LANCASTER CITY COUNCIL

Promoting City, Coast & Countryside

ENVIRONMENT ACT 1995 - PART IV

LOCAL AIR QUALITY MANAGEMENT

FURTHER ASSESSMENT OF LOCAL AIR QUALITY IN Galgate, Lancashire

November 2010

Prepared by the Air Quality Management Resource Centre,
University of the West of England, Bristol

Executive Summary

This Further Assessment undertakes a number of tasks:

- Analysis of ambient NO_2 monitoring data in Galgate 2006-2009;
- A detailed modelling study of the central road network in Galgate;
- A calculation of the required nitrogen oxide reductions necessary to achieve the 40µg/m^3 annual mean nitrogen dioxide air quality objective at all monitoring points near the Air Quality Management Area (AQMA);
- A breakdown of nitrogen dioxide emissions on modelled road links between those attributable to Light and Heavy Duty Vehicles;
- An analysis of temporal variations in road emissions on Main Road;

The findings of the Further Assessment are as follows:

- There are significant exceedences of the 2005 NO_2 annual mean objective still occurring in Main Road, Galgate at locations where there is relevant exposure as defined by guidance (principally residential properties);
- These exceedences appear to be limited to the stretch of the A6 (Main Road) between the railway bridge, extending north to just beyond the crossroads with Salford Road/Stoney Lane. However, all predicted exceedences are within the current AQMA and there is no need to extend the current boundaries;
- There is also no evidence to suggest that the boundaries could/should be reduced;
- At the worst case monitoring location in Main Road, estimates suggest that local emissions of nitrogen oxides would need to be reduced by around 44% in order to meet the AQ objectives;
- It is thought that the effect of queuing traffic in Main Road is having a significant effect on vehicle emissions. Therefore it is not expected that a 40% reduction in emissions relates to a 40% reduction in vehicle movements as a lower traffic volume may ease congestion;
- Despite Heavy Duty Vehicles only contributing to around 5% of vehicle flows on Main Road, their large size and respectively greater emissions mean that this relatively small number of vehicles contributes over 50% of the nitrogen oxide emissions within Main Road;
- Pollution concentrations in Main Road appear to be dominated by the morning peak hour traffic, although this is likely to be due to meteorological conditions rather than differences in traffic flows.

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CHAPTER 1: Introduction

1.1 Purpose and Aim of the Further Assessment

1.1.1 Requirements of the Further Assessment

This Further Assessment of Air Quality is carried out in respect of the Galgate Air Quality Management Area (see section 1.2). This report is required by Section 84(1) of the Environment Act 1995 which states that an authority which has designated an air quality management area (AQMA) shall:

"*for the purpose of supplementing such information as it has in relation to the designated area in question, cause an assessment to be made of:*

a) the quality for the time being, and the likely future quality within the relevant period, of air within the designated area to which the order relates; and

b) the respects (if any) in which it appears that air quality standards or objectives are not being achieved, or are not likely within the relevant period to be achieved, within that designated area."

Guidance provided by Defra and the Devolved Administrations[1] suggests that the further assessment should provide the technical justification for the measures an authority includes in its action plan.

The Further Assessment is intended to allow authorities to:

- Confirm their original assessment, and thus ensure they were correct to designate an AQMA in the first place;
- Calculate more accurately what improvement in air quality, and corresponding reduction in emissions, would be required to attain the air quality objectives within the AQMA;
- Refine their knowledge of sources of pollution, so that the air quality action plan may be appropriately targeted;
- Take account of any new guidance issued by Defra and the devolved administrations, or any new policy developments that may have come to light since declaration of the AQMA;
- Take account of any new local developments that were not fully considered within the earlier review and assessment work. This might, for example, include the implications of new transport schemes, commercial or major housing developments etc., that were not committed or known of at the time of preparing the Detailed Assessment;
- Carry out additional monitoring to support the conclusion to declare the AQMA;
- Corroborate the assumptions on which the AQMA has been based, and to check that the original designation is still valid, and does not need amending in any way; and

[1] LAQM Technical Guidance 2009

- Respond to any comments made by statutory consultees in respect of the Detailed Assessment.

1.1.2 Contents of this Report

As such this report presents information relating to all these points. In particular the following issues are dealt with:

- Further monitoring data collected since the time of the Updating and Screening Assessment in 2009 that led to the AQMA declaration;
- Lancashire County Council has undertaken special traffic counts for the purpose of the Further Assessment. These counts provide recent data for all significant road links in Galgate village centre.
- Detailed modelling of the main road network in Galgate has been carried out using the ADMS-Roads dispersion model (version 2.3);
- Data from both the modelling and monitoring studies has been used to estimate the reductions in both nitrogen dioxide and total nitrogen oxides required in order to achieve the annual mean air quality objective.
- Data from the modelling study and additional traffic count information has been analysed in order to estimate the relative contributions to pollution concentrations from Light Duty Vehicles (LDVs = motorcycles, private cars, and light goods vehicles), and Heavy Duty Vehicles (HDVs = rigid and articulated heavy goods vehicles, and public transport).

1.2 Galgate Air Quality Management Area

Galgate is a village on the A6 Preston to Lancaster road about 3 miles south of Lancaster (see Figure 1). It has a population of around 1,500–2,000. The West Coast Main Line (WCML) passes through the village on an elevated track. The M6 motorway passes just to the east of the village (500 m east of the main crossroads). The Lancaster Canal also passes through the village to the west of the railway line.

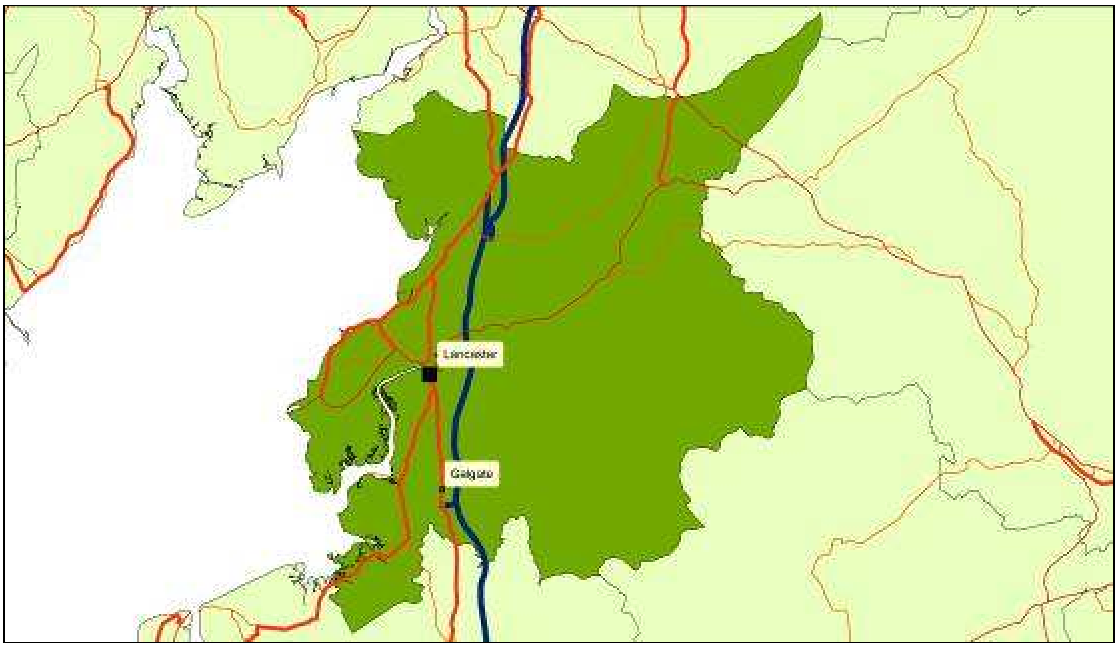

Figure 1: Location of Galgate within Lancaster Council boundaries

The current Air Quality Management Area for Galgate came into force on 16th November 2009. The area runs along Main Road Galgate, between property numbers 59 and 103, and extends 20 metres from the kerb on either side of the road (see Figure 2).

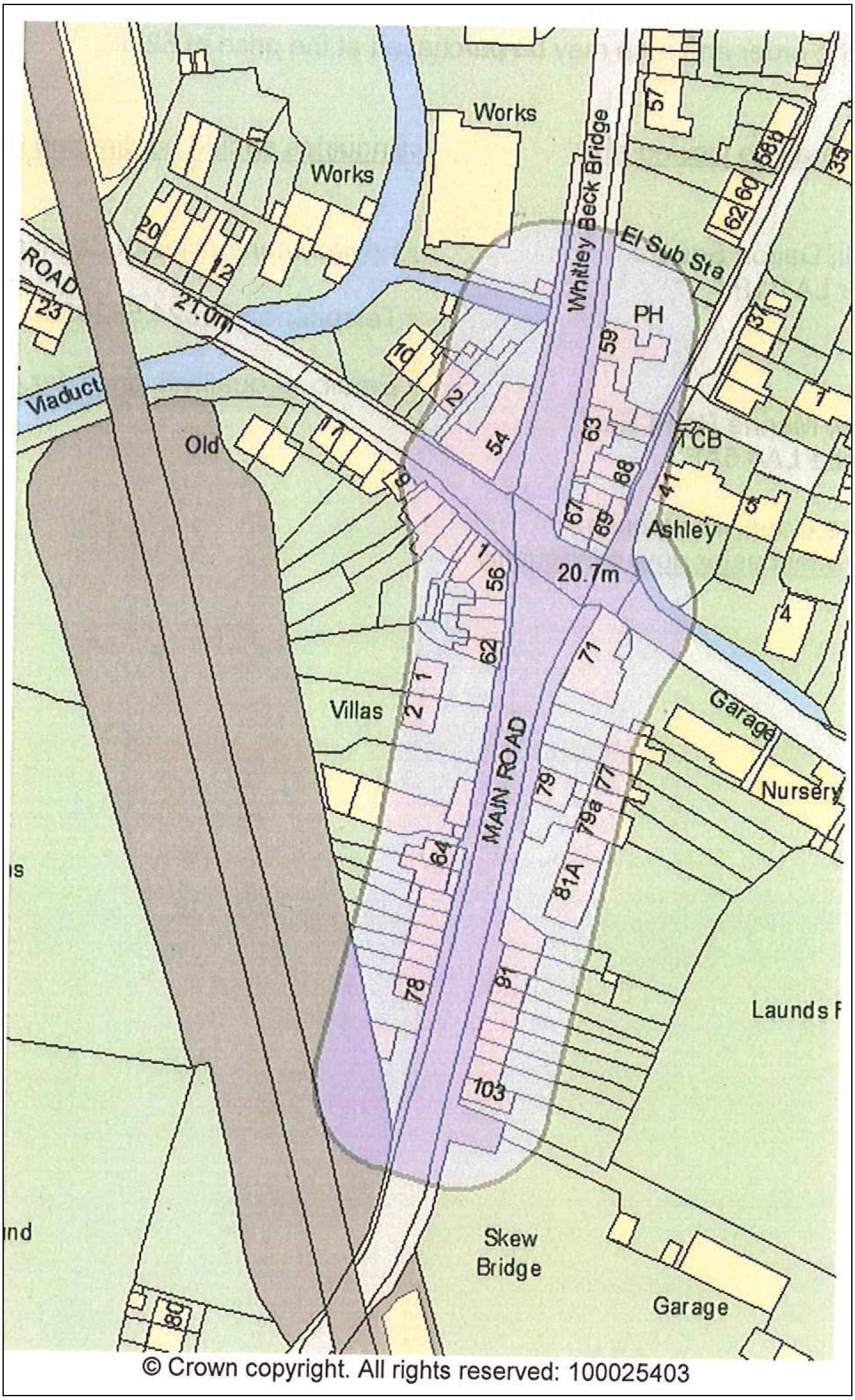

Figure 2: Galgate Air Quality Management Area

The AQMA was declared following the Council's Local Air Quality Management (LAQM) Updating and Screening Assessment report (May 2009) which reported exceedences of the annual mean air quality objective for nitrogen dioxide at diffusion tubes in the village.

1.3 Galgate

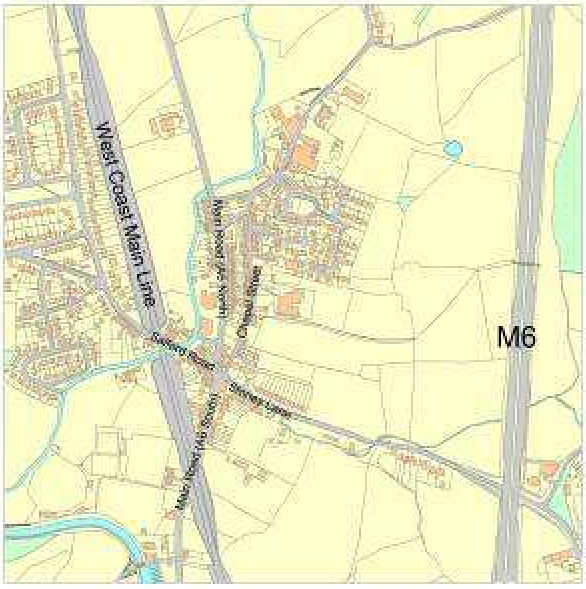

Figure 3: Key Roads in Galgate

Figure 4: Google Earth images of Galgate crossroads ©2010 Infoterra & Bluesky

Galgate lies along the A6 Preston/Lancaster Road (AADF ≈ 16-17,000). The crossroads with Stoney Lane (AADF < 2,000) and Salford Road (AADF < 2,000) forms the centre of the old village, with newer housing off to the west of the railway line. The junction is controlled by traffic lights and can often lead to queuing traffic along the A6, especially at peak hours.

The area around the crossroads is relatively level with no significant gradients, except for the railway embankment which runs well above roof height. Due to the height of the rail line it is not anticipated that emissions from trains will contribute significantly to NO_2 concentrations along Main Road. There is a considerable amount of on-street parking in the village centre – in particular along the east side of Main Road (both sides of the crossroads) and on the south side of Salford Road, immediately west of the crossroads. There are bus stops either side of the Main Road just to the north of the junction. There are approximately two buses an hour during the day on weekdays, and these can lead to some additional queuing but this is not considered to be particularly significant.

CHAPTER 2: Monitoring Data

2.1 Automatic Monitoring

There is no monitoring undertaken with continuous automatic analysers in Galgate. However, Lancaster City Council operates an automatic NOx and PM_{10} monitoring station in Lancaster City Centre located around 6 m from the kerb of Water Street and around 25 metres from the kerb of the A6 Cable Street section of the southern gyratory. To give an indication of long-term pollution trends in the area Table 1 shows monitoring results from this station between 2000 and 2008.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009*
Annual mean	33	35	30	32	31	32	32	28	31	30
Maximum hourly mean	126	136	115	147	120	121	116	111	-	140
Exceedences of hourly AQO	0	0	0	0	0	0	0	0	0	0
Data capture rate	98	97	98	100	97	96	99	94	99	99
	*Unratified data									

Table 1: NO_2 concentrations at Lancaster Water Street Automatic Monitor 2000-8

2.2 Diffusion Tube Monitoring

Lancaster City Council has 8 diffusion tube monitoring sites in Galgate. The latest (ZC) was only established in December 2009 and so isn't covered in any tables or maps within this report). The bias adjusted results are presented in Table 2. Details of bias adjustment factors used are provided in Appendix 1.

Tube	2006	2007	2008	2009*	Max
V	**41**	**43**	**43**	**49**	**49**
W	-	-	39	**42**	**42**
X	-	-	28	31	31
Y	-	-	38	**43**	**43**
Z	-	-	**43**	**47**	**47**
ZA	-	-	31	35	35
ZB	-	-	-	31	31
* Provisional bias adjustment factor used (see Appendix 1). **Bold** indicates concentration above objective.					

Table 2: Diffusion Tube Results (µg/m^3 bias adj.) 2003-7

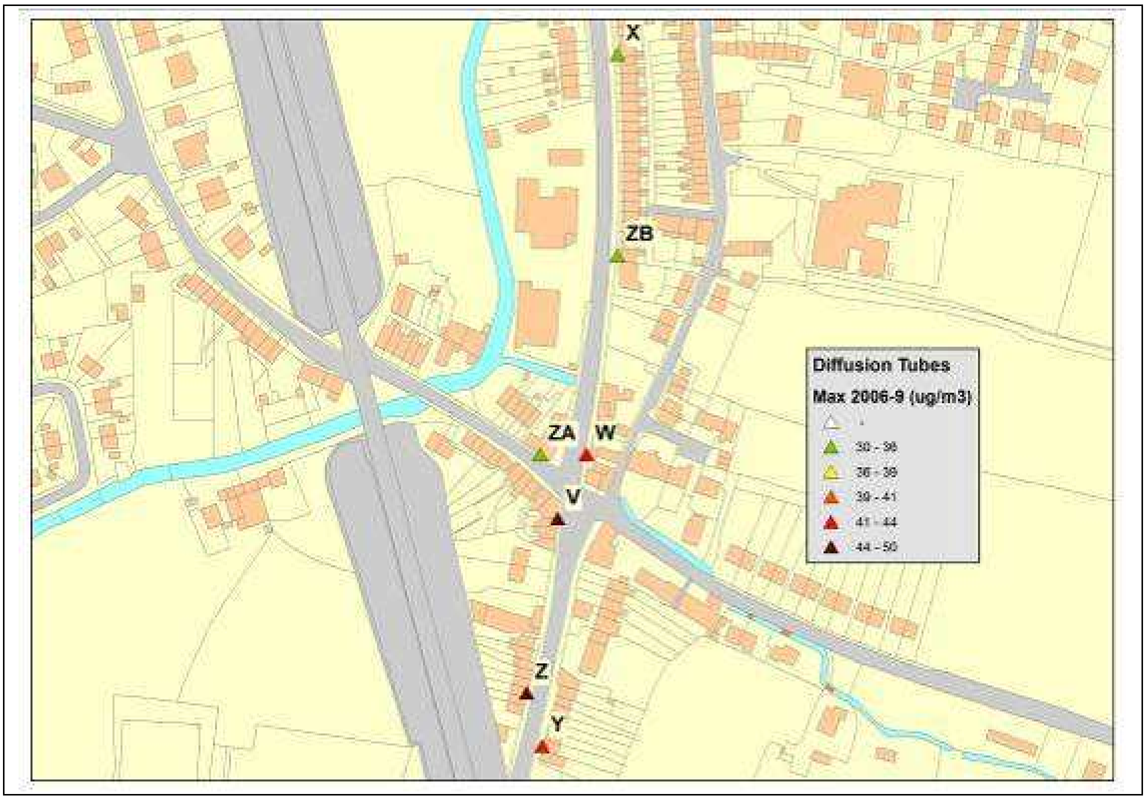

Figure 5: Galgate Diffusion Tubes (maximum concentration 2006-9).

Figure 5 and Table 2 show that the main problems with nitrogen dioxide in Galgate are being experienced along Main Road around the main crossroads, and south towards the railway bridge. Beyond the bridge to the south the village rapidly ends, and the road passes through open countryside, and is not susceptible to as much queuing traffic. To the north of the crossroads, the road is slightly more open, with properties having small front gardens rather than facing straight on to the road, thus allowing pollution to disperse more. Neither Stoney Lane, Salford Road nor Chapel Street have flows over 2,500 vpd. Any area of exceedence is likely to be limited to the area extending along Main Road from the railway bridge to just north of the crossroads.

CHAPTER 3: Input Data for Modelling

3.1 Traffic Data

Traffic data was provided by Lancashire County Council Traffic Counts Team, from counts undertaken specifically for this Further Assessment. Counts were undertaken at 5 locations (see Figure 6) representing flows on all roads being modelled. Results from the traffic counts were supplied as 'average weekday', Saturday and Sunday.

Additional traffic data was obtained from the Highways Agency for the M6.

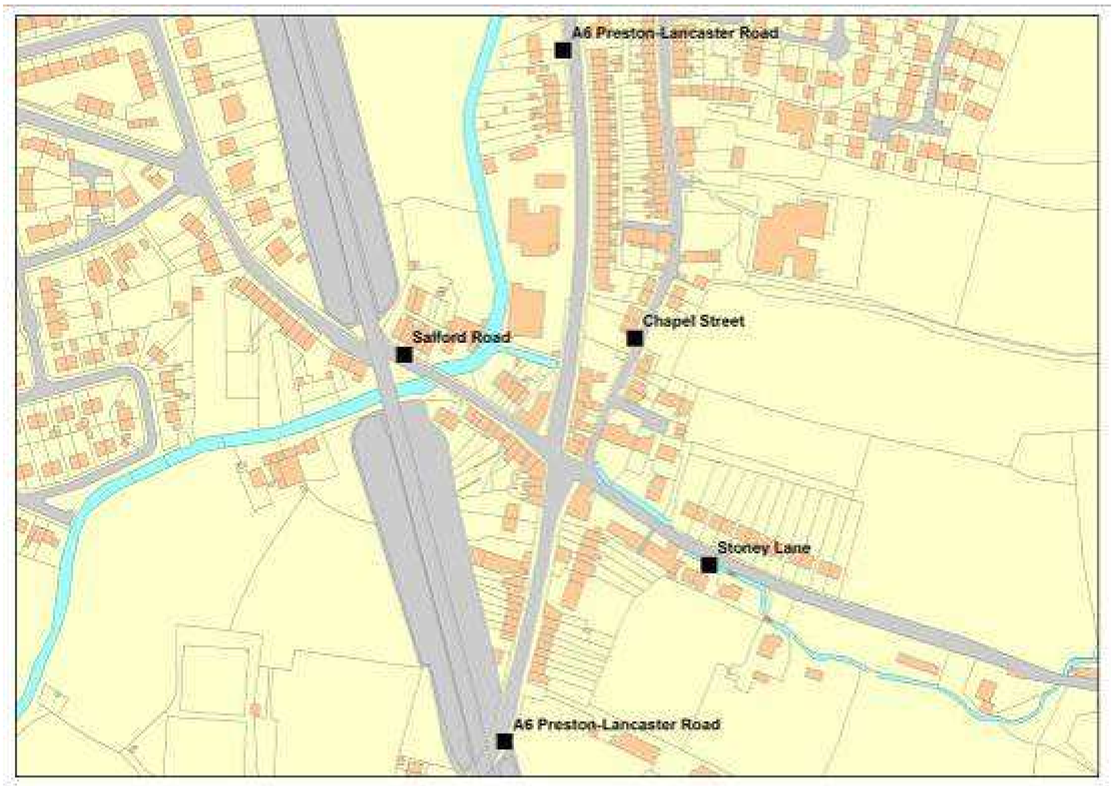

Figure 6: Location of traffic counts used for modelling

3.1.1 Flows

ROAD	Week	Total	LDV	HDV	%HDV	Speed kph	Total	LDV	HDV	%HDV	Speed kph	Total	LDV	HDV	%HDV
A6 (North of Xroads)		Northbound					Southbound					Both Directions			
	Week	8842	8397	445	5.0	28	8698	8338	360	4.1	24	17540	16735	805	4.6
	Sat	7038	6797	241	3.4	29	6737	6558	179	2.7	26	13775	13355	420	3.0
	Sun	6499	6347	152	2.3	29	6149	6040	109	1.8	26	12648	12387	261	2.1
	AADF	8250	7876	374	4.5	28	8054	7756	298	3.7	25	16304	15631	672	4.1
A6 (South of Xroads)		Northbound					Southbound					Both Directions			
	Week	8880	8385	495	5.6	24	8189	7876	313	3.8	27	17069	16261	808	4.7
	Sat	7077	6851	226	3.2	26	6497	6318	179	2.8	29	13574	13169	405	3.0
	Sun	6487	6312	175	2.7	27	5922	5807	115	1.9	28	12409	12119	290	2.3
	AADF	8281	7870	411	5.0	25	7623	7358	266	3.5	28	15904	15227	677	4.3
Stoney Lane		Eastbound					Westbound					Both Directions			
	Week	555	528	27	4.8	27	752	725	26	3.5	26	1306	1254	53	4.0
	Sat	440	430	10	2.3	30	536	532	4	0.7	29	976	962	14	1.4
	Sun	378	374	4	1.1	31	420	417	3	0.7	29	798	791	7	0.9
	AADF	513	492	21	4.1	28	673	654	20	2.9	27	1186	1146	41	3.4
Salford Road		Eastbound					Westbound					Both Directions			
	Week	1284	1220	64	5.0	18	1230	1194	37	3.0	16	2514	2413	101	4.0
	Sat	1049	1006	43	4.1	18	1069	1052	17	1.6	16	2118	2058	60	2.8
	Sun	1025	1013	12	1.2	18	984	972	12	1.2	17	2009	1985	24	1.2
	AADF	1213	1160	54	4.4	18	1172	1142	30	2.6	16	2385	2301	84	3.5
Chapel Street		Northbound					One-Way								
	Week	457	437	19	4.2	17									
	Sat	251	244	7	2.8	17									
	Sun	262	255	7	2.7	17									
	AADF	399	384	16	4.0	17									
M6												Both Directions			
	Week											-	-	-	-
	Sat											-	-	-	-
	Sun											-	-	-	-
	AADF											61329	50898	10431	17.0

Table 3: Summary of traffic data used for modelling

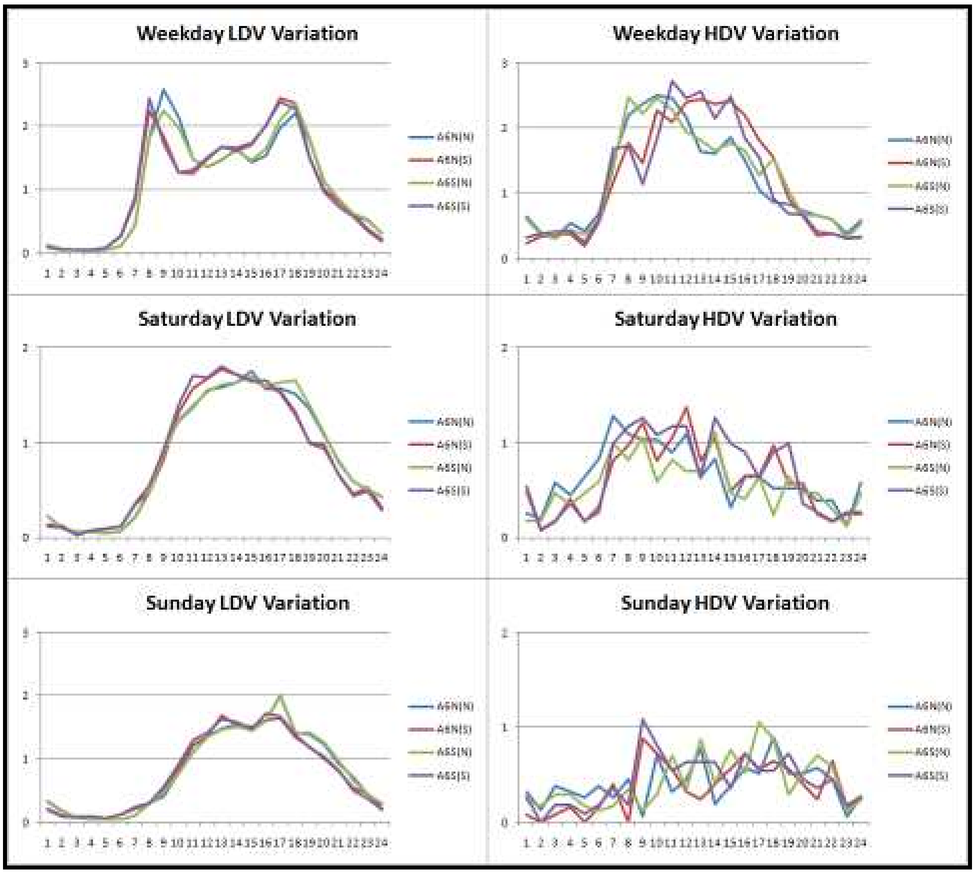

Figure 7: Diurnal/Weekly Traffic Profiles for A6 (Split LDV/HDV)

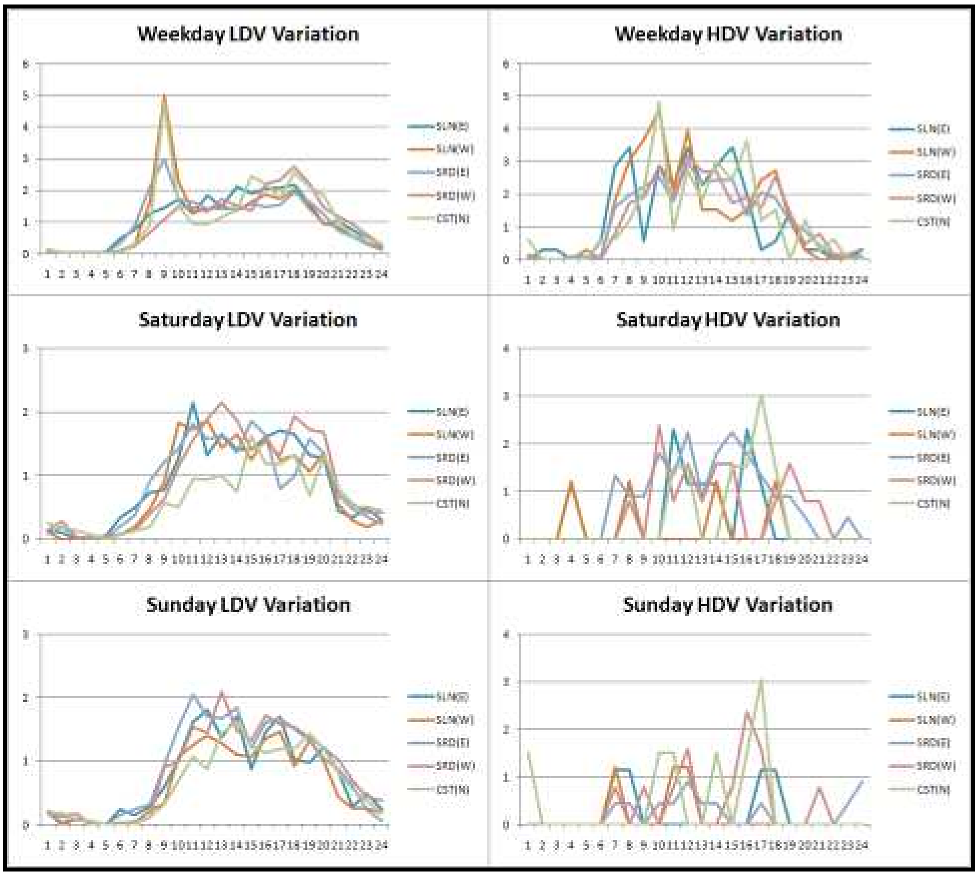

Figure 8: Diurnal/Weekly Traffic Profiles for Other Modelled Roads (Split LDV/HDV)

3.2 Emissions

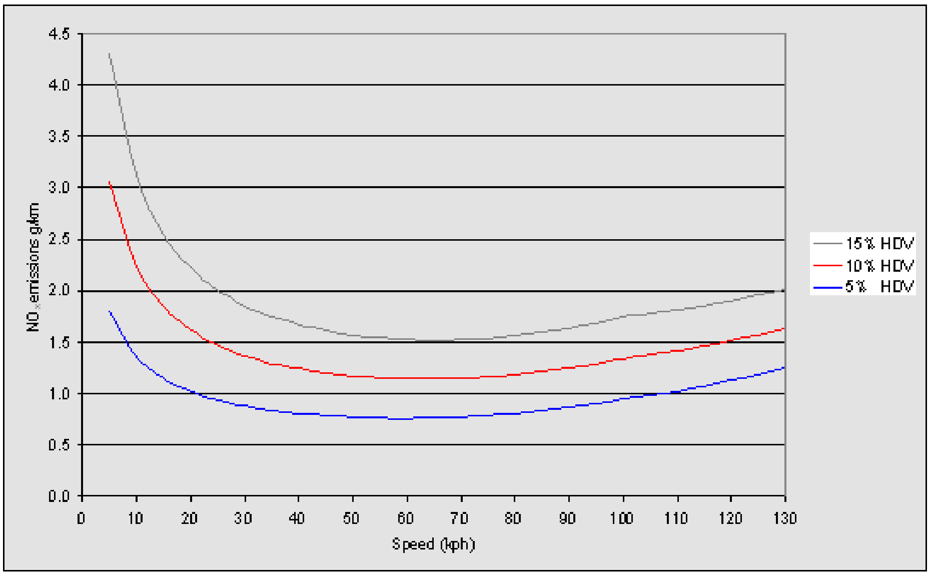

Figure 9: Graph showing vehicle emissions profiles from DMRB 11.3.1 (graph taken from http://www.highways.gov.uk/knowledge/1801.aspx)

Figure 9 shows the emissions factors used in the model from the 2003 version of the Design Manual for Roads and Bridges.

3.2.1 Speeds

For road sections away from junctions, the average speeds from the traffic counts were used. For sections close to and passing through junctions, guidance document TG(09) was used to inform the average speeds used in the model.

3.2.2 Queuing Traffic

All junction arms feeding into the crossroads incorporated queuing traffic in the model. This was done by modelling varying lengths of queue at a speed of 5 kph dependent on the relative flow of traffic along that road length e.g. at times when hourly flows were above the average hourly flow rate, a short queue was modelled, when they were twice the average hourly flow a longer queue was modelled, and when they were over three times the average an even longer queue was modelled. This slower average speed increases emissions in order to attempt to represent both standing and slow moving traffic.

3.2.3 Heavy Duty Vehicles classes

As described above, no detailed split of vehicle classes were provided and so vehicles were simply modelled according to an LDV/HDV split.

3.3 Building Height

No building heights were used in the modelling as none of the roads were considered to form a significant canyon effect.

3.4 Road Width

Road widths were measured using ArcGIS and Ordnance Survey MasterMap data.

Widths for each lane tended to be about 3–3.5 metres. Where cars were parked along the east side of Main Road (either side of the junction), the easternmost lane was aligned away from the kerb, and this was found to significantly improve model accuracy (due to reducing predicted concentrations along the eastern side of the road, and increasing them along the west).

3.5 Gradient

No gradients have been taken into account during the modelling, as no significant gradients were identified in the modelling area.

3.6 Background Data

No locally monitored background data was available, so a default, guidance document TG(09) recommends using background data from the LAQM Tools resource to represent background concentrations in LAQM modelling.

The area being modelled falls completely within a single 1 km grid square. The background NOx values used for the modelling had the 'within square' emissions from Primary Roads and Motorways subtracted from them as these were explicitly modelled (in particular as the M6 was to the easternmost side of the cell it was considered more appropriate to model it than to include it as a constant background source due to prevailing south-westerly winds). The background data is shown in Table 4.

	NOx (ug/m^3)		NO_2 (ug/m^3)	
	2008	**2009**	**2008**	**2009**
Total Background	19.9	18.7	16.0	15.3
M6	8.3	7.0	-	-
A Roads	0.8	0.7	-	-
Background for modelling	**10.8**	**11.0**	**16.0**	**15.3**

Table 4: Estimated background pollution concentrations for Galgate AEA/LAQM Tools)

3.7 Meteorological Data

Meteorological data was obtained from the UK Met Office. The nearest available site providing the full set of meteorological variables needed by the ADMS-Roads model (temperature, wind speed and direction, and cloud cover) is at Manchester (Ringway 2002 -2004, Woodford 2004 onwards), approximately 60 miles from the modelling locations. For a number of previous studies in Lancashire, temperature, windspeed and wind direction have been taken from Preston weather station – only 25 miles from the modelling locations. Unfortunately the Met Office have had problems supplying the Preston dataset and, due to a lack of any other suitable locally collected data, the meteorological data used has been from Manchester Woodford. Further details of the locations of the met sites and graphs of temperature, wind and cloud data can be found in Appendix 2.

3.8 Model Details and Settings

The model used was ADMS-Roads (v.2.3) supplied by CERC Ltd.

Settings used for the model were:

- Surface Roughness = 0.5 m (representing 'Open Suburbia')
- Monin-Obukhov Length = 10 m ('Small Towns <50,000 pop.')

Modelling was carried out for NOx only. No chemistry options were used.

CHAPTER 4: Model Verification and Adjustment

The modelling process was carried out following the guidance set out in LAQM.TG(09). This process requires model output to undergo 'verification and adjustment'. Initial predictions from dispersion models are unlikely to match local monitoring data for a number of reasons. These include:

- Estimates of background concentrations;
- Meteorological data uncertainties;
- Uncertainties in source activity data such as traffic flows, fleet composition and emission factors;
- Model input parameters such as roughness length, minimum Monin-Obukhov; and overall model limitations such as the poor representation of building effects;
- Uncertainties associated with monitoring data, including locations.

Following an initial comparison between modelled and monitored data, various elements of the model were adjusted, such as speed, location of lane centrelines (where traffic flows around parked cars) etc. Following these alterations to the model setup, the model output for nitrogen oxides still showed a degree of error, or difference, compared to estimations of NOx from road sources based on monitored data.

In order to adjust the model, the results from the modelled (Road) NOx are initially compared with estimates of Road NOx from monitoring data (see Table 5 and Figure 10). This showed that the model was underestimating monitor derived values by between 2.90 and 3.37 (which is consistent with our experience of what can be expected for 'good' model performance). An adjustment factor of 3.0544 was calculated by linear regression, and this was applied to the model output. The adjusted NOx value was then converted to NO_2 using the methodology set out in the guidance and the background NO_2 value added. This gave final predictions for total NO_2, with all locations within 6% of monitored NO_2 values (see Table 6 and Figure 11).

The model also showed a high degree of precision, with R-squared values on all the regression lines being over 0.97.

Site	NOx Rds Mon (µg/m³)	NOx Rds Mod (µg/m³)	Corr Fac	Adjusted Nox Rds Mod (µg/m³)	Dif. NOx (ug/m3)	Dif. NOx (%)
				Regression Factor 3.0544	NOx Tot Mod - NOx Tot Mon	(NOx Tot Mod - NOx Tot Mon) /NOx Tot Mon
V	97.13	31.79	3.06	97.09	-0.04	0.00
W	82.04	28.28	2.90	86.38	4.34	0.05
X	48.89	16.70	2.93	50.99	2.10	0.04
Y	80.17	25.99	3.08	79.39	-0.78	-0.01
Z	99.34	32.06	3.10	97.93	-1.41	-0.01
ZA	57.35	17.03	3.37	52.01	-5.34	-0.09

Table 5: Verification and adjustment of modelled and monitored NOx (2008).

Site	Monitored NO_2 (μg/m³)	Modelled NO_2 (μg/m³)	Difference NO_2 (μg/m³)	Difference NO_2 (%)
			NO_2 Tot Mod-NO_2 Tot Mon	(NO_2 Tot Mod - NO_2 Tot Mon)x100 / NO_2 Tot Mon
V	44.5	44.5	-0.01	-0.02%
W	40.3	41.5	1.25	3.11%
X	29.5	30.2	0.77	2.61%
Y	39.7	39.5	-0.24	-0.60%
Z	45.1	44.7	-0.38	-0.83%
ZA	32.5	30.6	-1.88	-5.78%

Table 6: Comparison of final modelled and monitored concentrations for Total NO_2 (2008).

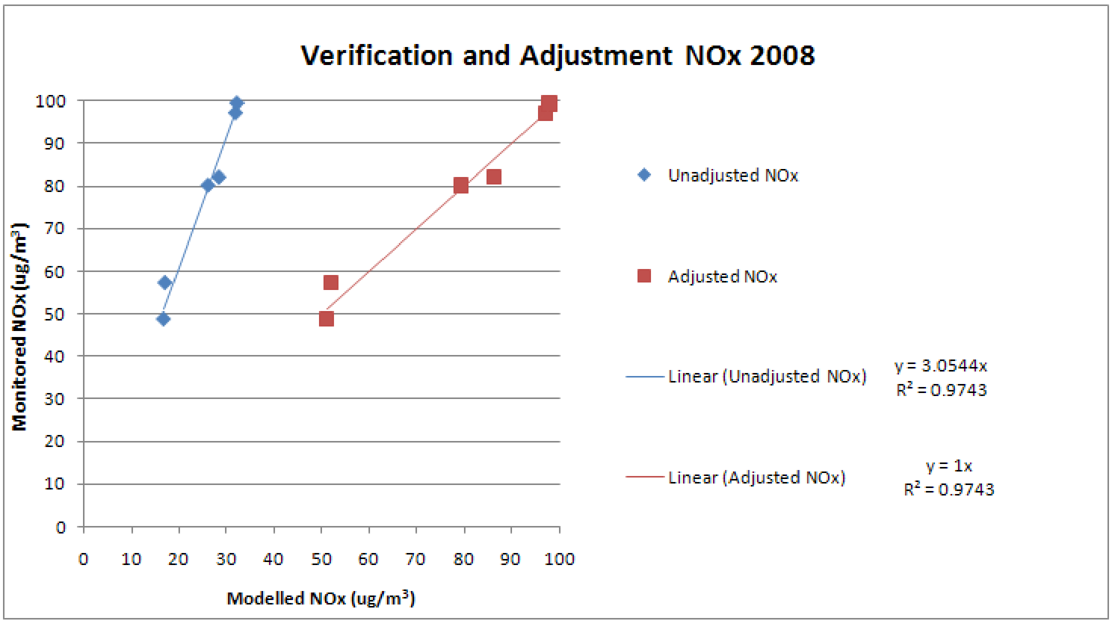

Figure 10: Comparison of modelled vs monitored data for NOx

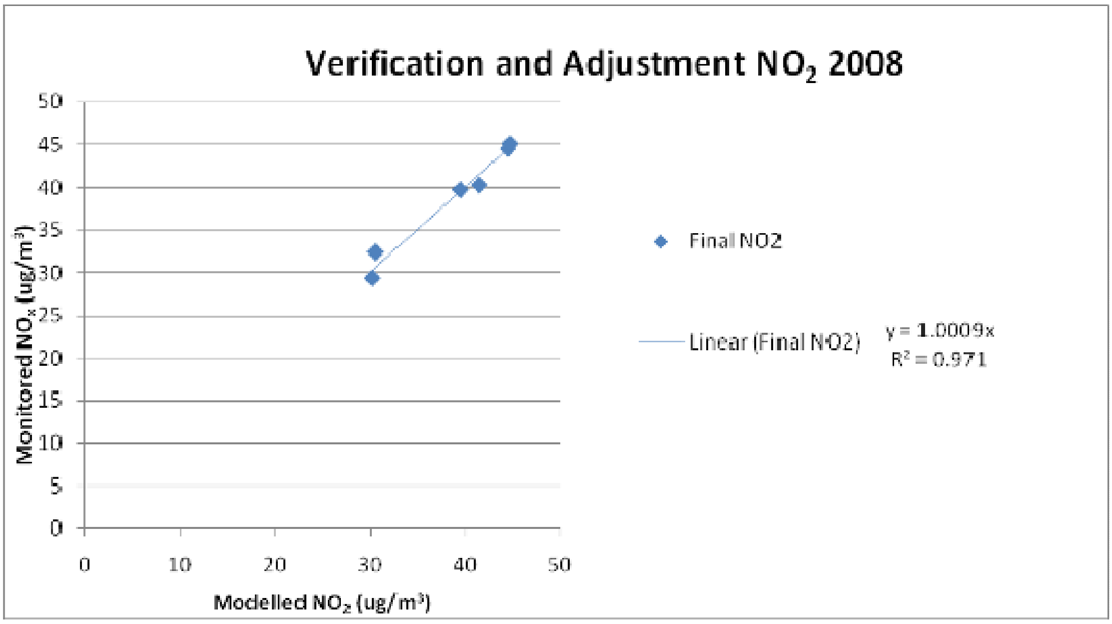

Figure 11: Comparison of modelled vs monitored data for NO_2 after all adjustments

CHAPTER 5: Model Output

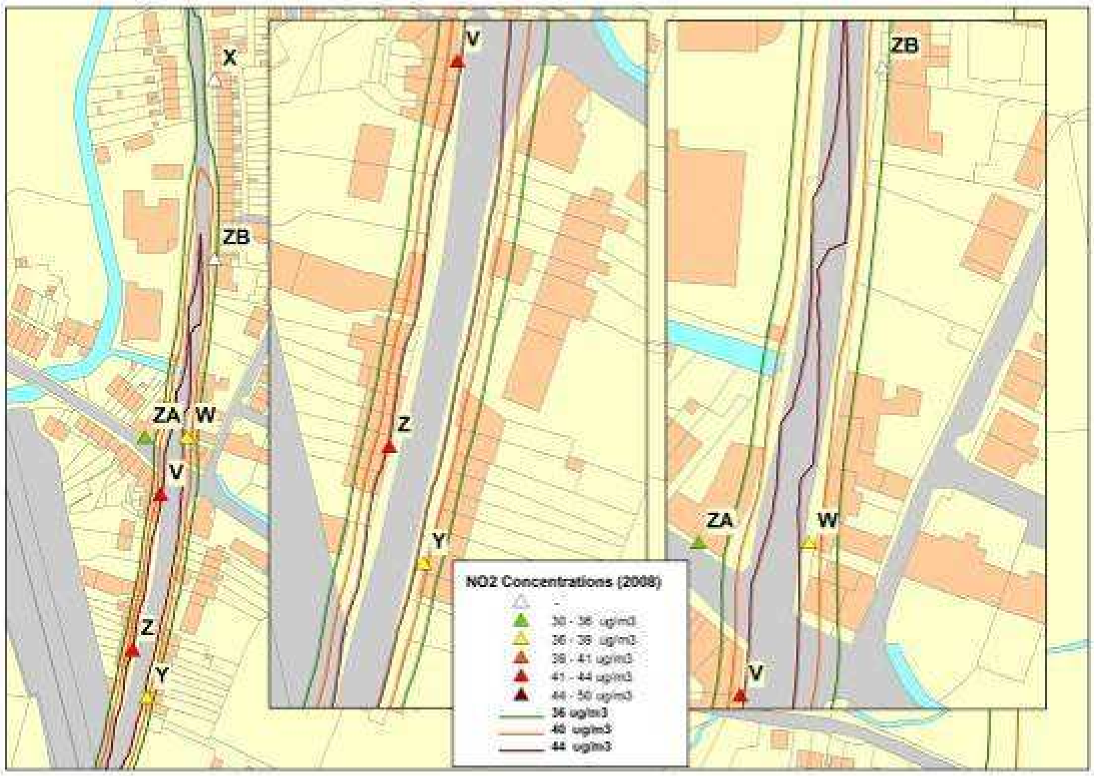

Figure 12: Modelled NO_2 concentrations across Galgate 2008

Figure 12 shows the final modelled 2008 concentrations of NO_2 for Galgate (presented along with the 2008 measured diffusion tube concentrations). The map strongly suggests that the current AQMA boundaries encompass the areas where exceedences are most at risk of occurring.

CHAPTER 6: Calculation of Required NOx Reductions

The modelled contribution to NOx from the M6 ranged between 7.3 and 8.2 µg/m^3 (following adjustment) at the receptor/diffusion tube sites. This matches very well with the LAQM Tool modelled background contribution which was 8.3 µg/m^3 as a 1 km grid average.

At each monitoring location within the study area, monitored data has been used to calculate the overall reduction in NO_2 concentrations *from the local roads (i.e. not including the M6 contribution)* at each point required to meet the 2005 NO_2 annual mean objective on the basis of the 2008 monitoring results.

This has then been used in combination with the predicted background concentrations and estimated NOx:NO_2 relationship to calculate the necessary reduction in NO_2 concentrations related to local road emissions and consequently the overall reduction in total NOx concentrations required to meet the objective.

Due to the number of approximations made in this calculation the figures cannot be expected to be very accurate. However, they do provide a rough indication of the very significant reduction in NOx emissions required to achieve the objective.

Without accounting for any reduction of background concentrations or from the M6 in future years, it is predicted that reductions in nitrogen oxide emissions of around 38–44% would be needed in Main Road to achieve the air quality objectives.

Site	Estimated Concentration						Required Reduction							
	NO_2			**NOx**			**NO_2**				**NOx**			
	Total	**Bkgrnd**	**Roads**	**Total**	**Bkgrnd**	**Roads**	**Total**		**From Roads**		**Total**		**From Roads**	
	µg/m^3	**µg/m^3**	**µg/m^3**	**µg/m^3**	**µg/m^3**	**µg/m^3**	**µg/m^3**	**%**	**µg/m^3**	**%**	**µg/m^3**	**%**	**µg/m^3**	**%**
V	**48.9**	16.0	32.9	**102.6**	18.5	**84.1**	8.9	**18**	8.9	**27**	32.7	**47**	23.2	**38**
W	**44.3**	16.0	28.3	**84.8**	18.8	**66.0**	4.3	**10**	4.3	**15**	14.9	**21**	5.08	**8**
X	**32.4**	16.0	16.4	**47.1**	19.0	**28.0**	No Reduction Required							
Y	**43.7**	16.0	27.7	**83.7**	18.1	**65.5**	3.7	**8**	3.7	**13**	13.7	**20**	4.63	**8**
Z	**49.6**	16.0	33.6	**105.9**	18.1	**87.8**	9.6	**19**	9.6	**28**	35.9	**51**	26.9	**44**
ZA	**35.7**	16.0	19.7	**57.3**	18.4	**38.9**	No Reduction Required							
Required Concentration				**Total**	**Bkgnd**	**Roads**								
			NO_2	**40.0**	**16.0**	**24.0**								
			NOx	**70.0**	**9.1**	**60.9**								

Table 7: Required NOx and NO_2 concentration reductions at each receptor point (µg/m^3 and %) 2008

CHAPTER 7: Source Apportionment

7.1 Source Apportionment by Vehicle Class

The data available from traffic counts was used to model Light Duty Vehicles and Heavy Duty Vehicles separately. As discussed in Section 3.2.3, the traffic count data was only available for a standard breakdown between Light and Heavy Duty Vehicles. To carry out the source apportionment, the information on vehicle flow, class of vehicle and average speed have been taken from the traffic counts for each road link and entered into the latest version of the LAQM Emission Factor Toolkit (version 4.0 released January 2010).

Table 8 and Table 9 show the division of emissions from light and heavy duty vehicles for both flow in each direction, and combined 2-way flow on each road link. The key roads of concern are the 2 stretches of the A6, and here it is notable that a 5% mix of HDVs contributes around 50% of all emissions.

	Flow			**Emissions**		**Flow**			**Emissions**	
Week	**AADF**	**%HDV**	**Speed**	**%LDV**	**%HDV**	**Total**	**%HDV**	**Speed**	**%LDV**	**%HDV**
A6 (N of Xroads)	**Northbound**					**Southbound**				
	8250	4.5	28	**46.3**	**53.7**	8054	3.7	25	**50.9**	**49.1**
A6 (S of Xroads)	**Northbound**					**Southbound**				
	8281	5.0	25	**43.1**	**56.9**	7623	3.5	28	**52.8**	**47.2**
Stoney Lane	**Eastbound**					**Westbound**				
	513	4.1	28	**48.7**	**51.3**	673	2.9	27	**57.5**	**42.5**
Salford Road	**Eastbound**					**Westbound**				
	1213	4.4	18	**46.1**	**53.9**	1172	2.6	16	**59.8**	**40.2**
Chapel Street	**Northbound**					**One Way**				
	399	4.0	17	**48.7**	**51.3**					

Table 8: Percentage of LDV or HDV emissions on each road link

	Flow			**Emissions**	
Week	**AADF**	**%HDV**	**Speed**	**%LDV**	**%HDV**
A6 (N of Xroads)	16304	4.1	27	**48.6**	**51.4**
A6 (S of Xroads)	15904	4.3	26	**47.2**	**52.8**
Stoney Lane	1186	3.4	3.4	**60.6**	**39.4**
Salford Road	2385	3.5	4.4	**59.9**	**40.1**
Chapel Street	399	4	17	**48.7**	**51.3**
M6	61329	17	113	**28.3**	**71.7**

Table 9: Percentage of emissions by LDV or HDV (2-way flow)

It is worth noting that the speeds for these flows are taken on the more freely-flowing sections of the road links away from the junction itself (see Figure 6). Close to the junction in the queuing traffic, it may be that HDVs add even more to the balance of emissions as their emissions tend to increase disproportionately when moving away from a standing start.

7.1.1 Hourly Patterns of NOx Concentrations in Main Road

There are very significant uncertainties involved in modelling of hourly values of pollution due to the likely representativeness of emissions information, knowledge of background concentrations and meteorological data. However, hourly data from the model has been used to build a weekly profile of pollution at Receptor Point V, the site of the diffusion tube reporting highest concentrations, just on the southwest corner of the crossroads. Concentrations of pollution from the modelled road sources have been plotted up, aggregated by hour for each day of the week (N.B. Although different traffic flows were not available for each weekday (Monday to Friday) each individual day has still been plotted in case there was any other variation apparent due to meteorological conditions). It represents nitrogen dioxide emissions from the modelled road sources only (split between LDV and HDV) and is presented as a proportion of total average concentrations over the week (rather than attempting to indicate actual resultant concentrations). It therefore represents a reasonable indicator of patterns in emissions at this point on Main Road. The profiles are shown in the graph in Figure 13.

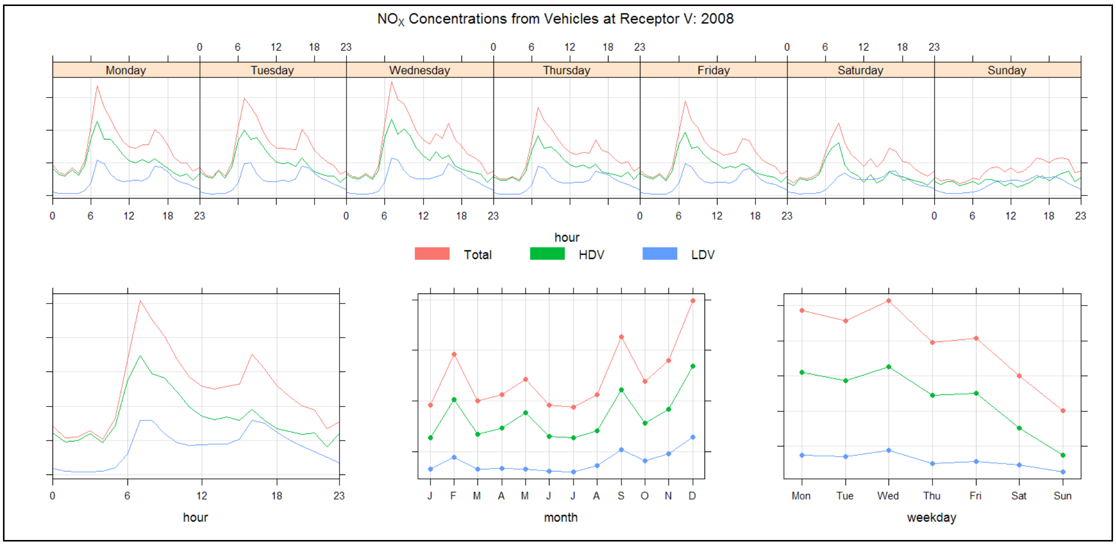

Figure 13: Patterns of NOx Concentrations at receptor point V on Main Road

The plots in Figure 13 confirm that most of the time the majority of emissions are being caused by HDVs during most of the day. It is of note though that during the evening peak hours, and for most of the day on Saturday and Sunday (after around 9 am) HDV and LDV emissions appear roughly similar.

Pollution concentrations appear to be dominated by morning peak time traffic. Traffic profiles (see Figure 7) do not indicate significantly higher flows of traffic in the morning than the evening (for either LDVs or HDVs) and so this may be due to more stable meteorological conditions in the morning leading to less dispersion of pollutants.

Also, as might be expected due to cold winter conditions, monthly patterns indicate that December and February are high in terms of pollution, as well as September which is also high; (this should be treated with some caution though due to the distance of the meteorological station from the modelling area, and the lack of seasonal variations in traffic flows).

CHAPTER 8: Relevant Local Developments or Actions

8.1 A proposed major road scheme – the M6 Heysham Link Road – was granted planning permission during 2007 and permission was reaffirmed by the Secretary of State after a public enquiry.

When completed, this new road will have significant implications for re-routing road traffic travelling to and from Lancaster, Morecambe or Heysham.

Environmental Impact Assessments carried out at the time of the planning application identified several roads, including A6 Main Road in Galgate, that would show an improvement in air quality once the M6 Heysham Link Road was built and operational.

8.2 Bailrigg Business Park, close to Lancaster University, was granted outline planning permission in 2009. A traffic assessment identified an increase in congestion in the Galgate area arising from this development without mitigation. However an air quality assessment identified little impact on air quality in Galgate. Several traffic related conditions were included in the planning permission.

8.3 Two planning applications for supermarkets, hotel and petrol station on land at Lawsons Bridge are currently awaiting a decision at the time of writing. The air quality assessment accompanying the larger of the two proposals did not identify any significant effects on air quality in Galgate. The air quality implications of the second application were still be considered at the time of writing.

CHAPTER 9: Summary and Conclusions

This Further Assessment has undertaken a number of tasks:

- Analysis of ambient NO_2 monitoring data in Galgate 2006-2009;
- A detailed modelling study of the central road network in Galgate;
- A calculation of the required nitrogen oxide reductions necessary to achieve the 40µg/m^3 annual mean nitrogen dioxide air quality objective at all monitoring points near the Air Quality Management Area (AQMA);
- A breakdown of nitrogen dioxide emissions on modelled road links between those attributable to Light and Heavy Duty Vehicles;
- A analysis of temporal variations in road emissions on Main Road;

The findings of the Further Assessment are as follows:

- There are significant exceedences of the 2005 NO_2 annual mean objective still occurring in Main Road, Galgate at locations where there is relevant exposure as defined by guidance (principally residential properties);
- These exceedences appear to be limited to the stretch of the A6 (Main Road) between the railway bridge, extending north to just beyond the crossroads with Salford Road/Stoney Lane. However, all predicted exceedences are within the current AQMA and there is no need to extend the current boundaries;
- There is also no evidence to suggest that the boundaries could/should be reduced;
- At the worst case monitoring location in Main Road, estimates suggest that local emissions of nitrogen oxides would need to be reduced by around 44% in order to meet the AQ objectives;
- It is thought that the effect of queuing traffic in Main Road is having a significant effect on vehicle emissions. Therefore it is not expected that a 40% reduction in emissions relates to a 40% reduction in vehicle movements as lower traffic volumes may lead to more freely flowing traffic;
- Despite Heavy Duty Vehicles only contributing to around 5% of vehicle flows on Main Road, their large size and respectively greater emissions mean that this relatively small number of vehicles contributes over 50% of the nitrogen oxide emissions within Main Road;
- Pollution concentrations in Main Road appear to be dominated by the morning peak hour traffic, although this is likely to be due to meteorological conditions rather than differences in traffic flows.

References

Environment Act 1995, HMSO, http://www.opsi.gov.uk/acts/acts1995/Ukpga_19950025_en_1.htm

LAQM TG(09) DRAFT Local Air Quality Management Technical Guidance, Defra, 2009 http://www.defra.gov.uk/environment/quality/air/airquality/local/guidance/documents/tech-guidance-laqm-tg-09.pdf

Local Authority Air Quality Support Helpdesk http://www.laqmsupport.org.uk

Review and Assessment Helpdesk http://www.uwe.ac.uk/aqm/review

APPENDIX 1: Additional Diffusion Tube Information

This section provides tables showing additional diffusion tube information: Locations, Tube analyzer, Grid refs, Bias Adjustment Factors, etc.

Site Name	**Site Type**	**OS Grid Ref**	**In AQMA?**	**Relevant Exposure?** *(Y/N with distance (m) to relevant exposure)*	**Distance (m) to kerb of nearest road** *(N/A if not applicable)*	**Worst-case Location?**
Galgate V	Residential	X 348359 Y 455352	Y	Y	1.5	Y
Galgate W	Residential	X 348372 Y 455381	Y	Y	2.4	Y
Galgate X	Residential	X 348388 Y 455564	N	Y	4.7	Y
Galgate Y	Residential	X 348352 Y 455249	Y	Y	2.7	Y
Galgate Z	Residential	X 348345 Y 455273	Y	Y	2.2	Y
Galgate ZA	Residential	X 348351 Y 455381	Y	Y	0.9	Y
Galgate ZB	Residential	X 348386 Y 455471	N	Y	0.8	Y

Table 10: Locations of diffusion tubes in Galgate operated by Lancaster City Council

9.1 Details of Bias Adjustment Factors (BAF)

Analysed By	Method	Year	Site Type	LA	Length of Study (months)	Diff Tube Mean Conc. (Dm) (µg/m3)	Auto Monitor Mean Conc. (Cm) (µg/m3)	Bias (B)	Tube Precision	BAF (A) (Cm/Dm)	Overall Factor
Lancashire CC	50% TEA in Acetone	2003	UC	Lancaster CC	12	27	32	-14.8%	P	**1.17**	1.17
Lancashire CC	50% TEA in Acetone	2004	UC	Lancaster CC	12	28	31	-10.5%	P	**1.12**	1.12
Lancashire CC	50% TEA in Acetone	2005	I	Lancaster CC	10	31	33	-6.2%	P	**1.07**	1.07
Lancashire CC	50% TEA in Acetone	2006	I	Lancaster CC	12	28	31	-10.6%	P	**1.12**	1.11
Lancashire CC	50% TEA in Acetone	2006	K	AEA E&E Intercomparison	9	102	112	-9.2%	G	**1.10**	
Lancashire CC	50% TEA in Acetone	2007	R	Lancaster CC	11	28	28	1.9%	P	**0.98**	1.00
Lancashire CC	50% TEA in Acetone	2007	K	AEA Tech Intercomparison	9	95	101	-5.7%	G	**1.06**	
Lancashire CC	50% TEA in Acetone	2007	UB	Preston CC	12	24	23	3.5%	P	**0.97**	

Table 11: Bias adjustment data for Lancashire County Council diffusion tubes

Nitrogen dioxide diffusion tubes used by Lancaster City Council up to and including 2008 are supplied and analysed by Lancashire County Council. Table 11 shows bias adjustment factors for co-location of Lancashire County Council diffusion tubes from the Defra diffusion tube bias factor database (v13/11/08).

Analysed By	Method	Year	Number of Studies	Overall BAF
Gradko	20% TEA in Water	2002	14	1.00
Gradko	20% TEA in Water	2003	12	0.96
Gradko	20% TEA in Water	2004	11	0.91
Gradko	20% TEA in Water	2005	14	0.97
Gradko	20% TEA in Water	2006	10	0.98
Gradko	20% TEA in Water	2007	22	0.89
Gradko	20% TEA in Water	2008	19	0.91

Table 12: Bias adjustment data for Gradko 20% TEA in Water diffusion tubes

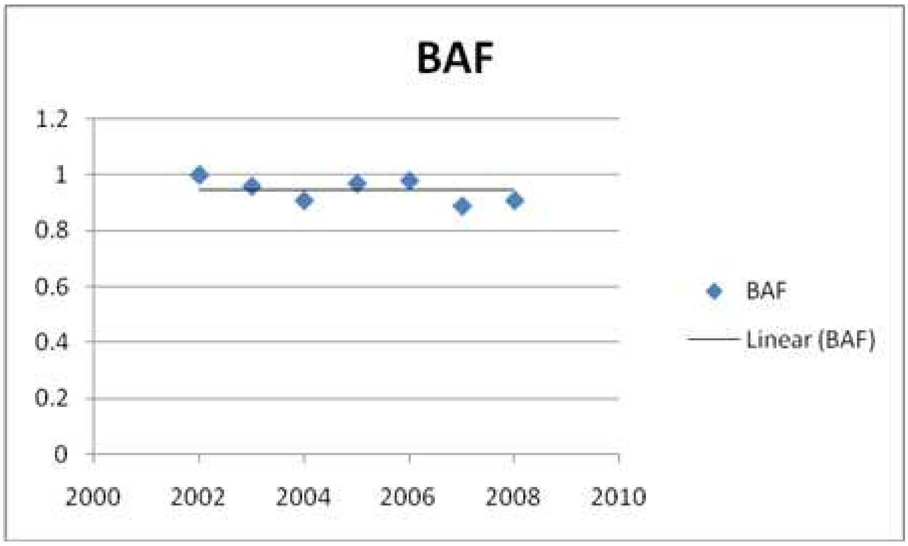

Figure 14: Bias Adjustment Factors for Gradko 20% TEA in Water Diffusion Tubes 2002-8

A Bias Adjustment Factor of 0.95 has been provisionally applied to the 2009 data based on an average of all years for which there is data for Gradko 20% TEA in Water tubes in the Review and Assessment BAF database. It is anticipated that this may be slightly conservative compared to the other method which would use the previous year's factor 0.91.

APPENDIX 2: Meteorological Data

As described in the main text, due to problems with the Met Office's ability to provide wind speed and direction data from Preston (Town Hall) met station as has been used in some previous assessments, the final set of met data used for modelling took all data meteorological parameters from Manchester Woodford. Although the site is some 80km from Carnforth, consideration of the other sites suggested this was the best option as:

- Blackpool and Crosby are significantly affected by coastal conditions;
- Stonyhurst does not record wind data;
- Neither Bury nor Crosby record cloud cover data.

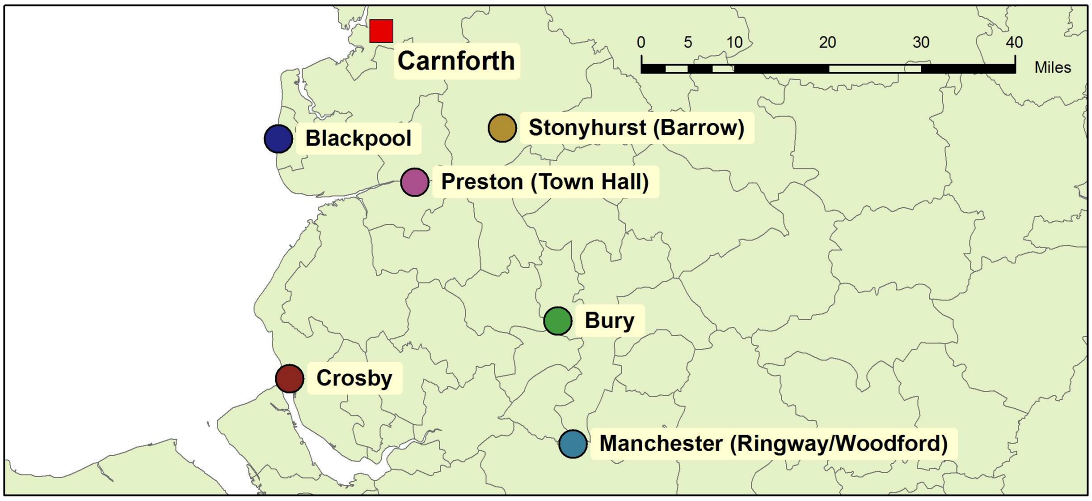

Figure 155: Map showing relative locations of Galgate to optional Met Sites

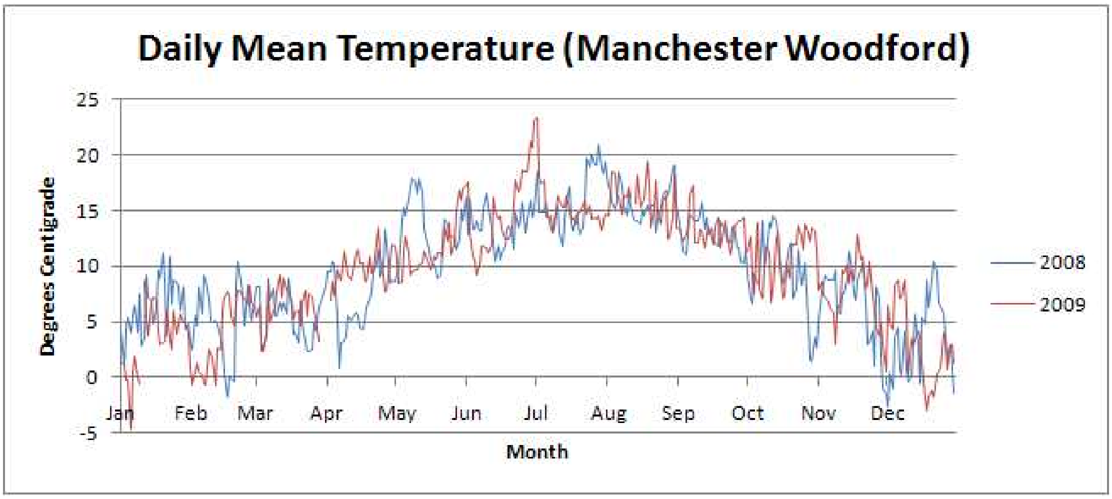

Figure 16: Average Daily Temperature at Manchester Woodford (2008/2009)

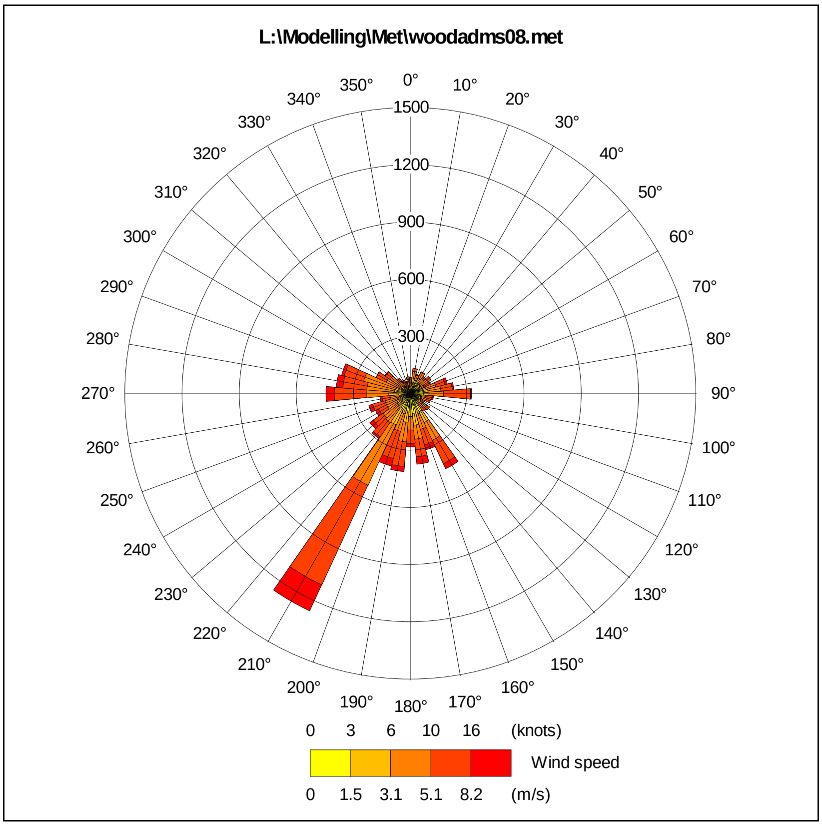

Figure 17: Wind rose for Manchester Woodford 2008

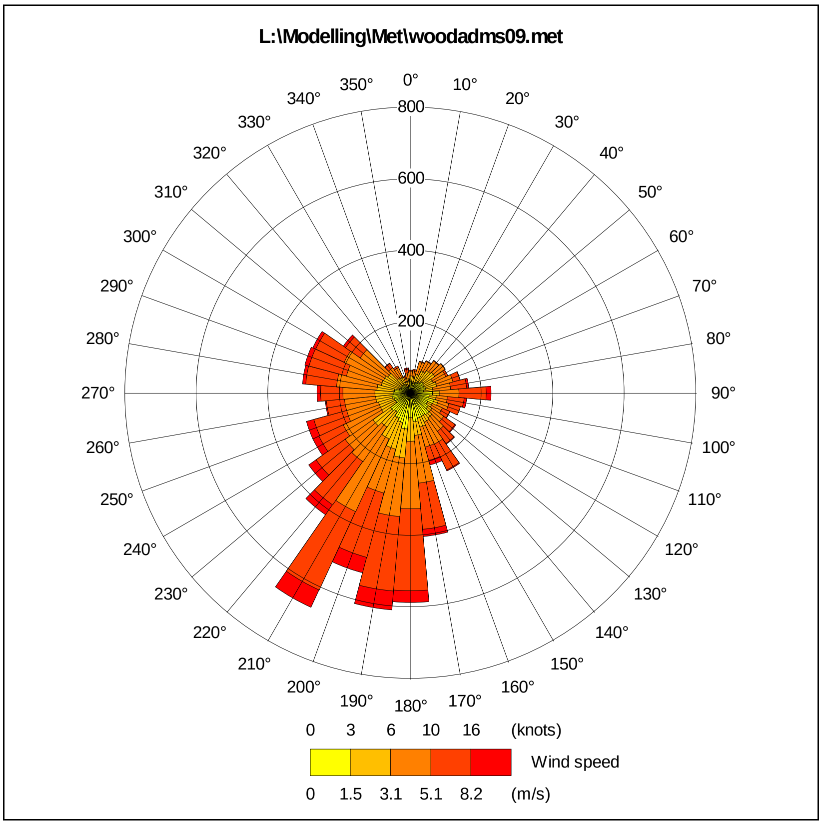

Figure 18: Wind rose for Manchester Woodford 2009

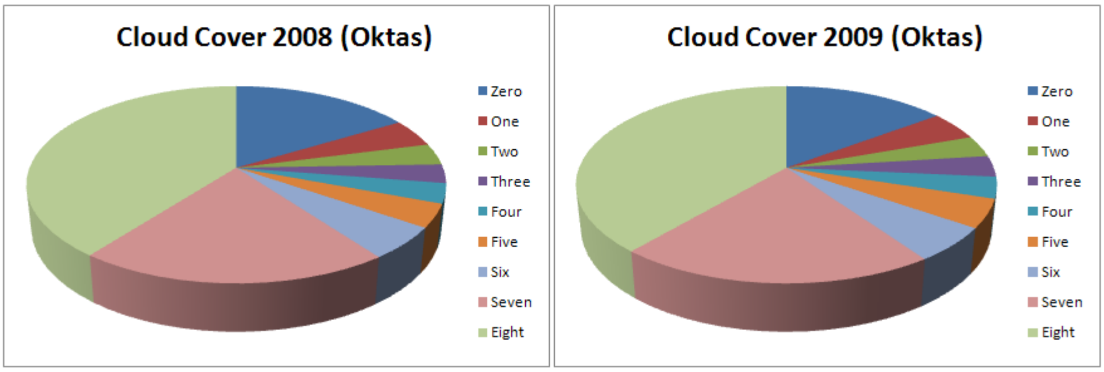

Figure 19: Pie-chart showing cloud cover for 2008/9 from Manchester Woodford