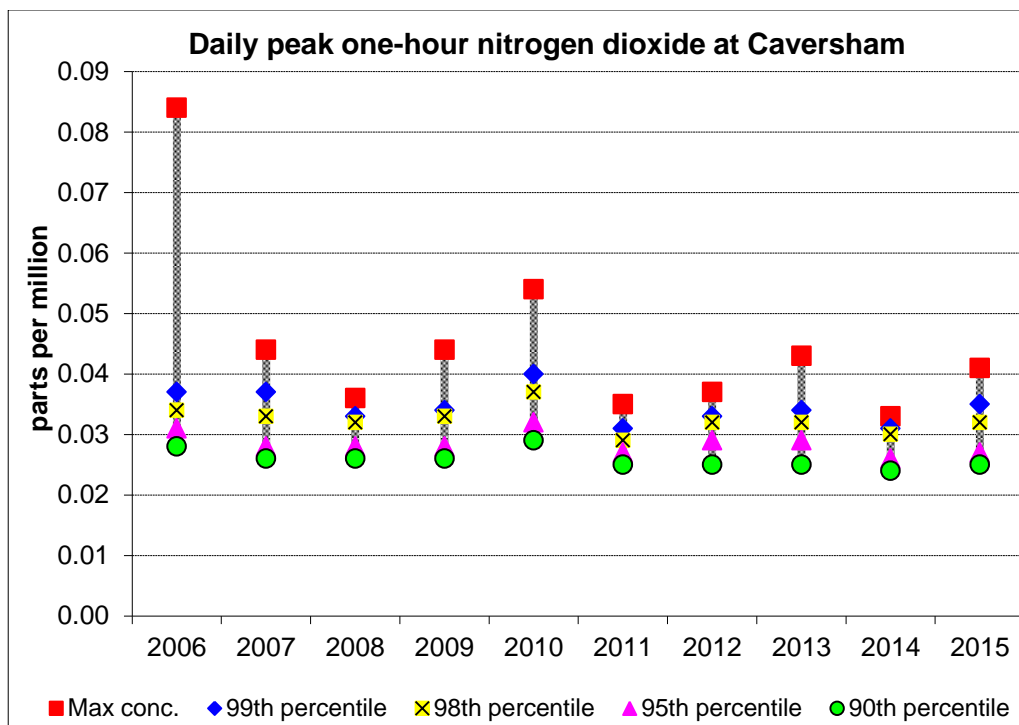


Figure A1-4 - one-hour nitrogen dioxide at Caversham

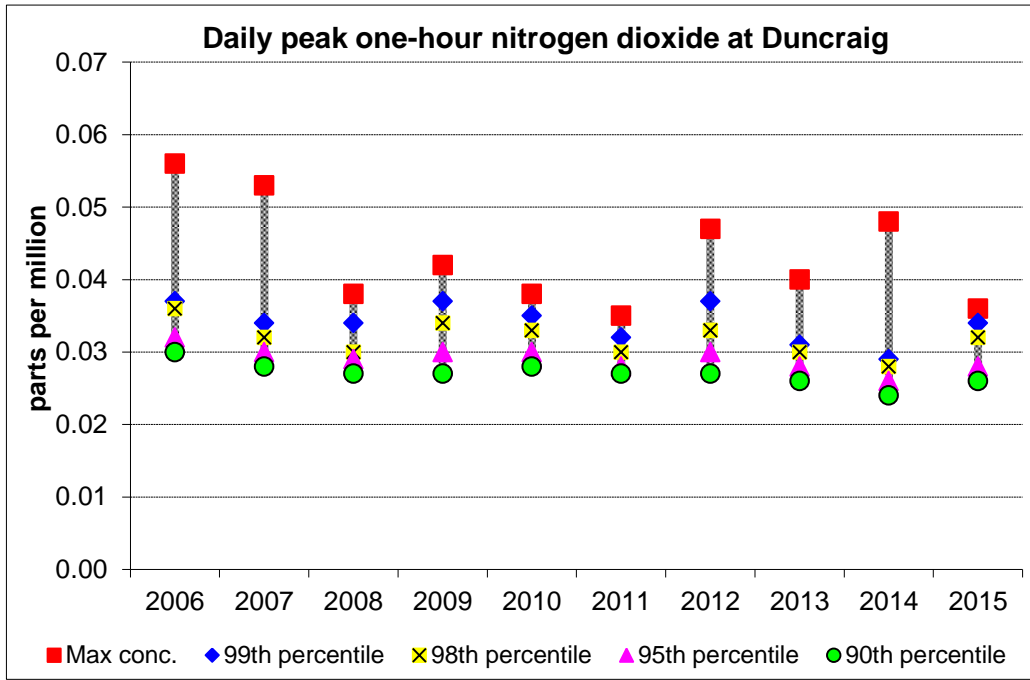


Figure A1-5 - one-hour nitrogen dioxide at Duncraig

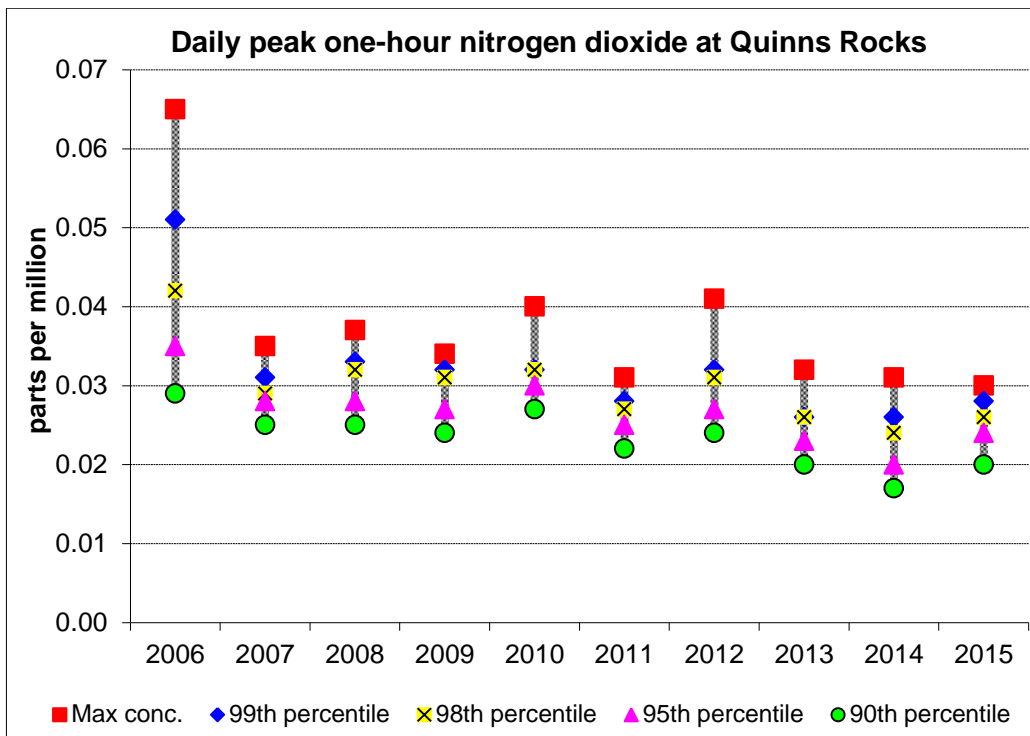


Figure A1-6 - one-hour nitrogen dioxide at Quinns Rocks

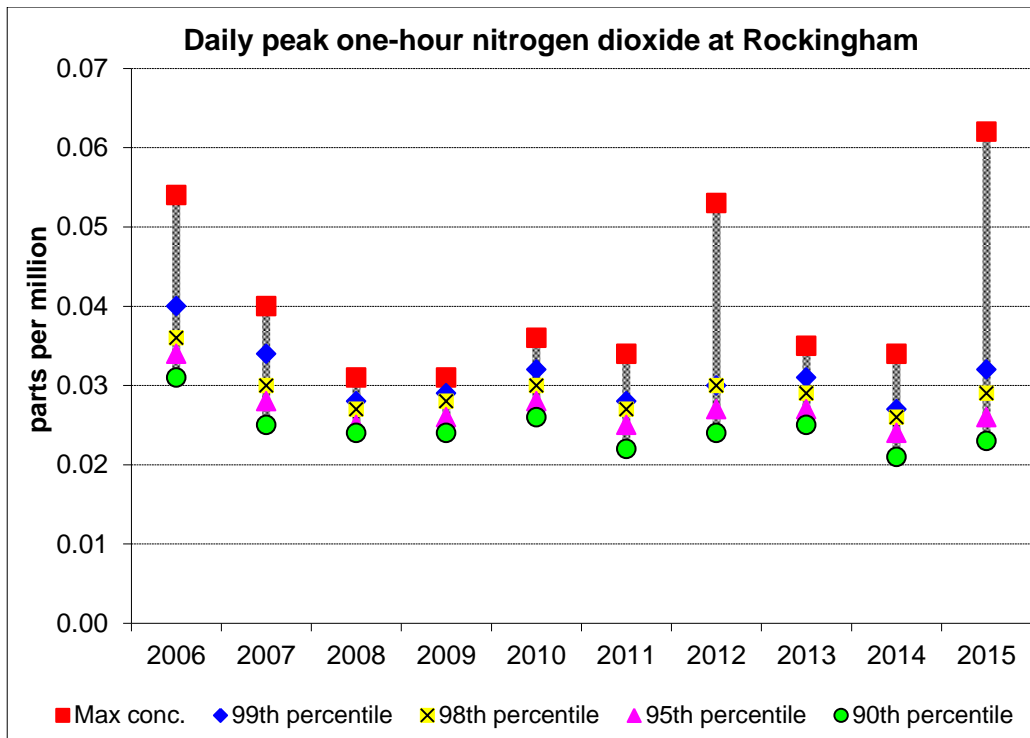


Figure A1-7 - one-hour nitrogen dioxide at Rockingham

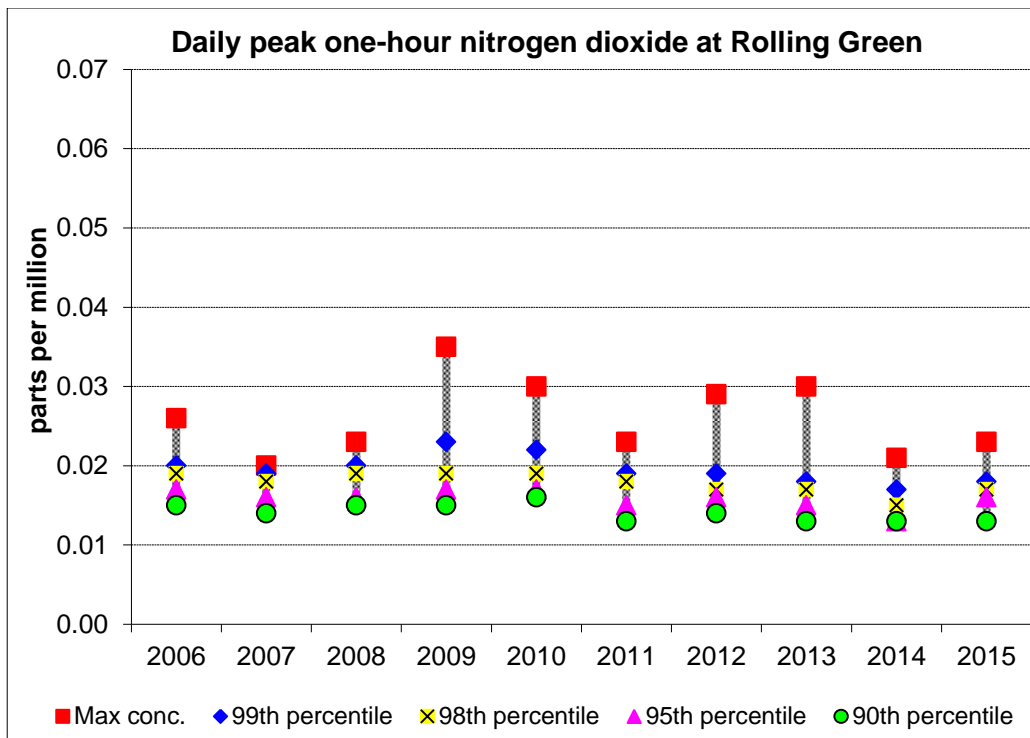


Figure A1-8 - one-hour nitrogen dioxide at Rolling Green

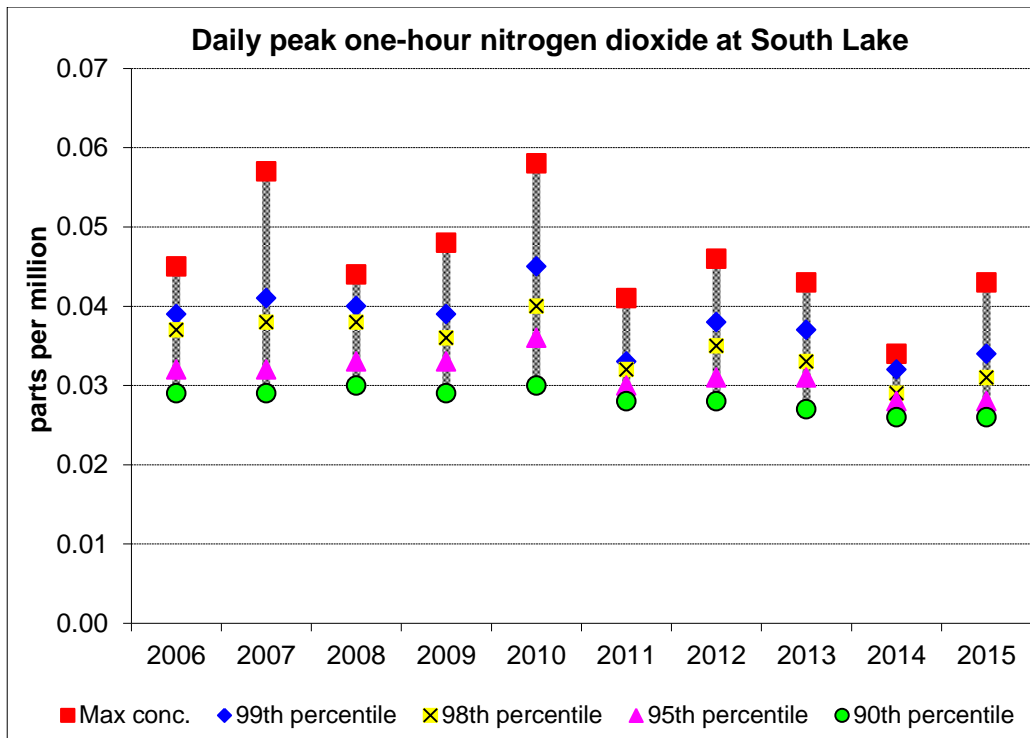


Figure A1-9 - one-hour nitrogen dioxide at South Lake

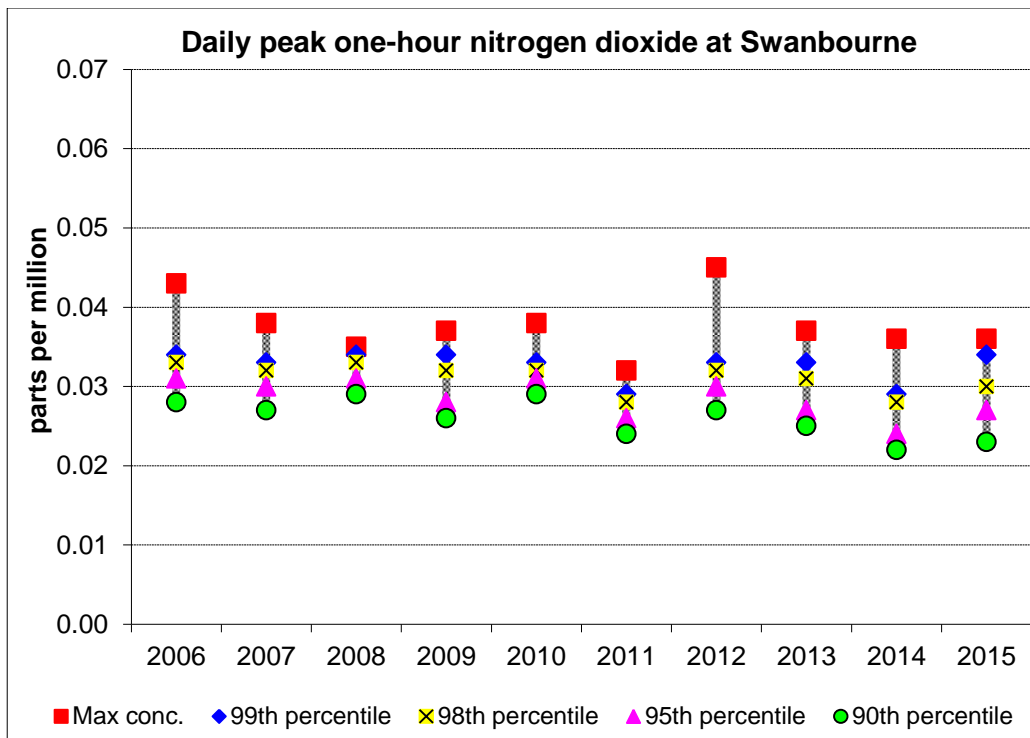


Figure A1-10 - one-hour nitrogen dioxide at Swanbourne

Ozone

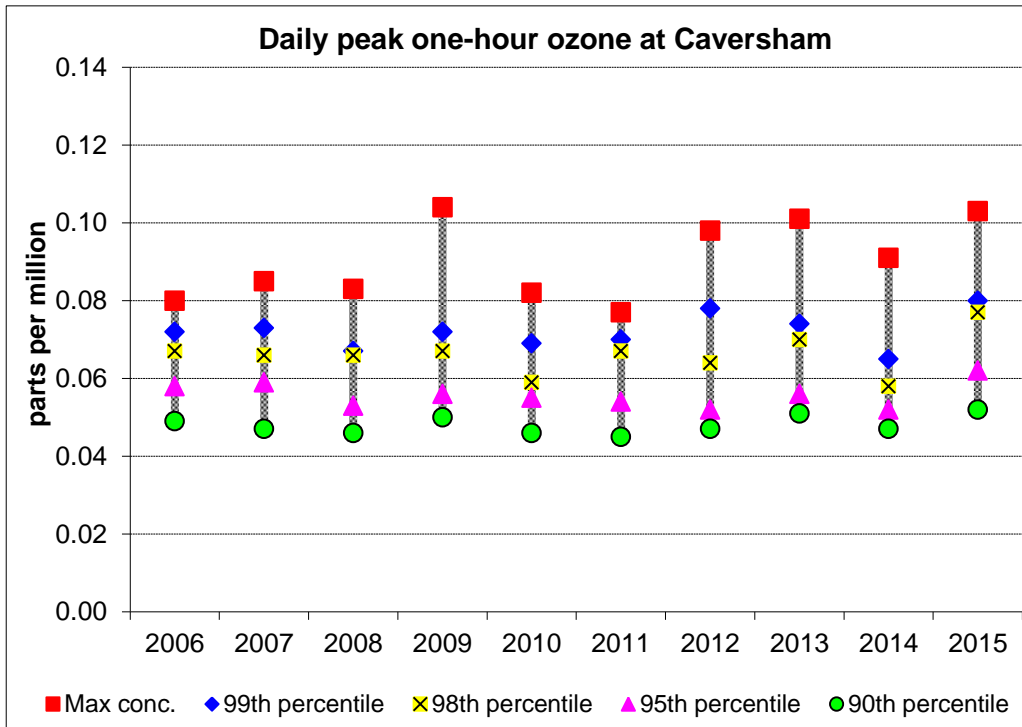


Figure A1-11 one-hour ozone at Caversham

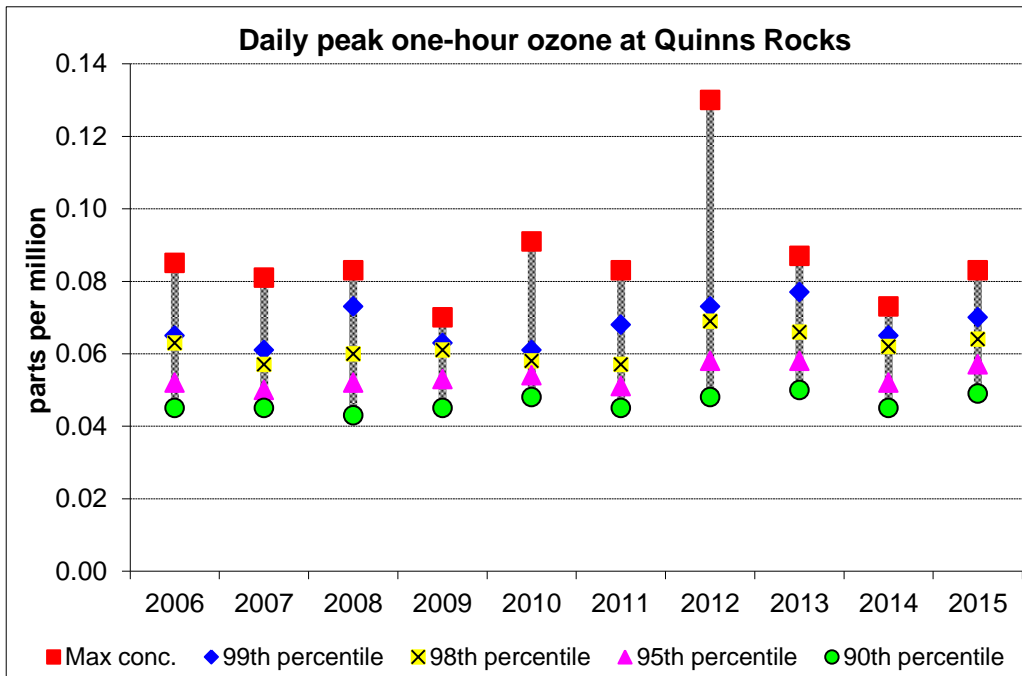


Figure A1-12 –one-hour ozone at Quinns Rocks

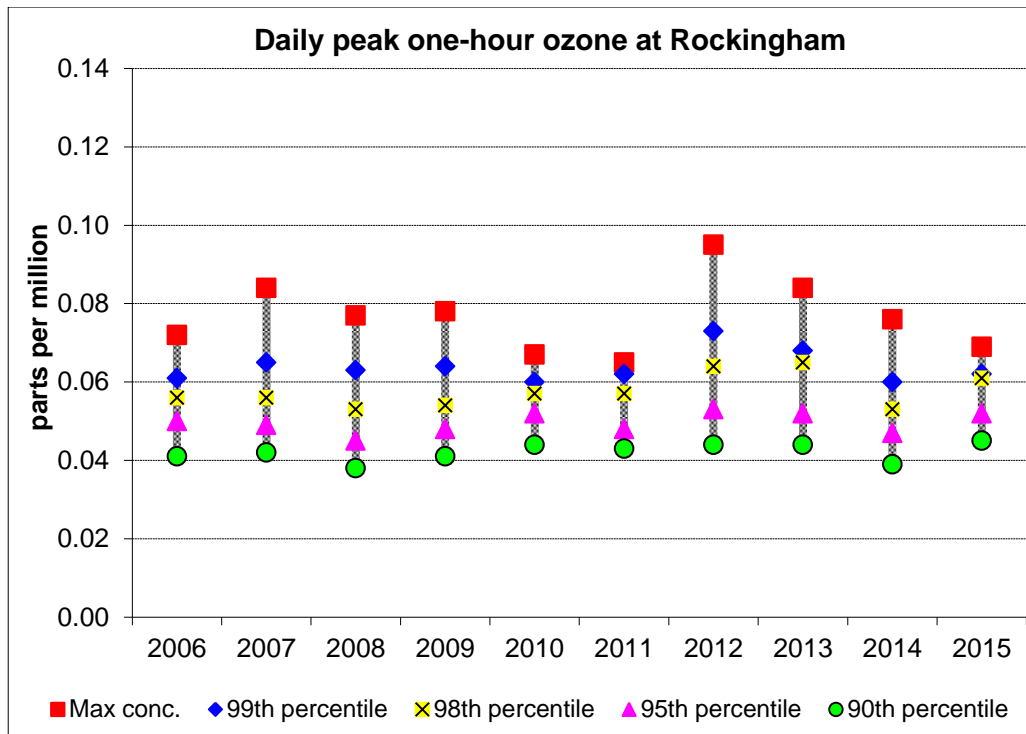


Figure A1-13 - one-hour ozone at Rockingham

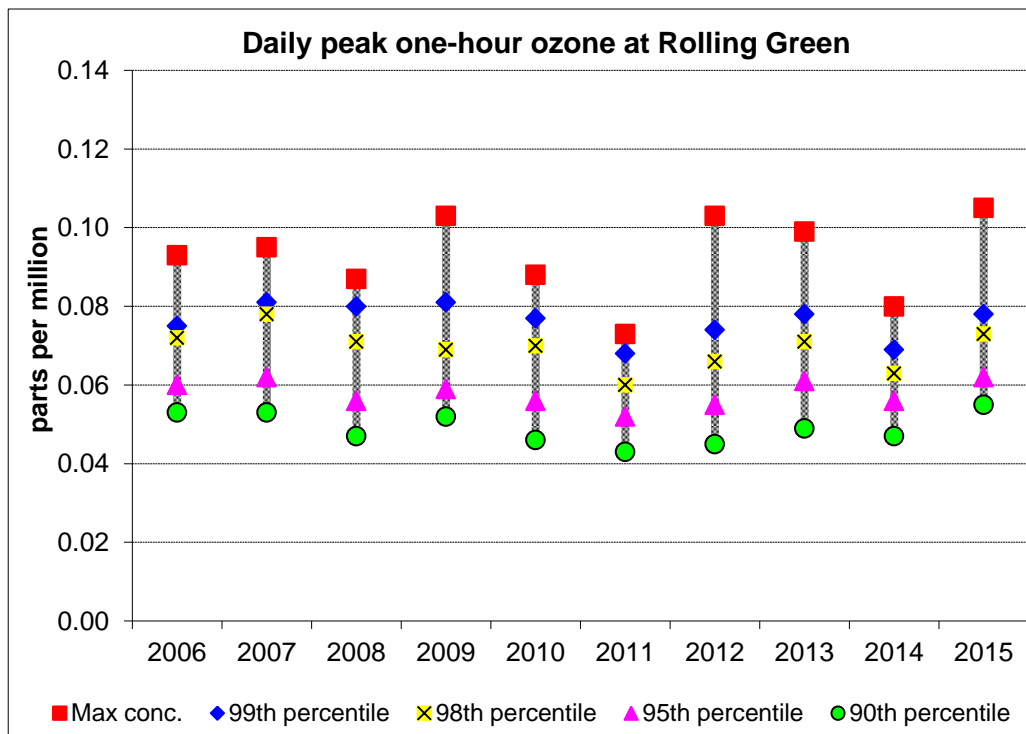


Figure A1-14 - one-hour ozone at Rolling Green

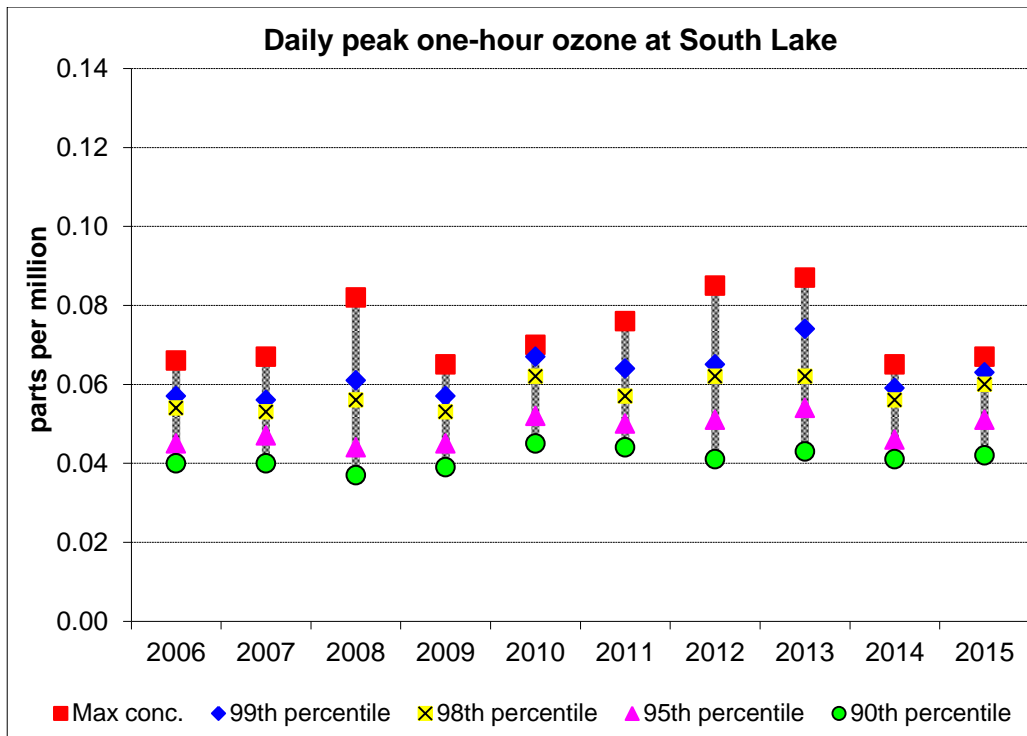


Figure A1-15 - one-hour ozone at South Lake

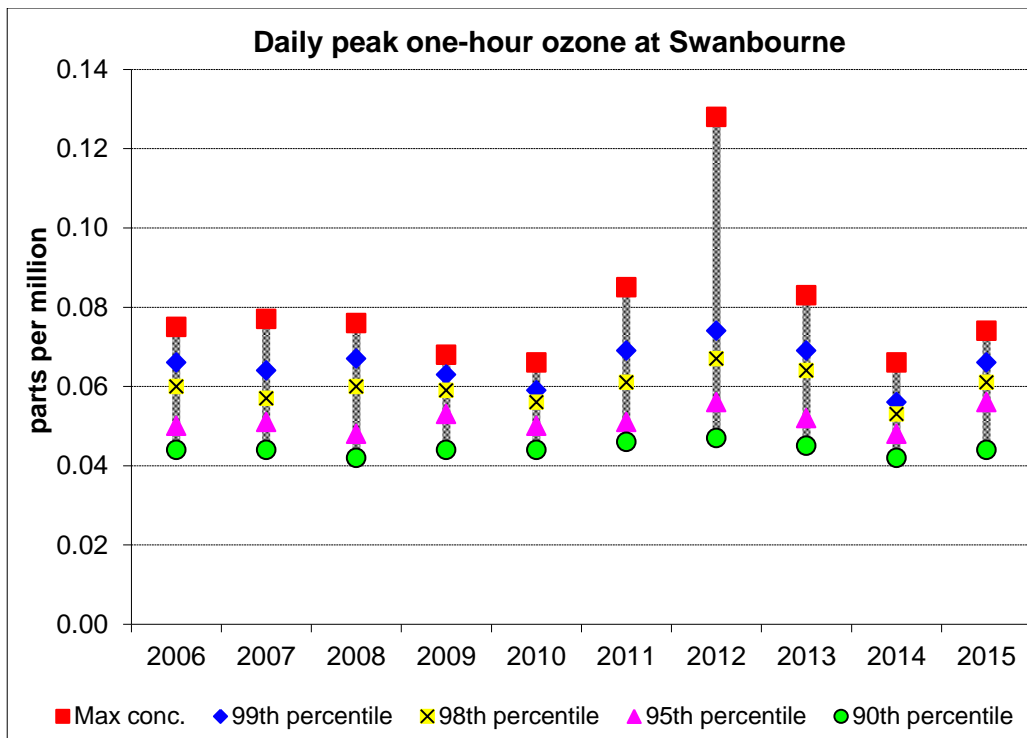


Figure A1-16 - one-hour ozone at Swanbourne

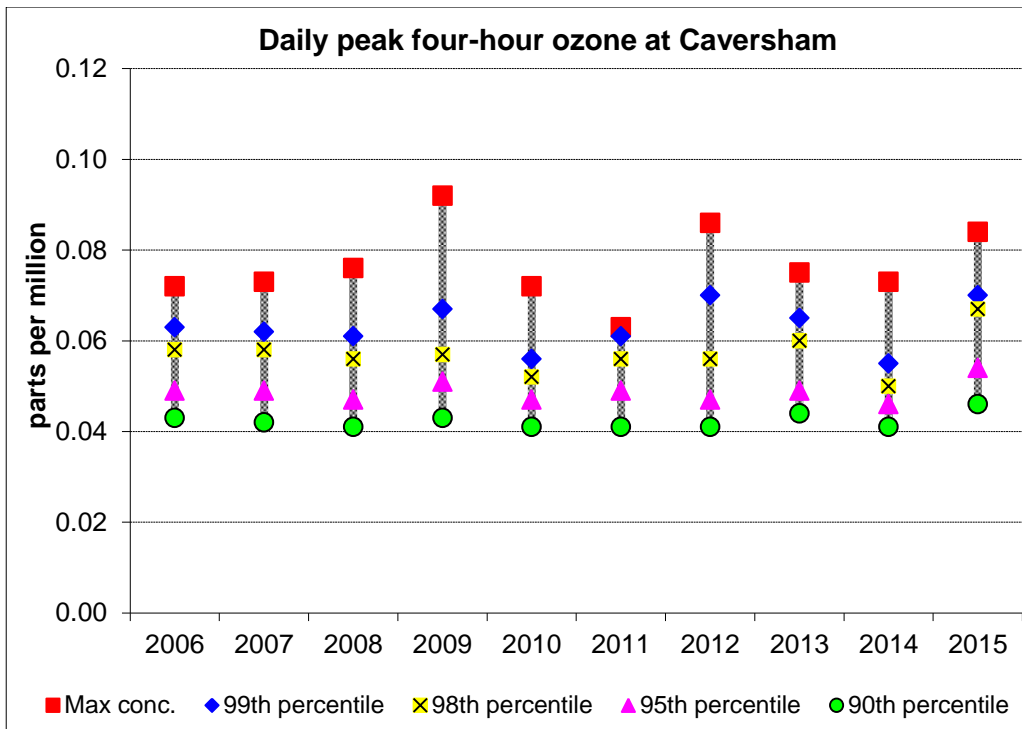


Figure A1-17 - four-hour ozone at Caversham

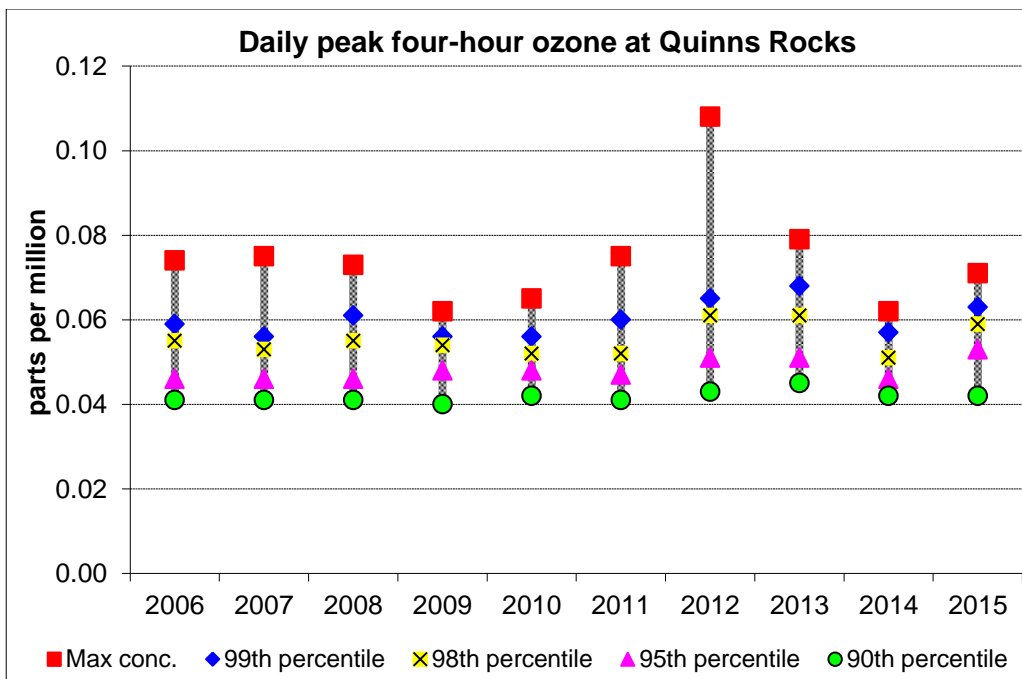


Figure A1-18 - four-hour ozone at Quinns Rocks

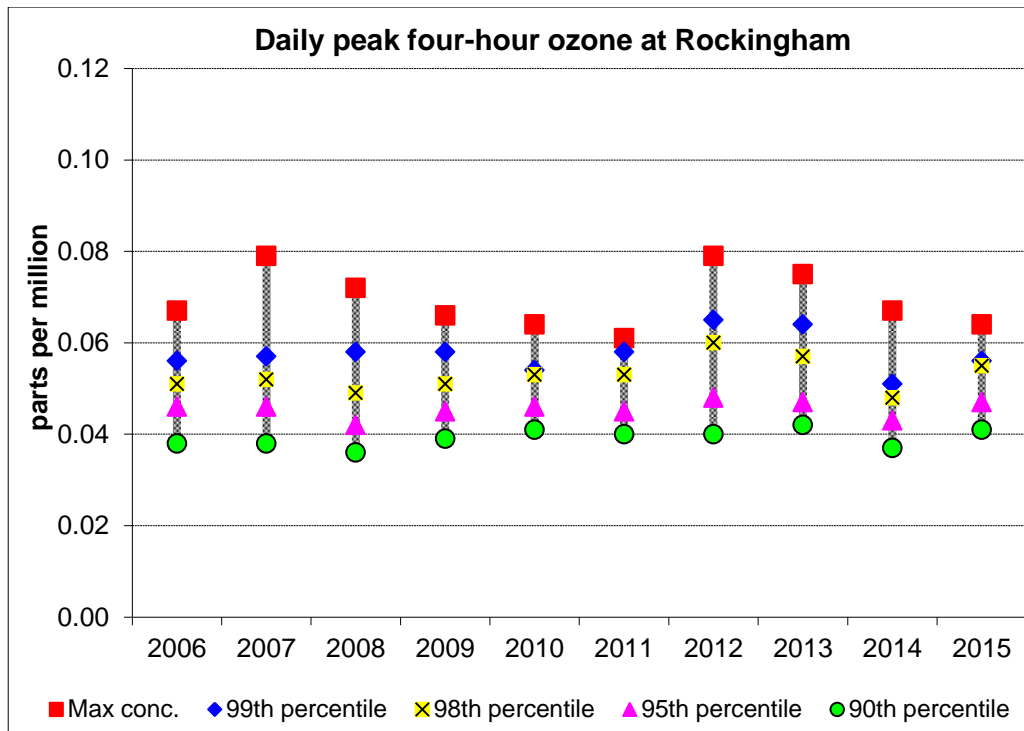


Figure A1-19 - four-hour ozone at Rockingham

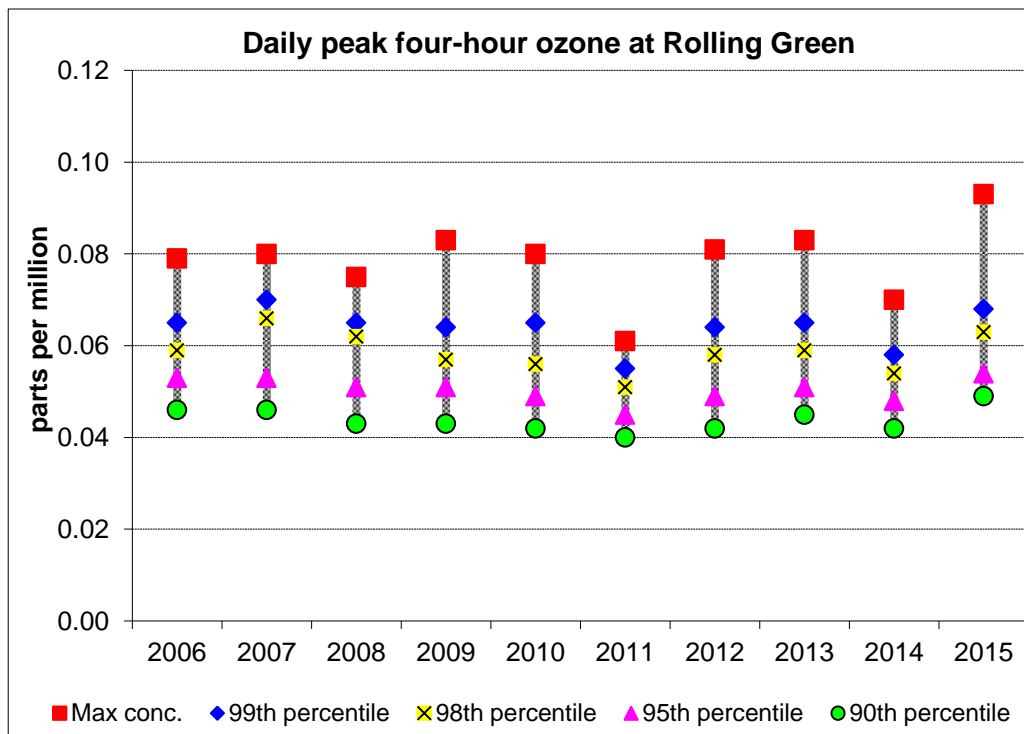


Figure A1-20 - four-hour ozone at Rolling Green

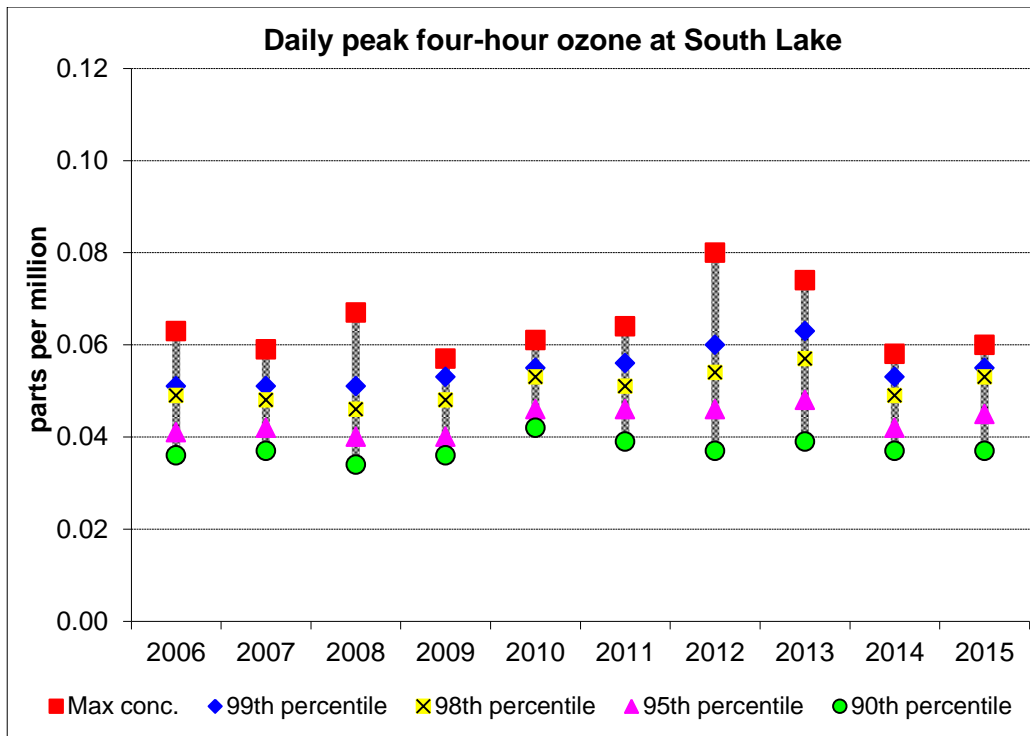


Figure A1-21 - four-hour ozone at South Lake

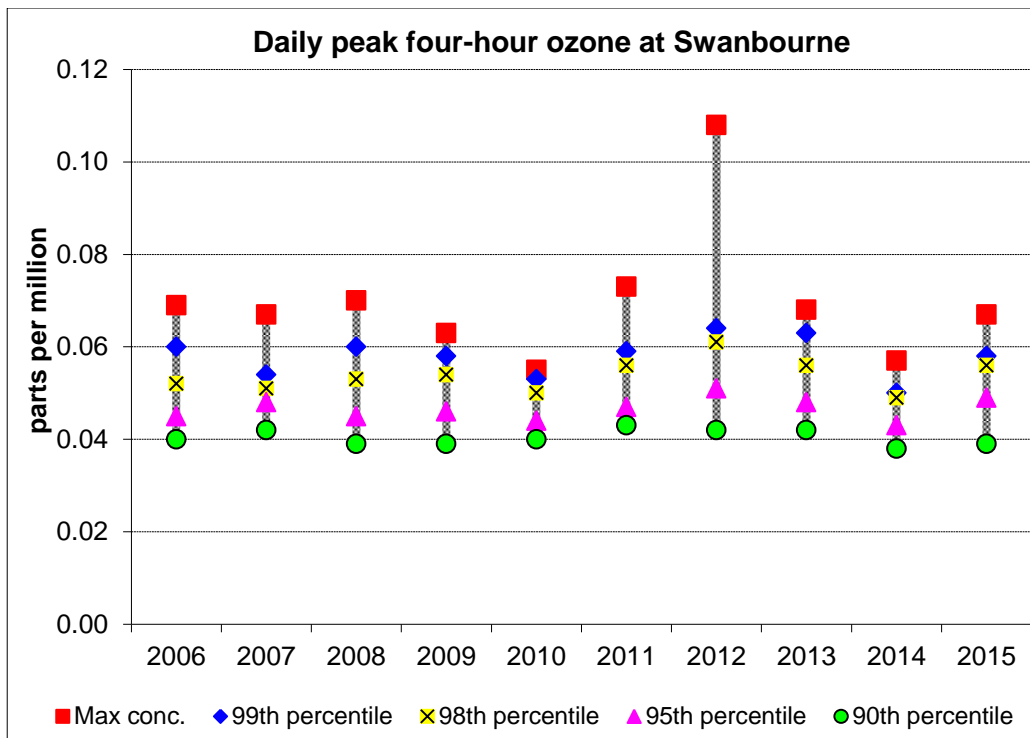


Figure A1-22 - four-hour ozone at Swanbourne

Sulfur dioxide

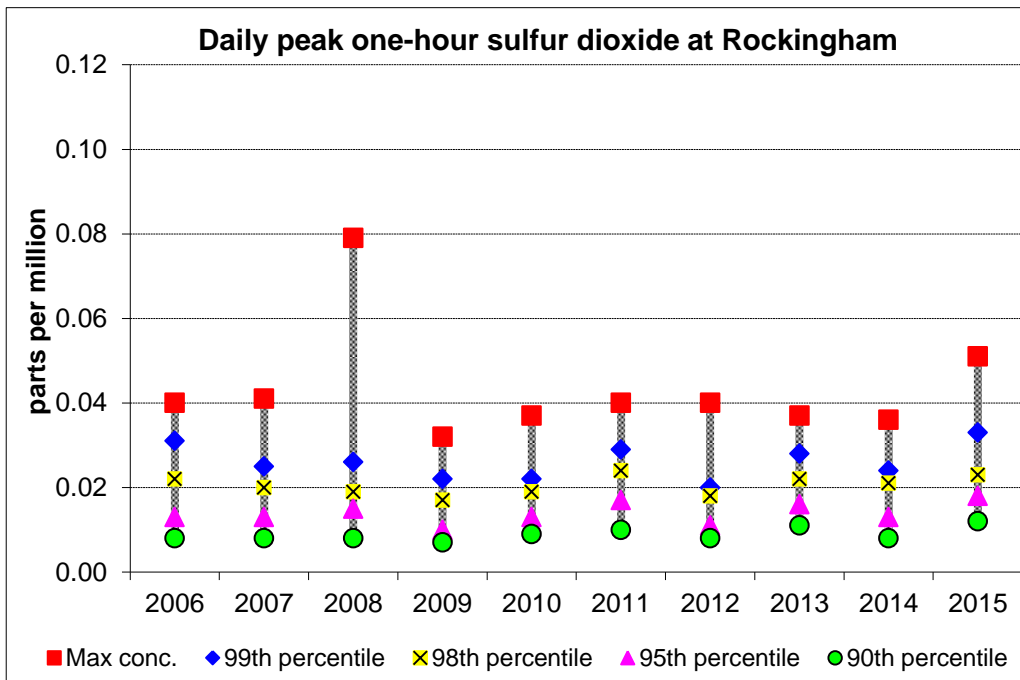


Figure A1-23 - one-hour sulfur dioxide at Rockingham

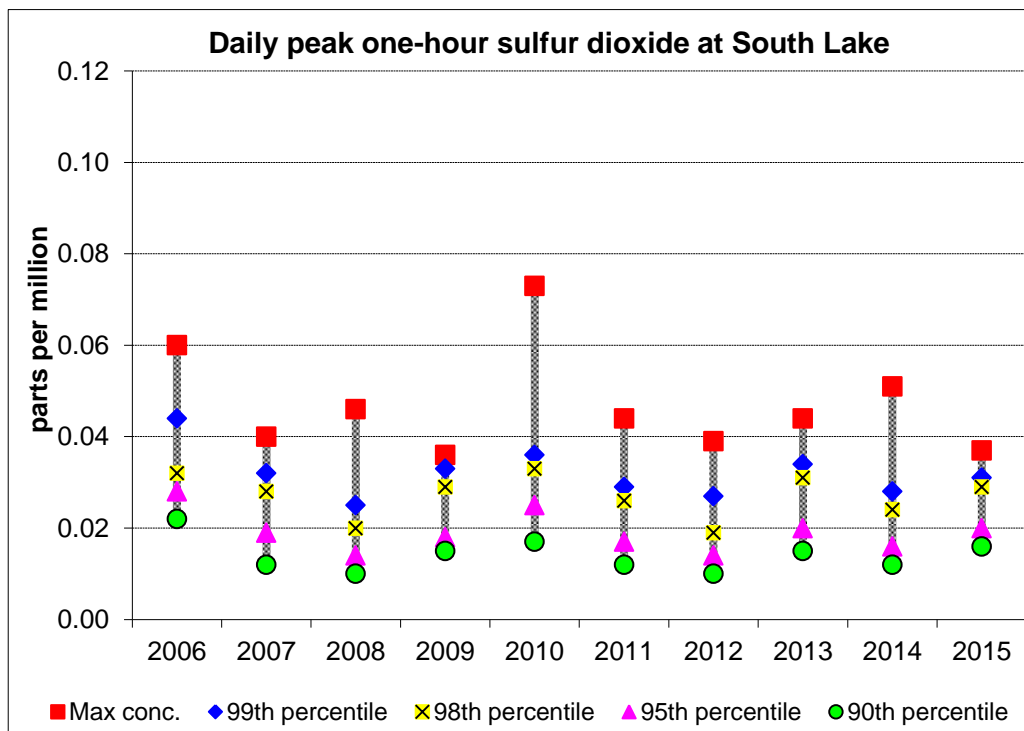


Figure A1-24 - one-hour sulfur dioxide at South Lake

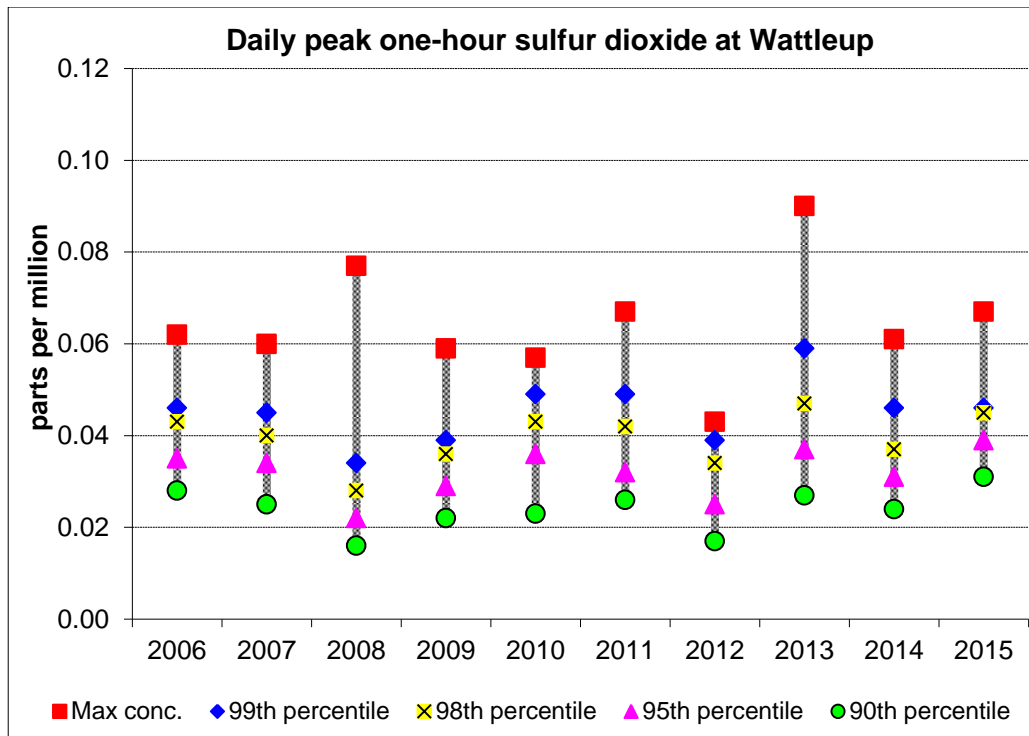


Figure A1-25 - one-hour sulfur dioxide at Wattleup

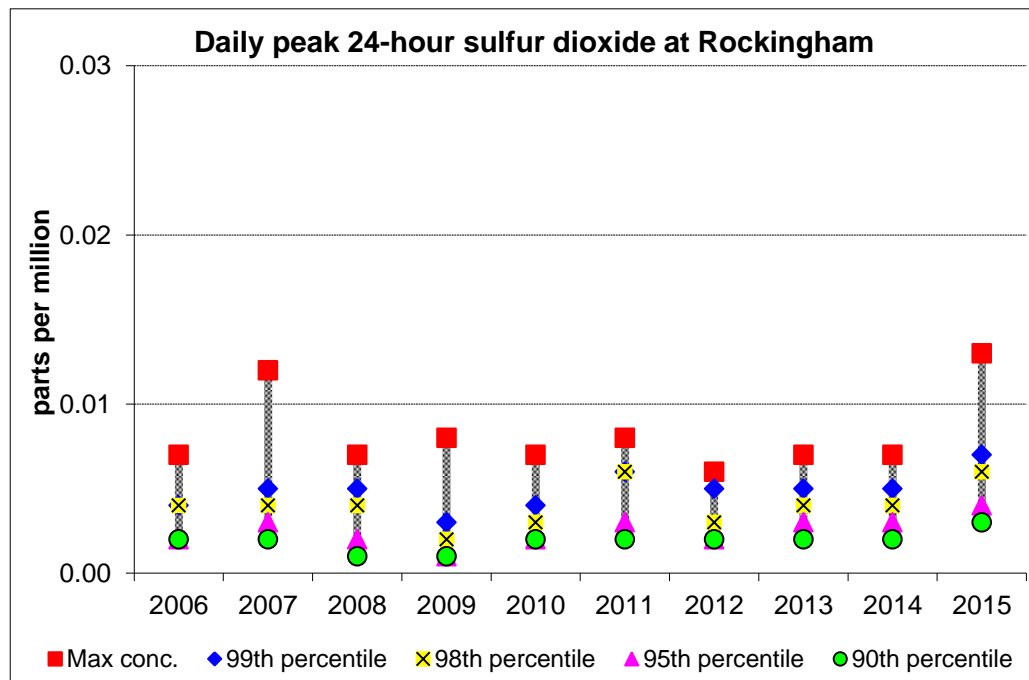


Figure A1-26 - 24-hour sulfur dioxide at Rockingham

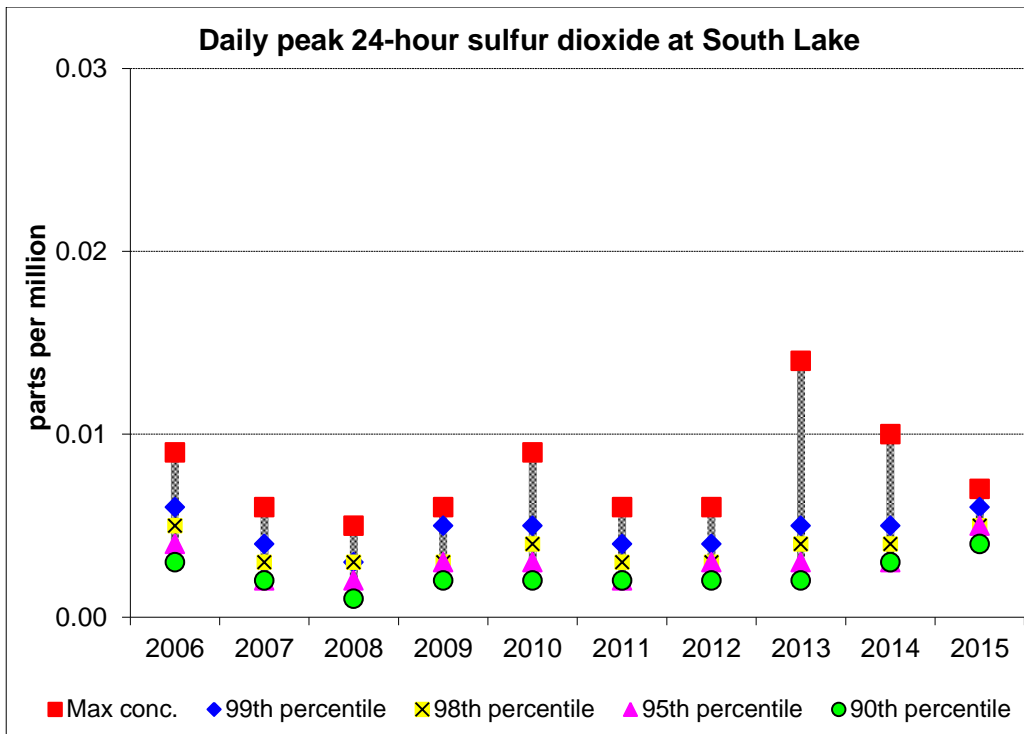


Figure A1-27 - 24-hour sulfur dioxide at South Lake

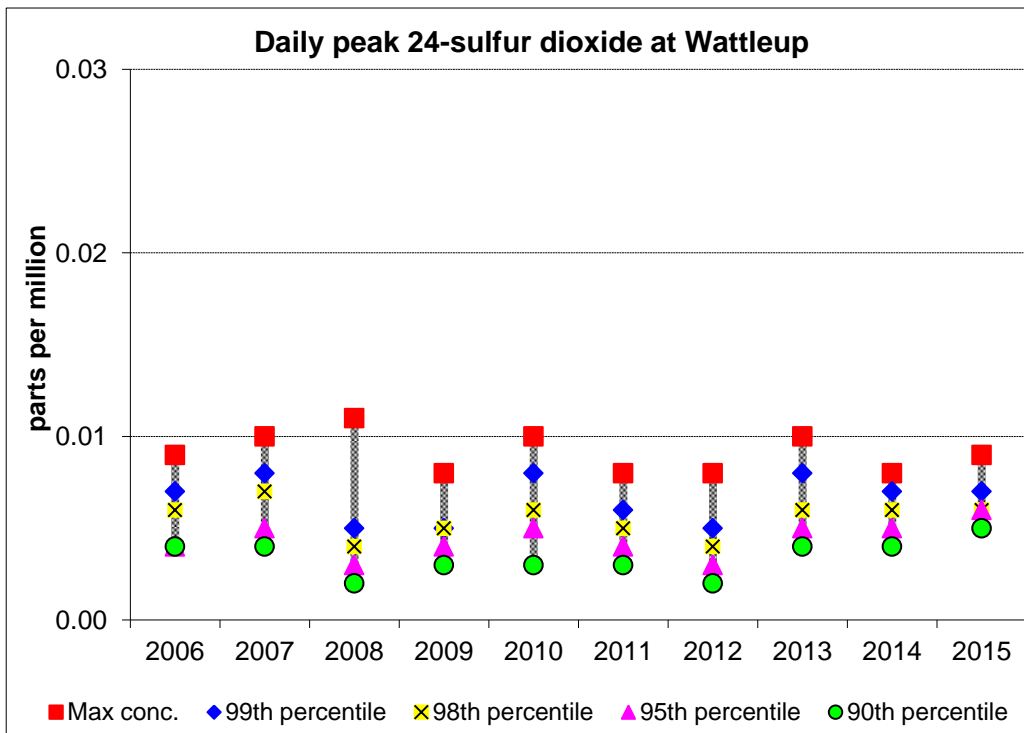


Figure A1-28 - 24-hour sulfur dioxide at Wattleup

Particles as PM₁₀

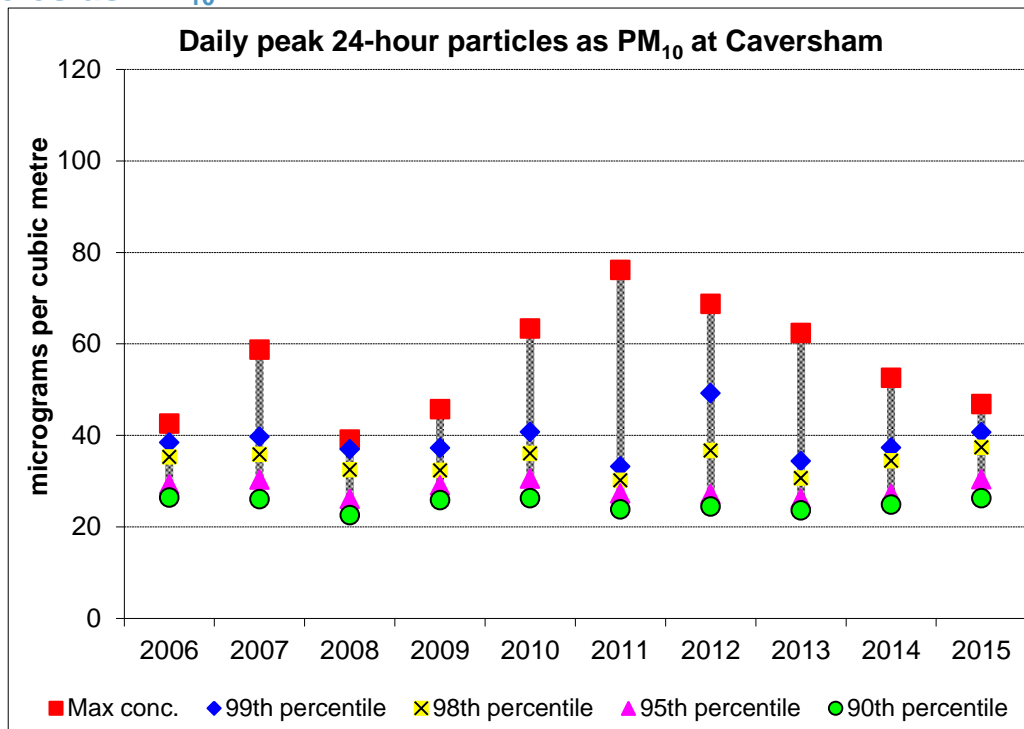


Figure A1-29 - 24-hour PM₁₀ at Caversham

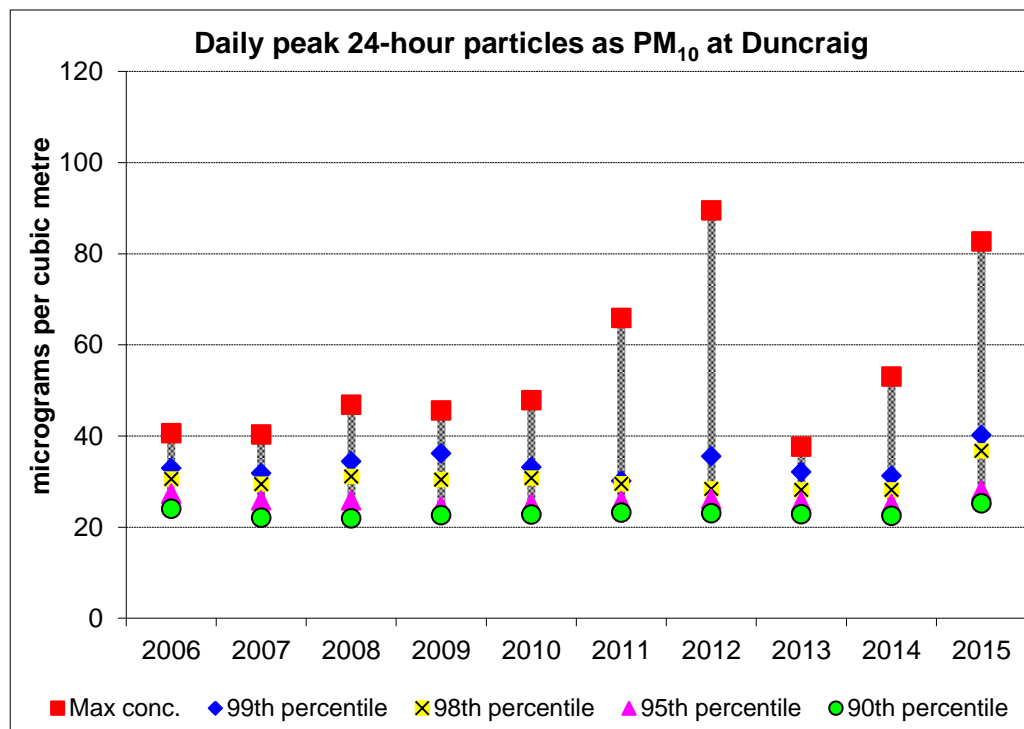


Figure A1-30 - 24-hour PM₁₀ at Duneraig

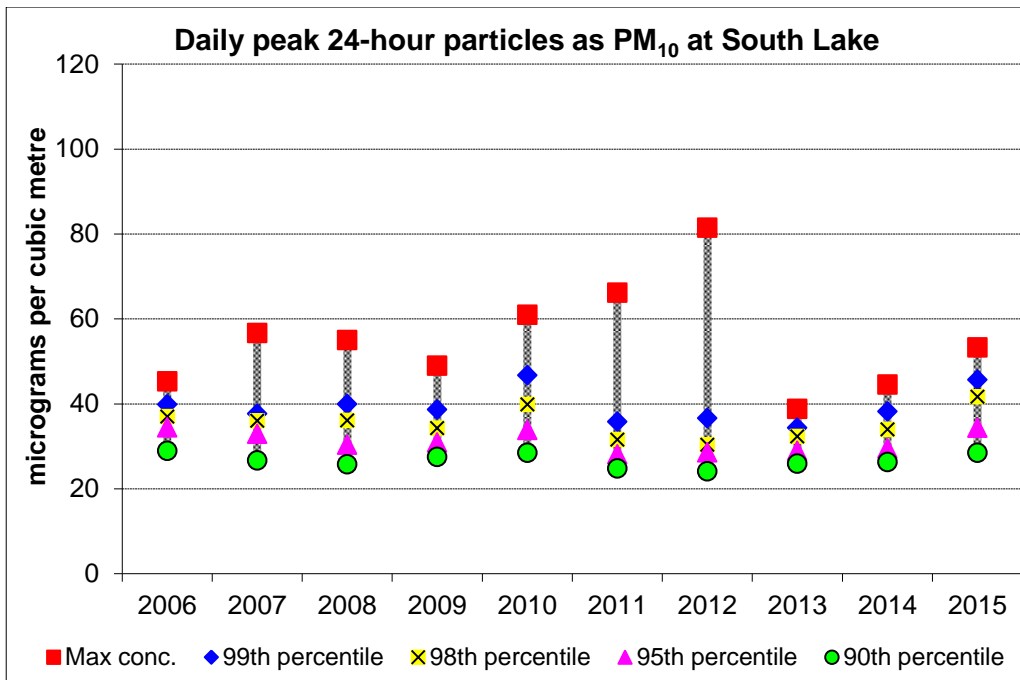


Figure A1-31 - 24-hour PM₁₀ at South Lake

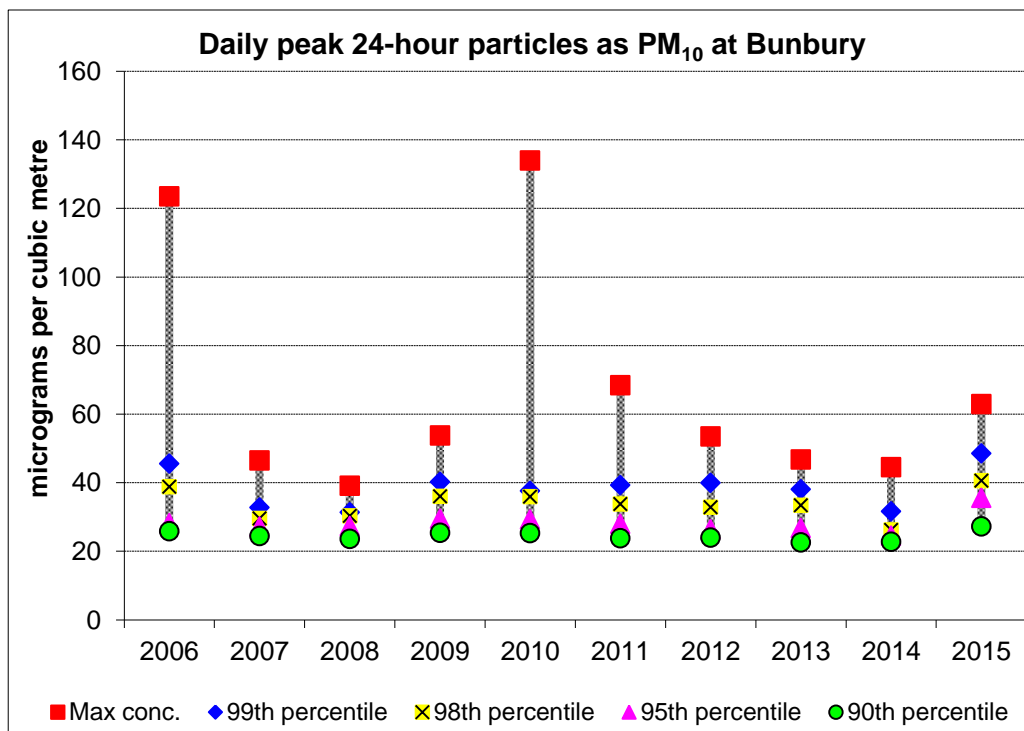


Figure A1-32 - 24-hour PM₁₀ at Bunbury

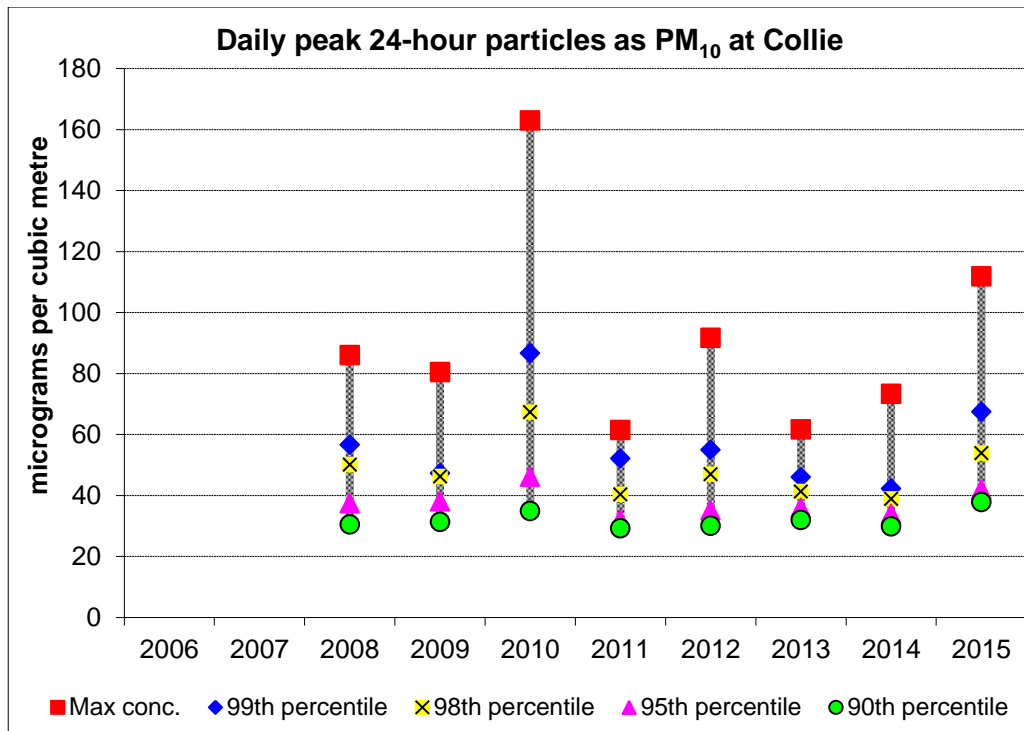


Figure A1-33 - 24-hour PM₁₀ at Collie

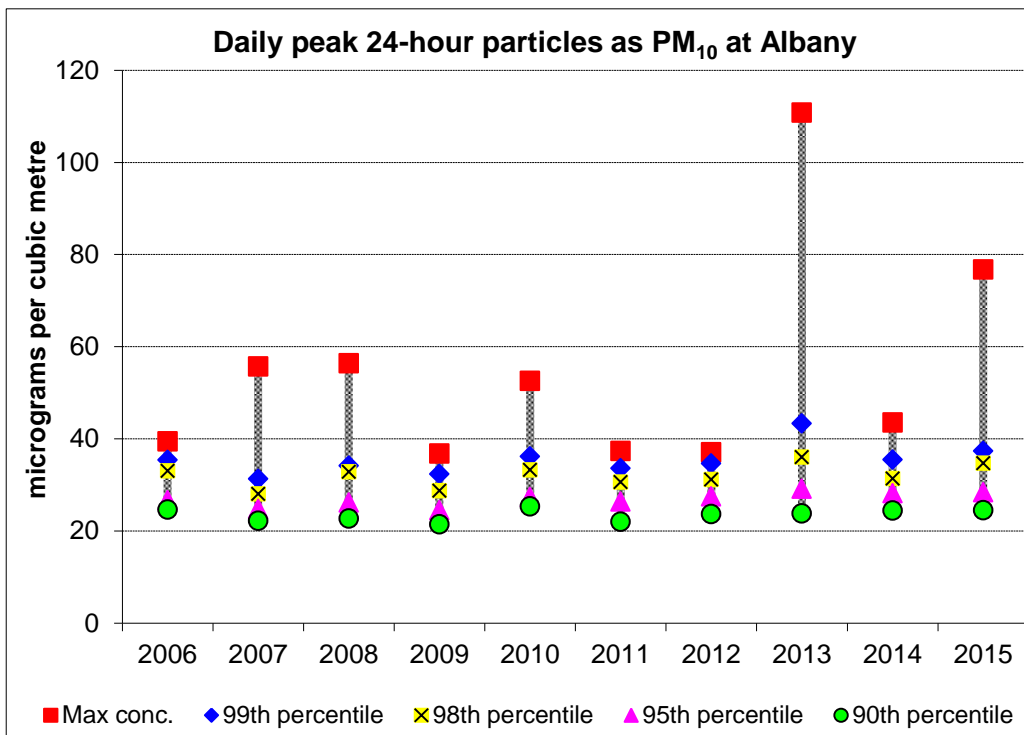


Figure A1-34 - 24-hour PM₁₀ at Albany

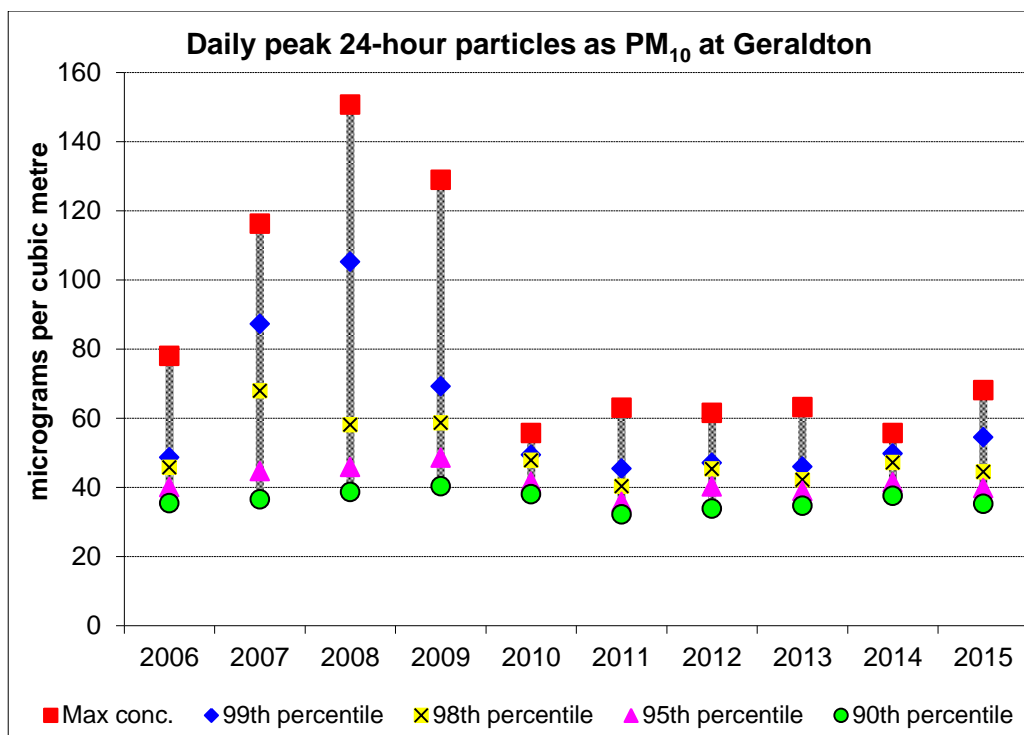


Figure A1-35 - 24-hour PM₁₀ at Geraldton

Particles as PM_{2.5}

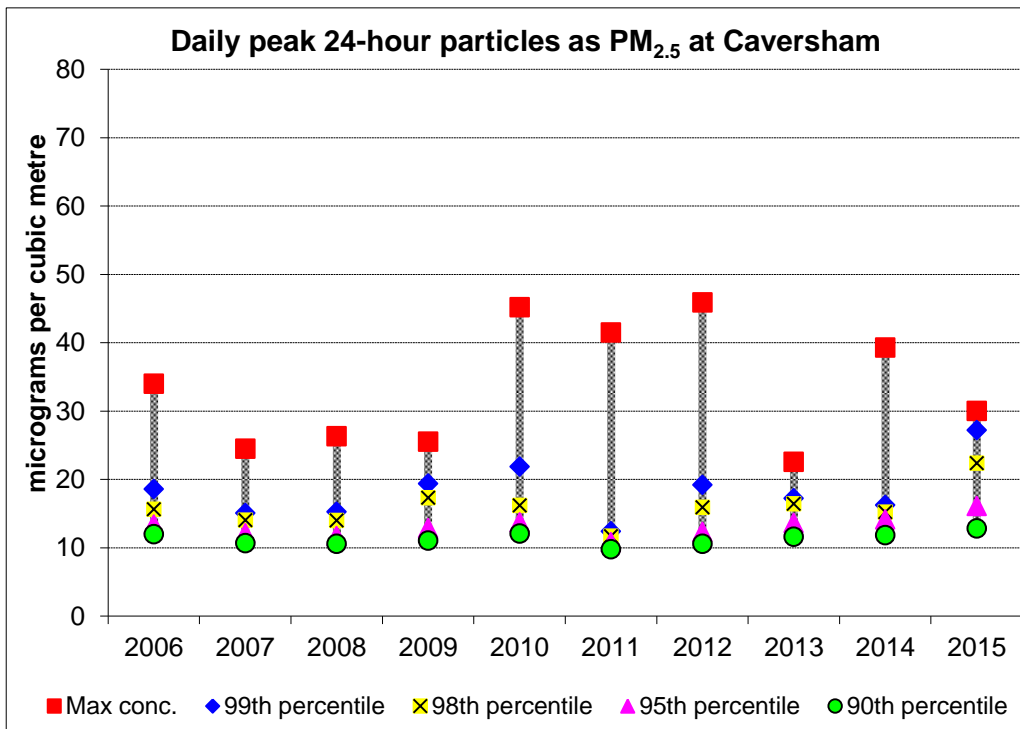


Figure A1-36 - 24-hour PM_{2.5} at Caversham

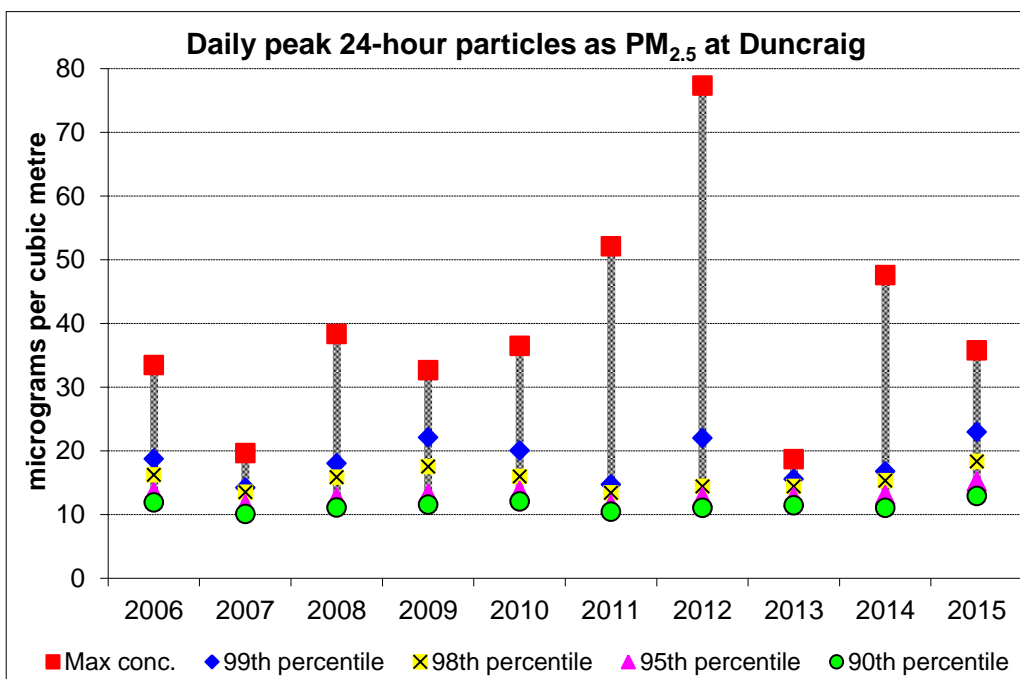


Figure A1-37 - 24-hour PM_{2.5} at DunCraig

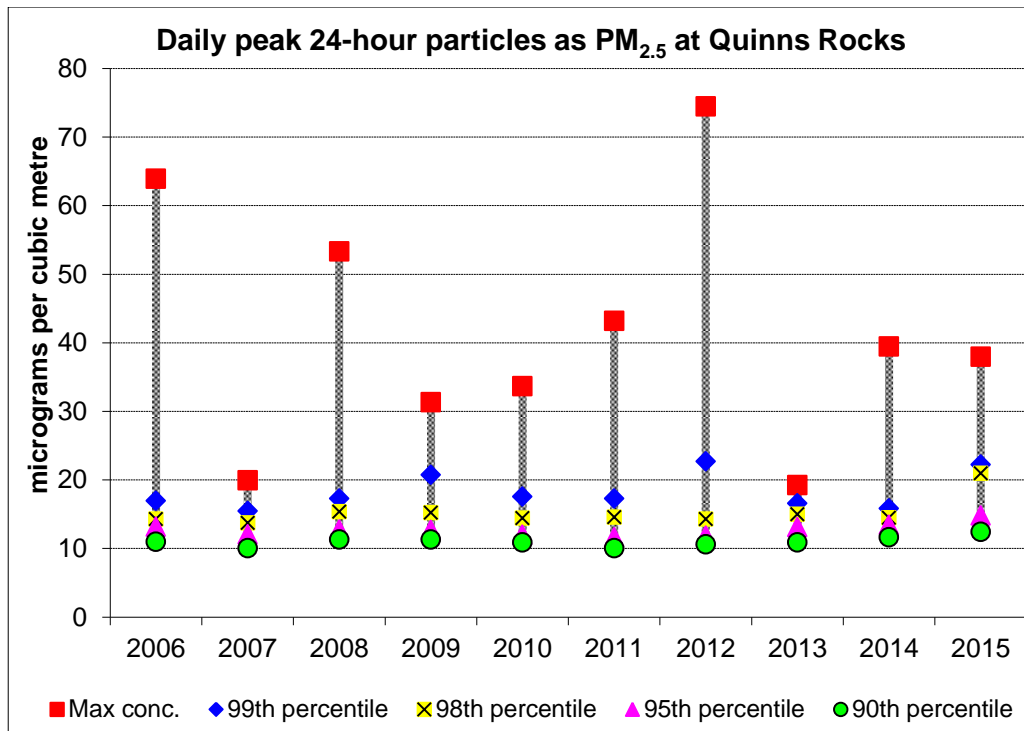


Figure A1-38 - 24-hour PM_{2.5} at Quinns Rocks

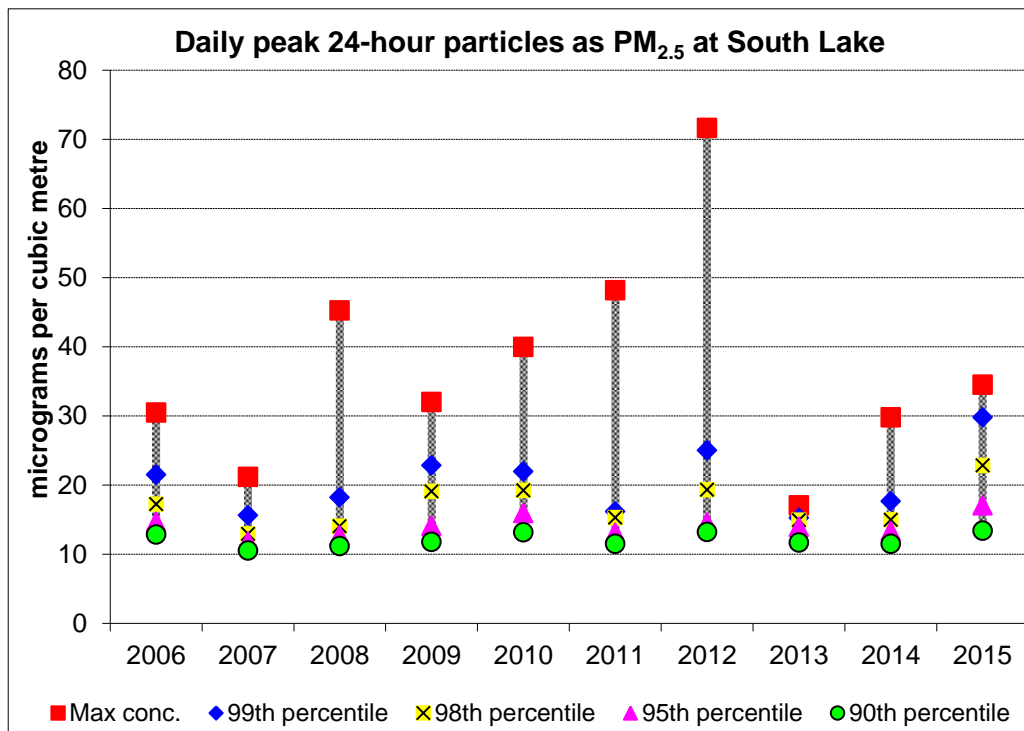


Figure A1-39 - 24-hour PM_{2.5} at South Lake

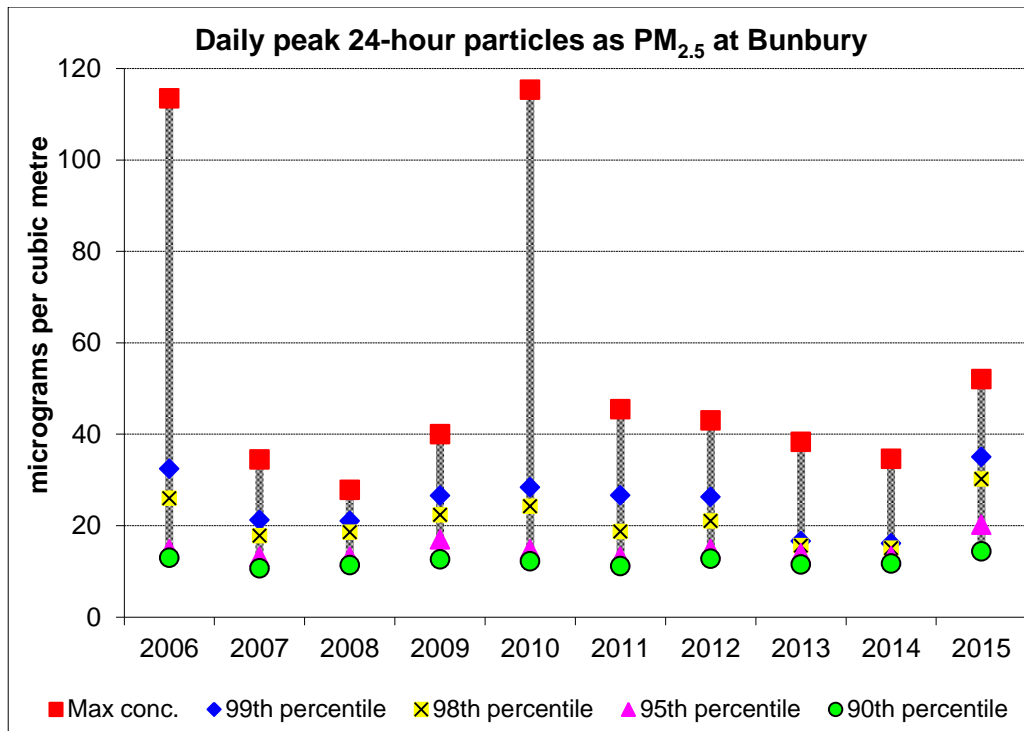


Figure A1-40 - 24-hour PM_{2.5} at Bunbury

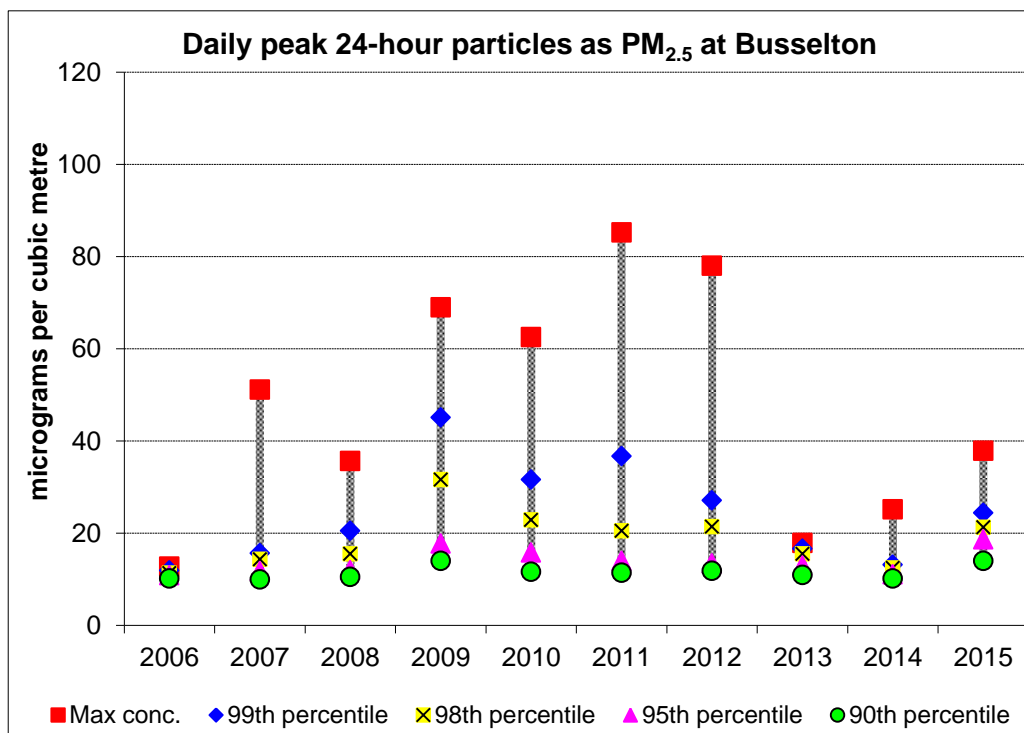


Figure A1-41 - 24-hour PM_{2.5} at Busselton

Attachment 2 – Exceedence summary

The following pages contain information specific to each parameter exceeding the relevant NEPM standard during 2015. Each analysis is provided in date order and may include one or more of a satellite image of the region, a back trajectory, concentration and/or wind plots together with information on the specific concentrations reached and possible sources.

Each back trajectory is specific to one event and shows a possible path that a parcel of air may have taken through space to have arrived at a particular location at a certain time. Where multiple trajectories are included on one map, the times and back trajectories displayed are those ending at the indicated location at 3am (red), 6am (orange), 9am (yellow), noon (green), 3pm (blue), 6pm (mauve), 9pm (purple) and midnight (black). A back trajectory does no more than use the wind speed and direction information recorded at various monitoring sites to track a simple path backwards to a possible origin site. Some major assumptions made in the calculation of these back trajectories, such as the meteorological conditions, can be interpolated between sites and no air dispersion throughout the path, create large uncertainties in the predicted path and must be acknowledged. Notwithstanding, the back trajectories as calculated provide a reasonable first approximation for the possible path taken by an air parcel in arriving at its destination.

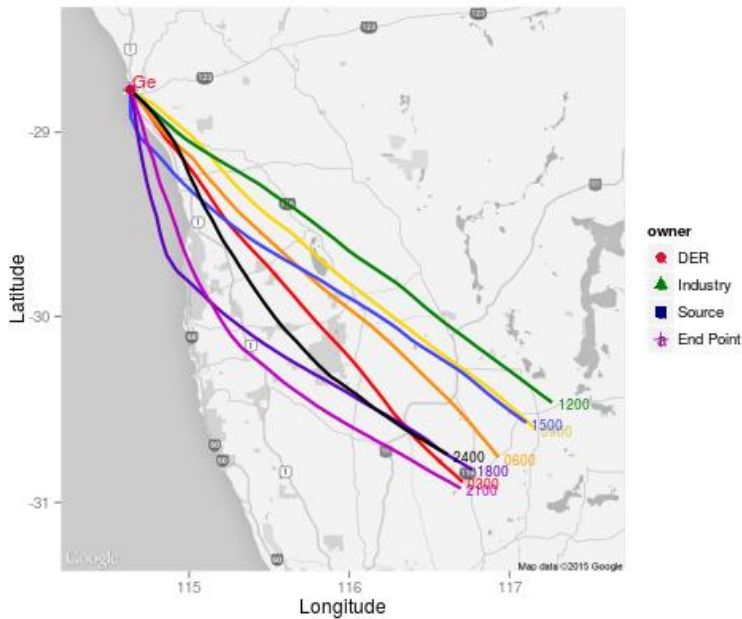
Satellite images are obtained from <https://earthdata.nasa.gov/labs/worldview> where available and cloud cover does not obscure the plume.

Abbreviations are occasionally used to represent air monitoring sites. The more common of these are:

Metropolitan sites	
Ca	Caversham
Du	Duncraig
QR	Quinns Rocks
Ro	Rockingham
RG	Rolling Green
SL	South Lake
Sw	Swanbourne
Wt	Wattleup

Regional sites	
Al	Albany
Bu	Bunbury
Bn	Busselton
Co	Collie
Ge	Geraldton

9 January 2015



Back trajectory over 14 hours ending at Geraldton at the indicated times.

Pollutant

PM₁₀

Monitoring Site

Geraldton

NEPM Standard

PM₁₀ – 50.0 µg/m³

Averaging Period

24 hours

Concentration (µg/m³)

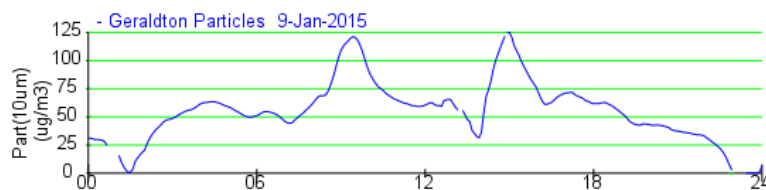
57.7 µg/m³

Description of Event

South easterly winds for the majority of the day causing long range transport of smoke from bushfire north of Boonanarring nature reserve.



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)



60 minute averaged time series plot of PM10 at Geraldton.

3 February 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)

Pollutant

PM₁₀

Monitoring Site

Collie

NEPM Standard

PM₁₀ – 50.0 µg/m³

Averaging Period

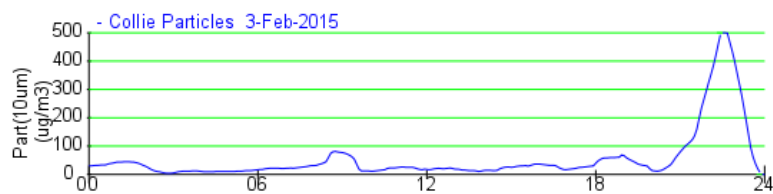
24 hours

Concentration (µg/m³)

54.0 µg/m³

Description of Event

A Lower Hotham Bushfire (about 20,000 ha) was dumping a lot of ash on the town of Collie through the night.

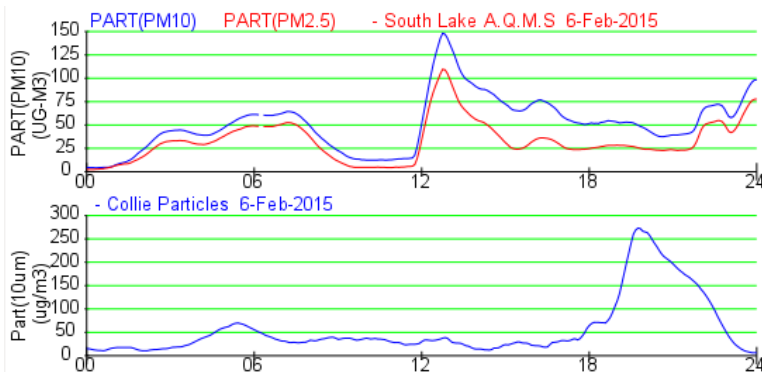


60 minute averaged time series plot of PM10 at Collie.

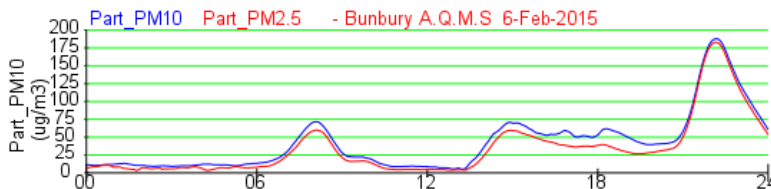
6 February 2015



Fire map showing hot spot locations from Aqua / MODIS
<https://earthdata.nasa.gov/labs/worldview>



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red) at South Lake and Collie.



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red) at Bunbury.

Pollutant

PM₁₀ & PM_{2.5}

Monitoring Sites

Site	Parameter
South Lake	PM ₁₀ & PM _{2.5}
Collie	PM ₁₀
Quinns Rocks	PM _{2.5}
Duncraig	PM _{2.5}
Caversham	PM _{2.5}
Bunbury	PM _{2.5}

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

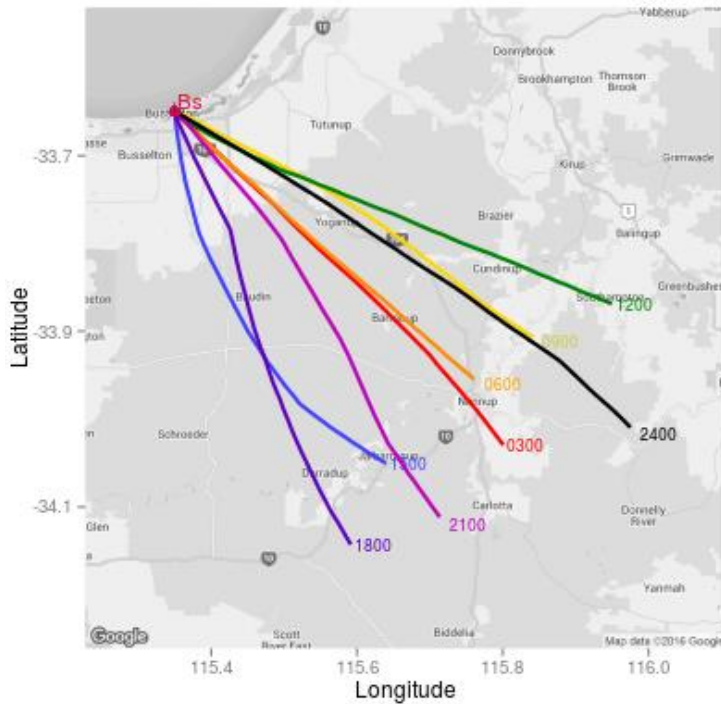
Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
South Lake	53.3	34.5
Collie	56.2	
Quinns Rocks		37.9
Duncraig	48.8	35.8
Caversham	37.2	27.6
Bunbury	42.8	35.0

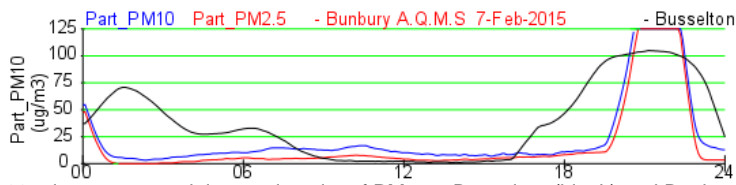
Description of Event

Smoke from a Lower Hotham Bushfire (about 20,000 ha) caused smoke impacts in the southwest and Perth metropolitan areas.

7 February 2015



Back trajectory over 24 hours ending at Busselton at the indicated times.



60 minute averaged time series plot of PM_{2.5} at Busselton (black) and Bunbury PM₁₀ (blue) and PM_{2.5} (red).

Pollutant

PM_{2.5}

Monitoring Sites

Busselton

NEPM Standards

PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

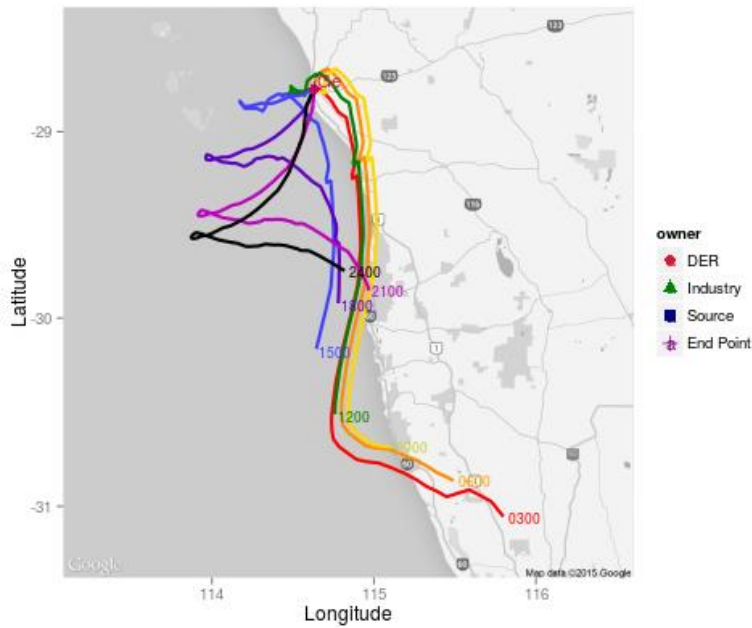
Concentrations (µg/m³)

37.8 µg/m³

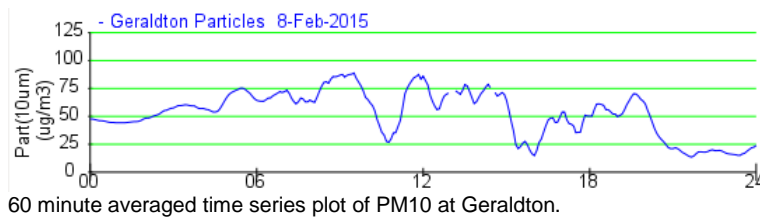
Description of Event

Smoke from a Lower Hotham Bushfire (about 20,000 ha) caused smoke impacts in the southwest and Perth metropolitan areas.

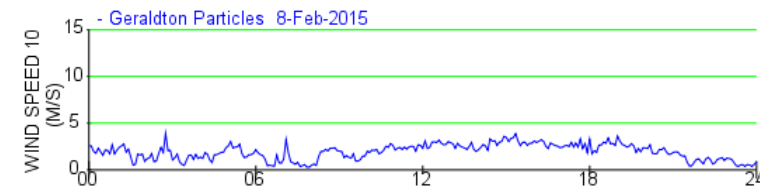
8 February 2015



Back trajectory over 24 hours ending at Geraldton at the indicated times.



60 minute averaged time series plot of PM10 at Geraldton.



5 minute averaged time series plot of wind speed at Geraldton.

Pollutant

PM₁₀

Monitoring Sites

Geraldton

NEPM Standards

PM₁₀ – 50.0 µg/m³

Averaging Period

24 hours

Concentrations (µg/m³)

52.5 µg/m³

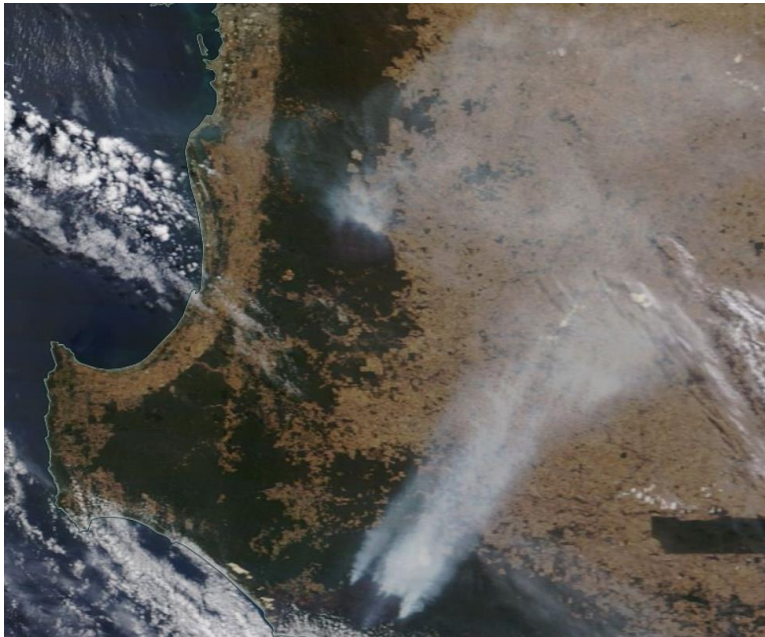
Description of Event

Possibly caused by recirculation of smoke from fires located in the southwest of the state.

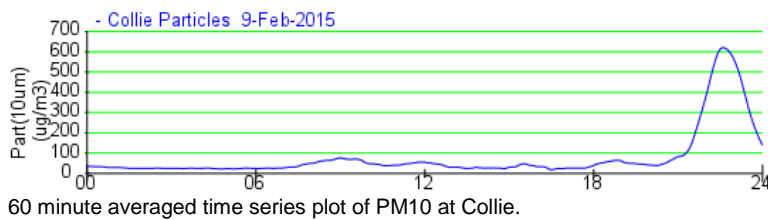
Wind speeds at Geraldton were low for the majority of the day.

There were no fires in the vicinity of Geraldton.

9 February 2015



Fire map showing hot spot locations from Terra / MODIS
<https://earthdata.nasa.gov/labs/worldview>



Pollutant

PM₁₀ & PM_{2.5}

Monitoring Sites

Site	Parameter
South Lake	PM _{2.5}
Collie	PM ₁₀

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

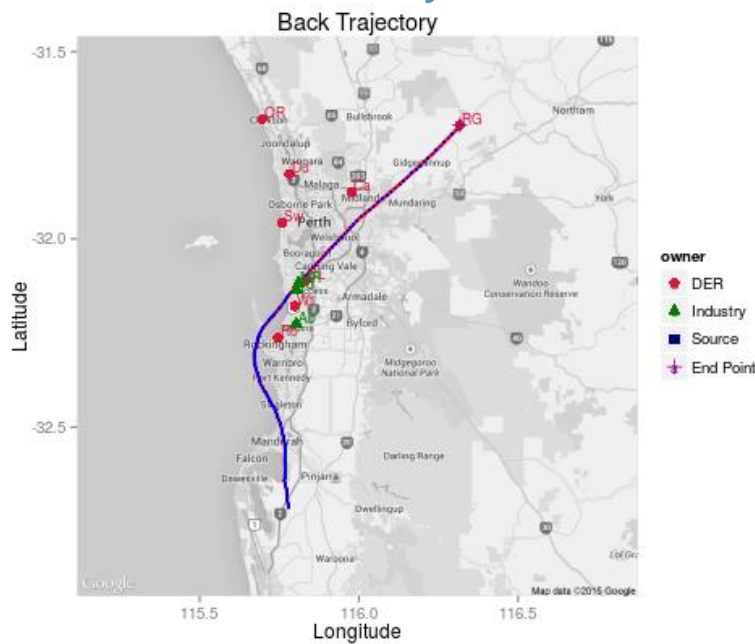
Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
South Lake	46.3	28.9
Collie	79.4	

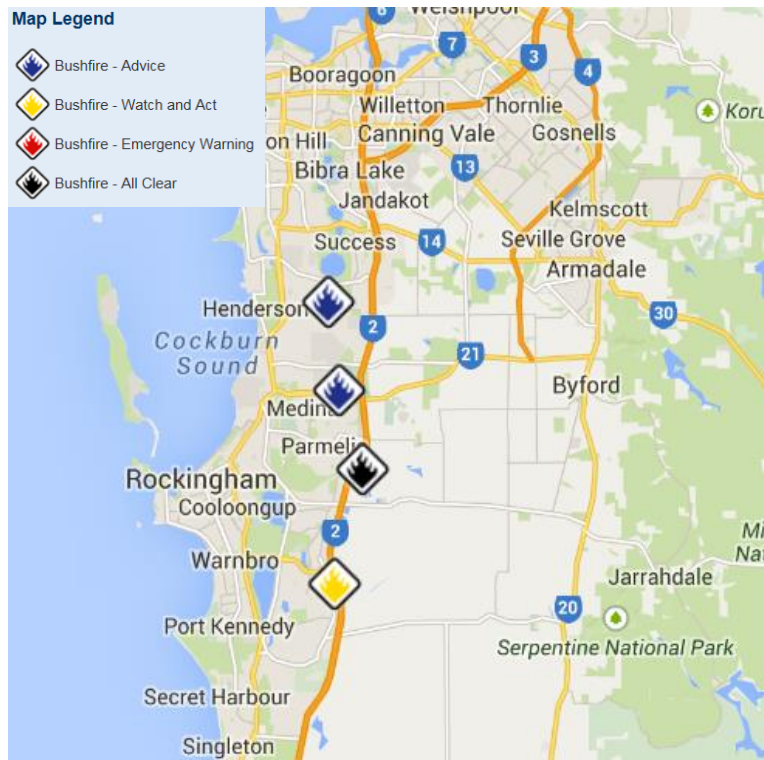
Description of Event

Smoke from a Lower Hotham Bushfire (about 20,000 ha) caused smoke impacts in the southwest and Perth metropolitan areas.

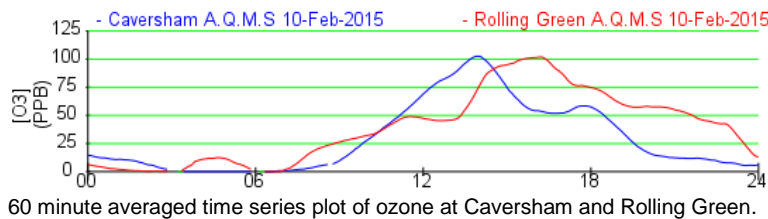
10 February 2015



Back trajectory over 12 hours ending at 1600 (4pm) at Rolling Green.



Fire map showing hot spot locations from Department of Fire and Emergency Services. <http://www.dfes.wa.gov.au/alerts/Pages/alertsmap.aspx>



60 minute averaged time series plot of ozone at Caversham and Rolling Green.

Pollutant

O₃, PM₁₀ & PM_{2.5}

Monitoring Sites

Site	Parameter
Ca	O ₃ (103 ppb 1hr) O ₃ (84 ppb 4 hr) PM _{2.5} (29.7 µg/m³)
Du	PM _{2.5} (28.2 µg/m³)
RG	O ₃ (105 ppb 1hr) O ₃ (93 ppb 4 hr)
SL	PM ₁₀ (51.0 µg/m³) PM _{2.5} (30.8 µg/m³)
QR	PM _{2.5} (35.8 µg/m³)
Bu	PM ₁₀ (62.9 µg/m³) PM _{2.5} (52.1 µg/m³)
Bs	PM _{2.5} (35.5 µg/m³)
Co	PM ₁₀ (68.5 µg/m³)
Ge	PM ₁₀ (68.1 µg/m³)

NEPM Standards

- O₃ – 100 ppb (1 hr)
- O₃ – 80 ppb (4 hr)
- PM₁₀ – 50.0 µg/m³ (24 hr)
- PM_{2.5} – 25.0 µg/m³ (24 hr)

Description of Event

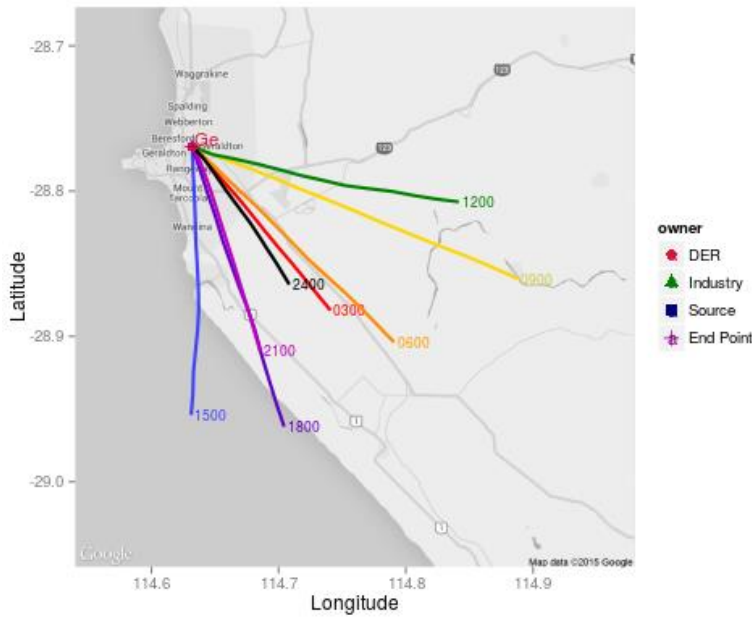
Fires in the southern Perth suburbs of Hammond Park, Success, The Spectacles, Wellard and Baldivis.

Geraldton smoke was a recirculation of smoke from fires in the southwest of the state.



23 February 2015

Back Trajectory



Back trajectory over 24 hours ending at Geraldton at the indicated times.

Pollutant

PM₁₀

Monitoring Sites

Geraldton

NEPM Standards

PM₁₀ – 50.0 µg/m³

Averaging Period

24 hours

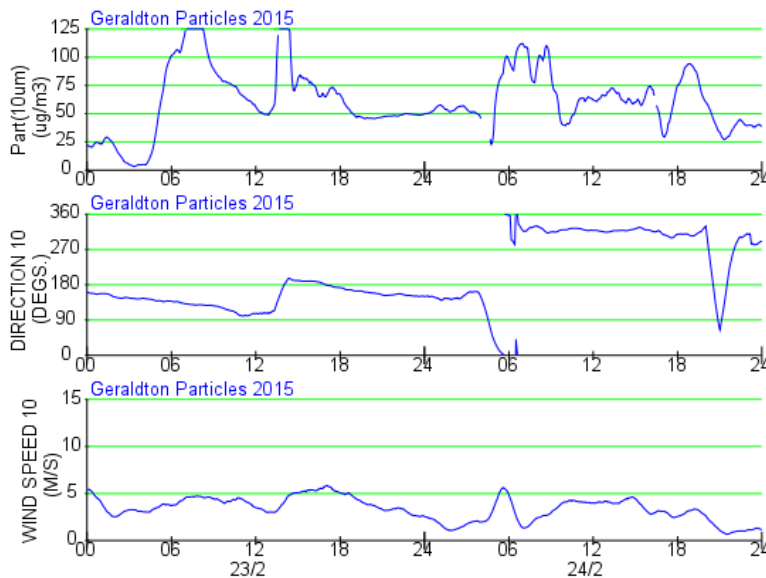
Concentrations (µg/m³)

63.1 µg/m³

Description of Event

Possible local activity.

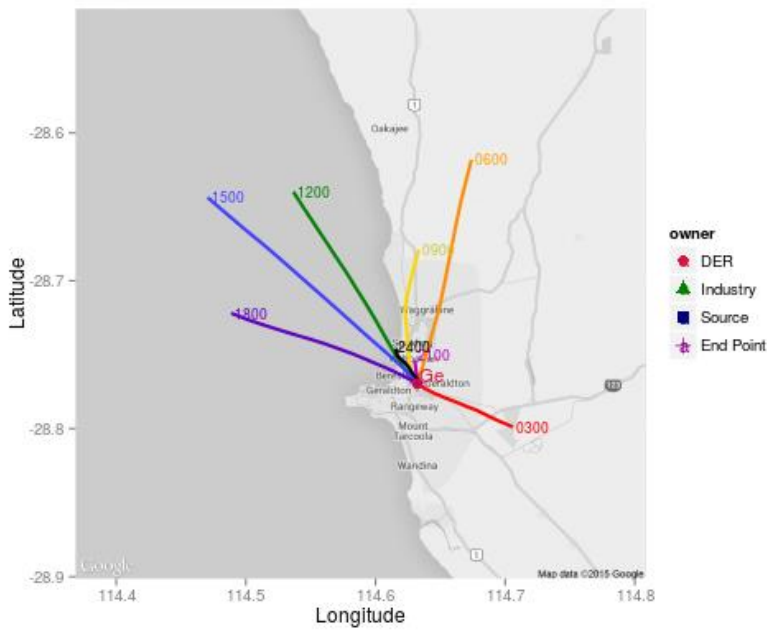
There were no fires in the vicinity of Geraldton.



60 minute averaged time series plot of particles at Geraldton.

24 February 2015

Back Trajectory



Pollutant

PM₁₀

Monitoring Sites

Geraldton

NEPM Standards

PM₁₀ – 50.0 µg/m³

Averaging Period

24 hours

Concentrations (µg/m³)

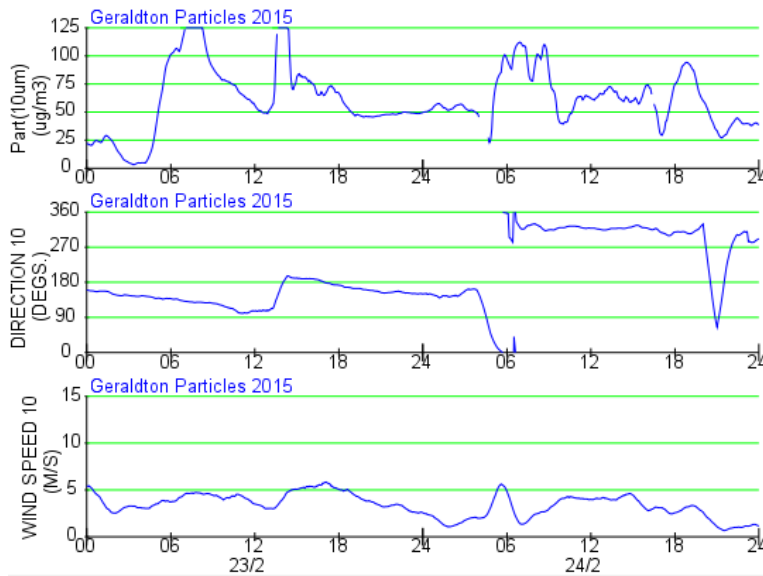
62.3 µg/m³

Description of Event

Possible local activity.

There were no fires in the vicinity of Geraldton.

Back trajectory over 24 hours ending at Geraldton at the indicated times.



60 minute averaged time series plot of particles at Geraldton.

22 April 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)

Pollutant

PM₁₀ & PM_{2.5}

Monitoring Sites

Site	Parameter
Collie	PM ₁₀
Bunbury	PM _{2.5}

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

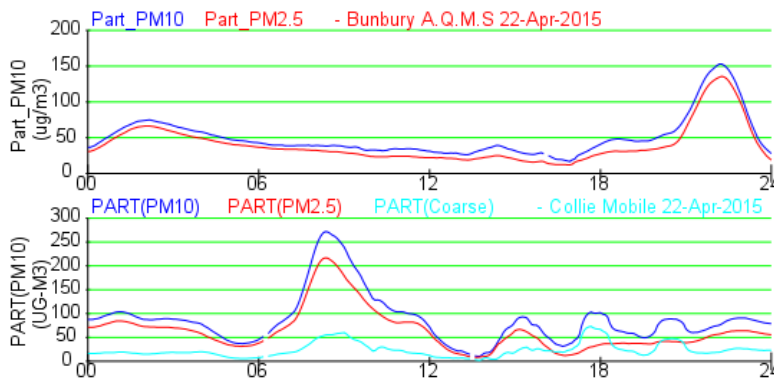
24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Collie	82.7	
Bunbury	49.9	39.9

Description of Event

Prescribed burn 15km east of Collie (2,800Ha).

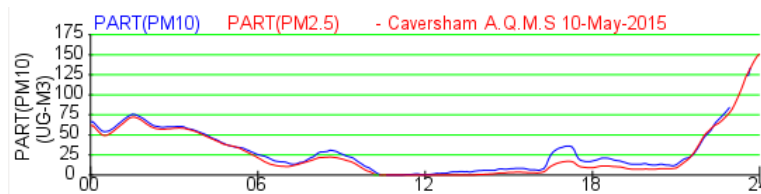


60 minute averaged time series plot of particles at Bunbury and Collie.

10 May 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red) at Caversham.

Pollutant

PM_{2.5}

Monitoring Sites

Caversham

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

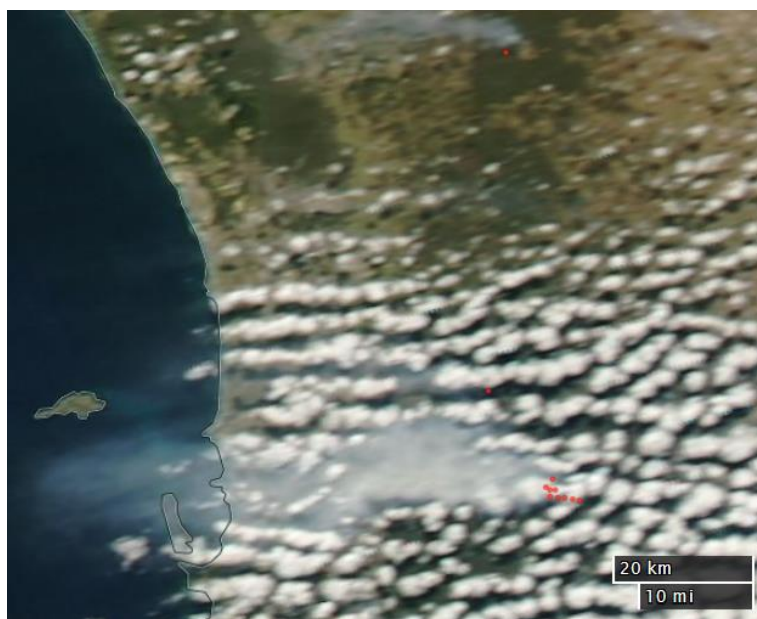
Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Caversham	33.1	28.3

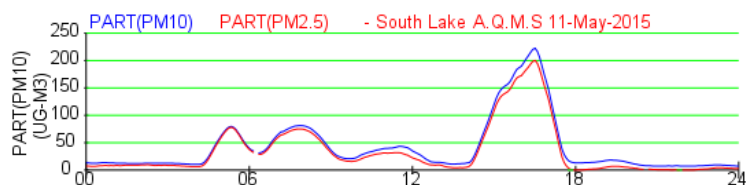
Description of Event

A number of prescribed burns were conducted in and around Perth metropolitan region.

11 May 2015



Fire map showing hot spot locations from Aqua / MODIS
<https://earthdata.nasa.gov/labs/worldview>



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red) at South Lake.

Pollutant

PM_{2.5}

Monitoring Sites

South Lake

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
South Lake	41.2	33.6

Description of Event

A number of prescribed burns were conducted in and around Perth metropolitan region.

14 May 2015



Fire map showing hot spot locations from Aqua / MODIS
<https://earthdata.nasa.gov/labs/worldview>

Pollutant

PM_{2.5}

Monitoring Sites

South Lake

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

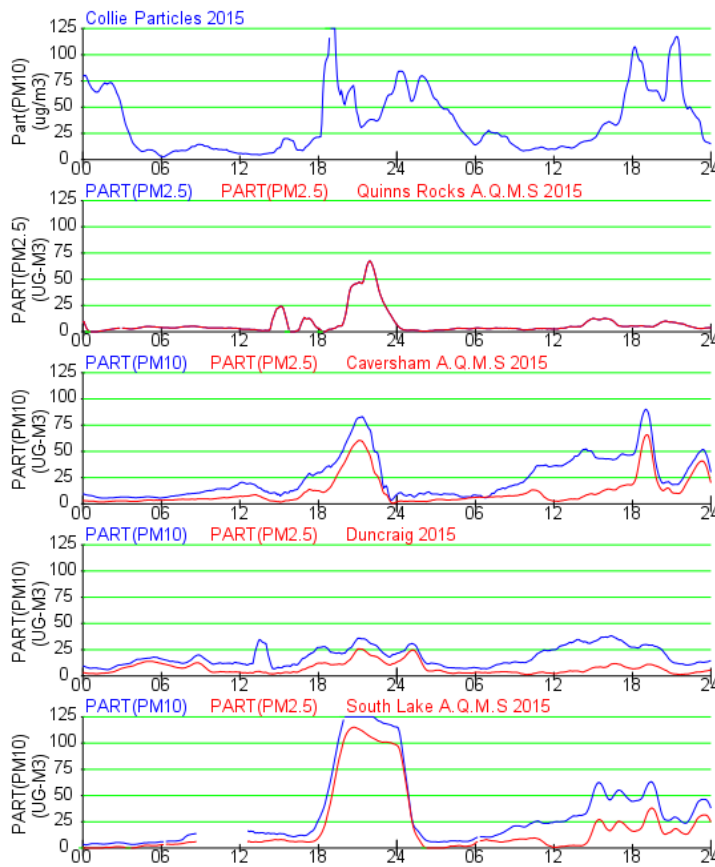
24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
South Lake	43.0	32.9

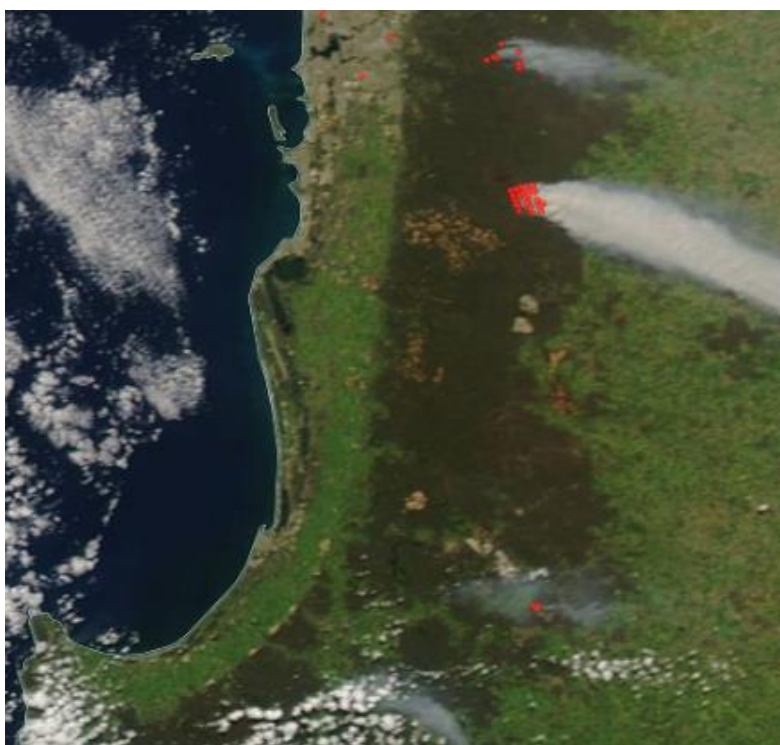
Description of Event

A number of prescribed burns were conducted in and around Perth metropolitan region.

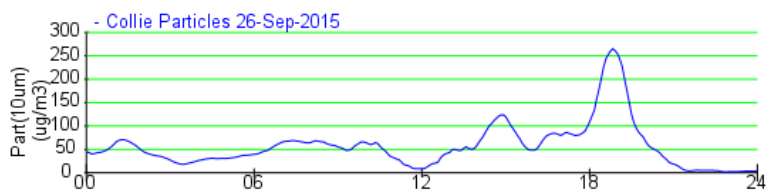


60 minute averaged time series plot of PM10 (blue) and PM2.5 (red) at various sites including South Lake.

26 September 2015



Fire map showing hot spot locations from Aqua / MODIS
<https://earthdata.nasa.gov/labs/worldview>



60 minute averaged time series plot of PM10 at Collie.

Pollutant

PM₁₀

Monitoring Sites

Collie

NEPM Standards

PM₁₀ – 50.0 µg/m³

Averaging Period

24 hours

Concentrations (µg/m³)

Site	PM ₁₀
Collie	55.7

Description of Event

A number of prescribed burns were conducted in the southwest including 4,000 hectares south of Collie.

8 October 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)

Pollutant

PM₁₀

Monitoring Sites

Collie

NEPM Standards

PM₁₀ – 50.0 µg/m³

Averaging Period

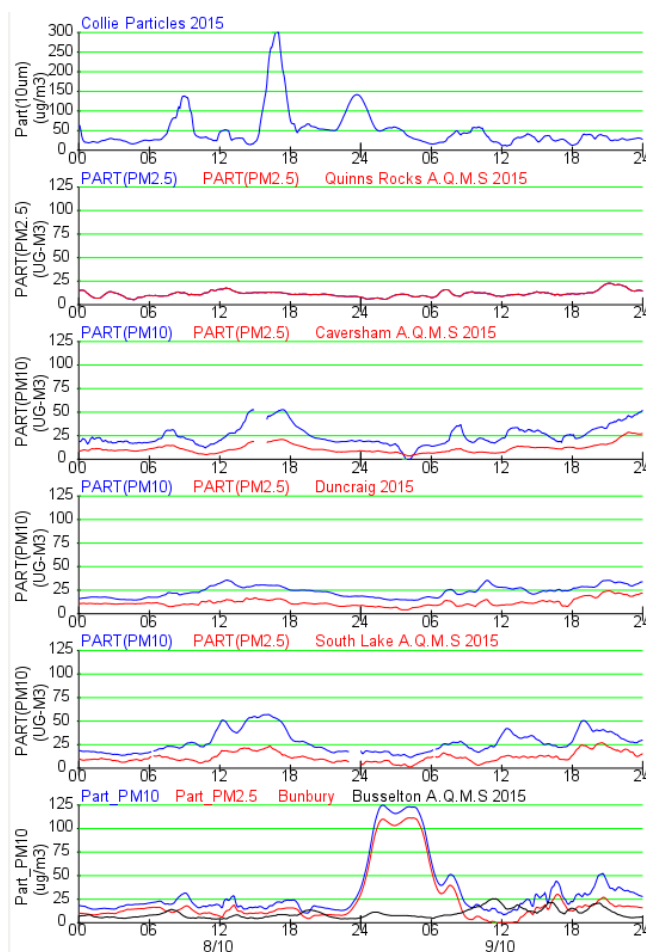
24 hours

Concentrations (µg/m³)

Site	PM ₁₀
Collie	66.6

Description of Event

A number of prescribed burns were conducted in the southwest including 500 hectares 16 km south-west of Collie and 500 hectares 9km north-west of Collie.



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

9 October 2015



Fire map showing hot spot locations from Aqua / MODIS
<https://earthdata.nasa.gov/labs/worldview>

Pollutant

PM_{2.5}

Monitoring Sites

Bunbury

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

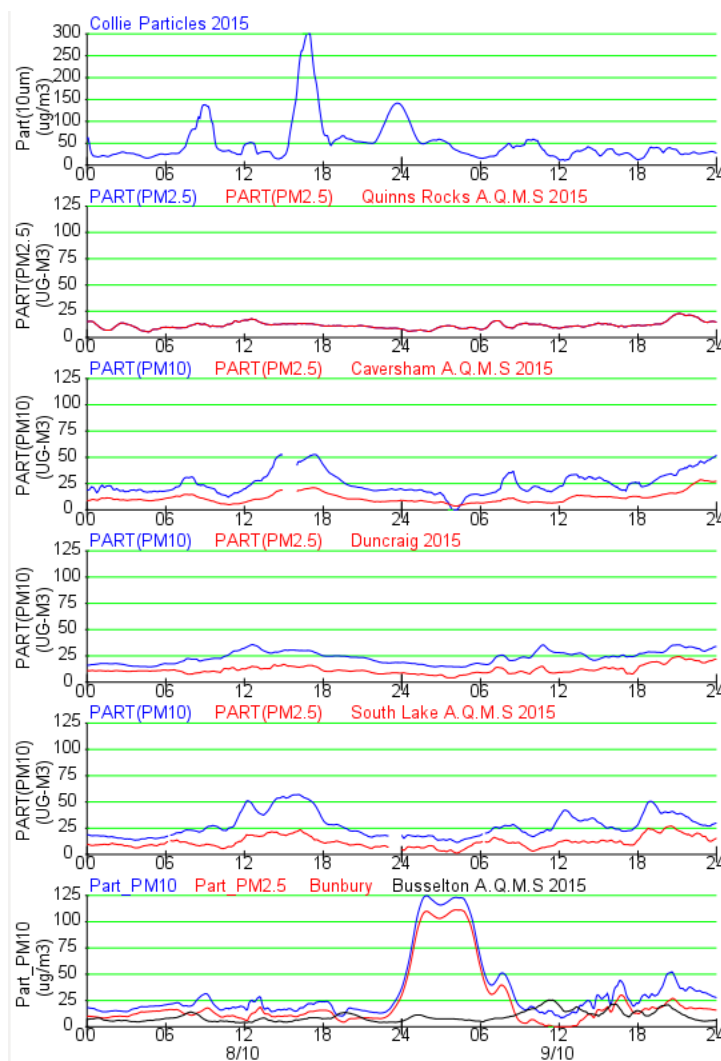
24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Bunbury	47.8	34.8

Description of Event

A number of prescribed burns were conducted in the southwest including 500 hectares 16 km south-west of Collie and 500 hectares 9km north-west of Collie.

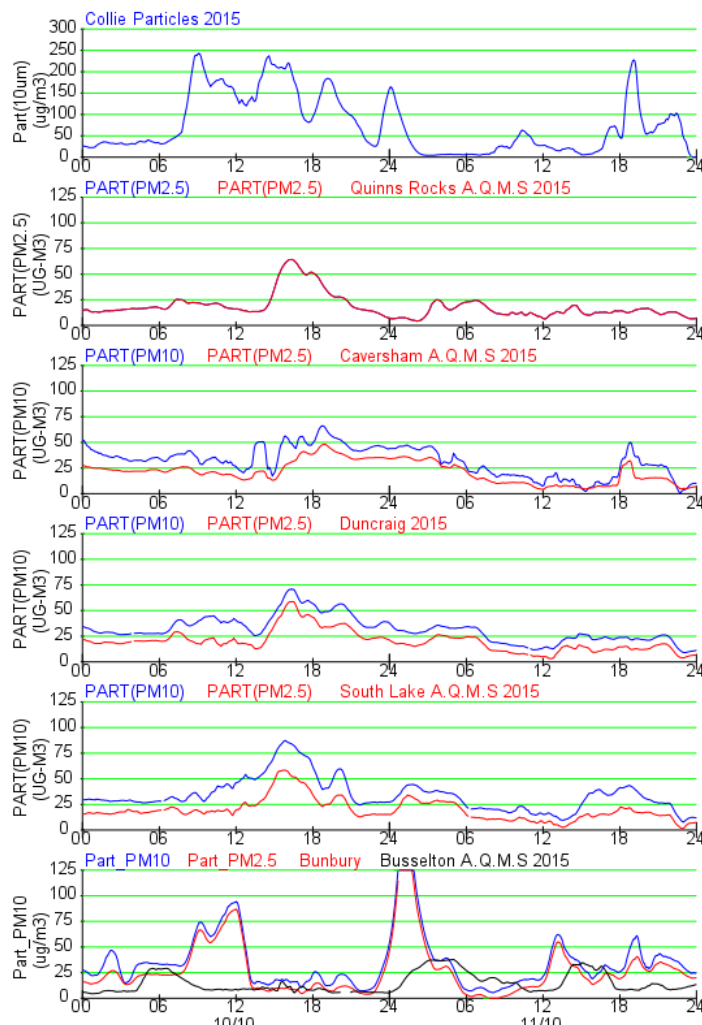


60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

10 October 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

Pollutant

PM₁₀ & PM_{2.5}

Monitoring Sites

- Collie (PM₁₀)
- Caversham (PM_{2.5})
- Duncraig (PM_{2.5})
- Bunbury (PM_{2.5})

NEPM Standards

- PM₁₀ – 50.0 µg/m³
- PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Collie	111.9	NA
Caversham	39.9	26.8
Duncraig	39.8	26.2
Bunbury	33.3	25.4

Description of Event

A number of prescribed burns were conducted in the southwest.

11 October 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)

Pollutant

PM_{2.5}

Monitoring Sites

Bunbury

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

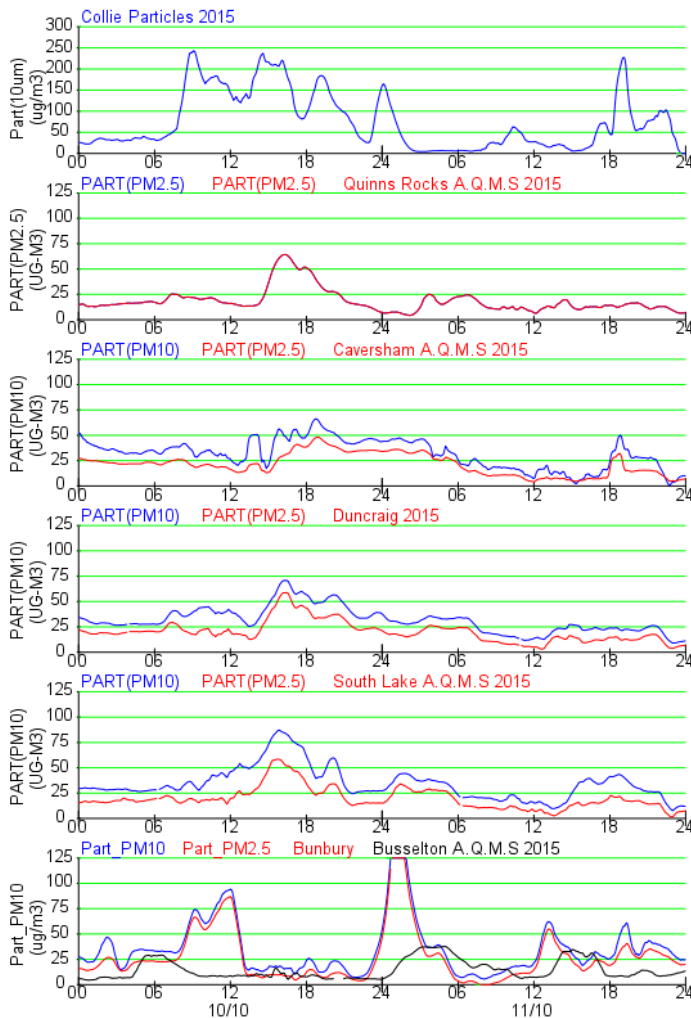
24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Bunbury	38.5	30.6

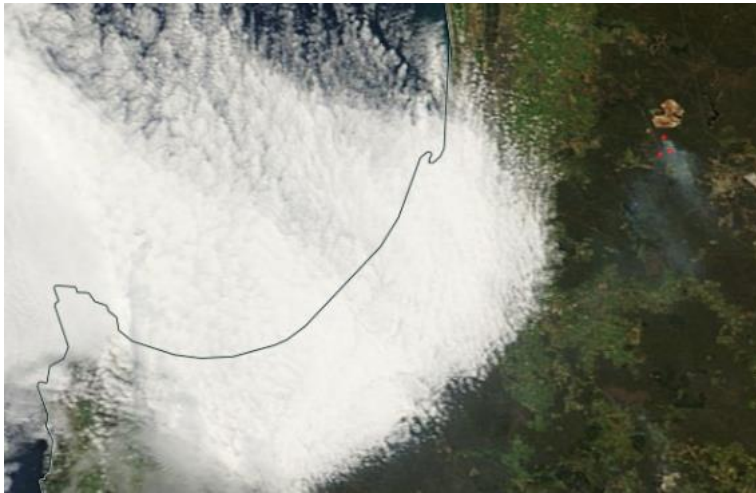
Description of Event

A number of prescribed burns were conducted in the southwest.



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

13 October 2015



Fire map showing hot spot locations from Terra / MODIS (<https://earthdata.nasa.gov/labs/worldview>)

Pollutant

PM₁₀

Monitoring Sites

Collie

NEPM Standards

PM₁₀ – 50.0 µg/m³

Averaging Period

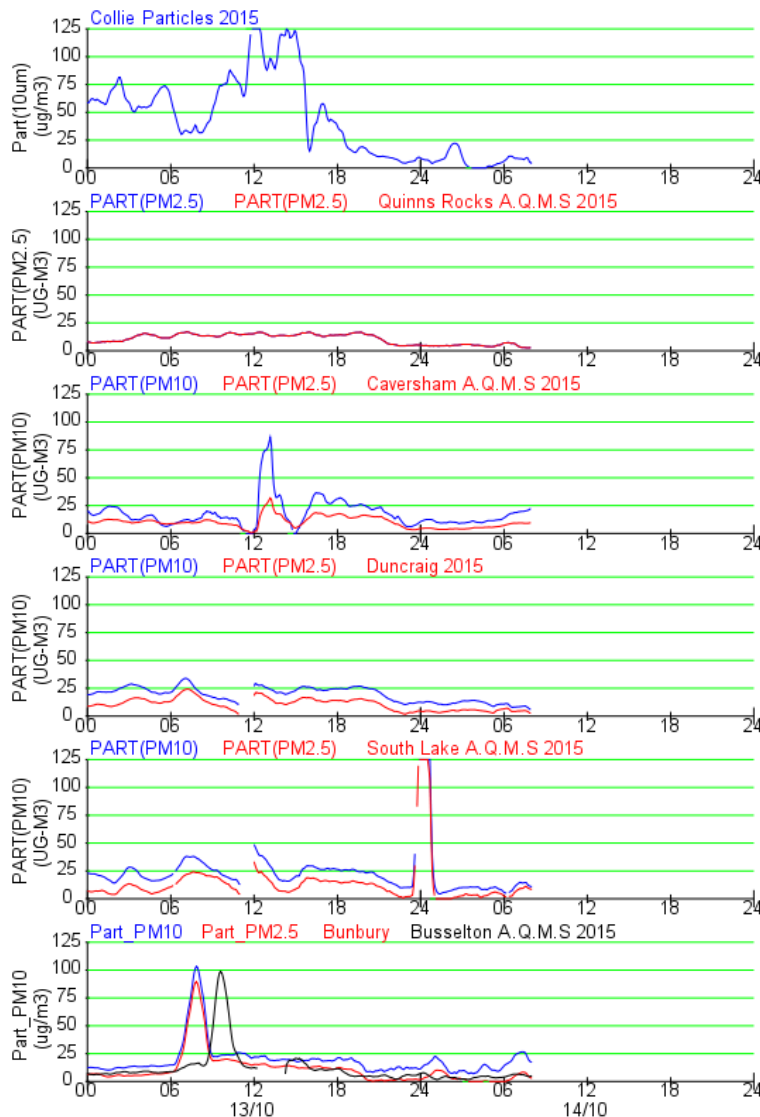
24 hours

Concentrations (µg/m³)

Site	PM ₁₀
Collie	53.7

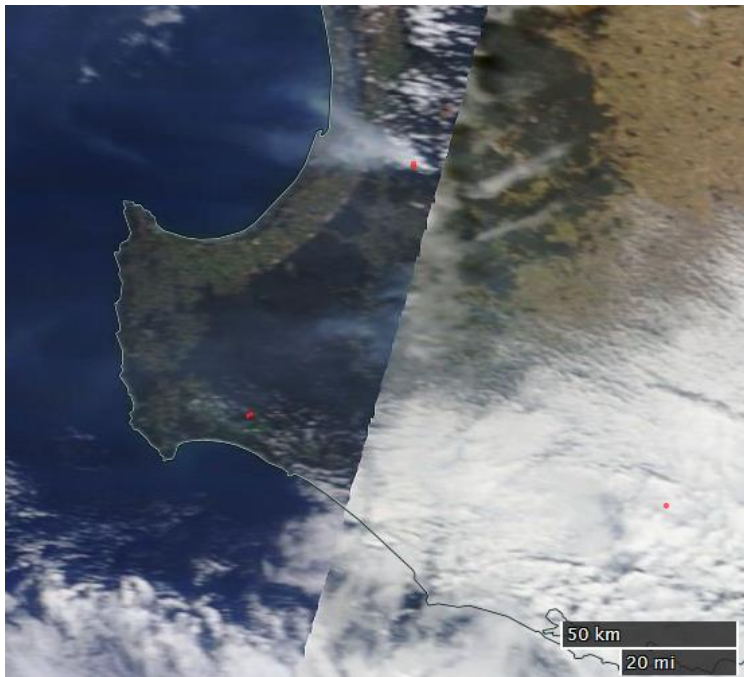
Description of Event

A number of prescribed burns were conducted in the southwest.



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

28 October 2015



Fire map showing hot spot locations from Terra / MODIS
<https://earthdata.nasa.gov/labs/worldview>

Pollutant

PM₁₀ & PM_{2.5}

Monitoring Sites

Bunbury

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

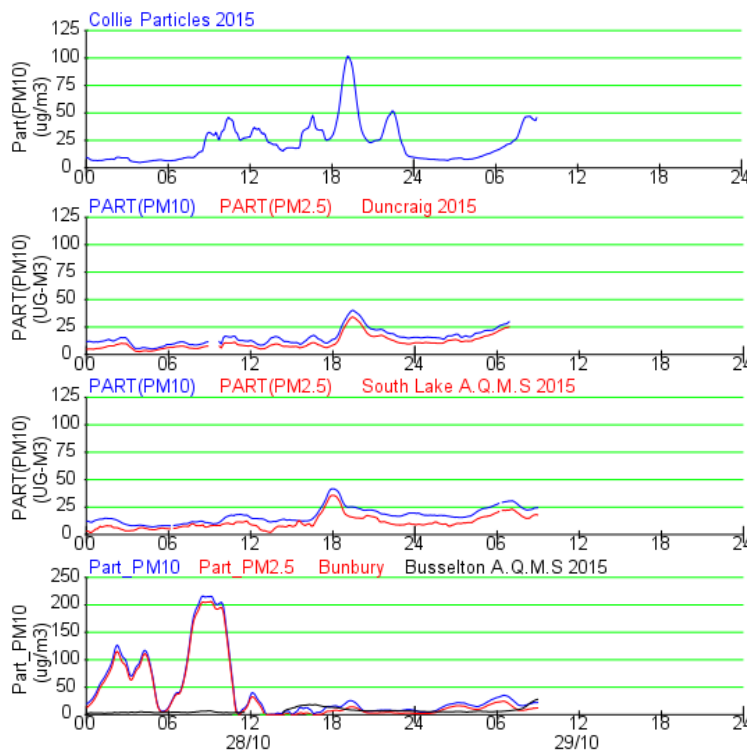
Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Bunbury	50.8	44.8
Collie	25.0	NA

Description of Event

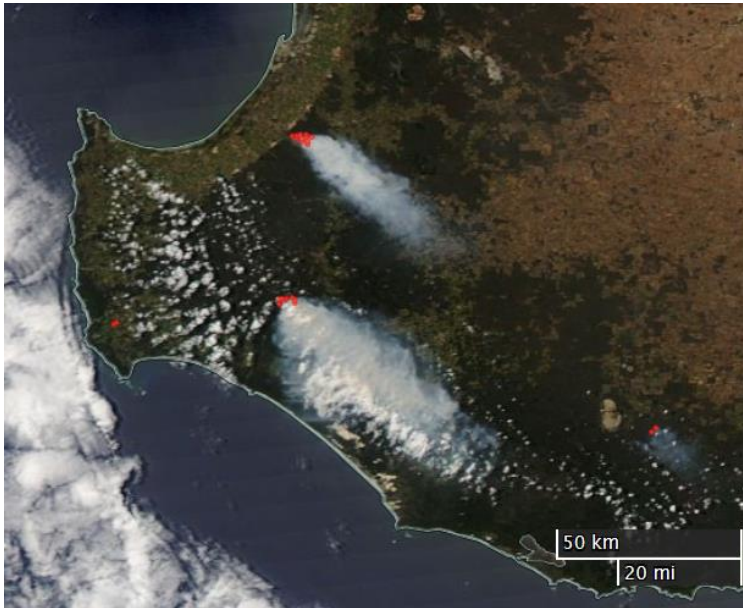
A number of prescribed burns were conducted to the east of Bunbury at a location 18 km WSW of Collie.

Collie did not exceed the NEPM standard for PM₁₀.

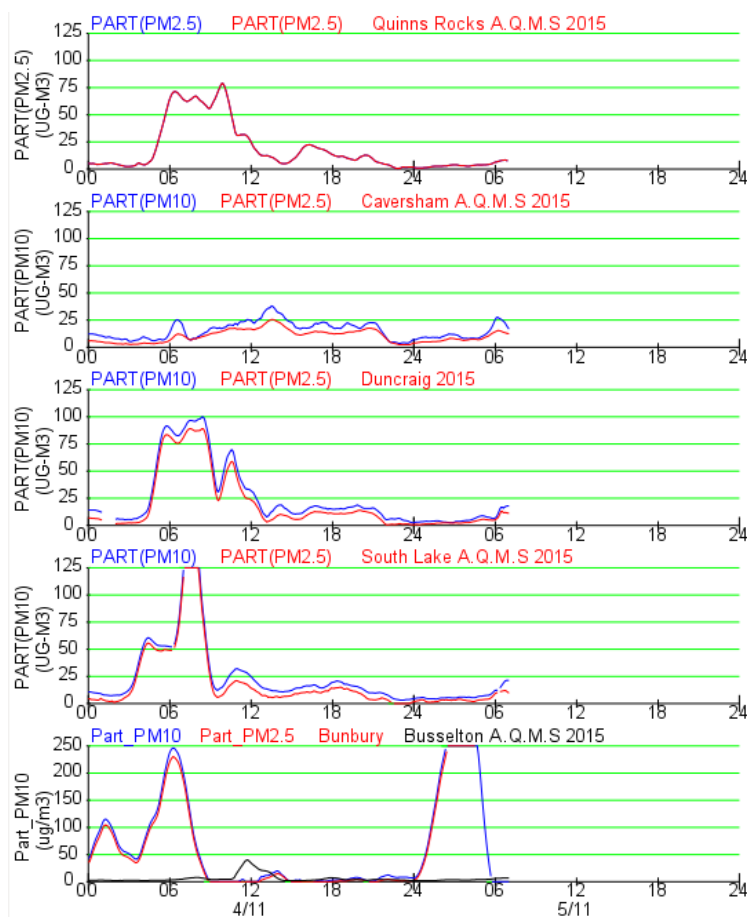


60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

4–5 November 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

Pollutant

PM₁₀ and PM_{2.5}

Monitoring Sites

Bunbury

NEPM Standards

PM₁₀ – 50.0 µg/m³
 PM_{2.5} – 25.0 µg/m³

Averaging Period

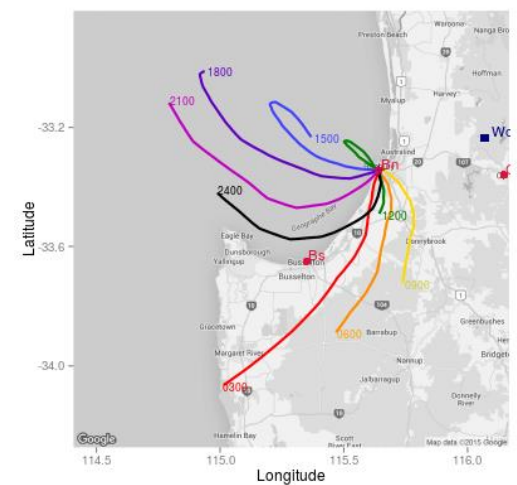
24 hours

Concentrations (µg/m³)

Date	PM ₁₀	PM _{2.5}
04/11/2015	40.9	35.1
05/11/2015	50.2	N/A

Description of Event

A number of prescribed burns were conducted to the south of Bunbury. All other sites met the NEPM with the highest Perth metropolitan concentrations at Duncraig of 30.7 µg/m³ (PM₁₀) and 24.6 µg/m³ (PM_{2.5}).

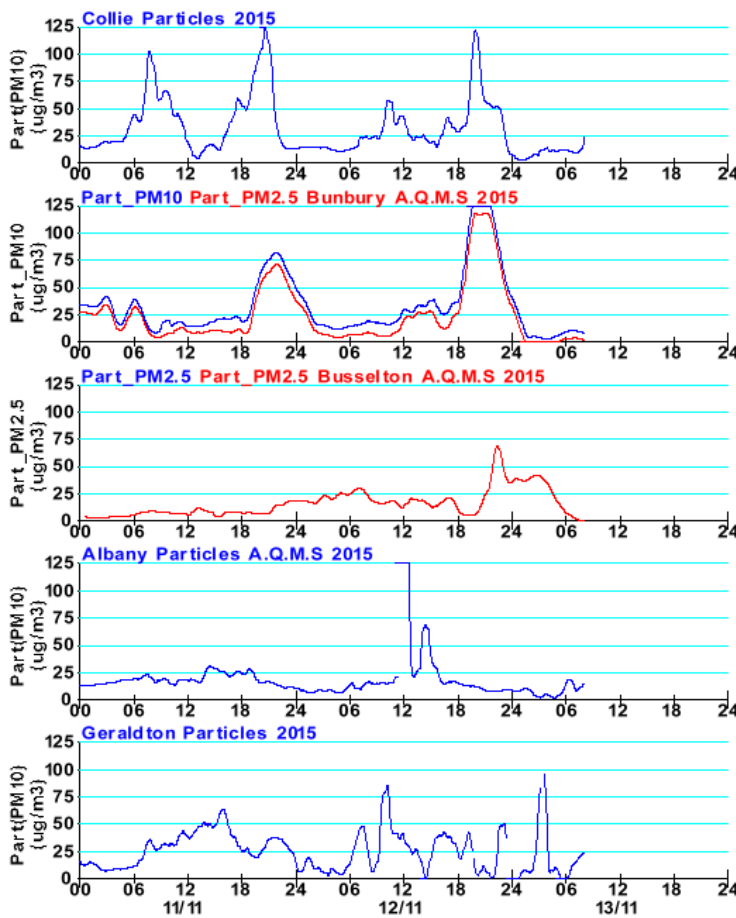


Series of back trajectories over 10 hours for 3am, 6am, 9am, 12noon, 3pm, 6pm, 9pm and midnight on 04/11/2015.

12 November 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

Pollutant

PM_{2.5}

Monitoring Sites

Bunbury

NEPM Standards

PM₁₀ – 50.0 µg/m³
PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

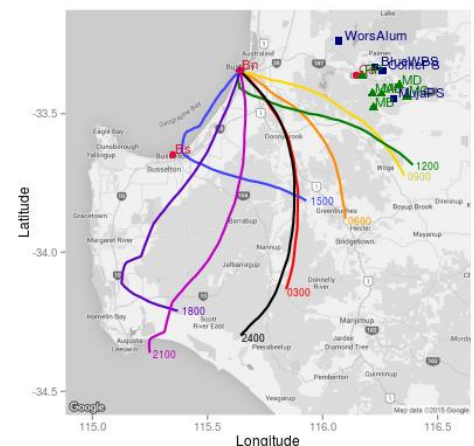
Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Bunbury	41.5	31.6

Description of Event

A number of prescribed burns were conducted to the south of Bunbury. All other sites met the NEPM with the highest Perth metropolitan concentrations at South Lake of 28.2 µg/m³ (PM₁₀) and Caversham of 12.6 µg/m³ (PM_{2.5}).

Bunbury did not exceed the NEPM standard for PM₁₀.



Series of back trajectories over 10 hours for 3am, 6am, 9am, 12noon, 3pm, 6pm, 9pm and midnight on 12/11/2015.

13–14 November 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)

Pollutant

PM₁₀

Monitoring Sites

Albany

NEPM Standards

PM₁₀ – 50.0 µg/m³

Averaging Period

24 hours

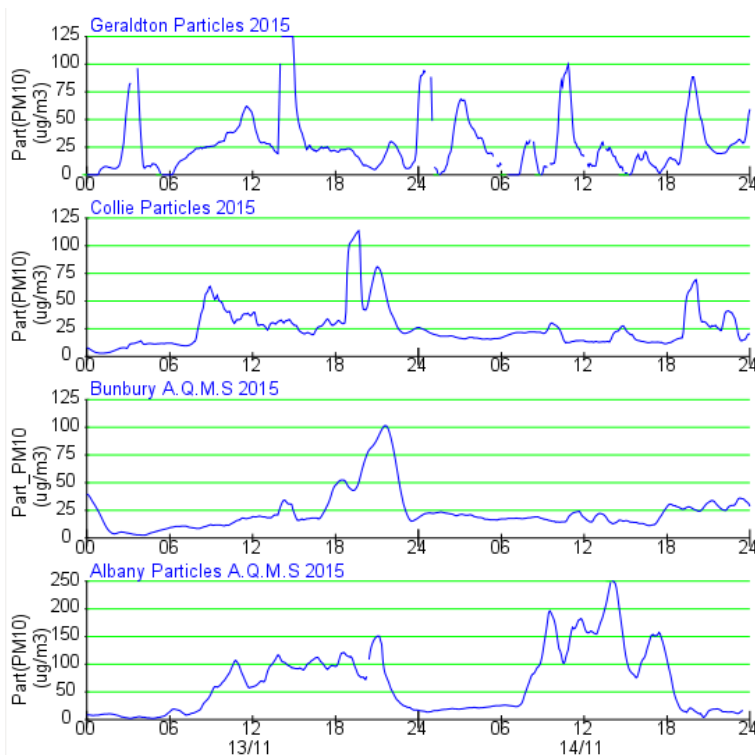
Concentrations (µg/m³)

Date	PM ₁₀
13/11/2015	56.9 µg/m ³
14/11/2015	76.7 µg/m ³

Description of Event

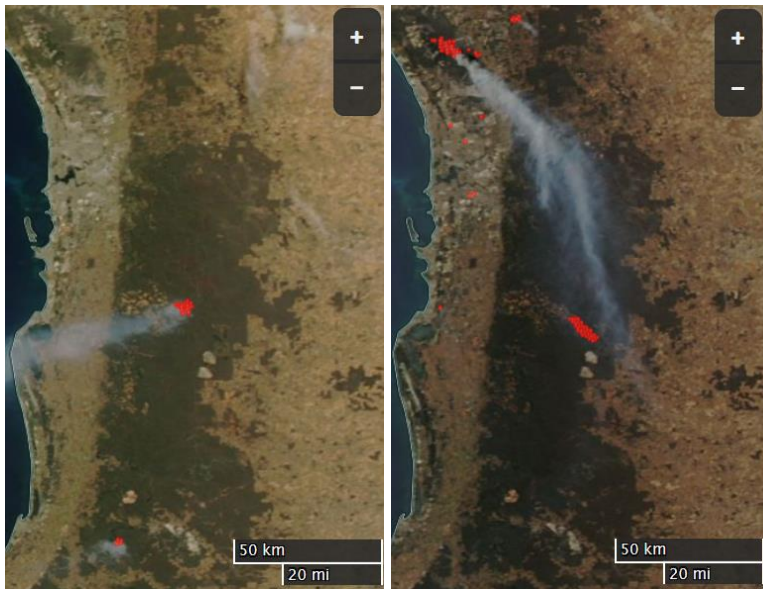
A number of prescribed burns were conducted between 30 and 60 km south-east of Manjimup (6,500 Ha) and south-east of Rocky Gully (4,900 Ha).

All other sites met the NEPM with the highest Perth metropolitan concentrations at South Lake of 26.2 µg/m³ (PM₁₀) and Quinns Rocks of 11.1 µg/m³ (PM_{2.5}).

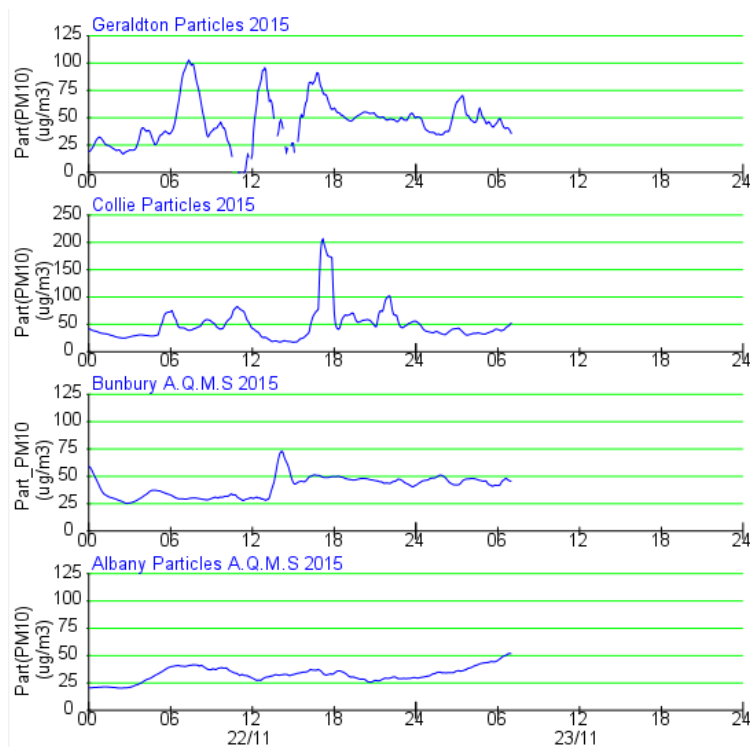


60 minute averaged time series plot of PM10 from DER regional sites.

22 November 2015



Fire map showing hot spot locations on 21/11/2015 (left) and 22/11/2015 (right) from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red).

Pollutant

PM₁₀

Monitoring Sites

Collie

NEPM Standards

PM₁₀ – 50.0 µg/m³

Averaging Period

24 hours

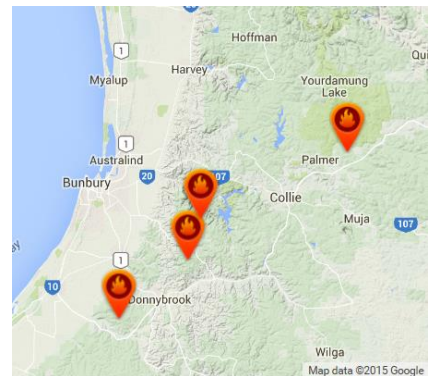
Concentrations (µg/m³)

Site	PM ₁₀
Collie	52.2

Description of Event

A number of prescribed burns were conducted both north and south of the Perth metropolitan region.

The highest metropolitan sites were South Lake and Duncraig which both recorded 24 hour averaged PM₁₀ of over 37 µg/m³.

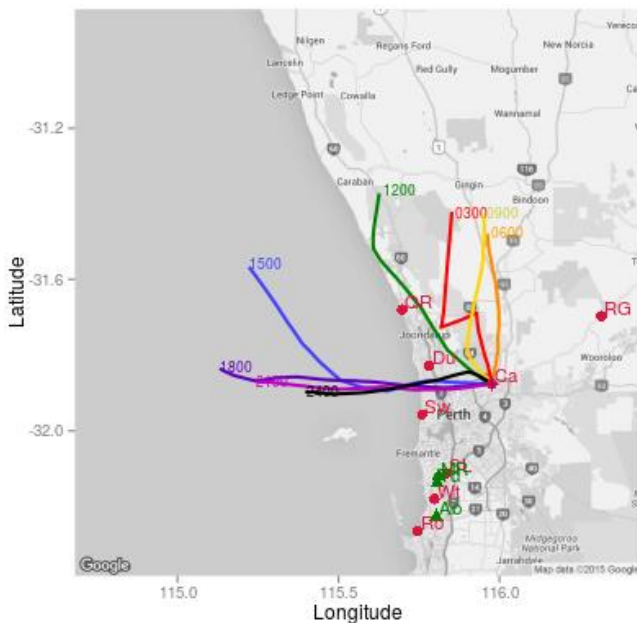


Active control burns around Collie on 22/11/2015.

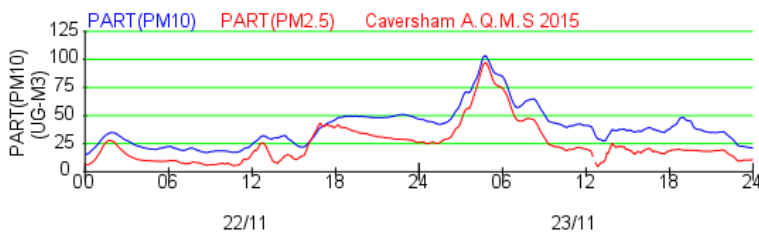
23 November 2015



Fire map showing hot spot locations from Aqua / MODIS (<https://earthdata.nasa.gov/labs/worldview>)



Series of back trajectories over six hours for 3am, 6am, 9am, 12noon, 3pm, 6pm, 9pm and midnight on 23/11/2015.



60 minute averaged time series plot of PM10 (blue) and PM2.5 (red) at Caversham.

Pollutant

PM_{2.5}

Monitoring Sites

Caversham

NEPM Standards

PM₁₀ – 50.0 µg/m³
PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Caversham	46.8	30.0

Description of Event

Smoke from bushfires in North Muchea in the shires of Chittering and Gingin impacted the Perth metropolitan region.

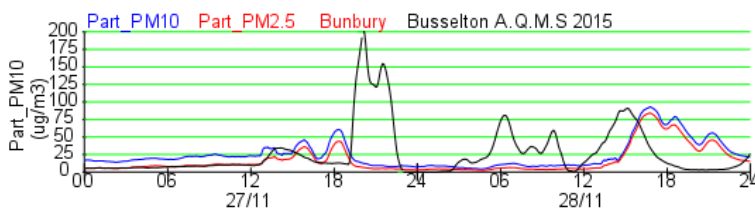
<http://www.skynews.com.au/news/top-stories/2015/11/22/bushfire-threatens-homes-and-lives-in-wa.html#sthash.Wsz7cpyL.dpuf> :

No other site exceeded the NEPM particle standards.

27–28 November 2015



Fire map showing hot spot locations from Aqua / MODIS
<https://earthdata.nasa.gov/labs/worldview>



60 minute averaged time series plot of PM_{2.5} (Black) at Busselton and PM₁₀ (blue) and PM_{2.5} (red) at Bunbury.

Pollutant

PM_{2.5}

Monitoring Sites

Busselton

NEPM Standards

PM_{2.5} – 25.0 µg/m³

Averaging Period

24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
27/11/2015	NA	27.3
28/11/2015	NA	26.4

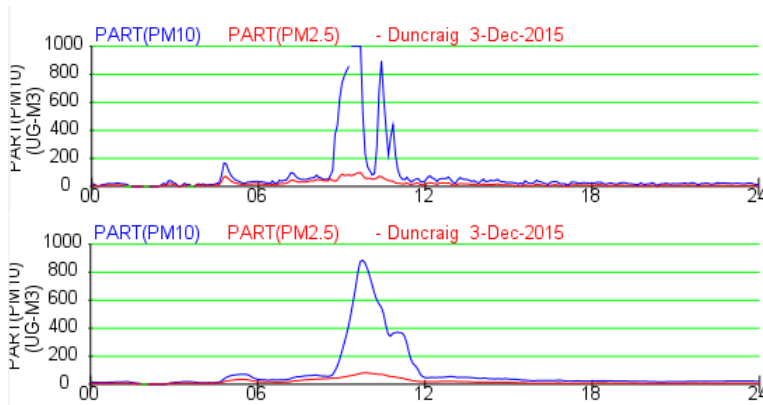
Description of Event

2,000 Ha prescribed burn 33 km west of Manjimup caused elevated smoke haze in Busselton.

3 December 2015



Council clearance of drainage pit within Duncraig compound.



5 minute (upper) and 60 minute (lower) averaged time series plot of PM₁₀ (blue) and PM_{2.5} (red) data at Duncraig for 03/12/2015.

Pollutant

PM₁₀

Monitoring Sites

Duncraig

NEPM Standards

PM₁₀ – 50.0 µg/m³

PM_{2.5} – 25.0 µg/m³
Averaging Period

24 hours

Concentrations (µg/m³)

Site	PM ₁₀	PM _{2.5}
Duncraig	82.7	18.1

Description of Event

Council cleanup of drainage pit at the Duncraig compound caused a local exceedence of the NEPM PM₁₀ standard.

Note the lower levels coinciding with the standard morning tea break taken between 10am and 10:15am.

There were no other exceedences within the metropolitan region.