Air Quality CONSULTANTS

Air Quality Assessment: Development Associated with the Local Plan, Warwick

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Experts in air quality
management & assessment

Document Control

Client	Warwick District Council	Principal Contact	Sam Holder

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Report Prepared By:	Dr Austin Cogan and Dr Clare Beattie

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Air Quality Consultants Ltd
23 Coldharbour Road, Bristol BS6 7JT Tel: 0117 974 1086
12 Airedale Road, London SW12 8SF Tel: 0208 673 4313
aqc@aqconsultants.co.uk

Registered Office: 12 St Oswalds Road, Bristol, BS6 7HT
Companies House Registration No: 2814570

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1 Introduction

1.1 Warwick District Council (WDC) has identified locations with measured exceedences of the annual mean nitrogen dioxide objective. As a result, Air Quality Management Areas (AQMAs) have been declared in Warwick, Leamington Spa and Kenilworth.

1.2 The spatial planning system has an important role to play in improving air quality and reducing exposure to air pollution both within these AQMAs and elsewhere in the district. In particular, the local planning policies set the framework for the determination of individual planning applications.

1.3 WDC is currently preparing a new Local Plan for Warwick District, which will guide the area's future development for the next 18 years. The Inspector looking at the Council's housing provision raised concerns about the levels of housing being proposed. As a result, WDC is looking at increasing the amount of housing identified in the Plan from 13,000 over the Plan period (to 2029) to 16,776 over the same period. As a result of this change, the preferred option for the new sites of additional housing is being assessed. This work updates previous work published in October 2013 (Air Quality Consultants Ltd, 2013).

1.4 The Local Plan process will consider various sources of evidence to inform the Council's emerging policies. Extensive analysis of the transport impacts of the proposals has already been undertaken using the S-Paramics model. This work included calculating the impacts of the proposals on peak-hour traffic flows within the Warwick, Leamington Spa and Kenilworth AQMAs, as well as within Stoneleigh. Air quality is an issue that has been identified as requiring further work to ascertain the impacts of development decisions on these areas in more detail. This report uses the outputs of the S-Paramics traffic model, to assess air quality impacts (in terms of concentrations) on these areas.

1.5 This report describes existing local air quality conditions (2015), which have also been used to verify the model, and the predicted air quality in 2028 assuming that the 'Preferred Option' to the allocation of growth, does, or does not proceed.

2 Policy Context and Assessment Criteria

Air Quality Strategy

2.1 The Air Quality Strategy (Defra, 2007) published by the Department for Environment, Food, and Rural Affairs (Defra) and Devolved Administrations, provides the policy framework for air quality management and assessment in the UK. It provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. Local authorities are seen to play a particularly important role. The strategy describes the Local Air Quality Management (LAQM) regime that has been established, whereby every authority has to carry out regular reviews and assessments of air quality in its area to identify whether the objectives have been, or will be, achieved at relevant locations, by the applicable date. If this is not the case, the authority must declare an Air Quality Management Area (AQMA), and prepare an action plan which identifies appropriate measures that will be introduced in pursuit of the objectives.

Planning Policy

National Policies

2.2 The National Planning Policy Framework (NPPF) (2012) sets out planning policy for England in one place. It places a general presumption in favour of sustainable development, stressing the importance of local development plans, and states that the planning system should perform an environmental role to minimise pollution. One of the twelve core planning principles notes that planning should *"contribute to…reducing pollution"*. To prevent unacceptable risks from air pollution, planning decisions should ensure that new development is appropriate for its location. The NPPF states that the effects of pollution on health and the sensitivity of the area and the development should be taken into account.

2.3 More specifically the NPPF makes clear that:

"Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan".

2.4 The NPPF is now supported by Planning Practice Guidance (PPG) (DCLG, 2014), which includes guiding principles on how planning can take account of the impacts of new development on air quality. The PPG states that *"Defra carries out an annual national assessment of air quality using* *modelling and monitoring to determine compliance with EU Limit Values"* and *"It is important that the potential impact of new development on air quality is taken into account … where the national assessment indicates that relevant limits have been exceeded or are near the limit".* The role of the local authorities is covered by the LAQM regime, with the PPG stating that local authority Air Quality Action Plans "*identify measures that will be introduced in pursuit of the objectives*".

2.5 The PPG states that:

"Whether or not air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to generate air quality impact in an area where air quality is known to be poor. They could also arise where the development is likely to adversely impact upon the implementation of air quality strategies and action plans and/or, in particular, lead to a breach of EU legislation (including that applicable to wildlife)".

2.6 The PPG sets out the information that may be required in an air quality assessment, making clear that *"Assessments should be proportional to the nature and scale of development proposed and the level of concern about air quality"*. It also provides guidance on options for mitigating air quality impacts, as well as examples of the types of measures to be considered. It makes clear that *"Mitigation options where necessary, will depend on the proposed development and should be proportionate to the likely impact".*

Local Policies

2.7 WDC's Local Plan (Warwick District Council, 2007) was published in September 2007. One of the Local Plan objectives is *"to protect and improve air quality"* (Objective 2F) and it contains the following policies relating to air quality:

Policy DP9 Pollution Control:

"Development will only be permitted which does not give rise to soil contamination or air, noise, radiation, light or water pollution where the level of discharge, emissions or contamination could cause harm to sensitive receptors.

Where there is evidence of existing land contamination, it will be necessary to ensure that that the land is made fit for its intended purpose and does not pose an unacceptable risk to sensitive receptors."

Policy DP7 Traffic Generation:

"Development will not be permitted which generates significant road traffic movements unless practicable and effective measures are taken to avoid adverse impact from traffic generation.

In appropriate circumstances, development proposals will be required to demonstrate how they comply with this policy by way of a Transport Assessment and, where necessary, Travel Plan."

2.8 The Council are in the process of preparing a New Local Plan, which will guide future development within the area for the next 18 years. The Preferred Options consultation document (Warwick District Council, 2012) identifies air quality as an issue and seeks to mitigate against negative transport impacts, such as the impact on air quality, by requiring developers to contribute to transport infrastructure improvements.

Assessment Criteria

Health Criteria

2.9 The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality (England) Regulations, 2000, Statutory Instrument 928 (2000) and the Air Quality (England) (Amendment) Regulations 2002, Statutory Instrument 3043 (2002).

2.10 The objectives for nitrogen dioxide and PM_{10} were to have been achieved by 2005 and 2004 respectively, and continue to apply in all future years thereafter. The $PM_{2.5}$ objective is to be achieved by 2020. Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded where the annual mean concentration is below 60 $\mu g/m^3$ (Defra, 2016a). Therefore, 1-hour nitrogen dioxide concentrations will only be considered if the annual mean concentration is above this level. Measurements have also shown that the 24-hour PM_{10} objective could be exceeded where the annual mean concentration is above 32 $\mu g/m^3$ (Defra, 2016a). The predicted annual mean PM_{10} concentrations are thus used as a proxy to determine the likelihood of an exceedence of the 24-hour mean PM_{10} objective. Where predicted annual mean concentrations are below 32 $\mu g/m^3$ it is unlikely that the 24-hour mean objective will be exceeded.

2.11 The objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Defra explains where these objectives will apply in its Local Air Quality Management Technical Guidance (Defra, 2016a). The annual mean objectives for nitrogen dioxide and PM_{10} are considered to apply at the façades of residential properties, schools, hospitals etc.; they do not apply at hotels. The 24-hour objective for PM_{10} is considered to apply at the same locations as the annual mean objective, as well as in gardens of residential properties and at hotels. The 1-hour mean objective for nitrogen dioxide applies wherever members of the public might regularly spend 1-hour or more, including outdoor eating locations and pavements of busy shopping streets.

2.12 The European Union has also set limit values for nitrogen dioxide, PM_{10} and $PM_{2.5}$. The limit values for nitrogen dioxide are the same numerical concentrations as the UK objectives, but achievement of these values is a national obligation rather than a local one (Directive 2008/50/EC of the European Parliament and of the Council, 2008). In the UK, only monitoring and modelling carried out by UK Central Government meets the specification required to assess compliance with the limit values. Central Government does not recognise local authority monitoring or local modelling studies when determining the likelihood of the limit values being exceeded.

2.13 The relevant air quality criteria for this assessment are provided in Table 1.

Table 1: Air Quality Criteria for Nitrogen Dioxide, PM_{10} and $PM_{2.5}$

Pollutant	Time Period	Objective
Nitrogen Dioxide	1-hour Mean	200 µg/m^3 not to be exceeded more than 18 times a year
	Annual Mean	40 µg/m^3
Fine Particles (PM_{10})	24-hour Mean	50 µg/m^3 not to be exceeded more than 35 times a year
	Annual Mean	40 µg/m^3 [a]
Fine Particles ($PM_{2.5}$) [b]	Annual Mean	25 µg/m^3

a A proxy value of 32 µg/m^3 as an annual mean is used in this assessment to assess the likelihood of the 24-hour mean PM_{10} objective being exceeded. Measurements have shown that, above this concentration, exceedences of the 24-hour mean PM_{10} objective are possible (Defra, 2016a).

b The $PM_{2.5}$ objective, which is to be met by 2020, is not in Regulations and there is no requirement for local authorities to meet it.

3 Assessment Methodology

Existing Conditions

3.1 Monitoring for nitrogen dioxide within the study area has been carried out by WDC at a large number of diffusion tubes sites in Warwick, Leamington Spa, Kenilworth and Stoneleigh over a number of years. The monitoring sites and study area for Warwick are shown in Figure 1, for Leamington Spa in Figure 2, for Kenilworth in Figure 3 and for Stoneleigh in Figure 4. WDC deployed diffusion tubes prepared and analysed by Walsall MBC (50% TEA in acetone) from April 2008 to March 2011, however this laboratory closed in March 2011. From April 2011 the diffusion tubes were supplied and analysed by Bristol Scientific Services (20% TEA in water) until this laboratory closed at the beginning of 2012. Since the beginning of 2012 diffusion tubes have been supplied and analysed by Staffordshire Scientific Services (20% TEA in water).

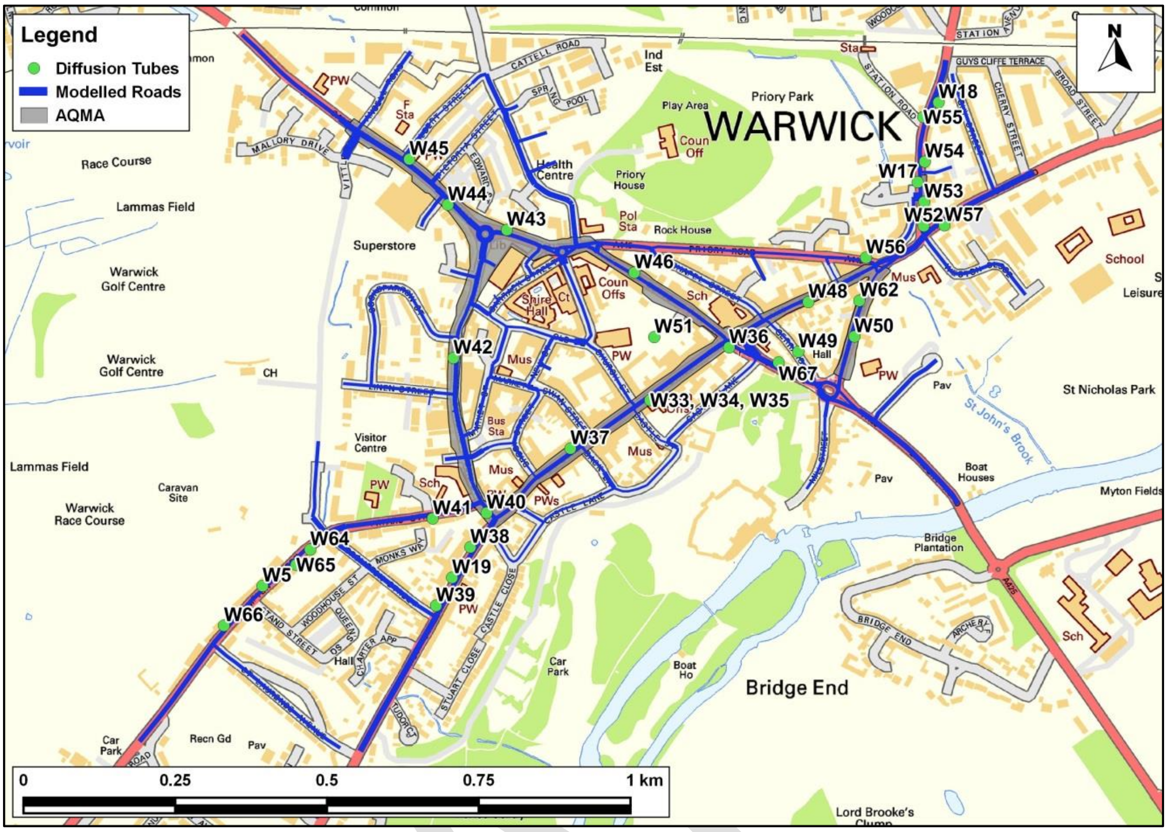

Figure 1: Warwick Detailed Assessment Study Area and Monitoring Locations. Roads explicitly included in the model shown in blue.

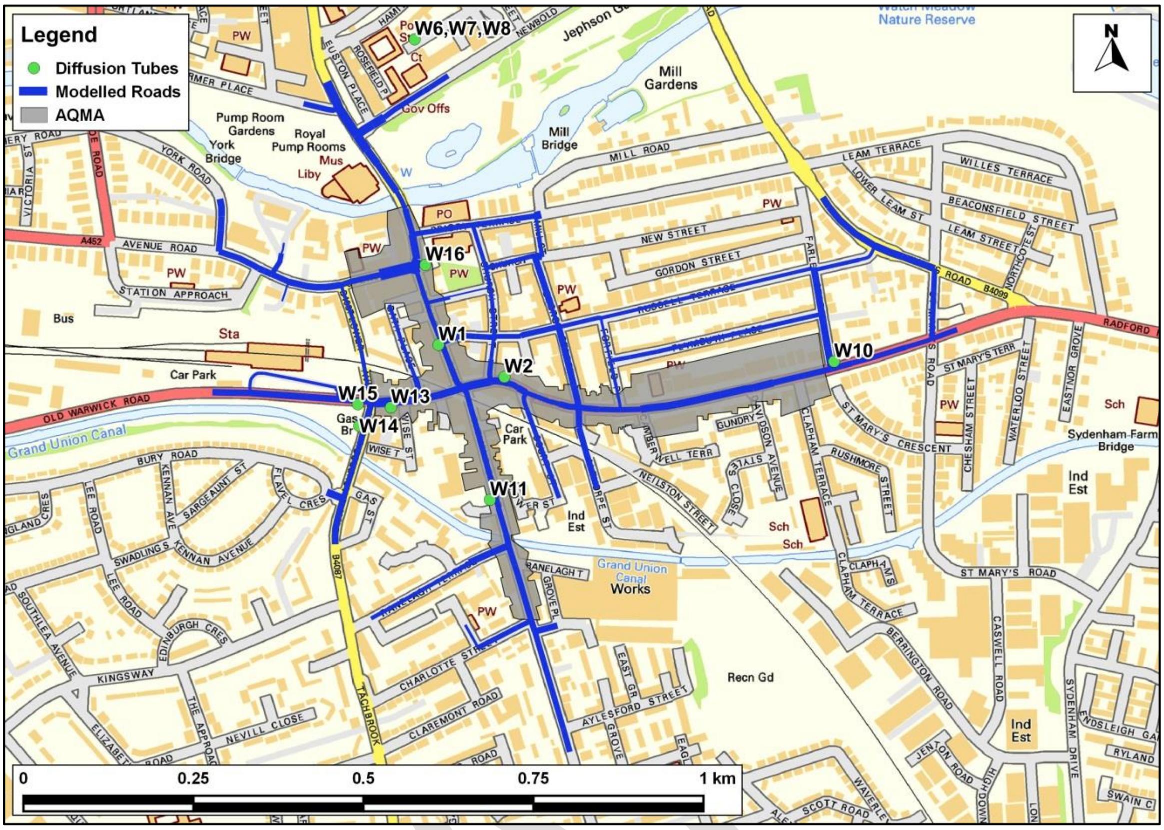

Figure 2: Leamington Spa Detailed Assessment Study Area and Monitoring Locations. Roads explicitly included in the model shown in blue.

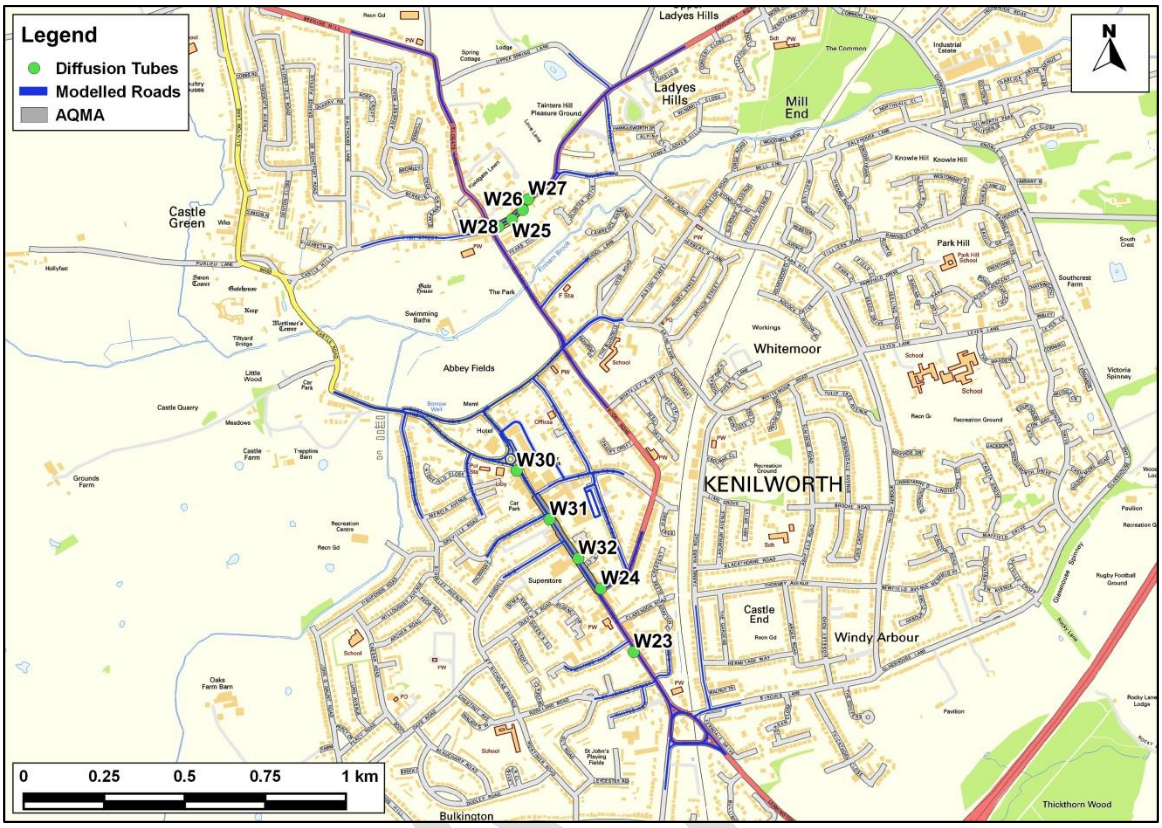

Figure 3: **Kenilworth Detailed Assessment Study Area and Monitoring Locations. Roads explicitly included in the model shown in blue.**

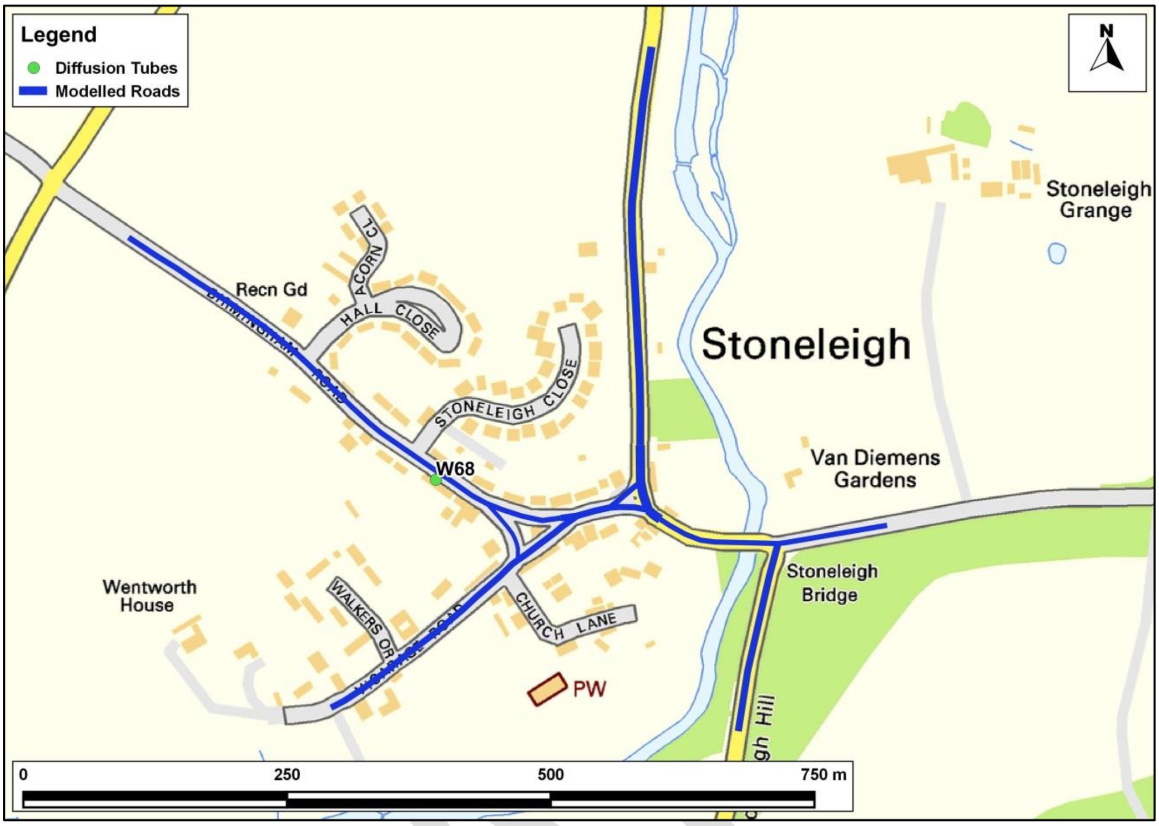

Figure 4: Stoneleigh Detailed Assessment Study Area and Monitoring Locations. Roads explicitly included in the model shown in blue.

3.2 WDC monitors air quality using both real time analysers and passive diffusion tubes. The results for nitrogen dioxide and PM_{10} real-time monitoring between 2011 and 2015 are presented in Table 2 and Table 3, respectively.

Table 2: Results of Automatic Monitoring of Nitrogen Dioxide: Comparison with the Annual Mean Objective (2011 – 2015) [a]

Site ID	Site Type	Within AQMA?	2011	2012	2013	2014	2015
Annual Mean Concentration $\mu g/m^3$							
Hamilton Terrace, Leamington Spa	Urban background	N	21.1	20.7	20.7	19.6	19.3
Pageant House, Warwick	Roadside	Y	**58.2**	**60.4**	39.7	**40.1**	-
Ruby Road, Leamington Spa	Roadside	N	-	19.5	21.2	21.1	20.2
Objective			40				
Number of Exceedences of the Hourly Mean (200 $\mu g/m^3$)							
Hamilton Terrace, Leamington Spa	Urban background	N	0	0	0 (77)	0 (74)	0
Pageant House, Warwick	Roadside	Y	17	379	4	0	-
Ruby Road, Leamington Spa	Roadside	N	-	0 (82)	1	0	0
Objective			18 (200) [b]				

[a] Exceedences of the objectives are shown in bold.

[b] Where data capture is less than 90%, 99.79th percentile of 1-hour means have been included in brackets.

Table 3: Results of Automatic Monitoring of PM_{10} Hamilton Terrace, Leamington Spa: Comparison with the Annual and Daily Mean Objectives (2011 – 2015)

Site ID	Site Type	Within AQMA?	2011	2012	2013	2014	2015
Annual Mean Concentration $\mu g/m^3$							
Hamilton Terrace, Leamington Spa	Urban background	N	20.0	26.3	17.9	15.9	14.9
Ruby Road, Leamington Spa	Roadside	N	-	11.6	15.8	14.7	14.5
Objective			40				
Number of Exceedences of Daily Mean Concentration (50 $\mu g/m^3$)							
Hamilton Terrace, Leamington Spa	Urban background	N	13	4	6 (39)	3	4
Ruby Road, Leamington Spa	Roadside	N	-	0 (20)	6 (29)	1 (30)	2
Objective			35 (50) [a]				

[a] Where data capture is less than 90%, 90th percentile of 24-hour means have been included in brackets.

3.3 Table 4 includes diffusion tube monitoring data from Warwick, Leamington Spa, Kenilworth and Stoneleigh, which have been used for verification of the model and for background information. There have been a number of exceedences of the annual mean nitrogen dioxide objective in Warwick, Leamington Spa over the last 5 years. There are no clear trends in the monitoring results for the past 5 years.

Table 4: Annual Mean Nitrogen Dioxide Concentrations (μg/m^3) in Warwick and Leamington Spa (2009-2012)

Site ID	Site Type	Within AQMA?	Annual mean concentration (adjusted for bias) μg/m^3				
			2011 (Bias Adjustment Factor = 1.32 and 0.81)	2012 (Bias Adjustment Factor = 0.84)	2013 (Bias Adjustment Factor = 0.85)	2014 (Bias Adjustment Factor = 0.83)	2015 (Bias Adjustment Factor = 0.84)
Warwick							
W51	Urban Background	N	15.6	19.6	19.3	18.2	17.4
W43	Roadside	Y	**43.1**	32.5	**44.3**	**45.4**	**43.4**
W46	Roadside	Y	36.9	36.4	35.4	34.3	34.2
W40	Kerbside	Y	37.1	**42.2**	39.8	40.0	**40.7**
W42	Roadside	Y	31.7	34.7	32.0	29.4	26.4
W33 W34 W35	Roadside Triplicate	Y	**57.8**	**46.1**	**40.8**	**41.3**	**41.2**
W37	Roadside	Y	37.5	36.6	38.3	34.6	37.5
W38	Kerbside	N	32.6	36.9	32.6	34.5	34.0
W19	Roadside	N	34.5	32.9	31.4	31.0	28.4
W39	Roadside	N	30.1	27.5	26.8	27.3	27.6
W41	Roadside	N	26.7	26.1	24.8	25.4	22.6
W44	Roadside	Y	30.9	31.6	29.9	31.9	28.6
W45	Roadside	Y	29.3	28.6	26.4	27.8	27.2
W48	Roadside	Y	37.5	36.0	33.5	33.8	32.7
W49	Roadside	N	24.6	24.7	22.9	23.3	22.1
W50	Roadside	N	31.7	30.0	29.4	28.7	27.9
W62	Roadside	Y	**47.5**	**45.6**	**43.8**	**44.0**	**42.5**
W56	Roadside	N	21.0	24.7	22.5	22.7	21.3
W52	Kerbside	Y	**43.3**	**42.0**	**41.4**	39.4	38.1
W53	Roadside	Y	**43.0**	**41.0**	**42.7**	**41.0**	38.5

Site ID	Site Type	Within AQMA?	Annual mean concentration (adjusted for bias) $\mu g/m^3$				
			2011 (Bias Adjustment Factor = 1.32 and 0.81)	2012 (Bias Adjustment Factor = 0.84)	2013 (Bias Adjustment Factor = 0.85)	2014 (Bias Adjustment Factor = 0.83)	2015 (Bias Adjustment Factor = 0.84)
W54	Roadside	N	31.3	32.5	34.0	32.9	31.0
W55	Roadside	N	30.4	29.4	29.9	28.5	27.3
W17	Kerbside	N	27.7	27.8	29.1	27.7	26.4
W18	Roadside	N	26.6	27.9	25.0	24.7	24.7
W57	Roadside	N	31.3	31.9	31.4	31.3	30.0
W36	Roadside	Y	**49.1**	**44.6**	**41.1**	**43.6**	**42.2**
W5	Roadside	N	33.5	36.0	32.7	33.8	34.5
W64	Roadside	N	30.6	27.5	25.3	25.4	22.4
W65	Roadside	N	27.2	25.9	24.3	23.2	**42.6**
W66	Roadside	N	28.2	30.0	29.0	25.2	-
W67	Roadside	N	-	-	-	**41.0**	-
Leamington Spa							
W6 W7 W8	Urban Background Triplicate	N	20.8	20.7	19.8	19.2	19.7
W2	Roadside	Y	**42.8**	39.3	33.5	32.6	38.2
W12	Roadside	Y	**40.7**	35.1	38.0	33.7	33.3
W10	Roadside	N	29.0	25.4	24.1	24.0	24.3
W11	Roadside	Y	22.9	25.5	32.9	23.7	23.2
W13	Roadside	Y	**52.7**	**49.6**	**42.8**	**47.0**	**48.6**
W14	Roadside	N	**41.9**	**40.6**	39.6	34.5	38.1
W15	Roadside	N	**41.9**	**45.2**	35.9	**41.0**	**43.9**
W16	Roadside	N	31.0	31.6	30.6	28.5	30.7
W1	Kerbside	Y	**49.0**	**44.0**	36.3	40.0	**43.4**
Kenilworth							
W31	Kerbside	Y	37.1	37.0	37.4	37.6	35.2
W25	Roadside	Y	26.2	27.0	34.6	34.5	31.3
W26	Roadside	Y	22.9	23.3	27.1	25.7	24.4
W27	Kerbside	N	38.5	39.8	23.1	22.5	21.6
W28	Roadside	Y	33.6	39.3	37.7	37.8	33.2

Site ID	Site Type	Within AQMA?	Annual mean concentration (adjusted for bias) μg/m³				
			2011 (Bias Adjustment Factor = 1.32 and 0.81)	2012 (Bias Adjustment Factor = 0.84)	2013 (Bias Adjustment Factor = 0.85)	2014 (Bias Adjustment Factor = 0.83)	2015 (Bias Adjustment Factor = 0.84)
W32	Roadside	Y	36.0	37.2	36.0	35.8	34.0
W23	Roadside	N	36.5	33.0	30.7	31.1	30.6
W24	Roadside	Y	27.8	30.9	30.2	29.7	28.2
W30	Roadside	N	27.7	28.1	25.0	26.1	24.0
Stoneleigh							
W68	Roadside	N	-	-	-	23.3	23.6
Objective			**40**				

Modelling

3.4 Annual mean nitrogen dioxide concentrations have been predicted using detailed dispersion modelling (ADMS-Roads v4). The input data used are described in Appendix 2. The model outputs have been verified against the monitoring data presented above, as described in Appendix A2 (paragraph A2.6). Concentrations have been predicted at a number of worst-case receptor locations representing existing residential properties within Warwick, Leamington Spa, Kenilworth and Stoneleigh, as shown in Figure 5, Figure 6, Figure 7 and Figure 8, respectively.

Figure 5: **AQMA and Receptor Locations in Warwick**

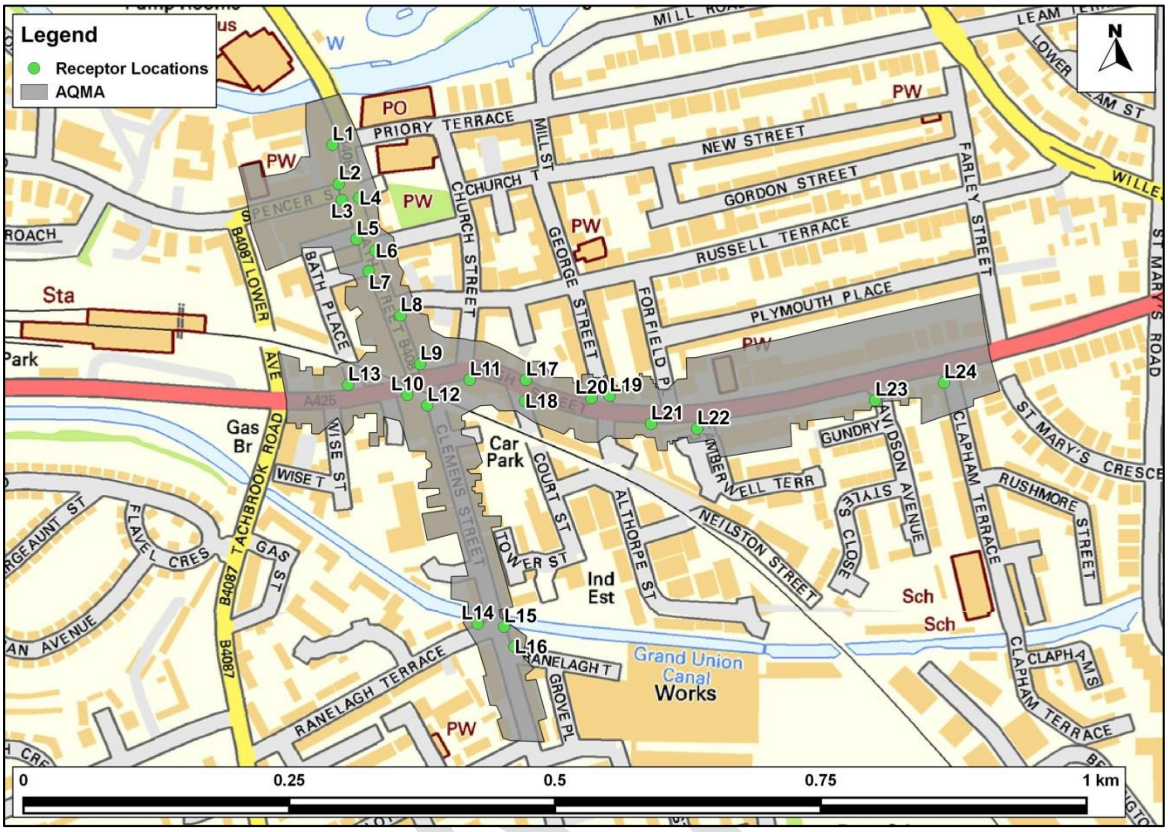

Figure 6: AQMA and Receptor Locations in Leamington Spa

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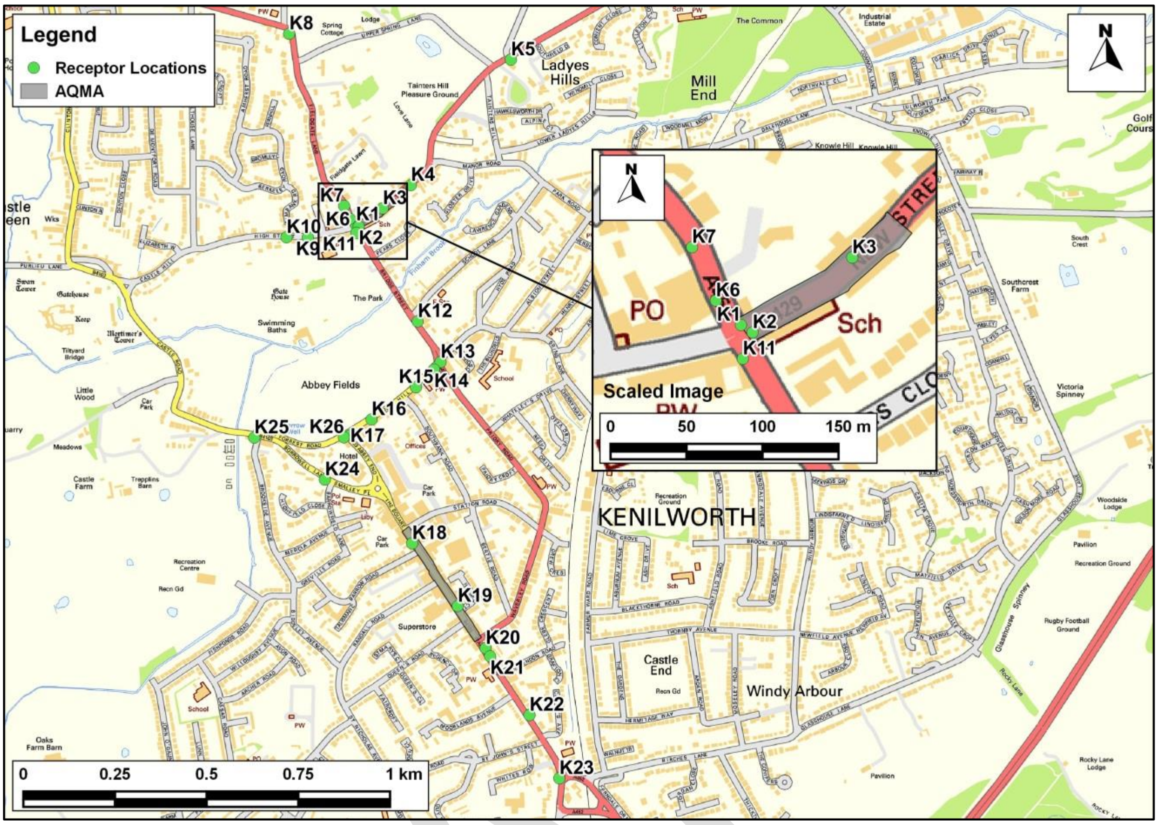

Figure 7: AQMAs and Receptor Locations in Kenilworth

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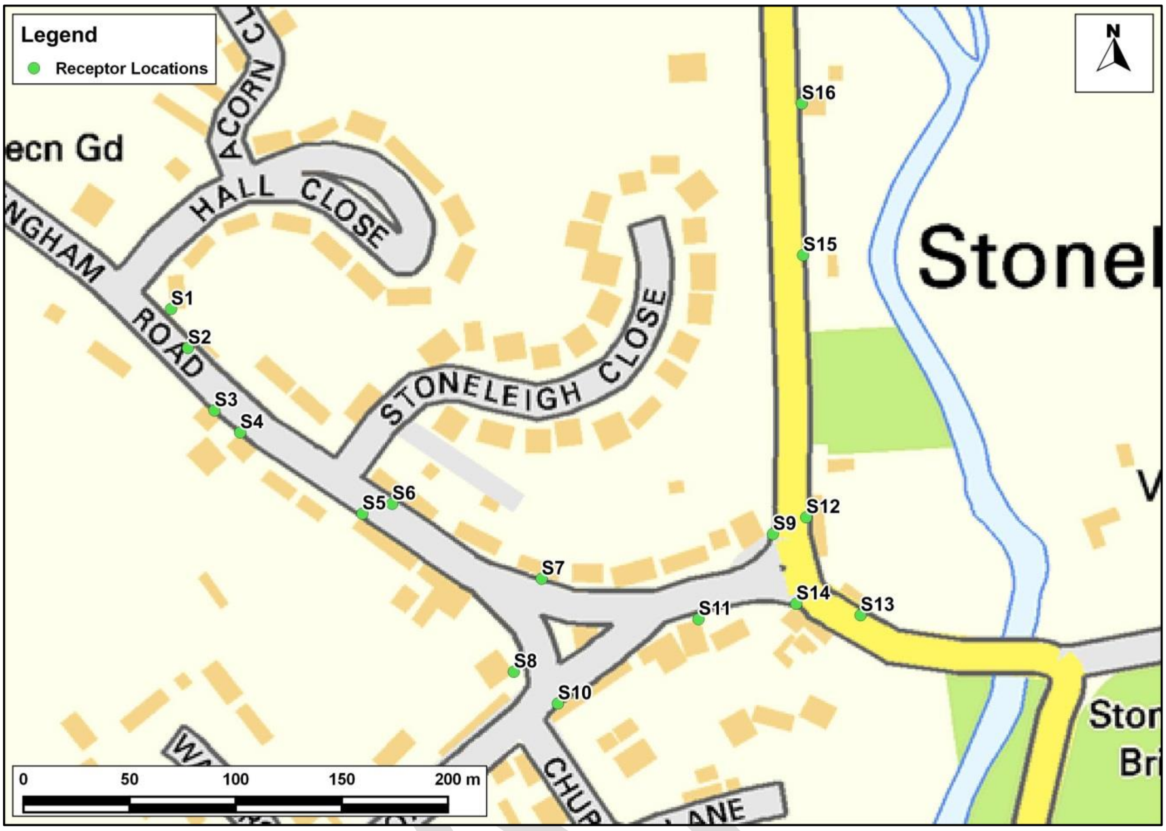

Figure 8: Receptor Locations in Stoneleigh

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Road Traffic Impacts

Sensitive Locations

3.5 Concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ have been predicted at the receptor locations both within, and close to, the Warwick, Leamington Spa and Kenilworth AQMAs, as well as Stoneleigh. Receptors have been identified to represent worst-case exposure within these areas. When selecting these receptors, particular attention has been paid to assessing impacts close to junctions, where traffic may become congested, and where there is a combined effect of several road links. The receptors have been located on the façades of the properties closest to the sources.

Assessment Scenarios

3.6 Predictions of nitrogen dioxide, PM_{10} and $PM_{2.5}$ concentrations have been carried out for a base year (2015), and for a future year (2028). For 2028, scenarios have been modelled assuming that the preferred option to the allocation of growth, does proceed ('Preferred Option'), or does not proceed ('Reference Case').

Modelling Methodology

3.7 Concentrations have been predicted for the baseline and future years using the ADMS-Roads dispersion model. Details of the model inputs and the model verification are provided in Appendix A2, together with the method used to derive current and future year background nitrogen dioxide concentrations.

3.8 Baseline concentrations for nitrogen dioxide in Warwick, Leamington Spa, Kenilworth and Stoneleigh are illustrated in Figure 9, Figure 10, Figure 11 and Figure 12, respectively.

Figure 9: 2015 Nitrogen Dioxide Annual Mean Concentrations in Warwick

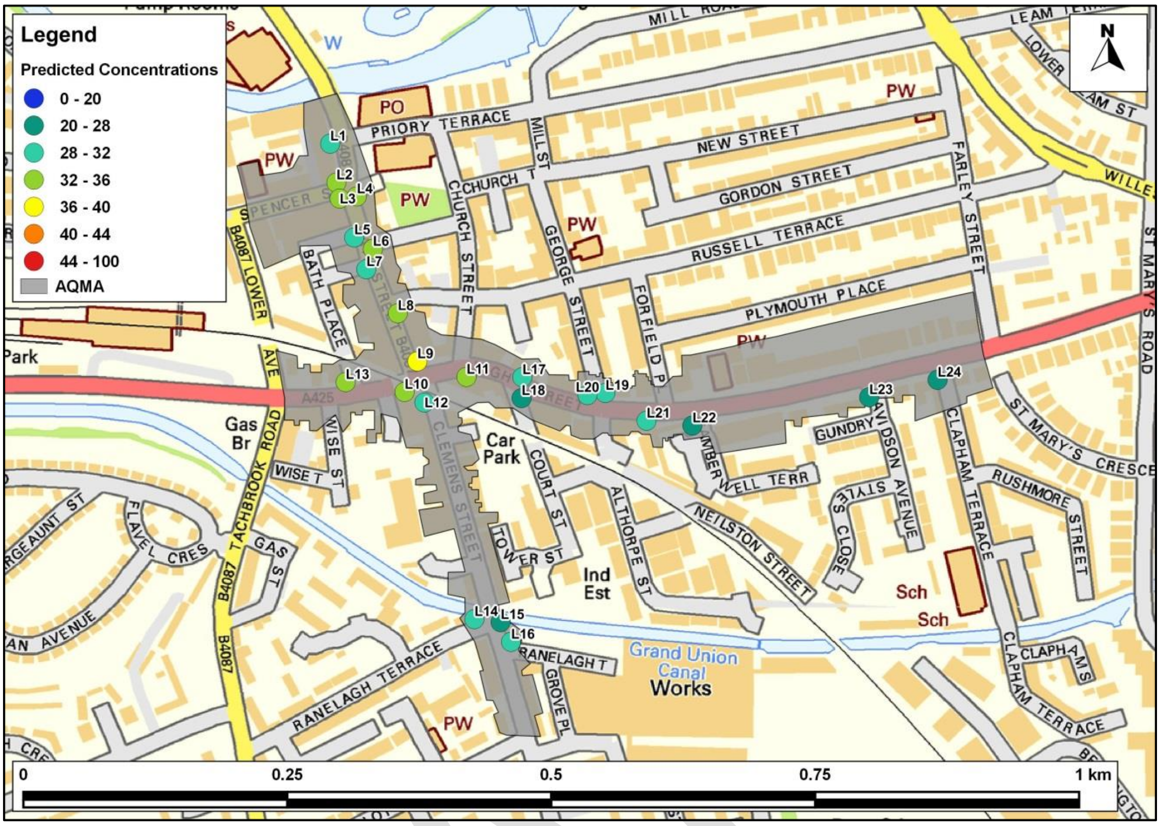

Figure 10: 2015 Nitrogen Dioxide Annual Mean Concentrations in Leamington Spa

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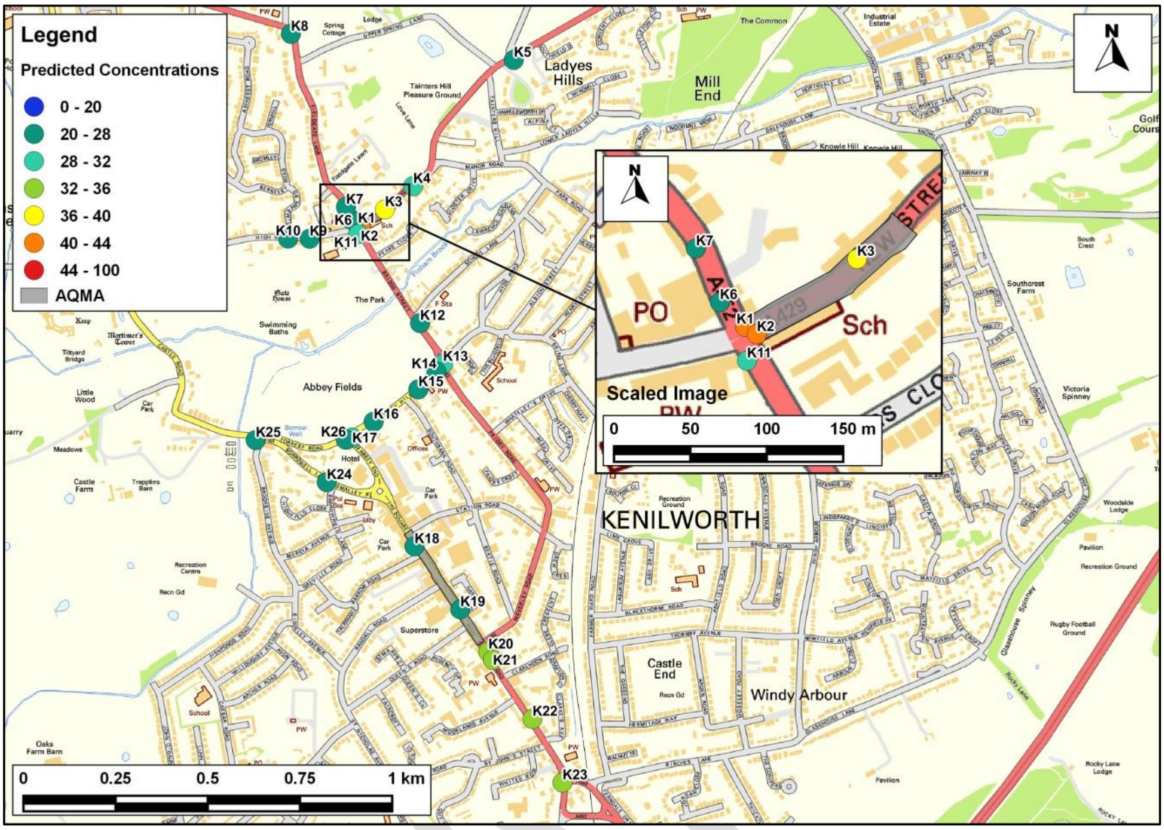

Figure 11: 2015 Nitrogen Dioxide Annual Mean Concentrations in Kenilworth

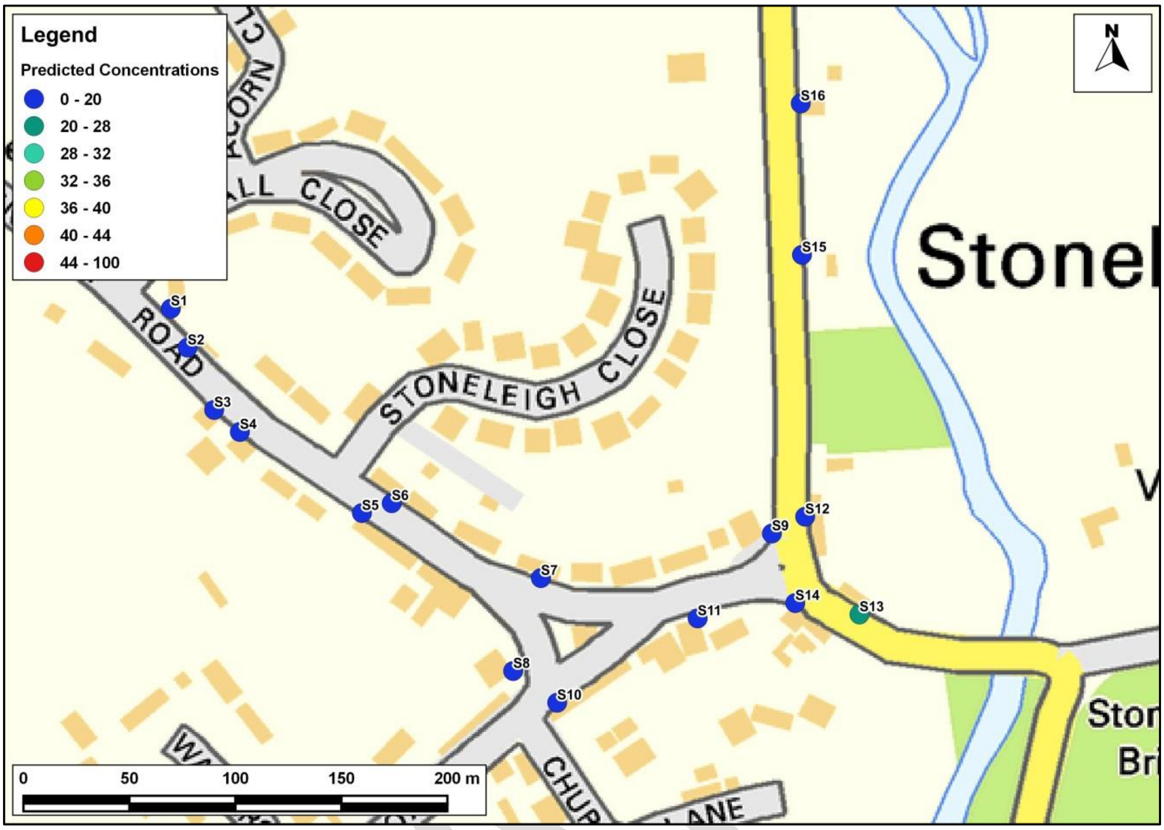

Figure 12: 2015 Nitrogen Dioxide Annual Mean Concentrations in Stoneleigh

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4 Results

Road Traffic Impacts

4.1 Predicted annual mean concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ are set out in Appendix A3 for the "Preferred Option" and "Reference Case" scenarios. Results are summarised below.

Nitrogen Dioxide

4.2 Concentrations of nitrogen dioxide are predicted to be much lower in 2028 than in 2015. This reduction is associated with the introduction of more stringent emissions controls on new vehicles via Euro standards; in 13 years' time these vehicles (Euro 6/VI) will make up the majority of the fleet on the roads in the UK. Background concentrations are also predicted to be substantially lower in 13 years' time, due to reductions in various contributing sectors.

4.3 When comparing the 'Preferred Option' with the 'Reference Case', there will be improvements in concentrations of nitrogen dioxide at some locations and dis-benefits at others. Figure 13, Figure 14, Figure 15 and Figure 16 show the difference between the two scenarios at each of the receptors (both positive and negative) in Warwick, Leamington Spa, Kenilworth and Stoneleigh, respectively. The differences between the two scenarios are much more marked in Warwick and Leamington Spa than in Kenilworth and Stoneleigh. While most changes are negligible, at some locations there will be an increase of up to 2.4 $\mu g/m^3$, which would be classed as a slight impact using the criteria set out in the approach developed jointly by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)[1] (EPUK & IAQM, 2015). Beneficial impacts are mainly seen along High Street and Jury Street in Warwick, and along The Square, High Street and Borrowell Lane in Kenilworth.

[1] The IAQM is the professional body for air quality practitioners in the UK.

Figure 13: 2028 Difference in Nitrogen Dioxide Concentrations between the Reference Case and the Preferred Option in Warwick

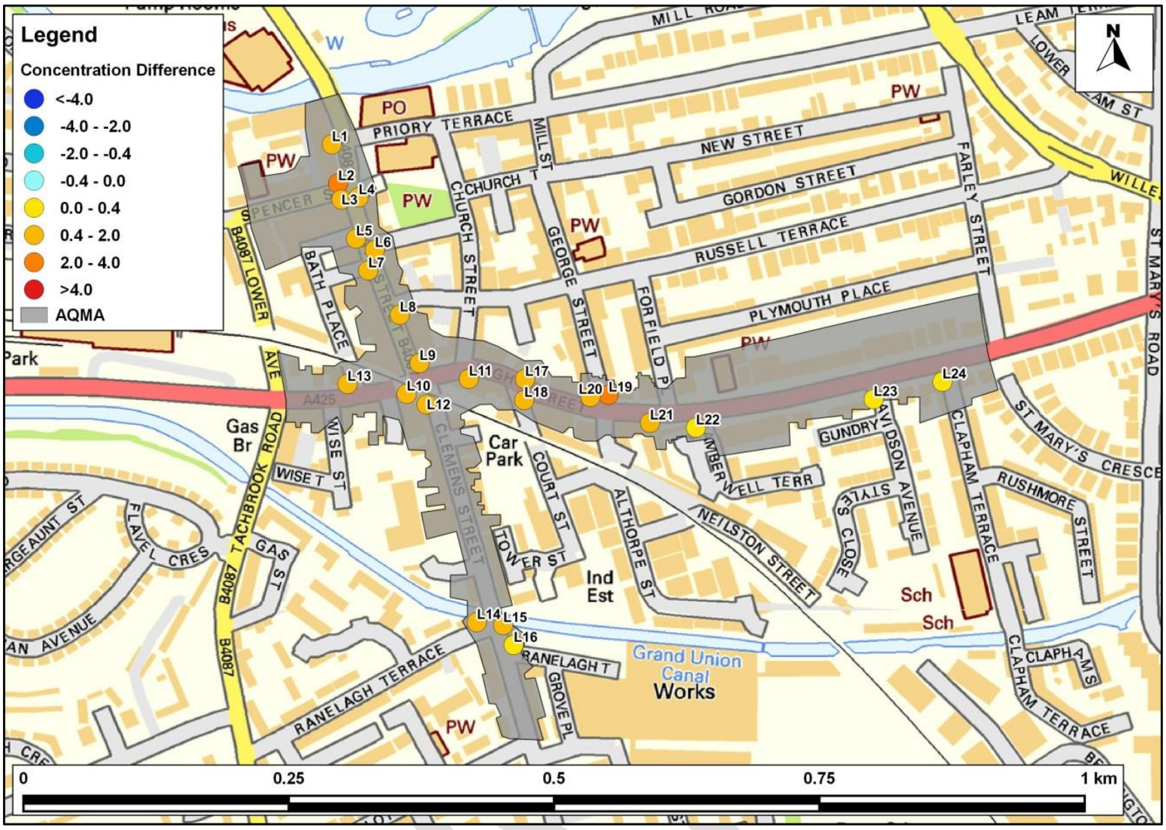

Figure 14: 2028 Difference in Nitrogen Dioxide Concentrations between the Reference Case and the Preferred Option in Leamington Spa

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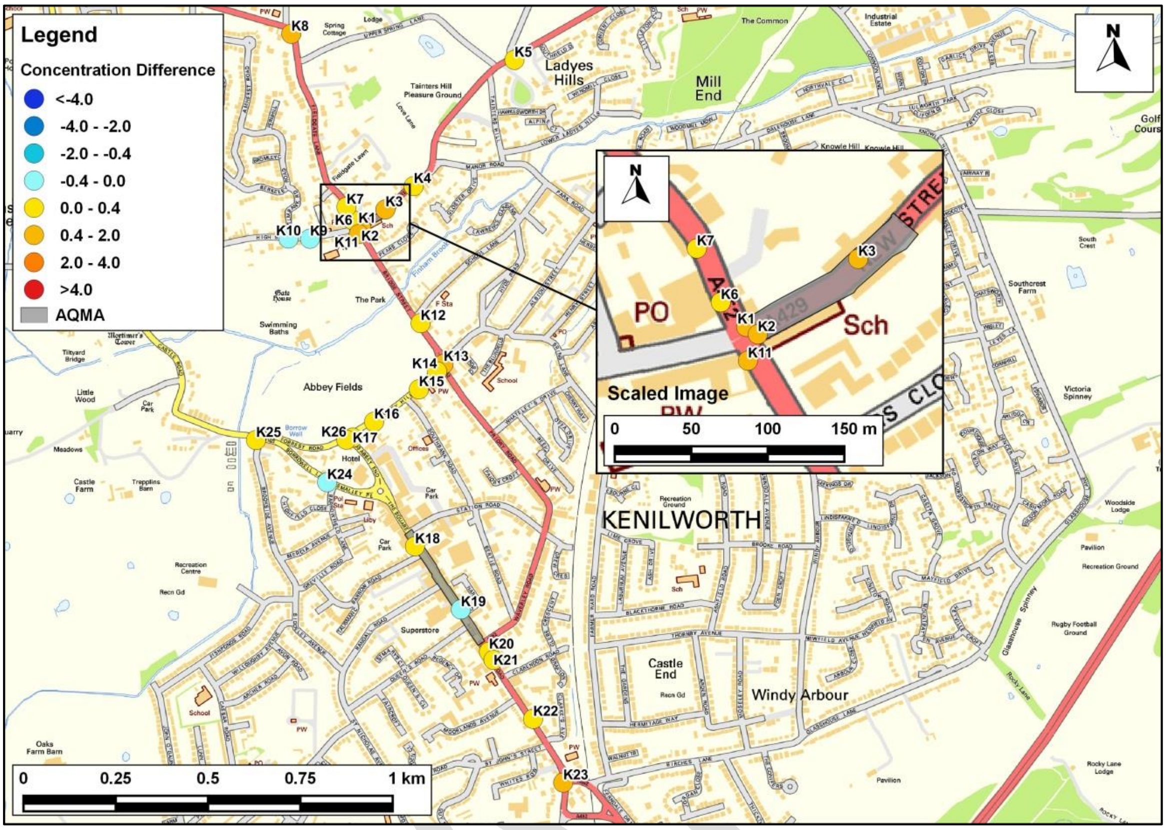

Figure 15: 2028 Difference in Nitrogen Dioxide Concentrations between the Reference Case and the Preferred Option in Kenilworth

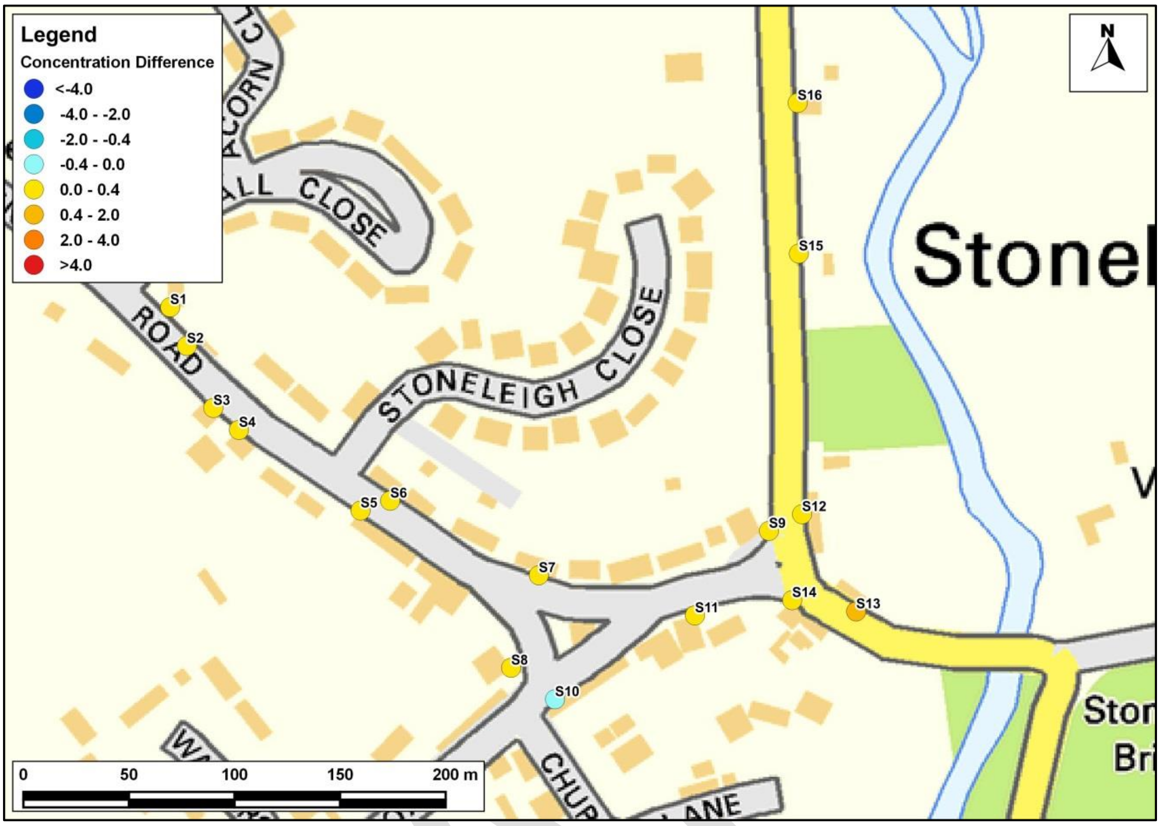

Figure 16: **2028 Difference in Nitrogen Dioxide Concentrations between the Reference Case and the Preferred Option in Stoneleigh**

PM_{10} and $PM_{2.5}$

4.4 The PM_{10} and $PM_{2.5}$ values are all well below the objectives at all receptors, in both 2015 and in 2028 for both scenarios. The patterns of impact of the scheme are the same for PM_{10} and $PM_{2.5}$ as they are for nitrogen dioxide (i.e. in terms of positive and negative impacts).

Uncertainty in Road Traffic Modelling Predictions

4.5 There are many components that contribute to the uncertainty of modelling predictions. The road traffic emissions dispersion model used in this assessment is dependent upon the traffic data that have been input, which will have inherent uncertainties associated with them. There are then additional uncertainties, as models are required to simplify real-world conditions into a series of algorithms.

4.6 An important stage in the process is model verification, which involves comparing the model output with measured concentrations (see Appendix A2). Because the model has been verified and adjusted, there can be reasonable confidence in the prediction of current year (2015) concentrations.

4.7 Predicting pollutant concentrations in a future year will always be subject to greater uncertainty. For obvious reasons, the model cannot be verified in the future, and it is necessary to rely on a series of projections provided by DfT and Defra as to what will happen to traffic volumes, background pollutant concentrations and vehicle emissions.

4.8 Historically, large reductions in nitrogen oxides emissions have been projected, which has led to significant reductions in nitrogen dioxide concentrations from one year to the next being predicted. Over time, it was found that trends in measured concentrations did not reflect the rapid reductions that Defra and DfT had predicted (Carslaw, Beevers, Westmoreland, & Williams, 2011). This was evident across the UK, although the effect appeared to be greatest in inner London; there was also considerable inter-site variation. Emission projections over the 6 to 8 years prior to 2009 suggested that both annual mean nitrogen oxides and nitrogen dioxide concentrations should have fallen by around 15-25%, whereas monitoring data showed that concentrations remained relatively stable, or even showed a slight increase. Analysis of more recent data for 23 roadside sites in London covering the period 2003 to 2012 showed a weak downward trend of around 5% over the ten years (Carslaw & Rhys-Tyler, 2013), but this still falls short of the improvements that had been predicted at the start of this period. This pattern of no clear, or limited, downward trend is mirrored in the monitoring data assembled for this study, as set out in earlier in paragraph 3.1.

4.9 The reason for the disparity between the expected concentrations and those measured relates to the on-road performance of modern diesel vehicles. New vehicles registered in the UK have had to meet progressively tighter European type approval emissions categories, referred to as "Euro" standards. While the nitrogen oxides emissions from newer vehicles should be lower than those from equivalent older vehicles, the on-road performance of some modern diesel vehicles has often been no better than that of earlier models. This has been compounded by an increasing proportion of nitrogen dioxide in the nitrogen oxides emissions, i.e. primary nitrogen dioxide, which has a significant effect on roadside concentrations (Carslaw, Beevers, Westmoreland, & Williams, 2011) (Carslaw & Rhys-Tyler, 2013).

4.10 A detailed analysis of emissions from modern diesel vehicles has been carried out (AQC, 2016a). This shows that although previous standards had limited on-road success, the 'Euro VI' and 'Euro 6' standards that new vehicles have had to comply with from 2013/16[2] are delivering real on-road improvements. By 2028, these vehicles will make up the majority of the fleet on the roads in the UK, which will lead to much lower pollutant concentrations.

[2] Euro VI refers to heavy duty vehicles, while Euro 6 refers to light duty vehicles. The timings for meeting the standards vary with vehicle type and whether the vehicle is a new model or existing model.

5 Summary and Conclusions

5.1 In 2015 there are exceedences of the annual mean nitrogen dioxide objective predicted in Warwick, Leamington Spa and Kenilworth, which reflects the outcomes of the Review and Assessment process. For PM_{10} and $PM_{2.5}$, there are no exceedences of the objectives, either in 2015, or in any of the 2028 scenarios.

5.2 For all pollutants, there are much lower concentrations in 2028 than in 2015. This reduction is associated with the introduction of more stringent emissions controls on new vehicles via Euro standards; in 13 years' time the Euro 6/VI vehicles will make up the majority of the fleet on the roads in the UK.

5.3 In general, the 'Preferred Option' scenario has mostly negligible to slight increases throughout Warwick, Leamington Spa, Kenilworth and Stoneleigh. Beneficial impacts are mainly seen on High Street and Jury Street in Warwick, and along The Square, High Street and Borrowell Lane in Kenilworth. The same patterns are apparent for PM_{10}, although the magnitudes of change are smaller.

5.4 Overall, the increase in emissions from road traffic generated by the Preferred Option for the housing provision of the Local Plan has a negligible impact on air quality conditions throughout Warwick, Leamington Spa, Kenilworth and Stoneleigh.

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7 Glossary

AADT	Annual Average Daily Traffic
ADMS-Roads	Atmospheric Dispersion Modelling System
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EFT	Emissions Factor Toolkit
Exceedence	A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure
HDV	Heavy Duty Vehicles (> 3.5 tonnes)
HGV	Heavy Goods Vehicle
LAQM	Local Air Quality Management
LDF	Local Development Framework
LDV	Light Duty Vehicles (<3.5 tonnes)
µg/m^3	Microgrammes per cubic metre
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
NPPF	National Planning Policy Framework
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometres in aerodynamic diameter
$PM_{2.5}$	Small airborne particles less than 2.5 micrometres in aerodynamic diameter
Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal
TEA	Triethanolamine – used to absorb nitrogen dioxide

8 Appendices

A1 Professional Experience

Stephen Moorcroft, BSc (Hons) MSc DIC MIEnvSc MIAQM CEnv

Mr Moorcroft is a Director of Air Quality Consultants, and has worked for the company since 2004. He has over thirty-five years' postgraduate experience in environmental sciences. Prior to joining Air Quality Consultants, he was the Managing Director of Casella Stanger, with responsibility for a business employing over 100 staff and a turnover of £12 million. He also acted as the Business Director for Air Quality services, with direct responsibility for a number of major Government projects. He has considerable project management experience associated with Environmental Assessments in relation to a variety of development projects, including power stations, incinerators, road developments and airports, with particular experience related to air quality assessment, monitoring and analysis. He has contributed to the development of air quality management in the UK, and has been closely involved with the LAQM process since its inception. He has given expert evidence to numerous public inquiries, and is frequently invited to present to conferences and seminars. He is a Member of the Institute of Air Quality Management.

Dr Clare Beattie, BSc (Hons) MSc PhD CSci MIEnvSc MIAQM

Dr Beattie is a Principal Consultant with AQC, with more than fifteen years' relevant experience. She has been involved in air quality management and assessment, and policy formulation in both an academic and consultancy environment. She has prepared air quality review and assessment reports, strategies and action plans for local authorities and has developed guidance documents on air quality management on behalf of central government, local government and NGOs. Dr Beattie has appraised local authority air quality assessments on behalf of the UK governments, and provided support to the Review and Assessment helpdesk. She has also provided support to the integration of air quality considerations into Local Transport Plans and planning policy processes. She has carried out numerous assessments for new residential and commercial developments, including the negotiation of mitigation measures where relevant. She has carried out BREEAM assessments covering air quality for new developments. Clare has worked closely with Defra and has recently managed the Defra Air Quality Grant Appraisal contract over a 4-year period. She is a Member of the Institute of Air Quality Management and is a Chartered Scientist.

Dr Austin Cogan, MPhys (Hons) PhD AMIEnvSc MIAQM

Dr Cogan is a Consultant with AQC and has over three years' experience in the fields of air quality modelling, monitoring and assessment. Prior to this he studied at the University of Leicester, gaining 2 years' experience of scientific instrument design and spent 4 years' pioneering research in satellite observations of carbon dioxide, including data validation, model comparisons, bias correction and software development. He now works in the field of air quality assessment and has been involved in air quality, odour and climate change assessments of residential and commercial developments, road schemes, airports, waste management processes, and industrial processes. Dr Cogan has also been involved in the analysis and interpretation of air quality data and the preparation of review and assessment reports for local authorities.

Full CVs are available at www.aqconsultants.co.uk.

A2 Modelling Methodology

Background Concentrations

A2.1 The background pollutant concentrations across the study area have been defined using the national pollution maps published by Defra (2016b). These cover the whole country on a 1x1 km grid and are published for each year from 2011 until 2030.

Model Inputs

A2.2 Predictions have been carried out using the ADMS-Roads dispersion model (v4). The model requires the user to provide various input data, including emissions from each section of road, and the road characteristics (including road width and street canyon height, where applicable). Vehicle emissions have been calculated based on vehicle flow, composition and speed data using the Emission Factor Toolkit (Version 6.0.2) published by Defra (2016b).

A2.3 Hourly sequential meteorological data from Coventry for 2015 have been used in the model. The Coventry meteorological monitoring station is located at Coventry Airport, approximately 2 km to the northeast of Stoneleigh. Warwick, Leamington Spa, Kenilworth, Stoneleigh and the Coventry meteorological monitoring station are located at flat-lying inland locations in the midlands where they will be influenced by the effects of inland meteorology on flat-lying topography. Coventry meteorological monitoring station is therefore deemed to be the nearest monitoring station representative of meteorological conditions in Warwick District.

A2.4 For the purposes of modelling, it has been assumed that the front façades of existing properties along a number of road links are within street canyons formed by the buildings along those road links. These road links include parts of Bath Street, Clemens Street, Charlotte Street, Church Street, George Street, Clapham Terrace, Rushmore Street, Castle Lane, Leycester Place, Castle Street, High Street (Warwick), Jury Street, Swan Street, Brook Street, New Street (Warwick), Market Street, Barrack Street, The Butts, Chapel Street, Smith Street, Mill Street, Gerrard Street, Guy Street, Cherry Street, St Nicholas Church Street, The Square, Priory Road, Bridge Street, New Street (Kenilworth), High Street (Kenilworth) and Fieldgate Lane. These roads have a number of canyon-like features which reduce dispersion of traffic emissions and can therefore lead to concentrations of pollutants being higher here than they would be in areas with greater dispersion. As a precautionary measure, these roads have been assumed to be canyons and ADMS-roads may therefore have over predicted concentrations at the façades of existing properties along these roads.

A2.5 AADT flows, proportions of HDVs and speeds have been provided by Warwick District Council. These were derived from the S-Paramics Micro-simulation traffic model. Diurnal flow profiles for the traffic have been derived from the national diurnal profiles published by DfT (DfT, 2011).

Model Verification

A2.6 In order to ensure that ADMS-Roads accurately predicts local concentrations, it is necessary to verify the model against local measurements. The verification methodology is described below.

A2.7 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2). The model has been run to predict the annual mean NOx concentrations during 2015 at all Warwick, Leamington Spa and Kenilworth roadside diffusion tube monitoring sites within the modelled road network.

A2.8 The model output of road-NOx (i.e. the component of total NOx coming from road traffic) has been compared with the 'measured' road-NOx. Measured road-NOx has been calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the NOx from NO_2 calculator (Version 4.1) available on the Defra LAQM Support website (Defra, 2016b).

A2.9 An adjustment factor has been determined as the slope of the best-fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure A2.1). Adjustment factors have been derived for Warwick, Leamington Spa and Kenilworth. Due to the lack on monitoring information in Stoneleigh, the adjustment factor for Kenilworth has been used for Stoneleigh. The following adjustment factors have been applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations:

- Warwick road adjustment factor : 3.781
- Warwick canyon adjustment factor : 6.414
- Leamington Spa road adjustment factor : 4.358
- Leamington Spa canyon adjustment factor : 5.824
- Kenilworth road adjustment factor : 2.570
- Kenilworth canyon adjustment factor : 4.853

A2.10 The total nitrogen dioxide concentrations have then been determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx to NO_2 calculator. Figure A2.2 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows a 1:1 relationship for Warwick, Leamington Spa and Kenilworth.

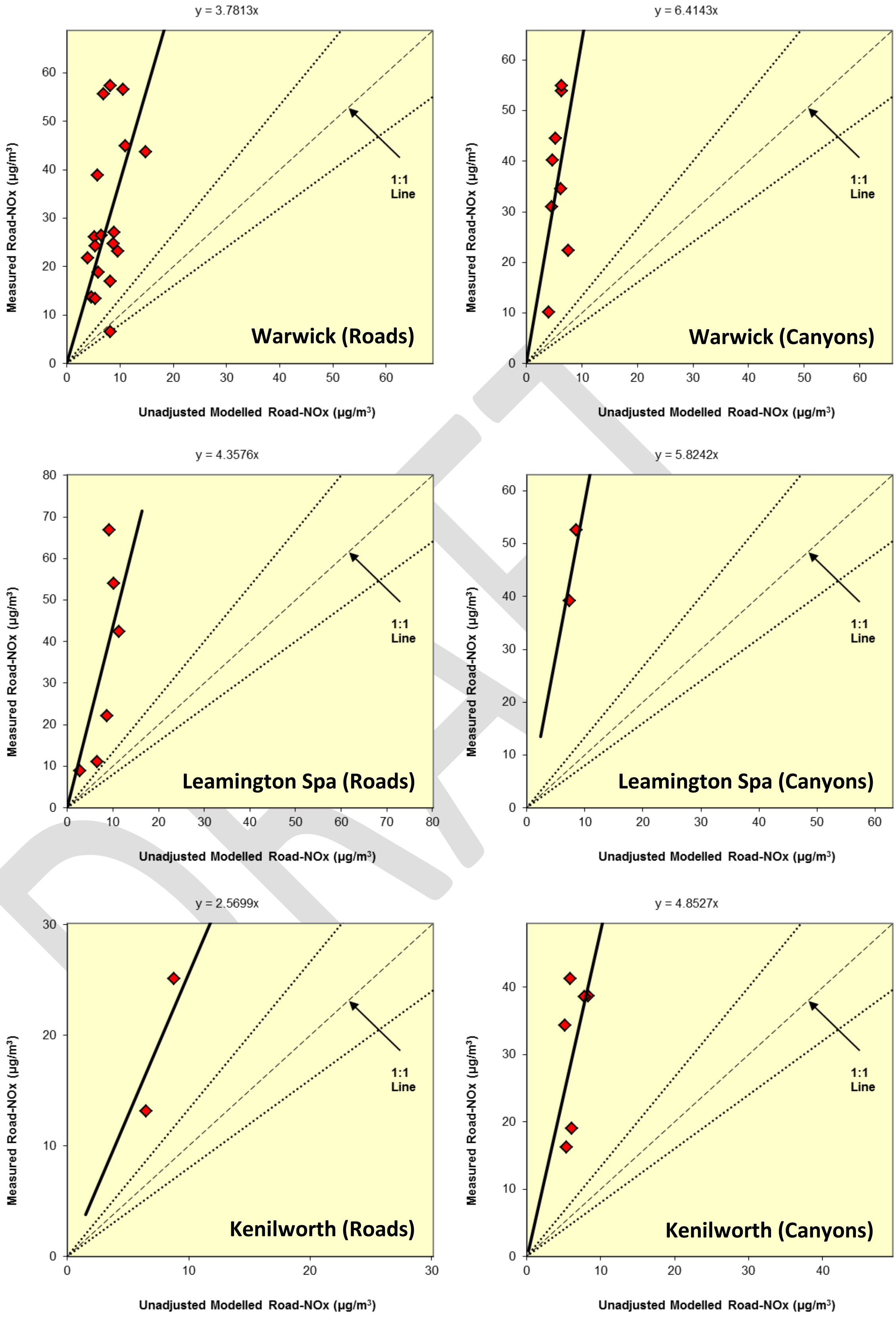

Figure A2.1: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations. The dashed lines show ± 25%.

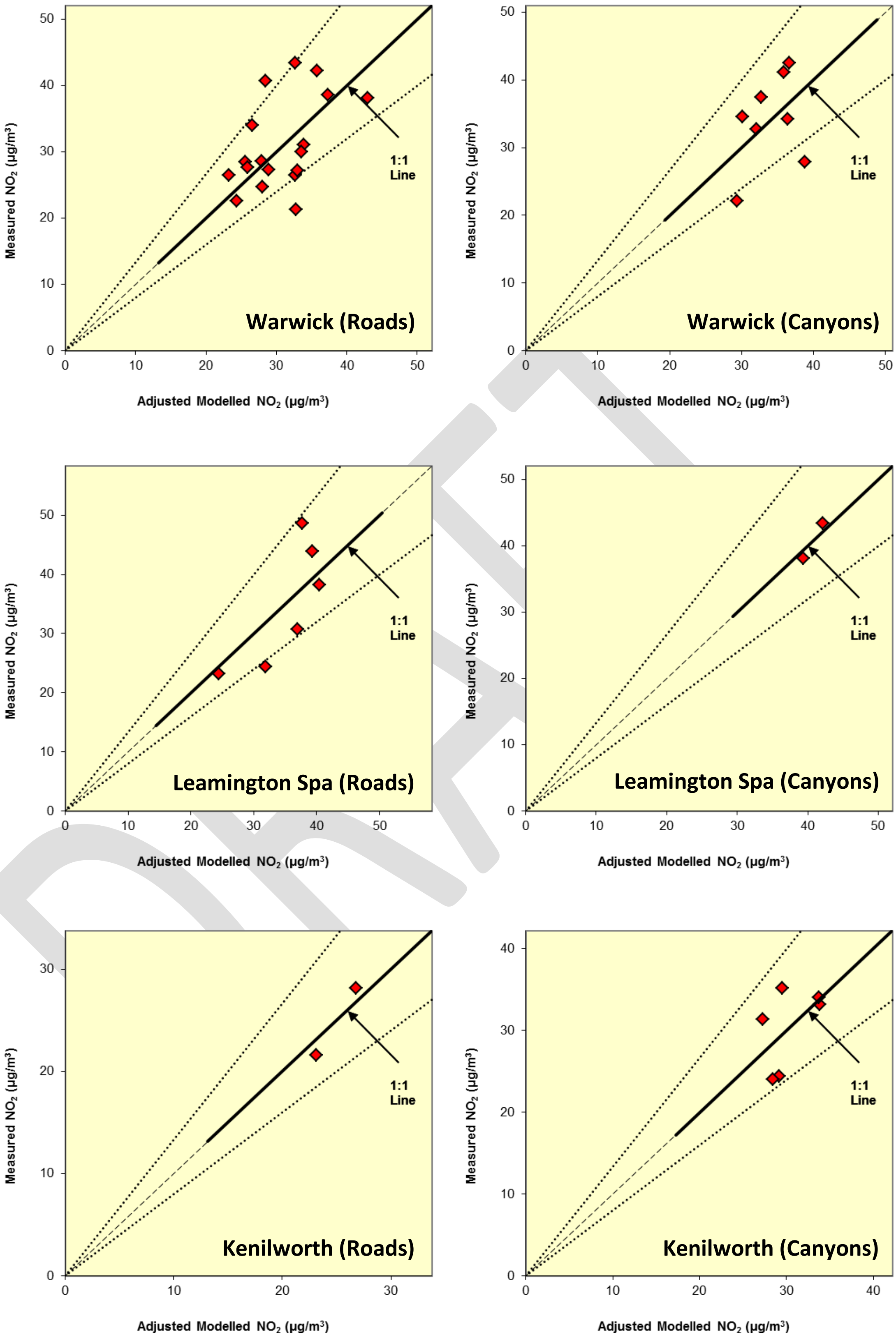

Figure A2.2: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

PM_{10} and $PM_{2.5}$

A2.11 There are no PM_{10} or $PM_{2.5}$ monitors within the modelled study areas. It has therefore not been possible to verify the model for PM_{10} or $PM_{2.5}$. The model outputs of road-PM_{10} and road-$PM_{2.5}$ have therefore been adjusted by applying the adjustment factors calculated for road NO_x.

Model Post-processing

A2.12 The model predicts road-NOx concentrations at each receptor location. These concentrations have then been adjusted using the primary adjustment factor, which, along with the background NO_2, is processed through the NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2016c). The traffic mix within the calculator was set to “All other urban UK traffic”, which is considered suitable for the study area. The calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NO_2. This is then adjusted by the secondary adjustment factor to provide the final predicted concentrations.

A3 Predicted Concentrations

Table A3.1: Predicted Annual Mean Nitrogen Dioxide Concentrations (µg/m^3) at Receptors

Receptor	2015	2028 Reference Case	2028 Preferred Option
Leamington Spa			
L1	31.4	21.8	23.2
L2	34.0	22.9	25.0
L3	32.8	22.4	24.1
L4	34.7	23.2	24.7
L5	30.6	21.3	22.3
L6	32.4	22.1	23.1
L7	31.1	21.5	22.3
L8	35.0	23.1	23.9
L9	37.9	23.7	24.3
L10	34.2	22.8	23.3
L11	32.7	21.2	22.1
L12	31.2	20.6	21.4
L13	33.5	22.6	23.7
L14	30.3	22.6	24.2
L15	27.2	21.3	21.9
L16	29.7	22.7	23.0
L17	29.3	19.5	20.5
L18	26.9	18.6	19.4
L19	31.6	20.8	22.9
L20	29.0	19.7	21.4
L21	29.7	19.3	20.1
L22	27.2	18.3	18.7
L23	25.3	17.5	17.7
L24	26.0	17.8	17.9
Warwick			
W1	25.6	15.6	16.1

Receptor	2015	2028 Reference Case	2028 Preferred Option
W2	**41.6**	22.3	24.5
W3	25.6	16.0	16.6
W4	29.2	17.4	18.2
W5	37.8	23.4	24.3
W6	26.0	16.5	17.0
W7	36.0	22.7	23.9
W8	26.6	17.0	17.4
W9	27.6	17.5	17.9
W10	23.7	15.8	16.0
W11	34.3	21.0	21.5
W12	38.7	23.3	23.9
W13	30.5	18.9	19.8
W14	24.8	16.1	16.7
W15	26.8	17.4	17.8
W16	37.7	23.9	24.4
W17	34.5	21.7	22.0
W18	33.0	21.0	21.1
W19	31.9	21.1	21.3
W20	34.6	22.1	21.7
W21	32.7	20.9	20.9
W22	33.7	21.7	21.5
W23	32.4	21.5	21.2
W24	25.9	18.1	17.8
W25	**42.4**	25.0	26.1
W26	**42.4**	26.4	27.4
W27	28.0	19.7	20.2
W28	28.2	19.8	20.4
W29	28.5	20.3	21.0
W30	31.3	21.9	23.1
W31	31.2	21.9	23.1
W32	**41.0**	27.9	29.5

Receptor	2015	2028 Reference Case	2028 Preferred Option
W33	33.3	21.7	22.4
W34	26.6	18.6	19.2
W35	35.6	22.6	24.6
W36	34.9	22.1	23.2
W37	38.6	23.2	24.4
W38	36.7	21.8	22.8
W39	32.3	20.6	21.4
W40	38.4	24.3	25.1
W41	38.6	24.4	25.1
W42	31.5	20.7	22.4
Kenilworth			
K1	**43.2**	22.4	23.3
K2	**42.1**	21.9	22.8
K3	37.5	19.8	20.5
K4	31.9	17.9	18.3
K5	25.6	15.5	15.8
K6	23.9	14.7	15.0
K7	21.3	13.7	14.0
K8	20.5	12.0	12.5
K9	21.0	13.6	13.6
K10	20.7	13.5	13.5
K11	29.7	16.8	17.4
K12	23.9	14.7	15.0
K13	31.7	17.7	18.6
K14	25.2	15.1	15.6
K15	23.7	14.6	15.0
K16	24.0	15.3	15.6
K17	29.6	17.5	17.9
K18	22.4	14.9	15.0
K19	23.6	15.6	15.6
K20	32.2	19.0	19.4

Receptor	2015	2028 Reference Case	2028 Preferred Option
K21	35.0	20.2	20.5
K22	33.7	19.5	19.8
K23	33.4	19.8	20.9
K24	24.0	15.4	15.4
K25	25.3	16.0	16.2
K26	21.8	14.5	14.7
Stoneleigh			
S1	15.9	10.8	11.0
S2	18.2	11.5	11.9
S3	15.2	10.5	10.7
S4	15.3	10.5	10.7
S5	15.9	10.7	10.9
S6	17.4	11.2	11.6
S7	16.2	10.8	11.0
S8	14.3	10.2	10.3
S9	16.9	11.2	11.5
S10	14.0	10.1	10.1
S11	15.7	10.7	10.9
S12	19.5	12.2	12.6
S13	24.8	14.4	15.2
S14	18.7	11.8	12.2
S15	17.6	11.5	11.8
S16	16.4	11.0	11.2
Objective	40		

Table A3.2: Predicted Annual Mean PM_{10} Concentrations ($\mu g/m^3$) at Receptors

Receptor	2015	2028 Reference Case	2028 Preferred Option
Leamington Spa			
L1	18.5	17.4	17.5
L2	18.8	17.7	17.9

L3	18.6	17.5	17.7
L4	18.8	17.6	17.8
L5	18.2	17.1	17.2
L6	18.5	17.3	17.4
L7	18.3	17.2	17.3
L8	18.8	17.6	17.6
L9	19.4	18.2	18.2
L10	18.7	17.6	17.6
L11	18.7	17.6	17.8
L12	18.6	17.5	17.6
L13	18.8	17.7	17.6
L14	20.7	19.5	20.0
L15	20.1	19.1	19.2
L16	20.7	19.6	19.7
L17	18.4	17.4	17.5
L18	18.1	17.1	17.2
L19	18.9	17.9	18.4
L20	18.5	17.5	17.9
L21	18.7	17.6	17.7
L22	18.2	17.1	17.2
L23	18.0	16.9	16.9
L24	18.1	16.9	17.0
Warwick			
W1	17.5	16.3	16.4
W2	20.4	18.6	19.0
W3	17.4	16.3	16.4
W4	18.1	16.8	16.9
W5	19.0	17.6	17.7
W6	17.4	16.3	16.4
W7	18.8	17.5	17.8
W8	17.6	16.5	16.6
W9	17.7	16.7	16.7

W10	17.1	16.1	16.2
W11	18.6	17.6	17.6
W12	19.5	18.4	18.4
W13	18.4	17.4	17.4
W14	17.1	16.2	16.1
W15	17.5	16.5	16.5
W16	19.2	18.5	18.4
W17	18.6	17.7	17.6
W18	18.3	17.6	17.4
W19	18.4	17.7	17.5
W20	18.6	17.7	17.4
W21	18.5	17.5	17.2
W22	18.9	17.9	17.5
W23	18.7	17.8	17.4
W24	17.3	16.4	16.3
W25	19.8	18.5	18.8
W26	19.7	18.7	18.8
W27	17.6	16.6	16.6
W28	17.6	16.6	16.7
W29	17.6	16.7	16.7
W30	18.0	17.1	17.2
W31	18.0	17.1	17.2
W32	19.4	18.7	18.9
W33	18.2	17.2	17.3
W34	17.4	16.3	16.4
W35	18.9	17.6	18.1
W36	18.5	17.2	17.4
W37	19.0	17.5	17.7
W38	18.7	17.1	17.3
W39	18.1	16.7	16.9
W40	19.3	18.4	18.3
W41	19.1	18.1	18.0

W42	18.0	16.9	17.1
Kenilworth			
K1	19.4	18.0	18.3
K2	19.3	17.9	18.2
K3	19.0	17.7	17.9
K4	18.1	17.0	17.1
K5	17.1	16.0	16.1
K6	16.6	15.5	15.6
K7	16.3	15.3	15.4
K8	16.7	15.7	15.9
K9	16.5	15.5	15.5
K10	16.4	15.5	15.5
K11	17.5	16.3	16.5
K12	17.0	16.0	16.1
K13	18.1	16.8	17.1
K14	17.1	16.0	16.1
K15	17.0	15.8	16.0
K16	16.9	15.8	15.9
K17	17.9	16.6	16.8
K18	16.6	15.5	15.6
K19	16.7	15.7	15.7
K20	18.4	17.2	17.3
K21	19.0	17.9	18.0
K22	18.6	17.4	17.5
K23	18.1	16.9	17.1
K24	16.9	15.8	15.8
K25	16.9	15.7	15.8
K26	16.5	15.4	15.5
Stoneleigh			
S1	16.6	15.5	15.6
S2	16.9	15.8	16.0
S3	16.4	15.4	15.5

S4	16.4	15.4	15.5
S5	16.5	15.5	15.6
S6	16.8	15.7	15.8
S7	15.9	14.9	15.0
S8	16.3	15.3	15.3
S9	16.1	15.0	15.1
S10	15.6	14.6	14.7
S11	15.8	14.8	14.9
S12	16.6	15.5	15.7
S13	17.3	16.0	16.3
S14	16.3	15.2	15.3
S15	16.3	15.3	15.4
S16	16.1	15.1	15.2
Objective	**40**		

Table A3.3: Predicted Annual Mean $PM_{2.5}$ concentrations ($\mu g/m^3$) at Receptors

Receptor	2015	2028 Reference Case	2028 Preferred Option
Leamington Spa			
L1	12.6	11.5	11.6
L2	12.8	11.6	11.8
L3	12.7	11.5	11.6
L4	12.8	11.6	11.7
L5	12.4	11.4	11.4
L6	12.6	11.5	11.5
L7	12.5	11.4	11.4
L8	12.8	11.6	11.6
L9	13.0	11.8	11.8
L10	12.7	11.6	11.6
L11	12.6	11.5	11.6
L12	12.5	11.5	11.5
L13	12.8	11.7	11.6
L14	13.5	12.5	12.8

L15	13.2	12.3	12.4
L16	13.5	12.5	12.6
L17	12.4	11.4	11.5
L18	12.2	11.2	11.3
L19	12.7	11.7	11.9
L20	12.5	11.5	11.7
L21	12.6	11.5	11.6
L22	12.3	11.3	11.3
L23	12.2	11.1	11.2
L24	12.2	11.2	11.2
Warwick			
W1	11.8	10.7	10.8
W2	13.6	12.0	12.2
W3	11.8	10.7	10.8
W4	12.2	11.0	11.1
W5	12.9	11.5	11.6
W6	11.8	10.8	10.8
W7	12.8	11.5	11.6
W8	11.9	10.9	10.9
W9	12.0	11.0	11.0
W10	11.6	10.7	10.7
W11	12.6	11.4	11.4
W12	13.1	11.9	11.9
W13	12.4	11.3	11.3
W14	11.6	10.7	10.7
W15	11.8	10.9	10.9
W16	12.9	11.9	11.9
W17	12.5	11.5	11.5
W18	12.4	11.4	11.3
W19	12.4	11.5	11.4
W20	12.6	11.5	11.3
W21	12.5	11.4	11.2

W22	12.7	11.6	11.4
W23	12.5	11.5	11.3
W24	11.7	10.8	10.7
W25	13.3	11.9	12.1
W26	13.2	12.1	12.1
W27	12.0	11.0	11.0
W28	12.0	11.0	11.0
W29	12.0	11.0	11.1
W30	12.3	11.3	11.3
W31	12.3	11.3	11.3
W32	13.1	12.1	12.2
W33	12.3	11.2	11.3
W34	11.9	10.9	10.9
W35	12.8	11.5	11.8
W36	12.6	11.3	11.5
W37	12.9	11.5	11.6
W38	12.7	11.3	11.4
W39	12.3	11.1	11.2
W40	13.1	12.0	11.9
W41	12.9	11.8	11.8
W42	12.3	11.2	11.3
Kenilworth			
K1	13.1	11.7	11.8
K2	13.0	11.6	11.8
K3	12.8	11.5	11.6
K4	12.2	11.2	11.2
K5	11.7	10.7	10.7
K6	11.4	10.4	10.4
K7	11.2	10.2	10.3
K8	11.2	10.3	10.4
K9	11.3	10.3	10.3
K10	11.2	10.3	10.3

K11	11.9	10.8	10.9
K12	11.6	10.6	10.7
K13	12.3	11.1	11.2
K14	11.7	10.6	10.7
K15	11.6	10.5	10.6
K16	11.6	10.5	10.6
K17	12.2	11.0	11.1
K18	11.4	10.4	10.4
K19	11.5	10.5	10.5
K20	12.5	11.3	11.4
K21	12.9	11.7	11.8
K22	12.6	11.5	11.5
K23	12.4	11.2	11.3
K24	11.6	10.6	10.6
K25	11.6	10.5	10.5
K26	11.3	10.3	10.4
Stoneleigh			
S1	11.0	10.1	10.1
S2	11.2	10.2	10.3
S3	10.9	10.0	10.1
S4	10.9	10.0	10.1
S5	11.0	10.1	10.1
S6	11.1	10.2	10.2
S7	10.8	9.9	10.0
S8	10.8	10.0	10.0
S9	10.9	10.0	10.1
S10	10.6	9.8	9.8
S11	10.8	9.9	9.9
S12	11.2	10.3	10.3
S13	11.7	10.5	10.7
S14	11.1	10.1	10.2
S15	11.1	10.1	10.2

S16	10.9	10.0	10.1
Objective	**25**		