A12 Chelmsford to A120 widening scheme

TR010060

6.3 ENVIRONMENTAL STATEMENT

APPENDIX 6.3 DISPERSION MODELLING PROCESS

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 6

August 2022

Infrastructure Planning

Planning Act 2008

A12 Chelmsford to A120 widening scheme

Development Consent Order 202[ ]

ENVIRONMENTAL STATEMENT
APPENDIX 6.3 DISPERSION MODELLING PROCESS

Regulation Reference	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010060
Application Document Reference	TR010060/APP/6.3
Author	A12 Project Team & National Highways

Version	**Date**	**Status of Version**
Rev 1	August 2022	DCO Application

CONTENTS

1 Air quality dispersion modelling process 2
1.1 Introduction 2
1.2 Background concentrations 2
1.3 Road parameters 3
1.4 Traffic data 3
1.5 Road traffic emissions 4
1.6 Meteorological data 4
1.7 Surface roughness length 5
1.8 Monin-Obukhov length 5
1.9 Terrain 6
1.10 Human health receptors 6
1.11 Compliance risk receptors 11
1.12 Ecological receptors 11
1.13 Model verification 12
1.14 Derivation of total NO_2, PM_{10} and $PM_{2.5}$ concentrations 12
1.15 Adjustment for long term trends in NO_2 12
References 14

LIST OF PLATES

Plate 1.1 Andrewsfield windrose for 2019 5

LIST OF TABLES

Table 1.1 Monitored and mapped concentrations for background adjustment (2019) 2
Table 1.2 Annual average time periods used 4
Table 1.3 Consented planning applications considered in the air quality assessment 7

1 Air quality dispersion modelling process

1.1 Introduction

1.1.1 The ADMS-Roads model has been developed by Cambridge Environmental Research Consultants Ltd and is a version of an atmospheric modelling system that focuses on road traffic as a source of pollutant emissions. Version 5.0 (March 2020) has been used for this study.

1.1.2 The modelling system takes into account the emissions produced by light duty and heavy duty vehicles (LDV and HDV, respectively) travelling within a certain speed band along a section of road over an average hour and predicts the dispersion of these emissions using appropriate historical meteorological data. The effect of meteorological conditions on dispersion is given a complex treatment within the model. The most significant factors are wind speed and direction, and the boundary layer height, which is the calculated mixed depth of the lower atmosphere.

1.2 Background concentrations

1.2.1 The background concentrations across the study area have been derived using the national pollution maps published by Defra (2020a). These cover the whole country on a 1km x 1km grid and are published for each year from 2018 until 2030.

1.2.2 To address the potential variation between mapped and monitored background nitrogen dioxide (NO_2) concentrations in the air quality study area, a comparison of 2019 background monitoring data was made against the 2019 mapped background concentrations for the grid squares corresponding to a number of nearby urban background monitoring sites.

1.2.3 The comparison of monitored to mapped background NO_x and NO_2 concentrations identified that the Defra maps tend to under predict NO_x concentrations on average. An adjustment factor of 1.178 was therefore applied to the mapped background oxides of nitrogen (NO_x) concentrations for each grid square used in the assessment. The calculations undertaken to determine the adjustment factor are shown in Table 1.1.

Table 1.1 Monitored and mapped concentrations for background adjustment (2019)

Site ID	Site name	OS grid coordinate (X,Y)	Monitored ($\mu g/m^3$)		Mapped ($\mu g/m^3$)		NO_x monitored/ mapped
			NO_x	NO_2	NO_x	NO_2	
UKA00409	Southend-on-Sea	585823, 186212	23.0	18.0	21.6	15.6	1.064
UKA00272	Thurrock	561069, 177893	42.0	23.0	31.9	21.5	1.315

Site ID	Site name	OS grid coordinate (X,Y)	Monitored (µg/m³)		Mapped (µg/m³)		NO_x monitored/ mapped
			NO_x	NO_2	NO_x	NO_2	
UKA00362	Wicken Fen	556316, 269179	10.0	8.0	8.7	6.8	1.153
						Adjustment Factor:	1.178

1.2.4 The ‘in-grid square’ contribution from major road sectors included in the model has been removed from the background map annual mean NO_x, PM_{10} and $PM_{2.5}$ concentration estimates, and background annual mean NO_2 estimates have been corrected using the Defra Sector Removal Tool Version v8.0 (2020b). This process has been undertaken to avoid double counting of road traffic emissions. The predicted background pollutant concentrations in the study area are below the relevant Air Quality Objectives (AQOs)[1].

1.3 Road parameters

1.3.1 The ADMS-Roads model requires lengths of road of equal width (and height if specified as a canyon) to be input into the model. Road alignment and width were determined using the OS MasterMap base mapping within the ArcGIS software package. All roads were modelled at grade.

1.4 Traffic data

1.4.1 Traffic data for the modelling scenarios were obtained from the A120 Braintree to Marks Tey A12 PCF Stage 3 DCO model, developed by Jacobs. The base year air quality modelling for verification of the ADMS-Roads predictions used traffic data, pollution measurements, background estimates and meteorological measurements from 2019. The future peak construction year modelling used traffic data and background data for 2025. The future opening year modelling used traffic data and background data for 2027. The future year modelling applied meteorological data for 2019.

1.4.2 Traffic data representing the average conditions occurring in specific time periods were provided for the periods specified in Table 1.2.

[1] National AQOs are defined in the Air Quality (England) Regulations 2000 and the Air Quality (England) (Amendment) Regulations 2002. The Ambient Air Quality Directive (2008/50/EC) forms the basis for UK air quality legislation. EU Limit Values are transposed into UK law by the Air Quality Standards (England) Regulations 2010.

Table 1.2 Annual average time periods used

Traffic period		Time period
Annual average daily traffic (AADT)		00:00 – 24:00
Annual average weekday traffic (AAWT)	AM Peak (AM)	07:00 – 10:00
	Inter-Peak (IP)	10:00 – 16:00
	PM Peak (PM)	16:00 – 19:00
	Off Peak (OP)	19:00 – 07:00

1.4.3 For each time period, the following traffic data parameters were provided:

- Total traffic flow, defined as vehicles/hour
- Percentage HDV
- Vehicle speed band

1.4.4 Speed bands were assigned for each individual modelled road link in accordance with DMRB LA 105 (Highways England, 2019).

1.4.5 More details on the traffic data are provided in Appendix 6.2 of the Environmental Statement [TR010060/APP/6.3].

1.5 Road traffic emissions

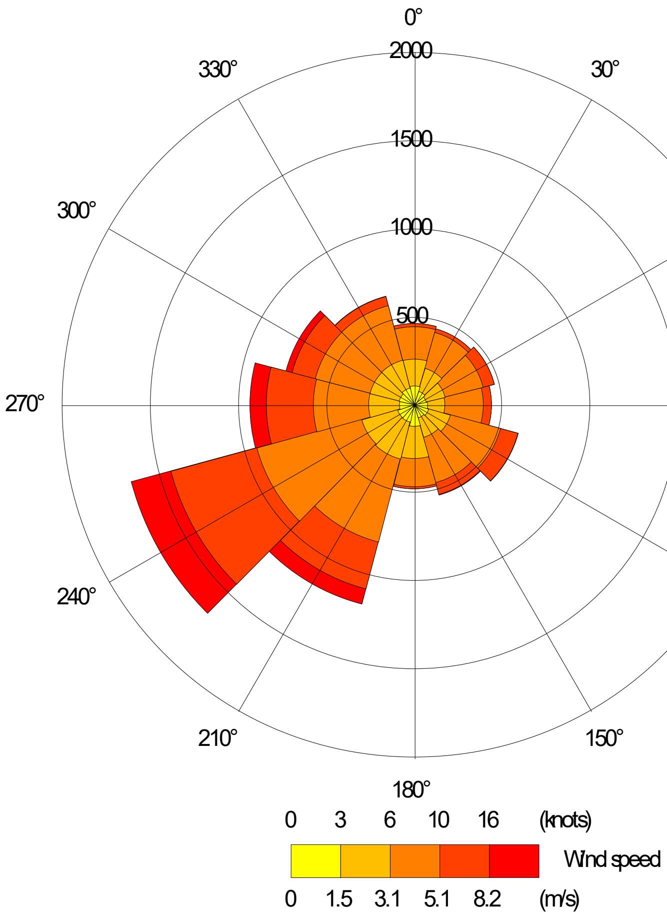
1.5.1 Emission rates for NO_x and PM_{10} were calculated for links in the traffic model based on the traffic flow, HDV composition, vehicle speed band and road type and utilised the National Highways (2020, formerly Highways England) v3.1 speed-banded emission factors. The emission factors are based on version 10.1 of the UK Emissions Factors Toolkit produced by Defra (2020c)).

1.6 Meteorological data

1.6.1 In order to assess the impact of the proposed scheme upon local air quality using a dispersion model, it is important to use representative meteorological data. After road traffic emissions, meteorology is the next most significant factor in determining ambient pollutant concentrations at roadside receptors locations.

1.6.2 Meteorological data for the dispersion modelling assessment were taken from Andrewsfield aerodrome which is considered to be the most representative site for the study area. The Andrewsfield meteorological site had complete wind and temperature data for 2019, with missing (19%) cloud cover information derived from the meteorological site at Stansted Airport. The windrose for Andrewsfield for 2019 is shown on Plate 1.1.

Plate 1.1 Andrewsfield windrose for 2019



1.7 Surface roughness length

1.7.1 The surface roughness is a length scale used to represent the turbulent effect of obstructions in the surrounding area. The surface roughness length at the meteorological data site, where the wind speed measurements were taken, was set at 0.3m to represent the rural setting of the meteorological site. The dispersion site surface roughness was set to 0.5m to reflect the relatively remote locations of receptors along the A12 corridor between urban areas.

1.8 Monin-Obukhov length

1.8.1 The ADMS-Roads model uses the Monin-Obukhov length as a parameter to describe the turbulent length scale which is dependent on meteorological conditions. A minimum length can be used to account for the urban heat island effect, whereby retained heat in cities causes convective turbulence, which prevents the formation of a very shallow boundary layer at night. A minimum Monin-Obukhov length of 30m was set for the study area in all model runs. Other key meteorological parameters were set as default.

1.9 Terrain

1.9.1 Terrain has an effect on the flow field in the air above it. It is recommended that the effect of terrain is incorporated into the ADMS-Roads model where gradients of greater than 1:10 exist within the modelled area, or a short way outside of it. No substantial gradients were identified in the air quality study area. Therefore, terrain has not been accounted for in the air quality modelling.

1.10 Human health receptors

1.10.1 The ADMS-Roads model is used to predict the road traffic contributions to NO_x, PM_{10} and $PM_{2.5}$ concentrations at specified sensitive receptors. The modelled concentrations of PM_{10} and $PM_{2.5}$ are then combined with background concentrations, whilst modelled Road-NO_x and background NO_2 are converted to total NO_2, using the Defra NO_x to NO_2 conversion tool (v8.1) (Defra, 2020d).

1.10.2 A combined total of 267 worst-case human health receptors were included in the assessment. A total of 159 receptors were assessed owing to their proximity to the construction traffic Affected Road Network (ARN), and 260 receptors were assessed in relation to the operational traffic ARN. Note, the construction ARN extended beyond the operational ARN and so seven receptors were construction affected only.

1.10.3 Building usage was determined using OS AddressBase+ data within ArcGIS (Ordnance Survey, 2021). The receptors selected were positioned to represent the façade of the property closest to the nearest affected road in order to provide an estimate of the maximum concentration or maximum change in pollutant concentrations to which that receptor would potentially be exposed. Equally, receptors were selected to indicate where air quality was considered likely to improve as a result of the proposed scheme.

1.10.4 The locations of all of the 267 modelled human health receptors are provided on Figure 6.1 [TR010060/APP/6.2]. The predicted absolute concentrations and changes in concentrations with the proposed scheme are presented on Figures 6.5, 6.6, 6.9 and 6.10 [TR010060/APP/6.2]. All of the modelled human health receptor results are presented in Appendix 6.5 [TR010060/APP/6.3] of the Environmental Statement.

1.10.5 The assessment also modelled 25 receptors (included in the total of 267 human health receptors) representing 39 committed developments within 200m of the ARN. Table 1.3 lists the committed developments represented by the receptors.

Table 1.3 Consented planning applications considered in the air quality assessment

Local authority	Application ID	Site location	Application status	Development status
Chelmsford City Council	14/01552/OUT	Land East Of Plantation Road Boreham Chelmsford Essex	Approved	Pre-construction
Chelmsford City Council	09/01314/EIA	Greater Beaulieu Park, White Hart Lane, Springfield, Chelmsford	Approved	Under Construction
Chelmsford City Council	19/01881/FUL	Land Rear Of 431 Springfield Road Chelmsford	Approved	Full Application
Chelmsford City Council	20/00340/FUL	Land South Of 124 Plantation Road Boreham Chelmsford Essex	Approved	Full Application
Braintree District Council	17/00341/OUT	Bury Farm Bury Lane Hatfield Peverel Essex CM3 2DG	Approved	Pre-construction
Braintree District Council	15/00430/OUT	Land Adjacent To Lodge Farm Hatfield Road Witham Essex	Approved	Pre-construction
Braintree District Council	15/00962/FUL	Land At St Andrew's Road Hatfield Peverel Essex	Approved	Pre-construction
Braintree District Council	16/01813/OUT	Land South Of Stonepath Drive Hatfield Peverel Essex	Approved after Appeal	Pre-construction
Braintree District Council	16/00569/OUT	Land North East Of Inworth Road Feering Essex	Approved	Pre-construction
Braintree District Council	19/00494/REM	Arla Dairy Station Road Hatfield Peverel Essex	REM Approved	Reserve Matters

Local authority	Application ID	Site location	Application status	Development status
Braintree District Council	17/02315/COUP A	East Of England Strategic Health Authority 8 Collingwood Road Witham Essex CM8 2TT	Prior Approval required and given	Pre-construction
Braintree District Council	17/00973/FUL	Land At Bury Lane Hatfield Peverel Essex	Approved	Pre-construction
Braintree District Council	16/02096/OUT	Land At Station Road Hatfield Peverel Essex	Approved	Pre-construction
Braintree District Council	06/01143/OUT	Land On The South Side Of Maltings Lane Witham Essex	Approved	Construction Completed
Braintree District Council	12/01071/OUT	Land On The South Side Of Maltings Lane Witham Essex	Approved	Under Construction
Braintree District Council	08/01171/REM	Pondholton Farm Maltings Lane Witham Essex CM8 3H	Approved	Construction Completed
Braintree District Council	14/00100/REM	Land On The South Side Of Maltings Lane Witham Essex	Approved	Construction Completed
Braintree District Council	14/00005/COUP A	1 Crittall Road Witham Essex CM8 3AF	Permitted Development	Construction Completed
Braintree District Council	15/00012/SCR	Gore Pit Inworth Road Feering Essex	Adopted	Under Construction1

Local authority	Application ID	Site location	Application status	Development status
Braintree District Council	14/01557/FUL	Land At South East Church Road Kelvedon Essex	Approved	Under Construction
Braintree District Council	14/01559/FUL	Land At 31 - 45 Church Road Kelvedon Essex	Approved	Under Construction
Braintree District Council	14/01556/FUL	Land At 29 - 43 Thorne Road Kelvedon Essex	Approved	Under Construction
Braintree District Council	15/01498/FUL	Grangewood Centre 10 - 12 High Street Kelvedon Essex CO5 9AG	Approved	Construction Completed1
Braintree District Council	16/01907/FUL	New Ivy Chimneys Hatfield Road Witham Essex CM8 1EN	Approved	Pre-construction
Braintree District Council	17/02304/FUL	Hatfield Place The Street Hatfield Peverel Essex CM3 2ET	Approved	Pre-construction
Braintree District Council	18/01591/FUL	Kelvedon House 86 High Street Kelvedon Essex	Approved	Pre-construction
Braintree District Council	18/01912/REM	Land Adjacent To Lodge Farm Hatfield Road Witham Essex	Approved	Pre-construction
Braintree District Council	18/00884/REM	Lodge Farm, Hatfield Road, Witham, CM8 1EJ	Approved	Reserved matters
Braintree District Council	18/01089/FUL	Salvator The Street Hatfield Peverel Essex CM3 2EG	Approved	Full Application
Braintree District Council	16/02156/OUT	Land North East Of Gleneagles Way Hatfield Peverel Essex	Approved after Appeal	Pre-construction

Local authority	Application ID	Site location	Application status	Development status
Colchester Borough Council	101255	St. Marys School For Girls, 247 Comrie House, London Road, Stanway Colchester CO3 8LT	Approved	Construction Completed1
Colchester Borough Council	161380	Land North of, Wyvern Farm, London Road, Stanway Colchester	Approved	Construction Completed1
Colchester Borough Council	90398	Swift Construction Group Ltd, Swift Construction Group Ltd, North Lane, Marks Tey Colchester CO6 1EG	Approved	Under Construction
Colchester Borough Council	81203	33-37 London Road, Marks Tey Colchester	Approved	Under Construction
Colchester Borough Council	145494	Land north of Wyvern Farm, London Road, Stanway	Approved	Under Construction
Colchester Borough Council	181859	Land North of, Wyvern Farm, London Road, Stanway Colchester	Approved	Pre-construction
Colchester Borough Council	172049	Land west of, Chitts Hill, Stanway	Approved	Full Application
Colchester Borough Council	200487	The Hayloft, Easthorpe Green F, A12 London Road Trunk Route So, Marks Tey Colchester CO6 1HA	Approved	Certificate Lawfull Development Approved
Colchester Borough Council	200730	Adcock Refrigeration & Air Con, 152 London Road, Copford Colchester CO6 1BQ	Approved	Full Application

1.11 Compliance risk receptors

1.11.1 A total of 73 compliance risk receptors were modelled at 4m distances from the road edge, spaced at approximately 50m distances along the three Pollution Climate Mapping (PCM) Census ID locations that coincided with the operational ARN (802048769, 802058301 and 802006208). Of these, the nine receptors adjacent to PCM Census ID 802006208 were also assessed in relation to the construction ARN. These receptors were deemed to be representative of qualifying features (i.e. features that meet Defra's interpretation of the Air Quality Directive). The locations of the compliance risk receptors are shown on Figure 6.8 [TR010060/APP/6.2].

1.12 Ecological receptors

1.12.1 The assessment compared the 2025 DM and DS, and the 2027 DM and DS for nitrogen deposition.

1.12.2 In order to assess the risk of air pollution impacts to ecosystems, Critical Loads are used as benchmarks. This information was obtained from the Air Pollution Information System (APIS) website (2021), based on habitats for sensitivity to nitrogen deposition confirmed by a competent expert for biodiversity.

1.12.3 Transects up to 200m from the road (measured from the edge of the road) were modelled based on professional judgement of where the impact would be highest. Transect points were positioned from the nearest site boundary point to the road with further transect points at 10m increments up to 200m.

1.12.4 A total of 43 ecological transects were included to represent 42 designated sites (i.e. 30 designated sites, of which 12 have dual designations within 200m of the ARN). The 42 designated sites include a named woodland (Porter's Grove) within 200m of the ARN that was assessed to potentially be of ancient woodland quality in an ecological survey for the proposed scheme. The designated sites are listed in Table 6.12 of Chapter 6: Air quality, of the Environmental Statement [TR010060/APP/6.1]. In addition, 40 single point receptors were modelled to represent veteran tree locations. Nitrogen deposition results for a further 12 veteran locations were assigned based on the nearest appropriate modelled receptor. Of these 12, five tree locations represented groups of veteran or ancient trees. Total tree numbers at these locations (e.g. for the construction dust assessment), were aggregated based on the survey information available. Veteran and ancient trees of both potential and verified status were considered in the assessment. All assessed ecological transects and veteran tree locations are shown on Figure 6.7 [TR010060/APP/6.2].

1.12.5 The total nitrogen deposition rates associated with road-increment NO_2 and ammonia (NH_3) were calculated at each ecological receptor location.

1.12.6 ADMS-Roads was used to calculate road NO_x contributions at each transect point. A verification adjustment factor was applied to the road NO_x (see Section 1.13 of this appendix) and road-NO_2 concentrations were calculated using Defra's NO_x to NO_2 Calculator (2020d; see Section 1.14 of this appendix). A long-term trend (LTT) adjustment was applied to the total NO_2 as outlined in Section 1.15 of this appendix.

1.12.7 In accordance with DMRB LA 105, the following conversion rates were applied to convert road increment NO_2 (in µg/m^3) to nitrogen deposition (kg N/ha/yr):

- grassland and similar habitats: 1 µg/m^3 of NO_2 = 0.14 kg N/ha/yr
- forests and similar habitats: 1 µg/m^3 of NO_2 = 0.29 kg N/ha/yr

1.12.8 The calculation of nitrogen deposition from road-increment NH_3 applied the Draft National Highways (2021) ammonia nitrogen deposition tool (version 2.0). ADMS-Roads was used to calculate the road NO_x contributions at each receptor made by heavy and light vehicles. The NH_3 nitrogen deposition tool calculates proxy NH_3 concentrations from heavy and light vehicles based on predetermined NO_x:NH_3 ratios for the dominant road type at each receptor. Application of LTTs is applied to NO_X emissions as the basis of estimating NH_3. Ammonia emissions are assumed to decrease substantially going forwards. The nitrogen deposition rate attributable to NH_3 is then calculated based on the total NH_3 concentration and habitat type (woodland or grassland).

1.12.9 The road nitrogen deposition rate for each point along the transect was then added to the corresponding background nitrogen deposition rate obtained from the APIS website (CEH, 2021).

1.12.10 The nitrogen deposition results for all designated ecological sites are presented in Appendix 6.5 [TR010060/APP/6.3] of the Environmental Statement.

1.13 Model verification

1.13.1 The derivation of the verification adjustment factor is described in Appendix 6.4 of the Environmental Statement [TR010060/APP/6.3]. The verification adjustment factor was applied to modelled road NO_x and PM_{10} concentrations, following the guidance in LAQM TG(16) (Defra, 2021).

1.14 Derivation of total NO_2, PM_{10} and $PM_{2.5}$ concentrations

1.14.1 Following application of the verification adjustment factor, the road NO_x concentrations were combined with the relevant background concentrations and processed using the Defra NO_x to NO_2 calculator v8.1 (Defra, 2020d) to calculate the road increment NO_2 and total NO_2 concentration at each receptor.

1.14.2 The total PM_{10} concentration was derived by summing the verification-adjusted modelled road PM_{10} concentration and the PM_{10} background concentration, for the relevant years.

1.14.3 The National Highways v3.1 speed-banded emission factors do not include emission factors for $PM_{2.5}$. The total $PM_{2.5}$ concentration was therefore derived by summing the verification-adjusted modelled road PM_{10} concentration and the $PM_{2.5}$ background concentration, for the relevant years.

1.15 Adjustment for long term trends in NO_2

1.15.1 In July 2011, Defra published a report, Trends in NO_x and NO_2 Emissions and Ambient Measurements in the UK (Defra, 2011), examining the long term air quality trends in NO_x and NO_2 concentrations. This identified that there has been a clear decrease in NO_2 concentrations between 1996 and 2002.

Thereafter, NO_2 concentrations have stabilised with little to no reduction between 2004 and 2012. The consequence of the conclusions of Defra's advice on long term trends is that there is now a gap between current projected vehicle emission reductions and projections on the annual rate of improvements in ambient air quality, which are built into vehicle emission factors, projected background maps and the NO_x to NO_2 Calculator.

1.15.2 National Highways (formerly the Highways Agency, 2013) developed the gap analysis methodology to adjust model predictions based on the method in LAQM TG(16) to account for the long term NO_x and NO_2 profiles. This uses the relationship between the base year vehicle emission rates and the opening year vehicle emission rates, and the measured trends in roadside air quality concentrations to uplift opening year predicted concentrations to align them better with the LTTs of NO_x and NO_2.

1.15.3 The current trends in air quality are based on measurements of emissions from the existing vehicle fleet. Newer vehicles have needed to comply with the more stringent Euro 6/VI emissions standards from September 2014 onwards. If the Euro 6/VI fleet emissions perform as predicted, then this should lead to substantial reductions in predicted future roadside air quality concentrations.

1.15.4 However, because the likely effects of Euro 6/VI vehicles on air quality are yet to be fully understood, a conservative approach of applying National Highways' LTT has been applied to the modelling results. These LTT assume a projected rate of decrease into the future based on past monitoring trends.

1.15.5 The gap analysis methodology, as set out in DMRB LA 105 (Highways England, 2019), incorporates the Euro 6/VI improvements. These LTT projection factors are referred to as 'LTTE6' (other LTT datasets that pre-date LTTE6 are also available). The LTTE6 factors assume that the measured trends from 2004 to 2012 continue to occur for all pre-Euro 6/VI fleet. They also take a precautionary approach to account for uncertainty associated with Euro 6/VI performance and fleet mix in the future, rather than assuming full reductions in emissions occur as predicted by Euro 6/VI, which has not been observed by air quality monitoring trends associated with recent Euro standards. This is implemented into LTTE6 by taking the mid-point between the measured trend predictions (which assume no improvement in emissions associated with Euro 6/VI) and predicted Euro 6/VI uptake and emission improvements.

1.15.6 On this basis, the LTTE6 projections are considered to be the most reasonable prediction of likely actual future NO_x and NO_2 concentrations and have been used in the calculations for this assessment.

1.15.7 As per DMRB LA 105, the gap analysis methodology was not applied to modelled compliance risk receptors, so the assessment is consistent with Defra's reporting on compliance with the EU Limit Values.

1.15.8 The gap analysis method is not required to be applied to PM_{10} and $PM_{2.5}$ predictions, as there is less uncertainty in future year concentrations of these pollutants, and the results based on the LAQM TG(16) method are the final predicted concentrations throughout the assessment.

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