A12 Chelmsford to A120 widening scheme

TR010060

6.3 ENVIRONMENTAL STATEMENT

APPENDIX 6.4 VERIFICATION OF DISPERSION MODEL RESULTS

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ENVIRONMENTAL STATEMENT
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1.1 Introduction

1.1.1 The comparison of modelled atmospheric pollutant concentrations with local monitored concentrations is a process termed 'verification'. Model verification investigates the discrepancies between modelled and measured concentrations, which can arise due to the presence of inaccuracies and/or uncertainties in model input data, modelling and monitoring data assumptions. The following are examples of potential causes of such discrepancies:

- Estimates of background pollutant concentrations
- Meteorological data uncertainties
- Traffic data uncertainties
- Vehicle emission factors uncertainties
- Model input parameters, such as 'roughness length'[1]
- Overall limitations of the dispersion model

1.2 Model precision

1.2.1 Residual uncertainty may remain after systematic error or 'model accuracy' has been accounted for in the final predictions. Residual uncertainty may be considered synonymous with the 'precision' 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 model precision provides an estimate of how the final predictions may deviate from true (monitored) values at the same location over the same period.

1.3 Model performance

1.3.1 An evaluation of model performance has been undertaken to establish confidence in the modelled results. LAQM.TG(16) (Defra, 2021) identifies a number of statistical procedures that are appropriate to evaluate model performance and assess uncertainty. The statistical parameters used in this assessment are:

- Root mean square error (RMSE)
- Fractional bias (FB)
- Correlation coefficient (CC)

[1] Topographic features, buildings or vegetation increase the ground's 'surface roughness' effecting dispersion because of the enhanced mechanical turbulence generated as the air moves over the ground.

1.3.2 A brief explanation of each statistic is provided in Table 1.1, and further details can be found in LAQM.TG(16) Box 7.17 (Defra, 2021).

Table 1.1 Model performance statistics

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, if the model predictions are for the annual mean NO_2 Air Quality Objective (AQO) of 40µg/m^3, an RMSE of 10µg/m^3 or above would suggest the model parameters and model verification should be revisited. Ideally, an RMSE within 10% of the AQO would be derived, which equates to 4µg/m^3 for the annual mean NO_2 AQO.	< 4.0
FB	FB is used to identify if the model shows a systematic tendency to over or under predict. FB values vary between + 2 and - 2 and has an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.	0.0
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.	1.0

1.3.3 These parameters estimate how the model results agree or diverge from the observations.

1.3.4 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.

1.3.5 The verification process involves a review of the modelled air 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.

1.3.6 Alternatively, the model may not perform well against the monitoring data, in which case there is a need to check all the input data to ensure that it is reasonable and accurately represented by 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 improve alignment with the monitoring data. This adjustment may be made either by using 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 spatial situations in the study area.

1.4 Air quality monitoring data

1.4.1 The air quality monitoring data collected as part of this assessment (i.e. the desktop study of Colchester, Maldon, Chelmsford and Braintree local authorities), as set out in Section 6.8 of Chapter 6: Air quality, of the Environmental Statement [TR010060/APP/6.1], were reviewed to determine the suitability of each of the monitoring locations for inclusion in the model verification process. The criteria used to determine the suitability of the monitoring data for inclusion into the verification process were:

- The monitoring site was at a roadside or near road location within 200m of the Affected Road Network (ARN)
- The location of the monitoring site could be accurately identified
- Data capture was greater than 75% in the relevant year
- The monitoring site was not influenced by substantial road or other emission sources for which data was not available in the traffic reliability area, and hence could not be included in the dispersion model
- The monitoring site was not influenced by any factors considered to have the potential to have a substantial influence on the dispersion of emissions affecting that location, and which could not be accurately accounted for within the modelling process (e.g. elevated road sections or sections of road in cutting, or walls/barriers/dense vegetation between the monitoring site and the nearest road traffic emission source)
- The monitoring site was not affected by local emission sources (e.g. from a petrol station, bus station, car park or buses accelerating from a bus stop)

1.4.2 A total of 11 sites were excluded from the final verification, from an initial selection of 21 sites within 200m of the ARN. Table 1.2 shows the monitoring sites that were excluded and the reasons for their exclusion.

Table 1.2 Monitoring sites excluded from the model verification, with reasons for exclusion

Verification site	OS grid coordinate (X,Y)	Reason for exclusion
BR5	582003, 215111	In proximity to several junctions. Potential queuing effects.
BR11	586386, 219106	Believed to be on building façade. Potential entrainment effects.

Verification site	OS grid coordinate (X,Y)	Reason for exclusion
BR22	582035, 215081	In proximity to several junctions. Potential queuing effects.
CB31	575265, 209975	Potential entrainment effects associated with façade, in proximity to bus stop and an indication that there is congestion during the AM peak not appropriately captured in model
CBC135	591366, 223679	Potential queueing effects not captured in model
CBC136	590444, 223500	Potential queuing effects not captured in model
CBC137	590324, 223493	Potential entrainment effects due to tube being located on facade
J3	582905, 214601	Traffic on the service road assumed not characterised well by traffic model
J4	584052, 216313	Traffic activity in remote road conditions assumed to not be characterised by traffic model
J5	585646, 217244	Traffic activity in remote road conditions assumed to not be characterised by traffic model
J7	587686, 218872	Possible gradient affecting emissions

1.4.3 The monitoring sites included in the final verification are presented in Table 1.3 and shown on Figure 6.2 [TR010060/APP/6.2].

1.5 Verification methodology – NO_X / NO_2

1.5.1 The verification method followed the process detailed in LAQM TG(16) (Defra, 2021). The first stage of verification was undertaken by comparing the modelled versus monitored contribution from road traffic sources i.e. road NO_x concentrations. Road NO_x contributions at the diffusion tube sites were calculated using the latest Defra NO_x to NO_2 Calculator (Defra, 2020), because diffusion tubes only measure total NO_2, from which the road NO_x needs to be estimated having first subtracted background NO_2 concentrations.

1.5.2 Once the modelled road NO_x component had been adjusted with the relevant verification adjustment factor, this value was used in the Defra NO_x to NO_2 Calculator to provide the 'adjusted' road NO_2 contribution. Comparisons could then be drawn between the adjusted total modelled NO_2 and monitored NO_2 components.

1.5.3 For the purposes of this assessment, one adjustment factor was derived and applied to all modelled human, ecological and PCM receptors.

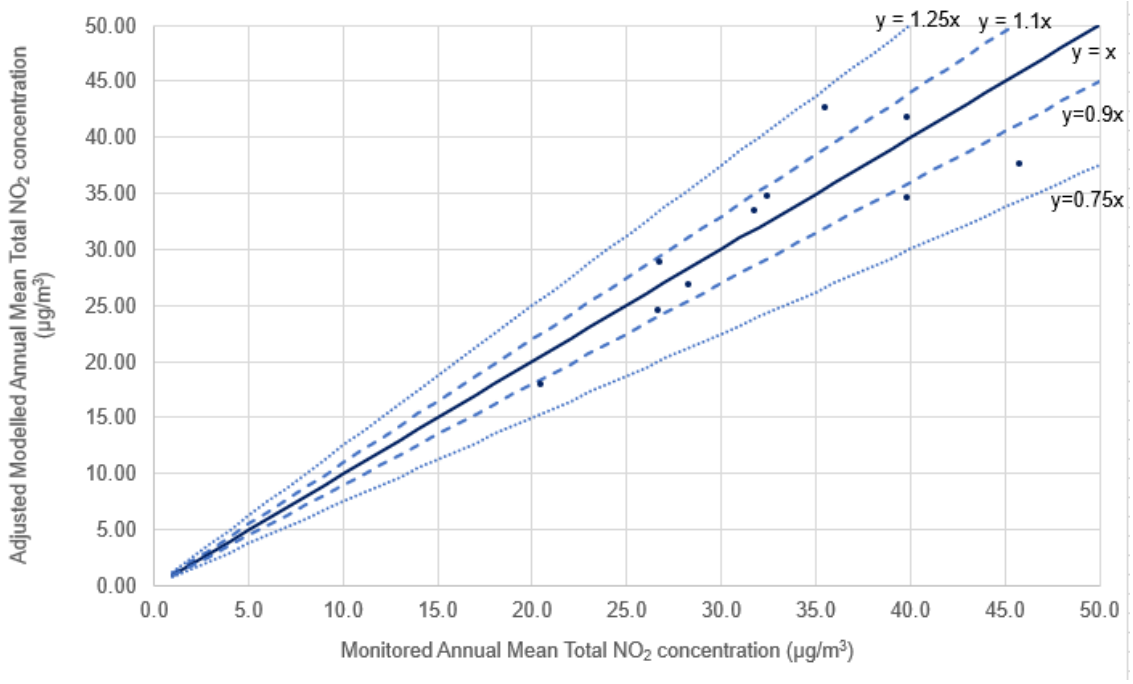
1.5.4 Table 1.3 depicts the monitored and modelled concentrations for the final verification site selection before and after adjustment.

Table 1.3 Monitored and modelled NO_2 concentrations

Site	Monitored NO_2 ($\mu g/m^3$)	Unadjusted total modelled NO_2 ($\mu g/m^3$)	Percentage difference (%)	Adjusted total modelled NO_2 ($\mu g/m^3$)	Percentage difference (%)
BR3	45.8	26.9	-41.4	37.6	-18.0
BR9	35.5	29.9	-15.6	42.6	20.1
CB27/27A/27B	31.8	24.9	-21.8	33.5	5.3
CBC90	26.7	21.2	-20.8	28.9	8.0
CBC131	39.8	29.9	-24.9	41.8	5.0
CBC132	32.5	25.6	-21.1	34.7	6.9
J1	26.7	19.5	-26.9	24.5	-8.3
J2	28.3	20.3	-28.3	26.9	-5.2
J8	20.5	14.9	-27.5	18.0	-12.2
J10	39.8	24.6	-38.3	34.6	-13.2

1.5.5 Plate 1.1 shows the monitored annual mean total NO_2 concentrations at the final ten verification sites compared to the adjusted modelled annual mean total NO_2 concentrations.

Plate 1.1 Monitored annual mean total NO_2 concentrations at the final ten verification sites, compared to modelled annual mean total NO_2 concentrations with the verification adjustment factor applied



1.6 Verification summary – NOx / NO_2

1.6.1 A review was undertaken of the monitored versus modelled performance at sites within 200m of the ARN. The summary results and model performance statistics defined in LAQM.TG(16) (Defra, 2021) are provided in Table 1.4.

Table 1.4 Verification summary and model performance

Statistical parameter	No adjustment	With adjustment
Number of monitoring sites	21	10
Road NOx adjustment factor	1.0	1.818
NO_2 adjustment factor	1.0	1.0
RMSE (µg/m^3)	11.3	4.2
FB	0.38	0.01
CC	0.74	0.84
Number within ± 10 %	1	6
Number within ± 25 %	1	10

1.6.2 The statistics support the methodology adopted. The statistics show that the RMSE and FB are improved when an adjustment is applied and the RMSE is below 10.0µg/m^3 after adjustment.

1.7 Verification methodology – PM_{10}

1.7.1 There was an insufficient number of PM_{10} analysers within the study area to enable model verification. Therefore, the road NOx adjustment factors have been applied to modelled road PM_{10} contributions, following guidance in LAQM TG(16) (Defra, 2021).

References

Department for Environment, Food and Rural Affairs (Defra) (2020). NO_X to NO_2 Calculator v8.1. Available from: https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html. Accessed March 2022.

Department for Environment, Food and Rural Affairs (Defra) (2021). Local Air Quality Management: Technical Guidance Note (LAQM TG(16)) v1, April 2021.