The Great Grid Upgrade

Sea Link

# Sea Link

## Volume 6: Environmental Statement

**Document: 6.3.2.8.B**
**Part 2 Suffolk**
**Chapter 8 Appendix 2.8.B**
**Air Quality Modelling Methodology**

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# Contents



### Table of Tables

# 1. Air Quality Modelling Methodology

## 1.1 Air quality model inputs

1.1.1 The Atmospheric Dispersion Modelling System ADMS-Roads (version 5.0) was used to predict nitrogen dioxide ($NO_2$), particulate matter less than 10 microns in diameter ($PM_{10}$) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) concentrations at sensitive human receptors in the study area.

1.1.2 The construction vehicle emissions assessment considered the following scenarios:

- Base Year (2023) – predicted baseline air quality scenario, used to characterise the air quality baseline and to carry out model verification;
- Do-Nothing (2028) – predicted future air quality scenario in the Proposed Project's worst case construction year, without the Proposed Project; and
- Do-Something (2028) – predicted future air quality scenario in the Proposed Project's worst case construction year, with the Proposed Project.

1.1.3 The dispersion model was built by digitising links from the traffic data to the Ordnance Survey (OS) Open Roads data and assigning road widths based on aerial imagery.

1.1.4 The following inputs and tools informed the air quality modelling assessment, each of which is explained in the following paragraphs:

- Traffic data;
- Emission factors toolkit (EFT);
- Oxides of nitrogen ($NO_X$) to $NO_2$ conversion;
- Meteorological data;
- Background pollutant concentrations; and
- Receptors.

### Traffic data

1.1.5 Traffic data used in the assessment was provided by the AECOM transport planning team and comprised the total number of vehicles, the number of Light Duty Vehicles (LDVs) and Heavy Duty Vehicles (HDVs) and speeds for the Base Year, Do-Nothing and Do-Something scenarios. Speed limits were provided in the absence of measured data.

1.1.6 Table 1.1 below presents the traffic data used in the assessment.

## Table 1.1 Traffic data

| Road Link ID | Road Name | Total Annual Average Daily Traffic (AADT) | | | HDV | | | Speed (mph) |
|---|---|---|---|---|---|---|---|---|
| | | 2023 Base Year | Do-Nothing 2028 | Do-Something 2028 | 2023 Base Year | Do-Nothing 2028 | Do-Something 2028 | |
| S-RL1 | A12 (south of A1094) | 14,169 | 14,759 | 14,983 | 792 | 825 | 929 | 50 |
| S-RL2 | A12 (between A1094 & B1121 Main Rd south junction) | 10,510 | 10,947 | 11,106 | 703 | 732 | 800 | 50 |
| S-RL3 | A12 (between B1121 Main Road junctions) | 8,759 | 9,124 | 9,280 | 650 | 677 | 738 | 60 |
| S-RL4 | A12 (north of B1121 Main Road northern junction) | 9,764 | 10,171 | 10,327 | 625 | 651 | 712 | 60 |
| S-RL5 | B1121 Main Road (east of A12) | 4,078 | 4,247 | 4,397 | 104 | 108 | 180 | 41.3 |
| S-RL6 | B1121 Main Road (south of B1119 Church Street) | 3,961 | 4,126 | 4,130 | 84 | 87 | 87 | 41.3 |
| S-RL7 | B1119 Church Street (east of B1121 Main Road) | 2,860 | 2,979 | 2,983 | 68 | 71 | 71 | 35.7 |
| S-RL8 | B1121 Aldeburgh Road (between A1094 and | 1,037 | 1,080 | 1,082 | 26 | 27 | 27 | 38.1 |

| Road Link ID | Road Name | Total Annual Average Daily Traffic (AADT) | | | HDV | | | Speed (mph) |
|---|---|---|---|---|---|---|---|---|
| | | 2023 Base Year | Do-Nothing 2028 | Do-Something 2028 | 2023 Base Year | Do-Nothing 2028 | Do-Something 2028 | |
| | B1121 Saxmundham Road) | | | | | | | |
| S-RL9 | B1121 Saxmundham Road (north of Grove Road) | 855 | 891 | 893 | 17 | 18 | 18 | 38.1 |
| S-RL10 | A1094 (between A12 and B1069 Snape Road) | 6,780 | 7,062 | 7,224 | 192 | 200 | 250 | 60 |
| S-RL11 | A1094 Aldeburgh Road (between B1069 Snape Road and Leiston Road) | 3,873 | 4,034 | 4,064 | 92 | 95 | 109 | 60 |
| S-RL12 | B1069 Snape Road (between A1094 Aldeburgh Road and Aldringham Lane) | 5,757 | 5,997 | 6,159 | 166 | 173 | 223 | 42.2 |
| S-RL13 | Leiston Road (between A1094 Aldeburgh Road and Aldringham Lane) | 2,537 | 2,642 | 2,650 | 101 | 105 | 107 | 39.4 |

## Emission factor tool kit

1.1.8 Road traffic emission factors for $NO_X$, $PM_{10}$ and $PM_{2.5}$ were generated from the Emission Factors Toolkit (EFT) v12.1 released August 2024 (Department for

Environment, Food and Rural Affairs, 2024). The road traffic emission factors were derived from the total number of vehicles and % HDVs from the traffic data, and the speed limits.

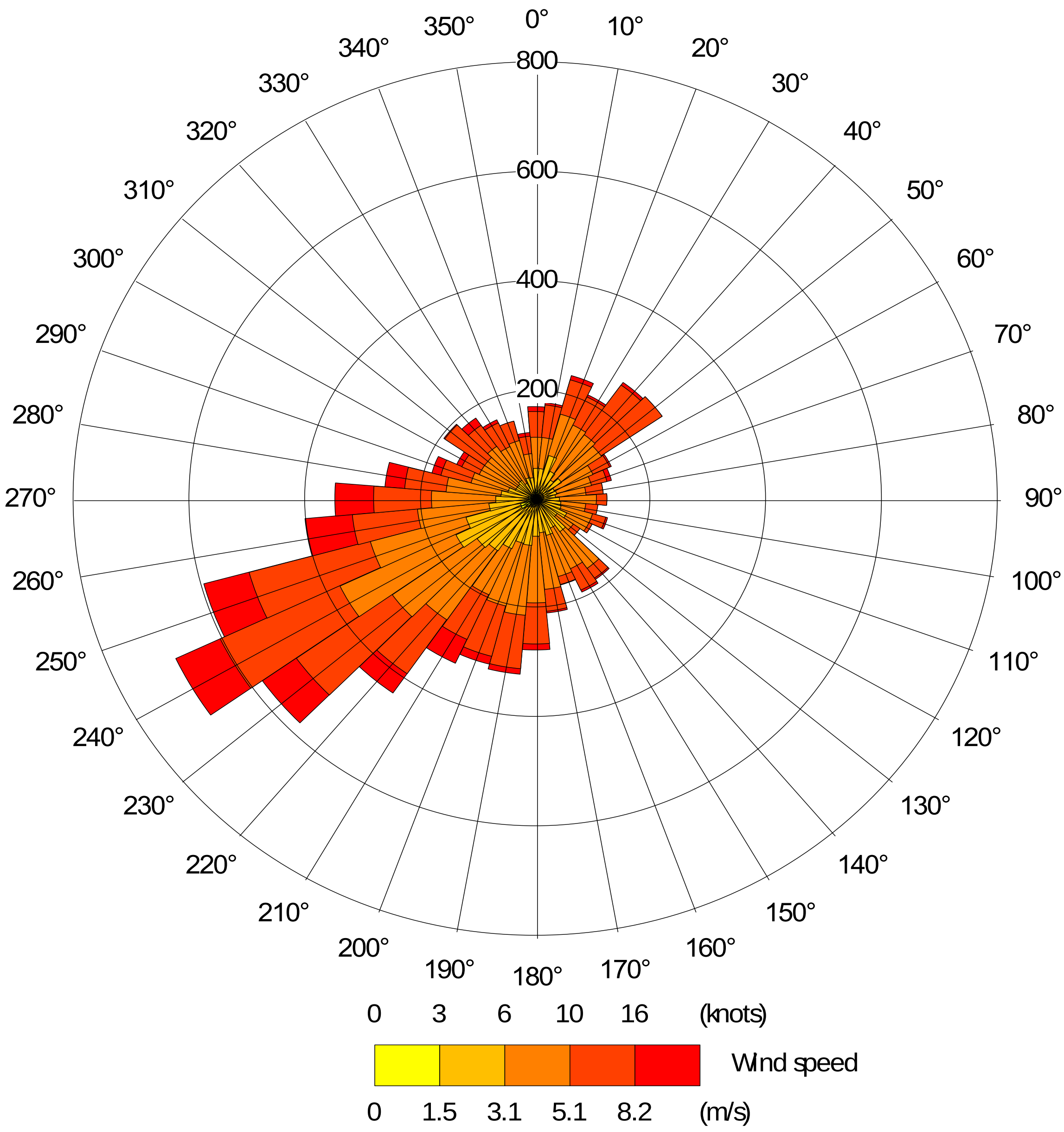
## $NO_X$ to $NO_2$ conversion

1.1.9 In accordance with Local Air Quality Management Technical Guidance LAQM.TG(22) , all modelled road-based concentrations of $NO_x$ were converted to annual mean $NO_2$ using the '$NO_x$ to $NO_2$' calculator (Department for Environment, Food and Rural Affairs, 2024).

1.1.10 Within the calculator, the traffic mix 'All non-urban UK traffic' was selected as being most representative of the modelled road network, and the local authority 'Suffolk Coastal District' was selected.

## Meteorological data

1.1.11 Meteorological data recorded at Wattisham Airfield during 2023 was used for the dispersion model. The wind rose for this meteorological site is displayed in Plate 1.1 below.




## Plate 1.1 2023 wind rose for Wattisham Airfield

1.1.12 A surface roughness value of 0.5 m and minimum Monin-Obukhov length of 10 m was used in the dispersion modelling. These parameters, which are determined by land use, influence wind patterns and atmospheric turbulence and, therefore, affect pollution dispersion. These values were selected as they were judged to be most representative of the predominant land use dispersion characteristics across the study area.

## Background pollutant concentrations

1.1.13 Total air pollutant concentrations comprise a background and local component, both of which must be independently considered for the air quality assessment. The background component is determined by regional, national, and international emissions, and often represents a significant proportion of the total pollutant concentration. The local component is affected by emissions from sources such as roads and chimney stacks, which are less well mixed locally and add to the background concentration.

1.1.14 Background pollutant concentrations are spatially and temporally variable throughout the UK and have been obtained for $NO_x$, $NO_2$, $PM_{10}$ and $PM_{2.5}$ from the UK-AIR website (Department for Environment, Food and Rural Affairs, 2024). Defra provides predictions based on a grid at a resolution of 1 $km^2$ across the whole of the UK and forecast from a base year of 2021. There are no background automatic monitoring stations in the vicinity of the Proposed Project for which 2023 data was available. As such, Defra background maps for 2023 were used for modelling of the Base Year scenario and 2028 for the Do-Nothing and Do-Something scenarios. The background concentrations used for the modelling are presented in Table 1.2 and Table 1.3, for 2023 and 2028, respectively.

### Table 1.2 Background pollutant concentrations 2023

| Pollutant | Concentration (µg/$m^3$) for Grid Square 635500,260500 | Concentration (µg/$m^3$) for Grid Square 636500,260500 |
|---|---|---|
| $NO_2$ | 5.6 | 5.8 |
| $PM_{10}$ | 11.1 | 11.5 |
| $PM_{2.5}$ | 5.8 | 5.8 |
| NOx | 7.0 | 7.4 |

### Table 1.3 Future background pollutant concentrations 2028

| Pollutant | Concentration (µg/$m^3$) for Grid Square 635500,260500 | Concentration (µg/$m^3$) for Grid Square 636500,260500 |
|---|---|---|
| $NO_2$ | 4.8 | 4.9 |
| $PM_{10}$ | 10.7 | 11.1 |
| $PM_{2.5}$ | 5.4 | 5.4 |
| NOx | 6.0 | 6.2 |

## Receptors

1.1.15 The study area for assessment of construction vehicle emissions is an area within 200 m of the construction traffic routes that exceed the IAQM and EPUK Development Control screening criteria (Institute of Air Quality Management and Environmental Protection UK, 2017), in accordance with DMRB LA105 (National Highways (formerly Highways England), 2024). Worst case sensitive receptors were selected from within the study area; receptor locations are presented in **Application Document 6.4.2.8.4 Air Quality Receptor and Verification Locations**.

## 1.2 Assessment of short-term $NO_2$ and $PM_{10}$ concentrations

1.2.1 LAQM.TG(22) (Department for Environment, Food and Rural Affairs, 2022) advises that exceedances of the 1-hour mean $NO_2$ AQS objective are unlikely to occur where the annual mean is less than 60 µg/m$^3$. Therefore, exceedances of 60µg/m$^3$ as an annual mean are used as an indicator of potential exceedances of the 1-hour mean $NO_2$ AQS objective.

1.2.2 The prediction of daily mean concentrations of $PM_{10}$ is available as an output option within the ADMS roads dispersion model for comparison against the short-term air quality objective. However, as the model output for annual mean concentrations is considered more accurate than the modelling of the daily mean, an empirical relationship has been used to determine daily mean $PM_{10}$ concentrations. In accordance with LAQM.TG(16) (2016), the following formula was used:

*No. of 24-hour mean exceedances = -18.5 + 0.00145 x annual mean$^3$ + (206 / annual mean)*

1.2.3 Based on this formula, an exceedance of the 24-hour mean $PM_{10}$ AQS objective is unlikely to occur where the annual mean $PM_{10}$ concentration is less than 32 µg/m$^3$.

## 1.3 Model verification

1.3.1 The comparison of modelled concentrations with local monitored concentrations is a process termed 'verification'. Model verification identifies any discrepancies between modelled and measured concentrations, which can arise for a range of reasons. The following are examples of potential causes of such discrepancies:

- background pollutant concentration uncertainties;
- meteorological data uncertainties;
- traffic data uncertainties;
- emission factor uncertainties; and
- overall limitations of the ability of the dispersion model to model dispersion in a complex urban environment.

1.3.2 The verification process involves a review of the modelled pollutant concentrations against corresponding monitoring data to determine how well the air quality model has performed. Depending on the outcome it may be considered that the model has performed adequately and that there is no need to adjust any of the modelled results.

1.3.3 Alternatively, the model may perform poorly against the monitoring data (acceptable limits of model verification performance are set out in LAQM.TG(22) (Department for Environment, Food and Rural Affairs, 2022)), in which case there is a need to check all the input data to ensure that it is reasonable and accurately represented in the air quality modelling process. Where all input data, such as traffic data, emissions rates, and background concentrations have been checked and considered reasonable, then the modelled results may require adjustment to best align them with the monitoring data. This may be either a single verification adjustment factor to be applied to the modelled concentrations across the study area or a range of different adjustment factors to account for different situations within the study area.

## Residual uncertainty and model performance

1.3.4 Residual uncertainty may remain after systematic error or 'overall model accuracy' has been accounted for in the final predictions. Residual uncertainty may be considered synonymous with the 'residual inaccuracies' of the model predictions, i.e. how wide the scatter or residual variability of the predicted values compare with the monitored 'true value', once systematic error has been allowed for. The quantification of final model accuracy provides an estimate of how the final predictions may deviate from the 'true' (monitored) values at the same location over the same period. It must, though, be recognised that some of the residual uncertainty will be down to uncertainties in the monitored values. This is greater for monitoring using diffusion tubes than for automatic monitors.

1.3.5 Suitable local monitoring data for the purpose of verification is available for concentrations of $NO_2$ at the locations shown in **Application Document 6.4.2.8.4 Air Quality Receptor and Verification Locations – Suffolk Onshore Scheme.** This monitoring data has been used to verify the dispersion model prediction and obtain adjustment factors which can be applied to predictions of pollutant concentrations in the base and opening years.

1.3.6 An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG(22) (Department for Environment, Food and Rural Affairs, 2022) identifies a number of statistical procedures that are appropriate to evaluate model performance and assess the uncertainty. The following statistical parameters were used in this assessment:

- Root Mean Square Error (RMSE);
- Fractional Bias (FB); and
- Correlation Coefficient (CC).

1.3.7 A brief explanation of each statistic is provided in Table 1.4, and further details can be found in LAQM.TG(22) Box 7.21 (Department for Environment, Food and Rural Affairs, 2022).

### Table 1.4 Statistical parameters used to estimate model performance

| Statistical parameter | Comments | Ideal value |
| --- | --- | --- |
| RMSE | RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared.<br>If the RMSE values are higher than 25% of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements.<br>For example, assuming the model predictions are for the annual mean $NO_2$ objective of 40 $\mu g/m^3$, if an RMSE of 10 $\mu g/m^3$ or above is determined for a model, it is advised to revisit the model parameters and model verification. | 0.01 |

| Statistical parameter | Comments | Ideal value |
| --- | --- | --- |
| | Ideally an RMSE within 10% of the air quality objective would be derived, which equates to ±4 µg/m$^3$ for the annual mean $NO_2$ objective. | |
| FB | FB is used to identify if the model shows a systematic tendency to over- or underpredict. FB values vary between +2 and −2 and have an ideal value of zero. Negative values suggest a model overprediction and positive values suggest a model underprediction. | 0.00 |
| CC | CC is used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship. This statistic can be particularly useful when comparing a large number of model and observed data points. | 1.00 |

1.3.8 These parameters estimate how the model results agree or diverge from the observations. These calculations have been carried out prior to, and after, adjustment and provide information on the improvement of the model predictions as a result of the application of the verification adjustment factors.

1.3.9 The air quality monitoring data collected as part of this assessment and detailed in the baseline section was reviewed to determine the suitability of each of the monitoring locations for inclusion in the model verification process.

1.3.10 The model Base Year is 2023, therefore monitoring data representative of 2023 was acquired to inform the model verification process.

1.3.11 Monitoring data was collated from ESC (as presented in **Application Document 6.3.2.8.C Appendix 2.8.C Air Quality Monitoring Data**). Determination of the suitability of the collected monitoring data for inclusion into the verification exercise, used the following criteria:

- monitoring sites that are within 200m of the ARN; and
- monitoring sites with at least 75% data capture in 2023.

Following the site selection process outlined in the criteria above, total modelled $NO_2$ concentrations were compared to those monitored at seven diffusion tube monitoring sites. The monitoring sites selected are presented in Table 1.5 and a scatterplot of the resulting comparison is shown in Plate 1.2. This graph shows that there is a tendency for the model to underpredict concentrations. It was therefore considered appropriate to examine whether the model performance could be improved through model verification and adjustment.

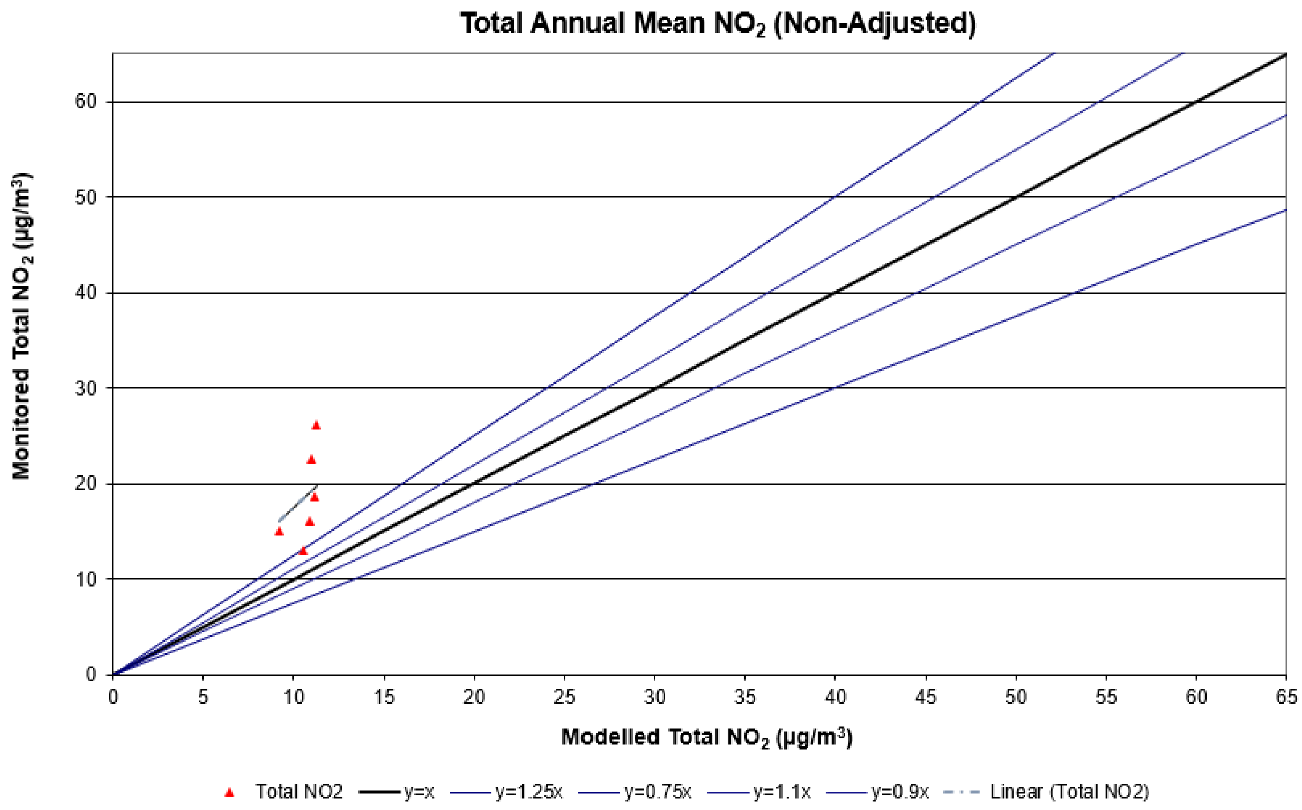



**Plate 1.2 Scatterplot of unadjusted modelled total annual mean $NO_2$ vs monitored total annual mean $NO_2$**

## Verification methodology

1.3.12 The verification method followed the process detailed in LAQM.TG(22) (Department for Environment, Food and Rural Affairs, 2022), which involves comparing modelled and monitored road $NO_x$ concentrations. Diffusion tube road $NO_x$ concentrations were calculated using the latest version of the Defra $NO_x$ to $NO_2$ calculator (v9.0) (Department for Environment, Food and Rural Affairs, 2024), because diffusion tubes only measure $NO_2$ and do not directly measure $NO_x$.

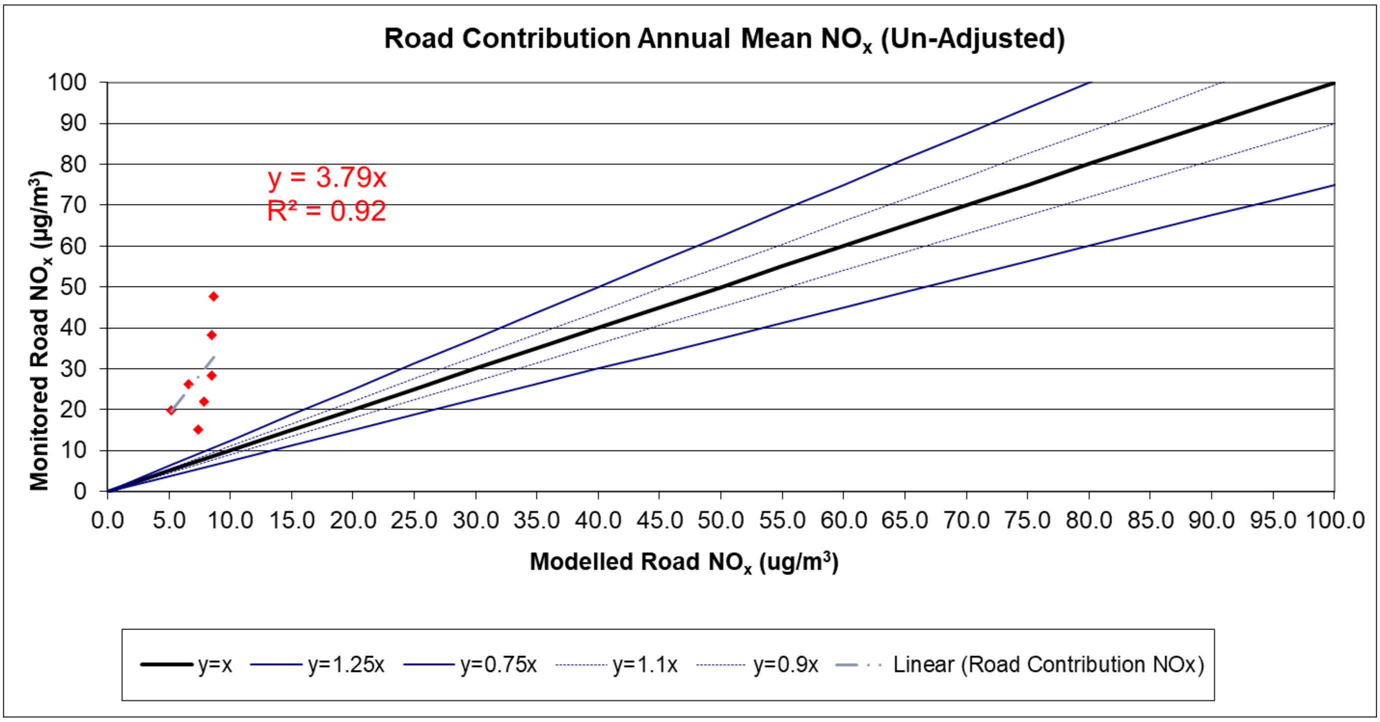
1.3.13 For each monitoring site, the relevant 1x1 km 2023 background concentrations for $NO_X$ and $NO_2$ were acquired by using the 2021 reference year Defra background maps (Department for Environment, Food and Rural Affairs, 2024), as presented in Table 1.2.

1.3.14 Table 1.5 summarises the background $NO_2$ concentrations, unadjusted modelled and monitored road $NO_x$ concentrations, and unadjusted modelled and monitored total $NO_2$ concentrations at the diffusion tube sites.

## Table 1.5 Diffusion tube monitored and unadjusted modelled results 2023 (total $NO_2$ and road NOx)

| Tube ID | X OS Grid Ref | Y OS Grid Ref | Background $NO_2$ (µg/m$^3$) | Monitored Total $NO_2$ (µg/m$^3$) | Modelled Total $NO_2$ (µg/m$^3$) | Ratio of monitored vs modelled total $NO_2$ | Monitored road $NO_x$ (µg/m$^3$) | Modelled road NOx (µg/m$^3$) | Ratio of monitored vs modelled road NOx |
|---|---|---|---|---|---|---|---|---|---|
| FAR1 | 636274 | 260134 | 5.8 | 16.1 | 9.7 | 1.7 | 22.0 | 7.8 | 2.8 |
| STA1abc | 635752 | 260003 | 5.6 | 22.6 | 9.8 | 2.3 | 38.3 | 8.5 | 4.5 |
| STA2 | 635733 | 259994 | 5.8 | 13.0 | 9.4 | 1.4 | 15.1 | 7.4 | 2.0 |
| STA6 | 635794 | 260042 | 5.6 | 15.0 | 8.2 | 1.8 | 19.8 | 5.2 | 3.8 |
| STA7 | 635735 | 259985 | 5.8 | 18.7 | 9.9 | 1.9 | 28.3 | 8.5 | 3.3 |
| STA8abc | 635742 | 259992 | 5.8 | 26.2 | 10.0 | 2.6 | 47.7 | 8.7 | 5.5 |
| FAR2abc | 636274 | 260120 | 5.8 | 17.9 | 9.1 | 2.0 | 26.2 | 6.6 | 4.0 |

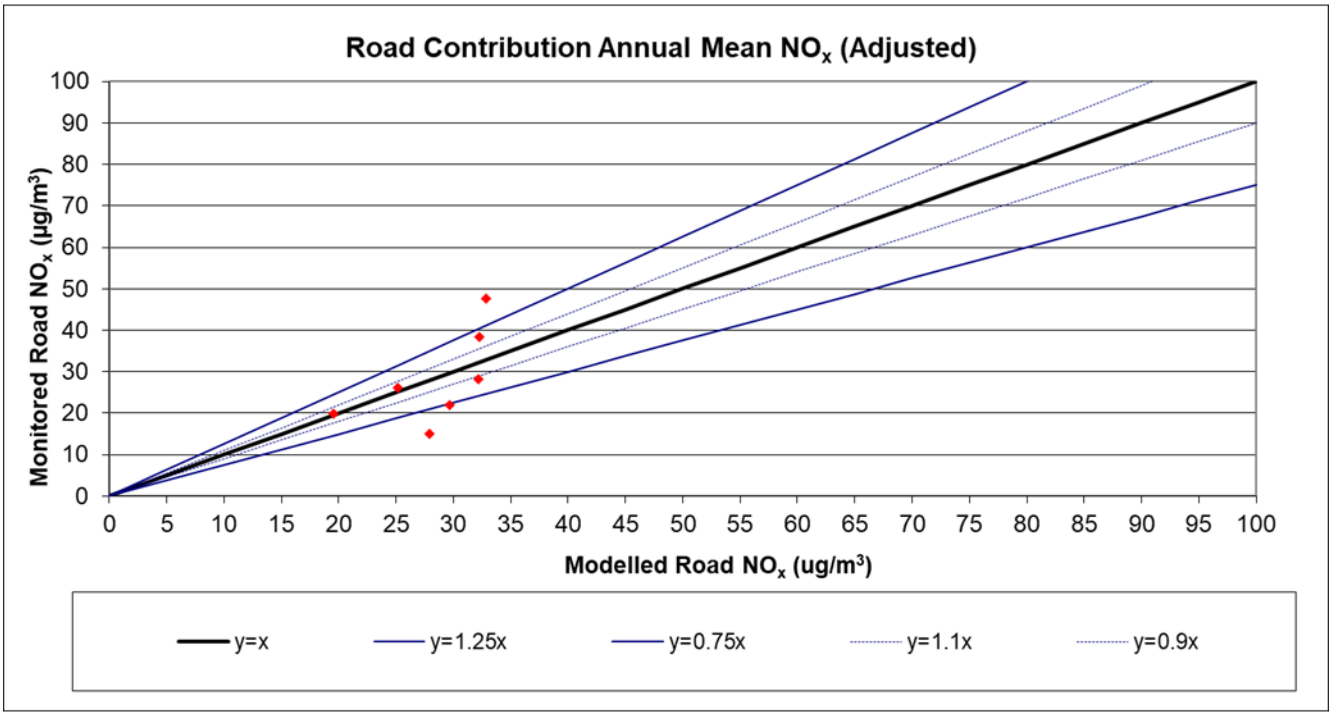
1.3.15 The modelled versus monitored road NOx component concentrations were plotted on a scatter graph as presented on Plate 1.3.



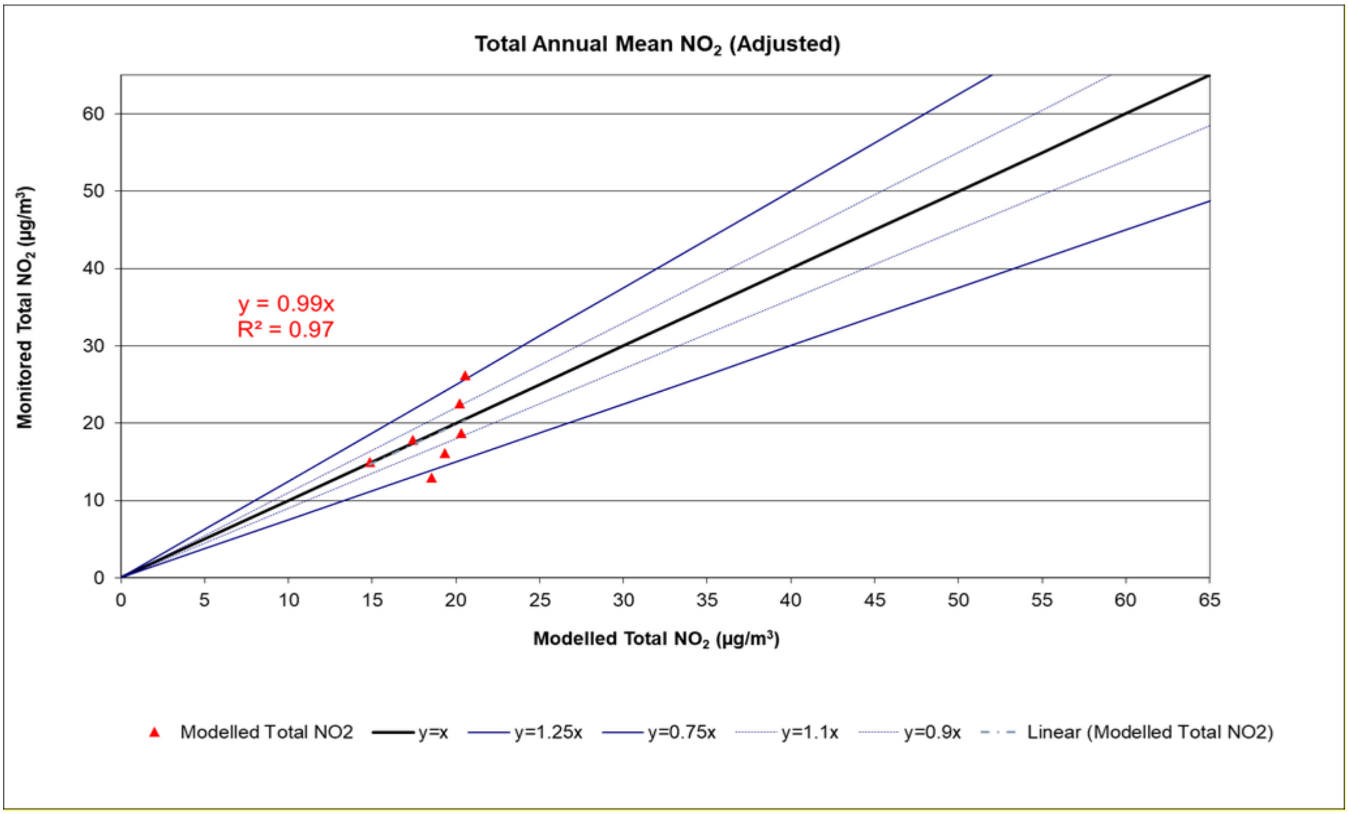

## Plate 1.3 Scatterplot of unadjusted modelled road $NO_x$ vs monitored road $NO_x$

1.3.16 The verification factor derived from the model verification as shown in Plate 1.3 was 3.79, showing the model underestimates $NO_2$ concentrations in relation to the monitored concentrations.

1.3.17 Adjusted modelled versus monitored road $NO_x$ concentrations are presented in Plate 1.4. Plate 1.5 presents the verified modelled versus monitored total $NO_2$ using the verification factor 3.79. Plate 1.5 demonstrates that once adjusted for road $NO_x$, total modelled $NO_2$ concentrations are much closer to monitored total $NO_2$ concentrations.




## Plate 1.4 Scatterplot of adjusted modelled road $NO_x$ vs monitored road $NO_x$




## Plate 1.5 Scatterplot of adjusted modelled total $NO_2$ vs monitored total $NO_2$

1.3.18 Table 1.6 below summarises the model performance statistics before and after adjustment.

## Table 1.6 Model performance statistics

| Summary Table | Before Adjustment | After Adjustment |
|---|---|---|
| Within +10% | 0 | 2 |
| Within -10% | 0 | 1 |
| Within +-10% | 0 | 3 |
| Within +10 to 25% | 0 | 2 |
| Within -10 to 25% | 0 | 1 |
| Within -+10 to 25% | 0 | 3 |
| Over 25% | 0 | 0 |
| Under 25% | 7 | 1 |
| Greater +-25% | 7 | 1 |
| Within +-25% | 0 | 6 |
| Total | 7 | 7 |
| **Correlation** | 0.6 | 0.6 |
| **RMSE** | 9.9 | 3.4 |
| **Fractional Bias** | 0.6 | 0.0 |

1.3.19 The model statistics show that the model tended to under predict actual concentrations because the fractional bias was greater than zero. When road $NO_x$ is adjusted by applying the verification factor, the RMSE is reduced from 9.9 µg/m$^3$ to 3.4 µg/m$^3$, which is within the 4 µg/m$^3$ guideline. The adjusted model thus provides an improved model performance.

1.3.20 To provide a robust assessment, the verification factor was applied to the modelling results for all receptors. The same verification factor was applied for $NO_x$, $PM_{10}$ and $PM_{2.5}$ modelled results at each relevant receptor, as $PM_{10}$ and $PM_{2.5}$ monitoring data was not available for verification purposes.

# References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