

Air Quality Assessment

1-2 Wesley Gate, Queens Road, Reading

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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 residential development located at 1-2 Wesley Gate in Reading, Berkshire. 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 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, Vol 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, February 2018



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.

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 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.

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



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

Pollutant	Objective	Concentration measured as
Particles (PM₁₀)	50µg/m ³ not to be exceeded more than 35 times a year	24 hour mean
	40µg/m ³	Annual mean
Particles (PM_{2.5})	25µg/m ³ (except Scotland)	Annual Mean
Nitrogen Dioxide (NO₂)	200µg/m ³ not to be exceeded more than 18 times a year	1 hour mean
	40µg/m ³	Annual mean

Objectives for PM_{2.5} were also introduced by the UK Government and the Devolved Administrations in 2010. However, the Air Quality Strategy has adopted an ‘exposure reduction’ approach for PM_{2.5} in order to seek a more efficient way of achieving further reductions in the health effects of air pollution by providing a driver to improve air quality everywhere in the UK rather than just in a small number of localised hotspot areas.

As defined in Table 4, background PM_{2.5} concentrations are well below the limit value of 25.0 µg/m³. As such, no further consideration has been given to PM_{2.5} within this assessment.

2.3 Clean Air Strategy

The Clean Air Strategy⁴ was published in January 2019 and sets out the comprehensive action that is required from across all parts of government and society to tackle all sources of air pollution. New legislation will create a stronger and more coherent framework for action to tackle air pollution. This will be underpinned by new England-wide powers to control major sources of air pollution, in line with the risk they pose to public health and the environment, plus new local powers to take action in areas with an air pollution problem. These will support the creation of Clean Air Zones to lower emissions from all sources of air pollution, backed up with clear enforcement mechanisms.

⁴ Clean Air Strategy 2019, Department for Environment, Food and Rural Affairs, January 2019



2.4 Local Air Quality Management (LAQM)

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.

2.4.1 Reading Borough Council

The Council has declared an AQMA that 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. The proposed development is located 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 updated National Planning Policy Framework (NPPF) for England, released in February 2019, 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.

Paragraph 103 within the NPPF states that the *“The planning system should actively manage patterns of growth in support of these objectives. Significant development should be focused on locations which are or can be made sustainable, through limiting the need to travel and offering a genuine choice of transport modes. This can help to reduce congestion and emissions, and improve air quality and public health. However, opportunities to maximise sustainable transport solutions will vary between urban and rural areas, and this should be taken into account in both plan-making and decision-making.”*.

It goes on to state in paragraph 181 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”*.

3.1.2 Land-Use Planning & Development Control

In January 2017, Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) produced guidance to ensure that air quality is adequately considered in the land-use planning and development control processes⁵. The guidance document is particularly applicable to assessing the effect of changes in exposure of members of the public resulting from residential and mixed-use developments, especially those within urban areas where air quality is poorer. It is also relevant to other forms of development where a proposal could affect local air quality and for which no other guidance exists.

⁵ 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. January 2017



4 ASSESSMENT METHODOLOGY

4.1 Operational Phase (Traffic Emissions)

4.1.1 Modelled Scenarios

Two scenarios have been modelled as part of this assessment. These are as follows:

- **Scenario 1 (2018)** – existing levels of air quality / model verification; and
- **Scenario 2 (2023)** – future impact of traffic emissions on the proposed development i.e. introduction of new exposure.

The current baseline year (2018) has been modelled as this corresponds with the latest air quality monitoring undertaken by the Council. A future year has been chosen (2023) representing the baseline year plus 5 years and will provide an assessment of the future impact of traffic emissions on the proposed development once completed and fully occupied.

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 model⁶. 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 9.0) which incorporates updated NO_x emissions factors and vehicle fleet information⁷. 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 2018 have been used for all modelled years.

4.1.4 Traffic Data

Baseline traffic flows along the A329 Queens Road are available from the Department for Transport (DfT)⁸. Baseline (2018) data has been projected to 2023. Projection of traffic data has been undertaken using growth factors specific to Reading Borough Council, obtained from

⁶ Model Version: 4.1.1. Interface Version 4.1.1 (18/01/2018)

⁷ https://laqm.defra.gov.uk/documents/EFT2019_v9.0.xlsb

⁸ <http://www.dft.gov.uk/traffic-counts/>



TEMPro⁹. The projected flow rates are provided in Table 3. It is assumed that the percentage HDV and speed will remain unchanged in future years.

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.

Table 3 – Annual Average Daily Traffic Flows, Percentage HDV and Speeds for Modelled Roads, 2018 and 2023

Link Name	AADT 2018	AADT 2023	HDV (%)	Speed (kph)
A329 Queens Road	19,529	20,541	1.8%	48

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 A329 Queens Road.

4.2 Background Concentrations

Background NO_x, NO₂ and PM₁₀ concentrations have been obtained from Defra¹⁰. These 1 km x 1 km grid resolution maps are derived from a base year of 2017 (for NO_x, NO₂, PM₁₀ and PM_{2.5} only), which are then projected to future years (2018). Background concentrations of NO_x, NO₂, PM₁₀ and PM_{2.5} derived from Defra are provided in Table 4.

Table 4 – Background NO_x, NO₂, PM₁₀ and PM_{2.5} Concentrations

Pollutant	X	Y	2018
NO ₂	471500	173500	27.7
NO _x			46.1
PM ₁₀			11.2
PM _{2.5}			16.2

In order to undertake a worst-case assessment, 2018 background concentrations have been assumed for all modelled scenarios.

⁹ TEMPro (Trip End Model Presentation Program) version 7.2, Department for Transport

¹⁰ <http://uk-air.defra.gov.uk/data/laqm-background-maps?year=2017>



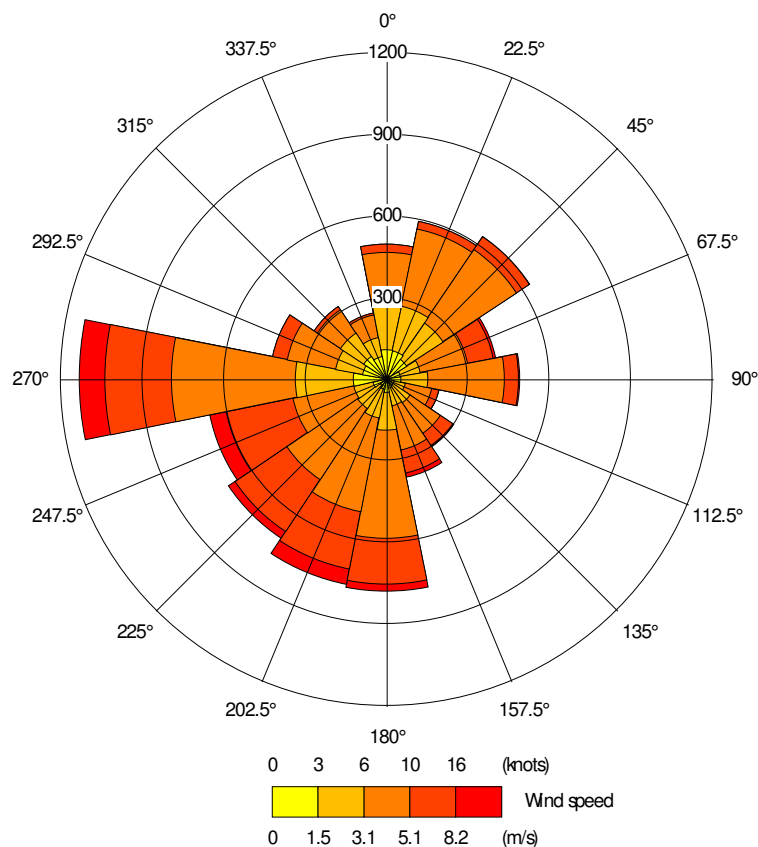
4.3 Surface Roughness

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 city. This value has been used across the modelled domain.

4.4 Meteorological Data

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

Figure 1 – Wind Speed and Direction Data, Heathrow Airport (2018)



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 increased¹¹. As such, a new NO_x to NO₂ calculator has been devised¹². 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 2003¹³ 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

Monitored concentrations from the following sites have been used for the purposes of model verification during the baseline year (2018).

Table 5 – Modelled Verification Locations

Site ID	Location	X	Y	Height (m)
DT01	Kings Oaks Flats, Queens Road	472014	173223	2.5

¹¹ Trends in Primary Nitrogen Dioxide in the UK, Air Quality Expert Group, 2007

¹² https://laqm.defra.gov.uk/documents/NOx_to_NO2_Calculator_v7.1.xlsm

¹³ Analysis of Relationship between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites, Laxen and Marner, 2003



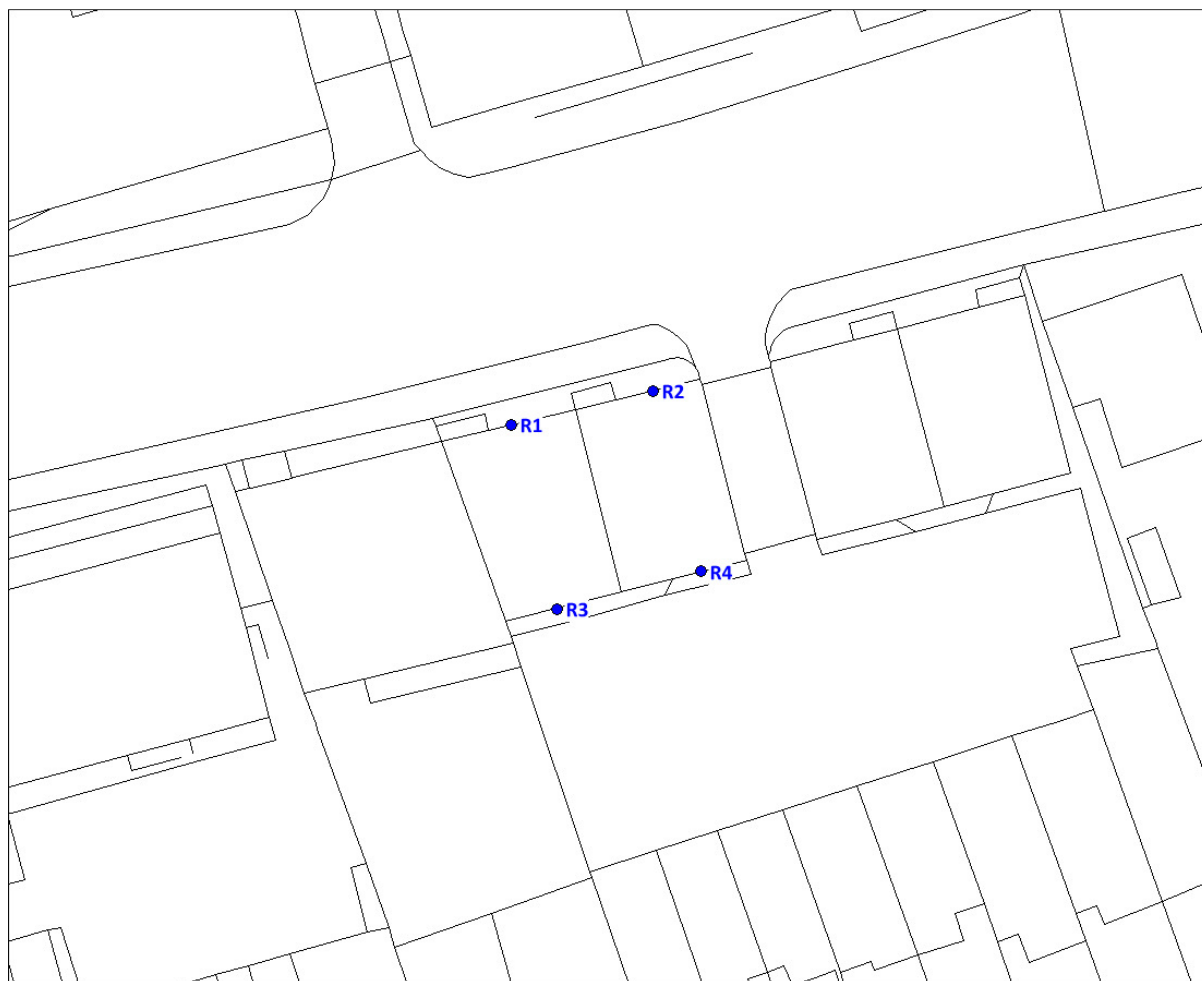
4.5.4 Receptor Locations

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. The location of these modelled 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	Height (m)	Description
R1	472152	173224	1.5, 4.5, 7.5 & 10.5	Proposed Receptors, Ground to Third Floor
R2	472162	173227		
R3	472155	173211		
R4	472166	173213		

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 group¹⁴. 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)

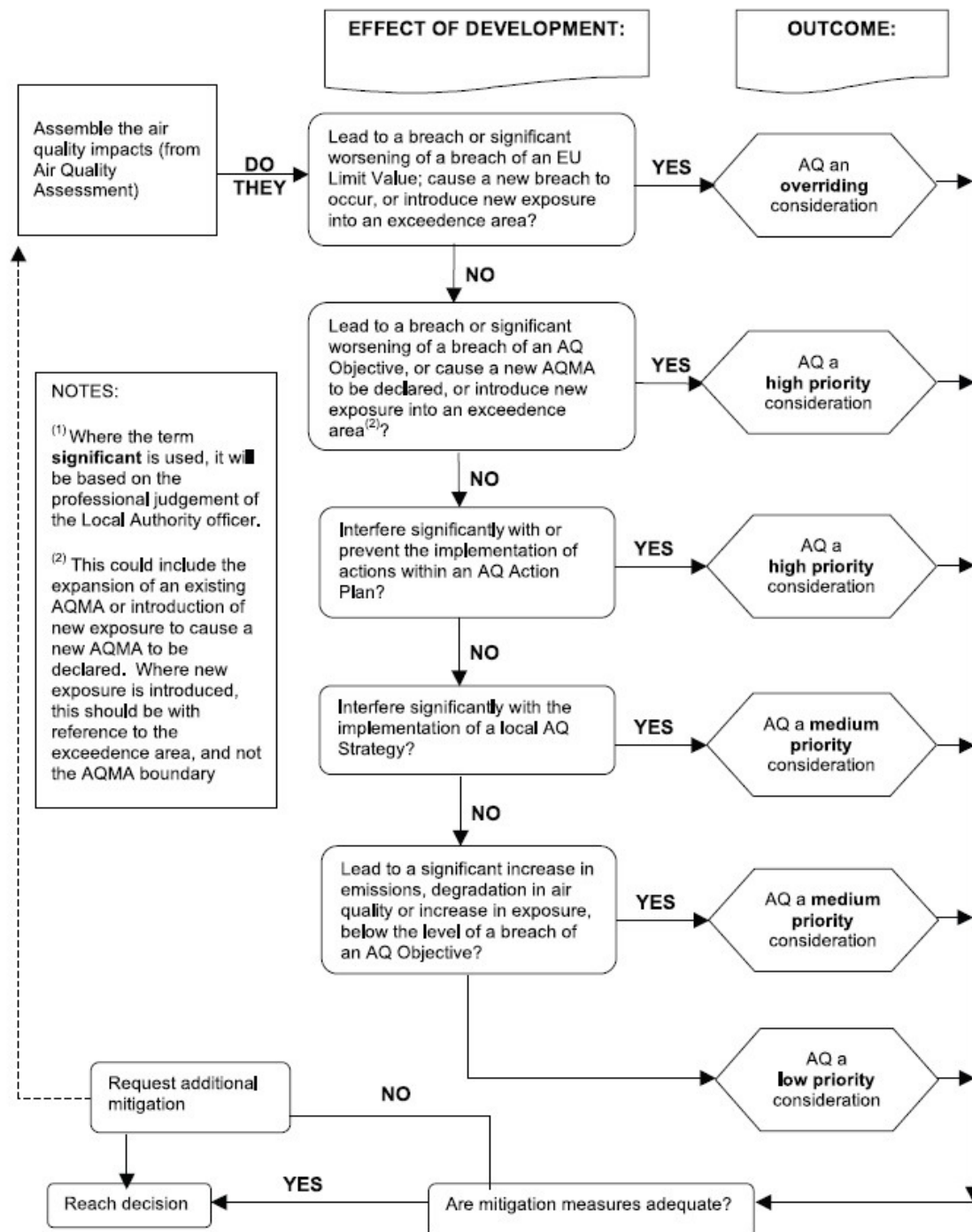
APEC Category	NO ₂	PM ₁₀	Recommendations
A	>5% below national annual mean objective	>5% below national annual mean objective >1-day less than national 24-hour objective	No air quality grounds for refusal; however mitigation of any emissions should be considered.
B	Between 5% below or above national annual 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.

¹⁴ 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 within the Local Air Quality Management Technical Guidance TG(16), 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 NO_x/NO₂ concentrations.

Table 8 – Comparison of Modelled and Monitored NO₂ Concentrations (µg/m³), 2018

Verification Location	Modelled Concentration	Monitored Concentration	Difference [(modelled - monitored)/monitored] x100
DT01	35.0	32.0	9.2%

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. Given that the modelled concentrations are within these limits no model adjustment is considered necessary. Moreover, the model verification shows an over-prediction meaning a worst case assessment across the proposed development

5.1.2 Nitrogen Dioxide

Predicted annual mean concentrations for NO₂ in 2018 and 2023 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)

Receptor ID	2018				2023			
	GF	1 st	2 nd	3 rd	GF	1 st	2 nd	3 rd
R1	36.6	35.5	34.8	34.4	36.9	35.8	35.2	34.7
R2	36.8	35.6	34.9	34.5	37.2	36.0	35.2	34.8
R3	30.2	29.6	28.9	28.4	30.3	29.7	28.9	28.4
R4	30.1	29.5	28.8	28.4	30.2	29.6	28.9	28.4
Objective	40.0							



The ADMS predictions for annual mean NO₂ concentrations in 2018 and 2023 indicate that the annual mean objective (40 µg/m³) would be achieved at all modelled receptors.

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 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. Given that predicted NO₂ concentrations in 2018 and 2023 are below 60 µg/m³ the likelihood of the short-term objective being exceeded is considered low.

5.1.3 Particulate Matter

Predicted annual mean concentrations for PM₁₀ in 2018 and 2023 are provided in Table 10.

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

Receptor ID	2018				2023			
	GF	1 st	2 nd	3 rd	GF	1 st	2 nd	3 rd
R1	12.5	12.4	12.3	12.2	12.6	12.4	12.3	12.3
R2	12.6	12.4	12.3	12.2	12.6	12.4	12.3	12.3
R3	11.6	11.5	11.4	11.3	11.6	11.5	11.4	11.3
R4	11.5	11.5	11.4	11.3	11.6	11.5	11.4	11.3
Objective	40.0							

The ADMS predictions for annual mean PM₁₀ concentrations in 2018 and 2023 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 2, less than the 35 exceedences allowed in the regulations.

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



6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Impact of Vehicle Emissions

The predicted concentrations of PM₁₀ and NO₂ in all modelled years are below the relevant objectives. Predicted concentrations at all the modelled receptors fall within APEC Category A, which states that there are “no air quality grounds for refusal, however, mitigation of any emissions should be considered”. Overall, using the flow chart presented in Figure 4, air quality is a low priority consideration at the modelled locations in each of the modelled years.

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.

