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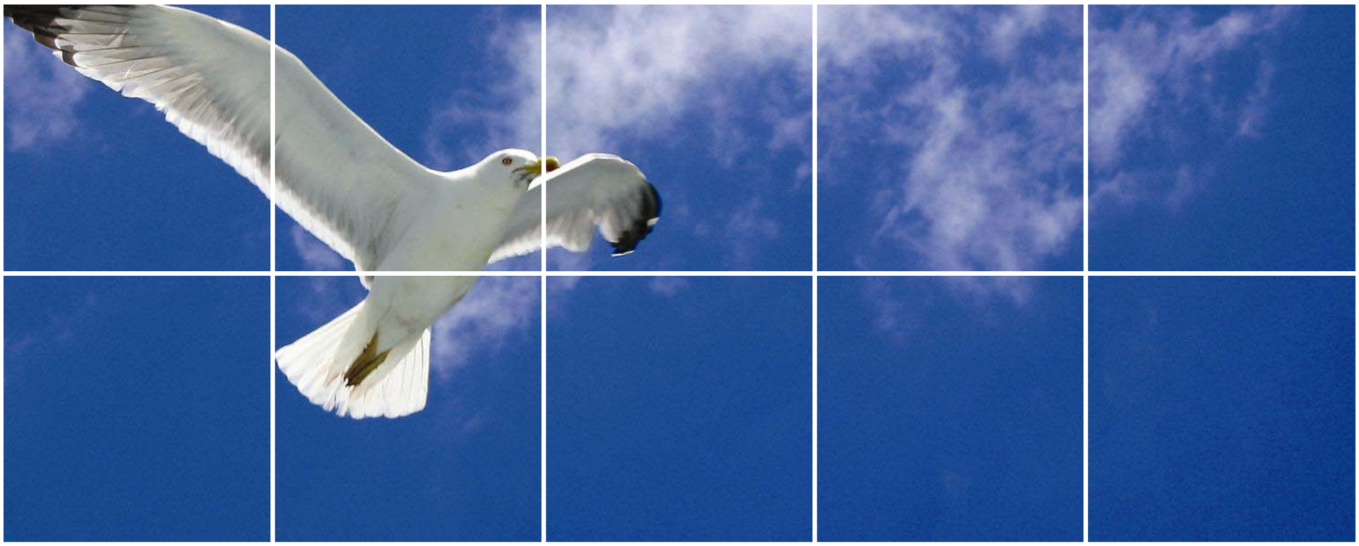

Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2007

Report to Public Health Services, States of Jersey

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AEA Energy & Environment
Building 551.11
Harwell International Business Centre
Didcot
OX11 0QJ

t: 0870 190 6518
f: 0870 190 6377

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and ISO14001

Author	Name	Alison Loader & Brian Stacey
Approved by	Name	Brian Stacey
	Signature	
	Date	24 April 2008

Executive summary

AEA Energy & Environment is undertaking an ongoing programme of air quality monitoring on Jersey, on behalf of the Public Health Services of the States of Jersey. This report presents the results of the 11th consecutive year of monitoring, calendar year 2007 – covered by the monitoring period 3rd January 2007 to 2nd January 2008.

Diffusion tube samplers were used for indicative monitoring of nitrogen dioxide (NO_2) at 24 sites, and hydrocarbons at six sites. Monitoring sites were selected to include areas likely to be affected by specific emission sources (such as petrol stations or the waste incinerator), as well as general background locations.

NO_2 and hydrocarbon diffusion tubes were exposed for twelve periods approximating to calendar months. The tubes were supplied and analysed by Gradko International Ltd, and changed by Technical Officers of Jersey's Health Protection Section.

The measured annual mean NO_2 concentration at one kerbside site (Weighbridge) in the centre of St Helier exceeded 40 μg m^{-3}. This is set as a Limit Value by EC Directive 1999/30/EEC (to be achieved by 2010), and as an Objective by the UK Air Quality Strategy (to have been achieved by 31st December 2005). However, application of an adjustment factor for known diffusion tube bias reduced the annual mean to 36 μg m^{-3}. Therefore this site has not exceeded the EC Limit Value and AQS Objective.

Annual mean NO_2 concentrations at all other sites were below 40μg m^{-3} in 2007. In particular, annual mean concentrations at all the urban and residential background sites were well below 40μg m^{-3} in 2007.

A statistically significant downward trend has been identified, in the average annual mean NO_2 concentrations for all kerbside and roadside sites. This is of particular interest, as it is sites of these types that are currently closest to the Limit Value and AQS Objective of 40μg m^{-3} for annual mean NO_2 concentration.

Annual mean concentrations of benzene, toluene, ethylbenzene and xylenes were measured at the six hydrocarbon monitoring sites. However, data capture from these sites was adversely affected by a significant number of hydrocarbon diffusion tubes being returned to the analyst with their caps missing, thus invalidating the results.

The highest annual mean benzene concentration of 4.2 μg m^{-3} was measured at Springfield Garage, where the tube is located at a petrol station. At all other sites the annual mean benzene concentration was below 2.0μg m^{-3}. All sites therefore met the UK Air Quality Strategy Objective of 16.25 μg m^{-3} for the running annual mean. All sites also met the EC 2nd Daughter Directive annual mean Limit Value of 5 μg m^{-3} (which is to be achieved by 2010).

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Appendices

1 Introduction

1.1 Background

AEA Energy & Environment, on behalf of the States of Jersey Public Health Services, has undertaken a further programme of air quality monitoring on the island of Jersey in 2007. This is the eleventh in a series of extensive annual monitoring programmes that began in 1997, and has since provided a long-term dataset of pollutant concentrations.

The pollutants measured were nitrogen dioxide (NO_2), and a range of hydrocarbon species (benzene, toluene, ethyl benzene and three xylene compounds). Average ambient concentrations were measured using passive diffusion tube samplers. NO_2 was measured at 24 sites on the island, using Palmes type diffusion tubes. Hydrocarbons were monitored using “BTEX” diffusion tubes at six sites.

This report presents the results obtained in the 2007 survey, and compares the data from Jersey with relevant air quality Limit Values, Objectives and guidelines, data from selected UK monitoring stations and previous years' monitoring programmes.

1.2 Objectives

This survey follows on from those in the years 1997 to 2006[1,2,3,4,5,6,7,8,9,10]. The objective, as in previous surveys, was to monitor at sites where pollutant concentrations were expected to be high, and compare these with background locations. The monitoring sites consisted of a mixture of urban and rural background sites, together with some locations where higher pollutant concentrations might be expected, such as roadside and kerbside sites, and some close to specific emission sources.

2 Details of Monitoring Programme

2.1 Pollutants Monitored

2.1.1 NO_2

A mixture of nitrogen dioxide (NO_2) and nitric oxide (NO) is emitted by combustion processes. This mixture of oxides of nitrogen is termed NO_x. NO is subsequently oxidised to NO_2 in the atmosphere. NO_2 is an irritant to the respiratory system, and can affect human health. Ambient concentrations of NO_2 are likely to be highest in the most built-up areas, especially where traffic is congested, or buildings either side of the street create a "canyon" effect, impeding the dispersion of vehicle emissions. The units used for NO_2 concentration in this report are microgrammes per cubic metre (μg m^{-3}). Some earlier reports in this series have used parts per billion (ppb): to convert to ppb to if required, the following relationship should be used:

1 μg m^{-3} = 0.523 ppb for nitrogen dioxide at 293K (20°C) and 1013mb.

2.2 Hydrocarbons

There are many sources of hydrocarbon emissions. Methane, for example, is a naturally occurring gas, while xylene compounds are synthetic and used in many applications, for example as a solvent in paint. A range of hydrocarbons is found in vehicle fuel, and occur in vehicle emissions. In most urban areas, vehicle emissions would constitute the major source of hydrocarbons, in particular benzene. Also, there is the potential that they may be released to the air from facilities where fuels are stored or handled (such as petrol stations).

A wide range of hydrocarbons is emitted from both fuel storage and handling, and from fuel combustion in vehicles. It is not easy to measure all of these hydrocarbon species (particularly the most volatile) without expensive continuous monitoring systems. However, there are four moderately volatile species, all of which may be associated with fuels and vehicle emissions, which are easy to monitor using passive samplers. These are benzene, toluene, ethyl benzene and xylene. They are not the largest constituents of petrol emissions, but due to their moderate volatility they can be monitored by diffusion tubes. Diffusion tubes are available for monitoring this group of organic compounds, and are known as "BTEX" tubes (BTEX being an acronym for the compounds measured).

(i) Benzene
Of the organic compounds measured in this study, benzene is the one of most concern, as it is a known human carcinogen; long-term exposure can cause leukaemia. It is found in petrol and other liquid fuels, in small concentrations. In urban areas, the major source is vehicle emissions. In the UK, annual mean benzene concentrations in ambient air are typically less than 3 μg m^{-3}. In this report, concentrations of benzene are expressed in microgrammes per cubic metre (μg m^{-3}). Some earlier reports in the series used parts per billion (ppb): to convert to ppb to if necessary, the following relationship should be used:

1 μg m^{-3} = 0.307 ppb for benzene at 293K (20°C) and 1013mb.
(only applicable to benzene).

(ii) Toluene
Toluene is also found in petrol in small concentrations. Its primary use is as a solvent in paints and inks; it is also a constituent of tobacco smoke. It has been found to adversely affect human health. Typical ambient concentrations range from trace to 3.8 μg m^{-3} in rural areas, up to 204 μg m^{-3} in urban areas, and higher near industrial sources. There are no recommended limits for ambient toluene

concentrations, although there are occupational limits for workplace exposure[11]. The best estimate for the odour threshold of toluene has been reported[12] as 0.16ppm (613μg m^{-3}). In this report, concentrations are expressed in microgrammes per cubic metre (μg m^{-3}). Some earlier reports in the series used parts per billion (ppb): to convert to ppb to if necessary, the following relationship should be used:

1 μg m^{-3} = 0.261 ppb for toluene at 293K (20°C) and 1013mb.
(only applicable to toluene).

(iii)ethyl benzene
Again, there are no limits for ambient concentration of ethyl benzene, and although there are occupational limits relating to workplace exposure[11], as discussed in previous reports in this series, they are several orders of magnitude higher than typical outdoor ambient concentrations.

(iv)xylene
Xylene exists in ortho (o), para (p) and meta (m) isomers. Occupational limits relating to workplace exposure, are 100 ppm over 8 hours, and 150 ppm over 10 minutes. Xylene, like toluene, can cause odour nuisance near processes (such as vehicle paint spraying), which emit it. Its odour threshold varies according to the isomer, but the best estimate for the odour threshold of mixed xylenes is 0.016ppm (16 ppb or 70 μg m^{-3})[12].

In this report, concentrations of ethylbenzene and xylenes are expressed in microgrammes per cubic metre (μg m^{-3}). Some earlier reports in this series used parts per billion (ppb): to convert to ppb to if required, the following relationship should be used:

1 μg m^{-3} = 0.226 ppb for ethyl benzene or xylenes at 293K (20°C) and 1013mb.
(applicable to ethylbenzene, m-, p- and o-xylene).

2.3 Air Quality Limit Values And Objectives

2.3.1 World Health Organisation

In 2000, the World Health Organisation published revised air quality guidelines[13] for pollutants including NO_2. These were set using currently available scientific evidence on the effects of air pollutants on health and vegetation. The WHO guidelines are advisory only, and do not carry any mandatory status. They are summarised in Appendix 1. There are WHO guidelines for ambient NO_2 concentrations (hourly and annual means) but not benzene.

2.3.2 European Community

Throughout Europe, ambient air quality is regulated by EC Directives. These set Limit Values, which are mandatory, and other requirements for the protection of human health and ecosystems. EC Daughter Directives covering pollutants including NO_2 and benzene [14,15] have been published in recent years. The Limit Values are summarised in Appendix 1. The States of Jersey have agreed to meet the EU health limits.

2.3.3 UK Air Quality Strategy

The UK Air Quality Strategy (AQS) contains standards and objectives for a range of pollutants including NO_2 and benzene[16]. These are also summarised in Appendix 1. Only those Objectives relating to the whole UK (as opposed to specifically England, Wales, etc.) are applicable to Jersey, and the AQS does not at present have mandatory status in the States of Jersey.

2.4 Methodologies

The survey was carried out using diffusion tubes for NO_2 and BTEX. These are "passive" samplers, i.e. they work by absorbing the pollutants direct from the surrounding air and need no power supply.

Palmes-type diffusion tubes were used for NO_2. These consist of a small plastic tube, approximately 7 cm long. During sampling, one end is open and the other closed. The closed end contains an absorbent for the gaseous species to be monitored, in this case NO_2. The tube is mounted vertically with the open end at the bottom. Ambient NO_2 diffuses up the tube during exposure, and is absorbed as nitrite. The average ambient pollutant concentration for the exposure period is calculated from the amount of pollutant absorbed.

BTEX diffusion tubes are different in appearance to NO_2 tubes. They are longer, thinner, and made of metal rather than plastic. These tubes are fitted at both ends with brass Swagelok fittings. A separate “diffusion cap” is supplied. Immediately before exposure, the Swagelok end fitting is replaced with the diffusion cap. The cap is removed after exposure, and is replaced with the Swagelok fitting. BTEX diffusion tubes are very sensitive to interference by solvents.

As of February 2007, diffusion tubes were prepared by Gradko International Ltd for AEA Energy & Environment. They were supplied to local Technical Officers of Jersey's Public Health Services, who carried out the tube changing. The tubes were supplied in sealed condition prior to exposure. The tubes were exposed at the sites for a set period of time. After exposure, the tubes were again sealed and returned to Gradko for analysis. The year was divided into twelve exposure periods approximating to calendar months. The duration of the exposure periods varied between four and five weeks.

Diffusion tubes are an indicative technique, and the results therefore have a greater uncertainty than those of more sophisticated automatic methods. The laboratory states that the margins of uncertainty on the diffusion tube analyses are typically $\pm$ 3.5% for NO_2 and $\pm$ 12% for BTEX hydrocarbons. However, uncertainties arising from the exposure phase also contribute to the overall uncertainty: it is usually estimated that the overall uncertainty on diffusion tube measurements is approximately $\pm$ 25% for NO_2 and $\pm$ 25% for BTEX hydrocarbons. The limits of detection vary from month to month, but are typically 0.4 $\mu g\ m^{-3}$ for NO_2 and 0.2 $\mu g\ m^{-3}$ for BTEX. It should be noted that tube results that are less than 10 x the limit of detection will have a higher level of uncertainty associated with them.

The Local Air Quality Management Technical Guidance LAQM.TG(03)[17] states that when using diffusion tubes for indicative NO_2 monitoring, correction should be made where applicable for any systematic bias (i.e. over-read or under-read compared to the automatic chemiluminescent technique, which is the reference method for NO_2). The bias adjustment factor applied to the annual mean diffusion tube measurements in this survey was **0.87**. This is based on 10 studies carried out by UK Local Authorities, using tubes of the same type and from the same supplier. It was obtained from a spreadsheet database maintained by Air Quality Consultants, available on the Web at http://www.uwe.ac.uk/aqm/review/diffusiontube290208.xls . (This applies only to NO_2 diffusion tubes, not BTEX tubes, as the latter are not affected by the same sources of interference). ***The NO_2 diffusion tube results in this report are uncorrected except where clearly specified.***

2.5 Monitoring Sites

Monitoring of NO_2 was carried out at 24 sites, the majority of which have been in use since 2000. Three new monitoring sites were started up during the year: a roadside site at Liberation Station, an urban background site at Seaton Place, and another roadside site at Central Market (Halkett Place, St Helier). At the Central Market site, diffusion tubes are exposed in triplicate. It is also co-located with the newly installed automatic monitoring site (data will be available from the latter from January 2008).

Table 1. NO_2 Monitoring Sites in Jersey

Site Name	Grid Reference	Description
Le Bas Centre	658 489	Urban Background
Mont Felard	629 501	Residential background, to SW of waste incinerator and 20m from busy road
Les Quennevais	579 496	Residential Background
Rue des Raisies	689 529	Rural Background
First Tower	636 497	Kerbside on major road
Weighbridge	651 483	Roadside at bus station near centre of St Helier
Langley Park	660 501	Residential background
Georgetown	661 480	Kerbside on major road
Clos St Andre	638 499	Residential area near Bellozanne Valley refuse Incinerator. Background
Beaumont	597 516	Kerbside
The Parade *	648 489	Roadside site at General Hospital
Maufant	683 512	Background site in Maufant village
Jane Sandeman	652 494	Urban background on housing estate
Saville Street	648 492	Background
Broad Street	652 486	Urban background
Beresford Street	653 486	Urban background
La Pouquelaye	654 496	Kerbside on St Helier ring road.
Union Street	653 486	Kerbside in St Helier – corner of Union St. & New St.
New Street	653 485	Kerbside in St Helier
Havre des Pas		Kerbside, beside main A4 in/out of St Helier
Commercial Buildings		Kerbside, Commercial Buildings, St Helier
Seaton Place	648 487	Kerbside to assess complaint re air quality
Liberation Station	652 485	Kerbside oppsite entrance to new bus station
Central Market	653 486	Halkett Pl., St Helier – co-located with automatic site.

*The Parade site was moved to its current roadside location at the end of 2000.

Kerbside: less than 1m from kerb of a busy road.
Roadside: 1-5m from kerb of a busy road.
Background: > 50m from the kerb of any major road.

Note: all grid references are from OS 1:25000 Leisure Map of Jersey and are given to the nearest 100m.

Figure 1a. Site Locations Outside St Helier

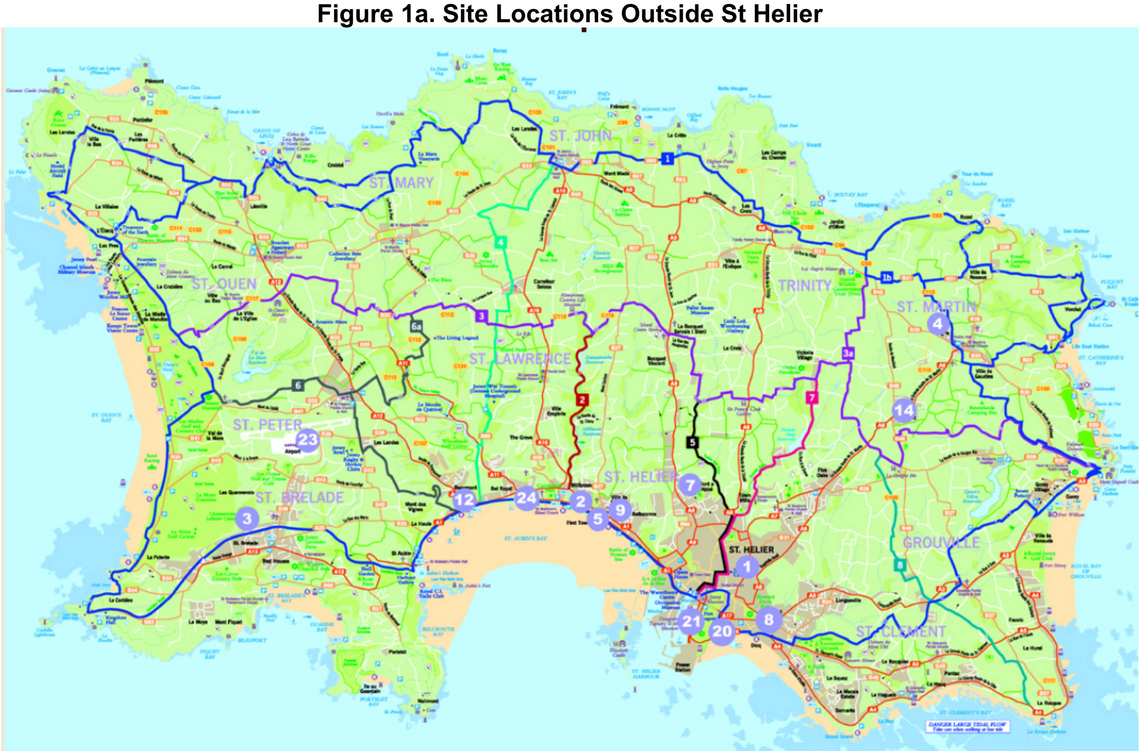
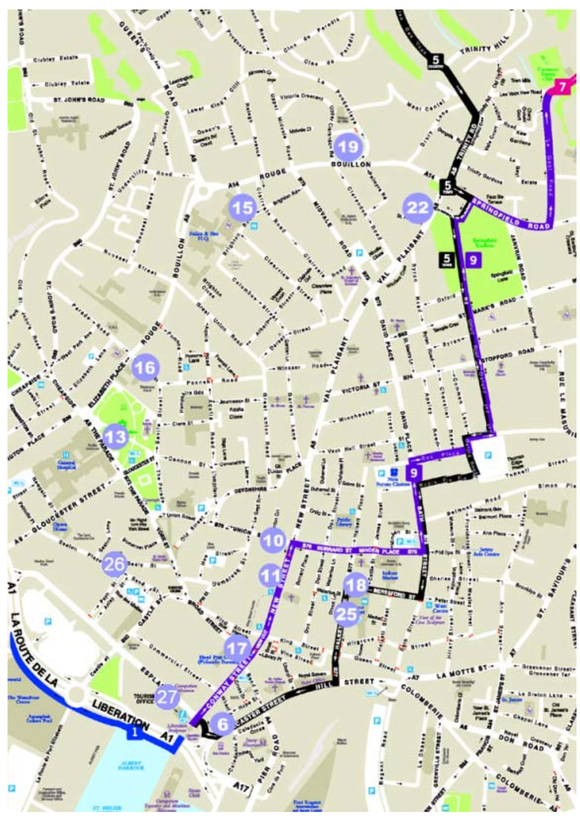


Figure 1b. Sites in St Helier town

Key:

1	Le Bas Centre	NO_2, BTEX
2	Mont Felard	NO_2
3	Les Quennevais	NO_2
4	Rue Des Raisies	NO_2
5	First Tower	NO_2
6	Weighbridge	NO_2
7	Langley Park	NO_2
8	Georgetown	NO_2
9	Clos St Andre	NO_2, BTEX
10	Union Street	NO_2
11	New Street	NO_2
12	Beaumont	NO_2
13	The Parade	NO_2
14	Maufant	NO_2
15	Jane Sandeman	NO_2
16	Saville Street	NO_2
17	Broad Street	NO_2
18	Beresford Street	NO_2, BTEX
19	La Pouquelaye	NO_2
20	Havre Des Pas	NO_2
21	Commercial Buildings	NO_2
22	Springfield Garage	BTEX
23	Airport	BTEX
24	Handsford Lane	BTEX
25	Central Market	NO_2, Auto
26	Seaton Place	NO_2
27	Liberation Station	NO_2



BTEX hydrocarbons were monitored at six sites during 2007. These are shown in Table 2. The aim was to investigate sites likely to be affected by different emission sources, and compare these with background sites. The sites at Beresford Street and Le Bas Centre are intended to monitor hydrocarbon concentrations at an urban roadside and urban background location respectively.

The Handsford Lane site is close to a paint spraying process – a potential source of hydrocarbon emissions, especially toluene and xylenes. This site replaced a similar site in Elizabeth Lane, which ceased operation when the process closed down in October 2003.

The Springfield Garage site is located by a fuel filling station, a potential sources of hydrocarbon emissions including benzene. In December 2003, the fuel supplier began using vapour recovery when filling the tanks; it was anticipated that subsequent results for this site would show a reduction in ambient concentrations of hydrocarbons.

The Clos St Andre site is located near the Bellozane Valley waste incinerator, and the Airport site is located at Jersey Airport, overlooking the airfield.

Table 2. BTEX Monitoring sites

Site Name	Grid Reference	Description
Beresford Street	653 486	Urban Roadside
Le Bas Centre	658 489	Urban Background
Springfield Garage	656 495	Urban background near fuel filling station
Clos St Andre	638 499	Residential area near Bellozanne Valley refuse incinerator.
Airport	587 509	Jersey Airport, overlooking airfield
Handsford Lane	633 499	Urban background near a paint spraying process.

2.6 Calendar of Exposure Periods

The calendar of exposure periods used for the NO_2 and BTEX diffusion tubes is shown below. They were intended to approximate to calendar months.

Month	*Start Date*	*End Date*
January	03-Jan-07	02-Feb-07
February	02-Feb-07	28-Feb-07
March	28-Feb-07	04-Apr-07
April	04-Apr-07	02-May-07
May	02-May-07	30-May-07
June	30-May-07	05-Jul-07
July	05-Jul-07	01-Aug-07
August	01-Aug-07	29-Aug-07
September	29-Aug-07	03-Oct-07
October	03-Oct-07	31-Oct-07
November	31-Oct-07	28-Nov-07
December	28-Nov-07	02-Jan-08

3 Results and Discussion

3.1 Nitrogen Dioxide

3.1.1 Summary of NO_2 Results

NO_2 diffusion tube results are presented in Table 3, and Figures 2 (kerbside and roadside sites) and 3 (background sites). Individual monthly mean NO_2 results ranged from 4.0 $\mu g\ m^{-3}$ (in July at the residential background Rue de Raisies site), to 55.2 $\mu g\ m^{-3}$ (in April at the kerbside Commercial Buildings site).

There were three occasions when no result was obtained because the tube went missing from the site during the exposure period. Evidence of a barbecue fire was found at Maufant after the July exposure period, but this does not appear to have affected the result.

Annual mean NO_2 concentrations ranged from 6.8 $\mu g\ m^{-3}$ (at the rural Rue des Raisies site) to 41.4 $\mu g\ m^{-3}$ at the Weighbridge site. The latter is a location in the centre of St Helier which is used as a central stopping point for buses.

3.1.2 Comparison with NO_2 Guidelines, Limit Values, and Objectives

Limit Values, AQS Objectives and WHO guidelines for NO_2 are shown in Appendix 1. These are based on the hourly and annual means. Because of the long sampling period of diffusion tubes, it is only possible to compare the results from this study against limits relating to the annual mean.

The WHO non-mandatory guideline[13] for NO_2 is that the annual mean should not exceed 40 $\mu g\ m^{-3}$. The EC 1st Daughter Directive[14] contains Limit Values for NO_2 as follows:

- 200 $\mu g\ m^{-3}$ as an hourly mean, not to be exceeded more than 18 times per calendar year. To be achieved by 1st January 2010.
- 40 $\mu g\ m^{-3}$ as an annual mean, for protection of human health. To be achieved by 1st January 2010.
- There is also a limit for annual mean total oxides of nitrogen (NO_x), of 30 $\mu g\ m^{-3}$, for protection of vegetation (relevant in rural areas).

The UK Air Quality Strategy[15] contains Objectives for NO_2, which are very similar to the EC Daughter Directive limits above: the only difference being that they had to be achieved by 31st December 2005.

Annual mean NO_2 exceeded 40$\mu g\ m^{-3}$ at just one site in 2007: Weighbridge. This urban kerbside site in the centre of St Helier has recorded relatively high annual mean NO_2 concentrations in previous years of this survey.

However, as explained in Section 2.4, it is necessary to take into account any systematic bias when comparing annual mean NO_2 concentrations based on diffusion tube results with the AQS Objective[17]. As explained in section 2.4, a bias adjustment factor of 0.87 was obtained for Gradko International's NO_2 diffusion tubes, based upon the combined results of 10 co-location studies carried out by UK Local Authorities using tubes of the same type and from the same supplier (see http://www.uwe.ac.uk/aqm/review/diffusiontube290208.xls).

Applying this factor reduces the annual means at all sites to below the AQS Objective of 40$\mu g\ m^{-3}$. The highest annual mean (at Weighbridge) is reduced from 41.4 $\mu g\ m^{-3}$ (unadjusted) to 36.0 $\mu g\ m^{-3}$ (adjusted). All Jersey sites therefore met the AQS Objective for annual mean NO_2.

The 30$\mu g\ m^{-3}$ limit for protection of vegetation is only applicable at the one rural background site, Rue des Raisies; the annual mean NO_2 concentration at this site was well within the limit.

Table 3. NO_2 Diffusion Tube Results 2007, Jersey. Concentrations in $\mu g\ m^{-3}$.

Site	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Average	*Bias adjusted*
First Tower (K)	34.8	32.7	27.9	40.8	31.7	28.4	34.6	33.6	32.3	35.5	38.7	30.5	33.5	*29.1*
Weighbridge (K)	48.2	31.7	31.7	45.2	44.4	46.5	53.3	45.7	41.6	33.8	44.2	30.4	**41.4**	*36.0*
Georgetown (K)	33.7	34.5	27.5	52.5	35.8	33.0	34.1	32.1	34.1	48.4	42.5	40.0	37.4	*32.5*
Beaumont (K)	41.7	33.8	33.9	44.4	43.0	40.0	41.2	TM	34.7	37.1	49.0	36.7	39.6	*34.4*
The Parade (K)	30.8	21.9	28.2	33.4	26.8	24.8	26.5	26.7	22.8	30.7	28.4	33.4	27.9	*24.2*
Broad Street (K)	38.0	32.4	30.4	34.3	36.3	39.8	42.7	32.2	26.0	TM	40.3	36.9	35.4	*30.8*
La Pouquelaye (K)	37.7	31.3	32.5	43.3	36.5	31.9	35.8	33.4	29.6	40.7	42.8	35.3	35.9	*31.2*
Havre des Pas (K)	22.3	20.3	20.7	32.6	18.4	18.5	21.0	20.7	20.3	25.4	21.0	21.3	21.9	*19.0*
Commercial Buildings (K)	33.2	26.9	36.0	55.2	33.6	21.7	26.5	35.5	36.7	43.9	42.6	24.1	34.7	*30.2*
New Street (R)	26.3	17.2	23.4	29.0	22.2	18.1	20.9	20.1	29.6	32.8	35.4	27.8	25.2	*22.0*
Union Street (R)	39.5	31.7	30.7	35.4	31.5	34.4	38.2	30.8	18.3	25.7	32.7	36.6	32.1	*27.9*
Central Market (avg. of 3 tubes) (R)		28.5	33.7	42.1	36.0	33.7	33.9	32.8	27.6	36.6	39.3	33.2	34.3	*29.8*
Liberation Stn (R)										40.2	42.1	33.2	38.5	*33.5*
Le Bas Centre (UB)	26.3	25.3	23.0	30.9	18.1	21.6	19.5	19.4	20.9	24.7	26.9	23.9	23.4	*20.3*
Seaton Place (UB)						18.3	21.7	23.0	20.9	28.2	30.8	29.2	24.6	*21.4*
Jane Sandeman (UB)	14.4	15.1	11.7	17.3	11.2	10.9	11.1	11.1	12.2	14.3	18.5	18.9	13.9	*12.1*
Saville Street (UB)	27.0	24.9	25.7	32.5	24.1	18.8	22.0	27.6	22.1	31.6	34.9	24.4	26.3	*22.9*
Beresford St (UB)	32.2	29.5	27.8	TM	27.4	28.4	27.3	25.9	34.4	35.9	34.4	32.1	30.5	*26.5*
Mont Felard (UB)	22.9	22.5	22.6	38.7	27.0	22.4	24.6	26.9	24.0	27.8	30.2	25.0	26.2	*22.8*
Les Quennevais (RB)	10.8	12.9	8.6	15.6	8.3	7.1	6.4	8.5	8.7	12.6	9.8	14.7	10.3	*9.0*
Langley Park (RB)	16.8	14.8	14.8	20.0	13.3	10.1	11.2	11.8	14.7	16.6	17.5	20.0	15.1	*13.2*
Clos St.Andre (RB)	15.8	19.8	14.1	21.1	11.0	12.2	12.7	11.3	14.6	16.0	15.6	20.0	15.4	*13.4*
Maufant (RB)	9.1	9.9	7.8	8.1	7.9	4.9	6.7	10.8	16.3	12.7	12.8	16.2	10.3	*8.9*
Rue Des Raisies (Rural)	8.3	7.4	6.3	10.9	5.4	4.3	4.0	5.7	5.4	7.4	6.3	9.8	6.8	*5.9*

K = Kerbside, R = Roadside, UB = Urban Background, RB = Residential Background, Rural = Rural Background. TM = tube missing, bdl = below detection limit.
*Annual mean concentrations greater than 40µg m^{-3} highlighted in **bold**.*

Figure 2. Comparison of Annual Nitrogen Dioxide Concentrations at All Jersey Sites, 2007 (Bias Adjustment Factor Applied)

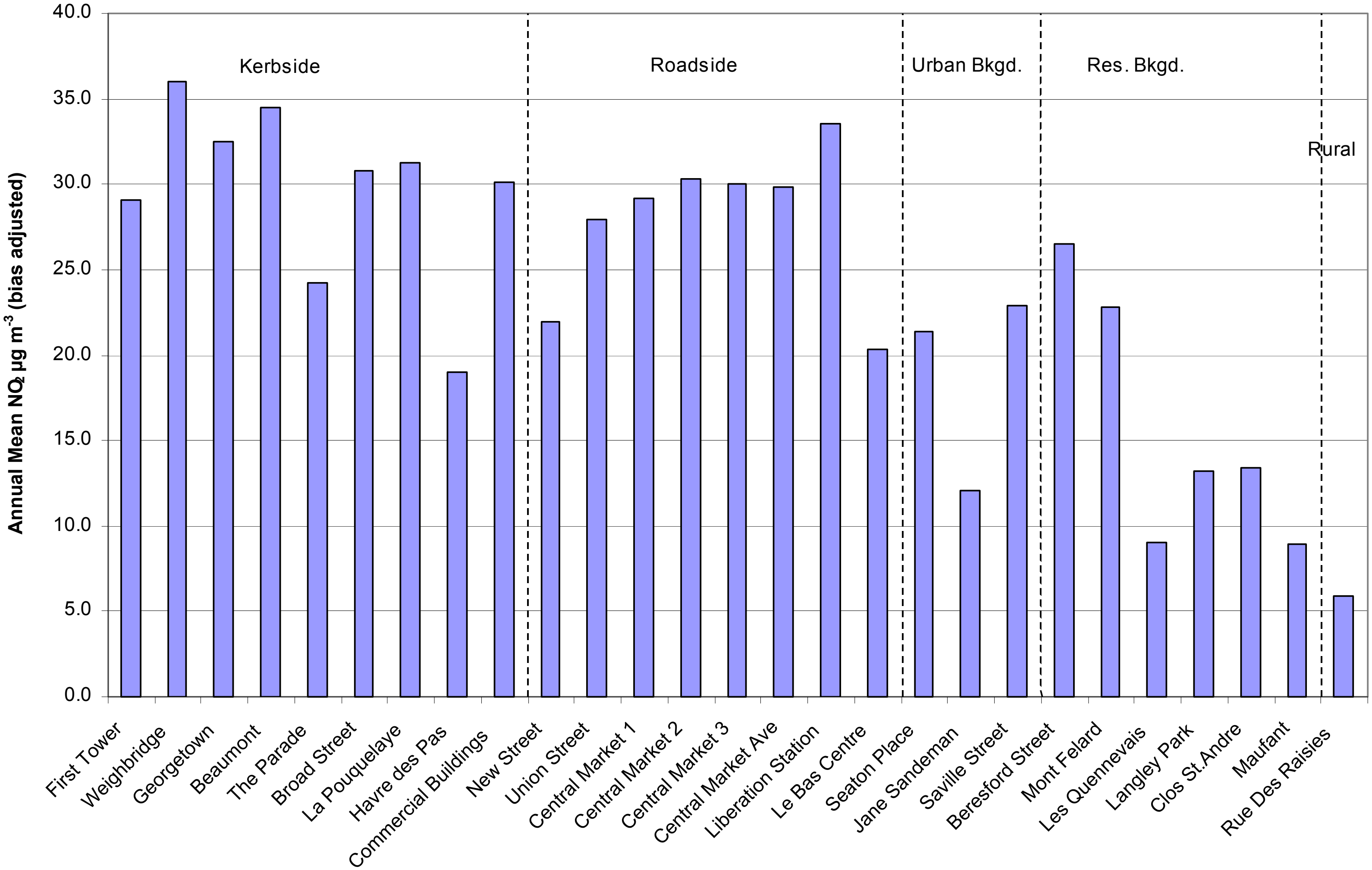
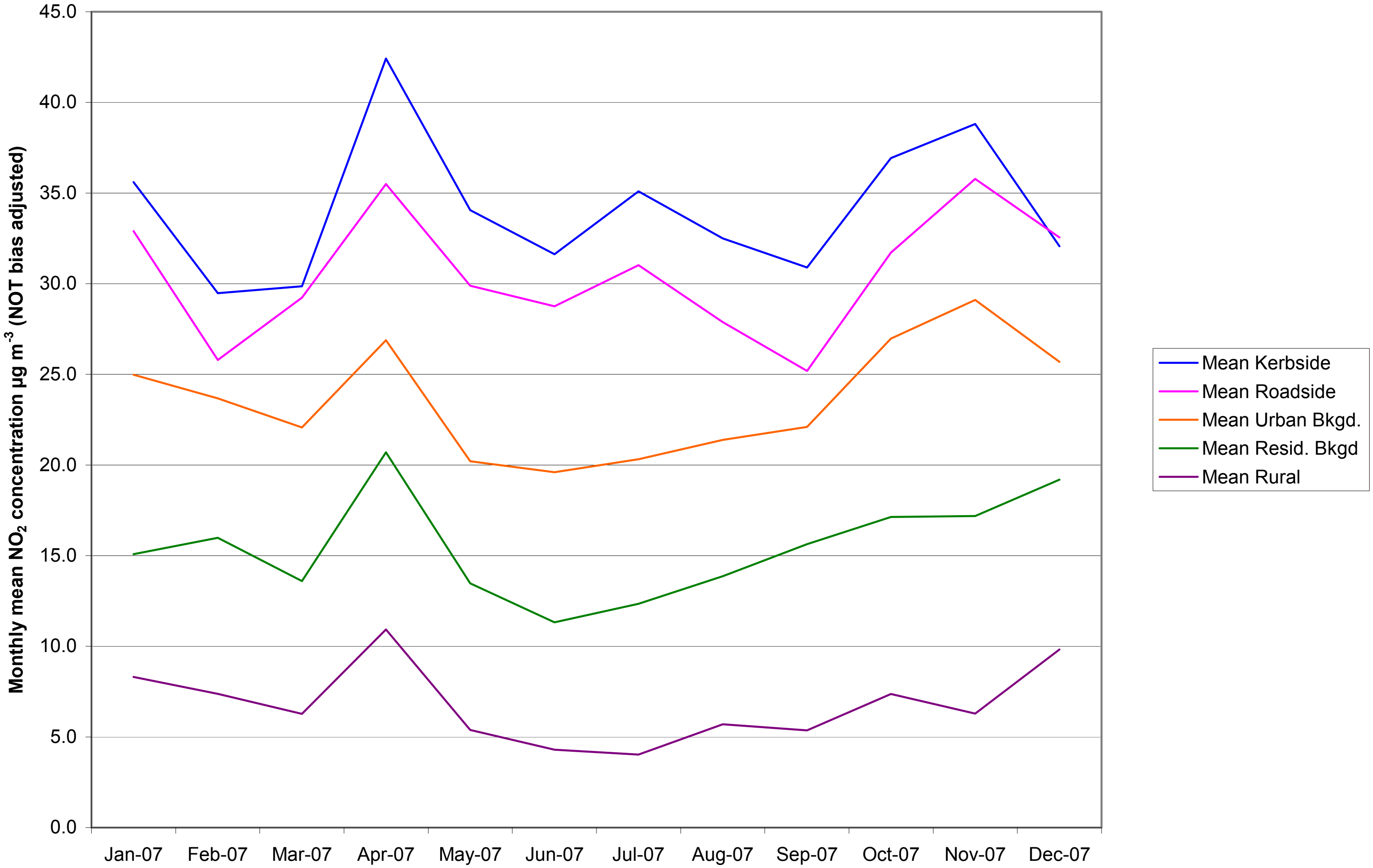


Figure 3. Seasonal Variation in Monthly Mean NO2 Concentration, Averaged for Each Site Type (NOT bias-adjusted).



3.1.3 Seasonal Variation in NO_2 Concentrations

Figure 3 shows how the monthly concentration varied throughout the year, for each of the various site types (kerbside, roadside, urban background, urban residential and rural sites). All site types showed a noticeable peak in nitrogen dioxide during April 2007: apart from this, there were no pronounced seasonal patterns. At urban, residential and rural background sites, NO_2 concentrations were slightly higher during winter months when emissions from heating etc. are typically greater.

3.1.4 Precision of Diffusion Tubes

Diffusion tubes were exposed in triplicate at the new Central Market site: this allows an investigation of diffusion tube precision. Precision may be expressed in terms of the coefficient of variation (CV) of the three replicate measurements. This parameter, also known as the relative standard deviation, is the standard deviation expressed as a percentage of the mean.

For diffusion tubes exposed in triplicate, the CV is usually expected to be within 10% on average. (This is based purely on experience of what a competent laboratory is typically able to achieve, although it can be affected by conditions at the site, or by bad handling of the tubes by the site operator). At Central Market, the CV of tube triplets ranged from 1.4% to 18.1%, with a mean of 6.4%.

The CV was within 10% on all but one occasion. This occasion was October 2007, when the three results were more widely spread than usual, leading to a CV of 18%. It is not uncommon for diffusion tube precision to occasionally be poor; this is not a cause for concern as the precision over the rest of the year was consistently good.

3.1.5 Comparison with UK NO_2 data

Table 4 shows annual mean NO_2 concentrations measured at a selection of UK air quality monitoring stations using automatic (chemiluminescent) NO_2 analysers. The automatic data have been fully ratified. The sites used for comparison are as follows:

- Exeter Roadside – a roadside site in the centre of Exeter, Devon.
- Brighton Roadside – a roadside site in the coastal city of Brighton, Sussex.
- Brighton Preston Park – an urban background site in Brighton.
- Southend on Sea – an urban background site in the coastal town of Southend, Essex.
- Lullington Heath - a rural site on the South Coast of England near the town of Eastbourne.
- Harwell - a rural site in the south of England, within 10km of a power station.

Table 4. Comparison of NO_2 in Jersey with UK Automatic Sites

Site	2007 Annual average NO_2, $\mu g\ m^{-3}$
Exeter Roadside	39
Brighton Roadside	41
Brighton Preston Park	22
Southend on Sea	25
Lullington Heath	10
Harwell	12

The bias adjusted annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey ranged from 19 to 36 $\mu g\ m^{-3}$. The annual means at Exeter Roadside and Brighton Roadside were at the upper end of this range. The Jersey urban background sites had (bias adjusted) annual mean NO_2 concentrations ranging from 12 $\mu g\ m^{-3}$ to 27 $\mu g\ m^{-3}$; the urban background sites in Southend and Brighton were therefore towards the upper end of this range. Residential background sites well outside Jersey's larger towns (e.g. Les Quennevais, Clos St Andre, Maufant, with the exception of Mont Felard) had bias-adjusted annual mean NO_2 ranging from 9 $\mu g\ m^{-3}$ to 13 $\mu g\ m^{-3}$, and thus were more comparable with rural sites such as Lullington Heath and Harwell. (Mont Felard, although designated residential background, had an annual mean more comparable with a coastal urban background site and has been redesignated as an urban background location). The bias-adjusted annual mean of 5.9 μg m^{-3} at the Jersey rural background site, Rue des Raisies, as in previous years, was considerably lower than that measured at either Harwell or Lullington Heath.

3.1.6 Comparison with Previous Years' Nitrogen Dioxide Results

Annual mean NO_2 concentrations for 2007, at the majority of sites, were comparable with previous year's results. With a few exceptions they were predominantly lower than last year. Some degree of fluctuation in annual mean concentrations is expected, due to meteorology.

Long-term trends were also investigated. The majority of the NO_2 monitoring sites in this survey have been in operation since 2000. However, the survey includes three longer-running sites, which were part of the former UK Nitrogen Dioxide Network and have been in operation since 1993. These are Beaumont (kerbside), Jane Sandeman Road (urban residential) and Maufant (residential background, rural location).

Table 5 and Figure 4 show annual mean NO_2 concentrations for all sites in the kerbside and roadside, urban background and residential background categories. Also shown are annual means from 1993 onwards for the three long-running sites. ***These data are not adjusted for diffusion tube bias; prior to 2002 there was no reliable information on which to carry out bias adjustment, so for consistency, unadjusted data are used in this section.***

Of the three long-running Jersey sites, only the residential background Jane Sandeman road site shows a small but consistent downward trend. In the case of the Maufant site, NO_2 concentrations are lower than they were in the early 1990s, but there is no clear trend in recent years. Nor is there any clear trend for the kerbside Beaumont site.

The average NO_2 concentration for all roadside and kerbside sites appears to show a small but consistent downward trend since 2000, with a particularly marked reduction since 2003 (which was a notably high year). Using Theil's non-parametric analysis, a significant downward trend has been confirmed in the annual mean NO_2 concentration, averaged over all Jersey's kerbside and roadside sites, over the past eight years. It is sites of this type which have in previous years been identified as at risk of exceeding the EC annual mean Limit Value of 40 μg m^{-3}, so any trends at these sites is of particular interest. However, it shold be noted that several of them remain close to the Limit Value.

There is no clear trend in the mean of all urban background sites, or all residential background sites. As observed in previous reports in this series, this means that sites which are currently at risk of exceeding the Limit Value will remain so for the foreseeable future. However, as all the urban background, urban residential and rural sites are well below the EC Limit Value of 40 μg m^{-3}, the fact that NO_2 concentrations at these sites are stable is not a cause for great concern.

Figure 4. Trends in Annual Mean NO_2 Concentrations (not corrected for diffusion tube bias).

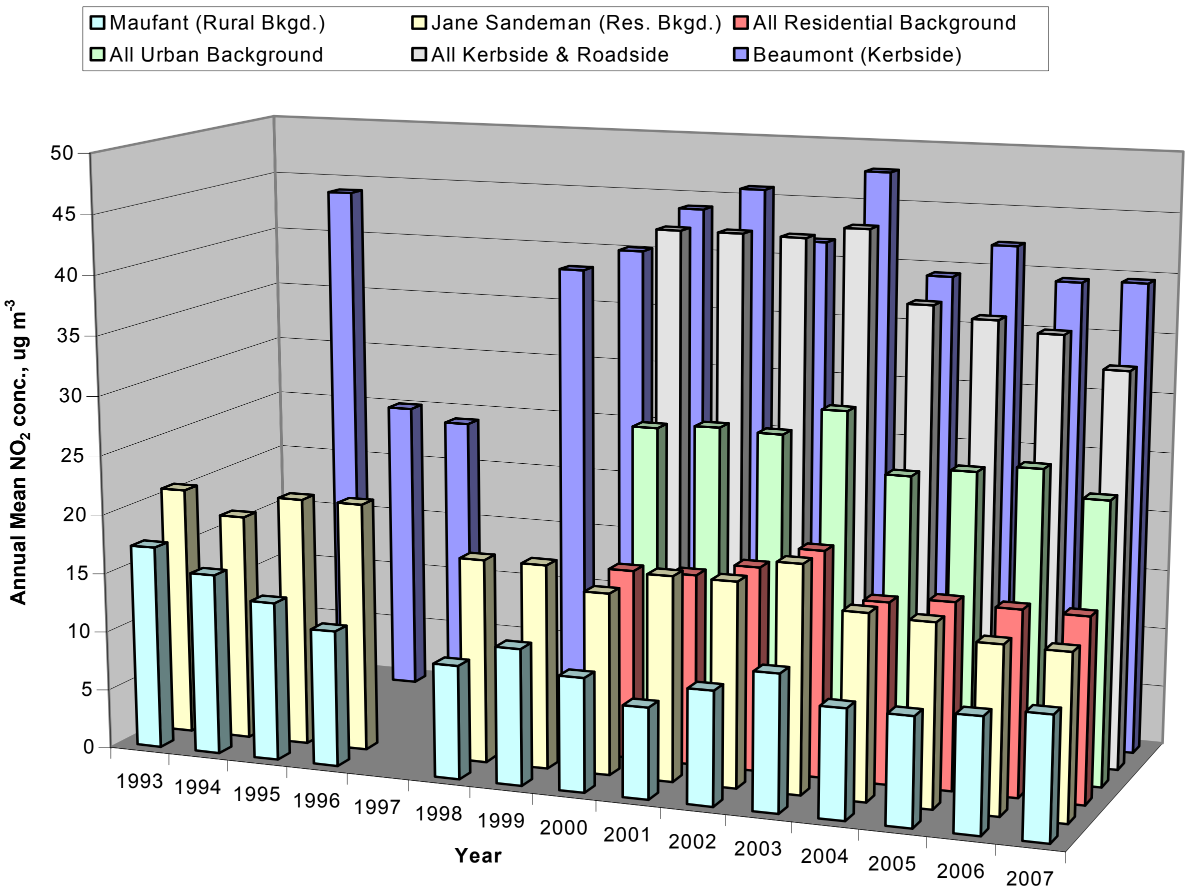


Table 5. Annual mean NO_2 concentrations, $\mu g\ m^{-3}$ (not bias adjusted)

Site	Beaumont (Kerbside)	Jane Sandeman (Res. Bkgd.)	Maufant (Rural Bkgd.)	Mean All Kerbside & Roadside	Mean All Urban Background	Mean All Residential Background
1993		21	17	-	-	-
1994	44	19	15	-	-	-
1995	25	21	13	-	-	-
1996	24	21	11	-	-	-
1997	-	-	-	-	-	-
1998	38	17	10	-	-	-
1999	40	17	11	-	-	-
2000	44	15	10	43	27	16
2001	46	17	8	43	27	16
2002	42	17	10	43	27	17
2003	48	19	11	44	30	19
2004	39	16	9	38	25	15
2005	42	15	9	37	25	16
2006	39	14	10	36	26	16
2007	40	14	10	33	24	15

3.2 Hydrocarbons

Results of the hydrocarbon survey for the six sites are shown in Appendix 2, Tables A2.1 to A2.6 respectively. Graphical representations are shown in Figures 5 to 10.

A summary of annual average hydrocarbon concentrations is shown in Table 6. Some measurements, particularly at the Airport site, were below the detection limit. By convention, when calculating annual averages and plotting graphs, such results are assumed to be half the detection limit.

Table 6. Summary of Average Hydrocarbon Concentrations, Jersey, 2007

Site	Benzene, $\mu g\ m^{-3}$	Toluene, $\mu g\ m^{-3}$	Ethyl Benzene, $\mu g\ m^{-3}$	m+p Xylene, $\mu g\ m^{-3}$	o Xylene, $\mu g\ m^{-3}$
Beresford Street	1.7	10.4	1.7	4.4	1.8
Le Bas Centre	1.5	6.5	1.3	3.2	1.3
Handsford Lane *(paint spraying)*	1.1	6.7	2.2	6.4	2.2
Springfield Garage *(petrol station)*	4.3	29.5	4.0	11.9	4.4
Clos St Andre	0.8	2.9	0.8	1.8	1.2
Airport	0.8	3.4	0.5	1.0	0.4

Not all sites achieved full data capture for hydrocarbons in 2007. The following losses of data occurred:

- (i) Beresford Street: the April BTEX tube went missing from the site, and the November tube was returned without its cap, thus invalidating the result.
- (ii) Le Bas Centre: the August tube was returned to the laboratory without its cap.
- (iii) Springfield Garage: the June and August tubes were returned to the laboratory without caps.
- (iv) Clos St Andre: the June tube was returned without its cap.
- (v) Airport: the June, August and November tubes were returned without their caps.

The majority of lost data was due to not replacing the caps tightly enough before returning the tubes for analysis. The tube changing procedure has been updated, which should prevent future recurrence.

In addition, the following data anomalies occurred:

1. the reported results for Handsford Lane for November were very low, while the travel blank results were unusually high. It appeared from the exposure record sheet that the blank tube had been exposed instead of the intended tube at this site. (This error is not unlikely, as the ID numbers of the tubes differed by just one digit.) We have therefore assumed this is the case.
2. Similarly, low results were also obtained for September at the same site. These have been rejected as the tube appeared unexposed, and in this case there was no evidence that any tubes had been mixed up.
3. An unusually high result was obtained for o-xylene in March, at Clos St Andre. This is inconsistent with the concentrations of other hydrocarbon species measured by the same tube. The most likely explanation is tube contamination, but in the absence of any evidence of this, the value has not been rejected

The Springfield Garage monitoring site continues to record the highest annual mean concentrations of all five BTEX compounds, as it typically has in previous years. The Handsford Lane site (near a paint spraying process) has in previous years also measured slightly higher levels of toluene, ethylbenzene and xylenes than most of the other sites. The Airport site, which is in rural surroundings, recorded the lowest annual mean concentrations of most of the BTEX hydrocarbons.

Benzene concentrations at Handsford Lane were no higher than those at Beresford Street or Le Bas; the nearby paint spraying process is not a significant source of benzene.

Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2007

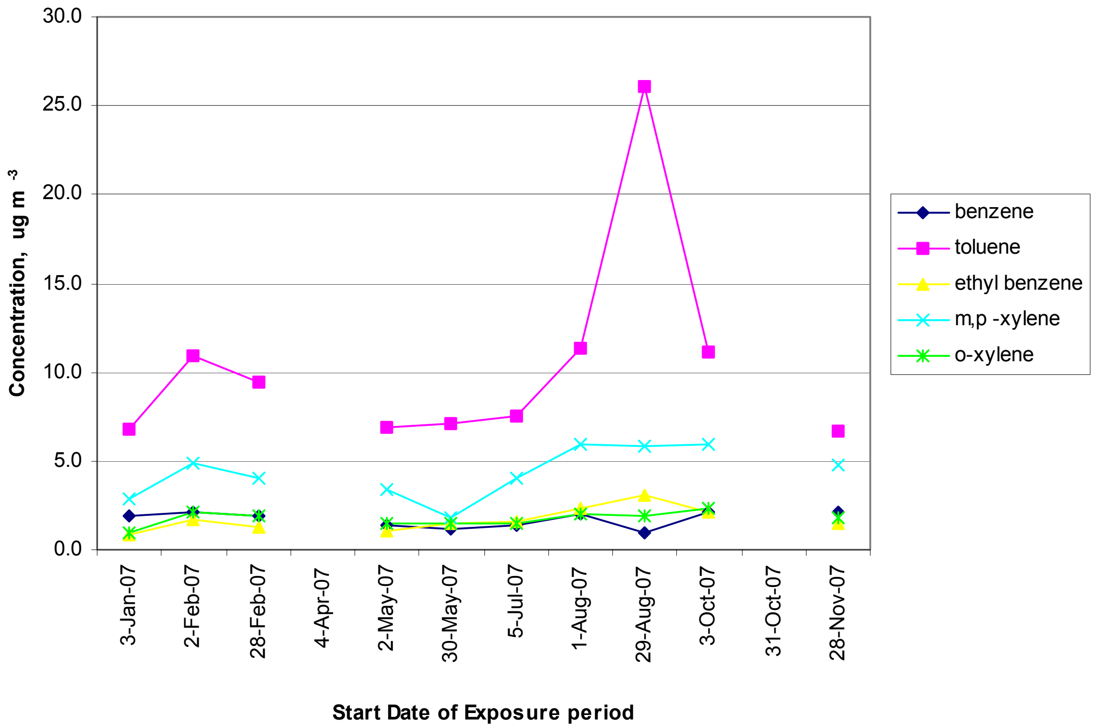


Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2007

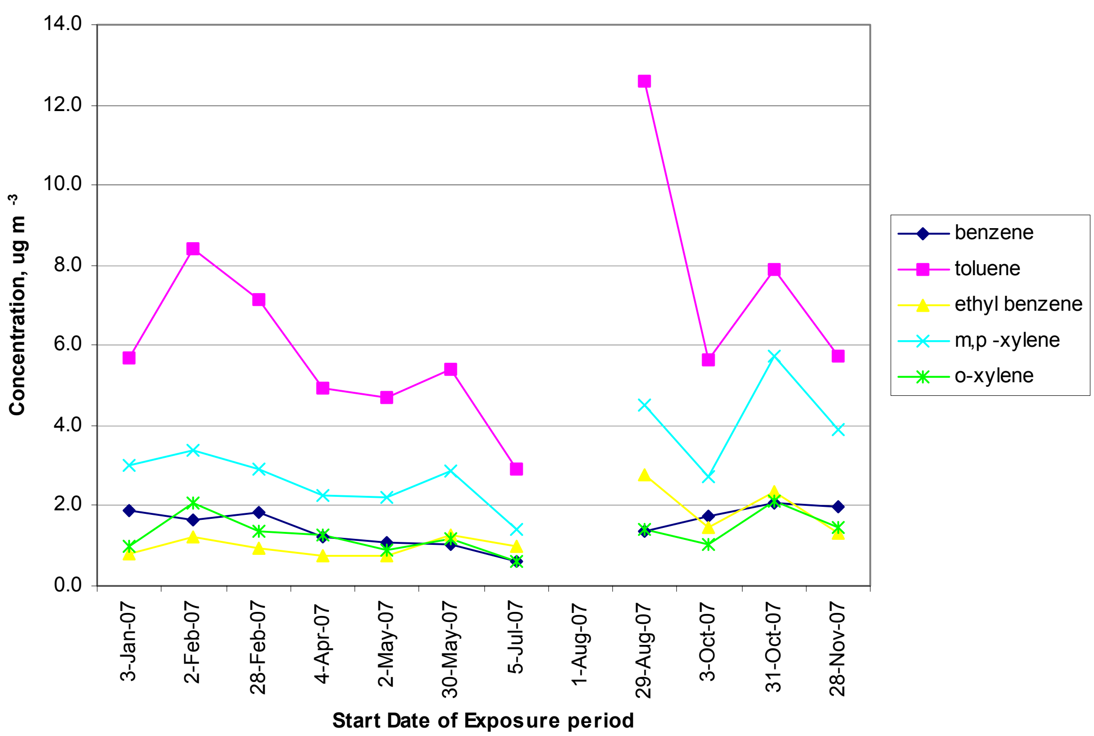


Figure 7. Monthly mean hydrocarbon concentrations at Handsford Lane, 2007

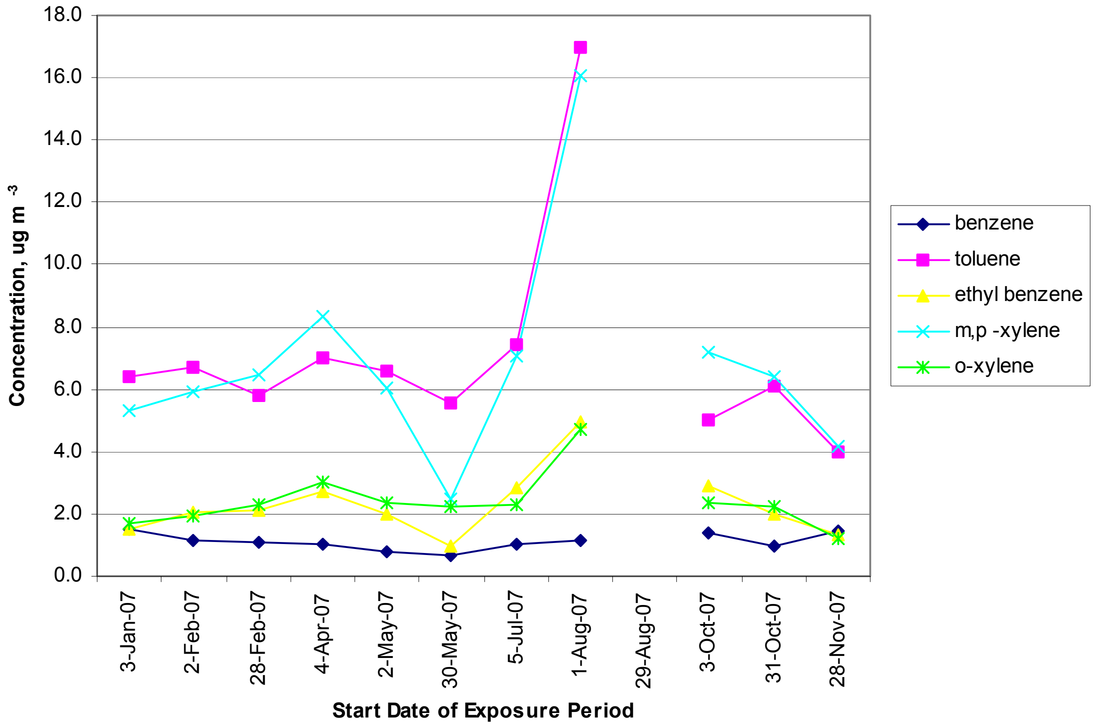


Figure 8. Monthly mean hydrocarbon concentrations at Springfield Garage, 2007

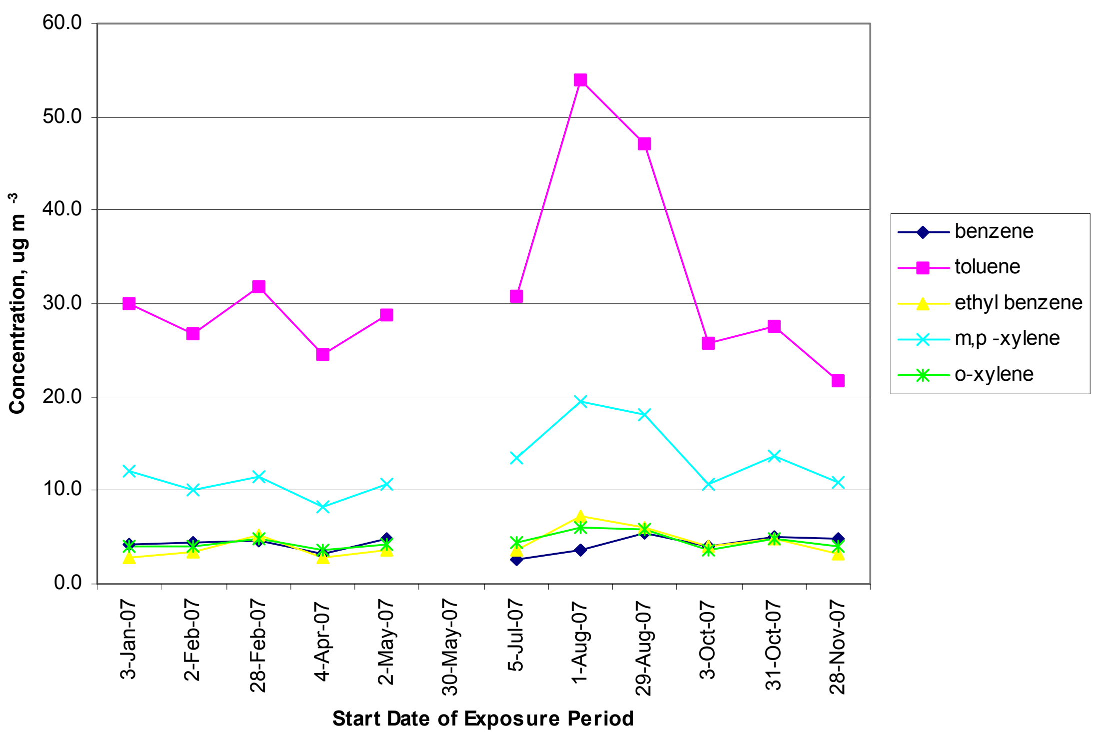


Figure 9. Monthly mean hydrocarbon concentrations at Clos St Andre, 2007

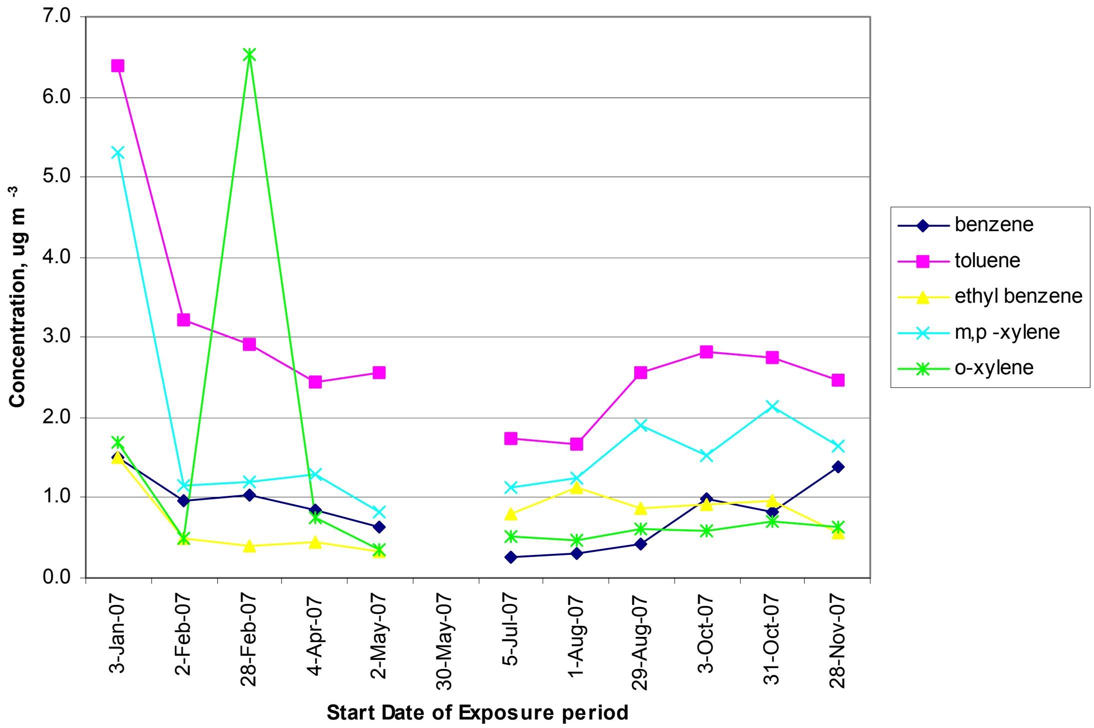
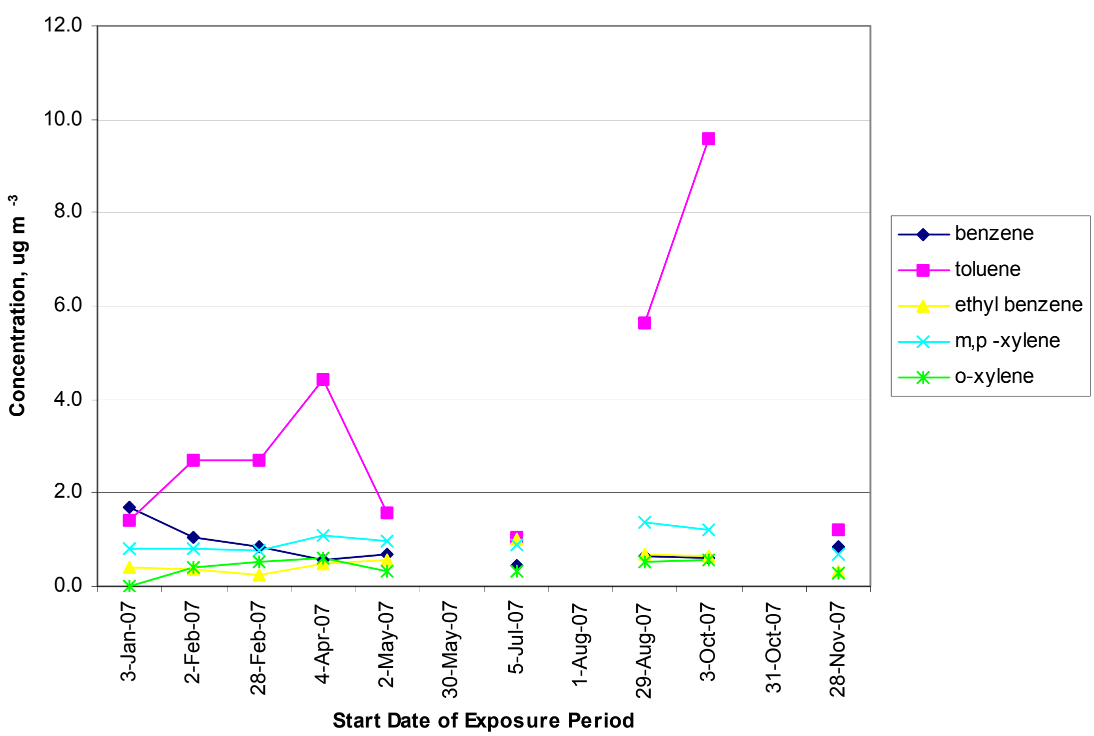


Figure 10. Monthly mean hydrocarbon concentrations at the Airport, 2007



3.2.1 Comparison With Limit Values and Objectives

Of the hydrocarbon species monitored, only benzene is the subject of any applicable air quality standards. The UK Air Quality Strategy sets the following objectives for benzene:

- 16.25µg m^{-3} (for the running annual mean), to have been achieved by 31st December 2003
- 3.25 µg m^{-3} (for the calendar year mean), to be achieved by 31st December 2010.

These are applicable to the whole UK (though not at present mandatory in Jersey). The annual mean benzene concentration (which can be considered a good indicator of the running annual mean) did not exceed 16.25µg m^{-3} at any of the Jersey sites. The calendar year mean was less than the 2010 objective of 3.25 µg m^{-3}, at all sites except Springfield Garage.

The EC 2nd Daughter Directive[15] sets a limit of 5µg m^{-3} for annual mean benzene, to be achieved by 2010. All sites met this limit in 2007.

3.2.2 Comparison with UK Benzene Data

Benzene was measured using pumped-tube samplers at a large UK-wide network of 30 UK sites in 2007. Annual mean concentrations ranged from 0.57 µg m^{-3} (at Bournemouth) to 1.87 µg m^{-3} (at Yarm, Stockton-on-Tees), but were typically in the range of 0.7- 1.5 µg m^{-3} at most urban sites.

Table 7 compares benzene data from the Jersey sites, with that from a selection of UK monitoring stations, located in cities on the south coast of England. The sites used for comparison are:

- Bournemouth – an urban background site in a coastal town.
- Hove Roadside – a roadside site in the coastal town of Hove, near Brighton, Sussex.
- Plymouth – an urban background site in the coastal city of Plymouth, Devon
- Portsmouth – an urban background site in Portsmouth , Hampshire
- Southampton – a roadside site in the city of Southampton
- Southend on Sea – an urban background site in Southend, Essex.

Table 7. Comparison with Benzene Concentrations at Other UK Sites, Calendar Year 2007 (With data capture in brackets).

Site	Benzene, µg m^{-3}
Jersey Sites	
Beresford Street	1.7
Le Bas Centre	1.5
Handsford Lane *(paint spraying)*	1.1
Springfield Garage *(petrol station)*	4.3
Clos St Andre	0.8
Airport	0.8
Mainland UK sites	
Bournemouth	0.57
Hove Roadside	1.01
Plymouth	1.04
Portsmouth	0.65
Southampton	0.99
Southend	0.71

The annual mean benzene concentration at Springfield Garage (where fuels are stored) was higher than any of the other Jersey or UK Network sites, including the roadside sites at Southampton and Hove. Prior to 2006 it was reported in this series of reports that benzene levels at Clos St Andre and the Airport were lower than typical UK urban levels; however, UK urban levels are decreasing and this is no longer the case.

3.2.3 Comparison with Previous Years' Hydrocarbon Results

Table 8 shows annual mean hydrocarbon concentrations for these sites, for years 1997 – 2007. Figures 11 to 15 illustrate how annual mean concentrations of these hydrocarbons have changed over the years of monitoring.

As well as the six sites currently in operation, Table 8 also shows previous years' results from a site at Elizabeth Lane. This site was located close to a paint spraying process: when the process closed down, monitoring was re-located to Handsford Lane, which is close to another similar process.

Annual mean levels of benzene at all sites were very slightly higher in 2007 than in the previous year; this is in contrast to the UK, where annual mean concentrations of this pollutant were typically lower than the previous year.

Annual mean toluene concentrations at all sites except Handsford Lane were slightly lower in 2006 compared to 2005. Annual mean concentrations of ethylbenzene and xylenes were lower compared to 2005 at all sites except the Airport. However, it is important to remember that pollutant concentrations are expected to show considerable year-to-year variation, due to meteorological and other factors. Year-to year changes are therefore of less importance than the observation of long-term trends, which are discussed below.

Table 8. Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2007.

	benzene, µg m^{-3}	toluene, µg m^{-3}	ethylbenzene µg m^{-3}	m+p xylene, µg m^{-3}	o-xylene, µg m^{-3}
Beresford Street					
1997	10.4	20.7	5.3	11.9	5.3
1998	8.1	18.8	4.0	10.2	4.4
1999	5.9	13.8	2.7	7.5	3.5
2000	2.9	14.2	3.5	10.2	4.0
2001	3.3	14.9	3.5	9.7	3.5
2002	2.6	13.0	2.7	8.0	3.1
2003	2.0	11.5	2.2	6.6	2.2
2004	1.9	9.8	5.1	5.5	2.0
2005	1.7	8.9	1.8	5.3	1.9
2006	2.2	7.4	1.3	4.6	1.6
2007	1.7	10.4	1.7	4.4	1.8
Le Bas Centre					
1997	9.1	17.2	5.3	9.7	4.4
1998	7.5	16.1	3.1	8.4	4.0
1999	3.6	11.1	2.2	5.7	2.7
2000	2.9	12.6	3.1	8.4	3.1
2001	2.6	13.4	2.7	7.5	3.1
2002	2.0	8.0	1.8	5.7	2.2
2003	1.3	8.0	1.8	4.9	1.8
2004	1.3	6.6	3.3	3.9	1.4
2005	1.3	5.3	1.1	3.4	1.2
2006	1.5	4.4	0.8	2.8	1.0
2007	1.5	6.5	1.3	3.2	1.3
Elizabeth Lane					
1997	6.2	16.9	6.2	7.5	9.7
1998	6.2	19.2	3.1	7.1	3.5
1999	3.3	12.6	2.2	5.3	2.7
2000	2.3	12.6	3.1	8.0	2.7
2001	2.3	15.7	3.1	8.8	3.5
2002	1.6	11.1	2.2	6.2	1.8
2003	2.0	11.9	2.2	6.2	2.2
Springfield Garage					
1997	25.0	47.9	8.4	19.0	8.4
1998	25.0	47.1	6.6	19.0	7.5
1999	14.6	41.7	5.7	16.8	6.6
2000	5.2	35.2	8.0	22.1	8.8
2001	6.8	42.9	8.0	23.0	8.4
2002	5.5	36.8	6.2	19.0	7.1
2003	4.9	34.1	5.7	15.9	5.7
2004	4.7	30.9	13.5	14.5	5.2
2005	3.3	22.8	3.6	11.2	4.0
2006	3.9	21.7	2.6	10.2	3.7
2007	4.3	29.5	4.0	11.9	4.4

Table 8. Comparison of Hydrocarbon Concentrations, -*continued :* Jersey, 1997 - 2007.

	benzene, $\mu g\ m^{-3}$	toluene, $\mu g\ m^{-3}$	ethylbenzene $\mu g\ m^{-3}$	m+p xylene, $\mu g\ m^{-3}$	o-xylene, $\mu g\ m^{-3}$
Stopford Road Outdoor					
2000	3.9	32.2	8.0	23.4	9.7
2001	5.7	46.8	9.8	30.0	11.6
Clos St Andre					
2000	1.0	3.4	0.9	2.7	0.9
2001	1.3	4.6	1.3	2.7	1.3
2002	1.0	2.7	0.9	2.2	0.9
2003	1.0	4.2	0.9	1.8	0.4
2004	0.7	2.2	1.2	1.2	0.4
2005	0.7	2.2	0.5	1.3	0.5
2006	1.0	2.0	0.4	1.2	0.4
2007	0.8	2.9	0.8	1.8	1.2
Airport					
2002	1.0	2.7	0.9	2.2	0.9
2003	1.0	3.1	0.4	0.9	0.4
2004	0.6	1.1	1.1	0.6	0.3
2005	0.6	1.6	0.2	0.6	0.2
2006	1.0	1.4	0.5	0.9	0.3
2007	0.8	3.4	0.5	1.0	0.4
Handsford Lane					
2004	1.0	16.1	7.3	8.5	2.0
2005	1.0	3.7	2.1	7.1	2.2
2006	1.2	4.8	1.3	5.1	1.6
2007	1.1	6.7	2.2	6.4	2.2

Figure 11. Trends in Benzene Concentration

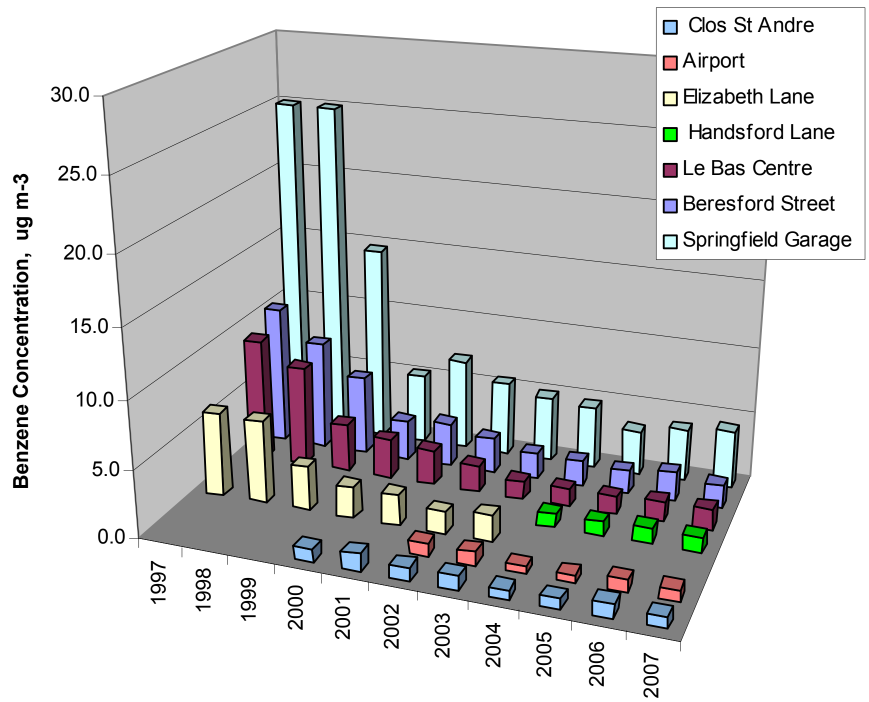


Figure 12. Trends in Toluene Concentration

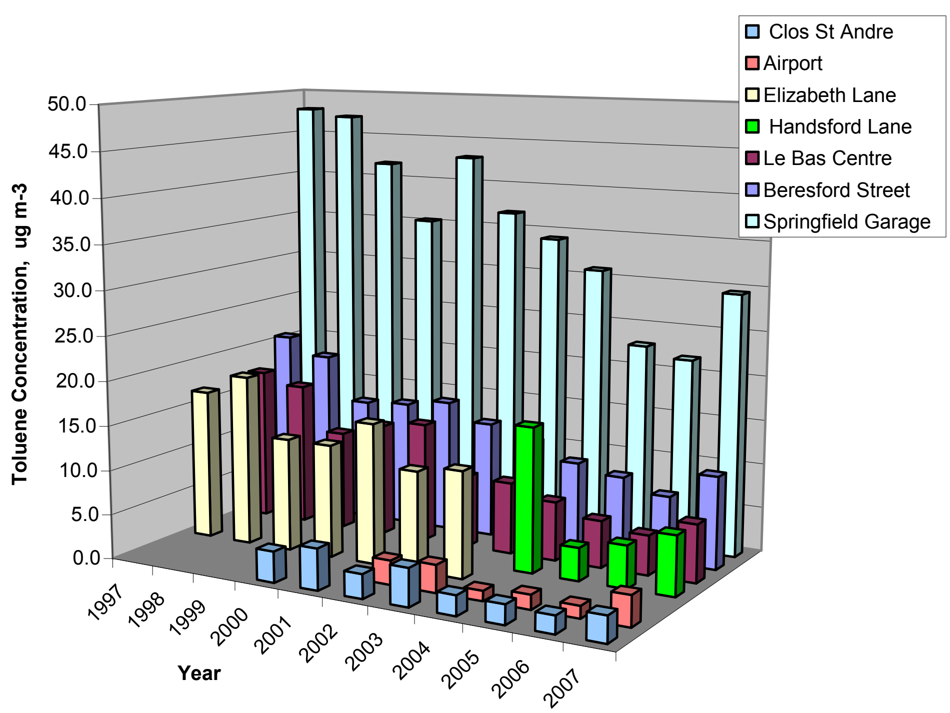


Figure 13. Trends in Ethylbenzene Concentration

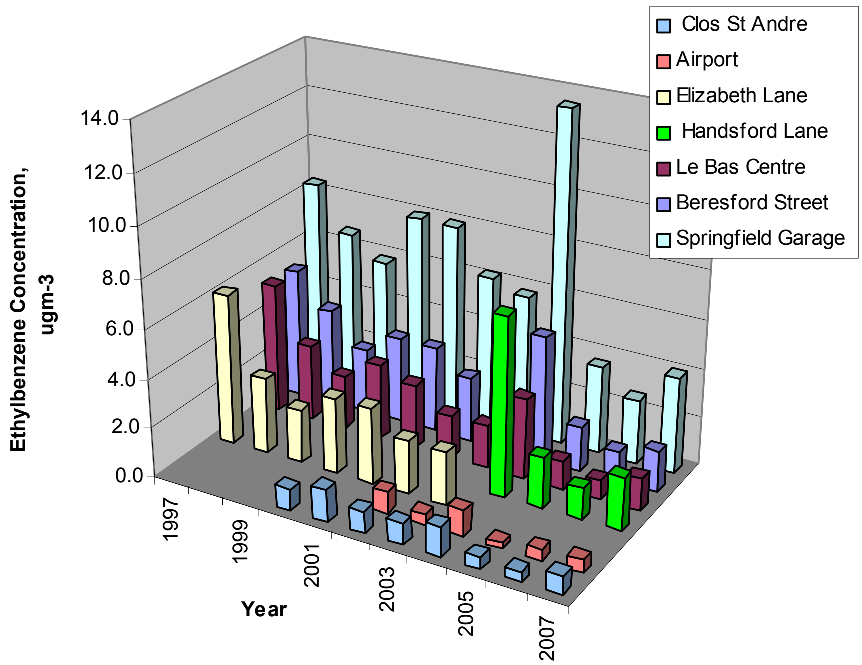


Figure 14. Trends in m+p- Xylene Concentration

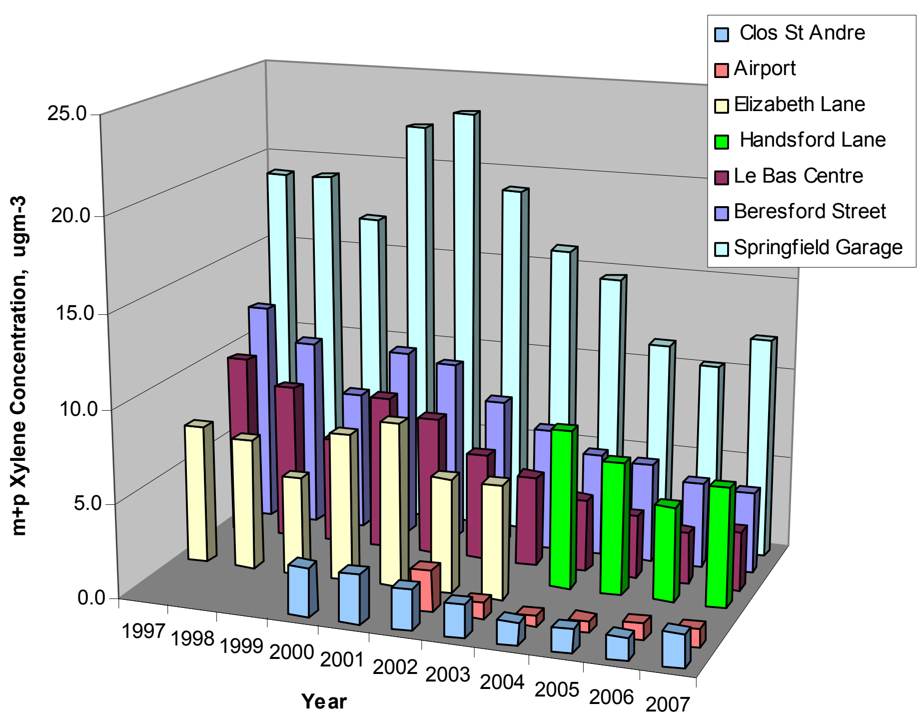
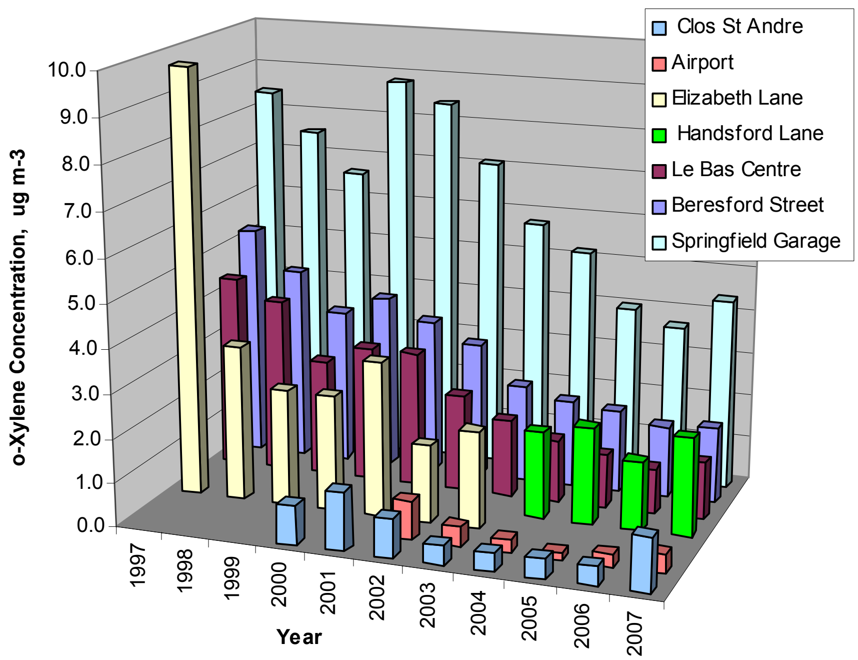


Figure 15. Trends in o-Xylene Concentration



Most hydrocarbon species appear to have decreased over the ten years of monitoring, being in most cases lower now than in the late 1990s.

- Benzene showed a marked drop in 2000: this is due to the maximum permitted benzene content of petrol sold in the UK being reduced from 2% in unleaded (5% in super unleaded), to 1% as of 1st January 2000. Concentrations have continued to fall slightly year on year.
- Toluene concentrations show a small but steady downward trend over the 11 years of the survey (1997-2007).
- Ethylbenzene concentrations have also generally decreased, despite an unexplained increase in 2004.
- Concentrations of m+p xylene, and of o-xylene, are also now generally lower than in the early years of the survey.

4 Conclusions

AEA Energy & Environment has undertaken a year-long diffusion tube monitoring study in Jersey during 2007, on behalf of the States of Jersey Public Health Services . This monitoring study has now been undertaken for eleven consecutive years.

- Diffusion tubes were used to monitor NO_2 at 24 sites.
- Hydrocarbons (benzene, toluene, ethyl benzene and xylenes, collectively termed BTEX) were measured at 6 sites.
- The sites were located at a range of different locations on the island, many of which have been in operation since 2000, and some since 1997.
- Three new sites were set up for monitoring of NO_2: a roadside site at the Central Market (at which diffusion tubes are co-located, in triplicate, with the new automatic monitoring station), a roadside site at Liberation Station, and an urban background site at Seaton Place.

NO_2 results

- The annual mean (uncorrected) NO_2 concentration at one kerbside site (Weighbridge) was above the EC Directive Limit Value and AQS Objective of 40 $\mu g\ m^{-3}$.
- Applying the analytical laboratory's recommended correction factor for diffusion tube bias to this annual mean results reduced it to 36 $\mu g\ m^{-3}$.
- Annual mean NO_2 concentrations at all urban, residential and rural background sites were all well below the EC Limit Value.
- Annual mean NO_2 concentrations at the monitoring sites were comparable with the previous year's results.
- A statistically significant downward trend has been identified, in the average annual mean NO_2 concentrations for all kerbside and roadside sites. This is of particular interest, as it is sites of these types that are currently close to the Limit Value and AQS Objective of 40$\mu g\ m^{-3}$ for annual mean NO_2 concentration.
- There does not appear to be any clear trend in NO_2 concentrations at urban background sites, or urban residential sites; these appear to be remaining stable. However, as they are all well below the Limit Value and AQS Objective, this is not a cause for great concern.

Hydrocarbon tube results

- No sites had annual mean benzene concentrations greater than the UK Air Quality Strategy Objective of 16.25 $\mu g\ m^{-3}$, which was to be achieved by the end of 2003.
- No sites had annual mean benzene concentrations greater than the EC 2nd Daughter Directive Limit Value of 5 $\mu g\ m^{-3}$ (which is to be achieved by 2010).
- One site (Springfield Garage) had an annual mean benzene concentration greater than the UK Air Quality Strategy Objective of 3.25 $\mu g\ m^{-3}$, which is to be achieved by January 2010.
- Annual mean concentrations of BTEX hydrocarbons were mostly slightly higher than, but still comparable with, those measured in 2006.
- The general pattern is that concentrations of most BTEX hydrocarbons are decreasing.
- There was significant data loss due to BTEX tubes losing their caps in transit: action has been taken to prevent this.

5 Recommendations

Results of the diffusion tube survey indicate that all monitoring sites in Jersey meet the UK Air Quality Strategy Objective of 40μg m^{-3} for the annual mean NO_2 concentration. However, some kerbside and roadside locations remain fairly close to this objective, despite some decrease in recent years. Monitoring at these sites should continue.

Significant data loss was caused this year by BTEX tubes being returned after exposure without their caps which had come off in transit. This problem has now been addressed.

6 Acknowledgements

AEA Energy & Environment gratefully acknowledges the help and support of the staff of the States of Jersey Health Protection Services, in the completion of this monitoring study.

7 References

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14. Council Directive 1999/30/EEC relating to Limit Values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. 22 April 1999.
15. Council Directive 2000/69/EC relating to Limit Values for benzene and carbon monoxide in ambient air. 16 Nov 2000.
16. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department of the Environment, Transport and the Regions. January 2000, ISBN 0 10 145482-1
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Appendices

Appendix 1: Air Quality Limit Values, Objectives and Guidelines

Appendix 2: Monthly Hydrocarbon Dataset

Appendix 1

Air Quality Limit Values, Objectives and Guidelines

Air Pollution Guidelines Used in this Report.

UK and International Ambient Air Quality Limit Values, Objectives and Guidelines

Nitrogen Dioxide

Guideline Set By	Description	Criteria Based On	Value[1] / μgm^{-3} (ppb)
The Air Quality Strategy[2]	Objective for Dec. 31st 2005, for protection of human health	1-hour mean	200 (105) Not to be exceeded more than 18 times per calendar year.
Set in regulations[3] for all UK:	Objective for Dec. 31st 2005, for protection of human health	Annual mean	40 (21)
Not intended to be set in regulations:	Objective for Dec. 31st 2000, for protection of vegetation.	Annual mean NO_x (NO_x as NO_2)	30 (16)
European Community 1985 NO_2 Directive [4] Limit remains in force until fully repealed 01/01/2010.	Limit Value	Calendar year of data: 98%ile of hourly means.	200 (105)
1st Daughter Directive[5]	Limit Value for protection of human health. To be achieved by Jan. 1st 2010	1 hour mean	200 (105) not to be exceeded more than 18 times per calendar year
	Limit Value for protection of human health. To be achieved by Jan. 1st 2010	Calendar year mean	40 (21)
	Limit Value (total NO_x) for protection of vegetation. To be achieved by Jul. 19th 2001	Calendar year mean	30 (16)
World Health Organisation[6] **(Non-Mandatory Guidelines)**	Health Guideline	1-hour mean	200
	Health Guideline	Annual mean	40

(1) Conversions between $\mu g\ m^{-3}$ and ppb are as used by the EC, i.e. 1ppb NO_2 = 1.91 $\mu g\ m^{-3}$ at 20°C and 1013 mB.
(2) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(3) Air Quality (England) Regulations 2000 (SI 2000/928), Air Quality (Scotland) Regulations 2000 (SSI 2000/97), Air Quality (Wales) Regulations 2000 (SI 2000/1940 (W138)).
(4) Council Directive 85/203/EEC.
(5) Council Directive 1999/30/EC. Transposed into UK Air Quality Regulations in England by SI 2001/2315, in Scotland by SSI 2001/224, in Wales by SI 2001/2683 (W224), and by Statutory Rule 2002 (94) in Northern Ireland.
(6) WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).

Benzene

Guideline Set By	Description	Criteria Based On	Value[1] / μgm^{-3} (ppb)
The Air Quality Strategy[2,3] All UK	Objective for Dec. 31st 2003	Running annual mean	16.25 (5)
England[4] & Wales[5] only:	Objective for Dec. 31st 2010	Annual mean	5 (1.54)
Scotland[6] & Northern Ireland	Objective for Dec. 31st 2010	Running annual mean	3.25 (1.0)
European Community 2nd Daughter Directive[8]	Limit Value. To be achieved by Jan 1st 2010	Annual calendar year mean	5 (1.5)

(1) Conversions between μg m^{-3} and ppb are those used by the EC, i.e. 1ppb benzene = 3.25 μg m^{-3} at 20°C and 1013 mB.
(2) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(3) Air Quality (England) Regulations 2000 (SI 2000/928), Air Quality (Scotland) Regulations 2000 (SSI 2000/97), Air Quality (Wales) Regulations 2000 (SI 2000/1940 (W138)).
(4) Air Quality (Amendment) (England) Regulations 2002 (SI 2002/3043)
(5) Air Quality (Amendment) (Wales) Regulations 2002 (SI 2002/3182 (W298))
(6) Air Quality (Amendment) (Scotland) Regulations 2002 (SI 2002/297)
(7) Council Directive 2000/69/EC. Transposed into UK Air Quality Regulations in England by SI 2002/3117, in Scotland by SSI 2002/556, in Wales by SI 2002/3183 (W299), and by Statutory Rule 2002 (357) in Northern Ireland.

Appendix 2

Monthly Mean Hydrocarbon Results

Contents

Table A2.1 Monthly Hydrocarbon concentrations at Beresford Street (μg m^{-3})

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-07	1.9	6.8	0.9	2.9	1.0
2-Feb-07	2.2	10.9	1.7	4.9	2.1
28-Feb-07	1.9	9.4	1.3	4.0	1.9
4-Apr-07	missing	missing	missing	missing	missing
2-May-07	1.3	6.8	1.1	3.4	1.5
30-May-07	1.1	7.2	1.5	1.8	1.5
5-Jul-07	1.4	7.5	1.6	4.1	1.5
1-Aug-07	2.0	11.4	2.3	6.0	2.0
29-Aug-07	1.0	26.0	3.1	5.9	1.9
3-Oct-07	2.2	11.1	2.2	6.0	2.3
31-Oct-07	cap off	cap off	cap off	cap off	cap off
28-Nov-07	2.2	6.7	1.4	4.8	1.8
Average	**1.7**	**10.4**	**1.7**	**4.4**	**1.8**

Table A2.2 Monthly Hydrocarbon concentrations at Le Bas Centre (μg m^{-3})

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-07	1.9	5.7	0.8	3.0	1.0
2-Feb-07	1.6	8.4	1.2	3.4	2.1
28-Feb-07	1.8	7.1	0.9	2.9	1.4
4-Apr-07	1.2	4.9	0.8	2.3	1.3
2-May-07	1.1	4.7	0.8	2.2	0.9
30-May-07	1.0	5.4	1.3	2.9	1.2
5-Jul-07	0.6	2.9	1.0	1.4	0.6
1-Aug-07	cap off	cap off	cap off	cap off	cap off
29-Aug-07	1.4	12.6	2.7	4.5	1.4
3-Oct-07	1.7	5.6	1.5	2.7	1.1
31-Oct-07	2.1	7.9	2.4	5.7	2.1
28-Nov-07	2.0	5.7	1.3	3.9	1.5
Average	**1.5**	**6.5**	**1.3**	**3.2**	**1.3**

Table A2.3 Monthly Hydrocarbon Concentrations at Handsford Lane ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-07	1.5	6.4	1.5	5.3	1.7
2-Feb-07	1.2	6.7	2.0	5.9	1.9
28-Feb-07	1.1	5.8	2.1	6.5	2.3
4-Apr-07	1.0	7.0	2.7	8.4	3.0
2-May-07	0.8	6.6	2.0	6.0	2.4
30-May-07	0.7	5.6	0.9	2.5	2.3
5-Jul-07	1.0	7.5	2.8	7.1	2.3
1-Aug-07	1.1	17.0	4.9	16.1	4.7
29-Aug-07	-	-	-	-	-
3-Oct-07	1.4	5.0	2.9	7.2	2.4
31-Oct-07	0.4	1.8	0.6	1.6	0.5
28-Nov-07	1.4	4.0	1.3	4.2	1.2
Average	**1.1**	**6.7**	**2.2**	**6.4**	**2.2**

Tube from period beginning 29 Aug was apparently unexposed.

Table A2.4 Monthly Hydrocarbon Concentrations at Springfield Garage ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-07	4.2	30.0	2.9	12.0	4.1
2-Feb-07	4.4	26.7	3.4	10.0	4.0
28-Feb-07	4.5	31.7	5.3	11.4	4.8
4-Apr-07	3.2	24.5	2.9	8.2	3.6
2-May-07	4.8	28.7	3.7	10.7	4.2
30-May-07	cap off	cap off	cap off	cap off	cap off
5-Jul-07	2.6	30.8	3.7	13.6	4.5
1-Aug-07	cap off	cap off	cap off	cap off	cap off
29-Aug-07	5.5	47.2	6.0	18.2	5.9
3-Oct-07	4.1	25.7	3.9	10.6	3.7
31-Oct-07	5.0	27.6	4.8	13.7	4.9
28-Nov-07	4.8	21.7	3.3	10.9	4.1
Average	**4.3**	**29.5**	**4.0**	**11.9**	**4.4**

Table A2.5 Monthly Hydrocarbon Concentrations at Clos St Andre ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-07	1.5	6.4	1.5	5.3	1.7
2-Feb-07	1.0	3.2	0.5	1.1	0.5
28-Feb-07	1.0	2.9	0.4	1.2	6.5
4-Apr-07	0.8	2.4	0.4	1.3	0.7
2-May-07	0.6	2.6	0.3	0.8	0.4
30-May-07	cap off	cap off	cap off	cap off	cap off
5-Jul-07	0.3	1.7	0.8	1.1	0.5
1-Aug-07	0.3	1.7	1.1	1.2	0.5
29-Aug-07	0.4	2.6	0.9	1.9	0.6
3-Oct-07	1.0	2.8	0.9	1.5	0.6
31-Oct-07	0.8	2.7	1.0	2.1	0.7
28-Nov-07	1.4	2.5	0.6	1.6	0.6
Average	**0.8**	**2.9**	**0.8**	**1.8**	**1.2**

Table A2.6 Monthly Hydrocarbon Concentrations at the Airport ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-07	1.7	1.4	0.4	0.8	bdl
2-Feb-07	1.0	2.7	0.4	0.8	0.4
28-Feb-07	0.8	2.7	0.2	0.8	0.5
4-Apr-07	0.6	4.4	0.5	1.1	0.6
2-May-07	0.7	1.6	0.6	1.0	0.3
30-May-07	cap off	cap off	cap off	cap off	cap off
5-Jul-07	0.5	1.1	1.0	0.9	0.3
1-Aug-07	cap off	cap off	cap off	cap off	cap off
29-Aug-07	0.7	5.6	0.7	1.4	0.5
3-Oct-07	0.6	9.6	0.6	1.2	0.6
31-Oct-07	cap off	cap off	cap off	cap off	cap off
28-Nov-07	0.8	1.2	0.3	0.7	0.3
Average	**0.8**	**3.4**	**0.5**	**1.0**	**0.4**

AEA Energy & Environment
From the AEA group

Building 551.11
Harwell International Business Centre
DIDCOT
Oxfordshire
OX11 0QJ

Tel: 0845 345 3302
Fax: 0870 190 6318

E-mail: info@aeat.co,uk

www.aea-energy-and-environment.co.uk