Bureau Veritas UK Ltd

LONDON WIDE ENVIRONMENT PROGRAMME

Nitrogen Dioxide Diffusion Tube Survey Annual Report 2008

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Clients

London Borough of Brent
London Borough of Bexley
London Borough of Croydon
Corporation of London
London Borough of Greenwich
London Borough of Hammersmith & Fulham
London Borough of Hillingdon
London Borough of Hounslow
Royal Borough of Kensington & Chelsea
London Borough of Lewisham
London Borough of Newham
London Borough of Richmond Upon Thames
City of Westminster

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Executive Summary

Bureau Veritas and its predecessor, have undertaken the London-Wide Environment Programme (LWEP) since 1986. The LWEP consists of the monitoring, analysis and reporting of key environmental indicators throughout the Greater London region. This report addresses one of these indicators – nitrogen dioxide (NO_2) concentrations in the air.

Nitrogen dioxide has been regarded as a one of the main pollutants that needs to be targeted due to high road traffic emissions levels in London. London Boroughs have a statutory duty to regularly review and assess air quality. This process is coupled with the Greater London Authority’s air quality management schemes that are outlined in the Mayor’s strategy, and which takes an over-arching view on London-wide air quality issues. Subsequent air quality management schemes that are to be introduced indicate the necessity for nitrogen dioxide monitoring data on a city-wide scale in order to estimate the effect on of the management schemes on a spatial and temporal basis. The LWEP is principally provided as a service for the London Boroughs.

In 2008, diffusion tubes were located at 307 monitoring sites spread over thirteen boroughs. Annual average NO_2 concentrations (January to December) that were above the 40 $\mu g/m^3$ Air Quality Objective were recorded at 29 urban background and 187 roadside sites; this is an increase of 3.6% in background sites and an increase of 18.8% in roadside sites compared to the previous year. Results from the 2008 survey indicate an overall decrease in annual mean NO_2 concentration at background sites, and an overall decrease at roadside sites compared to 2007.

The geographical spread shows higher concentrations in central parts of London and lower concentrations further away from the city centre. A few hot-spots are identified in boroughs on the outskirts of the city.

Long-term linear trend analysis continues to display a downward trend in annual mean NO_2 concentrations at urban background sites and an upward trend in roadside sites for the majority of participating Boroughs.

1 INTRODUCTION

In recent years, NO_2 diffusion tubes have proved to be a useful tool for local authorities in screening and baseline surveys, particularly with regards to the Review and Assessment of air quality for local air quality management (Part IV of the Environment Act 1995). Additionally, the Greater London Authority (GLA) has been given an important role to play in air quality management by virtue of the London Air Quality Strategy that must be taken into consideration by the local authorities when carrying out their statutory duties.

In year 2008 a total of twelve London Boroughs returned with one new Borough to participate in the nitrogen dioxide London-Wide Environment Programme:

- London Borough of Bexley
- London Borough of Brent
- Corporation of London
- London Borough of Croydon
- London Borough of Greenwich
- London Borough of Hammersmith & Fulham
- London Borough of Hillingdon
- London Borough of Hounslow
- Royal Borough of Kensington & Chelsea
- London Borough of Lewisham
- London Borough of Newham
- London Borough of Richmond-upon-Thames
- City of Westminster

1.1 Objectives

The overall objective of this report was to provide participating local authorities with an overview of the NO_2 concentrations recorded as part of the LWEP NO_2 Diffusion Tube Survey in 2008 and to view these results in the broader context of regulatory requirements and previous monitoring data.

This overall objective is met by:

- Outlining the reasons for undertaking the monitoring of ambient levels of NO_2;
- Outlining relevant existing and future legislative air quality requirements;
- Detailing the NO_2 sampling methods employed by Bureau Veritas in undertaking the LWEP NO_2 Diffusion Tube Survey, including the quality assurance and quality control procedures;
- Identifying the geographical spread of annual mean NO_2 concentration of participating boroughs at urban background and roadside sites;
- Assessing the long-term trends in NO_2 concentrations recorded as part of the LWEP NO_2 Diffusion Tube Survey since 1996;
- Reporting the annual mean NO_2 concentrations at each site for all participating boroughs in 2008 and to place these results in the context of other results gathered since 1996;
- Undertaking analysis of the results to assess trends in pollution at urban background and roadside sites for each participating borough;
- Identifying the elevation in NO_2 concentrations at roadside sites when compared to urban background levels;
- Validation of nitrogen dioxide diffusion tube data through the analysis of results from tubes co-located with automatic analysers.

2 FORMATION, SOURCES AND EFFECTS OF NO_2

2.1 Formation of atmospheric nitrogen dioxide

NO_2 is generated naturally and by man-made activities. NO_2 can be emitted directly (known as primary NO_2) or can form during a series of chemical reactions in the atmosphere involving NO_x ($NO + NO_2$) and ozone (referred to as secondary NO_2.) NO_2 can, in turn, act as a future source of oxygen in the formation of ozone under photochemical conditions. Due to the nature of the formation of NO_2 in the atmosphere, there is often an inverse relationship between concentrations of ozone and NO_2.

Combustion processes are the main anthropogenic source of NO_x emissions. These include road transport, power generation, and various high-temperature industrial processes.

The concentration of NO_2 in the atmosphere at any given location is influenced by a number of factors. These include the magnitude and proximity of NO_x emissions sources, the proportion of NO_x directly emitted as NO_2, the chemistry leading to the generation and destruction of NO_2, and meteorological conditions that affect the dispersion and accumulation of NO_2. During the winter months, anti-cyclonic weather systems often result in stable, cold weather conditions, which along with oxidation by atmospheric oxygen often give rise to pollution episodes. These are thought to be responsible for the extremely high NO_2 concentrations recorded over London in December 1991, when levels peaked at over 803.5 $\mu g/m^3$ in the evening rush hour. During the summer, increased temperatures and solar radiation serve to increase the rate of photochemical reactions in the atmosphere. The higher the concentration of NO_2, the more oxygen is available for the production of ozone leading to a general decrease in NO_2 when compared to the winter months.

2.2 Emission sources

Emissions inventories are an important means of quantifying emissions of NO_x from different sources at different times. The greatest contributor of nitrogen oxides (NO_x) in the UK is road transport. Fossil-fuelled power stations contributed around a quarter of the total NO_x, whilst the remainder comes from a variety of sources including industry and domestic activity.

Estimates indicate that 34% of total UK NOx emissions were produced by road transport in 2005[1]. Heavy-duty vehicles currently emit 43% of NOx emissions from road transport. However, these estimates are based on limited emissions tests on these vehicles. There has been a reduction in NO_x emissions from road transport since 1993 due to improvements in engine design, fitting of three-way catalysts and progressively stricter European vehicle emission standards for petrol cars. The contribution of road transport to NO_x emissions in urban areas is generally higher than the national average. In London 60% of NO_x emissions originate from road transport. Total UK emissions have fallen by 45% since 1990 as a result of alternative energy production and traffic abatement measures although these still comprise 59% of NOx emissions in 2005[2].

There is evidence that significant amounts of NO_2 are emitted directly from the tail pipe of diesel vehicles, with levels between 20 - 80% of total NO_X emissions. Primary emissions of NO_2 will be particularly significant for slow-moving buses and large HGVs, as well as Euro III diesel vans and taxis in the centre of towns and cities, as catalytically regenerative traps increase primary NO_2 emissions; these are fitted to 90% of London buses. The contribution from diesel cars in the UK partially results from the higher absolute emissions in comparison to petrol cars. At present there is no regulatory instrument to directly reduce NO_2 emissions only NOx and the TRAMAQ study shows in increase in NO_2 when newer vehicles complied to the new regulations on NO_x[3].

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[1] National Atmospheric Emissions Inventory (2007), UK Emissions of Air Pollutant 1970 - 2005

[2] National Atmospheric Emissions Inventory (2007) Air Quality Pollutant Inventories for England, Scotland, Wales and Northern Ireland 1990 – 2005.

[3] AQEQ (2007) Trends in Primary Nitrogen Dioxide in the UK

2.3 Health effects

Medical and epidemiological evidence suggests that nitrogen dioxide may have both acute and chronic effects on health.

Experimental evidence has shown that NO_2 probably exerts its biological damage by oxidation, with the primary toxic effect occurring in the respiratory system. Susceptible groups include young children, asthmatics and people with chronic respiratory diseases. It has also been shown that individuals sensitive to allergens will show a significant response to high concentrations of NO_2. Whilst there have been recorded responses in the susceptible groups listed, it has been demonstrated that individuals not suffering from respiratory disease will be, by-and-large, unaffected by air pollution episodes.

At present, there are still uncertainties concerning the effects of NO_2 exposure over a longer time scale[4]; this is due to the wide range of modifying influences on the behaviour of a single pollutant. It is difficult statistically to separate the impacts on health of NO_2 from those of other pollutants[5]. During the December 1991 episode, particles were also recorded at high levels. It is probable that a synergistic combination of pollutants gives rise to detrimental health effects, as opposed to individual pollutants acting alone. Research conducted at St Bartholomew's Hospital in London showed that exposure of asthmatics to high SO_2 and NO_2 levels in combination can increase the subject's response to airborne allergens. Many studies estimating the chronic effects of NO_2 use unquantified and indirect measures of exposure, though these studies do suggest that the effects of NO_2 exposure are significant.

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[4] World Health Organization. (2004) Health Aspects of Air Pollution – Answers to Follow-up Questions from CAFE. Report on a WHO Working Group Meeting, Bonn, Germany, 15-16 January 2004. Available at: http://www.euro.who.int/document/E82790.pdf

[5] Defra (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

3 POLICY FRAMEWORK

3.1 Standards and Objectives

Air quality standards relevant to NO_2 concentrations have undergone change, both nationally and on a European level. For Europe, the First Air Quality Daughter Directive (1999/30/EC) (and subsequent revisions) sets out limits for annual mean and hourly mean NO_2 concentrations and aims to achieve the objectives by 1^{st} January 2010.

Table 1 Air Quality Objectives for nitrogen dioxide in first Daughter Directive

	Concentration	Measured as	Achievement Date
Hourly	200 $\mu g/m^3$ not to be exceeded more than 18 times a year	1 hour mean	1 January 2010
Annual	40 $\mu g/m^3$	Annual mean	1 January 2010

Air quality standards relevant to the UK are found in The Air Quality Strategy for England, Scotland, Wales and Northern Ireland[6] Volume 1 and 2 (AQS). These documents were up-dated in July 2007, superseding the earlier Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2000) National Air Quality Strategy[7] (NAQS), published in March 1997. The 2007 review of the AQS[8] proposed to maintain the framework for reducing air pollution at national and local levels from a wide range of emission sources. The AQS Review retains the two Air Quality Objectives (AQOs), one hourly and one annual (Table 2), in line with those set in the European Directive, although an earlier date for the objectives to be achieved (of 31^{st} December 2005) had been set.

Table 2 Air Quality Objectives for nitrogen dioxide in AQS

	Concentration	Measured as	Achievement Date
Hourly	200 $\mu g/m^3$ not to be exceeded more than 18 times a year	1 hour mean	31 December 2005
Annual	40 $\mu g/m^3$	Annual mean	31 December 2005

The standards for the eight pollutants covered by the strategy are underpinned by recommendations made by the Government's Expert Panel on Air Quality Standards (EPAQS). The objective levels had been based on medical and scientific evidence of how each pollutant affects human health. Factors such as economic efficiency, practicability, technical feasibility and time-scale have also been taken into consideration by the government when setting the final objective values. Objectives for NO_2 are prescribed in the Regulations for the purpose of Local Air Quality Management (LAQM) and thus have direct relevance to the diffusion tube network in London.

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[6] DETR (2000) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland - Working together for Clean Air"

[7] DoE (1997) The United Kingdom National Air Quality Strategy

[8] Defra (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

LAQM is at the heart of the AQS. Local authorities are charged with reviewing current air quality and assessing whether the relevant AQO will be achieved by the target date. Those authorities that concluded that one or more of the objectives were unlikely to be achieved, were obliged to declare Air Quality Management Areas (AQMAs) and draw up action plans of how to reduce air pollution. Most London boroughs declared AQMAs on the prediction that the annual mean AQO for NO_2 would not be met by the end of 2005, as was verified by the 2005 monitoring results.

3.2 The Greater London Authority

The Greater London Authority (GLA), created under the Greater London Authority Act 1999 assumed its responsibilities on 3 July 2000. It was created to give London its own decision making authority, which is in line with the Government's wider environmental, transport, economic and planning objectives.

As a result, the Mayor has significant decision-making abilities being charged, amongst other things, with the responsibility for the London-wide environment and a duty to promote the health of Londoners. The Mayor has a duty to develop an air quality management strategy, in consultation with the London Boroughs, to deliver improvements to air quality in London. The Strategy for London is required to include proposals and policies from the National AQS as well as any other proposals and policies that the Mayor considers appropriate. The Mayor's Air Quality Strategy was published in September 2003, and states that meeting targets for NO_2 is the primary concern of the strategy.

The strategy recognises that road traffic is the primary cause of air pollution in London and is consequently linked to other relevant strategies and measures taken by Transport for London (TfL), the Greater London Authority, and the London Development Agency (LDA). TfL in particular are instrumental in tackling this problem by traffic reduction measures, promote and adopting cleaner technologies such as alternative fuels. Newer schemes such as a congestion-charging zone around London and the Low Emission Zone are likely to lead to environmental benefits. The impact of the LEZ would only become apparent with monitoring. In addition to road traffic, commercial and domestic space heating is another significant source of NO_2 though measures needed to reduce this emission source are yet uncertain.

Long-term monitoring of NO_2 by diffusion tubes with its geographical spread across London will assist in determining the effect of a number of these policies in the future. Recommendations in a review of the urban network for measurement of Black Smoke, SO_2 and NO_2 (2006) included the adoption of standardised operating methods, to make both equivalence demonstrable and cross-authority comparisons possible; and traceability to a reference method to facilitate central data collation[9]. The clear advantages of the LWEP NO_2 Programme are the existing adherence to the NETCEN guidelines and the centralised collection and analytical procedures recommended above.

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[9] A Review of the UK urban network for measurement of Black Smoke, $SO_{2,}$, and $NO_{2:}$ Summary Report (2006)

4 NO_2 DIFFUSION TUBE MONITORING

4.1 Diffusion tubes

Diffusion tubes are simple and inexpensive passive sampling devices that are widely used in the UK for measuring ambient NO_2 concentrations. The samplers are composed of an acrylic tube that can be sealed at both ends. One end of the tube contains two stainless steel mesh discs coated with triethanolamine (TEA) that adsorbs NO_2 to produce a nitrite salt that can be determined by colorimetry. Once the inlet cap is removed exposure begins, and a concentration gradient is established within the tube resulting in molecular diffusion takes place towards the TEA-coated grid. After exposure the total quantity of gas transferred along the tube is determined by chemical analysis, commonly ultra violet spectrometry.

There are a number of different diffusion tube preparation methods in use by laboratories in the UK. The difference relates to the way in which the metal grids are coated with TEA. The methods currently in use are 50% TEA in acetone, 50% TEA in water and 20% TEA in water. The methodologies of preparation, application and analysis have recently come under the review of the Defra Working Group on the Harmonisation of Diffusion Tubes[10].

4.2 Performance of diffusion tubes

NO_2 diffusion tubes are an indicative monitoring technique commonly exploited to investigate the temporal and spatial trends in NO_2 concentrations. These devices do not perform to the same accuracy as the automatic chemiluminescent analyser, which is identified by the EU as the reference method of measurement for nitrogen dioxide. Numerous studies have been undertaken to explore the factors affecting diffusion tube performance. These have focused on exposing diffusion tubes alongside chemiluminescence monitors. The results have observed that measurements by diffusion tubes over-estimate (positive bias) or underestimate (negative bias) the true ambient NO_2 concentrations. The various mechanisms[11] [12] that have been proposed to explain the over- and under-estimation of NO_2 concentrations by diffusion tubes include:

Over-estimation of ambient NO_2 concentrations

- Higher wind speeds can generate turbulence in the entrance of the diffusion tube causing a shortening of the diffusion tube length.
- Reduced NO_2 photolysis in the tube by the blocking of UV light by the tube material.
- Interference effects of the secondary particulate compound peroxyacteyl nitrate (PAN).
- Very high concentrations may occur due to sample contamination.

Under-estimation of ambient NO_2 concentrations

- Insufficient extraction of nitrite from the grids.
- Incorrect standard solution used for calibration.
- Increased exposure time that is thought to cause the degradation of absorbed nitrite over time.
- Very low concentrations may result from the grid disruption or loss; which are both outside the control of the analytical laboratory.

The factors[13] that have been suggested to influence diffusion tube performance are:

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[10] AEA Diffusion Tubes for Ambient NO_2 Monitoring: Practical Guide for Laboratories and Users, February 2008
[11] Air Quality Expert Group: Report on Nitrogen Dioxide in the United Kingdom, 2004,Appendix 1
[12] AEA Diffusion Tubes for Ambient NO_2 Monitoring: Practical Guide for Laboratories and Users, February 2008
[13] Compilation of Diffusion Tube Co-location Studies Carried out by Local Authorities, 2002, Air Quality Consultants

- The laboratory preparing and analysing the tubes.
- The exposure interval – weekly, 2-weekly or monthly.
- Time of year.
- The exposure setting – sheltered or exposed.
- The exposure location – roadside or background.
- The tube preparation method.
- The exposure concentration and NO_2/NO_x ratio.

4.3 Bias adjustment factors

The fact that diffusion tube measurements exhibit a bias compared to the reference method needs to be taken into consideration when results are to be compared with air quality standards and objectives. Defra's LAQM Technical Guidance TG(09) advises local authorities to examine the bias associated with their diffusion tubes and then apply an adjustment factor to the annual mean, if required, as part of their Updating Screening and Assessment of air quality. Co-location studies are recommended (for a minimum period of nine months) where diffusion tubes are exposed in triplicate concurrently with an automatic monitoring site.

In circumstances where local authorities do not have the opportunity to carry out a co-location study a default factor should be applied. Air Quality Consultants has established a spreadsheet on the Review and Assessment website[14] representing default bias correction factors compiled from co-location studies carried out by local authorities at roadside and background sites throughout the UK. Default bias correction factors are available for a number of UK laboratories and the key tube preparation methods.

4.4 LWEP monitoring programme

A total of 307 monitoring sites were active in the LWEP diffusion tube programme during 2008. The locations of the diffusion tubes are chosen by each authority to reflect the likely exposure of the public to concentrations of nitrogen dioxide. All monitoring site have been classified as either roadside (0-20 m) or background (>20 m) depending on the distance from the road. This classification is more rigid than the guidelines[15] (roadside, kerbside, urban centre, urban background and suburban)[16] for simplicity and historical continuity. The number of tubes exposed in each borough is at the discretion of each local authority involved in the monitoring programme. Nitrogen Dioxide concentrations in London are mainly attributable to road transport, which results in a strong bias towards roadside as the choice of site as compared to background sites.

4.4.1 Diffusion tube preparation and analysis

The diffusion tubes employed in the LWEP programme are prepared and analysed by UKAS accredited Gradko International Ltd. Diffusion tubes are prepared using the 50% v/v triethanolamine with acetone method and analysed using UV spectrometry. The diffusion tubes are labelled, and kept refrigerated in plastic bags prior to and after exposure.

As results from the LWEP are incorporated into the UK Nitrogen Dioxide Diffusion Tube Survey, the tubes are exposed for a four-to five-week period, consistent with the National Survey. Adherence to the changeover dates is important to enable as valid an inter-comparison as possible between boroughs.

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[14] http://www.uwe.ac.uk/aqm/review/diffusiontube290208.xls
[15] Defra Technical Guidance for LAQM TG(09)
[16] AEA Diffusion Tubes for Ambient NO_2 Monitoring: Practical Guide for Laboratories and Users, February 2008

4.4.2 Quality assurance and quality control

The EU Daughter Directive sets data quality objectives for nitrogen dioxide along with other pollutants. Under the Directive, annual mean NO_2 concentration data derived from diffusion tube measurements must demonstrate an accuracy of ±25 % to enable comparison with the Directive air quality standards for NO_2.

In order to ensure that NO_2 concentrations reported are of a high calibre, strict performance criteria need to be met through the execution of quality assurance and control procedures. As mentioned earlier, a number of factors have been identified as influencing the performance of diffusion tubes including the laboratory preparing and analysing the tubes and the tube preparation method. Quality assurance and control procedures are, therefore, an integral feature of any monitoring programme, ensuring that uncertainties in the data are minimised and allowing the best estimate of true concentration. The Harmonisation Working Paper published its findings in February 2008. This guidance provides a set of preparation and analytical procedures and guidelines for the deployment of diffusion tubes with the aim to standardize both. Gradko International were members of the Working Party and were key partners in the standardization of diffusion tubes.

Gradko International Ltd conducts rigorous quality control and assurance procedures in order to maintain the highest degree of confidence in their laboratory measurements. These are discussed in more detail below.

Workplace Analysis Scheme for Proficiency (WASP)

Gradko International Ltd participates in the Health and Safety Laboratory WASP[17] NO_2 diffusion tube scheme on a monthly basis. This is a recognised performance-testing programme for laboratories undertaking NO_2 diffusion tube analysis as part of the UK NO_2 monitoring network. The scheme is designed to help laboratories meet the European Standard EN482[18]. The laboratory performance for each month of 2008 was rated 'good' which signifies a high level of accuracy for laboratory measurements.

Network Field Inter-Comparison Exercise

Gradko International Ltd also takes part in the NO_2 Network Field Inter-Comparison Exercise, operated by AEA (formerly NETCEN), which complements the WASP scheme in assessing sampling and analytical performance of diffusion tubes under normal operating conditions. This involves the regular exposure of a triplet of tubes at an Automatic Urban Network site (AUN) site. These sites employ continuous chemiluminescent analysers to measure NO_2 concentrations. Of particular interest is the bias of the diffusion tube measurement relative to the automatic analyser that gives an indication of accuracy. AEA have established performance criterion for participating laboratories in line with the EU 1st Daughter Directive requirement for indicative monitoring techniques, as the 95% confidence interval of the annual mean bias which should not exceed ± 25%.

In conjunction with this, a measure of precision is determined by comparing the triplet co-located tube measurements commonly referred to as the coefficient of variation (CoV). This value is useful for assessing the uncertainty of results due to sampling and analytical techniques. The AEA performance criterion for precision is that the mean coefficient of variation for the full year should not exceed 10%.

The Field Inter-Comparison Exercise has historically generated the bias and precision results for each laboratory on an annual basis. This changed in 2004 to results being reported on a monthly basis. This enables a full year's inter-comparison against the AEA performance criteria to be carried, as shown in Table 3. The results below indicate that Gradko International Ltd diffusion tubes are well within the performance targets set by AEA.

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[17] Health and Safety Executive, Workplace Analysis Scheme for Proficiency

[18] European Committee for Standardisation (CEN) Workplace Atmospheres, General requirements for the performance of procedures for the chemical measurement of chemical agents, EN482, Brussels, CEN 1994.

Table 3 Summary of NO_2 Network Field Inter-Comparison Results, 2008

Annual Mean Bias		Precision	
AEA Performance Target	Gradko Annual Mean Bias	AEA Performance Target	Gradko Precision
±25%	**-11 %**	**10%**	**3 %**

Gradko International Ltd performs blank exposures that serve as a quality control check on the tube preparation procedure**.** All results are blank subtracted before they are issued to the relevant Borough.

Bureau Veritas conducts an ‘in-house’ co-location study to establish an LWEP bias adjustment factor based on triplicate NO_2 diffusion tubes sampling concurrently located with a continuous analysers for a number of local authorities. This is discussed in more detail in Chapter 9.

5 OVERVIEW OF RESULTS

5.1 Current year results

Table 4 shows summary statistics for the 307 diffusion tube sites operating in the 2008 LWEP Diffusion Tube Network.

Sites were excluded from analyses if data capture was calculated to fall below 75%. The effective qualifying number of sites operating throughout 2008 were 287. The summary statistics for these qualifying sites is shown in Table 4

Background annual mean concentrations elevate to a maximum of 89.4 µg/m^3 (Kensington & Chelsea, site KC 56)and roadside annual concentrations to 140.2 µg/m^3 (City of Westminster, site WM55).

In 2008 a total number of 216 sites exceeded the 2005 annual mean air quality objective, of which 87% were roadside monitoring sites.

At background sites, there was an increase in the average annual mean NO_2 concentration of 3.3 % when compared to 2007. At roadside sites, there was a decrease of 1.6 %.

The number of sites failing to meet the 2005 air quality objective increased by 3.3% in 2008 compared to the previous year.

Table 4 Summary statistics for all qualifying LWEP diffusion tubes monitoring sites 2008

Site Type	Number of Sites	Annual Mean NO_2 Concentration Ranges (µg/m^3)	Annual Mean NO_2 Concentration (µg/m^3) across all sites	Number of AQO Exceedances
Background	86	18.9 - 89.4	37.9	29
Roadside	211	28.7 – 140.2	58.7	187

5.2 Geographical spread of nitrogen dioxide concentrations

Maps 1 and 2 show the geographical spread of the annual mean concentrations (uncorrected for bias) for the nitrogen dioxide diffusion tube survey across London for 2008. The maps include data only from Boroughs that are part of the London Wide Environment Programme for nitrogen dioxide.

The higher NO_2 levels are concentrated around central parts of London while further away from the centre, the levels tend to decrease. Background sites predominantly recorded annual means in the 30-40 µg/m^3 range uniformly spread throughout London. The highest background annual mean concentrations are clustered within central London. Annual mean NO_2 concentrations at roadside sites are predominantly recorded in the 50-60 µg/m^3 concentration range. The centre of London maintains the highest levels of roadside NO_2 reaching with annual means recording over 100 µg/m^3.

Map 1 Annual Mean Roadside NO_2 Concentrations, 2008

Map 2 Annual Mean Background NO$_2$ Concentrations, 2008

5.3 Long term trends

To establish long-term trends, annual mean NO_2 concentrations recorded at both background and roadside sites from 1986 to the present day have been utilised. The introduction of the UK Nitrogen Dioxide Diffusion Tube Survey in 1993 and the resultant increase in exposure time of the diffusion tubes from 2 to 4 - 5 weeks showed an apparent change in long-term concentrations. The extension in exposure period had the effect of decreasing NO_2 concentrations. In order to strengthen the comparability and representation of long-term trends, data have been collated from diffusion tube sites only from 1993 to the present year. Sites were included if there were six or more years continuous data available. This subsequently provides a data set comprising of a total of fifty-one sites covering both roadside and background locations. Overall, this improves the inter-year and inter-site comparability of NO_2 concentrations over the past fifteen years.

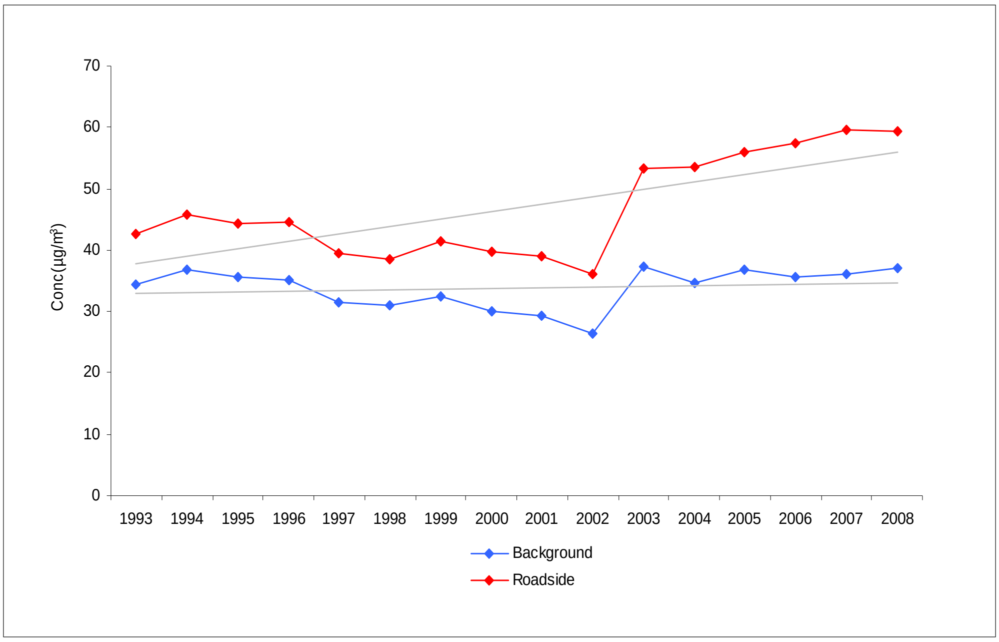

Figure 1 Long-term annual mean NO_2 concentrations at selection of background and roadside sites in London.

Long-term background and roadside sites follow very similar trends, and indicate a gradual decline in annual mean NO_2 concentration between 1993 and 2002. In 2003 a distinct increase in annual NO_2 concentration is recorded at both site types, and was initially attributed to poor meteorological conditions; however, roadside concentrations continued to increase in all subsequent years. Roadside NO_2 concentrations decreased in 2008 a change in the trend of recent years meaning 2007 concentrations were at their highest over the entire monitoring period. Background sites however show a slight increase over 2008 to concentrations close to those recorded in 2005.

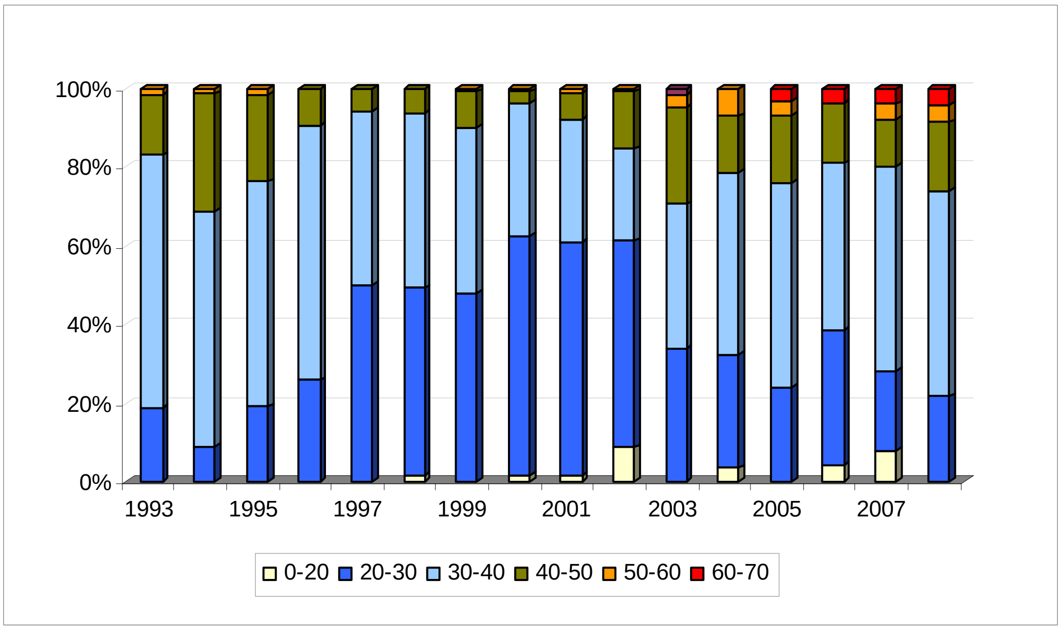

Figure 2 Frequency Distribution of Annual Mean Background NO_2 Concentrations, 1993-2008

In the early part of the programme the largest percentage of annual mean NO_2 concentrations was present in the 30-40 µg/m^3 banding. Approximately 5% of sites recorded concentration in the 50-60 µg/m^3 banding. From 1997 to 2002 there is a clear variation in the frequency of each banding. Annual mean NO_2 concentrations in the 50-60 µg/m^3 and 40-50 µg/m^3 banding reduce by approximately 50%. Annual mean NO_2 concentrations recorded in the 20-30 µg/m^3 range gradually increased over this period. In 1998 annual mean NO_2 concentrations were recorded in a new band: < 20 µg/m^3, and continue to be recorded in this banding over the next four years.

The 0-20 µg m^3 banding disappeared in 2003, reappeared in 2004 then disappeared in 2005. The 20-30 µg/m^3 banding are the most frequently recorded concentrations at London sites until 2003. The 50-60 µg m^3 banding was introduced in 2003 and a concentration range of 60-70 µg/m^3 was introduced in 2003 and was seen in subsequent years with the exception of 2006.. The highest percentage of background annual NO_2 means were recorded in the 30-40 µg/m^3 concentration range. In 2004, 2005, 2006 and 2007 the highest percentage of results was recorded within the 30-40 µg/m^3 bandings.

In 2008, the 0-20 µg/m^3 banding disappeared and 20-30 µg m^3 banding increased compared with the previous year's levels and the 40-50 µg/m^3 banding has decreased copared to 2007. The 50-60 µg/m^3 and 60-70 µg/m^3 remained consistent with 2007 levels. In 2008, the highest percentage of results was recorded within the 30-40 µg/m^3 banding.

The frequency distributions for background sites indicate that in 2008 a greater proportion of NO_2 concentrations are associated with the lower to middle concentration bandings.

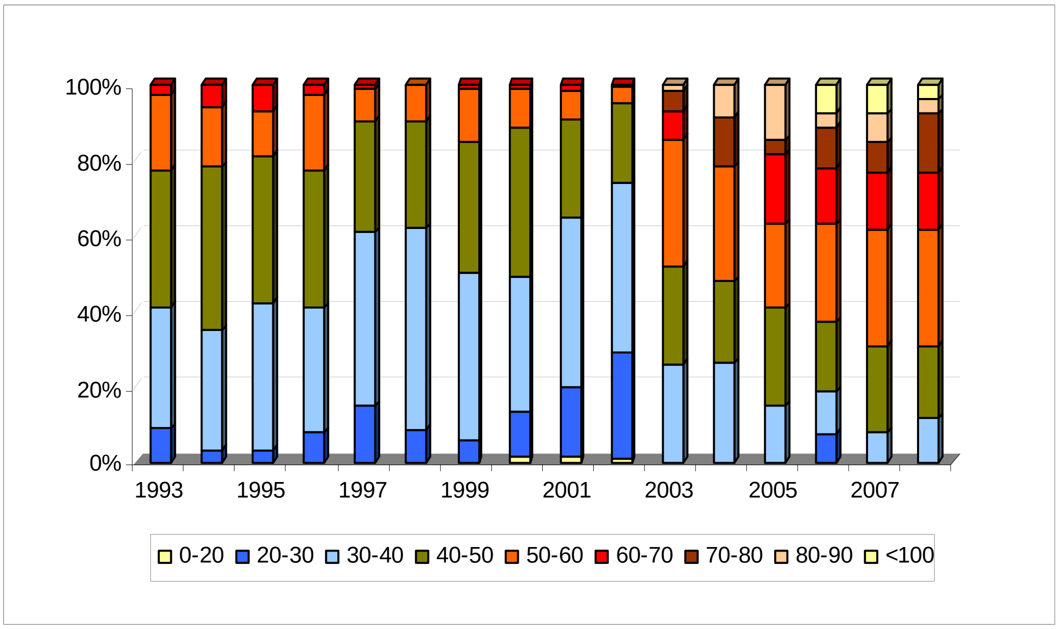

Figure 3 Frequency Distribution of Annual Mean Roadside NO_2 Concentrations, 1993-2008

Between 1993 and 1996 the highest percentage of annual mean NO_2 concentrations at roadside sites were present in the 40-50 µg/m^3 concentration banding. Approximately 10% of sites recorded concentrations over 60 µg/m^3 and a very low number showed concentration in the 20-30 µg/m^3 banding.

A reduction in the frequency of annual mean roadside NO_2 concentrations in the >60 µg/m^3, 50-60 µg/m^3 and 40-50 µg/m^3 bands are apparent from 1997 onwards. An elevation in sites recording concentrations in the 30-40 µg/m^3 band occurs in 1997 remaining at this frequency over the next 5 years. Between 2000 and 2002 sites begin to record concentrations >20 µg/m^3. In 2002 roadside sites recording in the banding of 20 to 30 µg/m^3 show a sharp increase, whereas sites recording the higher bandings decline.

A distinct change in the proportion of each concentration banding takes place in 2003 reflecting the sizeable elevation in NO_2 levels. In 2003 concentration bands 70-80 µg/m³ and 80-90 µg/m³ were introduced. Between 2003 and 2005 no concentrations falling with the range 20-30 µg/m³ were recorded. In 2004 no concentrations were recorded in the 60-70 µg m³ band and a higher percentage were recorded in the 50-60 µg/m^3 range. In 2005 the highest percentage results were recorded within the 40-50 µg/m³ band. A new band was introduced in 2006 to accommodate the >100 µg m^{-3} concentrations. However, the spread of concentrations was much greater than in the three previous years with the temporary re-emergence of the 20-30 µg/m^{-3} banding, the enlargement of the 60-70 µg/m^3 band and reduction of the 80-90 µg/m³ band.

In 2008, recorded results falling into the 30-40 µg/m^3 is greater than the 2007 levels and comparable to those recorded in 2006. The 40-50 µg/m^3 banding remained fairly consistent with 2007 results . The concentration results within the 50-60 µg/m^3 band have compared favourably with the previous two years. The 70-80 µg/m³ band, introduced in 2003, has increased throughout 2007 and 2008 but the number of concentrations in the 80-90 µg/m³ banding has reduced by 50%. The >100 µg/m³ has introduced in 2006 has significantly reduced in size compared with 2006 and 2007.

The frequency distributions for roadside sites indicate that in 2008 a greater proportion of NO_2 concentrations are associated with the middle to higher concentration bandings.

6 DATA ANALYSIS

6.1 Introduction

Prior to analysing the results, the entire year's data set for each local authority was validated for outliers and spurious results. Two screening procedures where adopted for this task. Firstly, monthly mean NO_2 concentrations recording under 5 µg/m^3 where removed. Secondly, only diffusion tube sites with at least nine months of validated monitoring data were then used for further analysis and reporting. To be considered valid the exposure period must also follow the Suggested Exposure Period calendar dates[19].

6.2 Data analysis

2008 Mean Values

Bar charts have been created showing the 2008 annual mean NO_2 concentration recorded at each site included in the LWEP survey. The sites were classified by the Local Authorities based on distance from the nearest major road into background or roadside types. Appendix 1 lists the NO_2 concentration for all the roadside and background sites in each borough. Sites that have exceeded the 40 µg/m^3 2005 air quality objective have been highlighted, Sites that would have exceeded the 40 µg/m³ 2005 air quality objective once a correction factor has been applied (accounting for the passive methodology and tendency to under or over estimate concentration) are also highlighted. Data capture is calculated across all qualifying sites for each Borough.

Site Time Series

Time series plots have been created for sites with over six years of continuous monitoring data. Each time series plot contains data for sites as grouped by their site class.

6.3 Analysis of results

Trend Analysis by Site Class

Monitoring sites with a minimum of six years continuous data were first identified. Individual concentrations are grouped by site class to provide an arithmetic mean for each site class. The mean annual class concentrations have been plotted and a simple linear trend model applied to assess whether concentrations have generally risen or fallen at background, and roadside locations within each Borough.

Roadside Elevation

Annual mean background concentrations were subtracted from annual mean roadside concentrations to calculate the elevation above background NO_2 concentration. This could provide an indication of the level of NO_2 being received at roadside locations from road transport sources.

Diffusion Tube sites were only included in the calculation of annual mean concentrations for each site class (roadside or background) if consistent and valid data were available. Any sites with 1 or more years of absent or invalid data were not used.

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[19] http://www.airquality.co.uk/no2caldr.php

7 REPORTING OF RESULTS – PARTICIPATING BOROUGHS

7.1 London Borough of Bexley

Annual Mean Values

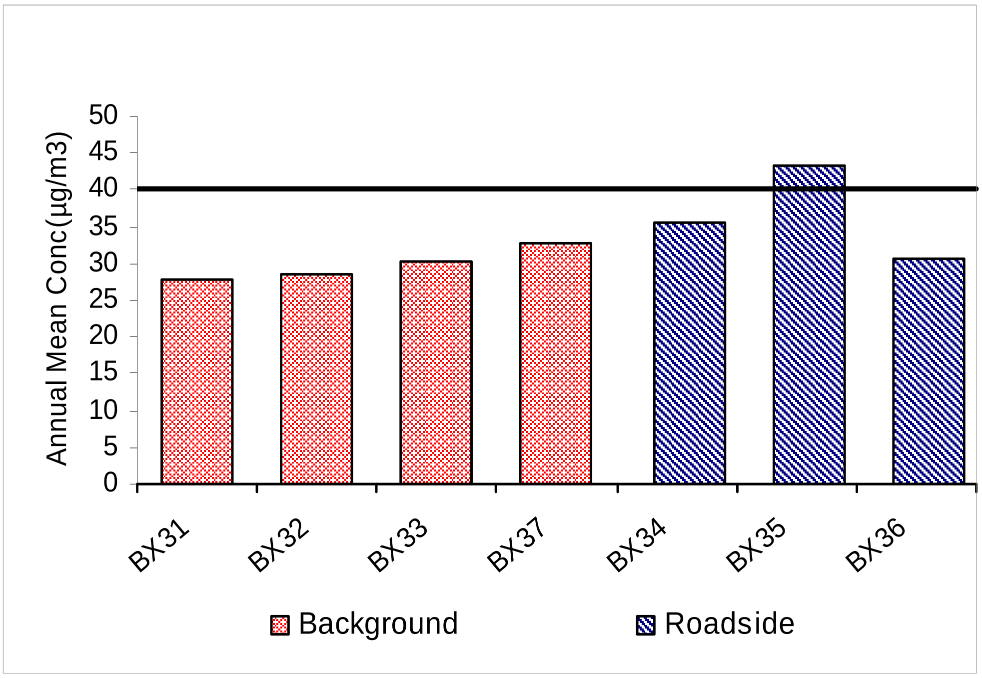

Figure 4 Bexley Background and Roadside Annual Mean NO_2 Concentrations, 2008

Bexley exposed diffusion tubes at seven monitoring locations in 2008, with no changes in sites numbers compared to the previous year. The data capture of qualifying sites for Bexley in 2008 was 92%. The annual mean NO_2 concentrations for all sites have been reported this year as the 75% data capture criterion was fulfilled. The results can be viewed in Appendix 1.

Background concentrations vary between 27.8 µg/m³ at site BX31 and 32.7 µg/m³ (BX37). The roadside concentrations reported vary between 30.5 µg/m³ (BX36) and 43.1 µg/m³ (BX35). The 2005 air quality objective was exceeded at one monitoring location site BX35; no change since the previous year.

Time Series

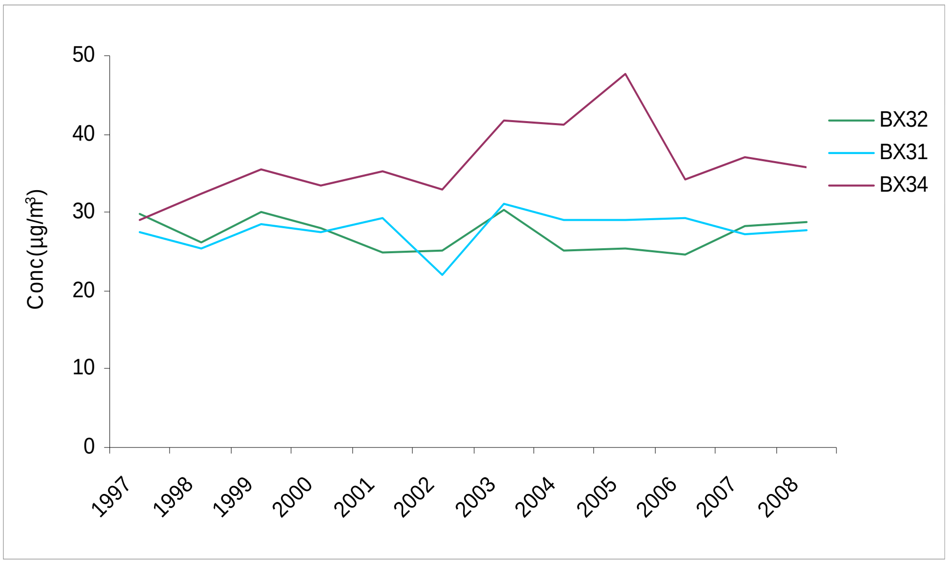

Figure 5 Bexley Background and Roadside Time Series, 1997-2008

Background concentrations are generally very similar since 1997 BX32 increased in 2003 I, 2005, 2007 and 2008. Site BX31 indicates an increase in NO_2 levels compared since 2006. Site BX33 is excluded from this comparison as it failed to meet the data capture criterion in 2007.

Roadside site BX34 shows the greatest variation across the years with a distinct decrease in 2002 followed by a marked increase in 2003 to a record high in 2005; concentrations at this site decreased in 2006, 2007 and 2008 to pre 2003 levels. Sites BX35 and BX36 were excluded from this comparison, despite having fulfilled the data capture criterion in 2007, due to incomplete data capture in 2004.

Trend Analysis

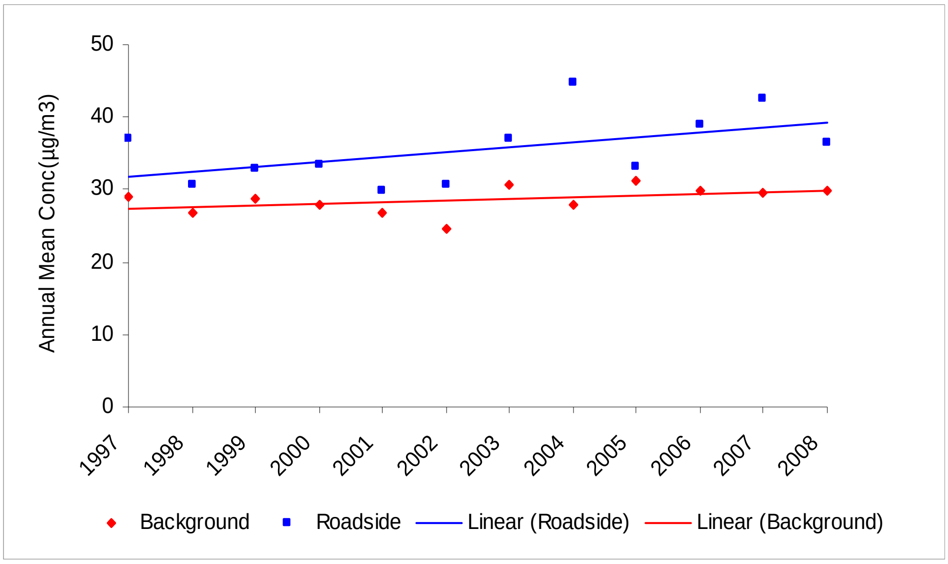

Figure 6 Bexley Background and Roadside Trend Analysis, 1997-2008

Long-term background annual mean NO_2 concentrations remain relatively constant at around 28-31 µg/m³. Site BX34 was the first roadside record since 2003 to exceed the Air Quality Objective. Long-term roadside annual mean NO_2 concentrations display a generally upward trend over this period, decreasing by 1.7% over average concentrations in 1997, however, this does not fully reflect the significant increase during 2004 and falls during 2005 and 2008.

Roadside Elevation

Table 5 Bexley Elevation Above Background NO_2 Concentration $\mu g/m^3$

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
3.7	4.3	5.5	3.0	6.2	6.5	16.7	2.0	9.0	13.1	6.6

The roadside elevation in NO_2 concentration drops by over 30% between 1998 and 2001, doubles in 2002 and continues to rise slightly in 2003. The roadside elevation concentration shows a marked increase 2004, reaching the highest level over the eight-year monitoring period. The reductions in the roadside elevations achieved during 2005 and 2008 due to exceptionally low concentrations recorded at BX35 have been negated by the increases in 2006 and 2007.

7.2 London Borough of Brent

Annual Mean Values

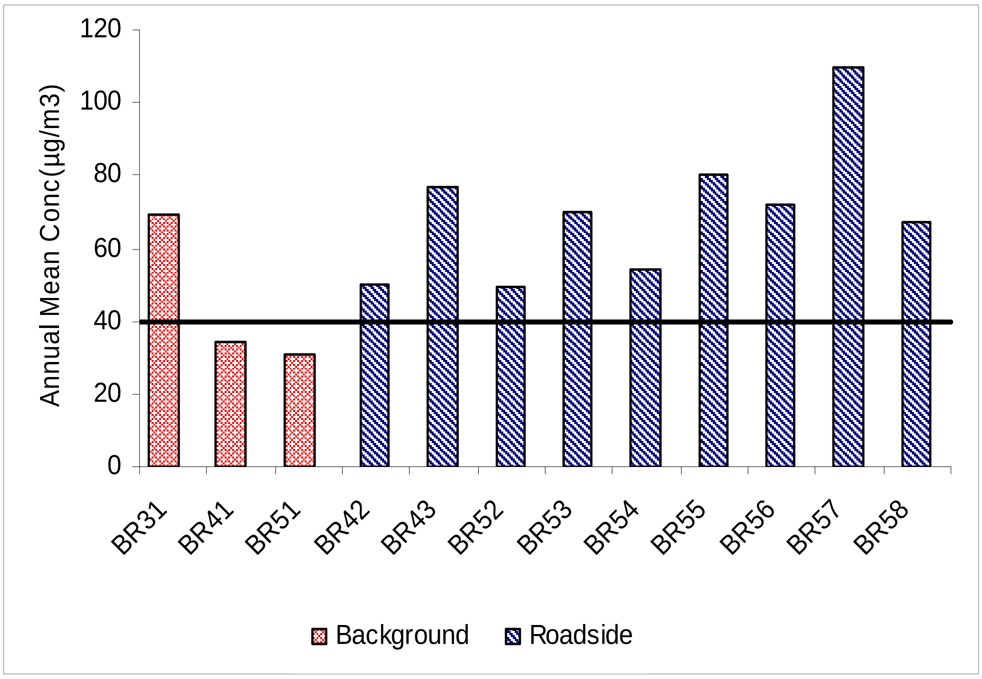

Figure 7 Brent Background and Roadside Annual Mean NO_2 Concentrations, 2008

Brent exposed diffusion tubes at 12 monitoring location in 2008, with no change in site numbers compared to the previous year. The data capture of qualifying sites for this year was 94%. Annual mean NO_2 concentration for all sites fulfilled the 75% data capture criterion.

Background concentrations vary between 31.1 µg/m³ (BR51) and 69.3 µg/m^3 (BR31). Roadside concentrations range between 49.9 µg/m³ (BR42) and 109.9 µg/m^3 (BR57). The air quality objective was exceeded at 83% of the borough's monitoring sites; no change in the number of sites recording an exceedence compared with 2006 and 2007.

Time Series

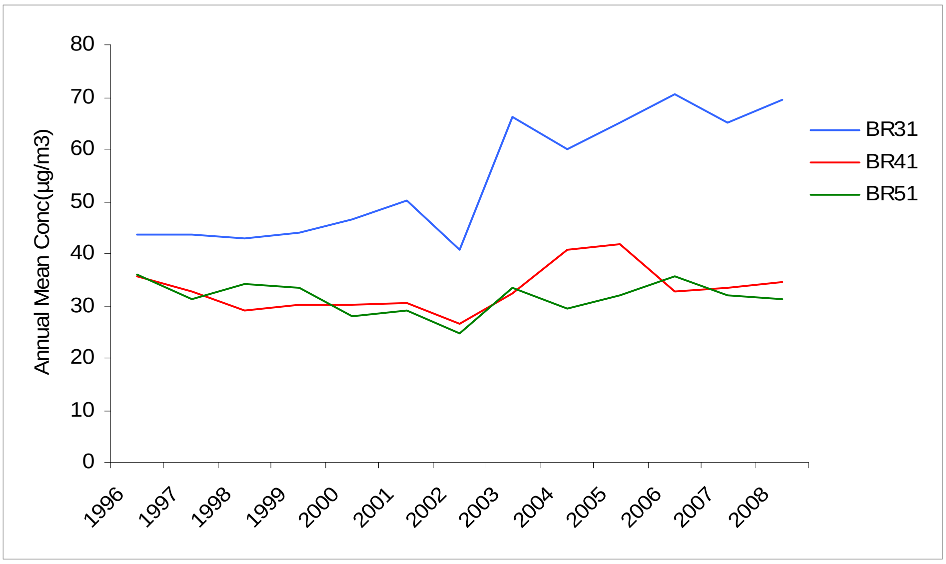

Figure 8 Brent Background Time Series, 1996-2008

The annual mean concentration monitored at intermediate site BR31 is consistently greater than the concentrations monitored at the background sites. Background concentrations at B41 and BR51 are generally very similar up to 2003 and again from 2005. In 2007 and 2008, there were slight increases in the monitored concentration at BR41 and there were noticeable decreases in concentrations recorded at BR51.. Compared with 2007's results, annual mean NO_2 levels at background sites in 2008 increased by 3.4 %, but are 27.2 % higher than in 1993.

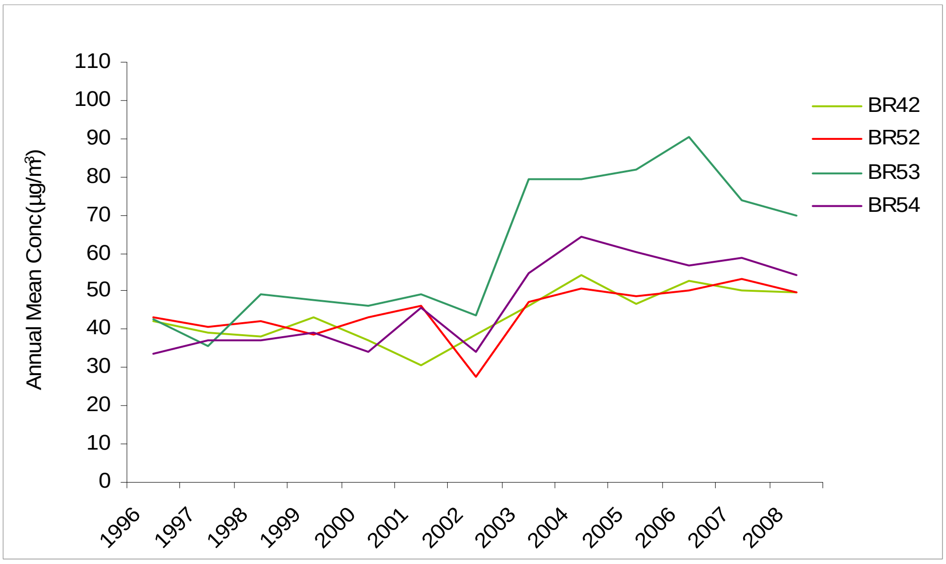

Figure 9 Brent Roadside Time Series, 1996-2008

Concentrations at roadside locations fluctuate between 1996 and 2002 with no obvious trend. NO_2 concentrations increase at all sites in 2003. A trend has emerged since 2003 with the increases recorded at all sites in 2003 and stabilisation since. Site BR43 has been removed from the set to clarify the overall position. During 2004 - 2006 the majority of these sites recorded decreasing concentrations. In 2007, the concentrations decrease at the following roadside sites BR42, BR53 and BR54. Comparing the annual mean NO_2 mean levels averaged across all roadside sites between 2007 and 2008, there has been an overall increase of 18.3 % in 2008 due to the high concentrations recorded at sites BR55, BR57 and BR63..

Trend Analysis

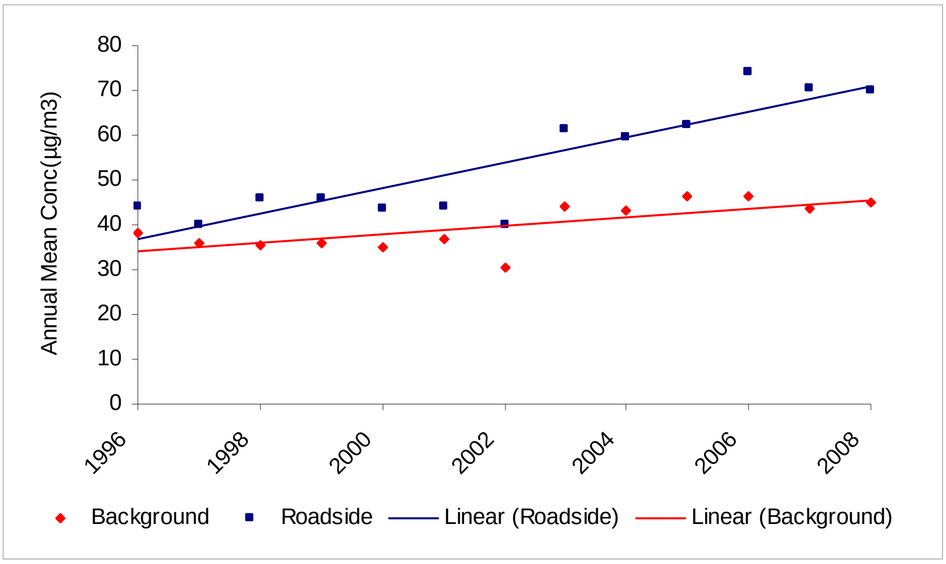

Figure 10 Brent Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations remained approximately constant at just under 40 µg/m^3 from 1996 to 2002. Increases in background concentrations can be traced to the meteorological conditions of 2003. Although the increments are smaller than between 2002-2003 there is still a largely upward trend. Long-term roadside annual mean NO_2 concentrations display an overall upward trend over this period. There were pronounced increases in 2003 and 2006 with decreases in 2004 and 2005, increasing by 59.4 % between 1996 and 2008.

Roadside Elevation

Table 6 Brent Elevation Above Background NO_2 Concentration µg/m^3

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
5.5	4.2	10.4	10.1	8.5	7.3	9.2	11.9	16.4	16.2	27.6	26.8	25.0

The roadside elevation in NO_2 concentration decreases in 1997 but then more than doubles in 1998. The roadside elevation in NO_2 concentration falls until 2003 then begins to rise over the next 4 years peaking at 27.2 µg/m^3 in 2006 before decreasing in 2007 and 2008.

7.3 Corporation of City of London

Annual Mean Values

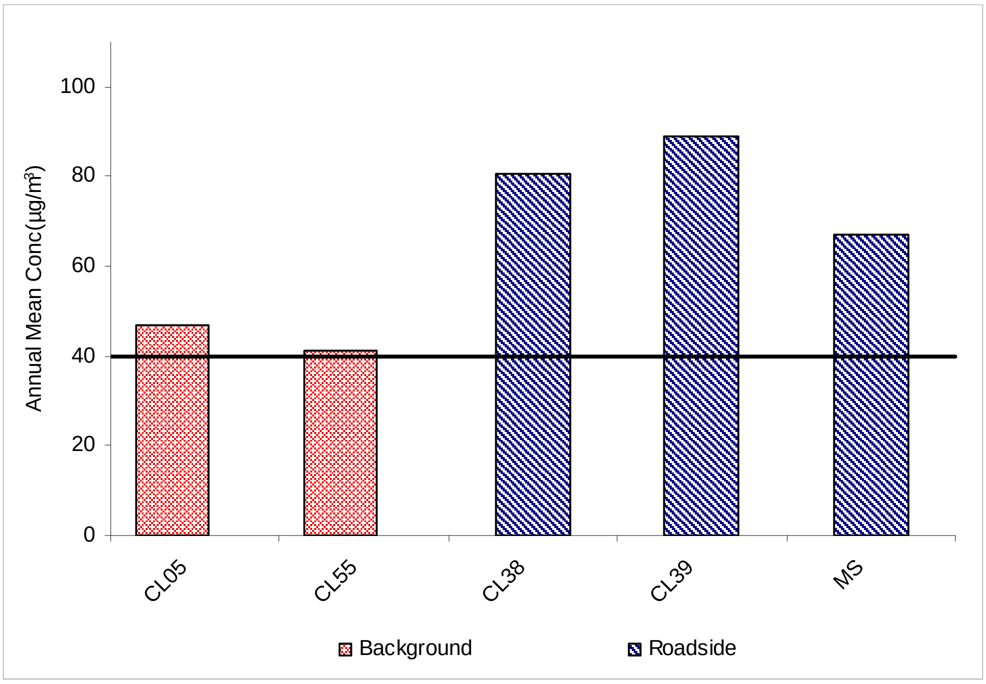

Figure 15 Corporation of London Background and Roadside Annual Mean NO_2 Concentrations, 2008

Corporation of London exposed diffusion tubes at 5 monitoring locations in 2005 with no change in site numbers since 2007. The data capture for Therefore only four sites qualified for inclusion. The data capture for this year was 97%.

Background concentrations vary between 41.3 µg/m³ (CL55) and 46.8 µg/m³ (CL05). Roadside concentrations range between 66.9 µg/m³ (CL38) and 89.0 µg/m³ (CL39). The 2005 air quality objective was exceeded at all five monitoring sites, representing 100% of the total number of current sites.

Time Series

Figure16 Corporation of London Background Time Series, 1997-2008

Long-term background concentrations follow a downward trend prior to 2002. The graph shows that the annual concentration rose in 2003 at both sites. This was followed by a reduction in concentrations at both sites in 2004 followed by an increase in concentrations at both sites in 2005, 2006 and 2007. Comparing the mean of the concentrations monitored at background sites between 2007 and 2008 there has been 2.8% decrease.

Figure 17 Corporation of London Roadside Time Series, 1997-2008

Concentrations fluctuate between decreases in 2002 and 2004 followed by increases in 2003, 2005 and 2006. Site CL38 recorded an increase in mean annual concentration during 2007 and CL39 a reduction since 2006. The peak concentration in 2005 recorded at CL39 was considered to be particularly high at 102.8µg/m^3, this site frequently records the highest annual concentration. In 2007 CL38 increased whilst the concentration recorded at CL39 decreased, which has persited during 2008. The concentrations recorded across all roadside sites increased by 1.5 % compared with 2007, however, if the site MS is included there would be a reduction of 5.6%. Sites previously reported have been excluded due to discontinuation of the sites and / or insufficient data capture.

Trend Analysis

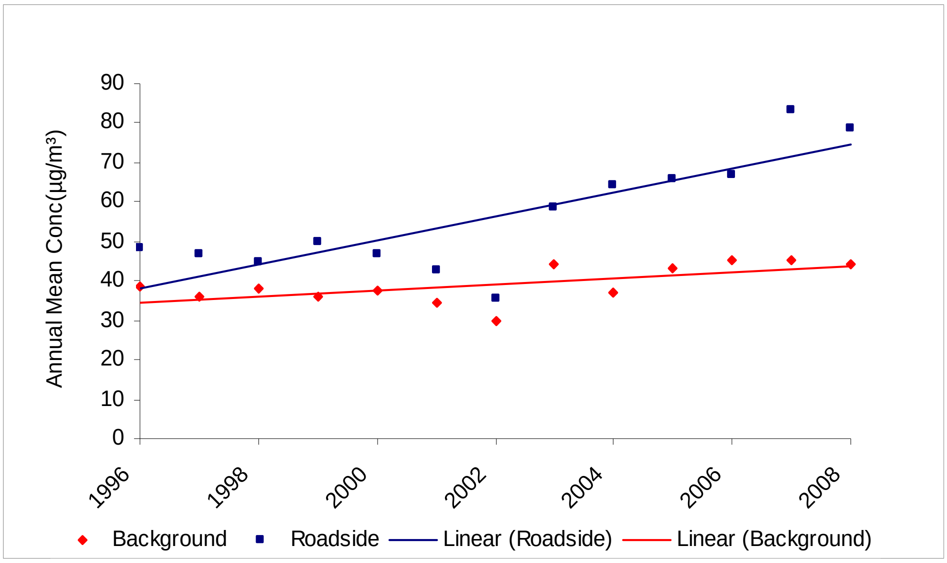

Figure 18 Corporation of London Background and Roadside Trend Analysis, 1996-2008

Background annual mean NO_2 concentrations display a very slightly negative trend, decreasing by 2.8% between 2007 and 2008, rises between 2003 and 2006 have shifted the long term trend towards a positive one. Roadside annual mean NO_2 concentrations decreased to display the downward trend of the last two years increasing by % between 1996 and 2007 comparing the two roadside sites in 2008 with the two sites monitored in 2007.

Roadside Elevation

Table 7 Corporation of London Elevation Above Background NO_2 Concentration $\mu g/m^3$

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
10.6	6.8	13.9	9.5	8.0	5.7	14.4	27.6	22.7	21.8	38.2	34.8

The roadside elevation fluctuates over the eleven-year monitoring period peaking in 1994, 1999 and 2003. The roadside elevation concentration shows a marked increased in 2004 before continuing to increase each year to a record level of 38.2 µg/m³ in 2007. An increase in roadside concentrations at a smaller number of sites operating during 2007 rather than any change in background concentrations The elevation calculated in 2008 is based on the sites operating both in 2007 and 2008.

7.4 London Borough of Croydon

Annual Mean Values

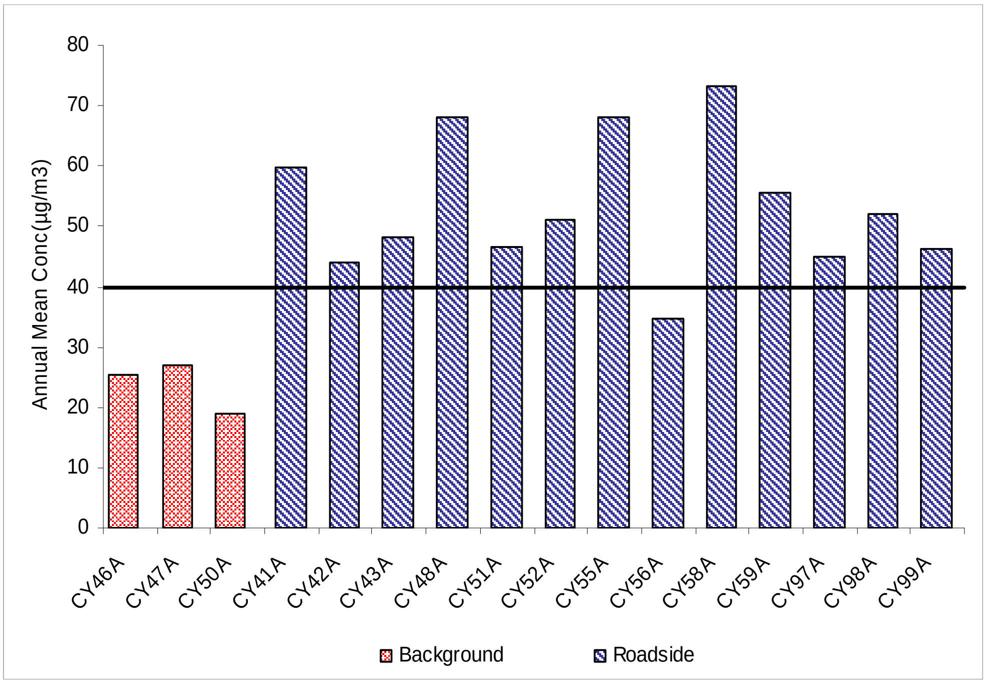

Figure 19 Croydon Background and Roadside Annual Mean NO_2 Concentrations, 2008

Croydon exposed diffusion tubes at 16 monitoring locations in 2008 with no sites discontinued within the year. The data capture for qualifying sites this year was 97%. No sites have been excluded due to low data capture.

Background concentrations vary between 18.9 µg/m³ (CY50A) and 26.9 µg/m^3 (CY47A). Roadside concentrations range between 34.7 µg/m³ (CY56A) and 73.2 µg/m^3 (CY58A). The 2005 air quality objective was exceeded at thirteen roadside sites, representing 81% of all monitoring sites. This is an increase compared to last year when 75% of sites recorded concentrations over 40 µg/m^3.

Time Series

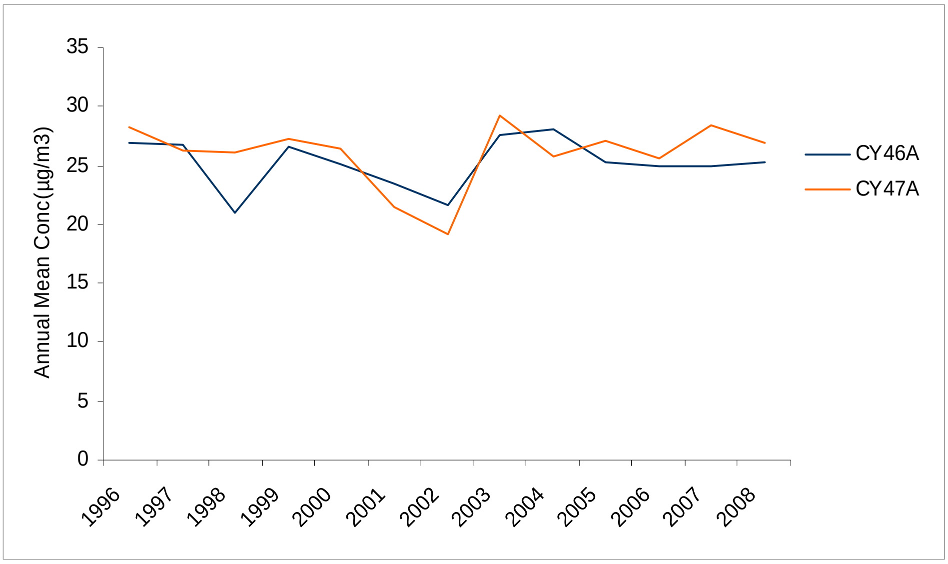

Figure 20 Croydon Background Time Series, 1996-2008

Background concentrations monitored at CY46A and CY47A are similar until 2006. Monitored concentrations increased in 2003 at both sites. When comparing the 2004 concentrations, the monitored concentration in 2005 at CY47A slightly increased whereas the monitored concentration at CY46A showed a marked decrease. During 2005 and 2007 CY46A recorded a significant increase in NO_2 concentration followed by decreases in the subsequent year. The concentration recorded at CY47A has remained fairly constant during the 2005 – 2008 period. Comparing the mean of the concentrations monitored at background sites between 2007 and 2008, there has been a decrease of 4.4%.

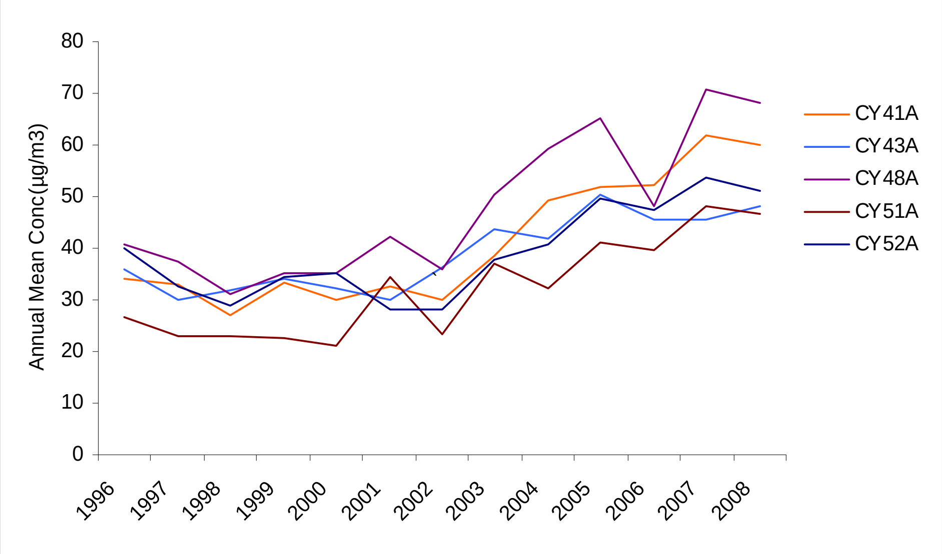

Figure 21 Croydon Roadside Time Series, 1996-2008

CY48A and CY51A follow similar trends prior to 2004. Concentrations monitored in 2005 vary however, most sites monitoring concentrations were at higher levels compared with 2004. Most sites recorded a small to moderate decrease in concentrations in 2006. Location sites CY41A, CY43A, CY48A, CY51A and CY52A reached new peak concentrations in 2007. In 2008 the majority of long term sites show a decrease in annual mean whereas CY43A increased. Comparing the mean of the concentrations monitored at roadside sites between 2007 and 2008, there has been decrease of 5%.

Trend Analysis

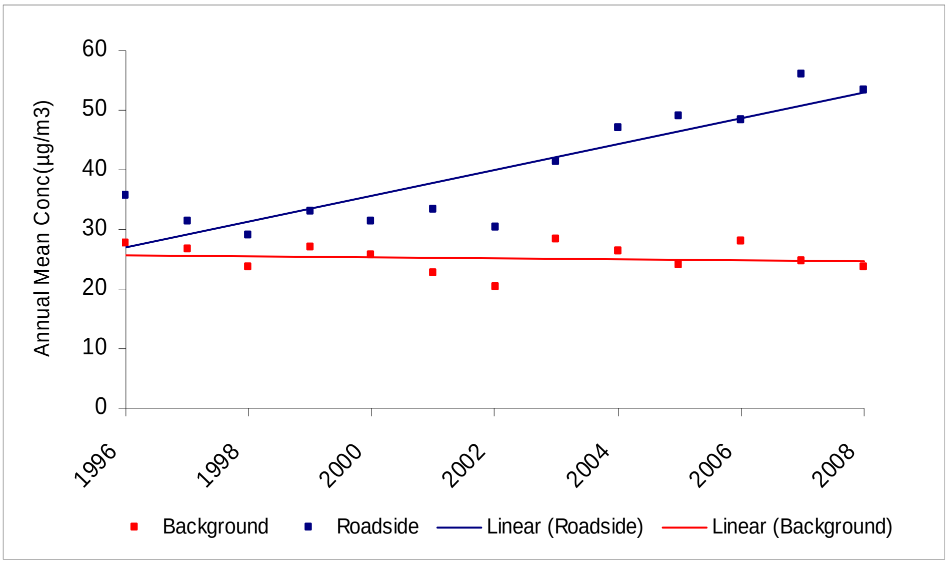

Figure 22 Croydon Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations remain relatively constant at around 25 µg/m^3 from 1996 to 2004; with larger increases in 2003 and 2006. Long-term roadside annual mean NO_2 concentrations display a positive trend between 1996 and 2007 with significant increases in 2003 and 2007.

Roadside Elevation

Table 8 Croydon Elevation Above Background NO_2 Concentration µg/m^3

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
4.8	5.3	6.1	5.6	10.8	10.0	13.1	20.7	24.8	20.5	31.3	29.6

There has been much variation in the elevations above background NO_2 concentrations since 1996. The roadside elevation in NO_2 concentration rises by approximately fifty percent in 2001 and 2002 with further increases over the following two years. In 2005 the roadside elevation in NO_2 concentration reached the highest level the twelve years. In 2006 the elevation fell to below 2004 levels. The 2008 elevation decreased from the 2007 peak of 33.1% which was, in part, due to the exclusion of CY56A from the dataset which usually records concentrations below the average roadside.

7.5 London Borough of Greenwich

Annual Mean Values

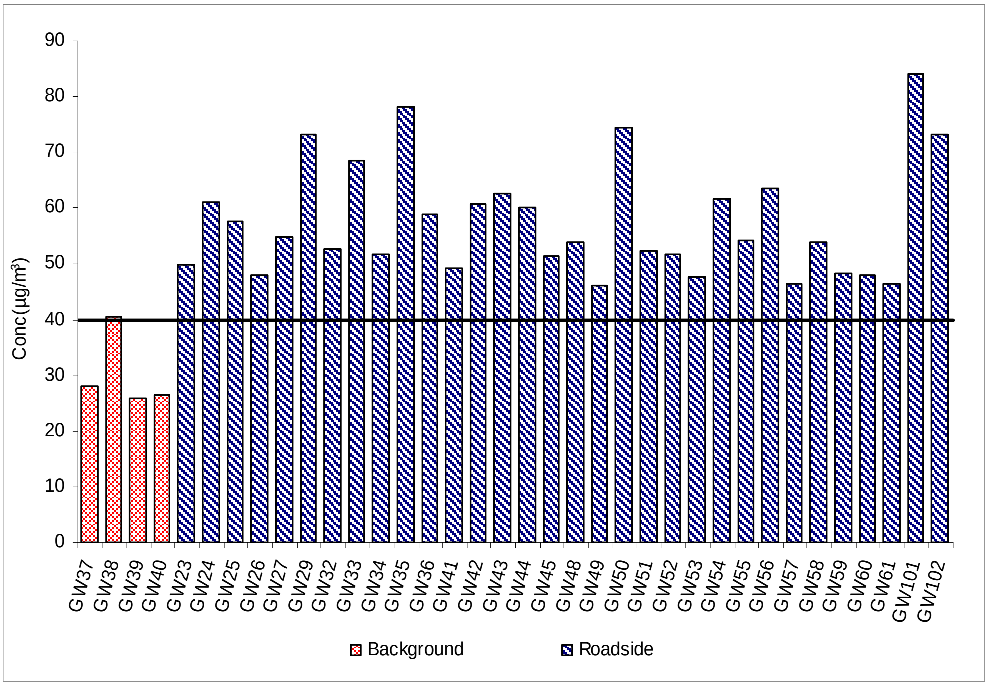

Figure 23 Greenwich Background and Roadside Annual Mean NO_2 Concentrations, 2008

Greenwich exposed diffusion tubes at 37 monitoring location in 2008; with no changes in site numbers compared to the previous year. The data capture for this year was 97%. The annual mean NO_2 concentration for all sites met the data capture criterion..

Background concentrations vary between 25.7 µg/m³ (GW39) and 40.4 µg/m³ (GW38). Roadside concentrations ranged between 46.1 µg/m³ (GW49), and 84.0 µg/m³ (GW101). The 2005 air quality objective was exceeded at 33 monitoring sites, representing 891.7% of the total number of sites. This is the highest number of exceedances recorded.

Time Series

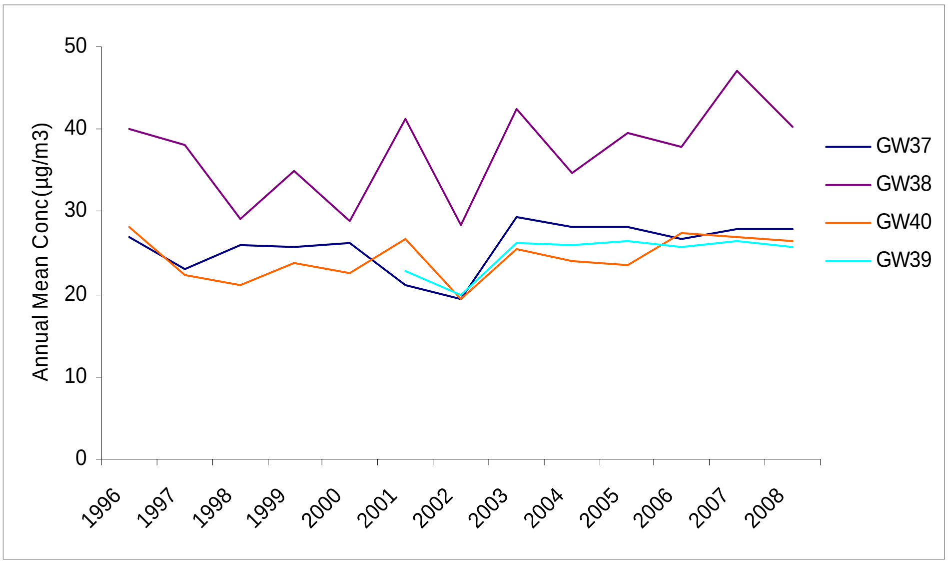

Figure 24 Greenwich Background Time Series, 1996-2008

Background site NO_2 concentrations fluctuate throughout the period 1996 – 2005. The concentrations monitored at GW38 are consistently higher than those monitored at GW37, GW39 and GW40, which are closely aligned particularly during the last four years. A concentration increase recorded in 2007 at GW38 was significantly, than those recorded at GW39 and GW37, concentration measured at GW40 decreased. Concentrations recorded at GW38, GW39 and GW 40 decreased during 2008, GW recorded a small increase compared to previous years. Comparing the mean of the concentrations monitored at background sites between 2007 and 2008, there has been 6.1% decrease.

Figure 25 Greenwich Roadside Time Series, 1996-2008

Nitrogen Dioxide concentrations at Roadside sites have fluctuated throughout the period 1996 – 2002. There is a marked decrease in concentration at the majority of sites in 2002, the only exception being GW35. Annual mean NO_2 concentrations decrease at all sites in 2002, increase in 2003 and fall once more in 2004. Sites GW35 and GW48 record the most significant differences in any two consequentive years and since 2003 record concentrations that differ to the general trend. Sites GW34, 36 and 41 increase concentrations while those recorded at the other sites decreased compared with 2007. Comparing the mean across all the roadside sites between 2007 and 2008, there has been a decrease of 2.3%.

Trend Analysis

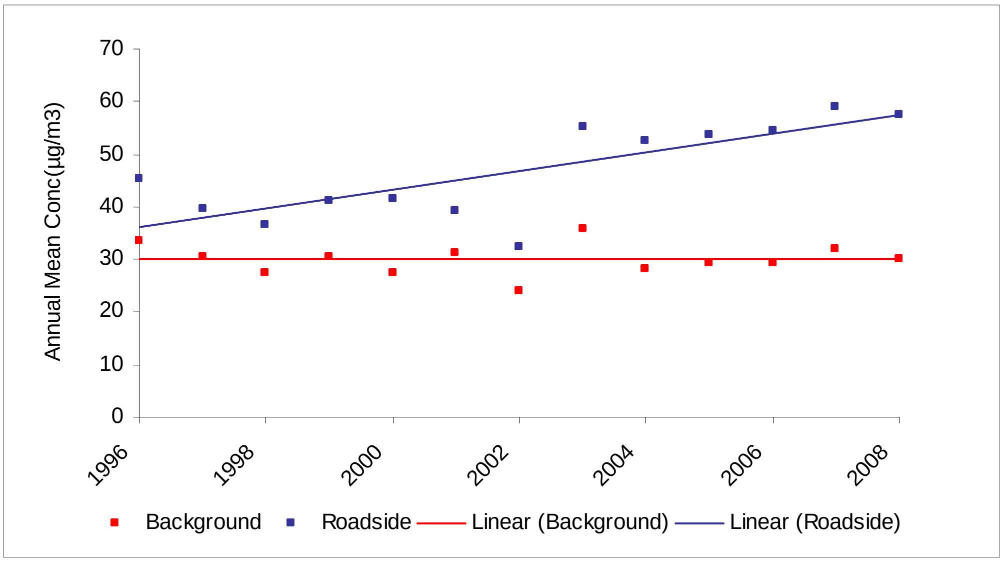

Figure 26 Greenwich Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations display a decreasing trend of 4.1% between 1996 and 2007. Long-term roadside annual mean NO_2 concentrations increased by 30.2% over the same period.

Roadside Elevation

Table 9 Greenwich Elevation Above Background NO_2 Concentration ($\mu g/m^3$)

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
9.1	9.0	10.9	13.8	8.0	8.6	19.3	24.1	24.4	24.9	26.9	27.5

The elevation above background NO_2 concentration decreases between 1997 and 1998 and then rises to 2000. There is a marked decrease in 2001 after which, elevations continue to increase without exception to the highest value in 2008.

7.6 London Borough of Hammersmith and Fulham

Annual Mean Values

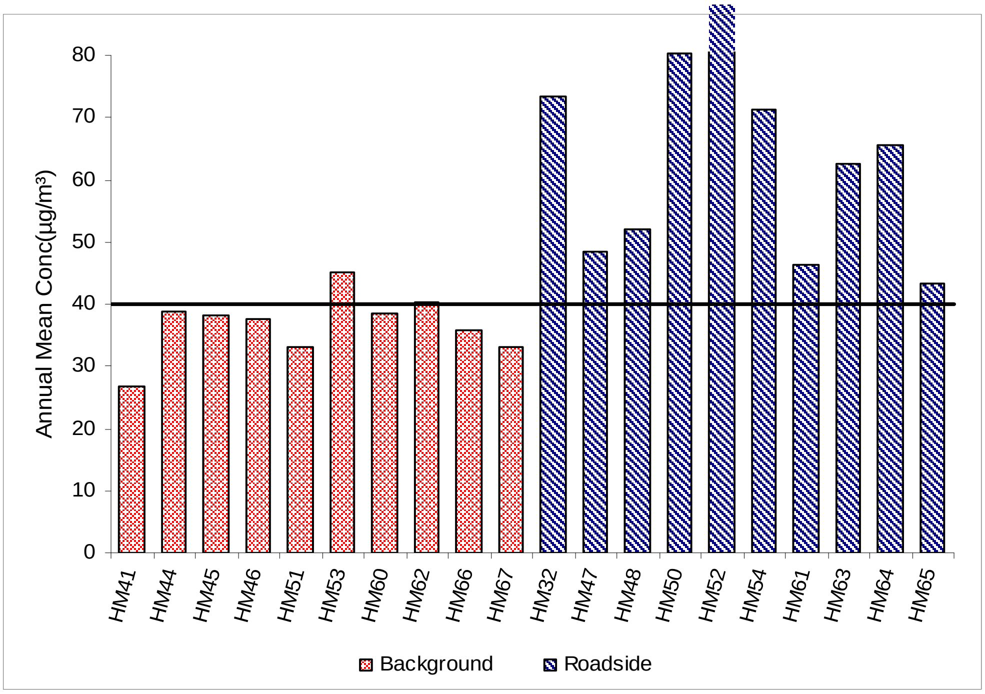

Figure 27 Hammersmith and Fulham Background and Roadside Annual Mean NO$_2$ Concentrations, 2008

Hammersmith and Fulham exposed diffusion tubes at 20 monitoring locations in 200, with no revision in site numbers compared to the previous three years. The data capture for this year was 96%.All sites met the data capture criterion and have been included in the analysis.

Background concentrations vary between 26.6 µg/m³ (HM41) and 45.0 µg/m^3 (HM53). Roadside concentrations range between 43.1 µg/m³ (HM65) and 89.8 µg/m^3 (HM52). The 2005 air quality objective was exceeded at twelve monitoring sites representing 60% of the authority's sites, and the same as the previous three years.

Time Series

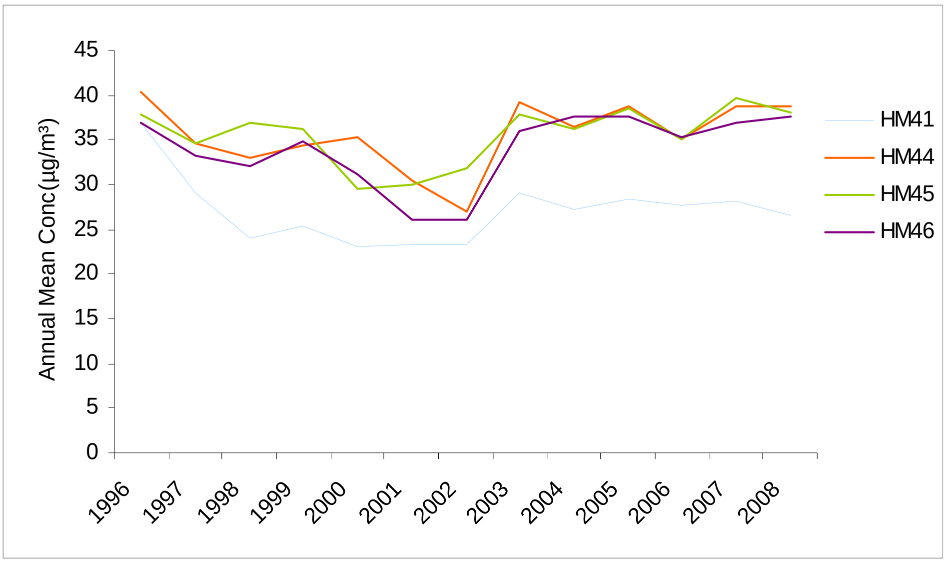

Figure 28 Hammersmith and Fulham Background Time Series, 1996-2008

The long-term data show annual mean background NO_2 level to be lowest at HM41. After peaking in 1996 the NO_2 concentration gradually decreases, remaining relatively constant from 2000 onwards. Annual mean NO_2 concentrations at HM44, HM45 and HM46 fluctuate over the ten-year monitoring period. In 2003 all background diffusion tube sites experience a rise in annual mean NO_2 concentrations. In 2006, there is a decrease in all monitored concentrations. Concentrations increase in 2007 at all sites although not markedly at HM41. During 2008 HM41 and HM45 record decreasing concentrations while those recorded at HM44 and HM46 increased. Comparing the mean of the concentrations monitored at background sites between 2007 and 2008, there has been an increase of 3,8%.

Figure 29 Hammersmith and Fulham Roadside Time Series, 1996-2008

HM32 records the highest roadside mean NO_2 concentration between 1993 and 2000. The annual mean NO_2 concentration at HM48 remains fairly constant from 1997 to 1999. Between 2000 and 2001 a reduction in concentration takes place followed by a period of fluctuation. HM32 and HM48 record a marked increase in annual mean NO_2 concentration in 2003. Concentrations fall in 2004 at HM32 and HM48 but increase in 2005 and 2007. In 2006, a small decrease is recorded at HM32 and HM52 no change at HM48. Site HM50 has recorded increasing concentrations since 2005. The concentrations increased in 2007 and in 2008 at all sites except HM48. Comparing 2007 with 2008 across all roadside sites there has been an average 2.6% decrease in concentrations.

Trend Analysis

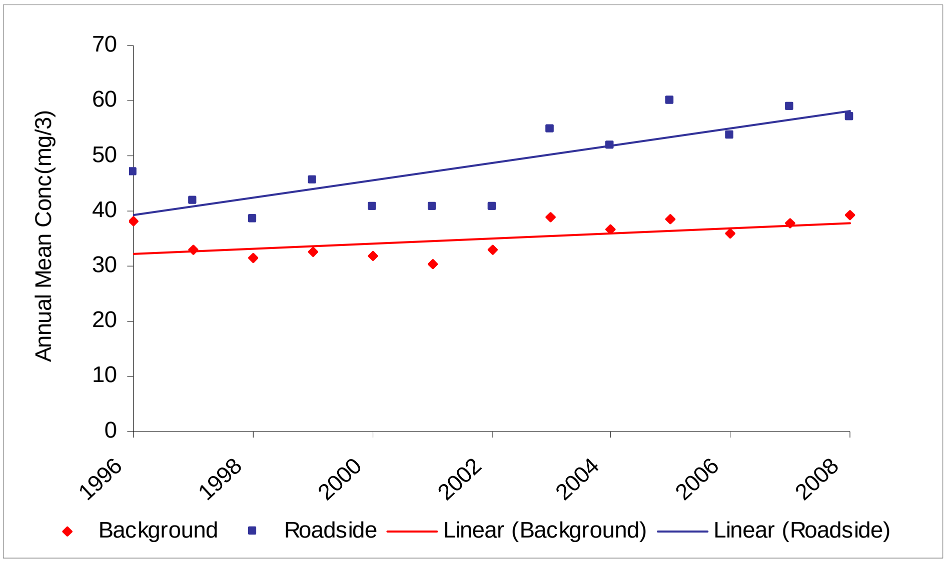

Figure 30 Hammersmith and Fulham Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations display a positive trend over the entire monitoring period and increased between 1996 and 2008 by 3.2%. Long-term roadside annual mean NO_2 concentrations display a very positive trend increasing by 22.1% between 1996 and 2008.

Roadside Elevation

Table 10 Hammersmith and Fulham Elevation Above Background NO_2 Concentration $\mu g/m^3$

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
8.9	7.2	12.9	8.8	10.4	11.6	18.9	15.8	21.3	22.1	21.0	18.0

The roadside elevation in NO_2 concentration decreases by between 1996 and 1998. Between 2000 and 2004 elevation concentration continually increase. In 2006 the roadside elevation exhibits a small increase in concentration, relative to 2005 results, and further increases in 2007 to reach the highest for the borough. In 2008 a reduction in the elevation is the first since 2004.

7.7 London Borough of Hillingdon

Annual Mean Values

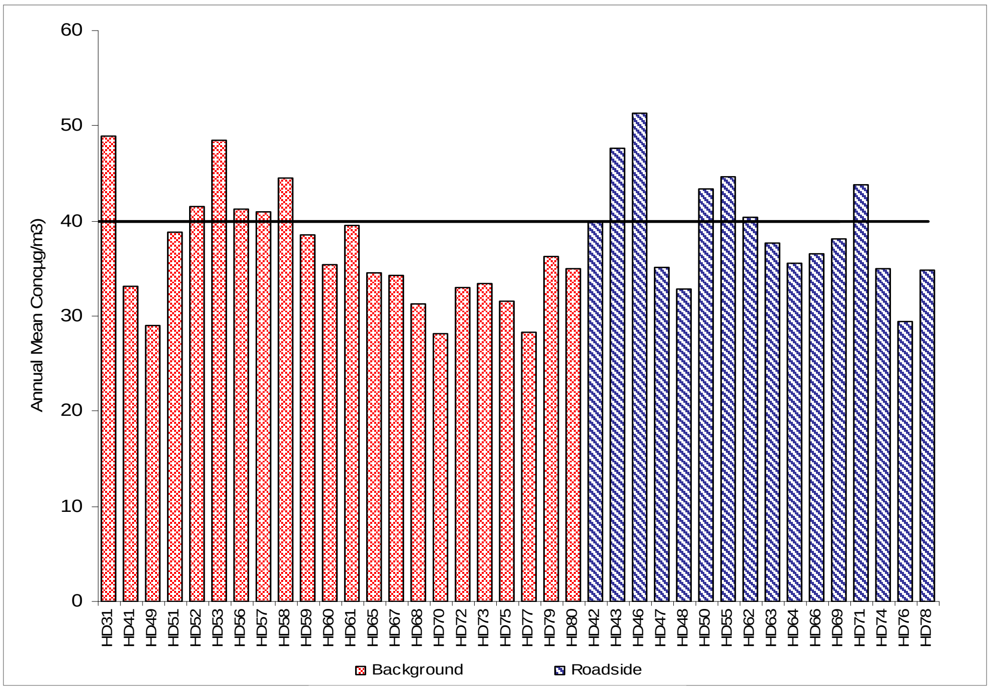

Figure 31 Hillingdon Background and Roadside Annual Mean NO_2 Concentrations, 2008

Hillingdon exposed diffusion tubes at 38 monitoring locations in 2008, with no change in the number of sites from the previous year[20]. The data capture for the year 2008 was 96%. The annual mean NO_2 concentrations for all sites has been reported as the 75% data capture criterion was fulfilled at all locations.

Background concentrations vary between 28.1 µg/m³ (HD70) and 48.9 µg/m^3 (HD31). Roadside concentrations range between 24.6 µg/m³ (HD76) and 51.3 µg/m^3 (HD46). The statutory air quality objective was exceeded at thirteen monitoring sites representing 34% of the total number of eligible sites. This is an increase compared to 2007 when 26% of sites recorded over 40 µg/m^3**.**

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[20] HD73, HD74, HD75, HD76, HD77, HD78, HD79 and HD80 added in December 2006

Time Series

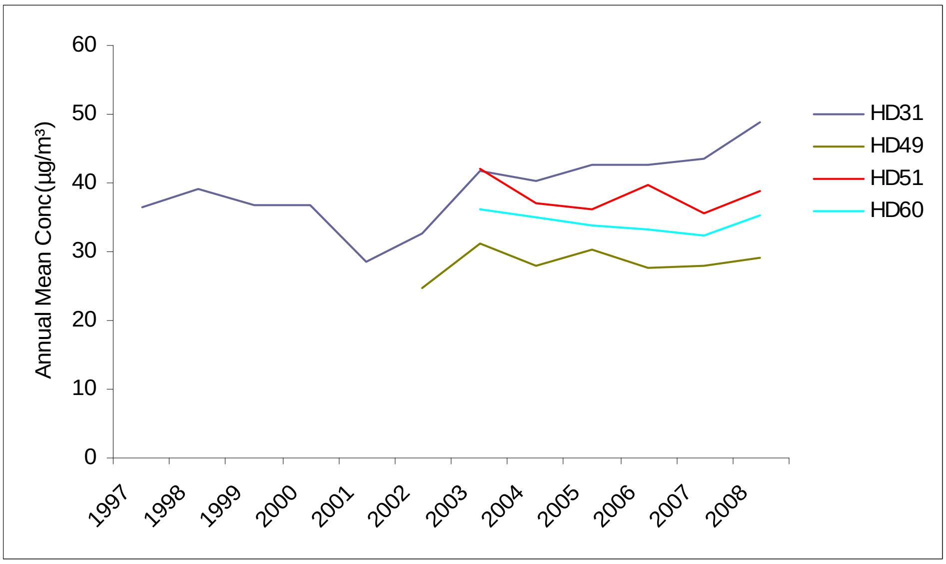

Figure 32 Hillingdon Background Time Series, 1997-2008

The background concentration monitored at HD31 varies between 1997 and 2005 . Sites HD31 and HD49 follow closely between 2002 and 2006. Sites HD51 and HD60 concentrations decreased in 2007, whereas slight increases were recorded at HD49 and HD31. There was a marked increase in 2003 at both background and roadside sites which was attributed to meteorological conditions. All sites recorded an increase in concentration during 2008. Comparing the background concentration in 2008 with 2007, there has been a 4.12% increase.

Figure 33 Hillingdon Roadside Time Series, 1997-2008

Roadside location HD46 replaces HD43 as the latter failed to meet the 75% data capture criterion. HD46 recoded almost continuous annual increases throughout the period 2004 – 2008. Site HD55 has six years continuous data and has been included for the first time and records a decreasing trend between 2003 and 2006 followed by two-years of increasing concentrations. HD42 peaked in 2005 and has continued to record decreasing annual concentrations until 2008. When comparing the roadside concentration recorded in 2008 with 2007, there has been a 6.5% increase.

Trend Analysis

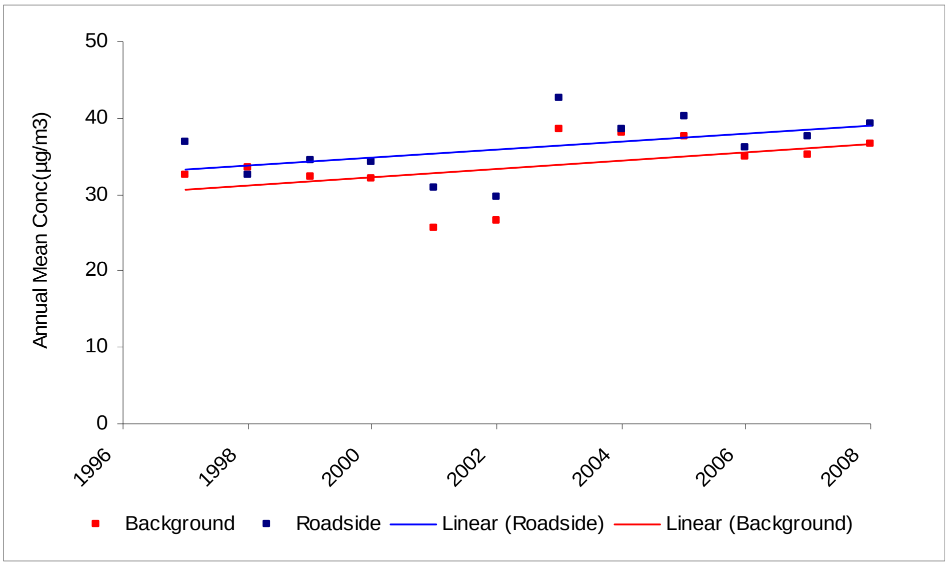

Figure 34 Hillingdon Background and Roadside Trend Analysis, 1997-2008

Long-term background annual mean NO_2 concentrations display a positive trend increasing by 13.8% from 1997 to 2008 due, in part, to the 2003 meteorological conditions and increase in number and the reassignment of site classes in 2007. Long-term roadside annual mean NO_2 concentrations display a positive trend increasing by 6.5% from 1997 to 2008. Concentrations recorded at both background and roadside sites appear to be converging although the influence of the proximity of Heathrow cannot be excluded.

Roadside Elevation

Table 11 Hillingdon Elevation Above Background NO_2 Concentration µg/m^3

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2007
4.4	-1.0	2.1	2.2	5.4	3.1	4.0	0.7	2.7	1.3	2.5	2.5

The roadside elevation in NO_2 concentration varies throughout the period. In 2007, following a request for clarification, sites were re-checked and some were reclassified. The elevation became negative in 1998 due to an increase in background concentrations above averaged roadside sites; roadside concentrations were subsequently greater than background concentrations in the period 1999 - 2008. The elevation has levelled during 2007 and 2008.

7.8 London Borough of Hounslow

Annual Mean Values

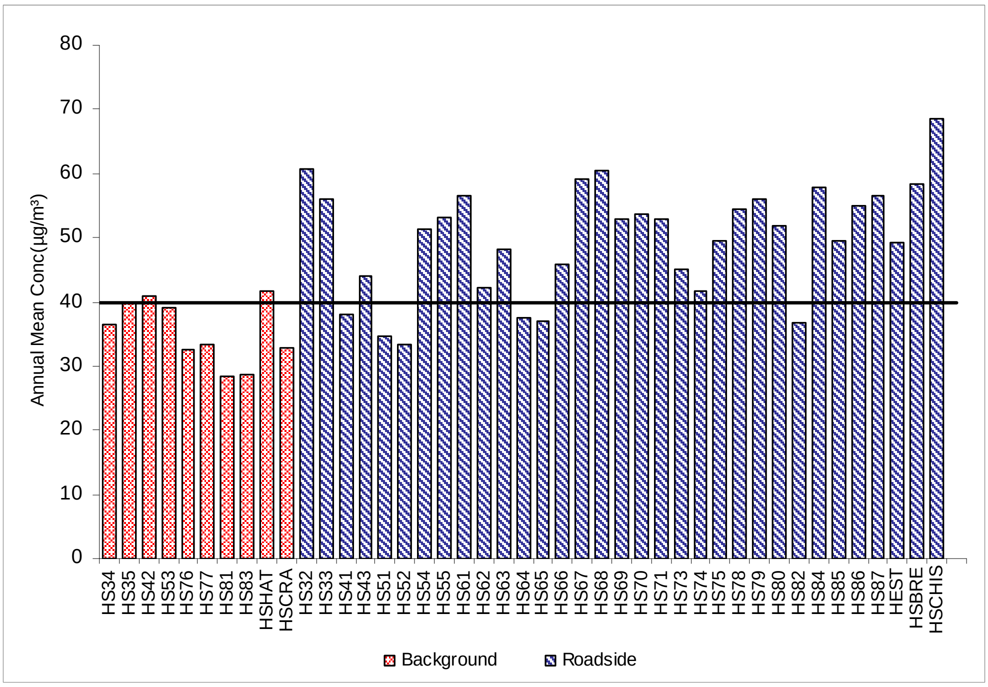

Figure 35 Hounslow Background and Roadside Annual Mean NO_2 Concentrations, 2008

Hounslow exposed diffusion tubes at 50 monitoring location in 2008,with some site changes compared to the previous year[21]. The data capture this year was 90%. Monitoring sites HS35, HS72, HS88, HS89, HS90, HS91, HS92 and HS93 have not been reported as the 75% data capture criterion was not fulfilled at these locations. Sites HS70, HS71 and HS73 to HS87 inclusive have been reported for the first time.

Background concentrations vary between 28.5 µg/m³ (HS81) and 41.0 µg/m^3 (HS42). Roadside concentrations range between 33.4 µg/m³ (HS52) and 68.6 µg/m^3 (HSCHIS). The statutory air quality objective was exceeded at wenty-eight monitoring sites representing 65% of the total number of eligible sites. This is return to high number of sites recording exceedences last seen in 2003 and follows reducing numbers of sites exceeding the directive in the period 2004 – 2007.

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[21] HS88, HS89, HS90, HS91, HS92, HS93 added in April 2008

Time Series

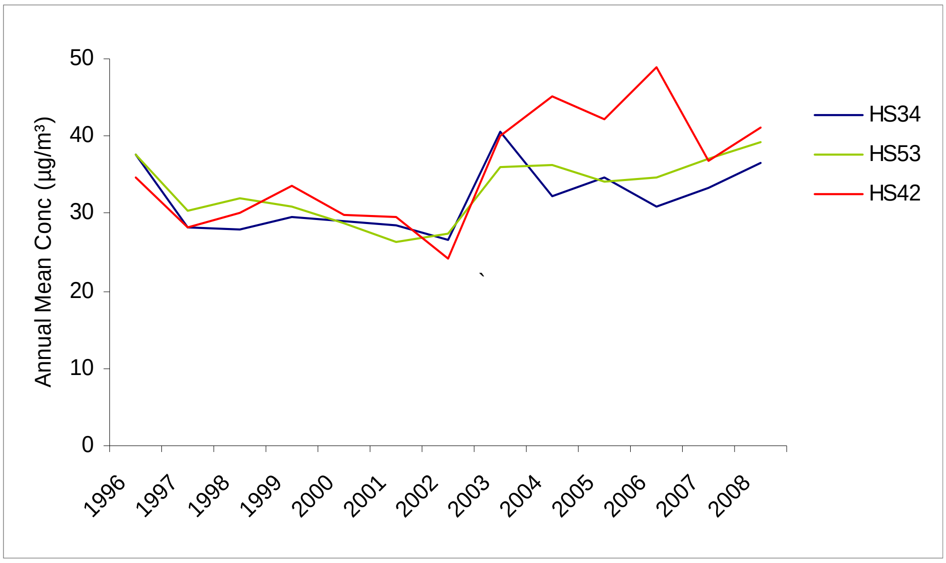

Figure 36 Hounslow Background Time Series, 1996-2008

The time series reveals all sites largely follow an identical trend from 1996 to 1997. Following a small peak in 1998, NO_2 concentrations increase until 2001, when concentrations declined slightly. Background concentrations increase between 2002 and 2004 at all locations. Site HS35 has been removed as data capture has failed to meet the data capture criterion. In 2004, a decrease in concentrations is monitored at HS34 and HS53, this trend continued in 2005. In 2006 concentrations at site HS34 decreased while those at HS42 and HS53 increased, a position which reversed in 2007. However, during 2008 all three sites recorded increased concentrations. Comparing the mean of all background concentrations monitored in 2008 with 2007, there is a 1.7% reduction.

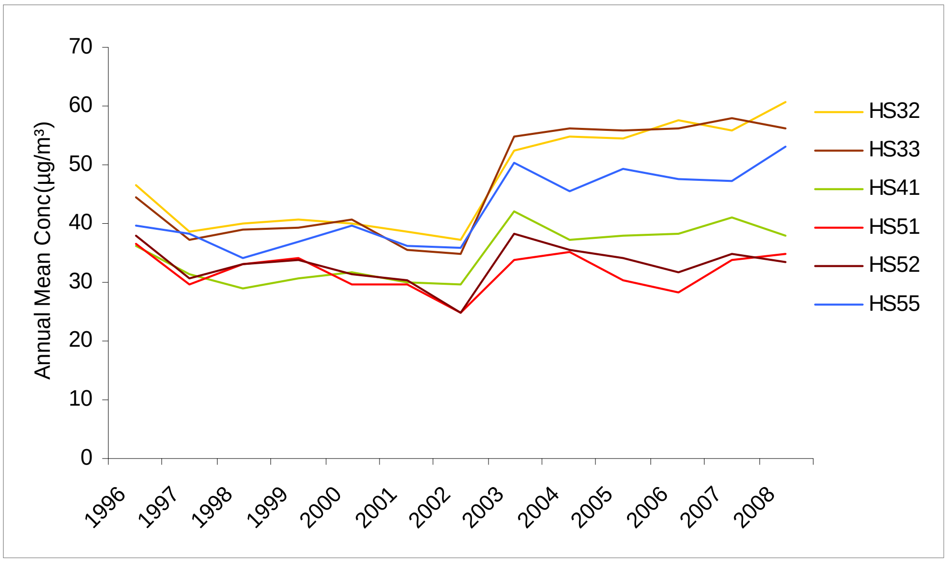

Figure 37 Hounslow Roadside Series, 1996-2008

Sites HS32 and HS33 follow near identical trends with a gradual decrease in NO_2 concentrations between 1996 and 2002. With the exception of HS55, the remaining sites reflect a similar rolling pattern peaking in 1996 and 1999, then falling sharply in 1997 and 2002. The 2003 conditions caused all roadside sites to experience a sharp elevation in annual mean NO_2 concentration. In 2006, all sites except, HS32 and HS41 have recorded decreases; in 2007 all sites except HS32 and HS55 concentrations increased. During 2008 some sites e.g. HS33 and HS41 recorded a lower annual mean other sites e.g. HS32 recorded an increase compared to 2007. Comparing the mean across all roadside concentrations monitored in 2008 with 2007, there is an increase of 5.3.

Trend Analysis

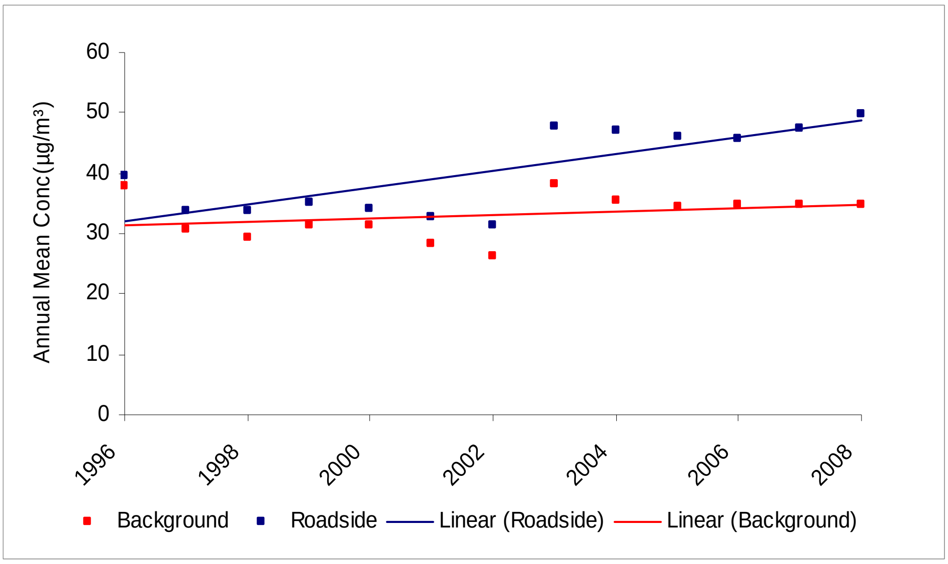

Figure 38 Hounslow Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations show a slightly decreasing trend. Between 1996 and 2008, concentrations have decreased by 7.8%. Long-term roadside annual mean NO_2 concentrations show a very positive trend. Between 1996 and 2008, roadside concentrations have increased by 26.6%.

Roadside Elevation

Table 12 Hounslow Elevation Above Background NO_2 Concentration $\mu g/m^3$

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.6	2.9	4.6	3.9	2.6	4.3	5.1	9.3	11.5	11.5	11.1	12.7	15.0

The elevation above background NO_2 concentration increased dramatically in 2003 compared with all previous years. The elevation continued to increase throughout the period 2004 - 2008 with a small decrease in 2006.

7.9 London Borough of Kensington and Chelsea

Annual Mean Values

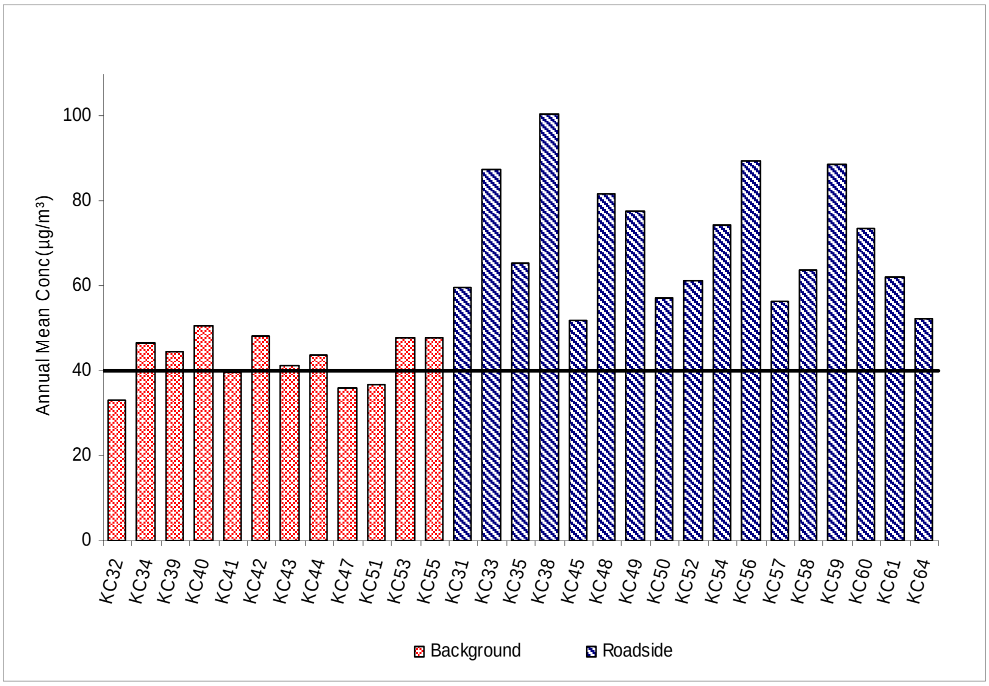

Figure 39 Kensington and Chelsea Background and Roadside Annual Mean NO_2 Concentrations, 2008

Kensington and Chelsea exposed diffusion tubes at 31 monitoring locations in 2008, with minor changes in site numbers compared with the previous year[22]. The data capture for this year was 98% and all sites have been reported, having met the 75% data capture criterion.

Background concentrations vary between 33.1 µg/m³ (KC32) and 50.8µg/m³ (KC40). Roadside concentrations range between 52.0 µg/m³ (KC45) and 100.7 µg/m³ (KC38). The 2005 air quality objective was exceeded at 25 monitoring sites representing 81% of the total number of sites. This is a small decrease compared to last year when 84% of monitoring sites showed exceedences.

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[22] Site KC46 closed in December 2007 and Site KC64 was opened in January 2008

Time Series

Figure 40 Kensington and Chelsea Background Time Series, 1996-2008

All background sites appear to follow a similar trend between 1996 and 1998 and the majority continue to do so until 2000. KC32 maintains the lowest annual mean NO_2 concentration over this monitoring period. An abrupt rise in NO_2 concentration takes place at all sites in 2003 with KC32, KC40 and KC42 recording their highest concentrations over the whole monitoring period. Concentrations increase in 2005 and 2007 and reduced at many sites in 2006, with the exception of KC42 in all years,. There is a 1.8% decrease of annual mean NO_2 concentrations between 2007 and 2008.

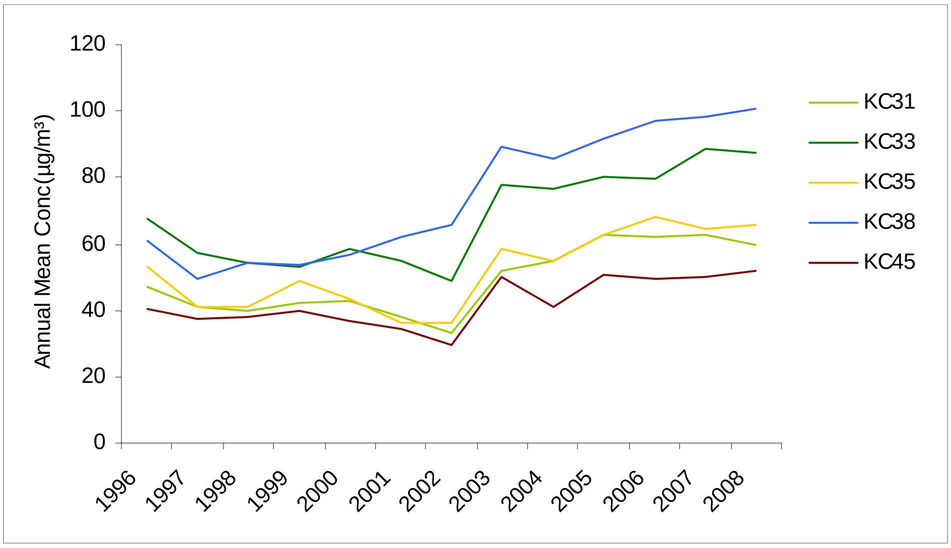

Figure 41 Kensington and Chelsea Roadside Time Series, 1996-2008

Sites KC33 and KC38 clearly show the highest NO_2 concentrations between 1996 and 2008. KC38 is the only site to show a continuous increase in NO_2 concentration, taking place between 1997 and 2003. The NO_2 concentration at KC33 reveals a gradual reduction from 1997 to 2002. The NO_2 concentrations at the remaining sites fluctuate but largely record increasing concentrations. Between 2002 and 2006 all roadside concentrations record an appreciable rise in NO_2 concentrations. New record high concentrations are recorded at KC33 and KC38 annually, KC31 and KS435 remained fairly stable. Comparing the mean of the concentrations monitored at roadside sites between 2007 and 2008, there is a decrease of 1.3%.

Trend Analysis

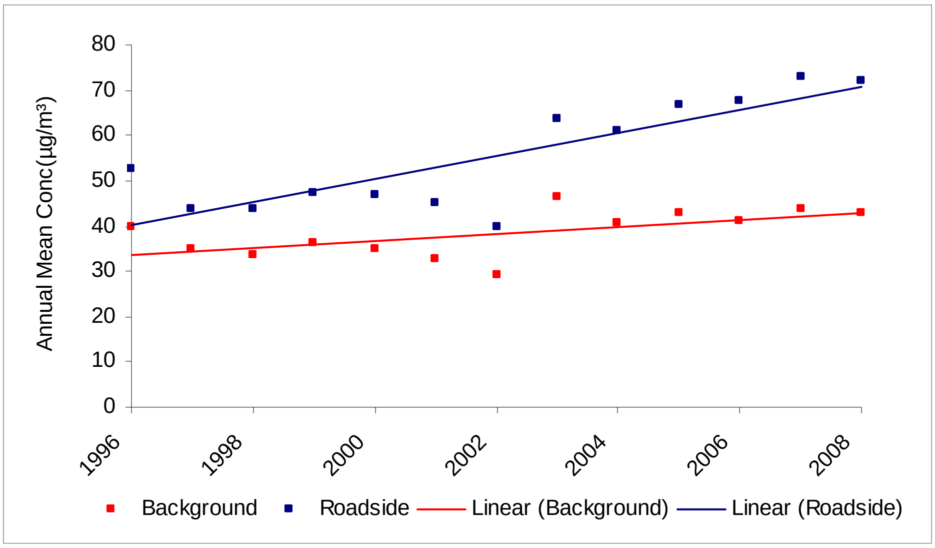

Figure 42 Kensington and Chelsea Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations show a slightly positive trend. Between 1996 and 2008, concentrations have increased by 8.4%. Long-term roadside annual mean NO_2 concentrations show a very positive trend. Between 1996 and 200,8 concentrations have increased by 36.7%.

Roadside Elevation

Table 13 Kensington and Chelsea Elevation Above Background NO_2 Concentration µg/m^3

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
9.2	9.9	11.0	11.9	12.2	10.6	17.3	20.4	23.6	26.6	29.1	28.9

The elevation above background concentration fluctuated between 9 - 12 µg/m³ between 1997 and 2002. However, in the period 2002 - 2003 this increased by 7 µg/m^3. The elevation continues to increase between 2004 and 2008 reaching the highest long-term value in 2007.

7.10 London Borough of Lewisham

Annual Mean Values

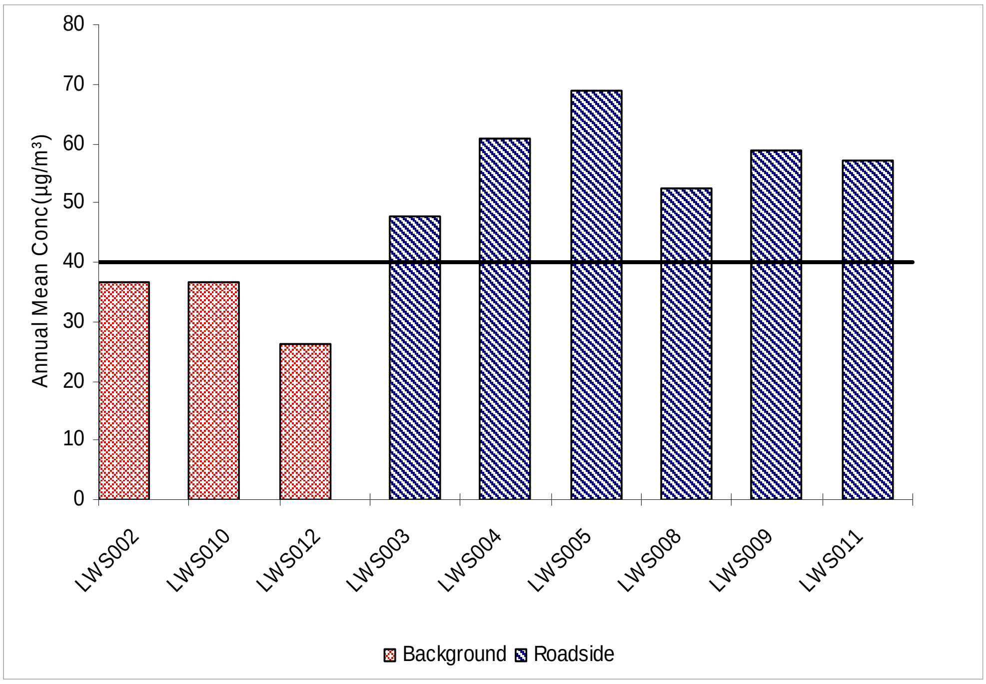

Figure 43 Lewisham Background and Roadside Annual Mean NO_2 Concentrations 2008

Lewisham exposed ten sites in 2008, of these LWS01 has been excluded as it failed to meet the 75% data capture criterion. Additional sites were added during 2008[23]; however these have also been excluded due to low data capture. It is anticipated these sites will be included in subsequent years.

The data capture for Lewisham is 78% although if site LWS is excluded this increases to 86%. Background concentrations range between 26.2 µg/m³ (LWS12) and 36.7 µg/m³ (LWS02). Roadside concentrations vary between 47.8 µg/m³ (LWS03) and 68.9 µg/m³ (LWS05). The 2005 objective was exceeded at 6 sites. This represents 60% of the total number of sites.

Roadside Elevation

Table 14 Lewisham Elevation above Background NO_2 Concentration µg/m³

Year	2008
Elevation	24.5

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[23] Site LWS01 closed due to persistent losses, LWS14 was introduced in December 2008.

7.11 London Borough of Newham

Annual Mean Values

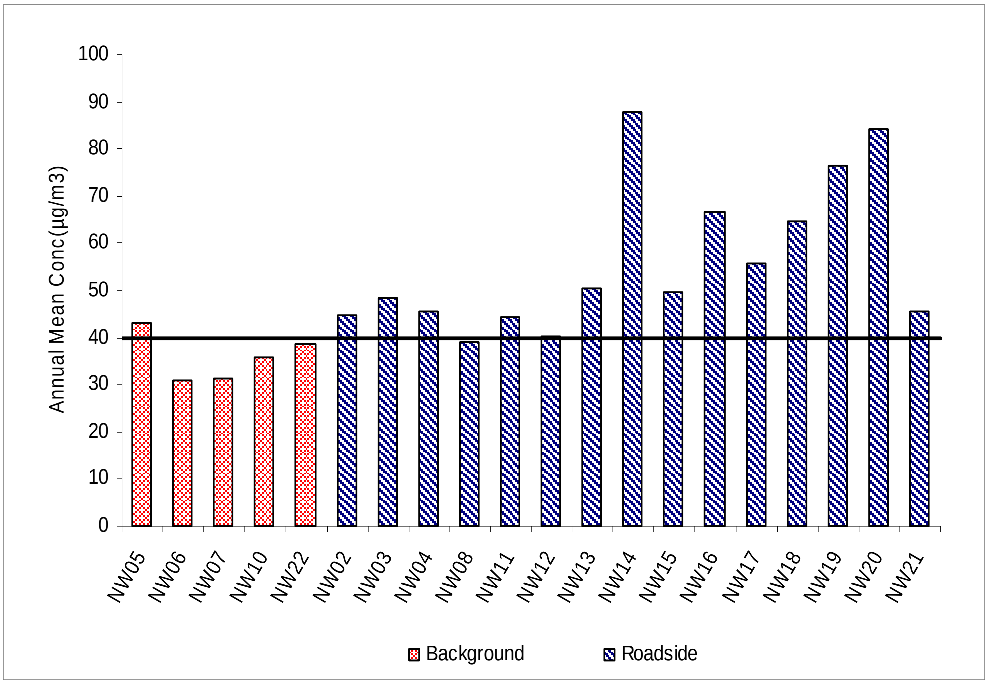

Figure 44 Newham Background and Roadside Annual Mean NO_2 Concentrations, 2008

Newham exposed diffusion tubes at 22 monitoring locations in 2008, with no change to the number of sites compared to the previous year. The data capture this year was 88%. The annual mean concentration for NW01 has not been reported as this site failed to meet the 75% criterion.

Background concentrations vary between 31.3 µg/m³ (NW07) and 43.1 µg/m^3 (NW05). Roadside concentrations range between 39.0 µg/m³ (NW08) and 87.8 µg/m^3 (NW14). The 2005 air quality objective was exceeded at 15 roadside and background monitoring sites representing 71.4% of the total number of sites. This represents a decrease compared to last year when 74% of sites breached the air quality objective.

Time Series

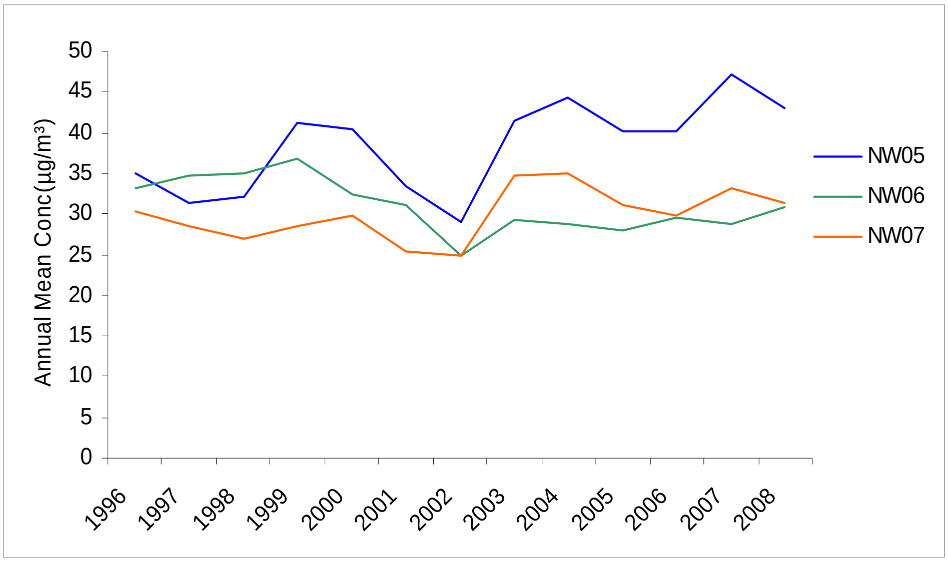

Figure 45 Newham Background Time Series, 1996-2008

NW05 and NW07 follow similar patterns, with annual mean NO_2 concentrations progressively decreasing between 2000 and 2002. A noticeable increase in annual mean NO_2 concentration takes place in 2003 at all sites. Increases in concentrations recorded in 2007 and decreases in 2006 2008 at sites NW05 and NW07 are not seen at site NW06. Comparing the mean of the concentrations monitored at background sites between 2007 and 2008, there has been a decrease of 6.1%.

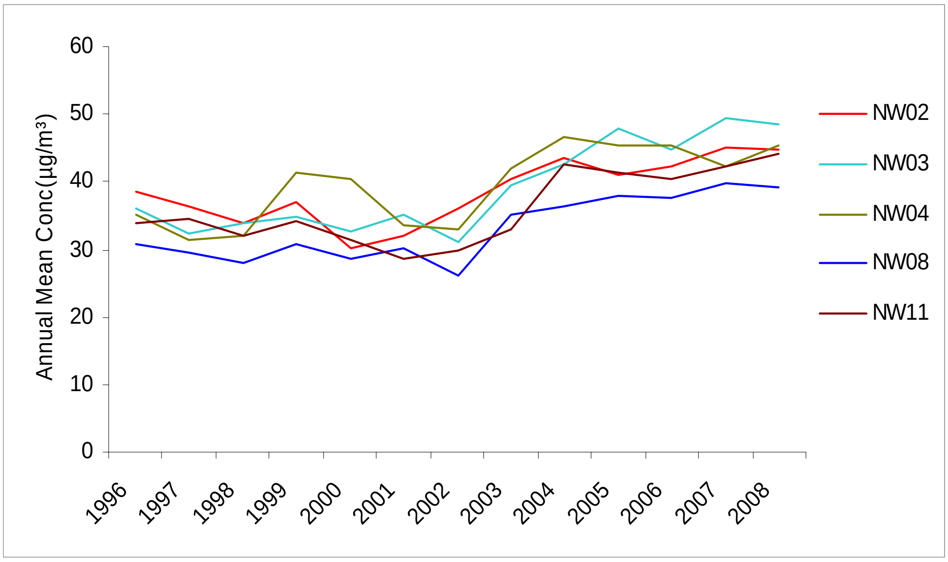

Figure 46 Newham Roadside Time Series, 1996-2008

Roadside site NO_2 concentrations appear to follow one another (except NW04) closely until 2003. Historic NO_2 levels appeared to peak in 1999 and 2003. Annual mean concentrations show a distinct increase from 2002 to 2003 and again in 2004 at all roadside sites. In 2005, annual mean concentrations decreased at all roadside locations except NW02 and NW08 where the concentrations increased. All sites except NW04 continue to follow the same trend with decreased annual mean concentrations in 2006, increases in 2007. In 2008 all sites record a decrease in the annual NO_2 concentration except NW04 and NW11 which increased. Comparing the mean of the concentrations monitored at roadside sites between 2007 and 2008, there has been an increase of 6.3%.

Trend Analysis

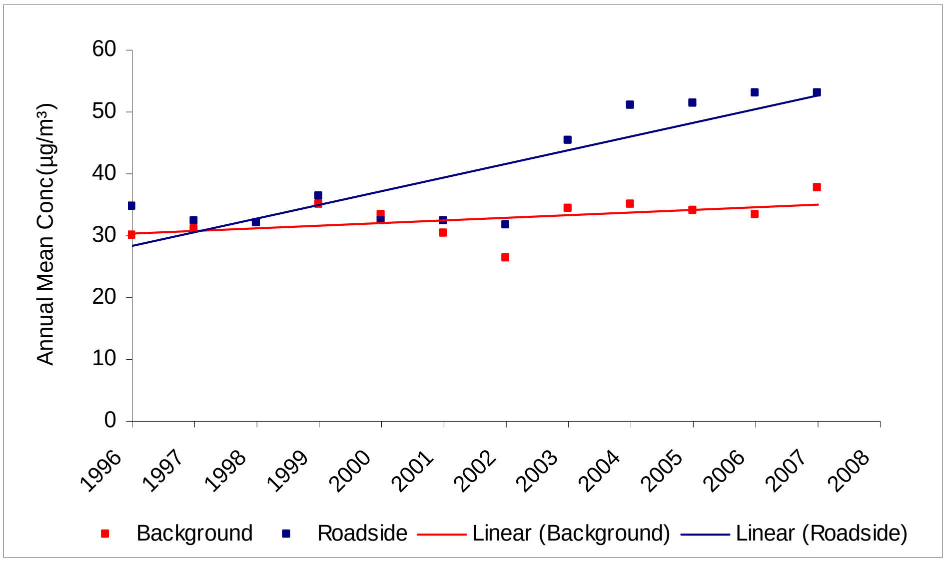

Figure 47 Newham Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations show a slight positive trend. Between 1996 and 2008, background concentrations have increased by 17.1% most noticeably in 2003. Long-term roadside annual mean NO_2 concentrations show a marked upward trend. Between 1996 and 2008, roadside concentrations have increased by 62.2% although this is partially explained by reclassification of sites and the general increase recorded in 2003.

Roadside Elevation

Table 15 Newham Elevation Above Background NO_2 Concentration $\mu g/m^3$

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.2	0.0	1.3	-1.0	1.8	5.3	11.2	16.2	17.5	19.7	15.4	21.0

Between 1997 and 2001 the roadside elevation concentration is extremely low. Between 1998 and 2001 background concentrations fluctuate above and below roadside concentrations. This pattern changes from 2002 onwards; with the roadside elevation significantly increasing with a record high in 2008, although the elevation reduced slightly in 2007.

7.12 London Borough of Richmond-Upon-Thames

Annual Mean Values

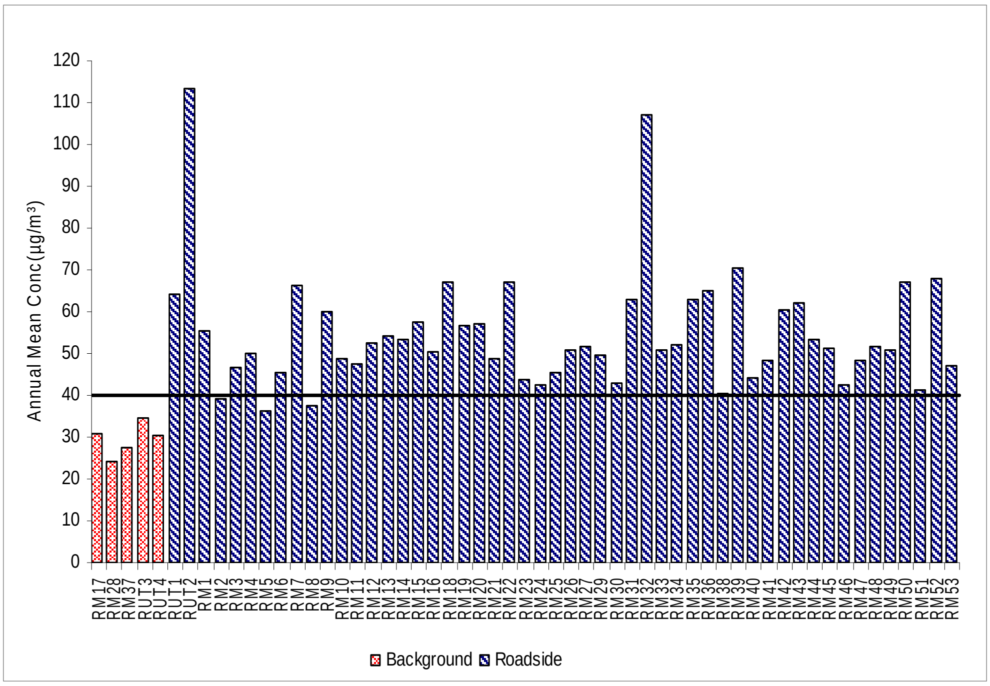

Figure 48 Richmond-upon-Thames Background and Roadside Annual Mean NO$_2$ Concentrations, 2008

Richmond-upon-Thames exposed diffusion tubes at 59 monitoring locations in 2008, with no change in site numbers compared with the previous year. Historically a number of sites which were changed in 2001 have been miscategorised; this has been corrected in this report[24]. The data capture for this year was 98% and all sites have been reported.

Background concentrations vary between 24.3 µg/m³ (RM28) and 34.6 µg/m^3 (RUT3). Roadside concentrations range between 36.1 µg/m³ (RM05) and 113.4 µg/m^3 (RUT2). The 2005 air quality objective was exceeded at sites representing 86.4% of monitoring locations. This represents an increase from the 82% of sites failing to meet the Air Quality Objective in 2007.

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[24] RM06, RM10, RM16, RM16, RM17, RM27, RM28, RM29, RM36, RM37

Time Series

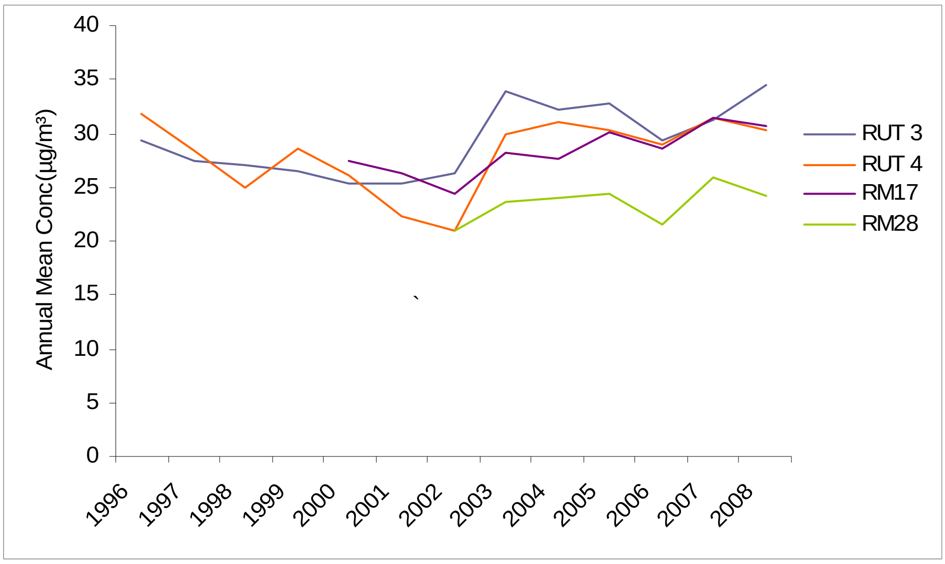

Figure 49 Richmond-Upon-Thames Background Time Series, 1996-2008

Background concentrations at RUT3 show a gradual reduction from 1996 to 2002. After a minor rise in 2002 NO_2 concentrations increase sharply in 2003. RUT4 shows gradual decrease in NO_2 concentration from 1996 to 2002. Sites RM28 and RM17 have followed a similar trend to RUT3 since 2002. A reduction was recorded at all sites in 2006. In 2007, all sites show increases in NO_2 concentrations after the reduction recorded in 2006. RUT3 continued to record increases in 2008 when the other sites all recorded a decrease.

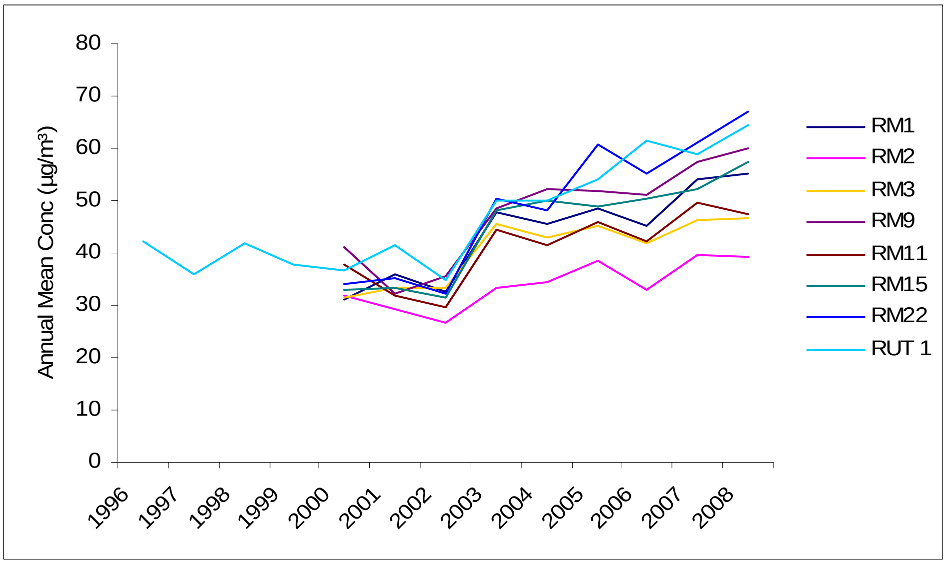

Figure 50 Richmond Upon Thames Roadside Time Series, 1996-2008

RUT1 is the only long term roadside site and set a trend to which most sites have followed since their addition in 2000. Annual mean NO2 concentrations at most sites, (excluding RM2, RM9 and RM11) increased between 2000 and 2001. All sites concentrations fluctuate slightly but follow a similar trend from 2003 onwards, RUT1 recorded an increase in concentration in

2006 when the majority of the sites recorded a decrease. RUT1 frequently does not record similar concentrations to the other sites; In 2007 all sites except RM15 and RUT1 recorded an increase in the annual NO_2 concentration, and in 2008 all sites except RM01 and RM11 have shown a decrease in the annual mean.

Trend Analysis

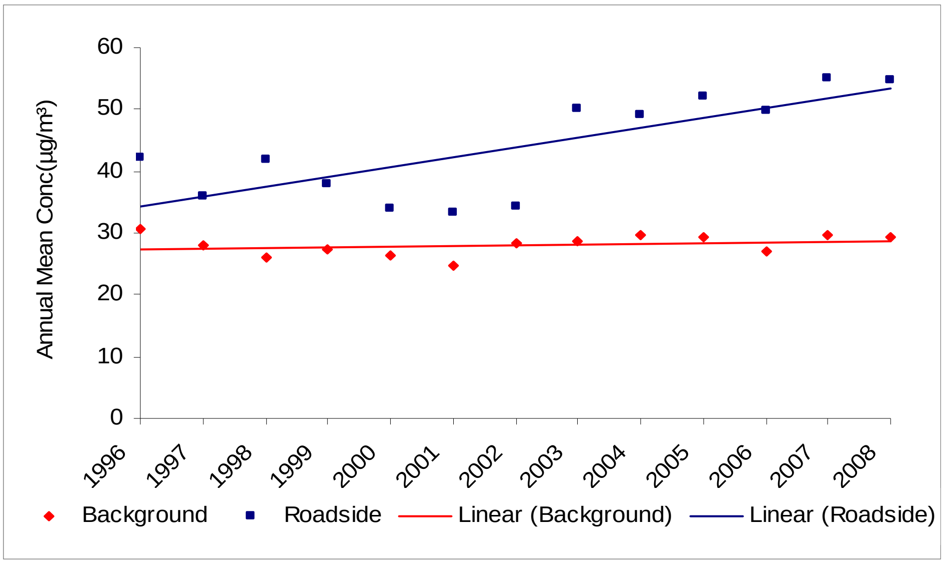

Figure 51 Richmond Upon Thames Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations show a stability with a slight negative trend. Between 1996 and 2008, concentrations have decreased by 3.6%. Long-term roadside annual mean NO_2 concentrations show a positive trend increasing by 29.6% between 1996 and 2008.

Roadside Elevation

Table 16 Richmond Upon Thames Elevation Above Background NO_2 Concentration µg/m^3

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
7.9	16.0	10.4	8.7	11.0	11.8	20.4	18.3	22.2	23.0	25.4	25.3

The roadside elevation fluctuates between 1996 and 2002, showing a sharp peak in 1998 at 16 µg/m^3 then falling over the next four years. In 2003 there is an approximate two-fold increase in the NO_2 elevation above background concentration; a trend which continued, (excluding the modest decline in 2004) until 2006. In 2007 elevation increased above background to a new record high of 25.4 µg/m^3 before stabilising in 2008.

7.13 London Borough of Westminster

Annual Mean Values

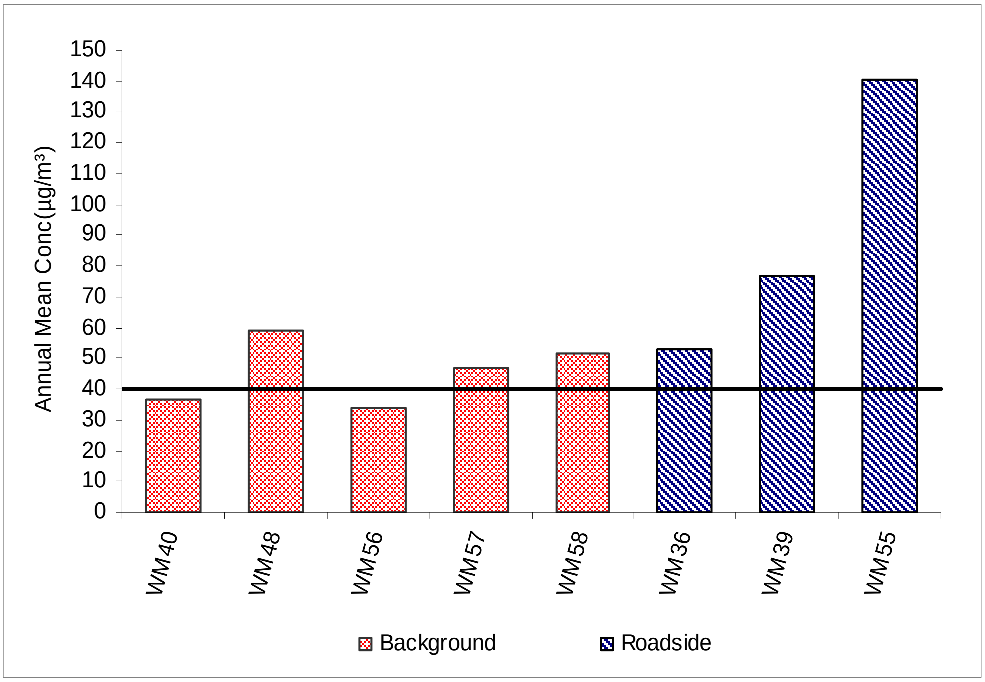

Figure 52 Westminster Background and Roadside Annual Mean NO$_2$ Concentrations, 2008

Westminster exposed diffusion tubes at 8 monitoring locations in 2008 with no changes in the number of monitoring sites. The data capture for this year was 94%. The annual means for all sites have been reported.

Background concentrations vary between 34.1 µg/m³ (WM56) and 58.9 µg/m^3 (WM48). Roadside concentrations range between 52.7 µg/m³ (WM36) and 140.2 µg/m^3 (WM55). The 2005 air quality objective was exceeded at six monitoring sites representing 83% of the total number of sites. This represents no change in the number of sites exceedencing since 2006, and a decrease compared to 2005 when 87% of the sites exceeded the air quality objective.

Time Series

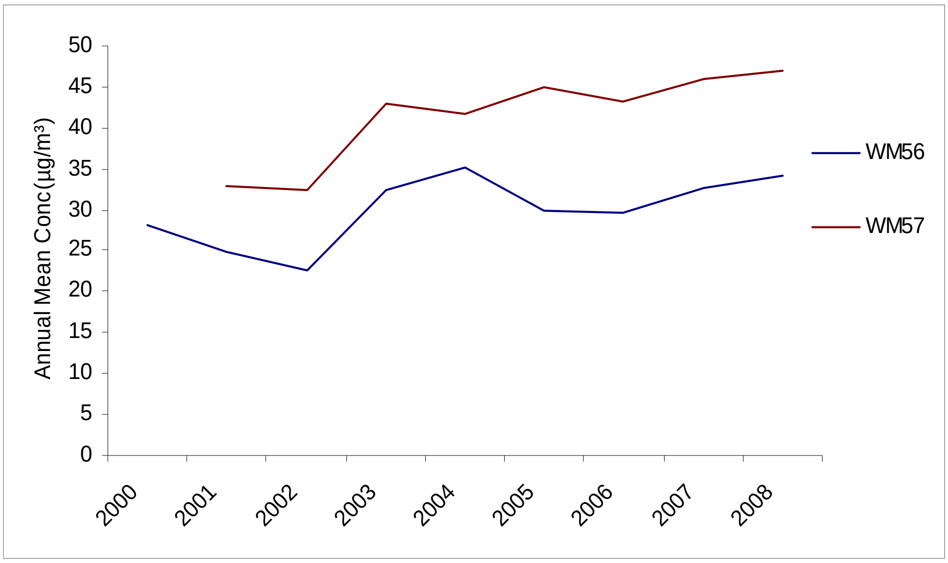

Figure 53 Westminster Background Time Series, 2000-2008

Discontinued and ineligible sites have been removed from the time series thus long term data are only available from 2000 onwards. A fluctuation in NO_2 concentration can be seen in the background sites. Both background locations experience a noticeable increase in annual mean NO_2 concentration in 2003 and 2004. Both sites record a reduction in annual NO_2 concentration in 2006 followed by increases in concentration. Comparing the average across monitored at these background sites between 2007 and 2008, there has been an increase of 5.1%.

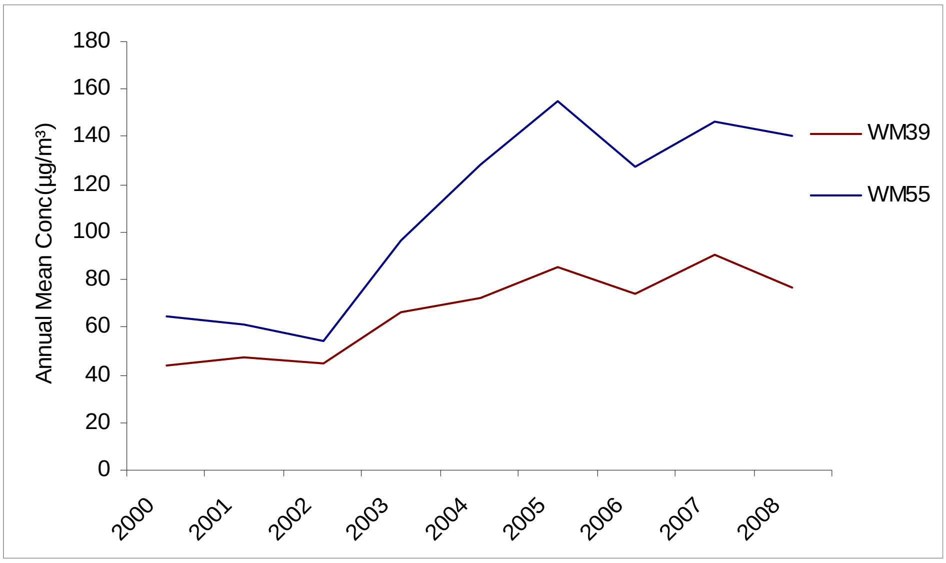

Figure 54 Westminster Roadside Time Series, 2000-2008

Discontinued and ineligible roadside sites have been removed from the Time Series. Site WM39 displayed a largely upward trend in annual mean NO_2 concentration with reductions recorded in 2004 and 2006. Between 2000 and 2007 the NO_2 concentration rises by over

100%. WM55 has been a continuously sampled location for a minimum of six years and has been included since 2005 and follows WM39 quite well. Between 2000 and 2005 an upward trend has been recorded at WM55; the first reduction occurred in 2006. These sites have recorded decreasing in the annual mean in 2008 and have remained below the 2005 peak concentration. Comparing the average across roadside sites between 2007 and 2008, there has been a decrease of 7.8%.

Trend Analysis

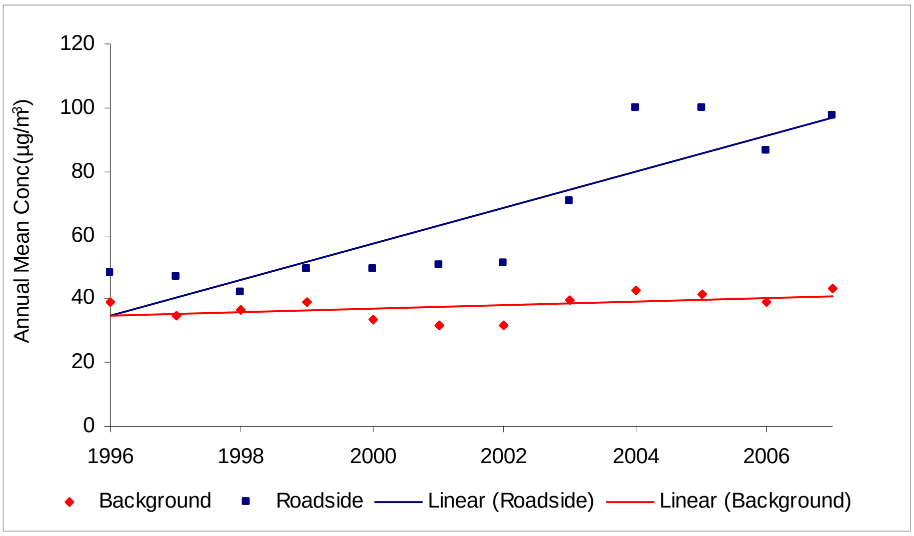

Figure 55 Westminster Background and Roadside Trend Analysis, 1996-2008

Long-term background annual mean NO_2 concentrations showed a decreasing trend until 2003. Between 1996 and 2008, averaged background concentrations have increased by 16.3%. Long-term averaged roadside annual mean NO_2 concentrations show a positive trend. Between 1996 and 2004, roadside concentrations appeared to have stabilised but the subsequent upward trend has resulted with an increase between 1996 and 2008 of 85.81 % (although since 2005 the number of background and roadside sites, upon which this calculation is made has decreased).

Roadside Elevation

Table 17 Westminster Elevation Above Background NO_2 Concentration µg/m^3

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
12.4	5.6	10.8	16.0	18.9	19.8	30.9	57.7	58.0	47.4	54.0	44.3

The elevation above background NO_2 concentration fluctuates between 1996 and 2002. The lowest concentration is recorded in 1998 where a drop of just over 50% takes place. Concentrations increase in 2005 reaching the highest level of the period, in part to the smaller number of locations. The elevation has been increasing since 2002, however, decreases in concentration occurred in 2006 and 2008 in an otherwise upward trend.

8 DIFFUSION TUBE CO-LOCATION STUDY

This section examines the results of triplicate diffusion tubes that have been co-located with a continuous NOx analyser operated by eight London authorities who participate in the LWEP nitrogen dioxide monitoring network. The mean bias correction factor derived from this study is intended to aid those local authorities that do not have the facilities to allow the calculation of their own correction factor. The study additionally aims to show compliance with EU Daughter Directive data quality objectives.

8.1 Co-location monitoring sites

Thirteen monitoring sites have been selected for this co-location study all of which operate as part of the Automatic Urban and Rural Network (AURN) or London Air Quality Network (LAQN). These sites are operated on behalf of DEFRA by Central Management and Coordination Units (CMCU) which are either Kings ERG (responsible for LAQN) or Bureau Veritas (responsible for AURN). The sites are summarised in Table 18. Recognised QA/QC procedures for calibration and data ratification of the continuous monitoring data are performed by AEA.

Triplicate diffusion tube NO_2 results associated with each monitoring site were averaged, and the annual mean NO_2 concentration compared to the equivalent concentration measured by the co-located continuous NOx analyser over the twelve-month period. Monthly continuous NO_2 data for each monitoring site has been retrieved from the Air Quality Archive.[18] Continuous analyser monthly mean results containing less than 75% data capture have been omitted to ensure a comparative and robust data set.

Table 18 Co-location monitoring sites details

Monitoring Site Name	Network	CMCU	Site Classification
Brent 1, Kingsbury	AURN	Bureau Veritas	Urban Background
Croydon, London Road	LAQN	Kings ERG	Kerbside
Croydon, George Street	LAQN	Kings ERG	Roadside
Greenwich 4, Eltham	LAQN	Kings ERG	Suburban
Greenwich 5, Trafalgar Road	LAQN	Kings ERG	Roadside/Kerbside
Greenwich 7, Blackheath	AURN	Bureau Veritas	Roadside
Hillingdon AURN	AURN	Bureau Veritas	Suburban
Hillingdon 1, South Ruislip	LAQN	Kings ERG	Roadside
Hillingdon 2, Hospital	LAQN	Kings ERG	Roadside
Hounslow 1, Brentford	LAQN	Kings ERG	Roadside
Hounslow, Chiswick High Street	LAQN	Kings ERG	Roadside
Kensington 1, North Kensington	AURN/ LAQN	Bureau Veritas / Kings ERG	Urban Background
Kensington 2, Cromwell Road	AURN	Bureau Veritas	Roadside
Lewisham 2, New Cross Road	LAQN	Kings ERG	Roadside /Kerbside
Richmond 1, Castlenau Library	LAQN	Kings ERG	Roadside
Richmond 2, Barnes Wetland Centre	LAQN	Kings ERG	Suburban

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[18] http://www.airquality.co.uk/archive/index.php

8.2 Results

Table 19 Bias adjustment factor and %bias of LWEP Co-location Study 2008

	Diffusion Tube	Continuous Analyser	Correction Factor (A)	% Bias based on continuous monitor (B)
London N. Kensington	36.0	34.1	0.96	4
London Cromwell Road 2	74.5	58.7	0.77	30
London Brent	31.1	34.3	1.11	-10
Croydon, London Road	68.2	66.8	1.00	0
Croydon, George Street	51.9	49.9	0.99	1
Hounslow, Chiswick High Road	68.6	71.5	1.04	-4
Hounslow, Brentford	58.4	57.6	0.99	1
Hillingdon, AURN	48.9	49.0	1.01	-1
Hillingdon 1, South Ruslip	51.3	46.0	0.90	11
Hillingdon 2, Hospital	43.4	35.2	0.82	22
Greenwich 4, Eltham Rd	25.7	27.3	1.07	7
Greenwich 5, Trafalgar Road	46.5	52.8	1.15	-13
Greenwich 7, Blackheath	53.9	45.2	0.86	16
Lewisham LW2, New Cross Road	68.9	61.9	0.95	5
Richmond 1, Castlenau Library	43.6	42.0	0.96	4
Richmond 2, Barnes Wetland Centre	27.6	30.7	1.12	-10
		Overall % Bias		**3.92**
		Mean Bias Adjustment Factor	**0.98**	

The bias adjustment factor ranges between 0.77 and 1.15 for the thirteen monitoring sites participating in the co-location study. The bias adjustment factor varies at background and roadside sites. The 2008 LWEP mean bias adjustment factor is calculated at 0.98. (This is the less than the 1.12 identified by Air Quality Consultants' spread sheet as the default value for Gradko diffusion tube prepared with 50% TEA with acetone method for 2008). The percentage bias figures in Table 19 show that diffusion tubes under-read or over read NO_2 concentrations between -10 and 30% when compared to the reference method of the continuous NOx analyser. The overall percentage bias for 2008 is 3.92, representing an over-estimation of the concentration compared to the previous year.

The variation in the mean bias adjustment factors over the past seven years can is shown in Table 20. As can be seen in Table 20 the mean % bias and bias adjustment factor results for 2003, 2004, 2005, 2006, 2007 and 2008 are clearly lower than those calculated in the preceding years. Gradko Internationally Ltd has been contacted with regards to the recent reduction in bias adjustment factors. The laboratory has guaranteed that any modifications have followed the new Defra guidance on the preparation or analytical procedures during this year. However, the temperature dependent co-efficient has not been applied to tubes analysed after April to ensure tubes concentrations calculated throughout the year have been determined by the same methodology.

Table 20 Mean correction factor and % bias from LWEP Studies 2001-2008.

Year	Mean Bias Adjustment Factors	Mean % Bias
2001	1.37	-26
2002	1.35	-26
2003	1.11	-10
2004	1.10	-9
2005	1.03	-3
2006	1.06	-4
2007	1.01	-1.06
2008	0.98	3.92

When the mean bias adjustment factor of 0.98 is applied to the raw diffusion tube NO_2, the number of sites showing exceedances increases. NO_2 concentrations above 40.9 $\mu g/m^3$ will exceed the Air Quality Objective; monitoring sites reporting NO_2 concentrations in excess of this concentration are highlighted in Appendix 1.

9 CONCLUSION

In 2008, annual mean NO_2 concentration averaged across all qualifying background monitoring sites experienced 3.3 % increase compared to 2007: the qualifying roadside sites recorded 1.6% decrease averaged across all sites. A total of 216 qualifying monitoring sites exceeded the Air Quality Objective of 40 µg/m^3, representing 70.6 % of qualifying diffusion tube monitoring sites, a decrease of 1.3 % compared with the previous year although the total number of roadside sites is less than in 2007. The long-term trend analysis continues to indicate a very slight decrease in concentrations of NO_2 over time at background sites whereas roadside sites reveal an increase. A summary of the results for background and roadside sites is as follows:

- The annual mean background NO_2 concentration averaged across all qualifying background sites was 37.9 µg/m^3; site concentrations were predominantly recorded in the 20-40 µg/m^3 concentration ranges.

- 29 qualifying background sites exceeded the air quality objective; an increase compared to the previous year.

- The annual mean roadside NO_2 concentration averaged across all qualifying roadside sites was 58.7 µg/m^3; site concentrations were predominantly recorded in the 50-70 µg/m^3 concentration ranges.

- 187 qualifying roadside sites exceeded the air quality objective, this is 15.4 % increase compared to the previous year.

Analysis of the roadside elevation is intended to provide an indication of the contribution of road traffic to total NO_2 concentrations. Contribution from road traffic to annual average NO_2 concentrations has increased in ten boroughs.

The LWEP co-location study extension includes the results from eight local authorities where triplicate diffusion tubes are concurrently situated with an automatic analyser. The results showed that the diffusion tubes used in this air quality programme over-read by 3.46%. This is well within the criterion of ±25% set by the AEA Inter-Comparison exercise. The mean bias adjustment factor derived from the LWEP collocation study for 2008 was calculated as 0.98. If the LWEP bias adjustment factor is applied to the raw diffusion tube results reported in this report, the number of sites showing exceedances decreases to 26 background sites and 183 roadside sites.

Appendix 1 Monthly and Annual Mean NO$_2$ Concentrations: All Sites, 2008

Site Code = Site exceeding AQO before bias corrected
Site Code = Site likely to exceed the AQO if the 0.98 bias adjustment factor is applied
Annual Mean = Value not reported data capture <9 months
* = No monitoring data

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg /m³
Bexley	BX31	B	25.65	34.32	26.84	1.73	30.02	20.88	25.31	19.34	26.69	30.36	31.15	35.64	**27.8**
	BX32	B	25.77	36.65	28.18	24.67	33.48	23.81	23.76	19.91	25.75	28.99	34.06	39.22	**28.7**
	BX33	B	27.11	37.76	26.96	26.08	37.34	23.45	*	14.92	29.54	31.95	36.44	39.89	**30.1**
	BX37	B	35.87	*	*	28.74	37.24	27.54	31.18	26.07	28.90	36.08	37.38	38.15	**32.7**
	BX34	R	28.03	45.38	30.61	*	53.16	28.81	45.56	18.71	27.72	32.86	36.19	44.83	**35.6**
	BX35	R	49.41	53.18	*	30.57	43.74	38.74	26.19	41.03	37.46	56.17	47.39	50.67	**43.1**
	BX36	R	25.98	37.99	23.09	38.51	38.01	20.84	26.88	20.87	27.99	*	40.33	34.95	**30.5**
Brent	BRT31	B	84.88	77.37	56.02	74.59	92.08	58.34	73.46	45.30	58.85	76.21	68.89	65.31	**69.3**
	BRT41	B	39.61	44.31	29.76	32.46	36.09	23.51	27.64	23.77	34.24	38.97	42.54	41.40	**34.5**
	BRT42	R	48.33	59.86	37.78	53.74	78.53	42.00	45.54	27.29	51.03	*	53.28	51.23	**49.9**
	BRT43	R	89.68	90.19	61.61	85.53	92.67	65.30	87.58	58.74	63.34	86.38	69.22	73.90	**77.0**
	BRT51	B	34.25	41.12	25.73	32.65	32.28	22.76	24.45	19.16	*	32.71	38.35	38.87	**31.1**
	BRT52	R	58.17	61.39	47.61	*	56.54	43.84	45.40	39.81	45.13	47.65	*	49.67	**49.5**
	BRT53	R	62.80	86.20	57.32	74.80	87.33	65.05	72.09	54.09	70.62	67.04	77.30	65.09	**70.0**
	BRT54	R	59.95	65.41	49.00	64.07	59.78	45.42	58.95	26.01	50.80	54.79	57.73	58.71	**54.2**
	BRT55	R	73.32	87.80	69.70	93.86	92.22	77.32	83.38	64.60	77.31	79.26	82.49	80.42	**80.1**
	BRT56	R	74.07	80.14	65.25	80.09	83.91	59.55	70.07	46.64	73.84	76.28	80.98	74.74	**72.1**
	BRT57	R	89.39	121.52	84.85	118.07	185.87	96.59	210.12	53.51	82.43	101.16	89.70	85.20	**109.9**
	BRT58	R	73.37	90.05	67.76	78.99	77.30	62.17	68.11	37.97	52.94	65.32	67.49	66.38	**67.3**
	BRT59		*	*	*	*	*	*	40.29	27.68	46.01	42.47	55.50	46.82	**43.1**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg /m³
City of London	CL 05	B	49.44	53.99	46.71	47.41	48.73	41.94	39.61	31.72	46.05	50.97	50.90	53.71	**46.8**
	CL 38	R	*	67.33	57.34	70.11	81.12	104.13	112.01	97.77	113.01	59.85	66.92	57.82	**80.7**
	CL 39	R	101.91	114.01	84.35	113.50	121.82	62.92	60.60	68.06	80.24	84.29	89.68	86.76	**89.0**
	CL 55	B	42.66	49.10	35.86	41.24	41.37	32.71	32.98	33.62	48.43	41.45	45.34	50.97	**41.3**
	MS CL 40	R	75.24	68.37	63.65	72.87	71.87	*	56.96	83.15	67.54	56.08	57.91	62.46	**66.9**
Croydon	CY 41A	R	58.35	62.21	*	74.91	83.60	57.54	17.90	54.38	55.91	65.59	63.35	65.14	**59.9**
	CY 42A	R	44.92	45.27	55.47	57.98	39.44	58.05	47.90	30.90	20.42	39.48	*	*	**44.0**
	CY 43A	R	41.89	50.32	41.90	55.76	70.49	49.97	42.68	31.30	45.19	37.92	52.18	57.14	**48.1**
	CY 46A	B	20.72	29.45	21.14	27.21	24.32	20.01	17.35	16.47	24.98	25.60	34.14	41.37	**25.2**
	CY 47A	B	22.68	32.37	21.90	31.57	32.16	22.19	20.99	18.92	26.73	26.36	31.08	36.41	**26.9**
	CY 48A	R	70.00	68.84	57.32	69.62	64.95	78.01	77.28	69.23	50.83	74.58	69.63	65.69	**68.0**
	CY 50A	B	12.94	26.79	14.13	20.68	21.03	15.84	12.56	10.75	20.89	12.42	25.42	33.13	**18.9**
	CY 51A	R	41.78	47.78	38.71	48.55	51.57	48.16	44.27	42.21	39.26	45.91	54.30	55.72	**46.5**
	CY 52A	R	45.06	54.90	41.96	56.57	55.40	51.90	47.17	40.00	44.07	52.98	60.98	63.07	**51.2**
	CY 55	R	50.71	69.29	71.95	76.56	111.42	66.32	61.50	54.01	64.15	56.03	67.94	68.75	**68.2**
	CY 56A	R	30.78	40.80	35.51	37.64	38.40	27.97	29.15	25.16	35.07	28.78	41.19	46.05	**34.7**
	CY 58A	R	79.07	74.17	57.46	84.34	*	64.56	67.33	64.76	66.31	110.30	64.99	72.35	**73.2**
	CY 59A	R	50.84	69.11	45.45	55.99	68.52	56.15	58.97	*	48.50	46.48	56.32	*	**55.6**
	CY 97A	R	30.16	45.42	35.15	46.01	55.64	41.65	37.48	48.32	41.21	49.75	54.05	56.28	**45.1**
	CY 98A	R	36.36	50.10	53.02	71.39	56.55	51.01	44.32	39.70	45.98	44.98	66.86	62.55	**51.9**
	CY 99A	R	45.09	52.57	39.47	50.25	65.77	33.36	41.24	39.02	46.09	40.85	46.59	56.69	**46.4**
Greenwich	GW 101	R	106.47	83.11	70.63	89.96	77.85	*	83.06	68.18	72.19	*	90.50	98.52	**84.0**
	GW 102	R	56.68	79.85	67.53	80.99	100.77	74.48	69.53	48.31	62.13	65.58	89.17	83.73	**73.2**
	GW 23	R	42.36	53.54	59.15	58.41	69.05	46.50	33.63	23.84	49.97	45.44	60.05	54.50	**49.7**
	GW 24	R	44.61	61.88	62.97	69.16	91.49	65.84	53.40	37.01	54.58	58.44	65.05	68.57	**61.1**
	GW 25	R	45.11	60.57	48.18	67.57	69.18	54.52	52.41	*	50.25	65.32	58.66	63.66	**57.8**
	GW 26	R	44.31	58.32	41.98	55.16	57.57	44.55	40.69	30.85	44.06	49.50	53.54	55.22	**48.0**
	GW 27	R	59.72	53.06	51.24	58.60	70.65	51.52	49.36	41.97	52.63	56.72	49.88	60.76	**54.7**
	GW 29	R	74.20	72.87	75.52	78.27	88.82	68.66	69.97	63.45	59.17	76.68	76.77	74.78	**73.3**
	GW 32	R	51.89	57.21	53.13	69.19	55.23	48.81	47.29	34.08	46.19	64.03	*	*	**52.7**
	GW 33	R	55.89	69.07	66.08	81.49	93.74	64.66	*	46.15	66.07	69.72	68.35	72.23	**68.5**
	GW 34	R	51.38	56.63	46.09	58.56	57.61	47.35	46.12	38.35	45.74	55.94	54.18	62.59	**51.7**
	GW 35	R	86.06	79.95	70.28	87.29	79.12	84.36	70.85	62.66	65.55	87.77	77.26	86.61	**78.1**
	GW 36	R	68.84	69.39	57.65	73.03	49.55	49.57	60.56	41.81	44.73	69.07	65.07	57.41	**58.9**
	GW 37	B	27.51	37.36	29.49	29.96	29.64	22.71	20.62	17.89	19.78	32.57	34.85	33.28	**28.0**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg/ m^3
Greenwich	GW 38	B	35.58	44.69	24.61	49.38	67.46	39.02	34.35	24.54	42.78	40.12	41.93	40.41	**40.4**
	GW 39	B	24.27	31.27	26.74	26.45	26.12	20.95	21.30	17.35	24.01	28.57	30.16	31.33	**25.7**
	GW 40	B	24.87	32.74	25.53	28.48	24.36	17.69	*	14.73	26.46	22.56	34.57	37.90	**26.4**
	GW 41	R	41.06	59.33	41.70	51.67	52.79	48.24	48.43	36.79	50.34	57.82	48.16	52.31	**49.1**
	GW 42	R	52.29	61.78	55.19	68.40	96.66	52.73	49.74	34.76	59.29	62.19	66.23	68.01	**60.6**
	GW 43	R	62.79	68.19	61.03	74.08	73.42	56.25	54.42	40.60	52.67	67.65	66.35	72.87	**62.5**
	GW 44	R	20.13	68.92	60.18	70.07	81.18	57.84	49.36	39.66	69.60	65.02	68.51	71.58	**60.2**
	GW 45	R	57.25	58.55	54.36	55.29	51.47	46.72	47.29	38.99	46.57	58.54	*	*	**51.5**
	GW 48	R	51.84	60.91	53.73	60.85	51.88	50.11	51.51	38.80	48.96	56.56	61.32	58.50	**53.7**
	GW 49	R	36.34	54.10	47.10	52.56	51.73	42.80	41.49	35.97	43.66	49.27	48.15	49.49	**46.1**
	GW 50	R	99.57	67.50	81.94	95.90	52.04	66.05	76.89	66.23	51.28	87.72	72.75	73.65	**74.3**
	GW 51	R	56.19	60.13	44.25	52.32	44.73	52.22	44.63	44.10	44.83	59.00	67.94	58.65	**52.4**
	GW 52	R	37.54	57.42	46.13	59.78	79.62	46.37	45.81	29.46	44.94	50.36	57.75	63.68	**51.6**
	GW 53	R	48.59	60.88	47.64	*	39.43	41.67	43.86	30.24	37.03	52.56	62.60	59.37	**47.6**
	GW 54	R	68.94	66.43	51.67	72.32	94.08	50.69	53.91	45.34	39.08	62.88	68.32	65.78	**61.6**
	GW 55	R	33.21	59.94	52.27	64.12	90.15	51.83	47.04	31.08	54.09	43.03	62.04	61.17	**54.2**
	GW 56	R	53.49	67.00	68.47	66.42	79.46	67.47	60.04	*	31.34	64.16	71.26	71.31	**63.7**
	GW 57	R	44.50	53.36	47.51	52.02	*	40.87	39.78	31.29	39.46	54.25	52.72	55.46	**46.5**
	GW 58	R	49.48	59.06	48.58	67.44	64.88	48.44	50.06	36.98	48.69	59.16	55.52	58.66	**53.9**
	GW59	R	36.69	54.60	41.56	56.82	74.93	42.35	45.32	33.21	44.37	47.69	46.56	53.62	**48.1**
	GW60	R	37.40	56.72	46.17	51.75	58.84	48.87	40.76	28.70	43.80	48.86	54.15	58.03	**47.8**
	GW61	R	50.97	50.25	47.71	48.50	54.95	35.30	39.92	34.00	42.36	51.39	51.70	49.02	**46.3**
Hammersmith & Fulham	HF 32	R	71.18	97.91	63.43	83.93	99.05	67.04	67.22	54.94	68.52	63.09	69.84	*	**73.3**
	HF 41	B	23.10	37.62	23.73	24.98	*	22.15	20.70	16.86	31.34	24.22	32.10	36.04	**26.6**
	HF 44	B	36.08	50.39	30.90	35.85	45.82	31.02	24.60	20.95	*	37.07	74.91	38.81	**38.8**
	HF 45	B	37.44	49.07	33.46	39.00	45.10	32.27	29.09	25.20	36.89	36.43	43.54	50.71	**38.2**
	HF 46	B	35.62	53.80	32.03	36.37	43.01	30.89	26.66	26.20	41.65	32.04	44.24	48.12	**37.6**
	HF 47	B	54.66	57.52	45.72	48.38	52.25	43.49	43.37	39.49	41.63	49.75	51.59	51.44	**48.3**
	HF 48	R	54.48	71.04	48.09	55.13	59.20	44.92	40.21	31.87	49.45	50.19	56.06	64.61	**52.1**
	HF 50	R	88.17	96.35	72.09	99.47	61.87	74.77	80.62	73.83	73.00	82.30	72.78	89.49	**80.4**
	HF 51	R	56.84	68.03	53.96	55.61	74.27	58.52	54.29	42.79	66.06	64.23	64.90	70.62	**60.8**
	HF 52	R	111.63	103.06	87.97	80.44	87.96	81.06	94.51	83.72	74.67	94.00	91.94	86.12	**89.8**
	HF 53	B	43.12	56.82	36.58	44.67	50.57	77.06	30.29	30.29	26.79	*	47.96	51.28	**45.0**
	HF 54	R	53.75	91.80	57.53	79.12	124.51	31.66	67.95	45.78	79.58	65.27	78.28	81.39	**71.4**
	HF 60	B	41.89	51.06	33.87	34.44	39.21	21.31	32.29	30.51	37.10	39.73	53.25	48.87	**38.6**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg/ m^3
Hammersmith & Fulham	HF 61	R	43.52	*	43.66	45.85	67.53	41.05	40.61	27.02	46.77	*	*	61.84	**46.4**
	HF 62	B	38.12	52.12	34.82	34.21	44.48	29.51	28.13	26.99	38.27	38.56	69.88	49.49	**40.4**
	HF 63	R	51.77	73.73	57.56	59.51	89.62	56.69	60.79	40.38	69.59	52.85	69.88	67.50	**62.5**
	HF 64	R	64.44	85.38	59.28	58.24	73.58	58.79	58.50	52.24	*	68.45	76.89	65.72	**65.6**
	HF 65	R	39.57	53.41	41.86	40.07	60.26	33.15	*	24.87	45.98	36.34	44.33	55.03	**43.2**
	HF 66	B	33.97	47.31	30.81	35.44	46.20	28.93	26.61	23.48	*	31.67	43.37	46.79	**35.9**
	HF 67	B	30.38	43.95	30.18	33.54	37.79	26.74	24.96	20.69	33.77	30.40	38.44	45.56	**33.0**
Hillingdon	HD 31	B	53.88	53.18	42.84	48.80	49.32	39.44	51.79	49.57	*	54.11	45.46	49.46	**48.9**
	HD 41	B	30.28	42.88	28.86	28.77	35.54	22.91	37.13	22.98	33.68	36.74	35.23	43.16	**33.2**
	HD 42	R	*	48.21	35.16	39.04	54.44	*	26.83	29.47	42.28	45.13	39.30	40.34	**40.0**
	HD 43	R	43.71	48.64	43.95	42.47	63.48	50.26	52.09	20.64	*	*	47.77	62.63	**47.6**
	HD 46	R	53.11	60.14	45.72	52.41	63.92	41.54	47.68	35.06	51.40	58.62	51.85	54.52	**51.3**
	HD 47	R	25.26	41.61	30.46	33.67	47.95	27.65	28.52	24.66	37.65	39.69	41.89	42.21	**35.1**
	HD 48	R	36.66	37.20	27.41	31.70	36.68	26.80	33.44	30.29	28.13	31.71	34.50	38.76	**32.8**
	HD 49	B	29.57	41.67	24.74	28.67	31.24	19.43	24.07	23.10	27.58	31.40	31.55	34.71	**29.0**
	HD 50	R	43.86	51.33	41.55	45.57	38.20	34.86	46.31	37.50	38.82	49.62	44.43	48.19	**43.4**
	HD 51	B	38.24	47.66	35.41	34.50	36.52	31.01	39.91	39.23	35.52	43.63	41.23	42.44	**38.8**
	HD 52	B	33.13	50.07	39.55	41.75	50.55	37.68	40.27	33.02	*	*	46.30	43.05	**41.5**
	HD 53	B	57.95	54.91	49.05	42.45	35.98	41.51	51.37	43.48	40.53	57.84	54.17	51.80	**48.4**
	HD 55	R	43.77	52.83	39.20	44.62	51.73	35.43	46.28	38.10	40.84	50.23	45.23	47.46	**44.6**
	HD 56	B	42.86	58.38	34.98	36.41	43.17	29.50	37.37	33.86	37.80	50.79	42.60	47.69	**41.3**
	HD 57	B	41.31	47.22	37.26	38.91	40.19	31.47	38.14	35.92	35.23	53.52	44.59	47.00	**40.9**
	HD 58	B	61.99	53.99	41.43	40.59	43.22	26.96	49.96	35.86	39.48	45.42	46.79	48.23	**44.5**
	HD 59	B	39.18	50.19	33.73	37.94	39.55	28.69	40.25	33.46	34.76	37.86	40.60	45.76	**38.5**
	HD 60	B	29.75	45.24	30.49	*	42.37	26.28	31.75	24.65	35.71	40.84	38.01	44.08	**35.4**
	HD 61	B	35.78	47.33	31.78	39.39	44.49	35.29	37.97	29.84	38.67	45.70	42.53	46.03	**39.6**
	HD 62	R	34.18	48.43	36.10	8.73	55.29	37.43	46.99	37.04	40.45	51.15	42.21	47.38	**40.4**
	HD 63	R	32.51	46.34	29.83	33.81	50.65	27.35	29.70	27.07	41.05	44.01	44.66	44.54	**37.6**
	HD 64	R	31.24	43.65	32.57	34.28	42.93	29.72	30.98	25.53	35.63	41.71	36.39	42.33	**35.6**
	HD 65	B	33.55	44.03	32.38	32.82	37.73	20.62	30.26	29.41	37.03	39.38	35.24	41.79	**34.5**
	HD 66	R	33.55	45.90	32.48	34.85	44.89	28.93	34.92	30.46	33.44	40.68	36.61	42.21	**36.6**
	HD67	B	33.93	41.23	30.91	33.24	42.86	28.09	32.00	29.18	33.86	34.65	34.25	37.16	**34.3**
	HD68	B	23.31	42.00	28.32	31.18	35.68	22.64	25.28	20.67	31.26	41.55	33.93	38.75	**31.2**
	HD69	R	36.16	45.36	37.94	37.81	41.45	32.63	33.23	24.39	37.34	47.12	41.63	42.77	**38.2**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg/ m^3
Hillingdon	HD70	B	25.50	39.35	21.98	33.23	28.97	*	23.53	19.08	27.96	29.88	25.99	34.19	**28.1**
	HD71	R	46.02	57.60	45.93	45.33	42.15	27.65	39.07	39.47	40.66	46.94	44.16	51.08	**43.8**
	HD72	B	31.25	42.55	28.44	30.45	39.15	21.44	29.76	26.99	33.10	39.13	33.26	40.17	**33.0**
	HD73	B	*	40.18	26.99	27.40	35.35	25.66	29.84	*	31.36	37.65	38.20	41.47	**33.4**
	HD74	R	35.95	44.39	29.89	30.42	44.35	26.04	30.14	21.85	37.09	35.15	37.55	47.32	**35.0**
	HD75	B	32.68	35.40	31.17	33.19	30.35	22.71	30.33	26.67	30.78	*	35.59	38.85	**31.6**
	HD76	R	26.37	36.54	24.21	26.82	39.30	32.51	24.33	19.20	29.76	25.50	33.17	35.28	**29.4**
	HD77	B	29.29	37.47	23.05	22.42	33.60	20.40	22.08	20.09	28.29	28.81	34.78	39.74	**28.3**
	HD78	R	42.39	44.40	35.52	32.29	26.07	29.42	37.45	31.99	32.74	35.17	35.97	35.02	**34.9**
	HD79	B	41.33	50.27	31.06	39.24	41.89	27.18	28.17	24.75	*	41.61	*	37.60	**36.3**
	HD80	B	36.24	46.72	28.67	37.47	45.21	23.95	28.37	24.56	*	40.46	*	38.39	**35.0**
Hounslow	HS32	R	61.71	63.84	46.14	68.48	76.63	61.05	69.77	52.41	44.88	53.37	64.56	64.64	**60.6**
	HS33	R	59.30	60.31	52.00	60.90	51.75	65.07	72.33	45.41	42.75	50.61	*	*	**56.0**
	HS34	B	36.19	46.25	29.57	32.00	50.15	27.38	34.22	21.80	29.06	31.76	42.23	56.86	**36.5**
	HS35	B	35.44	49.56	29.86	41.77	*	28.89	*	*	*	30.43	47.57	55.07	**39.8**
	HS41	R	32.37	43.36	32.04	36.72	51.37	42.55	31.71	19.95	33.41	31.63	49.08	51.32	**38.0**
	HS42	B	30.80	46.39	21.82	47.09	45.79	*	35.35	*	49.47	34.08	44.92	54.34	**41.0**
	HS43	R	42.10	45.83	35.01	42.22	59.02	45.85	45.14	25.87	36.42	36.84	56.38	58.26	**44.1**
	HS51	R	28.18	52.11	29.87	*	39.44	33.88	26.39	16.24	30.79	28.42	44.60	51.59	**34.7**
	HS52	R	36.78	41.67	32.24	34.24	45.88	32.05	24.23	15.63	32.85	24.73	47.48	*	**33.4**
	HS53	B	36.77	52.54	35.77	37.03	39.73	34.25	36.68	22.42	38.63	32.95	48.96	54.82	**39.2**
	HS54	R	54.03	64.83	46.97	61.45	60.98	43.71	51.08	35.69	38.10	43.09	53.23	62.57	**51.3**
	HS55	R	45.43	68.61	37.61	47.94	79.12	*	50.73	*	31.99	41.49	61.54	67.50	**53.2**
	HS61	R	64.64	69.06	50.09	66.21	17.75	64.20	74.24	43.74	59.36	56.62	*	*	**56.6**
	HS62	R	56.40	53.04	34.04	*	48.54	39.55	43.75	28.28	35.43	41.53	*	*	**42.3**
	HS63	R	41.36	55.86	39.47	*	62.27	50.36	50.46	38.14	39.31	41.26	*	63.65	**48.2**
	HS64	R	31.18	46.27	32.94	34.38	47.44	35.60	37.55	18.90	30.92	31.00	49.71	55.03	**37.6**
	HS65	R	32.60	49.53	24.69	40.83	39.29	32.58	41.86	*	11.76	34.19	44.62	54.25	**36.9**
	HS66	R	42.57	48.45	33.71	43.56	47.88	50.10	*	30.53	34.10	40.30	62.58	70.15	**45.8**
	HS67	R	63.42	61.29	43.88	61.56	72.59	64.37	73.71	45.43	47.76	38.00	63.15	73.37	**59.0**
	HS68	R	73.88	59.56	52.64	59.73	51.74	56.25	69.35	40.82	45.95	62.47	74.39	80.03	**60.6**
	HS69	R	46.51	59.17	42.78	40.59	88.90	51.16	62.33	35.17	44.05	38.96	47.60	76.31	**52.8**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg/ m^3
Hounslow	HS70	R	58.50	64.37	17.25	52.43	73.05	48.18	70.36	44.45	43.83	44.71	53.53	75.04	**53.8**
	HS71	R	57.70	58.68	53.23	57.45	48.08	52.56	64.50	42.45	43.48	50.13	*	*	**52.8**
	HS72	R	61.10	63.47	*	54.65	*	*	*	41.58	41.18	44.16	58.40	78.19	**55.3**
	HS73	R	42.67	53.48	30.24	42.71	55.82	*	39.24	31.27	32.69	38.81	62.24	65.49	**45.0**
	HS74	R	40.92	48.46	29.65	35.88	38.11	39.48	*	*	37.45	37.27	46.51	62.12	**41.6**
	HS75	R	52.93	57.74	36.58	47.41	59.97	52.87	49.94	39.30	40.20	41.53	*	66.77	**49.6**
	HS76	B	31.84	39.96	24.07	34.44	36.08	28.12	33.75	20.70	28.38	32.82	*	49.17	**32.7**
	HS77	B	31.90	42.65	23.89	28.02	39.78	28.62	26.23	19.40	29.27	*	43.51	52.81	**33.3**
	HS78	R	45.42	58.61	37.43	52.62	65.22	44.98	69.90	2.82	45.09	51.06	60.78	68.75	**54.5**
	HS79	R	41.39	76.14	34.67	55.26	68.86	53.92	54.58	40.14	46.09	56.67	70.37	75.06	**56.1**
	HS80	R	45.77	63.94	45.49	56.08	*	*	59.87	41.38	49.86	52.08	*	*	**51.8**
	HS81	B	30.96	40.63	28.75	28.35	30.43	25.00	27.18	15.60	29.96	28.47	*	*	**28.5**
	HS82	R	38.77	47.76	34.22	38.36	48.05	19.45	39.71	23.06	41.06	*	*	*	**36.7**
	HS83	R	20.37	36.81	19.31	24.13	29.52	33.04	*	*	39.72	13.68	31.24	38.84	**28.7**
	HS84	R	61.03	64.95	46.49	65.28	74.34	18.94	77.74	50.55	60.29	57.94	*	*	**57.8**
	HS85	R	45.24	51.92	43.01	45.70	46.31	62.85	54.75	32.58	48.52	47.81	54.46	59.69	**49.4**
	HS86	R	57.63	65.68	51.26	52.92	56.68	*	61.74	35.58	51.90	43.45	64.69	63.75	**55.0**
	HS87	R	60.92	67.93	41.70	56.01	58.32	54.17	64.38	43.58	56.64	44.72	63.17	67.49	**56.6**
	HS88		*	*	*	22.48	23.71	28.30	30.71	24.50	37.04	*	45.35	54.93	**33.4**
	HS89		*	*	*	*	18.28	*	3.58	12.82	28.76	*	35.32	38.16	**26.7**
	HS90		*	*	*	22.48	34.85	33.17	28.03	*	34.99	43.05	52.06	*	**35.5**
	HS91		*	*	*	20.89	32.77	28.16	28.09	31.91	41.39	35.62	49.86	*	**33.6**
	HS92		*	*	*	28.17	49.45	49.19	43.53	21.64	27.77	19.70	*	*	**34.2**
	HS93		*	*	*	29.09	40.16	<L.O.D	52.59	21.98	35.76	33.65	*	*	**35.5**
	HEST/ HS	R	41.21	57.82	41.60	52.88	*	39.43	*	35.07	55.88	44.58	*	74.65	**49.2**
	HAT/ MS	B	36.95	45.88	46.66	44.75	46.77	38.74	33.76	20.57	41.35	31.12	51.15	61.95	**41.6**
	HSBREN	R	49.84	61.42	43.25	59.08	76.55	64.08	68.67	42.02	47.11	45.41	70.57	72.28	**58.4**
	HSCHIS	R	66.31	77.33	52.41	72.68	87.75	61.56	83.37	50.02	53.15	62.68	77.83	78.36	**68.6**
	HSCRAN	B	32.44	53.51	22.78	33.12	39.79	22.33	27.50	22.23	27.28	27.05	37.08	47.58	**32.7**
Kensington & Chelsea	KC 31	R	49.29	65.14	45.54	66.09	91.94	57.65	49.80	39.39	74.09	53.19	59.14	64.99	**59.7**
	KC 32	B	35.54	44.98	28.59	32.86	35.99	24.00	25.84	23.94	31.64	31.32	38.42	44.06	**33.1**
	KC 33	R	87.56	90.43	81.85	102.53	110.30	52.92	87.53	86.13	99.93	71.66	87.59	90.35	**87.4**
	KC 34	B	50.96	57.16	37.19	46.47	55.46	33.09	41.13	37.27	50.08	43.98	52.35	55.59	**46.7**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg/ m³
Kensington & Chelsea	KC 35	R	76.86	77.27	49.68	63.65	68.08	60.30	71.99	70.24	53.60	64.38	63.54	66.65	**65.5**
	KC 38	R	118.41	106.96	83.92	105.90	104.86	99.65	*	109.26	83.70	92.82	103.98	98.18	**100.7**
	KC 39	B	38.58	50.11	38.17	47.28	49.59	34.44	35.96	34.44	53.17	43.12	52.10	58.35	**44.6**
	KC 40	B	50.84	62.43	42.23	54.95	59.79	40.33	45.25	49.84	45.33	53.11	52.40	52.82	**50.8**
	KC 41	B	37.21	53.16	34.67	38.14	50.47	32.52	29.67	28.45	45.91	33.33	45.44	48.48	**39.8**
	KC 42	B	47.57	57.56	44.91	49.93	51.53	41.29	44.17	42.58	45.35	43.59	59.35	52.55	**48.4**
	KC 43	B	45.95	57.84	31.89	39.96	63.18	28.12	30.57	26.89	43.79	32.20	46.37	47.13	**41.2**
	KC 44	B	52.63	51.92	38.07	54.71	46.14	35.43	38.46	32.22	*	36.04	47.38	50.42	**43.9**
	KC 45	R	49.99	59.14	41.38	57.50	77.11	42.88	49.54	46.17	47.24	48.02	51.80	52.79	**52.0**
	KC 47	B	37.78	48.51	29.80	32.50	45.95	27.26	28.77	26.97	35.36	33.16	43.21	42.35	**36.0**
	KC 48	R	85.02	97.14	68.13	92.06	106.97	71.27	79.48	66.76	71.73	77.75	82.71	81.97	**81.7**
	KC 49	R	77.76	84.71	63.45	55.82	121.20	63.48	68.39	68.33	77.96	*	88.95	84.26	**77.7**
	KC 50	R	57.84	65.32	48.43	35.41	78.93	51.16	61.66	*	59.55	54.57	58.26	60.48	**57.4**
	KC 51	B	35.21	41.81	30.80	44.05	41.32	27.52	*	27.30	29.58	37.47	44.06	46.12	**36.8**
	KC 52	R	65.29	61.70	48.76	64.19	82.59	55.42	58.21	50.26	65.91	55.21	64.33	64.90	**61.4**
	KC 53	B	47.62	59.32	41.71	48.72	57.79	37.16	46.05	45.53	49.69	41.06	48.39	52.47	**48.0**
	KC 54	R	84.36	88.40	66.75	77.83	91.06	62.64	70.75	68.30	64.94	64.98	76.96	76.86	**74.5**
	KC 55	B	45.33	60.15	41.58	48.51	57.73	38.12	41.15	36.01	*	*	54.78	54.95	**47.8**
	KC 56	B	127.38	83.07	62.27	84.01	107.71	79.63	131.85	80.11	79.63	72.66	82.27	81.85	**89.4**
	KC 57	R	50.07	63.14	53.43	56.61	77.57	47.72	55.07	44.64	59.63	48.08	62.56	60.56	**56.6**
	KC 58	R	61.38	74.38	57.78	66.24	69.04	65.53	71.05	53.78	61.15	50.95	68.37	65.53	**63.8**
	KC 59	R	87.17	88.69	88.71	92.54	91.89	97.97	94.18	74.68	87.87	70.06	94.52	95.24	**88.6**
	KC 60	R	77.86	90.44	60.08	73.85	84.17	59.75	79.68	71.66	72.81	61.44	77.97	74.51	**73.7**
	KC 61	R	57.65	74.63	54.12	62.58	69.83	67.77	56.07	43.54	63.22	50.27	78.55	68.82	**62.3**
	KC 64	R	40.91	59.48	44.57	53.73	71.12	50.71	46.47	38.29	56.91	38.92	64.02	61.99	**52.3**
Lewisham	LWS1	R	*	*	*	*	*	*	*	*	*	*	*	*	
	LWS2	B	*	48.70	29.86	31.57	31.13	34.40	31.71	28.28	27.87	42.97	49.26	47.68	**36.7**
	LWS3	R	*	52.75	34.24	45.89	58.47	51.80	51.25	40.61	33.12	51.45	53.76	51.97	**47.8**
	LWS4	R	*	57.16	44.02	62.85	100.86	65.25	50.17	47.72	49.64	59.24	64.98	69.20	**61.0**
	LWS5-7	R	*	69.18	57.95	57.91	89.97	72.15	60.05	63.37	52.77	69.85	81.17	83.73	**68.9**
	LWS8	R	*	58.74	*	48.53	72.10	57.99	48.74	37.28	44.23	45.37	*	58.15	**52.3**
	LWS9	R	*	67.67	50.07	59.00	51.22	66.19	64.88	50.80	44.95	65.62	58.79	66.78	**58.7**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg/ m³
Lewisham	LWS10	B	*	50.61	30.52	32.66	41.62	30.33	31.10	26.25	28.54	38.61	44.15	48.14	**36.6**
	LWS11	R	*	67.96	41.72	56.45	78.31	58.86	57.93	43.75	47.27	58.10	*	60.61	**57.1**
	LWS12	B	*	39.03	8.67	*	*	*	20.25	17.64	23.23	27.43	35.91	37.37	**26.2**
Newham	NH1	R	52.08	52.41	*	43.43	48.11	*	*	36.43	39.76	*	*	*	**45.4**
	NH2	R	49.63	49.58	39.97	41.87	42.12	40.59	39.46	37.93	*	50.00	45.30	54.84	**44.7**
	NH3	R	57.84	60.62	38.14	44.08	50.18	*	38.52	*	41.44	53.10	47.60	53.35	**48.5**
	NH4	R	46.48	57.79	44.81	42.70	*	*	35.32	34.03	*	47.10	52.30	49.04	**45.5**
	NH5	B	47.79	*	24.96	45.25	43.39	43.47	42.45	28.16	35.70	48.98	56.60	56.87	**43.1**
	NH6	B	30.02	34.98	26.36	*	35.52	25.52	*	24.71	30.33	23.24	35.64	41.73	**30.8**
	NH7	B	30.84	39.90	25.34	29.01	34.98	27.67	26.52	23.78	28.85	31.17	38.91	38.77	**31.3**
	NH8	R	43.32	46.68	37.06	36.10	49.03	33.37	32.14	26.27	37.37	39.82	40.12	47.00	**39.0**
	NH10	B	36.17	38.76	33.53	*	*	32.44	31.40	25.34	36.21	36.12	42.35	46.48	**35.9**
	NH11	R	40.31	50.66	36.56	44.23	48.00	37.41	*	33.35	37.80	46.62	54.88	55.73	**44.1**
	NH12	R	45.92	47.09	39.76	38.02	41.75	30.07	33.31	32.49	34.98	42.54	46.90	51.41	**40.4**
	NH13	R	*	67.18	43.77	49.09	59.07	*	43.86	44.10	42.92	48.46	*	54.04	**50.3**
	NH14	R	101.30	81.66	71.66	85.72	55.56	94.34	113.41	84.84	71.11	101.59	96.02	95.94	**87.8**
	NH15	R	54.54	62.32	43.94	65.34	43.87	35.45	38.55	39.90	41.77	52.19	62.80	55.87	**49.7**
	NH16	R	66.64	69.11	67.66	64.85	75.45	65.92	70.04	61.87	55.71	70.80	*	66.97	**66.8**
	NH17	R	51.84	58.46	49.23	58.46	69.44	*	48.24	54.27	63.34	47.05	54.91	57.93	**55.7**
	NH18	R	48.24	156.71	69.36	*	55.27	49.09	*	*	43.79	47.94	53.24	59.47	**64.8**
	NH19	R	82.10	99.80	70.40	73.07	40.80	76.48	75.29	74.67	*	86.36	80.53	82.24	**76.5**
	NH20	R	82.69	103.93	87.91	82.82	100.47	87.58	77.43	62.26	66.09	81.87	92.58	*	**84.1**
	NH21	R	49.71	54.61	49.57	42.23	40.89	47.04	40.94	33.16	40.15	42.40	53.58	51.92	**45.5**
	NH22	B	29.35	29.66	22.65	87.58	98.97	18.72	25.36	30.82	25.77	28.23	*	27.53	**38.6**
Richmond	RM01	R	69.21	62.25	50.01	56.49	55.23	47.12	56.04	40.08	52.89	50.78	60.05	63.11	**55.3**
	RM02	R	37.52	47.80	29.68	40.80	48.41	34.48	31.62	27.33	39.68	35.85	45.98	49.87	**39.1**
	RM03	R	42.42	52.07	39.48	46.74	51.82	45.47	42.09	30.92	53.89	45.23	52.25	58.93	**46.8**
	RM04	R	47.49	54.60	40.83	54.21	68.31	51.64	41.90	33.76	56.63	39.09	55.75	56.95	**50.1**
	RM05	R	29.14	44.88	32.47	39.75	41.39	33.83	29.16	27.81	32.85	33.82	40.38	47.88	**36.1**
	RM06	R	35.04	50.95	35.44	47.96	*	50.17	48.08	40.04	41.93	43.59	46.60	60.69	**45.5**
	RM07	R	47.26	79.91	53.42	73.10	104.82	73.76	60.81	37.14	68.95	51.99	66.61	78.40	**66.3**
	RM08	R	37.58	*	33.77	41.67	36.76	31.61	34.76	27.53	29.15	40.92	47.49	52.83	**37.6**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. μg/ m^3
Richmond	RM09	R	54.46	66.41	42.90	60.24	80.13	55.86	54.17	52.80	68.44	53.65	65.93	64.84	**60.0**
	RM10	R	44.97	58.09	45.87	44.19	68.15	41.03	41.86	31.49	51.77	42.08	52.49	61.13	**48.6**
	RM11	R	42.37	53.86	40.57	45.53	55.53	45.91	40.28	33.26	*	47.11	57.32	59.43	**47.4**
	RM12	R	48.63	64.27	41.24	56.79	63.50	47.79	45.91	33.71	55.63	52.31	59.23	62.83	**52.7**
	RM13	R	*	66.74	39.58	55.28	73.31	48.35	46.69	41.80	55.21	49.68	55.64	65.82	**54.4**
	RM14	R	40.95	53.93	39.48	51.98	76.99	53.02	49.29	36.40	49.01	*	68.65	65.85	**53.2**
	RM15	R	55.41	76.77	46.40	51.17	65.30	58.24	52.60	44.40	54.88	54.81	56.73	73.94	**57.6**
	RM16	B	49.86	58.10	50.99	51.29	53.38	47.18	41.51	32.09	48.21	48.64	55.43	66.67	**50.3**
	RM17	R	25.91	39.21	25.17	30.25	42.59	22.28	23.87	19.03	35.10	27.70	33.29	43.46	**30.7**
	RM18	R	56.11	76.26	49.98	69.40	90.93	66.97	66.24	42.36	76.42	62.04	68.42	81.38	**67.2**
	RM19	R	59.77	78.94	54.75	58.57	59.43	49.31	52.88	31.17	52.36	51.77	58.05	71.56	**56.5**
	RM20	R	57.65	80.52	49.63	62.24	61.80	48.59	52.04	48.87	59.44	54.25	56.06	55.53	**57.2**
	RM21	R	46.38	57.33	43.79	48.80	62.24	45.07	43.78	34.19	52.08	44.20	53.10	55.89	**48.9**
	RM22	R	80.54	88.61	46.30	57.65	82.31	52.76	54.43	56.08	77.04	67.76	64.03	77.37	**67.1**
	RM23	R	40.69	56.51	32.80	46.60	52.27	36.87	33.59	30.22	47.66	40.73	51.69	53.87	**43.6**
	RM24	R	40.77	52.16	34.21	42.60	52.66	38.37	29.96	28.82	49.99	42.97	48.24	51.51	**42.7**
	RM25	R	32.81	61.97	38.83	54.88	93.60	47.16	41.39	30.55	54.08	39.65	*	*	**45.6**
	RM26	R	48.50	59.94	55.29	52.25	55.77	42.05	42.23	33.92	47.25	51.14	55.19	65.62	**50.8**
	RM27	R	45.61	59.72	30.39	44.65	65.50	40.81	39.45	36.18	84.07	63.92	49.61	58.04	**51.5**
	RM28	B	21.30	35.40	19.42	24.62	29.93	17.68	15.89	13.77	26.10	22.12	30.73	34.24	**24.3**
	RM29	R	47.26	57.47	36.81	50.48	60.82	45.87	45.78	43.44	53.74	46.75	53.87	52.69	**49.6**
	RM30	R	32.80	44.86	32.50	44.99	62.02	37.18	30.18	24.47	52.38	54.50	49.01	52.06	**43.1**
	RM31	R	64.03	64.71	54.79	68.94	74.72	52.95	58.02	51.44	68.69	64.07	65.26	68.11	**63.0**
	RM32	R	97.30	118.32	80.22	104.72	167.93	99.48	108.22	98.80	93.95	102.87	104.13	109.12	**107.1**
	RM33	R	34.16	67.31	49.73	72.74	53.53	44.83	58.56	25.45	36.63	37.03	49.12	78.78	**50.7**
	RM34	R	55.17	56.63	40.88	40.16	46.23	55.18	64.17	*	43.96	58.73	57.11	52.89	**51.9**
	RM35	R	61.65	57.53	49.11	59.90	99.13	67.40	52.94	42.24	63.83	57.42	78.56	66.32	**63.0**
	RM36	R	56.88	83.46	48.73	66.17	103.39	61.96	60.28	39.45	70.03	49.67	71.11	69.96	**65.1**
	RM37	B	24.70	39.56	20.94	25.39	36.40	21.16	20.81	16.36	29.47	22.52	33.86	39.59	**27.6**
	RM38	R	36.05	48.76	31.30	39.51	47.33	38.81	36.44	32.47	33.17	43.33	43.75	54.03	**40.4**
	RM39	R	64.39	77.51	44.26	73.66	86.29	75.55	75.51	51.22	65.29	64.19	81.34	86.07	**70.4**

Borough	Site Code	Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Conc. µg/ m^3
Richmond	RM40	R	40.25	58.54	37.42	46.67	50.33	40.67	33.01	27.63	44.83	38.03	47.85	62.51	**44.0**
	RM41	R	52.03	55.23	44.49	42.50	65.86	43.69	41.44	35.59	44.95	43.22	51.28	60.37	**48.4**
	RM42	R	46.19	67.71	46.65	60.04	107.17	*	52.64	37.93	77.55	50.99	59.56	59.25	**60.5**
	RM43	R	50.46	71.87	46.38	65.56	98.51	63.60	55.38	43.74	62.30	45.92	70.99	72.35	**62.3**
	RM44	R	50.91	63.54	43.20	54.21	64.88	49.44	37.86	36.08	62.21	55.80	57.30	63.46	**53.2**
	RM45	R	44.49	74.29	39.84	57.35	65.73	50.38	41.55	33.00	41.28	42.89	54.85	70.17	**51.3**
	RM46	R	35.16	*	32.96	45.58	70.85	40.40	34.25	28.66	40.78	38.10	45.74	53.69	**42.4**
	RM47	R	39.88	55.84	47.22	53.53	52.55	54.44	40.63	31.08	39.60	47.08	51.02	64.89	**48.1**
	RM48	R	49.91	62.36	46.14	50.20	59.64	*	49.42	35.05	51.21	46.57	57.06	59.45	**51.5**
	RM49	R	38.00	60.95	40.86	69.62	75.57	49.23	41.75	30.26	51.60	39.35	56.43	58.65	**51.0**
	RM50	R	72.39	76.82	62.12	71.40	78.78	67.60	75.50	48.80	27.16	66.23	80.39	78.80	**67.2**
	RM51	R	38.00	49.91	32.18	51.64	62.64	31.77	28.18	24.92	44.31	36.76	44.63	48.68	**41.1**
	RM52	R	61.77	73.42	58.53	70.04	81.16	68.23	51.02	52.21	75.42	71.29	76.71	73.91	**67.8**
	RM53	R	46.18	54.70	38.72	50.66	53.24	39.51	42.17	38.40	48.40	47.92	49.01	54.98	**47.0**
	RM54		61.47	61.86	49.90	57.67	61.50	55.52	61.13	42.73	71.26	60.65	70.30	72.24	**60.5**
	RM55		52.10	68.70	45.67	55.13	53.58	56.79	49.87	51.12	63.74	67.04	64.46	68.99	**58.1**
	RUT01	R	63.52	69.61	43.12	60.39	84.38	63.97	61.37	43.48	67.19	63.13	62.06	89.56	**64.3**
	RUT02	R	100.10	93.40	80.54	112.04	130.87	117.64	129.45	105.62	139.79	111.14	93.50	147.28	**113.4**
	RUT03	B	31.10	49.12	30.30	33.96	41.86	26.60	24.40	19.00	31.65	30.04	38.60	58.22	**34.6**
	RUT04	B	30.86	43.64	*	27.36	30.04	23.74	26.16	23.12	26.89	30.62	31.56	39.51	**30.3**
City of Westminster	WM 36	R	47.28	66.90	50.34	58.83	85.53	52.16	47.45	19.12	64.37	39.13	65.17	35.95	**52.7**
	WM 39	R	83.79	93.24	65.50	84.11	102.22	90.13	*	35.66	56.32	76.89	*	80.29	**76.8**
	WM 55	R	*	301.62	135.23	148.04	158.71	147.58	183.48	105.77	126.20	139.61	44.87	50.96	**140.2**
	WM 40	B	44.77	*	38.40	39.93	41.10	27.97	29.44	10.54	43.08	*	42.91	47.60	**36.6**
	WM 48	B	47.14	49.93	36.55	40.53	43.51	32.52	37.46	11.07	44.94	36.97	174.31	152.48	**58.9**
	WM 56	B	31.83	38.91	26.62	32.75	47.06	25.40	32.70	13.73	34.19	29.08	34.08	63.15	**34.1**
	WM 57	B	44.20	70.09	43.59	49.05	80.29	33.73	50.70	15.14	42.53	34.61	49.44	49.97	**46.9**
	WM 58	B	49.42	61.88	41.07	*	65.27	40.57	96.57	22.33	40.85	35.66	55.44	58.86	**51.6**

Appendix 2 Co-location Sites Triplicate Diffusion Tube Monthly Mean NO_2 Concentrations 2008

Co-Location Site	Diffusion Tube Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Conc. (µg/m3)
Brent 1, Kingsbury	BR51	37.78	48.51	29.80	32.50	45.95	27.26	28.77	26.97	35.36	33.16	43.21	42.35	36
Croydon 5, London Road (Norbury Rd)	CY55A	84.36	88.40	66.75	77.83	91.06	62.64	70.75	68.30	64.94	64.98	76.96	76.86	74
Croydon 4, George Street	CY98A	34.25	41.12	25.73	32.65	32.28	22.76	24.45	19.16	*	32.71	38.35	38.87	31
Greenwich 4, Eltham Rd	GW39	50.71	69.29	71.95	76.56	111.4	66.32	61.50	54.01	64.15	56.03	67.94	68.75	68
Greenwich 5, Trafalgar Road	GW57	36.36	50.10	53.02	71.39	56.55	51.01	44.32	39.70	45.98	44.98	66.86	62.55	52
Greenwich 7, Blackheath	GW58	66.31	77.33	52.41	72.68	87.75	61.56	83.37	50.02	53.15	62.68	77.83	78.36	69
Hillingdon, AURN	HD31	49.84	61.42	43.25	59.08	76.55	64.08	68.67	42.02	47.11	45.41	70.57	72.28	58
Hillingdon 1, South Ruslip	HD46	32.44	53.51	22.78	33.12	39.79	22.33	27.50	22.23	27.28	27.05	37.08	47.58	33
Hillingdon 2, Hospital	HD50	53.88	53.18	42.84	48.80	49.32	39.44	51.79	49.57	*	54.11	45.46	49.46	49
Houndslow 4, Chiswick High Road	HSCHIS	53.11	60.14	45.72	52.41	63.92	41.54	47.68	35.06	51.40	58.62	51.85	54.52	51
Houndslow 5 ,Brentford	HSBREN	43.86	51.33	41.55	45.57	38.20	34.86	46.31	37.50	38.82	49.62	44.43	48.19	43
Hounslow 2, Cranford	HSCRAN	24.27	31.27	26.74	26.45	26.12	20.95	21.30	17.35	24.01	28.57	30.16	31.33	26
Kensington 1, North Kensington	KC47	44.50	53.36	47.51	52.02	*	40.87	39.78	31.29	39.46	54.25	52.72	55.46	46
Lewisham LW2, New Cross Road	LWS5-7	*	69.18	57.95	57.91	89.97	72.15	60.05	63.37	52.77	69.85	81.17	83.73	54
Richmond 1, Castlenau Library	RM23	40.69	56.51	32.80	46.60	52.27	36.87	33.59	30.22	47.66	40.73	51.69	53.87	69
Richmond 2, Barnes Wetland Centre	RM37	24.70	39.56	20.94	25.39	36.40	21.16	20.81	16.36	29.47	22.52	33.86	39.59	44

* No data recorded for this month or exposure period outside AEA calendar

Appendix 3 Co-location Sites Triplicate Automatic Analyser Monthly NO_2 Concentrations 2008

Co-Location Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean Conc. (µg/m^3)
Kensington 1, North Kensington	35.4		35.5	35.6	44.9	22.6	22.0	21.9	35.8	36.6	39.7	45.4	34.1
Kensington 2, Cromwell Road	65.3	75.8	69.9	75.8	78.1	57.2	47.6	32.9	30.5	36.2	71.4	64.3	58.7
Brent 1, Kingsbury	38.3	48.8	30.5	34.6	33.7	16.6	20.4	21.6	35.0	44.4	39.4	48.1	34.3
Croydon 5, London Road (Norbury Rd)	43.7	81.4	64.8	81.7	114.4	66.5	46.8	38.5	68.2	51.8	68.6	75.1	66.8
Croydon 4, George Street	43.0	60.9	50.9	53.3	59.1	49.7	36.6	31.7	51.4	46.1	55.1	61.1	49.9
Houndslow 4, Chiswick High Road	66.4	107.9	61.5	73.1	78.5	57.9	55.9	60.2	83.7	69.6	69.4	73.3	71.5
Houndslow,Brentford	45.4	70.9	55.6	60.1	75.8	60.3	52.5	42.6	65.3	45.4	54.1	63.7	57.6
Hounslow, Cranford	38.7	53.7	30.2	30.5	**42.4**	20.5	**17.0**	**19.7**	**36.9**	33.5	39.8	41.0	32.9
Hillingdon, AURN	54.9	66.7	43.0	53.1	*	**51.7**	41.8	44.4	43.7	50.1	42.1	50.3	49.0
Hillingdon, South Ruslip	46.5	64.4	44.2	51.1	50.2	35.5	33.5	35.3	45.1	43.5	46.3	56.4	46.0
Hillingdon, Hospital	37.4	54.1	37.6	35.3	26.2	23.2	27.0	26.6	34.5	43.5	36.3	40.9	35.2
Greenwich 4, Eltham	23.3	42.1	25.9	28.3	30.3	18.9	21.4	16.0	26.9	27.5	30.2	37.1	27.3
Greenwich 5, Trafalgar Road	46.6	78.1	63.0	56.7	56.8	44.3	36.8	30.0	53.3	49.0	59.3	59.3	52.8
Greenwich 7, Blackheath	40.5	64.5	47.5	43.3	50.3	38.7	43.6	30.1	43.5	37.9	46.4	55.4	45.2
Lewisham LW2, New Cross Road	48.6	80.4	58.9	58.8	81.8	*	53.9	38.9	62.2	56.0	66.9	74.2	61.9
Richmond 1, Castlenau Library	36.1	62.5	40.8	45.0	46.3	31.5	27.5	26.6	44.5	39.1	44.9	59.1	42.0
Richmond 2, Barnes Wetland Centre	23.4	50.3	32.1	34.1	40.5	19.8	20.9	16.7	34.6	24.4	30.0	42.0	30.7

A - Data capture below 75%

* Data not recorded for the month