Dover District Council

Air Quality Assessment in the Dover Area

August 2017

Move Forward with Confidence

BUREAU VERITAS

THIS PAGE IS LEFT BLANK INTENTIONALLY

Document Control Sheet

Issue/Revision	Issue 1	Issue 2	Issue 3	Issue 3
Remarks	Draft for comment	Minor amends based on BG comments	Revision of Figures	Collation of Tasks 1 and 2
Date	January 2017	January 2017	April 2017	August 2017
Submitted to	Brian Gibson and Adrian Fox	Brian Gibson and Adrian Fox	Brian Gibson and Adrian Fox	Brian Gibson and Adrian Fox
Prepared by	Max Nancarrow (Consultant)	Max Nancarrow (Consultant)	Max Nancarrow (Consultant)	Max Nancarrow (Consultant)
Signature				
Approved by	Jamie Clayton (Senior Consultant)	Jamie Clayton (Senior Consultant)	Jamie Clayton (Senior Consultant)	Jamie Clayton (Senior Consultant)
Signature				
Project number	6366970	6366970	6366970	6366970

Bureau Veritas UK Limited
66 Prescot Street
London
E1 8HG

Telephone: +44 (0) 207 6610700
Fax: +44 (0) 207 6610741
Registered in England 1758622
www.bureauveritas.co.uk

Registered Office
Suite 308 Fort Dunlop
Fort Parkway
Birmingham B24 9FD

Table of Contents

List of Figures

List of Tables

Executive Summary

Bureau Veritas UK Ltd has been commissioned by Dover District Council (the Council) to undertake an assessment of the potential effects of the implemented allocations in the Adopted Core Strategy/Land Allocations Local Plan on air quality in the Dover area and a review of the extent of the existing Air Quality Management Areas (AQMAs). This will subsequently feed into an updated Air Quality Action Plan (AQAP) and any review of the Local Plan.

The basis of the assessment is the updated Dover Transportation Strategy completed by WSP/Parsons Brinckerhoff, on which a report on Air Quality was originally produced in 2008. The transport model is itself built on analysis of the existing and future transport conditions in Dover using a multi-modal transport 'VISSUM' model.

The air quality assessment considered exposure of existing residential and ecological receptors to concentrations of Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}), using the ADMS-Roads dispersion model (version 4.0.1).

For NO_2, there are three predicted exceedences of the AQS objective at specific receptors, all of which lie within existing AQMAs. The maximum predicted annual mean NO_2 concentration in 2015 was at R16 and AR15 with a predicted concentration of 47.8µg/m^3. This represents 119.5% of the 40µg/m^3 annual mean AQS objective.

Comparison with the 2026 concentrations predicted in the original 2008 WSP report highlights some large discrepancies. The modelled 2015 concentrations are higher for a majority of receptors, with one exception, R1. Notable differences are at receptors R13-R16, which are all in and around the A20 AQMA. This highlights some possibly optimistic predictions for the concentrations around the A20 AQMA in the 2008 report.

Annual mean NO_2 concentrations at all assessed receptor locations, original and additional, are below the 60µg/m^3 limit given in LAQM.TG(16)[5], and therefore short-term NO_2 exposure from road traffic emissions at the assessed receptor locations are not considered to be in exceedence of the AQS objective.

Whilst there are a total of three locations in exceedence of the NO_2 40µg/m^3 annual mean AQS objective, each of these is within an existing AQMA, so there are no new exceedence areas that the Council has not previously identified. This does however highlight that existing Action Plan measures have not been completely effective in achieving compliance, and so will require updating.

For NO_x, regional background (the concentrations which DDC are not able to influence), account for only 19.9% of total concentrations. As such local policy should have a significant influence on NO_x concentrations. For NO_2, cars unsurprisingly represent the largest contribution of any specific vehicle type, at 23.5% of total emissions at receptors where NO_2 concentrations exceed the annual mean objective.

NO_2 concentration isopleths identified three main potential areas of exceedance of the NO_2 annual mean AQS objective, namely; the A2 roundabout in Whitfield; the area around the High Street/Ladywell AQMA and the area encompassing the A20 AQMA. The was confirmed to be no likely exceedance in Whitfield, and the isopleths for the two areas for which there are already AQMAs broadly follow the extent of the current declarations. Where that extent differs, the Council intends to implement further monitoring.

For PM_{10}, the maximum predicted annual mean PM_{10} concentration in 2015 at any receptor was at R14, with a predicted concentration of 23.2µg/m^3. This represents only 58.1% of the 40µg/m^3 annual mean AQS objective.

Comparison with the 2026 annual mean concentrations predicted in the 2008 WSP report highlights that predicted concentrations are broadly comparable. Concentrations are generally lower for 2015, which is not as anticipated, but this is likely a function of the higher background concentrations used in the original WSP assessment. However, 2015 concentrations are significantly higher at R14, again highlighting perhaps optimistic forecasts around the A20 AQMA.

The maximum number of exceedences of the 24-hour PM_{10} 50µg/m^3 AQS objective at any receptor location in 2015 was predicted at R14, with 8.6 days. This is well below the 35 permitted exceedences.

Comparison with the number of days predicted for 2026 in the 2008 WSP report highlights that the number of days is marginally less in 2015 than was anticipated for 2026, again this is likely to be a function of the higher background concentrations used in the original assessment. However, the number of days is significantly higher at R14 in 2015.

In conclusion, there are no exceedences of either PM_{10} AQS objective modelled in 2015. There is no requirement to declare an AQMA for this pollutant.

The assessment has also considered emissions of Nitrogen (as NO_x) from road traffic at existing ecological receptor locations. It should be noted that the ecological receptor points are those within the designated sites that are closest to the road. It is likely that deposition rates will be at a lower level across the rest of the site area.

At each of the three sites assessed, there are exceedences of the nutrient nitrogen deposition minimum Critical Load (CL_{min}). Each of the three exceedences are primarily attributed to the background deposition rate. Nutrient nitrogen deposition from the road contribution can therefore be regarded as not significant.

For acid deposition, at each site, there are exceedences of the CL_{min}. However, in each case the background deposition rate alone exceeds the CL_{min} prior to the addition of the road contribution. The maximum CL is not exceeded at any of the three sites.

Each of the three exceedences are therefore primarily attributed to the background deposition rate. The nitrogen component of acid deposition from the road contribution can therefore be regarded as not significant.

Given the above conclusions, the following actions are recommended;

- Increase the monitoring regimes in both the Town Centre and Eastern Docks regions to enable closer monitoring of the spatial extent of the AQMAs;
- The AQMAs remain as currently declared, though if the above monitoring confirms further exceedances, amendment need be considered;
- Commence work on an updated Air Quality Action Plan, using the source apportionment information as a basis for measures, and targeting specifically the roads along the A256 High Street to A20 Snargate Street link (the area identified as 'Domain 1' during model verification);
- Begin an options appraisal of the potential future policies within the Adopted Core Strategy/Land Allocations Local Plan that could affect future Air Quality, in order that they can be adequately assessed; and
- Consider options to adopt the Kent & Medway Air Quality Partnership Air Quality Planning Guidance Option B.

1 Introduction

1.1 Scope of Assessment

Bureau Veritas UK Ltd has been commissioned by Dover District Council (the Council) to undertake an assessment of the potential effect of the implemented allocations in the Adopted Core Strategy/Land Allocations Local Plan on air quality in the Dover area and a review of the extent of the existing Air Quality Management Areas (AQMAs). This will subsequently inform an updated Air Quality Action Plan (AQAP) and any review of the Local Plan.

The basis of this assessment is the Dover Transportation Strategy, first completed in 2008 and recently updated by WSP/Parsons Brinckerhoff. The strategy is built on an analysis of the existing and future transport conditions in Dover using a multi-modal transport 'VISSUM' model. This was updated by re-validating the base year with 2013 traffic data, 2011 Census data, new traffic data collected by Dover Harbour Board, traffic data collected from Automatic Traffic Counts in November 2015, mobile phone data and any completed/committed development since 2007.

Part of the original 2008 Strategy involved a separate analysis[1] of the air quality impacts of the significant growth Council's Adopted Core Strategy. This assessment uses the same receptor locations as that in the original 2008 analysis, so that indicative comparisons can be made to those conclusions.

There are currently two Air Quality Management Areas (AQMAs) declared in the district due to exceedences of the annual mean Air Quality Strategy (AQS) objective for nitrogen dioxide (NO_2), caused primarily by road traffic emissions. These are the A20 AQMA, declared in 2004 (and amended in 2007 and 2009) and the High Street/Ladywell AQMA, declared in 2007. The extent of these AQMAs has not been reviewed since 2009 and 2007 respectively.

The following are therefore the main objectives of the assessment:

- To assess the air quality at selected locations ("receptors") at the façades of existing residential units representative of worst-case exposure, based on modelling of emissions from road traffic on the local road network for the year 2015;
- To compare the predicted air pollutant concentrations with the objectives set out in the AQS[2]and set out by the Government in the Air Quality (England) Regulations 2000[3] and (Amended 2002 version[4]) for Local Air Quality Management (LAQM) purposes, in order to identify any issues pertinent to the exposure of residents to these pollutants; and
- To assess the nutrient nitrogen deposition at selected ecological receptors and compare these against the relevant Critical Loads
- Compare the conclusions of the assessment with the 2008 Air Quality Report; and
- Review of the Air Quality Management Area (AQMA) boundaries.

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 NO_2 and PM_{10}. These pollutants are the main pollutants of concern associated with

[1] http://www.dover.gov.uk/Planning/Planning-Policy/Local-Plan/Evidence Base/Studies/TRANSAirQualityReport.pdf

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

[3] The Air Quality (England) Regulations 2000 (Statutory Instrument 928).

[4] The Air Quality (England) (Amendments) Regulations 2002 (Statutory Instrument 3043).

traffic emissions, both nationally and within the Council's administrative area. Further general information in relation to these pollutants and urban pollution is provided in Appendix 1.

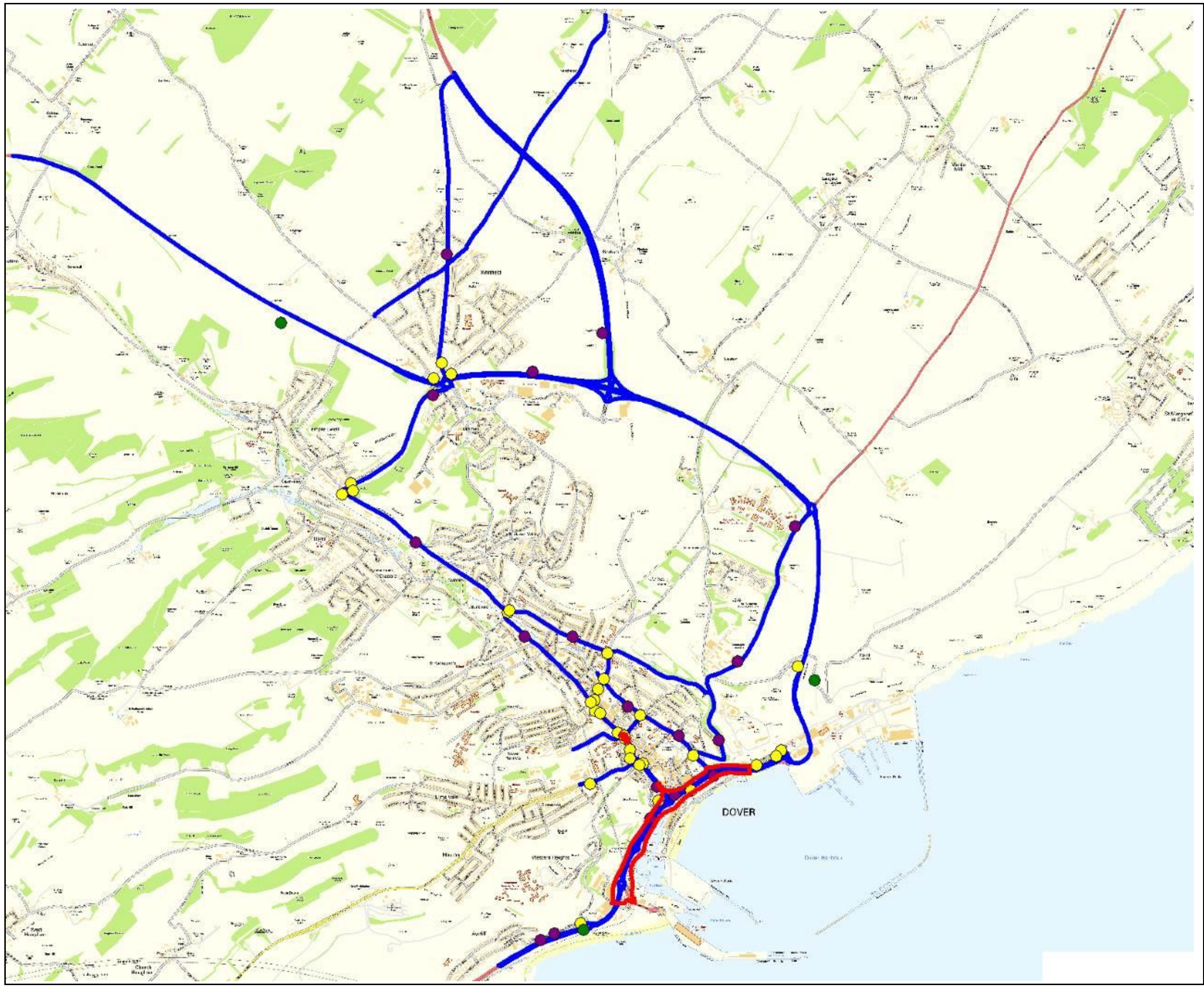
In order to ensure consistency with the Council's own work on air quality, the guiding principles for air quality assessments, as set out in the latest guidance provided by Defra for air quality assessment (LAQM.TG(16)[5]), have been used. Consultation[6] was also undertaken with the Council and WSP/Parsons Brinckerhoff to agree technical aspects of the air quality assessment.

The area considered as part of this study is illustrated in Figure 1.

[5] Local Air Quality Management Technical Guidance LAQM.TG(16). April 2016. Published by Defra in partnership with the Devolved Administrations, available at: http://laqm.defra.gov.uk/supporting-guidance.html.

[6] Pers. Comms. November 2016.

Figure 1 – Study Area



Legend

- Modelled Roads
- AQMAs
- Original Receptors
- Additional Receptors
- Ecological Receptors

BUREAU VERITAS

Air Quality
Bureau Veritas
5th Floor
66 Prescot Street
London, E1 8HG

Location District of Dover	
Title Study Area	
By MN	**Approved** JC
Scale Not To Scale	**Job Ref** 6366970
Date April 2017	**Figure No.** 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 (AQS)[2] 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[7] has been adopted and replaces all previous air quality Directives, except the 4th Daughter Directive[8]. 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[4] 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[2].

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. Table 1 taken from LAQM TG(16)[5] provides an indication of those locations that may or may not be relevant for each averaging period.

This assessment focuses on NO_2 and PM_{10} as these are the pollutants of most concern within the Council's administrative area. Moreover, as a result of traffic pollution the UK has failed to meet the EU Limit Values for NO_2 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.

[7] 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.

[8] 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.

Table 1 – Examples of where the Air Quality Objectives should Apply

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building facades 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
24-hour mean and 8-hour mean	All locations where the annual mean objectives would apply, together with hotels. Gardens or residential properties[1].	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 and 24 and 8-hour mean objectives would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend one hour or more. Any outdoor locations at which the public may be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-minute mean	All locations where members of the public might reasonably be expected to spend a period of 15 minutes or longer.	

[1] For gardens and playgrounds, such locations should represent parts of the garden where relevant public exposure is likely, for example where there is seating or play areas. It is unlikely that relevant public exposure would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied.

Table 2 – Relevant AQS Objectives for the Assessed Pollutants in England

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
Particulate Matter (PM_{10})	50 µg/m³ not to be exceeded more than 35 times per year	24-hour mean	31 December 2010
	40 µg/m³	Annual mean	31 December 2010

2.2 Local Air Quality Management (LAQM)

Part IV of the Environment Act 1995[9] 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[10] 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.

2.3 National Planning Policy

The National Planning Policy Framework[11] (NPPF), published on 27 March 2012, states that the planning system should contribute to and enhance the natural and local environment, by preventing new development from contributing or being adversely affected by unacceptable concentrations of air pollution. In specific relation to the air quality policy, the document states:

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

2.4 Local Policy

A number of local policy documents set out measures that relate to air quality, namely:

---

9 http://www.legislation.gov.uk/ukpga/1995/25/part/IV

10 LAQM Policy Guidance LAQM.PG(16) – April 2016. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

11 National Planning Policy Framework (2012) available at https://www.gov.uk/government/publications/national-planning-policy-framework--2

- The Core Strategy (2010)[12]
- The Local Plan (Adopted 2002, due for review in 2017)[13]
- Land Allocations Plan Local Plan (Adopted 2015)[14]
- Dover Transport Strategy (2007 – currently being updated)[15]
- The Local Transport Plan for Kent[16]
- Kent Environment Strategy[17]

Principal among these is the Dover Core Strategy, which is the District's key plan in the local development framework up to 2026. The core policies within the plan specifically addressing air quality are as follows:

Policy CP7 – Green Infrastructure Network – protecting and enhancing the existing network of green infrastructure. Proposals that would introduce additional pressure on the existing and proposed green infrastructure network are only permitted if they incorporate quantitative and qualitative measures, as appropriate, sufficient to address that pressure. Air quality monitoring will be used to help assess the need for mitigation measures and, if required, establish the nature of those measures.

Policy CP8 – Dover Waterfront – Planning permission only granted along the waterfront provided the proposals incorporate avoidance and mitigation measures to address impact on air quality issues associated with the A20 trunk road and the Port operations.

A second key facet of Dover's strategy towards air quality is its participation in the Kent and Medway Air Quality Partnership[18] (KMAQP), which aims to co-ordinate efforts across the numerous districts and boroughs in the region to improve air quality. As part of this, the partnership prepared Air Quality Planning Guidance (options A[19] and B[20]) aimed at providing clarity and consistency of approach for developers, the local planning authority and local communities. The two approaches differ only slightly in their approach to mitigation. As part of this, an annual review is also published tracking trends and changes across the region[21] which gives the Council an appreciation of the impact improvement measures are having in a wider context. Working with the partnership, the Council has been able to implement further direct measures to improve air quality, as referenced in the Council's 2016 Annual Status Report[22].

[12] http://www.dover.gov.uk/Planning/Planning-Policy/Local-Plan/Core-Strategy/Home.aspx

[13] http://dover.devplan.org.uk/document.aspx?document=26&display=contents

[14] http://www.dover.gov.uk/Planning/Planning-Policy/Local-Plan/Land-Allocations/Land-Allocations.aspx

[15] http://www.dover.gov.uk/Planning/Planning-Policy/Local-Plan/Evidence-Base/Studies/TRANSDoverTransportStrategy.pdf

[16] http://www.kent.gov.uk/about-the-council/strategies-and-policies/transport-and-highways-policies/local-transport-plan

[17] http://www.kent.gov.uk/about-the-council/strategies-and-policies/environment-waste-and-planning-policies/environmental-policies/kent-environment-strategy

[18] http://www.kentair.org.uk/

[19] http://www.kentair.org.uk/documents/K&MAQP_Air_Quality_Planning_Guidance_Mitigation_Option_A.pdf

[20] http://www.kentair.org.uk/documents/K&MAQP_Air_Quality_Planning_Guidance_Mitigation_Option_B.pdf

[21] http://www.kentair.org.uk/library

[22] https://www.dover.gov.uk/Environment/Environmental-Health/Air-Quality/Annual-Status-Report-2016.pdf

2.5 Critical Loads Relevant to the Assessment of Ecological Receptors

The APIS website[23] provides specific information on the potential effects of nitrogen deposition on various habitats and species. This information, relevant to habitats of some of the ecological receptors considered in this assessment, is presented in

Table 3 – Typical Habitat and Species Information Concerning Nitrogen Deposition from APIS

Habitat and Species Specific Information	Critical Load (kg N ha^{-1} yr^{-1})	Specific Information Concerning Nitrogen Deposition
Saltmarsh	30-40	Many saltmarshes receive large nutrient loadings from river and tidal inputs. It is unknown whether other types of species-rich saltmarsh would be sensitive to nitrogen deposition.
Littoral Sediments	20-30	Increase in late-successional species, increased productivity but only limited information available for this type of habitat.
Coastal Stable Dune Grasslands	10-20	Increase late successional species, increase productivity increase in dominance of graminoids.
Alkaline Fens and Reed beds	10-35	Foredunes receive naturally high nitrogen inputs. Key concerns of the deposition of nitrogen in these habitats relate to changes in species composition.
Temperate and boreal forests	10-20	Nitrogen deposition provides fertilization. Increase in tall graminoids (grasses or Carex species) resulting in loss of rare species and decrease in diversity of subordinate plant species.
Hay Meadow	20-30	Increased nitrogen deposition in mixed forests increases susceptibility to secondary stresses such as drought and frost, can cause reduced crown growth. Also can reduce the diversity of species due to increased growth rates of more robust plants.
Acid Grasslands	10-25	The key concerns are related to changes in species composition following enhanced nitrogen deposition. Indigenous species will have evolved under conditions of low nitrogen availability. Enhanced Nitrogen deposition will favour those species that can increase their growth rates and competitive status e.g. rough grasses such as false brome grass (Brachypodium pinnatum) at the expense of overall species diversity. The overall threat from competition will also depend on the availability of propagules
Raised bog and blanket bog	5-10	Nitrogen deposition provides fertilization to acid grasslands, this increase robust grass growth that may limit other species reducing diversity.
Oak Woodland	10-15	Nitrogen deposition provides fertilization, this increase robust vegetation growth that may limit other species reducing diversity

23 http://www.apis.ac.uk

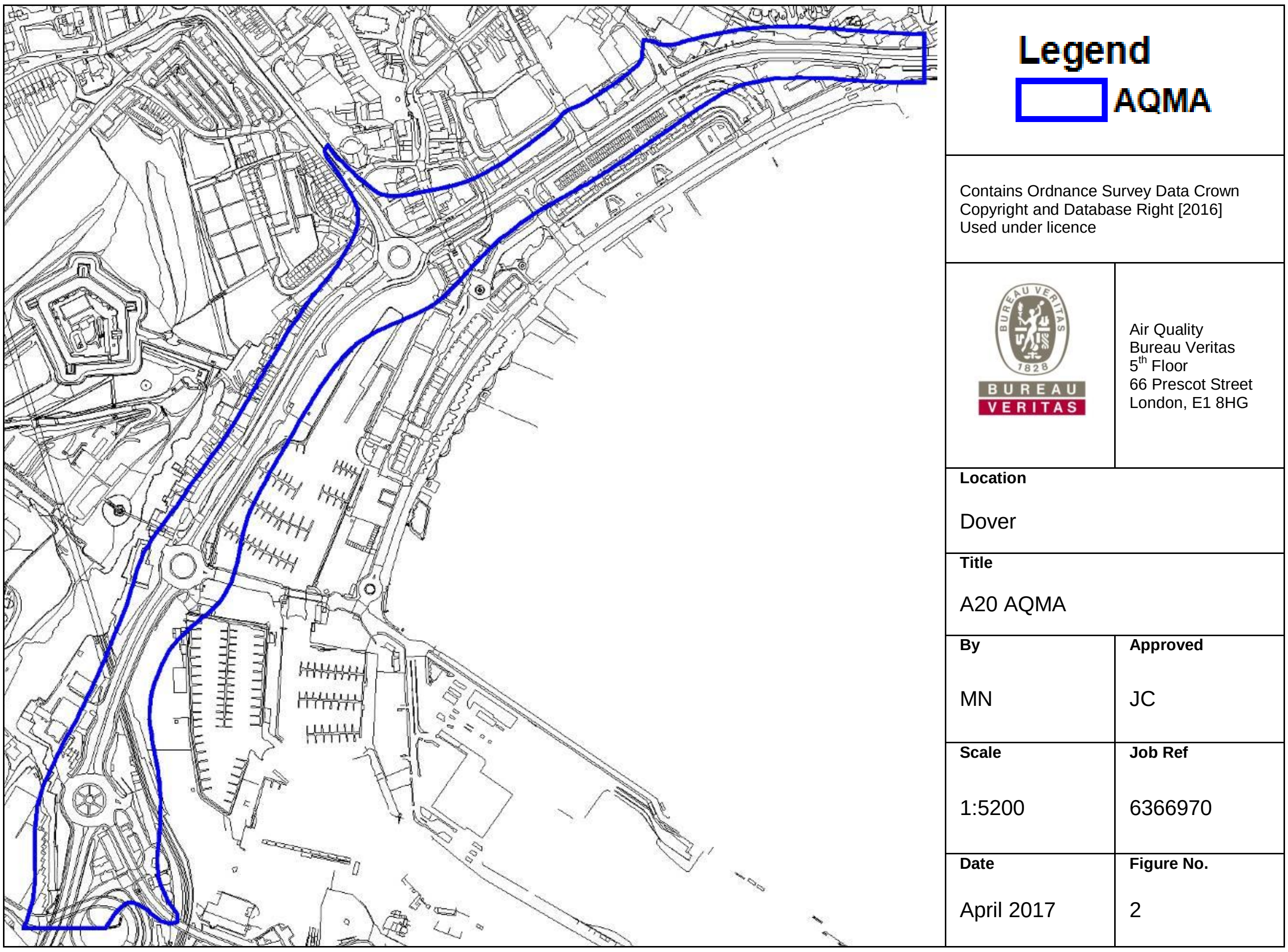
3 Review and Assessment of Air Quality Undertaken by the Council

3.1 Local Air Quality Management

The busy Port of Dover with regular cross-channel ships and large volumes of road traffic from the A2 and A20 entering and leaving the town predominately represents the main source of air pollution in the area.

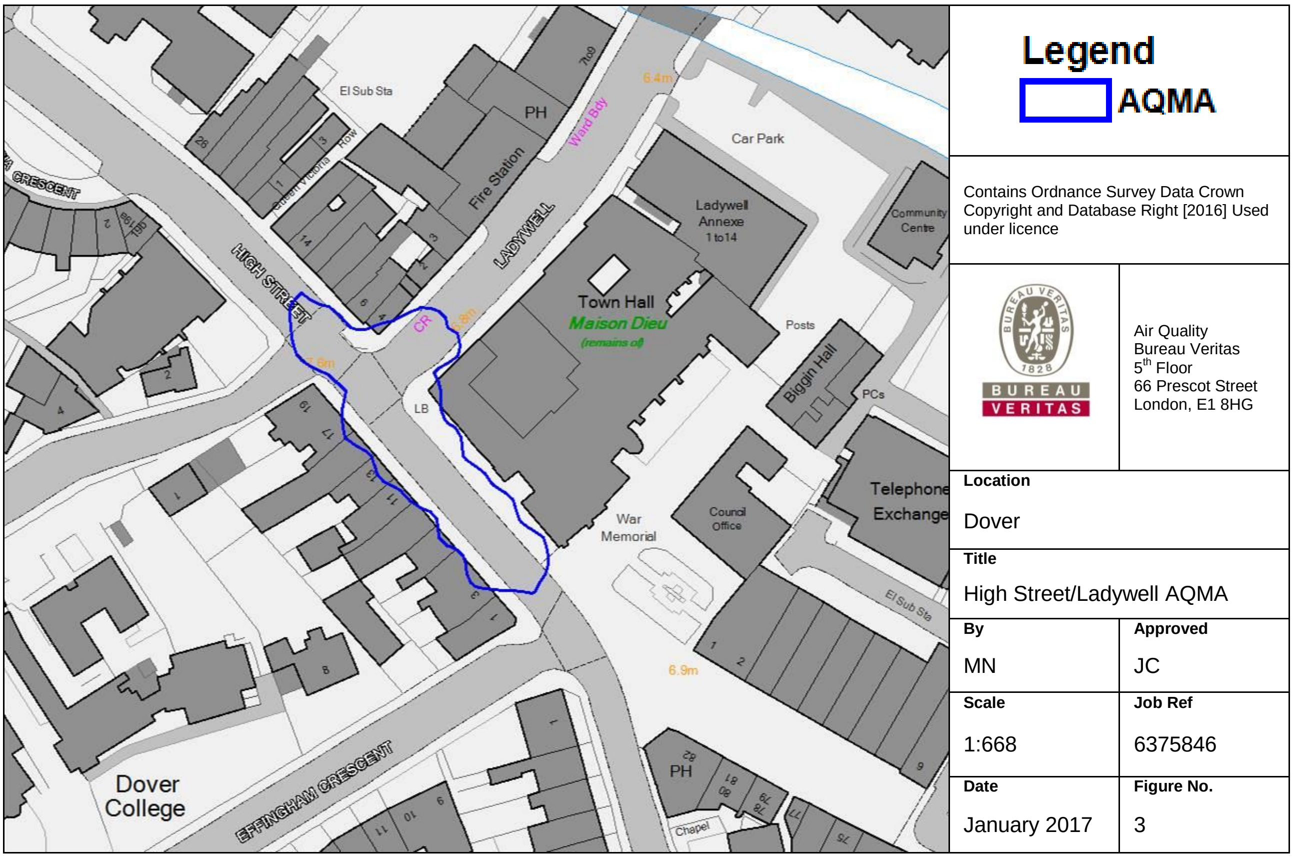
There are currently two AQMAs declared in the district due to exceedences of the annual mean Air Quality Strategy (AQS) objective for NO_2, caused primarily by road traffic emissions. These are the A20 AQMA (See Figure 2), declared in 2004 (and amended in 2007 and 2009) and the High Street/Ladywell AQMA (See Figure 3), declared in 2007. The Dover Docks AQMA, declared in 2002 for exceedences of the 15-min and 1-hr and 24-hr mean for sulphur dioxide (SO_2), was revoked in 2014. Dover has an active AQAP[24], which is designed to improve the problems identified in the AQMA areas.

Figure 2 – A20 AQMA



24 https://www.dover.gov.uk/Environment/Environmental-Health/Air-Quality/Dover-Air-Quality-Action-Plan-(No-2-A20).pdf

Figure 3 – High Street/Ladywell AQMA



3.2 Review of Air Quality Monitoring

Local Air Quality Monitoring

Dover District Council undertook automatic (continuous) monitoring at one site for PM_{10} during 2015. The data for this site can be downloaded from http://www.kentair.org.uk/data/. Details are given in Table 4 and a map showing this location is available in Figure 4.

Table 4 – LAQM Monitoring undertaken for PM_{10} in 2015 in the Assessment Area

Site ID	Site Location	Site Type	X OS Grid Ref	Y OS Grid Ref	Height (m)	Annual Mean NO_2 Concentration ($\mu g/m^3$) 2015*	Data Capture 2015 (%)
Dover Centre Roadside	A20 Townwall Street, Dover	Roadside	632302	141465	2	22.4	97.3
The monitoring results were provided by DDC.							

The Council also undertook non-automatic (passive) monitoring of NO_2 at thirteen sites during 2015 three of which were triplicate sites; these were:

- DV06-08 Townhall, Dover;
- DV11, 16 and 17 The Gateway, Dover; and
- DV12, 18 and 19 – St Martins, Dover.

The concentrations reported at these sites are those averaged between the diffusion tubes present in each month (i.e. usually three).

In 2015 the Council commissioned the following three new diffusion tube sites, all commencing in August:

- DV26 - 1 King Lear S Way, Dover;
- DV28 - Sunny Corner Nursing Home, Dover; and
- DV29 - Aycliffe County Primary School, Dover.

These new sites were added to the network due to the introduction of Operation TAP. Operation TAP provides traffic management measures so that port traffic is held up by traffic lights on the A20 outside Dover and then 'trickled' through the AQMA area of the A20 to the port. This has resulted in some small improvements to nitrogen dioxide levels around Snargate St.

Table 5 gives details of the diffusion tube network, and the locations are illustrated in Figure 4.

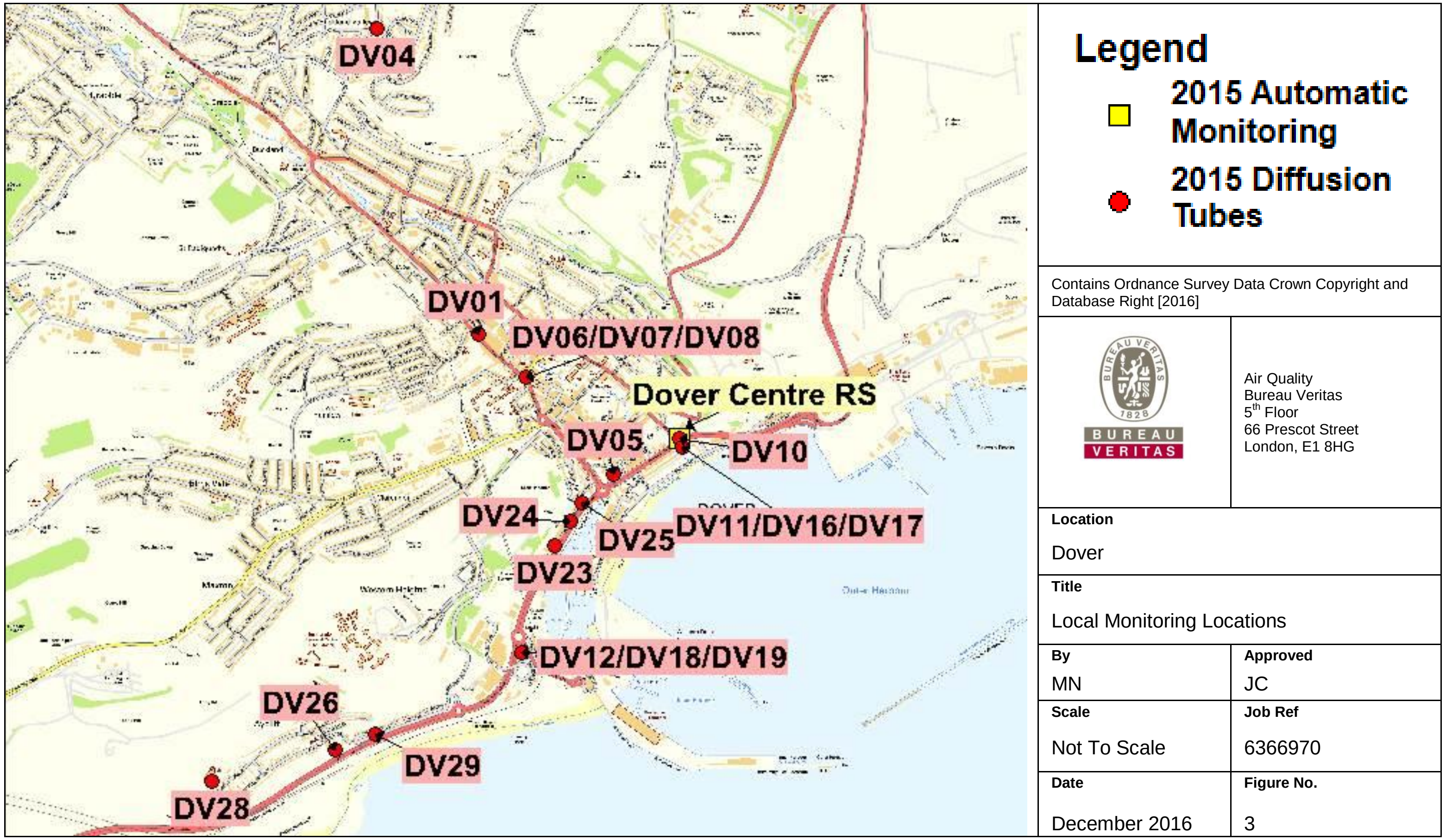
Table 5 – Diffusion Tube LAQM Monitoring undertaken for NO_2 in 2015 in the Assessment Area

Site ID	Site Location	Site Type	X OS Grid Ref	Y OS Grid Ref	Height (m)	Annual Mean NO_2 ($\mu g/m^3$)	Data Capture 2015* (%)
DV01	95 High Street	Roadside	631376	141949	2.6	30.2	75.0
DV04	Car Park - Opp 2	Urban Background	630905	143362	1.6	15.6	66.7
DV05	Bench Street	Urban Centre	631997	141296	3	31.1	66.7
DV06/DV07/ DV08	Town Hall	Roadside	631597	141748	3	**44.2**	91.7
DV10	Townwall Street	Roadside	632302	141465	2	**41.2**	75.0
DV11/DV16/ DV17	The Gateway	Roadside	632318	141422	3	35.4	91.7
DV12/DV18/ DV19	St Martins	Roadside	631573	140472	3	38.9	86.1
DV23	126 Snargate Street	Roadside	631727	140966	3	**43.2**	91.7
DV24	148 Snargate Street	Roadside	631802	141079	3	**49.1**	91.7
DV25	167 Snargate Street	Roadside	631854	141164	3	39.4	66.7
DV26	1 King Lear S Way	Urban Background	630715	140021	2	23.9	41.7
DV28	Sunny Corner Nursing Home	Urban Background	630147	139874	2	19.8	41.7
DV29	Aycliffe County Primary School	Roadside	630902	140095	2	20.4	41.7

The monitoring results were provided by DDC.
* - Where data capture is below 75%, results were annualised. See 2016 ASR[25]

[25] Dover District Council (2016) Annual Status Report, Available at: https://www.dover.gov.uk/Environment/Environmental-Health/Air-Quality/Annual-Status-Report-2016.pdf

Figure 4 – Local Monitoring Locations



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[26], based on the 1km grid squares which cover the modelled area and the affected road network. To avoid double counting of sources, it is necessary to remove road contributions to the background concentrations that are explicitly modelled. As such, Trunk_A_Rd_in and Primary_A_Rd_in sector contributions have been removed

Total and post-sector removal Defra mapped background concentrations for 2015 are presented in Table 6.

Table 6 – Background Pollutant Concentrations

Grid Coordinates		2015 Defra Mapped Background Concentration(µg/m^3)			2015 Defra Mapped Background Concentration Post-Sector Removal (µg/m^3)		
X	Y	NO_2	NO_X	PM_{10}	NO_2	NO_X	PM_{10}
630500	145500	10.7	14.6	15.2	10.7	14.6	15.2
631500	145500	11.1	15.2	15.0	10.5	14.3	15.0
630500	144500	12.5	17.2	15.8	11.6	16.0	15.8
629500	143500	11.4	15.6	14.9	10.7	14.6	14.9
631500	142500	14.0	19.7	15.1	13.2	18.5	15.0
630500	142500	12.8	17.8	15.1	12.1	16.8	15.1
631500	141500	15.6	22.1	15.9	14.2	20.1	15.9
632500	143500	12.9	17.9	14.9	12.2	17.0	14.8
632500	142500	13.6	19.0	14.7	13.0	18.2	14.6
632500	141500	16.0	23.0	15.4	14.7	20.9	15.3
631500	140500	14.6	20.7	15.8	13.1	18.4	15.8
630500	140500	12.2	16.9	14.8	11.9	16.5	14.8
633500	142500	15.0	21.5	15.0	14.4	20.5	15.0
628500	145500	9.8	13.2	16.2	9.0	12.2	16.2
630500	143500	11.9	16.4	14.8	11.7	16.1	14.8
630500	139500	13.2	18.5	14.9	12.1	16.9	14.8

The background concentrations presented in Table 6 and used for the purposes of this assessment are all below the respective annual mean AQS objectives. These were used in preference to local 'urban background' monitoring data points (see Table 5) as they provide a greater geographic coverage, and thus were deemed to be more representative at each specific location than applying a single concentration to such a wide area.

The predicted annual mean modelled road contributions are added to the relevant annual mean background concentration in order to predict the total pollutant concentration at each receptor

[26] Defra Background Maps http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

location. The total pollutant concentration can then be compared against the relevant AQS objectives to determine the event of an exceedence.

4 Assessment Methodology

The assessment and the prediction of ambient NO_2 and PM_{10} concentrations to which existing receptors may be exposed, and the comparison with the relevant AQS objectives, has been based on the following:

4.1 Dispersion Model

Emissions from road traffic have been determined using version 7.0 of the Emissions Factors Toolkit[27]. Road-NO_x and PM_{10} contributions for each source type 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

A 2015 base scenario has been assessed. This enables model verification and the assessment of receptor exposure.

The ADMS-Roads assessment incorporates numbers of road traffic vehicles, vehicle speeds and the composition of the traffic fleet. The traffic data for this assessment has been provided by appointed transport consultant, WSP/Parsons Brinckerhoff. The reduction of vehicle speed at junctions is accounted for in the transport model. However, where appropriate, the speeds have been further reduced from those given in the transport model to simulate queues at junctions, traffic lights and other locations where queues are known to be an issue.

A summary of the traffic data inputs applied within the dispersion modelling undertaken as part of this assessment is provided in Appendix 2 – Traffic Data Used in Assessment.

The background concentrations applied in the assessment of road traffic emissions are presented in Table 6.

The original receptors considered in the WSP assessment are shown in Table 7 and displayed in Figure 5. The additional receptors added as part of this assessment are detailed in Table 8 and displayed in Figure 6. The ecological receptors considered in the assessment are listed in Table 9 and their locations are illustrated in Figure 7. The ecological receptor points are those within the designated sites that are closest to the road and so are likely to demonstrate the maximum impacts. It is likely that deposition rates will be at a lower level across the rest of the site.

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

Table 7 – Receptor Locations considered in the Assessment of Emissions from Road Traffic – Original Receptors

Receptor ID	Description	X	Y	Height (m)
R1	Next to 107a Sandwich Road	630141	145666	1.5
R2	Location of proposed development at Whitfield	631412	145023	1.5
R3	Location of proposed development at Whitfield	630839	144712	1.5
R4	46-50 Old Park Wood	630029	144520	1.5
R5	21 London Road	629884	143324	1.5
R6	41 Barton Road	631168	142561	1.5
R7	209 London Road	630778	142560	1.5
R8	21-23 Hewitt Road	631616*	141990*	1.5
R9	Duke of York's Royal Military School	632982	143455	1.5
R10	Connaught Barracks	632514	142358	1.5
R11	Victoria Park Mews	632357	141719	1.5
R12	109 Maison Dieu Road	632034	141752	1.5
R13	150 to 167 Douro Place	632316	141428	1.5
R14	11 Bench Street	631998	141270	1.5
R15	19-23 Battle of Britain Houses	631856	141337	1.5
R16	149, Snargate Street	631804	141082	1.5
R17	18, Kings Ropewalk	631020	140146	1.5
R18	1, Kings Lears Way	630906	140096	1.5
*Moved from co-ordinates stated in original report which were listed as within the road width				

Table 8 – Receptor Locations considered in the Assessment of Emissions from Road Traffic – Additional Receptors

Receptor ID	Description	X	Y	Height (m)
AR1	14 Upper Road	633003.2	142315	1.5
AR2	2 Archers Court Road	630175.5	144695.9	1.5
AR3	12 Singledge Lane	630032.5	144659.9	1.5
AR4	4 Sandwich Road	630097.3	144781.9	1.5
AR5	5 Whitfield Hill	629359.6	143803.6	1.5
AR6	Woodside Care Home	629378	143746.5	1.5
AR7	87 London Road	629285.6	143714.2	1.5
AR8	4 Whitfield Avenue	630642.4	142754.3	1.5
AR9	3 Whitfield Avenue	630650.4	142770.4	1.5
AR10	14 Matthew's Place	631345.9	142046	1.5
AR11	6 Templar Street	631318	142028.2	1.5
AR12	103 High St	631350.1	141957.2	1.5
AR13	4 Victoria Crescent	631537.4	141778	1.5
AR14	8 Victoria Crescent	631585.1	141757.3	4.5
AR15	11 High St	631592	141727	4.5
AR16	17 Priory Road	631636.9	141640.4	1.5
AR17	29 York Street	631744.7	141525.5	1.5
AR18	Lancaster House	631712.5	141514.8	1.5
AR19	26 Adrian Street	631868.8	141228.3	1.5
AR20	The Gateway	632133	141305.8	1.5
AR21	5 East Cliff	632666.4	141517.7	1.5
AR22	32 East Cliff	632867.2	141632.1	1.5
AR23	4 Gloster Ropewalk	631229.8	140230.8	1.5
AR24	23 Marine Parade	632828.2	141584.6	1.5
AR25	2 Castle Street	632152	141591.1	1.5
AR26	15 Barton Road	631454.3	142421.7	1.5
AR27	48 Charlton Green	631423	142214.1	1.5
AR28	23 Bridge Street	631377.1	142130.7	1.5
AR29	High Street Surgery	631392.8	141934.6	1.5
AR30	1 Saxon Street	631634	141569.3	1.5
AR31	117-119 Folkestone Road	631312.4	141364.8	1.5
AR32	25 Park Street	631716.2	141921.1	1.5

Table 9 – Receptor Locations considered in the Assessment of Emissions from Road Traffic – Ecological Receptors

Receptor ID	Description	X	Y	Height (m)
ER1	Folkestone Warren	631256.9	140174.7	0
ER2	Dover to Kingsdown Cliffs	633140.4	142205.4	0
ER3	Lydden & Temple Ewell Downs	628791.4	145109.5	0

Figure 5 – Original Receptor Locations considered in the 2008 WSP Report

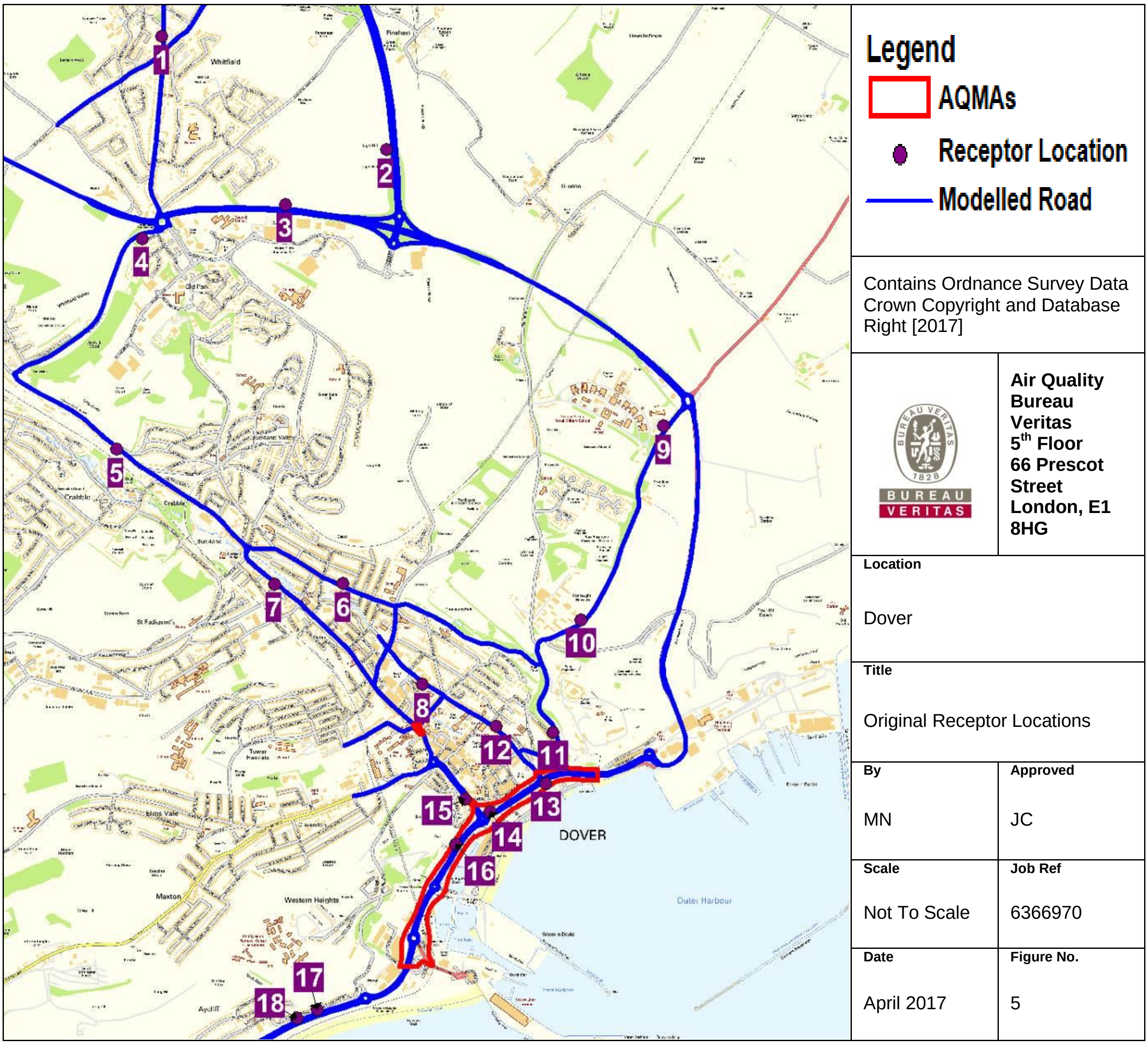


Figure 6 – Receptor Locations Considered in the Assessment in Addition to the Original Receptors from 2008 WSP Report

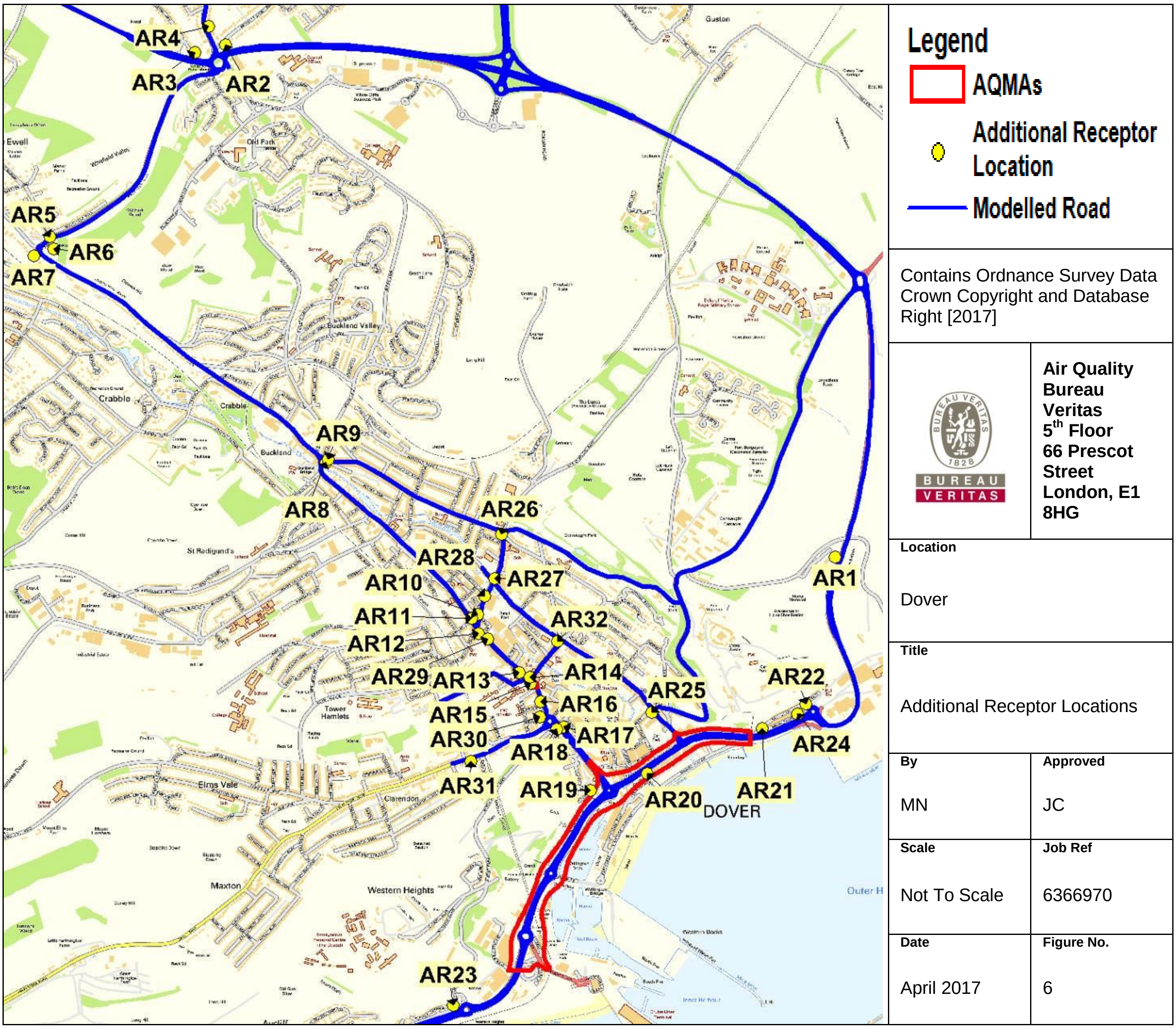
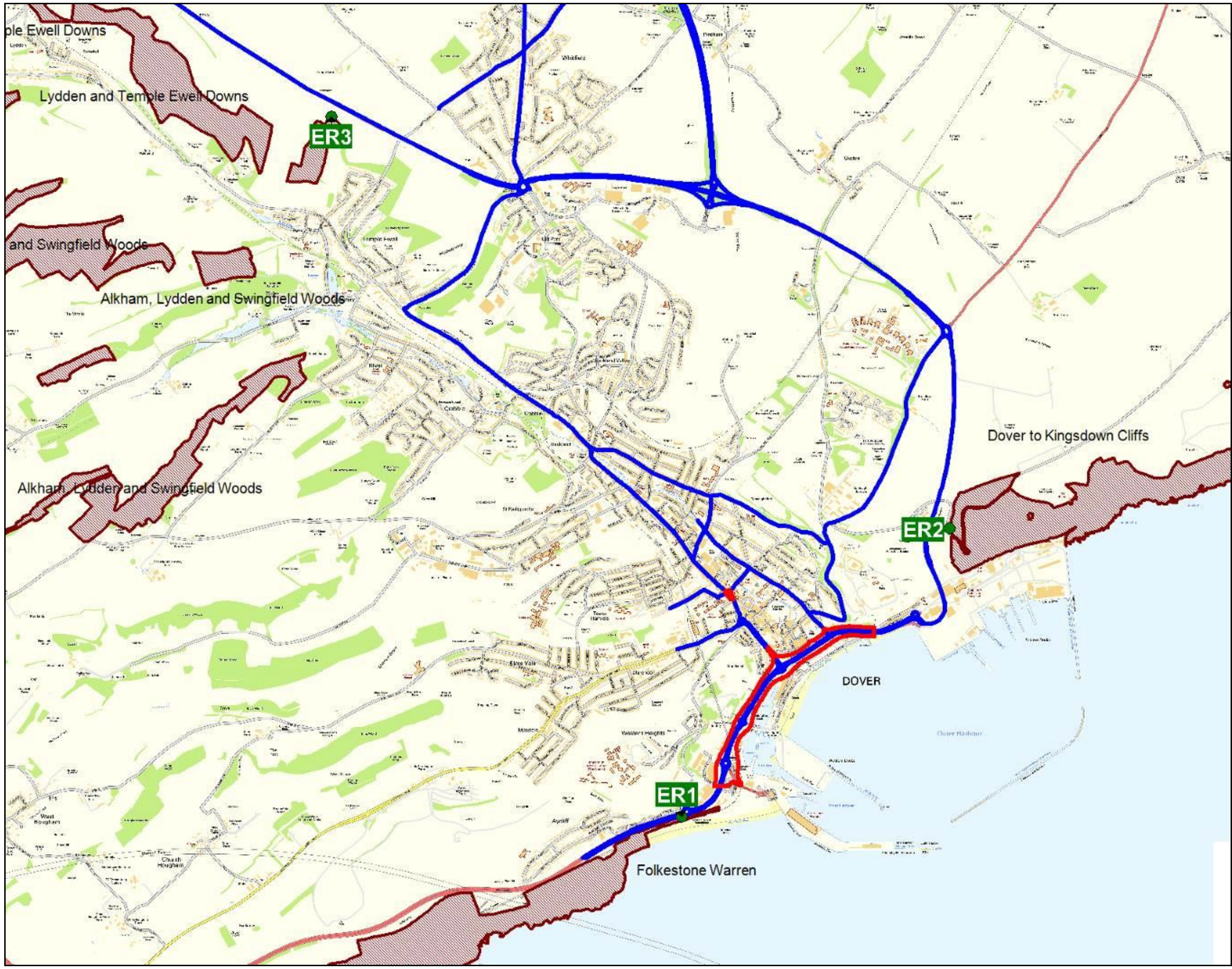


Figure 7 – Ecological Receptors Considered in the Assessment



Legend

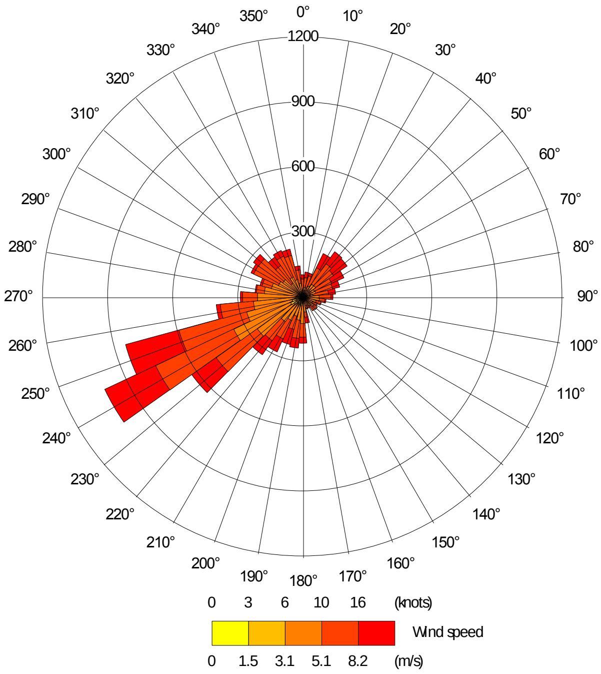
- AQMAs
- Ecological Receptors
- Modelled Road
- SSSI/SAC area

Contains Ordnance Survey Data Crown Copyright and Database Right [2017]

BUREAU VERITAS	**Air Quality Bureau Veritas 5th Floor 66 Prescot Street London, E1 8HG**
Location Dover	
Title Ecological Receptors	
By MN	**Approved** JC
Scale Not To Scale	**Job Ref** 6366970
Date April 2017	**Figure No.** 7

Meteorological data from a representative station is required as input to the dispersion model. 2015 meteorological data from the Langdon Bay weather station has been used in this assessment. A wind rose for this site for the year 2015 is shown in Figure 8. Most dispersion models do not use meteorological data if it relates 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)[5] 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 Langdon Bay includes 8,747 lines of usable hourly data out of the total 8,760 for the year, i.e. 99.9% usable data. This is therefore suitable for the dispersion modelling exercise.

Figure 8 – Wind rose for Langdon Bay Meteorological Data 2015



4.1.2 Deposition

The predominant route by which emissions will affect land in the vicinity of a source is by deposition of atmospheric emissions. Potential ecological receptors can be sensitive to the deposition of pollutants, particularly nitrogen and sulphur compounds, which can affect the character of the habitat through eutrophication and acidification.

Deposition processes in the form of dry and wet deposition remove material from a plume and alter the plume concentration. Dry deposition occurs when particles are brought to the surface by gravitational settling and turbulence. They are then removed from the atmosphere by deposition on the land surface. Wet deposition occurs due to rainout (within cloud) scavenging and washout (below cloud) scavenging of the material in the plume. These processes lead to a variation with downwind distance of the plume strength and may alter the shape of the vertical concentration profile as dry deposition only occurs at the surface.

Near to sources of pollutants (< 2 km), dry deposition is the predominant removal mechanism (Fangmeier et al. 1994). Dry deposition may be quantified from the near-surface plume concentration and the deposition velocity (Chamberlin and Chadwick, 1953);

$$F_d = v_d C(x, y, 0)$$

where:

F_d = dry deposition flux (μg m^{-2} s^{-1})

v_d = deposition velocity (m s^{-1})

$C(x, y, 0)$ = ground level concentration (μg m^{-3})

Assuming irreversible uptake, the total wet deposition rate is found by integrating through a vertical column of air;

$$F_w = \int_0^z \Lambda C \, dz$$

where;

F_w = wet deposition flux (μg m^{-2} s^{-1})

Λ = washout co-efficient (s^{-1})

C = local airborne concentration (μg m^{-3})

z = height (m)

The washout co-efficient is an intrinsic function of the rate of rainfall.

Environment Agency guidance AQTAG06 (Environment Agency, 2014) recommends deposition velocities for various pollutants, according to land use classification in Table 10.

Table 10 – Recommended Deposition Velocities

Pollutant	Deposition Velocity (m s^{-1})	
	Short Vegetation/Grassland	Long Vegetation/Forest
NO_x	0.0015	0.003

Source: Environment Agency (2014) 'Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air', AQTAG06 Updated Version (March 2014)'

In order to assess the impacts of deposition, habitat-specific critical loads and critical levels have been created. These are generally defined as (e.g., Nilsson and Grennfelt, 1988):

> *"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"*

It is important to distinguish between a critical load and a critical level. The critical load relates to the quantity of a material deposited from air to the ground, whilst critical levels refer to the concentration of a material in air. The APIS website[23] provides critical load data for ecological sites in the UK.

The critical loads used to assess the impact of compounds deposited to land which result in eutrophication and acidification are expressed in terms of kilograms of nitrogen deposited per hectare per year (kg N ha^{-1} y^{-1}) and kilo equivalents deposited per hectare per year (keq ha^{-1} y^{-1}). To enable a direct comparison against the critical loads, the modelled total wet and dry deposition flux (µg m^{-2} s^{-1}) must be converted into an equivalent value.

The annual deposition flux of nitrogen can be expressed as:

$$F_{NTot} = \left(\frac{K_2}{K_3}\right) \cdot t \cdot \sum_{i=1}^{T} F_i \left(\frac{M_N}{M_i}\right)$$

where:

F_{NYot} = Annual deposition flux of nitrogen (kg N ha^{-1} y^{-1})

K_2 = Conversion factor for m^2 to ha (= 1x104 m^2 ha^{-1})

K_3 = Conversion factor for µg to kg (= 1x109 µg kg^{-1})

t = Number of seconds in a year (= 3.1536x107 s y^{-1})

i = 1,2,3…….T

T = Total number of nitrogen containing compounds

F = Modelled deposition flux of nitrogen containing compound (µg m^{-2} s^{-1})

M_N = Molecular mass of nitrogen (kg)

M = Molecular mass of nitrogen containing compound (kg)

The unit eq (1 keq ≡ 1,000 eq) refers to molar equivalent of potential acidity resulting from e.g. sulphur, oxidised and reduced nitrogen, as well as base cations. Conversion units are provided in AQTAG(06):

- 1 keq ha^{-1} y^{-1} = 14 kg N ha^{-1} y^{-1}

For the purposes of this assessment, dry deposition rates of nitrogen and acidic equivalents at the identified ecological receptors have been calculated by applying the ‘grassland’ deposition velocities (as detailed in Table 10) to the modelled annual mean concentrations of NO_x. Wet deposition has not been assessed since this is not a significant contributor to total deposition over shorter ranges (Fangmeier et al. 1994; Environment Agency, 2006).

Estimated background deposition rates of nutrient nitrogen and total acid deposition for the UK are available via the Air Pollution Information Service (APIS) website[23]. Table 11 provides the estimated deposition rates for the ecological receptors considered in this study, as obtained from the APIS website[23]. It should be noted that the level of uncertainty associated with these modelled estimates is relatively high and the results are presented from the model across the UK on a coarse 5 km grid square resolution.

Table 11 – Estimated Background Deposition Rates

ID	Background Nitrogen Deposition (kg N ha^{-1} y^{-1})	Background Nitric Acid Deposition (keq ha^{-1} y^{-1})
ER1	15.4	1.1
ER2	14.4	1.0
ER3	17.9	1.3
Source: Air Pollution Information Service (APIS) website[23]		

4.1.3 Model Outputs

The background pollutant values discussed in the Section 3.3 have been used in the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_x and NO_2.

For the prediction of annual mean NO_2 concentrations for the modelled scenarios, the output of the ADMS-Roads model for road-NO_x has been converted to total-NO_2 following the methodology in LAQM.TG(16)[5] 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 5.0 (July 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.

Source apportionment was also carried out for the following vehicle classes, for both NO_x and NO_2:

- Cars;
- LGVs (Light Goods Vehicles);
- HGVs (Heavy Goods Vehicles);
- Buses/Coaches; and
- Motorcycles.

For the prediction of short term NO_2 impacts, LAQM.TG(16)[5] 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.

Annual mean PM_{10} road contributions were also output from the model and processed in a similar manner, i.e. combined with the relevant background annual mean PM_{10} concentrations to obtain an overall total PM_{10} concentration.

For the prediction of short term PM_{10}, LAQM.TG(16)[5] provides an empirical relationship between the annual mean and the number of exceedences of the 24-hour mean AQS objective for PM_{10} that can be calculated as follows:

$$Number\ of\ 24\ hour\ Mean\ Exceedences = -18.5 + 0.00145 * annual\ mean^3 + \frac{206}{annual\ mean}$$

This relationship has thus been adopted to determine whether exceedences of short-term PM_{10} AQS objective are likely in this assessment.

Verification of the ADMS-Roads assessment has been undertaken using those local authority monitoring locations that are located adjacent to the modelled road network. All NO_2 and PM_{10} results presented in the assessment are those calculated following the process of model verification.

For NO_2, the model is split into two verification Domains, named Domain 1 (A256 High Street to A20 Snargate Street) and Domain 2 (rest of modelled area). The verification factor for Domain 1 is 4.296, and the factor for Domain 2 is 2.390.

For PM_{10}, the Council maintains one roadside PM_{10} monitor, so therefore it was possible to also calculate a verification factor for this pollutant. This was 6.461.

Full details of the verification process are provided in Appendix 3.

4.1.4 Gridded outputs

Annual mean NO_2 concentrations were produced to assess the extent of the current AQMAs. Final gridded outputs were produced iteratively, and were initially predicted at generic receptor locations within a grid of varying spatial resolution, of approximately 150 x 150m covering a majority of the study area, and of 78 x 78m within the town of Dover itself. This was in addition to employing the intelligent gridding option in ADMS-Roads, which added receptors with a finer spatial resolution of every 36m and 15m respectively close to the road sources. This enabled the generation of concentration isopleths, which identified the areas of concern to be limited to the Whitfield A2 roundabout, the area around the existing High Street/Ladywell AQMA (including the A256 roundabout to the South) and the exiting A20 AQMA.

Owing to the relatively coarse spatial resolution of the grid required to model such an extensive area, it was considered appropriate to re-model these specific areas at a finer resolution, to ensure the isopleths were produced concisely. As such, separate model runs were produced for each of the above areas, at much finer spatial resolutions, summarised in Table 12. Finer resolutions are possible across smaller modelled domains, so the A20 AQMA was further sub-divided into 3 portions.

Table 12 – Spatial Resolutions

Model Area	Grid Resolution (m)	Minimum along-source spacing (m)
Whitfield A2 roundabout	6.4 x 3.4	2.4
High Street/Ladywell AQMA	3.2 x 3.8	1.7
A20_1 (East)	8.3 x 2.9	2.5
A20_2 (Mid)	4.1 x 3.5	1.9
A20_3 (South West)	13.9 x 13.2	6.8

4.1.5 Uncertainty in Future Year NO_x and NO_2 Trends

Recent studies have identified analyses of historical monitoring data within the UK that show a disparity between measured concentration data and the projected decline in concentrations associated with emission forecasts for future years[28]. The report identifies that trends in ambient concentrations of NO_x and NO_2 in many urban areas of the UK have generally shown two characteristics; a decrease in concentration from about 1996 to 2002-2004, followed by a period of more stable concentrations from 2002-2004 up until 2009. This trend of more stable recent years is expected to continue in more recent years. Trends in more rural, less densely trafficked

[28] Carslaw, D, Beevers, S, Westmoreland, E, Williams, M, Tate, J, Murrells, T, Steadman, J, Li, Y, Grice, S, Kent, A and Tsagatakis, I. 2011. Trends in NO_x and NO_2 emissions and ambient measurements in the UK. Prepared for DEFRA, 18th July 2011

areas, tend to show downward trend in either NO_x or NO_2, which are more in line with those expected.

The reason for this disparity is thought to be related to the actual on-road performance of vehicles, in particular diesel cars and vans, when compared with calculations based on the Euro emission standards. Preliminary studies suggest the following:

- NO_x emissions from petrol vehicles appear to be in line with current projections and have decreased by 96% since the introduction of 3-way catalysts in 1993;
- NO_x emissions from diesel cars, under urban driving conditions, do not appear to have declined substantially, up to and including Euro 5. There is limited evidence that the same pattern may occur for motorway driving conditions; and
- NO_x emissions from HDVs equipped with Selective Catalytic Reduction (SCR) are much higher than expected when driving at low speeds.

This disparity in the historical national data highlights the uncertainty of future year projections of both NO_x and NO_2.

Defra and the Devolved Administrations have investigated these issues and have since published an updated version of the Emissions Factor Toolkit (EFT Version 7.0) utilising COPERT 4 (v11) emission factors, which may go some way to addressing this disparity, but it is considered likely that a gap still remains. This assessment has utilised the latest EFT version 7.0 and associated tools published by Defra to help minimise any associated uncertainty when forming conclusions from this assessment.

5 Results

5.1 Human Receptors

The following section considers emissions of NO_2 and PM_{10} from road traffic at existing human receptor locations. The results of the dispersion modelling are provided below, for those human receptor locations detailed and illustrated previously.

5.1.1 Assessment of Nitrogen Dioxide (NO_2) at Human Receptors

Table 13 presents the annual mean NO_2 concentrations predicted at the receptor locations included in the original 2008 WSP assessment and contains comparisons with the concentrations predicted in the initial report, and against the 40µg/m^3 annual mean AQS objective.

There are two predicted exceedences of the AQS objective for these receptors, at R14 and R16, both of which lie within the existing A20 AQMA. The maximum predicted annual mean NO_2 concentration in 2015 was at Receptor 16, with a predicted concentration of 47.8µg/m^3. This represents 119.5% of the 40µg/m^3 annual mean AQS objective.

Comparison with the 2026 concentrations predicted in the 2008 WSP report highlights some large discrepancies. The modelled 2015 concentrations are higher for a majority of receptors, with one exception, R1. Notable differences are at receptors R13-R16, which are all in and around the A20 AQMA. This highlights some possibly optimistic predictions for the concentrations around the A20 AQMA in the 2008 report.

Table 14 presents the annual mean NO_2 concentrations predicted at the receptor locations added to this assessment and a comparison with the 40µg/m^3 annual mean AQS objective.

There is one predicted exceedence of the AQS objective for these receptors, at AR15. The maximum predicted concentration here is 47.8µg/m^3, representing 119.5% of the 40µg/m^3 annual mean AQS objective. This is within the current Ladywell AQMA and has been predicted at first floor level (4.5m), where there is potential for exposure relevant to the objective.

One further location is within 10% of the objective, AR20, but this is located within the existing A20 AQMA.

The empirical relationship given in LAQM.TG(16)[5] 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 assessed receptor locations, original and additional, are below this limit, and therefore short-term NO_2 exposure from road traffic emissions at the assessed receptor locations are not considered to be in exceedence of the AQS objective.

Table 13 – Predicted Annual Mean NO_2 Concentrations at original WSP receptors

ID	Annual Mean NO_2 (µg/m^3)				2015 as % of AQS Objective
	AQS Objective	2015	2026 Worst Case* WSP	Magnitude Difference	
R1	40	11.7	13.5	-1.8	29.2%
R2	40	12.7	12.3	0.4	31.7%
R3	40	19.7	15.3	4.4	49.3%
R4	40	18.6	13.7	4.9	46.5%
R5	40	15.2	13.6	1.6	37.9%
R6	40	21.9	18.4	3.5	54.7%
R7	40	18.3	15.0	3.3	45.9%
R8	40	19.2	18.3	0.9	48.0%
R9	40	16.8	12.6	4.2	41.9%

ID	Annual Mean NO_2 (µg/m³)				2015 as % of AQS Objective
	AQS Objective	2015	2026 Worst Case* WSP	Magnitude Difference	
R10	40	18.4	16.7	1.7	46.0%
R11	40	20.4	16.9	3.5	51.0%
R12	40	22.0	17.5	4.5	55.0%
R13	40	38.3	21.7	16.6	95.9%
R14	40	**45.4**	22.3	23.1	113.5%
R15	40	26.9	18.2	8.7	67.3%
R16	40	**47.8**	21.7	26.1	119.5%
R17	40	21.6	20.8	0.8	53.9%
R18	40	22.0	21.7	0.3	54.9%
In Bold – Exceedences of the 40 µg/m³ annual mean objective *- In each instance, the highest reported concentration is chosen, regardless of its scenario					

Table 14 – Predicted Annual Mean NO_2 Concentrations at additional receptors

ID	Annual Mean NO_2 (µg/m³)		2015 as % of AQS Objective
	AQS Objective	2015	
AR1	40	18.9	47.3%
AR2	40	21.4	53.5%
AR3	40	24.8	61.9%
AR4	40	18.0	45.1%
AR5	40	18.4	46.1%
AR6	40	14.5	36.2%
AR7	40	12.7	31.8%
AR8	40	18.6	46.6%
AR9	40	21.1	52.9%
AR10	40	18.9	47.2%
AR11	40	28.8	72.0%
AR12	40	33.9	84.8%
AR13	40	21.8	54.5%
AR14	40	35.3	88.3%
AR15	40	**47.8**	119.5%
AR16	40	26.2	65.5%
AR17	40	33.1	82.8%
AR18	40	28.5	71.2%
AR19	40	28.3	70.8%
AR20	40	37.8	94.4%
AR21	40	31.3	78.3%
AR22	40	24.1	60.3%
AR23	40	20.5	51.2%
AR24	40	29.8	74.4%
AR25	40	21.9	54.7%
AR26	40	23.8	59.4%
AR27	40	24.1	60.3%
AR28	40	26.0	65.1%
AR29	40	29.5	73.7%
AR30	40	22.5	56.2%
AR31	40	20.5	51.2%
AR32	40	19.5	48.9%
In Bold – Exceedences of the 40 µg/m³ annual mean objective			

5.1.2 Source Apportionment of NO_x and NO_2 at Human Receptors

To better understand the contribution of the main sources of pollution to the total annual mean NO_2 concentrations, a source apportionment exercise was undertaken, for both NO_x and NO_2.

NO_x

Source apportionment results for modelled NO_x concentrations are presented in the section below, as follows:

- Figure 9 illustrates the general breakdown of NO_x concentrations averaged across all modelled locations, providing information regarding:
  - the regional background, which DDC is unable to influence;
  - the local background, which DDC should have some influence over; and
  - other local sources (explicitly modelled), which DDC should be able to directly influence with policy intervention.
- Table 15 and Figure 10 provide a more detailed breakdown of the local sources contribution to NO_x concentrations, based on:
  - the average across all modelled receptors. This provides useful information when considering possible action measures to test and adopt. It will however understate road NO_x concentrations in problem areas;
  - the average across all receptors with NO_2 concentration greater than $40µg/m^3$. This provides an indication of source apportionment in areas known to be a problem (i.e. only where the AQS objective is exceeded). As such, this information should be considered with more scrutiny when testing and adopting action plan measures; and
  - the receptor where the maximum road NO_x concentration has been predicted. This is likely to be in the area of most concern and so a good place to test and adopt action plan measures. Any gains predicted by action plan measures are however likely to be greatest at this location and so would not represent gains across the whole modelled area.

Figure 9 – Average NO_x contribution Across All Modelled Receptors - General Breakdown

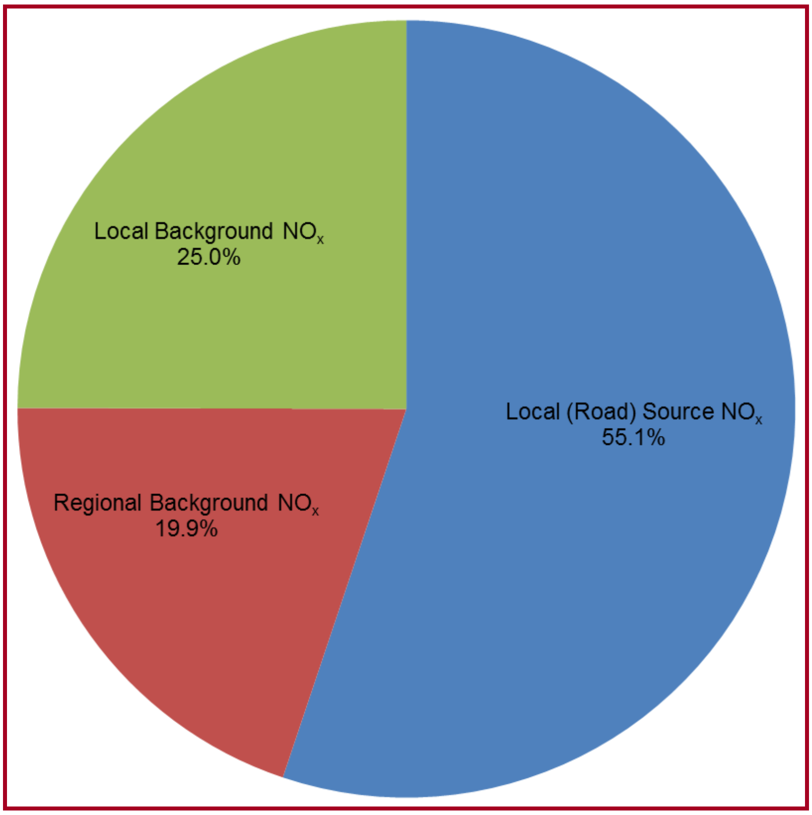
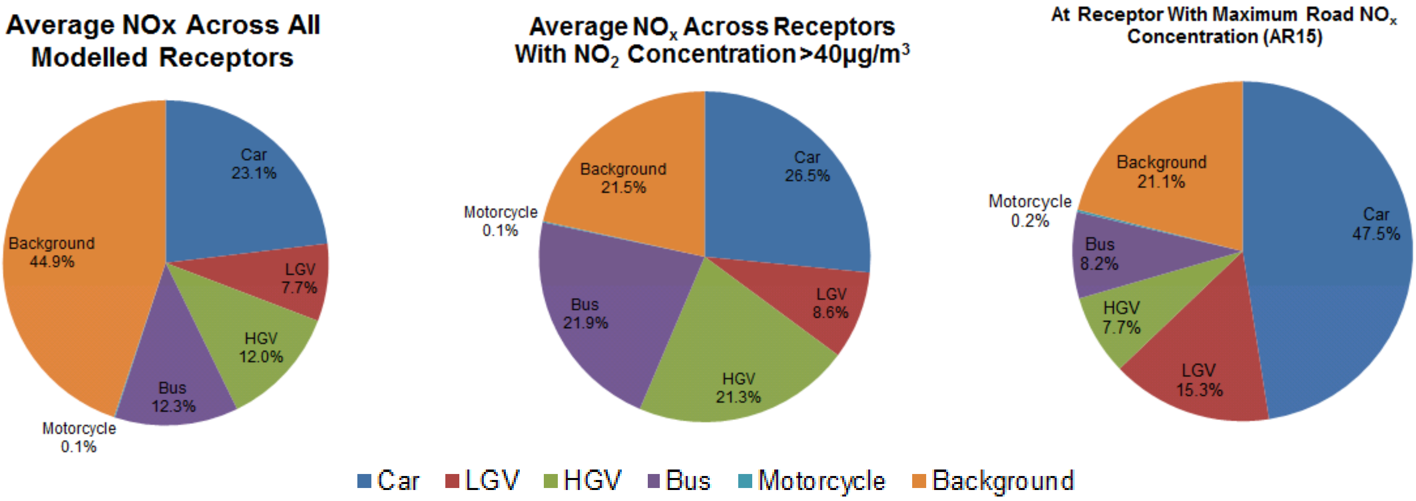


Table 15 – Source Apportionment of NO_x

Results	All Vehicles	Car	LGV	HGV	Bus	Moto	Background
Average across all modelled receptors							
NO_x Concentration (µg/m^3)	22.8	9.5	3.2	4.9	5.1	0.0	18.5
Percentage	55.1%	23.1%	7.7%	12.0%	12.3%	0.1%	44.9%
Percentage Road Contribution	100.0%	41.9%	14.0%	21.7%	22.2%	0.2%	-
Average across all receptors with NO_2 Concentration greater than 40µg/m^3							
NO_x Concentration (µg/m^3)	73.1	24.7	8.0	19.8	20.4	0.1	20.1
Percentage	78.5%	26.5%	8.6%	21.3%	21.9%	0.1%	21.5%
Percentage Road Contribution	100.0%	33.8%	11.0%	27.1%	28.0%	0.2%	-
At Receptor with maximum road NO_x Concentration (AR15)							
NO_x Concentration (µg/m^3)	75.2	45.3	14.6	7.3	7.8	0.2	20.1
Percentage	78.9%	47.5%	15.3%	7.7%	8.2%	0.2%	21.1%
Percentage Road Contribution	100.0%	60.2%	19.4%	9.7%	10.4%	0.3%	-

Figure 10 – Source Apportionment of NO_x - Detailed Breakdown



Of the contributors to total NO_x concentrations, local (road) sources are the largest at 55.1%, followed by local background at 25%, then regional background at 19.9%. This means DDC should be able to influence 80.1% of total NO_x concentrations with intervention policies.

When considering the average breakdown of NO_x concentration across all modelled receptors in more detail, road traffic accounts for 22.8µg/m^3 (55.1%) of total NO_x (41.3µg/m^3). Of this total average NO_x, Cars account for the most (23.1%) of any of the vehicle types on average, followed by Buses (12.3%).

When considering the average NO_x concentration at receptors with an NO_2 concentration greater than 40µg/m^3, road traffic contribution is much higher, accounting for 73.1µg/m^3 (78.5%) of total NO_x (93.2µg/m^3). Of this total average NO_x, Cars account for the most (26.5%) of any of the vehicle types, followed by Buses (21.9%) and HGVs (21.3%).

At the receptor where the maximum road NO_x concentration has been predicted (95.3µg/m^3, predicted at receptor AR15), road traffic accounts for 78.9% of the overall NO_x. Of this total NO_x, Cars account for the most (47.5%) of any of the vehicle types, followed by LGVs (15.3%) and Buses (8.2%).

NO_2

Figure 11, Table 16 and Figure 12 present source apportionment results for NO_2 concentrations using the same approach as was undertaken for NO_x, as follows:

- general breakdown averaged across all modelled locations; and
- detailed breakdown based on the average across all modelled locations, the average at all locations with NO_2 concentration greater than 40µg/m^3; and
- at the location where the maximum road NO_2 concentration has been predicted.

Figure 11 – Average NO_2 Contribution Across All Modelled Locations - General Breakdown

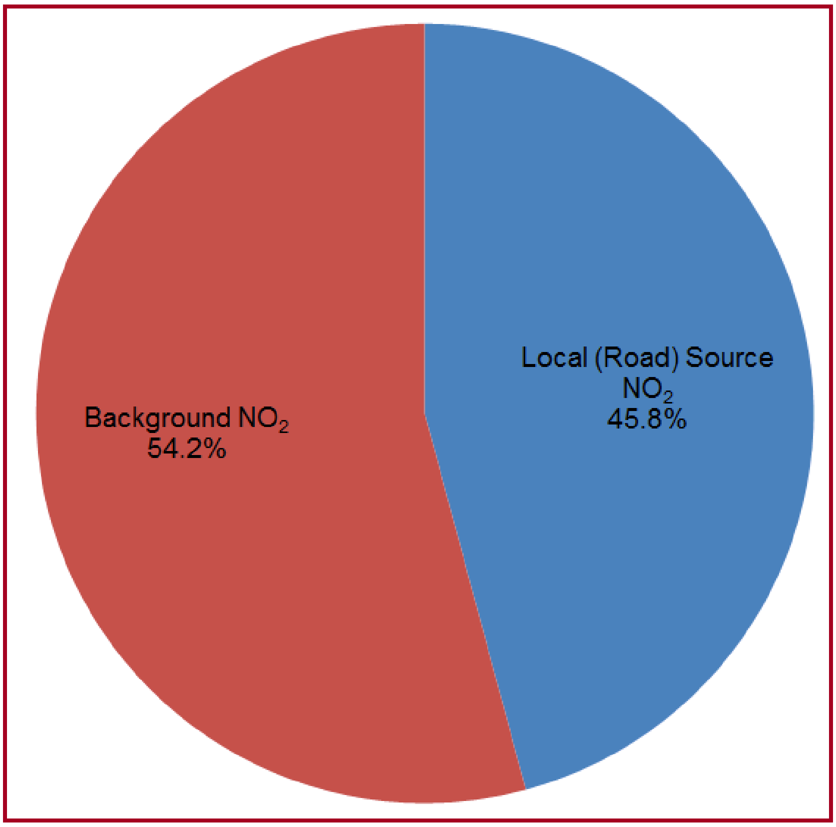
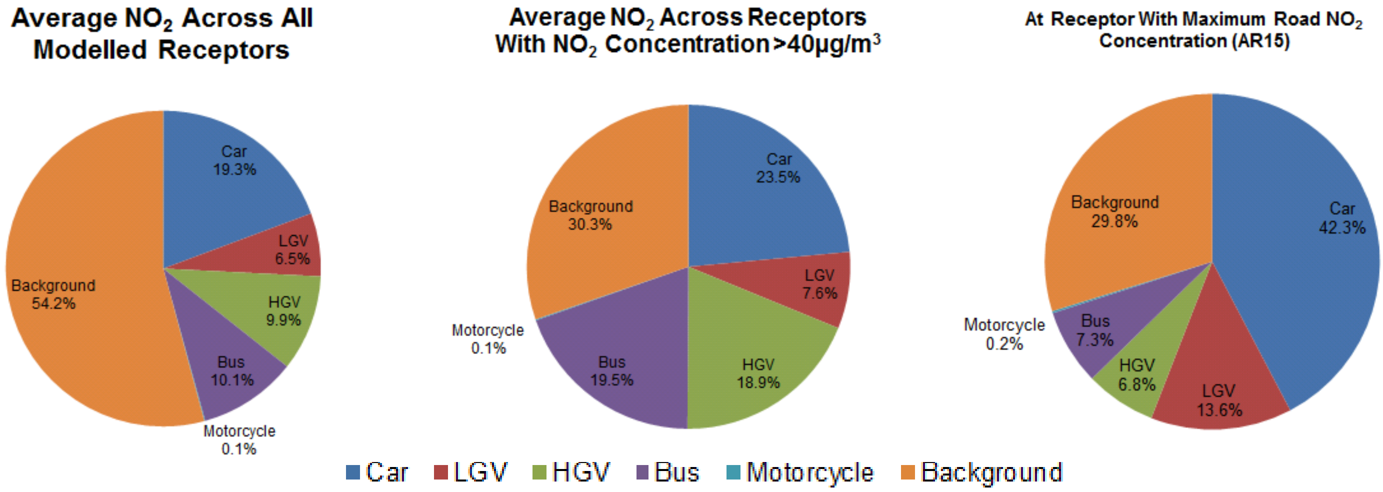


Table 16 – Source Apportionment of NO_2

Results	All Vehicles	Car	LGV	HGV	Bus	Moto	Background
Average across all modelled receptors							
NO_2 Concentration (µg/m^3)	11.2	4.7	1.6	2.4	2.5	0.0	13.2
Percentage	45.8%	19.3%	6.5%	9.9%	10.1%	0.1%	54.2%
Percentage Road Contribution	100.0%	42.2%	14.1%	21.5%	22.0%	0.2%	-
Average across all receptors with NO_2 Concentration greater than 40µg/m^3							
NO_2 Concentration (µg/m^3)	32.8	11.1	3.6	8.9	9.2	0.1	14.2
Percentage	69.7%	23.5%	7.6%	18.9%	19.5%	0.1%	30.3%
Percentage Road Contribution	100.0%	33.8%	11.0%	27.1%	28.0%	0.2%	-
At Receptor with maximum road NO_2 Concentration (AR15)							
NO_2 Concentration (µg/m^3)	33.6	20.2	6.5	3.3	3.5	0.1	14.2
Percentage	70.2%	42.3%	13.6%	6.8%	7.3%	0.2%	29.8%
Percentage Road Contribution	100.0%	60.2%	19.4%	9.7%	10.4%	0.3%	-

Figure 12 – Source Apportionment of NO_2 - Detailed Breakdown



Of the contributors to NO_2 concentrations, background is the largest at 54.2%, followed by local (road) sources at 45.8%.

When considering the average breakdown of NO_2 concentrations across all modelled receptors in more detail, road traffic accounts for 11.2µg/m^3 (45.8%) of total NO_2 (24.4µg/m^3). Of this total average NO_2, Cars account for the most (19.3%) of any of the vehicle types on average, followed by Buses (10.1%).

When considering the average NO_2 concentration at locations with an NO_2 concentration greater than 40µg/m^3, the road traffic contribution is much higher, accounting for 32.8µg/m^3 (69.7%) of total NO_2 (47.0µg/m^3). Of this total average NO_2, Cars account for the most (23.5%) of any of the vehicle types, followed by buses (19.5%) and HGVs (18.9%).

At the location where the maximum road NO_2 concentration has been predicted (47.8µg/m^3, predicted at receptor AR15), road traffic accounts for 70.2% of the overall NO_2. Of this total NO_2, Cars account for the largest contribution (42.3%) of any of the vehicle types, followed by LGVs (13.6%) and Buses (7.3%).

5.1.3 NO_2 Concentration Isopleths

Figure 13, Figure 14 and Figure 15-18 illustrate the annual mean NO_2 concentration isopleths at the Whitfield A2 roundabout, the area around the existing High Street/Ladywell AQMA and the existing A20 AQMA respectively. These areas were highlighted as potentially being of concern in relation to exceedences of the annual mean NO_2 AQS objective following initial analyses. To mitigate against the uncertainty of modelled exceedences, 40µg/m^3 and 36µg/m^3 concentration isopleths (i.e. within 90% of the AQS objective) are presented. 60µg/m^3 isopleths are also displayed, to indicate areas potentially at risk of exceedence of the 1-hour mean AQS objective, in line with the established empirical relationship between the 1-hour AQS objective and annual mean concentrations, as per LAQM.TG(16)[5].

- High concentrations are predicted at the A2 roundabout in Whitfield, as demonstrated in Figure 13, owing to a high volume of traffic approaching the junction. There are two commercial premises immediately adjacent to the junction to the north, and residential properties slightly further afield. The isopleth predicted no concentrations over 36µg/m^3 at any receptor.
- Elevated concentrations that lead to the declaration of the High Street/Ladywell AQMA are confirmed still to be present by Figure 14, and to largely the same spatial extent as is already declared. This is principally due to the limited dispersion in this area, though the

configuration of the traffic lights/junction with Ladywell is also likely to contribute. The 36µg/m^3 isopleth extends slightly further north along High Street, towards Victoria Crescent, than the existing AQMA. This indicates a risk of exceedance of the AQS objective. In addition the 40µg/m^3 isopleth encompasses the property on the corner of Effingham Crescent and High Street, which strictly speaking is currently outside of the AQMA. The gridded area also extended further south towards the A256 roundabout along Priory Road. The 36µg/m^3 isopleth overlaps the property on the corner of Priory Road and the public walkway leading to Biggin Street (currently the 'Prince Albert' pub) and also 14 Priory Road (currently the 'Dover Sea Angling Association'), though the use of these properties is such that this is not classed as a risk of an exceedance of the annual mean AQS objective, and the concentrations are low enough that it is not deemed a risk of exceedance of the 1-hour mean objective either. Further consideration was given to the properties adjacent to the roundabout on Priory Place (which includes commercial spaces with outdoor seating) and also the Church Hall adjacent to Saxon Street, but again concentrations here are sufficient to satisfy that there is no risk of exceedance of the NO_2 1-hour mean objective. The Council has given consideration to these points and concludes that further monitoring locations on Victoria Crescent and High St should be added to confirm the extent of any further exceedances in this area.

- Broadly speaking, the modelled NO_2 concentration isopleths demonstrated in Figure 18 follow the boundary of the existing AQMA, which gives confidence that the boundary of the existing AQMA is still relevant, and encompasses areas at risk of exceedance. That said, the northern perimeter of the AQMA along Townwall Street is now approximately 30m north of the isopleths, demonstrating some marginal improvements from the original declaration. The properties on Snargate Street (Figure 17), some of which appear residential, are subject to the highest concentrations, though exceedances and the risk of exceedance are highlighted at 'The Gateway'/Townwall Street, the area that was formerly Burlington House (Figure 16), St Martin's House, Cambridge Terrace and among some other commercial buildings. However, where the properties along Marine Parade come close to the Eastern Docks roundabout (Figure 17), the property directly on the corner (currently the East Cliff Hotel) is overlapped by both 36µg/m^3 and 40µg/m^3 isopleths and the AQMA does not currently extend this far east. The Council similarly proposes to extend the monitoring regime in this particular area. It is considered that operation TAP and the new junction improvements could have a significant benefit on the A20 in any case.

Figure 13 – Whitfield A2 Roundabout NO_2 Concentration Isopleths

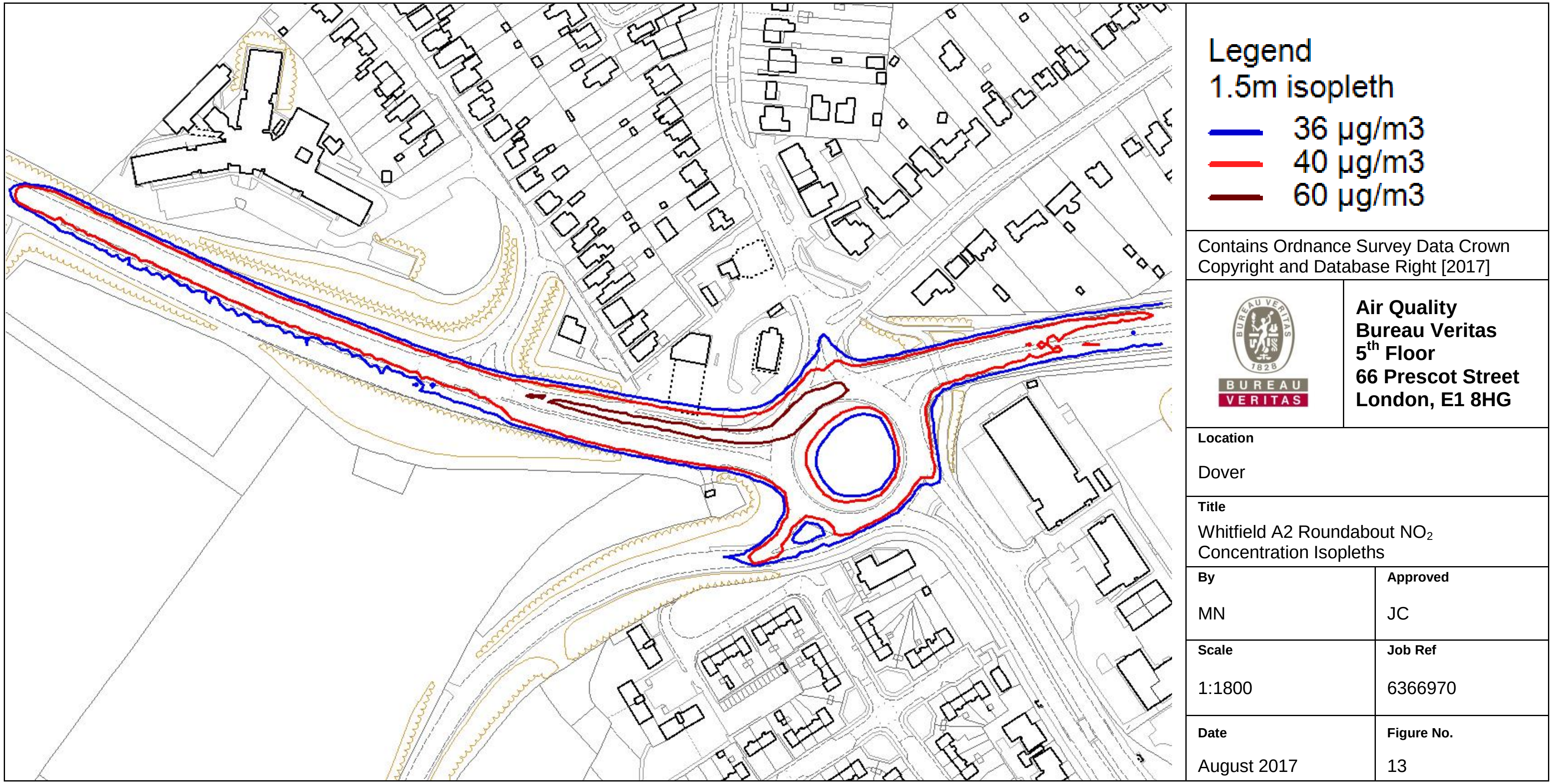
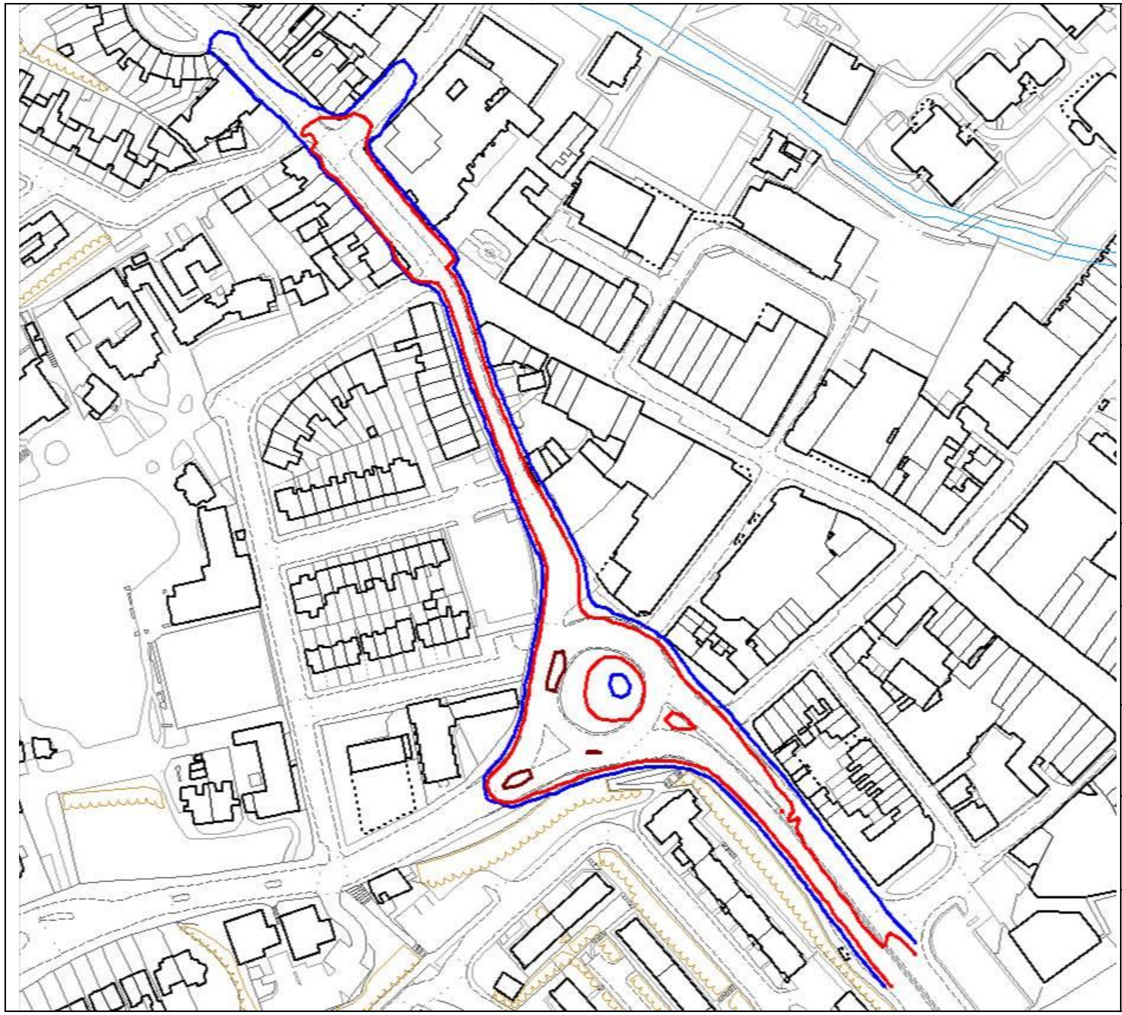


Figure 14 – High Street/Ladywell AQMA area NO_2 Concentration Isopleths



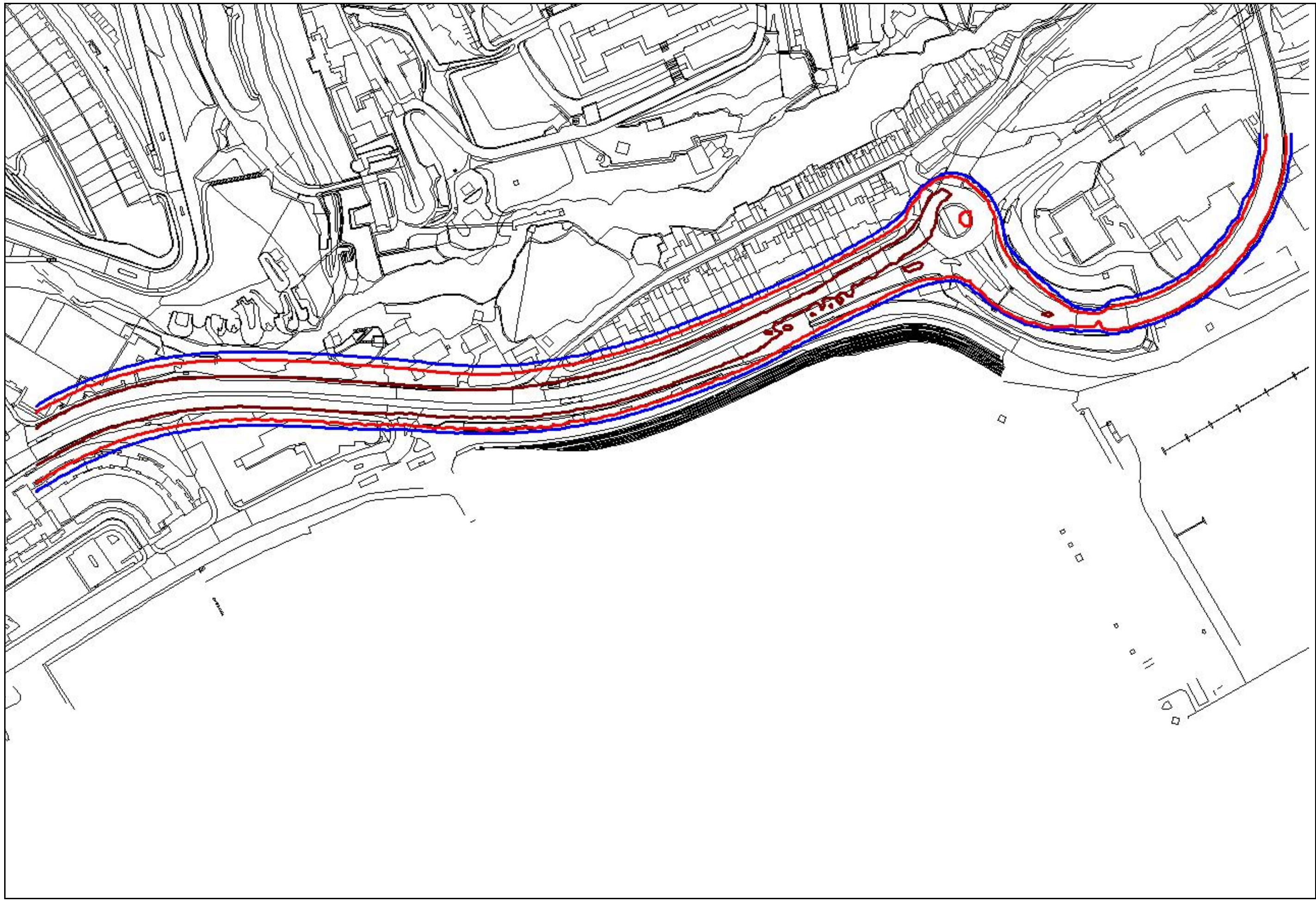
Legend
1.5m isopleth
36 µg/m3
40 µg/m3
60 µg/m3

Contains Ordnance Survey Data Crown Copyright and Database Right [2017]

Air Quality
Bureau Veritas
5th Floor
66 Prescot Street
London, E1 8HG

Location	
Dover	
Title	
High Street/Ladywell AQMA area NO_2 Concentration Isopleths	
By	**Approved**
MN	JC
Scale	**Job Ref**
1:1600	6366970
Date	**Figure No.**
August 2017	14

Figure 15 – A20_1 area NO_2 Concentration Isopleths



Legend
1.5m isopleth
36 µg/m3
40 µg/m3
60 µg/m3

Contains Ordnance Survey Data Crown Copyright and Database Right [2017]

Air Quality
Bureau Veritas
5th Floor
66 Prescot Street
London, E1 8HG

Location Dover	
Title A20_1 area NO_2 Concentration Isopleths	
By MN	**Approved** JC
Scale 1:2500	**Job Ref** 6366970
Date August 2017	**Figure No.** 15

Figure 16 – A20_2 area NO_2 Concentration Isopleths

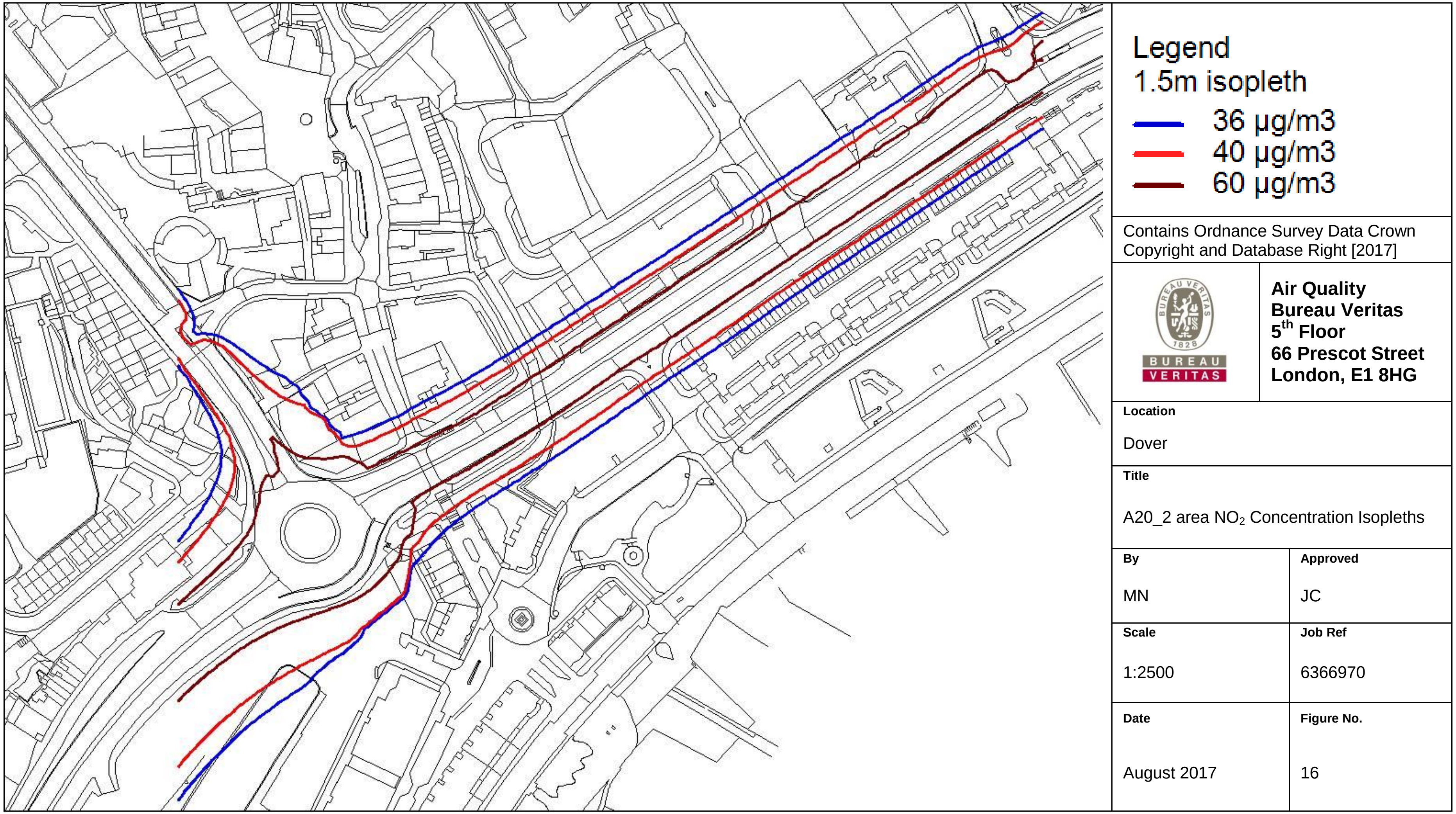
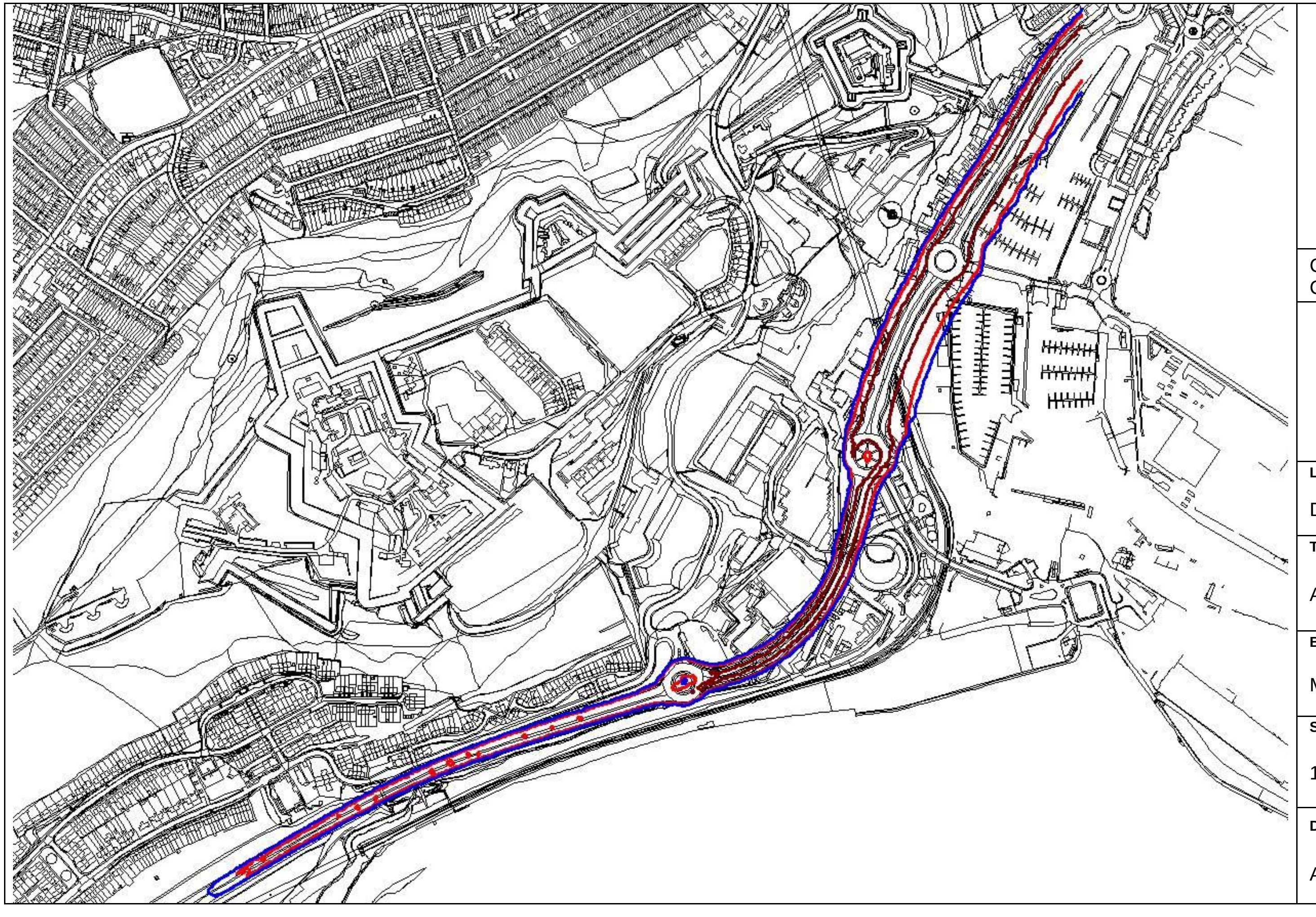
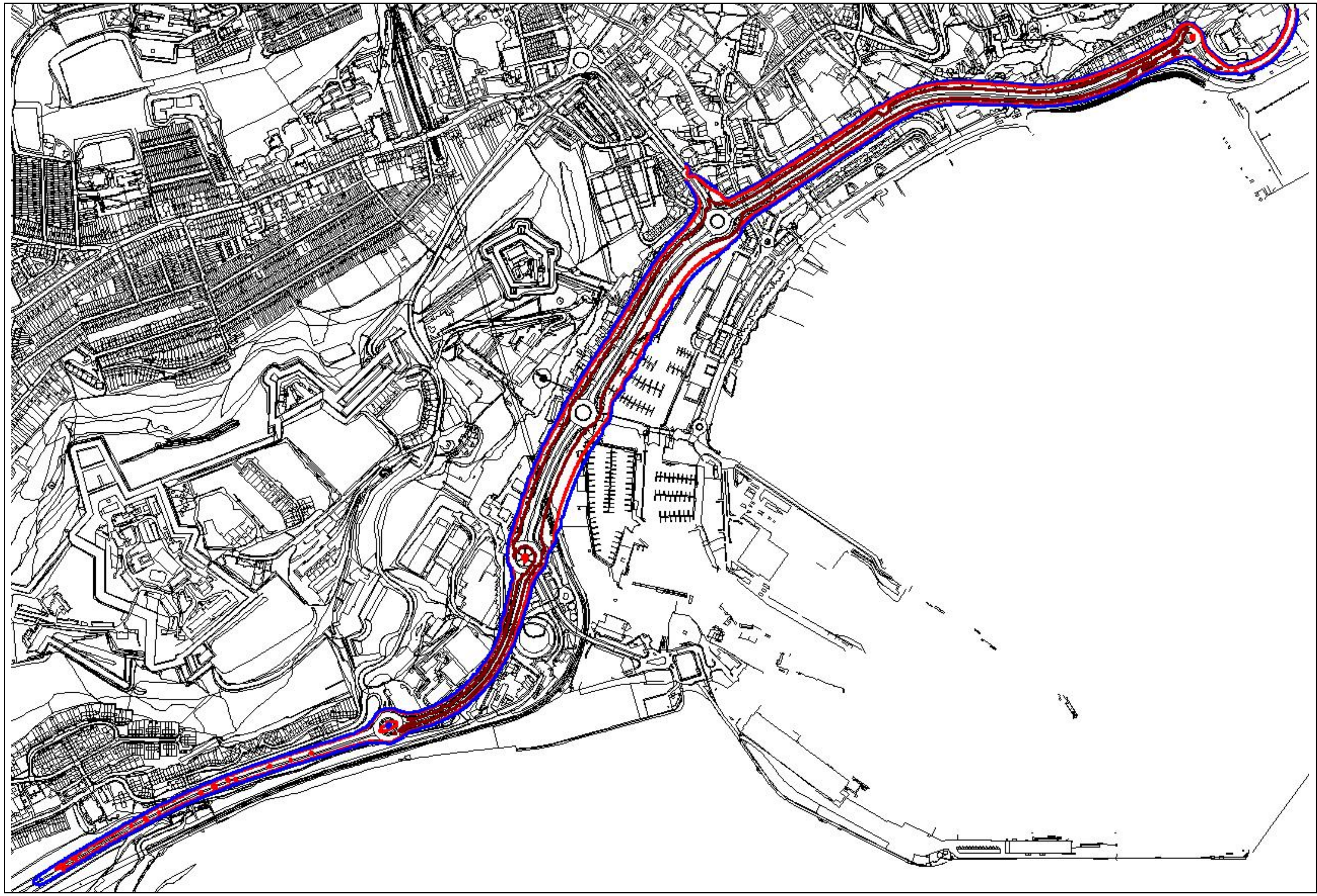


Figure 17 – A20_3 area NO_2 Concentration Isopleths



Legend 1.5m isopleth 36 µg/m3 40 µg/m3 60 µg/m3	
Contains Ordnance Survey Data Crown Copyright and Database Right [2017]	
	Air Quality **Bureau Veritas** **5th Floor** **66 Prescot Street** **London, E1 8HG**
Location Dover	
Title A20_3 area NO_2 Concentration Isopleths	
By MN	**Approved** JC
Scale 1:1650	**Job Ref** 6366970
Date August 2017	**Figure No.** 17

Figure 18 – Total A20 area NO_2 Concentration Isopleths



Legend
1.5m isopleth
36 µg/m3
40 µg/m3
60 µg/m3

Air Quality
Bureau Veritas
5th Floor
66 Prescot Street
London, E1 8HG

Location
Dover

Title
Total A20 area NO_2 Concentration Isopleths

By	**Approved**
MN	JC
Scale	**Job Ref**
1:7700	6366970
Date	**Figure No.**
August 2017	18

5.1.4 Assessment of Particulate Matter (PM_{10}) at Human Receptors

Table 17 presents the annual mean PM_{10} concentrations at the receptors included in the original 2008 WSP assessment and contains comparisons with the concentrations predicted in the initial report, and against the 40µg/m^3 annual mean AQS objective.

The maximum predicted annual mean PM_{10} concentration in 2015 for these receptors was at R14, with a predicted concentration of 23.2µg/m^3. This represents only 58.1% of the 40µg/m^3 annual mean AQS objective.

Comparison with the 2026 concentrations predicted in the 2008 WSP report highlights that predicted concentrations are broadly comparable. Concentrations are generally lower for 2015, which is a function of the higher background concentrations used in the original assessment. However, 2015 concentrations are significantly higher at R14.

Table 18 presents the annual mean PM_{10} concentrations predicted at the receptor locations added to this assessment and a comparison with the 40µg/m^3 annual mean AQS objective.

The maximum predicted concentration for these receptors is at AR15, at only 22.8µg/m^3, representing 57.0% of the 40µg/m^3 annual mean AQS objective.

Table 17 – Predicted Annual Mean PM_{10} Concentrations at original WSP receptors

ID	Annual Mean PM_{10} (µg/m^3)				2015 as % of AQS Objective
	AQS Objective	2015	2026 Worst Case* WSP	Magnitude Difference	
R1	40	15.6	18.3	-2.7	39.1%
R2	40	16.0	18.3	-2.3	40.0%
R3	40	18.7	19.5	-0.8	46.8%
R4	40	18.8	18.9	-0.1	47.0%
R5	40	17.1	18.6	-1.5	42.9%
R6	40	18.1	19.7	-1.6	45.2%
R7	40	17.3	19.5	-2.2	43.4%
R8	40	17.6	19.6	-2	44.1%
R9	40	16.8	18.1	-1.3	41.9%
R10	40	17.1	18.7	-1.6	42.7%
R11	40	17.3	18.8	-1.5	43.4%
R12	40	17.7	18.9	-1.2	44.3%
R13	40	20.8	20.0	0.8	52.1%
R14	40	23.2	20.7	2.5	58.1%
R15	40	17.9	19.5	-1.6	44.9%
R16	40	21.0	20.2	0.8	52.6%
R17	40	18.8	19.8	-1	47.1%
R18	40	18.5	20.1	-1.6	46.2%

In Bold – Exceedences of the 40 µg/m^3 annual mean objective
*- In each instance, the highest reported concentration is chosen, regardless of its scenario

Table 18 – Predicted Annual Mean PM_{10} Concentrations at additional receptors

ID	Annual Mean PM_{10} (µg/m^3)		2015 as % of AQS Objective
	AQS Objective	2015	
AR1	40	16.6	41.6%
AR2	40	18.9	47.3%
AR3	40	19.1	47.9%
AR4	40	18.1	45.3%
AR5	40	18.5	46.3%
AR6	40	16.7	41.7%
AR7	40	15.8	39.4%
AR8	40	17.3	43.4%
AR9	40	18.2	45.6%
AR10	40	17.2	43.0%
AR11	40	20.9	52.3%
AR12	40	19.7	49.3%
AR13	40	17.3	43.4%
AR14	40	17.6	43.9%
AR15	40	22.8	57.0%
AR16	40	18.2	45.5%
AR17	40	19.6	49.1%
AR18	40	18.7	46.7%
AR19	40	17.8	44.5%
AR20	40	21.0	52.5%
AR21	40	19.2	47.9%
AR22	40	17.4	43.6%
AR23	40	18.0	45.1%
AR24	40	18.7	46.7%
AR25	40	17.5	43.6%
AR26	40	18.8	46.9%
AR27	40	19.0	47.5%
AR28	40	20.5	51.2%
AR29	40	18.8	47.0%
AR30	40	17.5	43.8%
AR31	40	18.4	46.1%
AR32	40	17.8	44.6%
In Bold – Exceedences of the 40 µg/m^3 annual mean objective			

Table 19 shows the number of predicted exceedences of the 24-hour PM_{10} 50µg/m^3 AQS objective at the receptors included in the original 2008 WSP assessment and contains comparisons with the exceedences predicted in the initial report.

The maximum number of exceedences of the 24-hour PM_{10} 50µg/m^3 AQS objective at these receptor locations in 2015 was predicted at R14, with 8.6 days. This is well below the 35 permitted exceedences

Comparison with the number of predicted exceedences of the 24-hour PM_{10} 50µg/m^3 AQS objective for 2026 in the 2008 WSP report highlights that the number of days is marginally less in 2015 than was anticipated for 2026, again this is likely to be a function of the higher background concentrations used in the original assessment. However, the number of days is significantly higher at R14 in 2015.

Table 20 shows the number of predicted exceedences of the 24-hour PM_{10} 50µg/m^3 AQS objective at receptors added to this assessment.

The maximum number of exceedences of the 24-hour PM_{10} 50µg/m^3 AQS objective at these receptor locations in 2015 was predicted at AR20, with 4.7 days. This is well below the 35 permitted exceedences.

Table 19 – Predicted Number of Exceedences of 24-hour PM_{10} 50µg/m^3 AQS objective at original WSP receptors

ID	24-hour Mean PM_{10} (µg/m^3)			
	Number of allowed exceedences of PM_{10} 50µg/m^3 AQS Objective	2015 Actual + (Rounded)	2026 Worst Case* WSP	Magnitude Difference
R1	35	0.2 (<1)	2	-2
R2	35	0.3 (<1)	2	-2
R3	35	2 (2)	3	-1
R4	35	2.1 (2)	2	0
R5	35	0.8 (1)	2	-1
R6	35	1.5 (1)	3	-2
R7	35	0.9 (1)	3	-2
R8	35	1.1 (1)	3	-2
R9	35	0.6 (1)	2	-1
R10	35	0.8 (1)	2	-1
R11	35	0.9 (1)	2	-1
R12	35	1.2 (1)	2	-1
R13	35	4.5 (5)	3	2
R14	35	8.6 (9)	4	5
R15	35	1.4 (1)	3	-2
R16	35	4.8 (5)	4	1
R17	35	2.1 (2)	3	-1
R18	35	1.8 (2)	4	-2

Table 20 – Predicted Number of Exceedences of 24-hour PM_{10} 50µg/m^3 AQS objective at additional receptors

ID	24-hour Mean PM_{10} (µg/m^3)	
	Number of allowed exceedences of PM_{10} 50µg/m^3 AQS Objective	2015 Actual + (Rounded)
AR1	35	0.6 (1)
AR2	35	2.2 (2)
AR3	35	2.4 (2)
AR4	35	1.5 (1)
AR5	35	1.8 (2)
AR6	35	0.6 (1)
AR7	35	0.2 (0)
AR8	35	0.9 (1)
AR9	35	1.6 (2)
AR10	35	0.9 (1)
AR11	35	4.6 (5)

ID	24-hour Mean PM_{10} (µg/m^3)	
	Number of allowed exceedences of PM_{10} 50µg/m^3 AQS Objective	2015 Actual + (Rounded)
AR12	35	3.1 (3)
AR13	35	0.9 (1)
AR14	35	1.1 (1)
AR15	35	7.7 (8)
AR16	35	1.5 (2)
AR17	35	3 (3)
AR18	35	2 (2)
AR19	35	1.3 (1)
AR20	35	4.7 (5)
AR21	35	2.5 (2)
AR22	35	1 (1)
AR23	35	1.4 (1)
AR24	35	2 (2)
AR25	35	1 (1)
AR26	35	2 (2)
AR27	35	2.3 (2)
AR28	35	4 (4)
AR29	35	2.1 (2)
AR30	35	1.1 (1)
AR31	35	1.8 (2)
AR32	35	1.3 (1)

5.2 Ecological Receptors

The following section considers emissions of Nitrogen (as NO_x) from road traffic at existing ecological receptor locations. The results of the dispersion modelling are provided below, for those ecological receptor locations detailed and illustrated previously.

It should be noted that the ecological receptor points are those within the designated sites that are closest to the road and so are likely to demonstrate the maximum impacts. It is likely that deposition rates will be at a lower level across the rest of the site area.

5.2.1 Nutrient Nitrogen Deposition (NO_x)

The contributions to the total nutrient nitrogen deposition have been estimated for 2015 following the methodology described in Section 4.1.2, based on predicted deposition of the nitrogen component of NO_x. The results are presented in Table 21.

At each site, there are exceedences of the nitrogen deposition minimum Critical Load (CL_{min}). At two of the three sites, the background deposition rate exceeds the CL_{min} prior to the addition of the road contribution. The exception is ER2, where the road Process Contribution (PC) of 0.7 kg N/ha/yr causes an exceedence of the CL_{min}. However, this is only 4.8% of the total Predicted Environmental Deposition Rate (PEDR).

The maximum CL is not exceeded at any of the three sites.

The maximum PEDR is 21.5kg N/ha/yr at ER1. The road PC towards total PEDR is 40.5%, owing to the close proximity of the receptor point to the road (within 5m). However, at this location the background deposition alone creates an exceedence of the CL_{min}.

Each of the three exceedences are therefore primarily attributed to the background deposition rate. Nutrient nitrogen deposition from the road contribution can therefore be regarded as not significant.

Table 21 – Nitrogen Deposition Rates at Ecological Receptors

Receptor Name	Site	kg N ha^{-1} y^{-1}					Road PC as % of Cl_{min}
		CL_{min}	CL_{max}	Background Nutrient nitrogen deposition	Road PC	Total PEDR	
ER1	Folkestone Warren SSSI	15	25	**15.4**	6.1	**21.5**	40.5%
ER2	Dover To Kingsdown Cliffs SSSI/SAC	15	25	14.4	0.7	**15.1**	4.8%
ER3	Lydden and Temple Ewell Downs SSSI/SAC	15	25	**17.9**	0.3	**18.3**	2.4%
In Bold – Exceedences of the minimum Critical Load							

5.2.2 Nitrogen Component of Acid Deposition

Table 22 contains details of nitrogen component of the acid deposition in 2015 at ecological receptors.

At each site, there are exceedences of the CL_{min}. However, in each case the background deposition rate alone exceeds the CL_{min} prior to the addition of the road contribution.

CL_{max} is not exceeded at any of the three sites.

The maximum PEDR is 1.5 keq ha^{-1} y^{-1} at ER1. The road PC towards total PEDR is 50.7%, owing to the close proximity of the receptor point to the road (within 5m). However, at this location the background deposition alone creates an exceedence of the CL_{min}.

Each of the three exceedences are therefore primarily attributed to the background deposition rate. The nitrogen component of acid deposition from the road contribution can therefore be regarded as not significant.

Table 22 – Nitrogen Component of Acid Deposition Rates at Ecological Receptors

Receptor Name	Site	keq ha^{-1} y^{-1}					% N PC of CL_{min}	%N PEDR of CL_{min}
		CL_{min}	CL_{max}	N Background Deposition	Road PC	PEDR		
ER1	Folkestone Warren SSSI	0.9	5.7	1.1	0.4	1.5	50.7%	179.2%
ER2	Dover To Kingsdown Cliffs SSSI/SAC	0.9	4.9	1.0	0.1	1.1	6.0%	126.3%
ER3	Lydden and Temple Ewell Downs SSSI/SAC	0.9	4.9	1.3	<0.1	1.3	2.8%	152.3%
In Bold – Exceedences of the minimum Critical Load								

6 Conclusions and Recommendations

Bureau Veritas UK Ltd has been commissioned by Dover District Council (the Council) to undertake an assessment of the potential effect of the allocations in the Adopted Core Strategy/Land Allocations Local Plan on air quality in the Dover area. This will subsequently feed into and a review of the extent of the existing Air Quality Management Area (AQMA) and an updated Air Quality Action Plan (AQAP) for Dover.

6.1 Human Receptors

The ADMS-Roads dispersion model (version 4.0.1) has been used to determine the likely NO_2 and PM_{10} concentrations at existing residential receptor locations. These were predicted at the receptors included as part of the original 2008 WSP Report, as well as for several additional locations.

6.1.1 NO_2

Discrete Locations

For NO_2, there are two predicted exceedences of the AQS objective for the original WSP receptors, at R14 and R16, both of which lie within the existing A20 AQMA. The maximum predicted annual mean NO_2 concentration in 2015 was at Receptor 16, with a predicted concentration of 47.8µg/m^3. This represents 119.5% of the 40µg/m^3 annual mean AQS objective.

Comparison with the 2026 concentrations predicted in the 2008 WSP report highlights some large discrepancies. The modelled 2015 concentrations are higher for the majority of receptors, with one exception, R1. Notable differences are at receptors R13-R16, which are all in and around the A20 AQMA. This highlights some possibly optimistic predictions for the concentrations around the A20 AQMA in the 2008 report.

There is one further predicted exceedence of the AQS objective for the additional receptors, at AR15. The maximum predicted concentration here is 47.8µg/m^3, representing 119.5% of the 40µg/m^3 annual mean AQS objective. This is within the current Ladywell AQMA and has been predicted at first floor level (4.5m), where there is potential for exposure relevant to the objective.

Annual mean NO_2 concentrations at all assessed receptor locations, original and additional, are below the 60µg/m^3 limit given in LAQM.TG(16)[5], and therefore short-term NO_2 exposure from road traffic emissions at the assessed receptor locations are not considered to be in exceedence of the AQS objective.

In conclusion, whilst there are a total of three locations in exceedence of the 40µg/m^3 annual mean AQS objective, each of these is within an existing AQMA, so there are no new exceedence areas that the Council has not previously identified. This does however highlight that existing Action Plan measures have not been completely effective in achieving compliance, and so will require updating.

Source Apportionment

Detailed source apportionment of both NO_x and NO_2 concentrations was also conducted.

For NO_x, regional background (the concentrations which DDC are not able to influence), account for only 19.9% of total concentrations. As such local policy should have a significant influence on NO_x concentrations.

For NO_x and NO_2, vehicle emissions represent the largest proportion of total concentrations at receptors with NO_2 concentrations greater than 40µg/m^3, at 78.5% and 69.7% respectively.

For NO_2, cars unsurprisingly represent the largest contribution of any specific vehicle type, at 23.5% of total emissions at receptors where NO_2 concentrations exceed the annual mean objective. Second and third largest contributors behind this are Buses and HGVs, at 19.5% and 18.9% respectively.

NO_2 Concentration Isopleths

In respect of the isopleths produced for each area identified as being of potential concern, the following conclusions are drawn:

- High concentrations are predicted at the A2 roundabout in Whitfield, however the isopleths predicted no concentrations over 36µg/m^3 at any receptors.
- Elevated concentrations that lead to the declaration of the High Street/Ladywell AQMA are confirmed still to be present, and to largely the same spatial extent as is already declared an AQMA. Owing to potential further exceedances outside of the current AQMA in this area, The Council concludes that further monitoring locations on Victoria Crescent and High St should be added.
- The modelled NO_2 concentration isopleths to a large extent follow the boundary of the existing A20 AQMA, which gives confidence that the boundary of the existing AQMA is still relevant. However, the properties adjacent to the Eastern Docks roundabout are overlapped by the 36µg/m^3 isopleth and the AQMA does not currently extend this far east. The Council similarly proposes to extend the monitoring regime in this particular area.

6.1.2 PM_{10}

For PM_{10}, the maximum predicted annual mean PM_{10} concentration in 2015 for these receptors was at R14, with a predicted concentration of 23.2µg/m^3. This represents only 58.1% of the 40µg/m^3 annual mean AQS objective.

Comparison with the 2026 annual mean concentrations predicted in the 2008 WSP report highlights that predicted concentrations are broadly comparable. Concentrations are generally lower for 2015, which is not as anticipated, but this is likely a function of the higher background concentrations used in the original WSP assessment. However, 2015 concentrations are significantly higher at R14, again highlighting perhaps optimistic forecasts around the A20 AQMA.

The maximum number of exceedences of the 24-hour PM_{10} 50µg/m^3 AQS objective at the original WSP receptor locations in 2015 was predicted at R14, with 8.6 days. This is well below the 35 permitted exceedences.

Comparison with the number of days predicted for 2026 in the 2008 WSP report highlights that the number of days is marginally less in 2015 than was anticipated for 2026, again this is likely to be a function of the higher background concentrations used in the original assessment. However, the number of days is significantly higher at R14 in 2015.

The maximum predicted annual mean concentration for the additional receptors is at AR15, at only 22.8µg/m^3, representing 57.0% of the 40µg/m^3 annual mean AQS objective.

The maximum number of exceedences of the 24-hour PM_{10} 50µg/m^3 AQS objective at these additional receptor locations in 2015 was predicted at AR20, with 4.7 days. This is well below the 35 permitted exceedences.

In conclusion, there are no exceedences of either PM_{10} AQS objective modelled in 2015. There is no requirement to declare an AQMA for this pollutant.

6.2 Ecological Receptors

The assessment has also considered emissions of Nitrogen (as NO_x) from road traffic at existing ecological receptor locations. It should be noted that the ecological receptor points are those within the designated sites that are closest to the road and so are likely to demonstrate the maximum impacts. It is likely that deposition rates will be at a lower level across the rest of the site area.

6.2.1 Nutrient Nitrogen Deposition (NO_x)

At each of the three sites assessed, there are exceedences of the nitrogen deposition minimum Critical Load (CL_{min}). At two of the three sites, the background deposition rate exceeds the CL_{min} prior to the addition of the road contribution. The exception is ER2 (Dover To Kingsdown Cliffs SSSI/SAC), where the road Process Contribution (PC) of 0.7 kg N/ha/yr causes an exceedence of the CL_{min}. However, this is only 4.8% of the total Predicted Environmental Deposition Rate (PEDR). CL_{max} is not exceeded at any of the three sites.

The maximum PEDR is 21.5 kg N/ha/yr at ER1. The road PC towards total PEDR is 40.5%, owing to the close proximity of the receptor point to the road (within 5m). However, at this location the background deposition alone creates an exceedence of the CL_{min}.

Each of the three exceedences are therefore primarily attributed to the background deposition rate. Nutrient nitrogen deposition from the road contribution can therefore be regarded as not significant.

6.2.2 Nitrogen Component of Acid Deposition

At each site, there are exceedences of the CL_{min}. However, in each case the background deposition rate alone exceeds the CL_{min} prior to the addition of the road contribution. The maximum CL is not exceeded at any of the three sites.

The maximum PEDR is 1.5 keq ha^{-1} y^{-1} at ER1. The road PC towards total PEDR is 50.7%, owing to the close proximity of the receptor point to the road (within 5m). However, at this location the background deposition alone creates an exceedence of the CL_{min}.

Each of the three exceedences are therefore primarily attributed to the background deposition rate. The nitrogen component of acid deposition from the road contribution can therefore be regarded as not significant.

6.3 Outcomes

Given the above conclusions, the following actions are recommended;

- Increase the monitoring regimes in both the Town Centre and Eastern Docks regions to enable closer monitoring of the spatial extent of the AQMAs;
- The AQMAs remain as currently declared, though if the above monitoring confirms further exceedances, amendment need be considered;
- Commence work on an updated Air Quality Action Plan, using the source apportionment information as a basis for measures, and targeting specifically the roads along the A256 High Street to A20 Snargate Street link (area identified as 'Domain 1' when undertaking model verification);

- Begin an options appraisal of the potential future policies within the Adopted Core Strategy/Land Allocations Local Plan that could affect future Air Quality, in order that they can be adequately assessed; and

- Consider options to adopt the Kent & Medway Air Quality Partnership Air Quality Planning Guidance Option B.

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 and PM_{10} (PM of aerodynamic diameter less than 10µm) as these pollutants are least likely to meet their 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[29] regarding Air Quality Management Areas (AQMAs) show that approximately 640 AQMAs are declared in the UK. The majority 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 these two pollutants, describing briefly the sources and processes influencing the ambient concentrations, is presented below.

Particulate Matter (PM_{10})

Particulate matter is a mixture of solid and liquid particles suspended in the air. There are a number of ways in which airborne PM may be categorised. The most widely used categorisation is based on the size of particles such as $PM_{2.5}$, particles of aerodynamic diameter less than 2.5µm (micrometre = 10^{-6} metre), and PM_{10}, particles of aerodynamic diameter less than 10µm. Generically, particulate residing in low altitude air is referred to as Total Suspended Particulate (TSP) and comprises coarse and fine material including dust.

Particulate matter comprises a wide range of materials arising from a variety of sources. Examples of anthropogenic sources are carbon (C) particles from incomplete combustion, bonfire ash, recondensed metallic vapours and secondary particles (or aerosols) formed by chemical reactions in the atmosphere. As well as being emitted directly from combustion sources, man-made particles can arise from mining, quarrying, demolition and construction operations, from brake and tyre wear in motor vehicles and from road dust resuspension from moving traffic or strong winds. Natural sources of PM include wind-blown sand and dust, forest fires, sea salt and biological particles such as pollen and fungal spores.

The health impacts from PM depend upon size and chemical composition of the particles. For the purposes of the AQS objectives, PM_{10} or $PM_{2.5}$ is solely defined on size rather than chemical composition. This enables a uniform method of measurement and comparison. The short and long-term exposure to PM has been associated with increased risk of lung and heart diseases.PM

[29] Statistics from the UK AQMA website available at http://aqma.defra.gov.uk – Figures as of April 2016

may also carry surface-absorbed carcinogenic compounds. Smaller PM have a greater likelihood of penetrating the respiratory tract and reaching the lung to blood interface and causing the above adverse health effects.

In the UK, emissions of PM_{10} have declined significantly since 1980, and were estimated to be 114kt (kilotonne) in 2010[30]. Residential / public electricity and heat production and road transport are the largest sources of PM_{10} emissions. The road transport sector contributed 22% (25kt) of PM_{10} emissions in 2010. The main source within road transport is brake and tyre wear.

It is important to note that these estimates only refer to primary emissions, that is, the emissions directly resulting from sources and processes and do not include secondary particles. These secondary particles, which result from the interaction of various gaseous components in the air such as ammonia (NH_3), sulphur dioxide (SO_2) and NO_x, can come from further afield and impact on the air quality in the UK and vice versa.

Similarly to PM_{10}, emissions of $PM_{2.5}$ have declined since 1970, and were estimated to be 67kt in 2010, which makes over 58% of PM_{10} emissions. In 2010, the road transport sector emitted 28% (18kt) of the total $PM_{2.5}$ emissions in the UK.

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.

[30] National Atmospheric Emissions Inventory (NAEI) Summary Emission Estimate Datasets 2010. March 2012

Appendix 2 – Traffic Data Used in Assessment

Source ID	Node A	Node B	2015		Speed (kph)
			Traffic Flow (2-way 24 hr AADT)	% HGV	
1	1298	1310	17082	3.1	45.3
2	803	813	11233	1.2	19.5
3	1043	1063	9369	1.7	21.0
4	1063	1072	9784	1.6	20.3
5	948	983	12787	1.8	17.8
6	983	992	7464	1.2	15.5
7	992	1000	6690	1.3	5.0
8	1303	1306	10509	3.7	39.5
9	1072	1149	9197	1.9	18.3
10	1149	1151	9197	1.9	18.3
11	1151	1154	12076	1.6	20.5
12	1000	1041	6690	1.3	10.8
14	1041	1049	6690	1.3	18.5
15	1198	1225	10923	2.3	21.3
16	1306	1312	10509	3.7	35.0
17	1225	1242	7671	3.1	23.3
18	1064	1077	6690	1.3	7.0
19	1077	1084	6428	1.3	7.0
20	1084	1101	11151	1.4	7.0
21	1242	1266	8120	4.9	20.5
22	1312	1322	10246	3.6	35.0
23	1284	1286	6891	4.1	31.5
24	1286	1292	9804	3.4	31.3
25	1266	1278	7526	5.9	7.0
28	1292	1322	8327	4.3	36.3
29	1278	1291	6476	6.4	27.8
30	197	263	22764	1.4	53.3
31	410	421	0	0.0	35.8
32	1291	1296	8051	5.4	27.3
33	1195	1215	5827	3.3	7.3
34	263	354	22764	1.4	53.3
35	164	281	18407	1.7	58.5
37	281	349	16591	1.9	45.5
41	1297	1303	17641	2.8	30.3
42	421	497	18704	1.3	37.5
43	1136	1138	10288	1.9	14.0
44	1118	1128	5696	3.9	14.8
45	646	652	0	0.0	5.0
46	1417	1419	7609	4.7	5.5
47	1417	1423	8706	2.0	17.5
48	1137	1138	4377	0.2	16.0
49	1132	1137	4377	0.2	16.0
50	877	887	14582	2.1	18.0
51	1049	1064	6690	1.3	19.5
52	1199	1220	6304	5.3	7.3
53	989	990	15349	1.5	15.3
57	1029	1031	17447	1.5	13.5
58	1031	1032	17261	1.4	15.8
59	1024	1028	15514	1.5	14.5
61	1278	1284	6753	4.6	30.0
62	1101	1113	10426	1.5	13.0
64	1113	1121	11896	1.9	14.3
65	1138	1147	5910	3.7	16.5
66	1296	1305	0	0.0	5.0
67	1305	1307	0	0.0	18.0
68	1196	1199	0	0.0	14.3
69	1147	1166	4868	3.9	23.8
70	1177	1195	8437	4.0	16.5
71	1297	1298	17641	2.8	35.0
72	1181	1196	5565	3.0	16.0

Source ID	Node A	Node B	2015		Speed (kph)
			Traffic Flow (2-way 24 hr AADT)	% HGV	
73	1166	1181	5565	3.0	16.0
74	1165	1177	7346	3.1	14.5
75	1132	1146	7346	3.1	14.5
76	1146	1165	7346	3.1	14.5
77	1310	1417	16315	3.3	49.0
78	349	410	15418	1.7	32.3
79	813	827	0	0.0	16.0
80	164	166	14023	2.1	13.8
81	163	166	14451	1.2	10.3
83	163	164	13705	1.3	18.0
84	1128	1132	11731	1.9	13.3
85	1118	1121	17648	2.1	12.0
86	1121	1136	5758	3.8	12.8
87	354	394	11289	1.8	22.8
88	354	376	11475	1.0	5.0
89	183	197	22764	1.4	53.3
90	166	183	21003	1.5	38.3
92	514	541	20520	1.2	46.3
93	541	628	20133	1.3	47.5
94	628	636	18877	1.3	29.8
95	636	652	0	0.0	9.8
96	652	676	10819	1.6	13.3
97	636	646	0	0.0	15.8
98	676	737	10868	1.6	19.0
99	646	647	14534	1.6	11.3
101	799	853	14700	3.1	12.0
102	853	877	13816	2.4	5.3
103	887	936	14582	2.1	18.0
104	744	769	10170	1.1	19.8
105	936	963	15507	2.0	19.3
106	963	989	15369	1.8	18.0
107	990	1004	15342	1.5	18.5
108	769	803	12490	1.8	17.5
109	1004	1029	16433	1.9	14.5
110	827	848	0	0.0	14.8
111	848	879	11192	1.3	5.8
112	879	884	11227	1.7	8.3
113	1028	1032	16073	1.4	18.0
114	1017	1024	16336	1.4	14.5
115	884	929	11227	1.7	12.0
116	929	937	11454	2.0	14.5
117	937	948	11454	2.0	19.3
123	1001	1040	15426	1.1	30.8
128	1128	1112	15136	1.1	33.0
129	966	1001	16740	0.8	22.5
133	1112	1118	10935	1.4	17.0
134	1083	1112	16450	0.8	33.3
135	1052	1083	16841	0.8	34.0
136	1040	1052	13550	0.9	19.8
137	940	966	15426	1.1	31.3
158	1358	1360	12197	20.2	20.0
161	1241	1246	14270	19.5	23.0
162	1071	1122	12399	16.4	15.0
164	1244	1269	13038	15.8	8.5
165	1081	1131	13618	21.8	16.0
169	1381	1418	14270	7.1	37.8
170	417	425	10189	7.8	27.5
172	1123	1260	16128	7.9	40.0
173	1150	1260	14270	7.1	44.0
174	1260	1335	30398	7.5	77.0
175	1410	1411	6930	20.5	28.0
176	1410	1413	6930	20.5	28.0
179	603	943	10548	19.8	47.5

Source ID	Node A	Node B	2015		Speed (kph)
			Traffic Flow (2-way 24 hr AADT)	% HGV	
180	943	957	10548	19.8	23.3
181	615	952	11519	19.8	55.5
182	952	965	11519	19.8	30.8
189	290	299	11969	12.8	16.3
190	299	312	11969	12.8	16.3
191	1427	1428	6930	20.5	25.8
192	1424	1428	8801	11.8	5.8
193	1125	1142	12314	16.6	12.0
194	1412	1413	8801	11.8	39.0
195	1305	1352	12999	15.0	23.0
196	1307	1354	12119	20.4	13.3
197	1062	1079	12138	20.1	19.5
198	1053	1067	10567	20.0	19.3
199	1282	1300	12490	15.6	8.3
200	1230	1241	3155	1.9	10.8
201	1211	1221	2816	4.4	15.5
202	1197	1217	12314	16.6	12.5
203	1160	1197	12314	16.6	18.0
204	982	1062	12138	20.1	24.0
205	977	1053	10567	20.0	23.0
206	1408	1416	15730	16.1	52.8
207	1413	1428	15730	16.1	66.5
208	1223	1237	13097	16.0	6.0
209	1269	1282	13038	15.8	8.5
210	1163	1211	13925	20.8	30.3
211	1144	1163	13925	20.8	22.5
212	1237	1244	13097	16.0	6.0
213	1403	1408	8801	11.8	17.5
214	1400	1403	6754	5.1	15.5
215	1045	90011	9029	2.4	57.3
216	440	1035	8579	5.3	54.3
219	1021	1038	7164	5.2	23.5
220	1039	1047	4642	6.9	19.8
221	372	373	12569	2.1	16.5
222	1424	1427	13201	1.6	12.0
223	1023	1030	8051	3.3	12.8
225	1033	1035	10124	5.4	40.8
228	1418	1419	20972	6.4	13.0
229	1418	1422	7098	6.3	14.5
230	1422	1425	22719	6.5	12.8
231	1030	1039	4642	6.9	17.5
234	1048	1123	5932	0.7	25.3
236	389	417	11623	4.5	16.8
237	1081	1086	14394	22.3	16.5
238	1125	1141	417	5.8	11.8
239	1140	1141	14342	20.6	18.8
240	1122	1125	12725	16.4	13.3
241	1122	1131	332	13.6	18.0
242	1131	1140	13944	21.5	21.3
243	1071	1081	776	43.0	10.8
245	1067	1079	1845	0.9	10.8
246	1398	1400	9720	9.3	19.0
247	1220	1223	16610	13.3	14.3
248	1393	1396	12132	19.1	13.5
249	1393	1394	913	42.1	11.0
250	1217	1221	3853	1.5	13.8
251	975	977	11649	19.4	12.3
252	977	982	1082	12.9	20.5
253	957	965	1701	19.0	20.5
254	965	982	13221	19.5	17.5
255	1425	1426	10665	11.2	13.0
256	957	959	12256	19.6	14.3
257	376	394	9752	10.9	18.8

Source ID	Node A	Node B	2015		Speed (kph)
			Traffic Flow (2-way 24 hr AADT)	% HGV	
258	377	383	20450	9.0	17.8
259	1395	1400	2960	18.8	17.5
260	1394	1395	3872	24.9	12.8
261	1221	1226	6669	2.6	18.0
262	1226	1230	6669	2.6	18.0
263	1223	1230	3507	3.6	16.5
264	1085	1086	13305	21.3	13.8
266	1215	1220	10665	18.2	8.8
267	959	975	9720	20.9	13.0
268	394	401	20418	6.1	12.0
269	1211	1241	11108	25.1	18.0
270	1391	1399	6017	17.3	16.8
271	1423	1424	22002	5.3	10.5
272	1426	1427	20131	7.6	15.3
273	372	376	20587	5.6	17.8
276	1386	1393	11226	17.4	6.8
278	1381	1422	16024	7.8	11.3
280	425	565	10189	7.8	27.5
282	417	418	21813	6.0	11.8
283	1021	1023	7164	5.2	17.5
284	1035	1045	1545	7.8	17.5
285	1038	1047	0	0.0	17.5
286	1021	1039	0	0.0	17.5
287	373	377	27659	7.2	8.0
288	383	389	24792	7.9	16.0
291	1419	1423	13781	7.4	12.3
292	1080	1085	14296	19.8	13.5
293	1215	1217	16161	13.0	13.8
294	1079	1080	13990	17.5	16.0
297	1045	1048	10574	3.4	40.8
298	1047	1048	4642	6.9	17.5
299	901	1033	2960	6.4	34.5
300	1030	1150	7621	3.8	28.3
309	1246	1267	14270	19.5	23.0
310	401	418	12041	7.1	17.0
311	1399	1408	6930	20.5	13.5
312	245	2753	13266	11.7	16.3
313	248	2753	7640	11.2	31.3
314	1352	1361	12999	15.0	18.5
315	245	290	13266	11.7	16.3
316	389	561	13162	10.9	40.5
317	248	309	7640	11.2	31.3
318	1354	1358	11930	20.4	20.0
319	565	932	10189	7.8	27.5
321	1335	1381	30398	7.5	74.5
322	1300	1305	0	0.0	8.3
323	1142	1160	12314	16.6	11.0
324	1391	1394	2960	18.8	17.5
325	1382	1386	11226	17.4	11.8
326	1395	1399	913	42.1	12.0
327	1361	1382	11226	17.4	13.8
328	1272	1283	13996	19.4	26.3
329	1267	1272	13410	20.2	26.3
330	1412	1416	15730	16.1	57.5
331	309	372	8012	10.9	21.0
332	312	373	13547	11.9	5.0
333	1411	1412	6930	20.5	25.3
336	1283	1302	13996	19.4	24.8
337	1302	1307	12119	20.4	13.3
339	1141	1144	13925	20.8	22.5
596	996	997	7328	1.0	32.3
658	992	996	7328	1.0	28.5
671	1002	1017	221	0.0	23.5

Source ID	Node A	Node B	2015		Speed (kph)
			Traffic Flow (2-way 24 hr AADT)	% HGV	
680	998	1011	8136	1.3	26.8
682	997	998	7328	1.0	28.5
746	1110	1124	5174	0.8	27.8
803	1084	1110	4611	0.7	7.0
807	1042	1077	303	0.0	23.5
1381	213	288	815	0.0	31.3
1455	513	620	455	0.0	35.0
1458	479	513	455	0.0	23.5
1463	399	479	398	0.0	23.5
1468	326	400	884	0.6	23.5
1484	288	326	884	0.6	23.5
1546	1011	1017	8812	0.5	26.8
1690	418	426	9469	4.6	18.0
1733	379	385	8440	2.2	23.5
1734	383	385	4207	3.2	5.0
1735	358	365	2375	1.6	29.0
1736	355	358	8136	2.2	29.0
1737	352	355	8440	2.2	29.0
1738	352	379	8440	2.2	29.0
1740	365	397	2375	1.6	29.0
1741	404	405	1592	1.9	41.0
1742	397	400	1131	2.0	29.0
1743	399	402	1623	1.8	41.0
1744	399	400	2021	1.6	29.0
1745	363	406	1491	1.7	41.0
1746	404	406	1491	1.7	41.0
1747	402	405	1623	1.8	41.0
1748	363	366	1699	2.3	41.0
1749	375	420	1364	2.7	41.0
1750	420	440	44	0.0	20.5
1768	366	375	1699	2.3	41.0
1769	1296	1300	0	0.0	11.8
1770	1029	1036	6544	4.3	32.3
1771	1036	1106	4649	2.9	27.3
11065	1042	2814	234	0.0	23.5
11066	916	2814	234	0.0	23.5
11069	514	2816	19250	1.3	44.8
11070	497	2816	19395	1.3	44.8
11073	799	2818	15086	3.1	17.8
11074	737	2818	15086	3.1	17.8
11477	2753	3087	20906	11.4	87.8
11620	1106	3371	7858	1.9	37.0
11621	1303	3371	8901	1.7	36.5
11639	744	3381	12124	1.6	17.8
11650	1043	3387	9369	1.7	17.3
11651	1017	3387	13781	1.3	17.3
11660	1154	3392	12076	1.6	20.8
11661	1198	3392	12076	1.6	20.8
11662	1145	3393	4125	0.7	22.0
11663	1124	3393	3658	0.8	19.0
11669	377	385	5490	1.0	5.0
11670	1145	1151	4125	0.7	22.0
11690	561	901	13162	10.9	40.5
11692	932	1150	6649	10.8	38.5
11695	932	1023	3533	2.0	26.8
11699	901	1123	10202	12.0	49.0
11704	1033	1038	7164	5.2	21.0
11797	620	1022	328	0.0	48.0
1397906	1300	1302	0	0.0	17.5
1397925	3381	90009	12124	1.6	17.8
1397969	1360	90034	12197	20.2	20.0
1397975	1398	90035	7399	4.4	12.5
1397976	1396	90035	13397	17.3	17.3

Source ID	Node A	Node B	2015		Speed (kph)
			Traffic Flow (2-way 24 hr AADT)	% HGV	
1397998	1071	90048	13175	16.7	12.3
1397999	1067	90048	12412	17.0	12.3
1398005	1391	90051	8977	17.6	23.3
1398006	90034	90051	8977	17.6	23.3

Appendix 3 – 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)[5] 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 is that outlined Section 4.1.1.

The Council undertakes passive diffusion tube monitoring at 13 locations and continuous monitoring at one location as part of its LAQM commitments. All of the tubes were within the modelled area and all those that were not background sites were considered for the purpose of model verification.

The details of the LAQM monitoring site used for the purposes of model verification is presented in Table 5.

NO_2 Verification Calculations

The verification of the modelling output was performed in accordance with the methodology provided in Chapter 7 of LAQM.TG(16)[5].

For the verification and adjustment of NO_x/NO_2, the LAQM monitoring data was used, as presented in Table A1. Data capture for 2015 generally good across the sites, but for sites DV05, DV25 and DV29 it was necessary to annualise the monitoring results. Table A1 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 A1 – Comparison of Unverified Modelled and Monitored NO_2 Concentrations

Site ID	Background NO_2	Monitored total NO_2 (µg/m^3)	Unverified Modelled total NO_2 (µg/m^3)	% Difference (modelled vs. monitored)
DV01	14.2	30.2	18.6	-38.6
DV05	14.2	31.1	21.0	-32.6
DV06/DV07/DV08	14.2	44.2	21.9	-50.4
DV10	14.7	41.2	27.2	-34.1
DV11/DV16/DV17	14.7	35.4	23.3	-34.3
DV12/DV18/DV19	13.1	38.9	24.8	-36.2
DV23	13.1	43.2	20.9	-51.7
DV24	14.2	49.1	23.1	-53.1
DV25	14.2	39.4	21.4	-45.7
DV29	11.9	20.4	16.1	-21.1

The model was under predicting at each location and no further improvement of the modelled results could be obtained on this occasion. The difference between modelled and monitored concentrations greater than ±25%, up to a maximum of -53.1%, meaning adjustment of the results was necessary. The relevant data was then gathered to allow the adjustment factor to be calculated.

Model adjustment needs to be undertaken based for NO_x and not NO_2. For the diffusion tube monitoring results used in the calculation of the model adjustment, NO_x was derived from NO_2; these calculations were undertaken using a spreadsheet tool available from the LAQM website[31].

Table A2 provides the relevant data required to calculate the model adjustment based on regression of the modelled and monitored road source contribution to NO_x.

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

Table A2 – 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)
DV01	30.2	52.5	14.2	20.1	16.0	32.5	8.3
DV05	31.1	54.5	14.2	20.1	16.9	34.5	13.1
DV06/DV07/DV08	44.2	85.9	14.2	20.1	30.0	65.8	15.0
DV10	41.2	78.2	14.7	20.9	26.5	57.3	25.0
DV11/DV16/DV17	35.4	64.2	14.7	20.9	20.7	43.4	16.9
DV12/DV18/DV19	38.9	73.4	13.1	18.4	25.8	55.0	23.1
DV23	43.2	84.1	13.1	18.4	30.1	65.7	15.0
DV24	49.1	98.8	14.2	20.1	34.9	78.7	17.3
DV25	39.4	73.9	14.2	20.1	25.2	53.8	14.0
DV29	20.4	32.9	11.9	16.5	8.5	16.4	7.9

Figure A1 provides a comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution 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. The equation of the trend lines presented in Figure A1 gives an adjustment factor for the modelled results of 3.11.

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

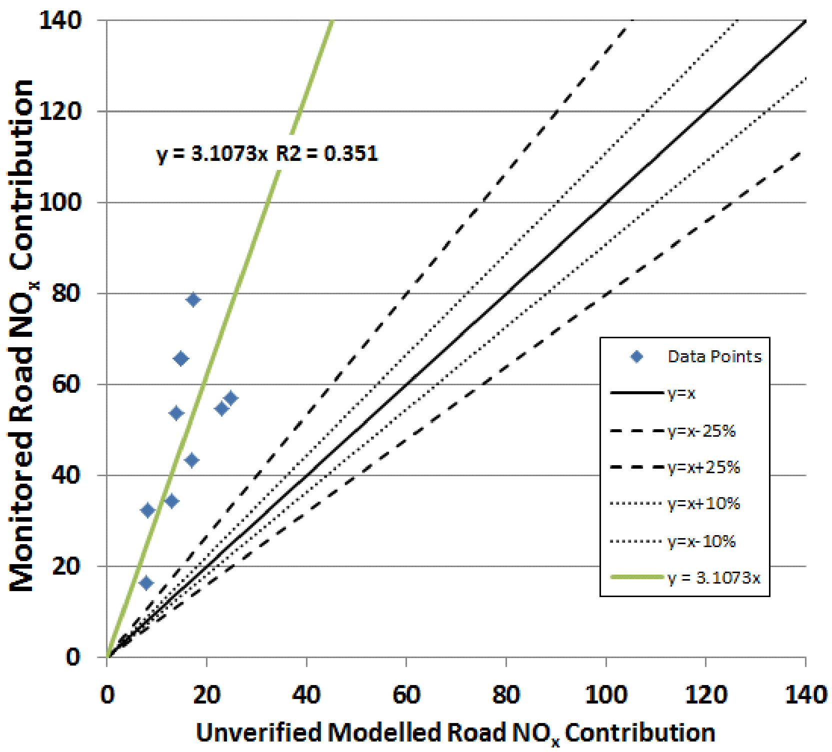


Table A3 shows the ratios between monitored and modelled NO_2 for each monitoring location based on the above adjustment factor. Using a factor of 3.11, whilst all the results are within 25%

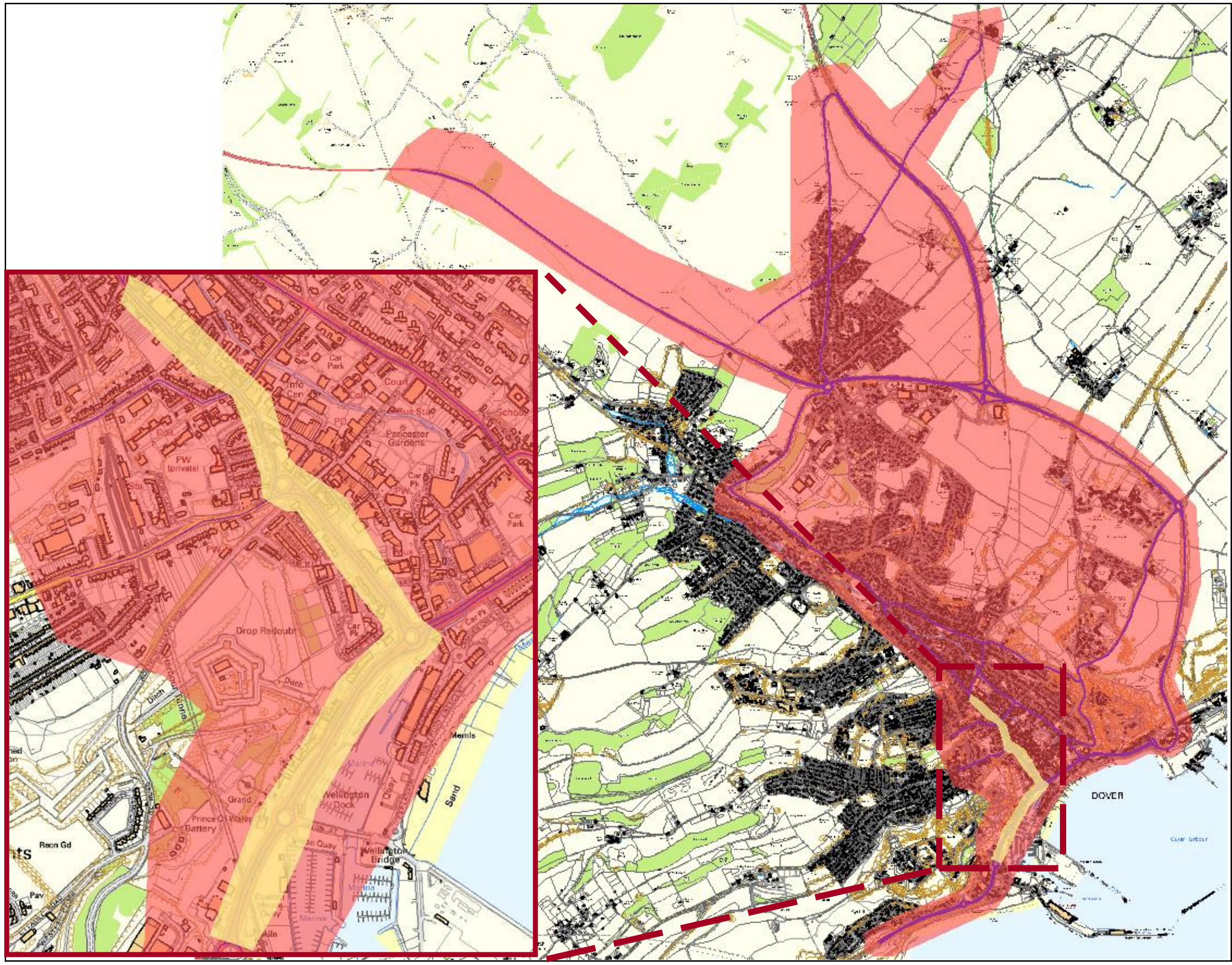
of the monitored, the threshold deemed acceptable in TG.16, there are significant variations between the adjustment ratios across the verification points. Ideally, concentrations should be within ±10%, but 12 sites were outside of this range. Significantly, there was also an under prediction in the Ladywell/Townhall area, within the current AQMA, where proportionally high concentrations were monitored and an over-prediction at the triplicate site DV12/18/19. Therefore, it was deemed 3.11 was not a suitable verification factor.

Table A3 – 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)
DV01	3.92	3.107	25.8	45.8	27.1	30.2	-10.3
DV05	2.63		40.7	60.8	33.9	31.1	8.9
DV06/DV07/DV08	4.38		46.7	66.8	36.5	44.2	-17.5
DV10	2.29		77.8	98.6	49.1	41.2	19.2
DV11/DV16/DV17	2.57		52.5	73.3	39.2	35.4	10.8
DV12/DV18/DV19	2.37		71.9	90.3	45.6	38.9	17.2
DV23	4.38		46.6	65.0	35.4	43.2	-18.1
DV24	4.55		53.8	73.8	39.4	49.1	-19.8
DV25	3.85		43.4	63.5	35.0	39.4	-11.1
DV29	2.07		24.6	41.1	24.4	20.4	19.6

In order to provide more confidence in the model predictions, the model was split into two verification domains, the A256 High Street to A20 Snargate Street area (Domain 1) and the rest of the modelled area (Domain 2), as illustrated in Figure A2.

Figure A2 – Verification Domains



Legend
- Domain 1
- Domain 2
- Modelled Roads

Contains Ordnance Survey Data Crown Copyright and Database Right [2017]

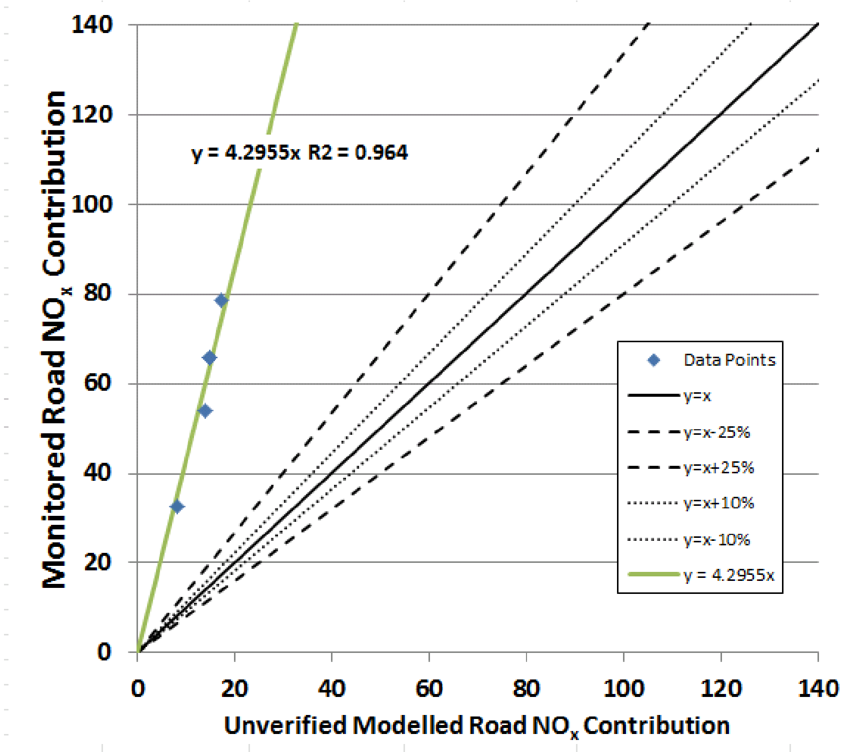
BUREAU VERITAS	**Air Quality Bureau Veritas 5th Floor 66 Prescot Street London, E1 8HG**
Location Dover	
Title Verification Domains	
By MN	**Approved** JC
Scale Not To Scale	**Job Ref** 6366970
Date January 2017	**Figure No.** A2

Splitting the modelled area into two domains results in an increase in the model verification factor for Domain 1, and increased alignment between monitored and modelled values, as shown in Table A4 and Figure A3. The equation of the new trend line presented gives an increased adjustment factor for the modelled results in Domain 1 of 4.296.

Table A4 - Adjustment Factor and Comparison of Verified Results Against Monitoring Results in Domain 1

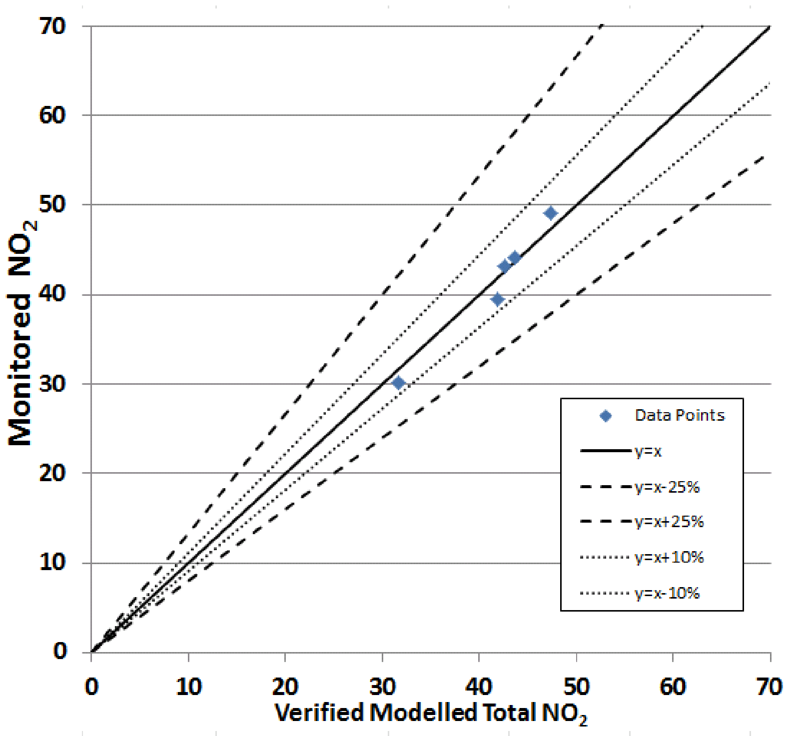
Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m^3)	Adjusted modelled total NO_x (including background NO_x) (µg/m^3)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m^3)	Monitored total NO_2 (µg/m^3)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
DV01	3.92	4.296	35.6	55.7	31.6	30.2	4.7
DV06/DV07/DV08	4.38		64.6	84.7	43.7	44.2	-1.1
DV23	4.38		64.4	82.8	42.7	43.2	-1.2
DV24	4.55		74.3	94.4	47.5	49.1	-3.3
DV25	3.85		60.0	80.1	41.9	39.4	6.4

Figure A3 – Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x in Domain 1



The adjustment factor of 4.296 was applied to the road-NO_x concentrations predicted by the model in Domain 1 to arrive at the final NO_2 concentrations. The sites then show strong agreement between the ratios of monitored and modelled NO_2, all within ±10%, as shown in a factor of 4.296 in Domain 1 also reduces the Root Mean Square Error (RMSE) from a value of 20.7 to 1.5.

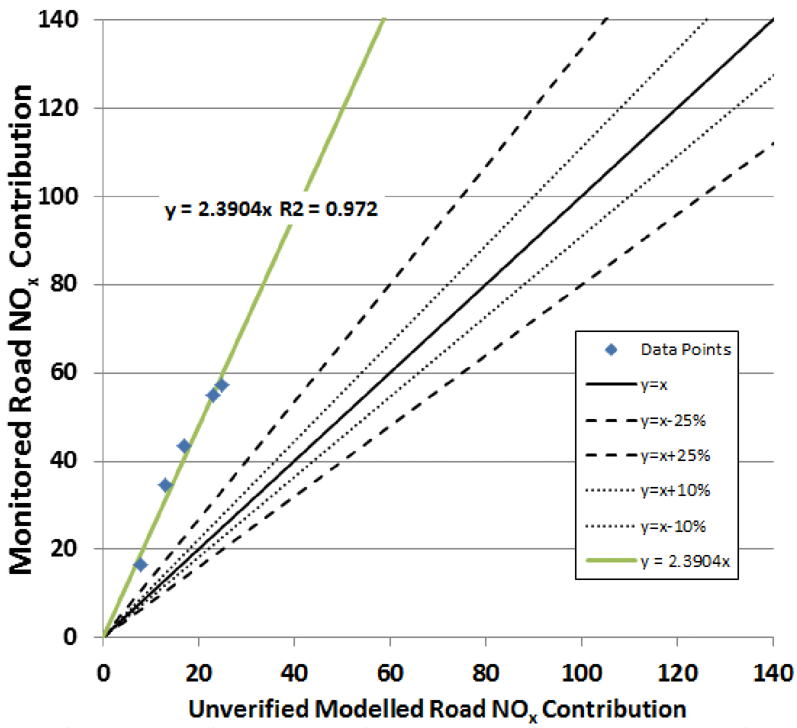
Figure A4 – Comparison of the Modelled NO_2 versus Monitored NO_2 in Domain 1



All NO_2 results residing within Domain 1 presented and discussed herein are those calculated following the process of model verification using an adjustment factor of 4.296.

For Domain 2, the equation of the new trend line presented gives an adjustment factor for the rest of the modelled results of 2.390, as shown in Figure A5 and Table A5.

Figure A5 – Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x in Domain 2

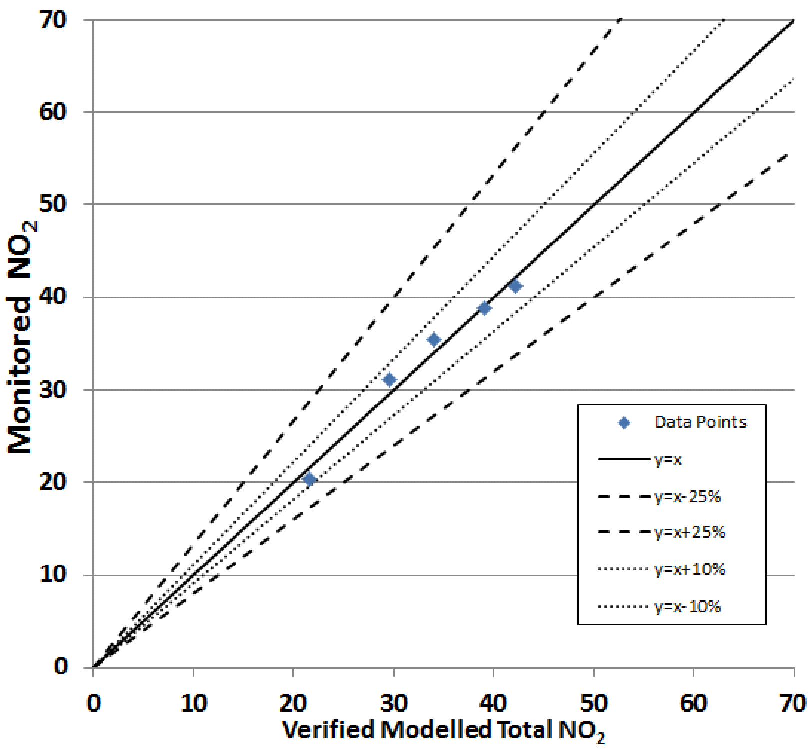


The adjustment factor of 2.390 was applied to the road-NO_x concentrations predicted by the model in Domain 2 to arrive at the final NO_2 concentrations. The sites show strong agreement between the ratios of monitored and modelled NO_2, with all within ±10%, as shown in Figure A6. A factor of 2.390 in Domain 2 also reduces the Root Mean Square Error (RMSE) from a value of 11.5 to 1.1.

Table A5 – Adjustment Factor and Comparison of Verified Results Against Monitoring Results in Domain 2

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/m³)	Adjusted modelled total NO_x (including background NO_x) (µg/m³)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m³)	Monitored total NO_2 (µg/m³)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
DV05	2.63	2.390	31.3	51.4	29.7	31.1	-4.6
DV10	2.29		59.8	80.7	42.2	41.2	2.5
DV11/DV16/DV17	2.57		40.4	61.2	34.1	35.4	-3.6
DV12/DV18/DV19	2.37		55.3	73.7	39.1	38.9	0.4
DV29	2.07		18.9	35.4	21.7	20.4	6.1

Figure A6 – Comparison of the Modelled NO_2 versus Monitored NO_2 in Domain 2



All NO_2 results in Domain 2 presented and discussed herein are those calculated following the process of model verification using an adjustment factor of 2.390.

PM_{10} Verification Calculations

The verification of the modelling output was performed in accordance with the methodology provided in Chapter 7 of LAQM.TG(16)[5].

For the verification and adjustment of PM_{10}, the LAQM monitoring data was used, as presented in Table 4. Data capture for 2015 was very good at 97.3%. Table A6 below shows an initial comparison of the monitored and unverified modelled PM_{10} results for the year 2015, in order to determine if adjustment was required.

Table A6 – Comparison of Unverified Modelled and Monitored PM_{10} Concentrations

Site ID	Background PM_{10}	Monitored total PM_{10} (µg/m^3)	Unverified Modelled total PM_{10} (µg/m^3)	% Difference (modelled vs. monitored)
DRS_Cont	15.3	22.4	16.4	-26.6

The model was under predicting and no further improvement of the modelled results could be obtained on this occasion. The difference between modelled and monitored concentrations greater than ±25% meaning adjustment of the results was necessary. The relevant data was then gathered to allow the adjustment factor to be calculated.

Table A7 provides the relevant data required to calculate the model adjustment based on the ratio of modelled and monitored road source contribution to PM_{10}.

Table A7 – Data Required for Adjustment Factor Calculation

Site ID	µg/m^3				Verification Factor
	Monitored total PM_{10}	Background PM_{10}	Monitored road contribution PM_{10} (total - background)	Modelled road contribution PM_{10} (excludes background)	Monitored road contribution / Modelled road contribution
DRS_Cont	22.4	15.3	7.1	1.1	6.461

All PM_{10} results presented and discussed herein are those calculated following the process of model verification using an adjustment factor of 6.461.