# APPENDIX E – MODEL VERIFICATION CALCULATIONS

The comparison of modelled 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 discrepancy:

a) estimates of background pollutant concentrations;

b) meteorological data uncertainties;

c) traffic data uncertainties;

d) model input parameters, such as 'roughness length'; and

e) overall limitations of the dispersion model.

**Verification Methodology**

Detail of the verification process data is presented in Table E2. The adjustment factor (**2.46**) was derived which shows model results were over-estimating current conditions when comparing to the measured concentrations.

**Table E2 – Verification Process Data**

| Site ID | Monitored Total $NO_2$ | Background $NO_2$ | Background $NO_x$ | 2012 Monitored Road Contribution $NO_2$ (total - background) | 2012 Monitored Road Contribution $NO_x$ (total - background) | 2012 Modelled Road Contribution $NO_x$ (excludes background) |
|---|---|---|---|---|---|---|
| DT25 | 33.9 | 10.9 | 15.0 | 23.0 | 48.8 | 15.2 |
| DT26 | 33.6 | 10.9 | 15.0 | 22.7 | 48.0 | 16.4 |
| DT30 | 25.8 | 11.0 | 15.0 | 14.8 | 30.0 | 16.6 |
| DT39 | 31.1 | 10.7 | 15.0 | 20.4 | 42.6 | 19.8 |

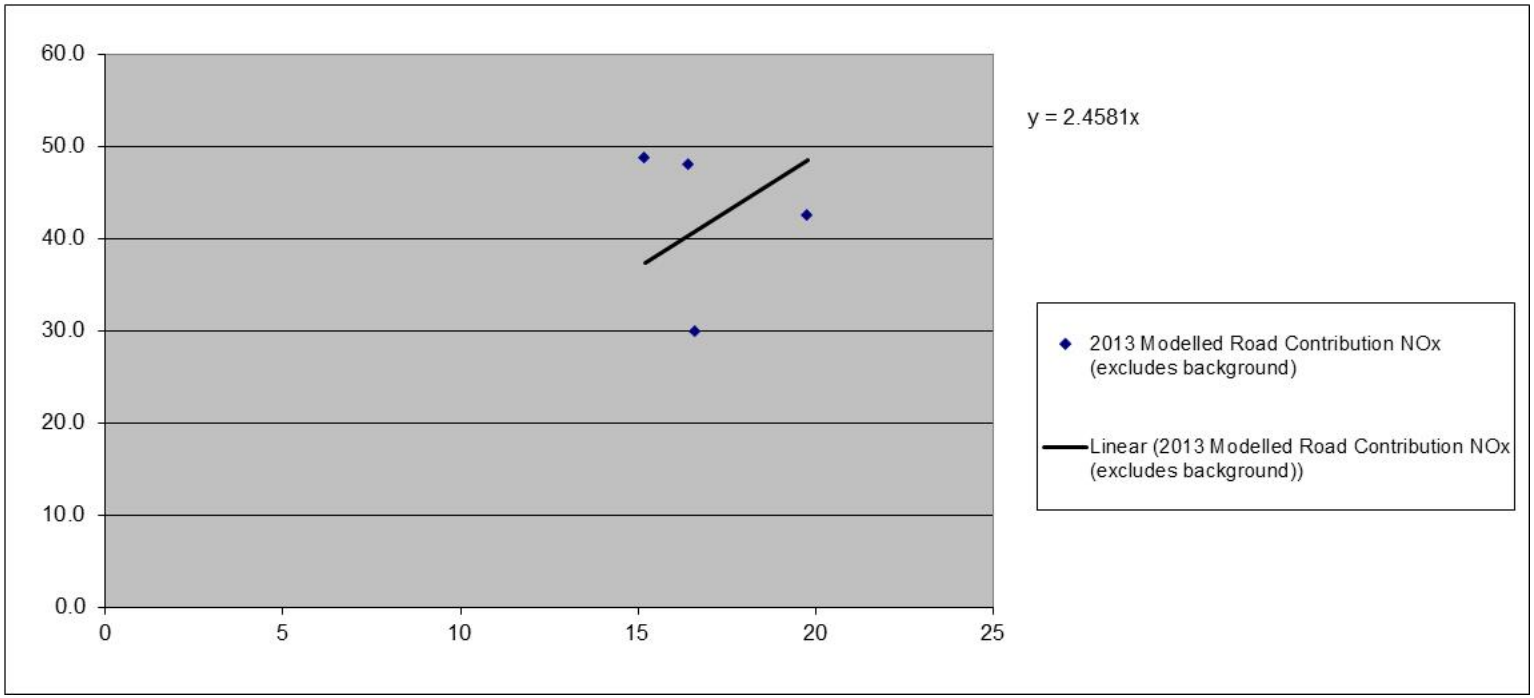

**Table E5 – Application of Adjustment Factor**

| Site ID | Ratio of monitored $NO_x$ road contribution /modelled road contribution $NO_x$ | Adjustment factor for modelled road contribution | Adjusted modelled road contribution $NO_x$ | Modelled Total $NO_2$ | Monitored Total $NO_2$ | % Difference |
|---|---|---|---|---|---|---|
| DT25 | 3.21 | **2.46** | 37.4 | 29.1 | 33.9 | -14 |
| DT26 | 2.92 | | 40.4 | 30.4 | 33.6 | -10 |
| DT30 | 1.80 | | 40.9 | 30.6 | 25.8 | 19 |
| DT39 | 2.16 | | 48.6 | 33.6 | 31.1 | 8 |

## Model Uncertainty

An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG(09) identifies a number of statistical procedures that are appropriate to evaluate model performance and assess the uncertainty. These include:

a) root mean square error (RMSE);

b) fractional bias (FB); and

c) correlation coefficient (CC).

These parameters estimate how the model results agree or diverge from the observations. These calculations can be carried out prior to, and after adjustment, or based on different options for adjustment, and can provide useful information on model improvement. A brief for explanation of each statistic is provided in Table E1, and further details can be found in Box A3.7 of LAQM.TG(09).

**Table E1 – Methods for describing model uncertainty**

| 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, if the model predictions are for the annual mean $NO_2$ objective of 40 µg/m$^3$, if an RMSE of 10 µg/m$^3$ or above is determined for a model it is advised to revisit the model parameters and model verification.<br>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. | 0.01 |
| Fractional Bias | It is used to identify if the model shows a systematic tendency to over or under predict.<br>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. | 0.00 |
| Correlation Coefficient | It 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.<br>This statistic can be particularly useful when comparing a large number of model and observed data points. | 1.00 |

To assess the uncertainty of a model, the RMSE is the simplest parameter to calculate providing an estimate of the average error of the model in the same units as the modelled predictions. It is also often easier to interpret the RMSE than the other statistical parameters and therefore it has been calculated in this assessment to understand the model uncertainty.

The RMSE value calculated after verification was 4 and therefore the final predictions are considered to be robust.