Detailed Assessment of Air Quality at the Two Gates Crossroads, Tamworth

Tamworth Borough Council

Report for Tamworth Borough Council

Ricardo-AEA/R/ED58885
Issue Number 2
Date 06/11/2013

Customer:

Tamworth Borough Council

Customer reference:

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Ricardo-AEA reference:

Ref: ED58885- Issue Number 2

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Executive summary

Ricardo-AEA have been commissioned by Tamworth Borough Council to undertake a Detailed Assessment of Air Quality for The Two Gates Crossroads area in Tamworth. The assessment has been undertaken to investigate the potential scale and extent of exceedances of Air Quality Objectives in the study area. This Detailed Assessment will allow Tamworth Borough Council to decide whether or not an Air Quality Management Area is required at the location.

The modelling study, which has used the most recent traffic, monitoring and meteorological data for a calendar year of 2012 has indicated that annual mean NO_2 concentrations in excess of the objective are occurring at locations where relevant human exposure is present.

The exceedance area encompasses six residential properties on Dosthill Road; and one on Tamworth Road close to the Two Gates junction.

In light of this Detailed Assessment of Air quality which is based on the available monitoring data from 2012, Tamworth Borough Council should consider declaring an Air Quality Management Area at this time to include all areas of exceedance of the annual mean NO_2 objective predicted in this study.

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1 Introduction

Ricardo-AEA has been commissioned by Tamworth Borough Council to undertake a Detailed Assessment of Air Quality at the Two Gates Crossroads in Tamworth. The assessment has been undertaken to investigate the scale and extent of potential exceedances of the UK Air Quality Objectives for nitrogen dioxide (NO_2) within the study area. The Detailed Assessment will allow Tamworth Borough Council to establish if an Air Quality Management Area is required at this location.

1.1 Policy Background

The Environment Act 1995 placed a responsibility on UK Government to prepare an Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland. The most recent version of the strategy (2007) sets out the current UK framework for air quality management and includes a number of air quality objectives for specific pollutants.

The 1995 Act also requires that Local Authorities "Review and Assess" air quality in their areas following a prescribed timetable. The Review and Assessment process is intended to locate and spatially define areas where the AQS objectives are not being met. In such instances the Local Authority is required to declare an Air Quality Management Area (AQMA), carry out a Further Assessment of Air Quality, and develop an Air Quality Action Plan (AQAP) which should include measures to improve air quality so that the objectives may be achieved in the future. The timetables and methodologies for carrying out Review and Assessment studies are prescribed in Defra's Technical Guidance - LAQM.TG(09).

Table 1 lists the objectives relevant to this assessment that are included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the purposes of Local Air Quality Management (LAQM).

Table 1: NO_2 Objectives included in the Air Quality Regulations and subsequent Amendments for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective	
	Concentration	Measured as
Nitrogen dioxide	200 µg.m^{-3} not to be exceeded more than 18 times a year	1 hour mean
	40 µg.m^{-3}	annual mean

1.2 Locations where the objectives apply

When carrying out the review and assessment of air quality it is only necessary to focus on areas where the public are likely to be regularly present and are likely be exposed over the averaging period of the objective. Table 2 summarises examples of where air quality objectives for NO_2 should and should not apply.

Table 2: Examples of where the NO_2 Air Quality Objectives should and should not apply

Averaging Period	Pollutant	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	NO_2	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1-hour mean	NO_2	All locations where the annual mean objective applies. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks and railway stations etc. which are not fully enclosed. Any outdoor locations to which the public might reasonably be expected to have access.	Kerbside sites where the public would not be expected to have regular access.

1.3 Purpose of this Detailed Assessment

This study is a Detailed Assessment, which aims to assess the magnitude and spatial extent of any exceedances of the NO_2 objectives at locations where relevant human exposure may occur within the study area in Tamworth.

1.4 Overview of the Detailed Assessment

The general approach taken to this Detailed Assessment was:

- Collect and interpret data from previous Review and Assessment reports.
- Collect and analyse recent traffic, monitoring, meteorological and background concentration data for use in a dispersion modelling study.
- Use dispersion modelling to produce numerical predictions of NO_2 concentrations at points of relevant exposure.
- Use dispersion modelling to produce contour plots of NO_2 concentrations;

- Recommend if Tamworth Borough Council should declare an AQMA at any location within the study area in Tamworth and suggest its spatial extent.
- The modelling methodologies provided for Detailed Assessments outlined in Defra Technical Guidance LAQM.TG(09)[1] were used throughout this study.

1.5 Previous review and assessment work to date

Progress report 2007 and Progress Report 2008

Following recommendations made in Tamworth Borough Council's 2006 Updating and Screening assessment, measurement of NO_2 concentrations commenced in Dosthill Road near the Two Gates junction in 2007.

The Progress Report 2007 concluded that the site at Dosthill Road may exceed the AQS objective for annual mean NO_2 concentrations in 2007 based on the limited data available at that time.

The progress Report 2008 concluded that the measured NO_2 annual mean of 39µg.m^{-3} in 2007 was not in excess of the 40 µg.m^{-3} objective therefore it was not required to proceed to a Detailed Assessment at that time; however based on the measured annual mean being close to the objective, three additional diffusion tube were deployed at other sites close to the junction at the start of 2008.

2009 Updating and Screening assessment

The annual mean NO_2 concentrations measured during 2008 at some of the Two Gates crossroads exceeded the annual mean objective. These were not however at points of relevant exposure; when the annual mean concentration was calculated at the nearest receptors using the nitrogen dioxide fall off with distance calculator it was found that NO_2 annual mean objective was not exceeded. Based on the 2008 measurements it was concluded that there was no requirement to conduct a Detailed Assessment at that time.

Progress report 2010 and Progress report 2011

From the 2009 and 2010 diffusion tube measurements, Tamworth Borough Council concluded that there was no requirement at that time to conduct a Detailed Assessment.

Updating and Screening assessment 2012

Based on an annual mean NO_2 concentration in excess of the 40 µg.m^{-3} objective at the diffusion tube site on Dosthill road; and the site being is a similar distance from the road as the nearby row of residential properties; the report concluded that a Detailed Assessment of NO_2 was required at the Two Gates Crossroads.

[1] Local Air Quality Management Technical Guidance LAQM.TG(09), Defra, 2009

2 Detailed Assessment study area

The borough of Tamworth is located 14 miles (22km) north-east of Birmingham in the West Midlands. It lies immediately north-west of the busy M42 motorway and south of the A38 Trunk Road. The study location covered in this assessment is located within the area known locally as "Two Gates Crossroads" where the A51 and B5404 roads intersect. The junction is known to become busy during peak traffic periods and in recent years annual mean NO_2 concentrations in excess of the 40µg.m^{-3} objective have been measured at nearby roadside diffusion tube sites.

The study area mainly comprises of residential properties on the roads approaching the junction with some commercial properties present at the junction. This assessment will consider road traffic emissions where relevant exposure is present close to the road. The study area, including the roads modelled and the extent of the detailed assessment is presented in Figure 1 below. The size of the study area is approximately 370m by 1 km.

Figure 1: Detailed Assessment Study Area

3 Information used to support this assessment

3.1 Maps

Ordnance Survey based GIS data of the model domain and a road centreline GIS dataset were used in the assessment. This enabled accurate road widths and the distance of the housing to the kerb to be determined in ArcMap.

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3.2 Road traffic data

3.2.1 Average flow, speed and fleet split

Traffic count data collected by Staffordshire County Council were used for the assessment; this included annual counts with 24-hr resolution for the roads being modelled. Vehicle classification split data was not available for all of the roads modelled; the fleet split from a nearby DfT count location was applied to all roads modelled.

Appendix 1 summarises all of the traffic flow data used and the road links modelled.

It should be noted that traffic patterns in urban locations are complex and it is not possible to fully represent these in atmospheric dispersion models. By attempting to describe these complex traffic patterns using quite simple metrics (AADT, average speed and vehicle split composition) a degree of uncertainty is introduced into the modelling.

3.2.2 Congestion

The Two Gates crossroads junction is known to become busy during peak traffic periods. During congested periods average vehicle speeds reduce when compared to the daily average; the combination of slower average vehicle speeds and more vehicles lead to higher pollutant emissions during peak hours; it's therefore important to account for this when modelling vehicle emissions to estimate pollutant concentrations.

No queue observation data from traffic surveys was available for the assessment. As an alternative indicative method of observing local traffic patterns, real time traffic flows were observed a number of times using the traffic layer on Google maps[2]. The observations indicated that traffic becomes regularly congested or slow moving during the morning/evening and late afternoon/evening inter-peak periods on all of the intersecting roads at locations close to the junction.

The TG(09) guidance states that the preferred approach to representing the resulting increase in vehicle emissions during these peak periods is to calculate the emission rate for the affected roads for each hour of the day or week, on the basis of the average speeds and traffic flows for each hour of the day. The hourly specific emission rates can then be used to calculate a 24-hr diurnal emission

[2] Google (2013) www.maps.google.co.uk

profile which can be applied to that section of road. In this case an annual average diurnal profile of traffic flow across the study area was available from local count data but no hourly speed measurement data was available. Peak periods in traffic flow were accounted for in the model by applying the diurnal traffic flow profile to the average hourly emission rate. To account for speed reductions during congested period, average speeds were reduced at road sections where traffic congestion commonly occurs.

3.2.3 Emissions factors

The most recent version of the Emissions Factors Toolkit[3] (EFT V5.2c Jan 2013) release) was used in this assessment to calculate pollutant emissions factors for each road link modelled. The calculated emission factors were then imported in to the ADMS-Roads model.

Parameters such as traffic volume, speed and fleet composition are entered into the EfT, and an emissions factor in grams of NOx/kilometre/second is generated for input into the dispersion model. In the latest version of the EfT, NOx emissions factors previously based on DFT/TRL functions have been replaced by factors from COPERT 4 v8.1. These emissions factors were published in May 2011 through the European Environment Agency and are widely used for the purpose of calculating emissions from road traffic in Europe.

The latest version of the EFT also includes addition of road abrasion emission factors for particulate matter; and changes to composition of the vehicle fleet in terms of the proportion of vehicle km travelled by each Euro standard, technology mix, vehicle size and vehicle category.

Vehicle emission projections are based largely on the assumption that emissions from the fleet will reduce as newer vehicles are introduced. Any inaccuracy in the emissions factors contained in the EFT will be unavoidably carried forward into this modelling assessment.

3.3 Ambient monitoring

Tamworth Borough Council currently undertakes monitoring of NO_2 within the immediate study area at four roadside diffusion tube sites; background NO_2 concentrations are also measured at other nearby diffusion tube sites in Tamworth. Further details of these monitoring locations and recent measured concentrations are provided in Section 4.

3.4 Meteorological data

Hourly sequential meteorological data (wind speed, direction etc.) for 2012 from the Birmingham Airport site was obtained from a third party supplier and used for the modelling assessment. The meteorological measurement site is located approximately 19 km to the south of the study area and has good data quality for the period of interest.

Meteorological measurements are subject to their own uncertainty which will unavoidably carry forward into this assessment.

3.5 Background concentrations

Background NOx concentrations for a dispersion modelling study can be accessed from either local monitoring data conducted at a background site or from the Defra background maps[4]. The Defra background maps are the outputs of a national scale dispersion model provided at a 1km x 1km resolution and are therefore subject to a degree of uncertainty.

[3] http://laqm1.defra.gov.uk/documents/tools/EFT_Version_4_2.zip
[4] Defra (2012) http://laqm1.defra.gov.uk/review/tools/background.php (accessed September 2012)

In this case there is an urban background diffusion tube site located at 12 Brookside Way in Tamworth, which is located approximately 1.4 km west of the study area. NO_2 concentrations measured at this site are considered to be representative of the NO_2 attributable to local background sources in the area. An NO_2 annual mean concentration of 24 $\mu g.m^{-3}$ was measured during 2012 at this site. Using the Defra NOx to NO_2 calculator to convert the measured NO_2 annual mean to NOx, taking into account estimated regional background concentrations, derives a background total annual mean NOx concentration of 44.2 $\mu g.m^{-3}$ for the study area.

4 Monitoring data 2012

Tamworth Borough Council currently undertakes monitoring of NO_2 within the immediate study area at four roadside diffusion tube sites, and at nearby urban background diffusion tube sites. A map showing the location of the diffusion tube sites is presented in Figure 2.

Details of the NO_2 diffusion tube monitoring site and the annual mean NO_2 concentrations measured during 2012 are presented in Table 3.

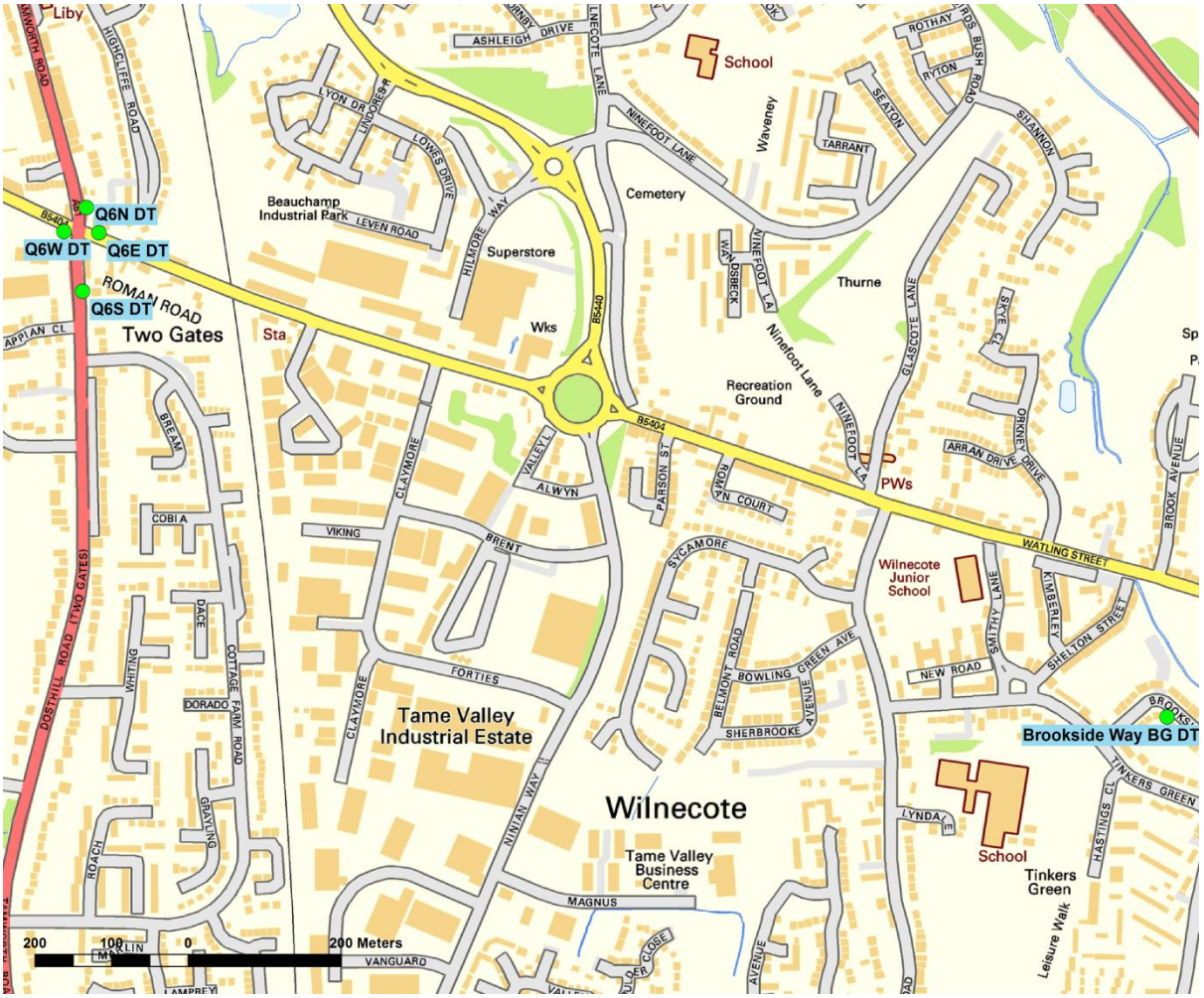
Annual mean NO_2 concentrations very close to, or in excess of, the 40 $\mu g.m^{-3}$ objective were measured during 2012 at all of the diffusion tubes located on the main roads in the study area. It should be noted that as the diffusion tubes are positioned at a greater height than ground level exposure (typically 1.5 m), and NO_2 concentrations tend to reduce with height as they disperse; it's likely that the concentrations at head height are greater than measured at 3m and above.

Full details of bias adjustment factors applied to the diffusion tube results and QA/QC procedures are presented in Appendix 4.

Table 3: NO_2 Diffusion tube measurements 2012

Site	Type	OS Grid Ref.		Approx. tube height (m)	Relevant exposure Y/N with distance (m)	Data Capture 2012 (%)	Bias corrected annual mean 2010 ($\mu g.m^{-3}$)
		Easting	Northing				
Q6S Dosthill Rd Two Gates	R	421588	301526	3	Yes – 12m	100 %	**42.6**
Q6W Watling St. Two Gates Club	R	421558	301605	3.2	No – 10m	100 %	39.8
Q6N Tamworth Rd. Two Gates	R	421580	301630	3.2	Yes – 15m	100 %	**40.6**
Q6E 440 Watling St.	R	421600	301600	3.3	Yes – 9m	100 %	**45.7**
12 Brookside Way	UB	423000	300970	3	Yes – 9m	100 %	24
	Exceedances of the annual mean objective are highlighted in **bold**						
	R – Roadside monitoring location, 1-5m from the kerb of a busy road UB – Urban Background, more than 50m from a busy road – residential						

Figure 2: Two Gates, Tamworth Diffusion Tube Locations



5 Modelling

5.1 Modelling methodology

Annual mean concentrations of NO_2 during 2012 have been modelled within the study area using the atmospheric dispersion model ADMS Roads (version 3.1).

The model was verified by comparing the modelled predictions of road NO_x with local monitoring results. The available roadside diffusion tube measurement within the study area (described in Section 4 above) were used to verify the annual mean road NOx model predictions.

Following initial comparison of the modelled concentrations with the available monitoring data, refinements were made to the model input to achieve the best possible agreement with the diffusion tube measurements. Further information on model verification is provided in Section 5.1.3 and Appendix 3.

A surface roughness of 1.5 m was used in the modelling to represent a large urban area in the model domain. A limit for the Monin-Obukhov length of 10 m was applied.

The source-oriented grid option was used in ADMS-Roads; this option provides finer resolution of predicted pollutant concentrations along the roadside, with a wider grid spaced at approximately 3.5 metres being used to represent concentrations further away from the road across the wider study area. The predicted concentrations were interpolated to derive values between the grid points using the Spatial Analyst tool in the GIS software ArcMap 10. This allows contours showing the predicted spatial variation of pollutant concentrations to be produced and added to the digital base mapping.

Queuing traffic was treated in the model using the methodology described in Section 3.2.2 above. A time varying emissions file was used in the model to account for daily variations in traffic flow.

It should be noted that any dispersion modelling study has a degree of uncertainty associated with it; all reasonable steps have been taken to reduce this where possible.

5.1.1 Treatment of modelled NOx road contribution

It is necessary to convert the modelled NOx concentrations to NO_2 for comparison with the relevant objectives.

The Defra NOx/NO_2 model[5] was used to calculate NO_2 concentrations from the NOx concentrations predicted by ADMS-Roads. The model requires input of the background NOx, the modelled road contribution and accounts for the proportion of NOx released as primary NO_2. For the Tamworth area in 2012 with the "All other UK urban Traffic" option in the model, the NOx/NO_2 model estimates that 22% of NOx is released as primary NO_2.

5.1.2 Validation of ADMS-Roads

Validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications; this is usually conducted by the model developer.

CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets, participating in EU workshops on short range dispersion models, comparing data between UK M4 and M25 motorway field monitoring data, carrying out inter-comparison studies alongside other modelling solutions such as DMRB and CALINE4, and carrying out comparison studies with monitoring data collected in cities throughout the UK using the extensive number of studies carried out on behalf of local authorities and Defra.

5.1.3 Verification of the model

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. This helps to identify how the model is performing at the various monitoring locations. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. LAQM.TG(09) recommends making the adjustment to the road contribution of the pollutant only and not the background concentration these are combined with.

The approach outlined in Example 2 of LAQM.TG(09) has been used in this case

The modelled NOx concentrations in this study were verified using the available kerbside and roadside diffusion tube site.

Following various refinements to the model input; the modelled Road NOx contribution required adjustment by an average factor of 1.022 to bring the predicted NO_2 concentrations within closer agreement of those results obtained from the monitoring data. This factor was applied to all Road NOx concentrations predicted by the model; the adjusted total NO_2 concentrations were then calculated using the Defra NOx/NO_2 calculator.

After the NOx/NO_2 model was run no further adjustments were made to the data. Model agreement for the NO_2 monitoring data after adjustment is presented in Table 4 and Figure 3. Full model verification data is provided in Appendix 3.

Model uncertainty can be estimated by calculating the root mean square error (RMSE). In this case the calculated RMSE was 0.7 $\mu g.m^{-3}$ after adjustment, which is within the suggested value (10% of the objective being assessed) in LAQM.TG(09). The model has therefore been assessed to perform sufficiently well for use within this assessment.

Verifying modelling data with diffusion tube monitoring data will always be subject to uncertainty due to the inherent limitations in such monitoring data (even data from continuous analysers has

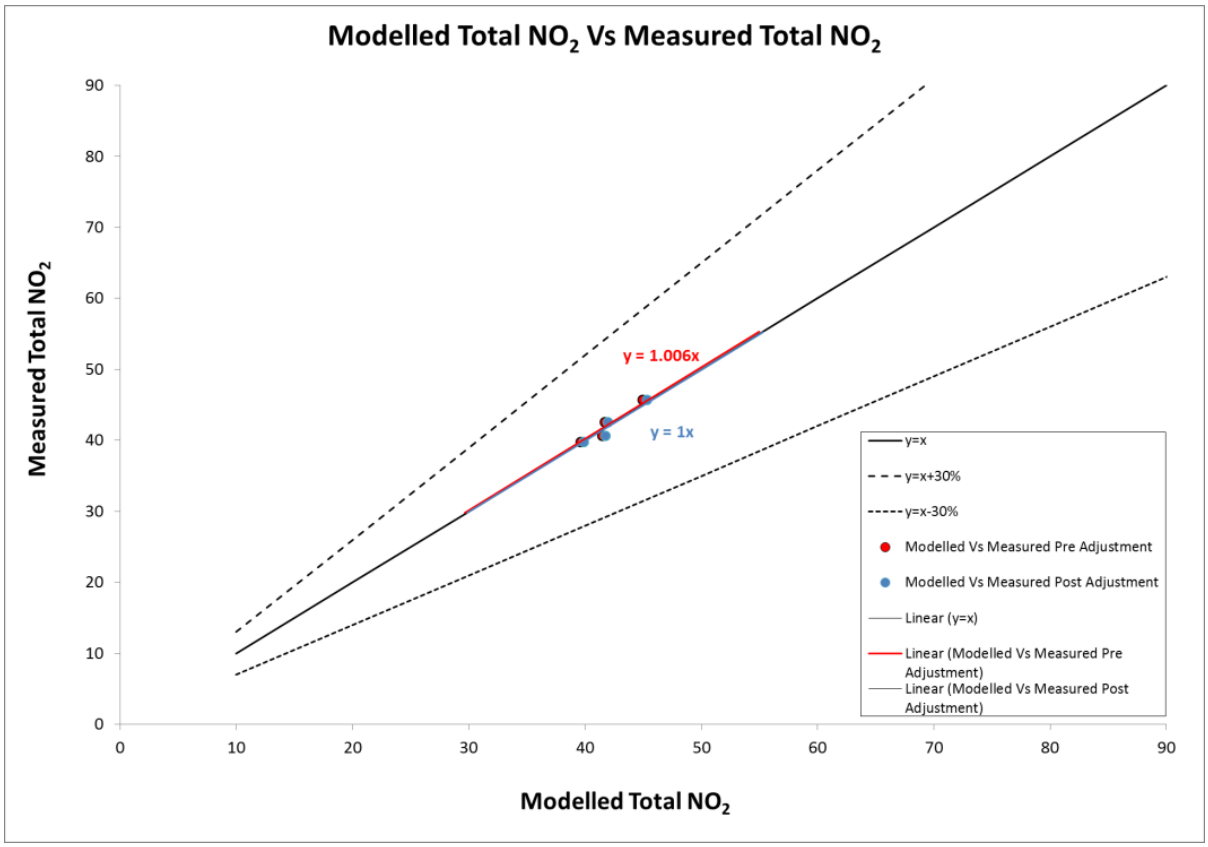
[5] Defra (2012) NOx NO_2 Calculator v3.2 released September 2012; Available at http://laqm.defra.gov.uk/tools-monitoring-data/no-calculator.html

notable uncertainty). The model results should be considered in this context. Further information on the verification process including the linear regression analysis is provided in Appendix 3.

Table 4: Modelled vs. measured annual mean NO_2 concentrations

Site	NO_2 annual mean concentration ($\mu g.m^{-3}$)	
	Measured	Modelled
Q6E 440 Watling St.	45.7	45.3
Q6N Tamworth Rd. Two Gates	40.6	41.8
Q6W Watling St. Two Gates Club	39.8	39.9
Q6S Dosthill Rd Two Gates	42.6	42.0
RMSE =		**0.69**

Figure 3: Linear regression analysis of modelled vs. monitored NO_2 annual mean



5.2 Modelling results

5.2.1 Model results at specified receptor locations

Annual mean NO_2 concentrations have been predicted at a selection of receptor locations within the study area. The receptors are located at the facade of residential buildings in the model domain where relevant exposure exists. The receptor locations selected are at the residential properties closest to the roads sources being modelled.

The receptors have been modelled at 1.5m height to represent ground level exposure. The predicted annual mean NO_2 concentrations at each of the specified receptors during 2012 are presented in Table 5. Maps representing the predicted annual mean NO_2 concentrations at the specified receptors using graduated colours are presented in Figure 4.

Annual mean NO_2 concentration in excess of the 40 $\mu g.m^{-3}$ objective were predicted at seven of the specified receptors all of which are located close to the crossroads junction on Dosthill Road, Tamworth Road and Watling Street. Three of the locations were however commercial properties where the annual mean objective does not apply.

Table 5: Predicted 2012 annual mean NO_2 concentrations at specified receptors

Receptor location	Receptor type	Height (m)	OS Grid reference		Annual mean NO_2 concentration ($\mu g.m^{-3}$)
			X	Y	
Tamworth Rd 1	Residential	1.5 m	421530	301851	35.8
Tamworth Rd 2	Residential	1.5 m	421543	301803	36.1
Tamworth Rd 3	Residential	1.5 m	421527	301787	33.4
Tamworth Rd 4	Residential	1.5 m	421558	301751	36.6
Tamworth Rd 5	Residential	1.5 m	421567	301718	37.1
Tamworth Rd 6	Residential	1.5 m	421549	301704	34.9
Tamworth Rd 7	Residential	1.5 m	421560	301666	37.0
Tamworth Rd 8	Residential	1.5 m	421580	301655	**41.6**
Bulls Head	Commercial	1.5 m	421567	301619	**48.9**
Harvest Showroom	Commercial	1.5 m	421591	301612	**50.8**
Dosthill Rd 1	Residential	1.5 m	421581	301572	**44.0**
Dosthill Rd 2	Residential	1.5 m	421581	301559	**42.5**
Dosthill Rd 3	Residential	1.5 m	421582	301548	**42.0**
Dosthill Rd 4	Residential	1.5 m	421595	301526	35.9
Fish Bar	Commercial	1.5 m	421619	301581	**40.4**
Watling St 1	Residential	1.5 m	421689	301570	39.6
Watling St 2	Residential	1.5 m	421704	301563	39.1
Watling St 3	Residential	1.5 m	421713	301559	38.8
Watling St 4	Residential	1.5 m	421703	301545	35.0
Watling St 5	Residential	1.5 m	421642	301570	37.9
Watling St 6	Residential	1.5 m	421497	301653	38.9
Watling St 7	Residential	1.5 m	421487	301658	38.5
Watling St 8	Residential	1.5 m	421475	301663	38.0
Watling St 9	Residential	1.5 m	421467	301667	37.5
Watling St 10	Residential	1.5 m	421456	301671	37.5
Watling St 11	Residential	1.5 m	421439	301679	37.0
Watling St 12	Residential	1.5 m	421429	301684	36.6
Watling St not in use	Residential	1.5 m	421670	301579	39.4

Figure 4: Predicted NO_2 annual mean concentrations at specified receptor Locations

N

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- 30 - 36
- 36 - 40
- 40 - 44
- 44 - 50
- 50 - 50.8

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5.2.2 Model results – contour plot

Contour plots showing the spatial variation of predicted annual mean NO_2 concentrations at ground level exposure height (1.5m) across the study area for each scenario modelled are presented in Figure 5 and Figure 6. The contour plots are created by interpolating predicted concentrations across a grid of discrete receptor points using the spatial analyst tool in ArcGIS. Figure 6 has been created using concentrations modelled across a finer resolution grid to provide a better indication of the spatial extent of predicted concentrations in excess of the objective at locations close to the crossroads.

The plots indicate that the main hotspots where high NO_2 annual mean concentrations are predicted are at roadside locations close to the junction; this includes the facades of residential properties on Dosthill Road and Tamworth Road. All other locations where the contour indicates that the objective is being exceeded are either at roadside locations where there are no buildings or at commercial properties where the annual mean objective does not apply as it not considered representative of relevant exposure. The contour indicates that annual mean NO_2 concentrations in excess of the objective occurred at seven residential properties within the study area during 2012; this equates to a population exposure of approximately 16 people based on an average household occupancy[6] of 2.3.

The results should be considered in context with the various uncertainties associated with the modelling process and the error (RMSE) of 0.7 $\mu g.m^{-3}$ calculated in the model verification process.

[6] Office for National Statistics (2013) Population and Household Estimates for the United Kingdom March 2011

Figure 5: Predicted spatial variation in annual mean NO_2 concentrations at 1.5m height

N

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- < 30
- 30 - 36
- 36 - 40
- 40 - 44
- 44 - 50
- 50 - 59.1

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Figure 6: Predicted annual mean NO_2 concentrations at 1.5m height - finer resolution at crossroad

N

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- < 30
- 30 - 36
- 36 - 40
- 40 - 44
- 44 - 50
- 50 - 59.1

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6 Conclusion

A dispersion modelling study of road traffic emission in the area around the Two Gates Crossroads in Tamworth has been conducted to allow a detailed assessment of nitrogen dioxide concentrations at this location.

The modelling study, which used traffic, monitoring and meteorological data for a calendar year of 2012 has indicated that annual mean NO_2 concentrations in excess of the objective are occurring at seven residential properties on Dosthill Road and Tamworth Road close to the Two Gates junction.

In light of this Detailed Assessment of Air quality which is based on the available monitoring data from 2012, Tamworth Borough Council should consider declaring an Air Quality Management Area at this time to include all areas of exceedance of the annual mean NO_2 objective predicted in this study.

Appendices

Appendix 1: Traffic Data

Appendix 2: Meteorological dataset

Appendix 3: Model Verification

Appendix 1 – Traffic data

Table A1.1 summarises the Annual Average Daily Flows (AADF) of traffic and fleet compositions used within the model for each road link. 2011 Annual counts with 24-hr resolution were provided by Staffordshire County Council. A local TEMPRO growth factor was applied to the count data to account for projected increase in traffic flows between 2011 and 2012. Fleet composition split data from 2011 was available from a DFT traffic count location approximately 1km south of Dosthill Road only; this fleet split has been applied across all road links modelled.

Table A1.1: Two Gates, Tamworth - Annual Average Daily Flows

Street	%Cars	%LGV	%HGV	%Bus	%2WM	AADF 2012
Dosthill Road	80.0	12.8	5.5	0.8	0.8	9308
Watling Street	80.0	12.8	5.5	0.8	0.8	15492
Atherstone Street	80.0	12.8	5.5	0.8	0.8	15492
Tamworth Road	80.0	12.8	5.5	0.8	0.8	12650

LGV – Light Goods Vehicles

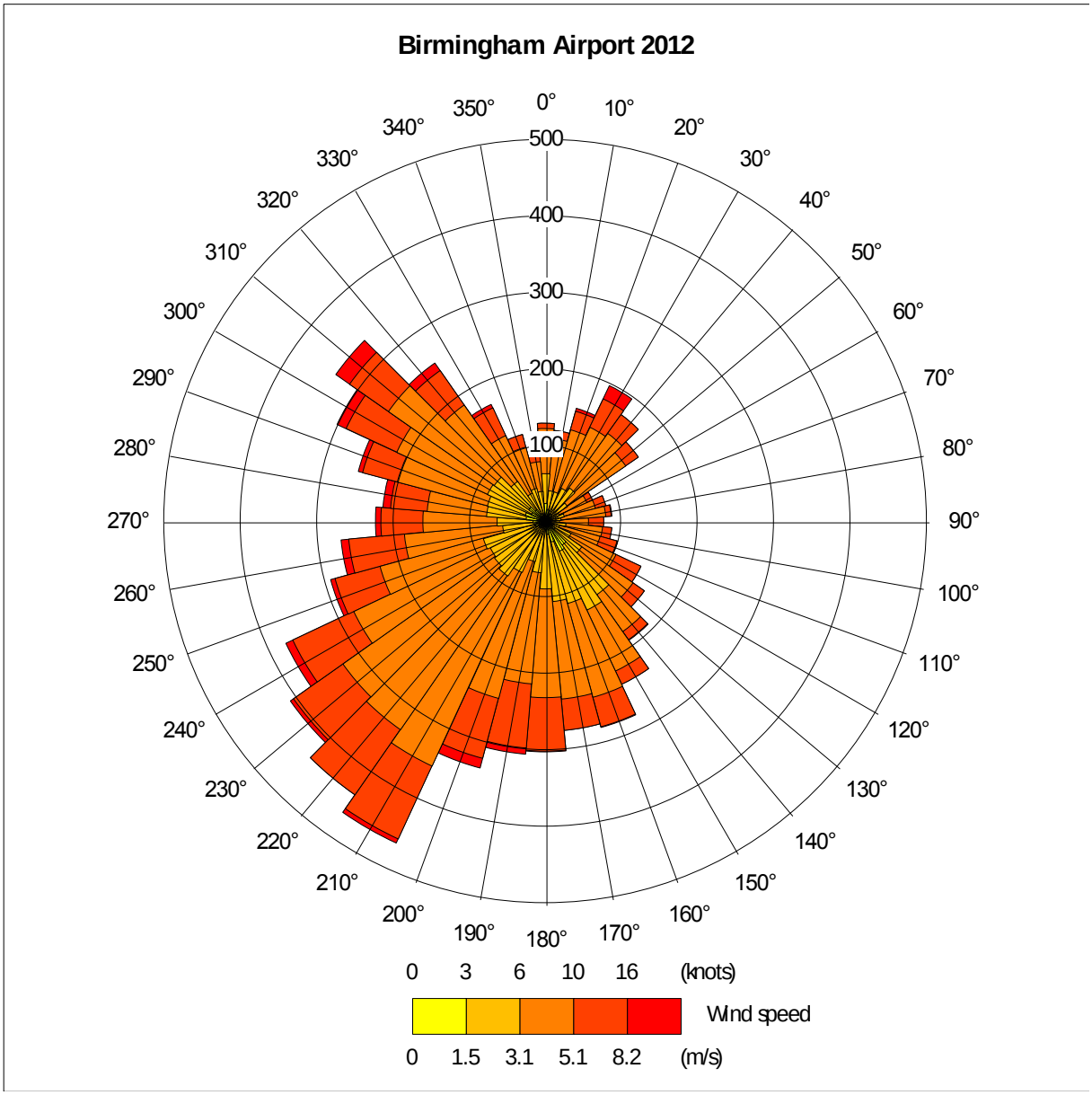
HGV – Heavy Goods Vehicles (Articulate and Rigid)

2WM - Motorcycles

Appendix 2 – Meteorological dataset

The Wind Rose for the 2012 Birmingham Airport meteorological dataset is presented in Figure A2.1

Figure A2.1 Meteorological dataset windrose



Appendix 3 – Model verification

Verification of the baseline model involves comparison of the modelled results with the available local monitoring data at relevant locations. This helps to identify how the model is performing at the various monitoring sites. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. This can be followed by adjustment of the modelled results if required. LAQM.TG(09) recommends making the adjustment to the road contribution only and not the background concentration these are combined with.

The approach outlined in Example 2 of LAQM.TG(09) has been used in this case.

It is appropriate to verify the ADMS Roads model in terms of primary pollutant emissions of nitrogen oxides (NO_x = NO + NO_2). The model has been run to predict annual mean Road NO_x concentrations during 2012 at the diffusion tube sites in the study area.

The model output of Road NO_x (the total NO_x originating from road traffic) has been compared with the measured Road NO_x, where the measured Road NO_x contribution is calculated as the difference between the total NO_x and the background NO_x value. Total measured NO_x for each diffusion tube was calculated from the measured NO_2 concentration using the 2012 version of the Defra NO_x/NO_2 calculator.

The initial comparison of the modelled vs measured Road NOx identified that the model was under-predicting the Road NOx contribution. Subsequently, various refinements were made to the model input to improve the overall model performance.

The gradient of the best fit line for the modelled Road NOx contribution vs. measured Road NOx contribution was then determined using linear regression and used as the adjustment factor. This factor was then applied to the modelled Road NOx concentration for each modelled point to provide adjusted modelled Road NOx concentrations. A linear regression plot comparing modelled and monitored Road NOx concentrations before and after adjustment is presented in Figure A3.1.

The background NOx concentration was then added to determine the adjusted total modelled NOx concentrations. The total annual mean NO_2 concentrations were then determined using the NOx/NO_2 calculator.

A primary adjustment factor (PAdj) of **1.022** was applied to all modelled Road NOx data prior to calculating an NO_2 annual mean. A plot comparing modelled and monitored NO_2 concentrations before and after adjustment during 2012 is presented in Figure A3.2.

Figure A3.1: Comparison of unadjusted modelled Road NO_x Vs Measured Road NO_x

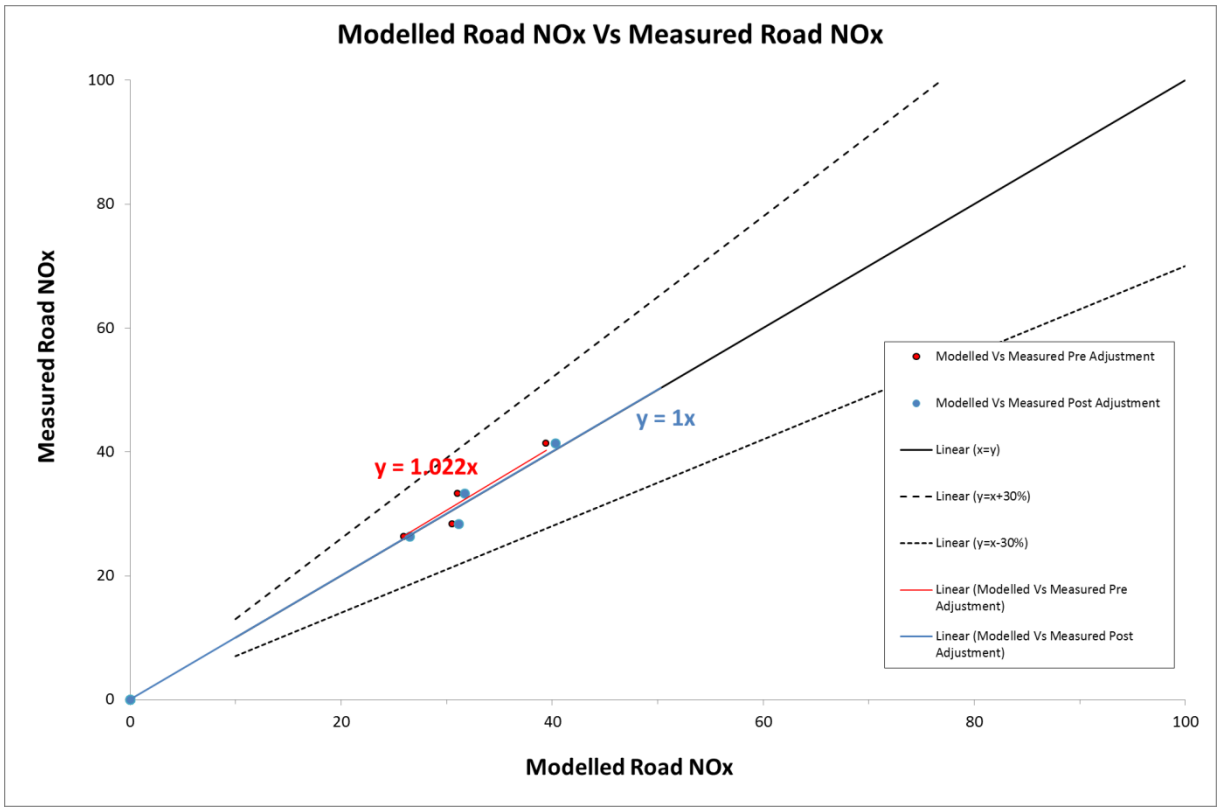
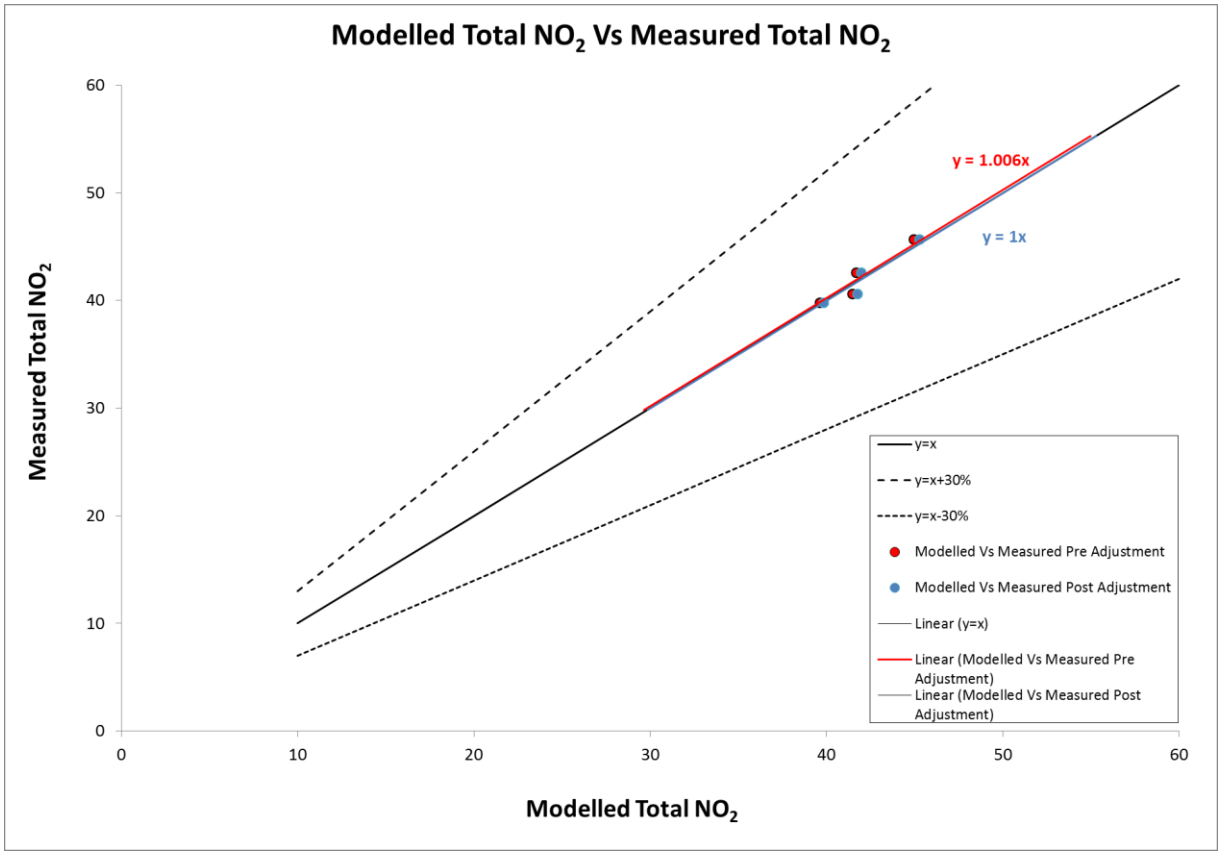


Figure A3.2: Linear regression analysis of modelled vs. monitored NO_2 annual mean



To evaluate the model performance and uncertainty, the Root Mean Square Error (RMSE) for the observed vs. predicted NO_2 annual mean concentrations was calculated, as detailed in Technical Guidance LAQM.TG(09), Box A3.7, Appendix 3. The calculated RMSE is presented in Table A3.1.

It is recommended that the RMSE is below 25% of the objective that the model is being compared against, but ideally under 10% of the objective i.e. 4 $\mu g.m^{-3}$ (NO_2 annual mean objective of 40 $\mu g.m^{-3}$). In this case the RMSE is calculated at 0.7 $\mu g.m^{-3}$, the model uncertainty is therefore considered acceptable and the model has performed sufficiently well for use within this assessment.

Table A3.1: Station Hill, Farnham model - Root mean square error

Site	NO_2 annual mean concentration ($\mu g.m^{-3}$)	
	Measured	Modelled
Q6E 440 Watling St.	45.7	45.3
Q6N Tamworth Rd. Two Gates	40.6	41.8
Q6W Watling St. Two Gates Club	39.8	39.9
Q6S Dosthill Rd Two Gates	42.6	42.0
RMSE =		**0.69**

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