Detailed Assessment of Air Quality in Hooley.

June 2011

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

Document Control

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Job Number	J1229

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Document Status and Review Schedule

Report No.	Date	Status	Reviewed by
1229/1/F3	17th May 2011	Final Report	Prof. Duncan Laxen

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Contents

Reigate and Banstead Borough Council confirms that it accepts the recommendations made in this report.

1 Introduction

1.1 Air Quality Consultants Ltd has been commissioned by Reigate and Banstead Borough Council (RBBC) to undertake a Detailed Assessment of air quality in Hooley. The study area is shown in Figure 1. In 2010 the Council completed a Progress Report which concluded that a Detailed Assessment was required due to measured exceedences of the annual mean nitrogen dioxide objective (RBBC, 2010). The aim of this Detailed Assessment is to determine whether the air quality objectives are being exceeded at locations with relevant exposure and if so, the extent of the Air Quality Management Area required.

Background

1.2 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Defra, 2007) sets 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 air quality in their areas. The role of this process is to identify areas where it is unlikely that the air quality objectives will be achieved. These locations must be designated as Air Quality Management Areas (AQMAs) and a subsequent Air Quality 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, second and third rounds of Review and Assessment, with the forth round underway.

1.4 Technical Guidance for Local Air Quality Management (LAQM.TG(09)) (Defra, 2009) sets out a phased approach to the Review and Assessment process. This prescribes an initial Updating and Screening Assessment (USA), which all local authorities must undertake. It is based on a checklist to identify any matters that have changed since the previous round. If the USA identifies any areas where there is a risk that the objectives may be exceeded, which were not identified in the previous 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 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; 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 local air quality.

The Air Quality Objectives

1.6 The Government's Air Quality Strategy (Defra, 2007) provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. 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. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. 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). Table 1 summarises the objectives which are relevant to this report. Appendix A1 provides a brief summary of the health effects of nitrogen dioxide.

1.7 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 some 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 concentration is greater than 60 $\mu g/m^3$ (Defra, 2009). 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 objective.

Table 1: Air Quality Objectives for Nitrogen Dioxide

Pollutant	Time Period	Objective
Nitrogen Dioxide	1-hour mean	200 $\mu g/m^3$ not to be exceeded more than 18 times a year
	Annual mean	40 $\mu g/m^3$

2 Assessment Methodology

Monitoring

2.1 Monitoring for nitrogen dioxide is carried out using passive diffusion tube at two locations in Hooley. The monitoring sites are shown in Figure 1. The diffusion tubes are prepared and analysed by Lambeth Scientific Services using 50% TEA Acetone. It is necessary to adjust diffusion tube data to account for laboratory bias. RBBC has co-located triplicate diffusion tubes with three of its automatic monitoring sites: Michael Crescent (RG1), The Crescent (RG2), and Poles Lane (RG3). Results from these three local surveys have been combined using orthogonal regression[1]. The adjustment factor for 2010 calculated in this way was 1.050 (further details available in RBBC, 2011).

Modelling

2.2 Annual mean nitrogen dioxide concentrations within the study area have been assessed using detailed dispersion modelling (ADMS-Roads v3). ADMS Roads is one of the dispersion models accepted for modelling within the Government's Technical Guidance (Defra, 2009). The model requires the user to provide various input data, including the Annual Average Daily Traffic (AADT) flow, the proportion of heavy duty vehicles (HDVs), road characteristics (including road width and street canyon height, where applicable), and the vehicle speed. Vehicle emissions are calculated within ADMS-Roads (v3) using this information and emission factors from the Emission Factor Toolkit (EFT, Version 4.2.2) published by Defra (Defra, 2011). A full year of hour-by-hour meteorological data from Gatwick Airport in 2010 was used in the model. The model outputs have been verified against the diffusion tube measurements described in paragraph 2.1. Sources not included explicitly in the model were accounted for using the national maps of ambient background concentrations published by Defra (Appendix A2; Defra, 2011).

2.3 AADT flows, and the proportions of HDVs, for Brighton Road have been determined from the interactive web-based map provided by the Department for Transport (DfT, 2011). The 2009 AADT flows were factored forwards to 2010, 2015 and 2020 using growth factors derived from the National Transport Model and associated guidance (DfT, 2007), adjusted to local conditions using the TEMPRO System v6.2 (DfT, 2009). Traffic speeds have been estimated from local speed restrictions and take account of the proximity to a junction. Traffic data used in this assessment are summarised in Appendix A2.

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1 Using the same method as is used in Defra's national co-location database.

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 have an intrinsic margin of error. Defra (2009) suggests that this is of the order of plus or minus 20% for diffusion tube data, provided that appropriate QA/QC procedures are applied. The model results rely on measured and projected traffic data which has its own inherent uncertainty. 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 the emissions per vehicle conform to the factors published in Defra's Emission Factor Toolkit (EFT V4.2.2); it has been assumed that wind conditions measured at Gatwick Airport during 2010 will occur throughout the study area, 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 (see Appendix A3 for details of the model verification).

2.5 Predicting pollutant concentrations in future years will always be subject to greater uncertainty. For obvious reasons, the model cannot be verified in the future, and it is necessary to rely on a series of projections as to what will happen to background pollutant concentrations, and to vehicle emissions. These projections are based on emission factors published by DfT.

2.6 Recently however, a disparity between the road transport emission projections and measured annual mean concentrations of nitrogen oxides and nitrogen dioxide has been identified by Defra (Carslaw et al, 2011). This applies across the UK, although there is considerable inter-site variation. Whilst the emission projections suggest that both annual mean nitrogen oxides and nitrogen dioxide concentrations should have fallen by around 15-25% over the past 6 to 8 years, at many monitoring sites levels have remained relatively stable, or have even shown a slight increase.

2.7 The precise reason for this disparity is not known, but is thought to be related to the actual on-road performance of diesel vehicles when compared to the calculations based on the Euro standards. It may therefore be expected that nitrogen oxides and nitrogen dioxide concentrations will not fall as quickly in future years as the current projections indicate. However, at this stage, there is no robust evidence upon which to carry out any revised predictions.

2.8 The implications for this assessment are that the nitrogen dioxide concentrations predicted in 2015 and 2020 may be higher than shown, although these concentrations should still be lower than those predicted for 2010.

3 Results

Monitoring

3.1 There are two diffusion tube monitoring sites within the Hooley study area (Figure 1). Monitoring commenced at these sites in 2009, and data for 2009 and 2010 are presented in Table 2. The annual mean concentrations are approaching or exceeding 60 µg/m^3 indicating a likely exceedence of the hourly mean objective, as well as the annual mean objective. Concentrations decreased at RB136 in 2010, but increased at RB137. There is not enough data available to draw any conclusion regarding trends at these locations.

Table 2: Annual Mean Nitrogen Dioxide Concentrations Measured at the Diffusion Tube Site on Reigate Hill (µg/m^3)

Site	Site Description	2009[a]	2010[b]
RB136	Lamp post 09766, outside 45, Brighton Road, Hooley	**66.3**	**64.7**
RB137	Lamp post 09761, opposite 23, Brighton Road, Hooley	**59.7**	**63.0**
Objective		**40**	

[a] Bias adjusted using a local factor of 1.014.

[b] Bias adjusted using a local factor of 1.050.

Modelling

3.2 Predicted annual mean nitrogen dioxide concentrations in 2010, 2015 and 2020 at each of the receptor locations shown in Figure 2 are set out in Appendix A4. In 2010, the annual mean objective is predicted to be exceeded at a large number of receptors within the study area. In addition, a number are also predicted to experience concentrations exceeding 60 µg/m^3, and the hourly mean nitrogen dioxide objective is thus at risk of being exceeded at these locations. Concentrations at receptors in Star Lane, those set back from Brighton Road, and those located close to Church Lane at the southern end of the study area (Receptors 33 and 35) are predicted to be below 40 µg/m^3 in 2010.

3.3 By 2015 and 2020, Defra expects a range of measures introduced at national and international levels to have reduced road traffic emissions and background air pollution levels. Thus, concentrations predictions for 2015 and 2020 are lower than those for 2010, and a smaller number of exceedences are predicted. By 2015, there are no predicted concentrations exceeding 60 µg/m^3, and thus the hourly mean objective is unlikely to be exceeded at any location. Concentrations remain above 40 µg/m^3 at a number of receptors in both 2015 and 2020. The limitations to the assessment set out in the uncertainty section should, however, be borne in mind when considering the results set out in the following sections.

3.4 Figures 3, 4 and 5 show concentration isopleths along Brighton Road in 2010, 2015 and 2020. In 2010, the annual mean objective is predicted to be exceeded at those properties closest to Brighton Road and the junction with Star Lane. The hourly mean objective is likely to be exceeded at those properties which are closest to Brighton Road, in particular, close to the Star Lane junction. By 2020, the area of exceedence of the annual mean objective is significantly smaller, with only two properties (Receptors 3 and 4) which are the closest to Brighton Road (on the east side of the road) near the junction with Star Lane.

3.5 The 40 $\mu g/m^3$ exceedence contour in each figure extends beyond the edges of the study area. North of the study area, there is a break in the properties and beyond this, properties are set further back from the road. South of the study area, properties are set further back from the road, and monitoring exists at the closest property which confirms there are no exceedences of the annual mean objective at this location.

4 Conclusions and Recommendations

4.1 A Detailed Assessment of nitrogen dioxide concentrations along Brighton Road in Hooley has been carried out. This area was identified as being at risk of exceeding the annual and hourly mean nitrogen dioxide objectives in the Council's 2010 Progress Report. The Detailed Assessment has been carried out using a combination of measurements and detailed dispersion modelling, with the model results verified against the measurements.

4.2 The assessment has identified locations where the annual mean nitrogen dioxide objective is being exceeded at locations of relevant exposure, and also where the hourly mean nitrogen dioxide objective is also likely to be exceeded, within Hooley. It is therefore recommended that the Council declares an AQMA for both the annual and hourly objectives. This should cover, as a minimum, the area shown in Figure 3 where locations with relevant exposure lie within the 40 $\mu g/m^3$ contour. A more precautionary approach would be to ensure that the area shown as exceeding 36 $\mu g/m^3$ in Figure 3 is declared in order to account for potential model uncertainty.

4.3 Reigate and Banstead Borough Council propose to declare the AQMA based on the 32 $\mu g/m^3$ contour in order to account for model uncertainty, including the disparity between the actual and theoretical performance of diesel vehicles.

5 References

Carslaw, D, Beevers, S, Westmoreland, E and Williams, M, 2011. Trends in NOx and NO_2 emissions and ambient measurements in the UK. Available at: http://uk-air.defra.gov.uk/library/reports?report_id=645

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

Stationery Office, 2002. 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.
NOx	Nitrogen oxides (taken as NO + NO_2)
NO	Nitric Oxide
NO_2	Nitrogen dioxide.
$\mu g/m^3$	Microgrammes per cubic metre.
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, 2009).
HDV	Heavy Duty Vehicle
LDV	Light Duty Vehicle

7 Figures

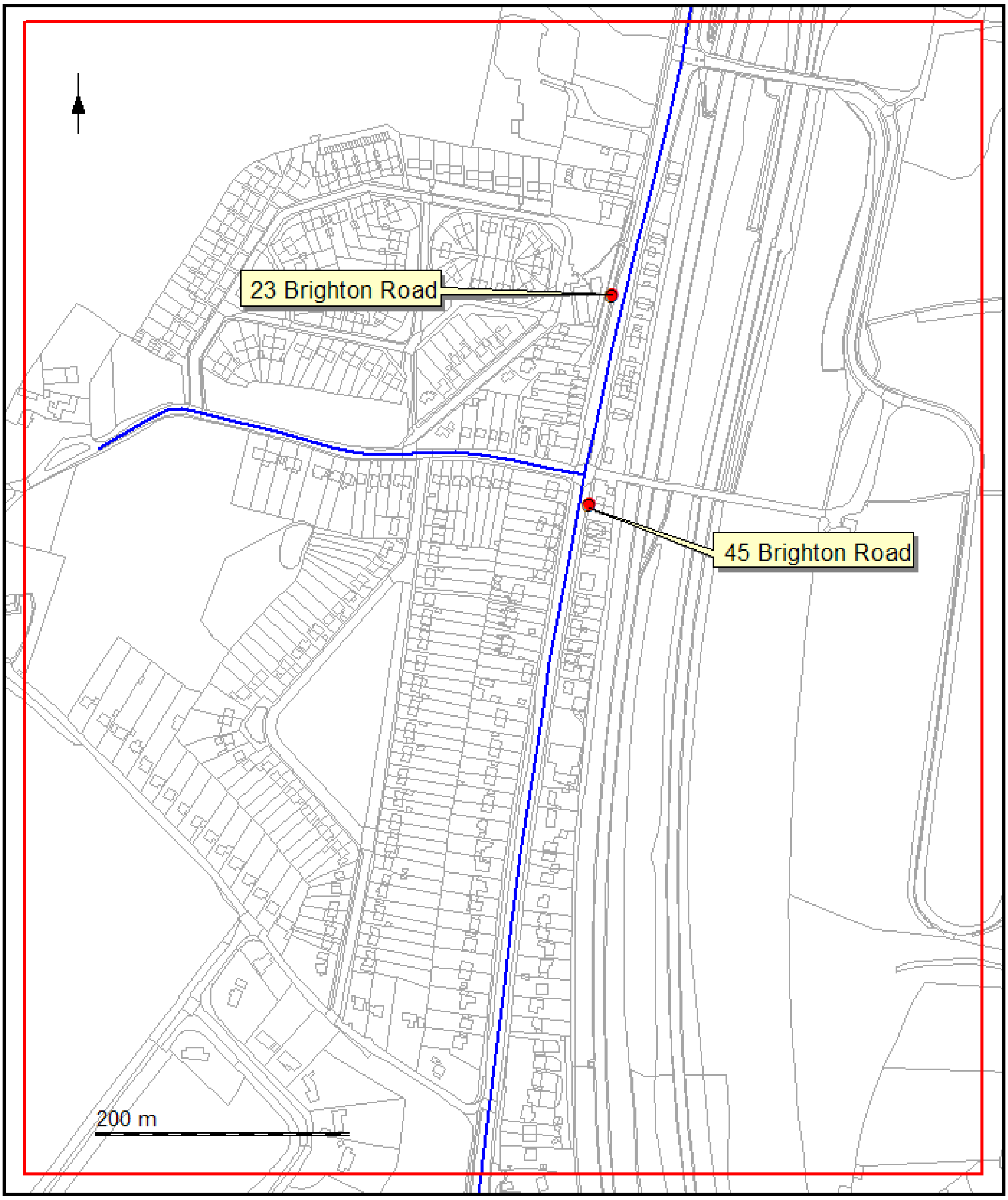

Figure 1: Hooley Study Area (red line) and Diffusion Tube Locations (red dots). Blue lines are those roads included in dispersion modelling. © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

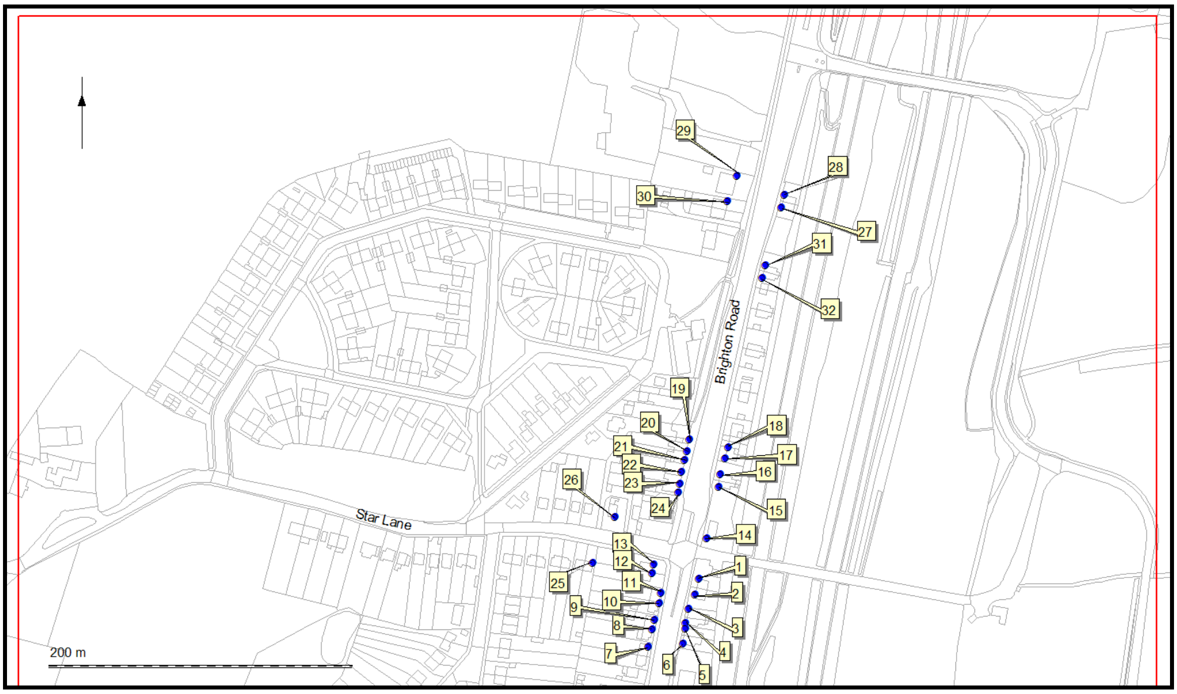

Figure 2a: Receptor Locations © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

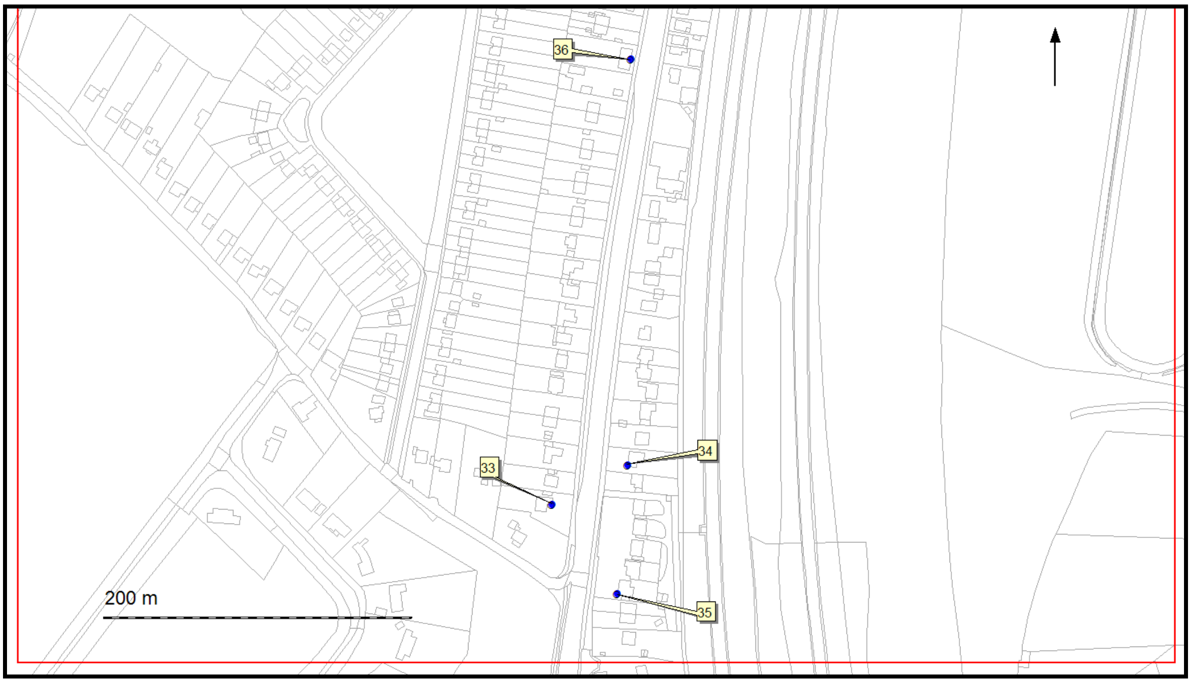

Figure 2b: Receptor Locations © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

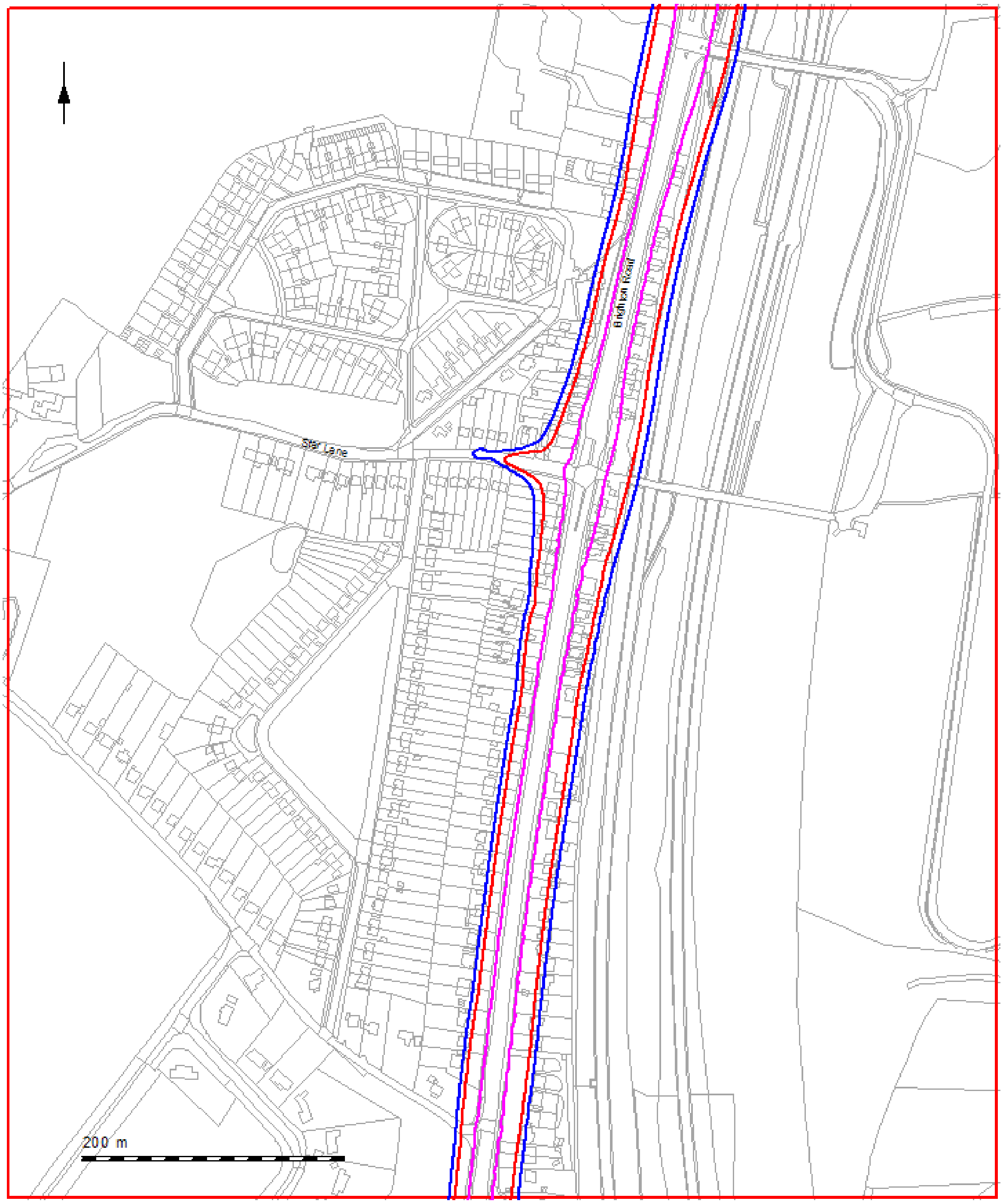

Figure 3: Nitrogen Dioxide Concentration Contours 2010. The red line represents the 40 µg/m^3 contour, purple 60 µg/m^3 and blue 36 µg/m^3. © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

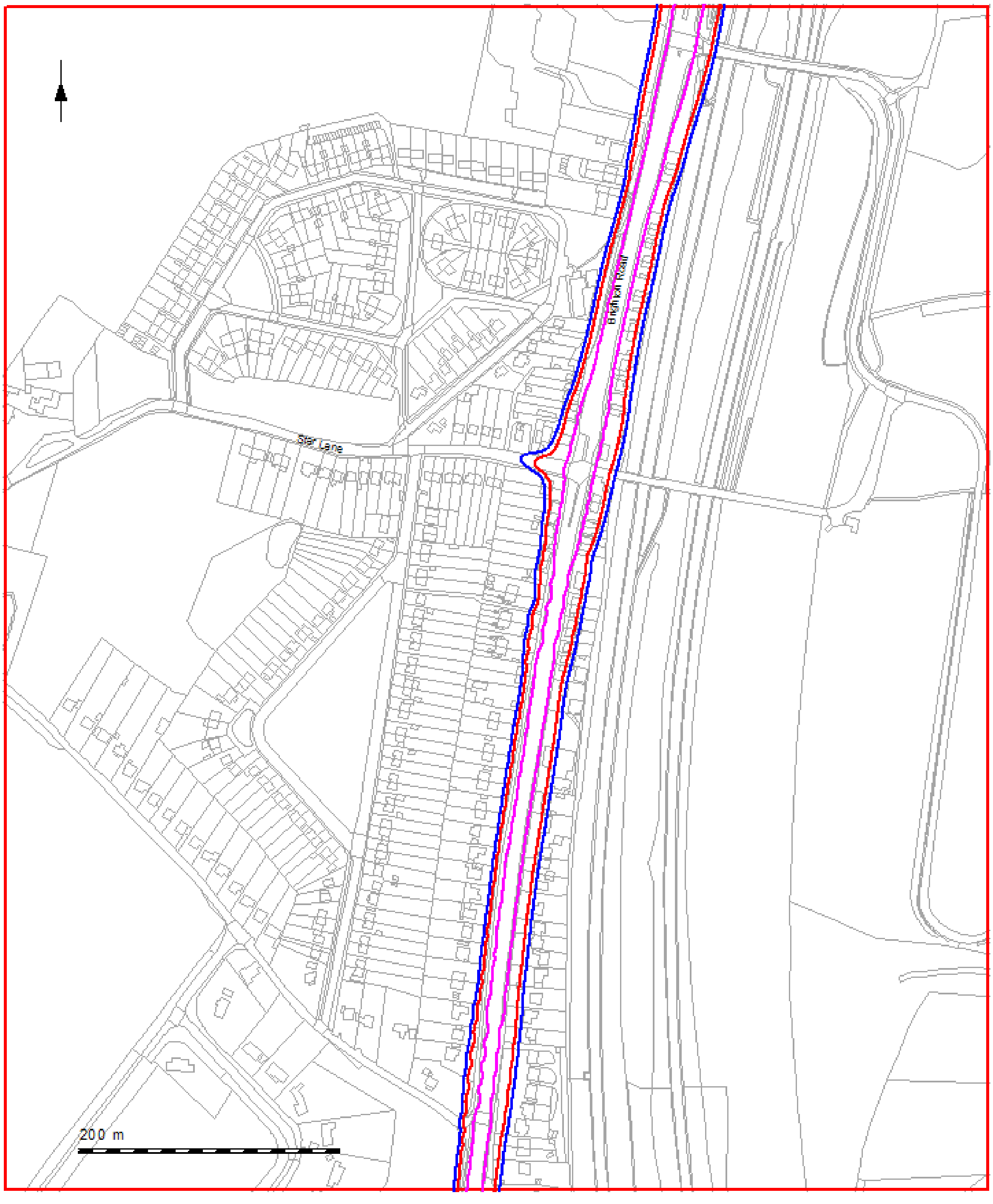

Figure 4: Nitrogen Dioxide Concentration Contours 2015. The red line represents the 40 µg/m^3 contour, purple 60 µg/m^3 and blue 36 µg/m^3. © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

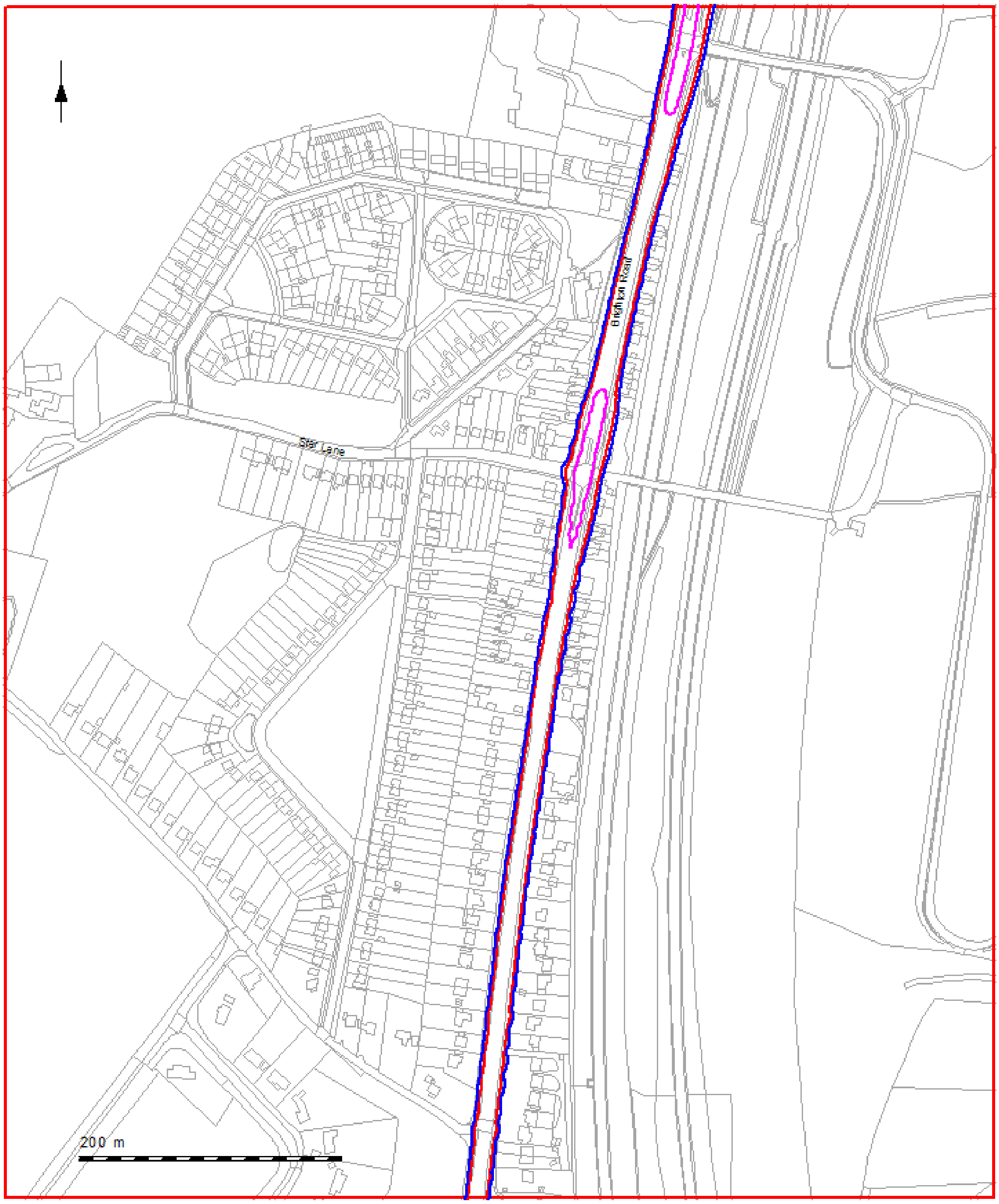

Figure 5: Nitrogen Dioxide Concentration Contours 2020. The red line represents the 40 µg/m^3 contour, purple 60 µg/m^3 and blue 36 µg/m^3. © Crown Copyright. Reigate & Banstead Borough Council. Licence no 100019405

A1 Appendix 1 – Summary of Health Effects of Nitrogen Dioxide

Table A1.1: 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, 2007).

A2 Appendix 2 – Traffic and Background Data

Traffic Data

A2.1 Traffic data used in the assessment and model verification are presented in Table A2.1.

Table A2.1: AADT Traffic Data[a]

Road Link	2010	2015	2020
Brighton Road north of Star Lane	32,714 (5.4%)	37,125 (5.4%)	40,001 (5.4%)
Brighton Road south of Star Lane	29,769 (5.4%)	33,783 (5.4%)	36,400 (5.4%)
Star Lane	5,000 (5.4%)	5,703 (5.4%)	6,144 (5.4%)

[a] Values in parentheses are proportion Heavy Duty Vehicles.

Background Concentrations

A2.2 Background concentrations for the study area have been taken from the national maps of background concentrations available from the Defra LAQM Support website (Defra, 2011), and are presented in Table A2.2.

Table A2.2: Background Concentrations within the Study Area

	NOx	NO_2
2010	18.5 – 21.3	13.3 – 15.1
2015	14.7 – 16.4	10.8 – 12.0
2020	11.5 – 12.4	8.6 – 9.3

A3 Appendix 3 – Model Verification

A3.1 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2). The model has been run to predict the annual mean road-NOx concentration during 2010 at diffusion tube sites RB136 and RB137, at a height of 2 m.

A3.2 The model output of road-NOx (i.e. the component of total NOx coming from road traffic) has been compared with the 'measured' road-NOx. Measured road-NOx was calculated from the measured NO_2 concentration and the predicted background NO_2 concentration using the NOx from NO_2 calculator available on the Air Quality Archive website (Defra, 2011).

A3.3 A primary adjustment factor was determined as the slope of the best fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure A3.1). This factor was then applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations. The total nitrogen dioxide concentrations were then determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration using the NOx from NO_2 calculator (Defra, 2011). A secondary adjustment factor was finally calculated as the slope of the best fit line applied to the adjusted data and forced through zero (Figure A3.2).

A3.4 The following primary and secondary adjustment factors have been applied to all modelled nitrogen dioxide data:

- Primary adjustment factor : 6.049
- Secondary adjustment factor: 1.019

A3.5 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 adjustment is minor.

A3.6 Figure A3.3 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows a 1:1 relationship.

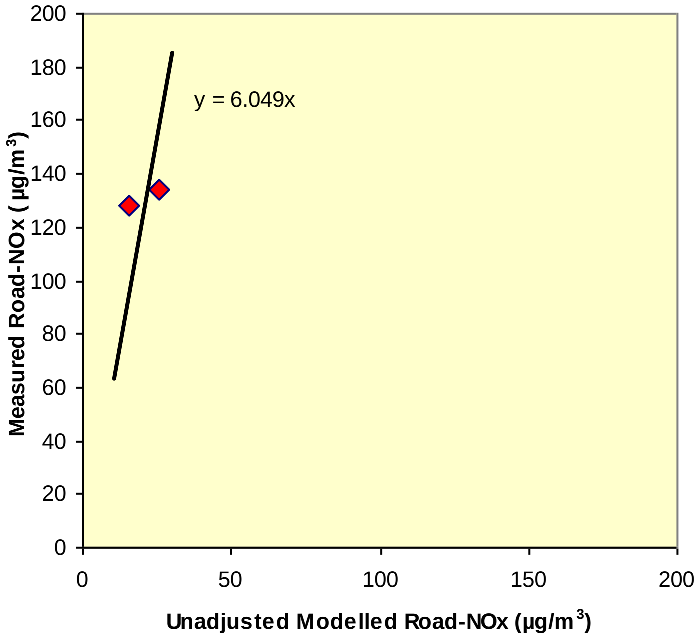

Figure A3.1: Comparison of Measured Road-NOx to Unadjusted Modelled Road-NOx Concentrations

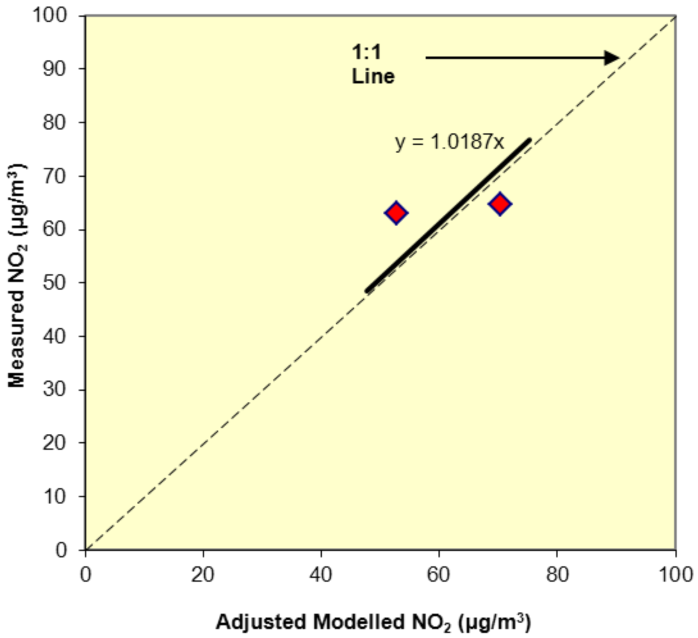

Figure A3.2: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations

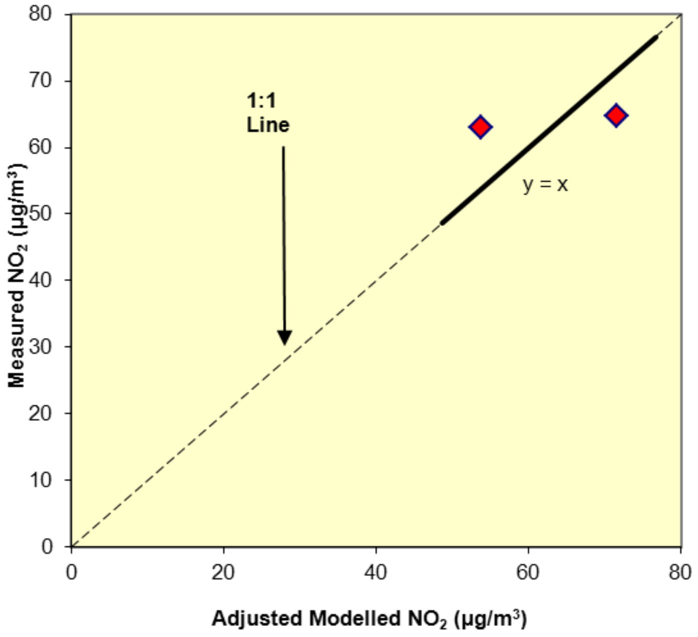

Figure A3.3: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations

A4 Appendix 4 – Results

Table A4.1: Modelled Annual Mean Nitrogen Dioxide Concentrations (µg/m³)

Receptor	2010	2015	2020
1	**63.8**	**53.9**	38.1
2	**63.3**	**53.5**	37.8
3	**69.6**	**59.4**	**42.2**
4	**67.8**	**57.8**	**41.1**
5	**65.7**	**55.7**	39.6
6	**61.9**	**52.2**	37.1
7	**54.3**	**45.1**	32.0
8	**58.1**	**48.7**	34.4
9	**59.5**	**50.0**	35.3
10	**63.3**	**53.6**	37.9
11	**63.5**	**53.7**	38.0
12	**50.3**	**41.5**	29.1
13	**52.0**	**43.1**	30.3
14	**65.5**	**55.6**	39.4
15	**64.0**	**54.2**	38.4
16	**64.0**	**54.1**	38.4
17	**60.4**	**50.8**	36.0
18	**58.2**	**48.7**	34.6
19[a]	38.9	31.3	22.1
20[a]	39.5	31.8	22.5
21[a]	**40.1**	32.3	22.8
22[a]	**40.7**	32.8	23.2
23[a]	**42.0**	33.9	23.9
24[a]	**42.5**	34.4	24.2
25	30.9	24.7	17.6
26	34.4	27.6	19.6
27	**61.3**	**51.7**	37.1
28	**61.6**	**52.0**	37.3
29	39.7	32.0	22.8

Receptor	2010	2015	2020
30	37.7	30.3	21.6
31	**60.2**	**50.6**	36.2
32	**61.2**	**51.6**	36.9
33	35.1	28.1	20.1
34	**40.6**	32.7	23.4
35	38.1	30.5	21.7
36	**47.6**	39.0	27.8
Objective	**40**		

[a] Receptors predicted at a height of 1.5 m to represent ground-floor exposure, except Receptors 19 – 24 for which concentrations have been predicted at a height of 4.5 m to represent first-floor exposure (above shops).