ARDENT CONSULTING ENGINEERS

13-17 RED LION SQUARE LLP

14 - 17 RED LION SQUARE, HOLBORN

AIR QUALITY ASSESSMENT

REPORT REF. Y740-008
PROJECT NO. Y740
DECEMBER 2015

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AIR QUALITY ASSESSMENT

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1.0 INTRODUCTION

Scope

1.1 Ardent Consulting Engineers Ltd has been commissioned to undertake a detailed air quality assessment, with specialist assistance from GEM Air Quality Ltd, based on the potential impacts of existing and future traffic levels on a proposed residential development located at 14 to 17 Red Lion Square in Camden, London. The pollutants modelled as part of this assessment are nitrogen oxides (NOx) and particulate matter (PM_{10}).

1.2 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.TG09)[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*".

1.3 It should be noted that the short term impacts of NO_2 and PM_{10} 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.

1.4 An Air Quality Neutral Assessment has also been undertaken based on the latest guidance issued by the Mayor of London.

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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 (TG09), Defra, February 2009

2.0 POLLUTANTS & LEGISLATION

Pollutant Overview

2.1 In most urban areas of the UK, traffic generated pollutants have become the most common pollutants. These are nitrogen dioxide (NO_2), fine particulates (PM_{10}), carbon monoxide (CO), 1,3-butadiene and benzene, as well as carbon dioxide (CO_2). This air quality assessment focuses on NO_2 and PM_{10}, as these pollutants are least likely to meet their Air Quality Strategy objectives near roads. Table 1 provides an overview of NO_2 and PM_{10}.

Table 1 – Overview of NO_2 and PM_{10}

Pollutant	Properties	Anthropogenic Sources	Natural Sources	Potential Effects
Particles (PM_{10})	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 (NO_2)	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

Air Quality Strategy

2.2 The UK Government and the devolved administrations published the latest Air Quality Strategy for England, Scotland, Wales and Northern Ireland on 17 July 2007[3]. 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.

2.3 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

[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

dioxide and particulates (PM_{10} 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 2007 which came into force on 15th February 2007. Table 2 provides the UK Air Quality Objectives for NO_2 and PM_{10}.

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 (PM_{10})	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 (NO_2)	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

2.4 Objectives for $PM_{2.5}$ were also introduced by the UK Government and the Devolved Administrations in 2007. However, these are not included in Regulations as 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 such, this assessment has not considered the impact on emissions of $PM_{2.5}$.

Local Air Quality Management

2.5 Part IV of the Environment Act 1995 requires local authorities to review and assess existing air quality within their boundaries, as well as predict future air quality as part of an ongoing Review and Assessment process. The current timetable for Review and Assessment (rounds 4, 5 and 6) requires every local authority to report to Defra up to and including 2018, with the different elements repeated over a three year cycle.

London Borough of Camden

2.6 The proposed development lies within the London Borough of Camden. The Council has declared an Air Quality Management Area (AQMA) that encompasses the entire Borough. As such, the proposed development lies within this AQMA.

3.0 PLANNING POLICY & GUIDANCE

National Planning Policy & Guidance

National Planning Policy Framework

3.1 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 2013, 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].

3.2 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".

3.3 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".

Land-Use Planning & Development Control

3.4 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.

3.5 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 processes [6].

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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

The Air Quality Expert Group

3.6 The Air Quality Expert Group (AQEG) is an advisory group that provides independent scientific advice on air quality. AQEG published *Air Quality and Climate Change: A UK Perspective*[7] in 2007. The report recognises the potential for both local and global air quality improvements. Local authorities will be looking towards reductions in both and developers should take this into account throughout the design, construction and operational phases of a development, bearing in mind any potential trade-offs between global and local air quality improvements.

Local Planning Policy

The Mayor's Air Quality Strategy

3.7 In October 2010, the Mayor's Air Quality Strategy[8] was released. The strategy sets out a framework for delivering improvements to London's air quality and includes measures aimed at reducing emissions from transport, homes, offices and new developments, as well as raising awareness of air quality issues and its impact on health.

The London Plan

3.8 In March 2015, the updated London Plan was published by the Greater London Authority[9]. The London Plan provides an overall strategic plan for London, setting out an integrated economic, environmental, transport and social framework for the development of London over the next 20–25 years. The Plan brings together the geographic and locational aspects of the Mayor's other strategies, including a range of environmental issues such as climate change (adaptation and mitigation), air quality, noise and waste.

3.9 Policy 7.14 relates specifically to improving air quality and states the following:

"*The Mayor recognises the importance of tackling air pollution and improving air quality to London's development and the health and well-being of its people. He will work with strategic partners to ensure that the spatial, climate change, transport and design policies of this plan support implementation of his Air Quality and Transport strategies to achieve reductions in pollutant emissions and minimize public exposure to pollution*".

3.10 It goes on to state the following with regards to planning decisions:

"*Development proposals should:*

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7 Air Quality Expert Group (AQEG) report – Air quality and climate change: a UK perspective, published for the Department for Environment, Food and Rural Affairs, Scottish Executive, Welsh Assembly Government and Department of the Environment in Northern Ireland, 2007

8 Clearing the Air: The Mayor's Air Quality Strategy. October 2010

9 The London Plan. The Spatial Development Strategy for London. Consolidated with Alterations. March 2015

a minimise increased exposure to existing poor air quality and make provision to address local problems of air quality (particularly within Air Quality Management Areas (AQMAs) and where development is likely to be used by large numbers of those particularly vulnerable to poor air quality, such as children or older people) such as by design solutions, buffer zones or steps to promote greater use of sustainable transport modes through travel plans (see Policy 6.3).

b promote sustainable design and construction to reduce emissions from the demolition and construction of buildings following the best practice guidance in the GLA and London Councils' 'The control of dust and emissions from construction and demolition' be at least 'air quality neutral' and not lead to further deterioration of existing poor air quality (such as areas designated as Air Quality Management Areas (AQMAs)).

c ensure that where provision needs to be made to reduce emissions from a development, this is usually made on-site. Where it can be demonstrated that on-site provision is impractical or inappropriate, and that it is possible to put in place measures having clearly demonstrated equivalent air quality benefits, planning obligations or planning conditions should be used as appropriate to ensure this, whether on a scheme by scheme basis or through joint area-based approaches.

d where the development requires a detailed air quality assessment and biomass boilers are included, the assessment should forecast pollutant concentrations. Permission should only be granted if no adverse air quality impacts from the biomass boiler are identified".

4.0 ASSESSMENT METHODOLOGY

Operational Phase (Traffic Emissions)

Modelled Scenarios

4.1 A future year has been chosen (2018) for the assessment, along with the baseline year (2013). 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 (2013); and
- **Scenario 2** – future impact of traffic emissions on the proposed development i.e. introduction of new exposure (2018).

4.2 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.

ADMS-Roads

4.3 Modelling the impact of traffic emissions on the proposed development will be undertaken using the latest version of the ADMS-Roads model[10]. 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.

Emission Factors

4.4 Defra and the Devolved Administrations have provided an updated Emission Factors Toolkit (Version 6.0) which incorporates updated NOx emissions factors and vehicle fleet information[11]. 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 2013 have been used for all modelled years.

Traffic Data

4.5 Baseline traffic flows along the local roads are available from the London Atmospheric Emissions Inventory (LAEI)[12]. Baseline data from the LAEI has been projected to 2014 and 2018. Projection of traffic data has been undertaken using growth factors specific to the London Borough of

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[10] Model Version: 3.4.2.0. Interface Version 3.4.0 (02/09/2014)
[11] http://laqm.defra.gov.uk/documents/EFT2014_v6.0.2.xls.zip
[12] LAEI (2008), Greater London Authority

Camden, obtained from TEMPro[13] and National Road Traffic Forecasts (NRTF)[14]. The projected flow rates are provided in Table 3. It is assumed that the percentage Heavy Duty Vehicle and speed will remain unchanged in future years. The A400 Bloomsbury Street has been modelled for the purposes of model verification.

4.6 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, 2013 and 2018

Link Name	AADT 2013	AADT 2018	HDV (%)	Speed (kph)
A400 Bloomsbury Street	**11,790**	**13,419**	14.0%	32
A40 High Holburn	**19,993**	**22,755**	9.2%	29
A401 Theobold's Road	**19,129**	**21,772**	10.9%	34
Proctor Street	**17,094**	**19,455**	12.6%	21

4.7 A newer version of the LAEI ("LAEI 2010") was released in July 2013. However, the traffic data provided as part of this update is no longer presented geographically but rather as an Access database with each link supplied with a unique topographic identifier (TOID). These identifiers can only be cross-referenced with OS MasterMap ITN (Integrated Transport Layer) map data, which must be purchased from a relevant supplier. Given that the LAEI data presented in the tables above will be modelled with the latest vehicle emissions data (section 4.2.3) and verified against local monitoring data (Section 4.6.3) it is not considered necessary to derive traffic flows from the newer version of the LAEI as any discrepancy in the traffic data will be highlighted by the model verification process[15].

4.8 It should also be noted that recent DfT data has indicated a stabilisation in vehicle numbers in recent years, which is not reflected in the projected traffic flows provided above. As such, there is speculation that vehicle flows have peaked in some areas, such as within towns and cities. However, in order to undertake a worst case assessment the projected 2018 traffic flows have been used within the assessment but should be treated with caution due to the uncertainties in forecasting future traffic flows.

13 Tempro (Trip End Model Presentation Program) version 6 , dataset v5.4 Department for Transport
14 National Road Traffic Forecasts (Great Britain) 1997, Department for Transport
15 GEM Air Quality Ltd has also encountered discrepancies between the LAEI 2010 TOID data and OS MasterMap ITN data, meaning the TOID data could not be matched within the two datasets meaning that the relevant traffic data could not be located. As such, traffic data from the LAEI 2008 database has been used.

Street Canyons

4.9 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 all modelled links.

Background Concentrations

4.10 Background NOx, NO_2 and PM_{10} concentrations have been obtained from Defra[16]. These 1 km x 1 km grid resolution maps are derived from a base year of 2011 (for NOx, NO_2, PM_{10} and $PM_{2.5}$ only), which are then projected to future years (2013). Background concentrations of NOx, NO_2 and PM_{10} derived from Defra are provided in Table 4.

Table 4 – Background NOx, NO_2 and PM_{10} Concentrations

Pollutant	X	Y	2013
NO_2	530500	181500	52.1
NOx			94.0
PM_{10}			26.0

4.11 The background concentrations, which are consistent with monitored concentrations undertaken by the London Borough of Camden averaged over the last three years, are already exceeding the relevant air quality objective for NO_2.

Surface Roughness

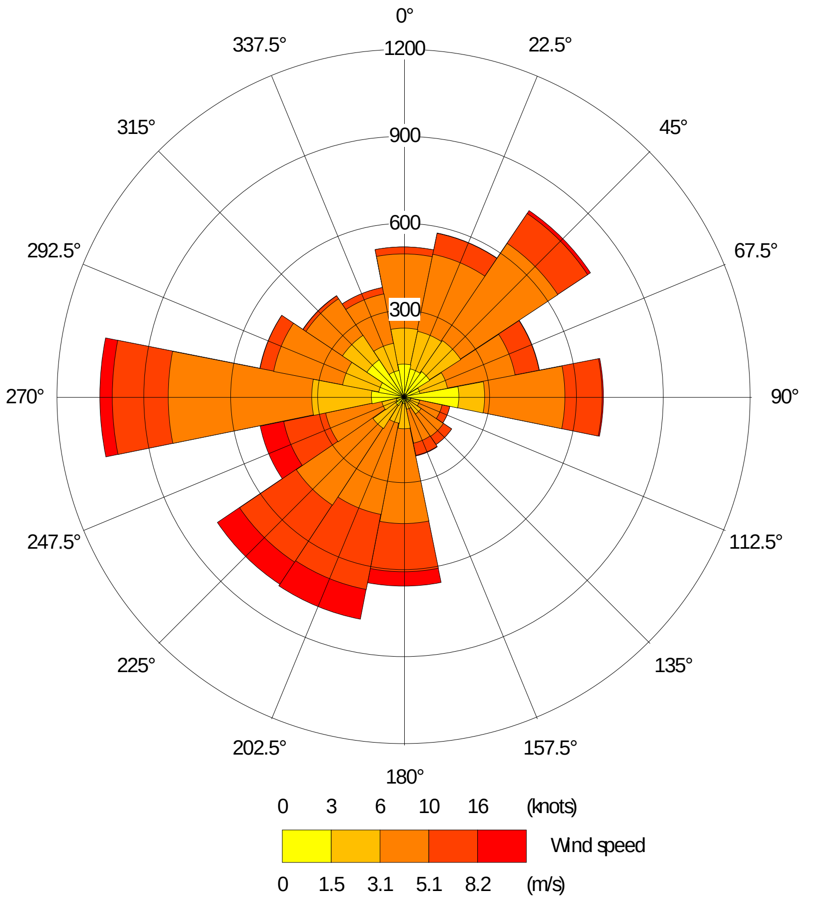
4.12 A surface roughness of 1.5 metre has been used in the model. This value is provided by ADMS-Roads as a typical roughness length for large urban areas. This value has been used across the modelled domain.

Meteorological Data

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

16 http://uk-air.defra.gov.uk/data/laqm-background-maps?year=2011

Figure 1 – Wind Speed and Direction Data, Heathrow Airport (2013)



Model Output

NOx/NO_2 Relationship

4.14 Following recent evidence that shows the proportion of primary NO_2 in vehicle exhaust has increased[17]. As such, a new NOx to NO_2 calculator has been devised[18]. This new calculator has been used to determine NO_2 concentrations for this assessment, based on predicted NOx concentrations using ADMS-Roads. Converted NO_2 concentrations are initially compared to local monitoring data in order to verify the model output. If the model performance is considered unacceptable then the NOx concentrations are adjusted before conversion to NO_2.

Predicted Short Term Concentrations

4.15 As discussed in the introduction, it has not been possible to model the short term impacts of NO_2 and PM_{10}. Research undertaken in 2003[19] has indicated that the hourly NO_2 objective is unlikely to be exceeded at a roadside location where the annual mean NO_2 concentration is less than 60 µg/m^3.

4.16 For PM_{10}, 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 x annual mean^3 + (206/annual mean)

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

Model Verification

4.18 The London Borough of Camden undertakes monitoring of NO_2 a roadside sites located near to the proposed development. Monitored concentrations from these sites have been used for the purposes of model verification during the baseline year (2013). The location of these verification sites is provided in Table 5.

Table 5 – Modelled Verification Locations

ID	Location	X	Y	Height (m)
CA21	Bloomsbury Street	529962	181620	2.5

Receptor Locations

4.19 In order to assess the potential impact of the traffic emissions from the local road network, a number of receptors have been identified

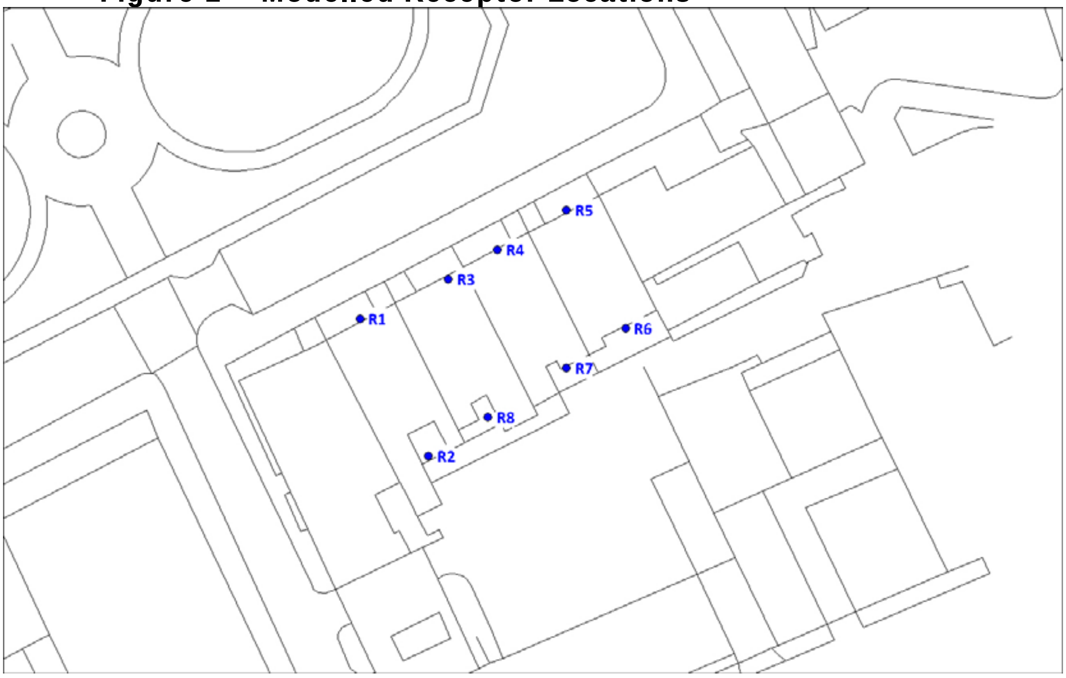
[17] Trends in Primary Nitrogen Dioxide in the UK, Air Quality Expert Group, 2007
[18] http://laqm.defra.gov.uk/documents/NOx-NO2-Calculator-v4.1.xls
[19] Analysis of Relationship between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites, Laxen and Marner, 2003

representing the different facades of the proposed development. 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	Height (m)	Description
R1	530641	181689	0.5, 3.5, 6.5, 9.5, 12.5	Proposed Residential Receptors
R2	530648	181675		
R3	530650	181693		
R4	530655	181696		
R5	530662	181700		
R6	530668	181688		
R7	530662	181684		
R8	530654	181679		

Figure 2 – Modelled Receptor Locations



Significance Criteria

Operational Phase

4.20 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 group[20]. 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.

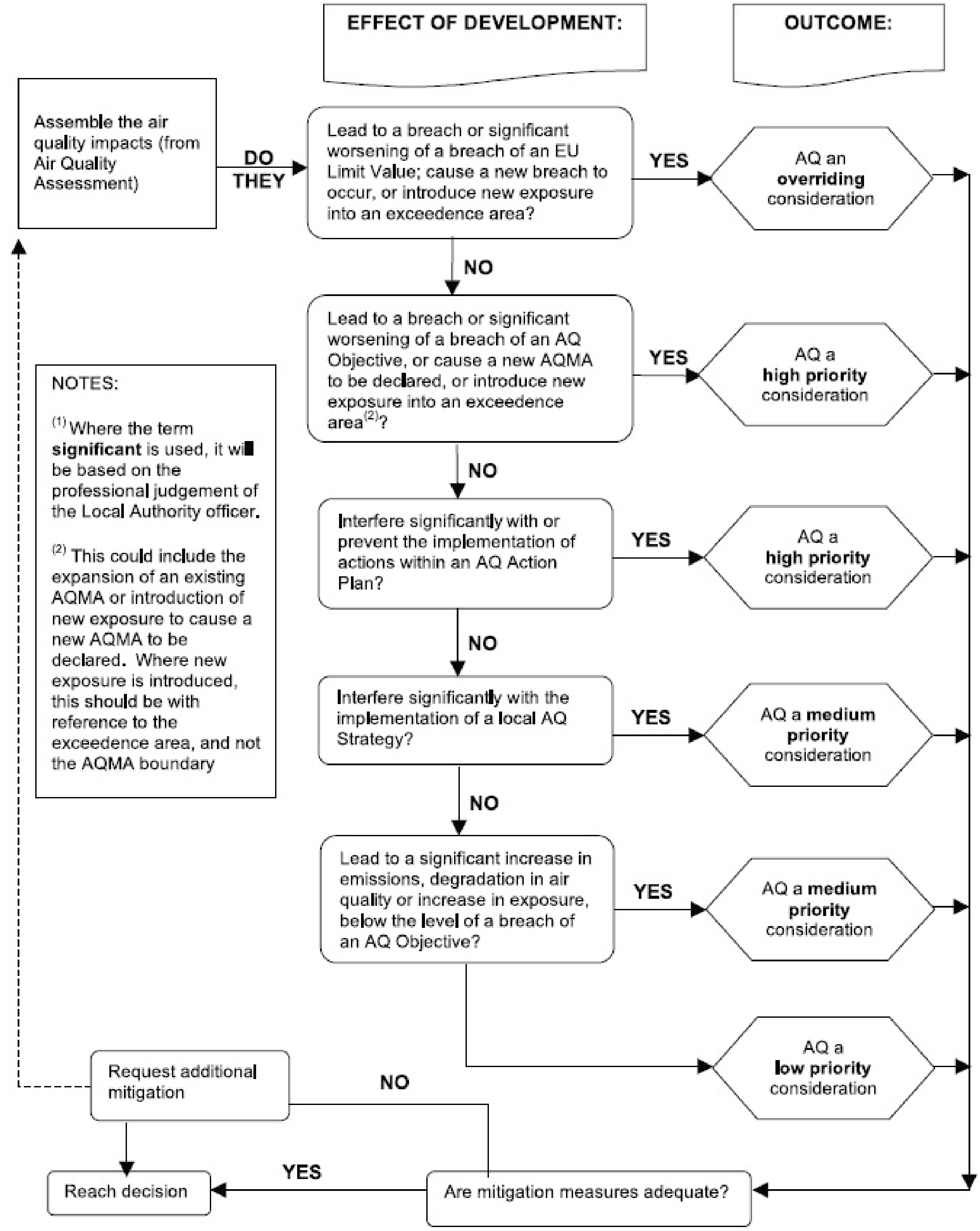
[20] Air Quality and Planning Guidance, written by the London Air Pollution Planning and the Local Environment (APPLE) working group, January 2007

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

4.21 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 4, has also been applied to the modelled results.

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



5.0 AIR QUALITY ASSESSMENT

Impact of Vehicle Emissions

Model Verification

5.1 Using the guidance provided in Box A3.6 within the Local Air Quality Management Technical Guidance TG(09)[21], 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 NOx/NO_2 concentrations.

Table 8 – Comparison of Modelled and Monitored NO_2 Concentrations (µg/m^3), 2013

Verification Location	Modelled Concentration	Monitored Concentration	Difference [(modelled - monitored)/ monitored] x100
CA21	65.9	76.1	-13.4%

5.2 As described in the Technical Guidance (LAQM.TG09), in order to provide more confidence in the model predictions and the decisions based on these, the majority of results should be within ±25% (ideally ±10%) of the monitored concentrations. In order to improve the confidence in modelled concentrations across the modelled domain the model output has been adjusted. This is described further in the next section.

Model Adjustment

5.3 In order to undertake model adjustment, it is first necessary to derive the monitored and modelled road contributions of NOx (excluding background). The modelled road contribution NOx is taken directly from the ADMS-Roads output before it has been converted to NO_2 using the NOx to NO_2 calculator described in Section 4.6.1. The NOx to NO_2 calculator can also be used to derive monitored road contributions of NOx from NO_2 diffusion tube results. A summary of these calculations is provided in Table 9.

5.4 Once the monitored and modelled road contributions of NOx (excluding background) have been derived the contributions of NOx are compared and a ratio derived. In this case the ratio is 1.9 and this factor has been used to adjust the modelled road contribution of NOx. This is shown in Table 10.

[21] Part IV of the Environment Act 1995, Local Air Quality Management Technical Guidance (TG09), Defra, February 2009

Table 9 – Monitored NOx and NO_2 concentrations, 2013

Site ID	Monitored Total NO_2	Defra Background NO_2	Monitored road contribution NO_2 (total – background)	Monitored road contribution NOx (total – background)	Modelled road contribution NOx (excludes background)	Ratio of monitored road contribution NOx / modelled road contribution NOx
CA21	76.1	52.1	24.0	72.0	38.4	1.9

Table 10 – Adjustment of Modelled NOx Contributions, 2013

AQA ID	Adjustment factor for modelled road contribution	Adjusted modelled road contribution NOx	Modelled total NO_2 (based on empirical NOx/NO_2 relationship)	Monitored total NO_2	% Difference [(modelled – monitored) / monitored] x 100
CA21	1.9	73.0	76.4	76.1	0.4%

5.5 Following adjustment of the modelled NOx concentrations by a factor of 1.9 the total NO_2 concentration at the model verification location has been calculated using the method described in Section 4.6.1. The revised NO_2 concentration, shown in Table 10, indicates a more acceptable model performance when compared against the monitored NO_2 concentrations. As such, an adjustment factor of 1.9 has been applied to all modelled NOx concentrations across the model domain before conversion to NO_2.

Nitrogen Dioxide

5.6 Predicted annual mean concentrations for NO_2 in 2013 and 2018 are provided in Table 11. As mentioned in Section 4.6.1, NO_2 concentrations have been calculated from the predicted NOx concentrations using the latest NOx-NO_2 conversion spreadsheet available from the Air Quality Archive.

Table 11 – Predicted NO_2 Concentrations, Annual Mean ($\mu g/m^3$)

Receptor ID	Basement	Ground Floor	1st Floor	2nd Floor	3rd Floor
2014					
R1	56.9	56.8	56.5	56.0	55.5
R2	56.8	56.7	56.4	55.9	55.4
R3	56.6	56.5	56.2	55.8	55.3
R4	56.5	56.3	56.1	55.7	55.3
R5	56.3	56.2	55.9	55.6	55.2
R6	56.2	56.1	55.8	55.5	55.1
R7	56.3	56.2	56.0	55.6	55.2
R8	56.6	56.5	56.2	55.8	55.3
2018					
R1	57.6	57.4	57.0	56.5	55.9

R2	57.4	57.3	56.9	56.4	55.9
R3	57.2	57.1	56.7	56.3	55.8
R4	57.0	56.9	56.6	56.2	55.7
R5	56.8	56.7	56.4	56.0	55.6
R6	56.7	56.6	56.3	56.0	55.5
R7	56.9	56.8	56.5	56.1	55.6
R8	57.2	57.0	56.7	56.3	55.8
Objective	**40.0**				

5.7 The predicted concentrations of NO_2 in 2013 and 2018 exceed the annual mean objective at all modelled receptor locations. Using the flow chart presented in Figure 4, air quality (NO_2) is a "medium priority consideration" in 2013 and 2018 at all the modelled receptors.

5.8 Nitrogen dioxide also has an hourly objective of 200 $\mu g/m^3$ 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 NO_2 concentrations was very weak. Nonetheless, research undertaken in 2003[22] has indicated that the hourly NO_2 objective is unlikely to be exceeded at a roadside location where the annual mean NO_2 concentration is less than 60 $\mu g/m^3$. Given that predicted NO_2 concentrations in 2013 and 2018 approach 60 $\mu g/m^3$ there is an increased likelihood of the short term objective being exceeded.

Particulate Matter

5.9 Predicted annual mean concentrations for PM_{10} in 2013 and 2018 are provided in Table 12.

Table 12 – Predicted PM_{10} Concentrations, Annual Mean ($\mu g/m^3$)

Receptor ID	Basement	Ground Floor	1st Floor	2nd Floor	3rd Floor
2014					
R1	26.3	26.3	26.3	26.2	26.2
R2	26.3	26.3	26.3	26.2	26.2
R3	26.3	26.3	26.2	26.2	26.2
R4	26.3	26.3	26.2	26.2	26.2
R5	26.2	26.2	26.2	26.2	26.2
R6	26.2	26.2	26.2	26.2	26.2
R7	26.3	26.2	26.2	26.2	26.2
R8	26.3	26.3	26.2	26.2	26.2
2018					
R1	26.3	26.3	26.3	26.3	26.2
R2	26.3	26.3	26.3	26.3	26.2
R3	26.3	26.3	26.3	26.3	26.2
R4	26.3	26.3	26.3	26.2	26.2
R5	26.3	26.3	26.3	26.2	26.2
R6	26.3	26.3	26.3	26.2	26.2
R7	26.3	26.3	26.3	26.2	26.2

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

R8	26.3	26.3	26.3	26.2	26.2
Objective	**40.0**				

5.10 The ADMS predictions for annual mean PM_{10} concentrations in 2014 and 2018 indicate that the annual mean objective (40 μg/m^3) would be achieved at all the modelled receptor locations. In addition, the maximum number of days when PM_{10} concentrations are more than 50 μg/m^3 is 16, less than the 35 exceedences allowed in the regulations.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Impact of Vehicle Emissions

6.1 Based on the outcome of this assessment mitigation measures would be required in order to mitigate the impact of poor air quality on the future occupants of the proposed development.

6.2 The Institute of Air Quality Management (IAQM) issued a position statement in relation to the mitigation of development air quality impacts[23]. Based on this statement, the IAQM recommends that the following basic hierarchy be used for mitigating the operational air quality impacts associated with the particular development:

1. Preference should be given to **preventing or avoiding** exposure/impacts to the pollutant in the first place by eliminating or isolating potential sources or by replacing sources or activities with alternatives;

2. **Reduction and minimisation** of exposure/impacts should next be considered, once all options for prevention/avoidance have been implemented so far as is reasonably practicable (both technically and economically);

3. **Off-setting** a new development's air quality impact by proportionately contributing to air quality improvements elsewhere (including those identified in air quality action plans and low emission strategies) should only be considered once the solutions for preventing/avoiding, and then for reducing/minimising, impacts have been exhausted.

6.3 Based on this hierarchy, Option 2 could be applied to the proposed development. Using Option 2, some form of mitigation could be implemented for all residential units so that the future occupants are not reliant solely on opening windows in order to ventilate their property. This would require an additional form of ventilation, whereby clean air is drawn in naturally or mechanically and maintained thereafter.

6.4 A mechanical ventilation system that draws air in from the roof may not be considered acceptable by the Council due to predicted exceedences at the fourth floor level. However, this assumes that there is no drop off in background concentrations meaning the predicted concentrations at the first floor and above may be lower than predicted.

6.5 Alternatively, air could be drawn in and filtered[24]. Such filtration systems would "scrub" the incoming air stream of NO_2, reducing the concentrations of NO_2 to well below the air quality objective within the building. Such systems are becoming more common, particularly at city centre locations where traffic emissions make it difficult to find locations where clean air can be drawn into the property. A filtered ventilation

23 Position Statement – Mitigation of Development Air Quality Impacts, IAQM, January 2015
24 Such devices include the AAC Swiftpack® with Nitrosorb® media for NO_2 and NOx removal, or the City Breathe: Indoor Air Quality Filtration System

system would also allow the inlets to be placed anywhere regardless of the predicted NO_2 concentrations, although they should ideally be placed as far away from emission sources as possible in order to reduce the burden on the filters. If such a filtration system is installed the Council will require details relating to the mechanical ventilation and air filtration systems, as well as the ongoing maintenance and cleaning of the these systems.