Chesterfield Borough 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. The Review and Assessment process is called LAQM (Local Air Quality Management). It is a progressive process starting with the screening assessment and leading to a more Detailed Assessment, if circumstances warrant so. The main aim of the LAQM is for the local authorities to review and assess the air quality periodically in their areas with regard to the Air Quality Objectives, to protect human health, prescribed by the government in the Air Quality Strategy (AQS). The local authorities are required to undertake a Detailed Assessment of the air quality in their areas if the Updating and Screening Assessment (USA) identifies areas where there is a potential risk of exceedence of Air Quality Strategy (AQS) Objectives.

First Round of Review and Assessment for Chesterfield Borough Council (CBC) concluded that the Air Quality Objectives for the seven pollutants, prescribed in the AQS, were expected to be met by their target dates throughout Chesterfield Borough Council's administrative area. In the Second Round of Review and Assessment some concerns were raised regarding the compliance of the AQS Objectives for PM_{10} and NO_2, however, due to inconclusive evidence it was recommended that these two pollutants should be monitored rigorously. The 2006 USA, undertaken at the start of Third Round of Review and Assessment, concluded that while the Air Quality Objectives for benzene, 1, 3-butadiene, carbon monoxide, lead, PM_{10} and sulphur dioxide will be met, the concerns were raised regarding the attainment of AQS Objective for NO_2 at a number of roadside locations. Therefore, a Detailed Assessment for NO_2 was recommended. The main objective of the Detailed Assessment is to 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 exceedence.

The USA 2006 showed that the annual mean concentrations for NO_2, based on the diffusion tube monitoring data for 2005, was either higher or very close to the annual AQS objective at the following road sections, in the vicinity of the residential properties, within Chesterfield:

- Derby Road (A61)
- Chatsworth and Markham Road (A619)
- Chesterfield Road, Staveley (A619)

The diffusion tube results for 2006 continue to record exceedence of the annual mean NO_2 Objective. This further justifies the need to undertake the Detailed Assessment.

This Detailed Assessment has been undertaken in accordance with the Technical Guidance provided by Defra, LAQM.TG(03). Detailed dispersion modelling has been undertaken using ADMS-Roads dispersion model from Cambridge Environmental Research Consultants (CERC).

The model has been verified against available roadside NO_2 diffusion tube data in 2005 and shows a good agreement. The comparison of the modelled and monitored data for 2005 shows that nine out of ten predicted concentrations agree within ±20% of the monitored data. The diffusion tube data for 2006 has also been included in model verification for comparison purposes.

Annual mean NO_2 concentrations for 2005 and 2010 have been predicted at 151 receptors specified at façades of the buildings along the road links mentioned above. In 2005, out of

151 modelled receptors, 84 show an exceedence for the annual mean AQS Objective for NO_2. For 2005, the maximum concentration, 54 μg/m^3, has been predicted for a receptor placed at the façade of a building adjacent to an uphill westbound section of Chesterfield Road, A619. Predicted breaches of the 40 μg/m^3 annual AQS Objective for NO_2 are widespread throughout the Detailed Assessment area close to the A61 and A619 roads. The model projections for 2010 show that the exceedence for the annual mean NO_2 AQS Objective is likely to remain at some hotspots within Chesterfield.

Nitrogen dioxide predictions have also been made at the grid receptors along modelled roads for 2005 and 2010. The maps of gridded concentrations have been produced in GIS, and concentration contours for 36 μg/m^3 and 40 μg/m^3 NO_2 have been drawn.

The maps of gridded concentrations in 2005 show the exceedence of the annual AQS objective is widespread along modelled roads. The contour maps show the extent of the exceedence and will assist the Council to declare the AQMA where the relevant exposure applies.

The gridded concentration and contour maps for 2010 show that the problems regarding the compliance of the annual AQS for NO_2 remains at some hotspots within Chesterfield even in 2010.

Based on this Detailed Assessment, the following recommendations are made to the Council:

- **To declare an AQMA under section 83 (1) of the Environment Act 1995. The locations should be represented by the 40 μg/m^3 contour as presented in appendix B. Checks should be made that these areas included within the contour line are representative for the relevant exposure. The Council should also consider some residential areas within 36 μg/m^3 contour, to take account of the uncertainties associated with modelling and meteorological influences**

- **To continue monitoring NO_2 at all the current (2006) diffusion tube locations in order to ensure that any future changes in air quality are detected**

- **To establish the additional monitoring for NO_2 at new locations close to worse case receptors representing the relevant exposure, identified in Appendix A, using the same methodologies as the existing tubes**

- **To undertake Further Assessment to confirm the conclusions of this Detailed Assessment and apportion the source contributions and estimate the reductions in emissions required to achieve the objective**

1 Introduction

1.1 Project Background

Bureau Veritas HS&E has been commissioned by Chesterfield Borough Council (CBC) to undertake a Detailed Assessment resulting from the requirement of the USA undertaken in 2006 as part of the Third Round of Review and Assessment of air quality. As the local authorities that have identified areas, within their USA, where there is a potential risk of exceedence of Air Quality Objectives a Detailed Assessment is required. The 2006 USA identified a potential of exceedence in three broad areas in and around Chesterfield and Staveley Village including:

- A61 Derby Road including Chesterfield Expressway
- A619 Chatsworth Road and Markham Road Expressway
- A619 Chesterfield Road, Staveley

1.2 Legislative Background

1.2.1 Air Quality Strategy Objectives

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS)[1] (along with its 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 regulation in England are shown in Table 1-1.

The Air Quality Standard Regulations 2007 came into force on 15th February 2007[5]. This brings together in one statutory instrument the governments requirements to fulfil separate EU Daughter Directives through a single consolidated statutory instrument, which is fully aligned with proposed new EU Air Quality Directive (CAFE – Clean Air For Europe)[6].

Provisional objectives set out in the addendum to the AQS for the assessment of PM_{10} (in response to the proposed EU Limit Values) are not included within the Regulations 2007 as these are unlikely to be considered further within the proposed new EU Air Quality Directive (CAFE)[6].

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

5 *Defra (2007) The Air Quality Standards Regulations 2007, Statutory Instruments 2007 No. 64*

6 *http://www.defra.gov.uk/environment/airquality/eu-int/cafe/index.htm*

The Regulations 2007 include requirements for the assessment of $PM_{2.5}$, Arsenic, Cadmium, Nickel and Benzo(a)pyrene. These are required to be assessed by Member States in response to the proposed new EU Air Quality Daughter Directive (CAFE)[6] but local authorities are not currently required to assess against these, subject to the ongoing Air Quality Strategy Review[7].

Table 1-1 - AQS Objectives and Standards for England

Pollutant	Air Quality Objective		AQS	2007 Regs
	Concentration	Measured as	Date to be achieved by	
Benzene	16.25 $\mu g/m^3$	Running annual mean	31.12.2003	
	5.00 $\mu g/m^3$	Annual mean	31.12.2010	01.01.2010
1,3 Butadiene	2.25 $\mu g/m^3$	Running annual mean	31.12.2003	
Carbon monoxide	10.0 mg/m^3	Maximum daily 8-hour mean	31.12.2003	
Lead	0.5 $\mu g/m^3$	Annual mean	31.12.2004	
	0.25 $\mu g/m^3$	Annual mean	31.12.2008	
Nitrogen dioxide	200 $\mu g/m^3$ not to be exceeded more than 18 times a year	1 hour mean	31.12.2005	01.01.2010
	40 $\mu g/m^3$	annual mean	31.12.2005	01.01.2010
Particles (PM_{10}) (gravimetric)[a]	50 $\mu g/m^3$ not to be exceeded more than 35 times a year	24 hour mean	31.12.2004	
	40 $\mu g/m^3$	annual mean	31.12.2004	
Sulphur dioxide	350 $\mu g/m^3$ not to be exceeded more than 24 times a year	1 hour mean	31.12.2004	
	125 $\mu g/m^3$ not to be exceeded more than 3 times a year	24 hour mean	31.12.2004	
	266 $\mu g/m^3$ 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.

The AQS Objectives take into account EU Directives that set Limit Values which Member

7 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

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).

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 Authorities 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. 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.

Guidelines for the 'Review and Assessment' of local air quality were first published in the 1997 National Air Quality Strategy (NAQS)[8] along with associated policy guidance and technical guidance. Within the First Round of Review and Assessment it was 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)[9]) and Policy Guidance (LAQM.PG(03))[10] 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 experience from the previous rounds of review and assessment. This current framework for review and assessment begins with an Updating and Screening Assessment (USA), which 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.

In March 2004, the review and assessment process had culminated in the declaration of around 120 separate AQMAs across the UK, of these 89 % were apportioned to road traffic emissions. Of the 89% of road traffic AQMAs around 55% represent problems in the attainment of the AQS Objectives for NO_2 alone, whilst the remaining 45% have been made

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8 DoE (1997) The United Kingdom Nation Air Quality Strategy The Stationery Office

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

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

on NO_2 in combination with PM_{10}[11]. Having declared an AQMA the authority is required to confirm the findings of the Detailed Assessment work through further monitoring or modelling assessments (Further Assessment). The 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)[9]), 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 (2006-8). 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).

1.3 Summary of Review and Assessment by Chesterfield Borough Council

The First Round assessments for Chesterfield Borough Council (CBC) concluded that the Air Quality Objectives were expected to be met by their target dates throughout Chesterfield Borough Council's administrative area.

Chesterfield Borough Council undertook its Second Round of Review and Assessment in 2003, this identified that two of the seven AQS pollutants; PM_{10} and NO_2 were at risk of exceeding their Objectives within the Borough. A Detailed Assessment of these pollutants was carried out during 2004 Due to the marginality of the results and a large error associated with the data it was recommended that no immediate action be taken, however, PM_{10} and NO_2 should remain under close review. It was advised that improvements in air quality monitoring across the Borough should be implemented and results be reviewed in subsequent reports. The Council's Progress Report 2005, detailed new monitoring data, including 2004 diffusion tube data, which highlighted a new potential hotspot at Derby Road (A61) South of Chesterfield City Centre.

The USA 2006, undertaken at the start of the Third Round of Review and Assessment, reported on 2005 diffusion tube NO_2 measurements. Three main areas were identified for the exceedence of NO_2 and included Chatsworth/Markham Road (A619), Derby Road (A61) and Chesterfield Road Staveley (A619). A Detailed Assessment was warranted for these road sections with a total length of over 14 km. It is important to note that the adjacent local authority, Bolsover, has declared an AQMA further east of Staveley on the A619.

The USA 2006 concluded that the current AQS Objectives for benzene, 1, 3-butadiene, carbon monoxide, lead, PM_{10} and sulphur dioxide will be met. There will be no requirement to undertake a Detailed Assessment for these pollutants.

[11] Evaluation of Local Authority Air Quality Action Planning through Local Air Quality Management. Casella Stanger and Transport Travel Research Ltd on behalf of Department for Environment, Food and Rural Affairs. May 2004

1.4 Scope and Methodology of the Detailed Assessment

The scope of this assessment is to predict the annual mean NO_2 concentrations along Chatsworth Road (A619), Derby Road (A61) and Chesterfield Road (A619), identified in CBC's USA 2006, as having likelihood of exceedence for annual 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 section 1.3 and more accurately assess the impact of pollution sources on local receptors at identified hotspots through detailed dispersion modelling. The aim of the dispersion modelling is to more precisely 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 exceedence.

Detailed dispersion modelling has been undertaken using the Cambridge Environmental Research Consultants (CERC) ADMS-Roads dispersion model using the vehicle emission factors released in 2004[12].

Concentrations of NO_2, measured at ten roadside diffusion tubes locations within the assessment areas in 2005, have been used to verify the model results. The diffusion tube data for 2006 has also been reported and included in the model verification for comparison purposes.

The model has been used to predict annual mean NO_2 concentrations for 2005. NO_2 concentrations for 2010 have been projected for 2010 using year correction factors provided by Defra[9]. The Detailed Assessment has been undertaken in accordance with the methodologies provided in the Technical Guidance (LAQM. TG (03))[9].

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

2 Baseline Information

2.1 Traffic Data

Derbyshire County Council have provided the traffic data used in this assessment. The traffic data is based on 12-hour manual classified counts in 2004 from the roads included in the assessment. A local factor (1.23) approved by Derbyshire County council has been used to convert 12-hour counts to 24 hour counts. The traffic data for 2005 have been calculated using growth factors obtained from Tempro[13] and NRTF[14] (National Road Traffic Forecasts). NRTF provides options to calculate growth factors at low, intermediate or high growth scenarios. In this case, a high growth scenario has been used, to represent worst-case in terms of traffic growth and to ensure a precautionary approach.

The 24-hour automatic counts from the A619 have been used to produce the hourly traffic profile. The hourly traffic flow pattern used in the assessment is shown in Figure 2-1. The speed data is derived from the traffic count data, provided by Derbyshire County Council, and where appropriate observations by BV staff during site visits. For the links approaching the junctions including cross roads and roundabouts, the vehicle speed has been reduced as suggested in the Technical Guidance, LAQM. TG (03)[9]. During a visit of the area, systematic queuing was observed at the junctions. Based on these observations a vehicle speed of between 15 and 30 km/h has been used for approaches and junctions links. Table 2-1 shows the AADT (Annual Average Daily Traffic) data and its breakdown in to LDVs (Light Duty Vehicles), HDV (Heavy Duty Vehicles) from the roads included in this assessment.

Table 2-1 - AADT and its breakdown in the various vehicle categories 2005

Road Name	Road	LGVs	HDVs	Total
Chatsworth Road	A619	16,133	810	16,943
Markham Road		19,957	1,307	21,264
Derby Road South	A61	17,715	928	18,643
Derby Road Expressway NB		19,841	1,038	20,879
Derby Road Expressway SB		21,420	1,120	22,540
Chesterfield Road Two Ways	A619	22,039	1,218	23,257
Chesterfield Road EB		11,352	595	11,947
Chesterfield Road WB		11,917	624	12,541

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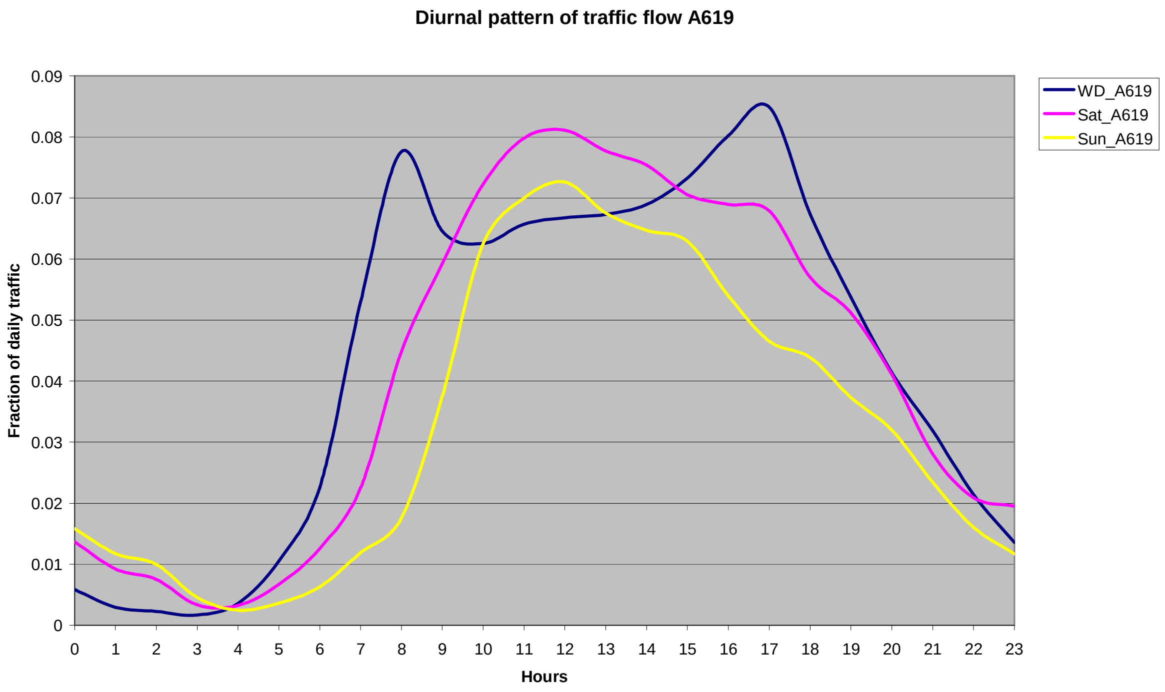
[13] Tempro (Trip End Model Presentation Program) version 4.2.3 , dataset v1.4, Department for Transport

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

Figure 2-1 – Diurnal traffic flow pattern based on the A619 flow



WD = Week Day

2.2 Air Quality Monitoring

The Council has two mobile automatic monitoring stations. . The results for NO_2, NO_x and PM_{10} measured at these stations in 2005 and 2006 are presented in Table 2-2.

Table 2-2 – Annual mean concentrations, µg/m^3, for NO_2, NO_x and PM_{10} measured at the continuous monitoring sites in Chesterfield

Site	2005			2006		
	NO_2	NO_x	PM_{10}	NO_2	NO_x	PM_{10}
Birdholme School	23.4	44.1	20.8	-	-	-
Bacons Lane	-	-	-	18.7	31.6	22.9
Whittington Moor	29.6	77.0	26.6	28.3	76	33.2

Birdholme site is located in a primary school at a distance greater than 30 m from Derby Road (A61) and represents an urban background site. In 2006 the site was moved to another background site, Bacons Lane. Whittington Moor is a roadside site adjacent to the A61.

Apart from the two continuous monitoring stations, the Council uses diffusion tubes at a number of locations to monitor NO_2. The diffusion tubes numbered 36 in 2006. The diffusion tubes are analysed by Rotherham MBC/South Yorkshire Laboratories using the 50% TEA (triethanolamine) in acetone method. In total 44 different diffusion tube locations have a monitoring record at some time between 2005 and 2006 where appropriate these have been utilised as part of the Detailed Assessment verification between monitoring and modelling.

Diffusion tubes are often co-located with continuous monitors in order to determine the bias of the diffusion tube measurements relative to the continuous monitor. Co-locating the diffusion tubes in triplicate also allows the precision and accuracy of the diffusion tube measurements to be determined. Bias of diffusion tubes is thought to be largely associated with the laboratory and preparation method used. The data from NO_2 diffusion tube co-location studies across the UK is collated on behalf of Defra, and is available thorough the Defra's Review and Assessment Helpdesk[15]. This allows the calculation of a default bias factor for the period under consideration and the laboratory.

It is preferable to use a local bias correction factor, based on the co-location of triplicate diffusion tubes and continuous NO_2 analyser within the local authority. However, if a local bias adjustment factor is not available, the default bias adjustment factor, provided by Defra for the laboratory that analyses local authority's diffusion tubes, should be employed. Because in 2005 the co-location within Chesterfield was less than 9 months (<75% time), the 2006 USA used a default bias adjustment factor of 0.96. For the purposes of consistency, in this assessment the same bias adjustment factor has been used to correct the diffusion tube results for 2005. In 2006, Chesterfield Borough Council set up two co-location sites. The data capture rate at these two sites was high, >75%, and precision of diffusion tube results were good, within 5%. An average local bias adjustment factor, 0.86, has been calculated based on these two co-location studies and this is used to correct the raw diffusion tubes results for 2006.

The bias corrected diffusion tube results, using bias adjustment factors as described above, are presented in Table 2-3. The table lists diffusion tube locations and bias adjusted results for 2005 and 2006 within the Detailed Assessment area. All results use the bias correction but do not include correction for distance from kerbside. The concentrations exceeding the annual AQS Objective are shown in bold. The table also shows the difference in concentration, $\mu g/m^3$, between 2006 and 2005 at the diffusion tubes where NO_2 was monitored during both the years.

Table 2-3 - Bias adjusted annual mean NO_2 concentrations $\mu g/m^3$, monitored at diffusion tubes within the Detailed Assessment area in 2005 and 2006

Tube ID	Tube Location	Type	2005 NO_2, $\mu g/m^3$	2005 month count	2006 NO_2, $\mu g/m^3$	2005 month count	Dif. 2006-2005
DT01	A619 Chesterfield Road, Bradbury Club	R[2]	-	-	38.3	7	-
DT02	A619 Markham Road, East View	R	-	-	**48.7**	12	-
DT03	St Augstines Road	K	35.3	9	31.3	11	-4.0
DT04	A61 Derby Road Development, Grasscroft	R	-	-	36.3	12	-
DT05	A619 Markham Road, South Place	R	-	-	**41.3**	12	-
DT6[1]	A619 Chesterfield Road Roundabout	R	-	-	**49.1**	12	-
DT07	A619 Duke Street, Staveley	R	-	-	**44.4**	5	-

[15] http://www.uwe.ac.uk/aqm/review/

2DT08	A61 Derby Road, St Augstines Church	K	**46.7**	11	**40.2**	12	-6.5
DT09	A61 Derby Road, Lincoln Street	K	**54.3**	9	**43.6**	12	-10.7
DT10	A619 18, Chesterfield Road	K	38.6	10	33.4	11	-5.2
DT13	A619 101, Chesterfield Road	R	**42.0**	11	**43.2**	12	**1.2**
DT15-17	A61, Whittington Moor (Triplicate mean)	R	34.7	7	29.4	10	-5.3
DT18-20	A61 Bacons Lane (Triplicate mean)	B	23.3	6	18.3	12	-5.0
DT21	Staveley Stables	I	23.0	11	25.1	11	**2.1**
DT25	A619 Chatsworth Road, Vincent Crescent	K	36.3	10	29.8	12	-6.5
DT30	A619 Chatsworth Road, Brampton Mile	R	**53.1**	10	36.8	12	-16.3
DT31	A61 Derby Road Jawbone Hill	K	**44.8**	11	33.5	8	-11.3
DT36	Queens Park	B	-	-	18.9	12	-
DT40	A61 Expressway, Travel Lodge	R	**41.1**	9	-	-	-
DT41	A61 Derby Road St Augstines, Rain Pipe	R	25.8	9	-	-	-
DT43	Staveley High Street	R	27.2	9	-	-	-

[1] This site moved to a close by new location for 2006

[2] Diffusion tube types R = roadside, K = Kerbside, I – Industrial and B = Background

The data for 2005 shows that the annual mean NO_2 concentrations monitored in Chesterfield, Brimington and Staveley are above the Objective at several locations notably Derby Road, Markham Road and Chesterfield Road providing justification for this detailed modelling assessment.

The comparison of the results for the diffusion tubes monitoring NO_2 concentrations in both the years, 2005 and 2006, show a systematic decrease in annual mean NO_2 concentrations in 2006. Out of the 11 diffusion tubes, nine show a lower annual mean concentration in 2006. Only two, out of 11 diffusion tubes, show a slightly higher concentration in 2006 when compared to 2005. The general trend for lower concentrations is consistent with modelling, which suggest significant decreases in levels of annual mean NO_2 by 2010 when compared with 2005 predictions. However, on inter-annual timescales concentrations may go up or down as discussed in section 4.1.

2.3 Background Concentrations

Defra provides the modelled background maps for the entire UK at a resolution of 1x1 km[16]. However, it is preferable to use local background data, if available, as it could be regarded as more representative for the area. The background concentrations used for this assessment are not based on the Defra map data, as these concentrations are considerably less than the levels measured at background diffusion tube locations in

[16] http://www.airquality.co.uk/archive/index.php

Chesterfield. The background NO_2 concentrations for 2005 from the Defra maps and the diffusion tubes are compared in Table 2-4. The continuous urban background analyser located at the Birdholme school has been used for NO_x and NO_2 background for 2005. The background concentrations used for 2005 are summarised in Table 2-5.

Table 2-4 – NO_2 background concentrations from Defra maps and diffusion tubes in Chesterfield

Location		Grid/ Tube Location		NO_x 2005 Annual Mean µg/m^3	NO_2 2005 Annual Mean µg/m^3
		X	Y		
Defra maps nearest square	**Derby Road South**	438500	369500	30.1	19.9
	Derby Rd Expressway	438500	371500	35.8	22.3
	Whittington Moor Roundabout	437500	373500	40.7	24.3
	Chatsworth Road	435500	370500	20.5	15.7
	Markham Road	437500	370500	35.4	22.1
	Chesterfield Road	473500	373500	29.9	19.7
	Chesterfield Rd Staveley	465500	375500	35.8	22.3
Background diffusion tubes in Chesterfield					
Industrial Staveley Stables		443417	374911	n/a	23
Birdholme triplicate		437900	369700	n/a	23.4
Background Continuous urban Monitoring station Chesterfield					
Birdholme School		437900	369700	44.1	23.4

Table 2-5 – Background concentrations for NO_2 and NO_x, µg/m^3, used for modelling

	2005
NO_2	23.4
NO_x	44.1

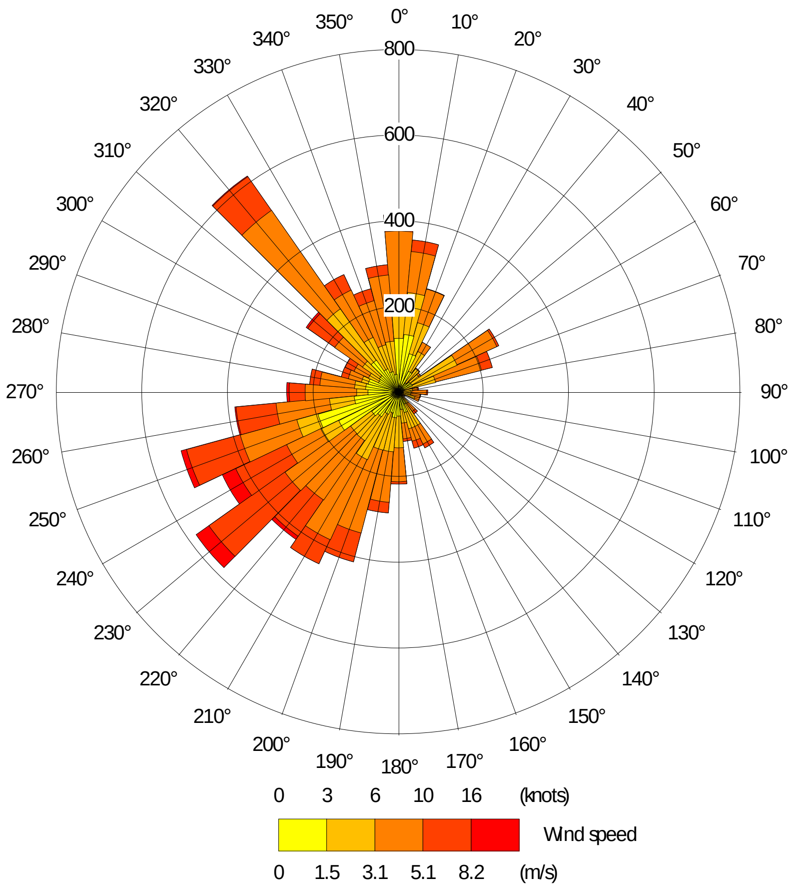
3 Dispersion Modelling Methodology

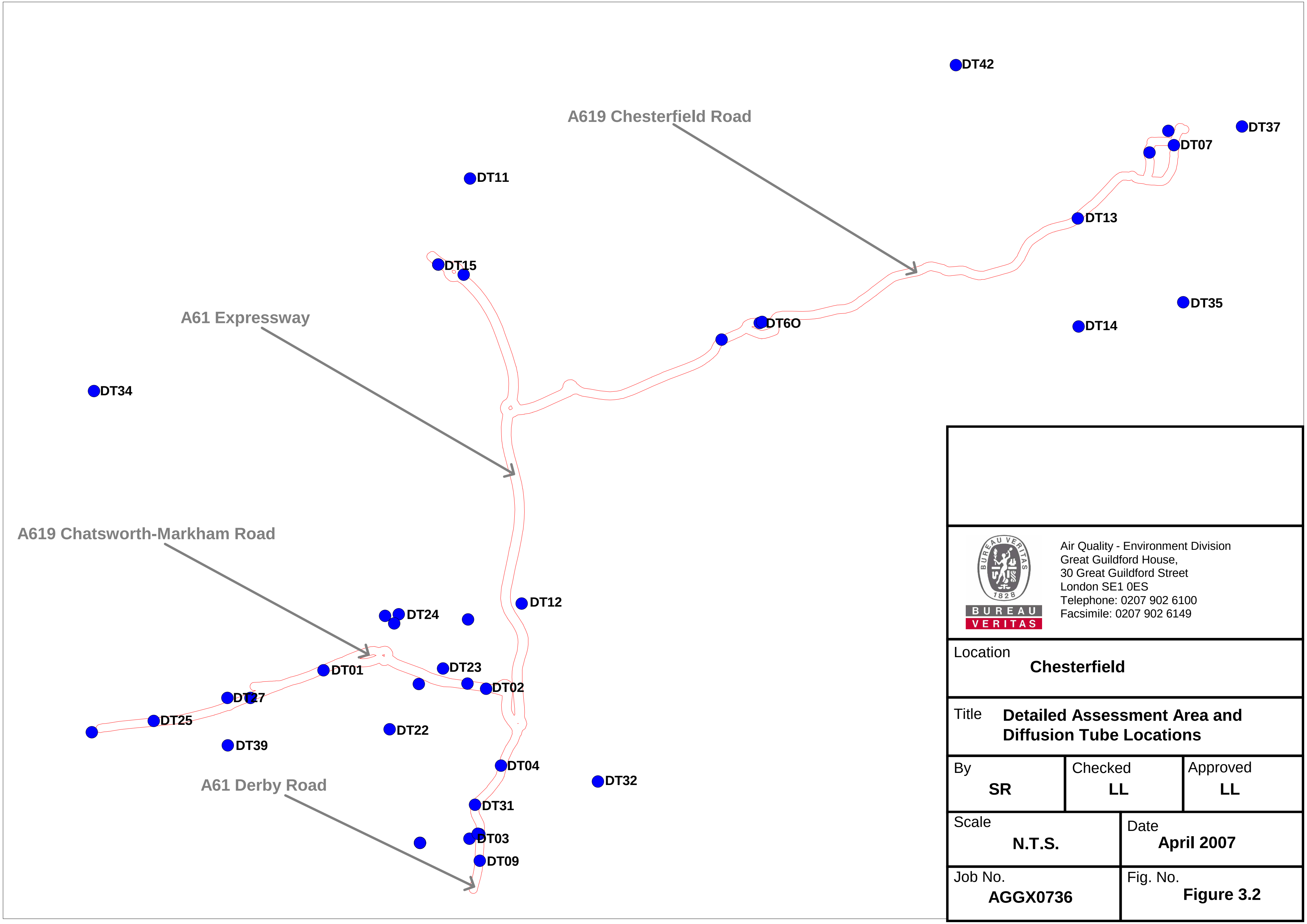
Detailed dispersion modelling for NO_2 has been undertaken using the Cambridge Environmental Research Consultants (CERC) Ltd ADMS-Roads advanced Gaussian air dispersion model. ADMS-Roads can model up to 150 road sources and 7 industrial sources at any one time. The model has been extensively used in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

3.1 Meteorological Data

The meteorological data for 2005 has been used from Rotherham meteorological station, situated approximately 20 km NNE of Chesterfield. The wind rose for Rotherham weather station data is provided in Figure 3-1. It shows that the dominant wind direction is south-westerly and there is a significant north and north west component.

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





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Title	**Detailed Assessment Area and Diffusion Tube Locations**

By	Checked	Approved
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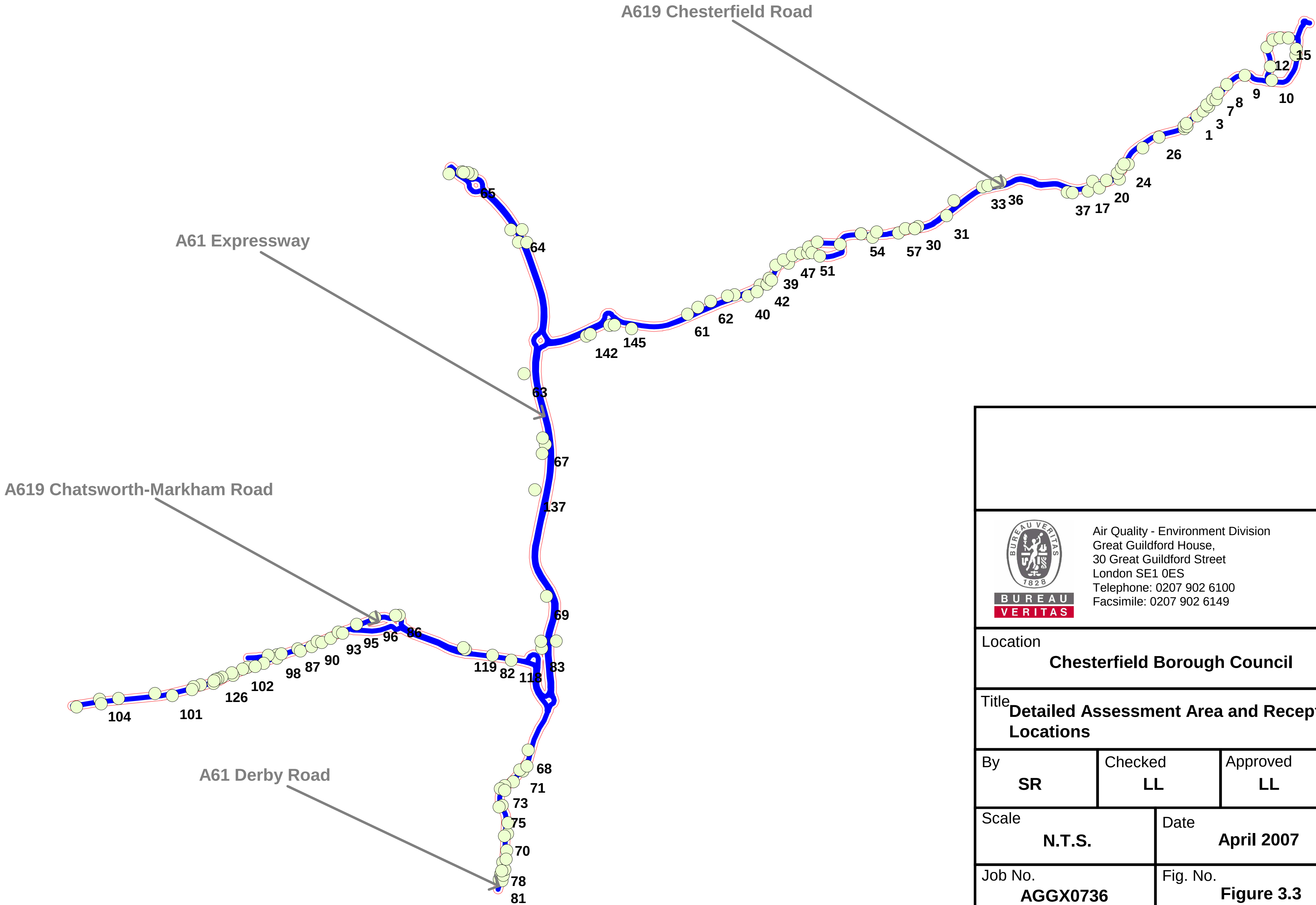
Scale	Date
N.T.S.	**April 2007**

Job No.	Fig. No.
AGGX0736	**Figure 3.2**



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Title
Detailed Assessment Area and Receptor Locations

By	Checked	Approved
SR	**LL**	**LL**

Scale	Date
N.T.S.	**April 2007**

Job No.	Fig. No.
AGGX0736	**Figure 3.3**

3.2 Model Set up

Figure 3-2 and Figure 3-3 show the roads, diffusion tubes and receptors in the assessment. In total 113 road links have been modelled as part of the Detailed Assessment.

3.2.1 Dual Carriageways and hills

A number of road links have been included in the model as two-way flows, where two-way traffic flows were available from Derbyshire County Council, for example Derby Road Expressway (A61, northbound and southbound), Chesterfield Road Brimington and Staveley (A619, eastbound and westbound). In some cases, where two-way flows were not available, the total traffic flow was divided 50/50 to represent the dual carriageway, for example, Markham Road (A619). Two-way flows were used to model locations with steep uphill climbs, for example, Chesterfield Road links near Brimington (A619) where the main road climbs 30 metres vertical as a 1:16 slope over 480 metres. These sections were assigned slower vehicle speeds resulting in higher emission from HDVs and LDVs on several uphill sections. The model accounts for lower HGV speeds on steeper hills and longer climbs.

3.2.2 Street Canyons

Certain road section sources for example Derby Road in the south of the Borough (A61) have been modelled as two sided street canyons. The street canyons are typically 10 to 15 meters deep and take account of the disruption that buildings and other obstacles (lines of trees and road cuttings) have on dispersion and local wind flow.

3.3 Emissions Factors

The emissions for NO_x resulting from the road traffic flows are calculated using the DMRB 2003 emission factors database incorporated within the ADMS-Roads model.

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 why 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 slightly higher predicted NO_2 concentrations compared to using default NO_2 proportion in the model.

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[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’

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 are incorporated into the model by selecting NO_x-NO_2 Correlation module of ADMS-Roads. The module uses the Derwent-Middleton relationship to estimate the concentration of NO_2 from NO_x concentrations.

A minimum Monin-Obukhov length (MOL) of 10 m has been selected to represent the dispersion characteristics of the modelling domain. A surface roughness length of 0.5 has been assigned in the model and sensitivity analysis suggests a closer agreement with diffusion tube results compared to using higher surface roughness values.

3.6 Model Output

The ADMS-Roads dispersion model produces modelled concentrations of NO_X and NO_2 at specific and grid receptors, selected for the prediction of air quality impacts. All specific receptors are set at a height of 1.5 m to represent typical exposure height.

The link to a Geographic Information System (GIS) for mapping purposes provides the best method of analysing the pollution output. GIS tools have been used to produce concentration maps for gridded receptor and draw the annual mean NO_2 concentrations contours from the model output to allow the areas of exceedence to be identified.

4 Results

4.1 Model Verification

The model has been used to predict concentrations of NO_2 at the roadside diffusion tube monitoring locations presented in Table 2-3. The predicted results have been compared with the bias adjusted diffusion tube data in order to verify the model performance. Ten roadside tube locations for 2005 have been used to evaluate the model performance. 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

The model verification results are shown in Table 4-1. The table shows the predicted annual mean concentrations, $\mu g/m^3$ from the ADMS-Roads dispersion model at the locations of the diffusion tubes included in this verification exercise, along with the bias adjusted annual mean diffusion tube concentrations for 2005 and 2006. The table also shows the difference between the predicted and monitored data for 2005 and 2006, as the absolute difference, $\mu g/m^3$, and percentage difference.

Table 4-1 – Model verification results for annual mean NO_2

Diffusion Tube ID	Diffusion tube location	ADMS predicted 2005, $\mu g/m^3$	Bias corrected diffusion tube annual average, $\mu g/m^3$		2005 Modelled-monitored difference		2005 Modelled-monitored difference	
			2005	2006	$\mu g/m^3$	%	$\mu g/m^3$	%
DT01	A619 Chesterfield Road, Bradbury Club	**46.8**	-	38.3	-	-	8.5	22.2
DT02	A619 Markham Road, East View	**43.9**	-	**48.7**	-	-	-4.8	-9.9
DT03	St Augstines Road	31.2	35.3	31.3	-4.1	-11.6	-0.1	-0.3
DT04	A61 Derby Road, Grasscroft House	**43.1**	-	36.3	-	-	6.8	18.7
DT05	A619 Markham Road, South Place	**43.1**	-	**41.3**	-	-	1.8	4.4
DT06[1]	A619 Chesterfield Road Roundabout	**45.4**	-	**49.1**	-	-	-3.7	-7.5
DT07	A619 Duke Street, Staveley	**50**	-	**44.4**	-	-	5.6	12.6

DT08	A61 Derby Road, St Augstines Church	**45.4**	**46.7**	**40.2**	-1.3	-2.8	5.2	12.9
DT09	A61 Derby Road, Lincoln Street	**44.4**	**54.3**	**43.6**	-9.9	-18.2	0.8	1.8
DT10	A619 18, Chesterfield Road	39.2	38.6	33.4	0.6	1.6	5.8	17.4
DT13	A619 101, Chesterfield Road	**48.1**	**42**	**43.2**	6.1	14.5	4.9	11.3
DT15	A61 Whittington Moor Triplicate	**41.2**	34.7	29.4	6.5	18.7	11.8	40.1
DT25	A619 Chatsworth Road, Vincent Crescent	**42.5**	36.3	29.8	6.2	17.1	12.7	42.6
DT30	A619 Chatsworth Road, Brampton Mile	**43.5**	**53.1**	36.8	-9.6	-18.1	6.7	18.2
DT31	A61 Derby Road Jawbone Hill	**46**	**44.8**	33.5	1.2	2.7	12.5	37.3
DT41	A61 Derby Rd St Augstines Rain Pipe	34.6	25.8	-	8.8	34.1	-	-

[1]This site moved to a close by new location for 2006

During the verification process, Bureau Veritas aim to show that all final modelled NO_2 concentrations are within 25% of the monitored NO_2 concentrations, and preferably within 15% of monitoring. Modelled results may not compare as well at some locations for a number of reasons including:

- Errors in traffic data (flows, speeds or fleet composition)
- Model set up (i.e. road widths, elevations and receptor locations)
- Model limitations (treatment of roughness and meteorological data)
- Uncertainty in monitoring data, such as bias adjustment for diffusion tubes
- Uncertainty in background concentrations

Model predictions have been made for 2005, therefore, for verification purposes the model data has been directly compared against the monitored data for 2005. The monitored data for 2006 have been included for comparison and not for model verification purposes.

For 2005, the model predictions for nine out of ten sites show agreement within ±20% with the monitored data. The tube locations show both over and under prediction within this error band. The model predictions are lower at four and higher at six diffusion tube locations.

The predicted data for only one diffusion tube, St Augstines rain-pipe, shows a difference greater than ±25%. This site ceased to monitor after 2005 and is set back from road sources included in the model, it is likely that the site is not influenced to such a degree by street canyon created by the church, and the model over predicts at this location. At a nearby diffusion tube, DT08 Derby Road St Augstines Church, the model shows an excellent agreement, within 5% of the monitored concentration. At DT30, Brampton Mile Chatsworth Road, the model predictions are 18% lower than monitoring. This in part, could be due to influence of close by side roads not included in the model. However, the model still predicts a breach of the objective as measured at this location. At DT09, close to the junction between Lincoln Street and Derby Road, the model under-predicts NO_2 concentration by 18%. The under-predictions at this site might be due to queuing of traffic resulting in idling emissions, which are not accounted far in the model. However, the model reproduces the monitored exceedence at this site.

The model predictions for 2005 at three out of ten diffusion tubes agree within ±5%, and at nine out of ten diffusion tubes show agreement within ±20% of the monitored data. Based on this comparison of modelled and monitored results for 2005, the agreement between the two datasets could be regarded as good.

The model results for 2005 show more frequent over-prediction when compared with 2006 diffusion tube results. It is important to note that the model would have predicted lower concentrations for 2006, under the same meteorological conditions, due to decreased background levels by about 4 $\mu g/m^3$ (see Table 2-2) and lower EF (Emissions Factors) for 2006 compared to 2005 incorporated in DMRB database. Also the atmosphere is a dynamic system and significant yearly variations are possible due to a number of factors that include:

- Meteorology – particularly poor dispersion
- Emissions – changes in source strengths specific to the monitoring period, such as, the number of HDVs due to some projects, construction etc. It has been mentioned in the Council's USA 2006 that the traffic on these roads appears to be increasing due to a number of developments taking place in the area close to the modelled roads and the model takes account of this when predicting the future scenario.
- As NO_2 is mainly a secondary pollutant, that is, produced due to chemical interactions in the atmosphere. A number of atmospheric sources and processes can result in the enhanced formation of NO_2 such as ozone concentration, sunlight and temperature.
- Changes in primary NO_2 concentrations – the current studies in the UK are suggesting that these concentrations are significantly higher than initially envisaged.

4.2 Modelled NO_2 Concentrations

Annual average concentrations for NO_2 have been predicted using the ADMS-Roads model at 151 selected receptors for 2005, the year in which the NO_2 AQS Objectives are to be met. Nitrogen dioxide concentrations for 2010 were projected using the year correction factor in accordance with the guidance provided in LAQM.TG(03)[9].

Receptors have been selected at the façades of buildings near the modelled roads, to represent locations with relevant exposure for the annual mean NO_2 Objective. All predicted results have been produced using the methodology described in Section 3 of this report. The predicted NO_2 concentrations at all the specific receptors for 2005 and 2010 are provided in Appendix A. The results for the receptors where the predicted concentrations are more than 36 μg/m³, within 10% of uncertainty boundary of the AQS Objective, are presented in the table below.

Table 4-2 - Results for predicted annual mean NO_2 in 2005 and 2010 at receptors with concentration greater than 36 μg/m³

Receptor ID	Receptor Location		2005 NO_2	2010 NO_2
	X(m)	Y(m)		
1	442815	374326	**45.3**	38.1
2	442855	374358	**45.2**	38.0
3	442889	374385	**42.4**	-
4	442877	374397	**41.9**	-
5	442915	374431	**41.8**	-
6	442938	374430	**41.5**	-
7	442949	374470	**41.5**	-
8	443006	374528	**46.6**	39.2
9	443121	374585	**46.1**	38.7
10	443294	374555	**44.9**	37.8
16	443448	374715	**43.1**	36.2
20	442235	373913	39.0	-
21	442317	373921	36.6	-
22	442304	373958	39.0	-
23	442330	373993	39.2	-
24	442373	374016	38.1	-
25	442467	374121	36.5	-
26	442571	374190	38.8	-
27	442733	374244	**42.9**	36.1
28	442732	374260	**49.5**	**41.6**
29	442750	374259	39.7	-
30	441026	373616	**49.9**	**42.0**
31	441209	373686	**51.7**	**43.5**
33	441439	373870	38.8	-
34	441474	373880	38.4	-
35	441532	373896	37.5	-
36	441553	373899	38.0	-
37	441983	373838	37.2	-
38	442015	373833	37.6	-
40	439936	373170	**45.1**	38.0
41	440013	373241	**48.5**	**40.8**
42	440057	373246	**42.5**	-
43	440072	373285	**42.3**	-
44	440087	373273	**42.2**	-
45	440196	373381	38.7	-
48	440273	373444	38.4	-
49	440317	373446	**44.0**	37.0
50	440324	373485	**47.9**	**40.3**
51	440346	373448	**45.3**	38.1
52	440381	373516	**46.0**	38.7
53	440397	373427	**44.6**	37.5
54	440660	373569	**41.2**	-
55	440660	373569	**41.2**	-

56	440735	373547	**40.8**	-
57	440900	373575	**54.2**	**45.6**
58	440945	373602	**52.8**	**44.4**
59	441005	373602	**51.4**	**43.2**
60	441005	373602	**51.4**	**43.2**
61	439549	373053	**40.4**	-
62	439697	373137	36.4	-
64	438486	373596	**41.4**	-
65	438166	373951	38.0	-
66	438141	373961	37.7	-
67	438636	372219	36.7	-
68	438527	370258	**41.8**	-
69	438644	371245	37.2	-
70	438394	369721	**40.2**	-
71	438493	370124	**44.9**	37.7
72	438431	370055	**42.4**	-
73	438376	370030	37.5	-
75	438360	369903	**45.5**	38.3
76	438396	369792	**42.7**	-
77	438389	369613	**43.8**	36.8
78	438364	369539	**43.1**	36.3
79	438350	369463	**42.3**	-
80	438341	369429	**41.5**	-
81	438358	369420	**40.1**	-
82	438297	370866	**44.5**	37.4
83	438615	370911	38.0	-
84	438706	370957	39.4	-
85	438609	370955	36.2	-
86	437699	371122	38.0	-
87	437048	370908	39.8	-
88	437066	370893	**41.1**	-
89	437138	370922	**44.2**	37.2
90	437173	370955	39.0	-
91	437202	370948	**40.8**	-
92	437259	370974	**42.2**	-
93	437309	371014	39.1	-
94	437336	371008	**42.4**	-
95	437427	371064	39.4	-
96	437545	371107	39.4	-
97	437675	371122	**43.5**	36.6
98	436916	370869	**48.3**	**40.6**
99	436916	370847	**53.1**	**44.6**
100	436945	370875	**41.2**	-
101	436244	370608	37.1	-
102	436694	370777	**43.8**	36.8
103	436726	370790	**44.3**	37.3
105	435789	370554	37.3	-
106	435899	370589	37.8	-
108	443451	374755	**42.8**	36.0
109	438472	370131	**41.7**	-
110	438367	369454	**43.0**	36.2

111	438376	369491	**43.3**	36.4
112	438356	369484	**42.6**	-
113	438385	369558	**41.2**	-
114	438374	369706	**46.2**	38.8
116	438376	369999	**40.2**	-
117	438518	370151	**41.9**	-
118	438418	370834	**44.2**	37.2
119	438124	370903	38.7	-
120	438111	370915	37.1	-
121	436859	370865	**46.1**	38.8
122	436830	370815	**51.2**	**43.1**
123	436634	370737	**44.5**	37.4
124	436626	370753	37.4	-
125	436563	370725	37.5	-
126	436537	370715	39.5	-
127	436523	370711	38.9	-
128	436508	370686	**43.0**	36.2
129	436511	370702	**44.6**	37.5
130	436426	370676	**40.4**	-
131	436381	370665	39.8	-
132	436370	370646	**40.1**	-
133	435630	370535	36.0	-
134	436776	370795	**50.2**	**42.2**
138	438464	373516	39.1	-
139	438518	373514	**44.3**	37.3
140	438415	373596	38.2	-
142	438899	372914	**41.4**	-
143	438925	372926	**41.5**	-
144	439049	372982	**40.7**	-
145	439079	372985	39.4	-
146	439190	372961	36.0	-
147	439615	373097	36.9	-
148	439804	373171	37.8	-
149	439849	373179	**40.1**	-
150	439994	373199	**45.9**	38.6
151	440527	373502	**51.5**	**43.3**
152	440760	373581	36.6	-
153	442346	374018	39.5	-
154	442747	374278	38.8	-
155	438102	373967	**40.7**	-
151	438112	373964	**40.1**	-

4.2.1 NO_2 results for 2005

The model results for 2005 show widespread exceedence of the annual AQS Objective. The predicted concentrations are in general agreement with the monitoring data for 2005 and 2006. The predicted concentrations vary from 33.1 to 54.2 μg/m^3. Almost ninety percent of the modelled receptors, 135 out of 151, are predicted to have concentrations greater than 36 μg/m^3. Over 56% of the receptors are predicted with concentrations greater than 40 μg/m^3. The model link to GIS was used to produce the concentration maps for the grid receptors and draw annual mean NO_2 concentration contours, 36 $\mu g/m^3$ and 40 $\mu g/m^3$. The contour maps for 2005 predictions are provided in Appendix B. The contour plots for 2005 show the exceedence of the annual AQS objective for NO_2 along the entire length of the A61 and A619, passing through Chesterfield, Brimington and Staveley. The area of exceedence, at some junctions extends to side roads adjoining the main A61 and A619. It will be important for the Council when declaring the AQMA, to identify the areas above 36 $\mu g/m^3$ and 40 $\mu g/m^3$ that have relevant long-term exposure.

4.2.2 NO_2 results for 2010

The projected results for 2010 show an overall reductions in NO_2 concentration, however, some hotspots still remain. The predicted annual mean concentrations vary from 27.9 to 45.6 $\mu g/m^3$. More than 30% of the modelled receptors are estimated to have NO_2 concentration greater than 36 $\mu g/m^3$ and almost 10% exceeding the AQS objective of 40 $\mu g/m^3$. GIS tools have been used to produce concentration maps for gridded receptors and concentration contours, as in case of 2005 and are provided in Appendix B. The results for 2010 will help the Council to identify the areas that require sustained and more stringent measures to achieve the Objective.

5 Conclusions and Recommendations

The USA 2006, undertaken at the start of the Third Round of Review and Assessment, identified three main areas within Chesterfield for the exceedence of the annual AQS Objective for NO_2 and included Chatsworth/Markham Road (A619), Derby Road (A61) and Chesterfield Road Staveley (A619). A Detailed Assessment was warranted for these road sections with a total length of over 14 km.

Nitrogen dioxide monitoring data for 2005 and 2006 has been reviewed, and suggest persistent exceedence of the annual AQS Objective, particularly at roadside locations, in both the years.

Advanced dispersion model, ADMS-Roads, has been used to predict 2005 annual mean NO_2 concentrations at specific grid receptors, along the roads identified in the USA causing concern for the compliance of the annual AQS Objective for this pollutant. The model results for 2005 have been projected for 2010 using the year correction factors provided by Defra.

The model has been verified by comparing model predictions for 2005 against the 2005 monitored data from roadside diffusion tubes. The two datasets show a good agreement.

The annual NO_2 concentrations have been predicted at 151 specific receptors, placed at the façade of the buildings close to the modelled roads. The results show that the annual AQS Objective exceeded at more than 56% receptors in 2005 and almost 10% of receptors in 2010. The maximum annual mean NO_2 concentration for 2005, 54 $\mu g/m^3$, is predicted at the façade of a building located adjacent to the westbound uphill carriageway (Staveley to Chesterfield section) of Chesterfield Road, A619.

The GIS link in the model has been used to produce concentration maps for grid receptors and annual mean NO_2 contours, 36 $\mu g/m^3$ and 40 $\mu g/m^3$. The contour maps for 2005 show the exceedence of annual AQS Objective along the entire length of the A61 and A619, and extending to some smaller roads emanating from these main roads. However, it will be important for the Council, when declaring the AQMA, to identify the areas where relevant exposure applies. The contour maps for 2010 show a few remaining hot spot locations that continue to exceed the Objective.

5.1 Recommendations

Based on this Detailed Assessment the following recommendations are made to the Council:

- The Chesterfield Borough Council should declare an AQMA under section 83 (1) of the Environment Act 1995. The locations should be represented by the 40 $\mu g/m^3$ contour as presented in appendix B. Checks should be made that these areas included within the contour line are representative of the relevant exposure. The Council should also consider to include some residential areas within the 36 $\mu g/m^3$ contour, to take into account uncertainties associated with modelling and meteorological influences

- The Council should continue monitoring NO_2 at all the current (2006) diffusion tube locations in order to ensure that any future changes in air quality are detected

- The Council need to establish the additional monitoring for NO_2 at new locations close to worse case receptors representative of relevant exposure, identified in Appendix A, using the same methodologies as the existing tubes

- The Council should undertake Further Assessment, as required under Section 84(1) of the Act, to confirm the conclusions of this Detailed Assessment and apportion the source contributions and estimate the reductions in emissions required to achieve the objective

Appendix A - Predicted annual mean NO_2 concentration, µg/m^3, for 2005 and 2010 at specified receptors along modelled roads (concentrations exceeding the annual mean AQS are shown in bold)

Receptor ID	Receptor location		2005 Annual NO_2 Concentration µg/m^3	2010 Annual NO_2 Concentration µg/m^3
1	442815	374326	**45.3**	38.1
2	442855	374358	**45.2**	38.0
3	442889	374385	**42.4**	35.7
4	442877	374397	**41.9**	35.2
5	442915	374431	**41.8**	35.2
6	442938	374430	**41.5**	34.9
7	442949	374470	**41.5**	34.9
8	443006	374528	**46.6**	39.2
9	443121	374585	**46.1**	38.7
10	443294	374555	**44.9**	37.8
16	443448	374715	**43.1**	36.2
17	442115	373843	35.6	30.0
18	442145	373907	33.6	28.3
19	442189	373864	35.6	30.0
20	442235	373913	39.0	32.8
21	442317	373921	36.6	30.8
22	442304	373958	39.0	32.8
23	442330	373993	39.2	33.0
24	442373	374016	38.1	32.0
25	442467	374121	36.5	30.7
26	442571	374190	38.8	32.7
27	442733	374244	**42.9**	36.1
28	442732	374260	**49.5**	**41.6**
29	442750	374259	39.7	33.4
30	441026	373616	**49.9**	**42.0**
31	441209	373686	**51.7**	**43.5**
32	441257	373781	34.7	29.2
33	441439	373870	38.8	32.6
34	441474	373880	38.4	32.3
35	441532	373896	37.5	31.5
36	441553	373899	38.0	32.0
37	441983	373838	37.2	31.3
38	442015	373833	37.6	31.6
39	440114	373369	35.1	29.5
40	439936	373170	**45.1**	38.0
41	440013	373241	**48.5**	**40.8**
42	440057	373246	**42.5**	35.8

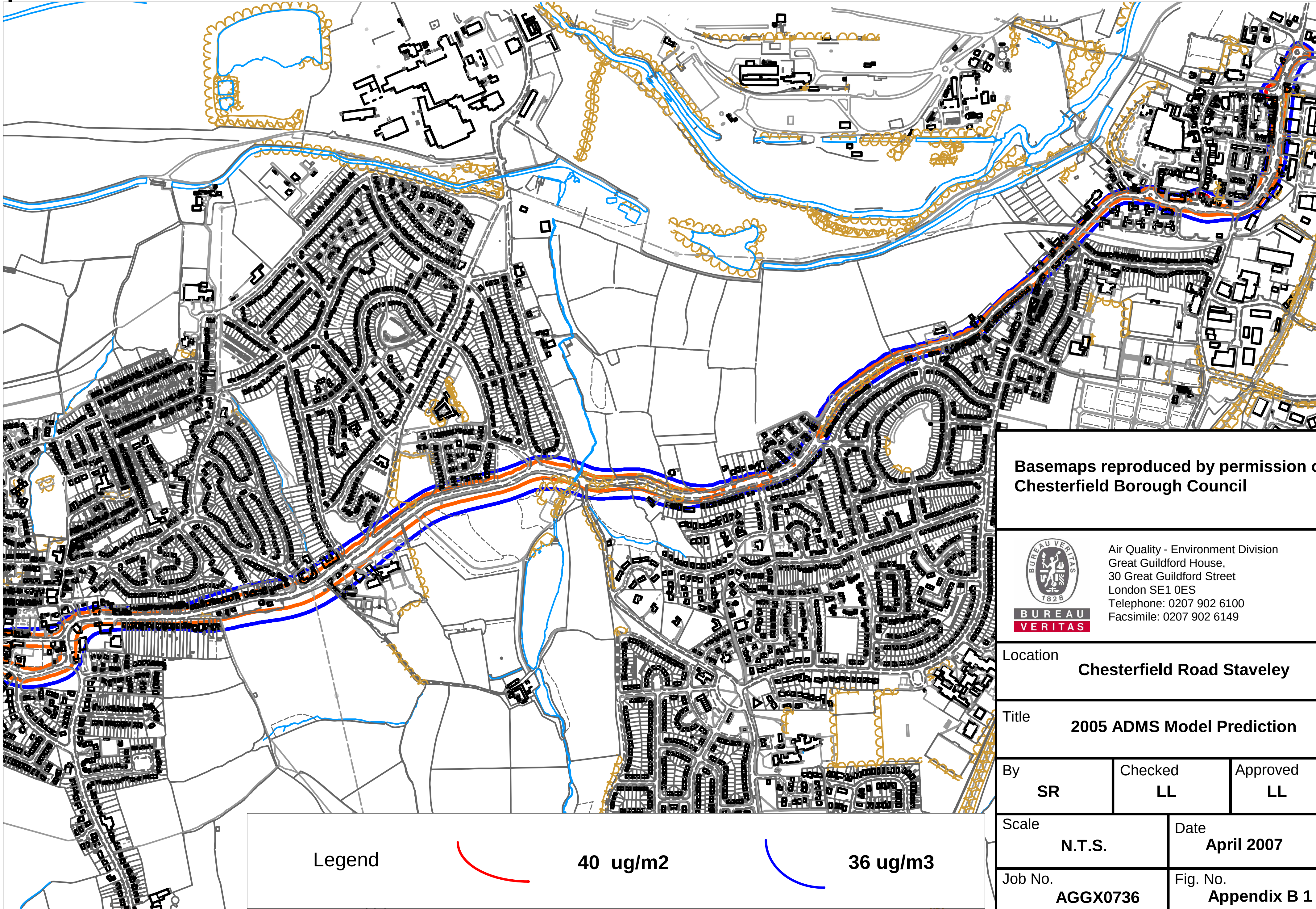
43	440072	373285	**42.3**	35.5
44	440087	373273	**42.2**	35.5
45	440196	373381	38.7	32.6
46	440163	373402	35.6	30.0
47	440222	373430	35.6	30.0
48	440273	373444	38.4	32.3
49	440317	373446	**44.0**	37.0
50	440324	373485	**47.9**	**40.3**
51	440346	373448	**45.3**	38.1
52	440381	373516	**46.0**	38.7
53	440397	373427	**44.6**	37.5
54	440660	373569	**41.2**	34.7
55	440660	373569	**41.2**	34.7
56	440735	373547	**40.8**	34.3
57	440900	373575	**54.2**	**45.6**
58	440945	373602	**52.8**	**44.4**
59	441005	373602	**51.4**	**43.2**
60	441005	373602	**51.4**	**43.2**
61	439549	373053	**40.4**	34.0
62	439697	373137	36.4	30.6
63	438500	372672	33.1	27.9
64	438486	373596	**41.4**	34.8
65	438166	373951	38.0	31.9
66	438141	373961	37.7	31.7
67	438636	372219	36.7	30.9
68	438527	370258	**41.8**	35.2
69	438644	371245	37.2	31.3
70	438394	369721	**40.2**	33.8
71	438493	370124	**44.9**	37.7
72	438431	370055	**42.4**	35.7
73	438376	370030	37.5	31.6
74	438348	370010	34.4	29.0
75	438360	369903	**45.5**	38.3
76	438396	369792	**42.7**	35.9
77	438389	369613	**43.8**	36.8
78	438364	369539	**43.1**	36.3
79	438350	369463	**42.3**	35.6
80	438341	369429	**41.5**	34.9
81	438358	369420	**40.1**	33.7
82	438297	370866	**44.5**	37.4
83	438615	370911	38.0	32.0
84	438706	370957	39.4	33.2
85	438609	370955	36.2	30.5
86	437699	371122	38.0	31.9
87	437048	370908	39.8	33.5
88	437066	370893	**41.1**	34.6
89	437138	370922	**44.2**	37.2
90	437173	370955	39.0	32.8
91	437202	370948	**40.8**	34.3
92	437259	370974	**42.2**	35.5
93	437309	371014	39.1	32.9

94	437336	371008	**42.4**	35.7
95	437427	371064	39.4	33.2
96	437545	371107	39.4	33.1
97	437675	371122	**43.5**	36.6
98	436916	370869	**48.3**	**40.6**
99	436916	370847	**53.1**	**44.6**
100	436945	370875	**41.2**	34.6
101	436244	370608	37.1	31.2
102	436694	370777	**43.8**	36.8
103	436726	370790	**44.3**	37.3
104	435778	370583	35.0	29.4
105	435789	370554	37.3	31.4
106	435899	370589	37.8	31.8
107	436133	370621	34.5	29.1
108	443451	374755	**42.8**	36.0
109	438472	370131	**41.7**	35.1
110	438367	369454	**43.0**	36.2
111	438376	369491	**43.3**	36.4
112	438356	369484	**42.6**	35.8
113	438385	369558	**41.2**	34.7
114	438374	369706	**46.2**	38.8
115	438340	369893	35.3	29.7
116	438376	369999	**40.2**	33.8
117	438518	370151	**41.9**	35.2
118	438418	370834	**44.2**	37.2
119	438124	370903	38.7	32.6
120	438111	370915	37.1	31.2
121	436859	370865	**46.1**	38.8
122	436830	370815	**51.2**	**43.1**
123	436634	370737	**44.5**	37.4
124	436626	370753	37.4	31.5
125	436563	370725	37.5	31.6
126	436537	370715	39.5	33.2
127	436523	370711	38.9	32.7
128	436508	370686	**43.0**	36.2
129	436511	370702	**44.6**	37.5
130	436426	370676	**40.4**	34.0
131	436381	370665	39.8	33.5
132	436370	370646	**40.1**	33.7
133	435630	370535	36.0	30.3
134	436776	370795	**50.2**	**42.2**
135	438617	372160	34.5	29.0
136	438619	372259	35.3	29.7
137	438569	371927	33.1	27.9
138	438464	373516	39.1	32.9
139	438518	373514	**44.3**	37.3
140	438415	373596	38.2	32.2
141	438019	373955	33.7	28.4
142	438899	372914	**41.4**	34.8
143	438925	372926	**41.5**	34.9
144	439049	372982	**40.7**	34.2

145	439079	372985	39.4	33.1
146	439190	372961	36.0	30.3
147	439615	373097	36.9	31.1
148	439804	373171	37.8	31.8
149	439849	373179	**40.1**	33.7
150	439994	373199	**45.9**	38.6
151	440527	373502	**51.5**	**43.3**
152	440760	373581	36.6	30.8
153	442346	374018	39.5	33.2
154	442747	374278	38.8	32.6
155	438102	373967	**40.7**	34.2
151	438112	373964	**40.1**	33.7

Appendix B – Annual mean NO_2 concentration contour maps for 2005 and 2010

red line	**40 μg/m^3**
blue line	**36 μg/m^3**



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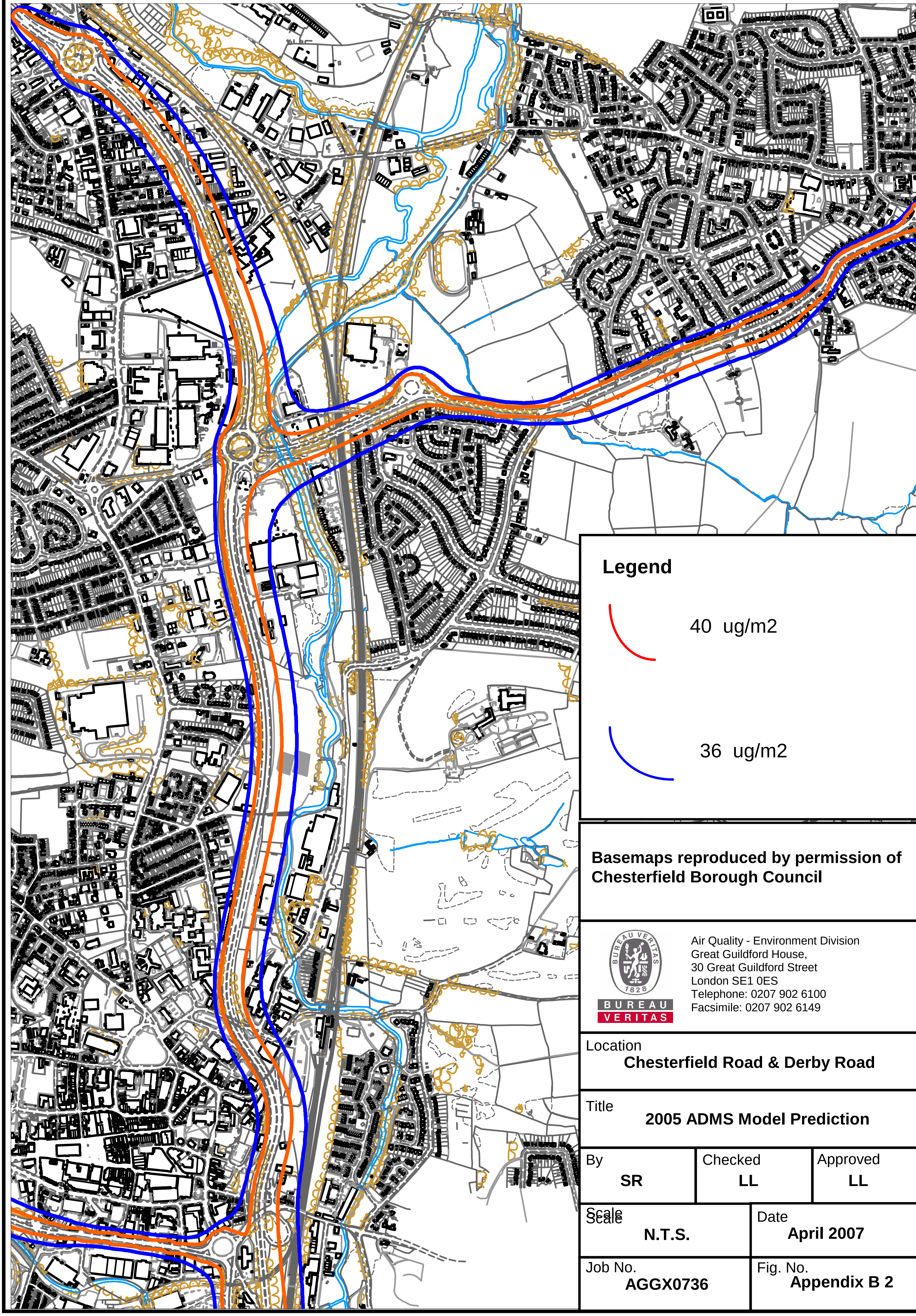
BUREAU VERITAS
Air Quality - Environment Division
Great Guildford House,
30 Great Guildford Street
London SE1 0ES
Telephone: 0207 902 6100
Facsimile: 0207 902 6149

Location	**Chesterfield Road Staveley**
Title	**2005 ADMS Model Prediction**

By	Checked	Approved
SR	**LL**	**LL**

Scale	Date
N.T.S.	**April 2007**

Job No.	Fig. No.
AGGX0736	**Appendix B 1**



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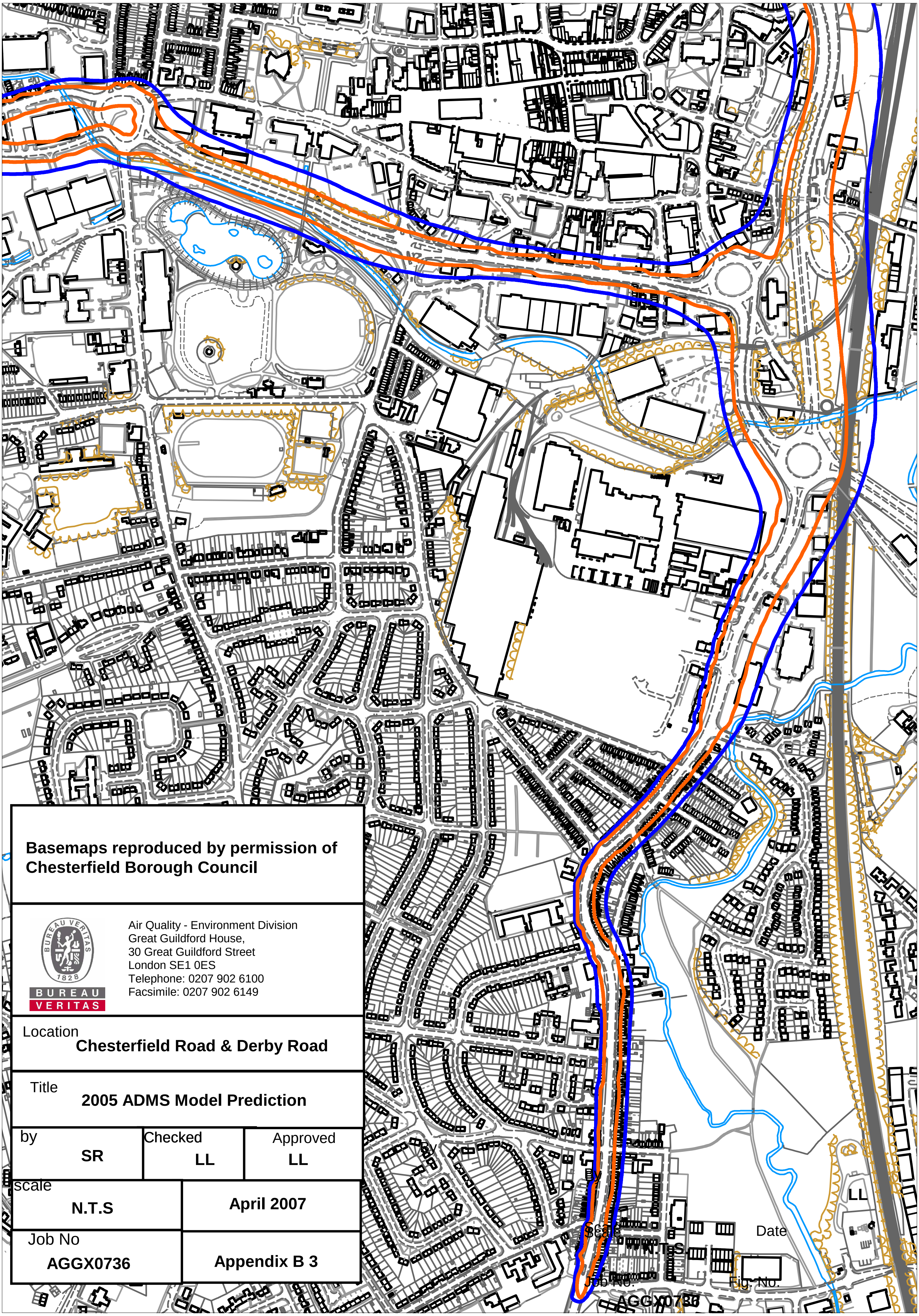
Location
Chesterfield Road & Derby Road

Title
2005 ADMS Model Prediction

By	Checked	Approved
SR	**LL**	**LL**

Scale	Date
N.T.S.	**April 2007**

Job No.	Fig. No.
AGGX0736	**Appendix B 2**



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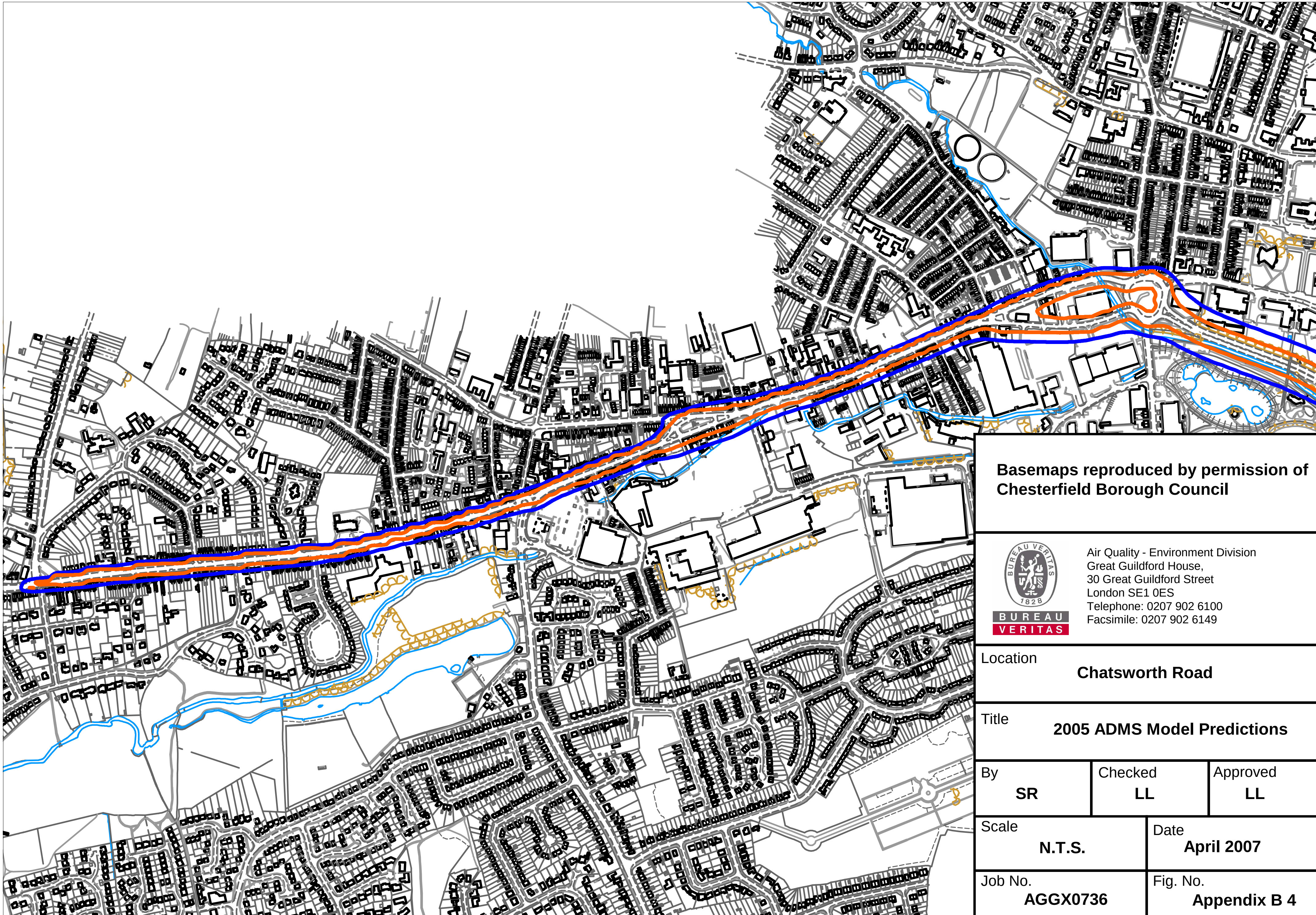
Location	**Chesterfield Road & Derby Road**
Title	**2005 ADMS Model Prediction**

by	Checked	Approved
SR	**LL**	**LL**

scale **N.T.S**	**April 2007**
Job No **AGGX0736**	**Appendix B 3**



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Location	Chatsworth Road		
Title	2005 ADMS Model Predictions		
By: SR	Checked: LL	Approved: LL	
Scale: N.T.S.		Date: April 2007	
Job No.: AGGX0736		Fig. No.: Appendix B 4	