

**Northern Territory Ambient Air Quality Monitoring
Report 2014**

**Compliance with the National
Environment Protection (Ambient
Air Quality) Measure**

August 2015

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1 Summary

Ambient air quality monitoring in the Darwin region between January and December 2014 showed no exceedences of the National Environment Protection Measure (Ambient Air Quality) (AAQ NEPM) air quality standards for carbon monoxide, nitrogen dioxide, particulate matter of 10 micrometres or less (PM₁₀) and ozone at any monitoring site. Exceedences of AAQ NEPM advisory standards for daily and annual particulate matter of 2.5 micrometres or less (PM_{2.5}) occurred at both monitoring stations.

These exceedences were linked to a combination of small scale local bush and grass fires and more distant large scale savannah fire activity. Analysis of 2014 monitoring data shows the timing of fire activity in relation to wind direction and temperature inversions appears to be a greater influence on PM_{2.5} levels in the Darwin region than the total area burnt. In 2014, PM_{2.5} and PM₁₀ levels were below average while total area burnt in the region was above average.

2 Background

Clause 18 of the AAQ NEPM requires jurisdictions to submit a report on their compliance with the AAQ NEPM for each calendar year. The content of the jurisdictional report is prescribed in clause 17 of the AAQ NEPM.

Consistent with the reporting period defined in the AAQ NEPM this report covers the calendar year ending on 31 December 2014. The report is based on Technical Paper No. 8 (Annual Reports) which details the format and data requirements of the Annual Report. It is a technical report to the National Environment Protection Council (NEPC) and supplements the annual summary report provided each year by each jurisdiction under the NEPC Act on the overall implementation of the AAQ NEPM.

This report is available on the NT EPA website at ntepa.nt.gov.au.

3 Overview of the 2014 AAQ NEPM Monitoring Network and Activities

3.1 Monitoring Requirements

The results of air quality monitoring in 2000-2001 were used to determine the monitoring requirements for the Northern Territory over the longer term. This monitoring identified particles

from landscape fires affecting the Darwin region as the primary air pollutant of concern in the Northern Territory. Analysis of the 2000-2001 data against the AAQ NEPM standards indicated that nitrogen oxides, sulfur dioxide, carbon monoxide, ozone and lead aerosols were not a cause for concern in the Darwin/Palmerston region or regional population centres.

Since the initial monitoring population and industrial activity in Darwin has increased and more detailed monitoring of airborne pollutants is required. In 2010 the establishment and operation of a comprehensive air quality monitoring system for the Darwin region commenced. This was completed in July 2012 allowing for monitoring of all pollutants identified in the AAQ NEPM with the exception of lead. Monitoring for lead was not deemed necessary as there are no significant sources close to populated areas in the region.

The air quality monitoring system consists of two stations, a performance monitoring station located near Palmerston and long term trend monitoring station located at the Bureau of Meteorology (BoM) site in Winnellie. The Winnellie station has been operational since the second half of 2012 while Palmerston station has been operational since the beginning of 2011.

3.2 Current Monitoring Stations for the Purposes of this Report

The Winnellie station meets requirements as a generally representative upper bound (GRUB) station. It is located between Darwin's northern suburbs and Darwin CBD, the two most densely populated areas in the Territory (Figure 1). The station consists of an air conditioned instrument shed which houses all instrumentation. A single gas sampling manifold supplies atmospheric gases for nitrogen oxides, ozone, sulfur dioxide and carbon monoxide analysis. Air for particulate sampling comes from a mast attached directly to the station roof. Meteorological data comes from BoM instruments located on the same site.

The Palmerston station has been located to provide information on airborne pollutants which may be moving from industrial activities in middle harbour to populations in the Palmerston area. This station meets all siting and instrumentation requirements for reporting under the AAQ NEPM. It is located in light bushland approximately 4km south west of Palmerston (Figure 1). The station houses the same gas and particulate sampling instruments as Winnellie and has instruments for collection of meteorological data.

Station instrumentation and siting details for both stations is at Tables 1 and 2 below.



Figure 1: Palmerston and Winnellie monitoring sites.

3.3 Determination of Exposed Population for each Performance Monitoring Station

Two areas within the Northern Territory exceeded the population threshold for ambient air quality monitoring of greater than 25,000. These are the Greater Darwin region (140,400) and Alice Springs (28,080).

The major air pollutant of concern for Darwin and Palmerston is particulate matter from bushfire smoke in the Dry season (April - October). Prevailing winds during the Dry season are South-Easterly to Easterly, causing the population of the region to be frequently exposed to particulate pollution from relatively small fires in local bushland and more distant large scale savannah fires.

Monitoring for particulates has been conducted at several sites in the Darwin / Palmerston region since 2002. From 2012 monitoring was conducted at two sites. Results from

simultaneous monitoring have shown that aside from spikes attributable to local fire events particulate levels are reasonably uniform across the region on a seasonal basis. This relationship was supported by the 2014 data. PM_{2.5}, 24 hour average levels for Palmerston were 9.28 and 8.1 for Winnellie in 2014. See Figure 1. As industrial development increases divergence in particulate and other pollutant levels may occur between sites.

No monitoring was undertaken in the Alice Springs region during the reporting period. The NT EPA intends to conduct monitoring in Alice Springs in future years.

Table 1: Summary of station instrument siting compliance with AS 2922-1987

Station	Location Category	Height above ground	Clear Sky Angle	Unrestricted airflow of 360°	20 m from trees	No boilers or incinerators nearby	Minimum distance from road or traffic
Winnellie DBE 1	Bushland	6 m	Yes	Yes	Yes	Yes	Yes
Palmerston DBE 2	Bushland	4.5 m	Yes	Yes	Yes	Yes	Yes

Table 2 – Ambient air quality station instrumentation

Parameter	Data available from	Data available to	Instrument	Sampling frequency
PM ₁₀	01/01/11 (Palmerston) 18/07/12 (Winnellie)	present	TEOM 1405D	continuous
PM _{2.5}	01/01/11 (Palmerston) 18/07/12 (Winnellie)	present	TEOM 1405D	continuous
SO ₂	01/01/11 (Palmerston) 18/07/12 (Winnellie)	present	Thermo Model 43i.	continuous
NO _x , NO, NO ₂	01/01/11 (Palmerston) 18/07/12 (Winnellie)	present	Thermo Model 42i.	continuous
O ₃	01/01/11 (Palmerston) 18/07/12 (Winnellie)	present	Thermo Model 49i.	continuous
CO	01/01/11 (Palmerston)	present	Thermo Model 48i.	Continuous

	18/07/12 (Winnellie)			
Meteorology (mast height: 10 m)				
Wind direction	01/01/12	present	RM Young, model 85000.	continuous
Wind speed	01/01/12	present	RM Young, model 85000.	continuous
Temperature	01/01/12	present	RM Young, model 41382LC	continuous
Humidity	01/01/12	present	RM Young, model 41382LC	continuous

3.4 Monitoring during the Reporting Period

Winnellie and Palmerston stations monitor the same range of pollutants. Particulate monitoring at the Palmerston station did not occur between 17 September 2013 and 4 February 2014 due to instrument failure.

3.5 Changes to the Approved Monitoring Plan

No change.

3.6 Unresolved Issues

There are no unresolved issues in the reporting period.

3.7 Status of NATA Accreditation

All data collection and validation processes are validated by National Association of Testing Authorities (NATA).

3.8 Methods Other than Physical Monitoring

No other methods were used in the reporting period.

4 Assessment of Compliance with the AAQ NEPM Standards and Goals

Standards and goals for pollutants in accordance with the AAQ NEPM are shown in Table 3.

Table 3: Air NEPM Standards

Pollutant	Averaging period	Maximum (ambient) concentration	Goal
Carbon monoxide	8 hour	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	0.10ppm	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
Particles as PM ₁₀	1 day	50 µg/m ³	5 days a year
Particles as PM _{2.5}	1 day	25 µg/m ³	Advisory standard
	1 year	8 µg/m ³	

The following tables summarise compliance with the standards and goals of the AAQ NEPM. Data availability (quarterly and annual), the number of days when standards were exceeded, the annual mean (where an annual standard exists) and an assessment of compliance are given for each pollutant.

Performance is assessed as not complying (i.e. 'NOT MET') if there is more than the number of exceedances specified in Schedule 2 of the AAQ NEPM.

CARBON MONOXIDE

Table 4: 2014 compliance summary for CO in the Northern Territory

**AAQ NEPM Standard
9.0 ppm (8 hour average)**

Region/ Performance monitoring station	Data Availability Rates (% of Days)					Number of exceedences (days)	Performance against the standard and goal
	Q1	Q2	Q3	Q4	Annual		
Winnellie	89	98	100	100	97	0	Met
Palmerston	89	92	83	80	86	0	Met

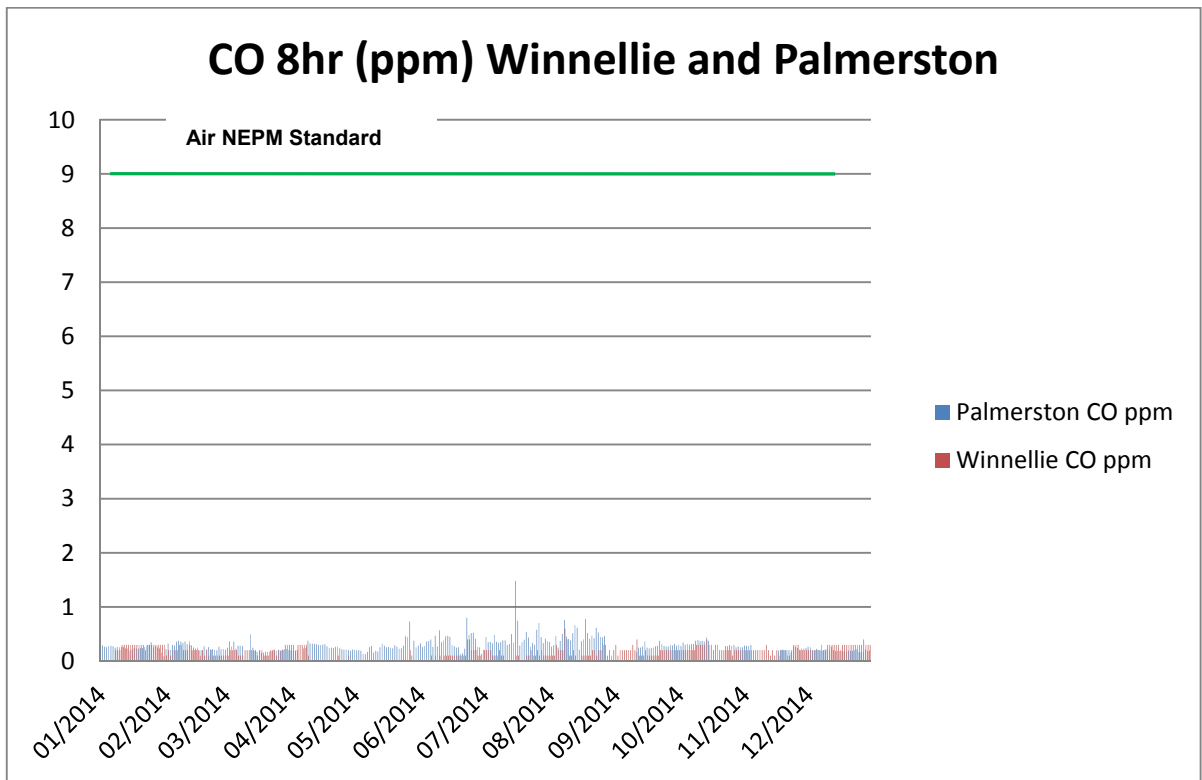


Figure 2: CO 8 hour

NITROGEN DIOXIDE

Table 5: 2014 compliance summary for NO₂ in the Northern Territory

AAQ NEPM Standard

0.12 ppm (1 hour average)

0.03 ppm (1 year average)

Region/ Performance monitoring station	Data Availability Rates (% of Days)					Number of exceedences (days)	Annual mean (ppm)	Performance against the standard and goal	
	Q1	Q2	Q3	Q4	Annual			1h	1y
Winnellie	24	95	95	79	73	0	0.0039	-	-
Palmerston	82	79	91	73	81	0	0.0037	met	met

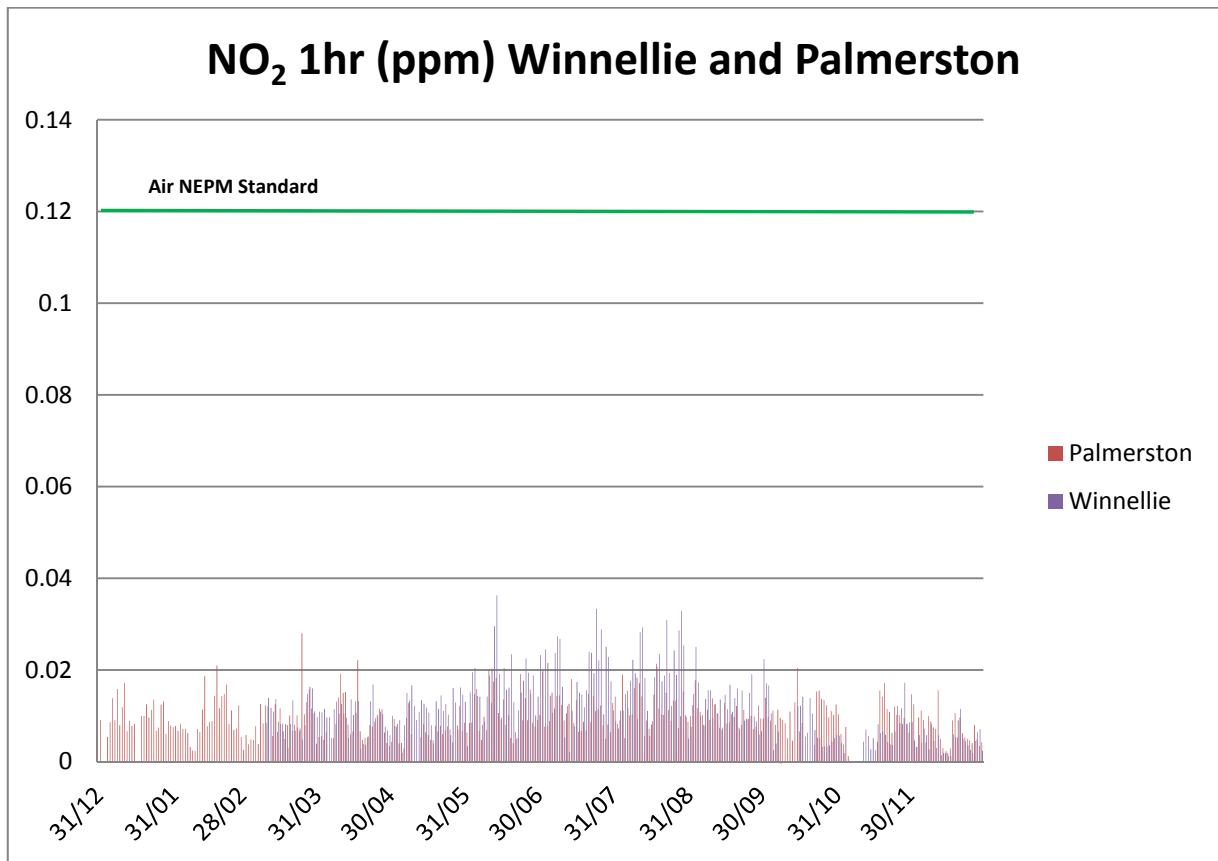


Figure 3: NO₂ 1 hour

OZONE

Table 6: 2014 compliance summary for Ozone in the Northern Territory

AAQ NEPM Standard

0.10 ppm (1 hour average)

0.08 ppm (4 hour average)

Region/ Performance monitoring station	Data Availability Rates (% of Days)					Number of exceedences (days)		Performance against the standard and goal	
	Q1	Q2	Q3	Q4	Annual	1 h	4 h	1h	4h
Winnellie	88	95	95	95	93	0	0	Met	Met
Palmerston	91	90	95	76	88	0	0	Met	Met

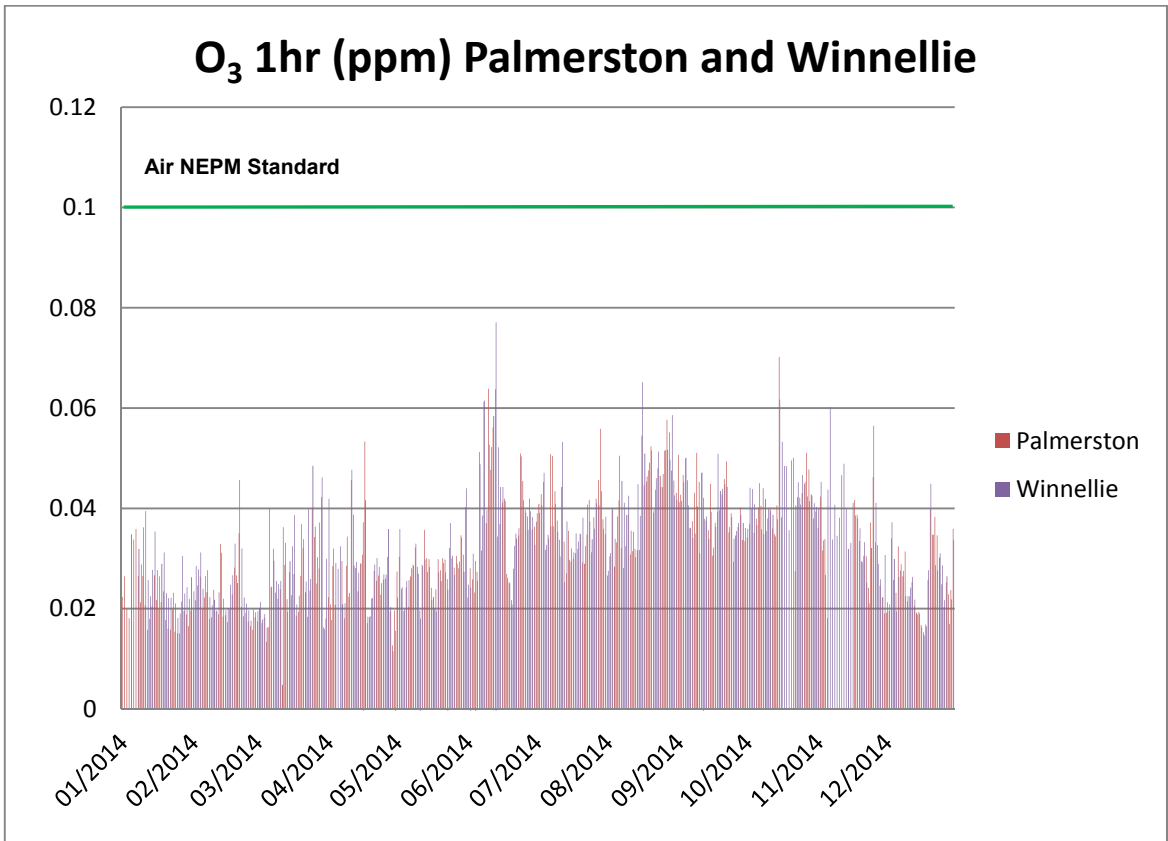


Figure 4: O₃ 1 hour

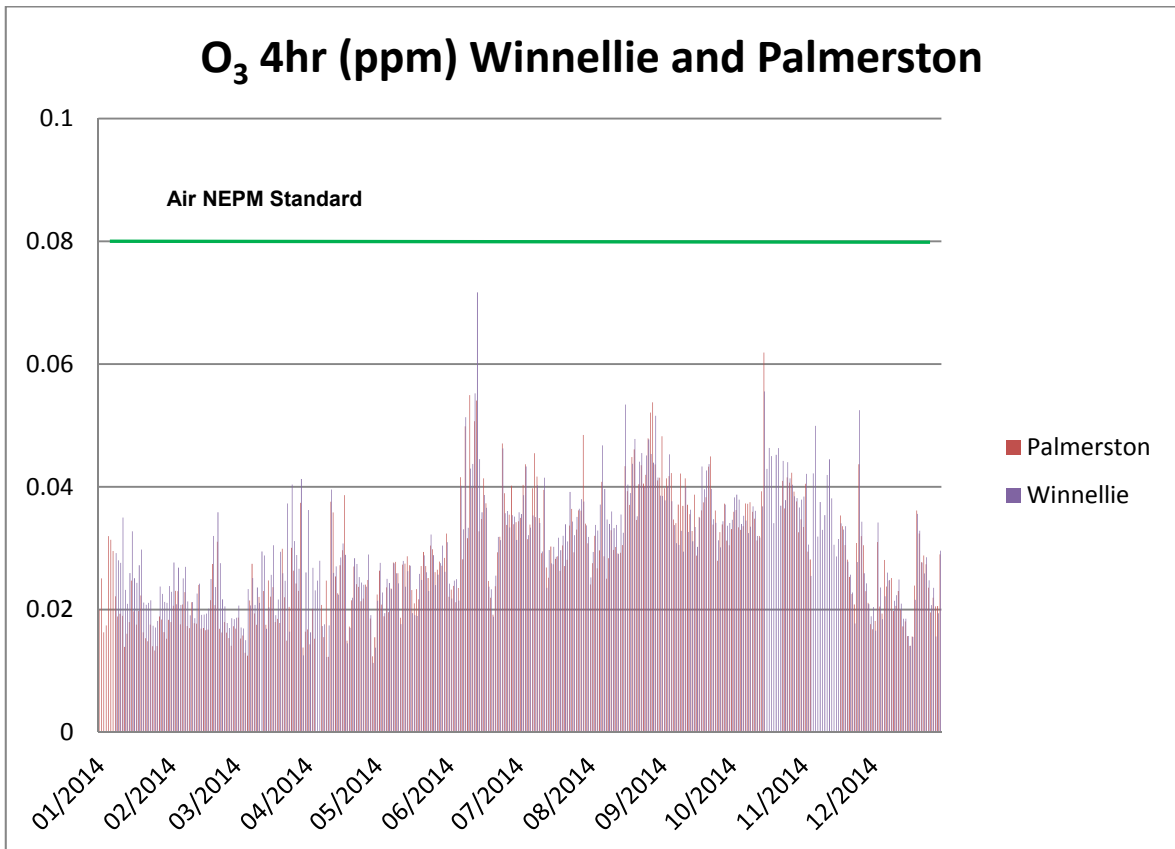


Figure 5: O₃ 4 hour

SULFUR DIOXIDE

Table 7: 2014 compliance summary for SO₂ in the Northern Territory

AAQ NEPM Standard

0.20 ppm (1 hour average)

0.08 ppm (24 hour average)

0.02 ppm (1 year average)

Region/ Performance monitoring station	Data Availability Rates (% of Days)					Number of exceedences (days)		Annual mean (ppm)	Performance against the standard and goal		
	Q1	Q2	Q3	Q4	Annual	1h	24h		1h	24h	1y
Winnellie	82	91	91	94	89	0	0	0.00035	Met	Met	Met
Palmerston	87	86	91	73	84	0	0	0.00042	Met	Met	Met

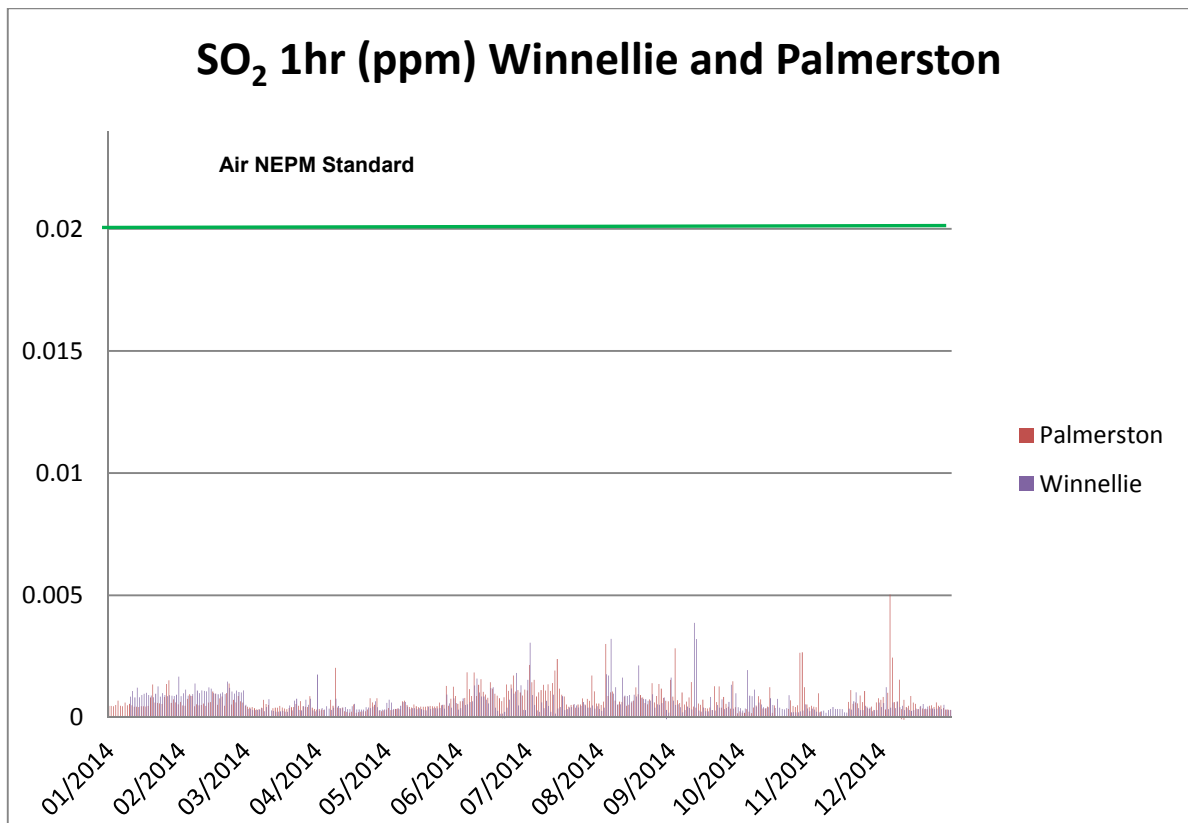


Figure 6: SO₂ 1 hour

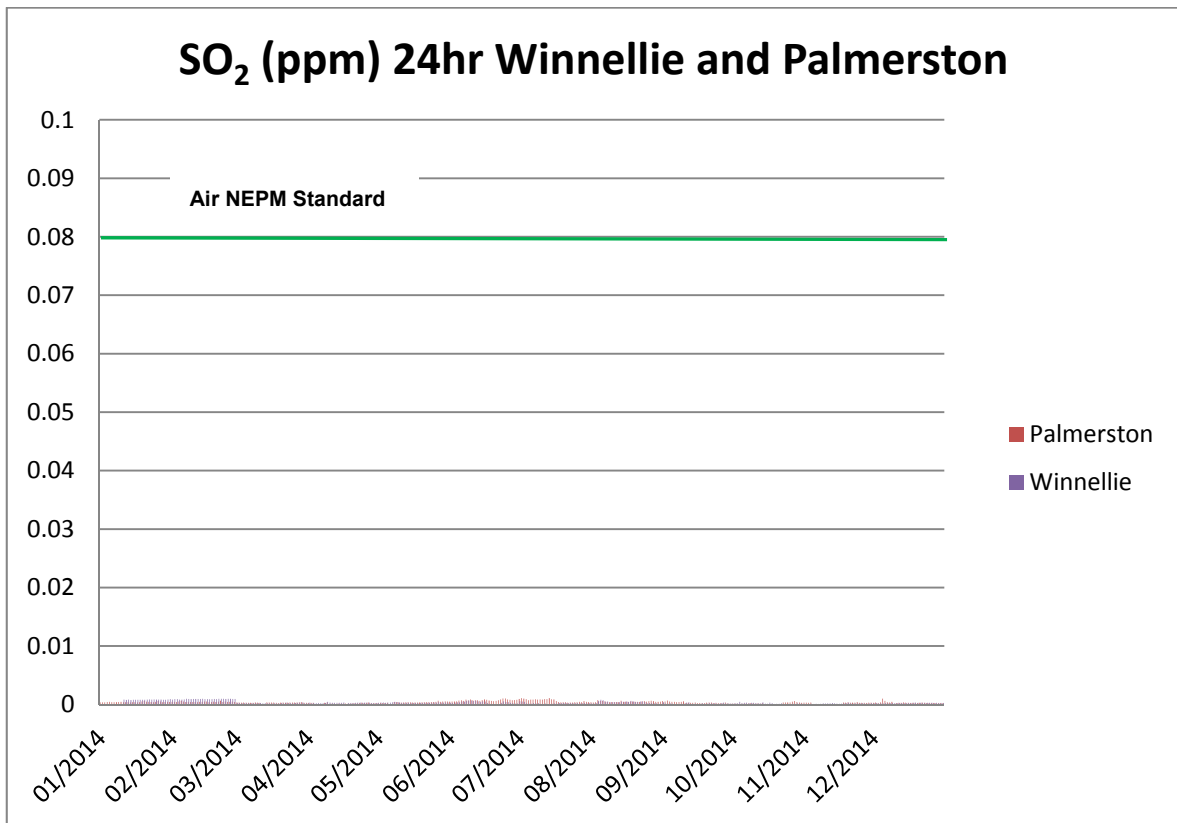


Figure 7: SO₂ 24 hour

PARTICULATES PM₁₀

Table 8: 2014 compliance summary for PM₁₀ in the Northern Territory

AAQ NEPM Standard

50 µg m⁻³ (24-hour average, 5 days/year)

Region/ Performance monitoring station	Data Availability Rates (% of Days)					Number of exceedences (days)	Performance against the standard and goal
	Q1	Q2	Q3	Q4	Annual		
Winnellie	65	82	98	100	86	3	Met
Palmerston	59	92	100	81	82	2	Met

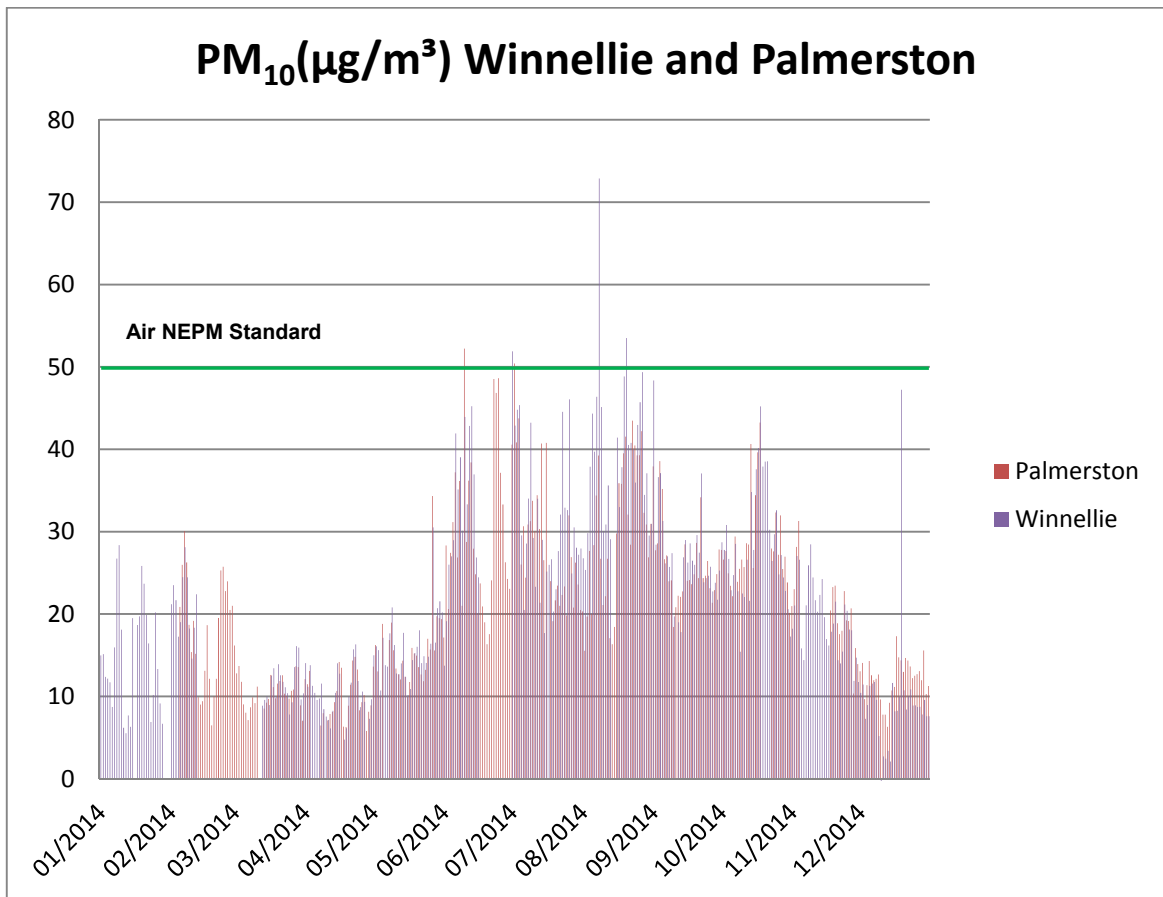


Figure 8: PM₁₀ 24 hour

PARTICULATES PM_{2.5}

Table 9: 2014 compliance summary for PM_{2.5} in the Northern Territory

AAQ NEPM Advisory Standard

25 µg/m³ (24-hour average)

8 µg/m³ (1 year average)

Region/ Performance monitoring station	Data Availability Rates (% of Days)					Number of exceedences (days)	Annual average µg/m ³ (24 hour)	Performance against the standard and goal
	Q1	Q2	Q3	Q4	Annual			
Winnellie	65	82	98	100	86	10	8.1	Not Met
Palmerston	59	92	100	81	82	12	9.25	Not Met

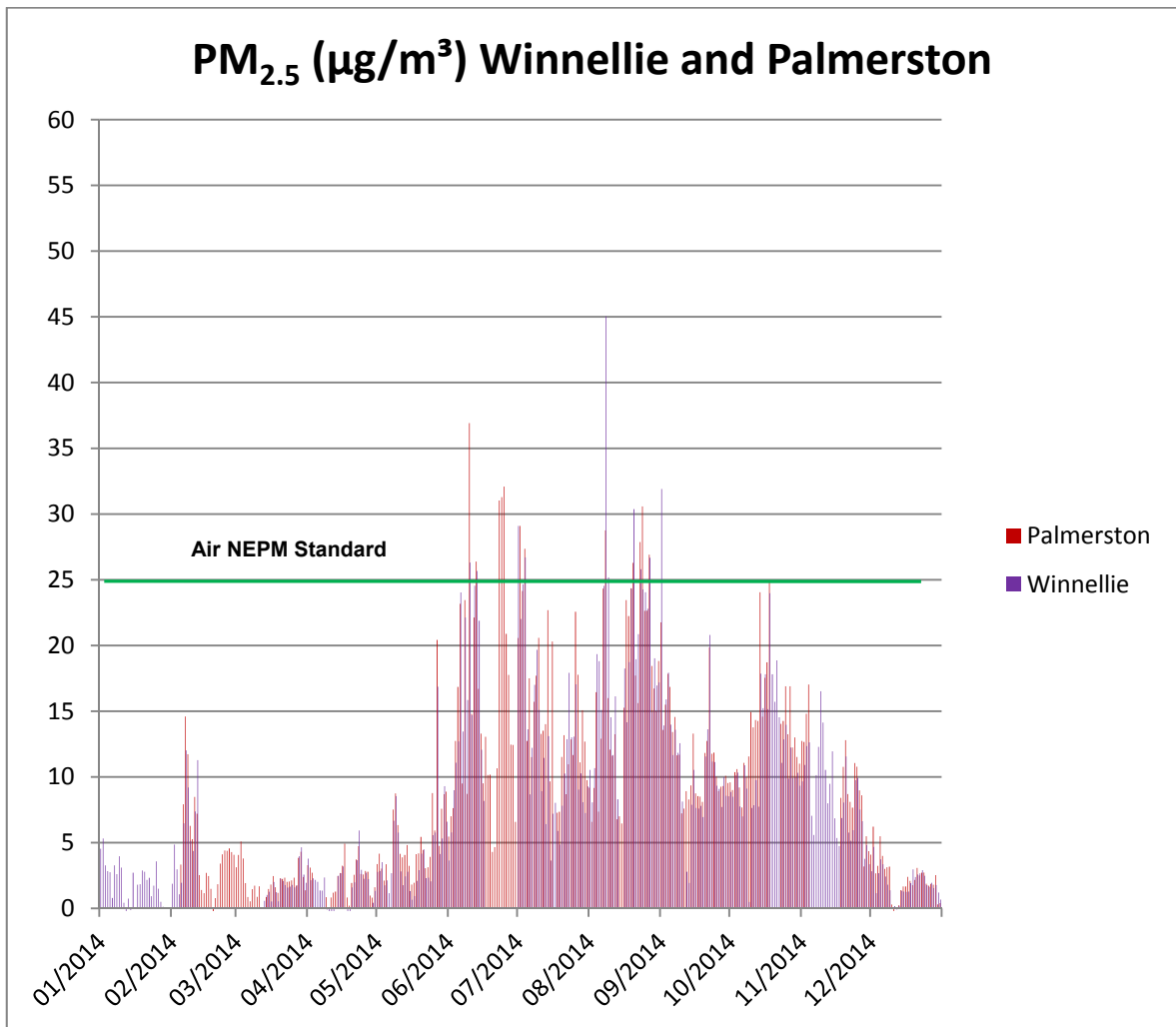


Figure 9: PM_{2.5} 24 hour

5 Assessment of Monitoring Data Against the Standards

Annual summary statistics are presented in this section. The AAQ NEPM states that the short-term standards should not be exceeded on more than one day for carbon monoxide, nitrogen dioxide, ozone and sulfur dioxide, or on more than five days per year for PM₁₀.

There were no exceedences of the compliance standards for any parameter during 2014. As in past years the advisory standard for PM_{2.5} was frequently exceeded at both stations. Figures 3-10 above show that for carbon monoxide, nitrogen dioxide, ozone and particularly sulphur dioxide levels were significantly below the Air NEPM standards.

Table 10: 2012 summary statistics for daily peak 8 hour CO in the Northern Territory

AAQ NEPM Standard

9.0 ppm (8 hour average)

Region/ Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2nd highest (ppm)	2nd Highest (date:hour)
Winnellie	354	0.0007	8/8/14 0800	0.0005	23/06/2014 0800
Palmerston	313	0.0015	16/07/14 0800	0.0008	23/06/2014 0800

Table 11: 2014 summary statistics for daily peak 1 hour NO₂ in the Northern Territory

AAQ NEPM Standard

0.12 ppm (1 hour average)

Region/ Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2nd highest (ppm)	2nd Highest (date:hour)
Winnellie	266	0.036	13/06/14 0800	0.034	13/06/14 0700
Palmerston	295	0.028	25/03/14 1300	0.022	17/04/15 1400

Table 12: 2014 summary statistics for daily peak 1 hour O₃ in the Northern Territory

AAQ NEPM Standard

0.10 ppm (1 hour average)

Region/ Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2nd highest (ppm)	2nd Highest (date:hour)
Winnellie	339	0.077	13/06/14 1600	0.077	13/06/14 1500
Palmerston	321	0.072	15/10/14 1500	0.065	15/10/14 1400

Table 13: 2014 summary statistics for daily peak 4 hour O₃ in the Northern Territory

AAQ NEPM Standard

0.08 ppm (4 hour average)

Region/ Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2 nd highest (ppm)	2 nd Highest (date:hour)
Winnellie	339	0.072	13/06/14 1600	0.060	13/06/13 2000
Palmerston	321	0.062	15/10/14 1600	0.055	10/06/14 2000

Table 14: 2014 summary statistics for 24 hour SO₂ in the Northern Territory

AAQ NEPM Standard

0.08 ppm (24 hour average)

Region/ Performance monitoring station	Number of valid days	Highest (ppm)	Highest (date)	2 nd highest (ppm)	2 nd Highest (date)
Winnellie	350	0.0010	07/02/14	0.0010	14/02/14
Palmerston	332	0.0011	2/07/14	0.0011	14/07/14

Table 15: 2014 summary statistics for 24 hour PM₁₀ in the Northern Territory

AAQ NEPM Standard

50 µg m⁻³ (24 hour average)

Region/ Performance monitoring station	Number of valid days	Highest (µg m ⁻³)	Highest (date)	6 th highest (µg m ⁻³)	6 th Highest (date)
Winnellie	315	72.88	08/08/14	48.35	01/09/14
Palmerston	303	52.23	10/06/14	43.75	04/07/14

Table 16: 2014 summary statistics for 24 hour PM_{2.5} in the Northern Territory

AAQ NEPM Advisory Standard

25 µg m⁻³ (24 hour average)

Region/ Performance monitoring station	Number of valid days	Highest (µg m⁻³)	Highest (date)	6th highest (µg m⁻³)	6th Highest (date)
Winnellie	315	45.04	08/08/14	26.68	27/08/14
Palmerston	303	36.92	10/06/14	29.10	02/07/14

6 Analysis of Exceedences and Progress in Achieving Air NEPM Goals

Particulates generated by vegetation burning are the primary air pollutant in the Darwin region. This results in significant variation in air quality between the Dry (May - November) and the Wet (December- April). In general, air quality was excellent during the Wet and poor during the Dry of 2014. Averaged daily levels of PM_{2.5} across both stations over the six months of the Dry were 12.5µg m⁻³, well above the Air NEPM annual Advisory standard of 8µg m⁻³ and significantly higher than levels in other Australian cities. Averaged daily PM_{2.5} levels during the Wet were 3.6µg m⁻³.

The advisory standard for PM_{2.5} had multiple exceedences in 2014 (Figure 10). There were 12 exceedences of the 24 hour standard at the Palmerston station and the annual advisory limit was also exceeded. The Winnellie station had 10 exceedences of the 24 hour standard and also exceeded the annual limit. Figure 10 presents daily data in as a line graph allowing data from both stations to be easily viewed. This shows a generally strong correlation between PM_{2.5} levels at both stations over 2014.

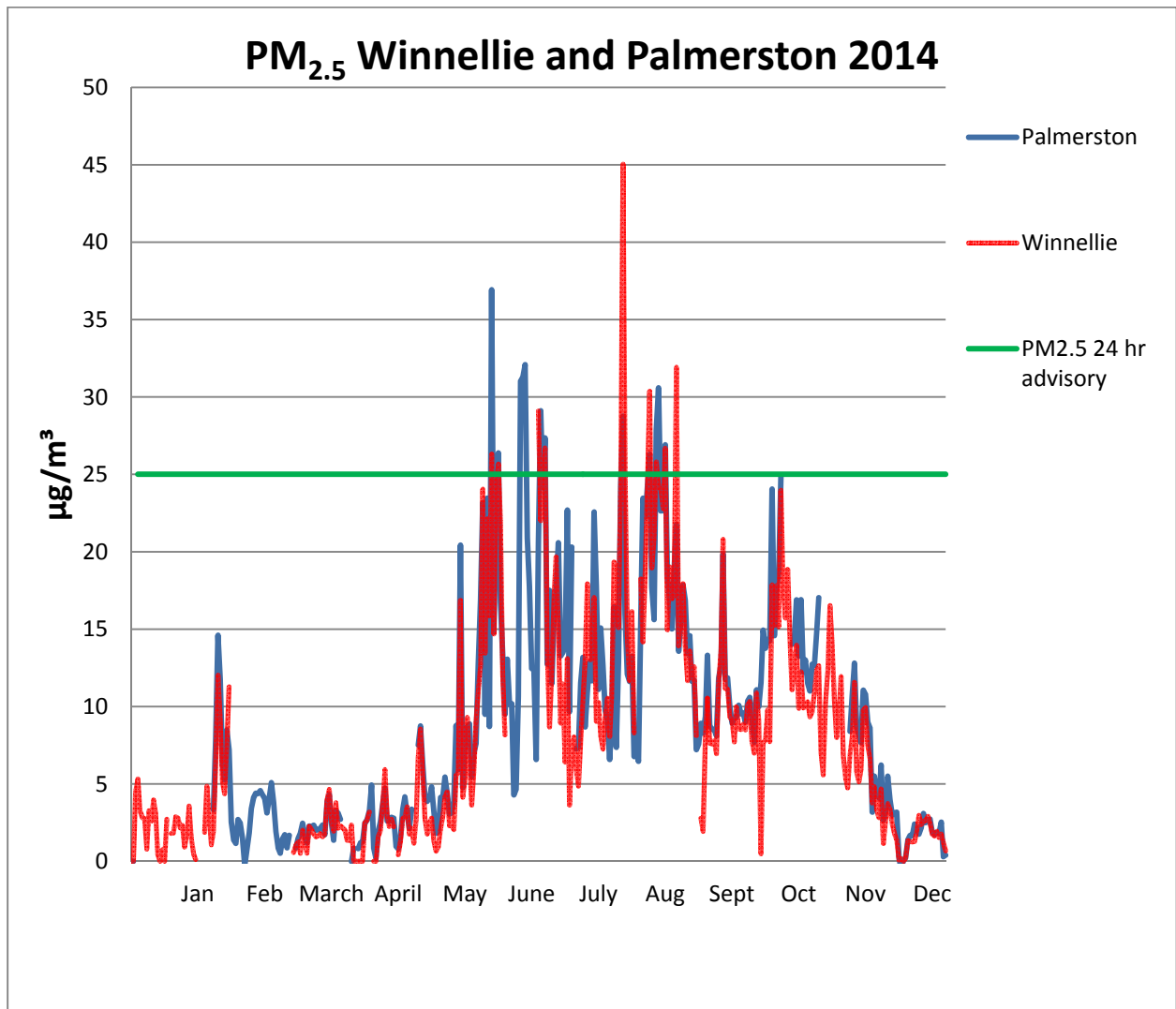


Figure 10: PM_{2.5} Winnellie and Palmerston

Both stations met the Air NEPM goal for PM₁₀ of no more than 5 exceedences of the 24 hour standard within the year. Winnellie station recorded three exceedences of the PM₁₀ standard and Palmerston two. As with PM_{2.5}, the majority of the exceedences were minor and a strong correlation between the stations existed, see Figure 11.

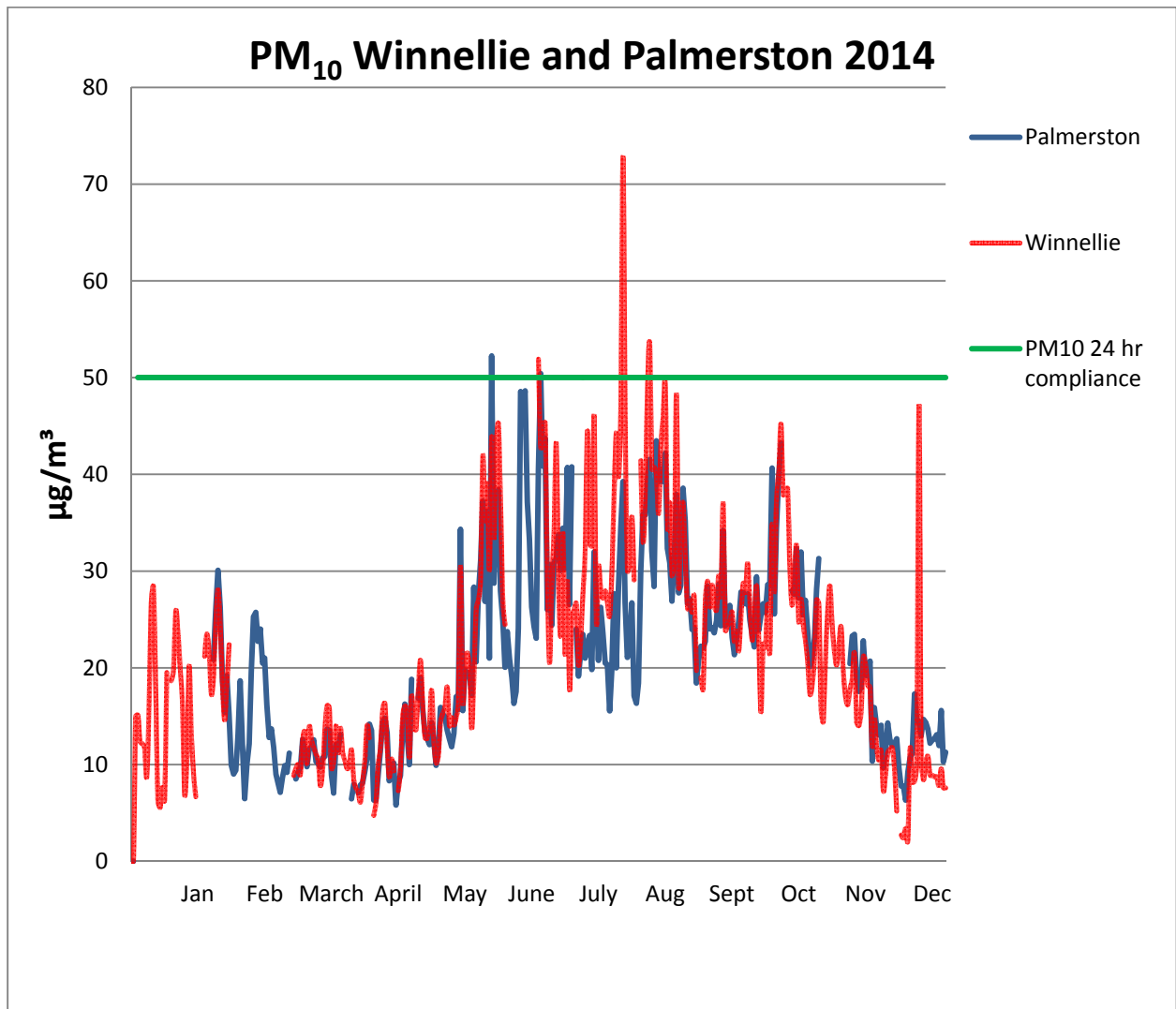


Figure 11 – PM₁₀ Winnellie and Palmerston

Analysis of PM_{2.5} exceedences shows a strong relationship between exceedences at both stations. Of the 10 exceedences at the Winnellie station and 12 at Palmerston 7 occurred simultaneously (Table 17). More distant large scale fire events are likely to cause simultaneous exceedences as particulates have time to disperse over a wider area, while local smaller fires may cause an exceedence at one station only. As discussed below, all exceedences of the PM₁₀ and the PM_{2.5} standard have been attributed to smoke from burning vegetation.

Table 17- Simultaneous Exceedences PM_{2.5}

Date	Winnellie (µg m ⁻³)	Palmerston (µg m ⁻³)
10/06	26.3	36.9
13/06	25.6	26.4
04/07	26.7	27.4

08/08	45.0	28.8
20/08	30.0	26.3
23/08	25.8	27.9
27/08	26.7	26.9

Analysis of timing of particulate spikes during simultaneous exceedences showed that in most cases particulate levels were highest from early to mid-morning. A typical example is shown at Figure 12. The most likely causes for the early morning particulate spikes is night-time temperature inversions¹ holding down smoke travelling overhead from distant fires to the south and east of Darwin.

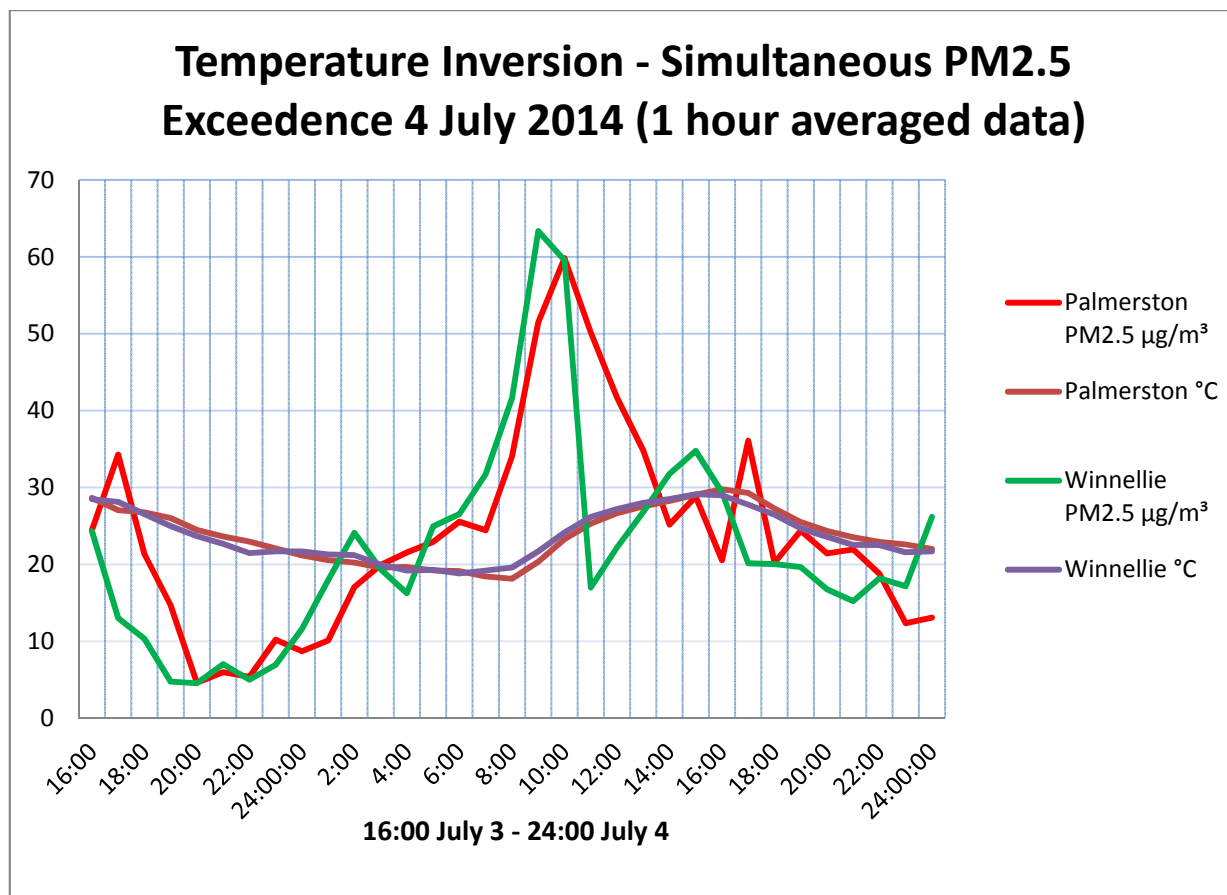


Figure 12: PM2.5 spike associated with temperature inversion

¹ An inversion occurs when air at ground level cools faster than the air above which then acts as a cap on the upward movement of air from the layers below. As a result, convection produced by the heating of air from below is limited to levels below the inversion. Diffusion of dust, smoke, and other air pollutants is likewise limited.

Satellite imagery from 3 July and 4 July (the date of the exceedence graphed in Figure 12) shows that this simultaneous exceedence was most likely due to large scale fires approximately 80km east of Darwin. Hotspots (active fires or areas still warm from recent fire activity) are outlined in red.

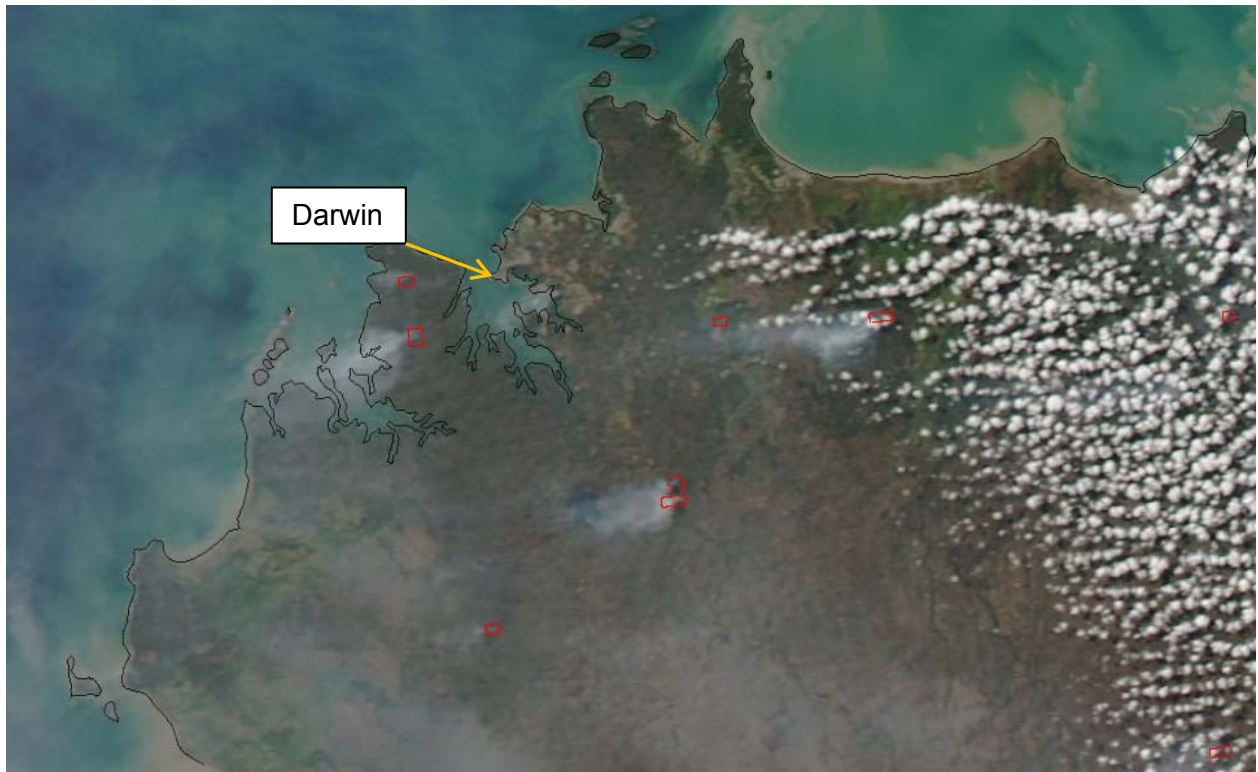


Figure 13: 3 July (early afternoon)

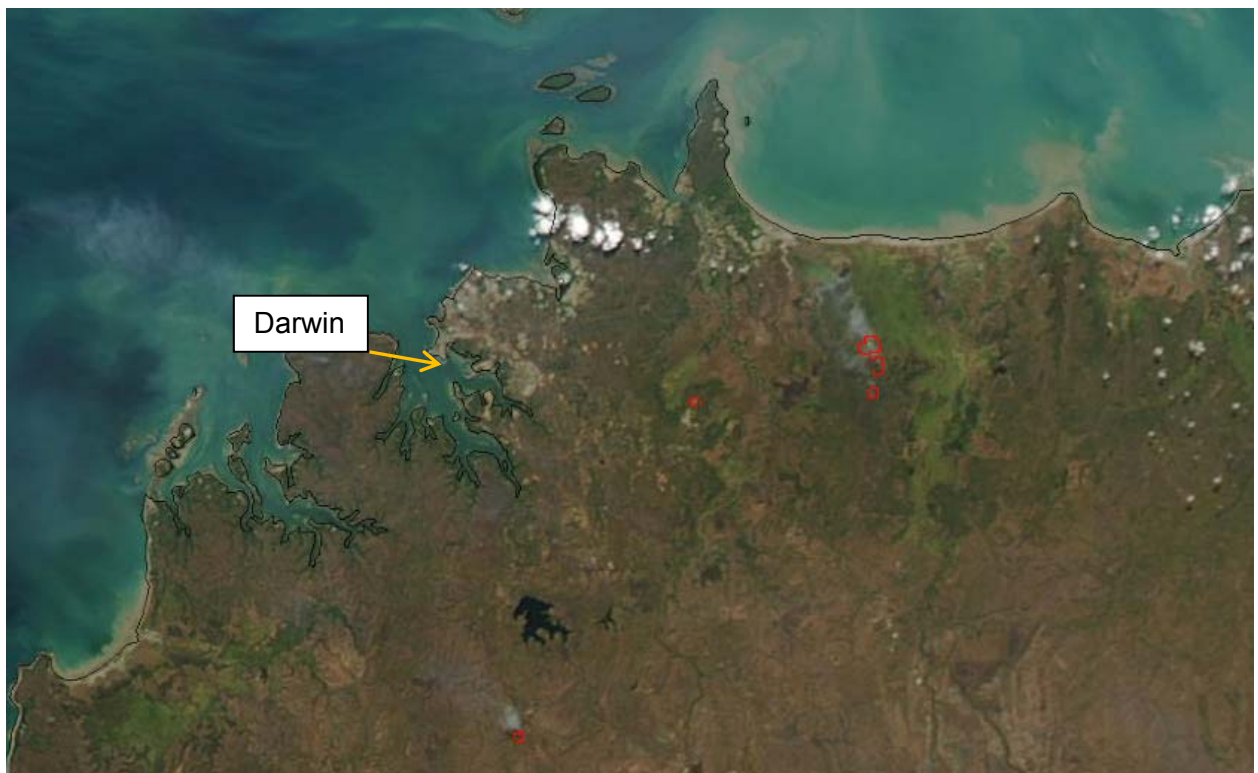


Figure 14: 4 July (early afternoon)

In the afternoon of 3 July there were a number of active fires due east of Darwin, smoke plumes can be observed moving west towards the Darwin region. Typical wind direction for this time of year is east to south easterly dropping off as night approaches. The smoke plumes observed in the satellite image would have been directed slightly north as the night approached and in combination with the temperature inversion, may have been responsible for the early morning PM spike on 4 July. Imagery from 4 July shows hotspots from earlier fires are still detected but there is very little visible smoke.

Tables 18- 21 show exceedences for both stations.

Table 18: 2014 PM₁₀ exceedences of NEPM reporting level at Palmerston

Date	PM ₁₀ m (µg m ⁻³)	Inferred Cause
10/06	52.2	smoke
02/07	50.4	smoke

Table 19: 2012 PM₁₀ exceedences of NEPM reporting level at Winnellie

Date	PM ₁₀ m (µg m ⁻³)	Inferred Cause
01/07	51.9	smoke
08/08	72.9	smoke
20/08	53.5	smoke

Table 20: 2012 PM_{2.5} exceedences of NEPM Advisory Standard at Palmerston

Date	TEOM PM _{2.5} m (µg m ⁻³)	Inferred Cause
10/06	36.9	smoke
13/06	26.4	smoke
23/06	31.0	smoke
24/06	31.3	smoke
25/06	32.1	smoke
02/07	29.1	smoke
04/07	27.4	smoke
08/08	28.8	smoke

20/08	26.3	smoke
23/08	27.9	smoke
24/08	30.1	smoke
27/08	26.9	smoke
Exceedence of NEPM Advisory Standard – Annual average PM_{2.5} 8 µg m⁻³		
2014	9.25	smoke

Table 21: 2014 PM_{2.5} exceedences of NEPM Advisory Standard at Winnellie

Date	PM_{2.5} m (µg m⁻³)	Inferred Cause
10/06	26.3	smoke
13/06	25.6	smoke
01/07	29.1	smoke
04/07	26.7	smoke
08/08	45.0	smoke
09/08	25.2	smoke
20/08	30.0	smoke
23/08	25.8	smoke
27/08	26.7	smoke
01/09	31.9	smoke
Exceedence of NEPM Advisory Standard – Annual average PM_{2.5} 8 µg m⁻³		
2014	8.1	smoke

Smoke from burning vegetation contains PM₁₀ and the PM_{2.5}, Figures 15 and 16 show the close relationship between these parameters at both stations during the Dry season.

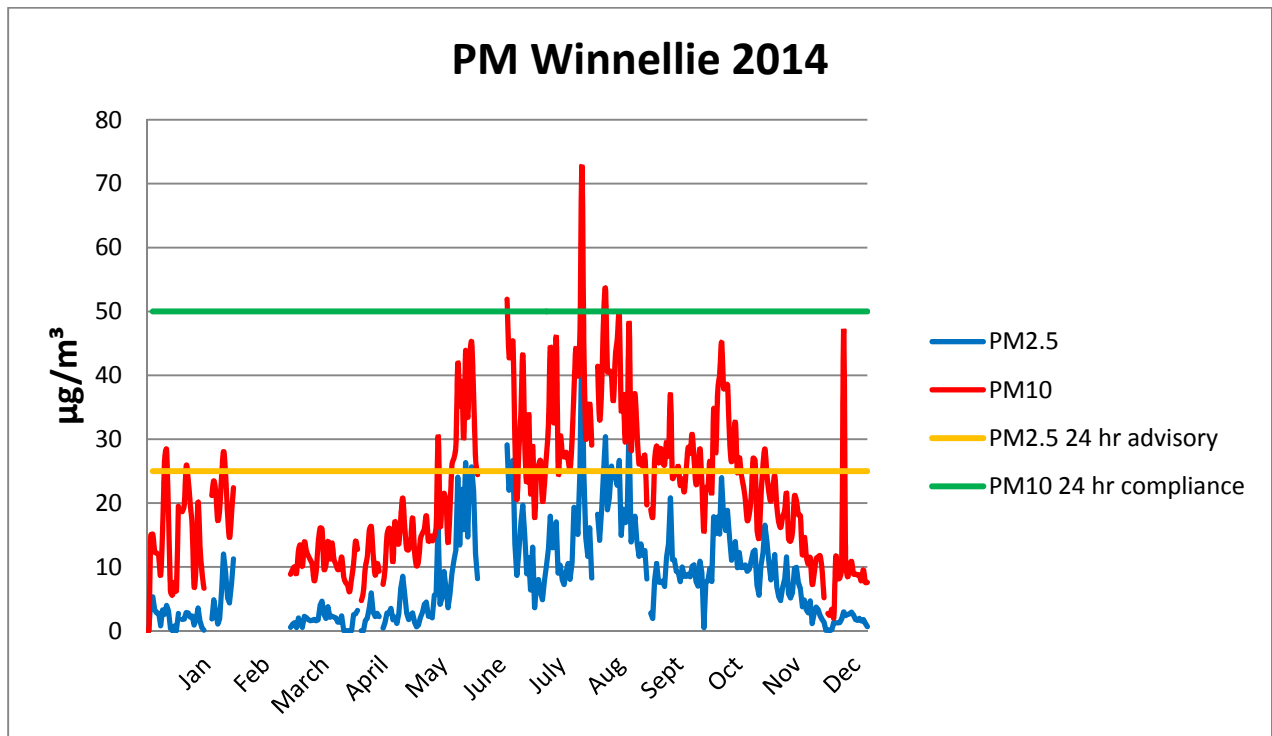


Figure 15

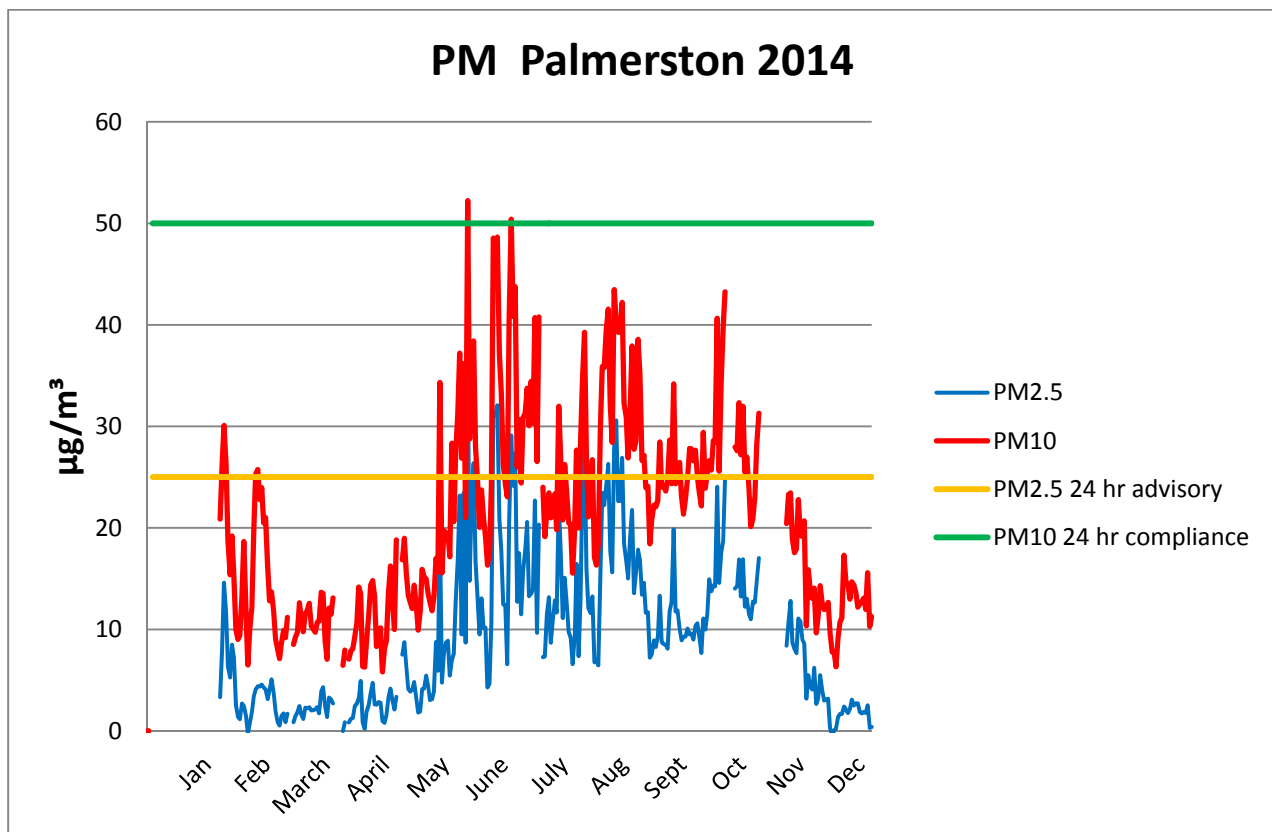


Figure 16

The high number of exceedences for the particulate standards is most likely due to distant large scale fire activity and local sources such as fire and dust associated with land clearing and

urban development. Other potential sources of particulates such as traffic or industry are not indicated by the monitoring results for 2014. If traffic or industry were significant contributors to particulate levels it would be expected that annual PM_{2.5} levels for Winnellie, which is located close to main roads and light industry, would be higher than for Palmerston which is located in light bushland far from roads and industry.

The advisory reporting standard for PM_{2.5} has the same numerical value as a compliance standard but without an associated goal setting a timeframe for compliance. There is no timeframe set for compliance with the standard or an allowable number of exceedences. There is strong evidence that PM_{2.5} poses a significant risk to human health and this remains a key driver for consideration of the need for compliance standards for this pollutant.

No monitoring has been undertaken in Alice Springs and compliance with the AAQ NEPM has not been demonstrated.

7 Data analysis and trends

Tables 23 and 24 below compare the number of exceedences in the NT over a longer period of time in accordance with AAQ NEPM technical requirements. This comparison is of limited utility in providing an accurate indication of particulate trends as different sampling techniques have been used since monitoring began in 2002 (TEOM and Partisol) and instruments have not been located consistently throughout the sampling period.

Issues with historical data include:

- 2004 - data collection for this project did not commence until the second quarter.
- 2004 and 2005 - TEOM was located in Palmerston at the Charles Darwin University Palmerston campus.
- 2006 - TEOM data availability was below 75% for each quarter so Partisol data was used.
- 2009 - dust produced from local construction activity in close proximity to the station required that exceedences for a period over the dry be removed as they were not necessarily representative of air quality in the larger air shed.
- 2010 – there was significant downtime with the Partisol and also TEOM instruments.

Since the establishment of the Palmerston station in 2011 and then the Winnellie station in 2012 data quality has generally improved. During the Wet of 2013 the Palmerston TEOM was offline for a number of months resulting in inadequate data collection for NEPM reporting. As the TEOM was operational for most of the Dry, when particulates are an issue, 2013 data from Palmerston is still useful when considering longer term trends in particulates.

Table 23: Trends daily peak concentration ($\mu\text{g m}^{-3}$) PM_{10} , 2004-2014

AAQ NEPM standard

50 $\mu\text{g m}^{-3}$ (24-hour average)

Year	Data Availability (% of days)	No. of exceedences (days)	Max. conc. $\mu\text{g m}^{-3}$
2004 Casuarina	69	1	54
2005 Casuarina	98	2	63
2006 Casuarina	97	0	44
2007 Casuarina	95	0	45
2008 Casuarina	97	1	65
2009 Casuarina	90	0	50
2010 Casuarina	78	1	54
2011 Palmerston	96	3	92
2012 Palmerston	91	23	70
2013 Palmerston	49	1	72
2013 Winnellie	76	3	58
2014 Palmerston	82	2	52
2014 Winnellie	86	3	73
Average	84.9	3.1	60.9

Table 24: Trends in daily peak concentration ($\mu\text{g m}^{-3}$) $\text{PM}_{2.5}$, 2004-2014

Year	Data Availability (% of days)	No. of exceedences (days)	Max. conc. $\mu\text{g m}^{-3}$
2004 Casuarina	60	5	37
2005 Casuarina	98	5	58
2006 Casuarina	97	5	30
2007 Casuarina	-	-	-
2008 Casuarina	72	2	32

2009 Casuarina	87	1	26
2010 Casuarina	62	2	30
2011 Palmerston	96	15	77
2012 Palmerston	91	23	44
2013 Palmerston	49	6	56
2013 Winnellie	76	5	34
2014 Palmerston	82	12	37
2014 Winnellie	86	9	45
Average	79.7	7.5	42.2

In the Darwin region, exceedences of the particulate standards are generally caused by smoke from burning vegetation. This connection has been made based on analysis of monitoring data, satellite imagery and observation of visible smoke on days when particulate standards have been exceeded. Analysis of firescar data (NAFI 2015) showing percentage area burnt by year for the region likely to generate smoke impacting Darwin shows there is no clear long term relationship between area burnt and particulate levels at the monitoring stations. Figure 17 shows relevant parameters by year.

As the total area burnt is not a key driver of particulate impacts on Darwin, other factors such as the timing of burns in relation to meteorological conditions must play a significant part in total particulate impacts on population centres. Success in reducing these impacts may be possible by addressing the timing of burns in relation to predicted meteorological conditions.

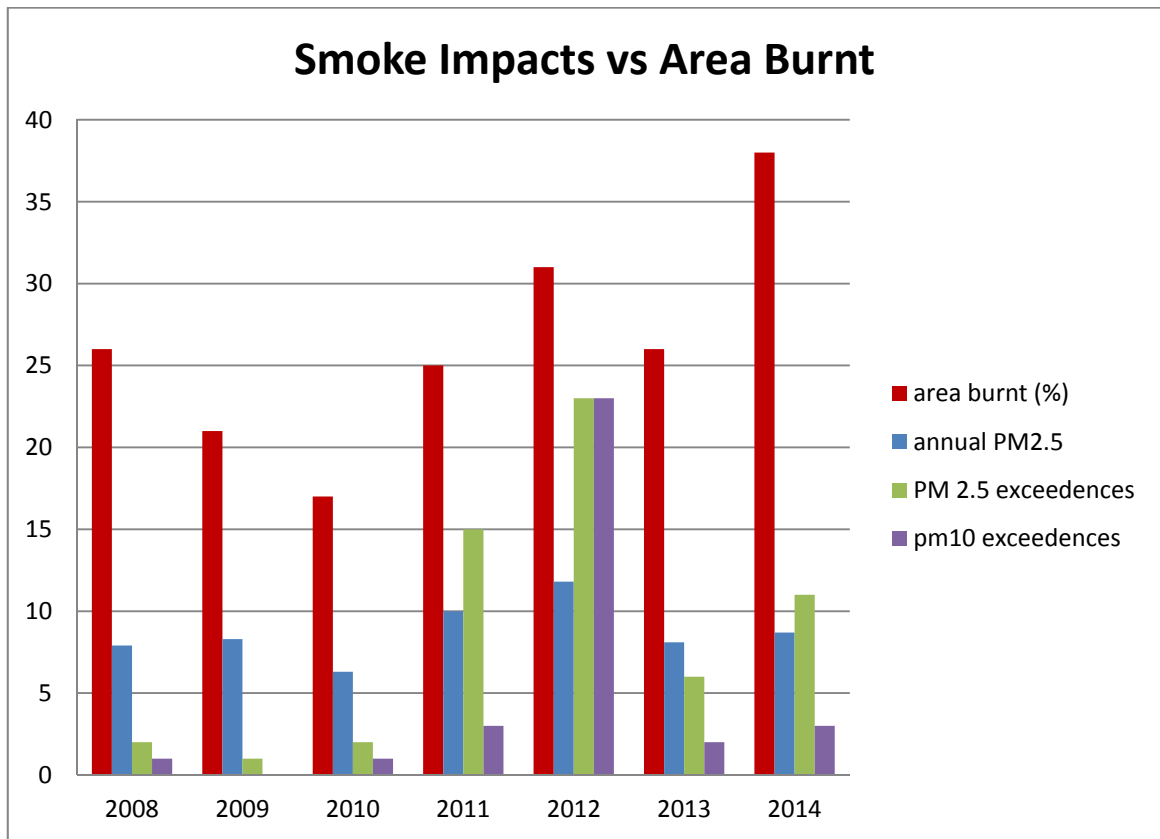


Figure 17

Figures 18-22 show satellite imagery for days where there were exceedences of the PM2.5 standard at both stations. The images come from NASA's Aqua satellite which passes south to north over the equator in the afternoon. They provide a snapshot of visible smoke plumes and hotspots from current and recent fire activity. Significantly high particulate levels can be experienced beyond the visible smoke plume. This is evident in the high particulate readings at times when the visible plume has dispersed before reaching the stations.



Figure 18: 10 June 2014

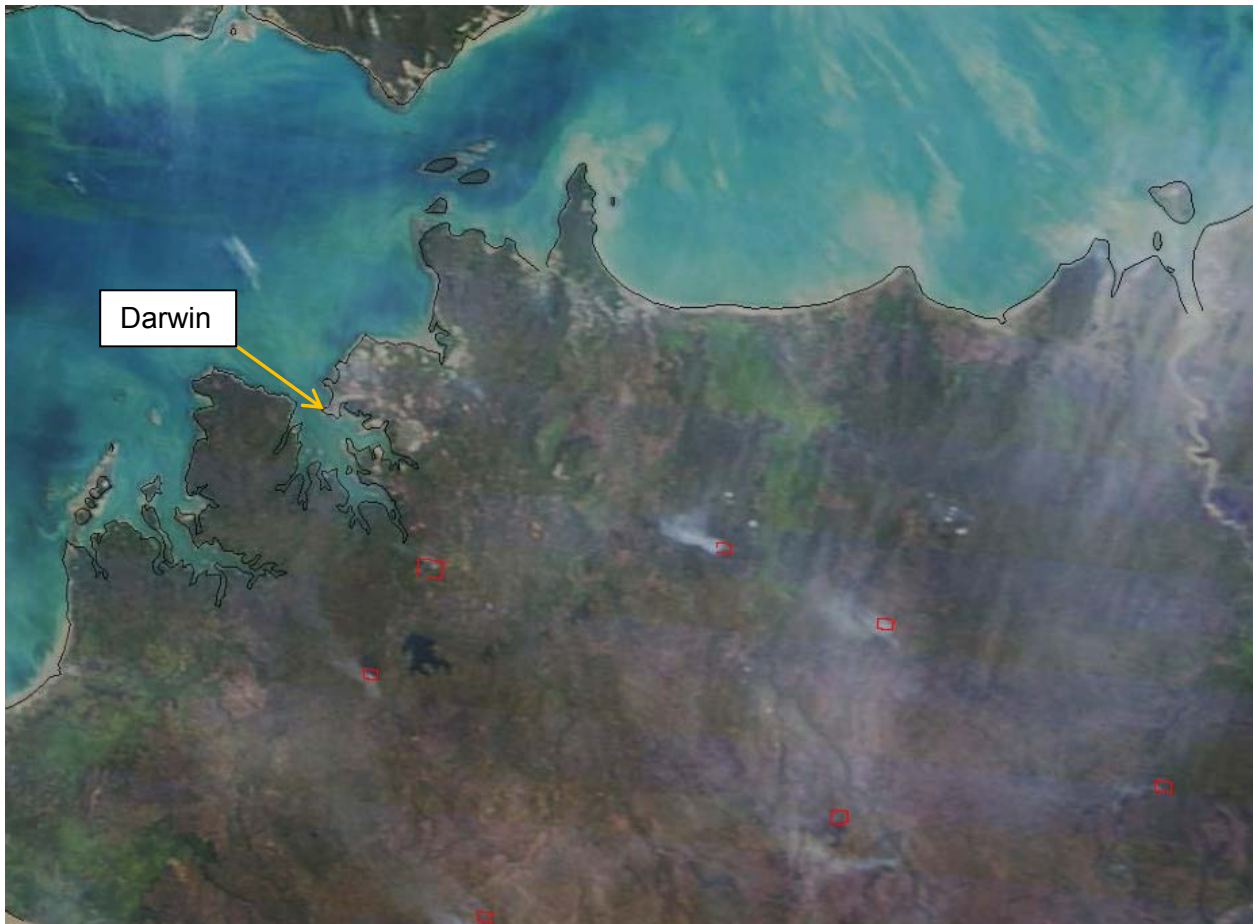


Figure 19: 13 June 2014



Figure 20: 20 August 2014



Figure 21: 23 August 2014



Figure 22: 27 August 2014

Analysis of fire activity data and particulate monitoring shows that fires greater than 150 km from Darwin are rarely linked to exceedences of the Air NEPM standards. The Bureau of Meteorology has developed a smoke model for a number of points in the Top End region. Points in the current model are located 200-300 kilometres to the east and southeast of Darwin (Figure 23). Smoke and particle dispersion modelled for these points would be similar to dispersion from fire points closer to Darwin. The model shows concentration of smoke as a fraction of the initial concentration but does not allow for positioning of particles relative to ground level. Near ground level conditions such as wind speed and temperature inversions are critical factors in determining the level of concentration of particulates from distant fires.

Monitoring of particles will contribute towards development of NT Government air quality policy and may provide the basis for the development of management strategies aimed at reducing the impact of particulates on urban populations in the future. Controlled burns present some opportunity for managing particulates. By timing the burn in consideration of wind direction and temperature inversion forecasts it may be possible to reduce particulate levels in population centres. There may also be scope for control of particulates from unintended fires (arson etc) by pre-emptively burning areas identified for planned burning activity when conditions (wind direction and temperature inversion activity) was forecast to result in smoke being directed away from population centres.

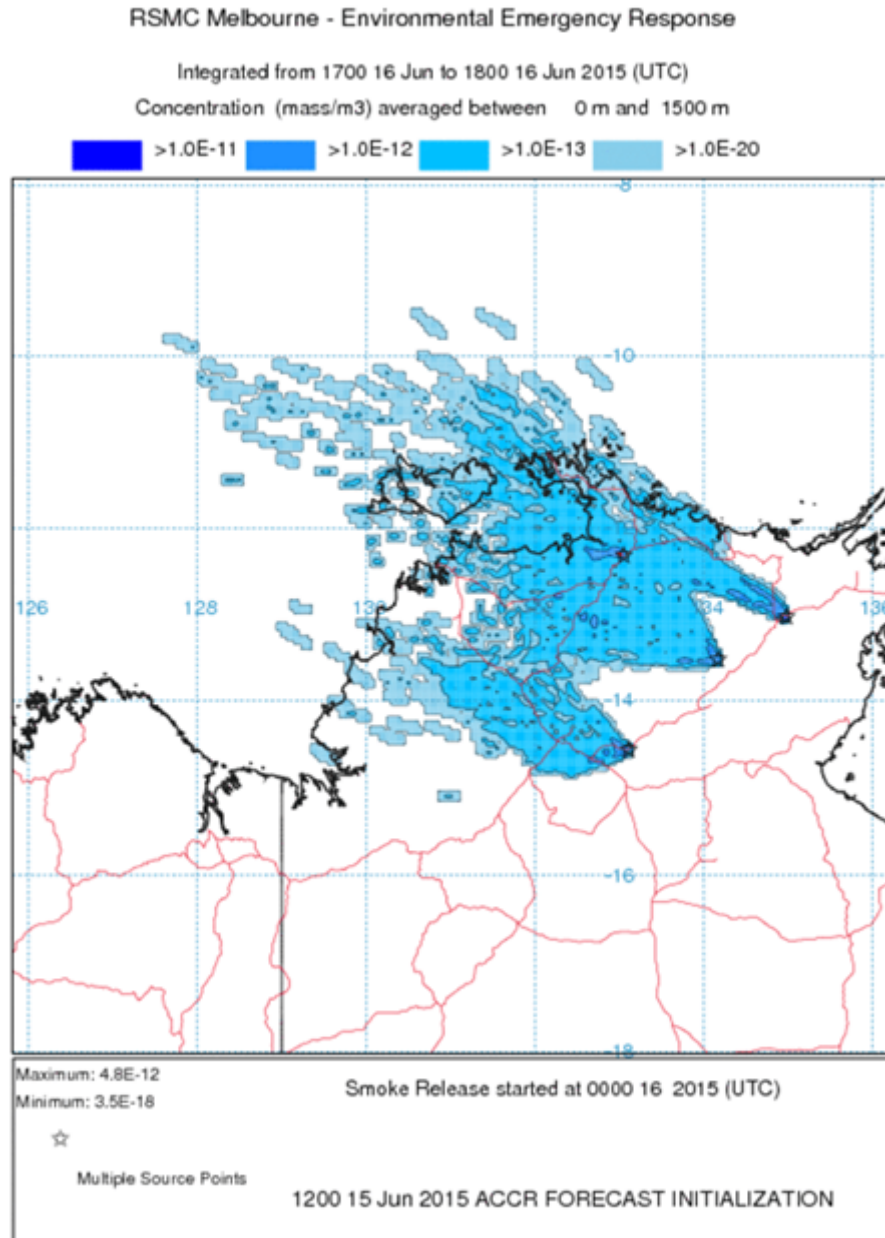


Figure 23: Smoke dispersion model, 15 June 2015

Reference

NAFI (North Australian Fire Information) www.firenorth.org.au, *Fire Reports, Fire History by Year - 2008-2014, Darwin region*, Accessed July 2014

NASA satellite imagery
<http://lancemodis.eosdis.nasa.gov/imagery/subsets/?project=&subset=Australia2>

Smoke Dispersion Model, Bureau of Meteorology, RSMC Melbourne – Environmental Emergency Response