SQ2443 - Air Quality Monitoring Program,
RAAF Base Amberley

Department of Defence

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Air Quality Monitoring Annual Report

Australian Super Hornet Flying Operations - June 2014 to May 2015

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Australian Super Hornet Flying Operations - June 2014 to May 2015

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Prepared by

AECOM Australia Pty Ltd
Level 8, 540 Wickham Street, PO Box 1307, Fortitude Valley QLD 4006, Australia
T +61 7 3553 2000 F +61 7 3553 2050 www.aecom.com
ABN 20 093 846 925

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			Name/Position	Signature
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Executive Summary

The Department of Defence (Defence) has engaged AECOM Australia Pty Ltd (AECOM, ABN 20 093 846 925) to undertake the implementation of the RAAF Base Amberley Australian Super Hornet Air Quality Monitoring Plan (AQMP). AECOM operates an ambient air quality monitoring station on behalf of Defence, measuring the parameters specified in the AQMP, and detailed in Section 2.2 of this report. The purpose of this report is to present results of air quality monitoring undertaken on behalf of Defence by AECOM for the annual period starting 1 June 2014 and finishing 31 May 2015 inclusive in order to satisfy Condition 4a of the Environmental Protection and Biodiversity Act 1999 approval for the Super Hornet flying operations at RAAF Base Amberley (EBPC Reference: 2008/4410).

The data availability and corrected data capture rate exceeded the requirements of NEPM Technical Paper No. 5 and industry standards for collection of air quality monitoring data.

There were no reportable exceedances of any of the Environmental Protection (Air) Policy 2008 (EPP(Air)) objectives during the annual monitoring period.

Based on the collected data, AECOM makes the following recommendations and observations:

- Australian Super Hornet movements during the annual period did not reach a sufficient level to allow validation of the modelling results.
- Formaldehyde monitoring should be discontinued due to consistently low detections (30 out of 61 samples were below the limit of reporting for the method used by the analysing laboratory), and no correlation between formaldehyde detections and Super Hornet activity.

Table 1 summarises measurements made during the annual monitoring period, comparing them to the relevant EPP(Air) objective, and Table 2 compares measurements to reportable EPP(Air) annual objectives.

Table 1 Summary of annual period – June 2014 to May 2015

Parameter	Period	Average Concentration	Maximum Concentration	EPP(Air) Objective	Reportable exceedances
CO	8 hours	-0.020 ppm	1.985 ppm	9 ppm	0
HCHO	24 hours	< LOR[a]	8.3 µg/m³	54 µg/m³	0
NO_2	1 hour	3.8 ppb	62.5 ppb	120 ppb	0
O_3	1 hour	21.7 ppb	107.7 ppb	100 ppb	0[b]
O_3	4 hour	21.6 ppb	81.3 ppb	80 ppb	0[b]
$PM_{2.5}$	24 hours	4.9 µg/m³	20.5 µg/m³	25 µg/m³	0
PM_{10}	24 hours	11.1 µg/m³	32.5 µg/m³	50 µg/m³	0
SO_2	1 hour	0.5 ppb	5.1 ppb	200 ppb	0
SO_2	24 hours	0.5 ppb	1.8 ppb	80 ppb	0

[a] Fewer than 75% of the samples were reported as being greater than the limit of reporting for the analysis method.

[b] EPP(Air) allows for one day in exceedance of the numerical objective. Peak ozone concentrations were measured on one day, and therefore the exceedances of the 1 and 4 hour average objectives are **not reportable exceedances**.

Table 2 Summary of annual period – reportable annual average concentrations – June 2014 to May 2015

Parameter	Cumulative average concentration	EPP (Air) annual objective	Result
NO_2	3.8 ppb	30 ppb	Not exceeded
$PM_{2.5}$	4.9 µg/m³	8 µg/m³	Not exceeded
SO_2	0.5 ppb	20 ppb	Not exceeded

1.0 Introduction

The Department of Defence (Defence) has engaged AECOM Australia Pty Ltd (AECOM, ABN 20 093 846 925) to undertake the implementation of the RAAF Base Amberley Australian Super Hornet Air Quality Monitoring Plan (AQMP). The AQMP was developed in response to the findings of the Australian Super Hornet Public Environment Report (PER).The purpose of the AQMP is to outline how Defence will comply with Condition 4 of the Environment Minister's approval of the Australian Super Hornet (ASH) flying operations at RAAF Base Amberley. Condition 4 of the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) approval of the Super Hornet flying operations at RAAF Base Amberley (EPBC Reference: 2008/4410) is as follows:

> *4. The person taking the action must provide for approval by the Minister an Air Quality Monitoring Plan that includes:*
>
> *a) Monitoring air quality near a sensitive receiver in close proximity to or on RAAF Base Amberley;*
>
> *b) A process for validation of the accuracy of Super Hornet air quality impacts modelled in the Public Environment Report of the action;*
>
> *c) Should the measured air quality values exceed relevant air quality objectives, a commitment to working with the relevant State authorities to determine sources of pollutants and potential mitigation measures;*
>
> *d) An undertaking to post the results of rain tank water quality testing conducted in accordance with the Public Environment Report on an appropriate website for public information;*
>
> *e) In the event that rainwater contamination is found to occur as a result of the proposal, identification and implementation of appropriate measures to mitigate the contamination.*

The purpose of this report is to present results of air quality monitoring undertaken on behalf of Defence by AECOM in order to satisfy Condition 4a. Reporting to satisfy Condition 4a comprises four quarterly reports per year of monitoring. The scope of works for the quarterly report is as follows:

- Presentation of all results for the quarterly monitoring period (including graphical representations).
- Comparison of results with standards and trigger values.
- Analysis of results at a quarterly scale, including running comparisons with previous results collected as part of the current program.
- Explanation/discussion of any exceedances detected during the reporting period.
- Identification of QA/QC and maintenance activities that took place during the month.

Following the four quarterly reports per year an annual monitoring report (this report) has been prepared. In addition to the information provided in the quarterly reports this annual reports includes the following:

- Presentation of full annual data sets, including the addition of meteorological data acquired from the Bureau of Meteorology.
- Examinations of annual trends and discussion on deviations and exceedances of standards.
- Examinations of longer term trends and, where available, compare current monitoring data to previous monitoring program data. For the first annual report of the current monitoring program no comparison with previous monitoring can be undertaken. Subsequent annual reports will include running comparisons with the previous annual report.
- A comparison and analysis of the annual monitoring data set alongside ASH air quality impacts modelled in the Public Environment Report. Analysis will be in order to satisfy Condition 4b of the ASH flying operations at RAAF Base Amberley EBPC Act approval.

2.0 Methodology

2.1 Location of monitoring station

The AQMP for the ASH operations at RAAF Base Amberley requires Defence to establish an air quality monitoring station near one of the sensitive receivers nominated in the PER. The AQMP also sets siting criteria for selecting a monitoring location out of the nominated sensitive receivers.

AECOM conducted an Air Quality Monitoring Station Site Selection analysis for ASH operations at RAAF Base Amberley (dated 23 May 2014). In accordance with the AQMP site selection criteria and the requirements of Australian Standard *AS/NZS 3580.1.1:2007 – Methods for sampling and analysis of ambient air Part 1.1: Guide to siting air monitoring equipment*, the site selection analysis nominated a preferred monitoring location. As a result of the site selection process, the preferred and selected location for the air quality monitoring station was identified as a grassed area on the western side of the parking lot behind building A052, shown as “Monitoring Location” in Figure 1. Coordinates of the monitoring station are: 27° 38’ 24.92” S, 152° 41’ 39.02” E.

Figure 1 Aerial of monitoring location

2.2 Parameters monitored

Monitored parameters as specified by Defence and the relevant standards under which they are monitored are detailed in Table 3.

Table 3 Summary of monitoring methodology

Parameter	Unit of reporting	Full scale range	Instrument	Relevant Standard	Uncertainty of method[1]
Carbon Monoxide	ppm by volume (ppm)	50 ppm	TAPI T300	AS/NZS 3580.7.1:2011	± 2.2 %
Formaldehyde	µg/m³	162 µg/m³	UMEx 100 passive sampler	USEPA TO11 A (as specified by NEPM (Air Toxics))	Not applicable
Nitrogen Dioxide	ppb by volume (ppb)	500 ppb	TAPI T200	AS/NZS 3580.5.1:2011	± 6.5 %
Ozone	ppb by volume (ppb)	500 ppb	TAPI T400	AS/NZS 3580.6.1:2011	± 2.9 %
Suspended particulate matter – $PM_{2.5}$	µg/m³	5000 µg/m³	FH62-C14	AS/NZS 3580.9.12:2013	± 1.1 %
Suspended particulate matter – PM_{10}	µg/m³	5000 µg/m³	FH62-C14	AS/NZS 3580.9.11:2008	± 1.1 %
Sulfur dioxide	ppb by volume (ppb)	500 ppb	TAPI T100	AS/NZS 3580.4.1:2008	± 6.0 %

[1] Uncertainty is expressed as a percentage of full scale range at a 95% confidence level with a coverage factor of 2

With the exception of formaldehyde, monitoring of suspended particulate and gaseous parameters is continuous. Formaldehyde is monitored on a six-day cycle in accordance with the National Environmental Protection (Air Toxics) Measure (NEPM (Air Toxics)), with a passive sampler being installed at the station and then removed for analysis after a 24 hour period has elapsed.

Two additional standards are referenced for the monitoring undertaken for this report:

- Australian Standard *AS/NZS 3580.1.1:2007 – Guide to siting air monitoring equipment* details requirements for station siting which were addressed during site selection as detailed in Claughton and Manley (23 May 2014) *Air Quality Monitoring Station Site Selection*. As per the standard, the site is audited annually for continued compliance with the standard.
- Australian Standard *AS/NZS 3580.2.2:2009 – Preparation of reference test atmospheres – Compressed gas method* details requirements for preparation of reference test atmospheres for the calibration of the T100, T200 and T300 gas analysers.

Formaldehyde samples are analysed by ALS Environmental Division Brisbane (NATA accreditation number 825). Results from the analysis are used to calculate a concentration based upon the UME^{X}100 specified sampling rate for formaldehyde of 28.6 ml/min (0.0412 m³ for a 24 hour day). The calculated concentrations are then normalised to standard temperature and pressure using temperature and pressure readings from the station. The limit of reporting (LOR) stated by the analysing laboratory is 0.08 µg per sample. A result is identified as being below the LOR ("< LOR") indicates that the sample contained less than the minimum amount of formaldehyde detectable by the analysis method. A < LOR result is conservatively assumed to be equal to the LOR concentration for calculation of averages.

2.3 Air quality objectives

Measured gas and particulate concentrations are compared against the air quality objectives for health and wellbeing detailed in Schedule 1 of the *Environmental Protection (Air) Policy 2008* (EPP (Air)) and detailed in Table 4.

Table 4 Air quality objectives for health and wellbeing, EPP (Air)

Parameter	Air quality objective	Period	Allowable exceedances of objective
Carbon monoxide (CO)	9 ppm	8 hours	1 day each year
Formaldehyde (HCHO)	54 µg/m³	24 hours	Nil
Nitrogen dioxide (NO_2)	120 ppb	1 hour	1 day each year
	30 ppb	1 year	Nil
Ozone (O_3)	100 ppb	1 hour	1 day each year
	80 ppb	4 hours	1 day each year
$PM_{2.5}$ particulate ($PM_{2.5}$)	25 µg/m³	24 hours	Nil
	8 µg/m³	1 year	Nil
PM_{10} particulate (PM_{10})	50 µg/m³	24 hours	5 days each year
Sulfur dioxide (SO_2)	200 ppb	1 hour	1 day each year
	80 ppb	24 hours	1 day each year
	20 ppb	1 year	Nil

For some parameters the EPP(Air) allows for the air quality objective to be exceeded for a set number of days each year, as detailed in Table 4. Exceedances are only considered as **reportable exceedances** where the number of days on which the air quality objective is exceeded is greater than the allowable number of days in exceedance as specified in the EPP(Air).

Furthermore, results are graded according to the Queensland Department of Environment and Heritage Protection (DEHP) Air Quality Index (Queensland Government, *Air Quality Index*, retrieved 26 August 2014, http://www.qld.gov.au/environment/pollution/monitoring/air-monitoring/air-quality-index/). The air quality index comprises five colour coded categories, based upon the percentage of the air quality objective:

Air quality index value = (pollutant concentration ÷ air quality objective for the pollutant) × 100

Very Good (0-33%)	Good (34-66%)	Fair (67-99%)	Poor (100-149%)	Very Poor (>150%)

Air quality index values of “Poor” and “Very Poor” indicate exceedance of the EPP (Air) objective.

2.4 Data capture rate

Data capture is reported as follows:

- Raw data capture, also called data availability, being the percentage coverage of the total time in the current reporting period.
- Corrected data capture, being the percentage coverage of the current reporting period excluding data loss from routine operational events such as maintenance checks and calibrations.

Actual expected data loss varies from month to month (due to differing maintenance requirements over specified time periods, and the varying number of days in a month), but at a minimum the gaseous analysers require 5% down time per month for routine calibrations and servicing events, and the BAMs require a minimum of 1% downtime per quarter. Additional downtime is required on a yearly basis for preventative maintenance.

2.5 Data validation and handling

AECOM uses methodology outlined in the National Environmental Protection Council's *National Environmental Protection (Ambient Air Quality) Measure: Technical Paper No. 5 – Data Collection and Handling* ("Technical Paper No. 5"). Technical Paper No. 5 details basic data validation methodologies, methods for calculation of average data, and reporting requirements for data.

Data reported in this report have undergone AECOM's internal data validation process. This process is based upon the process detailed in Section 4.3 of Technical Paper No. 5, and the relevant Australian Standard for the parameter measured.

2.6 Reporting of results

2.6.1 Calculation and labelling of results

Concentrations quoted in this report are averages of validated 10 minute monitored data from the station data logger, with the exception of formaldehyde concentrations, which are a discrete sample. Averages are calculated in accordance with Technical Paper No. 5, using the following definitions:

- "Average" means an arithmetic mean, reported at the frequency implied by the name of the dataset (for example, a single 24 hour average value is reported for each day).
- "Rolling average" means an arithmetic mean of the last *x* hours of the 1 hour average data set, reported at an hourly frequency (for example, an 8 hour rolling average consists of the arithmetic mean of eight 1 hour averages).
- A calculated concentration is considered "valid" where no less than 75% of the expected number of sample data sets are present and valid for the averaging period (for example, for a valid 24 hour average to be reported it must be calculated from at least 18 valid 1 hour averages).

Results are reported in the units listed in Table 3, and are calculated using the source data and expressed using the timestamp listed in Table 5.

Table 5 Calculation and labelling of reported results

Dataset	Source data	Timestamp	Example
1 hour	Validated 10 minute dataset	Time ending	1 hour result labelled "10:00" is calculated from six 10 minute values (09:10 to 10:00)
4 hour	Rolling average of 1 hour data	Time ending	4 hour result labelled "10:00" is calculated from four 1 hour averages (07:00, 08:00, 09:00 and 10:00)
8 hour	Rolling average of 1 hour data	Time ending	8 hour result labelled "10:00" is calculated from eight 1 hour averages (03:00 to 10:00 inclusive)
24 hour	Average of 1 hour data	Time beginning	24 hour result labelled "01/06/2014" is calculated from 24, 1 hour averages (1 hour averages labelled 01/06/2014 01:00 to 02/06/2014 00:00 inclusive)
Annual	Average of 1 hour data	Time beginning	Annual result labelled "1 June 2014 to 1 June 2015" is calculated from 8760, 1 hour averages (1 hour averages labelled 01/06/2014 01:00 to 01/06/2015 00:00 inclusive)

2.6.2 Time zone and volumetric normalisation

All dates and times referenced in this report are reported in Australian Eastern Standard Time (UTC + 10 hours).

Particulate concentrations stated in this report are reported as micrograms per cubic metre (µg/m³) normalised to standard temperature and pressure (0 °C and 101.3 kPa).

3.0 Meteorological Analysis

3.1 Meteorological Station

Meteorological data were sourced from the nearest Bureau of Meteorology (BoM) station, the Amberley AMO weather station, located approximately 2km to the north-east of the monitoring station at 27° 37' 47" S, 152° 42' 40" E. The location of the weather station relative to the monitoring station is illustrated in Figure 1 in Section 2.1. Data for wind speed, wind direction, and rainfall was collated and summarised to provide a description of meteorological conditions during the monitoring period (1 June 2014 to 31 May 2015 inclusive). Table 6 graphically illustrates the wind conditions during the entire annual period, while Table 7 graphically illustrates conditions for each season of the year.

Table 6 Wind data from Amberley AMO – annual monitoring period 1 June 2014 to 30 May 2015 (inclusive)

Wind Speed and Direction at Amberley AMO – Monitoring Period 1 June 2014 to 30 May 2015 (inclusive)

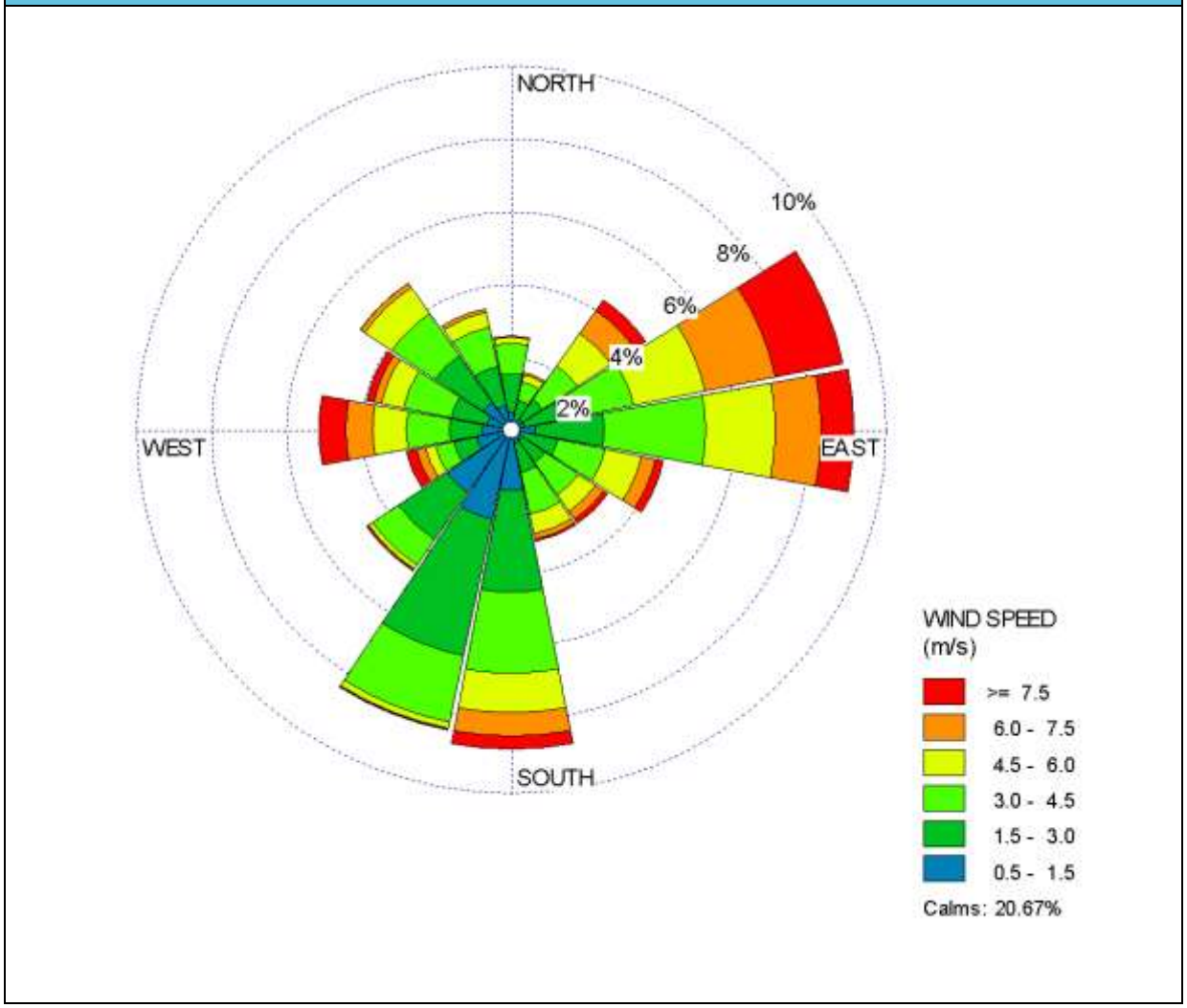
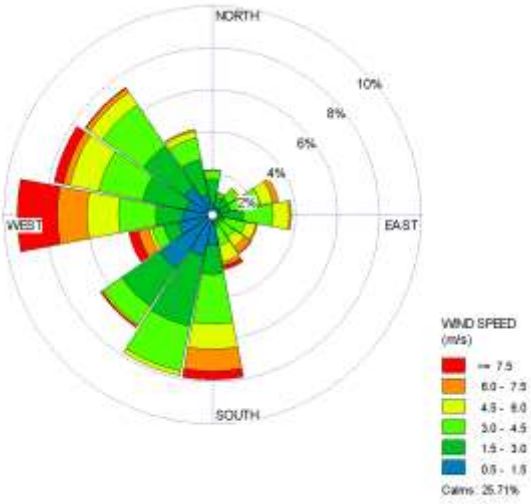
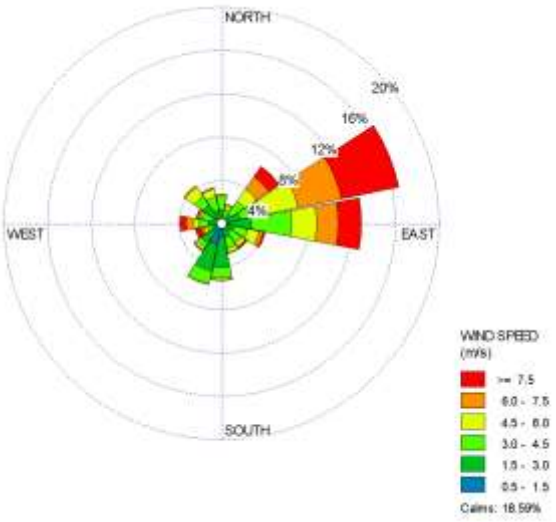
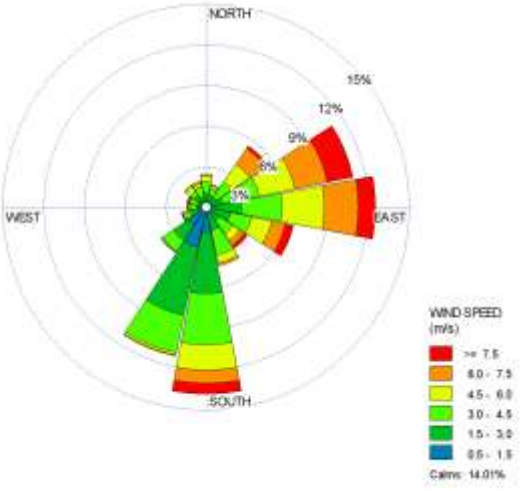
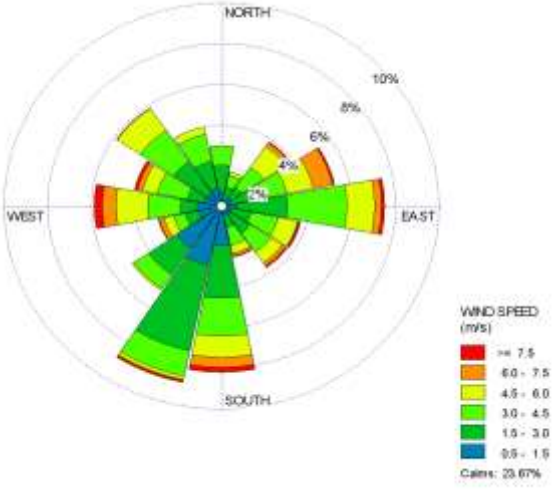


Table 7 Wind data from Amberley AMO – seasonal wind data for monitoring period 1 June 2014 to 30 May 2015 (inclusive)

Wind Speed and Direction at Amberley AMO – Seasonal wind roses	
	
Winter 2014 – 1 June to 31 August 2014 (inclusive)	Spring 2014 – 1 September to 30 November 2014 (inclusive)
	
Summer 2014/15 – 1 December 2014 to 28 February 2015 (inclusive)	Autumn 2015 – 1 March to 31 May 2015 (inclusive)

4.0 Aircraft movements

4.1 Provided data

AECOM obtained aircraft movement data from Defence covering the annual reporting period starting June 2014. Figure 2 graphically illustrates the supplied data, comparing the total number of aircraft movements to the number of ASH movements.

For the purposes of this analysis, an aircraft movement is defined as a departure from or arrival to RAAF Base Amberley. Due to a lack of available data, the analysis does not consider whether an arrival consisted of a full stop landing on arrival at the base or a series of circuits followed by a full stop landing. Therefore, no distinction is made between these types of arrival and consequently both types are counted as a single movement only.

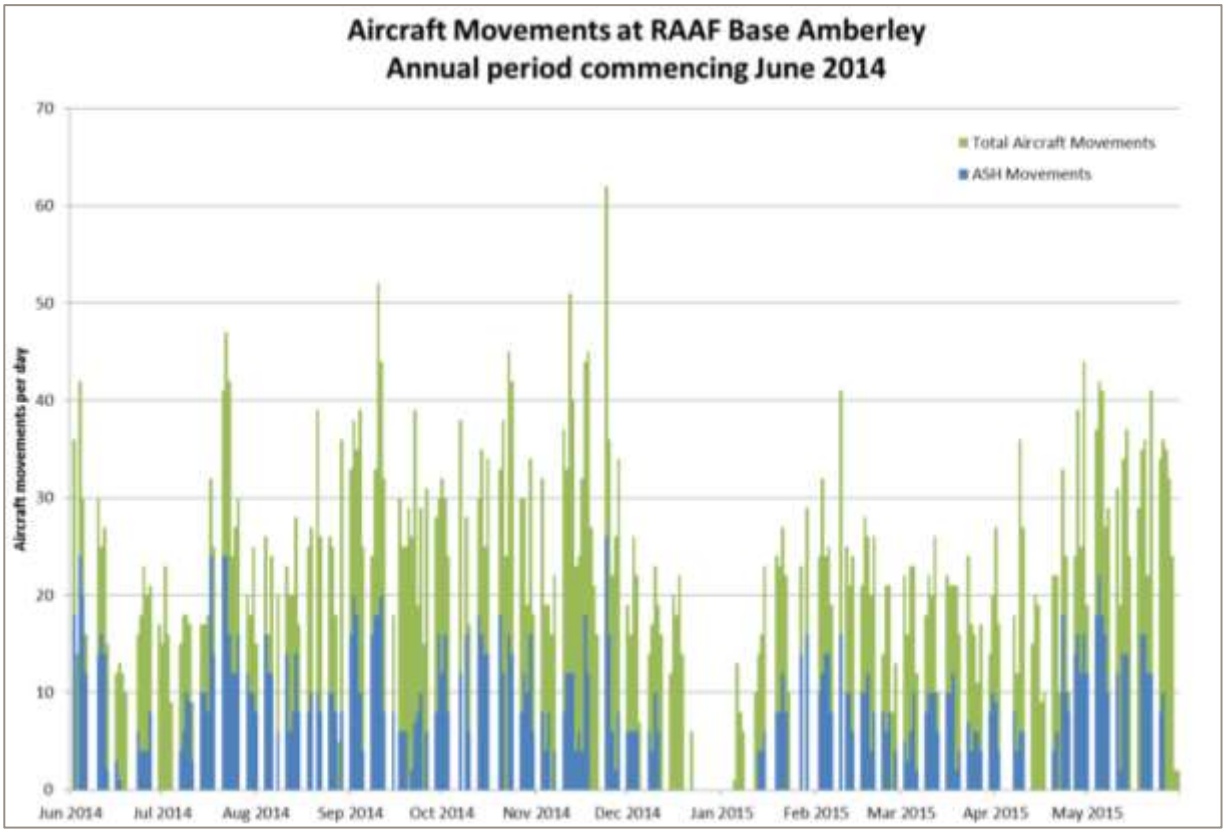


Figure 2 Graphical presentation supplied of aircraft movement data, 1 June 2014 to 31 May 2015 inclusive

4.2 Analysis of movement data

According to the data provided to AECOM, there were 5,833 aircraft movements at RAAF Base Amberley during the reporting period. Of these movements, 2,011 (or 34 %) were conducted by ASH aircraft. The largest number of ASH movements in a day was 26 ASH movements, on 24 November 2014. Of these movements, five were conducted between 11:00 and 12:00, three of them departures. This is too few movements to allow comparison of monitoring data to the “worst case” scenario of seven pairs of aircraft departing in one hour examined in the PER.

5.0 Results

This report summarises and provides further analysis of the results previously provided in four quarterly monitoring reports

- Air Quality Monitoring Quarterly Report, Australian Super Hornet Flying Operations – June to August 2014, dated 17 September 2014
- Air Quality Monitoring Quarterly Report, Australian Super Hornet Flying Operations – September to November 2014, dated 15 December 2014
- Air Quality Monitoring Quarterly Report, Australian Super Hornet Flying Operations – December 2014 to February 2015, dated 16 March 2015
- Air Quality Monitoring Quarterly Report, Australian Super Hornet Flying Operations – March to May 2015, dated 16 June 2015.

Table 8 summarises measurements made during the annual monitoring period, comparing them to the relevant EPP(Air) objective, and Table 9 compares measurements to reportable EPP(Air) annual objectives.

Table 8 Summary of annual period – reportable sub-annual average concentrations – June 2014 to May 2015

Parameter	Period	Average Concentration	Maximum Concentration	EPP(Air) Objective	Reportable exceedances
CO	8 hours	-0.020 ppm	1.985 ppm	9 ppm	0
HCHO	24 hours	< LOR[a]	8.3 µg/m³	54 µg/m³	0
NO_2	1 hour	3.8 ppb	62.5 ppb	120 ppb	0
O_3	1 hour	21.7 ppb	107.7 ppb	100 ppb	0[b]
O_3	4 hour	21.6 ppb	81.3 ppb	80 ppb	0[b]
$PM_{2.5}$	24 hours	4.9 µg/m³	20.5 µg/m³	25 µg/m³	0
PM_{10}	24 hours	11.1 µg/m³	32.5 µg/m³	50 µg/m³	0
SO_2	1 hour	0.5 ppb	5.1 ppb	200 ppb	0
SO_2	24 hours	0.5 ppb	1.8 ppb	80 ppb	0

[a] Fewer than 75% of the samples were reported as being greater than the limit of reporting for the analysis method.

[b] EPP(Air) allows for one day in exceedance of the numerical objective. Peak ozone concentrations were measured on one day, and therefore the exceedances of the 1 and 4 hour average objectives are **not reportable exceedances**, as detailed in Section 5.6.

Table 9 Summary of annual period – reportable annual average concentrations – June 2014 to May 2015

Parameter	Cumulative average concentration	EPP (Air) annual objective	Result
NO_2	3.8 ppb	30 ppb	Not exceeded
$PM_{2.5}$	4.9 µg/m³	8 µg/m³	Not exceeded
SO_2	0.5 ppb	20 ppb	Not exceeded

5.1 Compliance with standards

5.1.1 Site compliance audit

The monitoring site was audited for compliance with Australian Standard *AS/NZS 3580.1.1:2007 – Guide to siting air monitoring equipment* during initial setup of the monitoring station on 30 May 2014. Additionally, at the start of the second year of monitoring, the site was reassessed as required by the standard on 4 June 2015. The station was found to be in compliance with the standard on both occasions.

Table 10 summarises the requirements of *AS/NZS 3580.1.1:2007* for parameters monitored at RAAF Base Amberley, and lists the results of the site audits relevant to the period of monitoring discussed in this report (in this case, prior to the start of monitoring and at the end of the first year of monitoring).

Table 10 AS/NZS 3580.1.1 Site Compliance

Item	Parameters	Start of first annual period (30 May 2014)	End of first annual period (4 June 2015)
Clear sky angle of 120°	All parameters	Compliant	Compliant
Unrestricted airflow of 270° around inlet	All parameters	Compliant	Compliant
Inlet distance to supporting structure ≥ 1 m	All parameters	Compliant	Compliant
10 m from nearest object or drip line of trees that are higher than 2m below the sample inlet	$PM_{2.5}$, PM_{10}	Compliant	Compliant
10 m from drip line of trees that are higher than 2 m below the sample inlet	CO, NO_x, O_3, SO2	Compliant	Compliant
No extraneous sources nearby	$PM_{2.5}$, PM_{10}, CO, NO_x, SO_2	Compliant	Compliant
> 50 m from road	$PM_{2.5}$, PM_{10}	Compliant	Compliant
> 10 m from road	CO, NO_x, O_3	Compliant	Compliant
> 50 m from source	SO_2	Compliant	Compliant

5.1.2 Site maintenance and calibrations

Commissioning, servicing and maintenance for the annual reporting period shown in Table 1 was carried out in accordance with the relevant Australian Standards, listed in Table 3. Class 1 calibration results remained within acceptance limits during the annual reporting period. Class 1 calibration results are detailed in the relevant quarterly report (as listed in Section 5.0 above), and are omitted from this report for brevity.

Table 1 Site Maintenance Schedule for the annual reporting period June 2014 to May 2015

Required item	Due date	Performed	Comment
Installation, commissioning checks, initial calibration and site compliance audit	On commissioning	29 – 30 May 2014	Initial calibration values entered into instruments. Initial checks passed.
Parameter check, class 1 calibration check and filter change	July 2014	4 July 2014	All parameters and calibrations within acceptance limits
Parameter check, class 1 calibration check and filter change	August 2014	18 August 2014	All parameters and calibrations within acceptance limits
Quarterly maintenance including class 1 calibration check and filter change	September 2014	3 September 2014	All parameters and calibrations within acceptance limits
Parameter check, class 1 calibration check and filter change	October 2014	29 September to 3 October 2014	All parameters and calibrations within acceptance limits (routine maintenance performed, also rectification activities for T200 failure)
Parameter check, class 1 calibration check and filter change	November 2014	7 November 2014	All parameters and calibrations within acceptance limits
Six monthly maintenance including filter change and multipoint calibration checks	December 2014	26 November 2014	All parameters and calibrations within acceptance limits.
Parameter check, class 1 calibration check and filter change	January 2015	23 December 2014	All parameters and calibrations within acceptance limits
Parameter check, class 1 calibration check and filter change	February 2015	29 January 2015	All parameters and calibrations within acceptance limits
Quarterly maintenance including filter change	March 2015	27 February 2015	All parameters and calibrations within acceptance limits
Parameter check, class 1 calibration check and filter change	April 2015	24 March 2015	All parameters and calibrations within acceptance limits
Parameter check, class 1 calibration check and filter change	May 2015	29 April 2015	All parameters and calibrations within acceptance limits
Annual maintenance including filter change, multipoint calibration checks and site compliance audit	June 2015	3 to 9 June 2015, except T700 calibrator (2 July 2015), and T200 NO_x analyser (31 July to 6 August 2015)	All parameters and calibrations within acceptance limits.

5.2 Data capture

5.2.1 Data capture during the year commencing June 2014

All monitored parameters exceeded the industry-standard 90 % corrected data capture rate. All parameters also met the Technical Paper No.5 requirement for data availability (raw data capture rate) of greater than 75 % for each calendar quarter during the monitoring period, for the purposes of demonstrating annual compliance with air quality objectives.

The data capture rates for the monitored parameters are detailed in Table 11. Periods and causes of data loss during the year commencing June 2014, other than routine maintenance and calibration, are detailed in Table 12.

Table 11 Data capture during the annual reporting period June 2014 to May 2015

Parameter	Monitoring start date	Monitoring end date	Data availability	Corrected data capture
CO	1 June 2014	Ongoing	93 %	95 %
HCHO	1 June 2014	29 May 2015[a]	100 %	100 %
NO_2	1 June 2014	Ongoing	95 %	99 %
O_3	1 June 2014	Ongoing	96 %	99 %
$PM_{2.5}$	1 June 2014	Ongoing	99 %	99 %
PM_{10}	1 June 2014	Ongoing	97 %	98 %
SO_2	1 June 2014	Ongoing	95 %	99 %
Average of all collected monitoring data			**96 %**	**98 %**
Benchmark			**75 %**	**90 %**
Benchmark met or exceeded			**Achieved**	**Achieved**

[a] Formaldehyde sampling discontinued at the end of the last scheduled sampling period in the final month of the first year of monitoring (May 2015), in accordance with recommendations detailed in Section 8.0.

Table 12 Causes of data loss during the annual reporting period June 2014 to May 2015

Parameter	Start of data loss	End of data loss	Cause
CO	13/06/2014 10:50	17/06/2014 15:40	Failed bearing in instrument pump
All parameters	28/06/2014 20:20	29/06/2014 16:40	Tripped circuit breaker
All parameters	3/09/2014 12:00	4/09/2014 11:00	Logger fault during site maintenance visit.
All parameters	24/09/2014 09:00	24/09/2014 13:00	Power interruption. Loss of SO_2 24 hour average due warm-up time after power restored.
NO, NO_2	29/09/2014 15:00	2/10/2014 10:00	NO_x converter blockage. Part replaced and fault rectified.
PM_{10}	6/12/2014 14:00	12/12/2014 13:00	Instrument failure, followed by zero noise testing of replacement instrument (as required by AS/NZS)
CO	11/02/2015 00:00	18/02/2015 16:00	Instrument fault. Faulty internal components replaced and fault rectified.

5.3 Carbon monoxide (CO) results

Carbon monoxide concentrations remained in the “Very Good” range throughout the annual reporting period. The highest recorded 8 hour rolling average concentration was 1.985 ppm recorded on 4 July 2014 at 21:00.

Results of the 8 hour rolling average concentration dataset are summarised in Table 13. A graphical presentation of concentrations over the current reporting period is presented in Appendix A as Figure 4, Figure 5, Figure 6 and Figure 7, presenting concentration data for winter, spring, summer and autumn respectively.

Table 13 Carbon monoxide results – 8 hour rolling average concentrations

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (9 ppm)
Winter	June 2014	0.109 ppm	0.301 ppm	0
	July 2014	0.165 ppm	1.985 ppm	0
	August 2014	0.065 ppm	0.212 ppm	0
Seasonal results		**0.113 ppm**	**1.985 ppm**	**0**
Spring	September 2014	0.044 ppm	0.270 ppm	0
	October 2014	0.030 ppm	0.101 ppm	0
	November 2014	0.042 ppm	1.366 ppm	0
Seasonal results		**0.039 ppm**	**1.366 ppm**	**0**
Summer	December 2014	-0.210 ppm	0.004 ppm	0
	January 2015	-0.222 ppm	-0.030 ppm	0
	February 2015	-0.094 ppm	0.151 ppm	0
Seasonal Results		**-0.175 ppm**	**0.151 ppm**	**0**
Autumn	March 2015	-0.092 ppm	-0.021 ppm	0
	April 2015	-0.100 ppm	0.017 ppm	0
	May 2015	0.024 ppm	0.193 ppm	0
Seasonal results		**-0.056 ppm**	**0.193 ppm**	**0**
Annual results		**-0.020 ppm**	**1.985 ppm**	**0**

5.3.1 Negative average results

Some months in the dataset show negative average and/or maximum concentrations for the month. Averages less than zero are required to be reported as the actual average of the measured value according to section 3.4 of NEPM Technical Paper No. 5. Section 10.4 of *AS/NZS 3580.7.1:2011* requires adjustment of data if data falls outside the ± 2% (zero) or ± 5% (span) limits. CO calibrations for the reporting period were within these limits. It is noted that these negative values are within the uncertainty of the method of analysis which is ± 2.2 % of full scale range, or ± 1.1 ppm given the 50 ppm full scale range of the instrument, as detailed in Section 2.2.

5.3.2 Comparison of carbon monoxide results with ASH movements

Results of carbon monoxide monitoring do not show a direct relationship to ASH movements. As illustrated in Figure 4 and Figure 5 in Appendix A, CO concentrations do not appear to be proportionally related to ASH movements, and the CO peaks occur after periods of inactivity.

5.4 Formaldehyde (HCHO) results

5.4.1 Results of monitoring

Formaldehyde concentrations remained in the “Very Good” range throughout the annual reporting period. The highest recorded concentration was 8.3 µg/m³ on 23 March 2015. A total of 61 samples were taken on a six day cycle over the annual period starting June 2014. Of these 61 samples, 30 returned a result less than the limit of detection of the analysis method.

Results of the six day cycle 24 hour concentration dataset are summarised in Table 14. A graphical presentation of concentrations over the current reporting period is presented in Appendix A as Figure 8.

Table 14 Formaldehyde results - 24 hour samples

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (54 µg/m³)
Winter	June 2014	< LOR[a]	2.8 µg/m³	0
	July 2014	< LOR[a]	*All < LOR*	0
	August 2014	< LOR[a]	2.3 µg/m³	0
Seasonal results		**< LOR[a]**	**2.8 µg/m³**	**0**
Spring	September 2014	< LOR[a]	2.3 µg/m³	0
	October 2014	< LOR[a]	5.1 µg/m³	0
	November 2014	2.7 µg/m³	3.1 µg/m³	0
Seasonal results		**< LOR[a]**	**5.1 µg/m³**	**0**
Summer	December 2014	< LOR[a]	4.0 µg/m³	0
	January 2015	3.0 µg/m³	4.3 µg/m³	0
	February 2015	2.4 µg/m³	2.6 µg/m³	0
Seasonal Results		**2.9 µg/m³**	**4.3 µg/m³**	**0**
Autumn	March 2015	4.5 µg/m³	8.3 µg/m³	0
	April 2015	< LOR[a]	6.7 µg/m³	0
	May 2015	< LOR[a]	6.3 µg/m³	0
Seasonal results		**< LOR[a]**	**8.3 µg/m³**	**0**
Annual results		**< LOR[a]**	**8.3 µg/m³**	**0**

[a] Fewer than 75% of the samples were reported as being greater than the limit of reporting for the analysis method.

5.4.2 Comparison of formaldehyde results with ASH movements

Results of formaldehyde monitoring do not show a direct relationship to ASH movements. As illustrated in Figure 8 in Appendix A, during a period of relatively intense ASH activity during July 2014 there were no detections of formaldehyde greater than the laboratory limit of reporting. Conversely, during late March 2015 when the highest formaldehyde concentration was recorded there were a relatively low number of ASH movements.

5.5 Nitrogen dioxide (NO_2) results

Nitrogen dioxide concentrations ranged from “Very Good” to “Good” during the annual reporting period. The highest recorded 1 hour average concentration was 62.5 ppm recorded on 5 June 2014 at 01:00.

Results of the 1 hour average concentration dataset are summarised in Table 15. A graphical presentation of 1 hour average concentrations over the current reporting period is presented by season in Appendix A as Figure 9, Figure 10, Figure 11 and Figure 12.

Table 15 Nitrogen dioxide results – 1 hour average concentrations

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (120 ppb)
Winter	June 2014	10.1 ppb	62.5 ppb	0
	July 2014	8.4 ppb	40.7 ppb	0
	August 2014	5.1 ppb	28.8 ppb	0
Seasonal results		**7.9 ppb**	**62.5 ppb**	**0**
Spring	September 2014	5.5 ppb	32.1 ppb	0
	October 2014	4.2 ppb	38.0 ppb	0
	November 2014	3.3 ppb	17.1 ppb	0
Seasonal results		**4.3 ppb**	**38.0 ppb**	**0**
Summer	December 2014	0.6 ppb	17.3 ppb	0
	January 2015	1.2 ppb	15.8 ppb	0
	February 2015	0.9 ppb	10.5 ppb	0
Seasonal Results		**0.9 ppb**	**17.3 ppb**	**0**
Autumn	March 2015	-0.7 ppb	14.8 ppb	0
	April 2015	3.0 ppb	28.2 ppb	0
	May 2015	4.7 ppb	27.3 ppb	0
Seasonal results		**2.3 ppb**	**28.2 ppb**	**0**
Annual results		**3.8 ppb**	**62.5 ppb**	**0**

Table 16 Nitrogen Dioxide results – annual average concentration

Average period	Cumulative average concentration	EPP (Air) annual objective	Result
June 2014 to May 2015	3.8 ppb	30 ppb	Not exceeded

5.5.1 Negative average results

The average concentration for March 2015 shows a negative average for the month. Averages less than zero are required to be reported as the actual average of the measured value according to section 3.4 of NEPM Technical Paper No. 5. Section 10.4 of *AS/NZS 3580.5.1:2011* requires adjustment of data if data falls outside the ± 2% (zero) or ± 5% (span) limits. NO_2 calibrations for the reporting period were within these limits. It is noted that the negative average value is within the uncertainty of the method of analysis which is ± 6.5 % of full scale range, or ± 32.5 ppb given the 500 ppb full scale range of the instrument, as detailed in Section 2.2.

5.5.2 Comparison of nitrogen dioxide results with ASH movements

Results of nitrogen dioxide monitoring do not show a strong relationship to ASH movements. Nitrogen dioxide levels did not show the same magnitude of peaks during the late December 2014 to early January 2015 period as in the rest of the monitoring period, and there was a general break in reported aircraft movements at RAAF Base Amberley as shown in Figure 2 in Section 4.1 during this period. Conversely, during similar breaks in reported ASH flying operations during June 2014 and April 2015 there was no reduction in nitrogen dioxide readings as illustrated in Figure 9 and Figure 12 in Appendix A respectively. These results suggest the driving factor for nitrogen dioxide concentrations is not ASH flying operations.

5.6 Ozone (O_3) results

Ozone concentrations varied from “Very Good” to “Poor” throughout the reporting period. Ozone concentrations naturally follow a diurnal cycle, with peak concentrations coinciding with peak solar radiation input through the middle of the day. The highest recorded 1 hour average ozone concentration was 107.7 ppb recorded on 17 May 2015 at 17:00.

Results of the 1 hour average dataset are summarised in Table 17, and results of the 4 hour rolling average dataset are summarised in Table 18. A graphical presentation of 1 hour average concentrations over the current reporting period is presented by season in Appendix A as Figure 13, Figure 14, Figure 15 and Figure 16.

There was an exceedance of both the 1 hour and 4 hour average objectives on Friday 20 March 2015. Table 19 details these exceedances. The Queensland Department of Environment and Heritage Protection also reported an exceedance of the 1 hour objective at their nearby Flinders View monitoring location during the same period. The EPP (Air) ozone objectives allow exceedance of the objectives for one day each year. This is the first exceedance of the ozone objectives since monitoring began in June 2014. Analysis suggests that the exceedance was likely to be due to a regional ozone event unrelated to base activities, as discussed in Section 6.1.2.1.

The exceedance of the 1 hour and 4 hour average air quality objectives are **not reportable exceedances**, as the number of days in exceedance was not greater than the allowable number of days in exceedance.

Table 17 Ozone results – 1 hour average

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (100 ppb)
Winter	June 2014	16.3 ppb	36.2 ppb	0
	July 2014	19.5 ppb	47.0 ppb	0
	August 2014	25.1 ppb	52.1 ppb	0
Seasonal results		**20.3 ppb**	**52.1 ppb**	**0**
Spring	September 2014	25.9 ppb	51.7 ppb	0
	October 2014	28.4 ppb	74.2 ppb	0
	November 2014	26.9 ppb	65.8 ppb	0
Seasonal results		**27.0 ppb**	**74.2 ppb**	**0**
Summer	December 2014	23.0 ppb	76.8 ppb	0
	January 2015	18.9 ppb	67.3 ppb	0
	February 2015	16.3 ppb	58.1 ppb	0
Seasonal Results		**19.4 ppb**	**76.8 ppb**	**0**
Autumn	March 2015	24.0 ppb	107.7 ppb	1
	April 2015	19.9 ppb	52.2 ppb	0
	May 2015	16.0 ppb	38.2 ppb	0
Seasonal results		**20.0 ppb**	**107.7 ppb**	**1**
Annual results		**21.7 ppb**	**107.7 ppb**	**1 (1 allowed)**

Table 18 Ozone results – 4 hour rolling average

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (80 ppb)
Winter	June 2014	16.3 ppb	34.5 ppb	0
	July 2014	19.2 ppb	45.9 ppb	0
	August 2014	25.0 ppb	46.6 ppb	0
Seasonal results		**20.1 ppb**	**46.6 ppb**	**0**
Spring	September 2014	25.5 ppb	50.7 ppb	0
	October 2014	27.9 ppb	64.6 ppb	0
	November 2014	26.4 ppb	59.1 ppb	0
Seasonal results		**26.6 ppb**	**64.6 ppb**	**0**
Summer	December 2014	23.4 ppb	66.3 ppb	0
	January 2015	19.2 ppb	54.9 ppb	0
	February 2015	16.2 ppb	50.6 ppb	0
Seasonal Results		**19.6 ppb**	**66.3 ppb**	**0**
Autumn	March 2015	23.7 ppb	81.3 ppb	1
	April 2015	20.1 ppb	48.7 ppb	0
	May 2015	16.2 ppb	35.8 ppb	0
Seasonal results		**20.0 ppb**	**81.3 ppb**	**1**
Annual results		**21.6 ppb**	**81.3 ppb**	**1 (1 allowed)**

Table 19 Exceedances of objective – Ozone[a]

Date	Objective	Start of exceedance	End of exceedance	Maximum value
20 March 2015	1 hour – 100 ppb	20/03/2015 17:00	20/03/2015 17:00	107.7 ppb
20 March 2015	4 hour – 80 ppb	20/03/2015 17:00	20/03/2015 18:00	81.3 ppb

[a] The number of days in exceedance was not greater than the allowable number of days shown in Table 18. Consequently, the exceedances detailed in this table are **not reportable exceedances**.

5.6.1 Comparison of ozone results with ASH movements

Results of ozone monitoring do not show a direct relationship to ASH movements. As illustrated in Figure 13 and Figure 15 in Appendix A, ozone concentrations continue a diurnal pattern of unchanged magnitude in the absence of ASH movement activity.

5.7 Suspended Particulate – $PM_{2.5}$ results

Suspended particulate – $PM_{2.5}$ concentrations ranged from “Very Good” to “Fair” throughout the reporting period. The highest recorded 24 hour $PM_{2.5}$ concentration was 20.5 µg/m³ recorded on 9 November 2014.

Results of the 24 hour average dataset are summarised in Table 20, and the annual average for the current reporting year is presented in Table 21. A graphical presentation of concentrations over the current reporting period is presented in Appendix A as Figure 17.

Table 20 $PM_{2.5}$ results – 24 hour average concentration

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (25 µg/m³)
Winter	June 2014	4.3 µg/m³	8.3 µg/m³	0
	July 2014	5.6 µg/m³	10.8 µg/m³	0
	August 2014	4.5 µg/m³	13.2 µg/m³	0
Seasonal results		**4.8 µg/m³**	**13.2 µg/m³**	**0**
Spring	September 2014	5.1 µg/m³	9.5 µg/m³	0
	October 2014	6.3 µg/m³	13.6 µg/m³	0
	November 2014	7.0 µg/m³	20.5 µg/m³	0
Seasonal results		**6.1 µg/m³**	**20.5 µg/m³**	**0**
Summer	December 2014	5.0 µg/m³	10.5 µg/m³	0
	January 2015	4.3 µg/m³	7.3 µg/m³	0
	February 2015	3.1 µg/m³	5.1 µg/m³	0
Seasonal Results		**4.1 µg/m³**	**10.5 µg/m³**	**0**
Autumn	March 2015	5.9 µg/m³	13.0 µg/m³	0
	April 2015	3.5 µg/m³	6.6 µg/m³	0
	May 2015	3.9 µg/m³	7.1 µg/m³	0
Seasonal results		**4.4 µg/m³**	**13.0 µg/m³**	**0**
Annual results		**4.9 µg/m³**	**20.5 µg/m³**	**0**

Table 21 $PM_{2.5}$ results – annual average concentration

Average period	Cumulative average concentration	EPP (Air) annual objective	Result
June 2014 to May 2015	4.9 µg/m³	8 µg/m³	Not exceeded

5.7.1 Comparison of $PM_{2.5}$ results with ASH movements

Results of $PM_{2.5}$ monitoring do not show a direct relationship to ASH movements. As illustrated in Figure 17 in Appendix A, $PM_{2.5}$ concentrations do not appear to be proportionally related to ASH movements, and the highest 24 hour $PM_{2.5}$ concentration is measured on a day where there were no air movements at RAAF Base Amberley.

5.8 Suspended Particulate – PM_{10} results

Suspended particulate – PM_{10} concentrations ranged from "Very Good" to "Fair" throughout the reporting period. The highest recorded 24 hour PM_{10} concentration was 32.5 µg/m³ recorded on 6 March 2015.

Results of the 24 hour average dataset are summarised in Table 22. A graphical presentation of concentrations over the current reporting period is presented in Appendix A as Figure 18.

Table 22 PM_{10} results – 24 hour average concentration

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (50 µg/m³)
Winter	June 2014	9.4 µg/m³	20.0 µg/m³	0
	July 2014	12.3 µg/m³	21.3 µg/m³	0
	August 2014	9.5 µg/m³	18.4 µg/m³	0
Seasonal results		**10.4 µg/m³**	**21.3 µg/m³**	**0**
Spring	September 2014	13.0 µg/m³	27.5 µg/m³	0
	October 2014	16.3 µg/m³	30.1 µg/m³	0
	November 2014	15.8 µg/m³	26.6 µg/m³	0
Seasonal results		**15.0 µg/m³**	**27.5 µg/m³**	**0**
Summer	December 2014	12.1 µg/m³	24.9 µg/m³	0
	January 2015	8.9 µg/m³	17.0 µg/m³	0
	February 2015	6.6 µg/m³	11.7 µg/m³	0
Seasonal Results		**9.2 µg/m³**	**24.9 µg/m³**	**0**
Autumn	March 2015	12.7 µg/m³	32.5 µg/m³	0
	April 2015	8.2 µg/m³	14.4 µg/m³	0
	May 2015	8.8 µg/m³	21.3 µg/m³	0
Seasonal results		**9.9 µg/m³**	**32.5 µg/m³**	**0**
Annual results		**11.1 µg/m³**	**32.5 µg/m³**	**0**

5.8.1 Comparison of PM_{10} results with ASH movements

Results of PM_{10} monitoring do not appear to be consistently related to ASH movements. As illustrated in Figure 18 in Appendix A, PM_{10} concentrations do not appear to be solely influenced by ASH movements, though there may a general trend towards period of more intense flying activity leading to elevation of PM_{10} concentrations. Further trending analysis is required to determine the existence of this relationship.

5.9 Sulfur dioxide (SO_2) results

Sulfur dioxide concentrations remained in the “Very Good” range throughout the reporting period. The highest 1 hour average sulfur dioxide concentration was 5.1 ppb recorded on 24 January 2015 at 21:00.

Results of the 1 hour average dataset are summarised in Table 23 and results of the 24 hour average dataset are summarised in Table 24. The annual average for the current reporting year is presented in Table 25. A graphical presentation of 1 hour average concentrations over the current reporting period is presented by season in Appendix A as Figure 19, Figure 20, Figure 21 and Figure 22.

Table 23 Sulfur Dioxide results – 1 hour average concentration

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (200 ppb)
Winter	June 2014	0.5 ppb	4.1 ppb	0
	July 2014	0.7 ppb	4.9 ppb	0
	August 2014	0.5 ppb	2.6 ppb	0
Seasonal results		**0.5 ppb**	**4.9 ppb**	**0**
Spring	September 2014	0.4 ppb	4.6 ppb	0
	October 2014	0.6 ppb	3.1 ppb	0
	November 2014	0.5 ppb	2.7 ppb	0
Seasonal results		**0.5 ppb**	**4.6 ppb**	**0**
Summer	December 2014	0.1 ppb	2.7 ppb	0
	January 2015	0.3 ppb	5.1 ppb	0
	February 2015	0.4 ppb	3.8 ppb	0
Seasonal Results		**0.3 ppb**	**5.1 ppb**	**0**
Autumn	March 2015	0.4 ppb	2.7 ppb	0
	April 2015	0.6 ppb	3.7 ppb	0
	May 2015	0.7 ppb	4.3 ppb	0
Seasonal results		**0.6 ppb**	**4.3 ppb**	**0**
Annual results		**0.5 ppb**	**5.1 ppb**	**0**

Table 24 Sulfur Dioxide results – 24 hour average concentration

Season	Month	Average concentration	Maximum measured sample concentration	Number of exceedances of objective (80 ppb)
Winter	June 2014	0.5 ppb	1.2 ppb	0
	July 2014	0.7 ppb	1.8 ppb	0
	August 2014	0.5 ppb	0.9 ppb	0
Seasonal results		**0.5 ppb**	**1.8 ppb**	**0**
Spring	September 2014	0.4 ppb	0.8 ppb	0
	October 2014	0.6 ppb	1.0 ppb	0
	November 2014	0.5 ppb	0.9 ppb	0
Seasonal results		**0.5 ppb**	**1.0 ppb**	**0**
Summer	December 2014	0.1 ppb	0.7 ppb	0
	January 2015	0.3 ppb	0.9 ppb	0
	February 2015	0.4 ppb	0.8 ppb	0
Seasonal Results		**0.3 ppb**	**0.9 ppb**	**0**
Autumn	March 2015	0.4 ppb	0.9 ppb	0
	April 2015	0.6 ppb	1.1 ppb	0
	May 2015	0.7 ppb	1.3 ppb	0
Seasonal results		**0.6 ppb**	**1.3 ppb**	**0**
Annual results		**0.5 ppb**	**1.8 ppb**	**0**

Table 25 Sulfur Dioxide results – annual average concentration

Average period	Cumulative average concentration	EPP (Air) annual objective	Result
June 2014 to May 2015	0.5 ppb	20 ppb	Not exceeded

5.9.1 Comparison of sulfur dioxide results with ASH movements

Results of sulfur dioxide monitoring do not show a direct relationship to ASH movements. As illustrated in Figure 19 and Figure 21 in Appendix A, some of the highest sulfur dioxide concentrations occur on days where there are no ASH movements.

6.0 Annual Findings

6.1 Comparison of monitoring data to EPP (Air) objectives

6.1.1 Reportable exceedances

There were **no reportable exceedances** of the EPP (Air) air quality objectives. Exceedances of the numerical criteria that fall within the number of allowable exceedances specified in Table 4 in Section 2.3 are discussed in Section 6.1.2.

6.1.2 Allowable exceedances

Allowable exceedances are those where the EPP (Air) allows the air quality objective to be exceeded for a certain number of days per year, as detailed in Table 4 in Section 2.3. There was an allowable exceedance of the ozone 1-hour and 4-hour objectives on 17 March 2015. The 1-hour and 4-hour ozone objectives may be exceeded for one day each year.

6.1.2.1 Ozone 1-hour and 4-hour exceedance of EPP(Air) numeric objective, 17 March 2015

The DEHP air quality monitoring stations located at Pinkenba and Rocklea indicate that on 17 March 2015 there were elevated concentrations of ozone in the vicinity of the Brisbane City area, as shown in Table 26. The ozone concentrations tended to increase, peak and then decline as the afternoon progressed. The peak 1 hour averaged ozone concentrations were typically experienced later in the day the further each monitoring station was from the Brisbane City area. **Figure 3** illustrates the relative locations of the monitoring stations considered in this analysis.

It is considered likely that on 17 March 2015, elevated ozone concentrations experienced within the south east Queensland region originated within the Brisbane city area and, with the aid of an onshore breeze, were transported to the RAAF Base Amberley and beyond. Exceedances of the EPP (Air) air quality objective for 1 hour maximum ozone concentrations (100 ppb) were experienced up to 30km away from RAAF Base Amberley. Ozone concentrations measured at RAAF Base Amberley on 17 March 2015 are therefore considered likely to be due to a regional ozone event, and are unlikely to be related to base activity.

Table 26 1 hour ozone concentration (ppb) across selected SE QLD monitoring stations on 17 March 2015

Monitoring Site	DEHP Pinkenba	DEHP Rocklea	DEHP Flinders View	RAAF Base Amberley	DEHP Mutdapilly	BoM Brisbane wind direction
Location relative to Amberley	50 km ENE	30 km ENE	7 km ESE	-	14 km SW	
17/03/2015 13:00	56	63	54	57.2	35	ENE
17/03/2015 14:00	75	77	72	66.2	48	ENE
17/03/2015 15:00	79	**101**	77	77.8	72	ENE
17/03/2015 16:00	23	92	73	73.2	82	NNE
17/03/2015 17:00	20	44	**101**	**101.7**	87	NE
17/03/2015 18:00	13	23	53	61.8	95	NE
17/03/2015 19:00	20	12	25	31.4	40	NE

Department of Environment and Heritage Protection Air Quality Index for ozone 1-hour average:

Very Good (0-33 ppb)	Good (34-66 ppb)	Fair (67-99 ppb)	Poor (100-149 ppb)	Very Poor (>150 ppb)

An index of “Poor” or “Very Poor” indicates exceedance of the air quality objective.

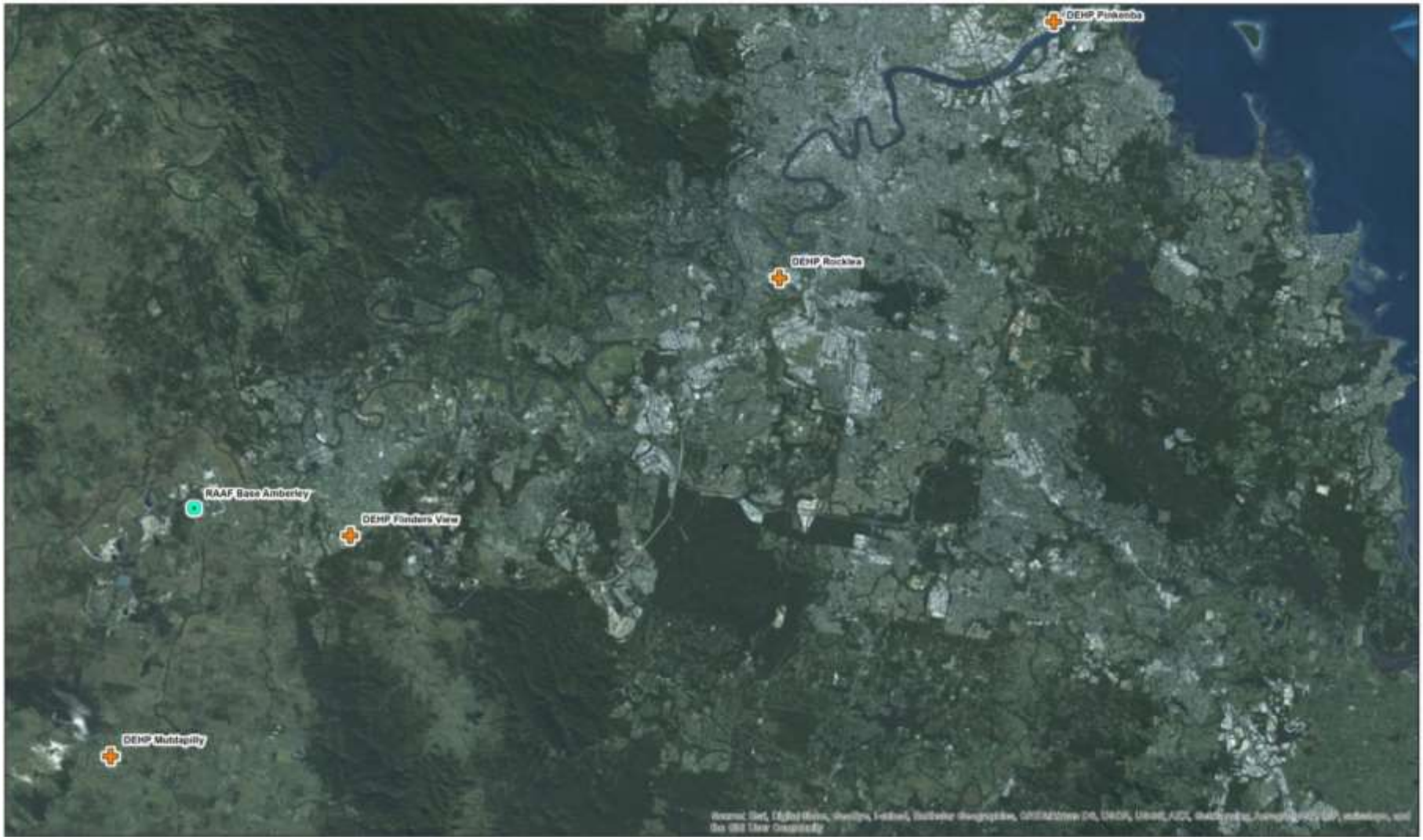


Figure 3 Regional monitoring locations

6.2 Current annual period trends

There was no general trend observed for any of the pollutant parameters monitored over the past 12 months, furthermore there were no correlation between ASH movement activities and pollutant concentrations observed at any time during the annual monitoring period. Spikes in pollutant concentrations tended to be isolated and independent of ASH movements. Some individual parameters showed seasonal variation which is detailed below.

6.2.1 Carbon Monoxide trends

Carbon monoxide concentrations remained near the instrument baseline measurement for the majority of the hours in the monitoring period. The two short term spikes in concentration apparent in the graphs (July 2014 and November 2014) are approximately 22 percent of the EPP(Air) objective. Scaling the graphical figures to display resolution of this magnitude (Y axis being 30% of the EPP(Air) CO objective) shows normal instrument baseline drift to be one of the larger contributors to variance in the readings over the period.

Demolition of an old tank facility and construction of replacement tanks took place approximately 150 m to the north-east of the monitoring station during 2014. Additionally, the Air Quality monitoring station is located approximately 10 m from a car park. There is insufficient information available to determine whether these works or the proximity to the carpark have contributed to carbon monoxide concentrations during the monitoring period, however it is noted that the station location comprehensively meets the siting requirements for carbon monoxide detailed in AS/NZS 3580.1.1.

Carbon monoxide concentrations do not show a trend away from baseline during any time in the monitoring period.

6.2.2 Formaldehyde trends

Thirty out of the 61 formaldehyde samples taken during the first year of the monitoring program were reported as having a concentration less than the reporting limit of the method of analysis by the analysing laboratory. There were more detections of formaldehyde during the summer and autumn seasons than during winter or spring.

Aside from ASH operations, there was no identified source of formaldehyde that was likely to impact upon the monitoring station during the annual period. The increase in the number of formaldehyde detections during summer and autumn did not correspond to an increased number of ASH movements, based upon the activity data provided to AECOM. Indeed, two of the three samples taken during the period 23 December 2014 to 4 January 2015 (where there was no aircraft movement activity at RAAF Base Amberley) had concentrations of formaldehyde greater than the limit of reporting for the analysis method.

There is a seasonal trend of increased formaldehyde concentrations in the summer and autumn months, but based upon the data available to AECOM this increase does not appear to be related to aircraft operations at RAAF Base Amberley.

6.2.3 Nitrogen dioxide trends

Nitrogen dioxide concentrations were generally higher through the late autumn, winter and spring months, and generally lower during the summer and early autumn months. This trend does not correspond with a similar trend in PM_{10} or $PM_{2.5}$ concentrations, so is unlikely to be related to domestic heating use or bushfires during the colder and drier months. As discussed in Section 5.5.2, there is not a strong relationship between ASH movements and nitrogen dioxide concentrations. It is considered likely that seasonal weather conditions combined with local industrial emissions and ground transportation are the primary drivers of the seasonal variance in nitrogen dioxide concentrations.

6.2.4 Ozone trends

Ozone showed a typically diurnal pattern during the annual monitoring period. The average one hour and rolling four hour ozone concentration remained within the range of 16.0 to 28.4 ppb throughout the monitoring period, though the peak ozone concentration tended to be higher during the late spring to early autumn period.

6.2.5 Suspended particulates trends ($PM_{2.5}$ and PM_{10})

Average $PM_{2.5}$ and PM_{10} concentrations were notably consistent throughout the monitoring period, only being notably higher during the spring months. While this coincided with the bushfire season, there was not a high level of bushfire activity in south-east Queensland during the monitoring period. It is likely that other regional events, such as transit of regional particulates carried by the strong north-easterly winds contributed to this apparent trend.

6.2.6 Sulfur dioxide trends

The highest sulfur dioxide one hour average reading during the monitoring period was 5.1 ppb, which is approximately 3 percent of the EPP(Air) objective. The compression in the scale of the graphs presented in Appendix A makes these relatively small variations in concentration appear more dramatic than they are, relative to both the instrument full scale range and the EPP(Air) objective for sulfur dioxide.

Like carbon monoxide, sulfur dioxide concentrations do not show a trend away from the instrument baseline at any time during the annual monitoring period.

6.3 Comparison to previous years

As this is the first year of monitoring under the AQMP, no comparison to previous years is possible. Future annual reports will examine long term trends.

7.0 Validation Analysis of PER Predicted Impacts

As discussed in Section 1.0, the air quality monitoring at RAAF Base Amberley is conducted to address Condition 4 of the EPBC Act approval of the Super Hornet flying operations. Condition 4b of the approval identifies the requirement of a validation procedure for the predicted air quality impacts as presented in the PER. Condition 4b is as follows:

> *4. The person taking the action must provide for approval by the Minister an Air Quality Monitoring Plan that includes:*
>
> *b) A process for validation of the accuracy of Super Hornet air quality impacts modelled in the Public Environment Report of the action;*

An AQMP was developed in response to the findings of the Australian Super Hornets PER. The purpose of the AQMP is to outline how Defence will comply with condition 4 of the EPBC Act approval of Super Hornet flying operations at RAAF Base Amberley. The AQMP sets the following guidance around a validation process of the accuracy of the PER predictions about Super Hornet air quality impacts:

> *24. Consultants will be engaged by Defence to collect, evaluate and report the air quality data collected from the air quality monitoring station. The results will be the production of an Air Quality Monitoring Report which is planned to be published annually, during testing periods. The report will evaluate the accuracy of the predictions about Super Hornet air quality impacts as modelled in the PER….*

This section of the report is intended to address the requirement to evaluate the accuracy of the predictions about Super Hornet air quality impacts as modelled in the PER. AECOM did not undertake independent investigations to verify the accuracy of the information contained within the PER. However a comparison of key variables used in the predictive modelling in the PER have been compared to actual conditions over the monitoring period (1 June 2014 to 31 May 2015 inclusive). The key variables used in the predictive modelling in the PER are as follows:

- Worst Case ASH movement data
- Meteorological conditions, primarily wind direction.

Both these variables need to be consistent between the PER and the conditions experienced during the current monitoring period for a direct comparison of monitoring results and predicted impacts in the PER.

7.1 Worst Case ASH Movements

To predict the possible worst case hourly air quality emissions the modelling undertaken in the PER had to assume a worse case ASH movements per hour. A summary of the assumed ASH movements used in the PER modelling and the actual most intensive hour of ASH movements is provided in Table 27.

Table 27 Comparison of PER Modelled vs. Actual: ASH Movement Data

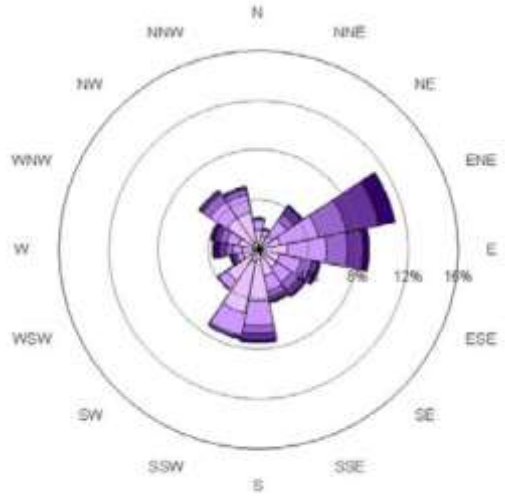
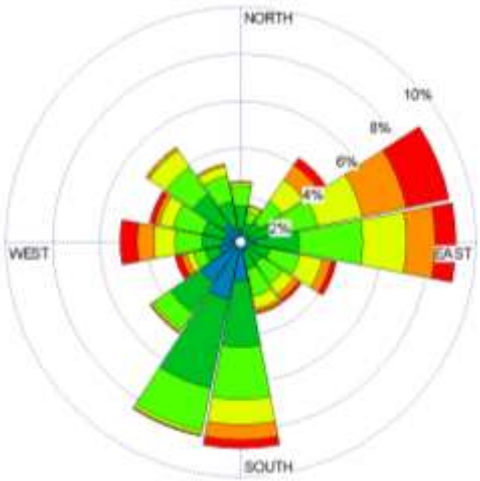
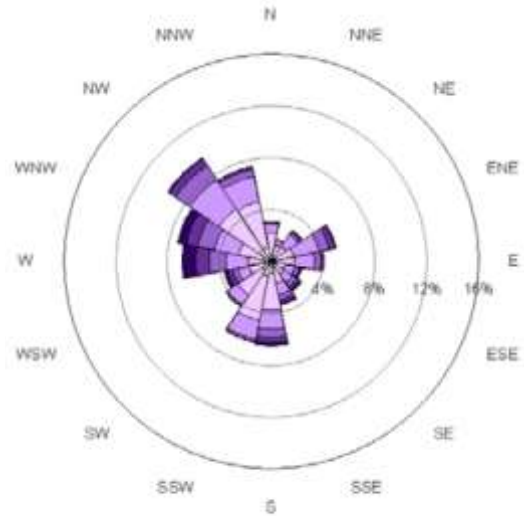
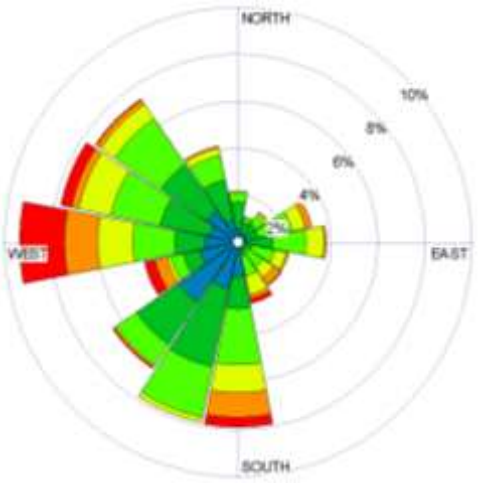
Scenario	Modelled PER	Actual: June 2014 – May 2015
Worst Case	*"The worst-case intensive hour for operations at RAAF Base Amberley is 14 aircraft taking-off in one hour, to occur anytime between 7 am and 12 pm" (PER, 2009)*	As discussed in Section 4.2, the largest number of ASH movements in a day was 26. During that day the most intensive hour of operations consisted of five ASH movements conducted between 11:00 and 12:00, three of which were departures.

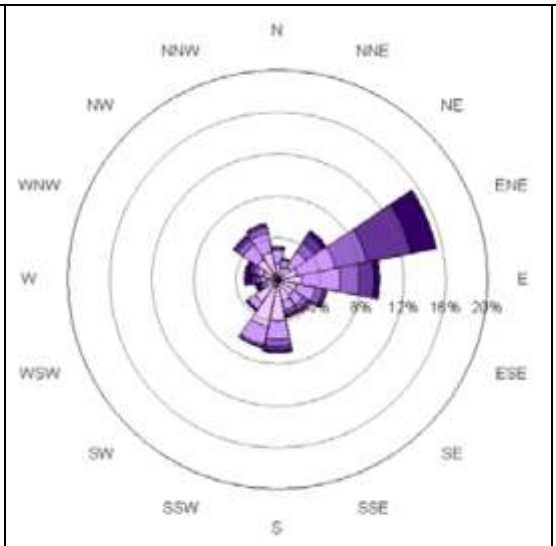
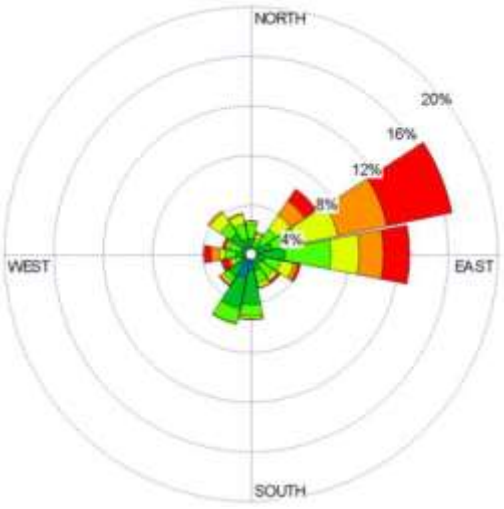
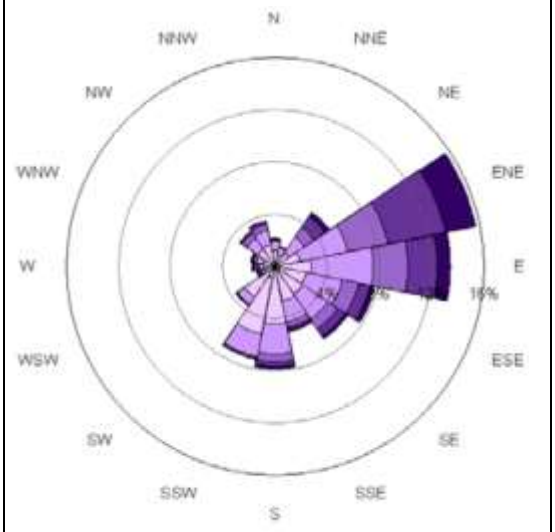
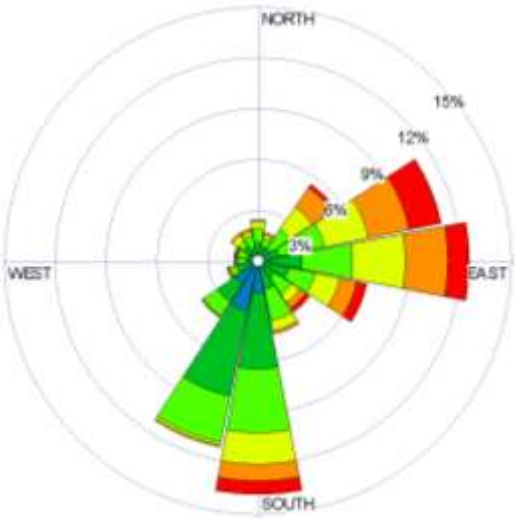
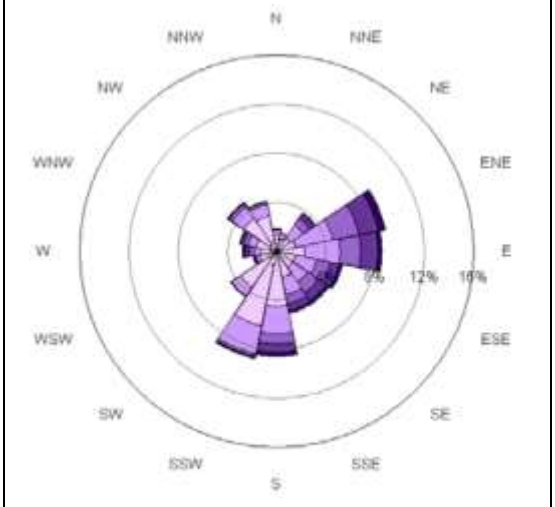
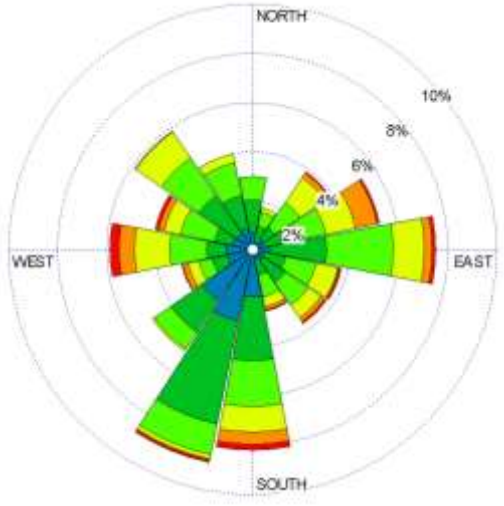
The modelled PER assumed a worst case of up to 14 ASH movements within an hour. During the monitoring period the most intensive hour of ASH movements involved less than half that amount with only five ASH movements. Therefore it is considered likely that modelled PER and monitoring period pollutant concentrations may not be directly comparable.

7.2 Meteorological Conditions

After the initial pollutant emissions due to ASH movements are considered the potential for dispersion due to prevailing winds needs to be considered. As discussed in Section 3.0 the closest BoM site to the RAAF Base Amberley that records hourly meteorological data is at the Amberley AMO. A seasonal comparison between the prevailing winds for the PER Modelling and the Amberley AMO station during monitoring period is provided in Table 28.

Table 28 Comparison of PER Modelled vs. Actual: Prevailing Winds

	Modelled conditions in PER (Figure 8.3)	Amberley AMO: June 2014 – May 2015
Annual		
Winter		

Spring		
Summer		
Autumn		

Overall, the wind roses indicate that the wind directions experienced at Amberley AMO during the monitoring period were similar to the modelled PER. Due to the monitoring station being located to the west of the RAAF

Base Amberley runways the proportion of easterly winds are of particular interest. In an annual context the winds from the east-northeast and east contributed between 8% and 12% for both the PER modelling and the Amberley AMO station during monitoring period. The prevailing easterly wind directions at the Amberley AMO station appear consistent with those used in the PER modelling. Therefore the frequency of time the air quality monitoring station was downwind of the RAAF Base Amberley runways during the current monitoring period was similar to the PER modelling.

7.3 Comparison of Monitoring Results and PER Predicted Impacts

The PER assessed potential ASH air quality impacts at the nearest sixteen sensitive receivers to RAAF Base Amberley. Because Condition 4b of the Super Hornet flying operations at RAAF Base Amberley EBPC Act approval necessitates the validation of the modelled air quality impacts in the PER, a representative monitoring site is limited to being at or near one of the sixteen PER sensitive receivers. To select a representative monitoring location AECOM conducted an Air Quality Monitoring Station Site Selection analysis for ASH operations at RAAF Base Amberley (dated 23 May 2014). As a result of the site selection process, the preferred and selected location for the air quality monitoring station was identified as being representative of the PER sensitive receptor 1 - Amberley State School. Table 29 provides a comparison between the modelled PER air quality impacts and the measured concentrations for the current monitoring period.

Table 29 Comparison of PER Modelled vs. Actual: Pollutant Concentrations

Parameter	Period	Modelled PER		Measured		EPP(Air) Objective
		Contribution	Cumulative	Average	Maximum	
CO	8 hr	0.08 ppm	4.08 ppm	-0.020 ppm	1.985 ppm	9 ppm
HCHO	24 hr	2.7 µg/m³	2.7 µg/m³	< LOR[a]	8.3 µg/m³	54 µg/m³
NO_2	1 hr	18.5 ppb	47.7 ppb	3.8 ppb	62.5 ppb	120 ppb
PM_{10}	24 hr	3.0 µg/m³	43.0 µg/m³	11.1 µg/m³	32.5 µg/m³	50 µg/m³
SO_2	1 hr	1.4 ppb	14.3 ppb	0.5 ppb	5.1 ppb	200 ppb

[a] - Fewer than 75% of the samples were reported as being greater than the limit of reporting for the analysis method.

As discussed in Section 7.1 the modelled PER and monitoring period pollutant concentrations may not be directly comparable due to different ASH movements. Notwithstanding the differences between the PER assumed worst case ASH movements and the actual most intensive hour of ASH movements, the following observations can be made:

- Maximum and average CO monitoring results for the monitoring period are below the PER modelled concentrations.
- Maximum HCHO monitoring results are above PER modelled concentrations however, as discussed in Section 5.4.2 results of HCHO monitoring do not show a direct relationship to ASH movements. Additionally, the maximum HCHO concentration was only 15 % of the EPP (Air) air quality objective.
- Average NO_2 monitoring results for the monitoring period are below the PER modelled concentrations.
- Maximum NO_2 monitoring results are above PER modelled concentrations however as discussed in Section 5.5.2 results of NO_2 monitoring do not show a strong relationship to ASH movements. Additionally, the maximum NO_2 concentration was only 52 % of the EPP (Air) air quality objective.
- Maximum and average PM_{10} monitoring results for the monitoring period are below the PER modelled concentrations.
- Maximum and average SO_2 monitoring results for the monitoring period are below the PER modelled concentrations.

8.0 Conclusion

Monitoring of parameters specified by Defence in order to meet the requirements of the RAAF Base Amberley Australian Super Hornet Air Quality Monitoring Plan was conducted for the annual period starting 1 June 2014 and finishing 31 May 2015 inclusive. The data availability and corrected data capture rate exceeded the requirements of NEPM Technical Paper No. 5 and industry standards for collection of air quality monitoring data. There were no reportable exceedances of any of the Environmental Protection (Air) Policy 2008 (EPP(Air)) objectives during the monitoring period.

AECOM offers the following recommendations based upon the collected data:

8.1 Continuation of monitoring program

The maximum number of ASH movements per hour during the annual period was insufficient to validate the air quality modelling results, therefore further monitoring is warranted. Additionally, further monitoring may show whether there is a relationship between PM_{10} concentrations and ASH movements, or if the weak relationship observed during the current annual period is due to coincidental concurrence of outside factors with ASH movements.

8.2 Recommendation for discontinuation of formaldehyde monitoring

Formaldehyde monitoring at RAAF Base Amberley did not show a direct relationship between measured formaldehyde concentration and ASH movements. In addition, 30 of the 61 samples were reported by the analysing laboratory to be below the limit of reporting for the analysis method. The maximum formaldehyde concentration measured during the year, 8.3 µg/m³, is only 15 % of the EPP(Air) objective of 54 µg/m³.

AECOM considers that continued formaldehyde monitoring at the current monitoring location is not warranted.

Appendix A

Graphical Presentation

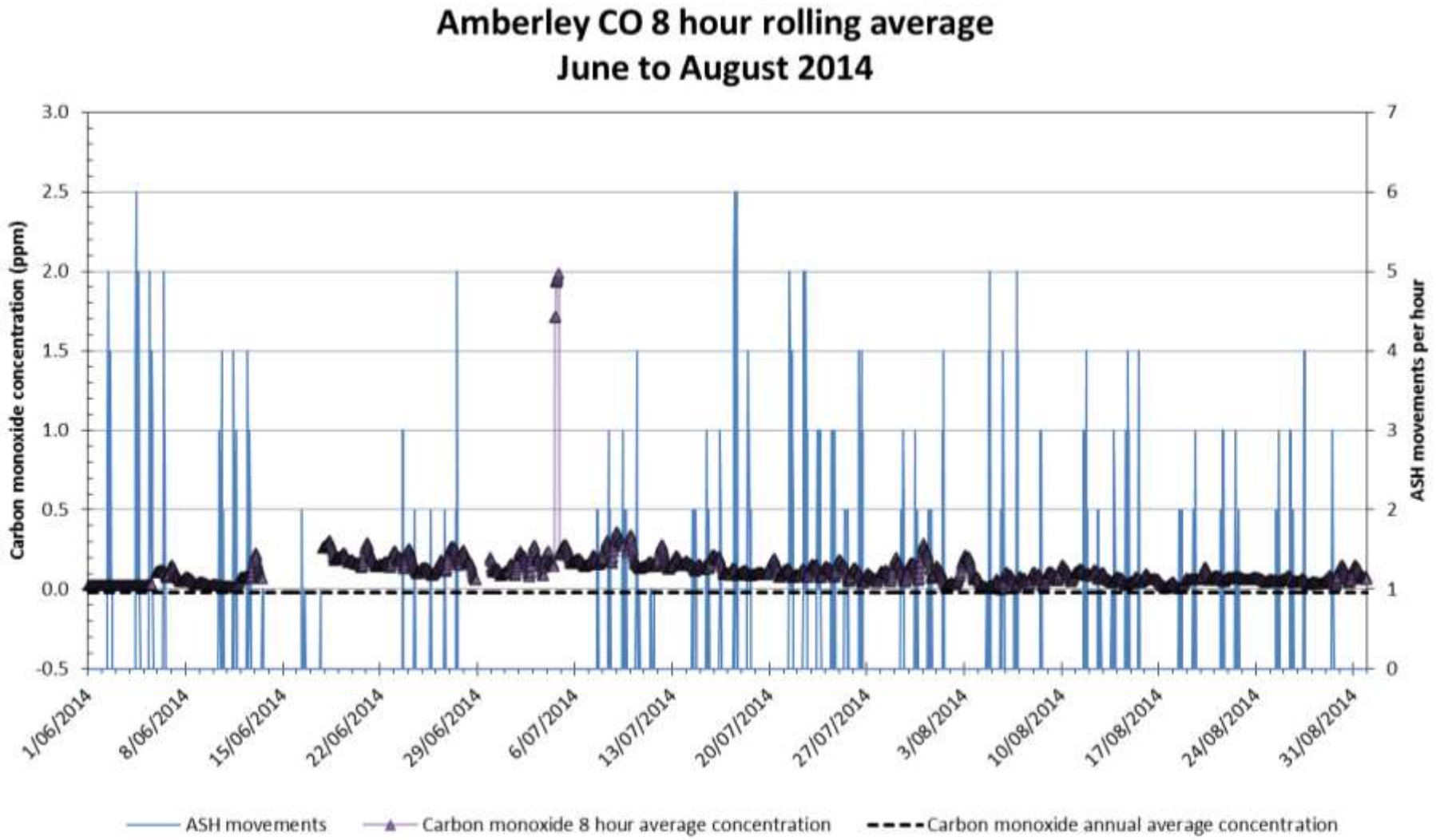


Figure 4 Carbon Monoxide results, 1 June to 31 August 2014 inclusive

Note: The EPP (Air) objective of 9 ppm CO (8 hour rolling average concentration) is not shown on the graph.

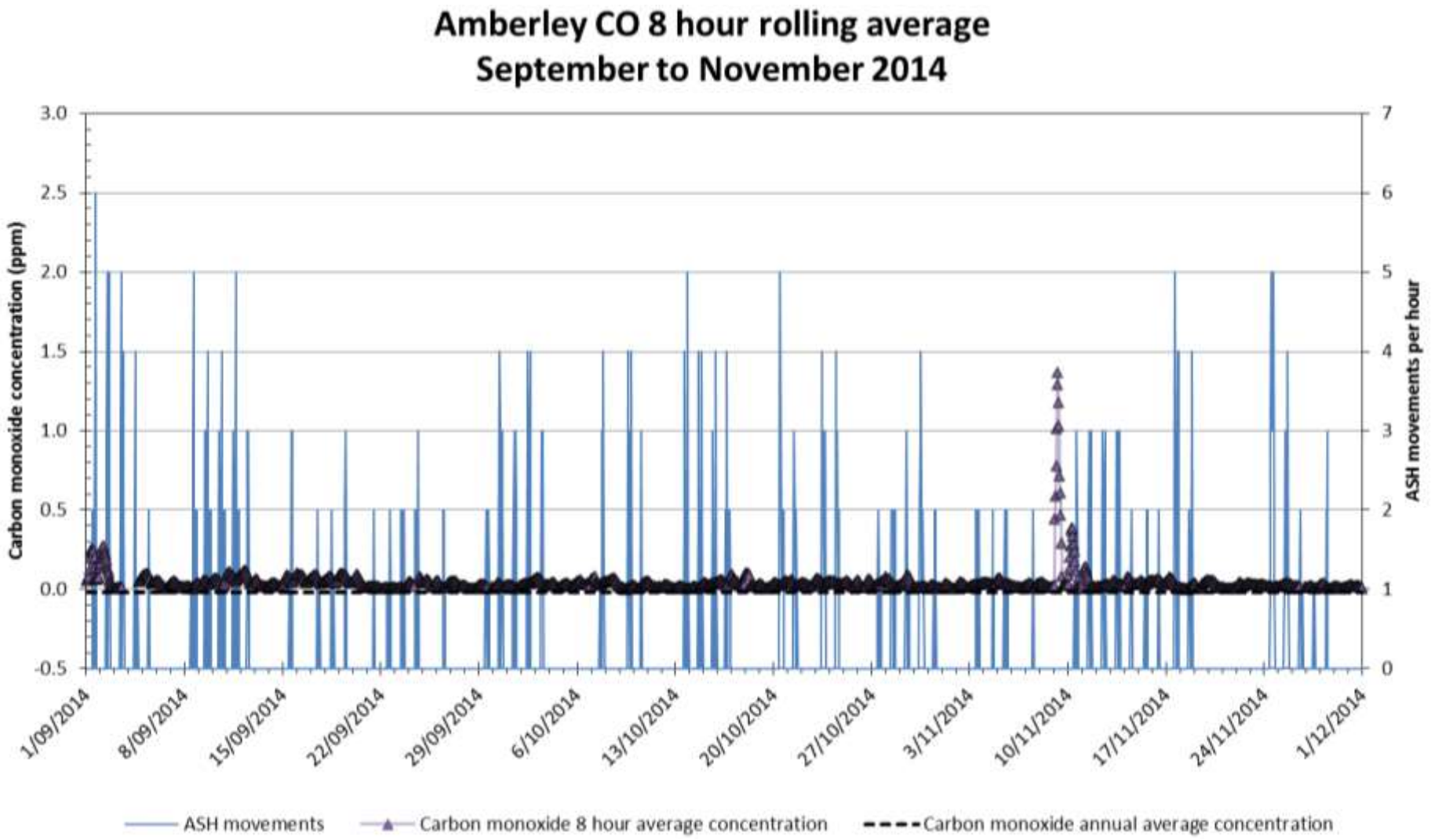


Figure 5 Carbon Monoxide results, 1 September to 30 November 2014 inclusive.

Note: The EPP (Air) objective of 9 ppm CO (8 hour rolling average concentration) is not shown on the graph.

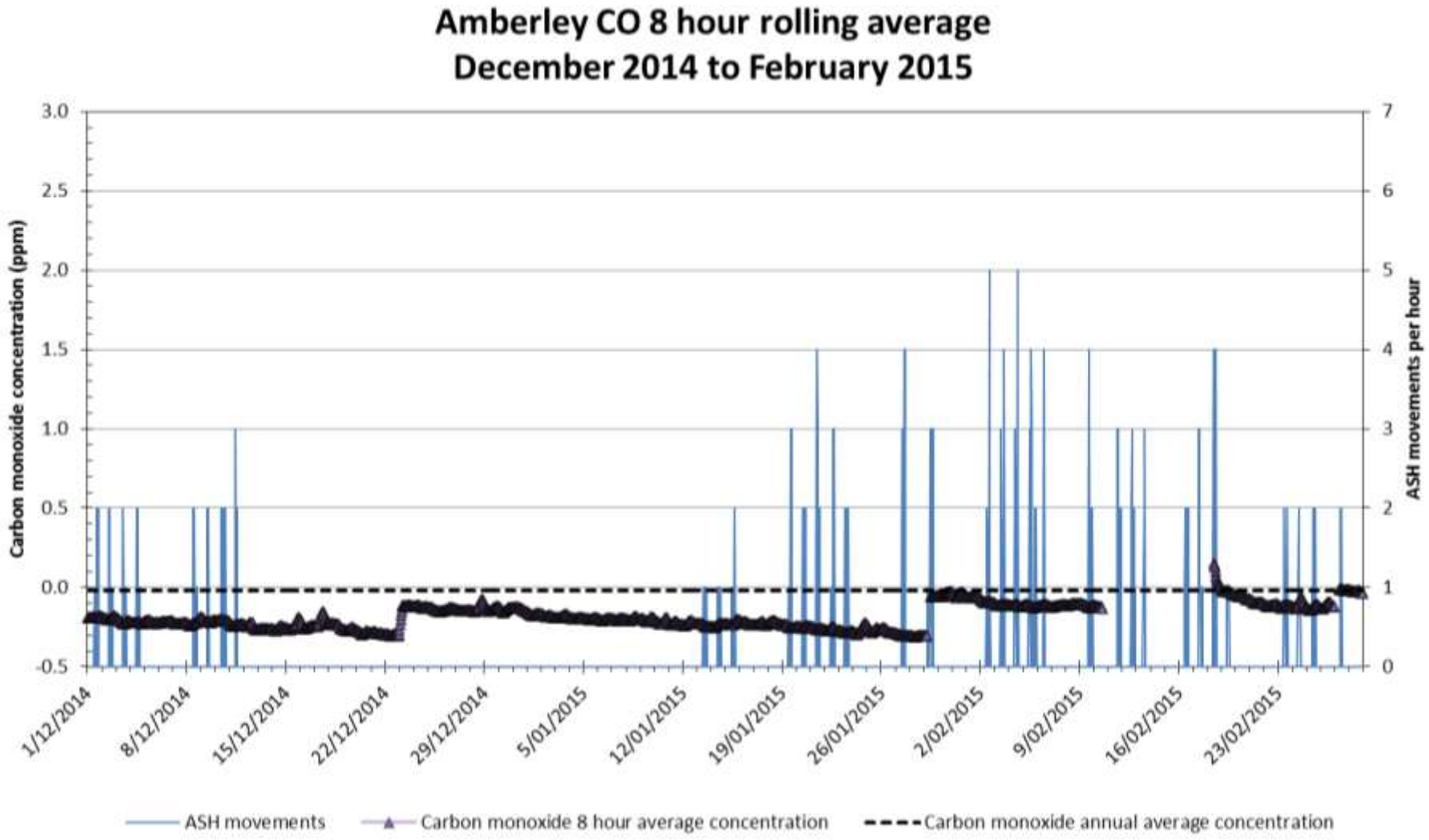


Figure 6 Carbon Monoxide results, 1 December 2014 to 28 February 2015 inclusive.

Note: The EPP (Air) objective of 9 ppm CO (8 hour rolling average concentration) is not shown on the graph.

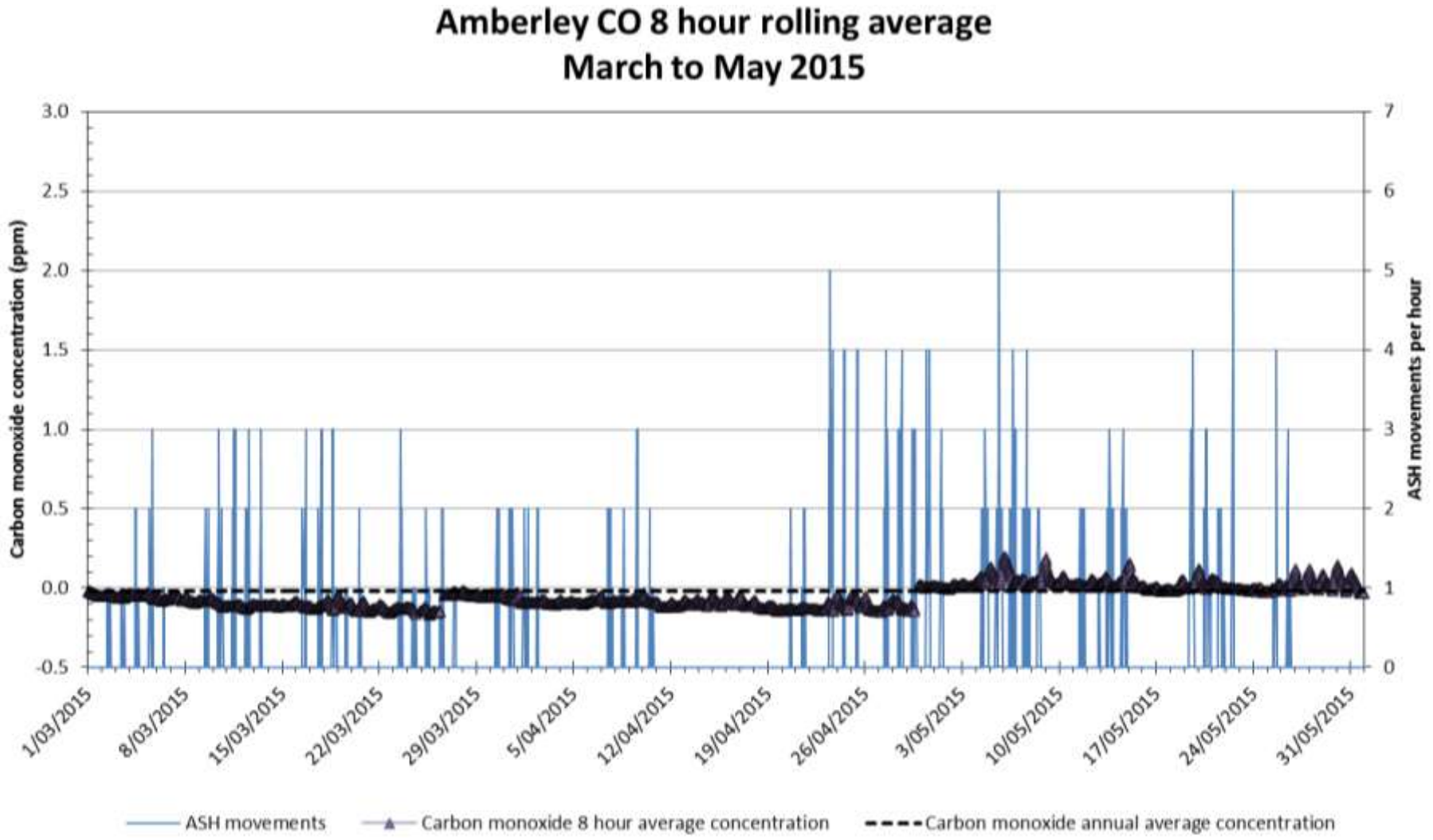


Figure 7 Carbon Monoxide results, 1 March to 31 May 2015 inclusive.

Note: The EPP (Air) objective of 9 ppm CO (8 hour rolling average concentration) is not shown on the graph.

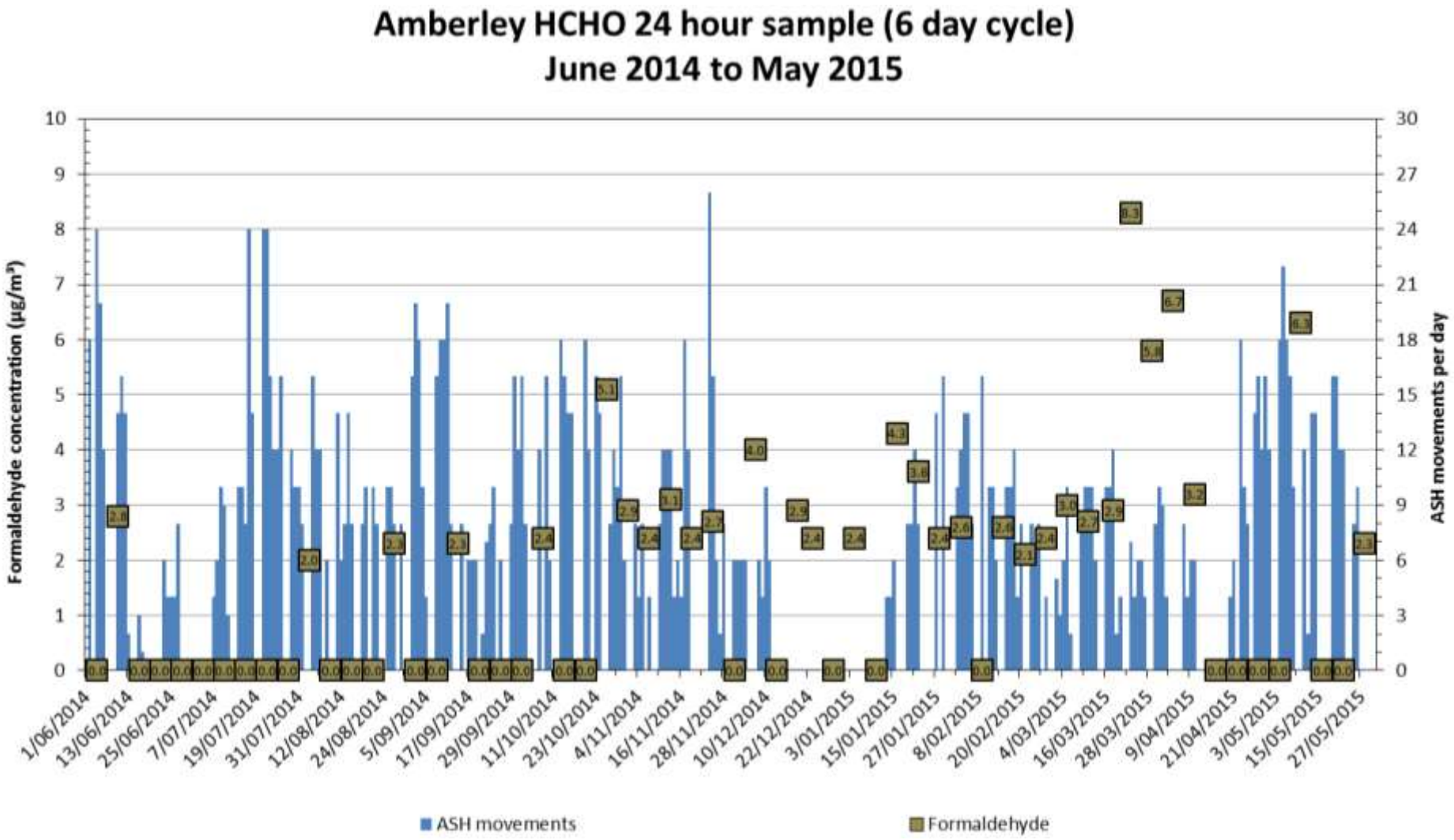


Figure 8 Formaldehyde results, 1 June 2014 to 31 May 2015 inclusive.

Note: Results less than the laboratory Limit of Reporting for the method are shown as "0.0" on the graph. The EPP (Air) objective of 54 µg/m³ is not shown on the graph.

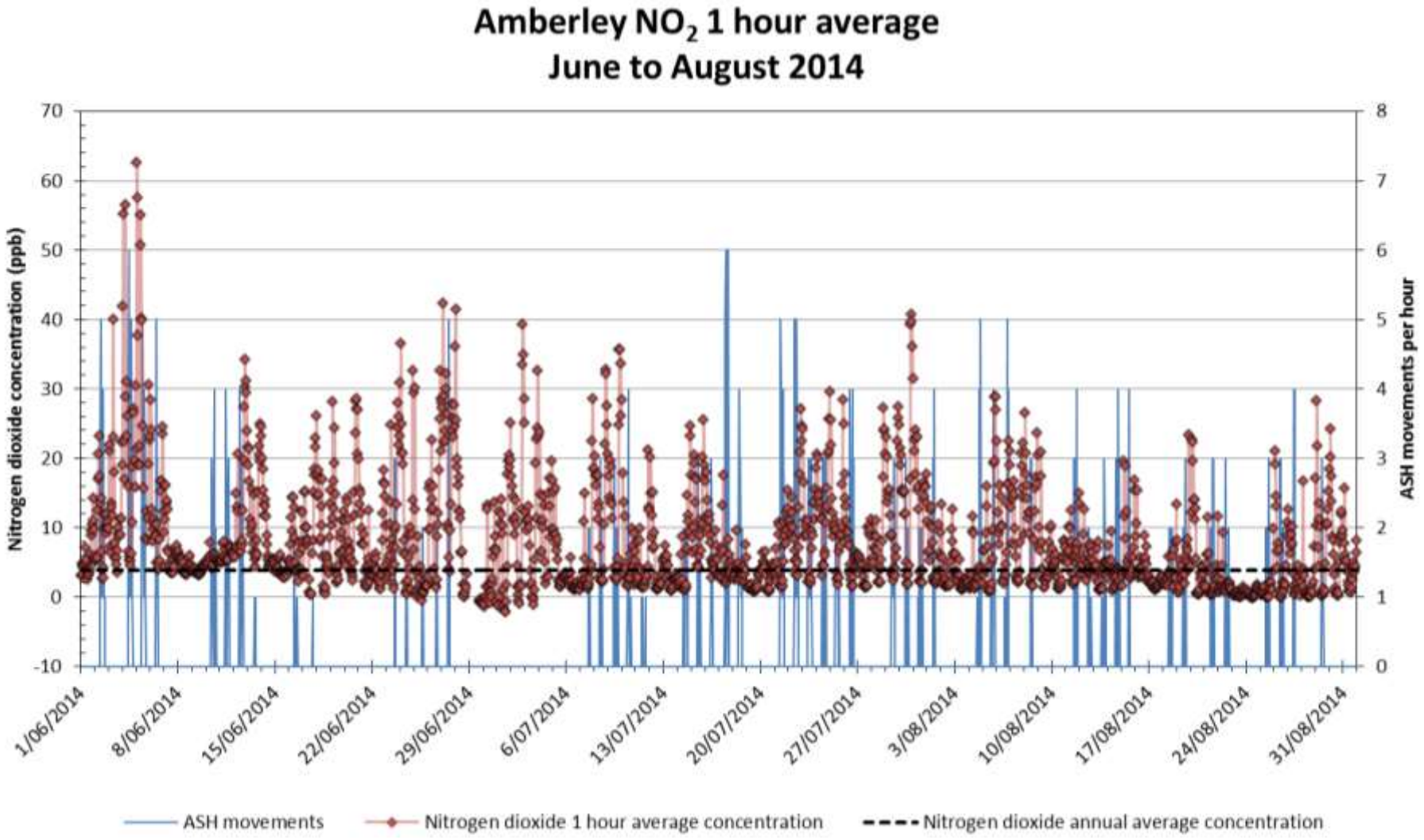


Figure 9 Nitrogen Dioxide results, June to August 2014 inclusive.

Note: The EPP (Air) objective of 120 ppb NO_2 (1 hour average concentration) is not shown on the graph.

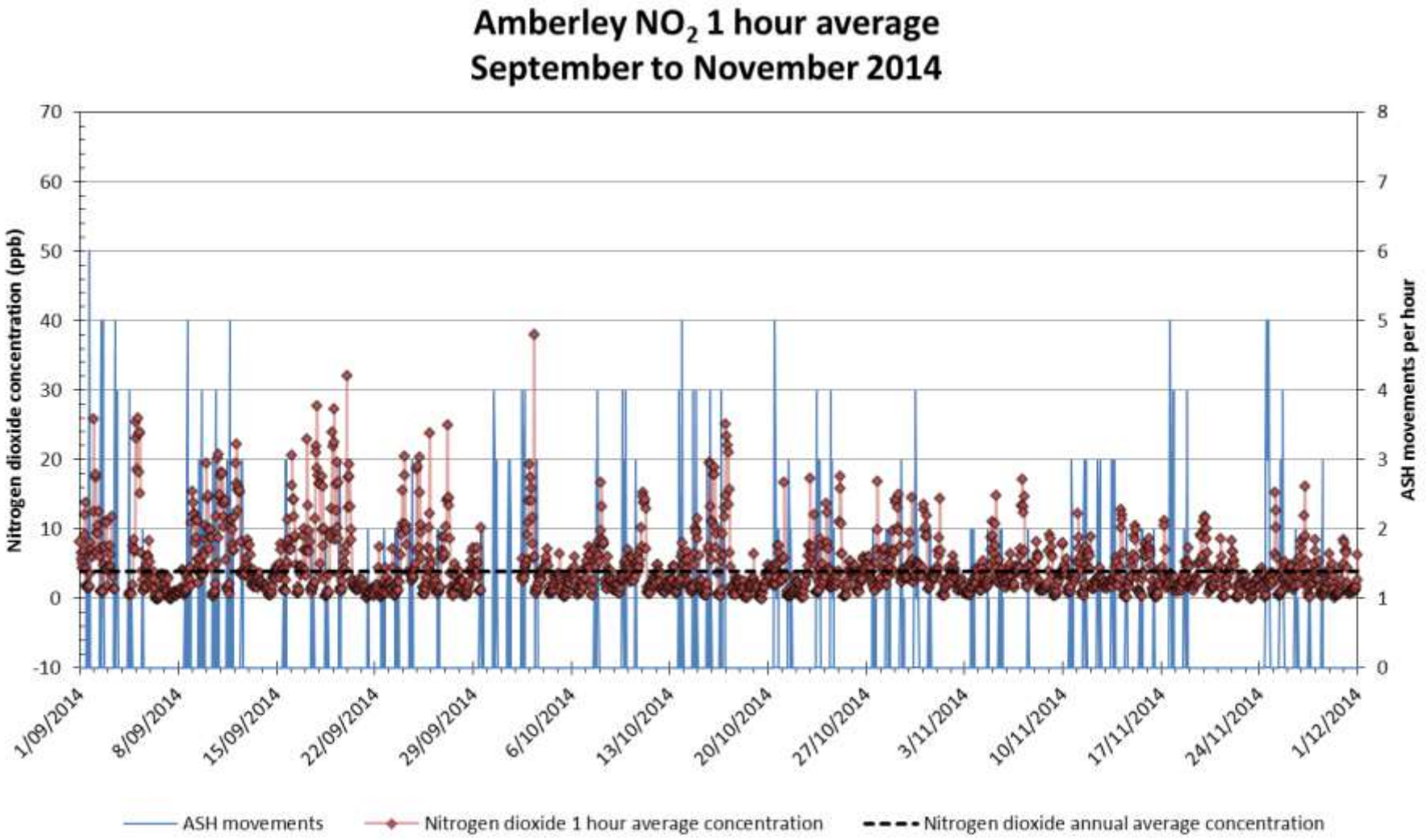


Figure 10 Nitrogen Dioxide results, September to November 2014 inclusive.

Note: The EPP (Air) objective of 120 ppb NO_2 (1 hour average concentration) is not shown on the graph.

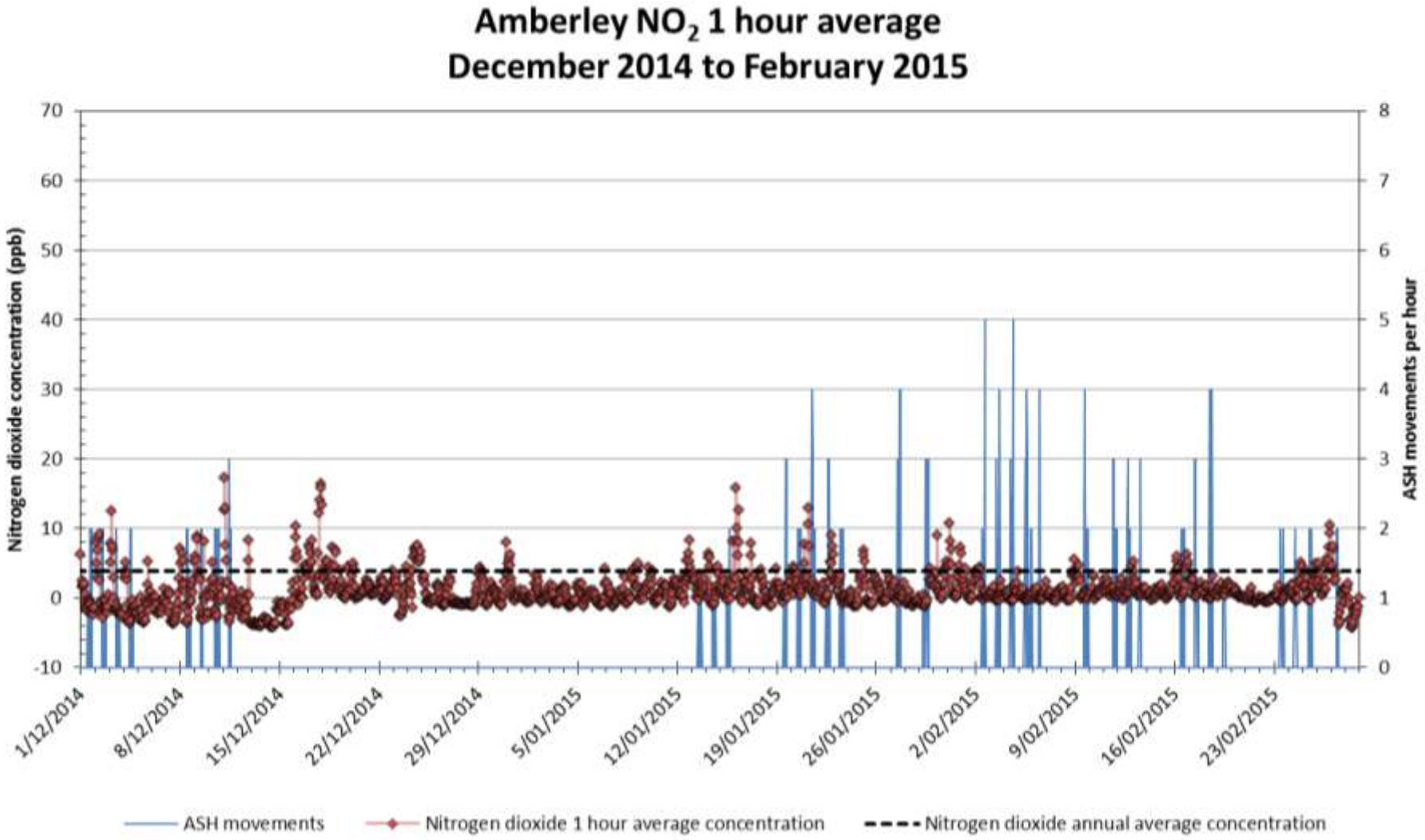


Figure 11 Nitrogen Dioxide results, December 2014 to February 2015 inclusive.

Note: The EPP (Air) objective of 120 ppb NO_2 (1 hour average concentration) is not shown on the graph.

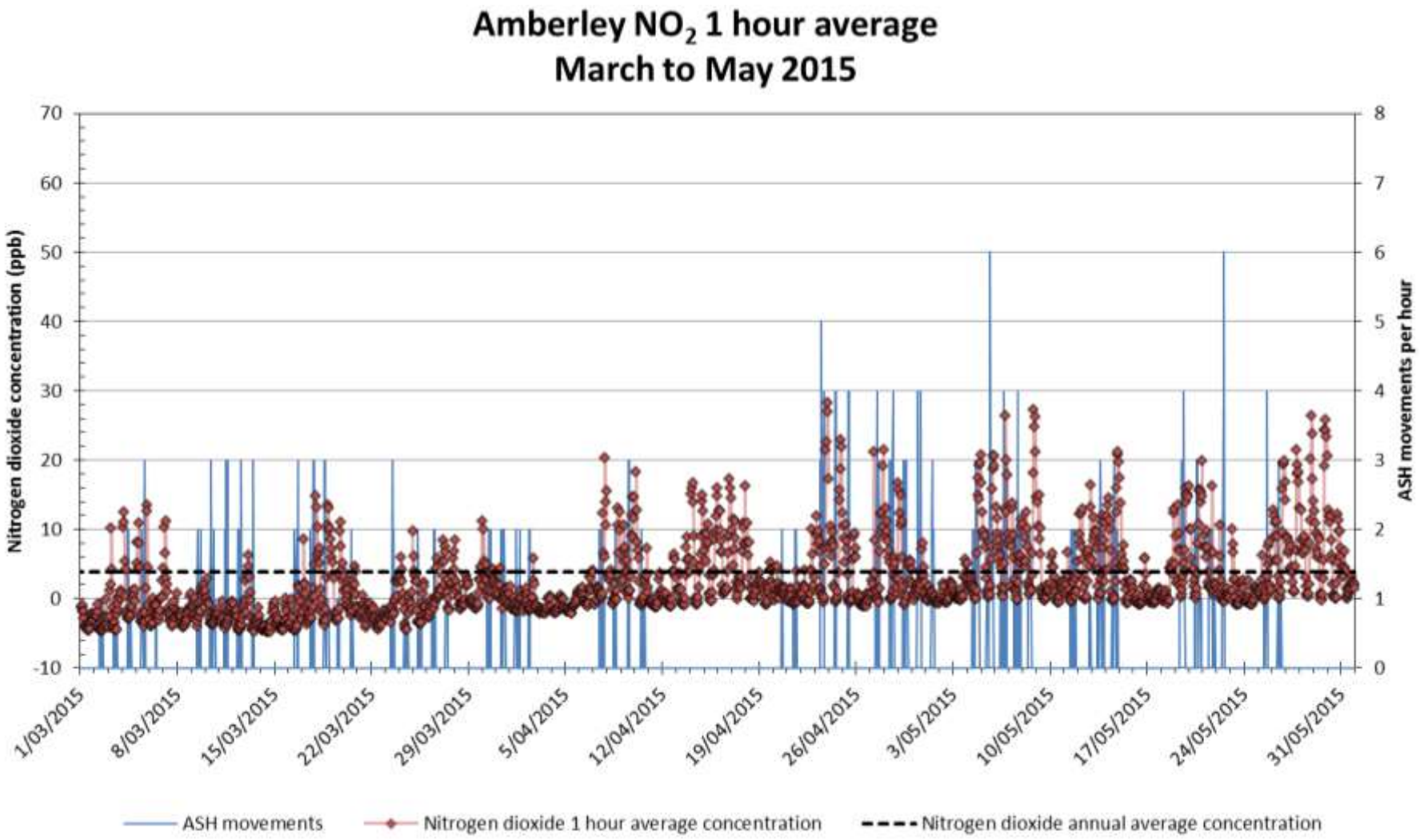


Figure 12 Nitrogen Dioxide results, March to May 2015 inclusive.

Note: The EPP (Air) objective of 120 ppb NO_2 (1 hour average concentration) is not shown on the graph.

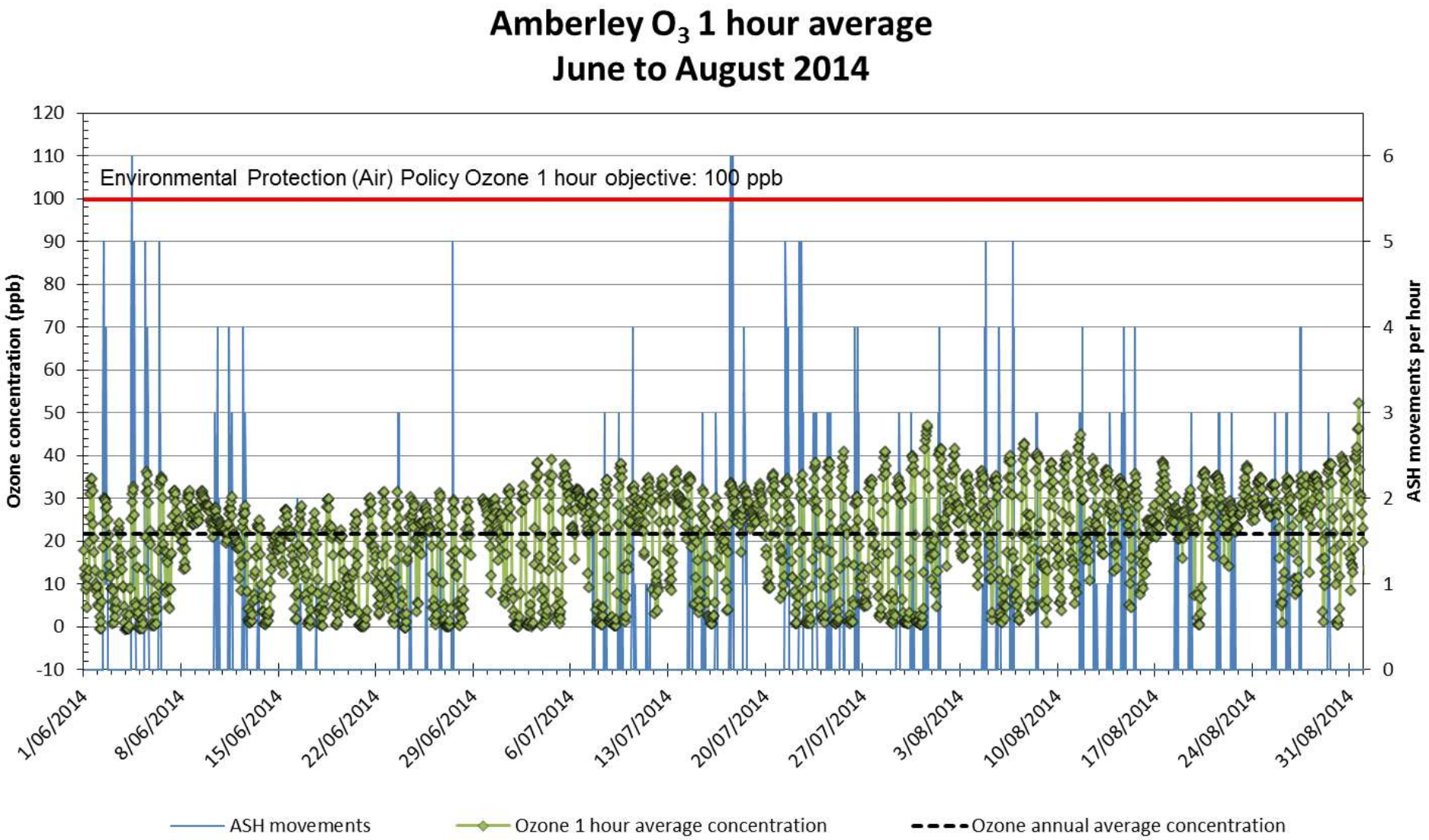


Figure 13 Ozone results, June to August 2014 inclusive.

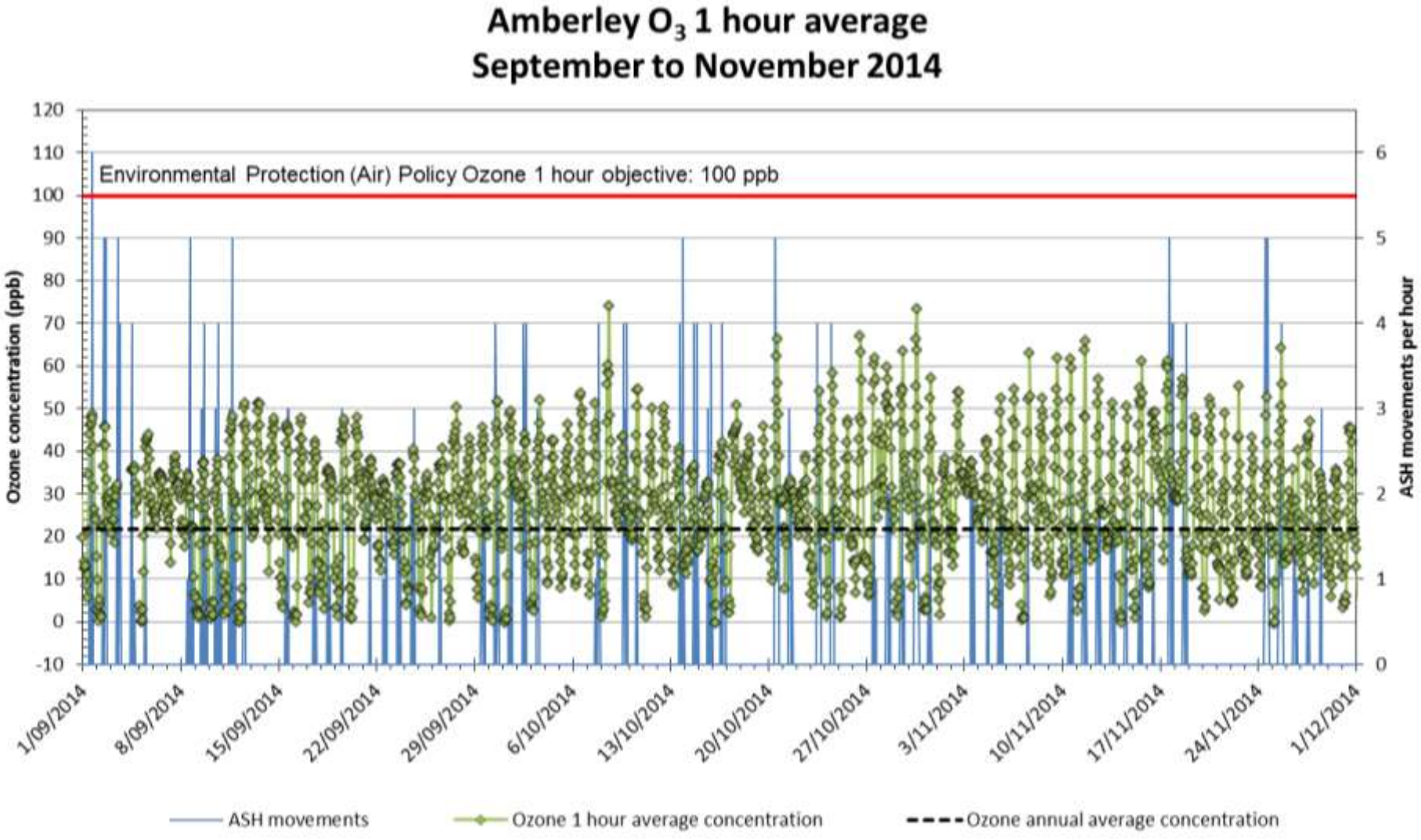


Figure 14 Ozone results, September to November 2014 inclusive.

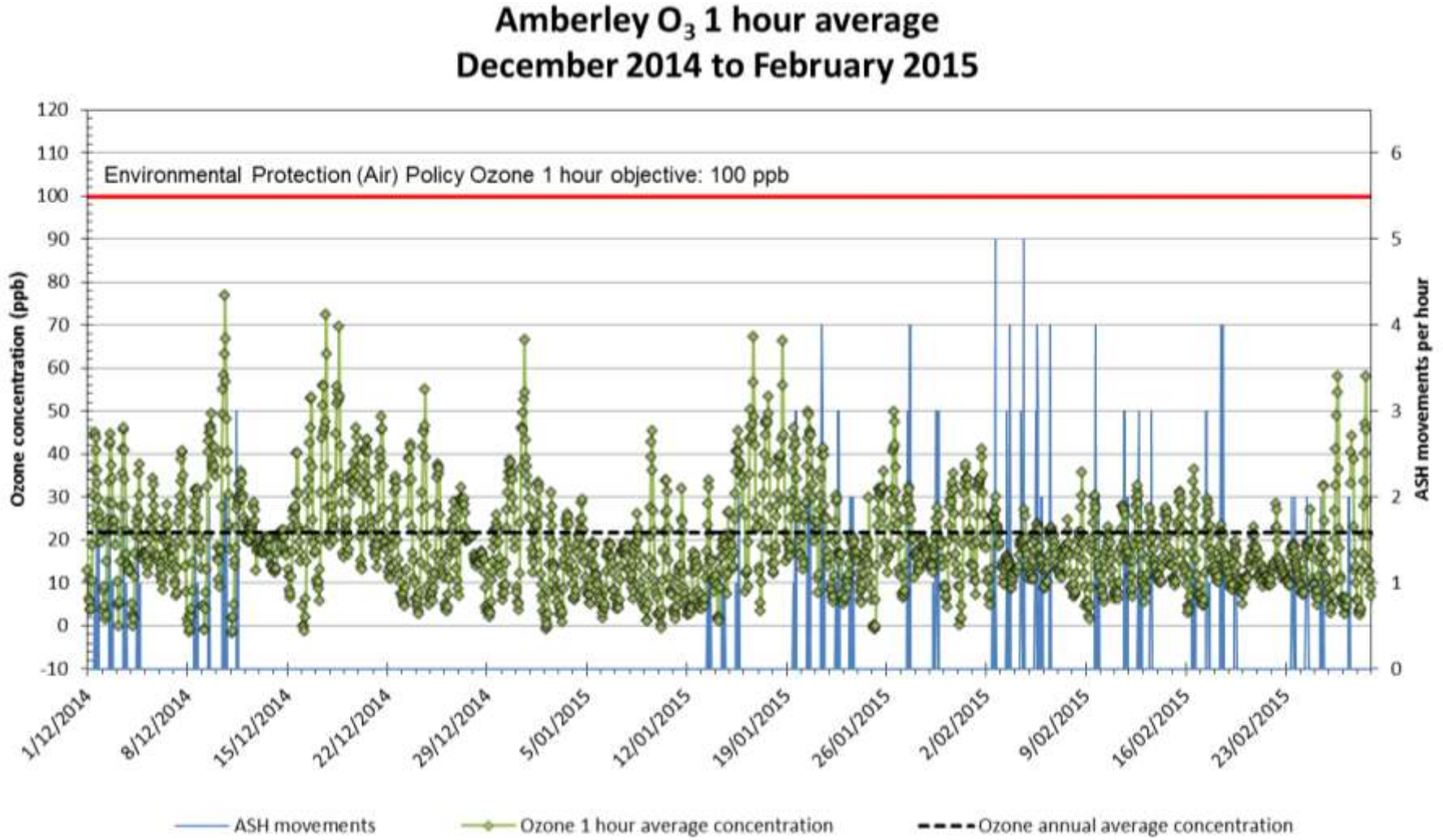


Figure 15 Ozone results, December 2014 to February 2015 inclusive.

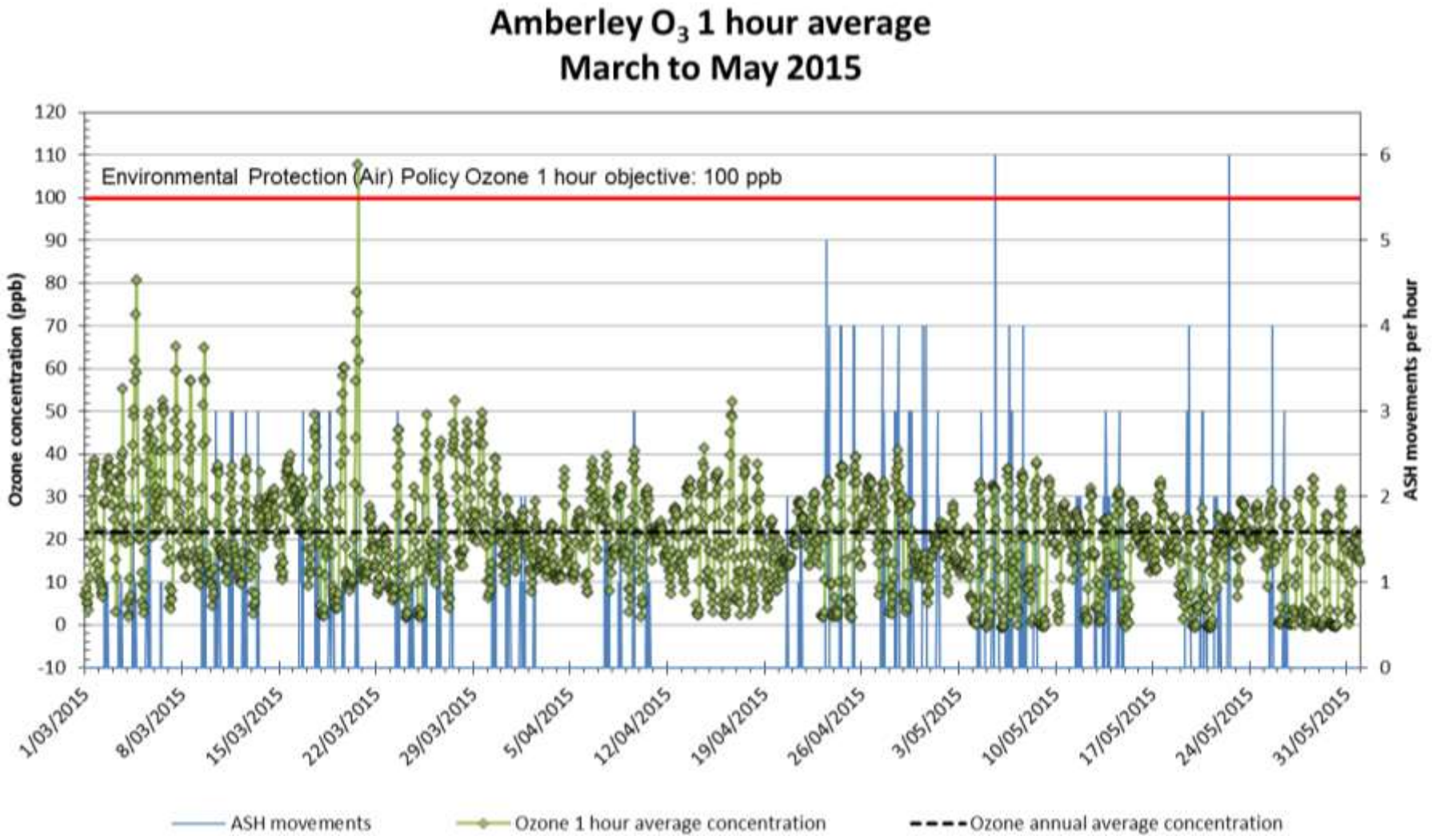


Figure 16 Ozone results, March to May 2015 inclusive.

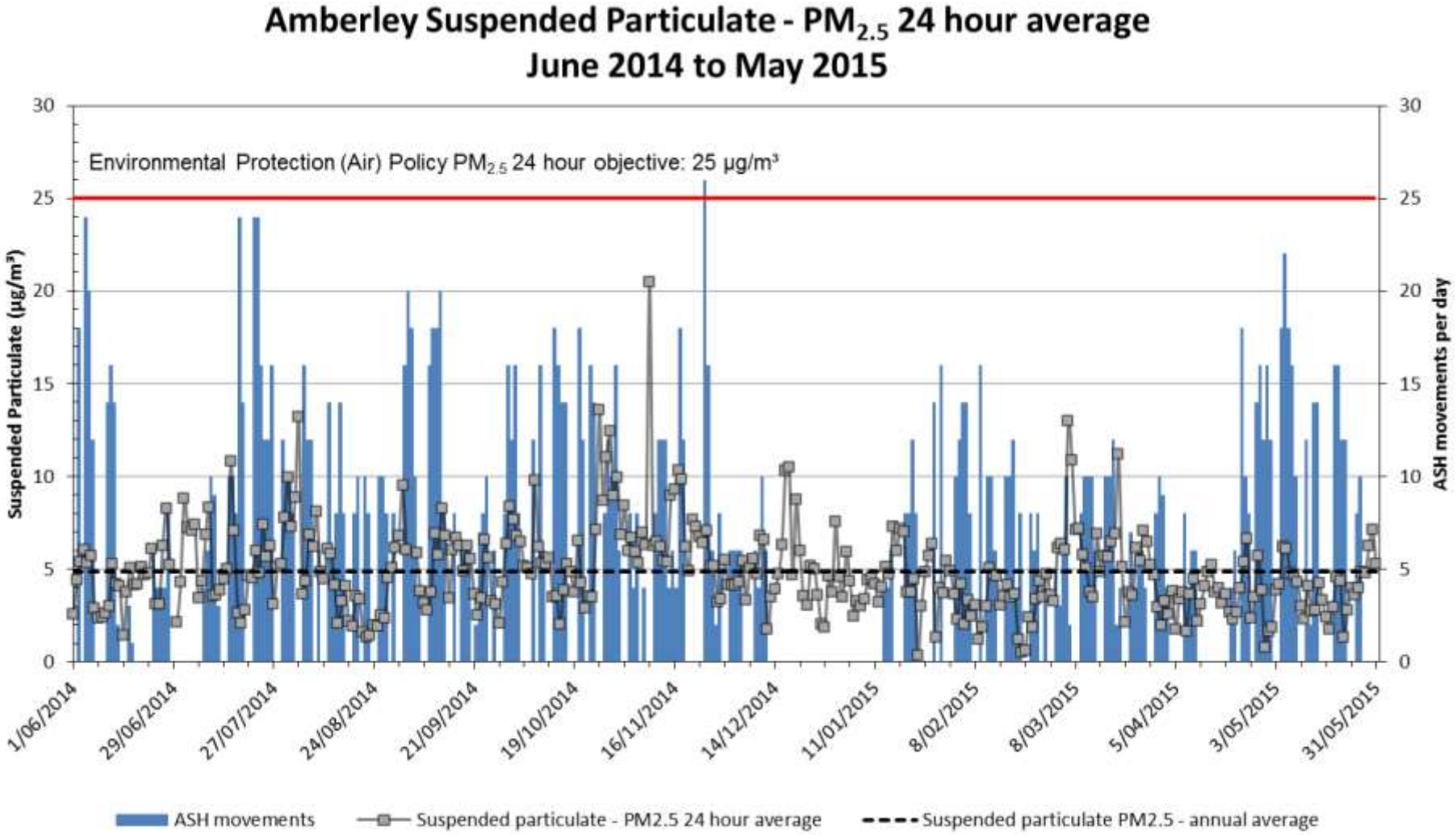


Figure 17 Suspended Particulate – $PM_{2.5}$ results, June 2014 to May 2015 inclusive.

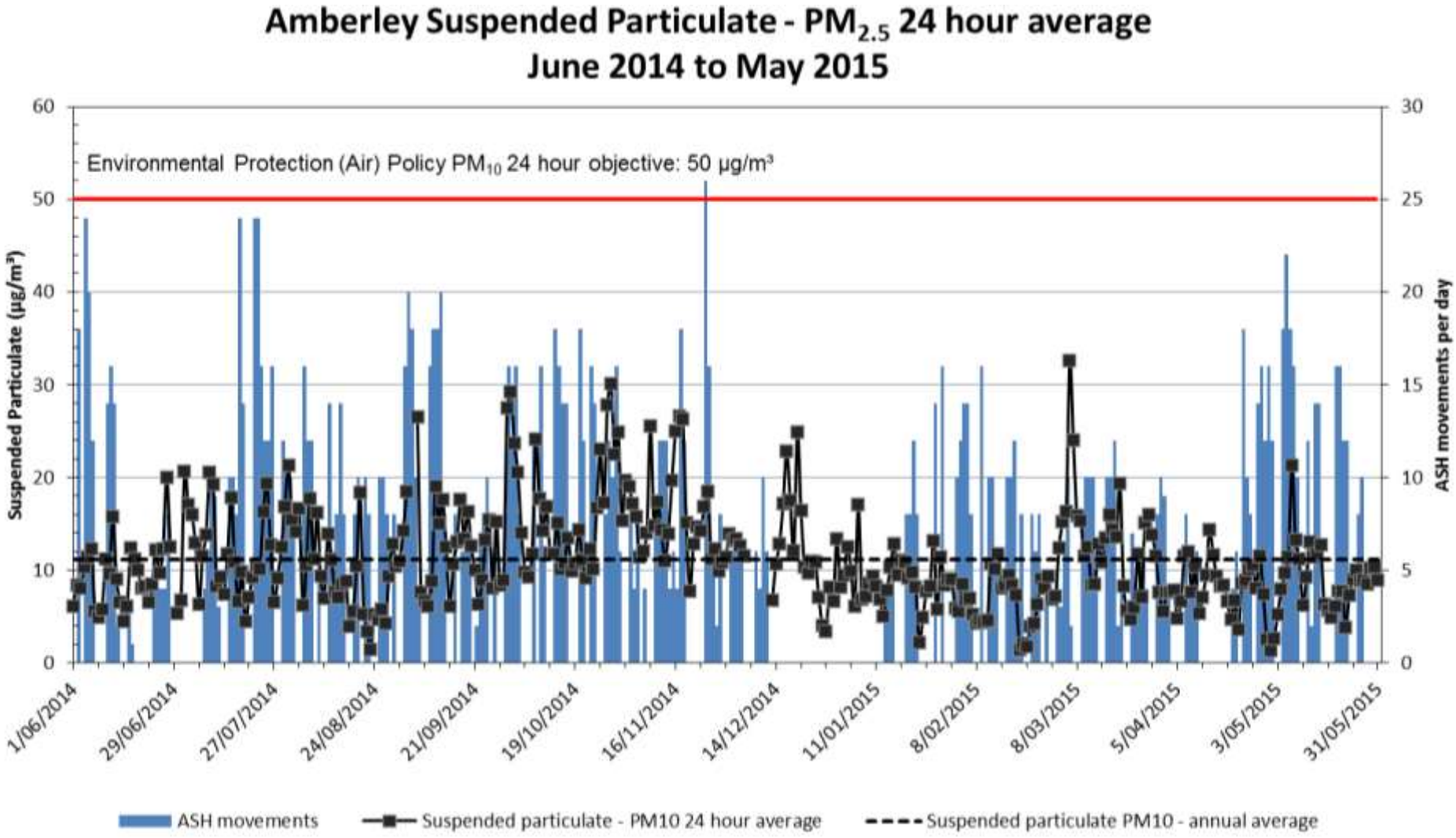


Figure 18 Suspended Particulate – PM_{10} results, June 2014 to May 2015 inclusive.

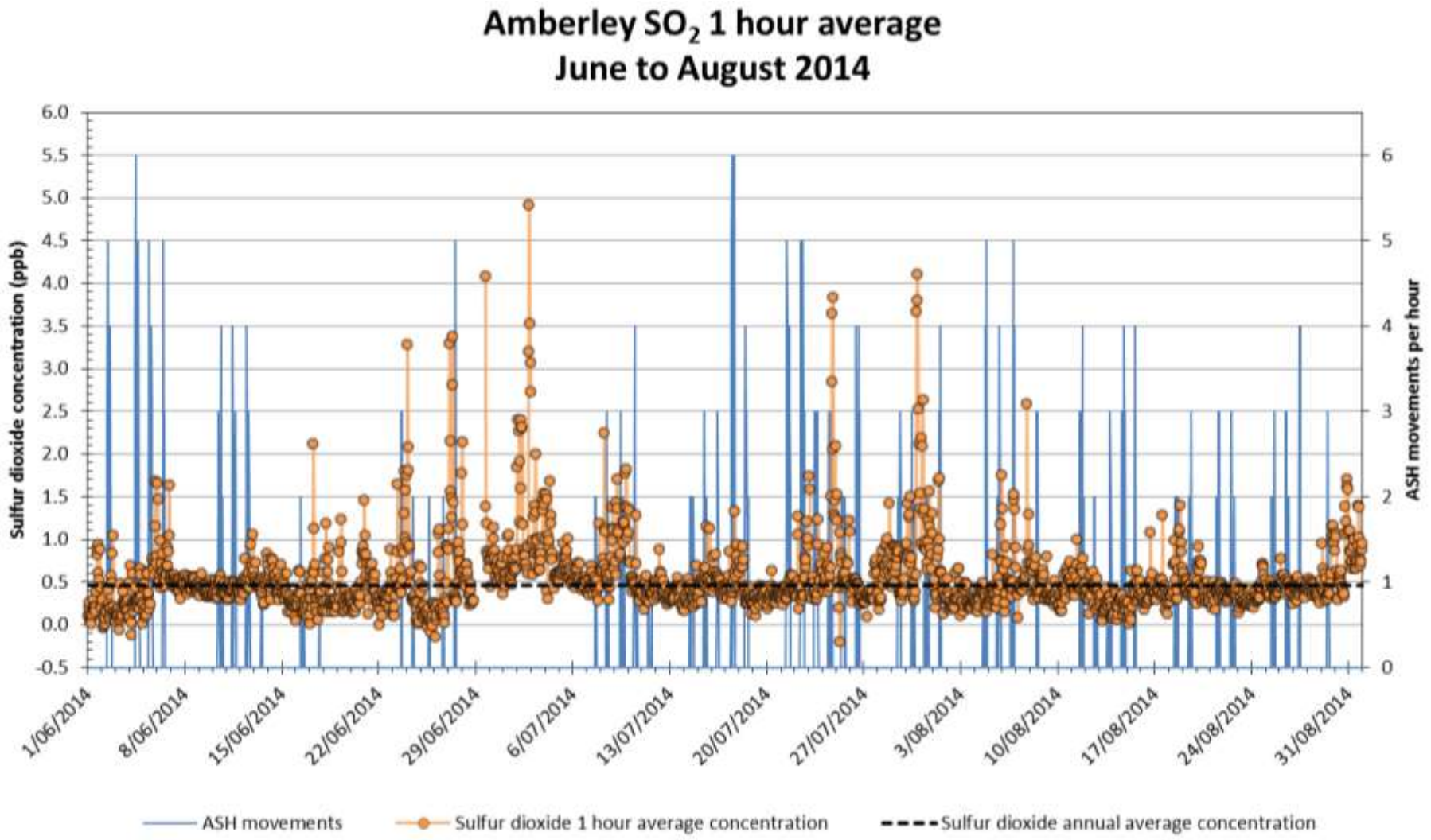


Figure 19 Sulfur Dioxide results, June to August 2014 inclusive.

Note: The EPP (Air) objective of 200 ppb SO_2 (1 hour average concentration) is not shown on the graph.

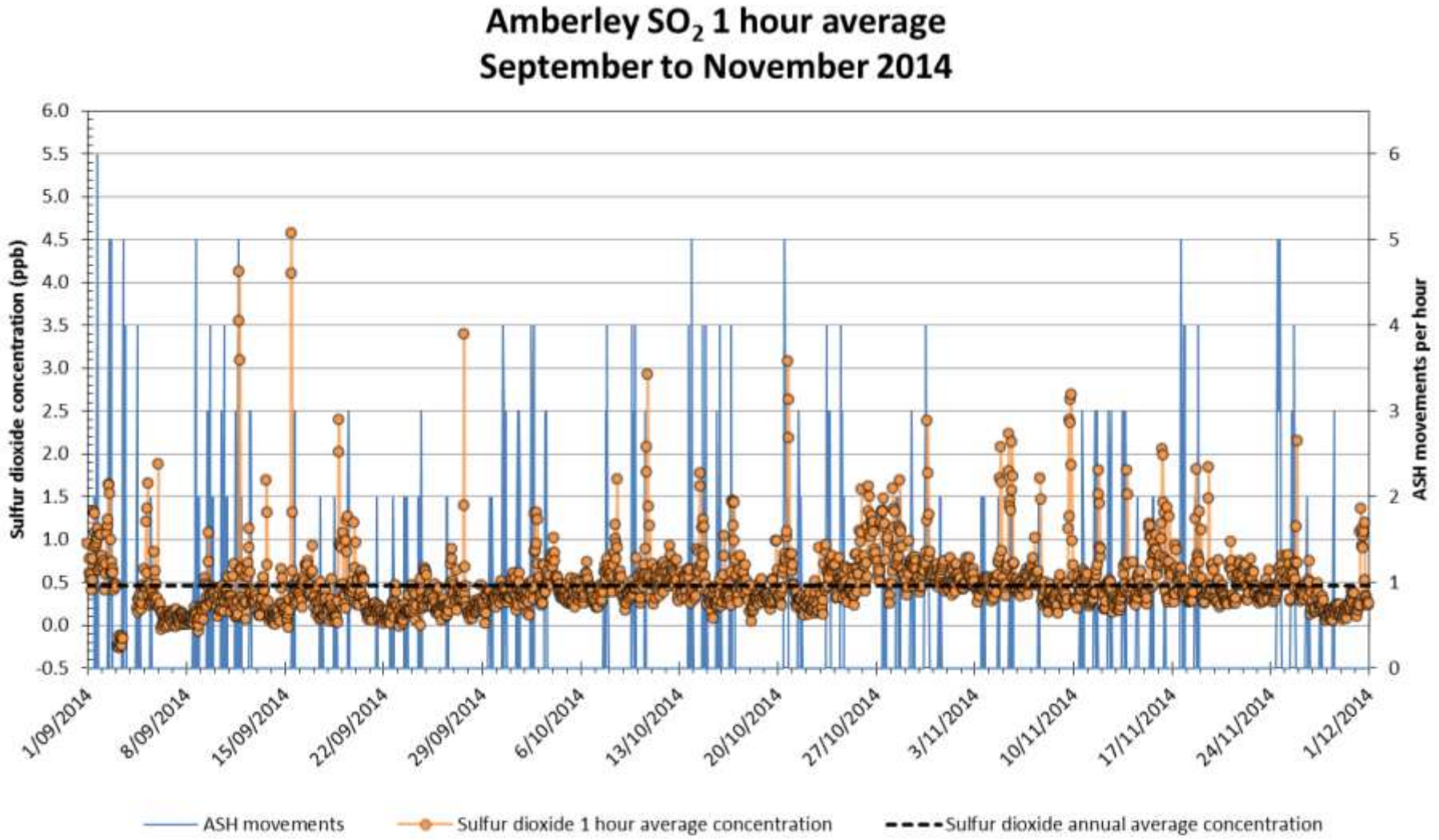


Figure 20 Sulfur Dioxide results, September to November 2014 inclusive.

Note: The EPP (Air) objective of 200 ppb SO_2 (1 hour average concentration) is not shown on the graph.

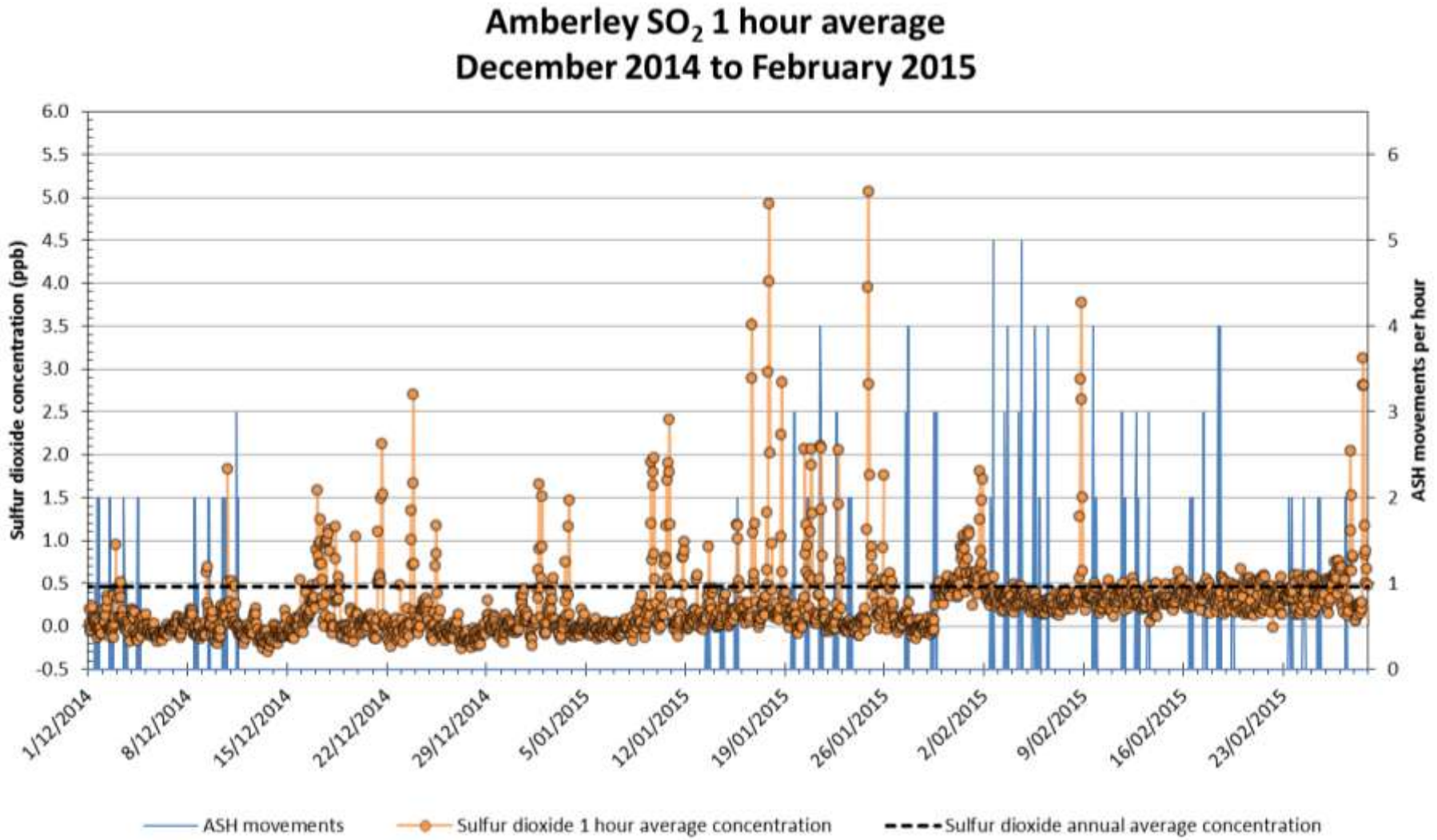


Figure 21 Sulfur Dioxide results, December 2014 to February 2015 inclusive.

Note: The EPP (Air) objective of 200 ppb SO_2 (1 hour average concentration) is not shown on the graph.

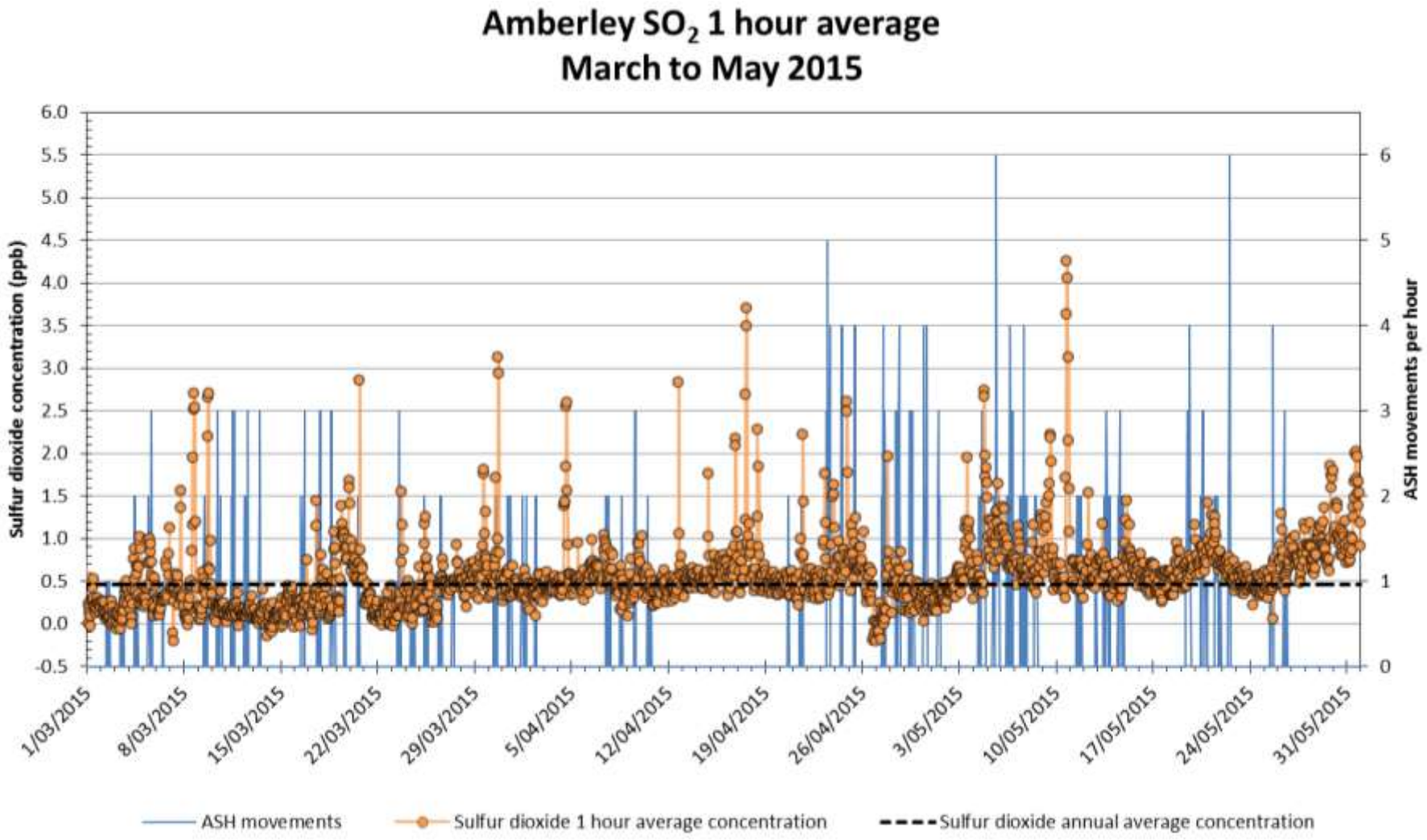


Figure 22 Sulfur Dioxide results, March to May 2015 inclusive.

Note: The EPP (Air) objective of 200 ppb SO_2 (1 hour average concentration) is not shown on the graph.

AECOM
AECOM Australia Pty Ltd
ABN 20 093 846 925