Ricardo Energy & Environment

Assessment of the impact of the proposed edge road on the Watlington AQMA – Addendum 1: Dispersion modelling using a different traffic dataset

Air Quality Impact Assessment

Report for South Oxfordshire District Council

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Executive summary

This report is an addendum to the main report 'Assessment of the impact of the proposed edge road on the Watlington AQMA'[1], which was carried out to investigate whether, with development proposed for Watlington and the surrounding area in place, an edge road would be needed to ensure compliance with Air Quality Objectives within the Watlington Air Quality Management Area (AQMA). This addendum study extends the original study by assessing air quality within the Watlington AQMA using a different traffic modelling dataset.

The village of Watlington falls under South Oxfordshire District Council and has had an AQMA declared for NO_2 exceedances since 31st March 2009. This is largely a result of traffic from the M40, including a significant proportion of heavy goods vehicles (HGVs), combined with a narrow 'street canyon' environment with slow moving, congested traffic hindered by parked cars.

This addendum air quality impact assessment includes three modelled scenarios using the new traffic data provided by SODC:

- 2018 Baseline: This represents 2018 traffic conditions within Watlington and provides an indication of current air quality conditions.
- 2024 Base: This is a future scenario without the proposed development at Britwell Road.
- 2024 S1: This is a future scenario with the proposed development at Britwell Road in place, and assuming only one access point to the development.

Annual mean pollutant concentrations for the years of interest were modelled using ADMS Roads 4.1. Street canyon impacts were modelled using the ADMS-Roads canyon module. The model was verified using 2018 annual mean NO_2 measurements from diffusion tube sites within the modelling domain.

The modelling indicates that areas within the AQMA, along Couching street, are close to or exceeding the annual mean NO_2 Air Quality Objective in 2018. However, the areas which exceed the annual mean air quality objective occur only in the middle of the road, and not where the air quality objectives apply. At all locations where the objective applies, the modelled concentration in 2018 was below the Objective of 40 $\mu g.m^{-3}$, although in some locations the concentration is close to 40 $\mu g.m^{-3}$.

Based on the traffic modelling dataset used in this addendum study, by 2024 all areas in Watlington are expected to be compliant with the Air Quality Objective as the result of predicted improvements in vehicle emissions technology. Under both the 2024 Base and 2024 S1 scenarios, NO_2 concentrations are expected to be below 35 $\mu m.m^{-3}$ throughout the Watlington AQMA.

The results from the addendum study have been compared to the results of the main study. The only modelled scenario which is common to both the main and addendum studies is the 2018 baseline scenario, which predicted similar NO_2 concentrations in both studies. The remaining scenarios between the two studies cannot be compared directly, as they represent different future scenarios with different development assumptions and different traffic modelling inputs. However, the dispersion modelling results for both the main and addendum studies indicate that by 2024, all areas in Watlington are forecast to be compliant with the Air Quality Objective as the result of predicted improvements in vehicle emissions technology. Based on the modelled scenarios, future compliance with the Air Quality Objective is not reliant on the presence of the edge road.

[1] Ricardo Energy & Environment, "Assessment of the impact of the proposed edge road on the Watlington AQMA", ED12538 Issue Number 3, 28 November 2019.

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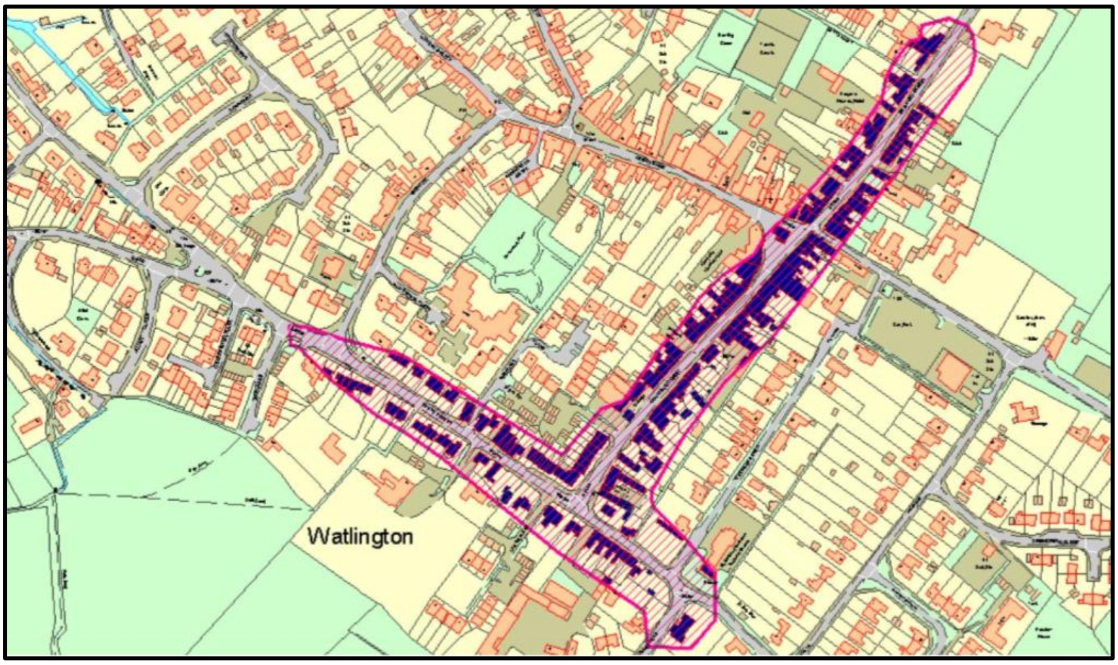
1 Introduction

This report is an addendum to the main report 'Assessment of the impact of the proposed edge road on the Watlington AQMA'[2].

The village of Watlington has an Air Quality Management Area (AQMA) declared along Shirburn Street, Couching Street and Brook Street as illustrated in Figure 1 below. The AQMA has been declared for NO_2 exceedance and is largely a result of traffic from the M40, of which a significant amount are heavy goods vehicles (HGVs), and a narrow 'street canyon' environment with slow moving congested traffic hindered by parked cars.

Ricardo Energy & Environment carried out an assessment of the AQMA as part of our work on a Low Emission Strategy (LES) for South Oxfordshire in 2014. The key proposal to solve the problem in Watlington was to remove the parking bays to ease the flow of traffic. This was estimated to have a significant impact on vehicle emissions and related NO_2 concentrations. A subsequent microsimulation traffic modelling study was then carried out which supported the proposal that removing the parking bays would smooth traffic flows and help emissions. However, this proposal has not been favoured by residents.

Figure 1: Watlington AQMA



At the time of the LES study the concept of a bypass was ruled out as the were no resources to develop such a scheme at the County Council. However, the County Council have since proposed building an "edge road" around Watlington to help improve congestion in the town centre and mitigate the impacts of new development around the edge of Watlington.

Ricardo Energy & Environment carried out a study[2] in 2019 to investigate whether, with development proposed for Watlington and the surrounding area in place, an edge road would be needed to ensure compliance with Air Quality Objectives within the Watlington AQMA. This study used traffic flow data from a traffic modelling study undertaken by AECOM for the Chalgrove airfield development, which

[2] Ricardo Energy & Environment, "Assessment of the impact of the proposed edge road on the Watlington AQMA", ED12538 Issue Number 3, 28 November 2019.

accounted for committed development in the area surrounding the Chalgrove airfield (including development in Watlington).

Section 7[2] of the report concluded that "At all locations where the objective applies, the modelled concentration in 2018 was below the Objective of 40 µg.m^{-3}, although in some locations the concentration is close to 40 µg.m^{-3}. … By 2024, all areas in Watlington are expected to be compliant with the Air Quality Objective as the result of predicted improvements in vehicle emissions technology. However, despite these predicted improvements in vehicle emissions in future years, increases in traffic flow mean that NO_2 concentrations are predicted to remain within 10% of the NO_2 objective in parts of Couching Street. As predictions of the future vehicle fleet and emission factors for future vehicles are subject to uncertainty, these areas remain at risk of exceedance in future years without the proposed edge road."

South Oxfordshire District Council have commissioned Ricardo Energy and Environment to carry out this addendum study using an updated transport modelling dataset developed by Clarkebond as part of a Traffic Assessment carried out for the developer Bloor Homes. Oxfordshire County Council commissioned Systra to independently validate the dataset from Clarkebond, and it is therefore considered to be the most robust transport modelling dataset currently available to use for air quality modelling in Watlington.

This addendum study has the following aims:

- Update the Baseline model for 2018 using the updated transport modelling dataset and re-verify the dispersion model against the latest air quality monitoring data.
- Use dispersion modelling to assess the air quality in the Watlington AQMA under two future 2024 scenarios: a 2024 Base scenario (without development scheme) and a 2024 S1 scenario (with development scheme). The 2024 S1 scenario refers to the proposed residential and commercial development of land at Britwell Road in Watlington with one point of access to the development site.

This report includes the model verification results and modelled annual mean NO_2 concentrations for the 2018 Baseline, as well as future scenario analysis.

2 Policy Context

2.1 National and Local Policy Background

The UK Air Quality Strategy (AQS) was developed by Government in 1997 and has subsequently been revised in 2003, 2007 and more recently 2019. This sets out the national policy approach to air quality across the UK. The AQS sets out a series of air quality objectives which Local Authorities must work towards achieving. The UK air quality objectives have derived from legally binding limit values set in EU legislation. An air quality objective is a date by which the relevant Standard should not be exceeded; these dates have now passed for all pollutants.

Council obligations in this regard are laid out in the Environment Act 1995 which set out a system called Local Air Quality Management (LAQM). Local authorities have a central role in achieving improvements in air quality. Their local knowledge and interaction with the communities that they serve mean that they are better able to know the issues on the ground in detail and the solutions that may be necessary or appropriate to the locality.

It should be noted that although the objectives are policy targets, all the UK objectives are at least as stringent as the European Limit Values for the various pollutants. The Limit Values carry legal standing and have been written into UK law through the various Air Quality Standards Regulations.

2.2 Air Quality and Planning Policy

The UK Government's air quality policy guidance (PG16) sets out the relationship between air quality management and planning for local authorities in England, excluding those in London who are provided guidance separately by the Mayor of London. Government advice is that air quality should be a consideration for large scale proposals, proposals in areas likely to be occupied by sensitive groups such as the elderly or young children, or areas likely to have cumulative effects. A study of air quality may be warranted, particularly for proposals which are likely to have a significant impact on air quality.

All impacts and their quantification should be included in an Impact Assessment, covering any wider economic, social and environmental implications. The Government has provided guidance for carrying out impact assessments, including specific advice in relation to air quality valuation.

2.3 National Planning Policy Framework

The National Planning Policy Framework was first published in March 2012 before being updated in July 2018 and most recently in February 2019. It sets out the Government's planning policies for England and how these are expected to be applied.

Planning policies and decisions should aim to contribute towards compliance with the relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement.

3 Air Quality Standards and Guidelines

The objectives specified in the Air Quality Strategy (AQS) mirror limit values required by EU Framework and Daughter Directives on Air Quality; and have been transposed into UK law through the Air Quality Standards Regulations 2007. A more recent EU Directive 2008/50/EC consolidates the Framework and first three Daughter Directives, and this has been transposed into English law via the Air Quality (Standards) Regulations 2010.

Table 1 summarises the air quality objectives relevant to this study. For Local Air Quality Management purposes, and for the assessment of air quality against the air quality objectives, personal exposure is also important. Therefore, predicted concentrations greater than the values listed at a given location do not necessarily indicate an exceedance of the Air Quality Objective. Rather, the predicted concentrations should be considered in the context of personal exposure, with consideration given to the types of locations where the Air Quality Objectives should apply (Table 2).

UK Local Authorities are required under the Environment Act 1995 to assess air quality in their areas on an annual basis against the air quality objectives; and are required to declare an Air Quality Management Area (AQMA) where they have identified that the air quality objectives are not being achieved.

Table 1: UK National Air Quality Objectives

Pollutant	Concentration	Measured as
Nitrogen dioxide (NO_2)	200 µg.m^{-3} not to be exceeded more than 18 times a year; equivalent to a 99.8th percentile of hourly means not exceeding 200 µg.m^{-3}	1-hour mean
	40 µg.m^{-3}	Annual mean

Table 2: Relevant receptors for Air Quality Objectives[3]

Averaging period	Objectives should apply at:	Objectives should not generally apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	All locations where the annual mean objectives apply, together with hotels and gardens of residential properties, and: Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

[3] Department for Environment Food and Rural Affairs, "Local Air Quality Management: Technical Guidance (TG16)", February 2018.

4 The study area and method of assessment

4.1 Study area

This study assess air quality within the Watlington AQMA, illustrated in Figure 1.

4.2 Method of assessment

Air quality for baseline conditions in 2018 and two future 2024 scenarios have been assessed using atmospheric dispersion modelling to predict annual mean concentrations of NO_2. The general approach taken was:

- Collect and analyse recent traffic, pollutant monitoring, meteorological and background pollutant concentration data for use in a dispersion modelling study. Traffic flow information (annual average daily traffic, AADT) was obtained from a transport modelling dataset developed by Clarkebond. None of the three modelled scenarios include the proposed edge road.
- Model Baseline road traffic emissions in 2018 using the ADMS-Roads atmospheric dispersion model and refine/verify the model to gain good agreement with the most recently available (2018) nearby NO_2 monitoring data.
- Use the verified dispersion model to predict annual mean pollutant concentrations at NO_2 monitoring locations within the study area for the following three scenarios:
    - 2018 Baseline: This represents 2018 traffic conditions within Watlington and provides an indication of current air quality conditions.
    - 2024 Base: This is a future scenario without the proposed development at Britwell Road.
    - 2024 S1: This is a future scenario with the proposed development at Britwell Road in place, and assuming only one access point to the development. While there was traffic modelling data available for both a single-access (S1) and a double-access (S2) scenario, the S1 scenario was selected for modelling because the S1 scenario results in a greater flow of traffic through the Watlington AQMA.
- Describe the predicted air quality within the Watlington AQMA, referring to modelled concentrations at NO_2 monitoring sites and contour maps of NO_2 concentrations across the study area.

The modelling methods outlined in the Defra Technical Guidance LAQM.TG(16)[3] were used throughout the study.

4.3 Pollutant monitoring data and model verification

South Oxfordshire District Council currently measures NO_2 concentrations at a number of locations in Watlington using both a continuous analyser and a network of 8 diffusion tubes. The locations of the measurement sites are presented in Table 3.

Annual mean NO_2 concentrations measured during 2018 using diffusion tubes were provided by South Oxfordshire District Council[4]. The NO_2 measurements at each site over the last five years are presented in Table 3. Measured annual mean NO_2 concentrations have been consistently close to the 40 $\mu g.m^{-3}$ objective at the measurement sites but have declined between 2017 and 2018 at all sites.

[4] South Oxfordshire District Council (2018) Local Air Quality Annual Status Report 2018

Table 3: NO_2 diffusion tube measurements in Watlington ($\mu g.m^{-3}$)

Site ID	Site name	Site type	Easting	Northing	2014	2015	2016	2017	2018
44	St Leonards Church	SUB	468479	194721	12	-	33	21	7*
45	57 Brook Street	R	468856	194293	35	26	28	34	29
46	27 Brook Street	R	468756	194360	28	25	37	39	26
47	9 Couching Street	R	468852	194343	33	29	32	36	25
48	41 Couching Street	R	468951	194457	55	44	50	58	39
49	48 Couching Street (Co-Op)	R	468962	194458	49	39	44	52	35
50	8 Shirburn Street	R	469017	194514	46	41	46	53	39
51	23 Shirburn Street	R	469061	194590	45	35	38	43	30

*Data capture was 17% for St. Leonards Church site in 2018

SUB – Suburban diffusion tube monitoring location
R – Roadside diffusion tube monitoring location

Figure 2: Watlington air quality monitoring sites

4.4 Background pollutant concentrations

Background pollutant concentrations for a modelling study within an urban environment can be sourced from either a local urban background monitoring location, or the background maps provided by Defra[5]. The background maps provide estimates of annual mean background concentrations of key pollutants at a resolution of 1 x 1km projected from a base year of 2017 and can be projected forward to future years up to 2030. NOx emissions are projected to decline over time as emissions are reduced by national policy implementation.

Mapped NOx concentrations for 2018 for the grid squares in Watlington are presented in Table 4.

Table 4: 2018 mapped NOx concentrations (Defra)[5]

Easting	Northing	Background NOx annual mean ($\mu g.m^{-3}$)
468500	194500	9.82
469500	194500	9.05
468500	193500	8.90
469500	193500	8.78

A South Oxfordshire District Council NO_2 background diffusion tube monitoring site is located to the northwest of Watlington at St. Leonard's Church. No automatic monitoring of urban background NO_2 concentrations is carried out in Watlington.

The NO_2 concentrations measured at St. Leonard's Church in the last 5 years are presented in Table 3; the low value measured for 2018 (7 $\mu g.m^{-3}$) is the result of extremely low data capture in this year. The values measured at the St. Leonard's Church site are significantly higher than those in the Defra background maps. With this in mind, the measured values at the St. Leonard's Church site have been used to provide a conservative estimate of background NO_2 concentrations in the area.

The measured value for 2017 (21 $\mu g.m^{-3}$) has been used to represent background pollutant concentrations in the modelling study, as this is the most recent year with acceptable data capture. It is expected that variation in background concentrations from 2017 to 2018 will be relatively small; furthermore, the 2017 value represents an average of the values measured in the last five years.

Background pollutant concentrations are expected to decrease in future years. Using the measured value for 2017 as the background NO_2 concentration throughout the study (including for the 2024 future scenarios) provides a conservative estimate of NO_2 concentrations in the future.

[5] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

5 Emissions inventory compilation

The development of the emission inventories was carried out through the following process:

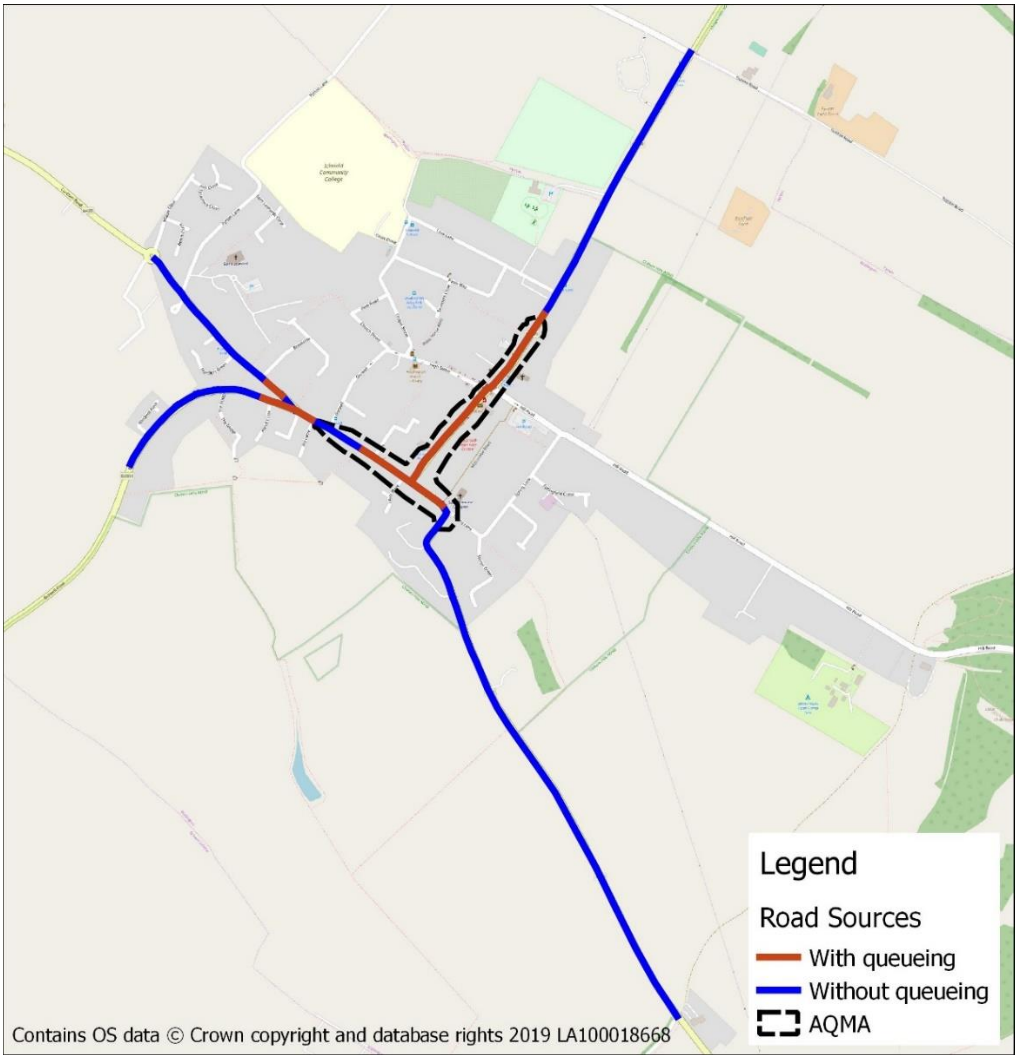
1. Collation of traffic data;
2. Traffic flow and fleet data were combined with emission factors from the most recent version of the Emission Factor Toolkit (EFT), version 9.0[6] to provide total annual emissions for the modelled road links;
3. Emissions from congested traffic were calculated following the methodology in LAQM TG(16);

5.1 Road traffic data

5.1.1 Average flow and fleet split

A map showing the road sections included in this assessment is presented in Figure 3. These are the main roads in the Watlington AQMA.

Figure 3: Road sources included in the modelling assessment



[6] https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

Annual average daily traffic (AADT) and fleet split data used for the assessment are presented in Tables Table 5 to Table 7 below. Traffic flow data (AADT) and percentage Heavy Goods Vehicle traffic (%HGV) were provided by South Oxfordshire District Council, based on a traffic modelling study undertaken by Clarkebond. The percentage of cars, Light Goods Vehicles (LGVs) and buses/coaches were calculated based on survey data obtained from the AECOM traffic modelling used in the previous report.[2]

Table 5: Modelled traffic flows and vehicle fleet split for 2018 Baseline scenario

Road	Total AADT (both directions)	% Car	% LGV	% HGV	% Bus/ Coach
Britwell Road	7883	85.1	12.6	2.0	0.2
Brook Street	9546	85.2	12.3	1.9	0.6
Couching Street	8193	77.2	13.1	9.4	0.3
Cuxham Road	4175	84.4	13.2	1.4	1.0
Ingham Lane	7456	82.5	15.5	1.6	0.4
Shirburn Street	7897	75.0	12.8	11.9	0.3

Table 6: Modelled traffic flows and vehicle fleet split for 2024 Base scenario

Road	Total AADT (both directions)	% Car	% LGV	% HGV	% Bus/ Coach
Britwell Road	8651	84.4	13.4	2.0	0.2
Brook Street	10476	84.4	13.0	1.9	0.6
Couching Street	8992	76.5	13.8	9.4	0.3
Cuxham Road	4582	83.7	14.0	1.4	1.0
Ingham Lane	8182	81.7	16.3	1.6	0.4
Shirburn Street	8666	74.3	13.4	11.9	0.3

Table 7: Modelled traffic flows and vehicle fleet split for 2024 S1 scenario

Road	Total AADT (both directions)	% Car	% LGV	% HGV	% Bus/ Coach
Britwell Road	9581	84.4	13.4	2.0	0.2
Brook Street	10892	84.4	13.0	1.9	0.6
Couching Street	9314	76.5	13.8	9.4	0.3
Cuxham Road	5096	83.7	14.0	1.4	1.0
Ingham Lane	8275	81.7	16.3	1.6	0.4
Shirburn Street	8989	74.3	13.4	11.9	0.3

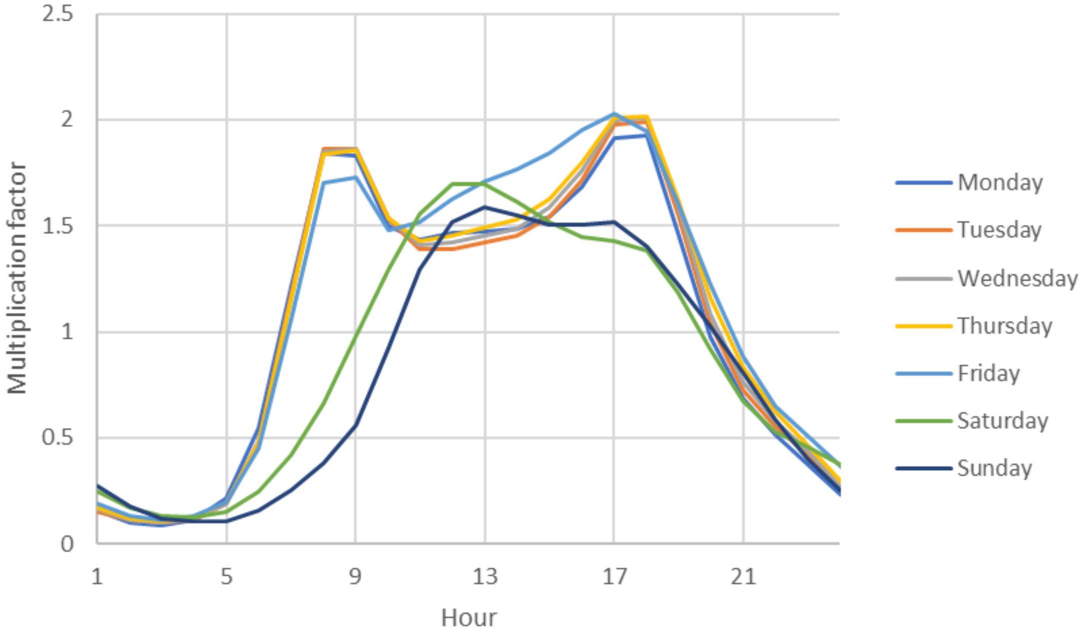
5.1.2 Free-flowing traffic speeds

As was the case in the main study[2], detailed modelled speed data were not available for the road network. Instead, Trafficmaster speed data derived from real-world vehicle travel times was used in the modelling for all years, with the underlying assumption that future traffic growth or changes will not significantly impact road speeds.

5.1.3 Time-varying emissions

Traffic flows and speeds vary systematically during the day, with higher traffic flows and lower free-flowing traffic speeds typically occurring during peak hours on weekdays. The weekly variation in emissions was taken into account by applying a set of diurnal profiles to the road emissions. National average diurnal profiles, published by the UK Department for Transport (DfT), were used. These profiles were applied to all roads in the model domain.

Figure 4: Time-varying emission profiles applied to free-flowing traffic sources



Note that the impact of emissions from idling vehicles during peak hours was treated separately; these emissions are described in Section 5.1.4.

5.1.4 Stationary traffic (congestion)

The roads running through the centre of Watlington are highly congested, with significant emissions deriving from idling traffic; the AQMA in the area has been declared as the result of the combination of high levels of congestion with street canyon effects. Emissions from idling traffic were calculated following LAQM.TG(16) guidance published by the Department for Environment Food and Rural Affairs[7]: exhaust emission factors for vehicles travelling at $5km.h^{-1}$ were used.

Roads with significant idling traffic were identified using “typical” traffic data from Google Traffic, together with aerial photography and expert judgement. Congested periods for each link were estimated from Google Earth traffic data and TrafficMaster speed data. These idling times were adjusted as part of the model verification process; the queuing model parameters used were found to produce the best agreement between modelled and measured annual mean NO_2 concentrations in the AQMA. In the final 2018 Baseline scenario modelling, congested links were assumed to have idling traffic for 5 minutes of each hour. Congestion was assumed to occur between 07:00 and 10:00, and between 16:00 and 19:00 during each weekday.

Congestion may occur along one or more lanes of a road. Roads representing bidirectional traffic flows may be congested in one or both directions. The number of queuing lanes was determined from aerial imagery and the road layout, with the assumption that any congested link would only be congested the

[7] https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

direction entering the nearest major junction. Queuing in both directions was modelled along sections of Couching Street.

An average queuing vehicle length of 6.75m was derived from aerial imagery of traffic queues in the South Oxfordshire region. This may lead to a slight overestimation of queuing impacts along roads with a high proportion of HGVs or buses, or a slight underestimation of queuing impacts along roads with very low proportions of these longer vehicles.

For the 2024 future scenarios, modelled queueing time was scaled with the change in AADT from the 2018 Baseline scenario. As for the baseline scenario, congestion was assumed to occur between 07:00 and 10:00, and between 16:00 and 19:00 during each weekday regardless of traffic flow changes.

5.1.5 Vehicle Emission factors

The latest version of the Emissions Factors Toolkit (EFT V9.0) was used in this assessment to calculate pollutant emission factors for each road link modelled. The calculated emission factors were then imported into the ADMS-Roads model.

Parameters such as traffic volume, speed and fleet composition are entered into the EFT, and an emissions factor in grams of pollutant/kilometre/second is generated for input into the dispersion model. In the latest version of the EFT, NOx emissions factors previously based on COPERT4 have been replaced by factors from COPERT5. These emissions factors are widely used for the purpose of calculating emissions from road traffic in Europe. Defra recognise these as the current official emission factors for road traffic sources when conducting local, regional and national scale dispersion modelling assessments.

5.1.6 Uncertainty in traffic emissions

Traffic patterns in urban locations are complex and it is not possible to fully represent these in atmospheric dispersion models. By attempting to describe these complex traffic patterns using quite simple metrics (AADT, average speed and vehicle split composition) a degree of uncertainty is introduced into the modelling.

Vehicle emission projections are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced at a renewal rate forecast by the DfT. Any inaccuracy in the projections or the COPERT 5 emissions factors contained in the EFT will be unavoidably carried forward into this modelling assessment.

5.2 Other sources

All other emissions sources in the area were assumed to be taken into account by the use of an urban background measured annual mean NO_2 concentration in the assessment.

6 Atmospheric Dispersion Modelling

Annual mean pollutant concentrations for the years of interest have been modelled within the study area using the atmospheric dispersion model ADMS Roads version 4.1.

6.1 Meteorology

Modelling was conducted using hourly sequential meteorological data (wind speed, direction etc.) for 2018 measured at the Benson site, supplemented by data measured at the High Wycombe and Brize Norton sites. Data filling was carried out where necessary following USEPA guidance which sets out the preferred hierarchy of routines to account for gaps (persistence, interpolation, substitution).

A surface roughness of 0.5m was used in the modelling to represent open suburbia in the model domain. A surface roughness of 0.2m was specified for the meteorological measurement site.

The primary meteorological measurement site is located approximately 7km SW of the study area. Meteorological measurements are subject to their own uncertainty which will unavoidably carry forward into this assessment.

A wind rose for the dataset is presented in Appendix 1 - Meteorological dataset. The wind rose shows the frequency of winds blowing from particular directions over the year. The length of each "spoke" around the circle is the frequency that the wind blows from that direction. The wind rose is typical for southern England, where south-westerly winds predominate.

6.2 Canyon modelling

The presence of buildings either side of a road can introduce 'street canyon' effects which result in pollutants becoming trapped, leading to increased pollutant concentrations. The densely packed buildings and narrow roads of Watlington produce a large number of street canyons, which contribute significantly to air quality issues in the study area.

Street canyon impacts were modelled using the ADMS-Roads canyon module. Building height data was sourced from LIDAR data published by the Environment Agency.[8]

6.3 Road gradients

Gradient effects were not included in the modelling, based on expert judgement; the Watlington region has very limited relief, and so any gradient effects will be insignificant. All road links were modelled at ground level in order to provide a conservative estimate of ground level concentrations; roads above ground will have a reduced impact on ground level concentrations due to elevation of the plume centreline.

6.4 NOx Chemistry

NOx to NO_2 chemistry was modelled using the NOx:NO_2 calculator published by Defra[9]. Modelled annual mean road NOx concentrations were combined with background NOx and modelled primary NO_2 fraction results to calculate NO_2 annual mean concentrations. The receptor specific fNO_2 fraction was calculated by dividing the modelled road NOx by modelled road NO_2 at each receptor.

[8] https://data.gov.uk/dataset/80c522cc-e0bf-4466-8409-57a04c456197/lidar-composite-dsm-1m

[9] https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

6.5 Validation of ADMS Roads

Validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications; this is usually conducted by the model developer.

CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets, participating in EU workshops on short range dispersion models, comparing data between UK M4 and M25 motorway field monitoring data, carrying out inter-comparison studies alongside other modelling solutions such as DMRB and CALINE4, and carrying out comparison studies with monitoring data collected in cities throughout the UK using the extensive number of studies carried out on behalf of local authorities and Defra.

6.6 Model verification

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. This helps to identify how the model is performing at the various monitoring locations. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. This can be followed by adjustment of the modelled results if required. LAQM.TG(16) recommends making the adjustment to the road contribution only and not the background concentration these are combined with.

The model was verified using annual mean NO_2 measurements from diffusion tube sites within the modelling domain. This was considered to be the best approach to assessing the model performance as these were the available monitoring data within the study area close to the AQMA.

It is appropriate to verify the ADMS Roads model in terms of primary pollutant emissions of nitrogen oxides ($NOx = NO + NO_2$). The model has been run to predict annual mean Road NOx concentrations during the 2018 calendar year at the diffusion tube sites. The model output of Road NOx (the total NOx originating from road traffic) has been compared with the measured Road NOx, where the measured Road NOx contribution is calculated as the difference between the total NOx and the background NOx value. Total measured NOx for each diffusion tube was calculated from the measured NO_2 concentration using the latest version of the Defra NOx/NO_2 calculator.

The initial comparison of the modelled vs measured Road NOx identified that the model was over-predicting the Road NOx contribution. The gradient of the best fit line for the modelled Road NOx contribution vs. measured Road NOx contribution was determined using linear regression and used as the adjustment factor. A linear regression plot comparing modelled and monitored Road NOx concentrations (gradient = 0.6233) is presented in Figure 5. This adjustment factor was then applied to the modelled road NOx concentrations prior to conversion to NO_2.

A plot comparing modelled and monitored NO_2 concentrations is presented in Figure 6. The total annual mean NO_2 concentrations were determined via the NOx/NO_2 calculator using the background NO_2 concentrations and settings within the calculator for the relevant year.

Figure 5: Comparison of modelled Road NOx Vs Measured Road NOx

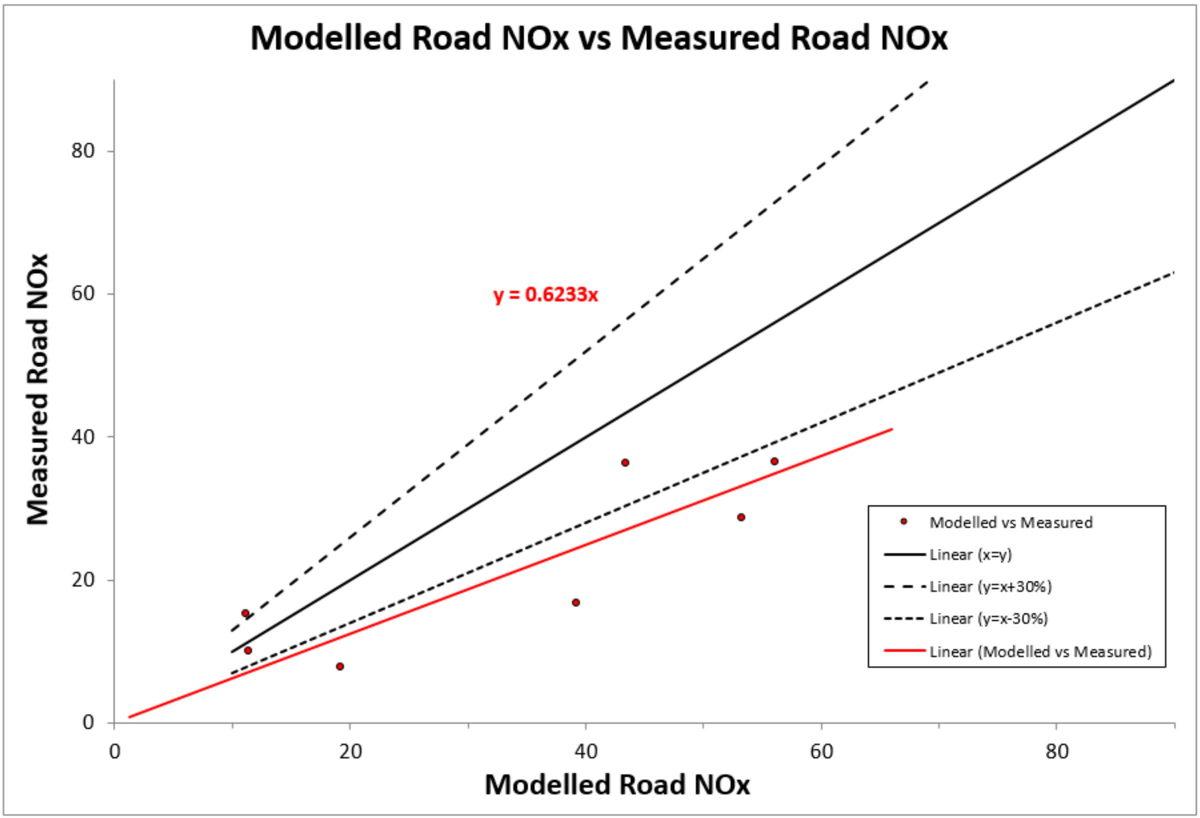
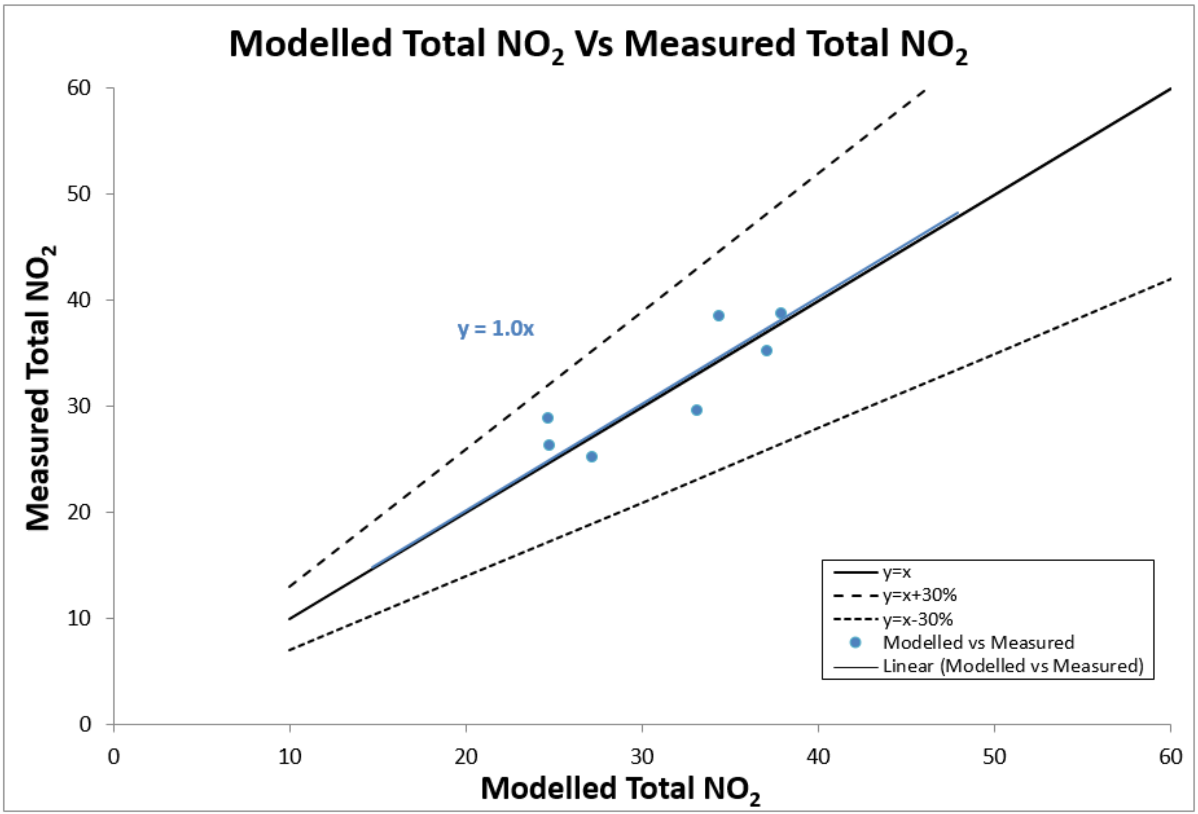


Figure 6: Comparison of modelled vs. monitored NO_2 annual mean



To evaluate the model performance and uncertainty, the Root Mean Square Error (RMSE) for the observed vs predicted NO_2 annual mean concentrations was calculated, as detailed in Technical Guidance LAQM.TG(16). The calculated RMSE is presented in Table 8.

It is recommended that the RMSE is below 25% of the objective that the model is being compared against, but ideally under 10% of the objective i.e. 4 $\mu g.m^{-3}$ (NO_2 annual mean objective of 40 $\mu g.m^{-3}$). In this case the RMSE is calculated at 2.88 $\mu g.m^{-3}$; the model uncertainty is therefore considered acceptable and the model has performed reasonably well for use in this type of impact assessment.

Table 8: Measured and modelled annual mean concentrations with RMSE calculation

NO_2 Monitoring Site*	Measured NO_2 annual mean	Modelled NO_2 annual mean
57 Brook Street	28.8	24.7
27 Brook Street	26.3	24.8
9 Couching Street	25.2	27.2
41 Couching Street	38.6	37.9
48 Couching Street (Co-Op)	35.1	37.2
8 Shirburn Street	38.5	34.4
23 Shirburn Street	29.5	33.2
	RMSE =	**2.88**

* St Leonards Church was not included in the model verification as this site was used to provide background NO_2 concentrations for the study

6.6.1 Comparison of queueing time and adjustment factor between the main study and addendum study

A queueing time of 20 minutes was used in the main study[1], and it was found that this provided an adjustment factor of 0.9267 (RMSE = 2.71). As part of the verification process for this study, the queueing time in the 2018 baseline model was varied between 0 and 20 minutes per hour during peak traffic times (assumed to be between 07:00 and 10:00, and between 16:00 and 19:00 during each weekday). In each case, the model was over-predicting the Road NOx contribution: a queueing time of 20 minutes resulted in an adjustment factor of 0.4881 (RMSE = 3.03) and a queueing time of 0 minutes (i.e. no queueing) resulted in an adjustment factor of 0.6895 (RMSE = 2.82). A queueing time of 5 minutes was selected as a balance point between model fit (adjustment factor being close to 1) and maintaining a queueing component within the model study (as queueing is known to occur within the AQMA, and the queueing component accounts for increased congestion in future scenarios by scaling the queueing time with the change in AADT).

In the main study, 2018 traffic flows (AADT) obtained from the traffic modelling dataset were considerably lower than traffic flows in this addendum study. It is possible that the input traffic flows in the main study were optimistic (low) and that the use of a longer queueing time (20 minutes) and a conservative value for background NO_2 concentration (21 μgm^{-3}) effectively compensated to bring the modelled Road NOx contribution in line with 2018 NO_2 monitoring results. The lower adjustment factor found for the addendum study suggests that the updated traffic modelling dataset is more reflective of 2018 traffic flows, and that the background concentration (21 $\mu g.m^{-3}$) is potentially pessimistic. For consistency, and to ensure an overall conservative approach to the modelling assessment, the same background annual mean NO_2 concentration (21 $\mu g.m^{-3}$) was used in both studies.

6.7 Dispersion Modelling Results

6.7.1 Nitrogen Dioxide annual mean concentrations

Annual mean NO_2 concentrations at diffusion tube locations for the 2018 Baseline scenario and the two 2024 future scenarios are presented in Table 9. No annual mean concentrations in excess of the 40 $\mu g.m^{-3}$ air quality objective are predicted at any of the specified receptors.

Table 9: Modelled annual mean NO_2 concentrations at diffusion tube locations (addendum study)

Receptor	Modelled NO_2 annual mean ($\mu g/m^3$)		
	2018 Baseline	2024 Base	2024 S1
St Leonards Church	21.3	21.3	21.3
57 Brook Street	24.7	23.5	23.5
27 Brook Street	24.8	23.6	23.7
9 Couching Street	27.2	24.8	24.9
41 Couching Street	37.9	31.3	31.7
48 Couching St (Co-Op)	37.2	30.8	31.2
8 Shirburn Street	34.4	28.8	29.1
23 Shirburn Street	33.2	28.1	28.3

Based on the traffic modelling dataset used in this addendum study, annual mean NO_2 concentrations at diffusion tube locations are predicted to decrease between 2018 and both of the future 2024 scenarios. Although there are increases in traffic flows across each road link between 2018 and 2024, there is predicted improvement in the fleet, i.e. less-polluting vehicles on the roads. The 2024 S1 scenario, which includes additional development and traffic as compared to the 2024 Base scenario, is predicted to have higher annual mean NO_2 concentrations than the 2024 Base scenario, particularly at monitoring locations along Couching Street and Shirburn Street. Nonetheless, under both the 2024 Base and 2024 S1 scenarios, 2024 NO_2 concentrations at diffusion tube locations are predicted to be well below the Air Quality Objective of 40 $\mu g.m^{-3}$. The predicted reduction in annual mean NO_2 concentrations between the 2018 and the two future 2024 scenarios is summarised in Table 10.

Table 10: Reduction in annual mean NO_2 concentrations between 2018 and 2024 scenarios (addendum study)

Receptor	Reduction compared to 2018 Baseline scenario			
	2024 Base ($\mu g.m^{-3}$)	2024 Base (%)	2024 S1 ($\mu g.m^{-3}$)	2024 S1 (%)
St Leonards Church	0.1	0.3	0.1	0.2
57 Brook Street	1.2	4.9	1.2	4.8
27 Brook Street	1.2	4.9	1.1	4.5
9 Couching Street	2.4	8.8	2.3	8.4
41 Couching Street	6.6	17.4	6.3	16.5
48 Couching St (Co-Op)	6.3	17.0	6.0	16.2
8 Shirburn Street	5.6	16.2	5.3	15.5
23 Shirburn Street	5.1	15.3	4.8	14.6

Contour plots showing the spatial variation in modelled annual mean NO_2 concentrations for the three scenarios are presented in Figure 7 to Figure 9.

Figure 7: Ground-level contour plot of predicted annual mean NO_2 concentrations in the Watlington AQMA for the 2018 Baseline scenario

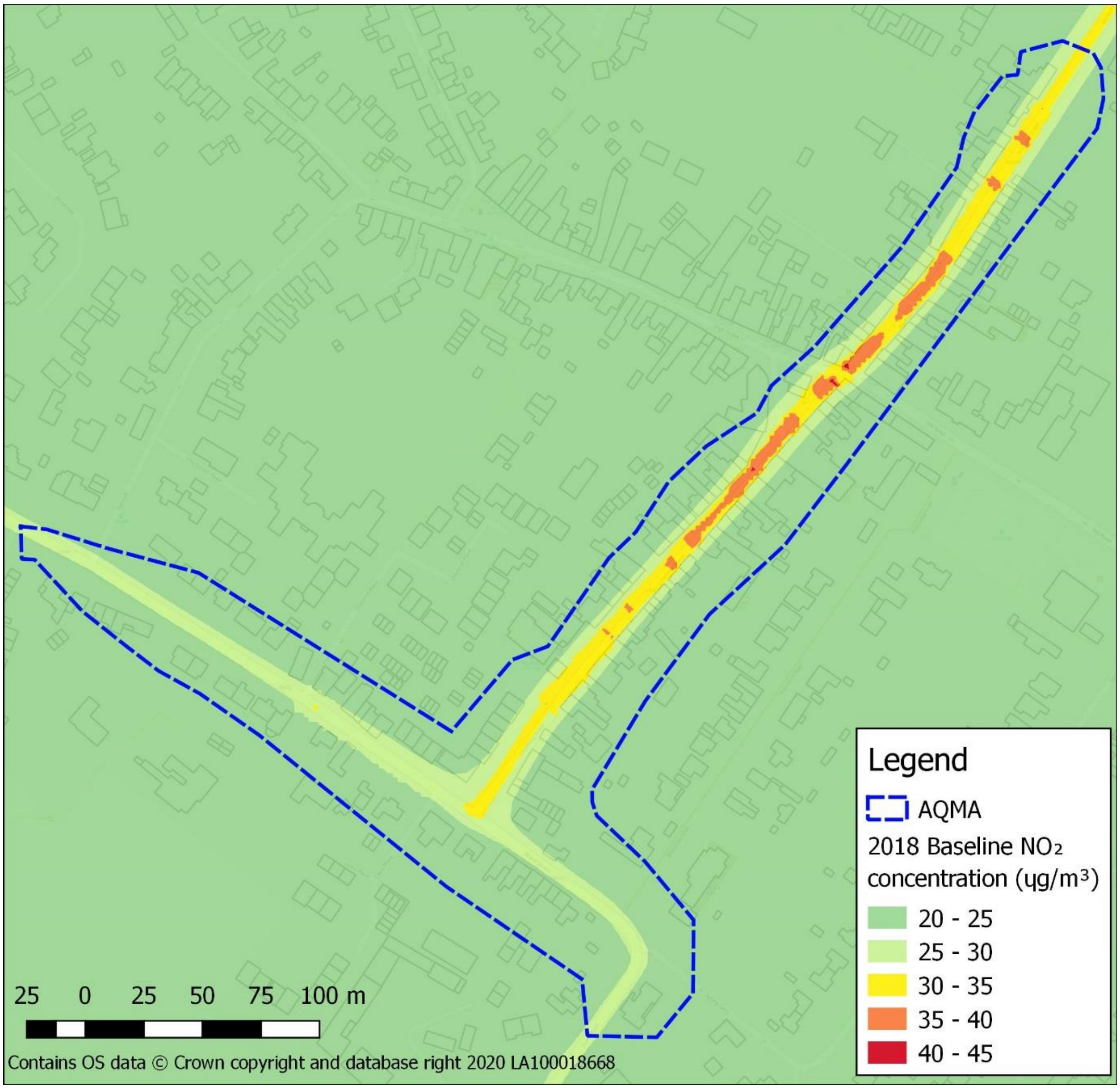


Figure 8: Ground-level contour plot of predicted annual mean NO_2 concentrations in the Watlington AQMA for the 2024 Base scenario

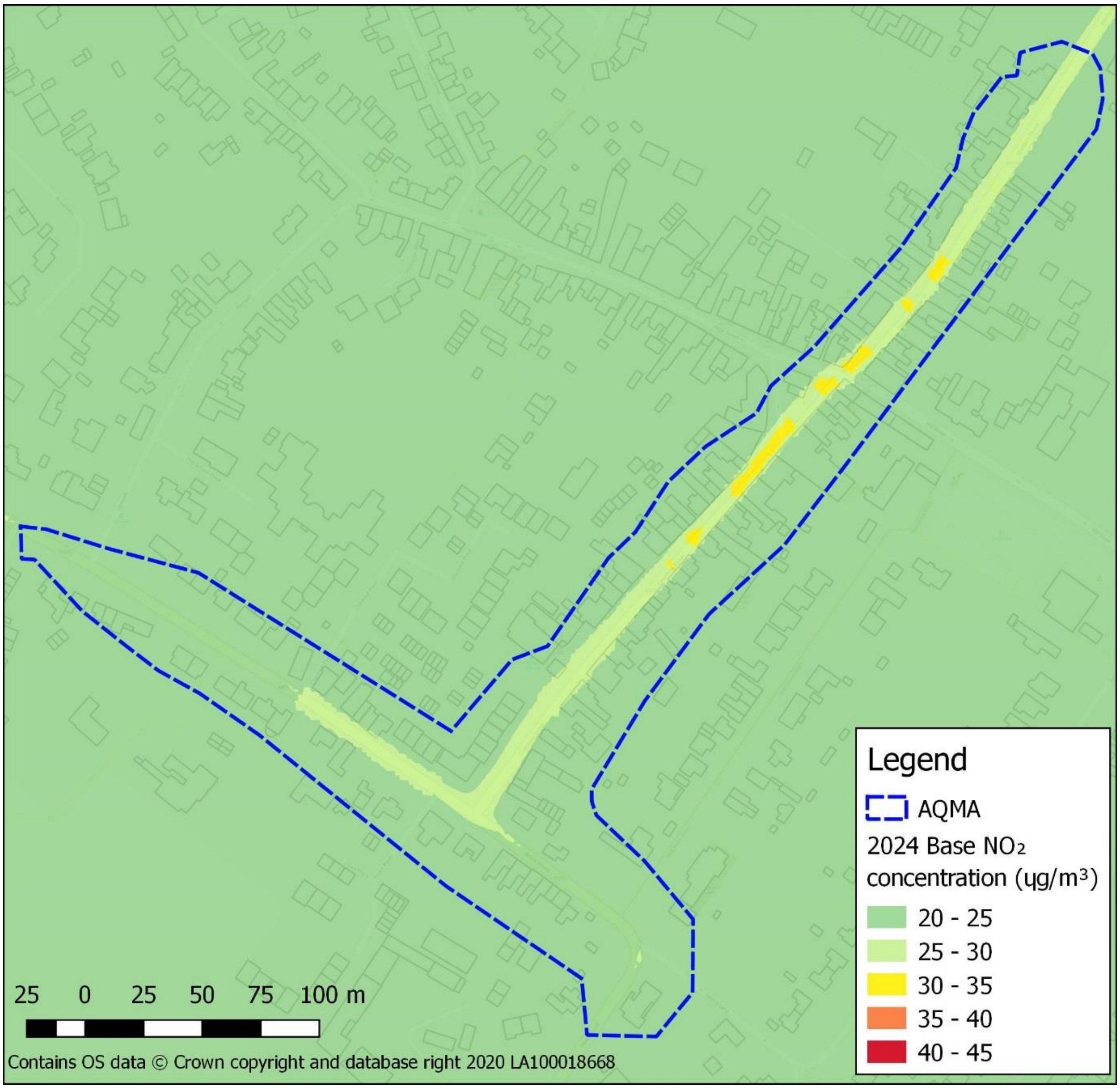
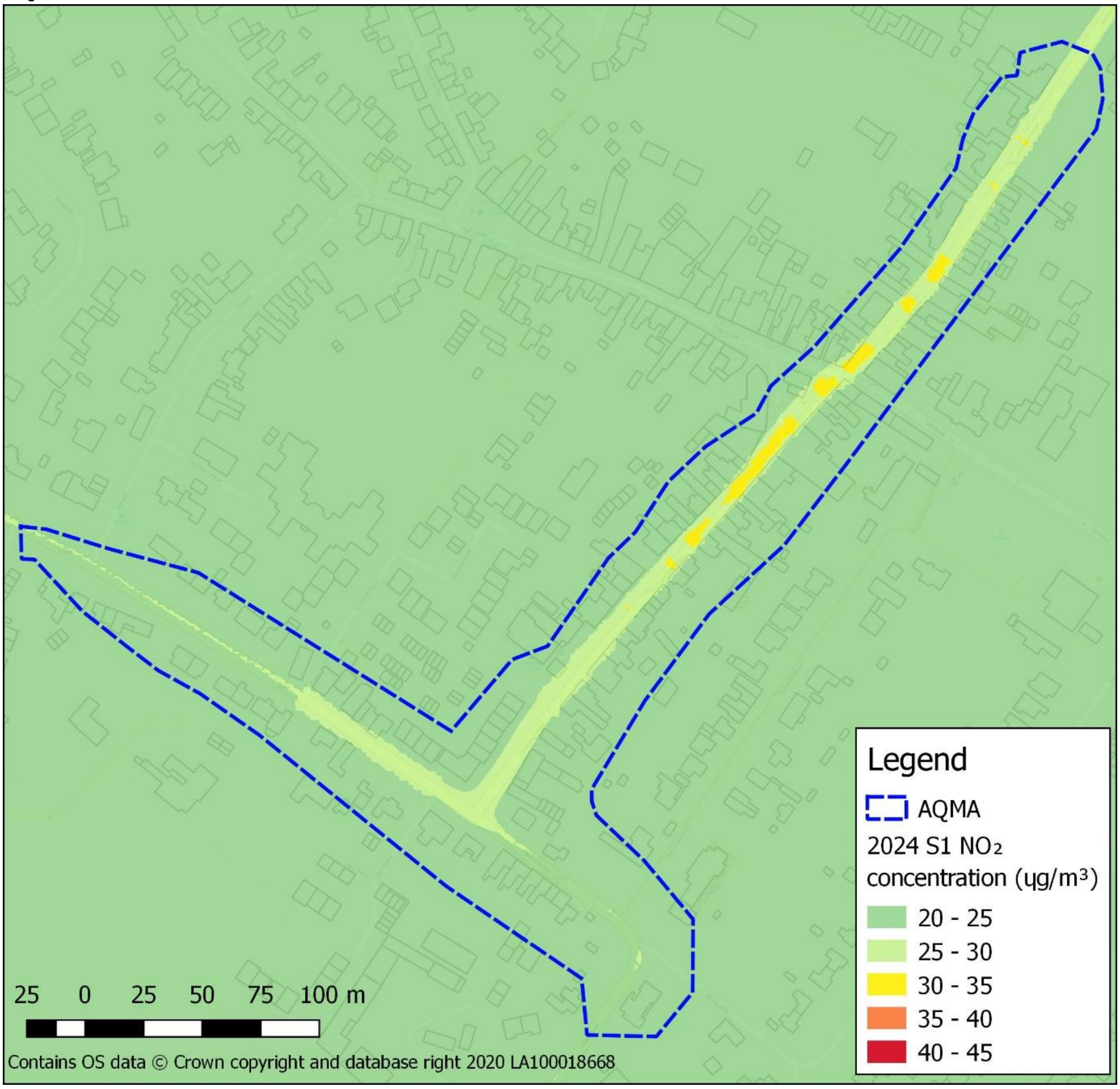


Figure 9: Ground-level contour plot of predicted annual mean NO_2 concentrations in the Watlington AQMA for the 2024 S1 scenario



The maximum predicted NO_2 concentrations are seen along Couching Street across all scenarios. Here, significant congestion, low free-flowing traffic speeds, and narrow street canyons combine to generate concentrations close to the Air Quality Objective along building façades, particularly around the High Street/Hill Road junction.

In 2018, there are small areas in the centre of Couching street that exceed the annual mean NO_2 objective; however, these areas occur in the centre of the street and not at locations where the Air Quality Objectives apply (see Table 2). These concentrations have decreased below 35 $\mu g.m^{-3}$ in both of the modelled 2024 scenarios.

The majority of areas in Watlington have modelled NO_2 concentrations of approximately 21–22 $\mu g.m^{-3}$; this is partially owing to the use of the background NO_2 concentration of 21 $\mu g.m^{-3}$ throughout the modelling. Based on Defra predictions, background concentrations will decrease between 2018 and 2024, so the modelled background concentrations in the contour plots below are likely to be a conservative estimate.

6.7.2 Comparison with results from the main study

For ease of reference, modelled annual mean NO_2 concentrations at diffusion tube locations from the main study[2] are reproduced in Table 11. The main study assessed three scenarios:

- 2018 Baseline (2018 BL): This represents 2018 traffic conditions within Watlington and provides an indication of current air quality conditions.
- 2024 Baseline without the proposed edge road (2024 No WTP): This scenario includes committed development allocations and the Chalgrove development but does not include the edge road.
- 2024 with the proposed edge road (2024 WTP): This scenario includes the developments included in the 2024 No WTP Scenario, as well as the proposed edge road.

Table 11: Modelled annual mean NO_2 concentrations at diffusion tube locations

Receptor	Modelled NO_2 annual mean ($\mu g/m^3$)		
	2018 BL	2024 No WTP	2024 WTP
St Leonards Church	21.4	21.4	21.2
57 Brook Street	25.8	26.0	23.6
27 Brook Street	25.8	26.0	23.6
9 Couching Street	27.4	27.1	24.3
41 Couching Street	38.3	37.3	29.9
48 Couching St (Co-Op)	37.2	36.3	29.3
8 Shirburn Street	33.8	32.7	27.3
23 Shirburn Street	32.8	31.8	26.8

The only modelled scenario which is common to both the main and addendum studies is the 2018 baseline scenario. However, the two 2018 baseline scenarios were modelled based on different traffic modelling inputs, with the main difference being that values for total flow (AADT) and percentage Heavy Goods Vehicles (% HGV) tend to be higher in the addendum traffic dataset. The modelled concentrations at diffusion tube locations are similar between the two studies. This would be expected, based on the model verification process which adjusted model parameters (congestion parameters in particular) to improve the agreement between modelled and measured 2018 concentrations.

The remaining four scenarios (2024 Base and 2024 S1 in the addendum study; 2024 No WTP and 2024 WTP in the main study) cannot be compared directly as they represent different future scenarios with different development assumptions and different traffic modelling inputs. However, the dispersion modelling results for both the main and addendum studies indicate that by 2024, all areas in Watlington are forecast to be compliant with the Air Quality Objective as the result of predicted improvements in vehicle emissions technology. Based on the modelled scenarios, future compliance with the Air Quality Objective is not reliant on the presence of the edge road.

7 Summary and Conclusions

This addendum air quality modelling study assessed the air quality within the Watlington AQMA under three scenarios: a 2018 Baseline scenario, a 2024 Base scenario (without the proposed development at Britwell Road) and a 2024 S1 scenario (with the proposed development at Britwell Road). The air dispersion modelling carried out in this addendum study was based on a traffic modelling dataset provided by South Oxfordshire District Council and developed by Clarkebond. This traffic modelling dataset was independently validated by Systra on behalf of Oxfordshire County Council, and is therefore considered to be the most robust transport modelling dataset currently available to use for air quality modelling in Watlington.

The modelling indicates that areas within the AQMA, along Couching street, are close to or exceeding the annual mean NO_2 Air Quality Objective in 2018. However, the areas which exceed the annual mean air quality objective occur only in the middle of the road, and not where the air quality objectives apply. At all locations where the objective applies, the modelled concentration in 2018 was below the Objective of 40 $\mu g.m^{-3}$, although in some locations the concentration is close to 40 $\mu g.m^{-3}$. Along Couching street, significant congestion, low free-flowing traffic speeds, and narrow street canyons coincide, leading to increased pollutant concentrations, particularly around the High Street/Hill Road junction.

Based on the traffic modelling dataset used in this addendum study, by 2024 all areas in Watlington are expected to be compliant with the Air Quality Objective as the result of predicted improvements in vehicle emissions technology. Compared to the 2024 Base scenario, the S1 scenario includes additional development at Britwell Road, has higher traffic flows (AADT) and slightly higher predicted concentrations, as demonstrated in both the modelled results at diffusion tube locations and the contour plots provided in this report. However, under both the 2024 Base and 2024 S1 scenarios, NO_2 concentrations are expected to be below 35 $\mu m.m^{-3}$ throughout the Watlington AQMA.

The results from the addendum study have been compared to the results of the main study. The only modelled scenario which is common to both the main and addendum studies is the 2018 baseline scenario, which predicted similar NO_2 concentrations in both studies. The remaining scenarios between the two studies cannot be compared directly, as they represent different future scenarios with different development assumptions and different traffic modelling inputs. However, the dispersion modelling results for both the main and addendum studies indicate that by 2024, all areas in Watlington are forecast to be compliant with the Air Quality Objective as the result of predicted improvements in vehicle emissions technology. Based on the modelled scenarios, future compliance with the Air Quality Objective is not reliant on the presence of the edge road. However, the results from the main study indicated that, without an edge road in place, annual mean NO_2 concentrations in 2024 are predicted to remain within 10% of the NO_2 objective in parts of Couching Street. As predictions of the future vehicle fleet and emission factors for future vehicles are subject to uncertainty, these areas could remain at risk of exceedance in future years without the proposed edge road when wider cumulative development is considered.

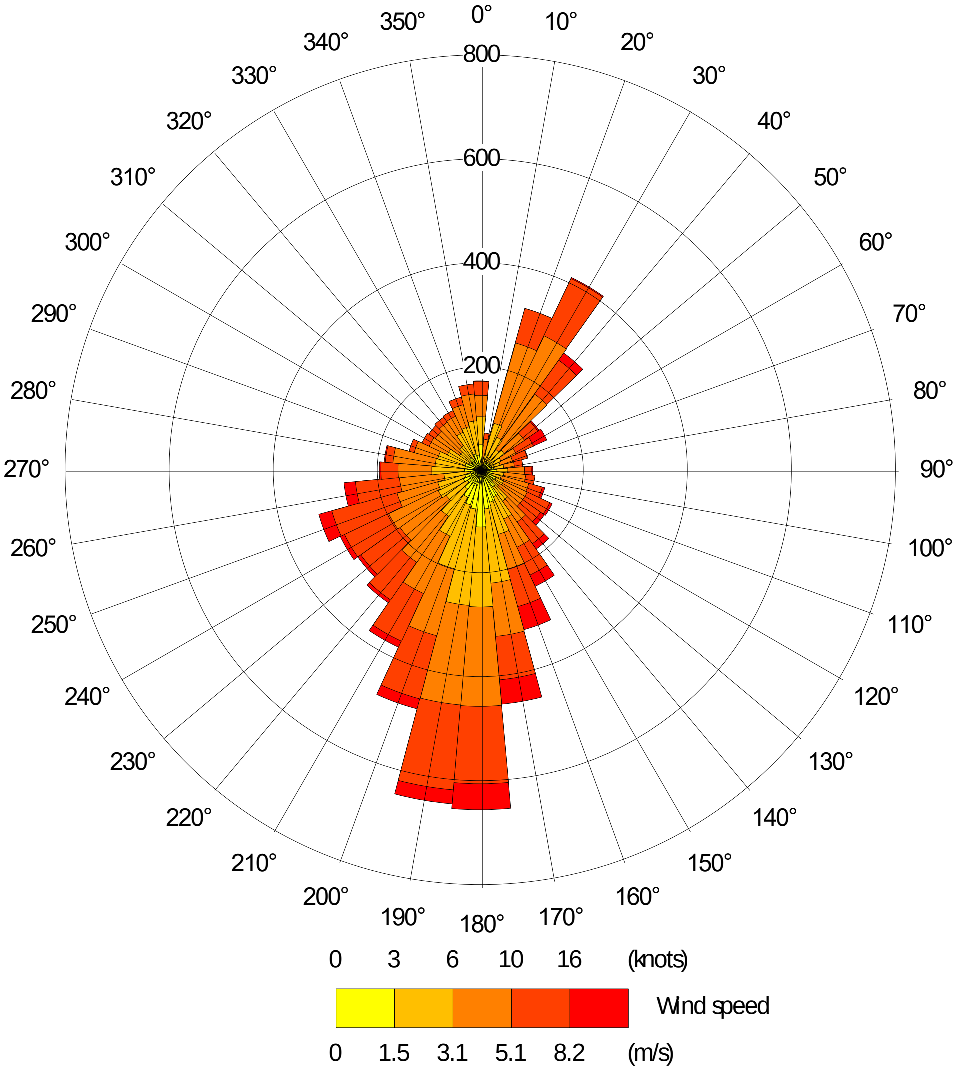
Appendices

Appendix 1: Meteorological dataset wind rose

Appendix 1 - Meteorological dataset

The wind rose corresponding to the 2018 meteorological data for this study, compiled as set out in the methodology in Section 6.1, is presented in Figure A. 1.

Figure A. 1: Wind rose



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