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Further Assessment of the Reigate High Street and A217 (Blackhorse Lane) Air Quality Management Areas.

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Further Assessment of Air Quality in Reigate High Street and Blackhorse Lane AQMAs

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1 Introduction

1.1 This report sets out the Further Assessment of air quality in the Borough of Reigate and Banstead at two locations that have been declared as Air Quality Management Areas (AQMAs). It forms part of the air quality Review and Assessment process prescribed by Defra. The two AQMAs included in this report are located at High Street, Reigate and Blackhorse Lane, Reigate, and are shown in Figures 1 and 2. They were declared because of a likely exceedence of the annual mean nitrogen dioxide objective.

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 about to start.

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 an 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.

The Air Quality Objectives

1.6 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) 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 (Defra, 2003a).

1.7 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 and 24-hour 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.

1.8 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.

1.9 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 μg/m^3 not to be exceeded more than 18 times a year	2005
		Annual mean	40 μg/m^3	2005
	EU Limit Value	1-hour mean	200 μg/m^3 not to be exceeded more than 18 times a year	2010
		Annual mean	40 μg/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.

Scope

1.10 This report represents the Further Assessment for the Reigate High Street and Blackhorse Lane AQMAs. The study areas assessed encompass the AQMA as well as the area immediately surrounding. The revised Stage 4 guidance note (UWE, 2006) explains that a Further Assessment allows authorities:

- to confirm their original assessment of air quality against the prescribed objectives, and thus to ensure that they were right to designate the AQMA;
- to calculate more accurately how much of an improvement in air quality would be needed to deliver the air quality objectives within the AQMA;
- to refine their knowledge of the sources of pollution so that air quality action plans can be properly targeted;
- to take account of national policy developments which may come to light after the AQMA declaration;
- to take account as far as possible of any local policy developments which are likely to affect air quality by the relevant date, and which were not fully factored into earlier calculations;
- to carry out real-time monitoring where this has not been done previously;
- to carry out further monitoring in problem areas to check earlier findings;
- to corroborate other assumptions on which the designation of the AQMA has been based, and to check that the original designation is still valid, and does not need amending in any way;
- to respond to any comments made by statutory consultees in respect of authorities' previous reports, particularly where these have highlighted that insufficient attention has been paid to, e.g., the validation of modelled data.

Report Structure and Issues Addressed

1.11 Section 2 of this report assesses the impact of new developments since the declaration of the AQMAs. Section 3 provides responses to the comments of consultees on the 2005 Progress Report (PR) and on the subsequent consultation carried out. Section 4 comprises a review of the monitoring data collected since the PR was produced, and the results of detailed dispersion modelling that has been carried out. These data are then used to determine the likelihood of exceedences of the objectives within the existing AQMAs. Section 5 estimates the relative contribution of the most significant pollution sources to overall concentrations. Section 6 estimates the reduction in local emissions necessary to achieve the Government's objectives. Section 7 appraises a range of nominal traffic control measures for their ability to bring about any necessary changes.

Key Findings of the Review and Assessment Process in relation to Reigate High Street and Blackhorse Lane

1.12 The USA for Reigate and Banstead Borough Council (RBBC, 2003) concluded that the objectives for carbon monoxide, benzene, 1,3-butadiene, lead and sulphur dioxide were likely to be achieved across the Borough and thus no further action was required regarding these pollutants in this round of Review and Assessment. The USA did, however, identify likely exceedences of both the nitrogen dioxide and PM_{10} objectives at a property on the southeast corner of the junction of Rushworth Road and the A217 and recommended a Detailed Assessment (RBBC, 2004) for this area.

1.13 Routine monitoring results presented in the 2005 Progress Report (RBBC, 2005) highlighted three areas currently outside AQMAs where exceedences of the annual mean nitrogen dioxide air quality objective were likely. As a consequence, the council progressed to a Detailed Assessment for nitrogen dioxide at Drift Bridge, and straight to declaration of AQMAs at Reigate High Street and the A217 Blackhorse Lane.

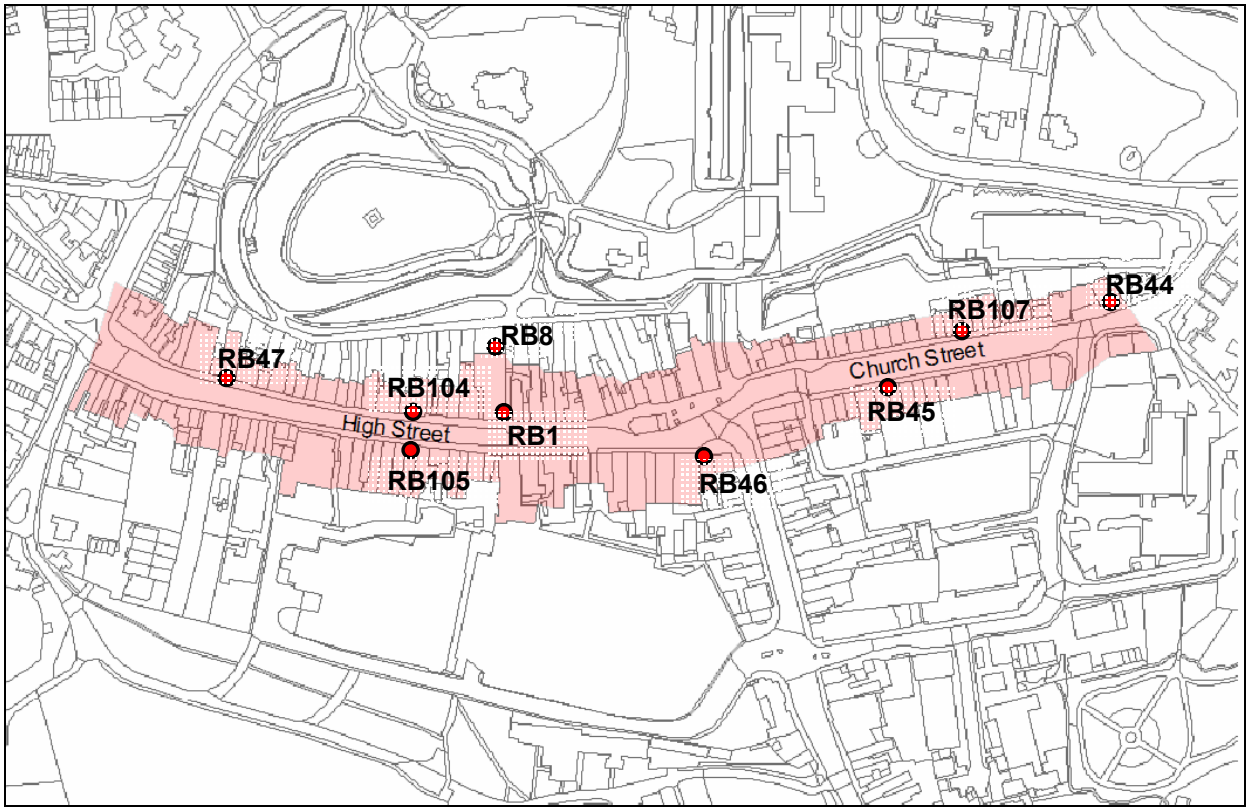

Figure 1: Reigate High street AQMA. Highlighted area shows extent of AQMA, whilst the red dots show diffusion tube monitoring locations. © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405.

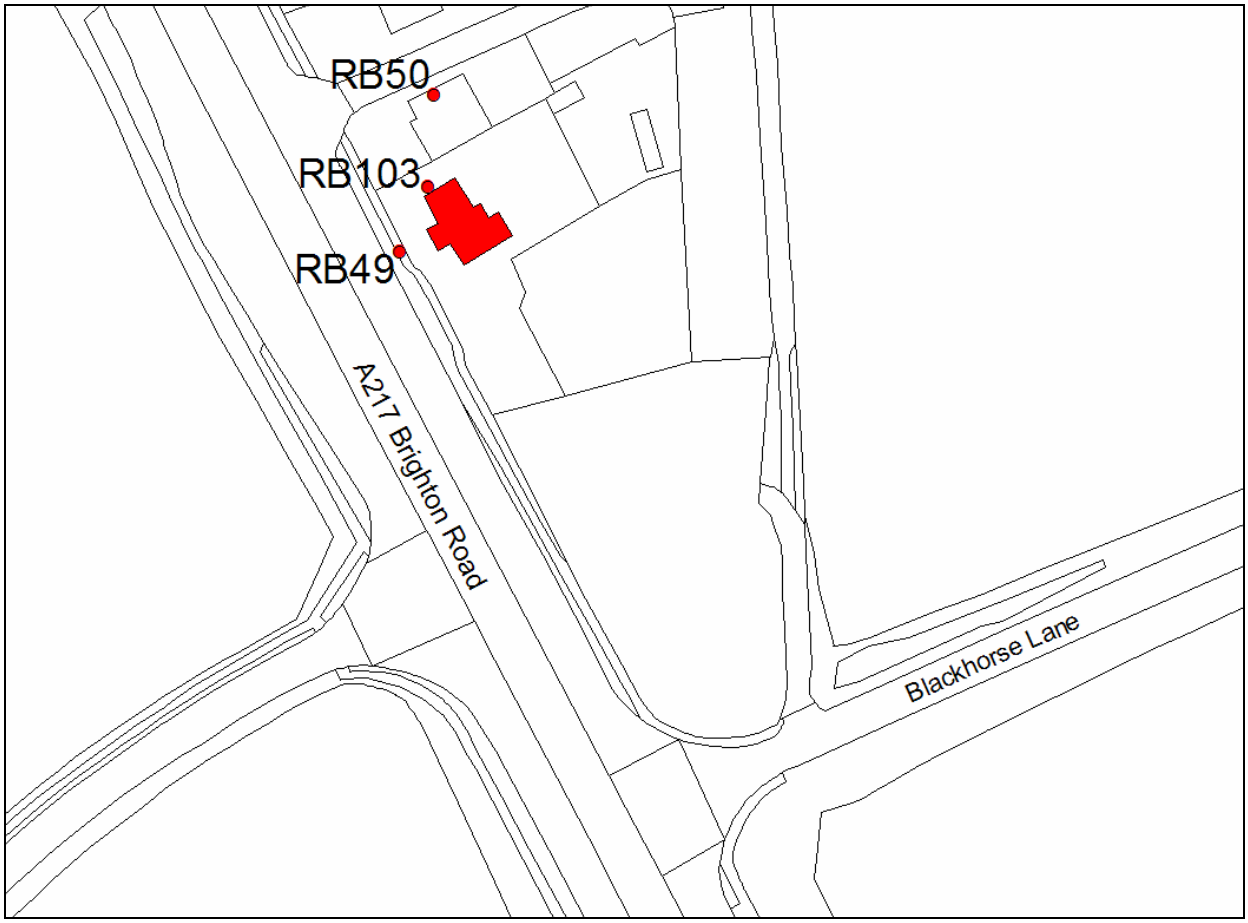

Figure 2: Blackhorse Lane AQMA. Red area shows extent of AQMA, whilst the red dots show the diffusion tube monitoring locations. © Crown Copyright. Reigate & Banstead Borough Council. Licence no. 100019405.

2 Developments since Declaration of the AQMA

2.1 There have been no new road or housing developments within close proximity to either the Reigate High Street AQMA or the Blackhorse Lane AQMA since the declaration of the AQMAs at the end of 2005.

3 Responses to Consultees Comments

3.1 Defra's USA Appraisal Report accepted the conclusions reached for all pollutants. The Appraisal report made one comment, which was that *for Sulphur Dioxide, no assessment of railway diesel locomotives has been mentioned. Although locations of relevant exposure within 15 m of idling diesel locomotives is unlikely, Reigate and Banstead Council should satisfy itself that it does not have such locations within its area*. Reigate and Banstead BC **have since confirmed to Defra that there is only one steam locomotive per week passing through the Borough, and that this does not stop, and there are no locations where diesel locomotives idle for any period of time outside of stations. Diesel locomotives do stop at Redhill Station to allow passengers to get on and off, however if the train is idle for longer than five minutes, it moves to the far end of the platform. Aside from the passengers on the platform, there is no relevant exposure around this station.**

3.2 Defra's Progress Report Appraisal accepted the Review and Assessment aspects of the Progress Report (RBBC, 2005) for monitoring data and new developments. It also accepted the council's plans to progress to a Detailed Assessment for nitrogen dioxide at Drift Bridge, and to proceed straight to declaration of AQMAs, and the associated Further Assessment of two locations, at Reigate High Street and the A217 Blackhorse Lane. Two points were noted:

1. *When using DMRB to extrapolate a diffusion tube concentration at the kerbside to a building façade set further back, you should use a factor based only on the roadside contribution (i.e. total concentration minus the background). The results sheet of DMRB separates out these two elements of the total predicted concentration.*

   AQQuIRE modelling rather than DMRB is used in this report to determine concentrations at the façade of buildings where diffusion tube monitoring is carried out closer to the kerb.

2. *It would be helpful to provide trends for any monitoring sites with a long term data set.*

   Three years of monitoring are presented in this Further Assessment report.

3.3 Reigate and Banstead Borough Council carried out consultation exercises to seek the views of residents within the two AQMAs. A number of local residents and High street employers were concerned about the effect of the air quality in the High Street on their health and on the health

of their customers, and of the effect traffic calming measures being implemented within the High Street on the flow of traffic would have on the air quality.

3.4 **Reigate & Banstead BC responded that whilst congestion in the High Street is a contributory factor to poor air quality, it is mainly due to the combination of high traffic flows and relatively narrow width of the street in relation to the height of the surrounding buildings, which limits the dispersion of pollutants. Future projections of air quality will be based on measurements made in 2005, and subsequently 2006, when the new measures on the High Street will have been in place and the impact will thus be taken into account. However, prevailing wind conditions have a more significant impact on air quality on a year-to-year basis.**

3.5 **Reigate & Banstead BC also highlighted the fact that only especially sensitive asthmatics or people with breathing problems may experience some problems with the concentrations of nitrogen dioxide on the High Street, and that the guideline workplace exposure limit, which would apply in work places (for an 8 hour period) is 1910 µg/m^3. Whilst the levels measured on the High Street are presented as annual mean values, it is extremely unlikely that the 8 hour exposure limit would be breached**.

3.6 Surrey County Council noted that emissions from traffic on roads which are their responsibility is a contributory factor in the requirement to declare AQMA's. They confirmed that they would be pleased to work alongside Reigate and Banstead BC in preparing appropriate action plans and that contact between Reigate and Banstead BC and the Surrey Local Transport Manager and Surrey Air Quality group was already in place.

3.7 A response was received from the office of the Mayor of London which expressed an interest in the changes to AQMAs within the borough. It also highlighted the Mayor's commitment to making London a Low Emission Zone.

4 Corroboration of Previous Findings

4.1 As noted above, this report encompasses two AQMAs and their surrounding areas. The results are discussed separately according to whether they are within or outside of one of the AQMAs.

New Monitoring

Automatic Monitoring within the AQMAs

4.2 Reigate and Banstead Borough Council do not carry out any automatic monitoring within either of the AQMAs.

Diffusion Tube Monitoring Within the AQMAs

4.3 Monthly average nitrogen dioxide concentrations have been measured at six locations within the Reigate High Street AQMA since 2002 using passive diffusion tubes. A further three monitoring locations were added during 2005 at locations on the façade of buildings or properties representative of relevant exposure. Diffusion tube monitoring has also taken place at two locations within the Blackhorse Lane AQMA for since 2002, however neither of these is representative of relevant exposure, and a further monitoring location on the façade of the Highlands property was added in 2005. The monitoring locations are shown in Figures 1 and 2. Table 2 sets out the annual mean measured concentrations at each site over the last three years, as well as the concentrations predicted for 2010, derived by adjusting the 2005 data in line with national trends and projections. The diffusion tubes used (50% TEA in acetone) are supplied by Lambeth Scientific Services. A local bias adjustment factor has been calculated (Appendix 2) using data from diffusion tubes collocated in triplicate with each of the three automatic monitoring sites within the borough.

4.4 The results show that, at monitoring locations within the AQMAs representative of relevant exposure, or at locations closer to the kerb and thus providing worst-case exposure levels, air quality during 2005 did not meet the annual mean nitrogen dioxide air quality objective. Monitoring data presented for previous years show considerable year-on-year variation at most of the monitoring locations, with 2003 being recognised nationally as a high pollution year.

Table 2: Measured 2003, 2004 and 2005 and Projected 2010 Annual Mean Concentrations at each Diffusion Tube Monitoring Site (µg/m^3). Exceedences of the level of the objective for 2005 are shown in bold.

Site Location	AQMA	Site Type[a]	2003[b]	2004[c]	2005[d]	2010[e]
RB1 Boots, High St	High Street	K	**52**	47	**41.3**	34.7
RB8 Castle Walk	High Street	UB	**42**	27	22.9	20.0
RB44 Gunshop, Church St	High Street	K	**45**	34	38.8	32.6
RB45 Bus stop, Church St	High Street	K	**46**	**45**	**44.4**	37.4
RB46 Gerrards Menswear, High St	High Street	K	**53**	**47**	**41.3**	34.7
RB47 Nationwide, High St	High Street	K	**50**	**41**	**46.3**	39.0
RB104 ASK façade, High St	High Street	R	-	-	38.5[f]	32.4
RB105 Finishing Touch façade, High St	High Street	R	-	-	38.9[f]	32.7
RB107 Sussex Blinds façade, High St	High Street	R	-	-	35.6[g]	30.0
RB49 Highlands, Brighton Rd	Blackhorse Lane	K	**59**	**59**	**59.0**	**49.6**
RB50 Yew Cottage, Brighton Rd	Blackhorse Lane	R	**41**	37	38.5	32.4
RB103 Highlands façade, Brighton Rd	Blackhorse Lane	R	-	-	36.9[f]	31.0

[a] R = Roadside; K = Kerbside; UB = Urban Background.
[b] Local bias adjustment factor of 1.29 applied by Reigate and Banstead BC (RBBC, 2005).
[c] Local bias adjustment factor of 1.32 applied by Reigate and Banstead BC (RBBC, 2005).
[d] Local bias adjustment factor of 1.35 applied, calculated from three collocation studies carried out across the borough (Appendix 2).
[e] Predicted from 2005 data using future year projection factors supplied by Defra (2006).
[f] Monitoring carried out for 5 months. Short term data adjusted to 2005 annual mean equivalent (see Appendix 3)
[g] Monitoring carried out for 4 months. Short term data adjusted to 2005 annual mean equivalent (see Appendix 3)

Diffusion Tube Monitoring Outside of the AQMAs.

4.5 There is no monitoring carried out within 500 m of either of the AQMAs. The closest diffusion tube monitoring carried out to the Reigate High street AQMA is at Rushworth Road. However, this area is also an AQMA for nitrogen dioxide and is currently the subject of a Further Assessment (AQC, 2006).

New Modelling

Definition of Potential Exceedence Area

4.6 Annual mean concentrations of nitrogen dioxide during 2005 have been predicted within the two study areas using the dispersion modelling methodology set out in Appendix 4. Figures 3 and 4

show the extent of predicted exceedences of the annual mean. At all modelled locations representing relevant exposure within each AQMA, the air quality objectives were exceeded in 2005. There are no predicted annual mean concentrations greater than 60 µg/m^3 at relevant locations and therefore it is unlikely that the 1-hour objective for nitrogen dioxide will be exceeded.

4.7 It is clear from Figure 3 that the area of predicted exceedence of the annual mean nitrogen dioxide objective is likely to extend beyond the current Reigate High Street AQMA boundary, however it is important to note that the contours describe all areas of exceedence, not necessarily coinciding with relevant exposure. The locations of residential properties which fall within the area of exceedence are shown in Figure 5.

Concentrations at Specific Receptors

4.8 In order to quantify the extent of the predicted exceedence at relevant locations, a number of specific locations within each AQMA were selected for modelling. These locations are at the façades of buildings representing worst-case residential exposure within the study areas and the locations are shown in Figures 3 and 4. The modelled (2005) annual mean nitrogen dioxide concentrations at each receptor are shown in Table 3. The highest predicted annual mean nitrogen dioxide concentration within the Reigate High Street AQMA in 2005 is 52 µg/m^3, whilst the highest within the Blackhorse Lane AQMA is 53 µg/m^3, both of which clearly represent large exceedences of the objective.

4.9 Future year projection factors, available from Defra (Defra, 2006), have been applied to the modelled 2005 data to enable a prediction of the concentrations at each worst case receptor in 2010. The concentrations in 2010 are predicted to be lower than those modelled for 2005 due to a range of measures implemented by the UK and the EU Governments to reduce emissions from vehicles and other sources. These measures are expected to more than offset the expected increase in vehicle numbers. The annual mean nitrogen dioxide objective is predicted to be achieved at the majority of relevant receptor locations in the Reigate High Street AQMA in 2010, however, exceedences are still predicted within the Blackhorse Lane AQMA.

Table 3: Modelled and Estimated Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) at the Worst-Case Representative Receptors.

Receptor	2005	2010[a]
Reigate High Street AQMA		
Receptor 1	**47.7**	**40.1**
Receptor 2	**44.5**	37.4
Receptor 3	**45.5**	38.3
Receptor 4	**46.9**	39.5
Receptor 5	**42.4**	35.7
Receptor 6	**45.1**	37.9
Receptor 7	**46.8**	39.4
Receptor 8	**52.0**	**43.7**
Blackhorse Lane AQMA		
Receptor 9	**51.0**	**42.9**
Receptor 10	**53.0**	**44.6**
Statutory Objective for 2005	**40**	
EU Limit Value for 2010		**40**

[a] Estimated using the future year projection factors available from Defra (2006).

Assessment Summary

4.10 The results of this Further Assessment confirm that Reigate & Banstead Borough Council was correct in its decision to declare AQMAs for nitrogen dioxide in Reigate High Street and for the relevant receptor location close to Blackhorse Lane. Based on the most recent monitoring results, exceedences of the annual mean nitrogen dioxide objective have been measured at locations of relevant exposure within the Reigate High Street AQMA, and at locations in close proximity to the Blackhorse Lane AQMA.

4.11 The results of the detailed modelling predict exceedences beyond the boundary of the existing Reigate High Street AQMA in 2005. The area of predicted exceedence extends out around 500 m to the west of the existing AQMA along West Street, and north around the one-way system including London Road and Castlefield Street. This area of predicted exceedence is shown in Figure 3. It is therefore recommended that additional diffusion tube monitoring should be carried out at a number of additional locations in London Road, Castlefield Street and West Street in order to more accurately define concentrations, and that the AQMA should be extended to include, as a minimum, all residential properties within the predicted area of exceedence.

4.12 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.

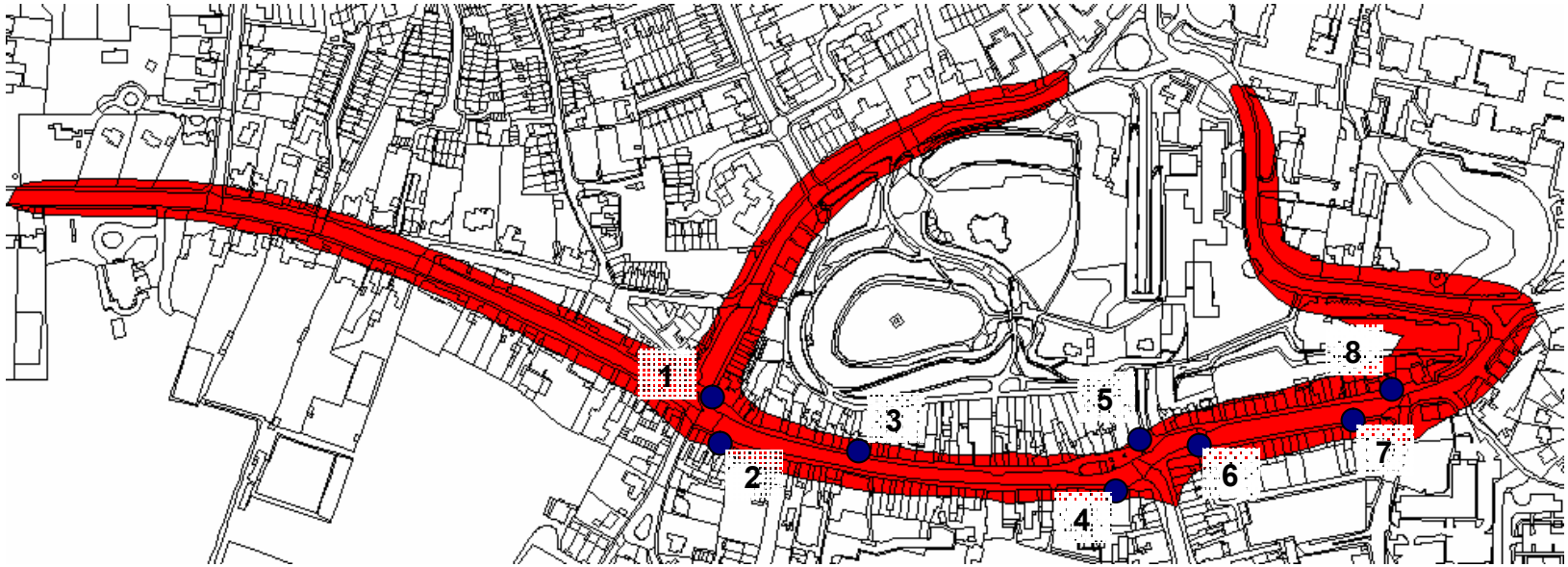

Figure 3: Predicted Area of Exceedence (highlighted red) of the Annual Nitrogen Dioxide Objective in 2005 around Reigate High Street AQMA.
Represent specific modelled locations.

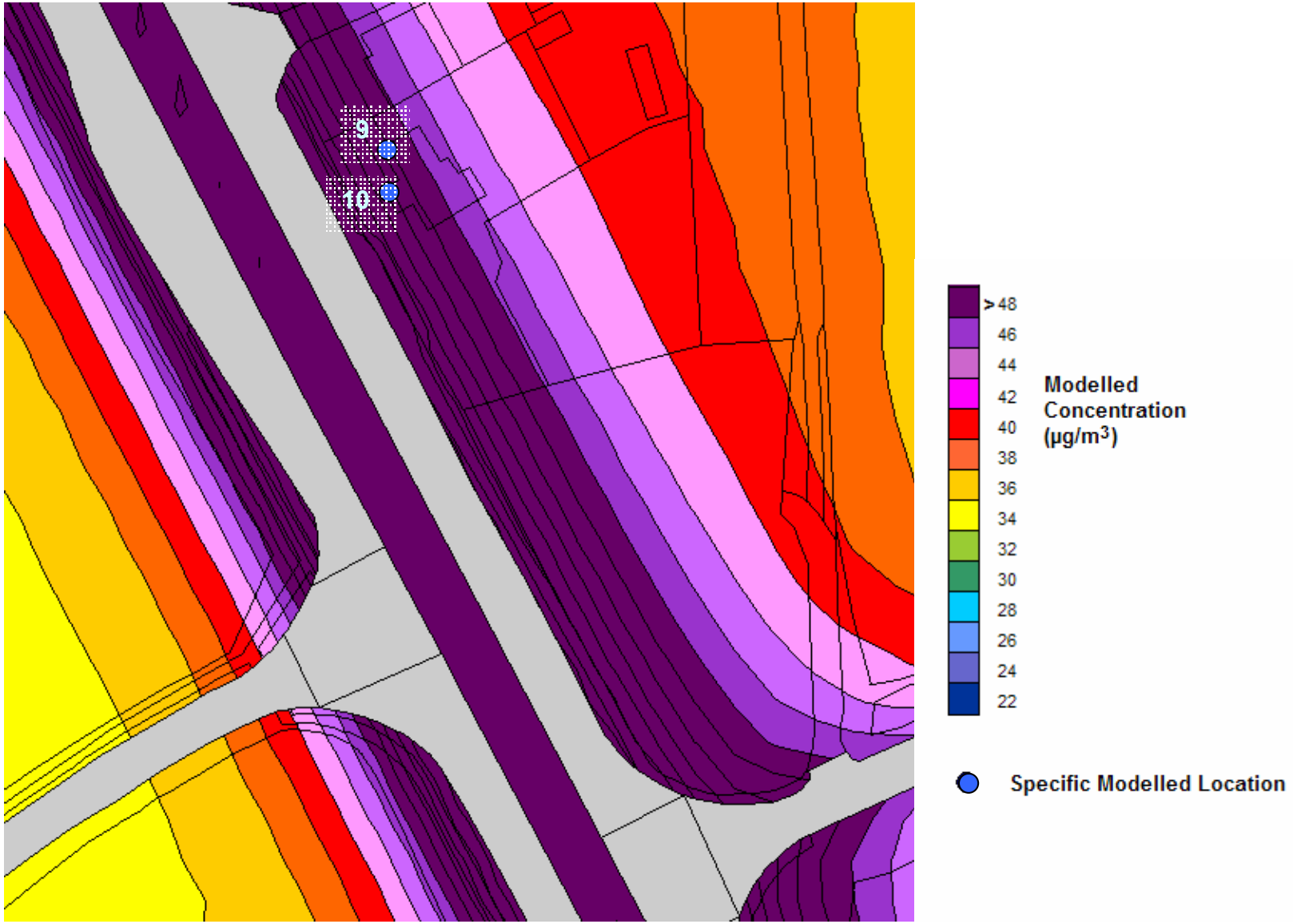

Figure 4: Modelled Annual Mean Nitrogen Dioxide Concentrations in 2005 around Blackhorse Lane AQMA.

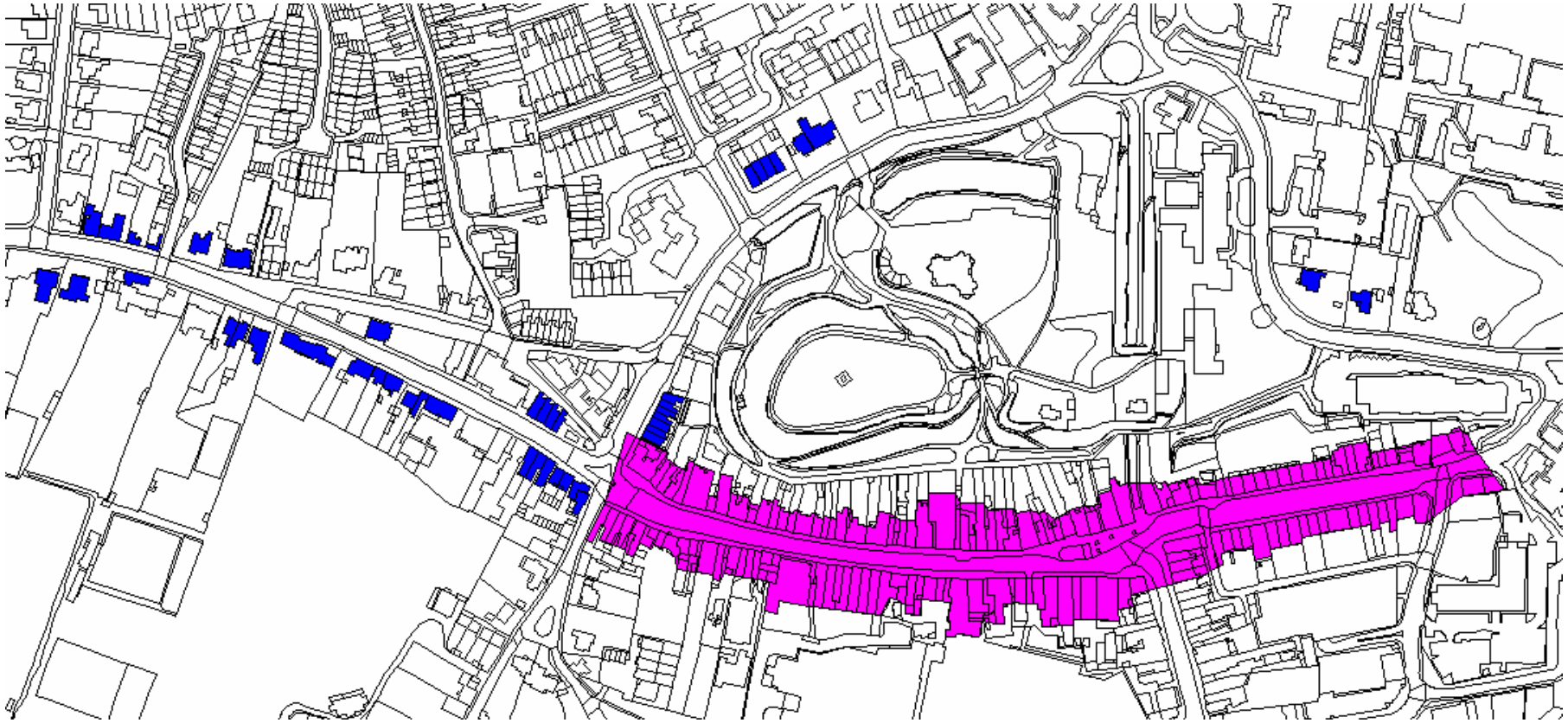

Figure 5: Reigate High Street AQMA and residential properties outside of the AQMA. The AQMA is shown as the pink shaded area and encompasses both residential and non-residential properties. Blue shaded properties outside of this area are residential properties which lie within the predicted area of exceedence.

5 Source Apportionment

5.1 Source apportionment data are presented for both study areas to identify the sources contributing to the nitrogen dioxide concentrations within the AQMAs. The data presented here could be used to inform any future traffic management decisions. Appendix 4 describes how the data were derived. Table 4 sets out the predicted annual mean nitrogen dioxide concentrations in 2005 at each of the receptor locations shown in Figures 3 and 4. Source contributions have been apportioned into the following categories, where data were available:

- Cars
- LGVs
- HGVs
- Public Service Vehicles (PSVs)
- Motorcycles (MCL)
- Ambient Background

5.2 The proportion of HGVs was 4.2% of the total vehicle flow at census points either side of the Blackhorse Lane AQMA during 2000 (NAEI, 2006) whilst within the Reigate High Street AQMA, they account for around 5% of the total. Around/within each AQMA, the total traffic flows are comprised mainly of cars.

5.3 At each of the specific receptors modelled, the background concentration contributes the largest proportion to the overall concentration. At the worst case receptor location within the Reigate High Street AQMA, 42% of the total modelled concentration is derived from the background, 30% is associated with HGVs, 26% with cars and 3% with Light Goods Vehicles. At the worst case receptor location in the Blackhorse Lane AQMA, 44% of the total modelled concentration is derived from the background, 33% is associated with cars and 24% with HGVs. This is shown graphically in Figures 6 and 7.

Table 4: Modelled Annual Mean (2005) Nitrogen Dioxide Concentrations at the Worst-Case Representative Receptors and the Contribution of Each Source to the Total.

Receptor	Background	Car	LGV	HGV	PSV	MCL	Total
Annual Mean Concentration (µg/m^3)							
Reigate High Street AQMA							
1	21.9	10.9	0.9	14.0	0.0	0.0	47.7
2	21.9	9.4	1.1	12.2	0.0	0.0	44.5
3	21.9	10.2	0.9	12.5	0.0	0.0	45.5
4	21.9	10.6	1.2	13.3	0.0	0.0	46.9
5	21.9	8.6	0.7	11.2	0.0	0.0	42.4
6	21.9	9.9	0.9	12.4	0.0	0.0	45.1
7	21.9	11.0	1.1	12.7	0.0	0.0	46.8
8	21.9	13.4	1.3	15.5	0.0	0.0	52.0
Blackhorse Lane AQMA							
9	23.1	16.3	-	11.7	-	-	51.0
10	23.1	17.3	-	12.5	-	-	53.0
Percentage Contribution to the Total [a]							
Reigate High Street AQMA							
1	46	23	2	29	0	0	**====**
2	49	21	2	27	0	0	**====**
3	48	22	2	27	0	0	**====**
4	47	23	3	28	0	0	**====**
5	52	20	2	26	0	0	**====**
6	49	22	2	27	0	0	**====**
7	47	24	2	27	0	0	**====**
8	42	26	3	30	0	0	**====**
Blackhorse Lane AQMA							
9	45	32	-	23	-	-	**====**
10	44	33	-	24	-	-	**====**

[a] contribution based on un-rounded results

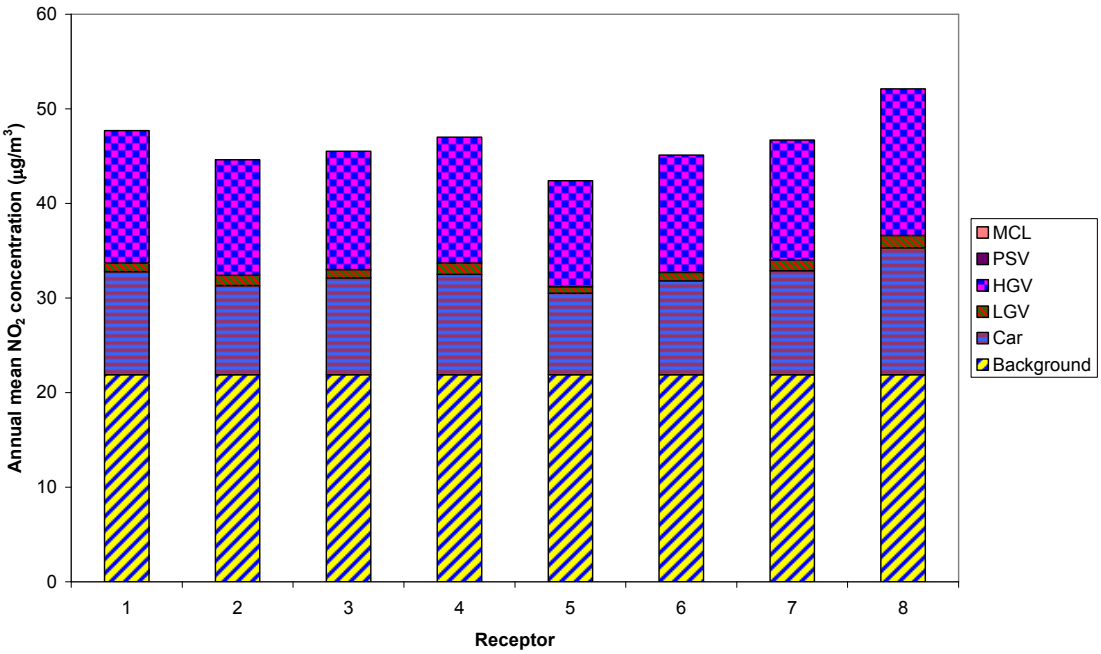

Figure 6: Relative Contribution of Each Source Type to the Total Modelled Annual Mean Nitrogen Dioxide Concentration (µg/m^3) at Worst Case Relevant Receptor Locations within the Reigate High Street AQMA.

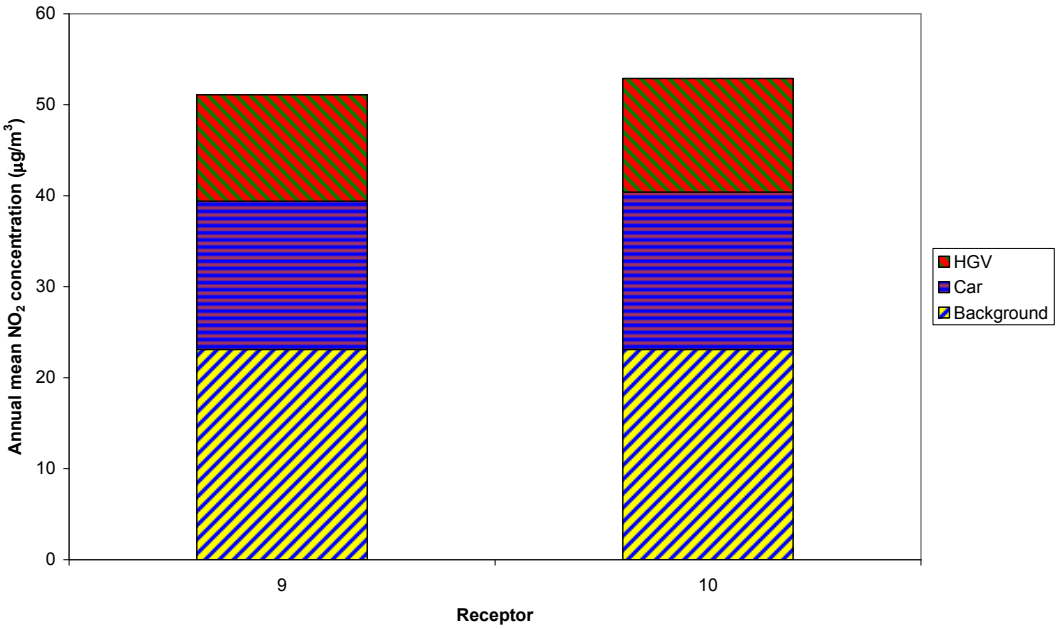

Figure 7: Relative Contribution of Each Source Type to the Total Modelled Annual Mean Nitrogen Dioxide Concentration (µg/m^3) at Worst Case Relevant Receptor Locations within the Blackhorse Lane AQMA.

6 Air Quality Improvements Needed

6.1 The degree of improvement needed in order for the annual mean objective for nitrogen dioxide to be achieved is defined by the difference between the highest predicted concentration in 2005 and the objective level (40 μg/m^3). The highest predicted concentration in the Reigate High Street AQMA is at Receptor 8 (52 μg/m^3) requiring a reduction of about 12 μg/m^3 in order for the objective to be achieved, whilst in the Blackhorse Lane AQMA, the highest predicted concentration is at Receptor 10 (53 μg/m^3) requiring a reduction of around 13 μg/m^3.

6.2 In terms of describing the reduction in emissions that is required it is more useful to consider nitrogen oxides (NOx). Table 5 sets out the required reduction in local emissions of NOx that would be required at each receptor in order for the annual mean objective to be achieved in 2005. At Receptor 10, local emissions would need to fall by 54%.

Table 5: Improvement in Annual Mean Nitrogen Dioxide Concentrations and in Emissions of Oxides of Nitrogen at the Worst-Case Representative Receptors in 2005[1].

Receptor	Required reduction in annual mean nitrogen dioxide concentration (μg/m^3)	Required reduction in emissions of oxides of nitrogen from local roads (%)
Reigate High Street AQMA		
1	7.7	38
2	4.5	26
3	5.5	30
4	6.9	36
5	2.4	15
6	5.1	28
7	6.8	35
8	12.0	51
Blackhorse Lane AQMA		
9	11.0	49
10	13.0	54

6.3 Table 6 sets out the required reduction in local emissions of NOx that would be required, at receptor locations where exceedences have been predicted in 2010, in order for the annual mean objective to be achieved in 2010. At Receptor 10, local emissions would still need to fall by 26%.

[1] These data are slightly different to those that can be derived using the NOx to NO_2 calculator published by Defra (2005). This is because the calculator is based on national default concentration relationships, but these data are derived directly from the model results and use the adjustment factors built into the model verification.

Table 6: Improvement in Annual Mean Nitrogen Dioxide Concentrations and in Emissions of Oxides of Nitrogen at the Worst-Case Representative Receptors in 2010.

Receptor	Required reduction in annual mean nitrogen dioxide concentration ($\mu g/m^3$)	Required reduction in emissions of oxides of nitrogen from local roads (%)
Reigate High Street AQMA		
1	0.1	<1
8	3.7	22
Blackhorse Lane AQMA		
9	2.9	18
10	4.6	26

6.4 However, it is very important to stress that these anticipated improvements do not take specific account of local factors. Furthermore, there is evidence at a national level, that concentrations at some roadside sites have not followed these predicted trends. Reasons for this are currently being explored by the Government's expert advisory panel AQEG; one potential factor may be the increased penetration of diesel vehicles, which emit a higher proportion of primary NO_2.

7 Management Planning

7.1 In order to inform the focus of potential measures within the action plan, a number of simple and hypothetical measures to deliver the required NOx reductions at the representative receptor locations have been explored. The measures that have been examined involve stepped reductions in emissions from each of the vehicle categories defined in Section 5. It is not within the remit of this report to speculate on how these reductions might be achieved, and the intention is simply to inform future management decisions. Tables 7 sets out the results.

7.2 The results presented in Table 7 highlight that targeting some vehicle types in isolation would achieve very little at most locations. The most effective measure for improving air quality at the worst-case location in Reigate High Street AQMA (Receptor 8) would be to reduce emissions from HGVs, however, even a 50% reduction in HGvs would not result in a concentration which meet the annual mean air quality objective.

7.3 A 50% reduction in all vehicles travelling through the Reigate High Street AQMA would result in achievement of the annual mean air quality objective at all but one of the worst case receptor locations. However, a 50% reduction in all vehicles travelling past the Blackhorse Lane AQMA would not result in the annual mean air quality objective being met at the worst case receptor location.

Table 7: Modelled Annual Mean Nitrogen Dioxide Concentration During 2005 Assuming Hypothetical Emission Reductions from Different Vehicle Classes.

Vehicle Type	% reduction in emissions	Predicted Concentration (µg/m^3)[a]									
		Reigate High Street AQMA								Blackhorse Lane AQMA	
		1	2	3	4	5	6	7	8	9	10
Cars	10%	46.9	43.9	44.8	46.2	41.7	44.4	46.0	51.2	49.9	51.9
	25%	45.7	42.8	43.6	45.0	40.7	43.3	44.8	49.8	48.1	50.0
	50%	43.7	40.9	41.6	43.0	39.0	41.3	42.7	47.4	45.0	46.7
LGVs	10%	47.6	44.5	45.4	46.9	42.3	45.0	46.7	52.0	-	-
	25%	47.5	44.3	45.3	46.7	42.2	44.9	46.6	51.8	-	-
	50%	47.4	44.2	45.2	46.5	42.1	44.8	46.4	51.6	-	-
HGVs	10%	46.7	43.6	44.6	46.0	41.5	44.2	45.9	51.0	50.2	52.2
	25%	45.2	42.3	43.2	44.5	40.2	42.8	44.5	49.4	49.0	50.9
	50%	42.5	*39.8*	40.7	41.9	*37.9*	40.3	42.0	46.6	46.8	48.6
PSVs	10%	47.7	44.5	45.5	46.9	42.4	45.1	46.8	52.0	-	-
	25%	47.7	44.5	45.5	46.9	42.4	45.1	46.8	52.0	-	-
	50%	47.7	44.5	45.5	46.9	42.4	45.1	46.8	52.0	-	-
MCLs	10%	47.7	44.5	45.5	46.9	42.4	45.1	46.8	52.0	-	-
	25%	47.7	44.5	45.5	46.9	42.4	45.1	46.8	52.0	-	-
	50%	47.7	44.5	45.5	46.9	42.4	45.1	46.8	52.0	-	-
All Vehicles	10%	45.9	42.9	43.8	45.1	40.8	43.4	45.0	50.0	49.1	51.0
	25%	42.9	40.2	41.0	42.2	*38.3*	40.6	42.1	46.7	45.9	47.7
	50%	*37.2*	*35.1*	*35.7*	*36.7*	*33.6*	*35.5*	*36.6*	40.3	*39.7*	41.2
Do Nothing (results from Table 6)	n/a	**47.7**	**44.5**	**45.5**	**46.9**	**42.4**	**45.1**	**46.8**	**52.0**	**51.0**	**53.0**

[a] Italicised values fall below the objective.

8 Summary

8.1 Nitrogen dioxide concentrations within two existing Air Quality Management Areas (AQMAs) have been assessed by both monitoring and dispersion modelling. The results show that the annual mean nitrogen dioxide objective was exceeded during 2005 within both the Reigate High Street and Blackhorse Lane AQMAs.

8.2 The results of the detailed modelling predict exceedences within the Blackhorse Lane AQMA and beyond the boundary of the existing Reigate High Street AQMA. It is therefore recommended that:

- The Blackhorse Lane AQMA should remain in its present form and monitoring should continue;
- Additional diffusion tube monitoring should be carried out at a number of additional locations in London Road, Castlefield Street and West Street in order to more accurately define concentrations; and
- The Reigate High Street AQMA should be extended to include, as a minimum, all residential properties within the predicted area of exceedence.

8.3 A reduction in the volume of traffic around each AQMA is predicted to result in a decrease in the concentrations of nitrogen dioxide within each AQMA, however a reduction in total vehicle numbers of greater than 50% would be required to achieve the annual mean air quality objective at all modeled receptor locations in 2005.

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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 using the data presented in Table A2.1, and 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 A number of additional diffusion tube monitoring sites were established during 2005. This resulted in data from these sites not being available for a full calendar year. Therefore these data have been adjusted to an annual mean based on the ratio of concentrations during the short-term monitoring periods to those over a full calendar year at four sites where long-term data are available, in accordance with the guidance in LAQM.TG(03). 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 relevant 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 the Overall Factor for each short-term monitoring period.

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**
4/10/05-3/1/06	32.5	56.3	34.7	38.0	-
Adjustment factor	**0.81**	**0.95**	**0.84**	**0.90**	**0.87**

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 11 km south of the Reigate High Street AQMA and 13 km south of the Blackhorse Lane AQMA.

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 primarily determined from the 2005 Surrey Traffic Model. Annual average vehicle speeds have been estimated based on speed restrictions and the proximity to junctions. Manual classified counts carried out at locations around Reigate High Street in 2002 were used to determine proportions of each vehicle category, whilst hourly count data (March 2005) measured close to the Blackhorse Lane AQMA were used to determine diurnal profiles for the north and south bound carriageways of the A217. Model input parameters are presented in Tables A4.1, A4.2 and A4.3.

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 diffusion tube monitoring sites within each 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 monitoring locations using the NOx to NO_2 calculator available on the Air Quality Archive website[2].

Step 2 The contribution of the road to this total concentration 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 For each of the two study areas, 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 – for example a concentration derived from a diffusion tube location where measurements had been made over the entire 2005 period was given twice the weighting of a concentration determined from a five month monitoring period.

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.

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

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

Reigate High Street AQMA

Primary adjustment factor: 8.10

Secondary adjustment factor: 0.97

Blackhorse Lane AQMA

Primary adjustment factor: 12.94

Secondary adjustment factor: 0.92

A4.8 Comparisons of how the modelled nitrogen dioxide concentrations compare to the actual measured diffusion tube concentrations at the monitoring locations within each study area, once both adjustment factors have been applied, are shown in Figures A4.1 and A4.2.

Source Apportionment

A4.9 Traffic count data measured in 2002 for roads around the Reigate High Street AQMA have been used to determine the proportion of vehicles for each of the vehicle categories listed below. These proportions were then applied to the total modelled traffic flows for 2005 to give flow data for each category. The categories assessed are:

Cars

Light Goods Vehicles (LGV)

Heavy Goods Vehicles (HGV)

Public Service Vehicles (PSV)

Motorcycles (MCL)

A4.10 Traffic count data available from the National Atmospheric Emissions Inventory (NAEI, 2006) for 2000, for the A217 close to the Blackhorse Lane AQMA have been used to determine the

proportion of HGVs passing the AQMA. This proportion has been applied to the AADT data from the Surrey Traffic Model to allow source apportionment to be carried out.

A4.11 Concentrations at each receptor have been modelled for each vehicle category independently. The total NO_2 concentration was initially apportioned to background and road components. The road NO_2 component was then further apportioned into source categories according to the relative contribution of each source to the total road NOx.

Table A4.1: AQQuIRE traffic input parameters for the Reigate High Street AQMA.

Road	Category	Peak hour flow	Speed (kph)	HGV (%)
Bell St South Southbound	Car	408	48	0
	LGV	10		0
	HGV	2		100
	PSV	1		0
	MCL	1		0
Bell St South Northbound	Car	462	48	0
	LGV	11		0
	HGV	3		100
	PSV	2		0
	MCL	1		0
Bell St North	Car	398	48	0
	LGV	48		0
	HGV	25		100
	PSV	7		0
	MCL	3		0
London Road	Car	1038	64	0
	LGV	115		0
	HGV	66		100
	PSV	13		0
	MCL	10		0
West St Westbound	Car	870	32	0
	LGV	106		0
	HGV	42		100
	PSV	7		0
	MCL	6		0
High St East	Car	1196	40	0
	LGV	156		0
	HGV	67		100
	PSV	9		0
	MCL	12		0
Church St East Westbound	Car	319	32	0
	LGV	39		0
	HGV	21		100
	PSV	5		0
	MCL	4		0
Church St East Eastbound	Car	28	40	0
	LGV	3		0
	HGV	2		100
	PSV	0		0
	MCL	0		0

Road	Category	Peak hour flow	Speed (kph)	HGV (%)
Church St centre	Car	1342	48	0
	LGV	164		0
	HGV	88		100
	PSV	20		0
	MCL	15		0
Castlefield St	Car	1034	64	0
	LGV	128		0
	HGV	69		100
	PSV	16		0
	MCL	12		0
West St Eastbound	Car	657	32	0
	LGV	68		0
	HGV	41		100
	PSV	7		0
	MCL	6		0
Church St West	Car	1342	48	0
	LGV	162		0
	HGV	77		100
	PSV	15		0
	MCL	14		0
Bancroft Road	Car	546	64	0
	LGV	16		0
	HGV	6		100
	PSV	1		0
	MCL	1		0
High St West	Car	1201	48	0
	LGV	150		0
	HGV	68		100
	PSV	12		0
	MCL	10		0
Park Lane Southbound	Car	94	48	0
	LGV	10		0
	HGV	2		100
	PSV	0		0
	MCL	0		0
Park Lane Northbound	Car	143	40	0
	LGV	13		0
	HGV	2		100
	PSV	1		0
	MCL	0		0
Safeways Wetsbound	Car	101	40	0
	LGV	11		0
	HGV	6		100
	PSV	2		0
	MCL	1		0
Safeways Eastbound	Car	37	40	0
	LGV	1		0
	HGV	0		100
	PSV	0		0
	MCL	0		0
London Rd – Castlefield Rd	Car	101	40	0
	LGV	12		0
	HGV	7		100
	PSV	2		0
	MCL	1		0

Road	Category	Peak hour flow	Speed (kph)	HGV (%)
Castlefield Rd – Church St	Car	1006	40	0
	LGV	124		0
	HGV	67		100
	PSV	15		0
	MCL	12		0
High St – London Rd	Car	381	40	0
	LGV	47		0
	HGV	25		100
	PSV	6		0
	MCL	4		0
High St – Park Lane	Car	820	32	0
	LGV	103		0
	HGV	42		100
	PSV	6		0
	MCL	6		0
Park Lane – West St	Car	870	32	0
	LGV	106		0
	HGV	42		100
	PSV	7		0
	MCL	6		0

An average diurnal profile for 2004 was taken from Traffic statistics provided by the DfT (www.dft.gov.uk/transtat/roadtraff)

Table A4.2: AQQuIRE traffic input parameters for the Blackhorse Lane AQMA.

Road	Category	Peak hour flow	Speed (kph)	HGV (%)
A217 North Southbound	Car	1131	64	0
	HGV	50		100
A217 South Southbound	Car	1163	64	0
	HGV	51		100
A217 North Northbound	Car	1659	64	0
	HGV	73		100
A217 South Northbound	Car	1719	64	0
	HGV	75		100
Blackhorse Lane Eastbound	Car	115	32	0
	HGV	5		100
Blackhorse Lane Westbound	Car	194	32	0
	HGV	9		100

Table A4.3: Diurnal profile data for AQQuIRE modelling of Blackhorse Lane AQMA.

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24
1	0.09	0.04	0.03	0.04	0.08	0.14	0.36	0.78	0.68	0.67	0.65	0.69	0.73	0.70	0.73	0.83	0.96	1.00	0.85	0.57	0.34	0.25	0.20	0.15
2	0.09	0.05	0.03	0.02	0.04	0.12	0.50	0.96	0.97	0.81	0.67	0.68	0.69	0.67	0.67	0.73	0.87	1.00	0.83	0.58	0.36	0.24	0.22	0.16
3	0.09	0.06	0.05	0.06	0.09	0.2	0.48	0.91	1.00	0.82	0.77	0.77	0.79	0.81	0.84	0.91	1.03	1.06	0.86	0.6	0.42	0.31	0.23	0.16

Profile 1: A217 Southbound, derived from automatic count data, March 2005

Profile 2: A217 Northbound, derived from automatic count data, March 2005

Profile 3: Blackhorse Lane. An average diurnal profile for 2004 was taken from Traffic statistics provided by the DfT (www.dft.gov.uk/transtat/roadtraff)

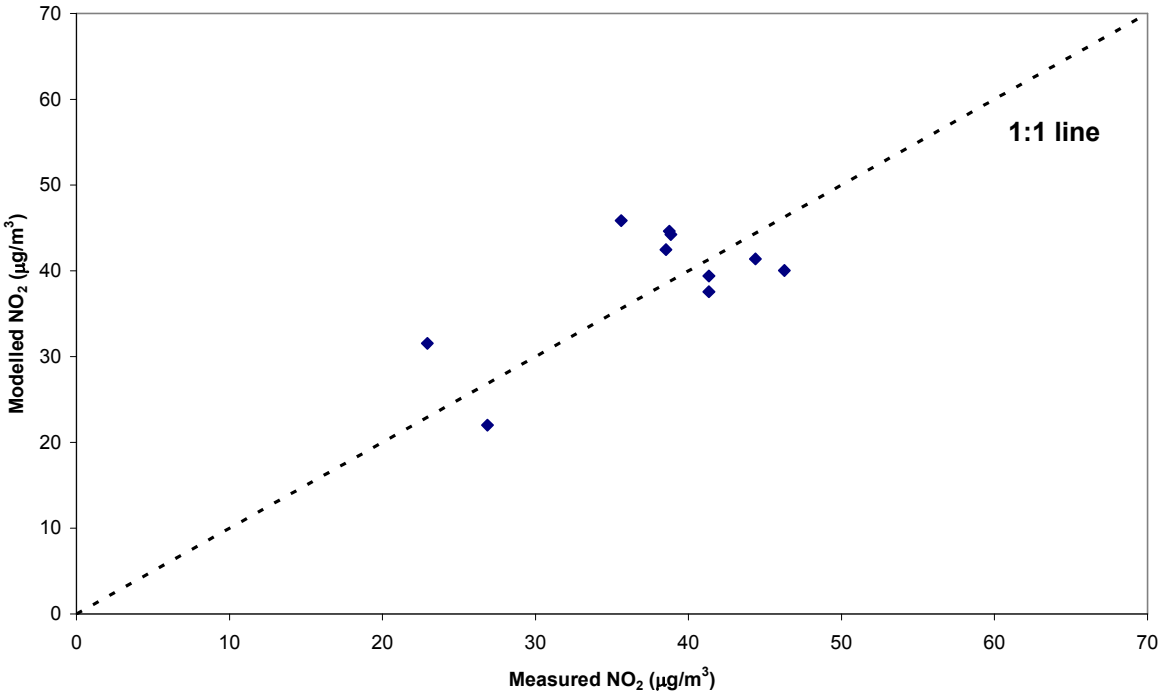

Figure A4.1: Comparison of measured nitrogen dioxide concentrations to fully adjusted modelled concentrations at each of the monitoring locations, within the Reigate High Street AQMA.

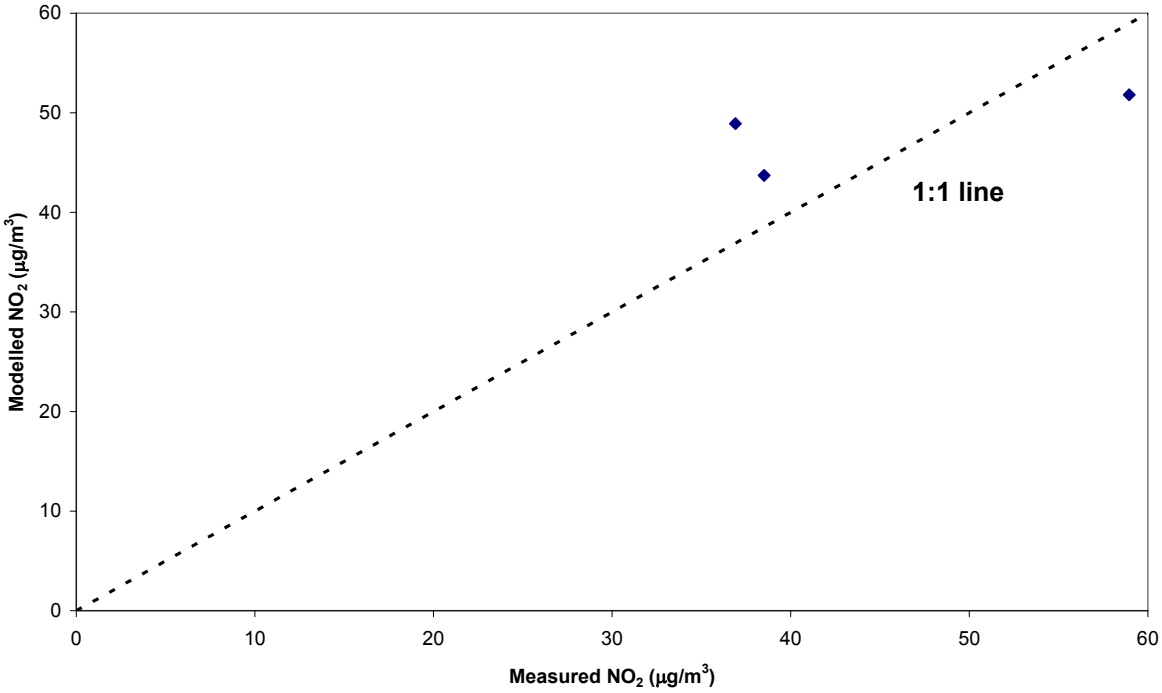

Figure A4.2: Comparison of measured nitrogen dioxide concentrations to fully adjusted modelled concentrations at each of the monitoring locations, within the Blackhorse Lane AQMA.