FIVE ESTUARIES OFFSHORE WIND FARM

ENVIRONMENTAL STATEMENT

VOLUME 6, PART 6, ANNEX 10.4: ROAD TRAFFIC DISPERSION MODELLING METHODOLOGY

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Five Estuaries Offshore Wind Farm

Environmental Statement

Annex 10.4 of Volume 6, Part 3, Chapter 10: Road Traffic Dispersion Modelling

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Making Sustainability Happen

Revision Record

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Basis of Report

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Acronyms and Abbreviations

Term	Definition
AADT	Annual Average Daily Traffic
AQAL	Air Quality Assessment Level
ASR	Annual Status Report
BC	Base Case
CBC	Colchester Borough Council
CERC	Cambridge Environmental Research Consultants
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
DM	Do Minimum
DS	Do Something
EACN	East Anglia Connection Node
ECC	Export Cable Corridor
EFT	Emission Factor Toolkit
HDV	Heavy Duty Vehicle
LAQM	Local Air Quality Management
LAQM.TG(22)	Local Air Quality Management Technical Guidance 2022
LDV	Light Duty Vehicle
MDS	Maximum Design Scenario
NF OWF	North Falls Offshore Wind Farm
NGET	National Grid Electricity Transmission
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NWP	Numerical Weather Prediction
OnSS	Onshore Substation
OWF	Offshore Wind Fam
PM_{10}	Particulate Matter
$PM_{2.5}$	Fine Particulate Matter
RMSE	Root Mean Squared Error
TDC	Tendring District Council
VE	Five Estuaries Offshore Wind Farm

1.0 Road Traffic Dispersion Modelling Methodology

In order to appropriately assess road traffic impacts associated with the construction phase of the onshore elements of Five Estuaries Offshore Wind Farm (VE) on sensitive receptors, detailed dispersion modelling has been undertaken.

This has comprised the use of Cambridge Environmental Research Consultants' (CERC) ADMS-Roads v5 dispersion model, focussing on concentrations of nitrogen dioxide (NO_2), particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$) for the following scenarios:

- 2019 Base Case (2019 BC) – Base flows for the year (2019);
- 2027 Do Minimum (2027 DM) – Future baseline flows for the earliest potential year construction will commence (2027), inclusive of any other relevant committed development flows and flows associated with live projects and plans; and
- 2027 Do Something (2027 DS) – 2027 DM flows, plus peak road traffic flows generated by VE construction activities.

For the above future year scenarios (2027), concurrent emission factors and background (projected) pollutant concentrations have been used – representing the earliest date of potential construction.

To ensure potential air quality impacts that may arise throughout the construction phase are understood, 2027 has been adopted for the purposes of dispersion modelling (i.e. earliest date of potential construction). Use of 2027 is believed to be conservative, given the forecasted reductions in vehicle emission factors and background pollutant concentrations (following the introduction of legislative and policy initiatives, alongside low emission technologies/ fuels), likely to exaggerate resultant concentrations and effects relative to what may occur in reality.

1.1 Traffic Inputs

Traffic data inputs used in support of the construction phase assessment has been informed by analysis undertaken and presented within Volume 6, Part 3, Chapter 8: Traffic and Transport.

Data has been supplemented from the Department for Transport (DfT) traffic count website (DfT, 2024) (where relevant) and adjusted accordingly - in line with the analysis undertaken as part of the transport assessment within Volume 6, Part 3, Chapter 8: Traffic and Transport.

To initially inform the spatial extent of the affected road network, changes in traffic volumes on the local road network were compared to human screening thresholds (See Section 10.5 - Volume 6, Part 3, ES Chapter 10: Air Quality). Where relevant, neighbouring links were also included within the dispersion model to facilitate a robust assessment, rather than rely on their individual contributions being represented within the appropriate background datasets. As such, the spatial extent of the dispersion model is greater than the affected road network – as it includes road links which may experience insignificant vehicle volumes.

Construction road traffic flows have been calculated using the maximum consecutive 12 months (representing annual) flow (Heavy Duty Vehicles (HDVs) and employees (Light Duty

Vehicles (LDVs)) separately) across the 18-month construction programme[1]. This Annual Average Daily Traffic (AADT) flow ensures the highest average period of construction has been captured for each section of the road network. This approach is considered appropriate in comparison to averaging out road traffic values across the full onshore construction period to derive AADT flows, which would dilute the predicted datasets. This approach assumes that the maximum consecutive 12-month vehicle flows generated throughout the whole construction phase occur under worst-case air quality conditions (2027 vehicle emission factors and background pollutant concentrations) projected for the full construction period. This is considered conservative.

Traffic flows used for the future 2027 assessment years includes maximum vehicle movements associated with:

- Relevant committed developments (see Volume 6, Part 3, Chapter 8: Traffic and Transport);
- North Falls Offshore Windfarm (NF OWF); and
- National Grid electricity transmission (NGET) Norwich to Tilbury Reinforcement project.

As described in Volume 6, Part 3, ES Chapter 1: Onshore Project Description, a co-ordinated approach with the adjacent NF OWF project is sought. NF OWF is not a consented project, so there is uncertainty regarding future co-ordination. To address this uncertainty, a series of scenarios are proposed, encompassing potential construction options.

In relation to potential impacts that could arise as a result of road traffic vehicle movements generated by VE construction activities, co-ordination Scenario 1 is considered to result in the worst-case assessment criteria for air quality. It has therefore been adopted as the primary assessment scenario, to ensure all potential scenarios and impacts are understood.

Co-ordination Scenario 1 comprises VE proceeding to construction and undertaking the additional onshore cable trenching and ducting works for NF OWF as part of a single civils campaign (ducting for four electrical circuits) for the Export Cable Corridor (ECC). VE would undertake the cable installation and onshore substation (OnSS) build for its project only (two electrical circuits). Whilst this scenario assumes the two projects would share accesses from the public highway for cable installation and substation construction, NF OWF traffic data considered in this assessment where relevant includes reinstatement of the accesses.

As VE will be undertaking additional works on behalf of NF OWF, higher road traffic vehicle movements are expected vs. other scenarios. Furthermore, it is assumed that NF OWF and VE are constructed concurrently in the same year, and peak construction vehicle trips will overlap and affect the same road links simultaneously. The combination of these parameters will result in worst-case impacts.

The dispersion modelling exercise is inherently cumulative, incorporating the assumption that committed schemes become fully operable at the time of assessment. Moreover, it assumes that NF OWF and the East Anglia Connection Node (EACN) substation , part of the NGET Norwich to Tilbury Reinforcement project will all receive consent. This

[1] The OnSS construction programme is anticipated to take place over an approximately 24-month period. The cable construction programme is anticipated to run concurrently for the first 18 months (though potentially up to 27 months). Therefore, assessment of the 18 months represents the maximum generation of construction trips.

presupposes that peak construction activities linked with VE, NF OWF and NGET Norwich to Tilbury Reinforcement project will coincide and impact the same road links simultaneously. This assumption is considered highly unlikely.

Traffic speeds were modelled at the relevant speed limit for each road as outlined in Table A. However, where appropriate, the speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues or slower traffic are known to be an issue, in accordance with the Department for Environment Food and Rural Affairs' (Defra's) Local Air Quality Management (LAQM) Technical Guidance 2022 (TG.22) (LAQM.TG22) (Defra, 2022).

Traffic speeds have been assumed to be consistent across all the modelled scenarios, with the exception of Bentley Road where a 40 mph speed limit has been adopted in the 2027 DS scenario only.

The temporary speed limit change at Bentley Road is part of a package of transport infrastructure upgrades along Bentley Road to facilitate construction works. This also comprises the widening of Bentley Road and junction works with the A120. These highway upgrades have been included in the 2027 DS scenario only.

The latest version of the Emission Factor Toolkit (EFT) version 12.0.1 (Defra, 2023) has been used to determine vehicle emission factors for input into the ADMS-Roads dispersion model, supporting each of the above scenarios.

Details of the traffic flows used in this assessment are provided in Table A, whilst the modelled roads in relation to the Order Limits are presented in Volume 6, Part 3, Chapter 10: Air Quality, Figure 10.3.

Table A: Traffic Data Used Within the Assessment

Link	2019 BC		2027 DM		2027 DS		Speed (kph) [A]
	AADT	% HDV	AADT	% HDV	AADT	% HDV	
A12 (N)	60,190	9.5	68,927	10.6	69,221	10.8	113
A12 (S)	70,063	8.3	79,913	9.3	80,204	9.5	113
A120 between J29 and A133	42,575	6.1	48,436	6.9	49,020	7.6	113
A120 between A133 and Harwich Road	11,777	11.4	13,763	14.2	14,294	16.3	113/ 80
A120 between Harwich Road and Bentley Road	11,928	12.1	13,921	14.6	14,688	16.4	80
A120 between Bentley Road and B1035	12,078	12.7	14,086	15.1	14,832	17.0	80
A120 East of B1035	14,761	11.9	16,675	12.4	16,781	12.3	97
A120 at Harwich	10,091	15.9	11,540	16.4	11,645	16.2	113
A133 between A120 and A133 Main Road	21,796	3.2	24,746	3.4	25,147	4.0	113
A133 between A133 Main Road and B1033	30,732	3.7	35,024	3.8	35,257	4.2	113/ 97
A133 between B1033 and B1027	20,556	2.7	23,492	3.0	23,896	3.7	97/ 80/ 48

Link	2019 BC		2027 DM		2027 DS		Speed (kph) (A)
	AADT	% HDV	AADT	% HDV	AADT	% HDV	
B1027 St John's Road (west of Clacton)	15,203	0.9	16,723	0.9	16,787	0.9	48
B1027 Valley Road (Clacton)	13,215	9.9	14,574	10.1	14,730	10.6	48
B1033 Colchester Road (west of B1441)	13,632	13.2	17,248	11.8	17,502	12.3	97
B1441 Clacton Road	5,419	16.4	6,402	15.7	6,533	16.3	97
B1033 Colchester Road (east of B1441)	9,137	15.6	10,503	15.3	10,645	15.6	97/ 48
B1035 south of A120	5,090	15.7	5,654	16.0	5,862	16.3	97
B1035 Clacton Road	7,637	15.7	8,409	15.8	8,462	15.9	97/ 64
Bentley Road	860	20.2	1,345	32.9	1,822	33.6	97/ 80 (64 2027 DS)
B1029 Harwich Road	2,177	3.6	2,423	3.6	2,423	3.6	64
A12 Main Carriageway (between junction)	39,913	12.4	44,415	12.4	44,415	12.4	113
Ipswich Road at J29 Roundabout	16,404	2.8	19,027	2.7	19,027	2.7	48
A12 (S) onslip at J29 Roundabout	11,957	9.8	13,658	9.9	13,804	10.5	113
A12 (N) offslip at J29 Roundabout	9,120	8.4	10,582	8.9	10,682	9.2	80
A12 (N) onslip at J29 Roundabout	8,817	12.1	10,245	12.5	10,345	12.8	113
A120 (E) offslip at J29 Roundabout	6,951	9.5	8,172	10.1	8,321	10.5	113
A120 (E) onslip at J29 Roundabout	8,142	9.9	9,498	10.3	9,646	10.7	113
A12 Offslip 1	19,698	6.1	22,894	7.9	23,039	8.2	113/ 80
A12 Offslip 2	13,741	4.1	16,356	7.5	16,501	8.0	113
A12 Onslip 1	17,310	5.6	20,236	7.6	20,381	8.1	113
A12 - Between J29 Slip Roads	20,277	3.7	24,512	7.2	24,611	7.4	113
A120 - Between A133 Slip Roads	31,677	7.1	36,063	8.0	36,447	8.8	113
A120 to A130 Slip Road	10,898	3.2	12,373	3.4	12,574	4.0	113/ 97
A130 to A120 Slip Road	10,898	3.2	12,373	3.4	12,574	4.0	97

Note:
(A) Speeds based upon National Speed Limits. Traffic speeds have been adjusted to take into account queues and congestion in accordance with LAQM.TG(22).

1.2 Meteorological Data

It is pertinent to use meteorological data that is representative of the modelled area. The modelled road network encompasses both coastal and inland locations, spanning rural and urban areas from Clacton-on-Sea to Colchester.

The nearest synoptic meteorological station relative to the modelled road network is Wattisham (>17 km away). The Wattisham meteorological station is located further inland, which may not fully represent the range of meteorological conditions across the modelled road network.

The nearest coastal synoptic meteorological station relative to the modelled road network is Shoeburyness Landwick (>35 km away). The meteorological vendor recommends that synoptic meteorological data may only be considered relevant for locations within 20 km of the dispersion site.

Based on the above outcomes, it was determined that there is no clear representative meteorological station within a suitable distance to the modelled road network which comprehensively reflect the diverse range of meteorological conditions.

In recognition of the above, Numerical Weather Prediction (NWP) meteorological data was consequently utilised for the assessment, centred on the model domain, relating to 2019.

The NWP data is derived from an approximate 9 km^2 grid coverage across the UK. The grid square centred on the model domain covers a large majority of the modelled road network. This approach was taken to ensure the diverse range of meteorological conditions across the modelled road network were accounted for to the best extent possible.

NWP meteorological data is considered an appropriate source of data in coastal locations where there is an unavailability of synoptic meteorological stations, as will better represent the local atmospheric stability. NWP meteorological data was provided by an accredited 3rd party vendor. A wind rose of the 2019 NWP data is presented in Figure A.

A surface roughness value of 0.3 m has used to represent the dispersion site. A minimum Monin-Obukhov Length value of 10 m has been used for both the dispersion site.

Dispersion characteristics were applied to the meteorological study area.

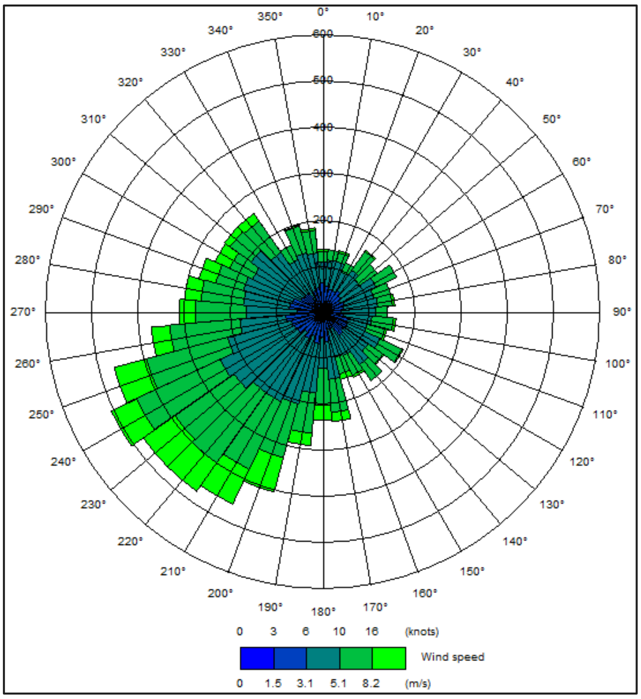

Figure A: Wind Rose for NWP Data (2019)

1.3 Sensitive Receptors

1.3.1 Human Receptors

Human receptors considered in the assessment of emissions from road traffic are shown in Table B, whilst their locations are illustrated in Volume 6, Part 3, Chapter 10: Air Quality, Figure 10.3.

The receptors are representative of worst-case exposure locations relative to the extent of the affected road network.

All receptors were considered in relation to exposure at breathing height at ground level relative to the adjacent modelled road.

Table B: Human Receptor Locations Considered

Receptor	X	Y	Height (m)
R1	614197	222477	1.5
R2	614124	222455	1.5
R3	613548	222572	1.5
R4	612972	222760	1.5
R5	611024	223481	1.5
R6	610797	223482	1.5
R7	609569	225073	1.5
R8	610771	225501	1.5
R9	611302	226513	1.5
R10	611274	226563	1.5

Receptor	X	Y	Height (m)
R11	611138	226669	1.5
R12	611506	226873	1.5
R13	612349	227370	1.5
R14	608777	225129	5.5
R15	608768	225016	7.5
R16	608203	225102	1.5
R17	604619	227055	3.5
R18	603135	227963	3.5
R19	602009	228775	5.5
R20	602211	229440	3.5
R21	602419	229740	1.5
R22	603024	230763	1.5
R23	603414	231908	1.5
R24	605495	235360	1.5
R25	598918	228905	5.5
R26	598571	228814	1.5
R27	596013	225339	5.5
R28	596016	225284	1.5
R29	595059	225172	1.5
R30	594955	225163	1.5
R31	595127	225132	1.5
R32	613934	221184	1.5
R33	614403	220519	1.5
R34	615225	220037	1.5
R35	616138	218318	1.5
R36	616959	217006	1.5
R37	616939	216901	1.5
R38	617134	216511	1.5
R39	617082	216471	1.5
R40	610700	227055	1.5

1.4 Background Datasets

1.4.1 Ambient Concentrations

Annual mean background concentrations used for the purposes of the assessment have been obtained from the Defra supplied background maps (2018 reference year) (Defra, 2020a), based on the 1 km grid squares which cover the dispersion model domain as presented in Table C.

To avoid double counting of potential background sources already contained within the ADMS-Roads dispersion model, relevant sources were removed. This was limited to the removal of 'Trunk A Road In' and 'Primary A Road In' for the assessment study area. For details on the model verification approach, see Section 2.1.

As the relationship between NO_2 and Nitrogen Oxides (NO_x) is not linear, the NO_2 Adjustment for NO_x Sector Removal Tool (Defra, 2020b) has been used – in accordance with LAQM.TG(22) (Defra, 2022).

Table C: Defra Mapped Background Pollutant Concentrations

Grid Square (X,Y)	Year	Annual Mean Concentration (µg/m^3)			
		NO_x	NO_2	PM_{10}	$PM_{2.5}$
614500, 222500	2019	10.7	8.3	15.0	9.2
	2027	8.3	6.5	13.9	8.3
613500, 222500	2019	12.0	9.2	15.4	9.4
	2027	8.9	7.0	14.3	8.5
612500, 222500	2019	11.4	8.8	15.8	9.4
	2027	8.6	6.7	14.6	8.5
611500, 223500	2019	12.0	9.2	16.5	9.7
	2027	9.0	7.0	15.3	8.8
610500, 223500	2019	12.6	9.6	17.1	9.9
	2027	9.3	7.3	15.9	9.0
609500, 225500	2019	14.8	11.2	16.9	10.0
	2027	10.4	8.0	15.7	9.0
610500, 225500	2019	12.1	9.3	16.3	9.7
	2027	9.0	7.0	15.2	8.8
611500, 226500	2019	11.4	8.8	16.0	9.6
	2027	8.6	6.8	14.8	8.7
612500, 227500	2019	11.3	8.7	16.6	9.7
	2027	8.6	6.7	15.5	8.8
608500, 225500	2019	14.2	10.8	15.7	9.6
	2027	10.1	7.8	14.6	8.7
604500, 227500	2019	15.0	11.3	16.4	10.0
	2027	10.8	8.4	15.2	9.1
603500, 227500	2019	16.6	12.4	15.5	9.9
	2027	11.7	9.0	14.3	9.0
602500, 228500	2019	19.2	14.2	16.3	10.4
	2027	13.4	10.2	15.0	9.4
602500, 229500	2019	20.9	15.3	17.2	10.9
	2027	14.1	10.7	16.0	9.8

Grid Square (X,Y)	Year	Annual Mean Concentration (µg/m^3)			
		NO_x	NO_2	PM_{10}	$PM_{2.5}$
603500, 230500	2019	15.0	11.4	16.0	9.9
	2027	10.8	8.3	14.8	9.0
603500, 231500	2019	17.1	12.8	17.7	10.6
	2027	11.7	9.0	16.5	9.6
605500, 235500	2019	15.3	11.5	16.6	10.1
	2027	10.6	8.2	15.5	9.2
598500, 228500	2019	19.2	14.2	17.9	10.9
	2027	13.0	9.9	16.7	9.9
596500, 225500	2019	26.9	19.2	18.0	11.3
	2027	17.0	12.7	16.8	10.3
595500, 225500	2019	20.3	14.9	17.4	10.9
	2027	13.6	10.3	16.1	9.9
594500, 225500	2019	20.6	15.1	18.0	11.0
	2027	13.6	10.3	16.8	10.1

1.5 Model Outputs

1.5.1 Ambient Concentrations

The background pollutant values have been used in conjunction with the concentrations predicted by the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$ for each respective scenario.

For the prediction of annual mean NO_2 concentrations for all modelled scenarios at receptor locations, the road NO_x contributions (adjusted as per Section 1.4.1) have been converted to total NO_2 following the methodology in LAQM.TG(22) (Defra, 2022) using the Defra's latest NO_x to NO_2 conversion tool (v8.1) (Defra, 2020c). The modelled NO_2 road contribution was then added to the appropriate NO_2 background concentration value to obtain an overall total annual mean NO_2 concentration.

For the prediction of short-term NO_2 impacts, LAQM.TG(22) advises that it is valid to assume that exceedances of the 1-hour mean AQAL for NO_2 are unlikely to occur where the annual mean NO_2 concentration is <60 µg/m^3. This approach has thus been adopted for the purposes of this assessment, at relevant receptor locations with an applicable exposure period.

For the prediction of short-term PM_{10}, LAQM.TG(22) provides an empirical relationship between the annual mean and the number of exceedances of the 24-hour mean Air Quality Assessment Level (AQAL) for PM_{10} that can be calculated as follows:

No. 24-hour mean exceedances = -18.5 + 0.00145 × annual mean^3 + (206/annual mean)

This relationship has thus been adopted to determine whether exceedances of the short-term PM_{10} AQAL are likely in this assessment.

Verification of the ADMS-Roads assessment has been undertaken as per Section 2.0. All results presented in the assessment are those calculated following the process of model verification, using an adjustment factor of 2.210.

1.6 Uncertainty

Dispersion modelling is inherently uncertain and is principally reliant on the accuracy and representativity of its inputs. In acknowledgement of this, the ADMS-Roads dispersion model has been verified with the latest complete set of representative publicly available local monitoring data as collected by Tendring District Council (TDC) (TDC, 2020) and Colchester Borough Council (CBC) (CBC, 2020).

It is acknowledged that CBC have published 2022 monitoring data (2023 Annual Status Report (ASR)). However, the latest published by TDC is 2021 (2022 ASR). Therefore, 2019 represents the latest complete set of monitoring data published by all authorities within the modelled domain, prior to the COVID-19 pandemic which can be used for model verification. Use of different monitoring years for model verification is not recommended.

Following verification, all model output statistical parameters (used to evaluate model performance and uncertainty) are within LAQM.TG(22) (Defra, 2022) prescribed ideal tolerances (Section 2.1).

In addition, there is a widely acknowledged disparity between emission factors and ambient monitoring data. To help minimise any associated uncertainty when forming conclusions from the results, this assessment has utilised the latest EFT version 12.0.1 (Defra, 2023) utilising COPERT 5.6 emission factors, and associated tools/ datasets published by Defra.

Furthermore, a series of conservative assumptions have been adopted to facilitate a precautionary assessment and provide greater confidence in the road traffic emissions assessment outcomes. This is referred to as a maximum design scenario (MDS). These include:

- The maximum consecutive 12-month vehicle flows generated throughout the whole construction phase occur under worst-case air quality conditions (2027 vehicle emission factors and background pollutant concentrations) projected for the full construction period:
    - Construction road traffic flows have been calculated with use of the maximum consecutive 12-month (representing annual) flows (HDVs) and employees (LDVs) separately) across the onshore cabling and OnSS construction programme. This ensures the highest average period of construction is captured for each section of the network; and
    - 2027 has been adopted for the purposes of dispersion modelling (i.e. earliest date of potential construction). Use of 2027 is conservative in recognition of the forecast reductions in vehicle emission factors and background pollutant concentrations – following the introduction of legislative and policy initiatives, alongside low emission technologies/ fuels. 2027 relates to worst-case air quality conditions projected to occur across the full construction period.
- The dispersion modelling exercise is inherently cumulative. It assumes that all considered committed schemes will become fully operable at the time of assessment. Moreover, it assumes that NF OWF and NGET Norwich to Tilbury Reinforcement project will receive consent. This presupposes that peak

construction activities linked with VE, NF OWF, and NGET Norwich to Tilbury Reinforcement project - EACN substation.

- substation will coincide and impact the same road links simultaneously; and
- Selection of co-ordination Scenario 1 with NF OWF for consideration within the air quality assessment. Scenario 1 involves VE undertaking additional works on behalf of NF OWF leading to higher road traffic vehicle movements compared to other scenarios. Furthermore, for the purposes of the air quality assessment, it is assumed that NF OWF and VE are constructed concurrently in the same year, and peak construction vehicle trips will overlap and affect the same road links simultaneously. Scenario 1 is considered to result in the worst-case assessment criteria for air quality. It has therefore been adopted as the primary assessment scenario, to ensure all potential scenarios and impacts are understood.

See Volume 6, Part 3, Chapter 10: Air Quality for further detail.

2.0 Model Verification

The ADMS-Roads dispersion model has been widely validated for this type of assessment and is specifically listed in LAQM.TG(22) (Defra, 2022) guidance as an accepted dispersion model.

Model validation undertaken by the software developer (CERC) will not have included validation in the vicinity of the modelled domain. It is therefore necessary to perform a comparison of modelled results with local monitoring data at relevant locations. This process of verification attempts to minimise modelling uncertainty and systematic error by correcting modelled results by an adjustment factor to gain greater confidence in the final results.

Prior to undertaking model verification, model setup parameters and input data were reviewed to maximise the performance of the dispersion model in relation to the real-world conditions. This included review of monitoring locations using street view imagery.

2019 has been used for the purposes of model verification. Subsequent years (i.e. beyond 2019) may be influenced by the COVID-19 pandemic and may not fully be representative of long-term baseline conditions and could lead to a systematic underprediction at modelled receptor locations.

2.1 NO_x/ NO_2 Verification

NO_x/ NO_2 verification relates to the comparison and adjustment of modelled road-NO_x (as output from the ADMS-Roads dispersion model), relative to monitored road-NO_x.

For NO_x/ NO_2 model verification, 2019 LAQM CBC and TDC monitoring data has been used for those roadside locations situated adjacent to a modelled link i.e. where traffic data exists (Table D). The locations of the monitors relative to the modelled road network are presented in Volume 6, Part 3, Chapter 10: Air Quality, Figure 10.1.

Table D: Local Monitoring Data Used for Model Verification

Site ID	X	Y	2019 Monitored NO_2 Concentration ($\mu g/m^3$)	2019 Data Capture (%)
CBC131	595025	225166	39.8	100.0
CBC132	595106	225123	32.5	100.0

Site ID	X	Y	2019 Monitored NO_2 Concentration (µg/m^3)	2019 Data Capture (%)
DT14,15,16 (triplicate)	616062	218517	31.6*	100.0
DT19	613924	227789	23.2	100.0
DT20	612619	227395	20.7	100.0
Table Notes *Represents a calculated mean 2019 concentration (given the triplicate location).				

As NO_2 concentrations are solely reported using diffusion tubes, NO_x was back calculated using the latest version of Defra's NO_x to NO_2 Calculator (Defra, 2023c). The NO_x to NO_2 Calculator was also used to facilitate the conversion of modelled road-NO_x (as output from the ADMS-Roads dispersion model) into road-NO_2.

Verification was completed using the 2019 Defra background mapped concentrations (2018 reference year) (Defra, 2020a) for the relevant 1 km grid squares (i.e. those within which the model verification sites are located), with those already modelled sources removed, to avoid duplication. This was limited to removal of 'Trunk A Road In' and 'Primary A Road In' for the verification exercise.

Initial comparison of the modelled vs. monitored road NO_x contribution at all relevant verification locations outlined in Table D is provided in Table E. An initial adjustment factor of 2.210 has been derived, based on a linear regression forced through zero, as shown in Figure B.

No further improvement to the ADMS-Roads dispersion model could be achieved.

Table E: NO_x/ NO_2 Model Verification (2.210)

Site ID	Monitored Road NO_x (µg/m^3)	Modelled Road NO_x (µg/m^3)	Ratio (Monitored vs. Modelled Road NO_x)	Adjustment Factor	Adjusted Modelled Total NO_2 (µg/m^3)	Monitored Total NO_2 (µg/m^3)	% Difference (Adjusted Modelled NO_2 vs Monitored NO_2)
CBC131	57.5	25.4	2.27	2.210	39.2	39.8	-1.53
CBC132	41.2	21.0	1.96		34.9	32.5	7.38
DT14,15,16	46.0	18.5	2.49		29.3	31.6	-7.49
DT19	28.7	12.7	2.25		22.9	23.2	-1.12
DT20	23.2	11.6	2.01		21.9	20.7	5.70

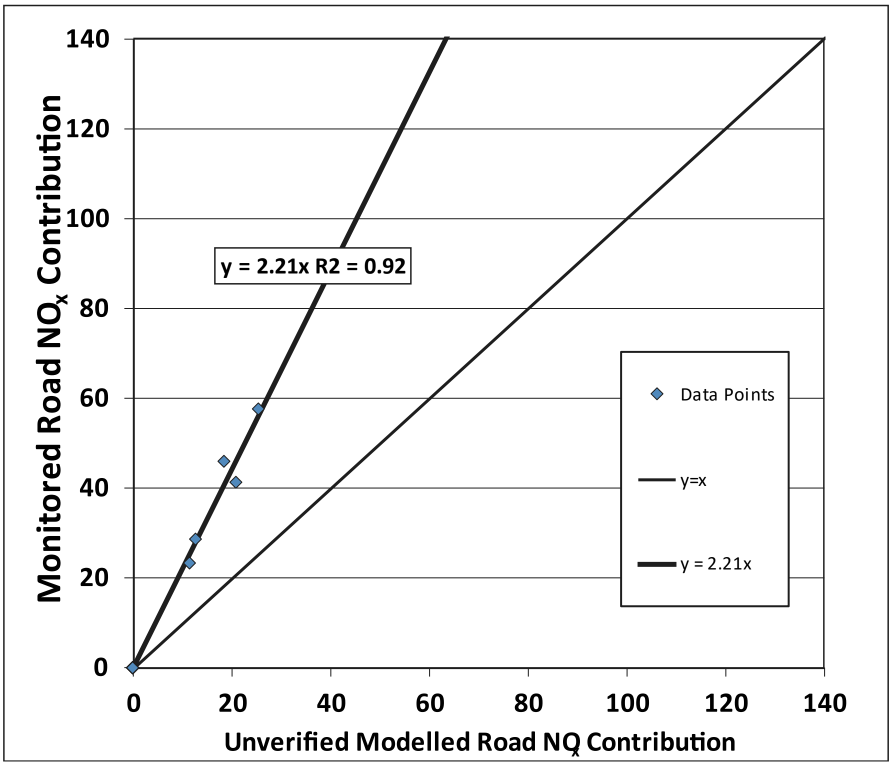

Figure B: Comparison of Modelled vs. Monitored Road NO_x Contribution (2.210)

Defra's LAQM.TG(22) states that:

> *"In order to provide more confidence in the model predictions and the decisions based on these, the majority of results should be within 25% of the monitored concentrations as a minimum, preferably within 10%".*

As noted in Table E, the difference between modelled vs. monitored NO_2 concentrations is within ±10% at all verification locations and therefore within the ideal LAQM.TG(22) (Defra, 2022) prescribed limit. In addition, a verification factor of 2.210 reduces the Root Mean Square Error (RMSE) from a value of 11.1µg/m^3 to 1.6µg/m^3 – within the ideal LAQM.TG(22) prescribed limit (10% of the annual mean AQAL).

On this basis, the derived verification factor (2.210) was considered acceptable and was subsequently applied to all road-NOx concentrations predicted (as output of the ADMS Roads dispersion model).

2.2 PM_{10}/ $PM_{2.5}$ Verification

The adjustment factor of 2.210 has also been applied to road-PM_{10} and $PM_{2.5}$ concentrations (as output of the ADMS Roads dispersion model) following the recommendations of LAQM.TG(22) (Defra, 2022), in the absence of local particulate monitoring.

3.0 Modelling Results

3.1 Human Receptors

3.1.1 NO_2 Modelling Results

Table F presents the annual mean NO_2 concentrations predicted at all assessed receptor locations of relevant exposure for the 2019 BC, 2027 DM and 2027 DS scenarios.

Table F: Predicted Annual Mean NO_2 Concentrations – 2027 Planned Construction Year

Receptor	Predicted Annual Mean NO_2 Concentration (µg/m^3)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R1	13.2	8.6	8.7	<0.1	21.8	Negligible
R2	14.9	9.4	9.5	0.1	23.8	Negligible
R3	18.2	11.0	11.1	0.1	27.8	Negligible
R4	16.0	10.0	10.0	<0.1	25.0	Negligible
R5	23.1	13.5	13.6	0.1	34.0	Negligible
R6	18.1	11.1	11.2	0.1	28.0	Negligible
R7	15.3	9.6	9.7	0.2	24.3	Negligible
R8	15.2	9.4	9.6	0.4	24.0	Negligible
R9	14.2	9.0	9.1	0.4	22.8	Negligible
R10	12.9	8.5	8.7	0.6	21.8	Negligible
R11	10.6	7.6	7.9	0.7	19.8	Negligible
R12	13.5	8.6	8.8	0.3	22.0	Negligible
R13	16.2	9.8	9.9	0.4	24.8	Negligible
R14	18.0	10.7	10.8	0.1	27.0	Negligible
R15	14.1	9.0	9.0	<0.1	22.5	Negligible
R16	18.0	10.7	10.7	0.1	26.8	Negligible
R17	22.1	12.8	12.9	0.1	32.3	Negligible
R18	22.5	13.1	13.2	0.1	33.0	Negligible
R19	22.7	13.6	13.7	0.1	34.3	Negligible
R20	23.2	13.6	13.6	<0.1	34.0	Negligible
R21	30.8	17.0	17.0	<0.1	42.5	Negligible
R22	38.8	20.3	20.3	0.1	50.8	Negligible
R23	26.0	14.3	14.4	<0.1	36.0	Negligible
R24	36.0	18.7	18.7	<0.1	46.8	Negligible
R25	25.7	14.5	14.5	<0.1	36.3	Negligible
R26	29.3	16.0	16.0	<0.1	40.0	Negligible

Receptor	Predicted Annual Mean NO_2 Concentration (µg/m^3)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R27	28.0	15.5	15.6	<0.1	39.0	Negligible
R28	45.1	23.6	23.7	0.1	59.3	Negligible
R29	39.0	20.6	20.7	0.1	51.8	Negligible
R30	34.8	18.4	18.5	<0.1	46.3	Negligible
R31	38.9	20.6	20.7	0.1	51.8	Negligible
R32	11.8	8.1	8.1	<0.1	20.3	Negligible
R33	10.5	7.5	7.5	<0.1	18.8	Negligible
R34	13.0	8.7	8.8	<0.1	22.0	Negligible
R35	14.2	9.3	9.4	0.1	23.5	Negligible
R36	17.4	10.9	11.0	0.2	27.5	Negligible
R37	15.7	10.4	10.5	0.1	26.3	Negligible
R38	24.3	14.7	14.9	0.3	37.3	Negligible
R39	21.3	13.3	13.4	0.2	33.5	Negligible
R40	9.5	7.1	7.2	0.3	18.0	Negligible

3.1.2 PM_{10} Modelling Results

Table G presents the annual mean PM_{10} concentrations predicted at all assessed receptor locations of relevant exposure for the 2019 BC, 2027 DM and 2027 DS scenarios.

Table G: Predicted Annual Mean PM_{10} Concentrations – 2027 Planned Construction Year

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m^3)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R1	15.8	14.7	14.7	<0.1	36.8	Negligible
R2	15.9	14.8	14.9	<0.1	37.3	Negligible
R3	16.6	15.4	15.5	<0.1	38.8	Negligible
R4	16.6	15.4	15.4	<0.1	38.5	Negligible
R5	18.1	16.9	16.9	<0.1	42.3	Negligible
R6	18.1	16.9	16.9	<0.1	42.3	Negligible
R7	17.5	16.3	16.4	<0.1	41.0	Negligible
R8	17.2	16.2	16.3	0.2	40.8	Negligible
R9	16.8	15.8	15.9	0.3	39.8	Negligible
R10	16.6	15.6	15.8	0.4	39.5	Negligible
R11	16.3	15.2	15.5	0.6	38.8	Negligible
R12	16.7	15.7	15.7	0.2	39.3	Negligible
R13	17.9	16.8	16.9	0.2	42.3	Negligible

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m³)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R14	16.5	15.3	15.4	<0.1	38.5	Negligible
R15	16.2	15.0	15.0	<0.1	37.5	Negligible
R16	16.5	15.3	15.3	<0.1	38.3	Negligible
R17	17.5	16.2	16.2	<0.1	40.5	Negligible
R18	16.6	15.3	15.3	<0.1	38.3	Negligible
R19	17.4	16.1	16.1	<0.1	40.3	Negligible
R20	18.3	17.0	17.0	<0.1	42.5	Negligible
R21	19.1	17.7	17.7	<0.1	44.3	Negligible
R22	18.9	17.5	17.5	<0.1	43.8	Negligible
R23	19.2	17.9	17.9	<0.1	44.8	Negligible
R24	19.3	18.0	18.0	<0.1	45.0	Negligible
R25	19.3	18.1	18.1	<0.1	45.3	Negligible
R26	19.7	18.4	18.4	<0.1	46.0	Negligible
R27	19.5	18.2	18.2	<0.1	45.5	Negligible
R28	21.4	20.0	20.0	<0.1	50.0	Negligible
R29	20.1	18.6	18.7	<0.1	46.8	Negligible
R30	20.3	18.9	19.0	<0.1	47.5	Negligible
R31	20.0	18.6	18.7	<0.1	46.8	Negligible
R32	17.0	15.8	15.9	<0.1	39.8	Negligible
R33	15.4	14.3	14.3	<0.1	35.8	Negligible
R34	15.3	14.2	14.2	<0.1	35.5	Negligible
R35	15.1	13.9	14.0	<0.1	35.0	Negligible
R36	16.4	15.2	15.2	<0.1	38.0	Negligible
R37	15.6	14.4	14.4	<0.1	36.0	Negligible
R38	17.6	16.4	16.5	0.1	41.3	Negligible
R39	16.9	15.7	15.8	<0.1	39.5	Negligible
R40	16.5	15.4	15.6	0.3	39.0	Negligible

3.1.3 $PM_{2.5}$ Modelling Results

Table H presents the annual mean $PM_{2.5}$ concentrations predicted at all assessed receptor locations of relevant exposure for the 2019 BC, 2027 DM and 2027 DS scenarios.

Table H: Predicted Annual Mean $PM_{2.5}$ Concentrations – 2027 Planned Construction Year

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (μg/m^3)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R1	9.7	8.8	8.8	<0.1	44.0	Negligible
R2	9.8	8.9	8.9	<0.1	44.5	Negligible
R3	10.2	9.1	9.2	<0.1	46.0	Negligible
R4	10.0	9.0	9.0	<0.1	45.0	Negligible
R5	10.8	9.7	9.7	<0.1	48.5	Negligible
R6	10.6	9.6	9.6	<0.1	48.0	Negligible
R7	10.4	9.4	9.4	0.1	47.0	Negligible
R8	10.3	9.4	9.4	0.3	47.0	Negligible
R9	10.1	9.2	9.3	0.3	46.5	Negligible
R10	10.0	9.1	9.2	0.5	46.0	Negligible
R11	9.8	8.9	9.0	0.6	45.0	Negligible
R12	10.0	9.1	9.2	0.2	46.0	Negligible
R13	10.5	9.5	9.6	0.2	48.0	Negligible
R14	10.2	9.2	9.2	<0.1	46.0	Negligible
R15	10.0	9.0	9.0	<0.1	45.0	Negligible
R16	10.2	9.1	9.2	<0.1	46.0	Negligible
R17	10.7	9.6	9.7	<0.1	48.5	Negligible
R18	10.7	9.6	9.6	<0.1	48.0	Negligible
R19	11.2	10.0	10.1	<0.1	50.5	Negligible
R20	11.6	10.5	10.5	<0.1	52.5	Negligible
R21	12.1	10.9	10.9	<0.1	54.5	Negligible
R22	11.9	10.6	10.6	<0.1	53.0	Negligible
R23	11.6	10.4	10.5	<0.1	52.5	Negligible
R24	12.0	10.7	10.7	<0.1	53.5	Negligible
R25	11.9	10.7	10.7	<0.1	53.5	Negligible
R26	12.1	10.9	10.9	<0.1	54.5	Negligible
R27	12.3	11.2	11.2	<0.1	56.0	Negligible
R28	13.6	12.2	12.2	<0.1	61.0	Negligible
R29	12.8	11.4	11.5	<0.1	57.5	Negligible
R30	12.6	11.4	11.4	<0.1	57.0	Negligible
R31	12.7	11.4	11.5	<0.1	57.5	Negligible
R32	9.9	9.0	9.0	<0.1	45.0	Negligible
R33	9.5	8.6	8.6	<0.1	43.0	Negligible

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (µg/m^3)			% Change of AQAL	% of 2027 DS Relative to AQAL	EPUK & IAQM Impact Descriptor
	2019 BC	2027 DM	2027 DS			
R34	9.6	8.6	8.6	<0.1	43.0	Negligible
R35	9.7	8.7	8.7	<0.1	43.5	Negligible
R36	10.2	9.2	9.2	0.1	46.0	Negligible
R37	10.5	9.5	9.5	<0.1	47.5	Negligible
R38	11.6	10.6	10.6	0.1	53.0	Negligible
R39	11.3	10.2	10.3	0.1	51.5	Negligible
R40	9.7	8.8	8.8	0.3	44.0	Negligible

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