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

Detailed Assessment of Air Quality in Merstham.

May 2007

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

Document Control

Client	Reigate and Banstead Borough Council	**Principal Contact**	Leon Hibbs

Job Number	J608

Report Prepared By:	Dr Denise Welch

Document Status and Review Schedule

Issue No.	Date	Status	Reviewed by
1	03/05/2007	Final Report	Prof. Duncan Laxen
2			
3			

Air Quality Consultants Ltd
23 Coldharbour Road, Bristol BS6 7JT Tel: 0117 974 1086
12 Airedale Road, London SW12 8SF Tel: 0208 673 4313
aqc@aqconsultants.co.uk

Contents

1 Introduction

1.1 Air Quality Consultants Ltd has been commissioned by Reigate and Banstead Borough Council to undertake a Detailed Assessment of air quality in Merstham. In May 2006, Reigate and Banstead Borough Council completed its Updating and Screening Assessment of air quality within the Borough. Routine monitoring of nitrogen dioxide at one location within Merstham 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 are being exceeded, and if so, the extent of the Air Quality Management Area required.

Background

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 and largely completed the second round, with the third round underway.

1.4 Local Air Quality Management Technical Guidance (LAQM.TG(03)) (Defra, 2003b) sets out a phased approach to the second and third rounds 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 an exceedence of an air quality objective is likely and the geographical extent of that exceedence. If the outcome of the DA

is that one or more of the air quality objectives are likely to be exceeded, then an Air Quality Management Area (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 justified; 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 local air quality.

1.6 This report represents a Detailed Assessment in the third round of Review and Assessment, following the findings from the Updating and Screening Assessment published in 2006.

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 set more stringent objectives for benzene and carbon monoxide which are relevant to the second round, but which were absent in the first. 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 only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). 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.

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. The limit values for nitrogen dioxide are the same levels as the UK objectives, and are to be achieved by 2010. The objectives are more stringent than the limit values, thus it is appropriate to focus the assessment on the objectives.

Table 1: Relevant Air Quality Objectives

Pollutant	Time Period	Objective	To be achieved by
Nitrogen Dioxide	1-hour mean	200 μg/m^3 not to be exceeded more than 18 times a year	2005
	Annual mean	40 μg/m^3	2005

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 within Merstham have been taken from the national maps of background concentrations available from the Air Quality Archive (Defra, 2007a). To avoid double counting the effect of the M25 motorway, the background concentrations have been derived following the procedure set out in Box 1.5 of LAQM.TG(03) (Defra, 2003b). This involves taking the average background concentration of the fourth grid square either side of the M25.

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 1.459. The factor provided for 2006 on the Review and Assessment Helpdesk website (version 03/07; Defra, 2007b) is 1.34 and is calculated from 8 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 (RB110), data were only available for seven months. The resulting short-term mean was therefore adjusted to an annual mean equivalent. Further details of this adjustment are provided in Appendix 3.

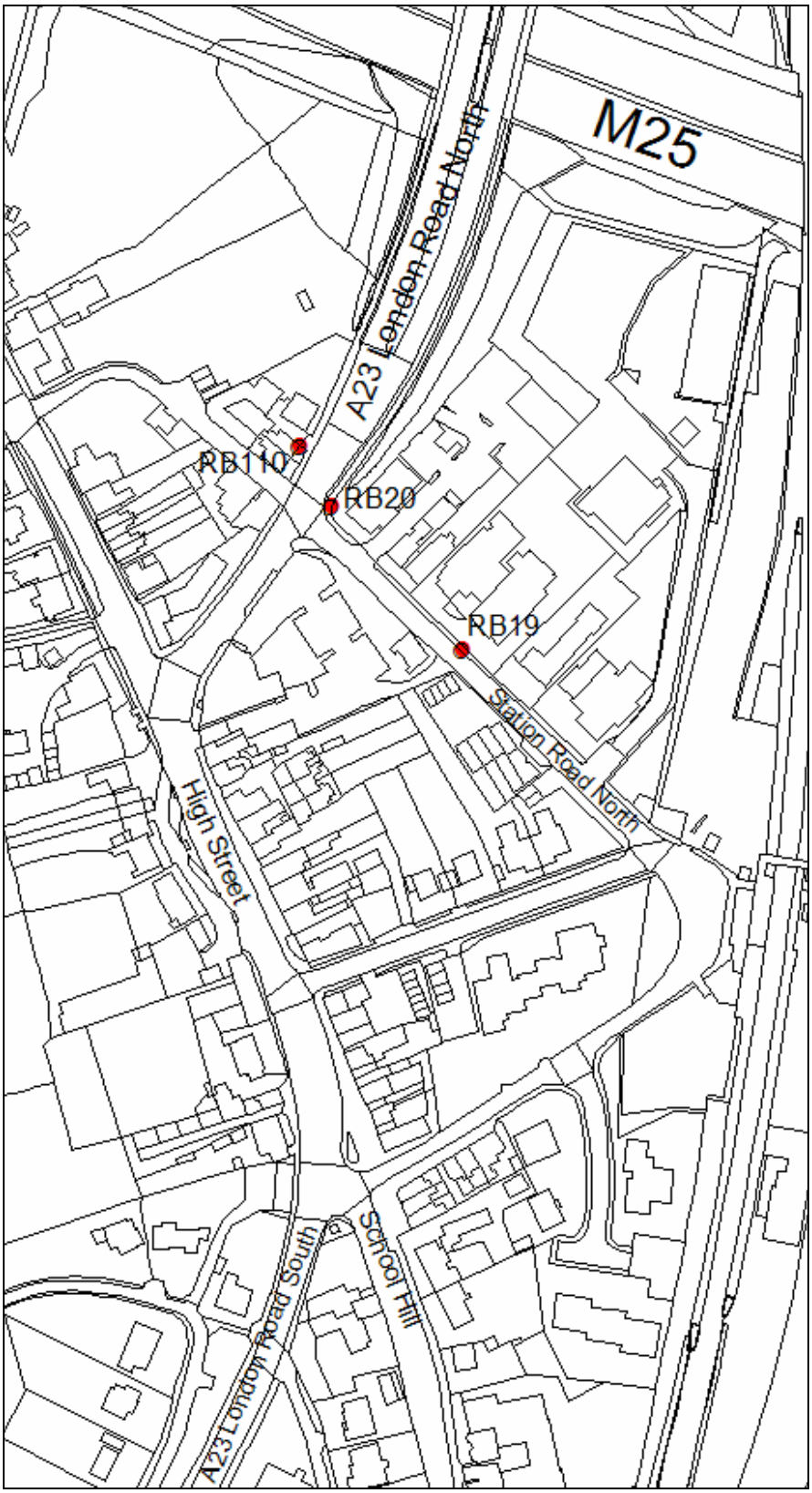

Figure 1: Map of study area. Red dots show diffusion tube monitoring locations. © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405

Table 2: Monitoring Locations in Merstham

Site Reference	Site Description	Site Type
RB19	Village Hall, Station Road North, Merstham	Urban Background
RB20	Corner of London Road and Station Road North, Merstham	Roadside
RB110	204 London Road, Merstham	Roadside

Modelling

2.3 Annual mean concentrations of nitrogen dioxide during 2006 have been modelled using the Atmospheric Dispersion Modelling System for Roads (ADMS Roads). ADMS Roads is one of the dispersion models accepted for modelling within the Government's Technical Guidance (Defra, 2003b). The model has been run using a full year of meteorological data for 2006 from the meteorological station near Gatwick Airport. Concentrations have been modelled for specific worst-case relevant receptor locations and diffusion tube monitoring locations (Figure 2). Concentrations have also been modelled for locations surrounding the relevant receptors where exceedences of the air quality objective have been predicted. The modelling methodology, and the input data utilised are described in Appendix 4. The model has been verified against the diffusion tube measurements and adjusted accordingly. Further details of model verification and adjustment are also supplied in Appendix 4.

Uncertainty

2.4 There is an element of uncertainty in all measured and modelled data. All values presented in this report are the best possible estimates, but uncertainties in the results might cause over-predictions or under-predictions. All of the measurements presented in have an intrinsic margin of error. Defra (2007c) suggest that this is of the order of plus or minus 20% for diffusion tube data and plus or minus 10% for automatic measurements. The model results rely on traffic count data, and predictions of future traffic flows, and thus any uncertainties inherent in these data will carry into this assessment. There will be additional uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. For example: it has been assumed that during each year, the vehicle fleet within the study area will conform to the national (UK) average composition; it has been assumed the emissions per vehicle conform to the factors published in DMRB 11.3; it has been assumed that wind conditions measured at Gatwick airport during 2006 will occur throughout the study area during 2010 and 2015; and it has been assumed that the subsequent dispersion of emitted pollutants will conform to a Gaussian distribution over flat terrain. An important step in the assessment is verifying the dispersion model against the measured data.

By comparing the model results with measurements, data have been corrected for any under- or over-prediction.

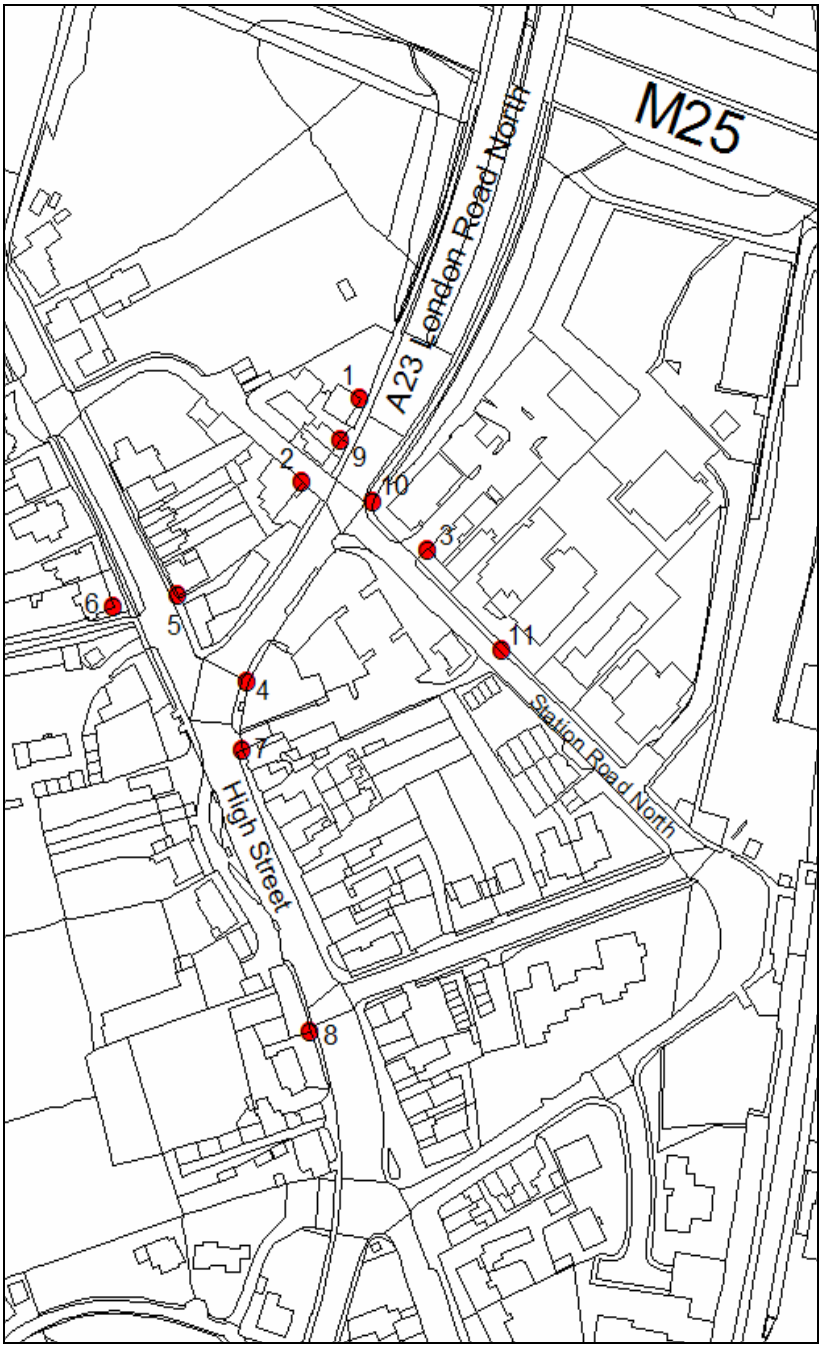

Figure 2: Specific Receptor Locations. © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405

2.5 The UK Government's Air Quality Expert Group (AQEG) has published a draft report on trends in primary nitrogen dioxide in the UK (AQEG, 2006). This examines evidence that shows that while NOx emissions have fallen in line with predictions made a decade previously, the composition of NOx has, in some urban environments, changed. This may have caused nitrogen dioxide levels at some locations to fall less rapidly than was expected. The latest guidance from Defra has been followed regarding NOx to NO_2 relationships, but there is still uncertainty as to whether these relationships will continue to apply in 2010 and 2015. Any effect is likely to be greatest close to major roads, where future baseline concentrations may have been underestimated.

2.6 The limitations to the assessment should be borne in mind when considering the results set out in the following sections. While the model should give an overall accurate picture, i.e. one without bias, there will be uncertainties for individual receptors. Clearly in future years the uncertainties are likely to be greater than they are now. The results are 'best estimates' and have been treated as such in the discussion.

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 roadside locations alongside London Road, in particular at the façade of the closest residential property to the road. At the monitoring location on Station Road North, the annual mean objective is being met, however this is not representative of the worst-case residential exposure along the A23.

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

Site Reference	Site	Relevant Exposure	2006[a]
RB19	Village Hall, Station Road North	No	33.0
RB20	London Rd/Station Rd North	No	**47.8**
RB110	204 London Road	Yes	**43.8**[b]

[a] Bias adjusted using a local bias adjustment factor of 1.459 (see Appendix 2).
[b] Annual mean equivalent concentration (see Appendix 3)

3.2 Because only one of the three measurements represent concentrations at worst-case residential exposure, concentrations have been predicted by modelling over a wider area. Modelled concentrations of nitrogen dioxide at the receptor locations shown in Figure 2 are presented in Table 4, and concentration contours for the wider study area in Figures 3, 4 and 5, for 2006, 2010 and 2015 respectively. These indicate that exceedences of the annual mean nitrogen dioxide objective are likely at the closest properties to the A23 during 2006 and 2010 alongside London Road North, High Street and at the junction of High Street/London Road South and School Hill. Beyond the junction of High Street/London Road South and School Hill, residential properties are located at a greater distance from the road, and lie well outside of the 40 µg/m^3 contour. By 2015, all worst-case receptors are predicted to experience concentrations below the annual mean objective. The margin by which the objective is predicted to be achieved at receptors 4 and 7 in 2015 is however considerably smaller than the uncertainty inherent in the model results.

3.3 No exceedences of 60 µg/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 4: Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) Modelled for Specific Receptor Locations

Receptor number	Location	Relevant Exposure	2006	2010	2015
1	206 London Road North	Yes	**46.4**	**40.5**	36.1
2	Flat above the Railway Arms	Yes	**41.2**	36.1	32.3
3	Closest residential properties to junction of Station Road North and London Road North	Yes	37.8	33.2	29.8
4	Feathers Pub	No	**50.3**	**43.8**	39.2
5	Closest property on east side of Quality Street to junction with London Road North/High Street	Yes	32.1	28.6	25.8
6	Closest property on west side of Quality Street to junction with London Road North/High Street	Yes	28.8	25.8	23.4
7	Closest shop to junction of London Road North and High Street	Yes	**50.1**	**43.6**	39.1
8	Residential property on High Street	Yes	**44.2**	38.7	34.7
9	RB110, 204 London Road North	Yes	**45.3**	39.5	35.3
10	RB20, Corner London Road North and Station Road North	No	**46.0**	**40.1**	35.9
11	RB19, Village Hall, Station Road North	No	34.6	30.5	27.5
Statutory Objective for 2005			**40**	**40**	**40**

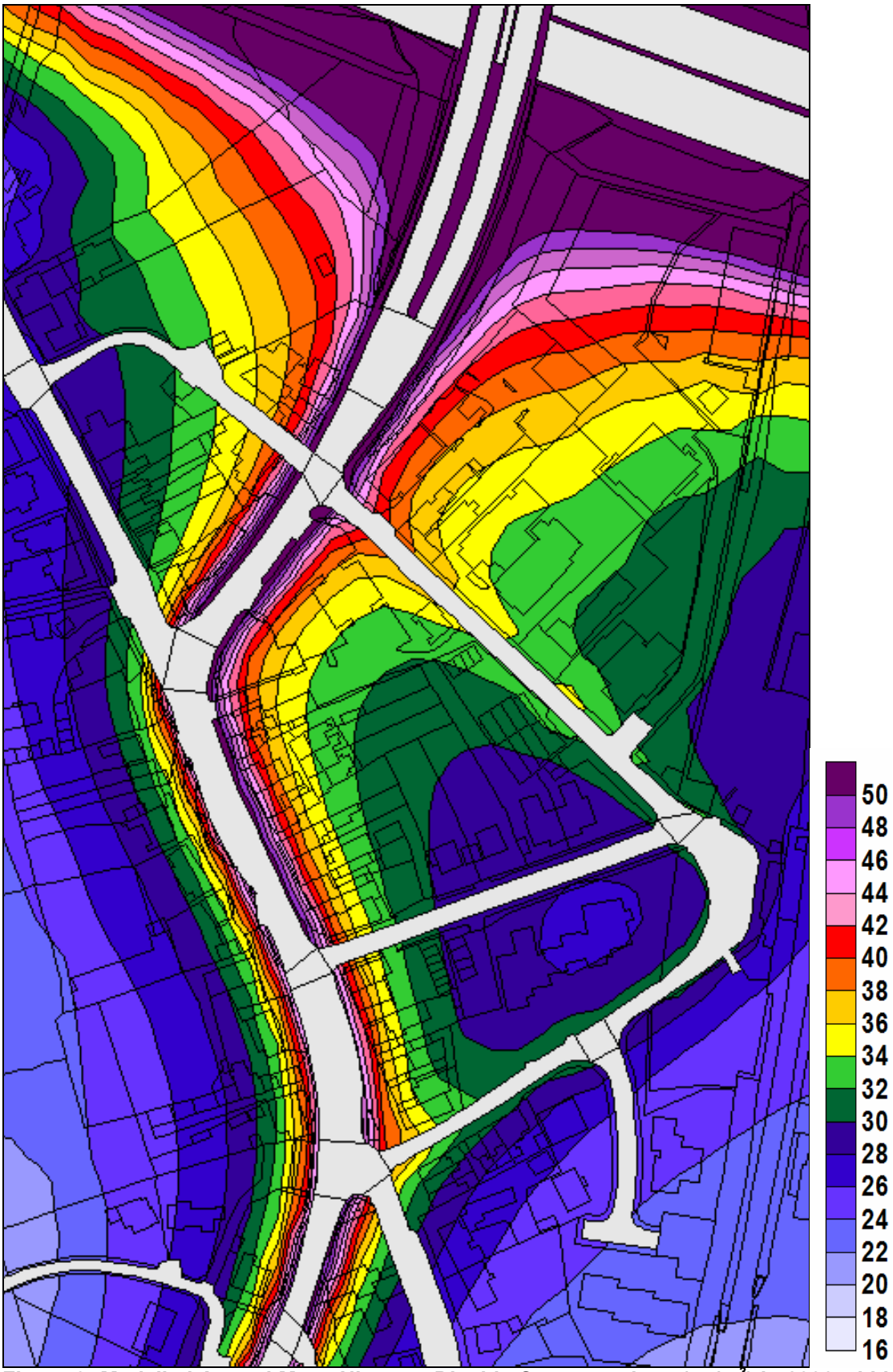

Figure 3: Modelled Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) in 2006 within the Study Area, Merstham.

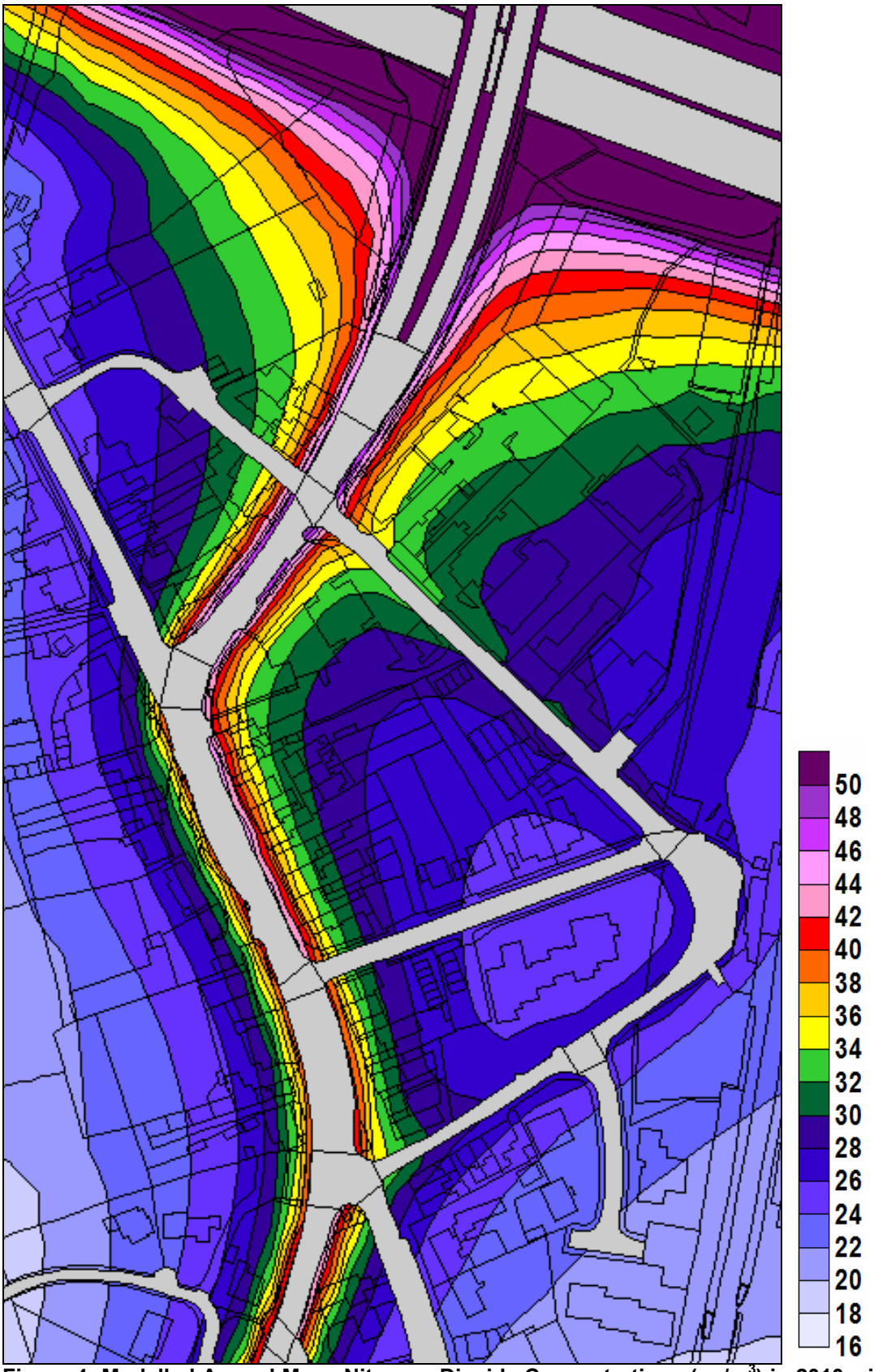

Figure 4: Modelled Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) in 2010 within the Study Area, Merstham.

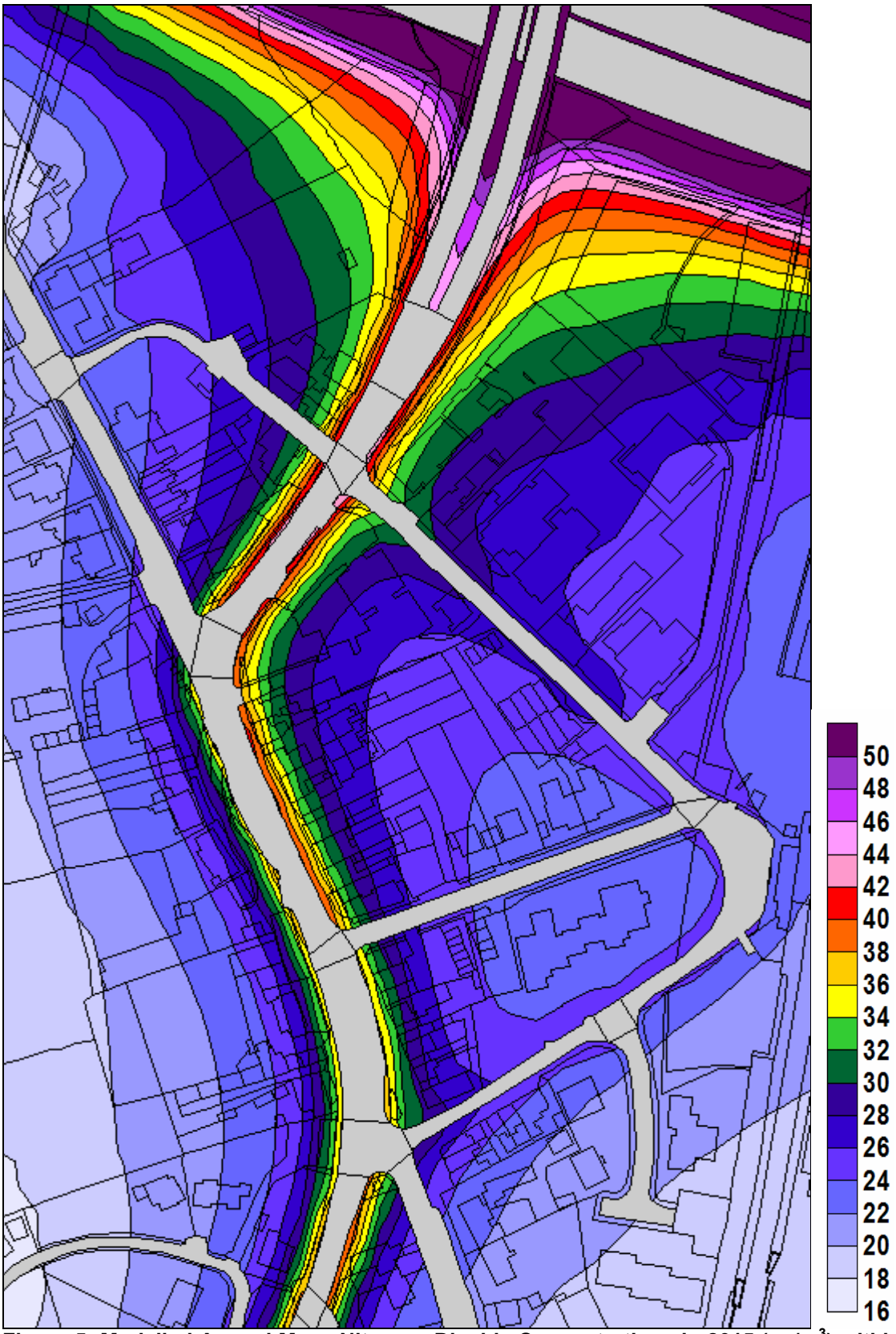

Figure 5: Modelled Annual Mean Nitrogen Dioxide Concentrations in 2015 (µg/m^3) within the Study Area, Merstham.

4 Conclusions

4.1 A Detailed Assessment of air quality has been carried out for properties located alongside the A23 London Road North in Merstham. This area was identified as being at risk of exceeding the annual mean air quality objective for nitrogen dioxide in the Updating and Screening Assessment (RBBC, 2006).

4.2 The Detailed Assessment has been carried out using a combination of monitoring data and modelled concentrations. Concentrations of pollutants have been modelled for 2006, 2010 and 2015 using the dispersion model ADMS Roads, and the model results verified against monitoring carried out alongside the A23 in 2006.

4.2.1 The results have determined that there is a likely exceedence of the annual mean nitrogen dioxide objective for properties alongside London Road North, the High Street and properties close to the junction of London Road South/High Street and School Hill in 2006 and 2010. By 2015, predicted concentrations at all worst-case receptors are below the annual mean objective. Therefore an Air Quality Management Area (AQMA) will be declared including all residential properties at the locations identified.

4.3 This assessment has been based on traffic count data for the A23 carried out around 1.5 km south of the study area. Additionally, flows have been assumed for Station Road North. It is therefore recommended that diffusion tube monitoring is carried out at the closest residential properties to the High Street and London Road South to determine the extent of the AQMA boundary.

5 References

Air Quality Expert Group, 2006. Trends in Primary Nitrogen Dioxide in the UK. Draft report for comment. August 2006.

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, 2007a. Air Quality Archive via the internet www.airquality.co.uk.

Defra, 2007b. Air Quality Review and Assessment Helpdesk website. Available at: www.uwe.ac.uk/aqm/review/

Defra, 2007c. National Atmospheric Emissions Inventory. www.naei.org.uk.

Defra, 2007d. FAQ - Is there a new NO_x to NO_2 calculator available to allow for the recent increase in primary NO_2 from traffic? Available at www.uwe.ac.uk/aqm/review

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

DfT, 2007. Annual Average Daily Flows available at www.dft-matrix.net .

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, 2007a.

RBBC, 2006. Updating and Screening Assessment, May 2006.

Stationery Office, 2000. Air Quality Regulations, 2000, Statutory Instrument 928.

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

6 Glossary

Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal.
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date, taking into account costs, benefits, feasibility and practicality. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides.
Exceedence	A period of time where the concentration of a pollutant is greater than the appropriate air quality objective.
AQMA	Air Quality Management Area
ADMS Roads	Atmospheric Dispersion Modelling System for Roads.
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometers in aerodynamic diameter.
NO_2	Nitrogen dioxide.
$\mu g/m^3$	Microgrammes per cubic metre.
Urban Background	An urban location distanced from sources and therefore broadly representative of city-wide background conditions (Defra, 2003b).
Roadside	A site sampling between 1 m of the kerbside of a busy road and the back of the pavement. Typically this will be within 5 m of the road, but could be up to 15 m (Defra, 2003b).

7 Appendix 1 – Summary of 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).

8 Appendix 2 – Diffusion Tube Bias Adjustment

8.1 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.

8.2 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 2006 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 in 2006

AQMS	Diffusion Tube	Automatic	Adjustment Factor
Michael Crescent, Horley	19.4	29.4	1.51
74 The Crescent, Horley	22.2	32.4	1.46
Poles Lane Pumping Station, Crawley	13.8	19.4	1.41
Overall Factor			**1.459**

9 Appendix 3 – Adjustment of Short-Term Data to Annual Mean

9.1 An additional diffusion tube monitoring site was established at the façade of 204, London Road North, Merstham (RB110) in May 2006. 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 (8 months; 30/5/06 – 3/1/07) 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) (Defra, 2003b).

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

Table A3.1: Data used for the Adjustment of Short-term Monitoring Data to 2006 Annual Mean

Period Mean Concentration ($\mu g/m^3$)	Teddington	Wandsworth	Michael Crescent, Horley	The Crescent, Horley	Overall Factor
2006	23.2	50.9	29.4	32.4	-
30/5/06 – 3/1/07	21.2	48.0	27.9	31.9	-
Adjustment Factor	**1.10**	**1.06**	**1.05**	**1.02**	**1.056**

10 Appendix 4 – Dispersion Modelling Methodology

10.1 Annual mean concentrations of nitrogen dioxide during 2006 have been modelled using the Atmospheric Dispersion Modelling System for Roads (ADMS Roads). ADMS Roads if one of the dispersion models accepted for modelling within the Government's Technical Guidance (Defra, 2003b).

Meteorological Data:

10.2 The model has been run using a full year of meteorological data for 2006 from the meteorological station near Gatwick Airport, which is approximately 15 km south of the study area.

Horizontal Road Alignment:

10.3 Road alignment was based around Ordnance Survey road centreline data. Each carriageway of each road was entered into the model separately, where data were available. Those roads not explicitly included have been accounted for via the background component of the modelled results.

Traffic Data:

10.4 Traffic data for London Road/High Street (A23) have been determined from counts carried out on London Road South in 2005. These data have been factored forward to the assessment years by Reigate and Banstead Borough Council using annual growth factors derived from TEMPRO v5.3. The Department for Transport has recently made all UK 2005 traffic count data accessible via an interactive web-based map (DfT, 2007). AADT flows, and the proportions of HDVs, for the M25 close to Merstham have been determined from this map, and the same growth factors applied to the A23 count data have been applied. Traffic count data are not available for Station Road North. Here, a flow has been estimated based on local knowledge. The speeds and road characteristics assumed for each section of road entered into the model are presented in Table A4.1. The associated flows in each assessment year are presented in Table A4.2.

Table A4.1: Summary of Road Characteristic Data

Link	Description	Road width (m)	Speed (kph)[a]
London Road North Northbound A	Northbound carriageway of the A23, north of Merstham heading over the M25.	19	55
London Road North Southbound A	Southbound carriageway of the A23, north of Merstham heading over the M25.	19	55
London Road North Northbound B	Northbound carriageway of the A23, north of the High Street, Merstham.	11	50
London Road North Southbound B	Southbound carriageway of the A23, north of the High Street, Merstham.	11	50
High Street Northbound A	Northern section of northbound carriageway of the A23 High Street.	14	50
High Street Southbound A	Northern section of southbound carriageway of the A23 High Street.	14	50
High Street Northbound B	Central section of northbound carriageway of the A23 High Street.	11	40
High Street Southbound B	Central section of southbound carriageway of the A23 High Street.	11	40
High Street Northbound C	Southern section of northbound carriageway of the A23 High Street.	13	50
High Street Southbound C	Southern section of southbound carriageway of the A23 High Street.	13	50
London Road South Northbound	Northbound carriageway of the A23, south of the High Street, Merstham.	8	50
London Road South Southbound	Southbound carriageway of the A23, south of the High Street, Merstham.	8	50
M25	The M25 north of Merstham.	37	100/115
Station Road North	Station Road North, between London Road North and London Road South.	7	40

[a] Average speed rounded to nearest 5 kph. Where two speeds are presented, the lower speed represents the speed assumed for HDVs, whilst the higher speed that assumed for LDVs.

Table A4.2: Summary of Traffic Flows used in Assessment[a]

	2006		2010		2015	
	LGV AAHT	HDV AAHT	LGV AAHT	HDV AAHT	LGV AAHT	HDV AAHT
A23[b] Northbound	620.5	31.3	660.4	33.3	711.4	35.9
A23[b] Southbound	609.8	22.7	649.0	24.2	699.1	26.1
M25	5783.9	682.1	6155.7	725.9	6631.2	782.0
Station Road North	202.7	8.9	215.8	9.5	232.4	10.2

[a] AAHT – Annual Average Hourly Traffic flow
[b] The A23 includes London Road North, the High Street and London Road South.

Background Concentrations:

10.5 As described in section 2.1, background concentrations of nitrogen dioxide have been taken from the national maps of background concentrations available from the Air Quality Archive (Defra, 2007a). However, to avoid double counting the effect of the M25 motorway, the background concentrations have been derived following the procedure set out in Box 1.5 of LAQM.TG(03) (Defra, 2003b). This involves taking the average background concentration of the fourth grid square either side of the M25. The background concentrations used in the assessment are therefore the average of those calculated from grid squares 526500, 155500 and 529500, 150500. The background concentrations derived from this procedure are presented in Table A4.3.

Table A4.3: Background Concentrations used to determine those appropriate for use in the Assessment

	Grid square	NOx	Average NOx	NO_2	Average NO_2
2006	526500, 155500	21.1	22.8	16.6	17.6
	529500, 150500	34.5		18.7	
2010	526500, 155500	17.5	20.2	15.5	16.8
	529500, 150500	22.8		18.0	
2015	526500, 155500	15.7	18.0	14.6	15.8
	529500, 150500	20.4		16.9	

Model Verification:

10.6 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of 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 road-NOx concentrations during 2006 at each diffusion tube location within the study area.

10.7 The model outputs of road-NOx (i.e. the component of total NOx coming from road traffic) have been compared with the measured road-NOx. Total measured NOx was calculated from the measured NO_2 concentrations at each of the three monitoring locations using the recently updated NOx from NO_2 calculator[1] available on the Air Quality Archive website (Defra, 2007a). The measured road-NOx contribution was then calculated as the difference between the total and the background value (determined as described in the previous section).

10.8 A weighted primary adjustment factor was then determined as the inverse of the best fit line between the calculated (measured) road contribution and the model derived road contribution. Each diffusion tube measurement was weighted according to its perceived relative accuracy – concentrations measured at RB19 and RB20 were given a weighting of one, as these monitoring sites are long term sites, with 11 and 12 months of data available, respectively. Monitoring at RB110 began in May 2006, and therefore only 7 months of data are available, and this location was given half the weighting.

10.9 The primary adjustment factor was then applied to each modelled road-NOx concentration to provide an adjusted modelled road-NOx concentration. The background concentration was added to these concentrations to determine the adjusted total modelled NOx concentration. The road contribution to the total annual mean nitrogen dioxide concentration was then determined from these adjusted modelled concentrations, following the method set out by Defra (2003b), taking into account the most recent guidance (Defra, 2007d):

$$NO_2 \text{ (road)} = NOx \text{ (road)} \times (-0.0719 * LN(NOx(total)) + 0.6248$$

10.10 The total nitrogen dioxide concentration was then determined by adding the background NO_2 concentration (determined as described above) to this calculated road contribution. A secondary adjustment factor was finally calculated as the inverse of the best fit line applied to the adjusted data.

[1] http://www.airquality.co.uk/archive/laqm/tools/NOxfromNO2calculator2007.xls

10.11 Primary and secondary adjustment factors have been applied to all modelled data presented in this report.

Primary adjustment factor : 3.58

Secondary adjustment factor: 0.99

10.12 The results imply that the model was under-predicting the road NOx contribution. This is a common experience with this and most other models. The final NO_2 adjustments are minor. Figure A4.1 compares the modelled concentrations at each diffusion tube, after all adjustments have been made, to the measured concentrations at these locations.

Figure A4.1: Comparison of Measured NO_2 to Fully Adjusted Modelled NO_2 Concentrations