Lower Thames Crossing

6.3 Environmental Statement Appendices
Appendix 5.1 - Air Quality Methodology

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Lower Thames Crossing

Appendix 5.1 – Air Quality Methodology

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1 Air quality monitoring methodology

1.1 Project survey bias adjustment

1.1.1 A Project-specific survey has been undertaken to address gaps in air quality monitoring data within the vicinity of roads likely to be affected by the Project. A total of 94 NO_2 diffusion tubes (using 20% Triethanolamine (TEA) in water method of preparation) were installed in the assessment study area and cover the monitoring periods shown in Table 1.1. The initial monitoring survey was conducted throughout 2018. Sites were later added in response to an increased understanding of the air quality baseline conditions to inform the assessment. Sites were mainly added where there was a risk of an exceedance of the annual mean NO_2 AQS objective based on the modelling presented in the Preliminary Environmental Information Report and Project monitoring data. The locations of these monitoring sites are shown in Figure 5.4 (Application Document 6.2).

1.1.2 Due to the inherent bias associated with the lower accuracy of passive NO_2 diffusion tubes in comparison to automatic monitoring methods, it is necessary to calculate a bias adjustment factor, which is applied to the raw monitoring results. Throughout the monitoring, triplicate diffusion tubes were co-located at two automatic monitors: Thurrock 8 (Purfleet, Thurrock) and Dartford 3 (A2 Bean Interchange), in accordance with Local Air Quality Management Technical Guidance, LAQM.TG(22) (Department for Environment, Food & Rural Affairs (Defra), 2022). Both of these stations were used to generate bias adjustment factors for all Project sites. It should be noted that the year 2018 bias adjustment factor available from the national bias adjustment spreadsheet published by Defra (version 09/19) was 0.88 (https://laqm.defra.gov.uk/air-quality/air-quality-assessment/national-bias/), which is lower than the co-location bias adjustment factor for the 12-month 2018 Project survey (0.95). The Project survey co-location bias adjustment factors were therefore used in preference, as using this bias adjustment factor results in higher monitored concentrations, as well as being more representative of the adjustments required for the specific periods of monitoring.

1.1.3 Bias adjustment factors were calculated for each Project monitoring period using the AEA_DifTPAB_v04 spreadsheet available from the Defra LAQM website (https://laqm.defra.gov.uk/bias-adjustment-factors/local-bias.html). The bias adjustment factors calculated and applied to each monitoring site are shown in Table 1.1.

Table 1.1 Project monitoring bias adjustment factors

Monitoring sites	Monitoring period	Bias adjustment factor
All LTC_ECO sites LTC1 to LTC77	12 months. January 2018 to December 2018	0.95
LTC78 and LTC79	Eight months. July 2018 to February 2019	0.92
LTC80 and LTC81	12 months. September 2018 to August 2019	0.90
LTC82 and LTC83	Six months. September 2019 to February 2019	0.93

Monitoring sites	Monitoring period	Bias adjustment factor
LTC84 to LTC96	10 months. March 2019 to December 2019	0.85

1.2 Project survey adjusted to 2016

1.2.1 As the Project's transport model base year is 2016, it was necessary to adjust the Project air quality monitoring survey results so that they are representative of a 2016 annual mean concentration. The Project survey data was adjusted following the same approach described in Box 7.9 of LAQM.TG22 (Defra, 2022). An adjustment factor was calculated from four background automatic stations using the following calculation:

2016 adjustment factor = 2016 annual mean concentration / period average concentration

1.2.2 The average of the 2016 adjustment factors calculated across the automatic stations was then applied to the Project monitoring survey results.

1.2.3 The 2016 adjustment factors were calculated from the nearest background stations to the Affected Road Network (ARN) where data capture was greater than 85% across 2016 as well as the monitoring period. The adjustment factors were calculated from the stations shown in Table 1.2.

Table 1.2 Background automatic stations used for 2016 adjustment

Monitoring stations	Background type	Source	X OS grid ref (m)	Y OS grid ref (m)
Bexley	Suburban	AURN	551859	176381
Maidstone	Rural	Maidstone Borough Council	580108	159703
Rochester Stoke	Rural	AURN	583158	176314
Thurrock	Urban	AURN	561069	177893
AURN – Automatic Urban and Rural Network				

1.2.4 The resulting annual adjustment factors calculated and applied to the Project site period concentrations are shown in Table 1.3.

Table 1.3 2016 adjustment factors applied to project monitoring data

Monitoring sites	2016 adjustment factor
All LTC_ECO sites, LTC1 to LTC77	1.07
LTC78 and LTC79	0.99
LTC80 and LTC81	1.11
LTC82 and LTC83	0.89
LTC84 to LTC96	1.28

1.3 National Highways monitoring adjusted to 2016

1.3.1 National Highways have historically undertaken diffusion tube monitoring surveys for other schemes (i.e. schemes other than the Project), and some of these monitoring sites fall within the assessment study area of the Project and so have been used to inform in the air quality assessment. These monitoring surveys were undertaken over different periods between September 2013 and December 2017, and varied in duration from 6 to 12 months. All of the scheme monitoring data has been bias adjusted using the national bias adjustment spreadsheet available from Defra.

1.3.2 The data was adjusted to a 2016 annual mean concentration following the same methodology and using the same automatic monitoring stations as outlined in Section 1.2. All of the stations had at least 85% data capture for each data period and were therefore suitable for use. The 2016 adjustment factor obtained and applied varied between 0.95 and 1.04 depending on the survey monitoring period. It should be noted that local authority and Project diffusion tube monitoring data was used in preference to National Highways monitoring data, where sites were in the same location.

1.4 Local authority monitoring adjusted to 2016

1.4.1 Some local authority diffusion tubes which measured annual mean NO_2 concentrations in 2018 or 2019 but not in 2016, were year-adjusted to provide a 2016 concentration, using adjustment factors calculated from the automatic stations shown in Table 1.2. The local authority diffusion tube sites adjusted are shown in Section 2, Appendix 5.2. The data capture for these stations was above 85% for the years considered, and an adjustment factor of 1.07 and 1.15 was calculated for 2018 and 2019, respectively, to calculate NO_2 concentrations for 2016.

2 Background air pollution maps

2.1.1 Total air pollutant concentrations comprise a background and local component, both of which have to 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.

2.1.2 Background pollutant concentrations are spatially and temporally variable throughout the UK and have been obtained for NOx, NO_2 and PM_{10}. from the UK-AIR website (https://uk-air.defra.gov.uk/data/laqm-background-home). Defra provides predictions based on a grid at a resolution of $1km^2$ across the whole of the UK and forecast from a base year of 2018. It should be noted that as the Project's transport model base year is 2016, the background NOx and PM_{10} maps were backcasted to 2016 using an adjustment factor calculated by comparing NOx and PM_{10} background concentrations monitored in 2016 and 2018. The closest sites to the ARN were selected where annual data capture was above 75% in 2016 and 2018, and where the sites were confirmed as representative of true background (i.e. not likely to be dominated by a single pollution source such as an airport or major road). The sites selected for the adjustment are shown in Table 2.1. Scatterplots of the monitored NOx and PM_{10} concentrations in 2018 and 2016 are shown in Plate 2.1 and Plate 2.2. Based on the equation of the trendline calculated for each pollutant, the Defra modelled background NOx and PM_{10} maps were adjusted by a factor of 1.26 and 0.97, respectively to adjust from 2018 to 2016.

2.1.3 A number of stakeholders that were consulted regarding the air quality assessment methodology, expressed a concern that the Defra background maps can underpredict background pollutant concentrations relative to monitoring data. In order to investigate this, Defra 2016 backcasted NOx and PM_{10} concentrations were compared to monitoring data from background sites selected as described in paragraph 2.1.2, and shown in Table 2.1.

Plate 2.1 Scatterplot of 2018 and 2016 monitored background annual mean NOx

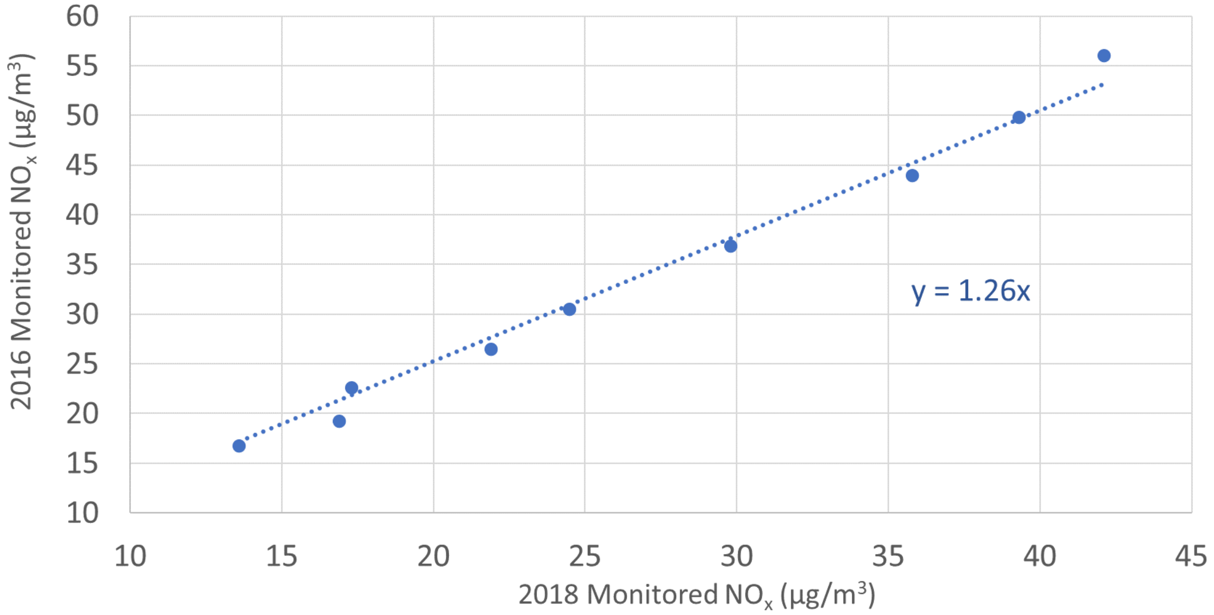


Plate 2.2 Scatterplot of 2018 and 2016 monitored background annual mean PM_{10}

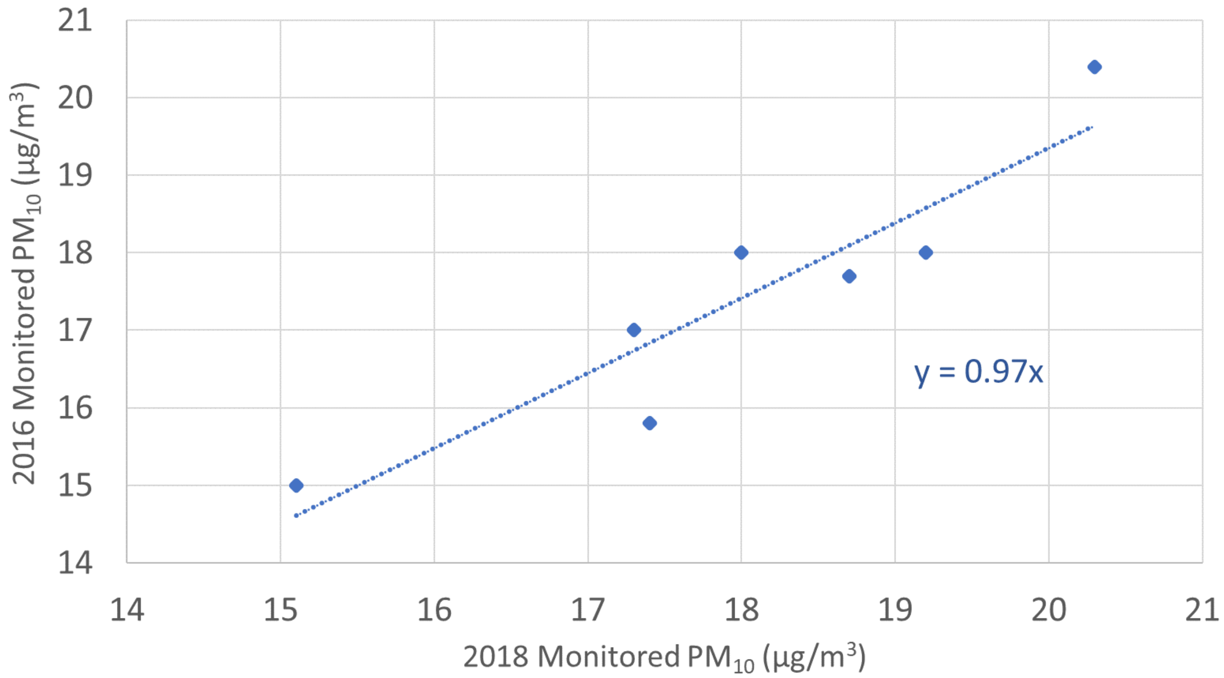


Table 2.1 Annual mean NOx and PM_{10} (μg/m^3) at background automatic monitoring stations and from Defra background maps

Station	X	Y	Defra NOx 2016	Monitored NOx 2016 (2018)	Defra PM_{10} 2016	Monitored PM_{10} 2016 (2018)
Maidstone Rural	580108	159703	22.3	16.7 (13.6)	14.5	20.4 (20.3)
Slade Green	551864	176379	37.0	44.0 (35.8)	18.0	18.0 (18.0)
Belvedere Primary School	549980	179064	40.7	49.8 (39.3)	16.9	17.7 (18.7)
Bexley Business Academy	548465	179469	35.3	36.8 (29.8)	16.7	15.0 (15.1)
Chaucer Technology School	616186	157320	18.9	22.6 (17.3)	14.4	17.0 (17.3)
Prince of Wales School	536885	198507	34.4	56.0 (42.1)	17.0	** (**)
Rochester Stoke	583164	176313	21.3	19.2 (16.9)	15.3	15.8 (17.4)
Greatness Park	553603	156774	22.1	26.5 (21.9)	15.2	18.0 (19.2)
Chalkwell Park	585823	186212	28.3	30.5 (24.5)	14.9	** (**)

Defra NOx and PM10 are Defra background maps backcasted to 2016 but prior to adjustment versus 2016 monitoring data

Monitoring data is shown for 2016 and for 2018 in parenthesis.

*** No PM10 monitoring undertaken from this site.*

2.1.4 Scatterplots of the monitored and Defra modelled background NOx and PM_{10} concentrations are shown in Plate 2.3 and Plate 2.4. Based on the equation of the trendline calculated for each pollutant, the Defra modelled background NOx and PM_{10} maps were further adjusted by a factor of 1.18 and 1.09, respectively, in all scenarios. The corresponding background NO_2 concentrations were then calculated using the NO_2 Adjustment for NOx Sector Removal Tool v8.0 available on the Defra LAQM website (https://laqm.defra.gov.uk/air-quality/air-quality-assessment/no2-adjustment-for-nox-sector-removal-tool/).

Plate 2.3 Scatterplot of Defra modelled background vs monitored annual mean NO_x

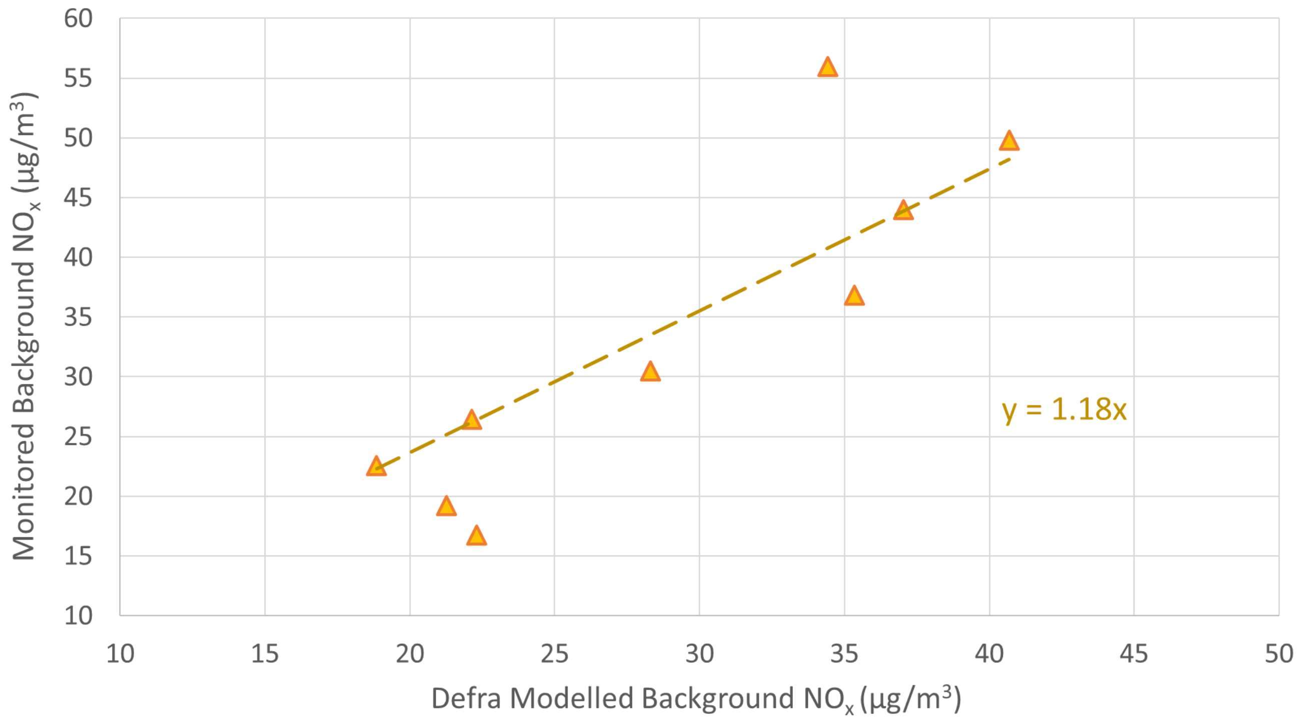
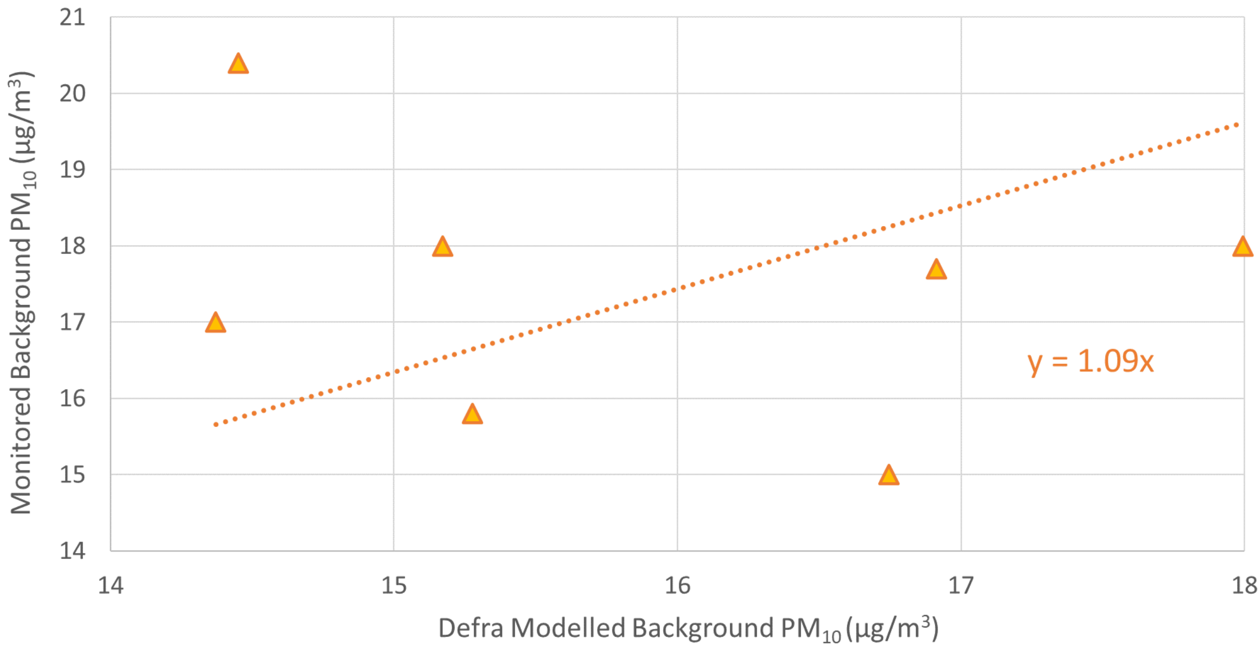


Plate 2.4 Plot of Defra modelled background vs monitored annual mean PM_{10}



2.1.5 Following the adjustment described above, 2016 Defra modelled background NO_2 concentrations were found to be in good overall agreement with background NO_2 monitoring data across the study area.

3 Model verification

3.1.1 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:

a. Background pollutant concentration uncertainties

b. Meteorological data uncertainties

c. Traffic data uncertainties

d. Emission factor uncertainties

e. Overall limitations of the ability of the dispersion model to model dispersion in a complex urban environment

3.1.2 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.

3.1.3 Alternatively, the model may perform poorly against the monitoring data (acceptable limits of model verification performance are set out in LAQM.TG(22) (Defra, 2022), as a result 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 be 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.

4 Residual uncertainty and model performance

4.1.1 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.

4.1.2 Suitable local monitoring data for the purpose of verification is available for concentrations of NO_2 at the locations shown in Figure 5.4 (Application Document 6.2). 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.

4.1.3 An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG(22) (Defra, 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:

a. Root Mean Square Error (RMSE)

b. Fractional Bias (FB)

c. Correlation Coefficient (CC)

4.1.4 A brief explanation of each statistic is provided in Table 4.1, and further details can be found in LAQM.TG(22) Box 7.21.

Table 4.1 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. 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. For example, assuming the model predictions are for the annual mean NO2 objective of 40µg/m3, if an RMSE of 10µg/m3 or above is determined for a model, it is advised to revisit the model parameters and model verification. Ideally an RMSE within 10% of the air quality objective would be derived, which equates to ±4µg/m3 for the annual mean NO2 objective.	0.01

Statistical parameter	Comments	Ideal value
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

4.1.5 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.

5 Air quality monitoring data

5.1.1 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.

5.1.2 The Project's transport model base year is 2016, therefore monitoring data representative of 2016 was acquired in order to inform the model verification process.

5.1.3 Monitoring data was collated from local authorities, National Highways, Connect Plus (work on behalf of National Highways to manage and operate the M25 Network) and from the dedicated Project air quality monitoring survey. Determination of the suitability of the collected monitoring data for inclusion into the verification exercise, used the following criteria:

a. Monitoring sites that are within 200m of the ARN

b. Roadside monitoring sites or those non-roadside sites that are likely to be heavily influenced by road traffic emissions from a neighbouring road (generally within 50m of major road sources such as motorways)

c. Monitoring sites with at least 75% data capture in 2016 or with 75% data capture across the monitoring period, where the data was trended to 2016

d. Automatic monitoring data used in preference to co-located diffusion tube data

e. Monitoring was excluded from verification if a road was not included in the Project's transport model (for example minor roads) but likely to influence the monitored concentrations, or where there were other sources present that may influence local monitoring concentrations (such as industrial stacks in close proximity).

f. Project and National Highways tubes which neighbour any newly constructed large-scale development[1] operational between the period of monitoring and 2016 (which may invalidate the survey-wide trend factors applied) were omitted from verification.

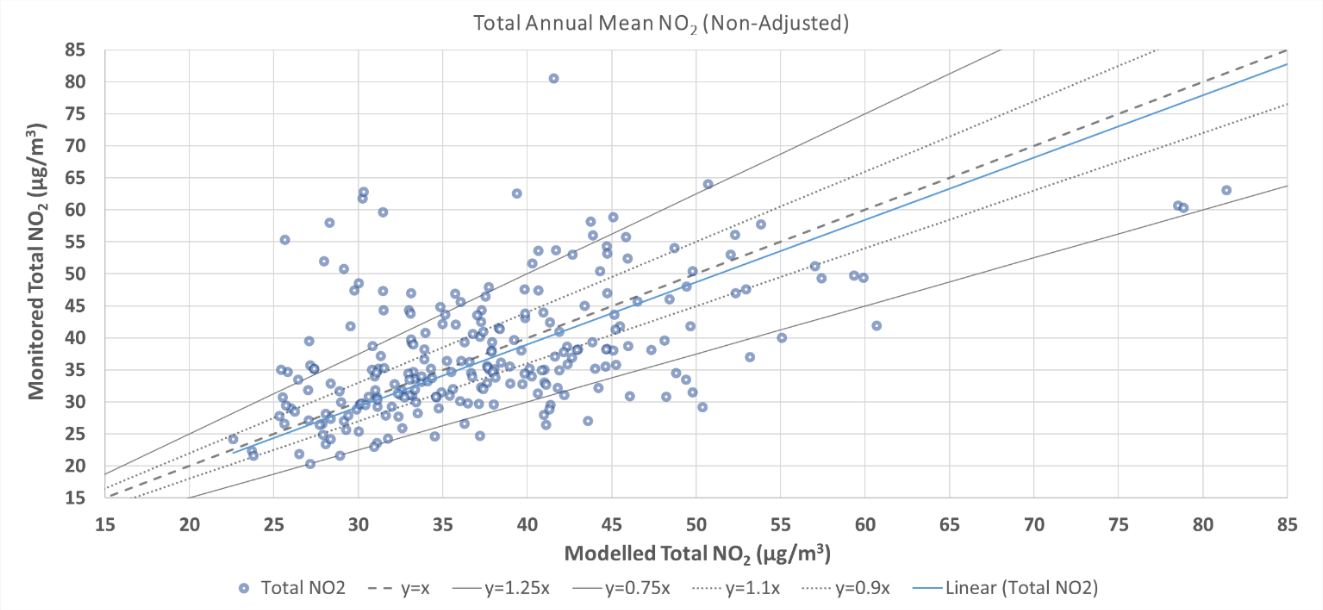
g. Sites were omitted from verification where the location of the monitoring could not be confirmed from Google Street View or from a visit to site, or where the sites did not look to be installed in a realistic location based on the site coordinates (e.g. in the middle of an open field).

5.1.4 Following the site selection process outlined in the criteria above, total modelled NO_2 concentrations were compared to those monitored at 241 diffusion tube and automatic monitoring sites. The monitoring sites selected are presented in Table

1 Large scale development defined as anything over 100 houses and 10,000m2 of gross development floor area as per cumulative impacts chapter

6.1 and a scatterplot of the resulting comparison is shown in Plate 5.1. This plate shows that there is a wide range of scatter in the agreement between modelled and monitored concentrations with less than half of the predictions lying within 10% of those monitored. It was therefore considered appropriate to examine whether the model performance could be improved through model verification and adjustment.

Plate 5.1 Scatterplot of unadjusted modelled total annual mean NO_2 vs monitored total annual mean NO_2



6 Verification methodology

6.1.1 The verification method followed the process detailed in LAQM.TG(22) (Defra, 2022), which involves comparing modelled and monitored road NOx concentrations. Diffusion tube road NOx concentrations were calculated using the version of the latest Defra NOx to NO_2 calculator (v8.1) available on the LAQM website (https://laqm.defra.gov.uk/air-quality/air-quality-assessment/nox-to-no2-calculator/), because diffusion tubes only measure NO_2 and do not directly measure NOx. It should be noted that the calculator only allows concentrations to be calculated for 2018 to 2030. Therefore, the method to generate the 2016 concentrations was agreed between National Highways and the developer of the tool (Ricardo-AEA) to allow concentrations to be calculated for the 2016 base year. This required input of the year 2016 primary NO_2 values available from the National Atmospheric Emission Inventory (NAEI), into the NOx to NO_2 calculator.

6.1.2 Concentrations of road NOx recorded at automatic monitors were calculated by subtracting background concentrations of NOx (acquired from Defra background maps) from the total NOx recorded at the automatic site.

6.1.3 For each monitoring site, the relevant 1x1km 2016 background concentrations for NOx and NO_2 were acquired by using the 2018 reference year Defra background maps which were adjusted by a monitoring-based adjustment factor to ensure that the modelled maps did not under-predict when compared to observed backgrounds. It should also be noted that the reference year of the background maps was also backcasted from 2018 to 2016 based on monitoring data from background sites.

6.1.4 Table 6.1 summarises the background NO_2 concentrations, unadjusted modelled and monitored road NOx concentrations, and unadjusted modelled and monitored total NO_2 concentrations at diffusion tube sites. Table 6.2 summarises the monitored NOx concentrations, background NOx concentrations, unadjusted modelled and monitored road NOx concentrations, and unadjusted modelled and monitored total NO_2 concentrations at the automatic stations.

Table 6.1 Diffusion tube monitored and unadjusted modelled results 2016 (total NO_2 and road NO_x)

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
BAS006	573194	187531	22.4	29.6	41.4	0.71	14.1	39.6	0.36
BAS007	572174	186914	20.1	29.8	36.5	0.82	19.0	33.4	0.57
BRW26	562286	196647	16.2	29.9	29.0	1.03	27.0	25.0	1.08
BRW32	556959	192286	19.4	33.1	41.0	0.81	27.5	45.3	0.61
BRW39	562412	189153	19.1	38.3	44.8	0.86	39.4	54.4	0.72
BB05	536213	200020	22.5	60.7	78.5	0.77	87.7	139.3	0.63
CP14	576379	188463	22.0	31.0	33.2	0.93	18.0	22.7	0.79
CB27	574080	203469	15.3	35.0	37.8	0.93	39.8	45.9	0.87
DA10	559189	174872	22.1	38.7	30.9	1.25	34.7	17.6	1.97
DA14	555495	174437	25.7	56.1	52.3	1.07	68.7	59.0	1.17
DA20	555662	174865	25.7	46.0	48.4	0.95	43.6	49.4	0.88
DA22	555605	174026	25.7	53.0	52.0	1.02	60.8	58.3	1.04
DA24	555632	173558	23.9	38.6	42.3	0.91	30.4	38.8	0.78
DA25	555801	173194	23.9	37.1	41.6	0.89	27.0	37.2	0.73
DA48	555297	171327	20.5	38.7	46.0	0.84	37.7	54.8	0.69
DA50	553783	172314	20.9	47.6	52.9	0.90	57.8	71.3	0.81
DA67	556900	171294	19.6	29.0	26.0	1.11	18.6	12.6	1.48
DA72	556451	172155	21.9	41.8	45.5	0.92	41.9	50.6	0.83

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
DA84	555574	174068	25.7	51.2	57.0	0.90	56.2	71.2	0.79
DA89	553798	172258	20.9	32.2	41.8	0.77	22.6	43.9	0.51
DA90	553962	172278	20.9	35.2	40.1	0.88	29.0	40.0	0.72
DA92	560534	174881	22.8	44.3	33.0	1.34	46.2	20.7	2.23
DA96	555117	175718	25.4	46.9	35.7	1.31	46.7	21.1	2.21
16BC	541308	200037	18.9	34.0	40.3	0.84	30.4	44.4	0.69
22BC	538710	199860	21.3	35.0	41.0	0.85	27.7	41.0	0.68
HAV47	554691	189516	22.1	46.5	37.5	1.24	52.5	31.8	1.65
DT12	546815	155850	14.0	43.1	39.9	1.08	61.2	53.5	1.14
LRAR	555301	179438	24.6	62.5	39.4	1.59	89.7	31.0	2.89
HR	559118	179462	24.9	31.5	34.9	0.90	13.3	20.5	0.65
NAS2	559720	179630	24.9	56.0	43.9	1.28	71.1	40.7	1.75
LRSS	559785	177910	29.4	39.6	39.2	1.01	21.4	20.5	1.04
WES	561958	180967	23.0	31.8	32.6	0.98	17.7	19.2	0.92
PKSL	567781	182399	22.6	29.0	34.8	0.83	12.6	24.7	0.51
FRC	559136	179084	24.9	33.2	33.8	0.98	16.8	18.0	0.93
LYD	560045	179869	24.6	30.8	48.2	0.64	12.4	51.5	0.24
LRARN	555280	179498	24.6	32.0	35.6	0.90	15.0	22.6	0.66
LRARMN	555299	179453	24.6	45.6	36.1	1.27	45.6	23.6	1.93
LRARMS	555332	179400	24.6	43.6	35.1	1.24	40.8	21.6	1.88

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
GR52	562450	174191	30.6	32.9	39.0	0.84	4.7	17.5	0.27
GR92	562324	172589	21.8	38.0	37.9	1.00	33.6	33.3	1.01
GR98	562529	174049	30.6	32.7	41.1	0.80	4.3	22.1	0.19
GR104	562465	172153	21.8	34.4	39.9	0.86	25.5	37.6	0.68
GR110	566150	170436	19.1	34.5	36.7	0.94	31.2	36.1	0.87
GR107	562272	172281	21.8	36.9	42.7	0.86	30.9	44.0	0.70
GR112	561502	174683	25.0	33.2	34.1	0.97	16.5	18.4	0.90
GR124	561338	174925	25.0	31.1	32.5	0.96	12.1	15.1	0.81
DT23	575044	171351	20.3	27.0	29.2	0.93	13.0	17.4	0.75
TN5a	572611	158545	18.2	35.5	44.6	0.80	34.9	55.9	0.63
TN7a	570392	159032	19.0	38.0	45.1	0.84	38.8	55.3	0.70
TN29	571734	158694	17.7	28.0	41.0	0.68	20.1	48.5	0.42
TN30	572016	158571	18.2	29.7	37.2	0.80	22.6	38.6	0.58
TN80a	572124	158627	18.2	34.9	41.9	0.83	33.6	49.4	0.68
TN101	572978	157727	17.5	37.2	31.3	1.19	40.4	27.5	1.47
TN60	572423	157932	17.5	44.8	34.9	1.28	58.3	35.2	1.65
DF1	572459	157904	17.5	44.3	31.5	1.41	57.1	27.9	2.04
Maid 03	575758	155639	20.0	44.3	37.3	1.19	51.6	35.5	1.46
Maid 10	575714	158504	18.4	31.0	35.4	0.87	24.7	34.3	0.72
Maid 26	575784	155678	20.0	31.0	33.0	0.94	21.9	26.1	0.84

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
Maid 94	575822	155579	20.0	35.5	39.0	0.91	31.5	39.2	0.80
Maid 105	577289	161502	18.5	24.7	37.2	0.66	11.8	38.0	0.31
ERFA	560962	179527	24.6	34.7	33.3	1.04	20.8	17.7	1.18
ERFB	560963	179558	24.6	33.6	33.3	1.01	18.4	17.8	1.03
ERTM	560965	179796	24.6	40.2	37.2	1.08	32.8	26.2	1.25
NC	561077	179912	24.7	36.2	38.5	0.94	23.5	28.6	0.82
HD	560003	179694	24.6	35.0	40.9	0.86	21.3	34.4	0.62
THB	557437	179099	24.1	38.2	44.7	0.85	29.2	44.0	0.66
SCR LTC	562380	181156	21.5	34.6	35.5	0.98	26.7	28.6	0.93
BSA LTC	563483	181069	21.6	25.6	29.3	0.88	7.9	15.3	0.52
BSB LTC	563572	180770	23.2	32.3	37.3	0.87	18.3	29.0	0.63
HR LTC	563782	180155	23.2	29.2	32.0	0.91	12.0	17.7	0.68
TTS LTC	563825	179595	22.8	25.4	30.0	0.85	5.0	14.3	0.35
GR137	570719	171143	18.5	32.8	28.4	1.16	28.9	19.5	1.49
GR138	570584	169550	18.5	30.8	30.6	1.01	24.5	24.0	1.02
GR141	569588	169603	18.0	31.4	40.6	0.77	26.6	47.3	0.56
GR142	567499	169832	17.4	58.9	45.1	1.31	94.9	59.1	1.61
LTC_ECO_05	567357	169801	17.4	33.0	37.6	0.88	31.3	41.5	0.75

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
LTC_ECO_06B	570966	168938	17.2	55.8	45.8	1.22	87.0	61.4	1.42
LTC_ECO_07	570651	166134	16.9	61.8	30.3	2.04	104.3	26.6	3.92
LTC_ECO_10	543670	154643	14.4	31.5	49.8	0.63	33.9	76.9	0.44
LTC_ECO_11	568293	169699	17.4	38.2	43.0	0.89	42.9	54.2	0.79
LTC_ECO_15	562992	179383	23.9	35.2	31.2	1.13	23.1	14.6	1.58
LTC_ECO_2b	558090	173100	20.9	30.7	31.1	0.99	19.5	20.4	0.96
LTC07	563595	180196	23.2	31.8	31.0	1.03	17.3	15.7	1.10
LTC13	565602	181268	22.4	38.2	33.9	1.13	32.6	23.2	1.41
LTC14	565363	182248	21.4	35.3	31.5	1.12	28.4	20.3	1.40
LTC16	562408	189151	19.1	54.3	44.7	1.21	78.4	54.3	1.44
LTC18	555245	189075	20.2	29.4	25.7	1.14	18.2	10.8	1.70
LTC20	560391	188790	18.7	42.5	37.3	1.14	49.8	37.9	1.31
LTC22	572273	186967	20.1	36.4	36.1	1.01	33.2	32.5	1.02
LTC23	574048	188044	22.2	35.2	44.0	0.80	26.4	46.2	0.57
LTC25	576773	189583	21.5	27.9	31.6	0.88	12.4	20.1	0.62
LTC29	555588	173351	23.9	53.0	42.7	1.24	64.7	39.6	1.64

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
LTC31	555431	174453	25.7	47.0	52.4	0.90	46.0	59.1	0.78
LTC32	555508	174445	25.7	48.0	49.4	0.97	48.4	51.9	0.93
LTC33	555264	171394	20.5	41.8	49.7	0.84	44.8	63.9	0.70
LTC38	562218	172312	21.8	43.6	45.2	0.97	46.2	49.9	0.93
LTC39	562431	172158	21.8	45.0	43.4	1.04	49.5	45.7	1.08
LTC40	566108	170251	19.1	28.8	29.9	0.96	19.2	21.4	0.89
LTC44	567081	172837	19.4	33.5	26.4	1.27	28.6	13.7	2.08
LTC45C	567574	172770	19.4	27.8	25.3	1.10	16.5	11.5	1.43
LTC47	568787	172044	18.3	30.7	25.5	1.20	24.9	14.2	1.75
LTC48	569392	171739	18.2	22.4	23.7	0.94	8.2	10.7	0.76
LTC49	570746	171119	18.5	35.7	27.2	1.31	35.2	17.0	2.08
LTC50	571202	170765	18.8	35.1	27.4	1.28	33.4	16.9	1.97
LTC51	570515	169558	18.5	32.0	37.4	0.86	27.0	38.8	0.69
LTC52	570726	169412	18.5	40.6	36.8	1.10	46.1	37.4	1.23
LTC53	571778	168082	18.9	35.2	34.3	1.03	33.2	31.2	1.06
LTC54	572672	166727	17.8	29.3	31.1	0.94	22.7	26.6	0.85
LTC56	574694	163008	18.8	39.3	43.8	0.90	42.2	52.7	0.80
LTC57	574549	162467	17.9	29.6	30.1	0.98	23.0	24.0	0.96
LTC58	574971	162355	17.9	29.8	30.2	0.99	23.4	24.2	0.97
LTC60	571806	158643	17.7	28.2	33.5	0.84	20.6	31.7	0.65

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
LTC61	570373	159030	19.0	38.1	47.4	0.80	39.1	60.8	0.64
LTC65	570487	165811	16.7	58.0	28.3	2.05	94.0	22.7	4.14
LTC68	550964	157662	13.7	39.5	27.1	1.46	53.3	26.1	2.04
LTC72	563554	180882	23.2	35.6	37.6	0.95	25.4	29.8	0.85
LTC73	563571	180771	23.2	36.2	36.6	0.99	26.7	27.5	0.97
LTC74	563405	181345	21.6	31.8	27.0	1.18	20.6	10.7	1.92
LTC75	565080	179651	21.7	34.7	25.8	1.34	26.6	8.0	3.31
LTC77	558321	185101	19.4	35.9	42.4	0.85	33.6	48.4	0.69
LTC78	560930	179856	24.6	53.6	40.7	1.32	65.6	33.9	1.93
LTC79	561058	179859	24.7	54.0	48.7	1.11	66.2	52.7	1.26
LTC80	571243	166976	16.7	59.6	31.5	1.89	98.4	29.4	3.35
LTC81	571173	166647	16.7	62.8	30.3	2.07	107.4	26.9	3.99
LTC84ABC	571257	166993	16.7	52.0	28.0	1.86	78.0	22.0	3.54
LTC86	571193	166702	16.7	28.5	26.2	1.08	23.1	18.5	1.25
LTC88ABC	570637	166093	16.9	35.2	27.4	1.28	37.2	20.6	1.80
LTC89	570615	166064	16.9	50.8	29.2	1.74	74.5	24.2	3.07
LTC90	570310	165175	16.7	24.2	22.6	1.07	14.4	11.2	1.28
LTC91	570288	164967	16.6	35.1	25.4	1.38	37.5	17.2	2.19
LTC93	570444	162872	17.9	55.3	25.7	2.16	83.6	15.0	5.56

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
A2BN_001_0913	555592	173376	23.9	52.4	45.9	1.14	63.2	47.3	1.34
A2BN_003_0913	556462	172137	21.9	41.0	41.9	0.98	40.1	42.1	0.95
A2BN_008_0913	558425	174632	23.4	42.4	41.3	1.03	40.3	37.8	1.07
A2BN_009_0913	558468	174671	23.4	50.4	44.3	1.14	59.8	44.8	1.33
A2BN_010_0913	556832	171333	19.6	28.1	28.1	1.00	16.8	16.7	1.00
A2BN_014_0913	562340	172686	21.8	42.2	35.0	1.21	43.2	26.9	1.61
A2BN_017_0913&A2BN_018_0913	564633	170962	18.5	40.0	55.1	0.73	44.8	82.3	0.54
M20J3J5_004_0813	575692	158506	18.4	30.1	36.0	0.84	23.0	35.6	0.64
M20J3J5_005_0813	575706	158608	18.4	26.4	41.1	0.64	15.4	47.1	0.33
M20J3J5_006_0813	575394	158793	18.4	33.9	36.7	0.92	31.0	37.2	0.83
M20J3J5_008_0813	575489	157943	18.3	27.4	28.4	0.97	17.7	19.7	0.90

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
M20J3J5_014_0813	571802	158656	17.7	26.6	36.3	0.73	17.3	37.8	0.46
M20J3J5_019_0813	570345	158965	17.8	37.8	42.2	0.90	40.9	51.0	0.80
M20J3J5_023_0813	568850	158768	18.3	24.9	27.9	0.89	12.7	18.7	0.68
M20J3J5_027_0813	563560	158670	15.9	27.1	27.1	1.00	21.8	21.7	1.00
M20J3J5_031_0813	560768	159699	14.8	21.6	28.9	0.75	12.9	27.7	0.47
M25J30_008_0913	559554	179546	24.9	35.4	37.7	0.94	21.5	26.5	0.81
M25J30_009_0913	560347	179782	24.6	51.6	40.3	1.28	60.4	33.1	1.83
M25J30_010_0913	561642	179407	24.7	36.7	33.9	1.08	24.7	18.7	1.32
M25J30_011_0913	555383	179910	24.6	35.1	38.0	0.92	21.4	27.8	0.77
M25J30_014_0913	559011	178966	26.4	47.9	37.7	1.27	47.0	23.4	2.01
M25J30_015_0913	555643	174871	25.7	41.3	45.2	0.91	32.7	41.8	0.78
A2EBB_003_0913	564009	170312	18.5	29.5	30.4	0.97	21.8	23.7	0.92

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
A2EBB_004_0913	564233	171600	19.2	36.4	35.3	1.03	35.3	32.8	1.08
A2EBB_013_0913	566125	170465	19.1	41.0	37.4	1.10	45.9	37.6	1.22
A2EBB_014_0913	566150	170290	19.1	24.6	34.5	0.71	10.7	31.3	0.34
A12Chel_021_0116	563260	197561	15.9	31.7	28.9	1.10	31.5	25.6	1.23
M25J28I_017_0116	557313	190348	18.9	38.0	39.7	0.96	39.1	42.9	0.91
M2J5_006_1215	588137	164233	16.3	28.8	41.3	0.70	24.8	52.6	0.47
M2J5_007_1215	587967	164216	15.8	25.9	32.6	0.79	19.5	33.5	0.58
M2J5_012_1215	588313	160896	14.7	20.3	27.2	0.75	10.5	24.2	0.43
J23-27_002_0117	535297	199994	21.8	39.6	48.1	0.82	36.9	57.1	0.65
J23-27_005_0117	536204	200038	22.5	49.7	59.3	0.84	59.1	84.0	0.70

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
J23-27_007_0117	538923	199797	21.3	34.7	37.9	0.91	27.1	34.1	0.79
J23-27_010_0117	545267	200963	16.7	39.3	37.9	1.04	46.6	43.5	1.07
J23-27_011_0117	545028	200951	16.7	39.2	33.2	1.18	46.4	32.9	1.41
Dartford_004_0117	555464	174128	25.7	35.8	45.3	0.79	20.6	41.8	0.49
Dartford_005_0117	555632	173523	23.9	38.1	43.0	0.89	29.2	40.2	0.73
Dartford_010_0117	555740	173678	23.9	50.4	49.8	1.01	58.2	56.6	1.03
Dartford_012_0117	555519	174208	25.7	49.3	57.4	0.86	51.5	72.2	0.71
DT41	570281	164949	16.6	26.6	25.6	1.04	19.5	17.5	1.12
DT42	570276	165016	16.7	21.6	23.8	0.91	9.3	13.6	0.68
DT43	570713	169417	18.5	33.8	38.1	0.89	30.8	40.4	0.76
CP29	580120	189646	23.2	32.8	39.7	0.83	19.4	34.6	0.56
CP30	579696	189697	20.8	30.7	34.6	0.89	19.9	28.3	0.70
LT	558007	178704	27.9	53.7	41.7	1.29	58.3	29.2	2.00

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
GR113	562281	173031	24.3	27.7	32.4	0.86	6.8	16.4	0.41
DT02	573482	169282	21.5	47.0	33.1	1.42	55.2	23.4	2.36
DT19	573328	169293	21.5	47.4	29.8	1.59	56.2	16.3	3.45
DT20	573168	169305	21.5	48.5	30.0	1.62	59.0	16.9	3.49
DT21	574999	170882	21.3	23.4	28.1	0.83	4.1	13.3	0.31
A2BN_005_0913	556750	173445	23.1	44.0	41.0	1.07	44.8	37.7	1.19
M2J5_014_1215	579733	163371	18.1	26.6	27.9	0.95	16.5	19.1	0.86
1.1CP	557515	177724	32.3	63.3	86.1	0.74	72.6	139.2	0.52
1.2CP	557517	177723	32.3	63.1	81.4	0.78	72.0	124.9	0.58
1.3CP	557519	177723	32.3	60.3	78.9	0.76	64.6	117.1	0.55
13CP	538998	199792	21.3	31.1	42.2	0.74	19.5	43.7	0.45
14CP	545220	200941	16.7	41.9	60.7	0.69	52.6	101.0	0.52
18CP	560938	159627	14.8	27.9	29.4	0.95	25.6	28.7	0.89
19CP	550529	197714	17.0	33.5	49.4	0.68	33.0	70.2	0.47
20CP	553535	195459	17.3	34.5	48.8	0.71	34.6	68.2	0.51
21CP	558177	184122	19.4	30.9	46.1	0.67	22.9	57.3	0.40
22CP	557505	181068	21.8	45.7	46.5	0.98	51.3	53.3	0.96
3CP	538441	154000	14.7	29.2	50.4	0.58	28.4	77.7	0.37

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
32.1CP	555717	167041	16.8	23.6	31.1	0.76	12.9	28.2	0.46
32.2CP	555724	167056	16.8	24.2	28.4	0.85	14.1	22.5	0.63
32.3CP	555734	167072	16.8	21.9	26.5	0.83	9.6	18.7	0.51
36CP	557351	178826	27.7	57.7	53.9	1.07	68.5	58.6	1.17
38.1CP	555763	173151	23.9	37.0	53.2	0.70	26.8	65.3	0.41
44CP	544541	201009	16.9	49.4	59.9	0.82	70.6	98.4	0.72
45CP	544554	201102	16.9	32.2	44.2	0.73	30.6	57.8	0.53
47CP	550923	157723	13.7	30.7	32.8	0.94	33.7	38.1	0.88
48CP	547282	156091	13.7	34.4	33.0	1.04	41.7	38.5	1.08
49CP	553374	167590	17.7	39.3	36.3	1.08	44.4	37.6	1.18
GR56	565211	172980	22.2	30.8	34.6	0.89	17.2	25.3	0.68
GR67	565215	172958	22.2	34.0	33.7	1.01	24.0	23.4	1.02
GR68	564808	173086	25.3	33.7	34.4	0.98	17.1	18.5	0.92
GR109	565229	172955	22.2	32.8	32.1	1.02	21.4	20.0	1.07
A2EBB_005_0913	564413	172432	21.5	35.0	30.8	1.14	27.6	18.7	1.48
A2EBB_009_0913	564454	172767	21.5	34.6	31.1	1.11	26.8	19.2	1.39
CP32	578347	190591	20.8	24.3	31.8	0.76	6.6	21.9	0.30
HAV32	553406	190559	23.1	53.2	44.8	1.19	75.9	51.3	1.48

Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
HAV39	551616	190622	23.0	31.3	32.3	0.97	17.8	20.2	0.88
RO012	580549	190629	22.2	43.8	39.9	1.10	45.9	36.7	1.25
RO015	580533	190748	22.2	43.6	37.1	1.18	45.2	30.4	1.49
RO016	580613	190551	22.2	47.3	31.5	1.50	54.2	18.5	2.94
SOU28	584932	188250	20.9	31.9	33.4	0.96	22.0	25.1	0.88
SOU29	584141	188238	20.9	23.0	30.9	0.74	4.0	20.0	0.20
KE4	584864	188230	20.9	33.4	33.0	1.01	25.3	24.4	1.04
KE6	584903	188232	20.9	30.4	31.2	0.97	18.8	20.4	0.92
KE7	584952	188294	20.9	41.5	38.3	1.08	43.4	36.1	1.20
TN92	570189	158328	17.8	43.8	33.1	1.32	55.3	30.8	1.80
DF7	570386	158311	17.8	41.8	29.6	1.41	50.5	23.3	2.17
LTC26	578405	190585	20.8	37.9	37.9	1.00	35.3	35.3	1.00
SW62	588178	164236	16.3	27.0	43.6	0.62	21.0	58.1	0.36
RDC-CRH	580554	190726	22.2	30.0	33.4	0.90	15.4	22.6	0.68
RDC-KGC	580776	190462	22.2	26.4	27.7	0.95	8.2	10.8	0.76
GW23	540420	177706	33.7	41.4	38.4	1.08	17.8	10.5	1.69
GW32	540664	177235	33.7	47.4	40.7	1.17	33.1	16.0	2.07
GW36	539320	179234	36.8	58.1	43.8	1.33	55.6	16.2	3.42
TILA	563498	176483	30.2	40.8	34.0	1.20	22.3	7.8	2.87
TILB	563645	176348	30.2	39.7	33.1	1.20	20.0	6.0	3.32

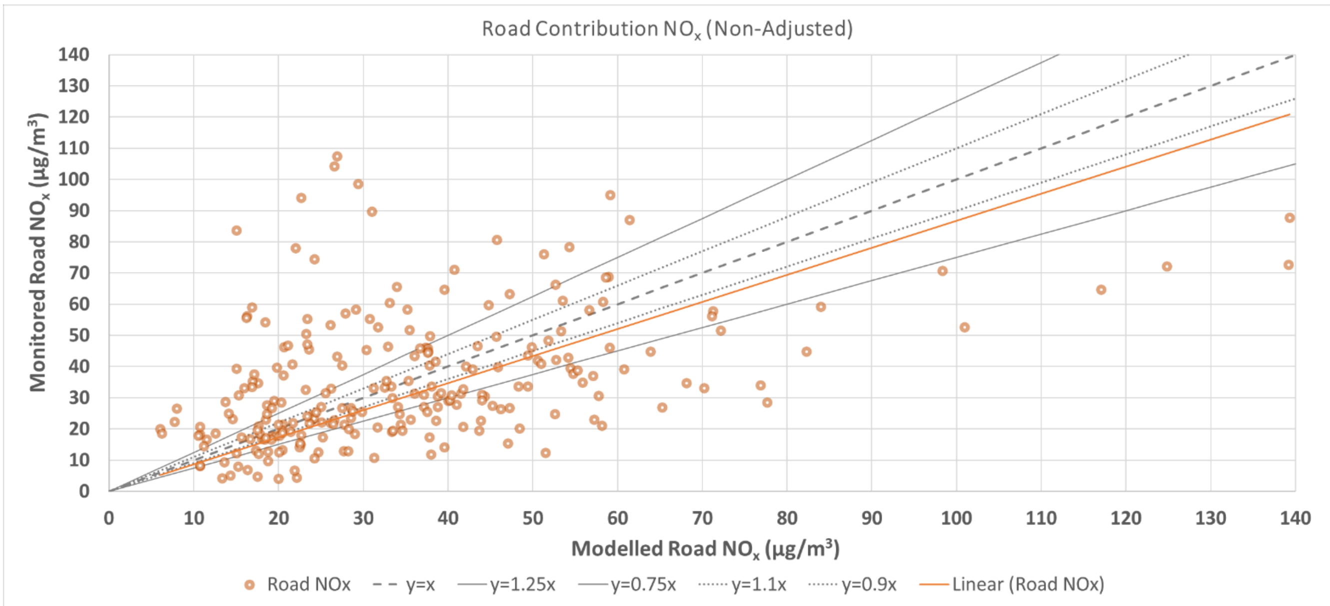
Tube ID	X OS grid ref	Y OS grid ref	Back-ground NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
TILC	563600	176321	30.2	39.0	33.3	1.17	18.5	6.3	2.95
DT L	541816	188161	31.1	47.6	39.8	1.19	39.7	19.8	2.00
DT M	541888	188136	31.1	80.5	41.6	1.94	149.5	24.0	6.22
DT Q	541992	191800	28.9	42.1	35.8	1.18	30.7	15.3	2.00

Table 6.2 Automatic station monitored and unadjusted modelled results 2016 (total NO_2, total NOx & road NO_x)

Auto station ID	X OS grid ref	Y OS grid ref	Monitored total NOx (µg/m³)	Back-ground NOx (µg/m³)	Monitored total NO_2 (µg/m³)	Modelled total NO_2 (µg/m³)	Ratio of monitored vs modelled total NO_2	Monitored road NOx (µg/m³)	Modelled road NOx (µg/m³)	Ratio of monitored vs modelled road NO_x
Dartford 1	558493	174668	116.5	35.9	47.0	44.7	1.05	80.6	45.8	1.76
ZG2	562589	172076	62.6	32.8	29.6	38.0	0.78	29.8	33.4	0.89
HV1	553114	182508	76.0	36.6	34.0	31.0	1.10	39.4	15.1	2.61
GR8	540200	178367	219.0	62.5	64.0	50.7	1.26	156.5	37.0	4.23

6.1.5 The modelled versus monitored road NOx component concentrations were plotted on a scatter graph as presented on Plate 6.1.

Plate 6.1 Scatterplot of unadjusted modelled road NOx vs monitored road NOx



6.1.6 Plate 6.1 illustrates that there is scatter in the modelled road NOx concentrations compared to the monitored concentrations. To examine whether this scatter could be due to some systematic feature, such as the type of road or geographic area, the ratio of modelled to monitored road NOx concentrations was examined across the study area using a combination of GIS and Google Earth software. Following this analysis process, it was evident that there were spatial patterns in the agreement between the monitored and modelled concentrations, which meant a single verification factor applied to the modelled results would not be appropriate. The modelled area was therefore split into different road corridors and geographic regions where there was similar model performance. This process is known as zonal verification. The monitoring sites were subsequently separated into 19 model verification zones as shown in Table 6.3.

Table 6.3 Road NOx verification factors per model verification zone

Verification zone description	Road NOx verification factor	Number of monitoring sites in zone
1. M25 A282 M20 M2 (E of J3) A249 (N of M2J5)	0.65	60
2. A102 London	3.71	4
3. A13, A1089, A1014 and A127 (E of A1245)	0.68	25
4. Rayleigh A1015 and A129	1.39	5
5. A2 Sittingbourne	0.41	2
6. A12 and A127 (E of M25J29)	1.08	6
7. A127 (W of M25J29)	1.47	4
8. A229	0.98	6

Verification zone description	Road NOx verification factor	Number of monitoring sites in zone
9. A228	3.10	13
10. Holmesdale Tunnel	0.65	3
11. Bell Common Tunnel	0.67	5
12. A2 & A289	0.80	18
13. Thurrock/Dartford/Gravesham Urban	1.36	61
14. Non Urban Road	0.93	7
15. A20 (W of M20J6)	1.79	5
16. M2 J1 to J3	1.03	8
17. A2 London Road	2.92	3
18. A1089 Tilbury	3.01	3
19. M11/A406	4.02	3

6.1.7 The verification factors in Table 6.3 were applied to the road NOx concentrations predicted at the monitoring sites residing within each zone. Table 6.4 shows the resulting modelled total NO_2 at each monitoring site compared with the concentrations monitored. Plate 6.2 also shows the total modelled and monitored NO_2 concentrations plotted against one another in a scatter graph and demonstrates that the agreement between the concentrations is better following adjustment, when compared to the unadjusted model predictions (see Plate 5.1).

Table 6.4 Monitored and adjusted total modelled NO_2 2016

Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2	Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2
BAS006	3	29.6	35.7	0.83	LTC75	13	34.7	27.2	1.27
BAS007	3	29.8	31.5	0.95	LTC77	1	35.9	35.0	1.03
BRW26	6	29.9	30.0	1.00	LTC78	13	53.6	45.8	1.17
BRW32	1	33.1	34.0	0.97	LTC79	13	54.0	56.0	0.96
BRW39	6	38.3	46.6	0.82	LTC80	9	59.6	56.9	1.05
BB05	10	60.7	61.7	0.98	LTC81	9	62.8	54.1	1.16
CP14	3	31.0	29.7	1.04	LTC84ABC	9	52.0	48.2	1.08
CB27	6	35.0	39.4	0.89	LTC86	9	28.5	43.7	0.65
DA10	13	38.7	33.8	1.14	LTC88ABC	9	35.2	46.6	0.76
DA14	1	56.1	43.8	1.28	LTC89	9	50.8	51.0	1.00
DA20	1	46.0	41.1	1.12	LTC90	9	24.2	34.0	0.71
DA22	1	53.0	43.6	1.21	LTC91	9	35.1	41.9	0.84
DA24	1	38.6	36.3	1.06	LTC93	9	55.3	40.4	1.37
DA25	1	37.1	35.8	1.04	A2BN_001_0913	13	52.4	52.7	0.99
DA48	1	38.7	37.8	1.02	A2BN_003_0913	14	41.0	40.7	1.01
DA50	12	47.6	47.4	1.01	A2BN_008_0913	13	42.4	47.0	0.90
DA67	14	29.0	25.6	1.13	A2BN_009_0913	13	50.4	50.8	0.99
DA72	12	41.8	41.2	1.01	A2BN_010_0913	14	28.1	27.5	1.02

Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2	Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2
DA84	1	51.2	47.2	1.08	A2BN_014_0913	13	42.2	39.3	1.07
DA89	12	32.2	38.0	0.85	A2BN_017_0913 &A2BN_018_0913	12	40.0	48.8	0.82
DA90	12	35.2	36.6	0.96	M20J3J5_004_0813	1	30.1	30.2	1.00
DA92	13	44.3	36.4	1.22	M20J3J5_005_0813	1	26.4	33.8	0.78
DA96	13	46.9	39.1	1.20	M20J3J5_006_0813	8	33.9	36.4	0.93
16BC	1	34.0	33.3	1.02	M20J3J5_008_0813	8	27.4	28.2	0.97
22BC	1	35.0	34.6	1.01	M20J3J5_014_0813	1	26.6	30.2	0.88
HAV47	7	46.5	44.1	1.06	M20J3J5_019_0813	1	37.8	34.3	1.10
DT12	1	43.1	31.6	1.37	M20J3J5_023_0813	14	24.9	27.3	0.91
LRAR	13	62.5	44.2	1.42	M20J3J5_027_0813	1	27.1	23.3	1.16
HR	13	31.5	38.2	0.82	M20J3J5_031_0813	1	21.6	24.2	0.89
NAS2	13	56.0	49.8	1.12	M25J30_008_0913	13	35.4	41.8	0.85

Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2	Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2
LRSS	13	39.6	42.5	0.93	M25J30_009_0913	13	51.6	45.3	1.14
WES	3	31.8	29.6	1.08	M25J30_010_0913	13	36.7	37.0	0.99
PKSL	13	29.0	38.8	0.75	M25J30_011_0913	3	35.1	33.9	1.04
FRC	13	33.2	36.7	0.90	M25J30_014_0913	13	47.9	41.4	1.16
LYD	3	30.8	41.2	0.75	M25J30_015_0913	1	41.3	38.9	1.06
LRARN	13	32.0	39.2	0.82	A2EBB_003_0913	14	29.5	29.6	1.00
LRARMN	13	45.6	39.8	1.15	A2EBB_004_0913	13	36.4	40.4	0.90
LRARMS	13	43.6	38.6	1.13	A2EBB_013_0913	13	41.0	43.2	0.95
GR52	13	32.9	41.8	0.79	A2EBB_014_0913	12	24.6	31.7	0.78
GR92	13	38.0	43.0	0.88	A12Chel_021_0116	6	31.7	29.9	1.06
GR98	13	32.7	44.6	0.73	M25J28I_017_0116	1	38.0	32.9	1.16
GR104	12	34.4	36.5	0.94	M2J5_006_1215	5	28.8	27.3	1.06

Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2	Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2
GR110	12	34.5	33.4	1.03	M2J5_007_1215	1	25.9	27.1	0.96
GR107	12	36.9	38.9	0.95	M2J5_012_1215	1	20.3	23.0	0.88
GR112	13	33.2	37.1	0.89	J23-27_002_0117	10	39.6	39.6	1.00
GR124	13	31.1	35.0	0.89	J23-27_005_0117	10	49.7	47.8	1.04
DT23	12	27.0	27.5	0.98	J23-27_007_0117	1	34.7	32.4	1.07
TN5a	1	35.5	36.2	0.98	J23-27_010_0117	11	39.3	31.4	1.25
TN7a	1	38.0	36.8	1.03	J23-27_011_0117	11	39.2	28.0	1.40
TN29	1	28.0	33.5	0.84	Dartford_004_0117	1	35.8	38.9	0.92
TN30	1	29.7	31.0	0.96	Dartford_005_0117	1	38.1	36.7	1.04
TN80a	1	34.9	34.3	1.02	Dartford_010_0117	1	50.4	41.5	1.21
TN101	15	37.2	41.0	0.91	Dartford_012_0117	1	49.3	47.5	1.04
TN60	15	44.8	46.7	0.96	DT41	9	26.6	42.4	0.63
DF1	15	44.3	41.3	1.07	DT42	9	21.6	37.3	0.58
Maid 03	8	44.3	36.9	1.20	DT43	16	33.8	38.7	0.87

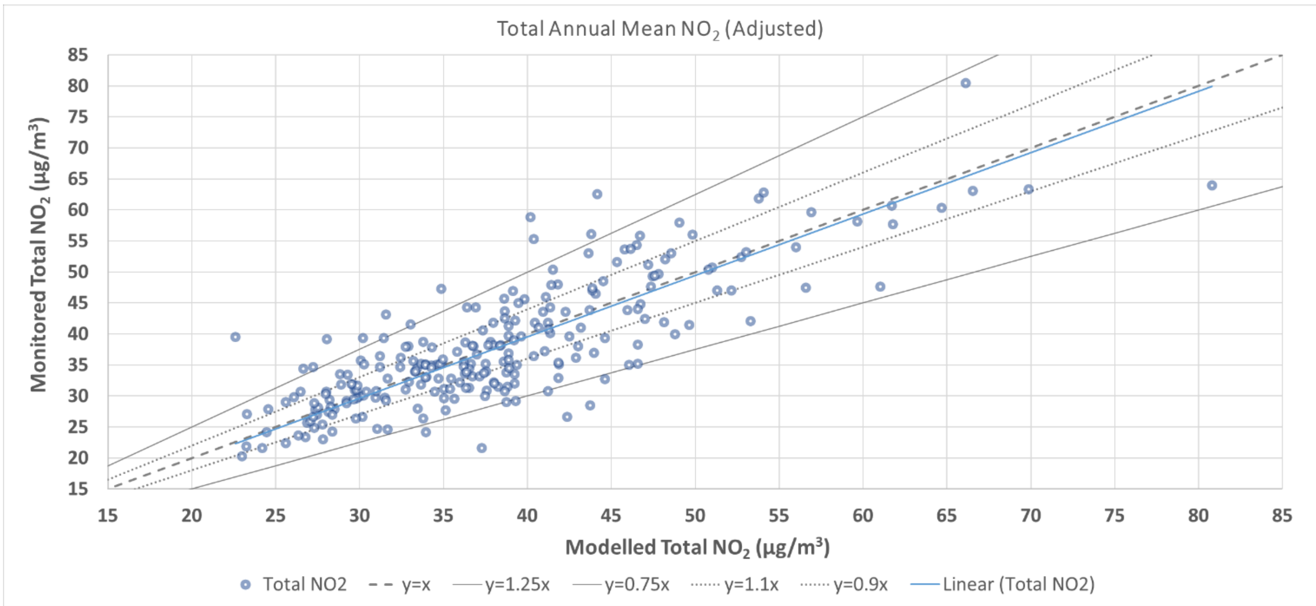
Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2	Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2
Maid 10	1	31.0	29.8	1.04	CP29	3	32.8	34.7	0.94
Maid 26	8	31.0	32.7	0.95	CP30	3	30.7	30.4	1.01
Maid 94	8	35.5	38.6	0.92	LT	13	53.7	46.1	1.16
Maid 105	1	24.7	31.1	0.79	GR113	13	27.7	35.1	0.79
ERFA	13	34.7	36.2	0.96	DT02	17	47.0	52.2	0.90
ERFB	13	33.6	36.3	0.93	DT19	17	47.4	43.9	1.08
ERTM	13	40.2	41.3	0.97	DT20	17	48.5	44.5	1.09
NC	13	36.2	42.9	0.84	DT21	12	23.4	26.8	0.87
HD	13	35.0	46.1	0.76	A2BN_005_0913	13	44.0	46.6	0.94
THB	1	38.2	38.0	1.01	M2J5_014_1215	14	26.6	27.2	0.98
SCR LTC	3	34.6	31.2	1.11	1.1CP	1	63.3	69.9	0.91
BSA LTC	3	25.6	26.9	0.95	1.2CP	1	63.1	66.5	0.95
BSB LTC	3	32.3	32.9	0.98	1.3CP	1	60.3	64.7	0.93
HR LTC	3	29.2	29.2	1.00	13CP	1	31.1	35.4	0.88
TTS LTC	3	25.4	27.8	0.91	14CP	11	41.9	48.2	0.87
GR137	13	32.8	31.7	1.04	18CP	1	27.9	24.5	1.14
GR138	16	30.8	31.0	0.99	19CP	1	33.5	39.2	0.85

Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2	Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2
GR141	12	31.4	36.5	0.86	20CP	1	34.5	38.9	0.89
GR142	12	58.9	40.2	1.46	21CP	1	30.9	37.6	0.82
Dartford 1	13	47.0	51.3	0.92	22CP	1	45.7	38.6	1.18
ZG2	12	29.6	35.0	0.85	3CP	1	29.2	39.3	0.74
HV1	13	34.0	33.3	1.02	32.1CP	1	23.6	26.3	0.90
LTC_ECO_05	12	33.0	33.9	0.97	32.2CP	1	24.2	24.5	0.99
LTC_ECO_06B	16	55.8	46.7	1.19	32.3CP	1	21.9	23.2	0.94
LTC_ECO_07	9	61.8	53.8	1.15	36CP	13	57.7	61.8	0.93
LTC_ECO_10	1	31.5	38.8	0.81	38.1CP	1	37.0	44.0	0.84
LTC_ECO_11	12	38.2	38.4	0.99	44CP	11	49.4	47.6	1.04
LTC_ECO_15	13	35.2	33.7	1.05	45CP	11	32.2	36.0	0.89
LTC_ECO_2b	13	30.7	34.5	0.89	47CP	1	30.7	26.5	1.16
LTC07	13	31.8	33.7	0.94	48CP	1	34.4	26.6	1.29
LTC13	13	38.2	37.7	1.01	49CP	1	39.3	30.2	1.30

Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2	Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2
LTC14	13	35.3	34.9	1.01	GR56	13	30.8	38.7	0.80
LTC16	6	54.3	46.5	1.17	GR67	13	34.0	37.5	0.91
LTC18	7	29.4	28.2	1.04	GR68	13	33.7	37.4	0.90
LTC20	6	42.5	38.6	1.10	GR109	13	32.8	35.5	0.93
LTC22	3	36.4	31.2	1.17	A2EBB_005_0913	13	35.0	33.9	1.03
LTC23	3	35.2	37.5	0.94	A2EBB_009_0913	13	34.6	34.3	1.01
LTC25	3	27.9	28.5	0.98	CP32	3	24.3	28.4	0.86
LTC29	13	53.0	48.6	1.09	HAV32	7	53.2	53.0	1.00
LTC31	1	47.0	43.9	1.07	HAV39	7	31.3	36.3	0.86
LTC32	1	48.0	41.8	1.15	RO012	4	43.8	46.0	0.95
LTC33	1	41.8	40.4	1.03	RO015	4	43.6	42.3	1.03
LTC38	12	43.6	40.9	1.07	RO016	4	47.3	34.9	1.36
LTC39	12	45.0	39.5	1.14	SOU28	3	31.9	29.5	1.08
LTC40	14	28.8	29.2	0.99	SOU29	3	23.0	27.8	0.83
LTC44	13	33.5	28.8	1.16	KE4	3	33.4	29.3	1.14
LTC45C	13	27.8	27.4	1.02	KE6	3	30.4	28.0	1.09
LTC47	13	30.7	28.0	1.10	KE7	3	41.5	33.1	1.26
LTC48	13	22.4	25.6	0.87	TN92	15	43.8	43.7	1.00

Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2	Site ID	Verification zone	Monitored total NO_2 (µg/m^3)	Adjusted modelled total NO_2 (µg/m^3)	Ratio of monitored vs modelled total NO_2
LTC49	13	35.7	30.1	1.19	DF7	15	41.8	38.0	1.10
LTC50	13	35.1	30.3	1.16	LTC26	3	37.9	32.7	1.16
LTC51	16	32.0	38.0	0.84	SW62	5	27.0	28.4	0.95
LTC52	16	40.6	37.4	1.09	RDC-CRH	4	30.0	37.5	0.80
LTC53	16	35.2	34.8	1.01	RDC-KGC	4	26.4	29.8	0.89
LTC54	16	29.3	31.6	0.93	GW23	2	41.4	49.7	0.83
LTC56	16	39.3	44.6	0.88	GW32	2	47.4	56.6	0.84
LTC57	8	29.6	29.8	0.99	GW36	2	58.1	59.7	0.97
LTC58	1	29.8	26.1	1.14	GR8	2	64.0	80.8	0.79
LTC60	1	28.2	28.3	1.00	TILA	18	40.8	41.3	0.99
LTC61	1	38.1	38.4	0.99	TILB	18	39.7	38.9	1.02
LTC65	9	58.0	49.1	1.18	TILC	18	39.0	39.2	1.00
LTC68	1	39.5	22.6	1.75	DT L	19	47.6	61.0	0.78
LTC72	3	35.6	33.2	1.07	DT M	19	80.5	66.1	1.22
LTC73	3	36.2	32.5	1.12	DT Q	19	42.1	53.3	0.79
LTC74	13	31.8	28.9	1.10					

Plate 6.2 Scatterplot of adjusted modelled total annual mean NO_2 vs monitored total annual mean NO_2



6.1.8 Table 6.5 summarises the model performance statistics and shows that the RMSE value is greater for the unadjusted model compared to the adjusted model. The adjusted model has an RMSE of 5.8µg/m^3 which is well within the Defra recommended RMSE value of 10µg/m^3. The model does not systematically under- or overpredict monitored concentrations, as shown by the FB which is zero. Additionally, following adjustment, the CC is closer to the ideal value of 1.0. The adjusted model thus provides an improved performance against monitoring data.

Table 6.5 Model performance statistics

Parameter	No adjustment	Adjustment
Root Mean Square Error (RMSE) µg/m3	9.5	5.8
Fractional Bias	0.0	0.0
Correlation Coefficient	0.52	0.82

6.1.9 The verification factors shown in Table 6.3 have been applied to the modelled road NOx concentrations predicted at human and ecological receptors which reside within the same geographical verification zones. These factors were applied throughout all of the modelled scenarios. It should be noted that no model adjustment factors were applied along the Project route, which is considered to be conservative, given that the model has a tendency to slightly overpredict concentrations from motorways and fast-flowing dual carriageways. It should also be noted that the road NOx adjustment factors were applied to modelled road contribution PM_{10} concentrations.

References

Department for Environment, Food and Rural Affairs (2022). Local Air Quality Management Technical Guidance (TG22).

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