# Air Quality Monitoring Annual Report 2010

## Birmingham Airport

**Report for Birmingham Airport Ltd.**

AEA in confidence
AEAT/ENV/R/3158
ED20645
Issue Number 1 - Final
Date 04/05/2011

**Customer:**

**Birmingham Airport Ltd.**

**Confidentiality, copyright & reproduction:**



**AEA reference:**

ID: AEAT/ENV/R/3158

Ref: ED20645- Issue Number 1 - Final

**Contact:**

Jo Green
AEA Technology plc
Gemini Building, Harwell, Didcot, OX11 0QR

t: 0870 190 8212

f: 0870 190 4850

e: jo.green@aeat.co.uk

AEA is a business name of AEA Technology plc

AEA is certificated to ISO9001 and ISO14001

**Author:**

Jo Green

**Approved By:**

Steve Telling

**Date:**

04 May 2011

**Signed:**

# Executive summary

Birmingham Airport commissioned AEA Technology Ltd (AEA) to undertake annual reporting to provide analysis and commentary on the 2010 Birmingham Airport air monitoring station annual data set, as managed and collated by AEA. This ambient air quality monitoring survey forms part of the Airport's commitment to monitor air quality within the requirements of the Section 106 Obligations with Solihull MBC. This monitoring survey is intended to provide information on the current air quality in the area and the levels of pollution to which the community is currently exposed.

The ambient air quality monitoring shows that all of the Air Quality Strategy Objectives for the protection of human health were met at the site during 2010. A demonstration of Birmingham Airports' compliance with the UK Objectives for $NO_2$ is provided in the table below. $NO_2$ is the pollutant which is of specific relevance for airport emission sources as detailed within TG(09).

| Pollutant | AQS Objective | Threshold | Result for Birmingham Airport | Objective met? |
|---|---|---|---|---|
| $NO_2$ | 1-hr mean not to be exceeded more than 18 times a year | 200 µg $m^{-3}$ | 0 exceedences | Yes |
| $NO_2$ | Annual mean | 40 µg $m^{-3}$ | 28 µg $m^{-3}$ | Yes |

The investigation of potential pollutant sources identified the airport as a key source of $NO_2$ and CO concentrations although a significant contribution to $NO_2$ from non-airport sources, most likely road traffic travelling along the A45 and M42, were also identified. $PM_{10}$ concentrations were found to be partially influenced by the airport but a more significant source was identified to the south east. This was also identified as most likely being a traffic source, such as from the A45 and M42, which carry significant volumes traffic travelling in and around the Birmingham area.

An examination of long term trends showed an increase in concentrations of $NO_2$ at Birmingham Airport and across the region in 2010 which did not continue the downward trend seen over recent years. Meteorological conditions during the winter months of 2010 (January and February, and November and December) are likely to have been the most significant factors in these increased concentrations.

# Table of contents



## Appendices

# 1 Introduction

Birmingham Airport has commissioned AEA Technology Ltd (AEA) to undertake annual reporting to provide analysis and commentary on the 2010 Birmingham Airport air monitoring station annual data set, as managed and collated by AEA. Birmingham Airport has undertaken continuous ambient air quality monitoring at the airport since April 1995. This ambient air quality monitoring survey forms part of the Airport's commitment to monitor air quality through the requirements of the Section 106 Obligations with Solihull MBC. This monitoring survey is intended to provide information on the current air quality in the area and the levels of pollution to which the community is currently exposed.

## 1.1 Emissions from airports

Aircraft produce the same types of emissions as any other combustion process. Aircraft jet engines, like many other vehicle engines, produce carbon dioxide ($CO_2$), water vapour ($H_2O$), nitrogen oxides ($NO_x$), carbon monoxide (CO), oxides of sulphur ($SO_x$), burned or partially combusted hydrocarbons, particulates and other trace compounds. In addition to the aircraft a source of emissions at airports is derived from the airside vehicles.

The current Technical Guidance TG(09) (Defra, 2009) has removed the requirement to review $PM_{10}$ emissions from airports due to previous assessments not highlighting any issues with $PM_{10}$ from this source. This leaves $NO_2$ as the key pollutant of concern from airports, but only for those airports with over 10 million passengers per annum.

Of the $NO_x$ emissions (of which $NO_2$ is a component) designated as airport-related, 72% occur from the aircraft during take-off and landing, although much of this will be at some distance from airport ground-level. Around a third of all $NO_x$ emissions from the aircraft (including ground-level emissions from auxiliary power units, engine testing etc, as well as take-off and landing) occur below 100 m in height. The remaining two-thirds occur between 100m and 1000 m and contribute little to ground-level concentrations. Receptor modelling studies show that there is an impact from airport activities on ground-level $NO_2$ concentrations. However, studies have shown that although emissions associated with individual vehicles are smaller than those associated with aircraft, their impact on population exposure at locations around airports are larger due to the inherent volume (AQEG, 2004).

## 1.2 UK Air Quality Strategy

Air quality issues in Europe were initially dealt with within four Directives (termed the Daughter Directives), which set limit values for key pollutants with known health impacts. The first, second and third Daughter Directives have recently been consolidated into one Directive covering ambient air quality and cleaner air for Europe EC (2008). The original Directives were transposed in UK law via The Environment Act 1995 which placed a requirement on the Secretary of State for the Environment to produce a national air quality strategy containing standards, objectives and measures for improving ambient air quality. The Environment Act 1995 also introduced the system of local air quality management (LAQM) that requires local authorities to review air quality and to assess the current, and likely future, air quality in their areas against the national air quality objectives. Where any objective is unlikely to be met by the relevant deadline, the local authority must designate an air quality management area (AQMA). Local authorities then have a duty to carry out further assessments within any AQMAs and draw up an action plan specifying the measures to be carried out and the timescale to bring air quality in this area back within the limits. The legal framework given in the Environment Act has been adopted in the UK via the UK Air Quality Strategy.

A key element of the Strategy has been the development of health-based air quality standards and objectives which have been set to act as reference points by which policies are to be directed. An initial target date of 2005 was set for achievement of these objectives. Standards are given in the Strategy for the key air pollutants that were covered by the European Daughter Directives. These standards also take into consideration recommendations of the Expert Panel on Air Quality Standards (EPAQS) about the levels of air pollutants at which there would be little risk to human health.

Since 1997 the UK Air Quality Strategy has undergone a number of amendments and reiterations. These have followed the ever improving knowledge base on air pollutants and their health affects and have incorporated new European limit values both for existing pollutants in the Strategy and newly introduced pollutants such as polycyclic aromatic hydrocarbons and, most recently $PM_{2.5}$. The latest version of the strategy was published in 2007 (Defra, 2007).

### 1.2.1 The UK Strategy and Birmingham Airport

The UK objectives contained within the Strategy apply anywhere that public exposure may occur, for example at residential properties, at a bus stop etc. As the airport monitoring site is located by the runway, where members of the public do not have access, these limits do not apply. This report, however, compares the data from the site with the UK Objectives with a view to achieving compliance at the site. If the site is showing compliance with the objectives for the primary pollutants that are likely to be emitted directly from the airport (namely $NO_2$, particulate ($PM_{10}$), CO and sulphur dioxide ($SO_2$)) then an assumption can be made that, in the absence of any other significant sources, the objectives are likely to be met at the nearby residential properties. The current UK air quality objectives for the pollutants monitored at Birmingham Airport are presented in Table 1.1.

For the purposes of LAQM, the airport falls under the jurisdiction of Solihull Metropolitan Borough Council. The Council has reviewed air quality across their area and pollutant levels do not exceed the AQ Objectives and therefore no air quality management areas have been declared.

***Table 1.1: Objectives included in the Air Quality Regulations for the purpose of Local Air Quality Management.***

| Pollutant | Air Quality Objective: Concentration | Air Quality Objective: Measured as | To be achieved by |
|---|---|---|---|
| **Benzene** | | | |
| All authorities | 16.25 µg $m^{-3}$ | Running annual mean | 31 December 2003 |
| England and Wales | 5.00 µg $m^{-3}$ | Annual mean | 31 December 2010 |
| Scotland and N. Ireland | 3.25 µg $m^{-3}$ | Running annual mean | 31 December 2010 |
| **Carbon Monoxide** | | | |
| England, Wales and N. Ireland | 10.0 mg $m^{-3}$ | Maximum daily running 8-hour mean | 31 December 2003 |
| Scotland Only | 10.0 mg $m^{-3}$ | Running 8-hour mean | 31 December 2003 |
| **Nitrogen Dioxide** | 200 µg $m^{-3}$ not to be exceeded more than 18 times a year | 1-hour mean | 31 December 2005 |
| | 40 µg $m^{-3}$ | Annual mean | 31 December 2005 |
| **Particles ($PM_{10}$) (gravimetric)** | | | |
| All authorities | 50 µg $m^{-3}$, not to be exceeded more than 35 times a year | 24 hour running mean | 31 December 2004 |
| | 40 µg $m^{-3}$ | Annual mean | 31 December 2004 |
| Scotland Only | 50 µg $m^{-3}$, not to be exceeded more than 7 times a year | 24 hour running mean | 31 December 2010 |
| | 18 µg $m^{-3}$ | Annual mean | 31 December 2010 |
| **Sulphur dioxide** | 350 µg $m^{-3}$, not to be exceeded more than 24 times a year | 1-hour mean | 31 December 2004 |
| | 125 µg $m^{-3}$, not to be exceeded more than 3 times a year | 24-hour mean | 31 December 2004 |
| | 266 µg $m^{-3}$, not to be exceeded more than 35 times a year | 15-minute mean | 31 December 2005 |
| **Ozone** * | 100 µg $m^{-3}$ not to be exceeded more than 10 times a year | 8 hourly running or hourly mean* | 31 December 2005 |

* not included in regulations at present.

# 2 Monitoring Methodology

## 2.1 Pollutants

The following pollutants were monitored at Birmingham Airport in 2009:

- $PM_{10}$;
- NOx which includes $NO_2$ and nitric oxide (NO);
- CO;
- $O_3$;
- $SO_2$;
- Hydrocarbons (benzene, toluene, xylene) – passive diffusion tube sampling (BTX).

It is important to note that the Government has recognised the problems associated with achieving the air quality objective for ozone. Ozone is a secondary pollutant and trans-boundary in nature and it is recognised that Local Authorities themselves can exert little influence on concentrations when they are the result of regional primary emission patterns.

Table 2.1 shows the measurement technique employed for each pollutant.

***Table 2.1: Measurement techniques employed at Birmingham Airport in 2010***

| Pollutant | Measurement Technique |
|---|---|
| $PM_{10}$ | Tapered Element Oscillating Microbalance (TEOM) |
| $NO_2$ | Chemiluminescence |
| NO | Chemiluminescence |
| CO | Non-dispersive infrared absorption (NDIR) |
| $O_3$ | Non-dispersive ultraviolet absorption technology (NDUV) |
| $SO_2$ | Ultraviolet Fluorescence (UVF) |
| Hydrocarbons | Monthly BTX diffusion tube (passive technique) |

Fortnightly Local Site Operator (LSO) calibrations are performed by staff at Birmingham Airport to monitor the performance of the analysers. Data from these fortnightly checks, and from two 6-monthly independent QA/QC audits carried out by AEA, are used to scale and ratify the data. This data scaling and ratification is carried out by AEA. The analysers are also serviced on a 6-monthly basis to ensure their continued operation.

All measurements in the report are quoted in $\mu gm^{-3}$ or $mgm^{-3}$ at reference conditions of 20 ℃, 1013 mbar.

Historically, benzene, toluene and xylene were measured using PID (photo ionization detection). However, the measured concentrations were consistently below the suggested limits, so these measurements are now made using diffusion tubes. These data provide monthly averages from two co-located tubes. This report compares benzene concentrations with the UK Objectives. The other hydrocarbons do not have an Objective values. During 2010 the monthly exposure periods of the diffusion tubes were not in sync with calendar months for the first three months of the year. This was resolved from April onwards.

## 2.2 Monitoring Location

The monitoring site is located on the airfield near airport buildings to the east of the runway and north-west of the Main Terminal (OS grid ref. 417395, 284240), having previously been located to the west of the apron area, approximately 300 m due west of the Main Terminal. The site relocation occurred in January 2006. The current location of the monitoring site is shown in Figure 2.1. A map showing the sites of both the old and new locations is included in Appendix 2.

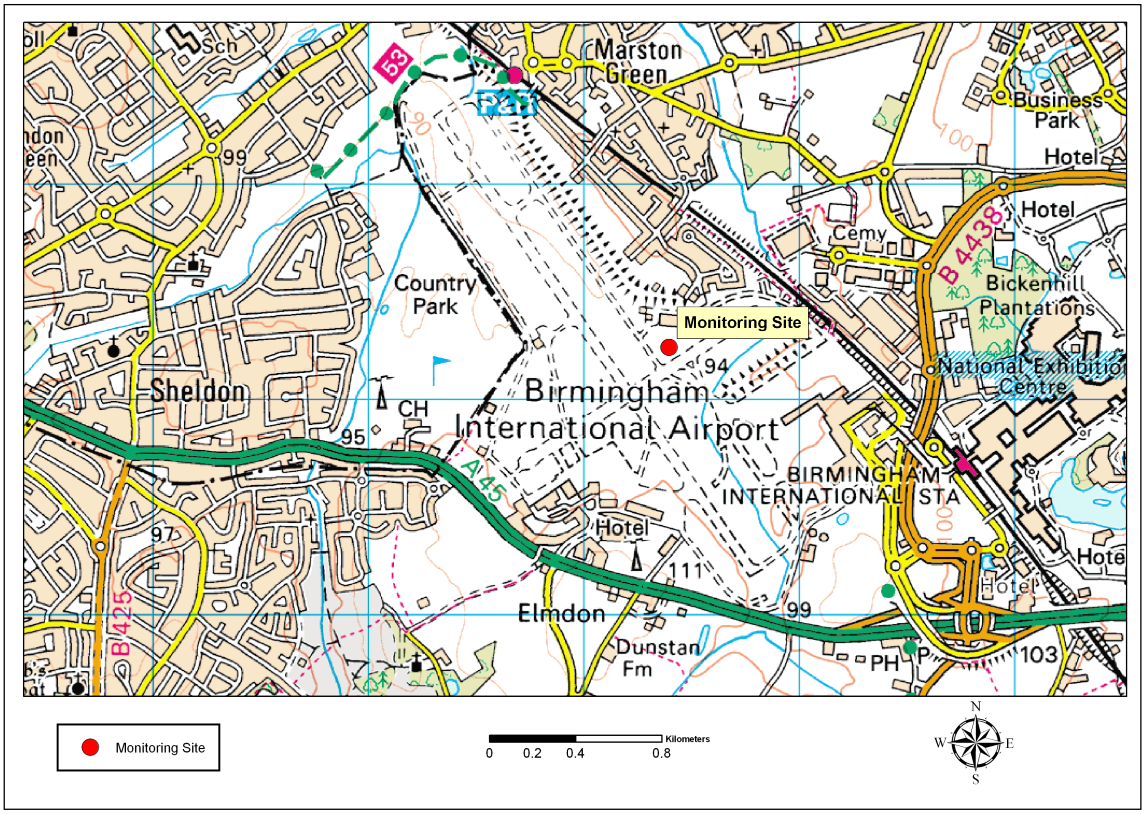



***Figure 2.1: Location of monitoring site.***

## 2.3 Meteorological Data

The following meteorological data were collected at the monitoring station:

- Ambient Temperature (℃)
- Pressure (mbar)
- Relative Humidity (%)
- Wind Direction (°)
- Wind Speed (m s-1)

The wind data collected in 2010 at the Birmingham Airport monitoring site was found to have some significant periods of static wind direction. This showed periods when the sensor was not working correctly. On comparison with other sites in the area the wind direction dataset was shown to correlate well with data from both the Slough Colnbrook and Harwell sites. Other more local sites were found to have poor correlation, suggesting local effects, or data capture was very poor. Of the two sites identified data capture was greatest at Slough Colnbrook, this was therefore the dataset used for the analyses in this report. The wind speed and direction frequencies for the whole of 2010 are shown in Figure 2.2 and the data split by month are shown in Figure 2.3. The meteorological data are summarised by direction and by different wind speed categories. Wind speeds are split into the 2 m s-1 intervals shown by the scale bar in each plot. The grey circles indicate the percentage of time over the period that the wind is measured from each direction, e.g. Figure 2.2 shows that the wind direction was from an easterly direction for just under 5% of the year.

The prevalent wind directions were westerly and south-westerly. Figure 2.3 shows that the strongest wind speeds from the southwest were recorded during July, August, September and November, as indicated by the direction bars having orange and red classifications for significant portions of time.

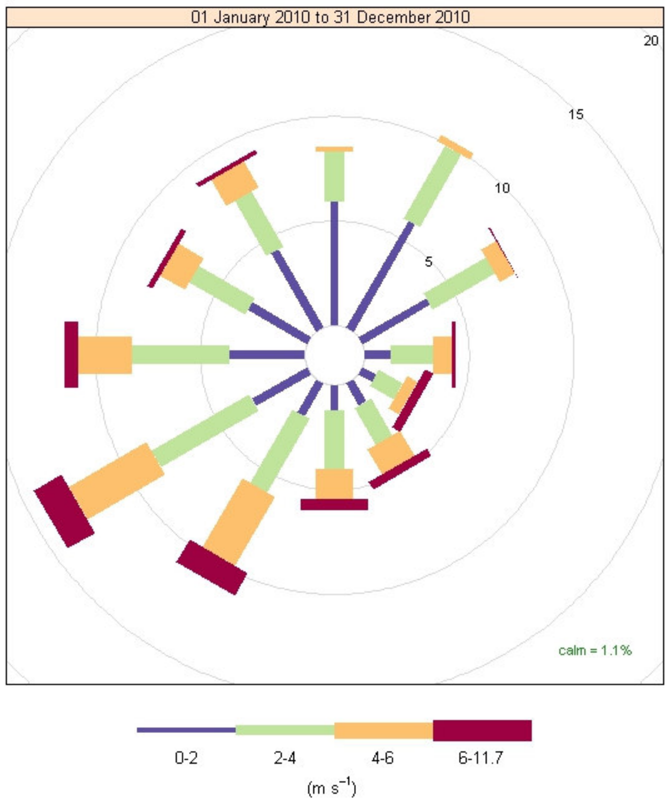



***Figure 2.2: Wind rose showing the wind speed and direction in 2010.***
***(The concentric circles indicate the percentage of time that the wind was blowing from each direction.)***

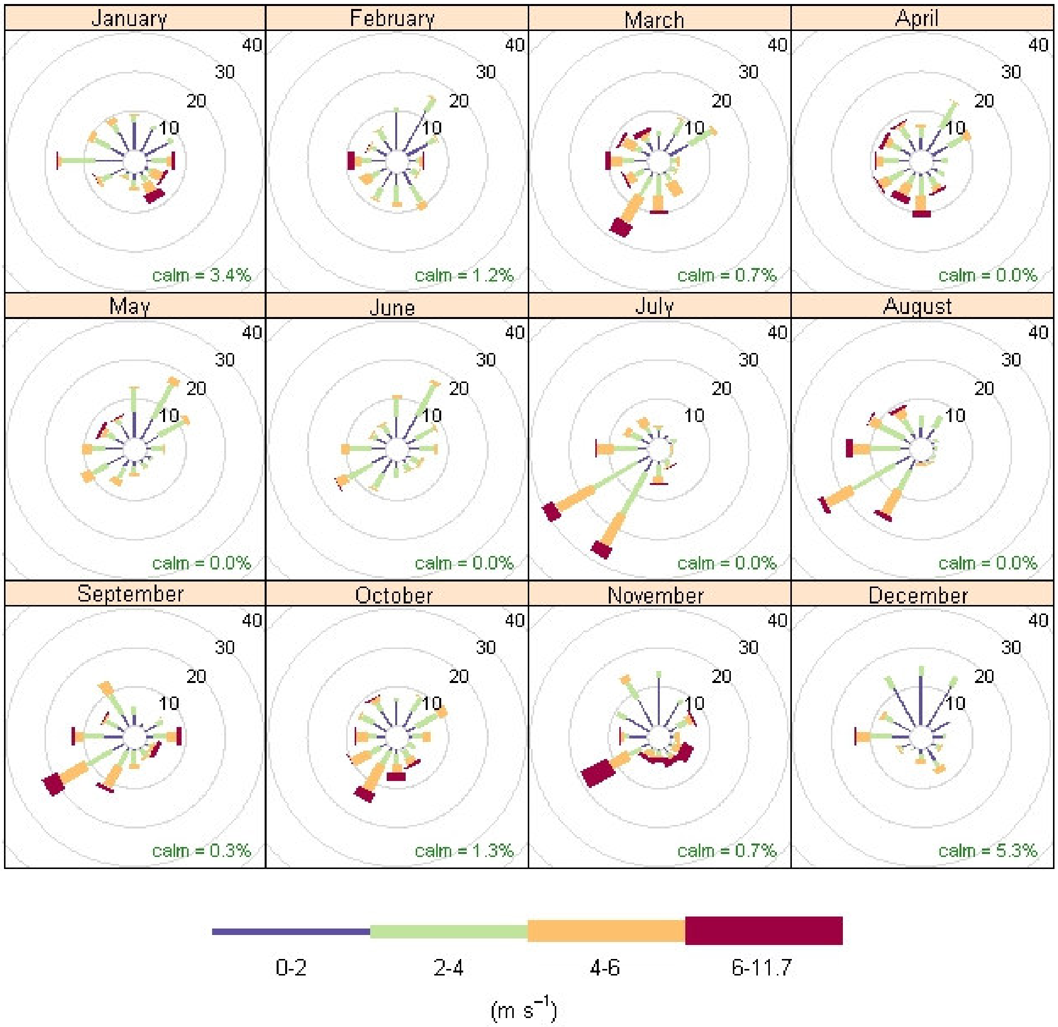



***Figure 2.3: Wind rose showing wind speed and direction by month.***

## 2.4 Regional Analysis

As part of the analyses presented in Section 3, pollutant concentrations from Birmingham Airport are compared to concentrations from other local monitoring sites. This enables the pollutant concentrations recorded at Birmingham Airport to be examined in a regional context. In previous reports two monitoring sites in Birmingham were used for this comparison: Birmingham Centre and Birmingham Tyburn. During January 2009 Birmingham Centre was closed and relocated in February to a roadside location close to Birmingham Tyburn. This is called Birmingham Tyburn Roadside. Both stations monitor $NO_x$, $O_3$, $PM_{10}$ and $PM2_{.5}$. At these site particulate monitoring has been undertaken using FDMS-TEOM since the start of 2009. Monitoring of $SO_2$ is also undertaken at Birmingham Tyburn.

The Birmingham Tyburn monitoring station site is classified as an 'Urban Background' site, located within the car park of council offices. The nearest main road is approximately 60 metres from the station, with the M6 motorway approximately 600 metres to the south.

The Birmingham Tyburn Roadside monitoring station site is classified as a 'Roadside' site, located on the south side of the A38 approximately, 7m from the kerbside, and 60 metres north of the Birmingham Tyburn site.

# 3 Data Analysis

This section provides a summary of the data for 2010 and a comparison with the Air Quality Strategy Objectives. It also presents analysis of episodes, identifies potential emissions sources and looks at long-term trends.

## 3.1 Annual Data Summary

Table 3.1 presents the key statistics for each pollutant. The recently published revision to the Technical Guidance (TG09) (Defra, 2009) requires the use of the Volatile Correction Model (VCM) to correct TEOM data against FDMS data as opposed to the previous requirement to apply a correction factor of 1.3 to raw TEOM data. The hourly average concentrations of $PM_{10}$ in this section are therefore corrected by Volatile Correction Model (VCM) to enable direct comparison with Air Quality Strategy (AQS) objectives. The methodology for the correction of $PM_{10}$ data with VCM is presented in Appendix 4.

Data capture for all monitored pollutants were above the Defra target of 90% (Defra, 2009) for ratified datasets. This target data capture rate does not include losses due to regular calibration or maintenance of the instrument. Any data capture rate above 75% is deemed representative of the full annual period.

A data capture of 93% was reported for $PM_{10}$ and a data capture of 97% or better was reported for all other pollutants over the period. The key period of data loss occurred between the 30th June and 17th July. This was due to a faulty data logger which had to be replaced. In addition there was a fault at the site between 18th and 21st December which resulted in no data being collected. The additional data loss from the $PM_{10}$ analyser is in part due to the VCM correction, where some loss occurred due to no corresponding FDMS data being available for the correction, and due to some intermittent periods of noisy data which were rectified by filter changes.

As discussed in Section 2.1 the benzene diffusion tubes were not exposed consistently to reflect monthly averages for the first quarter of the year. This has resulted in the calculation of an indicative annual mean figure only due to the figure being calculated from different exposure periods.

***Table 3.1: Summary air quality statistics for Birmingham Airport - 2010.***

| Statistic | $PM_{10}$ ($\mu gm^{-3}$)* | $NO_x$ (as $NO_2$) ($\mu gm^{-3}$) | NO ($\mu gm^{-3}$) | $NO_2$ ($\mu gm^{-3}$) | $O_3$ ($\mu gm^{-3}$) | $SO_2$ ($\mu gm^{-3}$) | CO ($mgm^{-3}$) | Benzene ($\mu gm^{-3}$) |
|---|---|---|---|---|---|---|---|---|
| Maximum hourly mean | 200 | 682 | 371 | 159 | 168 | 32 | 1.5 | - |
| Annual mean | 19 | 46 | 12 | 28 | 41 | 2 | 0.2 | 0.8** |
| Maximum daily mean | 48 | - | - | - | - | 7 | - | - |
| Maximum running 8-hr mean | - | - | - | - | 144 | - | 0.8 | - |
| Maximum 15-min mean | - | - | - | - | - | 32 | - | - |
| Data capture (%) | 93 | 99 | 99 | 99 | 99 | 97 | 97 | 100 |

* VCM corrected
** Indicative only

Table 3.2 compares the annual mean and maximum concentrations at Birmingham Airport with those measured at the two Birmingham AURN sites. The annual mean concentrations of $PM_{10}$ and $NO_2$ measured at the Birmingham Airport site are lower than the other sites in the region whilst the annual mean concentration of ozone is higher. These statistics indicate that the quantity of emissions in the immediate vicinity of the monitoring stations are greater at the two AURN sites compared to Birmingham Airport. The higher ozone is as expected as there is less $NO_2$ to react with the available ozone and thus ozone concentrations are not depleted.

Figure 3.1 presents the approximate monthly average concentrations of benzene and Figure 3.2 presents the hourly average concentration for each continuously monitored pollutant. The data for benzene and the other hydrocarbon species, including the true exposure periods, are presented in Appendix 3.

***Table 3.2: A comparison of summary statistics for Birmingham Airport and two local AURN monitoring sites.***

| | Birmingham Airport | Birmingham Tyburn Roadside | Birmingham Tyburn |
|---|---|---|---|
| Annual mean | | | |
| $PM_{10}$ (µg m$^{-3}$) | 19* | 20 | 25 |
| $NO_2$ (µg m$^{-3}$) | 28 | 51 | 37 |
| $O_3$ (µg m$^{-3}$) | 41 | 28 | 37 |
| $SO_2$ (µg m$^{-3}$) | 2 | - | 2 |
| CO (mg m$^{-3}$) | 0.2 | - | - |
| **Maximum hourly mean** | | | |
| $PM_{10}$ (µg m$^{-3}$)* | 200 | 179 | 150 |
| $NO_2$ (µg m$^{-3}$) | 159 | 254 | 302 |
| $O_3$ (µg m$^{-3}$) | 168 | 138 | 156 |
| $SO_2$ (µg m$^{-3}$) | 32 | - | 37 |
| CO (mg m$^{-3}$) | 1.5 | - | - |

* All PM VCM corrected

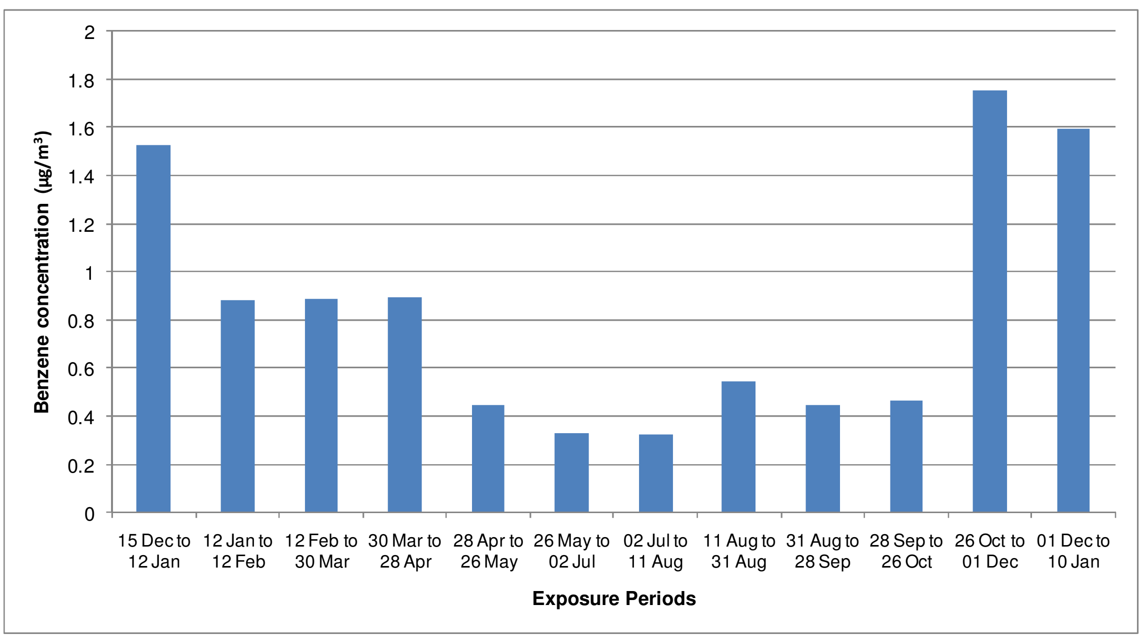



***Figure 3.1: Approximate average monthly concentrations of benzene – 2010.***

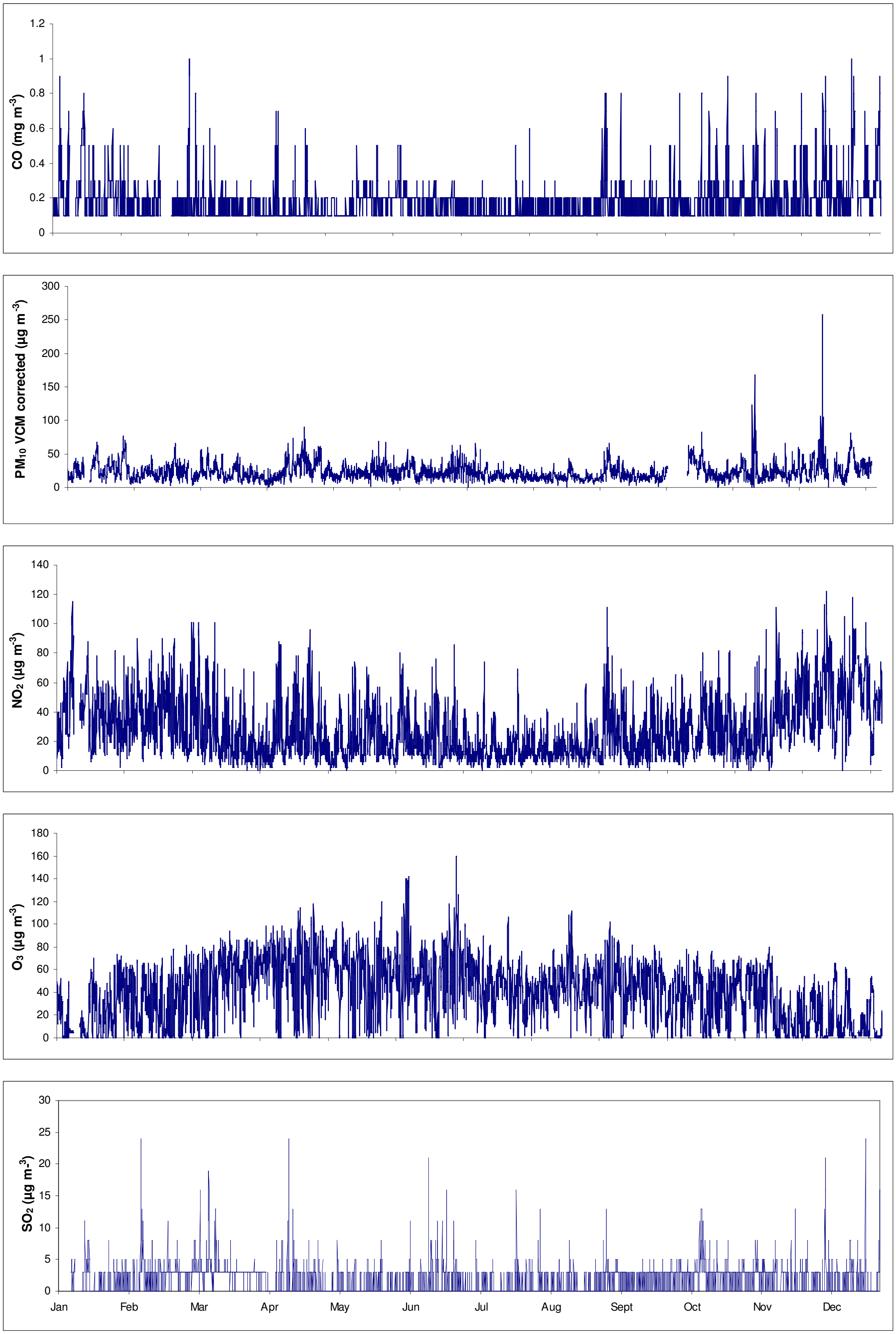



***Figure 3.2: Hourly mean pollutant concentration at Birmingham Airport – 2010.***

### 3.1.1 Air Pollution Episodes

Air pollution episodes can be identified as any breach of the Air Quality Objectives. The longer the period of time that the breach occurs and the maximum concentration that is reached defines the severity of the episode. Another method of identifying periods of high pollutant concentrations is to use the index and banding system approved by the Committee on Medical Effects of Air Pollution Episodes (COMEAP). This is used within the UK to provide information about air pollution levels to allow sensitive individuals to take action if required. The descriptions associated with each band are provided and the concentration ranges for each index are presented in Appendix 5.

Table 3.3 presents a comparison of the monitoring data with Air Quality Strategy Objectives for the protection of human health. The AQS Objectives for the pollutants included in the regulations were met in 2010 at Birmingham Airport. $NO_2$ is the key pollutant of concern within Local Air Quality Management, there were no exceedences measured of the $NO_2$ hourly mean objective. The annual mean concentration of 28 µg $m^{-3}$ was also well below the annual mean objective of 40 µg $m^{-3}$. There were 10 exceedences of the ozone objective, which was just at the limit of 10 allowed by the objective.

***Table 3.3: Comparison with AQS Objectives for the protection of human health.***

| Pollutant | AQS Objective | Threshold | Result for Birmingham Airport | Objective met? |
|---|---|---|---|---|
| $PM_{10}$ | 24-hr mean not to be exceeded more than 35 times a year | 50 µg $m^{-3}$ | 0 exceedences | Yes |
| $PM_{10}$ | Annual mean | 40 µg $m^{-3}$ | 19 µg $m^{-3}$ | Yes |
| $NO_2$ | 1-hr mean not to be exceeded more than 18 times a year | 200 µg $m^{-3}$ | 0 exceedences | Yes |
| $NO_2$ | Annual mean | 40 µg $m^{-3}$ | 28 µg $m^{-3}$ | Yes |
| $O_3$ | Daily maximum of running 8-hour means not to be exceeded more than 10 times a year | 100 µg $m^{-3}$ | 10 exceedences | Yes |
| $SO_2$ | 15-min mean not to be exceeded more than 35 times a year | 266 µg $m^{-3}$ | 0 exceedences | Yes |
| $SO_2$ | 1-hr mean not to be exceeded more than 24 times a year | 350 µg $m^{-3}$ | 0 exceedences | Yes |
| $SO_2$ | 24-hr mean not to be exceeded more than 3 times a year | 125 µg $m^{-3}$ | 0 exceedences | Yes |
| CO | Maximum daily running 8 hour mean | 10 mg $m^{-3}$ | 0.8 mg $m^{-3}$ | Yes |
| Benzene | Running annual mean | 16.25 µg $m^{-3}$ | 0.8 µg $m^{-3}$ | Yes |

The data from Birmingham Airport were compared to the bandings to identify if there were any elevated pollutant concentrations during 2010.

Table 3.4 shows the number of days when pollutant concentrations exceeded the LOW banding threshold. The concentrations of all the pollutants apart from ozone remained within LOW band threshold in 2010. Ozone saw 20 days when the MODERATE band was exceeded. This was only one day greater than seen during 2009. Please note that this is different to the Objective exceedence as displayed in Table 3.4 as the ozone banding criteria use the maximum of the 8-hour and hourly mean to calculate the index value. This can produce a higher number of exceedences compared to the Objective which is calculated on the 8-hour mean only. The key pollutants are discussed in more detail below.

***Table 3.4: Number of days during the year within each band.***

| Pollutant | $PM_{10}$ | $NO_2$ | Ozone | $SO_2$ | CO |
|---|---|---|---|---|---|
| Very High | 0 | 0 | 0 | 0 | 0 |
| High | 0 | 0 | 0 | 0 | 0 |
| Moderate | 0 | 0 | 20 | 0 | 0 |

### 3.1.2 Particulate Matter

Neither the 24-hour mean $PM_{10}$ nor the annual mean objective were breached at Birmingham Airport. The time series of 24-hour mean $PM_{10}$ concentrations (VCM corrected) is shown in Figure 3.3. Figure 3.4 shows the 24-hour mean $PM_{10}$ concentrations at Birmingham Airport and the two Birmingham AURN sites. This shows that the concentrations measured at Birmingham Airport followed regional trends.

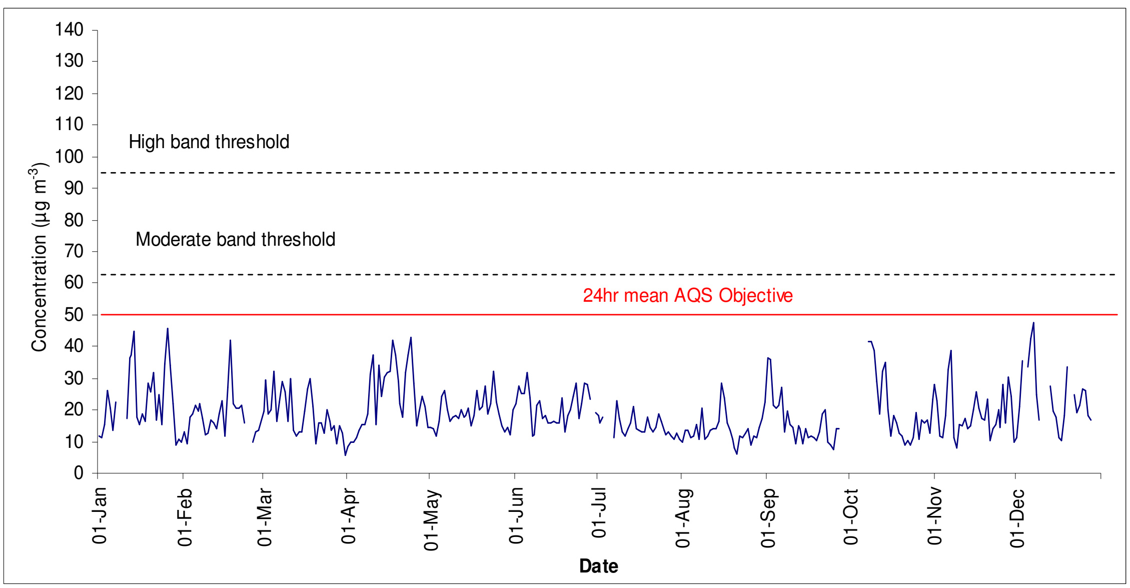



***Figure 3.3: $PM_{10}$ 24-hr mean concentrations at Birmingham Airport - 2010.***

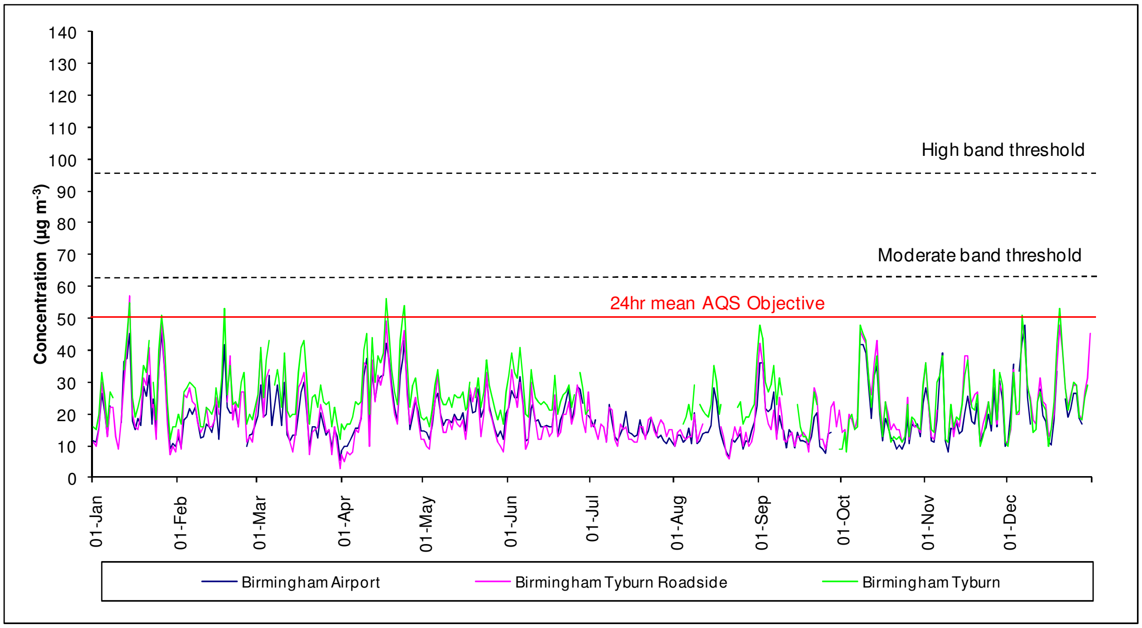



***Figure 3.4: $PM_{10}$ 24-hr mean concentrations at Birmingham Airport and two AURN sites – 2010.***

### 3.1.3 Nitrogen Dioxide

The 1-hour mean concentrations of $NO_2$ did not breach the Objective once during 2010. The time series of 1-hour mean $NO_2$ concentrations recorded at Birmingham Airport, Birmingham Tyburn and Tyburn Roadside are shown in Figure 3.5.

There was a period of higher $NO_2$ concentrations during November and December during the very cold weather experienced at this time. The elevated concentration led to one exceedence of the hourly Objective at Tyburn Roadside and seven exceedences at Tyburn. There was also one exceedence of the Moderate health band at the Tyburn sites.

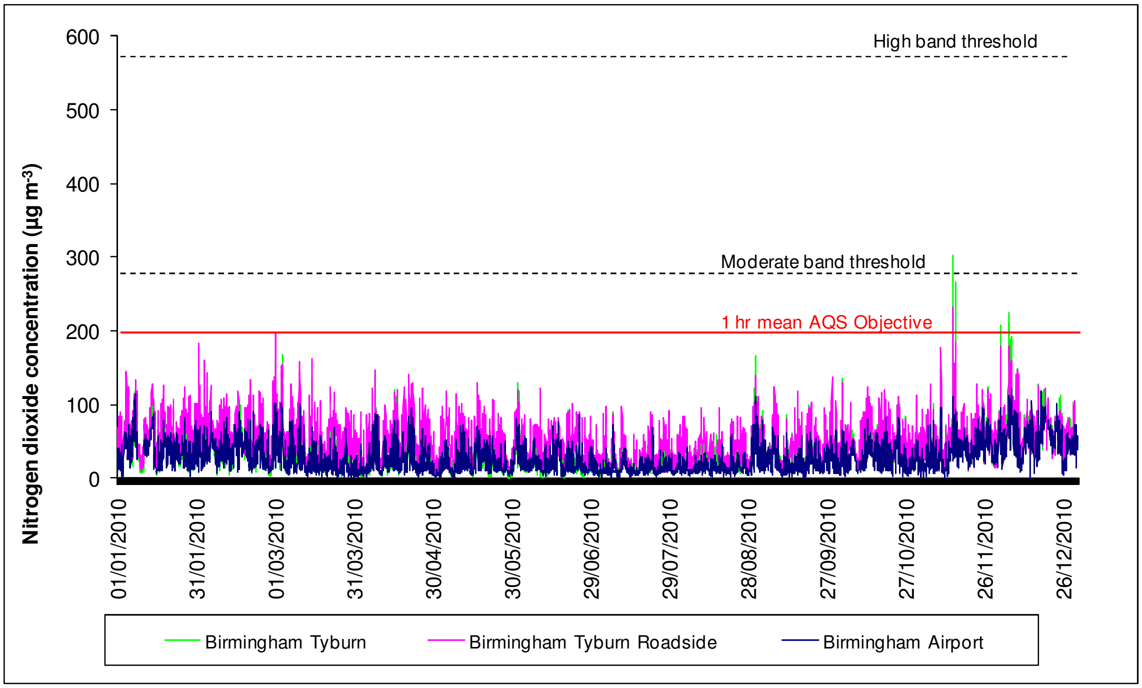



***Figure 3.5: $NO_2$ 1-hr mean concentrations at Birmingham Airport and two AURN sites – 2009.***

### 3.1.4 Ozone

The ozone Objective threshold of 100 µg $m^{-3}$ was breached on 20 days. The maximum 8-hour mean recorded was 144 µg $m^{-3}$. The time series of running 8-hour mean ozone concentrations is shown in Figure 3.6. The breaches of the Objective occurred on:

- 17$^{th}$, 18$^{th}$, 23$^{rd}$ and 24$^{th}$ April
- 7$^{th}$, 21$^{st}$ and 24$^{th}$ May
- 2$^{nd}$, 3$^{rd}$, 4$^{th}$, 5$^{th}$, 23$^{rd}$, 25$^{th}$, 26$^{th}$, 27$^{th}$, and 30$^{th}$ June
- 19$^{th}$ July
- 15$^{th}$ and 16$^{th}$ August
- 2$^{nd}$ September

A similar pattern of running 8-hour mean ozone concentrations recorded at Birmingham Airport can be seen at the two Birmingham sites presented in Figure 3.7.

These exceedences of the ozone Objective occurred across Birmingham (as demonstrated in Figure 3.7) and were most likely driven by weather conditions during the summer months, i.e. warm, sunny days which optimise the chemical reactions which lead to the production of ozone. Similarly low concentrations of ozone can be seen during the period of elevated $NO_2$ in November and December.

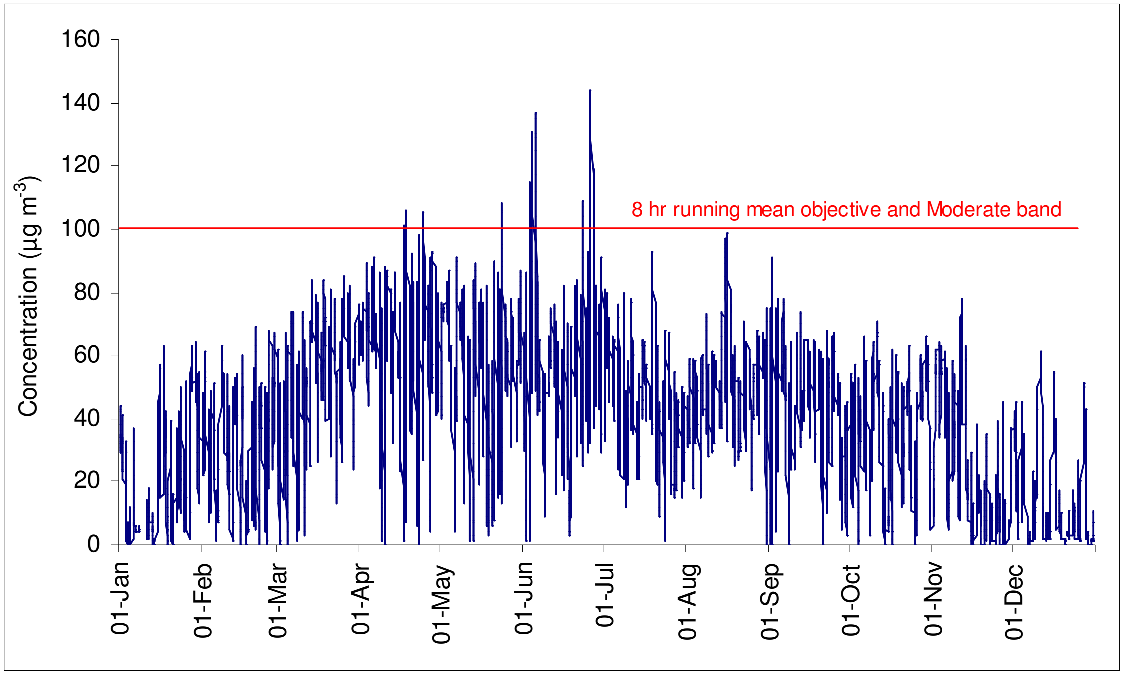



***Figure 3.6: Ozone 8 hr rolling mean concentrations at Birmingham Airport – 2010.***

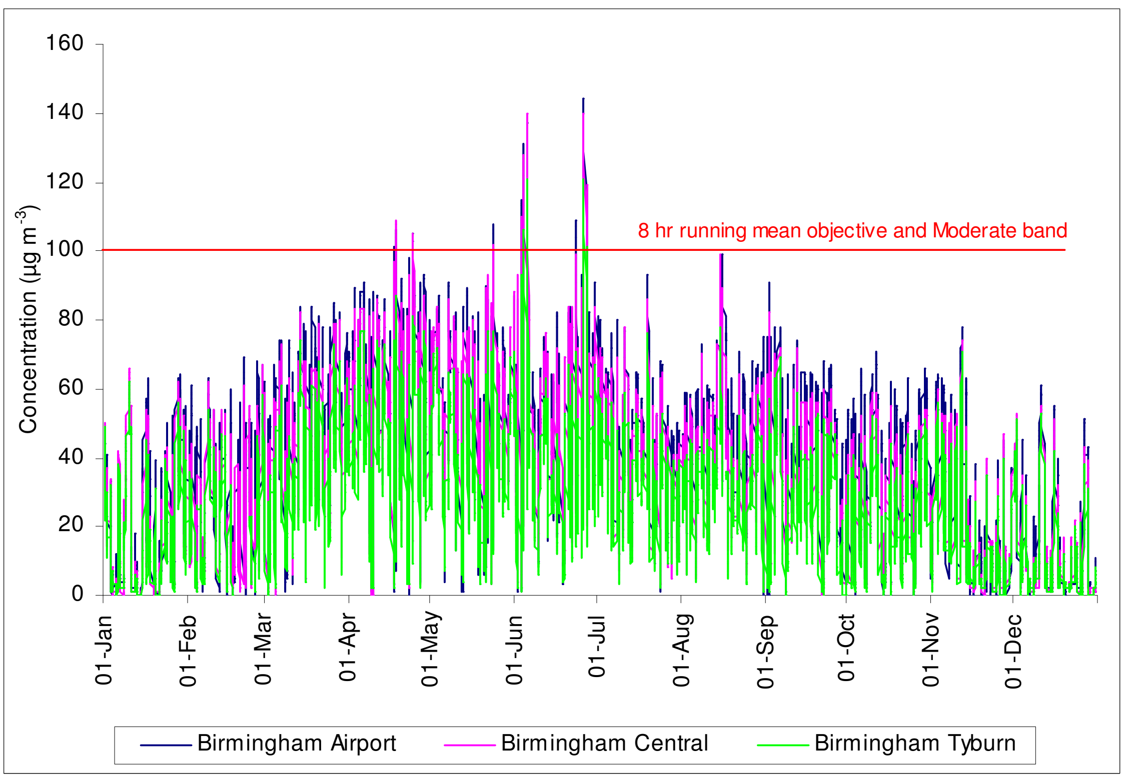



***Figure 3.7: Ozone 8 hr rolling mean concentrations at Birmingham Airport and at two AURN sites – 2010.***

## 3.2 Emissions Sources

In order to investigate the possible sources of air pollution that are being monitored at the Birmingham Airport site, meteorological data was used to add a directional component to the air pollutant concentrations. Figure 3.8 shows plots of hourly pollutant concentrations against the corresponding wind speed and wind direction. The further the data point is plotted from the central position on the plot the higher the wind speed when the value was recorded. These plots do not allow a derivation of any specific values or exceedences but provide a visual indication as to the direction of possible sources of pollution that are being measured at the site. The wind data was sourced from the Birmingham Airport and Slough Colnbrook meteorological masts.

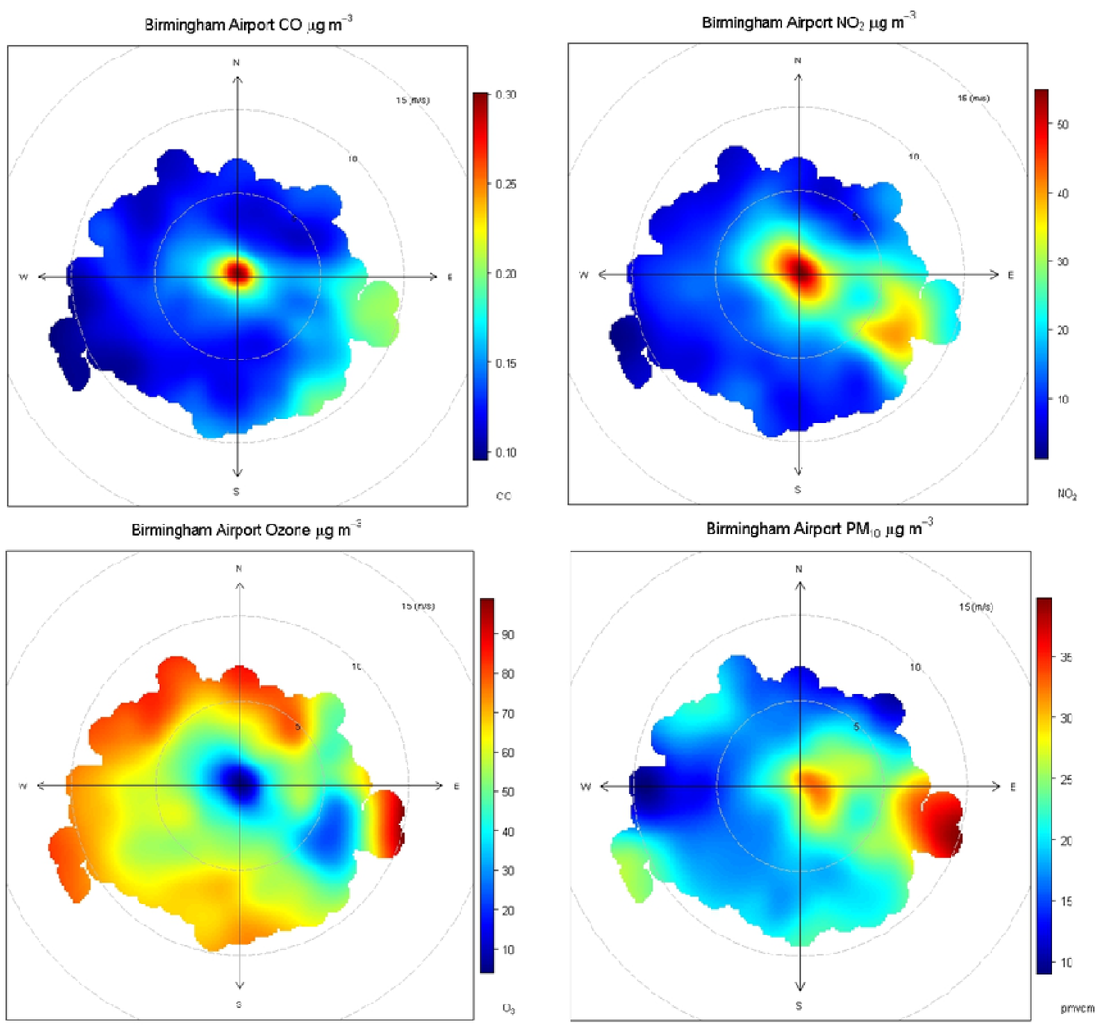



***Figure 3.8: Bivariate plots showing pollutant concentrations as a function of both wind direction and wind speed.***

As with previous years the plot of CO shows that the highest concentration is in the centre of the plot when wind speeds are low and there is a decrease in concentrations as wind speeds increase. This pattern indicates the main source of CO is in close proximity of the monitoring site (ie the runway) and dispersion of this pollutant increases with increasing wind speed. There is less evidence of the CO source indicated to the south side of the airport in 2009. It should be noted that the concentrations of CO are small.

The plot of $NO_2$ concentrations shows clearly that the airport is the primary emissions source of this pollutant at this location. However, it also suggests that there is another significant source to the southeast of the centre of the plot. As in 2008 and 2009 this source is characterised by concentrations around 30 ugm$^{-3}$ although the signature is weaker than seen in 2009. These concentrations most likely represent emissions from road traffic, such as from the A45 and M42, which carry significant volumes traffic travelling in and around the Birmingham area.

The bivariate plot for $PM_{10}$ shows some contribution from the airport to the east of the monitoring site but a more significant source of $PM_{10}$ can be seen in the south-east quadrant. As with $NO_2$ this is likely to be a signature from the A45 and the M42 which lie to the east.

The final bivariate plot shows concentrations of ozone. Being a secondary pollutant ozone is formed from chemical reactions in the ambient air. The plot demonstrates that elevated concentrations of ozone are measured at the site when wind speeds are sufficient to bring in ozone rich air from other areas of the region. The plot indicates that the most significant sources are from the rural areas to the east where ozone formation is allowed to continue unchecked by the influence of other pollutant emissions.

## 3.3 Long Term Trends

This section looks at the trends in annual mean concentrations at Birmingham Airport and compares these to trends seen at other AURN monitoring sites within the surrounding area. The data from the two different locations of the Birmingham Airport site have been incorporated into one data set. The data in this section are TEOM x 1.3 to allow for comparison with earlier years.

Figure 3.9 shows the trends in annual mean pollutant concentrations at a number of sites. The two AURN monitoring sites operated in Birmingham, which have been used throughout this section, are displayed in Figure 3.9. In addition data from the following sites are included:

- Coventry Memorial Park – urban background site located in Coventry Memorial Park
- Leamington Spa – urban background site located at the rear of a three-storey Regency Terrace near the town centre. The nearest urban road is approximately 50 metres.
- Sandwell West Bromwich – urban background site located on the top (1st) floor of an enclosed car park which serves the Council offices. The nearest main road (West Bromwich High Street - lies about 100 metres to the SW. This site monitors oxides of nitrogen and sulphur dioxide only.

These sites provide some additional information as to trends in the region. Carbon monoxide has not been included due to the pollutant no longer being measured at the local sites. Monitoring of $PM_{10}$ also ceased at Coventry Memorial. Also note that, as discussed previously, the Birmingham Centre site has been decommissioned and replaced by the site at Birmingham Tyburn Roadside.

In general, concentrations of all pollutants at Birmingham Airport are comparable to the other monitoring sites in the area.

Concentrations of $PM_{10}$ show no discernable regional trends with fluctuating concentrations for all sites year on year. Concentrations at Birmingham Airport remained lower than those recorded at local sites during 2010. The $PM_{10}$ concentrations measured at Birmingham Airport during 2010 remained at 2009 concentrations whilst concentrations at Birmingham Tyburn and Sandwell West Bromwich increased compare to 2009. Data capture for $PM_{10}$ at Tyburn Roadside was insufficient to produce an annual mean for 2010.

Concentrations of $NO_2$ at Birmingham Airport showed an increase in 2010, which is seen to some degree at all other sites in the area. Figure 3.10 demonstrates the high concentration measured at the new Birmingham Tyburn Roadside. Since 2004 $NO_2$ concentrations across the region had in general shown a slight downward trend until 2010. Meteorological conditions during the winter months of 2010 (Jan and February, and November and December) are likely to have been the most significant factors in the increase in concentrations seen in 2010. Winter pollution episodes occur during periods of cold, calm weather. In warmer weather heated air layers near the earths' surface rise, causing air pollutants to be dispersed vertically, and to be diluted. In winter, ground temperatures fall below those of the upper atmospheric layers, causing the air to stay near the ground so that pollutants do not disperse. This can lead to a gradual build up of pollution, often over several days. Such conditions occurred in the UK at the start and end of 2010 when the coldest weather seen in recent years occurred across the country. The elevated concentrations of nitrogen dioxide over these periods, particularly November and December, are shown in Figure 3.10.

Concentrations of $SO_2$ at all three sites which still measure this pollutant remained low during 2010.

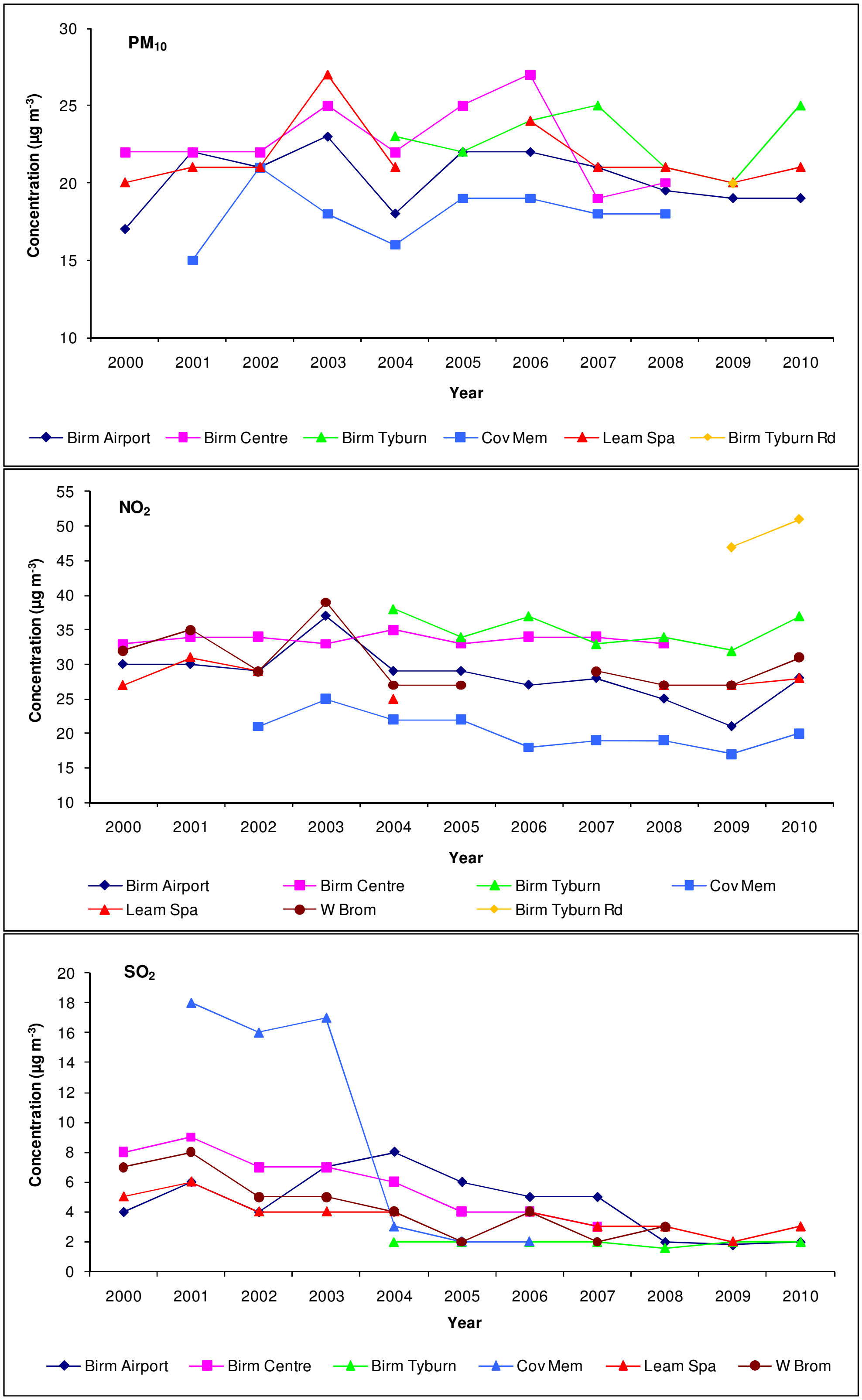



**Figure 3.9: Annual average trends at Birmingham Airport and other local AURN sites.**

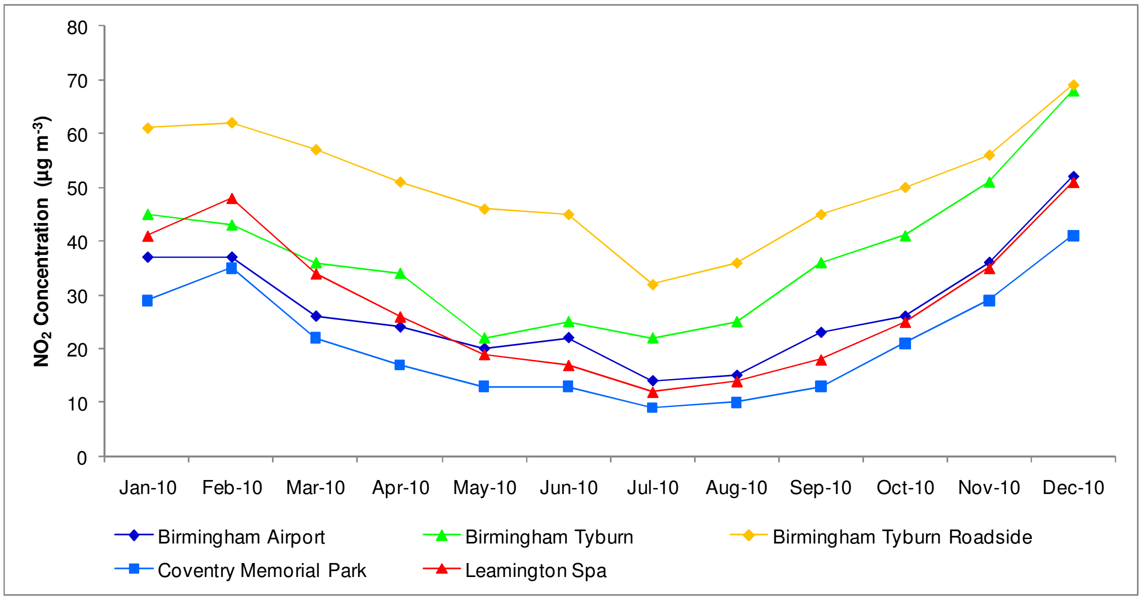



***Figure 3.10: Monthly average concentrations of nitrogen dioxide at Birmingham Airport and other local AURN sites.***

# 4 Summary

Birmingham Airport commissioned AEA Technology (AEA) to undertake annual reporting to provide analysis and commentary on the 2010 Birmingham Airport Air Quality Monitoring Station annual data set, as managed and collated by AEA. This ambient air quality monitoring survey forms part of the Airport's commitment to monitor air quality and the requirements of the Section 106 Obligations with Solihull MBC. This monitoring survey is intended to provide information on the current air quality in the area and the levels of pollution to which the community is currently exposed.

An analysis of data capture rates showed that all the pollutants were above the Defra target of 90% (Defra, 2008) which allowed for robust annual statistics. All of the Air Quality Strategy Objectives for the protection of human health were met at the site during 2010. A demonstration of Birmingham Airports' compliance with the UK Objectives for $NO_2$ is provided in the table below. $NO_2$ is the pollutants which is of specific relevance for airport emission sources as detailed within TG(09).

| Pollutant | AQS Objective | Threshold | Result for Birmingham Airport | Objective met? |
|---|---|---|---|---|
| $NO_2$ | 1-hr mean not to be exceeded more than 18 times a year | 200 µg m$^{-3}$ | 0 exceedences | Yes |
| $NO_2$ | Annual mean | 40 µg m$^{-3}$ | 28 µg m$^{-3}$ | Yes |

In the context of Local Air Quality Management airports are associated with contributing to local ambient $NO_2$ concentrations. The site recorded no exceedences of the $NO_2$ hourly mean objective, and the annual mean concentration of 28 µgm$^{-3}$ was well below the annual mean objective of 40 µgm$^{-3}$. A number of episodes of ozone were identified but all of these were regionally driven episodes and not a result of elevated emissions from the airport.

In order to investigate the possible sources of the air pollution that is being monitored at the Birmingham Airport site, the Birmingham Airport meteorological data was used to add a directional component to the air pollutant concentrations. This analysis does not allow a derivation of any specific values or exceedences but more provides a visual indication as to possible sources of pollution that are being measured at the site. This investigation of potential pollutant sources identified the airport as a source of $NO_2$ and CO concentrations although a significant contribution to $NO_2$ from non-airport sources was identified. This was identified as most likely being a traffic source to the south east, such as from the A45 and M42, which carry significant volumes traffic travelling in and around the Birmingham area. $PM_{10}$ concentrations were found to be partially influenced by the airport but a more significant source was identified to the south east. Again this was most likely due to a local traffic source.

An examination of long term trends showed an increase in concentrations of $NO_2$ at Birmingham Airport and across the region in 2010 which did not continue the downward trend seen over recent years. Meteorological conditions during the winter months of 2010 (Jan and February, and November and December) are likely to have been the most significant factors in these increased concentrations. These winter pollution episodes occur during periods of cold, calm weather which prevent the dispersion of pollutants. Such conditions occurred in the UK at the start and end of 2010 when the coldest temperatures recorded in recent years occurred across the country.

# 5 References

AQEG (2004). Nitrogen dioxide in the United Kingdom. A report by the Air Quality Expert Group prepared for Department for Environment, Food and Rural Affairs in partnership, Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. Defra publications.

Defra (2007). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1). Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. July 2007. http://www.defra.gov.uk/environment/airquality/strategy/pdf/air-qualitystrategy-vol1.pdf

Defra (2008). Local air quality management – technical guidance TG(08). Consultation document. Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. June 2008. http://www.defra.gov.uk/corporate/consult/airqualitymanage-guidance/technical-guidance.pdf

Defra (2009). Part IV of the EnvronmentAct 1995. Local air quality management – technical guidance TG(09). Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. January 2009. http://www.defra.gov.uk/environment/airquality/local/guidance/pdf/tech-guidance-laqm-tg-09.pdf

EC (2008) Council Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe [online]. Available from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT

# Appendices

Appendix 1: Statistical summary 2006 to 2010

Appendix 2: Monitoring station location

Appendix 3: Hydrocarbon results 2010

Appendix 4: PM Monitoring Adjustment

Appendix 5: Air pollution banding details

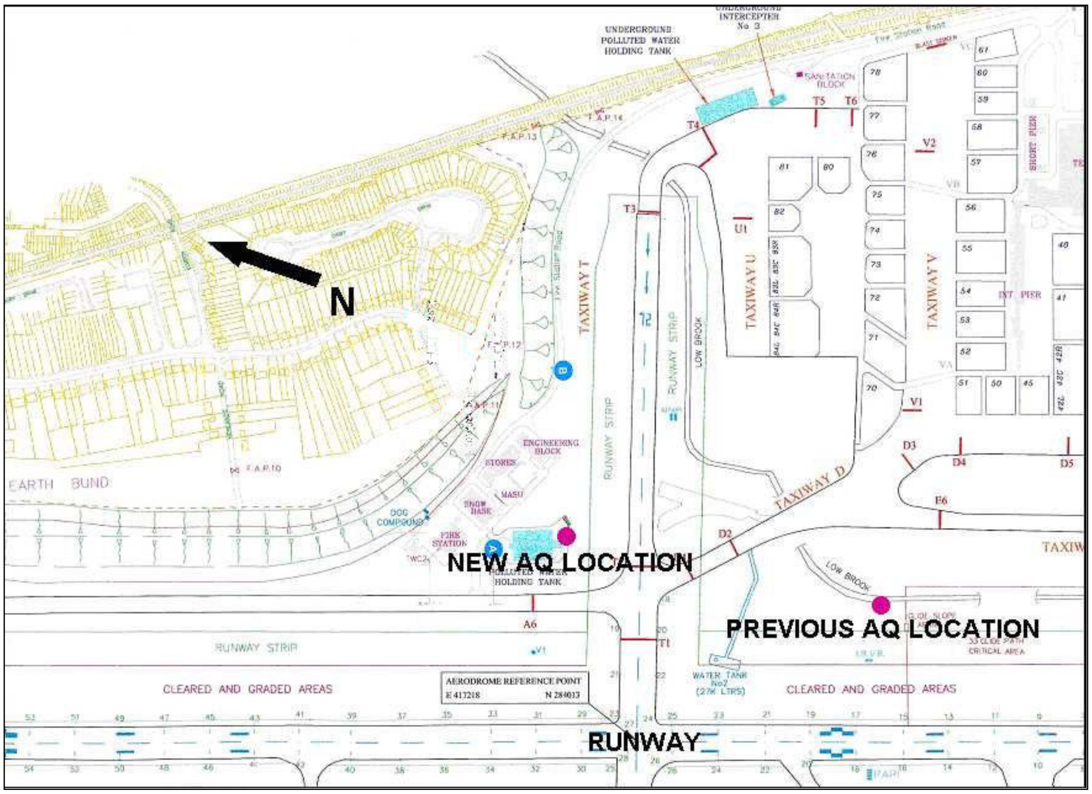
# Appendix 1 - Statistical summary 2006 to 2010

| Statistic | $PM_{10}$ ($\mu gm^{-3}$) VCM corrected from 2009 | $NO_x$ (as $NO_2$) ($\mu gm^{-3}$) | NO ($\mu gm^{-3}$) | $NO_2$ ($\mu gm^{-3}$) | $O_3$ ($\mu gm^{-3}$) | $SO_2$ ($\mu gm^{-3}$) | CO ($mgm^{-3}$) | Benzene ($\mu gm^{-3}$) |
|---|---|---|---|---|---|---|---|---|
| **2010** | | | | | | | | |
| Maximum hourly mean | 200 | 682 | 371 | 159 | 168 | 32 | 1.5 | - |
| Annual mean | 19 | 46 | 12 | 28 | 41 | 2 | 0.2 | 0.8** |
| Maximum daily mean | 48 | - | - | - | - | 7 | - | - |
| Maximum running 8-hr mean | - | - | - | - | 144 | - | 0.8 | - |
| Maximum 15-min mean | - | - | - | - | - | 32 | - | - |
| Data capture (%) | 93 | 99 | 99 | 99 | 99 | 97 | 97 | 100 |
| **2009** | | | | | | | | |
| Maximum hourly mean | 85 | 640 | 356 | 180 | 126 | 35 | 2.0 | - |
| Annual mean | 18 | 34 | 9 | 21 | 42 | 2 | 0.2 | *1.0** |
| Maximum daily mean | 55 | - | - | - | - | 10 | - | - |
| Maximum running 8-hr mean | - | - | - | - | 108 | - | 1.6 | - |
| Maximum 15-min mean | - | - | - | - | - | 37 | - | - |
| Data capture (%) | 92 | 94 | 94 | 94 | 94 | 94 | 94 | 100 |
| **2008** | | | | | | | | |
| Maximum hourly mean | 305 | 1289 | 720 | 220 | 158 | 29 | 3.1 | |
| Annual mean | 16 | 41 | 11 | 25 | 47 | 2 | 0.2 | 0.9** |
| Maximum daily mean | 61 | - | - | - | - | 9 | - | - |
| Maximum running 8-hr mean | - | - | - | - | 152 | - | 2.4 | - |
| Maximum 15-min mean | - | - | - | - | - | 29 | - | - |
| Data capture (%) | 91.3 | 95.6 | 95.6 | 95.6 | 91.5 | 95.6 | 95.6 | 100.0 |
| **2007** | | | | | | | | |
| Maximum hourly mean | 244 | 932 | 521 | 145 | 148 | *43** | 2.6 | |
| Annual mean | 21 | 49 | 14 | 28 | 40 | *5** | 0.2 | 1.0** |
| Maximum daily mean | 116 | - | - | - | - | *13** | - | |
| Maximum running 8-hr mean | - | - | - | - | 135 | - | 1.6 | |
| Maximum 15-min mean | - | - | - | - | - | *90** | - | |
| Data capture (%) | 89.7 | 86.5 | 86.5 | 86.5 | 99.2 | 40.2 | 97.5 | 100.0 |
| **2006** | | | | | | | | |
| Maximum hourly mean | 466 | 686 | 349 | 189 | 202 | 32 | 2.1 | |
| Annual mean | 22 | 47 | 13 | 27 | 47 | 5 | 0.2 | 1.1** |
| Maximum daily mean | 92 | - | - | - | - | 16 | - | |
| Maximum running 8-hr mean | - | - | - | - | 195 | - | 1.7 | |
| Maximum 15-min mean | - | - | - | - | - | 43 | - | |
| Data capture (%) | 90.4 | 79.8 | 79.8 | 79.8 | 93.8 | 91.6 | 93.3 | 100.0 |

* Results indicative only due to the low data capture.

** Results based on monthly exposure periods

# Appendix 2 – Monitoring station location




**Site 1 is the old AQ location. Site 2 is the current AQ location, operational from 10/1/06 onwards.**

# Appendix 3 – Hydrocarbon results 2010

| Approximate month | Date exposed | Date removed | Benzene (ppb) | Toluene (ppb) | Ethyl benzene (ppb) | mp-xylene (ppb) | o-xylene (ppb) | Benzene ($\mu gm^{-3}$) |
|---|---|---|---|---|---|---|---|---|
| Dec/Jan | 15/12/2009 | 12/01/2010 | 0.47 | 0.49 | 0.15 | 0.39 | 0.23 | 1.52 |
| Jan/Feb | 12/01/2010 | 12/02/2010 | 0.27 | 0.45 | 0.11 | 0.22 | 0.08 | 0.88 |
| Feb/Mar | 12/02/2010 | 30/03/2010 | 0.27 | 0.34 | 0.09 | 0.20 | 0.09 | 0.89 |
| April | 30/03/2010 | 28/04/2010 | 0.28 | 0.36 | 0.10 | 0.24 | 0.12 | 0.90 |
| May | 28/04/2010 | 26/05/2010 | 0.14 | 1.01 | 0.10 | 0.29 | 0.11 | 0.45 |
| June | 26/05/2010 | 02/07/2010 | 0.10 | 0.27 | 0.12 | 0.20 | 0.07 | 0.33 |
| July | 02/07/2010 | 11/08/2010 | 0.10 | 0.31 | 0.13 | 0.26 | 0.09 | 0.32 |
| Aug | 11/08/2010 | 31/08/2010 | 0.17 | 0.34 | 0.13 | 0.24 | 0.07 | 0.54 |
| Sept | 31/08/2010 | 28/09/2010 | 0.14 | 0.34 | 0.09 | 0.21 | 0.07 | 0.45 |
| Octr | 28/09/2010 | 26/10/2010 | 0.14 | 0.29 | 0.09 | 0.19 | 0.07 | 0.46 |
| Nov | 26/10/2010 | 01/12/2010 | 0.54 | 0.87 | 0.19 | 0.48 | 0.16 | 1.75 |
| Dec | 01/12/2010 | 05/01/2011 | 0.49 | 0.42 | 0.10 | 0.20 | 0.13 | 1.59 |

# Appendix 4 – PM Monitoring Adjustment

**TEOM**

The $PM_{10}$ monitoring data recoded by TEOM monitors were corrected with Volatile Correction Model (VCM). The Volatile Correction Model (VCM) web portal allows you to correct TEOM measurements for the loss of volatile components of particulate matter that occur due to the high sampling temperatures employed by this instrument. The resulting corrected measurements have been demonstrated as equivalent to the gravimetric reference equivalent.

Method:

The following data are required as inputs to the VCM:

- Daily or hourly average temperatures
- Daily or hourly pressures
- Daily or hourly TEOM concentrations ($\mu g\ m^{-3}$)
- Daily or hourly FDMS (Filter Dynamic Measurement System) purge measurements ($\mu g\ m^{-3}$)

The VCM works by using the volatile particulate matter measurements provided by nearby FDMS instruments (within 130 km) to assess the loss of $PM_{10}$ from the TEOM; this value is then added back onto the TEOM measurements.

The correction generated by the VCM is geographically specific, an exact location of your TEOM instrument is therefore required.

The VCM can be accessed through http://www.volatile-correction-model.info.

# Appendix 5 – Air pollution banding details

***Air pollution bandings and description.***

| Band | Index | Health Descriptor |
|---|---|---|
| Low | 1 to 3 | Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants |
| Moderate | 4 to 6 | Mild effects, unlikely to require action, may be noticed amongst sensitive individuals. |
| High | 7 to 9 | Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their 'reliever' inhaler is likely to reverse the effects on the lung. |
| Very High | 10 | The effects on sensitive individuals described for 'High' levels of pollution may worsen. |

***Boundaries between index points for each pollutant.***

| Band | Index | $O_3$ | $NO_2$ | $SO_2$ | CO | $PM_{10}$ (gravimetric) | $PM_{10}$ (Reference equiv.) |
|---|---|---|---|---|---|---|---|
| | | 8 hourly or hourly mean ($\mu g\ m^{-3}$)* | hourly mean ($\mu g\ m^{-3}$) | 15 minute mean ($\mu g\ m^{-3}$) | 8 hourly mean ($mg\ m^{-3}$) | 24 hour mean ($\mu g\ m^{-3}$) | 24 hour mean ($\mu g\ m^{-3}$) |
| Low | 1 | 0-32 | 0-95 | 0-88 | 0-3.8 | 0-21 | 0-19 |
| | 2 | 33-66 | 96-190 | 89-176 | 3.9-7.6 | 22-42 | 20-40 |
| | 3 | 67-99 | 191-286 | 177-265 | 7.7-11.5 | 43-64 | 41-62 |
| Moderate | 4 | 100-126 | 287-381 | 266-354 | 11.6-13.4 | 65-74 | 63-72 |
| | 5 | 127-152 | 382-477 | 355-442 | 13.5-15.4 | 75-86 | 73-84 |
| | 6 | 153-179 | 478-572 | 443-531 | 15.5-17.3 | 87-96 | 85-94 |
| High | 7 | 180-239 | 573-635 | 532-708 | 17.4-19.2 | 97-107 | 95-105 |
| | 8 | 240-299 | 636-700 | 709-886 | 19.3-21.2 | 108-118 | 106-116 |
| | 9 | 300-359 | 701-763 | 887-1063 | 21.3-23.1 | 119-129 | 117-127 |
| Very High | 10 | 360 or more | 764 or more | 1064 or more | 23.2 or more | 130 or more | 128 or more |

* For ozone, the maximum of the 8 hourly and hourly mean is used to calculate the index value.

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR

Tel: 0870 190 1900
Fax: 0870 190 4850

www.aeat.co.uk