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163 – 165 Caversham Road, Reading: Air Quality Assessment

**Prepared for
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**Report Ref: AQ0950
Date: December 2016**

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Title:

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Air Quality Assessment

Report Ref:

AQ0950

Date Issued:

December 2016

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CONTENTS

1	Introduction	1
1.1	Scope	1
2	Pollutants & Legislation	2
2.1	Pollutant Overview	2
2.2	Air Quality Strategy	2
2.3	Local Air Quality Management	3
2.3.1	Reading Borough Council	3
3	Planning Policy & Guidance	4
3.1	National Planning Policy & Guidance	4
3.1.1	National Planning Policy Framework	4
3.1.2	Land-Use Planning & Development Control	4
3.2	Local Planning Policy & Guidance	5
3.2.1	Reading Borough Council	5
4	Assessment Methodology	6
4.1	Operational Phase (Traffic Emissions)	6
4.1.1	Modelled Scenarios	6
4.1.2	ADMS-Roads	6
4.1.3	Emission Factors	6
4.1.4	Traffic Data	6
4.1.5	Street Canyons	7
4.2	Background Concentrations	8
4.3	Surface Roughness	8
4.4	Meteorological Data	8
4.5	Model Output	10
4.5.1	NO _x /NO ₂ Relationship	10
4.5.2	Predicted Short Term Concentrations	10
4.5.3	Model Verification	10
4.5.4	Receptor Locations	11
4.6	Significance Criteria	12

4.6.1	Operational Phase.....	12
5	Air Quality Assessment	14
5.1	Impact of Vehicle Emissions.....	14
5.1.1	Model Verification	14
5.1.2	Nitrogen Dioxide	15
5.1.3	Particulate Matter.....	16
6	Conclusions And Recommendations.....	17
6.1	Impact of Vehicle Emissions.....	17
6.1.1	Building Mitigation.....	17
6.2	Overall Conclusion	17

LIST OF TABLES

Table 1 – Overview of NO ₂ and PM ₁₀	2
Table 2 – UK Air Quality Objectives for Nitrogen Dioxide and Particulate Matter.....	3
Table 3 – Annual Average Daily Traffic Flows, Percentage HDV and Speeds for Modelled Roads, 2015 and 2018	7
Table 4 – Background NO _x , NO ₂ and PM ₁₀ Concentrations.....	8
Table 5 – Modelled Verification Locations	11
Table 6 – Modelled Receptor Locations	11
Table 7 – Air Pollution Exposure Criteria (APEC)	12
Table 8 – Comparison of Modelled and Monitored NO ₂ and PM ₁₀ Concentrations (µg/m ³), 2015	14
Table 9 – Predicted NO ₂ Concentrations, Annual Mean (µg/m ³)	15
Table 10 – Predicted PM ₁₀ Concentrations, Annual Mean (µg/m ³).....	16

LIST OF FIGURES

Figure 1 – Wind Speed and Direction Data, Heathrow	9
Figure 2 – Modelled Receptor Locations	11
Figure 3 – Assessing the Significance of Air Quality Impacts of a Development Proposal	13

1 INTRODUCTION

1.1 Scope

GEM Air Quality Ltd has been commissioned to undertake a detailed air quality assessment based on the potential impacts of existing and future traffic levels on a proposed development located at 163 – 165 Caversham Road in Reading, Berkshire. The assessment will focus on emissions from traffic using the A4155 Caversham Road. The pollutants modelled as part of this assessment are nitrogen oxides (NO_x) and particulate matter (PM₁₀).

The impacts of vehicle emissions have been assessed using the techniques detailed within Volume 11, Section 3 of the Design Manual for Roads and Bridges (DMRB)¹ and the Local Air Quality Management Technical Guidance (LAQM.TG16)². The impact of road traffic emissions will be assessed using the ADMS-Roads Extra air dispersion model. This model has been devised by Cambridge Environmental Research Consultants (CERC) and is described as a *“comprehensive tool for investigating air pollution problems due to small networks of roads”*.

It should be noted that the short-term impacts of NO₂ and PM₁₀ emissions have not been modelled as dispersion models are inevitably poor at predicting short-term peaks in pollutant concentrations, which are highly variable from year to year, and from site to site. Notwithstanding this, general assumptions have been made about short term concentrations based on the modelled annual mean concentrations.

¹ Design Manual for Roads and Bridges, Volume 11, Section 3, Part 1 – HA207/07, Highways Agency, May 2007

² Part IV of the Environment Act 1995, Local Air Quality Management Technical Guidance (TG16), Defra, April 2016

2 POLLUTANTS & LEGISLATION

2.1 Pollutant Overview

In most urban areas of the UK, traffic generated pollutants have become the most common pollutants. These are nitrogen dioxide (NO₂), fine particulates (PM₁₀), carbon monoxide (CO), 1,3-butadiene and benzene, as well as carbon dioxide (CO₂). This air quality assessment focuses on NO₂ and PM₁₀, as these pollutants are least likely to meet their Air Quality Strategy objectives near roads. Table 1 provides an overview of NO₂ and PM₁₀.

Table 1 – Overview of NO₂ and PM₁₀

Pollutant	Properties	Anthropogenic Sources	Natural Sources	Potential Effects
Particles (PM₁₀)	Tiny particulates of solid or liquid nature suspended in the air	Road transport; Power generation plants; Production processes e.g. windblown dust	Soil erosion; Volcanoes; Forest fires; Sea salt crystals	Asthma; Lung cancer; Cardiovascular problems
Nitrogen Dioxide (NO₂)	Reddish-brown coloured gas with a distinct odour	Road transport; Power generation plants; Fossil fuels – extraction & distribution; Petroleum refining	No natural sources, although nitric oxide (NO) can form in soils	Pulmonary edema; Various environmental impacts e.g. acid rain

2.2 Air Quality Strategy

The UK Government and the devolved administrations published the latest Air Quality Strategy for England, Scotland, Wales and Northern Ireland on 17 July 2007³. The Strategy provides an over-arching strategic framework for air quality management in the UK by way of the following:

- setting out a way forward for work and planning on air quality issues;
- setting out the air quality standards and objectives to be achieved;
- introducing a new policy framework for tackling fine particles; and
- identifying potential new national policy measures which modelling indicates could give further health benefits and move closer towards meeting the Strategy's objectives.

With regards to this assessment, the Air Quality Strategy contains national air quality standards and objectives established by the Government to protect human health. The objectives for nitrogen dioxide and particulates (PM₁₀ and PM_{2.5}) have been set, along with

³ The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland, July 2007

seven other pollutants (benzene, 1,3-butadiene, carbon monoxide, lead, PAHs, sulphur dioxide and ozone). Those which are limit values required by EU Daughter Directives on Air Quality have been transposed into UK law through the Air Quality Standards Regulations 2010 which came into force on 11th June 2010. Table 2 provides the UK Air Quality Objectives for NO₂ and PM₁₀.

Table 2 – UK Air Quality Objectives for Nitrogen Dioxide and Particulate Matter

Pollutant	Objective	Concentration measured as	Date to be achieved by and maintained thereafter
Particles (PM₁₀)	50µg/m ³ not to be exceeded more than 35 times a year	24 hour mean	31 December 2004
	40µg/m ³	Annual mean	31 December 2004
Nitrogen Dioxide (NO₂)	200µg/m ³ not to be exceeded more than 18 times a year	1 hour mean	31 December 2005
	40µg/m ³	Annual mean	31 December 2005

Objectives for PM_{2.5} were also introduced by the UK Government and the Devolved Administrations in 2010. However, this objective relates primarily to the identification of PM_{2.5} hot spots in relation to emission reduction. Such information will aid the direction of actions to specific priority areas that are most in need of reductions in PM_{2.5} levels, and allow measures to be targeted to the identified PM_{2.5}. As such, PM_{2.5} has not been assessed within this report.

2.3 Local Air Quality Management

At the core of LAQM delivery are three pollutant objectives; these are: Nitrogen Dioxide (NO₂), Particulate Matter (PM₁₀) and Sulphur Dioxide (SO₂). All current Air Quality Management Areas (AQMAs) across the UK are declared for one or more of these pollutants, with NO₂ accounting for the majority. It is a statutory requirement for local authorities to regularly review and assess air quality in their area and take action to improve air quality when objectives set out in regulation cannot be met.

2.3.1 Reading Borough Council

The Council has declared an Air Quality Management Area (AQMA), which encompasses Reading Town Centre, areas along the major radial road routes into Reading (including J11 of the M4) and along the railway lines where they pass through built-up areas. As such, the proposed development lies within this AQMA.

3 PLANNING POLICY & GUIDANCE

3.1 National Planning Policy & Guidance

3.1.1 National Planning Policy Framework

On a national level, air quality can be a material consideration in planning decisions. The National Planning Policy Framework (NPPF) for England, released on 27th March 2012, is considered a key part of the Governments reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. The NPPF replaces the Planning Policy Statement 23 (PPS23) *Planning and Pollution Control*⁴.

The NPPF states that the “planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability”.

It goes on to state that “planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan”.

3.1.2 Land-Use Planning & Development Control

In April 2010, guidance released by Environmental Protection UK (EPUK)⁵ provided a set of criteria used to determine whether a development will have a significant impact on air quality. If the proposed development results in a significant change in air quality or results in a change of relevant exposure to air quality, then it is reasonable to expect an air quality assessment to be undertaken.

In April 2015, Environmental Protection UK and the Institute of Air Quality Management (IAQM) released a final draft guidance to ensure that air quality is adequately considered in the land-use planning and development control processes⁶.

⁴ Planning Policy Statement 23: Planning and Pollution Control, Office of the Deputy Prime Minister (ODPM), November 2004

⁵ Development Control: Planning for Air Quality (2010 Update), Updated guidance from Environmental Protection UK on dealing with air quality concerns within the development control process, Environmental Protection UK, April 2010

⁶ Land-Use Planning & Development Control: Planning for Air Quality. Guidance from Environmental Protection UK and the Institute of Air Quality Management for the consideration of air quality within the land-use planning and development control processes. EPUK & IAQM. Final draft April 2015

3.2 Local Planning Policy & Guidance

3.2.1 Reading Borough Council

Policy DM19 in Reading Borough Council's Sites and Detailed Policy Document requires that development have regard to the need to improve air quality and to reduce the effects of poor air quality:

"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 significantly reduce air quality;*
- *Whether the development is within, or accessed via, an Air Quality Management Area;*
- *Whether it can be demonstrated that a local reduction in air quality would be offset by an overall improvement in air quality, for instance through reduction in the need to travel; and*
- *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."*

4 ASSESSMENT METHODOLOGY

4.1 Operational Phase (Traffic Emissions)

4.1.1 Modelled Scenarios

A future year has been chosen (2018) for the assessment, along with the baseline year (2015). The future year represents the assumed first full year of occupation following completion of the development. Two scenarios have been adopted as part of the assessment. These are as follows:

- **Scenario 1** – existing levels of air quality (2015); and
- **Scenario 2** – future impact of traffic emissions on the proposed development i.e. introduction of new exposure (2018).

Predicted concentrations will be compared to the Air Quality Strategy objectives. Background pollutant concentrations and vehicle emission rates for all modelled years are based on the latest data issued by Defra. These background concentrations and emission factors are discussed further in the following sections.

4.1.2 ADMS-Roads

Modelling the impact of traffic emissions on the proposed development will be undertaken using the latest version of the ADMS-Roads model⁷. ADMS-Roads is significantly more advanced than that of most other air dispersion models in that it incorporates the latest understanding of the boundary layer structure, and goes beyond the simplistic Pasquill-Gifford stability categories method with explicit calculation of important parameters. The model uses advanced algorithms for the height-dependence of wind speed, turbulence and stability to produce improved predictions.

4.1.3 Emission Factors

Defra and the Devolved Administrations have provided an updated Emission Factors Toolkit (Version 7.0) which incorporates updated NO_x emissions factors and vehicle fleet information⁸. These emission factors have been integrated into the latest ADMS-Roads modelling software. However, in order to undertake a worst case assessment emission factors for 2015 have been used for all modelled years.

4.1.4 Traffic Data

Baseline and future traffic flows along the A4155 Caversham Road are available from the Department for Transport (DfT)⁹. Baseline (2015) data from the DfT has been projected to

⁷ Model Version: 4.0.1, Interface Version: 4.0.0 (03/11/2015)

⁸ http://laqm.defra.gov.uk/documents/EFT2016_v7.0.xlsm.zip

⁹ <http://www.dft.gov.uk/traffic-counts/>

163 – 165 Caversham Road, Reading

Air Quality Assessment

Report Ref: AQ0950

2018. Projection of traffic data has been undertaken using growth factors specific to Birmingham City Council, obtained from TEMPro¹⁰ and National Road Traffic Forecasts (NRTF)¹¹. The projected flow rates are provided in Table 3. It is assumed that the percentage HDV and speed will remain unchanged in future years.

Table 3 – Annual Average Daily Traffic Flows, Percentage HDV and Speeds for Modelled Roads, 2015 and 2018

Link Name	AADT 2015	AADT 2018	HDV (%)	Speed (kph)
A4155 Caversham Road	28,035	29,810	4.4%	48

For the modelled speeds, the figures provided above have been used. However, where a link approaches a junction a speed of 20 kph has been modelled in order to represent queuing traffic at a junction. In order to undertaken a worst case assessment it has been assumed that there is queuing traffic along the entire length of the A4155 Caversham Road.

4.1.5 Street Canyons

A street canyon may be defined as a relatively narrow street with buildings on both sides, where the height of the buildings is generally greater than the width of the road. Street canyons may result in elevated pollutant concentrations from road traffic emissions due to a reduced likelihood of the pollutants becoming dispersed in the atmosphere. Street canyons have been modelled as part of this assessment along the A4155 Caversham Road, including the proposed development and model verification locations.

¹⁰ TEMPro (Trip End Model Presentation Program) version 7, Department for Transport

¹¹ National Road Traffic Forecasts (Great Britain) 1997, Department for Transport

4.2 Background Concentrations

Background NO_x, NO₂ and PM₁₀ concentrations have been obtained from Defra¹². These 1 km x 1 km grid resolution maps are derived from a base year of 2013 (for NO_x, NO₂, PM₁₀ and PM_{2.5} only), which are then projected to future years (2015). Background concentrations of NO_x, NO₂ and PM₁₀ derived from Defra are provided in Table 4.

Table 4 – Background NO_x, NO₂ and PM₁₀ Concentrations

Pollutant	Defra Background		2015
	X	Y	
NO ₂	471500	174500	25.8
NO _x			41.2
PM ₁₀			17.6

In order to undertake a worst case assessment, 2015 background concentrations have been assumed for all modelled scenarios.

4.3 Surface Roughness

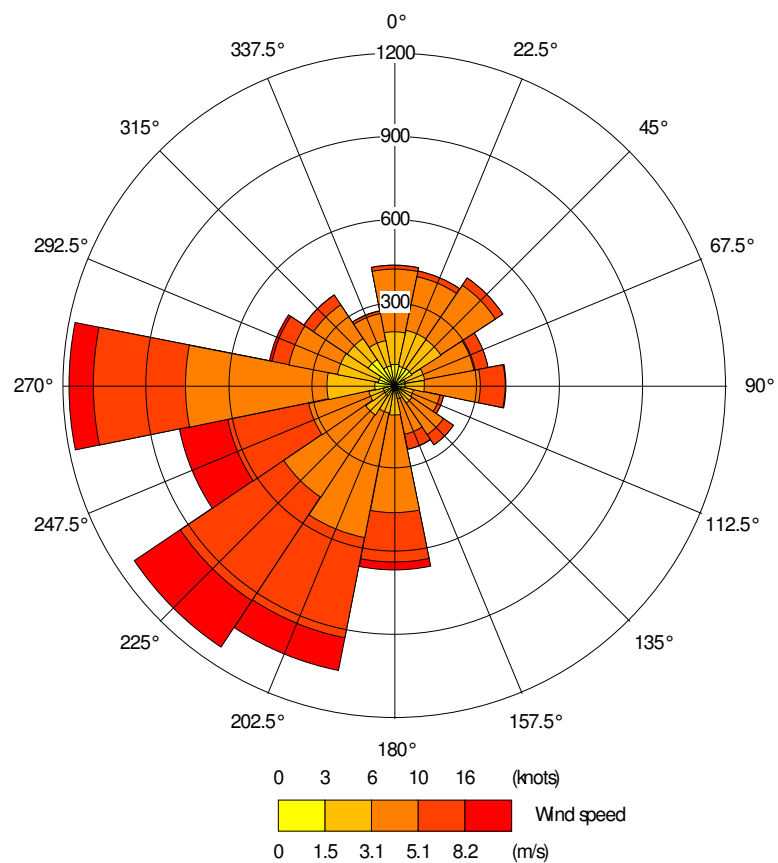
A surface roughness of 1.0 metre has been used in the model. This value is provided by ADMS-Roads as a typical roughness length for a town or city. This value has been used across the modelled domain.

4.4 Meteorological Data

Hourly sequential meteorological data from the Heathrow meteorological station has been used. Wind speed and direction data from the Heathrow meteorological station has been plotted as a wind rose in Figure 1.

¹² <http://uk-air.defra.gov.uk/data/laqm-background-maps?year=2013>

Figure 1 – Wind Speed and Direction Data, Heathrow



4.5 Model Output

4.5.1 NO_x/NO₂ Relationship

Following recent evidence that shows the proportion of primary NO₂ in vehicle exhaust has increased¹³. As such, a new NO_x to NO₂ calculator has been devised¹⁴. This new calculator has been used to determine NO₂ concentrations for this assessment, based on predicted NO_x concentrations using ADMS-Roads. Converted NO₂ concentrations are initially compared to local monitoring data in order to verify the model output. If the model performance is considered unacceptable then the NO_x concentrations are adjusted before conversion to NO₂.

4.5.2 Predicted Short Term Concentrations

As discussed in the introduction, it has not been possible to model the short term impacts of NO₂ and PM₁₀. Research undertaken in 2003¹⁵ has indicated that the hourly NO₂ objective is unlikely to be exceeded at a roadside location where the annual mean NO₂ concentration is less than 60 µg/m³.

For PM₁₀, a relationship between the annual mean and the number of 24-hour mean exceedences has been devised and is as follows:

- No. 24-hour mean exceedences = $-18.5 + 0.00145 \times \text{annual mean}^3 + (206/\text{annual mean})$

This relationship has been applied to the modelled annual mean concentrations in order to estimate the number of 24-hourly exceedences.

4.5.3 Model Verification

The Council undertakes monitoring of NO₂ at a diffusion tube located along the A4155 Caversham Road. Monitored PM₁₀ and NO₂ concentrations are also recorded at a roadside site (RD1). Monitored concentrations from these sites have been used for the purposes of model verification. The location of these verification sites are provided in Table 5.

¹³ Trends in Primary Nitrogen Dioxide in the UK, Air Quality Expert Group, 2007

¹⁴ http://laqm.defra.gov.uk/documents/no2tonox9_ja-forweb_june2016.xls

¹⁵ Analysis of Relationship between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites, Laxen and Marner, 2003

Table 5 – Modelled Verification Locations

Site ID	X	Y	Height (m)
RD1	471153	174429	1.5
V1	471161	174379	2.5
V2	471156	174424	1.5
V3	471293	174236	2.5
V4	471261	174236	2.5

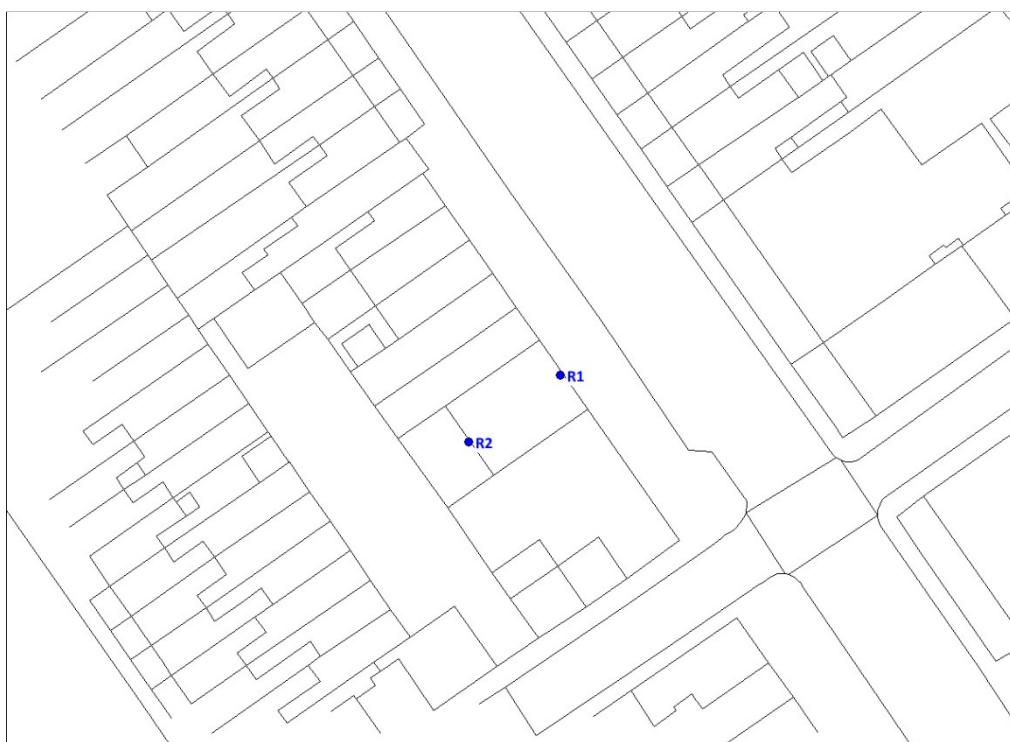
4.5.4 Receptor Locations

In order to assess the potential impact of the traffic emissions from the local road network, a number of receptors have been identified representing the different facades of the proposed development on the first and second floors. The location of these receptors, together with their height above ground level is provided in Table 6 and represented in Figure 2.

Table 6 – Modelled Receptor Locations

AQA ID	X	Y	Description	Height (m)
R1	471206	174315	Proposed Receptors: First and Second Floors	4.5 & 7.5
R2	471195	174307		

Figure 2 – Modelled Receptor Locations



4.6 Significance Criteria

4.6.1 Operational Phase

The significance of emissions will be determined by comparing the predicted results to the Air Pollution Exposure Criteria (APEC) detailed in the *Air Quality and Planning Guidance* written by the London Air Pollution Planning and the Local Environment (APPLE) working group¹⁶. The Air Pollution Exposure Criteria is considered appropriate to describe the significance of the impacts predicted, together with an indication as to the level of mitigation required in order for the development to be approved. The APEC table is provided below.

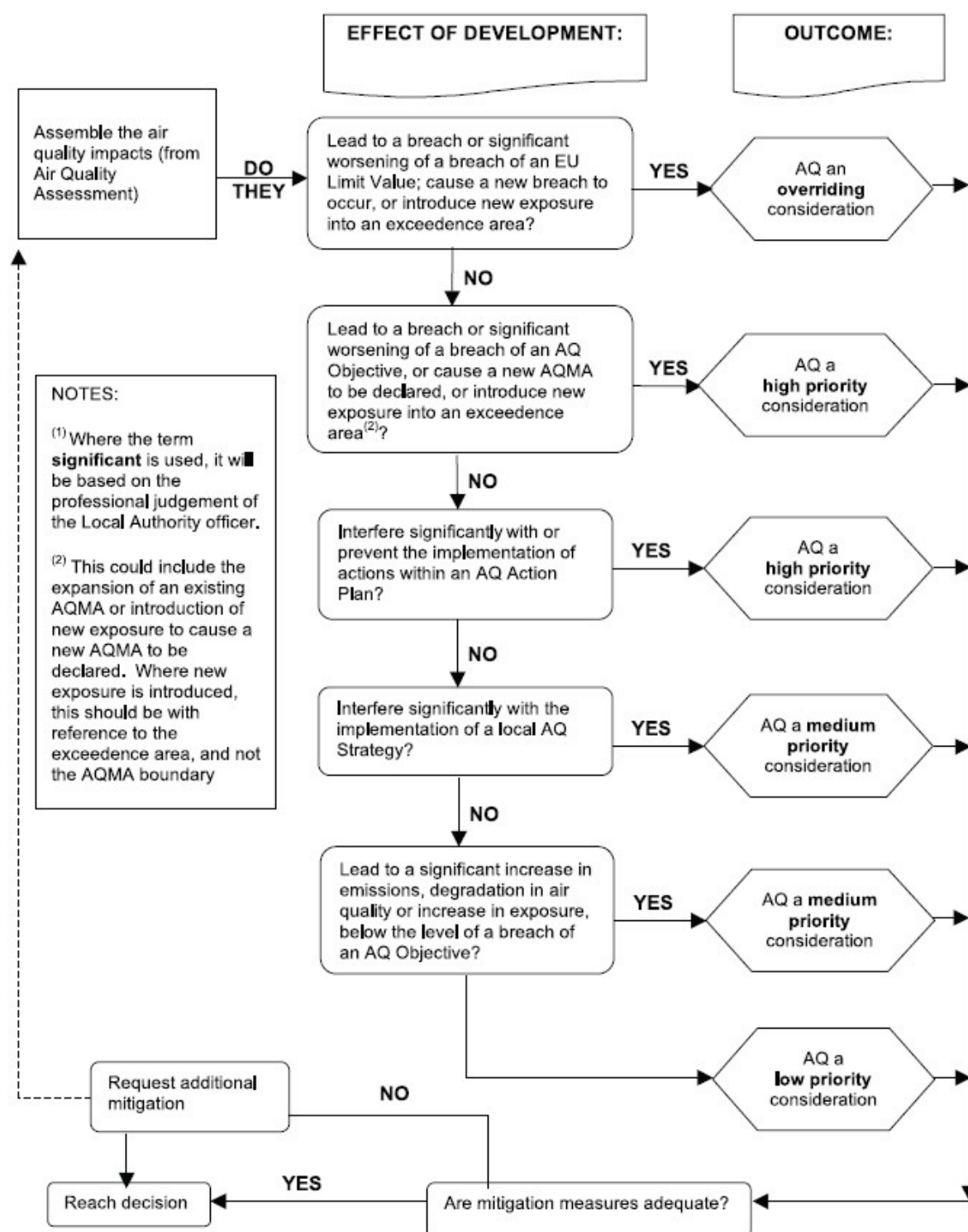
Table 7 – Air Pollution Exposure Criteria (APEC)

APEC Category	NO ₂	PM ₁₀	Recommendations
A	>5% below national annual mean objective	>5% below national annual mean objective >1-day less than national 24-hour objective	No air quality grounds for refusal; however, mitigation of any emissions should be considered.
B	Between 5% below or above national annual mean objective	Between 5% above or below national annual mean objective Between 1-day above or below national 24-hour objective	May not be sufficient air quality grounds for refusal, however appropriate mitigation must be considered
C	>5% above national annual mean objective	>5% above national annual mean objective >1-day more than national 24-hour objective	Refusal on air quality grounds should be anticipated, unless the Local Authority has a specific policy enabling such land use and ensure best endeavours to reduce exposure are incorporated

Furthermore, the guidance released by Environmental Protection UK also provides steps for a Local Authority to follow in order to assess the significance of air quality impacts of a development proposal. This procedure, shown in Figure 3, has also been applied to the modelled results.

¹⁶ Air Quality and Planning Guidance, written by the London Air Pollution Planning and the Local Environment (APPLE) working group, January 2007

Figure 3 – Assessing the Significance of Air Quality Impacts of a Development Proposal



5 AIR QUALITY ASSESSMENT

5.1 Impact of Vehicle Emissions

5.1.1 Model Verification

Using the guidance provided in Box 7.15 within the Local Air Quality Management Technical Guidance TG16¹⁷, the modelled output has been verified against the monitoring data obtained from the sites listed in Table 5. The following tables provide a summary of the model verification process for NO₂ and PM₁₀ concentrations.

Table 8 – Comparison of Modelled and Monitored NO₂ and PM₁₀ Concentrations (µg/m³), 2015

Site ID	Modelled Concentration	Monitored Concentration	Difference [(modelled - monitored)/monitored] x100
NO₂			
RD1	39.1	38.0	2.9%
V1	37.0	37.0	0.1%
V2	36.6	39.0	-6.1%
V3	37.0	38.0	-2.7%
PM₁₀			
RD1	26.0	28.0	-7.1%

As described in the Technical Guidance (LAQM.TG16), in order to provide more confidence in the model predictions and the decisions based on these, the majority of results should be within $\pm 25\%$ (ideally $\pm 10\%$) of the monitored concentrations. Since the modelled concentrations are within $\pm 10\%$ of the monitored concentrations no model adjustment has been undertaken.

¹⁷ Part IV of the Environment Act 1995, Local Air Quality Management Technical Guidance (TG16), Defra, April 2016

5.1.2 Nitrogen Dioxide

Predicted annual mean concentrations for NO₂ in 2015 and 2018 are provided in Table 9. As mentioned in Section 4.6.1, NO₂ concentrations have been calculated from the predicted NO_x concentrations using the latest NO_x-NO₂ conversion spreadsheet available from the Air Quality Archive.

Table 9 – Predicted NO₂ Concentrations, Annual Mean (µg/m³)

ID	2015		2018	
	1 st Floor	2 nd Floor	GF	1 st Floor
R1	35.4	34.1	35.9	34.6
R2	28.2	27.3	28.4	27.4
Objective	40.0			

The ADMS predictions for annual mean NO₂ concentrations in 2015 and 2018 indicate that the annual mean objective (40 µg/m³) would not be exceeded at any of the modelled locations.

Nitrogen dioxide also has an hourly objective of 200 µg/m³ not to be exceeded more than 18 times in one year. However, the hourly mean concentration has not been calculated directly by ADMS Roads. This is as a result of an evaluation of continuous monitoring data from across the UK that revealed that the relationship between the annual mean and hourly mean NO₂ concentrations was very weak. Nonetheless, research undertaken in 2003¹⁸ has indicated that the hourly NO₂ objective is unlikely to be exceeded at a roadside location where the annual mean NO₂ concentration is less than 60 µg/m³. Given that predicted NO₂ concentrations in 2015 and 2018 are below 60 µg/m³ the short term objective for NO₂ is unlikely to be exceeded.

¹⁸ Analysis of Relationship between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites, Laxen and Marner, 2003

5.1.3 Particulate Matter

Predicted annual mean concentrations for PM₁₀ in 2015 and 2018 are provided in Table 10.

Table 10 – Predicted PM₁₀ Concentrations, Annual Mean (µg/m³)

ID	2015		2018	
	1 st Floor	2 nd Floor	GF	1 st Floor
R1	18.9	18.7	18.9	18.8
R2	17.9	17.8	17.9	17.8
Objective	40.0			

The ADMS predictions for annual mean PM₁₀ concentrations in 2015 and 2018 indicate that the annual mean objective (40 µg/m³) would be achieved at all the modelled receptor locations. In addition, the maximum number of days when PM₁₀ concentrations are more than 50 µg/m³ is 3, less than the 35 exceedences allowed in the regulations.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Impact of Vehicle Emissions

Predicted PM₁₀ and NO₂ concentrations do not exceed the relevant air quality objectives in 2015 and 2018 at any of the modelled locations. Predicted concentrations fall within APEC Category A, which states that there are “no air quality grounds for refusal”. Using the flow chart presented in Figure 3, air quality is a low priority consideration.

6.1.1 Building Mitigation

Based on the results and discussion above there is no need to consider building mitigation.

6.2 Overall Conclusion

Based on the outcome of this assessment the current proposals are considered acceptable in terms of the potential air quality impacts across the development.