AECOM

SQ2443 - Air Quality Monitoring Program,
RAAF Base Amberley

Department of Defence

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# Air Quality Monitoring Annual Report 2

## Australian Super Hornet Flying Operations - June 2015 to May 2016

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Australian Super Hornet Flying Operations - June 2015 to May 2016

Client: Department of Defence

ABN: N/A

Prepared by

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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 2015 and finishing 31 May 2016 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 observation:

- Australian Super Hornet movements during the annual period did not reach a sufficient level to allow validation of the modelling results.

**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 2015 to May 2016**

| Parameter | Period | Annual average concentration | Maximum concentration | EPP(Air) objective | Reportable exceedances |
|---|---|---|---|---|---|
| CO | 8 hours | -0.003 ppm | 0.268 ppm | 9 ppm | 0 |
| $NO_2$ | 1 hour | 4.8 ppb | 39.3 ppb | 120 ppb | 0 |
| $O_3$ | 1 hour | 20.4 ppb | 85.1 ppb | 100 ppb | 0 |
| $O_3$ | 4 hour | *20.2 ppb* [a] | 70.9 ppb | 80 ppb | 0 |
| $PM_{2.5}$ | 24 hours | 5.4 µg/m³ | 16.2 µg/m³ | 25 µg/m³ | 0 |
| $PM_{10}$ | 24 hours | 9.8 µg/m³ | 24.9 µg/m³ | 50 µg/m³ | 0 |
| $SO_2$ | 1 hour | 0.5 ppb | 3.9 ppb | 200 ppb | 0 |
| $SO_2$ | 24 hours | *0.5 ppb* [a] | 1.4 ppb | 80 ppb | 0 |

[a] According to the National Environmental Protection Council's *National Environmental Protection (Ambient Air Quality) Measure: Technical Paper No. 5 – Data Collection and Handling*, annual averages are to be calculated from validated 1 hour average concentrations. The annual average concentration calculated from 4 hour $O_3$ and 24 hour $SO_2$ averages are presented here for comparative purposes only.

**Table 2 Summary of annual period – reportable annual average concentrations – June 2015 to May 2016**

| Parameter | Annual average concentration | EPP (Air) annual objective | Result |
|---|---|---|---|
| $NO_2$ | 4.8 ppb | 30 ppb | Not exceeded |
| $PM_{2.5}$ | 5.4 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 (June 2014 to May 2015) of the current monitoring program no comparison with previous monitoring was undertaken. Subsequent annual reports 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 % |
| 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

Monitoring of suspended particulate and gaseous parameters is continuous.

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.

## 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 |
| 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. 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 points 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 "01/06/2015" is calculated from 24, 1 hour averages (1 hour averages labelled 01/06/2015 01:00 to 02/06/2015 00:00 inclusive) |
| Annual | Average of 1 hour data | Time beginning | Annual result labelled "1 June 2015 to 31 May 2016" is calculated from 8784, 1 hour averages (1 hour averages labelled 01/06/2015 01:00 to 01/06/2016 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/m$^3$) 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 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 2015 to 31 May 2016 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 2015 to 31 May 2016 (inclusive)**

**Wind Speed and Direction at Amberley AMO – Monitoring Period 1 June 2015 to 31 May 2016 (inclusive)**

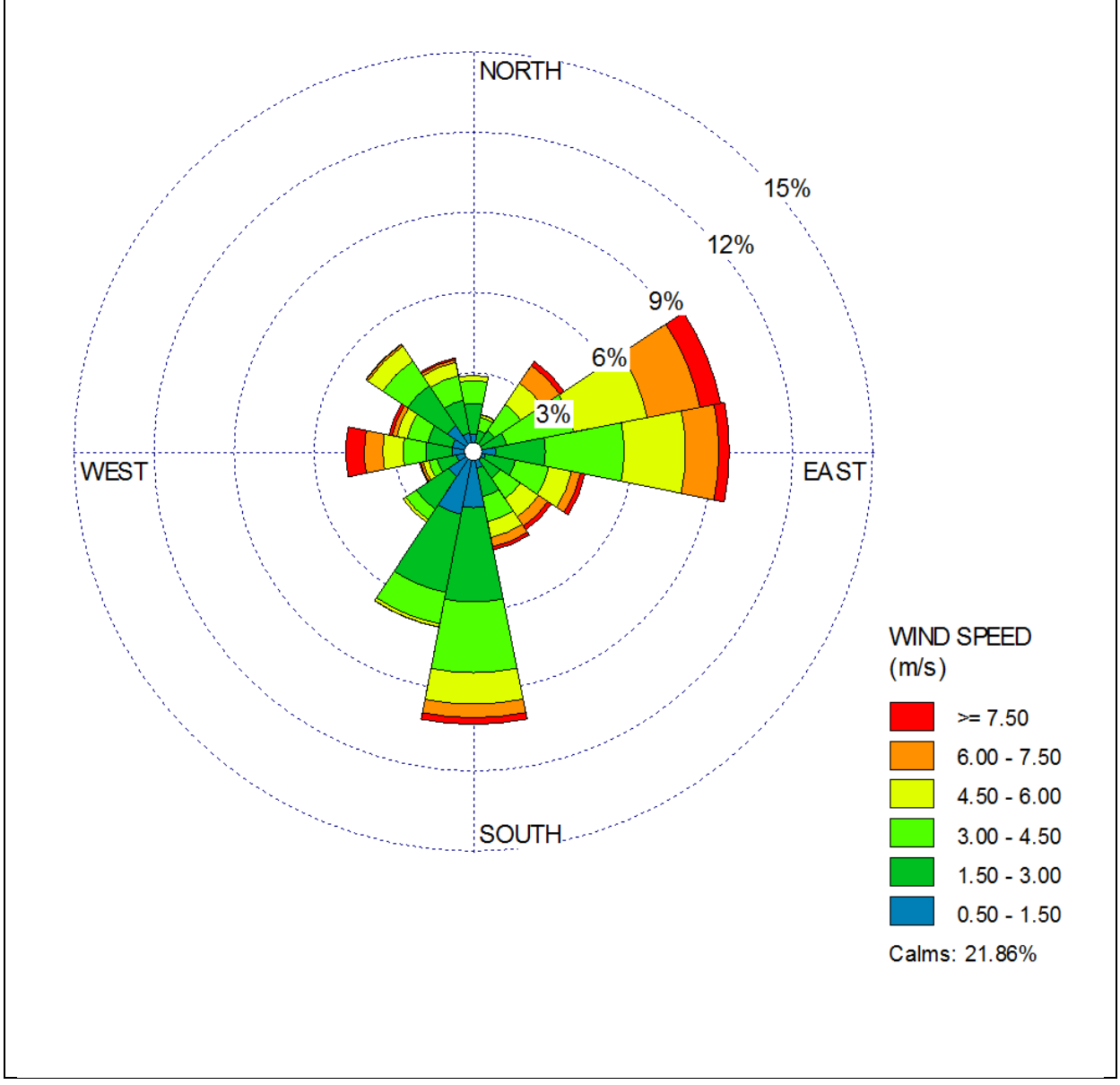
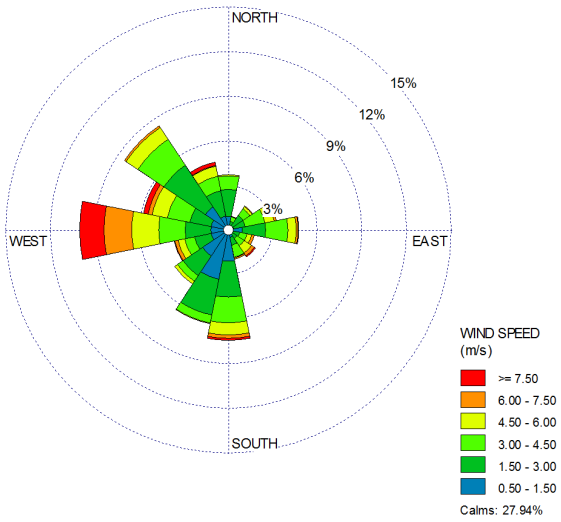
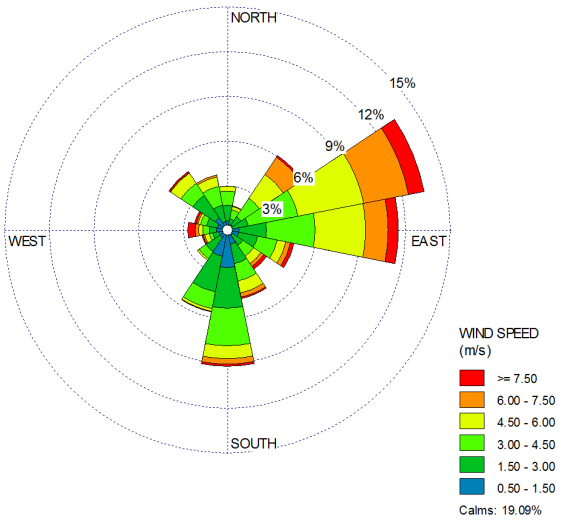


**Table 7 Wind data from Amberley AMO – seasonal wind data for monitoring period 1 June 2015 to 31 May 2016 (inclusive)**

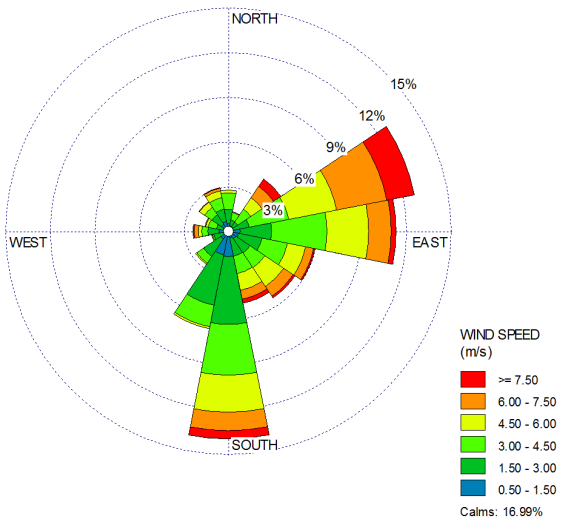
## Wind Speed and Direction at Amberley AMO – Seasonal wind roses



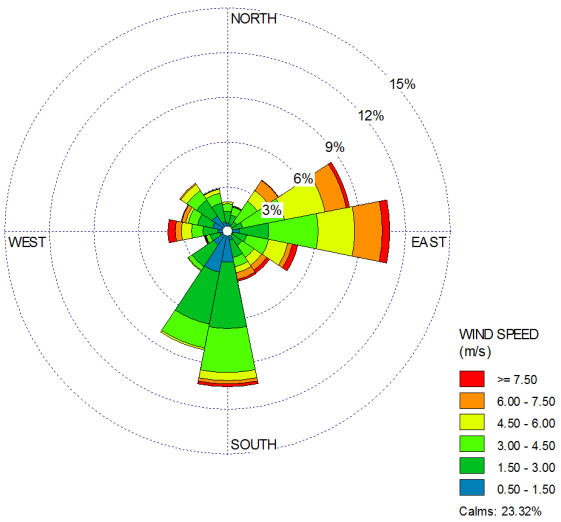

Winter 2015 – 1 June to 31 August 2015 (inclusive)




Spring 2015 – 1 September to 30 November 2015 (inclusive)




Summer 2015/16 – 1 December 2015 to 29 February 2016 (inclusive)




Autumn 2016 – 1 March to 31 May 2016 (inclusive)

# 4.0 Aircraft movements

## 4.1 Provided data

AECOM obtained aircraft movement data from Defence covering the annual reporting period starting June 2015. **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, a series of circuits followed by a full stop landing, or simply a transit of Amberley controlled airspace. Therefore, no distinction is made between these types of aircraft activity and consequently all activity types are counted as a single movement only.

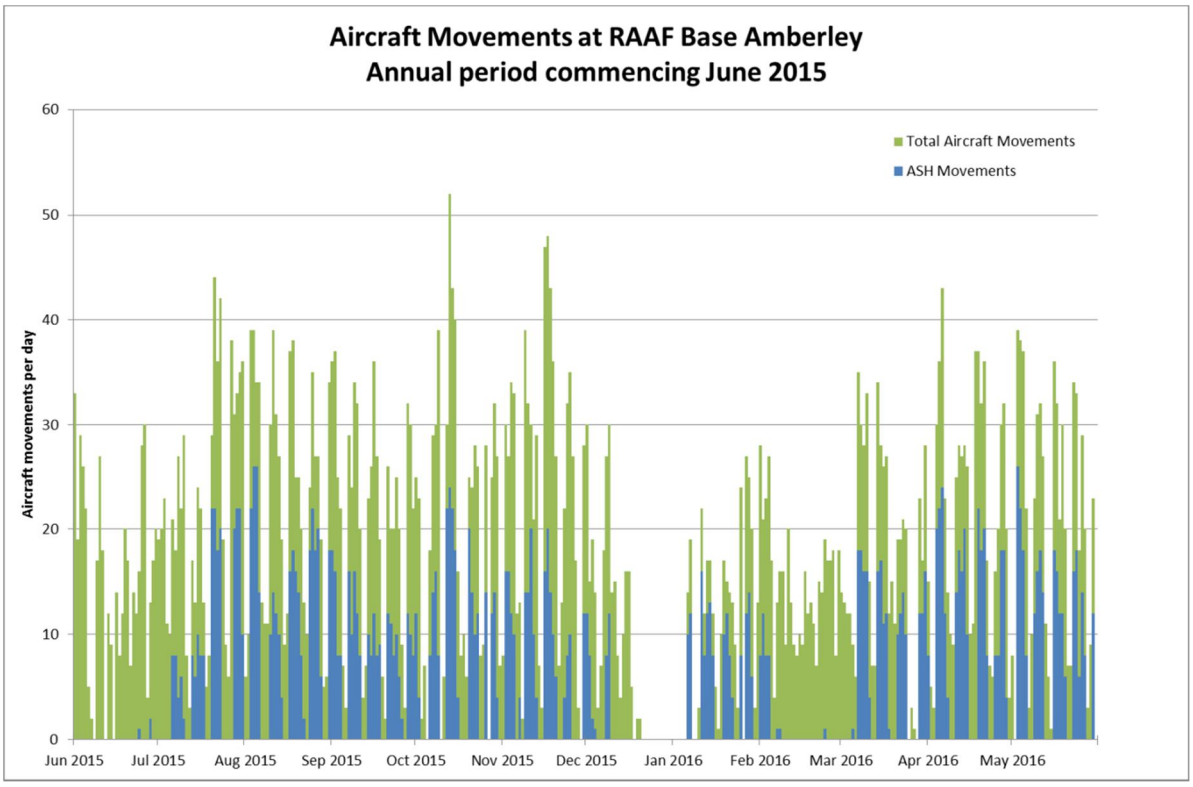



**Figure 2 Graphical presentation supplied of aircraft movement data, 1 June 2015 to 31 May 2016 inclusive**

## 4.2 Analysis of movement data

According to the data provided to AECOM, there were 7,212 aircraft movements at RAAF Base Amberley during the reporting period. Of these movements, 2,588 (or 35 %) were conducted by ASH aircraft. The largest number of ASH movements in a day was 27 ASH movements on 3 May 2016. There were two days of 26 ASH movements: on 4 August 2015 and 5 August 2015. Of these days, the most intensive hour saw seven ASH movements recorded between 19:00 and 20:00 on 4 August 2016, four of them departures.

Analysing hourly data over the period, there were two one hour periods during which eight ASH movements were recorded: 10:00 to 11:00 on 18 August 2015 and 14:00 to 15:00 on 17 November 2015.

There were insufficient ASH movements to allow a comparison of monitoring data to the “worst case” scenario of seven pairs of aircraft departing in one hour assessed 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 2015, dated 17 September 2015
- Air Quality Monitoring Quarterly Report, Australian Super Hornet Flying Operations – September to November 2015, dated 18 December 2015
- Air Quality Monitoring Quarterly Report, Australian Super Hornet Flying Operations – December 2015 to February 2016, dated 23 March 2016
- Air Quality Monitoring Quarterly Report, Australian Super Hornet Flying Operations – March to May 2016, dated 4 July 2016.

**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 2015 to May 2016**

| Parameter | Period | Annual average concentration | Maximum concentration | EPP(Air) objective | Reportable exceedances |
|---|---|---|---|---|---|
| CO | 8 hours | -0.003 ppm | 0.268 ppm | 9 ppm | 0 |
| $NO_2$ | 1 hour | 4.8 ppb | 39.3 ppb | 120 ppb | 0 |
| $O_3$ | 1 hour | 20.4 ppb | 85.1 ppb | 100 ppb | 0 |
| $O_3$ | 4 hour | *20.2 ppb* [a] | 70.9 ppb | 80 ppb | 0 |
| $PM_{2.5}$ | 24 hours | 5.4 µg/m³ | 16.2 µg/m³ | 25 µg/m³ | 0 |
| $PM_{10}$ | 24 hours | 9.8 µg/m³ | 24.9 µg/m³ | 50 µg/m³ | 0 |
| $SO_2$ | 1 hour | 0.5 ppb | 3.9 ppb | 200 ppb | 0 |
| $SO_2$ | 24 hours | *0.5 ppb* [a] | 1.4 ppb | 80 ppb | 0 |

[a] According to the National Environmental Protection Council's *National Environmental Protection (Ambient Air Quality) Measure: Technical Paper No. 5 – Data Collection and Handling*, annual averages are to be calculated from validated 1 hour average concentrations. The annual average concentration calculated from 4 hour $O_3$ and 24 hour $SO_2$ averages are presented here for comparative purposes only.

**Table 9 Summary of annual period – reportable annual average concentrations – June 2015 to May 2016**

| Parameter | Annual average concentration | EPP (Air) annual objective | Result |
|---|---|---|---|
| $NO_2$ | 4.8 ppb | 30 ppb | Not exceeded |
| $PM_{2.5}$ | 5.4 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, and again at the annual services on 4 June 2015 and 3 June 2016. The station was found to be in compliance with the standard on all three 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 and at the end of the second year of monitoring).

**Table 10 AS/NZS 3580.1.1 Site Compliance**

| Item | Parameters | Start of second annual period (4 June 2015) | End of second annual period (3 June 2016) |
|---|---|---|---|
| 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 11** was carried out in accordance with the relevant Australian Standards, listed in **Table 3** in **Section 2.2**. 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 11 Site Maintenance Schedule for the annual reporting period June 2015 to May 2016**

| Required item | Due date | Performed | Comment |
|---|---|---|---|
| Annual Maintenance including filter change | May/June 2015 | 3 – 11 June 2015 | All parameters and calibrations within acceptance limits |
| Parameter check and filter change | June 2015 | 2 July 2015 | All parameters within acceptance limits |
| Parameter check and filter change | July 2015 | 31 July 2015 | All parameters within acceptance limits |
| Quarterly Maintenance including filter change | August 2015 | 27 – 30 August 2015 | All parameters and calibrations within acceptance limits |
| Parameter check and filter change | September 2015 | 25 September 2015 | All parameters within acceptance limits |
| Parameter check and filter change | October 2015 | 22 October 2015 | All parameters within acceptance limits |
| Six monthly maintenance including filter change | November 2015 | 7 December 2015 | All parameters and calibrations within acceptance limits |
| Parameter check and filter change | December 2015 | 7 January 2016 | All parameters within acceptance limits |
| Parameter check and filter change | January 2016 | 25 January 2016 | All parameters within acceptance limits |
| Quarterly maintenance including filter change | February 2016 | 3 March 2016 | All parameters and calibrations within acceptance limits |
| Parameter check and filter change | March 2015 | 4 April 2016 | All parameters within acceptance limits |
| Parameter check and filter change | April 2016 | 5 May 2016 | All parameters within acceptance limits |
| Annual maintenance including filter change | May 2016 | 2-10 June 2016 | All parameters and calibrations within acceptance limits |

## 5.2 Data capture

### 5.2.1 Data capture during the year commencing June 2015

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 12**. Periods and causes of data loss during the year commencing June 2015, other than routine maintenance and calibration, are detailed in **Table 13**.

**Table 12 Data capture during the annual reporting period June 2015 to May 2016**

| Parameter | Monitoring start date | Monitoring end date | Data availability | Corrected data capture |
|---|---|---|---|---|
| CO | 1 June 2015 | Ongoing | 91 % | 99 % |
| $NO_2$ | 1 June 2015 | Ongoing | 91 % | 100 % |
| $O_3$ | 1 June 2015 | Ongoing | 94 % | 100 % |
| $PM_{2.5}$ | 1 June 2015 | Ongoing | 96 % | 97 % |
| $PM_{10}$ | 1 June 2015 | Ongoing | 99 % | 100 % |
| $SO_2$ | 1 June 2015 | Ongoing | 92 % | 100 % |
| **Average of all collected monitoring data** | | | **94 %** | **99 %** |
| **Benchmark** | | | **75 %** | **90 %** |
| **Benchmark met or exceeded** | | | **Achieved** | **Achieved** |

**Table 13 Causes of data loss during the annual reporting period June 2015 to May 2016**

| Parameter | Start of data loss | End of data loss | Cause |
|---|---|---|---|
| $PM_{2.5}$, $PM_{10}$ | 3/06/2015 | 4/06/2015 | Routine zero noise test as required by standard. |
| All parameters | 9/06/2015 12:00 | 9/06/2015 17:00 | Routine annual calibrations as required by standard. |
| CO | 9/06/2015 12:00 | 12/06/2015 17:00 | Failed internal pump. Replaced with external unit. |
| $NO_2$ | 31/07/2015 10:00 | 6/08/2015 16:00 | Routine annual maintenance (by external agent) and calibrations as required by standard. |
| $PM_{2.5}$ | 3/10/2015 | 12/10/2015 | Instrument internal fault. Rectified on 12/10/2015, and has not reoccurred. |

## 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 0.268 ppm recorded on 20 May 2016 at 02:00.

Results of the 8 hour rolling average concentration dataset are summarised in **Table 14**. A graphical presentation of concentrations over the current reporting period is presented in **Appendix A** as **Figure 3**, **Figure 4**, **Figure 5** and **Figure 6**, presenting concentration data for winter, spring, summer and autumn respectively.

**Table 14 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 2015 | -0.067 ppm | 0.163 ppm | 0 |
| | July 2015 | 0.019 ppm | 0.165 ppm | 0 |
| | August 2015 | 0.045 ppm | 0.221 ppm | 0 |
| **Seasonal results** | | **-0.001 ppm** | **0.221 ppm** | **0** |
| Spring | September 2015 | -0.013 ppm | 0.085 ppm | 0 |
| | October 2015 | 0.001 ppm | 0.121 ppm | 0 |
| | November 2015 | -0.001 ppm | 0.101 ppm | 0 |
| **Seasonal results** | | **-0.004 ppm** | **0.121 ppm** | **0** |
| Summer | December 2015 | -0.088 ppm | -0.008 ppm | 0 |
| | January 2016 | -0.026 ppm | 0.093 ppm | 0 |
| | February 2016 | -0.009 ppm | 0.074 ppm | 0 |
| **Seasonal Results** | | **-0.042 ppm** | **0.093 ppm** | **0** |
| Autumn | March 2016 | -0.019 ppm | 0.049 ppm | 0 |
| | April 2016 | 0.010 ppm | 0.078 ppm | 0 |
| | May 2016 | 0.102 ppm | 0.268 ppm | 0 |
| **Seasonal results** | | **0.031 ppm** | **0.268 ppm** | **0** |
| **Annual results** | | **-0.003 ppm** | **0.268 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 3** to **Figure 6** in **Appendix A**, CO concentrations do not appear to be proportionally related to ASH movements.

## 5.4 Nitrogen dioxide ($NO_2$) results

Nitrogen dioxide concentrations remained in the "Very Good" range throughout the annual reporting period. The highest recorded 1 hour average concentration was 39.3 ppm recorded on 19 May 2016 at 23:00.

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 7**, **Figure 8**, **Figure 9** and **Figure 10**.

**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 2015 | 5.5 ppb | 26.9 ppb | 0 |
| | July 2015 | 6.0 ppb | 32.6 ppb | 0 |
| | August 2015 | 7.6 ppb | 32.7 ppb | 0 |
| **Seasonal results** | | **6.3 ppb** | **32.7 ppb** | **0** |
| Spring | September 2015 | 5.7 ppb | 25.7 ppb | 0 |
| | October 2015 | 4.8 ppb | 29.4 ppb | 0 |
| | November 2015 | 4.0 ppb | 16.5 ppb | 0 |
| **Seasonal results** | | **4.8 ppb** | **29.4 ppb** | **0** |
| Summer | December 2015 | 3.0 ppb | 16.5 ppb | 0 |
| | January 2016 | 3.1 ppb | 15.0 ppb | 0 |
| | February 2016 | 2.9 ppb | 18.7 ppb | 0 |
| **Seasonal Results** | | **3.0 ppb** | **18.7 ppb** | **0** |
| Autumn | March 2016 | 3.5 ppb | 15.6 ppb | 0 |
| | April 2016 | 4.5 ppb | 20.4 ppb | 0 |
| | May 2016 | 8.1 ppb | 39.3 ppb | 0 |
| **Seasonal results** | | **5.4 ppb** | **39.3 ppb** | **0** |
| **Annual results** | | **4.8 ppb** | **39.3 ppb** | **0** |

**Table 16 Nitrogen Dioxide results – annual average concentration**

| Average period | Cumulative average concentration | EPP (Air) annual objective | Result |
|---|---|---|---|
| June 2015 to May 2016 | 4.8 ppb | 30 ppb | Not exceeded |

### 5.4.1 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 break in ASH flying activity during the late December 2015 to early January 2016 period or during February 2016, as during the rest of the monitoring period. However, during a period of low reported ASH flying operations during June 2015 there was no reduction in nitrogen dioxide concentrations as illustrated in **Figure 7** in **Appendix A**. These results suggest the driving factor for nitrogen dioxide concentrations is not ASH flying operations, and other base activities may be contributing to the nitrogen dioxide results.

## 5.5 Ozone ($O_3$) results

Ozone concentrations varied from “Very Good” to “Fair” 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 85.1 ppb recorded on 20 November 2015 at 14:00.

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 11**, **Figure 12**, **Figure 13** and **Figure 14**.

**Table 17 Ozone results – 1 hour average**

| Season | Month | Average concentration | Maximum measured sample concentration | Number of exceedances of objective (100 ppb) |
|---|---|---|---|---|
| Winter | June 2015 | 16.0 ppb | 38.0 ppb | 0 |
| | July 2015 | 18.6 ppb | 38.8 ppb | 0 |
| | August 2015 | 20.7 ppb | 54.9 ppb | 0 |
| **Seasonal results** | | **18.4 ppb** | **54.9 ppb** | **0** |
| Spring | September 2015 | 24.1 ppb | 52.6 ppb | 0 |
| | October 2015 | 27.4 ppb | 79.1 ppb | 0 |
| | November 2015 | 25.0 ppb | 85.1 ppb | 0 |
| **Seasonal results** | | **25.5 ppb** | **85.1 ppb** | **0** |
| Summer | December 2015 | 18.7 ppb | 70.4 ppb | 0 |
| | January 2016 | 20.6 ppb | 79.9 ppb | 0 |
| | February 2016 | 17.2 ppb | 84.9 ppb | 0 |
| **Seasonal Results** | | **18.9 ppb** | **84.9 ppb** | **0** |
| Autumn | March 2016 | 16.6 ppb | 56.4 ppb | 0 |
| | April 2016 | 20.5 ppb | 57.9 ppb | 0 |
| | May 2016 | 19.0 ppb | 58.3 ppb | 0 |
| **Seasonal results** | | **18.7 ppb** | **58.3 ppb** | **0** |
| **Annual results** | | **20.4 ppb** | **85.1 ppb** | **0** |

**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 2015 | 16.1 ppb | 34.6 ppb | 0 |
| | July 2015 | 18.9 ppb | 36.7 ppb | 0 |
| | August 2015 | 21.0 ppb | 47.0 ppb | 0 |
| **Seasonal results** | | **18.6 ppb** | **47.0 ppb** | **0** |
| Spring | September 2015 | 23.8 ppb | 48.8 ppb | 0 |
| | October 2015 | 26.9 ppb | 67.5 ppb | 0 |
| | November 2015 | 24.6 ppb | 70.9 ppb | 0 |
| **Seasonal results** | | **25.1 ppb** | **70.9 ppb** | **0** |
| Summer | December 2015 | 18.4 ppb | 61.6 ppb | 0 |
| | January 2016 | 20.2 ppb | 70.1 ppb | 0 |
| | February 2016 | 17.1 ppb | 66.8 ppb | 0 |
| **Seasonal Results** | | **18.6 ppb** | **70.1 ppb** | **0** |
| Autumn | March 2016 | 16.2 ppb | 48.0 ppb | 0 |
| | April 2016 | 20.3 ppb | 54.7 ppb | 0 |
| | May 2016 | 18.6 ppb | 51.0 ppb | 0 |
| **Seasonal results** | | **18.3 ppb** | **54.7 ppb** | **0** |
| **Annual results** | | **20.2 ppb** | **70.9 ppb** | **0** |

### 5.5.1 Comparison of ozone results with ASH movements

Results of ozone monitoring do not show a direct relationship to ASH movements. As illustrated in **Figure 11** and **Figure 13** in **Appendix A**, ozone concentrations continue a diurnal pattern of unchanged magnitude in the absence of ASH movement activity.

## 5.6 Suspended Particulate – $PM_{2.5}$ results

Suspended particulate – $PM_{2.5}$ concentrations ranged from "Very Good" to "Good" throughout the reporting period. The highest recorded 24 hour $PM_{2.5}$ concentration was 16.2 µg/m³ recorded on 8 August 2015.

Results of the 24 hour average dataset are summarised in **Table 19**, and the annual average for the current reporting year is presented in **Table 20**. A graphical presentation of concentrations over the current reporting period is presented in **Appendix A** as **Figure 15**.

**Table 19 $PM_{2.5}$ results – 24 hour average concentration**

| Season | Month | Average concentration | Maximum measured sample concentration | Number of exceedances of objective (25 µg/m³) |
|---|---|---|---|---|
| Winter | June 2015 | 3.0 µg/m³ | 5.0 µg/m³ | 0 |
| | July 2015 | 4.9 µg/m³ | 14.8 µg/m³ | 0 |
| | August 2015 | 7.0 µg/m³ | 16.2 µg/m³ | 0 |
| **Seasonal results** | | **5.0 µg/m³** | **16.2 µg/m³** | **0** |
| Spring | September 2015 | 5.1 µg/m³ | 11.7 µg/m³ | 0 |
| | October 2015 | 5.7 µg/m³ | 7.6 µg/m³ | 0 |
| | November 2015 | 6.7 µg/m³ | 15.0 µg/m³ | 0 |
| **Seasonal results** | | **5.8 µg/m³** | **15.0 µg/m³** | **0** |
| Summer | December 2015 | 5.5 µg/m³ | 8.2 µg/m³ | 0 |
| | January 2016 | 5.0 µg/m³ | 11.2 µg/m³ | 0 |
| | February 2016 | 5.0 µg/m³ | 8.9 µg/m³ | 0 |
| **Seasonal results** | | **5.1 µg/m³** | **11.2 µg/m³** | **0** |
| Autumn | March 2016 | 4.7 µg/m³ | 6.5 µg/m³ | 0 |
| | April 2016 | 5.4 µg/m³ | 9.2 µg/m³ | 0 |
| | May 2016 | 6.4 µg/m³ | 13.5 µg/m³ | 0 |
| **Seasonal results** | | **5.5 µg/m³** | **13.5 µg/m³** | **0** |
| **Annual results** | | **5.4 µg/m³** | **16.2 µg/m³** | **0** |

**Table 20 $PM_{2.5}$ results – annual average concentration**

| Average period | Cumulative average concentration | EPP (Air) annual objective | Result |
|---|---|---|---|
| June 2015 to May 2016 | 5.4 µg/m³ | 8 µg/m³ | Not exceeded |

### 5.6.1 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 15** in **Appendix A**, $PM_{2.5}$ concentrations do not appear to be proportionally related to ASH movements, with the highest recorded $PM_{2.5}$ concentration not coinciding with the days having the greatest number of ASH movements.

## 5.7 Suspended Particulate – $PM_{10}$ results

Suspended particulate – $PM_{10}$ concentrations ranged from "Very Good" to "Good" throughout the reporting period. The highest recorded 24 hour $PM_{10}$ concentration was 24.9 µg/m³ recorded on 27 November 2015.

Results of the 24 hour average dataset are summarised in **Table 21**. A graphical presentation of concentrations over the current reporting period is presented in **Appendix A** as **Figure 16**.

**Table 21 $PM_{10}$ results – 24 hour average concentration**

| Season | Month | Average concentration | Maximum measured sample concentration | Number of exceedances of objective (50 µg/m³) |
|---|---|---|---|---|
| Winter | June 2015 | 6.4 µg/m³ | 11.0 µg/m³ | 0 |
| | July 2015 | 8.5 µg/m³ | 23.3 µg/m³ | 0 |
| | August 2015 | 11.6 µg/m³ | 22.6 µg/m³ | 0 |
| **Seasonal results** | | **8.9 µg/m³** | **23.3 µg/m³** | **0** |
| Spring | September 2015 | 8.9 µg/m³ | 19.1 µg/m³ | 0 |
| | October 2015 | 10.1 µg/m³ | 17.0 µg/m³ | 0 |
| | November 2015 | 11.5 µg/m³ | 24.9 µg/m³ | 0 |
| **Seasonal results** | | **10.2 µg/m³** | **24.9 µg/m³** | **0** |
| Summer | December 2015 | 10.1 µg/m³ | 17.1 µg/m³ | 0 |
| | January 2016 | 9.3 µg/m³ | 17.0 µg/m³ | 0 |
| | February 2016 | 9.6 µg/m³ | 15.4 µg/m³ | 0 |
| **Seasonal results** | | **9.7 µg/m³** | **17.1 µg/m³** | **0** |
| Autumn | March 2016 | 8.7 µg/m³ | 12.9 µg/m³ | 0 |
| | April 2016 | 10.7 µg/m³ | 18.2 µg/m³ | 0 |
| | May 2016 | 12.0 µg/m³ | 23.4 µg/m³ | 0 |
| **Seasonal results** | | **10.5 µg/m³** | **23.4 µg/m³** | **0** |
| **Annual results** | | **9.8 µg/m³** | **24.9 µg/m³** | **0** |

### 5.7.1 Comparison of $PM_{10}$ results with ASH movements

Results of $PM_{10}$ monitoring do not show a direct relationship to ASH movements. As illustrated in **Figure 16** in **Appendix A**, $PM_{10}$ concentrations do not appear to be proportionally related to ASH movements, with the highest recorded $PM_{10}$ concentration not coinciding with the days having the greatest number of ASH movements.

## 5.8 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 3.9 ppb recorded on 16 May 2016 at 17:00.

Results of the 1 hour average dataset are summarised in **Table 22** and results of the 24 hour average dataset are summarised in **Table 23**. The annual average for the current reporting year is presented in **Table 24**. A graphical presentation of 1 hour average concentrations over the current reporting period is presented by season in **Appendix A** as **Figure 17**, **Figure 18**, **Figure 19** and **Figure 20**.

**Table 22 Sulfur Dioxide results – 1 hour average concentration**

| Season | Month | Average concentration | Maximum measured sample concentration | Number of exceedances of objective (200 ppb) |
|---|---|---|---|---|
| Winter | June 2015 | 0.2 ppb | 1.7 ppb | 0 |
| | July 2015 | 0.2 ppb | 1.7 ppb | 0 |
| | August 2015 | 0.6 ppb | 2.5 ppb | 0 |
| **Seasonal results** | | **0.3 ppb** | **1.7 ppb** | **0** |
| Spring | September 2015 | 0.7 ppb | 2.8 ppb | 0 |
| | October 2015 | 0.6 ppb | 2.3 ppb | 0 |
| | November 2015 | 0.4 ppb | 2.4 ppb | 0 |
| **Seasonal results** | | **0.5 ppb** | **2.8 ppb** | **0** |
| Summer | December 2015 | 0.4 ppb | 1.9 ppb | 0 |
| | January 2016 | 0.5 ppb | 2.3 ppb | 0 |
| | February 2016 | 0.8 ppb | 3.1 ppb | 0 |
| **Seasonal results** | | **0.6 ppb** | **3.1 ppb** | **0** |
| Autumn | March 2016 | 0.7 ppb | 1.9 ppb | 0 |
| | April 2016 | 0.4 ppb | 2.9 ppb | 0 |
| | May 2016 | 0.6 ppb | 3.9 ppb | 0 |
| **Seasonal results** | | **0.6 ppb** | **3.9 ppb** | **0** |
| **Annual results** | | **0.5 ppb** | **3.9 ppb** | **0** |

**Table 23 Sulfur Dioxide results – 24 hour average concentration**

| Season | Month | Average concentration | Maximum measured sample concentration | Number of exceedances of objective (80 ppb) |
|---|---|---|---|---|
| Winter | June 2015 | 0.2 ppb | 1.2 ppb | 0 |
| | July 2015 | 0.2 ppb | 0.8 ppb | 0 |
| | August 2015 | 0.6 ppb | 1.1 ppb | 0 |
| **Seasonal results** | | **0.3 ppb** | **1.2 ppb** | **0** |
| Spring | September 2015 | 0.7 ppb | 1.1 ppb | 0 |
| | October 2015 | 0.6 ppb | 1.1 ppb | 0 |
| | November 2015 | 0.4 ppb | 0.9 ppb | 0 |
| **Seasonal results** | | **0.5 ppb** | **1.1 ppb** | **0** |
| Summer | December 2015 | 0.4 ppb | 0.7 ppb | 0 |
| | January 2016 | 0.5 ppb | 1.2 ppb | 0 |
| | February 2016 | 0.8 ppb | 1.4 ppb | 0 |
| **Seasonal results** | | **0.6 ppb** | **1.4 ppb** | **0** |
| Autumn | March 2016 | 0.7 ppb | 1.2 ppb | 0 |
| | April 2016 | 0.4 ppb | 1.0 ppb | 0 |
| | May 2016 | 0.6 ppb | 1.4 ppb | 0 |
| **Seasonal results** | | **0.6 ppb** | **1.4 ppb** | **0** |
| **Annual results** | | **0.5 ppb** | **1.4 ppb** | **0** |

**Table 24 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 |

### 5.8.1 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 17** to **Figure 20** in **Appendix A**, variance in sulfur dioxide concentrations continue despite the lack of any ASH movements.

# 6.0 Annual Findings

## 6.1 Comparison of monitoring data to EPP (Air) objectives

There were **no reportable exceedances** of the EPP (Air) air quality objectives.

## 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. Scaling the graphical figures to display resolution of this magnitude (Y axis being 50% of the EPP(Air) CO objective) shows normal instrument baseline drift and subsequent calibration adjustments to be the major contributor to variance in the readings over the period.

The Air Quality monitoring station is located approximately 10 m from a car park. There is insufficient information available to determine whether the proximity to the carpark has contributed to carbon monoxide concentrations during the monitoring period; however it is noted that the station location 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 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 5.4.1**, 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.

### 6.2.3 Ozone trends

Ozone showed a typically diurnal pattern during the annual monitoring period. The average one hour and rolling four hour peak ozone concentration tended to be lower during the winter months compared to the spring and summer months, as expected.

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

Average $PM_{2.5}$ and $PM_{10}$ concentrations were notably consistent throughout the monitoring period, with the highest maximum 24-hour concentrations occurring in late winter and early spring.

### 6.2.5 Sulfur dioxide trends

The highest sulfur dioxide one hour average reading during the monitoring period was 3.9 ppb, which is approximately 2 % of the EPP(Air) objective of 200 ppb. The compression in the scale of the graphs presented in **Appendix A** makes these relatively small variations in concentration appear more significant than they actually are, relative to both the instrument full scale range and the EPP(Air) objective for sulfur dioxide.

Like carbon monoxide, normal baseline drift and calibration adjustments cause dramatic changes in the graphs at the presented magnification.

## 6.3 Comparison to previous years

This section compares the current annual reporting period, June 2015 to May 2016 (referred to in this section as “Year 2”) to the previous annual reporting period (June 2014 to May 2015, “Year 1”).

### 6.3.1 Conditions during the annual periods

During Year 1 there were 5,833 aircraft movements reported at RAAF Base Amberley, of which 2,011 were ASH movements. During Year 2, there were 7,212 reported aircraft movements, of which 2,588 were ASH movements, an increase of 577 ASH movements in Year 2 compared to Year 1.

### 6.3.2 Comparison of monitoring data, Year 1 and Year 2

A comparison of maximum concentrations measured at the reportable monitoring period is presented below as **Table 25.** The Year 2 maximum measured concentrations were lower across all monitored parameters compared to Year 1.

**Table 25 Comparison of Year 1 and Year 2 maximum concentrations**

| Parameter | Period | Year 1 maximum concentration | Year 2 maximum concentration | EPP(Air) objective |
|---|---|---|---|---|
| CO | 8 hours | 1.985 ppm | 0.268 ppm | 9 ppm |
| $NO_2$ | 1 hour | 62.5 ppb | 39.3 ppb | 120 ppb |
| $O_3$ | 1 hour | 107.7 ppb [a] | 85.1 ppb | 100 ppb |
| $O_3$ | 4 hour | 81.3 ppb [a] | 70.9 ppb | 80 ppb |
| $PM_{2.5}$ | 24 hours | 20.5 µg/m³ | 16.2 µg/m³ | 25 µg/m³ |
| $PM_{10}$ | 24 hours | 32.5 µg/m³ | 24.9 µg/m³ | 50 µg/m³ |
| $SO_2$ | 1 hour | 5.1 ppb | 3.9 ppb | 200 ppb |
| $SO_2$ | 24 hours | 1.8 ppb | 1.4 ppb | 80 ppb |

[a] 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 26** compares annual average concentrations across monitored parameters. Year 2 concentrations were not significantly dissimilar to Year 1 concentrations, though there was an observed increase in both the $NO_2$ and $PM_{2.5}$ annual averages in Year 2 when compared to the annual objective.

**Table 26 Comparison of Year 1 and Year 2 average concentrations**

| Parameter | Year 1 annual average concentration | Year 2 annual average concentration | EPP (Air) annual objective |
|---|---|---|---|
| CO | -0.020 ppm | -0.003 ppm | *No annual objective* |
| $NO_2$ | 3.8 ppb | 4.8 ppb | 30 ppb |
| $O_3$ | 21.7 ppb | 20.4 ppb | *No annual objective* |
| $PM_{2.5}$ | 4.9 µg/m³ | 5.4 µg/m³ | 8 µg/m³ |
| $PM_{10}$ | 11.1 µg/m³ | 9.8 µg/m³ | *No annual objective* |
| $SO_2$ | 0.5 ppb | 0.5 ppb | 20 ppb |

In the Year 1 annual report, a weak correlation between ASH movements and $PM_{10}$ 24-hour average concentration was observed. This correlation is not seen in the Year 2 monitoring data. It is likely that the $PM_{10}$ 24-hour average results were being driven by regional factors not related to ASH activity.

# 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 2015 to 31 May 2016 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**

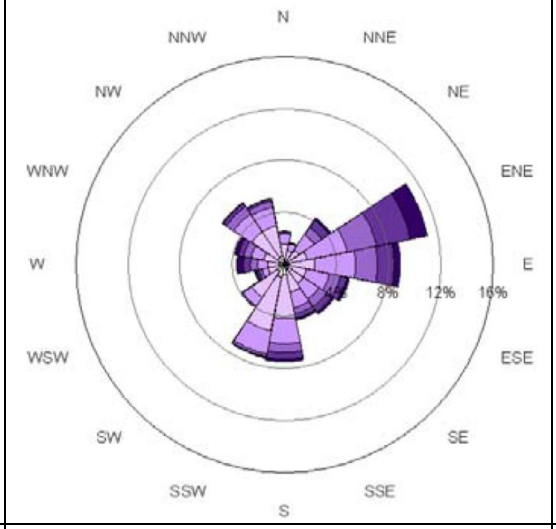
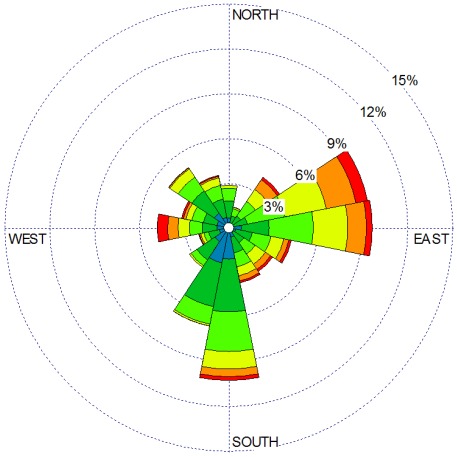
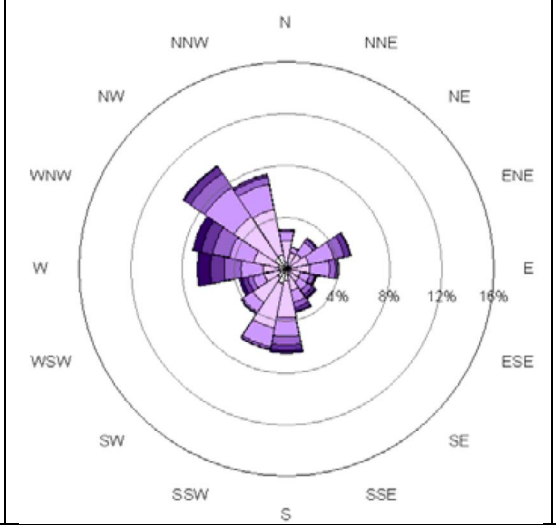
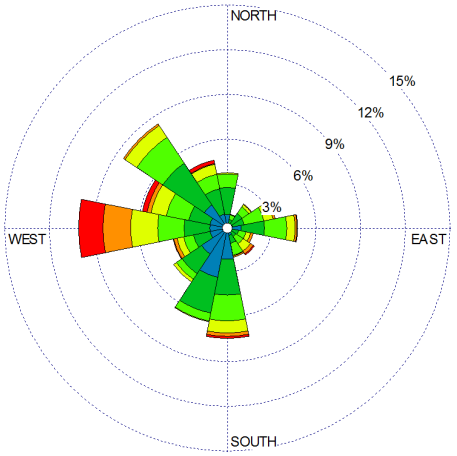
| Scenario | Modelled PER | Actual: June 2015 – May 2016 |
|---|---|---|
| Worst Case | *"The worst-case intensive hour for operations at RAAF Base Amberley is 14 aircraft taking-off in one hour, to occur anytime between 7 am and 12 pm" (PER, 2009)* | As discussed in **Section 4.2**, the largest number of ASH movements in a day was 27. The most intense hours saw eight ASH movements. |

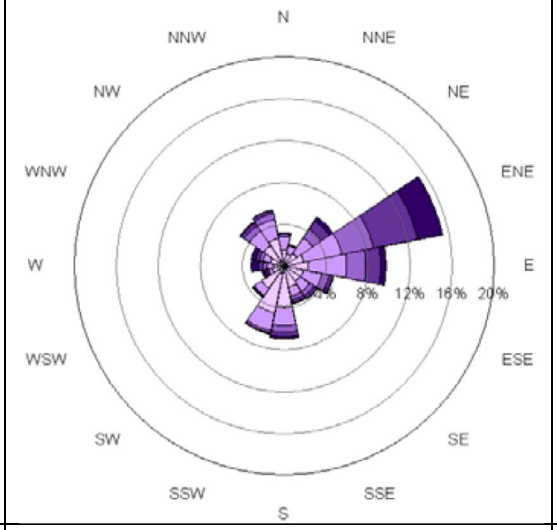
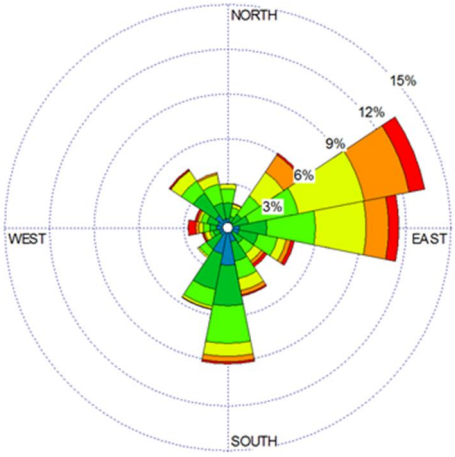
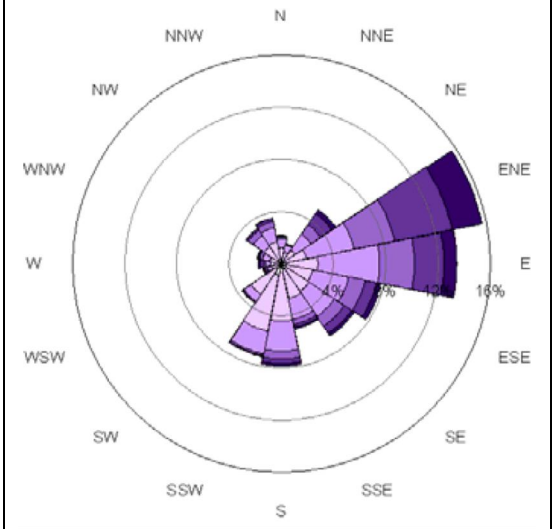
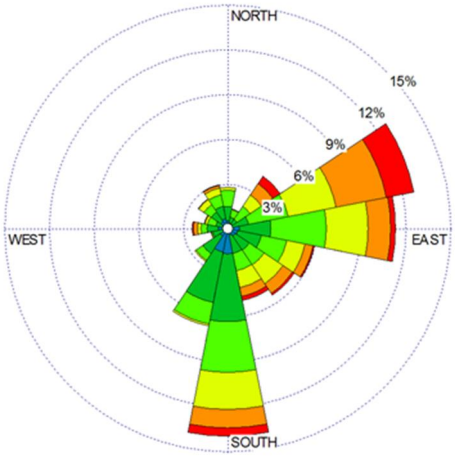
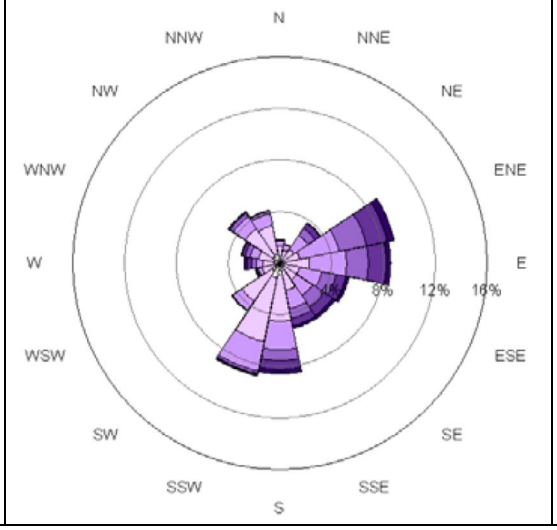
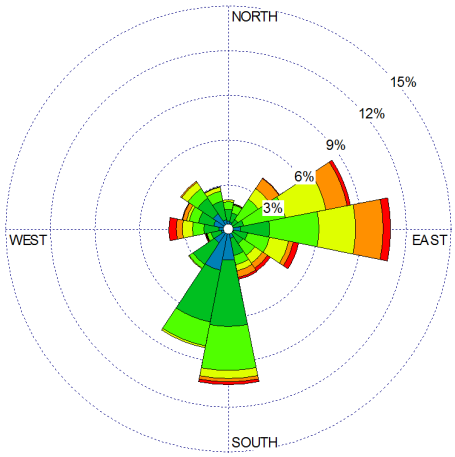
The modelled PER assumed a worst case of up to 14 ASH movements within an hour. During the monitoring period the most intensive hours of ASH movements involved only eight ASH movements consisting of both departures and arrivals. Therefore it is considered likely that modelled PER and monitoring period 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 2015 – May 2016 |
|---|---|---|
| Annual |  |  |
| Winter |  |  |

| | Modelled conditions in PER (Figure 8.3) | Amberley AMO: June 2015 – May 2016 |
|---|---|---|
| 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%, with a total combined contribution of approximately 19% from the east-northeast and east directions 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, while **Table 30** and **Table 31** present results from the busiest days in the reporting period for comparison against the PER predictions.

**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 | -0.003 ppm | 0.268 ppm | 9 ppm |
| $NO_2$ | 1 hr | 18.5 ppb | 47.7 ppb | 4.8 ppb | 39.3 ppb | 120 ppb |
| $PM_{10}$ | 24 hr | 3.0 µg/m³ | 43.0 µg/m³ | 9.8 µg/m³ | 24.9 µg/m³ | 50 µg/m³ |
| $SO_2$ | 1 hr | 1.4 ppb | 14.3 ppb | 0.5 ppb | 3.9 ppb | 200 ppb |

**Table 30 Comparison of PER Modelled vs Actual: Hourly Pollutant Concentrations during Hours of Highest Activity**

| Observation/Prediction | ASH Movements | $NO_2$ Concentration | $SO_2$ Concentration |
|---|---|---|---|
| 18/08/2015 11:00 | 8 | 5.8 ppb | 0.7 ppb |
| 17/11/2015 15:00 | 8 | 2.9 ppb | 0.5 ppb |
| Modelled PER (cumulative) | 14 | 47.7 ppb | 14.3 ppb |
| EPP(Air) Objective | *n/a* | 120 ppb | 200 ppb |

**Table 31 Comparison of PER Modelled vs Actual: Daily Pollutant Concentrations on Days of Highest Activity**

| Observation/Prediction | ASH Movements *(total for day)* | CO Concentration *(max 8-hour average during 24-hour period)* | $PM_{10}$ Concentration *(24-hour average)* |
|---|---|---|---|
| 4/08/2015 | 26 | 0.059 ppm | 11.5 µg/m³ |
| 5/08/2015 | 26 | 0.058 ppm | 8.2 µg/m³ |
| 3/05/2016 | 27 | 0.032 ppm | 6.8 µg/m³ |
| Modelled PER (cumulative) | 14 max in one hour | 4.08 ppm | 43.0 µg/m³ |
| EPP(Air) Objective | *n/a* | 9 ppm | 50 µg/m³ |

As discussed in **Section 7.1**, the modelled PER and monitoring period pollutant concentrations is not directly comparable due to difference  PER modelled ASH movements compared to actual ASH movements during the monitoring period. 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.
- Average $NO_2$ monitoring results for the monitoring period are below the PER modelled concentrations.
- 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.
- Measured concentrations on the days of highest ASH movement activity are below the PER modelled concentrations for CO, $NO_2$, $SO_2$ and $PM_{10}$.
- There appears to be no correlation between the number of ASH movements and the air quality monitoring results measured during periods of elevated activity in the reporting period. However, ASH activity did not approach levels assumed by the modelling conducted for the PER.

# 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 2015 and finishing 31 May 2016 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.

# Appendix A

## Graphical Results Presentation

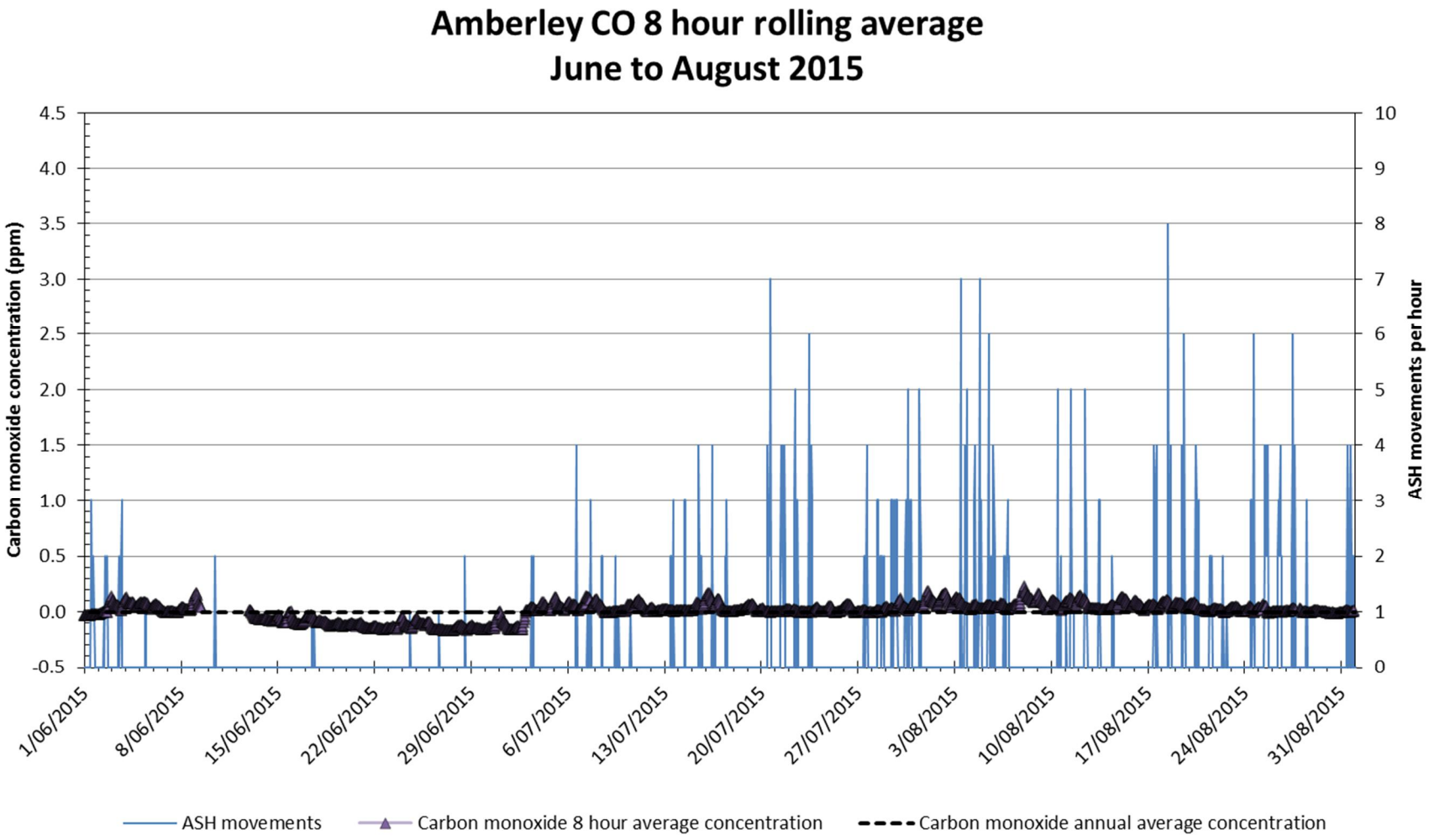



**Figure 3 Carbon Monoxide results, June to August 2015**

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

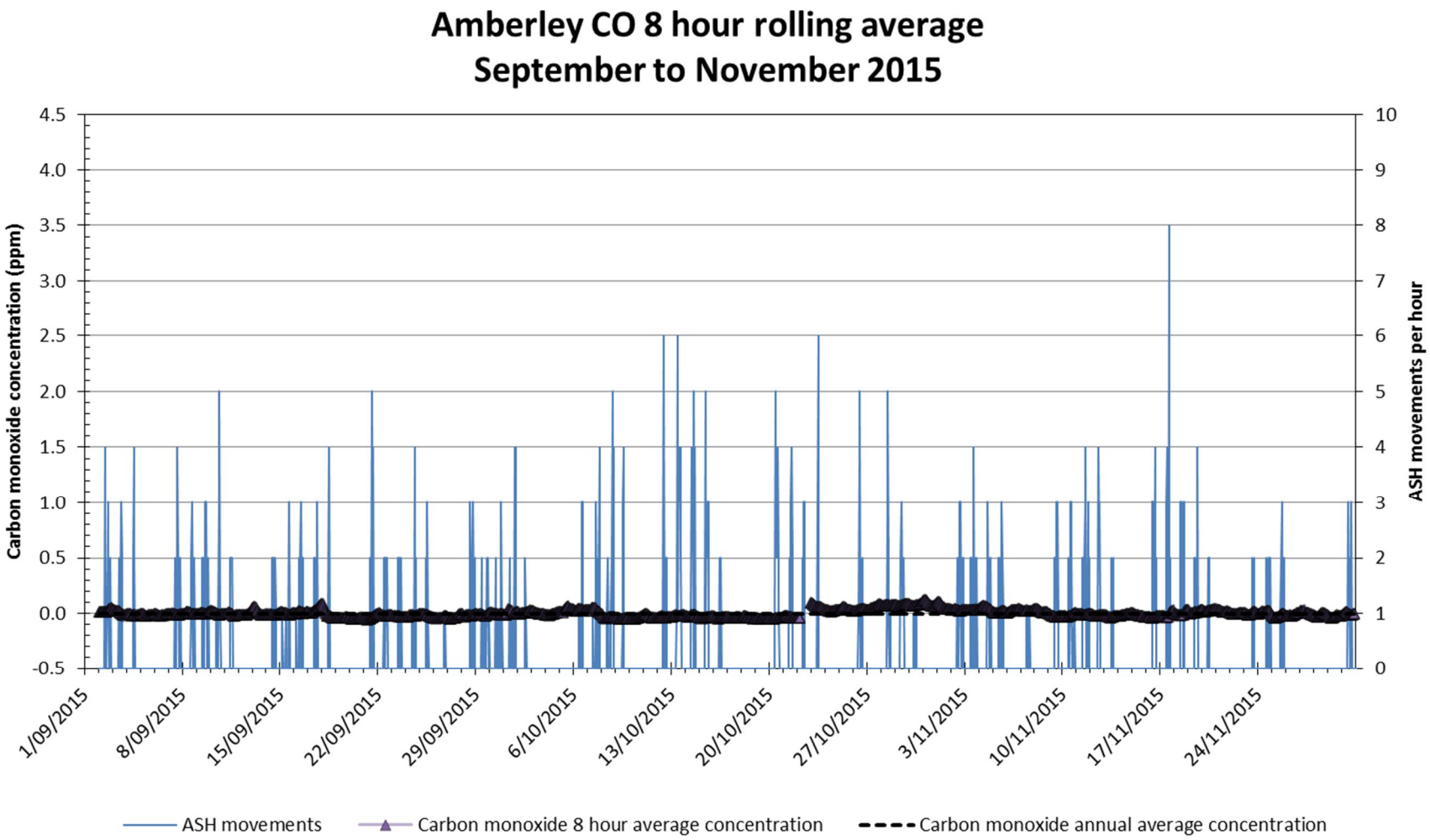



**Figure 4 Carbon Monoxide results, September to November 2015**

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

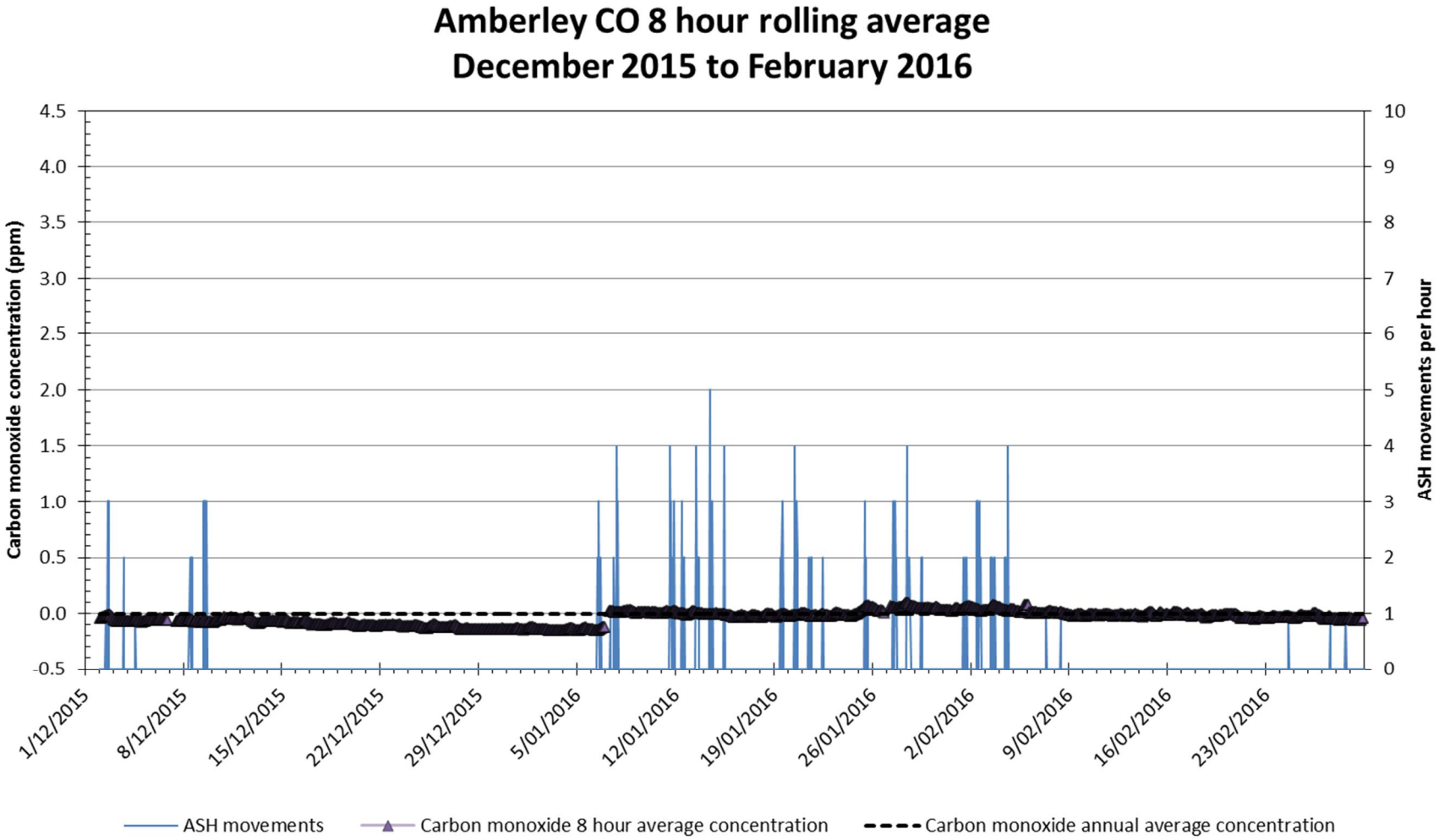



**Figure 5 Carbon Monoxide results, December 2015 to February 2016**

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

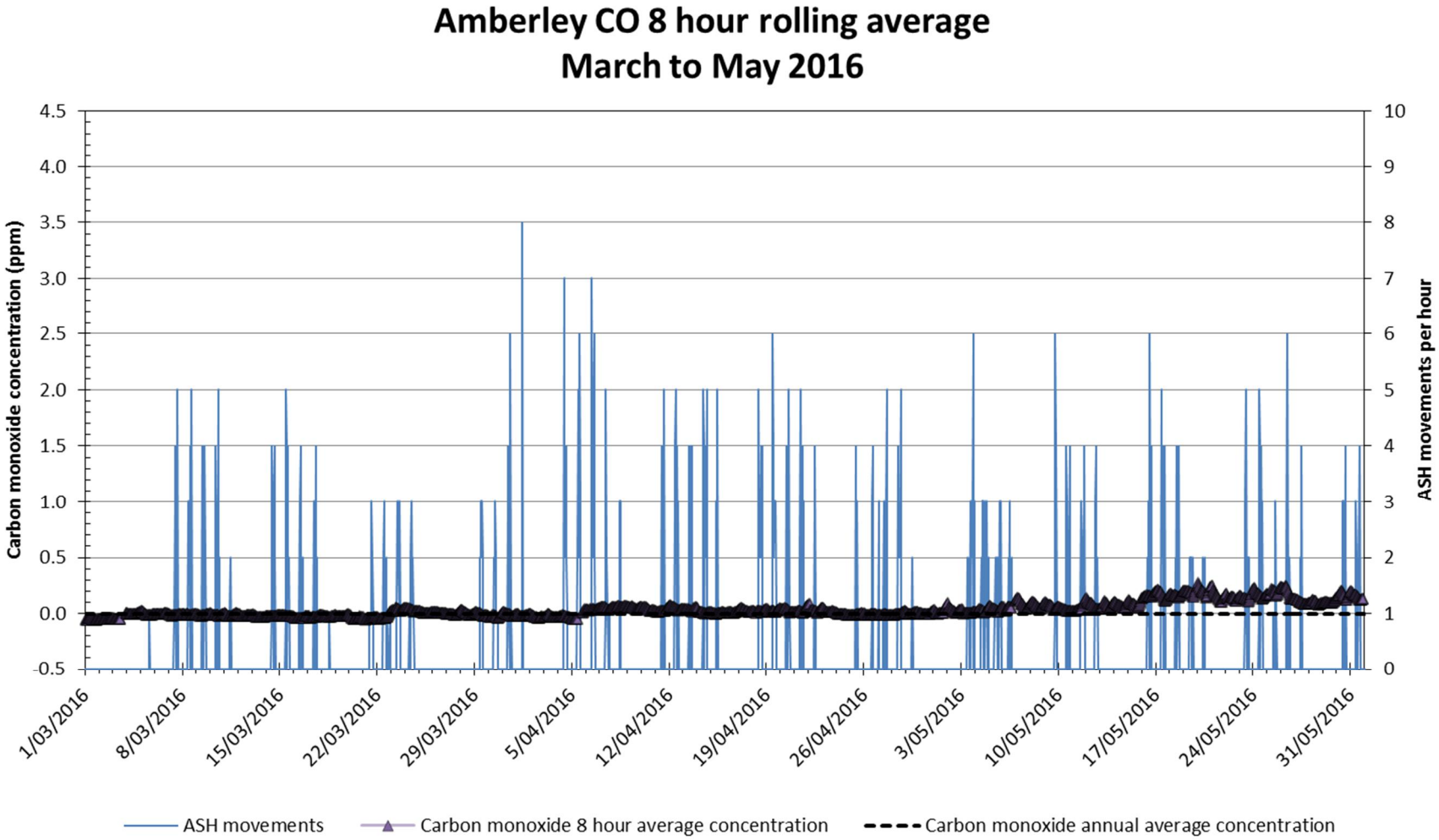



**Figure 6 Carbon Monoxide results, March to May 2016**

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

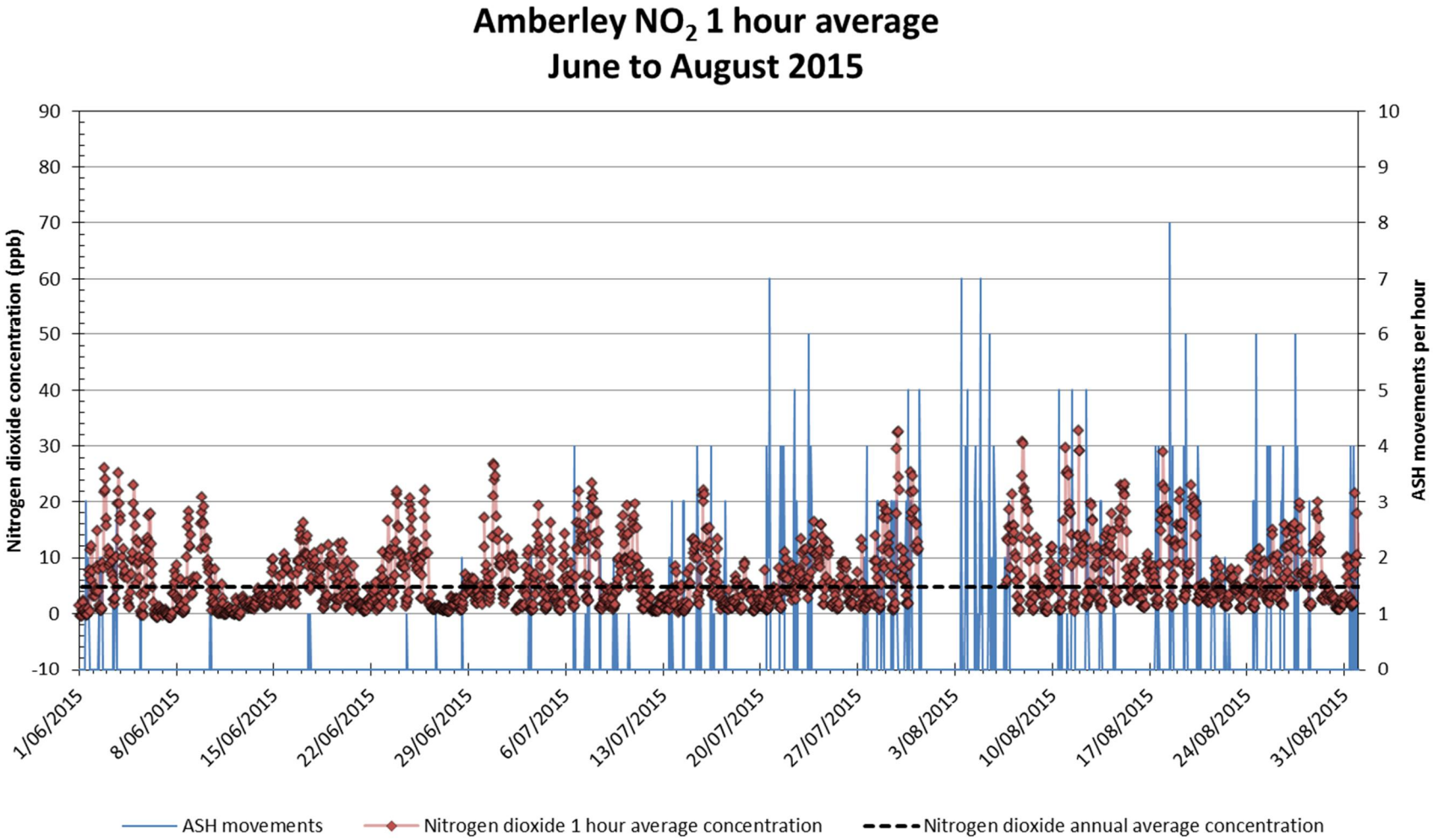



**Figure 7 Nitrogen Dioxide results, June to August 2015**

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

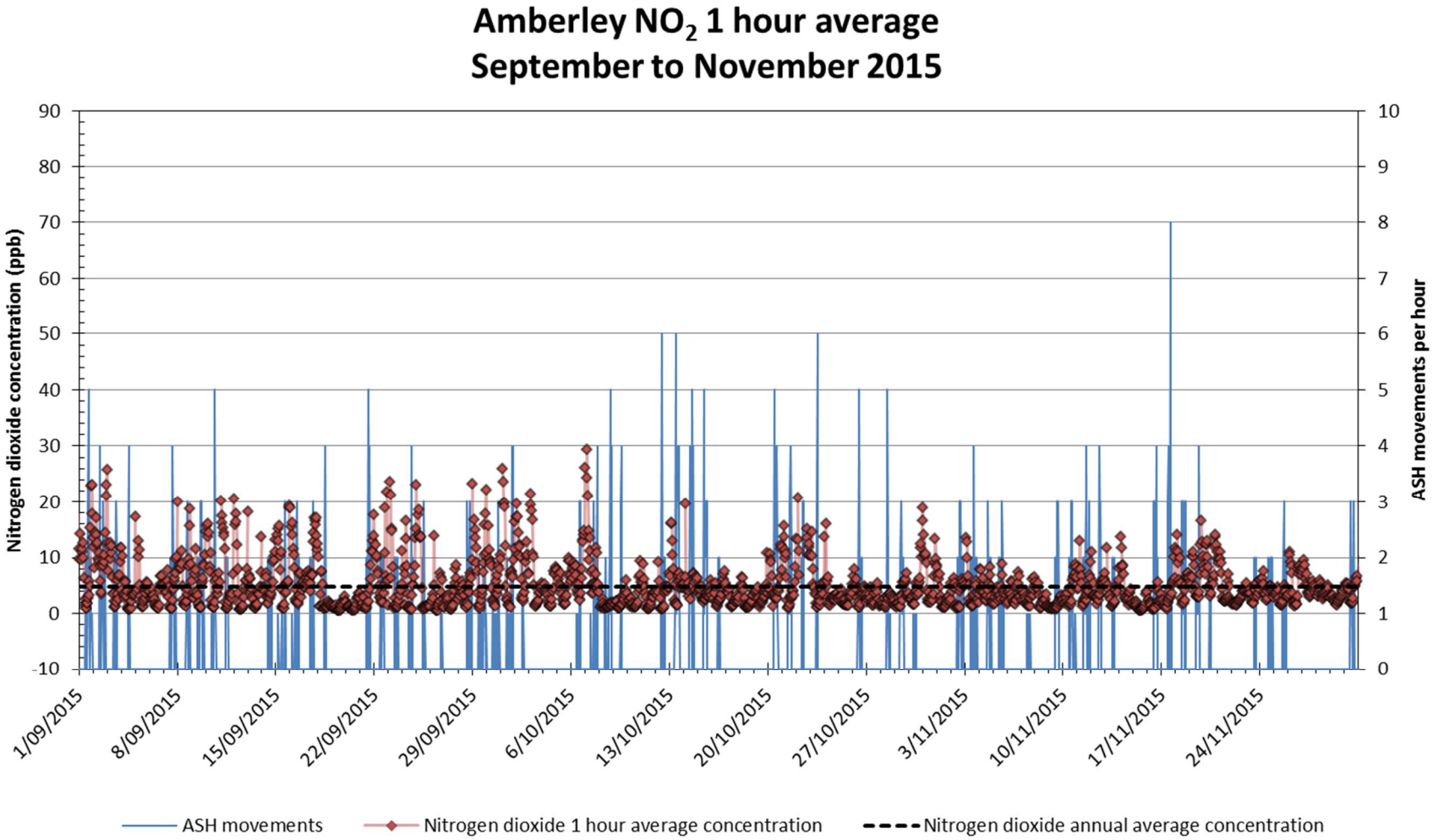



**Figure 8 Nitrogen Dioxide results, September to November 2015**

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

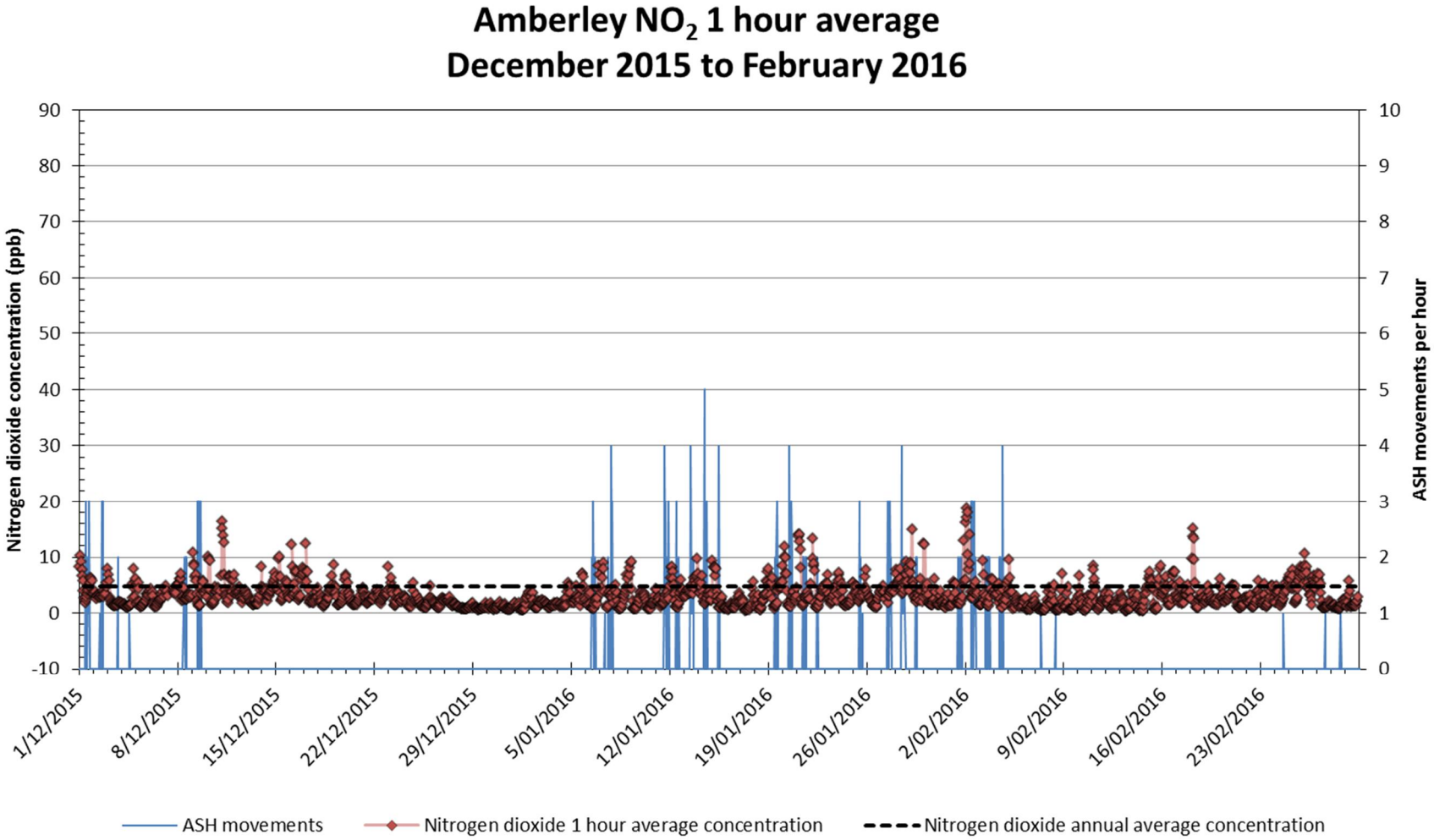



**Figure 9 Nitrogen Dioxide results, December 2015 to February 2016**

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

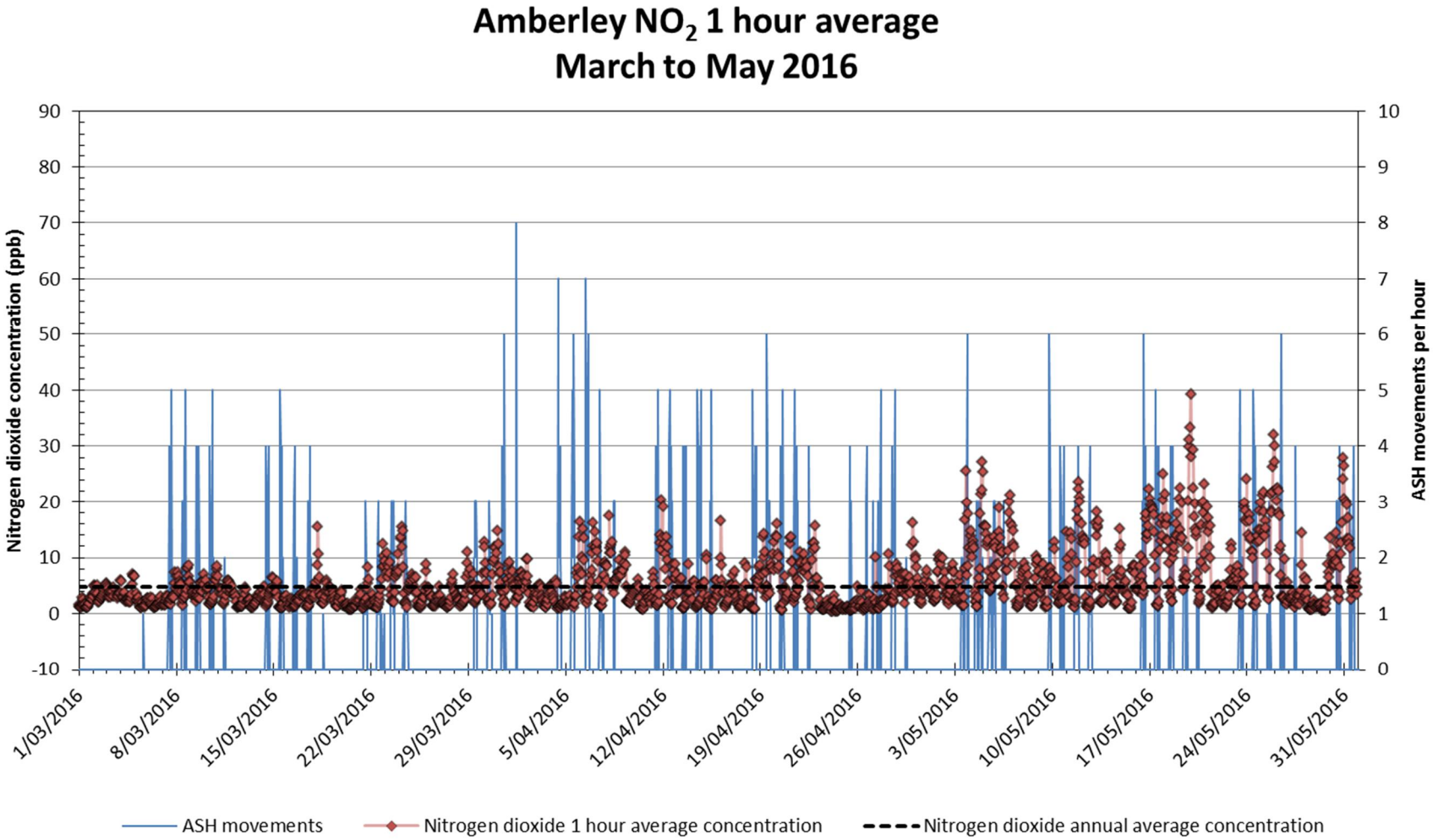



**Figure 10 Nitrogen Dioxide results, March to May 2016**

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

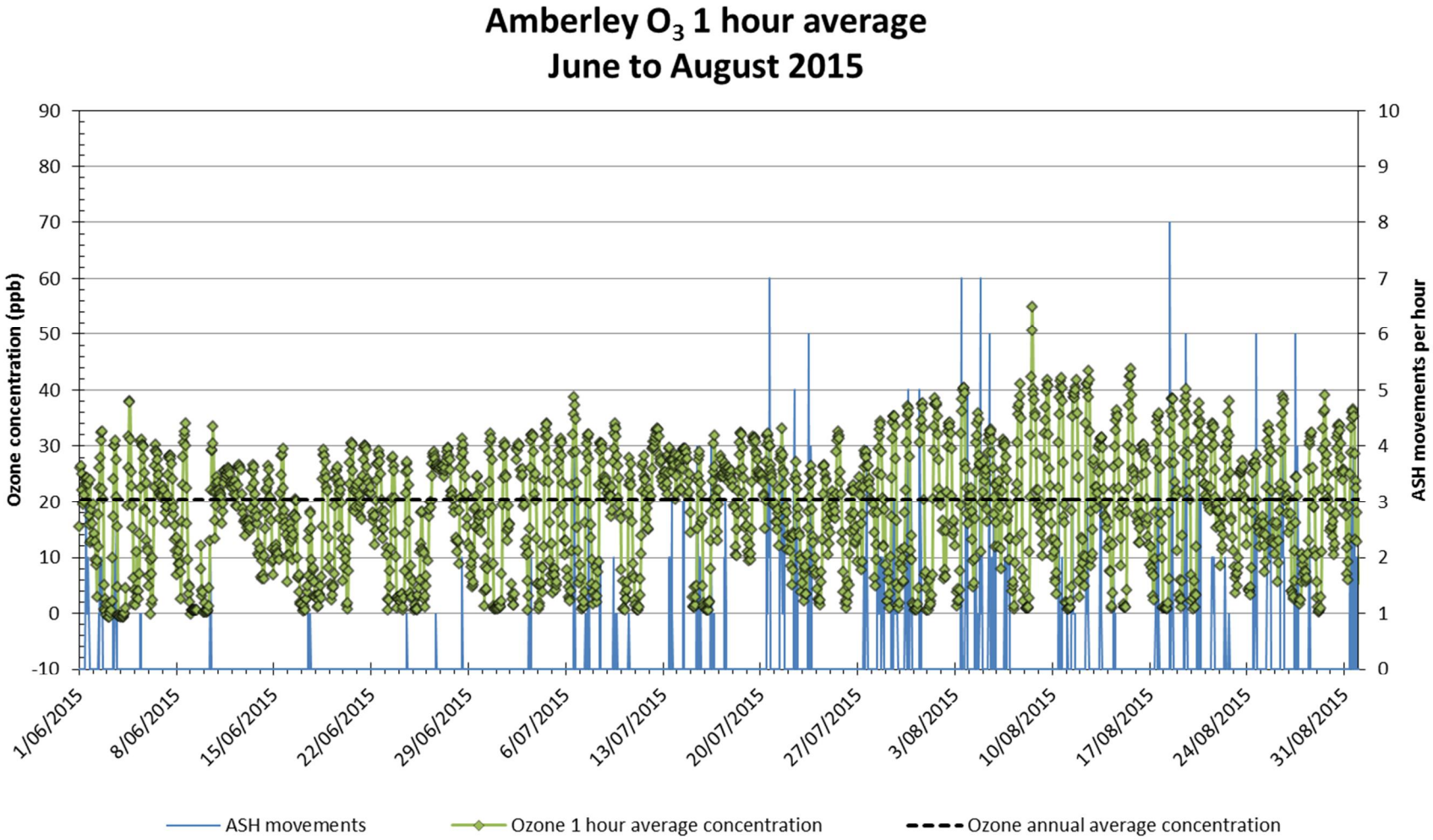



**Figure 11 Ozone results, June to August 2015**

*Note: The EPP (Air) objective of 100 ppb $O_3$ (1 hour average concentration) is not shown on the graph.*

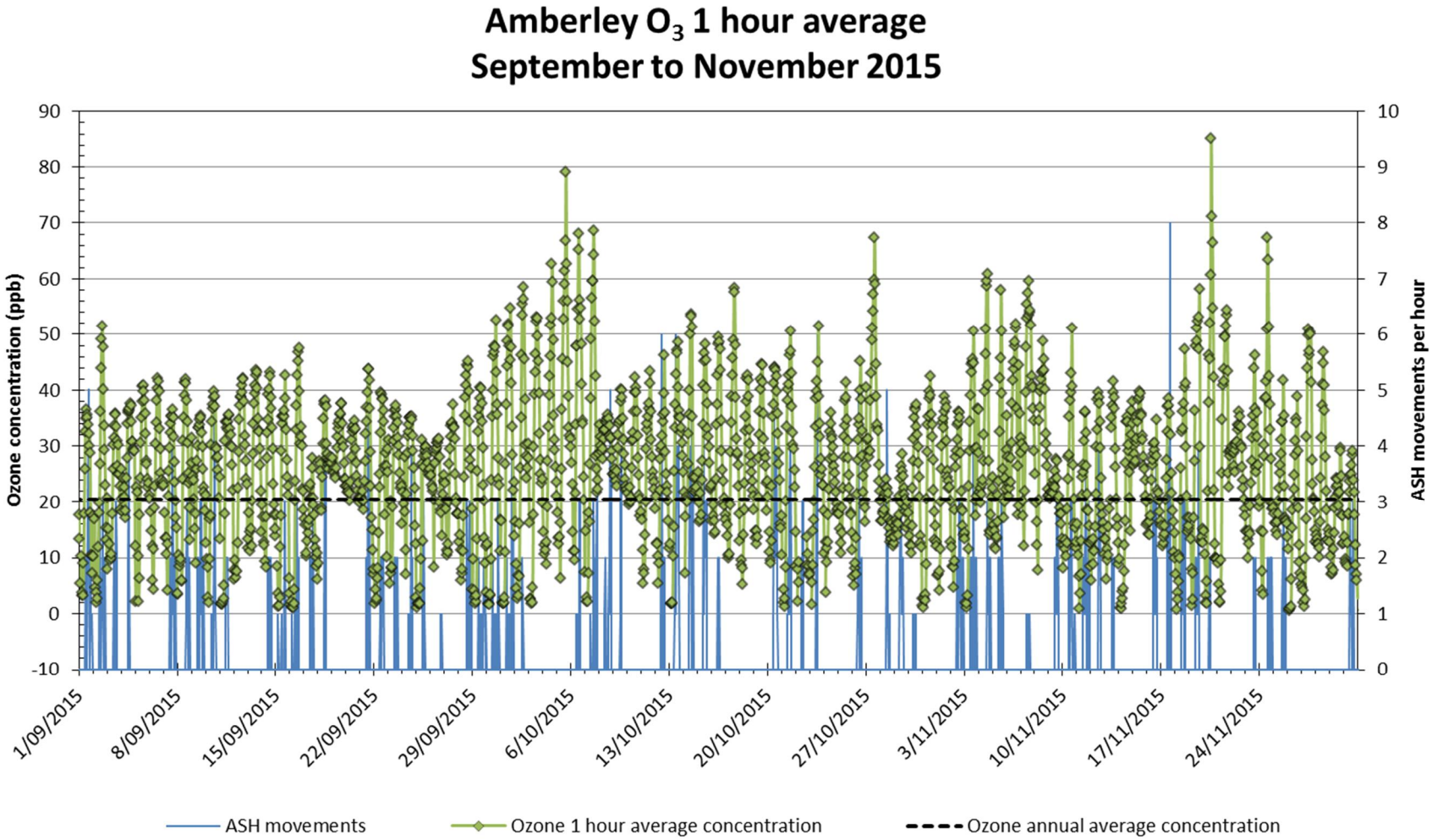



**Figure 12 Ozone results, September to November 2015**

*Note: The EPP (Air) objective of 100 ppb $O_3$ (1 hour average concentration) is not shown on the graph.*

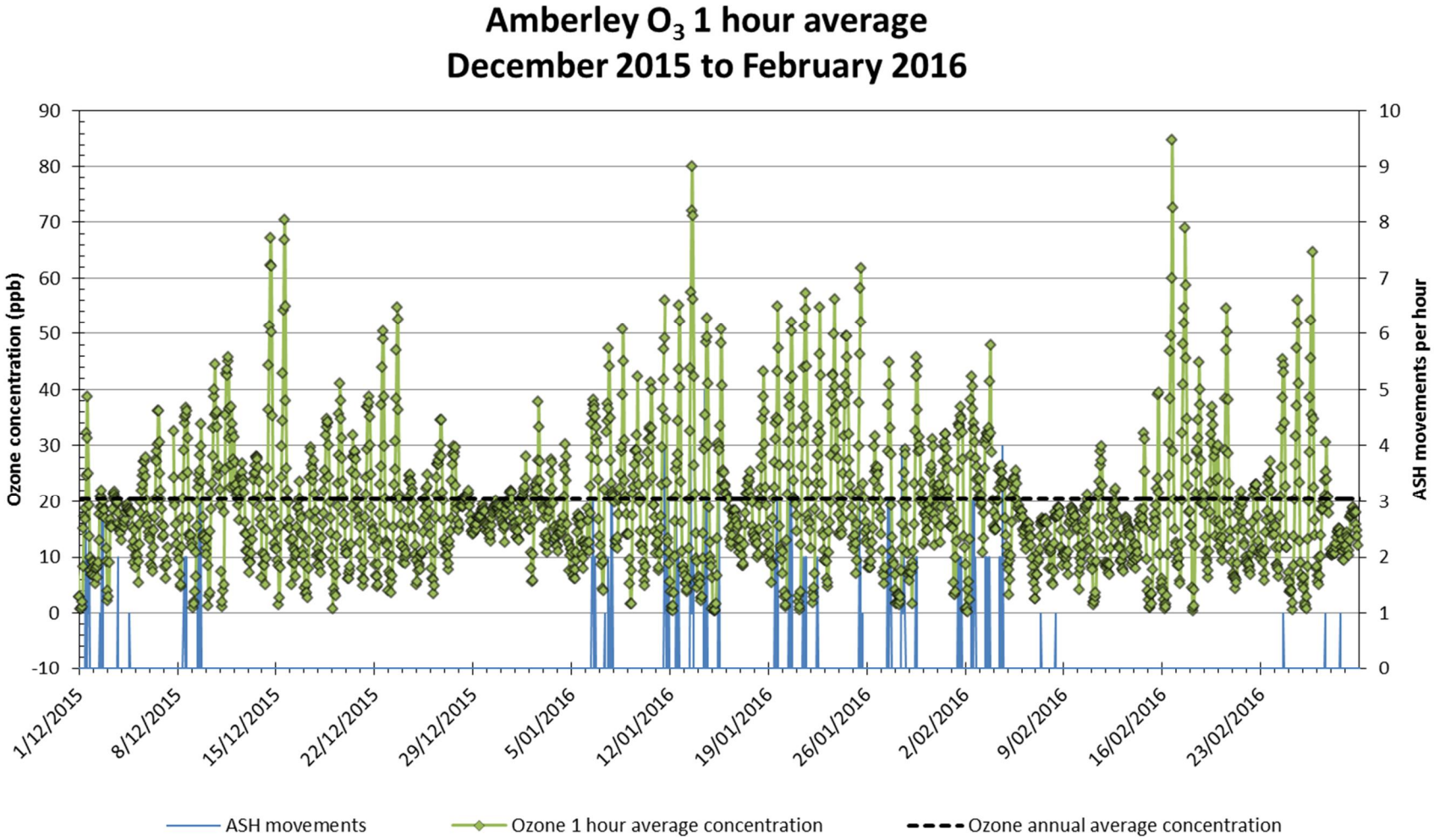



**Figure 13 Ozone results, December 2015 to February 2016**

*Note: The EPP (Air) objective of 100 ppb $O_3$ (1 hour average concentration) is not shown on the graph.*

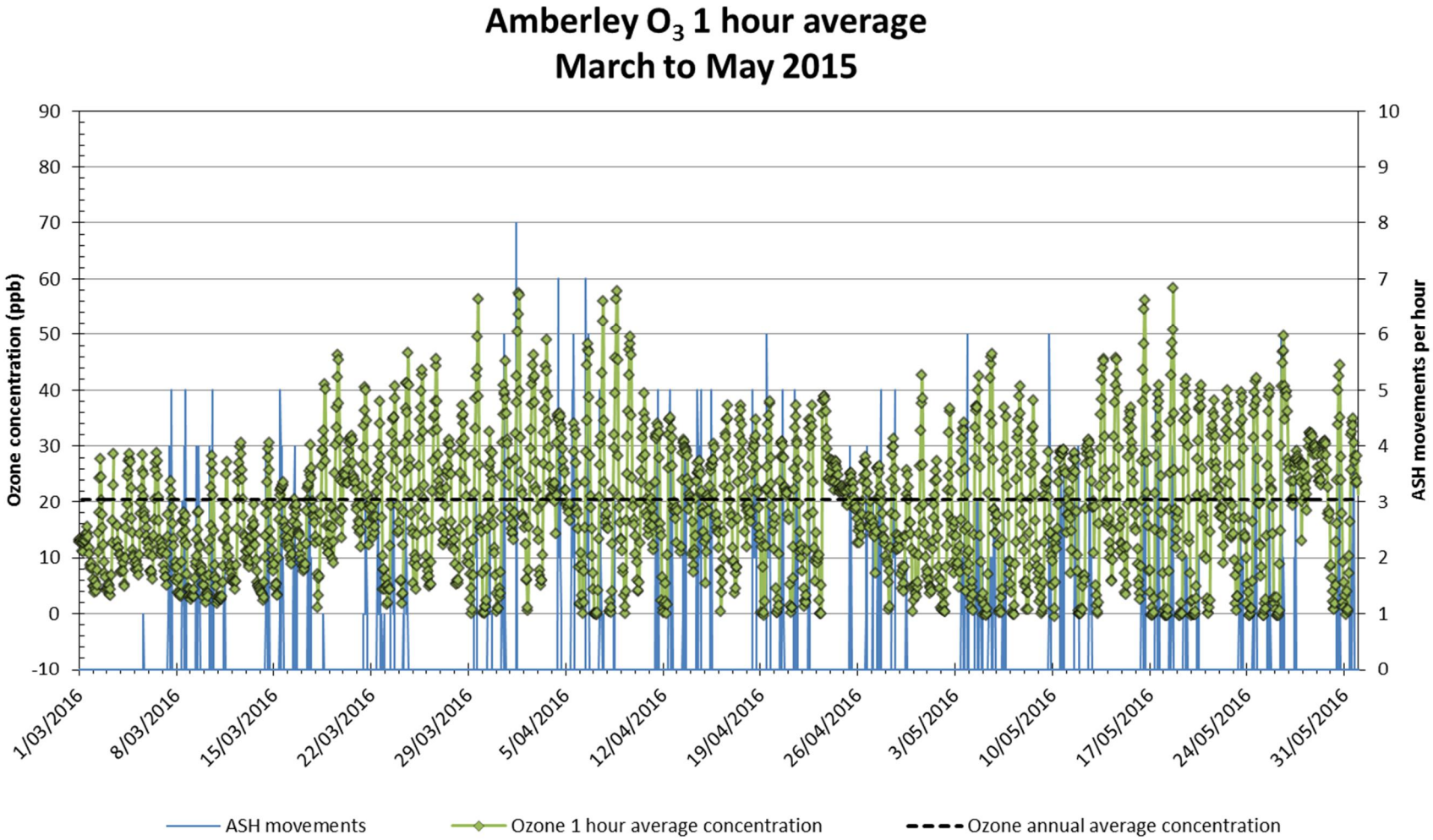



**Figure 14 Ozone results, March to May 2016**

*Note: The EPP (Air) objective of 100 ppb $O_3$ (1 hour average concentration) is not shown on the graph.*

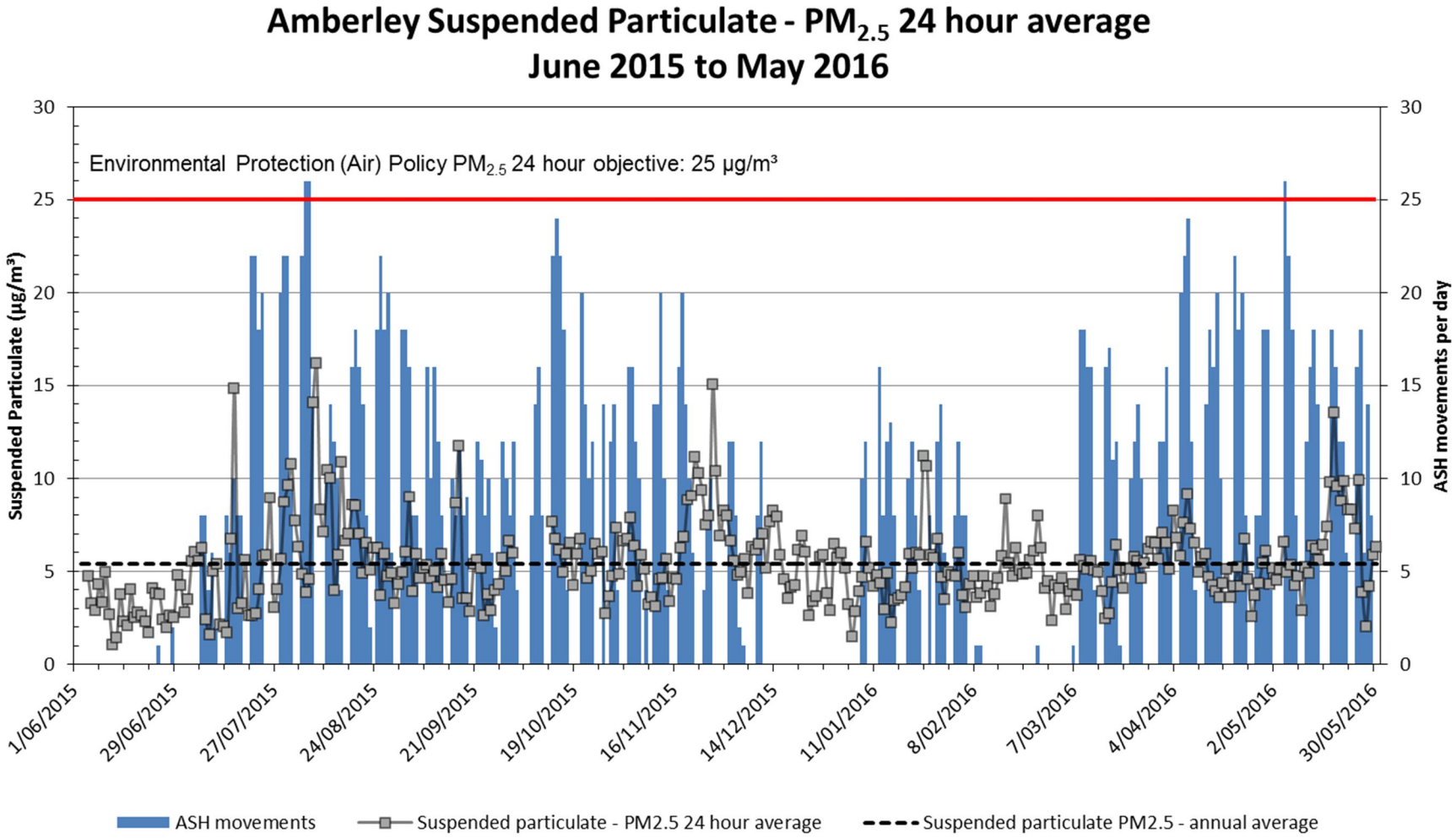



**Figure 15 Suspended Particulate – $PM_{2.5}$ results, June 2015 to May 2016**

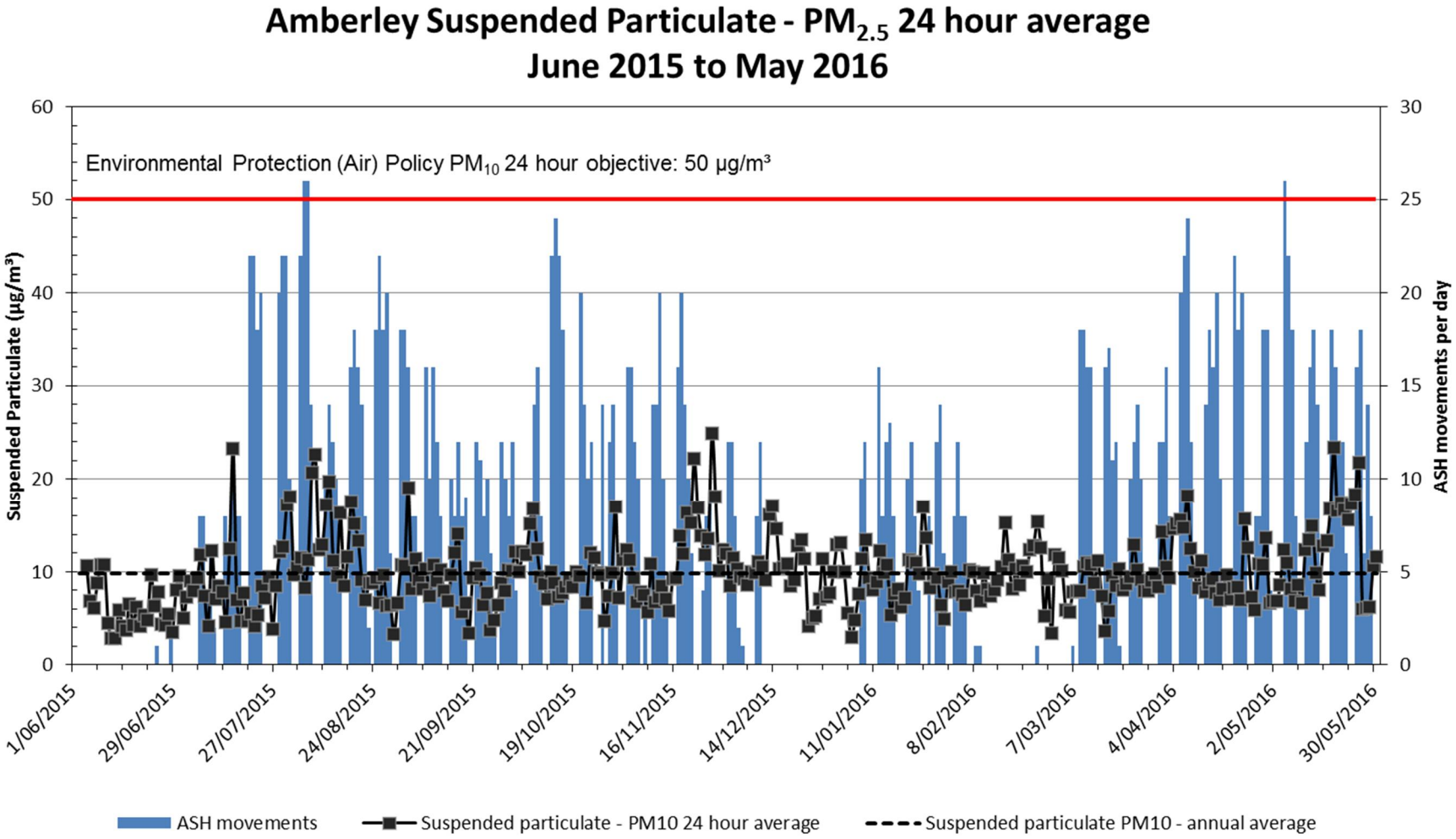



**Figure 16 Suspended Particulate – $PM_{10}$ results, June 2015 to May 2016**

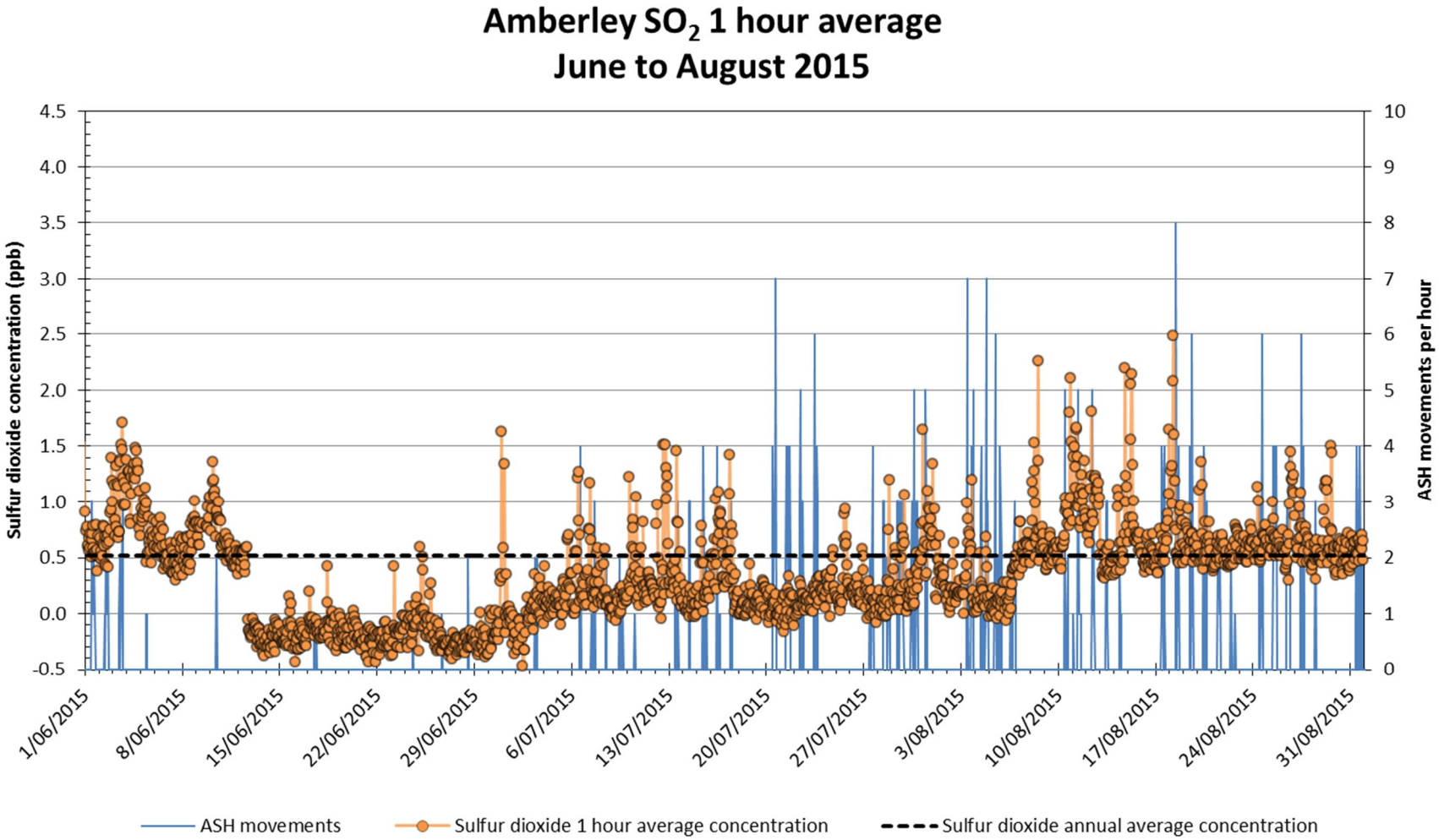



**Figure 17 Sulfur Dioxide results, June to August 2015.**

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

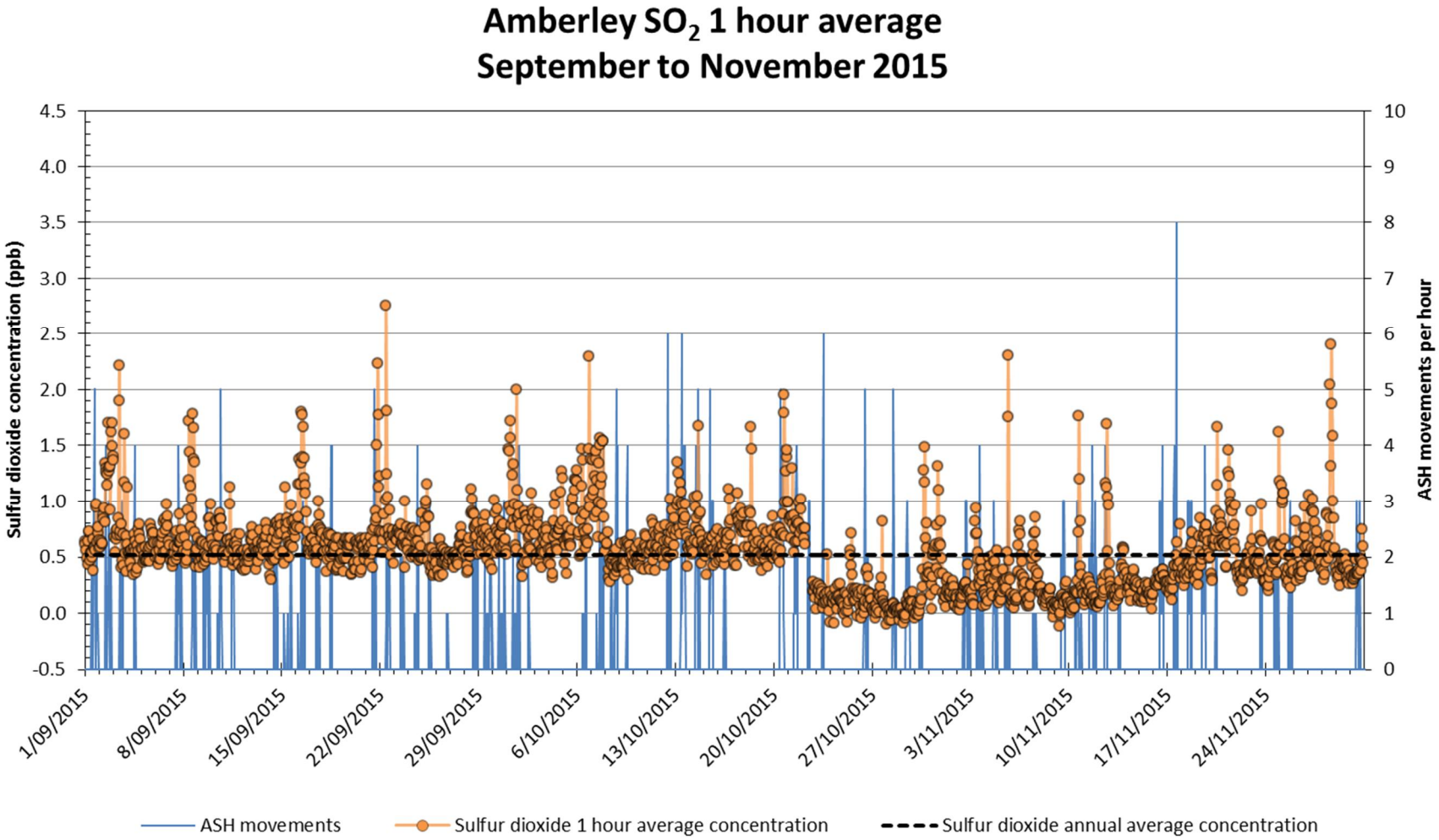



**Figure 18 Sulfur Dioxide results, September to November 2015**

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

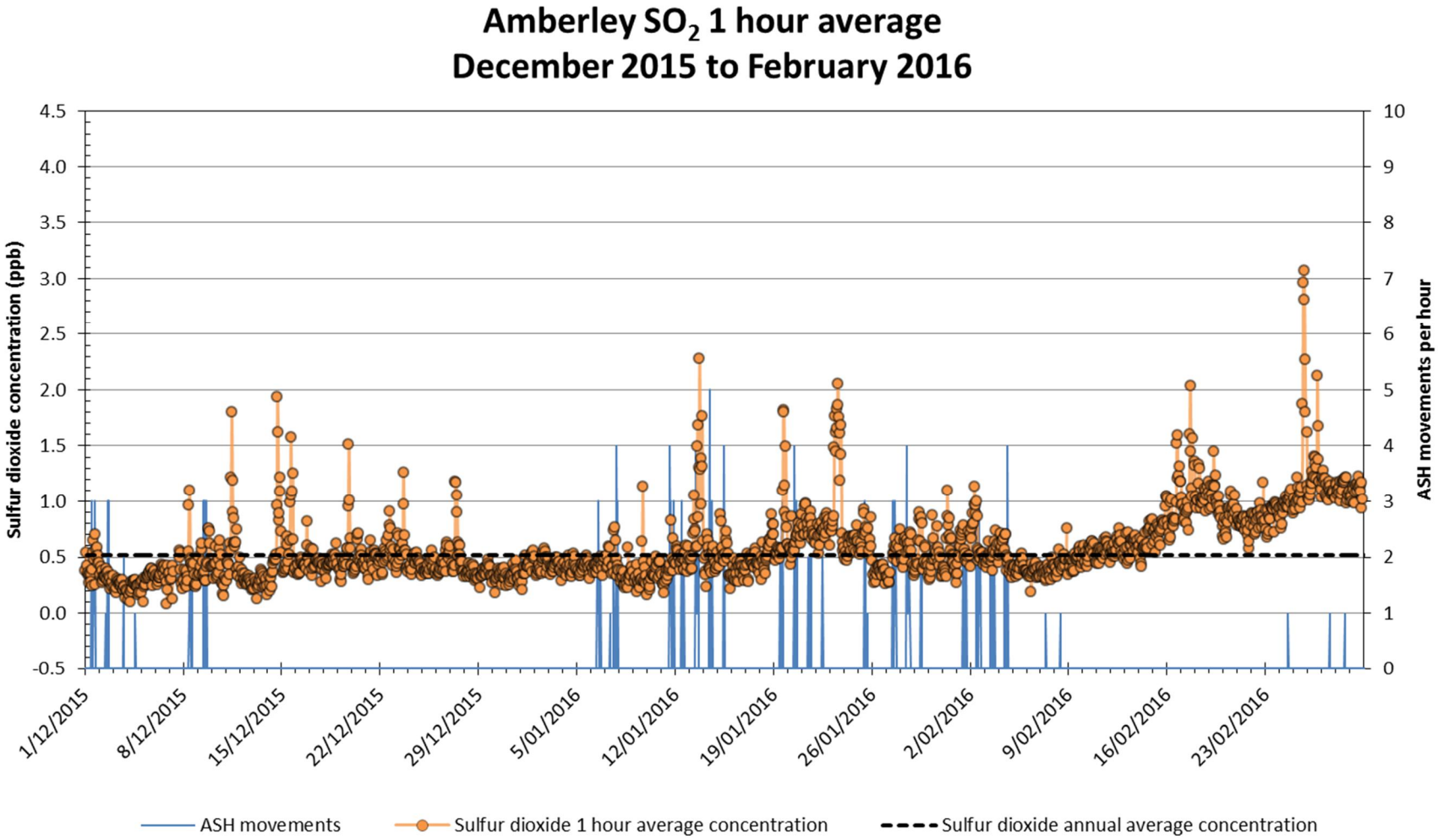



**Figure 19 Sulfur Dioxide results, December 2015 to February 2016**

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

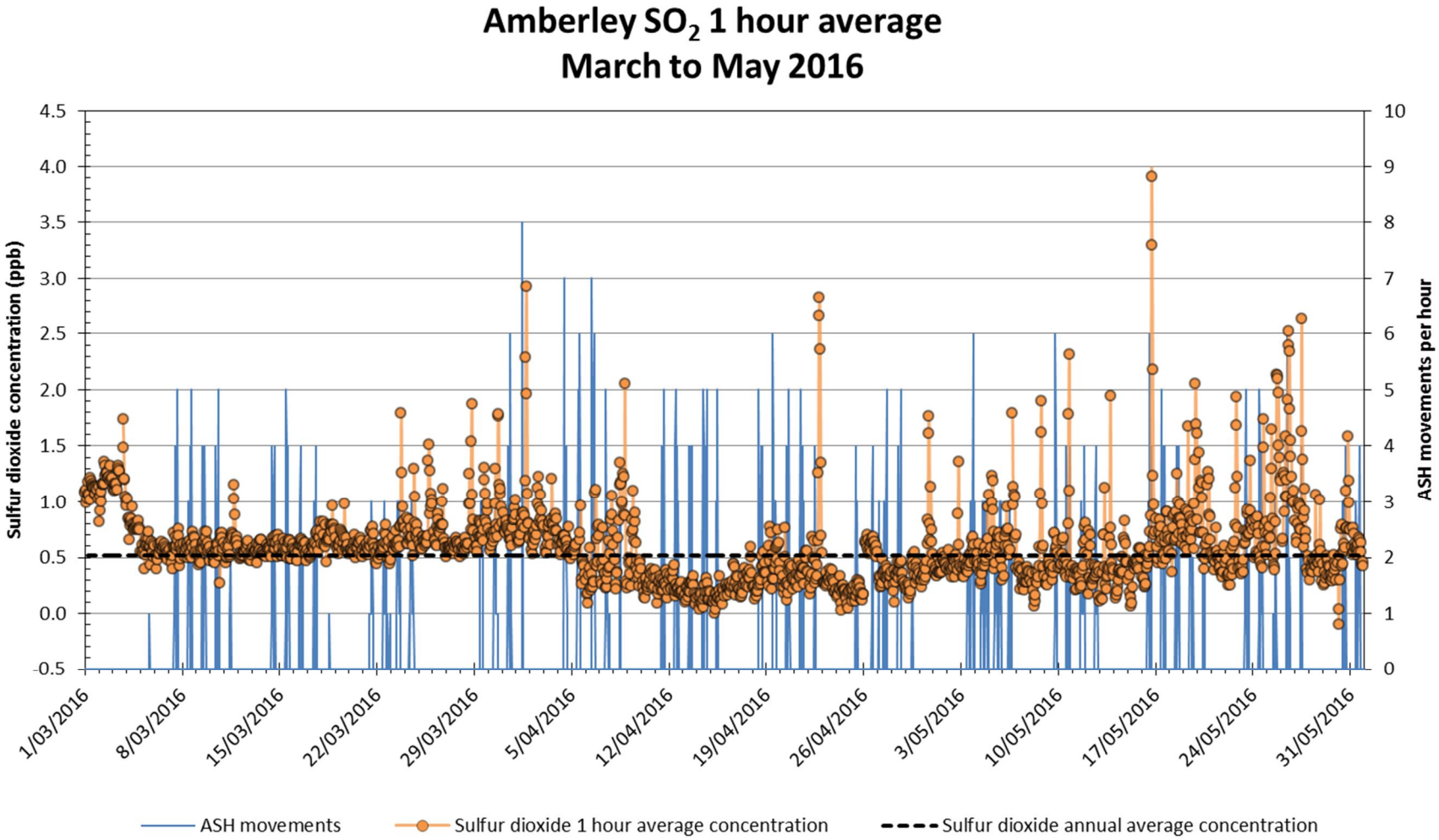



**Figure 20 Sulfur Dioxide results, March to May 2016**

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

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