Reigate & Banstead
BOROUGH COUNCIL
Banstead | Horley | Redhill | Reigate

Detailed Assessment of Air Quality in Drift Bridge.

August 2006

Reigate and Banstead Borough Council, Environmental Health Services,
Town Hall, Castlefield Road, Reigate, Surrey, RH2 0SH. Telephone: 01737 276403 Fax: 01737 276404.

Detailed Assessment of Air Quality in Drift Bridge

Prepared by

Prof. Duncan Laxen, Dr. Ben Marner

& Dr. Denise Welch

on behalf of

Reigate & Banstead Borough Council

May 2006

Air Quality Consultants Ltd 23 Coldharbour Road Bristol BS6 7JT
Tel: 0117 974 1086 Fax: 0117 973 9523 E-Mail: aqc@aqconsultants.co.uk

DOCUMENT CONTROL

Client

Reigate and Banstead BC	**Principal Contact**	**Leon Hibbs**

Job Number	J261

Report Prepared By:	Dr Denise Welch and Dr Ben Marner

Document Status and Review Schedule

Issue No.	Date	Status	Description	Reviewed by:
1	24/04/06	Draft Report	Sent by email to client	Prof. Duncan Laxen
2	17/5/06	Final Report	Sent by email to client	Leon Hibbs
3				

Contents

1 Introduction

1.1 In July 2005 Reigate & Banstead Borough Council completed its Progress Report on Air Quality within the Borough. Routine monitoring of nitrogen dioxide concentrations around the junction of the A2022 and the A240 at Drift Bridge highlighted possible breaches of the 2005 annual mean objective at locations of relevant exposure. The aim of this Detailed Assessment is to determine whether the air quality objectives were exceeded, and if so, the extent of any Air Quality Management Area required.

Introduction to the Second Round of Review and Assessment

1.2 The Government's Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DETR, 2000) and its addendum (Defra, 2003a), set out a framework for air quality management, which includes a number of air quality objectives. National and international measures are expected to achieve these objectives in most locations, but where areas of poor air quality remain, air quality management at a local scale has a particularly important role to play. Part IV of the Environment Act 1995 requires local authorities to periodically review and assess the current and likely future air quality in their area. The role of this process is to identify areas where it is unlikely that the air quality objectives will be achieved by the due date. These locations must be designated as AQMAs and a subsequent action plan developed in order to reduce pollutant emissions in pursuit of the objectives.

1.3 Review and Assessment is a long-term, ongoing process, structured as a series of 'rounds'. Local Authorities in England, Scotland and Wales have now completed the first round of Review and Assessment, the second round is currently underway and the third round has recently begun.

1.4 Local Air Quality Management Technical Guidance (LAQM.TG(03)) (Defra, 2003b) sets out a phased approach to the second round of Review and Assessment. This prescribes an initial Updating and Screening Assessment (USA), which all authorities must undertake. It is based on a checklist to identify any matters that have changed since the first round. If the USA identifies any areas where there is a risk that the objectives may be exceeded, which were not identified in the first round, then the Local Authority should progress to a Detailed Assessment (DA).

1.5 The purpose of the Detailed Assessment (DA) is to determine whether exceedence of an air quality objective is likely and the geographical extent of that exceedence. If the outcome of the DA is that the air quality objective(s) is(/are) likely to be exceeded, then an AQMA must be declared. Subsequent to the declaration of an AQMA, a Further Assessment should be carried out to confirm that the AQMA declaration is still justified and that the appropriate area has been declared; to ascertain the sources contributing to the exceedence; and to calculate the magnitude of reduction in emissions required to achieve the objective. This information can be used to inform an Air Quality Action Plan, which will identify measures to improve air quality.

1.6 This report presents the Detailed Assessment of Air Quality around the Drift Bridge Junction. It evaluates the likelihood of air quality objectives being exceeded at a number of relevant receptor locations that were identified in the Progress Report (RBBC, 2005). The area examined is presented in Figure 1.

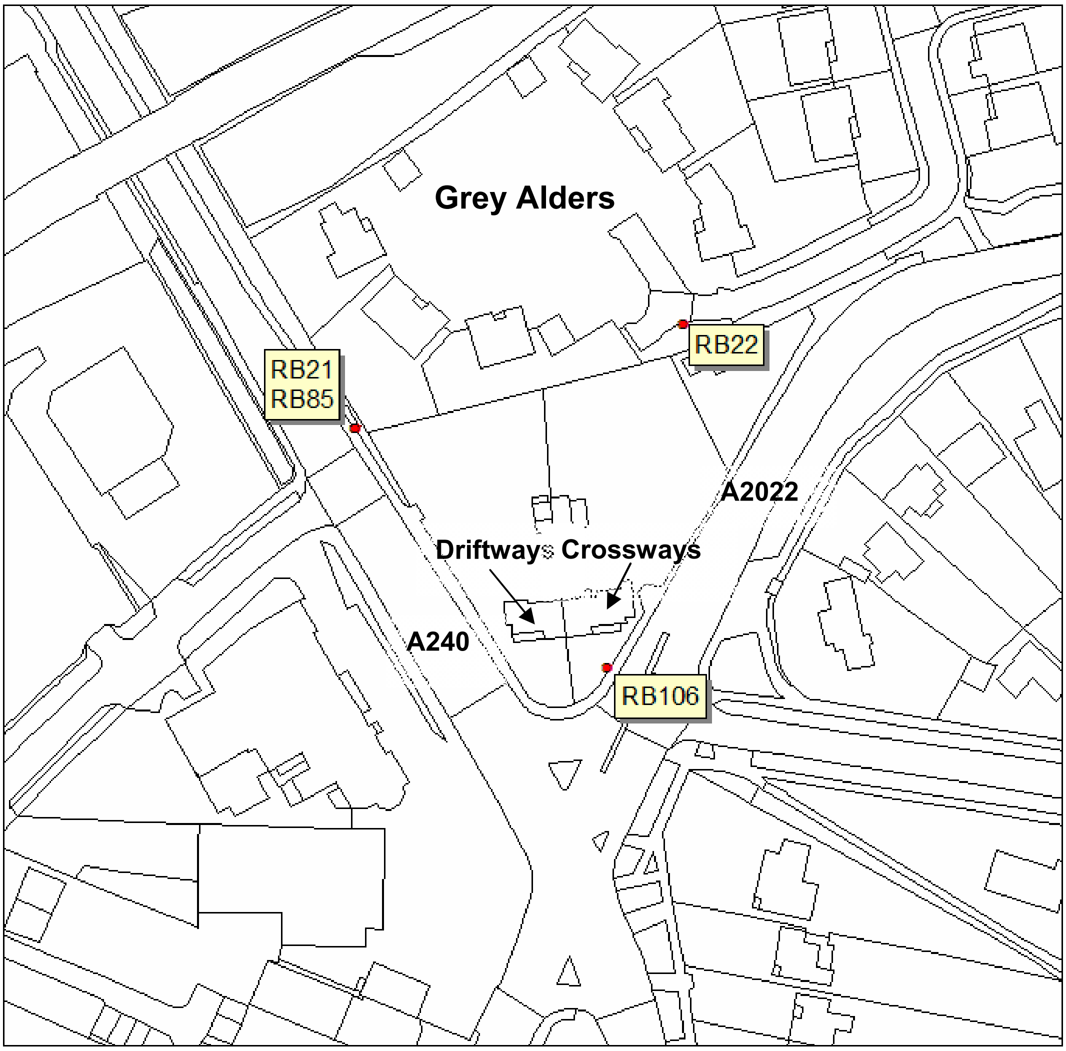

Figure 1: Map of study area. Red dots show diffusion tube monitoring locations. © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405.

The Air Quality Objectives

1.7 The Government's Air Quality Strategy (DETR, 2000) defines both standards and objectives for each of a range of air pollutants. The 'standards' are set as concentrations below which health effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of a particular pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of the costs, benefits, feasibility and practicality of achieving the standards. The objectives are prescribed within The Air Quality (England) Regulations 2000 (Stationery Office, 2000) and The Air Quality (England) (Amendment) Regulations 2002 (Stationery Office, 2002). This latter publication sets revised, more stringent objectives for benzene and carbon monoxide which are relevant to this second round, but which were absent in the first. The addendum to the air quality strategy (Defra, 2003a) also contains provisional objectives for PM_{10} to be achieved in 2010. As these are not in the regulations, they do not need to be acted upon in the Review and Assessment process. Table 1 summarises the objectives which are relevant to this report. Appendix 1 provides a brief summary of the health effects of nitrogen dioxide.

1.8 The air quality objectives are only applicable where members of the public are likely to be regularly present and are likely to be exposed over the averaging time of the objective. For annual mean objectives, relevant exposure is limited to residential properties, schools and hospitals. The 1-hour objective applies at these locations as well as at any outdoor location where a member of the public might reasonably be expected to stay for 1 hour or more, such as shopping streets, parks and sports grounds, as well as bus stations and railway stations that are not fully enclosed. Both the annual mean objective and the 1-hour mean objective are relevant to this assessment as the study area includes residential properties and a bus-stop on the A240.

1.9 Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded unless the annual mean nitrogen dioxide concentration is greater than 60 $\mu g/m^3$ (Laxen and Marner, 2003). Thus exceedences of 60 $\mu g/m^3$ as an annual mean nitrogen dioxide concentration are used as an indicator of potential exceedences of the 1-hour nitrogen dioxide objective.

1.10 The European Union has also set limit values for nitrogen dioxide. Achievement of these values is a national obligation rather than a local one. It is, however, worthwhile to note that the limit value is the same level as the UK objective (which was to be achieved by 2005), but is to be achieved by 2010 (and is thus less stringent).

Table 1: Relevant Air Quality Objectives

Pollutant	Status	Time Period	Objective / Value	To be Achieved by[a]
Nitrogen Dioxide	Statutory UK Objective	1-hour mean	200 $\mu g/m^3$ not to be exceeded more than 18 times a year	2005
		Annual mean	40 $\mu g/m^3$	2005
	EU Limit Value	1-hour mean	200 $\mu g/m^3$ not to be exceeded more than 18 times a year	2010
		Annual mean	40 $\mu g/m^3$	2010

[a] The achievement dates for the UK objectives are the end of the specified year; achievement dates for the EU limit values are the start of the specified year.

2 Assessment Methodology

Existing Air Quality

2.1 Air pollutant concentrations in the vicinity of an emission source will be related to both the source strength and the background concentration to which the local source is added. Background concentrations of nitrogen dioxide at Drift Bridge have been taken from the national maps of background concentrations available from the Air Quality Archive (Defra, 2006).

2.2 Monitoring for nitrogen dioxide is carried out using passive diffusion tubes at the locations shown in Figure 1 and described in Table 2. Reigate & Banstead Borough Council uses diffusion tubes prepared and analysed by Lambeth Scientific Services (50% TEA in acetone). All of the data presented in this report have been adjusted to account for diffusion tube bias using a locally derived factor of 1.349. The factor provided for 2005 on the Review and Assessment Helpdesk website (UWE, 2006) is 1.13 and is calculated from 5 studies, which include the 3 studies carried out by RBBC. The local factor is higher than the national factor, and thus provides a worst-case assessment of the results. Further details of the adjustment factors used are supplied in Appendix 2. Monitoring at two of the sites took place over a full annual mean period, but at the third site, data were only available for five months. The resulting short term mean was therefore adjusted to an annual mean equivalent. Further details of this adjustment are provided in Appendix 3.

Modelling

2.3 Annual mean concentrations of nitrogen dioxide during 2005 have been modelled using AAQuIRE 6.1.1 (Faber Maunsell, 2005) for locations surrounding the relevant receptors where exceedences of the air quality objective have been predicted. Concentrations have also been modelled for specific worst-case relevant receptor locations and diffusion tube monitoring locations. The modelling methodology, and the input data utilised are described in Appendix 4.

2.4 The model has been verified against the diffusion tube measurements and adjusted accordingly. Further details of model verification and adjustment are supplied in Appendix 4.

Uncertainty

2.5 There is an element of uncertainty in all measured and modelled data. This includes uncertainty within the model itself as well as in the input data (e.g. existing and predicted traffic flow and composition). There is also uncertainty arising from the year to year variability in air quality data, the likely reduction in background air quality concentrations and the monitoring equipment. The results of this assessment have therefore been interpreted with an awareness of the inherent uncertainties.

3 Results

3.1 Monitoring data for the sites identified in Figure 1 are presented in Table 3. The results indicate that the annual mean nitrogen dioxide objective is being exceeded at a kerbside location on the A240, however this site does not represent relevant exposure. The nearest property to this diffusion tube site is set around 15 m further from the road. At the two other monitoring locations the annual mean objective is likely to be met; however, tube RB106 is further from the A240 than the nearest residential property and thus will not accurately represent the highest relevant exposure concentrations. Furthermore, monitoring at this location was only carried out for 5 months during 2005. The data at this site have therefore been adjusted to an annual mean equivalent (Appendix 3) using appropriate local and national automatic monitoring data, however a greater uncertainty is attached to these results than those from the other monitoring sites.

3.2 Because the measurements do not represent worst-case residential exposure, concentrations across the study area have been predicted by modelling. Modelled concentrations of nitrogen dioxide are presented in Figure 2 and in Table 4. These indicate that exceedences of the annual mean nitrogen dioxide objective are unlikely at any of the properties in Grey Alders. However, the results suggest that the annual mean objective was exceeded at Driftways and only achieved by an extremely small margin at Crossways. The margin by which the objective was predicted to be achieved at Crossways is considerably smaller than the uncertainty inherent in the model results.

3.3 No exceedences of 60 $\mu g/m^3$ as an annual mean nitrogen dioxide concentration have been identified at locations relevant to the 1-hour objective and thus exceedences of the 1-hour objective are unlikely.

Table 3: Annual Mean Nitrogen Dioxide Concentrations (µg/m³) Measured using Diffusion Tubes

Site reference	Location	Relevant Exposure	2005[a]
RB21/85	Opp. Drift Bridge Hotel, Reigate Road	No	**45.2**[b]
RB22	Opp. 2 Grey Alders	No	25.6
RB106	Crossways, Fir Tree Road	No	29.8[c]
Statutory Objective for 2005			**40**

[a] Bias adjusted using a local bias adjustment factor of 1.349 (see Appendix 2).
[b] Average of two diffusion tubes.
[c] Annual mean equivalent concentration (see Appendix 3).

Table 4: Annual Mean Nitrogen Dioxide Concentrations (µg/m³) Modelled for Specific Receptor Locations

Receptor number	Location	Relevant Exposure	2005
1	Closest point of property in Grey Alders to A240	Yes	36.8
2	Closest point of property in Grey Alders to A240	Yes	36.4
3	Closest point on Driftways to A240	Yes	**43.7**
4	Closest point of Crossways to A240	Yes	38.8
5	Closest point of Crossways to A2022	Yes	39.7
6	Closest point on property in Grey Alders to A2022	Yes	29.3
Statutory Objective for 2005			**40**

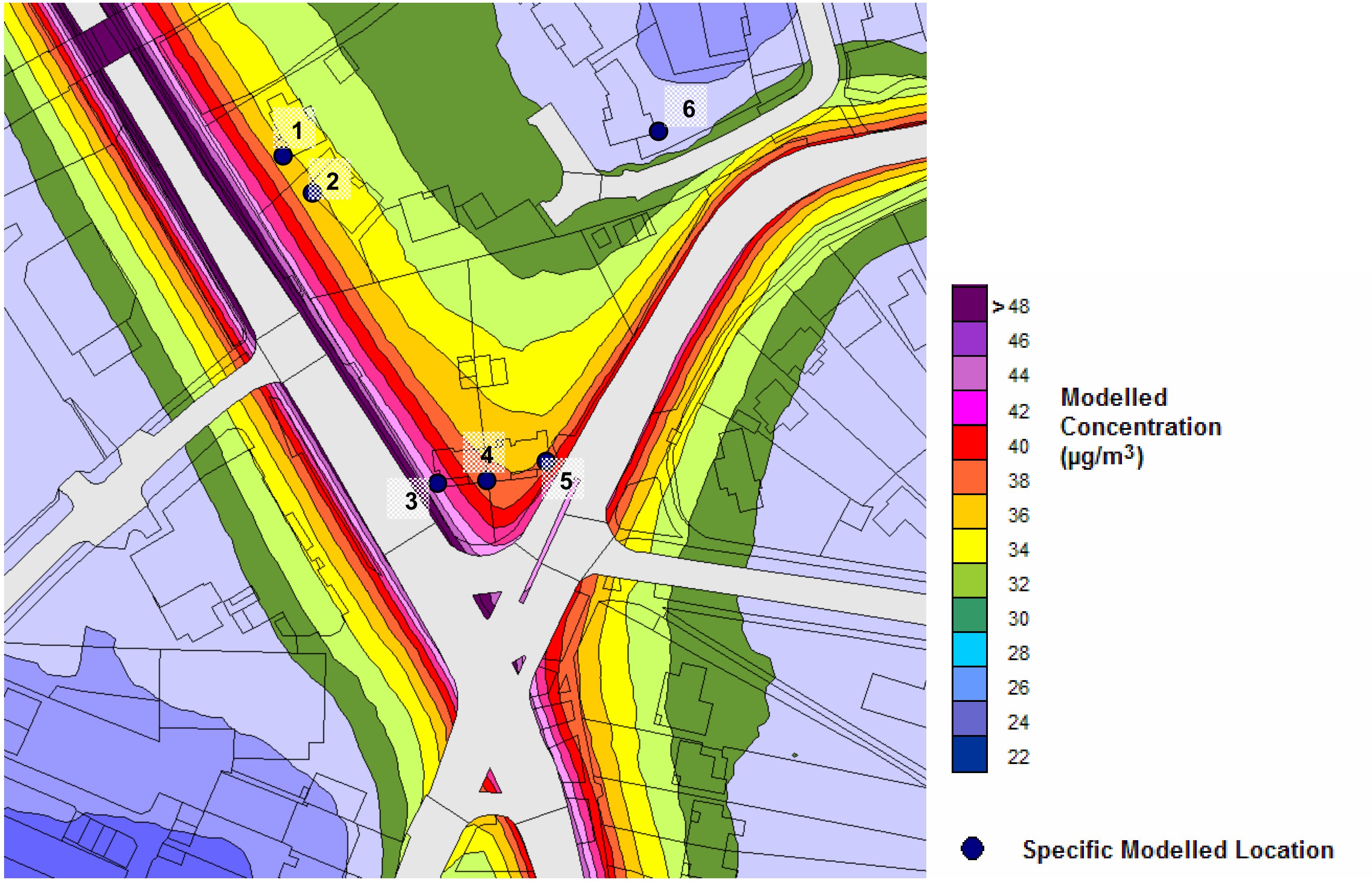

Figure 2: Modelled Annual Mean Nitrogen Dioxide Concentrations in 2005 around Drift Bridge.
© Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405

4 Conclusions

4.1 A Detailed Assessment of air quality has been carried out for the Drift Bridge junction of the A2022 and the A240. This area was identified as being at risk of exceeding the annual mean air quality objective for nitrogen dioxide in Progress Report (RBBC, 2005).

4.2 The Detailed Assessment has been carried out using a combination of monitoring data and modelled concentrations. Concentrations of pollutants have been modelled using the dispersion model AAQuIRE 6.1.1, and the model results verified against monitoring carried out close to the junction.

4.3 The results have determined that there is a likely exceedence of the annual mean nitrogen dioxide objective at the Driftways property close to the junction of the A240 and the A2022, and the modelled concentration at the façade of the neighbouring Crossways property is also very close to the level of the exceedences. Therefore an Air Quality Management Area (AQMA) will be declared including the Driftways and Crossways properties.

References

Defra, 2003a. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum. February 2003.

Defra, 2003b. Review & Assessment: Technical Guidance LAQM.TG(03).

Defra, 2006. Air Quality Archive via the internet www.airquality.co.uk.

DETR, 2000. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, January 2000.

Faber Maunsell, 2005. AQQuIRE 6.1.1 Ambient Air Quality in Regional Environments. February 2005 update.

Laxen and Marner, 2003. Analysis of the Relationship Between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites. Available from Defra, 2006.

RBBC, 2005. Progress Report on Air Quality within the Borough of Reigate and Banstead. July 2005. (www.reigate-banstead.gov.uk/Images/ProgressRep05_tcm5-16581.pdf)

Stationery Office, 2000. Air Quality (England) Regulations, 2000, Statutory Instrument 928.

Stationery Office, 2002. The Air Quality (England) (Amendment) Regulations 2002. Statutory Instrument 3043.

UWE, 2006. Review and Assessment Helpdesk Nitrogen Dioxide Diffusion Tube Bias Adjustment Factor Database version 03/06. www.uwe.ac.uk/aqm/review/diffusiontube310306.xls

Appendix 1 Health Effects of Nitrogen Dioxide

Pollutant	Main Health Effects
Nitrogen dioxide	Short-term exposure to high concentrations may cause inflammation of respiratory airways. Long-term exposure may affect lung function and enhance responses to allergens in sensitised individuals. Asthmatics will be particularly at risk (Defra, 2003a).

Appendix 2 Diffusion Tube Bias Adjustment

A2.1 Diffusion tubes are known to exhibit bias when compared to results from automatic analysers. Therefore diffusion tube results need to be adjusted to account for this bias. One of the main factors influencing diffusion tube performance is thought to be the laboratory that supplies and analyses the tubes. Reigate and Banstead Borough Council use diffusion tubes that are supplied and analysed by Lambeth Scientific Services. These are prepared using 50% TEA in acetone.

A2.2 In order to determine the bias exhibited by these tubes, studies are carried out using triplicate tubes collocated with each of the three automatic monitors within the Borough of Reigate and Banstead (data capture 75% or greater). All 2005 diffusion tube data presented in this report have been adjusted using the overall factor calculated from the data presented in Table A2.1, with the optimum relationship defined using orthogonal regression.

Table A2.1: Results of Diffusion Tube and Continuous Monitor Collocation Studies

Year	AQMS	Diffusion tube	Automatic	Adjustment Factor
2005	Michael Crescent, Horley	21.6	29.1	1.351
2005	74 The Crescent, Horley	24.3	34.3	1.411
2005	Poles Lane Pumping Station, Crawley	15.3	19.4	1.274
2005	**Overall factor** (after orthogonal regression)			**1.349**

Appendix 3 Adjustment of Short-Term Data to Annual Mean

A3.1 An additional diffusion tube monitoring site was established outside the Crossways property, Fir Tree Road (A2022), in August 2005. As a result, data for this site do not represent a full calendar year. Therefore, in accordance with the guidance in LAQM.TG(03), the data have been adjusted to an annual mean based on the ratio of concentrations during the short-term monitoring period (5 months; 2/8/05 – 3/1/06) to those over a full calendar year at four sites where long-term data are available. The Teddington AURN, Wandsworth AURN, Michael Crescent, Horley and The Crescent, Horley sites have been used for this purpose because they have reliable long-term datasets and are urban background sites, as recommended in LAQM.TG(03).

A3.2 The annual mean nitrogen dioxide concentrations and the period means for each of the four monitoring sites from which adjustment factors are to be calculated are presented in Table A3.1, along with an Overall Factor.

Table A3.1 Data used for the adjustment of short-term monitoring data to 2005 annual mean

Period Mean Concentration (μg/m^3)	Teddington	Wandsworth	Michael Crescent, Horley	The Crescent, Horley	Overall Factor
2005	26.3	53.4	29.1	34.3	-
2/8/05-3/1/06	28.0	54.8	31.0	35.3	-
Adjustment factor	**0.94**	**0.97**	**0.94**	**0.97**	**0.96**

Appendix 4 Dispersion Modelling Methodology

A4.1 Pollutant concentrations were assessed by modelling using the AAQuIRE 6.1.1 Local and Regional Air Quality Model (Faber Maunsell, 2005). The model uses dispersion algorithms contained in CALINE4 and AERMOD. Model input parameters are described below.

Meteorological data:

A4.2 These came from measurements made at the Gatwick Airport meteorological station during 2005, which is approximately 20 km south of the study area.

Horizontal Road Alignment:

A4.3 Road alignment was based around Ordnance Survey road centreline data, but was adapted, where appropriate, to better represent vehicle trajectories. This adaptation was based on photographic evidence. Each carriageway of each road was entered into the model separately. Those roads that were not explicitly included have been accounted for via the background component of the modelled results.

Traffic data:

A4.4 Traffic data were determined from the 2005 Surrey Traffic Model. Annual average vehicle speeds have been estimated based on speed restrictions and the proximity to junctions. Model input parameters are presented in Table A4.1.

Background Concentrations:

A4.5 These have been taken from the national maps supplied by Defra (2006).

Model Verification:

A4.6 The algorithms on which the AAQuIRE dispersion model is based have undergone extensive international validation. This validation has not, however, been performed for this specific geographical area and these specific input data. It is thus important to verify the model results by comparing them with local measurements. By adjusting the model to agree closely with the measured data, any inherent uncertainties can be minimised.

A4.7 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction from the primary pollutant, nitrogen oxides (NOx), with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions. The model has been run to predict annual mean concentrations of NOx during 2005 at the three diffusion tube monitoring sites within the study area.

Step 1 The diffusion tubes measured NO_2, and so the Total measured NOx was calculated from the measured NO_2 concentrations at each of the three monitoring locations using the NOx to NO_2 calculator available on the Air Quality Archive website[1].

Step 2 The contribution of roads to the total concentration values was then calculated as the difference between the total and the background value for the 1 x 1 km square in which the measurement was made (Defra, 2006).

Step 3 A weighted primary adjustment factor was then calculated using the best fit line between the calculated road contribution and the model derived road contribution. Each diffusion tube measurement was weighted according to its perceived relative accuracy – the concentration measured at RB21/85 was given a weighting of one, as the value was the average of two locations for a full year; RB22 was given half the weighting, as it was based on a measurement at one location for a full year; RB106 was given a quarter of the weight, as the measurement was based on only 5 months of monitoring at one location.

Step 4 The road contribution to the total annual mean nitrogen dioxide concentration was then calculated using the following relationship, specified in Defra (2003):

$$NO_2\ (road) = NO_x\ (road) \times (-0.068 \times Ln(NO_x(total))+0.53)$$

Step 5 The total nitrogen dioxide concentration was then determined by adding the background NO_2 concentration for the area (Defra, 2006) to this calculated road contribution. A secondary adjustment factor was then calculated using the best fit line applied to the adjusted concentration data.

Step 6 Primary and secondary adjustment factors were applied to all modelled data.

Primary (NO_x) adjustment factor: 20.2

Secondary (NO_2) adjustment factor: 0.94

[1] www.airquality.co.uk/archive/laqm/tools/nox_from_no2_calculatorv2.xls

A4.8 A comparison of how the modelled nitrogen dioxide concentrations compare to the actual measured diffusion tube concentrations at the three monitoring locations, once both adjustment factors have been applied is shown in figure A4.1.

Table A4.1: AQQuIRE traffic input parameters for Drift Bridge.

Contribution of:	To the flow on:	Peak hour flow	Speed (kph)	HGV (%)
A240 Reigate Road Southbound	**A2022 Fir Tree Road**	230	75	0.26
	A240 Southbound	442	68	0.26
	B291 Fir Tree Road	53	32	0.26
A2022 Fir Tree Road	**A240 Southbound**	3	48	0.04
	B291 Fir Tree Road	25	48	0.04
	A240 Northbound	326	48	0.04
A240 Reigate Road Northbound	**B291 Fir Tree Road**	2	32	0.4
	A240 Northbound	426	68	0.4
	A2022 Fir Tree Road	25	48	0.4
B291 Fir Tree Road	**A240 Northbound**	61	32	0.05
	A2022 Fir Tree Road	29	48	0.05
	A240 Southbound	0	48	0.05

An average diurnal profile was taken from Traffic statistics provided by the DfT (www.dft.gov.uk/transtat/roadtraff)

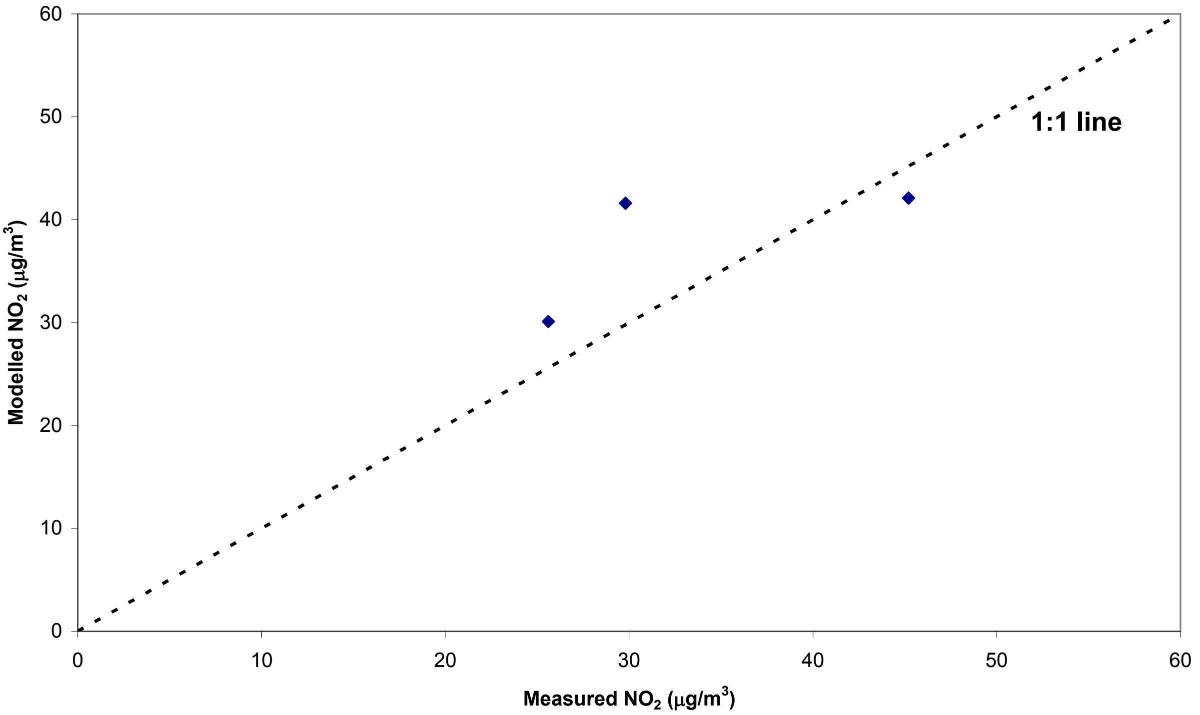

Figure A4.1: Comparison of measured nitrogen dioxide concentrations to fully adjusted modelled concentrations at each of the monitoring locations.