Newton Detailed Assessment of Air Quality

Report for West Lothian Council

ED 59713 | Issue Number 2 | Date 26/02/2016

Ricardo in Confidence

Customer:

West Lothian Council

Customer reference:

Contact:

Jennifer Simpson
Ricardo Energy & Environment
2nd Floor, Blythswood Square, Glasgow,
G2 4BG, United Kingdom

t: +44 (0) 1235 75 33346
e: Jennifer.simpson@ricardo.com

Ricardo-AEA Ltd is certificated to ISO9001 and ISO14001

Author:

Bouvet, Celine

Approved By:

Simpson, Jennifer

Date:

26 February 2016

Ricardo Energy & Environment reference:

Ref: ED59713- Issue Number 2

Executive summary

Ricardo Energy & Environment were commissioned by West Lothian Council to undertake a Detailed Assessment of Air Quality for the Newton area. The assessment has been undertaken to investigate the potential scale of exceedances of the PM_{10} annual mean Scottish Air Quality Objective in the study area.

This report describes a dispersion modelling study of road traffic and domestic fuel combustion emissions in the Newton area, which has been conducted to allow a detailed assessment of PM_{10} concentrations at this location.

A combination of the available automatic monitoring data and atmospheric dispersion modelling using ADMS-Roads has been used to conduct the study. The study utilises the latest available traffic, fuel combustion per household and meteorological data for 2014. The study also incorporates the findings of a domestic fuel survey that was undertaken in the study area in early 2016.

The modelling study has indicated the following:

- The 2 main sources of PM_{10} emissions in the Newton area are fuel combustion and road transport.
- There are exceedances of the PM_{10} annual mean Scottish Objective in most of Newton.
- Non road-traffic PM_{10} concentrations account for a significantly high proportion, up to 91.3% of total PM_{10} concentrations within the study area.
- The contribution from road traffic to PM_{10} concentration is higher for the receptors closer to the road.
- When only comparing the contribution of road traffic and domestic fuel combustion, the largest contribution at each receptor comes from domestic fuel combustion. The contribution of domestic fuel combustion goes from 50.2% for receptors closest to the road up to 92.6% for receptors further away from the road, excluding the background contribution.

In light of this Detailed Assessment of Air Quality in Newton using the available monitoring data from 2014, West Lothian Council is required to declare an Air Quality Management Area for exceedances of the PM_{10} annual mean Scottish objective.

Table of contents

Appendices

1 Introduction

Ricardo Energy & Environment were commissioned to undertake this Detailed Assessment of Air Quality for Newton, by West Lothian Council. This detailed assessment has been undertaken to determine whether an Air Quality Management Area is required and the potential scale and extent of exceedances of the annual mean PM_{10} objective.

1.1 Policy Background

The Environment Act 1995 placed a responsibility on 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 pertinent 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 PM_{10} 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
Particles (PM_{10}) (gravimetric)	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 the public are likely to be regularly present and are likely exposed over the averaging period of the objective. Table 2 summarises examples of where air quality objectives for NO_2 should and should not apply.

Table 2 Examples of where the PM_{10} Air Quality Objectives should and should not apply

Averaging Period	Pollutants	Objectives *should* apply at…	Objectives should *not* generally apply at…
Annual mean	PM_{10}	All locations where members of the public might be regularly exposed. Building facades 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 PM_{10} annual mean objective at locations with relevant exposure in Main Street, Newton, West Lothian Council.

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, all available domestic fuel use data, air quality monitoring data, meteorological and background concentration data for use in the dispersion model;
- Identify potential hotspots where it is likely that the AQS objectives would not be met
- Model PM_{10} concentrations surrounding these hotspots
- Produce contour plots of the modelled pollutant concentrations
- Recommend whether West Lothian Council should link Newton to the gas national grid

The modelling methodologies provided for Detailed Assessments outlined in Defra and DA Technical Guidance LAQM.TG(09)[1] were used throughout this study.

1.5 Previous Review and Assessment

A summary of recent review and assessment reports relevant to the Newton area are provided below.

2014 Air Quality Progress Report

In 2013, results from Newton automatic site show an increase, from the previous year, in measured PM_{10} concentration to 19µg/m^3 which exceeds the AQS objective of 18µg/m^3.

Newton has been identified as a new area of concern for which a Detailed Assessment needs to be undertaken.

2 Detailed Assessment study area

Newton is a town located in the north-east of West Lothian, close to the border with the City of Edinburgh. It lies 10 km west of Edinburgh.

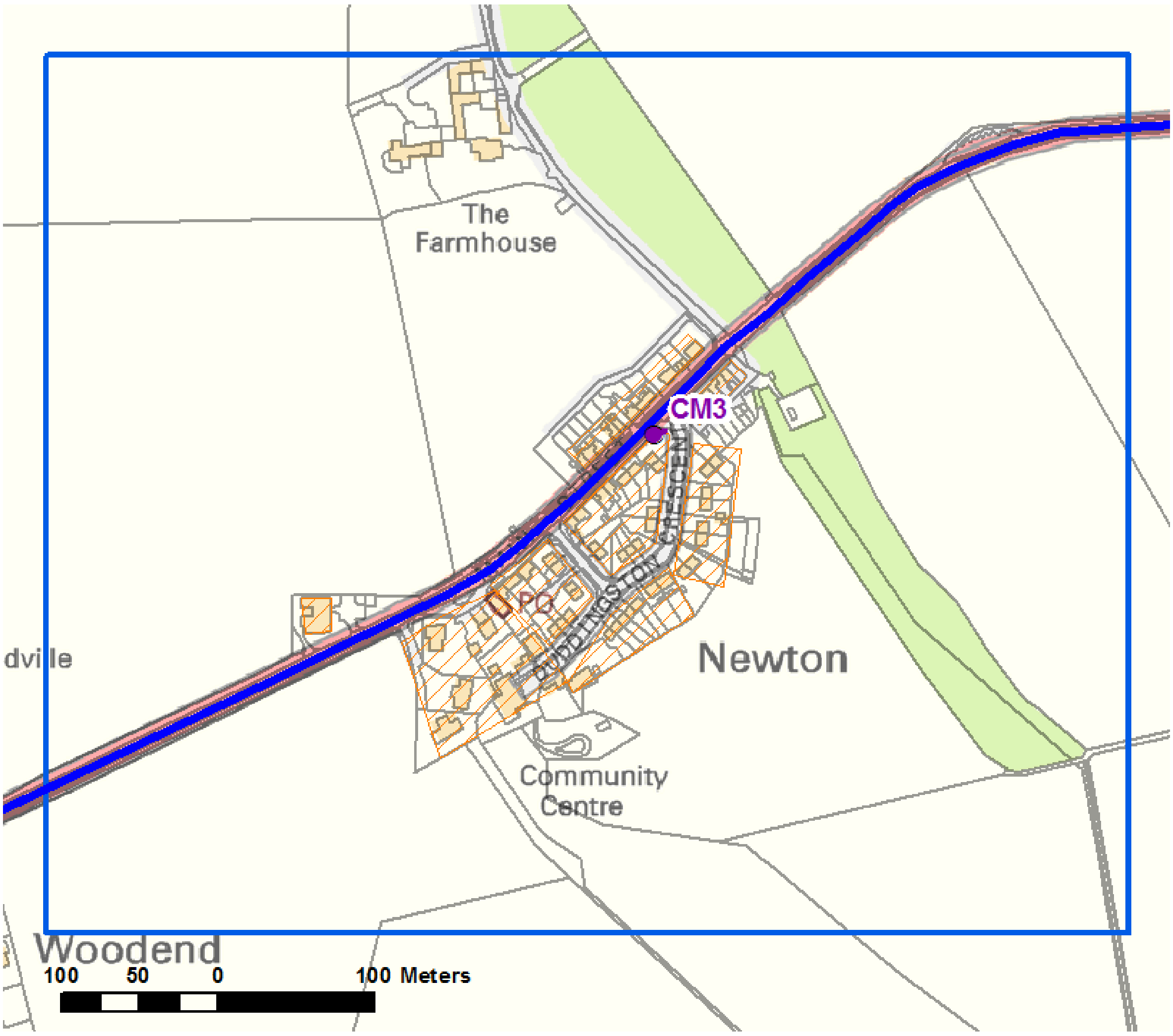
This Detailed Assessment is concerned with an area encompassing Newton Main Street which is part of the A904 and a main route accessing the Forth Road Bridge nearby. This assessment is to determine the main air quality issues in the area.

2.1 Model domain

The study area comprises of residential properties at ground and first floor height. The study area, including the roads and areas modelled and the extent of the detailed assessment is presented in Figure 1 below. The size of the study area is approximately 700 m by 600 m, with a grid resolution of 1.16 m x 3 m.

[1] Local Air Quality Management Technical Guidance LAQM.TG(09), Defra, 2009

Figure 1 Detailed Assessment Study Area



Legend:

- ADMS Road Source
- ADMS Area Source
- Model domain
- Automatic Monitoring Site

2.2 Receptor Locations

The model has been used to predict PM_{10} annual mean concentrations at a selection of discrete receptors within the study area in addition to the automatic site. The receptors are located at the façade of buildings in the model domain where relevant exposure exists within the pollution hotspots identified from the modelled contour plots. The receptors have been modelled at both 1.5 m and 4 m to represent human exposure at ground floor level and 1st floor height where present. The locations of the selected receptors are presented in Table 3 and shown in Figure 2.

Table 3 Receptor Locations

Receptor	Address	Easting	Northing
R1	3 Main Street	309145	677619
R2	24 Duddingston Crescent	309176	677588
R3	11 Main Street	309177	677648
R4	29 Duddingston Crescent	309225	677601
R5	19 Main Street	309228	677700
R6	10 Duddingston Crescent	309251	677657
R7	33 Main Street	309314	677741
CM3	Automatic site	309258	677728

Figure 2 Receptor locations

	**Legend :** ● Receptors	**Contains Ordnance Survey data © Crown copyright. All rights reserved. 2011 licence number LA100037194**

3 Emissions Inventory

An emission inventory of PM_{10} emissions in the Newton area has been undertaken using the data from the UK National Atmospheric Emissions Inventory (NAEI). The emissions inventory provides estimates of PM_{10} emissions in the Newton area from sources sectors including:

- Road traffic;
- Commercial and domestic combustion;
- Industrial combustion;
- Industrial processes;
- Other transport;
- Waste treatment and disposal;
- Solvent use;
- Agriculture; and
- Nature.

The NAEI is a national atmospheric emissions database which holds data on emissions from a variety of sources in 1km by 1km grid squares. Emissions were reported in tonners per year. The NAEI data can be downloaded from the NAEI website for each 1km by 1km grid square, in our case data for the 309500-677500 grid square have been directly downloaded from the NAEI website. The Newton area emissions inventory is based on the most recent NAEI data available, at the time of compiling this inventory were for 2012. The study assumed that 2012 emissions from the NAEI remain unchanged in 2014.

3.1 NAEI Road Traffic Data

The NAEI contains data on emission from all road traffic related emission data aggregated over $1km^2$ grid squares. The data from the NAEI includes emissions from exhausts, cold starts and brake and tyre wear.

3.2 NAEI Commercial and Domestic Combustion

The NAEI contains data on emissions from commercial and domestic combustion, a group which included stationary combustion sources in agriculture, domestic combustion, small scale industrial combustion, commercial combustion and public sector combustion. Commercial and domestic combustion is often highest in urban areas with a high concentration of public sector, commercial and domestic buildings.

3.3 NAEI Industrial Combustion and Industrial Processes

The NAEI holds data on the emission of pollutants from large industrial combustion sources. The sources in the group include combustion associated with ammonia production, cement production iron and steel production, and lime production. Emissions data from sources in this group is often obtained using data submitted to SEPA or the Environment Agency through IPPC (Integrated Pollution Prevention and Control) process.

A second group within the NAEI contains emissions data for industrial production processes. The sources in this group include nitric acid use in the chemical industry, primary aluminium production and solid smokeless fuel production.

3.4 NAEI Other Transport

The “other transport” group covers emissions from air, rail and marine transport. It also includes emissions from off road vehicles. Rail transport includes emissions from freight, intercity and regional.

3.5 NAEI Waste Treatment and Disposal

The NAEI contains a group with emission data from waste treatment and disposal activities. Sources included in this group are crematoria, incineration of animal carcasses, chemical waste and clinical waste, offshore oil and gas flaring and small-scale burning.

3.6 NAEI Solvent use

The NAEI also contains a group with emission data from solvent use associated with paints, glues, detergents and industrial processes. This data is often obtained from SEPA who regulate processes involving solvents.

3.7 NAEI Agriculture

The NAEI also contains a group with emission data from all agricultural livestock, poultry and agricultural off road machinery.

3.8 NAEI Nature

The NAEI also contains a group with emission data from naturally occurring emissions from woodlands, mines, quarries and opencast mines.

3.9 Emission Totals

The total atmospheric emissions from the 1km grid square covering Newton in 2012 are presented in Table 4 with the totals broken down by source in Figure 3. Emissions were reported in tonnes per year.

Table 4 Emission Totals in Newton

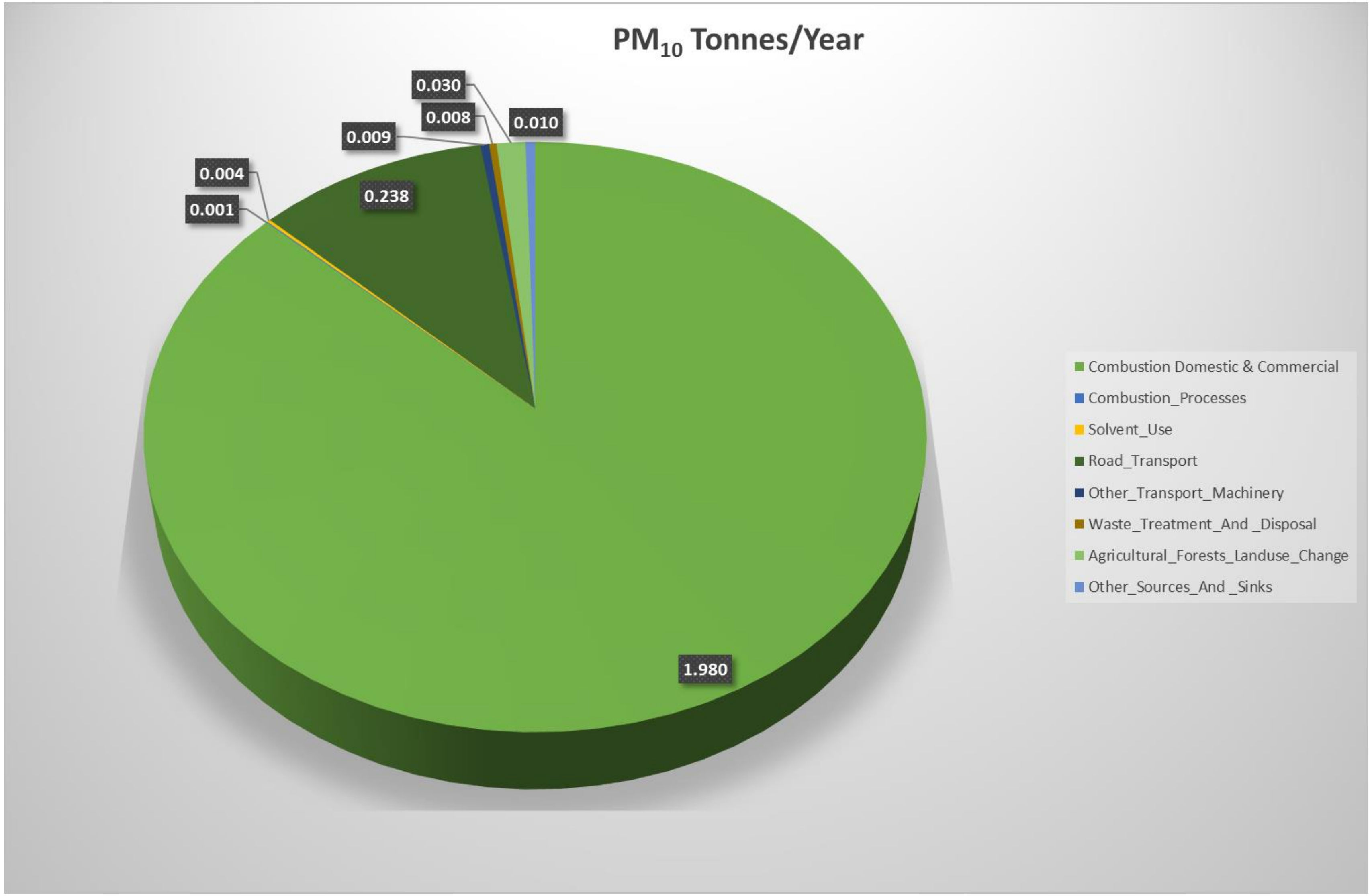
Source	PM_{10} emitted (tonnes/yr)
Road traffic	0.238
Commercial and domestic combustion	1.980
Industrial combustion	0
Industrial processes	0.001
Other transport	0.009
Waste treatment and disposal	0.008
Solvent use	0.004
Agriculture	0.030
Nature	0.010

Figure 3 indicates that 87% of PM_{10} emissions are attributable to commercial and domestic combustion, with 11% road transport and other sources (2%) account for the remainder of emissions. The main source of PM_{10} emissions in Newton is commercial and domestic combustion.

3.10 Domestic Fuel Survey

To better understand the PM_{10} emissions that are attributable to domestic combustion, a survey was also undertaken in February 2016. The survey consisted of a short questionnaire which asked the householders to specify the fuel and amount of fuel they may use each year. The questionnaire of the survey is shown in Appendix 2 and the findings from the survey were used to inform and validate the emissions inventory

Figure 3 Newton – Background PM_{10} source apportionment



4 Assessment methodology

The assessment is concerned with predicting annual mean PM_{10} concentrations in Newton. In this assessment we are considering all emission sources within the area. And as previously shown, the main sources of PM_{10} emissions in the Newton area are fuel combustion and road transport, the starting point requires an estimation of the amount of fuel being used in the area; this estimate is then used to inform a calculation of PM_{10} emissions. It should be noted that the data had to be manipulated in such a way as to make the emissions data suitable for input to the dispersion modelling software so that ambient predictions can be made. Therefore this section will only deal with emissions from domestic fuel combustion and road traffic.

It was decided that modelling the area with a series of individual area sources of PM_{10} was as robust as any comparable method. This meant that the methodology had to take available fuel use data and derive emissions for the area source in grams per metre squared per second. We have tried to minimise uncertainty in these calculations but assessments of this nature will always carry notable uncertainties regardless. Verifying the model against local monitoring is the main way of reducing uncertainty in dispersion modelling predictions (after standard check of input data) and has been carried out for this assessment.

Clearly there are several steps to moving from household fuel consumption to PM_{10} concentrations and these are outlined in subsequent sections as well as the methodology used to model road traffic on Main Street, Newton. This same methodology has previously been used for the Dunclug and Ballykeel Detailed Assessment of Air Quality.

4.1 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.

All maps in this document contain Ordnance Survey data © Crown copyright and database right 2015.

All OS Mastermap maps in this document are 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 LA100037194.

4.2 Road traffic data

4.2.1 Average flow, speed and fleet split

Traffic count data collected by a third party contractor[2] on behalf of West Lothian Council were used for the assessment, this included weekly automatic count and vehicle classification split data. Table 5 summarises the traffic flow data used for the road links modelled.

Table 5 Newton 2014 – Annual Average Daily Flows – both directions combined

Street	%Cars	%LGV	%Rigid HGV	%Artic HGV	%Bus	%Motorcycle	AADF 2014	Average Speed (kph)
Main Street, Newton	89.4	5.9	1.1	2.5	0.2	0.9	10,767	26.7

LGV – Light Goods Vehicles

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

[2] Sky High Count On Us – SCO 1464 West Lothian ATC Report – March 2015

It should be noted that traffic patterns 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.

4.2.2 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 a 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 were available for the assessment. The TG(09) guidance states that the preferred approach to representing the resulting increase in vehicle emissions during these peak periods is to calculate the emission rate for the affected roads for each hour of the day or week, on the basis of the average speeds and traffic flows for each hour of the day. The hourly specific emission rates can then be used to calculate a 24-hr diurnal emission profile which can be applied to that section of road.

In this case locally specific average weekday, Saturday and Sunday diurnal profiles of traffic flow across the study area were calculated using the local automatic traffic count data, but no hourly speed measurement were available. Peak periods in traffic flow were therefore accounted for in the model by applying the typical diurnal traffic flow profile to the average hourly emission rate assuming an average daily vehicle speed ad measured during the traffic survey.

4.2.3 Vehicle emission factors

The latest version of the Emissions Factor Toolkit[3] (EFT V6.0.2 November 2014 release) was used in this assessment to calculate pollutant emission factors for each road link modelled. The calculated emission factors were then 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. In the latest version of the EFT, PM_{10} emissions factors previously based on DFT/TRL functions have been replaced by factors from COPERT 4 v10. These emissions factors are widely used for the purpose of calculating emissions from road traffic in Europe. Defra recognise these as the current official emission factors for road traffic sources when conducting local, regional and national scale dispersion modelling assessments.

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, standard 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.

4.3 Ambient Monitoring

During 2014 West Lothian Council measured PM_{10} concentration at one automatic site on Main Street, Newton, which is within the study area modelled in this assessment. A map showing the location of the automatic site is presented in Figure 2.

Details of the PM_{10} automatic site are shown in Table 6.

PM_{10} measured concentration at the Newton automatic site is exceeding the Scottish annual mean objective in 2014, as shown in Table 7. Full details of QA/QC procedures are presented in the West Lothian Council 2015 LAQM Updating and Screening Assessment.

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

Table 6 Automatic site details 2014

Site Name	Site Type	OS Grid Reference		Monitoring Technique
Newton CNC	Roadside	309258	677728	TEOM / FDMS NOx analyser

Table 7 PM_{10} measured concentration at the automatic site in 2014

Pollutant	Data Capture (%)	Annual mean (µg.m^{-3})
PM_{10}	97.4	22.45

4.4 Meteorological data

Hourly sequential meteorological data (wind speed, direction etc.) for 2014 measured at the Edinburgh Airport site was used for the modelling assessment. The meteorological measurement site is located approximately 6.5 km south-east 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.

4.5 Background concentrations

Background PM_{10} concentrations for a dispersion modelling study can be assessed from either local monitoring data conducted at a background site or from the Defra background maps[4]. The Defra 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.

In this case there are no urban background monitoring site in Newton or in the surroundings therefore the mapped background PM_{10} concentrations for the relevant 1 km x 1 km grid squares were used. The mapped annual mean background PM_{10} concentrations used in this assessment are presented in Table 8. The contribution of domestic combustion within the grid square has been removed from the background concentration to avoid double counting.

Table 8 Newton Study Area background PM_{10} values 2014 (µg.m^{-3})

X	Y	Total background	Domestic combustion contribution	Total minus Domestic combustion
309500	677500	14.22	0.064	14.16

4.6 Mapping of the area and properties therein

GIS maps of the area were provided by West Lothian Council. The residential areas within Newton were estimated and split into a series of eight subdomains and the number of properties within each was estimated using ArcGIS and GoogleEarth. The size of each subdomain and the number of properties within each subdomain are shown in Table 9 below (and shown spatially in Figure 4).

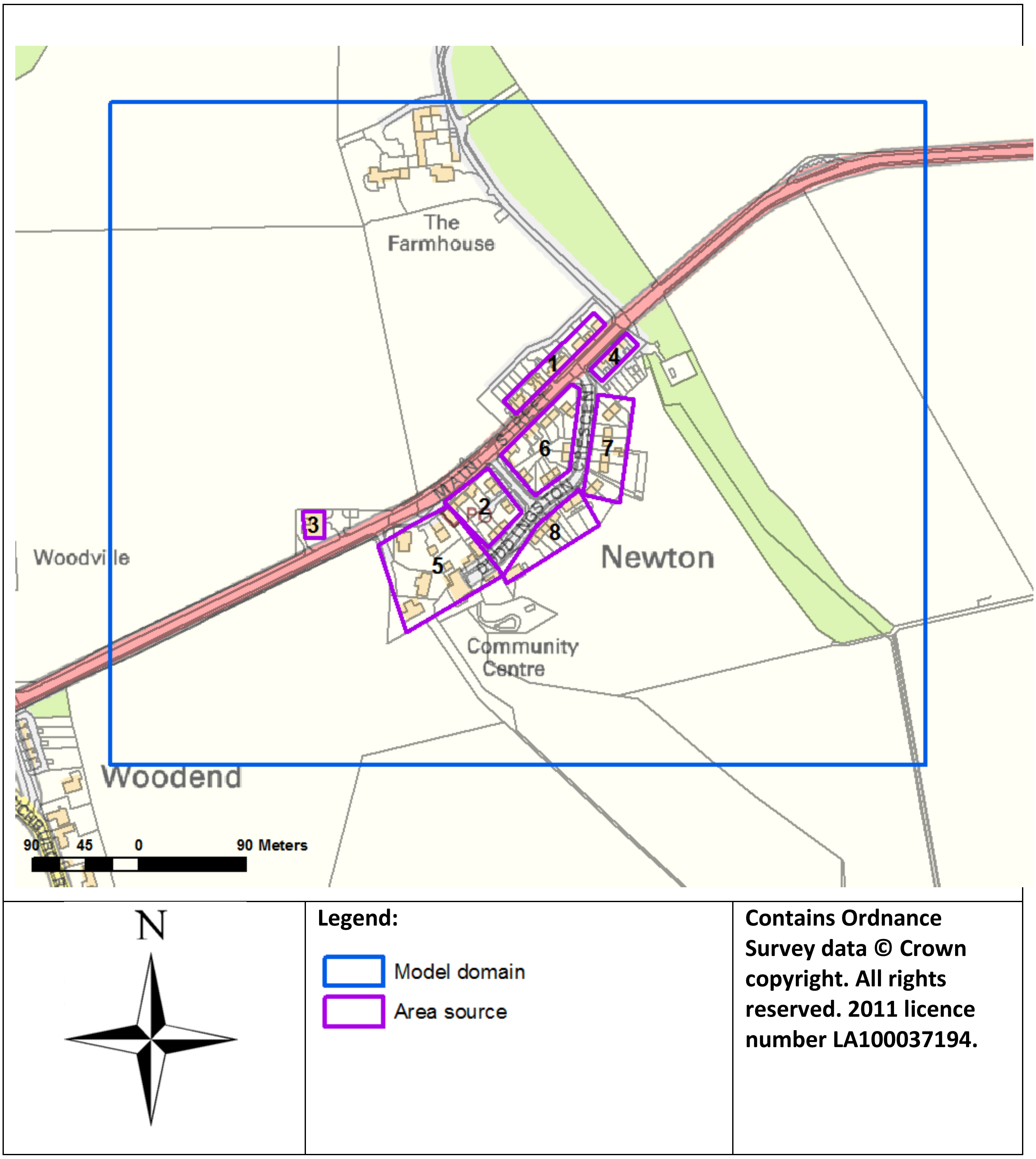
[4] Defra (2012) http://laqm1.defra.gov.uk/review/tools/background.php (accessed September 2012)

Table 9 Residential area modelled in Newton

Newton subdomain	Area m^2	Number of properties
1	1594	10
2	2217	10
3	390	1
4	591	6
5	6163	8
6	3186	15
7	2738	8
8	2234	8

It should be noted that the shapes used for the area sources are to some extent informed by the requirements of ADMS – it cannot make calculations for area sources which are concave.

Figure 4 Newton modelling subdomains



4.7 Monitoring data – PM_{10}

West Lothian Council measures PM_{10} in Newton with a TEOM FDMS analyser.

The data provided in Table 10 shows that the PM_{10} annual mean objective was exceeded at the monitoring site location in 2014.

Table 10 PM_{10} monitoring data from the Newton site with ratified data for 2014

Site	Site Type	Easting, Northing	Data Capture 2014 (%)	Annual Mean PM_{10} ($\mu g.m^{-3}$)
Newton CNC	Roadside	309258, 677728	97	22

4.8 Treatment of background concentrations

The background concentrations of PM_{10} in each of the AQMAs were derived from the maps produced by Defra. The modelled area falls within one 1km map square and so that concentration was used, minus the contribution from domestic sources in the area (this is removed to avoid double counting). For the purposes of verifying the model at Newton, the contribution to the total concentration from local sources is therefore the monitored value minus the background concentration in Table 11. The data used in this assessment is shown in Table 9.

Table 11 Newton background PM_{10} value 2014 (in µg.m^{-3})

X	Y	Total background	Domestic contribution	Total minus domestic
609500	677500	14.22	0.06	14.16

4.9 Emissions data

The census was used to calculate emissions rates within the area. Information in the census was provided as to the number of properties using either coal, mains/bottled gas or electricity. The typical consumption rates were provided by the Office of Gas and Electricity Markets [5](ofgem). The data from the census and ofgem were combined to apportion emissions to each subdomain in the area. The information obtained from the domestic fuel survey undertaken in February 2016 was then used to test the validity of the emissions estimates used within the model.

The data in Table 12 shows that the prevalence of solid fuel and oil is quite high.

Table 12 Central heating type in households in Newton – census data

Central heating type	Number of properties using this central heating	As % of total households
No central heating	2	2.9
Gas	12	17.1
Electric	15	21.4
Oil	17	24.3
Solid fuel (wood, coal)	17	24.3
Other	4	5.7
Two or more types	3	4.3

This data was combined with the ofgem data to estimate the average PM_{10} emission rate per household in Newton all fuel type combined. Indeed, a weighted average has been calculated multiplying the emission rate of each fuel type by the number of houses using that fuel, which was then summed up and divided by the total number of houses in the area. This method has been used as the fuel type used by each household is not known.

The emissions factors used were the most recent available at the time of writing from the National Atmospheric Emissions Inventory and are shown in Table 13. Since the emissions of PM_{10} from gas combustion are negligible, these were discounted from the study.

[5] Factsheet 96, Typical domestic energy consumption figures, Office of Gas and Electricity Markets, 2011

The derived "per property" emissions rates are shown in Table 14 below. As the number of houses using coal and wood is not known, an average of the emission rates for these two fuels has been calculated and is considered to be a conservative approach.

Table 13 2012 NAEI Emissions factors for PM_{10} from domestic combustion

Fuel type	2012 PM_{10} emission factor (g/kg)
Burning oil	0.14
Wood	7.9
Coal	11

Table 14 PM_{10} emission rates for an average property

Fuel type	Emission per property	
	Per year (g/year)	Per second (g/s)
Burning oil	196	0.000006
Average (wood + coal)	26,929	0.01445

Each emission rate was multiplied by the number of properties burning each fuel, which was then summed up and divided by the total number of properties in Newton to get an estimate of emissions per household. This average emission per house was multiplied by the number of properties within each subdomain.

The total emission for each subdomain was divided by the area in square metres to give an emission rate in grams per metre squared per second for input to ADMS-Roads.

The derived emissions rates used in the ADMS model are provided in Table 15.

Table 15 Newton area PM_{10} emission rates

Subdomain	Total emission g/s	Area emission $g/m^2/s$
1	2.08×10^{-3}	1.30×10^{-6}
2	2.08×10^{-3}	9.38×10^{-7}
3	2.08×10^{-4}	5.32×10^{-7}
4	1.25×10^{-3}	2.11×10^{-6}
5	1.66×10^{-3}	2.70×10^{-7}
6	3.12×10^{-3}	9.79×10^{-7}
7	1.66×10^{-3}	6.07×10^{-7}
8	1.66×10^{-3}	7.44×10^{-7}

4.10 Domestic fuel use survey results

A domestic fuel use survey has been carried out in Newton during February 2016 which consisted of a letter drop. The results of that survey are presented in Table 16.

Table 16 Central heating type in households in Newton – domestic fuel use survey results

Central heating type	Number of properties using this central heating	As % of total households
No central heating	-	-
Gas	3	9.7
Electric	7	22.6
Oil	9	29.0
Solid fuel (wood, coal)	9	29.0
Other	3	9.7
Two or more types	-	-

The survey only collects data from 31 households of Newton that comprises 70 households in total. The percentages of total households' use of each fuel type provided by the survey were found to be comparable to the information provided by the census. The change in percentage of total households using a certain type of fuel is less than 10% between to 2 sets of data.

The 'Domestic fuel use survey' carried out by Ricardo Energy & Environment gives a good representation of the fuel use in Newton, however the census is a more complete and robust set of data as it provides data for all the households in Newton. Therefore the census data has been used throughout this study.

5 Dispersion modelling

The most recent version of Atmospheric Dispersion Modelling System (v3.4.2) Roads was used in the assessment. The emissions data calculated above were input to the model alongside the model parameters shown in Table 17 below.

One year (2014) of hourly sequential meteorological data was sourced from the third party supplier for the Edinburgh Airport site – the data from this site was judged to be of good quality. A wind rose of the 2014 data is provided in Appendix 1.

As described previously the sources were modelled as area emissions at ambient temperature – since the emissions are spread over large areas it seems reasonable to assume low ambient release temperature.

A source height of 6m was selected, and values for surface roughness and limit Monin-Obhukov length were selected from model defaults that best describe the areas being modelled.

Table 17 ADMS model parameters

Model parameter	Model input
Source type	Area
Meteorology*	1 year (hourly sequential)
Surface roughness	0.5m
Source height	6m
Source temperature	As ambient
Monin-Obukhov length	10m
Output grid resolution	Approx 3m
*meteorological data from Edinburgh Airport, 2014	

5.1 Model verification

The model outputs were verified by comparing the annual mean predictions with the ratified PM_{10} monitoring data for the same time interval. For the purposed of verifying the model, the contribution from local sources is therefore the monitored value minus the background concentrations in Table 8.

When the background component of PM_{10} is removed from the annual mean measurement, and the model predictions are checked against the remaining locally contributed component, the model was found to underpredict the contribution from local sources by a factor of 3.191 (see Table 18).

Table 18 Newton study adjustment factor on PM_{10} values

X	Y	Modelled PM_{10}	Monitored PM_{10}	Adjustment factor
609500	677500	2.46	7.84	3.191

It is very common for dispersion models to under-predict concentrations in comparison with real measurements even using the best available data. In addition, the model has been reviewed and been improved as best as possible. This under-prediction of PM_{10} concentrations is due to not being able to capture all sources of PM_{10} as well as uncertainties in the fuel and traffic data which are then carried through to the emissions estimates and eventual concentration predictions. To account for these uncertainties the correction factor applied to all model outputs (the background is then added back in to give a total concentration for plotting in the GIS).

6 PM_{10} modelling results

6.1 Modelling Results – Specified Receptor Locations

The adjusted predicted annual mean PM_{10} concentrations at each specified receptors are presented in Table 19 with exceedances of the PM_{10} Scottish annual mean objective highlighted in pink cells.

Annual mean PM_{10} concentrations in excess of the 18 µg.m^{-3} annual mean objective were predicted at ground floor and first floor level at all receptor locations.

Table 19 Newton study adjustment factor on PM_{10} values

Receptor	Address	PM_{10} annual mean (µg.m^{-3}) at 1.5m	PM_{10} annual mean (µg.m^{-3}) at 4m
R1	3 Main Street	19.6	20.4
R2	24 Duddingston Crescent	18.8	20.7
R3	11 Main Street	20.8	21.6
R4	29 Duddingston Crescent	18.4	20.4
R5	19 Main Street	22.2	22.1
R6	10 Duddingston Crescent	20.1	22.9
R7	33 Main Street	21.8	23.1
CM3	Automatic site	22.2	22.8

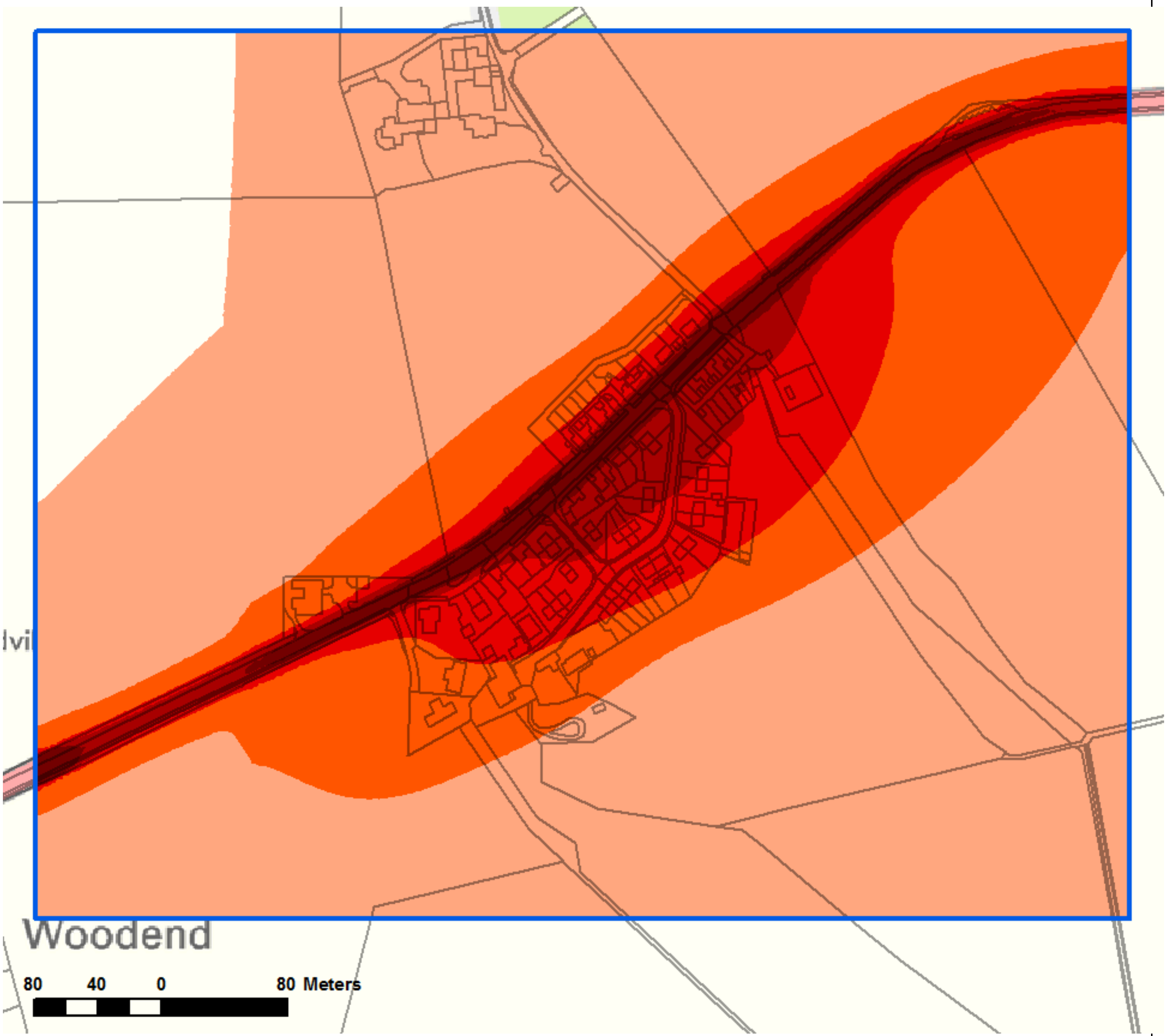
6.2 Modelling Results – Contour Plots

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

Contour plots showing the spatial variation of the predicted 2014 annual mean PM_{10} concentrations across the study area at ground floor level are presented in Figure 5. The modelling indicates that there are exceedances of the PM_{10} annual mean in most of Newton.

The dispersion modelling exercise indicates that West Lothian Council needs to declare an AQMA encompassing the Newton area.

Figure 5 Newton PM_{10} annual mean in 2014



Legend:

- <14
- 14 - 16
- 16 - 18
- 18 - 20
- 20 - 22
- 22 - 26.9

7 Source apportionment Study

Source apportionment is the process whereby the contribution of different pollutant sources to ambient concentrations are quantified. The source apportionment for the assessment should confirm which sources are responsible for the greatest contribution of PM_{10} within the study area.

The contributions from each of the following sources have been quantified:

- Background
- Road traffic
- Domestic fuel combustion

The respective contributions from the above sources have been modelled at a selection of the receptor locations across the study area; this includes the locations where the highest PM_{10} annual mean concentrations were predicted. These receptors are shown on Figure 2. Tables 20 and 21 summarise the relevant PM_{10} contributions from the above sources at the worst-case receptor locations. The source apportionment results are presented visually using segmented bar charts in Figures 6, 7 and 8.

Examination of the source apportionment results indicates that:

- Background PM_{10} concentrations account for a significantly high proportion, up to 91.3% of total PM_{10} concentrations within the study area.
- The contribution from road traffic to PM_{10} concentration is higher for the receptors closer to the road, such as R1, R3, R5 and R7.
- When only comparing the contribution of road traffic and domestic fuel combustion, the largest contribution at each receptor comes from domestic fuel combustion. The contribution of domestic fuel combustion goes from 50.2% for receptors closest to the road up to 92.6% for receptors further away from the road, excluding the background contribution.

Table 20 PM_{10} source apportionment – Contribution by source type ($\mu g.m^{-3}$)

Receptor location	Total PM_{10}	Background	Road traffic	Domestic fuel combustion
R1	15.8	14.1	0.6	1.1
R2	15.6	14.1	0.2	1.3
R3	16.2	14.1	0.9	1.2
R4	15.5	14.1	0.1	1.2
R5	16.7	14.1	1.3	1.3
R6	16.0	14.1	0.2	1.7
R7	16.5	14.1	1.0	1.4
CM3	16.7	14.1	1.1	1.4

Table 21 PM_{10} source apportionment – Contribution by source type not including the background (% of total PM_{10})

Receptor location	Total PM_{10}	Background	Road traffic	Domestic fuel combustion
R1	100.0%	89.1%	3.8%	7.0%
R2	100.0%	90.7%	1.2%	8.2%
R3	100.0%	87.1%	5.3%	7.6%
R4	100.0%	91.3%	0.9%	7.8%
R5	100.0%	84.7%	7.7%	7.5%
R6	100.0%	88.3%	1.4%	10.3%
R7	100.0%	85.4%	6.0%	8.6%
CM3	100.0%	84.7%	6.7%	8.6%

Figure 6 Newton – PM_{10} source apportionment (expressed in $\mu g.m^{-3}$)

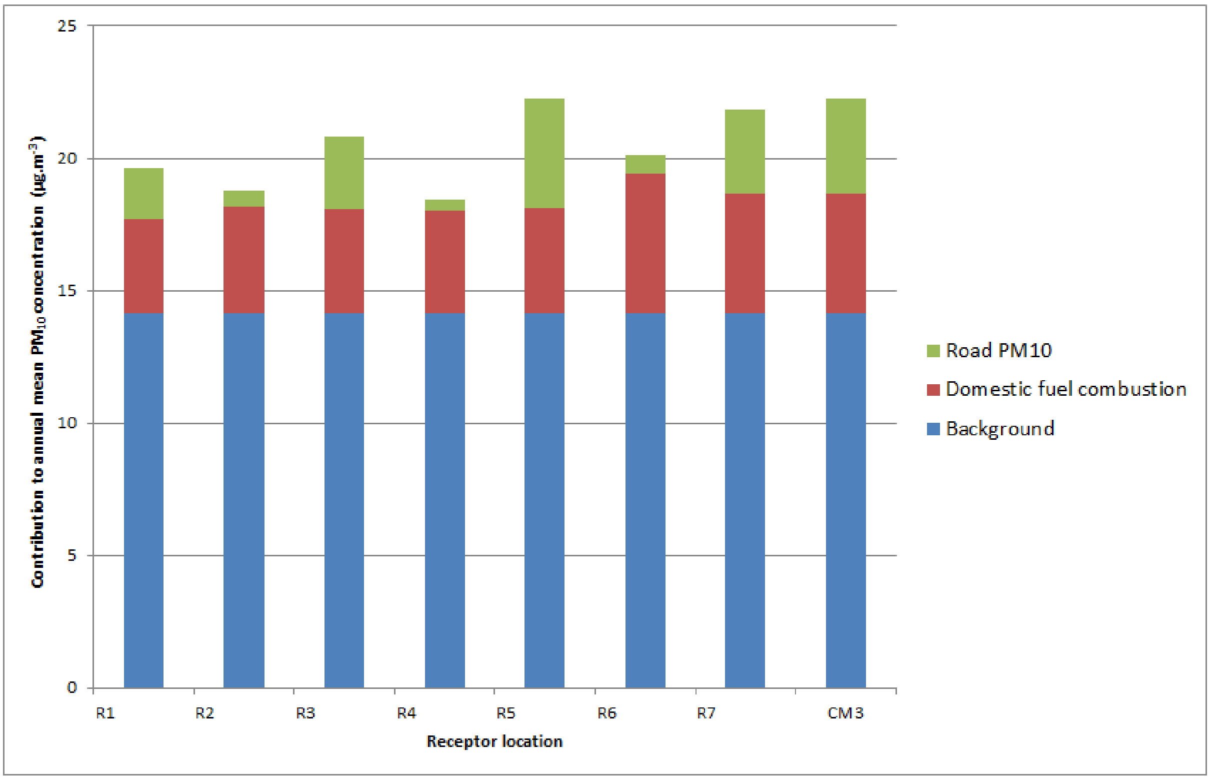


Figure 7 Newton – PM_{10} source apportionment (expressed as a percentage)

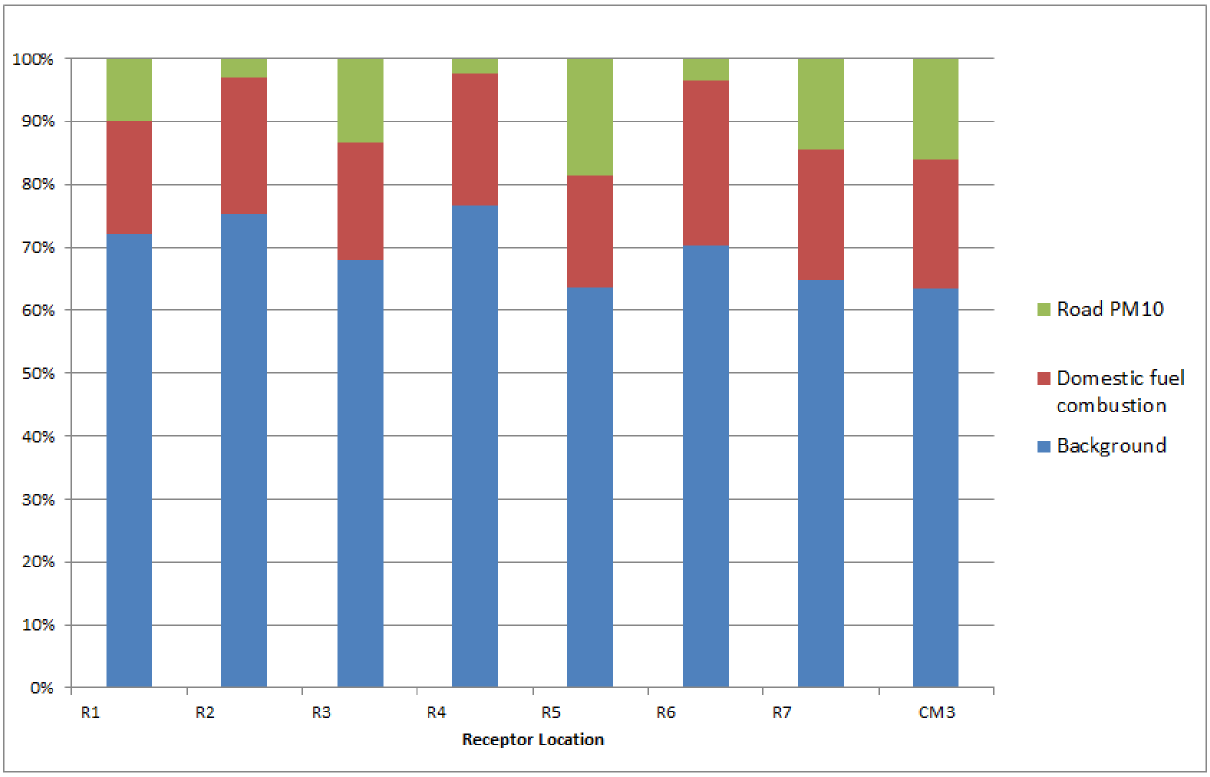
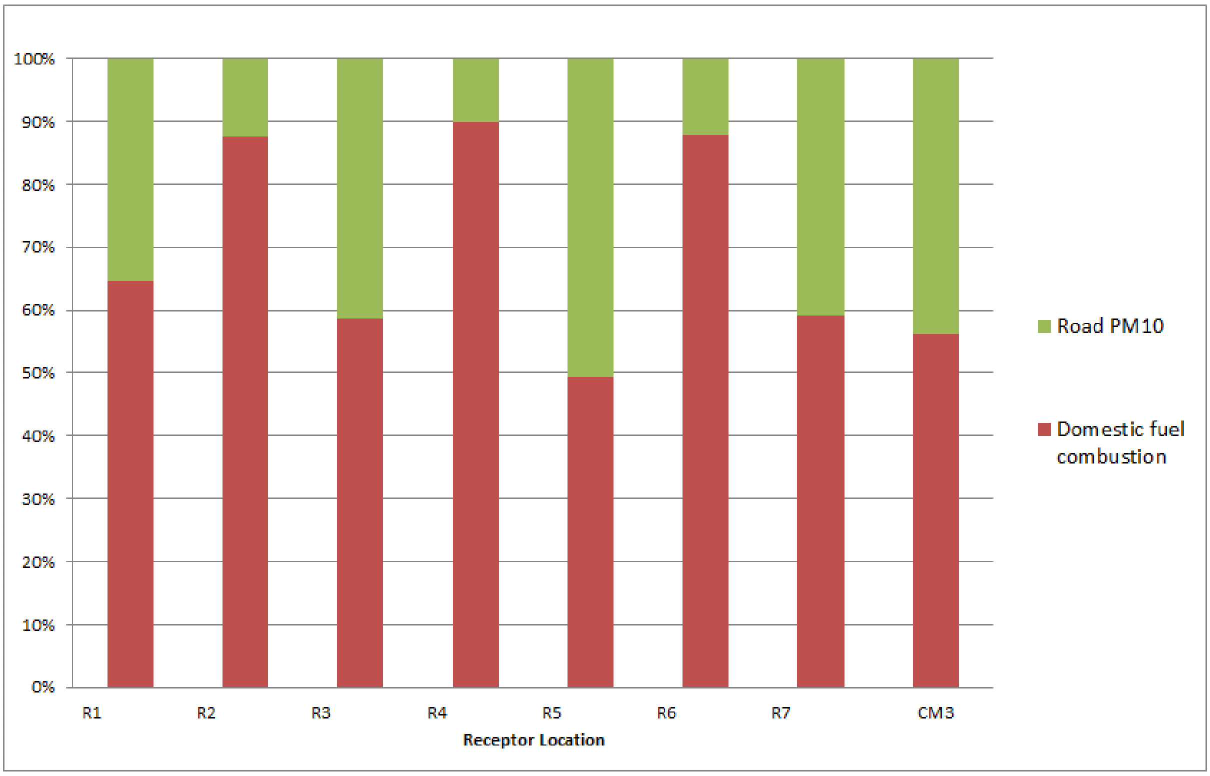


Figure 8 Newton – PM_{10} source apportionment, not including the background contribution (expressed as a percentage)



8 Summary and conclusion

This report described a dispersion modelling study of road traffic and fuel combustion emissions within the Newton area, West Lothian which has been conducted to allow a detailed assessment of PM_{10} concentrations at this location.

A combination of the available automatic monitoring data and atmospheric dispersion modelling using ADMS-Roads has been used to conduct the study. The study utilises the latest available traffic, fuel consumption per household and meteorological data for 2014.

The modelling study and source apportionment has indicated the following:

- The 2 main sources of PM_{10} emissions in the Newton area are fuel combustion and road transport.
- There are exceedances of the PM_{10} annual mean Scottish Objective in most of Newton.
- Background PM_{10} concentrations account for a significantly high proportion, up to 91.3 % of total PM_{10} concentrations within the study area.
- The contribution from road traffic to PM_{10} concentration is higher for the receptors closer to the road.
- When only comparing the contribution of road traffic and domestic fuel combustion, the largest contribution at each receptor comes from domestic fuel combustion. The contribution of domestic fuel combustion goes from 50.2% for receptors closest to the road up to 92.6% for receptors further away from the road, excluding the background contribution.

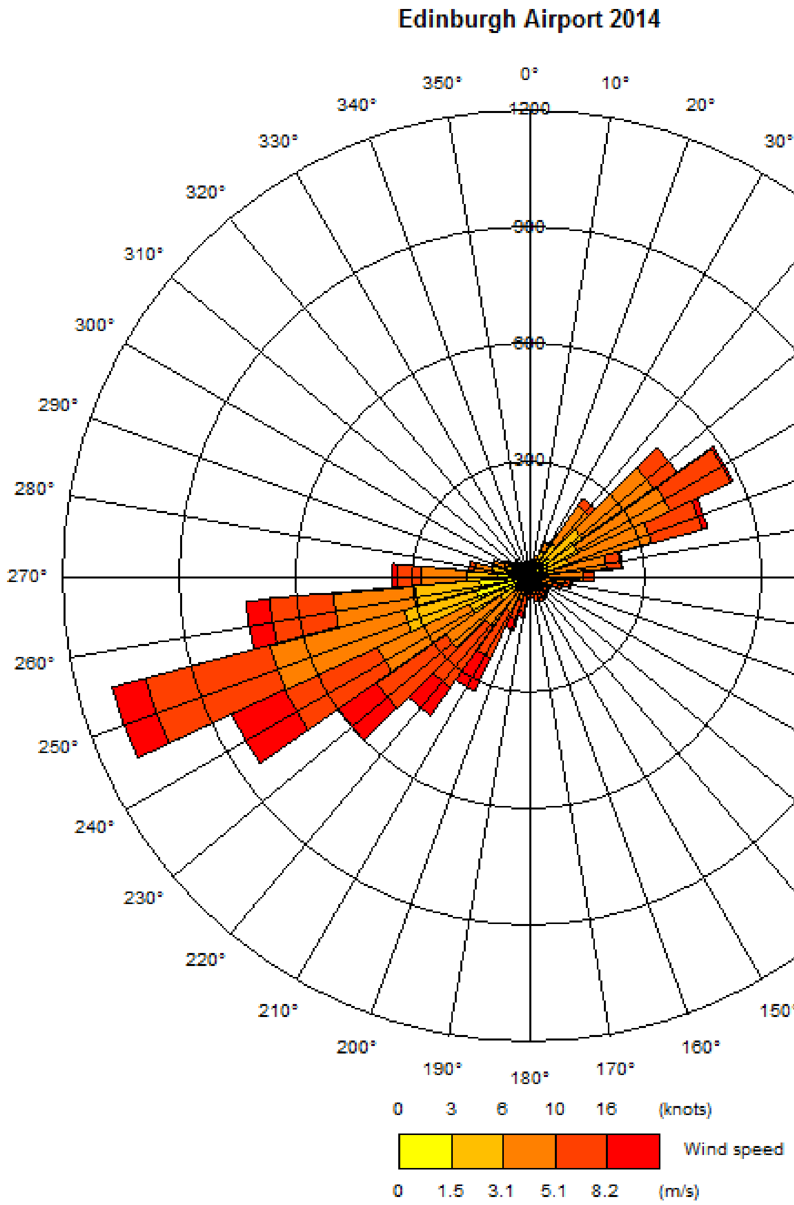
In light of this Detailed Assessment of Air Quality in Newton using the available monitoring data from 2014, West Lothian Council is required to declare an Air Quality Management Area for exceedances of the PM_{10} annual mean Scottish objective.

Appendices

Appendix 1 – Meteorological dataset

The wind rose for the Edinburgh Airport meteorological measurement site is presented in Figure A1.1.

Figure A1.1: Meteorological dataset wind rose



Appendix 1 – Domestic fuel use survey questionnaire

Household Fuel Survey for Newton

Question	**Please circle one answer where applicable**
Property Address (optional)	
What is the main fuel used for heating?	a. Solid b. Oil c. Gas d. Electric e. Economy Seven f. Other
Type of solid fuel	a. Coal b. Wood c. Smoke less fuel d. Other
Solid fuel appliance	a. Open fire b. Glass fronted c. Back boiler d. Aga/Raeburn
Typical frequency of lighting solid fuel appliance	a. Every day b. Week days only c. Weekends only d. Holidays e. Other
Amount of solid fuel purchased / consumed a year	Approximate number of 25 kg bags bought a year: a. More than 10 b. 5 to 10 c. Less than 5
Frequency of solid fuel purchased	a. Once a year b. Between 2 and 5 times a year c. More than 5 times a year
Seasonal solid fuel purchase / consumption data	Is solid fuel used as a backup: a. Once a year b. 2 to 30 times c. More than 30 times
Amount of oil purchased / consumed	a. More than 1000 litres a year b. Between 500 to 1000 litres a year c. Less than 500 litres a year
Daily pattern of oil-based heating	a. All day b. Twice a day c. Not very often
Amount of gas purchased	Approximate gas bill a year: £_______

Question	Please circle one answer where applicable
Frequency of oil & gas purchased	Is solid fuel used as a backup: a. Once a year b. 2 to 30 times c. More than 30 times
Back-up fuel use	a. Coal b. Wood c. Smoke less fuel d. Oil e. Gas f. Other
Back-up fuel use appliance	a. Open fire b. Glass fronted c. Back boiler d. Aga/Raeburn
Amount of back-up solid fuel	Approximate number of 25 kg bags bought a year: a. More than 10 b. 5 to 10 c. Less than 5
Amount of back-up 'other' fuel	a. Open fire b. Glass fronted c. Back boiler d. Aga/Raeburn
Intention to change fuel	Yes/No
Air quality perception issues/ additional comments	Please list:

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR
United Kingdom

t: +44 (0)1235 753000
e: enquiry@ricardo.com

ee.ricardo.com