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Updated Detailed Assessment of Air Quality - Kirkintilloch

Report for East Dunbartonshire Council

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Updated Detailed Assessment of Air Quality - Kirkintilloch

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Executive Summary

This Updated Detailed Assessment outlines a dispersion modelling study of road traffic emissions at the busy junction of Industry Street/Townhead, Kirkintilloch, East Dunbartonshire. The study assessed NO_2 and PM_{10} annual mean concentrations within the study area of Kirkintilloch.

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 Kirkintilloch 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 2015.

The modelling study has indicated that there are no exceedances of the NO_2 and PM_{10} annual mean objectives at any location with relevant exposure during 2015.

The 2013 Detailed Assessment of Air Quality in Kirkintilloch concluded that the Council should declare an AQMA for NO_2 and PM_{10} annual mean exceedances in Kirkintilloch. However, the measured NO_2 and PM_{10} concentrations have been below their respective objectives in Kirkintilloch over the past few years. As a result of the measured data; and the findings of this updated Detailed Assessment therefore, there is no need for East Dunbartonshire Council to declare an AQMA in Kirkintilloch.

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1 Introduction

Ricardo Energy & Environment were commissioned by East Dunbartonshire Council to undertake an Updated Detailed Assessment of Air Quality in Kirkintilloch. The conclusion of the 2013 Detailed Assessment recommended that an AQMA be declared in Kirkintilloch however, annual mean NO_2 and PM_{10} concentrations have declined over the past few years. This assessment has therefore been undertaken to assess whether the declaration of an AQMA in Kirkintilloch is still required.

The study area consists of a busy network of roads including:

- Lenzie Road;
- Kirkintilloch Link Road;
- New Lairdsland Road;
- B8048 (Waterside Road); and
- Industry Street.

The main air quality issues arise from the volume of traffic travelling on this road network and its slow movement through the town centre traffic light system.

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 Further 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(09).

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	200 $\mu g.m^{-3}$ not to be exceeded more than 18 times a year	1 hour mean
	40 $\mu g.m^{-3}$	Annual mean
Particles (PM_{10}) (gravimetric) Authorities in Scotland	50 $\mu g.m^{-3}$ not to be exceeded more than 7 times a year	24 hour mean
	18 $\mu g.m^{-3}$	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 the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. 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 and PM_{10} 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
24-hr mean	PM_{10}	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties (should represent parts of the garden where relevant public exposure is likely, local judgement should be applied)	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	NO_2	All locations where the annual mean and 24 and 8 hour mean objectives apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks and railway stations etc. which are not fully enclosed. Any outdoor locations to which the public might reasonably be expected to have access.	Kerbside sites where the public would not be expected to have regular access.

1.3 Purpose of the Detailed Assessment

This study is an updated 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 the study area. The study aims to determine whether the recommendation to proceed to the declaration of an AQMA in Kirkintilloch as stated in the 2013 Detailed Assessment, is still valid.

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 for use in a dispersion modelling study.
- 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 showing the expected spatial variation in annual mean NO_2 concentrations.
- Recommend if East Dunbartonshire Council should declare an AQMA at any location within the study area in Kirkintilloch and suggest its spatial extent.

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

1.5 Previous Review and Assessment

1.5.1 2013 Detailed Assessment

A Detailed Assessment study was undertaken in 2013 as the monitored annual mean NO_2 and PM_{10} concentrations since 2009 had indicated potential exceedance of the objectives for each pollutant.

Dispersion modelling results indicated that NO_2 concentrations were predicted to be exceeding the annual mean objective at the facades of properties on the Lenzie Road and Industry Street/Townhead junction. Exceedance of the annual mean PM_{10} objective were predicted over a wider area, incorporating the Lenzie Road and Industry Street/Townhead junction as well as an extended section of Lenzie Road to the roundabout junctions with New Lairdsland Road and Waterside Road.

The conclusion recommended that the Council should proceed with the declaration of an AQMA for NO_2 and PM_{10} annual mean exceedances in Kirkintilloch.

1.5.2 2014 Progress Report

The report concluded that there have been no exceedances of the NO_2 and PM_{10} annual mean objective in 2013, which would suggest that there are no requirements for the council to declare an AQMA.

The report concluded that a decision will be made in 2014 as to whether an AQMA in Kirkintilloch requires to be declared based on the 2013 Detailed Assessment and the most up to date data.

1.5.3 2015 Updating and Screening Assessment

Measured annual mean concentrations of NO_2 and PM_{10} met the air quality objective in 2014 in Kirkintilloch.

The report concluded that a decision would be made in 2015 as to whether an AQMA in Kirkintilloch requires to be declared based on the 2013 Detailed Assessment and the most up to date data.

2 Detailed Assessment study area

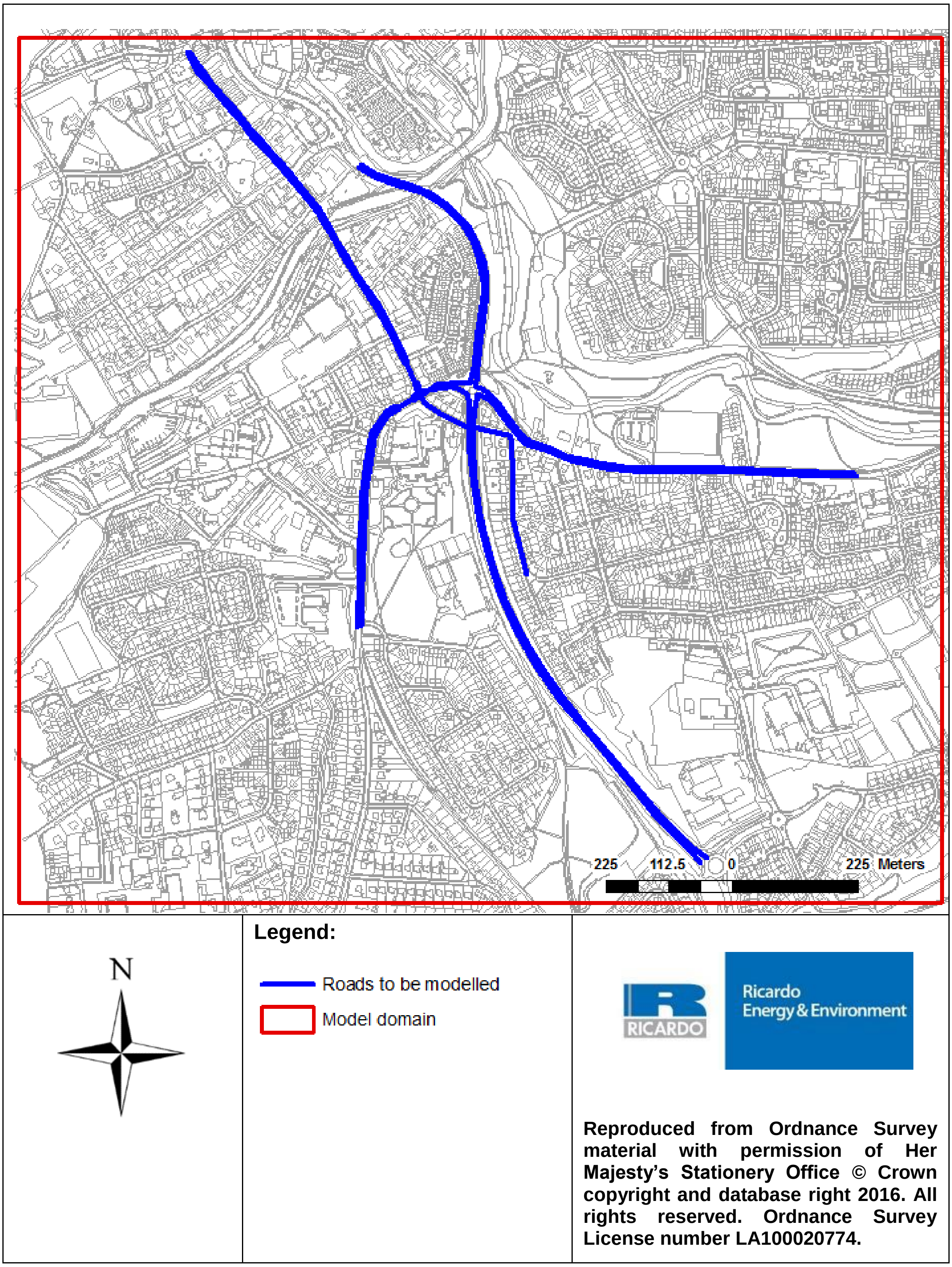
Kirkintilloch is a town within East Dunbartonshire Council located approximately 8 miles north east of central Glasgow.

This detailed assessment is concerned with road traffic emissions from roads including Lenzie Road, Kirkintilloch Link Road, New Lairdsland Road, B8048 (Waterside Road) and Industry Street. The assessment considers road traffic emissions where relevant exposure is present close to the road.

2.1 Model domain

The study area comprises of both residential and commercial properties with residential flats at both ground floor and first floor height above commercial properties at a few locations at the Industry Street/Townhead junction. The study area, including the road modelled and the extent of the detailed assessment is presented in Figure 1. The size of the study area is approximately 1,600 m by 1,500 m.

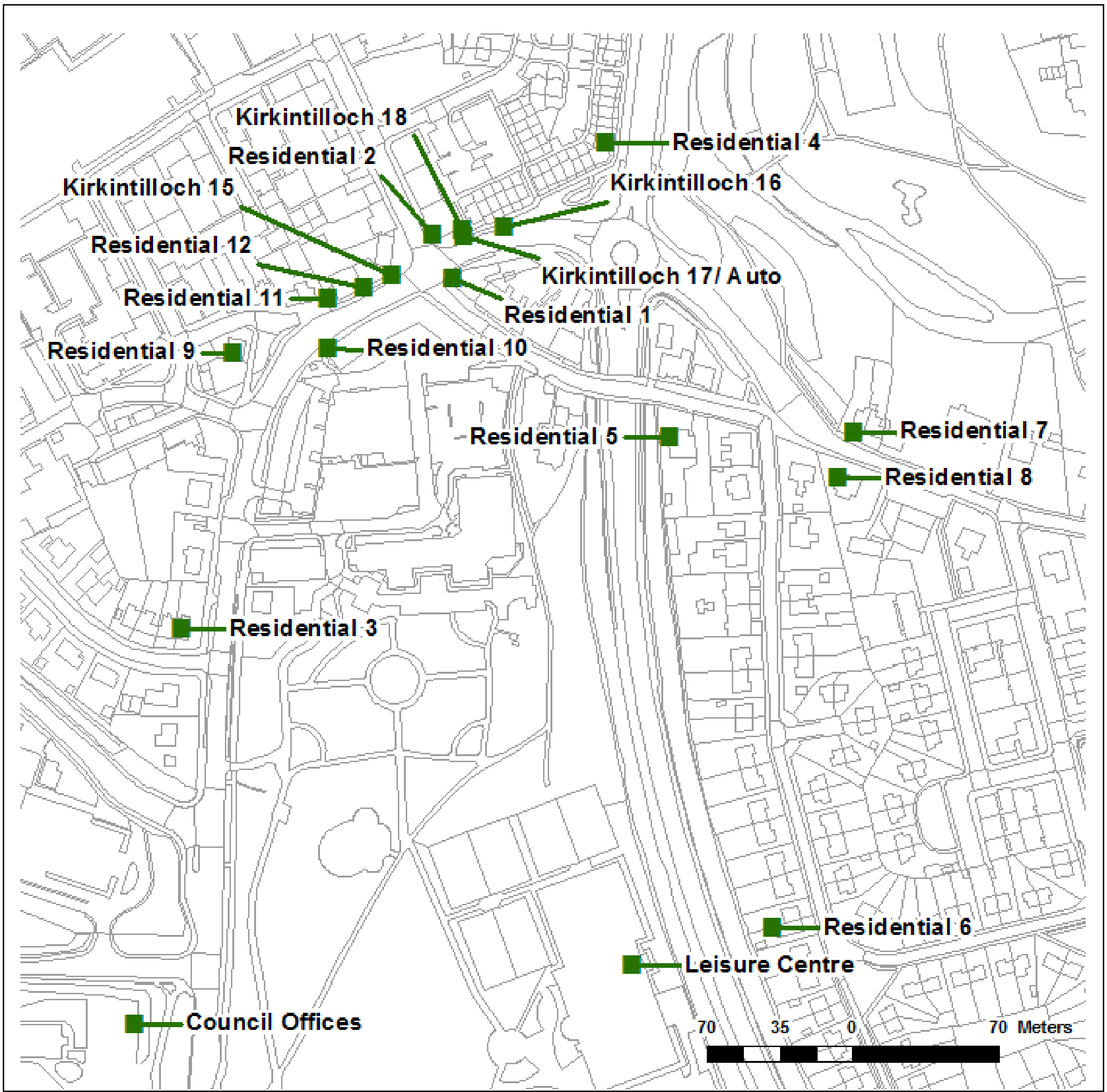
Figure 1: Detailed Assessment Study Area



2.2 Receptor Locations

The model has been used to predict NO_2 and PM_{10} annual mean concentrations at a selection of discrete receptors within the study area in addition to the diffusion tube sites. The specified receptors are located at the façade of buildings in the model domain where relevant exposure exists. The receptors have been modelled at both 1.5 m and 4 m heights to represent human exposure at both ground floor level and 1st floor height. The locations of the selected receptors are presented in Figure 2 and Table 3.

Figure 2: Additional model receptor locations



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ADMS Receptor

Table 3: Specified Receptors

Receptor Name	Description	Grid Reference - Easting	Grid Reference - Northing
Kirkintilloch 15	Diffusion tube	265641	673497
Kirkintilloch 16	Diffusion tube	265697	673524
Kirkintilloch 17 / Auto	Diffusion tube / Automatic monitor	265675	673516
Kirkintilloch 18	Diffusion tube	265674	673521
Residential 1	Industry Street	265670	673496
Residential 2	Townhead	265660	673517
Residential 3	Lenzie Road	265540	673328
Residential 4	New Lairdsland Road	265540	673328
Residential 5	A806	265774	673420
Residential 6	Woodhead Avenue	265823	673185
Residential 7	B8048 (Waterside Road) Eastbound	265862	673422
Leisure Centre	A806	265756	673167
Residential 8	B8048 (Waterside Road) Westbound	265854	673400
Former Council Offices	Lenzie Road	265518	673139
Residential 9	Lenzie Road	265565	673460
Residential 10	Lenzie Road	265610	673462
Residential 11	Lenzie Road	265610	673486
Residential 12	Lenzie Road	265627	673491

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.

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3.2 Road traffic data

3.2.1 Average flow and fleet split

Traffic flows data were provided by the Council from 2013 in addition with counts carried out by Streetwise at the request of East Dunbartonshire in February 2016 at Cowgate. A growth factor has been applied to the traffic flow collated from the Kirkintilloch Detailed Assessment.

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 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[1] (ET 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.

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

3.3 Ambient monitoring

During 2015, East Dunbartonshire Council measured NO_2 concentrations at four diffusion tube sites, including a co-located site, and one automatic site within the study area in Kirkintilloch. The automatic site also measures PM_{10} concentrations. Further details of these monitoring locations and recent measured concentrations are provided in Section 40.

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 22 km west of the study area and has good data quality for the period of interest.

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 NOx and PM_{10} annual mean concentrations for a dispersion modelling study can be accessed 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[2]. 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.

In this case there are no urban background monitoring sites in Kirkintilloch therefore the mapped background NOx and PM_{10} concentrations for the relevant 1 km x 1km grid square were used. The mapped annual mean background NOx concentration for 2015 was 18.7 $\mu g.m^{-3}$ and for PM_{10} was 10.9 $\mu g.m^{-3}$.

4 Monitoring Data

East Dunbartonshire Council currently measures NO_2 concentrations within the study area at 3 diffusion tubes and one automatic site that also measures PM_{10} concentrations. The location of each monitoring site is presented in Figure 3.

Details of the NO_2 diffusion tube monitoring sites and the annual mean NO_2 concentrations measured during 2015 are presented in Table 4.

Table 4: NO_2 diffusion tube measurements 2015

Site	Type	Easting	Northing	Data capture (%)	Annual mean 2015 ($\mu.m^{-3}$)
Automatic site					
Kirkintilloch 17	Kerbside	265700	673500	95.1	29.2
Diffusion tubes					
Kirkintilloch 15	Roadside	265640	673501	92.0	35.0
Kirkintilloch 16	Roadside	265695	673521	100.0	23.0
Kirkintilloch 18	Roadside	265667	673532	100	25.5

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

Table 5: PM_{10} automatic site measurements 2015

Site	Type	Easting	Northing	Data Capture (%)	Annual mean 2015 ($\mu g.m^{-3}$)
Kirkintilloch 17	Kerbside	265700	673500	83.0	16.6

Presented in Table 6 and Table 7 are the measured NO_2 and PM_{10} concentrations from 2012 to 2015. The annual mean NO_2 concentrations have remained below the annual mean objective since 2012. The annual mean PM_{10} concentrations have slightly decreased since 2012 and are been below the objective since 2013.

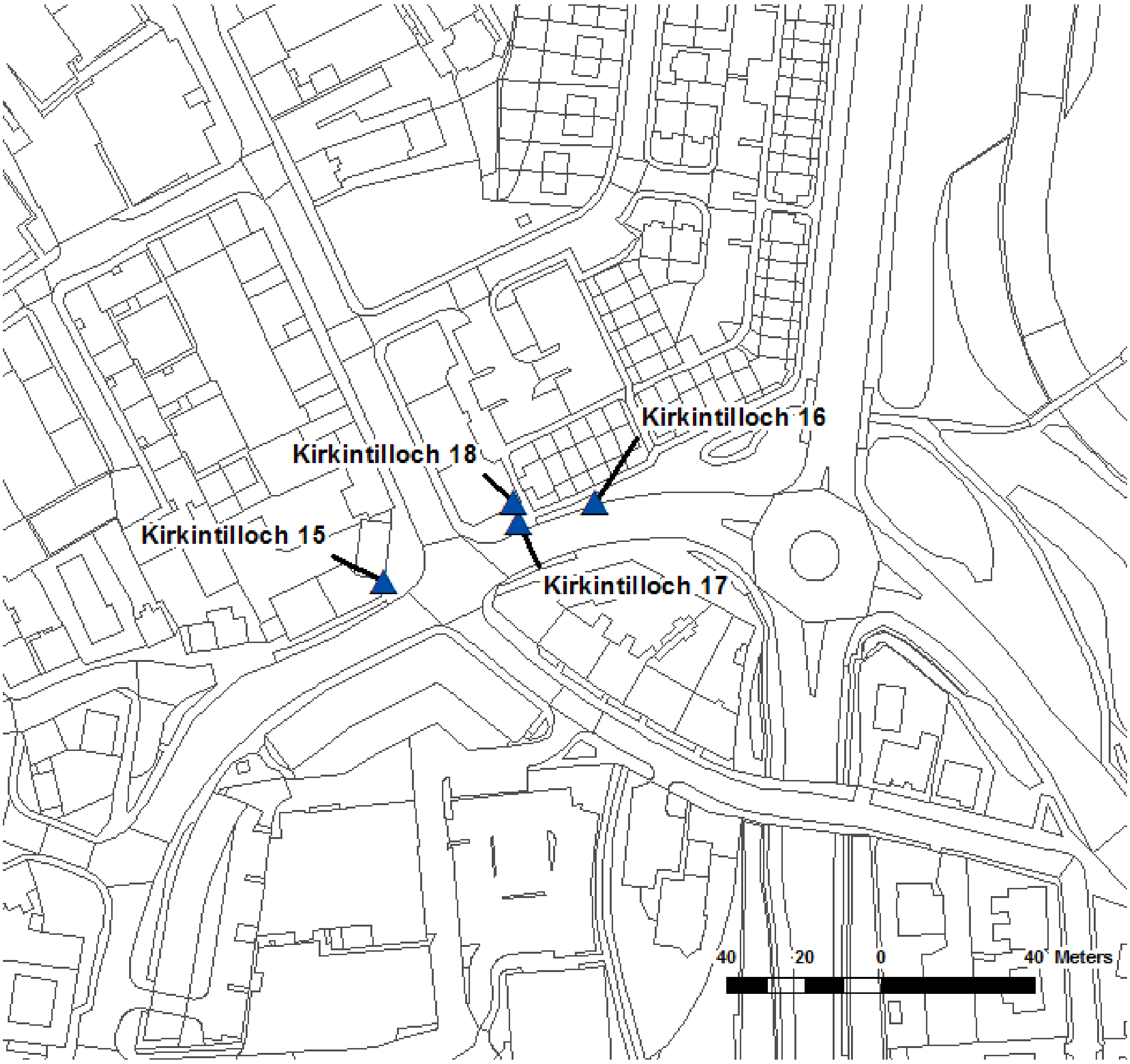
Table 6: Measured NO_2 annual mean concentrations

Site	2012	2013	2014	2015
Automatic site				
Kirkintilloch 17	34	31	29	29
Diffusion tubes				
Kirkintilloch 15	32.4	31.5	31.3	35.0
Kirkintilloch 16	33.7	35.2	32.6	23.0
Kirkintilloch 18	28.8	27.0	26.4	25.5

Table 7: Measured PM_{10} annual mean concentrations

Site	2012	2013	2014	2015
Automatic site				
Kirkintilloch 17	18	17	17	17

Figure 3: Kirkintilloch monitoring locations



N

Legend:

Kirkintilloch monitoring

Ricardo Energy & Environment

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 3.4).

The model has been verified by comparison of the modelled predictions of road NOx with local monitoring results. The available roadside diffusion tube measurements within the study area (described in Section 4 above) were used to verify the annual mean road NOx model predictions.

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 diffusion tube measurements. Further information on model verification is provided in Section 6 and Appendix 3.

A surface roughness of 0.5 m was used in the modelling to represent the sub-urban conditions in the model domain. A limit for the Monin-Obukhov length of 30 m was applied to represent a mixed urban and industrial area.

The source-oriented grid option was used in ADMS-Roads. This option provides finer resolution of predicted pollutant concentrations along the roadside, with a wider grid being used to represent concentrations further away from the road, the resolution of which 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 the GIS software ArcMap 10. This allows contours showing the predicted spatial variation of pollutant concentrations to be produced and added to the digital base mapping.

Queuing traffic was considered using the methodology described in Section 3.2 above; whereby a time varying emissions file was used in the model to account for daily variations in traffic.

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 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[3] 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. For the East Dunbartonshire Council area in 2014 with the "All other UK urban Traffic" option in the model, the NOx/NO_2 model estimates that 23.9% of NOx is released as primary NO_2.

5.2 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.

[3] Defra (2014) NOx NO_2 Calculator v4.1 released June 2014; Available at http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

6 Model Results

6.1 Verification of the Model

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. This helps to identify 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 and produce model outputs that are in better agreement with the monitoring results. LAQM.TG(16) recommends making the adjustment to the road contribution of the pollutant only not the background concentration these are combined with.

6.1.1 NO_2

The modelled NOx concentrations in this study were verified using all available roadside 2015 diffusion tube and automatic site measurements within the study area.

Following various checking and refinements to the model input; the modelled Road NOx contribution required adjustment by an average factor of 1.0413 to bring the predicted NO_2 concentrations within close agreement of those results obtained from the monitoring data. 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.

After the NOx/NO_2 model was run no further adjustments were made to the data. A comparison of measured vs modelled annual mean NO_2 concentrations at each measurement site, following model adjustment, is presented in Figure 4 and Table 8.

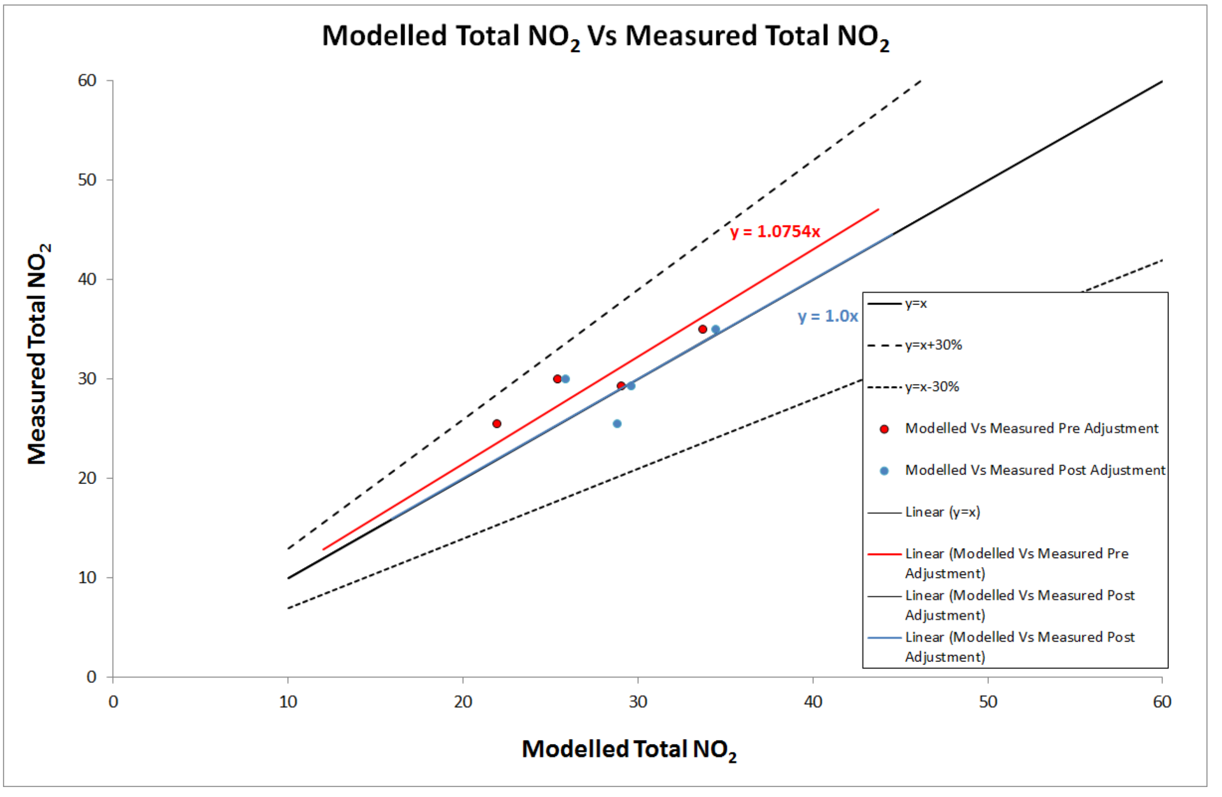
Model uncertainty can be estimated by calculating the root mean square error (RMSE). In this case the calculated RMSE was 2.65 µg.m^{-3} after adjustment which is within the suggested value (10% of the objective being assessed) in LAQM.TG(16). The model has therefore been assessed to perform sufficiently well for use within this assessment.

Verifying modelling data with diffusion tube monitoring data will always be subject to uncertainty due to the inherent limitations in such monitoring data (even data from continuous analysers has notable uncertainty). Further information on the verification process including the linear regression analysis is provided in Appendix 3.

Table 8 Modelled vs. measured annual mean NO_2 concentrations at monitoring sites 2015

Diffusion Tube Sites	Tube height(m)	Measured (µg.m^{-3})	Modelled (µg.m^{-3})
Automatic site			
Kirkintilloch 17 / Auto	2.3	29.2	29.7
Diffusion tubes			
Kirkintilloch 15	2.2	35.0	34.5
Kirkintilloch 16	2.3	29.9	25.9
Kirkintilloch 18	2.3	25.4	28.8
		RMSE	**2.65**

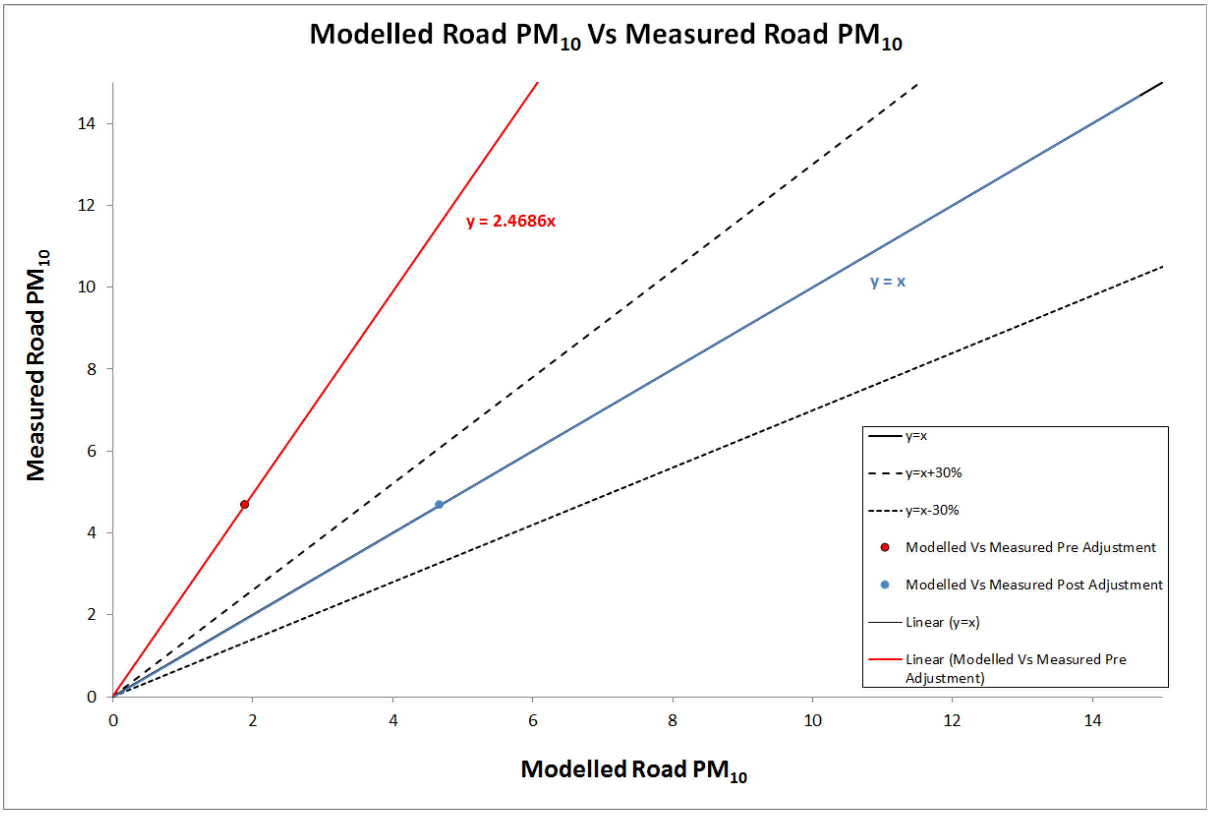
Figure 4 Linear regression plot of modelled vs. monitored NO_2 annual mean 2015



6.1.2 PM_{10}

The modelled PM_{10} concentrations in this study were verified against 2015 automatic site measurements from the Kirkintilloch automatic site. An adjustment factor of 2.469 was applied to all modelled PM_{10} concentrations before adding the background concentration.

Figure 5 Linear regression plot of modelled vs. monitored road 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 9.

There are no predicted exceedances of the NO_2 or PM_{10} objectives at any of the receptor locations.

Table 9 Predicted annual mean NO_2 and PM_{10} concentrations at specified receptors 2015

Receptor	NO_2 annual mean (µg.m^{-3})	PM_{10} annual mean (µg.m^{-3})
Kirkintilloch 15	35	17
Kirkintilloch 16	26	15
Kirkintilloch 17 / Auto	30	17
Kirkintilloch 18	29	16
Residential 1	22	14
Residential 2	25	15
Residential 3	15	13
Residential 4	18	13
Residential 5	14	12
Residential 6	13	12
Residential 7	20	15
Leisure Centre	13	12
Residential 8	16	13

Receptor	NO_2 annual mean (µg.m^{-3})	PM_{10} annual mean (µg.m^{-3})
Former Council Offices	14	12
Residential 9	15	13
Residential 10	21	14
Residential 11	21	14
Residential 12	26	15

6.3 Modelling results – contour plots

Annual mean NO_2 and PM_{10} concentrations have been predicted across a grid of points covering the entire study area. The gridded point values have been interpolated to produce contour plots showing the spatial variation of predicted concentrations across the study area. Each grid has been modelled at a height of 1.5m to represent human exposure at ground level.

6.3.1 NO_2

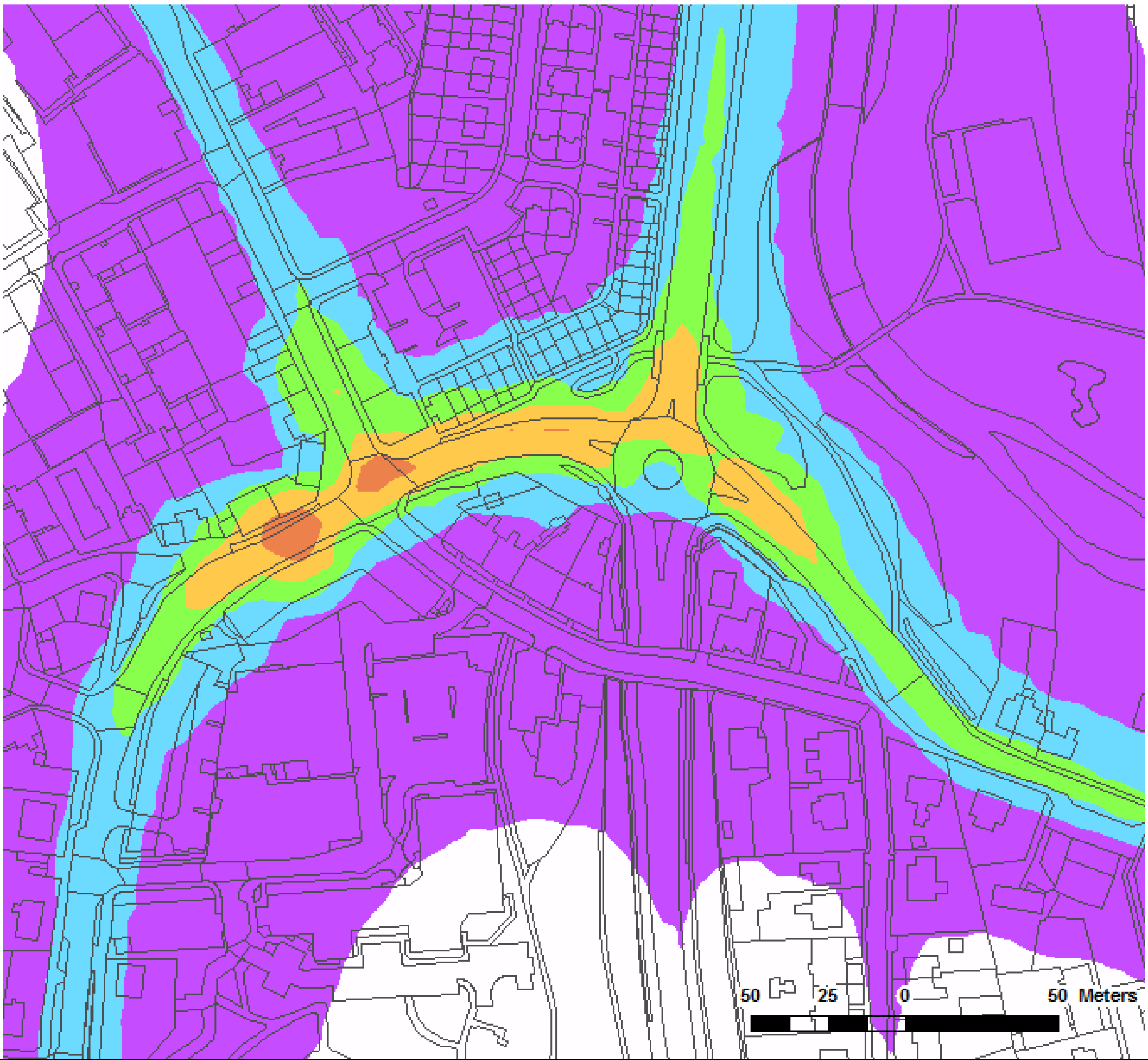
Contour plots showing the spatial variation of the predicted 2015 annual mean NO_2 concentrations across the study area at ground floor level are presented in Figure 6. The NO_2 annual mean contour plots indicate that the 40 µg.m^{-3} objective is not being exceeded at any location where there is relevant exposure in the study area. The contour plots show that predicted NO_2 concentrations are well below the objective at all locations with relevant exposure within the study area.

6.3.2 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 7. The PM_{10} annual mean contour plots indicate that the 18 µg.m^{-3} objective is not being exceeded at any locations where there is relevant exposure in the study area.

It has to be noted that PM_{10} concentrations are predicted to be just below 17 µg.m^{-3} at two receptors along Townhead (Kirkintilloch 15 and Kirkintilloch 17 / Auto). This has to be taken into account where the $PM_{2.5}$ objective will be put into place as this would mean that this objective would be reached at this location.

Figure 6: Modelled NO_2 annual mean concentrations 2015 at 1.5m height

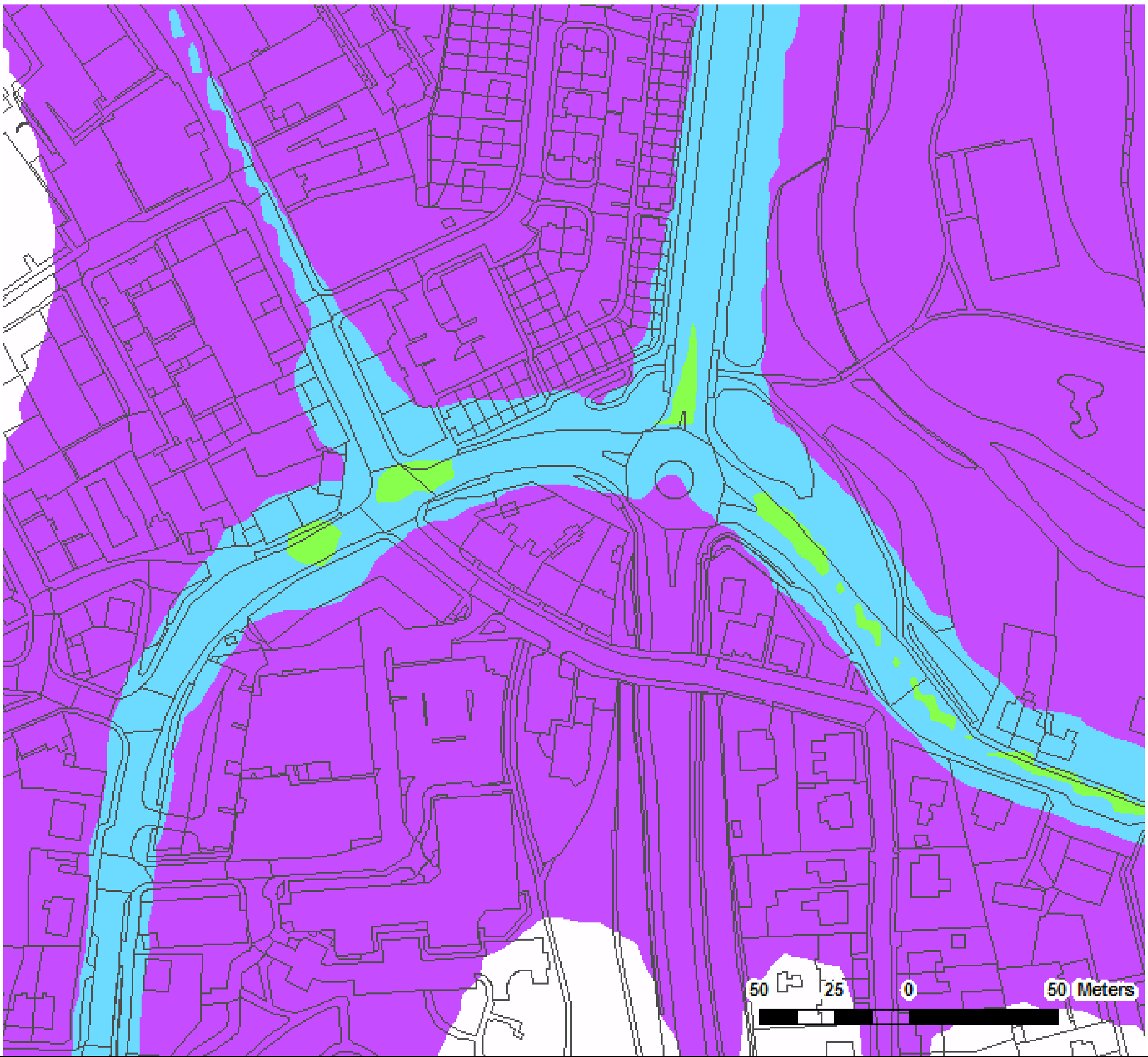


Legend:

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

- <13.8
- 13.8 - 18
- 18 - 22
- 22 - 26
- 26 - 30
- 30 - 33.6

Figure 7: Modelled PM_{10} annual mean concentrations 2015 at 1.5m height



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Legend:

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

- <12.1
- 12.1 - 14
- 14 - 16
- 16 - 17
- 17 - 18
- 18 - 19

7 Summary and Conclusions

This Updated Detailed Assessment outlines a dispersion modelling study of road traffic emissions at the busy junction of Industry Street/Townhead, Kirkintilloch, East Dunbartonshire. The study 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 Kirkintilloch 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 2015.

The modelling study has indicated that there are no exceedances of the NO_2 and PM_{10} annual mean objectives at any location with relevant exposure during 2015.

The 2013 Detailed Assessment of Air Quality in Kirkintilloch concluded that the East Dunbartonshire Council should declare an area of Kirkintilloch an AQMA for NO_2 and PM_{10} annual mean exceedances.

In conclusion, following detailed analysis of measured data and the findings of this updated detailed assessment, it is not necessary to declare an AQMA in Kirkintilloch.

Appendices

Appendix 1: Traffic Data

Appendix 2: Meteorological Dataset

Appendix 3: Model Verification

Appendix 1 – Traffic Data

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

Traffic data for Cowgate 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 fleet split.

Traffic data for all the other roads were taken from the 2013 Detailed Assessment with a growth factor applied to account for the growth of traffic between 2012 and 2015.

Table A1.1: Kirkintilloch 2015 – Annual Average Daily Flows

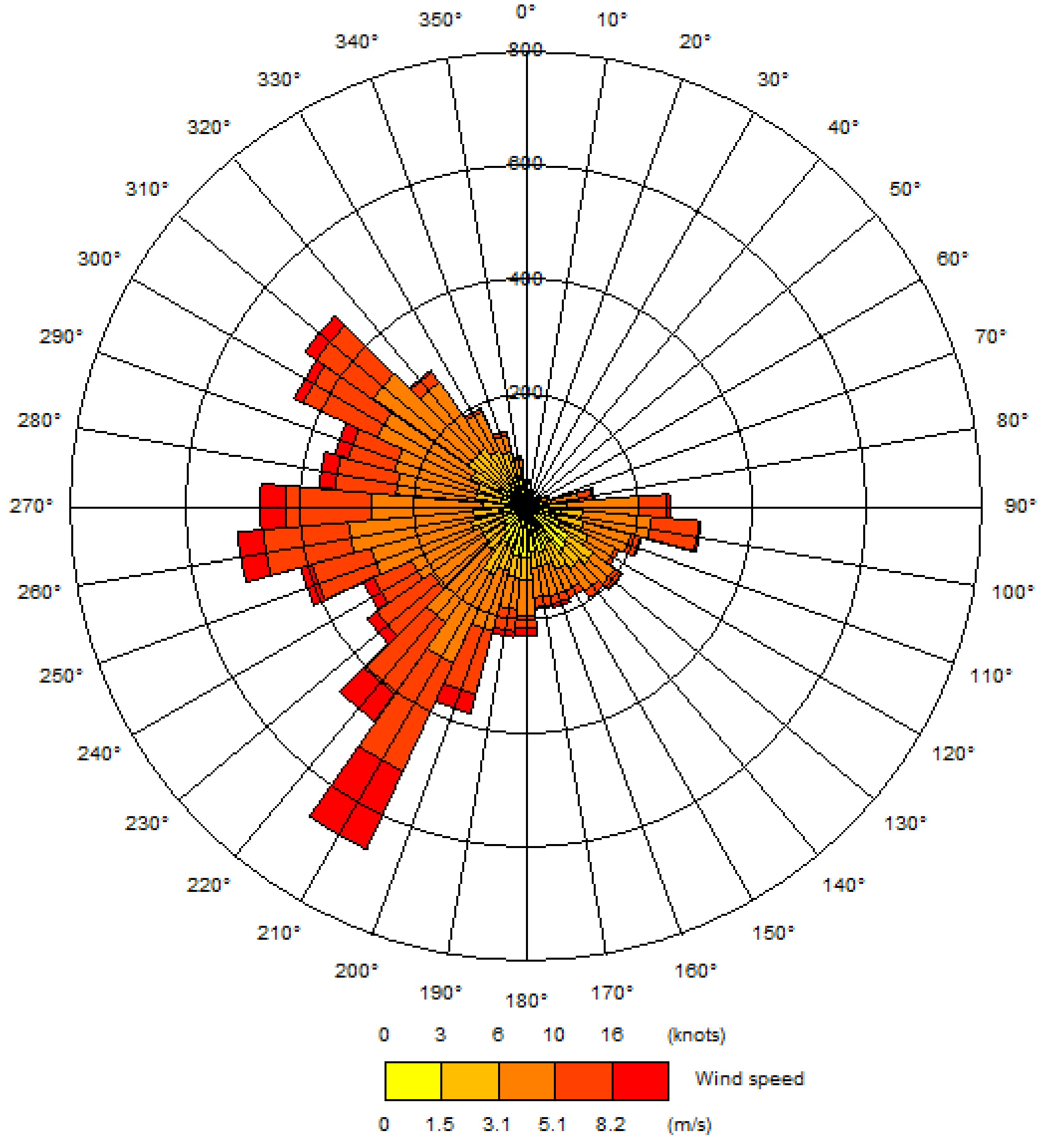
Street	HGV %	AADF 2015
Townhead Northbound	5.0	3172
Townhead Southbound	5.5	3480
Industry Street Eastbound	0.3	302
Industry Street Westbound	0.0	283
Lenzie Road Northbound	5.3	5987
Lenzie Road Southbound	5.5	5818
B8048 (Waterside Road) Eastbound	2.3	7007
B8048 (Waterside Road) Westbound	3.1	7243
New Lairdland Road Northbound	3.3	7684
New Lairdland Road Southbound	3.1	6773
Lenzie Road Eastbound	5.3	5987
Lenzie Road Westbound	5.5	5818
A806 Northbound	3.0	246
A806 Southbound	3.0	227
Cowgate Northound	18.1	1953
Cowgate Southbound	12.6	2760

HGV – Heavy Goods Vehicles

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 Kirkintilloch. 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 1.0413, 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 2.63 $\mu g.m^{-3}$ 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 2.469. 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

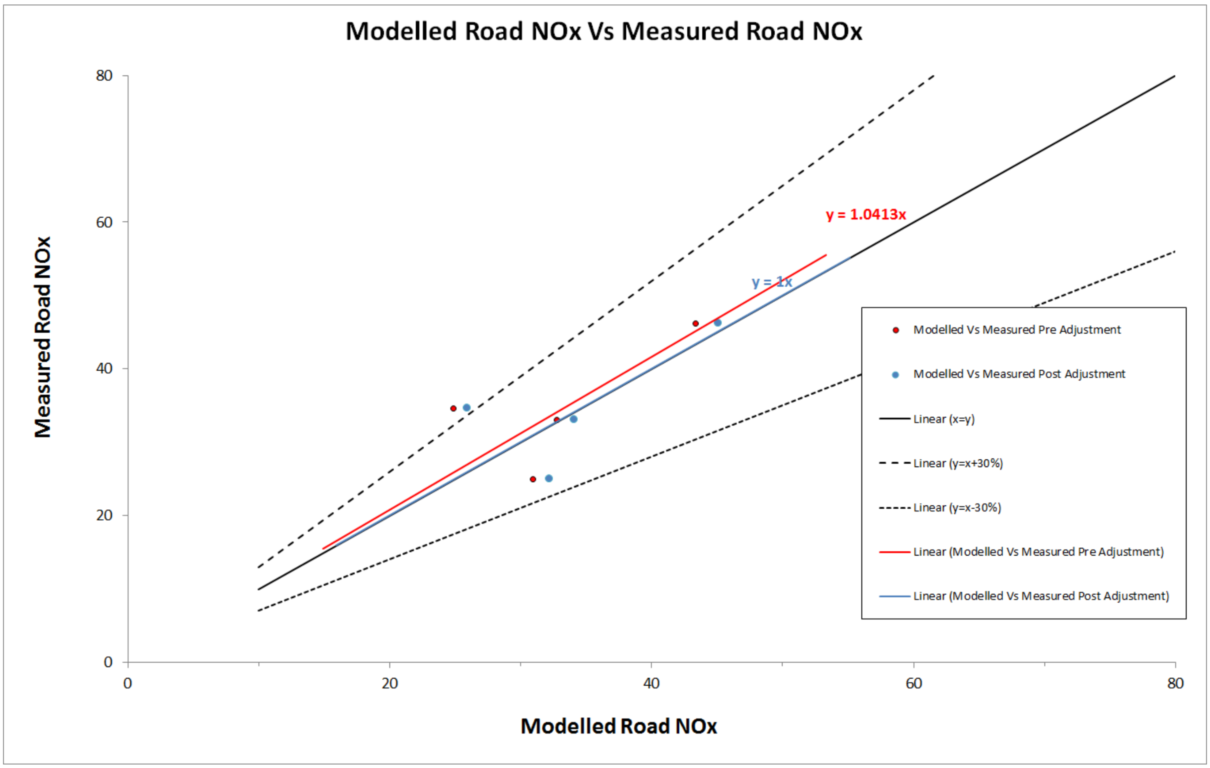
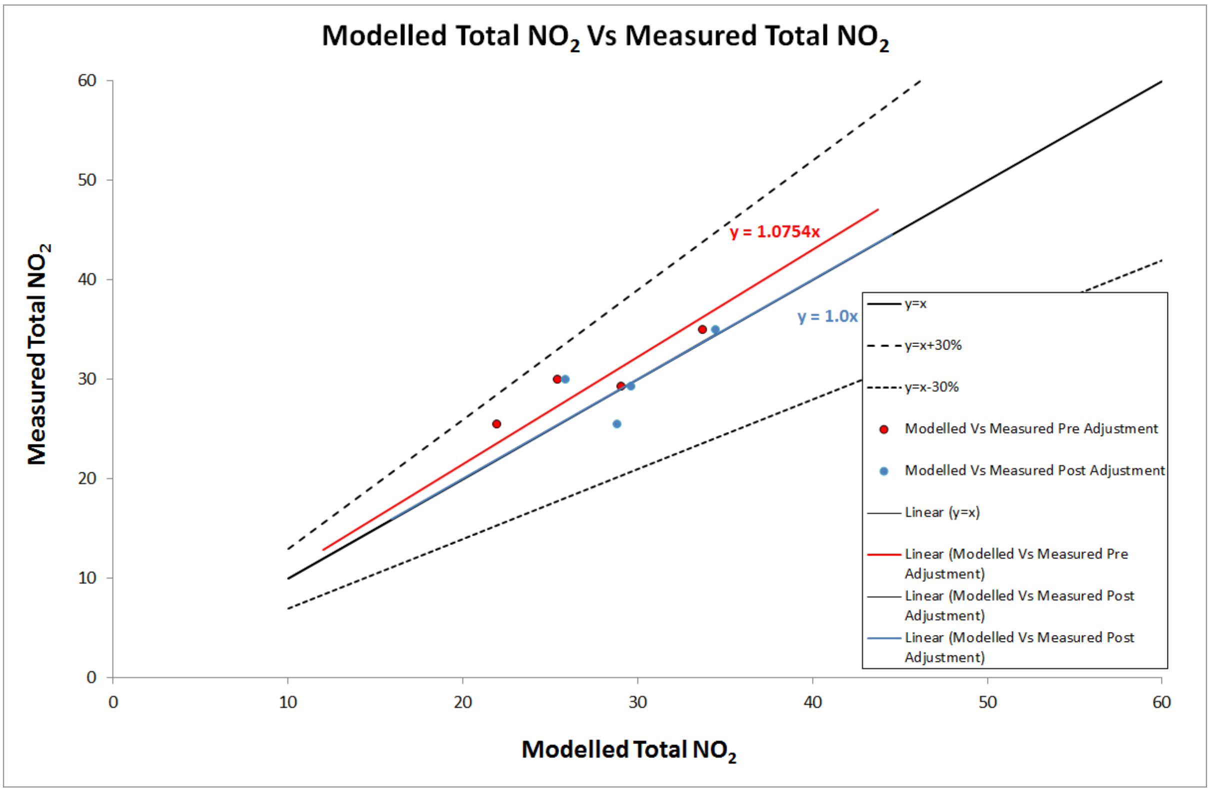


Figure A3.2: Comparison of modelled vs. monitored NO_2 annual mean 2015



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