



Air Quality Assessment	
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Prepared by:	Mr Bob Thomas

Air Quality Assessments Ltd
Tel: 07940 478134
Email: bob@aqassessments.co.uk
Web: <http://aqassessments.co.uk>

Registered Office: c/o Ardwyn Channon, 12 Victoria Street, Burnham-on-Sea, Somerset, TA8 1AL
Companies House Registration: 8895617

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Contents

1	Introduction	1
2	Air Quality Legislation and Policy	2
2.1.	Air Quality Legislation	2
2.2.	Planning Policy and Guidance	3
3	Assessment Methodology	7
3.1.	Existing Conditions	7
3.2.	Road Traffic Impacts.....	7
4	Baseline Conditions	10
4.1.	LAQM Review and Assessment	10
4.2.	Local Air Quality Monitoring	10
4.3.	Defra Background Concentrations	10
5	Impact Assessment.....	14
6	Mitigation	15
7	Residual Impacts.....	16
8	Conclusions.....	17
9	References	18
10	Glossary	20
11	Appendices	21

Tables

Table 1: The Objectives for NO _x , NO ₂ and PM ₁₀ and the PM _{2.5} Limit Value.....	3
Table 2: Description of Receptors.....	7
Table 3: Measured Annual Mean NO ₂ Concentrations ^a	11
Table 4: Exceedance Statistics for the 1-hour Mean NO ₂ Objective ^a	11
Table 5: Summary of PM ₁₀ Monitoring Data ^a	12
Table 6: Summary of PM _{2.5} Monitoring Data ^a	12
Table 7: Estimated Annual Mean Background Concentrations in 2024 (µg/m ³)	12
Table 8: Predicted Impacts on the Proposed Development in 2024.....	14
Table A1: Summary of Traffic Data used in the Assessment.....	22
Table A2: Evaluation of Model Performance.....	26

Figures

Figure 1: Location of New Receptors at the Proposed Development	8
Figure 2: Site Location and Air Quality Monitoring Sites	13
Figure 3: Modelled Roads	23
Figure 4: Comparison of Measured Road NO _x to Unadjusted Modelled Road NO _x Concentrations.....	25
Figure 5: Comparison of Measured Total NO ₂ to Primary Adjusted Modelled Total NO ₂ Concentrations.....	25

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1 Introduction

- 1.1.1 This Air Quality Assessment has been prepared by Air Quality Assessments Ltd in order to discharge Condition 8 of the planning approval for residential use at Alexander House, 205-207 Kings Road, Reading, RG1 4LS (Planning Application Ref: 210902). Condition 8 states that:

"8. No development shall commence on site until a detailed Air Quality Assessment to determine whether mitigation is required to protect the residents from the effects of poor air quality is submitted to and approved in writing by Local Planning Authority. Where this Air Quality Assessment identifies that future residents will be exposed to poor air quality, an air quality mitigation scheme shall accompany this assessment demonstrating sufficient mitigation to protect the occupants. The scheme shall be implemented as approved prior to occupation of any part of the development and retained as approved at all times thereafter."

REASON: These details are required due to insufficient information being contained within this submission and in order to protect the health of future occupants of the proposed development in accordance with Policies EN15 and CC8 of the Reading Borough Local Plan 2019."

- 1.1.2 This report describes the existing air quality conditions in proximity to the site. Reading Borough Council has declared Reading Town Centre and the major radial routes into Reading an Air Quality Management Area (AQMA) for exceedances of the annual mean nitrogen dioxide (NO₂) objective and the application site lies within this area.
- 1.1.3 The development will not significantly increase traffic on local roads; however, residents at the development 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 NO₂ and fine particulate matter (PM₁₀ and PM_{2.5}).
- 1.1.4 The assessment has been prepared taking into account all relevant local and national guidance and regulations.
- 1.1.5 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. Air Quality Legislation

- 2.1.1 The Air Quality Standards Regulations 2010 (as amended) set legally binding limit values for concentrations of major air pollutants in outdoor air that impact public health, including NO₂, PM₁₀ and PM_{2.5} (The Stationary Office, 2010). 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 limit values for PM₁₀ and NO₂ applied from 2005 and 2010 respectively, whereas the PM_{2.5} limit value applied from 2020.
- 2.1.2 Part IV of The Environment Act 1995, as amended by the Environment Act 2021, requires the UK Government to prepare a national Air Quality Strategy. A new Air Quality Strategy for England was published in April 2023 (Defra, 2023a). The Air Quality Strategy sets out the actions that Defra expects local authorities to take in support of long-term air quality goals, including new PM_{2.5} targets, and provides a framework to enable local authorities to make the best use of their powers and make improvements for their communities.
- 2.1.3 The strategy sets out air quality standards and objectives intended to protect human health and the environment. 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. The Government has also published a Clean Air Strategy, which provides an overview of the actions that the government will take to improve air quality (Defra, 2019). The actions in the Clean Air Strategy focus on emissions from transport, the home, farming, and industry.
- 2.1.4 The Air Quality Strategy also describes the system of Local Air Quality Management (LAQM), which was introduced in Part IV of the Environment Act 1995. LAQM 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 Air Quality Management Area (AQMA) and prepare an action plan which sets out appropriate measures to be introduced in pursuit of the objectives. PM_{2.5} is not included in the LAQM framework; however, the government expects all local authorities to effectively use their powers to reduce PM_{2.5} emissions from the sources which are within their control.
- 2.1.5 The objectives for NO₂ and PM₁₀, as prescribed by the Air Quality (England) Regulations 2000 and the Air Quality (England) (Amendment) Regulations 2002, are shown in **Table 1** (The Stationary Office, 2000; The Stationary Office, 2002). The objectives for NO₂ and PM₁₀ are the same as the limit values, but with differing compliance dates. The objectives for PM₁₀ and NO₂ were to have been achieved by 2004 and 2005 respectively and continue to apply in all future years thereafter.
- 2.1.6 The air quality limit value for PM_{2.5} is also shown in **Table 1**. The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023 set out two legally

binding targets for PM_{2.5}, with interim targets for each set out in the Environmental Improvement Plan 2023 (The Stationery Office, 2023; Defra, 2023b). The PM_{2.5} targets are:

- 10µg/m³ annual mean concentration PM_{2.5} nationwide by 2040, with an interim target of 12µg/m³ by January 2028; and
- 35% reduction in average population exposure by 2040, with an interim target of a 22% reduction by January 2028, both compared to a 2018 baseline.

Table 1: The Objectives for NO_x, NO₂ and PM₁₀ and the PM_{2.5} Limit Value

Pollutant	Concentration Measured As	Objective/Limit Value
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	20 µg/m ³

2.1.7 The objectives for human health 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, 2022) issued by the Department for Environment, Food and Rural Affairs (Defra). The annual mean NO₂ and PM₁₀ 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 PM₁₀ 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 NO₂ 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.

2.2. Planning Policy and Guidance

National Policies and Guidance

2.2.1 The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied (Department for Levelling Up, Housing and Communities, 2023). 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.”

- 2.2.2 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; ...”

- 2.2.3 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; ...”

- 2.2.4 The NPPF goes on to state at Paragraph 185:

“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.”

- 2.2.5 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.”

- 2.2.6 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."

- 2.2.7 The NPPG is supported by air quality national Planning Practice Guidance (nPPG) (Department for Levelling Up, Housing and Communities, 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."

- 2.2.8 The nPPG 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."

- 2.2.9 The nPPG 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."

- 2.2.10 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."

- 2.2.11 The nPPG makes clear that:

"... dust can also be a planning concern, for example, because of the effect on local amenity."

Local Policies

- 2.2.12 The Reading Local Plan includes Policy EN15: Air Quality, which states (Reading Borough Council, 2019):

"Development should have regard to the need to improve air quality and reduce the effects of poor air quality."

i. Development that would detrimentally affect air quality will not be permitted unless the effect is to be mitigated. The following criteria should be taken into account:

Whether the proposal, including when combined with the cumulative effect of other developments already permitted, would worsen air quality;

Whether the development is within, or accessed via, an Air Quality Management Area; and

Whether it can be demonstrated that a local worsening in air quality that would not detrimentally affect human health or the environment would be offset by an overall improvement in air quality, for instance through reduction in the need to travel.

ii. Where a development would introduce sensitive uses (such as residential, schools and nurseries, hospitals, care facilities) into, or intensify such uses within, an Air Quality Management Area, detrimental effects on that use will be mitigated. Mitigation measures should be detailed in any planning application. If there are significant detrimental effects that cannot be mitigated, the application should be refused.

iii. Where required, planning obligations will be used to secure contributions to measures to tackle poor air quality or for air quality monitoring.”

Air Quality Action Plan

- 2.2.13 Reading Borough Council has developed an Air Action Plan for the AQMA (Reading Borough Council, 2016). The Action Plan sets out measures that the council intends to implement in order to help meet the objectives.

3 Assessment 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 most recent publicly available Air Quality Annual Status Reports published by Reading Borough Council (Reading Borough Council, 2022); and
- Background pollutant concentration maps published by Defra (Defra, 2023c). 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 (v5.0.1.3) dispersion model (CERC, 2023). The model requires the input of a range of data, details of which are provided in **Appendix A1**.

Sensitive Locations

3.2.2 Receptors have also been identified within the proposed development where the impact from existing sources is likely to be greatest. The receptors are described in **Table 2** and are shown in **Figure 1**.

3.2.3 Concentrations at the proposed development have been modelled at a receptor height of 1.5m to represent exposure at the ground floor level. Pollutant concentrations decrease rapidly with distance from source and will be lower at receptors on higher levels.

Table 2: Description of Receptors

Receptor	Location	x	y	z
R1	Development Façade	472918.1	173234.7	1.5
R2	Development Façade	472928.1	173233.1	1.5
R3	Development Façade	472938.5	173231.5	1.5
R4	Development Façade	472948.5	173229.9	1.5

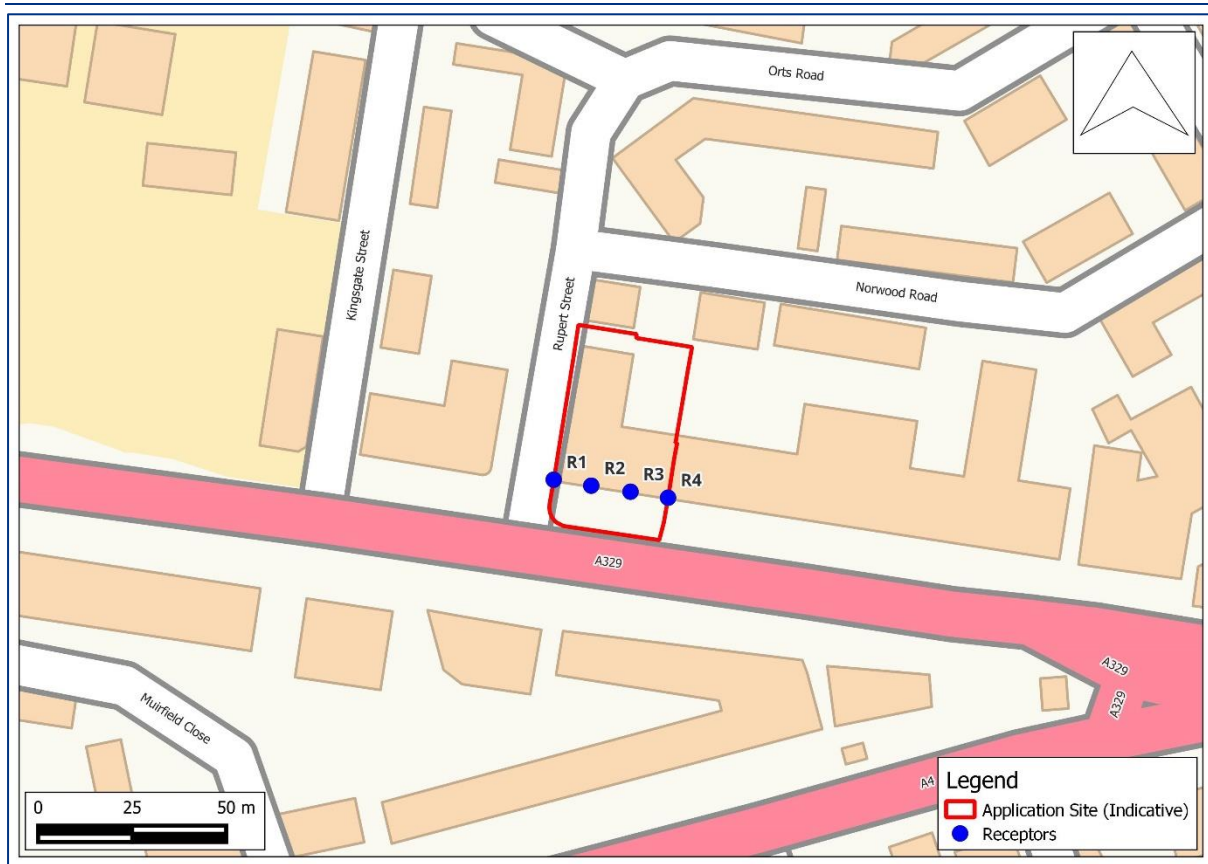


Figure 1: Location of New Receptors at the Proposed Development

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Assessment Scenarios

- 3.2.4 Concentrations of NO₂, PM₁₀ and PM_{2.5} have been predicted at the receptors assuming an opening year of 2024. Concentrations have also been predicted at monitoring sites operated by Reading Borough Council in 2019 in order to verify the model (see **Appendix A1**).

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.

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 the EPUK/IAQM in guidance

on Land-Use Planning & Development Control: Planning for Air Quality has been used for this assessment (EPUK and IAQM, 2017).

- 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.
- 3.2.8 The AQAL for NO₂ is 40µg/m³, based on the annual mean objective.
- 3.2.9 The AQAL for PM₁₀ is an annual mean concentration of 32µg/m³ as measured data show that the 24-hour PM₁₀ objective could be exceeded where annual mean concentrations are above 32µg/m³ (Defra, 2022).
- 3.2.10 The AQAL for PM_{2.5} is 20µg/m³, based on the annual mean air quality limit value. The legally binding PM_{2.5} target value of 10µg/m³ does not need to be achieved until 2040 and guidance on how to assess progress towards the target value has yet to be published. An assessment of whether the proposed development would hinder progress towards the target value has been undertaken based on the 20µg/m³ 2020 annual mean limit value and the 12µg/m³ 2028 interim annual mean target. Assuming a linear reduction, annual mean PM_{2.5} concentrations would need to fall by 1µg/m³/year in order to achieve the 2028 interim target value from the 2020 limit value. Therefore, predicted PM_{2.5} concentrations have also been compared with a 2024 annual mean PM_{2.5} assessment target of 16µg/m³.

4 Baseline Conditions

4.1. LAQM Review and Assessment

- 4.1.1 Reading Borough Council has declared Reading Town Centre and the major radial routes into Reading an Air Quality Management Area (AQMA) for exceedances of the annual mean NO₂ objective.
- 4.1.2 Reading Borough Council has concluded that it is highly unlikely concentrations of PM₁₀ or PM_{2.5} exceed the objectives at any location in the borough.

4.2. Local Air Quality Monitoring

- 4.2.1 Reading Borough Council operates four automatic monitoring sites and 50-60 diffusion tube monitoring sites. Data from the Reading AURN and RD4 automatic monitoring sites and diffusion tube monitoring sites located within 800m of the application site are shown in **Table 3**, **Table 4**, **Table 5**, and **Table 6**. The monitoring locations shown in **Figure 2**.
- 4.2.2 Annual mean NO₂ concentrations at roadside diffusion tube monitoring sites within 800m of the application site and at the London Road automatic monitoring site ranged from 26 to 48µg/m³ between 2015 and 2019 (**Table 3**). Exceedances of the annual mean NO₂ objective have been measured at two of the diffusion tube monitoring sites. The data show an overall decreasing trend in annual mean NO₂ concentrations and by 2019 the objective was achieved at all of the monitoring sites. In 2019 annual mean NO₂ concentrations ranged from 26 to 38µg/m³.
- 4.2.3 Background annual mean NO₂ concentrations ranged from 22 to 34µg/m³ between 2015 and 2019 (**Table 3**).
- 4.2.4 No exceedances of the 1-hour mean NO₂ objective have been measured at the automatic monitoring sites (**Table 4**). Measurements across the UK have shown that there is a risk of exceedances of the 1-hour NO₂ objective where the annual mean concentration is above 60 µg/m³ (Defra, 2022). Annual mean diffusion tube measurements between 2015 and 2019 have not exceeded 60 µg/m³; therefore, it is unlikely that the 1-hour objective has been exceeded.
- 4.2.5 No exceedances of the objectives for PM₁₀ or PM_{2.5} have been measured at the automatic monitoring sites (**Table 5** and **Table 6**).

4.3. Defra Background Concentrations

- 4.3.1 Estimated background concentrations at the application site are shown in **Table 7**. The background concentrations have been derived from data in the national maps published by Defra. The background concentrations are well below the objectives/limit values.

Table 3: Measured Annual Mean NO₂ Concentrations^a

Site ID in Figure 1	Location	Site Type ^b	Annual Mean (µg/m ³)				
			2015	2016	2017	2018	2019
Automatic Monitor							
Reading AURN	Reading Old Cemetery	UB	22	34	29	26	22
RD4	London Rd	R	-	32	28	30	27
Diffusion Tubes							
2	181 Kings Road	R	-	-	-	-	35
5	Amity Road	K	-	-	-	-	29
7	162 London Road	R	48	42	43	40	38
8	419 London Road	R	43	42	44	39	35
9	276 Kings Road	R	33	32	32	30	26
Objective			40				

a Exceedances are shown in bold.

b R = Roadside, K = Kerbside, UB = Urban Background.

Table 4: Exceedance Statistics for the 1-hour Mean NO₂ Objective^a

Site ID	Location	Site Type	Number of Hours > 200 µg/m ³				
			2015	2016	2017	2018	2019
Reading AURN	Reading Old Cemetery	UB	0	4	0	0	0
RD4	London Road	R	-	0	0	0	0
Objective			18				

a R = Roadside, UB = Urban Background.

Table 5: Summary of PM₁₀ Monitoring Data ^a

Table 3: Summary of PM ₁₀ Monitoring Data							
Site ID	Location	Site Type	2015	2016	2017	2018	2019
Annual Mean (µg/m³)							
Reading AURN	Reading Old Cemetery	UB	12	13	12	13	13
RD4	London Road	R	-	19	18	17	17
Objective			40				
Number of Days > 50 µg/m³							
Reading AURN	Reading Old Cemetery	UB	0	3	3	1	0
RD4	London Road	R	-	2	3	1	4
Objective			35				

a R = Roadside, UB = Urban Background.

Table 6: Summary of PM_{2.5} Monitoring Data ^a

Site ID	Location	Site Type	2015	2016	2017	2018	2018
Annual Mean (µg/m³)							
Reading AURN	Reading Old Cemetery	UB	7	9	10	7	8
Limit Value			20				

a UB = Urban Background.

Table 7: Estimated Annual Mean Background Concentrations in 2024 (µg/m³)

OS Grid (x,y)	NO ₂	PM ₁₀	PM _{2.5}
472500,173500	20.7	16.0	11.1
Objective/Limit Value	40	40	20

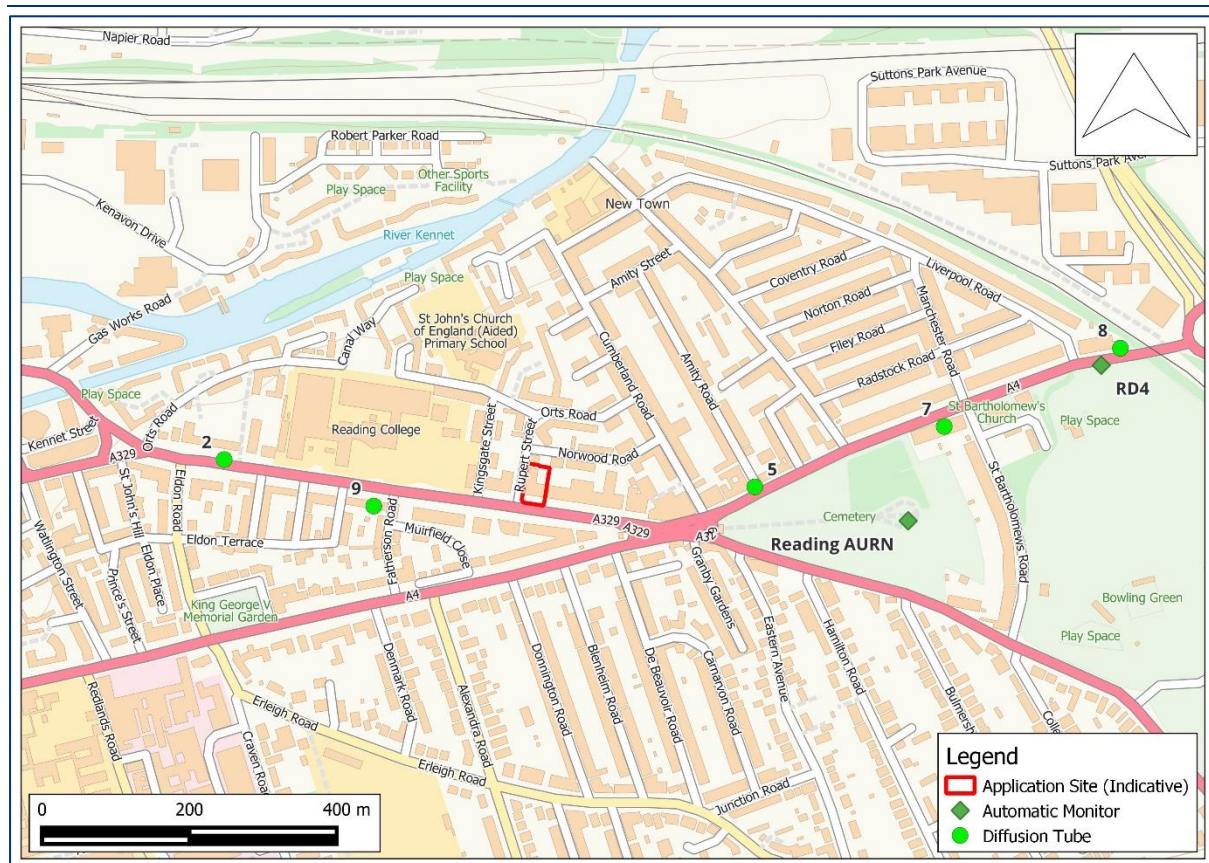


Figure 2: Site Location and Air Quality Monitoring Sites

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5 Impact Assessment

5.1.1 Predicted concentrations of NO₂, PM₁₀ and PM_{2.5} at the façade of the development are shown in **Table 8**. Annual mean concentrations are predicted to be well below the AQALs at all of the receptors; therefore, air quality at the development will be acceptable. The predicted annual mean PM_{2.5} concentrations are all well below the assessment target value of 16µg/m³; therefore, the development would not hinder progress towards the 2028 12µg/m³ interim target.

Table 8: Predicted Impacts on the Proposed Development in 2024

Receptor	Annual Mean (µg/m ³)		
	NO ₂	PM ₁₀	PM _{2.5}
R1	24.6	17.4	11.8
R2	24.7	17.4	11.8
R3	24.7	17.4	11.8
R4	24.8	17.4	11.8
AQAL	40	32	20

6 Mitigation

- 6.1.1 The assessment has demonstrated that the scheme will not introduce receptors into an area where the objectives/limit values 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. Therefore, as air quality at the development is acceptable, it is not considered appropriate to propose air quality mitigation measures for this scheme.

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7 Residual Impacts

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

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8 Conclusions

- 8.1.1 The impacts on air quality at the development due to emissions from the local road network have been shown to be acceptable, with predicted concentrations being well below the air quality objectives/limit values.
- 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 development will be exposed to exceedances of the objectives/limit values.
- 8.1.3 There should be no constraints to the development with regard to air quality, as the development is consistent with the relevant parts of:
- The NPPF and air quality nPPG; and
 - The Reading Local Plan.
- 8.1.4 It is considered that the evidence provided in this report is sufficient to discharge Planning Condition 8 of the planning consent for the development.

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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
DMP	Dust Management Plan
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/m³	Microgrammes per cubic metre
NO	Nitric oxide
NO₂	Nitrogen dioxide
NO_x	Nitrogen oxides (taken to be NO ₂ + NO)
NPPF	National Planning Policy Framework
nPPG	National Planning Policy Guidance
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
PM₁₀	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

11 Appendices

A1 Air Quality Modelling Methodology	22
A2 Professional Experience.....	27

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A1 Air Quality Modelling Methodology

A1.1. Model Inputs

Traffic Data

A1.1.1 Traffic data have been taken from the Department for Transport (DfT) database (DfT, 2023a). 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. The traffic data have been factored forward to the assessment year (2024) using the TEMPro System v8.1 (DfT, 2023b). Diurnal flow profiles for the traffic have been derived from the national diurnal profiles published by the DfT (DfT, 2023c). The traffic data used to calculate emissions are shown in **Table A1** and the modelled road network is shown in **Figure 3**.

Table A1: Summary of Traffic Data used in the Assessment

DfT Count Point	Road	AADT		% HDVs ^a
		2019	2024	
6127	A4	24,006	24,816	4.0
36125	A4	12,678	13,106	4.1
46955	A329	19,110	19,755	7.0
56881	A329	10,602	10,960	3.8

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

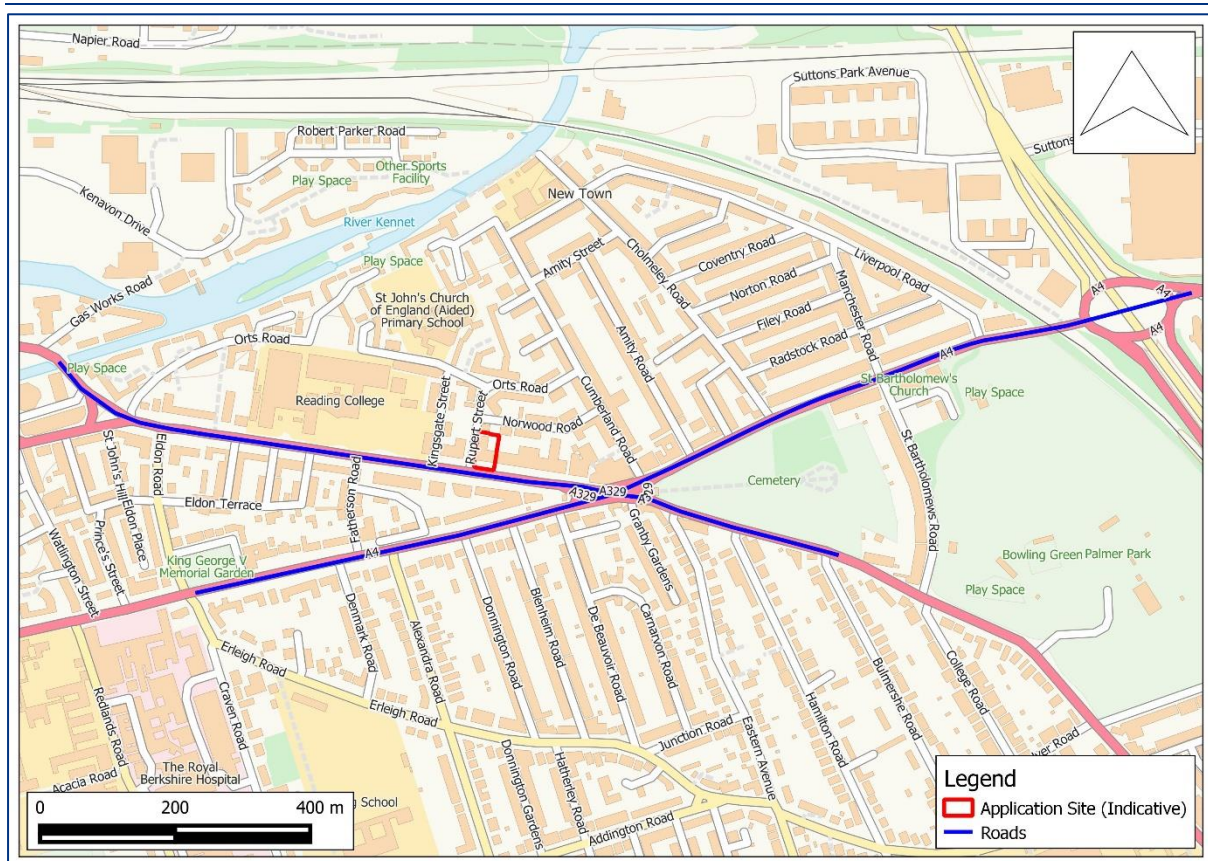


Figure 3: Modelled Roads

Contains Ordnance Survey data © Crown copyright and database right 2023

Emissions

A1.1.2 Emissions have been calculated using the most recent version of the Emissions Factor Toolkit (EFT) v11.0 (Defra, 2023c). The traffic data were 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 In order to provide a conservative assessment, the model has been run using the full year of meteorological data that corresponds with the last set of published monitoring data unaffected by Covid-19 travel restrictions (2019). The meteorological data has been taken from the monitoring station located at Heathrow Airport, which is considered suitable for the area.

A1.2. Background Concentrations

A2.1.1 Background concentrations have been assumed to be the same as those published by Defra (Defra, 2023c). 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

A3.1.1 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 RD4 automatic monitoring site and diffusion tube monitoring sites labelled as 2, 5, 7, 8 and 9 in **Table 3**. The verification methodology is described below.

NO₂

A3.1.2 Most NO₂ 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 (NO_x = NO + NO₂).

A3.1.3 The model output of road-NO_x has been compared with the 'measured' road-NO_x, calculated from the measured annual mean NO₂ concentrations and the background concentrations using the NO_x from NO₂ calculator v8.1 published by Defra.

A3.1.1 The slope of the best-fit line between the 'measured' road-NO_x contribution and the model derived road-NO_x contribution, forced through zero, has been used to determine the adjustment factor (**Figure 4**). The adjustment factor of 1.6 has been applied to the modelled road-NO_x concentration for each receptor to provide adjusted modelled road-NO_x concentrations. The NO_x to NO₂ calculator has then been used to determine total NO₂ concentrations from the adjusted modelled road-NO_x concentrations and the background NO₂ concentrations.

A3.1.2 A comparison of the final adjusted modelled total NO₂ at each monitoring site to the measured total NO₂ shows close agreement (**Figure 5**). The results imply that the model has under-predicted the road-NO_x 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**.

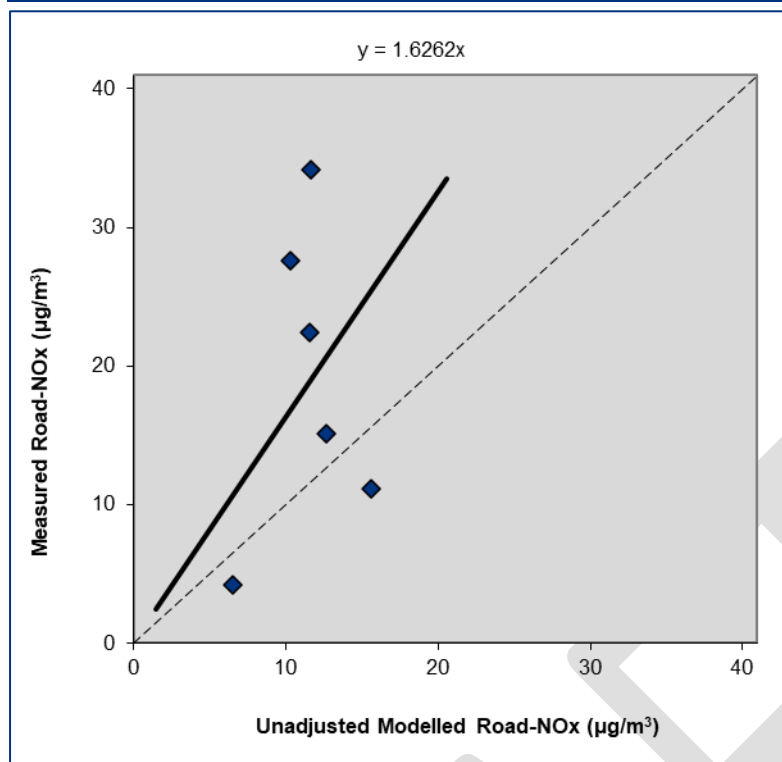


Figure 4: Comparison of Measured Road NO_x to Unadjusted Modelled Road NO_x Concentrations.

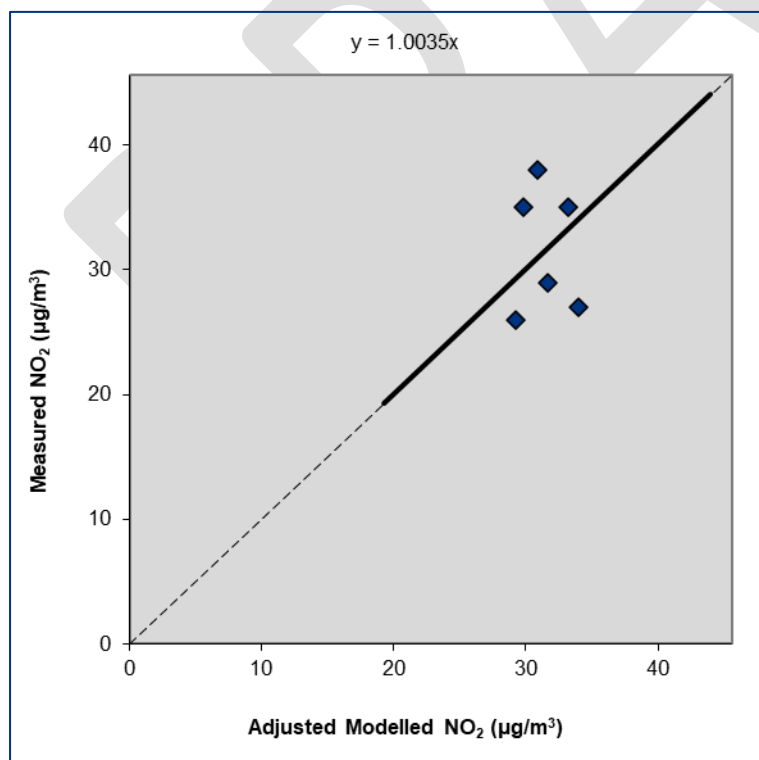


Figure 5: Comparison of Measured Total NO₂ to Primary Adjusted Modelled Total NO₂ Concentrations.

Table A2: Evaluation of Model Performance

Statistical Parameter	Description	Values		
		Before verification (Figure 4)	After verification (Figure 5)	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.	0.18	-0.06	1
Fractional bias	Identifies systematic tendency to over/under predict (negative = over-predict, positive = under-predict).	0.51	0.01	0.0
Root mean square error (RMSE)	Average error of the model ($\mu\text{g}/\text{m}^3$). Ideally within 10% of the annual mean NO_2 objective, i.e., $4 \mu\text{g}/\text{m}^3$; however, within 25% acceptable, i.e., $10 \mu\text{g}/\text{m}^3$.	12.64	4.95	0.0

PM₁₀ and PM_{2.5}

A1.3.3 The Defra estimated background PM_{10} concentration is higher than the measured roadside concentration at automatic monitoring site RD4 and the road contribution to PM_{10} at the monitoring site for use in a verification calculation cannot be determined. Therefore, the adjustment factor for NO_x has been used to adjust modelled road PM_{10} and $\text{PM}_{2.5}$.

A1.4. Model Post-processing

NO₂

A4.1.1 The NO_x to NO_2 calculator v8.1 published by Defra has been used to convert the modelled, verified road- NO_x output for each receptor to road- NO_2 . The background NO_2 concentrations have then been added to the predicted road- NO_2 concentrations to give the final predicted concentrations.

PM₁₀ and PM_{2.5}

A4.1.2 The verified road-PM outputs need no further processing and have been added to the background concentrations to give the final predicted concentrations.

A2 Professional Experience

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

Bob Thomas is a Director at AQA, with over twenty years working in the sciences and sixteen 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 PM₁₀, 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>