Bromsgrove District Council

LAQM Detailed Assessment

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EXECUTIVE SUMMARY

Part IV of the Environment Act 1995 places a statutory duty on local authorities to review and assess the air quality within their area. For local authorities that have identified areas, within their Updating and Screening Assessment (USA), where there is a potential risk of exceedence of Air Quality Strategy (AQS) objectives a Detailed Assessment is required. This Detailed Assessment is a requirement resulting from the Updating and Screening Assessment (USA) undertaken in 2006 at the beginning of the Third Round of Review and Assessment of air quality. The assessment has been undertaken in accordance with the Technical Guidance LAQM.TG (03).

Between 1998 and 2002, Bromsgrove District Council undertook its first round of review and assessment of air quality. The first round assessments (Stages 1, 2, 3 and 4) concluded that it was necessary to declare an Air Quality Management Area (AQMA) due to predicted exceedences of the annual mean objective for NO_2 at Lickey End, due to road traffic emissions from the M42 (Junction1).

The first phase of the second round of review and assessment, the USA, was completed in September 2003 and this provided an update with respect to air quality issues within Bromsgrove District Council. The USA concluded that a detailed assessment was required for nitrogen dioxide (NO_2) due to road traffic emissions from the A38 Redditch Road (Aston Road Industrial Estate), A456/A491 Hagley, and the A38 Marlbrook Crossroads. It was also recommended that a review of exceedences of the NO_2 annual mean Objective be undertaken at Lickey End (AQMA). The Detailed Assessment concluded that declaration of an AQMA was not warranted at any further locations.

The USA 2006, commenced the third round of review and assessment. This concluded that a detailed assessment was required for nitrogen dioxide because of measured exceedences of the annual mean objective at the nearest receptors to 2 monitoring locations: 93 Redditch Road, Buntsford Hill and 78 Kidderminster Road, Hagley. It was also recommended that the monitoring be made more robust at these locations by installing triplicate diffusion tubes.

Detailed dispersion modelling has been undertaken using the ADMS-Roads 2.2 dispersion model. Annual mean NO_2 concentrations have been modelled at specific receptors along Redditch Road, Buntsford Hill and Kidderminster Road, Hagley in the vicinity of the monitoring locations where exceedences were monitored. The selected receptors are appropriate exposure locations for the relevant objective. The model has been verified against the NO_2 diffusion tube sites in each assessment area.

The model results suggest that the annual mean objective for NO_2 is likely to be exceeded at the worst-case modelled receptors at Redditch Road, Buntsford Hill in 2006. By 2008, the predicted concentrations indicate the annual mean objective will be met due to expected reductions in background concentrations and improvements in vehicle emissions through implementation of national policies. The model results at Kidderminster Road, Hagley suggest that the annual mean objective for NO_2 is likely to be met at all receptors in 2006 and in subsequent years.

Based on this detailed assessment and review of the monitoring data within the areas under assessment, the following recommendations are made for Bromsgrove District Council:

- **To consider declaration of an Air Quality Management Area along Redditch Road, Buntsford Hill, on the basis of NO_2, where exceedences are predicted at relevant receptor locations;**
- **To consider introducing continuous monitoring in the Redditch Road, Buntsford Hill area – for a minimum of 6 months - to more accurately assess nitrogen dioxide levels and compliance with the annual mean objective;**
- **To continue monitoring NO_2 at all the current diffusion tube locations in order to ensure that any future changes in air quality are detected, notably locations representative of the relevant exposure, i.e., at the façade of the residential properties.**

1 Introduction

1.1 Project Background

Bureau Veritas HS&E have been commissioned by Bromsgrove District Council (BDC) to undertake the Detailed Assessment based on the information provided by the local authority.

This Detailed Assessment for nitrogen dioxide (NO_2) is required following the conclusions of the USA undertaken in 2006 as part of the third round of review and assessment of air quality. The 2006 USA identified potential exceedences within the vicinity of the Redditch Road, Buntsford Hill and Redditch Road, Kidderminster Road, Hagley.

1.2 Legislative Background

1.2.1 Air Quality Strategy Objectives

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS)[1] (and subsequent addendum[2]) contains national air quality standards and objectives established by the Government to protect human health. The objectives for seven pollutants have been prescribed within the Air Quality (England) Regulations 2000[3] and the Air Quality (England) (Amendment) Regulations 2002[4] (benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, sulphur dioxide and particulates). The AQS objectives set in Regulations in England (not London) are shown in Table 1-1. In February 2003, an addendum to the AQS was published, that included provisional objectives for PM10, to be achieved by 2010. These objectives have not been incorporated into the Regulations for England but local authorities have in the past been expected to consider them during their review and assessment of air quality. These provisional AQS Objectives are shown in Table 1-2 .

1 DETR (2000) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland – Working together for Clean Air, The Stationery Office

2 Defra (2002) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum, The Stationery Office

3 DETR (2000) The Air Quality Regulations 2000, The Stationery Office

4 Defra (2002) The Air Quality Regulations 2002,The Stationery Office

Table 1-1 Table 1-2.

In February 2003, an addendum to the AQS was published, that included provisional objectives for PM_{10}, to be achieved by 2010. These objectives have not been incorporated into the Regulations for England but local authorities have in the past been expected to consider them during their review and assessment of air quality. These provisional AQS Objectives are shown in Table 1-2 .

Table 1-1 - AQS Objectives in Regulations for England

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	16.25 μg/m^3	Running annual mean	31.12.2003
	5.00 μg/m^3	Annual mean	31.12.2010
1,3 Butadiene	2.25 μg/m^3	Running annual mean	31.12.2003
Carbon monoxide	10.0 mg/m^3	Maximum daily 8-hour mean	31.12.2003
Lead	0.5 μg/m^3	Annual mean	31.12.2004
	0.25 μg/m^3	Annual mean	31.12.2008
Nitrogen dioxide	200 μg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31.12.2005
	40 μg/m^3	annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)[a]	50 mg/m^3 not to be exceeded more than 35 times a year	24 hour mean	31.12.2004
	40 mg/m^3	annual mean	31.12.2004
Sulphur dioxide	350 mg/m^3 not to be exceeded more than 24 times a year	1 hour mean	31.12.2004
	125 mg/m^3 not to be exceeded more than 3 times a year	24 hour mean	31.12.2004
	266 mg/m^3 not to be exceeded more than 35 times a year	15 minute mean	31.12.2005

a. Measured using the European gravimetric transfer sampler or equivalent.

Table 1-2 Provisional Objectives for PM_{10} in England (not London) Outlined in the AQS Addendum

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Particles (PM_{10}) (gravimetric)	50 μg/m^3 not to be exceeded more than 7 times a year	24 hour mean	31.12.2010
	20 μg/m^3	Annual mean	31.12.2010

In April 2006, Defra published a draft for the Review of the AQS for consultation[5]. The draft AQS Review introduced a new approach, exposure reduction, to air quality management for non-threshold pollutants. This approach comprises of two basic elements:

- air quality objectives/limit values or " concentration cap"
- an objective based on reducing average exposure across the most heavily populated areas of the country (percentage reduction/exposure reduction).

The Review proposes that the AQS objectives in Table 1-1 are retained. With regard to the provisional long-term PM_{10} objective in Table 1-2, the Review suggests several courses of action. These include replacing the provisional PM_{10} objective with an exposure reduction objective for $PM_{2.5}$ and concentration cap or retaining the provisional PM_{10} objective until an exposure reduction target is agreed at EU level.

The AQS objectives take into account EU Directives that set limit values which member states are legally required to achieve by their target dates. The UK's AQS objectives are equal to, or more stringent than, the EU limit values (no Member State may promulgate air quality standards that are weaker than the EU Limit Values). In the case of NO_2, the EU limit value is equal to the associated AQS objective; this however is to be achieved by 2010.

The locations where the AQS objectives apply are defined in the AQS as locations outside buildings or other natural or manufactured structures above or below ground where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period of the AQS objective. Typically these include residential properties and schools/care homes for longer period (i.e. annual mean) pollutant objectives and high streets for short-term (i.e. 1-hour) pollutant objectives.

This detailed assessment considers only nitrogen dioxide concentrations.

1.2.2 Local Air Quality Management

Part IV of the Environment Act places a statutory duty on local authorities to periodically 'review and assess' the air quality within their area under the Local Air Quality Management (LAQM) regime. This involves consideration of present and likely future air quality against the AQS objectives prescribed within the Air Quality Regulations. Where the LAQM Review and Assessment process finds that pollutant concentrations are unlikely to meet the AQS objectives by their target dates in areas where the AQS objectives apply, the Local Authority are required to declare an Air Quality Management Area (AQMA) under Section 83(1) of the Environment Act 1995. The areas in which the AQS objectives apply are defined in the AQS as locations outside buildings or other natural or man-made structures above or below ground where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period of the AQS objective.

Guidelines for the 'Review and Assessment' of local air quality were first published in the 1997 National Air Quality Strategy (NAQS)[6] along with associated policy guidance and

[5] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. A consultation document on options for further improvements in air quality. April 2006. Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, The National Assembly for Wales and the Department of the Environment for Northern Ireland

technical guidance. The First Round of Review and Assessment recommended that local authorities fulfil their statutory duty under the LAQM regime by undertaking a three-stage assessment, increasing in detail at each stage.

In 2000, Government reviewed the NAQS and published the revised AQS, to which an addendum was issued in February 2003. Associated revised LAQM Technical Guidance (LAQM.TG(03))[7] and Policy Guidance (LAQM.PG(03))[8] were issued on behalf of DEFRA in January 2003. This guidance sets the framework for the requirements of review and assessment for future years, taking account of experiences from the previous rounds of review and assessment. This current framework for review and assessment begins with an Updating and Screening Assessment (USA) that considers the likelihood of all the AQS objectives being achieved across the Local Authority's administrative area. If the USA identifies that an AQS objective may not be met, then the Local Authority must proceed to a Detailed Assessment for that pollutant. If the results of the Detailed Assessment confirm that, an AQS objective is unlikely to be met they are required to declare an AQMA.

Having declared an AQMA the authority is required to confirm the findings of the Detailed Assessment work through further monitoring or modelling assessments. This Further Assessment should provide information on the source-apportionment of the pollutant emissions in order to identify the level of pollutant reduction required for the attainment of relevant air quality objectives. Additionally, consideration should be made to evaluating local management practices that could be used to improve air quality, and feed into the formulation of an Action Plan.

The Second Round of Review and Assessment (2003-2005) provided an opportunity for local authorities to update the findings of their first round of review and assessment. In doing so, local authorities were to take into consideration changes in AQS Objectives and revised Technical Guidance (LAQM.TG(03)), new emission sources, and any significant proposed planning developments due to take place before the relevant AQS Objective target date.

Additional guidance has been provided in the form of FAQs and updated LAQM tools in January 2006 to assist with Third Round of Review and Assessment (2006-2008). This includes revised modelled background concentration maps for NO_X, NO_2 and PM_{10}, updated future year calculation tools and updates on the assessment of specific sources (rail, shipping, poultry farms).

At the time of writing the Review and Assessment process has culminated in the declaration of over 200 separate AQMAs across the UK. The results have shown that it is road traffic emissions that are the main cause of exceedences of two pollutants listed within the AQS. Namely, it is fine particulates (PM_{10}) and nitrogen dioxide (NO_2) that are the pollutants of most concern. Whilst other pollutants such as carbon monoxide (CO) and benzene are associated with road traffic emissions, the latest national perspective on the occurrence of each of these pollutants suggests that these are no longer a problem at roadside locations across the UK.

[6] DoE (1997) The United Kingdom Nation Air Quality Strategy The Stationery Office

[7] Defra (2003) Technical Guidance LAQM.TG(03), Part IV of the Environment Act 1995, Local Air Quality Management, The Stationery Office

[8] Defra (2003) Policy Guidance LAQM.PG(03), Part IV of the Environment Act 1995, Local Air Quality Management, The Stationery Office

1.3 Summary of the Review and Assessment by Bromsgrove District Council

Between 1998 and 2002, Bromsgrove District Council undertook its first round of review and assessment of air quality. The first round assessments (Stages 1, 2, 3 and 4) concluded that it was necessary to declare an Air Quality Management Area (AQMA) due to predicted exceedences of the annual mean objective for NO_2 at Lickey End, due to road traffic emissions from the M42 (Junction1).

The first phase of the second round of review and assessment, the USA, was completed in September 2003 and this provided an update with respect to air quality issues within Bromsgrove District Council. The USA concluded that a detailed assessment was required for nitrogen dioxide (NO_2) due to road traffic emissions from the A38 Redditch Road (Aston Road Industrial Estate), A456/A491 Hagley, and the A38 Marlbrook Crossroads. It was also recommended that a review of exceedences of the NO_2 annual mean Objective be undertaken at Lickey End (AQMA). The Detailed Assessment concluded that declaration of an AQMA was not warranted at any further locations.

The Third Round of Review and Assessment started with the 2006 USA. It provided an update with respect to air quality issues within Bromsgrove District Council's administrative area since the previous USA, completed in 2003. The USA, in its assessment took account of a number of changes to the technical guidance for the review and assessment process since the USA undertaken in 2003. The USA concluded that the air quality objectives for benzene, 1, 3-butadiene, carbon monoxide, lead, PM_{10} and sulphur dioxide would be met. There was therefore no requirement to undertake a detailed assessment for these pollutants.

This concluded that a detailed assessment was required for nitrogen dioxide because of measured exceedences of the annual mean objective at the nearest receptors to two monitoring locations: 93 Redditch Road, Buntsford Hill and 78 Kidderminster Road, Hagley. It was also recommended that the monitoring be made more robust at these locations by installing triplicate diffusion tubes.

1.4 Scope and Methodology of the Detailed Assessment

The scope of this assessment is to predict the annual mean NO_2 concentrations along Redditch Road, Buntsford Hill and Kidderminster Road, Hagley identified in the 2006 USA as having likelihood of exceedences of the annual mean NO_2 objective. The purpose of the Detailed Assessment is to provide the local authority with an opportunity to supplement the information they have gathered in their earlier review and assessment work and more accurately assess the impact of pollution sources on local receptors at identified hotspots through complex dispersion modelling. Dispersion modelling can be used to predicted concentrations over a wider area than can be monitored. It is important to ensure, as far as possible, that the results of modelling reflect the results from local monitoring sites across the assessment area and allow comparison of pollutant concentrations against the AQS objectives. This Detailed Assessment will identify with reasonable certainty whether or not pollutant concentrations are likely to exceed the AQS objectives and, if so, define the extent and magnitude of the exceedences.

Detailed dispersion modelling has been undertaken using the Cambridge Environmental Research Consultants (CERC) ADMS-Roads 2,2 dispersion model using the latest vehicle emission factors released in 2002[9].

Concentrations of NO_2, measured at diffusion tubes locations within the assessment areas in 2006 have been used to verify the model results.

Concentrations of NO_2 have been predicted for 2006, the baseline year (last full year of monitoring), and for 2010, the date when the EU objectives are expected to be met. The Detailed Assessment has been undertaken in accordance with the methodologies provided in the Technical Guidance (LAQM. TG (03))[7].

2 Baseline Information

2.1 Traffic Data

Worcestershire County Council provided the annual average daily traffic flows (AADT) traffic data used in this assessment. The data for 2006 and 2010 has been projected using growth factors from Tempro[10] and NRTF[11] (National Road Traffic Forecasts) adjusted for the Bromsgrove area.

In the absence of speed data, speeds have been based on speed limits, modified according to local conditions to take account of congestion and stop/start vehicle movements at junctions. Speeds were reduced at busy junctions to 20kph to reflect the higher emissions of queuing traffic.

The AADT (Annual Average Daily Traffic) and vehicle split for 2006 and 2010 are shown Table 2-1.

[9] Released by NETCEN for the National Atmospheric Emissions Inventory in consultation with TRL.

[10] Tempro (Trip End Model Presentation Program) version 5.0 , dataset version 061005_53, Department for Transport

[11] DETR, National Road Traffic Forecasts (Great Britain) 1997

Table 2-1 - AADT and vehicle split on relevant roads for 2006 and 2010

Road No.	Location	%HDV	AADT 2006	AADT 2010
A38	Bromsgrove Eastern Bypass	6.3	20815	21661
U21033	Austin Road, Bromsgrove	1.8	4596	4783
A38	North	7.8	24734	25740
C2164	Stoke Road	6.1	9387	9769
A38	Stoke Heath	6.8	24948	25962
C3164	Charford Road	3.9	9279	9656
B4187	B4187 Park Road, Hagley	3.6	5859	6117
U 201463	U 201463 Park Road, Hagley	3.3	2883	3010
A456	Western Road, Hagley	8.7	24308	25378
A456	Hagley Police Station	6.9	39434	41170
A456	West Hagley	7.1	32970	34422
A450	Mustow Green	7.3	11262	11758
A456	Blakedown	7.0	21953	22920
A491	Hagley Cattle Market, Stourbridge	7.3	33746	35232
A456	Hagley Cattle Market - Halesowen	5.7	34518	36037
A456	Hagley Cattle Market - Kidderminster	7.6	44663	46630
B1487	A456 / B4187 Hagley	4.1	10083	10527
A456	Halesowen	8.7	23505	24540
U/C	Western Road - one way	4.3	91	95
A456	Kidderminster	7.4	29662	30968
U20432	Summervale Road	5.2	1173	1224

2.2 Air Quality Monitoring

There is currently continuous monitoring of nitrogen dioxide undertaken by Bromsgrove District Council at a roadside site within the Lickey End AQMA at Junction 1 of the M42 motorway. The Council calibrates the site every two weeks and ETi services the station 6 monthly. Data for 2006 has been ratified by Network Managers Bureau Veritas. The results show that the annual mean objective is exceeded - 49.8µg/m^3 (97% data capture).

There are no continuous monitoring sites in the areas being assessed within this Detailed Assessment.

Nitrogen dioxide is measured using diffusion tubes at 24 locations in the District of Bromsgrove. The diffusion tubes are supplied and analysed by Gradko International Limited utilising the 20% TEA[12] in water preparation method. Gradko International participates in the Workplace Analysis Scheme for Proficiency (WASP) for NO_2 diffusion tube analysis and the Annual Field Inter-Comparison Exercise. These provide strict performance criteria for participating laboratories to meet, thereby ensuring NO_2 concentrations reported are of a high calibre.

With regard to the application of a bias adjustment factor for the diffusion tubes, the technical guidance LAQM.TG (03) and Review and Assessment Helpdesk[13] recommends use of a local bias adjustment factor where available and relevant to diffusion tube sites. Bromsgrove District Council has triplicate co-located diffusion tubes at the Lickey End continuous roadside monitoring station in Lickey End, which has been used to derive a local bias adjustment factor for 2006 of 0.97. The calculation of bias is shown in Appendix 1. Annualisation of data has been undertaken for short-term sites in accordance with LAQM.TG(03).

The results for the diffusion tubes in 2006 are shown in Table 2-2. The concentrations exceeding the AQS objective are shown in bold.

[12] TEA-Triethanolamine

[13] www.uwe.ac.uk/aqm/review

Table 2-2 - Nitrogen dioxide diffusion tube average concentrations, µg/m^3, for 2006

Ref1	Ref2	X	Y	Site	No. Months	2006 Annual Mean (Corrected)
1N	BG1	396238	271118	Davenall House	12	36.8
3N	BG3	396755	270400	Finstall	11	22.8
4N	BG4	395917	269323	Charford	11	20.4
5N	BG5	395562	270249	Worcester Rd	12	35.1
1	1	396999	272979	3A Alcester Road, Lickey End.	12	31.9
5	13	396889	274133	485 Birmingham Road, Marlbrook.	12	31.7
15	5	396150	271068	Strand House, The Strand, Bromsgrove.	12	35.9
46	7	391437	281037	No.5 Stourbridge Road	12	23.5
82	16	394701	268444	58 Redditch Road Stoke Prior	12	36.7
83	11	390295	280043	74 Worcester Lane, Hagley	12	31.7
84	12	402958	276407	Woodbine Cottage, Birmingham Road, Hopwood	12	30.0
86	4	396935	272934	Birmingham Road, Lickey End	11	38.8
87	15	396933	274207	464 Birmingham Road	12	26.2
88	14	396872	274176	2 Golden Cross Lane	12	31.8
89	18	395180	268549	84 Redditch Road, Buntsford Hill	12	35.5
92	10	391458	280948	Location between A491 Roundabout and Stourbridge Road Junction.	11	31.7
93	8	391137	280638	77a Park Road	12	26.6
C13	TS	396613	275085	Smallholdings	12	30.7
C14	WL	396095	274592	Wildmoor Lane	11	30.1
C15	GH	401740	273196	Grosvenor House	11	32.6
C13/14/15	F1,2,3	397010	273112	Lickey End AQMA 1/ Forrest Inn Island (Triplicate)	12	**45.9**
	19/19a/19b	395188	268564	93 Redditch Road, Buntsford Hill (Triplicate)	12	**42.1**
	9/9a/9b	391213	280672	78 Kidderminster Road, Hagley (triplicate)	11	38.6

Monitoring undertaken in the Hagley Assessment Area
Monitoring undertaken in the Redditch Road, Buntsford Hill Assessment Area

2.3 Background Concentrations

Defra provides the background pollutant concentration maps at a resolution of 1x1 km for the entire UK and supplies the factors to calculate background pollutant concentrations for future years. These maps can be obtained from the UK Air Quality Information Archive[14]. The latest maps provide background for 2004, 2005 and 2010 as base years. These modelled background maps are used when there is no representative monitored background data. The background concentrations used for the Kidderminster Road, Hagley assessment are based on the latest Defra maps (x=391500, y=280500). For the Redditch Road, Buntsford Hill assessment, the background concentrations have been derived from the Charford background monitoring site. The background NO_2 and NO_x concentrations for 2006 and 2010 are shown in Table 2-3.

Table 2-3 – NO_2 and NO_x background concentrations, µg/m^3 for the assessment areas

Assessment Area	Pollutant	2006	2010
Redditch Road, Buntsford Hill	NO_2	20.4	18.3
	NO_x	30.7	26.1
Kidderminster Road, Hagley	NO_2	17.1	15.5
	NO_x	23.7	19.7

[14] The National Air Quality Information Archive website http://www.airquality.co.uk/archive/laqm/tools.php?tool=background

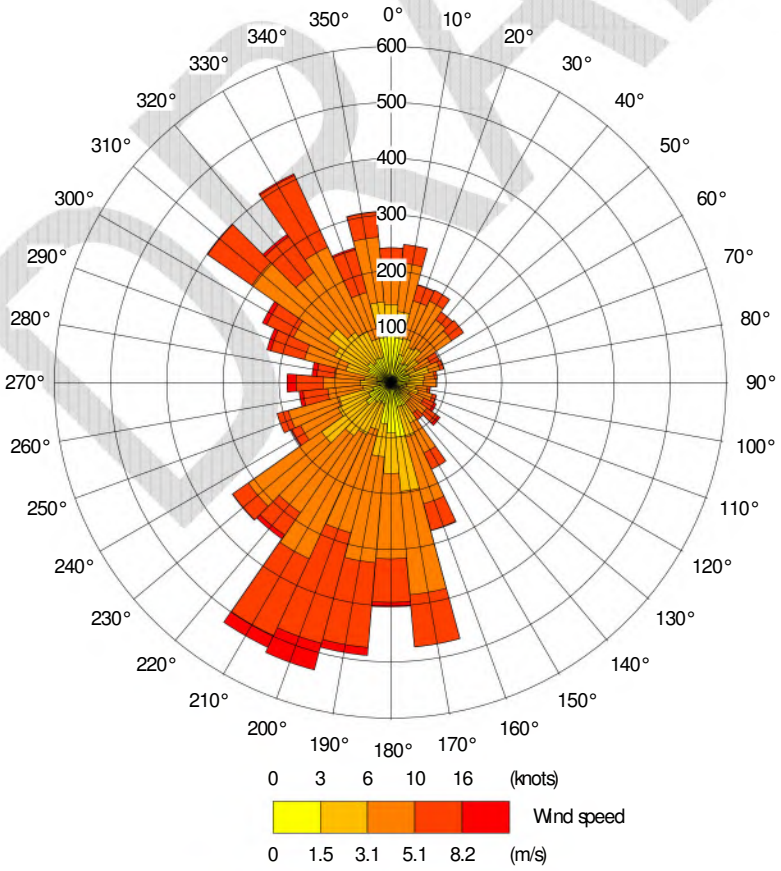
3 Dispersion Modelling Methodology

Detailed dispersion modelling of NO_2 was undertaken using the Cambridge Environmental Research Consultants (CERC) Ltd ADMS-Roads advanced Gaussian air dispersion model. ADMS-Roads can model up to 150 road sources and 7 industrial sources at any one time. The model is used extensively in local air quality management, and has formed the basis for many AQMA declarations. A considerable number of validation studies have been completed, showing overall excellent agreement between model outputs and observations at continuous monitoring sites. ADMS-Roads has integrated modules to take into the account the effects of street canyons and plume chemistry. Details of the model inputs are provided below.

3.1 Meteorological Data

The meteorological data for 2005 used is from Coleshill weather station. The wind rose for the Coleshill weather station data is given below. It shows that the dominant wind direction is southwesterly.

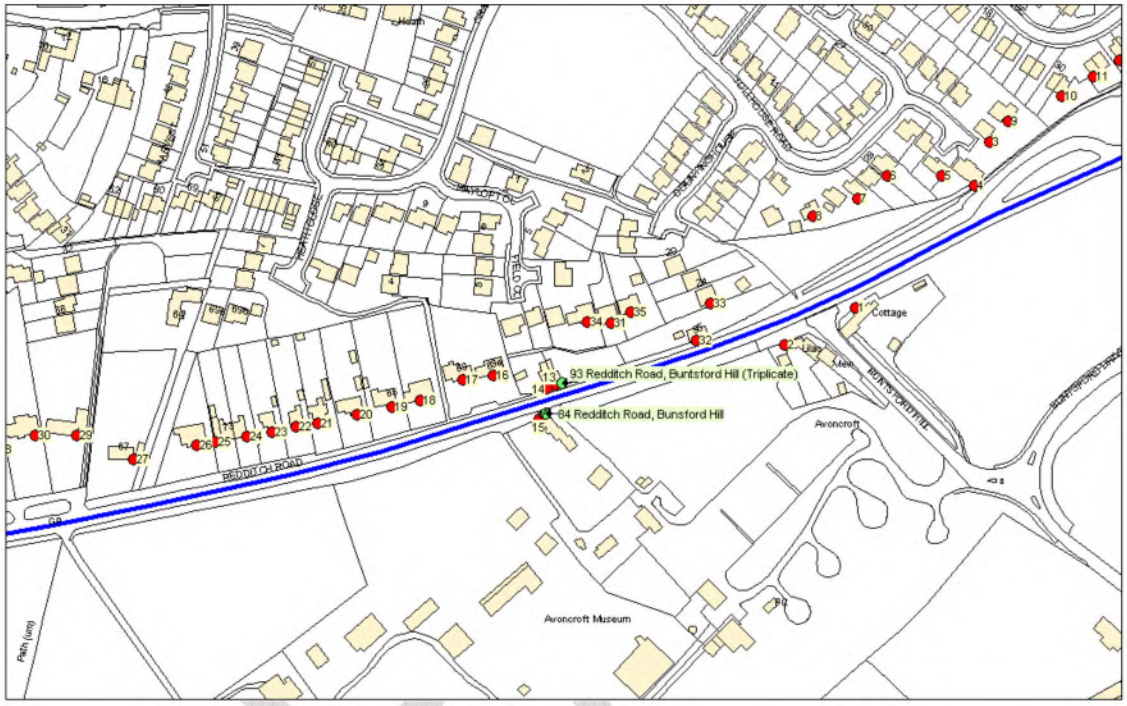
Figure 3-1 – Wind rose for 2005 Coleshill meteorological data



3.2 Model Set up

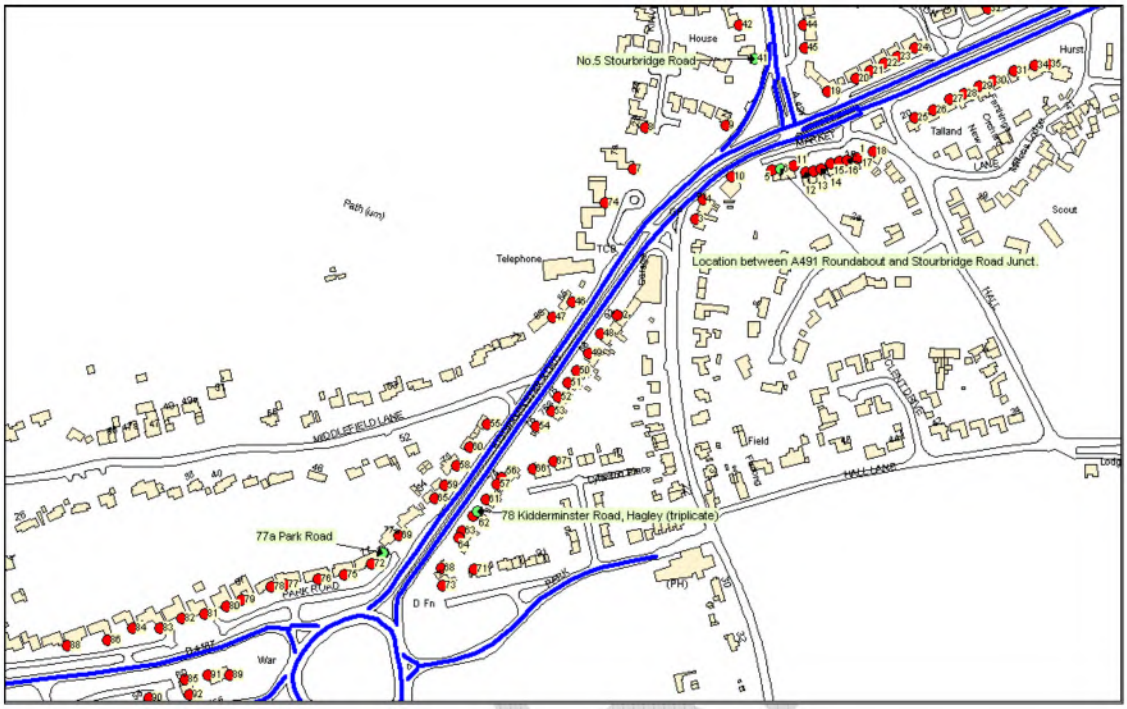
Figure 3-2 a & b shows the location of roads, receptors and diffusion tubes modelled in the assessment.

Figure 3-2a – Roads, receptors and diffusion tubes modelled in the Redditch Road, Buntsford Hill assessment



- Receptor
- Diffusion tube
- Roads modelled in the assessment

Figure 3-3b – Roads, receptors and diffusion tubes modelled in the Kidderminster Road, Hagley assessment



3.3 Emissions Factors

The emissions factors incorporated into ADMS-Roads, were used to calculate the NO_x emissions for each road link in the assessment. These emission factors are the most up-to-date emission factors available. These factors, released in 2002 by Defra and Department for Transport (D*f*T), are the same as those calculated with the Emission Factors Toolkit[15] and the DMRB[16] widely used throughout the UK. The emissions factors are available for three different road types which act as a proxy for the differences in fleet composition of traffic in different conditions; urban rural and motorway. For this assessment urban was selected to represent the type of road

For the primary NO_2 emissions, the default value in the model is 10%. However, many recent studies have pointed that the proportion of primary NO_2 might be significantly higher[17]. The consultation report[18] of AQEG (Air Quality Expert Group) analyses that why

[15] Emission Factor Toolkit developed by Casella Stanger for Defra. http://www.casellastanger.com/JointProjects/default.asp

[16] Design Manual for Roads and Bridges, Volume 11, Section 3, Part 1 Air Quality. The Highways Agency, February 2003.

[17] Carslaw DC *et al*. Atmospheric Environment, 39 (2005) 167-177.

[18] Defra (2006). AQEG Consultation Report 'Trends in Primary Nitrogen Dioxide in the UK'

the recent drops in annual mean NO_x concentrations have not translated in the similar reduction of NO_2 concentrations. The report concludes that monitoring and modelling results suggest that the proportion of primary NO_2 is higher than 10%, currently used in the model. For this assessment, a 15% has been used for primary NO_2 emissions, to represent the proportion of this pollutant more realistically. However, this will result in higher predicted NO_2 concentrations compared to using default NO_2 proportion in the model.

3.4 Background Concentrations

Background concentrations, as described in Section 2.3, have been incorporated into the model.

3.5 Model Input Parameters

Atmospheric chemical reactions have been incorporated into the modelling. The chemical reaction scheme module of ADMS-Roads 2.2 was selected for this assessment. A minimum Monin-Obukhov length of 10m was selected to represent the stability of the atmosphere due to the characteristics of the local area. The model considers this to be the minimum height above ground level above which vertical turbulence is inhibited.

A surface roughness length of 0.5 was assigned in the model.

3.6 Model Output

ADMS-Roads dispersion model produces modelled concentrations of NO_X and NO_2 at specific receptors, identified for the prediction of air quality impacts.

The link to a geographic information system (GIS) for mapping purposes provides the best method of analysing the pollution output. Maps have been produced illustrating NO_2 concentrations predicted at selected properties in the vicinity of the roads modelled. In those areas where predicted NO_2 concentrations at properties are likely to exceed the annual mean AQS objective, GIS tools have been used to draw detailed concentrations contours of the annual mean NO_2 concentrations from the model output to allow the areas of exceedence to be identified.

3.7 Model Verification

The model is used to predict concentrations of NO_2 at the diffusion tube monitoring locations, in order to verify the model against monitored concentrations. The following are the main objectives of the model verification:

- to evaluate model performance,
- to show that the baseline is well established and
- to provide confidence in the assessment results

As mentioned in section 2.2 there is no automatic monitoring undertaken in the areas of the assessment. However, there are roadside and façade diffusion tubes for monitoring NO_2. NO_2 annual mean concentrations have been predicted at all of these diffusion tube sites. Two triplicate diffusion tube sites (one in each area under assessment) provide the most accurate means of verifying the modelled data in the absence of continuous data and these

have been used for the model verification. The application of the verification factors derived from these site show that the approach is more precautionary than additionally including the single tube sites. Table 3-1 compares the modelled and monitored annual mean NO_2 concentrations for 2006. The full verification procedure is shown in Appendix 2.

Table 3-1 - Comparison of modelled and monitored 2006 annual mean NO_2 concentrations, µg/m^3

Diffusion tube site	Tube location		Monitored NO_2, µg/m^3 2006	Modelled NO_2, µg/m^3 2006
	X	Y		
No.5 Stourbridge Road	391437	281037	23.5	37.2
74 Worcester Lane, Hagley	390295	280043	31.7	34.5
Location between A491 Roundabout and Stourbridge Road Junction	391458	280948	31.7	38.1
77a Park Road	391137	280638	26.6	35.8
78 Kidderminster Road, Hagley (triplicate site)	391213	280672	38.6	38.6
93 Redditch Road, Buntsford Hill (Triplicate site)	395188	268564	42.1	42.1
84 Redditch Road, Buntsford Hill	395180	268549	35.5	42.0

During the verification process, Bureau Veritas aim for all final modelled NO_2 concentrations to be within 25% of the monitored NO_2 concentrations. The comparison of the monitored and modelled data shows reasonable agreement between the two datasets at most sites (No.5 Stourbridge Road and 77a Park Road in Hagley show modelled concentrations >+25% that monitored) and the modelled results are generally precautionary. Where discrepancies do exist, these could be due to a variety of reasons, for example:

- Uncertainty in traffic data (flows, speeds or fleet composition)
- Model set up (road widths, elevations and receptor locations)
- Model limitations (treatment of roughness and meteorological data)
- Uncertainty in monitoring data, such as use of diffusion tubes (notably where singly located) and application of bias adjustment factor for diffusion tubes
- Uncertainty in background concentrations

4 Results

Annual average concentrations for NO_2 are predicted using the ADMS-Roads 2.2 model at relevant receptors for the baseline year 2006 and 2010, the year in which the EU limit values for NO_2 are expected to be met. For intermediate years 2007, 2008 and 2009, the most recent projection factors from LAQM.TG (03) have been applied. The results are shown in tabular form in Appendix 3 and are mapped in Appendix 4.

Receptors have been selected at the façades of buildings near the modelled road links, Redditch Road, Buntsford Hill and Kidderminster Road, Hagley. The selected receptors represent locations with relevant exposure for the annual mean objective. All predicted results are produced using the methodology described in Section 3 of this report. The predicted NO_2 concentrations at specific receptors for 2006 and 2010 and are shown in Appendix 3. The concentrations exceeding the AQS objective are shown in bold.

The predicted concentrations for NO_2 at the modelled receptors in the Kidderminster Road, Hagley area show the AQS objective to be met in the modelled years, 2006 and 2010. The predicted concentrations for 2010 are systematically lower than in 2006, due to expected reductions in background concentrations and improvements in vehicle emissions through implementation of national policies.

The predicted concentrations for NO_2 at the modelled receptors in the Redditch Road, Buntsford Hill area show exceedences of the AQS annual mean objective in 2006. The façade based (triplicate) diffusion tube monitoring on Redditch Road Buntsford Hill, which shows exceedence of the annual mean objective in 2006, confirms this. By 2008, the predicted concentrations indicate the annual mean objective will be met due to expected reductions in background concentrations and improvements in vehicle emissions through implementation of national policies.

The Contours of predicted 2006 annual mean NO_2 concentrations in the vicinity of Redditch Road, Buntsford Hill are shown in Appendix 4. The contour map displays the area in which the AQS annual mean objective is likely to exceed. It can be seen from the contour map that a small number of residences closest to the roadside along this stretch of Redditch Road, Buntsford Hill will be in an area that will exceed the AQS objective and therefore an AQMA declaration should be considered. An indication of where the AQMA should be located can also be seen in Appendix 4.

5 Conclusions and Recommendations

A detailed assessment has been carried out for two areas that have been identified in the 2006 USA of Bromsgrove District Council as having a potential risk of exceedence of the annual mean NO_2 objective. The modelled areas are Redditch Road, Buntsford Hill and Kidderminster Road, Hagley. Annual mean NO_2 concentrations have been predicted at relevant receptors adjacent these roads.

The model results have been verified against (triplicate) NO_2 diffusion tube sites within the vicinity of the modelled road links.

The model results suggest that the annual mean objective for NO_2 is likely to be exceeded at the worst-case modelled receptors at Redditch Road, Buntsford Hill in 2006. By 2008, the predicted concentrations indicate the annual mean objective will be met due to expected reductions in background concentrations and improvements in vehicle emissions through implementation of national policies.

The model results at Kidderminster Road, Hagley suggest that the annual mean objective for NO_2 is likely to be met at all receptors in 2006 and subsequent years.

5.1 Recommendations

Based on this detailed assessment and review of the monitoring data the following recommendations are made for Bromsgrove District Council:

- To consider declaration of an Air Quality Management Area along Redditch Road, Buntsford Hill, on the basis of NO_2, where exceedences are predicted at relevant receptor locations;
- To consider introducing continuous monitoring in the Redditch Road, Buntsford Hill area – for a minimum of 6 months - to more accurately assess nitrogen dioxide levels and compliance with the annual mean objective;
- To continue monitoring NO_2 at all the current diffusion tube locations in order to ensure that any future changes in air quality are detected, notably locations representative of the relevant exposure, i.e., at the façade of the residential properties.

6 APPENDICES

APPENDIX 1 Calculation of Bias Adjustment

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Automatic Method Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data Capture Check
1	03/01/2006	31/01/2006	51.6	52.9	55.7	53	2.1	4	5.2	49.2	99.5	Good	Good
2	31/01/2006	28/02/2006	51.8	47.9	43.0	48	4.4	9	10.9	47.8	99.6	Good	Good
3	28/02/2006	04/04/2006	45.1	45.9	48.3	46	1.7	4	4.2	45.8	99.8	Good	Good
4	04/04/2006	02/05/2006	46.7	50.8	45.9	48	2.6	6	6.6	51.4	99.3	Good	Good
5	02/05/2006	30/05/2006	52.1	52.3	49.9	51	1.3	3	3.3	46.7	99.9	Good	Good
6	30/05/2006	27/06/2006	44.9	46.2	43.7	45	1.2	3	3.1	49.5	98.5	Good	Good
7	27/06/2006	01/08/2006	48.1	43.1	52.8	48	4.8	10	12.0	51.8	88.2	Good	Good
8	01/08/2006	29/08/2006	40.6	36.1	39.0	39	2.3	6	5.7	36.8	99.3	Good	Good
9	29/08/2006	03/10/2006	59.7	5.6	11.6	26	29.7	**116**	73.7	53	100	Poor Precision	Good
10	03/10/2006	31/10/2006	51.6	53.7	54.7	53	1.6	3	3.9	37	99.3	Good	Good
11	31/10/2006	28/11/2006	54.0	56.5	55.9	55	1.3	2	3.2	59.3	99.1	Good	Good
12	28/11/2006	02/01/2007	55.2	54.5	57.8	56	1.8	3	4.3	53.9	87.5	Good	Good
Without periods with CV larger than 20%	Bias factor A	**0.97** (0.89 - 1.08)			WITH ALL DATA	Bias factor A	1.02 (0.9 - 1.19)						
Bias calculated using 11 periods of data	Bias B	3% (-8% - 13%)			Bias calculated using 12 periods of data	Bias B	-2% (-16% - 12%)						
Accuracy (with 95% confidence interval)	Diffusion Tubes Mean:	49	μgm^{-3}		Accuracy (with 95% confidence interval)	Diffusion Tubes Mean:	47	μgm^{-3}					
	Mean CV (Precision):	5				Mean CV (Precision):	**14**		caution				

APPENDIX 2 Model Verification

Receptor name	X(m)	Y(m)	Modelled NO_2 in $\mu g/m^3$	Monitored NO_2 in $\mu g/m^3$	Modelled Roads NO_2 in $\mu g/m^3$	Monitored Roads NO_2 in $\mu g/m^3$	NO_2 correction factor	Corrected Modelled NO_2 in $\mu g/m^3$	Background NO_2 in $\mu g/m^3$
78 Kidderminster Road, Hagley (triplicate)	391213	280672	35.1	38.6	18.0	21.6	1.2	38.6	17.08
93 Redditch Road, Buntsford Hill (Triplicate)	395188	268564	30.5	**42.1**	10.1	21.7	2.2	42.1	20.4

APPENDIX 3 ADMS-Roads Modelled Nitrogen Dioxide Results in µg/m^3

Kidderminster Road, Hagley

Receptor ID	X	Y	2006 Modelled NO_2	2006 NO_2 projected to 2007	2006 NO_2 projected to 2008	2006 NO_2 projected to 2009	2010 Modelled NO_2
1	391520	280956	33.1	32.1	31.0	29.8	31.1
2	391326	280829	36.5	35.3	34.1	32.8	34.7
3	391390	280907	36.4	35.2	34.0	32.7	34.6
4	391396	280923	39.6	38.3	37.0	35.6	37.9
5	391451	280946	38.8	37.6	36.3	34.9	36.9
6	391458	280948	39.0	37.7	36.4	35.0	37.1
7	391339	280948	30.8	29.8	28.8	27.7	28.8
8	391349	280981	30.0	29.1	28.1	27.0	28.0
9	391414	280983	37.1	35.9	34.7	33.4	35.4
10	391419	280942	32.2	31.1	30.1	28.9	30.4
11	391468	280950	38.9	37.6	36.3	34.9	37.0
12	391478	280945	36.1	35.0	33.8	32.5	34.2
13	391484	280946	35.7	34.6	33.4	32.1	33.8
14	391491	280948	35.2	34.1	32.9	31.6	33.2
15	391499	280953	35.0	33.9	32.8	31.5	33.1
16	391505	280954	34.4	33.3	32.2	30.9	32.4
17	391512	280955	33.8	32.7	31.6	30.4	31.8
18	391533	280962	32.4	31.4	30.3	29.1	30.4
19	391496	281011	39.5	38.2	36.9	35.5	37.8
20	391519	281020	36.5	35.3	34.1	32.8	34.8
21	391530	281027	35.4	34.2	33.0	31.8	33.6
22	391542	281033	34.4	33.3	32.2	30.9	32.7
23	391552	281038	33.7	32.7	31.5	30.3	31.9
24	391566	281045	33.1	32.0	30.9	29.7	31.2
25	391566	280989	32.6	31.5	30.5	29.3	30.6
26	391581	280995	32.2	31.2	30.1	28.9	30.2
27	391595	281004	32.3	31.3	30.2	29.1	30.3
28	391606	281009	32.0	31.0	29.9	28.8	30.0
29	391619	281014	31.8	30.8	29.8	28.6	29.8
30	391630	281019	31.7	30.7	29.7	28.5	29.7
31	391646	281027	31.6	30.6	29.5	28.4	29.6
32	391626	281077	30.9	29.9	28.9	27.8	29.0
33	391647	281089	30.3	29.3	28.3	27.2	28.3
34	391664	281032	30.9	29.9	28.9	27.8	28.9
35	391674	281032	30.4	29.4	28.4	27.3	28.3
36	391753	281078	31.6	30.5	29.5	28.3	29.6
37	391814	281153	29.5	28.5	27.5	26.5	27.5
38	391784	281150	28.7	27.8	26.8	25.8	26.7
39	391774	281146	28.7	27.8	26.8	25.8	26.7
40	391739	281126	29.8	28.8	27.8	26.7	27.8
41	391437	281037	37.9	36.7	35.5	34.1	36.2
42	391425	281064	34.2	33.1	31.9	30.7	32.3
43	391474	281085	36.0	34.8	33.6	32.3	34.2
44	391477	281064	36.8	35.6	34.4	33.0	35.0
45	391477	281045	38.0	36.8	35.5	34.1	36.3

Receptor ID	X	Y	2006 Modelled NO_2	2006 NO_2 projected to 2007	2006 NO_2 projected to 2008	2006 NO_2 projected to 2009	2010 Modelled NO_2
46	391290	280840	35.3	34.2	33.0	31.7	33.5
47	391274	280828	33.5	32.4	31.3	30.1	31.6
48	391313	280814	37.5	36.3	35.1	33.7	35.8
49	391304	280799	37.1	35.9	34.7	33.3	35.4
50	391293	280785	37.3	36.1	34.9	33.5	35.6
51	391286	280775	37.4	36.2	35.0	33.6	35.7
52	391279	280764	37.2	36.0	34.8	33.5	35.5
53	391273	280752	36.4	35.3	34.1	32.7	34.7
54	391261	280740	37.7	36.5	35.2	33.9	36.0
55	391221	280742	35.6	34.4	33.2	31.9	33.7
56	391233	280698	38.0	36.7	35.5	34.1	36.2
57	391229	280693	38.0	36.8	35.5	34.1	36.3
58	391197	280708	35.7	34.6	33.4	32.1	33.9
59	391187	280693	36.4	35.2	34.0	32.7	34.6
60	391208	280723	35.6	34.5	33.3	32.0	33.8
61	391220	280681	38.3	37.1	35.8	34.4	36.6
62	391213	280672	38.7	37.5	36.2	34.8	37.0
63	391201	280655	39.3	38.0	36.7	35.3	37.6
64	391198	280650	39.3	38.0	36.7	35.3	37.6
65	391179	280682	36.8	35.6	34.4	33.1	35.0
66	391258	280705	33.6	32.5	31.4	30.2	31.8
67	391275	280712	32.2	31.2	30.1	28.9	30.3
68	391184	280626	39.2	37.9	36.7	35.2	37.6
69	391150	280652	35.9	34.8	33.6	32.3	34.1
70	391137	280638	36.3	35.2	34.0	32.6	34.5
71	391211	280625	34.4	33.2	32.1	30.9	32.6
72	391128	280629	36.5	35.4	34.2	32.8	34.7
73	391185	280611	37.7	36.5	35.2	33.9	36.0
74	391316	280921	30.6	29.6	28.6	27.5	28.6
75	391106	280620	35.4	34.3	33.1	31.8	33.5
76	391085	280616	33.7	32.6	31.5	30.3	31.7
77	391059	280612	31.4	30.4	29.4	28.2	29.4
78	391047	280610	30.6	29.6	28.6	27.5	28.6
79	391023	280600	29.4	28.5	27.5	26.4	27.4
80	391010	280594	28.9	28.0	27.1	26.0	26.9
81	390993	280589	28.3	27.4	26.5	25.4	26.3
82	390975	280585	27.7	26.8	25.9	24.9	25.6
83	390957	280577	27.5	26.6	25.7	24.7	25.4
84	390935	280577	26.8	26.0	25.1	24.1	24.7
85	390978	280536	30.4	29.5	28.5	27.3	28.7
86	390915	280567	26.7	25.9	25.0	24.0	24.7
87	390898	280501	28.5	27.5	26.6	25.6	26.6
88	390882	280563	26.2	25.3	24.5	23.5	24.1
89	391014	280539	32.3	31.3	30.2	29.0	30.6
90	390948	280520	29.9	28.9	27.9	26.9	28.1
91	390996	280539	31.2	30.1	29.1	28.0	29.4
92	390981	280523	31.8	30.8	29.7	28.6	30.1
93	390947	280510	30.9	29.9	28.8	27.7	29.1
94	390860	280450	30.3	29.4	28.4	27.2	28.5

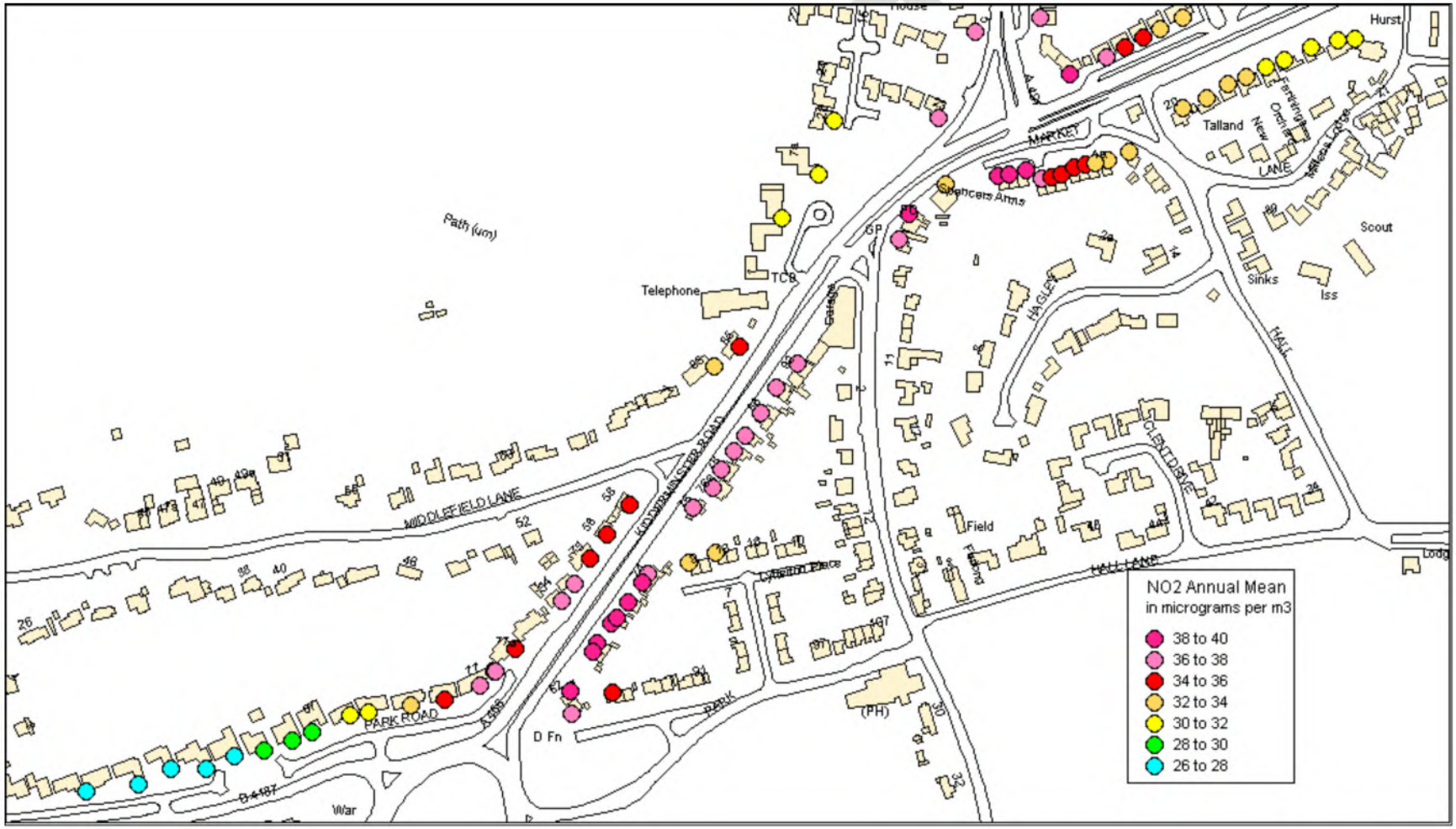
Receptor ID	X	Y	2006 Modelled NO_2	2006 NO_2 projected to 2007	2006 NO_2 projected to 2008	2006 NO_2 projected to 2009	2010 Modelled NO_2
95	390890	280472	30.7	29.7	28.7	27.6	28.9
96	390858	280463	28.7	27.8	26.8	25.8	26.8
97	390856	280476	27.7	26.9	25.9	24.9	25.8
98	390854	280489	27.2	26.3	25.4	24.4	25.2
99	390827	280429	29.1	28.2	27.2	26.2	27.2
100	390807	280411	28.8	27.9	26.9	25.9	26.9

Redditch Road, Buntsford Hill

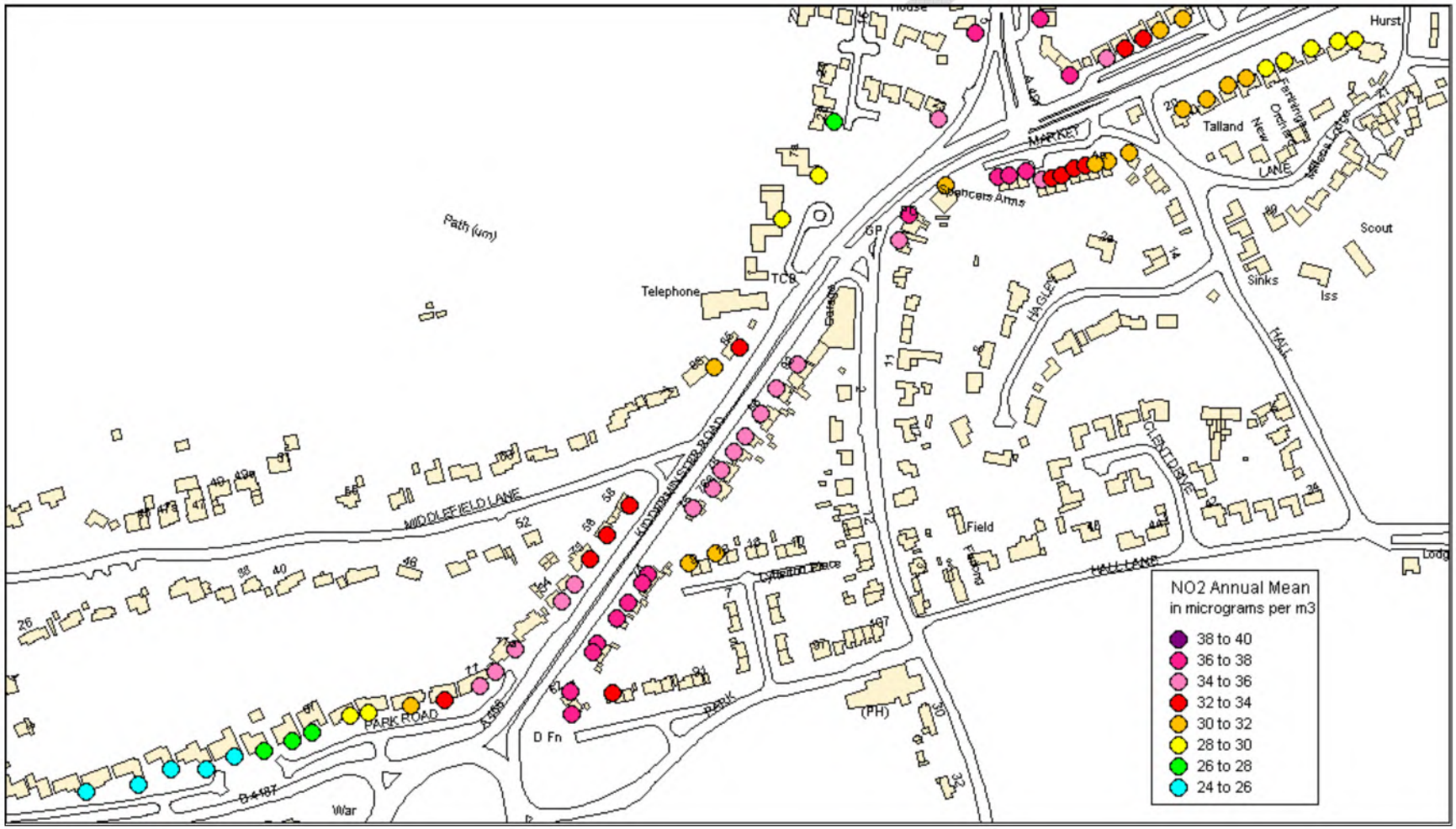
Receptor ID	X	Y	2006 Modelled NO_2	2006 NO_2 projected to 2007	2006 NO_2 projected to 2008	2006 NO_2 projected to 2009	2010 Modelled NO_2
1	395334	268601	**42.0**	**40.6**	39.3	37.7	34.4
2	395298	268583	**42.2**	**40.8**	39.4	37.9	33.3
3	395400	268683	**40.1**	38.8	37.5	36.0	30.6
4	395392	268662	38.8	37.5	36.3	34.8	32.6
5	395376	268667	35.8	34.6	33.4	32.1	30.8
6	395349	268667	38.1	36.9	35.6	34.2	29.6
7	395335	268655	35.9	34.8	33.6	32.3	29.8
8	395313	268647	34.5	33.4	32.3	31.0	29.5
9	395409	268694	34.7	33.6	32.4	31.2	30.3
10	395436	268706	34.4	33.3	32.1	30.9	30.7
11	395451	268716	35.4	34.2	33.1	31.8	31.0
12	395464	268724	35.9	34.7	33.5	32.2	31.4
13	395184	268563	36.2	35.0	33.8	32.5	35.8
14	395181	268561	36.6	35.4	34.2	32.9	36.1
15	395176	268546	**42.2**	**40.8**	39.4	37.9	34.8
16	395154	268568	**42.5**	**41.1**	39.7	38.2	31.4
17	395139	268566	**40.7**	39.4	38.1	36.6	30.9
18	395118	268555	36.7	35.5	34.3	33.0	31.5
19	395103	268552	36.1	34.9	33.7	32.4	31.3
20	395086	268548	36.8	35.6	34.4	33.1	31.1
21	395067	268544	36.5	35.3	34.1	32.8	30.9
22	395056	268542	36.3	35.1	33.9	32.6	30.8
23	395044	268540	36.1	34.9	33.7	32.4	30.7
24	395032	268538	36.0	34.8	33.6	32.3	30.6
25	395016	268535	35.9	34.7	33.5	32.2	30.5
26	395007	268533	35.7	34.6	33.4	32.1	30.5
27	394975	268526	35.6	34.5	33.3	32.0	30.4
28	394907	268531	35.6	34.4	33.2	31.9	28.6
29	394947	268538	35.5	34.4	33.2	31.9	28.7
30	394927	268538	33.3	32.2	31.1	29.9	28.4
31	395213	268594	33.5	32.4	31.3	30.1	30.4
32	395255	268585	33.1	32.0	30.9	29.7	35.9
33	395261	268603	35.5	34.3	33.1	31.9	31.4
34	395200	268594	**42.3**	**40.9**	39.5	38.0	30.0
35	395222	268599	36.6	35.4	34.2	32.9	30.2

APPENDIX 4 Mapped ADMS-Roads Modelled Nitrogen Dioxide Results in µg/m^3

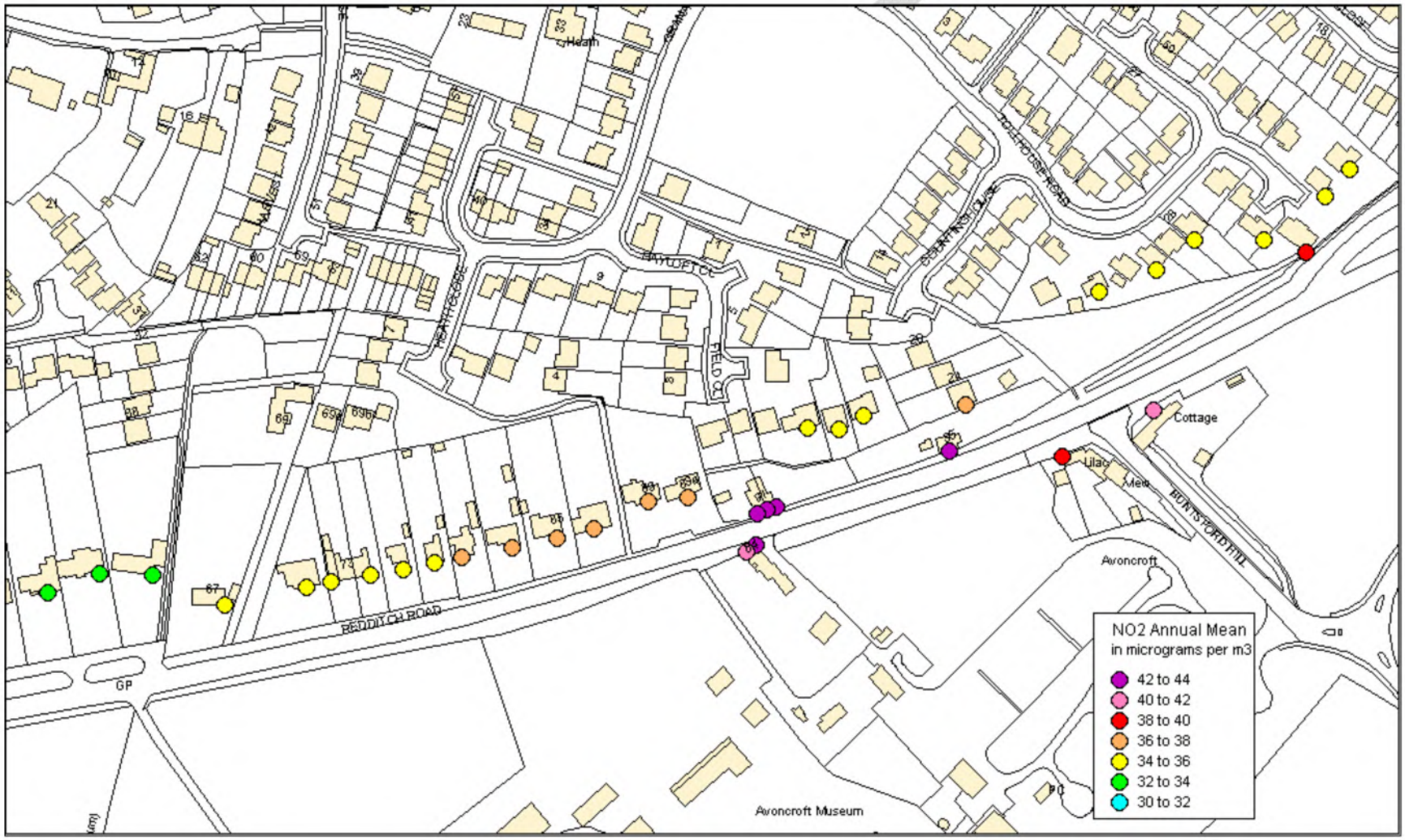
Kidderminster Road, Hagley – 2006 Modelled Annual Mean NO_2 in µg/m^3



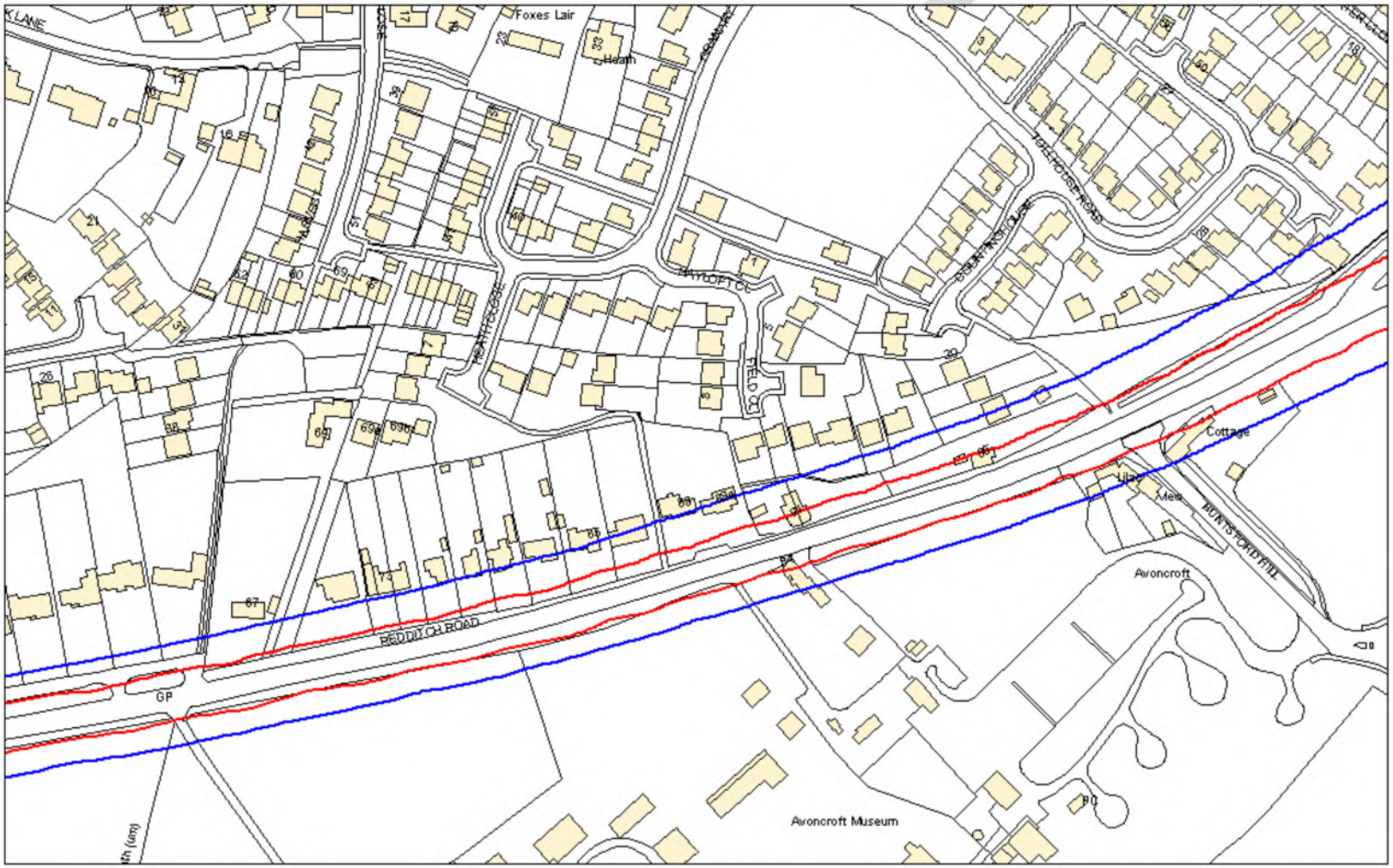
Kidderminster Road, Hagley – 2010 Modelled Annual Mean NO_2 in µg/m^3



Redditch Road, Buntsford Hill – 2006 Modelled Annual Mean NO_2 in µg/m^3



Redditch Road, Buntsford Hill – 2006 Modelled Annual Mean NO_2 in µg/m^3 (Contours)



Redditch Road, Buntsford Hill – 2010 Modelled Annual Mean NO_2 in µg/m^3