

Appendix 6.2: Air Quality Assessment Detailed Methodology

This appendix presents the technical information and data upon which the operational Proposed Development air quality assessment was based.

Model

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.

The effect of the Proposed Development on local air quality was assessed using the advanced atmospheric dispersion model ADMS-Roads, considering the contribution of emissions from forecast road-traffic on the local road network by the opening year of the Proposed Development.

ADMS-Roads

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.

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.

Model Scenarios

The year 2019 was modelled to establish the existing baseline situation as suggested by North Hertfordshire Environmental Protection Officer (Air Quality). Base year traffic data for 2019 and meteorological data for 2019 were also used to be consistent with the verification year.

To assess the effect of the Proposed Development on local air quality, future 'without Proposed Development' and 'with Proposed Development' scenarios were assessed for the year 2030, the year the Proposed Development is anticipated to be completed.

Model Uncertainty

Analyses of historical monitoring data by Defra identified a disparity between actual measured NO_x and NO₂ concentrations and the expected decline associated with emission forecasts, which form the basis of air quality modelling as described above. In February 2020, Air Quality

Consultants published a report on Performance of Defra's Emission Factor Toolkit 2013-2019¹. The report concluded that recent analysis of recent NO_x measurements provides evidence that vehicle controls are working, and as a result, the Emission Factor Toolkit (EFT) is now reflecting the rate of observed reductions. This air quality assessment has been undertaken using the latest emission factors published by Defra in the EFT version 12, which accounts for the uptake of low carbon passenger cars and light good vehicles with electric and hybrid electric propulsion systems.

Traffic Data

Traffic flow data comprising Annual Average Daily Traffic (AADT) flows, traffic composition (% Heavy-Duty Vehicles (HDVs)) used in the model was provided by the transport consultants, Woods Hardwick. Traffic data was also obtained from the DfT website for use in the air quality model verification. **Table B1** presents the traffic data used within the Air Quality Assessment.

Table B1: 24-hour AADT Data Used within the Assessment

Link Name	Speed (kph)	Base 2019		Without Proposed Development 2030		With Proposed Development 2030	
		AADT	%HDV	AADT	%HDV	AADT	%HDV
Mendip Way (South)	48	1,713	0.6	2,132	0.5	10,398	0.1
Great Ashby Way (East)	48	4,239	1.7	4,621	1.6	5,842	1.3
Great Ashby Way (West)	48	5,889	1.3	6,160	1.3	13,207	0.6
Orwell Avenue	48	2,528	0.4	3,394	0.3	4,749	0.2
Canterbury Way	48	14,610	1.3	16,017	1.2	21,708	0.9
Martins Way (West)	64	22,290	1.9	23,376	1.8	27,877	1.5
Grace Way	48	10,649	1.6	11,177	1.6	12,368	1.4
Gresley Way	64	9,555	1.4	10,150	1.4	11,112	1.2
Martins Way (East)	64	6,905	1.4	7,143	1.4	7,402	1.4
A1155	64	13,423	1.4	13,709	1.4	13,757	1.4
Pilgrims Way	48	7,466	1.6	7,625	1.6	7,835	1.5
Hitchins Road North*	64	40,811	1.7	-	-	-	-
Hitchins Road*	64	44,847	1.8	-	-	-	-
Hitchins Road South*	64	20,860	1.6	-	-	-	-
A602 East*	48	17,125	1.8	-	-	-	-
A602 West*	64	16,950	1.7	-	-	-	-
Lytton Way*	64	23,844	1.0	-	-	-	-

*Traffic data obtained from DfT website. Accessed at <https://roadtraffic.dft.gov.uk/manualcountpoints>

¹ Air Quality Consultants (2020): 'Performance of Defra's Emission Factor Toolkit 2013 – 2019'. February 2020.

Vehicle Speeds

To consider the presence of slow-moving traffic near junctions and at roundabouts with the model, the speed at each junction was reduced to 20 kph. This follows the criteria recommended within LAQM.TG(22)², which considers that in most instances the two-way average speed for all vehicles at a junction would be in the range of 20-40 kph based on the estimate that:

- Traffic pulling away from the lights, 40-50 kph;
- Traffic approach the lights when green, 20-50 kph; and
- Traffic on the carriageway approaching the lights when red, 5-20 kph, depending on the time of day and how congested the junction is.

Diurnal Profile

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, 2019³. **Figure B1** presents the diurnal variation in traffic flows which has been used within the model.

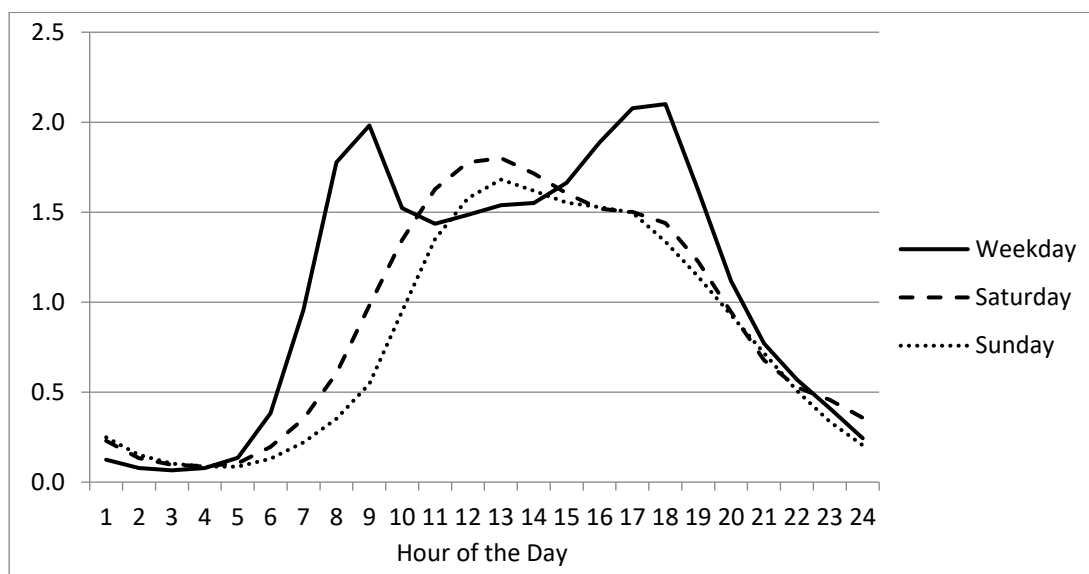


Figure B1: Department for Transport 2019 Diurnal Traffic Variation

² Defra, 2022, Local Air Quality Management Technical Guidance LAQM.TG(22)

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

Street Canyon Effect

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.

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(22) identifies a street canyon *“as narrow streets where the height of buildings on both sides of the road is greater than the road width.”*

Following a review of the road network to be included within the model, it was considered that modelled roads are relatively wide and the existing buildings along these roads are not considered to be tall.

The proposed buildings within the Site would not cause any street canyons to be created where there is sensitive public exposure. Therefore, no street canyons were included within the model for any of the scenarios considered.

Road Traffic Emission Factors

The latest version of the ADMS-Roads model (version 5.0.1.3) was used for the assessment. The model was input with the vehicle emission factors published by Defra in the Emission Factors Toolkit (v12.0 published in December 2023) and is based on the latest COPERT database published by the European Environment Agency.

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

Background Pollutant Concentrations

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.

LAQM Technical Guidance (TG22) classifies an urban background site as ‘an urban location distanced from sources and therefore broadly representative of city-wide background conditions urban background site is distanced from sources of pollution and representative of background conditions’.

In 2019, automatic background monitoring was undertaken within NHDC at two automatic monitors, Stevenage Road NO_x (NH1) and Stevenage Road PM (NH2), as shown in **Table 5.10** of the Air Quality ES Chapter. Both monitors are located approximately 7.1km west of the Site and are not considered representative of background concentrations at the Site. The NHDC Stevenage Road NO_x (NH1) and Stevenage Road PM (NH2) urban background automatic monitors were therefore not considered further.

In 2019, NHDC also measured annual mean NO₂ concentrations at 46 locations using diffusion tubes. However, none of the NHDC diffusion tubes were classified as urban background locations. As a result, the NHDC diffusion tubes were not considered representative of air quality conditions at the Site and have not been considered further.

At its nearest point, the Site is located within approximately 20m of SBC’s administrative boundary. In 2019 SBC undertook NO₂ and PM_{2.5} monitoring at the St Georges Way (AQMS

2) roadside automatic monitor, as shown in **Table 5.12** of the Air Quality ES Chapter. The St Georges Way (AQMS 2) automatic monitor is located approximately 4.2km southwest of the Site and is not considered representative of background concentrations at the Site. The SBC St Georges Way (AQMS 2) automatic monitor were therefore not considered further.

In 2019, SBC also measured annual mean NO₂ concentrations at one urban background location using diffusion tubes. The Fairlands Valley Park (DT18) diffusion tube is the closest urban background diffusion tube to the Site. The Fairlands Valley Park (DT18) diffusion tube is located approximately 3.1km southwest of the Site.

The Fairlands Valley Park (DT18) diffusion tube is located in a similar environment to the Site on the edge of a residential area in Fairlands Valley Park and located away from busy roads. The Fairlands Valley Park (DT18) diffusion tube was considered to be the most representative of background annual mean NO₂ concentrations at the Site and was therefore used within the assessment.

In addition to the monitoring data, forecast UK background of NO_x, NO₂, PM₁₀ and PM_{2.5} are available from the Defra LAQM Support website⁴ for 1x1km grid squares for assessment years between 2018 and 2030. **Table B2** presents the Defra background concentrations for the years 2019 and 2030, for the grid squares the Site is located within (525500, 227500, 526500, 227500 and 527500, 227500)

Table B2: Defra Background Maps in 2019 and 2030 for the Grid Squares covering the Site

Pollutant	Annual Mean Concentration (µg/m ³)					
	Grid Square 525500, 227500		Grid Square 526500, 227500		Grid Square 527500, 227500	
	2019	2030	2019	2030	2019	2030
NO ₂	11.1	8.1	10.9	8.0	9.7	7.2
PM ₁₀	15.4	14.2	15.4	13.9	14.8	13.7
PM _{2.5}	9.8	8.9	9.7	8.8	9.4	8.5

The data in **Table B2** shows that all pollutants are below the respective AQS objectives.

In the absence of representative PM₁₀ and PM_{2.5} monitoring data, the Defra background map concentrations for PM₁₀ and PM_{2.5} were used.

Table B3 presents the background concentrations used within the air quality assessment.

⁴ Defra Background Mapping data for local authorities, <https://uk-air.defra.gov.uk/data/laqm-background-maps>

Table B3: Background concentrations used in the assessment

Grid Square and Receptors	Pollutant	Annual Mean Concentration ($\mu\text{g}/\text{m}^3$)	
		2019	2030
522500, 226500 Verification DT17	NO ₂	17.1	10.8
	PM ₁₀	16.2	15.0
	PM _{2.5}	10.4	9.5
523500, 226500 Verification DT23	NO ₂	14.1	10.0
	PM ₁₀	14.8	13.7
	PM _{2.5}	9.7	8.8
525500, 227500 Receptors 1, 2 & 13	NO ₂	11.1	8.1
	PM ₁₀	15.4	14.2
	PM _{2.5}	9.8	8.9
526500, 227500 Receptors 3, 14, PR1 & PR2	NO ₂	10.9	8.0
	PM ₁₀	15.1	13.9
	PM _{2.5}	9.7	8.8
526500, 226500 Receptors 4, 5, 15 & 16	NO ₂	12.8	9.6
	PM ₁₀	14.5	13.3
	PM _{2.5}	9.7	8.8
525500, 226500 Receptor 6	NO ₂	13.8	10.0
	PM ₁₀	14.8	13.6
	PM _{2.5}	10.0	9.1
524500, 226500 Receptors 7, 9, 10 & 11	NO ₂	12.8	9.0
	PM ₁₀	15.1	13.9
	PM _{2.5}	9.9	9.0
524500, 225500 Receptor 8	NO ₂	13.7	9.7
	PM ₁₀	14.8	13.6
	PM _{2.5}	10.0	9.0
524500, 227500 Receptor 12	NO ₂	11.2	8.0
	PM ₁₀	15.4	14.2
	PM _{2.5}	9.7	8.8
523500, 225500 Verification DT21 & DT7 Receptor 17	NO ₂	16.1	11.1
	PM ₁₀	15.2	14.0
	PM _{2.5}	10.2	9.2

Meteorological Data

Local meteorological conditions strongly influence the dispersal of pollutants. Key meteorological data for dispersion modelling include hourly sequential data for 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.

Meteorological data to input into the model were obtained from the London Luton Airport Meteorological Station, which was considered to be the most representative. The 2019 data were used to be consistent with the base traffic year and model verification year. **Figure B2** presents the wind-rose for the meteorological data.

Most dispersion models do not use meteorological data if they relate to calm wind 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 Technical Guidance LAQM.TG(22) 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 exceedences. Technical Guidance LAQM.TG(22) recommends that meteorological data should only be used if the percentage of usable hours is greater than 85%. 2019 meteorological data from the London Luton Airport Meteorological Station includes 8,645 usable hours, which equates to 98.7%. The London Luton Airport meteorological data is above the 85% threshold and therefore adequate for the dispersion modelling.

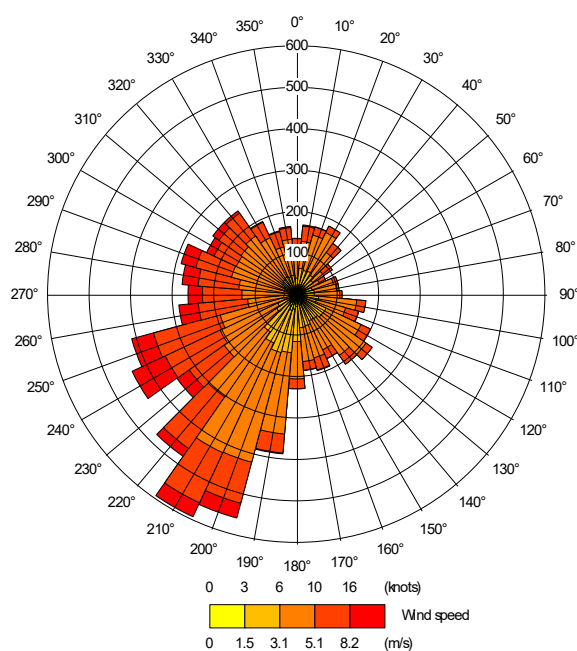


Figure B2: 2019 Wind Rose for the London Luton Airport Meteorological Site

A surface roughness value of 0.5 was used for the London Luton Airport Meteorological Station, which is representative of parkland and open suburbia. This was considered appropriate following a review of the local area.

Model Data Processing

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

NO_x emissions from combustion sources (including vehicle exhausts) comprise principally nitric oxide (NO) and NO₂. The emitted NO reacts with oxidants in the air (mainly ozone) to form more NO₂. Since only NO₂ is associated with impacts on human health, the air quality standards for the protection of human health are based on NO₂ and not total NO_x or NO.

The ADMS-Roads model was run without the Chemistry Reaction option to allow verification (see below). Therefore, a suitable NO_x:NO₂ conversion was applied to the modelled NO_x concentrations. There are a variety of different approaches to dealing with NO_x:NO₂ 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(22).

The LAQM Support website provides a spreadsheet calculator⁵ to allow the calculation of NO₂ from NO_x concentrations, accounting for the difference between primary emissions of NO_x and background NO_x, the concentration of O₃, and the different proportions of primary NO₂ emissions, in different years. This approach is only applicable to annual mean concentrations.

Research⁶ undertaken on behalf of Defra has indicated that the hourly mean limit value and objective for NO₂ is unlikely to be exceeded at a roadside location where the annual-mean NO₂ concentration is less than 60µg/m³, LAQM.TG(22) confirms that this assumption is still valid. The hourly objective is, therefore, not considered further within this assessment where the annual-mean NO₂ concentration is predicted to be less than 60µg/m³.

To calculate the number of daily exceedances of 50µg/m³ PM₁₀, the relationship between the number of 24-hour exceedances of 50µg/m³ and the annual mean PM₁₀ concentration from LAQM.TG (16) was applied as follows:

$$\text{Number of Exceedances} = -18.5 + 0.00145 \times \text{annual mean}^3 + (206/\text{annual mean})$$

Other Model Parameters

There are a number of other parameters that are used within the ADMS-Roads model which are described here for completeness and transparency:

- The model requires a surface roughness value to be inputted. A value of 0.5 was used for the Site, which is representative of parkland and open suburbia;
- A value of 0.5 was used for the London Luton Airport Meteorological Station, which is representative of parkland and open suburbia;
- The model requires the Monin-Obukhov length (a measure of the stability of the atmosphere) to be inputted. A value of 10m (representative of small towns) was used for the modelling; and
- The model requires the Road Type to be inputted. 'England [urban]' was selected and used for the modelling.

Model Verification

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

⁵ AEA, NO_x to NO₂ Calculator, <http://laqm1.defra.gov.uk/review/tools/monitoring/calculator.php> Version 8.1, August 2020

⁶ Defra (2022), 'Local Air Quality Management Policy guidance PG(22)', DEFRA, London

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

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.

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.

Box 7.15 of LAQM.TG(22) 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 NO₂ concentration at monitoring sites using the NO_x to NO₂ spreadsheet calculator as described above. The verification process applied here, has been based on Box 7.15.

Nitrogen Dioxide

The dispersion model was run to predict annual mean NO_x concentrations using the following four SBC diffusion tubes:

- Hitchin Road (DT17);
- Hitchin Road - Longfields (DT23);
- 13 Hitchin Road (DT21); and
- High Street (DT7).

These locations are roadside locations and therefore deemed suitable to be used in the model verification assessment.

The 2019 background data presented in **Table B4** were used in the verification. The following tables present the adjusted model results using these input values.

Table B4: 2019 Annual Mean NO₂ Modelled and Monitored Concentrations

Site ID	Monitored Annual Mean NO ₂ (µg/m ³)	Modelled Total Annual Mean NO ₂ (µg/m ³)	% Difference (modelled – monitored)
DT17	42.7	22.6	-47.1
DT23	33.1	22.1	-33.3
DT21	23.2	16.6	-28.4
DT7	29.5	19.1	-35.4

Table B4 indicates the model is under-predicting NO₂ at all diffusion tubes. Technical Guidance LAQM.TG(22) suggests that where there is a disparity of more than 25% between modelled and monitored results, adjustment of the modelling results is necessary. As the

monitor was underpredicting by a percentage of more than 25% an adjustment of the model results was undertaken to produce more accurate results. The steps involved in the adjustment process are presented in **Table B6** and **Table B7**.

Table B5: Model Verification Results for Unadjusted NO_x Emissions

Site ID	Monitored NO ₂ (µg/m ³)	Monitored Road NO _x (µg/m ³)	Modelled Road NO _x (µg/m ³)	Ratio of Monitored Road Contribution NO _x /Modelled Road Contribution NO _x
DT17	42.7	59.0	15.7	3.8
DT23	33.1	37.3	14.7	2.5
DT21	23.2	16.9	4.3	4.0
DT7	29.5	29.7	8.9	3.3

Figure B3 shows the mathematical relationship between modelled and monitored roadside NO_x (i.e. total NO_x minus background NO_x) in a scatter graph (data taken from **Table B6**), with a trendline passing through zero and its derived equation.

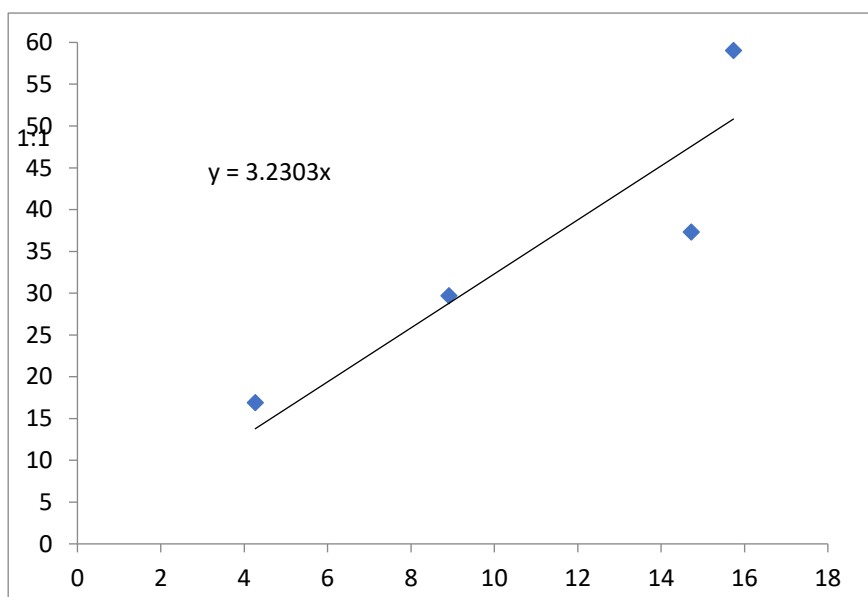


Figure B3: Unadjusted Modelled versus Monitored Annual Mean Roadside NO_x

In **Table B6** the adjustment factor (3.2303) obtained from **Figure B3** was applied to the relevant modelled NO_x Roadside concentrations before being converted to annual mean NO₂ using the NO_x:NO₂ spreadsheet calculator.

Table B6: Model Verification Result for Adjustment NO_x Emissions

Site ID	Adjusted Modelled Road NO _x (µg/m ³)	Modelled Total NO ₂ (µg/m ³)	Monitored Total NO ₂ (µg/m ³)	% Difference
DT17	50.8	39.2	42.7	-8.3
DT23	47.6	37.7	33.1	14.0
DT21	13.8	21.6	23.2	-6.9
DT7	28.8	29.1	29.5	-1.4

The data in **Table B7** indicates a closer average agreement between monitored and modelled annual mean NO₂ results compared to the unadjusted model in **Table B5**. The NO_x adjustment factor was applied to the roadside NO_x modelling for 2019 and 2030.

Particulate Matter (PM₁₀ and PM_{2.5})

Representative PM₁₀ and PM_{2.5} monitoring data is not available for the Site and local area. Therefore, the roadside modelled NO_x adjustment factor of 3.2303 was subsequently applied to all the roadside PM₁₀ and PM_{2.5} modelling results.

Statistical Analysis

To confirm the model is performing well, further statistical analysis of the performance of the modelled results has been undertaken using the methodology detailed in LAQM.TG(22) Box 7.17: Methods and Formulae for Description of Model Uncertainty. This statistical analysis checks the performance of the model used and the accuracy of the results (observed vs predicted).

The methodology for the calculations is presented in LAQM.TG(22) for the following:

- **Correlation Coefficient:** This is used to measure the linear relationship between the predicted and observed data. A value of zero means no relationship and a value of 1 means an absolute relationship. This statistic can be particularly useful when comparing a large number of model and observed data points.
- **Fractional Bias:** this is used to identify if the model shows a systematic tendency to over or under predict. Values vary between +2 and -2 and has an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.
- **Root Mean Square Error:** This is used to define the average error or uncertainty of the model. The units of the Root Mean Square Error are the same as the quantities compared.

The results of the statistical calculation are presented in **Table B7**.

Table B7: Statistical Calculations of Error for the Modelled Results

Statistical Calculation	Perfect Value	Acceptable Variable Tolerance	Unadjusted Model Score	Adjusted Model Score
Correlation Coefficient	1	N/A	0.910	0.909
Fractional Bias	0	+2 to -2	0.46	0.01
Root Mean Square Error	0	±10	13.0	3.0

Based on the results presented in **Table B7** it is considered that the adjusted model is performing well. There is no systematic over or under prediction of the adjusted model results and the root mean square error is within the acceptable tolerance levels, further adjustment is not necessary.

Verification Summary

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.

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

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.

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 Proposed Development on local air quality.

Assessor Experience

Name: Stephanie Jones

Years of Experience: 1

Qualifications:

- BSc (Hons) Geography
- MSc Environmental Consultancy

Stephanie is a Graduate Consultant working within the EIA and Air Quality team; with one year of experience assisting with the co-ordination of EIAs and preparing Environmental Statements for a range of projects for a variety of clients in both the public and private sector.

Name: Andy Fowler

Years of Experience: 14

Qualifications:

- CEnv
- BSc (Hons)
- Member of the IAQM
- 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.