Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2003

June 2004

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Executive Summary

Netcen (an operating division of AEA Technology Environment) has undertaken a programme of air quality monitoring on Jersey, on behalf of the Public Health Services and Planning and Environment Department of the States of Jersey. This report presents the results of the seventh consecutive year of monitoring, the period 31st December 2002 to 30th December 2003.

Diffusion tube samplers were used to monitor nitrogen dioxide (NO_2) at 21 sites, and hydrocarbons at seven sites. Monitoring sites were selected to include areas likely to be affected by specific emission sources (such as petrol stations or the waste incinerator), as well as general background locations.

NO_2 and hydrocarbon diffusion tubes were exposed for periods of typically 4 to 5 weeks. The exposure periods were based upon those used in the UK NO_2 Network. 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 six of the nine kerbside and roadside sites in built-up areas were greater than the Limit Value of 21ppb, 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 31 December 2005. After application of a correction factor for known diffusion tube bias, all sites were below 21ppb. The highest annual mean of 19.5ppb (after bias correction) was measured at the Weighbridge site. However, given the uncertainty in diffusion tube measurements, exceedence cannot be ruled out, and further monitoring using more accurate automatic techniques is recommended.

By contrast, annual mean concentrations at urban and residential background sites were all well below 21ppb.

Ambient NO_2 concentrations at most of the sites in Jersey were on average slightly higher in 2003 than the previous year. This is consistent with the findings of automatic and non-automatic monitoring networks throughout the rest of the UK, which also recorded increased NO_2 concentrations in 2003.

Ambient concentrations of NO_2 at the long-running sites show no clear trends, and despite some year-to-year fluctuations they remain generally stable. Unlike the UK as a whole, there is no apparent downward trend in Jersey's NO_2 concentrations. Sites that are currently close to the AQS Objective are likely to remain so, unless action is taken.

The highest annual mean benzene concentration of 1.5ppb 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 1.0ppb. All sites therefore met the UK Air Quality Strategy Objective of 5ppb (which applies to the running annual mean) by the end of 2003 as required. All sites also met the EC 2nd Daughter Directive annual mean Limit Value of 1.5ppb (which is to be achieved by 2010). 2003 was the first year in which Springfield Garage did not exceed this limit.

Three of the hydrocarbon sites have been in operation since 1997. The seven years' data from these long-running hydrocarbon sites appear to show a consistent decreasing trend in ambient concentrations of all the measured species except m+p xylene. This pollutant, by contrast, increased at most sites until around 2001 but also now appears to be falling.

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1 Introduction

1.1 BACKGROUND

Netcen, (an operating division of AEA Technology 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 2003. This is the seventh 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 21 sites on the island, and BTEX at seven sites.

Previous surveys also measured sulphur dioxide (SO_2), at a single monitoring site, Clos St Andre (near the Bellozanne Valley waste incinerator). However, the results established that concentrations were low, and very unlikely to cause a problem. Therefore, SO_2 monitoring was discontinued at the end of 2002 and SO_2 was not included in the 2003 study.

This report presents the results obtained in the 2003 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 2002[1,2,3,4,5,6]. 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. Most of the monitoring sites were the same as those used in the 2002 study, (although some changes were necessary during the course of the year). They 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. For consistency with previous years' reports, the units used for NO_2 in this report are parts per billion (ppb). To convert from ppb to microgrammes per cubic metre ($\mu g\ m^{-3}$) if required, the following relationship should be used:

1 $\mu g\ m^{-3}$ = 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 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. It is found in petrol and other liquid fuels, in small concentrations. In urban areas, the major source is vehicle emissions. Benzene concentrations in ambient air are generally between 1 and 5 ppb. In this report, concentrations of benzene are expressed in parts per billion (ppb). To convert from ppb to microgrammes per cubic metre ($\mu g\ m^{-3}$) if necessary, the following relationship should be used:

1 $\mu g\ m^{-3}$ = 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 $\mu g\ m^{-3}$ (1.0 ppb) in rural areas, up to 204 $\mu g\ m^{-3}$ (54 ppb) 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[7]: the occupational 8-hour exposure limit (OEL) is 50ppm (50,000ppb). The best estimate for the odour threshold of toluene has been reported[8] as 0.16ppm (160ppb).

(iii)ethyl benzene
Again, there are no limits for ambient concentration of ethyl benzene, although there are occupational limits relating to workplace exposure[7], of 100 ppm over 8 hours, and 125 ppm over 10 minutes. Ambient concentrations are highly unlikely to approach these levels.

(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)[8].

2.2 AIR QUALITY LIMIT VALUES AND OBJECTIVES

2.2.1 World Health Organisation

In 2000, the World Health Organisation published revised air quality guidelines[9] 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.

2.2.2 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 [10,11] have been published in recent years. The Limit Values are summarised in Appendix 1.

2.2.3 UK Air Quality Strategy

The UK Air Quality Strategy (AQS) contains standards and objectives for a range of pollutants including NO_2 and benzene[12]. 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.

2.3 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. During sampling, one end is open and the other closed. The closed end contains an absorbent for the gaseous species to be monitored, in this case NO_2. The tube is mounted vertically with the open end at the bottom. Ambient NO_2 diffuses up the tube during exposure, and is absorbed as nitrite. The average ambient pollutant concentration for the exposure period is calculated from the amount of pollutant absorbed.

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

Diffusion tubes were prepared by Harwell Scientifics Ltd for AEA Technology, 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. It was intended that exposure periods should

correspond (within ±2 days) to those used in the UK NO_2 Network, as has been the case in previous years. However, this was not always possible, due to late arrival of tubes.

The diffusion tube methodologies provide data that are accurate to ± 25% for NO_2 and ± 20% for BTEX. The limits of detection are 0.2 ppb for NO_2 and 0.1 ppb 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)[13] 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 correction factor of 0.78. (This applies only to NO_2 diffusion tubes, not BTEX tubes). ***The NO_2 diffusion tube results in this report are uncorrected except where clearly specified.***

2.4 MONITORING SITES

Monitoring of NO_2 was started in 1999 with just three sites. During 2000, this was expanded to 19 sites, all of which remain in operation; two further sites were added in 2003. These are shown in Table 1 and Figure 1.

The two new sites that started in 2003 are located at a taxi rank and a camera shop, both in La Colomberie in St Helier. They were set up to investigate possible changes in NO_2 concentrations as a result of traffic flow changes on the adjacent street.

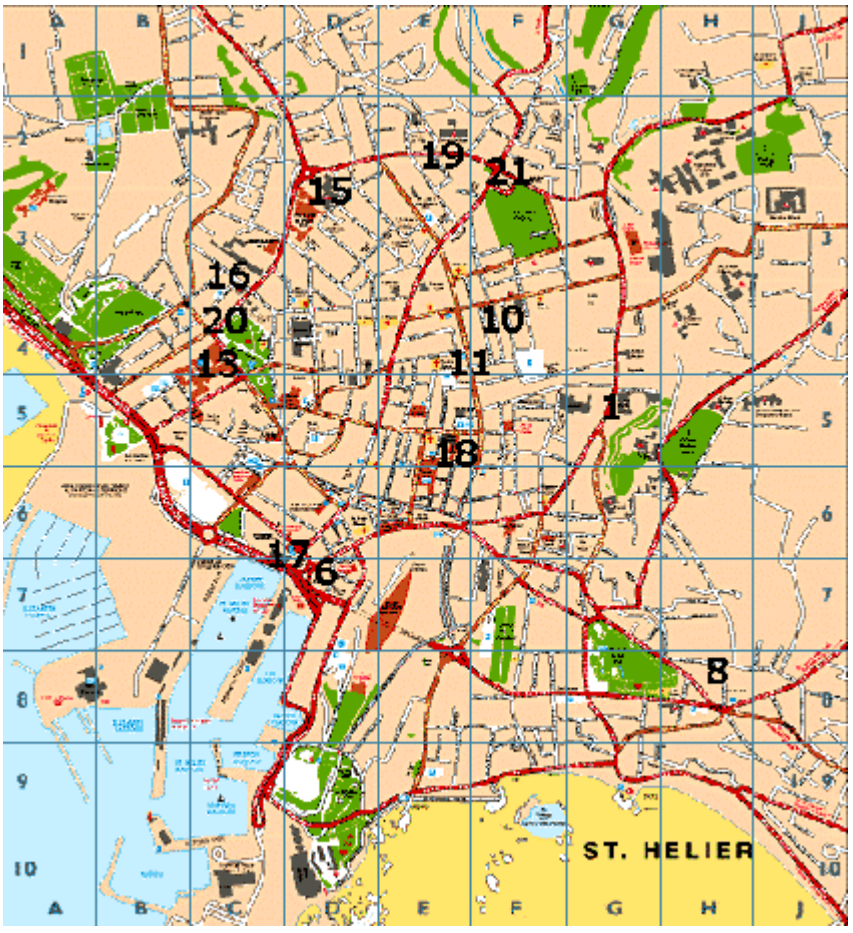
Table 1. NO_2 Monitoring Sites

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	656 490	Urban background close to ring road
N11	Robin Place	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.
N20	Camera Shop, La Columberie	657 484	Kerbside in St Helier
N21	Taxi Rank, La Columberie	657 484	Kerbside in 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.



Key:

1. Le Bas Centre
2. Mont Felard
3. Les Quennevais
4. Rue Des Raisies
5. First Tower
6. Weighbridge
7. Langley Park
8. Georgetown
9. Clos St Andre
10. L'Avenue et Dolmen
11. Robin Place
12. Beaumont
13. The Parade
14. Maufant
15. Jane Sandeman
16. Saville Street
17. Broad Street
18. Beresford Street
19. La Pouquelaye
20. Elizabeth Lane
21. Springfield Garage
22. N/A moved to airport
23. Airport

Figure 1. Site Locations

BTEX hydrocarbons were monitored at a total of eight sites during 2003. 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 Elizabeth Lane site was close to a paint spraying process – a potential source of hydrocarbon emissions, especially toluene and xylenes. This process closed down in October 2003, so the monitoring site was replaced. The new site is in Handsford Lane, near to a similar paint-spraying process.

The Springfield Garage site is located by a fuel filling station, a potential source of hydrocarbon emissions including benzene. In December 2003, the fuel supplier began using vapour recovery when filling the tanks; it is anticipated that the 2004 results for this site will show a reduction in ambient concentrations of hydrocarbons.

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 3	Elizabeth Lane	648 491	Urban background near paint spraying process
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	(Replaced Elizabeth Lane site): urban background near a paint spraying process.

3 Results and Discussion

3.1 NITROGEN DIOXIDE

3.1.1 Summary of NO_2 Results

NO_2 diffusion tube results are presented in Table 3, and Figures 2 (kerbside and roadside sites) and 3 (background sites). Individual monthly mean NO_2 results ranged from 2.4ppb (in June at the rural Rue des Raisies site), to 34.8ppb, (in March at the kerbside Georgetown site). Annual mean NO_2 concentrations ranged from 5.2ppb (at Rue des Raisies) to 26.0ppb at the Weighbridge site.

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[9] for NO_2 is that the annual mean should not exceed 21 ppb. The EC 1st Daughter Directive[10] contains Limit Values for NO_2 as follows:

- 105 ppb (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.
- 21 ppb (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 16 ppb (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 six of the nine kerbside and roadside sites exceeded 21ppb; these were Weighbridge, Beaumont, Georgetown, Broad Street, La Pouquelaye, and the Taxi Rank. The other three kerbside and roadside sites (the Camera Shop, the Parade, and First Tower) had annual mean NO_2 concentrations greater than 20ppb, and were therefore very close to the EC Limit Value and AQS Objective.

Harwell Scientifics' NO_2 diffusion tubes typically overestimate NO_2 concentration. Harwell Scientifics have quantified this overestimation, by a series of field tests in 2003, and provided a bias correction factor 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 21ppb. The highest annual mean (at Weighbridge) is reduced from 26.0ppb (uncorrected) to 19.5ppb (bias corrected). However, given the uncertainty on diffusion tube measurements, often around +/- 25%, it remains likely that some roadside and kerbside sites are currently "borderline" with respect to the Limit Value and AQS Objective for annual mean NO_2. The annual mean NO_2 concentrations at the 12 background sites were in most cases well below 21ppb, with the exception of Beresford Street, where the annual mean (uncorrected) was 20.0ppb.

The 16ppb limit for protection of vegetation is only applicable at the one rural background site, Rue des Raisies, where the annual mean NO_2 concentration at this site was well within the limit.

Table 3. NO_2 Diffusion Tube Results 2003, Jersey. Concentrations in ppb.

Site	From - To:	31 Dec - 5 Feb	5 Feb - 3 Mar	3 Mar - 1 Apr	1 Apr - 30 Apr	30 Apr – 6 Jun	6 Jun - 2 Jul	2 Jul - 31 Jul	31 Jul - 9 Sep	9 Sep - 1 Oct	1 Oct - 5 Nov	5 Nov - 3 Dec	3 Dec - 30 Dec	2003 Annual Mean	*Bias corr. AM 2003*
Le Bas Centre		11.7	18.7	17	15	17.4	13.9	16	16.3	17.7	16.3	19.1	17	16.3	*12.3*
Mont Felard		11.7	16.4	17.4	16.9	14.5	15.4	13.9	11	19.6	15.1	14.5	16.7	15.3	*11.4*
Les Quennevais		4.9	7.8	9.3	7.3	3.5	5.3	5	7.7	5.6	8.8	10.7	12.3	7.4	*5.5*
Rue Des Raisies		3.9	5.4	7.7	3.9	2.6	2.4	3.6	6.5	3.7	5.7	5.4	11	5.2	*3.9*
First Tower		14.1	24.6	24.9	7.5	21.7	20.8	20.1	24.1	24.4	21.5	21.9	21.7	20.6	*15.5*
Weighbridge		23.3	21.9	21.5	24.3	30.6	28.6	31.2	27.6	24.1	25.9	27.1	25.4	26.0	*19.5*
Langley Park		8.9	10.5	13.5	8.9	8.1	7.7	8.6	10.6	9.2	11.6	13.9	14.8	10.5	*7.9*
Georgetown		21.7	17.7	34.8	24.2	21.9	21.2	22	30.5	26.1	24.5	26.2	26.1	24.7	*18.6*
Clos St.Andre		8.7	12.2	12.1	22.1	7.6	6.1	6.6	8.9	8.9	8.9	13.4	15.6	10.9	*8.2*
L'Avenue et Dolmen		13.5	14.5	17	12.8	10.8	9	11.2	-	10.2	15	15.9	17.2	13.4	*10.0*
Robin Place		15.4	19.5	19.1	15.3	14.8	12.3	15.1	15.2	17.2	16.4	19.7	17.3	16.4	*12.3*
Beaumont		21.4	25.1	27.2	24	24.7	20.5	26.4	29.6	23.9	21.7	26.4	25.4	24.7	*18.5*
The Parade		19.2	20.6	21.7	18.1	17.3	19.9	20.6	23.6	21.3	20.1	21.8	22	20.5	*15.4*
Maufant		5.6	6.2	7.9	4.9	3.8	3.5	4.1	5.5	4.5	6.6	6.8	8.9	5.7	*4.3*
Jane Sandeman		10.9	12.3	12.7	8.8	6.4	6.4	7.8	9.1	8.3	10.6	11.6	12.6	9.8	*7.3*
Saville Street		15.6	19.5	19	17.4	14.3	14.4	14.3	18.4	16.9	16.2	17.3	17.1	16.7	*12.5*
Broad Street		20.2	19.7	23.9	21.9	22.3	20.9	23.3	24.5	23.3	21.5	22.8	21.4	22.1	*16.6*
Beresford Street		17.4	22.4	23.6	20.2	17.3	17.4	18.8	21.2	21.6	17.5	21.1	20.9	20.0	*15.0*
La Pouquelaye		20.9	25.8	27.7	22.3	28.4	25.7	25.9	29.2	24.7	22.8	26.3	24.7	25.4	*19.0*
Camera Shop, Colomberie		19.1	23.2	22.6	20.1	22.7	15.2	21.4	19.8	21	17.2	23.1	19.8	20.4	*15.3*
Taxi Rank, Colomberie		21.9	21.9	27	21.8	20.4	18.3	21.5	22.2	25.5	11.3	24.9	21.9	21.6	*16.2*

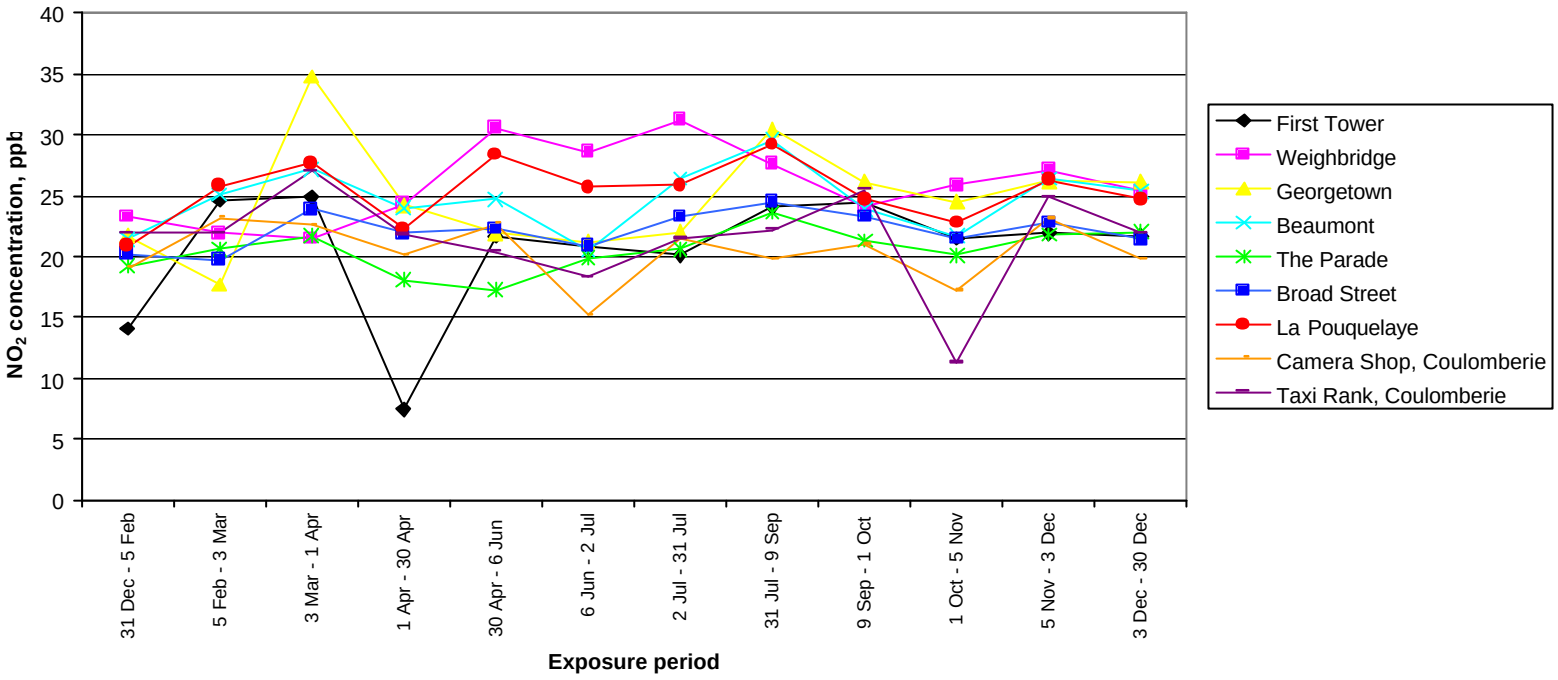


Figure 2. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2003

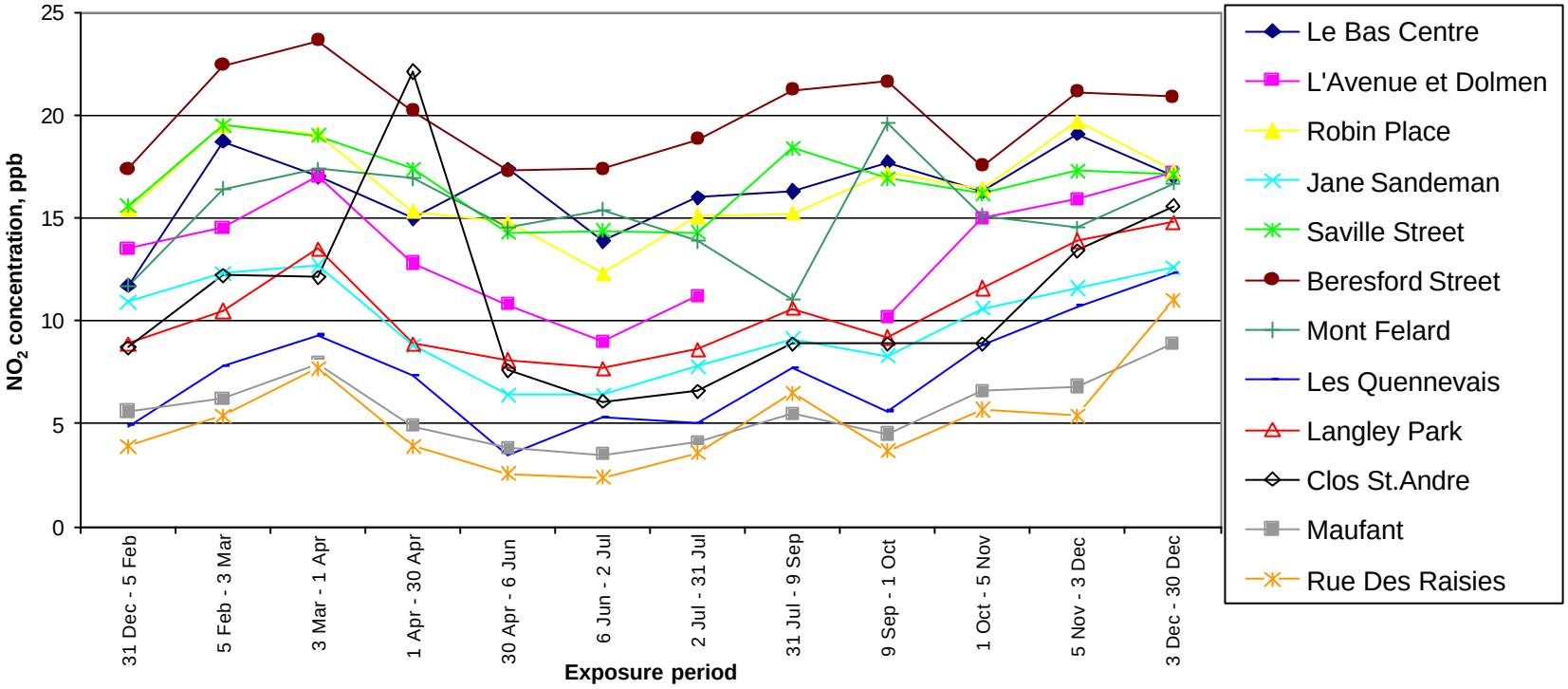


Figure 3. Monthly Nitrogen Dioxide Concentrations at Background Sites, 2003

Two anomalies are apparent: during April, an unusually high result for the background site Clos St Andre coincided with an unusually low result for the kerbside First Tower. These two sites are nearby, and are usually visited one after the other when tubes are changed. Having checked with the analyst that the results had been correctly reported, Netcen investigated the possibility that the April tubes for these two sites (which are labelled with the site numbers) may have been accidentally interchanged. The States of Jersey thought that this was indeed possible. However, in the absence of any evidence that such an error did occur, these two results must be accepted as they stand.

3.1.3 Comparison with UK NO_2 data

The UK Nitrogen Dioxide Survey monitored this pollutant at around 1200 sites across the UK during 2003, using diffusion tubes. This survey concentrates on urban, not rural, areas. Sites are categorised as;

- Roadside, 1-5m from the kerb of a busy road
- Urban background, more than 50m from any busy road and typically in a residential area.

The national annual averages for 2003 are provisional at present, pending full data ratification. Estimated UK NO_2 Network averages for 2003 were 23 ppb for roadside sites and 13 ppb for urban background sites. Both these average values are higher than those measured in 2002; both the Automatic Urban and Rural Network, and the NO_2 diffusion tube network recorded increases in 2003 compared with 2002. They are also slightly higher than the bias corrected 2003 averages for Jersey; 17 ppb for roadside and roadside sites and 9 ppb for background sites.

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.
- Plymouth Centre - an urban non-roadside site, in the centre of a coastal city.
- 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	2003 Annual average NO_2, ppb
Exeter Roadside	22
Plymouth Centre	15
Lullington Heath	7
Harwell	8

The bias corrected annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey ranged from 15ppb to 20ppb. The annual mean at Exeter Roadside was therefore slightly higher than these. The Jersey urban background sites had annual mean NO_2 concentrations ranging from 7ppb to 15ppb – typically a little lower than sites such as Plymouth Centre. Residential background sites well outside Jersey's larger towns (e.g. Les Quennevais, Clos St Andre, Maufant) had annual mean NO_2 ranging from 4ppb to 11ppb, and thus were more comparable with rural sites such as Lullington Heath and Harwell. The annual mean of 3.2ppb 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

Most of the sites have been operating for only four years, which is not long enough to identify trends. Very little change was observed at most of these sites for the previous three years, 2000 to 2002. It was observed in last year's report that those kerbside and roadside sites close to the AQS Objective for the annual mean are likely to remain so, unless action is taken.

Most of the NO_2 monitoring sites in Jersey showed a small increase in annual mean NO_2 in 2003, compared to 2002. This is consistent with the UK as a whole, where both automatic and non-automatic monitoring networks recorded an average increase in ambient NO_2 concentrations in 2003, compared to 2002.

Three sites have been in operation since 1993, as part of the UK Nitrogen Dioxide Network. Annual mean concentrations for these long-running sites are shown in Table 5 and Figure 4. ***These data are not bias corrected; prior to 2002 there was no reliable information on which to carry out bias correction, so for consistency, uncorrected data are used in this section.*** NO_2 concentrations have remained relatively stable over the period. NO_2 concentrations in Jersey do not appear to follow the downward trend observed for the UK as a whole.

Table 5 Annual mean NO_2 concentrations at Long-Term Sites (Not bias corrected)

Site	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Beaumont (Kerbside)	-	23	25	24	ND	20	21	23	24	22	25
The Parade (Intermediate*)	16	16	16	16	ND	13	14	13	-	-	-
Jane Sandeman (Background)	11	10	11	11	ND	9	9	8	9	9	10
Maufant (Background)	9	8	7	6	ND	5	6	5	5	5	6

**Intermediate sites were discontinued at the end of 2000. This site was replaced by a Roadside site, also at the Parade.*

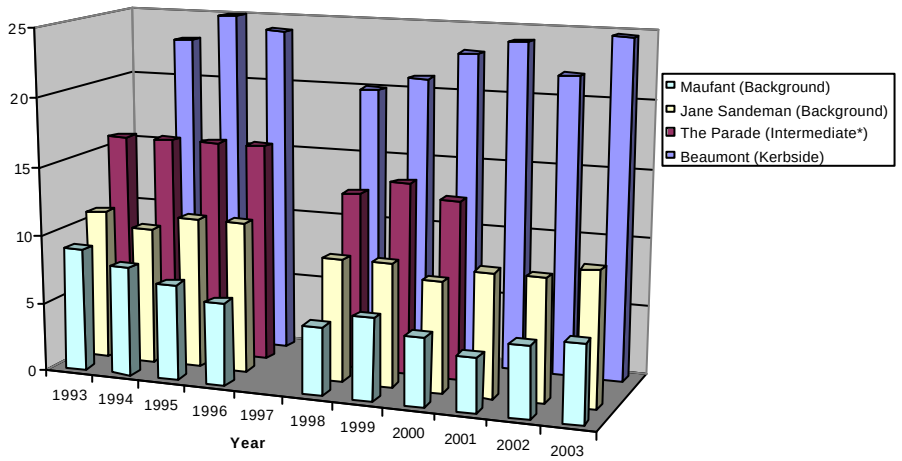


Figure 4. Trends in Annual Mean NO_2 Concentrations at Four Long-Term Sites (not corrected for diffusion tube bias).

3.2 HYDROCARBONS

3.2.1 Summary of Hydrocarbon Results

Results of the hydrocarbon survey for the seven sites are shown in Appendix 2, Tables A2.1 to A2.7 respectively. Graphical representations are shown in Figures 5 to 11.

The diffusion tube results show that average outdoor hydrocarbon concentrations in Jersey remain generally low. A summary of annual average hydrocarbon concentrations is shown in Table 6.

Table 6. Summary of Average Hydrocarbon Concentrations, Jersey, 2003

Site	Benzene, ppb	Toluene, ppb	Ethyl Benzene, ppb	m+p Xylene, ppb	o Xylene, ppb
Beresford Street	0.6	3.0	0.5	1.5	0.5
Le Bas Centre	0.4	2.1	0.4	1.1	0.4
Elizabeth Lane * *(Jan-Oct)*	0.6	3.1	0.5	1.4	0.5
Handsford Lane * *(Nov-Dec only)*	(0.9)	(7.2)	(1.1)	(3.1)	(0.9)
Springfield Garage# *(petrol station)*	1.5	8.9	1.3	3.6	1.3
Clos St Andre	0.3	1.1	0.2	0.4	0.1
Airport	0.3	0.8	0.1	0.2	0.1

**Elizabeth Lane site was replaced by Handsford Lane in November 2003.*
 # Data for January, July and November rejected as suspiciously low. April tube missing.

The following sites did not achieve full data capture:
(i) Elizabeth Lane, which closed at the end of October 2003, when the nearby paint spraying process shut down.
(ii) Handsford Lane, which replaced it in November.
(iii) Springfield Garage: the April tube was stolen from this site. In addition, suspiciously low concentrations (below detection levels or an order of magnitude below those measured at the background sites) were measured in January, July and November 2003. After careful consideration these were rejected. Eight months' valid data remain for Springfield Garage.
(iv) Airport: the October tube was exposed for two months: the result was therefore rejected.

Highest average concentrations of benzene were found at Springfield Garage, as in previous years. However, average benzene concentrations were less than 3ppb at all sites. Levels at Springfield Garage showed some reduction compared with its 2002 mean benzene concentration of 1.7ppb.

Annual mean toluene concentrations were less than 5ppb at all sites except Springfield Garage, where the annual mean was 8.9ppb. The two-month mean at the new Handsford Lane site was 7.2ppb.

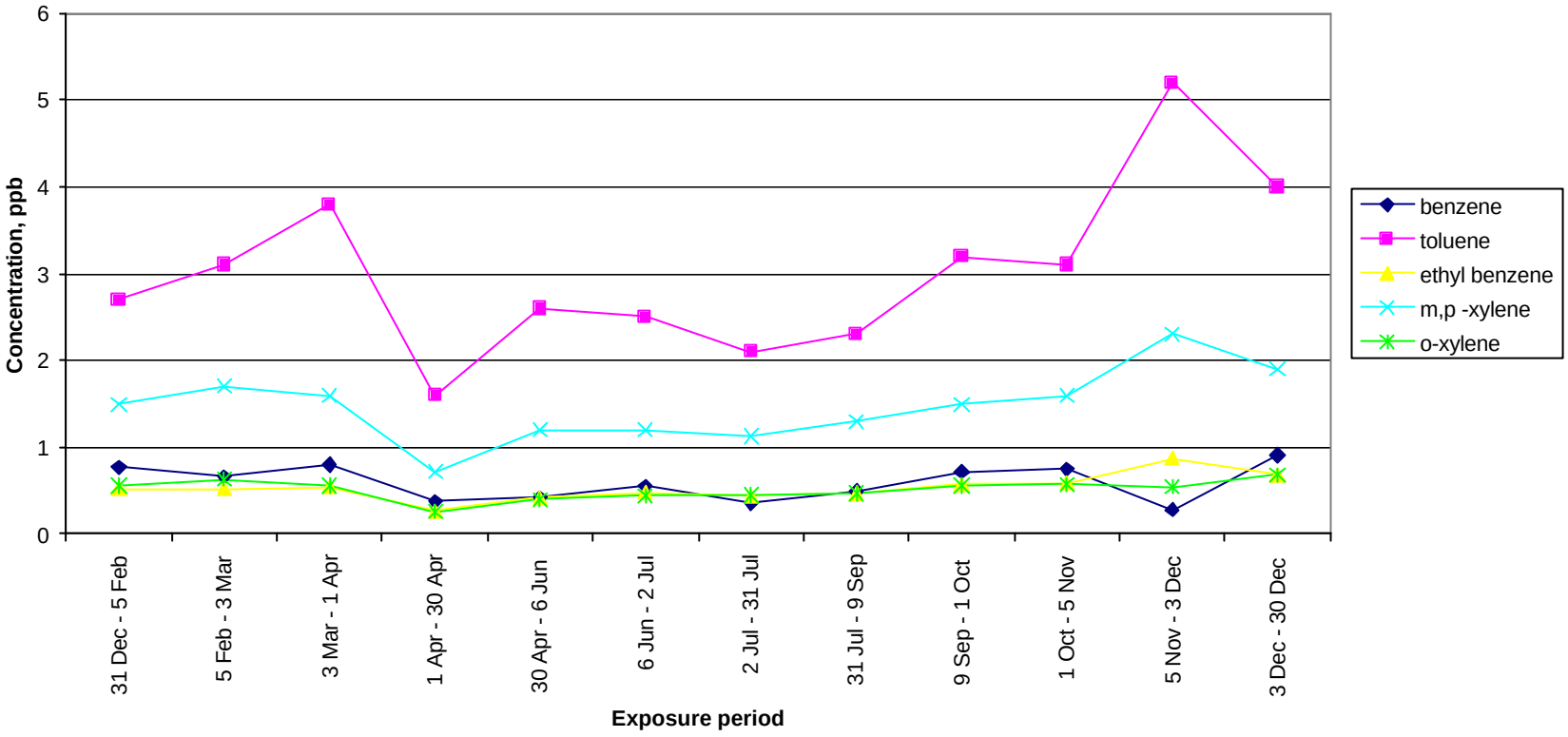


Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2003

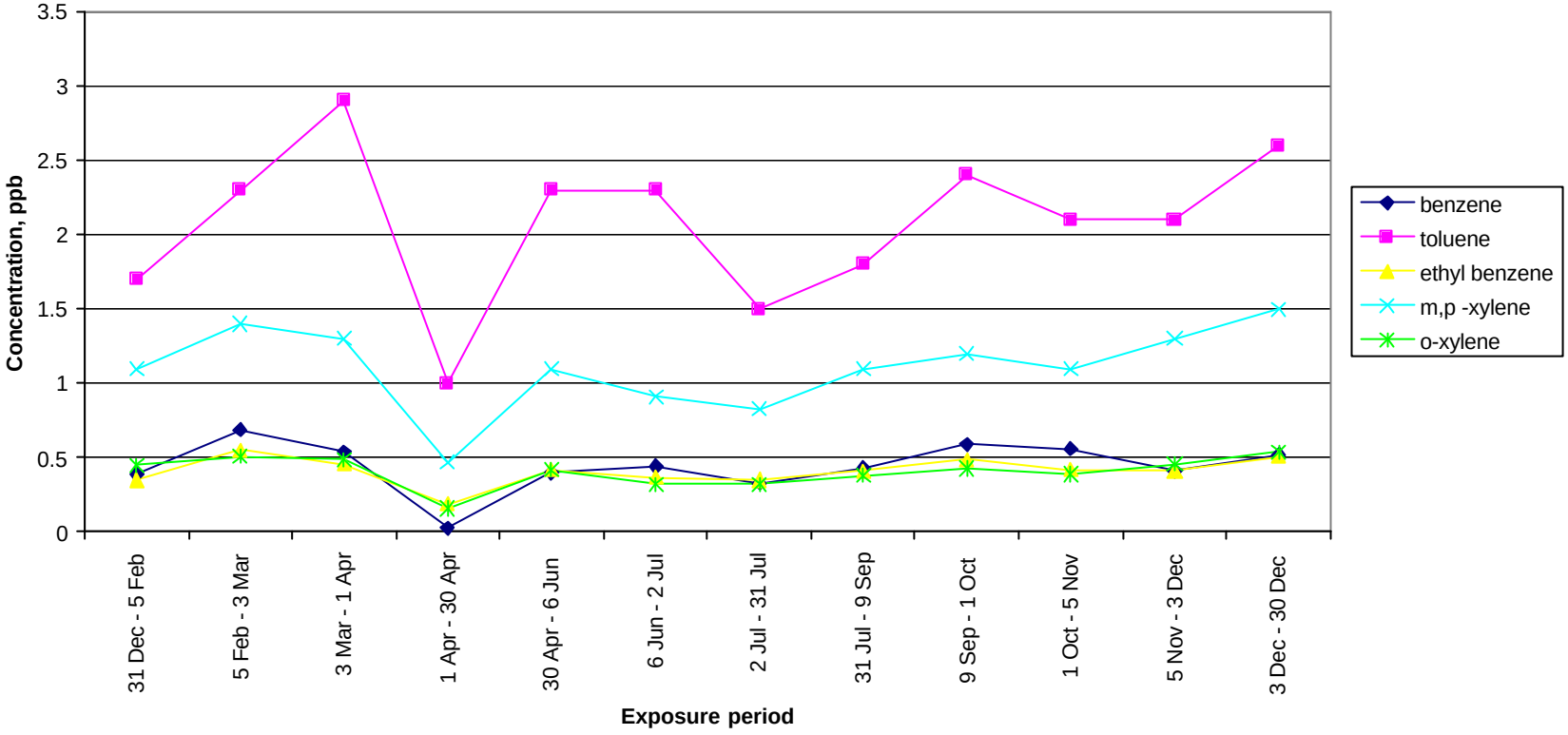


Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2003

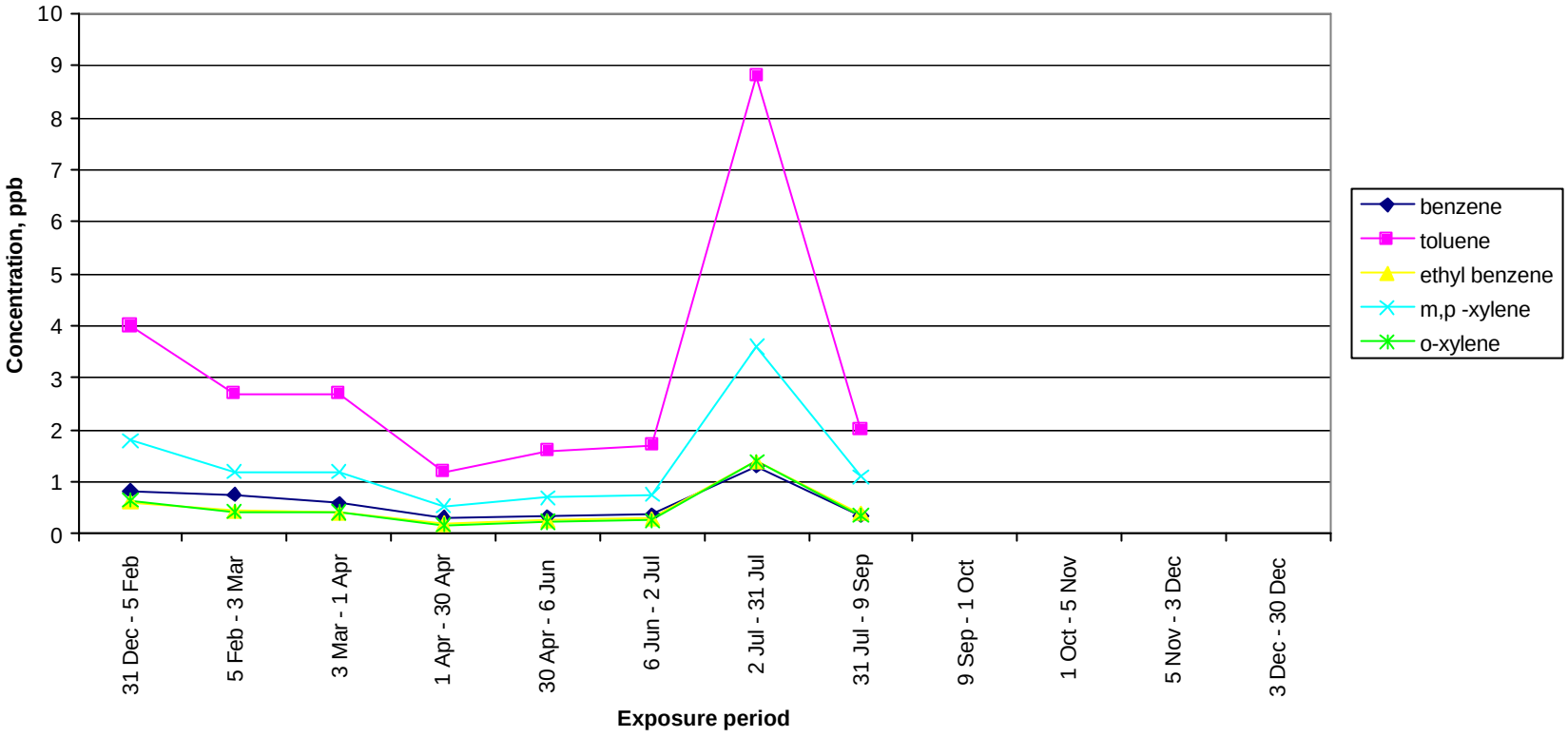


Figure 7. Monthly mean hydrocarbon concentrations at Elizabeth Lane, 2003

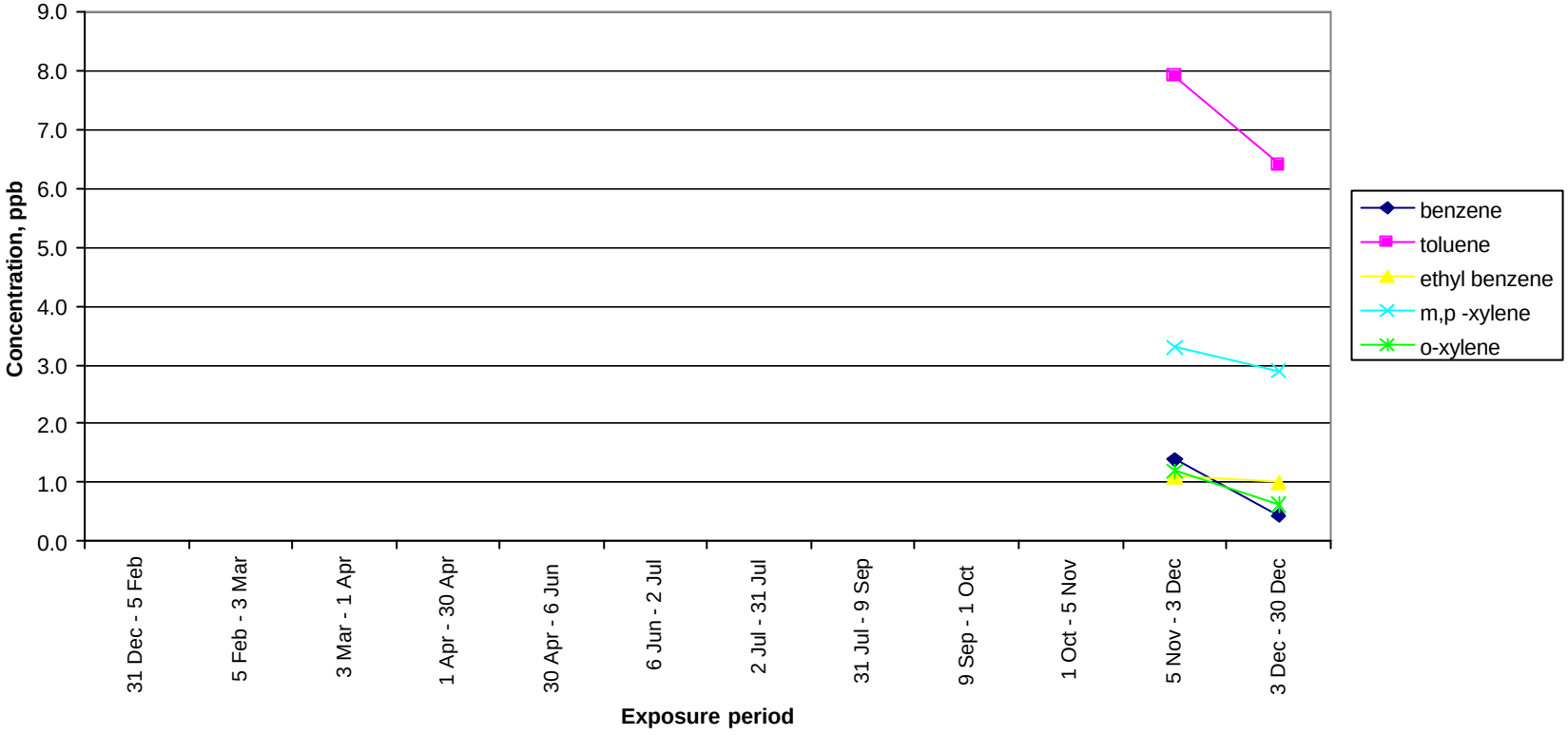


Figure 8. Monthly mean hydrocarbon concentrations at Handsford Lane, 2003

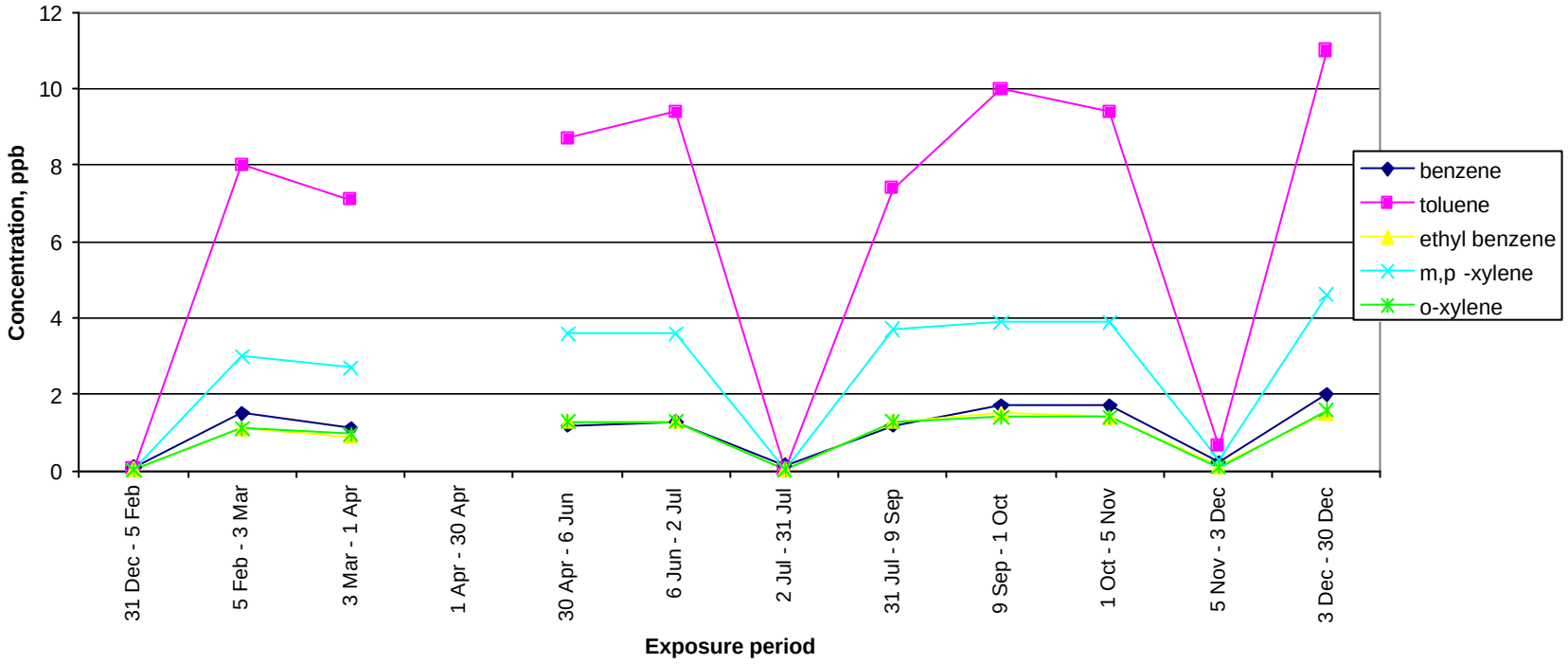


Figure 9. Monthly mean hydrocarbon concentrations at Springfield Garage, 2003
(Note: January, July and December results were rejected as they were suspiciously low. They are shown here for information, but were not included when calculating the annual means.)

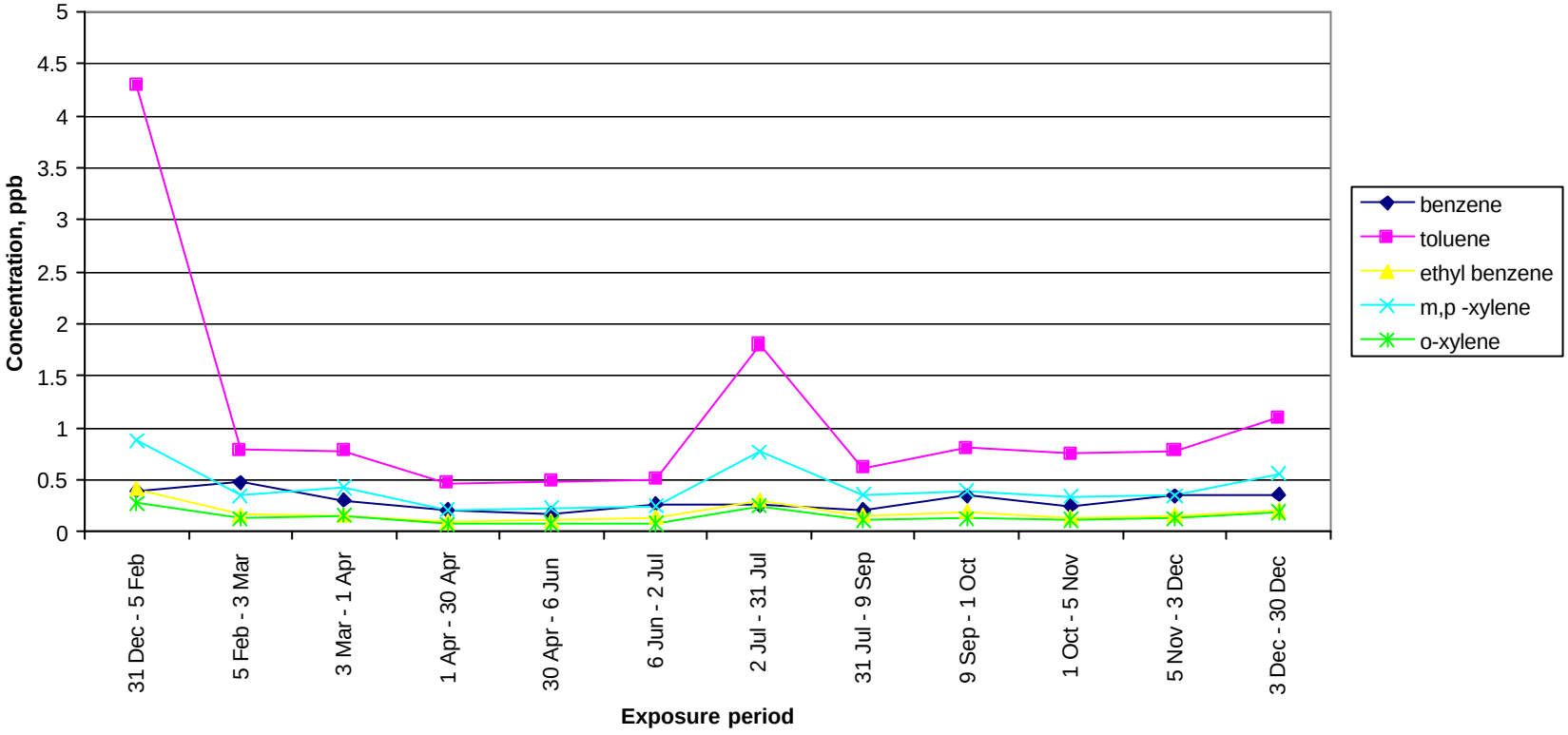


Figure 10. Monthly mean hydrocarbon concentrations at Clos St Andre, 2003

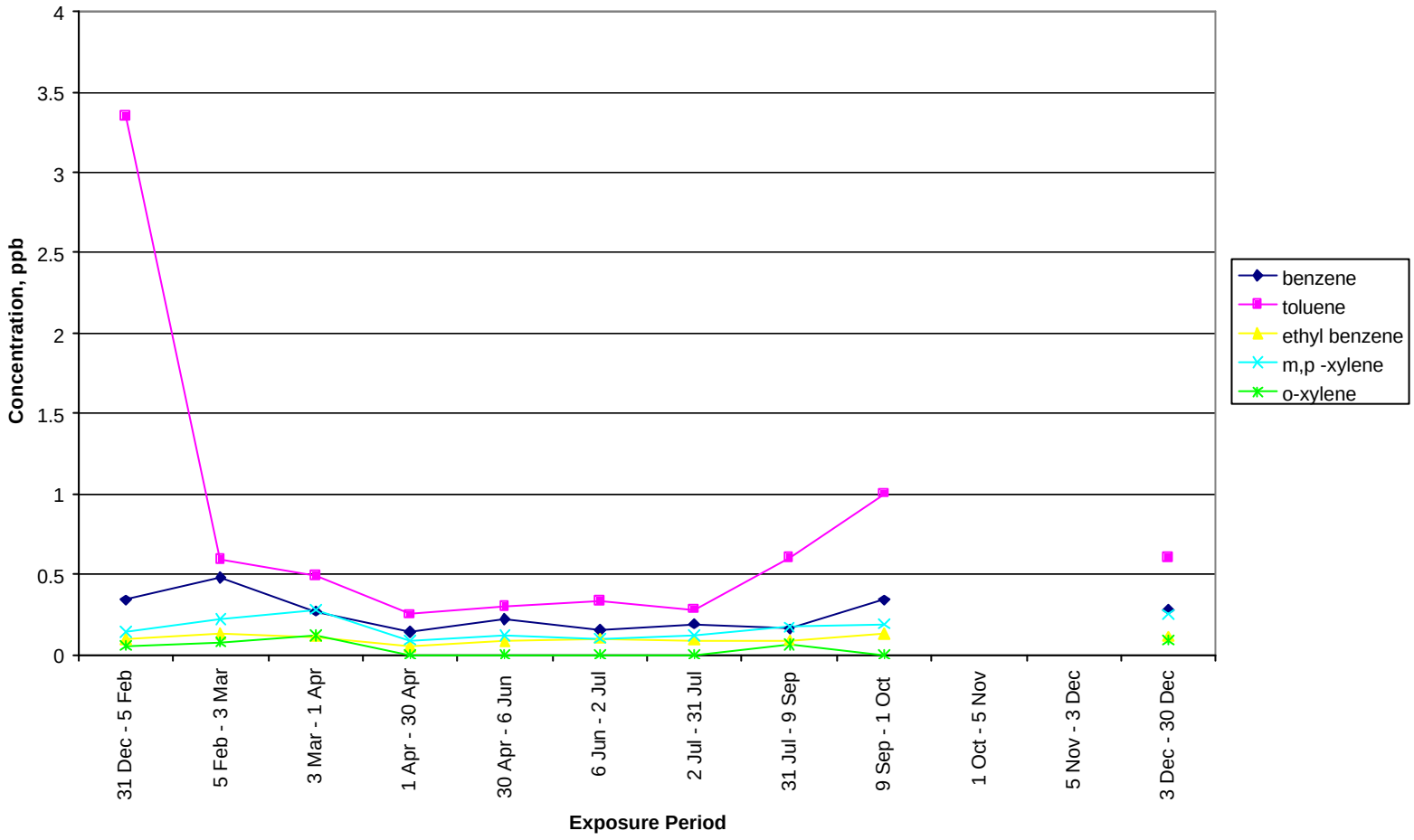


Figure 11. Monthly mean hydrocarbon concentrations at the Airport, 2003

3.2.2 Comparison with Hydrocarbon Guidelines, 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 an objective for the running annual mean of 5ppb, to be achieved by 31 December 2003, and 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 5ppb at any of the Jersey sites.

The EC 2nd Daughter Directive[10] sets a limit of 5μg m^{-3} (1.5ppb) for annual mean benzene to be achieved by 2010. The annual mean benzene concentration at Springfield Garage was 1.5ppb: at all other sites it was less than 1.0ppb. 2003 is the first year in which Springfield Garage has not exceeded this limit.

3.2.3 Comparison with UK Data

Table 7 compares hydrocarbon data from the 2003 Jersey survey with a selection of automatic UK air quality monitoring stations, which measure hydrocarbons using pumped tube samplers. The sites used for comparison are:

- London Marylebone Road - an urban kerbside site, located on a major route into Central London. Heavy traffic, and surrounded by tall buildings.
- Cardiff East - a residential site to the east of the city.
- Glasgow Kerbside – a city centre roadside site.
- Harwell - a rural site in the south of England, within 10km of a power station.

Table 7. Comparison with Hydrocarbon Concentrations at Other UK Sites, Calendar Year 2003

Site	Benzene, ppb	Toluene, ppb	m+p Xylene, ppb
Jersey Diffusion Tube Sites			
Beresford Street	0.6	3.0	1.5
Le Bas Centre	0.4	2.1	1.1
Elizabeth Lane * *(near paint spraying: Jan-Oct)*	0.6	3.1	1.4
Handsford Lane * (Nov-Dec only)	-	-	-
Springfield Garage *(petrol station)*	1.5	8.9	3.6
Clos St Andre	0.3	1.1	0.4
Airport	0.3	0.8	0.2
UK Automatic Sites			
London Marylebone Road	1.02	3.45	2.08
Cardiff Centre	0.36	1.02	0.55
Glasgow Kerbside	0.56	1.76	1.00
Harwell	0.18	0.37	0.17

Highest benzene, toluene and m+p xylene concentrations were measured at Springfield Garage (where fuels are stored), closely followed by London Marylebone Road (beside a very busy city road). Lower concentrations were measured at the background sites on Jersey; hydrocarbon levels at these sites appear comparable with those at the other two automatic sites in Cardiff and Glasgow, (where hydrocarbon concentrations appear to have fallen since last year), or the rural site at Harwell. Hydrocarbon levels at Clos St Andre and the Airport remain comparable with, although slightly higher than, the mean from the rural Harwell site. Concentrations at Elizabeth Lane were comparable to those at Beresford Street and Le Bas, despite the proximity of the paint spraying process.

3.2.4 Comparison with Previous Years' Hydrocarbon Results

Four sites (Beresford Street, Le Bas Centre, Elizabeth Lane and Springfield Garage) have been operating since 1997. The 2003 hydrocarbon concentrations were consistent with the previous year, though in most cases slightly lower. Table 8 shows annual means for these sites, also Clos St Andre.

Table 8. Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2003.

	benzene, ppb	toluene, ppb	Ethyl benzene, ppb	m+p xylene, ppb	o-xylene, ppb
Beresford Street					
1997	3.2	5.4	1.2	1.2	2.7
1998	2.5	4.9	0.9	1.0	2.3
1999	1.8	3.6	0.6	1.7	0.8
2000	0.9	3.7	0.8	2.3	0.9
2001	1.0	3.9	0.8	2.2	0.8
2002	0.8	3.4	0.6	1.8	0.7
2003	0.6	3.0	0.5	1.5	0.5
Le Bas Centre					
1997	2.8	4.5	1.2	1.0	2.2
1998	2.3	4.2	0.7	0.9	1.9
1999	1.1	2.9	0.5	1.3	0.6
2000	0.9	3.3	0.7	1.9	0.7
2001	0.8	3.5	0.6	1.7	0.7
2002	0.6	2.1	0.4	1.3	0.5
2003	0.4	2.1	0.4	1.1	0.4
Elizabeth Lane *					
1997	1.9	4.4	1.4	1.7	2.2
1998	1.9	5.0	0.7	1.6	0.8
1999	1.0	3.3	0.5	1.2	0.6
2000	0.7	3.3	0.7	1.8	0.6
2001	0.7	4.1	0.7	2.0	0.8
2002	0.5	2.9	0.5	1.4	0.4
2003	0.6	3.1	0.5	1.4	0.5
Springfield Garage *					
1997	7.7	12.5	1.9	1.9	4.3
1998	7.7	12.3	1.5	1.7	4.3
1999	4.5	10.9	1.3	3.8	1.5
2000	1.6	9.2	1.8	5.0	2.0
2001	2.1	11.2	1.8	5.2	1.9
2002	1.7	9.6	1.4	4.3	1.6
2003	1.5	8.9	1.3	3.6	1.3
Clos St Andre					
2000	0.3	0.9	0.2	0.6	0.2
2001	0.4	1.2	0.3	0.6	0.3
2002	0.3	0.7	0.2	0.5	0.2
2003	0.3	1.1	0.2	0.4	0.1

** 2003 means for Elizabeth Lane and Springfield Garage based on 10 and 8 months' data respectively.*

Figures 12 to 16 illustrate how annual mean concentrations of these hydrocarbons have changed over the years of monitoring.

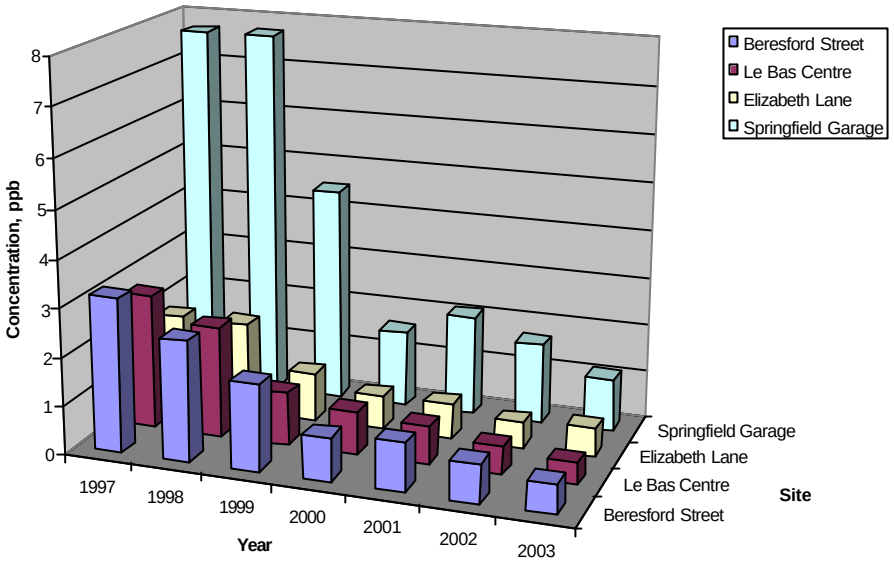


Figure 12. Trends in Benzene Concentration

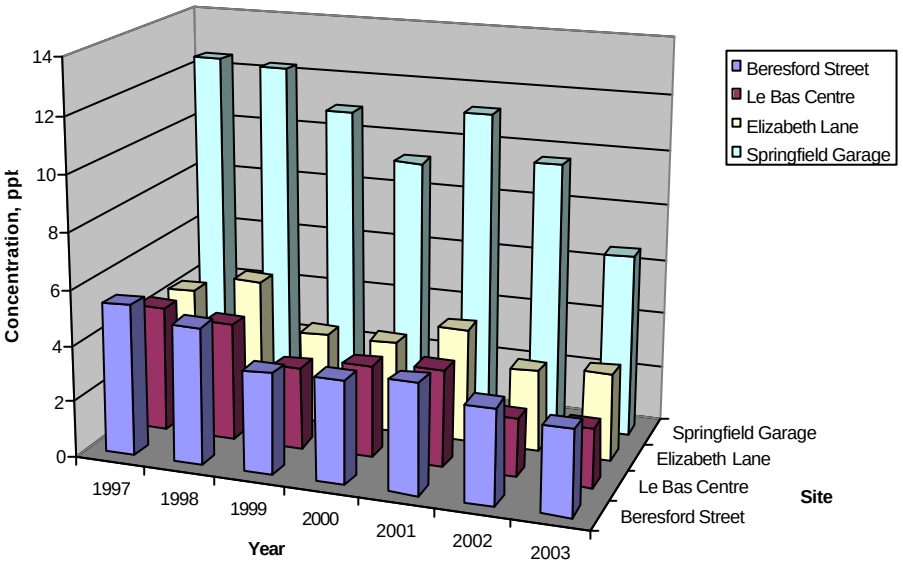


Figure 13. Trends in Toluene Concentration

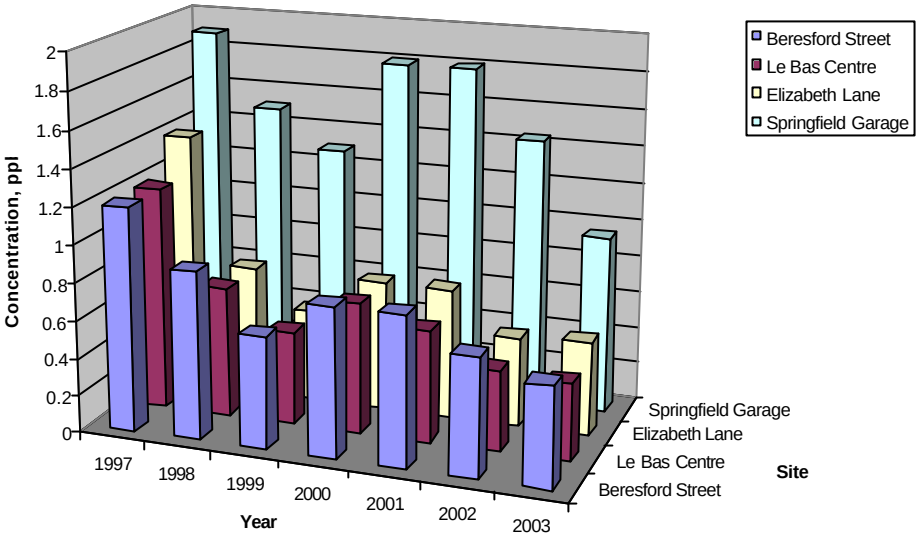


Figure 14. Trends in Ethylbenzene Concentration

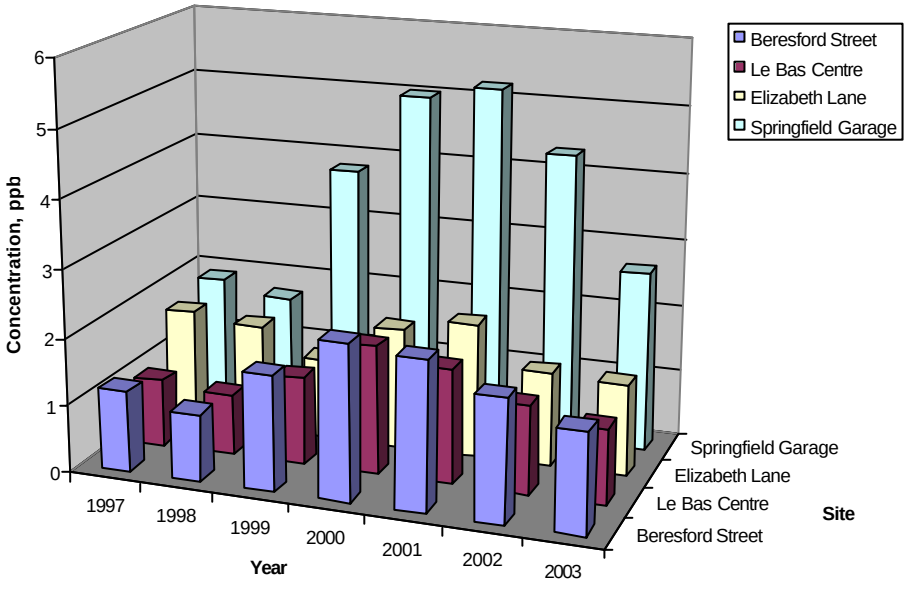


Figure 15. Trends in m+p- Xylene Concentration

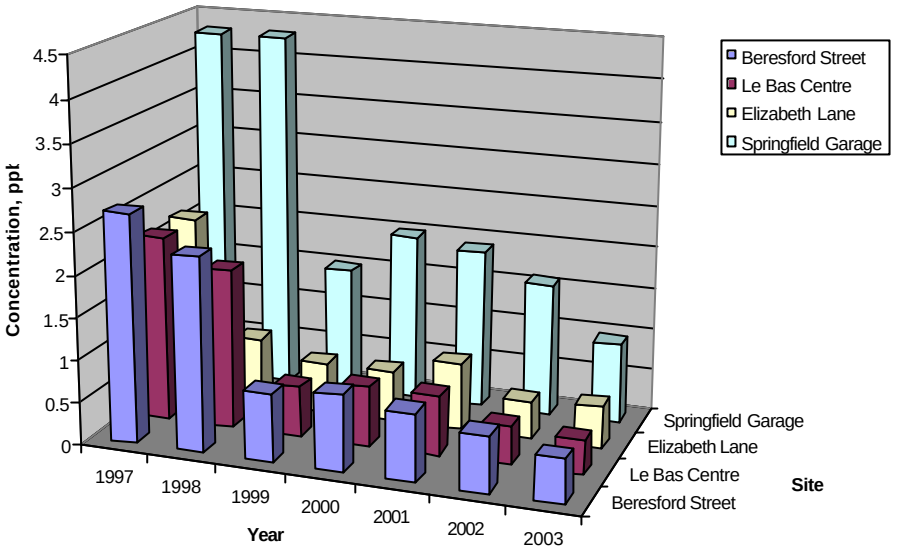


Figure 16. Trends in o-Xylene Concentration

Most hydrocarbon species appear to have decreased over the six years of monitoring, being in most cases lower now than in the late 1990s. Benzene in particular shows 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. In the earlier years of the survey, m+p xylene concentrations alone appeared to be increasing; however, since 2001, concentrations of this pollutant too have decreased.

4 Conclusions

- Netcen has undertaken a year-long diffusion tube monitoring study in Jersey during 2003, on behalf of the States of Jersey Public Health Services and Planning and Environment Department. This was the seventh consecutive year of monitoring.
- Diffusion tubes were used to monitor NO_2 at 21 sites.
- Hydrocarbons (benzene, toluene, ethyl benzene and xylenes, collectively termed BTEX) were measured at 7 sites, including a new site at Handsford Lane, which replaced Elizabeth Lane in November 2003.
- The sites were located at a range of different locations on the island, and in many cases have been used for several years.

NO_2 results

- Annual mean (uncorrected) NO_2 concentrations at six of the nine kerbside and roadside sites (Weighbridge, Beaumont, Georgetown, Broad Street, La Pouquelaye, and the Taxi Rank in La Colomberie) were above the EC Directive Limit Value and AQS Objective of 21ppb. The other three kerbside and roadside sites (the Camera Shop in La Colomberie, the Parade, and First Tower) had annual mean NO_2 concentrations greater than 20ppb, and were therefore very close to the EC Limit Value and AQS Objective.
- Applying the analytical laboratory's recommended correction factor for diffusion tube bias to these annual mean results reduces all of them to below 21ppb. However, given the uncertainty of $\pm$25% inherent in diffusion tube measurements, together with the apparent lack of any downward trend in NO_2 on Jersey, it is possible that Weighbridge, Beaumont, Georgetown, Broad Street, La Pouquelaye, and the Taxi Rank may remain close to 21ppb in future years.
- Annual mean NO_2 concentrations at all urban, residential and rural background sites were in most cases well below the EC Limit Value.
- Annual mean NO_2 concentrations at the 21 monitoring sites were typically slightly higher than those measured in 2002: this is consistent with the rest of the UK, where many monitoring sites showed increases in NO_2 concentration during 2003.
- Trends in NO_2 concentration were investigated using three long-running sites, which have operated since 1993 as part of the UK NO_2 Network. No distinct trends are apparent: NO_2 concentrations appear to have changed little from year to year.
- One implication of the apparent stability of NO_2 concentrations, is that sites currently close to the Limit Value and AQS Objective of 21ppb 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 5ppb, which is to be achieved by the end of 2003.
- All sites had annual mean benzene concentrations less than the EC 2nd Daughter Directive Limit Value of 1.5ppb (which is to be achieved by 2010). This includes the Springfield Garage site: 2003 was the first year in which this site achieved the Limit Value.
- Annual mean concentrations of BTEX hydrocarbons were slightly lower than those measured in 2002.
- Four of the BTEX sites (Beresford Street, Le Bas Centre, Elizabeth Lane, and Springfield Garage) have been in operation since 1997, and therefore yield some information on trends. Results from these sites appear to show a decreasing trend in most BTEX hydrocarbon concentrations, in particular benzene.
- In the earlier years of this survey, m+p xylene concentrations increased at all sites except Elizabeth Lane; however, since 2001 this species too appears to be decreasing.

5 Recommendations

1. Results of the diffusion tube survey indicate that most background locations in Jersey are likely to meet the UK Air Quality Strategy Objective for the annual mean NO_2 concentration by the end of 2005.
2. However, some kerbside and roadside locations remain “borderline” with respect to this objective, and there is no evidence of a downward trend. Measurements from diffusion tube surveys inevitably carry a high uncertainty, and are not sufficient on their own for determining compliance with Objectives and Directives. It is strongly recommended that the States of Jersey consider using a mobile automatic analyser, to investigate such sites further.
3. The series of diffusion tube surveys has proved very effective in providing information on spatial distribution of pollutant concentrations, and on trends. However, these data are retrospective, and they are unable to clearly highlight short-term pollution episodes. The States of Jersey should consider funding a permanent monitoring station, the results of which will offer the Island Government many advantages:

- Islanders can be provided with rapid information about air quality. Dissemination of this information could be helpful to people who are particularly sensitive to pollution exposure (e.g. asthma sufferers).
- The data from automatic analysers can be directly compared with data from EC Member States monitoring networks, subject to suitable data quality control procedures.
- Data can be used to monitor compliance with Objectives and Directives, and for determining policy.

6 Acknowledgements

AEA Technology Environment gratefully acknowledges the help and support of the staff of the States of Jersey Environmental Health Services, Planning, Environment and Public Services, in the completion of this monitoring study.

7 References

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10. 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.
11. Council Directive 2000/69/EC relating to Limit Values for benzene and carbon monoxide in ambient air. 16 Nov 2000.
12. 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
13. Part IV of the Environment Act 1995 Local Air Quality Management. Technical Guidance LAQM.TG(03).

Appendices

CONTENTS

Appendix 1 Air Quality Standards
Appendix 2 Hydrocarbon Results

Appendix 1
Air Quality Standards

Air Pollution Guidelines Used in this Report.

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

Nitrogen Dioxide

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

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

Benzene

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

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

Appendix 2
Hydrocarbon Results

Table A2.1 Monthly Hydrocarbon concentrations at Beresford Street (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.77	2.7	0.52	1.5	0.56
5 Feb - 3 Mar	0.66	3.1	0.52	1.7	0.63
3 Mar - 1 Apr	0.8	3.8	0.54	1.6	0.56
1 Apr - 30 Apr	0.38	1.6	0.27	0.72	0.26
30 Apr - 6 Jun	0.42	2.6	0.42	1.2	0.4
6 Jun - 2 Jul	0.55	2.5	0.48	1.2	0.44
2 Jul - 31 Jul	0.36	2.1	0.44	1.13	0.45
31 Jul - 9 Sep	0.49	2.3	0.47	1.3	0.47
9 Sep - 1 Oct	0.72	3.2	0.58	1.5	0.56
1 Oct - 5 Nov	0.75	3.1	0.59	1.6	0.57
5 Nov - 3 Dec	0.28	5.2	0.87	2.3	0.54
3 Dec - 30 Dec	0.91	4	0.68	1.9	0.68
Average	**0.6**	**3.0**	**0.5**	**1.5**	**0.5**

Table A2.2 Monthly Hydrocarbon concentrations at Le Bas Centre (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.39	1.7	0.35	1.1	0.45
5 Feb - 3 Mar	0.69	2.3	0.55	1.4	0.51
3 Mar - 1 Apr	0.54	2.9	0.46	1.3	0.49
1 Apr - 30 Apr	0.027	1	0.19	0.47	0.16
30 Apr - 6 Jun	0.4	2.3	0.42	1.1	0.42
6 Jun - 2 Jul	0.44	2.3	0.37	0.91	0.32
2 Jul - 31 Jul	0.33	1.5	0.35	0.83	0.32
31 Jul - 9 Sep	0.43	1.8	0.41	1.1	0.38
9 Sep - 1 Oct	0.59	2.4	0.49	1.2	0.43
1 Oct - 5 Nov	0.56	2.1	0.42	1.1	0.39
5 Nov - 3 Dec	0.41	2.1	0.41	1.3	0.46
3 Dec - 30 Dec	0.52	2.6	0.51	1.5	0.54
Average	**0.4**	**2.1**	**0.4**	**1.1**	**0.4**

Table A2.3 Monthly Hydrocarbon concentrations at Elizabeth Lane (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.83	4	0.61	1.8	0.66
5 Feb - 3 Mar	0.76	2.7	0.45	1.2	0.43
3 Mar - 1 Apr	0.59	2.7	0.41	1.2	0.42
1 Apr - 30 Apr	0.31	1.2	0.2	0.54	0.18
30 Apr - 6 Jun	0.34	1.6	0.27	0.7	0.24
6 Jun - 2 Jul	0.37	1.7	0.3	0.76	0.26
2 Jul - 31 Jul	1.3	8.8	1.4	3.6	1.4
31 Jul - 9 Sep	0.35	2	0.39	1.1	0.35
9 Sep - 1 Oct					
1 Oct - 5 Nov					
5 Nov - 3 Dec					
3 Dec - 30 Dec					
Average	**0.6**	**3.1**	**0.5**	**1.4**	**0.5**

Table A2.4 Monthly Hydrocarbon Concentrations at Handsford Lane (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb					
5 Feb - 3 Mar					
3 Mar - 1 Apr					
1 Apr - 30 Apr					
30 Apr - 6 Jun					
6 Jun - 2 Jul					
2 Jul - 31 Jul					
31 Jul - 9 Sep					
9 Sep - 1 Oct					
1 Oct - 5 Nov					
5 Nov - 3 Dec	1.4	7.9	1.1	3.3	1.2
3 Dec - 30 Dec	0.44	6.4	1	2.9	0.63
Average	**0.9**	**7.2**	**1.1**	**3.1**	**0.9**

Table A2.5 Monthly Hydrocarbon Concentrations at Springfield Garage (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb R	*0.11*	*0.05*	*0.032*	*<0.04*	*<0.04*
5 Feb - 3 Mar	1.5	8	1.1	3	1.1
3 Mar - 1 Apr	1.1	7.1	0.9	2.7	0.96
1 Apr - 30 Apr R	*lost*	*lost*	*lost*	*lost*	*lost*
30 Apr - 6 Jun	1.2	8.7	1.3	3.6	1.3
6 Jun - 2 Jul	1.3	9.4	1.3	3.6	1.3
2 Jul - 31 Jul R	*0.14*	*<0.06*	*<0.06*	*<0.06*	*<0.06*
31 Jul - 9 Sep	1.2	7.4	1.3	3.7	1.3
9 Sep - 1 Oct	1.7	10	1.5	3.9	1.4
1 Oct - 5 Nov	1.7	9.4	1.4	3.9	1.4
5 Nov - 3 Dec R	*0.21*	*0.64*	*0.12*	*0.3*	*0.1*
3 Dec - 30 Dec	2	11	1.5	4.6	1.6
Average	**1.5**	**8.9**	**1.3**	**3.6**	**1.3**

Average excludes rejected months marked R and shown in italics.

Table A2.6 Monthly Hydrocarbon Concentrations at Clos St Andre (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.4	4.3	0.42	0.88	0.28
5 Feb - 3 Mar	0.48	0.79	0.17	0.35	0.13
3 Mar - 1 Apr	0.31	0.78	0.16	0.43	0.16
1 Apr - 30 Apr	0.21	0.47	0.1	0.22	0.075
30 Apr - 6 Jun	0.18	0.49	0.11	0.23	0.08
6 Jun - 2 Jul	0.27	0.51	0.14	0.25	0.08
2 Jul - 31 Jul	0.26	1.8	0.31	0.77	0.25
31 Jul - 9 Sep	0.22	0.62	0.16	0.36	0.12
9 Sep - 1 Oct	0.35	0.81	0.2	0.4	0.13
1 Oct - 5 Nov	0.25	0.75	0.14	0.34	0.12
5 Nov - 3 Dec	0.35	0.78	0.16	0.35	0.13
3 Dec - 30 Dec	0.36	1.1	0.21	0.56	0.19
Average	**0.3**	**1.1**	**0.2**	**0.4**	**0.1**

Table A2.7 Monthly Hydrocarbon Concentrations at the Airport (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.34	3.35	0.095	0.14	0.054
5 Feb - 3 Mar	0.48	0.59	0.13	0.22	0.077
3 Mar - 1 Apr	0.27	0.49	0.11	0.28	0.12
1 Apr - 30 Apr	0.14	0.25	0.05	0.09	<.03
30 Apr - 6 Jun	0.22	0.3	0.08	0.12	<.04
6 Jun - 2 Jul	0.15	0.33	0.1	0.1	<.06
2 Jul - 31 Jul	0.19	0.28	0.09	0.12	<.06
31 Jul - 9 Sep	0.16	0.6	0.09	0.17	0.06
9 Sep - 1 Oct	0.34	1	0.13	0.19	<.08
1 Oct - 5 Nov *					
5 Nov - 3 Dec					
3 Dec - 30 Dec	0.28	0.6	0.11	0.25	0.09
Average	**0.3**	**0.8**	**0.1**	**0.2**	**0.1**

** Tube exposed for 2 months: invalid.*