Air Quality Monitoring Annual Report 2012

Birmingham Airport

Report for Birmingham Airport Ltd

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Executive summary

Birmingham Airport commissioned Ricardo-AEA to produce an annual report to provide analysis and commentary on the 2012 data sets from the Birmingham Airport air quality monitoring station, as managed and collated by Ricardo-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. The objective of the monitoring is to provide information on the current air quality in the area and the levels of pollution to which the community is currently exposed.

Nitrogen dioxide (NO_2) is the main pollutant of specific relevance to airport emission sources. All applicable Air Quality Strategy (AQS) objectives for this pollutant were met at the monitoring site during 2012. A demonstration of Birmingham Airport's compliance with the UK Objectives for NO_2 is provided in the table below.

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 exceedances	Yes
	Annual mean	40 µg m^{-3}	24 µg m^{-3}	Yes

The AQS objectives for carbon monoxide (CO), sulphur dioxide (SO_2), ozone (O_3) and PM_{10} particulate matter were also met during 2012.

The investigation of potential pollutant sources identified the airport as a key source of the NO_2, SO_2 and CO measured at the monitoring site, although for higher wind speeds a significant contribution from approximately the SSE direction was identified (this is the direction of a large car park). Particulate matter (PM_{10}) concentrations were found to be partially influenced by the airport but at higher wind speeds a source in the direction of the airport buildings dominated.

An examination of long term trends indicated at Birmingham Airport and nearby AURN sites showed no clear trends in PM_{10}. Concentrations of NO_2 at Birmingham Airport and across the region increased in 2012 compared to 2011. SO_2 concentrations remained low at all sites.

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1 Introduction

Birmingham Airport has undertaken continuous ambient air quality monitoring at a monitoring station on the airport premises since April 1995. This forms part of the Airport's commitment to monitor air quality through the requirements of the Section 106 Planning Agreement between Solihull Metropolitan Borough Council (SMBC) and Birmingham International Airport Limited. The monitoring is intended to provide information on current air quality in the area and the levels of pollution to which the neighbouring community is exposed. The data from the air monitoring station are managed and collated by Ricardo-AEA Ltd. This report has been prepared by Ricardo-AEA on behalf of Birmingham Airport, to provide analysis and commentary on the 2012 dataset.

1.1 UK Air Quality Strategy

Within the European Union, ambient air quality is covered by Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe[1], known as the Air Quality Directive (AQD). This consolidated four previously existing Directives, which set limit values for a range of air pollutants with known health impacts. The original Directives were transposed into UK law via The Environment Act 1995 and subsequent Statutory Instruments. This Act also 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). This requires local authorities to review and assess 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 to achieve the air quality objectives, and the timescale for this. The legal framework given in the Environment Act has been adopted in the UK via the UK Air Quality Strategy.

The air quality objectives are based on recommendations of the Expert Panel on Air Quality Standards (EPAQS) regarding the levels of air pollutants at which there would be little risk to human health. All Air Quality Strategy objectives must be at least as stringent as the EC limit values.

Since its original publication in 1997, the UK Air Quality Strategy has undergone a number of updates. These have reflected improvements in the understanding of air pollutants and their health effects. They have also incorporated new European limit values, both for pollutants already covered by the Strategy and for newly introduced pollutants such as polycyclic aromatic hydrocarbons and $PM_{2.5}$ particulate matter. The latest version of the strategy was published by Defra in 2007[2]. The current UK air quality objectives for the pollutants monitored at Birmingham Airport are presented in Table 1.1.

Table 1.1: Applicable objectives included in the Air Quality Standards Regulations (2010) for the purpose of Local Air Quality Management.

Pollutant	Air Quality Objective		To be achieved by
	Concentration	Measured as	
Benzene (England and Wales)	5.00 µg m^{-3}	Annual mean	31 December 2010
Carbon monoxide (CO) (England, Wales and N. Ireland)	10.0 mg m^{-3}	Maximum daily running 8-hour mean	31 December 2003
Nitrogen dioxide (NO_2)	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
Sulphur dioxide (SO_2)	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 (O_3)*	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 as part of the LAQM regime.**

1.2 Emissions from Airports

Aircraft produce the same types of emissions as many other combustion processes. Aircraft jet engines, like many other vehicle engines, produce carbon dioxide (CO_2), water vapour (H_2O), nitrogen oxides (NOx), carbon monoxide (CO), oxides of sulphur (SOx), particulate matter, hydrocarbons from partially combusted fuel, and other trace compounds. In addition to the aircraft, there will also be emissions from the airside vehicles, and from road vehicles travelling to and from the airport.

Previous rounds of Review and Assessment within the LAQM process have not highlighted any cases where airports appear to have caused exceedances of air quality objectives for particulate matter measured as PM_{10}. The key pollutant of concern from airports is NO_2. Local Authorities whose areas contain airports with over 10 million passengers per annum must take these into account in their annual Review and Assessment of air quality.

Of the NOx 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 NOx 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 100 m 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[3].

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, strictly these limits do not apply. However, this report compares the data from the site with the Air Quality Strategy (AQS) Objectives. 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, PM_{10}, CO and SO_2 - then it is reasonable to assume that, in the absence of any other significant sources, the objectives are likely to be met at the nearby residential properties.

For the purposes of LAQM, the airport falls under the jurisdiction of Solihull MBC. The Council has reviewed air quality across their area and found that pollutant levels do not exceed the AQS Objectives. Therefore no air quality management areas have been declared in Solihull.

2 Monitoring Methodology

2.1 Pollutants and Measurement Techniques

The following pollutants were monitored at Birmingham Airport in 2012:

- Particulate matter as PM_{10}
- Oxides of nitrogen - NOx, which comprises nitrogen dioxide (NO_2) and nitric oxide (NO).
- CO
- O_3
- SO_2
- A suite of four hydrocarbons (benzene, toluene, ethylbenzene and xylenes).

Ozone is a secondary pollutant and trans-boundary in nature. As a result, Local Authorities have little control over ozone concentrations in their areas. The Government has recognised the problems associated with achieving the air quality objective for ozone, and this is not included in the LAQM regime.

Table 2.1 shows the measurement technique employed for each pollutant.

Table 2.1: Measurement techniques employed at Birmingham Airport in 2012

Pollutant	Measurement Technique
PM_{10}	Tapered Element Oscillating Microbalance (TEOM)
NO_2	Chemiluminescence
NOx	Chemiluminescence
CO	Non-dispersive infrared absorption (NDIR)
O_3	Non-dispersive ultraviolet absorption technology (NDUV)
SO_2	Ultraviolet Fluorescence (UVF)
Hydrocarbons	BTEX diffusion tube (indicative passive sampling technique)

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

All ambient concentration measurements in the report are quoted in microgrammes per cubic metre (µg m^{-3}) or in the case of carbon monoxide milligrammes per cubic metre (mg m^{-3}) at reference conditions of 20 °C, 1013 mbar.

Historically, benzene, toluene and xylene were measured using PID (photo ionization detection). However, the measured concentrations were consistently low, so these measurements were discontinued. Indicative measurements are now made using “BTEX” diffusion tubes. BTEX (benzene,toluene, ethylbenzene and xylene) diffusion tubes are exposed monthly in pairs. Benzene is the only one of the BTEX hydrocarbons for which there is an AQS Objective.

2.2 VCM Correction of PM_{10} Data

The TEOM particulate monitor uses a 50 °C heated sample inlet to prevent condensation on the filter. Although necessary, this elevated temperature can result in the loss of volatile and semi-volatile components of PM_{10}, such as ammonium nitrate.

It is not possible to address this problem by applying a simple correction factor. However, King's College London (KCL) have developed a Volatile Correction Model[4], which allows TEOM PM_{10} data to be corrected for the volatile components lost as a result of the TEOM's heated inlet. The model is available at http://www.volatile-correction-model.info/Default.aspx. It uses data from nearby TEOM-FDMS particulate analysers, which measure the volatile and non-volatile components of the PM_{10}. The volatile component (which typically does not vary much over a large region), can be added to the TEOM measurement. KCL state that the resulting corrected measurements have been demonstrated as equivalent to the gravimetric reference equivalent. In this report, the VCM has been used to correct PM_{10} data where applicable. Where this has been done, it is clearly indicated. The methodology for the VCM correction of PM_{10} data is presented in Appendix 1.

2.3 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 old and new locations is included in Appendix 2.

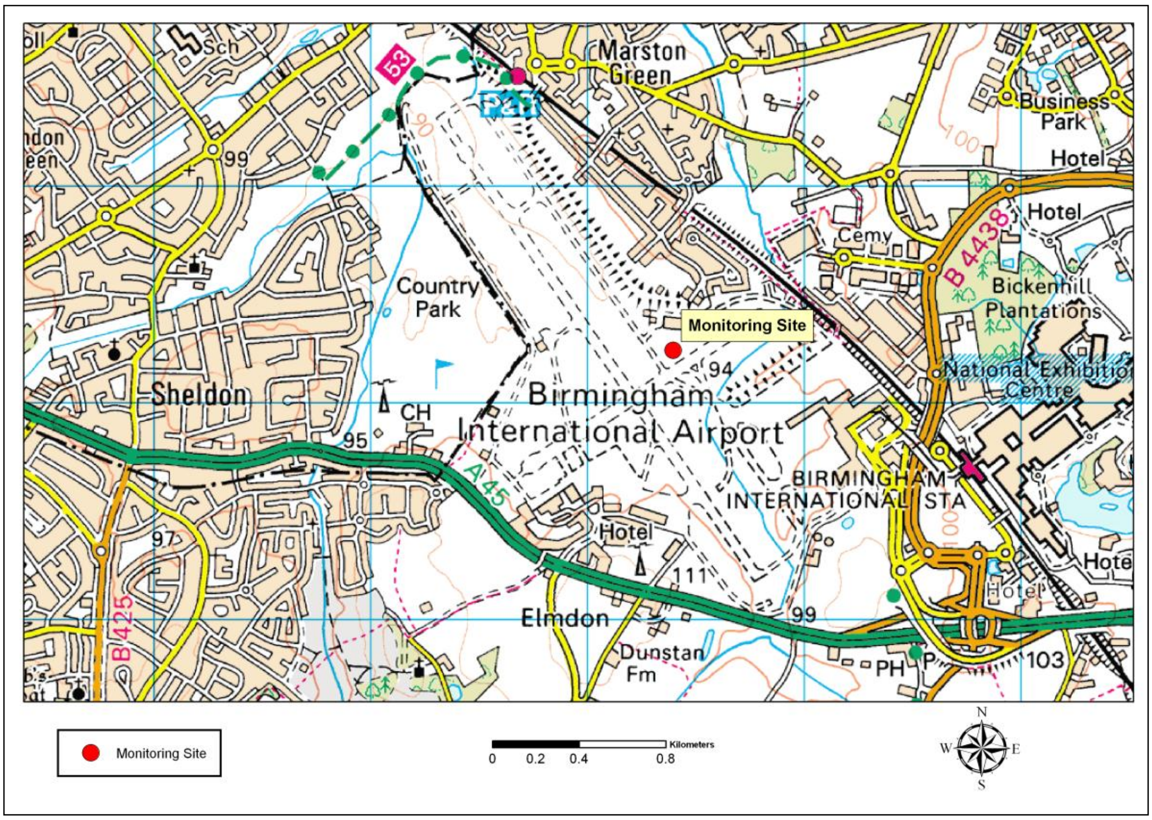

Figure 2-1: Location of monitoring site. *© Crown Copyright Ordnance Survey Reproduced from Landranger 1:50000 map series, Licence number 100020110*

2.4 Meteorological Data

The following meteorological data were collected at the monitoring station:

- Ambient Temperature (°C)
- Pressure (mbar)
- Relative Humidity (%)
- Wind Direction (°)
- Wind Speed (m s^{-1})

The meteorological data are not covered by the data management contract with Ricardo-AEA. All checking and QA/QC on the meteorological data are carried out by Birmingham Airport, who have sole responsibility for the accuracy of all meteorological data used in this report.

The wind speed and direction frequencies for the whole of 2012 are shown in Figure 2-2. 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 was measured from each direction, e.g. Figure 2-2 shows that the wind direction was from the north for 5% of the year. The prevalent wind directions were westerly and south-westerly.

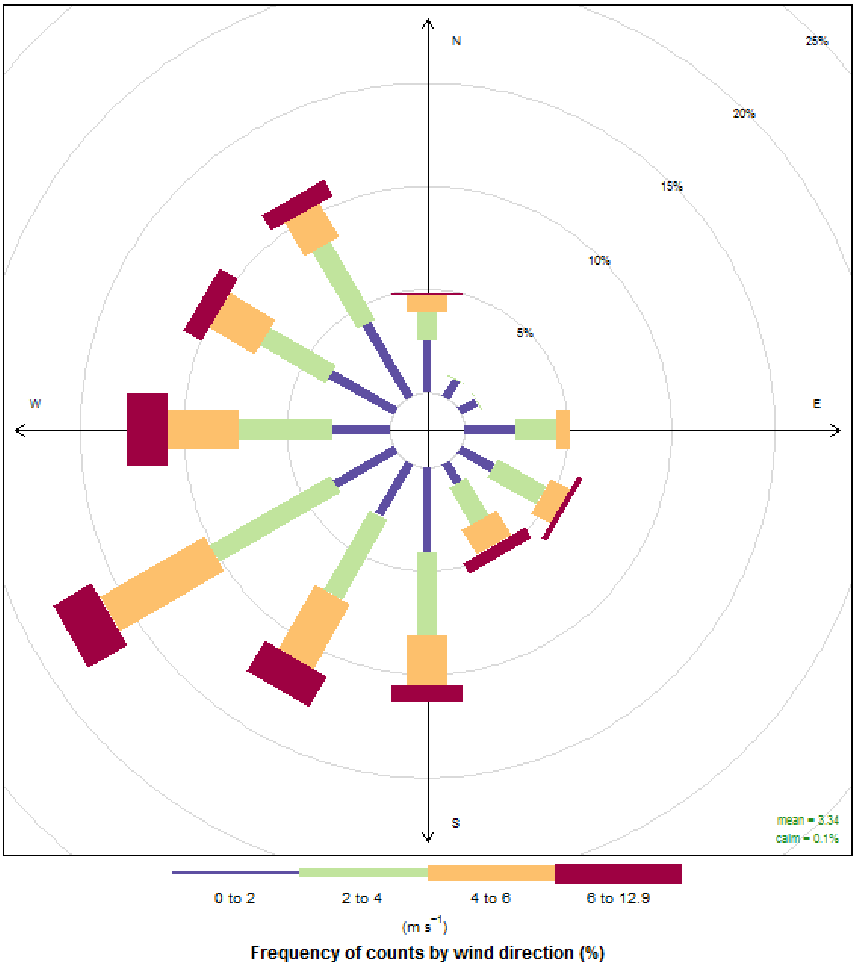

Figure 2-2: Wind rose showing the wind speed and direction in 2012.
(The concentric circles indicate the percentage of time that the wind was blowing from each direction.)

The wind speed and direction data, split by month, are shown in Figure 2-3. This shows that the strongest wind speeds from the south-west were recorded during January, February, June, September, October, November and December, as indicated by the direction bars having orange and red classifications for significant portions of time.

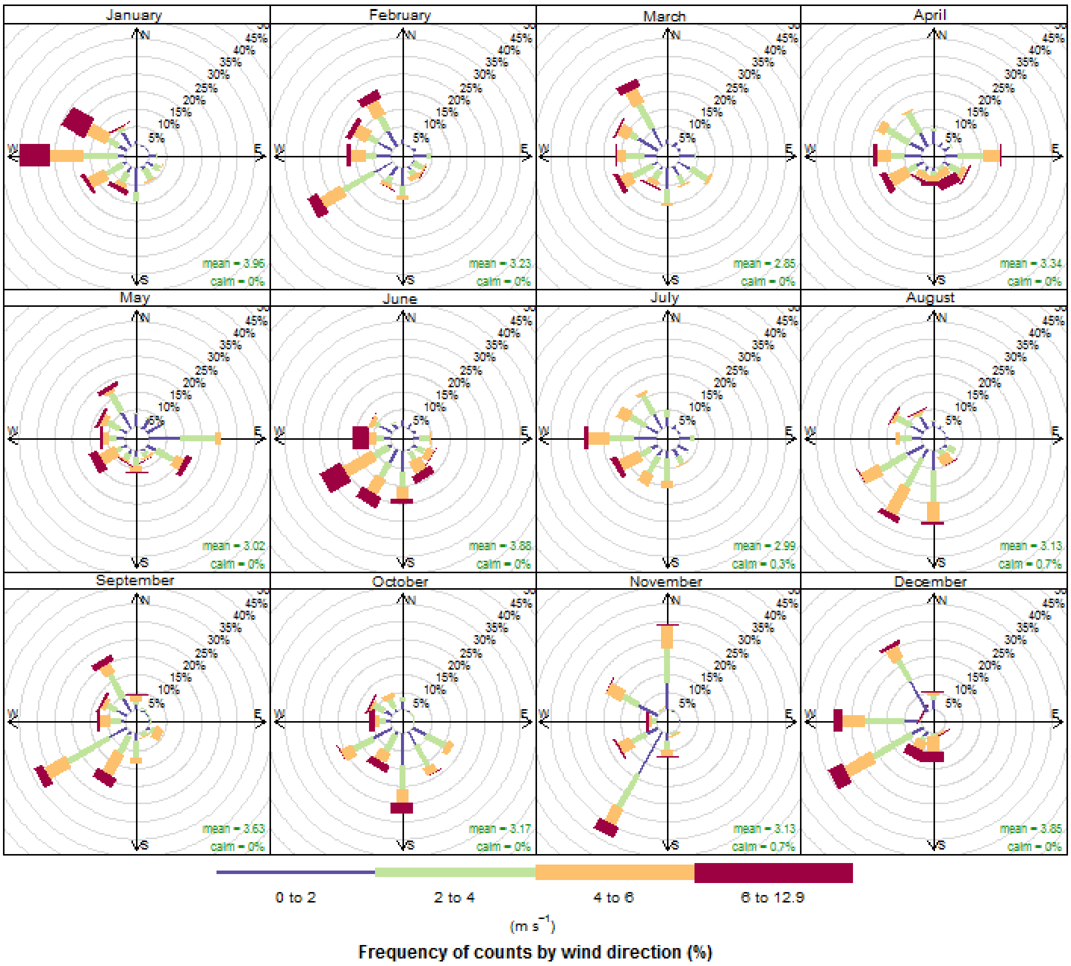

Figure 2-3: Wind rose showing wind speed and direction by month.

2.5 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. The two monitoring sites used for this comparison are Birmingham Tyburn and Birmingham Tyburn Roadside.

The Birmingham Tyburn monitoring station is classified as 'Urban Background', located to the rear of the 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. Both are part of the National Automatic Urban and Rural Network (AURN).

Both stations measure NOx, O_3, PM_{10} and $PM_{2.5}$. At these sites particulate monitoring has been undertaken using the FDMS-TEOM since the beginning of 2009. Monitoring of SO_2 is also undertaken at Birmingham Tyburn.

3 Data Analysis

This section provides a summary of the data for 2012 and a comparison with the Air Quality Strategy Objectives. It also presents analysis of pollution episodes, identifies potential emission sources and looks at long-term trends.

3.1 Annual Data Summary

3.1.1 Automatic monitoring data

Table 3.1 presents the key statistics for each pollutant. The Defra Technical Guidance document for LAQM (LAQM.TG(09))[5], requires the use of the Volatile Correction Model (VCM) to correct TEOM data against FDMS data as explained in section 2.2. The hourly average concentrations of PM_{10} in this section are therefore corrected using the VCM to enable direct comparison with the Air Quality Strategy (AQS) objectives. The FDMS data are from AURN sites: AURN data for October-December 2012 have not been fully ratified at the time of writing. Therefore it is possible there may be some minor changes to the VCM correction when the fully ratified dataset is released at the end of March 2013.

Data capture for all monitored pollutants was above the Defra target of 90%[5] for ratified datasets. This data capture target 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.

There were two significant periods of data loss. The first was for between 1st and 3rd January 2012. This was due to a communications failure (faulty data logger). The second period was between 23rd and 25th May 2012. This was due to power failure.

Table 3.1: Summary air quality statistics for Birmingham Airport - 2012.

Statistic	PM_{10} µg m^{-3}*	NO_x AsNO_2, µg m^{-3}	NO µg m^{-3}	NO_2 µg m^{-3}	O_3 µg m^{-3}	SO_2 µg m^{-3}	CO mg m^{-3}	Ben-zene µg m^{-3}
Maximum 15-minute mean	-	409	139	764	162	61	1.7	-
Maximum hourly mean	157	321	115	605	158	56	1.6	-
Maximum running 8-hour mean	-	272	88	495	144	25	1.2	-
Maximum running 24-hour mean	-	155	70	302	101	12	0.6	-
Maximum daily mean	51	127	70	263	96	11	0.5	-
Average	17	10	24	40	41	2	0.2	0.41**
Data capture	97.3	98.4 %	98.4 %	98.4 %	98.7 %	98.4 %	98.7 %	100%

* VCM corrected using provisional FDMS data from AURN sites
** Indicative only

Figure 3-1 presents the hourly average concentration for each continuously monitored pollutant.

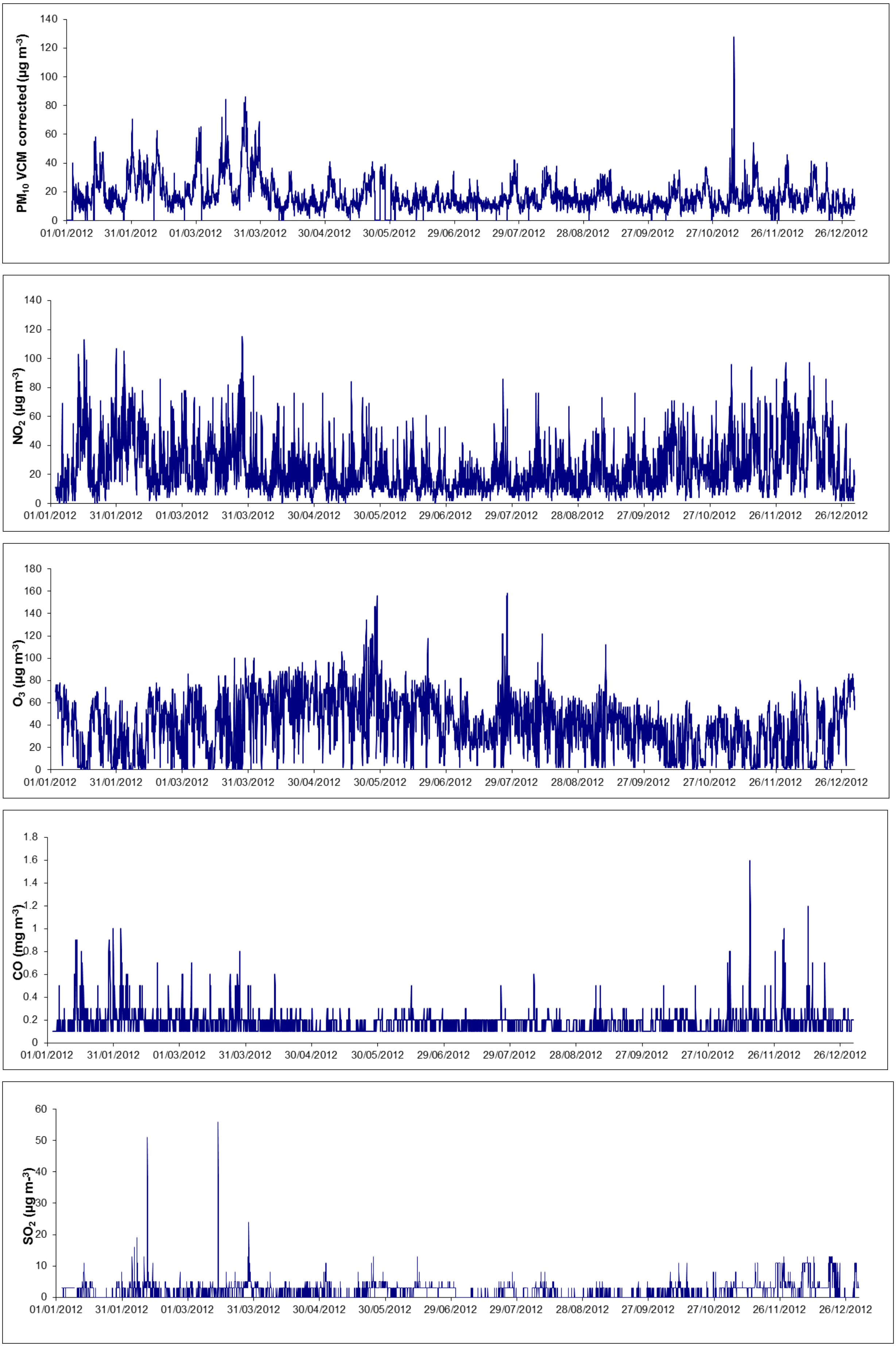

Figure 3-1: Hourly mean pollutant concentration at Birmingham Airport – 2012.

3.1.2 Non-automatic hydrocarbon monitoring data

The full dataset for benzene and the other hydrocarbon species are presented in Appendix 3.

Figure 3-2 presents the monthly average concentrations of benzene, as measured indicatively using BTEX diffusion tubes.

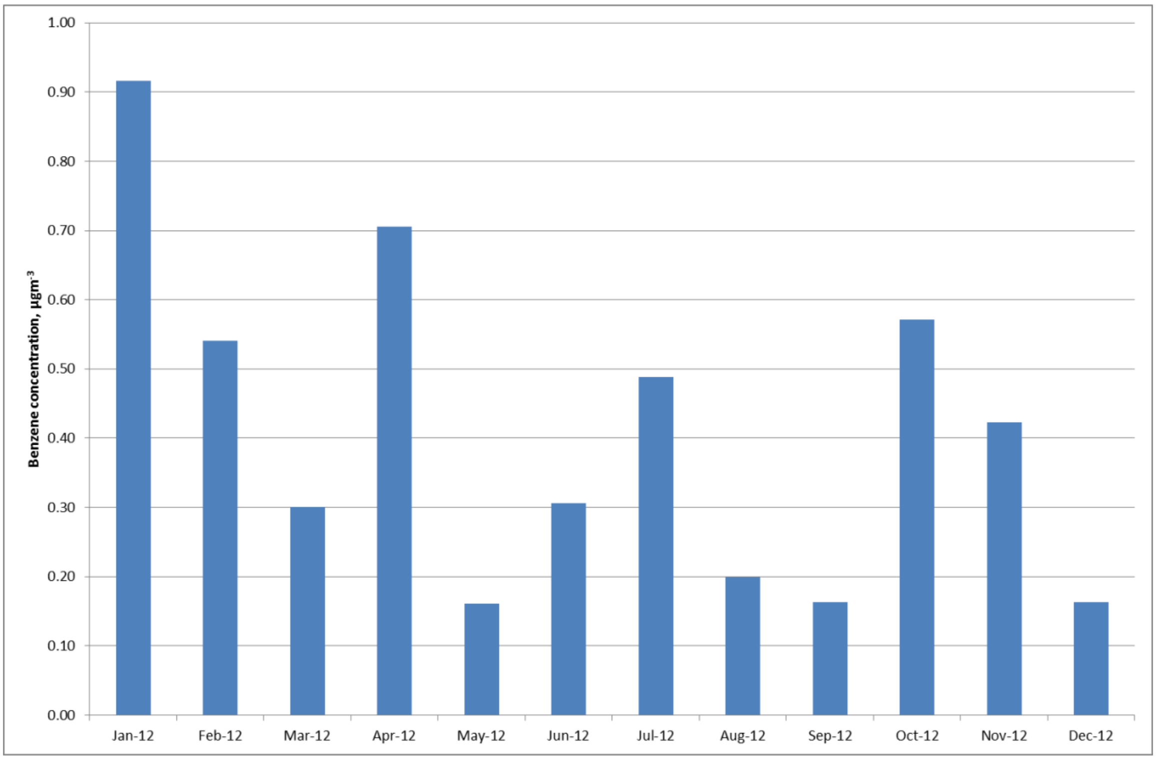

Figure 3-2: Monthly average concentrations of benzene – 2012.

The annual mean benzene concentration was 0.41 µg m^{-3}.

3.2 Comparison with Other Local Monitoring Sites

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 to react with the available ozone and thus ozone concentrations are not depleted.

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

Parameter	Birmingham Airport	Birmingham Tyburn Roadside	Birmingham Tyburn
Annual mean			
PM_{10} (µg m^{-3})	18*	22	19
NO_2 (µg m^{-3})	24	45	32
O_3 (µg m^{-3})	41	30	37
SO_2 (µg m^{-3})	2	-	2
CO (mg m^{-3})	0.2	-	-
Maximum hourly mean			
PM_{10} (µg m^{-3})	128*	295	288
NO_2 (µg m^{-3})	115	201	162
O_3 (µg m^{-3})	158	138	152
SO_2 (µg m^{-3})	56	-	67
CO (mg m^{-3})	1.6	-	-

* VCM corrected using provisional FDMS data from AURN sites

3.3 Comparison with AQS Objectives

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 2012 at Birmingham Airport.

There was one day on which the VCM-corrected daily mean PM_{10} concentration exceeded the AQS objective of 50 µg m^{-3}. This is well within the maximum number of exceedances permitted (35 per calendar year). The annual mean of 18 µg m^{-3} was below the AQS objective of 40 µg m^{-3}.

NO_2 is the key pollutant of concern within Local Air Quality Management, especially around airports. There were no measured exceedances of the NO_2 hourly mean objective. The annual mean of 24 µg m^{-3} was also well below the annual mean objective of 40 µg m^{-3}.

AQS objectives for CO, SO_2 and benzene were met in 2012.

The AQS objective for ozone was met in 2012. There were 8 days on which the maximum daily 8-hour mean ozone concentration exceeded 100 µg m^{-3}. This is within the permitted maximum of 10 days. As highlighted in section 2.1, ozone is currently not included in the LAQM regime, because it is a transboundary pollutant over which Local Authorities have very little control.

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}	5 days	Yes
	Annual mean	40 µg m^{-3}	18 µg m^{-3}	Yes
NO_2	1-hr mean not to be exceeded more than 18 times a year	200 µg m^{-3}	0 exceedances	Yes
	Annual mean	40 µg m^{-3}	24 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}	8 days	Yes
SO_2	15-min mean not to be exceeded more than 35 times a year	266 µg m^{-3}	0 exceedances	Yes
	1-hr mean not to be exceeded more than 24 times a year	350 µg m^{-3}	0 exceedances	Yes
	24-hr mean not to be exceeded more than 3 times a year	125 µg m^{-3}	0 exceedances	Yes
CO	Maximum daily running 8 hour mean	10 mg m^{-3}	0 exceedances	Yes
Benzene (England & Wales)	Calendar year mean	5 µg m^{-3}	0.41 µg m^{-3}	Yes

3.4 Periods of Elevated Pollution

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 based on the Daily Air Quality Index, which uses a banding system approved by the Committee on Medical Effects of Air Pollution Episodes (COMEAP). This defines thresholds corresponding to LOW, MODERATE, HIGH and VERY HIGH pollution, and is used within the UK to provide information about air pollution levels to allow sensitive people to take action if required.

The Daily Air Quality Index and the thresholds corresponding to each band were changed at the beginning of 2012. The descriptions associated with each band are provided and the concentration ranges for each index are presented in Appendix 4.

Table 3.4 shows the number of days when pollutant concentrations exceeded the LOW band. The concentrations of all the pollutants apart from PM_{10} and ozone remained within the LOW band in 2012. The running 24-hour mean PM_{10} concentration went into the MODERATE band during five days in 2012. Ozone went into the MODERATE band on 8 days.

The key pollutants are discussed in more detail below.

Table 3.4: Number of days during the year with "Moderate" or higher pollution

Pollutant	PM_{10}	NO_2	Ozone	SO_2	CO
Very High	0	0	0	0	0
High	0	0	0	0	0
Moderate	5	0	8	0	0

3.4.1 Particulate Matter

The 24-hour mean PM_{10} concentration went into the "Moderate" band on five days during 2012 (31^{st} January, 2^{nd}, 22^{nd}, 23^{rd} and 24^{th} March). A time series of 24-hour mean PM_{10} concentrations (VCM corrected using provisional AURN data) is shown in ***Figure 3-3***.

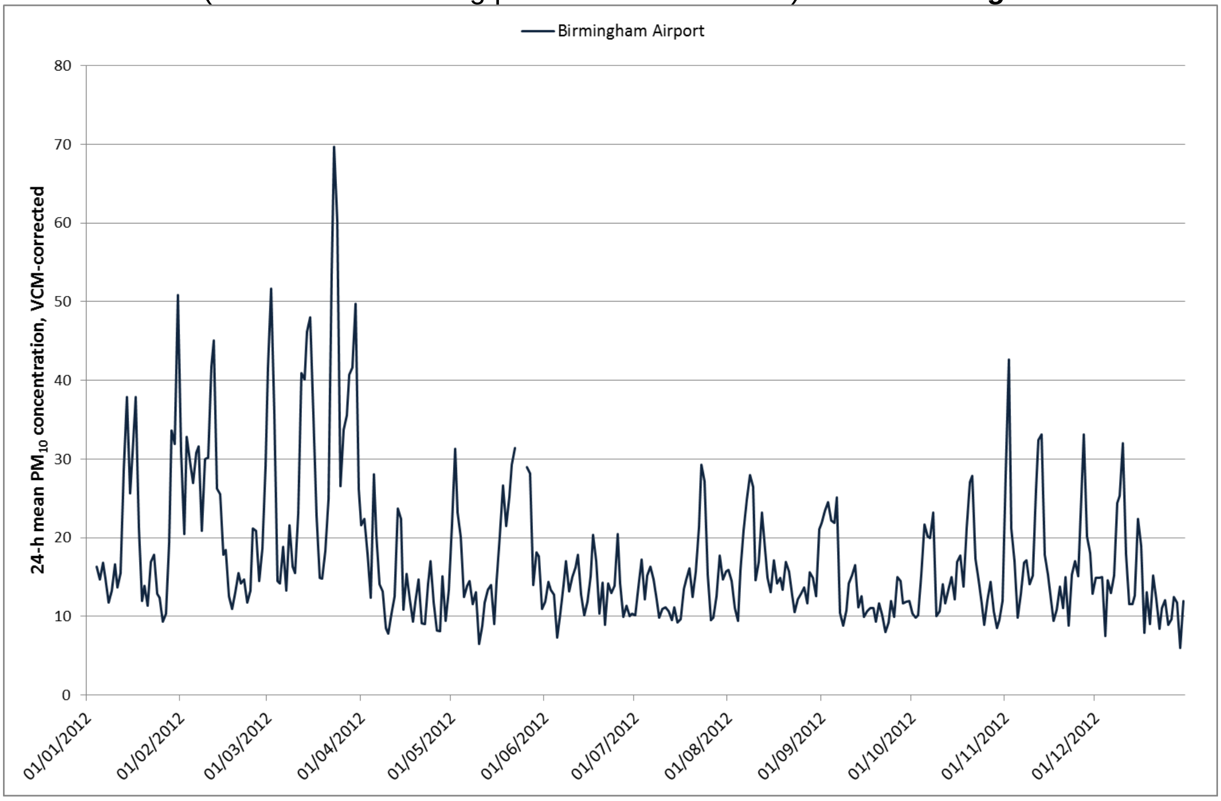

Figure 3-3: PM_{10} 24-hr mean concentrations at Birmingham Airport - 2012.

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.

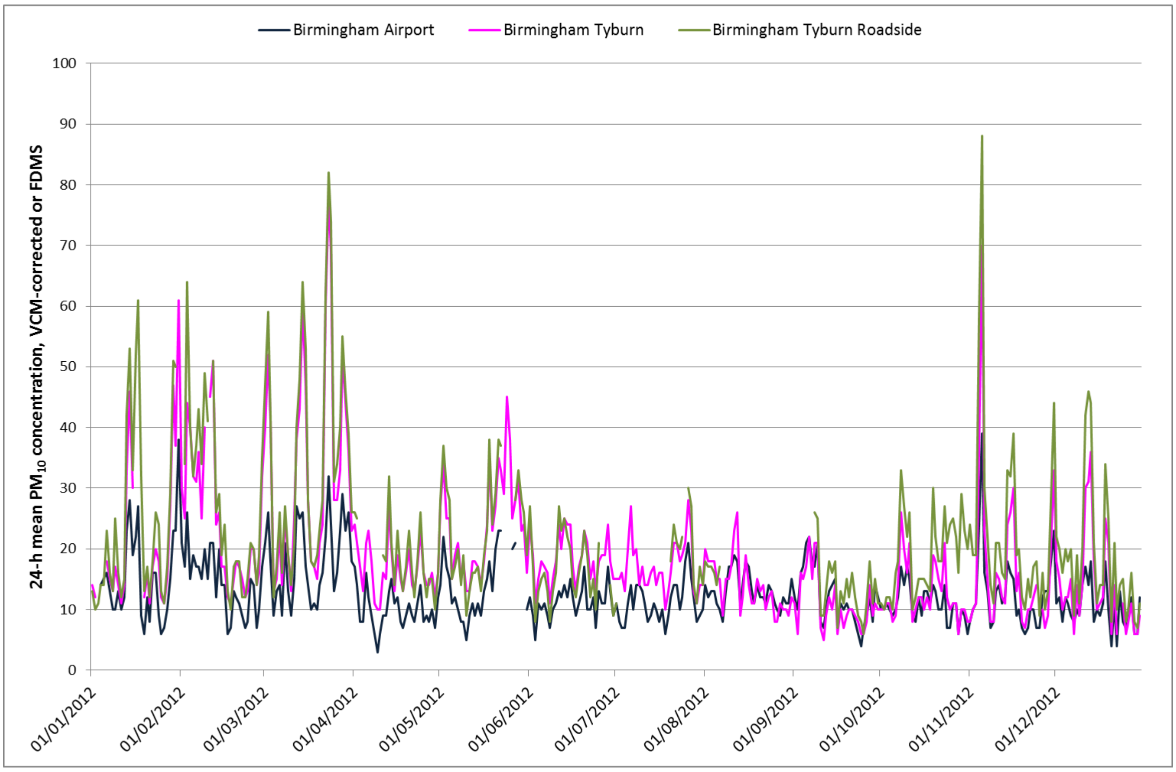

Figure 3-4: PM_{10} 24-hr mean concentrations at Birmingham Airport and two AURN sites – 2012.

3.4.2 Nitrogen Dioxide

The 1-hour mean concentrations of NO_2 remained within the "Low" band throughout 2012. 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.

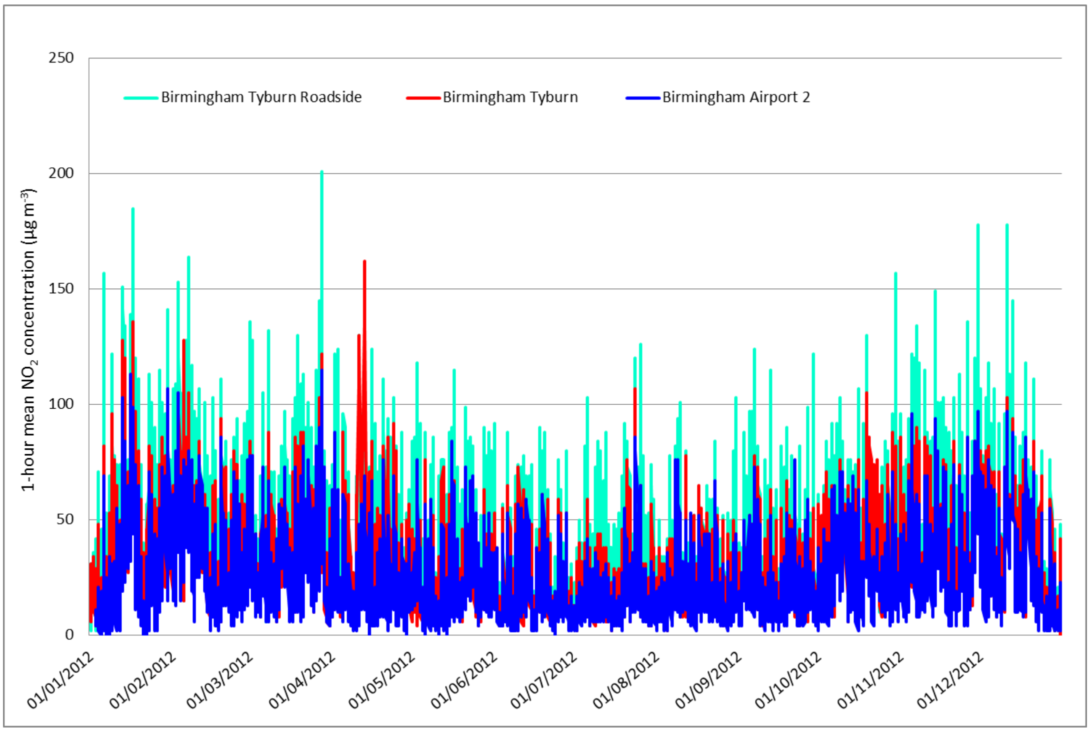

Figure 3-5: NO_2 1-hr mean concentrations at Birmingham Airport and two AURN sites – 2012.

These show that Birmingham Airport followed regional trends.

3.4.3 Ozone

The 8-hour mean ozone concentration went into the “Moderate” band on 8 days during 2012. All these days were between 23rd May and 11th August, reflecting the fact that ozone concentrations are usually highest during the summer months. The maximum 8-hour mean recorded was 144 µg m^{-3}. The time series of daily maximum running 8-hour mean ozone concentrations is shown in Figure 3-6.

A similar pattern of daily maximum running 8-hour mean ozone concentrations recorded at Birmingham Airport can be seen at the two Birmingham sites presented in Figure 3-7.

These exceedances 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 periods of slightly higher NO_2 in the winter months.

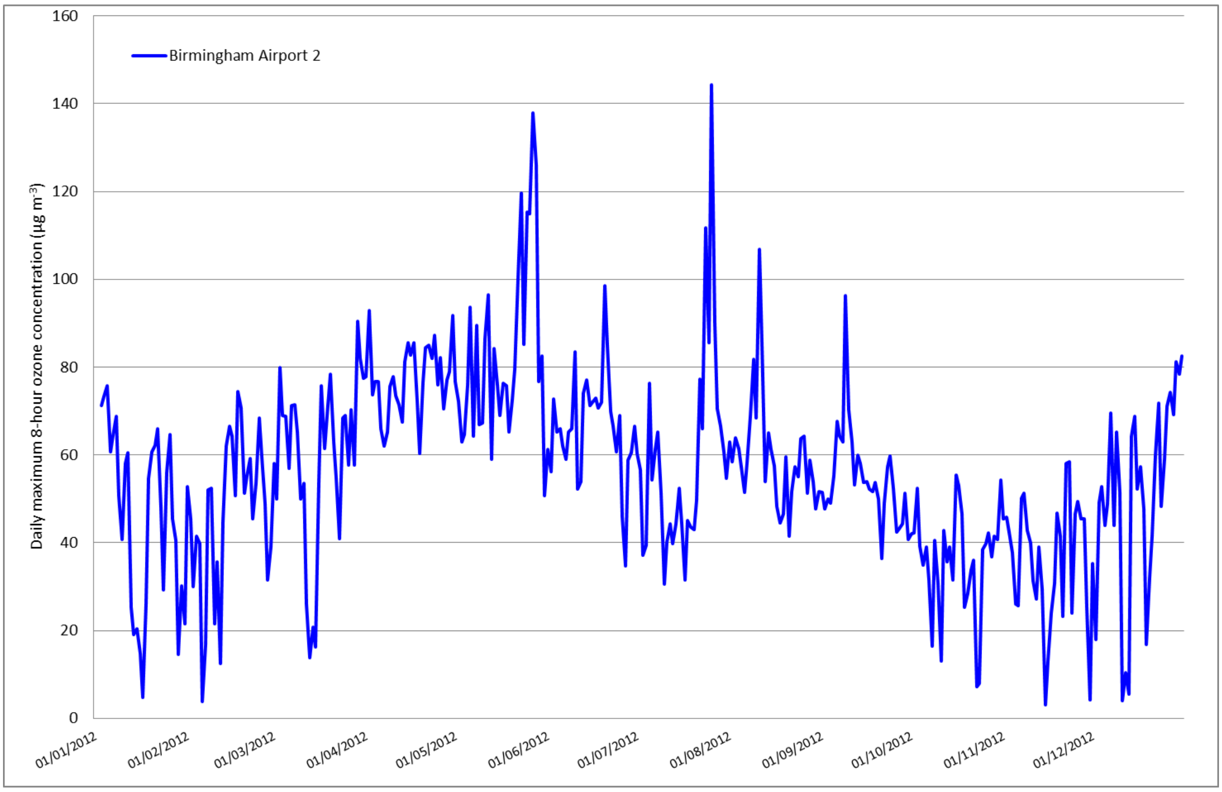

Figure 3-6: Daily Maximum 8-hr running mean Ozone concentrations at Birmingham Airport – 2012.

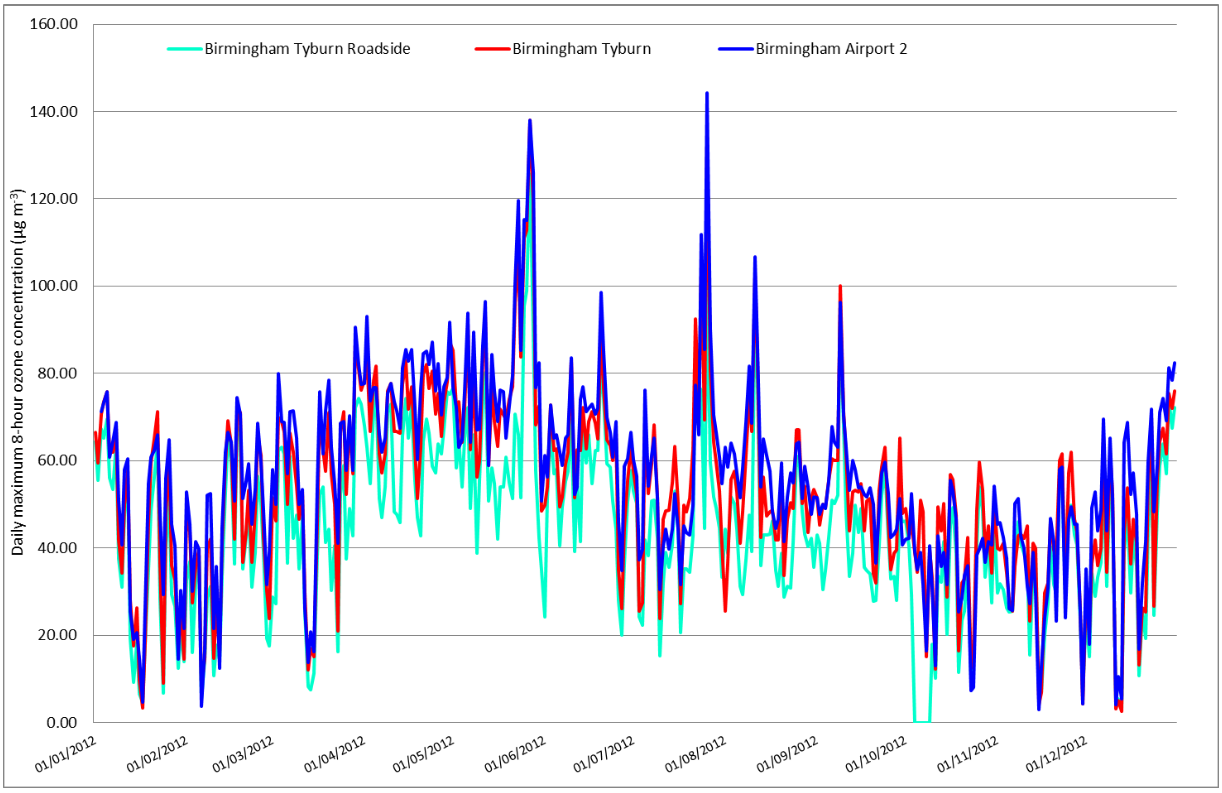

Figure 3-7: Daily Maximum 8-hr running mean Ozone concentrations at Birmingham Airport and at two AURN sites – 2012.

3.5 Emissions Sources

In order to investigate the possible sources of air pollution at the Birmingham Airport site, meteorological data from the site were used to produce plots of hourly pollutant concentrations against the corresponding wind speed and wind direction (Figure 3-8). 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 exceedances but provide a visual indication as to the direction of possible sources of pollution that are being measured at the site. **The meteorological data are not covered by the data management contract with Ricardo-AEA. All checking and QA/QC on the meteorological data are carried out by Birmingham Airport, who have sole responsibility for the accuracy of all meteorological data used in this report.**

As with previous years the plot of CO shows that the highest concentration is in the centre of the plot, i.e. when wind speeds are low. 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, and dispersion of this pollutant increases with increasing wind speed. At higher wind speeds, there appears to be evidence of another source of CO appears to be on a bearing of approximately 150º (or SSE): this is the direction of the runways, but also of a large car park.

The pollution rose for SO_2 shows a very different pattern spatial distribution of pollution to that of CO or NO. The highest concentrations are associated with the wind direction from the north-east and low wind speed (4 - 6 ms^{-1}). The main runway is located in this direction. There are also increased concentrations of SO_2 associated with wind directions from south-west and south-east. This source of SO_2 is most likely to be aircraft and airside vehicles and also vehicles entering and leaving the car parking areas in south-westerly direction.

NO (also a primary pollutant) shows a similar pattern to CO, with highest concentrations in the centre of the plot, i.e. at low wind speeds. For NO_2, which has both a primary and secondary component, there is more evidence of a source in the direction of the runways and car park. This is evident at a range of wind speeds.

The pollution rose for VCM-corrected PM_{10} shows clear area of red (indicating high concentrations) to the south-east of the site, in the direction of the main airport buildings. This is consistent pattern for a range of wind speeds. The second area of increased concentrations is associated with a north-westerly wind direction. This is only evident at higher wind speeds, (8-12 ms^{-1}), indicating a source possibly further away.

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, and lowest in the direction of the sources of primary pollutants.

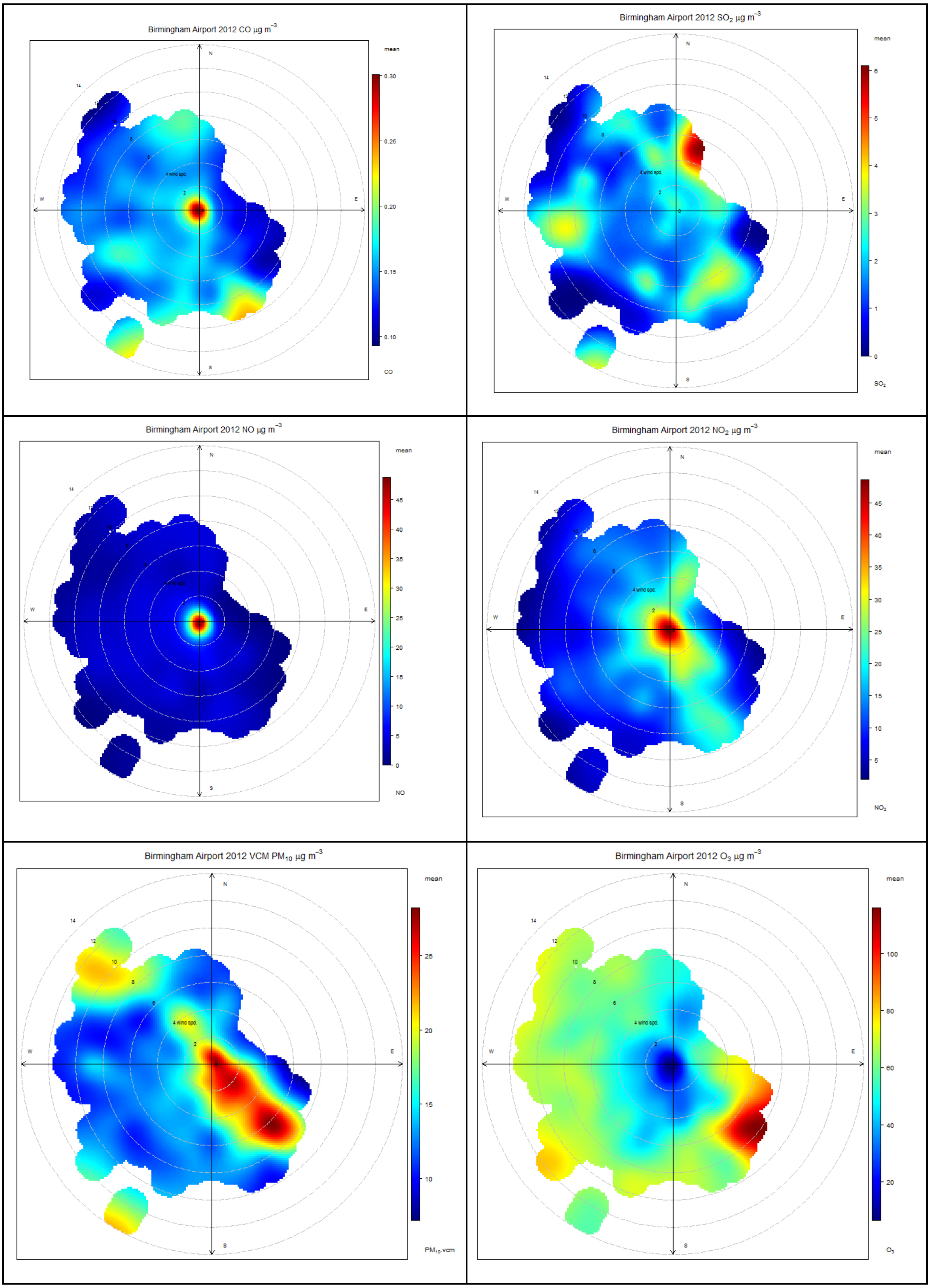

Figure 3-8: Bivariate plots showing pollutant concentrations as a function of both wind direction and wind speed.

3.6 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. For the purpose of investigating long-term trends, the data from the two different locations of the Birmingham Airport site have been incorporated into one data set.

Figure 3-9, Figure 3-10 and Figure 3-11 show the trends in annual mean pollutant concentrations at a number of AURN sites, as follows:

- Birmingham Tyburn (described in section 2.5)
- Birmingham Tyburn Roadside (also described in section 2.5)
- Coventry Memorial Park – urban background site located in Coventry Memorial Park. Monitoring of PM_{10} ceased in 2008.
- Birmingham Acocks Green, from 2011 onwards – an urban background site located within the grounds of an annex to a large school. The monitoring station is approximately 70 metres from the nearest road (other than car park access road), Shirley Road.
- 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 away.

Also included are Birmingham Centre (an urban background site that closed in 2008), and Sandwell West Bromwich (an urban background site that monitored NOx and SO_2 until it closed in 2011).

These sites provide some additional information as to trends in the region. Carbon monoxide has not been included, as it is no longer measured at any of the above sites. A minimum annual data capture of 75% is required for inclusion in these graphs.

For PM_{10}, the VCM was not available in the earlier years of this survey. At that time, the recommended approach was to multiply TEOM data by a factor of 1.3 to give an *approximate* indication of gravimetric equivalent. In Figure 3.9, this approach has been used for the AURN sites for the years before they were upgraded to FDMS instruments (upto and including 2006 at Birmingham Centre and Coventry Memorial Park, 2007 at Leamington Spa and 2009 at Birmingham Tyburn). The PM_{10} annual means shown for these AURN sites are as reported on the Defra online air quality resource, UK-AIR at http://uk-air.defra.gov.uk/. No data are included for Birmingham Tyburn Roadside because data capture was below 75% in all years. The annual means for Birmingham Airport are conventional TEOM x 1.3 until 2007 inclusive, then VCM-corrected. The annual means "as measured" by the TEOM are also shown (as a dotted line) for comparison.

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

Concentrations of PM_{10} (Figure 3.9) show no clear regional trends with fluctuating concentrations for all sites year on year. Concentrations at Birmingham Airport appear to have remained relatively stable during the past three years.

Concentrations of NO_2 at all the sites showed a slight increase in 2012, to compare to 2011.

Concentrations of SO_2 at all three sites which still measure this pollutant remained low during 2012.

Statistical summaries for years 2006 onwards are provided in Appendix 5.

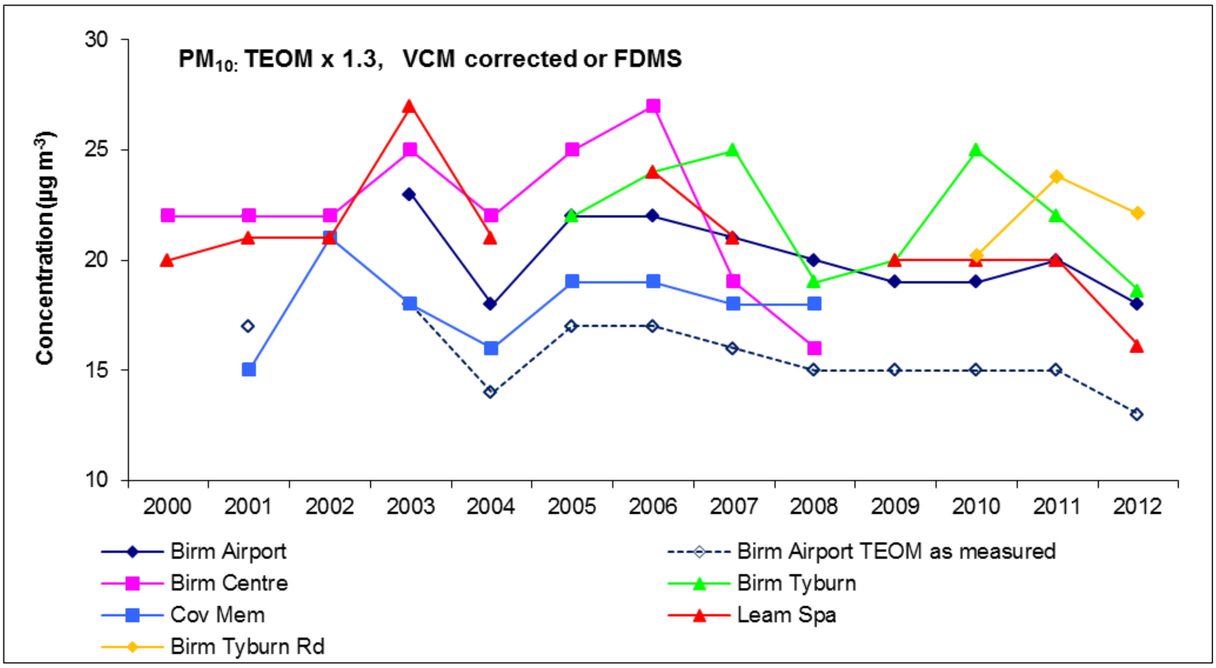

Figure 3-9: Annual average PM_{10} trends at Birmingham Airport and other local AURN sites.

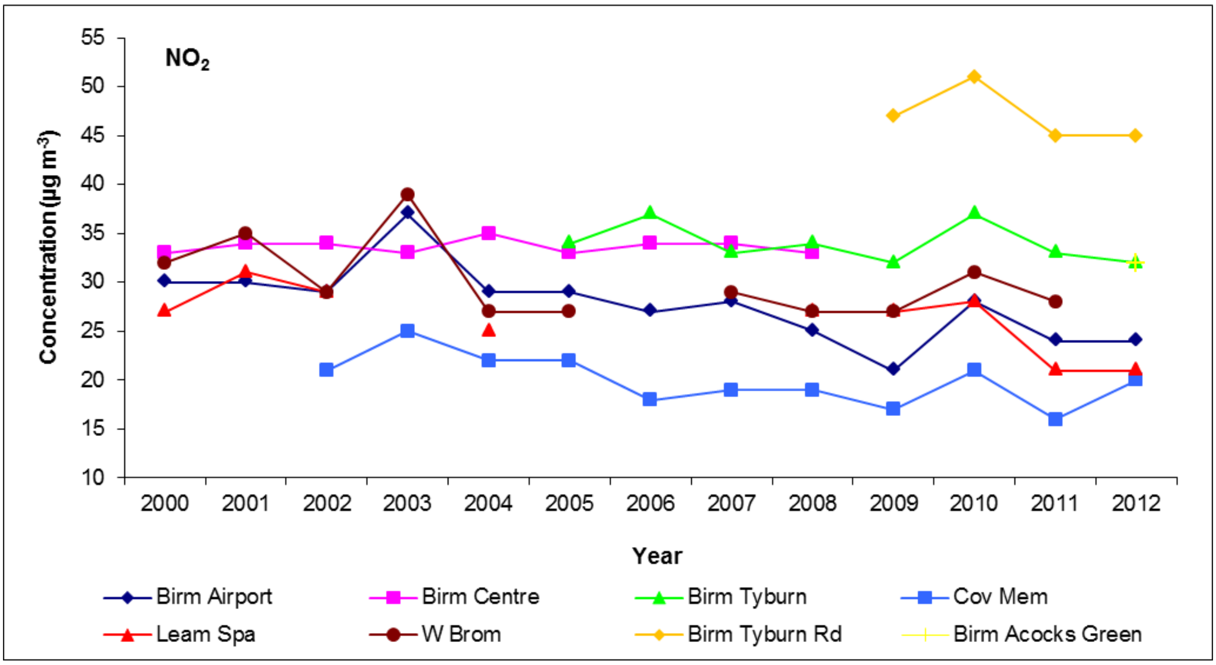

Figure 3-10: Annual average NO_2 trends at Birmingham Airport and other local AURN sites.

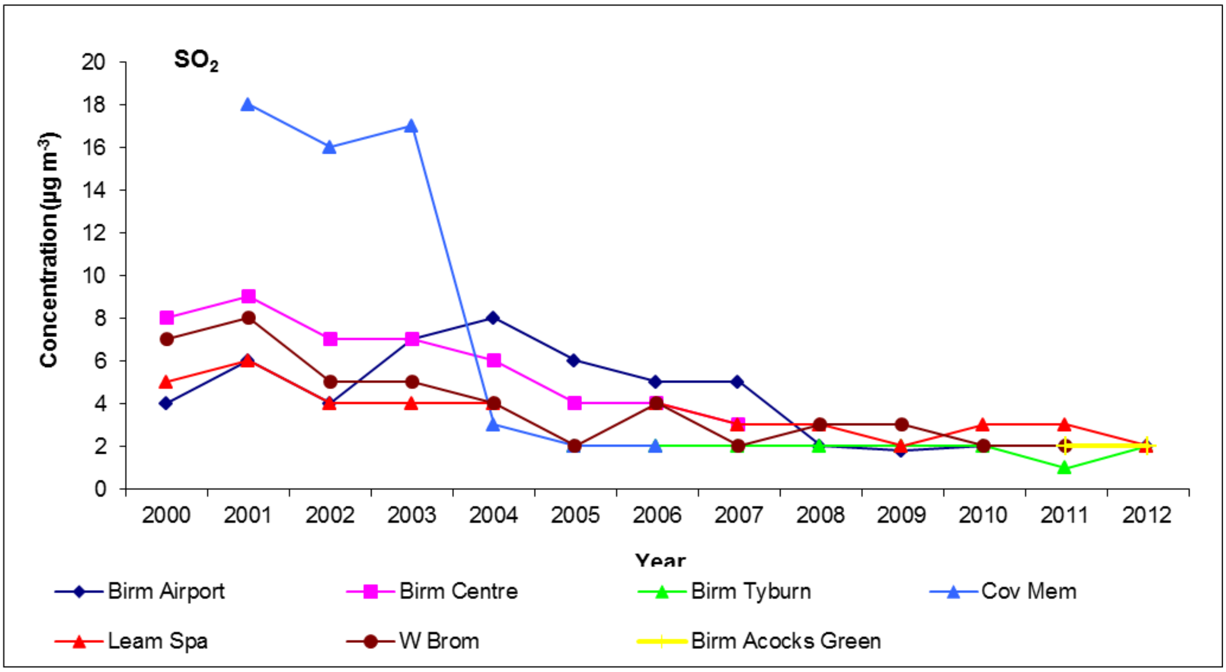

Figure 3-11: Annual average SO_2 trends at Birmingham Airport and other local AURN sites.

4 Conclusions

The conclusions of Ricardo-AEA's examination of the 2012 dataset from Birmingham Airport's ongoing air quality monitoring are as follows:

1. Data capture of at least 90% was achieved for all the pollutants monitored at Birmingham Airport. This met the Defra target of 90%[5], and allowed for calculation of robust annual statistics.

2. All of the Air Quality Strategy Objectives for the protection of human health were met at the site during 2012, with the exception of ozone which is not included in the regime.

3. NO_2 is the pollutant of most concern with specific relevance to airport emission sources as detailed within TG(09)[5]. No exceedances of the Air Quality Strategy objective for hourly mean NO_2 (200 µg m^{-3}, not to be exceeded more than 18 times a year) were recorded at Birmingham Airport.

4. The annual mean NO_2 concentration of 24 µg m^{-3} was within the Air Quality Strategy objective of 40 µg m^{-3}.

5. The Air Quality Strategy objective of 100 µg m^{-3} for 8-hour mean ozone concentration was exceeded on 8 days. This is within the maximum permitted 10 days.

6. Investigation of emission sources, using meteorological data from Birmingham Airport, indicated that the airport was a source of NO, NO_2 and CO. Also, at higher wind speeds a contribution to PM_{10} concentrations was identified from a distance emission source from the north-west direction.

7. PM_{10} showed a similar pattern at low wind speeds. However, at high wind speeds there was a large contribution from a source in the direction of the airport buildings.

8. Ozone concentrations showed a different pattern, consistent with its formation as a secondary pollutant. The most significant sources were from the rural areas to the east where it is likely that ozone formation was unchecked by the influence of other pollutant emissions, and lowest in the direction of the sources of primary pollutants.

9. There appeared to be no clear long term trends in annual mean in PM_{10} at Birmingham Airport and nearby AURN sites. Concentrations of NO_2 at Birmingham Airport and across the region decreased in 2012. SO_2 concentrations remained low at all sites.

It is recommended that the monitoring programme continues.

5 References

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2. 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/quality/air/air-quality/approach/ (Accessed 11th March 2013).

3. 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. Available at http://uk-air.defra.gov.uk/reports/aqeg/nd-contents-chapter1.pdf (Accessed 11th March 2013).

4. King's College London Volatile Correction Model available at http://www.volatile-correction-model.info/Default.aspx . July 2008. (Accessed 5th March 2013).

5. Defra (2009). Part IV of the Environment Act 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://laqm.defra.gov.uk/technical-guidance/ (Accessed 11th March 2013).

Appendices

Appendix 1 – VCM Correction of PM_{10} Data

TEOM

The PM_{10} monitoring data recorded by TEOM monitors were corrected with the king's College Volatile Correction Model (VCM). This online tool allows TEOM measurements to be corrected 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:

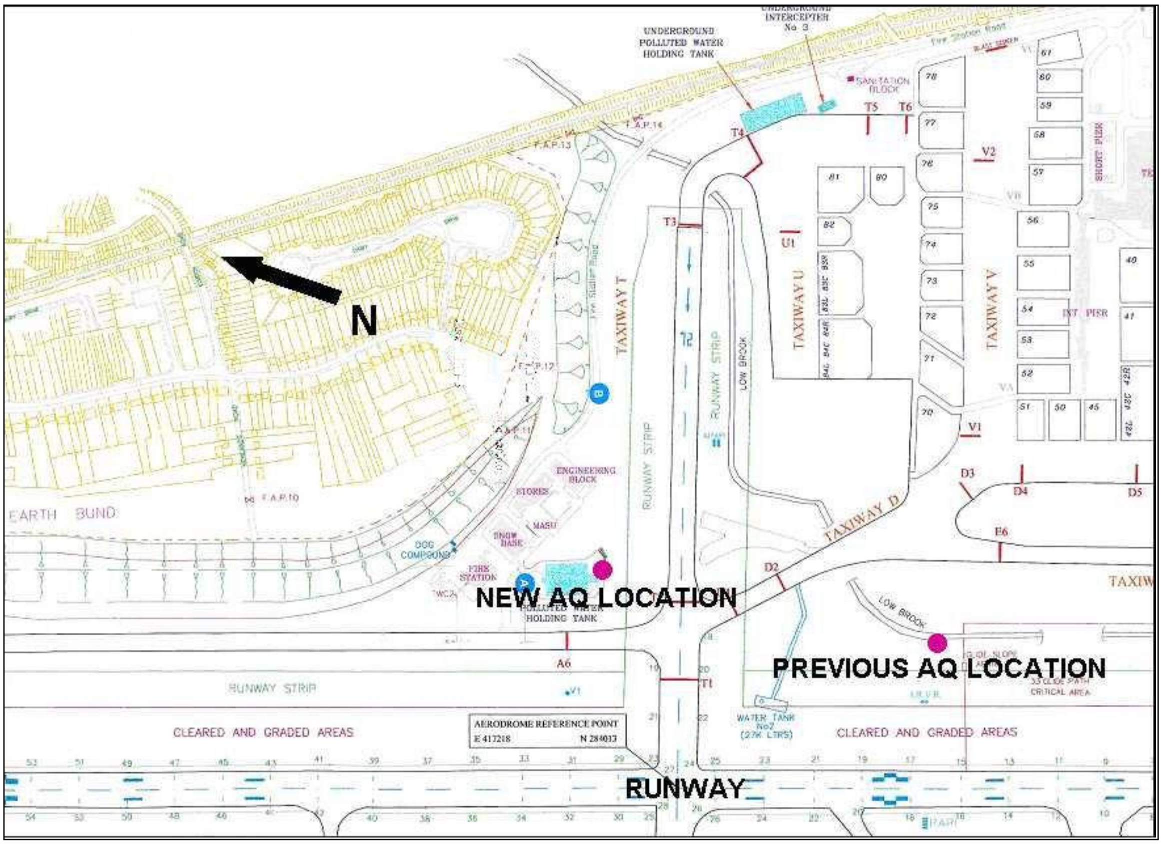
- Daily or hourly average temperatures
- Daily or hourly pressures
- Daily or hourly TEOM concentrations (µg m^{-3})
- Daily or hourly FDMS (Filter Dynamic Measurement System) purge measurements (µg m^{-3})

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, so an exact location of the TEOM instrument is therefore required.

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

Appendix 2 – Monitoring Station Location



Site 1 is the old AQ location. Site 2 is the current AQ location, operational from 10/01/06 onwards.

Appendix 3 – Hydrocarbon Diffusion Tube Results 2012

Approximate month	Date exposed	Date removed	Benzene (µgm^{-3})	Toluene (µgm^{-3})	Ethyl benzene (µgm^{-3})	mp-xylene (µgm^{-3})	o-xylene (µgm^{-3})
Jan 2012	13/01/2012	10/02/2012	0.92	0.87	0.25	0.50	0.18
Feb 2012	10/02/2012	09/03/2012	0.54	0.42	0.25	0.65	0.23
Mar 2012	09/03/2012	10/04/2012	0.30	0.39	0.13	0.27	0.13
Apr 2012	10/04/2012	11/05/2012	0.71	0.58	0.29	0.46	0.25
May 2012	11/05/2012	11/06/2012	0.16	0.25	0.14	0.16	< 0.31
Jun 2012	11/06/2012	09/07/2012	0.31	0.51	0.30	0.61	0.22
Jul 2012	09/07/2012	02/08/2012	0.49	0.92	0.62	1.55	0.62
Aug 2012	02/08/2012	30/08/2012	0.20	0.29	< 0.31	0.27	< 0.31
Sep 2012	30/08/2012	28/09/2012	< 0.33	0.53	0.23	0.76	0.25
Oct 2012	28/09/2012	26/10/2012	0.57	1.15	< 0.27	0.52	< 0.27
Nov 2012	26/10/2012	23/11/2012	0.42	0.69	0.22	0.36	< 0.27
Dec 2012	23/11/2012	21/12/2012	< 0.33	0.64	0.24	0.40	< 0.31
Mean 2012			**0.41**	**0.60**	**0.25**	**0.54**	**0.22**

Approximate month	Date exposed	Date removed	Benzene (ppb)	Toluene (ppb)	Ethyl benzene (ppb)	mp-xylene (ppb)	o-xylene (ppb)
Jan 2012	13/01/2012	10/02/2012	0.28	0.23	0.06	0.11	0.04
Feb 2012	10/02/2012	09/03/2012	0.17	0.11	0.06	0.15	0.05
Mar 2012	09/03/2012	10/04/2012	0.09	0.10	0.03	0.06	0.03
Apr 2012	10/04/2012	11/05/2012	0.22	0.15	0.07	0.10	0.06
May 2012	11/05/2012	11/06/2012	0.05	0.07	0.03	0.04	< 0.07
Jun 2012	11/06/2012	09/07/2012	0.09	0.13	0.07	0.14	0.05
Jul 2012	09/07/2012	02/08/2012	0.15	0.24	0.14	0.35	0.14
Aug 2012	02/08/2012	30/08/2012	0.06	0.08	< 0.07	0.06	< 0.07
Sep 2012	30/08/2012	28/09/2012	< 0.10	0.14	0.05	0.17	0.06
Oct 2012	28/09/2012	26/10/2012	0.18	0.30	< 0.06	0.12	< 0.06
Nov 2012	26/10/2012	23/11/2012	0.13	0.18	0.05	0.08	< 0.06
Dec 2012	23/11/2012	21/12/2012	< 0.10	0.17	0.05	0.09	< 0.07
Mean 2012			**0.13**	**0.16**	**0.06**	**0.12**	**0.05**

Appendix 4 – Daily Air Quality Index

The air quality index and bandings were updated in January 2012. The table below shows the new bandings, in use during 2012, the period covered by this report.

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	$PM_{2.5}$	PM_{10}
		Daily max 8-hr mean (µg m^{-3})*	hourly mean (µg m^{-3})	15 minute mean (µg m^{-3})	24 hour mean (µg m^{-3})	24 hour mean (µg m^{-3})
Low	1	0-33	0-66	0-88	0-11	0-16
	2	34-65	67-133	89-176	12-23	17-33
	3	66-99	134-199	177-265	24-34	34-49
Moderate	4	100-120	200-267	266-354	35-41	50-58
	5	121-140	268-334	355-442	42-46	59-66
	6	141-159	335-399	443-531	47-52	67-74
High	7	160-187	400-467	532-708	53-58	75-83
	8	188-213	468-534	709-886	59-64	84-91
	9	214-239	535-599	887-1063	65-69	92-99
Very High	10	240 or more	600 or more	1064 or more	70 or more	100 or more

Appendix 5 - Statistical Summary 2006 to 2012

Statistic	PM_{10} (μgm^{-3})†	NO_x (as NO_2) (μgm^{-3})	NO (μgm^{-3})	NO_2 (μgm^{-3})	O_3 (μgm^{-3})	SO_2 (μgm^{-3})	CO (mgm^{-3})	Benzene (μgm^{-3})
2012								
Max. hourly mean	157	605	321	115	158	56	1.6	-
Annual mean	18	40	10	24	41	2	0.2	0.41**
Max. daily mean	51	-	-	-	-	11	-	-
Max. running 8-hr mean	-	-	-	-	144	-	1.2	-
Max. 15-min mean	-	-	-	-	-	61	-	-
Data capture (%)	97	98	98	98	99	98	99	100
2011								
Max. hourly mean	135	460	241	117	158	35	0.9	-
Annual mean	21	36	8	24	49	2	0.2	0.51**
Max. daily mean	71	-	-	-	-	8	-	-
Max. running 8-hr mean	-	-	-	-	136	-	0.8	-
Max. 15-min mean	-	-	-	-	-	40	-	-
Data capture (%)	91	96	96	96	96	96	96	92
2010								
Max. hourly mean	200	682	371	159	168	32	1.5	-
Annual mean	19	46	12	28	41	2	0.2	0.8**
Max. daily mean	48	-	-	-	-	7	-	-
Max. running 8-hr mean	-	-	-	-	144	-	0.8	-
Max. 15-min mean	-	-	-	-	-	32	-	-
Data capture (%)	93	99	99	99	99	97	97	100
2009								
Max. hourly mean	85	640	356	180	126	35	2.0	-
Annual mean	18	34	9	21	42	2	0.2	*1.0**
Max. daily mean	55	-	-	-	-	10	-	-
Max. running 8-hr mean	-	-	-	-	108	-	1.6	-
Max. 15-min mean	-	-	-	-	-	37	-	-
Data capture (%)	92	94	94	94	94	94	94	100
2008								
Max. hourly mean	305	1289	720	220	158	29	3.1	
Annual mean	16	41	11	25	47	2	0.2	0.9**
Max. daily mean	61	-	-	-	-	9	-	-
Max. running 8-hr mean	-	-	-	-	152	-	2.4	-
Max. 15-min mean	-	-	-	-	-	29	-	-
Data capture (%)	91.3	95.6	95.6	95.6	91.5	95.6	95.6	100.0
2007								
Max. hourly mean	244	932	521	145	148	*43**	2.6	
Annual mean	21	49	14	28	40	*5**	0.2	1.0**
Max. daily mean	116	-	-	-	-	*13**	-	
Max. running 8-hr mean	-	-	-	-	135	-	1.6	
Max. 15-min mean	-	-	-	-	-	*90**	-	
Data capture (%)	89.7	86.5	86.5	86.5	99.2	40.2	97.5	100.0

2006

Max. hourly mean	466	686	349	189	202	32	2.1	
Annual mean	22	47	13	27	47	5	0.2	1.1**
Max. daily mean	92	-	-	-	-	16	-	
Max. running 8-hr mean	-	-	-	-	195	-	1.7	
Max. 15-min mean	-	-	-	-	-	43	-	
Data capture (%)	90.4	79.8	79.8	79.8	93.8	91.6	93.3	100.0

† - VCM corrected 2009 onwards; * Results indicative only due to the low data capture.; ** Results based on monthly exposure periods

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