373-375 Euston Road (Cambridge House)

Air Quality - Ventilation Strategy

July 2019

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Comments

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Executive Summary

Air quality modelling has been undertaken to inform the location of air intakes for the mechanical ventilation system within the approved planning application (Planning Reference: 2017/7079/P) of the educational development (the 'Development') at Cambridge House, 373-375 Euston Road, London (the 'Site').

This Air Quality Assessment uses the detailed dispersion model ADMS-Roads to predict existing concentrations of nitrogen dioxide (NO_2) at the Site for each floor level, on each façade, of the Development. Given the Development is for educational uses only (teaching facilities), in accordance with Defra Technical Guidance only the short-term Air Quality Strategy (AQS) objectives apply for the protection of health, as members of the public will not have regular access to the building.

No air quality monitoring has been undertaken. Following Defra Technical Guidance, the dispersion modelling outputs have been checked for accuracy against an air quality monitor operated by the London Borough of Westminster 900m west of the Site. In addition, for conservatism, the model considers a street canyon (a road where buildings can constrain the dispersion of air and can result in air quality concentrations to be elevated) along Euston Road.

The Site is located in the Ultra-Low Emission Zone (ULEZ). Transport for London have predicted the ULEZ will decrease nitrogen oxide (NOx) emissions from vehicles by 31% in Inner London by 2021. To take account of the benefits expected to be introduced by the ULEZ a sperate analysis has been undertaken, where a 31% reduced has been applied to the modelled road NOx concentrations prior to conversion to NO_2.

Without the benefits of the ULEZ, the modelling results show predicted concentrations of NO_2 at roof level on the north façade, located in the street canyon of Euston Road, is above the AQS objective and air should not be drawn in from this location. However, concentrations of NO_2 at roof level on the eastern, western and southern façade (outside of the Euston Road street canyon) are below the AQS objective for NO_2 and away from the local sources of air pollution; as such air could be drawn in from these locations. If air is taken from roof level on the eastern, western and southern façade, no further air quality mitigation, such as the use of NOx filtration is required.

With the ULEZ and expected benefit to NOx emissions, the modelling results show NO_2 are below the AQS objective on all facades. In this scenario whilst air could be drawn in from any façade at roof level, it is recommended that air is drawn in away from the Euston Road street canyon (i.e. from roof level on the eastern, western and southern façade). No further air quality mitigation, such as the use of NO_x filtration is required.

1. Introduction

1.1. This Air Quality Dispersion Modelling Assessment has been prepared by Waterman Infrastructure & Environment (hereafter referred to as 'Waterman') and considers the location of air intakes for the mechanical ventilation system within the approved planning application (Planning Reference: 2017/7079/P) of the educational development at Cambridge House, 373-375 Euston Road, London (hereafter referred to as the 'Site').

1.2. The redevelopment of the Site includes the change of use of the existing Site to Class D1; restoration and enhancement of the existing early twentieth century building; and the construction of a rooftop lecture facility (hereafter referred to as the 'Development').

1.3. The Site is approximately 380m^2 in area, centred on Ordnance Survey Grid Reference 528964,182170. The Site is bound to the north by Euston Road; to the west by Cleveland Street; to the south by Warren Street and to the east by office and commercial buildings.

1.4. The Site is located within the administrative area of London Borough of Camden (LBC). LBC has designated an Air Quality Management Area (AQMA) for exceedances of the annual mean nitrogen dioxide (NO_2) Air Quality Strategy (AQS) objective and the 24-hour mean particulate matter (PM_{10}) AQS objective attributed to vehicle emissions. The AQMA covers the whole Borough. Consequently, the Site is located within this AQMA. In addition, the Development is located in the Marylebone Road Air Quality Focus Area (AQFA), which is an area that exceeds the EU annual mean limit value for nitrogen dioxide (NO_2), and has high human exposure.

1.5. LBC has requested further details are provided to ensure air taken from roof level of the Development is below the Air Quality Strategy objectives for NO_2 for human health exposure; and the location of ventilation inlets are away from the local sources of air pollution. Consequently, this Air Quality Assessment uses the detailed dispersion model ADMS-Roads to predict existing concentrations of NO_2 at the Site for each floor of the Development.

1.6. The Air Quality Dispersion Modelling Assessment is accompanied by **Appendix A**, which presents the technical details of the assessment.

2. Assessment Methodology and Significance

Methodology

2.1. A summary of the air quality model technical details is provided below; further information is contained in **Appendix A**.

ADMS-Roads Model

2.2. The likely air quality concentrations at the Site resulting from traffic emissions on the surrounding roads have been assessed using the atmospheric dispersion models ADMS-Roads Version 4.1.1.0 and has included the latest vehicle emission factors[1].

Traffic Data

2.3. For the purposes of modelling, traffic data has been obtained by Waterman from the Department for Transport (DfT) road traffic statistics website[2]. Data has been collected for roads surrounding the Site for the latest year of data (as 2018). Details of the traffic data are presented within **Appendix A**.

2.4. Given 2018 data has been collected from the DfT website and the Development is car free, the air quality modelling has therefore considered conditions at the Site for the year 2018 (i.e. vehicle emissions and background conditions for 2018). The anticipated completion and opening year of the Development is 2020.

Background Pollutant Concentrations

2.5. To estimate the total concentrations due to the contribution of any other nearby sources of pollution, background pollutant concentrations need to be added to the modelled concentrations. Background concentrations has been based on LBC's automatic monitor at Bloomsbury. Full details of the background pollution data used within the air quality assessment are included in **Appendix A**.

Model Verification

2.6. Model verification is the process of comparing monitored and modelled pollutant concentrations and, if necessary, adjusting the modelled results to reflect actual measured concentrations, to improve the accuracy of the modelling results. The model has been verified by comparing the predicted annual mean NO_2 concentrations for the baseline 2018, with the results from the automatic monitor on Marylebone Road approximately 900m west of the Site. The verification and adjustment process is described in detail in **Appendix A**.

Proposed Receptors

2.7. The modelling has predicted annual mean NO_2 concentrations at each floor level within the Development on each façade. The receptor locations are presented in **Table 1** and **Figure 1**.

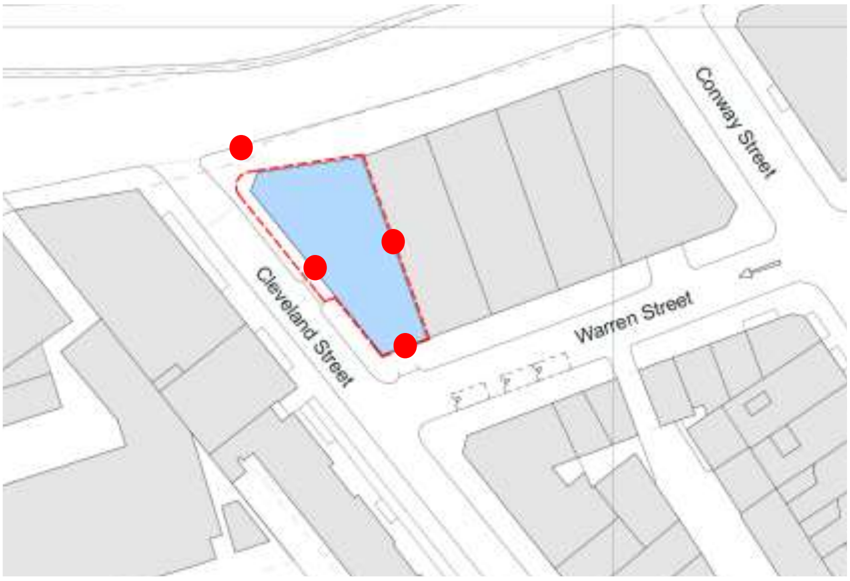
[1] Emissions Factors Toolkit (version 9.0) released May 2019
[2] https://roadtraffic.dft.gov.uk/#6/55.254/-6.064/basemap-regions-countpoints

Table 1: Modelled Receptor Locations

ID	Receptor Location	Grid Reference	Height Above Ground Level
1	North Façade Ground Floor*	528950 182184	0
2	North Façade First Floor*	528950 182184	3
3	North Façade Second Floor*	528950 182184	6
4	North Façade Third Floor*	528950 182184	9
5	North Façade Fourth Floor*	528950 182184	12
6	North Façade Fifth Floor*	528950 182184	15
7	North Façade Sixth Floor*	528950 182184	18
8	North Façade Roof Level	528950 182184	24
9	East Façade Fourth Floor	528972 182174	12
10	East Façade Fifth Floor	528972 182174	15
11	East Façade Sixth Floor	528972 182174	18
12	East Façade Roof Level	528972 182174	24
13	South Façade Ground Floor	528976 182157	0
14	South Façade First Floor	528976 182157	3
15	South Façade Second Floor	528976 182157	6
16	South Façade Third Floor	528976 182157	9
17	South Façade Fourth Floor	528976 182157	12
18	South Façade Fifth Floor	528976 182157	15
19	South Façade Sixth Floor	528976 182157	18
20	South Façade Roof Level	528976 182157	24
21	West Façade Ground Floor	528960 182168	0
22	West Façade First Floor	528960 182168	3
23	West Façade Second Floor	528960 182168	6
24	West Façade Third Floor	528960 182168	9
25	West Façade Fourth Floor	528960 182168	12
26	West Façade Fifth Floor	528960 182168	15
27	West Façade Sixth Floor	528960 182168	18
28	West Façade Roof Level	528960 182168	24

Note: *north facade has been modelled in the Euston Road street canyon (see **Appendix A**)
No east façade below the fourth floor
For conservatism each floor to floor height has been modelled at 3m, which is marginally lower than the Development proposals floor to floor height ranging between 3.4m to 3.6m

Figure 1: Modelled Locations



Future Air Quality Conditions at the Site

2.8. The Site is located in the Ultra-Low Emission Zone (ULEZ). Transport for London (TfL) have predicted the ULEZ will decrease NOx emissions from vehicles by 31% in Inner London and by 28% in outer London by 2021[3]. To take account of the benefits expected to be introduced by the ULEZ a sperate analysis has been undertaken, where a 31% reduced has been applied to the modelled road NO_x concentrations prior to conversion to NO_2.

Significance Criteria

2.9. The Government has established a set of air quality standards and objectives to protect human health. The current AQS objectives was published in July 2007[4] and sets out the objectives for Local Planning Authorities (LPA) in undertaking their Local Air Quality Management (LAQM) duties.

2.10. The AQS objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Box 1.1 of Defra's Local Air Quality Management Technical Guidance (LAQM.TG16)[5] explains the locations where these objectives apply. Given the Development is for educational uses only (teaching facilities), in accordance with Box 1.1 of LAQM.TG(16) only the short-term objectives apply as members of the public will not have regular access.

2.11. The European Union (EU) also sets Limit Values for NO_2, PM_{10} and $PM_{2.5}$[6], which have been adopted by the UK[7]. The Limit Value for NO_2 is the same numerical level but the target date differs. Achievement of these values is a national obligation rather than a local obligation. In the UK, only monitoring and modelling carried out by Defra and Central Government meets the specification required to assess compliance with the Limit Values. Furthermore, Defra and Central Government does not recognise local authority monitoring or local modelling studies when determining the

[3] https://www.london.gov.uk/sites/default/files/appendix_c1_supporting_information_document_-_copy
[4] Department of the Environment, Food and Rural Affairs (Defra), (2007). 'The Air Quality Strategy for England, Scotland, Wales & Northern Ireland'.
[5] Local Air Quality Management Technical Guidance (TG16) February 2018
[6] Council Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe.
[7] Defra, (2010) The Air Quality Standards (England) Regulations.

likelihood of the Limit Values being exceeded. As such the Limit Values have not been considered further in the Air Quality Assessment.

2.12. The UK AQS objectives of air pollutants relevant to the assessment are summarised in **Table 2**.

Table 2: Summary of Relevant Air Quality Strategy Objectives

Pollutant	Objective		Date by which objective is to be met
	Concentration	Measured as	
Nitrogen Dioxide (NO_2)	200µg/m^3	1 hour mean not to be exceeded more than 18 times per year	31/12/2005
	40µg/m^3	Annual Mean	31/12/2005

2.13. Research[8] undertaken on behalf of Defra has indicated that the hourly mean limit value and objective for NO_2 is unlikely to be exceeded at a roadside location where the annual-mean NO_2 concentration is less than 60µg/m^3, LAQM.TG(16) confirms that this assumption is still valid. The hourly objective is, therefore, not considered further within this assessment where the annual-mean NO_2 concentration is predicted to be less than 60µg/m^3.

[8] Defra (2016), 'Local Air Quality Management Policy guidance PG(16)', DEFRA, London

3. Modelled Results

3.1. The results of the ADMS-Roads air quality modelling for each floor level in the building is presented in **Table 3**.

Table3: Results of the ADMS Modelling at Each Floor Level (2018)

ID	Receptor Location	NO_2 Annual Mean (µg/m^3)
1	North Façade Ground Floor*	68.1
2	North Façade First Floor*	67.9
3	North Façade Second Floor*	67.3
4	North Façade Third Floor*	66.6
5	North Façade Fourth Floor*	66.1
6	North Façade Fifth Floor*	65.6
7	North Façade Sixth Floor*	65.3
8	North Façade Roof Level	64.9
9	East Façade Fourth Floor	39.1
10	East Façade Fifth Floor	38.4
11	East Façade Sixth Floor	37.9
12	East Façade Roof Level	37.3
13	South Façade Ground Floor	40.5
14	South Façade First Floor	40.3
15	South Façade Second Floor	39.9
16	South Façade Third Floor	39.3
17	South Façade Fourth Floor	38.7
18	South Façade Fifth Floor	38.2
19	South Façade Sixth Floor	37.8
20	South Façade Roof Level	37.3
21	West Façade Ground Floor	42.7
22	West Façade First Floor	42.3
23	West Façade Second Floor	41.2
24	West Façade Third Floor	40.0
25	West Façade Fourth Floor	39.1
26	West Façade Fifth Floor	38.4
27	West Façade Sixth Floor	37.9
28	West Façade Roof Level	37.3

3.2. As discussed, given the Development includes educational uses only in accordance with Box 1.1 of LAQM.TG(16) only the short-term objectives apply as members of the public will not have regular access. The 1-hour mean AQS objective for NO_2 is unlikely to be exceeded at a roadside location where the annual mean NO_2 concentration is less than 60µg/m^3.

3.3. **Table 3** shows the 1-hour objective for NO_2 of 60µg/m^3 is exceeded on the north façade of the Development for all floor levels (ranging between 68.1µg/m^3 to 64.9µg/m^3). For all other facades, and for all other floors the 1-hour objective for NO_2 is met (ranging between 43.5µg/m^3 to 37.3µg/m^3).

3.4. **Table 4** considers the predicted NO_2 concentrations at each floor level of the building taking account of the TfL prediction that NO_x concentrations will reduce by 31% by 2021 in Inner London with the implementation of the ULEZ.

Table 4: Results of the ADMS Modelling at Each Floor Level Taking Account of the ULEZ

ID	Receptor Location	NO_2 Annual Mean (µg/m^3)
1	North Façade Ground Floor*	59.4
2	North Façade First Floor*	59.3
3	North Façade Second Floor*	58.8
4	North Façade Third Floor*	58.4
5	North Façade Fourth Floor*	57.9
6	North Façade Fifth Floor*	57.6
7	North Façade Sixth Floor*	57.3
8	North Façade Roof Level	57.0
9	East Façade Fourth Floor	38.2
10	East Façade Fifth Floor	37.7
11	East Façade Sixth Floor	37.3
12	East Façade Roof Level	36.9
13	South Façade Ground Floor	39.1
14	South Façade First Floor	39.0
15	South Façade Second Floor	38.7
16	South Façade Third Floor	38.3
17	South Façade Fourth Floor	37.9
18	South Façade Fifth Floor	37.5
19	South Façade Sixth Floor	37.3
20	South Façade Roof Level	36.9
21	West Façade Ground Floor	40.7
22	West Façade First Floor	40.4
23	West Façade Second Floor	39.6
24	West Façade Third Floor	38.8
25	West Façade Fourth Floor	38.1
26	West Façade Fifth Floor	37.6

ID	Receptor Location	NO_2 Annual Mean (µg/m³)
27	West Façade Sixth Floor	37.3
28	West Façade Roof Level	36.9

3.5. **Table 4** shows the 1-hour objective for NO_2 of 60µg/m³ is met for all floor levels, including at roof level, for all facades.

Mechanical Ventilation

3.6. Based on the modelled results presented in **Table 3** predicted concentrations of NO_2 at roof level on the north façade, located in the street canyon of Euston Road, is above the AQS objective and air should not be drawn in from this location. However, concentrations of NO_2 at roof level on the eastern, western and southern façade (outside of the Euston Road street canyon) are below the AQS objective for NO_2 and away from the local sources of air pollution; as such air could be drawn in from these locations. If air is taken from roof level on the eastern, western and southern façade, no further air quality mitigation, such as the use of NOx filtration is required.

3.7. It is also noted that with the implementation of the ULEZ future conditions at the Site improve for all floor levels and, based on the results presented in **Table 4**, predicted concentrations at roof level are below the AQS objective for NO_2 on all facades. In this scenario whilst air could be drawn in from any façade at roof level, it is recommended that air is drawn in away from the Euston Road street canyon (i.e. from roof level on the eastern, western and southern façade). As above, no further air quality mitigation, such as the use of NO_x filtration is required.

4. Summary and Conclusions

4.1. Detailed air quality dispersion modelling of the pollutant NO_2 has been undertaken to ensure air taken from roof level of the educational development at Cambridge House, 373-375 Euston Road is below the AQS objectives for human health; and the location of ventilation inlets are away from the local sources of air pollution.

4.2. Without taking account of the benefit of the ULEZ, the modelling shows NO_2 concentrations are above the AQS objective at roof level of the north façade only. For all other facades NO_2 concentrations are below the AQS objective. If air is taken from roof level on the eastern, western and southern façade, no further air quality mitigation, such as the use of NOx filtration is required.

4.3. With the ULEZ and expected benefit to NO_x emissions, NO_2 concentrations are below the AQS objective at roof level on all facades. In this scenario whilst air could be drawn in from any façade at roof level, it is recommended that air is drawn in away from the Euston Road street canyon (i.e. from roof level on the eastern, western and southern façade). No further air quality mitigation, such as the use of NO_x filtration is required.

Appendix A: Air Quality Methodology Technical Details

1.1 This appendix presents the technical information and data upon which the air quality assessment is based.

Traffic Data

1.2 As discussed in the report; traffic flow data comprising Annual Average Daily Traffic (AADT) flows, traffic composition (% Heavy-Duty Vehicles (HDVs)) used in the model has been obtained by Waterman from the Department for Transport (DfT) road traffic statistics website[1]. **Table A.1** presents the traffic data used within the Air Quality Assessment.

Table A.1: 24-hour AADT Data Used within Assessment

Link	Link Name	Speed (kph)	2018 DfT Data	
			AADT	HDV
1	Marylebone Road - west of Albany Road	10	72,366	4,653
2	Marylebone Road - east of Albany Road	20	75,794	35,07
3	Euston Road - Hampstead Road and A400	20	55,347	2,500
4	Hampstead Road - south of Euston road	20	12,248	1,592
5	Hampstead Road - north of Euston Road	30	32,012	2,975
6	Albany Street	20	11,211	740
7	Euston Road between Melton Street and Eversholt Street	30	63,323	3,643
8	Euston Road between Eversholt Street and Midland Road	30	56,781	4,906

Vehicle Speeds

1.3 Using the criteria recommended within Local Air Quality Management Technical Guidance (LAQM.TG(16))[2] to take into account the presence of slow moving vehicles; traffic at junctions and traffic lights was reduced by 10kph on all roads.

Diurnal Profile

1.4 The ADMS-Roads model uses an hourly traffic flow based on the daily (AADT) flows. Traffic flows follow a diurnal variation throughout the day and week. Therefore, a diurnal profile was used in the model to replicate how the average hourly traffic flow would vary throughout the day and the week. This was based on data collated by Waterman from the Department for Transport (DfT) statistics Table TRA0307: 'Traffic Distribution by Time of Day on all roads in Great Britain', 2018[3]. The 2018 data was used to be consistent with the assessment. **Figure A.1** presents the diurnal variation in traffic flows which has been used within the model.

[1] https://roadtraffic.dft.gov.uk/#6/55.254/-6.064/basemap-regions-countpoints

2 Defra, 2016, Local Air Quality Management Technical Guidance LAQM.TG(16)

3 Department for Transport (DfT) Statistics, www.dft.gov.uk/statistics/series/traffic

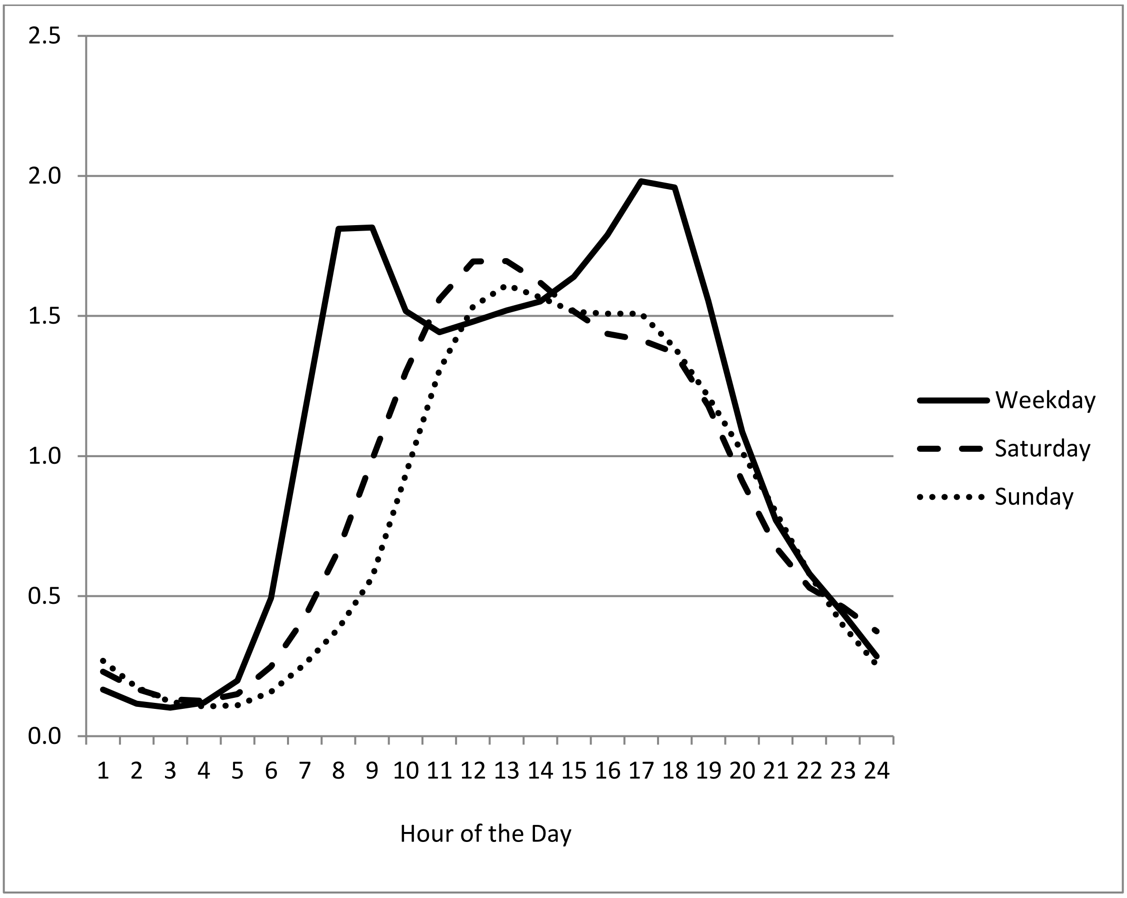


Figure A.1: Department for Transport Diurnal Traffic Variation

Street Canyon Effect

1.5 Narrow streets with tall buildings on either side have the potential to create a confined space, which can interfere with the dispersion of traffic pollutants and may result in pollutant emissions accumulating in these streets. In an air quality model, these narrow streets are described as street canyons.

1.6 ADMS-Roads includes a street canyon model to take account of the additional turbulent flow patterns occurring inside such a narrow street with relatively tall buildings on both sides. LAQM.TG(16) identifies a street canyon *"as narrow streets where the height of buildings on both sides of the road is greater than the road width."*

1.7 Following a review of the road network to be included within the model, for conservatism a street canyon was included along Euston Road and Marylebone Road. The proposed street canyons were modelled with a height of 27m to represent the 9 storey buildings opposite the Site on Euston Road; and 21m to represent 7 the storey buildings on Marylebone Road.

Road Traffic Emission Factors

1.8 The latest version of the ADMS-Roads model (version 4.1.1) was used for the assessment, which takes account of the latest vehicle emission factors published by Defra (published in May 2019).

Background Pollutant Concentrations

1.9 Background pollutant concentration data (i.e. concentrations due to the contribution of pollution sources not directly taken into account in the dispersion modelling) have been added to contributions from the modelled pollution sources, for each year of assessment.

1.10 London Borough of Camden (LBC) currently undertakes urban background monitoring of NO_2 and PM_{10} at Bloomsbury, 1.2km to the south east of the Site. The monitoring results for NO_2 and PM_{10} at the Bloomsbury automatic monitor are presented in **Table A.2** from 2015 to 2018.

Table A.2: Measured Concentrations at the LBC Bloomsbury Urban Background Monitor

Pollutant	Averaging Period	AQS Objective	2015	2016	2017	2018
NO_2	Annual Mean (µg/m^3)	40µg/m^3	**48**	**42**	38	36
	1-Hour Mean (No. of Hours)	200µg/m^3 not to be exceeded more than 18 times a year	0	0	0	0

Notes: Data obtained from London Borough of Camden Air Quality Annual Status Report for 2017 and www.londonair.org.uk
Exceedances shown in **BOLD**

1.11 The data in **Table A9.2** shows the annual mean NO_2 AQS objective of 40µg/m^3 was exceeded in 2015 and 2016 but was below the annual mean NO_2 AQS objective in 2017 and 2018.

1.12 LBC also undertakes background air quality monitoring of NO_2 at three diffusion tube locations within the Borough. The nearest diffusion tube to the Site is located on Tavistock Gardens approximately 900m to the east of the Site. **Table A.3** presents the latest monitoring data (for the years 2015 and 2016) at the Tavistock Gardens diffusion tube.

Table A.3: Annual Mean NO_2 Concentrations at the Tavistock Gardens Diffusion Tube (µg/m^3)

ID	Classification	Distance to centre of Site (m)	2015	2016
CA10	Urban Background	900	44.6	39.7

Notes: Data obtained from London Borough of Camden Air Quality Annual Status Report for 2017
Exceedances shown in **BOLD**

1.13 **Table A.3** shows that the monitored annual mean NO_2 concentrations were met at both locations in all years.

1.14 In addition to the monitoring data, background concentrations of NO_2 and NO_x are available from the Defra LAQM Support website[4] for 1x1km grid squares for assessment years between 2017 and 2030. **Table A.4** presents the Defra background concentrations for the years 2018, for the grid square the Site is located within (528500, 182500).

Table A.4: Defra Background Maps in 2018 for the Grid Square at the Site (µg/m^3)

Pollutant	Annual Mean Concentration
NO_x	61.8
NO_2	35.0

1.15 The Defra background map for the Site (as 35.0µg/m^3) is similar to the Bloomsbury automatic monitor (as 36.0µg/m^3). The 2016 monitoring at the Tavistock diffusion tube (as 39.7µg/m^3) is

[4] http://laqm.defra.gov.uk/

lower than the 2016 Bloomsbury automatic monitor (as 42.0µg/m^3). Consequently the 2018 background data from the Bloomsbury automatic monitor has been used in the air quality assessment.

1.16 The background concentrations used within the assessment are presented in **Table A.5**.

Table A.5 Background Concentrations used in the Assessment from the Bloomsbury Monitor

Pollutant	Annual Mean Concentration (µg/m^3)
	2018
NO_x	54
NO_2	36

Meteorological Data

1.17 Local meteorological conditions strongly influence the dispersal of pollutants. Key meteorological data for dispersion modelling include hourly sequential data including wind direction, wind speed, temperature, precipitation and the extent of cloud cover for each hour of a given year. As a minimum ADMS-Roads requires wind speed, wind direction, and cloud cover.

1.18 Meteorological data to input into the model were obtained from the London City Airport Meteorological Station, which is the closest to the Site (16km southeast of the Site) and considered to be the most representative. 2018 data were used to be consistent with the base traffic year and model verification year. **Figure A.2** presents the wind-rose for the meteorological data.

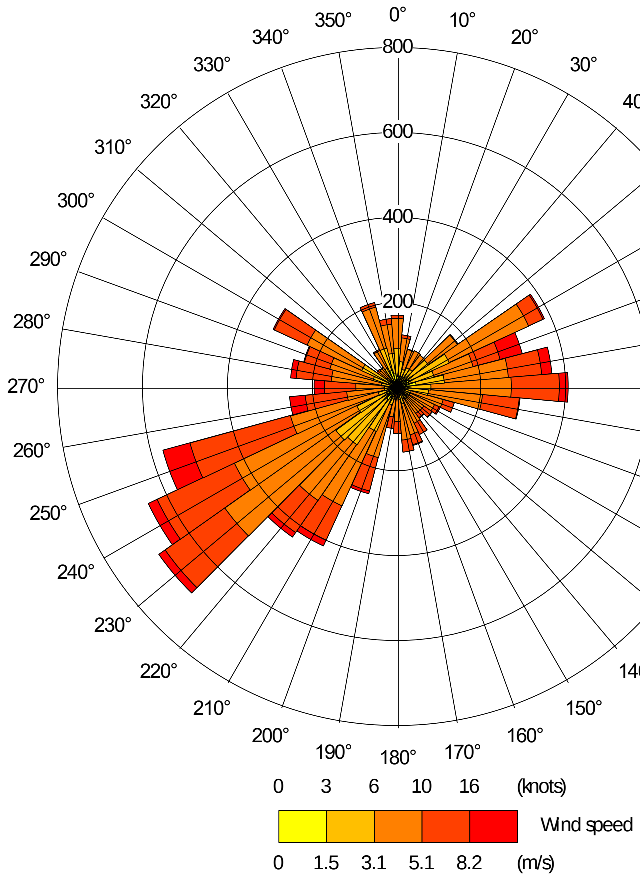


Figure A.2: 2018 Wind Rose for the London City Airport Meteorological Site

1.19 Most dispersion models do not use meteorological data if they relate to calm winds conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. ADMS-Roads treats calm wind conditions by setting the minimum wind speed to 0.75 m/s. It is recommended in LAQM.TG(16) that the meteorological data file be tested within a dispersion model and the relevant output log file checked, to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedances. LAQM.TG(16) recommends that meteorological data should only be used if the percentage of usable hours is greater than 85%. 2018 meteorological data from London City Airport includes 8,531 lines of usable hourly data out of the total 8,760 for the year, i.e. 97.4% of usable data. This is above the 85% threshold and is therefore adequate for the dispersion modelling.

1.20 A value of 1.0 was used for the London City Airport Meteorological Station, which is representative of cities and is considered appropriate following a review of the local area surrounding the Meteorological Station.

Model Data Processing

1.21 The modelling results were processed to calculate the averaging periods required for comparison with the Air Quality Strategy Objectives.

1.22 NO_X emissions from combustion sources (including vehicle exhausts) comprise principally nitric oxide (NO) and NO_2. The emitted NO reacts with oxidants in the air (mainly ozone) to form more NO_2. Since only NO_2 is associated with impacts on human health, the air quality standards for the protection of human health are based on NO_2 and not total NO_X or NO.

1.23 The ADMS-Roads model was run without the Chemistry Reaction option to allow verification (see below). Therefore, a suitable NO_X:NO_2 conversion was applied to the modelled NO_X concentrations. There are a variety of different approaches to dealing with NO_X:NO_2 relationships, a number of which are widely recognised as being acceptable. However, the current approach was developed for roadside sites, and is detailed within the Technical Guidance LAQM.TG(16).

1.24 The LAQM Support website provides a spreadsheet calculator[5] to allow the calculation of NO_2 from NO_X concentrations, accounting for the difference between primary emissions of NO_X and background NO_X, the concentration of O_3, and the different proportions of primary NO_2 emissions, in different years. This approach is only applicable to annual mean concentrations.

1.25 Research[6] undertaken on behalf of Defra has indicated that the hourly mean limit value and objective for NO_2 is unlikely to be exceeded at a roadside location where the annual-mean NO_2 concentration is less than 60µg/m^3, LAQM.TG(16) confirms that this assumption is still valid. The hourly objective is, therefore, not considered further within this assessment where the annual-mean NO_2 concentration is predicted to be less than 60µg/m^3.

1.26 To calculate the number of daily exceedances of 50µg/m^3 PM_{10}, the relationship between the number of 24-hour exceedances of 50µg/m^3 and the annual mean PM_{10} concentration from LAQM.TG (16) was applied as follows:

Number of Exceedances = -18.5+0.00145 x annual mean^3 + (206/annual mean)

Other Model Parameters

1.27 There are a number of other parameters that are used within the ADMS models which are described for completeness and transparency:

- The model requires a surface roughness value to be inputted.
  - A value of 1.5 was used for the Site, which is representative of large urban areas; and
  - A value of 1.0 was used for the London City Airport Meteorological Station, which is representative of cities and woodlands;
- The model requires the Monin-Obukhov length (a measure of the stability of the atmosphere) to be inputted. A value of 100m (representative of large conurbations >1 million) was used for the modelling; and
- The model requires the Road Type to be inputted. *'London [Inner]'* was selected for all roads.

5 AEA, NOX to NO2 Calculator, http://laqm1.defra.gov.uk/review/tools/monitoring/calculator.php Version 7.1, 15 April 2019

6 Defra (2016), 'Local Air Quality Management Policy guidance PG(16)', DEFRA, London

Model Verification

1.28 Model verification is the process of comparing monitored and modelled pollutant concentrations for the same year, at the same locations, and adjusting modelled concentrations if necessary to be consistent with monitoring data. This increases the robustness of modelling results.

1.29 Discrepancies between modelled and measured concentrations can arise for a number of reasons, for example:

- Traffic data uncertainties;
- Background concentration estimates;
- Meteorological data uncertainties;
- Sources not explicitly included within the model, for example car parks and bus stops;
- Overall model limitations, including treatment of roughness and meteorological data, treatment of speeds); and
- Uncertainty in monitoring data, particularly diffusion tubes.

1.30 Verification is the process by which uncertainties such as those described above are investigated and minimised. Disparities between modelling and monitoring results are likely to arise as result of a combination of all of these aspects.

1.31 Box 7.15 of LAQM.TG(16) provides guidance on approaching model verification and adjustment. This requires the roadside NO_x contribution to be calculated. In addition, monitored NO_x concentrations are required, which have been calculated from the annual mean NO_2 concentration at the diffusion tube sites using the NO_x to NO_2 spreadsheet calculator as described above. The verification process applied here, has been based on Box 7.15.

Nitrogen Dioxide

1.32 The dispersion model was run to predict annual mean NOx concentrations at the automatic monitor operated by London Borough of Westminster on Marylebone Road approximately 900m west of the Site. The Marylebone Road monitor is a roadside monitor and considered appropriate for the model verification.

1.33 LBC also operates an automatic monitor on Euston Road, approximately 1km east of the Site. This monitor was discounted for use, as the data capture in 2018 was below 75% and as such was considered to be of risk.

1.34 Box 7.15 in LAQM.TG(16) indicates a method based on comparison of the road NO_X contributions and calculating an adjustment factor. This requires the roadside NO_X contribution to be calculated. In addition, monitored NO_X concentrations are required, which were obtained from the monitoring site. The steps involved in the adjustment process are presented in **Table A.6**. The background data for 2018, as presented in **Table A.5** were used.

Table A.6: Model Verification Result for Un-adjustment NO_x Emissions (µg/m³)

Site ID	Modelled Total NO_2	Monitored Total NO_2	Monitored Total NO_x	Monitored Road NO_2	Monitored Road NOx	Modelled Road NOx	Ratio of Monitored Road Contributi	% Difference
Marylebone Road Monitor	89.0	82.0	295.3	49.0	186.5	168.6	1.1	4.8

1.35 Figure A.3 shows the mathematical relationship between modelled and monitored roadside NOx (i.e. total NOx minus background NOx) in a scatter graph (data taken from **Table A.6**), with a trendline passing through zero and its derived equation.

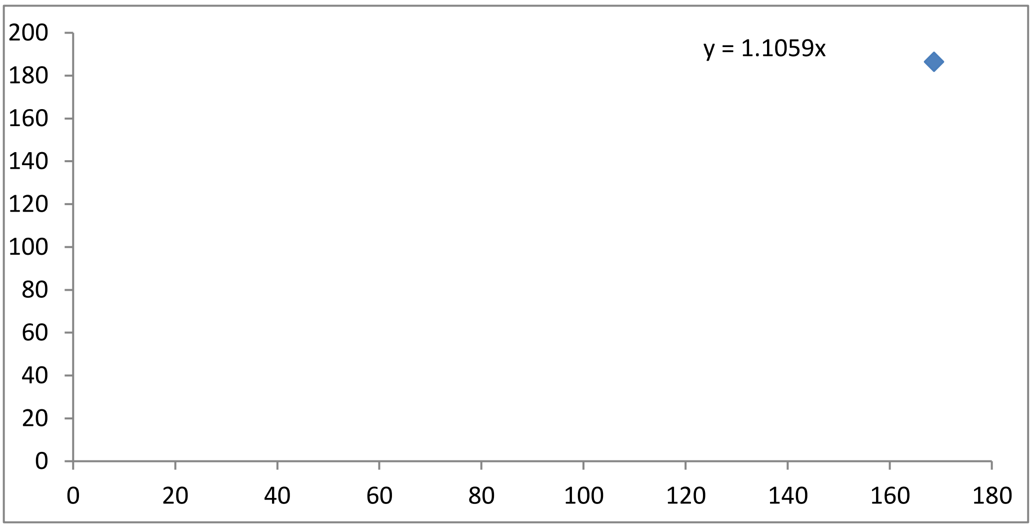


Figure A.3: Unadjusted Modelled versus Monitored Annual Mean Roadside NO_x at the Monitoring Sites (µg/m³)

1.36 Consequently, in **Table A.7** the adjustment factor (1.1059) obtained from **Figure A.3** is applied to the modelled NOx Roadside concentrations to obtain improved agreement between monitored and modelled annual mean NOx. This has been converted to annual mean NO_2 using the NOx:NO_2 spreadsheet calculator.

Table A.7: Model Verification Result for Adjustment NO_x Emissions (µg/m³)

Site ID	Adjusted Modelled Road NO_x	Adjusted Modelled Total NO_x	Modelled Total NO_2	Monitored Total NO_2	% Difference
Marylebone Road Monitor	240.7	295.1	107.4	93.7	10.2

1.37 The data in **Table A.7** shows that with the NOx adjustment factor the model now over predicts by 10.2% compared to the over prediction of 4.8% without the adjustment factor.

1.38 Given without the adjustment factor the model was considered to be performing well (predicted NO_2 concentration of 89µg/m³ compared to monitored NO_2 concertation of 82.0µg/m³) no adjustment factor has been applied to the modelled results.

Verification Summary

1.39 Any atmospheric dispersion model study will always have a degree of inaccuracy due to a variety of factors. These include uncertainties in traffic emissions data, the differences between available meteorological data and the specific microclimate at each receptor location, and simplifications made in the model algorithms that describe the atmospheric dispersion and chemical processes. There will also be uncertainty in the comparison of predicted concentrations with monitored data, given the potential for errors and uncertainty in sampling methodology (technique, location, handling, and analysis) as well as processing of any monitoring data.

1.40 Whilst systematic under or over prediction can be taken in to account through the model verification / adjustment process, random errors will inevitably occur, and a level of uncertainty will still exist in corrected / adjusted data.

1.41 Model uncertainties arise because of limited scientific knowledge, limited ability to assess the uncertainty of model inputs, for example, emissions from vehicles, poor understanding of the interaction between model and / or emissions inventory parameters, sampling and measurement error associated with monitoring sites and whether the model itself completely describes all the necessary atmospheric processes.

1.42 Overall, it is concluded that with the adjustment factors applied to the ADMS-Roads model, it is performing well, and modelled results are considered to be suitable to determine the potential effects of the Development on local air quality.

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