Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2006

Report to Public Health Services, States of Jersey

Restricted Commercial
ED 44958001
Issue 1
Jul 2007

Title	Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2006
Customer	Public Health Services, States of Jersey
Customer reference	
Confidentiality, copyright and reproduction	Copyright AEA Technology plc This report is submitted by AEA Technology plc in connection with a contract to supply goods and/or services and is submitted only on the basis of strict confidentiality. It may not be used for any other purposes, reproduced in whole or in part, nor passed to any organisation or person without the specific permission in writing of the Commercial Manager, AEA.
File reference	ED44958001
Reference number	AEA/ENV/R/2457 – Issue 1

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

t: 0870 190 6518
f: 0870 190 6377

AEA is a business name of AEA Technology plc

AEA is certificated to ISO9001 and ISO14001

Author	Name	Alison Loader
Approved by	Name	Brian Stacey
	Signature	
	Date	23rd Jul 2007

This report is an electronic copy of a document signed by Brian Stacey on 23/7/07. Hard copies are available from the address above.

Executive Summary

AEA Energy & Environment is undertaking an ongoing programme of air quality monitoring on Jersey, on behalf of the Public Health Services Department of the States of Jersey. This report presents the results of the tenth consecutive year of monitoring, calendar year 2006 – covered by the monitoring period 3rd January 2006 to 3rd January 2007.

Diffusion tube samplers were used to monitor nitrogen dioxide (NO_2) at 23 sites, and hydrocarbons at six sites. Monitoring sites were selected to measure traffic emissions and 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 periods approximating to calendar months. The tubes were supplied and analysed by Harwell Scientifics Ltd, and changed by Technical Officers of Jersey's Environmental Health Section.

Annual mean NO_2 concentrations at three kerbside and roadside sites in built-up areas (Weighbridge, Georgetown and La Pouquelaye) were greater than the Limit Value of 40μg m^{-3}, set by Directive 1999/30/EEC (to be achieved by 2010), and as an Objective by the UK Air Quality Strategy, to be achieved by 31st December 2005. However, application of an adjustment factor for known diffusion tube bias reduced the annual means at all sites to below 40μg m^{-3}. The highest annual mean of 36 μg m^{-3} (after bias adjustment) was measured at the Weighbridge site.

Annual mean concentrations at urban and residential background sites were all well below 40μg m^{-3} in 2006.

Ambient NO_2 concentrations at most of the sites in Jersey were similar to those measured in the previous year (2005); some fluctuation from year to year is to be expected, due to meteorological and other factors. Two sites (Georgetown and Weighbridge) showed slightly larger increases in 2006, and should be monitored closely to establish whether this continues.

Ambient concentrations of NO_2 at some sites are showing a small but steady year on year downward trend in NO_2 concentrations. However, this is not the case for all sites. The implication of this is that some kerbside sites that are currently close to the AQS Objective may remain so, unless action is taken.

The highest annual mean benzene concentration of 3.3μg 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).

Annual mean concentrations of the hydrocarbon species monitored in this study are showing a small decrease, year on year.

Table of contents

1 Introduction

1.1 Background

The States of Jersey are committed to achieving standards of ambient air quality as good as, or better than, those applying in the European Union. This includes meeting EU Limit Values for a range of air pollutants, within the next 3 years. In addition, the States of Jersey have international obligations under the Climate Change Convention to reduce emissions of greenhouse gases.

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 2006. This is the tenth in a series of extensive annual monitoring programmes that began in 1997.

The pollutants measured were nitrogen dioxide (NO_2), and a range of hydrocarbon species (benzene, toluene, ethyl benzene and three xylene compounds), collectively termed BTEX. Average ambient concentrations were measured using passive diffusion tube samplers. NO_2 was measured at 23 sites on the island, and BTEX at six sites.

This report presents the results obtained in the 2006 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 2005[1,2,3,4,5,6,7,8,9]. 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.

(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. Benzene is well known as one of the harmful compounds found in cigarette smoke, but it is also found in petrol and other liquid fuels, in small concentrations. In urban areas, the major source of benzene in ambient air is vehicle emissions. Benzene concentrations in ambient air are generally between 1 and 15 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[10]. The best estimate for the odour threshold of toluene has been reported[10] 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[10], 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. There are no limits for ambient concentration of xylenes, although (as in the case of toluene and ethyl benzene) there are occupational limits relating to workplace exposure. 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})[11].

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[12] 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 (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 [13,14] have been published in recent years. The Limit Values are summarised in Appendix 1.

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[15]. These are also summarised in Appendix 1. Only those Objectives relating to the whole UK (as opposed to 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.

Diffusion tubes for NO_2 consist of a small plastic tube, approximately 7 cm long (Figure 1). 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 (also shown in Figure 1) 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.

Diffusion tubes were prepared by Harwell Scientifics Ltd for AEA Energy & Environment, and 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 period of time. After exposure, the tubes were again sealed and returned to Harwell Scientifics for analysis. The year was divided into twelve exposure periods approximating to calendar months. The duration of the exposure periods varied between three and five weeks.

The diffusion tube methodologies provide data that are accurate to $\pm$ 25% for NO_2 and $\pm$ 20% for BTEX. 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)[16] 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). Harwell Scientifics state that their diffusion tubes typically exhibit a positive bias, and have provided a "bias adjustment factor" for 2006 of **0.75**. (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.***

Figure 1: Diffusion Tubes for Various Pollutants
from left to right: SO_2 tube *(not used in this study)*, BTEX tube (centre), and NO_2 tube.

2.5 Monitoring Sites

At the beginning of 2006, monitoring of NO_2 was being carried out at 21 sites, the majority of which had been in use since 2000. At the end of May / beginning of June 2006, two of the urban background sites (Robin Place and L'Avenue et Dolmen) were replaced by two roadside sites at Havre des Pas and Commercial Buildings. Havre des Pas and Commercial Buildings were added to assist Traffic and Transport Services (TTS) by providing screening data for the Health Impact Assessment associated with an Energy from Waste plant proposed for La Collette. Thus, the total number of sites in operation for part or all of 2006 was 23. The total number of NO_2 sites in operation at the end of 2006 remains at 21. The number of sites, and their locations, are to be reviewed for 2008.

Table 1. NO_2 Monitoring Sites in Jersey

Site number	Site Name	Grid Reference	Description
N1	Le Bas Centre	658 489	Urban Background
N2	Mont Felard	629 501	Residential background, to SW of waste incinerator and 20m from busy road
N3	Les Quennevais	579 496	Residential Background
N4	Rue des Raisies	689 529	Rural Background
N5	First Tower	636 497	Kerbside on major road
N6	Weighbridge	651 483	Roadside at bus station near centre of St Helier
N7	Langley Park	660 501	Residential background
N8	Georgetown	661480	Kerbside on major road
N9	Clos St Andre	638 499	Residential area near Bellozanne Valley refuse Incinerator. Background
N10	L'Avenue et Dolmen *(Closed end May 2006)*	656 490	Urban background close to ring road
N11	Robin Place *(Closed end May 2006)*	656 489	Urban background
N12	Beaumont	597 516	Kerbside
N13	The Parade *	648 489	Roadside site at General Hospital
N14	Maufant	683 512	Background site in Maufant village
N15	Jane Sandeman	652 494	Urban background on housing estate
N16	Saville Street	648 492	Background
N17	Broad Street	652 486	Urban background
N18	Beresford Street	653 486	Urban background
N19	La Pouquelaye	654 496	Kerbside on St Helier ring road.
N22	Union Street	653 486	Kerbside in St Helier – corner of Union St. & New St.
N23	New Street	653 485	Kerbside in St Helier
N24	Havre des Pas *(from Jun 2006)*		Kerbside, beside main A4 in/out of St Helier
N25	Commercial Buildings *(from Jun 2006)*		Kerbside, Commercial Buildings, St Helier

*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.

Figures 2a and 2b show the locations of the above sites. Figure 2b also shows the location of a new automatic monitoring site in Halkett Place, St Helier, started up at the start of 2007.

Figure 2a. Site Locations Outside St Helier

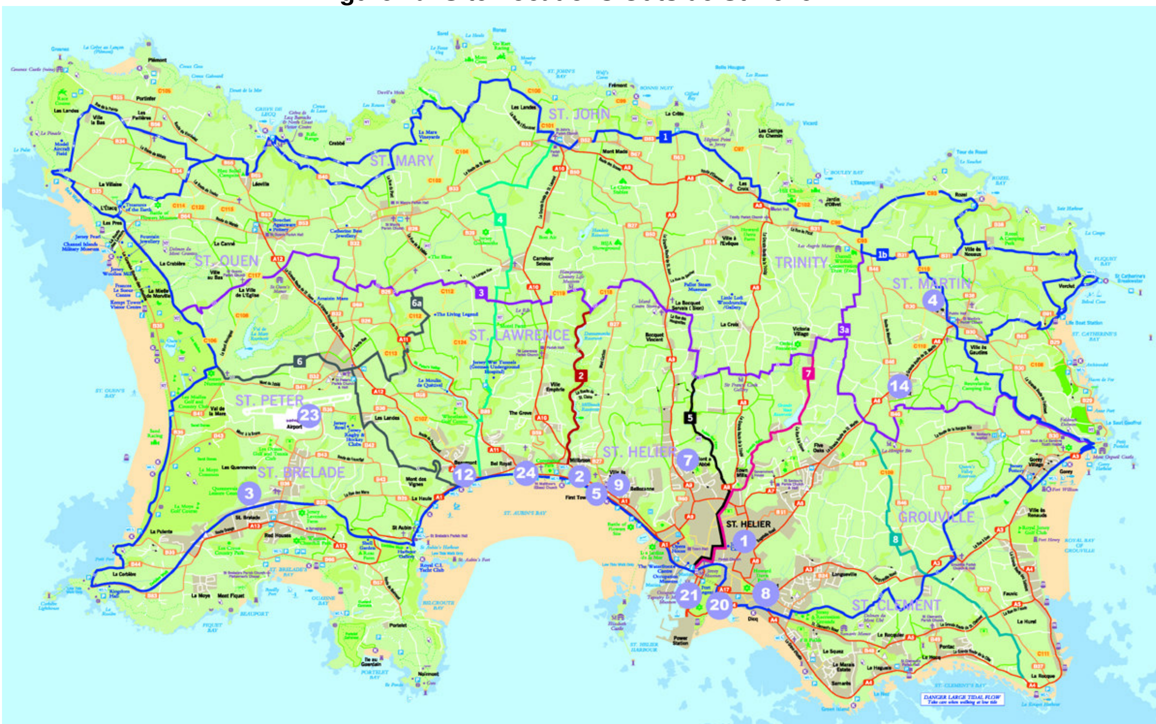
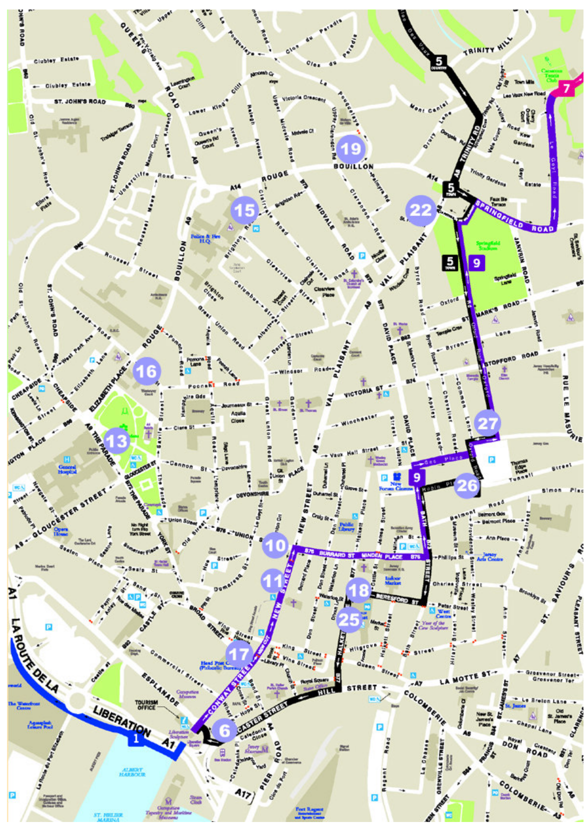


Figure 2b. Sites in St Helier town

Key: *(both maps)*

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	Le Pouquelaye	NO_2
20	Havre Des Pas	NO_2
21	Commercial Buildings	NO_2
22	Springfield Garage	BTEX
23	Airport	BTEX
24	Hansford Lane	BTEX
25	Halkett Place	NO_2, Auto
26	Robin Place	NO_2
27	L’Avenue et Dolmen	NO_2



BTEX hydrocarbons were monitored at six sites during 2006. 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 was 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. During 2006, a vapour recovery system was fitted, which should prevent discharge of fuel vapour when their tanks are filled: however, there will still be some releases of VOCs when customers fill their cars with fuel.

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

Table 2. BTEX Monitoring sites

Site number	Site Name	Grid Reference	Description
BTEX 1	Beresford Street	653 486	Urban Roadside
BTEX 2	Le Bas Centre	658 489	Urban Background
BTEX 4	Springfield Garage	656 495	Urban background near fuel filling station
BTEX 7	Clos St Andre	638 499	Residential area near Bellozanne Valley refuse incinerator.
BTEX 8	Airport	587 509	Jersey Airport, overlooking airfield
BTEX 9	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-06	08-Feb-06
February	08-Feb-06	02-Mar-06
March	02-Mar-06	05-Apr-06
April	05-Apr-06	03-May-06
May	03-May-06	31-May-06
June	31-May-06	29-Jun-06
July	29-Jun-06	31-Jul-06
August	31-Jul-06	31-Aug-06
September	31-Aug-06	04-Oct-06
October	04-Oct-06	01-Nov-06
November	01-Nov-06	27-Nov-06
December	27-Nov-06	03-Jan-07

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 Figure 3 (kerbside and roadside sites), Figure 4 (background sites), and Figure 5 (residential and rural sites). Individual monthly mean NO_2 results ranged from 2.6 μg m^{-3} (in October at the residential background Les Quennevais site), to 54.3 μg m^{-3} (in April at the kerbside Weighbridge site).

There were two occasions when no valid value was obtained: no tube was returned from Beresford Street in August, and Langley Park in September.

Two unusually low values were recorded: at Les Quennevais, the monthly mean for October was 2.6 μg m^{-3}, unusually low compared to typical results for the site. However, in the absence of any evidence to suggest that it is spurious, the value has not been rejected. Also, the September result from Clos St Andre was below the detection limit (<0.04μg m^{-3}). This is suspiciously low and the result has been disregarded as most likely a faulty tube.

Annual mean NO_2 concentrations ranged from 6.3 μg m^{-3} (at the rural Rue des Raisies site) to 48.2 μg 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[12] for NO_2 is that the annual mean should not exceed 40 μg m^{-3}. The EC 1st Daughter Directive[13] contains Limit Values for NO_2 as follows:

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

The UK Air Quality Strategy contains Objectives for NO_2, which are very similar to the EC Daughter Directive limits above: the only differences being the more stringent dates by which they must be attained (31 December 2005).

Annual mean NO_2 at three sites exceeded 40μg m^{-3}; these were Weighbridge, Georgetown and La Pouquelaye. All three are urban kerbside sites that have recorded relatively high annual mean NO_2 concentrations in previous years of this survey.

However, as explained in Section 2.3, 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[16]. Harwell Scientifics' NO_2 diffusion tubes typically overestimate NO_2 concentration. Harwell Scientifics have quantified this overestimation, by participation in ongoing co-location studies, and provided a bias adjustment factor (for 2006) of 0.75, to be applied to the annual mean NO_2 concentration.

Applying this factor reduces the annual means at all sites to below the AQS Objective of 40μg m^{-3}. The highest annual mean (at Weighbridge) is reduced from 48.2 μg m^{-3} (unadjusted) to 36.2 μg m^{-3} (adjusted). Application of the bias adjustment factor reduced the annual mean NO_2 concentrations at the 12 background sites to well below 40 μg m^{-3}. All Jersey sites met the AQS Objective for annual mean NO_2.

The 30μg 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 2006, Jersey. Concentrations in $\mu g\ m^{-3}$.

Site	From - To:	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Average	*Bias adjusted*
First Tower (K)		35.9	39.5	34.4	34.1	33	39.9	35	34.5	43	35.8	37.7	30.3	36.1	27.1
Weighbridge (K)		44.7	43.4	41.1	54.3	48.5	46.1	43.1	54.2	49.8	48.3	52.5	52.9	**48.2**	36.2
Georgetown (K)		49.1	52.1	40.5	41.9	30.3	50.3	44.3	31.6	39.9	41.4	41.6	39.9	**41.9**	31.4
Beaumont (K)		40.3	14	29.8	42.9	40.3	47.4	49	38.4	44.9	43.6	40.9	41.2	39.4	29.5
The Parade (K)		13.6	37.5	34.1	33.3	29.3	28.1	25.8	25.6	30.6	30.2	31.4	33.3	29.4	22.1
Broad Street (K)		37.4	32.1	39.2	43.5	45.3	34.2	39.4	33.4	47.1	41.5	41.1	35.2	39.1	29.3
La Pouquelaye (K)		42.9	47.2	41	44.8	44.5	46.9	34.7	31.9	37	42.4	39	39	**40.9**	30.7
Havre des Pas (K)							26.2	27.4	19.3	23.5	22.2	22.1	21.6	23.2	17.4
Commercial B (K)							39.8	36.4	26.6	29.2	26.3	33.1	33.9	32.2	24.1
New Street (R)		34.8	31.5	22.9	27.7	23.1	22.9	20.1	20.1	24.5	25.4	24.7	29	25.6	19.2
Union Street (R)		38.1	41.6	40.1	41.5	38.7	33.5	31.7	33.2	37	43.5	42.6	42.9	38.7	29.0
Le Bas Centre (UB)		30.3	30	24.5	29	23.7	22.9	23.2	21.7	27.6	27.9	27.6	27.4	26.3	19.7
L'Avenue et Dolmen (UB)		31.9	26.1	22.7	22.7	17.6								24.2	18.2
Robin Place (UB)		32.3	29.2	27.4	27.3	25.4								28.3	21.2
Jane Sandeman (UB)		24	15.3	16.1	14.5	11.3	12.2	11.4	11	14.7	15	4.1	18.5	14.0	10.5
Saville Street (UB)		33.4	31.8	26.5	28.1	20.8	28.6	28.2	21	26.6	25.6	27	29.2	27.2	20.4
Beresford Street (UB)		39.5	39.5	34.2	36.2	33.1	35.5	35.6	27.2	TM	36.4	37.2	33.4	35.3	26.4
Mont Felard (Res B)		17.3	27.9	21.7	27	23.5	21.2	29.2	24.2	23.9	26.6	24.4	23.1	24.2	18.1
Les Quennevais (Res B)		10.9	14.6	12.6	11.5	9.5	11.6	8	6.6	10.9	10.6	2.6	13	10.2	7.7
Langley Park (UB)		24.7	19.3	18.2	16.4	15.2	15	12.4	TM	15.5	17	18	17.4	17.2	12.9
Clos St.Andre (Res B)		18.7	17.5	15	15.9	12.7	11.2	13	10.8	bdl	31.8	17.5	18.5	16.6	12.5
Maufant (Res B)		8.6	12.2	9.3	11.1	8.8	10.3	10.9	7.9	7.5	8.5	9.2	11	9.6	7.2
Rue Des Raisies (Rur B)		2.7	8.9	7.3	7.7	5.9	7	7.2	4.9	5.7	5.9	6.3	6.1	6.3	4.7

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

Figure 3. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2006

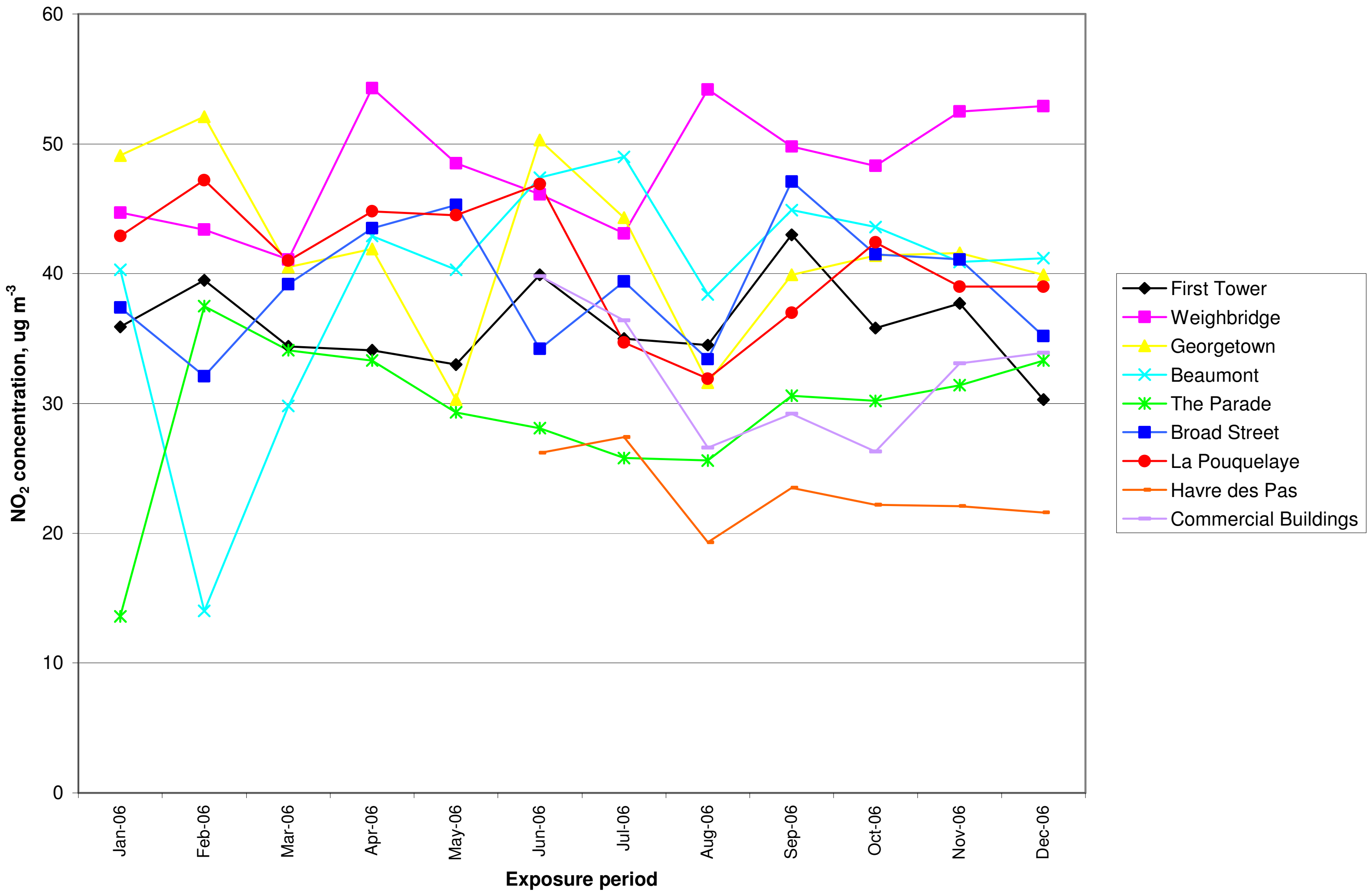


Figure 4. Monthly Mean Nitrogen Dioxide Concentrations at Urban Background Sites, 2006

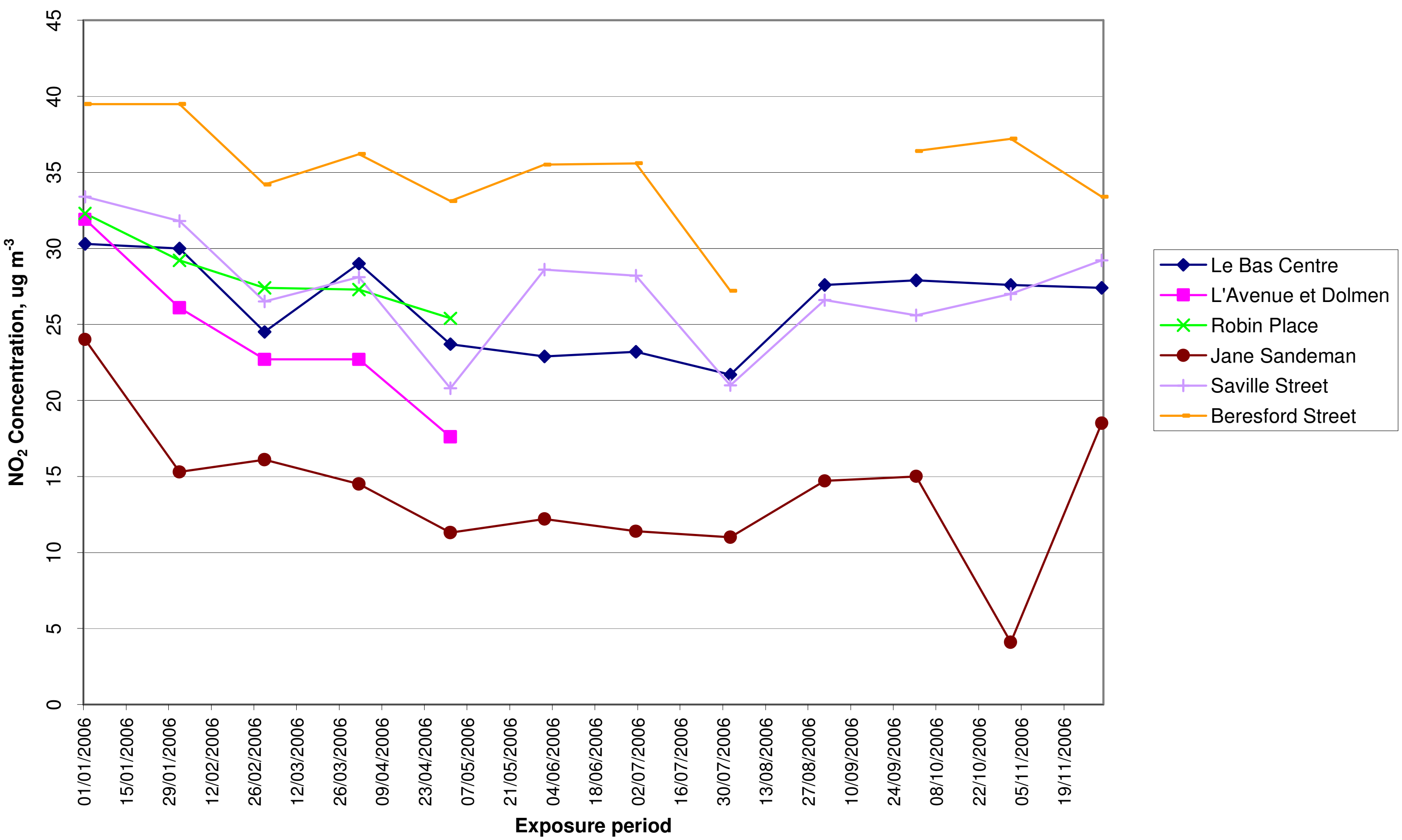
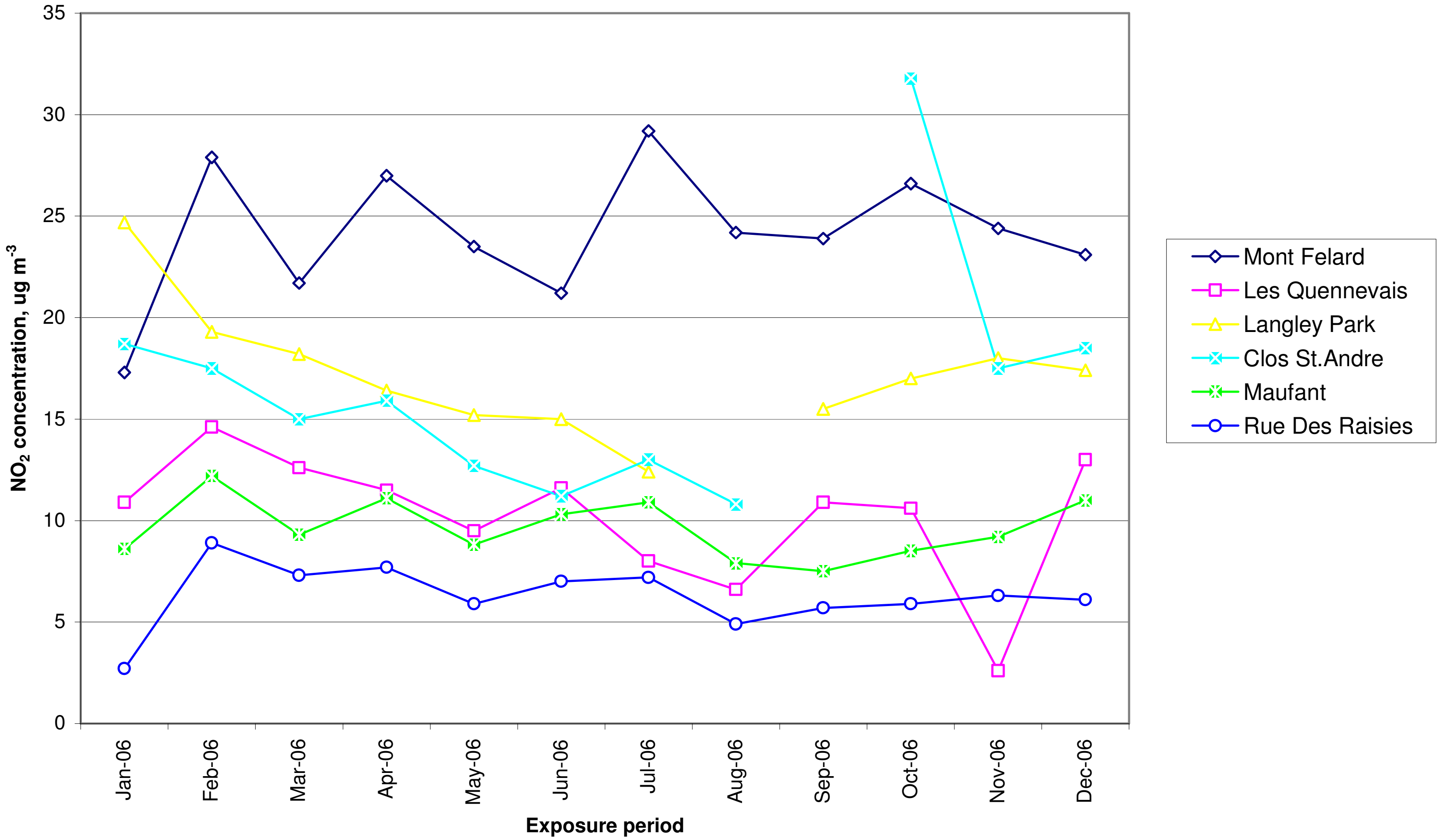


Figure 5. Monthly Mean Nitrogen Dioxide Concentrations at Residential and Rural Background Sites, 2006



3.1.3 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	2006 Annual average NO_2, $\mu g\ m^{-3}$
Exeter Roadside	39
Brighton Roadside	39
Brighton Preston Park	21
Southend on Sea	20
Lullington Heath	10.8
Harwell	11.5

The bias adjusted annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey ranged from 17 to 36$\mu g\ m^{-3}$. The annual means at Exeter Roadside and Brighton Roadside were slightly higher than these. The Jersey urban background sites had (bias adjusted) annual mean NO_2 concentrations ranging from 10 $\mu g\ m^{-3}$ to 26 $\mu g\ m^{-3}$; the urban background sites in Southend and Brighton were therefore within this range. Residential background sites well outside Jersey's larger towns (e.g. Les Quennevais, Clos St Andre, Maufant) had bias-adjusted annual mean NO_2 ranging from 7 $\mu g\ m^{-3}$ to 18 $\mu g\ m^{-3}$, and thus were more comparable with rural sites such as Lullington Heath and Harwell. The bias-adjusted annual mean of 4.7 $\mu g\ m^{-3}$ at the Jersey rural background site, Rue des Raisies, was considerably lower than that measured at either Harwell or Lullington Heath.

3.1.4 Comparison with Previous Years' Nitrogen Dioxide Results

Annual mean NO_2 concentrations for 2006, at the majority of sites, were within 2$\mu g\ m^{-3}$ of the previous year's annual mean – some higher and some lower than last year. The exceptions were Weighbridge, which recorded an increase of 4 $\mu g\ m^{-3}$, and Georgetown, which recorded an increase of 5 $\mu g\ m^{-3}$. Some degree of fluctuation in annual mean concentrations is expected, due to meteorology.

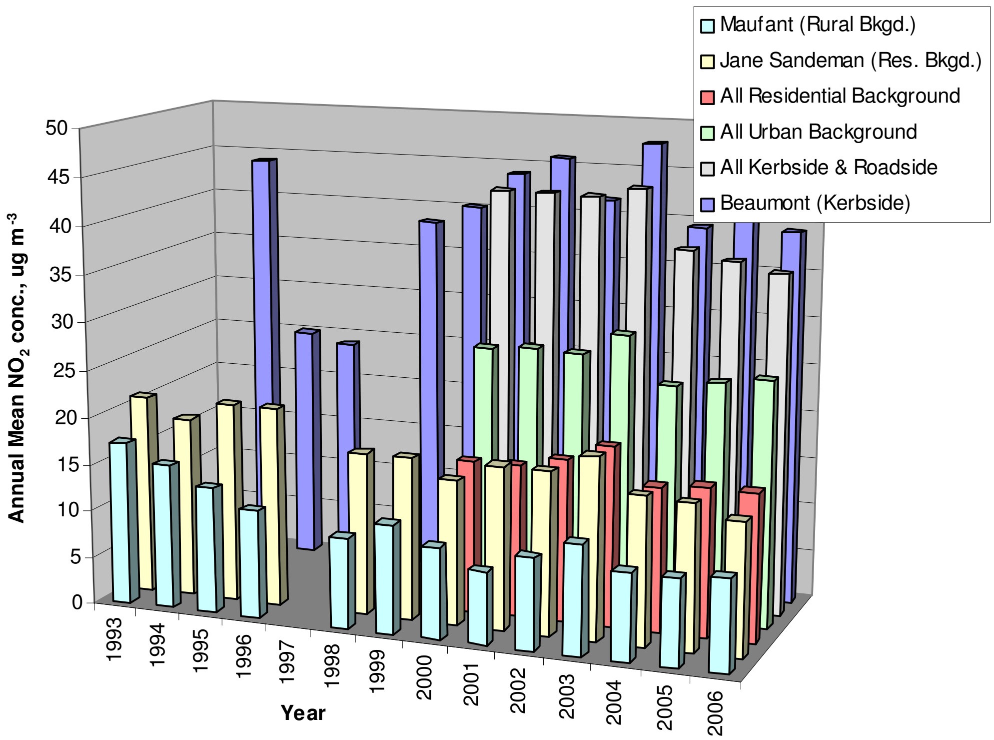
Long-term trends were also investigated. The majority of the NO_2 monitoring sites in this survey have been in operation since 2000. However, the survey includes three longer-running sites, which were part of the former UK Nitrogen Dioxide Network and have been in operation since 1993. These are Beaumont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

Table 5 and Figure 6 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, uncorrected 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). There is no clear trend in the mean of all urban background sites, or all residential background sites.

Figure 6. Trends in Annual Mean NO_2 Concentrations (not corrected for diffusion tube bias).



Trends were investigated at each individual site. Many of the kerbside and roadside sites showed small but consistent downward trends (two exceptions being Weighbridge and Broad Street). There is some indication of increasing levels at two non-roadside sites, Clos St Andre and L'Avenue et Dolmen). At the many sites at which there is no clear downward trend, sites currently at risk of exceeding AQS objectives or EC limit are likely to remain so.

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

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

3.2 Hydrocarbons

3.2.1 Summary of Hydrocarbon Results

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 7 to 12.

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, 2006

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	2.2	7.4	1.3	4.6	1.6
Le Bas Centre	1.5	4.4	0.8	2.8	1.0
Handsford Lane *(paint spraying)*	1.3	4.8	1.3	5.1	1.6
Springfield Garage *(petrol station)*	3.9	21.7	2.6	10.2	3.7
Clos St Andre	1.0	2.0	0.4	1.2	0.4
Airport	1.0	1.4	0.5	0.9	0.3

All sites achieved full data capture, except the following:

(i) Beresford Street: the March tube recorded values below the detection limit for all BTEX compounds. This atypically low result was rejected as spurious, being more likely to result from a faulty diffusion tube than genuinely low results at this site.
(ii) Beresford Street: the September hydrocarbon tube went missing from the site, as did the NO_2 tube for the same month.
(iii) the Airport, where the January tube could not be changed and was left in place for two months. The two-month average obtained was rejected as unreliable.

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. However, in 2006 levels of these compounds were comparable with Beresford Street and Le Bas Centre. Ambient concentrations of toluene decreased substantially in 2005, and have remained less than $5\mu gm^{-3}$ in 2006. The Airport site, which is in rural surroundings, recorded the lowest annual mean concentrations of most of the BTEX hydrocarbons. However, relatively high levels of ethylbenzene and xylenes were measured in September.

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 7. Monthly mean hydrocarbon concentrations at Beresford Street, 2006

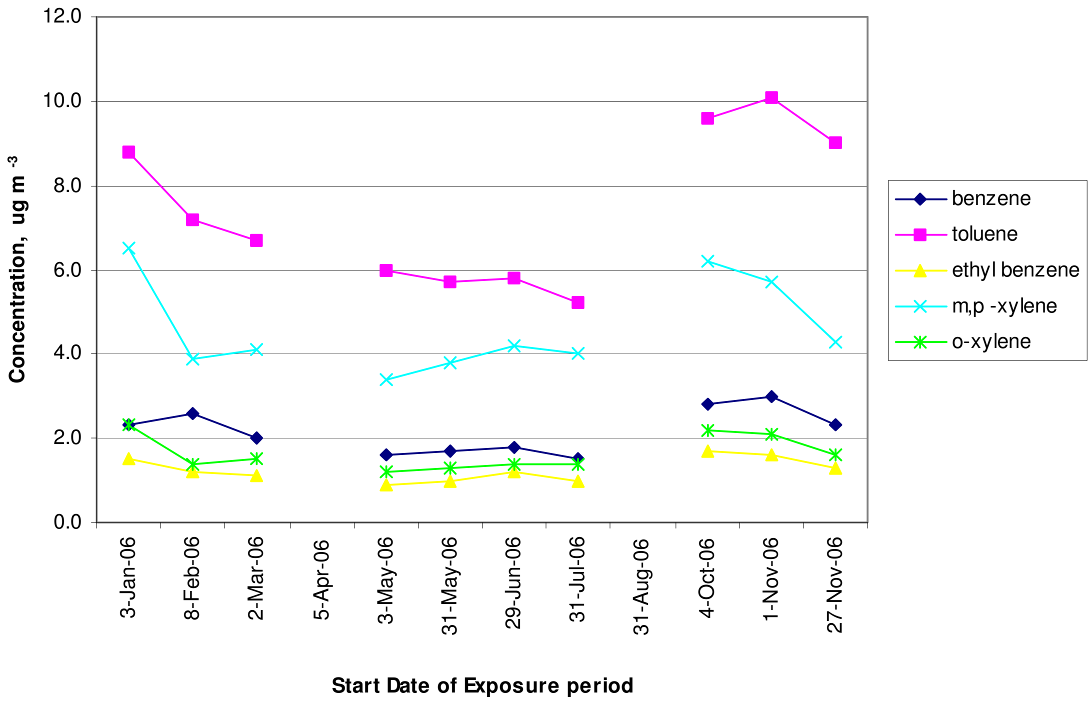


Figure 8. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2006

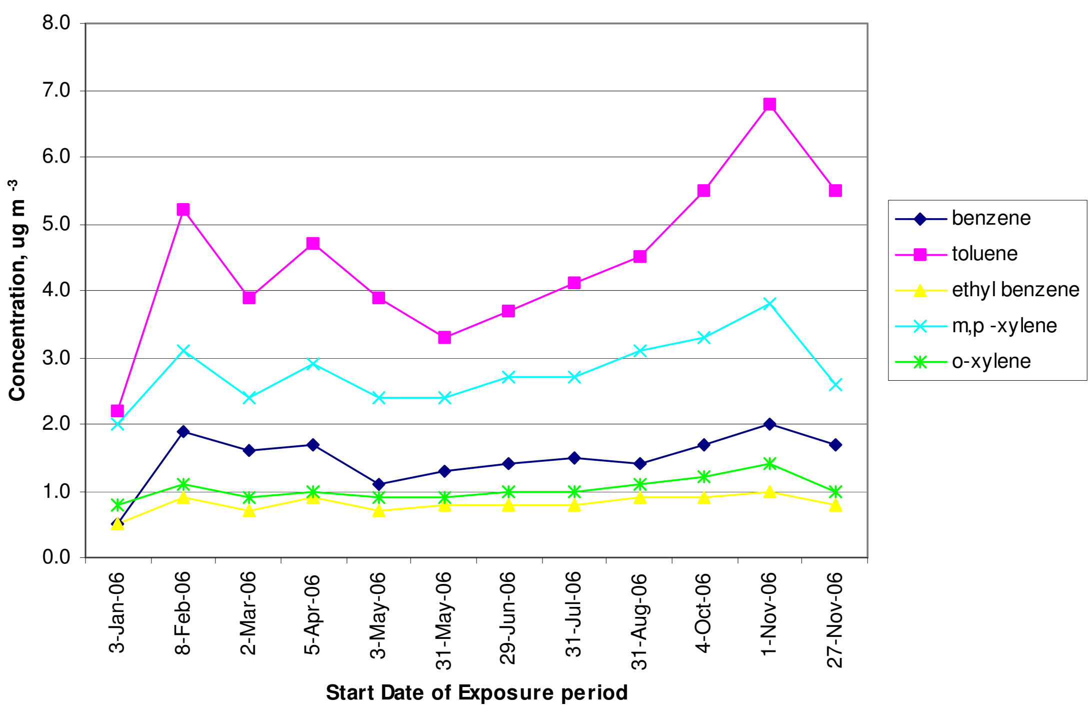


Figure 9. Monthly mean hydrocarbon concentrations at Handsford Lane, 2006

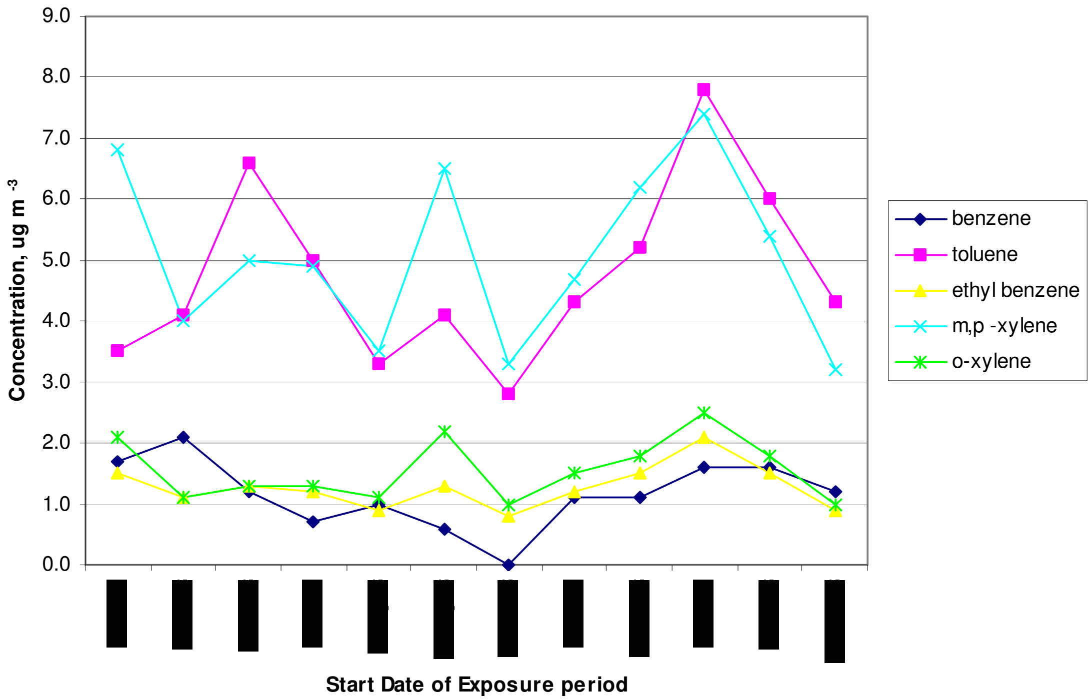


Figure 10. Monthly mean hydrocarbon concentrations at Springfield Garage, 2006

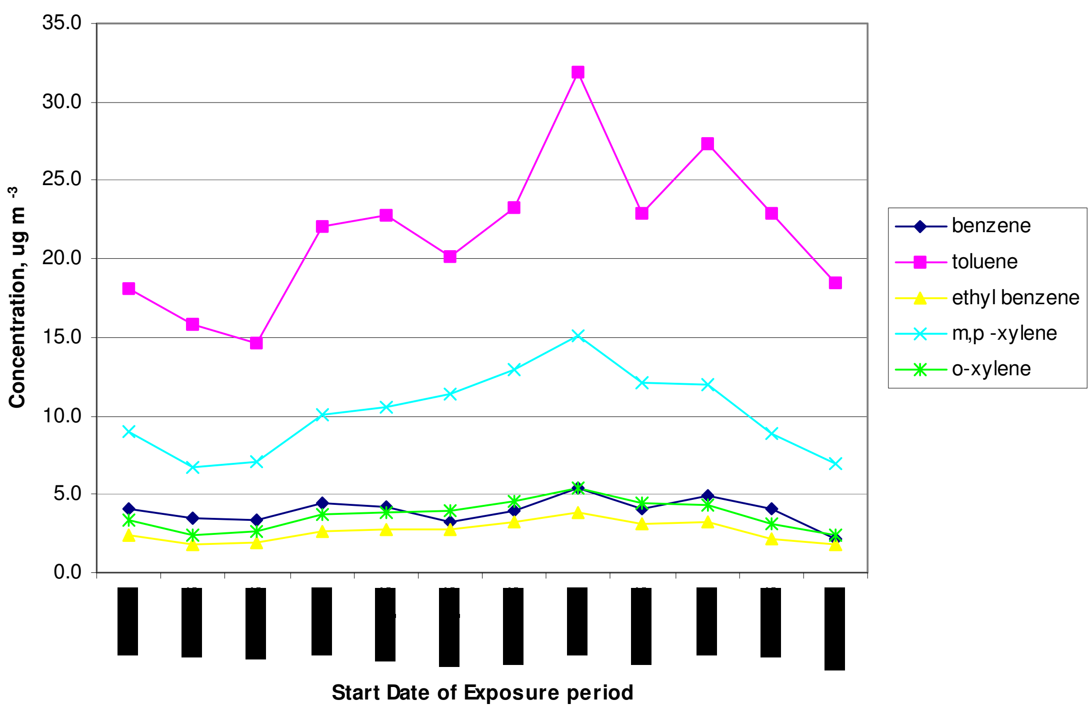


Figure 11. Monthly mean hydrocarbon concentrations at Clos St Andre, 2006

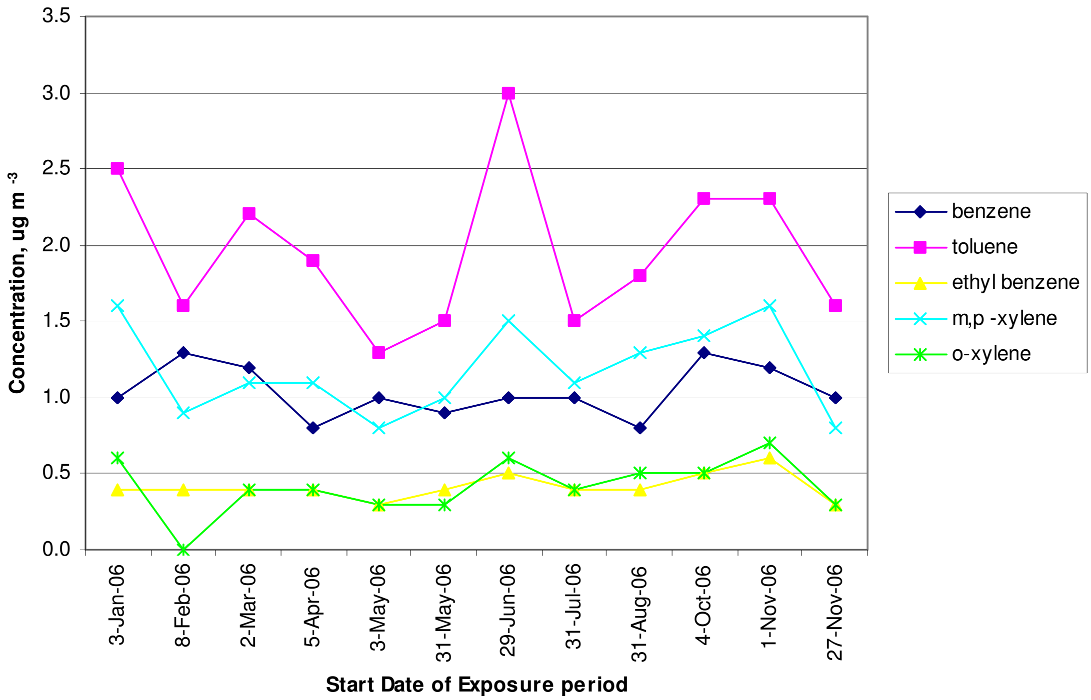
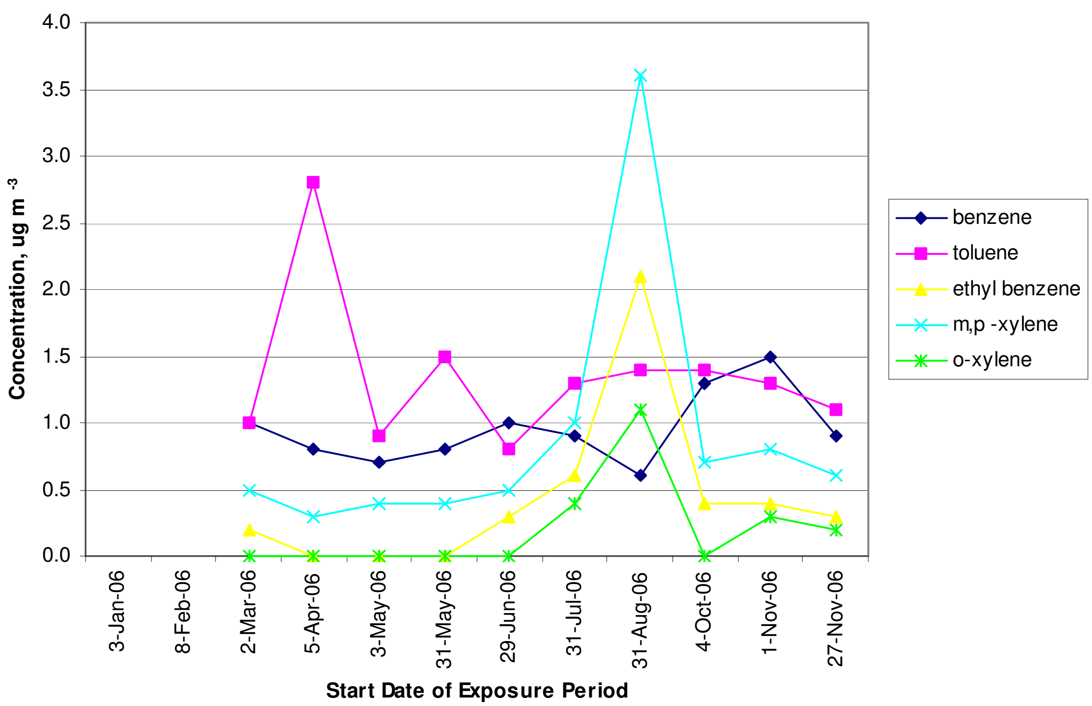


Figure 12. Monthly mean hydrocarbon concentrations at the Airport, 2006



3.2.2 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 be achieved by 31 December 2003
- 3.25 μg m^{-3} (for the calendar year mean), to be achieved by 31 December 2010.

These are applicable to the whole UK. Although they are not at present mandatory in Jersey, the States of Jersey are committed to meeting air quality standards at least as stringent as those applying throughout the EU.

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[14] sets a limit of 5μg m^{-3} for annual mean benzene, to be achieved by 2010. All sites met this limit.

3.2.3 Comparison with UK Benzene Data

Benzene was measured using pumped-tube samplers at a large UK-wide network of 30 UK sites in 2006. Annual mean concentrations ranged from 0.7 μg m^{-3} (at Coventry's Memorial Park) to 2.17 μg m^{-3} (at Birmingham Roadside), but were typically in the range of 1-2 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 2006 (with data capture in brackets).

Site	Benzene, μg m^{-3}
Jersey Sites	
Beresford Street	2.2
Le Bas Centre	1.5
Handsford Lane *(paint spraying)*	1.3
Springfield Garage *(petrol station)*	3.9
Clos St Andre	1.0
Airport	1.0
Mainland UK sites	
Bournemouth	0.75
Hove Roadside	1.13
Plymouth	0.92
Portsmouth	1.02
Southampton	1.45
Southend	0.98

n/a = not available.

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. In previous years it has been reported 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. However, it should be noted that the UK measurements are made with a different technique (pumped tube samplers) than the BTEX tubes used in the Jersey study, so this observed difference may be due at least in part to the difference in measurement techniques.

(Toluene, ethlybenzene and xylenes are no longer part of the UK monitoring programme).

3.2.4 Comparison with Previous Years' Hydrocarbon Results

Table 8 shows annual mean hydrocarbon concentrations for these sites, for years 1997 – 2006. Figures 13 to 17 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 2006 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 - 2006.

	benzene, $\mu g\ m^{-3}$	toluene, $\mu g\ m^{-3}$	ethylbenzene $\mu g\ m^{-3}$	m+p xylene, $\mu g\ m^{-3}$	o-xylene, $\mu g\ m^{-3}$
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
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
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

Table 8. Comparison of Hydrocarbon Concentrations, -*continued :* Jersey, 1997 - 2006.

	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
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
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

Figure 13. Trends in Benzene Concentration

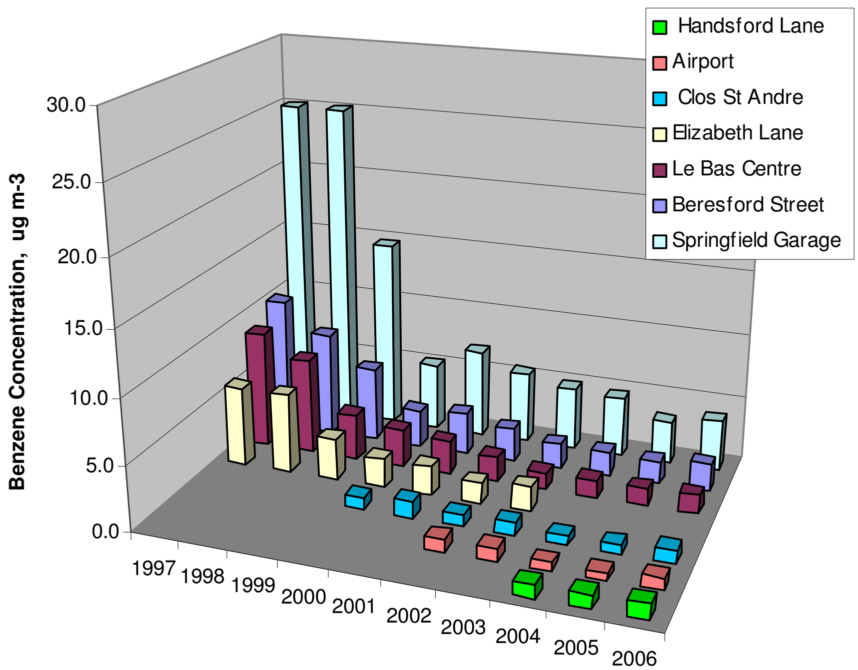


Figure 14. Trends in Toluene Concentration

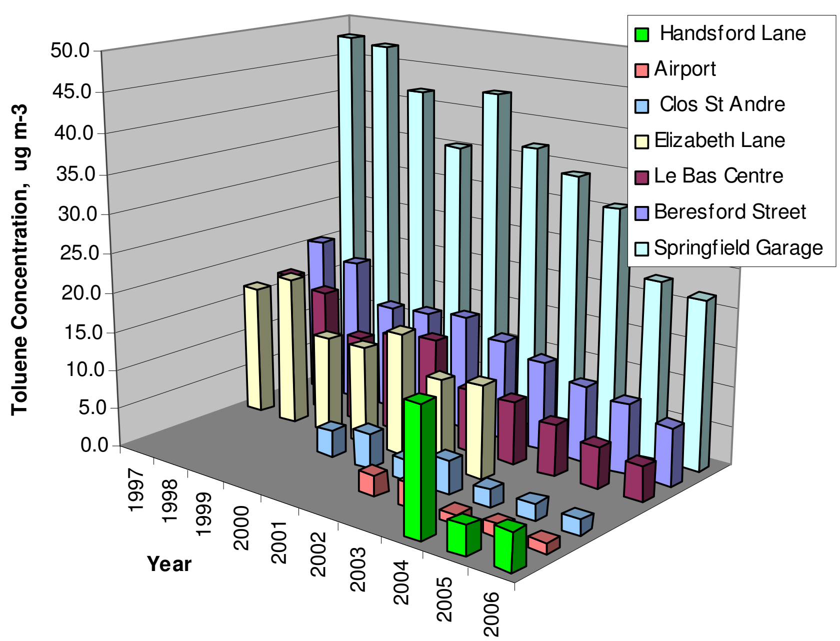


Figure 15. Trends in Ethylbenzene Concentration

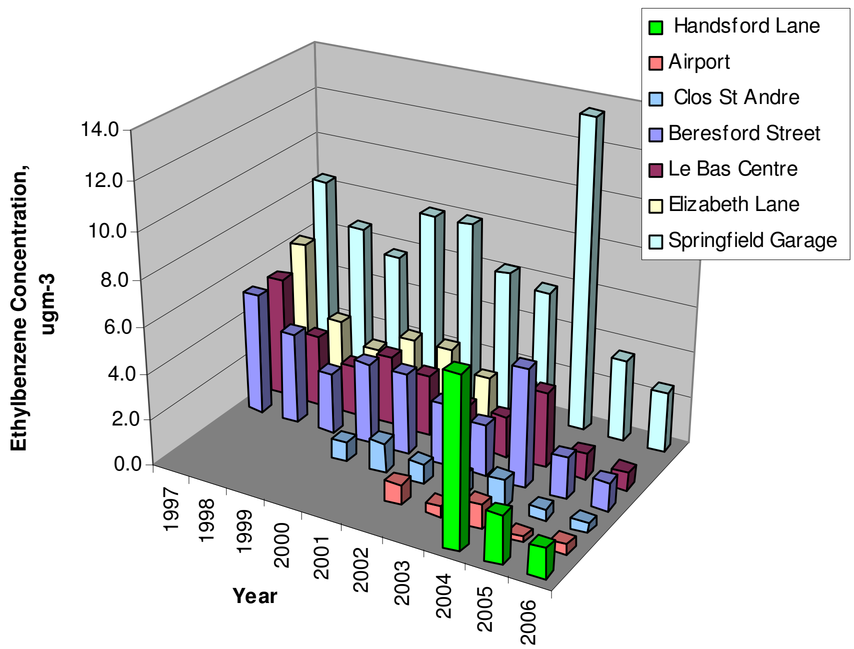


Figure 16. Trends in m+p- Xylene Concentration

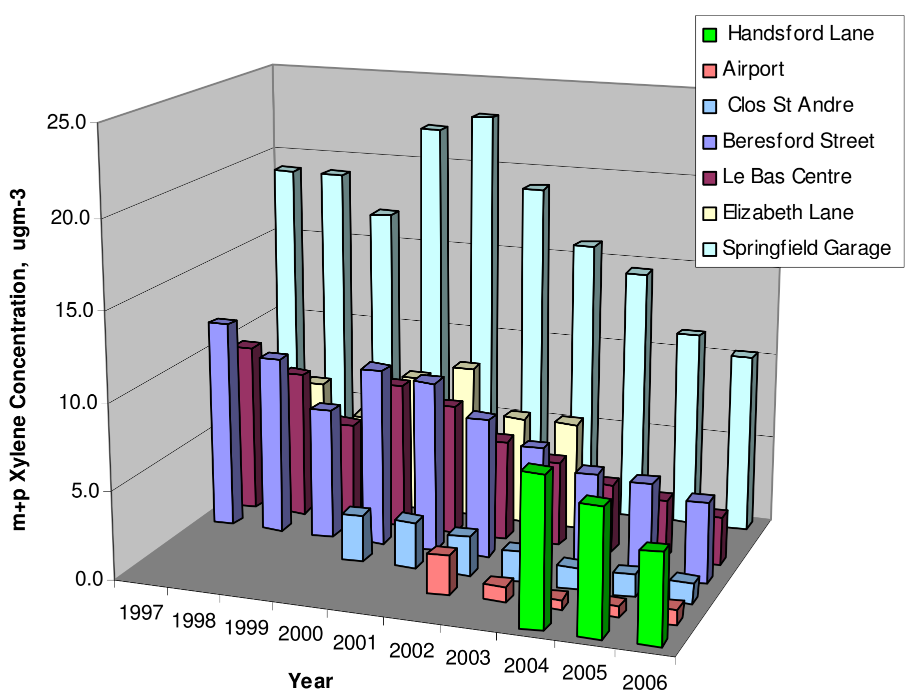
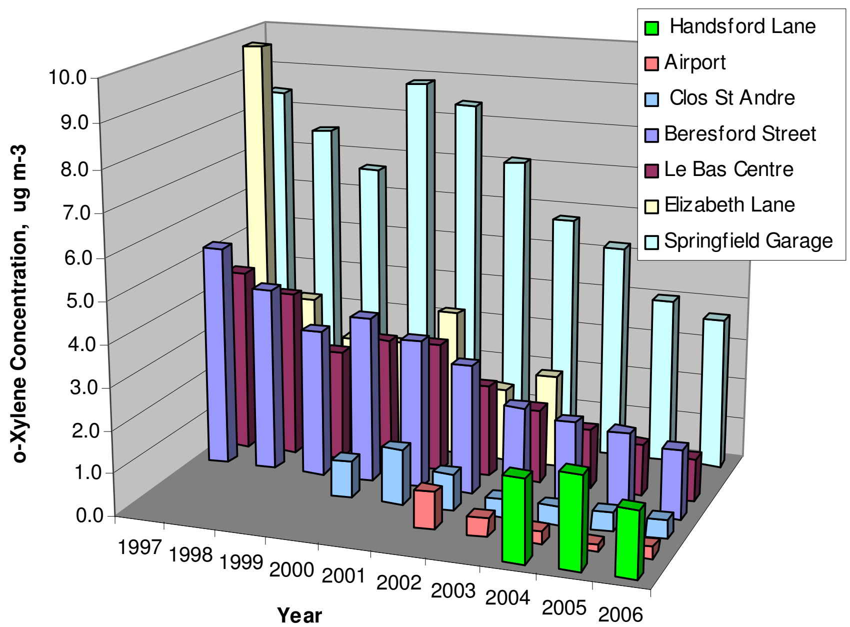


Figure 17. Trends in o-Xylene Concentration



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 10 years of the survey (1997-2006).
- 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 2006, on behalf of the States of Jersey Public Health. This monitoring study has now been undertaken for ten consecutive years.

- Diffusion tubes were used to monitor NO_2 at 23 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.
- Two new kerbside sites were set up for monitoring of NO_2. These were located at Commercial Buildings and Havre des Pas. They replaced two urban background sites (Robin Place and L'Avenue et Dolmen) which were no longer required.

NO_2 results

- Annual mean (uncorrected) NO_2 concentrations at two kerbside sites (Weighbridge, Georgetown and La Pouqulaye) were above the EC Directive Limit Value and AQS Objective of 40μg m^{-3}.
- Applying the analytical laboratory's recommended correction factor for diffusion tube bias to these annual mean results reduced all of them to below 40μg m^{-3}. However, given the uncertainty inherent in diffusion tube measurements, together with the lack of any clear downward trend in NO_2 concentrations on Jersey, it is possible that some kerbside and roadside sites will continue to be close to the limit value in future years.
- Annual mean NO_2 concentrations at all urban, residential and rural background sites were all below the EC Limit Value – in most cases by a substantial margin.
- Annual mean NO_2 concentrations at the monitoring sites were in most cases within of 4 μg m^{-3} of those measured the previous year, the exceptions being Georgetown and Weighbridge which recorded a larger increase.
- Of the three long-running sites, which have operated since 1993 as part of the UK NO_2 Network., only one (Jane Sandeman Rd) shows a clear downward trend in NO_2 concentration.
- There is a small but consistent downward trend in the average annual mean NO_2 concentrations for all kerbside and roadside sites, but not for all urban background sites, or all residential sites.
- Trends were briefly investigated for all sites: at most sites there was a slight downward trend or no clear trend. However, levels may possibly be increasing at Clos St Andre and L'Avenue et Dolmen.
- One implication of the apparent relative stability of NO_2 concentrations, is that sites currently close to the Limit Value and AQS Objective of 40μg m^{-3} for annual mean NO_2 concentration may remain so, unless action is taken to reduce urban roadside NO_2 levels.

Hydrocarbon tube results

- No sites had annual mean benzene concentrations greater than the UK Air Quality Strategy Objective of 16.25 μg 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 μg 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 μg m^{-3}, which is to be achieved by January 2010.
- Annual mean concentrations of BTEX hydrocarbons were mostly comparable with, or slightly lower than, those measured in 2005.
- Concentrations of most BTEX hydrocarbons are decreasing slightly year on year.

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. As there is no clear downward trend annual mean NO_2 concentration, this situation is likely to continue.

Measurements from diffusion tube surveys inevitably carry a high uncertainty. Previous years' reports have recommended that the States of Jersey consider using a mobile automatic analyser, for more accurate monitoring where needed: an automatic site has now been set up in St Helier (at the start of 2007) and data from this site will be included in the 2007 report.

It is recommended that NO_2 diffusion tubes (preferably in triplicate) be co-located with the real-time NO_2 analyser at the new automatic monitoring site at St Helier for comparative purposes.

It is understood that Jersey's Waterfront area will see an increase in traffic movements in the next few years associated with the proposed Castle Quays, new bus station and Island Quarter developments. It is recommended that diffusion tube surveys are carried out before and after the implementation of these developments to assess the changes in air pollution.

The diffusion tube survey for 2008 is currently being reviewed to ensure best value is being achieved both financially and from the point of view of air quality monitoring.

6 Acknowledgements

AEA Energy & Environment gratefully acknowledges the help and support of the staff of the States of Jersey Health Protection Unit, Planning and Environment and Traffic and Transport Services in the completion of this monitoring study. For more information on Air Pollution please visit www.gov.je and http://www.aea-energy-and-environment.com/

7 References

1. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 1997. B Stacey, report no. AEAT-3071, March 1998.
2. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 1998. B Stacey, report no. AEAT-5271, April 1999.
3. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 1999. B Stacey, A Loader, report no. AEAT-EQ0191, March 2000.
4. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 2000. J Lampert, B Stacey, report no. AEAT/ENV/R/0561, March 2001.
5. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 2001. B Stacey, A Loader report no. AEAT/ENV/R/1033, March 2002.
6. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 2002. B Stacey, A Loader report no. AEAT/ENV/R/1411, March 2003.
7. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 2003. B Stacey, A Loader report no. AEAT/ENV/R/1721, March 2004.
8. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 2004. B Stacey, A Loader report no. AEAT/ENV/R/1928, March 2005.
9. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 2005. A Loader, R Goodwin report no. AEAT/ENV/R/2165, March 2006.
10. EH40/2005. Occupational Exposure Limits 2005. http://www.hse.gov.uk/coshh/table1.pdf
11. Odour Measurement and Control - an update. Editors M Woodfield & D Hall. AEA Technology report AEA/CS/REMA/-038 ISBN 0 85624 8258. August 1994.
12. Guidelines for Air Quality, WHO, Geneva, 2000, WHO/SDE/OEH/00.02. www.who.int/peh/air/airqualitygd.htm
13. 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.
14. Council Directive 2000/69/EC relating to Limit Values for benzene and carbon monoxide in ambient air. 16 Nov 2000.
15. 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
16. Part IV of the Environment Act 1995 Local Air Quality Management. Technical Guidance LAQM.TG(03).

Appendices

Appendix 1: Air Quality Limit Values and Objectives

Appendix 2: Monthly Mean Hydrocarbon Results

Appendix 1

Air Quality Limit Values and Objectives

Contents: Air Pollution Guidelines used in this Report

Air Pollution Guidelines Used in this Report.

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

<u>Nitrogen Dioxide</u>

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^oC 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 $\mu g\ m^{-3}$ and ppb are those used by the EC, i.e. 1ppb benzene = 3.25 $\mu g\ m^{-3}$ 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) 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 ($\mu g\ m^{-3}$)

Exposure period start	benzene	Toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-06	2.3	8.8	1.5	6.5	2.3
8-Feb-06	2.6	7.2	1.2	3.9	1.4
2-Mar-06	2.0	6.7	1.1	4.1	1.5
5-Apr-06	-	-	-	-	-
3-May-06	1.6	6.0	0.9	3.4	1.2
31-May-06	1.7	5.7	1.0	3.8	1.3
29-Jun-06	1.8	5.8	1.2	4.2	1.4
31-Jul-06	1.5	5.2	1.0	4.0	1.4
31-Aug-06	-	-	-	-	-
4-Oct-06	2.8	9.6	1.7	6.2	2.2
1-Nov-06	3.0	10.1	1.6	5.7	2.1
27-Nov-06	2.3	9.0	1.3	4.3	1.6
Average	**2.2**	**7.4**	**1.3**	**4.6**	**1.6**

5 Apr – 3 May: all values below detection limit: rejected as suspect.
Missing tube for 31 Aug – 4 Oct.

Table A2.2 Monthly Hydrocarbon concentrations at Le Bas Centre ($\mu g\ m^{-3}$)

Exposure period start	benzene	Toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-06	0.5	2.2	0.5	2.0	0.8
8-Feb-06	1.9	5.2	0.9	3.1	1.1
2-Mar-06	1.6	3.9	0.7	2.4	0.9
5-Apr-06	1.7	4.7	0.9	2.9	1.0
3-May-06	1.1	3.9	0.7	2.4	0.9
31-May-06	1.3	3.3	0.8	2.4	0.9
29-Jun-06	1.4	3.7	0.8	2.7	1.0
31-Jul-06	1.5	4.1	0.8	2.7	1.0
31-Aug-06	1.4	4.5	0.9	3.1	1.1
4-Oct-06	1.7	5.5	0.9	3.3	1.2
1-Nov-06	2.0	6.8	1.0	3.8	1.4
27-Nov-06	1.7	5.5	0.8	2.6	1.0
Average	**1.5**	**4.4**	**0.8**	**2.8**	**1.0**

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-06	1.7	3.5	1.5	6.8	2.1
8-Feb-06	2.1	4.1	1.1	4.0	1.1
2-Mar-06	1.2	6.6	1.3	5.0	1.3
5-Apr-06	0.7	5.0	1.2	4.9	1.3
3-May-06	1.0	3.3	0.9	3.5	1.1
31-May-06	0.6	4.1	1.3	6.5	2.2
29-Jun-06	*< 0.2*	2.8	0.8	3.3	1.0
31-Jul-06	1.1	4.3	1.2	4.7	1.5
31-Aug-06	1.1	5.2	1.5	6.2	1.8
4-Oct-06	1.6	7.8	2.1	7.4	2.5
1-Nov-06	1.6	6.0	1.5	5.4	1.8
27-Nov-06	1.2	4.3	0.9	3.2	1.0
Average	**1.2**	**4.8**	**1.3**	**5.1**	**1.6**

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-06	4.1	18.1	2.4	9.0	3.3
8-Feb-06	3.5	15.8	1.8	6.7	2.4
2-Mar-06	3.3	14.6	1.9	7.1	2.6
5-Apr-06	4.4	22.1	2.6	10.1	3.7
3-May-06	4.2	22.8	2.7	10.6	3.8
31-May-06	3.2	20.1	2.8	11.4	3.9
29-Jun-06	3.9	23.2	3.2	12.9	4.5
31-Jul-06	5.4	31.9	3.8	15.1	5.4
31-Aug-06	4.1	22.9	3.1	12.1	4.4
4-Oct-06	4.9	27.3	3.2	12.0	4.3
1-Nov-06	4.1	22.9	2.2	8.9	3.1
27-Nov-06	2.1	18.4	1.8	6.9	2.4
Average	**3.9**	**21.7**	**2.6**	**10.2**	**3.7**

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-06	1.0	2.5	0.4	1.6	0.6
8-Feb-06	1.3	1.6	0.4	0.9	*< 0.2*
2-Mar-06	1.2	2.2	0.4	1.1	0.4
5-Apr-06	0.8	1.9	0.4	1.1	0.4
3-May-06	1.0	1.3	0.3	0.8	0.3
31-May-06	0.9	1.5	0.4	1.0	0.3
29-Jun-06	1.0	3.0	0.5	1.5	0.6
31-Jul-06	1.0	1.5	0.4	1.1	0.4
31-Aug-06	0.8	1.8	0.4	1.3	0.5
4-Oct-06	1.3	2.3	0.5	1.4	0.5
1-Nov-06	1.2	2.3	0.6	1.6	0.7
27-Nov-06	1.0	1.6	0.3	0.8	0.3
Average	**1.0**	**2.0**	**0.4**	**1.2**	**0.4**

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-06	-	-	-	-	-
8-Feb-06	-	-	-	-	-
2-Mar-06	1.0	1.0	0.2	0.5	*< 0.1*
5-Apr-06	0.8	2.8	*< 0.1*	0.3	*< 0.2*
3-May-06	0.7	0.9	*< 0.1*	0.4	*< 0.2*
31-May-06	0.8	1.5	*< 0.1*	0.4	*< 0.2*
29-Jun-06	1.0	0.8	0.3	0.5	*< 0.1*
31-Jul-06	0.9	1.3	0.6	1.0	0.4
31-Aug-06	0.6	1.4	2.1	3.6	1.1
4-Oct-06	1.3	1.4	0.4	0.7	*< 0.2*
1-Nov-06	1.5	1.3	0.4	0.8	0.3
27-Nov-06	0.9	1.1	0.3	0.6	0.2
Average	**1.0**	**1.4**	**0.5**	**0.9**	**0.3**

Tube not changed on 8 Feb.

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

Tel: 0870 190 6518
Fax: 0870 190 6377