Dover District Council

Air Quality Action Plan Inputs

Dispersion Modelling Assessment

March 2021

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Executive Summary

Bureau Veritas UK Ltd has been commissioned by Dover District Council ('the Council') to complete an Air Quality Assessment to support the development of the Council's Air Quality Action Plan (AQAP), covering primarily the A20 AQMA declared in 2004 (and amended in 2007 and 2009) and the High Street / Ladywell AQMA declared in 2007, both due to exceedances of the annual mean NO_2 Air Quality Strategy (AQS) objective.

The basis of the assessment is the updated Dover Transportation Strategy completed by WSP, 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 assessment considered exposure of existing residential receptors to concentrations of Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}), using the Cambridge Environmental Research Consultants ADMS-Roads™ dispersion model (version 5.0).

For NO_2, there is one predicted exceedance of the AQS NO_2 annual mean objective for all modelled receptors, at R58, which lies within the existing High St / Ladywell AQMA. This receptor location predicted the maximum concentration across the modelled receptor locations, reporting a concentration of 40.2µg/m^3, which is just over the AQS objective and represents 100.5% of the objective. One further location was predicted to be within 10% of the AQS Objective, at receptor location R54, within the A20 AQMA. This receptor location predicted a concentration of 37.5µg/m^3, representing 93.9% of the AQS Objective therefore highlighting an area of potential concern.

NO_2 concentrations predicted at all other modelled receptor locations were below the annual mean NO_2 AQS Objective and no further locations were within 10% of the objective. Additionally, 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)[4], and therefore short-term NO_2 exposure from road traffic emissions at the assessed receptor locations are not considered to be in exceedance of the AQS objective.

NO_2 concentration isopleths indicated that no change to either the High Street / Ladywell AQMA boundary and the A20 AQMA boundary is necessary. The modelled exceedances of the AQS objective are largely localised to the roadway and concentrations drop off as you move further from the road. Regarding the High Street / Ladywell AQMA, the elevated concentrations that led to the declaration of the AQMA are confirmed to still be present, however, the concentrations drop off further from the junction and exceedances have not been modelled north of the AQMA boundary. The 40µg/m^3 isopleth extends slightly to the south of the AQMA boundary along High Street to the junction with Effingham Crescent. However, the exceedances are modelled within the roadway and concentrations drop to below 36µg/m^3 at either side of the road, where receptors are present. Regarding the A20 AQMA, the area of potential concern is confirmed along Snargate street, where concentrations between 36-40µg/m^3 have been modelled along parts of the minor road where receptors are present. The extent of the 40µg/m^3 isopleth extends beyond the AQMA boundary to the north and south, however these concentrations are confined to the roadway and concentrations drop to below 36µg/m^3 at either side of the road, where receptors are present.

For NO_x, regional background (the concentrations which the Council are not able to influence), account for only 23.1% of total concentrations. As such local policy should have a significant influence on NO_x concentrations. At the receptor where the maximum road NO_x concentration has been predicted, located within the High Street / Ladywell AQMA, road traffic accounts for 77.4% of the overall NO_x. Of this total NO_x, Cars account for the most (42.6%) of any of the vehicle types, followed by LGVs (15.1%) and Buses (12.1%). This indicates that Cars, Buses and LGVs are largely responsible for the exceedances in the High St / Ladywell AQMA. Therefore, measures should focus specifically to reduce the number of these vehicle types travelling along the most vulnerable routes.

However, the receptor where the second highest road NO_x concentration was predicted, within the A20 AQMA, shows that different localised effects are influencing the NO_x concentrations. Cars are

the highest contributors to road NO_x (27.6%), however this is closely followed by HGVs (26.0%) and then LGVs (16.3%). This confirms the that this is a common route for HGVs to take in order to access the port and indicates that cars, HGVs and LGVs emissions are responsible for increasing NO_x concentrations in the A20 AQMA. Understanding the key routes into the town and towards the port, including how different vehicle types are using the surrounding roads, will help focus measures.

For PM_{10}, the maximum predicted annual mean concentration in 2019 was 21.4µg/m^3. This represents only 53.5% of the 40µg/m^3 annual mean AQS objective. The maximum number of exceedances of the 24-hour PM_{10} 50µg/m^3 AQS objective at all receptor locations in 2019 was 5 days. This is well below the 35 permitted exceedances. In conclusion, there are no exceedances of the PM_{10} AQS objectives modelled in 2019. There is no requirement to declare an AQMA for this pollutant.

On the basis of the results of the detailed dispersion modelling assessment, the following actions are recommended:

- The High St / Ladywell AQMA to remain as currently declared although the existing monitoring at High Street toward Victoria Crescent (DV30) should continue, with a focus on increasing data capture and ensuring relevant public exposure (i.e. located at the height of a residential property);

- The A20 AQMA to remain as currently declared, though monitoring to be continued to assess the current boundary, particularly at the monitoring locations along Snargate Street (DV23, DV24 and DV25) and outside of the AQMA boundary at the A20 Eastern Docks roundabout (DV33) to assess whether any permanent changes to HGV routes through Dover will worsen the air quality within the A20 AQMA. If the monitoring at DV33 identifies a new exceedance, amendment will 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;

- Re-evaluation of detailed modelling to be considered once permanent changes to HGV routes are known post-Brexit and considering the new White Cliffs Inland Border Facility.

1. Introduction

Bureau Veritas UK Ltd has been commissioned by Dover District Council ('the Council' / DDC) to complete a detailed dispersion modelling assessment to inform an update to the Council's AQAP. The work undertaken will help to ensure that the AQAP adheres to the Council's recently developed Local Plan as well as changes to national best practice measures. Prior to preparing the revised AQAP the Council requested a dispersion modelling assessment in the area covered by the Council's presently declared Air Quality Management Areas (AQMAs) to provide a detailed understanding of the existing conditions within Dover.

There are currently two AQMAs declared in the district due to exceedances 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 basis of this assessment is the Dover Transportation Strategy, first completed in 2008 and recently updated by WSP. 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 2015 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. A growth factor has been applied to the 2015 traffic data using the National Trip End Model (NTEM) to give a baseline of 2019.

1.1 Scope of Assessment

Based upon the requirements provided by the Council the main objectives of this assessment are as follows:

- 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 2019;
- To compare the predicted air pollutant concentrations with the objectives set out in the AQS[1] and set out by the Government in the Air Quality (England) Regulations 2000[2] and (Amended 2002 version[3]) for Local Air Quality Management (LAQM) purposes, in order to identify any issues pertinent to the exposure of residents to these pollutants;
- To determine the geographical extent of any potential exceedance of the annual mean AQS objectives for NO_2 and PM_{10};
- To determine the source apportionment at the worst-case receptor location within each AQMA; and
- To put forward recommendations as to the extent of any changes to the current AQMA boundaries or introduction of a new AQMA within Dover.

The approach adopted in this assessment to evaluate the impact of road traffic emissions on air quality has utilised Cambridge Environmental Research Consultants (CERC) ADMS-Roads™ dispersion model (version 5.0) with the latest vehicle emission factors released by the Department for Environment, Food and Rural Affairs (Defra) Emissions Factors Toolkit (EFT) version 10.1, focusing on NO_2 and PM_{10}. These pollutants are the main pollutants of concern associated with

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

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

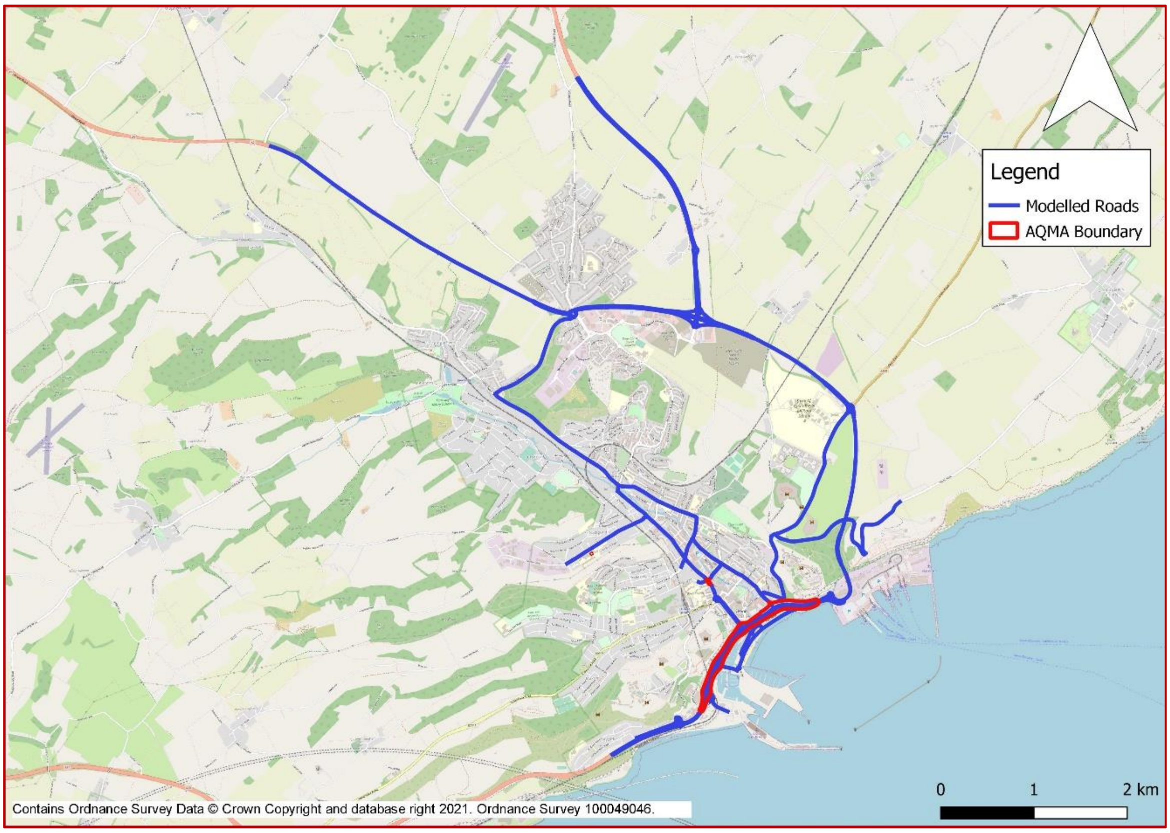
[3] The Air Quality (England) (Amendments) Regulations 2002 (Statutory Instrument 3043).

traffic emissions for comparison against the relevant Air Quality Standard (AQS) objectives, both nationally and within the Council's administrative area. Further general information in relation to these pollutants and urban pollution is provided in Appendix A.

In order to provide consistency with the Council's own work on air quality, the guiding principles for air quality assessments as set out in the latest guidance and tools provided by Defra (LAQM TG(16)[4]) have been used where relevant.

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

Figure 1-1 - Study Area



[4] LAQM Technical Guidance LAQM TG(16) – February 2018. Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland.

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)[5] 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[6] has been adopted and replaces all previous air quality Directives, except the 4th Daughter Directive[7]. The Directive introduces new obligatory standards for $PM_{2.5}$ for National Government but places no statutory duty on Local Governments to work towards achievement of these standards.

The Air Quality Standards (England) Regulations[8] 2010 came into force on 11 June 2010 in order to align and bring together in one statutory instrument the UK 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 2-1, taken from LAQM TG(16)[4], 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. Therefore, as a result, the UK Government has submitted time extension applications for compliance with the EU Limit Values; continued failure to achieve these limits may lead to EU fines.

In July 2017, the UK Government published its plan for tackling roadside NO_2 concentrations, which are, in many places within the UK, in exceedance of the EU Limit Values. This sets out UK Government policies for bringing NO_2 within statutory limits in the shortest possible time. Following on from the 2017 publication, the draft Clean Air Strategy was published in 2018, with the final version being published in January 2019. The strategy outlines how the UK will meet international commitments to significantly reduce emissions by 2020 and 2030 under the adopted revised National Emissions Ceiling Directive (NECD), with a focus on five of the most damaging air

[5] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007), Published by Defra in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland.

[6] 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.

[7] 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.

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

pollutants. The five pollutants cited are fine particulate matter, ammonia, nitrogen oxides, sulphur dioxide, and non-methane volatile organic compounds.

The AQS objectives for the pollutants that the assessment focuses on are presented in Table 2-2.

Table 2-1 – Examples of where the AQS 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.	

Notes:
[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 2-2 – 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 National Planning Policy

The National Planning Policy Framework[9] (NPPF) was published in March 2012 and revised in February 2019. The framework details the English Government's vision for growth in England, outlining the need to favour sustainable development. One of the overarching objectives for achieving sustainable development is the environmental objective:

"to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy."

With regard to air quality, the NPPF additionally states:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas.

... Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."

The Planning Practice Guidance (PPG), updated in November 2019, provides further detail about the assessment of air quality effects and when an air quality assessment is required. It states:

"As well as having direct effects on public health, habitats and biodiversity, … pollutants can combine in the atmosphere to form ozone, a harmful air pollutant (and potent greenhouse gas) which can be transported great distances by weather systems.

… It is important that the potential impact of new development on air quality is taken into account where the national assessment indicates that relevant limits have been exceeded or are near the limit, or where the need for emissions reductions has been identified.

…Whether air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to have an adverse effect on air quality in areas where it is already known to be poor, particularly if it could affect the implementation of air quality strategies and action plans and/or breach legal obligations (including those relating to the conservation of habitats and species). Air quality may also be a material consideration if the proposed development would be particularly sensitive to poor air quality in its vicinity."

2.3 Local Air Quality Management (LAQM)

Part IV of the Environment Act 1995[10] 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 exceedances 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

[9] National Planning Policy Framework. Published February 2019. Available at : https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

[10] Part IV of the Environment Act 1995. Published by the UK Government, 1st February 1996. Available at: http://www.legislation.gov.uk/ukpga/1995/25/part/IV

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[11] 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.

2.4 Local Planning Policy

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

- Core Strategy (to be replaced by new Local Plan)[12]
- Saved Policies from the Dover District Local Plan (Adopted 2002, currently being updated)[13]
- Land Allocations Local Plan (Adopted 2015, to be replaced by new Local Plan)[14]
- Dover Transport Strategy (2007 – currently being updated)[15]
- The Local Transport Plan for Kent[16]
- Kent Environment Strategy[17]
- Kent and Medway Energy and Low Emissions Strategy (June 2020)[18]

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.

[11] 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.

[12] Core Strategy (2010) https://www.dover.gov.uk/Planning/Planning-Policy-and-Regeneration/Adopted-Development-Plans/Core-Strategy.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] https://www.kent.gov.uk/__data/assets/pdf_file/0009/112401/Kent-and-Medway-Energy-and-Low-Emissions-Strategy.pdf

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 (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, 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 2020 Annual Status Report.

[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

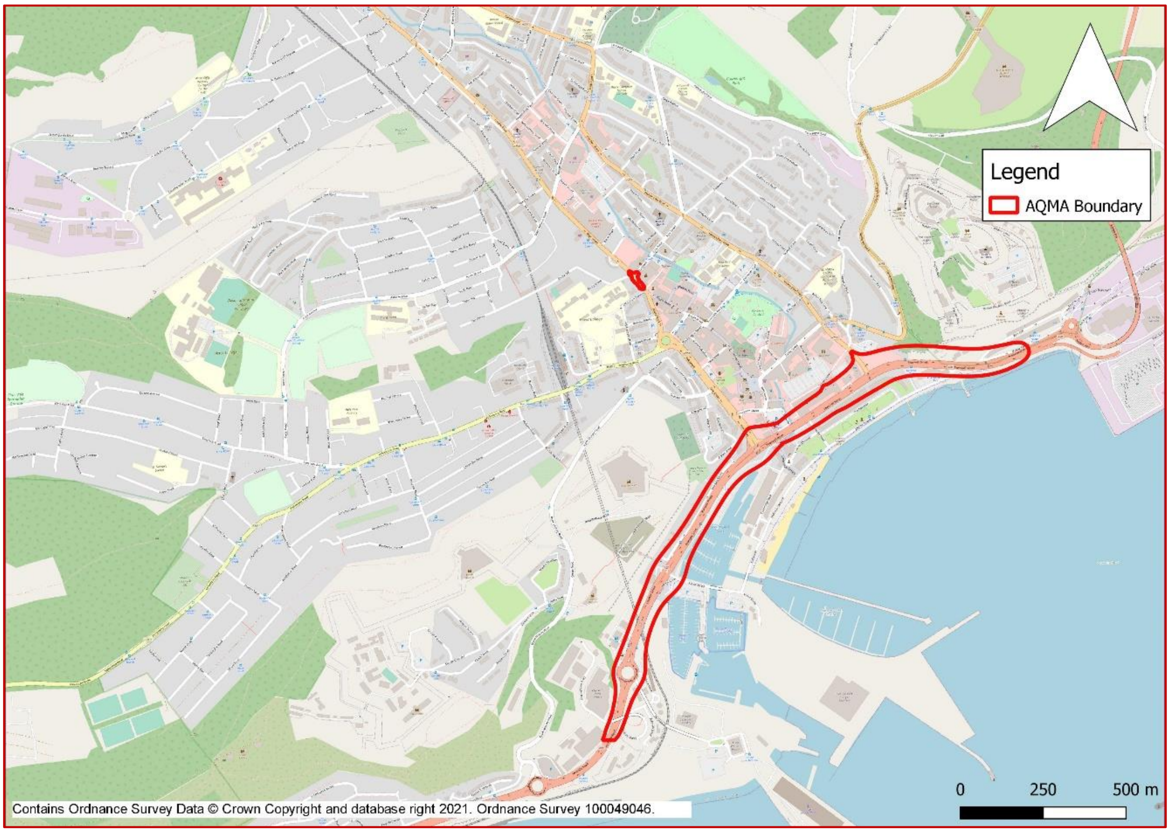
3. Review and Assessment of Air Quality Undertaken by the Council

3.1 Local Air Quality Management

The Council, under its obligations in Part IV of the Environment Act 1995, has maintained a thorough annual review and assessment of air quality through their statutory reporting, the most recent report (2020) can be found on the air quality section of the Councils website[21].

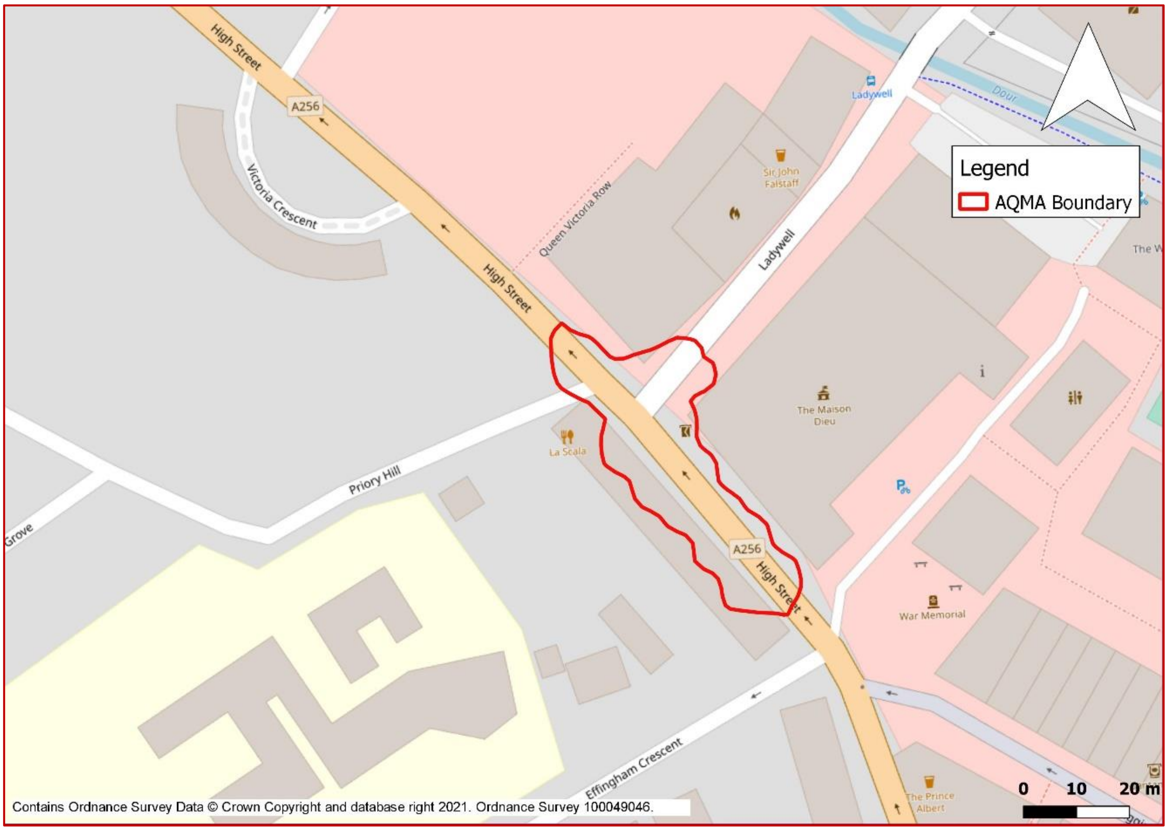
The Council have two declared AQMAs; A20 AQMA, declared in 2004 and amended in 2007 and 2009 (Figure 3-1), and High Street/Ladywell AQMA, declared in 2007 (Figure 3-2). Both AQMAs were designated due to exceedances of the annual mean Air Quality Strategy objective for concentrations of NO_2, caused primarily by traffic emissions.

Figure 3-1 - A20 AQMA Boundary



[21] https://www.dover.gov.uk/Environment/Environmental-Health/Air-Quality/Air-Quality-Monitoring.aspx

Figure 3-2 - High Street / Ladywell AQMA Boundary



3.2 Review of Air Quality Monitoring

3.2.1 Local Air Quality Monitoring

The most recent LAQM report the Council has published is the 2020 Air Quality Annual Status Report (ASR), inclusive of 2019 monitoring data that has been used in this assessment. In 2019 the Council undertook automatic continuous monitoring at one location, measuring PM_{10} and in addition NO_2 was monitored at 17 locations using passive diffusion tubes.

Details of monitoring locations across Dover, and the relevant 2019 pollutant concentrations are presented in Table 3-1 and Table 3-2. Four passive monitoring locations were not included in the modelling assessment: the urban background site DV04 and the urban centre site DV05 due to the distance from modelled roads, DV30 due to low data capture and DV12/DV18/DV19 due to lack of representativity in the model. Figure 3-3 shows a visual representation of the monitoring locations referenced against the AQMAs and the modelled road links, as detailed in Section 4.

It can be seen from the 2019 monitoring results that there was only one exceedance of the annual mean AQS objective for NO_2 and no exceedances for PM_{10}. The exceedance was recorded at DV30, which has not been used in the assessment due to low data capture (50%) and uncertainty surrounding the height of the monitoring location. The highest NO_2 concentration at the monitoring sites used within the assessment, was recorded at the triplicate site DV06/07/08, which is located within the High Street/Ladywell AQMA.

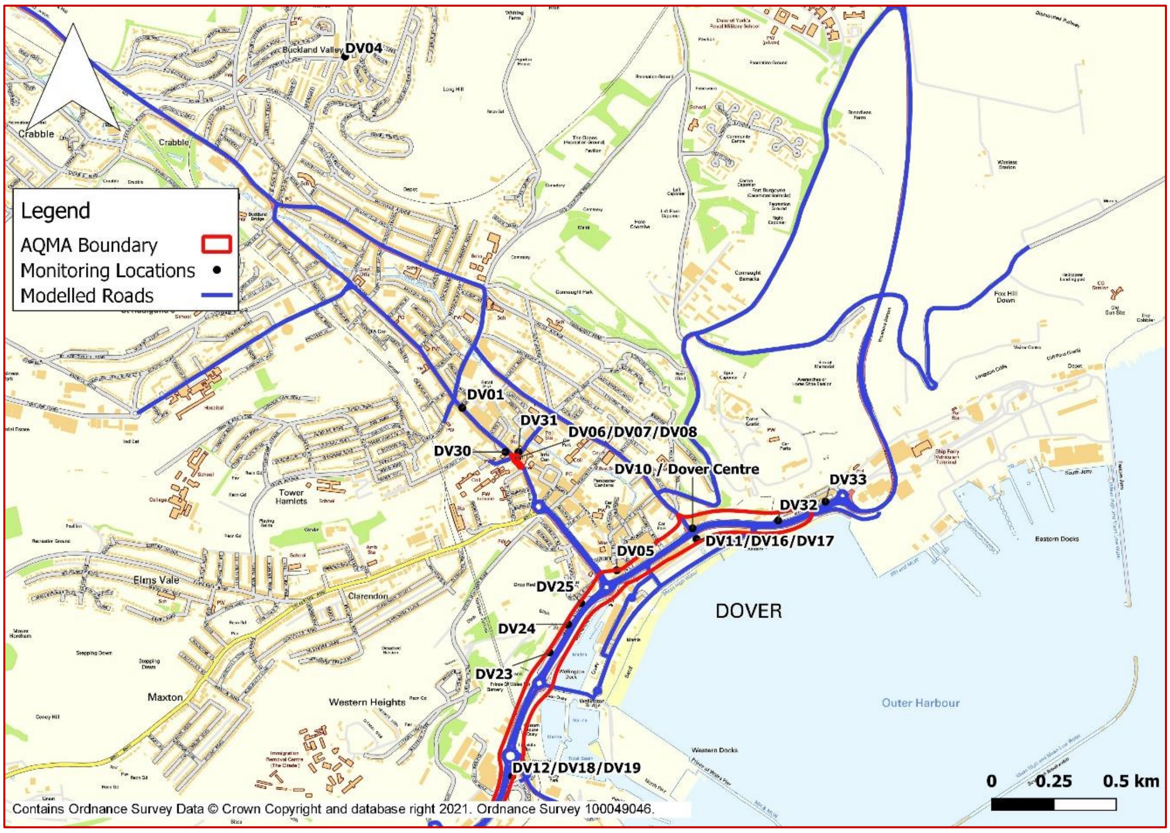
Table 3-1 – 2019 Dover PM_{10} Continuous Monitoring

Site ID	Site Type	Data Capture (%)	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	Annual Mean Concentration (µg/m³) PM_{10}	PM_{10} Daily Means in Excess of the 24-hour Objective (50µg/m³)
Dover Centre	Roadside	97%	632302	141465	22	8

Table 3-2 – 2019 Dover NO_2 Passive Monitoring

Site ID	Site Type	Data Capture (%)	X OS Grid Ref (Easting)	Y OS Grid Ref (Northing)	In AQMA	Annual Mean (µg/m³)
DV01	Roadside	92	631376	141949	NO	30.8
DV04	Urban Background	92	630905	143362	NO	15.3
DV05	Urban Centre	92	631997	141296	A20	24.4
DV06/ DV07/ DV08	Roadside	92	631597	141748	High St /Ladywell	39.8
DV10	Roadside	83	632302	141465	A20	35.9
DV11/ DV16/ DV17	Roadside	92	632318	141422	A20	28.1
DV12/ DV18/ DV19	Roadside	92	631577	140468	A20	31.5
DV23	Roadside	92	631727	140966	A20	31.2
DV24	Roadside	83	631802	141079	A20	33.7
DV25	Roadside	83	631854	141164	A20	29.3
DV30	Kerbside	50	631550	141772	NO	**40.4**
DV31	Kerbside	83	631602	141771	NO	31.5
DV32	Roadside	92	632646	141496	A20	31.7
DV33	Roadside	75	632836	141572	NO	35.9
DV34	Kerbside	71	633088	158032	NO	25.9
DV35	Kerbside	71	633174	158094	NO	16.1
DV36	Roadside	100	635696	152325	NO	18.5
Exceedances of the objective are shown in bold.						

Figure 3-3 – Dover District Council Monitoring Locations with Reference to Modelled Roads and AQMAs



3.2.2 Background Concentrations

DEFRA maintain a nationwide model of existing and future background air quality concentrations at a 1 km grid square resolution[22]. The data sets include annual average concentration estimates for NO_x, NO_2, PM_{10} and $PM_{2.5}$, using a base year of 2018. 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[23], 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. To complete this process the NO_x Sector Removal Tool[24] has been used. The background concentrations used in the modelling assessment are detailed in Table 3-3.

The background concentrations presented in Table 3-3 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 3-2) 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.

[22] UK AIR Background Mapping Tool. Available at: https://uk-air.defra.gov.uk/data/laqm-background-home

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

[24] NOx Sector Removal Tool https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxsector

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

Table 3-3 - Defra Background Map Concentrations used in the Modelling Assessment

Year	Grid Square (E,N)	Annual Mean Concentration (µg/m^3)		
		NO_2	NO_x	PM_{10}
2019	630500, 142500	10.6	14.0	14.7
2019	631500, 142500	11.3	15.1	14.4
2019	631500, 141500	12.4	16.8	14.7
2019	632500, 141500	13.0	17.7	13.9
2019	632500, 142500	11.3	15.1	13.3
2019	633500, 142500	12.3	16.6	13.5
2019	630500, 144500	10.2	13.5	14.5
2019	629500, 144500	9.0	11.8	14.1
2019	629500, 143500	9.7	12.7	14.0
2019	630500, 143500	10.3	13.6	14.1
2019	631500, 140500	12.5	17.0	14.2

4. Assessment Methodology

The approach adopted in this assessment to evaluate the impact of road traffic emissions on air quality has utilised Cambridge Environmental Research Consultants (CERC) ADMS-Roads™ dispersion model (version 5.0) with the latest vehicle emission factors released by the Department for Environment, Food and Rural Affairs (Defra) Emissions Factors Toolkit (EFT) version 10.1. The ADMS-roads software is used extensively throughout the UK for regulatory compliance purposes and is accepted as an appropriate air quality modelling tool by the Environment Agency and local authorities. A single scenario has been modelled reflecting concentrations as observed in 2019 focusing on emissions of NO_x and PM_{10}.

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

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

- Quantitative prediction of ambient NO_2 and PM_{10} concentrations, to which existing receptors may be exposed and comparison with the relevant AQS objectives; and

- Determination of the geographical extent of any potential exceedances with a view to possible amendment of the boundary of the AQMA(s).

4.1 Traffic Inputs

The ADMS-Roads assessment incorporates numbers of road traffic vehicles, the proportion of different vehicle classes and vehicle speeds on the local roads. The AADT and vehicle speed data was provided by the appointed transport consultant, WSP. The reduction of vehicle speed at junctions is accounted for in the transport model.

Department for Transport (DfT) road traffic statistics from 2019[25], where available, were assigned to each modelled road link, to provide the proportion of vehicle types that could be applied to the AADT that was supplied by the traffic consultants. This allowed the source apportionment exercise to be carried out, providing a breakdown by vehicle type. Department for Transport (DfT) road traffic statistics from 2019, where available, provided the vehicle proportions for road links for the following vehicle classes:

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

Where relevant DfT data was not available, source apportionment was not completed for these roads.

A desktop study also identified multiple street canyons within the central high street area within Dover, thus requiring additional model adjustments.

Using the traffic data inputs supplied by the appointed transport consultants and supplemented by DfT road traffic statistics, the Emissions Factors Toolkit (EFT) version 10.1 developed by Defra[26]

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[25] DfT Road Traffic Statistics https://roadtraffic.dft.gov.uk/#6/55.254/-6.053/basemap-regions-countpoints

[26] Defra, Emission Factors Toolkit (2020). http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

was then used to determine vehicle emissions for input into the ADMS-Roads model. The "Detailed Option 1" was used that allowed the percentage fleet input by: Car; Taxi; LGV; HGV; Bus and Coach; and Motorcycle.

The EFT v10.1 used to calculate emissions from road traffic in this assessment assumes a default proportion of vehicles of each vehicle type are a certain Euro emissions standard. This is based on a set of traffic activity projections from the DfT (RTF 2018, rebased to 2017 NAEI)[27] and DfT car sale projections (April 2019) including the uptake of low carbon passenger cars and LGVs with electric and hybrid electric propulsion systems.

Due to the scale of the model, a summary of the traffic data used in this assessment has not been appended to the report but can be provided in Excel format upon request. The modelled road links are presented in Figure 1-1.

4.2 Modelled Receptors

All receptors considered in the assessment of emissions from road traffic are presented in Table 4-1 and illustrated in Figure 4-1. Receptors relating to the AQMA areas are also illustrated in Figure 4-2. Receptors have been modelled at heights typical of human exposure i.e. 1.5m for ground level and 4m for first level exposure to account for relevant exposure to the air quality objectives as per Table 2-1.

Table 4-1 - Receptor Locations Considered in the Assessment of Emissions from Road Traffic

ID	Description	Coordinates		
		X	Y	Z
R1	Opposite Buckland Hospital	630305	142086	1.5
R2	5 Coombe Valley Rd	630871	142398	1.5
R3	Buckland Terrace	631097	142271	1.5
R4	303 London Rd	631230	142132	1.5
R5	103 High St	631354	141961	1.5
R6	8 Priory Hill	631557	141746	1.5
R7	Priory Rd	631627	141686	1.5
R8	Discovery Nursery	631869	141380	1.5
R9	York St	631892	141299	1.5
R10	Buckland Medical Centre	630679	142747	1.5
R11	26 A256	630743	142766	1.5
R12	75 A246	630821	142733	1.5
R13	90 A256	630902	142711	1.5
R14	157 A256	631027	142603	1.5
R15	190 A256	630670	142655	1.5
R16	204 A256	630767	142592	1.5
R17	219 London Rd	630836	142514	1.5
R18	Opposite Buckland Hospital	630425	142159	1.5
R19	Barton Junior School	631155	142539	1.5
R20	Opposite Barton Junior School	631155	142569	1.5
R21	69 Barton Rd	631248	142504	1.5
R22	St Edmunds Catholic School	631450	142448	1.5
R23	Dover Grammar School	631479	142377	1.5
R24	28 A256	631447	142291	1.5
R25	11 Bridge St	631358	142073	1.5
R26	69 Maison Dieu Rd	631578	142022	1.5
R27	50 Godwyn Cl	631788	141919	1.5

[27] DfT Road Traffic Forecasts 2018 https://www.gov.uk/government/publications/road-traffic-forecasts-2018

ID	Description	Coordinates		
		X	Y	Z
R28	Maison Dieu Nursery	631892	141850	1.5
R29	9 A256	632004	141749	1.5
R30	115 A256	632140	141652	1.5
R31	13 Castle Hill Rd	632284	141586	1.5
R32	2 Victoria Park	632379	141623	1.5
R33	11 Castle St	632135	141592	1.5
R34	York St	631761	141512	1.5
R35	Tancaster House	631719	141516	4
R36	Above Miles&Barr	631589	141757	4
R37	1 Upper Rd	632379	142209	1.5
R38	Wellesley Rd	632133	141306	1.5
R39	5 Marine Parade	632689	141518	1.5
R40	32 East Cliff	632878	141602	1.5
R41	A2	633003	142316	1.5
R42	Singledge Ln	630032	144659	1.5
R43	2 Archers Ct Rd	630178	144697	1.5
R44	Whitfield Hill	629731	144031	1.5
R45	Kearsney Ave	629360	143804	1.5
R46	London Rd	629401	143655	1.5
R47	London Rd	629658	143517	1.5
R48	15 London Rd	629944	143276	1.5
R49	98 A256	630250	143065	1.5
R50	55 A256	630410	142986	1.5
R51	Camden Cres	632068	141214	1.5
R52	Inchwater Home Care	632106	141184	1.5
R53	Waterloo Cres	631965	140962	1.5
R54	136 Snargate St	631765	141006	1.5
R55	161 Snargate St	631839	141139	4
R56	Gloster Ropewalk	631230	140231	4
R57	Kings Ropewalk	631039	140152	4
R58	11 High St	631595	141728	4
R59	150-167 Townwall St	632316	141428	4
R60	Victoria Crescent	631534	141781	1.5

Figure 4-1 – Receptor Locations with Respect to Modelled Road Links and AQMA Boundaries

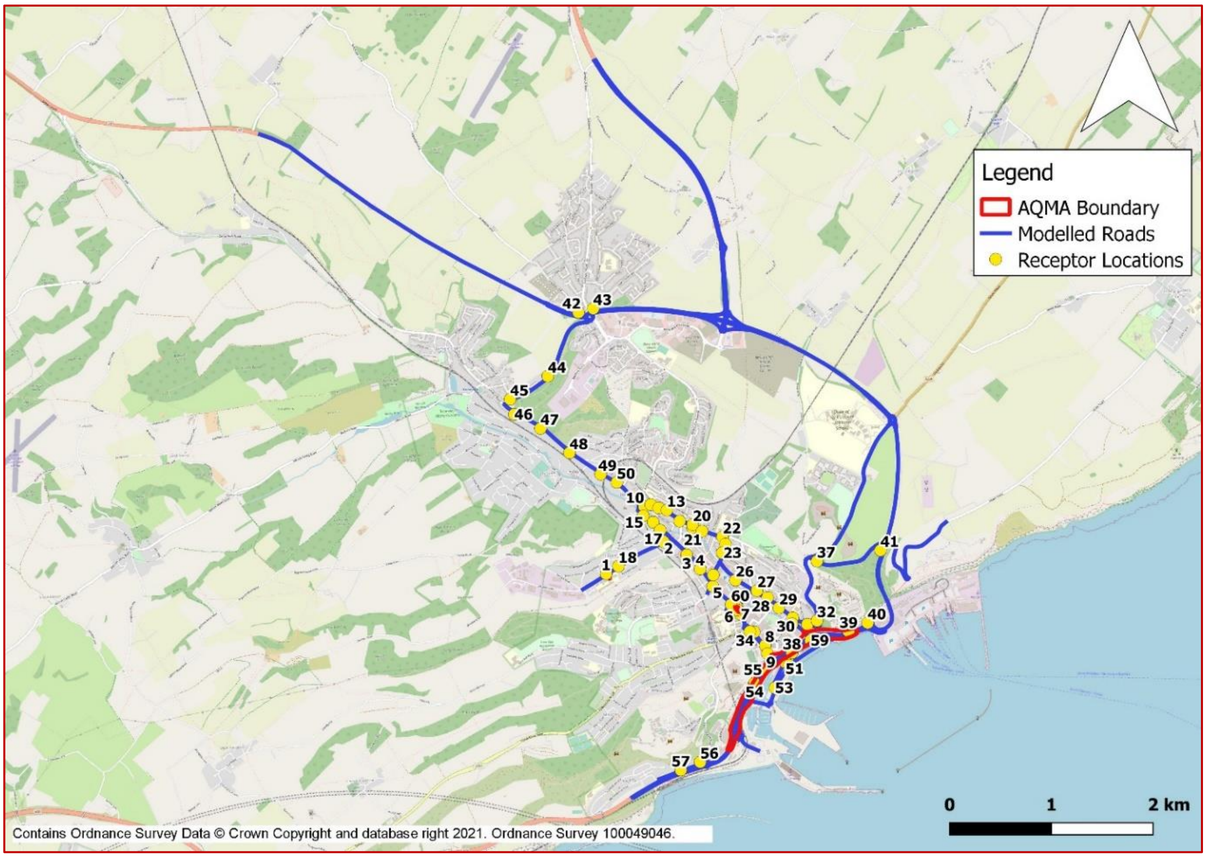
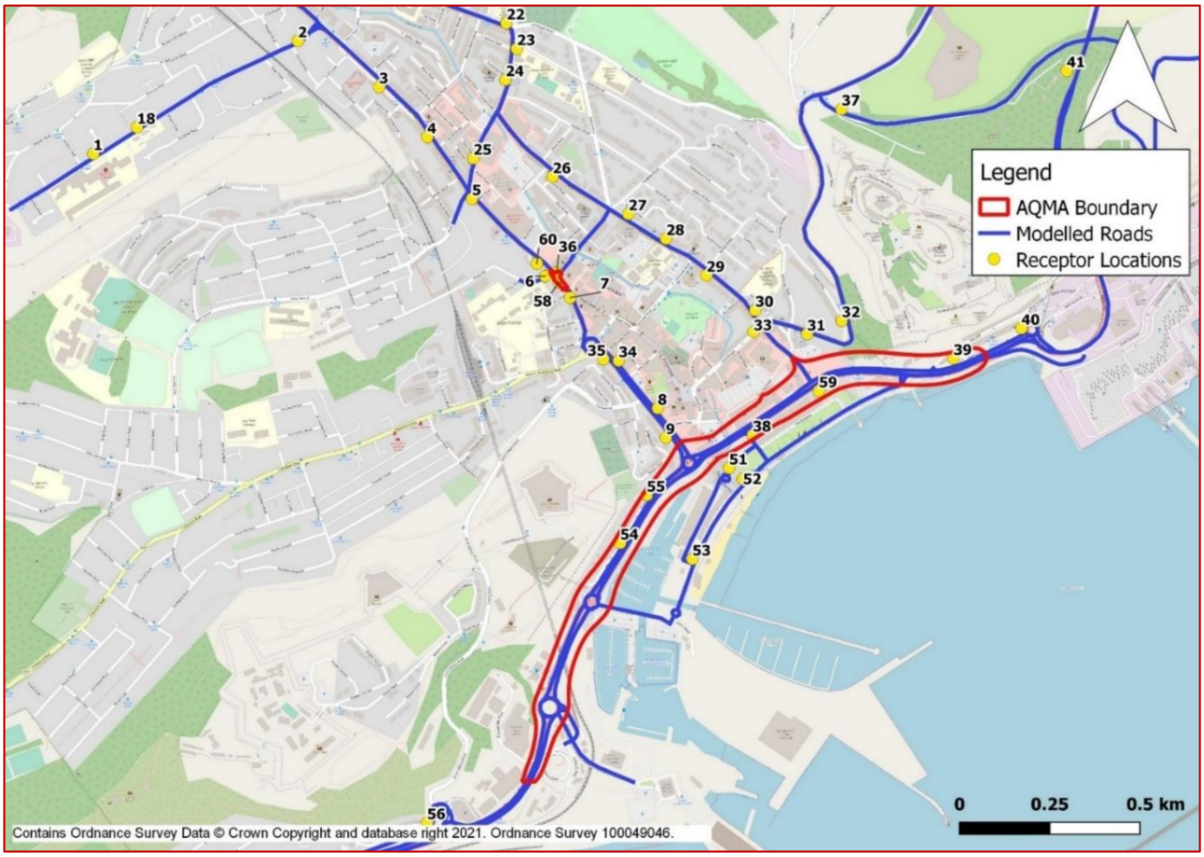


Figure 4-2 - Receptor Locations within Declared AQMAs with Respect to Modelled Road Links

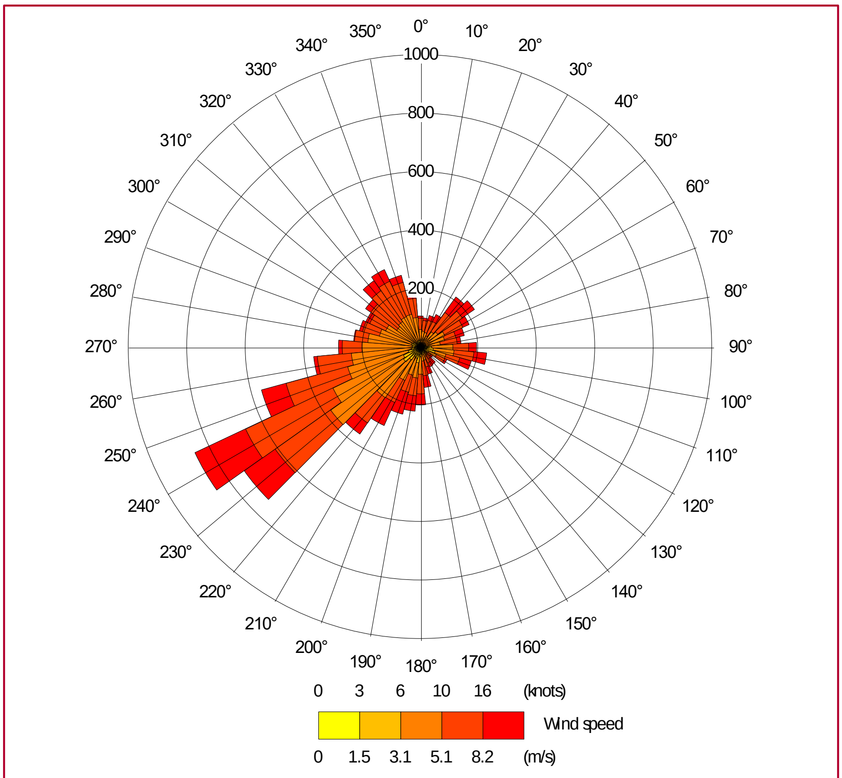


4.3 Meteorological Data

Meteorological data from a representative station to the study area is required as input to the dispersion model. 2019 meteorological data from the Langdon Bay weather station has been used in this assessment. A wind rose for this site for the year 2019 is shown in Figure 4-3. 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)[4] 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 exceedances. LAQM.TG(16) recommends that meteorological data should only be used if the percentage of usable hours is greater than 75%, and preferably 90%. The 2019 meteorological data from Langdon Bay includes 8,664 lines of usable hourly data out of the total 8,760 for the year, i.e. 99% usable data. This is therefore suitable for the dispersion modelling exercise.

A wind rose for this site for the year 2019 is presented in Figure 4-3.

Figure 4-3 – Wind Rose for Langdon Bay 2019 Meteorological Data



4.4 Surface Roughness

Roughness length, z_0, represents the aerodynamic effects of surface friction and is physically defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing.

The surface roughness length is related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas. CERC (2020)[28] suggests typical roughness lengths for various land use categories (Table 4-2).

Table 4-2 – Typical Surface Roughness Lengths for Various Land Use Categories

Land Use	Surface Roughness: z_0 (m)
Large urban areas	1.5
Cities, woodlands	1.0
Parkland, open suburbia	0.5
Agricultural areas (max.)	0.3
Agricultural areas (min.)	0.2
Root crops	0.1
Open grassland	0.02
Short grass	0.005
Sea	0.0001

Increasing the surface roughness length increases turbulent mixing in the lower boundary layer. This can often have conflicting impacts in terms of ground level concentrations:

- The increased mixing can bring portions of an elevated plume down towards ground level, resulting in increased ground level concentrations closer to the emission source; and
- The increased mixing increases entrainment of ambient air into the plume and dilutes plume concentrations, resulting in reduced ground level concentrations further downwind from an emission source.

The overall impact on ground level concentration is, therefore, strongly correlated to the distance and orientation of a receptor from the emission source.

Surface roughness length is entered within the model for both the dispersion site (the model domain), and for the location of where the meteorological data has been measured. As detailed above in Section 0, the meteorological data utilised within the modelling has been taken from the Langdon bay station. The weather station is located within mixed-use open grassland and agricultural land with the sea to the south, approximately 4km south east of Dover town centre. Given the variability of land types at this location, the surface conditions at this location have been defined as the median value, 0.02, which is open grassland.

The surface roughness length for the model domain has been defined as 1.0, which is representative of the built-up areas within Dover.

4.5 Minimum Monin-Obukhov Length

A Minimum Monin-Obukhov Length is used as a model input within ADMS Roads as a parameter to describe the turbulent length scale, which is dependent on meteorological conditions. A minimum length can be used to account for the urban heat island effect, whereby retained heat in cities causes convective turbulence, which prevents the formation of a very shallow boundary layer at night.

[28] CERC, ADMS-Roads V5.0 User Guide (2020).

Table 4-3 – Typical Minimum Monin-Obukhov Length for Various Land Use Categories

Type of Surface	Minimum Monin-Obukhov Length
Large Conurbations > 1 million	100
Cities and Large Towns	30
Mixed Urban / Industrial	30
Small Towns < 10,000	10

In accordance with CERC's ADMS Roads user guide[28], a minimum Monin-Obukhov Length of 30m will be used for the ADMS Roads model to reflect the local topography of the overall model domain.

4.6 Model Outputs

The background pollutant values discussed in Section 3.2.2 have been used in the ADMS-Roads model to calculate predicted total annual mean concentrations of NO_x, NO_2 and PM_{10}.

For the prediction of annual mean NO_2 concentrations for the modelled scenarios, the output of the ADMS-Roads modelled for road-NO_x has been converted to total-NO_2 following the methodology in LAQM.TG(16) 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 8.1 (August 2020) of the NO_x to NO_2 conversion tool. The road contribution is then added to the appropriate NO_2 background concentration value to obtain an overall total NO_2 concentration.

For the prediction of short term NO_2 impacts, LAQM.TG(16) advises that it is valid to assume that exceedances 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 overall total PM_{10} concentrations.

For the prediction of short term PM_{10}, LAQM.TG(16) provides an empirical relationship between the annual mean and the number of exceedances 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 been adopted to determine whether exceedances of short-term PM_{10} AQS objective are likely in this assessment.

Source apportionment was also carried out using Department for Transport (DfT) road traffic statistics from 2019, where available, to provide the vehicle proportions for road links for the following vehicle classes:

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

Where relevant DfT data was not available, source apportionment was not completed for these roads.

Verification of the NO_2 modelled concentrations has been undertaken using 10 monitoring locations operated by the Council, in two separate domains, consisting of 14 NO_2 diffusion tubes in total (including two triplicate sites). One verification domain used three monitoring locations and consisted of the section of road running parallel to the A20, along Snargate Street. It was found that the model was underpredicting in this area due to a minor road not being included in the model. As a result, a separate localised verification factor was required for increased accuracy. The other seven monitoring locations formed the remaining verification domain, which was used for model-wide verification. PM_{10} verification was undertaken using the Dover Centre monitoring site. All NO_2 and PM_{10} results presented in the assessment are those calculated following the process of model verification.

Full details of the model verification completed can be found in Appendix B.

4.7 Uncertainty

Due to the number of inputs that are associated with the modelling of the study area there is a level of uncertainty that has to be taken into account when drawing conclusions from the predicted concentrations of NO_2 and PM_{10}. The predicted concentrations are based upon a number of inputs from a number of different sources; traffic data, background concentrations, emission factors, meteorological data and availability of monitoring data from the assessment areas.

A degree of quality assurance/quality control (QA/QC) is completed throughout the modelling process, through the inputs, modelled outputs, and processing of results, to ensure that the accuracy of the modelled predictions is of a high standard to allow conclusions to be made upon them.

Analyses of historical monitoring data within the UK has identified a disparity between measured concentration data and the projected decline in concentrations associated with emission forecasts for future years[29]. 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. Trends in more rural, less densely trafficked 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 Factors Toolkit (EFT Version 10.1) utilising COPERT 5.3 emission factors, which may go some way to addressing this disparity, but it is considered possible that a gap still remains. This assessment has utilised the latest EFT version 10.1 and associated

[29] 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.

tools published by Defra to help minimise any associated uncertainty when forming conclusions from this assessment.

Given that the year of assessment is 2019, the uncertainty of NO_x/NO_2 predictions is a less significant issue than when assessing future years.

5. Air Quality Modelling Results

This assessment has considered emissions of NO_x/NO_2 and PM_{10} from road traffic at existing receptor locations, as detailed and illustrated in Section 4.2. The results of the dispersion modelling are summarised below.

5.1 Assessment of Nitrogen Dioxide (NO_2)

Table 5-1 presents the predicted annual mean nitrogen dioxide concentrations for all modelled receptors across the model domain, compared against the 40µg/m^3 annual mean AQS objective. The predicted results across the model domain are illustrated in Figure 5-1.

One exceedance has been predicted across the modelled area, at receptor location R58 within the High St / Ladywell AQMA, as illustrated in Figure 5-2. This receptor reported a concentration of 40.2µg/m^3, which is just over the AQS objective of 40µg/m^3 for annual mean NO_2. This predicted exceedance was modelled at the first floor level (4m) as a commercial property occupies the ground floor.

One further location was predicted to be within 10% of the AQS Objective (36 to 40µg/m^3), at receptor location R54, within the A20 AQMA, as illustrated in Figure 5-3. This receptor location predicted a concentration of 37.5µg/m^3, representing 93.9% of the AQS Objective therefore highlighting an area of potential concern.

NO_2 concentrations predicted at all other modelled receptor locations were below the annual mean NO_2 AQS Objective and no further locations were within 10% of the objective.

The empirical relationship given in LAQM.TG(16) states that exceedances 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 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 exceedance of the AQS objective.

Table 5-1 - Predicted Annual Mean NO_2 Concentrations at all Modelled Receptors

ID	Annual Mean NO_2 (µg/m^3)		2019 Annual Mean Concentration as a Percentage of the AQS Objective (%)
	AQS Objective	2019	
R1	40	11.2	28.0
R2	40	14.1	35.3
R3	40	16.7	41.7
R4	40	17.9	44.7
R5	40	33.4	83.4
R6	40	16.2	40.4
R7	40	22.8	56.9
R8	40	22.4	56.0
R9	40	20.2	50.5
R10	40	17.5	43.7
R11	40	20.9	52.3
R12	40	27.3	68.3
R13	40	28.0	70.0
R14	40	22.5	56.1
R15	40	18.8	46.9
R16	40	22.9	57.3
R17	40	16.9	42.2
R18	40	11.3	28.3
R19	40	18.3	45.7

ID	Annual Mean NO_2 (µg/m³)		2019 Annual Mean Concentration as a Percentage of the AQS Objective (%)
	AQS Objective	2019	
R20	40	22.5	56.1
R21	40	20.8	52.1
R22	40	26.7	66.8
R23	40	22.4	56.1
R24	40	21.6	53.9
R25	40	22.1	55.3
R26	40	16.3	40.7
R27	40	19.8	49.6
R28	40	20.4	51.0
R29	40	17.8	44.5
R30	40	22.9	57.3
R31	40	23.4	58.4
R32	40	20.2	50.4
R33	40	17.9	44.7
R34	40	22.1	55.3
R35	40	17.9	44.8
R36	40	26.5	66.2
R37	40	15.8	39.4
R38	40	32.0	80.1
R39	40	26.6	66.5
R40	40	32.2	80.4
R41	40	16.6	41.4
R42	40	20.4	51.1
R43	40	18.9	47.2
R44	40	19.9	49.6
R45	40	23.2	58.1
R46	40	15.0	37.4
R47	40	16.4	41.0
R48	40	18.1	45.2
R49	40	19.8	49.4
R50	40	30.4	76.0
R51	40	20.8	52.1
R52	40	18.2	45.6
R53	40	16.3	40.7
R54	40	*37.5*	93.9
R55	40	27.5	68.7
R56	40	20.4	51.1
R57	40	22.0	54.9
R58	40	**40.2**	100.5
R59	40	28.0	70.1
R60	40	16.3	40.6

In Bold – Exceedances of the 40 µg/m³ annual mean objective
In Italics – Within 10% of the 40 µg/m³ annual mean objective

Figure 5-1 - Modelled 2019 NO_2 Results at all Receptor Locations

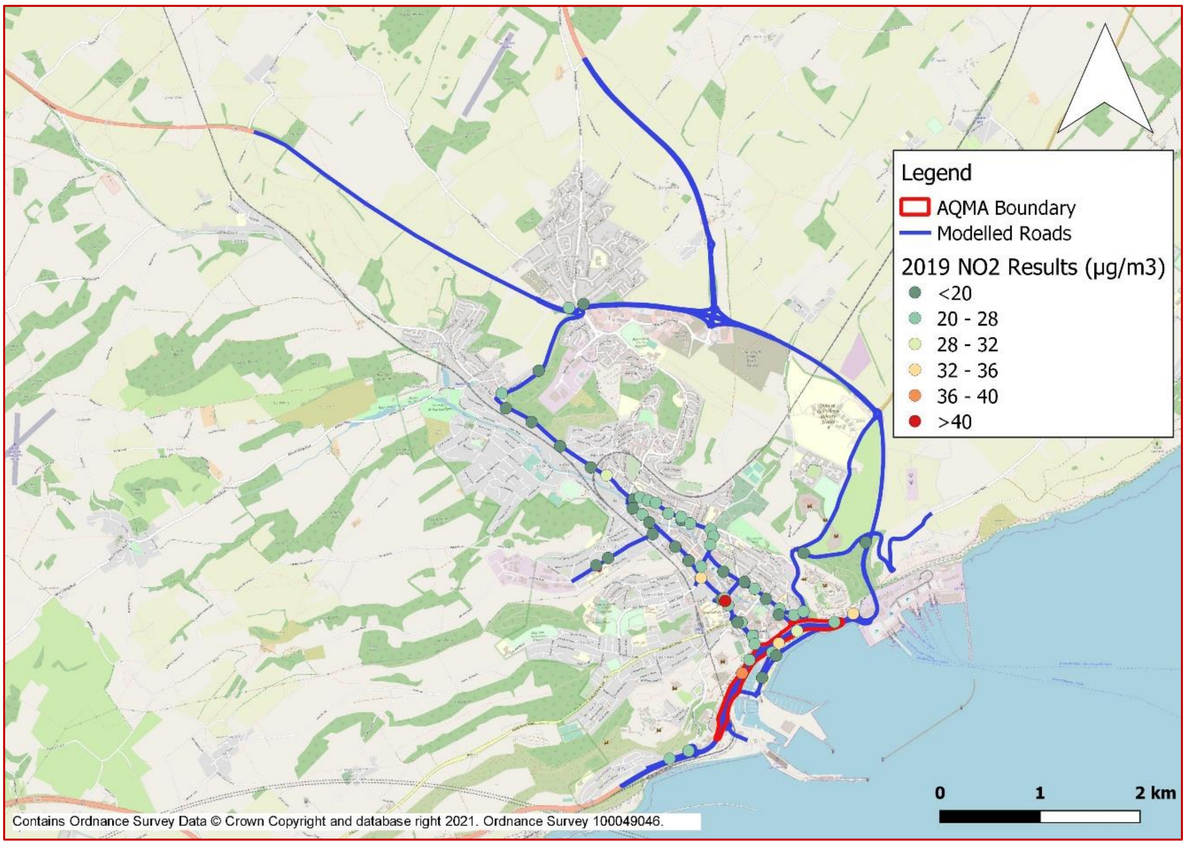


Figure 5-2 - Location of Receptor (R58) within Dover District Predicted to be Exceeding the 40µg/m^3 NO_2 AQS Annual Objective, located within the High St / Ladywell AQMA

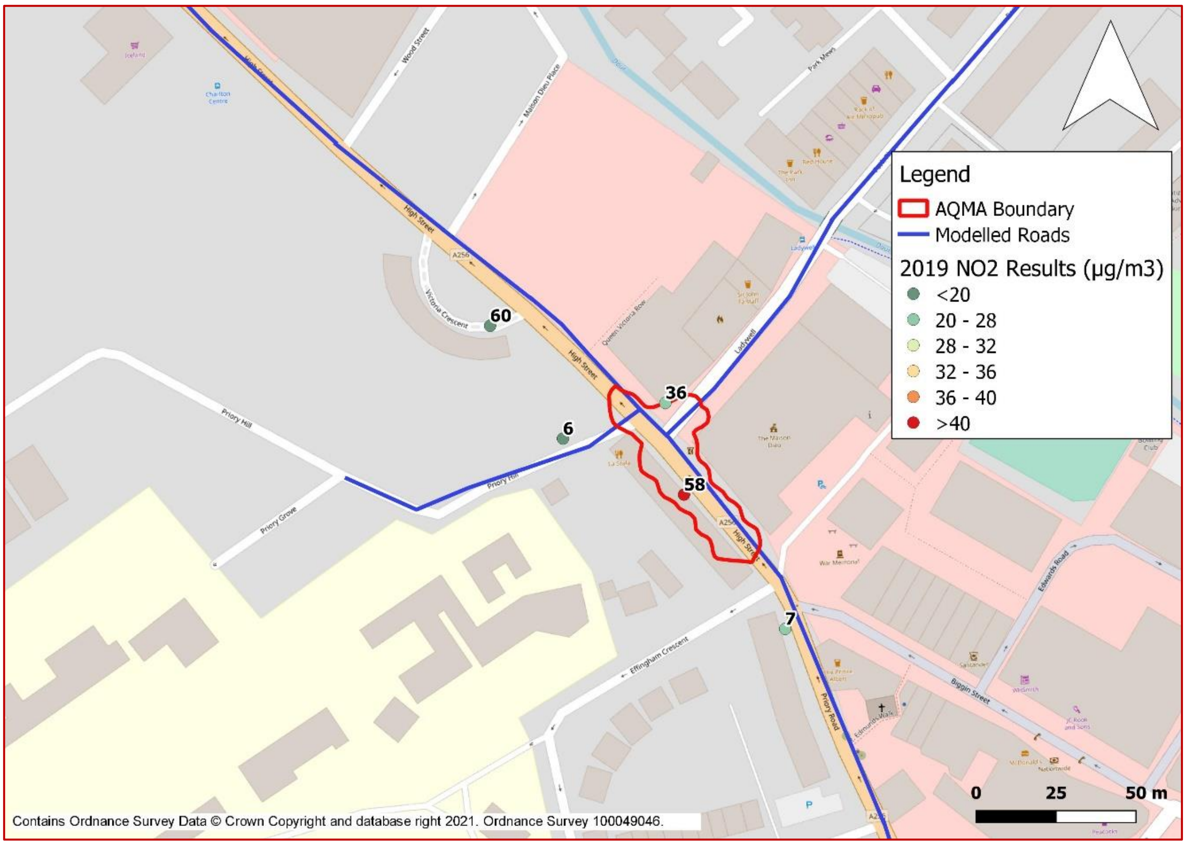
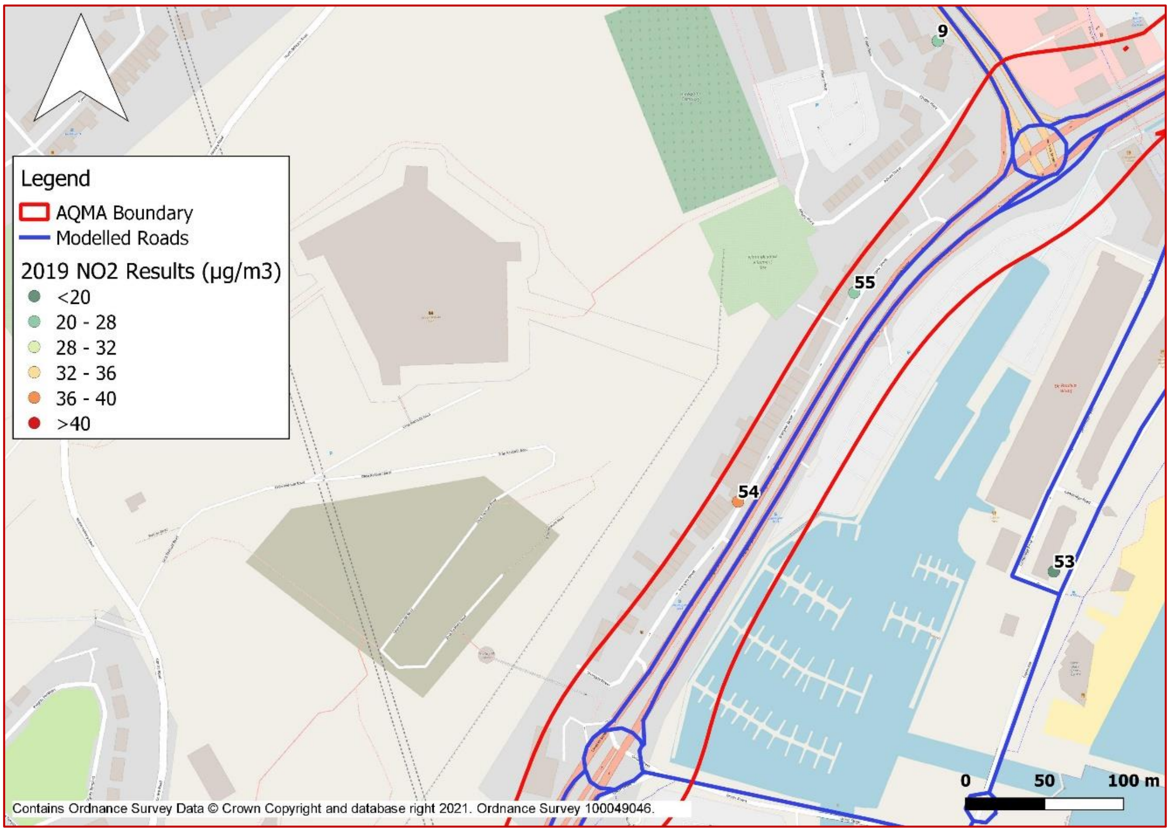


Figure 5-3 - Location of Receptor (R54) within Dover District Predicted to be within 10% of Exceeding the 40µg/m³ NO_2 AQS Annual Objective, located within the A20 AQMA



5.2 NO_2 Concentration Isopleths

Figure 5-4 and Figure 5-5 illustrate the annual mean NO_2 concentration isopleths for the areas around the High Street / Ladywell AQMA and the A20 AQMA. Both AQMA areas were highlighted as areas of potential concern in relation to exceedances of the annual mean NO_2 AQS Objective following the initial analyses. Concentration isopleths have been presented for 36µg/m³ (i.e. within 10% of the AQS objective), 40µg/m³ and 60µg/m³.

It can be seen that the exceedances of the AQS objective are largely localised to the roadway and concentrations drop off as you move further from the road.

Regarding the High Street / Ladywell AQMA, the elevated concentrations that led to the declaration of the AQMA are confirmed to still be present as shown in Figure 5-4. The 40µg/m³ isopleth encompasses the kerbside commercial properties, where the discrete receptor R58 reported an exceedance. However, it can be seen that the concentrations drop off further from the junction and that exceedances have not been modelled north of the AQMA boundary. The 40µg/m³ isopleth is concentrated on the western side of the road due to the prevailing wind direction from the meteorological data and the street canyon environment. The 40µg/m³ isopleth extends slightly to the south of the AQMA boundary along High Street to the junction with Effingham Crescent. However, the exceedances are only modelled within the roadway and concentrations drop to below 36µg/m³ at either side of the road, where receptors are present.

Regarding the A20 AQMA, the area of potential concern is confirmed along Snargate street, where concentrations between 36-40µg/m³ have been modelled along parts of the minor road where receptors are present, as shown in Figure 5-6. This is in line with the concentration reported at R54, 136 Snargate St, which reported within 10% of the AQS objective, 37.5µg/m³. It can be seen from Figure 5-5 that the extent of the 40µg/m³ isopleth extends beyond the AQMA boundary to the north and south, however these concentrations are confined to the roadway and concentrations drop to below 36µg/m³ at either side of the road, where receptors are present.

Figure 5-4 - High Street / Ladywell AQMA NO_2 Concentration Isopleths

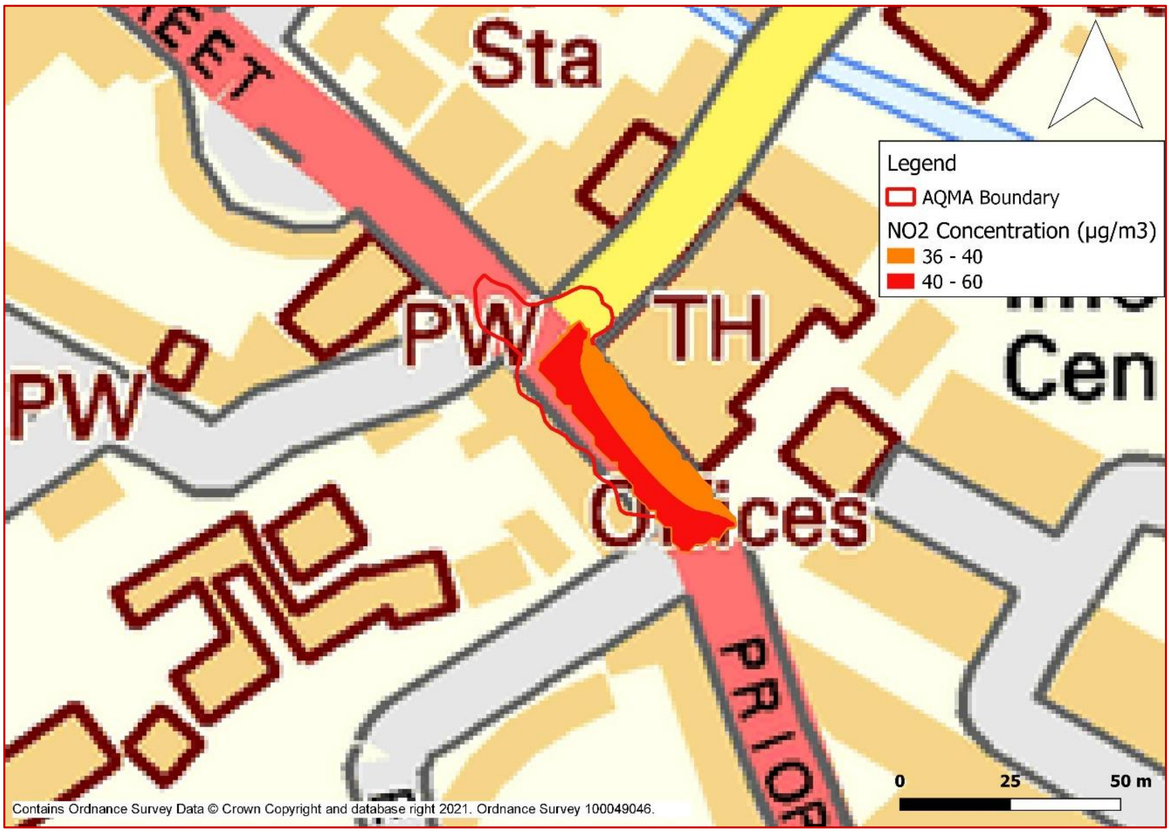
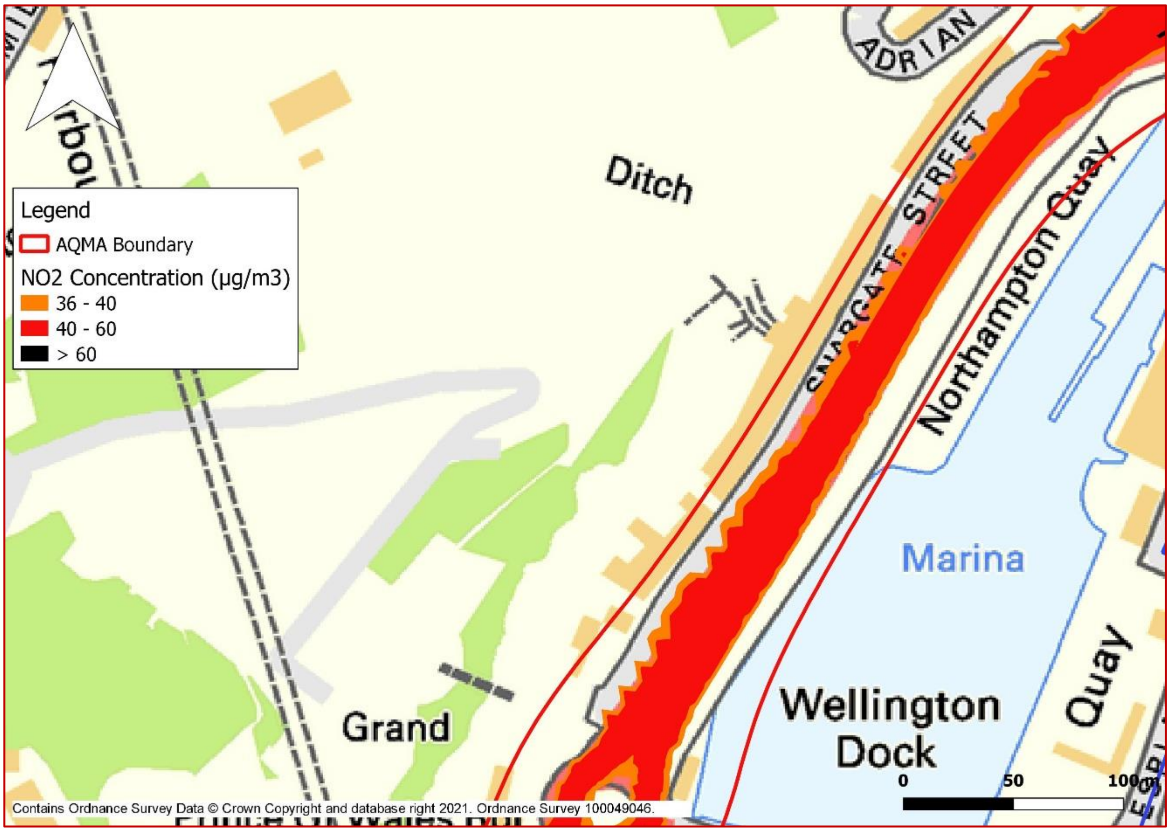


Figure 5-5 – A20 AQMA NO_2 Concentration Isopleths

Figure 5-6 - A20 AQMA NO_2 Concentration Isopleths along Snargate Street



5.3 AQMA Amendment

5.3.1 High Street / Ladywell AQMA

The predicted NO_2 concentrations following the modelling exercise do not indicate that a revocation of the High St / Ladywell AQMA is possible as an exceedance of the 40µg/m^3 AQS objective was predicted to be present at R58, within the existing AQMA boundary (Figure 5-2). The 2019 monitoring undertaken by the Council as part of its LAQM commitments also indicated an area of poor air quality within the declared AQMA at triplicate site DV06/07/08 (Figure 3-3) located at the junction within the High St / Ladywell AQMA. This site reported an annual mean NO_2 concentration that was within 10% of the AQS Objective (39.8µg/m^3). Additionally, one diffusion tube location reported an exceedance (DV30) and this was located approximately 25m from the boundary of the High St / Ladywell AQMA (see Table 3-2 and Figure 3-3). However, data capture for the 2019 monitoring year was 50% at this location and building works taking place meant that the height of the diffusion tube was not consistent throughout the year, and monitoring at a lowered height could have contributed to the high concentration reported at this location. For these reasons the diffusion tube was not included in our baseline model verification. The closest modelled receptor to this exceedance location was at the residential properties along Victoria Crescent, R60. The annual mean NO_2 concentration was predicted to be 16.3µg/m^3 at this location. This suggests that as you move away from the junction and traffic becomes more free-flowing, the concentrations drop substantially. The residential properties at Victoria Crescent are also set back from the road and are not located in the street canyon environment, thus allowing for more dispersion of pollutants.

Although there are three years of monitoring data available at DV30, adjacent to 19B High Street, indicating a slight exceedance just outside of the northern AQMA boundary, and near to residential properties, this has not been reflected in the modelled results (both discrete receptors and concentration isopleths). There are also uncertainties surrounding this monitoring data, discussed previously. It is therefore recommended that monitoring is continued within this area to continually assess the AQMA boundary, with a focus on increased data capture and consistency of the diffusion tube height throughout the year.

The results of the NO_2 concentration isopleths confirm the drop in concentrations further from the junction between High Street and Ladywell. Although the 40µg/m^3 isopleth extended beyond the southern AQMA boundary towards Effingham Crescent (Figure 5-4), the exceedances are confined to the roadway and drop off substantially at either side of the road. Therefore, the modelling results do not support an amendment to the High Street / Ladywell AQMA boundary.

5.3.3 A20 AQMA

One modelled receptor location predicted an NO_2 concentration within 10% of the NO_2 AQS Objective within the A20 AQMA, therefore highlighting an area of potential concern and not supporting a revocation of the A20 AQMA. This was also reflected in the NO_2 concentration isopleths, which show that Snargate Street is subject to NO_2 concentrations that are within 10% of the AQS objective, originating from the A20 (Figure 5-6). As all other modelled locations were reporting below 10% of the AQS Objective, there is potential that the AQMA boundary could be reduced to concentrate on the area of concern around Snargate street.

However, there is currently a lot of uncertainty in the port area of Dover relating to both the EU-Exit and the Covid-19 pandemic. At the time of writing, there is ongoing HGV congestion, leading to temporary changes to the HGV routes into Dover[30]. Additionally, the proposed Customs facility in Whitfield will further alter the HGV routes across Dover District on a more permanent basis[31]. These uncertainties will impact the HGV proportions that are already known to be a major contributor to NO_2 concentrations within the A20 AQMA, further outlined by the source apportionment exercise conducted at the worst-case receptor within the A20 AQMA (Figure 5-10). For this reason, an amendment to the boundary is not supported at this time until more is known about the certainty of preferred HGV routes around Dover in light of the UK leaving the EU and the Covid-19 pandemic.

In previous detailed modelling exercises, there were discussions surrounding the potential extension of the A20 boundary to the east to encompass the residential properties along East Cliff and Marine parade. The monitoring at DV33 in 2019 reported 35.9µg/m^3 at 24 Marine Parade, which is not within 10% of the AQS Objective. The closest modelled receptor, R40 is located at 32 East Cliff and the modelled NO_2 concentration was also reporting below the AQS Objective at 32.2µg/m^3. The NO_2 concentration isopleth indicates that the exceedances extend beyond the current AQMA boundary, however these high concentrations are confined to the roadway and therefore nearby receptors are not exposed to poor air quality (Figure 5-5). There is therefore not enough evidence to necessitate an extension of the AQMA boundary. However, this should be re-considered following any permanent changes to HGV routes and proportions across the District, and monitoring should continue to continually assess NO_2 concentrations in this area.

5.3.4 Source Apportionment of NOx

To help inform the development of measures as part of the action plan stage of the project, source apportionment of the different road traffic categories has been undertaken. It should be noted that emission sources of NO_2 are dominated by a combination of direct NO_2 (f-NO_2) and oxides of nitrogen (NOx), the latter of which is chemically unstable and rapidly oxidised upon release to form NO_2. Reducing levels of NOx emissions therefore reduces levels of NO_2. As a consequence, the source apportionment study has considered the emissions of NOx which are assumed to be representative of the main sources of NO_2.

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

- Figure 5-7 illustrates the general breakdown of NO_x concentrations averaged across all modelled locations, providing information regarding:

[30] Kent Traffic Management on M20 Motorway to Dover and Eurotunnel https://www.gov.uk/guidance/kent-traffic-management-on-m20-motorway-to-dover-and-eurotunnel

[31] White Cliffs Inland Border Facility, Dover https://inlandborderfacilities.uk/wp-content/uploads/2021/01/Online-Leaflet-Updated-22-Jan-2021.pdf

- the regional background, which the Council is unable to influence;
- the local background, which the Council should have some influence over; and
- other local sources (explicitly modelled), which the Council should be able to directly influence with policy intervention.

- Figure 5-8, Figure 5-9 and Figure 5-10 provide detailed breakdowns of the local source contributions to NO_x concentrations, based on:
  - the average across all modelled receptors (Figure 5-8). 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 receptor where the maximum road NO_x concentration has been predicted (Figure 5-9). 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.
  - the receptor where the second highest road NO_x concentration has been predicted (Figure 5-10). This is a good place to assess the main sources of concern in the worst-case receptor location within the A20 AQMA, as the sources differ from the model-wide worst-case receptor location that is located in the High Street / Ladywell AQMA.

Figure 5-7 - Average NO_x Contribution Across All Modelled Receptors – General Breakdown

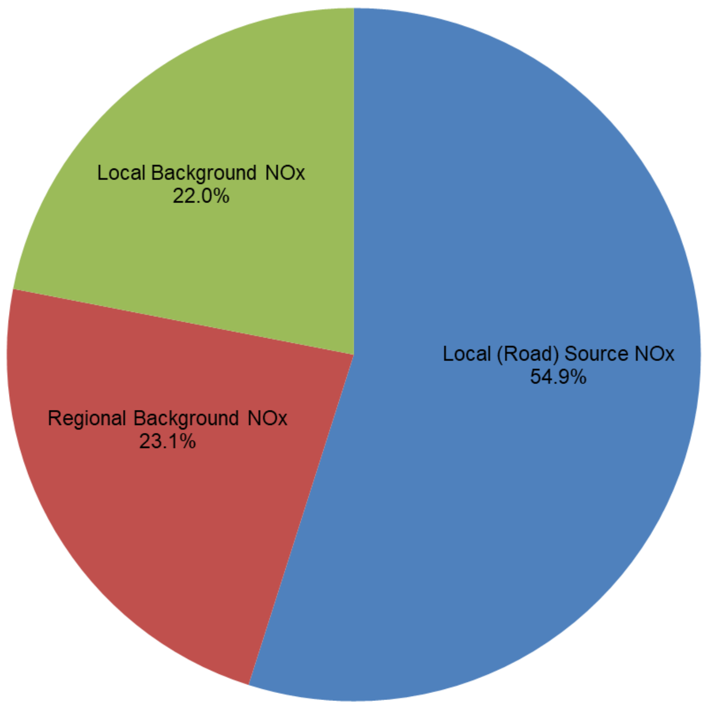


Table 5-2 - Source Apportionment of NOx

Results	All Vehicles	Car	LGV	HGV	Bus	Moto	Background
Average across all modelled receptors							
NO_x Concentration ($\mu g/m^3$)	19.0	9.8	4.2	3.3	1.6	0.0	15.6
Percentage of Total NOx	54.9%	28.4%	12.2%	9.6%	4.7%	0.1%	45.1%
Percentage Road Contribution	100.0%	51.8%	22.2%	17.4%	8.5%	0.1%	-
Receptor R58 within High St / Ladywell AQMA – exceeding the AQS Objective and reporting the maximum road NO_x Concentration							
NO_x Concentration ($\mu g/m^3$)	57.5	31.6	11.2	5.5	9.0	0.1	16.8
Percentage of Total NOx	77.4%	42.6%	15.1%	7.4%	12.1%	0.1%	22.6%
Percentage Road Contribution	100.0%	55.0%	19.6%	9.6%	15.7%	0.1%	-
Receptor R54 within A20 AQMA – reporting within 10% of AQS Objective							
NOx Concentration ($\mu g/m^3$)	50.7	18.6	11.0	17.6	3.5	0.0	16.8
Percentage of Total NOx	75.1%	27.6%	16.3%	26.0%	5.1%	0.1%	24.9%
Percentage Road Contribution	100.0%	36.8%	21.6%	34.7%	6.8%	0.1%	-

Figure 5-8 - Source Apportionment of NOx Averaged Across All Modelled Receptors

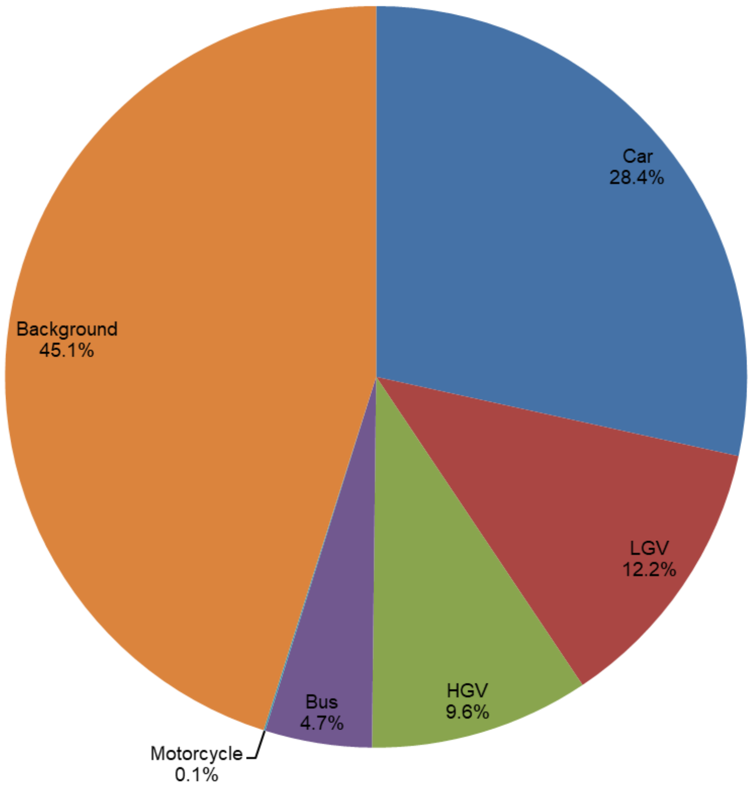


Figure 5-9 - Source Apportionment of NOx at Receptor with the Maximum Road NOx Concentration (R58), within the High St / Ladywell AQMA

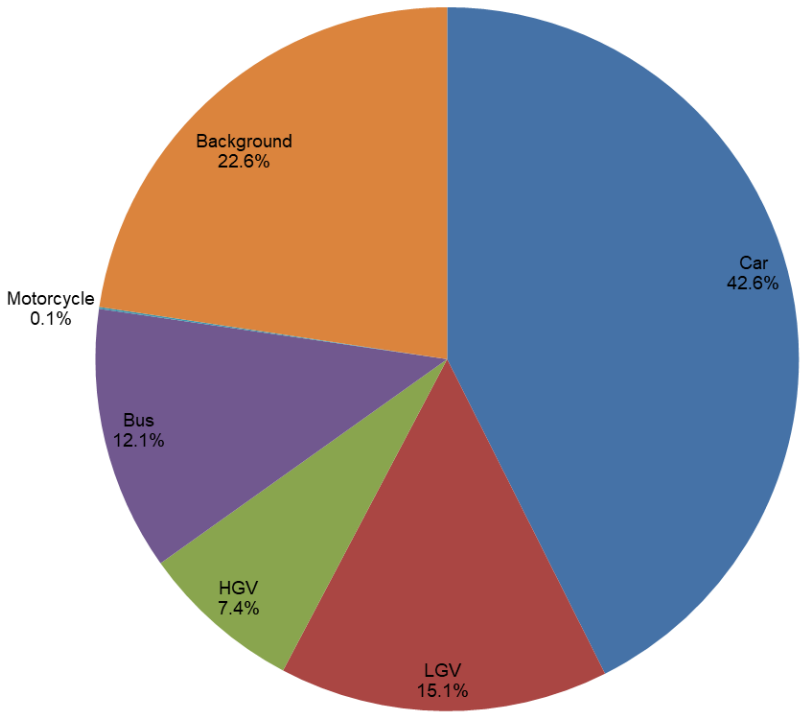
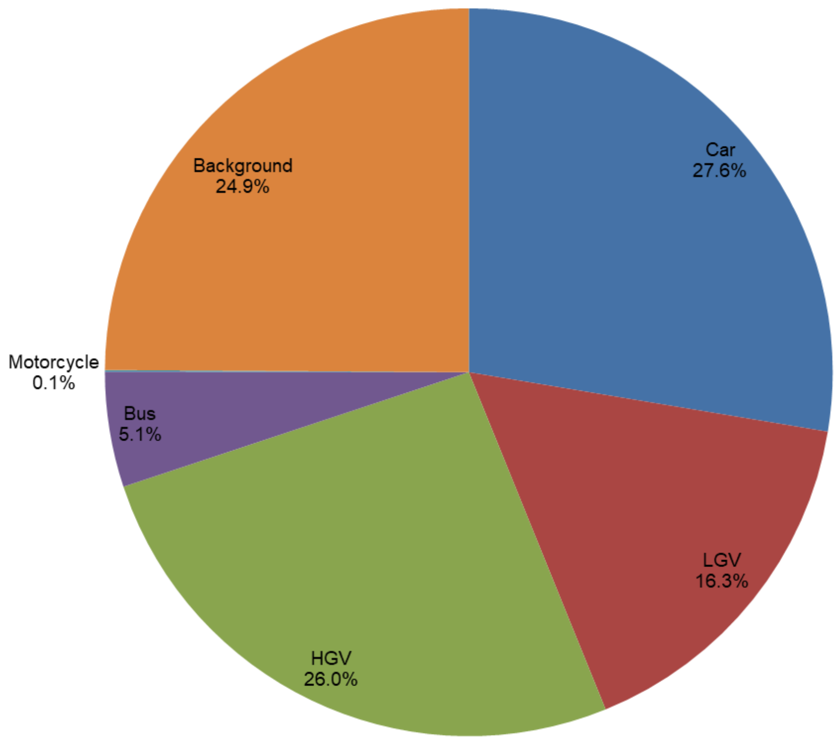


Figure 5-10 - Source Apportionment of NOx at Receptor R54, reporting within 10% of the AQS Annual Mean Objective for NO_2, within the A20 AQMA



Of the contributors to total NO_x concentrations, local (road) sources are the largest at 54.9%, followed by regional background at 23.1%, then local background at 22.0%. This means that the Council should be able to influence 76.9% 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 19µg/m^3 (54.9%) of total NO_x (34.6µg/m^3). Of this total average NO_x, Cars account for the most (28.4%) of any of the vehicle types on average, followed by LGVs (12.2%).

At the receptor where the maximum road NO_x concentration has been predicted (57.5µg/m^3, predicted at receptor R58), road traffic accounts for 77.4% of the overall NO_x. Of this total NO_x, Cars account for the most (42.6%) of any of the vehicle types, followed by LGVs (15.1%) and Buses (12.1%). This indicates that Cars, Buses and LGVs are largely responsible for the exceedances in the High St / Ladywell AQMA.

However, the receptor where the second highest road NO_x concentration was predicted, within the A20 AQMA, shows that different localised effects are influencing the NO_x concentrations. At R54, although Cars are the highest contributors to road NO_x (27.6%), this is closely followed by HGVs (26.0%) and then LGVs (16.3%). This confirms the that this is a common route for HGVs to take in order to access the port. Understanding the key routes into the town and towards the port, including how different vehicle types are using the surrounding roads will help focus measures.

5.3.5 Required Reduction in Emissions

In order to understand the scale of the challenge in achieving compliance of the annual mean NO_2 standard within the AQMA, focus on emissions reduction at the worse-case location should be considered. The approach to source apportionment reported above shows that location R58 is where currently the highest level of NO_x is reported, located within the High St / Ladywell AQMA.

In order to reduce NO_2 concentrations, it is important to consider reductions in emissions from the source. Reducing emissions will in turn reduce concentrations. In the case of NO_2 however, the relationship between emissions of NOx relative to the formation of NO_2 is not linear. That is, a reduction in NOx of 10% does not lead to a reduction in NO_2 of 10%.

For this reason, reductions in emissions to achieve compliance with the annual mean NO_2 standard are best considered in terms of the extent of NO_x reduction. Consideration is also made to the roadside contribution – above background – which local measures cannot influence.

Table 5-3 provides the details on the calculations of the NOx emission reduction at the worst-case exposure location, R58, which is associated with the High Street / Ladywell AQMA. The reduction in NO_x required to achieve compliance with the annual mean NO_2 objective of 40µg/m^3 at the worst-case location of R58 is **2.0%.** This reduction would achieve the compliance needed at the worst-case location, within the High Street / Ladywell AQMA. When considering the A20 AQMA, no exceedances were modelled, however there are uncertainties about future traffic flows, particularly relating to HGVs across Dover in the port area, relating to the A20 AQMA.

Table 5-3 – Required NO_x Emission Reduction at Worst-Case Relevant Exposure (R58)

Metric	Value (Concentrations as µg/m^3)
Worst-Case Relevant Exposure NO_2 Concentration	40.4
Equivalent NO_x Concentration	74.3
Background NO_x	16.8
Background NO_2	12.4
Road NO_x - Current	57.5
Road NO_x - Required (to achieve NO_2 concentration of 39.9µg/m^3)	56.3

Metric	Value (Concentrations as µg/m³)
Required Road NO_x Reduction	1.2
Required % Reduction	2.0%

5.4 Assessment of Particulate Matter (PM_{10})

The baseline modelled concentrations of PM_{10} were all well below the AQS annual mean objective of 40µg/m³ at all receptors, as presented in Table 5-4.

The maximum predicted annual mean PM_{10} concentration in 2019 for all receptors was at R50 with a predicted concentration of 21.4µg/m³. This represents only 53.5% of the 40µg/m³ annual mean AQS objective.

Table 5-4 - Predicted Annual Mean PM_{10} Concentrations at all Modelled Receptors

ID	Annual Mean NO_2 (µg/m³)		2019 Annual Mean Concentration as a percentage of AQS Objective (%)
	AQS Objective	2019	
R1	40	14.9	37.2
R2	40	15.7	39.2
R3	40	15.8	39.4
R4	40	16.3	40.8
R5	40	19.0	47.4
R6	40	15.7	39.2
R7	40	17.4	43.4
R8	40	17.5	43.8
R9	40	16.6	41.6
R10	40	16.7	41.8
R11	40	17.9	44.8
R12	40	19.9	49.9
R13	40	20.1	50.3
R14	40	16.7	41.8
R15	40	17.1	42.8
R16	40	18.4	46.0
R17	40	16.6	41.5
R18	40	14.9	37.3
R19	40	16.4	41.0
R20	40	17.7	44.3
R21	40	17.3	43.4
R22	40	19.0	47.5
R23	40	17.8	44.5
R24	40	17.4	43.4
R25	40	17.6	43.9
R26	40	15.9	39.6
R27	40	17.0	42.5
R28	40	17.2	43.0
R29	40	15.3	38.4
R30	40	16.3	40.7
R31	40	16.9	42.4
R32	40	15.9	39.8
R33	40	15.1	37.9
R34	40	17.6	44.1
R35	40	16.2	40.6
R36	40	18.6	46.4

ID	Annual Mean NO_2 (µg/m³)		2019 Annual Mean Concentration as a percentage of AQS Objective (%)
	AQS Objective	2019	
R37	40	14.8	36.9
R38	40	19.0	47.6
R39	40	17.8	44.6
R40	40	18.6	46.4
R41	40	15.0	37.5
R42	40	17.7	44.2
R43	40	17.3	43.2
R44	40	17.8	44.6
R45	40	18.3	45.8
R46	40	15.8	39.4
R47	40	16.3	40.7
R48	40	16.7	41.8
R49	40	17.0	42.4
R50	40	21.4	53.5
R51	40	15.9	39.7
R52	40	15.2	38.1
R53	40	15.2	38.1
R54	40	19.7	49.3
R55	40	17.7	44.2
R56	40	16.7	41.7
R57	40	17.4	43.5
R58	40	21.1	52.9
R59	40	17.9	44.8
R60	40	15.8	39.4
In Bold – Exceedances of the 40 µg/m³ annual mean objective *In Italics* – Within 10% of the 40 µg/m³ annual mean objective			

Table 5-5 shows the number of predicted exceedances of the 24-hour PM_{10} 50µg/m³ AQS objective at all modelled receptors against the permitted number of exceedances. The maximum number of exceedances of the 24-hour PM_{10} 50µg/m³ AQS objective at all receptor locations in 2019 were predicted at R50 and R58, both with 5 days. This is well below the 35 permitted exceedances.

Table 5-5 - Predicted Number of Exceedances of 24-hour PM_{10} 50µg/m³ AQS Objective at all Modelled Receptors

ID	24-hour Mean PM_{10} (µg/m³)	
	Number of allowed exceedances of PM_{10} 50µg/m³ AQS Objective	2019
R1	35	0
R2	35	0
R3	35	0
R4	35	0
R5	35	2
R6	35	0
R7	35	1
R8	35	1
R9	35	1
R10	35	1
R11	35	1
R12	35	3
R13	35	4
R14	35	1
R15	35	1

ID	24-hour Mean PM_{10} (µg/m^3)	
	Number of allowed exceedances of PM_{10} 50µg/m^3 AQS Objective	2019
R16	35	2
R17	35	1
R18	35	0
R19	35	0
R20	35	1
R21	35	1
R22	35	2
R23	35	1
R24	35	1
R25	35	1
R26	35	0
R27	35	1
R28	35	1
R29	35	0
R30	35	0
R31	35	1
R32	35	0
R33	35	0
R34	35	1
R35	35	0
R36	35	2
R37	35	0
R38	35	2
R39	35	1
R40	35	2
R41	35	0
R42	35	1
R43	35	1
R44	35	1
R45	35	2
R46	35	0
R47	35	0
R48	35	1
R49	35	1
R50	35	5
R51	35	0
R52	35	0
R53	35	0
R54	35	3
R55	35	1
R56	35	1
R57	35	1
R58	35	5
R59	35	1
R60	35	0

6. Conclusions and Recommendations

Bureau Veritas UK Ltd has been commissioned by Dover District Council to undertake the following tasks:

- Modelling of the current AQMAs to take into account latest available traffic data and 2019 air quality monitoring data, and carrying out a source apportionment exercise to inform the subsequent new action plan; and
- Production of a new AQAP, incorporating best practice measures from around the UK.

This report addresses the first task which involved modelling the existing AQMAs and undertaking a source apportionment assessment within Dover.

The assessment considered exposure of existing residential receptors to concentrations of Nitrogen Dioxide (NO_2) and Particulate Matter (PM_{10}), using the Cambridge Environmental Research Consultants ADMS-Roads™ dispersion model (version 5.0).

6.1 Nitrogen Dioxide (NO_2)

There is one predicted exceedance of the AQS NO_2 annual mean objective for all modelled receptors, at R58, which lies within the existing High St / Ladywell AQMA. This receptor location predicted the maximum concentration across the modelled receptor locations, reporting a concentration of 40.2µg/m^3, which is just over the AQS objective and represents 100.5% of the objective. This predicted exceedance was modelled at first floor level (4m) where there is potential for exposure relevant to the annual mean objective.

One further location was predicted to be within 10% of the AQS Objective (36 to 40µg/m^3), at receptor location R54, within the A20 AQMA. This receptor location predicted a concentration of 37.5µg/m^3, representing 93.9% of the AQS Objective therefore highlighting an area of potential concern.

NO_2 concentrations predicted at all other modelled receptor locations were below the annual mean NO_2 AQS Objective and no further locations were within 10% of the objective.

The empirical relationship given in LAQM.TG(16)[4] states that exceedances 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 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 exceedance of the AQS objective.

In conclusion, whilst there was one location in exceedance of the 40µg/m^3 annual mean AQS objective, and one location within 10% of the objective, each of these is within an existing AQMA, so there are no new exceedance areas that the Council has not previously identified.

NO_2 concentration isopleths indicated that no change to either the High Street / Ladywell AQMA boundary and the A20 AQMA boundary is necessary. The modelled exceedances of the AQS objective are largely localised to the roadway and concentrations drop off as you move further from the road.

6.1.1 High Street/Ladywell AQMA

The predicted NO_2 concentrations following the modelling exercise do not indicate that a revocation of the High St / Ladywell AQMA is possible as an exceedance of the 40µg/m^3 AQS objective was predicted to be present within the existing AQMA boundary (Figure 5-2).

The 2019 monitoring undertaken by the Council as part of its LAQM commitments also indicated an area of exceedance at one diffusion tube location (DV30), located approximately 25m from the boundary of the High St / Ladywell AQMA. This monitoring location was excluded from baseline model verification due to low data capture (50% in 2019) and the uncertainty surrounding the height of the receptor. The closest modelled receptor to this exceedance location was at the residential properties along Victoria Crescent (R60), where the annual mean NO_2 concentration was predicted to be 16.3µg/m^3. This indicates that as you move away from the junction, traffic becomes more free-flowing and concentrations drop substantially. The residential properties at Victoria Crescent are also set back from the road and are not located in the street canyon environment, thus allowing for more dispersion of pollutants.

Regarding the modelled NO_2 concentration isopleths within the High Street / Ladywell AQMA, the elevated concentrations that led to the declaration of the AQMA are confirmed to still be present, however, the concentrations drop off further from the junction and exceedances have not been modelled north of the AQMA boundary. The 40µg/m^3 isopleth extends slightly to the south of the AQMA boundary along High Street to the junction with Effingham Crescent. However, the exceedances are modelled within the roadway and concentrations drop to below 36µg/m^3 at either side of the road, where receptors are present.

Based on the modelling exercise, it is therefore recommended that the AQMA boundary remains unchanged. It is recommended that monitoring is continued within the area to continually assess the AQMA boundary, with particular attention paid to increasing data capture and monitoring at heights relevant for public exposure.

6.1.2 A20 AQMA

One modelled receptor location predicted a NO_2 concentration within 10% of the NO_2 AQS Objective within the A20 AQMA, therefore highlighting an area of potential concern and not supporting a revocation of the A20 AQMA. As all other monitoring locations were reporting below 10% of the AQS Objective, there is therefore potential that the AQMA boundary could be reduced to concentrate on the area of concern around Snargate street. This was confirmed by the modelled NO_2 concentration isopleths, where concentrations between 36-40µg/m^3 have been modelled along parts Snargate road where receptors are present. The extent of the 40µg/m^3 isopleth extends beyond the AQMA boundary to the north and south, however these concentrations are confined to the roadway and concentrations drop to below 36µg/m^3 at either side of the road, where receptors are present.

However, there is currently a lot of uncertainty in the port area of Dover relating to both the EU-Exit and the Covid-19 pandemic. At the time of writing, there are ongoing HGV traffic jams, leading to temporary changes to the HGV routes into Dover[32]. Additionally, the proposed Customs facility in Whitfield will further alter the HGV routes across Dover District on a more permanent basis[33]. These uncertainties will impact the HGV proportions that are known to be a major contributor to NO_2 concentrations within the A20 AQMA. For this reason, an amendment to the boundary is not supported at this time until more is known about the certainty of preferred HGV routes around Dover in light of the UK leaving the EU and the nature of the Covid-19 pandemic.

In previous detailed modelling exercises, there were concerns surrounding the potential extension of the A20 boundary to the east to encompass the residential properties along East Cliff and Marine parade. The monitoring at DV33 in 2019 reported 35.9µg/m^3 at 24 Marine Parade, which is not within 10% of the AQS Objective. The closest modelled receptor, R40 is located at 32 East Cliff and the modelled NO_2 concentration was also reporting below the AQS Objective at 32.2µg/m^3. Additionally, the NO_2 concentration isopleth confirmed that exceedances were confined to the roadway and concentrations drop to below 36µg/m^3 at receptor locations. There is therefore not enough evidence to necessitate an extension of the AQMA boundary. However this should be re-

[32] Kent Traffic Management on M20 Motorway to Dover and Eurotunnel https://www.gov.uk/guidance/kent-traffic-management-on-m20-motorway-to-dover-and-eurotunnel

[33] White Cliffs Inland Border Facility, Dover https://inlandborderfacilities.uk/wp-content/uploads/2021/01/Online-Leaflet-Updated-22-Jan-2021.pdf

considered following any permanent changes to HGV routes and proportions across the District, and monitoring should continue to continually assess NO_2 concentrations in this area.

6.1.3 Source Apportionment of NOx

Of the contributors to total NO_x concentrations, local (road) sources are the largest at 54.9%, followed by regional background at 23.1%, then local background at 22.0%. This means that the Council should be able to influence 76.9% 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 54.9% of total NO_x. Of this total average NO_x, Cars account for the most (28.4%) of any of the vehicle types on average, followed by LGVs (12.2%).

At the receptor where the maximum road NO_x concentration has been predicted (57.5µg/m^3, predicted at receptor R58), road traffic accounts for 77.4% of the overall NO_x. Of this total NO_x, Cars account for the most (42.6%) of any of the vehicle types, followed by LGVs (15.1%) and Buses (12.1%). This indicates that Cars, Buses and LGVs are largely responsible for the exceedances in the High St / Ladywell AQMA.

However, the receptor where the second highest road NO_x concentration was predicted, within the A20 AQMA, shows that different localised effects are influencing the NO_x concentrations. At R54, although Cars are the highest contributors to road NO_x (27.6%), this is closely followed by HGVs (26.0%) and then LGVs (16.3%). This confirms the that this is a common route for HGVs to take in order to access the port. Understanding the key routes into the town and towards the port, including how different vehicle types are using the surrounding roads will help focus measures.

6.1.4 NO_x Emission Reduction

The reduction in NO_x required to achieve compliance with the annual mean NO_2 objective of 40µg/m^3 at the worst-case location of R58 within the High Street / Ladywell AQMA is **2.0%.** This reduction would achieve the compliance needed at the worst-case location, however there are other uncertainties about future traffic flows, particularly relating to HGVs across Dover in the port area and relating to the A20 AQMA.

6.2 Particulate Matter – PM_{10}

The modelled concentrations of PM_{10} were all well below the AQS annual mean objective of 40µg/m^3 at all receptors. The maximum predicted annual mean PM_{10} concentration in 2019 for all receptors was at R50 with a predicted concentration of 21.4µg/m^3. This represents only 53.5% of the 40µg/m^3 annual mean AQS objective.

Additionally, the maximum number of exceedances of the 24-hour PM_{10} 50µg/m^3 AQS objective at all receptor locations in 2019 were predicted at R50 and R58, both with 5 days. This is well below the 35 permitted exceedances.

In conclusion, there are no exceedances of the PM_{10} AQS objectives modelled in 2019. There is no requirement to declare an AQMA for this pollutant.

6.3 Outcomes

Given the above conclusions, the following actions are recommended:

- The High St / Ladywell AQMA to remain unchanged, however the existing monitoring at High Street toward Victoria Crescent (DV30) should continue, with a focus on increasing data capture and ensuring relevant public exposure (i.e. located at the height of a residential property);

- The A20 AQMA to remain as currently declared, though monitoring to be continued to assess the current boundary, particularly at the monitoring locations along Snargate Street (DV23, DV24 and DV25) and outside of the AQMA boundary at the A20 Eastern Docks roundabout (DV33) to assess whether any permanent changes to HGV routes through Dover will worsen the air quality within the A20 AQMA. If the monitoring at DV33 identifies a new exceedance, amendment will 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;

- Re-evaluation of detailed modelling to be considered once permanent changes to HGV routes are known post-Brexit and considering the new White Cliffs Inland Border Facility.

Appendices

Appendix A – 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[34] regarding Air Quality Management Areas (AQMAs) show that approximately 650 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 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.

[34] Statistics from the UK AIR website available at https://uk-air.defra.gov.uk/aqma/summary – Figures as of November 2019

In the UK, emissions of PM_{10} have declined significantly since 1980, and were estimated to be 114kt (kilotonne) in 2010[35]. 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.

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.

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

Appendix B – 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) 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
- Checks on the monitoring data

NO_2 Verification Calculations

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

Monitoring data provided by the Council, as presented in Section 3.2 has been used from the most recent available year of 2019. Four passive monitoring locations were not included in the modelling assessment: the urban background site DV04 and the urban centre site DV05 due to the distance from modelled roads, DV30 due to low data capture and DV12/DV18/DV19 due to lack of representativity in the model. Although DV12/DV18/DV19 is a roadside site, it is located 10m from the A20, behind a large hedgerow and at a higher elevation than the road, therefore the location is not representative of the majority of the modelled roads and receptors. Figure 3-3 shows a visual representation of the monitoring locations used within the assessment referenced against the AQMAs and the modelled road links.

Verification of the NO_2 modelled concentrations has therefore been undertaken using 10 monitoring locations operated by the Council, in two separate domains, consisting of 14 NO_2 diffusion tubes in total (including two triplicate sites). One verification domain used three monitoring locations and consisted of the section of road running parallel to the A20, along Snargate Street, as the minor road was not included in the model, a separate verification factor was required for increased accuracy. The other seven monitoring locations formed the remaining verification domain, which was used for model-wide verification.

As per Section 3.2.2, background NO_x and NO_2 concentrations were obtained from the relevant Defra background maps for 2019. Table A-1 below shows an initial comparison of the monitored and unverified modelled NO_2 results for the year 2019, in order to determine if verification and adjustment was required.

Table A-1 – Comparison of Unverified Modelled and Monitored NO_2 Concentrations

Site ID	Site Location	Background NO_2 (µg/m^3)	Monitored total NO_2 (µg/m^3)	Unverified Modelled total NO_2 (µg/m^3)	% Difference (modelled vs. monitored)
DV23	126 Snargate St	12.5	31.2	17.19	-44.87
DV24	148 Snargate St	12.4	33.7	17.01	-49.57
DV25	167 Snargate St	12.4	29.3	16.29	-44.35
DV11/16/17	The Gateway	13.0	28.1	19.03	-32.25
DV10	Townwall St	13.0	35.9	23.75	-33.77
DV32	1 Marine Parade	13.0	31.7	21.05	-33.59
DV33	24 Marine Parade	13.0	35.9	20.58	-42.62
DV06/07/08	Town Hall	12.4	39.8	22.36	-43.80
DV31	3 Ladywell	12.4	31.5	18.66	-40.72
DV01	95 High St	12.4	30.8	17.17	-44.22

The model was under predicting at the majority of locations, all model inputs were checked to be accurate and no further improvement of the modelled results could be obtained on this occasion. The difference between modelled and monitored concentrations was greater than ±25% at all locations, with all locations under predicting, 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 for roads 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 the NO_x to NO_2 Calculator (version 8.1) spreadsheet tool available from the LAQM website[36].

Table A-2 provides the relevant data required to calculate the model adjustment based on regression of the modelled and monitored road source contribution to NO_x. Figure A-1 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 A-1 gives an adjustment factor for the modelled results of 2.991.

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

Table A-2 – Data Required for Adjustment Factor Calculation

Site ID	Monitored total NO_2 (µg/m³)	Monitored total NO_x (µg/m³)	Background NO_2 (µg/m³)	Background NO_x (µg/m³)	Monitored road contribution NO_2 (total - background) (µg/m³)	Monitored road contribution NO_x (total - background) (µg/m³)	Modelled road contribution NO_x (excludes background) (µg/m³)
DV23	31.2	53.7	12.5	17.0	18.7	36.8	8.7
DV24	33.7	59.2	12.4	16.8	21.3	42.4	8.5
DV25	29.3	49.7	12.4	16.8	16.8	32.9	7.1
DV11/16/17	28.1	47.0	13.0	17.7	15.1	29.3	11.2
DV10	35.9	63.7	13.0	17.7	22.8	46.0	20.5
DV32	31.7	54.6	13.0	17.7	18.7	36.9	15.1
DV33	35.9	63.7	13.0	17.7	22.9	46.0	14.2
DV06/07/08	39.8	72.9	12.4	16.8	27.3	56.1	18.8
DV31	31.5	54.3	12.4	16.8	19.0	37.5	11.6
DV01	30.8	52.9	12.4	16.8	18.3	36.1	8.8

Figure A-1 – Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x

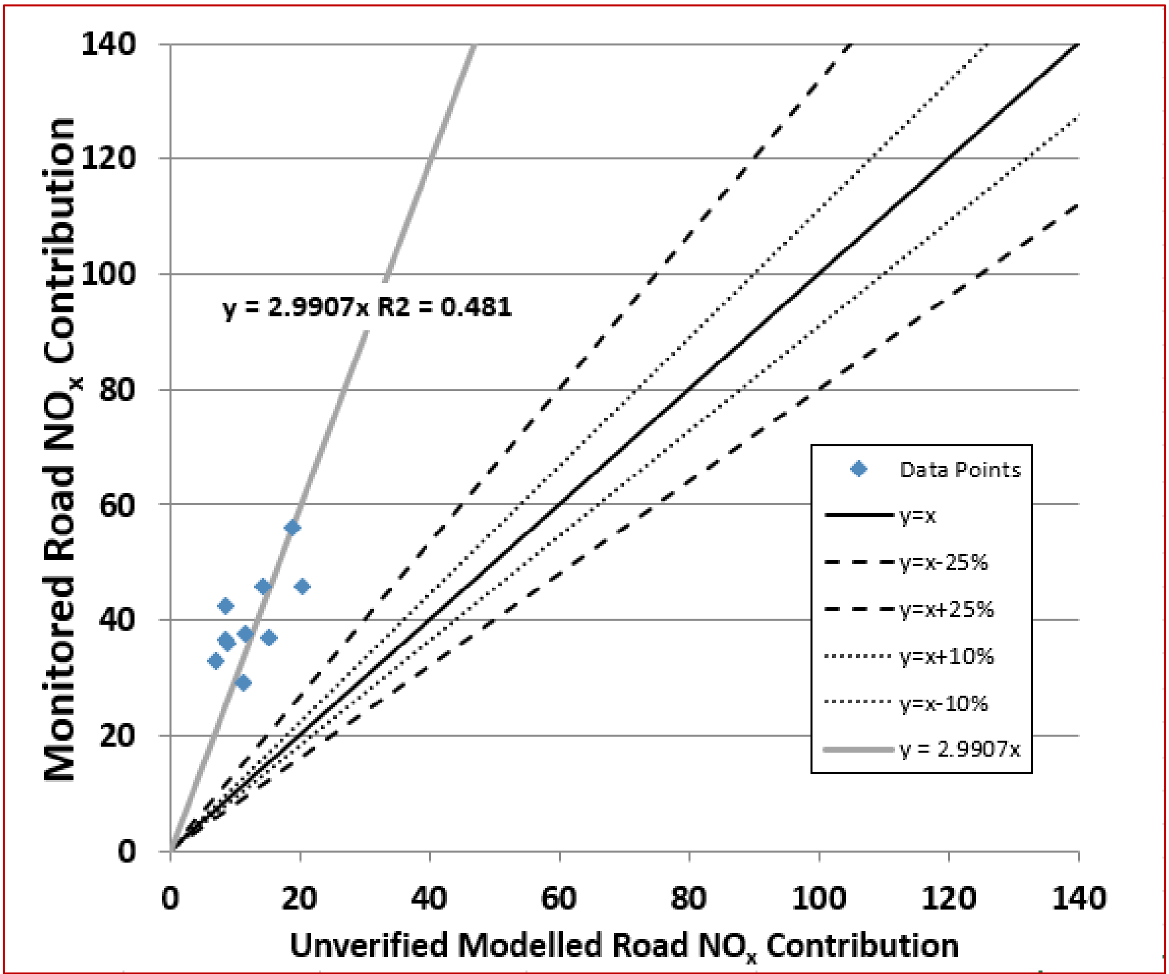


Table A-3 shows the ratios between monitored and modelled NO_2 for each monitoring location based on the above adjustment factor. Using a factor of 2.991, although all of the results are within 25% of the monitored value, the threshold deemed acceptable in TG.16, there are significant variations between the adjustment ratios across the verification points. Ideally, concentrations should be within ±10%, but 6 sites were outside of this range. Therefore, it was deemed 2.991 was not a suitable verification factor.

Table A-3 – 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)
DV23	4.23	2.991	26.04	42.99	26.03	31.18	-16.52
DV24	5.01		25.31	42.13	25.62	33.73	-24.04
DV25	4.63		21.23	38.05	23.60	29.27	-19.38
DV11/16/17	2.60		33.60	51.34	30.16	28.09	7.37
DV10	2.25		61.16	78.91	42.47	35.86	18.44
DV32	2.44		45.26	63.01	35.54	31.70	12.12
DV33	3.24		42.50	60.25	34.30	35.87	-4.37
DV06/07/08	2.98		56.19	73.01	39.85	39.79	0.16
DV31	3.23		34.70	51.51	30.15	31.48	-4.22
DV01	4.11		26.22	43.04	26.07	30.78	-15.31

In order to provide more confidence in the model predictions, the model was split into two verification domains, the area along Snargate St running parallel to the A20 (Domain 2), that accounts for the influence of the A20 but not accounting for the traffic influence of the minor road. Domain 1 consists of the remainder of the modelled area.

Figure A-2 - Verification Domain 2 in Relation to the A20 AQMA and Modelled Roads

Splitting the modelled area into two domains results in a decrease in the model verification factor for Domain 1, and generally an increased alignment between monitored and modelled values, as shown in Table A-4 and Figure A-3. The equation of the new trend line presented gives a decreased adjustment factor for the modelled results in Domain 1 of 2.782.

Table A-4 - 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)
DV11/16/17	2.60	2.782	31.26	49.00	29.05	28.09	3.42
DV10	2.25		56.91	74.65	40.66	35.86	13.39
DV32	2.44		42.11	59.86	34.12	31.70	7.64
DV33	3.24		39.54	57.29	32.94	35.87	-8.16
DV06/07/08	2.98		52.28	69.09	38.14	39.79	-4.14
DV31	3.23		32.28	49.09	29.00	31.48	-7.87
DV01	4.11		24.40	41.21	25.17	30.78	-18.24

Figure A-3 - Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x in Domain 1

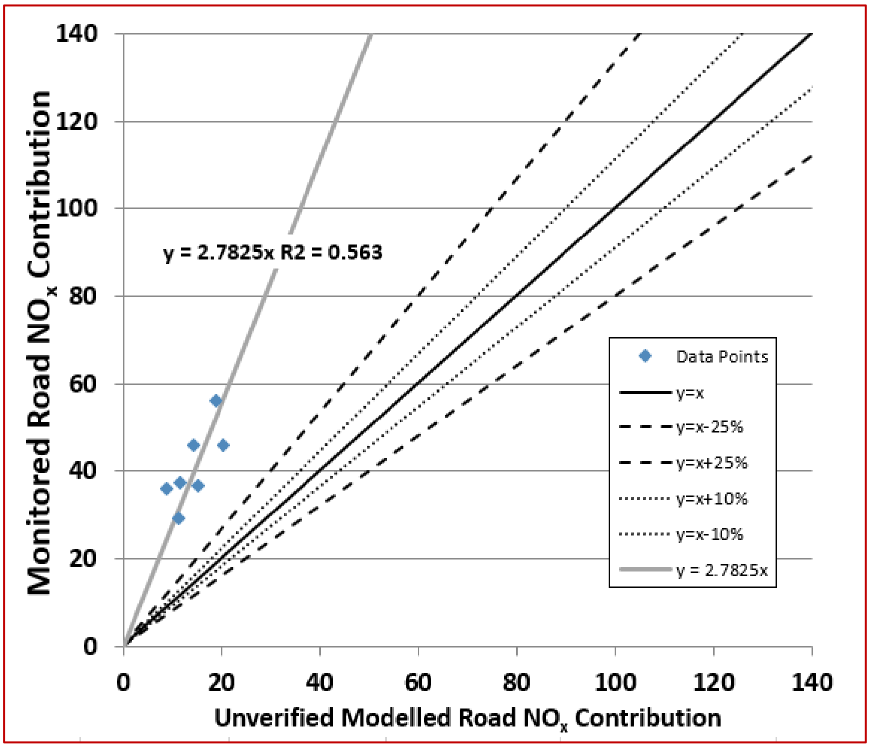
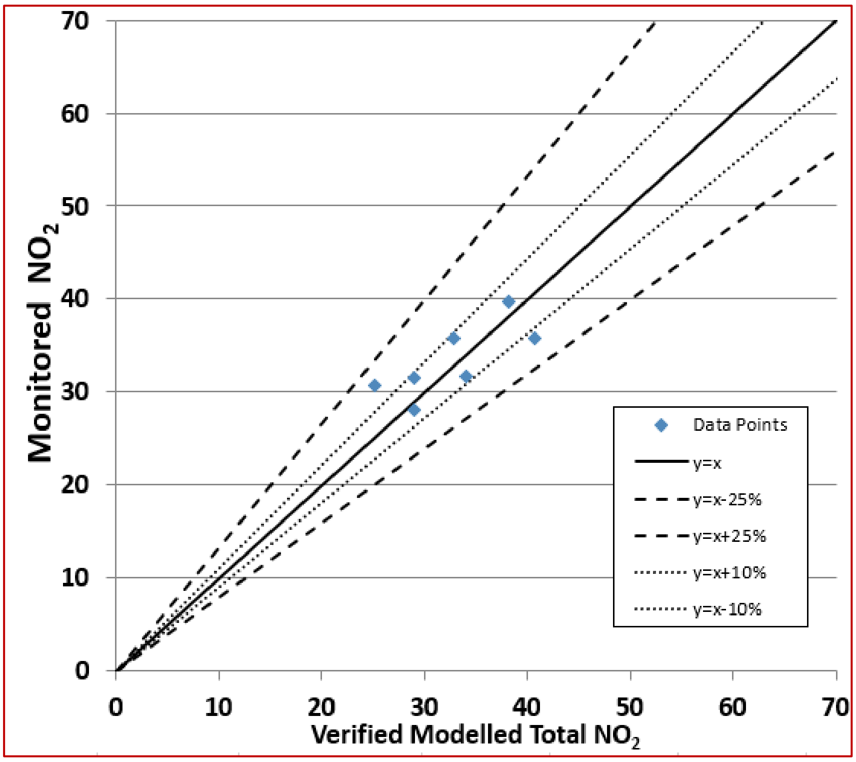


Figure A-4 - Comparison of the Modelled NO_2 versus Monitored NO_2 in Domain 1



The adjustment factor of 2.782 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 ±25%, as shown in Figure A-4. A factor of 2.782 in Domain 1 also reduces the Root Mean Square Error (RMSE) from a value of 13.3 to 3.4, which less than the guidance value of 4µg/m³ as stated within LAQM.TG(16).

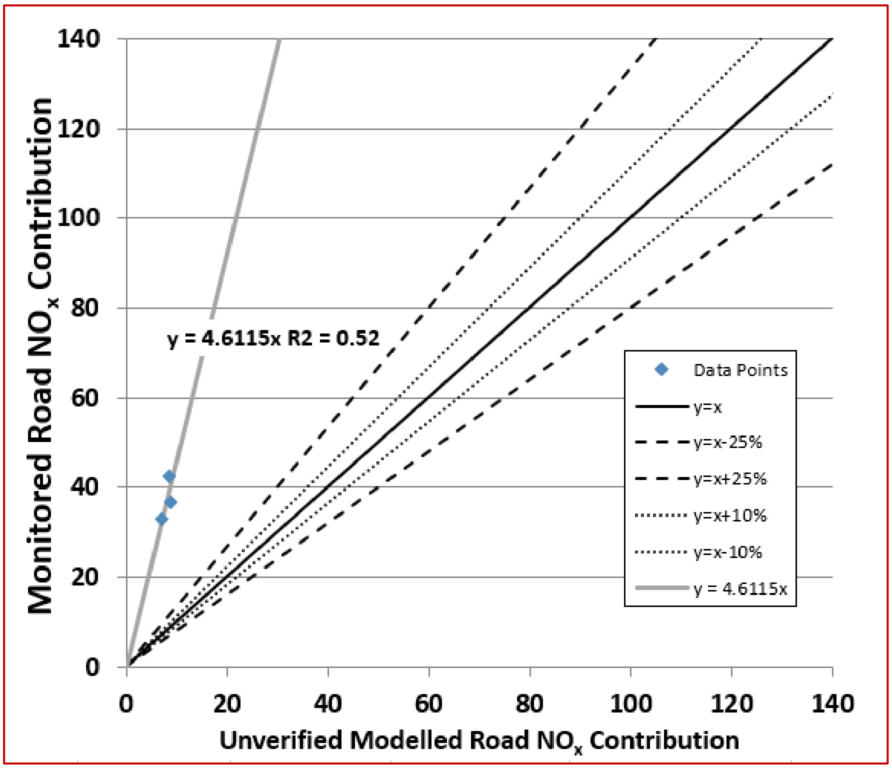
All NO_2 results residing within Domain 1 presented and discussed herein are those calculated following the process of model verification using an adjustment factor of 2.782.

For Domain 2, splitting the modelled area results in an increase in the model verification factor, and increased alignment between monitored and modelled values, as shown in Table A-5 and Figure A-5. The equation of the new trend line presented gives an increased adjustment factor for the modelled results in Domain 2 of 4.612.

Table A-5 - Adjustment Factor and Comparison of Verified Results Against Monitoring Results in Domain 2

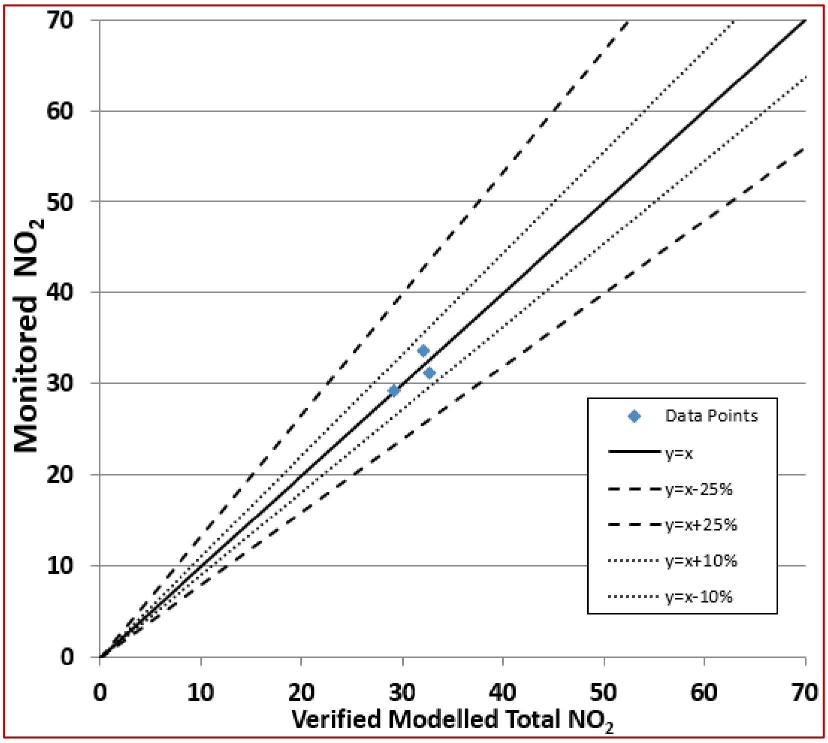
Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m³)	Adjusted modelled total NO_x (including background NO_x) (µg/m³)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m³)	Monitored total NO_2 (µg/m³)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
DV23	4.23	4.612	40.15	57.11	32.74	31.18	5.00
DV24	5.01		39.03	55.84	32.18	33.73	-4.59
DV25	4.63		32.74	49.56	29.22	29.27	-0.18

Figure A-5 - Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x in Domain 2



The adjustment factor of 4.612 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 then show strong agreement between the ratios of monitored and modelled NO_2, all within ±10%, as shown in Figure A-6. A factor of 4.612 in Domain 2 also reduces the Root Mean Square Error (RMSE) from a value of 14.6 to 1.3, which less than the guidance value of 4µg/m^3 as stated within LAQM.TG(16).

Figure A-6 - 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 4.612.

LAQM.TG(16) states that:

"In order to provide more confidence in the model predictions and the decisions based on these, the majority of results should be within 25% of the monitored concentrations, ideally within 10%."

Following verification within each Domain, the sites show good agreement between the ratios of monitored and modelled NO_2, It can be seen that all of the verification points lie within ±25%, and the majority lie close to the ±10% tolerance as detailed in LAQM.TG(16).

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).

For the verification and adjustment of PM_{10}, the LAQM monitoring data was used, as presented in Table 3-1. Data capture for 2019 was very good at 97%. Table A-6 below shows the relevant data required to calculate the model adjustment based on the ratio of modelled and monitored road source contribution to PM_{10}.

Table A-6 – PM_{10} Verification Calculations

Site	Monitored 2019 PM_{10} (µg/m^3)	Corrected Background 2019 PM_{10} (µg/m^3)	Monitored Road Contribution (µg/m^3)	Modelled Road Contribution (µg/m^3)	Verification Factor
Dover Centre	21.6	13.9	7.73	1.75	4.415

Following the verification of PM_{10} modelled results, all results presented within the assessment for all receptors are those calculated following the process of model verification using the adjustment factor of 4.415 for PM_{10}.