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Transport Research Laboratory

Local Air Quality Management
Further Assessment at Olney

by J. Price, A. Savage and K. Turpin

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by J. Price, A. Savage and K. Turpin (TRL)

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	Name	Date Approved
Project Manager	Jennifer Price	26/05/2009
Technical Referee	Anna Savage	26/05/2009

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Executive summary

This report constitutes an Air Quality Further Assessment conducted by the Transport Research Laboratory (TRL Ltd) for Milton Keynes Council (MKC) as part of their Local Air Quality Management (LAQM) duties. The focus of the Further Assessment is the market town of Olney, Buckinghamshire, where an Air Quality Management Area (AQMA) was declared for annual nitrogen dioxide (NO_2) concentrations in 2008.

Annual mean concentrations of NO_2 have been modelled using the ADMS-Roads dispersion model for the base year of 2007 and the future years of 2010 and 2016. The method used for conducting the modelling assessment is in line with Defra's recently issued technical guidance LAQM TG (09). Modelled results for the base year of 2007 exhibit a tendency for under-prediction compared to NO_2 diffusion tube measurements recorded in the same year. The model has been adjusted accordingly in line with LAQM TG (09).

The findings of the 2008 Detailed Assessment are confirmed in this report, with exceedances of the national Air Quality Strategy (AQS) objective for annual NO_2 concentrations identified along Bridge Street and High Street South in 2007. These exceedances are within the existing AQMA boundary and as such, this report concludes that there is no need for the boundary to be extended or for the AQMA to be revoked. Reductions in NO_X road traffic emissions and NO_2 concentrations are expected to occur between 2007 and 2010. Despite these reductions, exceedances of the AQS NO_2 objective are expected to occur at 3 modelled receptors in 2010. A contour plot for the future year of 2010 has been produced to illustrate predicted concentrations of NO_2 and to highlight the areas where exceedances are expected to occur. Predicted NO_2 concentrations in 2016 are presented to enable the integration of air quality management with the region's next Local Transport Plan (LTP). The AQS objective value for NO_2 is expected to be met at all receptors in 2016.

The report provides recommendations on measures that Milton Keynes Council (MKC) may consider for inclusion in an Air Quality Action Plan for introduction by the year 2010. Following a source apportionment exercise, it was deemed appropriate for Action Plan measures to focus on reducing the numbers of HGVs entering Olney. Three possible measures have been identified and their impacts on vehicle emissions and total NO_2 concentrations at a selection of receptors have been assessed using the ADMS-Roads model. Reductions in total NO_2 concentrations are found to result from the introduction of a complete ban on Heavy Goods Vehicles (HGVs) entering Olney or a complete ban on articulated HGVs entering Olney (both scenarios relate to a ban at all times of the day and night), with an average reduction compared to 2010 baseline conditions of 10% and 5% respectively. The implementation of restricted access times for all HGVs (between the hours of 08:00 and 10:00 and 15:00 and 18:00 on weekdays) is expected to result in an average reduction of 5% compared to 2010 baseline conditions. Of the three modelled receptors that are predicted to exceed the objective in 2010, NO_2 concentrations at the receptor at 2 Bridge Street are predicted to remain above the objective in all three scenarios and at the receptor at 14 High Street South under the ban on articulated HGVs and the restricted access scenario.

A sensitivity analysis has been carried out to determine the impact of assuming a primary NO_2 fraction applicable to all UK traffic rather than assuming a higher fraction suitable when there is a high proportion of HGVs in the vehicle fleet. Assuming this lower fraction, the total ban on HGVs is expected to result in a 12% reduction in NO_2 concentrations compared to 2010 baseline conditions. The ban on articulated HGVs and the restricted access scenario are expected to result in average reductions of 7% and 8% respectively.

The limitations of the modelling approach and recommendations for further modelling to assess the impacts of the scenarios in more detail are provided.

1 Introduction

This report constitutes a Further Assessment of air quality in Olney, Buckinghamshire, following the designation of an Air Quality Management Area (AQMA) for High Street South and parts of Bridge Street in 2008 (MKC, 2008). The report fulfils the requirements of the Local Air Quality Management (LAQM) framework, introduced under Part IV of the Environment Act 1995. Under this framework, local authorities are required to assess concentrations of specified air pollutants against standards and objectives listed in the Air Quality Strategy (AQS) document for England, Scotland, Wales and Northern Ireland (Defra, 2007). A summary of the pollutants contained within the AQS and the relevant objectives are presented in Appendix 1.

This Further Assessment report aims to:

1. Confirm the findings of the 2008 Detailed Assessment regarding concentrations of NO_2 relevant to prescribed air quality objectives.
2. Calculate the improvement in NO_2 concentrations (relative to 2007 values) that is required to meet the annual mean NO_2 objective value.
3. Assess whether the current AQMA designation is correct and whether any changes are needed.
4. Determine the contribution of key sources (*i.e.* in terms of different vehicle types) to road NO_X emissions.
5. Take into account new guidance or local developments that may have occurred since previous Review and Assessment reports.
6. Investigate the likely impacts on air quality of introducing potential action plan measures.

Atmospheric dispersion modelling using the ADMS-Roads model has been carried out for the base year of 2007 and the future years of 2010 and 2016. A base year of 2007 has been selected in order to confirm the findings of the 2008 Detailed Assessment (MKC, 2008), which recorded exceedances of the national Air Quality Strategy (AQS) objective for annual NO_2 concentrations at 2 diffusion tube monitoring locations in Olney. The Detailed Assessment led to the declaration of an AQMA in 2008. NO_2 concentrations have been predicted for the future year of 2010 to enable calculation of the emissions reduction required to meet the AQS objective. Three suitable Air Quality Action Plan measures are identified and the emissions reduction resulting from each measure in 2010 has been determined using ADMS-Roads. Predicted concentrations of NO_2 in 2016 at receptors have also been included to allow for the integration of air quality management into the Council's next Local Transport Plan (LTP).

2 Background

Olney is a market town in the Borough of Milton Keynes covering 3,410 acres with a population of around 6,000 people (2001 census data) (Office for National Statistics, 2008). The town is approximately 7 miles from the M1 motorway (Junction 14). The A509 runs in a north-south direction and includes Bridge Street, High Street South and the High Street.

Milton Keynes Council (MKC) recently completed an Air Quality Detailed Assessment for Olney and declared an Air Quality Management Area (AQMA) for annual mean nitrogen dioxide (NO_2) in December 2008 (MKC, 2008). The AQMA includes sections of Bridge Street and High Street South (see Figure 2.1) where residential properties are located in close proximity to the road. In the narrowest section of the road, heavy goods vehicles (HGVs) are unable to travel in opposite directions at the same time, which leads to queuing traffic and increased road traffic emissions, and adversely affects the dispersion of vehicle pollutants. NO_2 concentrations of approximately 43 $\mu g/m^3$ were measured using diffusion tubes at locations on Bridge Street and High Street South in 2007 (see Section 3).

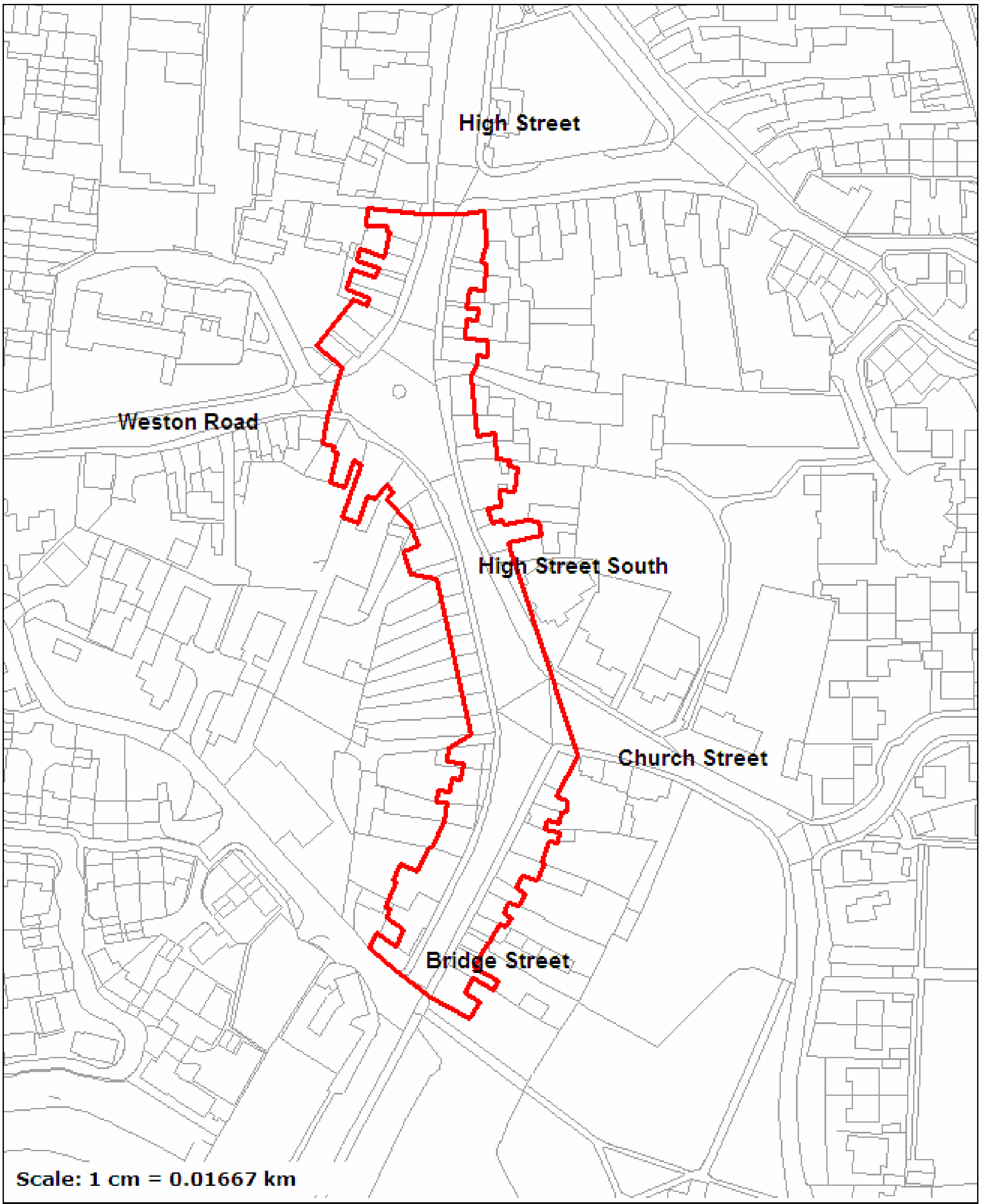

Figure 2.1: Olney Air Quality Management Area.
(Illustrated by red boundary line)

3 Monitoring data

Nitrogen dioxide (NO_2) diffusion tube monitoring has been undertaken at 12 locations in Olney in 2007 (see Table 3-1). Exceedances of the AQS objective value for annual average NO_2 has been measured at two locations on Bridge Street and High Street South.

Table 3-1: Nitrogen dioxide (NO_2) diffusion tube location and concentrations, 2007.

Diffusion tube location	Site classification	Easting	Northing	Bias adjusted NO_2 concentration ($\mu g/m^3$)[1]
18/20 Bridge Street	Urban Roadside	488917	251068	**43.2**
Courtney House, Bridge Street	Urban Roadside	488909	251077	39.7
9 High Street South	Urban Roadside	488904	251177	37.8
Cross Keys Office, High Street South	Urban Roadside	488898	251186	39.3
10 High Street South	Urban Roadside	488914	251173	**42.9**
22 High Street South	Urban Roadside	488901	251231	29.4
33 High Street South	Urban Roadside	488891	251248	35.8
20 High Street	Urban Roadside	488926	251455	24.1
17 High Street (Opposite 20 High Street)	Urban Roadside	488905	251456	27.5
Opposite 9 Weston Road	Urban Roadside	488840	251212	24.6
Mobile, High Street South/Church Street	Urban Roadside Co-location site	488937	251128	23.0▲
Corner of Coneygere and Palmers Street	Background	489108	251213	14.1

[1] Triplicate tubes located at all sites
▲ Site re-located in July 2008: average of 6 months data July-December

Nitrogen dioxide (NO_2) diffusion tubes are prepared and analysed 'in-house' by Milton Keynes Council (MKC) using the 20% triethanolamine (TEA) in water method (MKC, 2008). The Council participates in the Workplace Analysis Scheme for Proficiency (WASP) quality assurance scheme for diffusion tube analysis and has achieved 'good' precision and accuracy for all co-location and inter-comparison studies undertaken in 2007 (MKC, 2008). The bias adjustment factor used in 2007 was 0.72.

4 Modelling assessment

Atmospheric dispersion modelling for the base year of 2007 and the future years of 2010 and 2016 was undertaken using the Gaussian-based ADMS-Roads (Extra) software suite, developed by Cambridge Environmental Research Consultants (CERC)[1]. The ADMS-Roads model uses a number of input parameters to simulate the dispersion of pollutant emissions, predicting pollutant concentrations at specified receptors and across a user-defined area. The input parameters include emission source activity data, local meteorological conditions, chemical reactions and background pollutant concentrations.

4.1 Modelled domain and receptors

2007 was agreed as the base year for the modelling assessment due to the availability of traffic and meteorological data. 2010 was modelled as a future year to determine the emissions reduction required for compliance with the AQS objective value and to allow for the assessment of three possible Air Quality Action Plan measures. 2016 has also been modelled as a future year to enable consideration of the integration of air quality management within the area's third Local Transport Plan (LTP).

For the purpose of this assessment, pollutant concentrations have been modelled at 30 receptors (see Figure 4.1). These receptors were chosen by TRL and MKC and include 10 NO_2 diffusion tube monitoring sites and other locations where there is potential for public exposure. For all years included in this study, modelling predictions were undertaken at the selected receptors. For the future year of 2010, modelling predictions were also undertaken over a 2.2km by 2.5km calculation grid (known as the modelling domain). The ADMS-Roads model has applied a default 1089 receptor points to this domain and the grid resolution in this case is 69m by 80m. The 'intelligent gridding' feature of the ADMS-Roads model was utilised and further receptor points are added in close proximity to emission sources to optimise the modelling at relevant locations (*i.e.* for maximum public exposure). The minimum distance between these points in this study is 4.2m. This method complies with the recommendations regarding receptor grid spacing described in LAQM TG (09) (Defra, 2009).

[1] http://www.cerc.co.uk/software/admsroads.htm

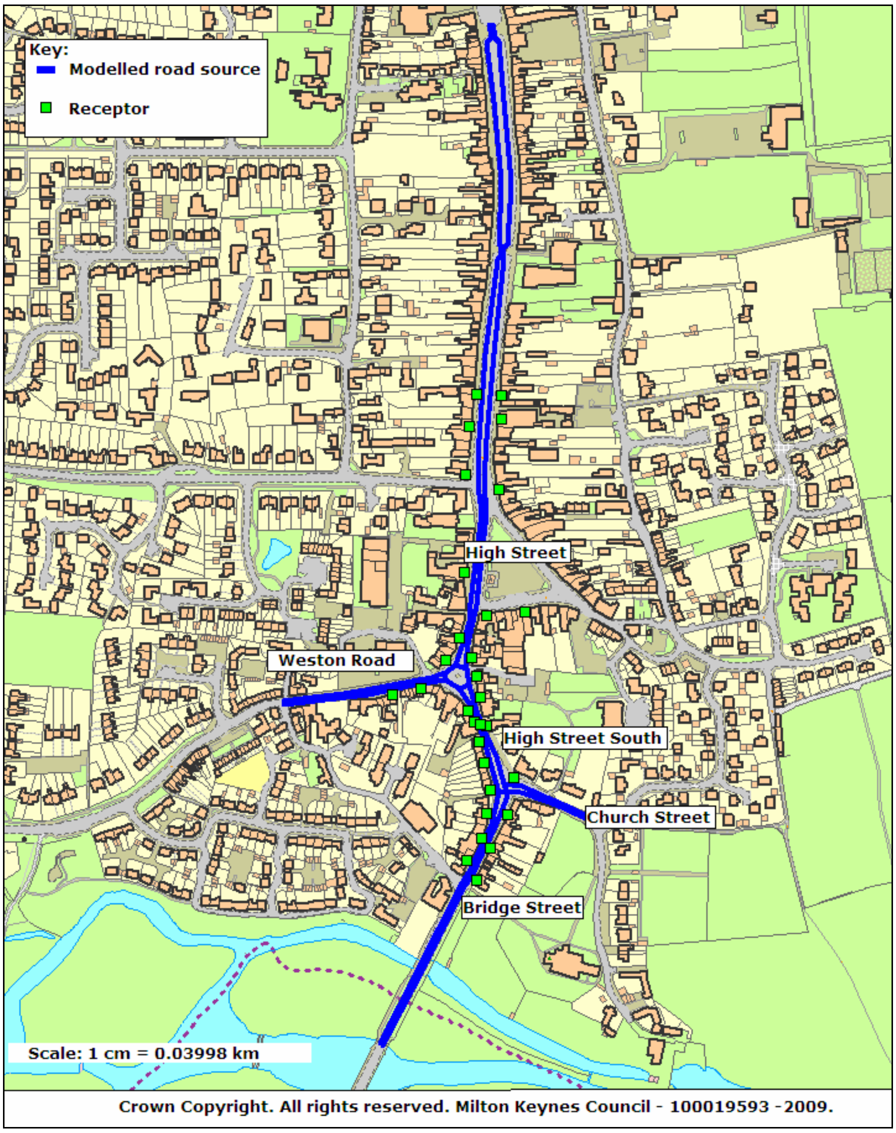

Figure 4.1: Modelling domain: Olney town centre.

4.2 Emissions source activity data

4.2.1 Traffic activity

Traffic count data for the A509 were provided by MKC for the year 2007 and forecast to 2010 and 2016 using the Automated Traffic Growth Calculator spreadsheet[2] and TEMPRO (Trip End Model Presentation Program)[3]. The use of TEMPRO allows for the calculation of a local growth factor: in this case the factor used is specific to Olney in the South East region. The traffic data used in this assessment consists of the Annual Average Daily Traffic (AADT) flow and fleet composition (*i.e.* percentage of passenger cars, light goods vehicles (LGVs), public service vehicles (PSVs), rigid heavy goods vehicles (HGVs) and articulated HGVs) for northbound and southbound directions on the A509. Summarised traffic data and the growth factors applied to forecast to 2010 and 2016 are provided in Appendix 2.

Speed data were provided for the year 2007 from surveys undertaken by MKC and from the DfT automatic traffic counter (ATC) situated south of Olney on the A509. Traffic

[2] http://www.uwe.ac.uk/aqm/review/
[3] http://www.tempro.org.uk/

counts on minor roads within the modelling domain (Weston Road and Church Street) were provided by MKC and are estimates of 2009 flows based on local knowledge of Olney. Estimates of the length and duration of queues along the A509 were also provided by MKC based on observed 2009 traffic flows. This information was incorporated into the ADMS-Roads model by including road links with AADT values of 30,000 vehicles and speeds of 5 kmh^{-1} that can be 'switched on/off' at the appropriate time of day. The following traffic queues were included in the assessment:

- Bridge Street and High Street South: Monday – Friday 06:00-19:00; Saturday/Sunday 08:00-10:00; 12:00-14:00; 17:00-19:00;
- High Street: Monday – Friday 07:00-09:00; 16:00-18:00.

Following an initial model run, queues were removed on Bridge Street at the junction with Church Street (see Figure 2.1) due to the modelled output over-estimating the NO_2 concentration measured by the diffusion tubes co-located at the continuous monitoring site. The road is wider at this point, which is likely to lead to more free-flowing traffic than occurs on the narrower sections of Bridge Street and High Street South.

4.2.2 Emission factor database

The fleet composition was derived from the traffic data provided and entered into version 1.03c of the Design Manual for Roads and Bridges (DMRB) spreadsheet (Highways Agency *et al*, 2007). For each defined road link, the DMRB spreadsheet was used to calculate emissions of oxides of nitrogen (NO_X).

In order to use the DMRB to produce an emissions estimate for each road link, the following information is required:

- The year of interest.
- The length of the link in kilometres.
- The annual average daily traffic flow (AADT).
- The annual average speed.
- The road type (A, B, C or D), where:
    - A = all motorways and A roads.
    - B = urban roads which are neither motorways nor A roads.
    - C = any other roads.
    - D = fleet composition known.
- The proportions of different generic vehicle categories in the traffic.

The 'road type' parameter acts as a proxy for differences in the coarse composition of the traffic under different conditions. When selecting road types A, B or C, only the proportions of light goods vehicles (LGVs) and heavy goods vehicles (HGVs) are specified. The selection of road type D allows a more detailed classification to be specified (*i.e.* percentage of passenger cars, LGVs, buses and coaches, rigid HGVs and articulated HGVs). Road type D was selected for the A509 as detailed fleet composition was derived from measured traffic data. Road type B was selected for minor roads where fleet composition has been estimated (*i.e.* Weston Road and Church Street). The DMRB calculates emissions on an annual basis and these are manipulated to derive emissions rates in g/km/s (*i.e.* suitable for use by the ADMS-Roads model).

4.2.3 Road geometry

The geometry of each road was determined using GIS mapping data. Road width is defined by the kerb-to-kerb measurement (km). The height of surrounding buildings is accounted for in the model wherever a ‘street canyon’ effect is observed. For atmospheric dispersion modelling assessments, a street canyon is defined by the building heights being greater than the building-to-building road width (aspect ratio greater than 1.0). Street canyons can have a significant impact on local dispersion processes with vortex air flows established through wind shear across the roof of the canyon. This movement of air within the canyon can influence ground level concentrations, with elevated concentrations typically forming at the bottom of the leeward side of the canyon. This effect is of particular relevance to this assessment, with sections of Bridge Street and High Street South exhibiting significant street canyon characteristics.

4.2.4 Time-varying emissions

Time-varying profiles have been included in the ADMS-Roads model. These consist of a data file which allows the model to take account of the variation in road traffic volumes over a 24-hour period, with the highest volumes in the daytime morning and afternoon peak periods and less traffic during the night. Within this assessment, generic diurnal profiles for minor roads and typical urban high streets were applied.

4.3 Background concentrations

The ADMS-Roads model was set up to model emissions from the road source only. The contribution of emissions from roads not modelled and other sources (such as rail and industries) in the local area, as well as regional sources, were therefore included from background files relevant to Olney, according to the recommended methodology in TG (09) (Defra, 2009). A summary of the contribution of the different sources to the total background NO_x concentration used for this modelling is given in Table 4-1: those sources within the relevant grid square are defined as ‘in’ and those outside the grid square are defined as ‘out’. The background NO_x concentrations for the three years were taken as the ‘total NO_x’ in the table and background concentrations of NO_2 for the three years were 14.2 $\mu g/m^3$ for 2007, 12.7 $\mu g/m^3$ for 2010 and 10.9 $\mu g/m^3$ for 2016.

Table 4-1: Summary of contribution of sources to background NO_x concentrations, all years.

NO_x concentration ($\mu g/m^3$)	2007	2010	2016
Total NO_x	19.0	16.6	13.6
Motorway in	0.0	0.0	0.0
Motorway out	1.6	1.3	0.7
Trunk A Road in	0.0	0.0	0.0
Trunk A Road out	0.2	0.2	0.1
Primary A Road in	1.0	0.8	0.5
Primary A Road out	0.7	0.6	0.4
Minor Road in	0.5	0.3	0.2
Minor Road out	0.6	0.4	0.2
Industry in	0.0	0.0	0.0
Industry out	0.3	0.3	0.3
Domestic in	1.3	1.1	1.0
Domestic out	0.5	0.5	0.4
Aircraft in	0.0	0.0	0.0
Aircraft out	0.0	0.0	0.0
Rail in	0.00	0.0	0.0
Rail out	0.1	0.1	0.1
Other in	0.2	0.1	0.1
Other out	0.6	0.6	0.5
Point Sources	0.1	0.1	0.1
Rural	11.3	10.2	9.1

Grid square coordinates: 488500, 251500

4.4 Atmospheric chemistry

The concentration of NO_2 at a specific location is determined by a combination of emissions, meteorology and atmospheric chemistry. Some NO_2 is emitted directly from vehicle exhaust (this is known as primary NO_2), mainly from diesel vehicles. Emissions of NO_X from vehicles are primarily in the form of nitrogen oxide (NO) (AQEG, 2007). NO undergoes a chemical reaction with oxidants such as ozone (O_3) to produce secondary NO_2. At a roadside location, there is routinely an excess of NO, and thus the limit to the formation of NO_2 is usually determined by the availability of O_3. Therefore, at heavily trafficked roadside locations, there is not a linear relationship between changes in NO_X emissions and NO_2 concentrations.

Nitrogen dioxide (NO_2) concentrations have been derived from the NO_X concentrations measured by the ADMS-Roads model using the calculator[4] available on the LAQM tools section of the UK Air Quality Archive website. A primary NO_2 fraction of 0.2 (20%) was assumed for Olney due to the presence of a large proportion of HGVs in the vehicle fleet.

4.5 Meteorological data

The ADMS-Roads model applies hourly sequential meteorological data to calculate atmospheric dispersion. This calculation involves a number of meteorological parameters including wind speed and direction, cloud cover and near surface temperature (the latter two parameters being important for the calculation of atmospheric stability, which affects how pollutants disperse). Bedford meteorological station is the site closest to Olney (approximately 20 km away) with the highest data capture rate for 2007 and which records the required parameters (with the exception of cloud cover). Cloud cover data was obtained from Wittering meteorological station,

[4] http://www.airquality.co.uk/archive/laqm/tools.php

which is approximately 60 km from Olney. A wind rose has been produced using 2007 data obtained from Bedford meteorological station (see Figure 4.2). The dominant wind speed is from the south west, with maximum speeds of 8-9 ms^{-1}.

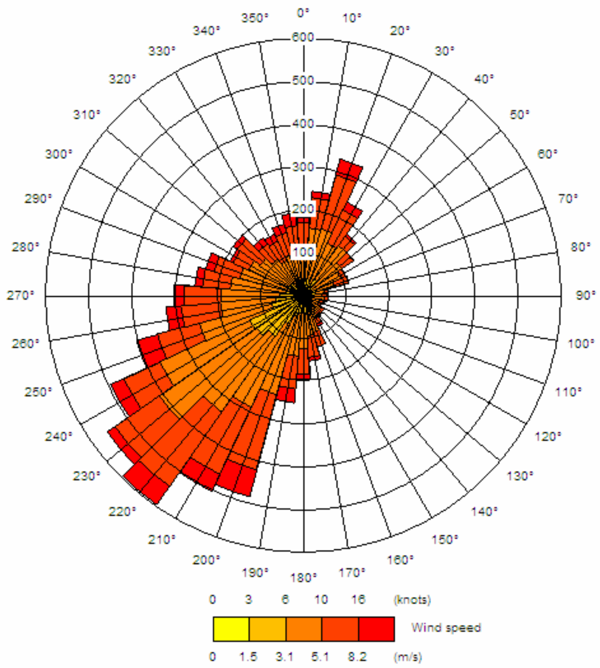

Figure 4.2: Wind rose based on 2007 data from Bedford meteorological station.

4.6 Surface roughness

The interaction of wind flow with the ground generates turbulence, influencing pollutant dispersion. The strength of this turbulence is dependent on the land use, with urban areas generating higher turbulence than open countryside. The ADMS-Roads user guide indicates that a surface roughness length of 1 m is suitable for cities and woodland and 0.5 m is suitable for parkland and open suburbia. This study used a surface roughness of 0.5 m for the modelling domain.

The ADMS-Roads model allows the user to specify the surface roughness length of the site where meteorological data has been recorded (used when the surface roughness length at the meteorological site differs from that at the area under assessment). In this way, the ADMS-Roads model modifies the meteorological data to accommodate differences in surface roughness between the modelling domain and the geographical area from which meteorological measurements are obtained. The surface roughness length at the meteorological site used in this study is 0.2 metres.

5 Results

5.1 Model verification

Model verification has been undertaken in line with LAQM TG (09) (Defra, 2009). This process allows uncertainties in model results to be investigated and minimised. Monitored NO_2 concentrations have been converted to road NO_X concentrations using the calculator[5] available on the LAQM tools section of the UK Air Quality Archive website, using the relevant background concentration of NO_x and NO_2. Comparison between the monitored road NO_X concentrations with modelled road NO_X concentrations is presented in Table 5-1. The results from 3 diffusion tube monitoring sites have been excluded from the model verification process. The tubes opposite 9 Weston Road have been excluded because there was insufficient traffic data to enable accurate modelling at this site (AADT flows and speed data have been estimated); the tubes at the continuous monitor have been excluded because there is less than 12 months of data available from this site; and the background site (Corner of Coneygere and Palmers Street) has been excluded because it is located outside of the modelling domain. The model has demonstrated an average under-estimate of road NO_X emissions of 17% compared to measured concentrations (based on 2007 data).

Table 5-1: Comparison between modelled and monitored NO_X concentrations, 2007.

Site ID	Monitored total NO_2	Monitored road NO_x	Modelled road NO_x
18/20 Bridge Street	**43.20**	80.48	62.10
Courtney House	39.70	67.70	45.85
9 High Street South	37.80	61.23	42.98
Cross Keys office	39.30	66.31	44.21
10 High Street South	**42.90**	79.34	65.46
22 High Street	29.40	35.93	41.66
33 High Street South	35.80	54.73	33.99
20 High Street	24.10	22.24	22.53
17 High Street	27.50	30.85	30.73

Comparison of the measured road NO_X contribution with the modelled road NO_X contribution allows an adjustment factor to be calculated and applied to the modelled concentrations to minimise uncertainty in the modelled results (see LAQM TG (09) (Defra, 2009)). Figure 5.1 illustrates the relationship between the measured and monitored road NO_X contribution. The equation of the trend line shown in Figure 5.1 has been used to obtain a factor (1.287) which is applied to the modelled road NO_X concentration to obtain the adjusted modelled NO_X concentrations at each receptor (see Table 5-2). This model adjustment factor has been applied to modelled NO_x concentrations for all three years (2007, 2010 and 2016).

The NO_2 concentration has been derived using the LAQM calculator tool[6] and comparison with the measured diffusion tube concentrations shows that following adjustment, the model is over-predicting by an average of 7% (see Table 5-2). The model has performed best at receptors on Bridge Street and High Street South, which are the areas of concern with respect to the declared AQMA. Exceedance of the AQS objective value for NO_2 has been measured at 2 NO_2 diffusion tube locations in 2007 (18/20 Bridge Street and 10 High Street South) and modelled results are in agreement with the

[5] http://www.airquality.co.uk/archive/laqm/tools.php
[6] http://www.airquality.co.uk/archive/laqm/tools.php

measured exceedances. Modelled concentrations at receptors on the High Street exhibit the worst agreement with measured concentrations, with an average over-reading of 20% in 2007. This may be due to the uncertainty surrounding the traffic queue information for this section of the road.

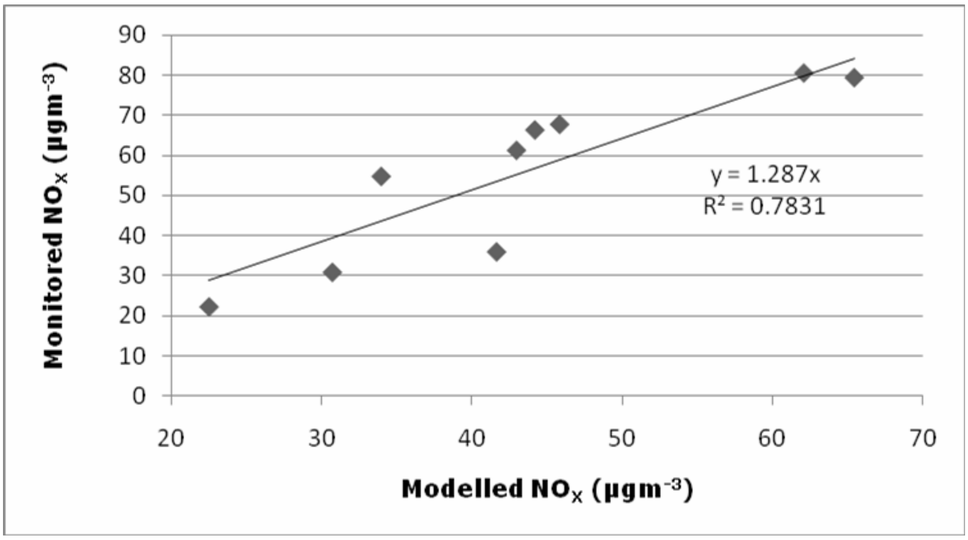

Figure 5.1: Comparison between modelled and monitored NO_X road contribution, 2007.

Table 5-2: Adjusted modelled NO_X contributions and model performance.

Site ID	Ratio (monitored road NO_X / modelled road NO_X)	Adjusted modelled road NO_X	Adjusted modelled total NO_2	Monitored NO_2	% Difference ((modelled-monitored) / monitored) *100
18/20 Bridge Street	1.30	79.92	**45.98**	**43.20**	6%
Courtney House	1.50	59.01	39.07	39.70	-2%
9 High Street South	1.42	55.32	37.76	37.80	0%
Cross Keys Office	1.50	56.89	38.32	39.30	-2%
10 High Street South	1.21	84.24	**47.31**	**42.90**	10%
22 High Street	0.86	53.62	37.15	29.40	26%
33 High Street South	1.61	43.74	33.46	35.80	-7%
20 High Street	0.99	29.01	27.52	24.10	14%
17 High Street	1.00	39.56	31.83	27.50	16%

5.2 Model uncertainty

The uncertainty of the model is expressed as the standard deviation of the model (SDM). The SDM is calculated using the following formula:

SDM = U x NO_2 annual mean objective value ($\mu g/m^3$)

Where: U = standard deviation of the modelling deviation (SD) / measured data mean.

To calculate the standard deviation of the modelling deviation (SD), a scatter plot of the monitored versus the verified modelled NO_2 annual mean concentrations has been produced using the results in Table 5-2 (see Figure 5.2). The modelling deviation is the difference between each data point and the trend line. The standard deviation of the modelling deviation (SD) is calculated from the modelling deviation results (in this case SD = 3.0).

The uncertainty value (U) is derived with the following calculation:

U = 3.0 / 35.5

U = 0.08

This equates to an uncertainty value of 8% for the annual mean NO_2 concentration.

Finally, the standard deviation of the model (SDM) is calculated as below:

SDM = 0.08*40

SDM = 3.2 µg/m^3 for NO_2.

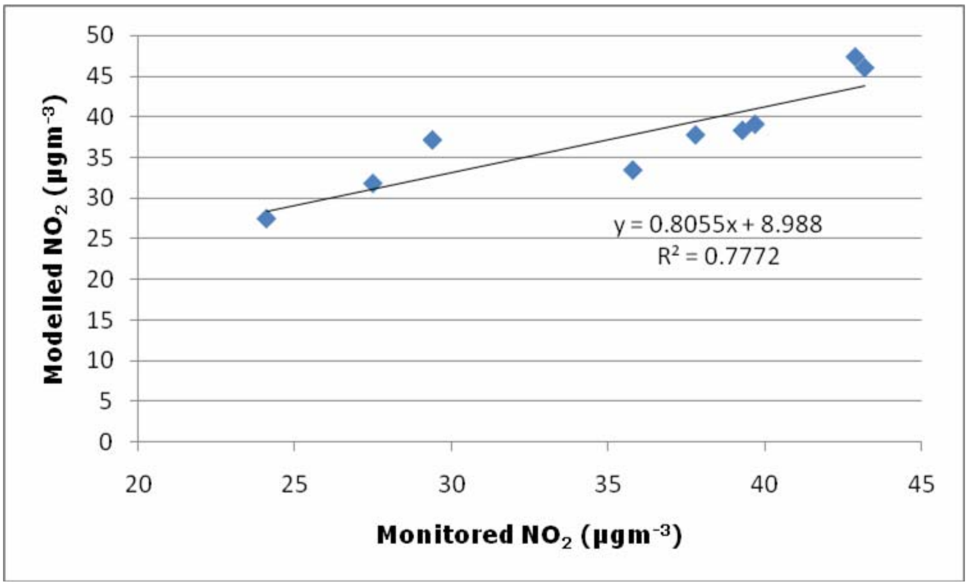

Figure 5.2: Comparison between monitored and modelled total NO_2, 2007.

5.3 2007 base year

Modelled concentrations at all receptors for the base year of 2007 are shown in Table 5-3. These concentrations are adjusted in line with LAQM TG (09) (Defra, 2009) as described in Section 5.1. Exceedance of the NO_2 AQS objective has occurred at 4 locations on Bridge Street and High Street South in 2007. The percentage reduction required to meet the AQS objective value (40 µg/m^3) is illustrated in Table 5-3.

Table 5-3: Adjusted modelled total NO_2 and reduction required to comply with NO_2 AQS objective, 2007.

Site ID	Adjusted Modelled total NO_2 ($\mu g/m^3$)	Reduction required for compliance with NO_2 AQS objective (%)
18/20 Bridge Street	**45.98**	-13%
Courtney House	39.07	-
Pembroke House	39.09	-
2 Bridge Street	**52.15**	-23%
28 Bridge Street	32.85	-
15 Bridge Street	30.02	-
1 High Street South	27.53	-
5 High Street South	37.71	-
8 High Street South	39.16	-
9 High Street South	37.76	-
Cross Keys Office	38.32	-
10 High Street South	**47.31**	-15%
14 High Street South	**48.99**	-18%
20 High Street South	35.64	-
22 High Street	37.15	-
25 High Street South	26.74	-
33 High Street South	33.46	-
38 Market Place	31.04	-
33 Market Place	20.32	-
1 Market Place	29.16	-
5 High Street	22.73	-
13 High Street	23.76	-
16 High Street	28.74	-
20 High Street	27.52	-
17 High Street	31.83	-
The Bull (Public house)	25.06	-
1 Weston Road	20.14	-
21 Weston Road	18.04	-
Mobile (continuous monitoring site)	28.18	-

5.4 2010 future year

Total adjusted modelled NO_2 concentrations are predicted to reduce at all sites in 2010 by an average of 13% compared to modelled 2007 concentrations (see Table 5-4). This reduction is predicted despite the slight increase in traffic that is expected to occur (see Appendix 2). The introduction of more stringent emissions standards is expected to result in a cleaner vehicle fleet in future years. Changes to the vehicle fleet are accounted for in the DMRB calculations and in this case, they are expected to offset the increase in traffic and lead to a reduction in NO_X emissions from road traffic sources.

Despite the reduction in NO_X emissions, exceedance of the AQS NO_2 objective value is predicted at 3 receptors in 2010. As in 2007, these sites are within the existing AQMA (Bridge Street and High Street South). The percentage reduction required for compliance with the NO_2 AQS objective value at each receptor where exceedance is predicted is illustrated in Table 5-4.

Table 5-4: Adjusted modelled total NO_2, reduction required to comply with NO_2 AQS objective and comparison with 2007 data, 2010.

Site ID	Adjusted modelled total NO_2 (µg/m³)	Reduction required for compliance with NO_2 AQS objective (%)	Reduction in total NO_2 2007-2010 (%)
18/20 Bridge Street	39.63	-	-14%
Courtney House	33.53	-	-14%
Pembroke House	33.41	-	-15%
2 Bridge Street	**44.95**	-11%	-14%
28 Bridge Street	28.64	-	-13%
15 Bridge Street	25.94	-	-14%
1 High Street South	24.02	-	-13%
5 High Street South	32.92	-	-13%
8 High Street South	33.58	-	-14%
9 High Street South	32.44	-	-14%
Cross Keys House	32.88	-	-14%
10 High Street South	**40.82**	-2%	-14%
14 High Street South	**42.21**	-5%	-14%
20 High Street South	30.92	-	-13%
22 High Street	32.46	-	-13%
25 High Street South	23.22	-	-13%
33 High Street South	28.85	-	-14%
38 Market Place	26.88	-	-13%
33 Market Place	17.76	-	-13%
1 Market Place	25.34	-	-13%
5 High Street	19.85	-	-13%
13 High Street	20.73	-	-13%
16 High Street	24.98	-	-13%
20 High Street	23.95	-	-13%
17 High Street	27.74	-	-13%
The Bull (Public house)	21.82	-	-13%
1 Weston Road	17.73	-	-12%
21 Weston Road	15.96	-	-12%
Mobile (continuous monitoring site)	24.64	-	-13%

Figure 5.3 illustrates predicted NO_2 concentrations for the entire modelling domain for the future year of 2010. Zoomed contour plots illustrating the predicted NO_2 concentrations on High Street South and Bridge Street are provided in Figure 5.4 and Figure 5.5. Taking the predicted area of exceedance to be the yellow boundary, the existing AQMA which includes Bridge Street and High Street South is suitable and will not need to be amended on the basis of this Further Assessment report. When incorporating modelling uncertainty (see Section 5.2), the areas within the light blue contour (36-40 µg/m³) are likely to exceed the NO_2 annual mean objective at 1 standard deviation (see Figure 5.3). Areas with relevant exposure within the light blue contour are included in the existing AQMA.

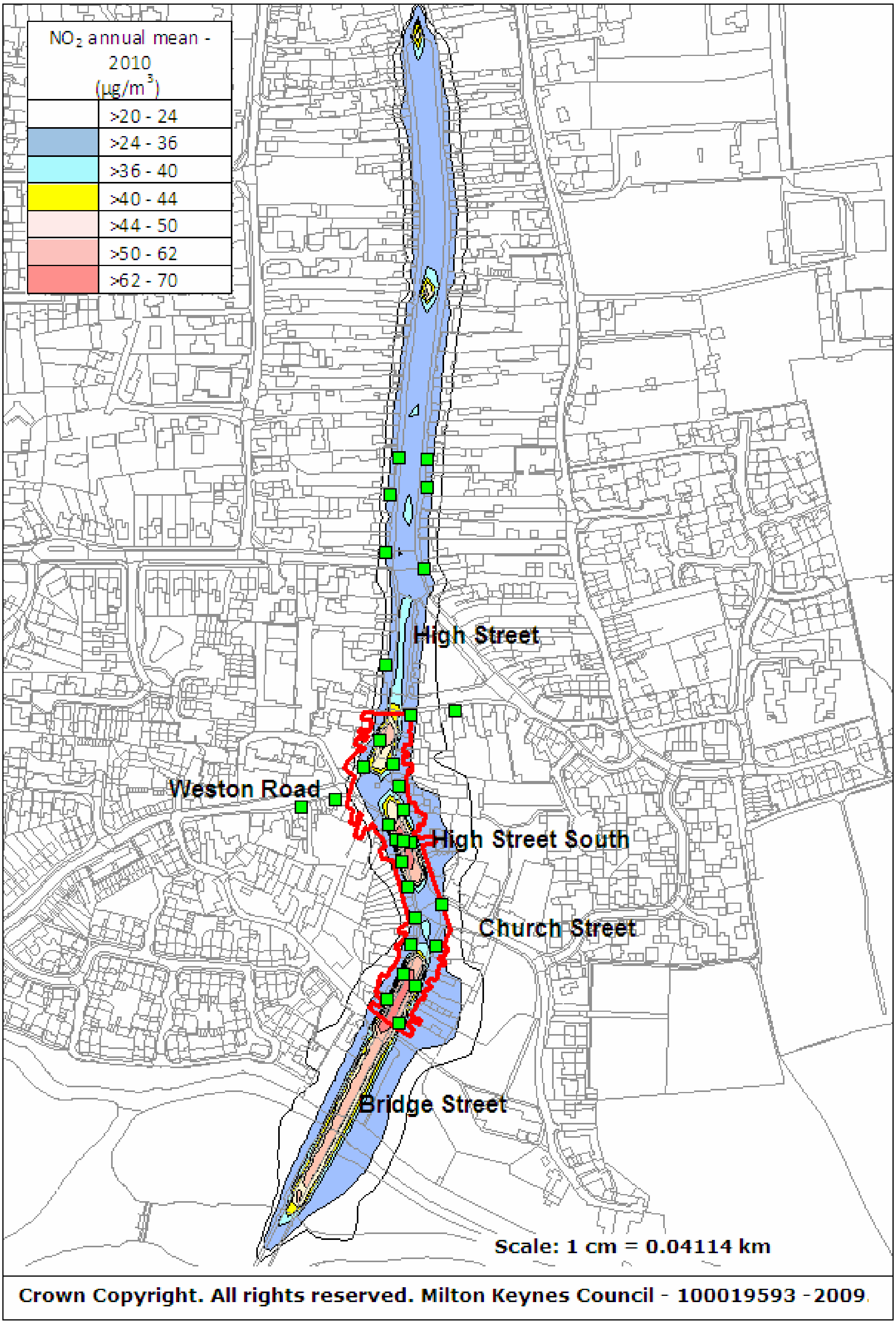

Figure 5.3: Contour plot of predicted NO_2 concentrations, AQMA boundary (red line) and receptor locations (green squares), 2010.

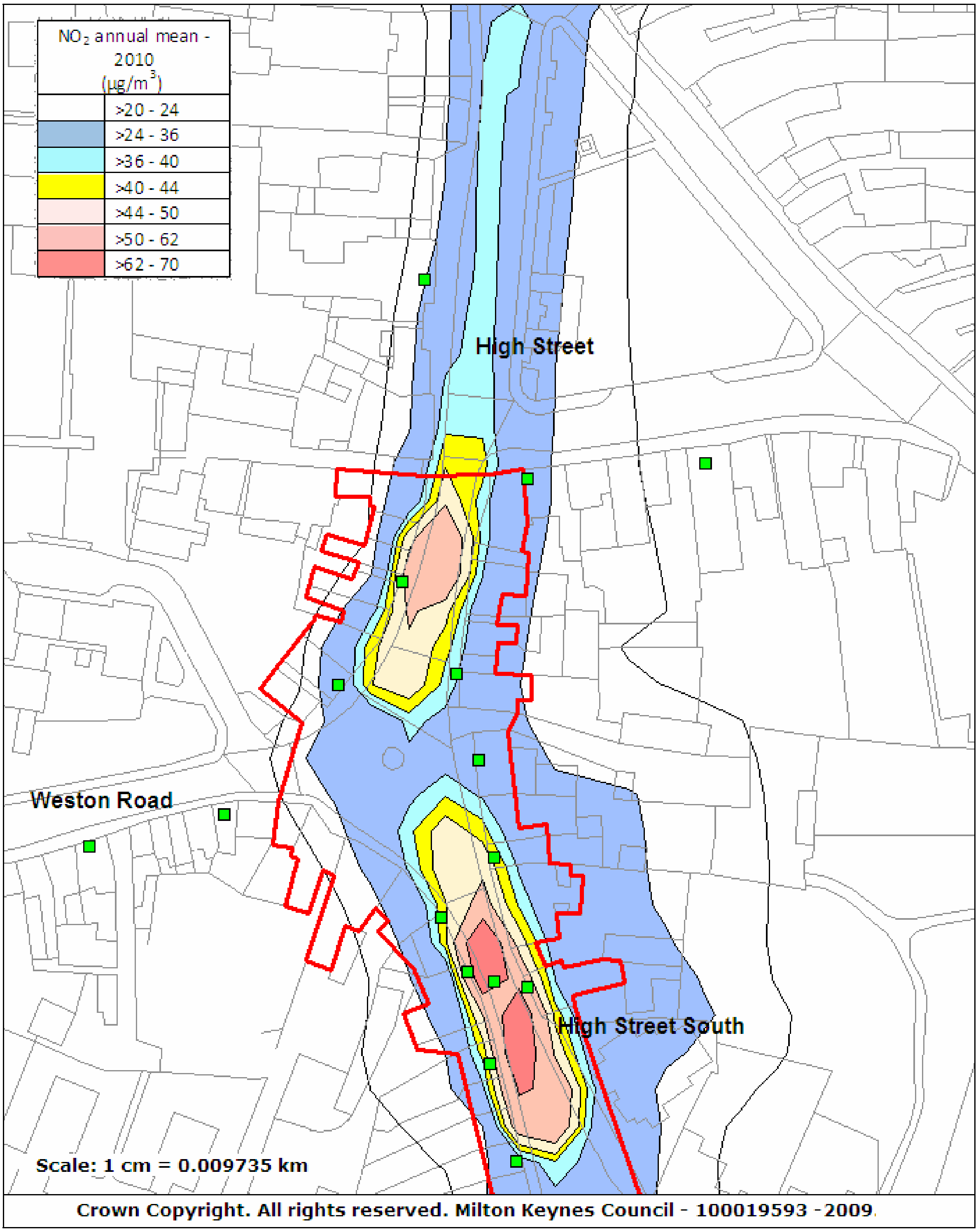

Figure 5.4: Zoomed contour plot of modelled NO_2 concentrations, AQMA boundary and receptor locations, High Street South and High Street, 2010.

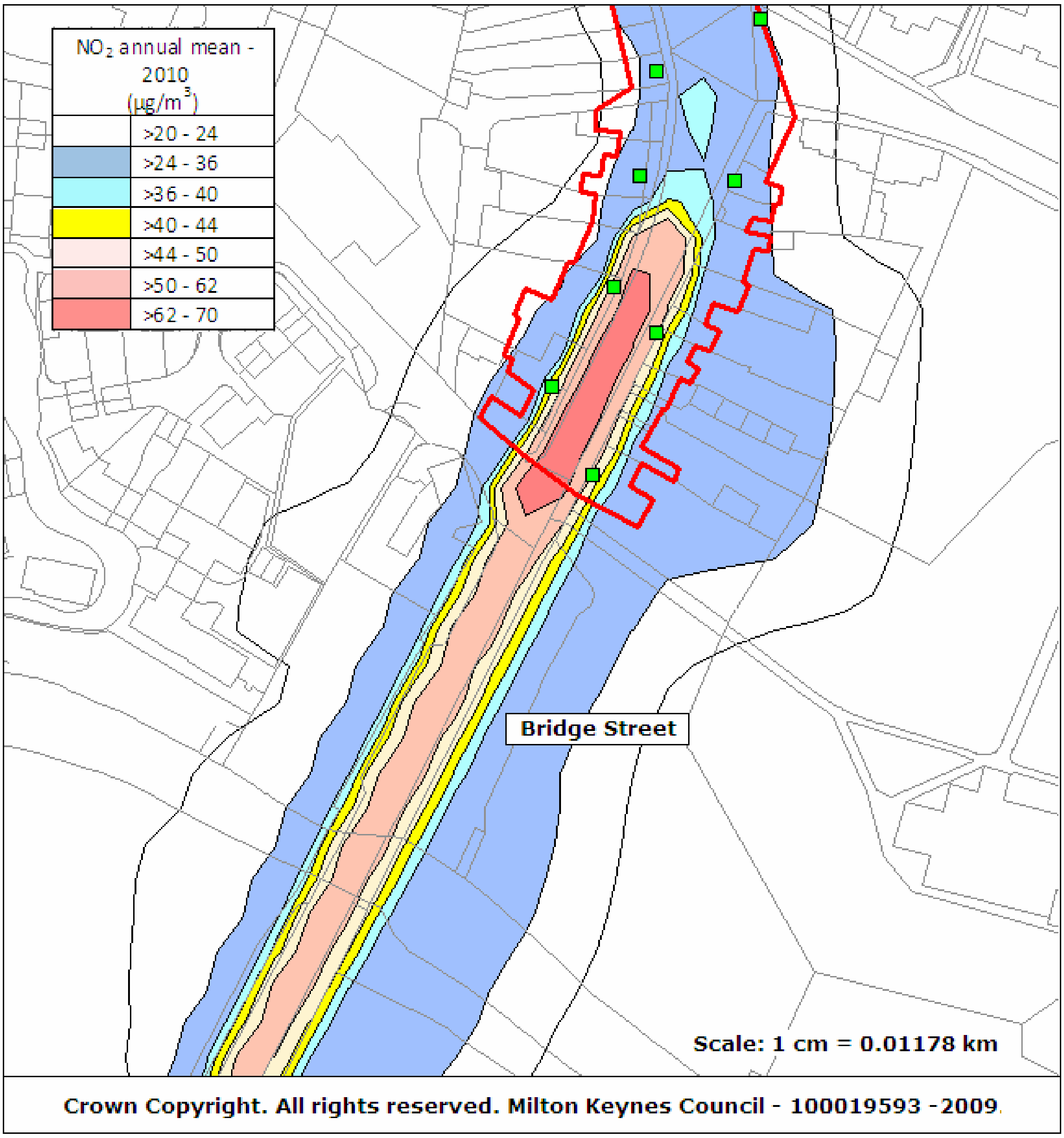

Figure 5.5: Zoomed contour plot of modelled NO_2 concentrations, AQMA boundary and receptor locations, Bridge Street, 2010.

5.5 2016 future year

An ADMS-Roads model run has been undertaken for the future year of 2016 to allow Milton Keynes Council (MKC) to integrate air quality management within their third Local Transport Plan (LTP). The modelled total NO_2 concentrations are presented in Table 5-5. All sites are expected to comply with the AQS objective value for NO_2 in 2016.

Table 5-5: Adjusted modelled total NO_2, 2016.

Site ID	Adjusted Modelled total NO_2 ($\mu g/m^3$)
18/20 Bridge Street	31.62
Courtney House	26.64
Pembroke House	26.39
2 Bridge Street	35.84
28 Bridge Street	23.39
15 Bridge Street	20.93
1 High Street South	19.62
5 High Street South	26.71
8 High Street South	26.62
9 High Street South	25.8
Cross Keys House	26.09
10 High Street South	32.58
14 High Street South	33.65
20 High Street South	25.03
22 High Street	26.58
25 High Street South	18.88
33 High Street South	23.13
38 Market Place	21.74
33 Market Place	14.63
1 Market Place	20.62
5 High Street	16.29
13 High Street	16.98
16 High Street	20.35
20 High Street	19.55
17 High Street	22.54
The Bull (Public house)	17.82
1 Weston Road	14.83
21 Weston Road	13.46
Mobile (continuous monitoring site)	20.24

6 Source Apportionment

A source apportionment exercise has been carried out in line with LAQM TG (09) (Defra, 2009) to determine the contribution of each vehicle category to road NO_X concentrations. The DMRB spreadsheet has been used to calculate emission rates for each vehicle type (cars, LGVs, buses/coaches, rigid HGVs and articulated HGVs) individually by adjusting the fleet composition and reducing the AADT (using the 2010 traffic flows as a baseline) accordingly. ADMS-Roads model runs have then been undertaken using these emission rates to determine the percentage of the road NO_X contributions from each vehicle type. The proportion of NO_X emissions from each vehicle type is derived by comparison with the 2010 baseline total road NO_X emissions. These proportions are then used to determine the percentage contribution of each vehicle type to total modelled road NO_X concentrations at each receptor. The results of the source apportionment exercise are presented in Table 6-1.

Table 6-1: Source Apportionment: Percentage road NO_X contribution by vehicle type.

Site ID	% NO_X contribution: Cars	% NO_X contribution: LGVs	% NO_X contribution: Buses/Coaches	% NO_X contribution: Rigid HGVs	% NO_X contribution: Articulated HGVs
18/20 Bridge Street	38	9	5	24	24
Courtney House	37	10	4	25	24
Pembroke House	37	9	4	25	24
2 Bridge Street	38	9	5	24	24
28 Bridge Street	39	9	5	24	24
15 Bridge Street	37	10	4	25	24
1 High Street South	36	10	4	25	25
5 High Street South	35	10	4	26	25
8 High Street South	36	10	4	25	25
9 High Street South	36	10	4	25	25
Cross Keys House	36	10	4	25	25
10 High Street South	37	9	5	25	24
14 High Street South	37	9	5	25	24
20 High Street South	38	9	5	25	24
22 High Street	38	9	5	24	24
25 High Street South	36	10	4	25	25
33 High Street South	36	10	4	25	25
38 Market Place	38	9	5	25	24
33 Market Place	37	9	5	25	24
1 Market Place	38	9	5	25	24
5 High Street	37	10	4	25	24
13 High Street	37	10	4	25	25
16 High Street	38	9	5	25	24
20 High Street	38	9	5	25	24
17 High Street	36	10	4	25	25
The Bull (Public house)	37	10	4	25	24
1 Weston Road	37	9	4	25	25
21 Weston Road	37	9	4	25	24
Mobile (continuous monitoring site)	38	9	5	25	24

7 Action Plan Measures

Milton Keynes Council (MKC) has stated that measures to be included in an Air Quality Action Plan must be proportionate and cost effective (MKC, 2008). The source apportionment exercise has illustrated that HGVs are expected to contribute approximately 50% of total NO_X emissions in 2010 (see Section 6). Action plan measures should therefore focus on reducing the numbers of HGVs entering Olney. Three possible measures for inclusion in the Action Plan have been identified and modelled to determine their impact on NO_2 concentrations at relevant receptors in the future year of 2010.

7.1 All Heavy Goods Vehicles: total ban

The introduction of a complete ban on HGVs entering Olney at all times of the day and night has been modelled by reducing the AADT for each road link by the number of HGVs and adjusting the fleet composition accordingly. Emission rates have been recalculated and the model re-run assuming the same queue lengths and numbers of other vehicle types as the 2010 baseline conditions. This scenario is expected to result in a 49% reduction in total NO_X emissions from the road, leading to an average reduction in modelled road NO_X concentrations of 22% and an average reduction in total NO_2 concentrations of 10% compared to 2010 baseline conditions (see Table 7-1). Exceedance of the NO_2 objective value is expected to occur at one receptor on Bridge Street following the introduction of this measure. This is an improvement compared to the 2010 baseline conditions, under which exceedances are expected to occur at three receptors (see Table 5-4). A reduction in the total NO_2 concentration of approximately 4% is still required at 2 Bridge Street for compliance with the NO_2 AQS objective value following the introduction of this measure.

Table 7-1: Scenario 1: Heavy Goods Vehicles (HGVs) total ban.

Site ID	Adjusted modelled total NO_2 2010 Base	Adjusted modelled total NO_2 2010 Scenario 1	Reduction 2010 base - 2010 Scenario 1 (%)
18/20 Bridge Street	39.63	36.44	-8%
Courtney House	33.53	30.8	-8%
Pembroke House	33.41	30.92	-7%
2 Bridge Street	**44.95**	**41.48**	-8%
28 Bridge Street	28.64	24.54	-14%
15 Bridge Street	25.94	22.99	-11%
1 High Street South	24.02	20.7	-14%
5 High Street South	32.92	27.59	-16%
8 High Street South	33.58	30.78	-8%
9 High Street South	32.44	29.73	-8%
Cross Keys House	32.88	30.17	-8%
10 High Street South	**40.82**	37.38	-8%
14 High Street South	**42.21**	38.51	-9%
20 High Street South	30.92	26.72	-14%
22 High Street	32.46	27.16	-16%
25 High Street South	23.22	20.84	-10%
33 High Street South	28.85	26.02	-10%
38 Market Place	26.88	23.82	-11%
33 Market Place	17.76	16.67	-6%
1 Market Place	25.34	22.16	-13%
5 High Street	19.85	17.97	-9%
13 High Street	20.73	18.59	-10%
16 High Street	24.98	21.89	-12%
20 High Street	23.95	21.09	-12%
17 High Street	27.74	23.84	-14%
The Bull (Public house)	21.82	19.47	-11%
1 Weston Road	17.73	16.97	-4%
21 Weston Road	15.96	15.57	-2%
Mobile (continuous monitoring site)	24.64	21.07	-14%

7.2 Articulated Heavy Goods Vehicles: total ban

The introduction of a complete ban on articulated HGVs entering Olney at all times of the day and night has been modelled using the same method used to model the impact of Scenario 1, as discussed in Section 7.1 (the AADT has been reduced by the number of articulated HGVs and the fleet composition adjusted accordingly). This scenario is expected to result in an average reduction in total NO_2 concentrations of 5% compared to 2010 baseline conditions. Exceedance of the NO_2 objective value is expected to occur at two receptors following the introduction of this measure, which demonstrates an improvement compared to 2010 baseline conditions. Reductions in the total NO_2 concentrations of approximately 8% and 1% are still required at 2 Bridge Street and 14 High Street South repectively for compliance with the NO_2 AQS objective value following the introduction of this measure.

Table 7-2: Scenario 2: Articulated Heavy Goods Vehicles (HGVs) total ban.

Site ID	Adjusted modelled total NO_2 2010 base	Adjusted modelled total NO_2 2010 Scenario 2	Reduction 2010 base - 2010 Scenario 2 (%)
18/20 Bridge Street	39.63	38.1	-4%
Courtney House	33.53	32.21	-4%
Pembroke House	33.41	32.2	-4%
2 Bridge Street	**44.95**	**43.28**	-4%
28 Bridge Street	28.64	26.68	-7%
15 Bridge Street	25.94	24.51	-6%
1 High Street South	24.02	22.4	-7%
5 High Street South	32.92	30.35	-8%
8 High Street South	33.58	32.22	-4%
9 High Street South	32.44	31.13	-4%
Cross Keys House	32.88	31.56	-4%
10 High Street South	**40.82**	39.16	-4%
14 High Street South	**42.21**	**40.44**	-4%
20 High Street South	30.92	28.91	-7%
22 High Street	32.46	29.95	-8%
25 High Street South	23.22	22.06	-5%
33 High Street South	28.85	27.48	-5%
38 Market Place	26.88	25.4	-6%
33 Market Place	17.76	17.22	-3%
1 Market Place	25.34	23.81	-6%
5 High Street	19.85	18.93	-5%
13 High Street	20.73	19.68	-5%
16 High Street	24.98	23.49	-6%
20 High Street	23.95	22.57	-6%
17 High Street	27.74	25.84	-7%
The Bull (Public house)	21.82	20.67	-5%
1 Weston Road	17.73	17.36	-2%
21 Weston Road	15.96	15.77	-1%
Mobile (continuous monitoring site)	24.64	22.92	-7%

7.3 All Heavy Goods Vehicles: restricted access

The effect of implementing restricted access for HGVs has been modelled using hourly HGV flows measured by the DfT ATC during one week in May 2007 (data provided by MKC). These flows have been analysed to identify times at which the highest number of HGVs travel through Olney. Peak times were identified as between 08:00 and 10:00, and between 15:00 and 18:00 on weekdays (no peak was identified on Saturdays or Sundays). Modelling has been undertaken to identify the impact on NO_2 concentrations of implementing a ban on all HGVs entering Olney during these times on weekdays.

The method involved forecasting the data obtained from the one week traffic count to 2010 vehicle flows (using the method described in Section 4.2.1) and summing the number of HGVs travelling through Olney in each direction (northbound and southbound) between 08:00 and 10:00 and between 15:00 and 18:00 on each weekday during the week for which counts were provided. The average number of HGVs travelling through Olney in both northbound and southbound directions was derived and the AADT on each road link reduced by the relevant amount. The fleet composition was adjusted accordingly and emission rates recalculated in the DMRB spreadsheet (Highways Agency *et al*, 2007).

The restricted access scenario is expected to result in an average reduction in total NO_2 concentrations of 5% compared to 2010 baseline conditions (see Table 7-3). Exceedance of the NO_2 objective value is expected to occur at two receptors following the introduction of this measure, which demonstrates an improvement compared to 2010 baseline conditions. Reductions in the total NO_2 concentrations of approximately 7% and 1% are still required at 2 Bridge Street and 14 High Street South repectively for compliance with the NO_2 AQS objective value following the introduction of this measure.

Table 7-3: Scenario 3: Heavy Goods Vehicles (HGVs) restricted access.

Site ID	Adjusted modelled total NO_2 2010 base	Adjusted modelled total NO_2 2010 scenario 3	Reduction 2010 base - 2010 scenario 3 (%)
18/20 Bridge Street	39.63	38.04	-4%
Courtney House	33.53	32.13	-4%
Pembroke House	33.41	32.13	-4%
2 Bridge Street	**44.95**	**43.22**	-4%
28 Bridge Street	28.64	26.62	-7%
15 Bridge Street	25.94	24.42	-6%
1 High Street South	24.02	22.3	-7%
5 High Street South	32.92	30.14	-8%
8 High Street South	33.58	32.14	-4%
9 High Street South	32.44	31.06	-4%
Cross Keys House	32.88	31.49	-4%
10 High Street South	**40.82**	39.1	-4%
14 High Street South	**42.21**	**40.38**	-4%
20 High Street South	30.92	28.85	-7%
22 High Street	32.46	29.91	-8%
25 High Street South	23.22	21.98	-5%
33 High Street South	28.85	27.39	-5%
38 Market Place	26.88	25.35	-6%
33 Market Place	17.76	17.2	-3%
1 Market Place	25.34	23.76	-6%
5 High Street	19.85	18.87	-5%
13 High Street	20.73	19.62	-5%
16 High Street	24.98	23.45	-6%
20 High Street	23.95	22.53	-6%
17 High Street	27.74	25.69	-7%
The Bull (Public house)	21.82	20.61	-6%
1 Weston Road	17.73	17.34	-2%
21 Weston Road	15.96	15.76	-1%
Mobile (continuous monitoring site)	24.64	22.87	-7%

8 Sensitivity Analysis

The conversion of modelled NO_X concentrations to NO_2 concentrations in this study has been undertaken assuming a primary NO_2 fraction of 0.2 (20%). It was considered appropriate to use a higher than typical NO_2 fraction due to the relatively high numbers of HGVs travelling through Olney. It has been shown that modern diesel vehicles directly emit a higher proportion of NO_2 than petrol vehicles, particularly those fitted with oxidation catalysts or certain types of particle abatement technologies (AQEG, 2007).

As the aim of each modelled Action Plan scenario was to reduce the number of HGVs travelling through Olney, this could result in a reduction in the primary NO_2 fraction of the local fleet after implementation of each measure. A sensitivity analysis was therefore conducted to calculate the NO_2 concentrations resulting from the modelled road NO_X for each scenario with a lower NO_2 fraction that considers a typical UK traffic mix (approximately 0.16 (16%) *i.e.* the default value in the NO_X/NO_2 calculator[7]). The results of this sensitivity analysis are provided in Table 8-1.

Assuming this primary NO_2 fraction suitable for all UK traffic, the total HGV ban at all times of the day and night is expected to result in an average reduction of 12% in total NO_2 concentrations compared to 2010 baseline conditions. The ban on articulated HGVs and the restricted access scenario are expected to result in average reductions of 7% and 8% respectively. When the UK traffic primary NO_2 fraction is assumed, there are no predicted exceedances of the NO_2 objective value resulting from implementation of a total ban on HGVs entering Olney. Exceedance of the objective value is expected to occur at one receptor location (2 Bridge Street) following implementation of the ban on articulated HGVs or the restricted access scenario, with reductions in total NO_2 concentrations of 3% (following the introduction of scenario 2) and 2% (following the introduction of scenario 3) still required at this receptor for compliance with the NO_2 AQS objective value.

[7] http://www.airquality.co.uk/archive/laqm/tools.php

Table 8-1: All scenarios: Adjusted modelled total NO_2, 2010 (assuming a primary NO_2 fraction appropriate for all UK traffic).

Site ID	Adjusted modelled total NO_2 2010 scenario 1	Reduction 2010 base -2010 scenario 1 (%)	Adjusted modelled total NO_2 2010 scenario 2	Reduction 2010 base -2010 scenario 2 (%)	Adjusted modelled total NO_2 2010 scenario 3	Reduction 2010 base -2010 scenario 3 (%)
18/20 Bridge Street	34.99	-12%	36.48	-8%	36.43	-8%
Courtney House	29.85	-11%	31.14	-7%	31.07	-7%
Pembroke House	29.96	-10%	31.13	-7%	31.07	-7%
2 Bridge Street	39.48	-12%	**41.07**	-9%	**41.02**	-9%
28 Bridge Street	24.04	-16%	26.03	-9%	25.98	-9%
15 Bridge Street	22.58	-13%	24.00	-7%	23.92	-8%
1 High Street South	20.41	-15%	22.02	-8%	21.93	-9%
5 High Street South	26.89	-18%	29.43	-11%	29.24	-11%
8 High Street South	29.83	-11%	31.15	-7%	31.08	-7%
9 High Street South	28.87	-11%	30.15	-7%	30.09	-7%
Cross Keys House	29.27	-11%	30.55	-7%	30.48	-7%
10 High Street South	35.83	-12%	37.43	-8%	37.37	-8%
14 High Street South	36.85	-13%	38.56	-9%	38.51	-9%
20 High Street South	26.07	-16%	28.10	-9%	28.05	-9%
22 High Street	26.49	-18%	29.07	-10%	29.03	-11%
25 High Street South	20.55	-11%	21.70	-7%	21.62	-7%
33 High Street South	25.42	-12%	26.78	-7%	26.70	-7%
38 Market Place	23.36	-13%	24.85	-8%	24.80	-8%
33 Market Place	16.57	-7%	17.10	-4%	17.08	-4%
1 Market Place	21.80	-14%	23.35	-8%	23.30	-8%
5 High Street	17.81	-10%	18.73	-6%	18.68	-6%
13 High Street	18.41	-11%	19.45	-6%	19.39	-6%
16 High Street	21.54	-14%	23.05	-8%	23.01	-8%
20 High Street	20.79	-13%	22.19	-7%	22.14	-8%
17 High Street	23.38	-16%	25.26	-9%	25.12	-9%
The Bull (Public House)	19.25	-12%	20.39	-7%	20.33	-7%
1 Weston Road	16.86	-5%	17.23	-3%	17.21	-3%
21 Weston Road	15.51	-3%	15.70	-2%	15.69	-2%
Mobile (continuous monitoring site)	20.77	-16%	22.51	-9%	22.47	-9%

9 Recommendations

The introduction of a ban or restricted access for all HGVs or articulated HGVs should only be considered in conjunction with a traffic modelling assessment of the air quality impact of these measures on surrounding towns and villages. If any of these measures are to be introduced, the effect of diverting HGVs away from Olney should be carefully studied and alternative routes defined such that there is minimal impact on air quality in any sensitive areas. A feasibility study examining suitable methods for enforcing a ban or restricting access for HGVs should also be undertaken prior to implementation.

There is an element of uncertainty surrounding the modelled impact of the restricted access scenario resulting from the difficulty in predicting the proportion of the HGV fleet that will divert away from Olney and the proportion that will alter delivery times to accommodate the restricted access. In addition, the impact that a reduced number of HGVs will have on queue lengths and the numbers of other vehicle types travelling through Olney is unknown for each scenario. It is possible that queue lengths in the vicinity of the narrowest section of the road will decrease but that the number of passenger cars and LGVs will increase if drivers are aware that HGVs are not travelling on this section of the A509. The reductions may therefore be greater or lower than the modelled results. The modelled results included in this report are a best-estimate assuming that the queue lengths and numbers of other vehicle types remain unchanged following the introduction of each scenario.

Acknowledgements

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References

AQEG (2007). Trends in Primary Nitrogen Dioxide in the United Kingdom. Report prepared for Department for Environment, Food and Rural Affairs, Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. Air Quality Expert Group. Defra, London.

Defra (2007). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. Defra, London.

Defra (2009). Local Air Quality Management Technical Guidance LAQM TG (09). Department for Environment, Food and Rural Affairs. Defra, London.

Highways Agency (2007). Design Manual for Roads and Bridges. http://www.standardsforhighways.co.uk/dmrb/index.htm [online]. Accessed April 2009.

MKC (2008). Local Air Quality Management Detailed Assessment of Nitrogen Dioxide in Olney. Milton Keynes Council.

Office for National Statistics (2008). http://www.ons.gov.uk/census/index.html [online]. Accessed April 2009.

Glossary of terms and abbreviations

AADT	Annual Average Daily Traffic
ADMS	Atmospheric Dispersion Modelling System
AQEG	Air Quality Expert Group
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
ATC	Automatic Traffic Counter
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
HGV	Heavy Goods Vehicle (over 7.5 tonnes)
GIS	Geographic Information System
LAQM	Local Air Quality Management
LGV	Light Goods Vehicle (between 3.5 tonnes and 7.5 tonnes)
LTP	Local Transport Plan
MKC	Milton Keynes Council
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_X	Total Oxides of Nitrogen
O_3	Ozone
ONS	Office for National Statistics
PM_{10}	Particulate matter less than 10 microns in diameter
PSV	Public Service Vehicle
TEA	Triethanolamine
TEMPRO	Trip End Model Presentation Program
TRL	Transport Research Laboratory
WASP	Workplace Analysis Scheme for Proficiency

Appendix 1: Air Quality Strategy (AQS) Objectives

Table A1.1: Summary of Air Quality Strategy (AQS) Objectives (Defra, 2007).

Pollutant	Objective	Compliance date
NO_2	Hourly mean concentration should not exceed 200 µg/m^3 more than 18 times a year. Annual mean concentration should not exceed 40 µg/m^3.	31 December 2005
Particulate matter, expressed as PM_{10}	24-hour mean concentration should not exceed 50 µg/m^3 more than 35 times a year. Annual mean concentration should not exceed 40 µg/m^3.	31 December 2004 31 December 2005
	Scotland: 24-hour mean concentration should not exceed 50 µg/m^3 more than 7 times a year. Annual mean concentration should not exceed 18 µg/m^3.	31 December 2010
Particulate matter, expressed as $PM_{2.5}$	*UK urban areas* Target of 15% reduction in concentrations at urban background.	Between 2010 and 2020
	Annual mean concentration should not exceed 25 µg/m^3.	31 December 2004
	Scotland: Annual mean concentration should not exceed 12 µg/m^3.	
Benzene	Running annual mean concentration should not exceed 16.25 µg/m^3.	31 December 2003
	Scotland & Northern Ireland: Running annual mean concentration should not exceed 3.25 µg/m^3.	31 December 2010
	England & Wales: Annual mean concentration should not exceed 5 µg/m^3.	31 December 2010
1,3-butadiene	Running annual mean concentration should not exceed 2.25 µg/m^3.	31 December 2003
CO	Maximum daily running 8-hour mean concentration should not exceed 10 mg/m^3. In Scotland it is expressed as a running 8-hr mean.	31 December 2003
PAHs	Annual mean concentration of B(a)P should not exceed 0.25 ng/m^3	31 December 2010
Lead (Pb)	Annual mean concentration should not exceed 0.5 µg/m/^{3}. Annual mean concentration should not exceed 0.25 µg/m^3.	31 December 2004 31 December 2008
SO_2	Hourly mean of 350 µg/m^3 not to be exceeded more than 24 times a year. 24-hour mean of 125 µg/m^3 not to be exceeded more than 3 times a year. 15-min mean of 266 µg/m^3 not to be exceeded more than 35 times a year.	31 December 2004 31 December 2005
Ozone (O_3)	Running 8-hour concentration of 100 µg/m^3 not to be exceeded more than 10 times a year	31 December 2005

Appendix 2: Traffic Data

Table A2.1: Annual Average Daily Traffic (AADT) flow, 2007, 2010 and 2016.

NORTHBOUND			
Year	A509	Weston Road	Church Street
2007	8625	1500	250
2010	8972	1640	273
2016	9722	1928	321
SOUTHBOUND			
Year	A509	Weston Road	Church Street
2007	8723	1500	250
2010	9046	1640	273
2016	9776	1928	321

Table A2.2: Fleet composition (% by vehicle type) northbound and southbound, 2007, 2010 and 2016.

NORTHBOUND					
Year	Cars	LGVs	PSVs	Rigid HGVs	Articulated HGVs
2007	83.8	10.1	0.6	3.7	1.5
2010	83.9	10.2	0.5	3.6	1.8
2016	83.5	11.1	0.5	3.3	1.6
SOUTHBOUND					
Year	Cars	LGVs	PSVs	Rigid HGVs	Articulated HGVs
2007	88.0	6.6	0.6	3.3	1.3
2010	88.1	6.7	0.6	3.1	1.5
2016	87.9	7.3	0.5	2.9	1.4

Table A2.3: Growth factors, 2010 and 2016.

Year	Local (Olney) factor	Regional (South East) factor	TEMPRO factor	All vehicles factor	Cars factor	LGVs factor	PSVs factor	Rigid HGVs factor	Articulated HGVs factor
2010	1.082	1.038	1.0424	1.0926	1.0926	1.1116	1.0241	1.0468	1.0512
2016	1.241	1.102	1.1261	1.2847	1.2720	1.4093	1.1064	1.1444	1.1502

MILTON KEYNES COUNCIL

Milton Keynes Council
Environmental Protection Team
Community Protection Division
Civic Offices
1 Saxon Gate East
Central Milton Keynes
MK9 3EJ

T 01908 252449
E ehept@milton-keynes.gov.uk

www.milton-keynes.gov.uk/environmental-health

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