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1 Introduction

1.1. Proposed Development

1.1.1 Air Quality Assessments Ltd (AQA) has been commissioned by AAA Property Group Ltd to undertake an air quality assessment for the proposed residential development at land off of Upper Hoyland Road, Barnsley. The proposed development would provide up to 19 new dwellings. The application site is shown in **Figure 1** on Page 8.

1.1.2 The application site lies approximately 2km to the east of an Air Quality Management Area (AQMA) that covers the M1 motorway, declared by Barnsley Metropolitan Borough Council (MBC) for exceedances of the annual mean nitrogen dioxide (NO_2) objective.

1.2. Scope of Assessment

1.2.1 The number of additional vehicle trips on local roads due to the proposed development would be significantly less than the 100 annual average daily trips from indicative screening criteria to proceed to an air quality assessment, published by Environmental Protection UK and the Institute of Air Quality Management (IAQM) (EPUK and IAQM, 2017). Therefore, the impacts on local air quality due to emissions from traffic generated by the proposed development have been screened out of the assessment.

1.2.2 The new residential properties will be subject to the impacts of road traffic emissions from the adjacent road network. The main air pollutants of concern related to traffic emissions are NO_2 and fine particulate matter (PM_{10} and $PM_{2.5}$).

1.2.3 The assessment has been prepared taking into account all relevant local and national guidance and regulations.

1.2.4 The references and a glossary of common air quality terminology used in this assessment are shown in **Section 10** and **Section 11** respectively.

2 Air Quality Legislation and Policy

2.1. EU Limit Values

2.1.1 The European Union's Directive on ambient air quality and cleaner air for Europe (European Parliament, Council of the European Union, 2008) set legally binding limit values for NO_2, PM_{10} and $PM_{2.5}$. The Air Quality Standards Regulations 2010 (The Stationary Office, 2010) implement the EU Directive limit values in English legislation. Achievement of the limit values is a national obligation rather than a local one.

2.1.2 The limit values are the same as the objective values (see **Table 1**); however, the compliance dates differ, and the limit values apply at all locations (apart from where the public does not have access, where health and safety at work provisions apply and on the road carriageway). The PM_{10} and NO_2 limit value applied from 2005 and 2010 respectively, whereas the $PM_{2.5}$ limit value applied from 2015.

2.1.3 The United Kingdom left the European Union on 31st January 2020; however, the EU legislation currently remains enshrined in UK law through the Air Quality Standards Regulations.

2.2. Clean Air Strategy

2.2.1 Part IV of The Environment Act 1995 required the UK Government to prepare an Air Quality Strategy which includes standards and objectives for air quality and sets out measures which are to be taken by local authorities and the government in order to achieve those objectives. The Clean Air Strategy provides an overview of the actions that the government will take to improve air quality and promises new legislation that will tackle air pollution (Defra, 2019).

2.2.2 Standards are the concentrations of pollutants in the atmosphere, below which there is a minimum risk of health effects or ecosystem damage; they are set with regard to scientific and medical evidence. Objectives are the policy targets set by the Government, taking account of economic efficiency, practicability, technical feasibility and timescale, where the standards are expected to be achieved by a certain date.

2.2.3 Part IV of the Environment Act 1995 also describes the system of Local Air Quality Management (LAQM), which requires every local authority to carry out regular review and assessments of air quality in its area. Where an objective has not been, or is unlikely to be achieved, the local authority must declare an AQMA, and prepare an action plan which sets out appropriate measures to be introduced in pursuit of the objectives.

2.2.4 The objectives for NO_2 and PM_{10}, as prescribed by the Air Quality (England) Regulations 2000 and the Air Quality (England) (Amendment) Regulations 2002 (The Stationary Office, 2000; The Stationary Office, 2002), are shown in **Table 1**. The objectives for PM_{10} and NO_2 were to have been achieved by 2004 and 2005 respectively and continue to apply in all future years thereafter. The $PM_{2.5}$ objective, also shown in **Table 1**, is to be achieved by 2020; however, although local authorities have a flexible role in working towards reducing emissions and concentrations of $PM_{2.5}$, there is no obligation for local authorities to try to meet the $PM_{2.5}$ objective, and it is not included in the Regulations.

Table 1: The Objectives for NO_2, PM_{10} and $PM_{2.5}$

Pollutant	Concentration Measured As	Objective
NO_2	1-hour Mean	200 µg/m^3 not to be exceeded more than 18 times a year
	Annual Mean	40 µg/m^3
PM_{10}	24-hour Mean	50 µg/m^3 not to be exceeded more than 35 times a year
	Annual Mean	40 µg/m^3
$PM_{2.5}$	Annual Mean	25 µg/m^3

2.2.5 The objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. Examples of where the objectives should apply are provided in the Local Air Quality Management Technical Guidance (Defra, 2021a) issued by the Department for Environment, Food and Rural Affairs (Defra). The annual mean NO_2 and PM_{10} objectives should apply at the building façades of residential properties, schools, hospitals, care homes etc.; they should not apply at the building façades of places of work, hotels, gardens or kerbside sites. The 24-hour mean PM_{10} objective should apply at all locations where the annual mean objective applies, as well as the gardens of residential properties and hotels. The 1-hour mean NO_2 objective should apply at all locations where the annual and 24-hour mean objectives apply, as well as at kerbside sites where the public have regular access, e.g., the pavements of busy shopping streets.

2.3. Planning Policy

National Policies and Guidance

2.3.1 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied (Ministry of Housing, Communities & Local Government, 2021). It provides a framework within which locally prepared plans for development can be produced. At Paragraph 8c, the NPPF states that the purpose of the planning system is to contribute to the achievement of sustainable development and includes an overarching environmental objective:

"To protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy."

2.3.2 With regard to environmental impacts from traffic, at Paragraph 104 the NPPF states that:

"Transport issues should be considered from the earliest stages of plan-making and development proposals, so that: …

d) the environmental impacts of traffic and transport infrastructure can be identified, assessed and taken into account – including appropriate opportunities for avoiding and mitigating any adverse effects, and for net environmental gains; …"

2.3.3 The NPPF also states at Paragraph 174 that:

"Planning policies and decisions should contribute to and enhance the natural and local environment by: …

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; …"

2.3.4 The NPPF goes on to state at Paragraph 18:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development."

2.3.5 With specific reference to air quality, the NPPF states at Paragraph 186 that:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."

2.3.6 The NPPF also includes the following statement at Paragraph 188:

"The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a particular development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities."

2.3.7 The NPPF is supported by Planning Practice Guidance (PPG) (Ministry of Housing, Communities & Local Government, 2019). The PPG states that:

"Defra carries out an annual national assessment of air quality using modelling and monitoring to determine compliance with relevant Limit Values. It is important that the potential impact of new development on air quality is taken into account where

the national assessment indicates that relevant limits have been exceeded or are near the limit, or where the need for emissions reductions has been identified."

2.3.8 The PPG goes on to state that:

"Whether air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to have an adverse effect on air quality in areas where it is already known to be poor, particularly if it could affect the implementation of air quality strategies and action plans and/or breach legal obligations (including those relating to the conservation of habitats and species). Air quality may also be a material consideration if the proposed development would be particularly sensitive to poor air quality in its vicinity."

2.3.9 The PPG also sets out the information that may be required in an air quality assessment, stating that:

"Assessments need to be proportionate to the nature and scale of development proposed and the potential impacts (taking into account existing air quality conditions), and because of this are likely to be locationally specific."

2.3.10 It also provides guidance on options for mitigating air quality impacts, and makes clear that:

"Mitigation options will need to be locationally specific, will depend on the proposed development and need to be proportionate to the likely impact."

Local Policies

2.3.11 The Barnsley Local Plan includes the following policies relating to air quality and relevant to the proposed development (Barnsley MBC, 2019a).

2.3.12 Policy Poll1 Pollution Control and Protection states:

"Development will be expected to demonstrate that it is not likely to result, directly or indirectly, in an increase in air, surface water and groundwater, noise, smell, dust, vibration, light or other pollution which would unacceptably affect or cause a nuisance to the natural and built environment or to people.

We will not allow development of new housing or other environmentally sensitive development where existing air pollution, noise, smell, dust, vibration, light or other pollution levels are unacceptable and there is no reasonable prospect that these can be mitigated against.

Developers will be expected to minimise the effects of any possible pollution and provide mitigation measures where appropriate."

2.3.13 Policy AQ1 Development in Air Quality Management Areas states:

"Development which impacts on areas sensitive to air pollution in air quality management areas will be expected to demonstrate that it will not have a harmful effect on the health or living conditions of any future users of the development in terms of air quality (including residents, employees, visitors and customers), taking into account any suitable and proportionate mitigation required for the development.

We will only allow residential development which impacts on areas sensitive to air pollution, where the developer provides an assessment that shows living conditions will be acceptable for future residents, subject to any required mitigation.

We will only allow development which impacts on areas sensitive to air pollution which could cause more air pollution, where the developer provides an assessment that shows there will not be a significantly harmful effect on air quality, subject to any required mitigation.

Furthermore, development which impacts on areas sensitive to air pollution due to traffic emissions will be expected to demonstrate suitable and proportionate mitigation relative to the increased traffic emissions generated by the development."

Air Quality Action Plan

2.3.14 Barnsley MBC has developed an Air Quality Action Plan (AQAP) for its AQMAs, with actions that include traffic management, raising awareness of air quality issues, and the promotion and improvement of sustainable transport modes (Barnsley MBC, 2019b).

3 Methodology

3.1. Existing Conditions

3.1.1 Information on existing air quality within the study area has been collated from the following sources:

- The results of monitoring and the LAQM Air Quality Annual Status Reports undertaken by Barnsley MBC (Barnsley MBC, 2021);
- Background pollutant concentration maps published by Defra (Defra, 2021b). These cover the whole country on a 1 x 1 km grid.

3.2. Road Traffic Impacts

Modelling Methodology

3.2.1 Concentrations have been predicted using the ADMS Roads (v5.0.0.1) dispersion model (CERC, 2021). The model requires the input of a range of data, details of which are provided in **Appendix A1**, along with details of the model verification calculations.

Sensitive Locations

3.2.2 The masterplan for the proposed development has not been finalised; therefore, receptors have been identified at the application site boundary closest to the A6195 where the impact from existing road traffic emissions sources are likely to be greatest. The receptors are described in **Table 2** and are shown in **Figure 1**. Concentrations have been modelled at receptor heights of 1.5m to represent exposure at the ground floor level.

Table 2: Description of Receptors

Receptor	Location	OS Grid Ref		Height (m)
		x	y	
R1	Application Site Boundary	436221.4	401511.9	1.5
R2	Application Site Boundary	436188.3	401499.2	1.5
R3	Application Site Boundary	436155.2	401486.7	1.5

Assessment Scenarios

3.2.3 Concentrations of NO_2, PM_{10} and $PM_{2.5}$ have been predicted at the receptors assuming an opening year of 2022.

3.2.4 Concentrations have also been predicted at automatic monitoring sites CM1 and CM2 and diffusion tube monitoring sites 24, 25, 26, 27, 31 and 32 in 2019 in order to verify the model (see **Appendix A1**).

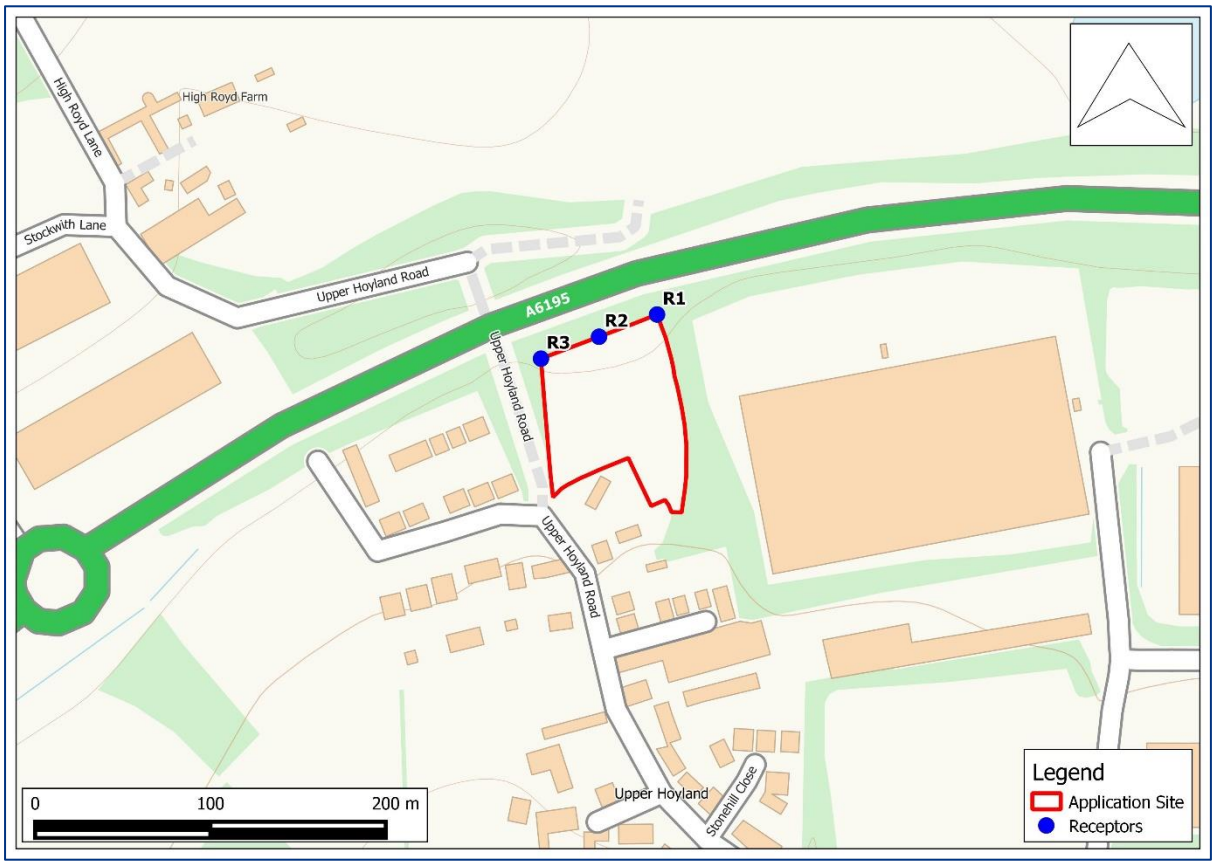

Figure 1: Location of Receptors
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Uncertainty

3.2.5 There are many factors that contribute to uncertainty when predicting pollutant concentrations. The emission factors utilised in the air quality model are dependent on traffic data, which have inherent uncertainties associated with them. There are also uncertainties associated with the model itself, which simplifies real world conditions into a series of algorithms. The model verification process, as described in **Appendix A1**, minimises the uncertainties; however, future year predictions use projected traffic data, emissions data, and background concentrations. The most recent emission factors and background data have been used in this assessment; however, there are still uncertainties associated with this data.

Assessment Criteria and Significance

3.2.6 There is no official guidance in the UK on how to describe air quality impacts, nor how to assess their significance. The approach suggested by Environmental Protection UK (EPUK) and the IAQM in guidance on Land-Use Planning & Development Control: Planning for Air Quality (EPUK and IAQM, 2017) has been used for this assessment.

3.2.7 A predicted exceedance of an air quality assessment level (AQAL) will be considered as significant, unless provision is made to reduce the exposure by some other means. Predicted concentrations below the AQALs will be considered as insignificant. The AQALs for NO_2 and $PM_{2.5}$ are based on the annual mean objectives (as shown in

Table 1). The AQAL for PM_{10} is an annual mean concentration of 32 µg/m^3 as measured data show that the 24-hour PM_{10} objective could be exceeded where annual mean concentrations are above 32 µg/m^3 (Defra, 2021a).

3.2.8 The determination of the significance of the effects includes elements of professional judgement and the professional experience of the consultant preparing the report is set out in **Appendix A2**.

4 Baseline Conditions

4.1. Site Description

4.1.1 The application site is currently an empty plot of land bounded by the A6195 to the north, commercial use to the east, Upper Hoyland Road and residential areas to the west and residential areas to the south.

4.2. LAQM Review and Assessment

4.2.1 Barnsley MBC has declared six AQMA for exceedances of the annual mean NO_2 objective; however, none of these areas are affected by the proposed development.

4.2.2 In terms of PM_{10}, Barnsley MBC has concluded that there are no exceedances of the objectives; therefore, it is highly unlikely concentrations in the vicinity of the application site exceed the objectives.

4.3. Local Air Quality Monitoring

4.3.1 Barnsley MBC operates three automatic monitoring sites and an NO_2 diffusion tube monitoring network. Data from diffusion tube monitoring sites located within 2km of the application site and the automatic monitoring sites used for model verification, are shown in **Table 3**, **Table 4** and **Table 5**, with the monitoring locations shown in **Figure 2** and **Figure 3**.

4.3.2 Measured annual mean kerbside/roadside NO_2 concentrations ranged from 23.6 to 44.8 µg/m^3 between 2016 and 2019, with exceedances measured at diffusion tube monitoring sites 25 and 26. There has been an overall decreasing trend in annual mean NO_2 concentrations, and by 2019 the maximum measured concentration was 40.3 µg/m^3 at diffusion tube monitoring site 26. Diffusion tube monitoring sites 25 and 26 are located within 2m of the kerb of the A61.

4.3.3 The low concentrations measured in 2020 are due to travel restrictions brought in to control the Covid-19 pandemic and would not be representative of the usual air quality.

4.3.4 Measurements across the UK have shown that there is a risk of exceedances of the 1-hour mean nitrogen dioxide objective where the annual mean concentration is above 60 µg/m^3; therefore, it is unlikely that the 1-hour mean objective has been exceeded at any of the diffusion tube monitoring sites. No exceedances of the 1-hour mean NO_2 limit value have been measured at the CM2 automatic monitoring site.

4.3.5 Measured PM_{10} concentrations have remained well below the objectives at the CM1 automatic monitoring site.

4.4. Background Concentrations

4.4.1 Estimated background concentrations at the application site are shown in **Table 6**. The background concentrations have been derived from data in the national maps published by Defra. The background concentrations are all well below the objectives.

Table 3: Measured Annual Mean NO_2 Concentrations [a]

Site ID	Location	Site Type [b]	Annual Mean (µg/m³)				
			2016	2017	2018	2019	2020
Automatic Monitor							
CM2	Barnsley A628	R	36	35	32	32	25
Diffusion Tubes							
24	A6135 Hoyland	K	32.5	40.0	30.2	30.3	20.6
25	A61 Sheffield Rd	R	**42.9**	**40.2**	34.3	38.6	26.0
26	A61 Sheffield Rd	R	**44.8**	**43.2**	**40.1**	**40.3**	25.7
27	A61 Sheffield Rd	R	39.5	38.6	39.1	39.8	23.9
28	Tankersley School	R	25.5	22.6	23.9	23.6	15.1
29	Moor Lane	UB	31.3	32.1	27.6	28.3	17.8
30	The Walk	R	32.6	36.2	29.5	33.4	20.1
31	Sheffield Rd	R	33.2	31.8	29.7	29.7	19.1
32	Sheffield Rd	R	37.9	38.5	32.8	35.5	23.0
Objective			**40**				

a Exceedances are shown in bold.
b R = Roadside, UB = Urban Background, K = Kerbside.

Table 4: Exceedance Statistics for the 1-hour Mean NO_2 Objective

Site ID	Location	Site Type [a]	Number of Hours > 200 µg/m³				
			2016	2017	2018	2019	2020
CM2	A628	R	2	4	0	0	0
Objective			**18**				

a R = Roadside.

Table 5: Summary of PM_{10} Monitoring Data

Site ID	Location	Site Type [a]	2016	2017	2018	2019	2020
Annual Mean (µg/m³)							
CM1	Barnsley A635	R	22	17	18	20	20
Objective			**40**				
Number of Days > 50 µg/m³							
CM1	Barnsley A635	R	11	5	5	11	3
Objective			**35**				

a R = Roadside.

Table 6: Estimated Annual Mean Background Concentrations in 2019 and 2022 (µg/m³)

Year	NOx	NO_2	PM_{10}	$PM_{2.5}$
2019	17.9	13.2	11.5	7.3
2022	15.7	11.7	11.1	6.9
Objective	-	**40**	**40**	**25**

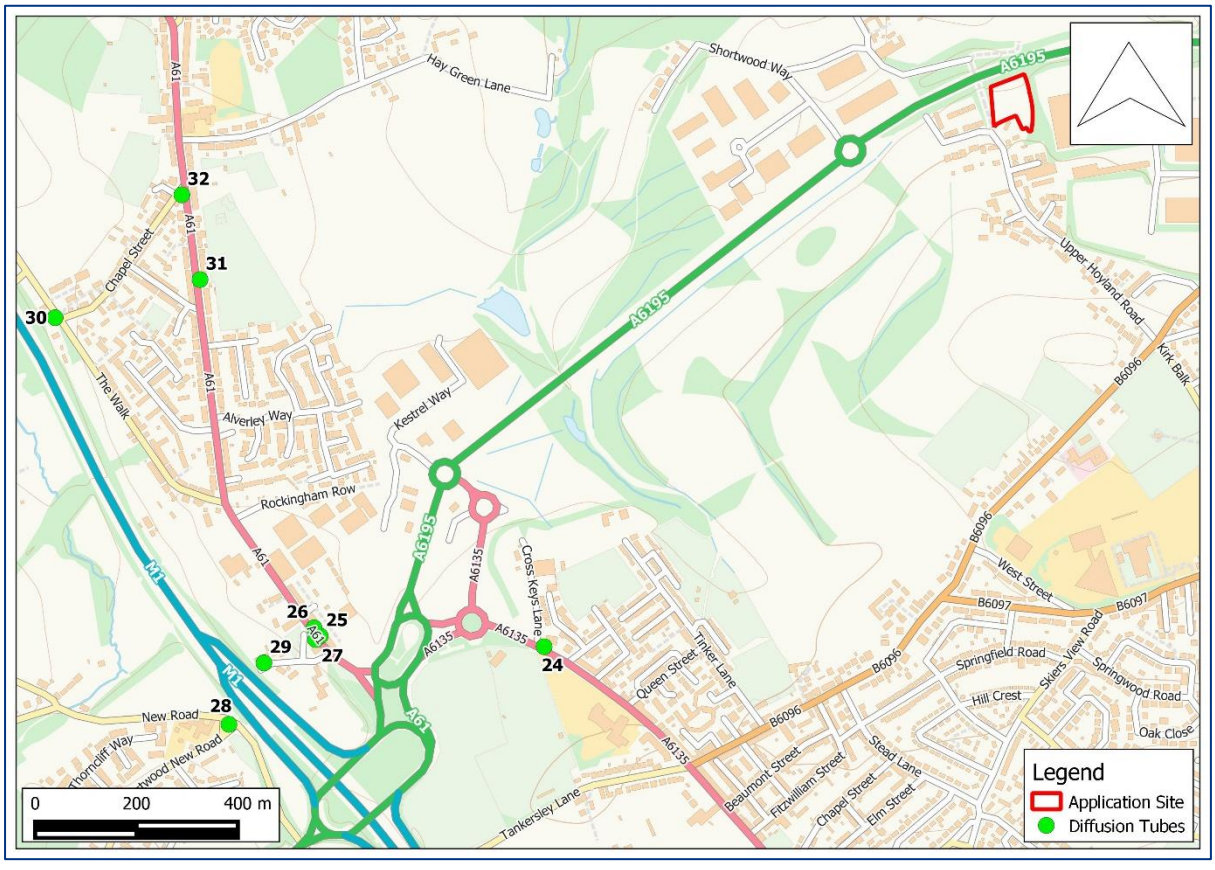

Figure 2: Air Quality Monitoring Sites – Diffusion Tubes
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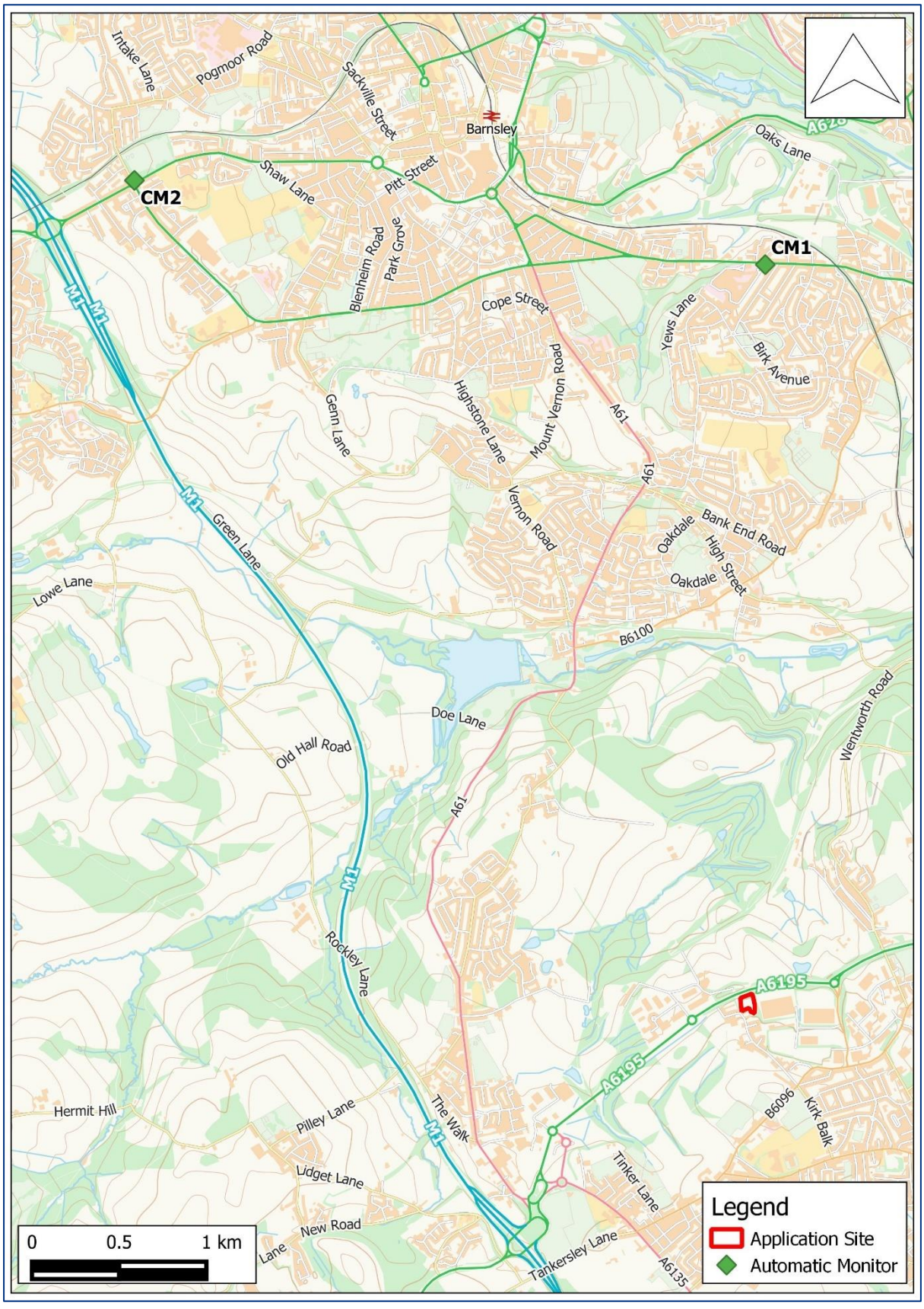

Figure 3: Air Quality Monitoring Sites – Automatic Monitors
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5 Road Traffic Impacts

5.1.1 Predicted concentrations of NO_2, $PM_{2.5}$ PM_{10} at the application site boundary closest to the A6195 are shown in **Table 7**. Annual mean concentrations are predicted to be well below the AQALs at all of the receptors. Pollutant concentrations decrease rapidly with distance from source; therefore, air quality would be acceptable across the entire application site.

Table 7: Predicted Impacts on the Proposed Development in 2022

Receptor	Annual Mean (µg/m³)		
	NO_2	PM_{10}	$PM_{2.5}$
R1	18.6	16.9	10.2
R2	18.1	16.5	9.9
R3	18.1	16.4	9.9
AQAL	**40**	**32**	**25**

6 Mitigation

6.1.1 The assessment has demonstrated that the scheme will not introduce receptors into an area where the objectives are exceeded. Mitigation measures to reduce pollutant emissions from road traffic are principally being delivered in the longer term by the introduction of more stringent emissions standards, largely via European legislation.

7 Residual Impacts

7.1.1 The residual impacts will be the same as those identified in **Section 5**.

8 Conclusions

8.1.1 The impacts on air quality at the proposed development due to emissions from the local road network have been shown to be acceptable, with predicted concentrations being below the air quality objectives.

8.1.2 The operational air quality impacts on the development are judged to be insignificant. This professional judgement takes account of the conclusion that no residents of the proposed development will be exposed to exceedances of the objectives.

8.1.3 There should be no constraints to residential development at the application site with regard to air quality, as the proposed development is consistent with the relevant parts of:

- The NPPF; and
- Policy Poll1 and Policy AQ1 of the Barnsley Local Plan.

9 References

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10 Glossary

AQAL	Air quality assessment level
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network
Defra	Department for Environment, Food and Rural Affairs
EPUK	Environmental Protection UK
Exceedance	A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure
IAQM	Institute of Air Quality Management
LAQM	Local Air Quality Management
µg/m^3	Microgrammes per cubic metre
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
NPPF	National Planning Policy Framework
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. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometres in aerodynamic diameter
$PM_{2.5}$	Small airborne particles less than 2.5 micrometres in aerodynamic diameter
SPG	Supplementary Planning Guidance
Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal

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A1 Modelling Methodology

A1.1. Model Inputs

Traffic Data

A1.1.1 Traffic data has been obtained from the interactive web-based map provided by the Department for Transport (DfT) (DfT, 2021a). The baseline traffic flows have been factored forward to the assessment year (2022) using the TEMPRO System v7.2c (DfT, 2021b). Traffic speeds have been estimated based on the speed limit and the road layout, reduced to 20km/h within 25m of a junction stop line. Diurnal flow profiles for the traffic have been derived from the national diurnal profiles published by the DfT (DfT, 2021c). The traffic data used to calculate emissions are shown in **Table A1** and the modelled road network is shown in **Figure 4.**

Table A1: Summary of Traffic Data used in the Assessment

Road Link	DfT Count Point	AADT		% HDVs [a]
		2019	2022	
M1	26006	101,774	104,550	10.9
A61	28491	38,197	39,239	5.1
A365	38061	19,687	20,224	3.9
A6133	38789	10,644	10,934	3.2
A628 E	38837	15,686	16,114	4.0
A61	46618	17,009	17,473	4.9
A628 W	57089	27,271	28,015	4.2
A6135 E	90077	9,091	9,339	2.5
A6195	90078	25,016	25,698	5.2
A6195	90079	26,533	27,257	5.7
A6135 N	90080	2,090	2,147	2.4
A6135 W	90081	15,159	15,572	3.7

a HDV is heavy duty vehicle >3.5 tonnes (heavy goods vehicle + buses).

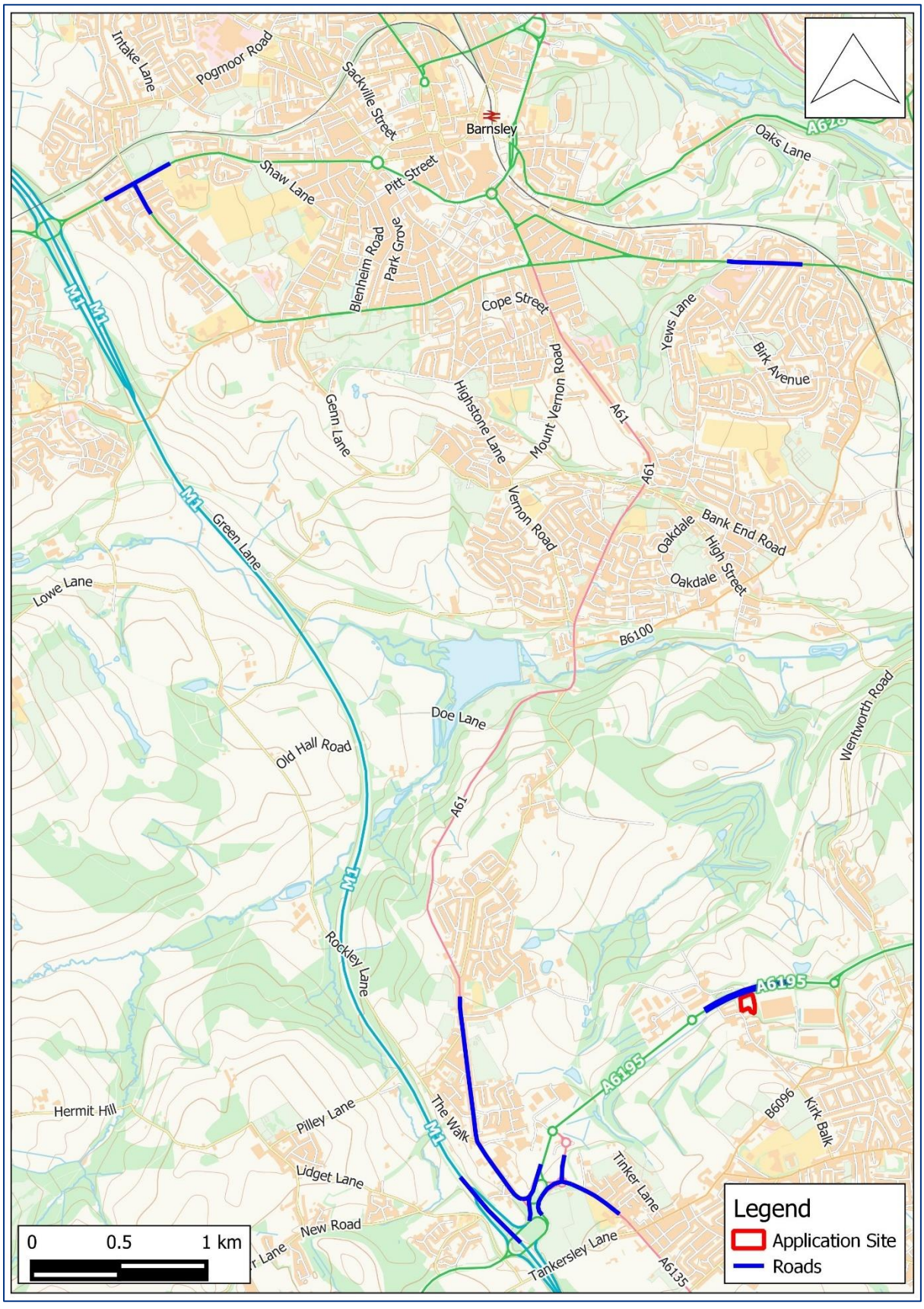

Figure 4: Modelled Roads

Emissions

A1.1.2 Emissions have been calculated using the most recent version of the Emissions Factor Toolkit (EFT) v11.0 (Defra, 2021b). The traffic data have been entered into the EFT in order to calculate a combined emission rate for each of the road links in the modelled network.

Meteorological Data

A1.1.3 The model has been run using the full year of 2019 meteorological data taken from the monitoring station located at Doncaster Sheffield Airport, which is considered suitable for the area.

A1.2. Background Concentrations

A1.2.1 Background concentrations have been assumed to be the same as those published by Defra (Defra, 2021b). These cover the whole country on a 1 km by 1 km grid and are published for each year from 2018 to 2030. The current maps have been verified against measurements undertaken during 2018.

A1.3. Verification

A1.3.1 The verification process seeks to minimise uncertainties associated with the air quality model by comparing the model output with locally measured concentrations. The model has been verified against 2019 data from the CM1 and CM2 automatic monitoring sites and diffusion tube monitoring sites 24, 25, 26, 27, 31 and 32, as shown in **Table 3** and **Figure 3**. Travel restrictions to control the Covid-19 pandemic resulted in low measured concentrations in 2020 and the use of this data for verification would likely result in an underprediction of future concentrations. The verification methodology is described below.

NO_2

A1.3.2 The model output of road-NOx has been compared with the 'measured' road-NOx, calculated from the measured annual mean NO_2 concentrations and the background concentrations using the NOx from NO_2 calculator v8.1 published by Defra (Defra, 2021b).

A1.3.3 The slope of the best-fit line between the 'measured' road-NOx contribution and the model derived road-NOx contribution, forced through zero, has been used to determine the adjustment factor (**Figure 5**). The adjustment factor of 2.9 has been applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations. The NOx to NO_2 calculator has then been used to determine total NO_2 concentrations from the adjusted modelled road-NOx concentrations and the background NO_2 concentrations.

A1.3.4 A comparison of the final adjusted modelled total NO_2 at each monitoring site to the measured total NO_2 shows close agreement (**Figure 6**).

A1.3.5 The results imply that the model has under-predicted the road-NOx contribution. This is a common experience with this and most other models. An evaluation of the model performance using statistical methods is shown in **Table A2**.

PM_{10} and $PM_{2.5}$

A1.3.6 PM_{10} is measured at the CM1 automatic monitoring site and an adjustment factor for PM has been calculated as follows:

- Measured PM_{10} : 20 µg/m^3
- Background PM_{10} : 11.3 µg/m^3
- 'Measured' road-PM_{10} : 8.7 µg/m^3
- Modelled road-PM_{10} = 0.9 µg/m^3
- Road-PM adjustment factor: 8.7/0.9 = 9.5

A1.4. Model Post-processing

NO_2

A1.4.1 The NOx to NO_2 calculator v8.1 published by Defra has been used to convert the modelled, verified road-NOx output for each receptor to road-NO_2. The background NO_2 concentrations have then been added to the predicted road-NO_2 concentrations and adjusted using the secondary verification factor to give the final predicted concentrations.

PM_{10} and $PM_{2.5}$

A1.4.2 The verified road-PM outputs need no further processing and have been added to the background concentrations to give the final predicted concentrations.

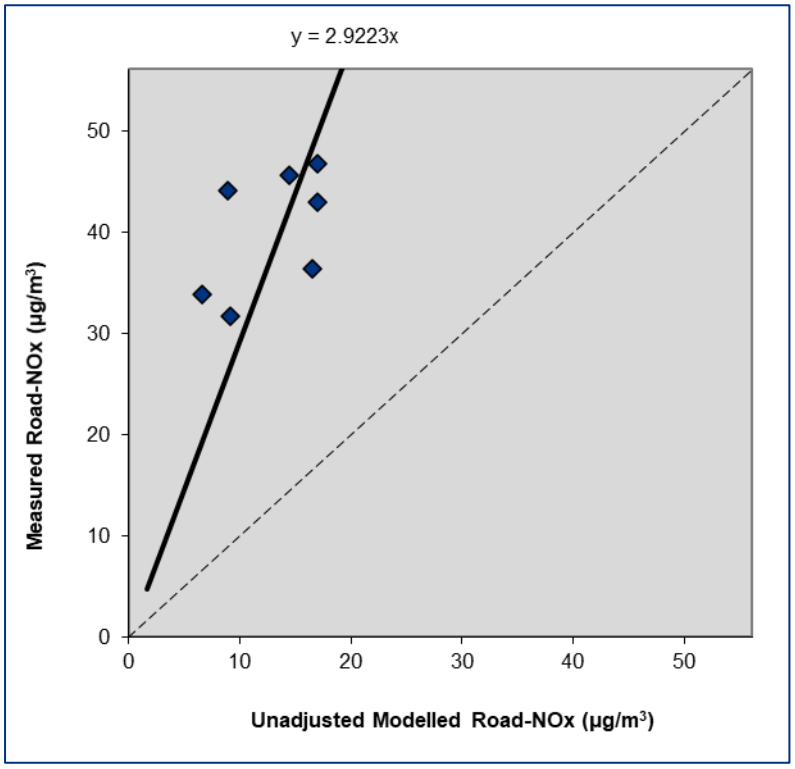

Figure 5: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations.

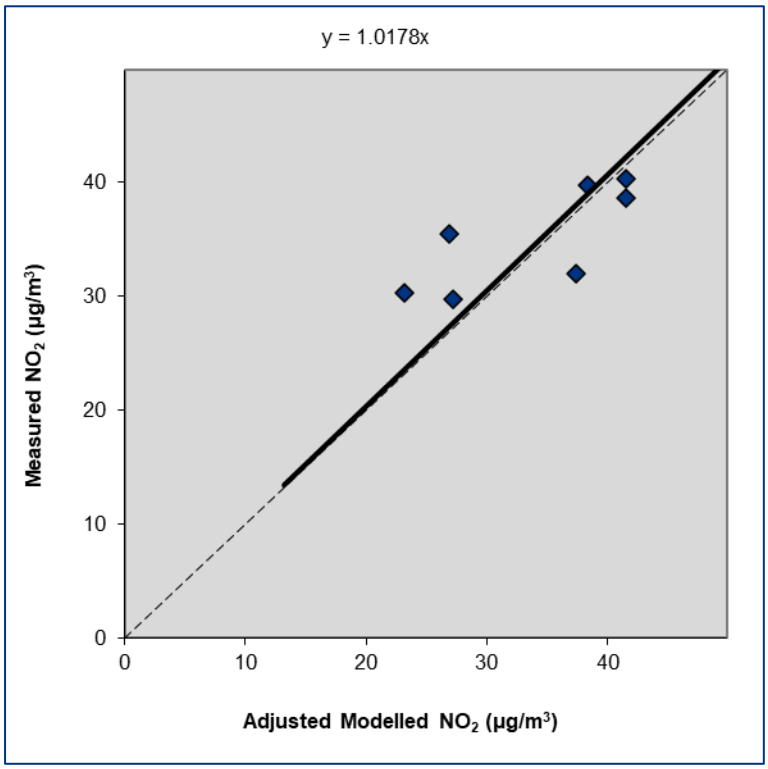

Figure 6: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations.

Table A2: Evaluation of Model Performance

Statistical Parameter	Description	Values		
		Before verification (Figure 5)	After verification (Figure 6)	Ideal
Correlation coefficient	Linear relationship between predicted and observed data. Less useful for small datasets as single high/low values can have a large effect.	0.55	0.77	1
Fractional bias	Identifies systematic tendency to over/under predict (negative = over-predict, positive = under-predict).	10.4	0.04	0.0
Root mean square error (RMSE)	Average error of the model (µg/m^3). Ideally within 10% of the annual mean NO_2 objective, i.e., 4 µg/m^3; however, within 25% acceptable, i.e., 10 µg/m^3.	27.84	4.95	0.0

A2 Professional Experience

Bob Thomas, BSc (Hons) PgDip MSc MIEnvSc MIAQM CSci

Bob Thomas is a Director at AQA, with over fourteen years' experience in the field of air quality management and assessment. He has carried out air quality assessments for a wide range of developments, including residential, commercial, industrial, minerals and waste developments. He has been responsible for air quality projects that include ambient air quality monitoring of nitrogen dioxide, dust and PM_{10}, the assessment of nuisance odours and dust, and the preparation of Review and Assessment reports for local authorities. He has extensive dispersion modelling experience for road traffic, energy centre and industrial sources, and has completed many stand-alone reports and chapters for inclusion within an Environmental Statement. Bob has worked with a variety of clients to provide expert air quality services and advice, including local authorities, planners, developers, architects and process operators, and has provided expert witness services at public inquiry. He is a Chartered Scientist, a Member of the Institute of Air Quality Management and a Member of the Institution of Environmental Sciences.

A full CV for Bob Thomas is available at http://aqassessments.co.uk/about