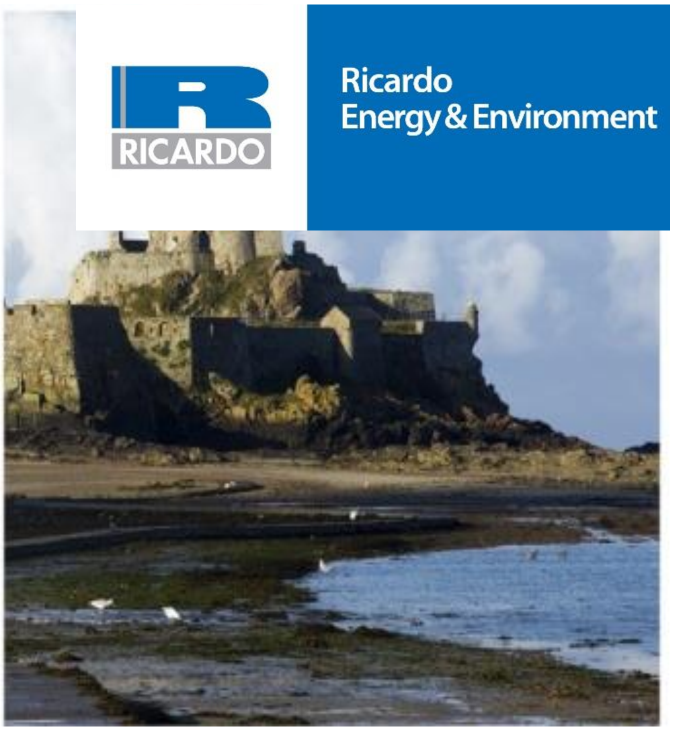

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Energy & Environment

Air Quality monitoring in Jersey 2019

Report for the Government of Jersey
ED12333 2019 Report

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Contact:

Ben Davies
Ricardo Energy & Environment
Gemini Building, Harwell, Didcot, OX11 0QR,
United Kingdom

t: +44 (0) 1235 75 3069
e: Ben.Davies@ricardo.com

Ricardo-AEA Ltd is certificated to ISO9001 and ISO14001

Author:

Ben Fowler

Approved By:

Ben Davies

Date:

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Executive summary

This report presents the results for 2019 of an ongoing programme of air quality monitoring in Jersey, carried out by Ricardo Energy & Environment on behalf of the Environmental Health Department of the Government of Jersey.

An automatic monitoring station for nitrogen dioxide (NO_2) has been located in the Central Market, Halkett Place, St Helier since January 2008. In addition, non-automatic diffusion tube samplers were used for indicative monitoring of NO_2 at 17 sites, and a suite of four hydrocarbons (benzene, toluene, ethylbenzene and xylenes) at a further five sites. Hydrocarbon monitoring sites included areas likely to be affected by specific emission sources (such as a petrol station and a paint-spraying process), as well as general background locations. The 2019 non-automatic monitoring programme continued a long-term survey that has operated in Jersey since 1997.

NO_2 and hydrocarbon diffusion tubes were exposed for twelve periods approximating to calendar months, based on the UK's Defra diffusion tube calendar. The tubes were supplied and analysed by Gradko International Ltd and changed by Technical Officers of Jersey's Environmental Health Department. From January 2019 five new diffusion tube sites were installed, two of which are aimed to measure concentrations related to activity near schools and three that are aimed to measure baseline concentrations near the newly proposed hospital location prior to its construction. This project is currently on hold and monitoring is now directed at assessing traffic related concentrations in the area.

The automatic monitoring site at Halkett Place met the EC Directive limit value (and AQS objective) for both the 1-hour mean NO_2 concentration (with 4 of 18 allowed 1-hour exceedances) and the annual mean NO_2 concentration.

After the application of a diffusion tube bias adjustment factor, annual mean concentrations of NO_2 did not exceed the EC Directive limit value at any of the sites. Diffusion tubes measure over a monthly period therefore, the results are an average and not applicable to measuring peaks or low levels of pollution at any specific time.

The diurnal pattern in concentrations of oxides of nitrogen at Halkett Place was similar to that observed in previous years. There was a clear peak in the early morning between 07:00 and 08:00, with another slight peak in the afternoon rush-hour. The morning peak is thought to reflect early activity of market retailers arriving to set-up for the day using refrigerated vehicles and daily refuse collections. These vehicles may need to be left with engines running whilst carrying out their operations, contributing to NO_2 levels.

Each of the hydrocarbon sites provided annual means below that required of the EC Directive limit value for benzene (5 µg m^{-3} as an annual mean, to be achieved by 2010[4]). Since the introduction of catalytic converters in 1991 and the limiting of benzene concentrations in petrol to 1% in the year 2000, ambient measured concentrations have declined in the UK[8]. The site at Faux Bie Terrace measured the highest annual mean benzene concentration, of 0.9 µg m^{-3}. Faux Bie Terrace represents the nearest relevant public exposure to a petrol station.

Overall hydrocarbons showed no significant increase or decrease compared with 2018. Over the long term, hydrocarbon concentrations have generally decreased at La Bas Centre, Halkett Place and Hansford Lane. However, at the Faux Bie site concentrations had sharply increased until 2016 followed by substantial decreases between 2016 and 2019. The Airport fence site was discontinued at the end of 2018 as it was primarily measuring traffic generated readings rather than aircraft. It was replaced with a new site named Harrington's Garage located on the A13 La Route de Genets starting January 2019.

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1 Introduction

1.1 Background

This report describes a programme of air quality monitoring carried out on the island of Jersey in 2019, undertaken by Ricardo Energy & Environment, on behalf of the Government of Jersey Public Health Services. This is the 23rd consecutive year in which an annual monitoring programme has been carried out; the first was undertaken in 1997. This ongoing monitoring programme has provided a long-term dataset of pollutant concentrations.

The pollutants measured were nitrogen dioxide (NO_2), and a range of hydrocarbon species (benzene, toluene, ethylbenzene and three xylene compounds). NO_2 was measured by an automatic monitor, situated at Halkett Place, St Helier. This was supplemented by indicative monitoring of NO_2 at 17 locations on the island (including Halkett Place), using low cost passive samplers (Palmes type diffusion tubes). The suite of hydrocarbon species were monitored using 'BTEX' diffusion tubes at five sites.

This report presents the results obtained in the 2019 survey and compares the data from Jersey with relevant air quality limit values, objectives and guidelines as well as data from selected UK monitoring stations and previous years' monitoring programmes.

1.2 Objectives

This year's monitoring is the continuation of a survey that has been carried out since 1997. This report is the latest in a series of annual reports[1]. The objective, as in previous years, was to monitor at sites where pollutant concentrations were expected to be high and compare these with background locations. The monitoring sites consisted of urban and rural background sites, in addition to locations where higher pollutant concentrations might be expected, such as roadside and kerbside sites, as well as locations close to specific emission sources (for example, a petrol station).

2 Details of Monitoring Programme

2.1 Pollutants Monitored

2.1.1 NO_x

A mixture of nitrogen dioxide (NO_2) and nitric oxide (NO) is emitted by combustion processes. The 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 where buildings either side of the street create a 'canyon' effect, impeding the dispersion of vehicle emissions. The units used for NO_2 concentration in this report are micrograms per cubic metre (µg m^{-3}). The earliest reports in this series used parts per billion (ppb). To convert from µg m^{-3} to ppb for comparison with the earlier reports, if required, the following relationship should be used:

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

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 solvents in paint. A range of hydrocarbons are found in vehicle fuel and occur in vehicle emissions. In most urban areas, vehicle emissions constitute the major source of hydrocarbons, in particular benzene. There is the potential they may be released to the air from facilities where fuels are stored or handled (such as petrol stations).

A wide range of hydrocarbons are emitted from fuel storage, handling and combustion. 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, ethylbenzene 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).

2.1.2.1 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 small concentrations in petrol and other liquid fuels; for urban areas, the major source for benzene is vehicle emissions. In the UK, the annual mean concentrations for benzene in ambient air are typically less than 3 µg m^{-3} and have declined since the introduction of catalytic converters in 1991 and the limiting of benzene concentrations in petrol to 1% in the year 2000[8]. In this report, concentrations of benzene are expressed in micrograms per cubic metre (µg 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 µg m^{-3} = 0.307 ppb for benzene at 293 K (20 °C) and 1013 mb (only applicable to benzene).

2.1.2.2 Toluene

Toluene is found in petrol; it can be used as a solvent in paints and inks; it is also a constituent of tobacco smoke. There are no EU limit values for ambient toluene concentration, although there are occupational limits for workplace exposure[2], and a World Health Organisation (WHO) guideline of 260 µg m^{-3} for the weekly mean[3].

The major concern associated with human exposure to toluene is its effect on the central nervous system: it is not believed to be carcinogenic[3]. Typical ambient concentrations are usually less than 5 µg m^{-3} in rural areas and in the range 5-150 µg m^{-3} in urban areas[3].

In this report, concentrations are expressed in micrograms per cubic metre (µg 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 µg m^{-3} = 0.261 ppb for toluene at 293 K (20 °C) and 1013 mb (only applicable to toluene).

2.1.2.3 Ethylbenzene

There are no limits for ambient concentrations of ethylbenzene. Although, there are occupational limits relating to workplace exposure[2], as discussed in previous reports, these are several orders of magnitude higher than typical outdoor ambient concentrations.

2.1.2.4 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 where it is used (such as vehicle paint spraying).

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

1 $\mu g\ m^{-3}$ = 0.226 ppb for ethylbenzene or xylenes at 293 K (20 °C) and 1013 mb (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 summarised in Appendix 1 and below.

2.2.1 World Health Organisation

The most recent World Health Organisation revised air quality guidelines[7] were published in 2005, 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 also WHO guidelines for ambient concentrations of, benzene and toluene[3].

The WHO non-mandatory guideline[7] for NO_2 is that the annual mean should not exceed 40 $\mu g\ m^{-3}$. For toluene, the WHO recommends a guideline[3] value of 0.26 mg m^{-3} (260 $\mu g\ m^{-3}$) for the weekly mean.

2.2.2 European Community

Throughout Europe, ambient air quality is regulated by the most recent EC Directive on Ambient Air Quality and Cleaner Air for Europe (2008/50/EC)[4]. This Directive (referred to as the Air Quality Directive) sets limit values, which are mandatory, and other requirements for the protection of human health and ecosystems. Both NO_2 and benzene are covered by this Directive. The Government of Jersey have agreed to meet the EU health limits.

The Air Quality Directive[4] contains limit values for NO_2 as follows:

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

The same Directive[4] also sets a limit of 5 $\mu g\ m^{-3}$ for the annual mean of benzene, to have been achieved by 2010. Having achieved the limit values by the due dates, Member States must maintain compliance in future years.

2.2.3 UK Air Quality Strategy

The UK Air Quality Strategy (AQS)[5] contains standards and objectives for a range of pollutants including NO_2 and benzene. 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 Government of Jersey.

The UK Air Quality Strategy's objectives for NO_2 are very similar to the EC Directive limits above, the only difference being that they had to be achieved by 31st December 2005.

The UK Air Quality Strategy[5] sets the following objectives for benzene:

- 16.25 µg m^{-3} (for the running annual mean), to have been achieved by 31st December 2003.
- 3.25 µg m^{-3} (for the calendar year mean in Scotland and Northern Ireland), to have been achieved by 31st December 2010.
- 5 µg m^{-3} (for the calendar year mean in England and Wales), to have been achieved by 31st December 2010.

Both the 2010 benzene objectives apply to specific parts of the UK only, so strictly speaking do not apply in Jersey. However, the objective of 5 µg m^{-3} applicable to England and Wales is the same as the EC Directive limit value, which is applicable in Jersey.

2.2.4 Jersey Air Quality Strategy

The most recent Jersey Air Quality Strategy was published in 2013[10] and is largely based on the WHO[7], EU[4] and UK[5] policies described above and its limit values are the same. As Jersey is not an EU member state there is no legal requirement to implement the EU Directive however, the Government of Jersey recognise the importance and relevance of the limit values to Jersey. The Jersey Air Quality Strategy works within the EU and UK limit values and puts in place a project plan and policies to ensure compliance.

2.3 Monitoring Methodologies

2.3.1 Automatic Methods

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_x analyser provides a continuous output, proportional to the pollutant concentration. The output is recorded and stored every 10 seconds and averaged to 15-minute average values by internal data loggers. The analyser is connected to a modem and interrogated by telephone to download the data to Ricardo Energy & Environment. Data are downloaded daily and uploaded onto the publicly available website: http://jerseyair.ricardo-aea.com

2.3.2 Diffusive Sampling of NO_2 and Hydrocarbons

The automatic monitoring site at Halkett Place was supplemented by indicative monitoring, using diffusion tubes, for NO_2 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. They are located in places and heights of relevant exposure, usually attached to lampposts at approximately 3m-4m above ground.

2.3.2.1 NO_2 diffusion tubes

Palmes-type diffusion tubes were used for NO_2. These consist of a small plastic tube, approximately 7 cm long. During sampling, one end is open and the other closed. The closed end contains an absorbent for the gaseous species (in this case NO_2) to be monitored. 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.

2.3.2.2 BTEX diffusion tubes

BTEX diffusion tubes are different in appearance from 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.

2.3.2.3 Preparation and analysis

Diffusion tubes were prepared and analysed by Gradko International Ltd. They were supplied to the local Technical Officers of Jersey's Public Health Services, who carried out the tube changing. The tubes were supplied in a sealed condition prior to exposure. The tubes were exposed at the sites for a set period. 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.

The UK Local Air Quality Management Technical Guidance LAQM.TG(16)[6] 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; the reference method for 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 be applied to the annual mean diffusion tube measurements in this survey. The NO_2 diffusion tube results in this report are uncorrected except where clearly specified. BTEX diffusion tubes are not affected by the same sources of bias as NO_2 diffusion tubes, therefore the BTEX results have not been bias adjusted.

Each monthly batch of diffusion tubes was accompanied by a 'travel blank' NO_2 and BTEX tube. These tubes were taken with the exposure tubes to the site but were not exposed. They were returned to the site operator's premises and were kept in a sealed bag in a cupboard. When the exposed tubes were collected, the 'travel blank' tubes were taken by the operator to the site. The travel blanks were sent with the exposed tubes for analysis. The purpose of these tubes was to indicate if any contamination of the tubes had occurred. This was particularly relevant in the case of the BTEX tubes because they can easily be contaminated by exposure to solvents.

Gradko also retained one tube from each batch, in a sealed bag in their premises, as a 'laboratory blank'. The travel blank results for NO_2 were not used to apply any correction to the results from the exposed tubes – only to highlight possible contamination issues. BTEX results were blank corrected using the travel blank, or the laboratory blank where the analyst judged this to be appropriate.

2.3.2.4 Calendar of diffusion tube exposure periods

The calendar of exposure periods used for the NO_2 and BTEX diffusion tubes is shown in Table 2–1. They were intended to be an approximation to calendar months, while allowing for the tubes to be changed on a consistent day of the week.

Table 2–1: Diffusion tube exposure periods

Month	Start date	End date
January	09/01/19	06/02/19
February	06/02/19	06/03/19
March	06/03/19	03/04/19
April	03/04/19	01/05/19
May	01/05/19	05/06/19
June	05/06/19	03/07/19
July	03/07/19	07/08/19
August	07/08/19	04/09/19
September	04/09/19	02/10/19
October	02/10/19	06/11/19
November	06/11/19	04/12/19
December	04/12/19	09/01/20

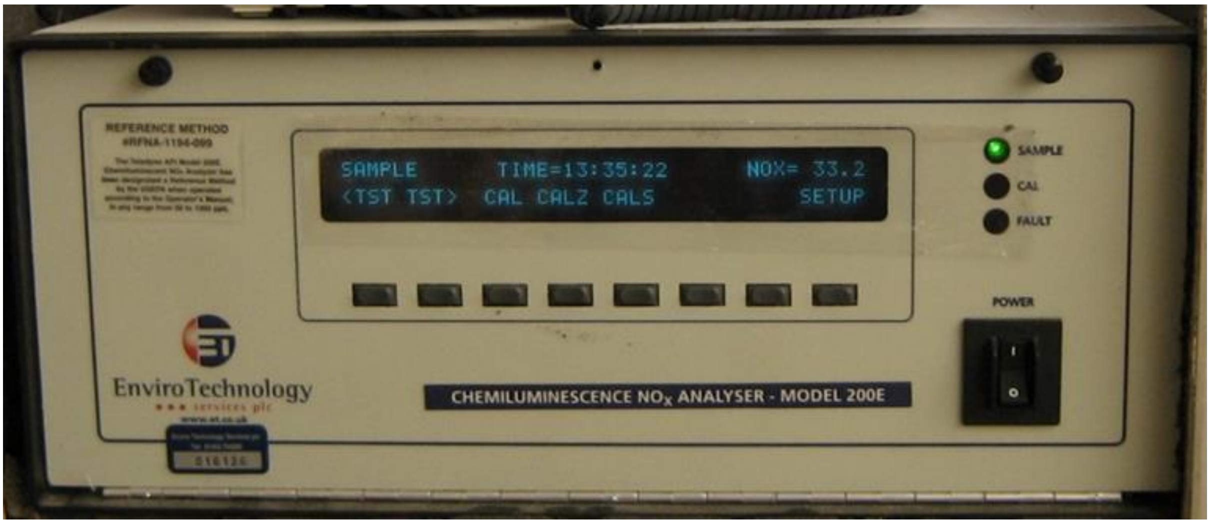
2.4 Monitoring sites

Automatic monitoring of oxides of nitrogen was carried out at the Central Market, Halkett Place, in St Helier (Figure 2-1). This site represents a roadside location where levels of NO_2 are expected to be high and where members of the public are regularly exposed for periods of one hour or more. The inlet funnel (circled) 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 four metres.

Figure 2-1: Automatic NO_x monitoring site, Halkett Place, St Helier

The chemiluminescent NO_x analyser itself, Figure 2-2, is located within the building. The analyser is calibrated monthly by the Government of Jersey's Environmental Health Team. Details of the calibration procedure are provided in Appendix 2.

Figure 2-2: Automatic NO_x analyser at Halkett Place, St Helier



As explained in section 2.3, diffusion tubes were used to monitor NO_2 at sites in a range of different environments around Jersey. Table 2–2 lists the 17 NO_2 diffusion tube sites used during 2019, Figure 2-3 to Figure 2-6 show their locations.

Table 2–2: NO_2 monitoring sites in Jersey

Site name	Grid Reference	Method	Description
Halkett Place (Central Market)	653 486	Automatic analyser, diffusion tubes in triplicate	Central Market, Halkett Place, St Helier
Le Bas Centre	658 489	Diffusion tube	Urban background
Union Street	653 486	Diffusion tube	Kerbside in St Helier – corner of Union Street and New Street
St Saviours Hill	659 494	Diffusion tube	Kerbside in St Helier
Broad Street	652 486	Diffusion tube	Urban background
Weighbridge	651 483	Diffusion tube	Roadside at bus station near centre of St Helier
Liberation Station	652 485	Diffusion tube	Kerbside opposite entrance to new bus station
Georgetown	661 480	Diffusion tube	Kerbside on major road
The Parade	648 489	Diffusion tube	Roadside site at General Hospital
Les Quennevais	579 496	Diffusion tube	Residential background
Beaumont	597 516	Diffusion tube	Kerbside
Rue des Raisies	689 529	Diffusion tube	Rural background
Rouge Bouillon School	650 494	Diffusion tube	Kerbside
St Savours School	667 495	Diffusion tube	Kerbside
Gloucester Street (Hospital)	648 487	Diffusion tube	Kerbside
Kensington Place (Hospital)	646 486	Diffusion tube	Kerbside
Esplanade (Hospital)	645 485	Diffusion tube	Kerbside

Kerbside: less than 1 m from kerb of a busy road.

Roadside: 1 – 5 m from kerb of a busy road.

Background: > 50 m from the kerb of any major road.

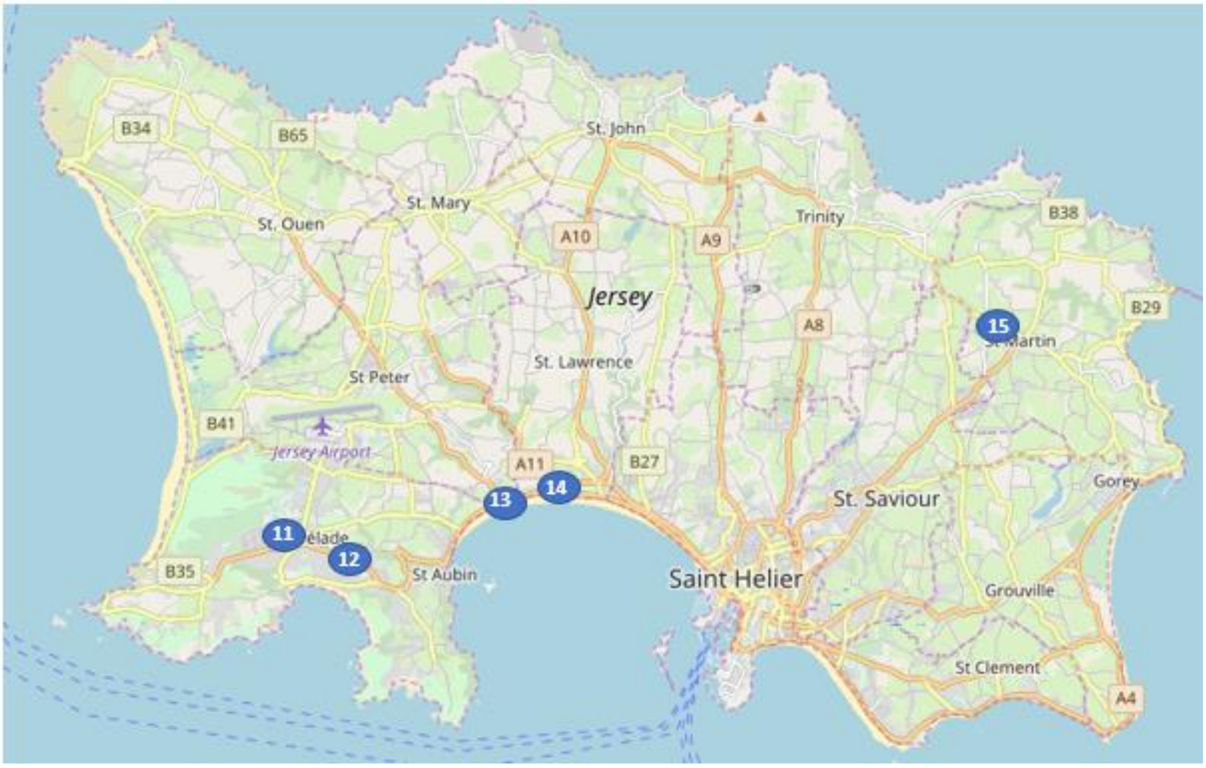
Note: all grid references are from OS 1:25000 Leisure Map of Jersey and are given to the nearest 100 m.

Figure 2-3: Site locations in St Helier town

Key:

Number	Site name	Pollutants	Number	Site Name	Pollutants
1	Les Bas Centre	NO_2. BTEX	7	The Parade	NO_2
2	Halkett Place (Central Market)	NO_2, BTEX, automatic NO_x (and automatic PM_{10} – locally managed)	8	Faux Bie	BTEX
3	Union Street	NO_2	9	Georgetown	NO_2
4	Broad Street	NO_2			
5	Weighbridge	NO_2	10	St Saviours Hill	NO_2
6	Liberation Station	NO_2			

Figure 2-4: Site locations outside St Helier



Key:

Number	Site name	Pollutants	Number	Site name	Pollutants
11	Les Quennevais	NO_2	14	Hansford Lane	BTEX
12	Harrington's Garage	BTEX	15	Rue Des Raisies	NO_2
13	Beaumont	NO_2			

Figure 2-5: Site locations near hospital

Key:

Number	Site name	Pollutants
16	Esplanade (Hospital)	NO_2
17	Kensington Place (Hospital)	NO_2
18	Gloucester Street (Hospital)	NO_2

Figure 2-6: Site locations near schools

Key:

Number	Site name	Pollutants
19	Rouge Bouillon School	NO_2
20	St Savours School	NO_2

Following completion of the 2018 dataset the following sites were discontinued: La Collette Gardens, South Hill Fort Regent, South Hill Park, Junction of Castle Street & Esplanade, and Carey Olson Esplanade. These were then replaced with the following sites beginning January 2019: Rouge Bouillon School, St Savours School, Gloucester Street, Kensington Place and Esplanade. Of these new site locations, the two sites located near schools are close to busy roads. The St Savours School site is located near the drop off and collection point and the Rouge Bouillon School site is located close to a busy roundabout a few metres away from the playground at the school. The remaining three new sites (all collectively grouped as Hospital) are provided to determine a baseline of air quality prior to the new hospital development. At present this project has been put on hold therefore these monitoring sites are currently providing concentrations representative of urban traffic use in the area.

Diffusion tubes were 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_2. The tubes at this site were exposed in triplicate, to allow assessment of precision. All other diffusion tube sites use single tubes.

BTEX hydrocarbons were monitored at five sites during 2019, shown in Table 2–3. The aim was to investigate sites likely to be affected by different emission sources and compare these with background sites.

Table 2–3: BTEX diffusion tube monitoring sites

Site name	Grid reference	Description
Les Bas Centre	658 489	Urban background site which has operated since 1997.
Central Market	653 486	Central Market, Halkett Place, St Helier
Harrington's Garage	585 489	Roadside site located on Rue de Genets.
Hansford Lane	633 499	Urban background site near a paint spraying process.
Faux Bie	658 495	Urban background site, near fuel filling station. Represents the nearest public exposure to a petrol station.

Le Bas Centre is intended to monitor hydrocarbon concentrations at an urban background location. Hansford Lane is close to a paint spraying process, a potential source of hydrocarbon emissions, especially toluene and xylenes.

The Faux Bie site is located near a fuel filling station, a potential source of hydrocarbon emissions including benzene. The monitoring site is between a fuel filling station and a nearby block of flats and is intended to represent public exposure to emissions from the filling station. The fuel supplier uses a vapour recovery system to reduce emissions when filling the storage tanks and has done so since December 2003.

The Harrington's Garage site was introduced as a replacement to the Airport Fence location and has been in operation since January 2019. The Airport Fence location was discontinued at the end of 2018 because the site was predominantly measuring traffic related emissions from the Grand Route de St Pierre and was therefore not representative of any aircraft emissions. The Harrington's Garage site is located on the A13 Rue de Genets, aiming to assess levels of BTEX from a typical garage with petrol and diesel storage and dispensing facilities.

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, summarised in Table 3-1In addition to instrument and calibration standard checking, the air intake sampling system is cleaned, and all other aspects of site infrastructure are checked. The 2019 audit and service were delayed until October 2019 due to poor weather causing ferry cancellations.

Table 3-1: Results of October 2019 intercalibration audit

Species	Analyser Serial no	Zero Response	Zero uncertainty ppb	Calibration Factor	Factor uncertainty %	Converter eff. (%)
NOx	1002	0.9	2.7	1.2449	3.5	98.4
NO	1002	-0.3	2.7	1.2311	3.5	n/a

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 shown in Table 3–1. These are given in ppb, the “native” unit of the automatic data.

Table 3–1: Estimated accuracy and precision of the data presented

Pollutant	Precision	Accuracy
NO	± 5 ppb	± 15%
NO_2	± 5 ppb	± 15%

3.2 Data Capture

Overall data capture statistics for the monitoring site are given in Table 3–2. An annual data capture rate of 85% or greater for ratified data is recommended in the Defra Technical Guidance LAQM TG(16)[6] in order to assess annual data sets against long term targets. The Halkett Place site surpassed this target capture rate. There were no instances of data gaps (where data were rejected) over 24 hours, and only one instance of a data gap of 3 hours or more which occurred on 29th November due to the annual service taking place.

Table 3–2: Jersey Halkett Place – Data capture statistics 2018

Site	NO	NO_2	NO_x
Jersey Halkett Place	95.6%	95.6%	95.6%

3.3 Diffusion Tube Uncertainty and Detection Limits

Diffusion tubes are an indicative technique, with greater uncertainty than more sophisticated automatic methods. The reported margins of uncertainty on the analysis was ± 9.7% for the NO_2 diffusion tubes ± 16.2% for the 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 are approximately ± 25% for NO_2 and BTEX hydrocarbons.

The limits of detection in ambient air depend partly on the exposure time, and therefore vary to some extent from month to month. The analytical limit of detection was in the range 0.028 µg NO_2 to 0.031 µg NO_2: the ambient concentration that this equates to depends on the exposure period, but for the 4-week and 5-week periods used in this study, the limit of detection ranged from 0.458 µg m^{-3} to 0.636

µg m^{-3} For benzene, the limit of detection equated to an ambient concentration between 0.12 µg m^{-3} and 0.15 µg m^{-3}. The laboratory advises that results lower than 10 times the limit of detection LOD will have a higher level of uncertainty. In the case of the NO_2 sites, ambient concentrations are well above this threshold, apart from at Les Quennevais and Rue des Raisies. Therefore, the NO_2 measurements at these two sites are likely to have overall uncertainty greater than ± 25% and should be treated as indicative only. However, for BTEX hydrocarbons at Jersey, this was the case for most measurements except for toluene and m+p xylenes at some sites and other isolated measurements. The BTEX hydrocarbon measurements are therefore likely to have overall uncertainty greater that ± 25% and should be treated as indicative only.

4 Results and Discussion

4.1 Presentation of Results

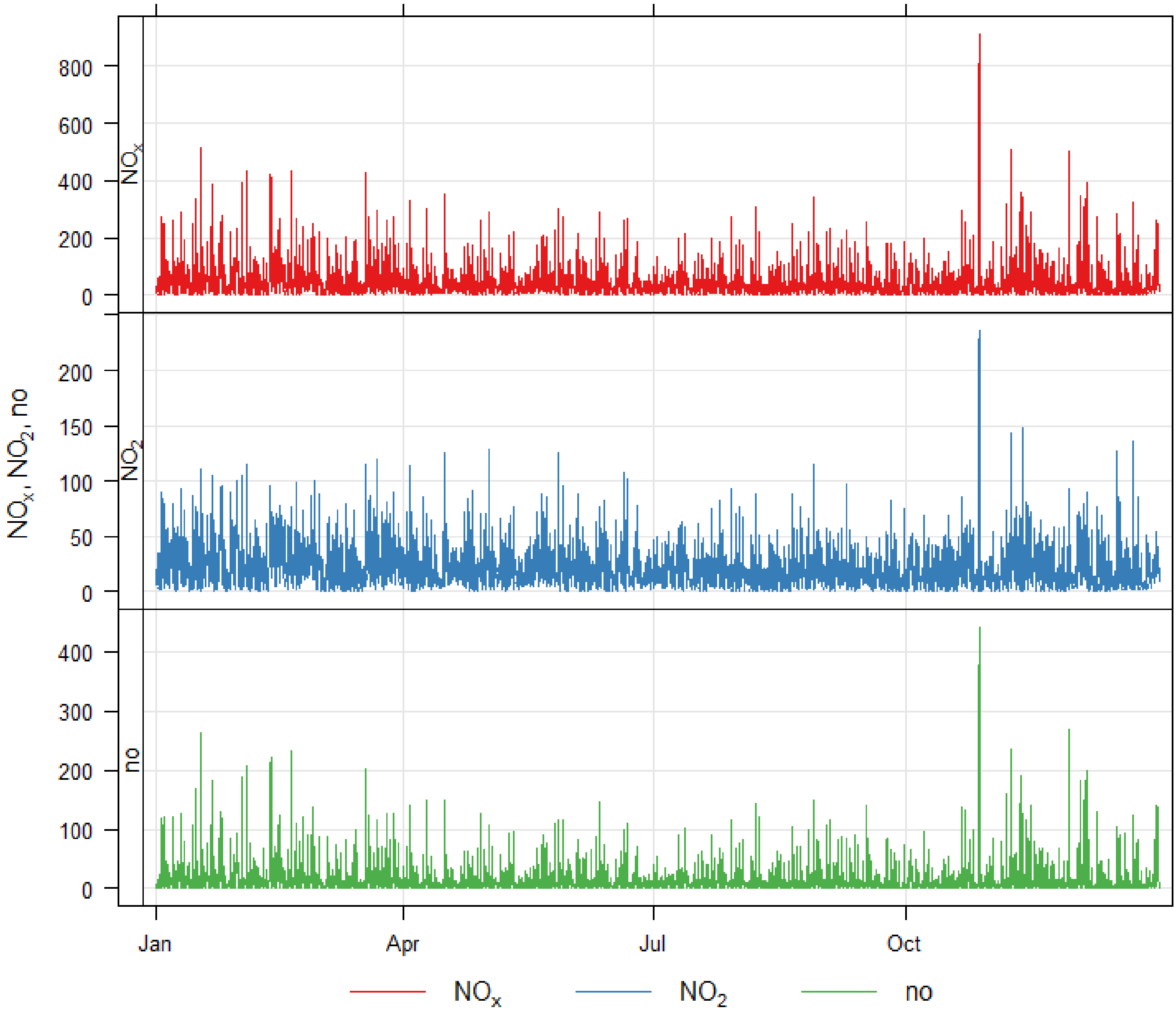
4.1.1 Automatic NO_2 Monitoring Results

Table 41 shows the key statistics for oxides of nitrogen measured by the automatic analyser at Halkett Place. Table 41 shows time series plots of hourly mean NO, NO_2 and NO_x concentrations. The purpose of these plots is to illustrate how concentrations of these pollutant species varied on a short time scale and throughout the year, Figure 41.

Table 41: Oxides of nitrogen at Jersey Halkett Place – air quality statistics for 2019

Pollutant	NO µg m^{-3}	NO_2 µg m^{-3}	NO_x µg m^{-3}
Maximum 15-minute mean	665	355	1160
Maximum hourly mean	440	235	911
Maximum running 8-hour mean	320	180	672
Maximum running 24-hour mean	125	73	265
Maximum daily mean	124	72	262
Average	14	22	43
Data capture	95.6%	95.6%	95.6%

Figure 41: Time series plots of hourly mean pollutant concentrations at Halkett Place, 2019 (µg m^{-3})



4.1.2 NO_2 Diffusion Tube Results

NO_2 diffusion tube results are presented in Table 4.2. Although reported by the analyser 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. There are two exceptions - Les Quennevais and Rue des Raisies – where concentrations are typically less than 10 µg m^{-3}: These sites' results are given to one decimal place.

After December 2018 four sites were discontinued: La Collette Gardens, South Hill Fort Regent, Castle Street & Esplanade Junction, and Carey Olson Esplanade. In January 2019 five sites were commissioned: Rouge Bouillon School, St Savours School, Gloucester Street (Hospital), Kensington Place (Hospital) and Esplanade (Hospital). Therefore, these five new sites were exposed for a full calendar year.

The data for Rouge Bouillon School in the January 2019 and June 2019 batches all appear unusually low, and it was documented in both periods that the *"tube had been knocked to floor"*. These results are therefore considering spurious and may be unrepresentative of actual levels and therefore neither have been used in calculations of the annual means. There is no data present in December 2019 for Union Street as it was documented from the previous batch (November 2019) that the tubes were *"returned with two grey filter cap ends"* meaning that subsequent analysis could not be completed in December 2019.

The data for St Saviours Hill in the March 2019, April 2019 and October 2019 batches all appears unusually low, and in all these periods it was documented that cobwebs were present in the tubes. These results are therefore considering spurious and may be unrepresentative of actual levels. As a result, these three results were not used in calculations of the annual means.

Table 4.2 includes monthly values as well as annual and bias adjusted annual means. Raw (not bias adjusted) monthly values are reported to allow for comparison against past data recorded before bias adjustment was introduced. Individual monthly mean NO_2 results ranged from 3.3 µg m^{-3} (in September at the Les Quennevais site), to 48 µg m^{-3} (in April at the Esplanade (Hospital) site).

Table 4–2: NO_2 diffusion tube results 2019, Jersey. Concentrations (rounded), µg m^{-3}.

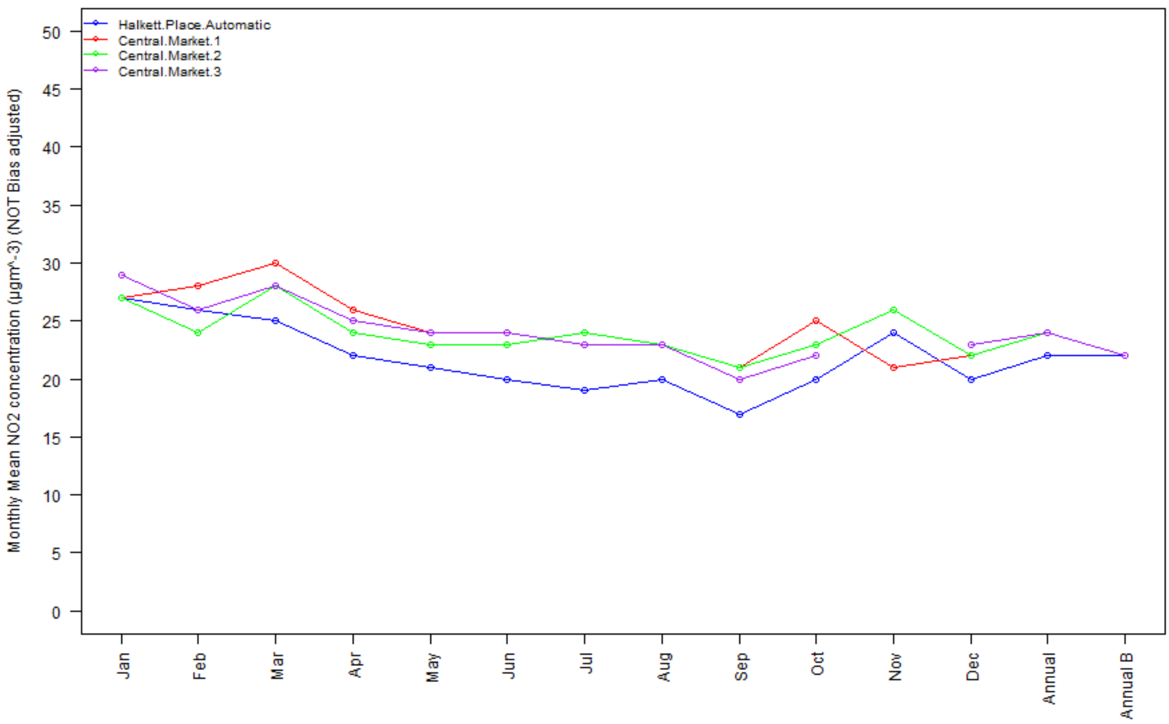
Site	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Annual mean µg m^{-3}	Annual mean X BAF µg m^{-3}
Le Bas Centre (UB)	22	23	19	18	17	17	17	19	18	18	21	20	19	17
St Saviours Hill (R)	44	41	29	31	43	43	46	42	44	25	39	39	42	39
Union Street (R)	29	34	32	28	25	25	24	26	23	21	28	-	27	24
Halkett Place 1 (R)	27	28	30	26	24	24	23	23	21	25	21	22	24	22
Halkett Place 2 (R)	27	24	28	24	23	23	24	23	21	23	26	22	24	22
Halkett Place 3 (R)	29	26	28	25	24	24	23	23	20	22	0.6	23	24	22
Halkett Place Mean	28	26	29	25	24	24	23	23	20	23	24	22	24	22
Weighbridge (K)	36	35	35	30	34	35	33	32	28	22	25	32	31	29
Liberation Station (R)	38	26	32	39	25	35	36	30	31	24	0.6	20	30	28
Broad Street (K)	32	30	28	23	24	24	24	26	22	24	28	26	26	23
The Parade (K)	28	25	23	24	23	23	23	23	17	36	21	22	24	22
Les Quennevais (S)	5.8	9.4	5.8	7.6	5.3	5.6	5.1	3.8	3.3	5.4	0.6	6.1	5.7	5.2
Beaumont (K)	41	32	35	38	33	36	37	31	32	25	29	25	33	30
Rue des Raises (Ru)	5.9	6.4	5.2	5.4	4.7	4.5	5.1	4.2	3.5	4.4	5.3	5.1	5.0	4.5
Georgetown (K)	37	37	31	33	32	31	31	31	27	27	31	28	31	29
Rouge Bouillon School	17	22	21	20	20	12	21	22	18	19	24	20	21	19

Site	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Annual mean µg m^{-3}	Annual mean X BAF µg m^{-3}
St Savours School	19	20	18	18	15	17	15	15	13	15	14	17	16	15
Gloucester Street (Hospital) (K)	44	34	34	32	31	34	36	31	29	30	31	28	33	30
Kensington Place (Hospital) (K)	31	31	27	25	28	29	30	26	22	29	30	28	28	25
Esplanade (Hospital) (R)	34	40	36	48	39	45	43	33	33	29	37	29	37	34

K = kerbside, R = roadside, UB = urban background, S = suburban, Ru = rural.

Figure 4-2 shows the monthly mean NO_2 concentrations, as measured by diffusion tubes and by the automatic analyser, at Halkett Place. Agreement between the two methods were generally good.

Figure 4-2: Co-location results at Halkett Place, Jersey, 2019



4.2 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.

The Air Quality Directive[4] contains limit values for NO_2 as follows:

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

The UK Air Quality Strategy[5] contains objectives for NO_2, which are very similar to the Directive limits above, the only difference being they had to be achieved by 31st December 2005.

The 1-hour mean at the Halkett Place automatic monitoring site exceeded the 200 µg m^{-3} on four occasions in 2019. Therefore, this site met the EC Directive limit value and AQS objective for this parameter. The annual mean concentration of 22 µg m^{-3} as measured by the automatic analyser at Halkett Place was well within the EC limit value of 40 µg m^{-3}.

Due to 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. After applying the bias adjustment factor, no sites exceeded the annual mean limit value of 40 µg m^{-3}.

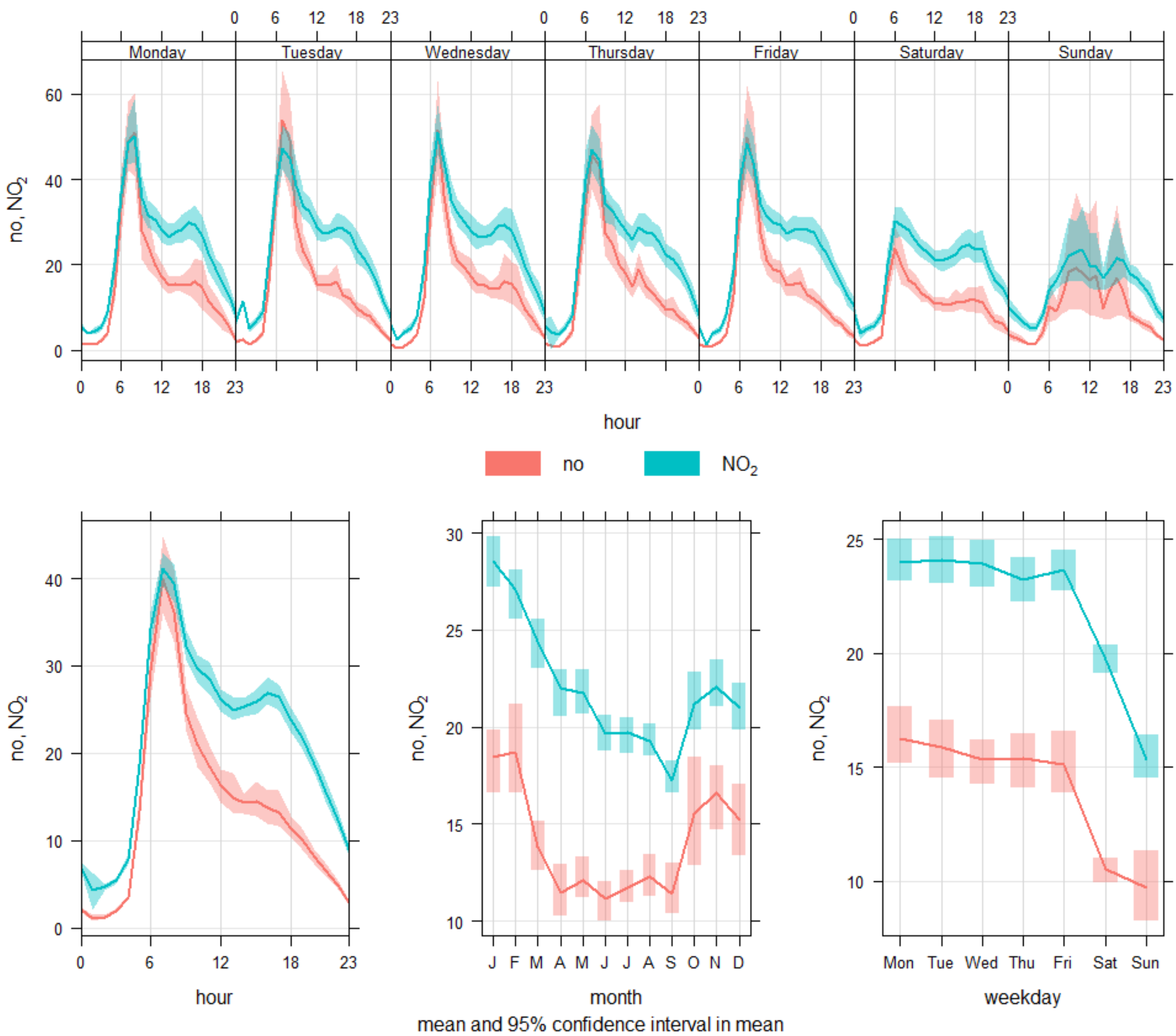
The 30 µg m^{-3} limit for protection of vegetation is only applicable at rural sites and is therefore only relevant to Rue des Raisies. The annual mean NO_2 concentration of 4.5 µg m^{-3} at this rural site was well within the limit value.

4.3 Temporal Variation in NO_2 Concentration

4.3.1 Temporal Variation in NO and NO_2 at Halkett Place 2019

Figure 4-3-1 shows how concentrations of nitric oxide (NO) and nitrogen dioxide (NO_2) typically varied over monthly, weekly, daily and hourly timescales, as measured by the automatic monitor at Halkett Place and averaged over the course of the year.

Figure 4-3-1: Temporal variation in concentrations of NO and NOx at Halkett Place, 2019



Seasonal variations are common for the pollutants measured at this site and can be observed in the 'month' plots of figure 4-3-1. Clear seasonal variation can be seen in the NO and NO_2 concentrations. The autumn and winter months recorded higher levels when emissions may be higher with increased vehicle usage in poor weather. Periods of cold, still weather also reduce pollutant dispersion.

The analyses of each pollutants' weekly variation showed that the same type of diurnal patterns occur for all the days of the week. NO early morning and late afternoon rush hour peaks are, in general, much more pronounced Monday to Friday and overall levels are lower over the weekend. Particularly Sundays when most shops are closed. Monday mornings and Friday afternoons show higher trends than the same times on other days. This is likely due to increased numbers of deliveries for the market in preparation for the week ahead and higher numbers of weekend visitors and commuters respectively.

The diurnal variation analyses viewed in the 'hour' plots in figure 4-3-1 showed typical urban area daily patterns for NO and NO_2. Pronounced peaks can be seen for these pollutants during the morning, corresponding to rush hour traffic at around 07:00. However, at Halkett Place it is particularly early and sharp. This may be explained by the 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 with refrigerated lorries making deliveries, just prior to the market opening at 07:30. In addition, a refuse lorry arrives at this time to collect the previous day's waste. It is believed vehicle emissions from these activities are responsible for the distinctive morning pattern at Halkett Place particularly considering the need for the refrigerated and refuse vehicles needing to keep their engines running to maintain temperatures and operate lifting equipment respectively. Concentrations tend to decrease during the middle of the day, with a much broader evening road traffic rush-hour peak, building up slightly from early afternoon.

Halkett Place exhibits a gentle afternoon NO_2 rush hour peak (as observed at many roadside AURN sites), however this is lower than the magnitude of the morning rush hour peak. In the afternoon, concentrations of oxidising agents in the atmosphere (particularly ozone) tend to increase, leading to enhanced oxidation of NO to NO_2. This typically causes the afternoon NO_2 peak at many urban sites to be higher than the morning NO_2 peak. However, this is not the case at Halkett Place. The likely reason is that there is little afternoon rush hour traffic in this area. Most traffic is associated with the market and shoppers, occurring during the morning, afternoons are relatively quiet.

4.3.2 Source investigation

In order to investigate the possible sources of air pollution being monitored around Halkett Place, meteorological data measured at Jersey airport was used to add a directional component to the air pollutant concentrations. Wind speed and direction data was gathered using data from the National Oceanic and Atmospheric Administration (NOAA) meteorological database.

Figure 4-3-2 shows the measured wind speed and direction data. The lengths of the "spokes" against the concentric circles indicate the percentage of time during the year that the wind was measured from each direction. The prevailing wind can be seen to be from the west. Each "spoke" is divided into coloured sections representing wind speed intervals of 2 ms^{-1}, followed by a final spoke of 13.53 ms^{-1} as shown by the scale bar in the plot. The mean wind speed was 5.92 ms^{-1}. The maximum measured wind speed was 19.53 ms^{-1}. The top three highest wind speeds were all recorded during December 2019 with other high wind speeds occurring in February and August.

Figure 4-3-2: Wind rose showing the wind speeds and directions at Jersey airport, 2019

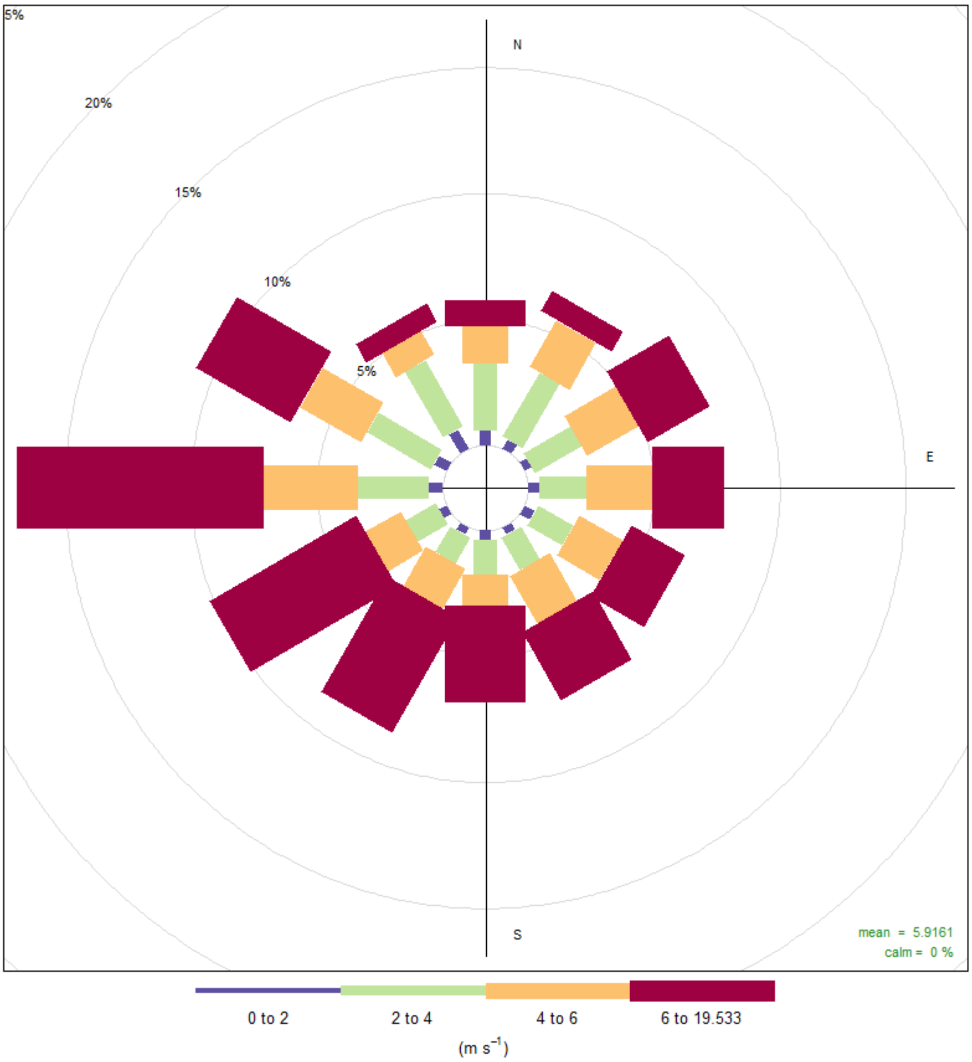


Figure 4-3-3 and Figure 4-3-4 show bivariate plots of hourly mean concentrations of NO and NO_2 at Halkett Place against wind speed and wind direction.

These plots should be interpreted as follows:

- The wind speed is indicated by the distance from the centre of the plot; the grey circles indicate wind speeds in 5 ms^{-1} intervals.
- The pollutant concentration is indicated by the colour (as indicated by the scale).

These plots therefore show how pollutant concentrations varied with wind direction and wind speed.

The plots do not show distance of pollutant emission sources from the monitoring site. However, in the case of primary pollutants such as NO, the concentrations at very low wind speeds are dominated by emission sources close by, while at higher wind speeds, effects are seen from sources further away.

Figure 4-3-3: Pollution rose for NO at Halkett Place, 2019

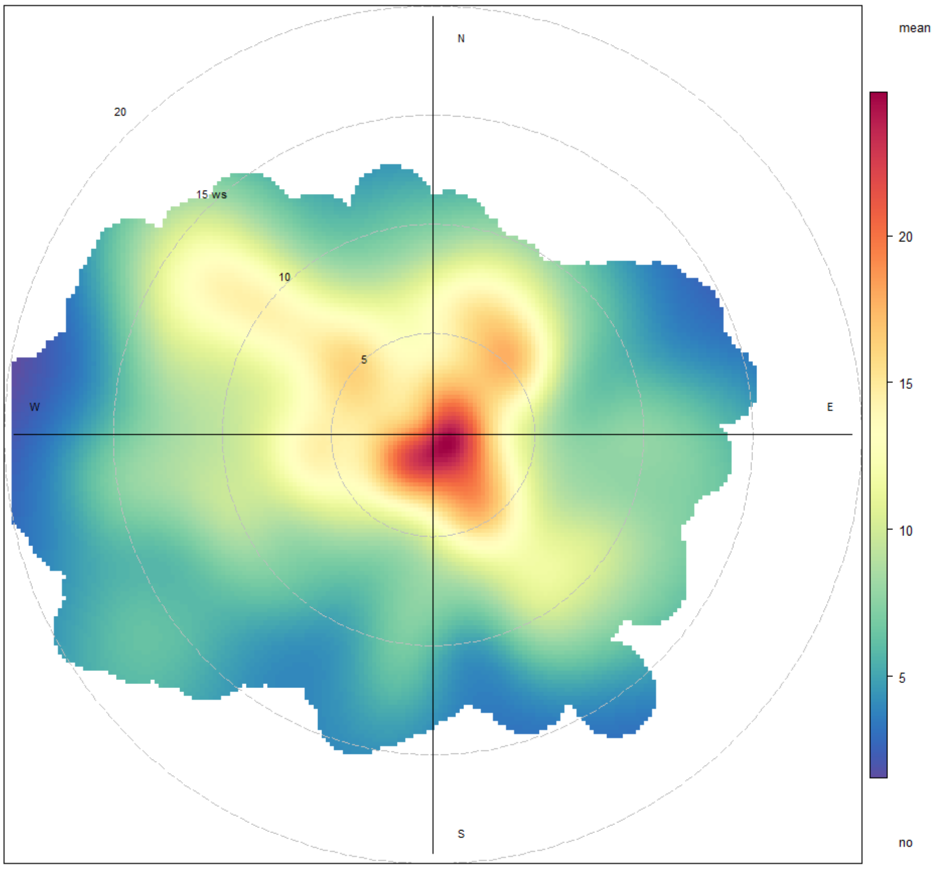
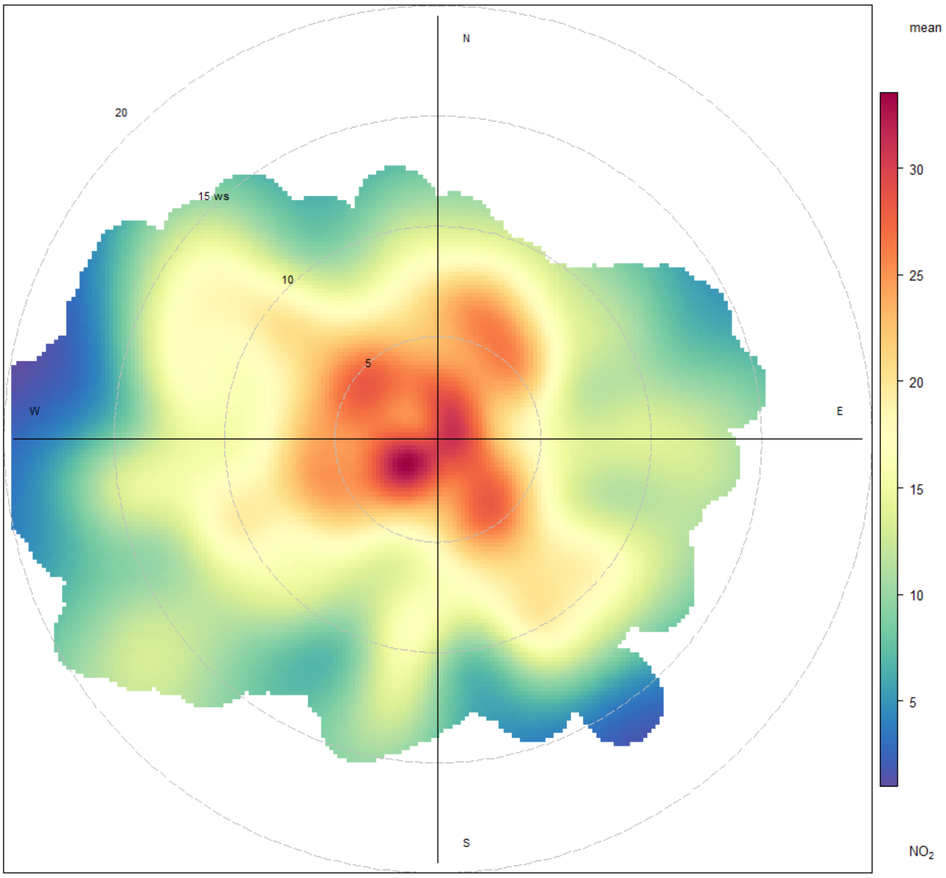


Figure 4-3-4: Pollution rose for NO2 at Halkett Place, 2019



Figures 4-3-3 and 4-3-4 show that the highest concentrations of NO occurred under calm and light wind conditions. Such conditions will have allowed NO and NO_2 emitted from nearby sources to build up, reaching higher concentrations. These sources are primarily vehicles on the surrounding streets and those using Halkett Place as a cut through or parking location. Delivery drivers to the market are advised not to leave engines idling in order to help reduce this however, refrigerated vehicles may not be able to abide by this.

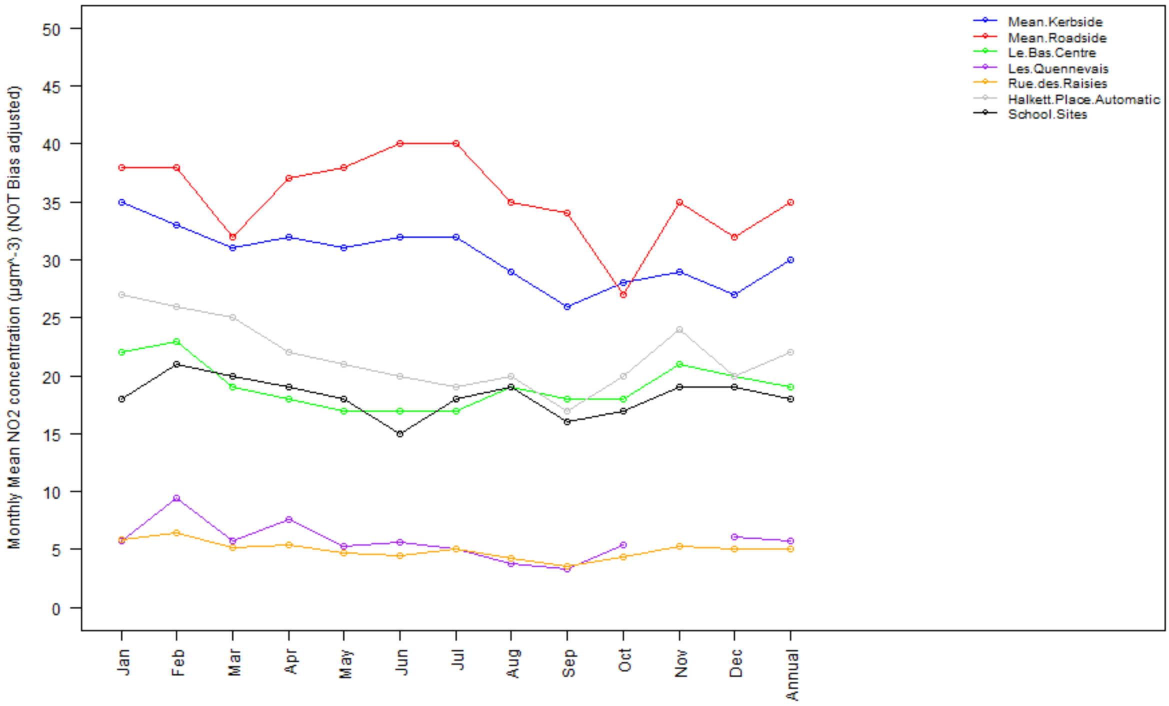
There is also evidence of higher concentrations of both pollutants seen under windier conditions from the North and North West, although not as high as in previous years. As in previous years this shows evidence of a source from the A9 and A2 main roads, Burrard Street, Waterloo Street and Don Street as well as the majority of the developed areas that lie to the North West of the monitoring site, all of which would account for increased concentrations. There is also the possibility of a street canyon effect which would allow concentrations of pollutants to build up when prevailing wind from the NW blows across the top of the buildings rather than along Halkett Place in its roughly NNE-SSW orientation.

4.3.3 Seasonal Variation in NO_2 Concentration

Figure 4-4 shows the monthly mean NO_2 concentrations measured at the diffusion tube sites and Halkett Place. Including:

- The mean of the eight kerbside sites.
- The mean of the four roadside sites.
- The monthly means measured at:
    - The single urban background site (Le Bas Centre).
    - The suburban residential site (Les Quennevais).
    - The rural site (Rue des Raisies).
    - The school sites (Rouge Bouillon School and St Savours School).
- The monthly means (based on the same periods as the diffusion tube exposures) for the Halkett Place automatic site.

Figure 4-4: Monthly mean NO_2 concentrations (NOT bias adjusted) at diffusion tube sites and Halkett Place,



The typical pattern in UK urban areas is for NO_2 concentrations to be generally higher in the winter and lower in the summer. Historically, the sites in Jersey have not shown this, or indeed any, consistent seasonal pattern. In 2019, urban concentrations resembled a slight seasonal pattern, with concentrations generally appearing higher in the winter months. The outliers to this are the mean kerbside and roadside locations where local factors such as traffic volume may influence measurements. The highest monthly mean out of all sets of sites were recorded in June and July at the roadside sites measuring an average of 40 µg/m^{-3}. This elevated trend in June and July was only exhibited elsewhere at the kerbside locations which supports the theory that localised factors, most likely increased visitor numbers, may play an important role at these locations. Generally, the trend against the automatic analyser agrees well demonstrating higher concentrations in the winter months and higher in the summer months.

4.3.4 Comparison with UK NO_2 data

Table 4–3 compares the annual NO_2 concentration measured at Halkett Place with those measured at a selection of UK air quality monitoring stations in the national Automatic Urban and Rural Network using automatic (chemiluminescent) NO_2 analysers. The sites used for comparison are listed below.

- Brighton Preston Park – an urban background site in Brighton, Sussex
- Exeter Roadside – a roadside site in the centre of Exeter, Devon
- Plymouth Centre – an urban centre site in the coastal city of Plymouth, Devon
- Yarner Wood – a rural moorland site in Devon.

Table 4–3: Comparison of NO_2 in Jersey with UK automatic sites, 2019

Site	2019 Annual mean NO_2 concentration µg m^{-3}
Brighton Preston Park	15
Exeter Roadside	28

Plymouth Centre	19
Yarner Wood	4
Jersey Halkett Place (automatic)	22

After bias adjustment, the annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey (rounded to the nearest integer) ranged from 22 to 39 µg m^{-3} and are comparable with the annual means at Exeter Roadside and Plymouth Centre (28 µg m^{-3} and 19 µg m^{-3} respectively). The mean concentration measured at Exeter Roadside is higher with the annual mean of 22 µg m^{-3} as measured by the automatic analyser at Halkett Place. The Jersey urban background site at Le Bas Centre had a (bias adjusted) annual mean NO_2 concentration of 17 µg m^{-3}, slightly lower than the annual mean from the urban background site at Plymouth Centre. The residential background site at Les Quennevais had a bias-adjusted annual mean NO_2 concentration of 5.2 µg m^{-3}, this is slightly higher than the rural Yarner Wood site in Devon. The bias-adjusted annual mean of 4.5 µg m^{-3} at the Jersey rural background site, Rue des Raisies, was comparable to that measured at the Yarner Wood site.

4.3.5 Trends in NO_2 at Long-running Sites

There are ten sites in the survey which have been in operation since 2005 or earlier and therefore now have 14 years of data. The annual mean NO_2 concentrations are shown in Table 4–4 and illustrated in Figure 4-5. The data is not adjusted for diffusion tube bias as there was no reliable information on which to carry out bias adjustment prior to 2002. Therefore, for consistency, unadjusted data is used in this section.

Annual mean NO_2 concentrations at historic 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). Several exceeded the EC Directive limit value of 40 µg m^{-3}, and there were no sign of concentrations decreasing. From 2004 onwards however, concentrations began to decrease. In 2019, (after application of the bias adjustment factor), all sites remained below 40 µg m^{-3}.

Figure 4-5 illustrates how the annual mean concentrations remained stable from 2000 to 2003. This was followed by a period when NO_2 concentrations at the urban sites appeared to show a general decrease, until around 2012. However, since then, annual mean NO_2 concentrations at several of the sites have remained stable with typical fluctuations from year to year due to meteorological conditions and other factors. Most sites exhibited a slight increase in concentrations when compared to 2018 but were still lower than those in 2017.

As traffic volumes have increased since monitoring began, fluctuations in concentrations are likely linked to increased vehicle efficiency and cleaner fuels. A recent study into vehicle emissions in Jersey[9] found that newer petrol vehicles produce fewer NO_x emissions. It also found that there is an increase in newer petrol cars compared to a decline in diesel on the island. Plans to introduce MOT style testing are currently being implemented with full implementation expected to be in place from 2022. This will further increase visibility of emissions and potentially reduce the number of heavily polluting vehicles on the roads, in turn contributing to a continued reduction in ambient concentrations.

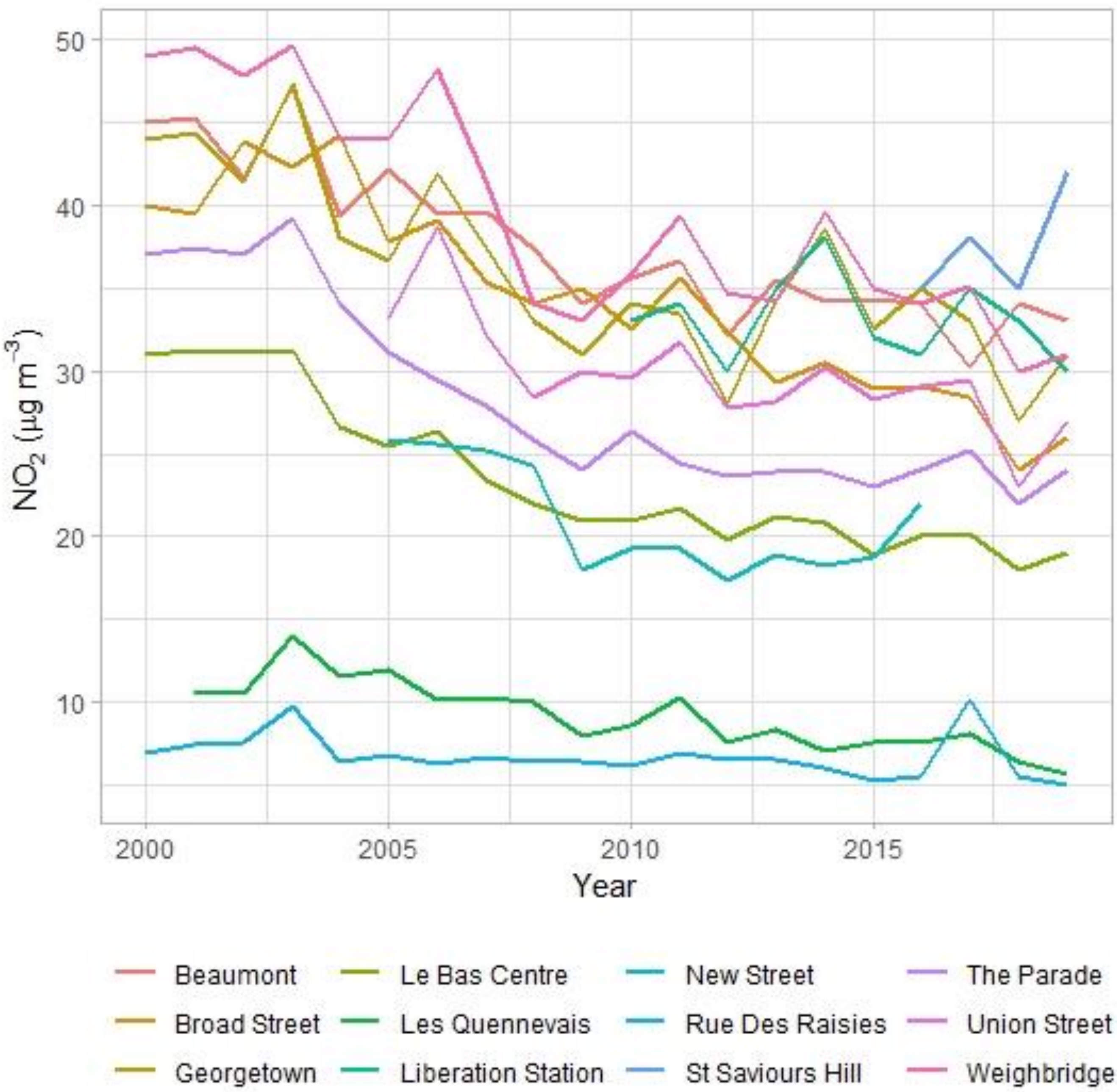
As a more focused example of the differences between site locations; it is interesting to note the lower trend of readings from the now discontinued New Street site compared to Union Street. The two locations were very close with the Union Street tube located on the corner of Union Street and New Street which run perpendicular to each other. New Street is access only and therefore, carries much lower traffic volumes. As the prevailing wind is from the West with the least wind coming from the North, very little of the pollution from Union Street is carried to the more southerly New Street location. This indicates how localised NO_2 distribution can be with certain mitigating factors.

Table 4–4: Annual mean NO_2 concentrations at the diffusion tube sites, μg m^{-3} (NOT bias adjusted)

Site	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Beaumont (K)	45	45	42	47	39	42	39	40	37	34	36	37	32	35	34
Broad Street (K)	40	39	44	42	44	38	39	35	34	35	32	36	32	29	30
Georgetown (K)	44	44	41	47	38	37	42	37	33	31	34	33	28	34	39
The Parade (K)	37	37	37	39	34	31	29	28	26	24	26	24	24	24	24
Weighbridge (K)	49	49	48	50	44	44	48	41	34	33	36	39	35	34	40
Rouge Bouillon School (K)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St Savours School (K)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gloucester Street (Hospital) (K)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kensington Place (Hospital) (K)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Esplanade (Hospital (K)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Street (R)	-	-	-	-	-	26	26	25	24	18	19	19	17	19	18
Union Street (R)	-	-	-	-	-	33	39	32	28	30	30	32	28	28	30
Le Bas Centre (UB)	31	31	31	31	27	25	26	23	22	21	21	22	20	21	21
Les Quennevais (S)	-	11	11	14	12	12	10	10.3	10.1	8.0	8.7	10.4	7.6	8.4	7.1
Rue Des Raisies (Ru)	7	7	8	10	6	7	6	6.8	6.5	6.4	6.2	7.0	6.6	6.6	6.1
Liberation Station (R)	-	-	-	-	-	-	-	-	-	-	33	34	30	35	38
St Saviours Hill (R)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

K = kerbside, R = roadside, UB = urban background, S = suburban, Ru = rural

Figure 4-5: Annual mean NO_2 concentrations (NOT adjusted for diffusion tube bias)



4.4 Hydrocarbons

Full monthly results of the hydrocarbon survey for the five BTEX sites and a summary of the annual average hydrocarbon concentrations are shown in Appendix 4. Travel blank values are included in Appendix 4. These gave consistently lower results than the exposed tubes.

Table 4–5 Summary of average hydrocarbon concentrations (µg m^{-3}), Jersey, 2019

Site	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene
Le Bas Centre	0.6	0.6	1.7	0.7	2.4
Halkett Place (Central Market)	0.7	2.6	3.7	1.4	2.6
Harrington's Garage	0.8	0.9	2.3	1	4.9
Hansford Lane	0.4	0.9	2.9	0.9	2.6
Faux Bie Terrace	0.9	1.4	3.6	1.4	5.6
Travel blank	0.1	0.2	0.1	0.2	0.1

Highest annual mean concentrations of benzene in 2019 were measured at Faux Bie, which is between a petrol station and the nearest housing to it (12m from flats). It is likely that the evaporation of benzene and toluene, from fuel as it is stored or dispensed, is contributing to ambient levels.

The trend at Faux Bie Terrace for the concentrations of all species to increase year on year, particularly since 2012, appears to have stopped over the past two years, with all hydrocarbon pollutants decreasing at this location. The reasons for this cannot be determined from the results alone and may be due to numerous factors relating to the fuel filling station (its infrastructure, usage and vapour recovery technologies employed), meteorological conditions and other layouts and usage of space in the area surrounding the tube location. The fuel storage tanks were replaced during August 2017 incorporating an upgraded vapour recovery system. Although this is likely a contributing factor to the lower readings since the end of 2017, the readings had begun to decline before this work took place. Further investigation into the filling station usage and monitoring location infrastructure would be required to more accurately assess the cause of the increase in concentrations should the trend re-appear in future years and if deemed necessary. It is important to note that, despite the higher concentrations at Faux Bie Terrace compared to other Jersey sites, the annual mean of 0.9 µg m^{-3} for Benzene is still well below the annual limit value of 5 µg m^{-3}.

The Hansford Lane site (near a paint spraying process) has in the past measured relatively high concentrations of m+p-xylene and o-xylene while not thought to be a significant source of benzene or toluene. Graphical representations of monthly mean hydrocarbon concentrations are shown in Figure 4-6 to Figure 4-10.

The Airport Fence location was discontinued as the end of 2018 as results were representative of traffic emissions from the Grand Route de St Pierre, rather than aircraft activity. The site was relocated to Harrington's Garage beginning in January 2019 which represents relevant exposure to the public from a typical domestic fuel filling station.

Figure 4-6: Monthly mean hydrocarbon concentrations at Le Bas Centre, 2019

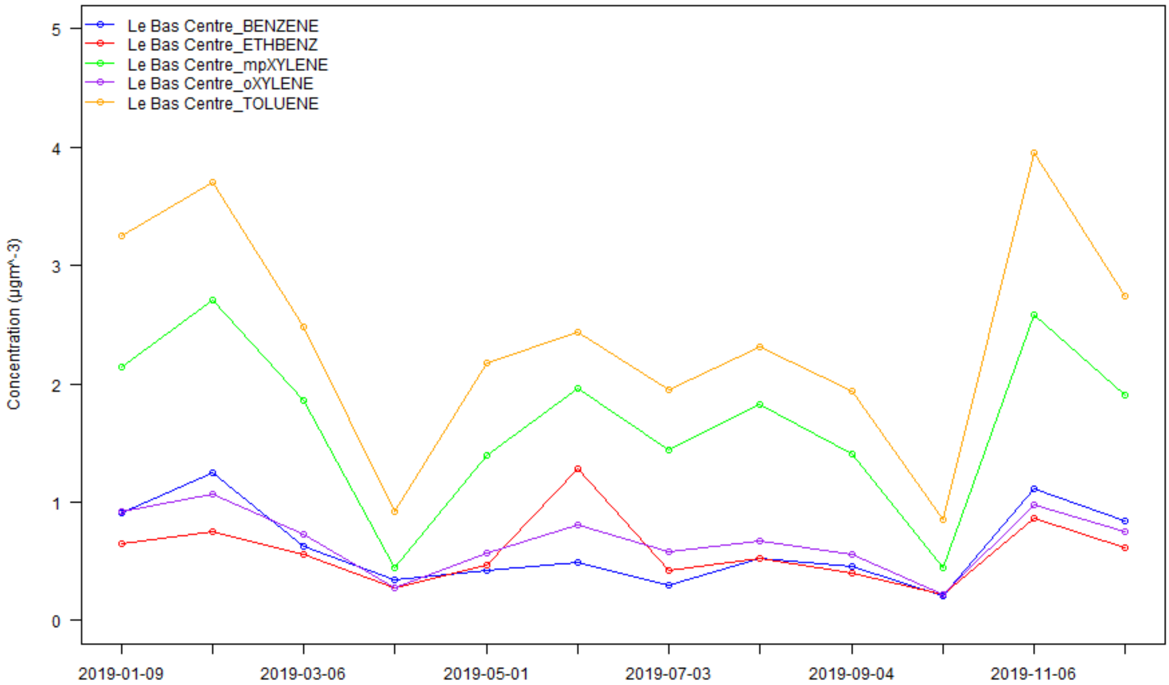


Figure 4-7 Monthly mean hydrocarbon concentrations at Halkett Place, 2019

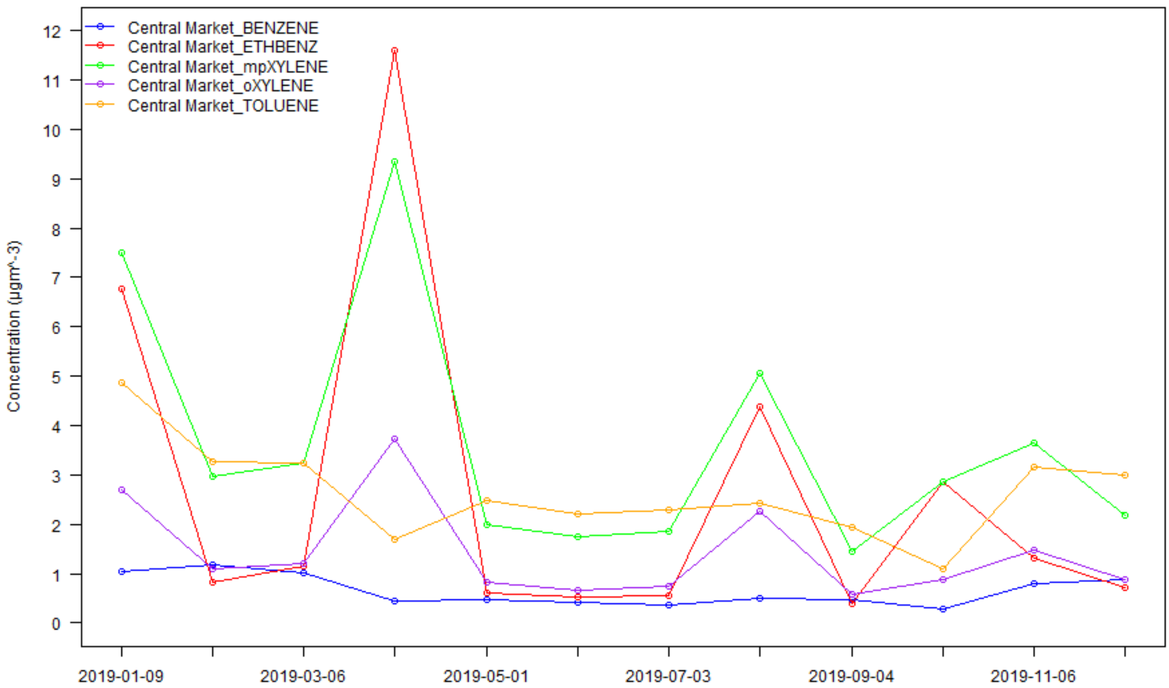


Figure 4-8: Monthly mean hydrocarbon concentrations at Harrington's Garage, 2019

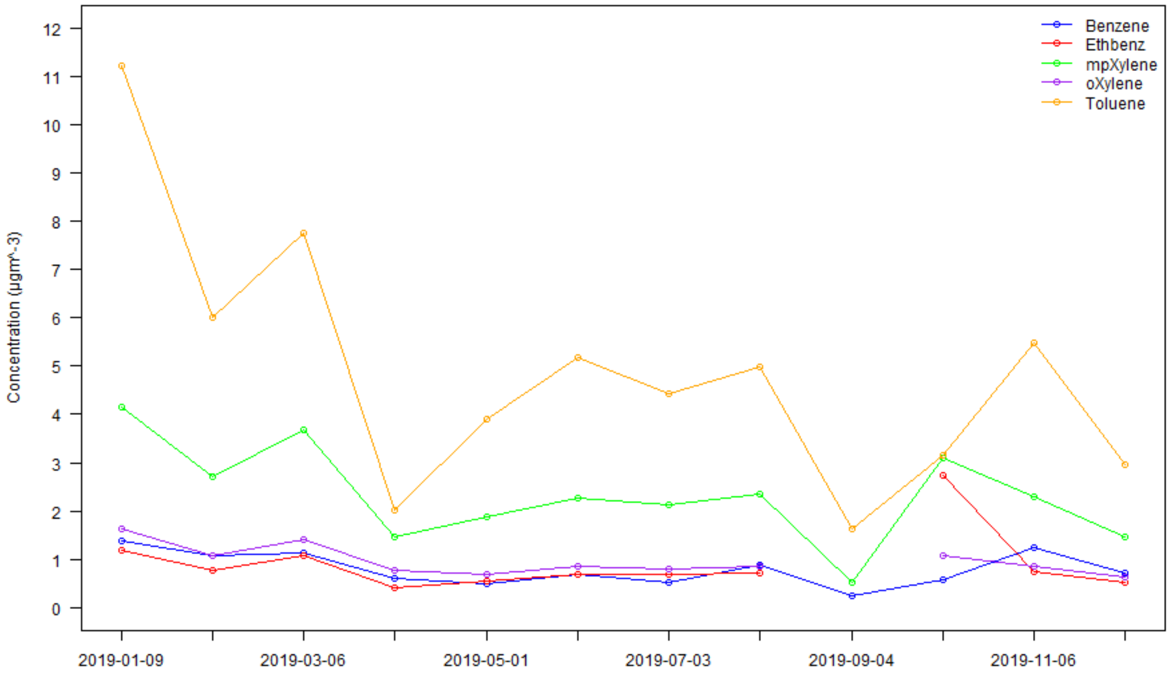


Figure 4-9: Monthly mean hydrocarbon concentrations at Hansford Lane, 2019

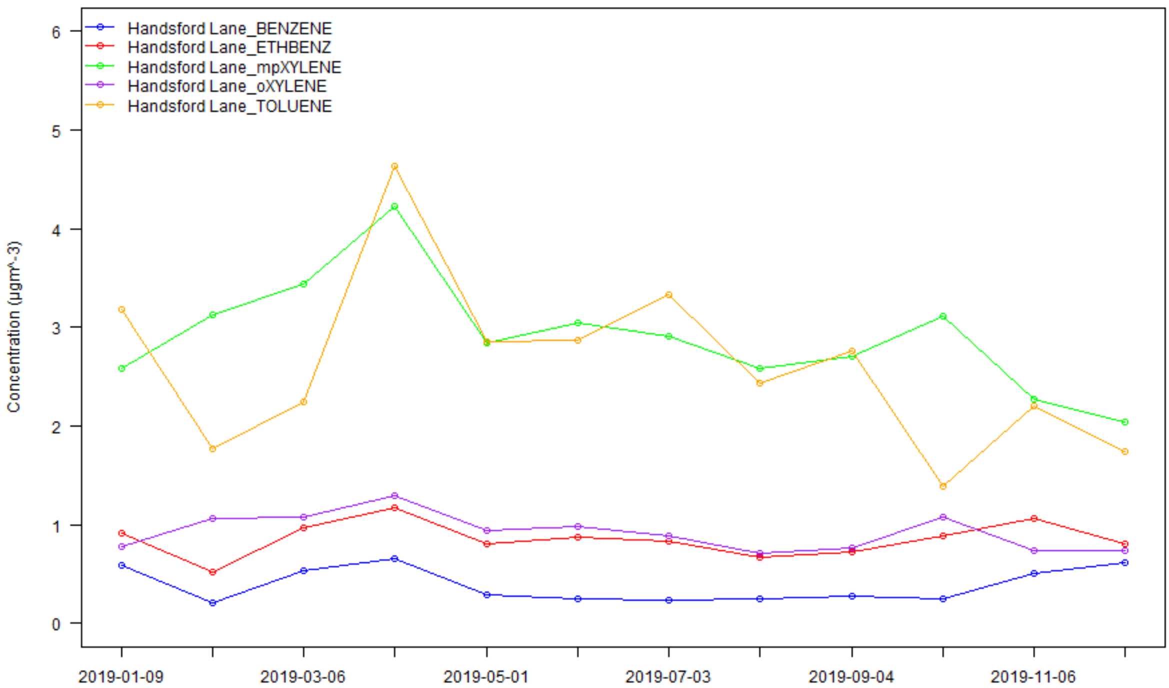
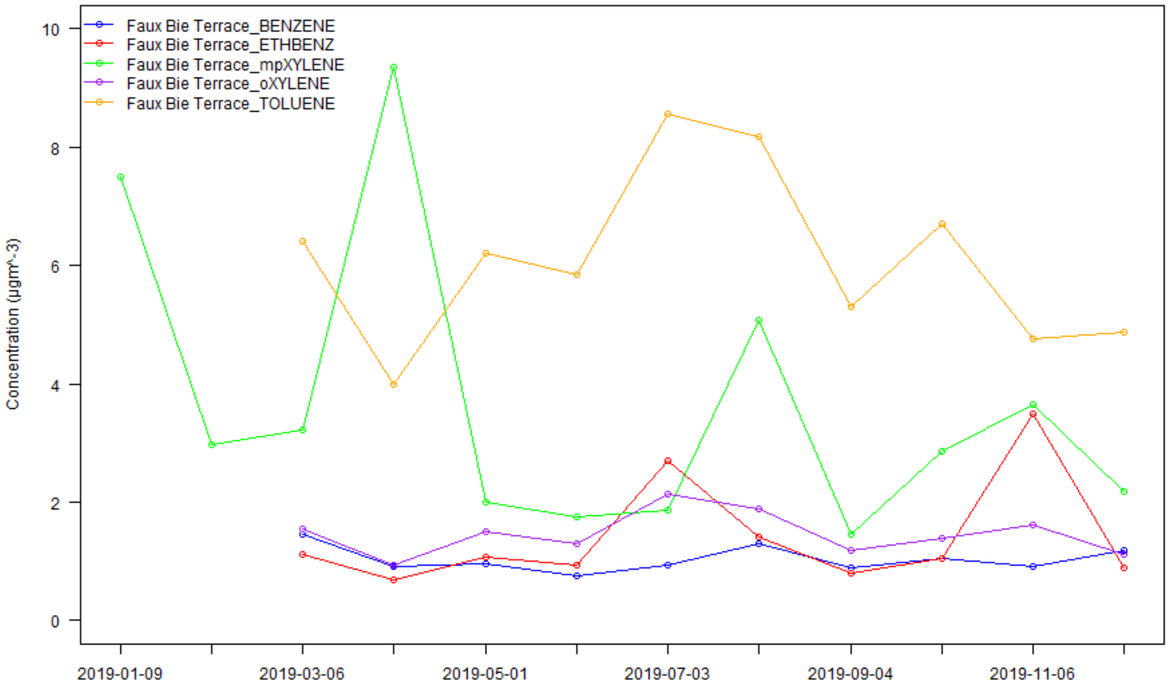


Figure 4-10: Monthly mean hydrocarbon concentrations at Faux Bie, 2019



The charts clearly show the differences in hydrocarbon concentrations between each location. The Le Bas Centre site recorded the lowest concentrations of all the BTEX hydrocarbons, occasionally below the detection limit except for Benzene. Data from Faux Bie are absent for January and February, this was because in January the sampling tube was missing upon collection and in February a tube was not deployed.

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 Air Quality Directive[4] sets a limit of 5 µg m^{-3} for the annual mean of benzene, to be achieved by 2010. All sites met this limit in 2019 and have done so since 1999 (or since they started operation).

The UK Air Quality Strategy[5] sets the following objectives for benzene:

- 16.25 µg m^{-3} (for the running annual mean), to have been achieved by 31st December 2003.
- 5 µg m^{-3} (for the calendar year mean), to have been achieved by 31st December 2010 in England and Wales. This is the same as the EC limit value.
- 3.25 µg m^{-3} (for the calendar year mean), to have been achieved by 31st December 2010 in Scotland and Northern Ireland.

These AQS objectives are not at present mandatory in Jersey.

The annual mean benzene concentration (which can be considered a good indicator of the running annual mean) was well within the 2003 objective of 16.25 µg m^{-3} at all the Jersey sites. The calendar year mean benzene concentration was below 3.25 µg m^{-3} at all Jersey sites. Therefore, these sites meet the tightest AQS objectives for benzene (those applying to Scotland and Northern Ireland).

4.4.2 Comparison with Previous Years' Hydrocarbon Results

Figure 4-11 to Figure 4-15 show how the annual mean hydrocarbon concentrations at the five Jersey sites have changed over the years of monitoring. The data is also provided in tabular form in Appendix 4.

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 4-11: Time series of benzene concentrations

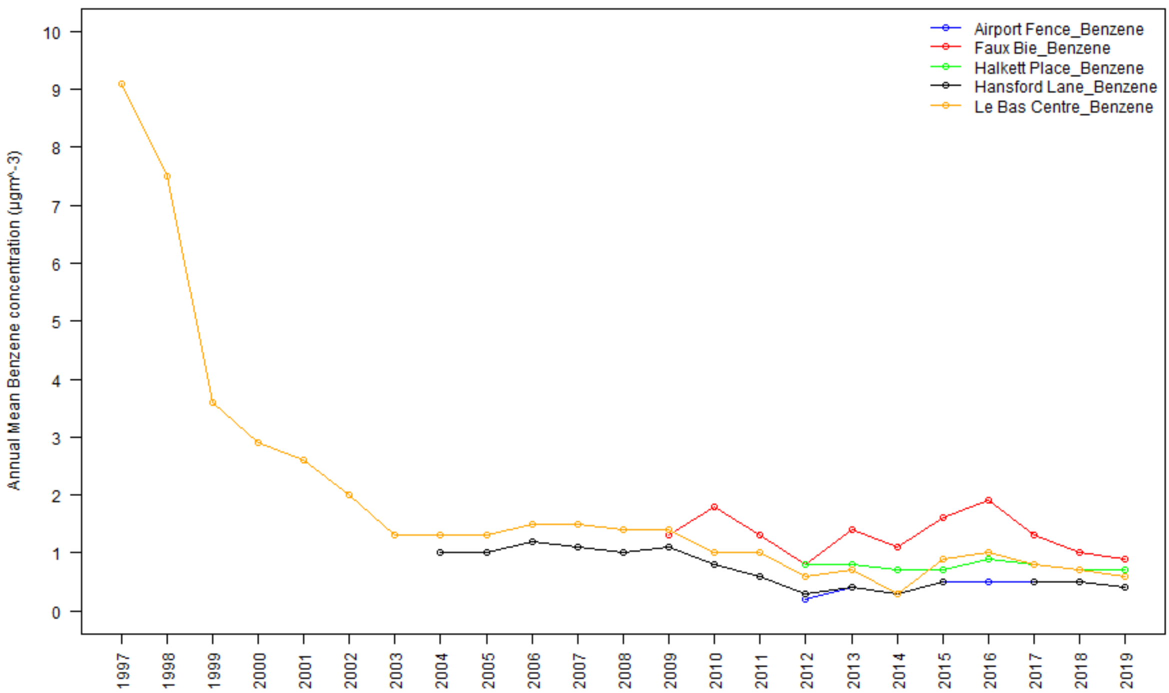
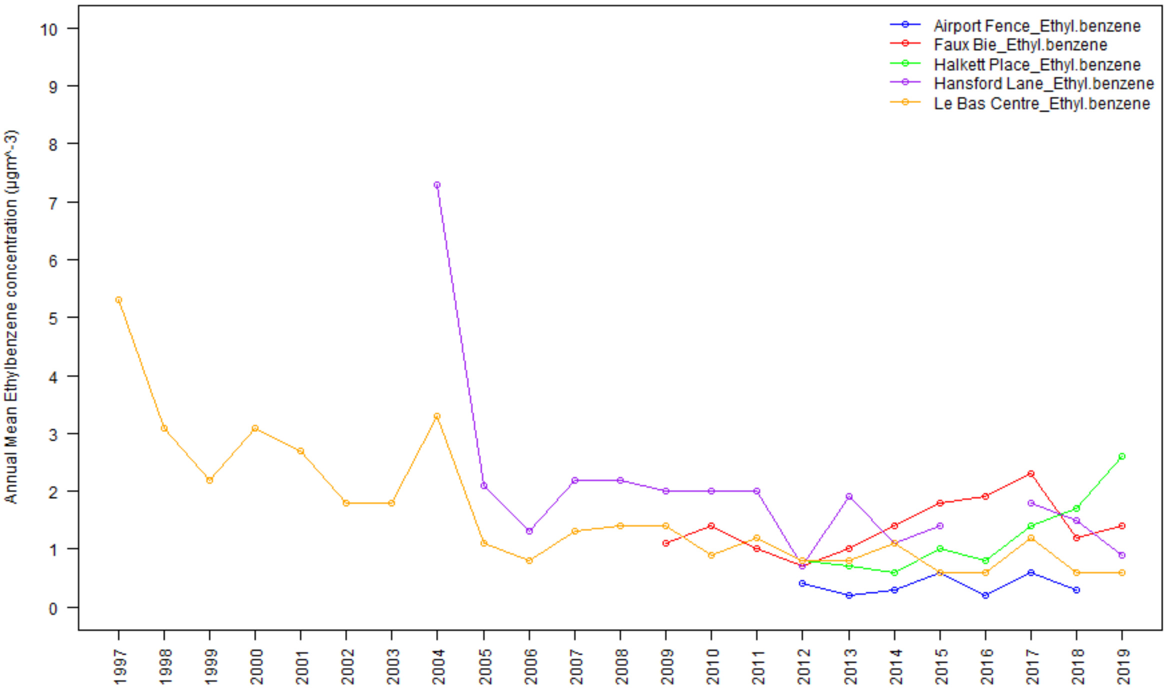


Figure 4-11 shows the annual mean benzene concentrations. The EU limit value is 5 µg m^{-3} and the Typical LoD as concentration equivalent is 0.097 µg m^{-3}. Le Bas Centre has been in operation since 1997 and the annual mean concentrations of benzene show a marked drop over the years running to the year 2000 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. This site has shown a further modest decrease between 2009 and 2012, as has Hansford Lane. Annual mean concentrations at all sites were equal to or lower than 1 µg m^{-3} in 2019 and represent a similar annual average to concentrations measured in 2018.

Figure 4-12: Time series of toluene concentrations

Figure 4-12 shows toluene concentrations. The ambient concentration equivalent to the typical LoD for toluene is 0.11 µg m^{-3}. The two longest-running sites, Le Bas Centre and Hansford Lane, show general decreases over the past twelve years, though these are not consistent. All sites have had relatively stable yearly averages since 2012 except for concentrations at the Faux Bie site which have increased year on year between 2012 and 2016. However, concentrations decreased considerably until 2018 where they have remained similar in 2019. 2019 average concentrations at Harrington's Garage were 4.9 µg m^{-3}, only Faux Bie Terrace measured higher than this in 2019.

Figure 4-13: Time series of ethylbenzene concentrations



The pattern for ethylbenzene, Figure 4-13, generally show all sites bar Halkett Place and Hansford Lane showing relatively annual averages between over the past two years. In 2019 ethylbenzene concentrations at Halkett place increased considerably whereas 2019 concentrations at Hansford Lane decreased. This illustrates that local meteorological conditions and other local factors can strongly influence measurements.

Figure 4-14 Time series of m+p-xylene concentrations

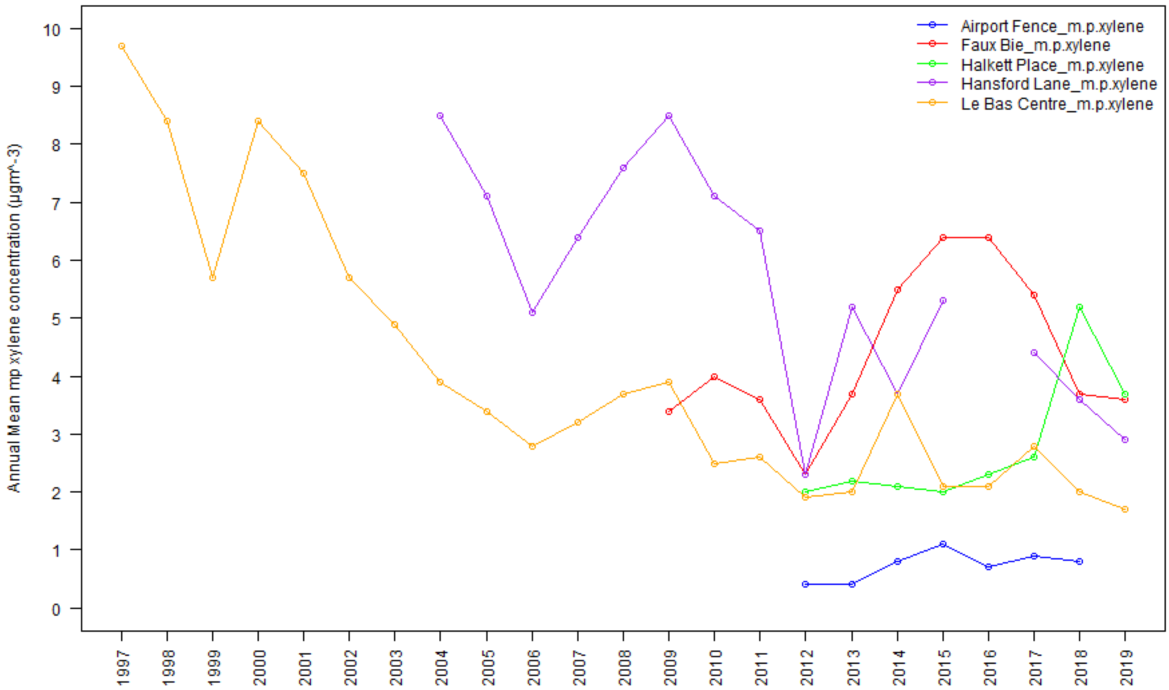
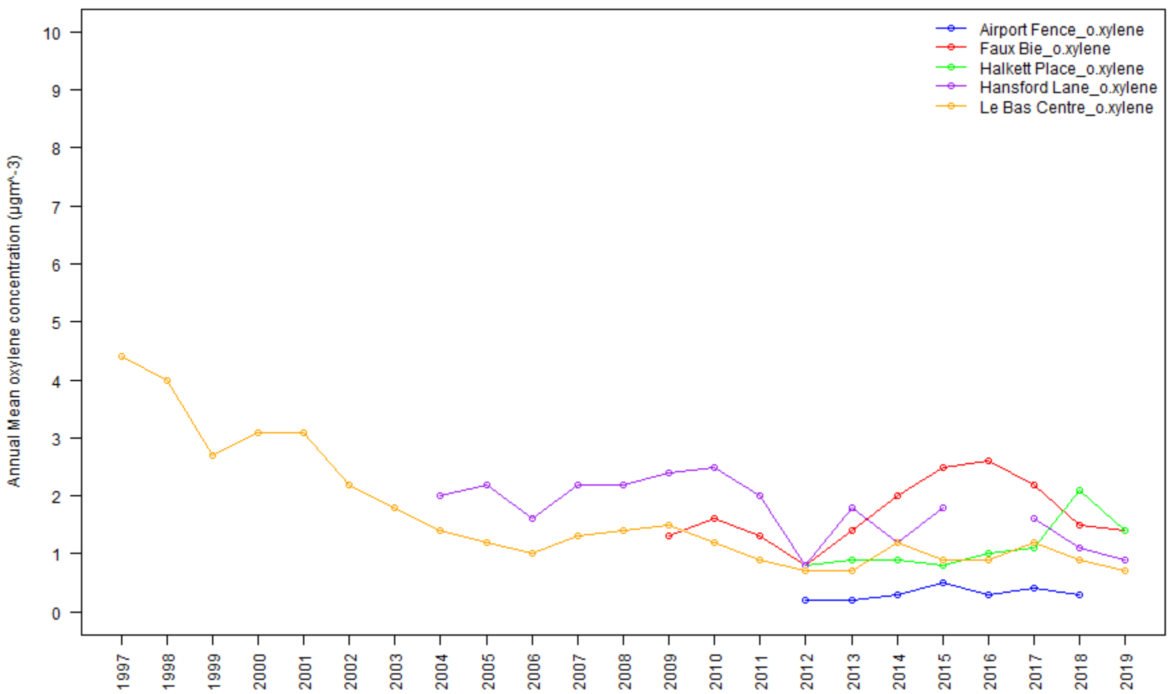


Figure 4-15 Time series of o-xylene concentrations



Concentrations of xylenes (Figure 4-14 and Figure 4-15) have generally decreased since monitoring began with the exception of Faux Bie which has seen a steady increase since 2012, though this has started to decrease again since 2017. At Hansford Lane (near the paint spraying process), concentrations of m+p-xylene and of o-xylene have fluctuated considerably from year to year; however, overall concentrations are low and the general trend is one that is decreasing.

M+pxylene and oxylene concentrations in 2019 at Harrington's Garage measured 2.3 and 1 respectively µg m^{-3}, a further detailed analysis of annual concentrations at this site will be made as multiple years of data are obtained.

It is also important to note how low current hydrocarbon concentrations are, compared to the LoD equivalent concentration (in 2019, typically around 0.15 µg m^{-3} for benzene, 0.15 µg m^{-3} for toluene and 0.12 µg m^{-3} for the other hydrocarbons).

5 Conclusions and Recommendations

Ricardo Energy & Environment has continued the ongoing air quality monitoring programme in Jersey during 2019, on behalf of the Government of Jersey Public Health Services. This was the 23rd 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. Diffusion tubes were also co-located (in triplicate) with the automatic site at Halkett Place. This was supplemented by diffusion tubes for indicative monitoring of NO_2 at an additional 16 sites around the island.

Hydrocarbons (benzene, toluene, ethylbenzene and xylenes, collectively termed BTEX) were measured at five sites, using diffusion tubes. The sites were located at a range of different locations on the island, one of which has been in operation since 1997.

5.1 NO_2 Results

1. The annual mean NO_2 concentration measured by the automatic analyser at Halkett Place was 22 µg m^{-3}. This is within the EC Directive limit value and AQS objective of 40 µg m^{-3} for annual mean NO_2. Having achieved compliance by 2010 as required by all European Union member states the Government of Jersey are advised to continue to demonstrate ongoing compliance as has been done since 2010.
2. The EC Directive limit value (and AQS objective) for 1-hour mean NO_2 concentration is 200 µg m^{-3}, with 18 exceedances permitted per calendar year. There were four hourly means greater than this value measured at Halkett Place. Therefore, Halkett Place met the limit value objective.
3. Diffusion tubes exposed in triplicate alongside the automatic analyser gave an annual mean of 22 µg m^{-3}, which was the same as the annual mean measured by the automatic analyser.
4. Annual mean NO_2 concentrations at all diffusion tube monitoring sites were within the EC limit value.
5. The diurnal variation in oxide concentrations of nitrogen at Halkett Place were generally typical of an urban site but had a particularly early (and sharp) morning rush hour peak, with a slight afternoon rush hour peak. This is thought to be due to traffic patterns around the site; this being early morning traffic associated with the market and waste collection from the previous day. Refrigerated and refuse lorries are commonly left with engines running to allow them to cool and lift bins respectively.
6. Monthly mean NO_2 concentrations at the diffusion tube sites showed a slight seasonal pattern did not show a typical seasonal pattern; on average the highest concentrations in 2019 were generally measured in January although this is site dependent.
7. Annual mean NO_2 concentrations at Jersey's urban sites appear to have generally decreased between 2003 and 2012. Since then, concentrations have remained generally stable at most sites, with a general slight increase occurring in 2019.
8. Annual mean NO_2 concentrations at a number of Jersey's diffusion tube monitoring sites were higher in 2019 compared with 2018. Pollutant concentrations are expected to fluctuate from year to year, due to meteorological and other factors.

5.2 Hydrocarbon Diffusion Tube Results

1. Annual mean benzene concentrations at all four sites with annual averages were within the EC Directive limit value of 5 µg m^{-3}. Having achieved compliance by 2010 as required, the Government of Jersey must continue to demonstrate ongoing compliance.
2. The Le Bas Centre site recorded the lowest concentrations of all the BTEX hydrocarbons, and several results were below the limit of detection of the method.
3. Annual mean concentrations of BTEX hydrocarbons were comparable with those measured in recent years, except for xylenes at Halkett Place due to a decrease in levels since elevated levels were recorded in July 2018. Ethylbenzene at Halkett place demonstrated a sharp increase when compared to 2018.

5.3 Recommendations

It is recommended that the monitoring programme be continued as part of Jersey's Air Quality Strategy[10].

Measured concentrations of BTEX hydrocarbons at most of the sites were very low. The results should therefore only be taken as indicative measurements, for the purpose of confirming that benzene concentrations at the sites are within relevant limit values. However, if accurate measurement of hydrocarbons are required, it may be appropriate to consider installation of pumped-tube sampling at key sites, as used at UK mainland Non-Automatic Hydrocarbon Network sites. It is recommended that the Handsford Lane site is discontinued with a new site identified if required, this is because benzene concentrations sit at only 8% of the limit value and have been low for a number of years now.

A review of the diffusion tube network is recommended to assess any sites that no longer represent relevant exposure and can be removed or relocated.

The diffusion tube results indicate no sites breaching or close to the annual average NO_2 limit values. As such, an expansion of the automatic NOx monitoring network is not recommended at this time. Based on the 2019 Clean Air Strategy[11] and its emphasis on $PM_{2.5}$ reduction the Government of Jersey may wish to install reference equivalent analysers in an aim to expanding their particulate monitoring network and demonstrating compliance with the annual WHO $PM_{2.5}$ guideline of 10 µg m^{-3}.

6 Acknowledgements

Ricardo Energy & Environment gratefully acknowledges the help and support of the staff of the Government of Jersey Environmental Health in this monitoring study.

7 References

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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 and annual means 1997 - 2019

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

Table A1- 1 Nitrogen Dioxide

Guideline set by	Description	Criteria based on	Value[1]/µg m^{-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)
ED Directive on Ambient Air Quality and Cleaner Air for Europe[4]	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[5] (Non-Mandatory Guidelines)	Health Guideline	1-hour mean	200
	Health Guideline	Annual mean	40

[1] Conversions between µg m^{-3} and ppb are as used by the EC, i.e. 1 ppb NO_2 = 1.91 µg m^{-3} at 20 °C and 1013 mB.
[2] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. March 2011.
[3] Air Quality Regulations 2007 (SI 2007/64), Air Quality Standards (Wales) Regulations 2007 (Welsh SI 2007 717 (W63)), Air Quality Standards (Scotland) Regulations 2007 (SSI 2007 No. 182), Air Quality Standards (Northern Ireland) Regulations 2007 (Statutory Rule 2007 No. 265).
[4] Council Directive 2008/50/EC.
[5] WHO Air Quality Guidelines for Europe (2000).

Table A1- 2 Benzene

Guideline set by	Description	Criteria based on	Value[6]/µg m^{-3} (ppb)
The Air Quality Strategy[7,8] All UK	Objective for Dec. 31st 2003	Running annual mean	16.25 (5)
England[9] & Wales[10] only:	Objective for Dec. 31st 2010	Annual mean	5 (1.54)
Scotland[11] & Northern Ireland	Objective for Dec. 31st 2010	Running annual mean	3.25 (1.0)
ED Directive on Ambient Air Quality and Cleaner Air for Europe **[12]**	Limit Value. To be achieved by Jan 1st 2010	Annual calendar year mean	5 (1.5)

Table A1- 3 Toluene

Guideline set by	Description	Criteria based on	Value[1]/µg m^{-3} (ppb)
World Health Organisation[13] (Non-Mandatory Guideline)	Health Guideline	1-week mean	260 µg m^{-3} or 0.26 mg m^{-3}

[6] Conversions between µg m^{-3} and ppb are as used by the EC, i.e. 1 ppb NO_2 = 1.91 µg m^{-3} at 20 °C and 1013 mB.
[7] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. July 2007, The Stationery Office, ID 5611194 07/07.
[8] 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)).
[9] Air Quality (Amendment) (England) Regulations 2002 (SI 2002/3043).
[10] Air Quality (Amendment) (Wales) Regulations 2002 (SI 2002/3182 (W298)).
[11] Air Quality (Amendment) (Scotland) Regulations 2002 (SI 2002/297).
[12] Council Directive 2008/50/EC.
[13] WHO Air Quality Guidelines for Europe (2000).

Appendix 2 - Calibration procedures for automatic analyser

The analyser at Halkett Place is calibrated monthly by the Environmental Health 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 from the Gas Standards Calibration Laboratory at Ricardo Energy & Environment. 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.

An important aspect of QA/QC procedures is the annual intercalibration and audit check undertaken every 12 months. This audit has two principal 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. Ricardo Energy & Environment's audit calibration procedures are UKAS accredited to ISO 17025.

At these visits, the essential functional parameters of the monitors, such as noise, linearity and, for the NO_x monitor, the efficiency of the NO_2 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. In 2019 this exercise was followed by a full service of the analyser and sampler pump.

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_x 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_2) is calculated as follows.

Percentage bias B = 100 x (D - C) / C

Where D = the average NO_2 concentration as measured using diffusion tubes; and

C = the average NO_2 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_2 concentrations as measured using diffusion tubes and the automatic analyser respectively, as above.

These calculations were carried out using a spreadsheet tool developed by Ricardo Energy & Environment (at that time trading as AEA Energy & Environment): Figure A3- 1, see below. This spreadsheet shows the diffusion tube concentrations to one 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, except at the sites with lowest concentrations.

Figure A3- 1 Precision and bias spreadsheet showing Halkett Place dataset

	Diffusion Tubes Measurements									Automatic Method		Data Quality Check	
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm⁻³	Tube 2 µgm⁻³	Tube 3 µgm⁻³	Triplicate Mean	Standard Deviation	Coefficient of Variation	95% CI of mean	Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor
1	09/01/2019	06/02/2019	27.2	27.3	28.6	28	0.8	3	1.9	27	95.8	Good	Good
2	06/02/2019	06/03/2019	28.0	24.3	25.7	26	1.9	7	4.6	26	95.7	Good	Good
3	06/03/2019	03/04/2019	29.6	28.2	28.1	29	0.8	3	2.1	25	95.2	Good	Good
4	03/04/2019	01/05/2019	25.5	23.7	24.9	25	0.9	4	2.3	22	96.1	Good	Good
5	01/05/2019	05/06/2019	24.1	23.0	23.6	24	0.6	2	1.4	21	95.8	Good	Good
6	05/06/2019	03/07/2019	23.7	23.0	23.8	24	0.4	2	1.1	20	96.3	Good	Good
7	03/07/2019	07/08/2019	22.9	23.9	22.8	23	0.6	3	1.5	19	95.6	Good	Good
8	07/08/2019	04/09/2019	23.1	23.1	23.0	23	0.1	0	0.1	20	95.2	Good	Good
9	04/09/2019	02/10/2019	20.5	20.5	19.9	20	0.3	2	0.9	17	95.4	Good	Good
10	02/10/2019	06/11/2019	25.2	22.5	21.8	23	1.8	8	4.5	20	95.4	Good	Good
11	06/11/2019	04/12/2019	21.3	25.7		24	3.1	13	28.0	24	94.8	Good	Good
12	04/12/2019	09/01/2020	22.3	22.1	22.5	22	0.2	1	0.5	20	96.6	Good	Good
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Good Overall DC

(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Jersey Halkett Place

Precision: 12 out of 12 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval) without periods with CV larger than 20%

Bias calculated using 12 periods of data

Bias factor A 0.91 (0.87 - 0.95)

Bias B 10% (5% - 15%)

Diffusion Tubes Mean: 24 µgm⁻³

Mean CV (Precision): 4

Automatic Mean: 22 µgm⁻³

Data Capture for periods used: 96%

Adjusted Tubes Mean: 22 (21 - 23) µgm⁻³

Accuracy (with 95% confidence interval) WITH ALL DATA

Bias calculated using 12 periods of data

Bias factor A 0.91 (0.87 - 0.95)

Bias B 10% (5% - 15%)

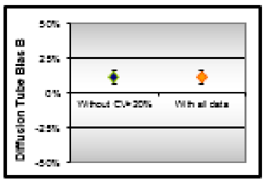
Diffusion Tubes Mean: 24 µgm⁻³

Mean CV (Precision): 4

Automatic Mean: 22 µgm⁻³

Data Capture for periods used: 96%

Adjusted Tubes Mean: 22 (21 - 23) µgm⁻³



Jaume Targa, for AEA

Version 04 - February 2011

Appendix 4 - BTEX diffusion tubes: Monthly dataset and annual means 1997 - 2019

Figures in red are results less than the analytical limit of detection. They have been treated as ½ LoD for calculation purposes. Results are supplied in units of parts per billion (ppb) and converted.

Table A4- 1 Monthly mean hydrocarbon concentrations, µg m^{-3} – Le Bas Centre

Le Bas Centre	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene
09/01/2019	0.91	3.25	0.65	2.14	0.92
06/02/2019	1.25	3.70	0.75	2.71	1.07
06/03/2019	0.63	2.48	0.56	1.86	0.73
03/04/2019	0.34	0.92	0.27	0.45	0.27
01/05/2019	0.42	2.18	0.46	1.39	0.56
05/06/2019	0.49	2.43	1.28	1.96	0.81
03/07/2019	0.30	1.95	0.43	1.44	0.58
07/08/2019	0.53	2.31	0.52	1.82	0.67
04/09/2019	0.46	1.94	0.40	1.41	0.56
02/10/2019	0.21	0.85	0.22	0.44	0.22
06/11/2019	1.11	3.95	0.86	2.58	0.98
04/12/2019	0.84	2.74	0.61	1.91	0.75
Average	**0.63**	**2.39**	**0.58**	**1.68**	**0.68**

Table A4- 2 Monthly mean hydrocarbon concentrations, µg m^{-3} – Halkett Place

Halkett Place	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene
09/01/2019	1.05	4.87	6.76	7.49	2.70
06/02/2019	1.18	3.25	0.81	2.97	1.09
06/03/2019	1.03	3.24	1.16	3.23	1.20
03/04/2019	0.46	1.68	11.59	9.35	3.72
01/05/2019	0.48	2.48	0.60	2.00	0.82
05/06/2019	0.42	2.20	0.51	1.74	0.65
03/07/2019	0.37	2.29	0.57	1.86	0.76
07/08/2019	0.51	2.43	4.38	5.07	2.26
04/09/2019	0.47	1.94	0.40	1.45	0.59
02/10/2019	0.29	1.10	2.86	2.86	0.89
06/11/2019	0.81	3.15	1.31	3.66	1.46
04/12/2019	0.88	3.00	0.72	2.18	0.88
Average	**0.66**	**2.64**	**2.64**	**3.65**	**1.42**

Table A4- 3 Monthly mean hydrocarbon concentrations, µg m^{-3} – Harrington's Garage

Harrington's Garage	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene
09/01/2019	1.37	11.22	1.19	4.14	1.63
06/02/2019	1.07	6.00	0.77	2.72	1.07
06/03/2019	1.12	7.76	1.08	3.68	1.41
03/04/2019	0.60	2.02	0.41	1.46	0.78
01/05/2019	0.50	3.92	0.55	1.88	0.69
05/06/2019	0.68	5.17	0.69	2.26	0.85
03/07/2019	0.51	4.42	0.69	2.11	0.81
07/08/2019	0.87	4.97	0.70	2.36	0.85
04/09/2019	0.24	1.64	N/A	0.52	N/A
02/10/2019	0.57	3.15	2.75	3.10	1.08
06/11/2019	1.24	5.48	0.73	2.29	0.86
04/12/2019	0.70	2.97	0.52	1.47	0.62
Average	**0.79**	**4.89**	**0.92**	**2.23**	**0.97**

Table A4- 4 Monthly mean hydrocarbon concentrations, µg m^{-3} – Hansford Lane

Hansford Lane	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene
09/01/2019	0.59	3.18	0.91	2.58	0.78
06/02/2019	0.21	1.77	0.52	3.13	1.06
06/03/2019	0.53	2.25	0.97	3.44	1.08
03/04/2019	0.65	4.63	1.18	4.23	1.30
01/05/2019	0.29	2.86	0.81	2.84	0.95
05/06/2019	0.24	2.86	0.87	3.04	0.98
03/07/2019	0.24	3.33	0.84	2.91	0.89
07/08/2019	0.25	2.43	0.67	2.59	0.71
04/09/2019	0.28	2.76	0.72	2.70	0.76
02/10/2019	0.24	1.39	0.89	3.11	1.08
06/11/2019	0.51	2.20	1.06	2.27	0.73
04/12/2019	0.62	1.74	0.81	2.04	0.74
Average	**0.39**	**6.08**	**0.85**	**2.91**	**0.92**

Table A4- 5 Monthly mean hydrocarbon concentrations, µg m^{-3} – Faux Bie

Faux Bie	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene
09/01/2019	N/A	N/A	N/A	N/A	N/A
06/02/2019	N/A	N/A	N/A	N/A	N/A
06/03/2019	1.45	6.42	1.12	4.09	1.54
03/04/2019	0.91	3.99	0.69	2.41	0.94
01/05/2019	0.96	6.21	1.08	3.94	1.51
05/06/2019	0.75	5.85	0.94	3.33	1.29
03/07/2019	0.94	8.55	2.70	5.91	2.13
07/08/2019	1.29	8.18	1.41	4.94	1.89
04/09/2019	0.90	5.30	0.81	3.09	1.18
02/10/2019	1.04	6.71	1.05	3.75	1.38
06/11/2019	0.92	4.75	3.50	4.59	1.62
*04/12/2019	1.19	4.88	0.89	2.92	1.11
Average	**1.04**	**6.08**	**1.42**	**3.90**	**1.46**

** Original measurements from December 2019 were those of the travel blank for the same period. It has been assumed that this was an error in analysis and therefore measurements of Faux Bie and the travel blanked were switched for December 2019.*

Table A4- 6 Monthly mean hydrocarbon concentrations, µg m^{-3} – Travel blank

Travel blank	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene
09/01/2019	0.04	0.25	0.14	0.24	0.05
06/02/2019	0.02	0.06	0.04	0.03	0.01
06/03/2019	0.13	0.05	0.03	0.06	0.03
03/04/2019	0.06	0.04	0.03	0.03	0.00
01/05/2019	0.08	0.05	0.01	0.09	0.03
05/06/2019	0.12	0.03	0.01	0.04	0.01
03/07/2019	0.12	0.02	0.00	0.02	0.00
07/08/2019	0.09	0.01	0.01	0.03	0.03
04/09/2019	0.07	0.10	0.02	0.04	0.01
02/10/2019	0.10	0.05	0.02	0.03	0.02
06/11/2019	4.38	0.66	0.11	0.24	0.09
*04/12/2019	0.16	0.17	0.21	0.21	0.21
Average	**0.53**	**0.12**	**0.05**	**0.09**	**0.04**

** Original measurements from December 2019 were those of Faux Bie for the same period. It has been assumed that this was an error in analysis and therefore measurements of Faux Bie and the travel blanked were switched for December 2019.*

Table A4- 7 Comparison of hydrocarbon concentrations, Jersey, 1997 – 2019

	Benzene µg m^{-3}	Toluene µg m^{-3}	Ethylbenzene µg m^{-3}	m+p-xylene µg m^{-3}	o-xylene µg m^{-3}
Le Bas Centre					
1997	9.1	17.2	5.3	9.7	4.4
1998	7.5	16.1	3.1	8.4	4
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	8	1.8	5.7	2.2
2003	1.3	8	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
2007	1.5	6.5	1.3	3.2	1.3
2008	1.4	5.6	1.4	3.7	1.4
2009	1.4	5.4	1.4	3.9	1.5
2010	1	3.6	0.9	2.5	1.2
2011	1	5.1	1.2	2.6	0.9
2012	0.6	3	0.8	1.9	0.7
2013	0.7	2.4	0.8	2.0	0.7
2014	0.5	2.1	0.5	1.7	0.6
2015	0.9	2.6	0.6	2.1	0.9
2016	1	2.5	0.6	2.1	0.9
2017	0.8	2.5	1.2	2.8	1.2
2018	0.7	2.6	0.6	2	0.9
2019	0.6	2.4	0.6	1.7	0.7
Halkett Place					
2012	0.8	3.1	0.8	2	0.8
2013	0.8	2.9	0.7	2.2	0.9
2014	0.7	2.9	0.6	2.1	0.9
2015	0.7	2.3	1.0	2.0	0.8
2016	0.9	2.9	0.8	2.3	1
2017	0.8	2.6	1.4	2.6	1.1
2018	0.7	3.2	1.7	5.2	2.1
2019	0.7	2.6	2.6	3.7	1.4
Harrington's Garage					
2019	0.8	4.9	0.9	2.3	1.0
Hansford Lane					
2004	1	16.1	7.3	8.5	2
2005	1	3.7	2.1	7.1	2.2
2006	1.2	4.8	1.3	5.1	1.6

Table A4- 8 (Continued) Comparison of hydrocarbon concentrations, Jersey, 1997 – 2019

	Benzene µg m^{-3}	Toluene µg m^{-3}	Ethylbenzene µg m^{-3}	m+p-xylene µg m^{-3}	o-xylene µg m^{-3}
2007	1.1	6.7	2.2	6.4	2.2
2008	1	4	2.2	7.6	2.2
2009	1.1	4.9	2	8.5	2.4
2010	0.8	2.6	2	7.1	2.5
2011	0.6	1.9	2	6.5	2
2012	0.3	1.1	0.7	2.3	0.8
2013	0.4	2.6	1.9	5.2	1.8
2014	0.3	2.1	1.1	3.7	1.2
2015	0.5	2.9	1.4	5.3	1.8
2016	N/A	N/A	N/A	N/A	N/A
2017	0.5	2.8	1.8	4.4	1.6
2018	0.5	2.8	1.5	3.6	1.1
2019	0.4	2.6	0.9	2.9	0.9
Faux Bie					
2009	1.3	5.5	1.1	3.4	1.3
2010	1.8	6.7	1.4	4	1.6
2011	1.3	6.2	1	3.6	1.3
2012	0.8	4.5	0.7	2.3	0.8
2013	1.4	6.7	1.0	3.7	1.4
2014	1.1	8.7	1.4	5.5	2.0
2015	1.6	10.3	1.8	6.4	2.5
2016	1.9	12	1.9	6.4	2.6
2017	1.3	8.6	2.3	5.4	2.2
2018	1	5.7	1.2	3.7	1.5
2019	1	6.1	1.4	3.9	1.5

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR
United Kingdom

t: +44 (0)1235 753000
e: enquiry@ricardo.com

ee.ricardo.com