Appendix 9.2: Air Quality Assessment Detailed Methodology

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

Construction Dust Assessment

1.2 Table A1 provides examples of the potential dust emissions classes for each of the construction activities, in line with the Mayor of London Control of Dust and Emissions Supplementary Planning Guidance (SPG)[1] (with reference to the IAQM 2014 'Guidance on the Assessment of Dust from Demolition and Construction[2]). Noted not all the criteria need to be met for a class. Once the class has been determined, the risk category can be determined from the matrices presented in Tables 9.4 to 9.7 in **Chapter 9: Air Quality**.

Table A1: Criteria for the Potential Dust Emissions Class

Activity	Class	Example Criteria
Demolition	Large	Total Building volume >50,000m^3, potentially dusty construction material (e.g. concrete), on site crushing and screening, demolition activities >20m above ground level.
	Medium	Total Building volume 20,000-50,000m^3, potentially dusty construction material, demolition activities 10-20m above ground level.
	Small	Total Building volume <20,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months.
Earthworks	Large	Total site area >10,000m^2, potentially dusty soil type (e.g. clay which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of stockpile enclosures >8m in height, total material moved >100,000 tonnes.
	Medium	Total site area 2,500m^2 - 10,000m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of stockpile enclosures 4m-8m in height, total material moved 20,000 tonnes – 100,000 tonnes (where known).
	Small	Total site area <2,500m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of stockpile enclosures <4m in height, total material moved <10,000 tonnes, earthworks during wetter months.
Construction	Large	Total Building volume >100,000m^3, piling, on site concrete batching, sand blasting.
	Medium	Total building volume 25,000 m^3 - 100,000m^3, potentially dusty construction material (e.g. concrete), on site concrete batching.
	Small	Total building volume <25,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber).
Trackout	Large	>50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay/silt content), unpaved road length >100m.
	Medium	10-50 HDV (>3.5t) trips in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50-100m (high clay content).

[1] Mayor of London (2014) Control of Dust and Emissions Supplementary Planning Guidance (SPG)

[2] Institute of Air Quality Management (2014) 'Guidance on the Assessment of Dust from Demolition and Construction'.

	Small	<10 HDV (>3.5t) trips in any one day, surface material low potential for dust release, unpaved road length <50m.

1.3 Once the risk category has been defined, the significance of the likely dust effects can be determined, considering the factors that define the sensitivity of the surrounding area. Examples of the factors defining the sensitivity of the area, as set out in the SPG, are presented in Table A2.

Table A2: Examples of Factors Defining Sensitivity of the Area

Type of Effect	Sensitivity of Receptor	Examples
Sensitivities of People to Dust Soiling Effects	High	Users can reasonably expect an enjoyment of a high level of amenity; or The appearance, aesthetics or value of their property would be diminished by soiling; and the people or property would reasonably be expected[1] to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Indicative examples include dwellings, museums and other culturally important collections, medium and long-term car parks[2] and car showrooms.
	Medium	Users would expect[1] to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; The appearance, aesthetics or value of their property could be diminished by soiling; or The people or property would not reasonably be expected[1] to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Indicative examples include parks and places of work.
	Low	The enjoyment of amenity would not reasonably be expected[1]; or Property would not reasonably be expected[1] to be diminished in appearance, aesthetics or value by soiling; or There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Indicative examples include playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks[2] and roads.
Sensitivities of People to Health Effects of PM_{10}	High	Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, relevant location would be one where individuals may be exposed for eight hours or more in a day).[3] Indicative examples include residential properties. Hospitals, schools and residential care homes should also be considered as having equal sensitivity to residential areas for the purposes of this assessment.
	Medium	Locations where the people exposed are workers[4], and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). Indicative examples include office and shop workers, but will generally not include workers occupationally exposed to PM_{10}, as protection is covered by Health and Safety at Work legislation.

Type of Effect	Sensitivity of Receptor	Examples
	Low	Locations where human exposure is transient.[5] Indicative examples include public footpaths, playing fields, parks and shopping streets.
Sensitivities of Receptors to Ecological Effects	High	Locations with an international or national designation and the designated features may be affected by dust soiling; or Locations where there is a community of a particularly dust sensitive species such as vascular species included in the Red Data List for Great Britain[6]. Indicative examples include a Special Area of Conservation (SAC) designated for acid heathlands or a local site designated for lichens adjacent to the demolition of a large site containing concrete (alkali) buildings.
	Medium	Locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown; or Locations with a national designation where the features may be affected by dust deposition. Indicative example is a Site of Special Scientific Interest (SSSI) with dust sensitive features.
	Low	Locations with a local designation where the features may be affected by dust deposition. Indicative example is a local Nature Reserve with dust sensitive features.

1 People's expectations will vary depending on the existing dust deposition in the area.

2 Car parks can have a range of sensitivities depending on the duration and frequency that people would be expected to park their cars there, and the level of amenity they could reasonably expect whilst doing so. Car parks associated with work place or residential parking might have a high level of sensitivity compared to car parks used less frequently and for shorter durations, such as those associated with shopping. Cases should be examined on their own merits.

3 This follows Defra guidance as set out in LAQM.TG(16)[3].

4 Notwithstanding the fact that the air quality objectives and limit values do not apply to people in the workplace, such people can be affected to exposure of PM_{10}. However, they are considered to be less sensitive than the general public as a whole because those most sensitive to the effects of air pollution, such as young children are not normally workers. For this reason workers have been included in the medium sensitivity category.

5 There are no standards that apply to short-term exposure, e.g. one or two hours, but there is still a risk of health impacts, albeit less certain.

6 Cheffing C. M. & Farrell L. (Editors) (2005); The Vascular Plant. Red Data List for Great Britain, Joint Nature Conservation Committee.

1.4 Table A3, Table A4 and Table A5 show how the sensitivity of the area may be determined for effects related to dust soiling (nuisance), human health and ecosystem respectively. Distances are to the dust source and so a different area may be affected by the on-Site works than by trackout (i.e. along the routes used to access the Site). The IAQM guidance advises that the highest level of sensitivity from each table should be recorded.

[3] Defra (2016); 'London Local Air Quality Management (LLAQM) Technical guidance 2016 (LLAQM.TG (16))', DEFRA, London.

Table A3: Sensitivity of the Area to Dust Soiling Effects on People and Property

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table A4: Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM_{10} Concentration	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32µg/m^3	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32µg/m^3	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28µg/m^3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24µg/m^3	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low	Low
	-	1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table A5: Sensitivity of the Area to Ecological Impacts

Receptor Sensitivity	Distance from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Operational Phase Assessment

Model

1.5 In urban areas, pollutant concentrations are primarily determined by the balance between pollutant emissions that increase concentrations, and the ability of the atmosphere to reduce and remove pollutants by dispersion, advection, reaction and deposition. An atmospheric dispersion model is used as a practical way to simulate these complex processes; which requires a range of input data, which can include pollutant emissions rates, meteorological data and local topographical information.

1.6 The effect of the Development on local air quality was assessed using the advanced atmospheric dispersion models ADMS-Roads and ADMS 5, considering the contribution of emissions from forecast road-traffic on the local road network and from the heating plant by the completion year respectively.

ADMS-Roads

1.7 The ADMS-Roads model is a comprehensive tool for investigating air pollution in relation to road networks. On review of the Site, and its surroundings, ADMS-Roads was considered appropriate for the assessment of the long and short-term effects of the proposals on air quality. The model uses advanced algorithms for the height-dependence of wind speed, turbulence and stability to produce improved predictions of air pollutant concentrations. It can predict long-term and short-term concentrations, including percentile concentrations.

1.8 ADMS-Roads model is a formally validated model, developed in the United Kingdom (UK) by CERC (Cambridge Environmental Research Consultants). This includes comparisons with data from the UK's air quality Automatic Urban and Rural Network (AURN) and specific verification exercises using standard field, laboratory and numerical data sets. CERC is also involved in European programmes on model harmonisation, and their models were compared favourably against other EU and U.S. EPA systems. Further information in relation to this is available from the CERC web site at www.cerc.co.uk.

ADMS 5

1.9 ADMS 5 is a Gaussian atmospheric dispersion model widely used for investigating air pollution from controlled or fugitive emissions. The model is used for a wide range of air quality assessments, from small energy centres in urban areas to large industrial facilities. It is also used to model the dispersion of odours to determine the potential for nuisance at sensitive receptors around installations. The model uses advanced algorithms for the height-dependence of wind speed, turbulence and atmospheric stability which improve calculations of air pollutant concentrations. It can predict long-term and short-term concentrations, as well as concentration percentiles.

1.10 ADMS 5 is developed in the UK by Cambridge Environmental Research Consultants (CERC) and has been extensively validated against field data sets to assess various configurations of the model such as flat or complex terrain, line/area/volume sources, buildings, dry deposition, fluctuations and visible plumes. Further information in relation to the model validation is available from the CERC website at www.cerc.co.uk.

Model Scenarios

1.11 To assess the potential effects of the Development on local air quality, future ‘without Development’ and ‘with Development’ scenarios were assessed. The Development is anticipated to be complete in 2026 and therefore this is the year in which these future scenarios were modelled.

1.12 The year 2017 was also modelled to establish the existing baseline situation as this is the latest full year of available London Borough of Southwark (LBS) monitoring data. Base year traffic data for 2017 and meteorological data for 2017 were also used to be consistent with the verification year.

1.13 Taking into account recent analyses by Defra[1] showing that historical NO_X and NO_2 concentrations are not declining in line with emission forecasts, as outlined in the Air Quality Assessment, a sensitivity analysis was undertaken on the basis of no future reductions in NO_X/NO_2 concentrations (i.e. considering the potential effects of the Development against the baseline 2017 conditions by applying the 2026 road traffic data to 2017 background concentrations and road traffic emission rates). The results for this sensitivity analysis are presented in Table 14 of the Report and Table A14 below.

Traffic Data

1.14 Traffic flow data comprising Annual Average Daily Traffic (AADT) flows, traffic composition (% Heavy-Duty Vehicles (HDVs)) used in the model were provided by Transport Planning Practice Ltd and used in the model for the surrounding road network.

1.15 The methodology for calculating the expected change in vehicle trips because of the Development, once completed and operational, is set out in detail within the Transport Statement. The assessment covers all traffic generated by the Development, including servicing and delivery trips. **Table A6** presents the traffic data used within the Air Quality Assessment.

Table A6: 24-hour AADT Data Used within the Assessment

ID	Link Name	Speed (kph)	Base 2017		Without 2026		With 2026	
			AADT	%HDV	AADT	%HDV	AADT	%HDV
1	Borough High Street to the south of White Yart Yard	20	14,326	16.6	14,717	16.6	14,896	16.5
2	Thomas Street	25	6,104	9.3	6,325	9.7	6,435	10.1
3	White Hart Yard	20	26	19.2	26	19.2	178	2.8
4	Southwark Bridge Road to the north of Marshalsea Road	20	14,493	12.2	14,693	12.2	14,797	12.2
5	Marshalsea Road	32	14,311	14.3	14,511	14.2	14,615	14.2
6	Borough High Street to the north of White Yart Yard	10	19,622	18.2	19,884	18.1	19,917	18.1

Vehicle Speeds

1.16 To take into account the presence of slow moving traffic near junctions and at roundabouts, the speed on each junction was reduced to 5-10kph, using the following criteria recommended within LAQM.TG(16) [4]:

- Traffic on the carriageway approaching the lights when red, e.g. 5-20 kph, depending on the time of day and how congested the junction is.

[4] Defra, 2016, Local Air Quality Management Technical Guidance LAQM.TG(16)

Diurnal Profile

1.17 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 (the latest available at the time of the assessment) collated by Waterman from the Department for Transport (DfT) statistics Table TRA0307: 'Traffic Distribution by Time of Day on all roads in Great Britain', 2017[5], which is the latest data available at the time of undertaking the air quality assessment. **Figure A1** presents the diurnal variation in traffic flows which has been used within the model.

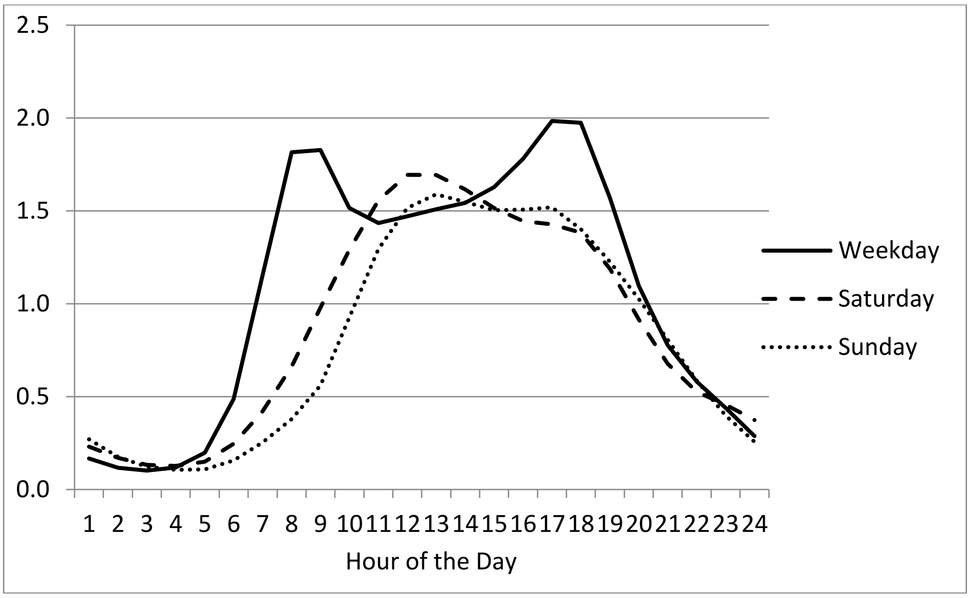

Figure A1: Department for Transport Diurnal Traffic Variation

Street Canyon Effect

1.18 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.

1.19 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."*

1.20 Following a review of the road network to be included within the model, the street canyon option was included for road links. Reasonable judgement was applied to try and replicate the height of the buildings along the following road links

- St Thomas Street at a height of 22m to represent a four-storey building;
- Borough High Street North at a height of 22m to represent a four-storey building;
- White Hart Yard at a height of 10m to represent a two-storey building;
- Borough High Street South at a height of 18m to represent a four-storey building; and

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

- Marshalsea Marshalsea Road at a height of 15m to represent a three-storey building.

Road Traffic Emission Factors

1.21 The latest version of the ADMS-Roads model (version 4.1.1) was used for the assessment. The model includes the latest vehicle emission factors published by Defra in the Emission Factors Toolkit (EFT) (version 9.0 published in May 2019).

1.22 The EFT uses several parameters (traffic flow, percentage of HDV, speed and road type) to calculate road traffic emissions for the selected pollutants.

Heating and Energy Strategy

1.23 The heating and energy strategy for the Development would provide five 665kW gas-fired boilers and two gas fired water heaters. Technical details of plant have been provided by Chapman BDSP and the stack parameters used within the ADMS 5 model are presented in **Table A7** below.

1.24 To take account of the multiple point sources from the boilers and water heaters, ADMS 5 contains the ability to combine multiple point sources into a single stack. The stack parameters for the energy centre, as presented in **Table A7**, have been combined using the additional input file option within ADMS 5.

Table A7: Onsite Plant Stack Parameters

Unit	No.	Grid Ref.	Flue Diameter (m)	Release Rate (m/s)	Release Height (m)	Release Temp (deg ºC)	Total NOx Emissions (g/s)
665 kW Boiler	3	532733, 180150	0.25	10	142	71	0.01940
665 kW Boiler	2	532733, 180151	0.25	10	142	71	0.01293
124 kW Water Heater	2	532741, 180145	0.25	10	142	60	0.00255

Note: For gas-fired plants emission factors are not provided for PM_{10} because gas-fired plants do not emit any significant level of particulates.

Building Parameters

1.25 Buildings can have a significant effect on the dispersion of pollutants from sources and can increase the maximum predicted ground level concentrations. ADMS 5 allows buildings to be included in to the model domain as a rectangle or as a circle.

1.26 The buildings module is based on experiments in which there was one dominant site building and several smaller surrounding buildings less important for dispersion.

1.27 For the heating and energy Centre, the building the flue is located on is considered as the main building. These main buildings have been considered as a rectangular building. The parameters are presented in **Table A8**.

Table A8: Building Parameters

Building	X	Y	Height (m)	Length (m)	Width (m)	Angle (deg)
Georgian Terrace	532734.4	180166.9	15.1	42.32	10.24	120
Keats House	532771.3	180144.0	16.1	17.16	9.92	120
Tower (Main)	532738.5	180139.3	139	50.97	22.07	120

Background Pollutant Concentrations

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

1.29 Background monitoring of NO_2 is undertaken in LBS at the Elephant and Castle automatic monitor as shown in **Table A9**.

Table A9: Annual Mean Monitored Concentrations at Elephant & Castle Automatic Monitor

Monitor	Pollutant	Averaging Period	AQS Objective	2013	2014	2015	2016	2017
Elephant & Castle	NO_2	Annual Mean (µg/m^3)	40µg/m^3	**42**	37	**41**	39	34
		1-Hour Mean (No. of Hours)	200µg/m^3 not to be exceeded more than 18 times a year	0	0	0	0	0
	PM_{10}	Annual Mean (µg/m^3)	40µg/m^3	20	19	20	21	19
		24-Hour Mean (No. of Days)	50µg/m^3 not to be exceeded more than 35 times a year	0	1	1	7	5

Notes: Data obtained from www.londonair.org.uk
Exceedences of the Air Quality Strategy (AQS) Objectives shown in **bold** text.

1.30 **Table A2** shows that the monitored annual mean NO_2 concentrations were exceeded in 2013 and 2015. All other NO_2 and particulate matter (as PM_{10}) AQS objectives were met in all years at the Elephant & Castle automatic monitor.

1.31 In addition to the monitoring data, background concentrations of NO_2, PM_{10} and $PM_{2.5}$ are available from the Defra LAQM Support website[6] for 1x1km grid squares for assessment years between 2015 and 2030. **Table A10** presents the Defra background concentrations for the year 2016, for the grid square the Site is located within (532500, 180500).

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

Table A10: Defra Background Maps in 2017 and 2026 for the Grid Square at the Site

Pollutant	Annual Mean Concentration ($\mu g/m^3$)	
	2017	**2026**
NO_2	45.5	30.5
PM_{10}	19.5	17.6
$PM_{2.5}$	13.1	11.6

1.32 The urban background annual mean concentration for NO_2 at the Early Road, Witney diffusion tube was considered representative of the conditions at the Site due to it being the closest monitor to the Site with similar surrounding land use characteristics. The 2016 background concentration at the Early Road, Witney diffusion tube monitor is higher than the Defra Background maps, and so has been used in the assessment for a more conservative approach.

1.33 The urban background concentrations for NO_2 and PM_{10} at the Elephant & Castle automatic monitor are lower than the Defra Background Maps. The Defra Background Maps have therefore been used in the assessment for a more conservative approach. The background concentrations data used within the assessment are presented in **Table A11**.

Table A11: Background Concentrations used in the Assessment ($\mu g/m^3$)

Pollutant	Annual Mean Concentration ($\mu g/m^3$)	
	2017	**2026**
Grid Square 532500, 180500; Verification – SDT 81, SDT 82, Receptors 1-5, 7-12, and 16		
NO_2	45.5	30.5
PM_{10}	19.5	17.6
$PM_{2.5}$	13.1	11.6
Grid Square 532500, 179500; Verification – SDT 84, Receptors 6, 13, 14, and 15		
NO_2	38.4	25.3
PM_{10}	19.5	17.7
$PM_{2.5}$	13.0	11.6

Meteorological Data

1.34 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 requires wind speed, wind direction, and cloud cover.

1.35 Meteorological data to input into the model were obtained from the London City Airport Meteorological Station. The London City Airport Meteorological Station was used as it was considered representative of the Site. The 2017 data was used. **Figure A2** presents the wind-rose for the meteorological data.

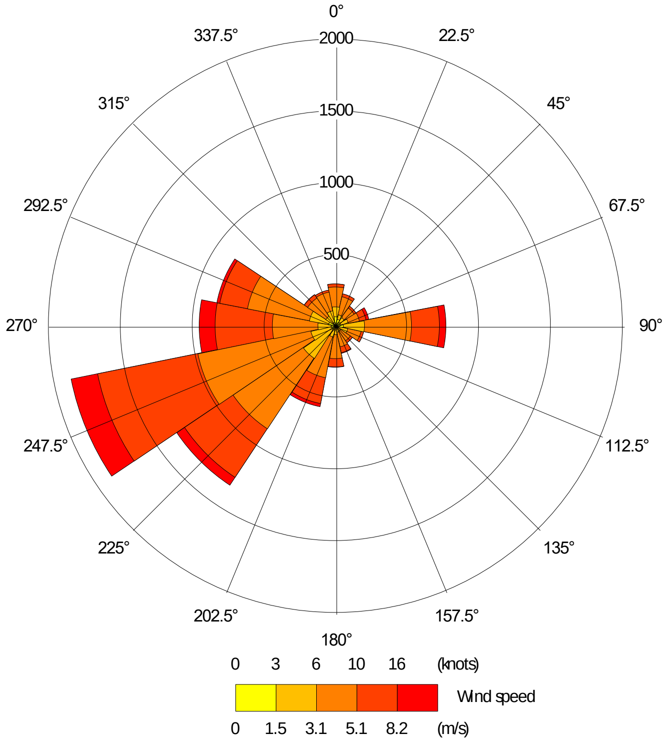

Figure A2: 2017 Wind Rose for the London City Airport Meteorological Site

1.36 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 5 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%. 2017 meteorological data from Heathrow includes 8,680 lines of usable hourly data out of the total 8,760 for the year, i.e. 99.1% of usable data. This is above the 85% threshold and is therefore adequate for the dispersion modelling.

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

Model Data Processing

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

1.39 NO_X emissions from combustion sources (including vehicle emissions and energy centres) 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.

1.40 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 LLAQM.TG(16).

1.41 The LAQM Support website provides a spreadsheet calculator[7] 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.

1.42 LLAQM.TG(16) states that where stacks are included within models representing wider urban areas and where the annual mean concentrations are the main focus (as is the case in this assessment) then the spreadsheet calculator, described above, can be used for the conversion of total annual mean NO_X to annual average NO_2 concentrations. This guidance was followed for the assessment NO_X concentrations due to the heating plant emissions.

1.43 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, LLAQM.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.

1.44 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 LLAQM.TG (16) was applied as follows:

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

Model Parameters

1.45 There are several other parameters that are used within the ADMS model 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 also 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) was used for the modelling; and
- The model requires the Road Type to be inputted. *'London [Central]'* was selected and used for the modelling of the road links.

Model Verification

1.46 Model verification is the process of comparing monitored and modelled pollutant concentrations for the same year, at the same locations, and adjusting modelled

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

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

concentrations if necessary to be consistent with monitoring data. This increases the robustness of modelling results.

1.47 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 (e.g. car parks and bus stops);
- Overall model limitations (e.g. treatment of roughness and meteorological data, treatment of speeds); and
- Uncertainty in monitoring data, particularly diffusion tubes.

1.48 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.

1.49 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

1.50 The dispersion model was run to predict annual mean NO_x concentrations using the LBS diffusion tubes on Lamppost No 02 Borough High Street (SDT 81), Lamppost no 01 Adjacent to 125 Borough High St (SDT 82), and Little Dorritt Park Entrance Lamppost No 8 (SDT 84). This monitoring location is classified as being kerbside. Kerbside monitors are not generally recommended for the adjustment of road traffic modelling results as the inclusion of these sites may lead to an over-adjustment of modelling at roadside sites. The kerbside Borough High Street (SDT 81) diffusion tube was however, used because of its proximity to the Site. The verification would result in a conservative assessment.

1.51 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 calculated from the annual mean NO_2 concentration at the monitoring site using the NO_X to NO_2 spreadsheet calculator as described above. The steps involved in the adjustment process are presented in **Table A11**. The background data for 2017, as presented in **Table A6** were used.

Table A12: 2017 Annual Mean NO_2 Modelled and Monitored Concentrations (µg/m^3)

Site ID	Monitored Annual Mean NO_2 (µg/m^3)	Modelled Total Annual Mean NO_2 (µg/m^3)	% Difference (modelled – monitored)
SDT 81	82.3	63.0	-23.4
SDT 82	71.0	64.9	-8.6
SDT 84	60.1	46.5	-22.7

1.52 **Table A11** indicates that the model under predicts at all three diffusion tubes. Technical Guidance LAQM.TG(16) suggests that where there is a disparity of more than 10% between modelled and monitored results, adjustment of the modelling results is necessary. The steps involved in the adjustment process are presented in **Table A12** and **Figure A3**.

Table A13: Model Verification Result for Adjustment NOx Emissions (µg/m³)

Site ID	Monitored NO_2 (µg/m³)	Monitored Road NOx (µg/m³)	Modelled Road NOx (µg/m³)	Ratio of Monitored Road Contribution NO_X/Modelled Road Contribution NO_X
SDT 81	82.3	115.0	48.6	2.4
SDT 82	71.0	74.7	54.5	1.4
SDT 84	60.1	39.8	19.8	2.0

1.53 **Figure A3** 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 A12**), with a trendline passing through zero and its derived equation.

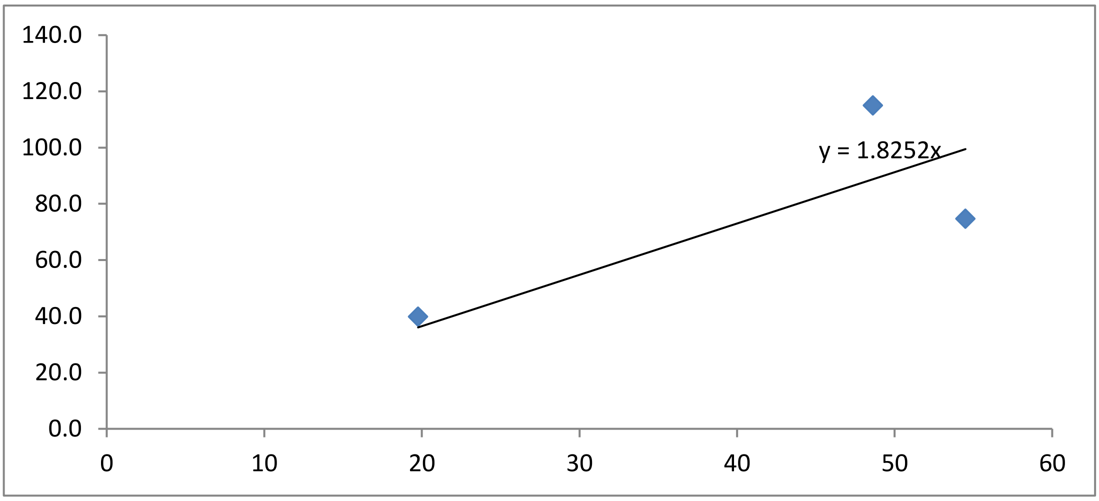

Figure A3: Unadjusted Modelled versus Monitored Annual Mean Roadside NO_X at the Monitoring Sites (µg/m³)

1.54 Consequently, in **Table A13** the adjustment factor (1.8252) obtained from **Figure A3** was applied to the relevant modelled NOx Roadside concentrations before being converted to annual mean NO_2 using the NO_X:NO_2 spreadsheet calculator.

Table A14: Model Verification Result for Adjustment NOx Emissions (µg/m³)

Site ID	Adjusted Modelled Road NO_X	Modelled Total NO_2	Monitored Total NO_2	% Difference
SDT 81	88.7	75.0	82.3	-8.8
SDT 82	99.5	78.0	71.0	9.9
SDT 84	36.1	52.5	60.1	-12.8

1.55 The data from the adjusted/verified model in **Table A13** indicates a more conservative agreement between monitored and modelled annual mean NO_2 results compared to the unadjusted model in **Table A11**.

1.56 The NO_X adjustment process was therefore applied to the roadside NOx modelling for 2017 and 2026 'without' and 'with' the Development in place.

Particulate Matter (PM_{10} and $PM_{2.5}$)

1.57 PM_{10} and $PM_{2.5}$ monitoring data is not available for the Site and local area. Therefore, the roadside modelled NO_X adjustment factor of 1.8252 was subsequently applied to all the roadside PM_{10} and $PM_{2.5}$ modelling results.

Verification Summary

1.58 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.

1.59 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.

1.60 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.

1.61 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.

Assessor Experience

Name: Andy Fowler

Years of Experience: 8

Qualifications:

- CEnv
- BSc (Hons)
- Associate Member of the IAQM
- AIEMA (Associate Member of the Institute of Environmental Management and Assessment)
- Full Member of the Institution of Environmental Sciences (IES)

Andy has been responsible for the technical delivery of a wide range of air quality projects for a variety of clients in both the public and private sector. These projects include consideration of emissions from both transportation and industrial sources, through both monitoring and modelling, and therefore he has an in depth understanding of the regulatory requirements for these sources and the published technical guidance for their assessment.

References

1 http://laqm.defra.gov.uk/faqs/faqs.html: Measure (NO_2) concentrations in my local authority area do not appear to be declining in line with national forecasts.