Breckland District Council

Swaffham

Detailed Assessment

October 2016

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Document Control Sheet

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Executive Summary

Part IV of the Environment Act 1995 places a statutory duty on local authorities to review and assess the air quality within their area. For local authorities that have identified areas where there is a potential risk of exceedence of Air Quality Strategy (AQS) objectives, a Detailed Assessment (DA) is required.

Following nitrogen dioxide (NO_2) diffusion tube monitoring at site S8 on the A1062 (Station Street), Breckland District Council has identified an exceedence of the NO_2 objective occurring consistently since 2010. The site is representative of relevant exposure being located on a residential property and there is further relevant residential exposure along the length of Station Street. Slow moving traffic currently passes this location on the lead up to the northern arm of the central junction with Lynn Street and Mangate Street. Due to traffic signals being located at this junction there are times where traffic backs up and queues are experienced northerly on Station Street having a significant impact on pollutant concentrations.

Bureau Veritas UK Ltd has therefore been commissioned by Breckland District Council to undertake the Detailed Assessment for the area of Station Street (A1062) from the junction with Sporle Road to the junction with Market Place incorporating the central junction with Lynn Street and Mangate Street, to determine existing concentrations at relevant receptors.

In order to provide consistency with Breckland District Council's own work on air quality, the guiding principles for air quality assessments, as set out in the latest guidance and tools provided by Defra for air quality assessment (LAQM.TG(16)[1]), have been used.

The area was modelled using the advanced atmospheric dispersion model ADMS-Roads (Version 4.0.1). Two separate scenarios were modelled; the first based on the existing road layout of the A1062 junction, and the second an alternative road layout (Option 1) based upon a study on reducing NO_x concentrations at the junction completed by Norfolk County Council[2].

Annual mean NO_2 concentrations were found to be below the 40µg/m^3 annual mean AQS objective at all receptors across both modelled scenarios. Three receptors, 21 Station Street, 15 Station Street and 57 Lynn Street, were within 10% of the objective for the Existing scenario. The highest modelled concentration was at receptor 3 – 21 Station Street for both scenarios, with a predicted annual mean NO_2 concentration of 36.7µg/m^3 and 33.9µg/m^3.

On the basis of the model predicted annual mean NO_2 concentrations and the published empirical relationship with exceedences of the short-term AQS objective limit, it is considered unlikely that the short-term hourly mean NO_2 AQS objective would be exceeded at any receptors given the concentrations modelled.

The gridded output of the model demonstrates that the geographical extent of the exceedence covers the area along the A1062 from south of the junction with Sporle Road, incorporating the central junction with Lynn Street and Mangate Street, and reaching south to the junction with Market Place. The extent of the exceedence is reduced slightly in the Option 1 scenario compared to the Existing scenario where the road layout has been adapted to match studies completed by Norfolk County Council[2].

The modelled road layout was amended for the second modelled scenario based on findings made by Norfolk County Council[2]. A reduction was experienced at all modelled receptors for the Option 1 scenario, and also the geographical extent of the areas in exceedence of the annual mean AQS objective or within 10% of the objective was reduced.

[1] Local Air Quality Management Technical Guidance LAQM.TG(16). April 2016. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

Following the results of the report, the below recommendations are made:

- That an Air Quality Management Area (AQMA) be declared in the assessment area, the extent of which is proposed in Figure 5.3.
- Continuation of diffusion tube monitoring in the area of the proposed AQMA, particularly at sites S1, S7, S8, S11 and S12 to confirm existing concentrations in the modelled exceedence area, and to continue diffusion tube monitoring further south down on London Street to assess concentrations south of the recommended AQMA boundary.
- An Air Quality Action Plan is drawn up to determine the best policies and intervention measures to put in place in order to reduce local NO_2 concentrations.
- Additional traffic surveys are undertaken in the vicinity of the proposed AQMAs. This will minimise the manipulation of traffic data inputs required for future dispersion modelling studies, thereby reducing the associated uncertainties of model outputs.
- Further assessment of the changes to the road network proposed in the Option 1 scenario in respect to potential queuing traffic.

1 Introduction

1.1. Scope of Assessment

Following NO_2 diffusion tube monitoring within Swaffham at site S8 located on Station Street, Breckland District Council (the Council) has identified a consistent exceedence of the NO_2 objective since 2010. There is relevant exposure in the form of residential properties on Station Street where traffic slows before the junctions with Lynn Street and Mangate Street in the centre of Swaffham.

Bureau Veritas UK Ltd has therefore been commissioned by the Council to undertake a Detailed Assessment (DA) for the area of Station Street, Mangate Street and Lynn Street in Swaffham, to determine existing concentrations at relevant receptors. The area considered as part of this study is illustrated in Figure 1.1.

It is the general purpose and intent of this assessment to determine, with reasonable certainty, the magnitude and geographical extent of any exceedence so that the Council can have confidence in the potential declaration of an AQMA.

The following are the main objectives of the assessment:

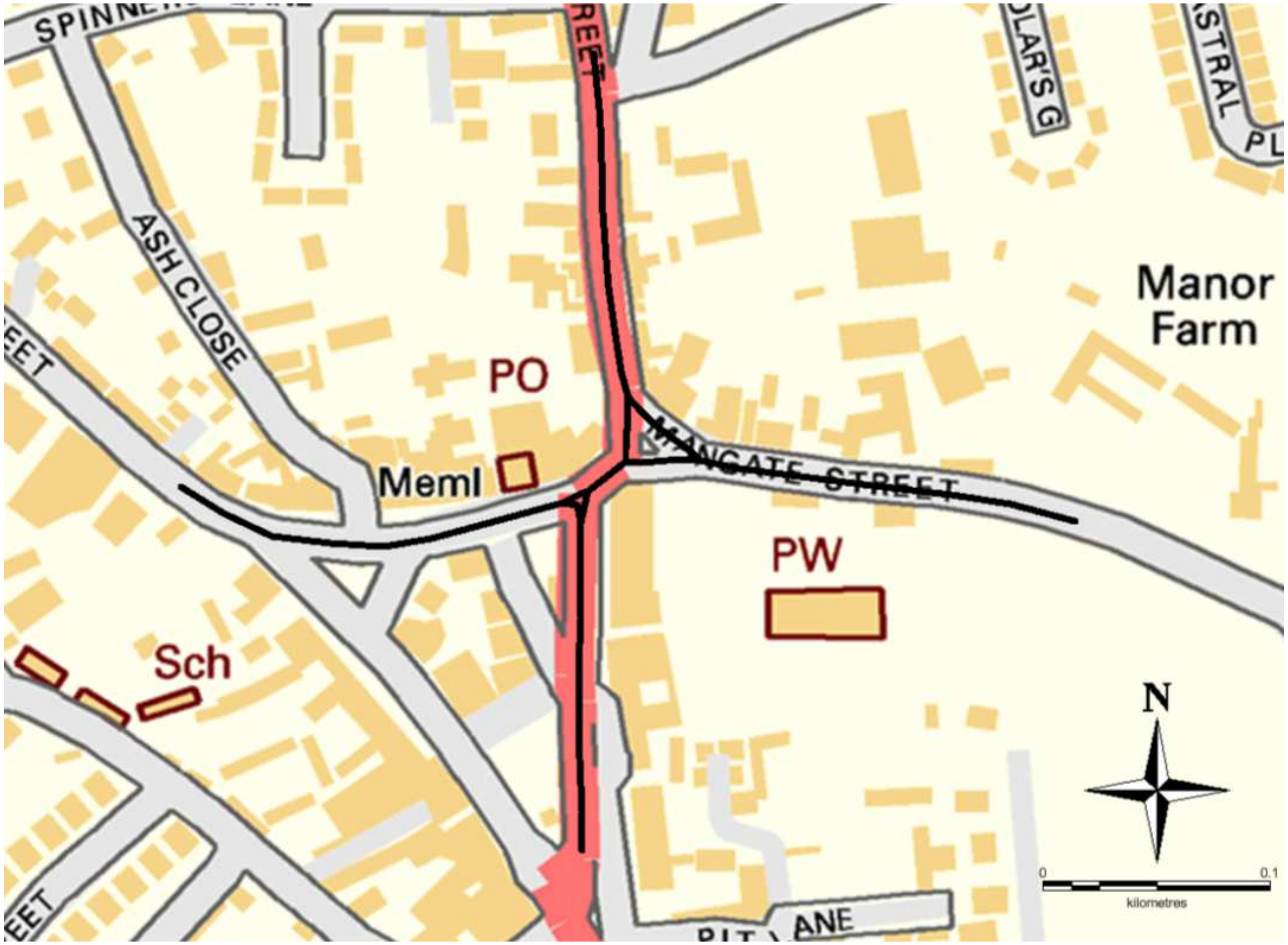
- To assess the air quality at selected locations ("receptors") at the façades of the existing residential units, representative of worst-case exposure, based on modelling of emissions from road traffic on the Existing local road network for 2015;
- To determine the geographical extent of the potential exceedence;
- To model a second scenario whereby the road layout is changed to reflect Option 1 outlined in the Technical Note completed in August 2015[2]; and
- To put forward conclusions and recommendations as to the extent of any proposed AQMA and necessary future monitoring.

The approach adopted in this assessment to assess the impact of road traffic emissions on air quality utilised the atmospheric dispersion model ADMS Roads version 4.0.1, focusing on emissions of nitrogen oxides (NO_x).

In order to provide consistency with the Council's own work on air quality, the guiding principles for air quality assessments as set out in the latest guidance and tools provided by Defra for air quality assessment (LAQM.TG(16)[1]) have been used.

[2] Norfolk County Council (2015). A1065 Swaffham – Option Testing – Traffic and Air Quality Assessment Technical Note – August 2015.

Figure 1.1 – Modelled Existing Road Network



Legend
Modelled Road Link

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66 Prescott Street
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Location	
Swaffham, Norfolk	
Title	
Modelled Existing Road Network	
By	**Approved**
PB	JC
Scale	**Job Ref**
As shown	6355043
Date	**Figure No.**
September 2016	**1.1**

2 Air Quality – Legislative Context

2.1. Air Quality Strategy

The importance of existing and future pollutant concentrations can be assessed in relation to the national air quality standards and objectives established by Government. The Air Quality Strategy[3] (AQS) provides the over-arching strategic framework for air quality management in the UK and contains national air quality standards and objectives established by the UK Government and Devolved Administrations to protect human health. The air quality objectives incorporated in the AQS and the UK Legislation are derived from Limit Values prescribed in the EU Directives transposed into national legislation by Member States.

The CAFE (Clean Air for Europe) programme was initiated in the late 1990s to draw together previous directives into a single EU Directive on air quality. The CAFE Directive[4] has been adopted and replaces all previous air quality Directives, except the 4th Daughter Directive[5]. The Directive introduces new obligatory standards for $PM_{2.5}$ for Government but places no statutory duty on local government to work towards achievement of these standards.

The Air Quality Standards (England) Regulations[6] 2010 came into force on 11 June 2010 in order to align and bring together in one statutory instrument the Government's obligations to fulfil the requirements of the new CAFE Directive.

The objectives for ten pollutants – benzene (C_6H_6), 1,3-butadiene (C_4H_6), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), particulate matter - PM_{10} and $PM_{2.5}$, ozone (O_3) and polycyclic aromatic hydrocarbons (PAHs) have been prescribed within the AQS[3].

The EU Limit Values are considered to apply everywhere with the exception of the carriageway and central reservation of roads and any location where the public do not have access (e.g. industrial sites). The AQS objectives apply at 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. Typically these include residential properties and schools/care homes for long-term (i.e. annual mean) pollutant objectives and high streets for short-term (i.e. 1-hour) pollutant objectives.

This assessment focuses on NO_2 as this is the pollutant of most concern within the Council's administrative area. The monitoring concentrations recorded at S8 – Station Street have been shown to exceed the annual mean objective for NO_2 in 2014 and previous years. Moreover, as a result of traffic pollution the UK has failed to meet the EU Limit Values for this pollutant by the 2010 target date. As a result, the Government has had to submit time extension applications for compliance with the EU Limit Values. Continued failure to achieve these limits may lead to EU fines. The AQS objectives for these pollutants are presented in Table 2.1.

Table 2.1 – Relevant AQS Objectives in England for the Assessed Pollutants

Pollutant	AQS Objective	Concentration Measured as:	Date for Achievement
Nitrogen dioxide (NO_2)	200 µg/m³ not to be exceeded more than 18 times per year	1-hour mean	31 December 2005
	40 µg/m³	Annual mean	31 December 2005

[3] Defra (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland.

[4] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.

[5] Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic hydrocarbons in ambient air.

[6] The Air Quality Standards Regulations (England) 2010, Statutory Instrument No 1001, The Stationary Office Limited.

2.2. Local Air Quality Management (LAQM)

Part IV of the Environment Act 1995 places a statutory duty on local authorities to periodically Review and Assess the current and future air quality within their area, and determine whether they are likely to meet the AQS objectives set down by Government for a number of pollutants – a process known a Local Air Quality Management (LAQM). The AQS objectives that apply to LAQM are defined for seven pollutants: benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, sulphur dioxide and particulate matter.

Where the results of the Review and Assessment process highlight that problems in the attainment of health-based objectives for air quality will arise, the authority is required to declare an Air Quality Management Area (AQMA) – a geographic area defined by high concentrations of pollution and exceedences of health-based standards.

Where an authority has declared an AQMA, and development is proposed to take place either within or near the declared area, further deterioration to air quality resulting from a proposed development can be a potential barrier to gaining consent for the development proposal. Similarly, where a development would lead to an increase of the population within an AQMA, the protection of residents against the adverse long-term impacts of exposure to existing poor air quality can provide the barrier to consent. As such, following an increased number of declarations across the UK, it has become standard practice for planning authorities to require an air quality assessment to be carried out for a proposed development (even where the size and nature of the development indicates that a formal Environmental Impact Assessment (EIA) is not required.

One of the objectives of the LAQM regime is for local authorities to enhance integration of air quality into the planning process. Current LAQM Policy Guidance[7] clearly recognises land-use planning as having a significant role in terms of reducing population exposure to elevated pollutant concentrations. Generally, the decisions made on land-use allocation can play a major role in improving the health of the population, particularly at sensitive locations – such as schools, hospitals and dense residential areas.

[7] Defra (2016). LAQM Policy Guidance LAQM.PG(16).

3 Review and Assessment of Air Quality Undertaken by the Council

3.1. Local Air Quality Management

Table 3.1 – Summary of Review and Assessment Undertaken by Breckland District Council

Title	Outcome
Updating and Screening Assessment 2003	Exceedence of the objective for PM_{10} at East Wretham Heath identified.
Detailed Assessment 2004	Declaration of an AQMA for PM_{10} at East Wretham Heath in 2005
Further Assessment 2006	No exceedences of any objectives likely and no more than the permitted number of exceedences for AQMA (PM_{10})
Progress Report 2007	No exceedences of any objectives recorded.
Progress Report 2008	An exceedence of the annual mean objective for NO_2 in London Street (A1065) in Swaffham was recorded.
Updating and Screening Assessment 2009	No exceedences of any objectives were recorded. It was noted that NO_2 levels at London Street (A1065) in Swaffham were close to the objective levels.
Progress Report 2010	No exceedences of any objectives were recorded. It was noted that NO_2 levels at London Street and Station Street (A1065) in Swaffham were close to the objective levels.
Progress Report 2011	One exceedence as well as a number of results close to the objective levels were recorded along London Street and Station Street (A1065).
Updating and Screening Assessment 2012	One exceedence as well as a number of results close to the objective levels were recorded along London Street and Station Street (A1065). Recommended proceed to Detailed Assessment for Station Street.
Detailed Assessment 2012	A detailed assessment was completed to assess the requirement for an AQMA due to monitored NO_2 exceedences within Swaffham. It was concluded that an AQMA wasn't required as the exceedence was small, monitoring was to continue to assess the effects of proposed developments.
Progress Report 2013	No exceedences of any objective likely. It was noted that the NO_2 concentration in Station Road and London Street, Swaffham were close to the annual mean objective level.
Progress Report 2014	An exceedence of the annual mean objective for NO_2 was again experienced within Swaffham. It was concluded that a second Detailed Assessment should be produced to further investigate NO_2 concentration in Swaffham.
Updating and Screening Assessment 2015	No exceedences of the annual mean objective for NO_2 were experienced within Swaffham. A feasibility study has been completed assessing road layout to be used to inform the DA.

3.2. Review of Air Quality Monitoring

3.2.1 Automatic Monitoring data

NO_2 automatic monitoring is currently undertaken by the Council at two locations: the Rural Background site off Thetford Road, Wretham, and the Roadside site on London Street, Swaffham. The continuous monitor located at Wretham is located 21km from Swaffham to the south east and therefore is not considered within this report. The continuous monitor located in Swaffham is co-located with diffusion tubes and a bias adjustment factor for the area is calculated using the results.

Table 3.2 – Swaffham Continuous Monitor Details

Site Name	Site Type	OS Grid	Pollutants Monitored	In AQMA?	Method Used	Relevant Exposure?	Distance to kerb of nearest road
S3	Roadside	582093, 308469	NO_2	N	Chemilumine-scence	Yes	2m

Details of the automatic monitoring site S3 are provided in Table 3.2. Recent monitoring results for the automatic monitoring site within Swaffham are shown in Table 3.3 and Table 3.4.

Table 3.3 – Swaffham Continuous Monitoring Annual Mean Results

Site Name	Valid Data Capture for period of monitoring %	Valid Data Capture 2014 %	Annual Mean Concentration (µg/m^3)						
			2009	2010	2011	2012	2013	2014	2015
S3	99.9	99.9	32	35	31	31	33	33	29

Table 3.4 – Swaffham Continuous Monitoring Hourly Exceedence Results

Site Name	Valid Data Capture for period of monitoring %	Valid Data Capture 2014 %	Number of Exceedences of Hourly Mean (200 µg/m^3)						
			2009	2010	2011	2012	2013	2014	2015
S3	99.9	99.9	0	0	1	1	0	0	0

Results for 2015 indicate that both the annual mean objective and the 1-hour objective for NO_2 were met at the Swaffham S3 continuous monitoring location.

3.2.2 Nitrogen Dioxide Diffusion Tube Data

In 2015 the Council undertook passive diffusion tube monitoring of NO_2 at 26 locations throughout the District. Table 3.5 provides details of the 7 diffusion tube monitoring sites located close to the modelled road area, with recorded concentrations given for years 2010 to 2015. The locations of the diffusion tube monitoring locations relative to the modelled road network are illustrated in Figure 3.1.

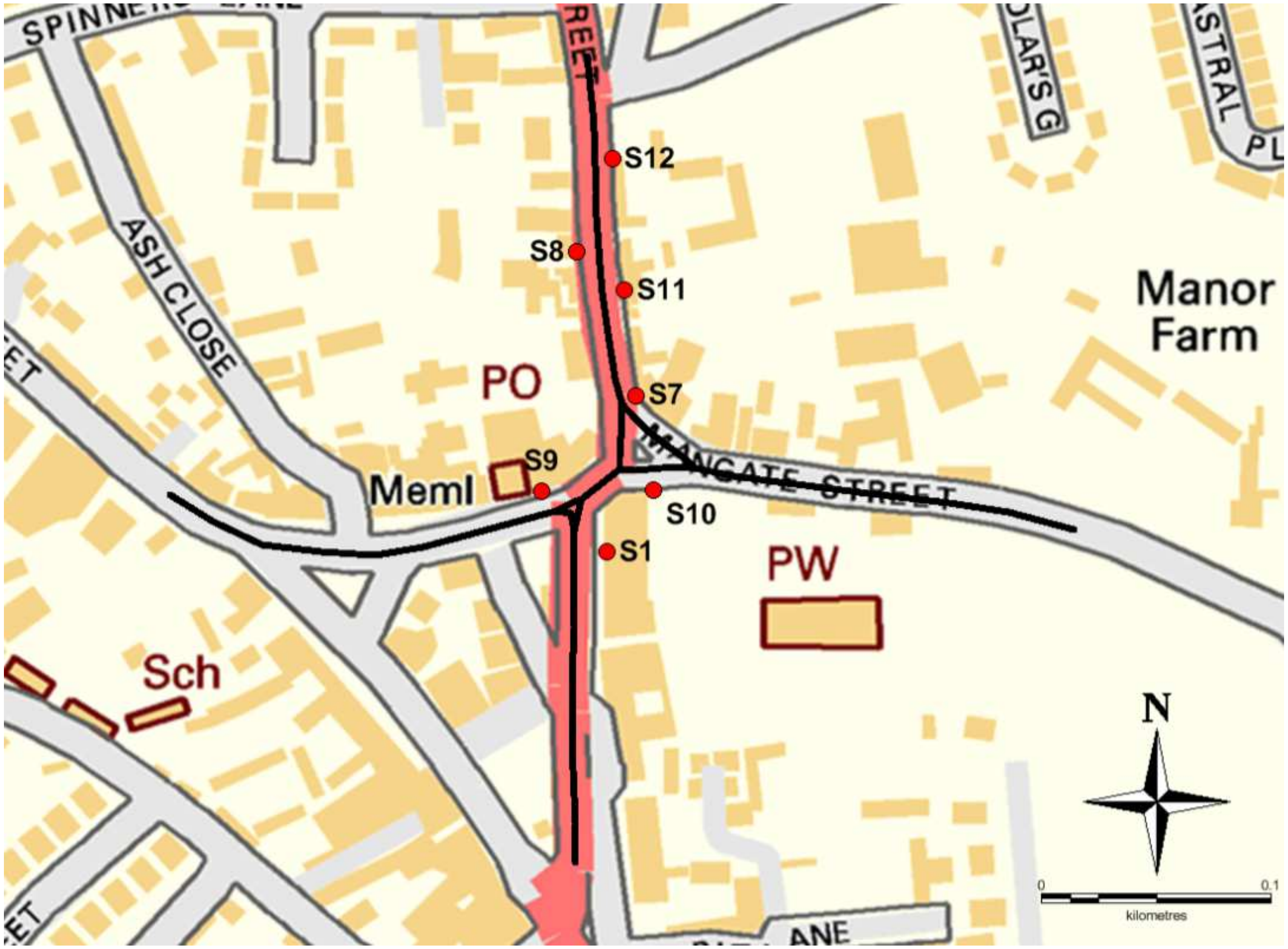
The NO_2 annual mean concentration at S8 has been observed to be above the 40µg/m^3 Air Quality Strategy (AQS) objective for four out of the past six years. Concentrations have been relatively consistent over the past six years with a range of 3.9µg/m^3 and an average of 39.8µg/m^3 over the period.

S8 is located on the A1065 Station Street where traffic queues are apparent from the junction with Mangate Street/Lynn Street. S7, S11 and S12 are also located on Station Street and recorded concentrations between 31.4µg/m^3 and 34.8µg/m^3 in 2015. During the past six years there have not been any exceedences of the annual mean AQS objective at these locations.

Table 3.5 – LAQM Diffusion Tube Monitoring undertaken within the modelled area

Site ID	Site Type	OS Grid Ref	In AQMA	Distance to Road (m)	Annual Mean NO_2 Concentration (µg/m[3])					
					2010	2011	2012	2013	2014	2015
S1	UC	581986, 309031	N	5	27.8	25.3	25.5	25.9	25.3	22.6
S7	RS	581999, 309143	N	7	38.7	35.1	36.0	36.4	34.9	34.8
S8	RS	581980, 309143	N	5	**40.0**	**40.4**	38.8	**41.6**	**40.4**	37.7
S9	RS	581949, 309055	N	4	-	25.1	28.6	30.7	28.2	26.4
S10	RS	581977, 308970	N	3	-	22.9	28.1	28.0	25.9	24.7
S11	RS	581942, 309162	N	3	-	36.0	35.2	36.7	35.6	34.0
S12	RS	581987, 309136	N	3	-	36.6	35.2	35.7	34.4	31.4
In **bold**, exceedence of the NO_2 annual mean AQS objective of 40 µg/m[3] RS = Roadside, UC – Urban Centre										

Figure 3.1 – Diffusion Tube Locations within Modelled Road Area



Legend

Diffusion Tube

Modelled Road Link

Air Quality
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Location

Swaffham, Norfolk

Title

Diffusion Tube Locations within Modelled Road Area

By	Approved
PB	JC
Scale	**Job Ref**
As shown	6355043
Date	**Figure No.**
September 2016	**3.1**

3.3. Background Concentrations used in the Assessment

Defra maintains a nationwide model of existing and future background air quality concentrations at a 1km grid square resolution. The data sets include annual average concentration estimates for NO_x, NO_2, PM_{10} and $PM_{2.5}$, using a base year of 2013. The model used is semi-empirical in nature; it uses the national atmospheric emissions inventory (NAEI) emissions to model-predict the concentrations of pollutants at the centroid of each 1km grid square, but then calibrates these concentrations in relation to actual monitoring data.

Annual mean background concentrations have been obtained from the Defra published background maps[8], based on the 1km grid squares which cover the modelled area and the affected road network. The Defra mapped background concentrations for 2015 are presented in Table 3.6.

Table 3.6 – Background Pollutant Concentrations (Defra Background Maps)

Grid Square (E,N)	2015 Annual Mean Concentration (µg/m^3)	
	NO_x	**NO_2**
581500, 309500	14.6	10.7
581500, 308500	13.0	9.6
582500, 309500	13.5	10.0
AQS objective	-	**40**

These mapped background levels are below the respective annual mean AQS objectives.

The predicted annual mean road contributions are added to the relevant annual mean background concentration in order to predict the total pollutant concentration at each receptor location. The total pollutant concentration can then be compared against the relevant AQS objectives to determine the event of an exceedence.

8 Defra Background Maps (2014). http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

4 Assessment Methodology

The approach used in this assessment has been based on the following:

- Prediction of ambient NO_2 concentrations using the existing road network, to which existing receptors may be exposed and comparison with the relevant AQS objectives;
- Determination of the geographical extent of any potential exceedence;
- Prediction of ambient NO_2 concentrations using the proposed option 1 road network, to which existing receptors may be exposed and comparison with the relevant AQS objectives; and
- Assessing the change in NO_2 concentrations between the two modelled scenarios.

4.1. Traffic Assessment

Emissions from road traffic have been predicted using version 7.0 of the Emissions Factor Toolkit[9]. Road-NO_x contributions at receptor locations were modelled using the ADMS-Roads (Version 4.0.1) atmospheric dispersion model developed by Cambridge Environmental Research Consultants (CERC).

4.1.1 Model Inputs

The ADMS-Roads assessment incorporates numbers of road traffic vehicles, vehicle speeds on the local roads and the composition of the traffic fleet. The traffic data for this assessment has been provided by Traffic Survey Partners in conjunction with Norfolk County Council[10]. A traffic turning count was completed on Tuesday the 24th of March 2015 where all turning points were surveyed over a 12-hour period. A factor was provided by Ian Parkes of Norfolk County Council to factor the 12-hour data up to 24-hour Average Annual Daily Traffic (AADT), the factor provided was 1.208.

Traffic speed data was estimated and confirmed with Breckland District Council to be representable of existing conditions on the modelled road links. Where appropriate, the speeds have been reduced to simulate queues at junctions and traffic lights. Traffic data used within this assessment is outlined in Table 4.1.

Table 4.1 – Traffic Data used in the Detailed Assessment

Link [a]	Link Total (24-hour)	% Car	% LGV	% HGV	% Bus and Coach	% Motocycle
A – A	10	50%	50%	-	-	-
A – B	600	87.93%	11.07%	0.20%	0.20%	0.60%
A – C	2919	82.77%	12.74%	3.63%	0.41%	0.45%
A – D	753	77.37%	8.83%	5.62%	7.54%	0.64%
B – A	539	84.53%	15.02%	0.22%	-	0.22%
B – B	0	-	-	-	-	-
B – C	914	84.81%	12.29%	2.64%	0.26%	-
B – D	1099	85.6%	10.22%	1.87%	1.98%	0.33%
C – A	3138	83.22%	12.25%	4.04%	0.38%	0.12%
C – B	437	80.39%	11.05%	6.63%	1.93%	-

[9] EFT_v7.0 available at - http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

[10] Traffic Survey Partners (2015). Swaffham Manual Classified Traffic Count (TSP12144), 24th March 2015, 07:00 – 19:00.

Link [a]	Link Total (24-hour)	% Car	% LGV	% HGV	% Bus and Coach	% Motocycle
C – C	0	-	-	-	-	-
C – D	182	82.78%	11.92%	-	4.64%	0.66%
D – A	1138	80.15%	10.30%	3.61%	5.41%	0.53%
D – B	1053	86.81%	11.47%	0.46%	0.8%	0.46%
D – C	310	81.71%	17.90%	-	-	0.39%
D – D	0	-	-	-	-	-
[a] Links: A – A1065 Station Street, B – Mangate Street, C – Lynn Street, D – A1065						

The assessment has assumed traffic flows and background monitoring data for the year 2015.

Background pollutant concentrations have been taken from the estimated background concentrations compiled by Defra[8], as discussed previously in Section 3.3. Background concentrations used in the assessment of road traffic emissions are shown in Table 3.6.

The receptors considered in the assessment of emissions from road traffic are shown in Table 4.2 and their location illustrated in Figure 4.1. NO_2 concentrations were also modelled across a regular gridded area of 550x400m with receptors spaced every 4 metres. Additional receptor points were added close to the modelled road links, using the intelligent gridding tool in ADMS Roads.

Table 4.2 – Swaffham Receptor Locations

ID	Receptors	Coordinates		Height (m)
		X	Y	
1	26 Station Street	581969	309237	1.5
2	20-24 Station Street	581971	309190	1.5
3	21 Station Street	581992	309186	1.5
4	16-20 Station Street	581972	309171	1.5
5	15 Station Street	581991	309166	1.5
6	12 Station Street	581975	309146	1.5
7	7 Station Street	581998	309126	1.5
8	10 Station Street	581976	309125	1.5
9	8 Station Street	581980	309108	1.5
10	1 Station Street	582008	309094	1.5
11	17 Mangate Street	582049	309077	1.5
12	57 Lynn Street	581976	309070	1.5
13	42 Market Place	581934	309055	1.5
14	31-33 Market Place	581889	309048	1.5
15	61 Market Place	581987	309047	1.5
16	69 Market Place	581986	309011	1.5
17	77/81 Market Place	581986	308987	1.5
18	87 Market Place	581999	308934	1.5
19	91 Market Place	581997	308912	1.5
20	Market Place	581962	308911	1.5
21	13 Market Place	581951	308974	1.5
22	10 Market Place	581939	308999	1.5
23	5 Market Place	581929	309028	1.5
24	5a Market Place	581913	309024	1.5

The road layout for the Option 1 scenario has been taken from the Norfolk County Council Technical Note[2] which has been identified as the best performing of 4 road layout options in relation to % reduction of NO_x emissions. Option 1 includes the removal of all traffic signal junctions from the intersection replacing them with two major/minor priority junctions and uncontrolled pedestrian crossings with a central refuge across all four approaches. The Option 1 modelled road network, including receptor locations is presented in Figure 4.2.

Meteorological data from a representative station is required by the dispersion model. 2015 meteorological data from Marham weather station has been used in this assessment. A wind rose for this site for the year 2015 is shown in Figure 4.3. Most dispersion models do not use meteorological data if they relate to calm winds conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. ADMS-Roads treats calm wind conditions by setting the minimum wind speed to 0.75m/s. It is recommended in LAQM.TG(16) that the meteorological data file be tested within a dispersion model and the relevant output log file checked, to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedences. LAQM.TG(16) recommends that meteorological data should only be used if the percentage of usable hours is greater than 75%, and preferably 90%. 2015 meteorological data from Marham includes 8,744 lines of usable hourly data out of the total 8,760 for the year, i.e. 99.82% usable data, this is therefore suitable for the dispersion modelling exercise.

4.1.2 Model Outputs

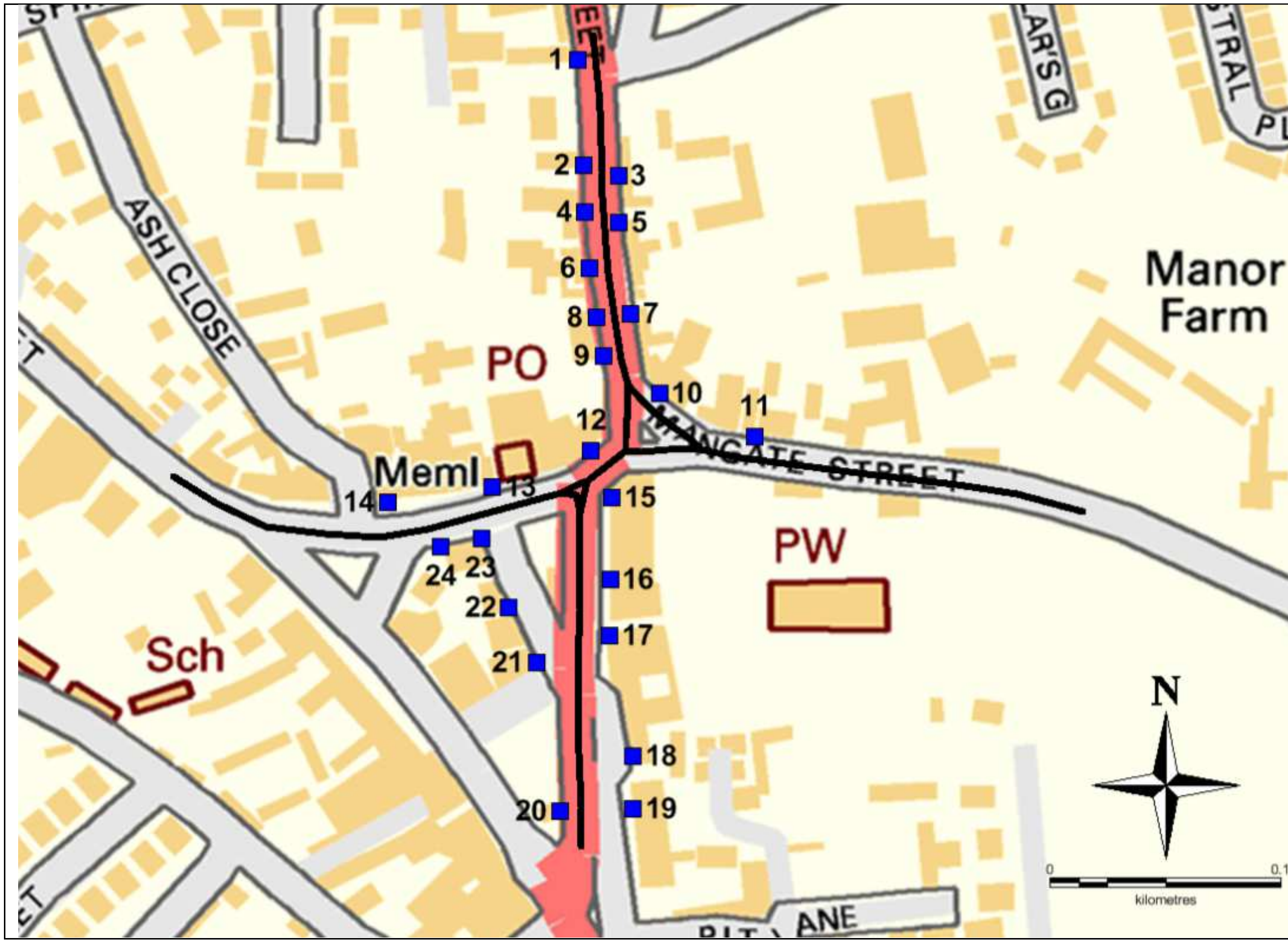
The background pollutant values available from Defra[8] have been used in the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_x and NO_2. These background pollutant concentrations are based upon all of the sources of air pollutants in the 1km grid square and any air pollutants from adjacent grid squares which may be of relevance.

For the prediction of annual mean NO_2 concentrations for the modelled scenario, the output of the ADMS-Roads model for NO_x has been converted to NO_2 following the methodology in LAQM.TG(16)[1] and using the NO_x to NO_2 conversion tool developed on behalf of Defra. This tool also utilises the total background NO_x and NO_2 concentrations. This assessment has utilised version 5.1 (June 2016) of the NO_x to NO_2 conversion tool. The road contribution is then added to the appropriate NO_2 background concentration value to obtain an overall total NO_2 concentration.

For the prediction of short term NO_2 impacts, LAQM.TG(16) advises that it is valid to assume that exceedences of the 1-hour mean AQS objective for NO_2 are only likely to occur where the annual mean NO_2 concentration is 60µg/m^3 or greater. This approach has thus been adopted for the purposes of this assessment.

Verification of the ADMS assessment has been undertaken using the local authority monitoring locations which are located adjacent to the affected road network. All NO_2 results presented in the assessment are those calculated following the process of model verification, using a factor of 3.734 for all receptors. Appendix 2 – ADMS Model Verification provides full details of the model verification process.

Figure 4.1 – Modelled Receptor Locations – Existing Road Network



Legend
Receptor Location
Modelled Road Link

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Location	
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Title	
Modelled Receptor Locations	
By	**Approved**
PB	JC
Scale	**Job Ref**
As shown	6355043
Date	**Figure No.**
September 2016	**4.1**

Figure 4.2 – Modelled Receptor Locations – Option 1 Road Network

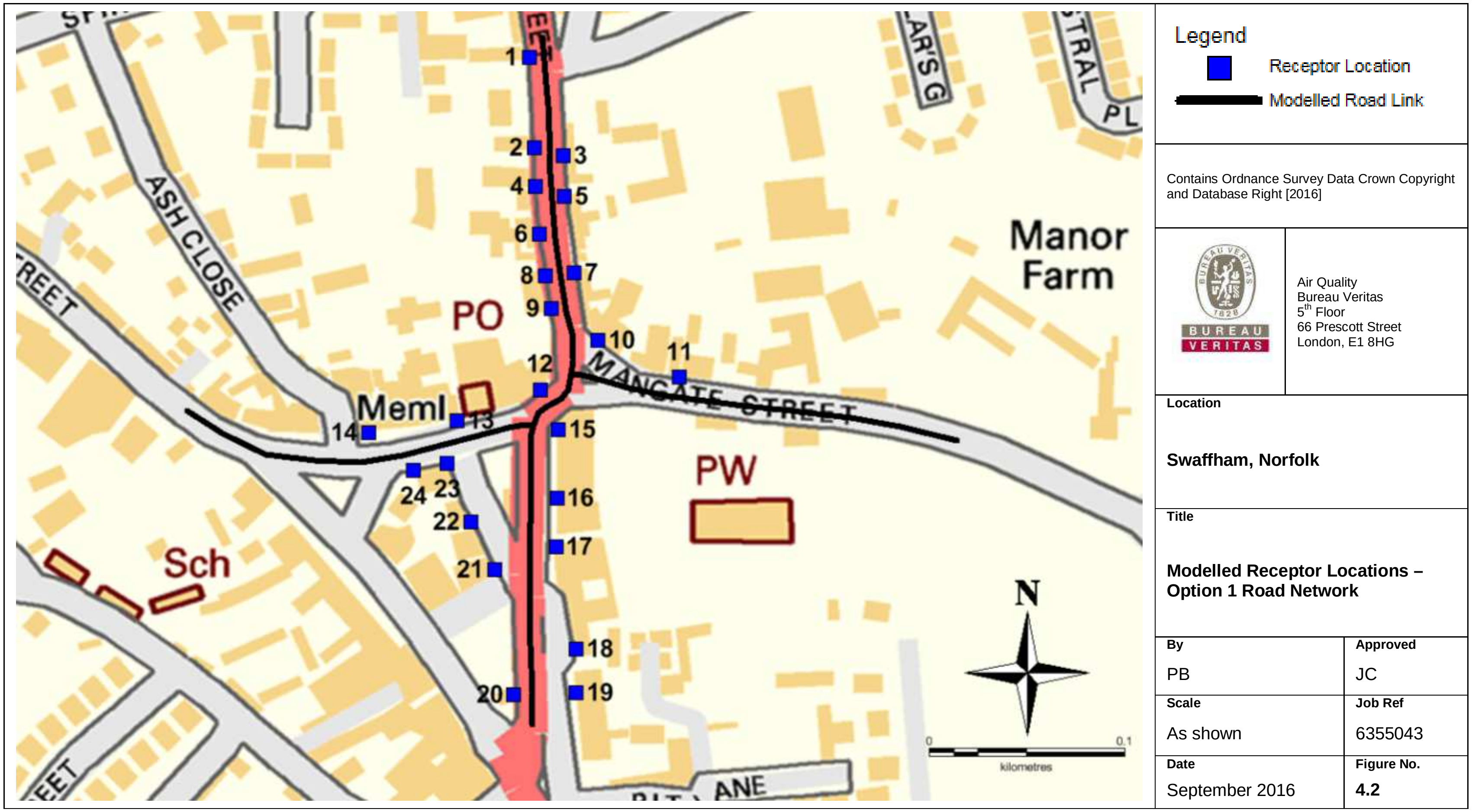
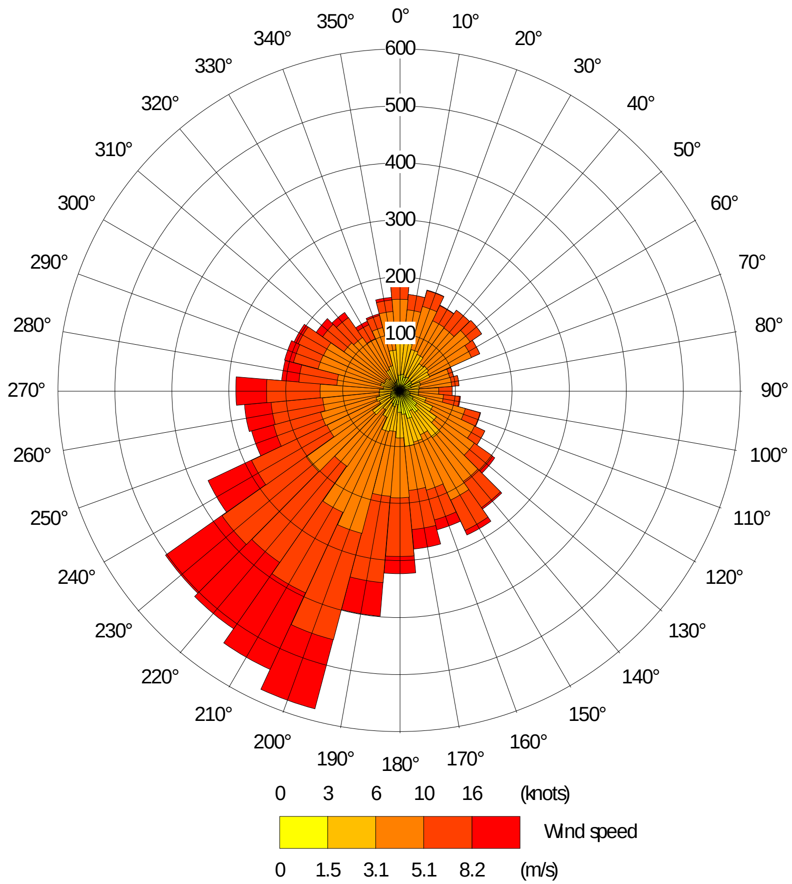


Figure 4.3 – Wind rose for Marham Meteorological Data 2015



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Wind Rose for Marham Meteorological Data 2015

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5 Results

This assessment has considered emissions of NO_x from road traffic and the resultant NO_2 concentrations at existing receptor locations. The results of the dispersion modelling are provided below, for those receptor locations detailed and illustrated in Table 5.1, Figure 5.1, and Figure 5.2 respectively.

Table 5.1 presents the annual mean NO_2 concentrations predicted at existing residential receptor locations for 2015 for both the Existing and Option 1 road networks modelled scenarios, and the % reduction in concentration between the two scenarios.

The model suggests that the 40µg/m^3 annual mean AQS objective is observed to be met at all receptor locations, with three receptors within the Existing scenario (21 Station Street, 15 Station Street and 57 Lynn Street) being within 10% of the objective. The maximum annual mean NO_2 concentration for both modelled scenarios was predicted at receptor 3 – 21 Station Street, with predicted concentrations of 36.7µg/m^3 and 33.9µg/m^3 respectively.

The empirical relationship given in LAQM.TG(16)[1] states that exceedences of the 1-hour mean objective for NO_2 are only likely to occur where annual mean concentrations are 60µg/m^3 or above. Annual mean NO_2 concentrations at all receptor locations are below this limit, and therefore short-term NO_2 exposure from road traffic emissions at the assessed receptor locations is not considered to be significant.

Table 5.1 – Predicted Annual Mean NO_2 Concentrations for 2015

ID	Height (m)	AQS objective (µg/m^3)	Existing 2015 (µg/m^3)	% of AQS Objective	Option 1 2015 (µg/m^3)	% of AQS Objective	% Reduction between Existing and Option 1
1	1.5	40	23.5	58.63	21.2	52.95	9.68
2	1.5	40	27.4	68.55	25.4	63.45	7.44
3	1.5	40	<u>36.7</u>	91.75	33.9	84.68	7.71
4	1.5	40	26.9	67.18	25.0	62.40	7.11
5	1.5	40	<u>36.4</u>	90.98	33.6	83.88	7.80
6	1.5	40	27.3	68.25	25.4	63.53	6.92
7	1.5	40	31.5	78.63	30.0	74.90	4.74
8	1.5	40	28.5	71.13	26.9	67.35	5.31
9	1.5	40	30.8	76.98	29.3	73.25	4.84
10	1.5	40	26.5	66.25	24.4	61.08	7.81
11	1.5	40	21.5	53.70	18.7	46.63	13.18
12	1.5	40	<u>36.2</u>	90.58	31.8	79.45	12.28
13	1.5	40	23.9	59.75	20.7	51.80	13.31
14	1.5	40	19.8	49.60	17.2	42.93	13.46
15	1.5	40	31.1	77.80	27.8	69.53	10.64
16	1.5	40	25.5	63.70	22.1	55.25	13.27
17	1.5	40	23.6	58.90	19.6	49.00	16.81
18	1.5	40	16.8	42.03	14.6	36.53	13.09
19	1.5	40	15.3	38.20	13.6	33.90	11.26
20	1.5	40	22.6	56.45	18.7	46.63	17.40
21	1.5	40	19.7	49.35	16.9	42.13	14.64
22	1.5	40	17.1	42.70	15.2	38.03	10.95
23	1.5	40	21.5	53.63	18.7	46.70	12.91
24	1.5	40	20.8	52.03	18.0	44.93	13.65

In **bold**, exceedence of the NO_2 annual mean AQS objective of 40 µg/m^3
<u>Underlined</u>, result within 10% of annual mean NO_2 objective of 40 µg/m^3

From Table 5.1 it can be seen that NO_2 concentrations are reduced at all modelled receptors when comparing the Existing scenario with the Option 1 scenario. The range of reduction is 12.66% and the highest reduction of 17.40% was experienced at receptor 20 (Market Place).

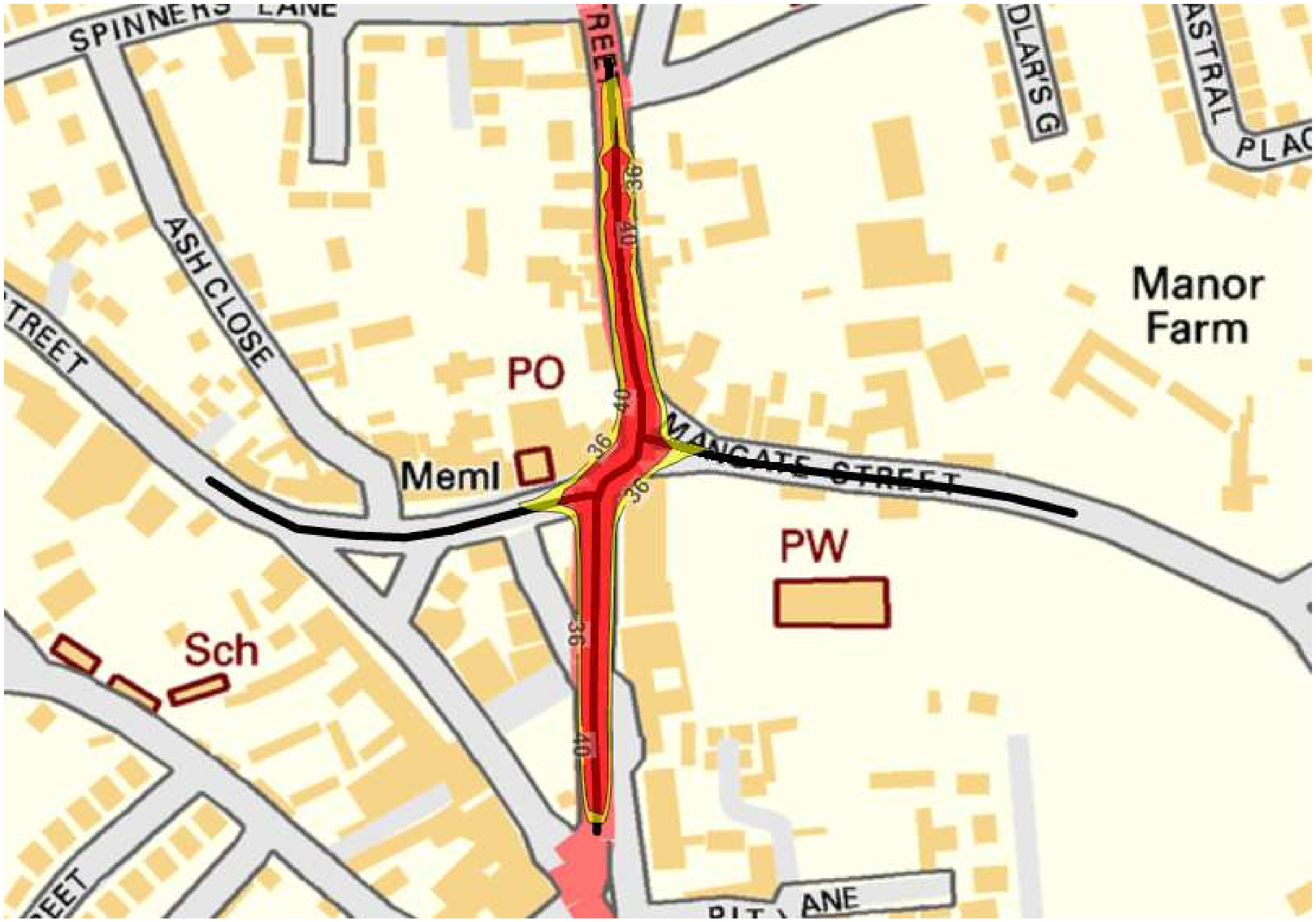
Annual mean NO_2 concentrations were also predicted at gridded receptor locations within a grid with a minimum spatial resolution of 4m, covering the modelled area for the purposes of generating concentration isopleths.

Figure 5.1 and Figure 5.2 illustrate the annual mean NO_2 concentration isopleths for both the Existing road network and the Option 1 road network modelled scenarios. To mitigate against the uncertainty of the modelled results, 40µg/m^3 and 36µg/m^3 concentration isopleths (i.e. ±10% of the AQS objective) are presented.

The difference in modelled concentrations can be seen between Figure 5.1 and Figure 5.2, with a slight reduction in the area predicted to be above the annual mean AQS objective of 40µg/m^3 apparent in the Option 1 scenario. The second isopleth of 36µg/m^3 can be seen to remain largely constant on Station Street between both scenarios with slight reductions of area on the other junction links.

Given the modelled results and that there is exposure of relevant receptors to concentrations within 10% of the AQS objective, coupled with the uncertainties associated with the model outputs and continual development in and around Swaffham, it is recommended that an AQMA should be designated for the area. The proposed extent of the AQMA area is presented in Figure 5.3.

Figure 5.1 – Annual Mean NO_2 Concentration Isopleths ($\mu g/m^3$) Existing Road Network



Legend

- 36µg/m3 Concentration
- 40µg/m3 Concentration
- Modelled Road

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Annual Mean NO_2 Concentration Isopleths ($\mu g/m^3$) Existing Road Network

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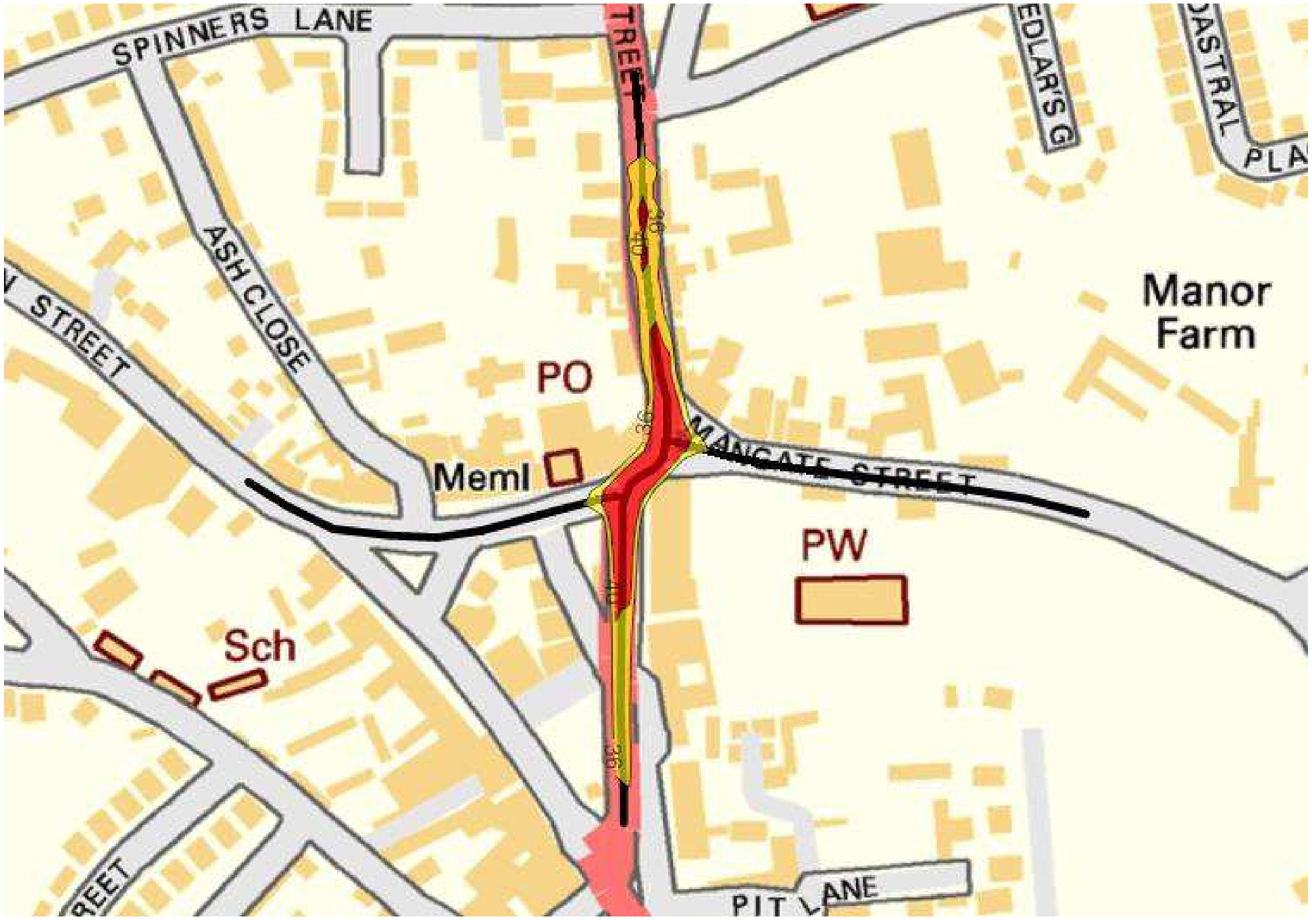
Figure 5.2 – Annual Mean NO2 Concentration Isopleths (µg/m3) Option 1 Road Network



Legend

- 36µg/m3 Concentration
- 40µg/m3 Concentration
- Modelled Road

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Location

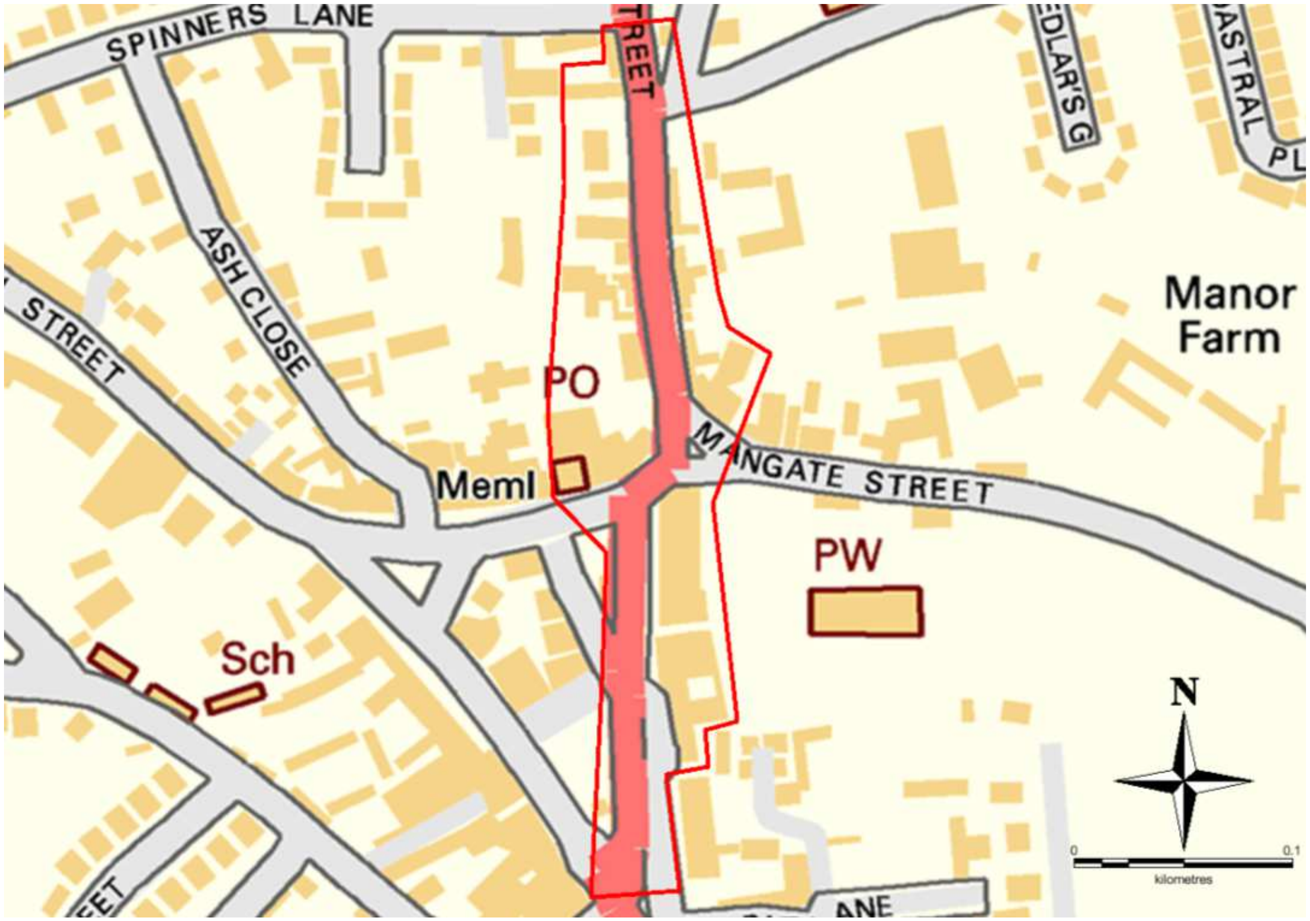
Swaffham, Norfolk

Title

Annual Mean NO_2 Concentration Isopleths (µg/m^3) Option 1 Road Network

By	Approved
PB	JC
Scale	**Job Ref**
As shown	6355043
Date	**Figure No.**
September 2016	**5.2**

Figure 5.3 – Proposed AQMA Boundary



Legend

Proposed AQMA Boundary

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Title

Proposed AQMA Boundary

By	**Approved**
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Scale	**Job Ref**
As shown	6355043
Date	**Figure No.**
September 2016	**5.3**

6 Conclusions and Recommendations

Bureau Veritas UK Ltd, on behalf of Breckland District Council, has produced a Detailed Assessment of nitrogen dioxide (NO_2) concentrations at the cross junction at the centre of Swaffham where the A1065 forms a junction with Lynn Street and Mangate Street. The following section provides the conclusions of this assessment.

6.1. Predicted Concentrations

The ADMS-Roads dispersion model (version 4.0.1) has been used to determine the likely NO_2 concentrations at existing receptor locations. Two separate scenarios were modelled; the first based on the existing road layout of the A1062 junction, and the second an alternative road layout (Option 1) based upon a study on reducing NO_x concentrations at the junction completed by Norfolk County Council[2].

Assessed locations included 24 existing receptors around the main roads of concern, representative of worst-case exposure. The main area of concern was highlighted as Station Street where a diffusion tube monitoring site had exceeded the NO_2 annual mean AQS objective of 40µg/m^3 in previous years monitoring results. Annual mean NO_2 concentrations were found to be below the annual mean AQS objective at all receptors for both modelling scenarios. Three receptors (21 Station Street, 15 Station Street and 57 Lynn Street) were found to be within 10% of the objective for the Existing scenario, no receptors were above 10% of the objective for the Option 1 scenario. The highest modelled concentration was at receptor 3 – 21 Station Street for both modelling scenarios, with a predicted annual mean NO_2 concentration of 36.7µg/m^3 and 33.9µg/m^3.

With respect to the hourly NO_2 objective, all modelled concentrations were below the 60µg/m^3, above which exceedences of the short-term NO_2 AQS objective are considered possible, and thus exceedences of the 1-hour mean AQS objective are considered unlikely at any receptors.

The gridded output of the model demonstrates that the geographical extent of the exceedence covers the area along the A1062 from south of the junction with Sporle Road, incorporating the central junction with Lynn Street and Mangate Street, and reaching south to the junction with Market Place. The extent of the exceedence is reduced slightly in the Option 1 scenario compared to the Existing scenario where the road layout has been adapted to match studies completed by Norfolk County Council[2].

Although no exceedences were predicted at receptor locations for either modelled scenario, NO_2 concentrations at three residential receptor locations for the Existing scenario were found to be within 10% of the annual mean AQS objective. The concentrations at these receptor locations fell below within 10% of the AQS objective when the road layout was changed for the Option 1 scenario. Due to changes in the road layout not being confirmed the Council should look to declare an AQMA incorporating all locations where annual mean concentrations of NO_2 within the assessment area are exceeding, or are within 10% of the annual mean AQS objective.

An additional scenario (Option 1) was modelled based on a study completed by Norfolk County Council comparing predicted reductions of NO_x within the assessment area[2]. The road layout of the model was changed to match the Option 1 scenario presented in the report to assess possible reductions of NO_2 concentrations from changing the existing road layout. A reduction was experienced at all modelled receptors for the Option 1 scenario, and also the geographical extent of the areas in exceedence of the annual mean AQS objective or within 10% of the objective was reduced. The scenario assumed that traffic through the central junction was more free flowing due to the removal of all traffic signals and introducing two major/minor priority junctions. Although a reduction was recorded in the Option 1 scenario, it is recommended that further investigation work be completed in the Option 1 road layout to assess the possibility of queuing traffic where vehicles would have to wait to complete manoeuvres across oncoming traffic.

In conclusion, this assessment has demonstrated that in the area of the A1062 from the junction with Sporle Road to the junction with Market Place, including the central junction with Lynn Street and Mangate Street, local NO_2 concentrations are in breach of the 40µg/m^3 annual mean AQS objective with the current road network in place. Although concentrations are below the objective at residential receptor locations, they are receptors exposed to levels within 10% of the objective limit. Given the uncertainties associated with the model outputs and continual development planned in around Swaffham, it is therefore recommended that an AQMA be declared. The proposed extent of the AQMA is illustrated in Figure 5.3.

6.2. Future Recommendations

Following the above conclusions, the following recommendations are made:

- That an Air Quality Management Area (AQMA) be declared in the assessment area, the extent of which is proposed in Figure 5.3.
- Continuation of diffusion tube monitoring in the area of the proposed AQMA, particularly at sites S1, S7, S8, S11 and S12 to confirm existing concentrations in the modelled exceedence area, and to continue diffusion tube monitoring further south down on London Street to assess concentrations south of the recommended AQMA boundary.
- An Air Quality Action Plan is drawn up to determine the best policies and intervention measures to put in place in order to reduce local NO_2 concentrations.
- Additional traffic surveys are undertaken in the vicinity of the proposed AQMAs. This will minimise the manipulation of traffic data inputs required for future dispersion modelling studies, thereby reducing the associated uncertainties of model outputs.
- Further assessment of the changes to the road network proposed in the Option 1 scenario in respect to potential queuing traffic.

Appendices

Appendix 1 – Background to Air Quality

Emissions from road traffic contribute significantly to ambient pollutant concentrations in urban areas. The main constituents of vehicle exhaust emissions, produced by fuel combustion are carbon dioxide (CO_2) and water vapour (H_2O). However, combustion engines are not 100% efficient and partial combustion of fuel results in emissions of a number of other pollutants, including carbon monoxide (CO), particulate matter (PM), Volatile Organic Compounds (VOCs) and hydrocarbons (HC). For HC, the pollutants of most concern are 1,3 - butadiene (C_4H_6) and benzene (C_6H_6). In addition, some of the nitrogen (N) in the air is oxidised under the high temperature and pressure during combustion; resulting in emissions of oxides of nitrogen (NO_x). NO_x emissions from vehicles predominately consist of nitrogen oxide (NO), but also contain nitrogen dioxide (NO_2). Once emitted, NO can be oxidised in the atmosphere to produce further NO_2.

The quantities of each pollutant emitted depend upon a number of parameters; including the type and quantity of fuel used, the engine size, the vehicle speed, and the type of emissions abatement equipment fitted. Once emitted, these pollutants disperse in the air. Where there is no additional source of emission, pollutant concentrations generally decrease with distance from roads, until concentrations reach those of the background.

This air quality assessment focuses on NO_2 as this pollutant is unlikely to meet respective Air Quality Strategy (AQS) objectives near roads. This has been confirmed over recent years by the outcome of the Local Air Quality Management (LAQM) regime. The most recent statistics[11] regarding Air Quality Management Areas (AQMAs) show that, 601 AQMAs were declared in the UK, of which 562 include NO_2 and 99 include PM_{10} (a number of AQMAs have been declared for both pollutants). The majority (92%) of existing AQMAs have been declared in relation to road traffic emissions.

In line with these results, the reports produced by the Council under the LAQM regime have confirmed that road traffic within their administrative area is the main issue in relation to air quality.

An overview of NO_2, describing briefly the sources and processes influencing ambient concentrations, is presented below.

Nitrogen Oxides (NO_x)

NO and NO_2, collectively known as NO_x, are produced during the high temperature combustion processes involving the oxidation of N. Initially, NO_x are mainly emitted as NO, which then undergoes further oxidation in the atmosphere, particularly with ozone (O_3), to produce secondary NO_2. Production of secondary NO_2 could also be favoured due to a class of compounds, VOCs, typically present in urban environments, and under certain meteorological conditions, such as hot sunny days and stagnant anti-cyclonic winter conditions.

Of NO_x, it is NO_2 that is associated with health impacts. Exposure to NO_2 can bring about reversible effects on lung function and airway responsiveness. It may also increase reactivity to natural allergens, and exposure to NO_2 puts children at increased risk of respiratory infection and may lead to poorer lung function in later life.

In the UK, emissions of NO_x have decreased by 62% between 1990 and 2010. For 2010, NO_x (as NO_2) emissions were estimated to be 1,106kt. The transport sector remained the largest source of NO_x emissions with road transport contribution 34% to NO_x emissions in 2010.

[11] Statistics from the UK AQMA website available at http://aqma.defra.gov.uk – Figures as of January 2013

Appendix 2 – ADMS Model Verification

The ADMS-Roads dispersion model has been widely validated for this type of assessment and is specifically listed in the Defra's LAQM.TG(16)[1] guidance as an accepted dispersion model.

Model validation undertaken by the software developer (CERC) will not have included validation in the vicinity of the proposed development site. It is therefore necessary to perform a comparison of modelled results with local monitoring data at relevant locations. This process of verification attempts to minimise modelling uncertainty and systematic error by correcting modelled results by an adjustment factor to gain greater confidence in the final results.

The predicted results from a dispersion model may differ from measured concentrations for a large number of reasons, including uncertainties associated with:

- Background concentration estimates;
- Source activity data such as traffic flows and emissions factors;
- Monitoring data, including locations; and
- Overall model limitations.

Model verification is the process by which these and other uncertainties are investigated and where possible minimised. In reality, the differences between modelled and monitored results are likely to be a combination of all of these aspects.

Model setup parameters and input data were checked prior to running the models in order to reduce these uncertainties. The following were checked to the extent possible to ensure accuracy:

- Traffic data;
- Distance between sources and monitoring as represented in the model;
- Speed estimates on roads;
- Background monitoring and background estimates; and
- Monitoring data.

The traffic data for this assessment has been collated from a Traffic Count Survey completed by Traffic Survey Partners for Norfolk County Council on the 14th March 2015[10]. Traffic speed data have been estimated and agreed with the Council to be representative of the separate road links that have been modelled. Where appropriate, the speeds have been reduced to simulate queues at junctions and traffic lights.

Breckland District Council undertakes passive monitoring as part of its LAQM commitments at 30 locations (2 automatic, 28 passive), 7 of which are located in the modelled area and have been used for the purpose of model verification.

Details of the 7 LAQM monitoring sites considered for the purposes of model verification are presented in Table A1.

Table A1 – Local Monitoring Data Suitable for Model Verification

Site ID	Location	OS Grid Reference [a]	Data Capture for 2015	2015 Annual Mean NO_2 (µg/m^3)
S1	Simpsons Butchers, 73 Market Place	581986, 309031	100%	22.6
S7	Station Street	581999, 309099	100%	34.8
S8	Station Street	581979, 309162	91.7%	37.7
S9	Anglia Computer Solutions, 53 Market Place	581959, 309057	100%	26.4
S10	Kev's Tackle, 2 Mangate Street	582007, 309058	100%	24.7
S11	13 Station Street	581990, 309145	100%	34.0
S12	Glaisedale Lamp Post, Station Street	581978, 283336	100%	31.4
In **bold**, exceedence of the NO_2 annual mean AQS objective of 40 µg/m^3				

Verification calculations

The verification of the modelling output was performed in accordance with the methodology provided in Chapter 7 of LAQM.TG(16)[1].

For the verification and adjustment of NO_x/NO_2, the LAQM diffusion tube monitoring data was used as detailed above. The data capture for 2015 at the 7 sites was above 75% so there were no sites requiring annualisation. Table A2 below shows an initial comparison of the monitored and unverified modelled NO_2 results for the year 2015, in order to determine if verification and adjustment was required.

Table A2 – Comparison of Unverified Modelled and Monitored NO_2 Concentrations

Site ID	Site Type	Background NO_2	Monitored total NO_2 (µg/m^3)	Modelled total NO_2 (µg/m^3)	% Difference (modelled vs. monitored)
S1	Urban Centre	10.7	22.6	24.50	8.36
S7	Roadside	10.7	34.8	33.24	-4.57
S8	Roadside	10.7	37.7	36.08	-4.25
S9	Roadside	10.0	26.4	26.61	0.83
S10	Roadside	10.7	24.7	24.37	-1.18
S11	Roadside	10.7	34.0	34.19	0.44
S12	Roadside	10.7	31.4	33.72	7.42

The model was found to be under-predicting at 3 locations and over-predicting at 4 locations, no further improvement of the modelled results could be obtained on this occasion. The relevant data was gathered to allow an adjustment factor to be calculated.

Model adjustment needs to be undertaken based on NO_x and not NO_2. For the diffusion tube monitoring results that have been used in the calculation of the model adjustment, NO_x concentrations have been derived from NO_2 concentrations; these calculations were undertaken using the NO_x to NO_2 Calculator tool available from the LAQM website[12]. Table A3 provides the relevant data required to calculate the model adjustment based on regression of the modelled and monitored road source contribution to NO_x.

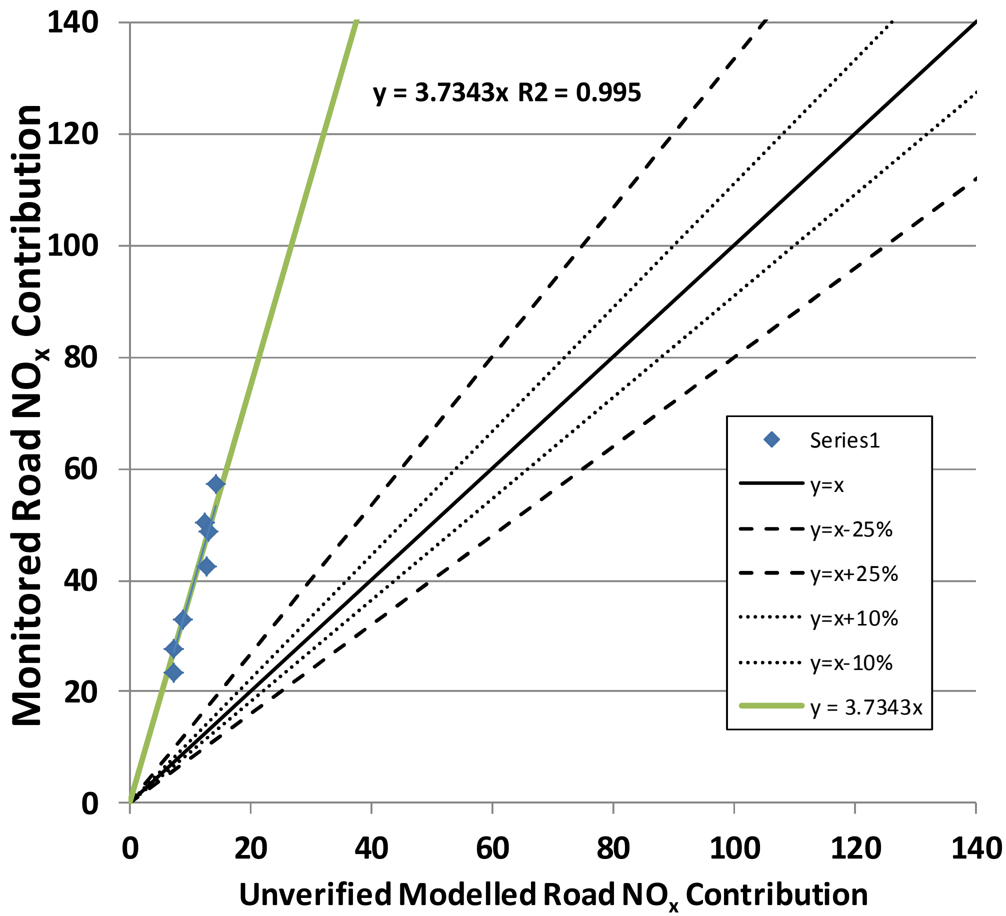
[12] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

Table A3 – Data Required for Adjustment Factor Calculation

Site ID	Monitored total NO_2 (µg/m^3)	Monitored total NO_x (µg/m^3)	Background NO_2 (µg/m^3)	Background NO_x (µg/m^3)	Monitored road contribution NO_2 (total - background) (µg/m^3)	Monitored road contribution NO_x (total - background) (µg/m^3)	Modelled road contribution NO_x (excludes background) (µg/m^3)
S1	22.6	37.9	10.7	14.6	11.9	23.3	7.3
S7	34.8	65.0	10.7	14.6	24.1	50.4	12.5
S8	37.7	71.9	10.7	14.6	27.0	57.3	14.3
S9	26.4	47.4	10.0	14.6	16.4	32.8	8.9
S10	24.7	41.2	10.7	13.5	14.0	27.6	7.2
S11	34.0	63.2	10.7	14.6	23.3	48.6	13.1
S12	31.4	57.0	10.7	14.6	20.7	42.4	12.8

Figure A1 provides a comparison of the Monitored Road NO_x Contribution versus the Unverified Modelled Road NO_x and the equation of the trend line based on linear regression through zero. The Total Monitored NO_x concentration has been derived by back-calculating NO_x from the NO_x/NO_2 empirical relationship using the spreadsheet tool available from Defra's website[12]. The equation of the trend lines presented in Figure A1 gives an adjustment factor for the modelled results of 3.734.

Figure A1 – Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x



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Location
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Title
Comparison of Modelled Road NO_x versus Monitored Road NO_x

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Date	**Figure No.**
September 2016	**A1**

Figure A1 and Table A4 show the ratios between monitored and modelled NO_2 for each monitoring location. LAQM.TG(16)[1] states that In order to provide more confidence in the model predictions, the majority of results should be within 25%, ideally within 10% of the monitored. The sites show an acceptable level of agreement, consequently a factor of 3.734 can therefore be used for verification.

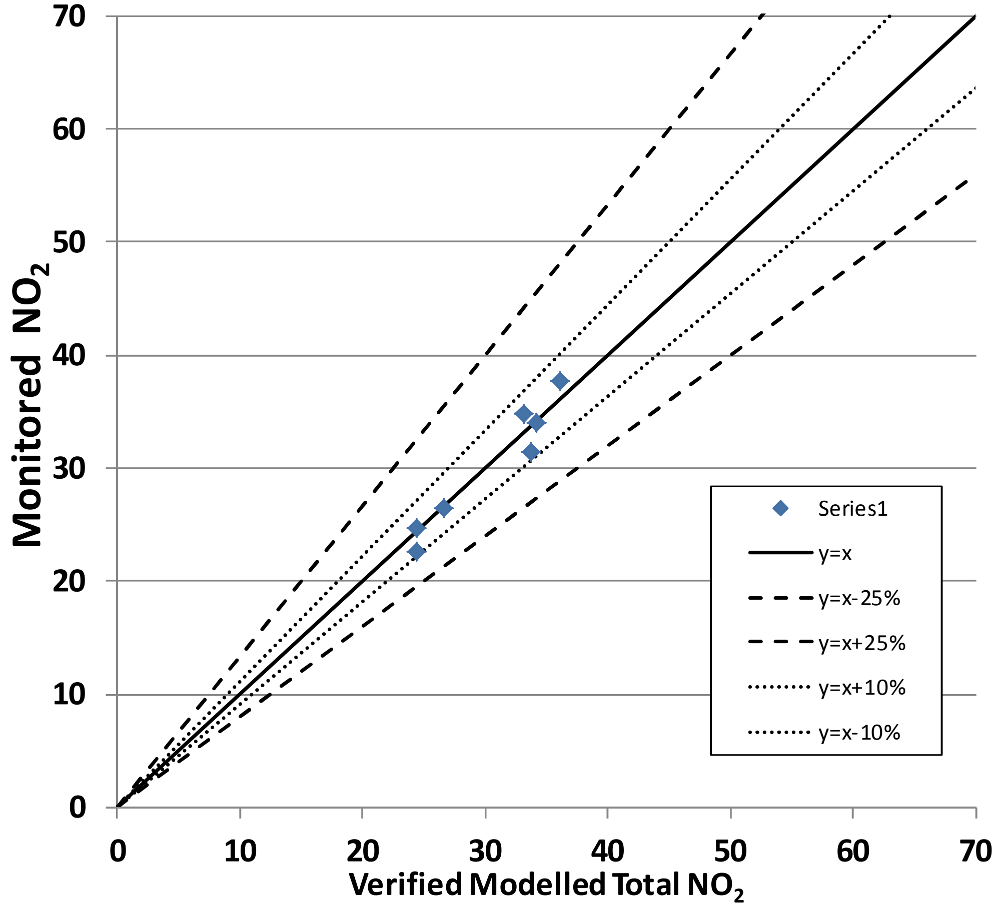
Table A4 – Adjustment Factor and Comparison of Verified Results Against Monitoring Results

Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m^3)	Adjusted modelled total NO_x (including background NO_x) (µg/m^3)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m^3)	Monitored total NO_2 (µg/m^3)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
S1	3.19	3.734	27.30	41.90	24.50	22.61	8.36
S7	4.03		46.68	61.28	33.24	34.83	-4.57
S8	4.00		53.40	68.01	36.08	37.68	-4.25
S9	3.68		33.27	47.88	26.61	26.39	0.83
S10	3.82		27.04	40.57	24.37	24.66	-1.18
S11	3.71		48.92	63.52	34.19	34.04	0.44
S12	3.31		47.80	62.40	33.72	31.39	7.42

Table A4 and Figure A2 show the ratios between monitored and modelled NO_2 for each monitoring location. The sites show acceptable agreement between the ratios of monitored and modelled NO_2, being within ±25%. A verification factor of 3.734 was therefore used to adjust the model results. A factor of 3.734 reduces the Root Mean Square Error (RMSE) from a value of 11.445 to 9.737.

The verification factor was applied to the road contribution NO_x contribution predicted by the model to arrive at the final NO_2 concentrations. NO_2 results presented and discussed herein for all receptors are those calculated following the process of model verification using the calculated adjustment factor of 3.734.

Figure A2 – Comparison of the Modelled NO_2 versus Monitored NO_2 in Verification Zone A



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Location	
Swaffham, Norfolk	
Title	
Comparison of Modelled NO_2 versus Monitored NO_2	
By	**Approved**
PB	JC
Scale	**Job Ref**
As shown	6355043
Date	**Figure No.**
September 2016	**A2**