

# Air Quality Monitoring in Jersey 2008

Report to Public Health Services, States of Jersey

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## Executive summary

This report presents the results for 2008 of an ongoing programme of air quality monitoring in Jersey, carried out by AEA on behalf of the Public Health Services and Planning and Environment Department of the States of Jersey.

In early 2008, an automatic monitoring station was installed in the Central Market, Halkett Place, St Helier. This was used to monitor nitrogen dioxide (NO<sub>2</sub>) throughout the year. This was supplemented by non-automatic monitoring of NO<sub>2</sub> and a suite of four hydrocarbon pollutants (benzene, toluene, ethylbenzene and xylenes).

The non-automatic monitoring was the continuation of a long-term monitoring programme that has operated in Jersey for the past 12 years. Diffusion tube samplers were used for indicative monitoring of nitrogen dioxide (NO<sub>2</sub>) at 24 sites, and hydrocarbons at six sites. Monitoring sites included areas likely to be affected by specific emission sources (such as petrol stations or the waste incinerator), as well as general background locations. In February 2008, the NO<sub>2</sub> monitoring programme was streamlined, and the number of NO<sub>2</sub> diffusion tube sites reduced to 12.

NO<sub>2</sub> 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 Environmental Health Section.

The automatic monitoring site at Halkett Place met the EC Directive Limit Value (and AQS Objective) for both the 1-hour mean NO<sub>2</sub> concentration and the annual mean NO<sub>2</sub> concentration.

Twelve NO<sub>2</sub> diffusion tube monitoring sites remained in operation for the full year. Annual mean concentrations at all 12 of these sites were within the EC Directive Limit Value, and were generally comparable with the previous year's results.

All six hydrocarbon monitoring sites met the EC Directive Limit Value for benzene (5 µg m<sup>-3</sup> as an annual mean, to be achieved by 2010).

All sites met the current (2003) UK Air Quality Strategy objective for benzene. Five of the six sites also met the 2010 UK Air Quality Strategy Objective for this pollutant (3.25 µg m<sup>-3</sup>, to be achieved by January 2010). However, one site (Springfield Garage) had an annual mean benzene concentration of 4.2 µg m<sup>-3</sup> and therefore does not at present meet the 2010 benzene objective. This site is located in a petrol station forecourt, where there are no vapour recovery abatement systems in place.

The diurnal pattern in concentrations of oxides of nitrogen at Halkett Place showed a clear peak in the early morning (0600 – 0800). This is thought to reflect the early morning activity of market retailers arriving to set up for the day, and of daily refuse collections.

Data from long-running diffusion tube sites confirm that levels of NO<sub>2</sub> at urban roadside and kerbside sites continued to decrease in 2008. NO<sub>2</sub> concentrations at residential and rural background sites do not appear to show any upward or downward trend, but are already low.

Hydrocarbon concentrations (particularly that of benzene) are also now lower than during the earlier years of the survey.

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# 1 Introduction

## 1.1 Background

AEA, 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 2008. This is the twelfth 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<sub>2</sub>), and a range of hydrocarbon species (benzene, toluene, ethyl benzene and three xylene compounds). An automatic monitoring station at Halkett Place was used to monitor NO<sub>2</sub>. This was supplemented by indicative monitoring of NO<sub>2</sub> using low cost passive samplers (Palmer type diffusion tubes) at 12 sites on the island. In addition, the suite of four hydrocarbons was monitored using “BTEX” diffusion tubes at six sites.

This report presents the results obtained in the 2008 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 2007<sup>1,2,3,4,5,6,7,8,9,10,11</sup>. 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<sub>2</sub>

A mixture of nitrogen dioxide (NO<sub>2</sub>) and nitric oxide (NO) is emitted by combustion processes. This mixture of oxides of nitrogen is termed NO<sub>x</sub>. NO is subsequently oxidised to NO<sub>2</sub> in the atmosphere. NO<sub>2</sub> is an irritant to the respiratory system, and can affect human health. Ambient concentrations of NO<sub>2</sub> are likely to be highest in the most built-up areas, especially where traffic is congested, or where buildings either side of the street create a “canyon” effect, impeding the dispersion of vehicle emissions. The units used for NO<sub>2</sub> concentration in this report are microgrammes per cubic metre ( $\mu\text{g m}^{-3}$ ). Some earlier reports in this series have used parts per billion (ppb): to convert from  $\mu\text{g m}^{-3}$  to ppb for comparison with the earlier reports if required, the following relationship should be used:

**1  $\mu\text{g m}^{-3}$  = 0.523 ppb for nitrogen dioxide at 293K (20°C) and 1013mb.**

#### 2.1.2 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 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 species associated with fuels and vehicle emissions which, though not the largest constituent of such emissions, are easy to monitor using passive samplers due to their moderate volatility. These are benzene, toluene, ethyl benzene and xylene. 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  $3 \mu\text{g m}^{-3}$ . In this report, concentrations of benzene are expressed in microgrammes per cubic metre ( $\mu\text{g m}^{-3}$ ). Some earlier reports in the series used parts per billion (ppb): to convert to ppb if necessary, the following relationship should be used:

**1  $\mu\text{g m}^{-3}$  = 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  $3.8 \mu\text{g m}^{-3}$  in rural areas, up to  $204 \mu\text{g m}^{-3}$  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<sup>12</sup>. The best estimate for the odour threshold of toluene has been reported as 0.16ppm ( $613 \mu\text{g m}^{-3}$ )<sup>13</sup>. In the present report,

concentrations are expressed in microgrammes per cubic metre ( $\mu\text{g m}^{-3}$ ). Some earlier reports in the series used parts per billion (ppb): to convert to ppb to if necessary, the following relationship should be used:

**$1 \mu\text{g m}^{-3} = 0.261 \text{ ppb}$  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<sup>12</sup>, 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  $70 \mu\text{g m}^{-3}$ )<sup>13</sup>.

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

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

## **2.2 Air Quality Limit Values And Objectives**

This report compares the results of the monitoring survey with air quality Limit Values and Objectives applicable worldwide, in Europe and the UK. These are summarized in Appendix 1 and below.

### **2.2.1 World Health Organisation**

In 2000, the World Health Organisation published revised air quality guidelines<sup>14</sup> for pollutants including NO<sub>2</sub>. 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<sub>2</sub> concentrations (hourly and annual means) but not benzene. The WHO non-mandatory guideline<sup>14</sup> for NO<sub>2</sub> is that the annual mean should not exceed  $40 \mu\text{g m}^{-3}$ .

### **2.2.2 European Community**

Throughout Europe, ambient air quality is regulated by the EC Directive on Ambient Air Quality and Cleaner Air for Europe (2008/50/EC)<sup>15</sup>. This Directive sets Limit Values, which are mandatory, and other requirements for the protection of human health and ecosystems. Both NO<sub>2</sub> and benzene are covered by this Directive. The States of Jersey have agreed to meet the EU health limits.

The EC Directive on Ambient Air Quality and Cleaner Air for Europe<sup>15</sup> contains Limit Values for NO<sub>2</sub> as follows:

- $200 \mu\text{g m}^{-3}$  as an hourly mean, not to be exceeded more than 18 times per calendar year. To be achieved by 1<sup>st</sup> January 2010.
- $40 \mu\text{g m}^{-3}$  as an annual mean, for protection of human health. To be achieved by 1<sup>st</sup> January 2010.

- There is also a limit for annual mean total oxides of nitrogen (NO<sub>x</sub>), of 30 µg m<sup>-3</sup>, for protection of vegetation (relevant in rural areas).

The EC Directive on Ambient Air Quality and Cleaner Air for Europe<sup>15</sup> sets a limit of 5 µg m<sup>-3</sup> for annual mean benzene, to be achieved by 2010.

### 2.2.3 UK Air Quality Strategy

The UK Air Quality Strategy (AQS) contains standards and objectives for a range of pollutants including NO<sub>2</sub> and benzene<sup>16</sup>. 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.

The UK Air Quality Strategy's objectives for NO<sub>2</sub> are very similar to the EC Directive limits above: the only difference being that they had to be achieved by 31<sup>st</sup> December 2005

The UK Air Quality Strategy<sup>16</sup> sets the following objectives for benzene:

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

## 2.3 Methodologies

Oxides of nitrogen were monitored using a chemiluminescent analyser, located at the Central Market, Halkett Place, St Helier. This automatic monitoring site started operation in January 2008.

The chemiluminescent NO<sub>x</sub> analyser provides a continuous output, proportional to the pollutant concentration. This output is recorded and stored every 10 seconds, and averaged to 15-minute average values by internal data loggers. The analysers are connected to a modem and interrogated by telephone to download the data to AEA. Data are downloaded daily and uploaded onto the publically available website [www.jerseymet.gov.je](http://www.jerseymet.gov.je)

The automatic monitoring site at Halkett Place was supplemented by indicative monitoring, using diffusion tubes, for NO<sub>2</sub> and BTEX hydrocarbons. Diffusion tubes 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<sub>2</sub>. 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<sub>2</sub>. The tube is mounted vertically with the open end at the bottom. Ambient NO<sub>2</sub> 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<sub>2</sub> 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 and analysed by Gradko International Ltd. 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  $\text{NO}_2$  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  $\text{NO}_2$  and  $\pm 25\%$  for BTEX hydrocarbons. The limits of detection vary from month to month, but are typically  $0.4 \mu\text{g m}^{-3}$  for  $\text{NO}_2$  and  $0.2 \mu\text{g m}^{-3}$  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(09)<sup>17</sup> states that when using diffusion tubes for indicative  $\text{NO}_2$  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  $\text{NO}_2$ ). By co-locating diffusion tubes with the automatic monitoring site at Halkett Place, it was possible to calculate a bias adjustment factor, which could then be applied to the annual mean diffusion tube measurements in this survey. (This applies only to  $\text{NO}_2$  diffusion tubes, not BTEX tubes, as the latter are not affected by the same sources of interference). ***The  $\text{NO}_2$  diffusion tube results in this report are uncorrected except where clearly specified.***

## 2.4 Monitoring Sites

Automatic monitoring of oxides of nitrogen was carried out at the Central Market, Halkett Place, in St Helier (Figure 1). This site represents a roadside site where levels of  $\text{NO}_2$  were expected to be high, and where members of the public are regularly exposed for periods of one hour or more.

Figure 1 Automatic  $\text{NO}_x$  Monitoring Site, Halkett Place, St Helier



Figure 1 shows the location of the monitoring site. The inlet funnel is just visible as a white tube protruding from the building façade above the hanging basket just beyond the yellow shop front. It is at a height of about 5m. Monitoring began in January 2008.

Figure 2 shows the chemiluminescent NO<sub>x</sub> analyser itself, which is located within the building. The analyser is calibrated monthly by the States of Jersey's Health Protection Team. Details of the calibration procedure, and an example of the calibration form used, are provided in Appendix 2.

**Figure 2 Automatic NO<sub>x</sub> Analyser at Halkett Place, St Helier**



Diffusion tubes were also used to monitor NO<sub>2</sub> at a range of sites around Jersey. At the beginning of 2008, 24 NO<sub>2</sub> diffusion tubes were in operation. The majority of these had been in use since 2000. However, at the end of February 2008 the States of Jersey streamlined their monitoring programme, reducing the number of sites to 12. Table 1 lists the NO<sub>2</sub> diffusion tube sites, and Figures 3a and 3b show their locations..

Diffusion tubes are also co-located with the automatic monitoring site at Halkett Place, and the results of this co-located monitoring are used to assess the precision and accuracy of the diffusion tubes, relative to the automatic chemiluminescent analyser, which is defined within Europe as the reference method for NO<sub>2</sub>. The tubes at this site are exposed in triplicate, to allow assessment of precision. All other diffusion tube sites are single tube sites.

**Table 1 NO<sub>2</sub> Monitoring Sites in Jersey**

Site Name	Grid Reference	Method	Description
<b>Central Market, Halkett Place</b>	653 486	Automatic analyser Diffusion tubes in triplicate	Halkett Pl., St Helier – co-located with automatic site.
<b>Le Bas Centre</b>	658 489	Diffusion tube	Urban Background
<i>Mont Felard (Ceased Feb 2008)</i>	629 501	<i>Diffusion tube</i>	<i>Residential background, to SW of waste incinerator and 20m from busy road</i>
<b>Les Quennevais</b>	579 496	Diffusion tube	Residential Background
<b>Rue des Raisies</b>	689 529	Diffusion tube	Rural Background
<i>First Tower (Ceased Feb 2008)</i>	636 497	<i>Diffusion tube</i>	<i>Kerbside on major road</i>
<b>Weighbridge</b>	651 483	Diffusion tube	Roadside at bus station near centre of St Helier
<i>Langley Park (Ceased Feb 2008)</i>	660 501	<i>Diffusion tube</i>	<i>Residential background</i>
<b>Georgetown</b>	661 480	Diffusion tube	Kerbside on major road
<i>Clos St Andre (Ceased Feb 2008)</i>	638 499	<i>Diffusion tube</i>	<i>Residential area near Bellozanne Valley refuse Incinerator. Background</i>
<b>Beaumont</b>	597 516	Diffusion tube	Kerbside
<b>The Parade *</b>	648 489	Diffusion tube	Roadside site at General Hospital
<i>Maufant (Ceased Feb 2008)</i>	683 512	<i>Diffusion tube</i>	<i>Background site in Maufant village</i>
<i>Jane Sandeman (Ceased Feb 2008)</i>	652 494	<i>Diffusion tube</i>	<i>Urban background on housing estate</i>
<i>Saville Street (Ceased Feb 2008)</i>	648 492	<i>Diffusion tube</i>	<i>Background</i>
<b>Broad Street</b>	652 486	Diffusion tube	Urban background
<i>Beresford Street (Ceased Feb 2008)</i>	653 486	<i>Diffusion tube</i>	<i>Urban background</i>
<i>La Pouquelaye (Ceased Feb 2008)</i>	654 496	<i>Diffusion tube</i>	<i>Kerbside on St Helier ring road.</i>
<b>Union Street</b>	653 486	Diffusion tube	Kerbside in St Helier – corner of Union St. & New St.
<b>New Street</b>	653 485	Diffusion tube	Kerbside in St Helier
<i>Havre des Pas (Ceased Feb 2008)</i>		<i>Diffusion tube</i>	<i>Kerbside, beside main A4 in/out of St Helier</i>
<i>Commercial Buildings (Ceased Feb 2008)</i>		<i>Diffusion tube</i>	<i>Kerbside, Commercial Buildings, St Helier</i>
<i>Seaton Place (Ceased Feb 2008)</i>	648 487	<i>Diffusion tube</i>	<i>Kerbside to assess complaint re air quality</i>
<b>Liberation Station</b>	652 485	Diffusion tube	Kerbside opposite entrance to new bus station

\*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 3a Site Locations Outside St Helier

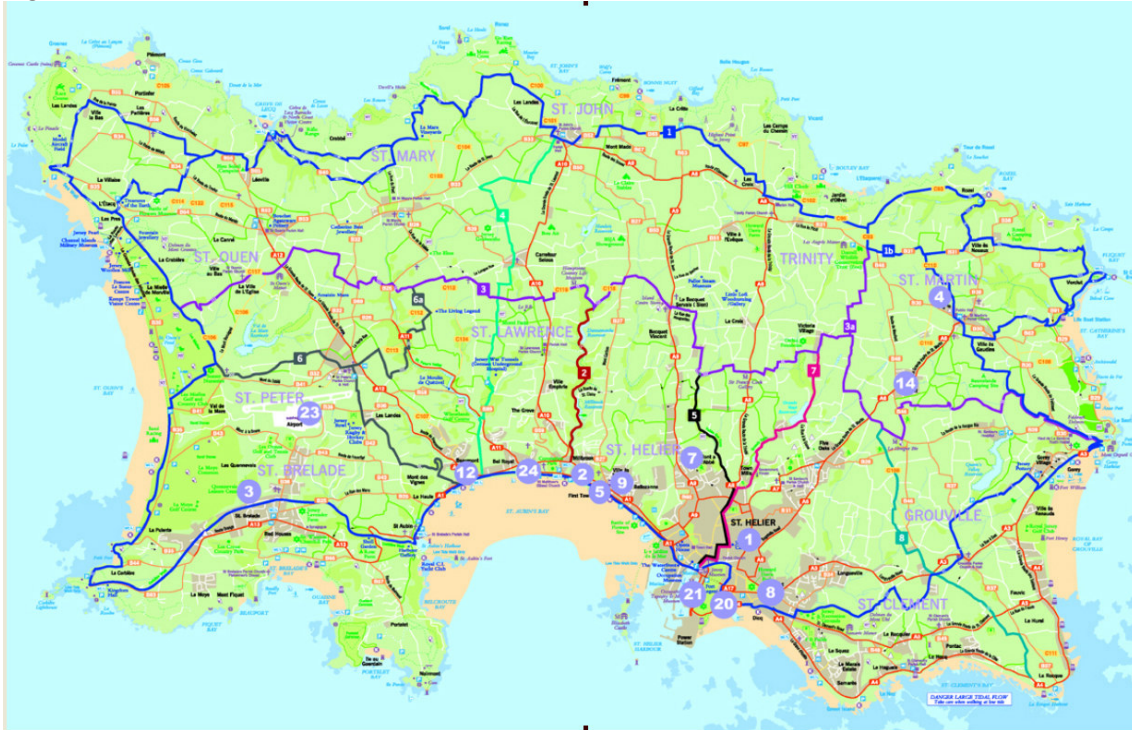
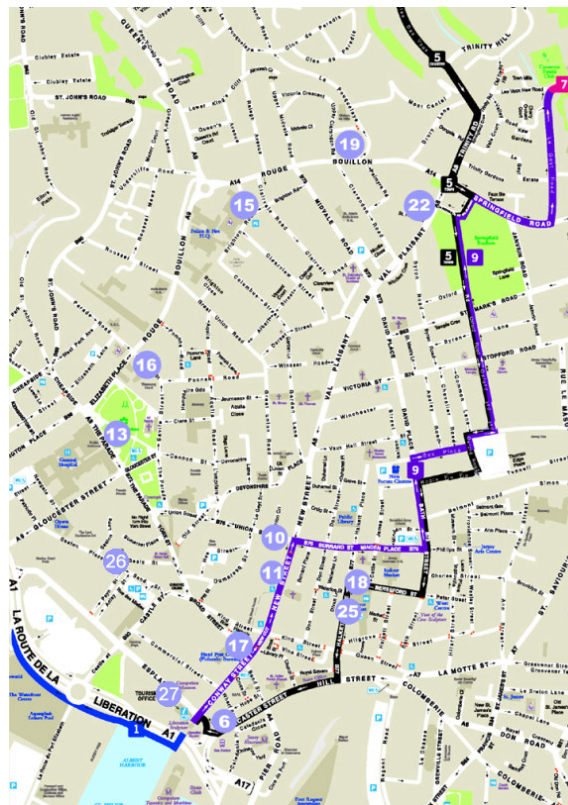


Figure 3b Sites in St Helier town

Key:

1	Le Bas Centre	NO <sub>2</sub> , BTEX
2	Mont Felard	NO <sub>2</sub>
3	Les Quennevais	NO <sub>2</sub>
4	Rue Des Raisies	NO <sub>2</sub>
5	First Tower	NO <sub>2</sub>
6	Weighbridge	NO <sub>2</sub>
7	Langley Park	NO <sub>2</sub>
8	Georgetown	NO <sub>2</sub>
9	Clos St Andre	NO <sub>2</sub> , BTEX
10	Union Street	NO <sub>2</sub>
11	New Street	NO <sub>2</sub>
12	Beaumont	NO <sub>2</sub>
13	The Parade	NO <sub>2</sub>
14	Maufant	NO <sub>2</sub>
15	Jane Sandeman	NO <sub>2</sub>
16	Saville Street	NO <sub>2</sub>
17	Broad Street	NO <sub>2</sub>
18	Beresford Street	NO <sub>2</sub> , BTEX
19	La Pouquelaye	NO <sub>2</sub>
20	Havre Des Pas	NO <sub>2</sub>
21	Commercial Buildings	NO <sub>2</sub>
22	Springfield Garage	BTEX
23	Airport	BTEX
24	Handsford Lane	BTEX
25	Halkett Place	NO <sub>2</sub> , Auto
26	Seaton Place	NO <sub>2</sub>
27	Liberation Station	NO <sub>2</sub>



BTEX hydrocarbons were monitored at six sites during 2008. These sites, which have been used for several years, 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. As of December 2003, the fuel supplier has used vapour recovery when filling the tanks.

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 Diffusion Tube 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.

## 2.5 Calendar of Diffusion Tube Exposure Periods

The calendar of exposure periods used for the NO<sub>2</sub> and BTEX diffusion tubes is shown in Table 3 below. They were intended to approximate to calendar months.

**Table 3 Diffusion Tube Exposure Periods**

Month	Start Date	End Date
January	03/01/2008	30/01/2008
February	30/01/2008	28/02/2008
March	28/02/2008	02/04/2008
April	02/04/2008	30/04/2008
May	30/04/2008	28/05/2008
June	28/05/2008	02/07/2008
July	02/07/2008	29/07/2008
August	29/07/2008	03/09/2008
September	03/09/2008	01/10/2008
October	01/10/2008	29/10/2008
November	29/10/2008	03/12/2008
December	03/12/2008	07/01/2009

## 3 Quality Assurance and Data Capture

### 3.1 Quality Assurance And Quality Control

A full intercalibration audit of the Jersey Halkett Place air quality monitoring site takes place annually. In addition to instrument and calibration standard checking, the air intake sampling system is cleaned and all other aspects of site infrastructure are checked.

Following the instrument and calibration gas checking, and the subsequent scaling and ratification of the data, the overall accuracy and precision figures for the pollutants monitored at Jersey can be summarised as in Table 4:

**Table 4 Estimated Accuracy and Precision of the Data Presented**

Pollutant	Precision	Accuracy %
NO	±5 ppb	±15%
NO <sub>2</sub>	±5 ppb	±15%

### 3.2 Data Capture

Overall data capture statistics for the monitoring site are given in Table 5. A data capture rate of 90% or greater for ratified data is recommended in the Defra Technical Guidance LAQM.TG(09)<sup>17</sup>.

**Table 5 Jersey Halkett Place - Data Capture Statistics 2008**

Site	NO	NO <sub>2</sub>	NO <sub>x</sub>
Jersey Halkett Place	90.0 %	90.0 %	90.0 %

Data capture of 90% was achieved for NO<sub>2</sub>: thus the data capture target of LAQM.TG(09) was met. However, the following significant gaps in data capture occurred during the year, as shown in Table 6:

**Table 6 Data Gaps 2008**

Site	Pollutant	Period	No. of Days	Reason
Jersey Halkett Place	All NO <sub>x</sub>	1 <sup>st</sup> – 22 <sup>nd</sup> Jan	22	Prior to site start-up.
		28 <sup>th</sup> Aug – 11 <sup>th</sup> Sep	15	Analyser service

## 4 Results and Discussion

### 4.1 Presentation of Results

#### 4.1.1 Automatic NO<sub>2</sub> Monitoring Results

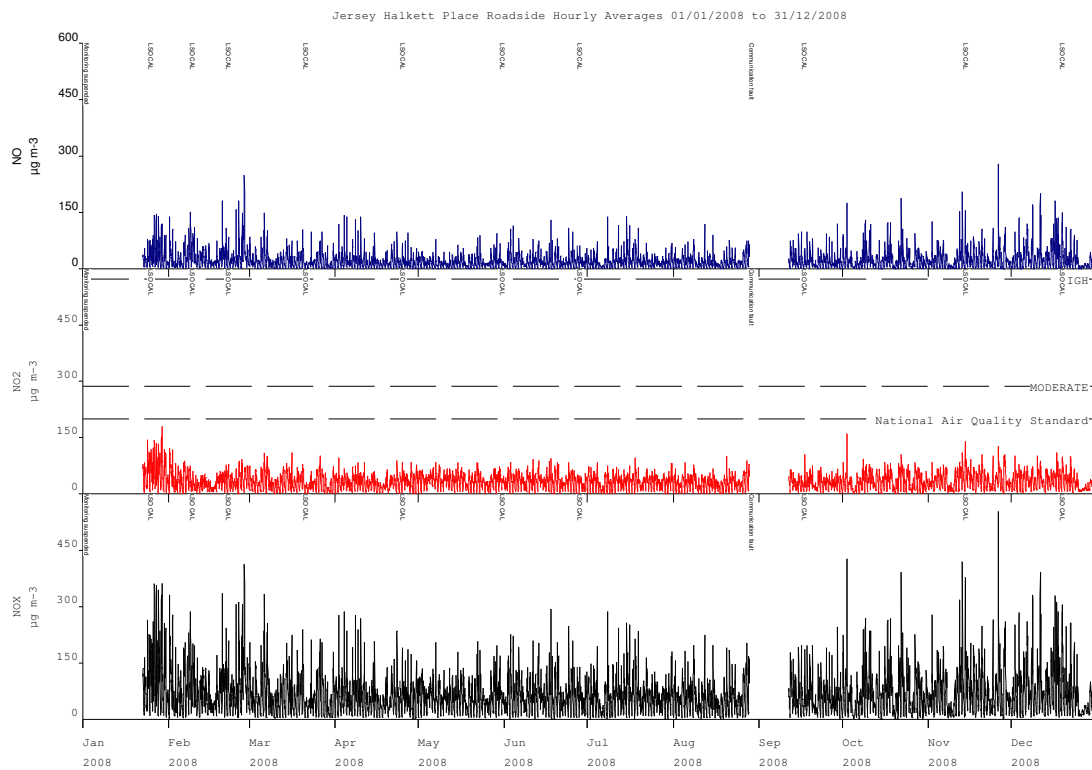
Table 7 shows the key statistics for oxides of nitrogen measured by the automatic analyser at Halkett Place. Figure 4 shows timeseries plots of hourly mean NO, NO<sub>2</sub> and NO<sub>x</sub> concentrations.

**Table 7 Oxides of Nitrogen: Air Quality Statistics for 2008**

POLLUTANT	NO µg m <sup>-3</sup>	NO <sub>2</sub> µg m <sup>-3</sup>	NO <sub>x</sub> µg m <sup>-3</sup>
Maximum 15-minute mean	524	367	884
Maximum hourly mean	279	180	554
Maximum running 8-hour mean	165	117	285
Maximum running 24-hour mean	93	77	179
Maximum daily mean	83	71	169
Average	21	32	64
Data capture	90.0 %	90.0 %	90.0 %

All mass units are at 20 Celsius and 101.3 kPa.

**Figure 4 Time series plots of hourly mean pollutant concentrations at Halkett Place, 2008**



### 4.1.2 NO<sub>2</sub> Diffusion Tube Results

NO<sub>2</sub> diffusion tube results are presented in Table 8 and Figure 4. Although reported by the analyst to two decimal places, the monthly mean results reported here have been rounded to the nearest integer, in view of the estimated uncertainty of +/- 25% on diffusion tube measurements.

Individual monthly mean NO<sub>2</sub> results ranged from 3 µg m<sup>-3</sup> (in July at the rural background Rue de Raisies site), to 55 µg m<sup>-3</sup> (in May at the kerbside Beaumont site). One tube (the November tube, at Georgetown) inadvertently had the wrong end cap removed and gave a result below the detection limit (which was rejected).

Results from the Halkett Place site (where diffusion tubes are co-located with an automatic analyser) were used to calculate a bias adjustment factor of 0.98 – see Appendix 3.

Annual mean NO<sub>2</sub> concentrations (after application of this bias adjustment factor) ranged from 6 µg m<sup>-3</sup> (at the rural Rue des Raisies site) to 38 µg m<sup>-3</sup> 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, and has produced the highest annual mean concentration in several previous years.

### 4.1.3 Precision and Accuracy of NO<sub>2</sub> Diffusion Tubes

Diffusion tubes are an indicative monitoring technique: although they are economical and easy to use, they do not give the same level of precision and accuracy as more expensive automatic monitoring methods. For this reason, as explained in section 2.3 above, the Local Air Quality Management Technical Guidance LAQM.TG(09)<sup>17</sup> states that when using diffusion tubes for indicative NO<sub>2</sub> 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<sub>2</sub>.

This is usually done by co-locating diffusion tubes with a chemiluminescent analyser and comparing the results of the two methods. By exposing diffusion tubes in triplicate at Halkett Place, it was possible to compare their precision and accuracy with that of the automatic monitor, and to calculate a “bias adjustment factor” which could be applied to the annual mean NO<sub>2</sub> concentrations measured at the other diffusion tube sites, in order to correct for any “bias”.

Exposing tubes in triplicate allowed 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. It is not uncommon for diffusion tube precision to occasionally be poor; this is not a cause for concern if the precision over the rest of the year is consistently good.

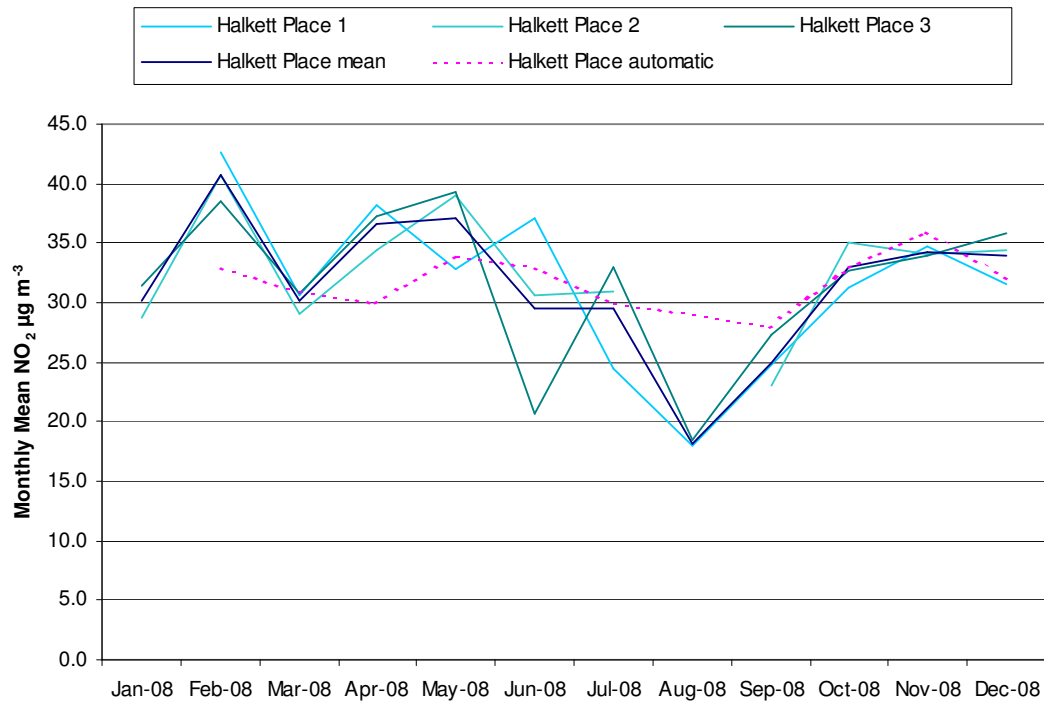
At Central Market, the CV of the monthly tube triplets ranged from 1% to 28%, with a mean of 11%. There were three occasions when this value was particularly high. In January, the three results were 19 µg m<sup>-3</sup>, 29 µg m<sup>-3</sup> and 32 µg m<sup>-3</sup>. The lowest of these results is much lower than the other two. It therefore appears to be an outlier (possibly a faulty tube), and was been rejected from the dataset. Similarly, in August the three results were 18 µg m<sup>-3</sup>, 12 µg m<sup>-3</sup> and 19 µg m<sup>-3</sup>. The lowest of these appears to be an outlier and was rejected as most likely a faulty tube. In June, the three results were 21 µg m<sup>-3</sup>, 31 µg m<sup>-3</sup> and 37 µg m<sup>-3</sup>. In this case, there is no obvious outlier and none of the three results have been rejected.

The rejected values were not included in the calculation of the annual mean result for the site, or in calculating the bias adjustment factor. Removing these two values reduced the mean CV to 8%. Once these two outlying values had been removed, the mean NO<sub>2</sub> concentration as measured by the diffusion tubes was 32 µg m<sup>-3</sup>.



Figure 5 shows the monthly mean NO<sub>2</sub> concentrations, as measured by diffusion tubes and by the automatic analyser, at Halkett Place. Although the bias exhibited by the diffusion tubes varied considerably from month to month, the annual mean concentrations as measured by the automatic analyser and the diffusion tubes were within 1 µg m<sup>-3</sup>.

**Figure 5 Monthly mean NO<sub>2</sub> concentrations (diffusion tubes and automatic analyser) at Halkett Place**



The bias adjustment factor was calculated as 0.98 (see Appendix 3).

## 4.2 Comparison with NO<sub>2</sub> Guidelines, Limit Values, and Objectives

Limit Values, AQS Objectives and WHO guidelines for NO<sub>2</sub> are shown in Appendix 1. These are based on the hourly and annual means.

The WHO non-mandatory guideline<sup>14</sup> for NO<sub>2</sub> is that the annual mean should not exceed 40 µg m<sup>-3</sup>. The EC Directive on Ambient Air Quality and Cleaner Air for Europe<sup>15</sup> contains Limit Values for NO<sub>2</sub> as follows:

- 200 µg m<sup>-3</sup> as an hourly mean, not to be exceeded more than 18 times per calendar year. To be achieved by 1<sup>st</sup> January 2010.
- 40 µg m<sup>-3</sup> as an annual mean, for protection of human health. To be achieved by 1<sup>st</sup> January 2010.
- There is also a limit for annual mean total oxides of nitrogen (NO<sub>x</sub>), of 30 µg m<sup>-3</sup>, for protection of vegetation (relevant in rural areas).

The UK Air Quality Strategy<sup>16</sup> contains Objectives for NO<sub>2</sub>, which are very similar to the EC Directive limits above: the only difference being that they had to be achieved by 31<sup>st</sup> December 2005.

The 1-hour mean at the Halkett Place automatic monitoring site did not exceed 200 µg m<sup>-3</sup> on any occasion during 2008. Therefore this site meets the hourly mean EC Directive Limit Value and AQS Objective for this parameter. The annual mean concentration of 32 µg m<sup>-3</sup> at Halkett Place is within the EC Limit Value of 40 µg m<sup>-3</sup>.

Because of the long sampling period of diffusion tubes, it is only possible to compare the results from the diffusion tube sites in this study against limit values relating to the annual mean. Annual mean NO<sub>2</sub> concentrations did not exceed 40 µg m<sup>-3</sup> at any sites in 2008. The highest annual mean concentration of 38 µg m<sup>-3</sup> (after bias adjustment) was measured at Weighbridge. This urban kerbside site in the centre of St Helier has recorded relatively high annual mean NO<sub>2</sub> concentrations throughout previous years of this survey, and has, in previous years, exceeded the EC Limit Value. As annual mean NO<sub>2</sub> concentrations can vary considerably from year to year due to meteorological and other factors, it is possible that exceedences could occur in future years.

The 30 µg m<sup>-3</sup> limit for protection of vegetation is only applicable at rural sites, and is therefore only relevant to Rue des Raisies. The annual mean NO<sub>2</sub> concentration of 6 µg m<sup>-3</sup> at this rural site was well within the limit value.

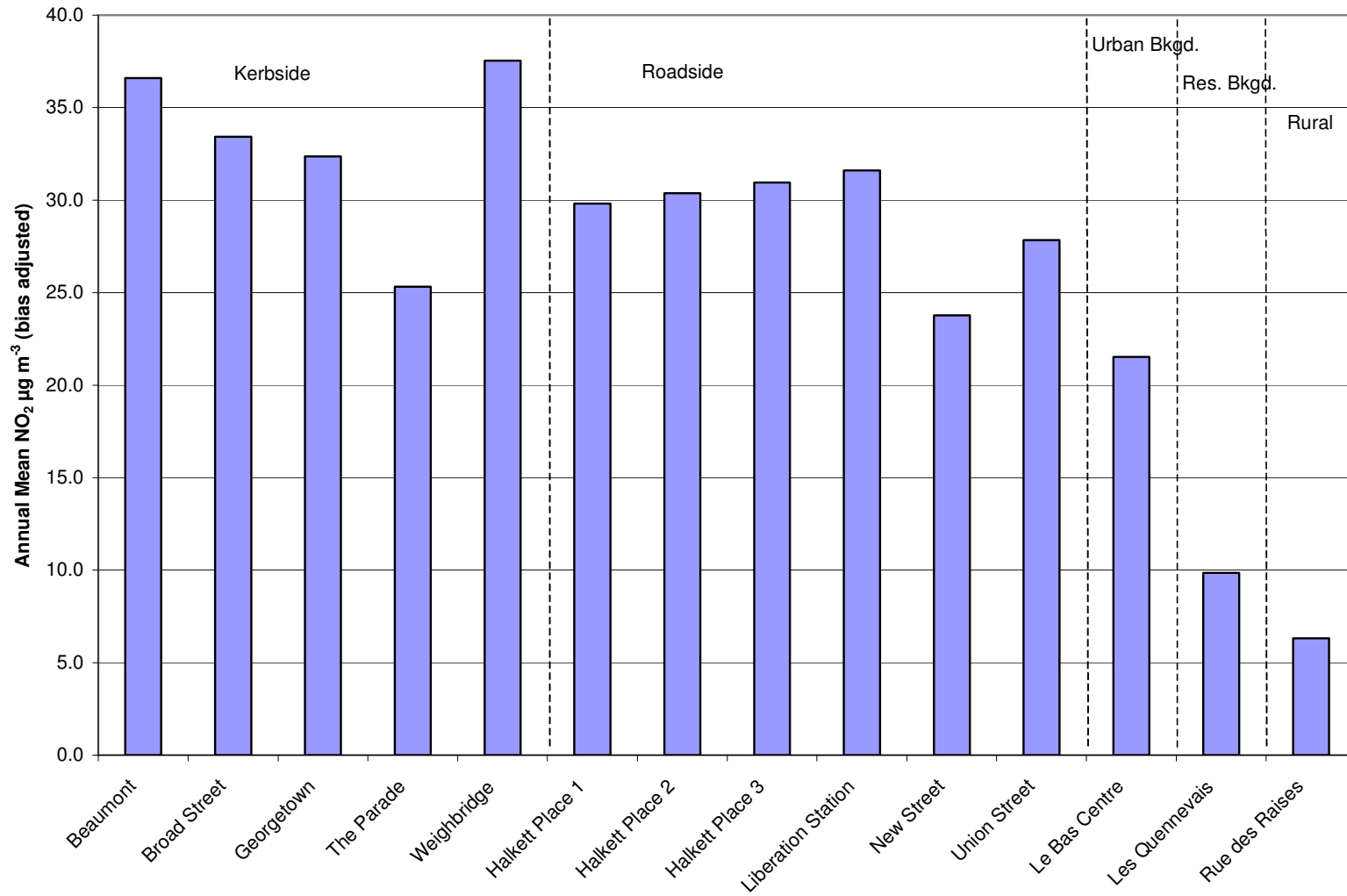
**Table 8** **NO<sub>2</sub> Diffusion Tube Results 2008, Jersey. Concentrations (rounded to nearest integer) in µg m<sup>-3</sup>.**

Site	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Mean	<i>Bias adjusted</i>
First Tower (K)	33	43												
Weighbridge (K)	36	38	36	41	41	40	46	31	24	49	41	38	<b>38</b>	<b>38</b>
Georgetown (K)	29	46	27	36	49	36	30	14	23	36	no data	38	<b>33</b>	<b>32</b>
Beaumont (K)	30	45	36	47	55	45	37	16	20	28	45	46	<b>37</b>	<b>37</b>
The Parade (K)	30	40	27	29	22	19	25	13	14	30	30	31	<b>26</b>	<b>25</b>
Broad Street (K)	34	44	37	38	31	38	39	23	17	44	36	28	<b>34</b>	<b>33</b>
La Pouquelaye (K)	38	52												
Havre des Pas (K)	19	32												
Commercial Buildings (K)	19	43												
New Street (R)	26	48	21	36	34	14	18	16	17	18	16	27	<b>24</b>	<b>24</b>
Union Street (R)	47	33	35	24	22	25	28	16	17	31	32	33	<b>28</b>	<b>28</b>
Halkett Place 1 (R)	(19 *)	43	31	38	33	37	24	18	25	31	35	32	<b>31</b>	<b>31</b>
Halkett Place 2 (R)	29	41	29	34	39	31	31	(12 *)	23	35	34	34	<b>33</b>	<b>32</b>
Halkett Place 3 (R)	31	39	31	37	39	21	33	19	27	33	34	36	<b>32</b>	<b>31</b>
Halkett Place (avg. of 3 tubes) (R)	<b>30</b>	<b>41</b>	<b>30</b>	<b>37</b>	<b>37</b>	<b>30</b>	<b>29</b>	<b>18</b>	<b>25</b>	<b>33</b>	<b>34</b>	<b>34</b>	<b>32</b>	<b>32</b>
Liberation Stn (R)	26	41	28	37	41	38	34	18	18	30	38	38	<b>32</b>	<b>32</b>
Le Bas Centre (UB)	26	33	21	25	23	15	21	13	14	22	24	26	<b>22</b>	<b>22</b>
Seaton Place (UB)	34	44												
Jane Sandeman (UB)	16	24												
Saville Street (UB)	15	36												
Beresford St (UB)	30	43												
Mont Felard (UB)	21	32												
Les Quennevais (RB)	10	19	6	10	14	7	6	5	8	10	12	15	<b>10</b>	<b>10</b>
Langley Park (RB)	16	25												
Clos St.Andre (RB)	16	24												
Maufant (RB)	15	23												
Rue Des Raisies (Rural)	6	13	4	7	7	6	4	3	4	5	7	12	<b>7</b>	<b>6</b>

\* = outlying values in co-located triplet, rejected.

K = Kerbside, R = Roadside, UB = Urban Background, RB = Residential Background, Rural = Rural Background.

Figure 6 Comparison of Annual Mean Nitrogen Dioxide Concentrations at All Jersey Sites, 2008 (Bias Adjustment Factor Applied)



## **4.3 Diurnal and Seasonal Variation in NO<sub>2</sub> Concentration**

### **4.3.1 Diurnal variation in NO<sub>2</sub> concentration at Halkett Place**

Figure 7 shows how concentrations of nitrous oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) typically varied over the course of the day, at Halkett Place.

The curve for NO (which is a primary pollutant, i.e. directly emitted from source, and arises from road vehicles and other combustion sources) shows a very sharp morning peak at 0600 - 0800. Concentrations decrease during the middle of the day, with an afternoon "plateau" before concentrations fall at around 1800. There is barely any afternoon or evening rush-hour peak.

For NO<sub>2</sub>, which has both primary (directly emitted) and secondary (due to oxidation of NO) components, there is again a pronounced morning rush-hour peak, only slightly lower than for NO. There is no real afternoon peak.

Based on AEA's experience with data from the Automatic Urban and Rural Network, the morning peak in NO and NO<sub>2</sub> is typical for urban sites, reflecting the increased levels of these pollutants associated with morning rush-hour traffic. However, at Halkett Place it is particularly early and particularly sharp. This may be explained by the fact that there is a market at Halkett Place every day except Sundays: the peak coincides with the time at which the market traders arrive and set up for the day. In addition, a skip lorry arrives at this time to collect the previous day's refuse. It is believed that vehicle emissions from these activities are responsible for the distinctive morning pattern at Halkett Place.

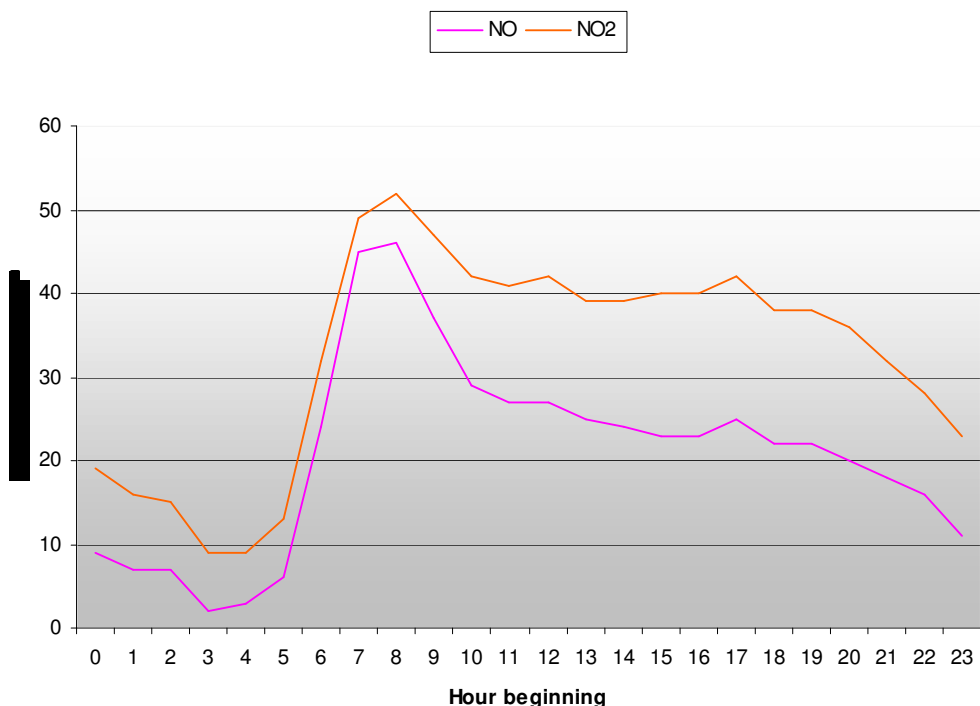
Halkett Place does not exhibit an afternoon or evening rush-hour peak (as observed at many roadside AURN sites). This is unusual for an urban site: in the afternoon, concentrations of oxidising agents, particularly ozone, in the atmosphere tend to increase, leading to enhanced oxidation of NO to NO<sub>2</sub>. This typically causes the afternoon NO<sub>2</sub> peak at many urban sites to be higher than the morning NO<sub>2</sub> peak. However, this is not the case at Halkett Place.

### **4.3.2 Seasonal variation in NO<sub>2</sub> concentration**

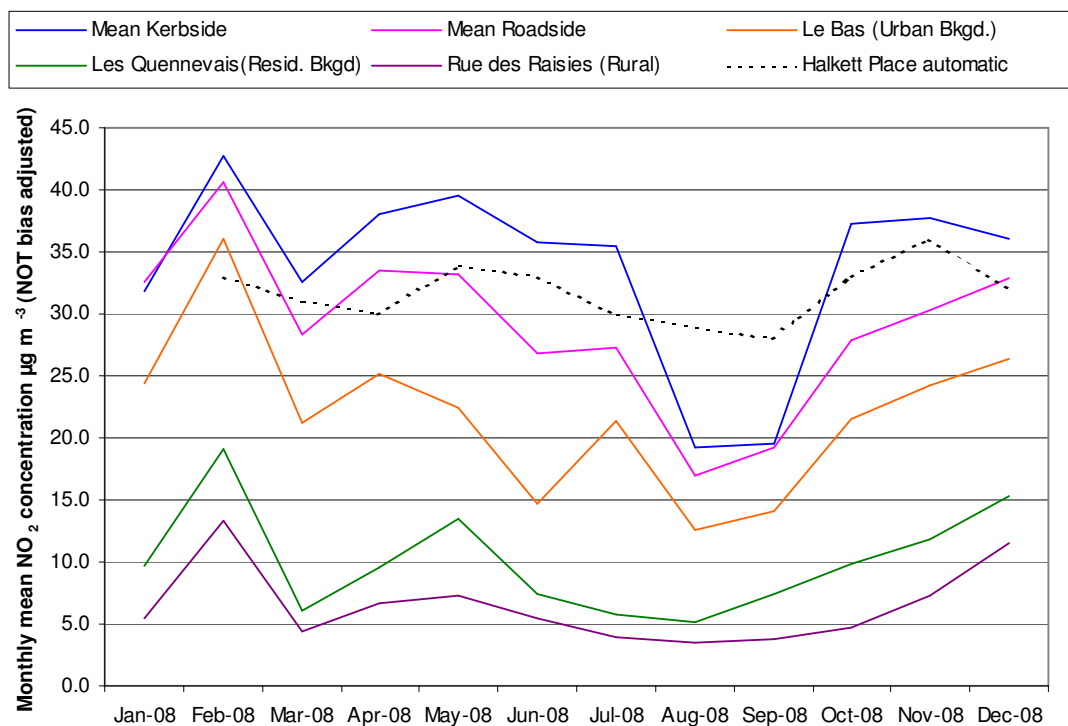
Figure 8 shows the monthly mean NO<sub>2</sub> concentrations measured at the diffusion tube sites and at Halkett Place. This shows the means of the five kerbside and four roadside sites which continued operation for the full year, and the monthly means measured at the single urban background site (Le Bas Centre), urban residential site (Les Quennevais) and rural site (Rue des Raisies). Monthly means (based on the same periods as the diffusion tube exposures) are also shown for the Halkett Place automatic site.

The typical pattern in urban areas is for NO<sub>2</sub> concentrations to be generally higher in the winter and lower in the summer. In 2008, the highest concentrations at the diffusion tube sites were typically measured in February (although Halkett Place measured its highest monthly mean in November.) Lowest monthly means occurred in August and September. These general patterns are consistent with those observed in the UK as a whole; much of the UK saw high levels of NO<sub>x</sub> in February 2008.

**Figure 7 Diurnal Variation in concentrations of oxides of nitrogen, Halkett Place**



**Figure 8 Monthly Mean NO<sub>2</sub> Concentrations at Diffusion Tube Sites and Halkett Place**



### 4.3.3 Comparison with UK NO<sub>2</sub> data

Table 9 compares the NO<sub>2</sub> concentrations measured at Halkett Place with those measured at a selection of UK air quality monitoring stations using automatic (chemiluminescent) NO<sub>2</sub> 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 9 Comparison of NO<sub>2</sub> in Jersey with UK Automatic Sites**

Site	2008 Annual average NO <sub>2</sub> , µg m <sup>-3</sup>
Exeter Roadside	38
Brighton Roadside	38
Brighton Preston Park	20
Southend on Sea	23
Lullington Heath	9.7
Harwell	10.1
Halkett Place (auto.)	32

The bias adjusted annual mean NO<sub>2</sub> concentrations measured at the kerbside and roadside sites in Jersey (rounded to the nearest integer) ranged from 24 to 38 µg m<sup>-3</sup>. The annual means at Exeter Roadside and Brighton Roadside were at the upper end of this range, and were higher than the annual mean at the Halkett Place automatic site (and co-located diffusion tubes). The Jersey urban background site at Le Bas Centre had a (bias adjusted) annual mean NO<sub>2</sub> concentration of 22 µg m<sup>-3</sup>; this is comparable to the annual means from the urban background sites in Southend and Brighton. The residential background site at Les Quennevais had a bias-adjusted annual mean NO<sub>2</sub> concentration of 10 µg m<sup>-3</sup> - more comparable with rural sites such as Lullington Heath and Harwell. The bias-adjusted annual mean of 6.3 µg m<sup>-3</sup> 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.

### 4.3.4 Comparison with Previous Years' Nitrogen Dioxide Results

In February 2008, the three longest-running NO<sub>2</sub> diffusion tube sites (Beaumont, Jane Sandeman Road and Maufant) were closed as part of the streamlining of the monitoring programme. These sites (which had been in operation since 1993 as part of the former UK Nitrogen Dioxide Network) predated the rest of the survey by several years, and were used to monitor long-term trends in previous reports in this series. However, this poses no difficulty, as several of the remaining sites have been in operation since 2000, which is long enough to assess trends. Accordingly, this section is based on these long-running sites.

Table 10 shows annual mean concentrations at the eight sites in operation since 2000 and remain in operation at the present time. These annual means are also illustrated in Figure 9. **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.**

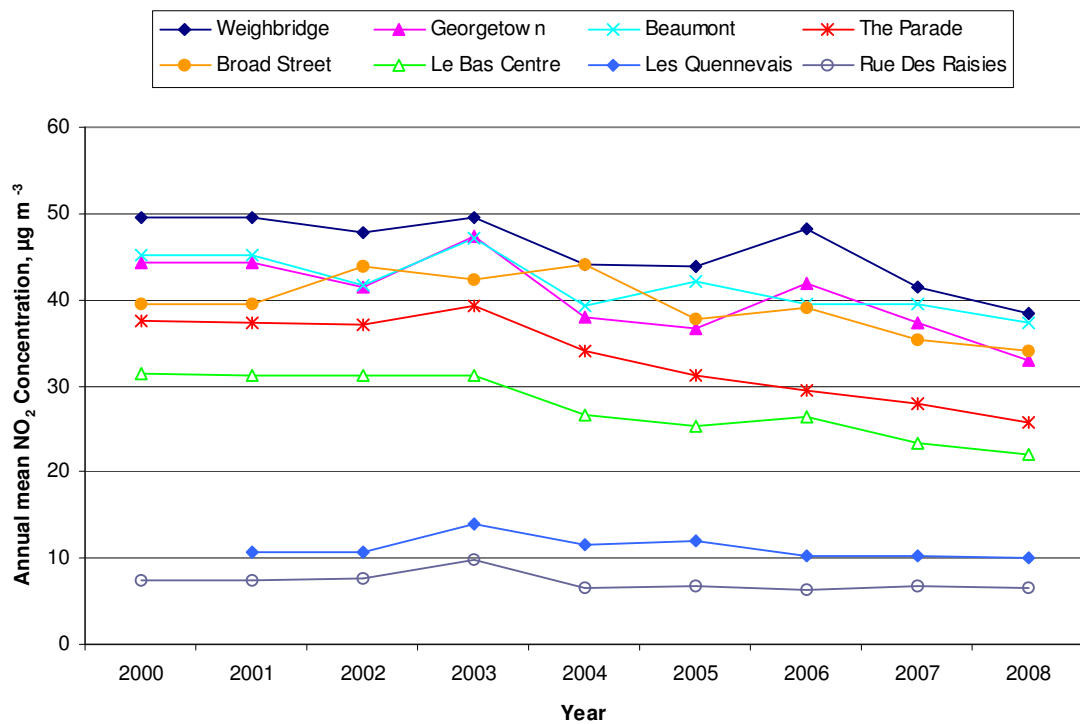
Annual mean NO<sub>2</sub> concentrations at the kerbside, roadside and urban background sites (Weighbridge, Georgetown, Beaumont, the Parade, Broad Street, and Le Bas) gave cause for concern in the early years of the study (2000 to 2003). Many were above the EC Directive Limit Value of 40 µg m<sup>-3</sup>, and there was no sign of concentrations decreasing. However, from 2004 onwards, concentrations began to decrease, and all are now within the Limit Value (although exceedences in future years cannot be ruled out, as NO<sub>2</sub> concentrations vary from year to year due to meteorological and other factors).

The residential background and rural sites at Les Quennevais and Rue des Raisies do not show any consistent upward or downward trend in NO<sub>2</sub> concentration: but levels here are already low so this is not of concern.

**Table 10** Annual mean NO<sub>2</sub> concentrations, µg m<sup>-3</sup> (not bias adjusted)

Site	2000	2001	2002	2003	2004	2005	2006	2007	2008
Weighbridge	49	49	48	50	44	44	48	41	38
Georgetown	44	44	41	47	38	37	42	37	33
Beaumont	45	45	42	47	39	42	39	40	37
The Parade	37	37	37	39	34	31	29	28	26
Broad Street	40	39	44	42	44	38	39	35	34
Le Bas Centre	31	31	31	31	27	25	26	23	22
Les Quennevais	-	11	11	14	12	12	10	10	10
Rue Des Raisies	7	7	8	10	6	7	6	7	7

**Figure 9** Annual Mean NO<sub>2</sub> Concentrations (not adjusted for diffusion tube bias).





## 4.4 Hydrocarbons

Full monthly results of the hydrocarbon survey for the six sites are shown in Appendix 4, Tables A3.1 to A3.6. Graphical representations are shown in Figures 10 to 15.

A summary of annual average hydrocarbon concentrations is shown in Table 11.

**Table 11 Summary of Average Hydrocarbon Concentrations, Jersey, 2008**

Site	Benzene, $\mu\text{g m}^{-3}$	Toluene, $\mu\text{g m}^{-3}$	Ethyl Benzene, $\mu\text{g m}^{-3}$	m+p Xylene, $\mu\text{g m}^{-3}$	o Xylene, $\mu\text{g m}^{-3}$
Beresford Street	1.6	6.1	1.4	4.3	1.6
Le Bas Centre	1.4	5.6	1.4	3.7	1.4
Handsford Lane ( <i>paint spraying</i> )	1.0	4.0	2.2	7.6	2.2
Springfield Garage ( <i>petrol station</i> )	4.2	21.7	3.5	11.4	4.4
Clos St Andre	0.8	2.1	1.0	1.5	0.5
Airport	0.6	1.7	0.3	0.8	0.3

Full data capture was achieved at all sites, except Springfield Garage, where the November tube went missing and was not returned.

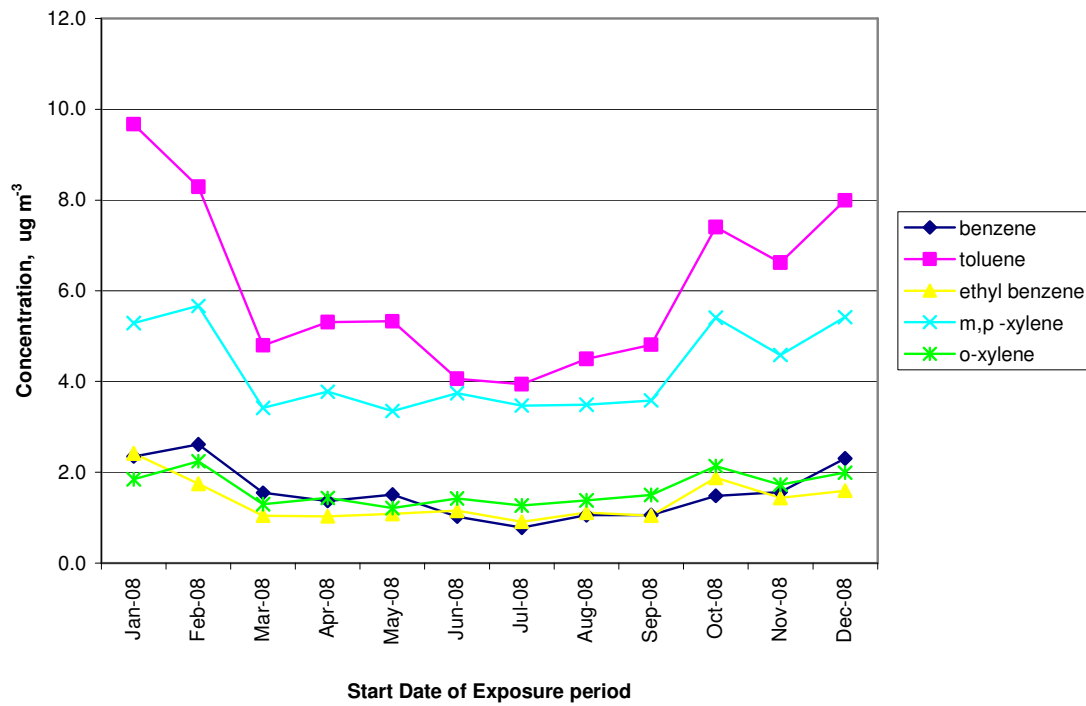
In addition, the following data anomaly occurred: the reported April results for Springfield Garage were very low compared to what is usual at the site, while the reported April results at Clos St Andre were very high compared to the site's usual measurements. It is therefore strongly suspected that the April tubes for these two sites were accidentally confused or mis-labelled at some stage. However, there is no evidence that this has indeed happened, and in the absence of proof, the April results from both sites have been treated as spurious and 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 site is currently located on the forecourt of a fuel filling station, which is adjacent to a residential area. There are no fuel vapour recovery systems in place at the station. The site is not truly representative of the exposure of the neighbouring residents; consideration is being given to relocating this site during 2009 to more accurately reflect population exposure.

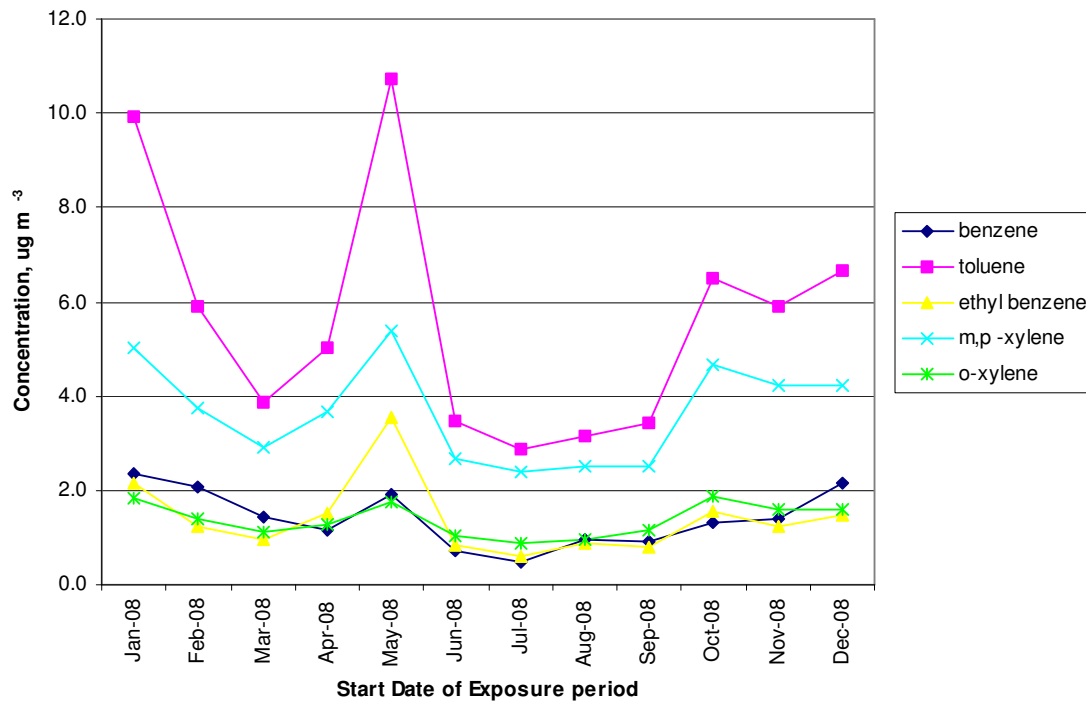
The Handsford Lane site (near a paint spraying process) measured second highest levels of ethylbenzene and xylenes than most of the other sites, as it typically has in previous years. However, benzene concentrations at Handsford Lane were no higher than those at Beresford Street or Le Bas; the nearby paint spraying process is not a significant source of benzene. In previous years, Handsford Lane has also measured second highest levels of toluene; but in 2008 toluene concentrations there were no higher than those at the two urban background sites, Beresford Street and Le Bas Centre.

The Airport site, which is in rural surroundings, recorded the lowest annual mean concentrations of all the BTEX hydrocarbons. BTEX concentrations at Clos St Andre were only slightly higher.

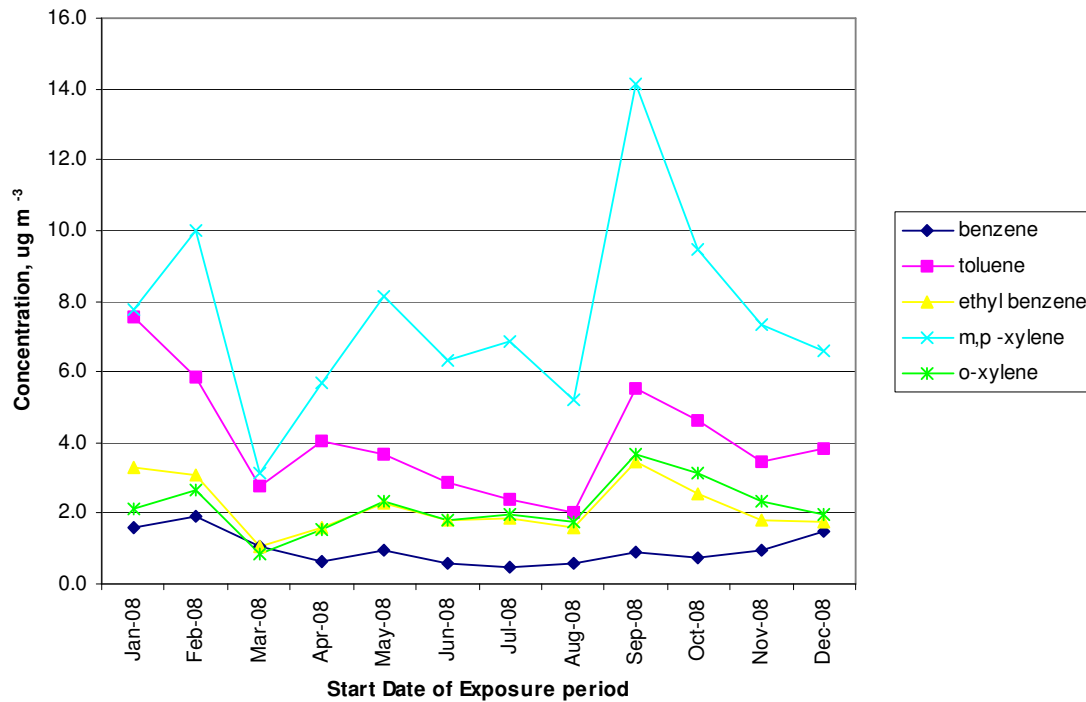
**Figure 10 Monthly mean hydrocarbon concentrations at Beresford Street, 2008**



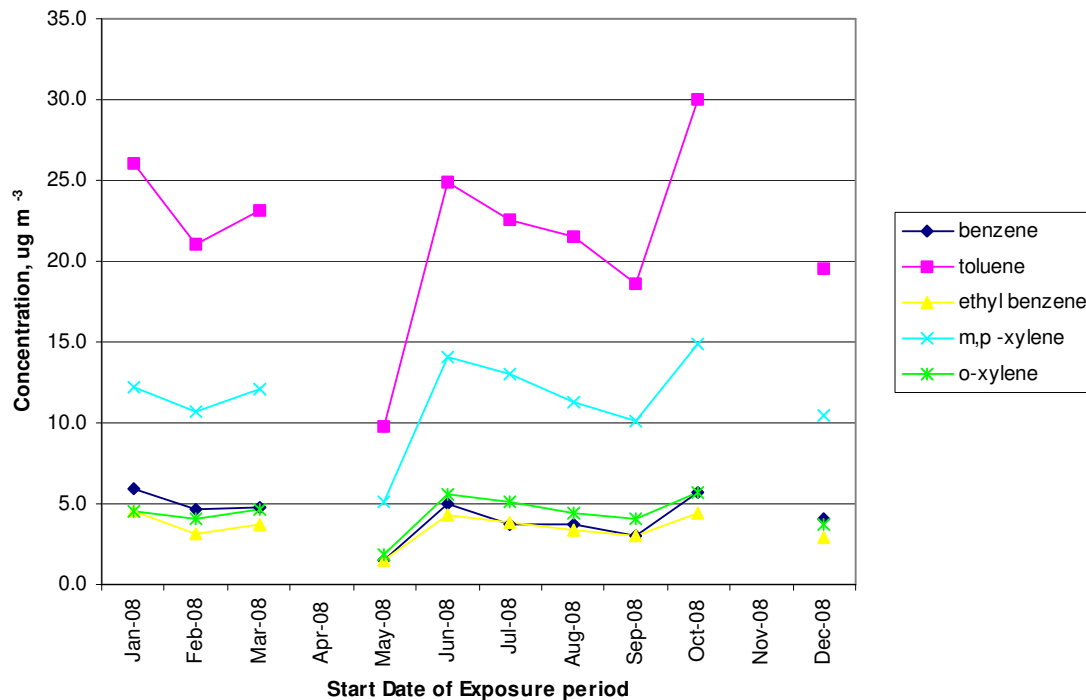
**Figure 11 Monthly mean hydrocarbon concentrations at Le Bas Centre, 2008**



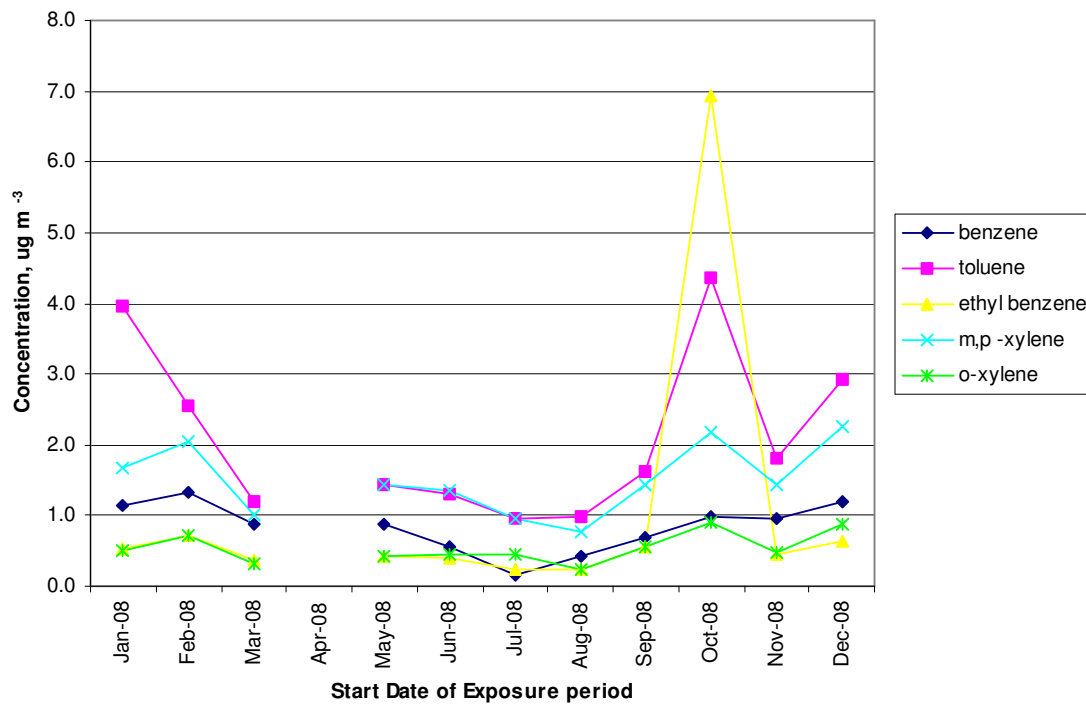
**Figure 12 Monthly mean hydrocarbon concentrations at Handsford Lane, 2008**



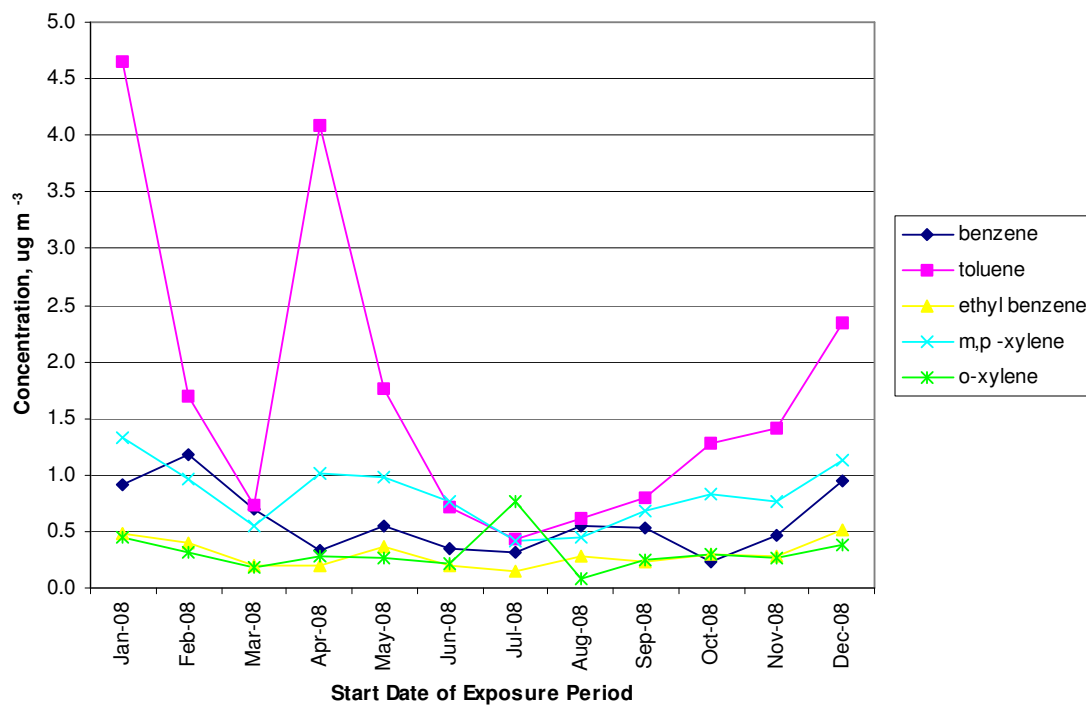
**Figure 13 Monthly mean hydrocarbon concentrations at Springfield Garage, 2008**



**Figure 14 Monthly mean hydrocarbon concentrations at Clos St Andre, 2008**



**Figure 15 Monthly mean hydrocarbon concentrations at the Airport, 2008**



#### 4.4.1 Comparison With Limit Values and Objectives

Of the hydrocarbon species monitored, only benzene is the subject of any applicable air quality standards. The EC Directive on Ambient Air Quality and Cleaner Air for Europe<sup>15</sup> sets a limit of  $5 \mu\text{g m}^{-3}$  for annual mean benzene, to be achieved by 2010. All sites met this limit in 2008.

The UK Air Quality Strategy<sup>16</sup> sets the following objectives for benzene:

- $16.25 \mu\text{g m}^{-3}$  (for the running annual mean), to have been achieved by 31<sup>st</sup> December 2003
- $3.25 \mu\text{g m}^{-3}$  (for the calendar year mean), to be achieved by 31<sup>st</sup> 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 the 2003 Objective of  $16.25 \mu\text{g m}^{-3}$  at any of the Jersey sites. However, one site (Springfield Garage) had an annual mean of  $4.2 \mu\text{g m}^{-3}$ : this is greater than the 2010 objective of  $3.25 \mu\text{g m}^{-3}$ , therefore Springfield Garage does not at present meet this Objective.

#### 4.4.2 Comparison with UK Benzene Data

Benzene was measured using pumped-tube samplers at a large UK-wide network of 30 UK sites in 2008. Annual mean concentrations ranged from  $0.44 \mu\text{g m}^{-3}$  (at Oxford St Ebbes) to  $1.44 \mu\text{g m}^{-3}$  (at Yarm, Stockton-on-Tees).

Table 12 compares benzene data from the Jersey sites, with two UK monitoring stations, located in cities on the south coast of England and one urban background site in central London. (Please note that not all the sites used for comparison in previous years were available for 2008). The comparison sites are:

- Plymouth – an urban background site in the coastal city of Plymouth, Devon
- Southampton – a roadside site in the city of Southampton
- Urban background site in central London

It should be noted that these sites use a different technique (pumped tubes) for measuring benzene than the Jersey sites. Therefore this comparison should be treated as indicative only.

**Table 12 Comparison with Benzene Concentrations at Other UK Sites, 2008**

Site	Benzene, $\mu\text{g m}^{-3}$
<b>Jersey Sites</b>	
Beresford Street	1.6
Le Bas Centre	1.4
Handsford Lane ( <i>paint spraying</i> )	1.0
Springfield Garage ( <i>petrol station</i> )	4.2
Clos St Andre	0.8
Airport	0.6
<b>Mainland UK sites</b>	
Plymouth	0.58
Southampton	0.94
London Bloomsbury	0.78

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 site at Southampton and

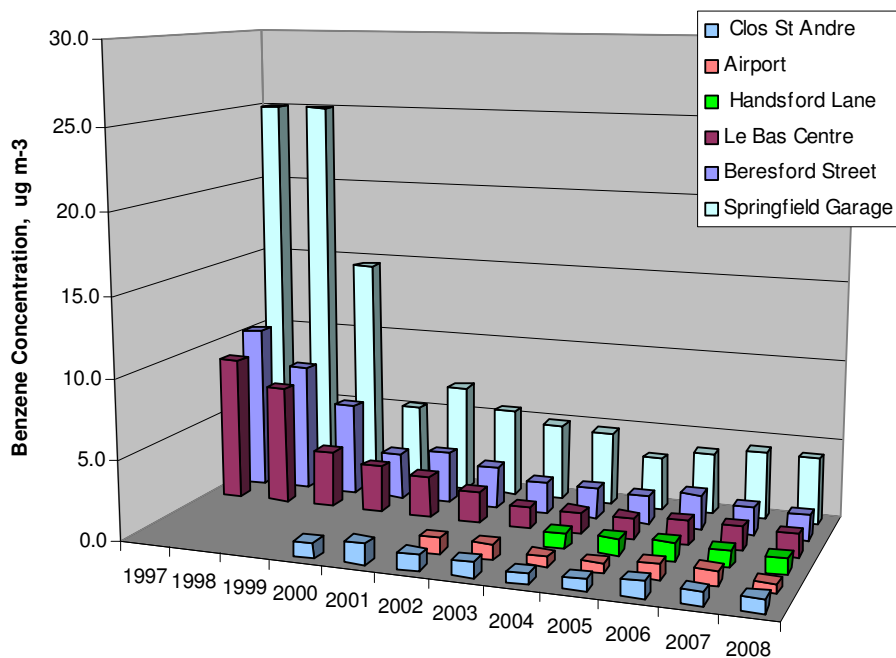
Howe. Prior to 2006 it was reported that benzene levels at Clos St Andre and the Airport were lower than typical UK urban levels; however, UK urban levels have decreased and this is no longer the case.

### 4.4.3 Comparison with Previous Years' Hydrocarbon Results

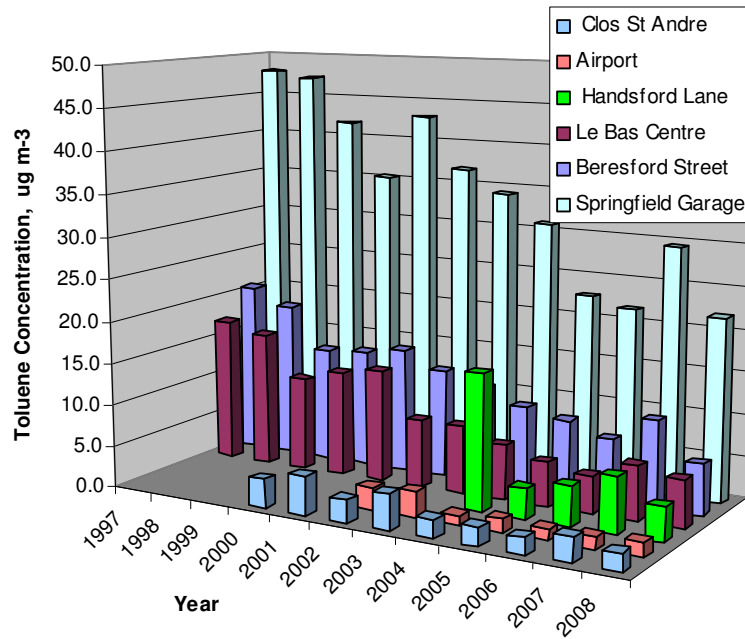
Figures 16 – 21 show how annual mean hydrocarbon concentrations at the six Jersey sites have changed over the years of monitoring. These data are also provided in tabular form in Appendix 4.

Annual mean levels of benzene were slightly lower in 2008 than in the previous year, at all sites except Clos St Andre where they were the same. Annual mean toluene concentrations at all sites were lower in 2008 compared to 2007. Annual mean concentrations of ethylbenzene and xylenes were comparable with 2007 concentrations at all sites – at some, they were slightly higher, at others lower. 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.

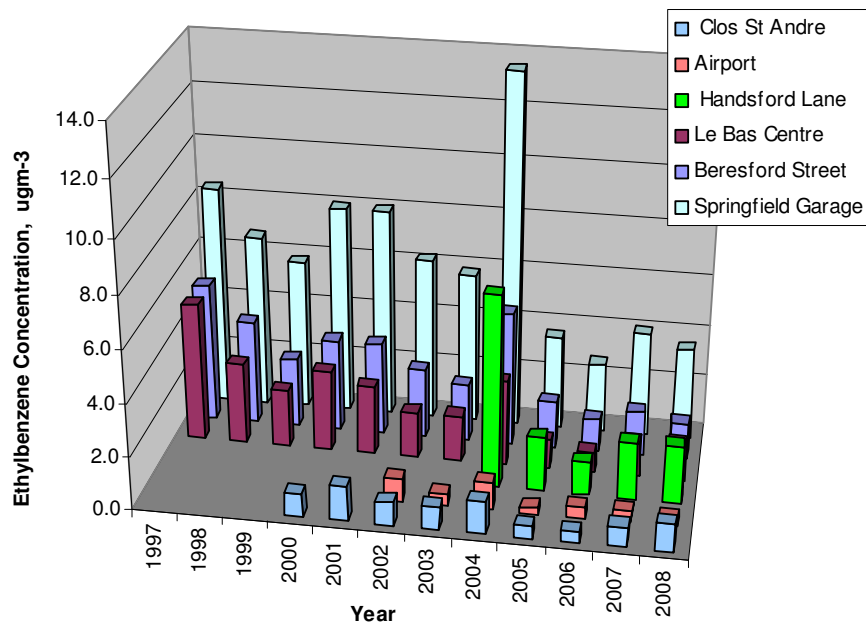
**Figure 16 Trends in Benzene Concentration**



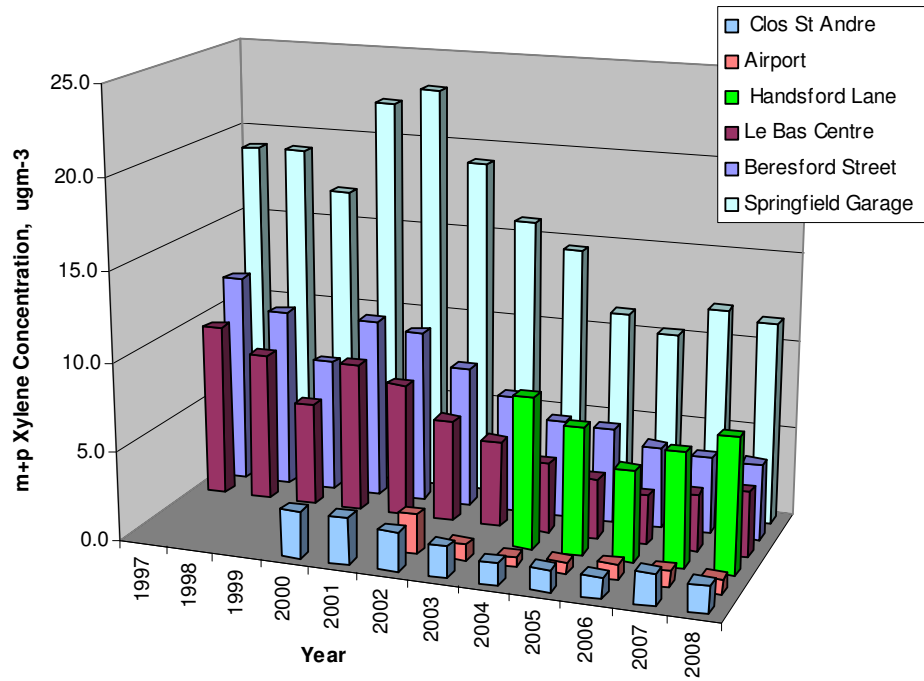
**Figure 17 Trends in Toluene Concentration**



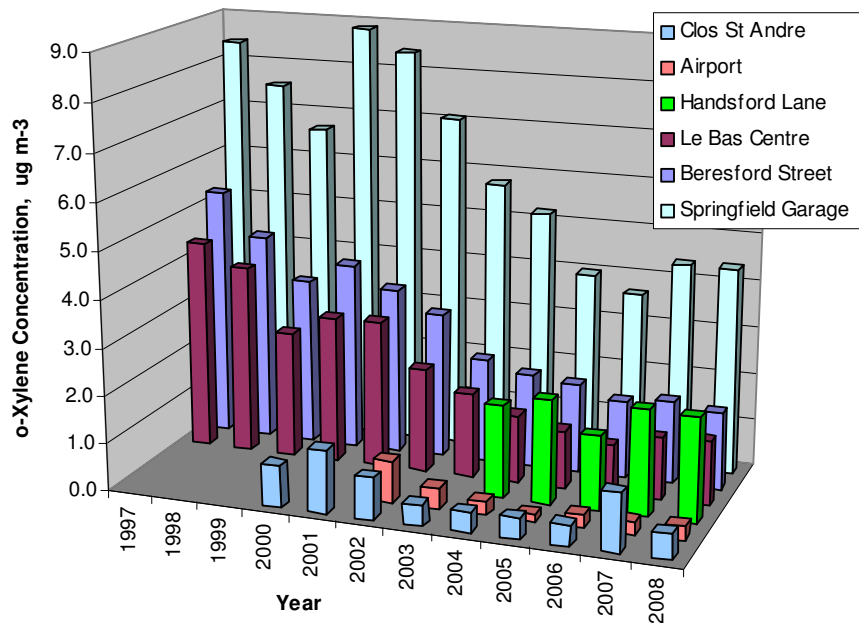
**Figure 18 Trends in Ethylbenzene Concentration**



**Figure 20 Trends in m+p- Xylene Concentration**



**Figure 21 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. Key observations include:

- Benzene showed a marked drop in 2000, especially at Springfield Garage: 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 1<sup>st</sup> January 2000. Concentrations have remained stable (with small fluctuations) since around 2004.
- Toluene concentrations show a downward trend over the earlier years of the survey (1997-2004) but little consistent change thereafter.
- Ethylbenzene concentrations have generally decreased, despite an unexplained increase in 2004.
- Concentrations of m+p xylene, and of o-xylene, are now generally lower than in the early years of the survey.

## 5 Conclusions

AEA has continued the ongoing air quality monitoring programme in Jersey during 2008, on behalf of the States of Jersey Public Health Services. 2008 was the twelfth year of monitoring. Oxides of nitrogen were monitored at one automatic monitoring station, located in a roadside position at the Central Market, Halkett Place in St Helier. 2008 was the first year of operation of this automatic monitoring station. Diffusion tubes were used to monitor NO<sub>2</sub> at 12 sites (the number of sites was reduced from 24 in February 2008). Diffusion tubes were co-located (in triplicate) with the automatic site at Halkett Place. Hydrocarbons (benzene, toluene, ethyl benzene and xylenes, collectively termed BTEX) were measured at 6 sites, also using diffusion tubes. 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. Conclusions of the monitoring programme were as follows:

### NO<sub>2</sub> results

1. The maximum hourly mean NO<sub>2</sub> concentration at the Halkett Place automatic monitoring station was 180 µg m<sup>-3</sup>. The site therefore met the EC Directive Limit Value (and AQS Objective) of 200 µg m<sup>-3</sup> for 1-hour mean NO<sub>2</sub> concentration, which must not be exceeded more than 18 times per calendar year.
2. The annual mean NO<sub>2</sub> concentration at Halkett Place was 32 µg m<sup>-3</sup>. This is within the EC Directive Limit Value and AQS Objective of 40 µg m<sup>-3</sup>.
3. Annual mean NO<sub>2</sub> concentrations at all 12 diffusion tube monitoring sites were within the EC Limit Value, and were generally comparable with the previous year's results.
4. Eight diffusion tube sites have been in operation since 2000. These indicate that while in the early years of the survey (2000 – 2004) annual mean NO<sub>2</sub> concentrations at kerbside and roadside sites showed little change, they now appear to be decreasing.
5. There does not appear to be any clear trend in NO<sub>2</sub> concentrations at the long running urban background site (Le Bas Centre), urban residential site (Les Quennevais) or rural site (Rue des Raisies); 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 diffusion tube results

6. No sites had annual mean benzene concentrations greater than the UK Air Quality Strategy Objective of 16.25 µg m<sup>-3</sup>, which was to be achieved by the end of 2003.
7. No sites had annual mean benzene concentrations greater than the EC Directive Limit Value of 5 µg m<sup>-3</sup> (which is to be achieved by 2010).
8. One site (Springfield Garage) had an annual mean benzene concentration greater than the UK Air Quality Strategy Objective of 3.25 µg m<sup>-3</sup>, which is to be achieved by January 2010.
9. Annual mean concentrations of BTEX hydrocarbons were comparable with those measured in 2007.
10. Concentrations of all BTEX hydrocarbons (especially benzene) are considerably lower than in the early years of the survey. However, there has been little consistent change in the most recent years.

## **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.

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## **Appendices**

Appendix 1: Air Quality Limit Values, Objectives and Guidelines

Appendix 2: Calibration Procedures for Automatic Analyser

Appendix 3: Nitrogen Dioxide Diffusion Tubes: Bias Adjustment Factor

Appendix 4: BTEX Diffusion Tubes: Monthly 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 <sup>(1)</sup> / $\mu\text{g m}^{-3}$ (ppb)
<b>The Air Quality Strategy<sup>(2)</sup></b>	Objective for Dec. 31 <sup>st</sup> 2005, for protection of human health	1-hour mean	200 (105) Not to be exceeded more than 18 times per calendar year.
<b>Set in regulations<sup>(3)</sup> for all UK:</b>	Objective for Dec. 31 <sup>st</sup> 2005, for protection of human health	Annual mean	40 (21)
<b>Not intended to be set in regulations:</b>	Objective for Dec. 31 <sup>st</sup> 2000, for protection of vegetation.	Annual mean NO <sub>x</sub> (NO <sub>x</sub> as NO <sub>2</sub> )	30 (16)
<b>European Community 1985 NO<sub>2</sub> Directive<sup>(4)</sup></b> Limit remains in force until fully repealed 01/01/2010.	Limit Value	Calendar year of data: 98 <sup>th</sup> ile of hourly means.	200 (105)
ED Directive on Ambient Air Quality and Cleaner Air for Europe <sup>(5)</sup>	Limit Value for protection of human health. To be achieved by Jan. 1 <sup>st</sup> 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. 1 <sup>st</sup> 2010	Calendar year mean	40 (21)
	Limit Value ( total NO <sub>x</sub> ) for protection of vegetation. To be achieved by Jul. 19 <sup>th</sup> 2001	Calendar year mean	30 (16)
<b>World Health Organisation<sup>(6)</sup></b>	Health Guideline	1-hour mean	200
<b>(Non-Mandatory Guidelines)</b>	Health Guideline	Annual mean	40

(1) Conversions between  $\mu\text{g m}^{-3}$  and ppb are as used by the EC, i.e. 1ppb NO<sub>2</sub> = 1.91  $\mu\text{g m}^{-3}$  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 2008/50/EC.

(6) WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).

Benzene

Guideline Set By	Description	Criteria Based On	Value <sup>(1)</sup> / $\mu\text{g m}^{-3}$ (ppb)
<b>The Air Quality Strategy<sup>(2,3)</sup></b> <b>All UK</b> <b>England<sup>(4)</sup> &amp; Wales<sup>(5)</sup> only:</b>  <b>Scotland<sup>(6)</sup> &amp; Northern</b> <b>Ireland</b>	Objective for Dec. 31 <sup>st</sup> 2003	Running annual mean	16.25 (5)
	Objective for Dec. 31 <sup>st</sup> 2010	Annual mean	5 (1.54)
	Objective for Dec. 31 <sup>st</sup> 2010	Running annual mean	3.25 (1.0)
ED Directive on Ambient Air Quality and Cleaner Air for Europe <sup>(8)</sup>	Limit Value. To be achieved by Jan 1 <sup>st</sup> 2010	Annual calendar year mean	5 (1.5)

(1) Conversions between  $\mu\text{g m}^{-3}$  and ppb are those used by the EC, i.e. 1ppb benzene = 3.25  $\mu\text{g m}^{-3}$  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 2008/50/EC.



## **Appendix 2**

# **Calibration Procedures for Automatic Analyser**

The analyser at Halkett Place is calibrated monthly by the Health Protection team. Standard gas calibration mixtures are used to check the instrument's span, and chemically scrubbed air is used to check the instrument's zero. All gas calibration standards used for routine analyser calibration are certified against traceable primary gas calibration standards at the Gas Standards Calibration Laboratory at AEA. The calibration laboratory operates within a specific and documented quality system and has UKAS accreditation for calibration of the gas standards used in this survey. The calibration form used is shown below.

**Jersey Calibration Form**

**JERSEY**  
**HALKETT PLACIDOPERATOR**  **DATE**  **EPISODE? y/n**   
**TIME**  GMT  
**SAMPLE SYSTEM OK?**  y/n

**Pre Calibration Checks**

**NOx**

Analyser OK:   
Sample LED on:   
Cal LED on:   
Fault LED off:   
Serial Number:

Time:   
Flange:   
Units:   
Stabilit:  ppb  
Sample Flow:  cc/min  
Ozone Flow:  cc/min  
PMT:  mV  
Norm PMT:  mV  
Azero:  mV  
HWFS:  V  
Roell Temp:  deg C  
Box Temp:  deg C  
PMT Temp:  deg C  
I2S Temp:  deg C  
Moly Temp:  deg C  
RCEL:  inHg  
SAMP:  inHg  
NOx Slope:   
NOx Offs:  mV  
NO Slope:   
NO Offs:  mV

**Calibration**

**Zero**

1	2	3	(Average)
NOx:			
NO:			
NO2:			

**Cal Cylinder**

1	2	3	(Average)
NOx:			
NO:			
NO2:			

Cyl no:  Pressure:  psi

**Final Checks**

Analyser OK:  y/n  
Analyser sampling ambient:  y/n  
Tubing connected to inlet:  y/n

Cylinder turned off:  y/n  
Filter changed:  y/n  
Status flags off:  y/n

Comments:

Calibration end time:  GMT

**Post Calibration Checks**

**NOx**

Analyser OK:   
Sample LED on:   
Cal LED on:   
Fault LED off:   
Serial Number:  16126

Time:   
Flange:   
Units:   
Stabilit:  ppb  
Sample Flow:  cc/min  
Ozone Flow:  cc/min  
PMT:  mV  
Norm PMT:  mV  
Azero:  mV  
HWFS:  V  
Roell Temp:  deg C  
Box Temp:  deg C  
PMT Temp:  deg C  
I2S Temp:  deg C  
Moly Temp:  deg C  
RCEL:  inHg  
SAMP:  inHg  
NOx Slope:   
NOx Offs:  mV  
NO Slope:   
NO Offs:  mV

An important aspect of QA/QC procedures is the 12-monthly intercalibration and audit check undertaken every 12 months. This audit has two principle functions, firstly to check the instrument and the site infrastructure, and secondly to recalibrate the transfer gas standards routinely used on-site, using standards recently checked in the calibration laboratory. AEA's audit calibration procedures are UKAS accredited to ISO 17025.

In line with current operational procedures within the Defra Automatic Urban and Rural Network (AURN), full intercalibration audits take place at the end of winter and summer. At these visits, the essential functional parameters of the monitors, such as noise, linearity and, for the NO<sub>x</sub> monitor, the efficiency of the NO<sub>2</sub> to NO converter are fully tested. In addition, the on-site transfer calibration standards are checked and re-calibrated if necessary, the air intake sampling system is cleaned and checked and all other aspects of site infrastructure are checked.

## Appendix 3

# Nitrogen Dioxide Diffusion Tubes: Bias

## Adjustment Factor

The precision and accuracy of the diffusion tubes in this study were quantified by exposing them in triplicate alongside the automatic NO<sub>x</sub> analyser at Halkett Place.

The percentage by which the diffusion tubes over-or under-estimate with respect to the automatic chemiluminescent analyser (defined within the European Community as the reference method for NO<sub>2</sub>) is calculated as follows:

Percentage bias  $B = 100 \times (D-C)/C$

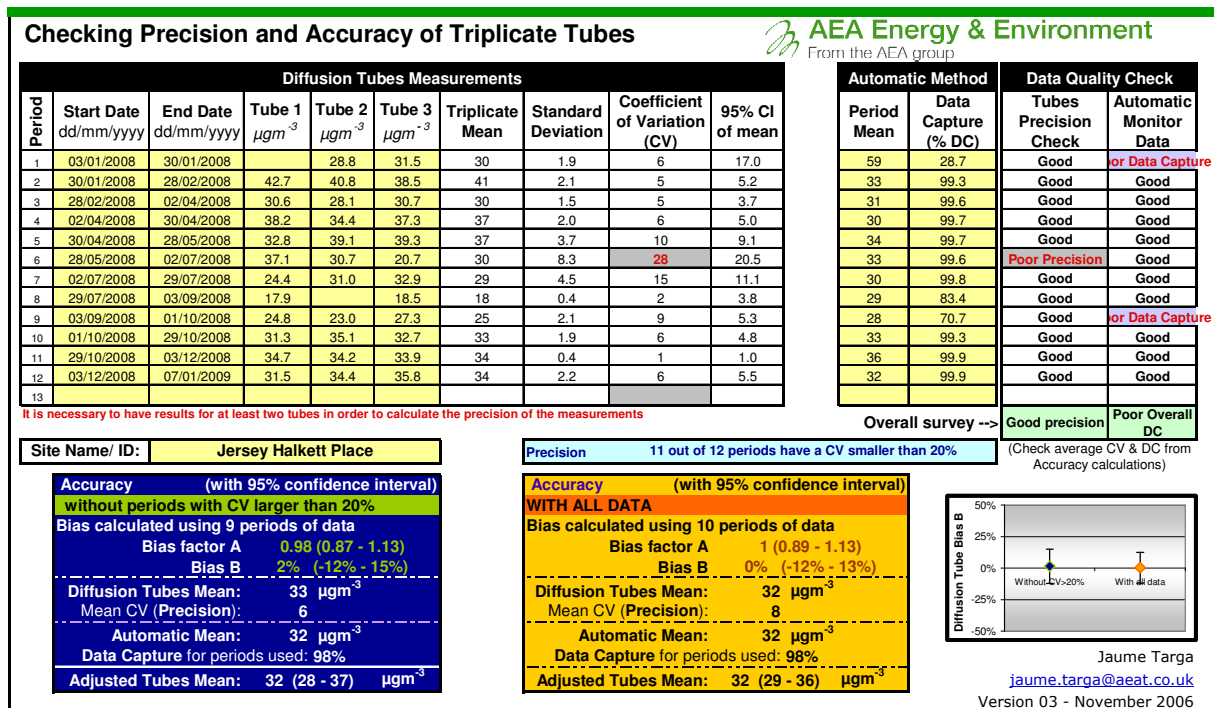
- where D = the average NO<sub>2</sub> concentration as measured using diffusion tubes and C is the average NO<sub>2</sub> concentration as measured using the automatic analyser.

The diffusion tube annual mean concentrations measured at the other (non-co-located) sites can be adjusted for the diffusion tube over/under-read, by application of a bias adjustment factor, calculated as follows:

Bias adjustment factor =  $C/D$  (where D and C are the annual mean NO<sub>2</sub> concentrations as measured using diffusion tubes and the automatic analyser respectively, as above).

These calculations were carried out using a spreadsheet tool developed by AEA: see Figure A3.1 below. This spreadsheet shows the diffusion tube concentrations to 1 decimal place as reported by the analyst – but given the uncertainty on diffusion tube measurements it is only considered valid to report to the nearest integer in the report.

Figure A3.1 Precision and Bias Spreadsheet, showing Halkett Place dataset.



## **Appendix 4**

# **BTEX Diffusion Tubes: Monthly Dataset and Annual Means 1997-2008**

**Table A4.1 Monthly mean Hydrocarbon Concentrations,  $\mu\text{g m}^{-3}$  – Beresford Street**

<b>Start Date</b>	<b>benzene</b>	<b>toluene</b>	<b>ethyl benzene</b>	<b>m,p-xylene</b>	<b>o-xylene</b>
3-Jan-08	2.3	9.7	2.4	5.3	1.8
30-Jan-08	2.6	8.3	1.7	5.7	2.2
28-Feb-08	1.5	4.8	1.0	3.4	1.3
2-Apr-08	1.4	5.3	1.0	3.8	1.4
30-Apr-08	1.5	5.3	1.1	3.4	1.2
28-May-08	1.0	4.1	1.2	3.7	1.4
2-Jul-08	0.8	3.9	0.9	3.5	1.3
29-Jul-08	1.1	4.5	1.1	3.5	1.4
3-Sep-08	1.1	4.8	1.0	3.6	1.5
1-Oct-08	1.5	7.4	1.9	5.4	2.1
29-Oct-08	1.6	6.6	1.4	4.6	1.7
3-Dec-08	2.3	8.0	1.6	5.4	2.0
<b>Average</b>	<b>1.6</b>	<b>6.1</b>	<b>1.4</b>	<b>4.3</b>	<b>1.6</b>

**Table A4.2 Monthly mean Hydrocarbon Concentrations,  $\mu\text{g m}^{-3}$  – Le Bas Centre**

<b>Start Date</b>	<b>benzene</b>	<b>toluene</b>	<b>ethyl benzene</b>	<b>m,p-xylene</b>	<b>o-xylene</b>
3-Jan-08	2.3	9.9	2.1	5.0	1.8
30-Jan-08	2.1	5.9	1.2	3.8	1.4
28-Feb-08	1.4	3.9	1.0	2.9	1.1
2-Apr-08	1.2	5.0	1.5	3.7	1.3
30-Apr-08	1.9	10.7	3.5	5.4	1.8
28-May-08	0.7	3.5	0.9	2.7	1.0
2-Jul-08	0.5	2.9	0.6	2.4	0.9
29-Jul-08	0.9	3.2	0.9	2.5	0.9
3-Sep-08	0.9	3.4	0.8	2.5	1.1
1-Oct-08	1.3	6.5	1.5	4.7	1.9
29-Oct-08	1.4	5.9	1.2	4.2	1.6
3-Dec-08	2.2	6.7	1.5	4.2	1.6
<b>Average</b>	<b>1.4</b>	<b>5.6</b>	<b>1.4</b>	<b>3.7</b>	<b>1.4</b>

**Table A4.3 Monthly mean Hydrocarbon Concentrations,  $\mu\text{g m}^{-3}$  – Springfield Garage**

Start Date	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-08	6.0	26.1	4.5	12.2	4.5
2-Feb-07	4.7	21.0	3.2	10.6	4.1
28-Feb-07	4.7	23.1	3.7	12.1	4.6
4-Apr-07	<b>(0.5)</b>	<b>(1.2)</b>	<b>(0.3)</b>	<b>(0.8)</b>	<b>(0.4)</b>
2-May-07	1.6	9.8	1.5	5.1	1.9
30-May-07	5.0	24.9	4.3	14.1	5.5
5-Jul-07	3.7	22.5	3.9	13.0	5.1
1-Aug-07	3.7	21.6	3.4	11.2	4.4
29-Aug-07	3.0	18.6	3.0	10.2	4.1
3-Oct-07	5.7	30.0	4.4	14.9	5.7
31-Oct-07	No tube	No tube	No tube	No tube	No tube
28-Nov-07	4.0	19.5	3.0	10.4	3.7
<b>Average</b>	<b>4.2</b>	<b>21.7</b>	<b>3.5</b>	<b>11.4</b>	<b>4.4</b>

No tube was returned from the site after the November exposure period.

April results at Springfield Garage were unusually low. This was thought to be either a faulty tube, or that the tubes from Springfield Garage and Clos St Andre (where the April results were unusually high) had been accidentally confused. In the absence of proof that the tubes had been mixed up, the April results from these two sites have been rejected as spurious.

**Table A4.4 Monthly mean Hydrocarbon Concentrations,  $\mu\text{g m}^{-3}$  – Clos St Andre**

Start Date	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-08	1.1	4.0	0.5	1.7	0.5
30-Jan-08	1.3	2.6	0.7	2.1	0.7
28-Feb-08	0.9	1.2	0.4	1.0	0.3
2-Apr-08	<b>(4.1)</b>	<b>(22.7)</b>	<b>(3.5)</b>	<b>(12.0)</b>	<b>(4.6)</b>
30-Apr-08	0.9	1.4	0.4	1.4	0.4
28-May-08	0.6	1.3	0.4	1.4	0.4
2-Jul-08	0.2	1.0	0.2	1.0	0.4
29-Jul-08	0.4	1.0	0.2	0.8	0.2
3-Sep-08	0.7	1.6	0.5	1.4	0.5
1-Oct-08	1.0	4.4	6.9	2.2	0.9
29-Oct-08	1.0	1.8	0.5	1.4	0.5
3-Dec-08	1.2	2.9	0.6	2.3	0.9
<b>Average</b>	<b>0.8</b>	<b>2.1</b>	<b>1.0</b>	<b>1.5</b>	<b>0.5</b>

April results at Clos St Andre were unusually high. This was thought to be either a contaminated tube, or that the tubes from Clos St Andre and Springfield Garage (where the April results were unusually low) had been accidentally confused. In the absence of proof that the tubes had been mixed up, the April results from these two sites have been rejected as spurious.

**Table A4.5 Monthly mean Hydrocarbon Concentrations,  $\mu\text{g m}^{-3}$  – Handsford Lane**

<b>Start Date</b>	<b>benzene</b>	<b>toluene</b>	<b>ethyl benzene</b>	<b>m,p -xylene</b>	<b>o-xylene</b>
3-Jan-08	1.6	7.6	3.3	7.8	2.1
30-Jan-08	1.9	5.9	3.1	10.0	2.7
28-Feb-08	1.1	2.8	1.1	3.1	0.9
2-Apr-08	0.7	4.0	1.6	5.7	1.6
30-Apr-08	1.0	3.7	2.3	8.1	2.3
28-May-08	0.6	2.9	1.8	6.3	1.8
2-Jul-08	0.5	2.4	1.9	6.8	2.0
29-Jul-08	0.6	2.0	1.6	5.2	1.8
3-Sep-08	0.9	5.5	3.5	14.2	3.7
1-Oct-08	0.8	4.6	2.5	9.5	3.2
29-Oct-08	1.0	3.4	1.8	7.3	2.3
3-Dec-08	1.5	3.8	1.7	6.6	2.0
<b>Average</b>	<b>1.0</b>	<b>4.0</b>	<b>2.2</b>	<b>7.6</b>	<b>2.2</b>

**Table A4.6 Monthly mean Hydrocarbon Concentrations,  $\mu\text{g m}^{-3}$  – Airport**

<b>Start Date</b>	<b>benzene</b>	<b>toluene</b>	<b>ethyl benzene</b>	<b>m,p -xylene</b>	<b>o-xylene</b>
3-Jan-08	0.9	4.6	0.5	1.3	0.4
30-Jan-08	1.2	1.7	0.4	1.0	0.3
28-Feb-08	0.7	0.7	0.2	0.6	0.2
2-Apr-08	0.3	4.1	0.2	1.0	0.3
30-Apr-08	0.6	1.8	0.4	1.0	0.3
28-May-08	0.3	0.7	0.2	0.8	0.2
2-Jul-08	0.3	0.4	0.1	0.4	0.8
29-Jul-08	0.5	0.6	0.3	0.5	0.1
3-Sep-08	0.5	0.8	0.2	0.7	0.2
1-Oct-08	0.2	1.3	0.3	0.8	0.3
29-Oct-08	0.5	1.4	0.3	0.8	0.3
3-Dec-08	0.9	2.3	0.5	1.1	0.4
<b>Average</b>	<b>0.6</b>	<b>1.7</b>	<b>0.3</b>	<b>0.8</b>	<b>0.3</b>



**Table A4.7 Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2008.**

	benzene, $\mu\text{g m}^{-3}$	toluene, $\mu\text{g m}^{-3}$	ethylbenzene $\mu\text{g m}^{-3}$	m+p xylene, $\mu\text{g m}^{-3}$	o-xylene, $\mu\text{g m}^{-3}$
<b>Beresford Street</b>					
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
2008	1.6	6.1	1.4	4.3	1.6
<b>Le Bas Centre</b>					
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
2008	1.4	5.6	1.4	3.7	1.4
<b>Handsford Lane</b>					
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
2008	1.0	4.0	2.2	7.6	2.2

**Table A4.7 continued Comparison of Hydrocarbon Concentrations, -continued : Jersey, 1997 - 2008.**

	benzene, $\mu\text{g m}^{-3}$	toluene, $\mu\text{g m}^{-3}$	ethylbenzene $\mu\text{g m}^{-3}$	m+p xylene, $\mu\text{g m}^{-3}$	o-xylene, $\mu\text{g m}^{-3}$
<b>Springfield Garage</b>					
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
2008	4.2	21.7	3.5	11.4	4.4
<b>Clos St Andre</b>					
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
2008	0.8	2.1	1.0	1.5	0.5
<b>Airport</b>					
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
2008	0.6	1.7	0.3	0.8	0.3

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