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Detailed Assessment of Air Quality – Bishopbriggs

Report for East Dunbartonshire Council

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Bishopbriggs Detailed Assessment

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Executive Summary

Ricardo Energy & Environment were commissioned by East Dunbartonshire Council to undertake a Detailed Assessment of Air Quality for the area comprising of Bishopbriggs. The assessment has been undertaken to investigate the potential scale and extent of exceedances of the Scottish Air Quality Objectives in the study area for NO_2 and PM_{10}.

An AQMA within Bishopbriggs was declared in 2005 consisting of an area covering a 60m corridor along the A803 Kirkintilloch Road between Colston Road and a point 30m north of Cadder Roundabout. The AQMA was declared for both NO_2 and PM_{10} exceedances

This report describes a dispersion modelling study of road traffic emissions in Bishopbriggs to determine if the existing AQMA boundary is still relevant and to allow a detailed assessment of NO_2 and PM_{10} concentrations in Bishopbriggs.

In 2009 the finalised AQAP for Bishopbriggs was issued to outline East Dunbartonshire's proposed actions to reduce pollutant concentrations within the declared AQMA.

A combination of the available diffusion tube and automatic monitoring data and atmospheric dispersion modelling using ADMS-Roads has been used to conduct the study. The study utilises the latest available traffic count data provided by East Dunbartonshire Council and meteorological data for 2015 from Glasgow Bishopton.

The modelling study has indicated the following:

- NO_2 concentrations in excess of the 40 µg.m^{-3} annual mean objective did not occur at ground level locations with relevant exposure during 2015.
- There are no exceedances of the PM_{10} annual mean objective of 18 µg.m^{-3} in 2015 at ground floor height, where relevant exposure is present.

Monitoring data collected between 2012 and 2015 indicates that concentrations of NO_2 and PM_{10} within the AQMA have decreased over the past years. There were no exceedances of the AQS annual mean objective for NO_2 in 2014 or 2015 at all locations. There have been no measured exceedances of the annual mean objective for PM_{10} at the Bishopbriggs automatic monitoring station since 2010, however this site has experienced sampling issues which have resulted in poor data capture over the past few years.

In light of the results from the Detailed Assessment of Air Quality in Bishopbriggs, East Dunbartonshire Council can revoke the existing AQMA for NO_2 and PM_{10} within the area along the A803. They however may wish to undertake additional diffusion tube monitoring at the identified hotspot at Colston Road. As a result of the poor data capture for PM_{10} data within the AQMA East Dunbartonshire Council may wish to postpone revoking until significant PM_{10} data has been collected from the Bishopbriggs automatic monitoring station.

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1 Introduction

Ricardo Energy & Environment were commissioned by East Dunbartonshire Council to undertake a Detailed Assessment of Air Quality in Bishopbriggs. The assessment has been undertaken to assess if the current AQMA declared along the A803 for PM_{10} and NO_2 exceedances requires to be amended or revoked. The current AQMA was determined in 2005 following exceedances of the Air Quality Scotland annual mean objectives for NO_2 and PM_{10}.

In recent years the concentrations of NO_2 and PM10 within Bishopbriggs have declined, as a result East Dunbartonshire commissioned a detailed study of the current AQMA to determine if the AQMA can be revoked if exceedances of the AQS annual mean objectives are no longer being measured.

1.1 Policy Background

The Environment Act 1995 placed a responsibility on the UK Government to prepare an Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland. The most recent version of the strategy (2007) sets out the current UK framework for air quality management and includes a number of air quality objectives for specific pollutants.

The 1995 Act also requires that Local Authorities “Review and Assess” air quality in their areas following a prescribed timetable. The Review and Assessment process is intended to locate and spatially define areas where the AQS objectives are not being met. In such instances the Local Authority is required to declare an Air Quality Management Area (AQMA), carry out a Detailed Assessment of Air Quality, and develop an Air Quality Action Plan (AQAP) which should include measures to improve air quality so that the objectives may be achieved in the future. The timetables and methodologies for carrying out Review and Assessment studies are prescribed in Defra’s Technical Guidance - LAQM.TG(16).

Table 1 lists the objectives relevant to this assessment that are included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the purposes of Local Air Quality Management (LAQM).

Table 1 NO_2 Objectives included in the Air Quality Regulations and subsequent Amendments for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective Concentration	Measured as
Nitrogen dioxide	40 µg.m^{-3}	Annual mean
Particles (PM_{10}) (gravimetric) Authorities in Scotland	18 µg.m^{-3}	Annual mean

1.2 Locations where the objectives apply

When carrying out the review and assessment of air quality it is only necessary to focus on areas where relevant public exposure is present. Table 2 summarises examples of where the air quality objectives for NO_2 and PM_{10} should and should not apply.

Table 2 Examples of where the NO_2 Air Quality Objectives should and should not apply

Averaging Period	Pollutant	Objectives should apply at….	Objectives should not generally apply at…
Annual mean	NO_2, PM_{10}	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term

1.3 Purpose of the Detailed Assessment

This study is a Detailed Assessment, which aims to assess the magnitude and spatial extent of any exceedances of the NO_2 and PM_{10} annual mean objectives at locations where relevant human exposure may occur within Bishopbriggs. The study aims to determine if the current AQMA boundary along the A803 remains unchanged since it was previously assessed.

1.4 Overview of the Detailed Assessment

The general approach taken to this Detailed Assessment was:

- Collect and interpret data from previous Review and Assessment reports;
- Collect and analyse recent traffic, monitoring, meteorological and background concentration data before use in the dispersion model;
- Use dispersion modelling to produce numerical predictions of NO_2 and PM_{10} concentrations at points of relevant exposure;
- Use dispersion modelling to produce contour plots of NO_2 and PM_{10} concentrations;
- Recommend if East Dunbartonshire should amend or revoke the current AQMA declared within Bishopbriggs.

The modelling methodologies provided for Detailed Assessments outlined in the Scottish Government and Defra Technical Guidance LAQM.TG (16)[1] were used throughout this study.

1.5 Previous Review and Assessment

1.5.1 2016 Annual Progress Report

The 2016 Annual Progress Report reviews measured pollutant concentrations from within the East Dunbartonshire Council area for the calendar year of 2015 and considers the potential for exceedances of air quality objectives.

The latest monitoring over 2015 indicates that overall, levels of pollutant are going down, with no exceedances of the Scottish Air Quality Objectives for NO_2 or PM_{10} annual mean. The overall concentrations at all four sites were lower than in 2014.

[1] Local Air Quality Management Technical Guidance LAQM.TG(16), DEFRA, 2016.

1.5.2 2015 Updating and Screening Assessment

The 2015 Updating and Screening assessment reviewed monitoring data from a network of 42 diffusion tubes measuring NO_2 and 4 automatic monitoring stations, measuring NO_2 and PM_{10}. The Annual Mean NO_2 concentrations measured at the Bishopbriggs monitoring site in 2014 was 29 µg.m^{-3}, below the annual mean objective of 40 µg.m^{-3}.

The 2015 Updating and Screening Assessment concluded that the measured concentrations at Bearsden, Bishopbriggs, Kirkintilloch and Milngavie for PM_{10} and NO_2 met the AQS annual mean objectives. Concentrations measured during 2014 were lower than those measured in 2013.

East Dunbartonshire continued to work towards improving air quality in their two established AQMA's at Bearsden and Bishopbriggs.

2 Detailed Assessment study area

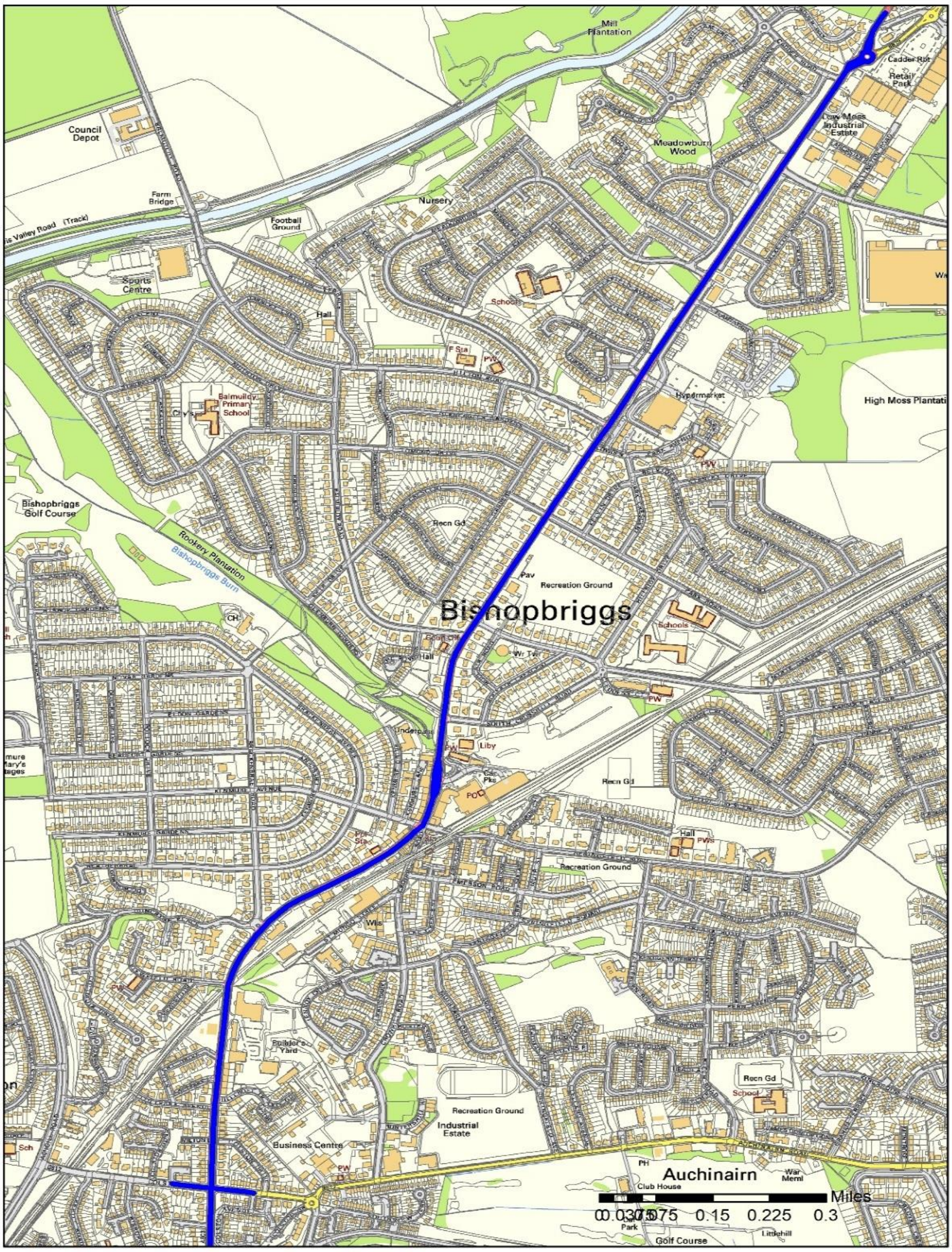
Bishopbriggs is a town within East Dunbartonshire, to the north of Glasgow approximately 4miles north of Glasgow city centre. Bishopbriggs currently has an AQMA declared for both annual mean NO_2 and PM_{10} exceedances. This assessment considers the current AQMA as well as areas out with the current AQMA to assess if the current boundary is still valid.

This Detailed Assessment is concerned with road traffic emissions predominantly from the A803 which runs through Bishopbriggs. The road network is predominately single lane, 2-way traffic within the town centre with dual lane 2-way traffic along many sections of the A803. The A803 acts as the main transport artery between Springburn, Glasgow and Kirkintilloch. The assessment considers road traffic emissions where relevant exposure is present close to the road.

2.1 Model domain

The study area has a mix of both detached residential properties, commercial and public properties with residential flats at first floor height above commercial properties at many locations along the A803. The study area, including the roads modelled and the extent of the detailed assessment is presented in **Figure 1**.

Figure 1: Detailed Assessment Study Area



Legend

ADMS Road Source

2.2 Receptor Locations

The model has been used to predict NO_2 and PM_{10} annual mean concentrations at a selection of receptors within the study area in addition to the monitoring locations, therefore some of the receptors shown below represent monitoring locations only which were used to carry out model verification in addition to receptors which represent locations of relevant exposure. The receptors within the model domain are located at roadside locations, either on the public walkway or on the façade of buildings along the A803. The specified receptors are locations of relevant exposure. Where residential receptors are present above commercial properties, receptors have been modelled at both 1.5 m and 4 m to represent human exposure at ground floor level and 1st floor height. The locations of the specified receptors are presented in Table 3 and shown in Figure 2 and Figure 3.

Table 3: Receptor Locations

Receptor	Address	Description	Easting	Northing	Height Modelled
Bishopbriggs 17*	1495 Springburn Road	Diffusion Tube	260547.4	669312.4	2.8
Bishoprbriggs 14 *Auto	128 Kirkintilloch Road/Crowhill Road	Automatic monitoring site	261002.3	670132.7	1.8
Bishopbriggs 6*	145 Kirkintilloch Road	Diffusion Tube	261012.3	670187.4	2.8
Bishopbriggs 16*	24 Kirkintilloch Road	Diffusion Tube	260581.6	669526.9	2.8
Receptor 1- 1495 Springburn Road	1495 Springburn Road (Building Façade)- Detached House	Residential	260547.4	669312.4	1.5
Receptor 2 - 145 Kirkintilloch Road	145 Kirkintilloch Road-1st floor flat	Residential	261012.3	670187.4	4
Receptor 3 - 24 Kirkintilloch Road	24 Kirkintilloch Road - Ground floor flat	Residential	260581.6	669526.9	1.5
Receptor 4- 106 Colston Road	106 Colston Road- Detached Property	Residential	260576.3	669311.8	1.5
Receptor 5- 89 Kirkintilloch Rd	89 Kirkintilloch Rd -Semi Detached Property	Residential	260765.5	670009.1	1.5
Receptor 6- 87 Kirkintilloch Rd	87 Kirkintilloch Rd – Semi Detached Property	Residential	260759.6	670006.4	1.5
Receptor 7- 121 Kirkintilloch Rd	121 Kirkintilloch Rd— Ground floor property	Residential	260942.8	670121.3	1.5
Receptor 8 -141 Kirkintilloch Rd	141 Kirkintilloch Rd- 1st Floor flat	Residential	261010.3	670183.6	4
Receptor 9- 239 Kirkintilloch Road	239 Kirkintilloch Road- Detached Property	Residential	261252.7	670890.1	1.5
Receptor 10- 1 Cadder Road	1 Cadder Road-Detached Property	Residential	261893.6	671949.9	1.5

***Included for model verification purposes only, representing diffusion tube locations, rather than sensitive receptor locations.**

Figure 2: Receptor Locations Bishopbriggs- Colston Road

N

Legend

■ ADMS Receptor

Figure 3: Receptor Locations Bishopbriggs- Springfield Road

N	**Legend** ■ ADMS Receptor	RICARDO Ricardo Energy & Environment **Reproduced from Ordnance Survey material with permission of Her Majesty's Stationery Office © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey License number LA100020774**

3 Information used to support this assessment

3.1 Maps

Ordnance Survey based GIS data of the model domain and a road centreline GIS dataset were used in the assessment. This enabled accurate road widths and the distance of the housing to the kerb to be determined in ArcMap.

3.2 Road traffic data

3.2.1 Average flow and fleet split

Traffic count data provided by East Dunbartonshire Council at two count points along the A803 were used for the assessment. This data included a split of LDV vehicles and a more detailed split of HGV and buses. Appendix 1 summarises all of the traffic flow data used for the road links modelled. The traffic counts were undertaken in June/July 2016. These counts were compared to the national Department for Transport (DfT) count points present along the A803 for 2016.

Within the current AQMA monitoring is undertaken at the A803 junction with Colston Road, from the available traffic data there were no vehicle counts available for the Colston Road Junction. In order to more accurately assess the emissions, it was agreed with East Dunbartonshire Council that an AADT for the road of 10,000 vehicles would be a realistic estimation of traffic movements at the east and west arm of the junction.

It should be noted that traffic patterns in urban locations are complex and it is not possible to fully represent these in atmospheric dispersion models. By attempting to describe these complex traffic patterns using quite simple metrics (AADT, average speed and basic vehicle split composition) a degree of uncertainty is introduced into the modelling.

3.2.2 Congestion

During congested periods average vehicle speeds reduce when compared to the daily average; the combination of slower average vehicle speeds and more vehicles lead to higher pollutant emissions during peak hours; it's therefore important to account for this when modelling vehicle emissions to estimate pollutant concentrations.

No queue observation data from traffic surveys was available for the assessment.

3.2.3 Vehicle emission factors

The latest version of the Emissions Factors Toolkit[2] (EFT V7.0 July 2016 release) was used in this assessment to calculate pollutant emission factors for each road link modelled. The calculated emission factors were imported into the ADMS-Roads model.

Parameters such as traffic volume, speed and fleet composition are entered into the EFT, and an emissions factor in grams of pollutant/kilometre/second is generated for input into the dispersion model.

The latest version of the EFT also includes addition of road abrasion emission factors for particulate matter; and changes to composition of the vehicle fleet in terms of the proportion of vehicle km travelled by each Euro standard, technology mix, vehicle size and vehicle category. Much of the supporting data in the EfT is provided by the Department for Transport (DfT), Highways Agency and Transport Scotland.

Vehicle emission projections are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced at a renewal rate forecast by the DfT. Any inaccuracy in the projections or the COPERT IV emissions factors contained in the EFT will be unavoidably carried forward into this modelling assessment.

[2] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft

3.3 Ambient monitoring

During 2015 East Dunbartonshire Council measured annual mean NO_2 concentrations at 42 diffusion tube sites, 8 of these sites are roadside sites within the study area. In addition, NO_2 and PM_{10} concentrations are monitored at 1 automatic monitoring site within the study area in Bishopbriggs, just off the A803.

The monitoring data for NO_2 used within this assessment included the roadside diffusion tubes and automatic monitoring site.

Further details of these monitoring locations and measured concentrations between 2012 and 2015 for NO_2 and PM_{10} are provided in Section 4.

3.4 Meteorological data

Hourly sequential meteorological data (wind speed, direction etc.) for 2015 measured at the Glasgow Bishopton site was used for the modelling assessment. The meteorological measurement site is located approximately 17 km West of the study area.

Meteorological measurements are subject to their own uncertainty which will unavoidably carry forward into this assessment. A wind rose of the meteorological site is presented in Appendix 2.

3.5 Background concentrations

Background NO_x and PM_{10} annual mean concentrations for a dispersion modelling study can be assessed from either local monitoring data conducted at a background site or from the background maps produced by Ricardo Energy and Environment on behalf of the Scottish Government[3]. The background maps are the outputs of a national scale dispersion model provided at a 1 km x 1 km resolution and are therefore subject to a degree of uncertainty. Both NO_x and PM_{10} emissions are projected to decline over time as emissions are reduced by national policy implementation.

There are two urban background diffusion tube monitoring sites in the Bishopbriggs area. There are no PM_{10} urban background monitoring locations, therefore the mapped background NO_x and PM_{10} concentrations for the relevant 1 km x 1 km grid squares were used in order to keep the approach consistent. The mapped annual mean background NO_x and PM_{10} concentrations used in this assessment are presented in Table 4. The contribution of A-roads within each grid square has been removed from the background concentrations to avoid double counting of traffic emissions. The study area is located over 3 grid squares. From the background concentration the grid square most central to the study are, at the automatic monitoring station was used to represent the study area (260500, 670500).

Table 4:Bishopbriggs Study Area background NO_x and PM_{10} 2015 ($\mu g.m^{-3}$)

X	Y	Total background	Total minus A Roads (NOx only)	Total minus A Roads and Break and Tyre Wear (PM_{10} only)
		NO_x		
260500	669500	28.7	26.9	-
261500	670500	24.9	23.6	-
260500	670500	22	21.6	-
		PM_{10}		
260500	669500	13.1	-	12.8
261500	670500	12.6	-	12.4

[3] Scottish Air Quality http://www.scottishairquality.co.uk/data/mapping?view=data

260500	670500	12.1	-	12.0

4 Monitoring Data

4.1 NO_2

East Dunbartonshire Council currently measures NO_2 concentrations within the study area at 8 roadside diffusion tube locations (Figure 4) and one automatic site (Figure 5) which measures both NO_2 and PM_{10} concentrations.

East Dunbartonshire operates 1 automatic monitoring site within the current AQMA boundary. The Bishopbriggs air quality site measures NO_2 concentrations using Horiba 360 chemiluminescence sampling equipment situated on Crowhill Road off the A803.

Details of the NO_2 diffusion tube and automatic monitoring sites as well as the annual mean NO_2 concentrations measured between 2011 and 2015 are presented in Table 5. In 2015 all diffusion tube sites and automatic monitoring station measured annual mean concentrations less than 40 $\mu g.m^{-3}$.

Over the past 3 years' concentrations measured within the Bishopbriggs AQMA have declined at most passive diffusion tube monitoring locations compared to 2012 measured concentrations. The automatic monitoring site located on Crowhill Road has seen a continued decrease in the NO_2 annual mean measured since 2013. The highest measuring diffusion tube within the study area in 2015 measured 36 $\mu g.m^{-3}$, however this location (Bishopbriggs 13) is a roadside location where no receptors are present, the nearest sensitive receptor is present at the diffusion tube location Bishopbriggs 17, against the façade of the building. Bishopbriggs 17 measured 27.1 $\mu g.m^{-3}$ in 2015.

Table 5: NO_2 Monitoring Data 2012 to 2015

Site	Type	Easting	Northing	Data Capture % 2015	2012 (Bias Adjustment Factor =0.95)	2013 (Bias Adjustment Factor =0.98)	2014 (Bias Adjustment Factor =0.9)	2015 (Bias Adjustment Factor =1.02)
Diffusion Tubes								
Bishopbriggs 5	UB	260948	669610	75	15.8	14.2	11.3	14.4
Bishopbriggs 6	R	261016	670198	100	30.5	28.3	25	28.1
Bishopbriggs 12	R	260581	669527	83	37.3	30.7	29	27.9
Bishopbriggs 13	R	260549	669312	100	43.2	40.5	30.5	36
Bishopbriggs 14- Tubes (A,B,C- Average)	R	260995	670130	83 (lowest)	**29.4**	**28.3**	**25.6**	**30**
Bishopbriggs 16	R	260580	669533	100	30	29.0	27.7	25
Bishopbriggs 17	R	260552	669320	100	35.6	35.5	32.3	27.1
Bishopbriggs 18	UB	260604	670337	100	16.1	20.4	16.9	19.1
Bishopbriggs 19	R	261280	670431	83	-	-	17.9*	18.3
Bishopbriggs 20	R	261285	670451	100	-	-	21.6*	19

Automatic Monitoring								
Bishopbriggs 14	R	260995	670130	99.5	30	32	29	27

*This concentration has been annualised following the TG(09) method.

Bold- This concentration is the mean of triplicate tubes located at monitoring site

R – Roadside, within 5m of the road.
UB – Urban background, representative of city-wide background conditions.
K – Kerbside, within 1m of the kerbside of a busy road.

4.2 PM_{10}

East Dunbartonshire measures PM_{10} concentrations using Eberline Beta-attenuation measuring equipment within Bishopbriggs at one automatic site.

Since 2013, data capture has been low with a data capture of 23% in 2015. 2014 had an annual mean concentration of 16.8 µg.m^{-3}, which is below the Scottish annual mean objective of 18µg.m^{-3}. Further monitoring of PM_{10} should continue in order to confirm if PM_{10} concentrations are below the annual mean objective due to the poor data capture over the past 3 years.

For PM_{10} due to the low level of data capture for 2015 (23%) the annual mean concentration wasn't available. The 2015 annual mean was calculated for indicative purposes only with the low data capture.

In light of the low data capture for 2015, the 2016 period mean was calculated from the available data and annualised against the 2015 dataset for comparison to ensure that the verification factor derived for the 2015 dataset was robust. The results indicated a higher annual mean concentration being calculated for 2015. The 2015 annual mean concentration calculated was used for PM_{10} verification as representing the worst case scenario, resulting in a higher verification factor for PM_{10} across the study area.

Monitoring data for the past 3 years are presented in Table 6. The location of the sites measuring PM_{10} are presented in Figure 5.

Table 6: PM_{10} Monitoring Data 2012 to 2015

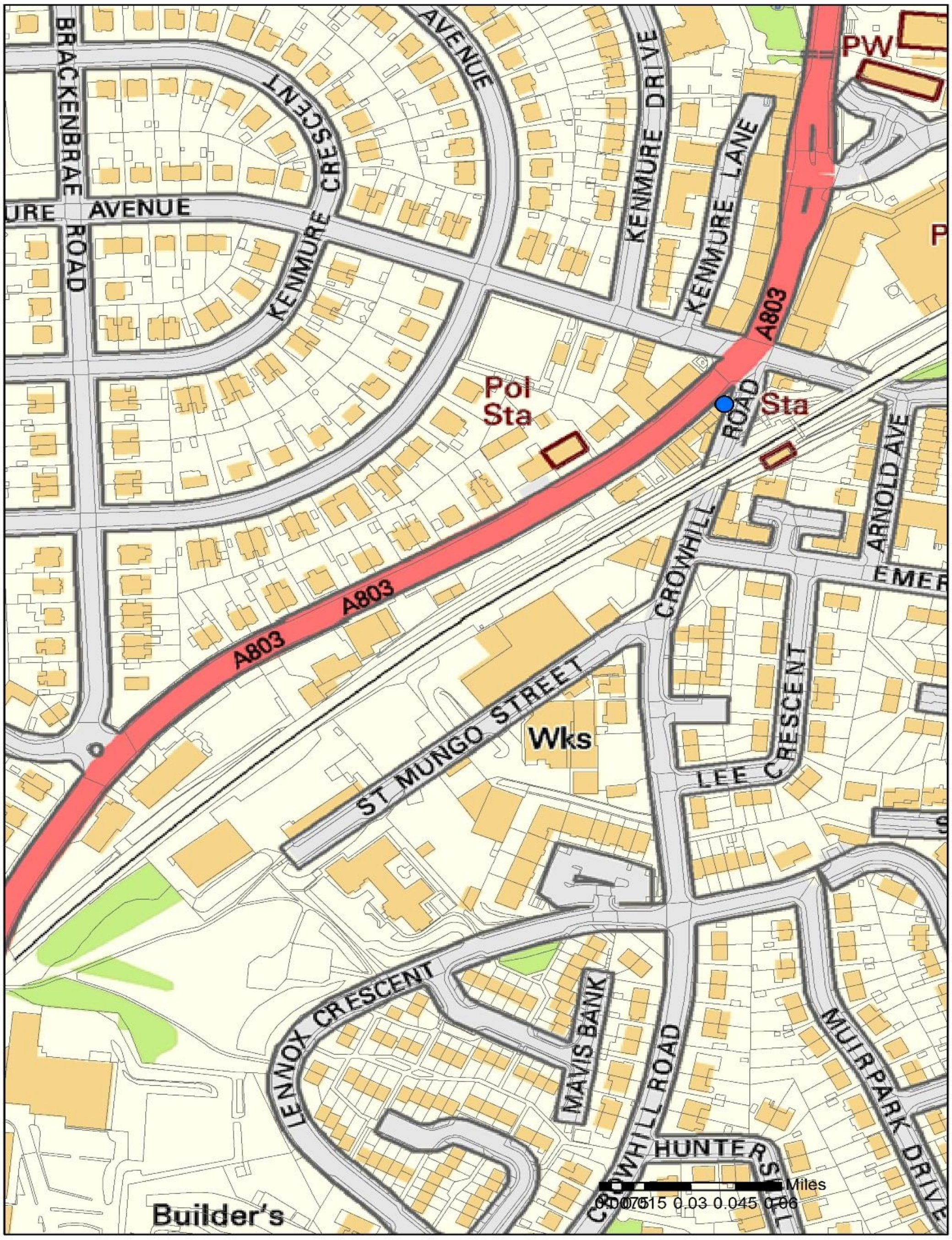
Site	Type	X	Y	Data Capture 2015 %	2012	2013	2014	2015
Bishopbriggs	R	260995	670130	23	15	n/a	16.8	13.8*

*Calculated for the purpose of the study only- for use in verification

Figure 4 Bishopbriggs Non-Automatic Monitoring Site Locations

N	**Legend** Non-automatic monitoring sites	RICARDO Ricardo Energy & Environment **Reproduced from Ordnance Survey material with permission of Her Majesty's Stationery Office © Crown Copyright and database right 2015. All rights reserved. Ordnance Survey License number LA100020774**

Figure 5 Automatic Monitoring Locations



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● Automatic monitoring site

5 Modelling methodology

Annual mean concentrations of NO_2 and PM_{10} during 2015 have been modelled within the study area using the atmospheric dispersion model ADMS Roads (version 4.1).

The model has been verified by comparing the modelled predictions of road NOx and road PM_{10} with available local monitoring results for NOx and PM_{10}. A verification factor is calculated using the difference between the modelled results and the measured results. The available roadside monitoring sites measurements within the study area (described in Section 4 above) were used to verify the annual mean road NOx model predictions. For site 14, where automatic monitoring was undertaken as well as triplicate diffusion tube monitoring, the automatic monitoring results have been used to verify the modelling results.

Following initial comparison of the modelled concentrations with the available monitoring data, refinements were made to the model input to achieve the best possible agreement with the monitoring sites measurements. Further information on model verification is provided in Section 6.1 and Appendix 3.

A surface roughness of 1 m was used in the modelling to represent the urban conditions in the model domain. A limit for the Monin-Obukhov of 10 m was applied to represent a small town.

The source-oriented grid option was used in ADMS-Roads, this option provides finer resolution of predicted pollutant concentrations in close proximity to the roadside, with a wider grid being used to represent concentrations further away from the road. The resolution is dependent upon the total size of the domain being modelled. The predicted concentrations were interpolated to derive values between the grid points using the Spatial Analyst tool in GIS software ArcMap 10.2. This allows contours showing the predicted spatial variation of pollutant concentrations across the modelling study domain.

Queuing traffic was considered using the methodology described in Section 3.2.2 above. It should be noted that any dispersion modelling study has a degree of uncertainty associated with it; all reasonable steps have been taken to reduce this where possible.

5.1.1 Treatment of modelled NOx road contribution

It is necessary to convert the modelled NOx concentrations to NO_2 for comparison with the relevant objectives.

The Defra NOx/NO_2 model[4] was used to calculate NO_2 concentrations from the NOx concentrations predicted by ADMS-Roads. The model requires input of the background NOx, the modelled road contribution and accounts for the proportion of NOx released as primary NO_2.

5.1.2 Validation of ADMS-Roads

Validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications; this is usually conducted by the model developer.

CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets, participating in EU workshops on short range dispersion models, comparing data between UK M4 and M25 motorway field monitoring data, carrying out inter-comparison studies alongside other modelling solutions such as DMRB and CALINE4, and carrying out comparison studies with monitoring data collected in cities throughout the UK using the extensive number of studies carried out on behalf of local authorities and Defra.

[4] Defra (2016) NOx NO_2 Calculator v5.1 released June 2016; Available at http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

6 Model Results

6.1 Verification of the Model

The modelling results were compared to the local monitoring data results at roadside locations along the A803. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in agreement with the monitoring results. LAQM.TG (16) recommends making the adjustment to the road contribution of the pollutant only and not the background concentrations these are combined with.

6.1.1 NO_2

The modelled NOx concentrations in this study were verified using the available 2015 roadside diffusion tube locations and the automatic monitoring site within Bishopbriggs. Urban background sites were not appropriate for model verification as traffic data for the study was only available for the A803.

Following initial refinements to the model input parameters, the modelled road contributions required adjustment by 1.1598 on average. The model adjustment calculated allowed concentrations modelled to be in line with the measurement results obtained. This factor was applied to all Road NOx concentrations predicted by the model; the adjusted total NO_2 concentrations were then calculated using the Defra NOx/NO_2 calculator[5].

Comparison of the measured concentrations against the modelled concentrations following adjustment are presented in Table 7 and Figure 6. Full model verification data is provided in Appendix 3.

Model uncertainty can be estimated by calculating the root mean square error (RMSE). In this case the calculated RMSE was 1.57 µg.m^{-3} after adjustment which is within the suggested value (10% of the objective being assessed) in LAQM.TG (16). The model has therefore been assessed to perform sufficiently well for use within this assessment.

Verifying modelling data with diffusion tube data will always be subject to uncertainty due to the inherent limitations in such monitoring data (even data from continuous analysers has notable uncertainty). The model results should be considered in this context.

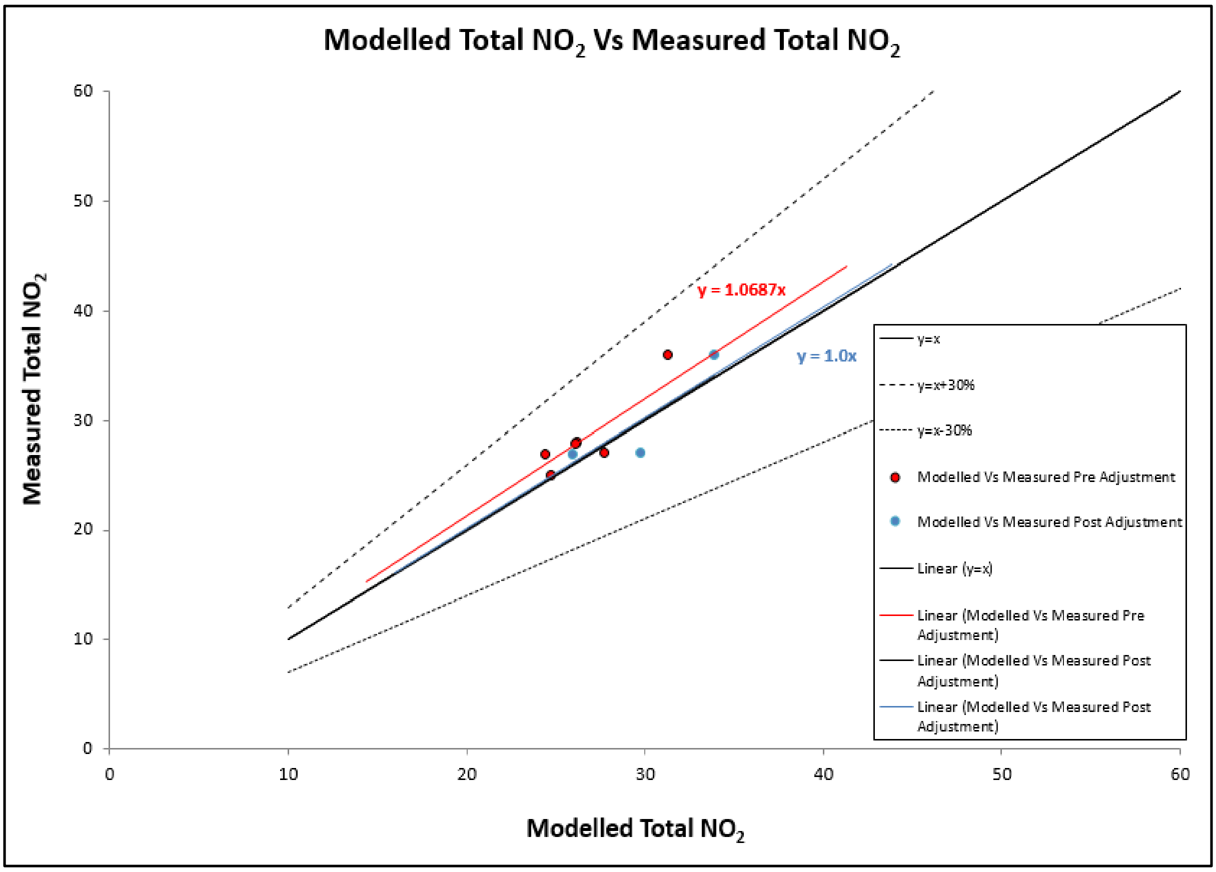
It was noted that following the model verification the concentration modelled at Bishopbriggs 13 was under predicting. This site is subject to monitoring at two locations within close proximity where the concentrations are measured at the roadside and at the façade of the building, in line of each other.

Table 7:Modelled vs. measured annual mean NO_2 concentrations 2015

Site	Measured (µg.m^{-3})	Modelled (µg.m^{-3})
Bishopbriggs 13	35.99	33.8
Bishopbriggs 17	27.08	29.7
Bishopbriggs 14-Automatic site	27	26.0
Bishopbriggs 6	28.11	28.1
Bishopbriggs 12	27.93	28.0
Bishopbriggs 16	24.96	26.4
	RMSE	**1.57**

[5] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOXNO2calc

Figure 6:Linear Regression plot of post modelled vs. monitored NO_2 annual mean 2015

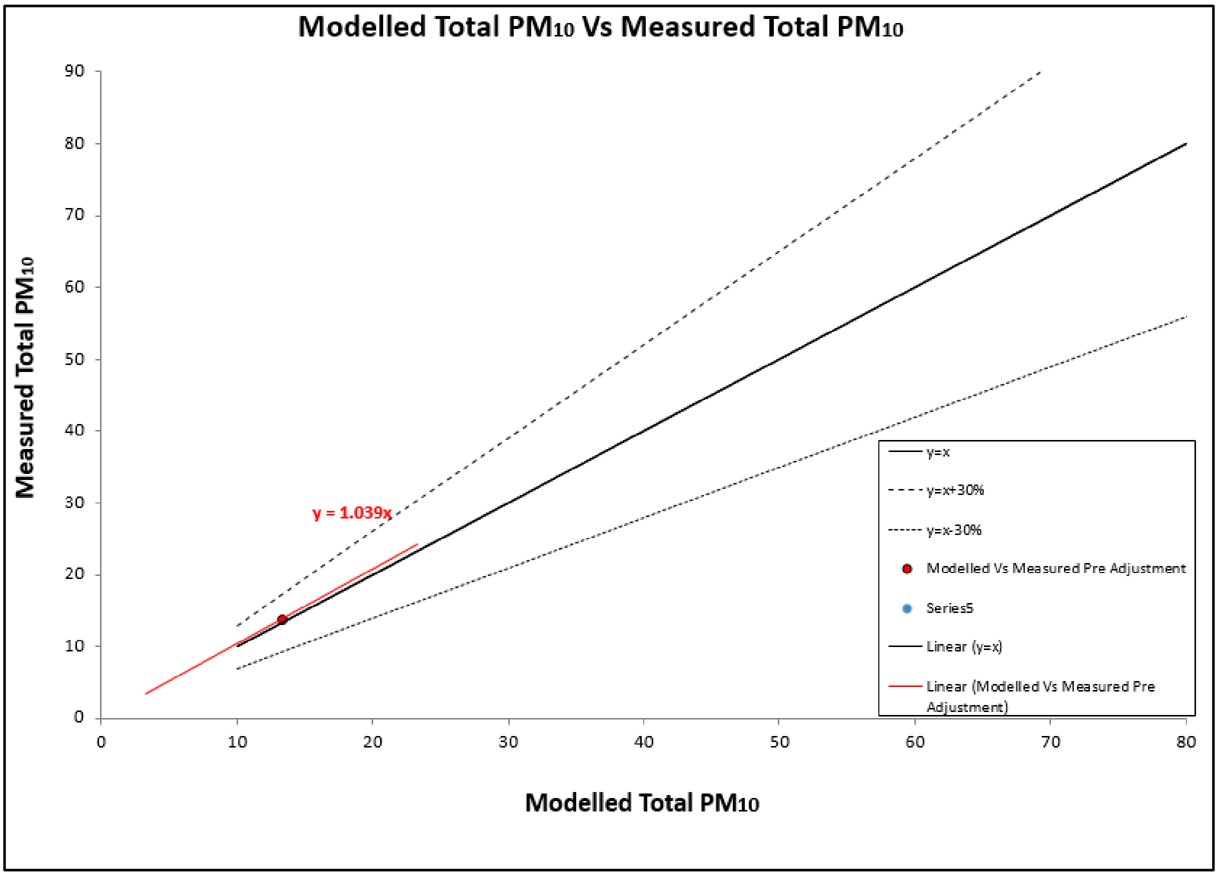


6.1.2 PM_{10}

The modelled PM_{10} concentrations in this study were verified against the calculated 2015 automatic site measurements from the Bishopbriggs automatic site. The PM_{10} model verification was derived from the background PM_{10} concentrations and the calculated Road PM_{10} against the measured PM_{10} concentration. An adjustment factor of 1.39 was calculated and applied to all modelled road PM_{10} concentrations before adding the background concentration.

During 2015 the Bishopbriggs automatic site only obtained a 23% data capture for PM_{10}. In light of this the annual mean for 2015 was calculated for indicative purpose only. In addition, the annual mean for 2016 was calculated from the available January 2016 to July 2016 data. From this the 2015 annual mean was calculated as 13.8 $\mu g.m^{-3}$. The 2016 annualised data calculated an annual mean concentration of 13.6 $\mu g.m^{-3}$. For the purpose of the assessment, despite the low data capture the measured concentration of 13.8 $\mu g.m^{-3}$ for 2015 was used for this study as representing the worst case scenario to ensure results are conservative. Further details on Model Verification are available in Appendix 3. The modelled vs. measured PM_{10} concentration following the adjustment of the initial modelling results by a factor of 1.39, is presented in Figure 7.

Figure 7: Linear regression plot of post modelled vs. monitored PM_{10} annual mean 2015



6.2 Adjusted Modelling Results

The adjusted predicted annual mean NO_2 and PM_{10} concentrations at each specified receptors are presented in Table 8 and Table 9 respectively. The results presented indicate there are no exceedances of the AQS annual Mean objective for both NO_2 and PM_{10} at locations with relevant exposure.

6.2.1 NO_2

The predicted NO_2 annual mean concentrations at the receptors outlined in Table 8 are less than the 40 µg.m^{-3} objective. This result should however be considered in context with the estimated model uncertainty (RMSE as described in Section 5.1.3) which was 1.57 µg.m^{-3}.

Table 8: Predicted annual mean NO_2 concentrations at specified receptors 2015

Receptor	Address	NO_2 annual mean (µg.m^{-3})	Height Modelled
Bishopbriggs 17*	1495 Springburn Road	29.7	2.8
Bishoprbriggs 14 Auto	128 Kirkintilloch Road/Crowhill Road	26.0	1.8
Bishopbriggs 6*	145 Kirkintilloch Road	28.1	2.8
Bishopbriggs 16*	24 Kirkintilloch Road	26.4	2.8
Receptor 1- 1495 Springburn Road	1495 Springburn Road (Building Façade)- Detached House	33.9	1.5

Receptor	Address	NO_2 annual mean ($\mu g.m^{-3}$)	Height Modelled
Receptor 2 - 145 Kirkintilloch Road	145 Kirkintilloch Road-1st floor flat	23.3	4
Receptor 3 - 24 Kirkintilloch Road	24 Kirkintilloch Road - Ground floor flat	29.7	1.5
Receptor 4- 106 Colston Road	106 Colston Road- Detached Property	34.7	1.5
Receptor 5- 89 Kirkintilloch Rd	89 Kirkintilloch Rd -Semi Detached Property	33.0	1.5
Receptor 6- 87 Kirkintilloch Rd	87 Kirkintilloch Rd – Semi Detached Property	32.7	1.5
Receptor 7- 121 Kirkintilloch Rd	121 Kirkintilloch Rd— Ground floor property	25.1	1.5
Receptor 8 -141 Kirkintilloch Rd	141 Kirkintilloch Rd- 1st Floor flat	23.4	4
Receptor 9- 239 Kirkintilloch Road	239 Kirkintilloch Road- Detached Property	23.7	1.5
Receptor 10- 1 Cadder Road	1 Cadder Road-Detached Property	23.5	1.5

***Included for model verification purposes only, representing diffusion tube locations, rather than sensitive receptor locations.**

6.2.2 PM_{10}

The predicted PM_{10} concentrations outlined in Table 9 below were all below the Annual mean objective for PM_{10} of 18$\mu g.m^{-3}$.

Table 9:Predicted annual mean PM_{10} concentrations at specified receptors 2015

Receptor	Address	PM_{10} annual mean ($\mu g.m^{-3}$)	Height Modelled
Bishoprbriggs 14 Auto	128 Kirkintilloch Road/Crowhill Road	13.8	1.8
Receptor 1- 1495 Springburn Road	1495 Springburn Road (Building Façade)- Detached House	15.4	1.5
Receptor 2 - 145 Kirkintilloch Road	145 Kirkintilloch Road-1st floor flat	13.5	4
Receptor 3 - 24 Kirkintilloch Road	24 Kirkintilloch Road - Ground floor flat	14.8	1.5
Receptor 4- 106 Colston Road	106 Colston Road- Detached Property	15.5	1.5
Receptor 5- 89 Kirkintilloch Rd	89 Kirkintilloch Rd -Semi Detached Property	14.7	1.5

Receptor	Address	PM_{10} annual mean ($\mu g.m^{-3}$)	Height Modelled
Receptor 6- 87 Kirkintilloch Rd	87 Kirkintilloch Rd – Semi Detached Property	14.6	1.5
Receptor 7- 121 Kirkintilloch Rd	121 Kirkintilloch Rd— Ground floor property	14.0	1.5
Receptor 8 -141 Kirkintilloch Rd	141 Kirkintilloch Rd- 1st Floor flat	13.5	4
Receptor 9- 239 Kirkintilloch Road	239 Kirkintilloch Road- Detached Property	13.7	1.5
Receptor 10- 1 Cadder Road	1 Cadder Road-Detached Property	13.8	1.5

6.2.3 Modelling Results - Contour Plots

The gridded point values for annual mean concentrations have been interpolated to produce contour plots showing the spatial variation of predicted concentration across the Bishopbriggs study area. Each grid has been modelled at heights of 1.5m and 4m to represent human exposure at ground and first floor levels.

6.2.3.1 NO_2

Contour plots showing the spatial variation of the predicted 2015 annual mean NO_2 concentrations across the study area at ground floor level are presented in

Figure **8** and Figure 9. The NO_2 annual mean contour plots indicate that the 40 µg.m^{-3} objective is being met at all locations where there is relevant human exposure. The contour plot highlights annual mean NO_2 concentration in excess of 40 ug m^{-3} at 1.5m height close to the road centre lines of the A803, Residential properties within Bishopbriggs generally have relevant exposure at 1.5m (ground level) with some properties above commercial units where relevant exposure is present at 4m.

6.2.3.2 PM_{10}

Contour plots showing the spatial variation of the predicted 2015 annual mean PM_{10} concentrations across the study area at ground level are presented in Figure 10 and Figure 11. The PM_{10} annual mean contour plots indicate that the 18 µg.m^{-3} objective is being met at all locations with relevant human exposure. The contour plot highlights PM_{10} exceedance at 1.5m close to the road centre lines of the A803. Residential properties within Bishopbriggs generally have relevant exposure at 1.5m (ground level) with some properties above commercial units where relevant exposure is present at 4m.

Figure 8: Modelled NO_2 annual mean concentrations 2015 at 1.5m height – North

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- 13.9 - 20
- 20.01 - 30
- 30.01 - 38
- 38.01 - 40
- 40.01 - 45
- 45.01 - 54.26

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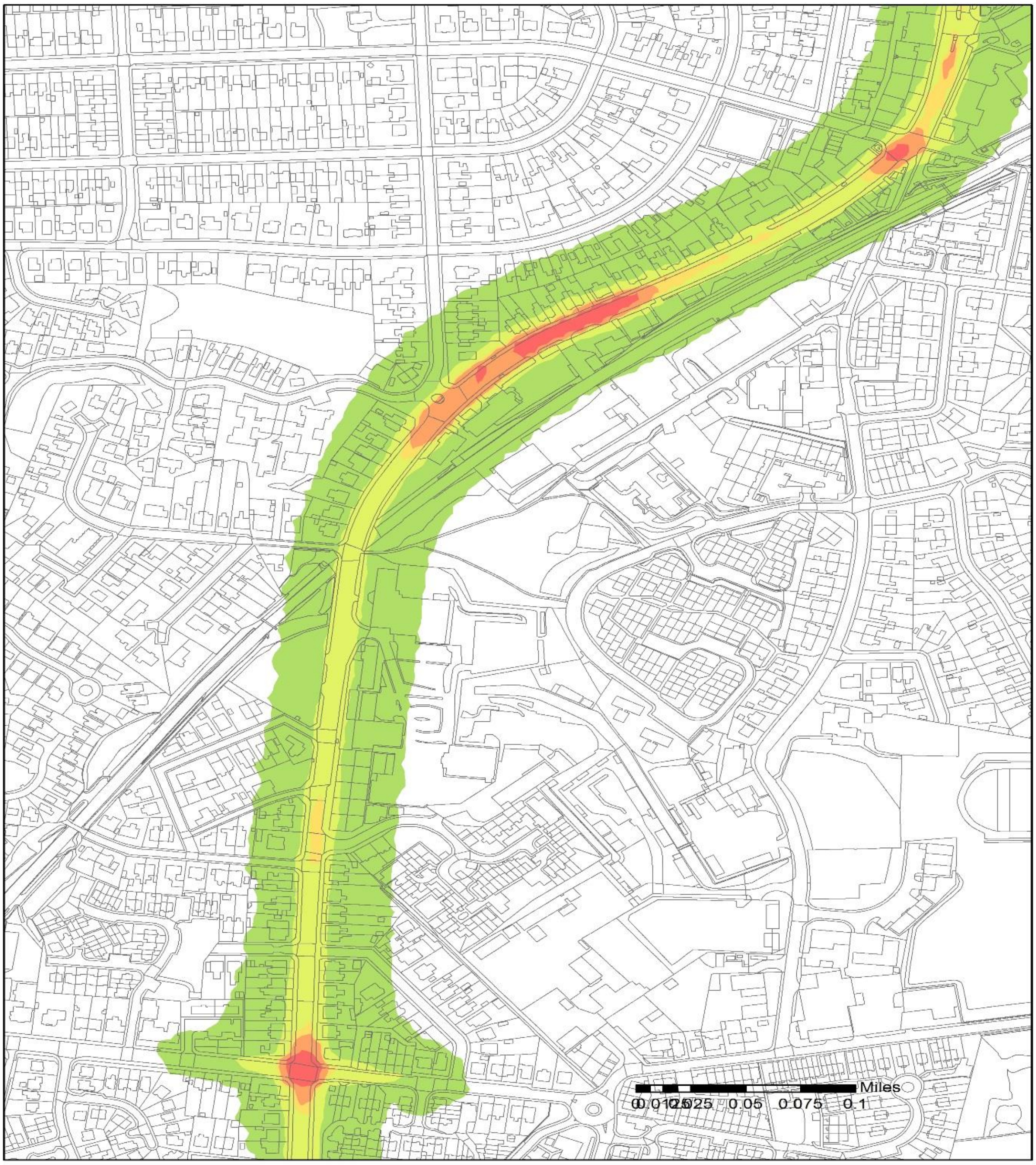
Figure 9: Modelled NO_2 annual mean concentrations 2015 at 1.5m height –South



Legend:
NO_2 annual mean concentration (µg.m^{-3})

- 13.9 - 20
- 20.01 - 30
- 30.01 - 38
- 38.01 - 40
- 40.01 - 45
- 45.01 - 54.26

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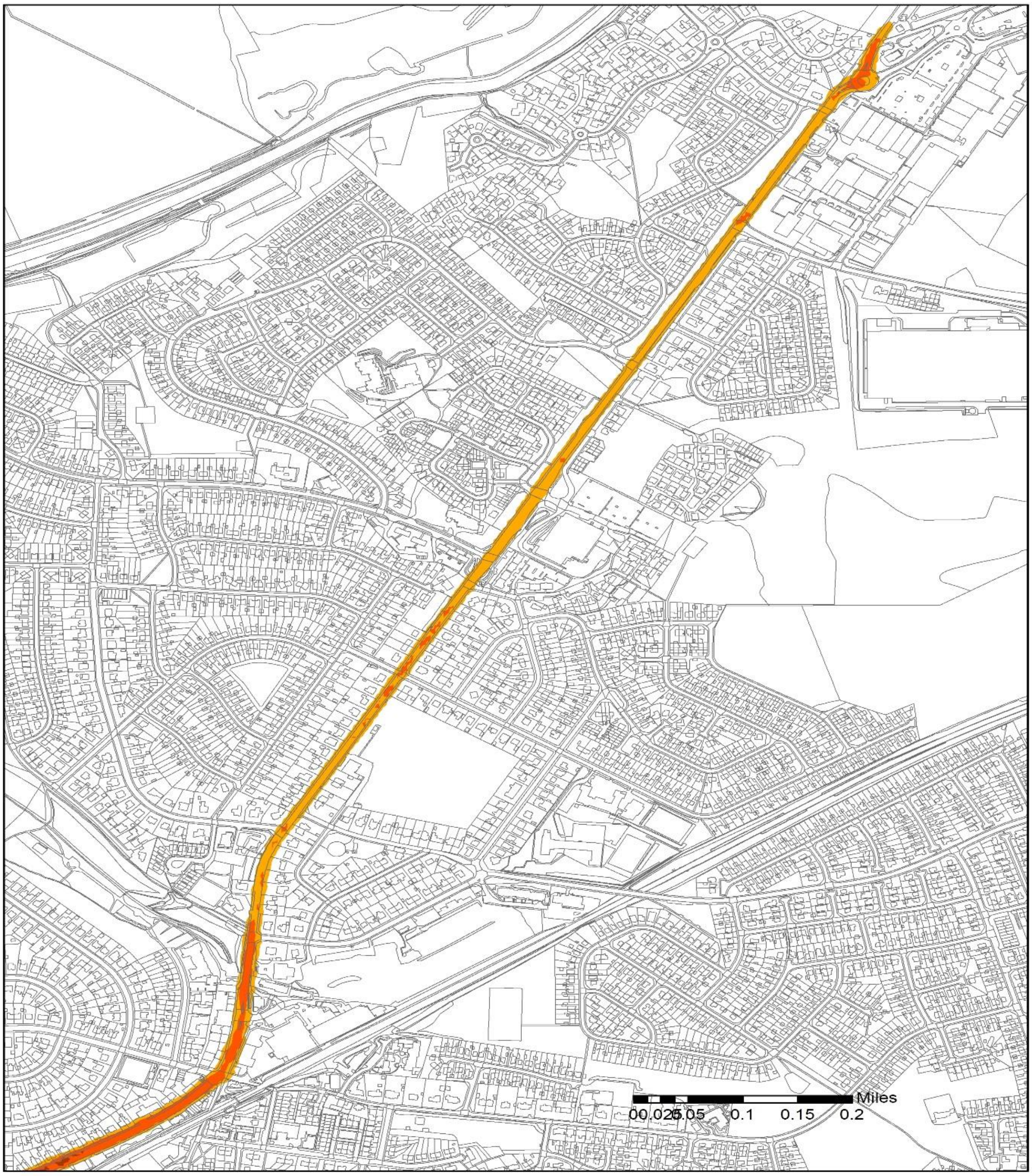
Figure 10: Modelled PM_{10} annual mean concentrations 2015 at 1.5m height – North



N

Legend:

PM_{10} annual mean concentration (µg.m^{-3})

- 12.1 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17
- 17.01 - 18
- 18.01 - 19.22

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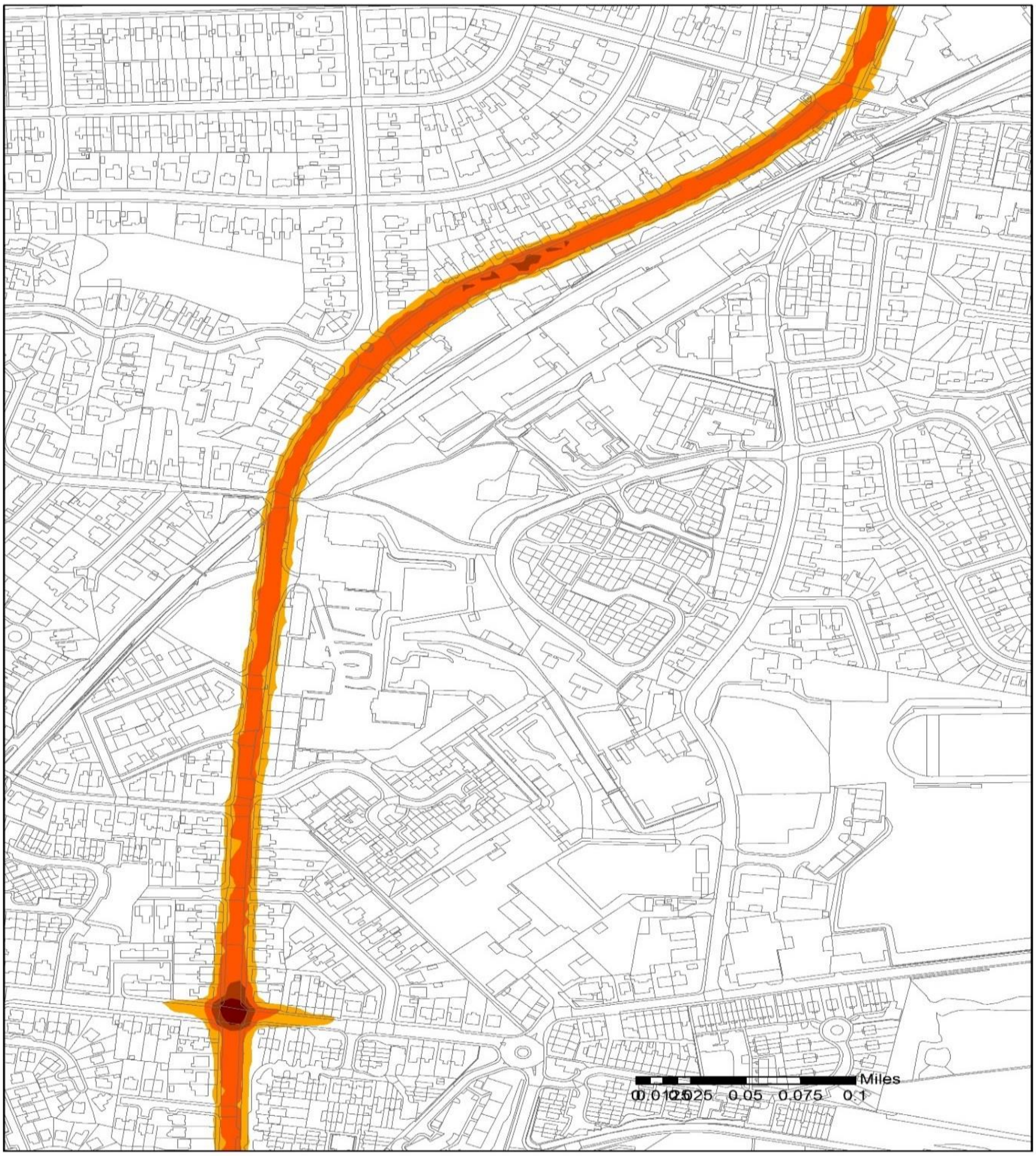
Figure 11:Modelled PM_{10} annual mean concentrations 2015 at 1.5m height – South



Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- 12.1 - 14
- 14.01 - 15
- 15.01 - 16
- 16.01 - 17
- 17.01 - 18
- 18.01 - 19.22

7 Summary and Conclusions

This detailed assessment outlines a dispersion modelling study of road traffic emissions along the A803 in Bishopbriggs, East Dunbartonshire. The study has assessed NO_2 and PM_{10} concentrations within the study area.

The study has been conducted using available diffusion tube data measured during 2015 at a variety of locations within the study area. The study also used available automatic monitoring data for NO_2 and PM_{10} from the Bishopbriggs automatic monitoring site. ADMS-Roads has been used to conduct the study. The study utilises the latest available traffic data supplied by East Dunbartonshire Council and meteorological data from Glasgow Bishopton for 2015.

The modelling study has indicated the following:

- NO_2 concentrations in excess of the 40 $\mu g.m^{-3}$ annual mean objective did not occur at ground level locations with relevant exposure during 2015.
- There are no exceedances of the PM_{10} annual mean objective of 18 $\mu g.m^{-3}$ in 2015 at ground floor height, where relevant exposure is present.

In light of the results from the Detailed Assessment of Air Quality in Bishopbriggs, East Dunbartonshire Council can consider revoking the existing AQMA for NO_2 and PM_{10} exceedances within the area along the A803. As a result of the assessment it is advised that East Dunbartonshire Council carry out additional monitoring near to the junction of Colston Road with the A803 on the Eastern side as current monitoring is carried out on the Westerly side. In light of the poor data capture for PM_{10} at the Bishopbriggs automatic site, East Dunbartonshire should continue to monitor and review the available PM_{10} data. This would give East Dunbartonshire further support to consider revoking their current AQMA in the near future.

Appendices

Appendix 1 – Traffic Data

Table A1.1 summarises the Annual Average Daily Flows (AADF) of traffic on fleet compositions used within the model for each road link.

Traffic data for Bishopbriggs was available from a local survey commissioned by East Dunbartonshire Council. The traffic surveys conducted in July 2016 provided information on daily average flow and a LDV/HDV fleet split.

The locally collected traffic count data was compared to the national Dft count point data available for Bishopbriggs, this data is presented in Table A1.2

Table A1.1 Bishopbriggs 2015 – Local Authority Annual Average Daily Flows – Roads modelled

Street	ATC	LDV	HGV (Rigid)	HGV (Artic)	Bus	HDV	HDV %	AADF 2015
A803 Kirkintilloch Road (n)	1	13391	784	57	240	1081	7.5	14472
A803 Kirkintilloch Road (s)	2	15361	990	73	187	1250	7.5	16611

LGV – Light Goods Vehicles

HGV – Heavy Goods Vehicles (split in Rigid and Articulated)

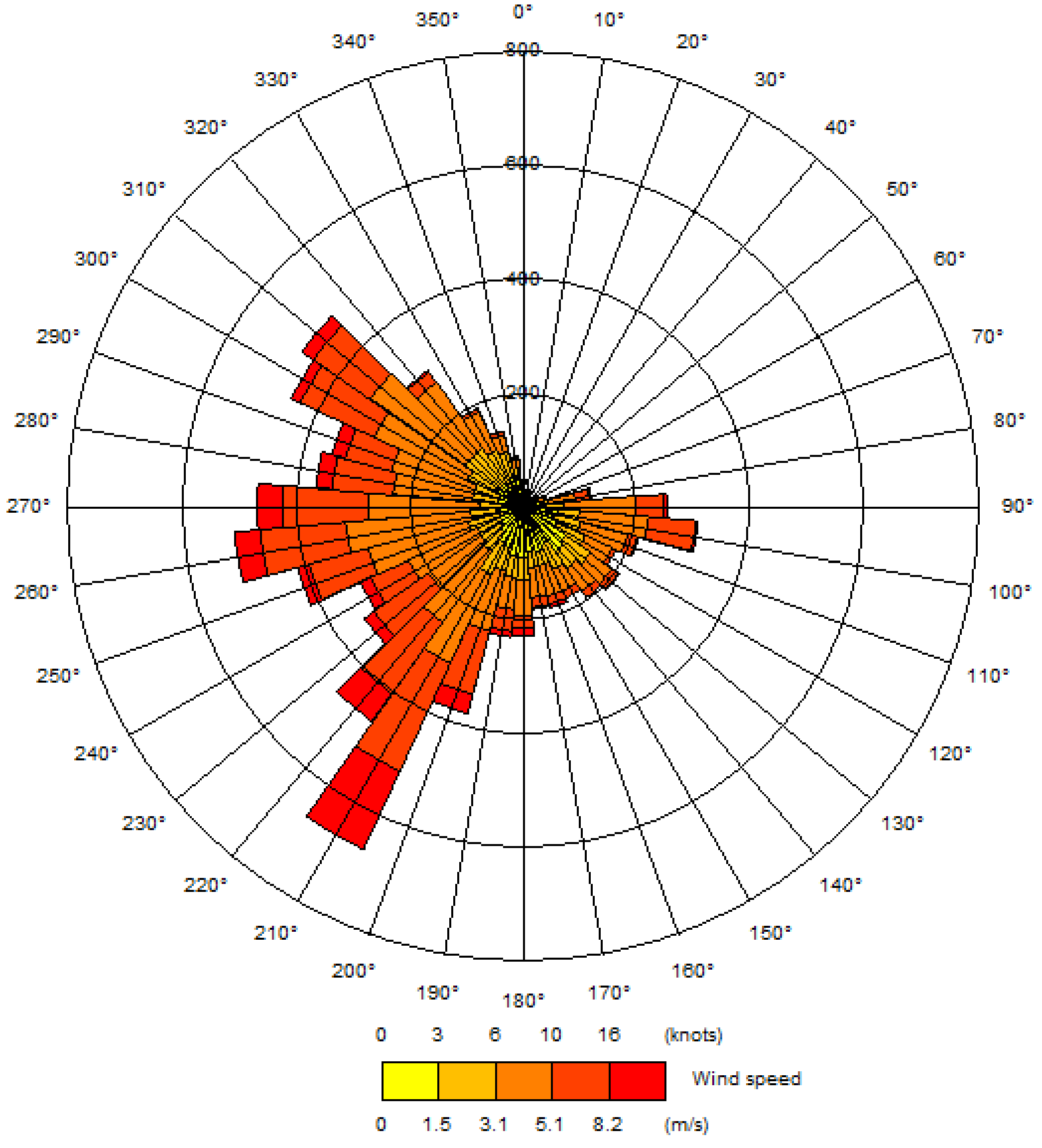
A1.2 DFT Count point counts- Annual Average Daily Flows 2015- Roads modelled

Street	CP	Cars	LGV	HGV (Rigid)	HGV (Artic)	Bus	Motorcycle	AADF 2015
A803	10917	13127	1432	322	56	259	36	15230
A803	78668	11945	1303	292	51	235	33	13859

Appendix 2 – Meteorological dataset

The wind rose for the Glasgow Bishopton meteorological measurement site for 2015 is presented in Figure A2.1.

Figure A2.1: Meteorological dataset wind rose



Appendix 3 – Model Verification

Verification of the model involves comparison of the modelled results with available local monitoring data. This identifies how the model is performing at the various monitoring locations. The verification process involves checking and refining the model input data to try and reduce uncertainties in the model and produce model outputs that are in better agreement with the monitoring results. This can be followed by adjustment of the modelled results if required. LAQM.TG(16) recommends making the adjustment to the road contribution only and not the background concentration these are combined with.

As stated in Section 6.1 above, the model was verified using annual mean NO_2 measurements from the various NO_2 diffusion tube sites and one automatic monitoring site within the study area in Bishopbriggs. It is appropriate to verify the ADMS Roads model in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2). The model has been run to predict annual mean Road NOx concentrations during 2015 calendar year at the monitoring sites. The model output of Road NOx (the total NOx originated from road traffic) has been compared with the measured Road NOx, where the measured Road NOx contribution is calculated as the difference between the total NOx and the background NOx value. Total measured NOx for each monitoring site was calculated from the measured NO_2 concentration using the latest version of the Defra NOx/NO_2 calculator.

The initial comparison of the modelled vs measured Road NOx identified that the model was underpredicting the Road NOx contribution. Subsequently, some refinements were made to the model input to improve the overall model performance.

The gradient of the best fit line for the modelled NOx contribution vs. measured Road NOx contribution was determined using linear regression and used as the adjustment factor. This factor was then applied to the modelled Road NOx concentration for each modelled point to provide adjusted modelled Road NOx concentrations. A linear regression plot comparing modelled and monitored Road NOx concentrations before and after adjustment is presented in Figure A3.1.

A primary adjustment factor (PAdj) of 1.1598, based on model verification using 2015 monitoring results was applied to all modelled Road NOx data prior to calculating the NO_2 annual mean. A plot comparing modelled and monitored NO_2 concentrations before and after adjustment is presented in Figure A3.2.

Model uncertainty can be estimated by calculating the root mean square error (RMSE). In this case the calculated RMSE was 1.57 $\mu g.m^{-3}$ after adjustment which is within the suggested value (10% of the objective being assessed) in LAQM.TG (16). The model has therefore performed sufficiently well for use within this assessment.

The comparison of the modelled vs measured PM_{10} identified that the model was under-predicting the road PM_{10} contribution by a factor of 1.37. This factor was applied to all model road PM_{10} concentrations before adding the background concentration to predict the annual mean PM_{10} concentrations.

Figure A3.1: Comparison of modelled Road NOx vs. Measured Road NOx

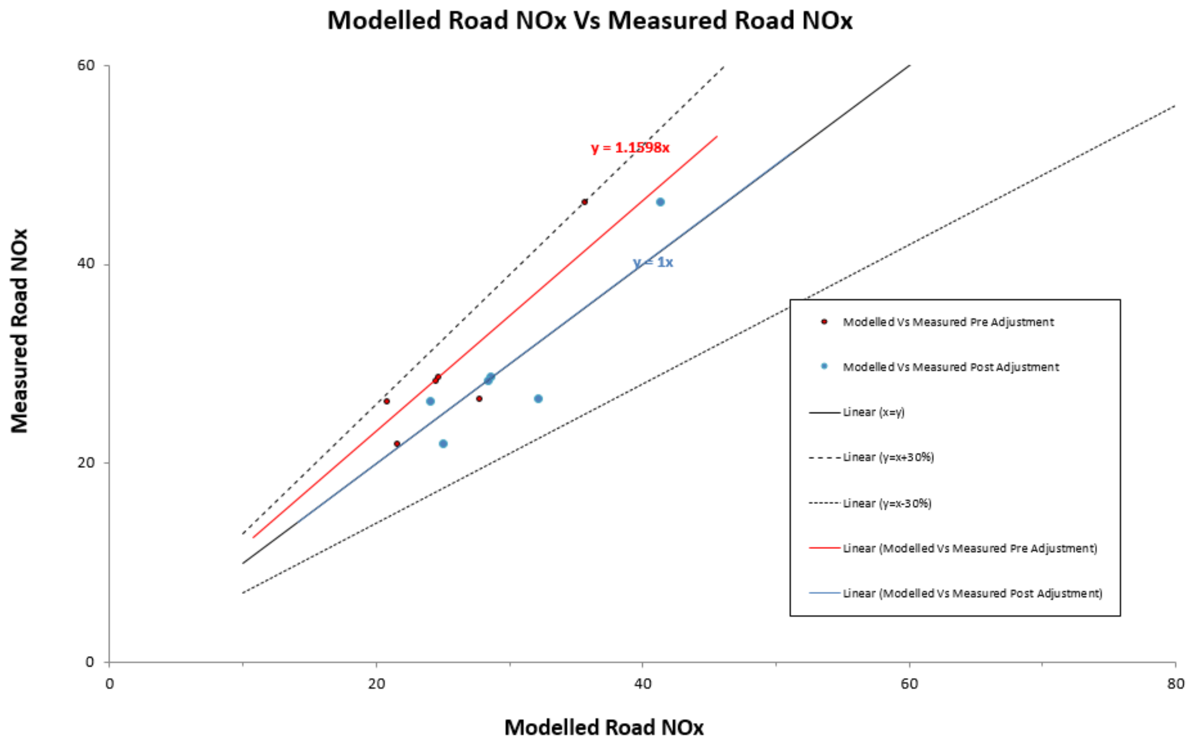
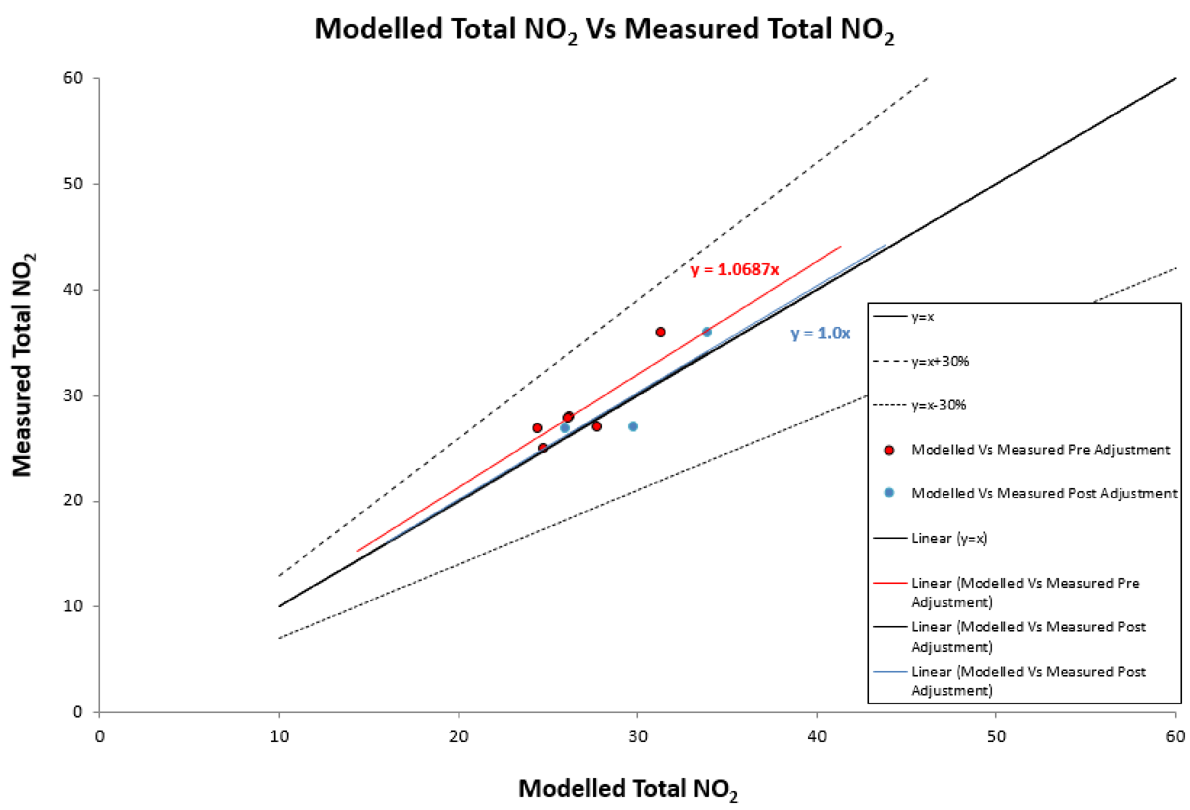


Figure A3.2: Comparison of modelled vs. monitored NO_2 annual mean 2015



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