FOREST OF DEAN DISTRICT COUNCIL

Detailed Assessment for

Lydney, Forest of Dean

February 2009

Produced with assistance from the Air Quality Management Resource Centre, University of the West of England, Bristol.

Executive Summary

Forest of Dean District Council's Progress Report, submitted to the Department for Environment, Food and Rural Affairs (Defra) in July 2007, identified the need for a Detailed Assessment at Hill Street, Lydney on the basis of exceedences of the annual mean objective for nitrogen dioxide (NO_2) (40 µg/m^3) at sites of relevant exposure.

This Detailed Assessment reports on the results of the diffusion tube monitoring in Lydney in 2007 and uses atmospheric dispersion modelling to estimate the extent of likely NO_2 exceedences. Contour mapping derived from the model is then used to indicate the need for, and the suggested extent of, an Air Quality Management Area (AQMA) for Lydney.

The NO_2 diffusion tube monitoring and atmospheric dispersion modelling indicates that there are exceedences of the annual mean NO_2 objective at sites of relevant exposure along High Street, Lydney. It is recommended that the Forest of Dean declare an AQMA to cover, as a minimum, the roads and affronting residential properties in Lydney High Street as far as the junction with Temple Way, Hill Street up to Bathurst Park Road, and Bream Road up to The Orchards turnoff. It is also recommended that the NO_2 monitoring network be improved within the proposed AQMA to assist the Council with their Further Assessment to be completed 12 months after the AQMA is declared.

Document Control Sheet

CLIENT(S)	Forest of Dean District Council, Gloucestershire		
UWE CONTACT	Air Quality Management Resource Centre, Faculty of Environment and Technology, University of the West of England, Frenchay Campus, Coldharbour Lane, Bristol, BS16 1QY Tel: 0117 32 81626 Fax: 0117 32 83002 Web: www.uwe.ac.uk/aqm		
COLLABORATION CONTACT	N/A		
PROJECT TEAM	Jo Barnes (UWE) (Author/Contact) Dr. Enda Hayes (UWE) (Author/Contact)		
DOCUMENT STATUS	STATUS	DATE	DESCRIPTION
	Draft report	December 2008	Circulated to Forest of Dean for comments
	Draft report	February 2009	Comments received and draft resent
	Final report	February 2009	Sent to Forest of Dean as pdf and two printed copies

Table of Contents

List of Figures

List of Tables

List of Boxes

Copyright Statement

Glossary of Abbreviations

%	Percentage
AADF	Annual Average Daily Flow (relating to traffic)
AAHF	Annual Average Hourly Flow (relating to traffic)
ADMS	Atmospheric Dispersion Modelling Systems
AQMA	Air Quality Management Area
CERC	Cambridge Environmental Research Consultants
Defra	Department for Environment, Food and Rural Affairs
HGV	Heavy Goods Vehicles – road vehicles greater than 3.5 tonnes weight
LAQM	Local Air Quality Management
LGV	Light Goods Vehicles – road vehicles less than 3.5 tonnes weight
m	Metres
m/s	Metres per second
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides ($NO+NO_2$)
TG(03)	Technical Guidance 2003
$\mu g/m^3$	Micrograms per cubic meter of air

1. Introduction

This report is a requirement of the Environment Act 1995, which places a duty on local authorities to review and assess air quality within their administrative area. Forest of Dean District Council is undertaking this Detailed Assessment to consider its compliance with the air quality objectives, as set out in the Air Quality Regulations 2000 and Air Quality (England) (Amendment) Regulations 2002.

As part of Forest of Dean District Council's requirements under Local Air Quality Management process, the authority completed an Updating and Screening Assessment (USA) in 2006 and a Progress Report in 2007. The USA did not indicate any exceedences of the national Air Quality Objectives, however the 2007 Progress Report identified the need for a Detailed Assessment at Hill Street, Lydney on the basis of exceedences of the annual mean objective for NO_2 (40 μg/m^3) at sites of relevant exposure. This report fulfils that requirement. Forest of Dean District Council does not currently have any Air Quality Management Areas (AQMAs) for any pollutants within their administrative area.

1.1. Introduction to Forest of Dean District Council

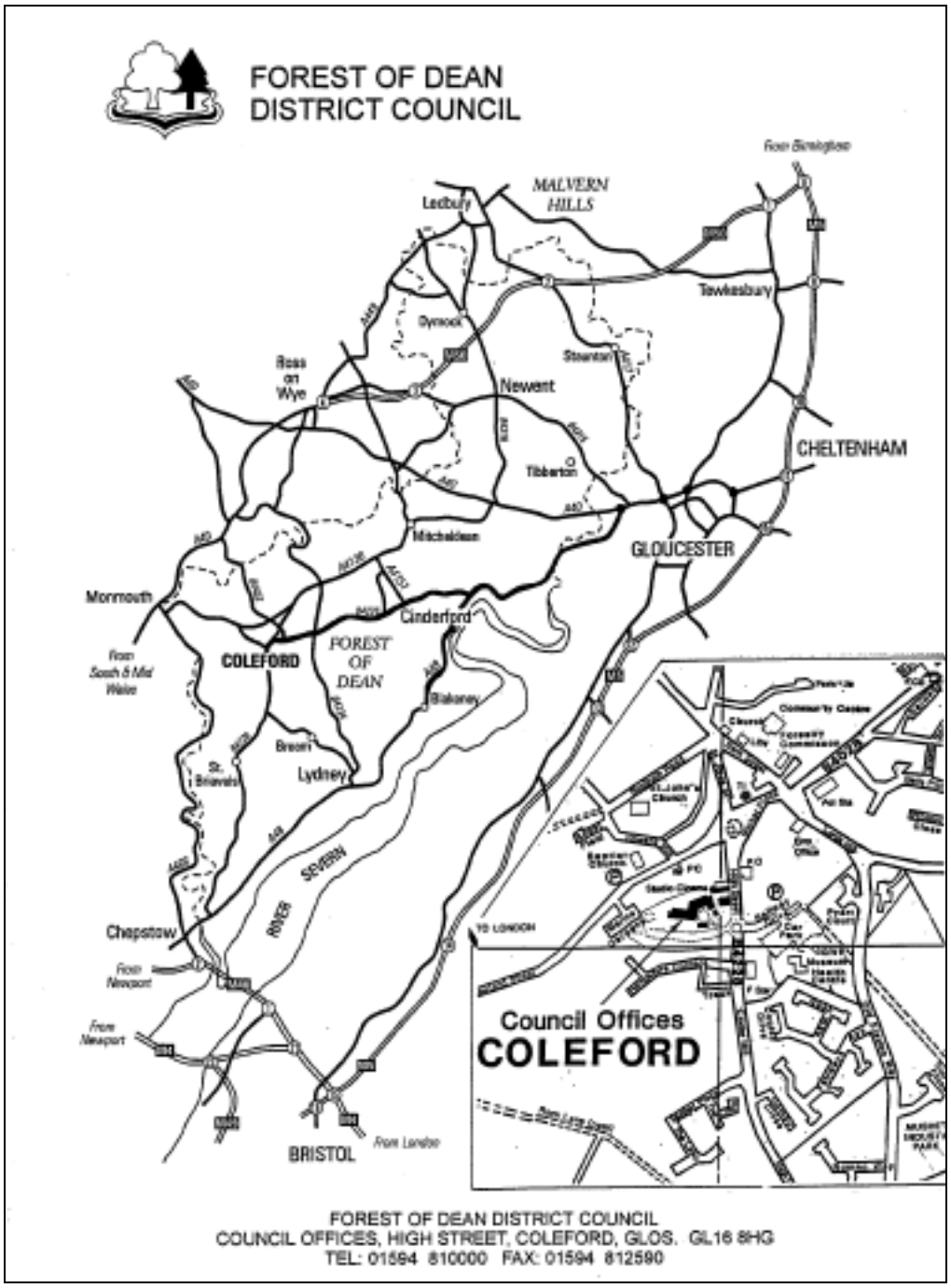
The Forest of Dean is a rural community situated in Gloucestershire. It is made up of four major towns (Lydney, Coleford, Cinderford and Newent) surrounded by numerous villages, with the remainder of the District comprising wooded areas and open space. The main industry is manufacturing and primary industry with many light engineering firms. The population is just over 80,000 with approximately 32,000 households. The main routes through the District include the M50 in the north of the District and numerous A-roads (e.g. A48 and the A40) (See Figure 1).

There are no major industrial areas within the district or close-by that significantly impact on air quality. The industries within the District that emit any of the prescribed pollutants are not located close to relevant public exposure. The scale on which they operate does not produce emissions that significantly affect local air quality.

1.2. Introduction to Lydney

Lydney is the main town in the Severn Valley area of the Forest of Dean and comprises a thriving business and shopping area. Lydney town centre is located on an incline with residential properties situated within 5 m of the roadside in places. There is a Tesco Store on High Street and Lydney's Hill Street, High Street and Bream Road are also major routes for Heavy Goods Vehicles (HGVs) accessing the quarry at Stowe, to the northeast of Lydney and the A48 bypass to the south.

Figure 1: Map of the Forest of Dean area



2. Activities undertaken with regard to this study

The activities undertaken in this study include:

- The examination of new and existing NO_2 monitoring data taken from passive monitoring sites (diffusion tubes) collected for 2007 in Lydney.
- Utilisation of atmospheric dispersion modelling (ADMS-Roads v. 2.3) to assess the area of concern as having the potential to exceed the annual mean NO_2 objective of 40 μg/m^3 (namely Lydney town centre).
- The conclusions of the monitoring data review and the atmospheric dispersion modelling outcomes will be utilised to inform a decision on the declaration of an AQMA.

3. NO_2 monitoring in the Forest of Dean District Council

The following sections will provide information relating to all NO_2 monitoring that has been undertaken in Forest of Dean District Council's administrative area, primarily focusing on any monitoring undertaken in Lydney High Street.

3.1. Diffusion tube monitoring

Forest of Dean District Council undertook diffusion tube monitoring at 25 locations in 2007, including 6 sites in Lydney (Table 1, Table 2). The diffusion tubes (20% TEA in water) are supplied and analysed by Bristol Scientific Services. The tubes at all locations throughout the area have a monthly exposure period. A bias adjustment factor of 0.77 has been applied, which was obtained from the national Bias Adjustment Spreadsheet (v.11/08). Further details of the tube locations, bias adjustment and results can be found in Appendix 1: Diffusion tube monitoring information.

Two diffusion tubes exceeded the annual mean objective for NO_2 in 2007, both of which are in Lydney: 29 High Street (47.1 μg/m^3) and 61 High Street (42.5 μg/m^3). An exceedence of 56.3 μg/m^3 was also recorded at Unit 1 Regents Walk, Newerne Street, however this annual mean concentration was questionable due to two months of erroneous data in 2007. Forest of Dean District Council will continue to monitor NO_2 concentrations at this location. Diffusion tube monitoring in 2006 identified concentrations exceeding the annual mean NO_2 objective at Hill Street, Lydney. Monitoring data in 2007 for this site recorded an annual bias adjusted mean of 38.8 μg/m^3, therefore not exceeding the objective for NO_2. This Detailed Assessment remains justified however, on the basis of the exceedences identified from the diffusion tube monitoring in Lydney High Street.

Table 1: NO_2 diffusion tube annual mean concentrations (2007)[A]

Tube Name	Grid Reference		NO_2 Conc. ($\mu g/m^3$)
	x	y	
St Briavels - Grove House	355195	205120	6.60
Staunton Service Station Coleford	355025	212658	13.93
Five Acres - cross roads	358048	212291	19.88
Edge End - crossroads	359290	213166	15.05
Cinderford - 9 St Whites Rd	365548	212958	19.99
Cinderford - Bus Station	365843	214046	16.10
Cinderford - High St.	365243	214748	15.90
Nailbridge	364538	216171	29.49
Mitcheldean - Lamb Inn, Monmouth Rd	366516	218276	26.58
Huntley - crossroads	371698	219356	31.14
Huntley - The Red Lion	372193	219378	31.31
Newent - Community Centre	372023	226234	18.02
Newent - F.O.D.D.C. Branch Office	372238	225834	23.35
Bromsberrow - Freedom Farm	373218	232814	22.45
Lydney - 61 High Street	363147	203072	**42.50**
Lydney - 45 High Street	363115	203032	33.00
Lydney - 29 High Street	363026	202964	**47.10**
Lydney - 21 High Street	362995	202940	37.12
Westbury-on-Severn	371695	214031	21.91
Newnham-on-Severn	369060	211608	31.31
Lydney - Unit 1 Regents Walk, Newerne Street	363189	203111	39.13[B]
Lydney -1 Hill St	363452	203213	38.81
Lydney Bypass	363455	202438	14.00
Sedbury - A48	354282	194228	23.31
Coleford - Bank St	357610	210756	27.13

A – Bias adjusted data (0.77) (v. 11/08)
B - Revised annual mean concentration following the removal of two month's erroneous data – September and November 2007 (see Table 3)

4. Detailed Assessment – NO_2

The monitoring data for 2007 indicates that exceedences of the annual mean NO_2 objective have occurred on the façade of locations with relevant exposure. The detailed dispersion modelling in the subsequent sections will determine the spatial extent of the exceedences.

4.1. Detailed dispersion modelling of NO_2

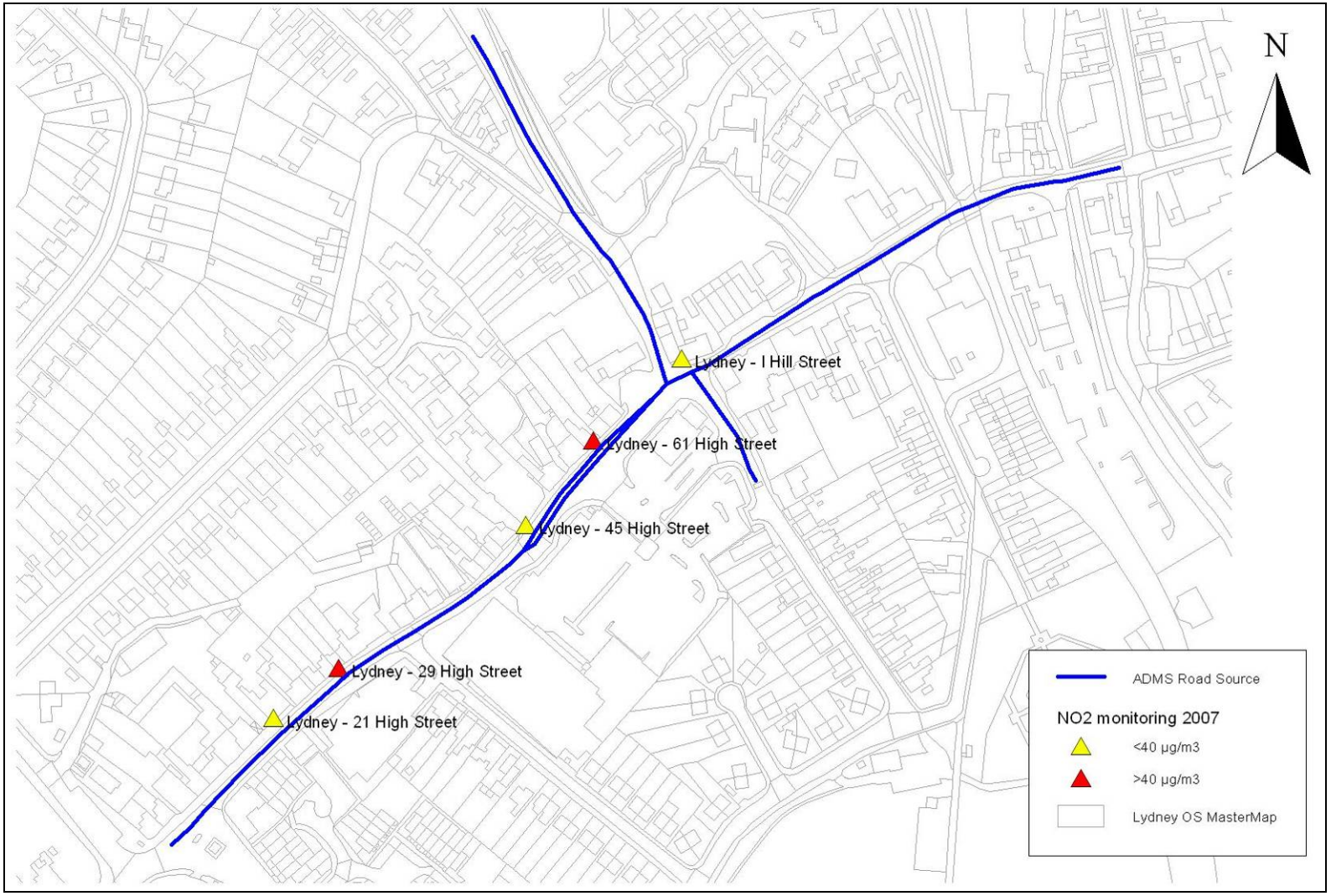
ADMS Roads (Version 2.3), an atmospheric dispersion modelling program developed by Cambridge Environmental Research Consultants Ltd (CERC) was used to model NO_2 concentrations at the areas of concern. Table 2 provides the NO_2 bias adjusted diffusion tube concentrations in the areas of concern. (Full diffusion tube results for 2007 can be found in Table 3 in Appendix 1.) Figure 2 shows the road sections for which dispersion modelling was undertaken highlighted in blue.

Table 2: Monitored concentrations in Lydney (2007)

Tube Name	Grid Reference		NO_2 Conc. ($\mu g/m^3$)	Data capture
Lydney				
Lydney - 1 Hill St	363452	203213	38.81	100%
Lydney - Regents Walk, Newerne Street	363189	203111	39.13	42%
Lydney - 61 High Street	363147	203072	**42.50**	100%
Lydney - 45 High Street	363115	203032	33.00	92%
Lydney - 29 High Street	363026	202964	**47.10**	83%
Lydney - 21 High Street	362995	202940	37.12	83%

Due to the low data capture value (42%) at Regents Walk, Newerne Street, this site was not included for verification and adjustment of the dispersion model output. 1 Hill Street was also excluded as it is not within the area of exceedence identified by the 2007 diffusion tube monitoring data. (Further information on the verification and adjustment process can be found in Appendix 3: Model verification and adjustment.)

Figure 2: Map of monitoring locations and roads modelled at the junction of High Street, Hill Street and Bream Road, Lydney for 2007



(Ordnance Survey Licence No. 100019102)

4.2. Dispersion model data sources

In undertaking the dispersion modelling the following input data were used:

- *Traffic flows*: hourly average data derived from traffic data provided by Gloucestershire County Council.
- *Heavy Duty/Light Duty Vehicle mix*: obtained from traffic data provided by Gloucestershire County Council.
- *Vehicle speed:* As measured speed data were unavailable for the area being modelled, estimated speeds were used based on Appendix 2 of the Defra LAQM Technical Guidance document TG(03) and previous site visits.
- *Road geometry:* The location of roads and buildings (including road width) were obtained using OS MasterMap data provided under licence by Forest of Dean District Council.
- *Background pollution data:* Background pollution concentrations for NO_2 for 2003 were obtained from the LAQM Tools section of the Air Quality Archive Website (http://www.airquality.co.uk/archive/laqm/tools.php?tool=background)
- *Meteorological data:* As site specific meteorological data was unavailable at the time of completing this modelling exercise, meteorological data was obtained from the UK Met Office. The nearest suitable site providing the full set of meteorological variables needed by the ADMS-Roads model was Little Rissington.
- *Emission factors:* The emission factors used were those built into the ADMS-Roads model, derived from DMRB 2003.

Further details on input data can be found in Appendix 2: Input data for the dispersion model.

4.3. Output of the dispersion modelling exercise for Lydney

This section presents the model output predictions for 2007 relevant to the annual mean NO_2 objective concentration (40 µg/m^3). Details of the model verification and adjustment can be found in Appendix 3: Model verification and adjustment.

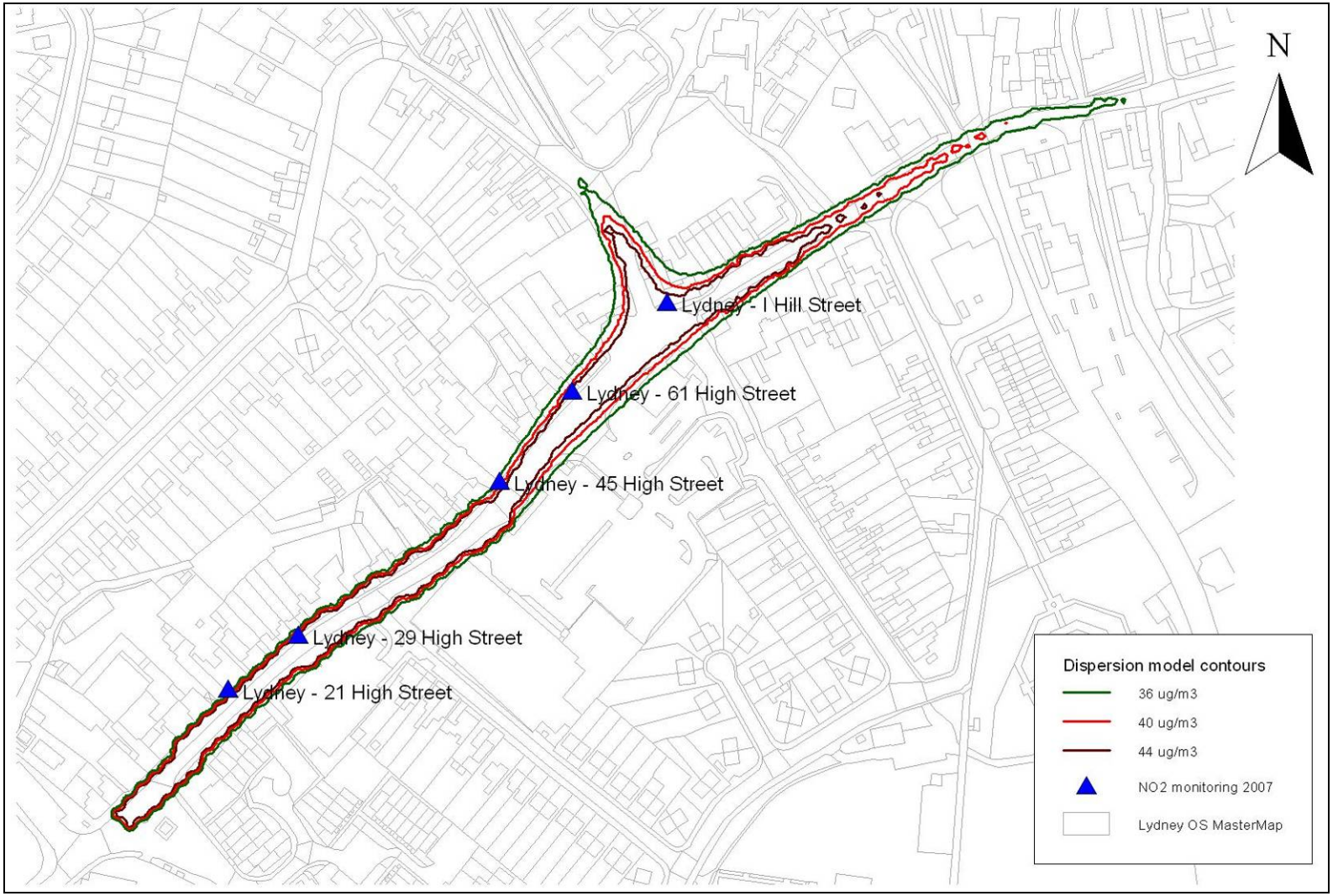
To briefly summarise the modelling process, these are the key steps:

1. Input data for 2007 is entered into the model (traffic flows/mix/speeds, emissions factors and meteorological data).
2. The model is run to produce estimates of nitrogen oxides (NO_x = NO + NO_2) from the road sources.
3. Following the guidance in Appendix 3 of TG(03) and subsequent updates relating to the NO_X/NO_2 relationship, this is adjusted using data from local monitoring sites and NO_x background concentrations so that the model results can be compared against suitable monitoring data (and thereby deriving a correction factor and a factor to ascertain how much of the total NO_x is converted to NO_2 at each location).
4. The adjusted NO_2 concentration fields for roads emissions are then added to the 2007 NO_2 background concentrations to produce contours for annual mean NO_2 in 2007.

Figures 3, 4 and 5 illustrate the contours representing the annual mean concentrations of 36, 40 and 44 µg/m^3 of NO_2. Figure 3 shows the whole area modelled; Figure 4 focuses on the junction of High Street, Hill Street and Bream Road, and Figure 5 focuses on the High Street section to the west. The contours shown are based on model results adjusted on the basis of appropriate monitoring data from the sites shown. The contours are limited to the extent of the road sources modelled and do not necessarily represent the full extent of potential exceedences of the annual mean NO_2 objective. Further information relating to the verification and adjustment of the modelling output can be found in Appendix 3: Model verification and adjustment.

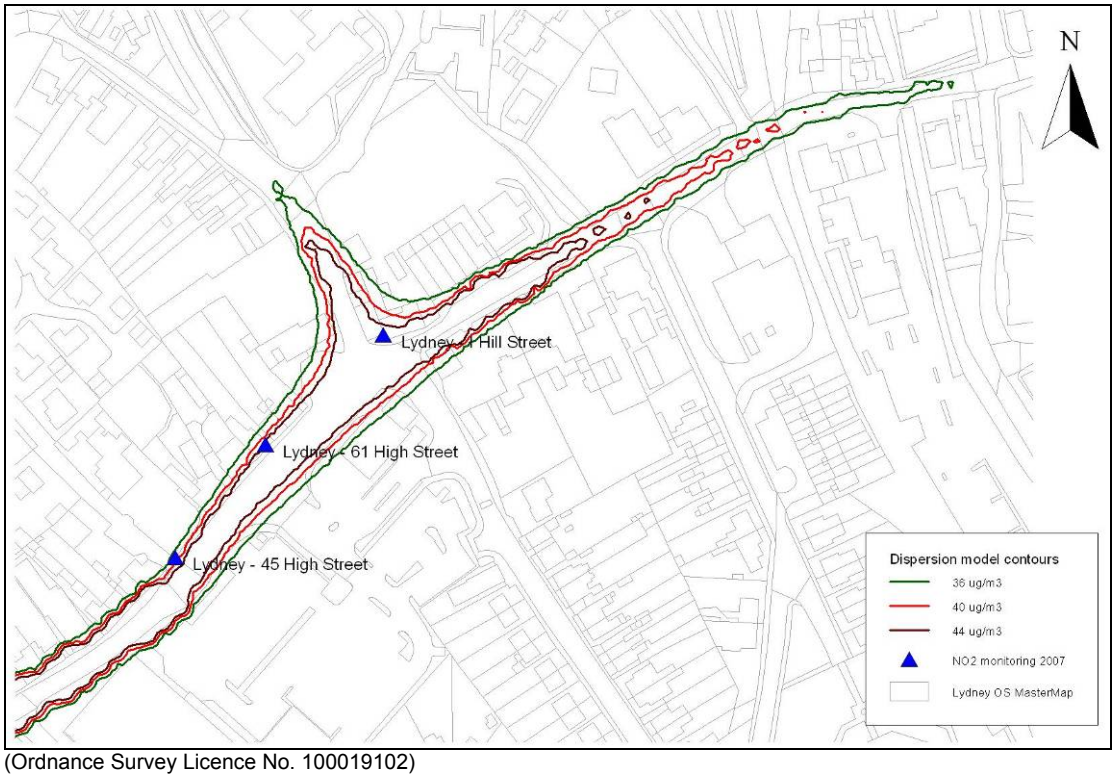
Where appropriate, initial recommendations have been given regarding the declaration of an AQMA.

Figure 3: Predicted NO_2 concentrations for 2007 in Lydney



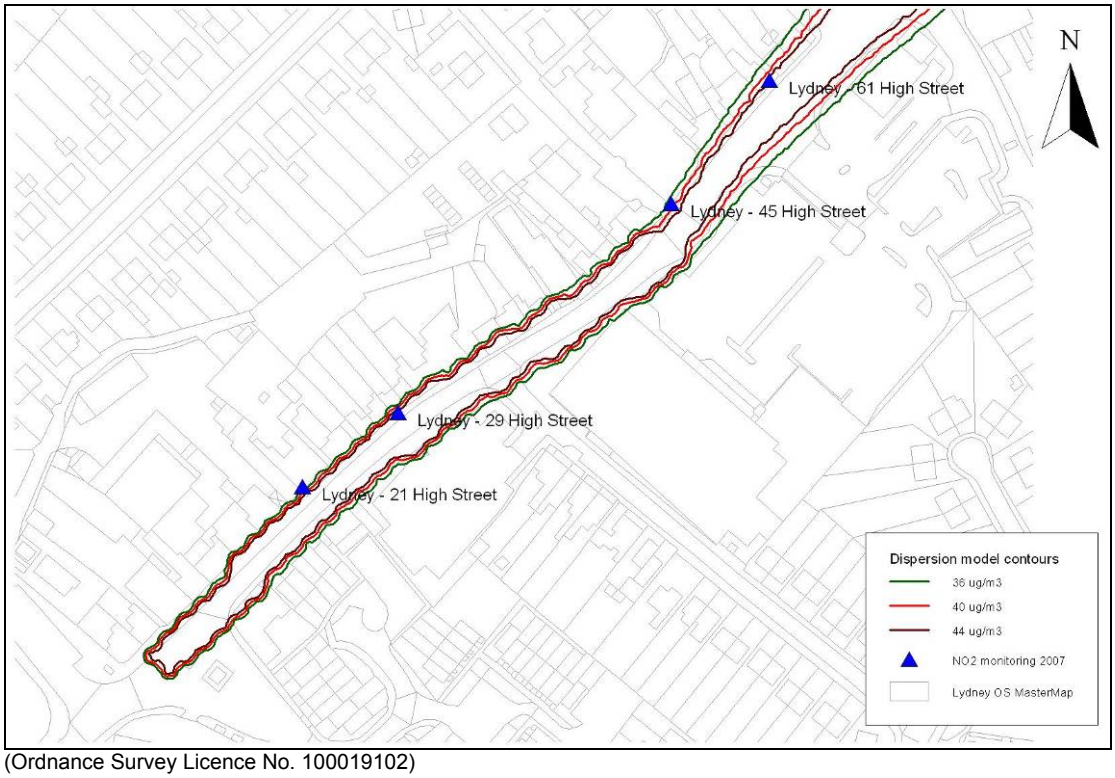
(Ordnance Survey Licence No. 100019102)

Figure 4: Predicted NO_2 concentrations for 2007 at the junction of High Street, Hill Street and Bream Road, Lydney



(Ordnance Survey Licence No. 100019102)

Figure 5: Predicted NO_2 concentrations for 2007 at High Street, Lydney



(Ordnance Survey Licence No. 100019102)

4.4. Detailed Assessment - Conclusions and recommendations

The results from the diffusion tube monitoring study in conjunction with this dispersion modelling study in Lydney indicate that the 40 μg/m^3 NO_2 annual mean objective is being exceeded at the façade of buildings with relevant exposure.

The following recommendations are made:

- Forest of Dean District Council should declare an Air Quality Management Area which should include, as a minimum the roads and affronting residential properties in Lydney High Street as far as the junction with Temple Way, Hill Street up to Bathurst Park Road, and Bream Road up to The Orchards turnoff. Given the limited extent of the road sources modelled, and the nature of traffic movements around Lydney, the Council may wish to investigate the possibility of declaring a larger, more strategic AQMA to incorporate more than just the area described above.
- It is recommended that the NO_2 monitoring network be expanded and improved within the proposed AQMA to assist the Council with their Further Assessment to be completed 12 months after the AQMA is declared. In particular it is recommended that diffusion tubes are sited according to the Practical Guidance report available on the Review & Assessment website http://www.airquality.co.uk/archive/reports/cat05/0802141004_NO2_WG_PracticalGuidance_Issue1a.pdf.

5. Appendix 1: Diffusion tube monitoring information

5.1. NO_2 diffusion tube monitoring

Passive monitoring of NO_2 has been carried out for a number of years by the Forest of Dean District Council at numerous locations across the District. In 2007 the authority monitored NO_2 at 25 locations using diffusion tubes supplied and analysed by Bristol Scientific Services (20% TEA in Water). The 2007 NO_2 raw diffusion tube data and adjusted annual mean concentrations can be found in Table 3.

5.2. Details of bias adjustment

Forest of Dean District Council utilises diffusion tubes supplied and analysed by Bristol Scientific Services (20% TEA in Water). A bias adjustment factor of 0.77 was estimated from five studies for 2007 using the published Bias Adjustment Factors Spreadsheet (v.11/08) (see Figure 6).

Figure 6: Bias adjustment calculation for 2007 diffusion tube results

Spreadsheet Version Number: 11/08

Follow the steps below **in the correct order** to show the results of **relevant** collocation studies

This spreadsheet will be updated in lat February 2009 on the R&A website

Data only apply to tubes exposed monthly and are not suitable for correcting individual short-term monitoring periods
Whenever presenting adjusted data, you should state the adjustment factor used

This spreadhseet will be updated every few months: the factors may therefore be subject to change. This should not discourage their immediate use.

Published by Air Quality Consultants Ltd on behalf of Defra, the Welsh Assembly Government, the Scottish Executive and the Department of the Environment Northern Ireland

Step 1:	Step 2:	Step 3:	Step 4:
Select the Laboratory that Analyses Your Tubes from the Drop-Down List	Select a Preparation Method from the Drop-Down List	Select a Year from the Drop-Down List	Where there is only one study for a chosen combination, you should use the adjustment factor shown with caution. Where there is more than one study, use the overall factor[3] shown in blue at the foot of the final column.
If a laboratory is not shown, we have no data for this laboratory.	If a preparation method is not shown, we have no data for this method at this laboratory	If a year is not shown, we have no data[2]	If you have your own collocation study then see footnote[4]. If uncertain what to do then contact the Review and Assessment Helpdesk 0117 328 3668 aqm-review@uwe.ac.uk.

Analysed By[1]	Method (To undo your selection, choose (All) from the pop-up list)	Year[5] (To undo your selection, choose (All))	Site Type	Local Authority	Length of Study (months)	Diffusion Tube Mean Conc. (Dm) (µg/m3)	Automatic Monitor Mean Conc. (Cm) (µg/m3)	Bias (B)	Tube Precision[4]	Bias Adjustment Factor (A) (Cm/Dm)
Bristol Scientific Services	20% TEA in Water	2007	Rural	Pembrokeshire CC	11	7	5	36.9%	G	**0.73**
Bristol Scientific Services	20% TEA in Water	2007	R	Brighton and Hove CC	12	46	33	38.2%	G	**0.72**
Bristol Scientific Services	20% TEA in Water	2007	K	South Gloucestershire	9	29	24	21.0%	G	**0.83**
Bristol Scientific Services	20% TEA in Water	2007	R	West Wiltshire DC	9	38	26	48.6%	G	**0.67**
Bristol Scientific Services	20% TEA in Water	2007	K	AEA Tech Intercomparison	12	115	103	12.0%	G	**0.89**
Bristol Scientific Services	20% TEA in Water	2007		Overall Factor[3] (5 studies)				Use		0.77

Table 3: NO_2 diffusion tube monitoring data for 2007 in Forest of Dean District

	NO_2 DIFFUSION TUBE RESULTS 2007	Jan-07 Net NO_2 ug/m^3	Feb-07 Net NO_2 ug/m^3	Mar-07 Net NO_2 ug/m^3	Apr-07 Net NO_2 ug/m^3	May-07 Net NO_2 ug/m^3	Jun-07 Net NO_2 ug/m^3	Jul-07 Net NO_2 ug/m^3	Aug-07 Net NO_2 ug/m^3	Sep-07 Net NO_2 ug/m^3	Oct-07 Net NO_2 ug/m^3	Nov-07 Net NO_2 ug/m^3	Dec-07 Net NO_2 ug/m^3	Annual mean	Bias adjusted annual mean (0.77)	Data capture
SO 55195 05120	St Briavels - Grove House	8.8	12.3		8.5	9.4	7.3	4.9	5.0	6.3	5.7	11.3	14.9	8.6	6.60	92%
SO 55025 12658	Staunton Service Station Coleford	15.2	20.7	16.4	17.5	15.5	15.6	13.7		12.7	22.1	24.1	25.5	18.1	13.93	92%
SO 58048 12291	Five Acres - cross roads	24.0	31.6	20.5	29.0	28.9	22.5	14.6	21.5	22.7	39.7	25.4	29.4	25.8	19.88	100%
SO 59290 13166	Edge End - crossroads	12.9	19.6	16.3	23.7	26.6	14.9	12.5	19.0	18.6	30.2	17	23.2	19.6	15.05	100%
SO 65548 12958	Cinderford - 9 St Whites Rd	27.7	28.5	27.1	24.2	22.3	19.5	17.5	22.6	22.8	33.0	33.8	32.5	26.0	19.99	100%
SO 65843 14046	Cinderford - Bus Station	19.5	17.8	19.9	23.0	19.3	20.8	14.3	16.6	17.7	28.7		32.5	20.9	16.10	92%
SO 65243 14748	Cinderford - High St.	23.6	27.6	17.8	24.0	19.8	17.4	13.2	15.3	15.6	24.1	24.1	25.4	20.7	15.90	100%
SO 64538 16171	Nailbridge	34.3	39.3	35.8	43.3	36.4	34.2	29.7	36.0	33.7	46.2	48	42.7	38.3	29.49	100%
SO 66516 18276	Mitcheldean - Lamb Inn, Monmouth Rd	28.1	42.9	31.8	44.2	25.0	36.3	27.0	31.6	29.9	38.3	39.5	39.6	34.5	26.58	100%
SO 71698 19356	Huntley - crossroads	23.5	31.2	34.9	43.5	37.0	43.0	31.4	45.5	42.9	56.6	52.3	43.5	40.4	31.14	100%
SO 72193 19378	Huntley - The Red Lion	40.2	17.5	42.1	36.2	44.4	43.1		41.9	38.7	49.4	50.5	43.3	40.7	31.31	92%
SO 72023 26234	Newent - Community Centre	22.5	29.9		25.2	18.9	22.8	24.1	18.0	16.6	26.8	24.6	27.9	23.4	18.02	92%
SO 72238 25834	Newent - F.O.D.D.C. Branch Office	26.5	34.0		39.0	25.4	32.0	16.8	25.1	26.4	35.2	36.8	36.3	30.3	23.35	92%
SO 73218 32814	Bromsberrow - Freedom Farm	27.6	26.4		35.6	27.9	32.2	12.7	26.2	28.7	36.2	34.9	32.3	29.2	22.45	92%
SO 63145 03078	Lydney - 61 High Street	19.5	52.3	58.7	72.3	67.7	39.4	57.5	53.9	51.1	60.8	67.9	61.2	55.2	42.50	100%
SO 63117 03045	Lydney - 45 High Street	25.6	53.5	38.2	67.1	42.1	32.0		34.9	24.5	54.6	49.6	49.2	42.9	33.00	92%
SO 63075 02993	Lydney - 29 High Street	23.8	56.9	58.9	66.7	65.2	41.6			61.2	89.7	78.1	69.5	61.2	47.10	83%
SO 62995 02940	Lydney - 21 High Street	22.0	38.0	48.1		58.8		43.3	44.3	42.7	63.2	66	55.7	48.2	37.12	83%
SO 71695 14031	Westbury-on-Severn	30.4	13.1	29.7	32.2	24.2	25.5	27.2	23.9	26.6	39.6	34.5	34.5	28.5	21.91	100%
SO 69060 11608	Newnham-on-Severn	34.3	40.0	37.6	49.8	48.3	35.2	31.9	31.8	33.3	55.0	43.8	47.1	40.7	31.31	100%
SO 63180 03110	Lydney – Unit 1 Regents Walk Newerne St		49.3	43.2				48.6		(17.0)	49.7	(241.1)	63.4	50.8	39.13	42%
SO 63452 03213	Lydney - 1Hill St	45.3	44.3	49.5	67.6	62.8	34.2	42.5	39.4	43.6	60.0	63	52.5	50.4	38.81	100%
SO 63455 02438	Lydney Bypass	20.3	24.5	18.2	18.6	13.3	11.3	15.7	14.0	13.2	21.9	23.8	23.4	18.2	14.00	100%
ST 54282 94228	Sedbury - A48	27.5	33.7	28.2	34.4	34.9	24.1	15.1	24.2	24.5	37.4	39.5	39.9	30.3	23.31	100%
SO 57610 10756	Coleford - Bank St	33.6	35.6	38.5	41.3	40.3	30.2	20.7	31.5	27.3	47.3	33	43.4	35.2	27.13	100%

Key: Yellow = >40 µg/m^3 NO_2 annual mean objective; Orange = within 10% of NO_2 annual mean objective; Red = poor data capture; brackets = data removed from annual mean calculation.

6. Appendix 2: Input data for the dispersion model

Table 4: Traffic data used in dispersion model

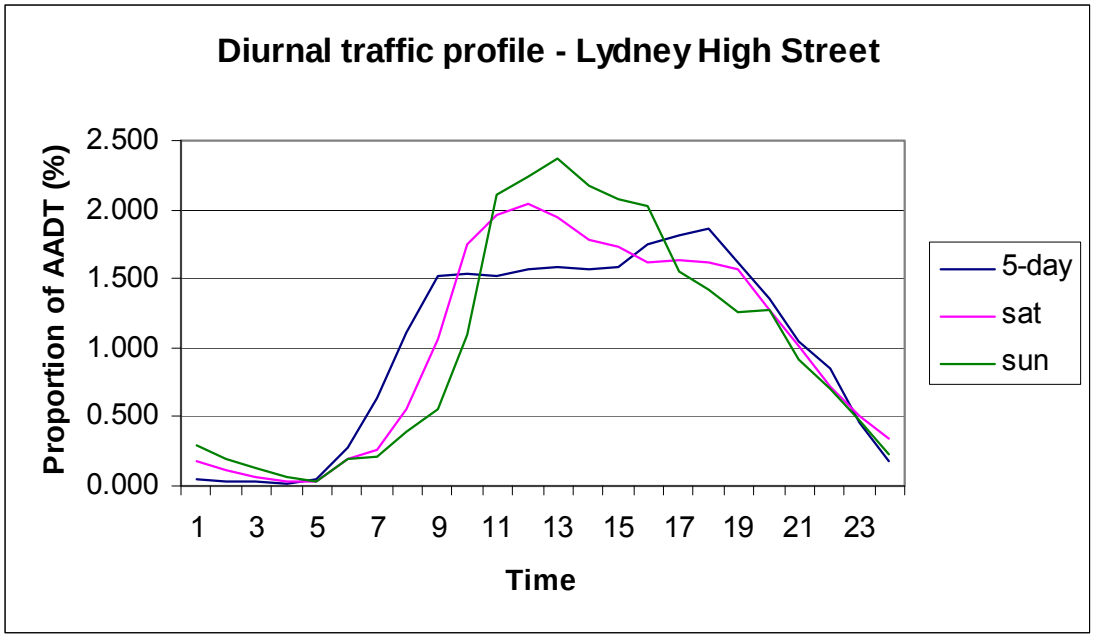
Source Name	Vehicle Type	Average Speed (kph)	2007 AADF	2007 AAHF	Emission Category
		High Street, Lydney			
VicSt_slow	LGV	10	125	5	Urban
	HGV	-	-	-	Urban
HillStE_vslow	LGV	5	13930	580	Urban
	HGV	5	261	11	Urban
HillStE_slow	LGV	10	13930	580	Urban
	HGV	10	261	11	Urban
HillStE_med	LGV	20	13930	580	Urban
	HGV	20	261	11	Urban
HillStE_fast	LGV	30	13930	580	Urban
	HGV	30	261	11	Urban
HillStE_vfast	LGV	40	13930	580	Urban
	HGV	40	261	11	Urban
BreamRd_vslow	LGV	5	6251	260	Urban
	HGV	5	394	16	Urban
BreamRd_slow	LGV	10	6251	260	Urban
	HGV	5	394	16	Urban
BreamRd_med	LGV	20	6251	260	Urban
	HGV	20	394	16	Urban
BreamRd_fast	LGV	30	6251	260	Urban
	HGV	30	394	16	Urban
BreamRd_vfast	LGV	40	6251	260	Urban
	HGV	40	394	16	Urban
HighStW_vslow	LGV	5	14276	595	Urban
	HGV	5	442	18	Urban
HighStW_east_slow	LGV	10	7885	329	Urban
	HGV	10	280	12	Urban
HighStW_west_slow	LGV	10	6291	262	Urban
	HGV	10	262	11	Urban
HighStW_east_med	LGV	20	7885	329	Urban
	HGV	20	280	12	Urban
HighStW_west_med	LGV	20	6291	262	Urban
	HGV	20	262	11	Urban
HighStW_fast	LGV	30	14276	595	Urban
	HGV	30	442	18	Urban
HighStW_vfast	LGV	40	14276	595	Urban
	HGV	40	442	18	Urban

Table 5: Road widths, canyon height and road elevation used in the dispersion model.

Source name	Road Width (metres)	Canyon Height (metres)	Road Elevation (metres)
	High Street, Lydney		
VicSt_slow	7.5	0	0
HillStE_vslow	14.5	0	0
HillStE_slow	7.5	8	0
HillStE_med	6.5	0	0
HillStE_fast	8.0	0	0
HillStE_vfast	6.0	0	0
BreamRd_vslow	14.5	0	0
BreamRd_slow	6.0	0	0
BreamRd_med	8.5	0	0
BreamRd_fast	6.5	0	0
BreamRd_vfast	6.5	0	0
HighStW_vslow	14.5	0	0
HighStW_east_slow	3.0	0	0
HighStW_west_slow	11	0	0
HighStW_east_med	5.0	0	0
HighStW_west_med	6.5	0	0
HighStW_fast	14.0	8	0
HighStW_vfast	12.0	8	0

Table 4 and Table 5 illustrate the road/traffic input data to the ADMS-Roads dispersion model. The road geometry (centrelines and width) were obtained using Ordnance Survey MasterMap data, whilst estimates of average building heights along each road were determined by site visits and examining photographs of the area (Appendix 4: Photographs of Lydney monitoring sites). Traffic counts were obtained from Gloucestershire County Council. AADT figures for 2007 were derived along with a site-specific diurnal traffic profile which was applied to the model (Figure 7).

Figure 7: Mean diurnal traffic profile for High Street, Lydney



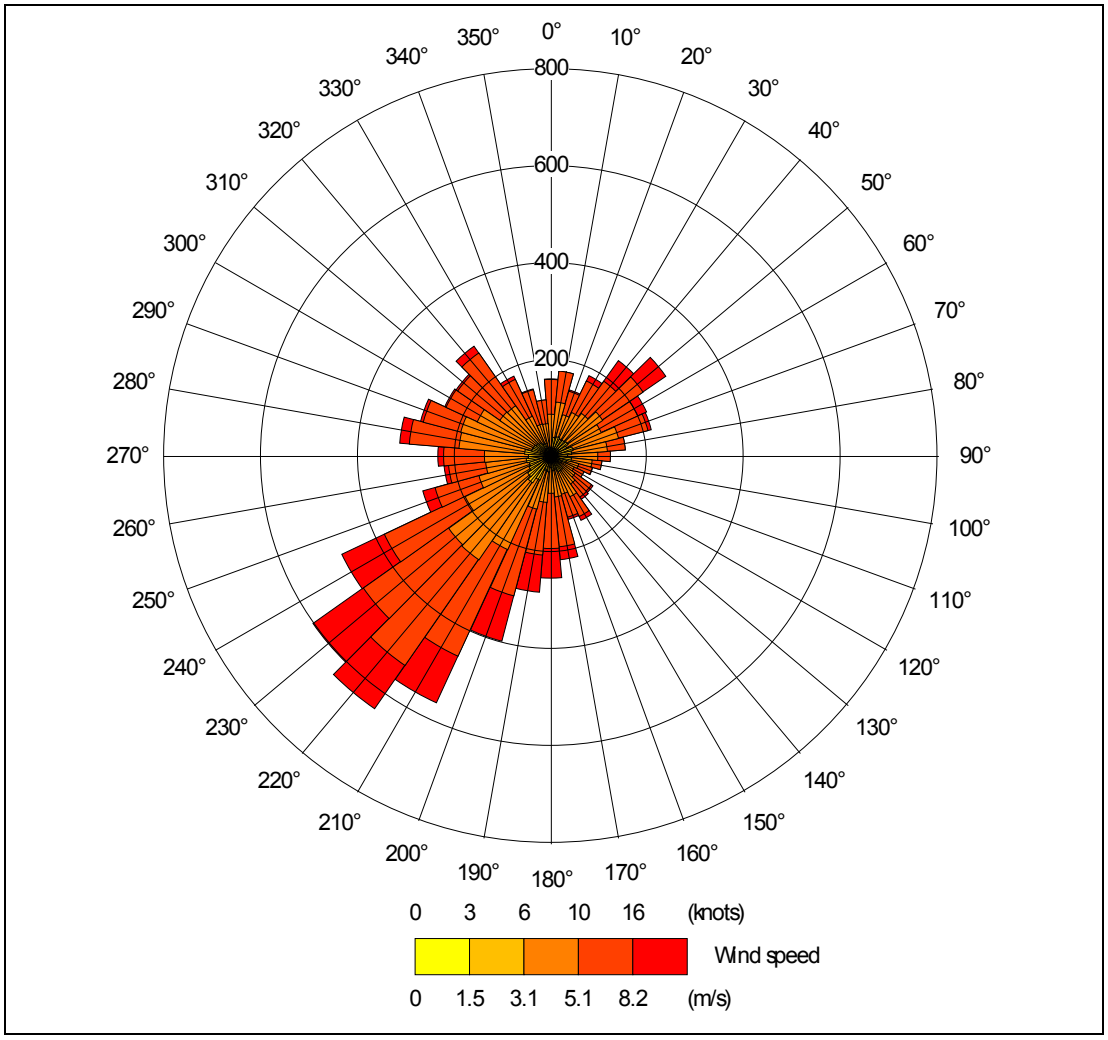
6.1. Background data

Background NOx and NO_2 data were obtained from the LAQM Section of the Air Quality Archive Website (http://www.airquality.co.uk/archive/laqm/laqm.php). This data comes as discrete 1 km resolution grid points. To provide a representative background value for the area the mean value was taken for the four grid points surrounding the area. The mean background concentration of NO_2 was calculated as 13.3 µg/m^3 and the background concentration of NOx derived as 16.9 µg/m^3.

6.2. Meteorological data

The meteorological data utilised came from Little Rissington. Little Rissington is similar both geographically and meteorologically to the area being modelled.

Figure 8: Windrose for Little Rissington meteorological data



7. Appendix 3: Model verification and adjustment

7.1. Verification and adjustment

Model verification is the process by which raw output from the dispersion model is compared with monitoring data in order to assess the overall error in the model (Box 1). There are a number of assumptions and potential inherent uncertainties in undertaking a dispersion modelling study, these may include:

- Uncertainties in traffic flow data: actual number of vehicles, vehicle mix and speed;
- Simplification in terms of street geography: road width and canyon height;
- Error in the emission factors used, and in their representativeness for local vehicle fleets;
- Estimates of background concentrations;
- Uncertainties and representativeness of meteorological data;
- Model input parameters such as roughness length and Monin-Obukhov length; and
- General limitations in the physics of the model itself.

In order to account for these uncertainties the model predictions are verified against available monitoring data and then adjusted to correct for them. This process allows the spatial dispersion of pollution to be based on the model results, whilst the actual predicted concentrations are linked to the available monitoring results. The verification calculations are described in detail in Box 1 and the results from these calculations at the diffusion tube/receptor sites used are given in Table 6.

Box 1: Model verification process

Roadside total monitored NO_2 concentration = $[NO_2]$TotMon

Roadside total monitored NO_X concentration = $[NO_x]$TotMon*

Background NO_x = [NOx]Bkgd

Background NO_2 [NO2]Bkgd

Modelled roadside NO_x contribution = $[NO_x]$RoadsMod

Step 1: Calculate monitored roadside contribution for NO_x and NO_2 (µg/m^3)

$[NO_x]$TotMon – $[NO_x]$Bkgd = $[NO_x]$RoadsMon

$[NO_2]$TotMon – $[NO_2]$Bkgd = $[NO_2]$RoadsMon

Step 2: Determine adjustment factor for modelled roadside contribution

$[NO_x]$RoadsMon / $[NO_x]$RoadsMod = NO_x[AdjustmentRoadsMod] = Correction Factor

All modelled roads contributions should be multiplied by this factor to give the corrected modelled contribution, NO_x[CorrRoadsMod].

NO_x[CorrRoadsMod] = $[NO_x]$RoadsMod x NO_x[AdjustmentRoadsMod]

Note, NO_x[CorrRoadsMod] should equal the $[NO_x]$RoadsMon for verification sites.

Step 3: Calculate Factor F (proportion of NO_x converted to NO_2)

F = –0.068 x LN([NOx]TotMon) + 0.53

The factor F varies between sites depending on the total NO_x and must be calculate for all results.

Step 4: Calculate modelled roadside NO_2 contribution (µg/m^3)

$[NO_2]$RoadsMod = NO_x[CorrRoadsMod] x Factor F

Step 5: Calculate final NO_2 concentration (µg/m^3)

$[NO_2]$TotMod = $[NO_2]$RoadsMod + $[NO_2]$Bkgd

The concentration derived in this step should equal or closely approximate the total monitored NO_2 concentration.

* NOx total monitoring value has been derived using the '*NOx from roadside NO2*' excel spreadsheet

Table 6: Table of calculations for model verification/adjustment based on TG(03) methodology

Loc.	DT	**NO_2 Tot Mon**	NOx Total Mon	NOx BK	NO_2 BK	NO_2 Rds Mon	**NOx Rds Mon**	**NOx Rds Mod**	**Corr Fact**	Corr NOx Rds Mod	Total NOx Corr	F Fact	NO_2 Rds Mod	**NO_2 Tot Mod**	Diff %
Lydney	61 High Street	42.50	121.20	16.90	13.30	14.13	104.30	29.20	7.38	104.30	121.20	0.28	29.19	42.49	-0.02
	45 High Street	33.00	80.60	16.90	13.30	10.38	63.70	19.70	6.14	63.70	80.60	0.31	19.70	33.00	0.00
	29 High Street	47.10	143.00	16.90	13.30	19.53	126.10	33.80	6.46	126.10	143.00	0.27	33.79	47.09	-0.01
	21 High Street	37.12	97.40	16.90	13.30	7.20	80.50	23.82	11.19	80.50	97.40	0.30	23.79	37.09	-0.08
	AREAL								**7.79**						

The model results from ADMS-Roads have been verified against diffusion tube sites at each location. A correction factor of 1.0 would indicate that the model was predicting pollution concentrations exactly.

As can be noted from Table 6, the various monitoring sites can produce different correction factors for the modelled NO_X. In this instance, it is thought that the variation is primarily due to the influence of the street canyon in High Street and the locations of some of the monitoring sites. An areal verification and adjustment factor (7.79) has been utilised, but it is recommended that the diffusion tube network is evaluated and diffusion tubes are sited according to the Practical Guidance report (http://www.airquality.co.uk/archive/reports/cat05/0802141004_NO2_WG_PracticalGuidance_Issue1a.pdf).

8. Appendix 4: Photographs of Lydney monitoring sites

Figure 9: Lydney – Unit 1, Regents Walk, Newerne Street (site of 2006 exceedence)

Figure 10: Lydney - 1 Hill Street (on the corner of a busy junction)

Figure 11: Lydney - 61 High Street (opposite entrance to Tesco store)

Figure 12: Lydney - 45 High Street (showing turning right lane for Tesco)

Figure 13: Lydney - 29 High Street (note proximity of residences to the road)

Figure 14: Lydney - 21 High Street (note the shadows indicating the proximity of buildings opposite causing a canyon effect)